Appendix D

MODELLING AND APPRAISAL DOCUMENTS

APPENDIX D: MODELLING AND APPRAISAL DOCUMENTS

i. LLITM Traffic Forecasting Report
ii. LLITM 2014 Base Data Collection Report
iii. LLITM 2014 Base Highway Model LMVR – Local Area Validation
iv. LLITM 2014 Base PT Model LMVR
v. LLITM 2014 Base Demand Model Report
vi. LLITM 2014 Base Local Forecasting Report
vii. LLITM 2014 Base Highway Model LMVR
viii. Economic Assessment Report

LLITM 2014 Base

North & East Melton Mowbray Distributor Road Full Business Case

Model Specification Report

Leicestershire County Council

April 2022

Quality information

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Section 1 – Introduction

1.1 Context

1.1.1 In 2007, Derby City Council, Derbyshire County Council, Leicester City Council, Leicestershire County Council, Nottingham City Council and Nottingham County Council received Transport Innovation Funding (TIF) to undertake a congestion management study. This work was completed and published in April 2008 as the 6Cs Congestion Management Study. The study examined the extent and severity of traffic congestion over the next 20 years. It examined options for managing and reducing traffic congestion over the medium to long-term across the sub-region.

1.1.2 To build on this initial study, further investigation, development, refinement and appraisal of options was required. To this end, Leicestershire County Council, in partnership with Leicester City Council, developed a transport and land-use modelling suite named the Leicester and Leicestershire Integrated Transport Model, or LLITM.

1.1.3 This model represented a base year of (September) 2008, and was developed over the course of 2009 and 2010. During the model's lifetime a number of updates were made, mainly enhancing the performance of the highway assignment model included in the model suite. During this time the model was used for major scheme business cases, the development of local Core Strategies and the assessment of proposed major developments within the county.

1.1.4 Given the age of the data underpinning the LLITM suite, Leicester City and Leicestershire County Councils require a new model to incorporate newly collected observed data, such as mobile network data and new roadside interview data, and including the recent 2011 Census data. This new model, named LLITM 2014 Base, (and now built) represents a neutral month within a base year of 2014, making use of updated observed datasets and following the latest TAG.

1.1.5 This Model Specification Report sets out AECOM and David Simmonds Consultancy's (DSC's) methodology for developing this model in response to the requirements of this new model as set out in LCC's brief for the LLITM 2014 Base model suite.

1.1.6 It is expected that this model will be required to assess land-use and transport changes from the base year of 2014 to an ultimate forecast year of 2051.

1.1.7 As with the previous LLITM (v5.2), we assume that the LLITM 2014 Base model will be required to provide evidence for the development of local Core Strategies and major proposed developments within the county, and potentially for any major scheme business cases that the City or County Councils wish to develop.

This Model Specification Report has been produced to discuss the specification of the overall model suite. The model has been specified to evaluate schemes such as the proposed North and East Melton Mowbray Distributor Road (NEMMDR). This version of the Model Specification Report includes a section discussing the application of the specified model structure with the assessment of the proposed NEMMDR in mind. This discussion is included within Section 12.

1.1.8 Blue boxes like the one above are used throughout this document to give additional context or to link to other relevant documentation related to the NEMMDR Full Business Case.

1.2 Report Structure

1.2.1 This Model Specification Report contains a number of sections detailing AECOM's and DSC's methodology for developing the LLITM 2014 Base model. Following this introduction, this report contains the following structure:

- Section 2 – Specification and Zoning: this section details the specification task for the LLITM 2014 Base model, and in particular considers the development of the model zone system which is a key task at the start of the proposed programme of work.
- Section 3 – Data Sources: this section discusses the known data sources that are available for developing the LLITM 2014 Base model. These include data expected to be used for the

development of the highway demand matrices such as roadside interview data and traffic counts, and data required for the development of the land-use model.

- Section 4 – Model Suite, Scope and Interfaces: this section considers an overview of the model suite, and the likely interactions between different components of the model, including the iteration between these components during the running of the model.
- Section 5 – Highway Travel Demand: this section discusses the proposed methodology for developing the highway prior matrices.
- Section 6 – Highway Traffic Supply Model: this section considers the development of the highway modelled network, and the subsequent calibration and validation of the model given the highway prior matrices developed for this model.
- Section 7 – Public Transport Passenger Demand: as with the development of highway travel demand matrices, this section considers the development of prior matrices for the public transport model based on the available data sources.
- Section 8 – Public Transport Passenger Supply Models: this section details the development of the public transport, both rail and bus, network, including the representation of service patterns and frequencies in the model, the derivation of fare assumptions within the model, and the development of access / egress walk links required within the public transport model to access services.
- Section 9 – Demand and Trip-End Models: this section details the proposed structure and functionality of the demand model and trip-end models to be included in the LLITM 2014 Base model suite. This includes both the proposed segmentation of demand within the demand model and the representation of parking within the model suite.
- Section 10 – Land-Use Model: this section details the development and functionality proposed to be included in the land-use model to be included within the LLITM 2014 Base model suite.
- Section 11 – Forecasting, Analysis and Handover: this section discusses the proposed forecasting processes within the model, and also details the demonstration testing included in this proposal and the handover process of the model to LCC.

As the LLITM 2014 Base suite has now been produced, this Model Specification Report should be read in conjunction with the Local Model Validation Reports for the highway and public transport models, the Demand Model Development Report, and the Forecasting Report which detail the development of the model suite. In addition to these key reports, a number of other reports and technical notes have been produced which provide further details on areas of the model development.

Section 2 – Specification and Zoning

2.1 Introduction

2.1.1 The project will begin with a detailed specification exercise for each component of the model. This report outlines the overall project scope in full and the major project tasks, but the precise methodologies are not specified in full detail as they will rely, in part, on a review of the available data. The specification, scope, budget and programme will be kept up-to-date in consultation and agreement with LCC before and during the model development work. More in-depth task-specific specification notes will be prepared prior to each major task and agreed with LCC before work begins.

2.2 Model Development Principles and Guidance

2.2.1 LLITM 2014 Base will be developed with reference to national guidance, particularly the Department for Transport's Web Transport Analysis Guidance (TAG), and will seek to accord with this guidance where possible in all modelling principles, as well as using the guidance to obtain economic parameters (such as fuel prices and values of time) and elasticities for benchmarking the demand model performance.

2.2.2 Other relevant guidance documents include some parts of the Design Manual for Roads and Bridges (DMRB), although most of this advice has been superseded by TAG; and Traffic Appraisal Manual (TAM) on highway matrix building. Some rail-specific advice is available from PDFH; this may be referred to where TAG lacks detail.

2.3 Specification

2.3.1 The specification will result in a series of technical notes which we will start to produce early in 2014. Priority will be given to specifying tasks that are required to start early in programme; the notes relating to less time-critical tasks, such as the demand model, may be undertaken later in the year.

2.3.2 The first step will be the preparation of a scoping note defining clearly what the objectives, purpose and scope of the LLITM 2014 Base model are. This is critical to all subsequent work, and should be agreed and circulated in draft before the zone system work begins. It will specify what interventions and policies LLITM 2014 Base will be required to test, what outputs are expected to be obtained from it and for what purpose, the degree of detail required, and the expected run times and usability of LLITM 2014 Base as a tool.

2.3.3 Many of the technical notes will draw on material produced for the initial development of the existing LLITM model or as part of updates to it. Some areas are not covered by existing notes, and some existing notes are no longer relevant, so significant new material will be required.

2.3.4 Other reports, not related to specification, such as model validation reports, coding manuals and a user guide, will of course also be produced as part of the project. These are described later under model component chapters and in Section 11.3.

2.4 Zone System

2.4.1 The zone system for LLITM 2014 Base will be based upon 2011 Census geography. This is primarily formed of output areas (OAs), but to address issues experienced with the existing LLITM, large employment zones will be disaggregated using employment zones (EZs). Thus, most zones will be aggregations of 2011 output areas, but in urban centres output areas will sometimes be split into a number of zones using the 2011 employment zones.

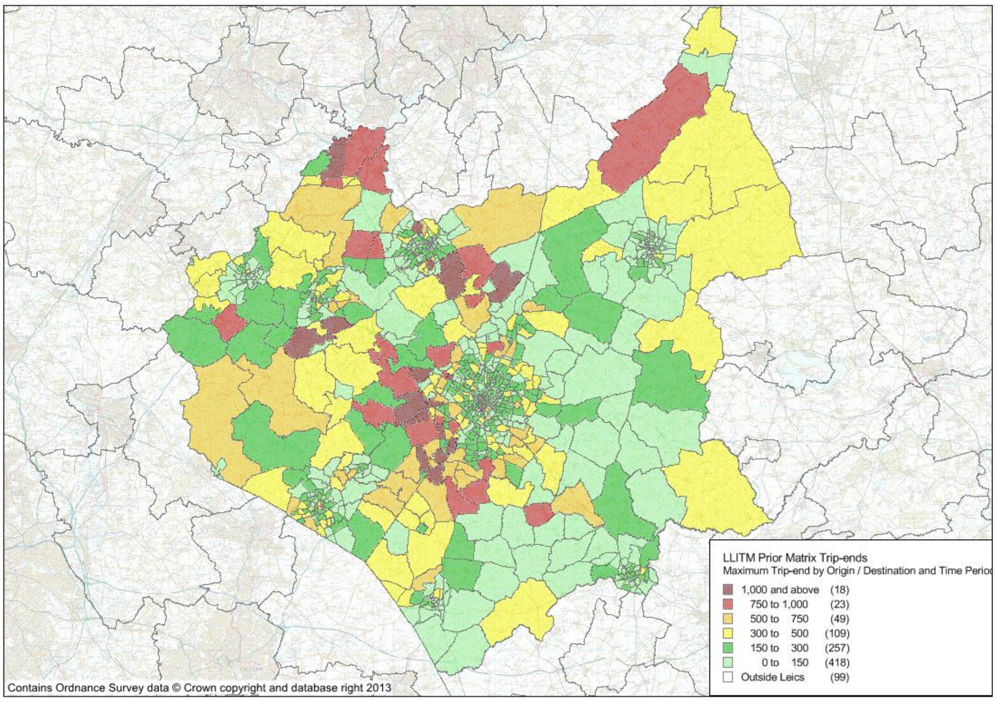
2.4.2 In defining the zoning, consideration will be given to the level of detail required for a ring of zones outside the intended simulation area (broadly speaking the county boundary). The existing LLITM contains relatively large zones in this area, and greater zonal detail in this area will help provide better routeing decisions in these areas of the highway network. This additional detail may address localised oddities in the existing LLITM v5.2 land-use forecasts (e.g. Melton), may better represent (spatially) forecast land-use change where major impacts are expected (e.g. south Nottinghamshire), and would better future-proof the model if further extension of the simulation network is required.

2.4.3 We expect that all components of the model will share the same zoning system; this will make data transfer between components much easier. Consideration will however be given, in consultation with LCC, to more detailed zoning for the public transport model to enable more precise modelling of bus stops.

2.4.4 The general level of detail in the zoning will initially be derived from the existing LLITM, with boundaries converted to the new 2011 OAs / EZs. However, this will be comprehensively reviewed, with both increases and decreases in zoning detail considered across the network. Particular attention will be paid to the following areas:

- Consultation with LCC regarding the locations of major development sites in the county will be used to future-proof the zoning system to be usable in forecasting. A suitable number of zones will be put in place to model these development sites at an appropriate level of detail. In addition, some spare zones (for discussion, but likely around 20) will be retained for use in forecasting land-use developments not foreseen during model development.
- The zone system immediately outside Leicestershire was not specified at a level of detail in the existing LLITM; it is considered that finer detail in this area, especially in Nuneaton, Nottingham and Derby, would be beneficial to the model forecasts.
- A review has been undertaken of the levels of base traffic loaded per zone (see Figure 2.1). This has demonstrated both some areas, especially in rural Melton and Harborough, where zonal traffic is low enough to consider aggregating zones, and areas where zonal traffic is higher than preferred, especially west of Leicester (TAG suggests that a few hundred vehicles per zone per hour is a sensible target in the area of detailed modelling). The existing planning data will also need to be critically reviewed as part of this exercise, as traffic levels will depend on these (e.g. previously identified anomalies in the north east of the county, suggesting errors in the base planning data).

Figure 2.1: Trip-Ends by Zone, Existing LLITM Model



Contains Ordnance Survey data © Crown copyright and database right 2013

2.4.5 Some key principles to be followed in designing and reviewing the zone system are outlined as follows. These principles will inform and prioritise choices in developing a practical zone system. It will be necessary to be proportionate in defining the zones, with as few zones as is necessary, but meeting the following constraints.

- Generally each zone should be as homogenous as possible, i.e. it should represent similar groups of people, premises and land-use.
- Zones internal to the area of detailed modelling should ideally be roughly equal in terms of trip generation. They may become larger as they move away from the boundary of the study area (as the proportion of trips accessing the study area declines). External zones are necessary to enable the modelling of trips which start or end outside the study area.
- Zones should be consistent with geographical boundaries to be used in obtaining zonal data; in this case 2011 Census output areas and employment zones are most relevant. For external zones distant from Leicestershire, districts and counties may also be used as zones, and internal zones should not cross district or county boundaries.
- Zones should anticipate, where practicable, future significant changes in land-use, so reducing the reliance on development zones.
- From the perspective of the supply models, zones should be spatially defined around a convenient and realistic loading point, that is, land-use within a zone should have reasonably homogeneous access to the transport networks.
- The zoning should take account of model size and run times, and also of likely increases in computing power over the next few years.

The development of the adopted zone system for LLITM 2014 Base is detailed within Section 4.3 of the ‘*NEMMDR FBC - Local Highway LMVR*’.

Section 3 – Data Sources

3.1 Overview

3.1.1 We outline here the data sources we are aware of and intend to use as part of the development of LLITM 2014 Base, including both currently existing data, and data the collection of which is currently programmed by LCC. This section is not a detailed data collection specification (we have prepared this separately for LCC, see the technical notes *'Consideration of Public Transport Model Matrix Build Data Requirements'* and *'Consideration of Highway Model Matrix Build Data Requirements'*), or report of data collection, but simply a summary of the available data.

3.2 Roadside Interview Data

3.2.1 Approximately 110 new roadside interview surveys (RSIs) are due to be collected during 2013 and 2014, and will be available for use in the development of LLITM 2014 Base. These are based on the locations of the existing RSIs, as used for the development of the existing LLITM, but with the survey locations refined to intercept traffic with fewer sites where possible, and to provide better spatial detail in some urban areas to increase the proportion of observed sector-to-sector movements within the partially observed RSI matrix.

3.2.2 RSI data will be collated into a single database for ease of analysis, and a thorough checking and cleaning programme conducted. Origins and destinations will be checked graphically by RSI site to identify illogical records, and sense checks on data columns (such as high vehicle occupancies) will be put in place. Illogical records will in general be deleted from the analysis, and the remaining records expanded to the full count.

3.2.3 The data from these 2013/14 RSI surveys will be a key observed dataset for use in developing the highway demand matrices. Where appropriate, consideration will be made to make some limited use of the older RSI data, if appropriate.

3.2.4 In developing demand matrices for SRN through-traffic (that passing through Leicestershire), we will consider the use of available OD data, such as the use of demand data from Highways England's [now National Highways'] J16-J19 M1 model, if available. This will be considered in a highway matrix development specification note, which will be one of the higher priority notes to be drafted early in the project.

3.3 Mobile Network Data

3.3.1 The use of mobile phone positioning data (mobile network data) is a data source that is starting to be used by the transport planning community to try to develop demand matrices, which are one of the key components of the LLITM 2014 Base suite.

3.3.2 AECOM has experience of both using and auditing mobile network data, and based on this experience, the knowledge of the problems encountered by other consultants, and the lack of formal DfT guidance, a view was formed in 2013 that there was too much technical and programme risk associated with using mobile network data as the primary source of new observed data, including risks associated with:

- disaggregating mobile network data into mode, vehicle types and trip purposes;
- bias associated with the expansion of the observed mobile network data records; and
- bias associated with a possible tendency for mobile network data to under-report short trips.

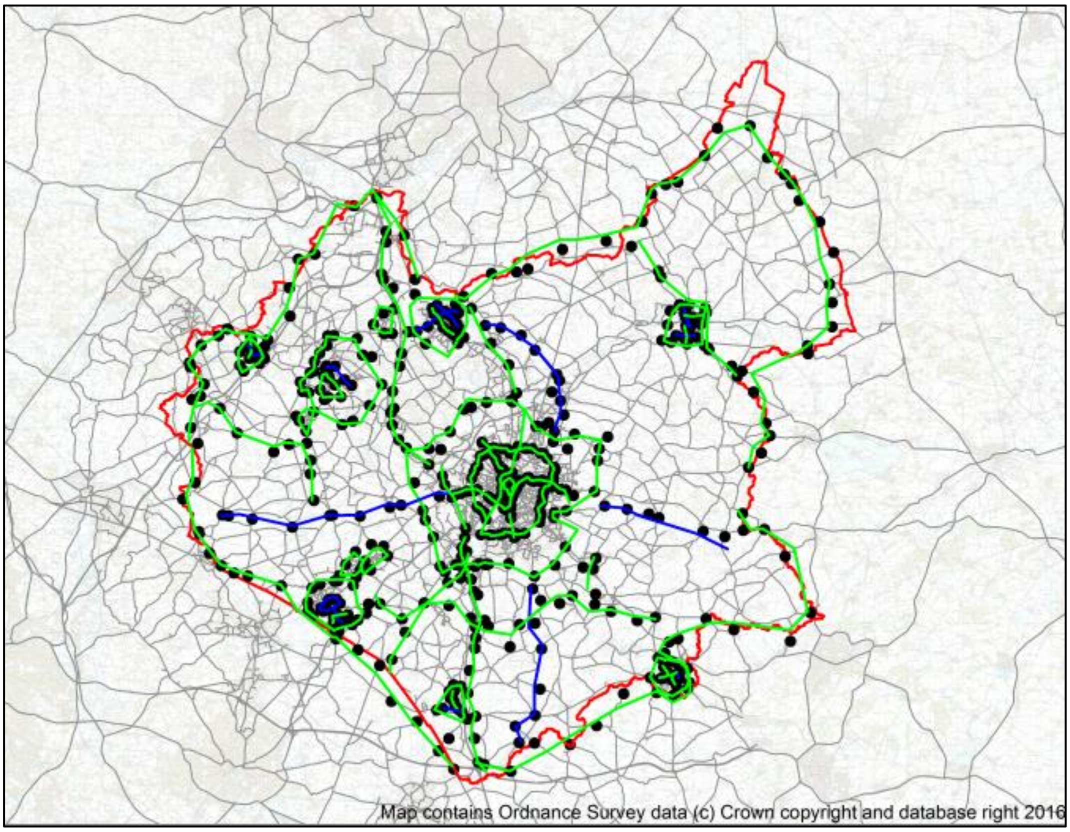
3.3.3 In recent months [in 2014], AECOM has become involved in exclusive discussions with one of the large mobile phone operators to work in partnership to take mobile network data and develop the required data processing and assumptions to a point at which the data are useable in transport models; i.e. a verified 'proof-of-concept'. This 'proof-of-concept' will use the RSI data to undertake a verification process of the developed mobile network data to understand the strengths and weaknesses of the two data sources for highway demand matrices, and to use the data sources accordingly.

3.4 Traffic Count Data

3.4.1 Traffic count data were collated for the LLITM model, covering around 30 cordons and screenlines around Leicestershire and Leicester incorporating around 400 sites. Most of these data were collected for the development of the existing LLITM model, and date from 2009 or earlier.

3.4.2 An extensive new programme of traffic counts will be undertaken in the first half of 2014, covering the count sites required for the calibration and independent validation of the new model. We assume that these sites will be defined by AECOM and LCC, and commissioned by LCC. The indicative count locations and their associated cordon and screenline definitions are shown in Figure 3.1.

Figure 3.1: Indicative Highway Screenlines and Cordons in Leicestershire



3.4.3 LCC now uses a cloud server to host its traffic counts, making maintenance and end-use easier. We assume that this portal will be used to provide the county traffic counts, making batch processing easier.

3.4.4 In addition to these Leicester and Leicestershire data, the Highway's Agency's [now National Highways] TRADS data will be available, and used, for counts on the strategic road network.

3.5 Highway Journey Time Data

3.5.1 The existing LLITM model used a journey time data hierarchy of locally collected GPS data, HATRIS data, and Trafficmaster data to validate the highway model network speeds. The GPS data were collected as part of LCC's TIF congestion monitoring data collection programme, and will not be updated for use in LLITM 2014 Base.

3.5.2 Of the remaining two datasets, recent analysis of Trafficmaster journey time data has resulted in discrepancies being identified between this data and the locally collected GPS data, which with limited investigation have not been explained. We therefore suggest an evaluation and comparison of alternative journey time datasets, such as TomTom data, with the aim of providing confidence in one or more of these data sources; however we are aware of similar comparisons undertaken elsewhere (for example, an AECOM analysis for Highways England [now National Highways]) which have shown a good correlation between Trafficmaster journey time data and other observed data sources. All journey time data will be checked for plausibility by considering speed limits and available knowledge of congestion.

3.6 Highway Network Data

3.6.1 In terms of the required information on network links, this is predominantly information on link lengths, the number of lanes and the standard of road, or link type. The link lengths, number of lanes and speed limits can be determined through use of aerial photography, such as that available within Google Maps or Bing Maps, or from LCC's GIS data. Use of information available through these services also provides details on speeds limits and road classification, which will be used to determine the link type within the highway network.

3.6.2 Similarly information is also required for the junctions represented within the model. Again, use of aerial photography will be the primary source of information on junction type and standard. This includes information on the major / minor arms of priority junctions, the presence of flared approaches to junctions and 'right-turn' lanes, and the quality of the junction. The standard, or quality, of a given junction will take account of the turning radii and other factors such as visibility at each junction represented in the model.

3.6.3 One limitation of using aerial photography for this purpose is that the date of the images available on these online services is generally not known. Therefore information on network changes within Leicestershire over the past five years will be sought to ensure that the developed highway network represents the situation in the defined base month within 2014.

3.6.4 Recent LLITM model updates have highlighted a need to produce a standardised format for signal timing data, which is the main source of network data not available from aerial photography. This will enhance transparency of the signal timing assumptions in the model, and will make the coding of these data more straightforward.

3.6.5 The extent of the signal timing data are unknown, and for the purposes of this proposal, it is expected that AECOM defines a standardised format for signals data, and that LCC will complete the pro forma for the signals for which there are data available.

3.6.6 Signals data for the SRN will be sought from Highways England [now National Highways].

3.7 Public Transport Ticket Sales Data

3.7.1 Electronic ticket machine (ETM) sales data for both bus and rail travel will be available for LLITM 2014 Base. LENNON data for rail will be used to build the rail matrices. It is intended that recent (2013 or 2014) LENNON data be used; however the availability of these data has not yet been confirmed. 2008 LENNON data were used for the previous LLITM model, and these will be used if no recent data can be obtained. LENNON data contain origin and destination stations, time and day purchased, and ticket types.

3.7.2 Bus ticket sales data will be available from the major bus operators, covering the majority of bus services in Leicester and Leicestershire. These are likely to be less complete than the LENNON data; it is expected that full destination information will not always be available from these sources of data.

3.8 Public Transport Passenger Interview Data

3.8.1 A programme of passenger interviews for bus services is expected in early 2014. This will cover the bus stops in the centres of Leicester and the market towns, as well as Loughborough University and the bus stops near the major railway stations.

3.8.2 It is expected that these interviews will intercept the majority of passenger movements. Boarding and alighting counts will be collected together with the interviews so that they can be expanded to total passengers.

3.8.3 These passenger interview data will then be combined with the ETM data to produce a bus matrix that maximises the value available from each of these data sources.

3.8.4 No interviews are anticipated for rail passengers, due to the higher quality of the ticket data expected and the higher quality of alternative sources of information. Nevertheless, rail interview data are available from the existing LLITM model, from 2008 and 2003. These cover the five largest railway stations in Leicester and Leicestershire.

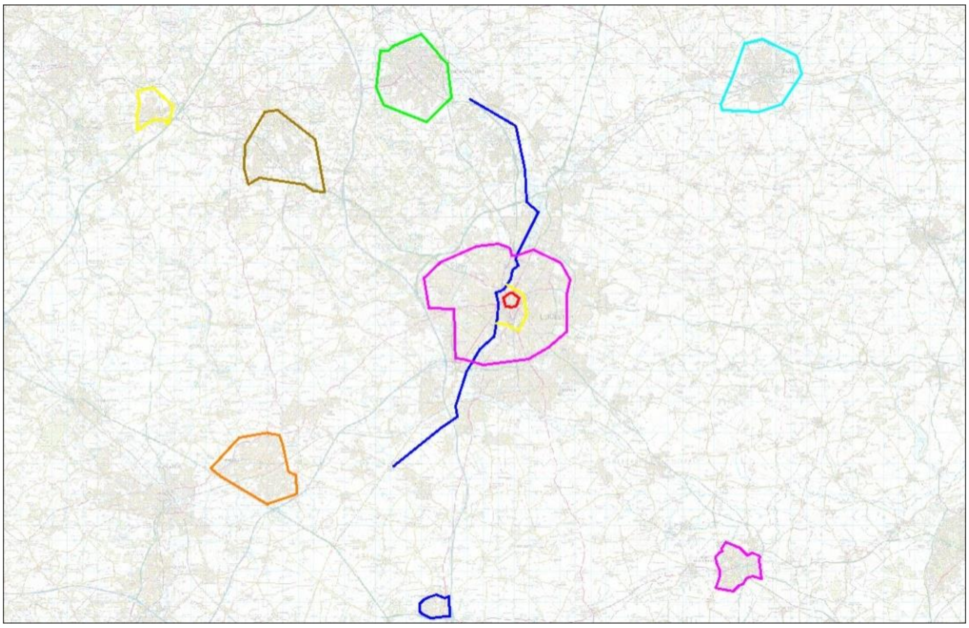
3.8.5 In addition, the National Rail Travel Survey (NRTS) was conducted in 2005, covering all of England and Wales, and provides very detailed information for rail travel, but has not been updated since. It is possible that useful information can be extracted from this source, and we will request access to it. These sources, combined with National Travel Survey data, will be used to obtain information (such as journey purposes) not available from the ticket data.

3.9 Public Transport Passenger Count Data

3.9.1 In addition to the boarding and alighting counts to be collected as part of the bus interviews, counts will be made of passengers boarding and alighting trains at the largest railway stations over a day.

3.9.2 Link passenger flow data (collected via one day on-board surveyor counts) will be available on buses at cordons around each major urban area and across screenlines in Leicester, as shown in Figure 3.2. Data in Leicester are collected annually as part of a monitoring programme; data around the market towns were collected in 2013 and will be used for this project. Where older (duplicate) data are is available, these will be used as a sense check on any newer available counts.

Figure 3.2: Bus Passenger Flow Count Cordons



3.10 Public Transport Service Pattern Data

3.10.1 CIF or XML-format data of all bus journeys made each year are available from LCC and / or the Traveline FTP server. Data for a suitable neutral month will be extracted and used to build service patterns for the model.

3.10.2 The National Public Transport Data Repository has previously been used to provide the data for service patterns; this dataset is no longer maintained. However, there is a new dataset, the Traveline National Dataset (TNDS) that contains the same type of bus data as used in LLITM v5.2, but does not include national coach services or heavy rail. However, the data format is different (xml-based), and so refinements to the process will be required before the data can be converted to a format that can be used in LLITM 2014 Base.

3.11 Household Interview Data

3.11.1 A household interview survey was conducted in Leicestershire in 2009 for the development of LLITM. While it is not proposed to repeat this for LLITM 2014 Base, the data will be available and of use in developing and validating the LLITM 2014 Base demand matrices.

3.11.2 In addition to this, the National Travel Survey (NTS) is carried out every year, and will also provide useful data for developing LLITM 2014 Base, most notably the demand matrices; we will obtain access to NTS.

3.12 Land-Use Data

3.12.1 Deriving suitable 2014 land-use data is essential for both the land-use and transport models (this derivation is discussed in Section 10). When finalised, the 2014 land-use data will be used to develop all day trip-ends (via a customised version of the DfT's CTripEnd model) by mode and purpose, which in-turn will be used as constraints in developing the 2014 highway, public transport and active mode demand matrices.

3.12.2 A number of sources of land-use data will be used in preparing the land-use model's base year database. These will include the Council Tax Register (for the numbers of dwellings), Land Registry data on house prices, Valuation Office Commercial Floorspace and Rateable Value Statistics, as well as Census data (discussed below).

3.12.3 Information on the scale and distribution of planned development across the land-use model's Fully Modelled Area will also be required for model forecasting; this will be supplied by LCC and the district councils in Leicestershire and Leicester.

3.13 Census Data

3.13.1 The 2011 Census will be a key source of information on households, population, levels of car ownership, journey-to-work flows, workforce characteristics, migration and workplace employment and will be used in creating a revised base year database within the land-use model.

3.13.2 The preparation of the 2014 base year database will draw upon both 2011 Census outputs and other published information that captures change in population, households and employment, in the period from 2011 to 2014. The Census outputs provide comprehensive and consistent small-area information on the number of households and people employed. It also travel to work data that are used, within the land-use model, to create the base year travel to work data base, which in turn is a key input to the land-use model's employment status model.

3.13.3 If there is a delay in the release of travel-to-work data then we would look to alternative sources when preparing this part of the 2014 base year database. Specifically use can be made of the 2014 travel to work matrix in the current version of LLITM v5.

3.14 Parking Data

3.14.1 Parking supply data (i.e. number of spaces by zone, by parking type) will be required for the area to be covered by the parking model, discussed in Section 9.7. Where 2014 data are not available, then estimates will be required, either from the existing LLITM, from local surveys, local knowledge, or through a rules-based estimate.

3.14.2 Estimates from the existing model or a rules-based estimate will primarily be undertaken by AECOM; we assume that LCC will facilitate the provision of actual parking spaces data.

3.14.3 It is noted that there has been a significant increase in the number of residents' permit parking zones in recent years, which, depending on the timing of the parking restrictions, may act to reduce the available supply of on-street parking. A definition of the residential parking zone areas will be required.

3.14.4 Parking demand (occupancy) data will also be required. The existing LLITM uses observed ins and outs to calibrate park-and-ride sites, and end of time period occupancy for all other parking zones.

3.14.5 The calibration of the model is more accurate if ins and outs data are available, so that modelled 'churn' of the car park better reflects reality. We therefore recommend that ins and outs be collected wherever possible. These data should be readily available for the larger barriered off-street car parks with electronic data. For other types of parking, either end-of period estimates may have to be used, either from local spot surveys, the existing LLITM, or from new rules-based estimates.

3.14.6 Estimates of parking demand from the existing model or a rules-based estimate will primarily be undertaken by AECOM; we assume that LCC will facilitate the provision of actual parking demand data.

3.15 Freight Demand Data

3.15.1 The Continuing Survey of Road Goods Transport (CSRGT) is a domestic data source for GB registered Heavy Goods Vehicles, consisting of ~120,000 vehicle records and ~1 million trip records. These HGV demand data will be used in the derivation of freight demand matrices (the data provide district-based trip-end estimates for HGVs).

3.15.2 There is less information available specifically for LGVs; the DfT publish some data such as average trip length, which will be combined with the LGV records from the RSI surveys to yield estimates of LGV demand. There are some ageing van surveys[1] which may be of use; these will be considered.

3.15.3 A report[2] by the Independent Transport Commission on Van Travel in Great Britain will also be reviewed and considered.

3.16 Economic Data

3.16.1 Economic assumptions will largely be obtained from the refresh of the Department for Transport's TAG advice (https://www.gov.uk/transport-analysis-guidance-webtag). Some information about income distributions will be derived from the LLITM household survey, discussed in Section 3.11.

3.16.2 We recognise that LLITM 2014 Base may have wider application then purely transport appraisal. Other stakeholders, such as the LEP may wish to make use of the model for economic appraisal. It may be that for this they would require economic assumptions that are consistent with their own economic forecasts (and not necessarily apply TAG derived forecasts). The land-use model is capable of running with different scenarios. We will provide an option for the provision of a second scenario.

The data collated for use in the development of the LLITM 2014 Base suite are detailed within the LLITM '*NEMMDR FBC - Data Collection Report*'.

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[1] http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/statistics/datatablespublications/freight/sourcesofroadfreightinfo.pdf

[2] http://www.theitc.org.uk/docs/111.pdf

Section 4 – Model Suite, Scope and Interfaces

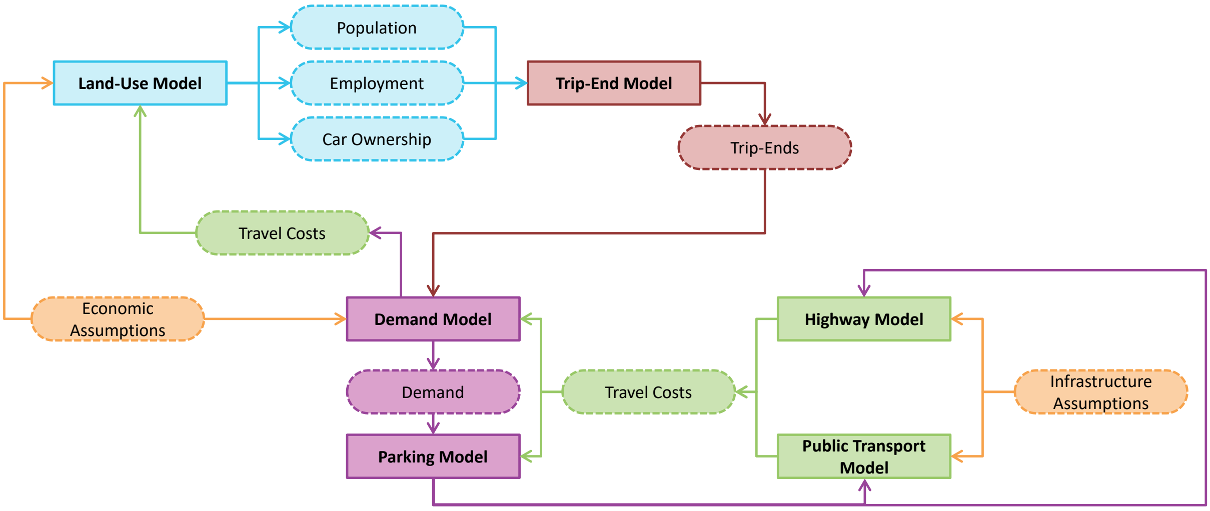
4.1 Overview

4.1.1 LLITM 2014 Base will be an integrated land-use-transport-interaction (LUTI) model. It will comprise six main modelling components:

- A land-use model, which forecasts future land-use, including population, households and employment by detailed categories. This depends upon a range of inputs, including transport costs / accessibility by area.
- A trip-end model, which forecasts future trip-making as a function of future land-use.
- A variable demand model, which uses forecast trip-ends combined with transport network / cost information, to estimate patterns, modes and times of day for travel, iterating with the supply models.
- A highway traffic supply model, which routes traffic on the road network, and forecasts traffic flows and highway travel times and costs.
- A public transport passenger supply model, which routes passengers on the public transport network, and forecasts patronage and public transport travel times and costs.
- A parking and park-and-ride model, which estimates parking search times and costs and allocates highway traffic to park-and-ride sites and other parking types.

4.1.2 The latter five components constitute the "transport model", and will be developed by AECOM. The land-use model will be developed by David Simmonds Consultancy (DSC). The broad interaction between these components is illustrated below. Model components are illustrated as rectangles, while data passed between them are shown as ovals.

Figure 4.1: LLITM 2014 Base Model Suite Interactions



4.1.3 Many of the model components will be practically usable in isolation or with a limited number of components of the overall suite, and this enables the testing of certain scenarios more quickly. For example, minor network changes could be assessed in the highway model alone.

4.1.4 The three modes of operation will be:

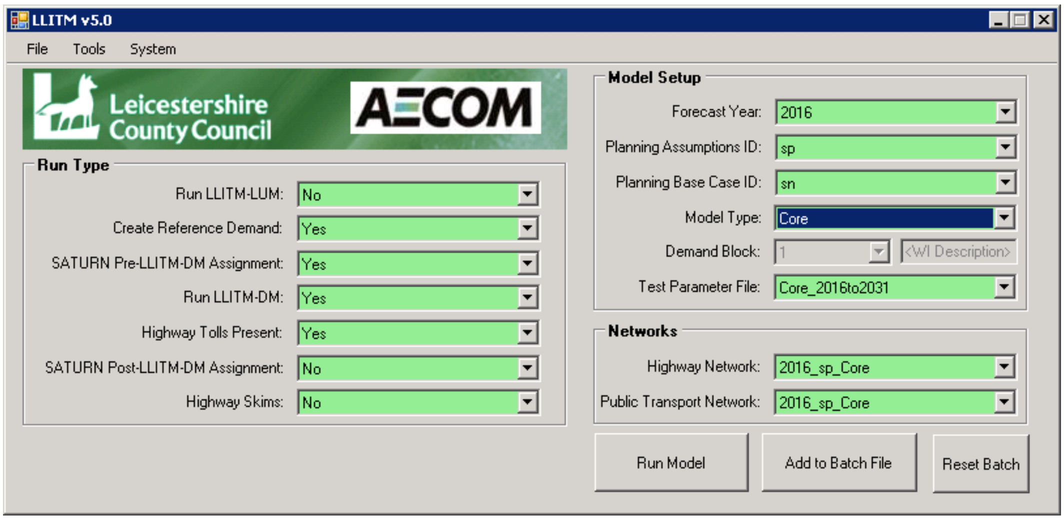
- using the full transport and land-use model;
- using the transport model only; and
- using the assignment models only.

4.2 Software Platforms and Interfacing

4.2.1 The various components of LLITM 2014 Base will be built using different software packages. The overall suite will be controlled by DOS batch files, which will enable the entire suite to be run automatically, without any user intervention during a scenario run. These batch files will be operable from a graphical front-end, which will enable the user to select inputs and set up tests or series of tests without the need to edit batch files or understand the detailed workings of the model.

4.2.2 The existing LLITM v5.2 front-end is illustrated below; for LLITM 2014 Base it is expected that a similar interface will be used. The front-end will enable tests using the full LLITM 2014 Base suite, and the transport elements without the land-use model using NTEM or user-defined planning inputs.

Figure 4.2: LLITM Front-End



Run Type

Run LLITM-LUM: No
Create Reference Demand: Yes
SATURN Pre-LLITM-DM Assignment: Yes
Run LLITM-DM: Yes
Highway Tolls Present: Yes
SATURN Post-LLITM-DM Assignment: No
Highway Skims: No

Model Setup

Forecast Year: 2016
Planning Assumptions ID: sp
Planning Base Case ID: sn
Model Type: Core
Demand Block: 1 <WI Description>
Test Parameter File: Core_2016to2031

Networks

Highway Network: 2016_sp_Core
Public Transport Network: 2016_sp_Core

4.2.3 The land-use model will be built in DSC's DELTA software. The trip-end model will be based on the Department for Transport's National Trip-End Model (NTEM); implemented in Microsoft Access and Visual Basic. The demand model and public transport model will be implemented in INRO's Emme transport modelling software, and the highway model will be based in the SATURN traffic assignment package.

4.2.4 The land-use and trip-end models carry out specialised tasks that standard transport modelling software does not generally support, hence their construction externally. Emme does not support detailed congestion or quasi-dynamic traffic modelling, so SATURN is preferred for this purpose, but SATURN does not have Emme's matrix manipulation, public transport assignment, or general transport modelling capabilities, being specialist traffic assignment software.

4.2.5 At many points in a LLITM 2014 Base run it will be necessary to run a process for a number of different categories; for example, the demand models will need to be run for different travel purposes and the highway model for different time periods. To minimise run times, we will use AECOM-developed software to exploit whatever multi-core processing is available to the software; the LLITM 2014 Base model will be primarily developed on a 12-core rack server of a similar specification available to LCC.

4.3 Consistency of Assumptions

4.3.1 It is highly desirable that the assumptions underpinning the various components of the LLITM 2014 Base suite be as consistent as possible, to ensure the overall model results and conclusions are robust. Two key issues are discussed below.

4.3.2 Consistency of demand data between the demand and supply models is desirable. The demand data in the demand model will be (as discussed in Section 9) tour-based, that is, outbound and return legs will be linked. These tours can be converted to trip-level for the supply models, but matrix estimation in the supply models will in general make it hard to reconcile the resulting trips with the original tours.

4.3.3 Consistency of economic assumptions, including public transport fare growth, vehicle operating costs, values of time and other elements of generalised cost, across all models will also be required. A master spreadsheet will be developed to calculate all economic data, derived primarily from TAG, for all component models.

4.4 Model Segmentation

4.4.1 The various components of LLITM 2014 Base will use different methods for segmenting people and travel into categories. In general, the land-use and demand models will use more detailed segmentation than the highway and public transport models. It is, however, essential that the segmentation in the model components is compatible as it will be necessary to convert data between each.

4.4.2 Segmentation is discussed in detail in the individual model component chapters. However, the modelled time periods will be broadly consistent across the transport models, anticipated as follows:

- Off-peak (Night-time, 19:00 to 07:00);
- AM Peak (07:00 to 10:00; the highway model will also consider the peak hour 08:00 to 09:00);
- Interpeak (10:00 to 16:00); and
- PM Peak (16:00 to 19:00; the highway model will also consider the peak hour 17:00 to 18:00).

4.4.3 The exact definitions of hours and periods will be reviewed, primarily using highway traffic count data.

4.4.4 The land-use model will not consider time periods as it does not represent travel. The parking / park-and-ride model may need to distinguish morning from evening off-peak to build up car park usage across the day.

4.4.5 The LLITM 2014 Base highway model will represent single peak hours in the AM and PM Peaks, and the travel costs generated by these models will relate to these single peak hour demand patterns. The LLITM 2014 Base demand model will represent whole time periods, rather than peak hours, and as such, the costs used by the demand model ought to be representative of average period hour demand.

4.4.6 In order to better represent the travel costs that are representative of an average peak period hour, we will assign average 3-hour period demand during the iterative demand-supply loop (see Section 9.8), rather than the peak hour demand used in the main highway model. Following convergence of the demand-supply loop, the final peak hour assignments will be performed for reporting and analysis.

4.4.7 The public transport assignment model, since it will not depend on the level of public transport demand to estimate travel times, will model an average period hour throughout, so this issue will not apply. An average period hour is preferred, as the modelling of crowding in the public transport model is not proposed, and generally public transport demand is relatively low. Also public transport services can be irregular and the definitions of what exactly is in the modelled hour can have a marked effect. It is therefore much more difficult to establish a peak hour rather than period hour public transport model.

4.5 Highway and Public Transport Model Interaction

4.5.1 The highway model network will be used to provide a basis for the bus network as well, with node numbers and links consistent between the two. The two networks will not be entirely identical, because rail and walk links will also be needed by the public transport model, but they should remain similar and highly compatible.

4.5.2 Two forms of interaction are sometimes modelled between highway and bus model networks. Firstly, bus routes may be transferred from the bus to the highway model to take account of the impact of buses upon road congestion. Secondly, traffic congestion may be transferred from the highway to the bus model to allow bus journey times to be reflective of road conditions.

4.5.3 Implementing these processes robustly and consistently at a detailed network link level requires that the two model networks remain entirely consistent in all forecasting. This is a potentially onerous requirement, making it harder for highway and public transport coding to be accomplished in parallel and potentially slowing down all forecasting tasks.

4.5.4 Some degree of representation of the effect of changes in congestion on bus travel times, as well as some representation of the effect of bus vehicles on congestion, are considered to be necessary in the

LLITM 2014 Base suite. However, the level of detail required for each of these processes will require further thought and discussion; one of the proposed specification technical notes will be on this subject.

4.6 Iteration and Convergence

4.6.1 There will be four levels of “loop” in the LLITM 2014 Base forecasting process, whereby outputs from one process feed a second process that feeds back into the first process, as follows:

- The highway model assigns traffic to routes based on the route travel times. These travel times of course depend on the level of traffic, which depends on the routes.
- The highway model also simulates junction performance as a function of turning flows. These turning flows depend on the assignment results, but the assignment results depend on travel times which depend on junction performance.
- The demand model estimates demand patterns as a function of the "generalised cost” (including travel time) of travel. The highway supply model forecasts travel times and other components of generalised cost, but these forecasts depend on the demand supplied by the demand model.
- The land-use model estimates land-use as a function of travel costs. However, travel costs are produced by the transport models and depend on the demand, which depends on the population and employment data that are output by the land-use model.

4.6.2 The latter two loops are illustrated graphically in Figure 4.1.

4.6.3 All but the last of these loops will be resolved by repeatedly running the two halves of the loop and passing data between them until the data produced stops changing significantly. This requires a measure of convergence: the degree to which the data are consistent between iterations of the loop. LLITM 2014 Base model convergence will be consistent with TAG. These measures are discussed in more depth in Section 6 and Section 9.

4.6.4 The land-use / demand model loop is processed by feeding the model results back into each other over model years, as described in Section 11.1.

Since the submission of the Outline Business Case, the DELTA land-use model has not been maintained and so has not been used for the Full Business Case modelling and forecasts.

Section 5 – Highway Travel Demand

5.1 Overview

5.1.1 The highway matrix development process for LLITM 2014 Base will be built using a combination of MS Excel, MS Access and Emme transport modelling software, and will be controlled by macros to ensure transparency and repeatability.

5.1.2 All data collection is, by its nature, subject to error. This includes sampling error resulting from expanding an observed sample to be representative of all travel, and measurement error, miscounting or recording survey responses incorrectly. Best practice in developing demand matrices is designed to minimise the residual error in the demand matrices.

5.2 Data Availability and Use

5.2.1 There is no single source of data which would, of itself, provide all the information required for satisfactory highway trip matrices. We therefore need to maximise the quality of the trip matrices by integrating information from a range of data sources:

- mobile network data for trips intercepting a cordon containing Leicestershire;
- roadside interview (RSI) surveys, there will be RSI data available from ~110 sites with older RSI data available for reference as appropriate;
- traffic counts for trunk and motorway networks and for local authority monitoring sites;
- planning data in the form of trip-end estimates from the LLITM 2014 Base land-use and trip-end models;
- National Travel Survey (NTS) data for the East Midlands; and potentially
- demand data from other models.

5.2.2 We have not included the 2011 Census Journey to Work (JTW) tables in this list as we have significant reservations relating to their use for the development of highway demand matrices (though they are considered suitable for use within the land-use model). The 2001 Census is more than a decade old, and 2011 JTW data may not be available in project timescales[3].

5.2.3 Furthermore, there are inconsistencies between the definitions used in the Census data and the measure of travel on an average weekday we will require for our modelling. In particular, the definition of ‘usual’ mode used and ‘normal’ workplace used in the Census differ appreciably from the average day in travel models as well as including only commuting trips, and result in inconsistencies with the observed trip pattern on an average working day. We do not, therefore, expect to make use of these data for the highway matrix development.

5.2.4 However, and bearing the limitations of the dataset in mind, the 2011 Census Journey to Work tables may be used at a high level to provide a measure of verification of the highway demand matrices.

5.3 Demand Matrix Requirements

5.3.1 The highway matrices for LLITM 2014 Base will be developed as two-legged tour matrices for home-based purposes, stored in production-attraction (PA) format, and as trip matrices for non-home-based purposes and freight demand, stored in origin-destination (OD) format. A “tour” is assumed to be a pair of journeys, from home and then back to home again, linked together.

5.3.2 The representation of tours and PA format has no direct relevance for the SATURN highway model, which will assign OD vehicle matrices. The PA tours for home-based purposes are of importance for the demand model, their use having the following key properties:

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[3] The land-use model requires JTW data from the Census at a later stage in the programme, and so depending on the release of the 2011 Census JTW data this data will be included within the land-use model if possible.

- ensuring that the representation of home and non-home related land-use patterns are appropriately represented in the demand model, through the linkage of homes to trip productions rather than origins;
- the enabling of from-home and to-home legs of individuals' daily travel to be linked, ensuring that both legs of the tour will be sensitive to the travel costs of each direction of travel; and
- ensuring that the from-home and to-home legs use the same main mode(s) of travel.

5.3.3 The tour matrices will be formed of 15 time period pairs defining the time of the from-home and to-home legs of the tour constituting a 24-hour average neutral weekday in 2014 (assuming the time periods as defined in Paragraph 4.4.2, noting that these are subject to review).

5.3.4 Table 5.1 shows the time period pairs to be modelled, based on the assumption that a to-home leg will not occur in an earlier time period than the from-home leg; hence the return leg is assumed to occur within the same day. This assumption removes 10 permutations (shaded grey), which will reduce data storage and run time requirements by ~40%.

Table 5.1: Time Period Pairs for Matrix Building

Outbound \ Return	Off-Peak E	AM Peak	Interpeak	PM Peak	Off-Peak L
Off-Peak Early					
AM Peak	■				
Interpeak	■	■			
PM Peak	■	■	■		
Off-Peak Late	■	■	■	■	

5.3.5 Since non-home-based trips and freight demand cannot so easily be classified into simple tours, these will be represented as single-leg trip matrices for each of the five time periods, stored in OD format.

5.3.6 The demand matrices will be developed for the journey purposes shown in Table 5.2.

Table 5.2: Journey Purposes

Representation	Purpose
Home-Based (Tours)	Commuting
	Education
	Employers' Business
	Shopping
	Other
Non-Home-Based (Trips)	Employers' Business
	Other
	LGV
	OGV

5.3.7 The matrices will then be further segmented by household income, using income data from the land-use model, rather than the illustrative TAG assumptions (TAG encourages the use of local data in models where available). However, since this information will not be available from the roadside interview data or mobile network data, the split will be applied following the main process to create matrices by purpose and time period.

5.4 Verification of Mobile Network Data

5.4.1 There are known issues with mobile network data that will need to be resolved. For context, a comparison of the characteristics of RSI data and mobile network data is provided in Table 5.3, focussing solely on the use of mobile network data for deriving motorised highway demand. The key strength of the mobile network data is the large sample of all travel.

Table 5.3: Key Characteristics of Mobile Network Data and RSI data for Matrix Building

Attribute / Consideration	RSI Data	Mobile Network Data
Type of raw data	Cross-sectional (a sample from a single day)	Longitudinal (cross-sectional data collected over a period of time)
Sampling approach	Specified locations for selected roads; Random sample of drivers at these locations	Full population of Operator’s subscribers
Sample rate (for a given road)	10% to 20% (individual sample)	~30% (repeated sample over several days)
Variation of trips observed in the data	Spatial variation	Spatial and temporal variation
Data bias	Potential for response bias, this could be minimised through careful survey design and sampling strategy	Potential for bias towards the profile of 'subscribers' if different, bias could be corrected largely if identified properly
Expansion of data	Relatively straightforward using count data and statistical analysis where journeys traverse more than one sample site.	More complicated, requiring information on how the mobile phone users relate to total population
Identify trip purposes	Straightforward; survey question	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Identify vehicle type	Straightforward; survey observation	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Identify vehicle occupancy	Straightforward; survey observation	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Geographical scope of data	Only those movements intercepted by screenlines / cordons	In theory all movements, though short trips may be omitted
Proportion of unobserved OD trips in the matrix	Relatively large, depending on number of RSI sectors	None or very low (short trips)

5.4.2 Given these key characteristics of the two datasets, a series of verification tasks will be defined to understand the strengths and weaknesses of the two sources of demand data. These will be defined, in part, during the verification stage responding to the outcomes of the investigations; however we would expect the verification to include:

- checks on the trip-rates implied within mobile network data compared with independent sources (such as NTEM and NTS);
- checks on the trip-length distribution within mobile network data compared with the RSI data and other data sources (such as NTS);

- checks on the location of trip origins and destinations within mobile network data against independent data sources; and
- checks on the pattern of trip movements at a sector level between the mobile network data and the RSI records.

5.4.3 The approach to deriving the base year highway demand matrices will then be developed based on the outcomes of this verification exercise of mobile network data and the known strengths and weaknesses of the available data sources. This may result in mobile network data being used for all movements where trips have been reliably observed (i.e. excluding external-external and short distance trips), mobile network data being used for movement unobserved by the RSI records, or mobile network data not being used within the base year matrices.

5.5 Development of Partially Observed Matrices

5.5.1 Depending on the adopted methodology for building the base year highway matrices, it may or may not be necessary to build partially observed matrices based on the collected RSI data. If partially observed matrices are required, these will be built using a variance weighting approach as discussed below. Some of these tasks and process will be required for the verification of mobile network data, and will be undertaken whether or not a partially observed matrix is required.

Expanded Site and Cordon Demand

5.5.2 The roadside interview data, both old and new, will have already undergone a checking and cleaning process. We will make our own logic and consistency checks before committing the data to the matrix-building process, following up any identified data anomalies.

5.5.3 RSI survey data will be processed using standard rules and methods. We will review the raw data to identify implausible trip origins and destinations given the direction and location of the survey site. These data will be excluded and the surveys re-expanded to the MCC totals for three vehicle groups (car, LGV, OGV) and then across groups using ATC totals.

5.5.4 The RSI surveys will have been undertaken in one direction only, but will generally contain some information on the timing of reverse direction trips. It will sometimes be necessary to deduce or estimate the time period in which the reverse trip is made, where this information is not available. These assumptions will be made based on a combination of household survey data, NTS outbound-return proportions by time period pair, directionality information from the RSI survey, which will indicate at least whether a trip is outgoing or returning home, and the profile of traffic counts in the reverse direction.

5.5.5 Expansion factors will be calculated to match the count data for the reverse direction for the three vehicle groups. These will be recalculated for any previously expanded RSI data, to take account of the 2014 traffic count data to be used, and to build the matrices at the tours level. Non-home-based trips will be dealt with separately, as directional trips rather than tours.

5.5.6 Given the 12-hour span of the RSI surveys, there will be no observed OD data for OP_{early}-OP_{early}, OP_{late}-OP_{late} or OP_{early}-OP_{late}. We will therefore make estimates of this demand, again deriving suitable factors from household surveys and assumed patterns of travel from other time periods.

5.5.7 There will be a need to rebase some count data to 2014. Traffic counts will therefore be adjusted to take account of local growth between the time of each survey and the LLITM 2014 Base year. The growth factors will be based on count data at the survey site or at nearby sites. Newer data will be prioritised over older data.

5.5.8 Where there are gaps in the survey data, consideration will be given to infilling missing information, for example, using data from other time periods at the same site together with information on purpose mix at that time of day from other sites, and, for minor unsurveyed routes, information from adjacent sites, expanded to count data on the unsurveyed route.

5.5.9 Some holes in cordons and screenlines may be too large to justify infilling in this way. Of particular note is through trips on the major trunk roads and motorways (the M1 and M69). We plan to investigate use of mobile network data (subject to verification) or Highways England's [now National Highways'] J16-J19 M1 Model (the matrices for which were built using mobile network data) to obtain most of this demand.

5.5.10 The matrices will be built for both observed people (all vehicle occupants) and vehicles, as vehicles are required by the highway assignment model, and people by the demand model.

Observed Partial Matrices

5.5.11 Matrices across cordons and screenlines will be merged using a variance weighting method. This approach uses estimates of the statistical accuracy of the surveys where trips cross multiple screenlines or cordons, and is therefore more robust than simpler approaches.

5.5.12 The sample variance of RSI data are a measure of the uncertainty in the expanded observed matrix obtained from an RSI screenline (or site). This ensures that, other things being equal, larger samples will be treated as more reliable than small ones. The variance for records crossing a given RSI screenline will be calculated as follows:

$$\sigma_{ij}^2 = O_{ij}\left(\frac{E_{ij}}{O_{ij}}\right)^2$$

where:

- σ_{ij} is the variance of observed vehicles between zones i and j;
- O_{ij} is the number of observed vehicles between zones i and j; and
- E_{ij} is the number of expanded vehicles between zones i and j.

5.5.13 Variances will be calculated separately for car, LGV and HGV trips at each RSI screenline so that the different sample rates (and hence variances) obtained for different vehicle types are taken into account.

5.5.14 The variance for transposed trips will be increased to reflect the increased uncertainty in these data, using factors previously derived by AECOM for this purpose, subject to review. Consideration will be given to applying other variances based on age of data and other characteristics if this is felt significant.

5.5.15 The final merged matrices will be created by weighting individual estimates of a given trip movement by the inverse of the variance squared. Estimates with high variance will thus have less weight. The process will be capable of merging any number of estimates. Many movements, for example, will be available from only a single cordon (meaning there is no weighting to do), while some long distance movements may cross several screenlines and cordons and the overall estimate will be a robust merge of them all.

5.6 Gravity Modelling

5.6.1 Whichever process is adopted for the development of the base year highway matrices, synthetic demand will be required for some movements. No source of data available for LLITM 2014 will have reliably captured short distance trips for example, and therefore synthetic demand is likely to be the source of data for these movements.

5.6.2 With a set of 2014 planning data from the land-use model, and having tested the customised model, we will apply the trip-end model (discussed in Section 9.3) to estimate car driver and passenger trip productions and attractions in the LLITM 2014 Base zone system.

5.6.3 There is no such data source for freight trip-ends. The DfT's national model has drawn on national survey data, and we will consider the use of the information from Great Britain Freight Model as aggregate (sector) constraints.

5.6.4 The gravity models will also need indicative generalised cost data from the SATURN highway model. Some interim demand, probably derived from the old LLITM model, will be used for this. It is intended to have a suitable LLITM 2014 Base network, albeit not finalised, available for assignment. Generalised costs will be built using TAG economic assumptions as they will be used in the final LLITM 2014 Base demand model (see Section 9.4).

5.6.5 The period-specific OD generalised costs will be combined to establish all-day purpose specific costs in PA format, obtained using conversion factors derived from RSI data and NTS. These cost estimates will be verified against costs derived from the final model to ensure consistency.

5.6.6 The all-day PA cost data will be used to estimate deterrence functions, constrained to trip-ends separately for each purpose, of the following form:

$$Demand_{ij} = k_i P_i A_j Cost_{ij}^{\beta} exp^{\alpha Cost_{ij}}$$

where:

- $\mathrm{P_i}$ is the production trip-end for zone i;
- A_j is the attraction trip-end for zone j;
- k_i is a factor to control the total production demand to the production trip-end, equal to a sum over j of the right-hand side of the equation from A_j onwards; and
- α and β are calibrated parameters.

5.6.7 By fitting the synthetic, purpose-specific, trip length distribution in observed movements to that observed in the RSI surveys, the synthetic matrix provides an unbiased basis to extrapolate travel patterns to unobserved trip cells. Household survey data and local East Midlands NTS data will be used to validate this extrapolation, as they contain complete distributions of trip-lengths, unlike the RSI data.

5.6.8 Having created the all-day synthetic PA demand matrices, we will apply conversion factors (discussed below) to disaggregate all day PA person tours between individual time period pairs. The total OD period specific trips will be accumulated by adding to-home and transposed from-home trips to create OD demand for assignment. Finally, vehicle occupancy factors will be applied to estimate period-specific vehicle trips.

5.6.9 Both the creation of generalised costs in PA form and the conversion of synthetic demand back to OD assignment format require conversion factors; some of these will also be needed by the demand model in forecasting. They will be obtained primarily from RSI data (although data from NTS may be used to infill missing data), and will be of three kinds:

- factors to split all-day demand into time period pairs (home-based tours) and time periods (non-home-based and freight trips);
- factors to convert from person to vehicle trips by applying group size (vehicle occupancy); and
- factors to convert between AM and PM three-hour peak periods and the AM and PM Peak hours.

5.6.10 In principle the conversion factors are simply defined by the observed demand. For example, average car occupancy for home-to-work in the morning peak, is defined by the total (expanded) number of surveyed individuals divided by the total (expanded) number of vehicles, for the given period and purpose. It will be necessary to assume factors for unobserved movements based on the observed data available.

5.6.11 The output of this process will be a set of factors used to disaggregate all day synthetic production-attraction trip matrices to period specific origin-destination vehicle matrices. Separate factors will be derived for each purpose.

5.7 Matrix Estimation

5.7.1 Following the development of the base year highway prior matrices, we will apply highway matrix estimation techniques, if necessary, to draw upon accurately measured data from traffic count sites. The steps will be to:

- validate the original prior matrix against counts, and adjust the network or assignment where discrepancies appear to relate to the network or assignment process;
- undertake matrix estimation by short screenlines (these will generally be disaggregated from the RSI cordons and screenlines and will include traffic count data not used in the RSI build);
- formally validate the estimated matrix against independent sites excluded from the initial estimation;
- undertake a further estimation using, in addition, the independent sites; this maximises the use of information and accuracy of the model; and
- undertake final validation demonstrating the extent of changes that the final estimation made to the trip matrix.

5.7.2 The matrix estimation and assessment of its impact will be done in accordance with guidance detailed in TAG Unit M3.1.

The adopted approach to developing the base year highway trip matrices is detailed within Section 7 of the ‘*NEMMDR FBC - Local Highway LMVR*’.

Section 6 – Highway Traffic Supply Model

6.1 Overview

6.1.1 The SATURN highway network for LLITM 2014 Base will be based on the existing LLITM network. This was partially reviewed in depth as part of an update for LLITM in 2013.

6.1.2 While the LLITM network will be used as the basis for the LLITM 2014 Base network, the following tasks will be undertaken to further enhance the network:

- Centroid connectors in LLITM were coded in an inefficient way, using four nodes and five links. This will be revised to a simpler two node and two link approach, significantly reducing network complexity, making analysis easier, and shortening run times. As part of this process, all centroid connector loading points will be reviewed to ensure that traffic is loaded at the most logical points by zone.
- Over half of simulation junctions in the LLITM model were reviewed for the 2013 update to ensure they were coded accurately and consistently. The same process will be applied to the remaining junctions so that all network coding is consistent.
- The external buffer network, a long way from Leicestershire, has substantially more complexity, particularly in terms of unnecessarily long “chains” of links, than necessary, which slows run times and makes converting the network between software packages harder. This complexity will be removed. However, link shape will be retained for graphical purposes, using functionality in SATURN to allow a single link to be plotted as a series of straight lines, rather than a single line. Some buffer network is likely to be removed altogether.
- The network immediately outside Leicestershire requires additional detail and junction modelling to ensure that route choice between Leicestershire and routes immediately outside are modelled accurately. The focus of effort is expected to include Nuneaton and Rugby, but the areas will be discussed with the client.
- The 2008 network will be updated to 2014 by reviewing and coding schemes implemented between 2008 and 2014. The existing 2014 LLITM forecast networks will be used as a starting point.
- A check on the network topology will be conducted by comparing the network against GIS data or aerial photography to ensure that all strategic and connection routes are included. The model will not in general represent residential streets or very minor roads.
- All available signal timing data will be incorporated into the model in the coding of signalised junctions; it is assumed for the purposes of this proposal that these data will be provided using an agreed signals data pro forma that is specified by AECOM and agreed with LCC.
- Banned network movements for car and freight will be reviewed and updated; we assume that LCC will provide GIS layers containing these data.
- Approximate demand for the year 2041 will be prepared and assigned on the network to perform a “stress test” and identify any likely areas of significantly poor performance in the future. Where these result from likely coding errors, the issues will be addressed as appropriate.

6.2 Coding Principles and Quality Assurance

6.2.1 A SATURN model coding manual, *‘TN101 - LLITM SATURN Coding Manual’*, was prepared as part of the 2013 LLITM update. This document will be reviewed and updated as appropriate, and will form the basis of further coding. Any refinements to the coding approach will need to be considered with respect to the network that was updated as part of the 2013 update. The coding approach will accord with industry best-practice, and will be reviewed by an experienced SATURN modeller separate from the model development team.

6.2.2 We envisage the SATURN coding task for the new 2014 base year model to be undertaken by one person over approximately 6 months. This will ensure consistency of approach and removes the practical complexities associated with multiple coders working in parallel.

6.2.3 An experienced SATURN modeller, separate from the model development team, will spend 0.5 days per week during this coding period independently reviewing and checking a sample of the coded network. This peer review will focus on areas of the network that are considered to be more critical / sensitive to LCC. Findings and remedial action from this review will all be documented.

6.2.4 Some of the more detailed requirements of the brief (such as coding methodology for motorway merges) will be addressed in the coding manual.

6.3 Buffer Network Congestion

6.3.1 LLITM will contain SATURN “buffer” network outside the main simulation area which will cover Leicester, Leicestershire, and some surrounding area. In the buffer network, junctions will not be modelled and the network will be skeletal. It will be necessary to ensure boundary effects between simulation and buffer (potentially resulting in spurious route choice, demand model, or land-use effects) are minimised.

6.3.2 We plan to do this by using buffer links speeds that are fixed in any given model run, but reduce over time in-line with national congestion trends, derived with reference to both the internal model and to published National Transport Model trends. In this way, congestion will affect simulation and buffer areas similarly, and yet the model will not need to forecast capacities and demand precisely a long distance from Leicestershire.

6.4 Road Charging and Tolls

6.4.1 There are no road tolls or user charges in Leicestershire or Leicester currently, so the LLITM 2014 Base model will not contain any charges. However, it will be set-up appropriately to allow charges to be tested in forecasting.

6.4.2 Road user charges could take a number of forms, including, in approximate order of likelihood:

- workplace parking levies; these would be modelled in the LLITM 2014 Base demand model, rather than the highway model;
- cordon charges around urban areas; these would be represented by charges on links in the highway model, and will be able to vary by time of day;
- new tolled roads; also would be represented by link-based charges, however, some consideration of external choice modelling might be required depending on location and context; and
- marginal social cost (MSC) charging; this would require a more complex external process to calculate charges, but would also be modelled at a link-based charge level.

6.4.3 The highway model will allow charges to be specified within the network, by time period, and ensure that monetary costs are able to be extracted for journeys and passed to the demand model.

6.5 Flow and Journey Time Validation

6.5.1 With the development of the coded highway network and the prior matrices (as discussed in Section 5) the assignment of these matrices onto the network in the three modelled hours can be assessed against observed data. This observed data will consist of both link counts and journey times along defined routes.

6.5.2 The assessment of the assignment results against observed data will follow TAG, and will consider both the comparison of modelled screenline and individual count locations flows against observed data and the comparison of modelled and observed journey times. In addition to this, if matrix estimation is required as part of the calibration of the highway model, the changes to the prior matrices due to this process in terms of individual cell values, sector-to-sector values and trip-ends will be assessed.

6.5.3 It should be noted that current TAG places particular emphasis on minimising the changes to the prior matrices above link and journey time performance against observed data. With that said, it is acknowledged that a key requirement for the highway model is to get as close to TAG acceptability criteria in terms of link and journey time validation, given the type of scrutiny that the model is expected to undergo (Core Strategies, AAPs, EIPs etc.). The balance of weight to be placed on the matrix changes and the assignment performance will be discussed with LCC prior to and during the calibration process.

6.5.4 An additional complexity within the calibration of the highway model is the application of the parking model. In the base year this will influence the routeing in and around the areas included within the parking model; however the parking model can only be realistically applied after the base year highway model has been calibrated. Running and calibrating the parking model during each run of the matrix estimation process would add significant time to the programme for this task.

6.5.5 In order to account for this effect within the highway model calibration, the expected change in modelled flows due to the application of the parking model will be applied to the counts used within the calibration and validation process. With the final base year model having been run, including the application of the parking model, these adjustments will be removed and the reported calibration and validation will be based on these post-parking model results.

6.5.6 It is anticipated that these adjustments to the observed counts to account for the likely effect of the parking model will initially be taken from the existing LLITM highway model. However, providing that the base year demand model is operational during the calibration of the highway model, these adjustments will be updated from interim versions of the base year demand model where possible.

The development of the base year highway networks is detailed within Section 6 of the '*NEMMDR FBC - Local Highway LMVR*', with the process and results of the model calibration and validation detailed within Section 11.

Section 7 – Public Transport Passenger Demand

7.1 Overview

7.1.1 The public transport matrix development process for LLITM 2014 Base will be built using a combination of MS Excel, MS Access and Emme transport modelling software, and will be controlled by macros to ensure transparency and repeatability. Separate and different processes will be developed for bus and rail trips.

7.1.2 There is little available guidance or consensus regarding the best methods for building public transport matrices. We will seek to use all available data as well as possible, placing higher confidence in data with less survey error and data with larger sample sizes.

7.2 Data Availability and Use

7.2.1 The following data sources are or will be available for constructing public transport matrices:

- bus passenger interview data in urban centres collected in 2014;
- bus passenger counts, boarding and alighting in urban centres and flow exiting and entering main urban areas, collected in 2013 and 2014;
- bus passenger ticket sales data, collected in 2014;
- National Travel Survey (NTS) data for the East Midlands and National Rail Travel Survey (NRTS) data for Leicestershire. NTS is for 2002 to 2012 and NRTS from 2005;
- rail ticket sales data, LENNON, for Leicestershire, for 2008 or 2013, depending on availability;
- rail passenger boarding and alighting counts, collected in 2014, at major railway stations in Leicestershire; and
- Leicestershire household survey data, collected in 2009.

7.3 Demand Matrix Requirements

7.3.1 The bus and rail matrices for LLITM will be developed as two-legged tour matrices for home-based purposes, stored in production-attraction (PA) format, and as trip matrices for non-home-based purposes, stored in origin-destination (OD) format. A “tour” is defined as a pair of journeys, from home and then back to home again, linked together.

7.3.2 The representation of tours and PA format has no direct relevance for the public transport assignment model, which will assign OD people. The PA tours for home-based purpose are of importance for the demand model, their use having the following key properties:

- ensuring that the representation of home and non-home related land-use patterns are appropriately represented in the demand model, through the linkage of homes to trip productions rather than origins;
- the enabling of from-home and to-home legs of individuals’ daily travel to be linked, ensuring that both legs of the tour will be sensitive to the travel costs of each direction of travel; and
- ensuring that the from-home and to-home legs use the same main mode(s) of travel.

7.3.3 The tour matrices will be formed of 15 time period pairs defining the time of the from-home and to-home legs of the tour constituting a 24-hour average neutral weekday in 2014 (assuming the time periods as defined in Paragraph 4.4.2, noting that these are subject to change).

7.3.4 Table 7.1 shows the time period pairs to be modelled, based on the assumption that a to-home leg will not occur in an earlier time period than the from-home leg; hence the return leg is assumed to occur within the same day. This assumption removes 10 permutations (shaded grey), which will reduce data storage and run time requirements by 40%.

Table 7.1: Time Period Pairs for Matrix Building

Outbound \ Return	Off-Peak E	AM Peak	Interpeak	PM Peak	Off-Peak L
Off-Peak Early					
AM Peak	■				
Interpeak	■	■			
PM Peak	■	■	■		
Off-Peak Late	■	■	■	■	

7.3.5 Since non-home-based trips cannot so easily be classified into simple tours, these will be represented as single-leg trip matrices for each of the five time periods, stored in OD format.

7.3.6 The demand matrices will be developed for the journey purposes shown in Table 7.2.

Table 7.2: Journey Purposes, Public Transport

Representation	Purpose
Home-Based (Tours)	Commuting
	Education
	Employers' Business
	Shopping
	Other
Non-Home-Based (Trips)	Employers' Business
	Other

7.3.7 The matrices will then be further segmented by household income and car availability. Income data may not be available from the passenger interviews or ticket sales data, so the split will be applied following the main process to create matrices by purpose and time period using NTS and NRTS data. Car availability data may be taken from the passenger interviews, but this is likely to be applied at a more aggregate level as a post-build process rather than the matrices being built separately by car-availabilities.

7.4 Rail Demand Matrices – Overview

7.4.1 The process for constructing rail demand will be as follows:

- Create origin-station to destination-station rail matrices for the whole country using LENNON data.
- Use the LLITM survey data and / or NRTS, along with zonal population and employment data to run an access / egress model to adjust the LENNON trip-ends within Leicestershire so that they represent ultimate trip-ends rather than stations. This will distribute trip-ends within station "catchment areas" as a function of access costs and population / attraction factors.
- Apply NRTS data to derive splits by time period pairs and purpose, and NTS data to derive splits by income and car availability.

7.4.2 A synthetic gravity model is considered unnecessary, as both LENNON and NRTS are in principle complete representations of rail demand. A matrix estimation process is also thought to be unnecessary, as the matrix build process should ensure that total passengers using each station are broadly correct. Any failure to reproduce patronage would suggest that either the assignment needed adjusting or that the catchment areas used for the access / egress model were poorly chosen, and would therefore be corrected by adjusting one of these processes.

7.5 LENNON Data

7.5.1 It is intended to obtain LENNON data for 2013 or 2014 for the LLITM 2014 Base rail demand. If this is unavailable, the original 2008 LENNON data will be expanded to account for rail growth between 2008 and 2014, subject to agreement that this data source is appropriate for use in LLITM 2014 Base.

7.5.2 LENNON ticket data for the whole country for September and October 2008 were available previously. These comprised 1,649,052 records (a record contains all tickets sold of a specific type between two specific stations, so there are many more trips than records), 652 different ticket types and 632,040 unique station pairs. These were a complete representation of all tickets sold and were used as the starting point for matrix construction. Should 2013 / 2014 data be available but more limited (e.g. Leicestershire only), we assume that 2008 data would be used to fill in the gaps.

7.5.3 Ticket sales must be converted to trips / tours made. In particular, it is necessary to estimate the number of trips made by season tickets. Estimates of total trips made per ticket issued, by ticket type, were required to create the matrices initially. For each ticket type in the LENNON database a decision will be made on whether this related to a single trip or a tour, and the number of trips that the ticket entitles the customer to over the duration of its validity. Most of these estimates will be acquired from databases that were already at our disposal; some may need to be filled in logically.

7.5.4 In order to produce average weekday trip and tour rail demand matrices, it will be necessary to allocate stations to model zones, before tabulating the data.

7.6 Rail Access / Egress Model

7.6.1 As LENNON data represent trips from station to station, and the demand matrices must represent travellers' ultimate origins and destinations (and subsequently productions and attractions), it will be necessary to distribute demand over access / egress zones. It will be assumed, principally on the basis of zone size, that for trip-ends outside Leicestershire, the station zone and the actual origin / destination zone are the same. For trip-ends within Leicestershire, a gravity model will be constructed as follows to distribute trip-ends:

$$D_{ijab} = D_{ab} k_{ab} P_i A_j * \left(d_{ia}^{(\lambda_{l1}-1)} e^{\mu_{l1} d_{ia}} \right) * \left(d_{jb}^{(\lambda_{l2}-1)} e^{\mu_{l2} d_{jb}} \right)$$

where:

- i is the origin zone;
- j is the destination zone;
- a is the origin station zone (from LENNON data);
- b is the destination station zone (from LENNON data);
- D_{ab} is the demand (from LENNON data);
- P_i and A_j are the production and attraction factors, equal to population plus employment (persons plus jobs) by zone. P_i and A_j are assumed to be the same, as we are distributing an all-purpose matrix;
- d_{ia} is the distance from origin zone i to origin station a;
- λ_{l1} and μ_{l1} are calibrated parameters for access, by trip length (from a to b) band l;
- λ_{l2} and μ_{l2} are calibrated parameters for egress, by trip length (from a to b) band l; and
- k_{ab} are factors to control total demand from a to b to the total in the LENNON matrix.

7.6.2 Demand will then be aggregated over i and j: the final demand matrices will not be stored by origin and destination station, so:

$$D_{ij} = \sum_{ab} D_{ijab}$$

7.6.3 i and j will be considered for a given a and b only if they fall into a defined "catchment area" for each station. In the case of external zones, a stations catchment area will be its own zone only; in the case of Leicestershire zones, it will be a larger area around the station. All Leicestershire zones will be within the catchment area of at least one station.

7.6.4 λ and μ parameters for distance will be calibrated, by length of rail trip, using NRTS data.

7.7 Rail Matrix Splitting

7.7.1 LENNON data contain tickets sold by type, issuing station, origin station and destination station but lack the following:

- trip purpose; and
- time periods of outgoing and return trips.

7.7.2 NRTS data will be used to apply splits by time period pair and journey purpose. These will be calculated by trip length bands, and by production sector within Leicestershire.

7.8 Bus Demand Matrices – Overview

7.8.1 The bus matrix build process for LLITM 2014 Base will be as follows:

- Electronic Ticket Machine (ETM) data will be processed to create a series of stop to stop matrices of demand for each service. This will involve estimating alighting points for ticket types that lack this information, which will be done with reference to the distribution of alighting points for those tickets for which this information is available.
- These will be converted to zones using catchment areas for each stop, estimated based on a typical maximum walk distance of a few hundred metres to a bus stop. The distribution among zones will be based on land-use/ trip-end data.
- The data will already be by time period. They will be split based on returning periods and purpose of travel using the passenger interview data and the National Travel Survey.
- Passengers travelling on services operated by operators for which no ETM data exist will be estimated using counts and passenger interview data.

7.9 Bus Passenger Interviews

7.9.1 Bus passenger interviews are expected to contain almost all information required to create transport model matrices, including origins, destinations, travel times, return times, journey purpose and car availability. They may lack income data which may have to be filled in using NTS data as a final step at the end of the process.

7.9.2 However, the interviews will only cover a portion of bus trips in Leicester and Leicestershire. It is expected that a slight majority of tours will be intercepted by the interviews (clearly the interviews will be only of a sample of the intercepted journeys, however), due to their location in urban centres, to and from which most bus travel occurs.

7.9.3 However, the sample size is expected to be very low by comparison with the ETM ticket sales data, and the sample that is interviewed will be biased in favour of longer trips. Interviews often lack reliable (or at least precise) geographic details for at least one end of the trip as interviewees understandably are often unable to supply a postcode for the non-home end of their trip.

7.9.4 The precise methodology for building the bus demand matrices will need to be refined following further work, as Leicester and Leicestershire ticket sales data have not been used for this purpose previously. A detailed specification note will be provided.

7.10 ETM Ticket Data

7.10.1 ETM data are expected to be available from the major bus operators in Leicester.

7.10.2 It will be necessary to match boarding points and services in the ETM data to surveyed boarding stops, stop clusters and services to enable it to be used in expanding interviews. Services in the ETM data will need to be mapped to services in the bus network. Boarding and alighting points will need to be matched to model zones or groups of zones. These mapping tasks will consume considerable time; automated processes will be considered to reduce this, but it is likely that complete manual checking of each mapping process will be required.

7.11 Unobserved Bus Trips

7.11.1 Any wholly unobserved movements (found in neither the ticket sales nor the interview data) will be infilled using a synthetic model. Bus service occupancies by time of day and other characteristics considered relevant will be estimated either from ticket data for other services, or, where available, from link count data. Trips will then be distributed using suitable functions, calibrated to the considerable quantity of observed data available, and making use of trip-end and cost data.

7.12 Matrix Estimation

7.12.1 As the rail matrices will be relatively simple to produce, representing, at a service level, movements between a small number of railway stations in Leicestershire, we do not expect to require matrix estimation techniques to improve the matrix quality. The observed boardings and alightings will be compared with those modelled, and any discrepancies considered individually and adjustments made to the matrix building process if considered appropriate.

7.12.2 Matrix adjustment is expected to be necessary for the bus matrices; to reconcile the matrices and the observed link flow counts. A tours-based matrix estimation is proposed, carried out using the 'gradient method' documented in *"A Gradient Approach For The O-D Matrix Adjustment Problem", Spiess, 1990*. The process can be adapted so that it estimates tour matrices rather than trip matrices (in effect estimating all time periods simultaneously). This will ensure that the estimated matrices remain wholly compatible with the original prior tour demand, and that no reconciliation step is required and no inconsistency between the supply and demand models is created.

The development of the base year demand matrices for rail and bus used within the model’s development is detailed within Section 4 of the ‘*NEMMDR FBC - Public Transport LMVR*’.

Section 8 – Public Transport Passenger Supply Models

8.1 Scope

8.1.1 The public transport supply model will represent four periods for an average neutral weekday in 2014, assumed to be, subject to confirmation:

- an AM Peak period (07:00 to 10:00);
- an interpeak period (10:00 to 16:00);
- a PM Peak period (16:00 to 19:00); and
- a four-hour off-peak period (06:00 to 07:00 and 19:00 to 22:00), with this period reflecting an absence of services at night.

8.1.2 It should be noted that the off-peak period will not be formally validated. It will be used solely to provide representative costs to the demand model for night-time (19:00 to 07:00) public transport demand.

8.1.3 The model will have several modes of transport, including public transport modes of ‘bus’, ‘park-and-ride bus’, ‘coach’ and ‘rail’, and access / egress / interchange modes ‘walk’ and ‘car’. It will model three “user classes” with varying modes of travel enabled, as follows:

- bus passengers, who can use bus, park-and-ride bus, coach and walk;
- no-car-available rail passengers, who can use rail, bus, park-and-ride bus and walk; and
- car-available rail passengers, who can use rail, walk and car.

8.1.4 Allocation of demand among user classes will be undertaken by the demand model.

8.1.5 Consideration will also be given to distinguishing concessionary travellers from those who pay for bus fares. This decision will depend upon the foreseen applications for the model, as well as on the degree to which fares are considered to influence route choice. If adopted, the split will be a relatively simple one; we will not model entirely separate demand model segments for concessionary bus passengers, but split them relatively globally prior to the sub-mode choice model.

8.2 Networks and Services

8.2.1 The public transport supply representation will include several network components:

- a road network, taken directly from the SATURN highway model, which includes bus-only links and bus lanes, and converted to Emme format;
- a rail network, coded for LLITM 2014 Base using appropriate GIS data;
- a selection of walking routes, connecting the road network to the rail network and providing additional connectivity in urban centres; this will be coded for LLITM 2014 Base, with reference to the LLITM network; and
- zone connectors, for assigning public transport passengers to the network; these will be coded manually with reference to GIS and land-use data.

8.2.2 It will also include a representation of public transport services on these networks:

- all bus services that pass through Leicester and / or Leicestershire, derived from TransXChange-format data provided by LCC for a suitable period in a neutral month in 2014;
- all rail services that pass through Leicester and/or Leicestershire, derived from inspection of the National Rail Enquiries website or published timetables for 2014;
- a representation of coach services passing through Leicester and Leicestershire; this will be derived from 2011 National Public Transport Data Repository (NPTDR) data, unless some more recent source can be acquired; and
- a strategic representation of rail service frequency on rail corridors immediately outside Leicestershire and on main strategic routes throughout Britain.

8.2.3 The coding of many of these components is discussed in more detail in the following sections. A public transport model coding manual will be prepared in advance of the work to specify how the services and network will be coded in Emme and to ensure consistency.

8.3 Public Transport Fares

8.3.1 Estimates of fares paid will be required in LLITM 2014 Base. These will probably be modelled at a network level, such as to influence route-choice; they will certainly be required for the demand modelling.

8.3.2 We will develop new fare functions for LLITM 2014 Base. Three functions will be prepared, for rail, bus, and park-and-ride bus. The fare functions will be based on average fares actually paid per trip, including all forms of concession and discount.

8.3.3 The appropriate information should be available from ticket sales data for rail and bus trips. For park-and-ride bus, we will consider using specific information to the Leicester park-and-ride services if it is suitably detailed. If not, we will assume the same function as ordinary buses; the functions will still be distinguished to allow different assumptions about fare changes over time to be represented.

8.3.4 For coach services, ticket sales data are not expected to be available. A suitable function will be estimated based on operator website searches, including consideration of available discounts.

8.3.5 We expect to create functions based on service boardings and distance travelled. The function of distance is not expected to be linear; longer distance trips are generally cheaper per unit distance than shorter distance trips.

8.4 Assignment Principles

8.4.1 The LLITM 2014 Base public transport model will be a frequency-based model, incorporating fares in the assignment (and demand model). That is, it will represent the frequencies or headways of each service, but not the precise timetables, arrival and departure times. Like the highway model, it will be a static model, not taking account of the passage of time over the course of a passenger journey. For example, in a long journey, the time period and consequently running service patterns or frequencies could in principle change over the course of the journey.

8.4.2 A timetable approach, where each service has its precise timetable coded, is possible in Emme, but requires substantially more detailed data regarding desired departure times and is much more time-consuming to calibrate; given the relatively high frequencies of urban buses which are the focus of the model, it is not considered useful.

8.4.3 Assignment will be conducted on an “optimal strategy” basis, where the model calculates an optimal strategy for each destination at each node in the network, choosing services that take the traveller closer to their goal either representing the quickest service or providing a sufficient reduction in expected wait time to offset any increase in expected travel time.

8.4.4 This approach results in the creation of single optimal strategies for each journey and does not explicitly allow for any variation in personal preferences or level of information. However, it does not in general assign each traveller to a single path, as their strategy may result in boarding from a set of services, divided among them by the service frequency.

8.4.5 The approach makes the following implicit assumptions:

- that all travellers have complete knowledge of the service routes, interchange points, and frequencies;
- that travellers are, however, unaware of the precise arrival and departure times, and must decide as they encounter a service whether to board it or not (this is generally quite realistic in a congested urban context, as buses often do not adhere precisely to timetables, especially in peak periods);
- that at each network “node”, it is possible to observe service arrivals at that node only and not at any nearby nodes;
- that travellers seek to minimise their “generalised cost”, which includes walking times, in-vehicle times, waiting times, fares and boarding penalties, all with appropriate weights; and

- that services are, and that travellers know them to be, evenly spaced, so that if, for example, there are two services going in one direction, they will not always arrive together, but arrive half way between the intervals between each other.

8.4.6 This is an appropriate methodology for a relatively high frequency urban bus situation such as LLITM 2014 Base will be primarily modelling. It is generally poorer at assigning passengers to very low frequency services, such as long-distance coaches, but even here may perform suitably if there is no route choice anyway.

8.4.7 The approach requires assumption of weights and values for the various components of generalised cost:

- walking time;
- car access and egress time;
- waiting time;
- in-public-transport-vehicle time;
- fares; and
- boarding of services / interchanging.

8.4.8 These will largely be derived from TAG advice, though some of them, such as boarding penalties, can be adjusted as part of the model validation and calibration. The values may differ by the user classes discussed in Section 8.1.

8.4.9 The LLITM 2014 Base public transport model will not represent passenger crowding, that is, the discomfort associated with travel on crowded services, inability to get a seat, or inability to board a service through overcrowding resulting in increased waiting times. These are not generally considered significant for bus travel, and are typically only modelled on very busy rail services.

8.4.10 Assignment of rail passengers will require the model to favour rail over bus for these so that rail trips do actually use rail services in preference to bus where they are available. This will be achieved using suitable boarding penalties and / or in-vehicle time adjustments.

8.5 Rail Network

8.5.1 The rail network will be coded using GIS data showing rail lines in Britain. It will not include every railway line, only public passenger-serving railways in Leicester, Leicestershire and the immediate surroundings and the most strategic routes elsewhere. This is likely to include:

- the Midland Mainline from London to Derby, Nottingham and Sheffield, through Market Harborough, Leicester and Loughborough;
- Nuneaton to Peterborough, going through Hinckley, Leicester, Melton Mowbray and Oakham;
- Tamworth to Derby;
- Nottingham to Peterborough;
- the West Coast Mainline from London to Glasgow;
- the East Coast Mainline from London to Edinburgh; and
- other significant strategic movements required to ensure zone connectivity in the external network.

8.5.2 Key railway stations will be identified based on the zone system. This will include all 10 railway stations within Leicester and Leicestershire; outside the county more minor stations will not be included.

8.5.3 All services running through Leicestershire will be coded as accurately as possible with reference to the timetables and stopping patterns. Outside Leicestershire we will merely seek to ensure that connectivity and broad service frequencies are correct; the coding will not attempt to reproduce the stopping patterns precisely.

8.6 Bus Service Supply Data

8.6.1 TransXChange-format (or similar xml-format) data will be taken from the Traveline FTP server. These will cover all bus journeys Leicester and Leicestershire in 2014, detailing all timetabled arrival and departure times and stops for every service. We will select a suitable neutral weekday in the year and extract services for that day.

8.6.2 An automatic process will be applied, based on an updated process as used for the LLITM model, to process these data and convert them to a suitable format for use in the public transport model. This has three key steps:

- extract relevant services, during weekdays for the day selected, not specific to bank or school holidays, and allocate these services to model time periods;
- remove duplicate journeys, and combine journeys into modelled “transit lines”, where the latter is a combination of service number, direction of travel, and stopping pattern; and
- allocate bus stops to nodes in the model network, and build travel times between nodes.

8.6.3 From previous experience in working with similar data, considerable effort will be required to remove duplicates and to ensure that services are not represented multiple times. An approach considered robust is to consider services duplicates where they share service numbers and have at least three identical stops with identical arrival times.

8.6.4 The allocation of bus stops to model nodes will involve finding the closest points of stop coordinates on model links, with reference to direction of travel where one-way links are modelled. The process may depend to some degree on the specified approach to modelling interaction between the bus and highway models.

8.6.5 TransXChange data do not explicitly record bus routes as such, but only the stops called at and their order. We will use Traveline East Midlands routeing data to check the allocated routeing in the public transport model if these can be obtained in GIS format; the checks will be prioritised according to the likelihood of there being routeing problems (for example, infrequent stopping services are more likely to need amending as there are fewer routeing data points in the TransXChange data.

8.6.6 Travel times will be derived from the published timetables. Some degree of congestion feedback over time, whereby increases in highway congestion are taken account of in the bus model, is required. We plan to adopt a matrix-based approach, where origin-destination movements by bus experience a comparable increase in delay to that observed in the highway model.

8.6.7 A network-based method, where highway congestion on links feeds directly into the bus model, while clearly more precise, has large implications for model complexity and development costs. It forces complete consistency between highway and public transport network models, which is both difficult to establish and still more difficult to maintain in scheme coding and model application. It is considered not be worth the development cost, unless specific appraisal of bus priority schemes such as bus lanes was desired, in which case it would be necessary.

8.7 Connectors, Walk Links and Access / Egress

8.7.1 Zone connectors will be required to load passenger demand onto the network. These will in general be fed into the centre of population in each zone. Connectors in external zones will be linked to the main railway station in the zone. One connector will be used per zone. Longer distance access and egress will be modelled on the road and limited pedestrian network itself.

8.7.2 Travel times on connectors will be estimated by zone type. Internal urban zones will be assigned a suitable short walk distance (of the order of 300 metres). External zones will have static connector times of the order of half an hour. These times and distances will be derived with reference to survey data where possible (household survey, NTS, possibly passenger surveys); they are of limited importance to the model as such since they cannot affect routeing or demand model choices.

8.7.3 Walk-only links will be added in urban centres; these will be coded with reference to the LLITM model and to GIS mapping as available. LCC will be consulted on the coverage.

8.7.4 Access to and egress from public transport services will be modelled using two modes: walk and car. Car will be available, to car-available rail passengers only, on all non-bus-exclusive road links, respecting one-way roads, and walk on all non-rail links, ignoring one-way allocations. Suitable fixed average speeds will be used, for example, 4 kph for walk and 30 kph for car. The walk mode will still be available for car-available rail passengers, who will use it to walk from the road network to the rail network (as in walking from the car park to the platform).

8.8 Network Checking and Validation

8.8.1 Two levels of checking will be carried out on the public transport networks, as follows:

- Service Validation: The coded services will be checked against existing services and timetables to ensure they are represented accurately.
- Assignment Validation: Route choices through the network will be checked to ensure that the assignment actually allocates passengers to realistic routes and services.

8.8.2 The service checking for bus services will be carried out by defining a structured checking procedure to check services converted from TransXChange data and comparing them to published online timetables. We assume that we will use Traveline East Midlands routeing data to check the allocated routeing in the public transport model if these can be obtained in GIS format; the checks will be prioritised according to the likelihood of there being routeing problems (for example, infrequent stopping services are more likely to need amending as there are fewer routeing data points in the TransXChange data). We will also seek local, independent checks on the coded services from LCC as part of this review.

8.8.3 This will serve as a check both on the accuracy of the TransXChange data and the robustness of our conversion of the data to Emme format. If any discrepancies are observed, we will attempt to correct these in a generic way (thus hopefully addressing any other similar errors), and a new set of services will be selected for checking. This process will be repeated until the random set of services contains no significant errors.

8.8.4 For rail services, the coding will be checked by a second, independent, staff member, not involved in the original coding, who will compare the coded services with the timetables. All services in Leicestershire will be checked, along with a sample of strategic routes outside the county.

8.8.5 Assignment validation will begin with of selection of a sample of plausible origin to destination journeys, ideally with reference to the demand matrices to ensure the validation focuses on trips that are actually made in practice. These journeys will be assessed in the model with reference to both an online journey planner and to broad plausibility.

8.8.6 In addition to checking the validity of modelled routes, the analysis will ensure that any journeys for which usage of rail is at all practical are assigned to rail usage for the “rail passenger” user classes, thus allowing the demand model to allocate demand between bus and rail where appropriate.

The development of the base year networks for the public transport model contained within LLITM 2014 Base is detailed in Section 3 of the public transport Local Model Validation Report.

Section 9 – Demand and Trip-End Models

9.1 Overview

9.1.1 The LLITM 2014 Base demand model will forecast traveller demand based on three main inputs:

- the 2014 base year demand, developed from observed data, described in Section 5 and Section 7;
- trip-end data, supplied by the trip-end model (described in Section 9.3 below), derived from land-use data from the land-use model; and
- generalised costs of travel by each mode, produced by the highway and public transport supply models described in Section 6 and Section 8.

9.1.2 It will be an **incremental hierarchical logit model**, as described in TAG. By "incremental" we mean that it will forecast changes in base year demand derived from observed data based on changes in the cost of travel; this contrasts with an "absolute" model which forecasts demand from scratch based on the absolute costs of travel.

9.1.3 The demand model will be based primarily on two-legged "tours", linked outbound and returning trips, which will be processed as single entities. Thus outbound and returning travel responses will be linked, so for example, an intervention which penalises commuting traffic in the morning will also have an effect upon returning traffic in the evening. Freight demand will be modelled as single-leg trips.

9.2 Segmentation

9.2.1 The demand model will be more-heavily segmented than the supply models. Fifteen time-period pairs (where the pair represent the outbound and returning time periods), as shown in Table 5.1, will be used.

9.2.2 The demand model will consider six modes of travel:

- car;
- park-and-ride (car-bus mixed-mode);
- rail;
- bus and coach;
- active mode (walk and cycle); and
- freight: LGV and HGV.

9.2.3 It will model six person types, based on two categories of household car-availability (available or not available) and three categories of household income (banded into low, medium and high).

9.2.4 Finally, five travel purposes will be modelled, as follows:

- commuting;
- shopping;
- employers' business;
- education; and
- other.

9.2.5 Not all categories of segmentation will apply everywhere. Freight trips will be divided solely into Light Goods Vehicles (LGVs) and Heavy Goods Vehicles (HGVs), and not further segmented by purpose, mode or person type. Employers' business trips will not be segmented by income because they are already very price-insensitive. Car-availability will only be used in the mode-choice model, not in choosing a travellers' time period or destination.

9.3 Trip-End Model and Matrix Balancing

9.3.1 The trip-end model's purpose is to use land-use data, populations and employment by category, to estimate trips produced and attracted to each model zone by purpose, using suitable trip rates.

9.3.2 The LLITM 2014 Base trip-end model will be based on the DfT's National Trip-End Model (NTEM) software CTripEnd. This will be modified to work in the LLITM 2014 Base zoning system and to allow it to run automatically as part of the model suite. Land-use data will be taken from the LLITM 2014 Base land-use model in normal operation.

9.3.3 It will be necessary to estimate trip-ends for freight travel. CTripEnd only produces trip rates and trip-ends for personal travel, so this will require an additional process. Freight trip rates will be obtained from TRICS and applied to the employment data; this process will be incorporated into the trip-end model.

9.3.4 Explicit provision will be made in the trip-end model for East Midlands Airport. CTripEnd does not calculate demand separately for airports and consequently does not generally produce plausible trip forecasts for airport passengers and employment. A process will be put in place to ensure airport trip-ends are at an appropriate scale; they will remain functions of airport employment, but trip-rates specific to the airport will be used.

9.3.5 CTripEnd calculates trip-ends by outbound time period, by mode, by car-availability and by purpose. The outputs lack two required data for the demand model segmentation:

- income level; and
- returning time period (i.e. CTripEnd does not fully categorise trip-ends into tours).

9.3.6 Data will be extracted from CTripEnd at a 24-hour level, allowing the base year matrix proportions to split demand back to time periods, so the lack of a return time period does not concern us. The income band will be obtained by splitting the trip-ends with reference to the input land-use data (which do contain indicators of income based on socio-economic level, household size and employment status), taking account of differences in trip-rates by income. This will ensure that income and car-availability are forecast to vary sensibly over time.

9.3.7 Following derivation of trip-ends, “reference” demand will be produced for input to the demand models. The reference demand represents trips adjusted from the base year to account for increases in and changes in the makeup of population and employment, but not yet adjusted to account for any changes in the cost of travel.

9.3.8 Future year model trip-ends will be derived by calculating the forecast change in trip-ends from CTripEnd and applying to the trip-ends in the base year model (the LLITM 2014 Base trip-ends and CTripEnd trip-ends will not be the same due to local observed data that will be used in the model). Reference demand will be obtained by running a matrix balancing procedure on the base 2014 matrices using the future year model trip-ends. This consists of repeatedly factoring the matrix rows and columns until both match the required trip-ends.

9.3.9 New developments will require special treatment in deriving robust estimates of reference demand, since the base matrices will not necessarily contain reasonable initial distributions. Gravity models will be used for this purpose, to produce reasonable initial distributions of travel to and from developments based on travel times and distances and locations of nearby employment and population.

9.3.10 The trip-end model will be based on the most recent available release of NTEM and CTripEnd software at the start of project. It will be capable of forecasting up to 2051.

9.4 Generalised Cost

9.4.1 The demand models require forecasts of the “generalised cost” of travel to make adjustments to the patterns of travel. These costs include monetary costs, but also travel times and perceived penalties with appropriate weights varying by mode, purpose and person type. Generalised costs, despite the name, are usually presented in time units, minutes in the case of LLITM 2014 Base.

9.4.2 Generalised cost of travel will be built up as follows:

$$\mathrm{GenCost_{Highway}} = \mathrm{t_t} + \mathrm{t_s} + \left(\frac{\mathrm{M_F} + \mathrm{M_O} + \mathrm{M_T}}{\mathrm{V} * \mathrm{O}}\right) + \mathrm{f_a t_a}$$

$$\mathrm{GenCost}_{\mathrm{Bus/Rail}} = \mathrm{t_t} + \mathrm{t_h} + \mathrm{f_w t_w} + \mathrm{f_a t_a} + \left(\frac{\mathrm{M_T}}{\mathrm{V}}\right)$$

$$\mathrm{GenCost}_{\mathrm{Active}} = \mathrm{t_a}$$

$$\mathrm{GenCost}^{\mathrm{ij}}_{\mathrm{ParkRide}} = \mathrm{GenCost}^{\mathrm{ip}}_{\mathrm{Highway}} + \mathrm{GenCost}^{\mathrm{pj}}_{\mathrm{Bus}}$$

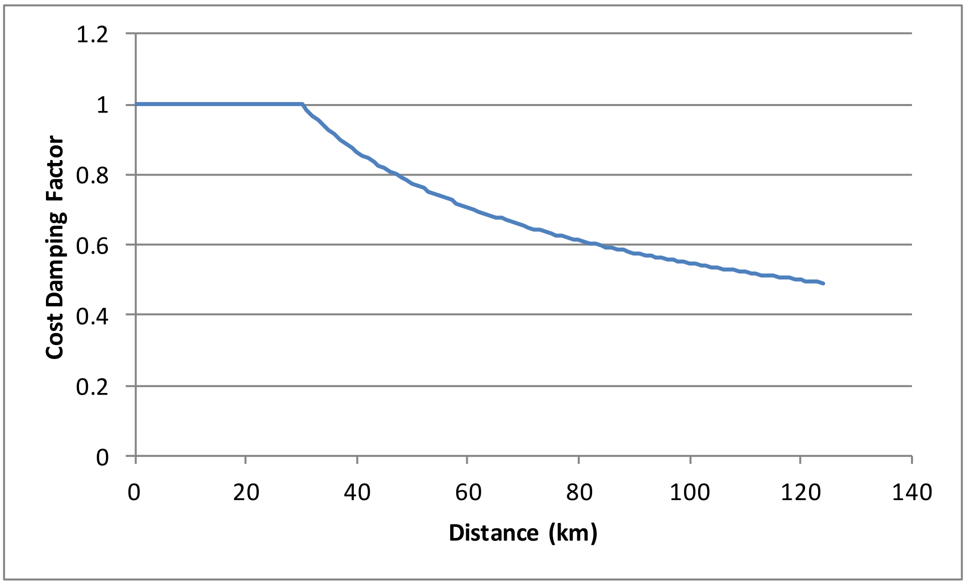
where:

- $M_F = p_F * l * i * \left(\frac{f_a}{v} + f_b + f_c v + f_d v^2\right)$ is the monetary cost of fuel, where:
    - P_F is the fuel price (pence per litre)
    - l is the assigned distance;
    - i is the fuel improvement factor, which reduces fuel consumption over time;
    - f_a, f_b, f_c and f_d are the fuel consumption parameters defined within TAG; and
    - v is the average assigned speed for the movement (in kph).
- $M_O = l * \left(n_a + \frac{n_b}{v}\right)$ is the monetary non-fuel costs, which is assumed to be non-zero for business and freight trips only, and n_a and n_b are non-fuel cost parameters from TAG;
- M_T is the monetary cost of all tolls and charges (including parking charges and public transport areas);
- t_t is the travel time, which is the timetables in-vehicle time for public transport;
- t_s is the search time for a parking space;
- f_a is the weighting factor for active mode legs of mixed mode trips, initially assumed to be 2;
- t_a is the walk time, derived approximately from a shortest path assignment of walk trips on the bus network with an assumed, fixed average walk speed;
- t_h is the delay time to (non-timetabled) highway congestion for bus and coach trips;
- f_w is the weighting applied to waiting time for public transport trips, initially assumed to be 2;
- t_w is the waiting time for public transport services;
- V is the value of time for a given demand segment (in pence per minute); and
- O is the average vehicle occupancy.

9.4.3 Generalised costs for long-distance trips will be reduced using “cost damping” procedures to reduce the sensitivity of long-distance trips to proportionally small changes in cost. This will be done following TAG advice. Two processes will be used; one to damp all components of generalised cost and one to increase values of time with distance (in effect to damp monetary components of cost only).

9.4.4 A function showing the factors that might be applied to generalised cost based on trip distance is shown below; this is illustrative only. The process will ensure that longer trips continue to experience larger costs; the damping process causes this relationship to be non-linear, but still increasing.

Figure 9.1: Illustrative Cost Damping Function



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9.5 Active Modes

9.5.1 The demand model will forecast and require generalised cost for active mode travel- that is walking and cycling trips. We do not propose to build validated walking and cycling models using detailed observed data, as such data do not currently exist and is difficult to collect and routeing choices for pedestrians are not well understood.

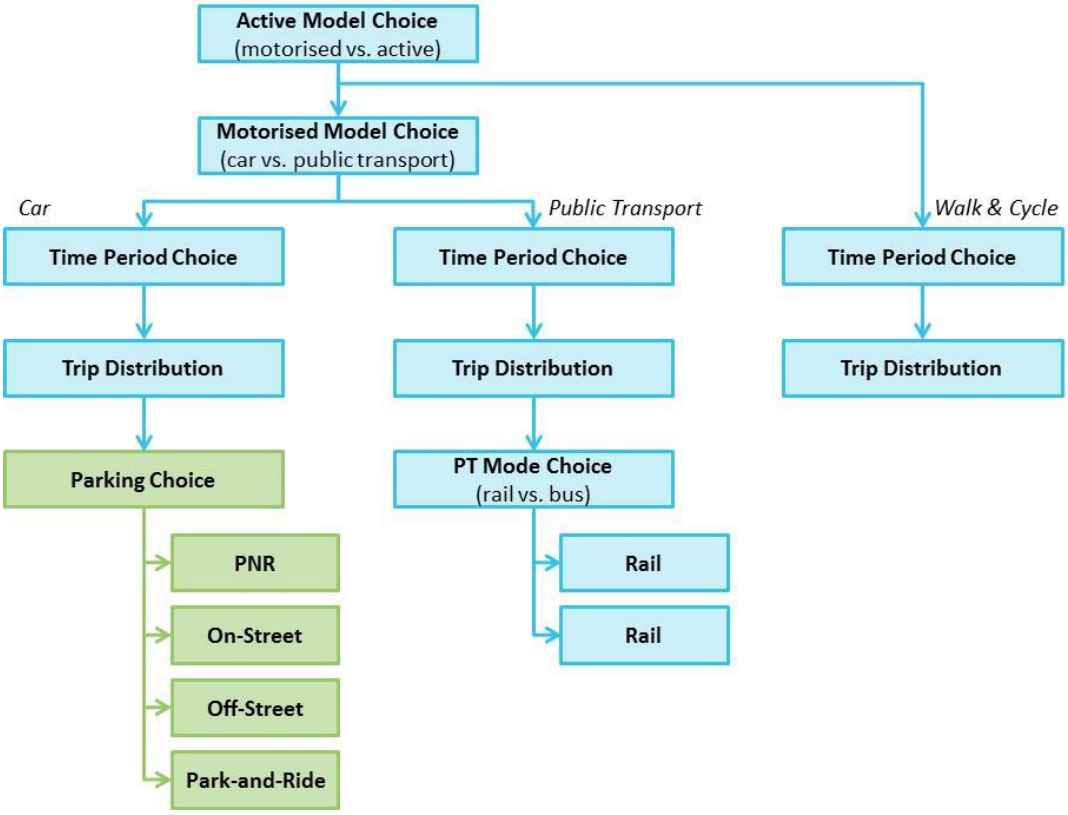
9.5.2 Accordingly, we will construct a simple walking model using the public transport assignment model with only the "walk" mode enabled. This will allow reasonable estimates of zone-to-zone walk times to be produced, which will be used to calculate generalised costs for active mode.

9.6 Choice Models

9.6.1 LLITM 2014 Base will be a hierarchical demand model, comprising several traveller choice models applied sequentially to transport demand. The hierarchy is illustrated in Figure 9.2. Two different forms of model will be used. Most choice models (blue) will be incremental, adjusting the reference matrices and proportions. The parking model will an absolute model (green), estimating proportions from scratch.

9.6.2 The scope of the parking model component is discussed in Section 9.7 below.

Figure 9.2: Indicative LLITM 2014 Base Demand Model Choice Structure



9.6.3 No-car available demand will not be permitted to choose a car mode, so the motorised mode choice for such persons will allocate all demand to public transport. Freight demand will use a significantly simplified structure with only time period choice and trip distribution.

9.6.4 All choice models will be logit-based, functions of the form:

$$\widehat{D}_{pmtui*} = \widehat{D}_{pm**i*}\frac{D_{pmtui*}e^{-\lambda_t\Delta C_{pmtui*}}}{\sum_{tu}\left(D_{pmtui*}e^{-\lambda_t\Delta C_{pmtui*}}\right)}$$

9.6.5 The example above is a model forecasting demand D for time period choice, allocating input demand ($pm ** i *$) among outbound and return time periods t and u based on the changes in generalised cost (ΔC). The lambda (λ) values are model sensitivities, derived from the LLITM household survey to represent as well as possible travellers' actual sensitivity to cost changes.

9.6.6 The mode choice models allocate demand among two options each; the time period choice models among fifteen time period pairs, and the distribution models among as many attraction zones as there are in the model zone system.

9.6.7 The models will make use of "composite costs", a form of average over options. For example, the time period choice model will use as inputs generalised cost changes by production zone, aggregated over all attraction zones. The expressions for calculating these (simple demand-weighted averages would not be correct), are of the form:

$$\Delta C_{pmtui*} = log_e\left(\frac{\sum_j D_{pmtuij}e^{-\lambda_d\Delta C_{ptmuij}}}{\sum_j D_{pmtuij}}\right)$$

9.6.8 This expression calculates "average" cost changes ΔC over all attraction zones j. The cost changes are weighted by demand D, but are not a simple weighted average.

9.7 Parking Model

9.7.1 LLITM 2014 Base will represent parking costs in major urban areas, namely the centres of Leicester and Loughborough. As part of this process, it will contain a choice model to divide travellers into a few types of parking, including Private Non-Residential (PNR), on-street parking, off-street parking and park-and-ride (P&R).

9.7.2 Park-and-ride travel will be modelled in a slightly more complex way, so that a park-and-ride tour in the demand model will generate both two trips in the highway assignment model (between the trip production and the park-and-ride site), and two trips in the public transport assignment model (between the park-and-ride site and the trip attraction). Similarly the generalised cost for park-and-ride travel will be an appropriate combination of the highway and public transport cost.

9.8 Iteration and Convergence

9.8.1 The highway and public transport supply models and the demand model will be run in sequence iteratively until LLITM 2014 Base is deemed to have converged (discussed below). The costs from the supply models and functions will be fed into the demand calculations, with the resulting demand used to recalculate the costs in the supply models. This process continues until model convergence has been achieved.

9.8.2 Demand smoothing will be used to ensure that LLITM 2014 Base and the network models reach a convergent state. Demand matrices are assigned in the supply models, which generate costs to be used in the demand model. Following choice model calculations, new demand is calculated, from which the **%Gap convergence** measure is calculated prior to the averaging process which is then applied to the demand matrices. These averaged demand matrices are reassigned in the supply models in the next iteration of the overall LLITM suite.

9.8.3 The demand smoothing will use the following function, a variation of the method of successive averages (MSA) algorithm that we have used in existing demand models:

$$\widehat{D}_{X+1} = \frac{2D_X}{X-1} + \frac{(X-3)\widehat{D}_X}{X-1}$$

where:

- X is the current iteration of LLITM;
- $\widehat{D}_X$ is the averaged demand matrix used as input to the supply models in iteration X.
- D_X is the demand matrix produced by the demand model in iteration X.

9.8.4 The measure of convergence of the demand and supply models is the demand-supply gap, as defined in TAG Unit M2. The %Gap is calculated as follows:

$$\%Gap = \frac{\sum_{pmtuij} C\left(D_{pmtuij}\right) * \left|D_{pmtuij} - D\left(C\left(D_{pmtuij}\right)\right)\right| * 100}{\sum_{pmtuij} C\left(D_{pmtuij}\right) * D_{pmtuij}}$$

where:

- D_{pmtuij} is the production-attraction demand;
- $C(D_{pmtuij})$ is the production-attraction generalised cost generated by the assignment of D_{pmtuij} on the network;
- $D(C(D_{pmtuij}))$ is the production-attraction demand generated by the demand model in response to the cost changes created from $C(D_{pmtuij})$; and
- p is the demand segment (purpose and person type), m is the mode, t and u are the outbound and return time periods, and i and j are the production and attraction zones.

9.8.5 The %Gap will be calculated across all of the person demand segments, as well as LGV and HGV, for each of the time periods and for all modes. TAG guidance suggests that a convergence gap of 0.1 is should be the target value. The value that is adopted will be influenced by the convergence of the SATURN highway models, but should be around this level.

9.8.6 We will evaluate the convergence gap for a subset of the demand matrix. Previous experience suggests that it is quite common for the external demand, which will constitute the vast majority of total demand, the matrix representing the whole country as it does, to stabilise very quickly, leading to a very low convergence gap, while the demand in the modelled area (which is what is really of concern) has not reached a reasonable level of convergence. We have previously used demand with a production end in the internal area as a sub-matrix for evaluation of convergence, and will use this in LLITM 2014 Base.

9.9 Calibration and Realism Testing

9.9.1 We will calibrate LLITM 2014 Base following TAG, such that its response to cost changes is at an acceptable and reasonable level. In particular, we will aim to achieve the following:

- an elasticity of car vehicle kilometres with respect to car fuel cost of around -0.3;
- an elasticity of car trips with respect to car journey time of more than -2, ideally much closer to 0 than -2;
- an elasticity of public transport trips with respect to fare of -0.2 to -0.9; and
- an elasticity of parking usage with respect to charges of the order of -0.2 to -0.6.

9.9.2 All of these tests will be conducted in the base year of 2014. Following TAG advice, the car journey time elasticity test will be carried out using a single demand-supply iteration; all other tests will be iterated to convergence; this is consistent with TAG.

9.9.3 In addition to the required TAG realism tests on the model's sensitivity to changes in cost, we will also undertake a series of sensitivity/demonstration tests of the model in forecasting mode. These demonstration tests will review the model's responses to changes in land-use, highway and public transport assumptions in forecast years. These demonstration tests are discussed in Section 11.2.

The implementation and calibration of the variable demand model contained within LLITM 2014 Base is detailed within the '*NEMMDR FBC - Demand Model Development Report*'.

Section 10 – Land-Use Model

10.1 Context

10.1.1 The LLITM 2014 Base land-use model will forecast population and employment by model zone and by household and employment type. It will be based on the existing land-use model used in the existing version of LLITM.

10.1.2 In preparing a set of model enhancements we are conscious that the model should be suitable for use and that primarily it must meet both LCC and Leicester City Council's transportation planning needs. This includes the need to understand:

- the impacts of land-use developments upon the immediate transport networks; and
- the impacts of development strategies (for example, the LDF's Core Strategies) upon the wider transport network.

10.1.3 We note that the Department for Transport has recently said that it is considering an increased use of Land-Use and Transport Interaction models (LUTI models). We will continue to monitor Central Government guidance and identify any changes that are required to comply with DfT advice.

10.1.4 In addition we believe that the model is a powerful tool for policy appraisal and that it has wider application then just transport-related work. We recognise that governance structures are currently evolving and that things may change over the course of the next 5-6 years. However we believe there are several potential applications of the model, either as a free standing land-use model or as a LUTI model. For example:

- to support the policy and strategy development within the Local Enterprise Partnership;
- to inform prioritisation of infrastructure investment across land-use, regeneration, transport and other public-sector funded infrastructure; and
- to provide forecasts of housing need and employment land need to inform the land-use planning process.

10.2 Enhancements to the LLLUM Database

10.2.1 The existing LLITM is largely based upon 2001 Census data and assumptions on the change that took place between that Census and the model's 2008 Base Year. The 2013 update identified incompatibilities between forecasts for 2011, based upon that base year database, and the initial 2011 Census results. Specifically the mix of household types that were input, into the base year database was incompatible with the 2011 Census household mix.

10.2.2 We will undertake an update to the base year database, which will:

- take account of recently published data (including the 2011 Census); and
- create a new base year of 2014.

10.2.3 In effect there will be a two-stage process. We will first create a 2011 base year database. Then we will run the model forward to 2014 taking account of development 2011-2014, changes in employment, population etc. to create a 2014 database. This will be a similar process to that undertaken for the original LLITM model where a 2001 base was first created and then this was used as the base for a model run through to 2008 and the creation of a new base year.

10.2.4 Table 10.1 sets out the main tasks we have identified that are required to update the database.

Table 10.1: Updates to LLITM Land-use Model Base Year Data

Database	Description	Task
Activity	Information upon both households and employment by type, at zone level	Update this information drawing upon the 2011 Census, BRES and other published sources for the period 2011-2014 We would propose to review and revise the household activities. The current disaggregation of households is based upon 1981 definitions. We would propose to change these to ensure consistency with the disaggregation used in the 2011 Census Census tables. We would also look to include additional categories of activity to represent student households and population not in households. Student households are not explicitly modelled within LLITM currently (they are included within other household categories). Non-resident population is not currently modelled within LLITM but are clearly significant within parts of the County We would explore options to disaggregate the employment activities so that they are consistent with LEP priority sectors.
Floorspace	Information on the amount of floorspace by land-use type, including amount of floorspace, vacancy rates and rents, by zone	Update this information drawing upon the 2011 Census, the Council Tax Database, Valuation Office Data and other sources
Car Ownership	Information on car ownership by household type by zone	Update this information drawing upon the 2011 Census
Distance	Distance between zones	Recalculation of distance matrix, if a new zoning system is introduced
Environmental	Information on the zone-level environment	Range of sources can be used including extracts from the Index of Multiple Deprivation and Open Space database
Travel to Work database	Information on zone-to-zone flows	The 2011 Census travel to work data are unlikely to be made available until 2015 or later. In the short-term a TTW database based upon the 2001 Census will be necessary. Once the 2011 data are available then this matrix will need to be reviewed and a revised version implemented if appropriate

10.2.5 The current definition of DELTA areas is based upon the 2001 Travel to Work Areas. These in turn are based upon the 2001 Census travel to work analysis. The timetable for the release of 2011 Census travel to work data, and any subsequent review of Travel to Work Areas means that there are not likely to be any 'final' revisions to the TTWAs within the timescale envisaged for this model development. We do not therefore propose to review DELTA areas at this point.

10.2.6 It is recommended that as and when new TTWAs are published that a review be undertaken of the changes and their likely impact were they to form the basis of new DELTA areas, within the LLITM 2014 Base land-use model.

10.2.7 We would seek agreement with LCC, at the outset, as to the sources of data that will be used for the updating of the LLITM land-use base year database. If local sources are identified by LCC then these should be made available at the outset of this work.

10.2.8 Within the work programme we would differentiate between:

- the updating of the base year database with information that is also required as input to the transport model development (for example, information on the numbers of households, population and employment within each zone); and
- the updating of the base year database with information that is required internally to the land-use model (for example, land-use, car ownership, the DELTA travel to work matrix).

10.3 Planning Inputs

10.3.1 The planning policy inputs inform the scale and distribution of future modelled development within the land-use model. With the current model version, development may only take place in zones where there are planning policy inputs. Further the total development cannot exceed the quantity input within the planning policy inputs.

10.3.2 The planning policy inputs within the current version of the model are based upon:

- the information captured in 2009/10 as part of the development of the existing land-use model; and
- a partial refresh of the data in 2012 that was limited to the main development sites identified within the emerging and approved LDFs.

10.3.3 We recommend a regular update of the planning policy inputs at 18-24 month intervals. This ensures that model application continues to be based upon the latest understanding of future development and reflects both the policies and other strategies of the local planning authorities across the County, and the anticipated development in those areas where there is high pressure for development and new applications are approved.

10.3.4 Two of the model enhancements described in Section 10.5 (modelling development viability and modelling of redevelopment and intensification) would require additional data to be collected as part of the collection of planning policy inputs. The specification of what information will be required will be drawn up at the outset (following agreement of what, if any, enhancements are to be implemented).

10.3.5 Within the work programme we would differentiate between:

- information on completions for the period 2011 to 2014; and
- information on development for the period post 2014.

10.3.6 The first of these will be required at an early stage in the work programme as this will inform the process of moving from a 2011 base year database (based upon 2011 Census data) to a 2014 base year database (to be used in the LLITM 2014 Base model). The latter will be required at a later stage of the work programme.

10.4 Scenarios

10.4.1 The model's demographic and economic scenarios determine:

- for population and households the 'top-down' level of growth across the Modelled Area; and
- for the economy the broad level of growth within each DELTA area. They currently are based upon NTEM v6.2.

The land-use model scenario will be updated as and when updated NTEM forecasts are issued, to ensure that the model continues to be compliant with TAG.

10.4.2 We also recommend an alternative scenario, based upon LEP and / or Planning Authority forecasts. This would enable the model to be used to inform the LEP or Planning Authorities strategy development in a way that was consistent with their assumptions on future growth.

10.5 Model Functionality and Calibration

10.5.1 In this section we consider first the zones and forecasting time horizon applied within LLITM 2014 Base. Then we consider the introduction of functionality that we believe would be beneficial for LLITM 2014

Base (in meeting the user needs identified in Section 10.2 above). Finally, we consider recalibration of the model.

10.5.2 A review of the zones will be undertaken (see Section 2.4). Any significant change will require:

- the creation of a new base year database (as described above); and
- the defining of a new set of DELTA areas and some recalculation of the area databases.

10.5.3 The forecast time horizon for the land-use model will be extended to 2051.

10.5.4 As with the existing land-use model, the model run time for the land-use model is relatively short; it is the transport model that requires heavy processing resource. An extension of the forecast horizon would extend run times for the full LUTI model, but it would continue to be the case that in most applications, the model would only be run for five or ten years post the modelled intervention in order to gauge the land-use impacts.

10.5.5 Table 10.2 summarises the key improvements to functionality that are anticipated.

Table 10.2: Updates to LLITM Land-use Model Functionality

Functionality	Description
Modelling of development viability	This enhancement introduces a viability test into the development process. This takes account of the development costs associated with site preparation and relates it to the returns to the developer. Sites with high preparation costs are unlikely to come forward. **Application**: the modelling of regeneration schemes. **Data requirements**: additional data required on site preparation costs.
Modelling of redevelopment and intensification	This enhancement allows underused floorspace to be redeveloped for alternative use (consistent with planning policy) and floorspace in areas of high demand to be redeveloped at a higher level of intensity. It permits the better modelling of the re-cycling of the built environment. It is particularly useful for ensuring that the model continues to model development (consistent with planning policy) beyond the end of the LDF plan period. **Data requirements:** additional data on local planning policy.
Modelling of Land as additional to floorspace	This enhancement relates to the development model. It would permit quantities of land to be input, within the planning inputs and for the model to determine the appropriate use and density of development. This would overcome the problem currently identified that many employment allocations are described in terms of hectares of land rather than floorspace of office, warehouse or industrial land (or specific use class designations). The model would select a preferred land-use based upon demand, and constrained to planning policy on what would be permitted on a site. It would also select a density of development based upon demand.
Location Modelling: distance deterrence	Currently the residential location model applies a distance deterrence function to ensure households may move cross DELTA area boundary. This enhancement would introduce a similar functionality for employment related land-uses. This would ensure that the model does not underestimate some short distance moves, for example, from Leicester to some of the adjacent Areas, when new employment floorspace is provided close to the Leicester Area but within the neighbouring DELTA areas
Disaggregation of generalised costs	A straightforward implementation that would split the Generalised Cost file into several files. Currently the file is of a size that is too large to open in many text editors. A series of smaller files would allow easier interrogation of the generalised costs and identification of problems as required.
Freight Modelling- what could be done with existing LLITM	DSC's PN8 set out a proposal for Freight modelling. This would base the flows of Freight upon LLLUM employment forecasts. Implementation of this would largely be within the transport model
Freight Modelling – what could be done with enhanced version	A more sophisticated modelling could be scoped. This might include: a) Application of elements of DSC's Regional Economic Model within LLLUM. This might include the modelling of goods and the basing of freight flows on goods rather than employment b) Better modelling of some of the large Freight generators (for example, the Distribution Centres) where activity may be driven by demand outside the LLUM Modelled Area (i.e. movement of goods from Felixstowe to East Midlands, then transhipment to HGVs for movement elsewhere).
Model Outputs	A review of the model applications over the past three years has identified a number of model outputs that are frequently requested by clients. We would

Functionality	Description
	look to either standardise the outputs or refine EASE in order to provide this information.

10.6 Calibration and Model Review

10.6.1 The development of a new database will require a recalibration of the model. Previously the recalibration has been based upon a number of different sources. These include:

- published research where it is specific to the processes modelled within DELTA;
- the constraining of the model to generate outputs that are consistent with published research;
- local surveys; and
- professional judgement.

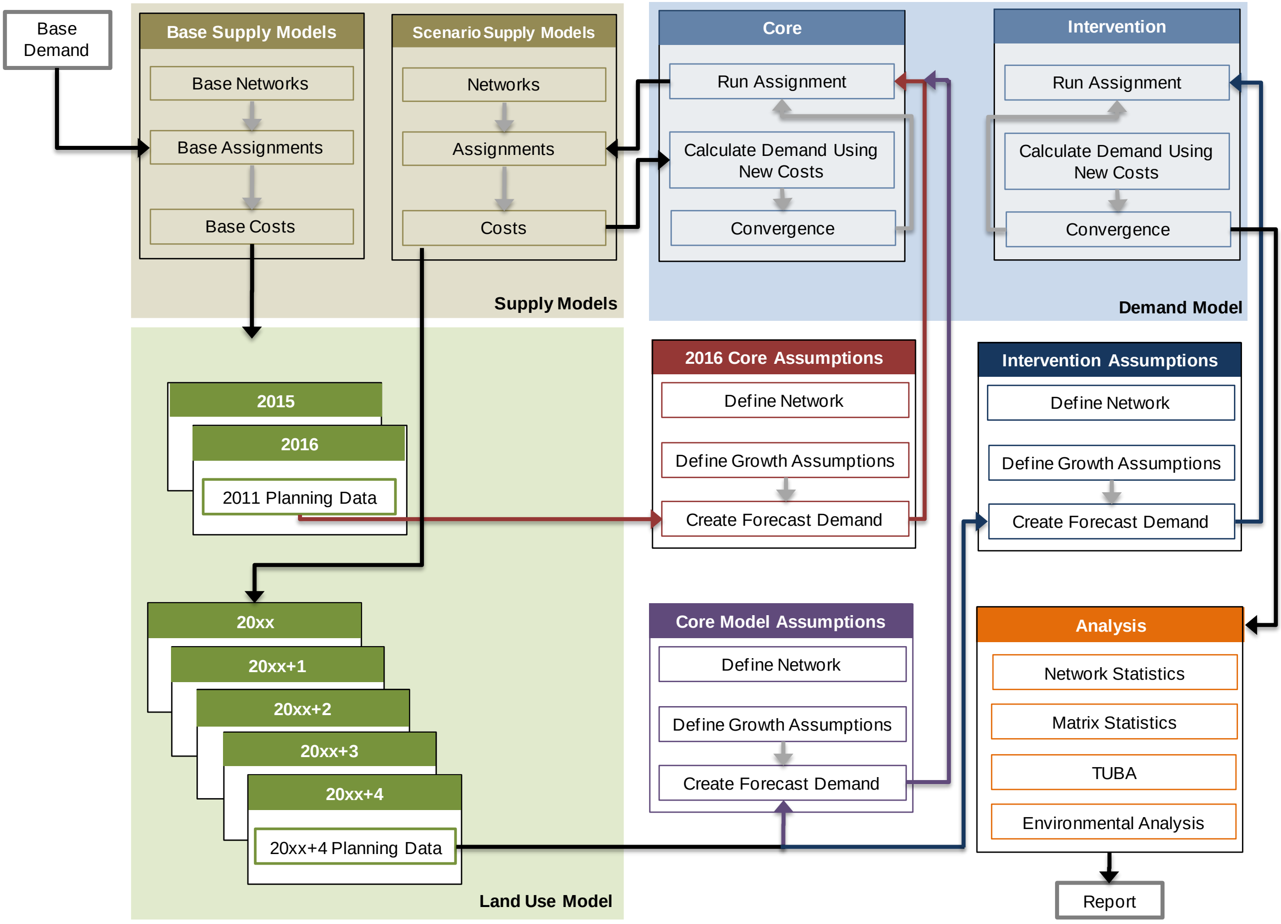
10.6.2 The interface between the land-use model and the transport model will require review following the change to the zone system.

Section 11 – Forecasting, Analysis and Handover

11.1 Forecasting Process

11.1.1 The operation of the LLITM 2014 Base suite for a forecast scenario is illustrated graphically below. The land-use-transport interaction will be modelled on a “time-delay” basis.

Figure 11.1: LLITM Forecasting Process



11.1.2 The base year 2014 transport model will be run to generate “base costs”. These will be supplied to the land-use model which will then run for 2015 and 2016, forecasting land-use planning data, which will be supplied to the 2016 transport model to estimate demand. The 2016 transport model will then be run, supplying generalised costs back to the land-use model to run land-use forecasts for 2017, 2018, 2019, 2020 and 2021, and the process repeated from 2021 to 2026, and in five year blocks thereafter to 2051.

11.1.3 In this way a transport model is run for every five years, while the land-use model is run between these transport model runs for every year. The five-yearly interaction represents the inevitable delay in response of population and employment locations in reacting to transport infrastructure changes.

11.1.4 Within the transport model, the trip-end model will be used to create forecast reference demand, the assignments will be run in the highway and public transport models, these will create costs which will be supplied to the demand model to calculate new demand and the demand supply loop will be iterated to convergence.

11.2 Demonstration Testing

11.2.1 As part of the model development, AECOM and DSC will carry out a set of tests to demonstrate that the model operates appropriately and forecasts plausible and realistic results. This will include the preparation of a series of future year core model runs, containing a "most likely" future scenario.

11.2.2 AECOM and LCC will agree a list of "schemes" to be included in the core model runs. These will include highway, public transport, residential, employment, active mode, "Smarter Choices" and parking interventions, and will include both new infrastructure and developments and removal of the same (for example, the cancelling of a bus service or closure of a parking site). This scheme list will then form a useful starting point for modelling work in LLITM 2014 Base, although it is expected that most model applications will require minor changes to scheme lists.

11.2.3 Public transport and highway networks, parking and active-mode inputs, and planning data will be prepared for each model year, including the appropriate schemes by year. The core models will be run through to the year 2051, the last model year that LLITM 2014 Base will forecast. This will involve eight transport model years.

11.2.4 The process will include an allowance for the calibration of "Smarter Choices" schemes; following TAG guidance these require iterative model runs to ensure the modelled response is appropriate.

11.3 Model Documentation

11.3.1 The following final project reports will be prepared, as follows:

- a Data Collection Report, outlining the data collected for the LLITM 2014 Base model development and the checks made to verify the data;
- a Highway Local Model Validation Report (LMVR), outlining the construction of the highway model and the validation and calibration performance;
- a Public Transport Local Model Validation Report (LMVR), outlining the construction of the public transport model and the validation and calibration performance;
- a Demand Model Development Report, outlining the construction of the demand and trip-end models and the realism testing and calibration performance;
- a Forecasting Report, detailing forecasting assumptions, core scheme list and summarising the core model forecasts;
- a Land-use Model Development Report;
- a Land-use Model Demonstration Report;
- a Land-use Model Forecasting Report;
- a Land-use Model Enhancements Demonstration Report;
- a LLITM 2014 Base User Guide, explaining the operation of the LLITM 2014 Base suite in practice; and
- a DELTA User Guide.

11.3.2 In addition to these reports, technical notes, including coding manuals for the highway and public transport models, will be produced starting early in the project programme to specify tasks in detail, as discussed in Section 2.2.

11.4 Environmental Analysis Suite (EASE)

11.4.1 The LLITM model included a tool designed to calculate environmental statistics, including carbon emissions, air quality emissions, road accidents, and noise, and to display these, along with results from the assignment and land-use models, in GIS software.

11.4.2 This EASE suite or a similar tool will be retained for LLITM 2014 Base. This will use the Emissions Factor Toolkit (EFT), published by Defra, to calculate carbon air quality emissions, and will estimate link-based noise and accidents following TAG and CoBA accident tables. The most recent available version of the EFT will be used. These and other useful link-based quantities, such as traffic flows, will be converted to GIS format to facilitate analysis.

11.4.3 The DfT now has an Excel (VBA)-based tool to assess accident savings, called CoBA-LT, which supersedes CoBA for this purpose. EASE in the existing LLITM contains an accident analysis module; we will replace this with CoBA-LT, seeking to integrate CoBA-LT within EASE.

11.5 Handover

11.5.1 The entire LLITM 2014 Base suite, including all data and processes, will be handed over to LCC, along with the core networks and inputs prepared for the demonstration testing. A user guide will be provided to inform users how to use the suite. AECOM will provide a day's handover session with suitable LCC staff, explaining the operation of the tool and its functionality.

A Forecasting Report has been produced based on the 'Core Scenario' assumptions regarding land-use changes and transport infrastructure schemes collated as part of the development of the LLITM 2014 suite. This report details the forecast assumptions adopted and summarises the results of the model forecasts for this 'Core Scenario'.

Section 12 – Application of Model for NEMMDR

12.1 Application of Specified Model for Assessment

12.1.1 LLITM 2014 Base has been specified to be able to represent a number of different interventions (land-use and infrastructure) and to assess the forecast impact of these interventions across Leicestershire. This includes responses within the land-use model to changes in travel costs, relocating residential and employment development, and responses within the demand model to changes in travel costs which influence mode choice, time of day choice and trip distribution.

12.1.2 The model has been specified with significant detail, both in terms of zoning and network detail, within urban areas, and market towns inside Leicestershire and also covers, albeit in a lower level of detail, areas in the immediate vicinity of Leicestershire.

12.1.3 Based on previous assessments of the proposed scheme, it is expected that the specified model contains the required level of detail and model responses to represent the expected impacts of the proposed NEMMDR.

12.1.4 This is subject to the results contained in the LLITM 2014 Base highway and public transport Local Model Validation Reports, reported by areas of the County, alongside a detailed assessment of the performance of the developed model within the vicinity of the scheme.

12.1.5 This review should detail the performance of the base year highway model against observed counts and journey times, and also review the developed base year matrices against any independent data sources for demand produced by, attracted to, or travelling through Melton Mowbray.

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LLITM 2014 Base

North & East Melton Mowbray Distributor Road
Full Business Case

Data Collection Report

Leicestershire County Council

April 2022

Quality information

Prepared by	Checked by	Approved by
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Revision History

Revision	Revision date	Details	Authorised	Name	Position
v1	2017-06-07	v1 for issue	Yes	Mark Dazeley	Regional Director
v2	2017-09-29	Addressing minor comments	Yes	Mark Dazeley	Regional Director
v3	2017-12-12	Minor updates following DfT comments	Yes	Mark Dazeley	Regional Director
v4	2022-04-21	Cosmetic update for NEMMDR FBC	Yes	Mark Dazeley	Regional Director

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1. Overview

1.1 Context

1.1.1 The Leicester and Leicestershire Integrated Transport Model (LLITM) was commissioned by Leicestershire County Council (LCC), and is a suite of models containing highway and public transport assignment models; a demand model, which includes a parking model of Leicester City and Loughborough town centre; and a land-use model.

1.1.2 The LLITM was originally developed over the course of 2009 and 2010, with the model launched during May 2011. Since that time the model has been used for numerous applications, during which, a number of local recalibration exercises have taken place to improve the highway model performance in specific areas (including Loughborough, Lubbesthorpe and Hinckley).

1.1.3 In light of these local recalibrations, a programme of short-term maintenance work was commissioned by LCC to build on the lessons learnt from these local recalibration exercises, completing in 2013. The main focus of this short-term maintenance work with regards to the highway model was a comprehensive review of the simulation network coding within Leicestershire in reference to updated coding guidelines, which has been reviewed and agreed with Highways England’s [now National Highways’] TAME [now TPG], and a review of the observed count and journey time datasets used in the validation of the model.

1.1.4 Subsequent to this short-term maintenance work, LCC has commissioned a new LLITM 2014 Base, drawing on and augmenting the highway network coding used in the previous version of LLITM, extending the coverage of the detailed model area, creating demand matrices to include 2011 Census data[1], incorporating significant new observed data (highway RSIs and counts, and public transport counts) and making best use of electronic ticketing and mobile network data. The new NTEM 7.2 has also been incorporated in the LLITM model.

1.1.5 This report details the data collected for the development of the new LLITM 2014 Base model.

1.2 Report Structure

1.2.1 This report sets out the data collected for the development of LLITM 2014 Base; its source, scope and checks and verification applied to the data. The structure of this report is as follows:

- **Chapter 2 - Traffic Count Data**, discussing the sources of data, how they were processed and checked, and how they were assembled into cordons and screenlines for use in the SATURN highway assignment model.
- **Chapter 3 - Roadside Interview Data**, discussing the sources of data, how they were processed, checked and cleaned.
- **Chapter 4 -** , discussing how the data were specified and verified.
- **Chapter 5 - Highway Journey Time Data**, discussing how Trafficmaster and HATRIS journey time data were processed, checked and merged into a validation dataset.
- **Chapter 6 - Bus Electronic Ticket Machine Data**, discussing the scope of data received and the checks made.

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[1] At the time of this model update the 2011 Census data had not been released at the required level of detail for inclusion within LLITM.

- **Chapter 7 - Rail LENNON Ticket Data**, discussing the scope of data received and the checks made.
- **Chapter 8 - Bus Passenger Interview Data**, discussing the scope of data received and the checks made.
- **Chapter 9 - Public Transport Count Data**, discussing the scope of data received and the checks made.
- **Chapter 10 - Public Transport Service Data (TNDS)**, discussing the scope of data received and the checks made.

2. Traffic Count Data

2.1 Introduction

2.1.1 This chapter discusses the traffic counts collected for use in the calibration and validation of the LLITM 2014 Base highway model. The observed count dataset has been derived from:

- permanent count sites from 2012 to 2015;
- temporary counts (most collected specifically for the development of LLITM 2014 Base in neutral months in 2014/2015); and
- TRADS data from Highways England's [now National Highways'] HATRIS (now WebTRIS) online database.

2.1.2 An overarching aim from the outset was to collate a count database sufficient in size to:

- be based entirely on automatic traffic counts (ATCs), rather than relying in part on less reliable manual classified counts (MCCs);
- to make best use of existing permanent and temporary count data; and
- to be extensive enough to support both calibration and independent validation datasets in Leicester City and in each district in Leicestershire, and to provide a county cordon, intercepting movements across the Leicestershire boundary.

2.1.3 The count data processing focussed on producing a consolidated database containing count data that are representative of Monday to Thursday in April/May/June 2014, excluding weeks with bank holidays. These days over the three-month period are considered to be the 'neutral month' for the LLITM 2014 Base highway model.

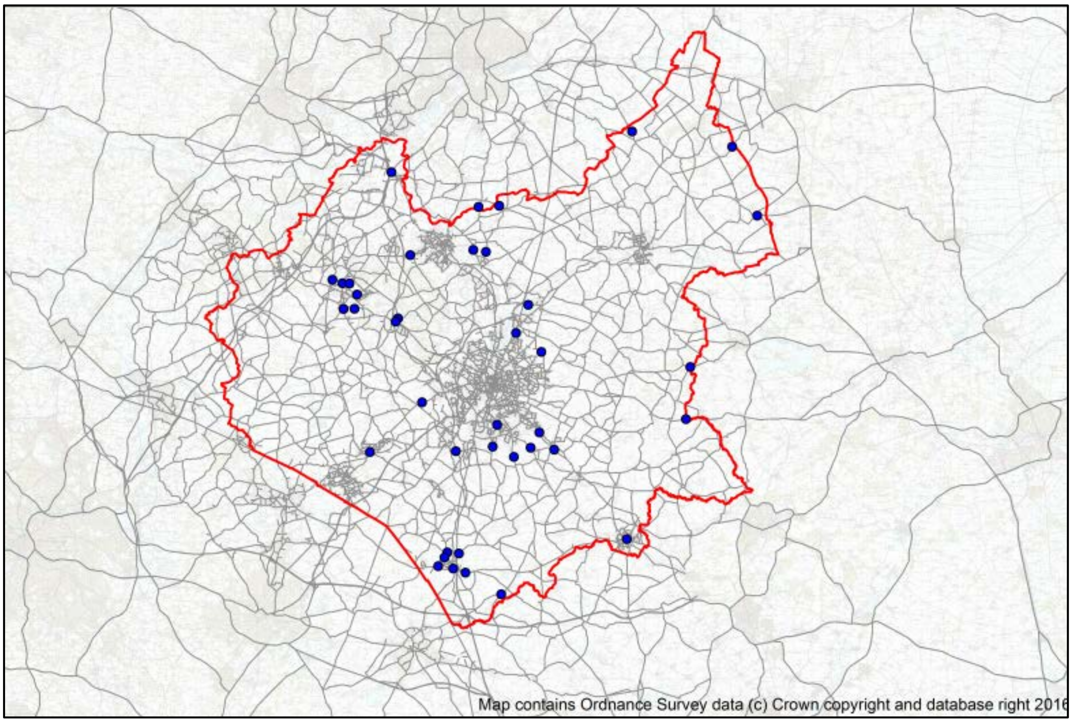
2.2 Permanent Traffic Counts

2.2.1 As part of LCC's continuous traffic monitoring there are 108 permanent traffic counts throughout Leicester and Leicestershire. These were made available to AECOM through LCC's access to the C2 Cloud website. Although 108 permanent counts exist, only 39 were used in the calibration and validation screenlines and cordons for the LLITM 2014 Base highway model (discarded sites were not consistent with the cordon and screenline definitions). These 39 site locations are shown in Figure 2.1.

2.2.2 Due to their location, these permanent counts could not be organised into distinct screenlines and cordons, and so they have formed LLITM 2014 Base screenlines and cordons alongside RSI counts and other temporary counts.

2.2.3 Permanent counts were also used to derive temporal and seasonal adjustment factors, discussed in Section 2.7. This allowed the adjustment and use of count data not collected in April/May/June 2014.

Figure 2.1: Permanent Traffic Counts used in LLITM 2014 Base



2.3 Temporary Traffic Counts | Roadside Interview Sites

2.3.1 A significant roadside interview (RSI) programme was undertaken for the development of LLITM 2014 Base, with surveys commissioned at 106 locations. At each of these RSI locations, in addition to the interview surveys (discussed in Chapter 3) the following data were collected:

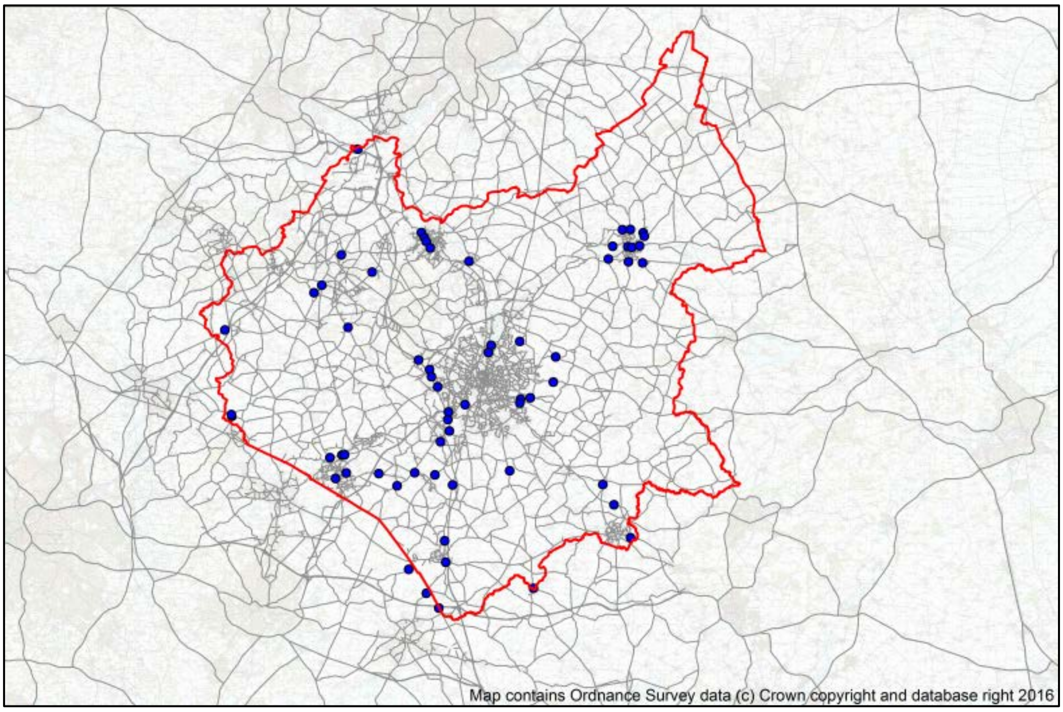
- a two-week automatic traffic count (ATC), one week prior to the interview survey and one week after; and
- a one-day manual classified count (MCC) undertaken on the day of the interview survey, used to provide a vehicle split between car, LGV and HGV, to be applied to the ATC data.

2.3.2 These RSI locations were defined to form a series of screenlines and cordons within Leicester and Leicestershire. There were some holes in these screenlines either because the roads were too minor or in a few instances where the RSI survey was cancelled. For these locations, ATCs were commissioned.

2.3.3 There were 62 counts associated with RSIs that were instead used in the final calibration and validation screenlines and cordons LLITM 2014 Base highway model. These are shown in Figure 2.2.

2.3.4 These RSI locations include cordons for movements entering and leaving Leicester City and the market towns. In addition, there are some counts that are part of larger screenlines that capture movements between urban centres, such as can be seen between Leicester and South Leicestershire, or intra urban movements, as can be seen in Loughborough. Some RSIs that are used on the county boundary can also be seen.

Figure 2.2: Counts at RSI Site Locations used in LLITM 2014 Base Count Dataset



2.4 Temporary Traffic Counts | Other Locations

2.4.1 TAG states that in building highway models there should be two distinct count datasets. The first of these is a count dataset to be used within the calibration of the model (i.e. within matrix estimation) to adjust the trip movements. The second dataset would then be independent of the calibration dataset, therefore providing independent validation of the modelled flows.

2.4.2 As there were limited permanent count data on the defined cordons and screenlines (shown in Figure 2.1) and also limited counts available at RSI locations (shown in Figure 2.2), a substantial number of temporary counts were required to provide a suitable dataset, one which would provide calibration and independent validation data in Leicester City and in each district in Leicestershire.

2.4.3 TAG also states that these calibration and validation datasets should be primarily constructed from ATC data, given the additional variability and uncertainty associated with one-day MCC data. As the ATC data for RSIs and the LCC permanent counts did not adequately cover the locations required to develop the validation and calibration count datasets for cordons and screenlines in each district, further temporary ATC surveys were required to fill these gaps.

2.4.4 Before commissioning further ATC surveys, the temporary data already available on LCC's C2 database were reviewed for suitability in terms of:

- location – checking that the temporary count for a screenline/cordon was not separated from the screenline/cordon by significant land-use or a highway junction;
- age – checking that the count was less than four years old and not anywhere that has known recent network changes or developments that might result in error when applying temporal adjustments to the count; and
- data quality – checking that there were two weeks of consistent data without non-neutral days such as bank holidays or school holidays.

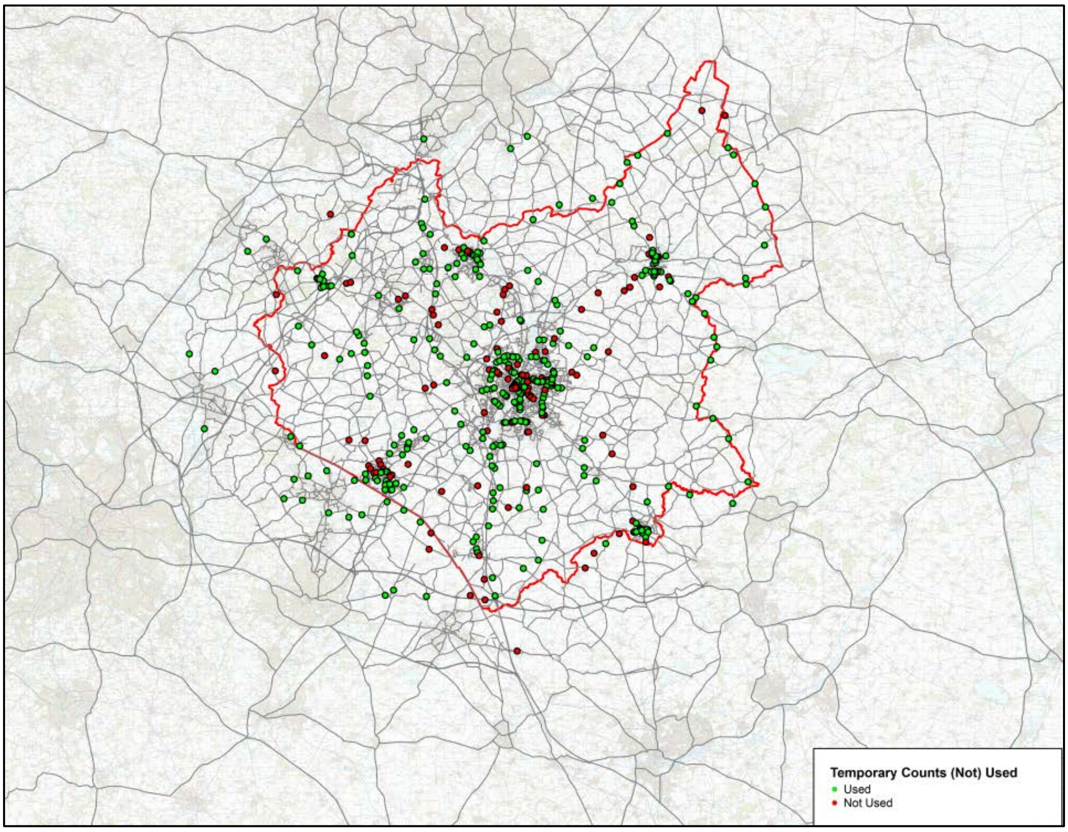
2.4.5 If following these checks a temporary C2 count was deemed suitable, it was added to the count log and its location removed from the list of required survey locations.

2.4.6 After reviewing the temporary counts available through the C2 website, there were still 465 locations for which counts were commissioned during 2014 and 2015. These counts were almost entirely collected in neutral months only, so that there would be less reliance on temporal adjustment factors.

2.4.7 The temporary ATC counts collected and used in the LLITM 2014 Base Highway Model are shown in green in Figure 2.3 and those not ultimately used are shown in red. Those count data that were not used either:

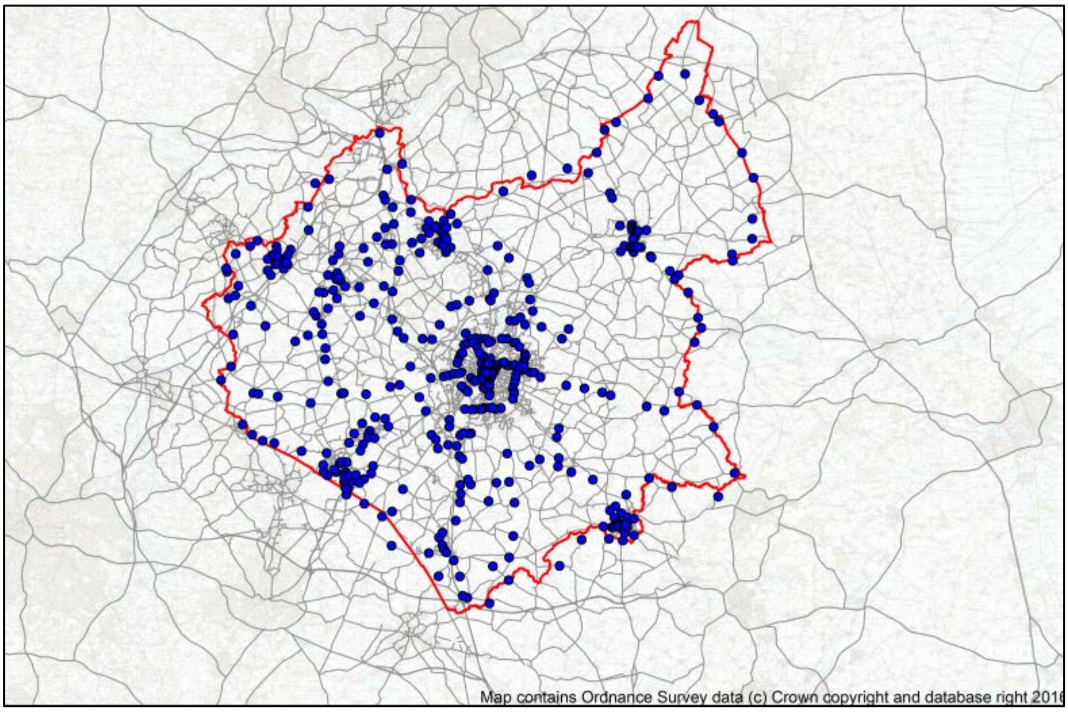
- formed screenlines that ran parallel to other screenlines, and so capturing similar movements; or
- formed screenlines that were not used in the final calibration/validation dataset; or
- were defined as screenlines when the surveys were specified, which were subsequently modified following review of the data used in LLITM 2014 Base as the model development progressed.

Figure 2.3: Usage of Temporary Traffic Counts collected for LLITM 2014 Base



2.4.8 By combining the temporary ATC counts that previously existed with those collected for LLITM 2014 Base, there are 480 temporary counts that have ultimately been used in the calibration and validation of the highway model, as shown in Figure 2.4.

Figure 2.4: Temporary Traffic Counts used in LLITM 2014 Base

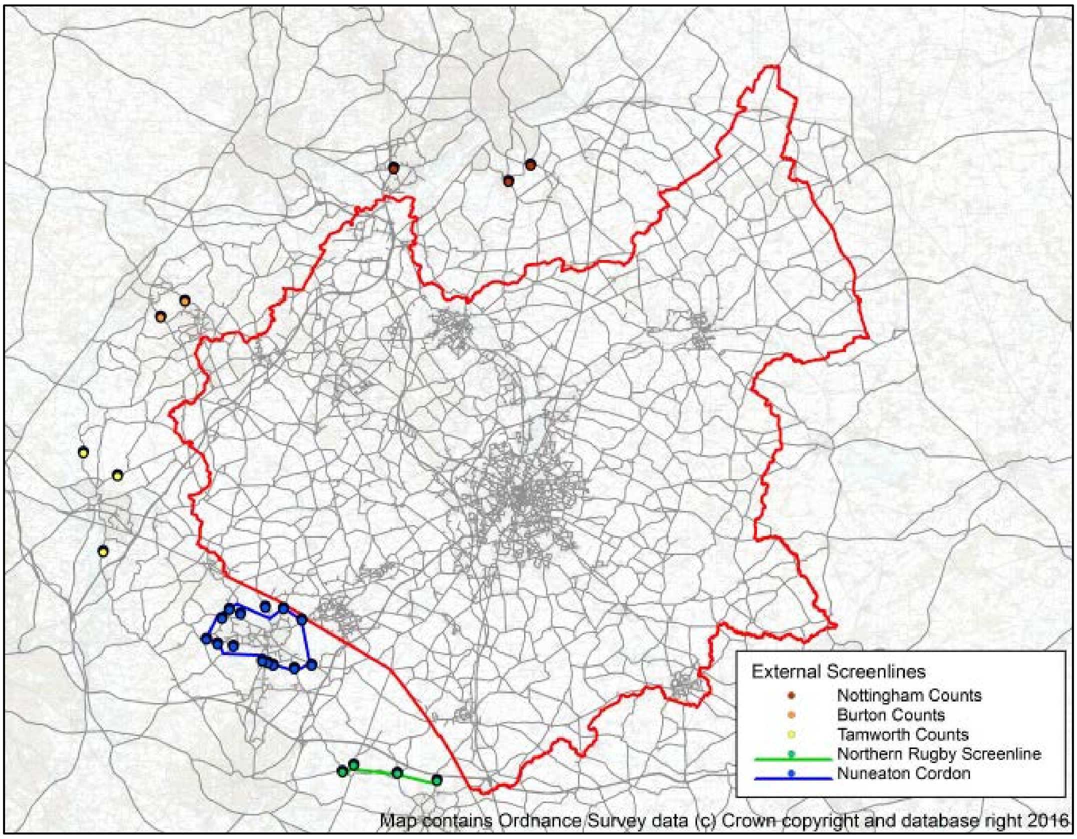


Map contains Ordnance Survey data (c) Crown copyright and database right 2016

2.5 Temporary Traffic Counts | External Screenlines

2.5.1 The LLITM 2014 Base highway network has been extended to include additional network, particularly west into Warwickshire and north into Nottinghamshire. To complement the extension of the simulation network, 26 additional counts have been defined outside the county. Any counts that were commissioned were on ‘A roads’ and ‘B roads’ only. The network detail is such that this means they do not necessarily form complete screenlines or cordons but they do cover strategic traffic around Nuneaton, Rugby, Nottingham and Tamworth and the key routes to/from Leicestershire. These 26 count locations are shown in Figure 2.5.

Figure 2.5: External Calibration Screenlines



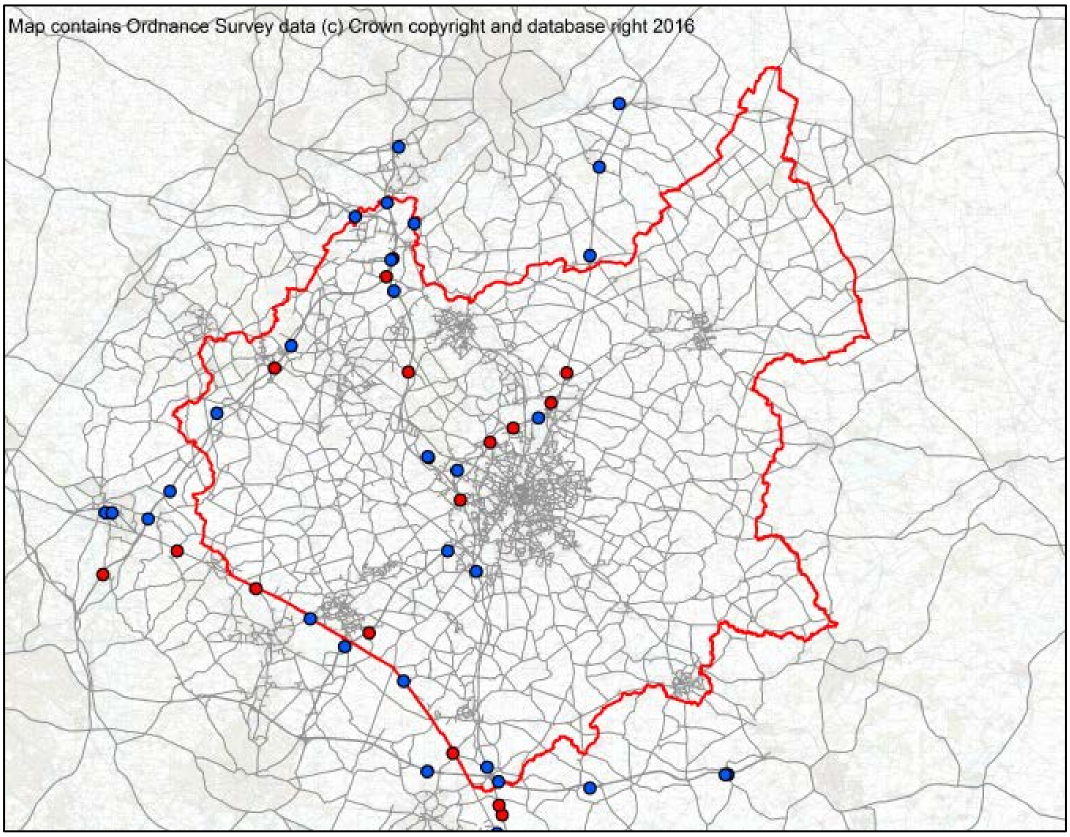
2.5.2 Data from these count sites have been derived either from data already available from other authorities, or supplementary counts that were commissioned. There are counts on strategic movements from Nottingham, Burton and Tamworth to Leicestershire, a complete cordon around Nuneaton and screenline capturing movements north of Rugby.

2.6 Highways England [now National Highways] Traffic Counts

2.6.1 Every section of Highways England [now National Highways] road in Leicestershire (i.e. from junction to junction) has a count available as well as counts along important Highways England [now National Highways] roads in the vicinity of Leicestershire such as the M6, M42, A1, A5 and A14.

2.6.2 Figure 2.6 shows the locations for which count data have been processed on the Strategic Road Network (SRN). The locations in blue indicate where a traffic count has been used within matrix estimation to calibrate the modelled flows. Locations in red are independent validation traffic counts. Along each strategic route there are validation and calibration counts. Along a route, the counts alternate between validation and calibration.

Figure 2.6: Locations of SRN Counts (Blue = Calibration / Red = Validation)



2.6.3 Traffic counts for the SRN have been extracted from the (now defunct) TRADS online database for all days, and individual hours within those days, for April, May and June 2014.

2.6.4 For a few sections there were no available counts for either April, May or June in 2014. For these counts, depending on data availability, an alternative has been downloaded for either April/May/June in 2013 or alternatively for October 2014. For either alternative, nearby SRN count data have been processed to derive a suitable count adjustment factor, yielding a proxy April/May/June 2014 SRN count.

2.6.5 To split the total observed traffic flows from TRADS into car, LGV and HGV needed for the highway calibration, the DfT manual classified count database[2] has been used (as with previous LLITM versions). Taking into account that MCC data are less reliable than ATC data, the MCC data have been processed by taking all available MCC data from the DfT database and grouping by road name, county and modelled time period. The car, LGV and HGV flow records within these groups have been summed, and average vehicle type proportions have then been calculated from these aggregated data.

2.6.6 These vehicle type proportions, available by road, county and modelled time period, have then been applied to the TRADS data, resulting in a classified count dataset for the SRN that can be in the required format for the LLITM highway model calibration and validation.

2.7 Processing of Traffic Counts

2.7.1 The processing of count data (both ATC and MCC) was done within an MS Access database. The processing consisted of a number of distinct stages; these are summarised below.

---

[2] http://data.gov.uk/dataset/gb-road-traffic-counts

Stage 1: Collate data from various sources into a consistent format

2.7.2 The count data used in the count database came from the following sources:

- C2 Cloud, LEICESTERSHIRE node (real-time ATC sites);
- C2 Cloud, LEICESTERSHIRE_ATC node (permanent ATC sites);
- C2 Cloud, LEICESTERSHIRE_TEMP node (temporary ATC sites);
- C2 Cloud, LEICESTERSHIRE_MCC node (temporary MCC sites);
- LLITM RSI surveys;
- Highways England [now National Highways] TRADS data; and
- other miscellaneous counts.

2.7.3 Each data source had a different data format; each was reformatted into a single normalised count data format.

Stage 2: Selection of the most appropriate C2 data source and year

2.7.4 In this stage, a prioritisation process gave preference to the C2 data, taking account of the source of the data and the year of the survey. Ideally, data from April/May/June 2014 would be used. If data were not available for this ‘neutral month period’, then the following table in the database defines which data source to take data from.

Table 2.1: Prioritisation of C2 Data Sources

Source	Year	Priority
C2 LEICESTERSHIRE_ATC	2014	1
C2 LEICESTERSHIRE_ATC	2015	2
C2 LEICESTERSHIRE_ATC	2013	3
C2 LEICESTERSHIRE_ATC	2012	4
C2 LEICESTERSHIRE_ATC	2011	5
C2 LEICESTERSHIRE_TEMP	-	6
C2 LEICESTERSHIRE	-	7
C2 LEICESTERSHIRE_MCC	-	8

Stage 3: Remove duplicate records and aggregate to hourly data

2.7.5 In this stage, any 15-minute data were aggregated to hourly data, and duplicate records were then identified and removed from the database.

Stage 4: Remove Fridays, weekends and bank holidays

2.7.6 In this stage, any data recorded on a Friday, on a bank holiday or in a week with a bank holiday in it were identified and removed from the database.

Stage 5: Remove outliers

2.7.7 In this stage, outliers in the count data were identified and removed from the database. A Z-score was calculated using the following formulation:

$$Z_i = \frac{Y_i - \bar{Y}}{s}$$

Where:

Y_i is the hourly traffic flow of an observation

$\bar{Y}$ is the sample mean

s is the sample standard deviation

2.7.8 Where the sample for a site was greater than 20, a record was deemed to be an outlier if it received an absolute Z-score in excess of 2.5. For smaller samples, the Z-score was not used, as Z-score values can be misleading with a small sample. In these cases, a GEH statistic was calculated, comparing the flow record with the sample mean. Through trial and error, records with a GEH value in excess of 4 were considered to be outliers.

2.7.9 With this two-stage detection of outliers, the detected records were removed from the count database.

Stage 6: Calculate and apply temporal factors

2.7.10 Where count data were not defined from April/May/June 2014, some adjustment was required to make them 'proxy' Spring 2014 counts.

2.7.11 The long-term count data available in the count database were used to derive two types of factor:

- factors that adjust for traffic between months (seasonality factors); and
- factors that adjust for year-on-year traffic growth (or decline).

2.7.12 The monthly traffic variation and year-on-year traffic growth over the period 2010-2015 are shown in Figure 2.7 and Figure 2.8 respectively.

Figure 2.7: Monthly Traffic Variation, Long-Term C2 Count Data, 2010-2015

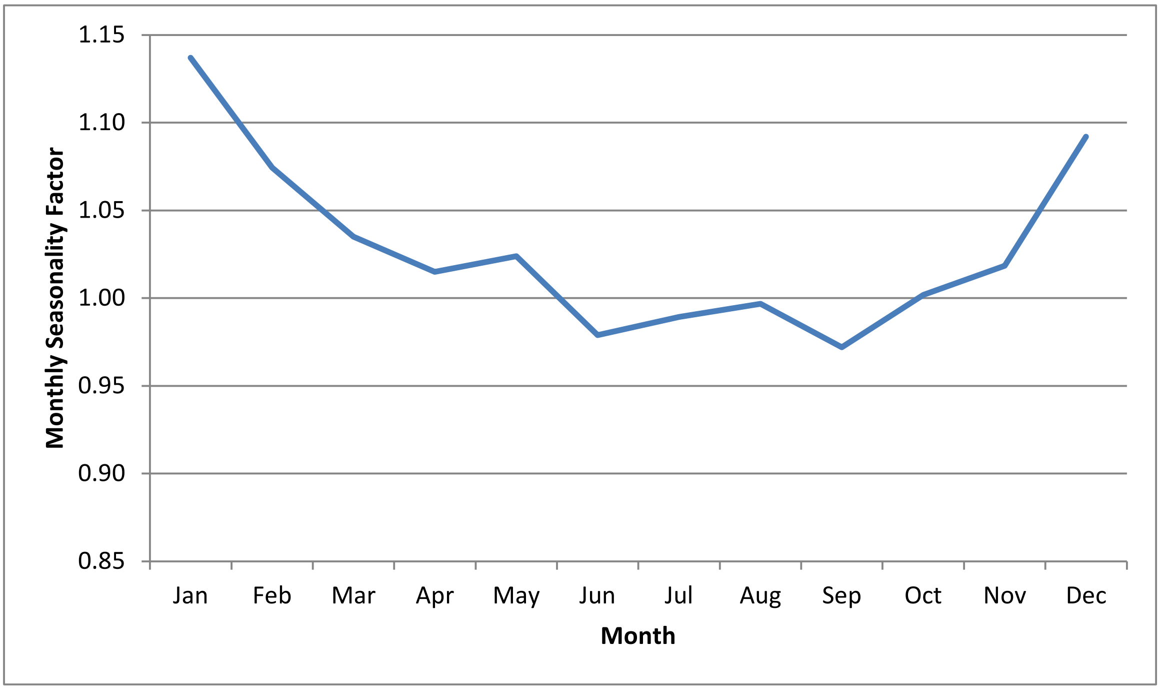
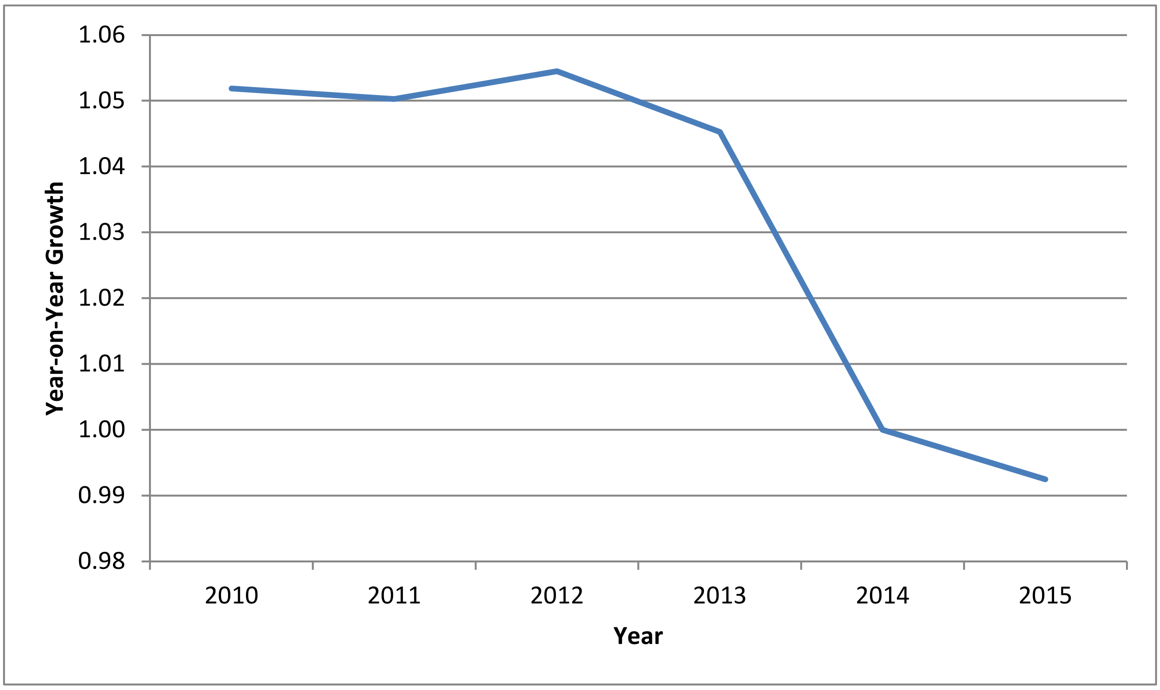
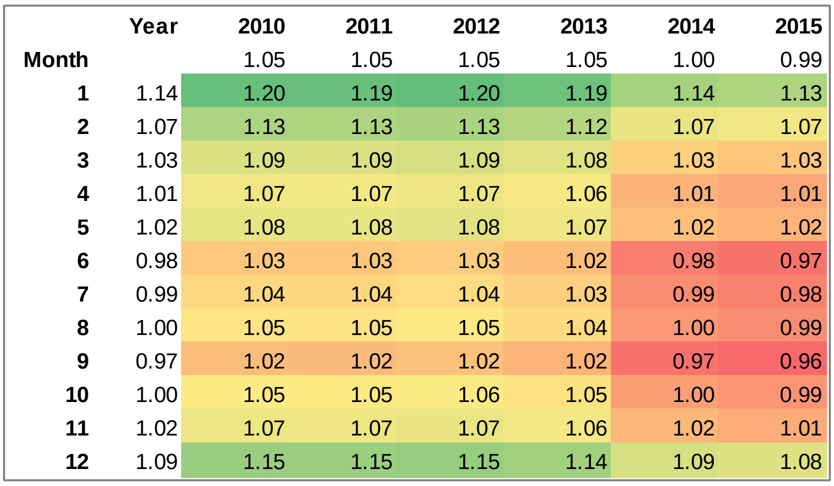


Figure 2.8: Year-on-Year Traffic Growth, Long-Term C2 Count Data, 2010-2015



2.7.13 The product of the monthly variation and year-on-year growth factors yields a combined temporal adjustment factor that can be applied to counts collected during non-neutral months, and/or in years other than 2014. The final calculated temporal factors are shown in Table 2.2.

Table 2.2: Temporal Factors Derived from Long-Term C2 Count Data



	Year	2010	2011	2012	2013	2014	2015
Month		1.05	1.05	1.05	1.05	1.00	0.99
1	1.14	1.20	1.19	1.20	1.19	1.14	1.13
2	1.07	1.13	1.13	1.13	1.12	1.07	1.07
3	1.03	1.09	1.09	1.09	1.08	1.03	1.03
4	1.01	1.07	1.07	1.07	1.06	1.01	1.01
5	1.02	1.08	1.08	1.08	1.07	1.02	1.02
6	0.98	1.03	1.03	1.03	1.02	0.98	0.97
7	0.99	1.04	1.04	1.04	1.03	0.99	0.98
8	1.00	1.05	1.05	1.05	1.04	1.00	0.99
9	0.97	1.02	1.02	1.02	1.02	0.97	0.96
10	1.00	1.05	1.05	1.06	1.05	1.00	0.99
11	1.02	1.07	1.07	1.07	1.06	1.02	1.01
12	1.09	1.15	1.15	1.15	1.14	1.09	1.08

2.7.14 Temporal factors were initially calculated by road type, time periods, urban classification and district, but the relatively limited sample available when segmenting the data in this way led to either gaps in the grid shown in Table 2.2 and/or counter-intuitive profiles, attributable to localised issues such as new developments, new infrastructure and roadworks, as well as the expected day-to-day variation of the count data.

2.7.15 The final outcome was therefore a set of temporal factors that were applied to all road types and time periods, as shown in Table 2.2.

Stage 7: Calculate final traffic flows

2.7.16 The final stage in the count processing was to calculate the final traffic flows for use in the highway matrix build process and for the SATURN highway model calibration and validation.

2.8 Checking of Traffic Counts

2.8.1 The checking of LLITM 2014 Base counts was divided into top-down checks to ensure that trends in the data are sensible and that data are in the correct locations, correct direction and assigned to the correct SATURN link. The second approach was to take a sample of counts and review to both verify the data observed are sensible and secondly have been processed correctly.

Location Checks

2.8.2 The first check was on the location of the LCC MapInfo locations of Leicestershire permanent and temporary counts with the coordinates of the same counts as defined on the C2 website. Any discrepancies were discussed with LCC and the correct location was confirmed.

2.8.3 Once count site locations were verified, the count location was compared with the mid-point of the allocated SATURN link. This was a check on the process of allocating counts to highway model links. If the distance between the count location and the mid-point was greater than 50% of the crow-fly distance of the SATURN link length then the count was flagged for further inspection. There could be various reasons for the discrepancy including:

- the count is on a different link but there is no junction;
- the count is on the other side of a development zone centroid connector;
- the C2 co-ordinates are wrong – in this case verification was required from LCC; and
- the curviness of the link or the proximity of the count at the extreme of the link means the count location is more than 50% of the link crow-fly distance from the mid-point.

Screenline Checks

2.8.4 Each of the defined screenlines and cordons was checked for holes, looking for instances where we had a SATURN network link and no count, by conducting a visual check after plotting each highway model link with a count in MapInfo. There were some queries during the first round of this but each was resolved before the screenlines were finalised.

2.8.5 A second check reviewed individual counts along each screenline to review the observed volume in each time period compared with other counts along that screenline or cordon; a check on tidality. Plots were produced in MapInfo and each count was reviewed to consider whether the observed volumes were plausible or not. For anything flagged, the raw data and processing were reviewed. If the raw data were considered unusual, then alternative counts were sought for verification and possible replacement.

Direction Checks

2.8.6 The direction of the data was checked compared with the SATURN link direction as well as the direction of the screenline. This would confirm that the count direction in the database is correct and that each screenline and cordon has data grouped correctly by direction. The first check, on the SATURN direction and direction specified in the count data calculates a SATURN direction based on the proximity of the B node compared with the A node. In the majority of cases this was consistent. There were some issues, but these were caused by mislabelling of direction in the data and the processing of counts was updated to correct for this. These link directions were then imported into MapInfo for a check against the screenline or cordon direction and this was confirmed to be correct.

Count Date and Direction Checks

2.8.7 The count data used in LLITM 2014 Base highway model were checked to verify that there were no data used that were more than 4 years older than the base year of 2014. The number of days of processed data was also checked to confirm that there were no 1-day MCCs labelled as ATCs being used. Again, this was a useful check as some MCC and ATC data on the C2 website are allocated the same site ID, and we wanted to ensure that ATC data were used in preference to MCC data.

Raw vs Processed Data Checks

2.8.8 As a high-level check of the count processing, the output flow estimates in the AM Peak hour were compared with the equivalent average from raw data. The raw data included weekends, bank holidays, failures and other events so the processed volume was on average 1.3 times higher than the raw data. As each data point was plotted in a scatter graph, this check was also used to identify outlier points so that the processing could be investigated and verified.

Observed Volume vs Capacity Checks

2.8.9 A straightforward check that can highlight suspicious counts is to compare the observed flow with the coded capacity in the highway model. In the event that the observed flow is greater than the count then either the coded capacity needs reviewing and/or the count. In the majority of cases this highlighted that observed signal timings were not compatible with observed flows. With a sample over two weeks or more, the ATC counts are likely to be more reliable than short samples of signal timing data. Journey time data were also used to indicate if observed signal timing data contained excessive delay at certain signalised junctions; in these cases, some edits were made to the coded networks.

Consistency of Peak Behaviour Checks

2.8.10 Two checks were conducted on the peak hour behaviour. The first was to consider the peak direction in the AM Peak hour and the peak direction in the PM Peak hour and verify that these were opposite directions or that no significant peak can be recognised. A threshold of 15% between the two directions was used to define a screenline as having a ‘peak direction’.

2.8.11 The second check was that the counts along a screenline should have a consistent peak direction to that of the screenline. The first iteration of this check, along with the check of count duration, highlighted an error in the count processing in that some 1-day MCC data were being used rather than the full 2-week ATC. Once corrected, the count data tended to show the same peak direction as the total screenline direction unless there was something unique such as a one-way system, a large employment site, school, station, hospital, leisure or shopping facility etc.

Individual Count Checks

2.8.12 As well as high-level check, there were also bottom-up checks on individual counts. In total 30 counts that were selected for review, representing a selection of permanent and temporary counts from C2 and ATCs collected as part of the RSI data collection programme. The counts were randomly selected using a random number generator. Each count was reviewed for:

- accuracy of location;
- accuracy of direction;
- a sense check of data compared with the counts location;
- a variability check; by modelled hour are the data consistent or is there significant variability;
- differences in pre-processed and processed averages; is there any error/bias in the processing; and
- consistent ratios between time periods and by direction; are there any anomalous patterns in traffic volumes by modelled hour or direction.

2.8.13 Although there were some queries that arose from these individual count checks, there were no critical issues with the raw data or processing of the counts that were reviewed. The variability in some of the counts appeared to be resolved either by a T-test or the removal of outliers.

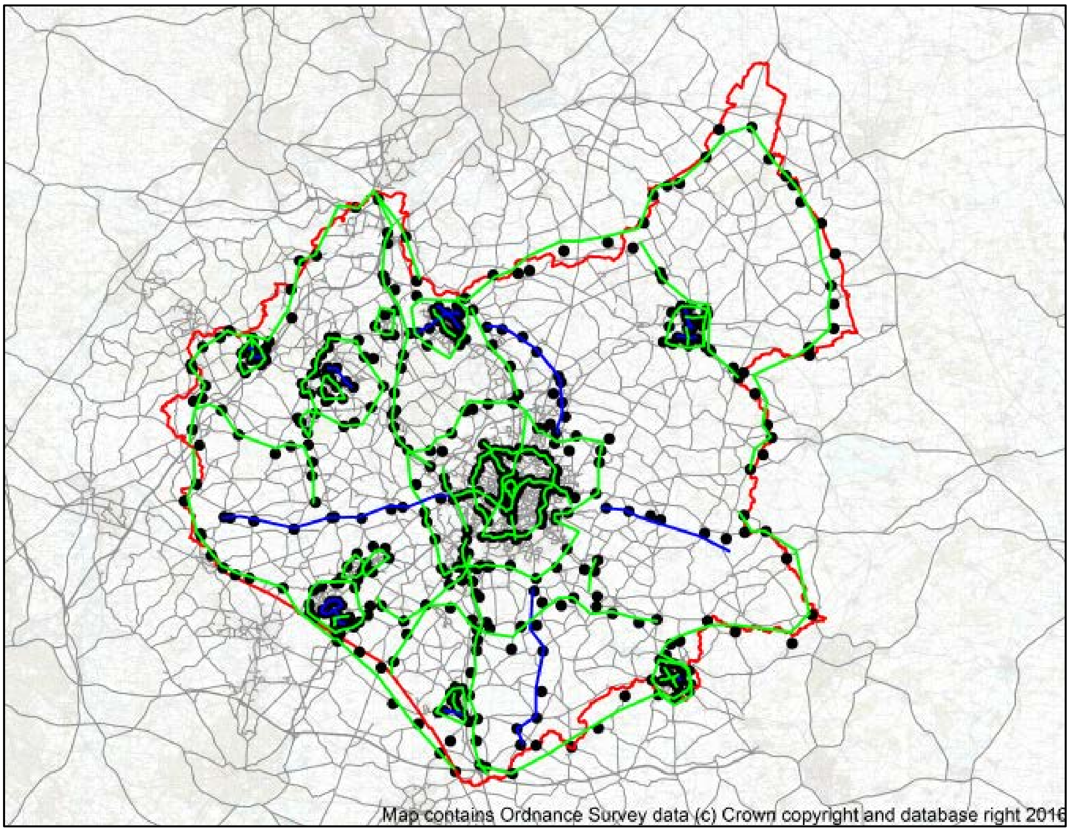
2.9 Definitions of Screenlines and Cordons

2.9.1 A total of 39 screenlines have been defined within Leicester City and Leicestershire, along with 15 cordons. These screenlines, cordons and the constituent count locations are shown in Figure 2.9.

2.9.2 The calibration screenlines and cordons are shown in green and the independent validation screenlines and cordons are shown in blue. There is a mixture of urban cordons, strategic inter-urban screenlines and intra-urban screenlines in the market towns and Leicester City. This cordon/screenline definitions were designed to cover all market towns in Leicestershire, the hinterland between these towns, and to provide sufficient urban detail.

2.9.3 There is also a complete cordon of the county that is split into four screenlines. As there was an extensive count data collection programme there are no holes in these cordons and screenlines for modelled links.

Figure 2.9: Leicestershire Screenlines and Cordons



Map contains Ordnance Survey data (c) Crown copyright and database right 2016

2.9.4 There is a total of 618 counts within this subset of the count dataset, which altogether form the 39 screenlines and 15 cordons. This dataset has been extensively reviewed and processed, as discussed in Section 2.7. Each screenline and cordon has been split into 'mini screenlines' for the purposes of model calibration, as recommended by TAG.

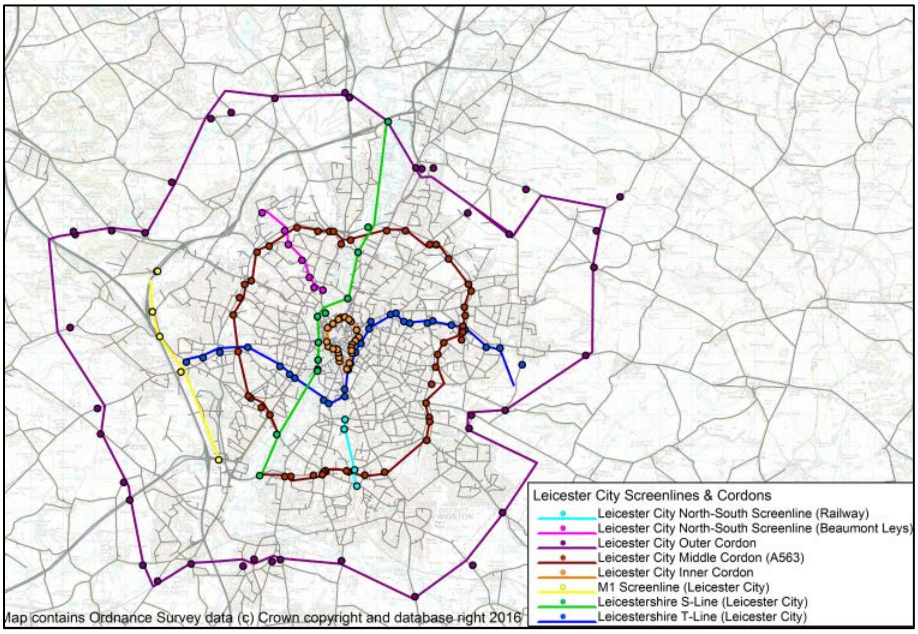
2.10 Summary of Traffic Counts

2.10.1 These five datasets, counts at RSI locations, permanent Leicestershire counts, temporary Leicestershire counts, SRN counts and external screenlines, result in a total of 689 counts within the observed traffic flow dataset. These 689 counts have been used to form a total of 58 screenlines and cordons.

2.10.2 Each of these screenlines and cordons has been allocated to one of a number of reporting areas. These can be broadly defined as countywide, Leicester City and surrounding areas, North Leicestershire, North-East Leicestershire, South and South-East Leicestershire, South-West Leicestershire and North-West Leicestershire. In addition to this there is separate reporting for the external screenlines (as shown in Figure 2.5) and the Strategic Road Network (as shown in Figure 2.6).

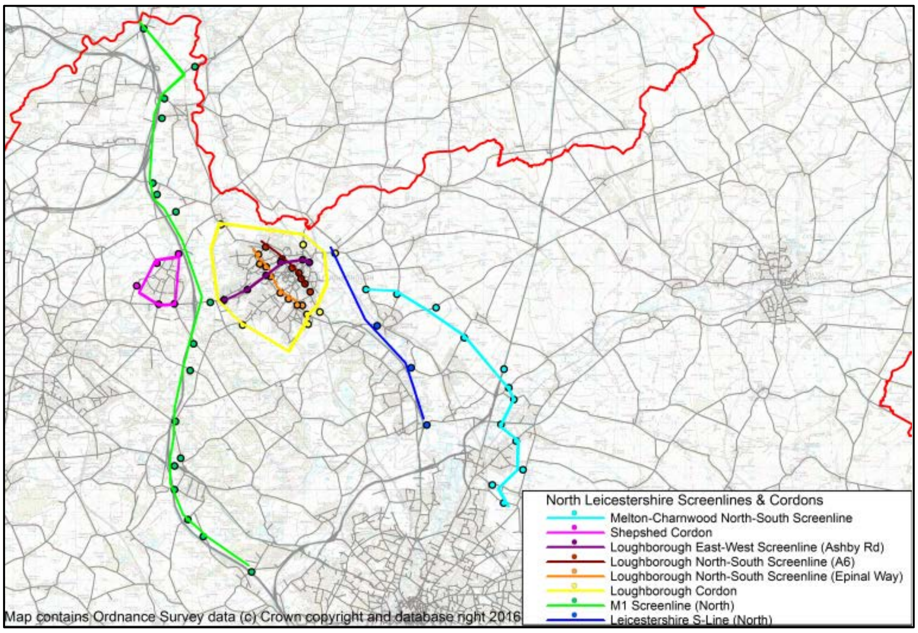
2.10.3 The screenlines and cordons in Leicester City are shown in Figure 2.10. There are three cordons, inner, middle and outer, that capture traffic going into and out of the city centre, that are crossing the A563 and into the wider Leicester area respectively. The M1 screenline captures all traffic travelling east-west from the M1 to Leicester City. The counts along the 'Leicestershire S-Line' provide a central north-south screenline with two more north-south screenlines: 'Railway' in the south and 'Beaumont Leys' in the north. The counts along the 'Leicestershire T-Line' capture north south movements in Leicester from the M1 to the 'outer cordon'.

Figure 2.10: Leicester City Screenlines and Cordons



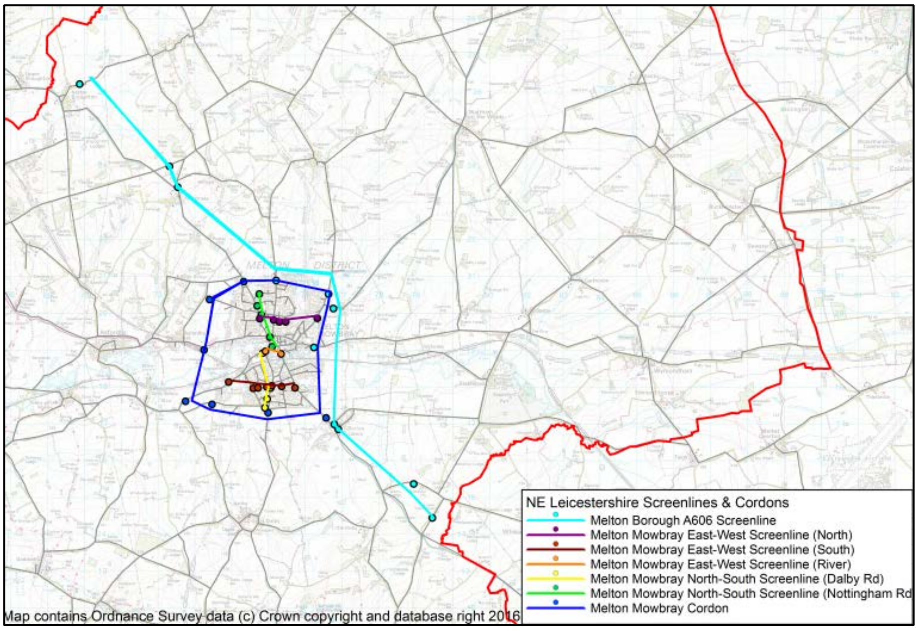
2.10.4 The screenlines and cordons in North Leicestershire are shown in Figure 2.11; these focus around Loughborough where there is a cordon, one east-west and two north-south screenlines (one parallel to the A6 and one parallel to Epinal way). There is also a cordon around Shepshed, the second largest town in North Leicestershire, and three rural north-south screenlines. Both the ‘M1 Screenline’ and ‘Leicestershire S-Line’ have counts that fall in North Leicestershire from Leicester City to the county boundary. The final north-south screenline intercepts inter-district movements and is called the ‘Melton-Charnwood North-South Screenline’ running from Troon Way in Leicester to Coates Road, just south-east of Loughborough.

Figure 2.11: North Leicestershire Screenlines and Cordons



2.10.5 The screenlines and cordons in North-East Leicestershire are shown in Figure 2.12. The majority of screenlines and the cordon are in and around Melton Mowbray. There is a cordon around the town and an east-west screenline capturing movements across the river. Two screenlines follow Dalby and Nottingham Road north-south and approximately halfway along each of these screenlines they intersect an east-west screenline for south and north Melton Mowbray respectively. There is a single rural screenline that runs north-south parallel to the A606 that joins the county boundary at both ends and runs east of Melton Mowbray.

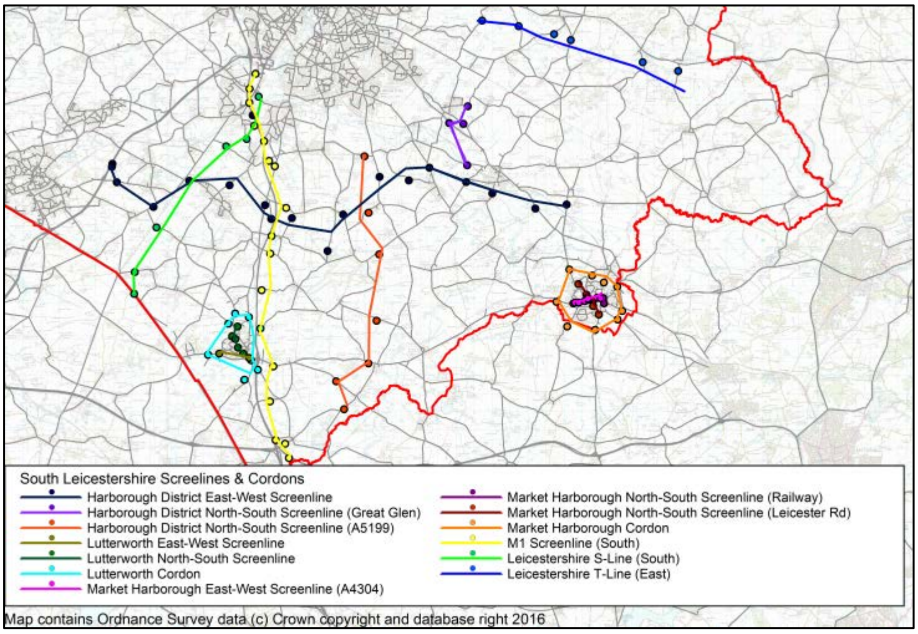
Figure 2.12: North-East Leicestershire Screenlines and Cordons



Map contains Ordnance Survey data (c) Crown copyright and database right 2016

2.10.6 The screenlines and cordons for South and South-East Leicestershire are shown in Figure 2.13. There are two urban centres; Lutterworth and Market Harborough. Both have cordons and both have east-west screenlines. Lutterworth has a single north-south screenline and Market Harborough has two, one running parallel to Leicester Road and one crossing the railway. There are a number of rural screenlines in this district. Each of the M1 screenline, T Line and S Line all have counts in South & South-East Leicestershire. Each of these run from Leicester to the county boundary. As well as these screenlines there is an east-west screenline across the district from the M69 to Harborough Road and two north-south screenlines, with the first parallel to the A5199 and second in the Great Glen/Newton Harcourt area.

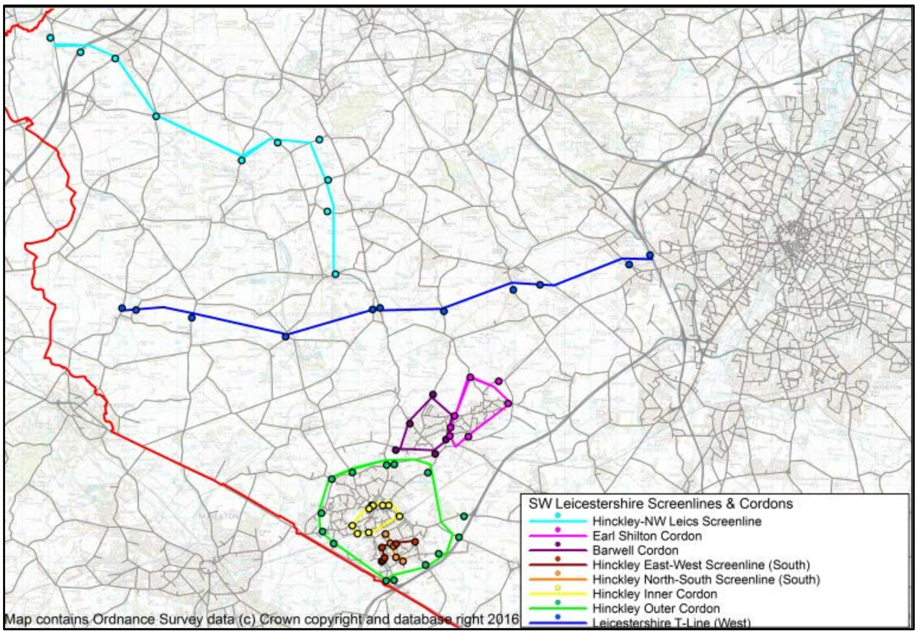
Figure 2.13: South and South-East Leicestershire Screenlines and Cordons



Map contains Ordnance Survey data (c) Crown copyright and database right 2016

2.10.7 The screenlines and cordons for South-West Leicestershire are shown in Figure 2.14. There are four cordons: an outer and inner Hinckley cordon and cordons around Barwell and Earl Shilton. In south Hinckley there are also north-south and east-west screenlines separating south Hinckley into quadrants. There are two rural screenlines, with the western counts of the 'Leicestershire T-Line' providing a useful east-west cordon mid-way through the district from the M1 to the county border. The 'Hinckley-North-West Leicestershire' screenline follows the boundary between these two districts from the county border in the north-west to the 'Leicestershire T-Line' in the south-east.

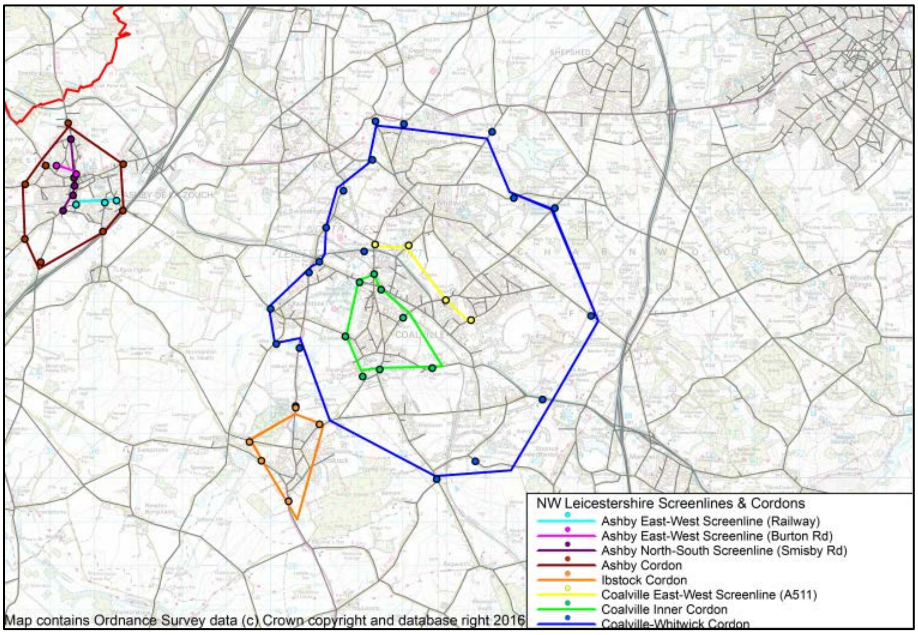
Figure 2.14: South-West Leicestershire Screenlines and Cordons



Map contains Ordnance Survey data (c) Crown copyright and database right 2016

2.10.8 The screenlines and cordons for North-West Leicestershire are shown in Figure 2.15. There are four cordons: Ashby-de-la-Zouch, wider Coalville-Whitwick, Coalville inner and Ibstock cordon. There are also four screenlines, one in Coalville running parallel to the A511 and three in Ashby-de-la-Zouch. There are two east-west screenlines, located along the Railway and Burton Road, and a north-south screenline running parallel to Smisby Road in Ashby-de-la-Zouch.

Figure 2.15: North-West Leicestershire Screenlines and Cordons



Map contains Ordnance Survey data (c) Crown copyright and database right 2016

3. Roadside Interview Data

3.1 RSI Sources

3.1.1 The LLITM 2014 model uses 159 RSI sites that include 156,602 records. These RSI data come from different sources/years, namely the original 2008 LLITM model, a data collection programme around Loughborough in 2011, and a new RSI programme for the LLITM 2014 Base model, conducted in 2013/2014.

3.1.2 Table 3.1 summarises the data availability for each of these RSI sites. Of the 159 sites, just under 70% of the trip records are new records collected in 2013/2014.

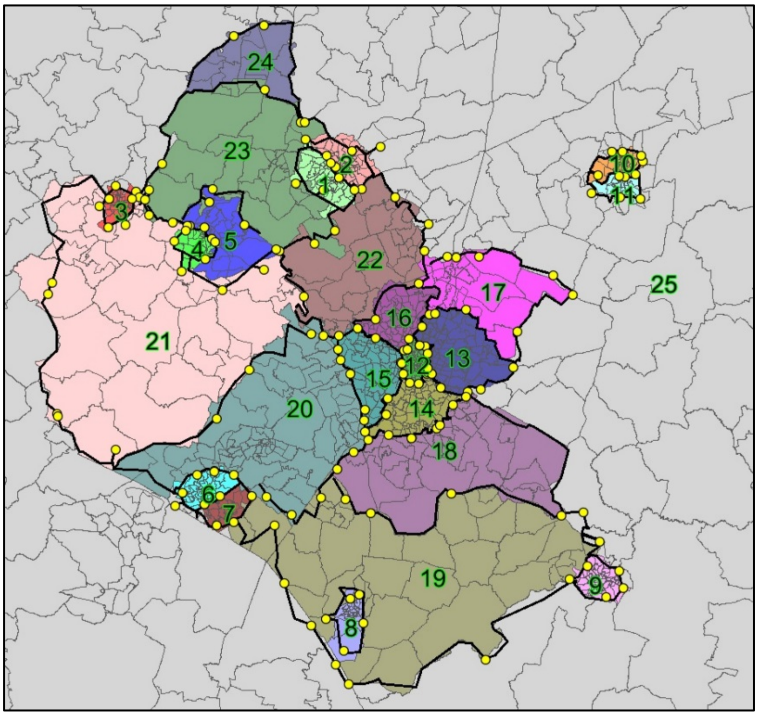
Table 3.1: Summary of RSI Data Availability

Source	Number of sites	Number of records	% of total
LLITM 2008	46	41,219	26.32%
Loughborough 2011	7	7,904	5.05%
LLITM 2014 Base 2013/2014	106	107,479	68.63%
Total	**159**	**156602**	**100%**

3.2 RSI Locations and Sector Definition

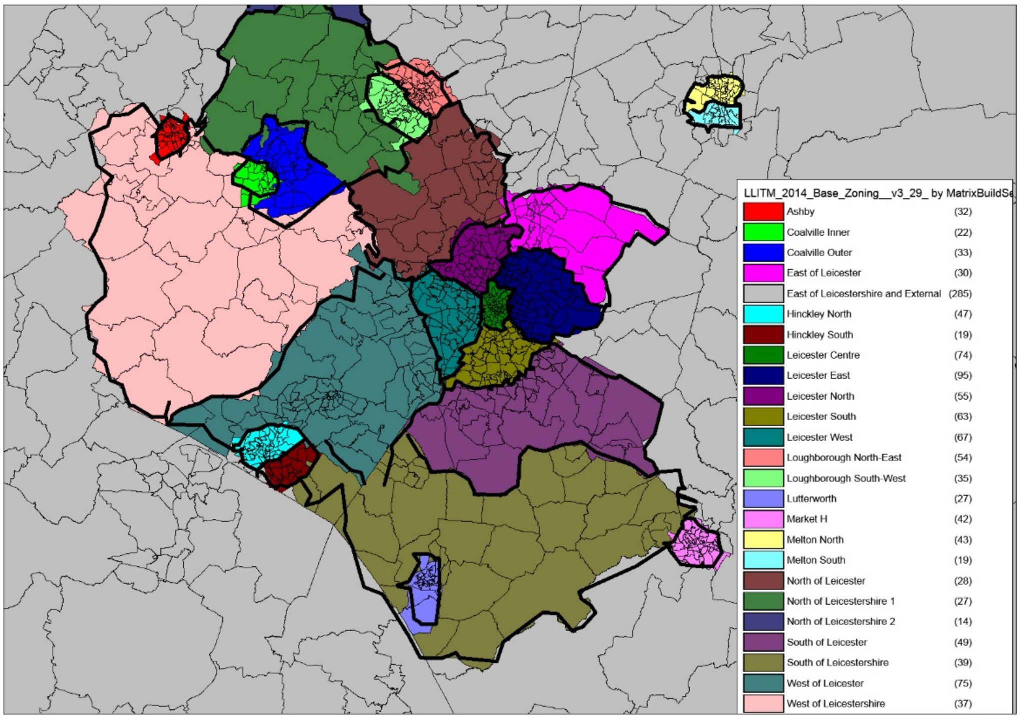
3.2.1 Figure 3.1 shows the RSI sites (yellow), the screenlines built around the sites (black), and the RSI sectors formed (coloured areas).

Figure 3.1: RSI Sites, Screenlines and Sectors for LLITM 2014 Base



3.2.2 Figure 3.2 shows the sectors created using the RSI sites, used during the matrix build process.

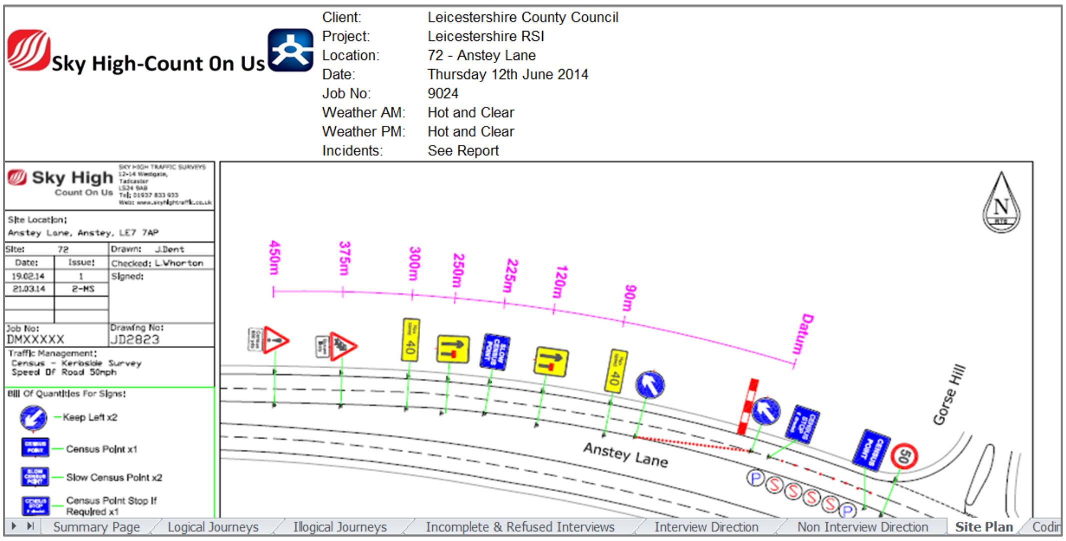
Figure 3.2: Screenlines and Sectors Definitions in LLITM 2014 Base



3.3 RSI Data Format

3.3.1 The survey company provided data for each site, consisting of an ATC report for the RSI site, an RSI report showing the location plan of the site (see Figure 3.3), an hourly summary of link count and interviews collected, and all the RSI records (see Figure 3.4) with information that includes record ID, time, vehicle type, vehicle occupancy, origin postcode, origin purpose, destination postcode, destination purpose, parking location, and return time. Mobile phone provider was included as a question in the 2014 surveys, used in the processing of the mobile network data.

Figure 3.3: Sample RSI Site Plan


Client: Leicestershire County Council
Project: Leicestershire RSI
Location: 72 - Anstey Lane
Date: Thursday 12th June 2014
Job No: 9024
Weather AM: Hot and Clear
Weather PM: Hot and Clear
Incidents: See Report

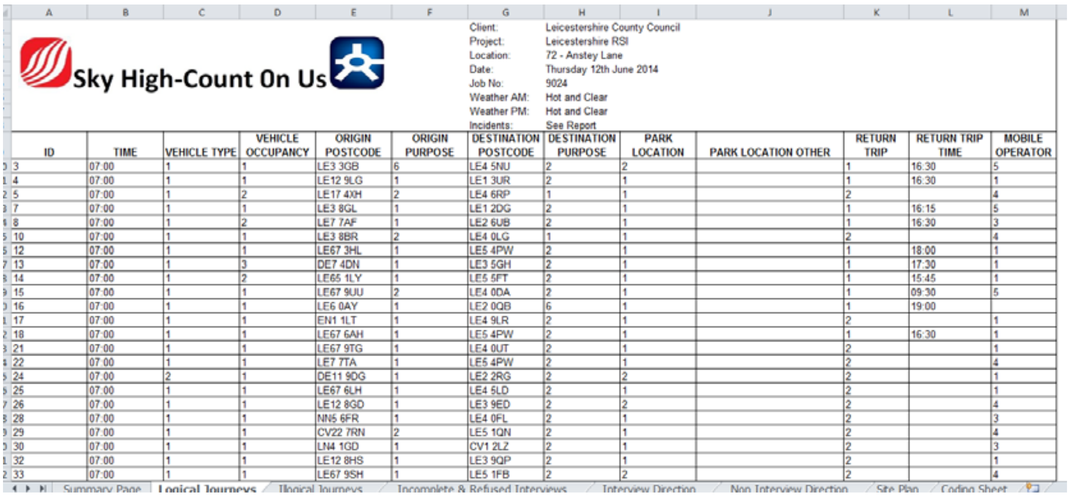
Site Location:
Anstey Lane, Anstey, LE7 7AP

Site: 72		Drawn: J.Dent
Date:	Issue:	Checked: L.Whorton
19.02.14	1	Signed:
21.03.14	2-MS	
Job No: DMXXXXX		Drawing No: JD2823

Traffic Management:
Census - Kerbside Survey
Speed Of Road 50mph

Bill Of Quantities For Signs:
Keep Left x2
Census Point x1
Slow Census Point x2
Census Point Stop If Required x1

Figure 3.4: Sample RSI Survey Record Data File



Sky High-Count On Us

Client: Leicestershire County Council
Project: Leicestershire RSI
Location: 72 - Anstey Lane
Date: Thursday 12th June 2014
Job No: 9024
Weather AM: Hot and Clear
Weather PM: Hot and Clear
Incidents: See Report

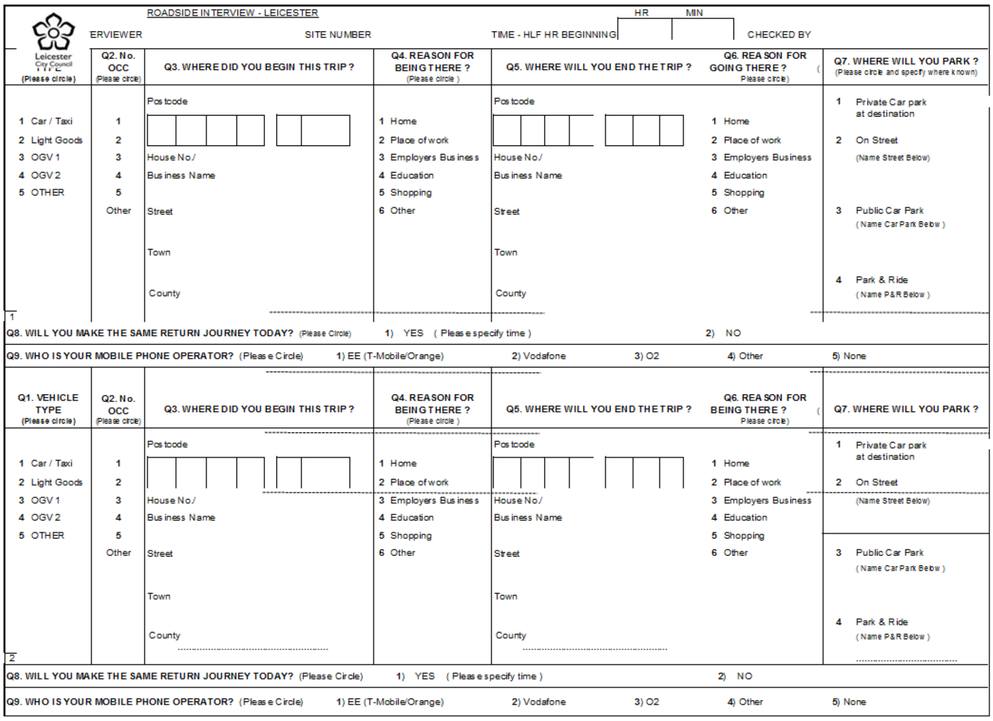
ID	TIME	VEHICLE TYPE	VEHICLE OCCUPANCY	ORIGIN POSTCODE	ORIGIN PURPOSE	DESTINATION POSTCODE	DESTINATION PURPOSE	PARK LOCATION	PARK LOCATION OTHER	RETURN TRIP	RETURN TRIP TIME	MOBILE OPERATOR
3	07:00	1	1	LE3 3GB	6	LE4 5NU	2	2		1	16:30	5
4	07:00	1	1	LE12 9LG	1	LE1 3UR	2	1		1	16:30	1
5	07:00	1	2	LE17 4XH	2	LE4 6RP	1	1		2		4
7	07:00	1	1	LE3 8GL	1	LE1 2DG	2	1		1	16:15	5
8	07:00	1	2	LE7 7AF	1	LE2 6UB	2	1		1	16:30	3
10	07:00	1	1	LE3 8BR	2	LE4 0LG	1	1		2		4
12	07:00	1	1	LE67 3HL	1	LE5 4PW	2	1		1	18:00	1
13	07:00	1	3	DE7 4DN	1	LE3 5GH	2	1		1	17:30	1
14	07:00	1	2	LE65 1LY	1	LE5 5FT	2	1		1	15:45	1
15	07:00	1	1	LE67 9UU	2	LE4 0DA	2	1		1	09:30	5
16	07:00	1	1	LE6 0AY	1	LE2 0QB	6	1		1	19:00	
17	07:00	1	1	EN1 1LT	1	LE4 9LR	2	1		2		1
18	07:00	1	1	LE67 6AH	1	LE5 4PW	2	1		1	16:30	1
21	07:00	1	1	LE67 9TG	1	LE4 0UT	2	1		2		1
22	07:00	1	1	LE7 7TA	1	LE5 4PW	2	1		2		4
24	07:00	2	1	DE11 9DG	1	LE2 2RG	2	2		2		1
25	07:00	1	1	LE67 6LH	1	LE4 5LD	2	1		2		1
26	07:00	1	1	LE12 8GD	1	LE3 9ED	2	2		2		4
28	07:00	1	1	NN5 6FR	1	LE4 0FL	2	1		2		3
29	07:00	1	1	CV22 7RN	2	LE5 1QN	2	1		2		4
30	07:00	1	1	LN4 1GD	1	CV1 2LZ	2	1		2		3
32	07:00	1	1	LE12 8HS	1	LE3 9QP	2	1		2		1
33	07:00	1	1	LE67 9SH	1	LE5 1FB	2	2		2		4

3.3.2 Each site also included an auxiliary report that mentions any notes of observations/problems that occurred during the interview day: accidents, significant delays, etc.

3.3.3 Although, in general, each record contains similar information (vehicle type, origin and destination, purpose), the survey questionnaires and thus structure of data for each tranche of data are different, with some information coded in a different way.

3.3.4 For example, in the 2013/2014 data collection programme, a new question was incorporated (see Figure 3.4 and Figure 3.5) that asked for the mobile operator the vehicle driver was using. This subsequently gave an understanding of a key driver of expansion bias in mobile network data (applying expansion at a geographical level that is too aggregate).

Figure 3.5: Roadside Interview Questionnaire used in the 2013/2014 Survey Programme



ROADSIDE INTERVIEW - LEICESTER

Leicester City Council

ERVIEWER SITE NUMBER TIME - HLF HR BEGINNING HR MIN CHECKED BY

(Please circle)	Q2. No. OCC (Please circle)	Q3. WHERE DID YOU BEGIN THIS TRIP ?	Q4. REASON FOR BEING THERE ? (Please circle)	Q5. WHERE WILL YOU END THE TRIP ?	Q6. REASON FOR GOING THERE ? (Please circle)	Q7. WHERE WILL YOU PARK ? (Please circle and specify where known)
1 Car / Taxi 2 Light Goods 3 OGV 1 4 OGV 2 5 OTHER	1 2 3 4 5 Other	Postcode House No./ Business Name Street Town County	1 Home 2 Place of work 3 Employers Business 4 Education 5 Shopping 6 Other	Postcode House No./ Business Name Street Town County	1 Home 2 Place of work 3 Employers Business 4 Education 5 Shopping 6 Other	1 Private Car park at destination 2 On Street (Name Street Below) 3 Public Car Park (Name Car Park Below) 4 Park & Ride (Name P&R Below)

1

Q8. WILL YOU MAKE THE SAME RETURN JOURNEY TODAY? (Please Circle) 1) YES (Please specify time) 2) NO

Q9. WHO IS YOUR MOBILE PHONE OPERATOR? (Please Circle) 1) EE (T-Mobile/Orange) 2) Vodafone 3) O2 4) Other 5) None

Q1. VEHICLE TYPE (Please circle)	Q2. No. OCC (Please circle)	Q3. WHERE DID YOU BEGIN THIS TRIP ?	Q4. REASON FOR BEING THERE ? (Please circle)	Q5. WHERE WILL YOU END THE TRIP ?	Q6. REASON FOR BEING THERE ? (Please circle)	Q7. WHERE WILL YOU PARK ?
1 Car / Taxi 2 Light Goods 3 OGV 1 4 OGV 2 5 OTHER	1 2 3 4 5 Other	Postcode House No./ Business Name Street Town County	1 Home 2 Place of work 3 Employers Business 4 Education 5 Shopping 6 Other	Postcode House No./ Business Name Street Town County	1 Home 2 Place of work 3 Employers Business 4 Education 5 Shopping 6 Other	1 Private Car park at destination 2 On Street (Name Street Below) 3 Public Car Park (Name Car Park Below) 4 Park & Ride (Name P&R Below)

2

Q8. WILL YOU MAKE THE SAME RETURN JOURNEY TODAY? (Please Circle) 1) YES (Please specify time) 2) NO

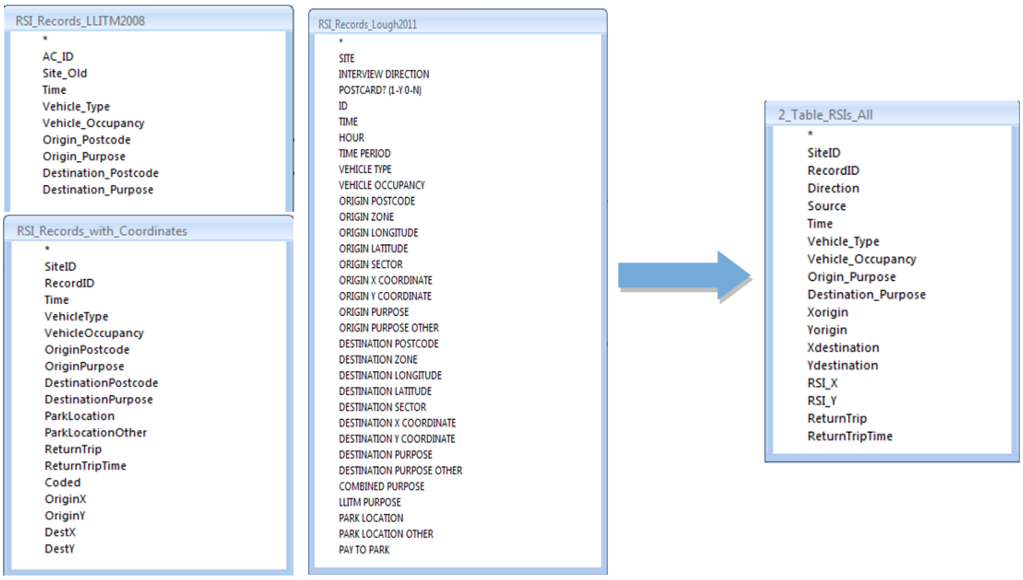
Q9. WHO IS YOUR MOBILE PHONE OPERATOR? (Please Circle) 1) EE (T-Mobile/Orange) 2) Vodafone 3) O2 4) Other 5) None

3.4 RSI Data Normalisation and Cleaning

3.4.1 Due to differing data structures in the different sources of RSI data, once the data were collected and received, it was necessary to create a general database with all RSI records merged and consistently formatted with the same structure. To do this, a process in MS Access was implemented that removed the non-common columns in each database and created a normalised database for each set of records (2008, 2011 and 2013/2014) applying the same coding to then merge them in a unique database.

3.4.2 Figure 3.6 shows the structure of each source RSI data table, and the structure of the final data table.

Figure 3.6: Normalising RSI Databases from Different Sources.



3.4.3 An important task in developing the LLITM 2014 Base highway demand is to check and verify that the data obtained through the roadside interviews (RSIs) are valid, as the RSI data form a basis for the demand patterns throughout the LLITM 2014 Base model.

3.4.4 The following tests were applied to the RSI records:

- **Test 1**: Using GIS, is the origin-destination movement via the survey site logical? A separate analysis was undertaken for each RSI site, comparing the origin and destination locations for each surveyed record.
- **Test 2**: Taking into account vehicle type, is the reported vehicle occupancy plausible (for car, a maximum occupancy of 7 was allowed)?
- **Test 3**: Is the reported return time consistent with reported outbound time, and whether the trip is reported to be ‘from home’ (i.e. outbound) or ‘to home’ (i.e. returning)?
- **Test 4**: Is the reported trip purpose logical? For example, home-to-home trips, which would not be assigned in a network model.
- **Test 5**: Is the reported trip time missing?
- **Test 6**: Is the reported vehicle type missing?
- **Test 7**: Is the reported vehicle occupancy missing?
- **Test 8**: Is the reported origin purpose missing?
- **Test 9**: Is the reported destination purpose missing?

3.4.5 Of the 156,602 RSI records from 159 RSI sites, Table 3.2 summarises the numbers of records flagged as either having logical errors, or having missing data.

Table 3.2: Summary of RSI Record Data Checks

Test	# Records	%
Test 1	12,133	7.75%
Test 2	10	0.01%
Test 3	8,659	5.53%
Test 4	619	0.40%
Total Errors	***12,595***	***8.04%***
Test 5	0	0.00%
Test 6	12	0.01%
Test 7	5	0.00%
Test 8	5	0.00%
Test 9	39	0.02%
Total Missing	***60***	***0.04%***

4. Mobile network data

4.1 Introduction

4.1.1 When LLITM 2014 Base was specified, the LLITM project team was aware of the possibility of using mobile network data in developing travel demand matrices, but early efforts in using this information by a range of consultants had resulted in mixed outcomes and over-enthusiastic statements regarding data quality and its use in transport models.

4.1.2 A decision was therefore made to proceed with a full roadside interview (RSI) data collection programme, and to also investigate the use of mobile network data to support the matrix building process. The RSI data would provide a rich source of data with which to verify the processed mobile network data, also drawing on the local planning dataset developed by David Simmonds Consultancy, and 2009 Leicester and Leicestershire household survey data.

4.1.3 AECOM then entered into a contractual relationship with Telefonica under which the LLITM data were being used to review, verify, and refine Telefonica's processing assumptions in developing demand matrices from O2 mobile network data.

4.1.4 The resulting mobile network data provided by Telefonica for use in LLITM 2014 Base are segmented and disaggregated as far as can be confidently done using the mobile network data. The specification and overview of the processing is provided in this Chapter.

4.2 Mobile network data Specification

4.2.1 Following discussions with Telefonica and LCC, a specification for the provision of mobile network data was prepared, discussed below.

4.2.2 LLITM 2014 Base, as with most transport models, represents a typical average weekday (excluding Fridays) for a 'neutral' month (defined as April/May/June 2014 for weeks without bank holidays). The data were specified and provided for an average weekday, calculated using a month of data from 24th February to 23rd March 2014.

4.2.3 The following time periods were defined for the period in which trips start their journey (taking into account that LLITM 2014 Base is a tours-based model, with distinct off-peak$_{early}$ and off-peak$_{late}$ time periods):

off-peak$_{early}$ period	00:00 to 07:00;
AM Peak period	07:00 to 10:00;
Interpeak period	10:00 to 16:00;
PM Peak period	16:00 to 19:00; and
Off-peak$_{late}$ period	19:00 to 00:00.

4.2.4 These five time periods represent a complete, 24-hour, neutral average weekday, used for both the demand model and highway model matrix development. In addition, two peak hours of data were provided, to be used to calculate peak period to peak hour factors in the highway assignment model:

AM Peak hour	08:00 to 09:00; and
PM Peak period	17:00 to 18:00.

4.2.5 The vehicle types provided are:

- road vehicle trips excluding HGV: all car driver and passenger, motorcyclist, taxi, LGV, bus and coach trips (walking, cycling, rail and HGV are excluded); and
- Heavy Goods Vehicle (HGV) trips.

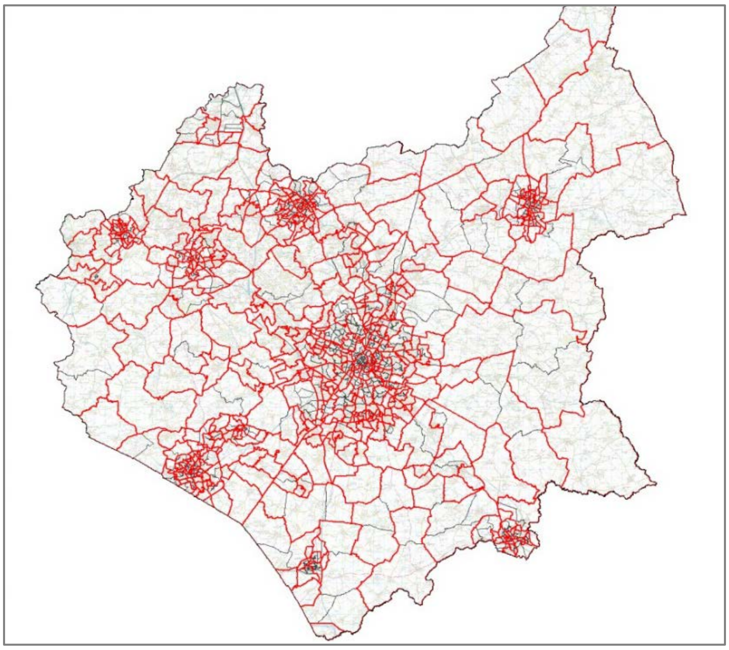
4.2.6 The non-HGV road vehicle mobile network data matrices are then split in the following purposes:

- home-based work (HBW) trips between a place of residence and a regular place of work;
- home-based other (HBO) trips between a place of residence and any other destination, including education trips; and
- non-home-based (NHB) trips between two points, neither of which is a place of residence.

4.2.7 The spatial accuracy of mobile network data varies with geographical context/location, and so LLITM 2014 Base zoning was aggregated to create a sector system, consisting of 628 sectors, with which Telefonica could use to provide the mobile network data. The sectors defined do not imply that mobile network data are spatially accurate at this level (tests were subsequently undertaken to establish the spatial accuracy).

4.2.8 Figure 4.1 shows the sectoring system defined for the provision of Telefonica mobile network data (red) and the LLITM 2014 Base zones (grey) for Leicester and Leicestershire.

Figure 4.1: Mobile network data Sectoring and LLITM 2014 Base Zoning



4.3 Mobile network data Verification

4.3.1 There is a technical note detailing the verification of the mobile network data. The methodology adopted for verification is summarised below; the technical note should be referred to for more detail[3].

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[3] Note that as part of a contractual agreement between AECOM and Telefonica, this note can only be shared with LCC, Highways England [now National Highways] and DfT.

Data Sources

4.3.2 Various sources of data were used to verify the processed mobile network data including:

- 2011 Census population data;
- 2011 Census Journey to Work (JTW) data;
- LLITM 2014 Base roadside interview (RSI) data;
- LLITM 2014 Base traffic count data;
- 2009 LLITM household survey data; and
- LLITM 2014 Base trip-end model estimates (based on revised 2014 local planning data).

Sector Systems for Analysis

4.3.3 To assess the spatial accuracy of the mobile network data, the 628 sector system discussed in Paragraph 4.2.7 was further aggregated to two further sector systems: S1 (mainly MSOA boundaries with more aggregation in Leicester, ~100 sectors) and S2 (aggregations of S1, ~40 sectors). These are shown in Figure 4.2 and Figure 4.3 below.

Figure 4.2: Geographical Definition of Defined Sectors (S1) within Leicestershire (~100 Sectors)

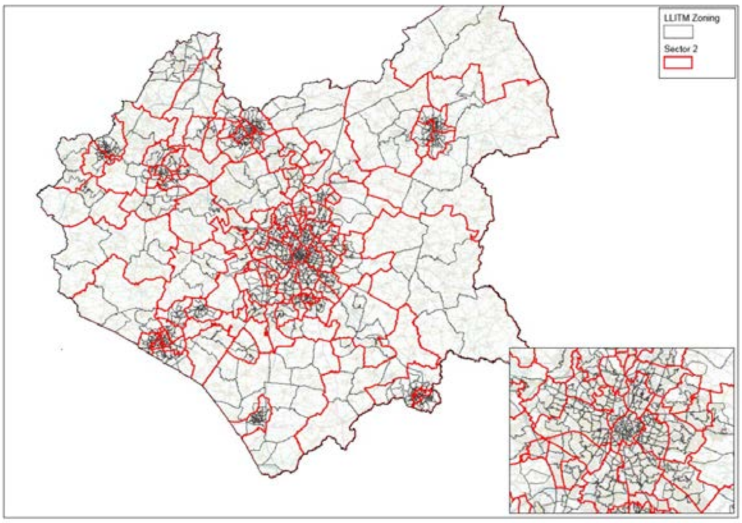
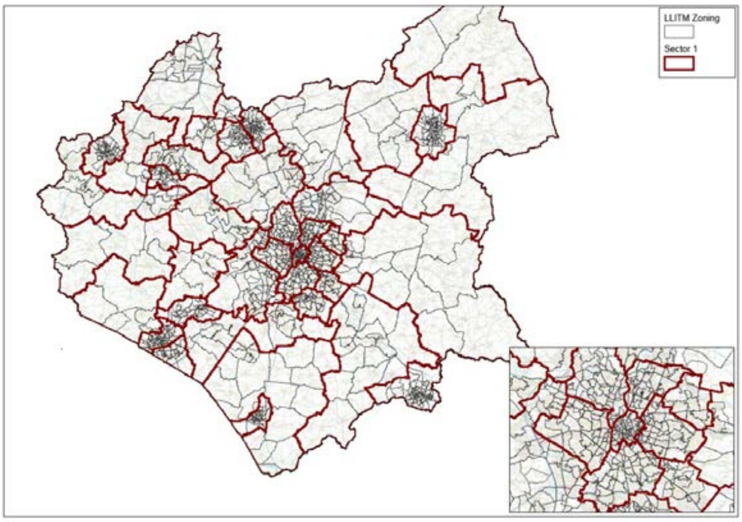


Figure 4.3: Geographical Definition of Defined Sectors (S2) within Leicestershire (~40 Sectors)



Analysis of Trip Ends

4.3.4 Comparisons were made for trip origins in the AM period and trip destinations in the PM period where the majority of trip-ends are expected to be the ‘home’ locations of travellers; these are therefore expected to be positively correlated with population. The results showed that trip-ends and population are highly correlated where about 96% of variation in trip-ends is explained by the population data.

4.3.5 The relationship between home-based work trip-ends from processed mobile network data and Census Journey to Work data in the two sectoring systems defined (see Figure 4.2 and Figure 4.3) was assessed. This analysis tends to compare the ‘home’ and ‘work’ location of commuters between the Census and those derived from mobile network data. In general, there was a good correlation between the two sources of data, taking into account various sources of error and inconsistency between data definitions.

4.3.6 To check and verify trip-ends for other trip purposes, mobile network data trip-ends were compared with estimates from the LLITM trip-end model, which are based on local planning and land-use data, separately for all home-based and non-home-based trips. These comparisons showed strong correlations of $\sim r^2=0.98$.

4.3.7 Overall, the comparison of trip-ends between mobile network data and independent sources of data showed a reasonably good correlation, suggesting a plausible distribution of trip-ends in mobile phone trip matrices.

Analysis of Trip Distribution Patterns

4.3.8 In order to verify whether patterns of trips derived from mobile network data are plausible, the distribution of home-based work trips in AM period from mobile network data was compared with the distribution of Census Journey to Work trips.

4.3.9 The results suggest that there is generally a good correlation between mobile network data and Journey to Work data in terms of trip distribution pattern of commuting trips. The correlation is much stronger when trip distribution is compared in district level.

Analysis of Trip Rates

4.3.10 The outturn person trip rates were calculated for mobile network data by dividing total trip origins in S1 sectors by the Census population.

4.3.11 On average, total number of trips per person is calculated to be about 2.35 and the highest trip rate (5.30) is found in Leicester City. The results suggest limited variation in trip rates between different sectors within Leicestershire. It should be noted that these trip rates include trips made by motorcycles, car, LGV and bus. The average trip rate calculated based on LLITM 2014 Base trip-end model results is about 2.06 (excluding trips made by bus, motorcycles and LGVs). The equivalent NTEM v6.2[4] trip rate for Leicestershire is 2.27.

4.3.12 Figure 4.4 shows the distribution of all day trip rates, calculated from mobile network data matrices, within Leicestershire. This shows a plausible distribution of trip rates where trip rates tend to be higher in Leicester City and other urban areas.

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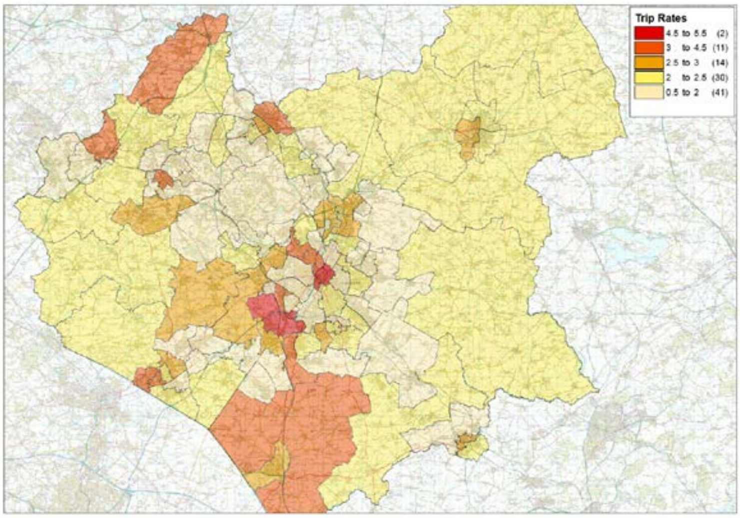
[4] At the time of mobile data verification, NTEM v6.2 was the live version of NTEM; since superseded by v7.2.

Figure 4.4: Distribution of All Day Trip Rates from Mobile network data Matrices



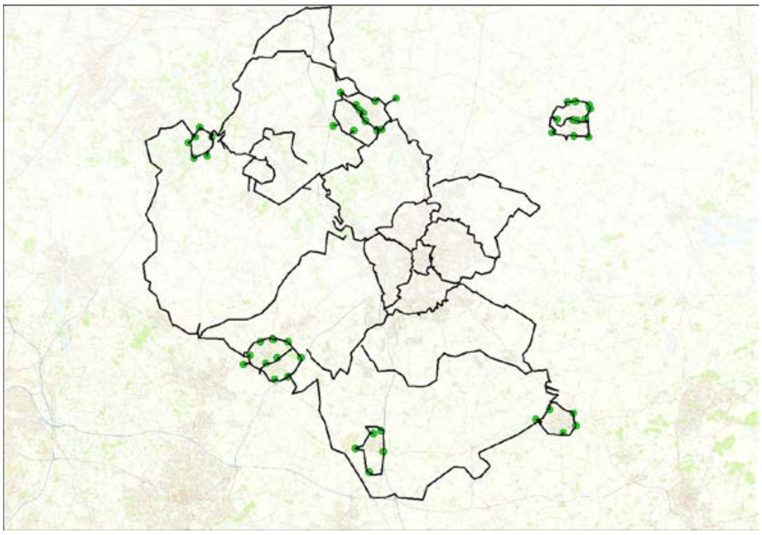
Comparison of Trip Length Profiles

4.3.13 Trip length profiles of the mobile network data compared with the 2009 LLITM household survey data and 2011 Census Journey to Work data were compared for home-based work trips. There is a reasonable correlation between the trip length profiles for both AM and PM periods. When estimation error is taken into account, the results suggest that trip length distributions of mobile network data are not different significantly (at 95% confidence level) from that based on other sources of data.

Comparison of RSI Data: Total Inbound Trips

4.3.14 The availability of RSI data for a number of market towns in Leicestershire provided the opportunity to define cordons and compare the expanded number of trips and trip patterns for these cordons between mobile network data and RSI data. Figure 4.5 shows the location of RSI sites and cordons used for this comparison; these include Ashby-de-la-Zouch, Loughborough, Hinckley, Lutterworth, Market Harborough, and Melton (these were the only complete cordons available at the time of the analysis, as the RSI data collection programme was still ongoing).

Figure 4.5: RSI Cordons used for Comparison with Mobile network data Trips



4.3.15 Taking into account the inconsistencies and errors of the mobile network data and RSI data, the results showed a reasonable level of correlation between trips estimated from these two independent data sources. There was no evidence suggesting any systematic bias in mobile network data trip estimates and that all estimates were distributed randomly around the regression line with a reasonably high value of r^2.

Comparison of RSI Data: Total Distribution Pattern

4.3.16 In order to verify the pattern of trips derived from mobile network data, the distributions of trips entering the cordons by origin sector were compared between RSI data and mobile network data. A correlation analysis was undertaken, separately for each cordon, and for each available purpose (home-based work, home-based other, non-home-based) where correlation coefficients between the two sources of data were calculated.

4.3.17 A consistently high value of correlation coefficient (r^2) confirmed a very similar pattern of trips between estimates from mobile network data and RSI data across all three trip purposes assessed.

5. Highway Journey Time Data

5.1 Introduction

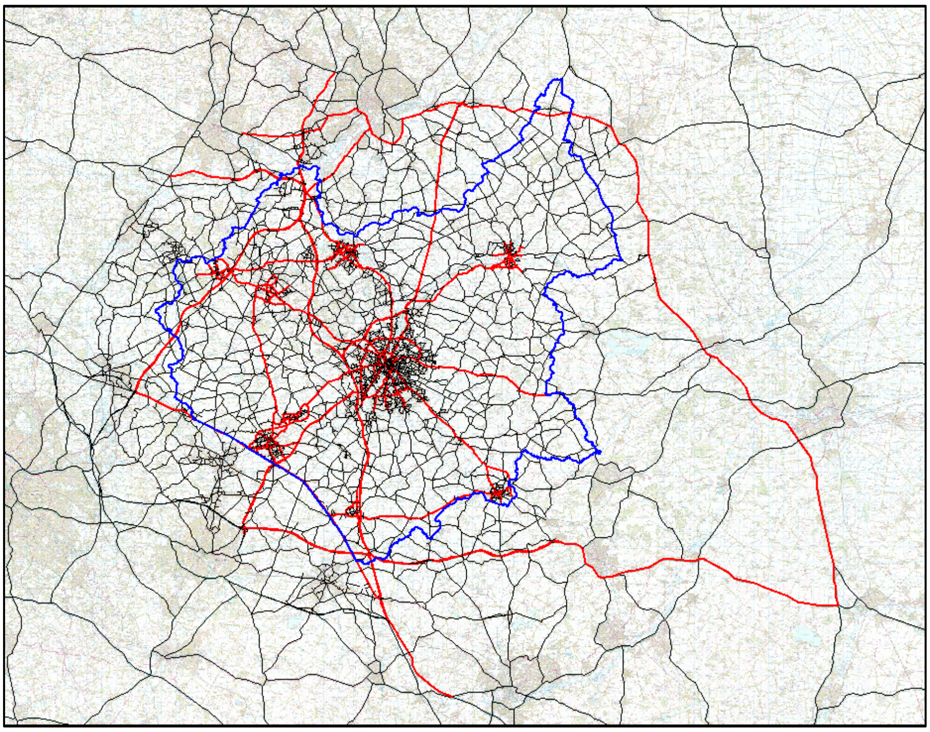
5.1.1 This chapter details the processing of Trafficmaster and HATRIS journey time data for use in the validation of the highway journey times within LLITM 2014 Base. These data have been used to create observed journey time data for a number of routes within the model in the AM Peak hour (08:00 to 09:00), average interpeak hour (10:00 to 16:00) and PM Peak hour (17:00 to 18:00).

5.1.2 Within the LLITM 2014 Base highway journey time dataset, a total of 150 routes (i.e. 75 routes each in two directions) have been defined within Leicester City, Leicestershire and the surrounding areas. These can be summarised as:

- 32 routes within Leicester City and the Principal Urban Area;
- 18 routes within Charnwood, including 12 routes within Loughborough;
- 12 routes within Melton Borough, including 10 routes within Melton Mowbray;
- 18 routes within Harborough, including 6 routes within Market Harborough and 6 routes within Lutterworth;
- 24 routes within Hinckley and Bosworth, including 10 routes within Hinckley and 8 routes within Barwell / Earl Shilton;
- 24 routes within North-West Leicestershire, including 10 routes within Coalville and 8 routes within Ashby; and
- 22 routes along the Strategic Road Network (SRN).

5.1.3 These journey time routes can also be seen in Figure 5.1.

Figure 5.1: Location of LLITM 2014 Base Highway Journey Time Routes



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5.1.4 The remainder of this chapter discusses the processing of the Trafficmaster and HATRIS journey time data, and the collation of these two data sources to form the journey time dataset used for the highway model validation within LLITM 2014 Base.

5.2 Processing of Trafficmaster Journey Time Data

5.2.1 Trafficmaster journey time data have been provided for all links within Leicester City and Leicestershire. These data have been provided attached to Integrated Transport Network (ITN) mapping for Leicester City and Leicestershire. This means that observed journey time data are available for each link within the ITN, providing a detailed dataset from which to construct observed journey times.

5.2.2 The process of generating journey times from the Trafficmaster data includes the following tasks:

- the definition of journey time routes in the ITN;
- the calculation of average and 95% confidence interval journey times for the selected ITN links; and
- the mapping of these ITN link to the SATURN highway network.

Creating Journey Time Routes in the ITN

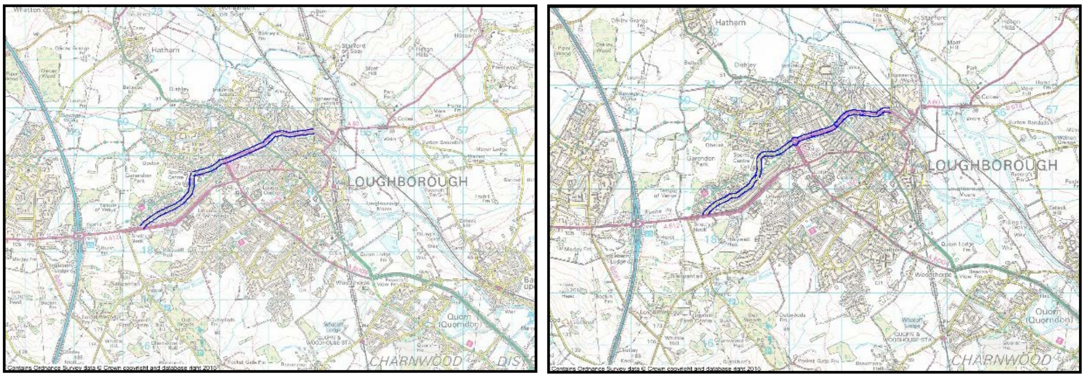
5.2.3 The journey time validation routes have been defined within the SATURN network. These routes therefore need to be replicated within the ITN to identify the links within this network which make up the defined journey time routes.

5.2.4 To do this Dijkstra’s algorithm has been applied on the ITN, creating trees within a network from a start location, finding the shortest route from the origin to each node within the network. Once the desired end location has been reached, this process provides the shortest path between the start and end locations within the network.

5.2.5 For some journey time routes, the route definition does not follow the shortest path between the start and end locations. For example, the shortest path between the start and end points on a journey time route which follows a bypass of an urban area is often a direct route through the urban area itself. To account for this a number of intermediate points have been defined for some journey time routes to ensure that the route selected within the ITN is the same as that defined within the SATURN network.

5.2.6 With Dijkstra’s algorithm applied, each journey time route defined in the ITN has been reviewed to ensure that the route definition is the same as that defined within the SATURN highway network. Figure 5.2 shows an example of this comparison for a journey time route within Loughborough.

Figure 5.2: Example of SATURN (left) and ITN (right) Journey Time Route Definitions

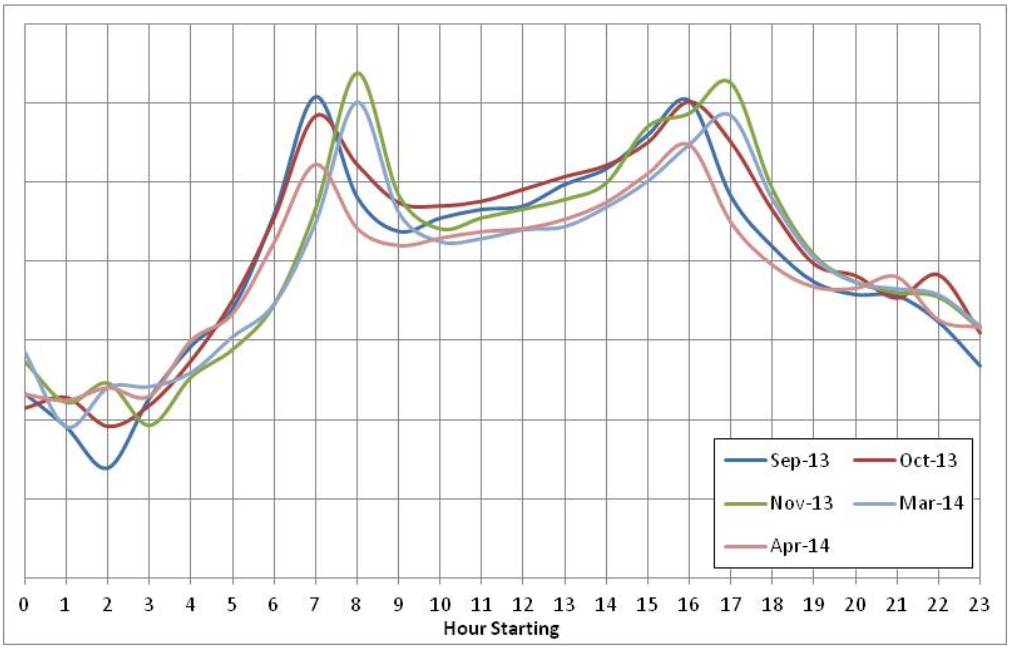


Processing Trafficmaster Journey Time Data

5.2.7 With the links within the ITN selected for each journey time route, the observed journey time data for each link is processed for use in the journey time validation. This process uses Trafficmaster journey time data for April, May and June 2014, with only weekdays (Monday-Thursday) which do not fall in a week containing a Bank Holiday retained within the source dataset.

5.2.8 At this stage the journey time data are also adjusted for British Summer Time (BST). All Trafficmaster journey time data are recorded using Greenwich Mean Time (GMT), and so for data within April, May and June 2014 this adjustment is required. Figure 5.3 shows the aggregate journey times within Leicester City for all routes in a selection of months. This shows that in March and November the peak journey time in the morning is during 08:00 and 09:00 GMT as expected. However, the raw data for April, September and October shows a peak journey time between 07:00 and 08:00 GMT, which requires adjustment to 08:00 until 09:00 BST.

Figure 5.3: Aggregate Journey Time Data Showing GMT and BST Adjustment Required



5.2.9 For each ITN link and modelled time period the average journey time, the standard deviation in journey times and the number of observations is calculated. Using the count of the number of observations and the Student's t-distribution for a 95% confidence interval, the t-value for each link and time period can be calculated.

5.2.10 This t-value is then used in the following equation to calculate the upper and lower 95% confidence intervals on the observed journey time data by link and time period;

$$Upper / Lower = Avg \pm \left(\frac{StDev}{\sqrt{Count}} \right) * TValue$$

5.2.11 These average journey times, along with the 95% upper and lower confidence intervals are then output for each link in the ITN which forms part of the definition of a journey time route. The final stage of the process is to allocate these observed data to the SATURN network.

Mapping ITN Links to SATURN Links

5.2.12 For each journey time route we have a definition both in terms of SATURN links and ITN links, and a correspondence between the two networks is required. This process uses the coordinates of nodes within both route definitions to determine if a SATURN and ITN node are likely to represent the same location.

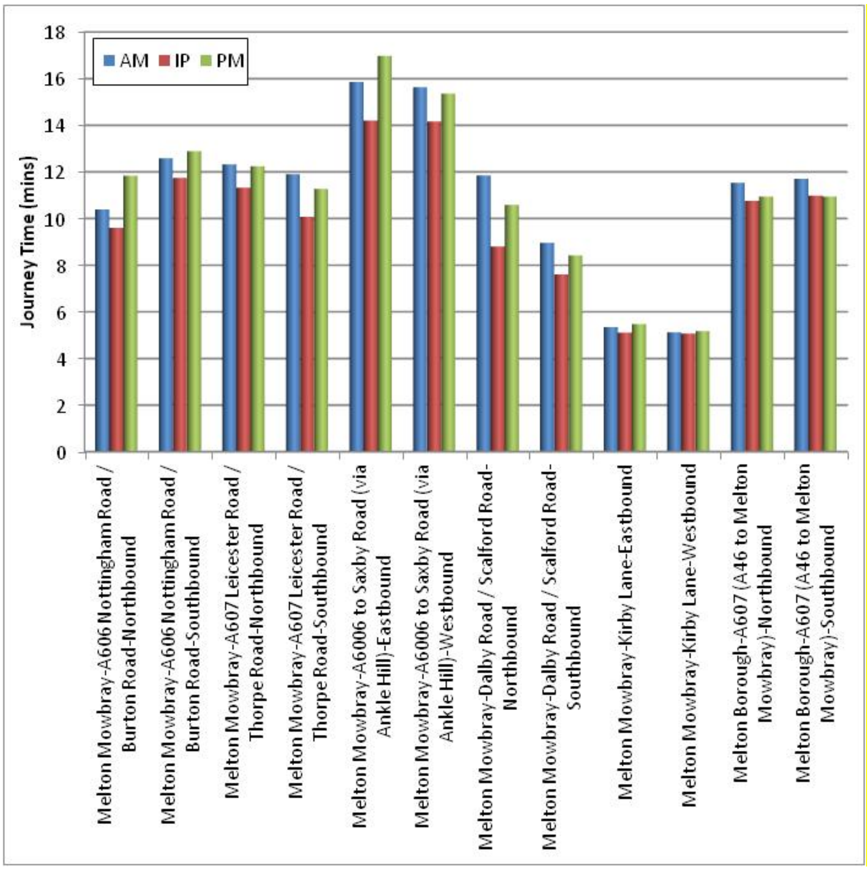
5.2.13 This process works by looking at each route in turn, and works along the journey time route using the SATURN links. If the B-node of a given SATURN link is within a given threshold (assumed to be 25m) of the B-node of an ITN link, then we assume that the B-nodes of both networks represent the same location. In this case, the ITN link is mapped to the corresponding SATURN link, and this forms a timing point in the journey time validation.

5.2.14 To ensure that the final timing point is at the end of both route definitions, the last ITN link in the journey time route is automatically matched to the final link in the SATURN definition irrespective of the distance between the B-nodes of these two links.

5.2.15 With the matching process undertaken for all journey time routes, the observed data are aggregated across timing points to provide the combined journey time data between timing points in the SATURN network. This processed journey time data have then been reviewed to consider the variation in journey times across the three modelled hours.

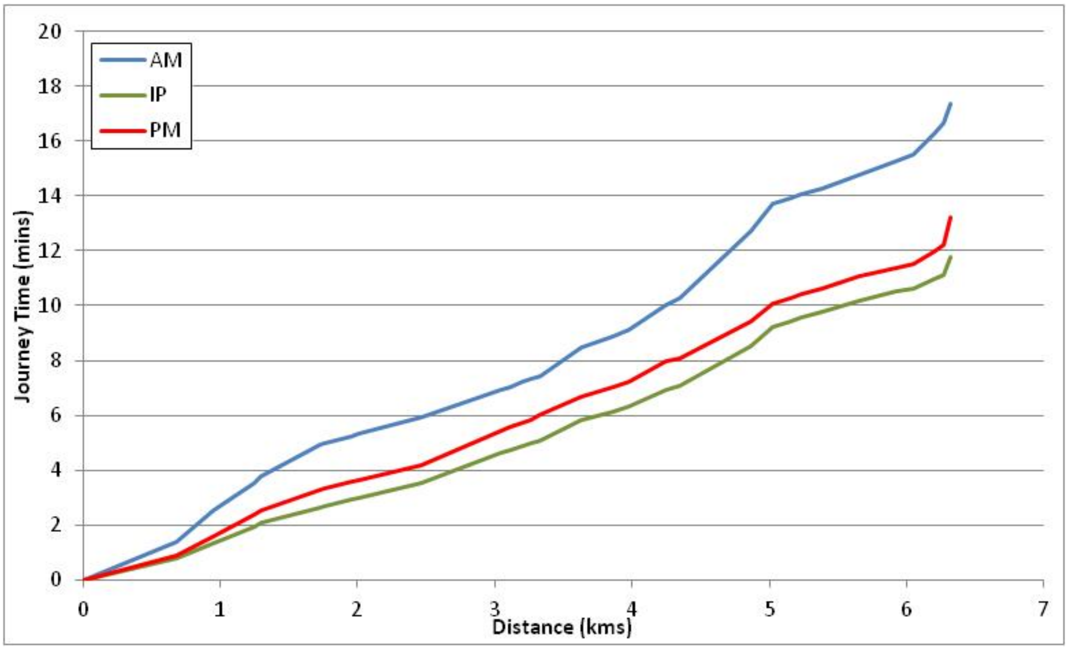
5.2.16 For example, Figure 5.4 shows the review of the total route journey times for the three modelled hours for routes within Melton Borough. This shows that in general the interpeak journey time is the quickest journey time across the three time periods, and for locations where there is a significant difference in traffic flows by direction in the two peaks, the relative levels of AM Peak and PM Peak journey times has also been reviewed.

Figure 5.4: Journey Time Route Totals for Melton Borough



5.2.17 In addition to reviewing aggregate journey times, the journey times for each route have been reviewed across the three modelled time period. Figure 5.5 shows an example of this review for the A6 inbound route within Leicester City from Birstall. This shows that the AM Peak has the longest journey time of the three time periods, with the PM Peak being slower than the interpeak. From this figure it is also possible to identify areas of congestion, such as at the end of the journey time route (as the route reaches the A594) where there is delay in all three time periods.

Figure 5.5: Example Route Journey Time Review: Leicester City A6 Birstall Inbound



5.3 Processing of HATRIS Journey Time Data

5.3.1 Journey time data from HATRIS are provided at a more aggregate level than is available within the Trafficmaster data, and are only available for the SRN. In general, HATRIS data provide the journey times between major junctions along SRN routes, with no detail on the variation of journey speeds within HATRIS journey time sections.

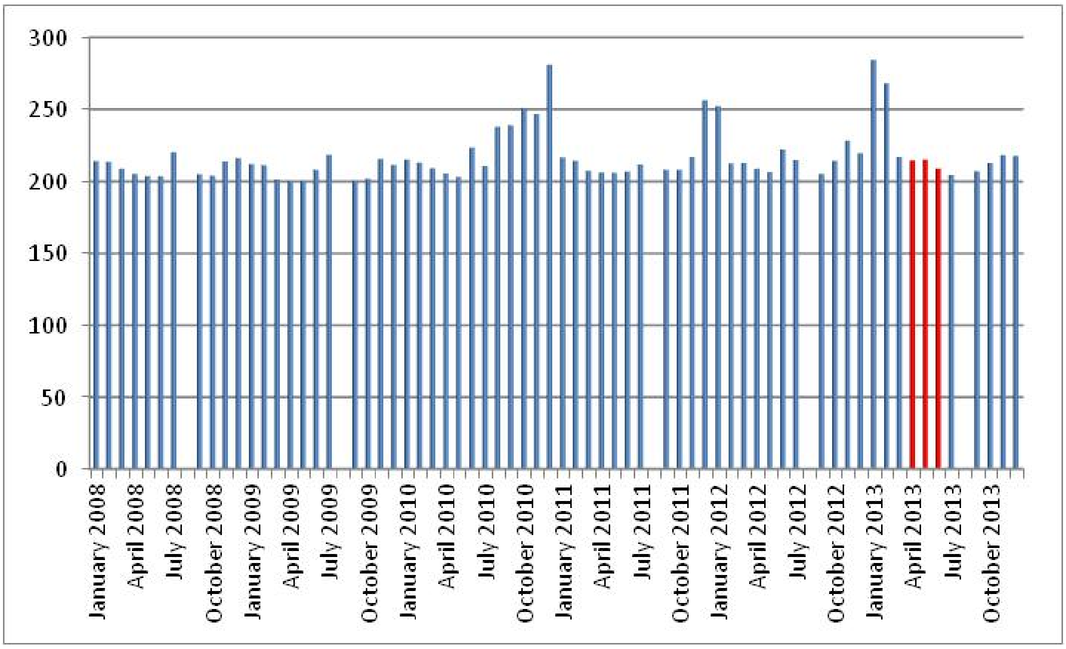
5.3.2 The first stage of the processing is to select all the HATRIS journey time route sections required to cover the selected SRN routes to be included in the LLITM 2014 Base highway model validation. With these sections selected, the journey time data can then be processed for use in the model validation.

5.3.3 For the selected HATRIS route sections, the average journey time by modelled time period has been calculated using the April, May and June 2013 journey time data. This includes only weekdays on weeks which do not contain a Bank Holiday. 2014 data were not available at the time of the analysis.

5.3.4 As with the processing of the Trafficmaster data, the 95% upper and lower confidence intervals have been calculated using the Student's t-distribution and the number of observations in for each HATRIS section in a given time period. These are calculated using the same equation as given in Paragraph 5.2.10.

5.3.5 At the time of processing, detailed HATRIS data were available from January 2008 until December 2013. Analysis has been performed to look at the variation in journey times through these six years of data. Figure 5.6 shows an example of this analysis for the M1 southbound between Junctions 20 and 19 in the PM Peak hour, with the columns highlighted in red being those used for the LLITM 2014 Base journey time dataset.

Figure 5.6: Example HATRIS Journey Time Variation: M1 Junction 20 to 19 PM Peak



5.3.6 With the data processed, each HATRIS section used within the model is assigned to the corresponding SATURN link which defines the end of the given HATRIS section. These links define the timing points within the journey time validation process.

5.4 Collation of Trafficmaster and HATRIS Journey Time Data

5.4.1 For the majority of routes there is only one data source available for highway journey time data. Within the county, all non-SRN routes only have observed data from Trafficmaster, and outside the county Trafficmaster data have not been provided and so HATRIS is the only source of information. However, for the SRN routes inside the county boundary we have estimates of journey times from both HATRIS and Trafficmaster. There is therefore a question as to which data source to use for these locations; this is discussed below.

Variation in Leicestershire SRN Journey Times from HATRIS and Trafficmaster

5.4.2 Trafficmaster and HATRIS data have been processed using the same processes for the sections of the SRN which fall within Leicestershire. This allows a direct comparison between the two data sources for these sections and routes.

5.4.3 Table 5.1 shows the results of this comparison between Trafficmaster and HATRIS journey time data. A column showing the length of the two journey time routes (Trafficmaster and HATRIS) has been included within this analysis. This is due to the fact that the definition of the start / end points of the HATRIS journey time sections are not precise, and so an assumption has had to be made as to the corresponding location within the ITN. In general, the start / end points of sections have been assumed to be around the mid-point between the off- and on-slips at a given junction.

5.4.4 Across the five SRN routes contained within the comparison, there is general consistency between the journey time route lengths. In general the differences between journey time route lengths are less than 0.5%, with two outliers for the M69 northbound and the A46 southbound.

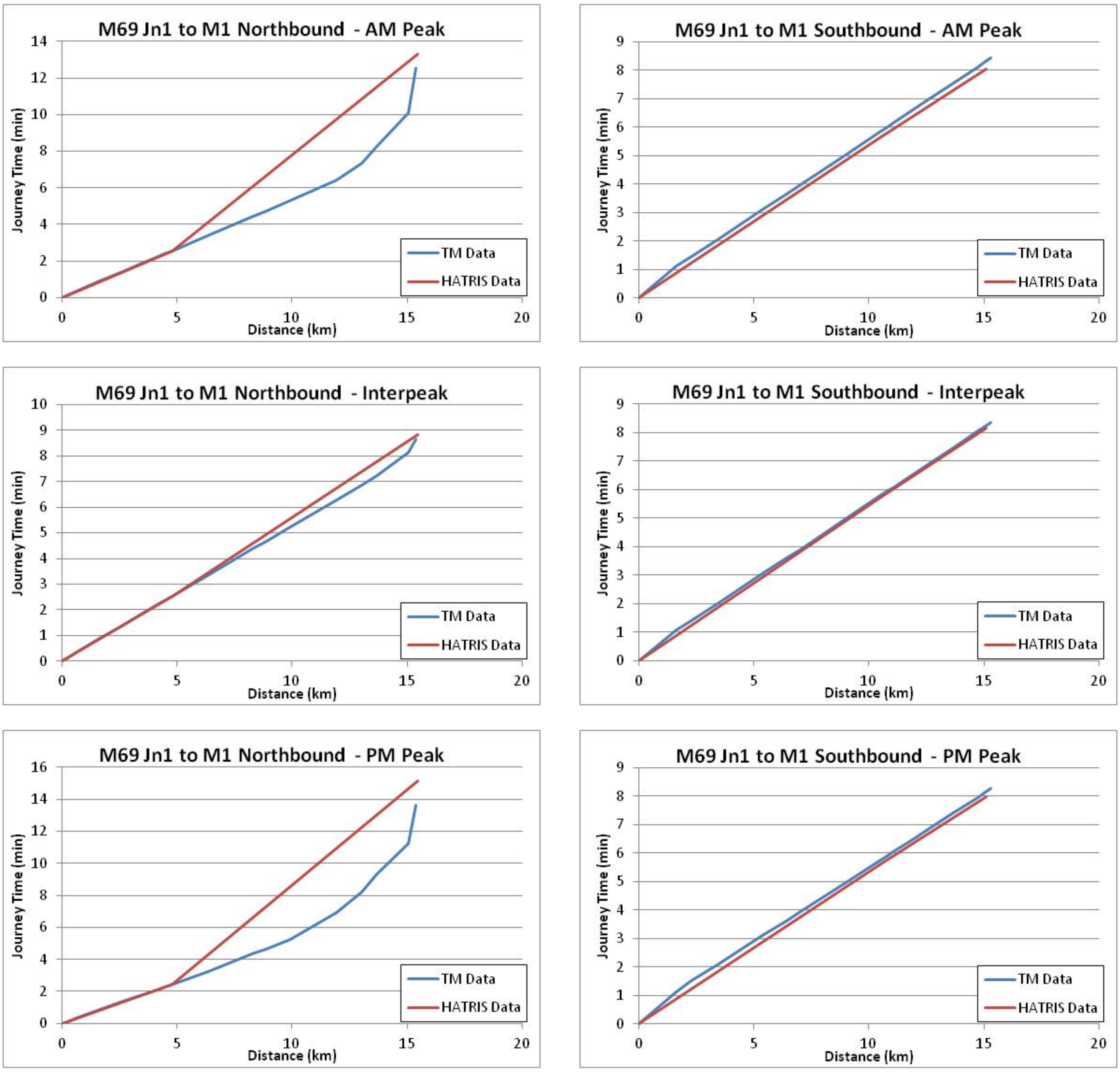
5.4.5 In general the Trafficmaster journey times are slower than those contained within the HATRIS data, with the larger discrepancies present on A-roads where there are at-grade junctions. This is particularly noticeable on the A5 and A46 comparisons, which have consistently higher journey times in the Trafficmaster data compared with the HATRIS data.

Table 5.1: Comparison of Trafficmaster and HATRIS SRN Journey Times

Route	Direction	Source	Length (km)	AM	IP	PM
M1: Jn19 to Jn24a	Northbound	TM	55.07	30.90	32.86	40.27
		HATRIS	55.07	30.03	31.24	38.42
		%Diff	0.0%	2.9%	5.2%	4.8%
	Southbound	TM	55.52	35.86	31.66	32.29
		HATRIS	55.53	35.52	31.42	32.66
		%Diff	0.0%	1.0%	0.8%	-1.2%
M69: Jn1 to M1	Northbound	TM	15.38	12.54	8.66	13.64
		HATRIS	15.47	13.32	8.82	15.12
		%Diff	-0.6%	-5.8%	-1.8%	-9.8%
	Southbound	TM	15.31	8.43	8.37	8.26
		HATRIS	15.11	8.04	8.17	7.99
		%Diff	1.3%	4.9%	2.5%	3.4%
M42 / A42: A444 to M1	Northbound	TM	23.23	13.89	14.16	14.08
		HATRIS	23.20	13.33	13.28	13.52
		%Diff	0.1%	4.2%	6.6%	4.2%
	Southbound	TM	23.37	14.96	13.88	13.82
		HATRIS	23.42	13.53	13.37	13.31
		%Diff	-0.2%	10.6%	3.8%	3.9%
A46: M1 to A606	Northbound	TM	30.09	19.91	18.33	22.77
		HATRIS	29.82	17.45	17.32	18.76
		%Diff	0.9%	14.1%	5.8%	21.3%
	Southbound	TM	29.79	22.86	18.28	18.09
		HATRIS	30.20	19.70	17.74	17.55
		%Diff	-1.4%	16.1%	3.0%	3.1%
A5: A426 to A47	Eastbound	TM	19.05	18.38	16.78	17.39
		HATRIS	18.98	16.50	15.39	15.65
		%Diff	0.3%	11.4%	9.0%	11.1%
	Westbound	TM	18.99	18.25	17.08	23.42
		HATRIS	19.00	15.71	15.27	17.88
		%Diff	-0.1%	16.1%	11.8%	31.0%

5.4.6 Considering a couple of routes in more detail, Figure 5.7 shows the comparison of Trafficmaster and HATRIS journey time data both northbound and southbound on the M69 between Junction 1 (Hinckley) and the M1 in the three modelled time periods. Figure 5.8 shows the same comparison but for the A46 between the M1 and the A606.

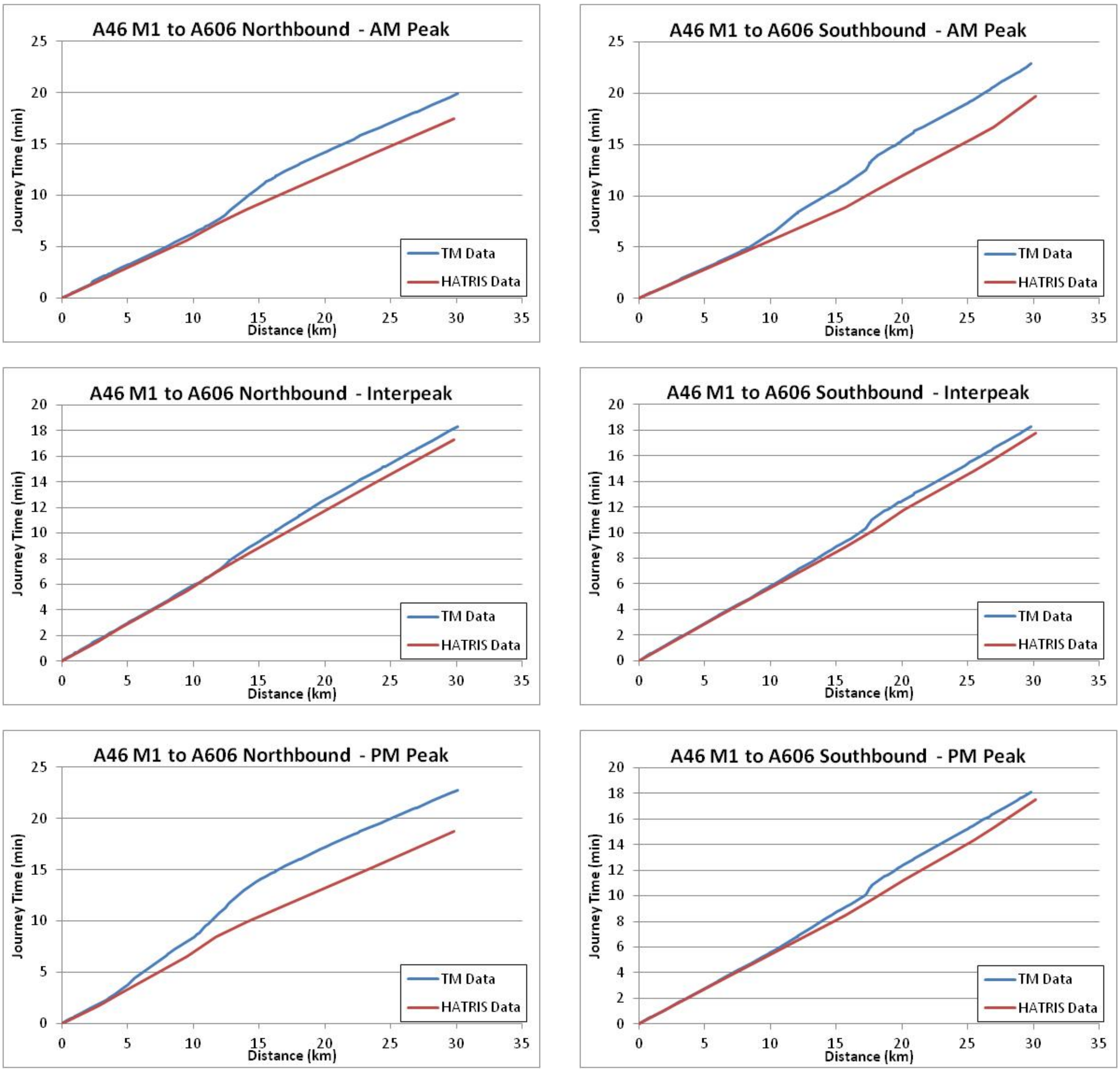
Figure 5.7: Comparison of Trafficmaster and HATRIS Journey Times: M69 Junction 1 to M1



5.4.7 Considering Figure 5.7, in both directions there is a good consistency in terms of overall travel times, particularly southbound, with Trafficmaster journey times generally being lower in the northbound direction compared with HATRIS data.

5.4.8 It is worth noting that there are only two HATRIS journey time sections which make up this journey time route, compared with 16 or 17 ITN links within the Trafficmaster data (depending on direction). This gives more detailed information on where delays are accrued in the Trafficmaster data, which can be seen in the northbound direction comparisons in Figure 5.7 where the delays build as the route approaches the junction between the M69 and the M1.

Figure 5.8: Comparison of Trafficmaster and HATRIS Journey Times: A46 M1 to A606



5.4.9 Considering the A46 comparison, there is a large difference between the Trafficmaster and HATRIS journey time data for this route. In both directions, and consistently across modelled time periods, there are locations where the Trafficmaster journey time data show additional, localised delay compared with the HATRIS data.

5.4.10 An example of this is at around 17 to 18 kilometres along the southbound journey time route. This is at the Hobbyhorse Junction between the A46 and the A607, where there are a number of ITN links representing the junction itself where the observed speed is around 30kph. This is compared within observed speeds of around 90kph and 100kph to the north and west of this junction.

5.4.11 Similarly, there is also delay evident northbound at around 13 to 15km along the route which is the section of the northbound journey time route passing through the Hobbyhorse Junction. Analysis of the A5, which has similar “steps” in the observed Trafficmaster data shows that these occur on the eastbound and westbound journey time routes as they pass through Junction 1 of the M69, and again in the westbound direction in the vicinity of the junction with the A47 near Hinckley.

5.4.12 These locations are known congestion areas on the SRN within Leicestershire, and therefore we would expect to see delays in the observed journey time data at these locations. These delays are evident in the Trafficmaster data, but do not appear to be present to the same extent in the HATRIS data. On this basis, Trafficmaster data are to be used for the journey time data along the SRN within Leicestershire, supplemented with HATRIS data for sections of the SRN outside the county boundary.

6. Bus Electronic Ticket Machine Data

6.1 ETM Data Received

6.1.1 Electronic ticket machine (ETM) data have been collected from nine bus operators in Leicestershire. Between them, they cover an estimated 99% of public scheduled local bus services that operate in Leicester or Leicestershire. The missing data are primarily from two operators, Midland Classic and Travel De Courcey (about 1% in total), that each operate a few bus journeys per day into Leicestershire from outside the county.

6.1.2 The coach operators, National Express and Megabus, were also not approached for data. Coach journeys represent about 1% of total scheduled bus journeys in the county.

6.1.3 The data are summarised below. 'Daily Journeys' refers to vehicle trips, not number of passengers.

Table 6.1: ETM Data – Data Collected by Bus Operator

Operator	Services Operated	Daily Journeys	Operating Area	Total Passenger Records
Arriva	68	2,823	Leicester and Leicestershire	4,906,481
First	19	1,406	Leicester only	2,847,370
Centrebus	33	790	Leicester, Melton, Market Harborough	776,921
Kinchbus	7	597	Loughborough	881,211
Stagecoach	4	583	Hinckley, Leicester, Inter-town	486,572
Roberts Coaches	7	268	Park-and-Ride, Inter-town	188,647
Paul S Winson	5	124	Loughborough	70,191
NCT	1	84	Nottingham - Loughborough	272,865
Macpherson Coaches	3	33	Ashby-de-la-Zouch	43,473
Total	**149**	**6,708**	-	**10,473,731**

6.1.4 Although there is variation in the format of data provided, the bus operators have generally provided record-based data, containing one passenger boarding or other event per record. This generally covers most of the following:

- bus service number;
- bus journey departure time;
- boarding event time;
- ticket type;
- fare paid;
- boarding stage identifier; and
- alighting stage identifier (certain ticket types only).

6.1.5 In principle, the data cover all passenger boardings, including concessions, use of return tickets, and use of smartcards and other passes, as well as actual ticket sales. Comparison with other data sources suggests that the substantial majority of boardings are included (at least 90%), but it is possible there is limited non-recording of boardings where no ticket sale occurs.

6.1.6 Two operators, Kinchbus and Nottingham City Transport (NCT), provided boarding information by NaPTAN[5] bus stop code. All other operators used only their own fare stage codes which identify a group of bus stops in the same general area (such as ‘Loughborough University’).

6.1.7 Four operators provided significantly different data formats:

- Macpherson Coaches provided only total passengers and fare by a few ticket types, with no bus service number or geographic information.
- Centrebus, Paul S Winson and Roberts Coaches provided matrix-based boarding / alighting data by service, containing total passengers by origin fare stage and destination fare stage. These data lack travel times, day of week, and breakdown into ticket types. Centrebus and Paul S Winson in addition provided separate summary tables containing passengers by service, date, and time of day, but without geographic data. Roberts provided no additional data.

6.1.8 With the exception of Centrebus, these are relatively minor operators with only a few services.

6.2 ETM Data Checking

6.2.1 The various ETM data received in varying formats were checked for completeness and consistency. There are uncertainties with the data, such as the local geographical detail of boardings and alightings (especially so with the latter), but this is the nature of ETM data, and an issue for processing (discussed in ‘*PR202 – LLITM 2014 Base Public Transport LMVR’*).

6.2.2 The services for which ETM data were received were compared against the timetable data in the model to identify services missing. These missing service were as follows:

- the Travel De Courcey service X6 between Leicester and Coventry;
- the Midland Classic services 19 and 19A between Ashby and Burton; and
- all Megabus and National Express coaches, all dedicated school buses, and non-scheduled and non-public services (e.g. coach excursions).

6.2.3 All other bus services were included.

6.2.4 The total trips in the ETM data were compared with the passenger interviews (discussed in Chapter 8), to validate both data sources. This comparison is shown in Table 6.2.

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[5] National Public Transport Access Node (NaPTAN)

Table 6.2: Trips by Town, Interviews versus Model Matrices, 07:00 to 19:00 Average Weekday

Town	Interview Counts, Boardings	Interview Counts, Alightings	ETM Data, Origins
Ashby-de-la-Zouch	550	466	424
Coalville	1,171	736	1,484
Hinckley	1,194	662	2,445
Loughborough	6,414	4,909	9,618
Lutterworth	217	122	336
Market Harborough	962	639	931
Melton Mowbray	1,287	494	1,955
Leicester	42,998	40,171	76,419
All	**54,794**	**48,199**	**126,715**

6.2.5 Note that we do not expect these totals in general be equal; inter-town trips will add boardings/alightings to two different towns, and the boarding/alighting counts do not include any trips not visiting urban centres. However, they should agree in broad order of magnitude of demand assuming the interview sites have been chosen to appropriately include the main central bus stops.

6.2.6 The correlation is fairly good, with there being a clear relationship between the interview totals and the model demand. In theory we should expect the ETM data always to be larger than the boardings derived from interviews (since the ETM data include all trips and the interview counts only those boarding in the centre). This is not quite true, but the two exceptions (Ashby-de-la-Zouch and Market Harborough) are only just exceptions and are probably within the sampling error that might be expected in the interview counts.

6.2.7 Overall, the ETM data exceeds the sum of the boardings and alightings, suggesting that there are more bus trips that do not use any urban centre bus stop than there are that use two. This appears plausible.

6.2.8 Trip lengths in the processed ETM data can also be compared with the National Travel Survey (NTS). The ETM data have an average crow-fly distance trip length of 4.2 kilometres, compared with 5.4 kilometres for NTS average total bus journey trip length in the East Midlands. This appears plausibly consistent given that crow-fly distances will be 20-30% shorter than actual travelled distance and the NTS figure will include some short access and egress (walk) legs as well.

7. Rail LENNON Ticket Data

7.1 LENNON Data

7.1.1 LENNON ticket data were obtained for the whole country for March 2014. These comprise 4.2 million records and 50 million ticket sales. They are a complete representation of all national rail tickets sold in the UK.

7.1.2 As with the bus ETM data, LENNON data are record based. However, they represent ticket sales rather than vehicle boardings.

7.1.3 LENNON data do contain some notable omissions regarding certain kinds of ticket and certain modes (e.g. underground, tram, Eurostar, Heathrow Express). However, these almost exclusively affect large metropolitan areas, especially London; so far as Leicester and Leicestershire are concerned, the data are effectively complete.

7.1.4 Table 7.1 shows the trips in the LENNON data by most frequently used ticket types, along with the number of tickets of that type sold in Leicestershire. These most common tickets represent about 87% of Leicestershire rail journeys; the data received, however, covered all rail journeys. Some ticket types in this list, for example, the “SEASONS VB 3” represent very few sales, but a large number of actual journeys, as they are season tickets with a long validity period.

Table 7.1: Breakdown of Ticket Sales by Common Ticket Types, Leicester and Leicestershire

Ticket	Sales
STANDARD DY RTN 2BAF	47,468
SEASONS VB 1 2MTA	1,593
SAVER RETURN HI 2BFP	30,982
CHEAP DY RTN HI 2BDY	25,103
7 DAY SEASON 2MQA	4,844
ANYTIME RETURN STANDARD 2BUA	12,135
SUPER OFF PK SSR 2BSO	11,518
STANDARD SINGLE 2AAA	22,372
SEASONS VB 3 2MTW	42
STD CHEAP SNGL 2ADA	13,063
REDUCED SINGLE2 2AGH	4,802

7.2 LENNON Data Checking

7.2.1 The LENNON data received were checked for completeness and consistency. There are uncertainties with the data, such as the expansion of ticket sales to trips, but this is the nature of LENNON data, and an issue for processing (discussed in ‘*PR202 – LLITM 2014 Base Public Transport LMVR*’).

7.2.2 Following processing into station-to-station trip matrices, the data have been compared with the Office of Rail and Road’s official station patronage statistics and other sources, as shown in Table 7.2.

Table 7.2: LENNON vs. ORR and NRTS, Rail Passengers Beginning Journey, Weekday

Station	ORR Annual	ORR Weekday	LENNON Data	LENNON vs. ORR	NRTS 2005	2015 Surveys
Barrow-Upon-Soar	44,687	150	149	-1%	78	116
Bottesford	23,711	74	67	-9%	-	-
East Midlands Parkway	164,223	511	485	-5%	-	881
Hinckley	143,326	446	394	-12%	631	495
Leicester	2,426,954	7,550	7,504	-1%	8,482	6,702
Loughborough	620,623	1,931	1,975	2%	2,736	1,554
Market Harborough	398,945	1,241	1,153	-7%	1,033	1,389
Melton Mowbray	120,573	375	344	-8%	572	475
Narborough	195,141	607	629	4%	363	356
Sileby	55,739	187	193	3%	133	208
South Wigston	33,329	104	101	-3%	86	69
Syston	87,805	295	306	4%	267	307
Totals	**4,315,056**	**13,471**	**13,300**	**-1%**	**14,381**	**12,553**

7.2.3 The ORR data are for annual trips. They have been corrected to average weekday using the numbers of days in a year combined with a weekend correction factor derived from NTS. The average weekend day has 63% of the rail demand of an average weekday; this has been used for all stations except Sileby, Syston and Barrow-upon-Soar. These stations have no Sunday service; for them, a weekend factor equal to the average Saturday relative to average weekday (86%), divided by two (43%), was used.

7.2.4 The comparison against ORR data are extremely good; this confirms that the LENNON data have been received, interpreted and processed correctly for LLITM. However, the ORR data are also based partly on LENNON, so this is not a wholly independent validation of LENNON itself as data source.

7.2.5 However, we also have comparisons available against the National Rail Travel Survey (NRTS) and a separate set of one-day passenger counts carried out for the LLITM 2014 Base model in 2015. Both of these are wholly independent of LENNON, although they certainly have their own weakness (the NRTS data are 11 years’ old, while the 2015 survey was for a single day and thus subject to quite large sampling error).

7.2.6 These data sources match less well against the LENNON data, as might be expected, but there is still a strong correlation, the overall totals compare well, and the LENNON data are quite often midway between the NRTS and 2015 survey values (e.g. Market Harborough, Loughborough, Leicester, Syston, Sileby).

8. Bus Passenger Interview Data

8.1 Bus Passenger Interview Data

8.1.1 Around 16,000 interviews of bus passengers were carried out in 2014 in urban centres in Leicester and Leicestershire. These recorded ultimate origin and destination information for the interviewed passengers' journeys, as well as travel purpose, household car ownership and times of day, including information on returning times for outbound trips. Associated boarding and alighting counts were collected to allow these interviews to be expanded.

Table 8.1: Bus Passenger Interview Locations

Town	Bus Stops	Survey Date
Ashby-de-la-Zouch	Market Street 1, 2 & 3	22/05/2014
Coalville	Ashby Road 1	04/06/2014
	Marlborough Square 6 & 7	04/06/2014
	High Street, opposite Family Planning Centre	04/06/2014
	Memorial Square 1 & 2	22/05/2014
	Memorial Square 5	04/06/2014
Hinckley	Regent Street R1 to R4	05/06/2014
	Bus Station W1 to W5	05/06/2014
Loughborough	Centre, Stands A,D-G,K-L,N-Q	15/05/2014 to 12/06/2014
	High Street C1,C2,B1,B	05/06/2014
	Railway Station, Stand R	12/06/2014
	University	12/06/2014
Lutterworth	George Street	22/05/2014
	High Street 1 & 2	10/06/2014
	Magna Park	10/06/2014
Market Harborough	Market Square 1 to 4	22/05/2014 to 10/06/2014
	Market Hall Bus Station	10/06/2014
Melton Mowbray	St Mary's Way S1 to S4	11/06/2014
	Wilton Road	11/06/2014
	Windsor Street W1 to W4	22/05/2014 to 11/06/2014
Leicester	Beaumont Leys, 1 to 7	20/05/2014
	Fosse Park	15/05/2014 to 24/06/2014
	All within Inner Ring Road (99)	06/05/2014 to 25/06/2014
	Leicester Railway Station	05/06/2014
	University of Leicester	03/06/2014
	Leicester General Hospital	20/05/2014

8.1.2 These data were used both to supply purpose, car ownership and travel time information for the demand matrices, and to validate and compare against the geographical distributions implied by the Electronic Ticket Machine (ETM) data.

8.1.3 The number of bus passenger interview records from each urban area is summarised in Table 8.2 below:

Table 8.2: Number of Bus Passenger Interviews by Urban Area

Town	Interviews
Leicester	12,541
Market Harborough	304
Melton Mowbray	581
Loughborough	1,231
Lutterworth	158
Ashby-de-la-Zouch	338
Coalville	454
Hinckley	443
Total	**16,050**

8.2 Bus Passenger Interview Data Checking

8.2.1 The bus passenger interview data were checked and reviewed for internal consistency and any apparent bias. Key observations are as follows, which were taken into account when developing trip matrices of bus demand, documented in '*PR202 – LLITM 2014 Base Public Transport LMVR'.*

8.2.2 Generally the interviewers did not interview under-16s. This means that the surveys understate school pupils using public buses.

8.2.3 The data are precise to variable levels of geographic detail. Some respondents gave actual postcodes, and their origins / destinations are thus correct to a high level of precision. However, many records were allocated roughly to a 'central' postcode by the surveyors based on a vague description by the interviewee (e.g. "shopping in the centre of Leicester"), meaning that the data are not precise at a zonal level. Due to the way the data have been coded, it is not possible to determine with certainty how precise any given record is, although general patterns can be identified.

8.2.4 About 20% of records are missing either origin or destination information altogether, and about 2% are missing both.

8.2.5 A question regarding time of day in which a reverse-direction trip was made was asked. This appeared to return reasonable results for passengers interviewed travelling from home, but not for passengers travelling to home; the question does not seem to have been correctly interpreted for returning passengers.

8.2.6 The data can be compared by town against the ETM data; this is shown in Table 6.2 in Chapter 6.

8.2.7 Average trip lengths have also been extracted for the interview data, shown in Table 8.3.

Table 8.3: Bus Trip Lengths by Purpose, Kilometres

Purpose	NTS In-vehicle	Interview Crow-Fly
HB Work	4.4	9.0
HB Business	4.4	10.8
HB Education	6.6	11.2
HB Shopping	4.4	7.5
HB Other	6.6	9.8
NHB Business	5.9	7.0
NHB Other	5.2	10.6
All	**5.4**	**9.3**

8.2.8 The comparison is poor; the more so when it is understood that the interview figures are for crow-fly (point to point) distances while the NTS ones are actual distance travelled. The interviews overstate trip lengths by about a factor of two.

8.2.9 There are a number of reasons for this:

- The interview data are derived from an intercept survey. Because they ’intercept’ travellers at a point (bus stops), they are more likely to capture longer trips than shorter trips. This is estimated to account for roughly half of the discrepancy shown in Table 8.3: the interview data tend to omit the shortest trips (those that get on and off the bus outside the urban centre), and count the longest trips (the inter-town ones) twice.
- The interview data contain a small number of extremely long trips. About 1% of the journeys in the data are longer than 100 kilometres. Since coach services were explicitly excluded from interviews, these clearly do not represent majority-mode bus trips and thus can be regarded as erroneous. Excluding this 1% reduces the average trip lengths by around 2 kilometres, and thus accounts for over a third of the discrepancy. The average home-based business trip length reduces from 10.8 kilometres to 8.5 kilometres when a single trip 160 kilometres long is excluded; this represents quite neatly one drawback to using the mean as a measure of average.
- There is likely to be some response bias in the interview data towards longer trips. Passengers travelling further will generally allow more time at the bus stop, leading to them being more likely to be interviewed. It is noticeable that the interviews do appear to have over-sampled non-home-based other trips, which tend to be longer than average. This could account for up to around a fifth of the discrepancy, though it is not thought to be the major influence because the purpose split recorded by the interviews is generally reasonably consistent with other sources.

9. Public Transport Count Data

9.1 Public Transport Count Data

9.1.1 Bus and rail patronage count data were obtained from a number of sources, as follows:

- Platform count surveys at all railway stations in Leicestershire (excluding Bottesford) plus East Midlands Parkway, conducted in Summer 2015.
- Leicester City LTP monitoring site data for 2014. These consist of link counts of bus passengers, conducted via a mixture of on-board and road-side surveys, around cordons and screenlines in the city. 2014 data were used where possible; some directions for some sites were only surveyed in 2013 or 2009.
- Bus passenger volumes counted in cordons around the seven market towns in 2013. These were conducted via on-board surveys. A few holes in these cordons were infilled with data collected in 2014.
- Bus boarding and alighting volumes collected as part of the LLITM 2014 Base bus passenger interview surveys in urban centres, collected in 2014 and discussed in Chapter 8.

9.1.2 Almost all the data used were from 2013, 2014, or 2015 (rail only). A very small number of Leicester City cordon counts had to be taken from 2009 data, but this only affected a few small sites. Bus data not from 2014 were factored to 2014 values using factors derived from annual bus patronage data obtained via LCC’s LTP monitoring process.

9.1.3 The adjustment factors are shown below. Loughborough is unusual in that bus patronage appears to have risen slightly since 2009; Hinckley on the other hand has seen a particularly large fall; the general trend has been for lower bus patronage post-2008, which is attributed to significant real growth in bus fares. Data were not available by town for the smaller market towns.

Table 9.1: Bus Passenger Flows, Adjustment Factors to 2014 Values

Area	2009	2013
Loughborough	0.9973	1.0135
Coalville	0.8842	0.9689
Ashby-de-la-Zouch	0.8842	0.9689
Lutterworth	0.8842	0.9689
Melton Mowbray	0.8842	0.9689
Hinckley	0.7834	0.9391
Market Harborough	0.8842	0.9689
Leicester	1.0515	0.9441

9.1.4 Count locations, derived from the LTP monitoring and bespoke survey data, are illustrated in the figures below. Stars represent boarding and alighting counts at bus stops (consistent with the interview location discussed in Section 8), while circles and squares represent link counts, the former in Leicester City (a combination of on-board and roadside surveys) and the latter in the market towns (all on-board).

9.1.5 Link counts are labelled with IDs. Boarding surveys are identified with one star per bus stop cluster rather than one star per bus stop.

Figure 9.1: Leicester Cordons, Screenlines and Boarding Surveys, City Centre

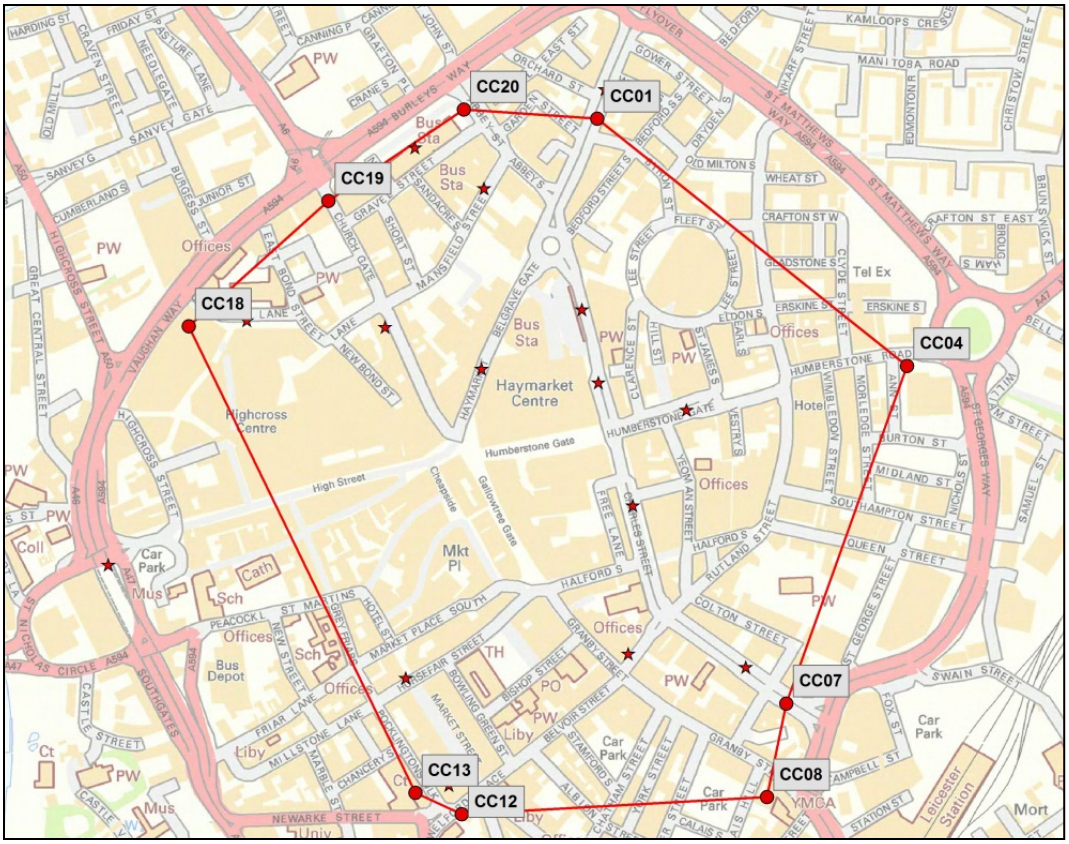


Figure 9.2: Leicester Cordons, Screenlines and Boarding Surveys, Inner

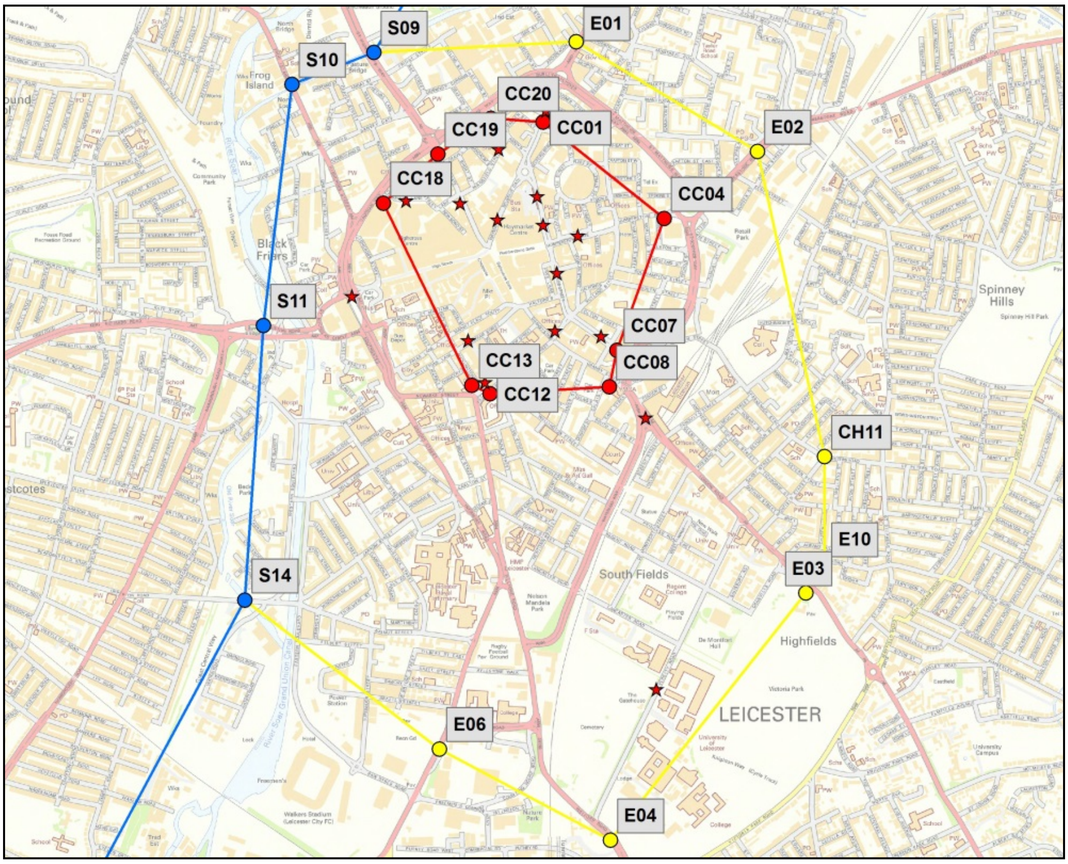


Figure 9.3: Leicester Cordons and Screenlines, Outer

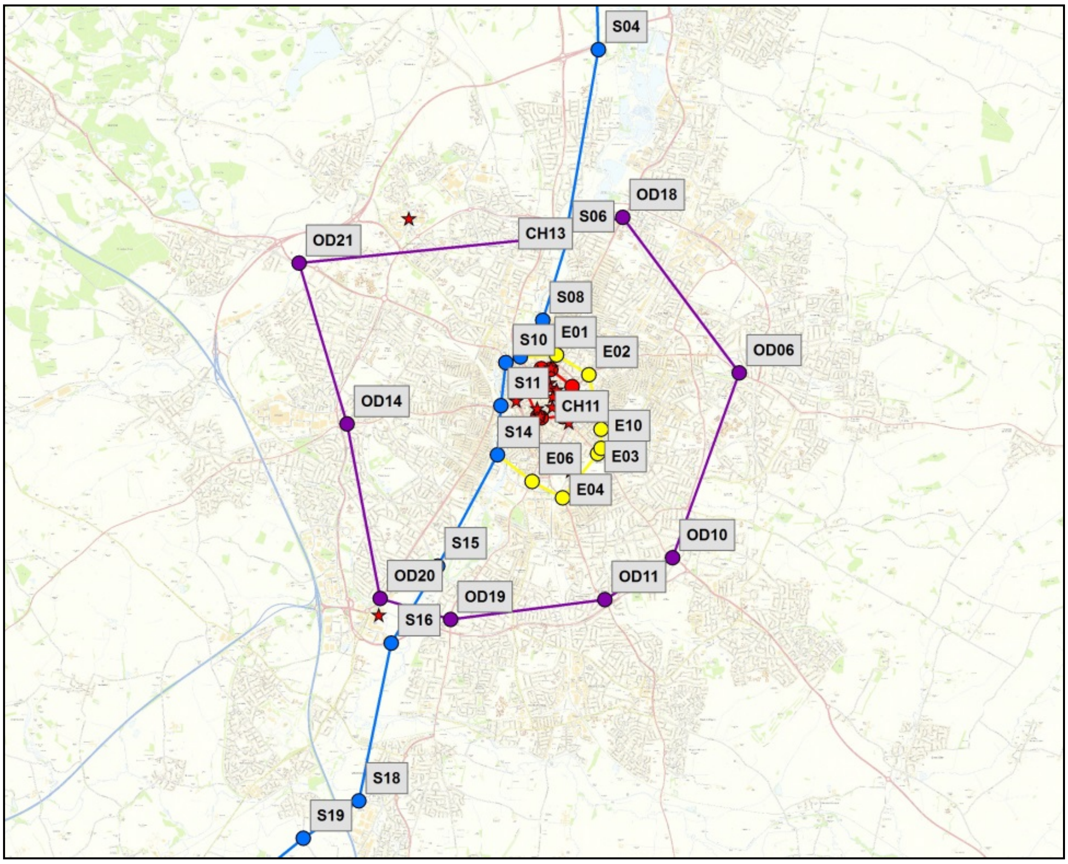


Figure 9.4: Loughborough Cordon and Boarding Surveys

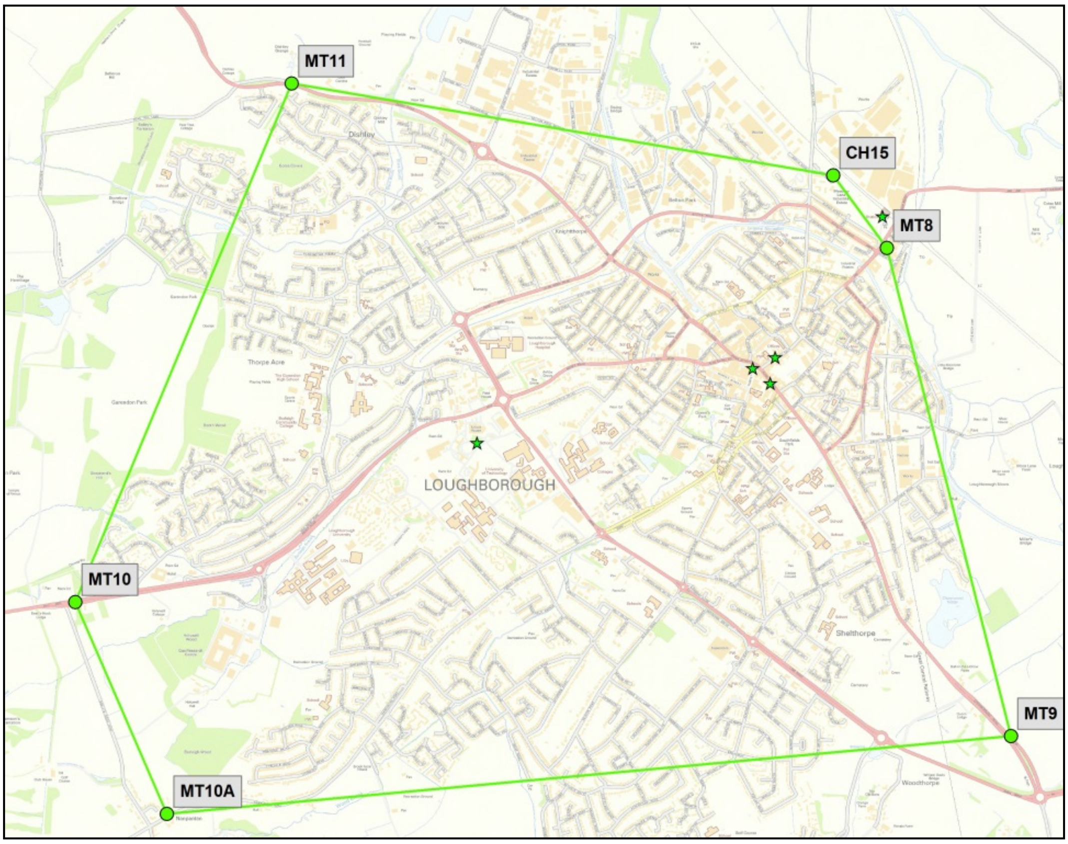


Figure 9.5: Melton Mowbray Cordon and Boarding Surveys

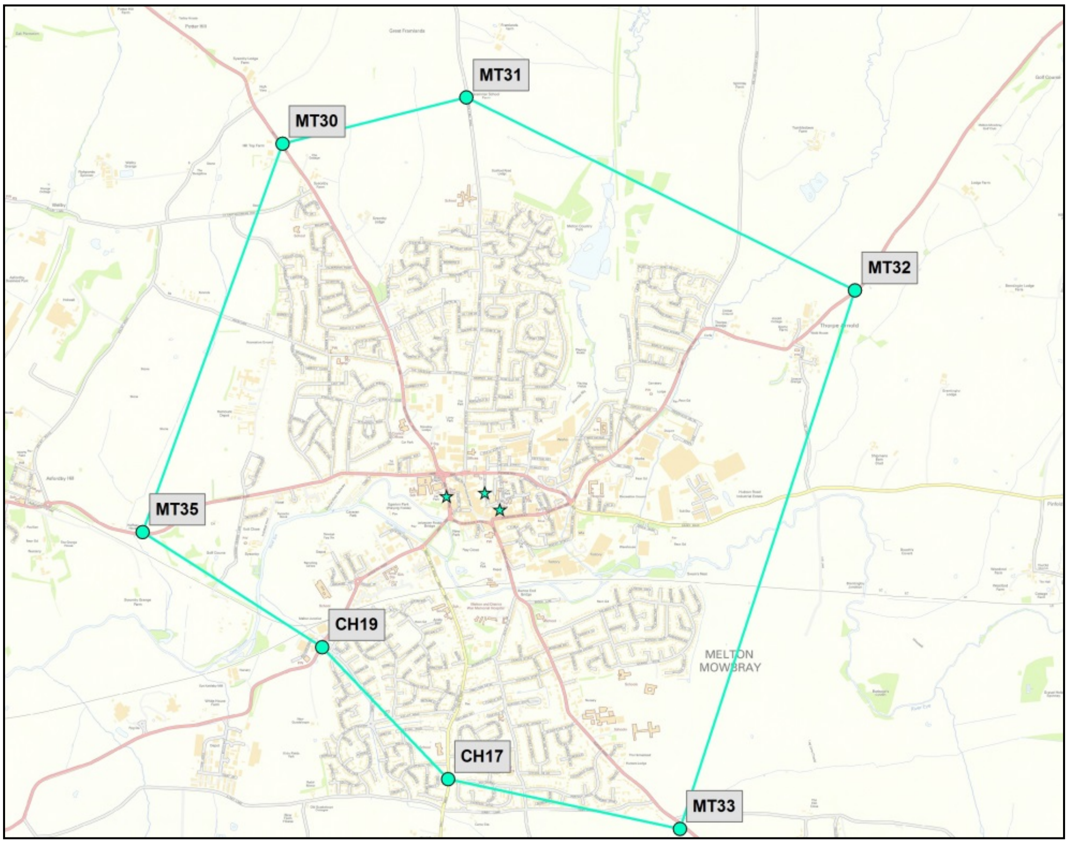


Figure 9.6: Market Harborough Cordon and Boarding Surveys

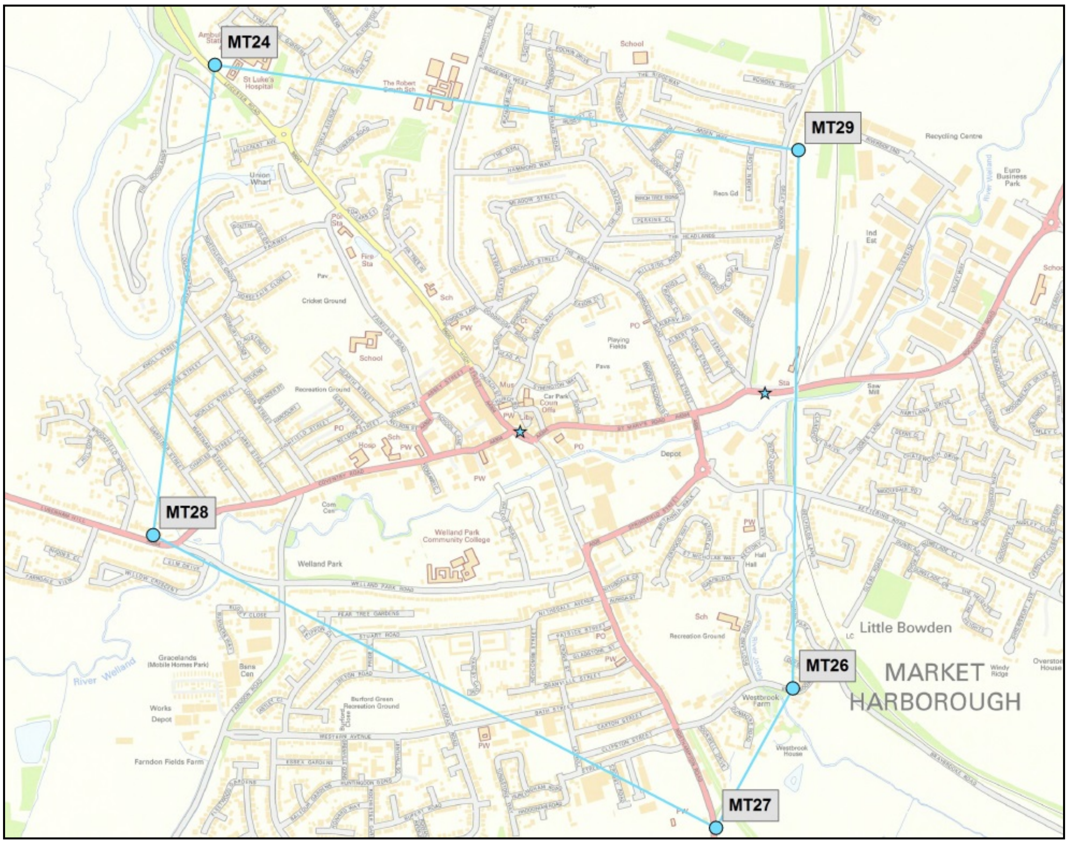


Figure 9.7: Lutterworth Cordon and Boarding Surveys

Figure 9.8: Hinckley Cordon and Boarding Surveys

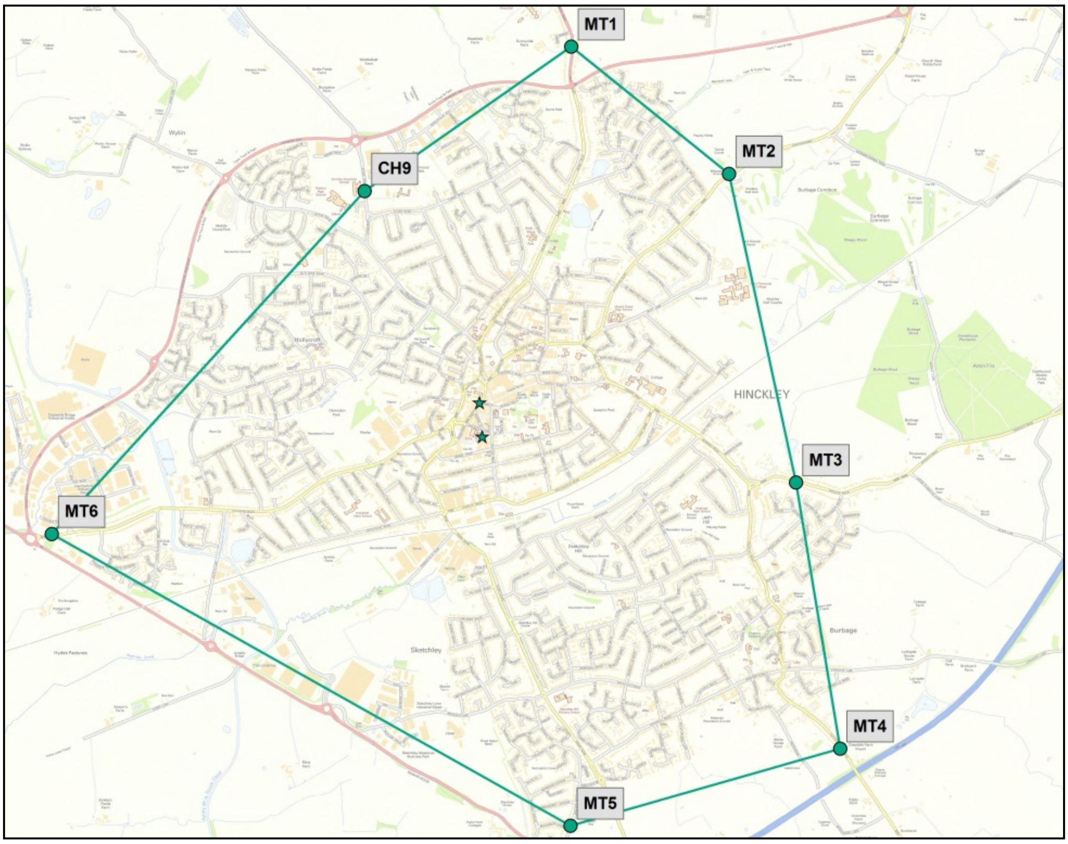
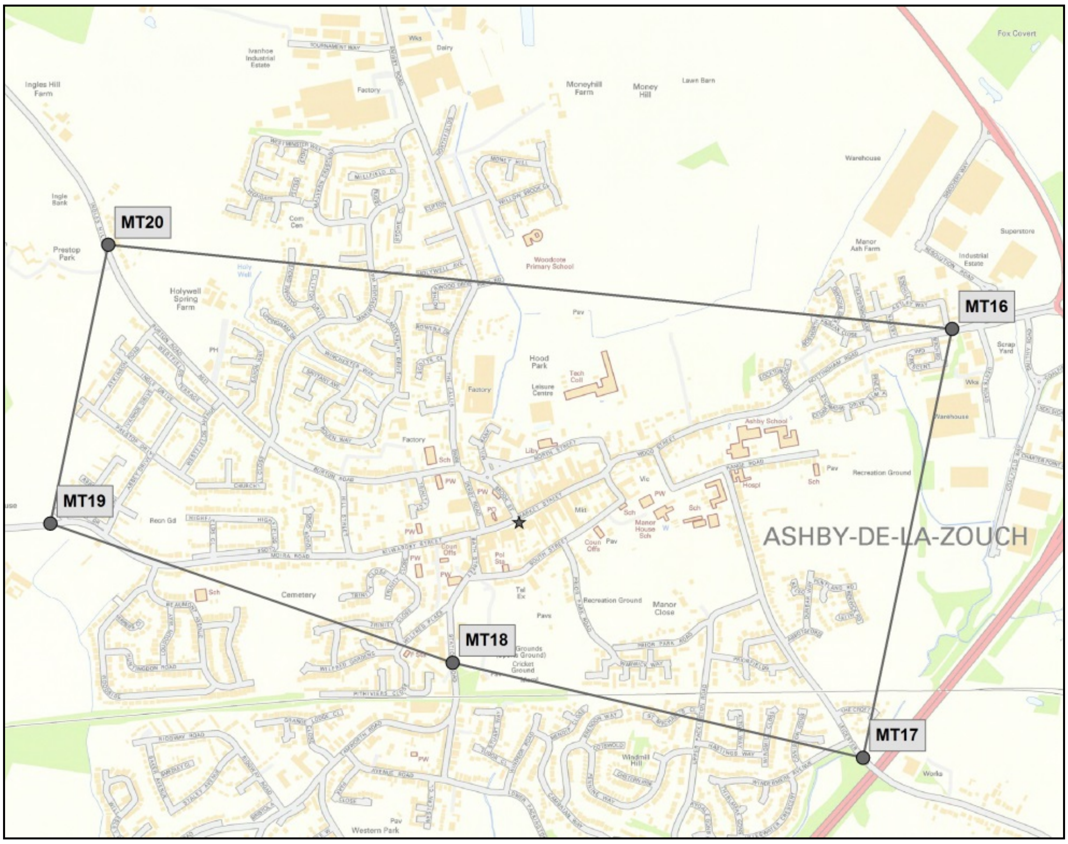


Figure 9.9: Coalville Cordon and Boarding Surveys

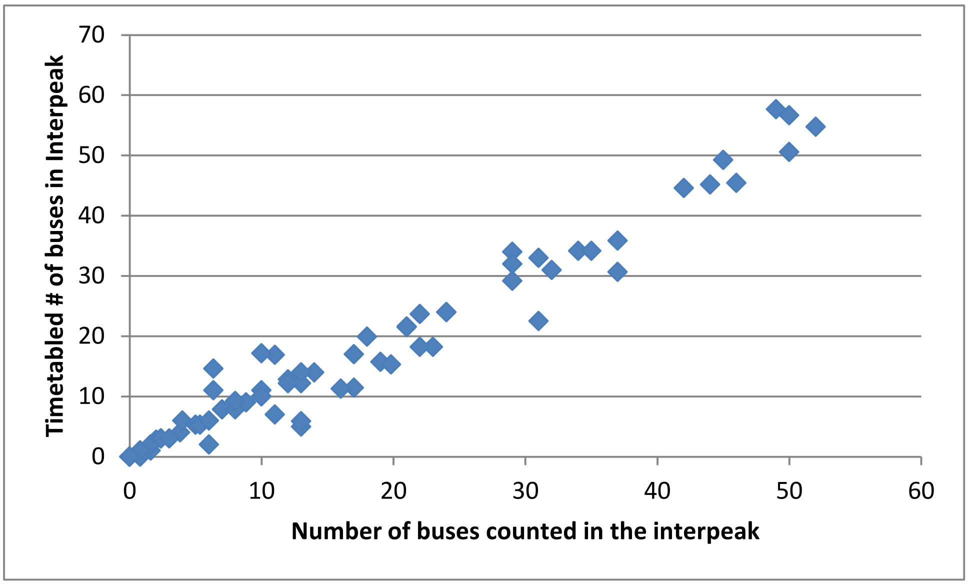
Figure 9.10: Ashby-de-la-Zouch Cordon and Boarding Surveys



9.2 Public Transport Count Data Checking

9.2.1 Since the manual classified traffic counts also counted bus vehicles, it has been possible to compare these vehicle counts with the timetable data in the model to confirm the count data. This is shown below, for the interpeak period.

Figure 9.11: Counted and Timetabled Buses in the Interpeak Period, by Count Site



9.2.2 The correlation is generally very good. The largest outliers have been checked and found to be generally instances where the timetables have recently changed, or buses sometimes take alternative routes. The links counts have been manually checked for plausibility. Zero values in particular were investigated to discover whether any buses ran along the link.

9.2.3 In a separate exercise, the boarding and alighting count data would in principle be expected to be broadly the same for each town, as most bus trips will be two-way. They have been compared, as shown below.

Table 9.1: Observed Daily Bus Stop Boardings and Alightings, 2014

Town	Boarding	Alighting	Difference
Ashby-de-la-Zouch	550	466	-15%
Coalville	1,171	736	-37%
Hinckley	1,194	662	-45%
Loughborough	6,414	4,909	-23%
Lutterworth	210	115	-45%
Market Harborough	962	639	-34%
Melton Mowbray	1,287	494	-62%
Leicester City	41,417	38,747	-6%

9.2.4 Except in Leicester City, where there is a good match, they do not generally compare well; the alightings are always substantially lower than the boardings.

9.2.5 It is unclear exactly why the alightings are consistently lower; however identical issues were seen in the dataset used in the older LLITM v5 model. One potential cause is that the surveys were principally conducted to interview boarding passengers, with the alighting counts being secondary. It is possible that those stops at which passengers generally or exclusively alighted rather than boarded were not surveyed or were surveyed incompletely.

9.2.6 It is also possible that in reality there is more of a tendency for passengers to alight from stops a little outside the town centres, especially if there is significant highway congestion; but that when returning they prefer to board at the main central bus stops, especially if buses wait at these for a short period. This would also explain the issue, and since the Leicester City surveys were more complete and covered a larger area, this would also explain the substantially reduced scale of the problem in the City.

9.2.7 Given this analysis, the alighting counts are thus considered to be unreliable, and this has been borne in mind when calibrating the public transport model (reported in '*PR202 – LLITM 2014 Base Public Transport LMVR*').

10. Public Transport Service Data (TNDS)

10.1 Public Transport Service Data

10.1.1 Bus service data were extracted from the Traveline National Dataset (TNDS) in the TransXChange file format, for 2014. This file format is used for the interchange of timetable information.

10.1.2 The TNDS data cover all publicly accessible bus and coach services that are operational in the UK, with details of the origin and destination for each service, each bus stop at which the services stop and the times that each service is scheduled to call at each stop. It should be noted that detailed routes between stops are not included in these data.

10.1.3 The data give detailed information about each bus stop as location records. This record assigns each stop a unique identifier, and provides a description of each location, along with the grid reference, the Gazetteer code and the type of bus stop. All stops within the country are included.

10.1.4 Bus routes in the TransXChange file are specified by their service number and direction and include a list of each bus stop that the service passes along on route. Each stop the bus passes has scheduled arrival and departure times and defined the activity at each stop (i.e. pick up only, set down only, both pick up and set down or neither (as in the case of express services)).

10.1.5 Days of the week and other special days (e.g. bank holidays, school term time) that the journey operates are recorded in the data, as are the first and last dates of operation of the journey.

10.1.6 236 routes were used from the TNDS data in this way in the LLITM 2014 Base model. These call at around 7,000 bus stops.

Table 10.1: TNDS Data – Summary of Bus Service Data used by Bus Operator

Operator	Services/Day
Arriva Midlands	2,570
First in Leicester	1,482
Centrebus Midlands	768
Kinchbus	479
Stagecoach in Warwickshire	457
Hinckley Bus	260
Roberts Coaches	267
Paul S Winson Coaches	121
Stagecoach in Northants	91
Nottingham City Transport	81
Trent Barton	60
Midland Classic	50
Macpherson Coaches	33
De Courcey	23
Stagecoach East Midlands	22
Leicester Bus and Truck	20
Megabus	11
Soar Valley Community Bus	9
National Express	8
Coalville Yellow Cabs	7
NJ Travel	4
Murphy's Taxis	4
Beaver Bus	4
Pulfreys Coaches	4
Chapel End Coaches	2
Harpurs Coaches	2
Midland Classic Limited	1
Total	**6,840**

10.2 Public Transport Service Data Checking

10.2.1 The TNDS data contain many duplicates, as when minor changes to services and timetables are made, often a new record for the revised route/timetable is added and the old records are not always properly removed. These have been checked by running code to detect services departing from the same points (or similar points) at the same time with the same service number going in the same direction. Over time we have developed an algorithm that successfully removes the substantial majority of duplicates.

10.2.2 The TNDS data were reviewed in terms of bus services represented, their frequencies and their routes, both by AECOM internally for a random subset and by LCC who undertook detailed checks on all service routes and frequencies against their own data.

10.2.3 The LCC checks were reviewed in full by AECOM, and about half of the comments resulted in corrections to the model. 6 services out of around 180 were found to have incorrectly coded frequencies; around 20 had minor problems with their route coding (the latter are not strictly related to the TNDS data as the TNDS data only cover bus stops on the route, not the route taken between bus stops).

10.2.4 Most of the LCC comments that were not taken forward related to extremely minor variations in route that were below the level the model network detail could represent. There were also a few instances of service frequencies having changed between the model base and the time LCC undertook the review, but these were rare.

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LLITM 2014 Base

North & East Melton Mowbray Distributor Road Full Business Case

(Local) Highway Model LMVR

Leicestershire County Council

November 2022

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Revision History

Revision	Revision date	Details	Authorised	Name	Position
v1.0	May 2017	Initial draft for comment	Yes	Mark Dazeley	Regional Director
v1.1	June 2017	Responding to comments	Yes	Mark Dazeley	Regional Director
v1.2	July 2017	Responding to minor comments	Yes	Mark Dazeley	Regional Director
v1.3	December 2017	Minor edits following DfT comments	Yes	Mark Dazeley	Regional Director
v1.4	December 2017	Highway desire line analysis added	Yes	Mark Dazeley	Regional Director
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v2.1	2022-11-16	Addressing DfT Comments	Yes	Mark Dazeley	Regional Director

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Section 1 – Introduction

1.1 Context

1.1.1 This report forms an addendum to the LLITM 2014 Base Highway Local Model Validation Report (LMVR), and provides additional detail on the performance of the highway model in and around Melton Mowbray.

1.1.2 This local review of the model performance is part of the modelling work for the Outline Business Base (OBC) for the proposed North and East Melton Mowbray Distributor Road (NEMMDR), and includes analysis in response to comments from the DfT at a meeting to discuss the OBC for the scheme in March 2017.

1.1.3 This local LMVR does not seek to reproduce the information contained within the main LMVR for the highway model, and as such this report should be read in conjunction with the main LMVR. This report builds on the information provided for the highway model development and performance, and provides the results of additional analysis on the model performance in and around Melton Mowbray in the context of comments raised by DfT specifically.

1.1.4 This additional analysis includes:

- a detailed review of the highway network coding;
- a review of the base year highway matrices (which have made use of travel demand data from mobile network data),and checked against independent sources of data on travel demand; and
- the comparison of the modelled flows against additional count data collected in Melton Mowbray since the development of the base year highway model.

1.1.5 The performance of the highway model as reported within the LMVR across the county in terms of screenlines, individual link counts and journey times is given in Table 1.1 to Table 1.3 below. This demonstrates that across the county the model performs well against TAG criteria, with:

- the percentage of screenlines meeting TAG criteria being in excess of 90% in all three time periods;
- the percentage of individual link counts meeting TAG criteria is at or above 85% in all three time periods; and
- the percentage of journey time routes meeting TAG criteria is above 85% in all three time periods.

1.1.6 The North-East Leicestershire reporting area in Table 1.1 to Table 1.3 closely aligns with Melton Borough, and for this area the model performs well against TAG criteria for flows and journey times.

Table 1.1: Leicestershire Screenline Performance (Total Vehicle Flows)

	AM Peak Hour		**Interpeak Hour**		**PM Peak Hour**	
	Total %	ScnLine Passes	Total %	ScnLine Passes	Total %	ScnLine Passes
Leicester City	0.2%	94%	0.4%	100%	0.7%	100%
North Leicestershire	-0.1%	94%	0.7%	88%	1.1%	88%
North-East Leicestershire	0.1%	86%	0.9%	93%	0.4%	93%
South Leicestershire	-0.6%	85%	0.3%	96%	0.3%	88%
South-West Leicestershire	0.7%	100%	0.1%	100%	1.0%	88%
North-West Leicestershire	-0.5%	88%	-0.5%	100%	-0.2%	94%
Countywide	1.1%	100%	0.5%	100%	0.7%	100%
SRN (Int)	1.7%	100%	1.4%	100%	1.0%	95%
Leicestershire	***0.5%***	***93%***	***0.6%***	***97%***	***0.7%***	***93%***

Table 1.2: Leicestershire Link Flow Performance (Total Vehicle Flows)

	AM Peak Hour		**Interpeak Hour**		**PM Peak Hour**	
	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)
Leicester City	79%	78%	88%	88%	80%	79%
North Leicestershire	82%	81%	91%	90%	80%	78%
North-East Leicestershire	93%	93%	96%	95%	91%	90%
South Leicestershire	90%	89%	94%	94%	89%	89%
South-West Leicestershire	88%	88%	98%	98%	89%	89%
North-West Leicestershire	94%	93%	95%	95%	93%	92%
Countywide	89%	86%	97%	96%	87%	84%
SRN (Int)	97%	97%	100%	100%	96%	96%
Leicestershire	***87%***	***86%***	***94%***	***93%***	***86%***	***85%***

Table 1.3: Journey Time Validation

	No. of Routes	**AM %Pass**	**IP %Pass**	**PM %Pass**
Leicester City	32	91%	84%	84%
North Leicestershire	18	89%	94%	89%
North-East Leicestershire	12	100%	92%	92%
South Leicestershire	18	94%	100%	83%
South-West Leicestershire	24	92%	92%	92%
North-West Leicestershire	24	92%	100%	92%
SRN (Int)	10	90%	100%	100%
Leicestershire	**138**	**92%**	**93%**	**89%**
SRN (Ext)	12	83%	100%	100%

1.1.7 An initial area of interest has been defined by running a LLITM 2014 Base forecast with and without the proposed scheme and identifying those links where the flows change by more than 5%. To remove links with low flows where a small absolute change in flow results in a large percentage change, the absolute flow change for those identified links must also be over 30 PCUs[1].

1.1.8 Any model zone with at least one link which has changed by more than 5% and 30 PCUs has been included within the initial area of interest. The identified links (blue) and the defined area of interest (red) are shown in Figure 1.1. This analysis is likely to include an element of convergence ‘noise’ within the model forecasts; therefore as the majority of links highlighted fall within Melton Borough, the borough itself has been used to define the focus of this local LMVR.

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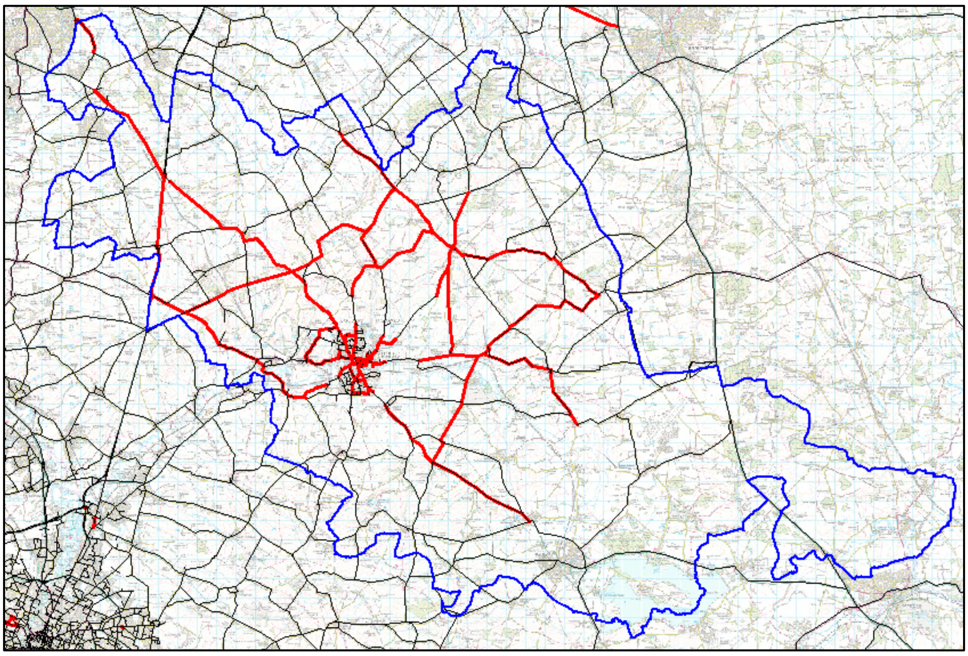
[1] Passenger car unit, where cars and LGVs have a weight of 1 and HGVs have a weight of 2

Figure 1.1: Initial Area of Interest



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1.2 Report Structure

1.2.1 This addendum to the LLITM 2014 Base Highway LMVR contains the following sections:

- **Section 2 – Calibration and Validation Data**: this section details the calibration and validation count data included within the development of the base year model, the additional count data collated since the development of the model within Melton Mowbray, and the observed journey times routes used in the validation of the highway model.
- **Section 3 – Local Highway Network Review**: this section discusses the checks undertaken as part of the review of the base year network coding, and details the recommended updates which are applied to the base year highway network coding.
- **Section 4 – Highway Matrix Review**: this section details the analysis undertaken to compare the base year highway demand matrices against independent data sources on travel demand, including the 2014 roadside interview surveys undertaken around Melton Mowbray.
- **Section 5 – Assignment Calibration and Validation**: this section details the performance of the base year highway model against observed count and journey time data, focussing on the performance within Melton Borough.
- **Section 6 – Conclusions**: this section provides a summary of the local LMVR and its findings.

Section 2 – Calibration and Validation Data

2.1 Introduction

2.1.1 This section details the observed data collated to calibrate and validate the base year traffic volumes within Melton Borough, to validate the modelled journey times within Melton Borough, and the additional recent count data provided to supplement the existing count dataset within Melton Mowbray for the purposes of this local Melton Mowbray LMVR.

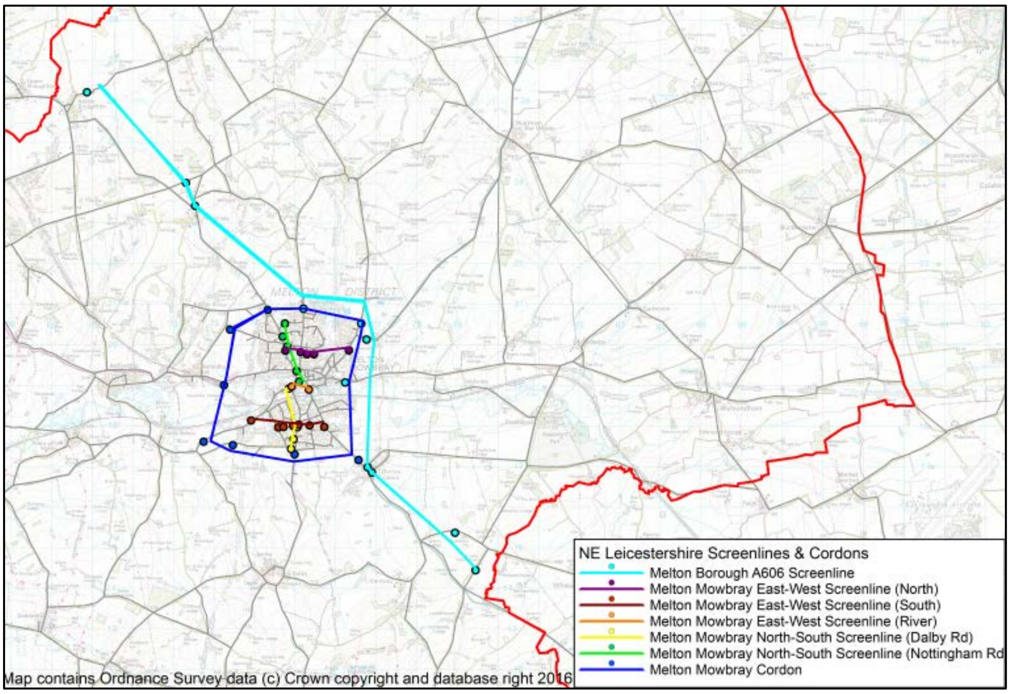
2.1.2 The processing of the count data and journey time data used within the calibration and validation of the base year highway model is detailed within the LLITM 2014 Base LMVR, and is not reproduced here.

2.2 Existing Calibration and Validation Count Data

2.2.1 Within the existing count dataset collated for the development of the base year model, a total of seven screenlines and cordons were defined within Melton Borough. These are shown in Figure 2.1, and consist of:

- a cordon of the Melton Mowbray urban area;
- five screenlines within Melton Mowbray, which are:
    - a river screenline in Melton Mowbray town centre;
    - a north-south screenline running parallel to the A606 Nottingham Road in the northern half of Melton Mowbray;
    - an east-west screenline within the northern half of Melton Mowbray;
    - a north-south screenline running parallel to Dalby Road in the southern half of Melton Mowbray; and
    - an east-west screenline within the southern half of Melton Mowbray.
- a screenline running broadly parallel to the A606 through Melton Borough, and following the Melton Mowbray Cordon around the eastern side of the urban area.

Figure 2.1: Melton Borough Screenlines and Cordons



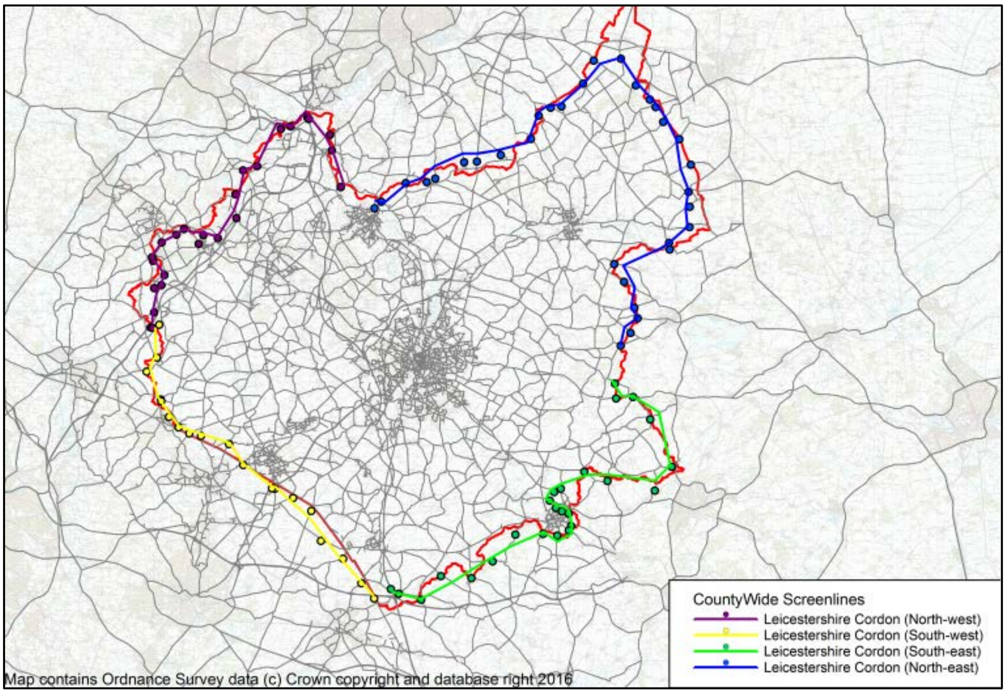
2.2.2 These screenlines provide coverage of traffic entering and leaving the urban area, and also for travel within Melton Mowbray. In total these screenlines and cordon consist of around 40 individual count locations within Melton Borough, with count data in both directions of travel (except in cases where the surveyed location is a one-way street).

2.2.3 All of these screenlines and cordons have been used as calibration data within the development of the highway model with the exception of the Melton Mowbray River Screenline, the Melton Mowbray Nottingham Road Screenline and the East-West Melton Mowbray Screenline within the southern half of the town.

2.2.4 These three screenlines have been used as independent validation data as part of the development of the model.

2.2.5 In addition to these screenlines, a cordon following the Leicestershire County boundary was also included in the count dataset for the base year model. This Leicestershire County cordon is shown in Figure 2.2, and this cordon has been split into four sections. The north-east section of the Leicestershire Cordon covers the Melton Borough boundary with neighbouring counties, and also includes some counts within Charnwood and Harborough. This cordon of the county has been used as calibration data within the matrix estimation of the base year model.

Figure 2.2: Leicestershire County Screenline



2.3 Observed Journey Time Routes

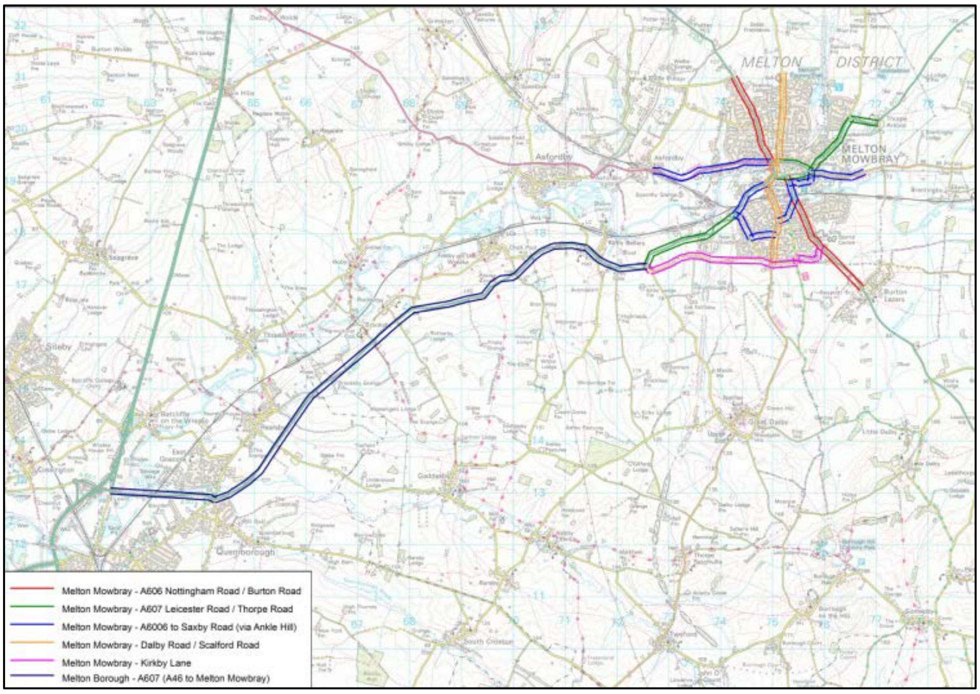
2.3.1 In addition to the count data within Melton Borough detailed in Section 2.2, a number of journey time routes have been defined to validate the modelled journey times in the base year. Detail on the use and processing of Trafficmaster data to derive these observed journey times is detailed within the LLITM 2014 Base highway LMVR.

2.3.2 Within Melton Borough a total of six, two-way journey time routes have been defined, which focus on the Melton Mowbray urban area. These are shown in Figure 2.3, and consist of journey time routes along:

- the A606 Nottingham Road and Burton Road;
- the A607 Leicester Road and Thorpe Road;
- the A6006 to Saxby Road via Ankle Hill;

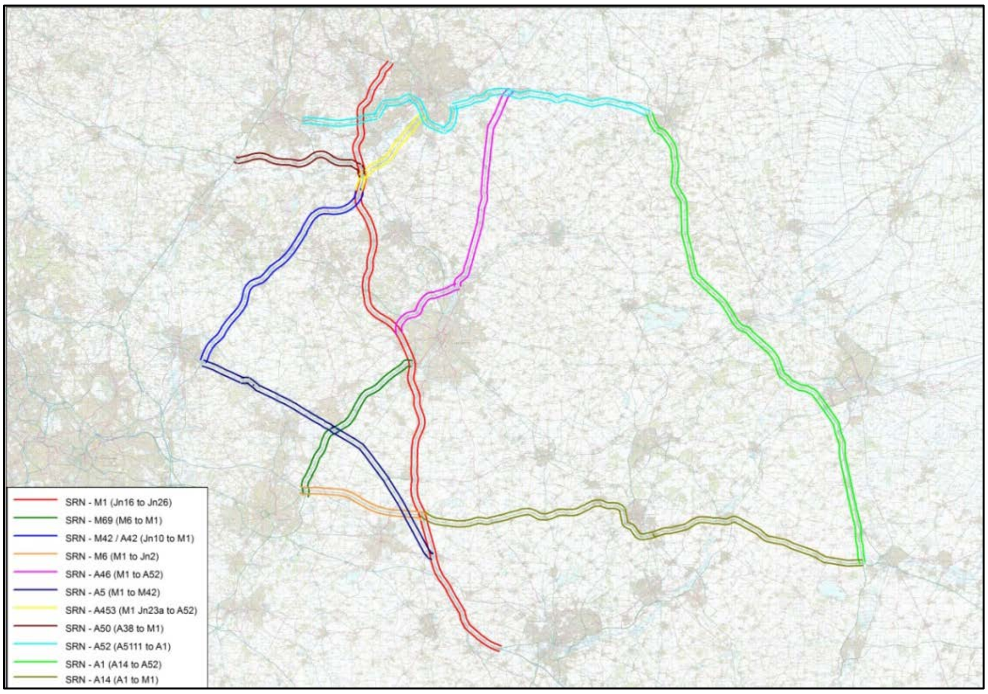
- Dalby Road and Scalford Road;
- Kirby Lane; and
- the A607 between the A46 and the junction with Kirby Road.

Figure 2.3: Melton Borough Journey Time Routes



2.3.3 In addition to these journey time routes derived within Melton Borough, observed journey time routes have also been defined to cover all the Strategic Road Network within Leicestershire. These journey time routes are shown in Figure 2.4, and include a journey time route along the A46, some of which runs along the western boundary of Melton Borough.

Figure 2.4: Strategic Road Network Journey Time Routes



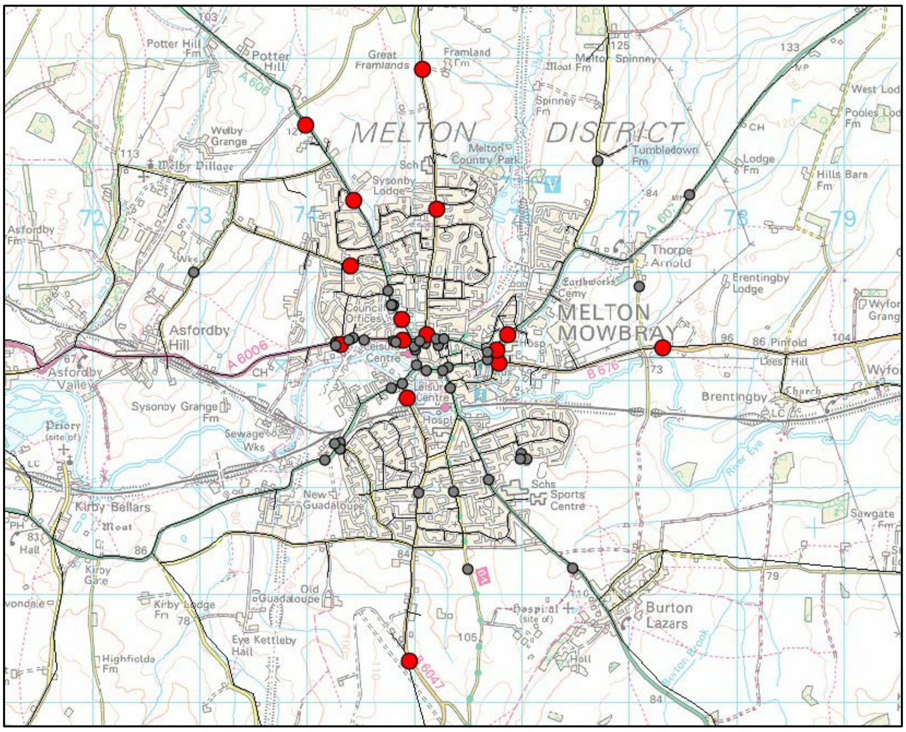
2.4 Additional Local Count Data

2.4.1 Since the count data were collected as part of the original model development, additional counts have been undertaken within Melton Mowbray. In total, an additional 57 Automatic Traffic Counts (ATCs) have been undertaken during October and November 2016.

2.4.2 Some of these count locations are on roads which are not represented within the base year highway model, and others are duplicates of counts locations already included within the dataset or are in close proximity to existing count locations. Removing these locations results in a total of 15 new counts to compare the modelled base year flows against.

2.4.3 The additional count locations are shown in Figure 2.5 with those which have been identified for use within this local LMVR highlighted.

Figure 2.5: Locations of Additional Melton Mowbray Counts (Red=used | Grey=not used)



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2.4.4 With the 15 additional ATC locations identified, these data were cleaned through a process of analysing the raw data for outliers within the dataset. Any outliers which were identified within the dataset were removed from the dataset. The count data were then summarised for an average day between Monday and Thursday for the three modelled hours: AM Peak hour (08:00 to 09:00); interpeak hour (average between 10:00 and 16:00); and PM Peak hour (17:00 to 18:00).

2.4.5 Given that the count data were collected during October and November 2016, they have then been adjusted to represent the base year / month of the highway model, which is April, May and June 2014. To make this adjustment, long-term ATC data across Leicestershire have been processed to estimate factors to both adjust between 2016 and 2014, but also to take account of the seasonality of traffic volumes between months of the year.

2.4.6 This processing of the long-term ATC data is discussed in '*PR205 - LLITM 2014 Base Data Collection Report*', with the outturn calculated adjustment factors as follows:

Table 2.4: Temporal Factors Derived from Long-Term C2 Count Data

	Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Month		1.052	1.050	1.054	1.045	1.000	0.992	**0.986**
1	1.137	1.196	1.194	1.199	1.189	1.137	1.128	1.122
2	1.074	1.130	1.128	1.133	1.123	1.074	1.066	1.060
3	1.035	1.089	1.087	1.091	1.082	1.035	1.027	1.021
4	1.015	1.068	1.066	1.070	1.061	1.015	1.007	1.001
5	1.024	1.077	1.075	1.080	1.070	1.024	1.016	1.010
6	0.979	1.030	1.028	1.032	1.023	0.979	0.971	0.966
7	0.989	1.041	1.039	1.043	1.034	0.989	0.982	0.976
8	0.997	1.048	1.047	1.051	1.042	0.997	0.989	0.983
9	0.972	1.022	1.021	1.025	1.016	0.972	0.965	0.959
10	**1.002**	1.054	1.052	1.056	1.047	1.002	0.994	**0.988**
11	**1.018**	1.071	1.070	1.074	1.064	1.018	1.011	**1.005**
12	1.092	1.149	1.147	1.151	1.141	1.092	1.084	1.077

2.4.7 These are summarised as follows:

- 2016 to 2014 adjustment of 0.986 (i.e. an average 1.4% increase in traffic between 2014 and 2016)
- October to April/May/June adjustment of 1.002, and between November and April/May/June of 1.018
- Combined, this results in an adjustment factor of 0.988 for counts undertaken in October 2016, and 1.005 for counts undertaken in November 2016.

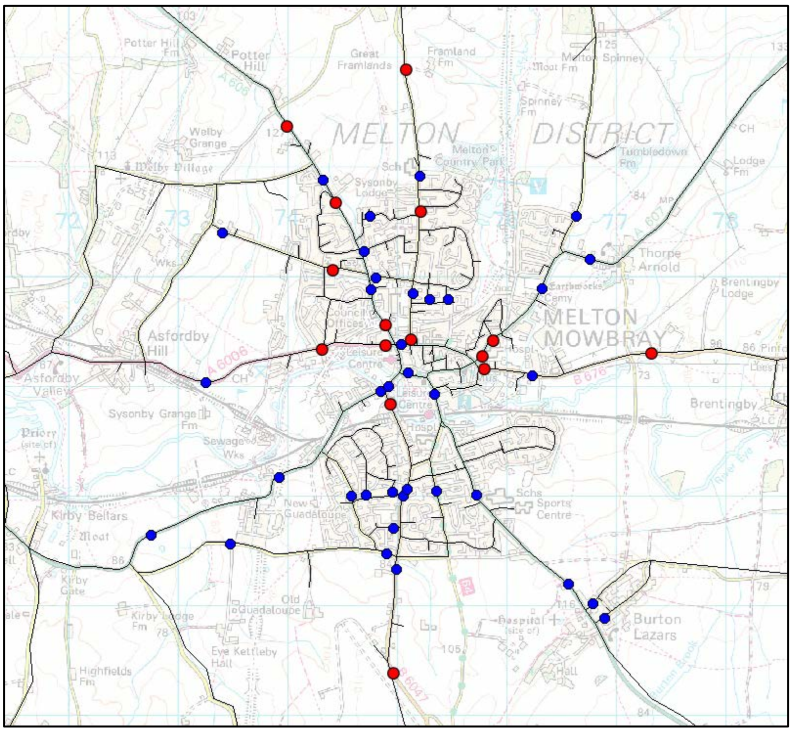
2.4.8 The ATC data processed give observed total volumes, but do not provide an accurate classification of these volumes by vehicle type. Unlike the counts collated for the calibration and validation of the base year highway model, where the majority of ATCs had a corresponding manual classified count from which vehicle splits could be calculated, associated manual counts were not available for the additional 15 count locations.

2.4.9 Therefore, vehicle splits between car, LGV and HGV traffic have been calculated from the existing count dataset. Vehicle splits from a nearby count location or locations have been used to provide the proportion of car, LGV and HGV traffic at the additional count locations.

2.4.10 The location of these additional counts in relation to the existing counts used in the development of LLITM 2014 Base is shown in Figure 2.6. This demonstrates that there are existing counts, from which the vehicle split has been sourced, within a reasonable distance to most of the additional counts available within Melton Mowbray. There are some additional counts where the distance between these locations and existing counts is larger, and these locations are on the edge of the urban area. In these locations there are no significant junctions or developments between the count locations.

2.4.11 Based on this, it is thought that use of the existing counts provides a reasonable estimate of the vehicle splits for the additional count data provided for this review.

Figure 2.6: Locations of Additional Melton Mowbray Counts (Red) and Existing Count Locations (Blue)



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2.4.12 With the additional counts processed, these have been checked for internal consistency and for consistency with the existing counts used in the calibration and validation of the highway model. Based on this review, two of the fifteen additional counts have been removed from the analysis.

- Two additional counts have been provided on Thorpe Road to the north of Norman Way, which are within ~200m of one another. This section is represented by a single link within the highway model, and so only one count can be applied to this link. Upon review of the consistency of these counts with counts elsewhere on Thorpe Road, the more northerly count on this section has been retained.
- An additional count has been provided on Dalby Road to the south of Melton Mowbray. This has been compared with the calibration count on Dalby Road to the south of Kirby Lane, just outside the urban area of Melton Mowbray. There is little land-use between these two counts, so the expectation is that the counts should be similar; however significant differences between the two counts were found. Therefore, the additional count on this road has been removed from the additional count dataset.

Section 3 – Local Highway Network Review

3.1 Introduction

3.1.1 The first stage of the model review was to undertake a detailed review of the highway network coding within Melton Borough, which broadly aligns with the anticipated area of influence of the proposed scheme options.

3.1.2 This review has considered the coverage of the simulation network within Melton Borough and also the coding of this network against the standards set out in the agreed LLITM 2014 Base coding manual (*‘TN206 - LLITM 2014 Base SATURN Coding Manual’*).

3.1.3 The main LMVR for the highway model includes route analysis at a county-level as part of the validation of the model. To supplement this analysis, additional route analysis has been undertaken for routes within and passing through Melton Mowbray.

3.2 Local Network and Zone Coverage

3.2.1 Figure 3.1 shows the zone system adopted within LLITM 2014 Base for Melton Borough and for Melton Mowbray itself. Within the borough there are a total of 95 model zones, with around 60 of these covering the urban area of Melton Mowbray. The derivation of the model zones is detailed within the LLITM 2014 Base highway model LMVR; however the zone boundaries shown in Figure 3.1 are based on 2011 Census geographies.

3.2.2 Figure 4.5 within the highway model LMVR shows the maximum trip-ends across time periods and origins / destinations within Leicestershire, and highlights those zones with more than the suggested 300 PCU threshold contained within TAG. This figure shows that there are very few zones within Melton Borough with trip-ends of more than 300 PCUs.

3.2.3 Figure 3.2 shows the coded highway network within the base year model for Melton Borough and for Melton Mowbray. Within the figure for Melton Borough the extent of the simulation network (shown in black) is shown, with buffer network links shown in red. This figure shows that all major routes, the majority of rural routes, all known local rat-runs, and a significant proportion of the residential routes within Melton Mowbray have been coded into the base year model.

3.2.4 The simulation network extends to the north-west of the borough towards Nottingham, with limited buffer network to the east of Melton Borough, outside Leicestershire. Based on the analysis shown in Figure 1.1, all locations where significant flow changes due to the proposed scheme are expected are within the coded simulation network.

Figure 3.1: LLITM 2014 Base Zone System (Melton Borough and Melton Mowbray)

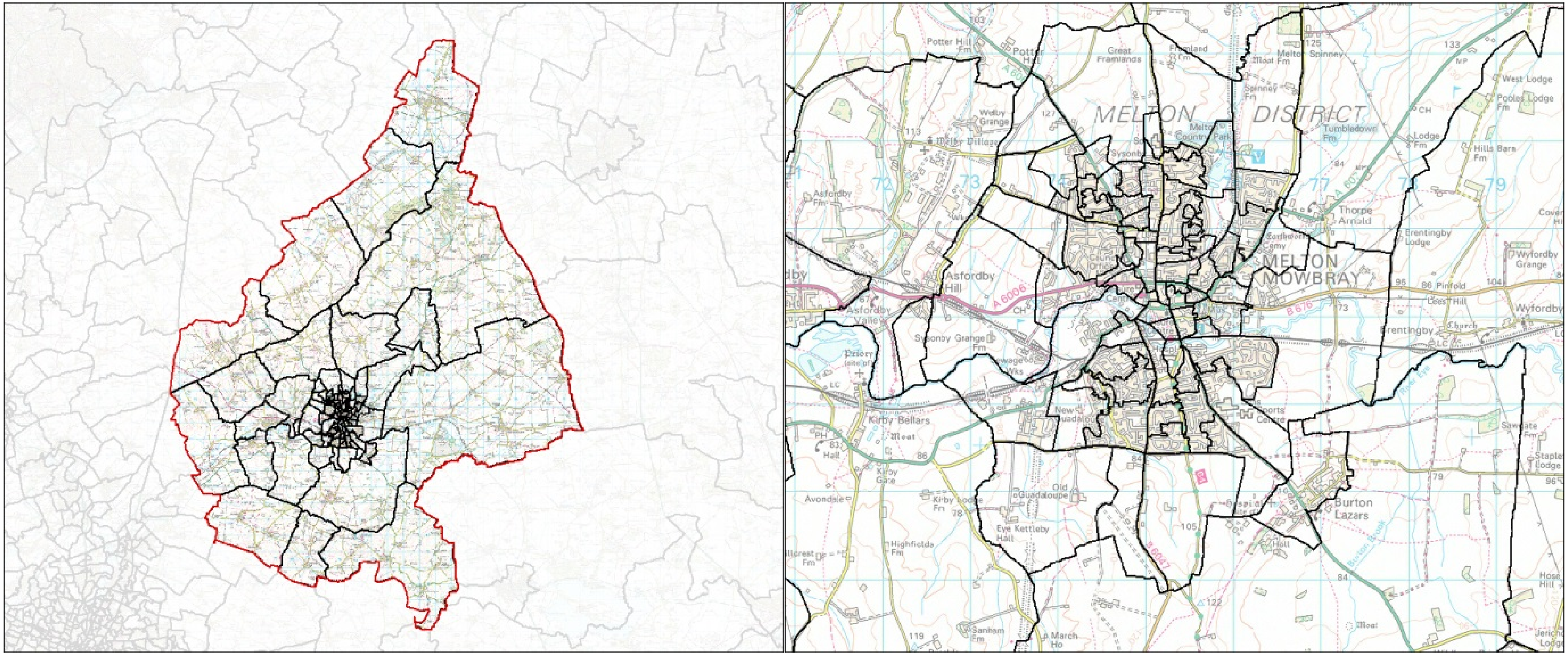

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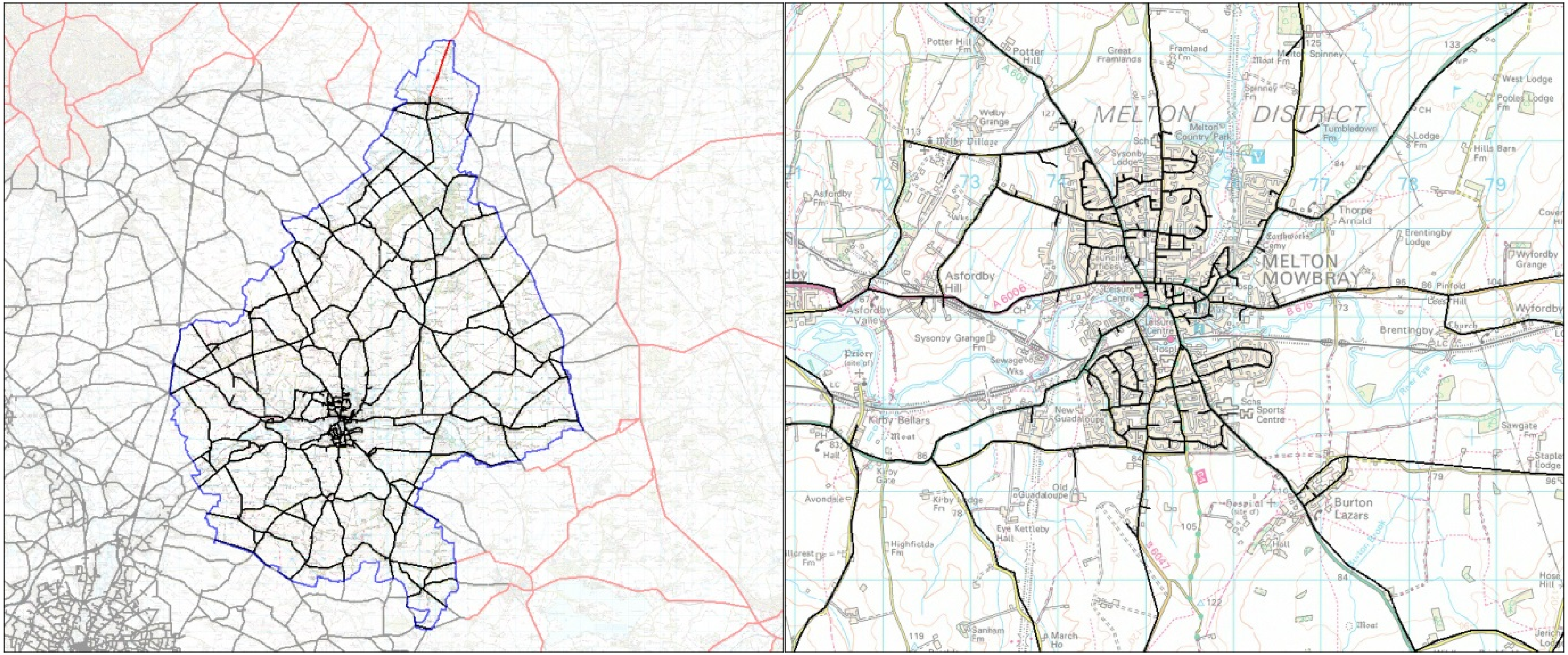
Figure 3.2: LLITM 2014 Base Network (Melton Borough and Melton Mowbray)



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3.3 Local Highway Network Coding Review

3.3.1 As part of the highway network coding review, the following four attributes of the coded network have been reviewed:

- the coded link distances within Melton Borough (aligned with the initial Area of Influence);
- the coded number of lanes and the applied speed-flow curve for links within Melton Borough;
- the coded junction type and the applied saturation flows for all junctions within Melton Mowbray; and
- the location of centroid connectors for zones within Melton Mowbray.

3.3.2 The focus of the review of junction coding and centroid connectors has been focussed on the Melton Mowbray urban area, and does not cover Melton Borough as a whole. The rationale for this is that it is the junctions within the urban area which are likely to generate delay due to congestion, and the junctions within the rural areas of Melton Borough are likely to be significantly below capacity. Within the rural areas the key driver to routeing will be the coded distances and speed-flow curves, which is why these areas have been included in the review of these network attributes.

Coded Link Distances

3.3.3 For the coded link distance review, the node coordinates for the nodes at either end of a link have been used to calculate the “crow-fly” distance for each link. This “crow-fly” distance forms a lower bound on the coded distance, and we would also not expect the coded distances to be significantly longer than the “crow-fly” distance. This analysis relies on the accuracy of the coded node coordinates, and any errors in the node coordinates will impact on the outcomes of this review.

3.3.4 Based on this analysis, any link which is more than 10% shorter than the “crow-fly” distance, and where the absolute difference between the coded and “crow-fly” distance is greater than 30m have been investigated. There are 44 links within the area of interest which meet this criterion. For links which are longer than the “crow-fly” distance, this criterion has been adapted such links are highlighted where the coded distance is more than 30% longer than the “crow-fly” distance and the absolute difference is at least 30m. There are 59 links which meet this criterion.

3.3.5 With these links reviewed, the majority of links identified have been coded correctly, but errors in the coded node coordinates leads to the given links being highlighted as part of this analysis. Two adjacent links were identified with an error in the coded distance: the section of the A606 Nottingham Road between St Bartholomew’s Way and Brampton Road; and the section of St Bartholomew’s Way approaching the A606 Nottingham Road.

3.3.6 These sections of the A606 Nottingham Road and St Batholomew’s Way have been recoded from 435m to 320m and 149m from 115m respectively. Speed flow curves in this area were reassessed and small changes were made on St Bartholomew’s Way to ensure consistency with the surrounding area of the model and maintain the flow performance against counts on Welby Road.

Coded Link Lanes and Speed-Flow Curves

3.3.7 The coded number of lanes and the speed-flow curves has been extracted from the base year highway model. Figure 3.3 and Figure 3.4 show the coded number of lanes within the area of interest and within Melton Mowbray respectively. Figure 3.3 shows that within the area of interest the majority of links, with the exception of the A46, are coded with a single lane. Analysis of this figure has highlighted has however highlighted some coding errors at the junction between the A46 and the A606.

3.3.8 The A46 / A606 junction was thoroughly reviewed and a number of changes made. This review included the number of coded lanes and associated speed-flow curves, and also the connectivity of the routes accessing the A46 / A606 junction. An amendment to the location of the junction between the gyratory and Kinoulton Lane was made as part of this review.

Figure 3.3: Coded Number of Lanes (Area of Interest)

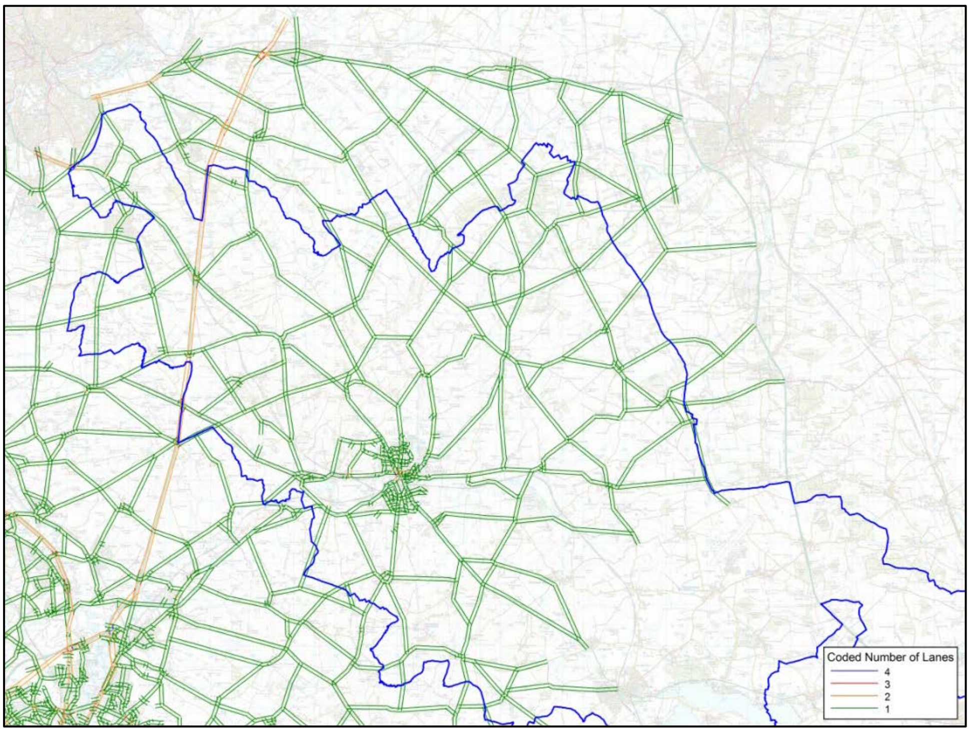

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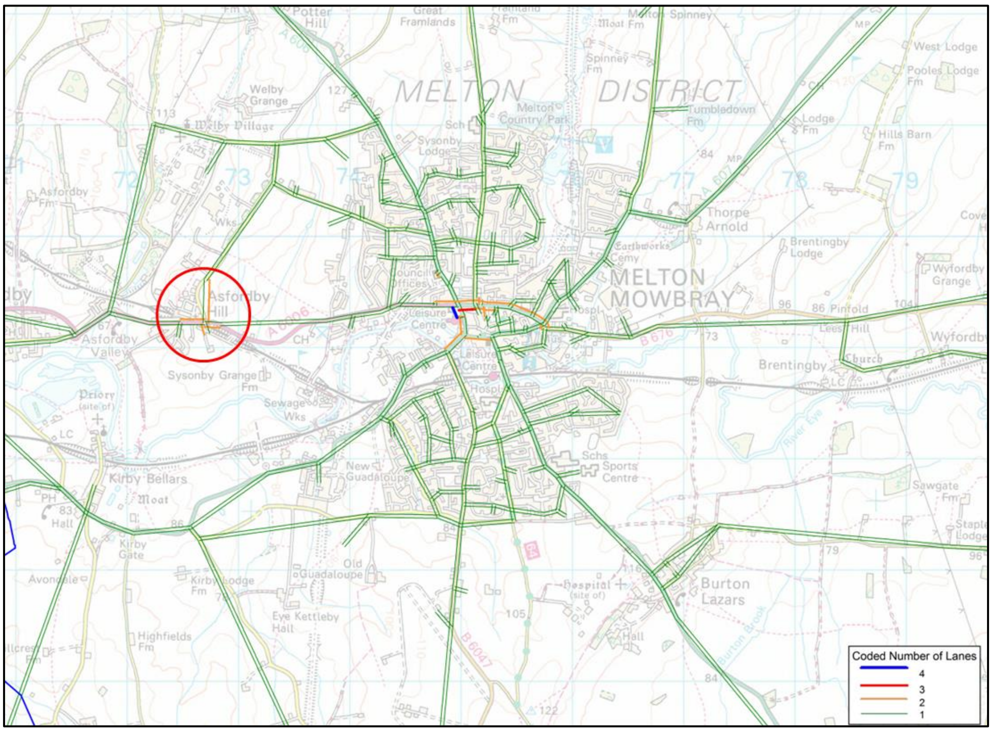
Figure 3.4: Coded Number of Lanes (Melton Mowbray)



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3.3.9 Considering Figure 3.4 which shows the coded number of lanes within Melton Mowbray, these have been reviewed based on imagery from Google Maps. The only inconsistency highlighted as part of this review relates to the coding of links approaching the junction between the A6006 Asfordby Road and Welby Road (highlighted). This has, incorrectly, been coded as a two-lane approach with a flare, whereas these links should be coded as a single-lane approach with a flare. This has been corrected within the base year highway networks.

3.3.10 In addition to the coded number of lanes, the speed-flow curve applied to the links has been reviewed. The focus of this review has been on the coded free-flow speeds and their consistency with the posted speed limits, and Figure 3.5 and Figure 3.6 show the coded free-flow speeds within the area of interest and within Melton Mowbray respectively.

Figure 3.5: Coded Free-Flow Speed (kph) (Area of Interest)

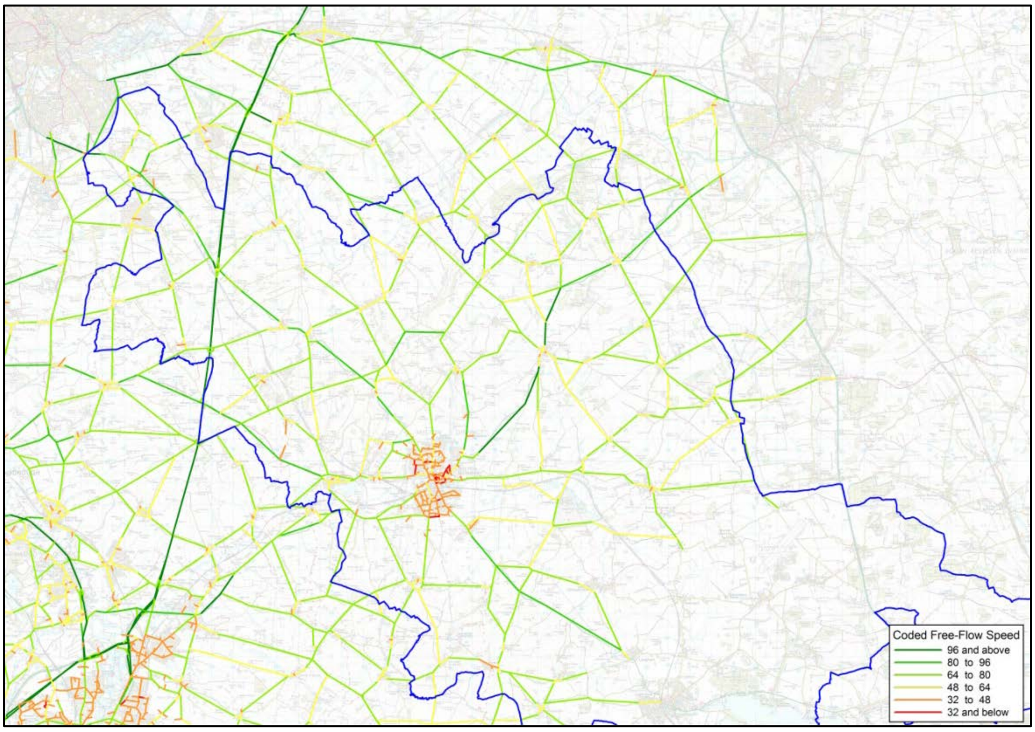

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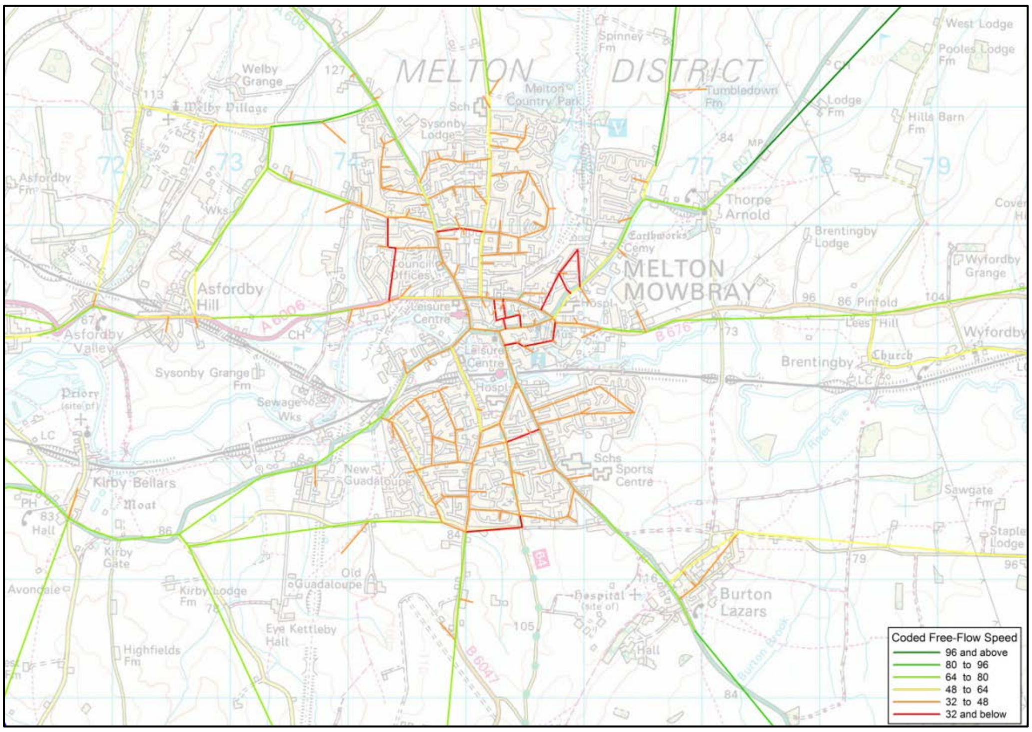
Figure 3.6: Coded Free-Flow Speed (kph) (Melton Mowbray)



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3.3.11 It is also possible to use this analysis to cross-check the coded number of lanes with the applied speed-flow curve. The only inconsistency between the coded number of links and speed-flow curve is on the approaches to the A6006 Asfordby Road junction with Welby Road. As previously discussed, at this location the coded number of lanes is incorrect; however a single-lane speed-flow curve has been applied to these links. On this basis it is not expected that correcting this error will result in significant flow changes within the base year models.

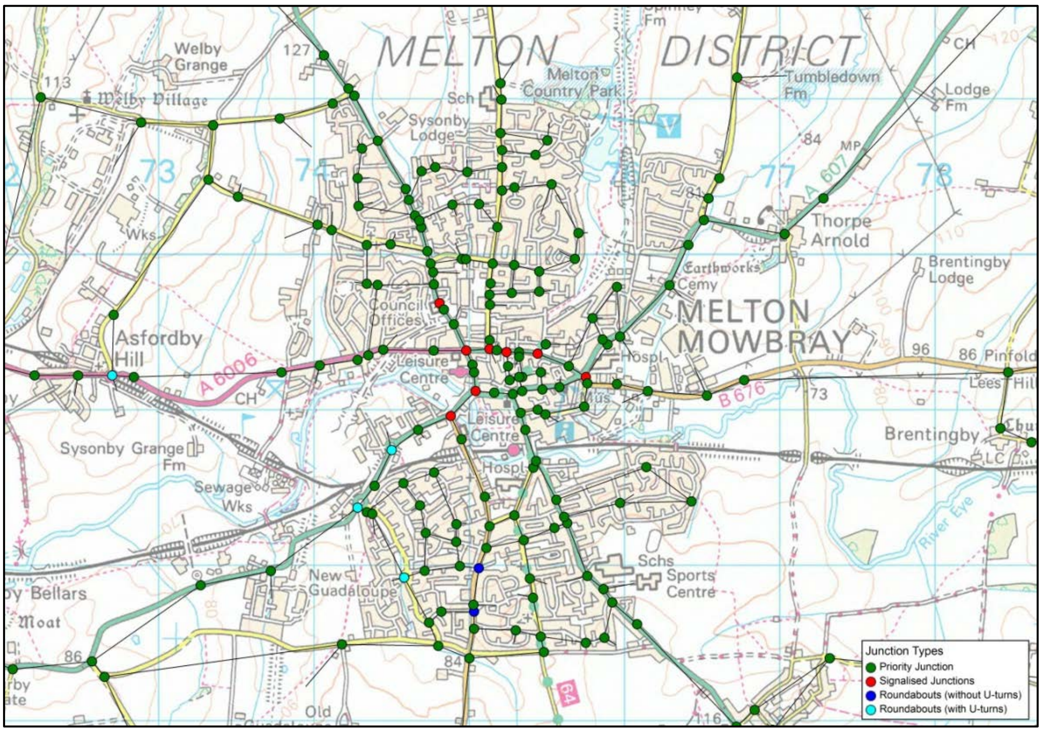
3.3.12 Taking into account that the coded free-flow speeds, especially within Melton Mowbray where fixed speed links have predominately been coded, will have been calibrated to improve the model routeing and journey time validation, no errors in the coded speed-flow curves have been identified as part of this review.

Coded Junction Types and Saturation Flows

3.3.13 The coded junction types have been extracted from the base year networks for Melton Mowbray, and have been compared against Google Maps. The classification of coded junctions into priority junctions, signalised junctions and roundabouts for Melton Mowbray is shown in Figure 3.7.

3.3.14 The outcome of this review was that no instance of an incorrectly coded junction type has been found within Melton Mowbray.

Figure 3.7: Coded Junction Type (Melton Mowbray)



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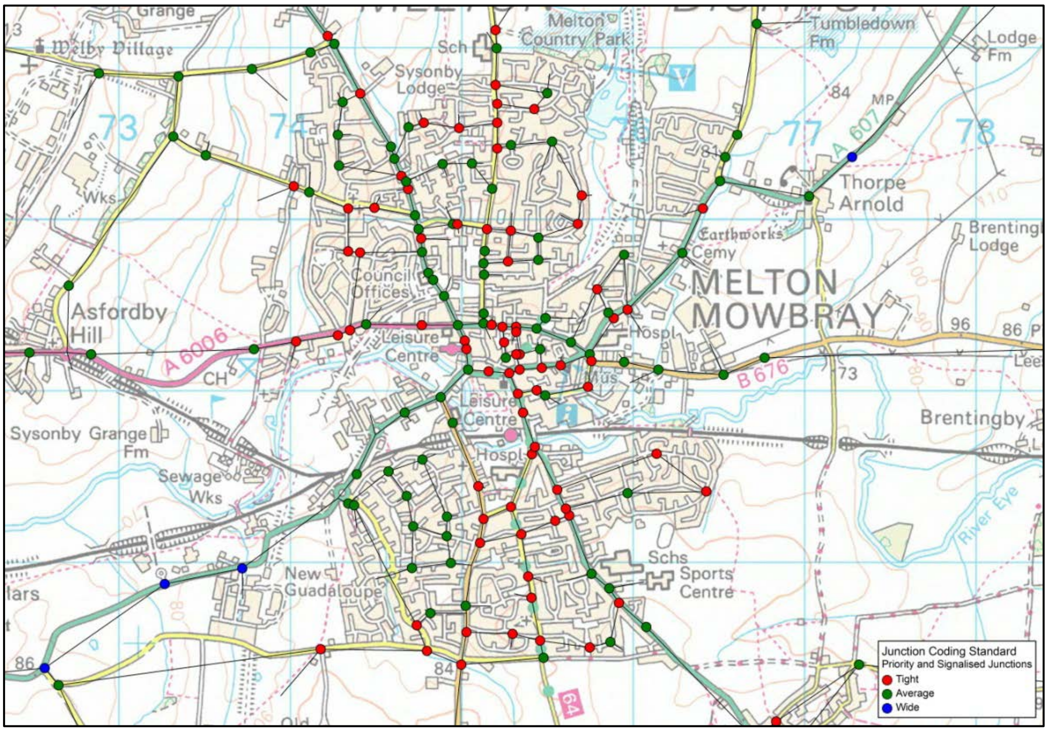
3.3.15 In addition to the coded junction type, the 'standard' of the coded junction has also been reviewed. Within the coding manual for LLITM 2014 Base, three standards of junction have been defined for priority and signalised junctions. Figure 3.8 shows the standard adopted within the base year model for all priority and signalised junctions within Melton Mowbray.

Figure 3.8: Coded 'Standard' of Priority and Signalised Junctions (Melton Mowbray)



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3.3.16 It is recognised that, as with the coded fixed speeds within the urban area, these assumptions on the standard of priority and signalised junctions may have been calibrated as part of the base year model validation. With this in mind, the review of the coded junction standards has not resulted in any junctions being identified where we judge there to be an error in the application of the coding standards.

3.3.17 This review of coded saturation flows against the agreed assumptions detailed within the highway coding manual has also considered the application of the standard saturation flows to the individual turns at the junctions within Melton Mowbray. This review has highlighted a small number of junctions where the saturation flows defined within the coding manual have been incorrectly applied based on the given turn at the junction. These have been corrected within the base year highway networks.

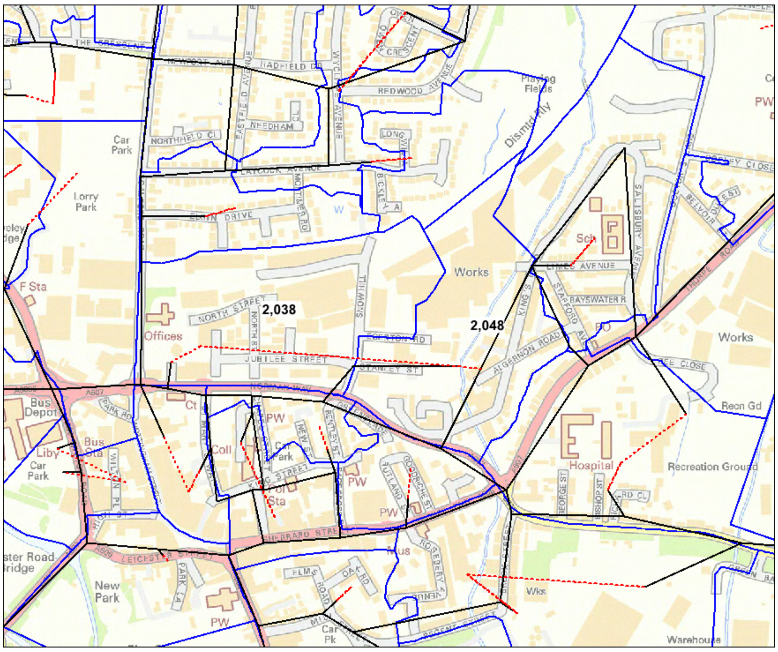
Coding of Centroid Connectors

3.3.18 The final stage of the network review was to undertake a review of the location of the centroid connectors coded to connect the model zones to the network. As with the coding of the junctions, this review has focussed on the Melton Mowbray urban area.

3.3.19 TAG advises that each zone be connected to the network at one location, representing the “average” location for demand to access the network to / from the given zone. There are some zones within the model whereby there are more than one zone loading point, and these multiple locations have been represented, although these instances have been kept to a minimum.

3.3.20 This review of centroid connectors has highlighted two areas where adjustments to the zone loading points have been investigated. The first of these are zones 2038 and 2048 to the north of the town centre. The zone loading for these two zones is shown in Figure 3.9.

Figure 3.9: Zone Loading Points for Zone 2038 and 2048



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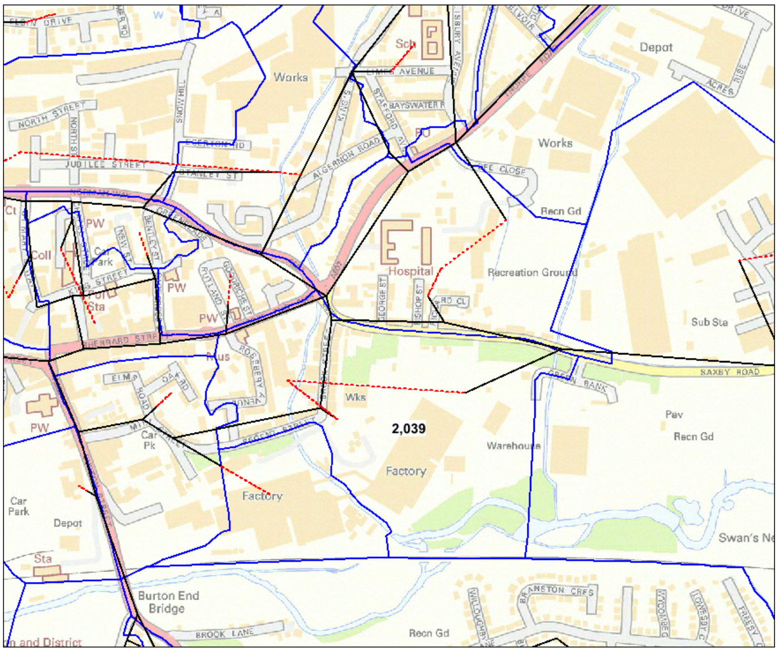
3.3.21 The most westerly of these two zones (zone 2038) loads onto the network at two locations: firstly onto the A607 Norman Way via Soho Street; and secondly also onto Norman Way, but via Snow Hill. Considering the land-use within this zone, it was felt that the majority of the demand to / from this zone is loaded onto the network via the connector representing Snow Hill only, and that the connector to Soho Street should be removed.

3.3.22 For this zone, the approach of connecting the zone only via Snow Hill was tested and found to generate significant inbound rat-running between Nottingham Road and Scalford Road, significantly affecting the flows at the count locations closest to Norman Way. The connection via Soho Street was therefore retained, to represent the loading of the western part of the zone and minimise the impact on the model flow validation.

3.3.23 For the second of these two zones (zone 2048), the majority of the land-use contained within this zone is residential development along King's Road. Currently this zone also uses the connector representing Snow Hill, and the loading for this zone has been updated such that this zone loads onto the network in the vicinity of King's Road.

3.3.24 The second area highlighted within this review is zone 2039 to the south-east of the town centre. This zone contains both the Mars factory, which accesses the network on the B676 Saxby Road, and also the residential area between Brook Street and Rosebery Avenue, which accesses the network via both Brook Street and also onto the A606 Sherrard Street view Rosebery Avenue. Currently this zone is coded with loading points for the Mars access on the B676 and also onto Brook Street.

Figure 3.10: Zone Loading Points for Zone 2039



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3.3.25 The existing loading point onto Brook Street is a now disused exit from the Mars factory and testing has been undertaken with this connection removed, with and without a loading point via Rosebury Avenue onto the A606 Sherrard Street. Without the connection onto the A606, a large proportion of westbound trips rerouted via the exit onto the B676 and back into central Melton Mowbray on the B676. This approach created larger than observed flows on the westbound B676 and suggests that other loading points further east are required. With no other suitable loading point on the eastern part of Brook Street, the original loading point was retained and the additional loading point onto Sherrard Street via Rosebury Avenue was also added.

3.3.26 Given the location of this zone, it is judged that the adopted loading of demand to / from this zone would not have a material impact on the assessment of the proposed scheme, and is therefore appropriate for this application of the model.

3.4 Local Highway Network Routeing Review

3.4.1 In addition to reviewing the highway network coding, the routeing of traffic through Melton Mowbray has been reviewed. This review is in addition to the route analysis contained within the LLITM 2014 Base highway LMVR, and considered four zones within Melton Mowbray (north-east, north-west, south-east and south-west) and seven zones within the rural areas surrounding Melton Mowbray (to the north, north-east, north-west, south, south-east, south-west and east). Modelled routeing, by time period and vehicle type, has been reviewed for movements between these locations.

3.4.2 Due to the number of plots which have been produced as part of this review it is not possible to include all figures within this report; however Figure 3.12 provides a selection of model routes by vehicle type for a subset of the zone pairs and time periods assessed.

3.4.3 There is no independent information available on the routeing of traffic through Melton Mowbray, and therefore this review of the modelled routeing has been based on online route planners and knowledge of local congestion hot-stops which may influence traffic to favour minor roads. Our judgement on the modelled routeing based on the assessed zone pairs is that the routeing is plausible given the network topography and the congestion within the base year model.

3.4.4 It is worth noting that the routeing of HGV traffic is heavily influenced by the presence of HGV bans within the coded base year network. These bans allow traffic to access / exit zones, but do not allow through trips to use identified links. For example, within the Melton Rural North or Melton Rural South in the PM Peak routeing contained within Figure 3.12, the routeing of HGV demand is as a result of the HGV bans coded within the network.

3.4.5 Figure 3.11 shows the location of these coded HGV bans within the base year network, with the highlighted links being those where an HGV ban has been applied.

Figure 3.11: Coded HGV Bans within Base Year Network

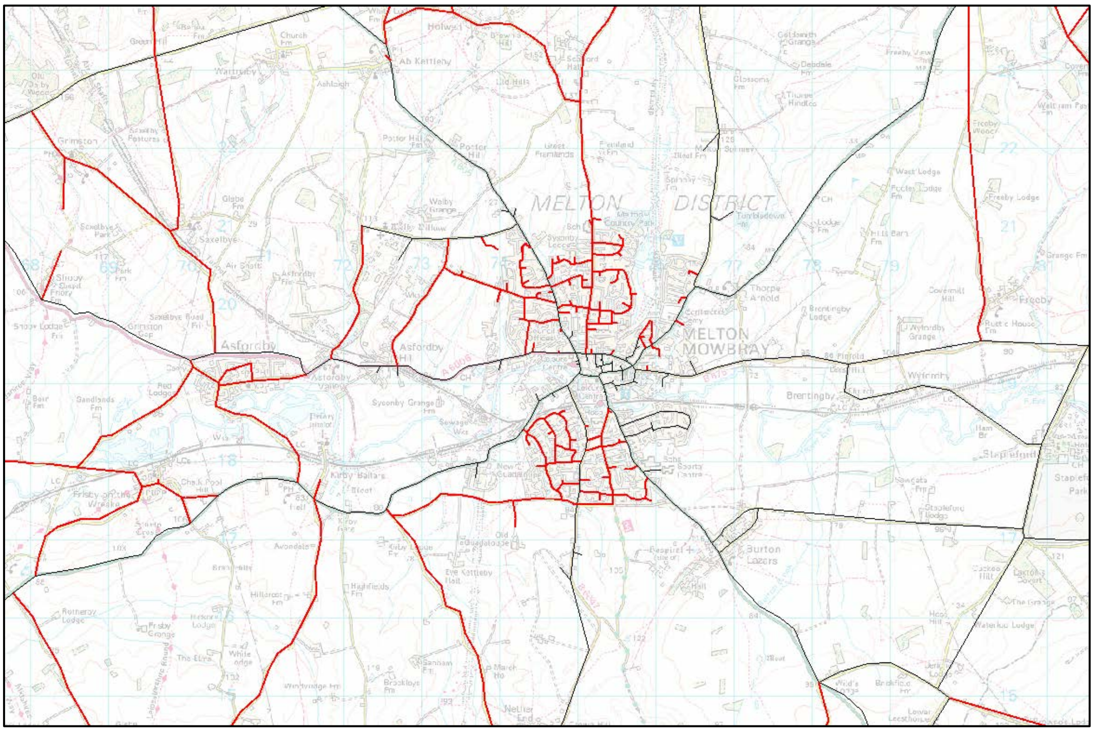

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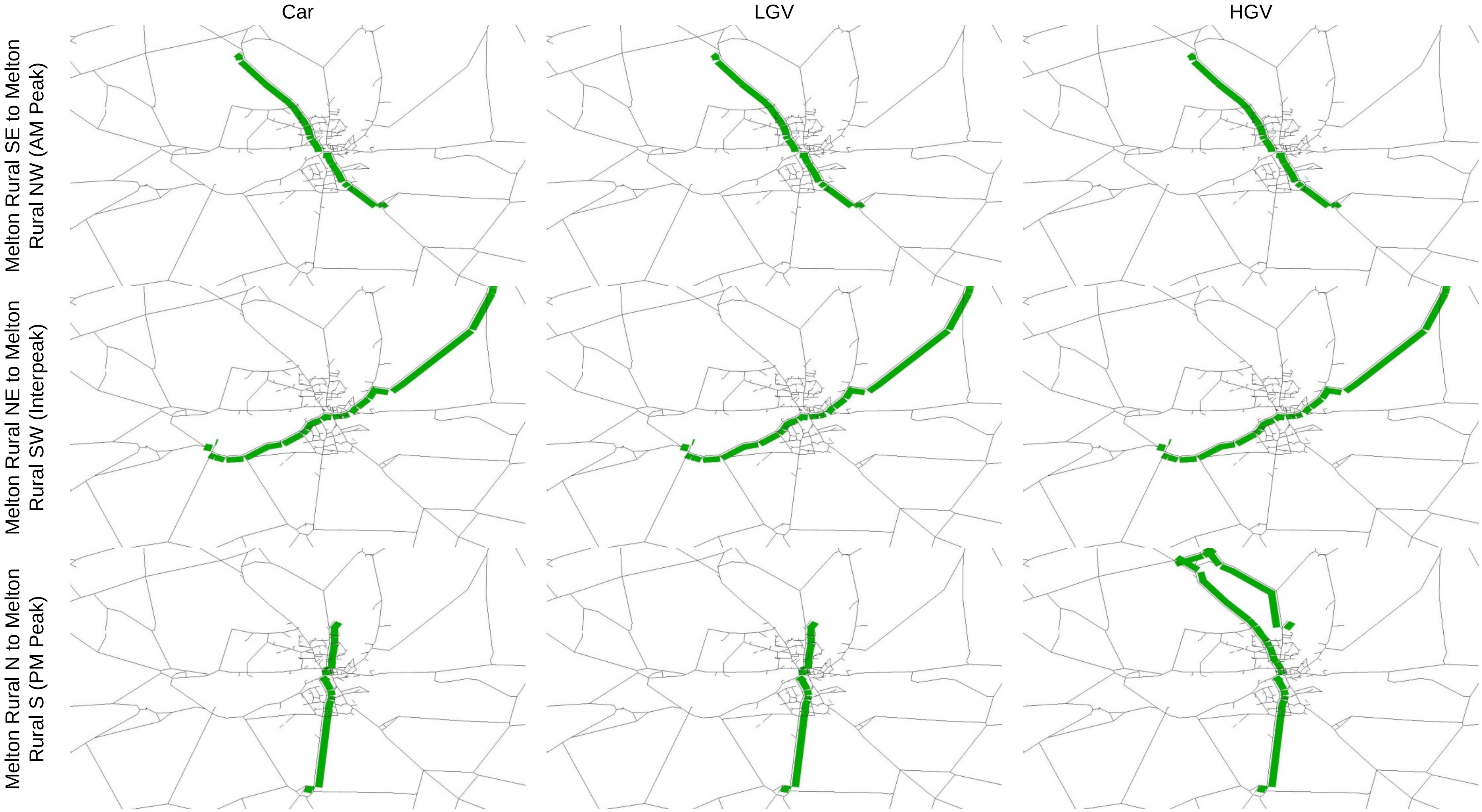
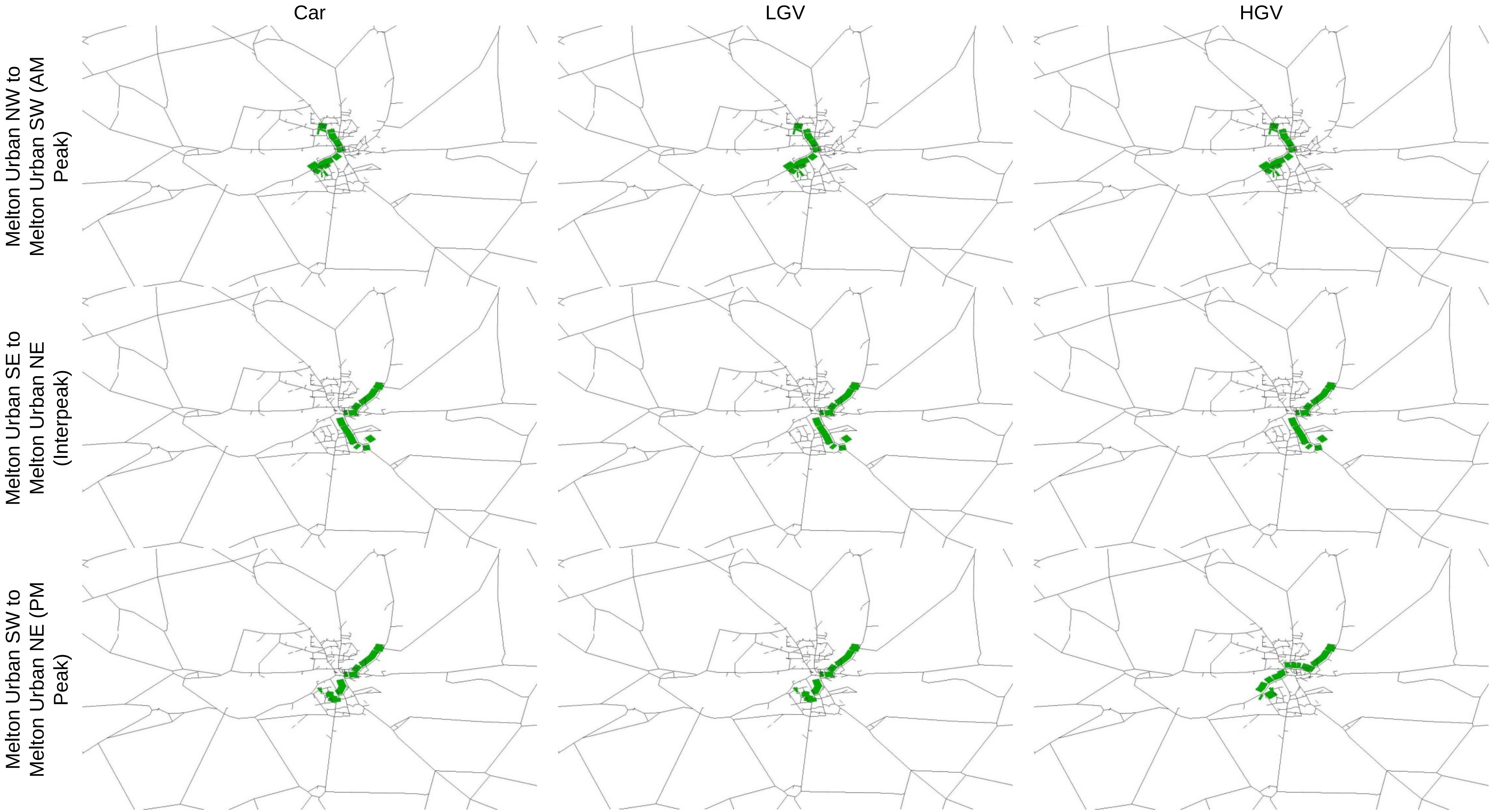
Figure 3.12: Selected Model Route Analysis Results




Car
LGV
HGV
Melton Urban NW to Melton Urban SW (AM Peak)
Melton Urban SE to Melton Urban NE (Interpeak)
Melton Urban SW to Melton Urban NE (PM Peak)

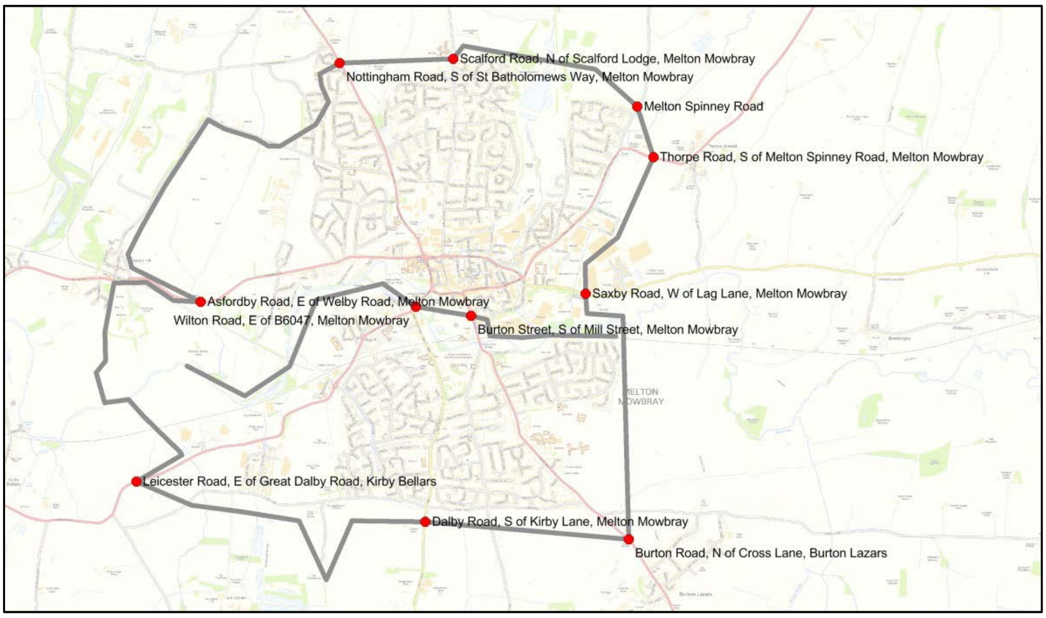
Section 4 – Highway Matrix Review

4.1 Introduction

4.1.1 In addition to reviewing the coded highway network, the base year highway matrices have been reviewed against other available data sources.

4.1.2 As part of the development of the LLITM 2014 Base highway model, a programme of roadside interview (RSI) surveys were undertaken across Leicestershire. This programme of RSI surveys included a cordon of Melton Mowbray urban area and RSI surveys at the two bridges across the River Eye within Melton Mowbray. These RSI locations are shown in Figure 4.1.

Figure 4.1: Melton Mowbray RSI Surveys



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4.1.3 When analysing data from the RSI surveys, RSI records from within the peak periods have been used in the comparison with the AM Peak and PM Peak modelled hours. This approach has been adopted to increase the sample size used within the RSI data, and is based on the assumption that the pattern of trips within the peak periods and individual peak hours are consistent[2]. Note that there is no distinction in time period definition within the interpeak between the RSI data and the model as both represent an average hour within the period.

4.1.4 To illustrate the broad travel patterns for trips intercepted by the Melton Mowbray RSI cordon surveys, 12-hour desire lines are shown in Figure 4.2, provided separately by car, LGV and HGV.

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[2] A comparison of the pattern of trips observed within the modelled hour and the period within the morning and evening peak has been undertaken to confirm this assumption. When limiting the RSI records to the individual peak hour, the pattern of observed trips was not significantly different from that observed within the peak period.

Figure 4.2: 12 Hour Demand Desire Lines (Melton Mowbray RSI Cordon): Car

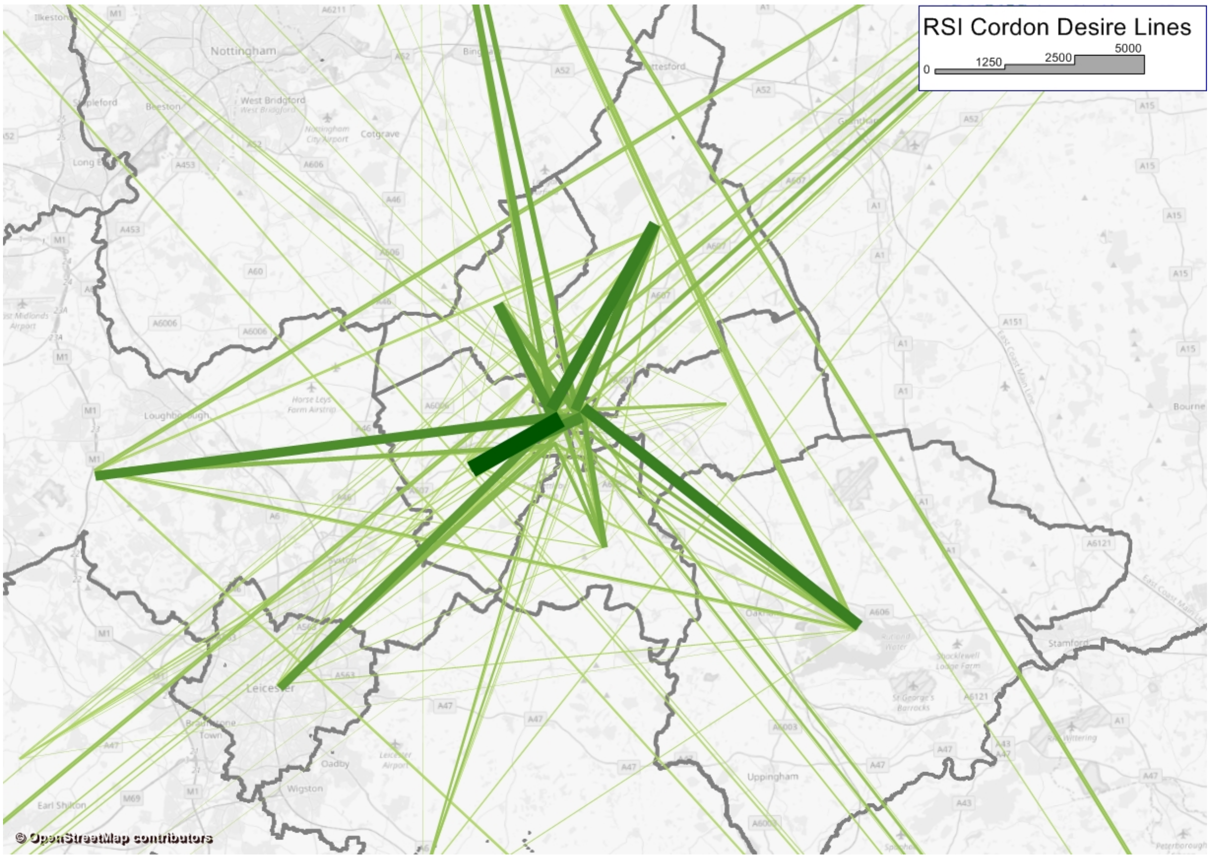


Figure 4.3: 12 Hour Demand Desire Lines (Melton Mowbray RSI Cordon): LGV

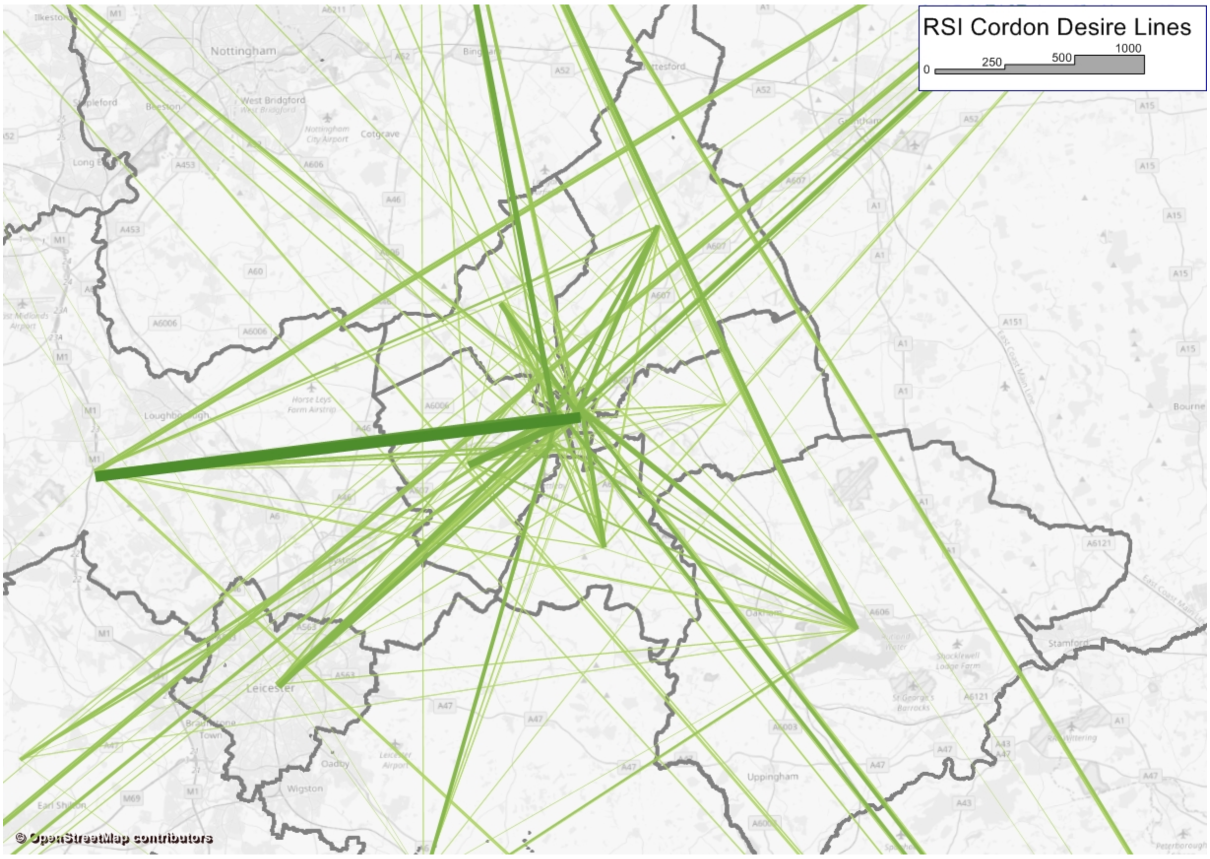
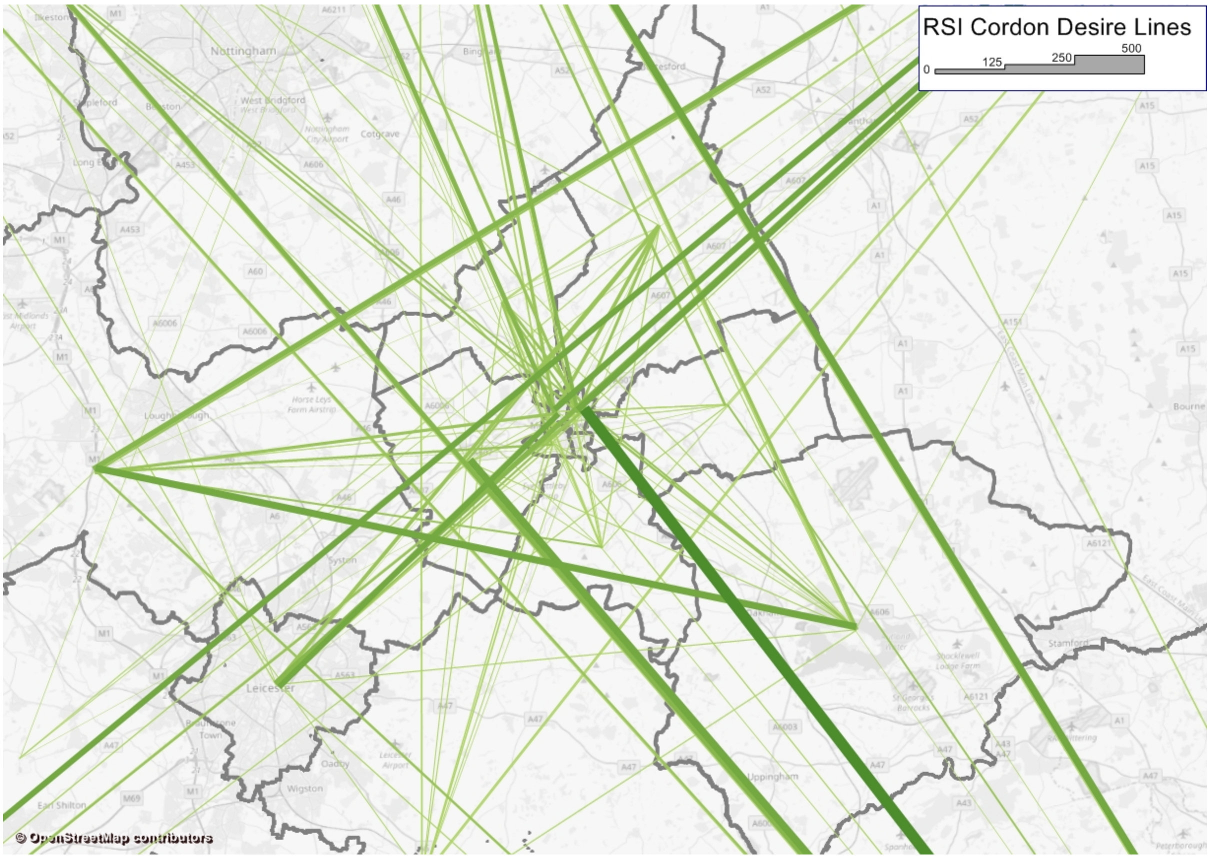


Figure 4.4: 12 Hour Demand Desire Lines (Melton Mowbray RSI Cordon): HGV



© OpenStreetMap contributors

4.1.5 In addition to the 2014 RSI surveys undertaken around Melton Mowbray, the 2011 Census Journey to Work data also provides an independent data source for commuting demand, and has been used as part of this matrix review. It should be recognised that the 2011 Census Journey to Work matrix is not directly comparable with the commuting demand matrix due to differences in definition between the two datasets, and there are three years between the 2011 Census and the 2014 base year of the model.

4.1.6 For car travel demand, the primary source of data used in the highway matrix development is mobile network data. Details on the verification of this data and the processing of this data for use within LLITM 2014 Base are given in the main LMVR for the highway model. One weakness of demand data from mobile network data is the identification of short distance trips, and therefore shorter distance trips (less than 2.5kms) within the highway model have been infilled with synthetic demand. This means that, for car demand, the majority of trips within the Melton Mowbray urban area will be derived from the synthetic matrices, and are not observed within mobile network data.

4.1.7 Freight demand within the base year model is purely synthetic as freight trips could not be accurately identified within the mobile network data. This synthetic matrix build used trip-ends derived from the base year planning data and TRICS trip rates, and observed trip-lengths profiles from the National Travel Survey for LGV and the collated RSI data for HGV. The HGV demand was also controlled to the DfT's Base Year Freight Matrices.

4.1.8 The process by which freight trips have been removed from the mobile network data provided is discussed within Section 7.6 of the original PRTM highway LMVR under "Segmentation". This process used synthetic demand by vehicle type and purpose to disaggregate the provided mobile network data.

4.2 Melton Mowbray Cordon Comparison

4.2.1 The Melton Mowbray Cordon captures highway demand entering and leaving the Melton Mowbray urban area. This cordon consists of 9 RSI surveys and includes two 'holes' within the cordon on Kirby Lane and Welby Lane. For these two locations, where an RSI survey has not been undertaken, an estimation of proxy RSI data have been made to provide a complete picture of travel demand to and from the urban area. The 'hole' at Kirby Lane has used RSI records from the A607 Leicester Road adjacent to Kirby Lane, and proxy RSI records for Welby Lane have been estimated from a select link process on the previous 2008 base year version of LLITM. At both these locations, the proxy RSI records have been expanded to a count at the cordon 'hole'.

4.2.2 In order to compare the modelled demand against these RSI surveys, a series of select links within the prior matrix assignment and the matrix estimated assignment has been undertaken at the RSI survey locations. Any routeing errors in the assignments will impact on this analysis, but given that the base year model has been calibrated and validated, and given the topography of the road network in and around Melton Mowbray, it is thought that there are unlikely to be any significant routeing issues within the network.

4.2.3 Using the RSI surveys and the select links from the model, three comparisons of the demand have been undertaken. These are a comparison of average trip-lengths, a comparison of trip-length profiles, and a comparison of the proportion of through-traffic between the RSI surveys and the modelled demand.

4.2.4 Table 4.1 shows the average trip-lengths for all cordon crossing points combined in both the inbound and outbound direction by time period for the prior matrix assignment, the post-matrix estimation assignment, and the average trip-lengths based on the RSI surveys. This table shows that there is a good fit between the modelled and observed average trip-lengths for car and LGV trips. There is more variation between the modelled and RSI average trip-lengths for HGV traffic, although it should be noted that the sample size for HGV traffic at the Melton Mowbray Cordon within the RSI data is small.

4.2.5 In the AM Peak the HGV average trip-length observed at the Melton Mowbray Cordon is based on around 100 observations, with around 230 observations in the interpeak period and around 50 observations in the PM Peak. This low sample size increases the uncertainty in the observed data for HGV traffic at the cordon.

Table 4.1: Average Trip-Lengths (km) for Melton Mowbray Cordon

	Prior Matrix			**Post-ME Matrix**			**RSI Matrix**		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
HGV	131	149	129	131	117	120	74	63	93
LGV	66	71	61	51	50	49	57	50	54
Car	41	42	41	39	40	42	41	42	41
Overall	**54**	**63**	**49**	**48**	**48**	**46**	**45**	**45**	**44**

4.2.6 Whilst the sample size for LGV traffic is higher than that for HGV traffic, it is not sufficient to consider the average trip-lengths for either freight vehicle class at a more disaggregate level. For car traffic, the average trip-lengths have been calculated for inbound (the observed direction for the RSI surveys) and outbound direction, and for A-roads and non-A-roads separately. The results of this analysis is shown in Table 4.2, which demonstrates that there is a good fit between the modelled and observed average trip-lengths for car traffic at the Melton Mowbray Cordon.

Table 4.2: Average Trip-Lengths (km) for Melton Mowbray Cordon (Car)

	Prior Matrix			**Post-ME Matrix**			**RSI Matrix**		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
Overall	41	42	41	39	40	42	41	42	41
Inbound	39	41	42	37	39	42	39	43	42
Outbound	43	42	40	41	41	42	43	42	41
A-roads	42	44	41	41	42	44	42	45	43
Other	40	38	40	35	34	40	38	36	37

4.2.7 In addition to calculating the average trip-lengths, Figure 4.6 shows a comparison of the trip-length profiles for car traffic at the Melton Mowbray Cordon. This analysis shows the trip-length profiles by time period for all sites combined and in both directions, for inbound and outbound travel separately, and also separately for A-road and non-A-road traffic.

4.2.8 Figure 4.6 shows that for car traffic there is a good correlation between the modelled and observed trip-length profiles within the interpeak model; however the comparison in the AM Peak and PM Peak models shows a similar discrepancy between the modelled and observed data.

4.2.9 In the interpeak trip-length profiles, there are two distinct peaks within the profile at around 15 and 30kms, with the first of these two peaks containing a higher proportion of traffic. This pattern is reproduced within the RSI survey data in the two peak hours, but it is not reproduced within the modelled data for these two periods. Within the modelled data for the AM Peak and PM Peak, the second peak at around 30kms is the stronger peak within the profile, with a weaker peak in the trip-length profile at around 10 to 15kms.

4.2.10 Considering the inbound AM Peak car trips to the Melton Mowbray Cordon, Table 4.3 shows the top five sector-to-sector movements within the assignment of the prior matrices and the RSI survey data. The sector system has been defined based on districts within Leicestershire, and counties outside Leicestershire. The urban area of Melton Mowbray has been separated from the Melton Borough sector within this analysis. This sector system is shown in Figure 4.5.

4.2.11 This shows that whilst the top sector movement is the same in each dataset (Rest of Melton Borough to Melton Mowbray), the proportion of inbound traffic at the cordon making this movement is around 30% in the RSI data compared with around 20% in the prior matrix. Table 4.3 also shows that for some of the longer distance movements (such as Lincolnshire and Rutland to Melton Mowbray, Leicester City to Melton Mowbray, and Nottinghamshire to Melton Mowbray) there is a higher proportion of demand within the model compared with the RSI survey data.

Figure 4.5: Matrix Analysis Sector System

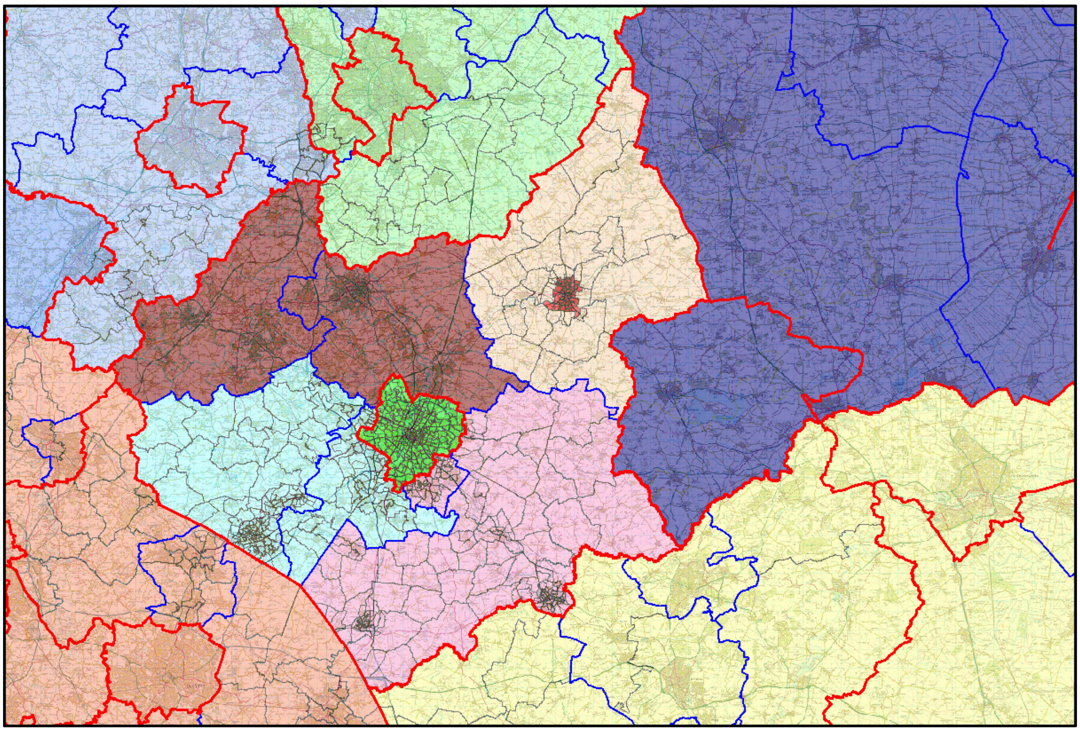


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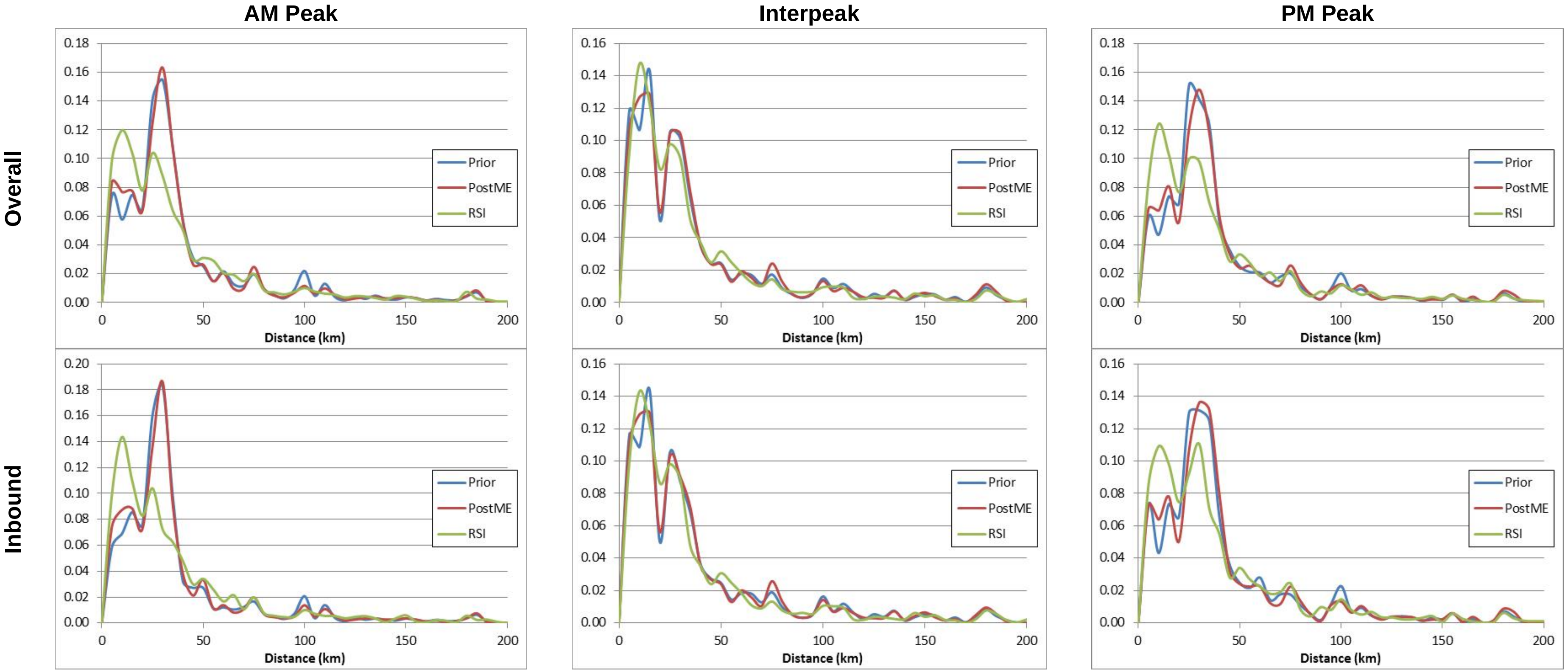
Table 4.3: Top Sector Movements for AM Peak Inbound Car Demand

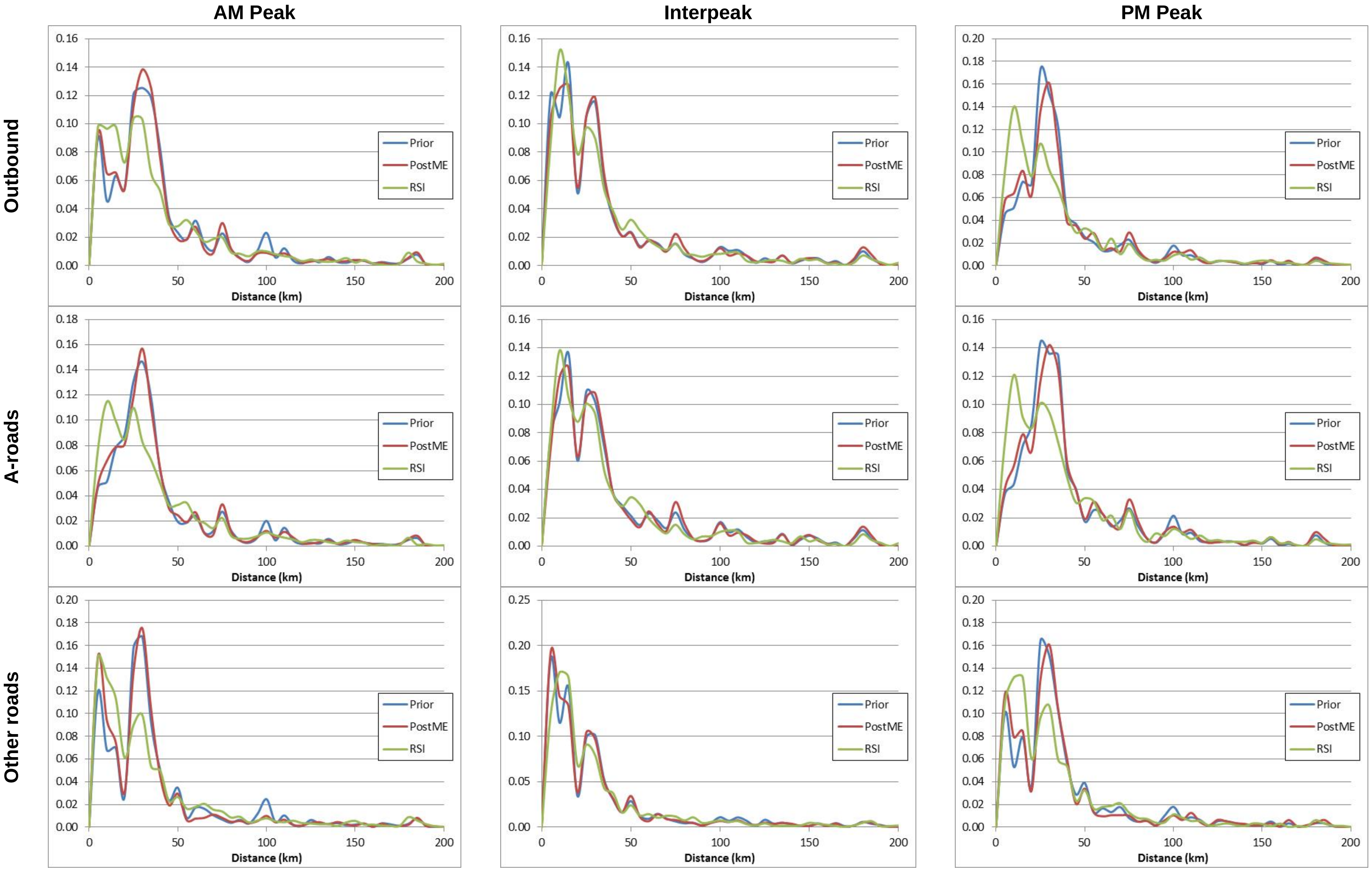
	Prior Matrix		RSI Data	
1	Rest of Melton Borough - Melton Mowbray	19%	Rest of Melton Borough - Melton Mowbray	31%
2	Lincolnshire and Rutland - Melton Mowbray	14%	Lincolnshire and Rutland - Melton Mowbray	9%
3	Leicester City - Melton Mowbray	12%	Charnwood and NW Leics - Melton Mowbray	7%
4	Nottinghamshire - Melton Mowbray	9%	Rest of Melton Borough - Rest of Melton Borough	5%
5	Charnwood and NW Leics - Melton Mowbray	8%	Nottinghamshire - Melton Mowbray	5%

4.2.12 The analysis contained within Table 4.3 suggests that, compared with the RSI survey data, the model understates the proportion of travel to / from Melton Mowbray and the rest of the borough, and overstates the proportion of demand to / from Melton Mowbray and Leicester City, Nottinghamshire and Lincolnshire and Rutland. This is consistent with the trip-length profile analysis, which also suggests that the model has an overstatement of movements around 30kms in length when compared with the RSI survey data.

4.2.13 Based on the sample size, the 95% confidence intervals around these proportions within the RSI data are expected to be around ±5 percentage points. This means that, given the uncertainty in the observed RSI data, the difference between the prior matrix and RSI proportions for all sector-sector movements except the ‘Rest of Melton Borough to Melton Mowbray’ movement are likely to be within the 95% confidence interval of the RSI data.

Figure 4.6: Melton Mowbray Cordon Trip-Length Profile Comparison (Car)




AM Peak
Interpeak
PM Peak
Outbound
A-roads
Other roads
Prior
PostME
RSI
Distance (km)
0
50
100
150
200
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.05
0.15
0.25

4.2.14 Considering inbound car traffic to the Melton Mowbray Cordon only, Table 4.4 provides a high-level summary of the key movements for car traffic inbound to the Melton Mowbray Cordon. This shows that the external-external movement (i.e. the Melton Mowbray through trips) is around 25% and 30% of traffic within the model, compared with between 30% and 35% for the RSI data.

4.2.15 The proportion for trips with an origin external to the RSI cordon and a destination within Melton North is comparable between the modelled data and the RSI data across all time periods. Compared with the RSI data, the overstatement of external-external trips within the model is largely countered by a corresponding understatement in the proportion of trips with an origin external to the RSI cordon and a destination within Melton South.

Table 4.4: High-Level Summary of Inbound Trips at Melton Mowbray Cordon (Car)

	Prior Matrix			Post-ME Matrix			RSI Matrix		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
External-External	26%	28%	25%	26%	27%	26%	35%	31%	34%
External-Melton North	42%	45%	46%	47%	50%	48%	48%	53%	46%
External-Melton South	31%	27%	29%	27%	23%	26%	16%	15%	19%

Note that figures may not sum to 100% due to a small amount of traffic with an origin within Melton Mowbray which is also inbound to the cordon

4.2.16 Finally, using the RSI data and modelled data for the Melton Mowbray Cordon, the proportion of traffic which is through-traffic (i.e. has both trip-ends outside the Melton Mowbray Cordon) has been calculated. This analysis is shown in Table 4.5 which gives the proportion of through-traffic by time period and for overall traffic, and for inbound and outbound traffic.

4.2.17 Considering the inbound (i.e. observed) direction in more detail, the modelled proportion of through trips does not change significantly as a result of applying matrix estimation. The modelled proportions of through trips are however consistently lower than those observed within the RSI data by around 10 percentage points in the AM Peak and PM Peak hours, and around 4 percentage points in the interpeak hour.

4.2.18 In terms of the number of trips that this relates to, the inbound car cordon flows are around 2,500 vehicles in the two peak hours and around 1,650 vehicles in the interpeak hour. Applying the percentages detailed in Table 4.5 to these flows suggests that the model underrepresents car through trips by around 200 vehicles in the AM Peak and PM Peak, and by around 50 vehicles in the interpeak hour.

4.2.19 It is important when reviewing this analysis to consider confidence intervals around the observed data. All the RSI surveys were undertaken in the inbound direction, and for these locations the 95% confidence internal around the RSI through trip proportion is around ±7 percentage points in the AM Peak and PM Peak time periods, and around ±5 percentage points in the interpeak model at individual sites. There is additional uncertainty for the outbound direction where the observed RSI records have been reversed to estimate travel patterns, and this additional uncertainty has not been quantified.

Table 4.5: Proportion Through Trips at Melton Mowbray Cordon (Car)

	Prior Matrix			Post-ME Matrix			RSI Matrix		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Overall	**26%**	**27%**	**26%**	**27%**	**27%**	**27%**	**35%**	**31%**	**34%**
Inbound	26%	28%	25%	26%	27%	26%	35%	31%	34%
Outbound	27%	26%	27%	28%	26%	29%	35%	31%	34%

4.3 Melton Mowbray River Screenline Comparison

4.3.1 In the context of the scheme a specific comparison has been undertaken using the two RSI surveys which form the Melton Mowbray River Screenline and select links on the prior matrix and post-matrix estimation matrix assignments.

4.3.2 At these two locations, the sample size for freight demand is small, especially for HGV traffic. This leads to significant uncertainty around the data for HGV traffic even for calculating average trip-lengths. The sample size for LGV traffic is higher, with around 60 records in the AM Peak, 90 in the interpeak and 35 in the PM Peak, but caution should be exercised when reviewing the results of the RSI surveys for LGV traffic.

4.3.3 Based on the observed data at the Melton Mowbray River Screenline, Table 4.6 presents the average trip-lengths by time period and vehicle class from the prior matrices, the post-matrix estimation matrices and the RSI surveys. The results for HGV traffic are included, but the sample size is too small to place any confidence on the RSI data for this vehicle class.

4.3.4 For LGV traffic the average trip-lengths from the RSI surveys are similar to those contained within the model; however for car traffic the modelled average trip-lengths are generally shorter than those observed at the RSI surveys. The difference varies by time of day, but the modelled average trip-lengths (after the application of matrix estimation) are between 20% and 30% lower than observed at the RSI surveys.

Table 4.6: Average Trip-Lengths (km) for Melton Mowbray River Screenline

	Prior Matrix			Post-ME Matrix			RSI Matrix		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
HGV	135	155	134	143	126	134	38	23	75
LGV	43	47	36	39	39	36	43	49	29
Car	18	19	21	19	21	20	25	29	28
Overall	**30**	**39**	**28**	**29**	**29**	**25**	**27**	**32**	**28**

4.3.5 Considering the car trip-lengths in more detail, Table 4.7 provides a breakdown of the average trip-lengths for car demand by direction of travel across the screenline. Northbound at the Melton Mowbray River Screenline is the observed direction, with the observed RSI records having been reversed to estimate the southbound demand at the screenline. Table 4.7 shows that for car traffic at the Melton Mowbray River Screenline there is little variation in average trip-lengths by direction in either the modelled or observed data.

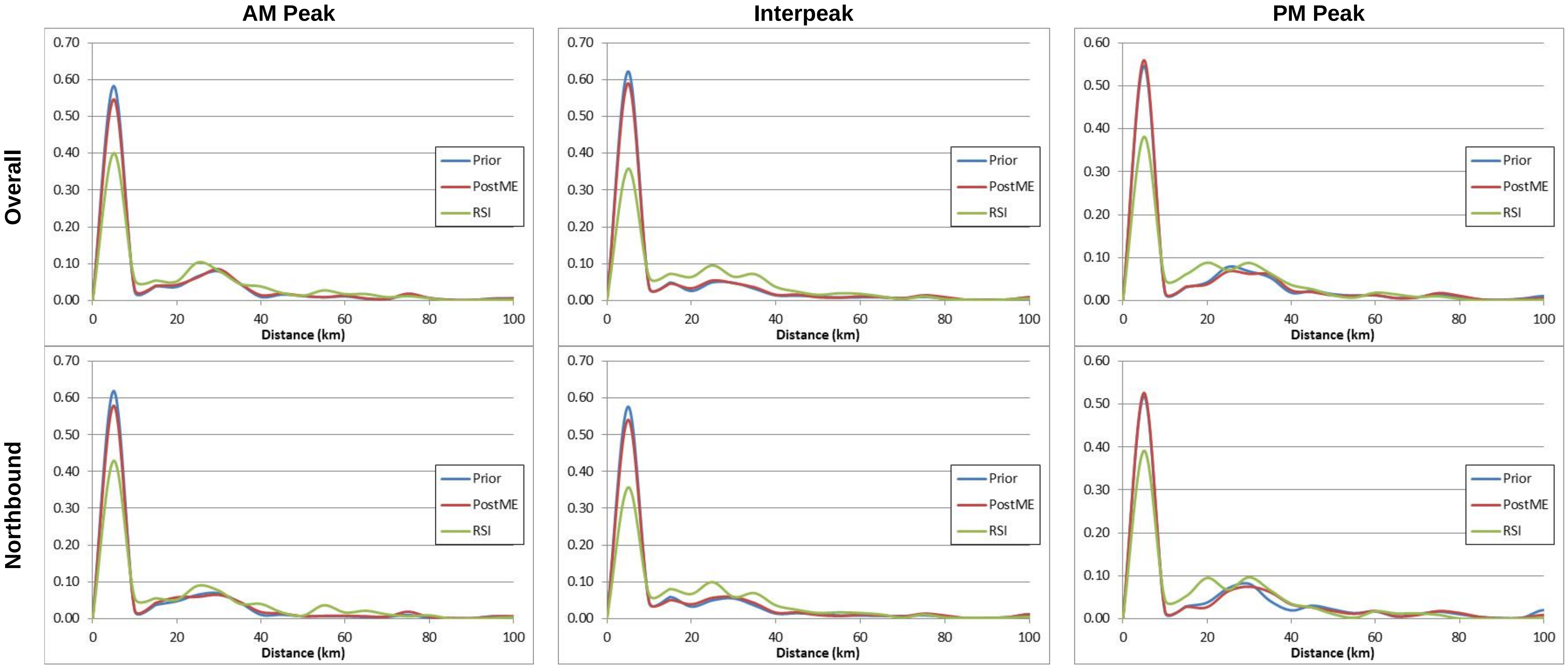
Table 4.7: Average Trip-Lengths (km) for Melton Mowbray Cordon (Car)

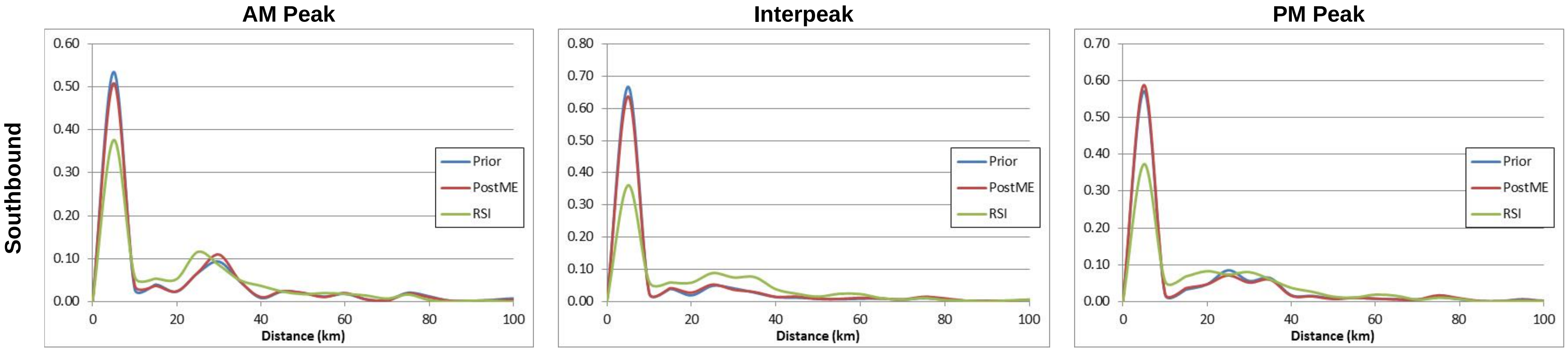
	Prior Matrix			Post-ME Matrix			RSI Matrix		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Overall	18	19	21	19	21	20	25	29	28
Northbound	16	20	24	18	22	23	24	29	28
Southbound	21	18	17	22	19	17	26	29	28

4.3.6 Figure 4.7 shows the trip-length profiles from the assignments of the prior demand and matrix estimated demand, and also that derived from the RSI surveys for car travel across the Melton Mowbray River Screenline by time period and for both directions combined, and for each direction of travel separately.

4.3.7 The analysis contained within Figure 4.7 shows that the peak within the trip-length profile is at the same point within both the modelled data and the observed data, at trips of length around 5km, but that this peak is stronger in the modelled data than compared with the RSI survey data. This is consistent across modelled time periods and direction of travel. This means that a greater proportion of demand has these shorter trip-lengths within the model than compared with the RSI surveys, and this is consistent with the analysis of average trip-lengths.

Figure 4.7: Melton Mowbray River Screenline Trip-Length Profile Comparison (Car)





AM Peak

Interpeak

PM Peak

4.3.8 Table 4.8 provides a high-level summary of the proportion of trips within key movements for northbound car trips at the Melton Mowbray River Screenline. Some of the minor movements which contain a small proportion of demand have been excluded from Table 4.8.

4.3.9 Melton South to Melton North trips (i.e. internal cross-river) are a higher proportion of demand within the model than within the RSI data. Within the model this movement is broadly between 50% and 60% of northbound car traffic at this screenline, compared with around 25% to 30% of traffic observed within the RSI surveys. This overstatement in internal cross-river traffic is countered by an understatement compared with the RSI data of trips with at least one trip-end external to the urban area. That is trips external to external (i.e. through trips), external to Melton North and Melton South to external.

Table 4.8: High-Level Summary of Northbound Trips at Melton Mowbray River Screenline (Car)

	Prior Matrix			**Post-ME Matrix**			**RSI Matrix**		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
External-Melton North	24%	22%	28%	23%	22%	28%	31%	25%	36%
Melton South-Melton North	59%	51%	49%	55%	49%	49%	29%	27%	27%
External-External	9%	11%	11%	10%	12%	10%	12%	18%	14%
Melton South-External	7%	15%	11%	10%	16%	12%	17%	22%	13%

Note that figures may not sum to 100% due to minor movements being omitted from this table

4.3.10 Table 4.9 provides additional analysis on the pattern of traffic within the model crossing the Melton Mowbray River Screenline which is internal to the urban area, i.e. trips within the urban area from north of the screenline to south of the screenline and vice-versa. This analysis has been undertaken for both directions combined, by direction at the screenline, and for the individual sites along the screenline.

4.3.11 As with the through trip analysis of the Melton Mowbray Cordon, based on the sample size for each RSI, it has been calculated that the 95% confidence internals for the northbound (i.e. interview) direction at each RSI site are around ±6 percentage points in the AM Peak and PM Peak models, and around ±4 percentage points in the interpeak model. As with the Melton Mowbray Cordon, there is additional uncertainty in the non-interview direction where the RSI records have been revered, and this additional uncertainty has not been quantified.

Table 4.9: Proportion Internal Cross-River Trips at Melton Mowbray River Screenline (Car)

	Prior Matrix			**Post-ME Matrix**			**RSI Matrix**		
	AM	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
Overall	55%	56%	51%	51%	54%	53%	27%	26%	27%
Northbound	59%	51%	49%	55%	49%	49%	29%	27%	27%
Southbound	50%	61%	54%	47%	59%	56%	24%	25%	27%

4.3.12 This outcome is consistent with the analysis of the Melton Mowbray Cordon. The comparison of the modelled flows against counts (discussed in Section 5) shows that there is a good fit between the modelled flows and the observed link flow data within Melton Mowbray. As the analysis of the Melton Mowbray Cordon suggests that, compared with the RSI data, the model understates through Melton Mowbray trips, these ‘missing’ trips need to be replaced with other movements to meet TAG criteria for link flows. To meet these criteria, the analysis of the Melton Mowbray River Screenline suggests that the base year matrices overstate internal Melton Mowbray traffic compared with the RSI data.

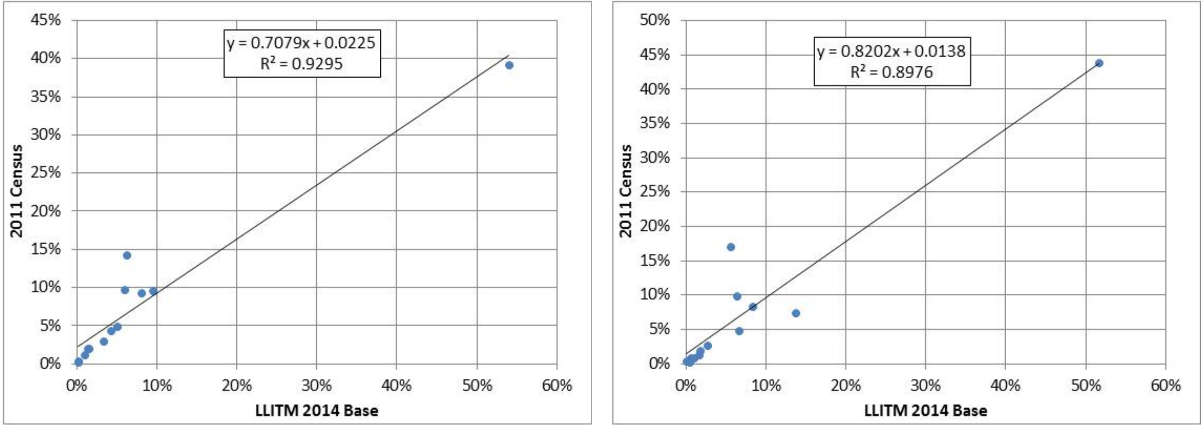
4.4 2011 Census Journey to Work Comparison

4.4.1 The 2011 Census Journey to Work data provide an insight into commuting demand, but there are some important definitional differences between the data collected as part of the Census (which is usual place of work) and the definition of commuting demand within transport models (commuting trips on an average weekday). In an attempt to account for this, adjustments have been made to the Journey to Work data in an attempt to account for:

- annual leave (assumed to be 5.6 weeks per worker, including Bank Holidays, based on details from gov.uk);
- sick leave (based on an average of 4.21 sick days per worker from analysis of ONS data);
- weekday / weekend commuting (based on analysis of NTEM 7 data);
- proportion of full-time and part-time working (based on analysis of the 2011 Census); and
- trip production change between 2011 and 2015 (based on analysis of NTEM 7 data.

4.4.2 Using this adjusted Census Journey to Work matrix, a comparison has been undertaken between this data source and the LLITM 2014 Base 24-hour commuting matrix for the model's base year. This comparison has considered, at a sector level, the location of attractions for trips produced within Melton Mowbray and the location of trip productions for commuting trips attracted to Melton Mowbray. Scatterplots of these comparisons are shown in Figure 4.8, with the underlying data presented within Table 4.10.

Figure 4.8: Comparison of Highway Commuting Trip-Ends between LLITM 2014 Base and 2011 Census



Attraction location for trips produced within Melton Mowbray

Production location of trips attracted to Melton Mowbray

Table 4.10: Comparison of Highway Commuting Trip-Ends between LLITM 2014 Base and 2011 Census

	Attractions for Melton Mowbray Productions		Productions for Melton Mowbray Attractions	
	LLITM	**Census**	**LLITM**	**Census**
Melton Mowbray	54%	39%	52%	44%
Rest of Melton Borough	6%	14%	6%	17%
Leicester City	6%	10%	6%	10%
Harborough and Oadby	1%	2%	2%	2%
Blaby and Hinckley	4%	4%	3%	3%
Charnwood and NW Leics	8%	9%	8%	8%
Nottinghamshire	5%	5%	7%	5%
Derbyshire	1%	1%	1%	1%
Lincolnshire and Rutland	9%	10%	14%	7%
SE External	3%	3%	2%	1%
SW External	1%	2%	1%	1%
NW External	0%	0%	0%	0%
NE External	0%	0%	0%	0%

4.4.3 The scatterplot analysis contained within Figure 4.8 shows that there is a good correlation between the location of trip-ends within the adjusted 2011 Census Journey to Work matrix and the all-day modelled base year commuting demand, with R^2 values around 0.9 for the location of trip attractions and productions.

4.4.4 Considering the results in Table 4.10, this shows that compared with the Census data, the model overstates internal commuting trips within Melton Mowbray. This is consistent with the analysis of RSI data for the Melton Mowbray River Screenline. This overstatement of internal Melton Mowbray commuting is countered by an understatement of commuting trips compared with the Census between Melton Mowbray and the rest of Melton Borough and Leicester City.

4.5 Impact of Matrix Estimation within Melton Borough

4.5.1 Section 10.4 of the main LLITM 2014 Base highway model LMVR provides analysis of the impact of the changes to the prior matrices due to matrix estimation based on the criteria set out within TAG. As discussed within this section, there is no guidance within TAG as to the subset of the matrix over which these tests should be applied; however the analysis presented focusses on the whole matrix (with the exception of trip-length profile analysis). Additional information, beyond TAG requirements, is given for Leicestershire trips which are the subset of the matrix most likely to be impacted by matrix estimation.

4.5.2 Analysis presented within Sections 4.2 and 4.3 give some information on the impact of matrix estimation within Melton Borough, as the analysis presented within these sections show that the matrix statistics do not in general alter significantly between the assignment of the prior matrices and the post-matrix estimation matrices. In addition to this analysis, the analysis required for TAG has been repeated but focusing on trips with an origin within Melton Borough.

4.5.3 Considering first the matrix zonal changes for trips with an origin in Melton Borough, Table 4.11 provides the regression statistics for movements within the matrix with an origin within Melton Borough. TAG states that the intercept should be near zero, the slope should be between 0.98 and 1.02, and the R^2 value should be in excess of 0.95; however this is assumed to apply to the matrix as a whole.

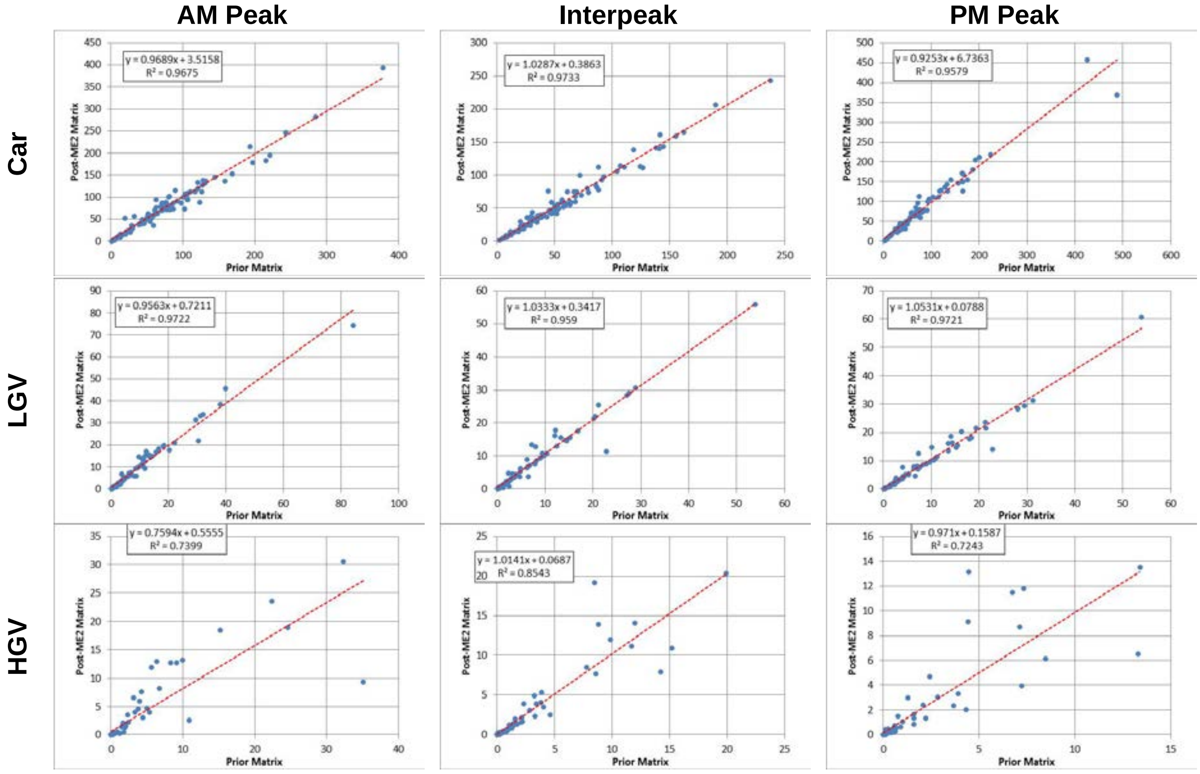
Table 4.11: Matrix Estimation Regression Statistics for Melton Borough Origins – Cell Movements

		AM	IP	PM
Car	Intercept	0.00	0.00	0.00
	Slope	0.97	1.00	0.95
	R^2	0.93	0.96	0.93
LGV	Intercept	0.00	0.00	0.00
	Slope	0.97	0.97	1.00
	R^2	0.91	0.88	0.93
HGV	Intercept	0.00	0.00	0.00
	Slope	0.69	0.93	0.81
	R^2	0.61	0.83	0.66

4.5.4 Table 4.11 shows that for car and LGV demand, the regression statistics are close to meeting TAG, with some time periods meeting the criteria set out, and LGV demand generally showing a larger change in matrix cells than car demand due to matrix estimation. HGV demand has the lowest R^2 values, and along with the statistics for LGV demand, demonstrates the greater uncertainty in the demand data source for freight demand compared with car demand.

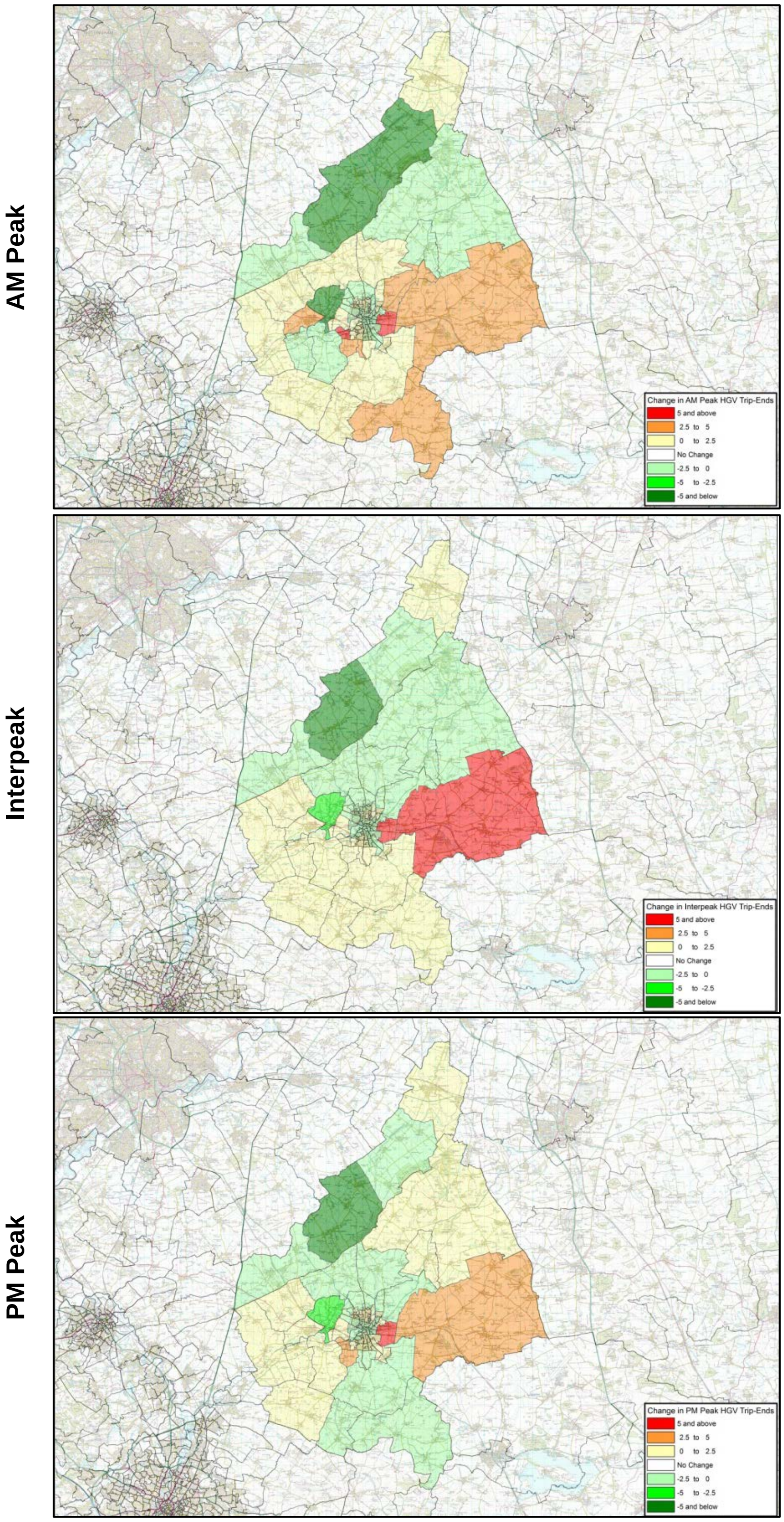
4.5.5 In terms of trip-ends, TAG sets out that the intercept should be close to zero, the slope between 0.99 and 1.01, and the R^2 value in excess of 0.98. Figure 4.9 shows the scatterplots for origin trip-ends for trips with an origin within Melton Borough by time period and vehicle type. As with the zonal matrix changes, the regression statistics are close to meeting TAG guidelines for car and LGV traffic, with larger changes due to matrix estimation for HGV traffic, even when considering the local study area only.

Figure 4.9: Matrix Estimation Regression Statistics for Melton Borough Origins – Trip Origins



4.5.6 Considering the change in HGV trip-ends due to matrix estimation in more detail, Figure 4.10 shows the change in HGV origin trip-ends due to matrix estimation in the three modelled time periods from the prior matrices to the estimated matrices within Melton Borough.

Figure 4.10: Change in HGV Trip Origins within Melton Borough due to Matrix Estimation



Map contains Ordnance Survey data © Crown copyright and database right 2022

4.5.7 It is firstly important to note the scale of change presented within Figure 4.10 for HGV origin trip-ends. Within each time period there are few zones where the HGV origin trip-end changes by more than 5 vehicles, either increasing or decreasing. The pattern of change in HGV origin trip-ends shows some differences by time period, suggesting that there are no systematic biases in the matrix development. However, the following changes are consistent across time periods:

- increases in HGV trip-ends to the east of Melton Mowbray;
- decreases in HGV trip-ends to the north-west of Melton Mowbray and in the north of the district.

4.5.8 In addition to considering the changes within the matrices at a zonal and trip-end level, TAG also sets out guidelines for the changes to the trip-lengths represented within the matrices. Within the main LLITM 2014 Base LMVR this analysis has been undertaken for trips with an origin within Leicestershire, and this has been repeated for those trips with an origin within Melton Borough.

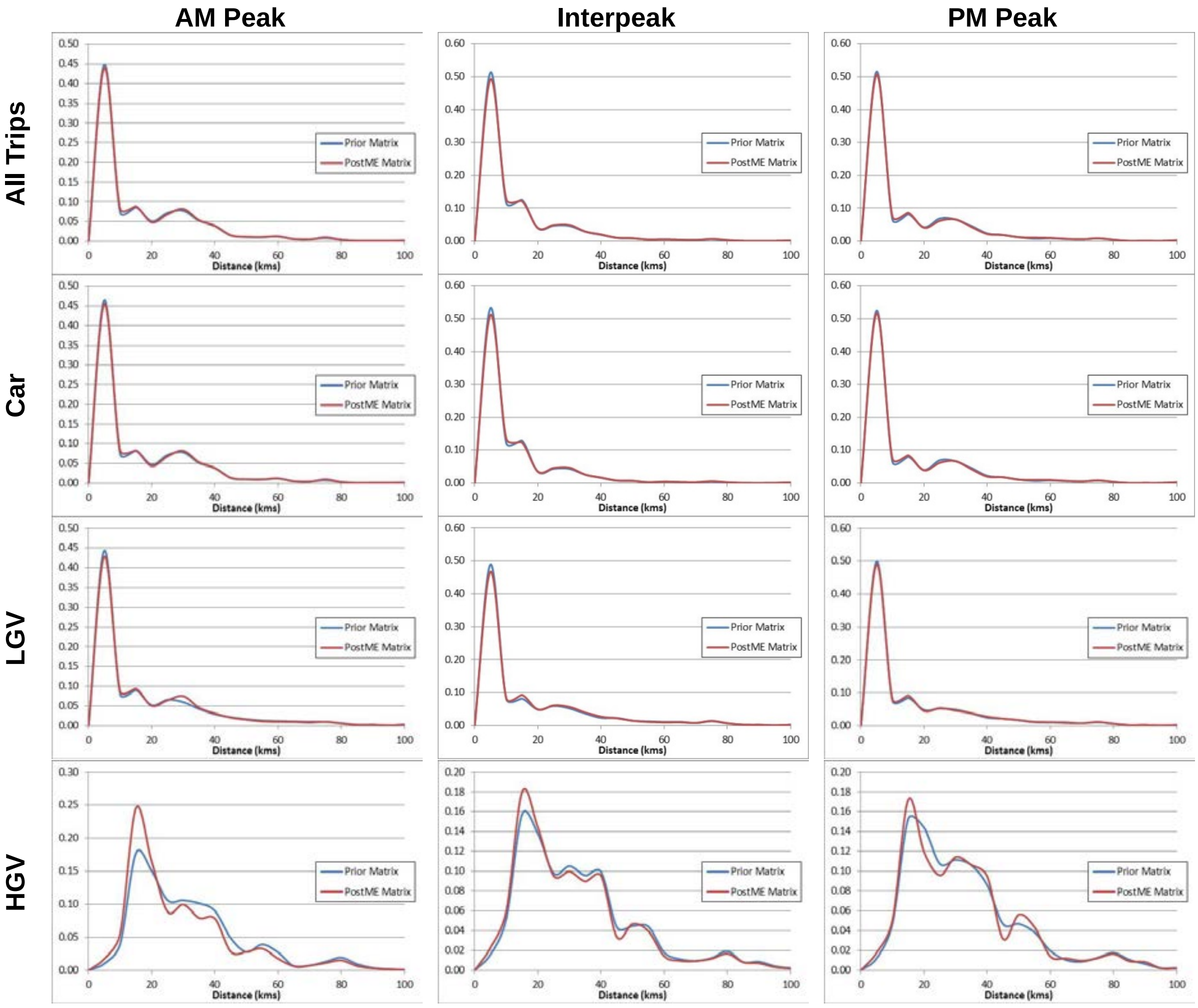
4.5.9 Table 4.12 provides the average trip-lengths and standard deviation of trip-lengths by time period and vehicle type within the prior matrices and the post-matrix estimation matrices. TAG sets out that the average trip-length and the standard deviation in trip-lengths should not change by more than 5% due to matrix estimation. In general, the changes in the trip-length statistics for Melton Borough origins are within 5% due to matrix estimation, with some statistics showing a greater change.

Table 4.12: Trip-Length Statistics for Melton Borough Origins

		Prior Avg.	Post-ME Avg.	%Change	Prior St. Dev.	Post-ME St. Dev.	%Change
AM Peak	All trips	17.7	17.7	-0.2%	26.3	25.8	-1.9%
	Car	17.1	17.2	0.7%	26.5	26.1	-1.6%
	LGV	19.1	18.7	-1.9%	27.8	26.7	-3.9%
	HGV	30.4	27.3	-10.3%	21.2	20.4	-3.5%
Interpeak	All trips	13.9	14.8	5.9%	25.8	27.4	6.3%
	Car	13.0	13.9	7.3%	26.0	27.9	7.4%
	LGV	17.5	17.7	1.2%	26.5	26.0	-1.8%
	HGV	31.3	29.7	-5.0%	21.7	21.3	-1.6%
PM Peak	All trips	15.6	16.3	4.6%	24.1	26.2	8.8%
	Car	15.2	16.0	5.0%	24.0	26.4	9.8%
	LGV	17.1	17.1	0.4%	26.0	25.9	-0.4%
	HGV	31.0	30.9	-0.1%	20.7	21.2	2.3%

4.5.10 In addition to the trip-length statistics, Figure 4.11 shows the modelled trip-length profiles before and after the application of matrix estimation by time period and vehicle type. As with other metrics on the changes to the matrices due to matrix estimation, the largest changes to the modelled trip-length profiles are for HGV traffic where the uncertainty in the underlying matrix data is greatest.

Figure 4.11: Trip-Length Profiles for Melton Borough Origins



Section 5 – Assignment Calibration and Validation

5.1 Introduction

5.1.1 The base year highway assignment has been assessed, using TAG criteria, against observed count and journey time data across the county. The main highway model LMVR provides details on the model performance against counts and journey times across the wider model. This section provides further detail on the local model performance within Melton Borough, and also compares the modelled flows against the newly collected counts within Melton Mowbray.

5.1.2 As discussed within Section 2, a number of updates to the highway networks have been adopted as part of a detailed review of the network coding within the area of interest. These changes will impact on the assigned flows within the base year model, and therefore potentially impacts on the performance of the model across the county. However, with the exception of the corrections at the A46 / A606 junction, the network updates are local in nature and therefore are not expected to impact on the wider model performance.

5.1.3 This section of the Melton Mowbray local LMVR firstly presents the performance of the model against flows and journey times as reported within the main highway model LMVR. This analysis is then reproduced using the updated base year networks to demonstrate that the changes adopted have not had a negative impact on the wider model performance. Finally, the modelled flows will be compared within the additional count data provided as part of this study, which provides additional flow validation sites within Melton Mowbray.

5.2 Existing Highway Model Performance

5.2.1 The following tables have been extracted from the main highway model LMVR, and show the wider model performance against observed data before the network updates detailed within this report have been applied.

5.2.2 Table 5.1 shows the performance of the model against screenline flows for total vehicle flows by time period, detailing the aggregate difference between modelled and observed flows and the number of screenlines which pass TAG criteria. Table 5.2 shows the percentage of links which meet TAG guidelines, both including and excluding duplicate count locations. (A duplicate count is one which is used on more than one screenline.) Finally, Table 5.3 shows the percentage of journey time routes which meet TAG criteria by time period.

5.2.3 In all of these tables, the reporting area of ‘North-East Leicestershire’ broadly corresponds with Melton Borough. The performance of the model in this area is therefore an approximation for the performance of the model within the area of interest.

Table 5.1: Original Leicestershire Screenline Performance (Total Vehicle Flows)

	AM Peak Hour		**Interpeak Hour**		**PM Peak Hour**	
	Total %	ScnLine Passes	Total %	ScnLine Passes	Total %	ScnLine Passes
Leicester City	0.2%	94%	0.4%	100%	0.7%	100%
North Leicestershire	-0.1%	94%	0.7%	88%	1.1%	88%
North-East Leicestershire	0.1%	86%	0.9%	93%	0.4%	93%
South Leicestershire	-0.6%	85%	0.3%	96%	0.3%	88%
South-West Leicestershire	0.7%	100%	0.1%	100%	1.0%	88%
North-West Leicestershire	-0.5%	88%	-0.5%	100%	-0.2%	94%
Countywide	1.1%	100%	0.5%	100%	0.7%	100%
SRN (Int)	1.7%	100%	1.4%	100%	1.0%	95%
Leicestershire	***0.5%***	***93%***	***0.6%***	***97%***	***0.7%***	***93%***

Table 5.2: Original Leicestershire Link Flow Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)
Leicester City	79%	78%	88%	88%	80%	79%
North Leicestershire	82%	81%	91%	90%	80%	78%
North-East Leicestershire	93%	93%	96%	95%	91%	90%
South Leicestershire	90%	89%	94%	94%	89%	89%
South-West Leicestershire	88%	88%	98%	98%	89%	89%
North-West Leicestershire	94%	93%	95%	95%	93%	92%
Countywide	89%	86%	97%	96%	87%	84%
SRN (Int)	97%	97%	100%	100%	96%	96%
Leicestershire	***87%***	***86%***	***94%***	***93%***	***86%***	***85%***

Table 5.3: Original Journey Time Validation

	No. of Routes	AM %Pass	IP %Pass	PM %Pass
Leicester City	32	91%	84%	84%
North Leicestershire	18	89%	94%	89%
North-East Leicestershire	12	100%	92%	92%
South Leicestershire	18	94%	100%	83%
South-West Leicestershire	24	92%	92%	92%
North-West Leicestershire	24	92%	100%	92%
SRN (Int)	10	90%	100%	100%
Leicestershire	**138**	**92%**	**93%**	**89%**
SRN (Ext)	12	83%	100%	100%

5.3 Revised Highway Model Performance (including network updates)

5.3.1 Table 5.4, Table 5.5 and Table 5.6 provide the same analysis of the model performance against screenline flows, individual link flows and journey times as detailed in Section 5.2, but include the network updates detailed in Section 3.

- In terms of the performance against screenline flows, the proportion of screenlines which meet TAG criteria is unchanged from that reported in the main highway model LMVR.
- In terms of individual flows, excluding duplicate counts, the interpeak statistics are unchanged, with some minor changes in the AM Peak hour model, and a small improvement in the model performance across Leicestershire in the PM Peak hour model (from 85% to 86% of links passing).
- For journey times, the interpeak performance is unaffected by the network changes, there are some minor changes in the PM Peak hour model, and a small reduction in the number of routes passing in the AM Peak hour due to journey time routes within North Leicestershire.

5.3.2 It should be noted that there are no changes in these high-level statistics for North-East Leicestershire due to the changes in the network coding applied within the base year model in this area. This suggests that the changes to the wider model performance are largely due to the convergence of the highway assignment and not due to the network changes adopted.

5.3.3 The analysis contained within Table 5.4, to Table 5.6 demonstrates that with the inclusion of the network updates, the highway model meets TAG criteria for screenline flows, individual link flows and journey times across the county. In addition to this, within North-East Leicestershire (broadly Melton Borough) the model performs well against observed data.

Table 5.4: Updated Leicestershire Screenline Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	Total %	ScnLine Passes	Total %	ScnLine Passes	Total %	ScnLine Passes
Leicester City	-0.0%	94%	0.4%	100%	0.6%	100%
North Leicestershire	-0.2%	94%	0.7%	88%	1.1%	88%
North-East Leicestershire	0.2%	86%	1.0%	93%	0.5%	93%
South Leicestershire	-1.1%	85%	0.3%	96%	0.2%	88%
South-West Leicestershire	0.6%	100%	0.1%	100%	1.0%	88%
North-West Leicestershire	-0.6%	88%	-0.5%	100%	-0.2%	94%
Countywide	1.0%	100%	0.5%	100%	0.8%	100%
SRN (Int)	1.5%	100%	1.4%	100%	1.1%	95%
Leicestershire	***0.4%***	***93%***	***0.6%***	***97%***	***0.7%***	***93%***

Table 5.5: Updated Leicestershire Link Flow Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)
Leicester City	79%	78%	88%	88%	81%	80%
North Leicestershire	82%	81%	91%	90%	79%	78%
North-East Leicestershire	93%	93%	96%	95%	91%	90%
South Leicestershire	89%	88%	94%	94%	89%	89%
South-West Leicestershire	88%	88%	98%	98%	90%	90%
North-West Leicestershire	94%	93%	95%	95%	93%	92%
Countywide	89%	87%	97%	96%	87%	84%
SRN (Int)	97%	97%	100%	100%	96%	96%
Leicestershire	***87%***	***86%***	***94%***	***93%***	***86%***	***86%***

Table 5.6: Updated Journey Time Validation

	No. of Routes	**AM %Pass**	**IP %Pass**	**PM %Pass**
Leicester City	32	91%	84%	88%
North Leicestershire	18	78%	94%	89%
North-East Leicestershire	12	100%	92%	92%
South Leicestershire	18	94%	100%	83%
South-West Leicestershire	24	92%	92%	88%
North-West Leicestershire	24	92%	100%	92%
SRN (Int)	10	90%	100%	100%
Leicestershire	**138**	**91%**	**93%**	**89%**
SRN (Ext)	12	83%	100%	100%

5.3.4 In addition to this high-level reporting of the model performance, the following tables and figures provide further details on the model performance within Melton Borough. Table 5.7 provides further details on flow performance for those screenlines identified within Section 2.2, with Table 5.8 providing details on the performance of the journey time routes within Melton Borough (shown in Figure 2.3). Figure 5.1 provides the journey time graphs for these identified journey time routes for each time period. Those screenlines which are used for independent validation are highlighted in orange within Table 5.7.

5.3.5 The following provides a summary of the performance of the highway model against observed count and journey time data within Melton Mowbray:

- All calibration screenlines in the three modelled time period meet TAG criteria. (Note that the Melton Mowbray East-West River Screenline contains only two counts, and therefore adopts the adjusted TAG criteria detailed within the main highway LMVR.)
- Five out of six validation screenlines meet TAG criteria in each of the modelled hours. In the AM Peak and interpeak models, it is the Nottingham Road North-South Screenline in the eastbound direction which fails, and in the PM Peak model it is the same screenline but in the westbound direction.
- In terms of individual link counts, 91%, 94% and 88% of all link counts within Melton Mowbray meet TAG criteria in the AM Peak, interpeak and PM Peak models respectively. The proportion of calibration counts which meet TAG is 95%, 95% and 90% in the three modelled hours, with 85%, 93% and 85% of validation links meeting the criteria in the three modelled hours.
- Of the twelve journey time routes identified within this local LMVR, all meet TAG criteria in the AM Peak hour, with one failure in the interpeak and PM Peak models. In both of these modelled hours it is the Dalby Road / Scalford Road journey time route in the southbound direction which does not meet TAG criteria.

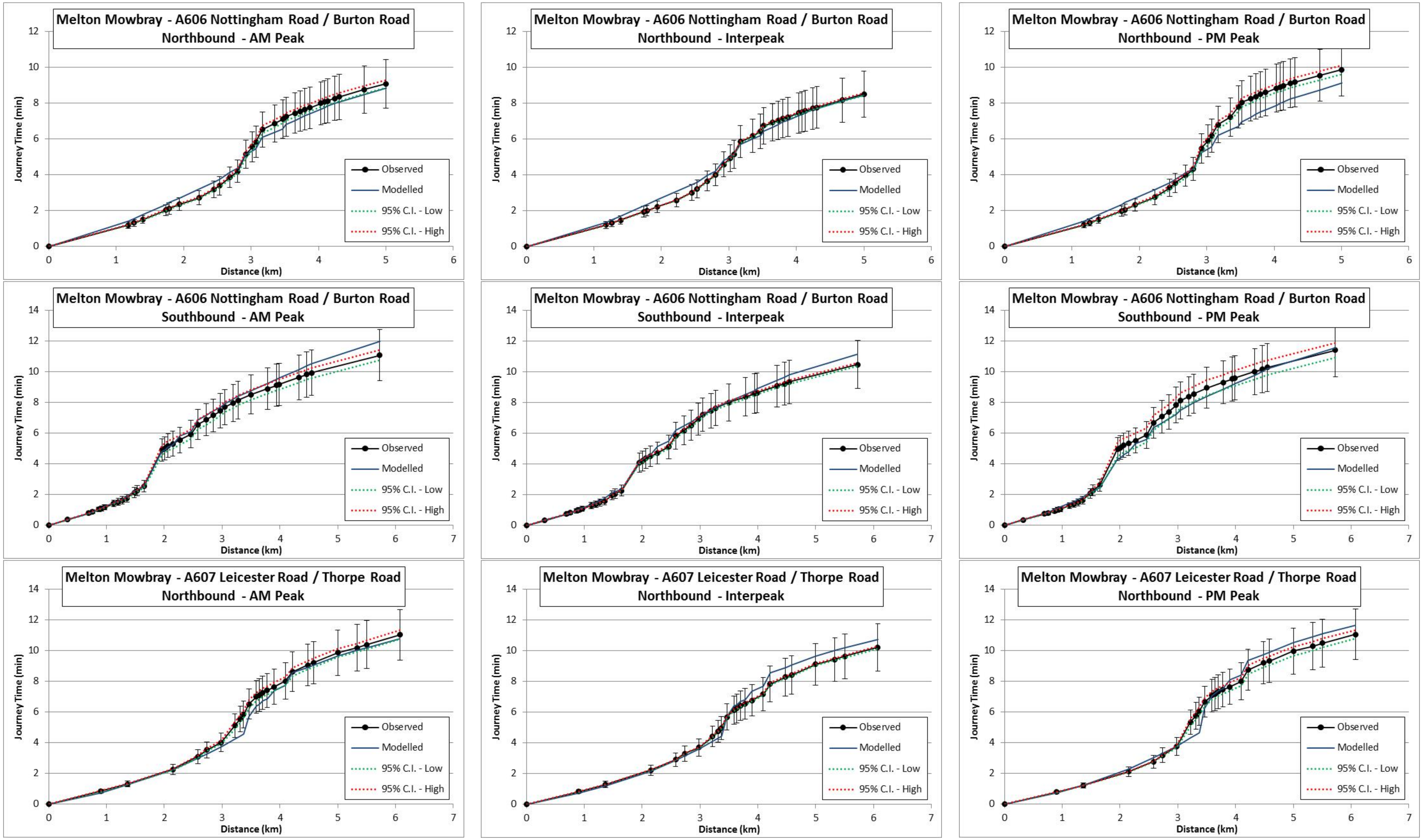
Table 5.7: Flow Performance within Area of Interest (Total Flows)

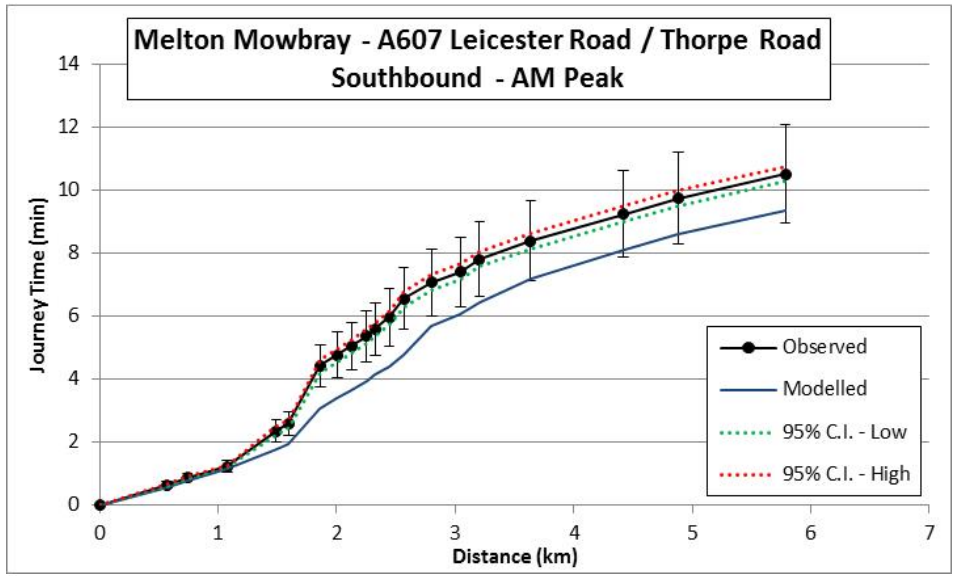
	AM Peak					Interpeak					PM Peak				
	Observed	Modelled	Abs.	%Diff	%Links	Observed	Modelled	Abs.	%Diff	%Links	Observed	Modelled	Abs.	%Diff	%Links
Melton Mowbray Cordon Inbound	3,235	3,200	-35	-1.1%	91%	2,125	2,139	14	0.6%	100%	3,184	3,153	-31	-1.0%	91%
Melton Mowbray Cordon Outbound	3,054	2,974	-80	-2.6%	100%	2,200	2,205	5	0.2%	100%	2,920	2,910	-10	-0.3%	100%
Melton Mowbray North-South Screenline (Nottingham Rd) Eastbound	1,044	1,239	196	18.8%	75%	930	1,033	102	11.0%	100%	1,266	1,313	47	3.7%	100%
Melton Mowbray North-South Screenline (Nottingham Rd) Westbound	1,430	1,455	25	1.7%	60%	1,231	1,255	24	1.9%	60%	1,556	1,680	124	8.0%	60%
Melton Mowbray North-South Screenline (Dalby Rd) Eastbound	1,107	1,104	-4	-0.3%	75%	756	759	3	0.4%	100%	1,054	1,062	8	0.7%	75%
Melton Mowbray North-South Screenline (Dalby Rd) Westbound	944	957	13	1.4%	100%	792	791	-2	-0.2%	100%	1,049	1,052	3	0.3%	100%
Melton Mowbray East-West Screenline (River) Northbound	1,554	1,703	149	9.6%	50%	1,192	1,241	49	4.1%	100%	1,526	1,553	28	1.8%	50%
Melton Mowbray East-West Screenline (River) Southbound	1,494	1,497	4	0.2%	100%	1,301	1,333	32	2.5%	100%	1,686	1,778	92	5.5%	100%
Melton Mowbray East-West Screenline (South) Northbound	1,846	1,762	-84	-4.5%	100%	1,277	1,228	-49	-3.8%	100%	1,830	1,828	-2	-0.1%	100%
Melton Mowbray East-West Screenline (South) Southbound	1,716	1,695	-21	-1.2%	100%	1,333	1,315	-17	-1.3%	100%	1,788	1,733	-55	-3.1%	86%
Melton Mowbray East-West Screenline (North) Northbound	1,031	1,039	8	0.7%	100%	1,138	1,157	19	1.7%	100%	1,728	1,751	23	1.3%	100%
Melton Mowbray East-West Screenline (North) Southbound	1,759	1,745	-14	-0.8%	100%	1,092	1,086	-6	-0.5%	60%	1,451	1,463	12	0.8%	60%
Leicestershire Cordon (North-East) Inbound	4,956	5,021	64	1.3%	97%	2,770	2,791	21	0.7%	97%	4,449	4,495	46	1.0%	94%
Leicestershire Cordon (North-East) Outbound	4,385	4,370	-14	-0.3%	91%	2,826	2,846	20	0.7%	97%	5,036	5,170	134	2.7%	94%

Table 5.8: Journey Time Performance within Area of Interest

	AM Peak					Interpeak					PM Peak				
	Observed	Modelled	Abs.	%Diff	Pass	Observed	Modelled	Abs.	%Diff	Pass	Observed	Modelled	Abs.	%Diff	Pass
A606 Nottingham Road / Burton Road Northbound	09:04	08:50	-00:14	-2.6%	✓	08:30	08:27	-00:03	-0.5%	✓	09:52	09:07	-00:45	-7.6%	✓
A606 Nottingham Road / Burton Road Southbound	11:05	11:58	00:54	8.1%	✓	10:28	11:08	00:40	6.4%	✓	11:24	11:32	00:09	1.3%	✓
A607 Leicester Road / Thorpe Road Northbound	11:02	10:45	-00:16	-2.5%	✓	10:13	10:44	00:31	5.1%	✓	11:04	11:38	00:35	5.2%	✓
A607 Leicester Road / Thorpe Road Southbound	10:31	09:22	-01:09	-11.0%	✓	09:08	08:48	-00:20	-3.6%	✓	09:50	09:16	-00:34	-5.7%	✓
A6006 to Saxby Road (via Ankle Hill) Eastbound	14:53	13:44	-01:09	-7.7%	✓	12:51	13:25	00:34	4.4%	✓	14:43	13:44	-00:59	-6.7%	✓
A6006 to Saxby Road (via Ankle Hill) Westbound	13:37	13:00	-00:37	-4.5%	✓	12:42	12:48	00:06	0.8%	✓	14:11	13:08	-01:03	-7.5%	✓
Dalby Road / Scalford Road Northbound	09:41	09:11	-00:30	-5.1%	✓	07:50	08:39	00:49	10.4%	✓	09:25	09:21	-00:04	-0.8%	✓
Dalby Road / Scalford Road Southbound	07:44	08:15	00:31	6.7%	✓	06:52	07:59	01:08	16.4%	×	06:56	08:30	01:35	22.7%	×
Kirby Lane Eastbound	05:10	05:34	00:24	7.7%	✓	04:57	05:33	00:36	12.2%	✓	05:07	05:34	00:27	8.8%	✓
Kirby Lane Westbound	04:58	05:37	00:39	13.1%	✓	04:53	05:36	00:42	14.4%	✓	05:08	05:36	00:29	9.4%	✓
A607 (A46 to Melton Mowbray) Northbound	11:09	10:25	-00:44	-6.6%	✓	10:27	09:53	-00:34	-5.4%	✓	10:39	10:23	-00:16	-2.5%	✓
A607 (A46 to Melton Mowbray) Southbound	11:04	10:36	-00:29	-4.3%	✓	10:37	10:06	-00:32	-5.0%	✓	10:32	10:25	-00:07	-1.1%	✓

Figure 5.1: Journey Time Graphs within Area of Interest




Melton Mowbray - A607 Leicester Road / Thorpe Road
Southbound - AM Peak
Journey Time (min)
0
2
4
6
8
10
12
14
Distance (km)
0
1
2
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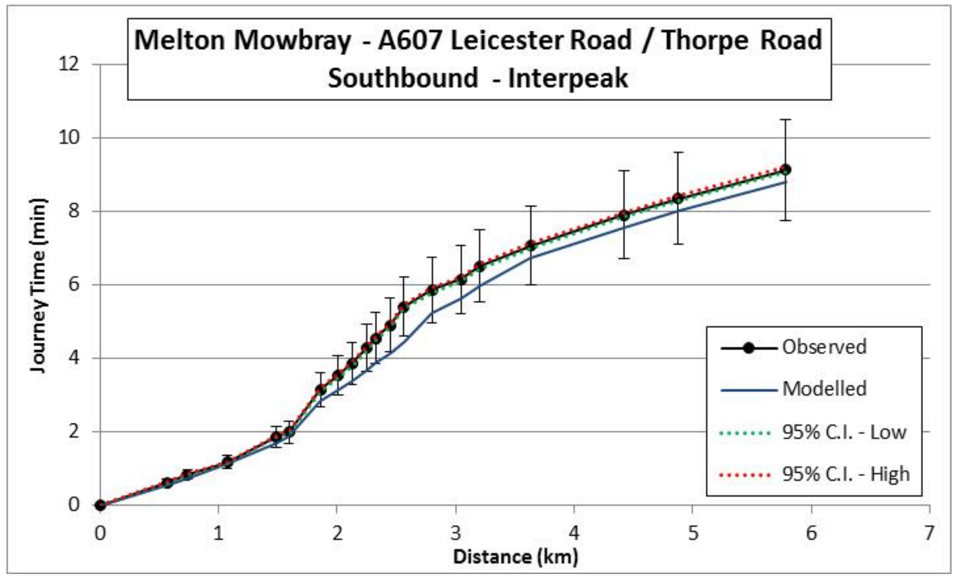
4
5
6
7
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A607 Leicester Road / Thorpe Road
Southbound - Interpeak
Journey Time (min)
0
2
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8
10
12
Distance (km)
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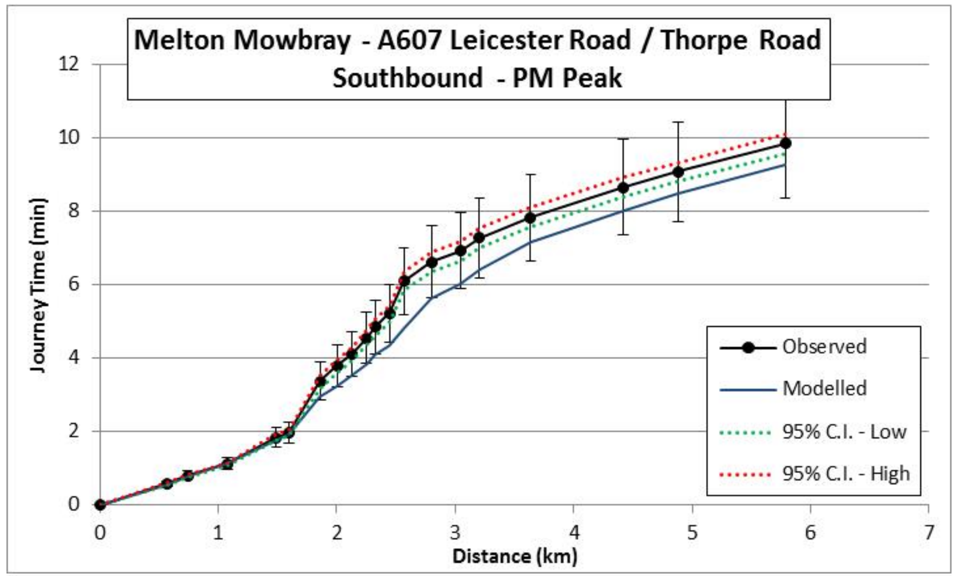
6
7
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A607 Leicester Road / Thorpe Road
Southbound - PM Peak
Journey Time (min)
0
2
4
6
8
10
12
Distance (km)
0
1
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4
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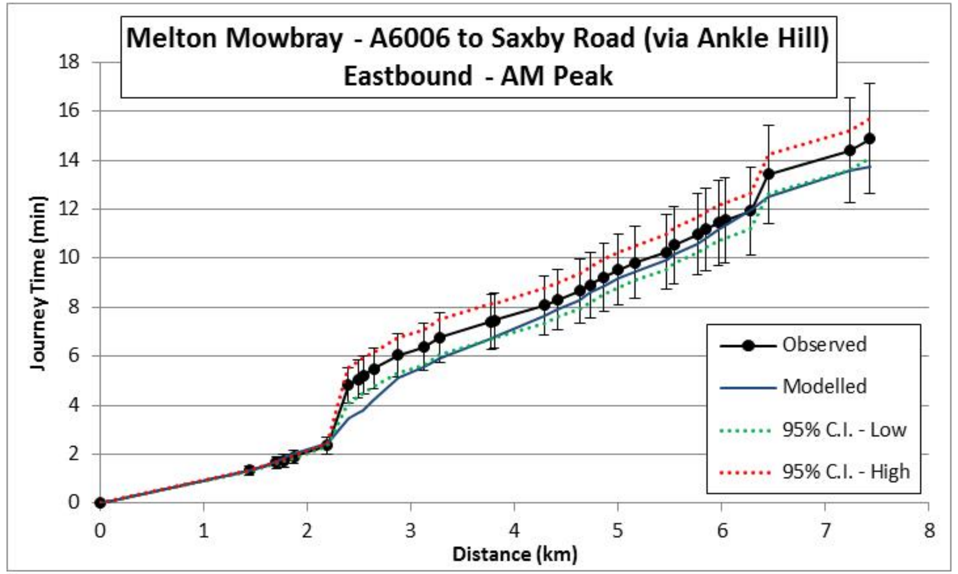
6
7
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill)
Eastbound - AM Peak
Journey Time (min)
0
2
4
6
8
10
12
14
16
18
Distance (km)
0
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4
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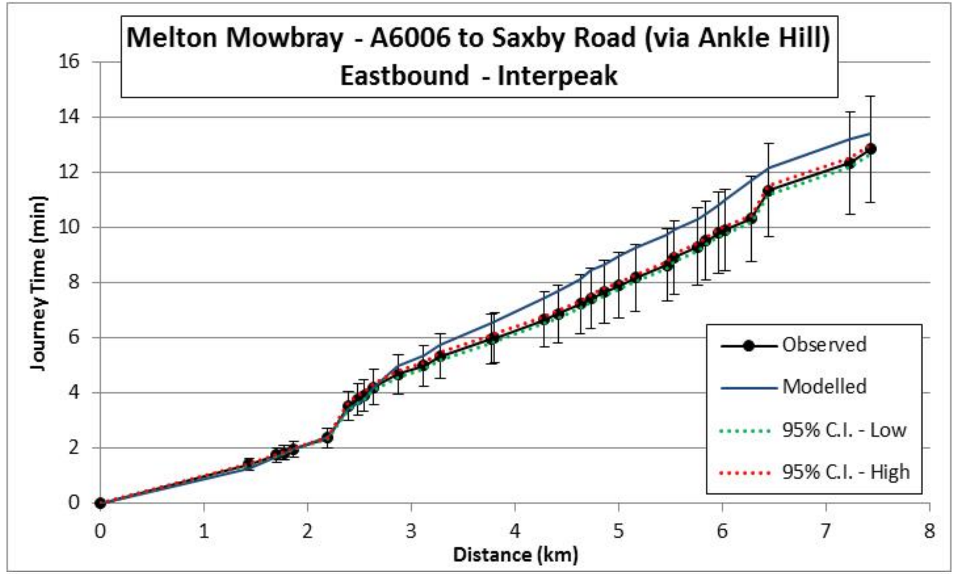
7
8
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill)
Eastbound - Interpeak
Journey Time (min)
0
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4
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8
10
12
14
16
Distance (km)
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4
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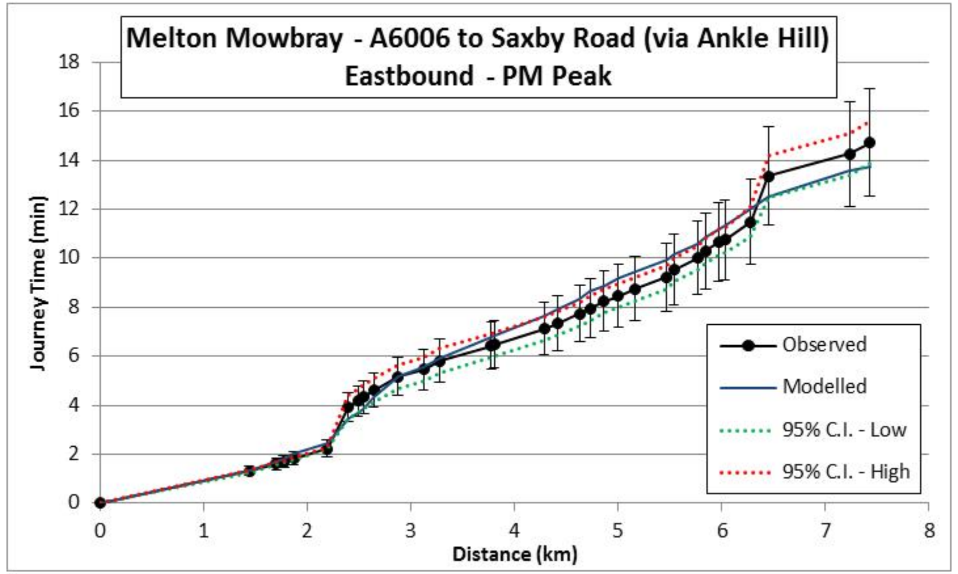
8
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill)
Eastbound - PM Peak
Journey Time (min)
0
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4
6
8
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14
16
18
Distance (km)
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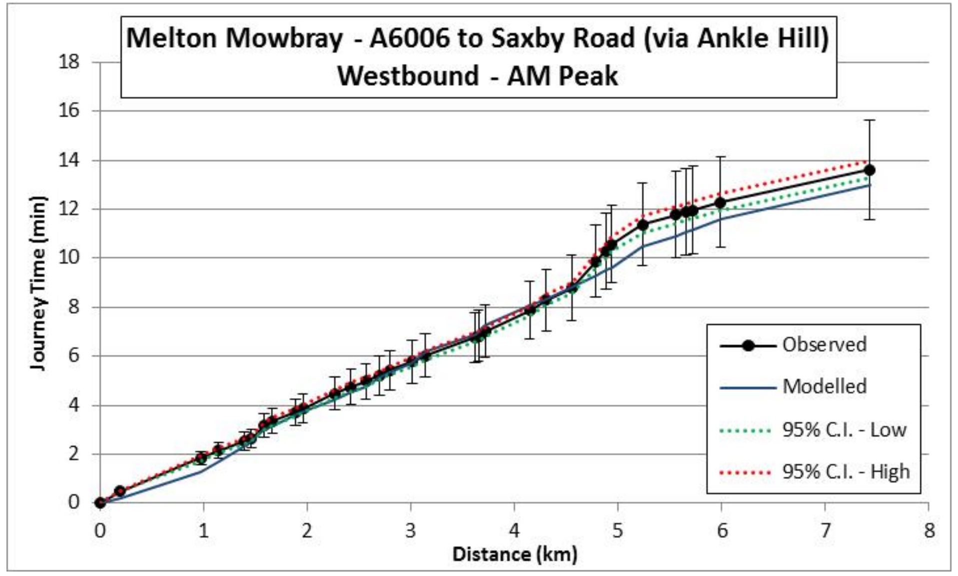
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill)
Westbound - AM Peak
Journey Time (min)
0
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14
16
18
Distance (km)
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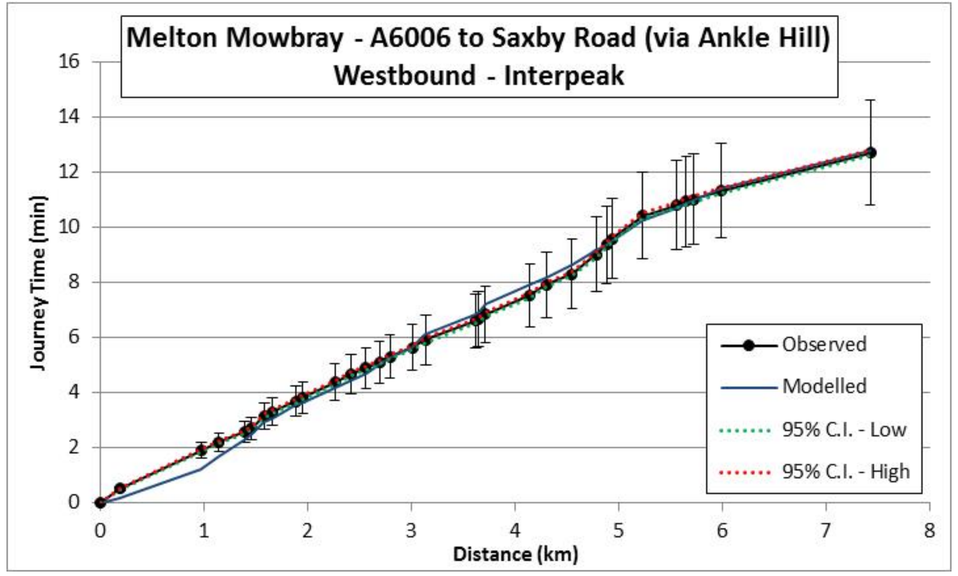
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill)
Westbound - Interpeak
Journey Time (min)
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14
16
Distance (km)
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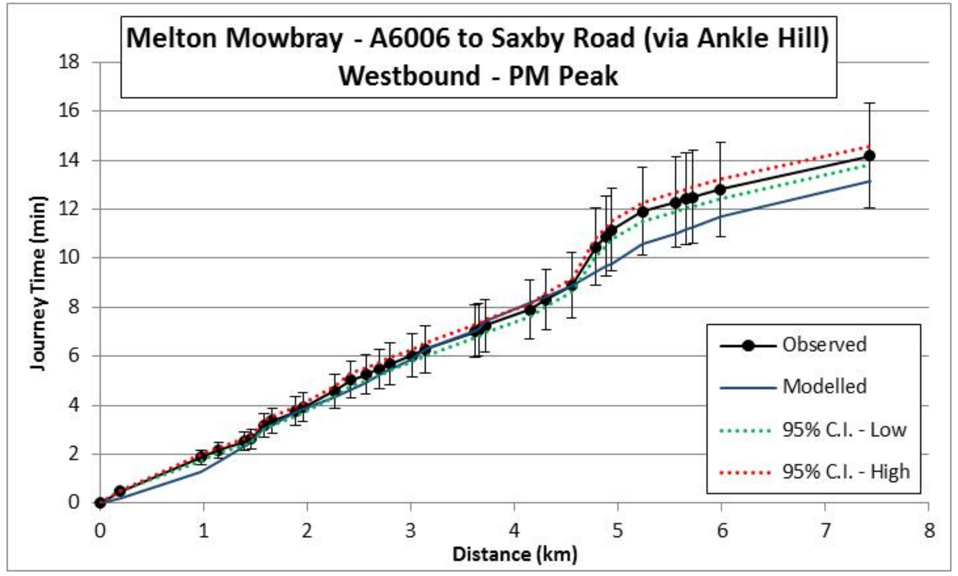
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill)
Westbound - PM Peak
Journey Time (min)
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Distance (km)
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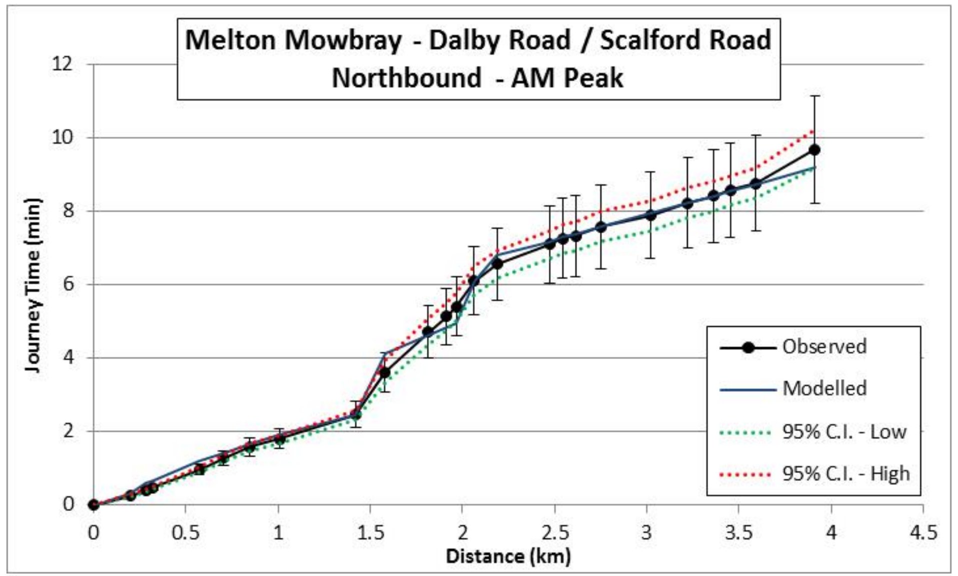
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Northbound - AM Peak
Journey Time (min)
0
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12
Distance (km)
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0.5
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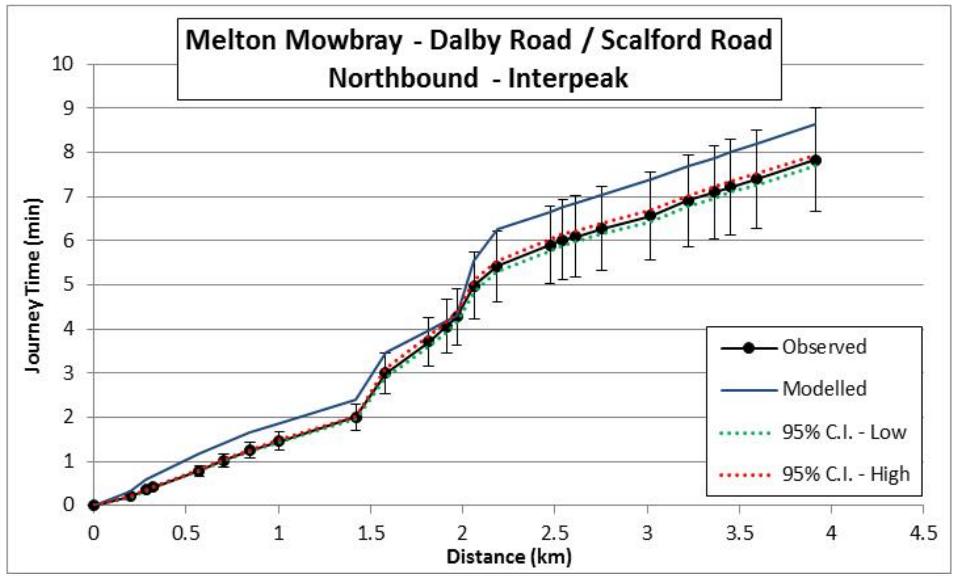
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Northbound - Interpeak
Journey Time (min)
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Distance (km)
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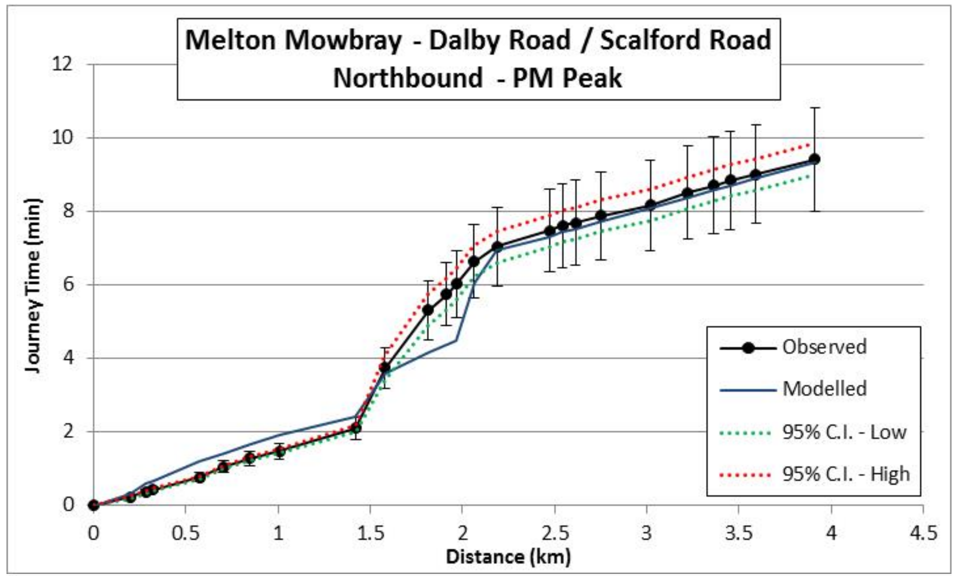
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Northbound - PM Peak
Journey Time (min)
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Distance (km)
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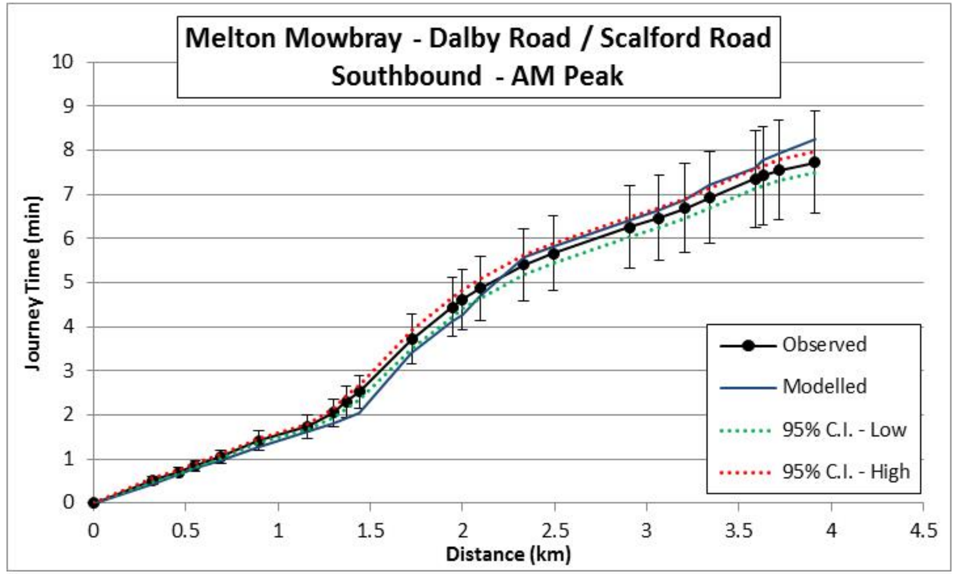
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Southbound - AM Peak
Journey Time (min)
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Distance (km)
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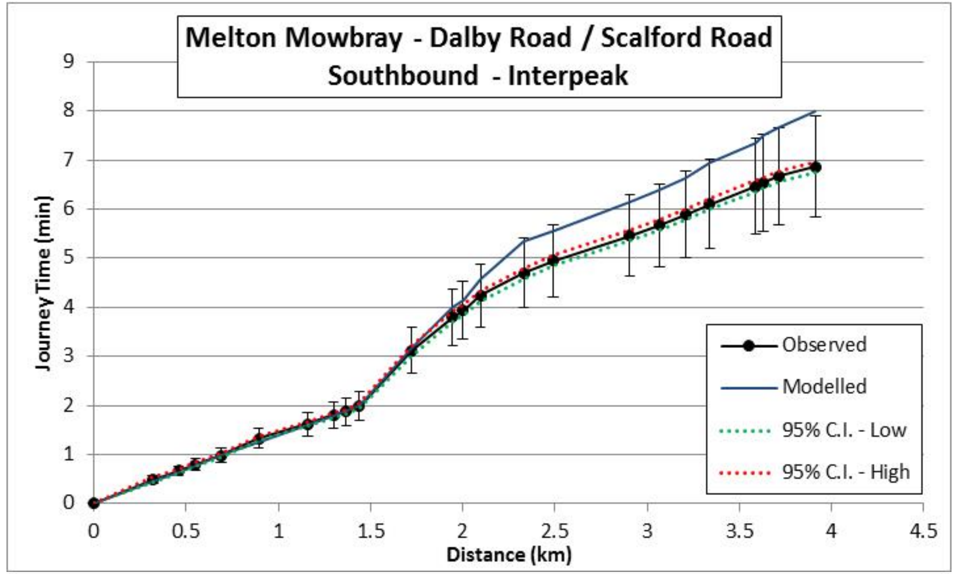
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Southbound - Interpeak
Journey Time (min)
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Distance (km)
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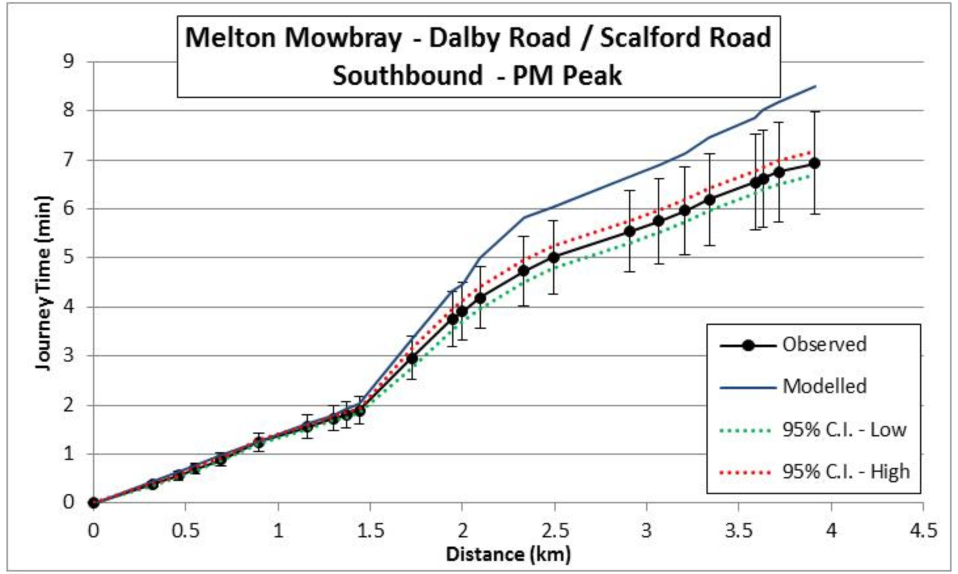
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Southbound - PM Peak
Journey Time (min)
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Distance (km)
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Observed
Modelled
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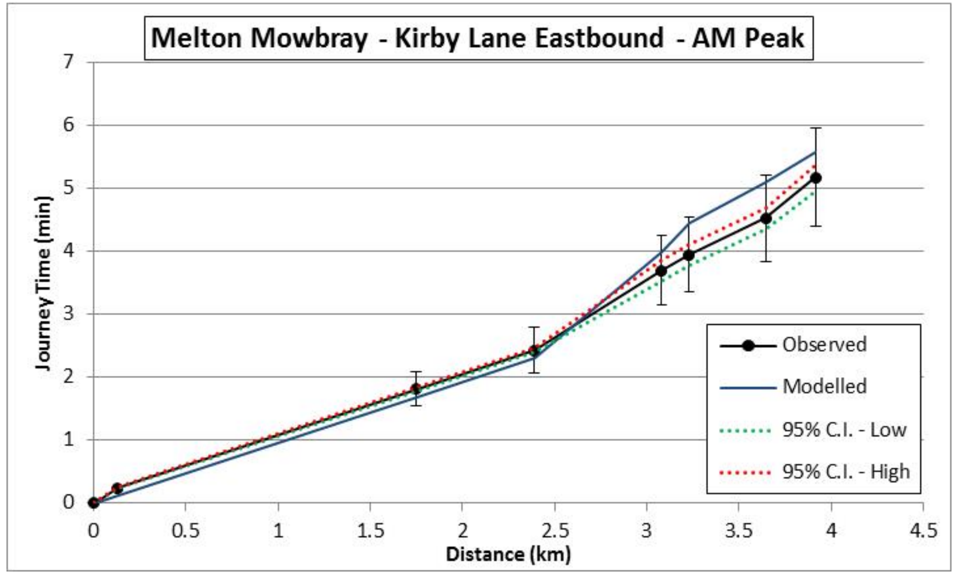
95% C.I. - High


Melton Mowbray - Kirby Lane Eastbound - AM Peak
Journey Time (min)
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1
2
3
4
5
6
7
Distance (km)
0
0.5
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1.5
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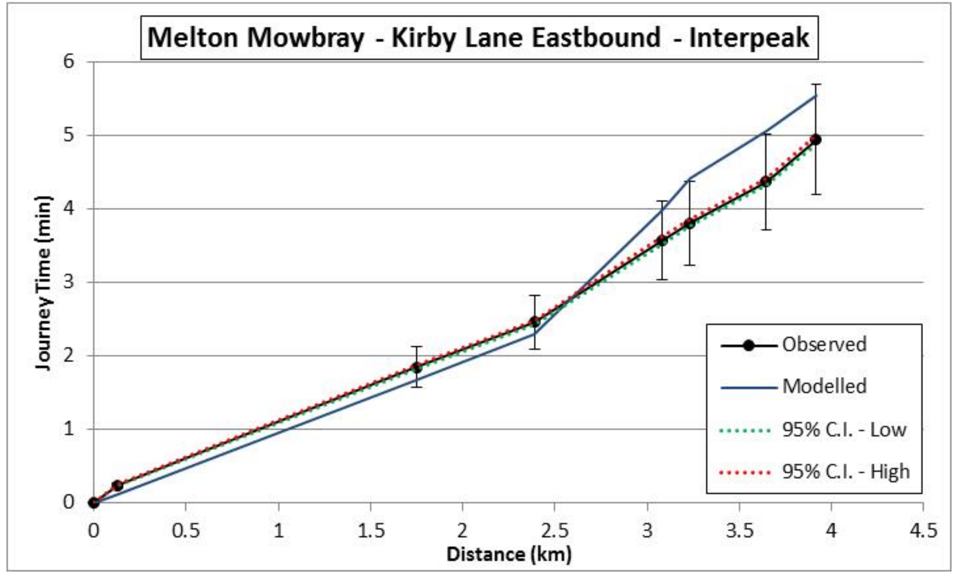
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Kirby Lane Eastbound - Interpeak
Journey Time (min)
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Distance (km)
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Observed
Modelled
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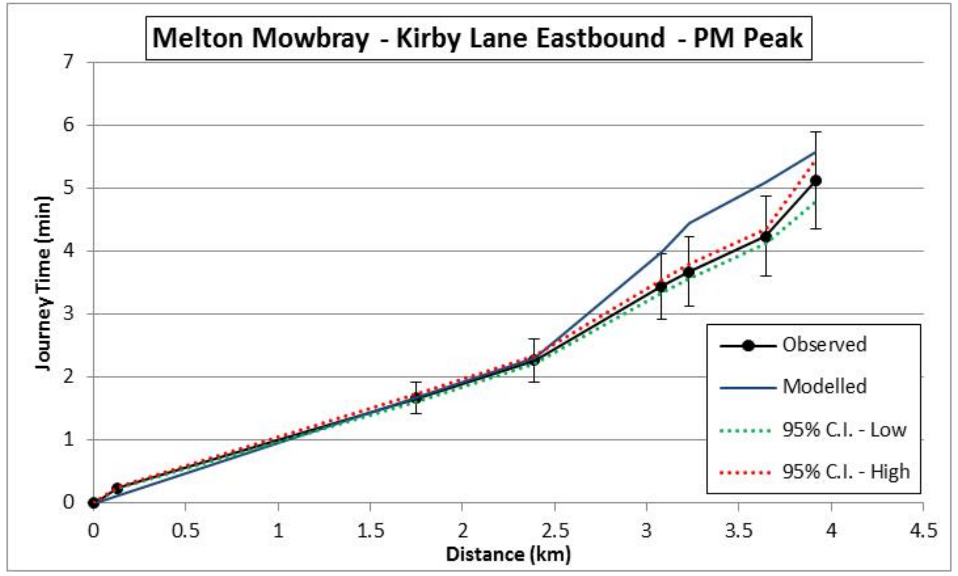
95% C.I. - High


Melton Mowbray - Kirby Lane Eastbound - PM Peak
Journey Time (min)
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7
Distance (km)
0
0.5
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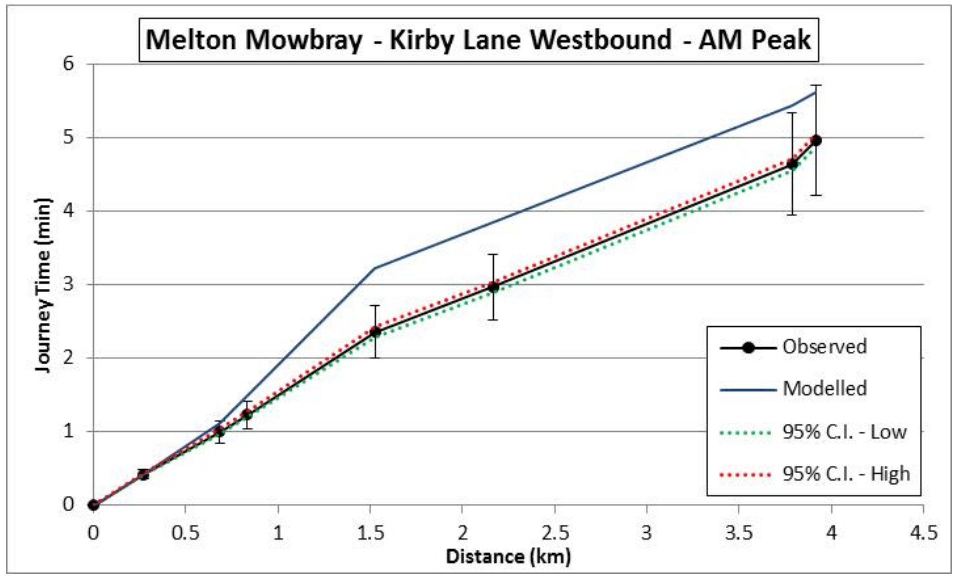
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Kirby Lane Westbound - AM Peak
Journey Time (min)
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6
Distance (km)
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0.5
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3.5
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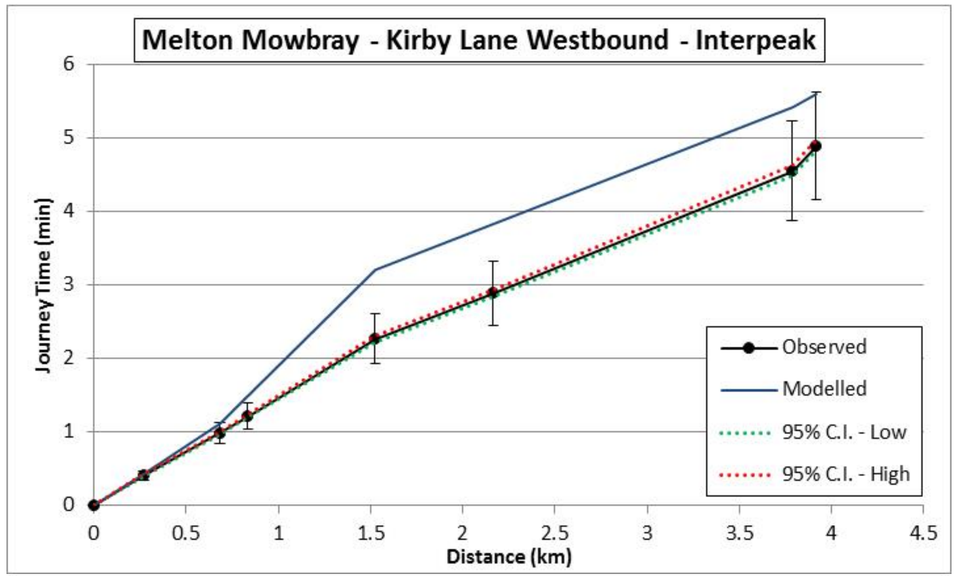
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Kirby Lane Westbound - Interpeak
Journey Time (min)
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1
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6
Distance (km)
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0.5
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1.5
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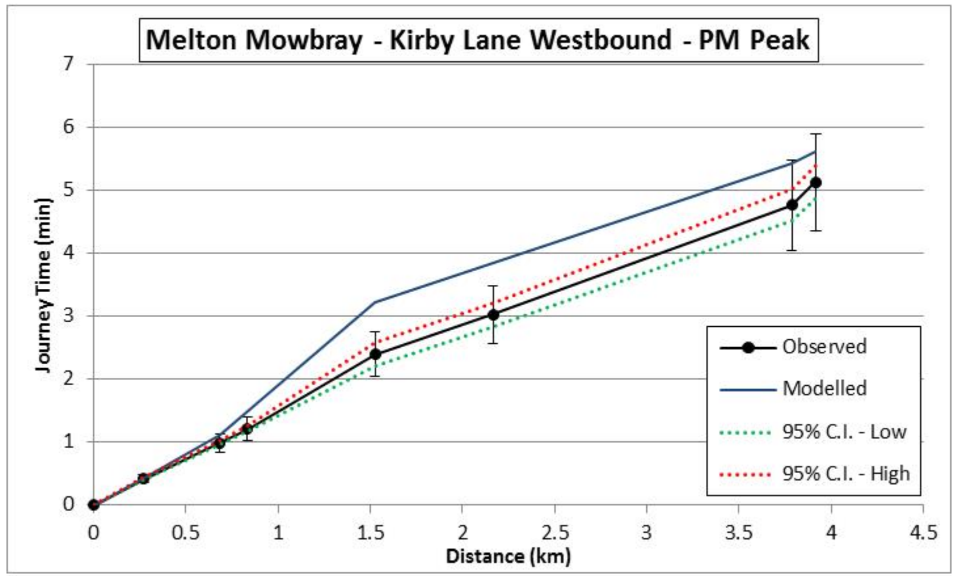
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Kirby Lane Westbound - PM Peak
Journey Time (min)
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1
2
3
4
5
6
7
Distance (km)
0
0.5
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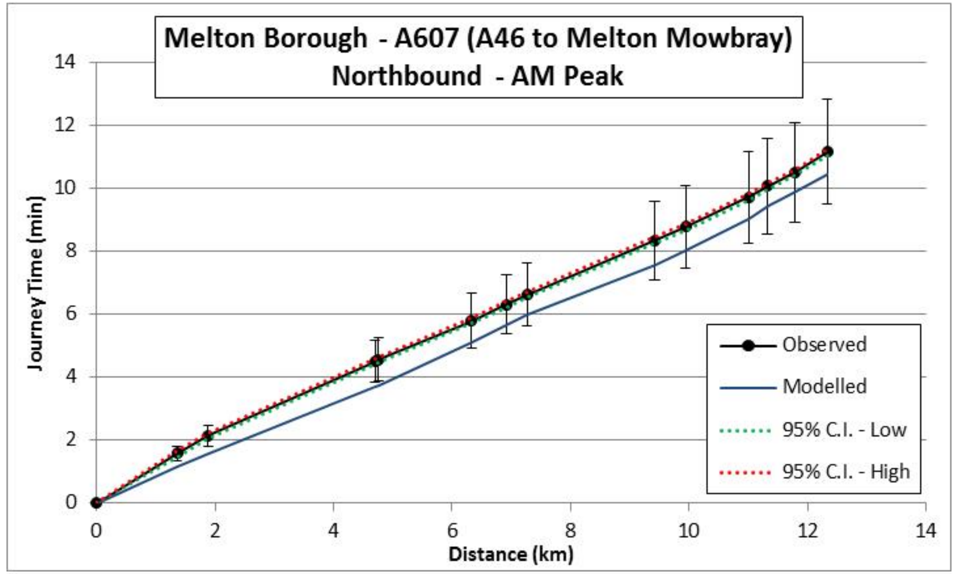
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Borough - A607 (A46 to Melton Mowbray)
Northbound - AM Peak
Journey Time (min)
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8
10
12
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Distance (km)
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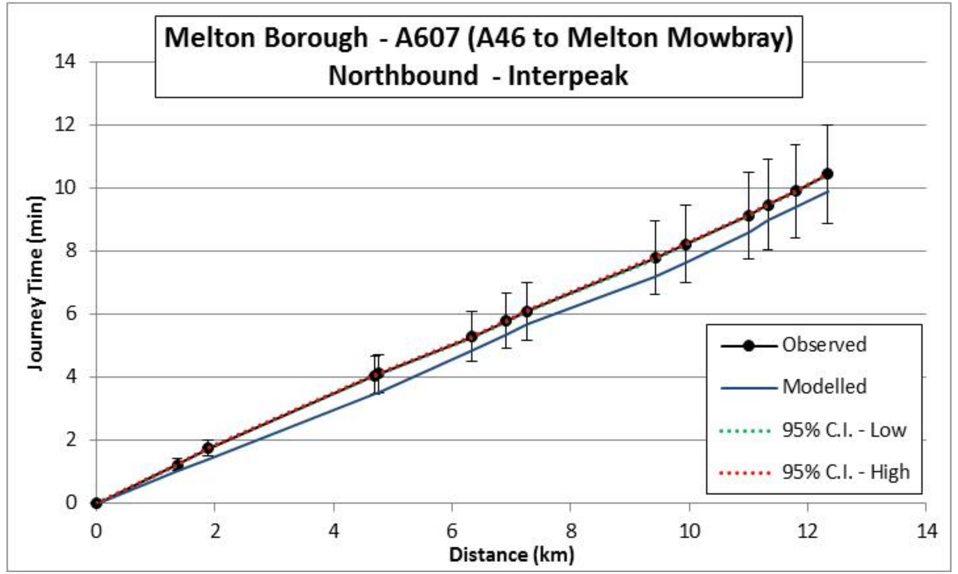
2
4
6
8
10
12
14
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Borough - A607 (A46 to Melton Mowbray)
Northbound - Interpeak
Journey Time (min)
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Distance (km)
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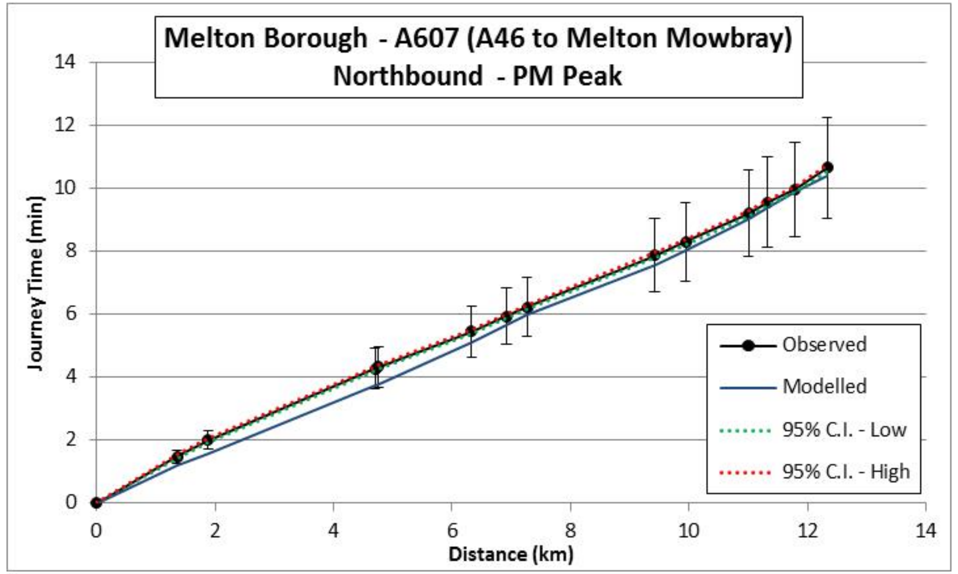
12
14
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Borough - A607 (A46 to Melton Mowbray)
Northbound - PM Peak
Journey Time (min)
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Distance (km)
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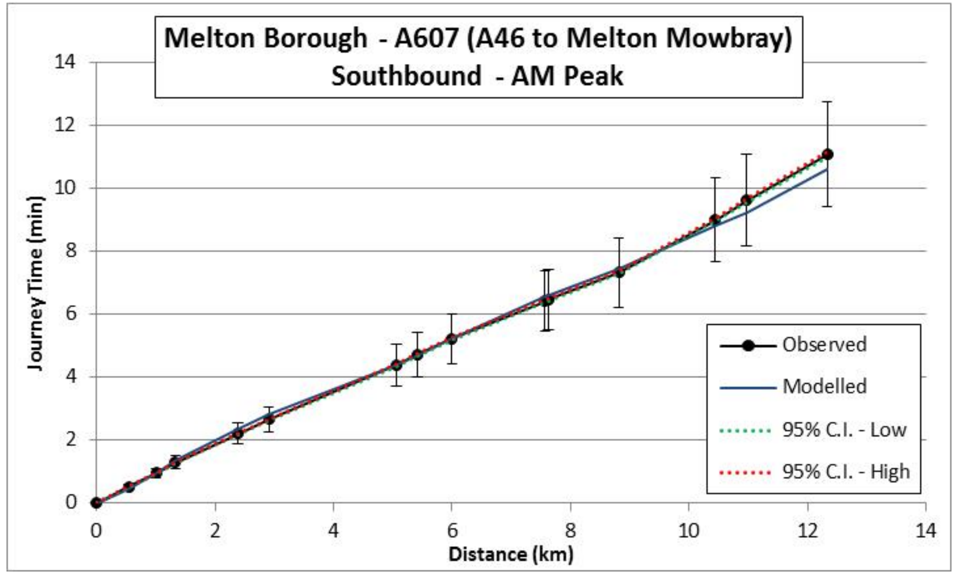
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Borough - A607 (A46 to Melton Mowbray)
Southbound - AM Peak
Journey Time (min)
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2
4
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8
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12
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Distance (km)
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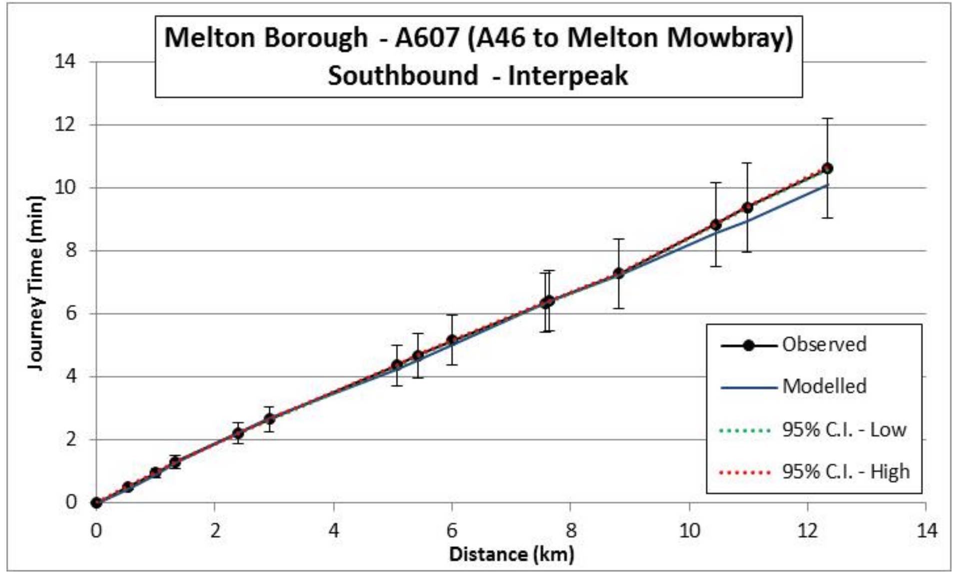
14
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Borough - A607 (A46 to Melton Mowbray)
Southbound - Interpeak
Journey Time (min)
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Distance (km)
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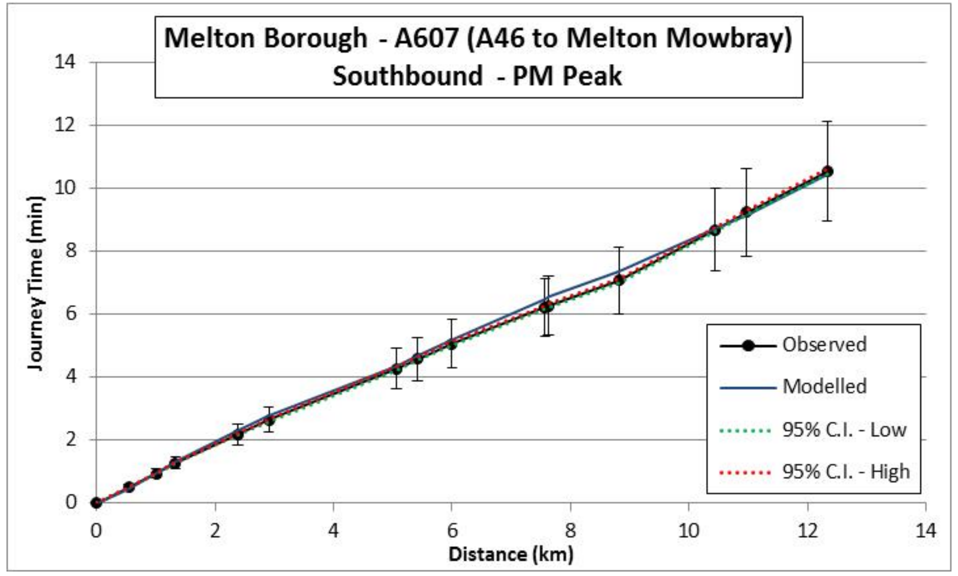
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Borough - A607 (A46 to Melton Mowbray)
Southbound - PM Peak
Journey Time (min)
0
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8
10
12
14
Distance (km)
0
2
4
6
8
10
12
14
Observed
Modelled
95% C.I. - Low
95% C.I. - High

5.4 Comparison with Additional Count Data

5.4.1 As discussed in Section 2.4, additional count data have been provided within Melton Mowbray, and from this additional dataset 15 counts have been identified and processed for use in validation of the modelled flows within the base year highway model. Two of these counts have been removed due to inconsistencies between count data, leaving 13 additional counts. These counts have not been used as part of the original model development, and as such are over and above the requirements contained within TAG.

5.4.2 We would not expect, given that the counts have not been used in the model development, that 85% of these locations meet TAG criteria. The local nature of these counts also introduces potential inconsistencies with the defined model zone system, whereby the counts are not located near zone boundaries and therefore the location of the centroid connector can have a significant impact on the apparent model performance.

5.4.3 It should also be recognised that these counts were undertaken during October and November 2016, and have been adjusted using long-term count data to represent flows in April, May and June 2014. This adjustment will add uncertainty to the observed flows, and therefore there is an argument for relaxing the TAG criteria to account for this greater uncertainty within the observed data.

5.4.4 Therefore, based on the above comments, any comparison of modelled flows against counts should be viewed as an indication of the model’s performance and not as a measure of whether the model meets TAG guidelines or not.

5.4.5 Table 5.9 provides a summary on the performance of the modelled flows against the additional count locations within Melton Mowbray by time period for total vehicle flows. Overall, the pass rate is 88% in the AM Peak hour, 85% in the interpeak hour and 73% in the PM Peak hour. This equates to 3 locations in the AM Peak., 4 locations in the interpeak and 7 locations in the PM Peak out of the 26 count locations which do not meet TAG criteria for individual link counts.

5.4.6 Considering the count locations which do not meet TAG criteria in each time period, no count locations in the AM Peak hour have a GEH statistics of greater than 7.5, with one location having a GEH value of greater than 7.5 in the interpeak hour, and in the PM Peak four locations have a GEH value greater than 7.5.

5.4.7 In the AM Peak and interpeak hours, the performance against these additional counts is consistent with the performance of the model against the calibration and validation counts used in the development of the model. The performance in the PM Peak against these additional counts is below the county and North-East Leicestershire average (as shown in Table 5.5), and below the guideline of 85% of individual links contained within TAG. However, given comments above regarding the uncertainty surrounding this additional count data and the fact that these data have not been used in the model development, this analysis does not contradict the good performance of the model against observed data presented elsewhere within this section.

Table 5.9: Model Flow Performance against Additional Counts (Total Flows)

	AM Peak					Interpeak					PM Peak				
	Obs.	Mod.	Diff	GEH	Pass	Obs.	Mod.	Diff	GEH	Pass	Obs.	Mod.	Diff	GEH	Pass
Nottingham Road, North of St Bartholomew's Way, Northbound	402	423	21	1.0	✓	306	318	12	0.7	✓	369	476	107	5.2	×
Nottingham Road, South of Lynton Road, Northbound	448	393	-55	2.7	✓	359	353	-6	0.3	✓	442	513	71	3.3	✓
Nottingham Road, North of Norman Way, Northbound	473	444	-29	1.4	✓	546	470	-76	3.4	✓	692	762	70	2.6	✓
Nottingham Road, North of St Bartholomew's Way, Southbound	355	417	62	3.1	✓	294	265	-29	1.8	✓	490	518	29	1.3	✓
Nottingham Road, South of Lynton Road, Southbound	427	483	56	2.6	✓	344	335	-10	0.5	✓	548	469	-79	3.5	✓
Nottingham Road, North of Norman Way, Southbound	512	491	-21	0.9	✓	455	342	-113	5.7	×	523	346	-177	8.5	×
Scalford Road, near Framland Farm, Northbound	126	107	-19	1.8	✓	85	72	-13	1.5	✓	125	77	-48	4.7	✓
Scalford Road, South of Wymondham Way, Northbound	287	249	-38	2.3	✓	218	219	1	0.1	✓	409	294	-115	6.1	×
Scalford Road, North of Norman Way, Northbound	276	366	90	5.0	✓	391	417	26	1.3	✓	581	588	8	0.3	✓
Scalford Road, near Framland Farm, Southbound	119	113	-6	0.5	✓	95	58	-37	4.3	✓	144	86	-58	5.4	✓
Scalford Road, South of Wymondham Way, Southbound	455	311	-144	7.4	×	227	209	-18	1.2	✓	336	306	-30	1.7	✓
Scalford Road, North of Norman Way, Southbound	610	727	118	4.6	✓	458	496	38	1.7	✓	467	749	282	11.4	×
Thorpe Road, North of hospital, Northbound	404	345	-60	3.1	✓	460	345	-115	5.7	×	559	535	-24	1.0	✓
Thorpe Road, North of hospital, Southbound	492	540	47	2.1	✓	447	470	23	1.1	✓	546	508	-38	1.7	✓
Saxby Road, East of Lag Lane, Eastbound	195	154	-40	3.1	✓	147	112	-35	3.1	✓	209	176	-33	2.4	✓
Saxby Road, West of Brook Street, Eastbound	317	374	57	3.1	✓	240	284	44	2.7	✓	331	379	48	2.6	✓
Saxby Road, East of Lag Lane, Westbound	232	219	-13	0.9	✓	159	132	-26	2.2	✓	189	131	-58	4.6	✓
Saxby Road, West of Brook Street, Westbound	310	259	-51	3.0	✓	230	193	-37	2.6	✓	248	308	60	3.6	✓
Dalby Road, South of Leicester Road, Northbound	300	207	-92	5.8	✓	225	136	-90	6.7	✓	288	152	-136	9.1	×
Dalby Road, South of Leicester Road, Southbound	339	381	42	2.2	✓	327	366	39	2.1	✓	499	444	-55	2.5	✓
Asfordby Road, near West Avenue, Eastbound	443	410	-33	1.6	✓	325	272	-53	3.1	✓	419	330	-89	4.6	✓
Asfordby Road, West of Nottingham Road, Eastbound	530	383	-148	6.9	×	380	251	-128	7.2	×	460	249	-210	11.2	×
Asfordby Road, near West Avenue, Westbound	312	271	-41	2.4	✓	318	245	-73	4.4	✓	450	404	-46	2.2	✓
Asfordby Road, West of Nottingham Road, Westbound	332	212	-120	7.2	×	350	206	-145	8.7	×	480	336	-145	7.2	×
Welby Road, East of Sysonby Street, Eastbound	91	76	-15	1.6	✓	95	56	-39	4.4	✓	138	58	-80	8.0	✓
Welby Road, East of Sysonby Street, Westbound	96	50	-46	5.4	✓	70	51	-19	2.4	✓	101	73	-27	2.9	✓

Section 6 – Conclusions

6.1 Summary

6.1.1 This local LMVR has reviewed the highway model component of LLITM 2014 Base, considering the coding of the highway network, the base year highway demand matrices and the performance of the model against observed data within Melton Borough.

6.1.2 The network coding review highlighted a limited number of minor corrections to the network coding, which have been implemented and shown to have a minimal impact on the model performance against observed data.

6.1.3 In terms of the performance of the model against observed flow and journey time data, across the county the model meets TAG guidelines for screenline flows, individual flows and journey times. Within North-East Leicestershire (which broadly represents Melton Borough) the percentage of individual links meeting TAG criteria is at or above 90% in all three time periods. Similarly the proportion of journey time routes meeting TAG criteria within North-East Leicestershire is above 90% in all three time periods.

6.1.4 Within LLITM 2014 Base there are two sources of demand data for Melton Mowbray: the processed and adopted mobile network data; and a series of roadside interviews. It is unusual for a model to have two independent sources of demand data to be able to perform a review of the base year demand. There are uncertainties with both sources of data, both of which are samples and therefore subject to biases.

6.1.5 However, there are differences in trip patterns and across the trip length distributions; including for movements likely to be affected by the scheme. The comparison of the base year demand matrices against the independent roadside interview data suggests that the model may understate trips which pass through Melton Mowbray, and overstate trips which are wholly internal to Melton Mowbray.

6.1.6 Given the performance of the highway model against the flow and journey time criteria contained within TAG, it is considered that the model is suitable for the central scope of the Outline Business Case, including the noise and air quality assessments of the scheme.

6.1.7 Whilst we do not know the precise implications of the difference in trip patterns observed against the RSI data on the value for money assessment of the scheme, and on the basis of wanting to de-risk any potential uncertainty around the Transport Economic Efficiency benefits, work is being undertaken to recalibrate the base year highway model making use of the roadside interview data within the highway matrices. This alternative base year model will provide a sensitivity test to determine if the differences in the pattern of demand within Melton Mowbray is significant or not to the value for money assessment.

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LLITM 2014 Base

North & East Melton Mowbray Distributor Road Full Business Case

(Local) Highway Model LMVR Addendum

Leicestershire County Council

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Quality information

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Section 1 – Introduction

1.1 Context

1.1.1 This report forms an addendum to the NEMMDR Local Highway LMVR[1] and provides detail on the performance of the base year LLITM highway model in and around Melton Mowbray. This local review of the model performance is part of the modelling work for the Full Business Case (FBC) for the proposed North and East Melton Mowbray Distributor Road (NEMMDR).

1.1.2 In Summer 2019, AECOM was commissioned by Leicestershire County Council to review and update the LLITM highway model used in the Outline Business Case (OBC) with the aim of ensuring that the model was up-to-date for use in the FBC modelling which was (then) scheduled to begin in Spring 2020. The modelling for the FBC has since been delayed until Winter 2021/22 reflecting changes to the wider NEMMDR programme.

1.1.3 This local LMVR addendum does not seek to reproduce the information contained within the main LLITM highway model LMVR[2] nor the local LMVR produced for the OBC[1], and as such this report should be read in conjunction with these main and local LMVR documents. The main LLITM highway LMVR and the local LMVR that were submitted to DfT as part of the OBC documentation have not been updated as part of the FBC, with the intent being to reduce the amount of DfT review time that would otherwise have been triggered had the two aforementioned documents been updated.

1.1.4 This Local LMVR addendum documents the updates made since the OBC submission to prepare the model for the FBC, updates that can be summarised as follows:

- investigation of local routeing in Melton Mowbray (see Section 2.1);
- reviewing, analysing and debugging forecasting highway convergence issues (see Section 2.2);
- implementing the latest (July 2021) TAG data book values (see Section 2.3); and
- inclusion of updates made as part of the development of the 'LLITM Standard' (see Section 2.4).

1.1.5 To define the focus of the local LMVR an area of interest was defined by running a base year LLITM forecast with and without the proposed scheme and identifying those links where traffic flows changed by more than 5%. To remove links with low flows where a small absolute change in flow results in a large percentage change, the absolute flow change for those identified links must also be over 30 PCUs[3]. Note that this area of interest was defined for the OBC forecasting and appraisal and has not been refreshed for the purposes of this addendum.

1.1.6 Links on which flows changed by more than 5% and 30 PCUs were included within the initial area of interest. The identified links (red) and the defined area of interest (blue) are shown in Figure 1-1. This analysis is likely to include an element of convergence 'noise' within the model forecasts; therefore, as most highlighted links fall within Melton Borough, the borough itself was used to define the focus of this local LMVR.

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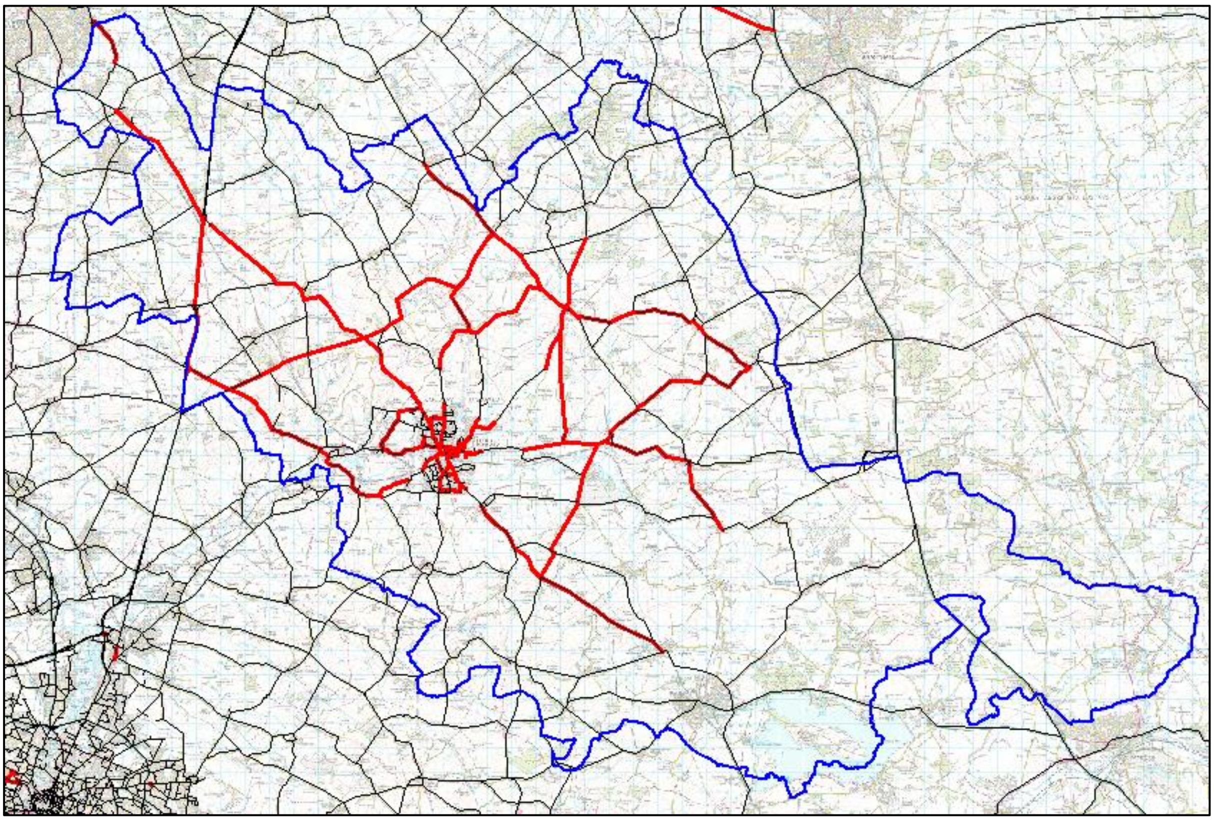
[1] NEMMDR Local Highway Model LMVR (December 2017, AECOM)
[2] LLITM 2014 Base Highway Assignment LMVR (13th December 2017, AECOM)
[3] Passenger car unit, where cars and LGVs have a weighting of 1 and HGVs have a weighting of 2

Figure 1-1: Area of Interest



Map contains Ordnance Survey data © Crown copyright and database right 2022

1.1.7 To put the local performance of the model in Melton Borough into context within Leicestershire, the performance of the updated FBC highway model across the county in terms of screenlines, individual link counts and journey times is summarised below. This demonstrates that across Leicestershire the model performs well against TAG criteria, with:

- more than 90% of screenlines meeting TAG criteria in all three modelled time periods;
- at least 85% of individual link counts meeting TAG criteria in all three modelled time periods; and
- more than 85% of journey time routes meeting TAG criteria in all three modelled time periods.

1.1.8 The 'North-East Leicestershire' model reporting area closely aligns with Melton Borough, which is used as the area of interest. For this area, the model performs well against TAG criteria for both flows and journey times.

1.1.9 Full details of the model's performance in terms of screenlines, individual link counts and journey times are given in Section 3.

1.2 Report Structure

1.2.1 This addendum to the LLITM 2014 Base Local Melton Borough Highway Model LMVR contains the following sections:

- Section 2 – Post-OBC Local Highway Model Review and Updates: this section discusses the updates undertaken as part of the base year highway model review.
- Section 3 – Assignment Calibration and Validation Performance: this section details the performance of the latest updated base year highway model against observed count and journey time data, focussing on the performance within Melton Borough.
- Section 4 – Conclusions: this section provides a summary of the local LMVR and its findings.

Section 2 – Post-OBC Local Highway Model Review and Updates

2.1 Routeing Investigation and Checks

2.1.1 These checks form part of the base year network update of the OBC networks for use in the FBC in response to issues found during the OBC modelling.

2.1.2 The routeing investigations started with an issue raised by Leicestershire County Council (LCC) in central Melton Mowbray where the model routes traffic travelling from north-west to south-east across Melton through the centre of the town along Chapel Street / King Street / Sage Cross Street rather than along Norman Way and Thorpe End on the gyratory. Following analysis of count data and Google Maps routeing information, the conclusion, with input from LCC was that flows along this ‘rat-run’ could not be lowered further without artificially penalising the ‘rat-run’ or running matrix estimation with additional new counts. As a result, it was decided that this should be noted for model development tasks in the future.

2.1.3 Other general routeing checks were undertaken by looking at a range of movements crossing Melton Mowbray and comparing the modelled routeing in 2014 and 2051 without and with the NEMMDR scheme and comparing the 2014 routeing against Google Maps.

2.1.4 The post-OBC routeing checks detailed above did not result in any changes to the base year model. This has allowed the calibrated matrices from the OBC to be retained and used for the FBC.

2.2 Highway Convergence Review

2.2.1 As part of the post-OBC (2019) model update, several convergence issues were addressed that existed in the OBC future year forecasts and impacted the stability of the economic appraisal results in several locations.

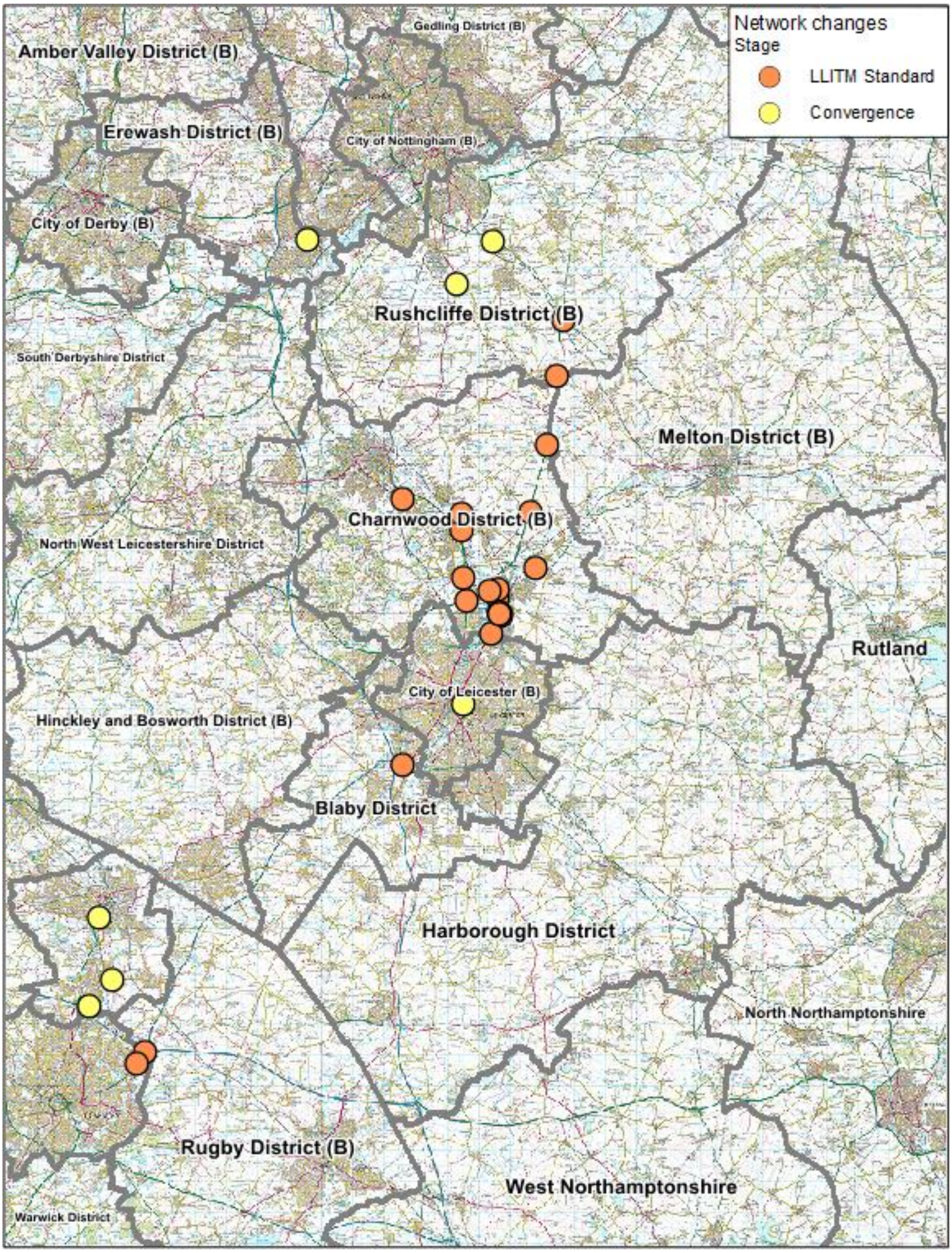
2.2.2 To fully identify issues, a systematic review of the time skim outputs from the model for each modelled year, with and without the scheme, was undertaken. This resulted in a list of locations which required further checking to understand issues and develop solutions as appropriate. Each of the following locations was identified and has received network edits as follows:

- node 74278 (Tollerton Lane / A606, Tollerton) – adjusted the signal timings to provide more green-time for the major arm (A606) flow;
- node 73946 (A60 / Bradmore Lane, Bradmore) – added a missing right-turn flare;
- zone 8046 (Bayton Road Industrial Estate, Bedworth) – corrected the saturation flows and added filter lane at node 73831 and added another centroid connector to the north;
- zone 2 (Rutland Street, Granby Street, central Leicester) – adjusted the signal timings at node 1677 and added another centroid connector to the west;
- zone 8032 (Bull Ring, Nuneaton) – added a flare to node 73811; and
- zone 8067 (A6005, Long Eaton) – added an extra centroid connector.

2.2.3 These edits are all in locations that are outside Melton Borough and have a negligible impact on the base year calibration and validation in the area of interest for the FBC. The locations are shown in yellow in Figure 2-1, showing two stages of network changes vis-à-vis the OBC modelling:

- **LLITM Standard**: network updates made as part of a wider model update; and
- **Convergence** .network updates made as part of an exercise to improve the model convergence specifically for the FBC forecasting and appraisal

Figure 2-1: Location of Network Updates



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2.2.4 Additionally, revised convergence parameters in the highway model were introduced to further improve the stability of the highway assignment results and ultimately the economic assessment. The STPGAP parameter has been adjusted from 0.01 (OBC) to 0.006 (FBC), i.e. a more stringent convergence standard. This change also has a negligible impact on the base year calibration and validation throughout the model.

2.3 July 2021 TAG Data book Update

2.3.1 The final element of the highway model review has been to update the LLITM 2014 Base pence per minute (ppm) and pence per kilometre (ppk) parameters to be in-line with the July 2021 TAG data book. The updated values are given in Table 2.1.

Table 2.1: LLITM 2014 Base Year Model PPM and PPK Parameters

User Class	AM Peak		Interpeak		PM Peak	
	ppm	ppk	ppm	ppk	ppm	Ppk
HGV	42.42	47.06	42.42	47.06	42.42	47.06
LGV	21.29	14.93	21.29	14.93	21.29	14.93
Employers' Business	29.38	13.56	30.11	13.56	29.81	13.56
'Other' Low Value of Time	12.18	7.29	12.98	7.29	12.76	7.29
'Other' Medium Value of Time	13.60	7.29	14.48	7.29	14.24	7.29
'Other' High Value of Time	15.09	7.29	16.08	7.29	15.81	7.29
Commuting Low Value of Time	15.33	7.29	15.58	7.29	15.38	7.29
Commuting Medium Value of Time	19.71	7.29	20.03	7.29	19.77	7.29
Commuting High Value of Time	25.03	7.29	25.44	7.29	25.11	7.29

2.4 'LLITM Standard' Network Updates

2.4.1 In addition to the network changes discussed above, which were in response to observations made when using the model for the OBC forecasting, further, more general, updates have been made to the LLITM as part of its ongoing maintenance.

2.4.2 Since the development of the OBC model in 2017, AECOM carried out a separate stream of work unrelated to the NEMMDR to develop the 'LLITM Standard'. The 'LLITM Standard' update involved the following elements which have been carried forward into the FBC model version:

- a change of planning data input to the trip end model (planning data tables replacing land-use model outputs), which does not affect the base year; and
- numerous updates to the highway network resulting from the base year model being locally reviewed when it was used to assess other highway schemes.

2.4.3 The highway network updates included in the base year LLITM model to be used for the FBC are as follows:

- node 9619 (A5460 / A563, near M1 Junction 21) – revised the lane allocations and saturation flows on approach from node 9589;
- bus route 336, Leicester City – revision of the modelled bus route to be along Highcross Street rather than Great Central Street;
- node 73734 (Craftsman Way / A607, East Goscote) – updated to a signalised junction using signal timings provided by LCC, new node (69910) added to model flared approach to junction, and speed flow curves updated and new node (69909) added to represent 50mph speed limit along this section of the A607;
- node 1768 (A6/A46 Birstall Interchange, Leicester) – adjusted saturation flow from 2,000 to 1,860 for turn onto eastbound A46;
- node 60362 (A6/A6004 roundabout near Loughborough) – lane allocation adjustments;
- adjustments to speed flow curves on Sileby Road and Slash Lane between A6 and Sileby to improve link performance;
- Hobby Horse Roundabout, Leicester – A607 slip-road and Wanlip Road speed flow curves adjusted to reduce speeds;

- Saxon Drive development south of Rothley – zone 9060 used to represent the development, with changes to network coding to represent development access;
- various corrections of distances on A46 between A606 and Hobby Horse, Leicester;
- node 2133 (Hobby Horse roundabout, Leicester) – update to speed flow curve on southbound A46 approach;
- node 60252 (Seagrave Road/A46, near Thrussington) – correction to number of lanes on Seagrave Road approach;
- node 60403 (Six Hills Lane/A46, Six Hills) – correction of saturation flows;
- node 10576 – (Back Lane/A46, near Willoughby-on-the-Wolds) – altered junction to merge coding rather than priority coding;
- A46/A606 – corrected junction coding to include two lanes on the gyratory;
- nodes 79674 and 79668 (A4600 near M6) – correction of speed flow curve; and
- various nodes at A607 / Melton Road / Barkby Thorpe Lane (Thurmaston Roundabout, Leicester):
    - node 2163 – updated to be two lanes plus a flare and link from node 2147 increased to three lanes;
    - link lengths at nodes 2150, 69964 and 2059 updated, and link approach node 2150 increased to three lanes; and
    - new node (2148) added to represent three lane approach to node 2147, and node 2147 signalised using standard signal timings.

2.4.4 Some of these network updates are located at or near the edge of Melton Borough, however, none are situated within the authority's boundary. Therefore, whilst there are improvements in terms of the model's calibration/validation performance (see Section 3), it has not been deemed appropriate to revisit (i.e. re-estimate) the calibrated demand for the FBC. The locations are shown in Figure 2-1 in orange.

Section 3 – Assignment Calibration and Validation Performance

3.1 Introduction

3.1.1 The base year highway assignment was assessed using TAG criteria against observed count and journey time data across the county. The main highway model LMVR provides details on the model performance against counts and journey times across the wider model, however, it has not been updated to reflect the calibration/validation performance of the FBC version of the model. The performance of the FBC version of the model is given in Section 3.3 and Appendix A.

3.1.2 This section provides further detail on the local performance of the FBC highway model within Melton Borough and compares the modelled flows against more recently collected counts within Melton Mowbray. Note that these more recently collected counts are used purely to validate the model and not for the purpose of calibration.

3.1.3 As discussed in Paragraph 1.1.4, the following updates to the highway model have been made as part of the FBC enhancements[4]:

- reviewing, analysing and debugging forecasting convergence issues (Section 2.2);
- implementing the latest (July 2021 TAG) data book values (Section 2.3); and
- inclusion of updates made as part of the development of the 'LLITM Standard' (Section 2.4).

3.1.4 These changes have a modest impact on the assigned flows within the base year model and therefore potentially impact the performance of the model across the county.

3.1.5 This section firstly presents the performance of the model against flows and journey times as reported for the OBC version of the model. This analysis is then reproduced using the FBC base year model to demonstrate that the changes adopted have not had a negative impact on the wider model performance. Finally, the modelled flows are compared with the additional count data provided as part of this study, which provide additional flow validation sites within Melton Mowbray.

3.2 OBC Model Version – Highway Model Performance

3.2.1 Table 3.2 presents the base year convergence statistics and shows that the highway model reaches the criteria in 14, 7 and 29 iterations for each time period, respectively. The thresholds for %Delays and %Gap are 98.0 and 0.0100, respectively.

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[4] Note that the highway demand matrices in the FBC model version are the same as those in the OBC model version

Table 3.1: OBC Model Base Year Highway Assignment Convergence

Iteration	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	%Delays	%Gap	%Delays	%Gap	%Delays	%Gap
1	93.3	0.138	19.4	0.422	95.9	0.189
2	96.7	0.058	96.2	0.047	97.2	0.127
3	97.7	0.029	98.5	0.027	97.6	0.077
4	98.2	0.098	99.1	0.0091	98.1	0.039
5	98.3	0.014	99.5	0.0075	98.5	0.035
6	98.9	0.009	99.6	0.0067	98.7	0.077
7	99.1	0.013	99.7	0.0055	98.5	0.059
8	99.1	0.0075			98.6	0.028
9	99.2	0.0053			98.8	0.031
10	99.1	0.07			98.8	0.025
11	99	0.0062			98.9	0.019
12	99.4	0.0055			99.2	0.015
13	99.4	0.0051			99.1	0.018
14	99.4	0.006			99.2	0.010
15					99.4	0.013
16					99.3	0.015
17					99.4	0.010
18					99.4	0.014
19					99.3	0.011
20					99.4	0.013
21					99.4	0.0099
22					99.5	0.010
23					99.5	0.010
24					99.6	0.0078
25					99.6	0.010
26					99.4	0.0082
27					99.5	0.0089
28					99.5	0.0071
29					99.6	0.0098

3.2.2 The following tables were extracted from the main highway LMVR[5] and show the wider model performance against observed data before the FBC updates detailed within this report were applied.

3.2.3 Table 3.2 shows the OBC model performance in terms of screenline flows for total vehicle flows by time period, detailing the aggregate difference between modelled and observed flows and the number of screenlines which pass TAG criteria. Table 3.3 shows the percentage of links which met TAG guidelines, both including and excluding duplicate count locations (a duplicate count is one which is used on more than one screenline). Finally, Table 3.4 shows the percentage of journey time routes which met TAG criteria by time period.

3.2.4 In these tables, the reporting area of ‘North-East Leicestershire’ broadly corresponds with Melton Borough. The performance of the model in this area is therefore an approximation for the performance of the model within the Area of Interest.

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[5] LLITM 2014 Base Local Melton Borough Highway Model LMVR (December 2017, AECOM)

Table 3.2: OBC Model – Leicestershire Screenline Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	Total %	ScnLine Passes	Total %	ScnLine Passes	Total %	ScnLine Passes
Leicester City	-0.0%	94%	0.4%	100%	0.6%	100%
North Leicestershire	-0.2%	94%	0.7%	88%	1.1%	88%
North-East Leicestershire	0.2%	86%	1.0%	93%	0.5%	93%
South Leicestershire	-1.1%	85%	0.3%	96%	0.2%	88%
South-West Leicestershire	0.6%	100%	0.1%	100%	1.0%	88%
North-West Leicestershire	-0.6%	88%	-0.5%	100%	-0.2%	94%
Countywide	1.0%	100%	0.5%	100%	0.8%	100%
SRN (within Leics.)	1.5%	100%	1.4%	100%	1.1%	95%
Leicestershire	***0.4%***	***93%***	***0.6%***	***97%***	***0.7%***	***93%***

Table 3.3: OBC Model – Leicestershire Link Flow Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)
Leicester City	79%	78%	88%	88%	81%	80%
North Leicestershire	82%	81%	91%	90%	79%	78%
North-East Leicestershire	93%	93%	96%	95%	91%	90%
South Leicestershire	89%	88%	94%	94%	89%	89%
South-West Leicestershire	88%	88%	98%	98%	90%	90%
North-West Leicestershire	94%	93%	95%	95%	93%	92%
Countywide	89%	87%	97%	96%	87%	84%
SRN (within Leics.)	97%	97%	100%	100%	96%	96%
Leicestershire	***87%***	***86%***	***94%***	***93%***	***86%***	***86%***

Table 3.4: OBC Model – Journey Time Validation

	No. of Routes	**AM %Pass**	**IP %Pass**	**PM %Pass**
Leicester City	32	91%	84%	88%
North Leicestershire	18	78%	94%	89%
North-East Leicestershire	12	100%	92%	92%
South Leicestershire	18	94%	100%	83%
South-West Leicestershire	24	92%	92%	88%
North-West Leicestershire	24	92%	100%	92%
SRN (within Leics.)	10	90%	100%	100%
Leicestershire	**138**	**91%**	**93%**	**89%**
SRN (Ext)	12	83%	100%	100%

3.3 FBC Model Version – Highway Model Performance

3.3.1 Table 3.5 presents the base year convergence statistics and shows that the highway model reaches the criteria in 21, 15 and 22 iterations for each time period, respectively. The thresholds for %Delays and %Gap are 98.0 and 0.0060, respectively.

Table 3.5: FBC Model Base Year Highway Assignment Convergence

Iteration	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	%Delays	%Gap	%Delays	%Gap	%Delays	%Gap
1	93.5	0.129	22.2	0.439	96.0	0.105
2	97.1	0.043	96.2	0.066	97.6	0.062
3	98	0.022	98.5	0.028	98.0	0.037
4	98.5	0.098	99.1	0.010	98.4	0.025
5	98.4	0.015	99.5	0.012	98.5	0.061
6	99	0.012	99.6	0.0062	98.6	0.033
7	99.2	0.0083	99.7	0.0065	98.6	0.016
8	99.1	0.011	99.7	0.0071	98.9	0.014
9	99.3	0.0085	99.8	0.0049	99.1	0.0079
10	99.5	0.0077	99.8	0.0033	99.3	0.0089
11	99.4	0.008	99.8	0.0065	99.3	0.010
12	99.5	0.0067	99.8	0.0035	99.3	0.0066
13	99.6	0.0047	99.8	0.004	99.4	0.0076
14	99.4	0.0076	99.8	0.0028	99.5	0.005
15	99.5	0.0048	99.9	0.0037	99.5	0.0069
16	99.6	0.0042			99.4	0.0059
17	99.5	0.007			99.6	0.0042
18	99.5	0.0045			99.5	0.0079
19	99.7	0.0039			99.5	0.0046
20	99.7	0.004			99.6	0.0052
21	99.7	0.0039			99.6	0.0054
22					99.7	0.0044

3.3.2 Table 3.6, Table 3.7 and Table 3.8 provide the same analysis of the model performance against screenline flows, individual link flows and journey times as detailed in Section 3.2, but reflect all of the FBC updates detailed in Section 2. In Leicestershire, compared with the OBC model:

- the proportion of screenlines which meet TAG criteria has remained stable in the AM Peak hour, and increased slightly in the interpeak and PM Peak hours;
- the proportion of individual link flows that meet TAG criteria has remained stable in the AM Peak and PM Peak hours, and increased slightly in the interpeak hour; and
- the proportion of journey times meeting TAG criteria has slightly increased in the AM Peak and the interpeak hours, and remained stable in the PM Peak hour.

3.3.3 The changes in these statistics for the North-East Leicestershire reporting area (largely Melton Borough) are:

- improvements in screenline performance in the interpeak and PM Peak hours to 100% pass due to better performance of the Melton Mowbray North-South Screenline (Nottingham Road) validation screenline;

- improvement in the AM Peak hour screenline performance from 86% to 93% due to the Melton Borough A606 Screenline North-Eastbound calibration screenline changing to a pass;
- improvements in individual link flow performance in the AM Peak hour (one percentage point excluding duplicates), interpeak hour (three percentage points excluding duplicates), and PM Peak hour (five percentage points excluding duplicates); and
- improvements in journey time performance to 100% in the interpeak and PM Peak hours due to better performance on the Dalby Road / Scalford Road journey time route.

3.3.4 The analysis shown in Table 3.6 to Table 3.8 demonstrates that with the inclusion of the network updates (Section 2.4), the July 2021 TAG data book (Section 2.3), and improved convergence (Section 2.2), the highway model meets TAG criteria for screenline flows, individual link flows, and journey times across the county. Individual screenline and journey time route performance data are given in Appendix A at a countywide level. In addition to this, within North-East Leicestershire (broadly Melton Borough) the model performs well against observed data.

Table 3.6: FBC Model – Leicestershire Screenline Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	Total %	ScnLine Passes	Total %	ScnLine Passes	Total %	ScnLine Passes
Leicester City	-0.1%	94%	0.4%	100%	0.4%	100%
North Leicestershire	-0.2%	88%	0.9%	94%	0.2%	81%
North-East Leicestershire	-0.3%	93%	0.6%	100%	-1.0%	100%
South Leicestershire	-0.7%	85%	0.3%	92%	-0.2%	88%
South-West Leicestershire	0.4%	100%	0.2%	100%	0.5%	94%
North-West Leicestershire	-0.8%	88%	-1.1%	100%	-0.8%	94%
Countywide	0.4%	100%	0.5%	100%	0.6%	100%
SRN (within Leics.)	1.2%	100%	1.6%	100%	0.2%	100%
Leicestershire	**0.2%**	**93%**	**0.7%**	**98%**	**0.2%**	**94%**

Table 3.7: FBC Model – Leicestershire Link Flow Performance (Total Vehicle Flows)

	AM Peak Hour		Interpeak Hour		PM Peak Hour	
	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)	%Links	%Links (ex dupl.)
Leicester City	78%	77%	89%	89%	79%	78%
North Leicestershire	83%	82%	93%	93%	84%	83%
North-East Leicestershire	94%	94%	96%	95%	89%	88%
South Leicestershire	89%	89%	92%	92%	89%	88%
South-West Leicestershire	89%	88%	97%	97%	89%	89%
North-West Leicestershire	94%	93%	95%	95%	89%	88%
Countywide	89%	87%	97%	97%	87%	84%
SRN (within Leics.)	97%	97%	100%	100%	94%	94%
Leicestershire	**87%**	**86%**	**94%**	**94%**	**86%**	**85%**

Table 3.8: FBC Model – Journey Time Validation

	No. of Routes	AM %Pass	IP %Pass	PM %Pass
Leicester City	32	91%	84%	88%
North Leicestershire	18	89%	94%	83%
North-East Leicestershire	12	100%	100%	100%
South Leicestershire	18	100%	100%	83%
South-West Leicestershire	24	92%	92%	92%
North-West Leicestershire	24	92%	100%	88%
SRN (within Leics.)	10	90%	100%	100%
Leicestershire	**138**	**93%**	**94%**	**89%**
SRN (Ext)	12	83%	100%	92%

3.3.5 In addition to this high-level reporting of the model performance, the following tables and figures provide further details on the model performance within Melton Borough.

3.3.6 Table 3.9 provides further details on flow performance for the screenlines in North-East Leicestershire. In summary:

- all calibration screenlines in the three modelled time periods now meet TAG criteria (note that the Melton Mowbray East-West River Screenline contains only two counts, and therefore adopts the adjusted TAG criteria detailed within the LLITM 2014 Base highway model LMVR); and
- for validation screenlines, in the AM Peak hour the Nottingham Road North-South Screenline eastbound fails to meet TAG criteria, and in the interpeak and PM Peak hours all the validation screenlines meet TAG criteria.

3.3.7 In terms of individual link counts, 94%, 95% and 88% of all link counts within North-East Leicestershire meet TAG criteria in the AM Peak, interpeak and PM Peak hours respectively. The proportions of calibration counts which meet TAG criteria are 94%, 96% and 85% in the three modelled hours and 93%, 93% and 93% of validation counts meet TAG criteria in the three modelled hours respectively. Three out of the eight PM Peak hour calibration failures relate to modelled flows being above the observed data on Kirby Lane and correspondingly below observed data on Leicester Road; these include one marginal failure.

3.3.8 Table 3.10 provides details on the performance of the journey time routes within Melton Borough. Figure 3-1 provides the journey time graphs for these identified journey time routes for each time period.

3.3.9 All 12 journey time routes in Melton Borough shown in Table 3.10 meet TAG criteria across all three time periods.

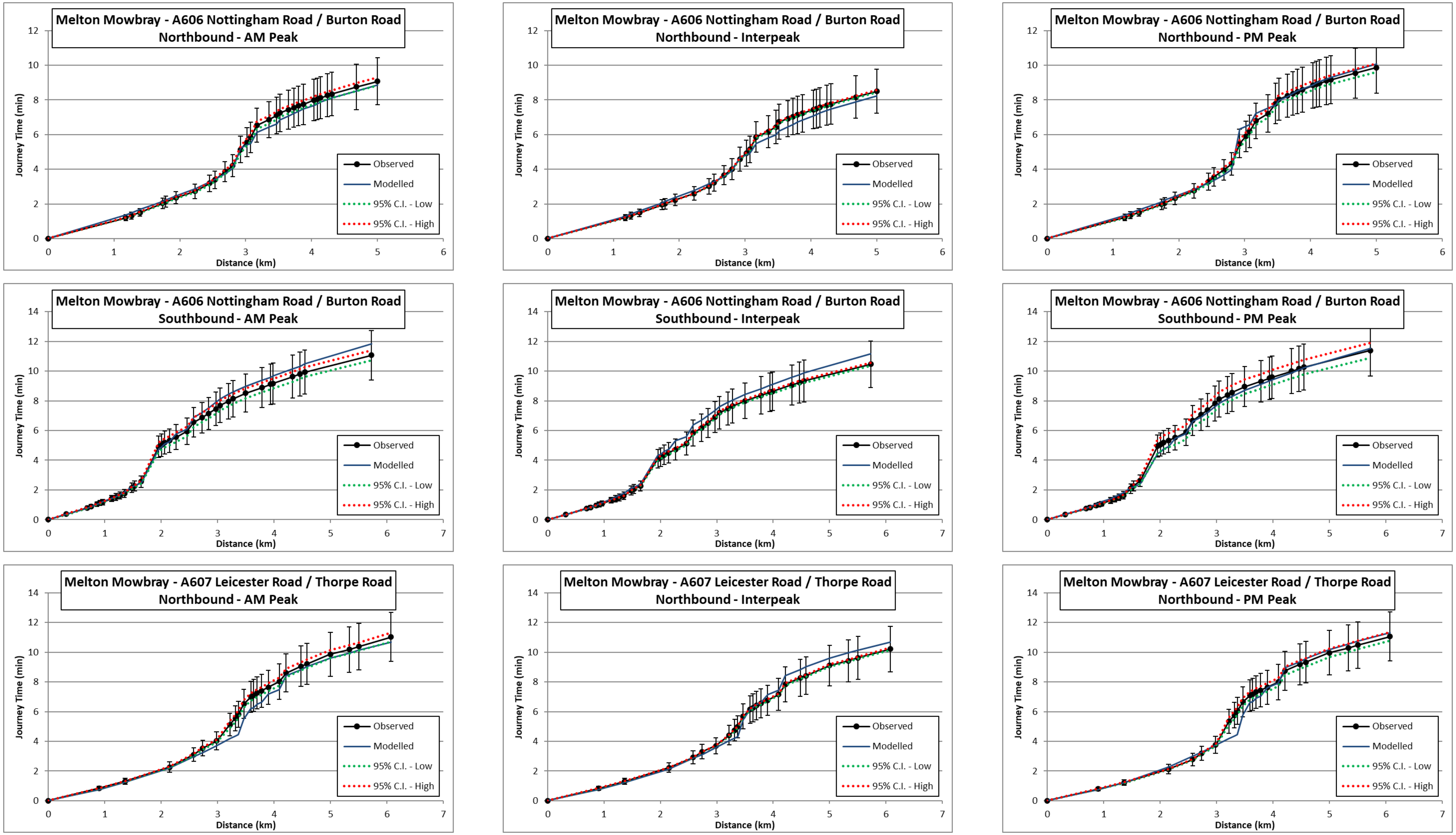
Table 3.9: FBC Model – Flow Performance within the Area of Interest (Total Flows)

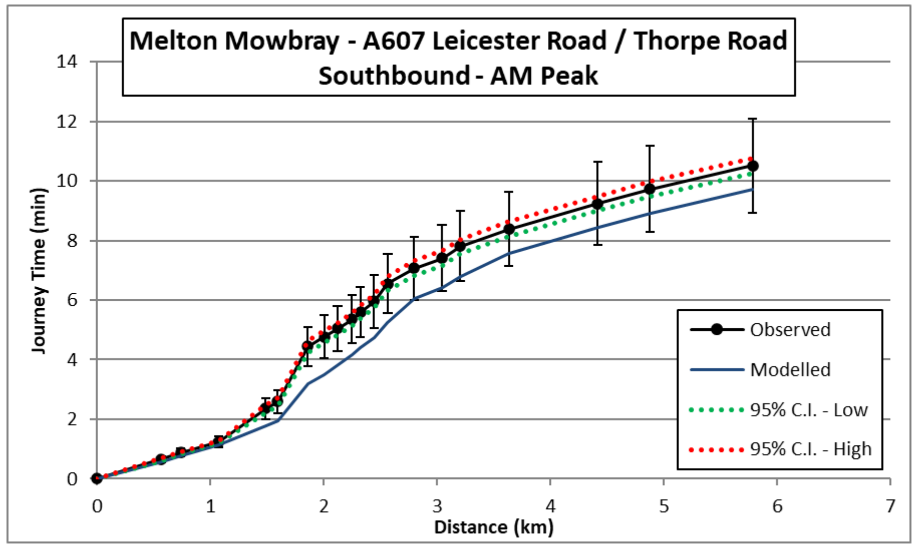
	AM Peak					Interpeak					PM Peak				
Screenlines used for independent validation are shown in orange	Obs.	Mod.	Abs.	%Diff	%Links	Obs.	Mod.	Abs.	%Diff	%Links	Obs.	Mod.	Abs.	%Diff	%Links
Melton Mowbray Cordon Inbound	3,235	3,179	-56	-1.7%	82%	2,125	2,137	12	0.6%	100%	3,184	3,099	-85	-2.7%	82%
Melton Mowbray Cordon Outbound	3,054	2,949	-105	-3.4%	100%	2,200	2,202	2	0.1%	100%	2,920	2,864	-56	-1.9%	82%
Melton Mowbray North-South Screenline (Nottingham Rd) Eastbound	1,044	1,267	224	21.4%	75%	930	1,028	97	10.5%	100%	1,266	1,344	78	6.1%	100%
Melton Mowbray North-South Screenline (Nottingham Rd) Westbound	1,430	1,489	58	4.1%	80%	1,231	1,252	22	1.8%	60%	1,556	1,576	20	1.3%	100%
Melton Mowbray North-South Screenline (Dalby Road) Eastbound	1,107	1,112	5	0.5%	100%	756	758	1	0.1%	100%	1,054	1,047	-7	-0.7%	100%
Melton Mowbray North-South Screenline (Dalby Road) Westbound	944	961	17	1.8%	100%	792	795	2	0.3%	100%	1,049	1,063	14	1.4%	75%
Melton Mowbray East-West Screenline (River) Northbound	1,554	1,667	113	7.3%	100%	1,192	1,237	46	3.8%	100%	1,526	1,486	-40	-2.6%	100%
Melton Mowbray East-West Screenline (River) Southbound	1,494	1,476	-18	-1.2%	100%	1,301	1,333	31	2.4%	100%	1,686	1,761	75	4.5%	100%
Melton Mowbray East-West Screenline (South) Northbound	1,846	1,752	-94	-5.1%	100%	1,277	1,231	-47	-3.6%	100%	1,830	1,784	-46	-2.5%	100%
Melton Mowbray East-West Screenline (South) Southbound	1,716	1,697	-19	-1.1%	100%	1,333	1,319	-13	-1.0%	100%	1,788	1,741	-47	-2.6%	71%
Melton Mowbray East-West Screenline (North) Northbound	1,031	1,014	-17	-1.6%	100%	1,138	1,122	-16	-1.4%	100%	1,728	1,680	-48	-2.8%	100%
Melton Mowbray East-West Screenline (North) Southbound	1,759	1,712	-47	-2.7%	80%	1,092	1,081	-11	-1.0%	60%	1,451	1,438	-14	-0.9%	60%
Leicestershire Cordon (North-East) Inbound	4,956	5,001	45	0.9%	97%	2,770	2,816	46	1.6%	97%	4,449	4,500	52	1.2%	97%
Leicestershire Cordon (North-East) Outbound	4,385	4,366	-19	-0.4%	94%	2,826	2,859	33	1.2%	97%	5,036	5,141	105	2.1%	94%

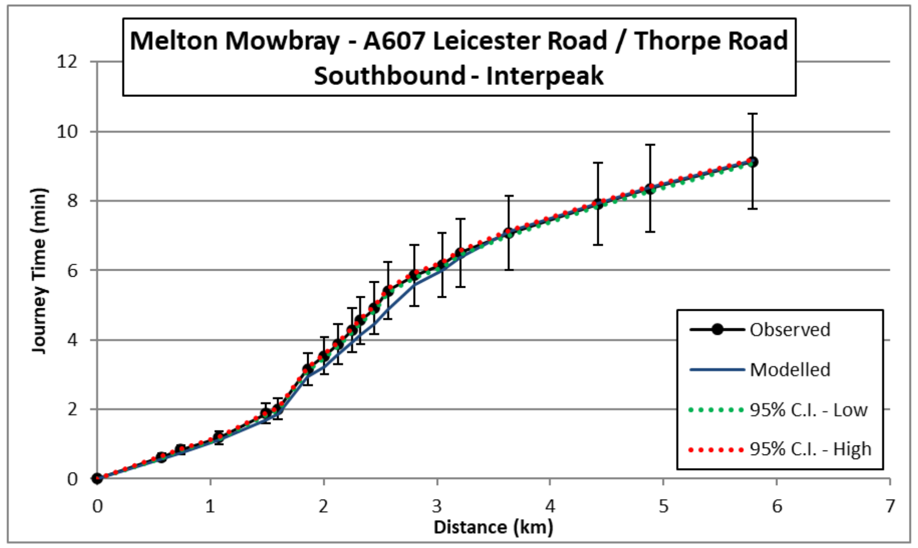
Table 3.10: FBC Model – Journey Time Performance within the Area of Interest

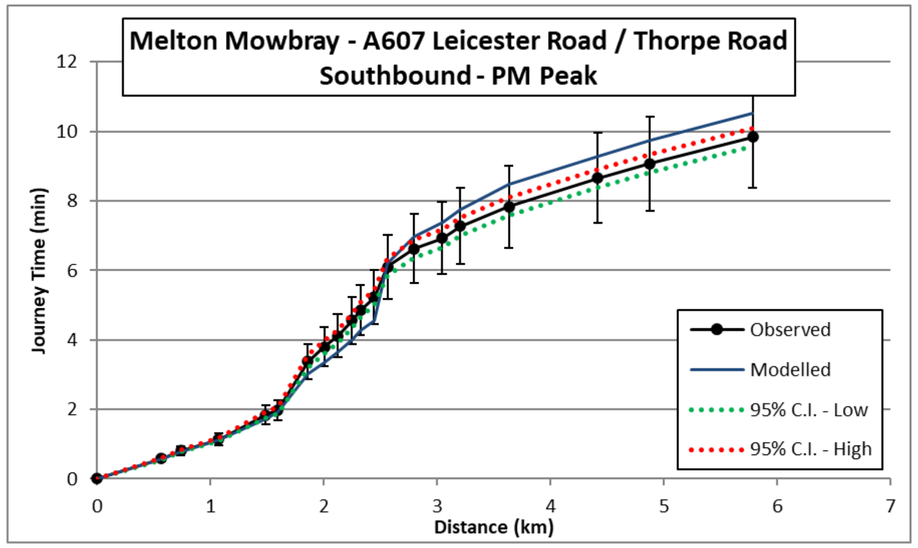
	AM Peak					Interpeak					PM Peak				
	Obs.	Mod.	Abs.	%Diff	Pass	Obs.	Mod.	Abs.	%Diff	Pass	Obs.	Mod.	Abs.	%Diff	Pass
A606 Nottingham Road / Burton Road Northbound	09:04	08:52	-00:13	-2.3%	✓	08:30	08:13	-00:17	-3.3%	✓	09:52	10:05	00:13	2.2%	✓
A606 Nottingham Road / Burton Road Southbound	11:05	11:51	00:47	7.0%	✓	10:28	11:11	00:42	6.7%	✓	11:24	11:32	00:08	1.2%	✓
A607 Leicester Road / Thorpe Road Northbound	11:02	10:41	-00:20	-3.0%	✓	10:13	10:42	00:28	4.6%	✓	11:04	11:18	00:15	2.2%	✓
A607 Leicester Road / Thorpe Road Southbound	10:31	09:42	-00:49	-7.7%	✓	09:08	09:10	00:02	0.4%	✓	09:50	10:32	00:42	7.0%	✓
A6006 to Saxby Road (via Ankle Hill) Eastbound	14:53	13:21	-01:33	-10.4%	✓	12:51	13:05	00:15	1.9%	✓	14:43	13:14	-01:30	-10.1%	✓
A6006 to Saxby Road (via Ankle Hill) Westbound	13:37	12:45	-00:52	-6.3%	✓	12:42	12:34	-00:08	-1.0%	✓	14:11	12:44	-01:28	-10.3%	✓
Dalby Road / Scalford Road Northbound	09:41	08:38	-01:03	-10.9%	✓	07:50	08:15	00:25	5.4%	✓	09:25	09:16	-00:09	-1.6%	✓
Dalby Road / Scalford Road Southbound	07:44	07:47	00:03	0.6%	✓	06:52	07:29	00:37	9.0%	✓	06:56	07:55	00:59	14.3%	✓
Kirby Lane Eastbound	05:10	05:07	-00:03	-0.9%	✓	04:57	05:06	00:09	3.1%	✓	05:07	05:08	00:00	0.1%	✓
Kirby Lane Westbound	04:58	05:09	00:12	3.9%	✓	04:53	05:08	00:15	5.1%	✓	05:08	05:10	00:02	0.7%	✓
A607 (A46 to Melton Mowbray) Northbound	11:09	10:46	-00:23	-3.4%	✓	10:27	10:18	-00:09	-1.5%	✓	10:39	10:44	00:05	0.8%	✓
A607 (A46 to Melton Mowbray) Southbound	11:04	10:51	-00:13	-2.0%	✓	10:37	10:18	-00:19	-3.0%	✓	10:32	10:36	00:04	0.7%	✓

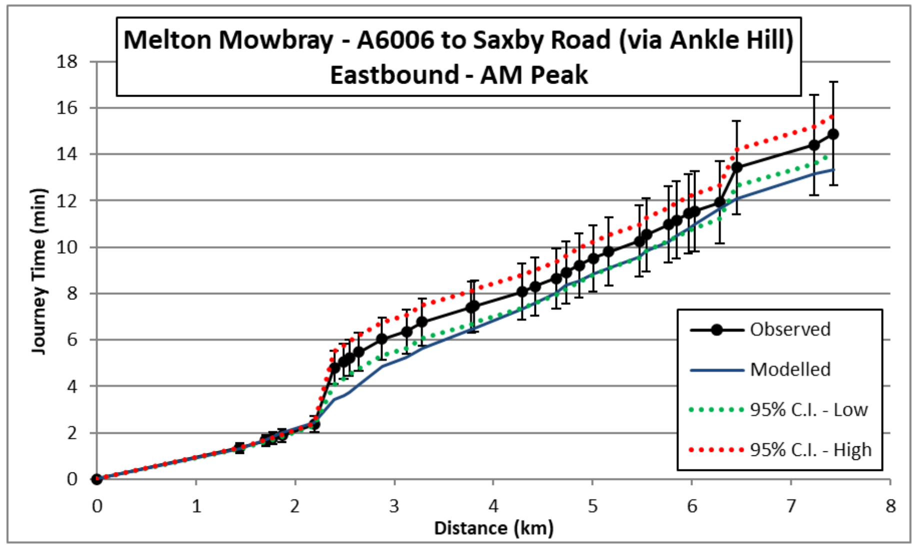
Figure 3-1: FBC Model – Journey Time Graphs within the Area of Interest

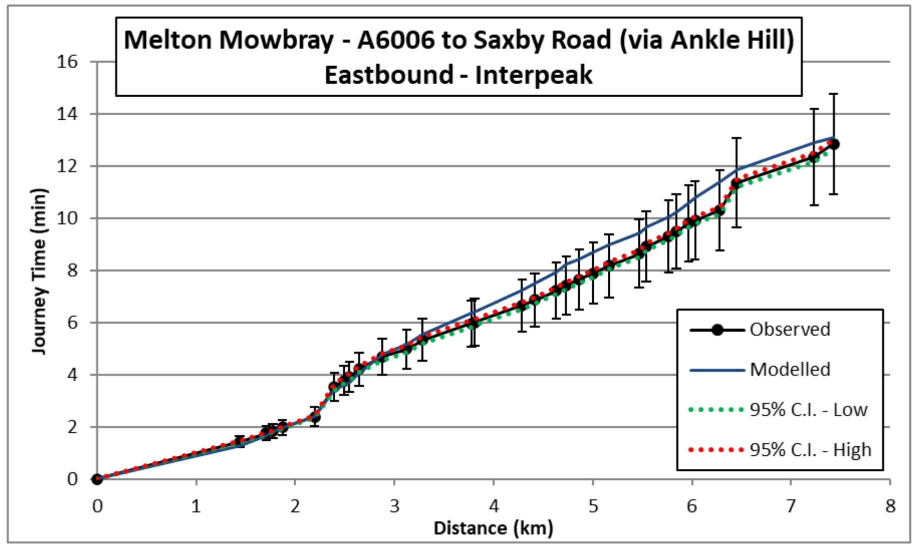


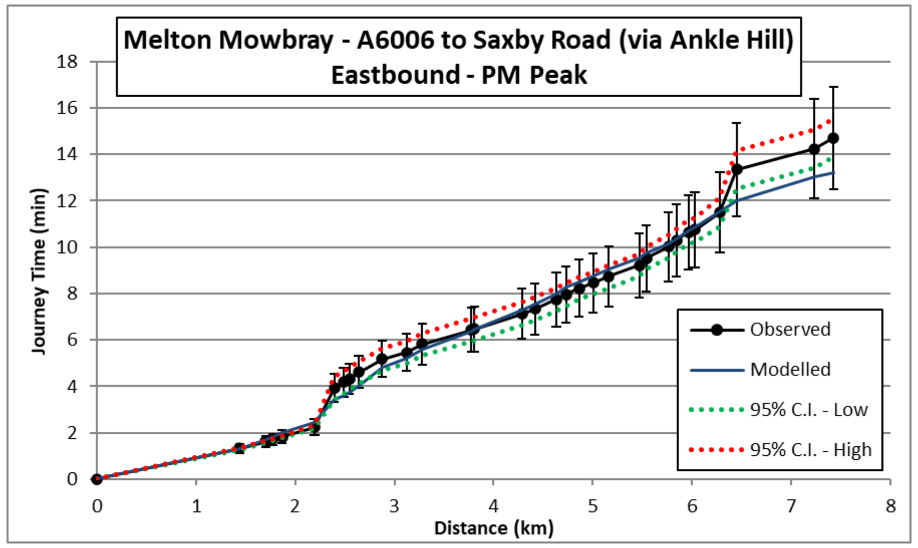

Melton Mowbray - A607 Leicester Road / Thorpe Road Southbound - AM Peak


Melton Mowbray - A607 Leicester Road / Thorpe Road Southbound - Interpeak


Melton Mowbray - A607 Leicester Road / Thorpe Road Southbound - PM Peak


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill) Eastbound - AM Peak


Melton Mowbray - A6006 to Saxby Road (via Ankle Hill) Eastbound - Interpeak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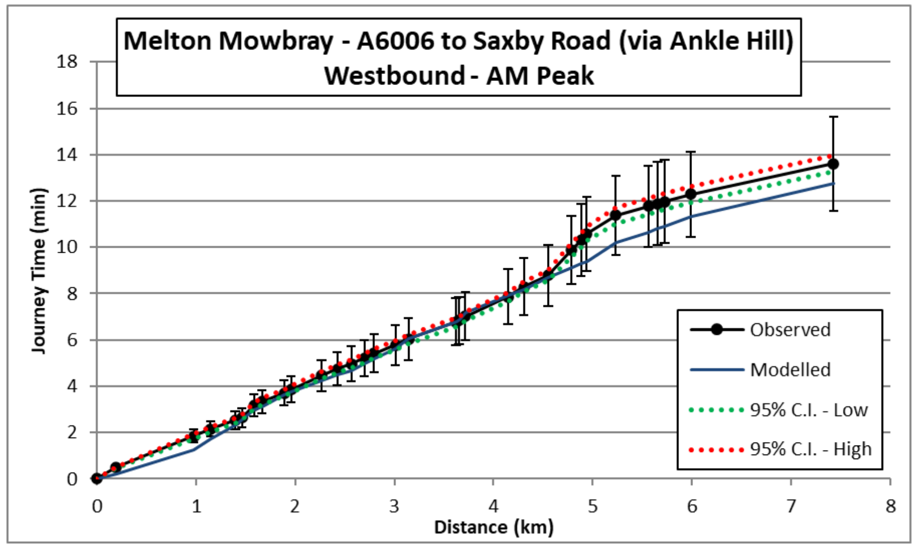
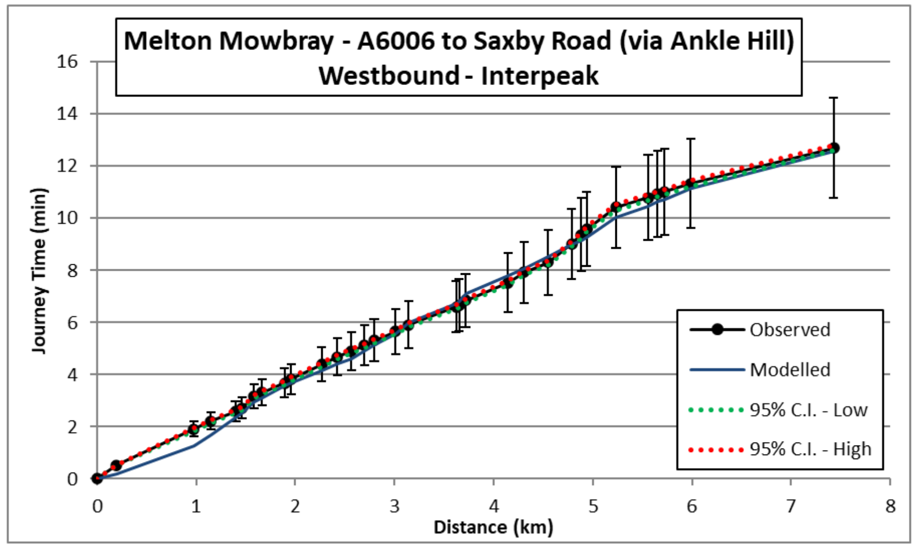
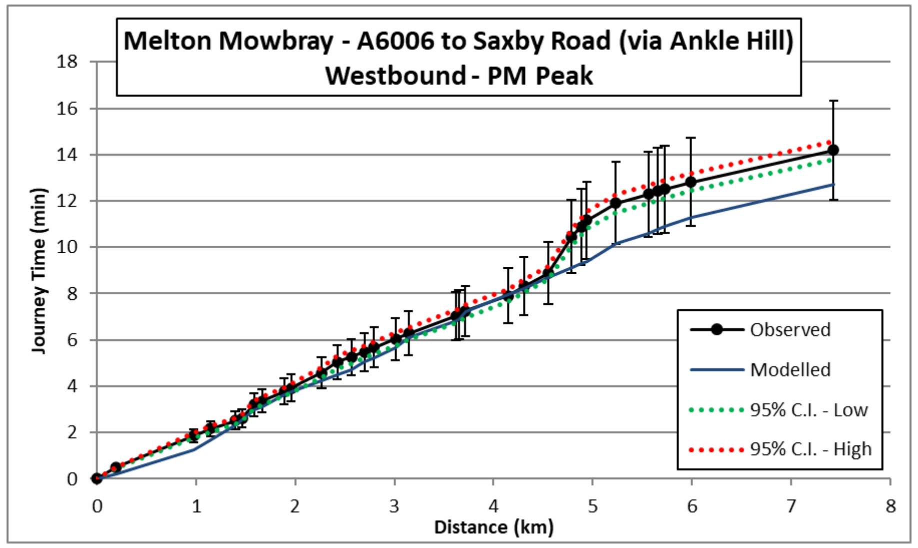
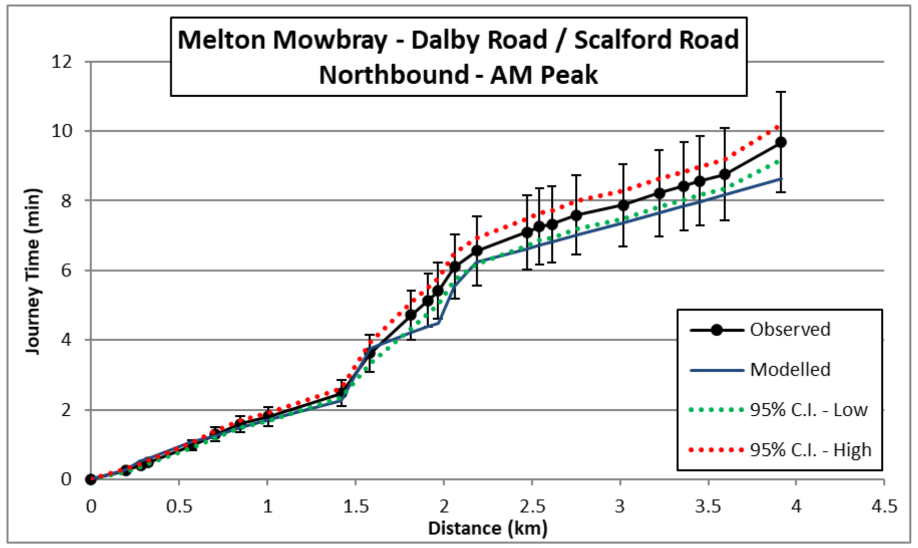
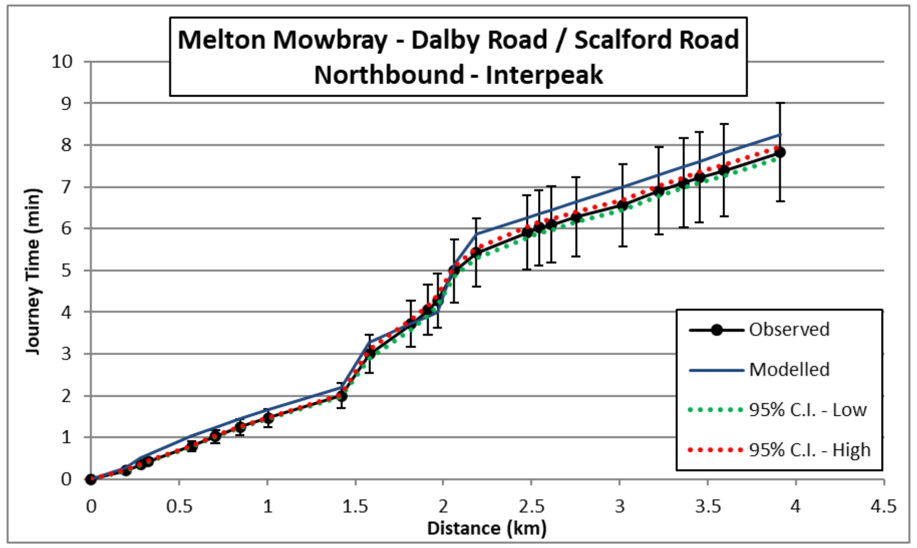
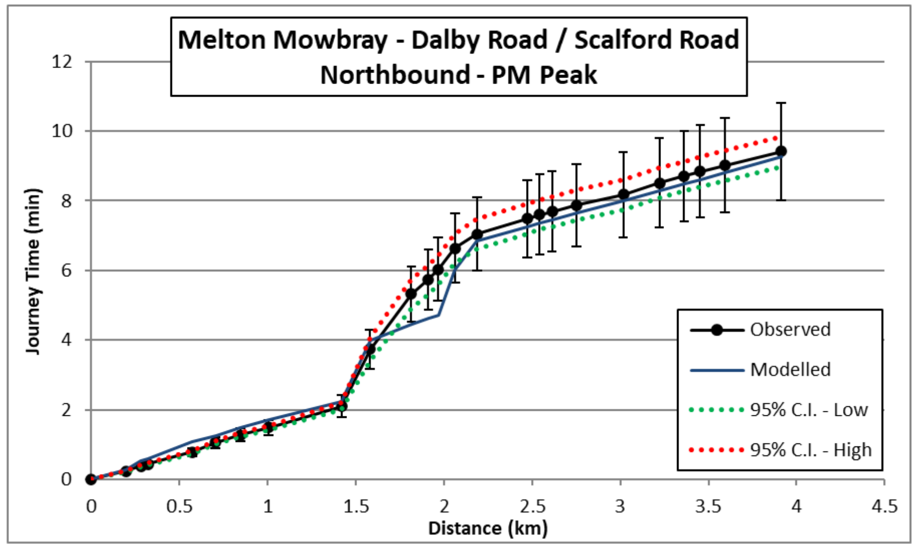

Melton Mowbray - A6006 to Saxby Road (via Ankle Hill) Westbound - AM Peak

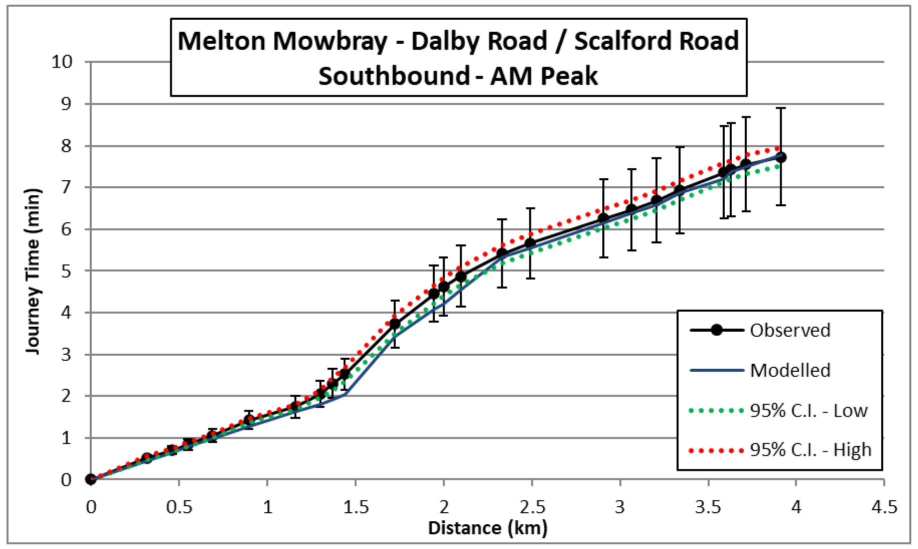

Melton Mowbray - A6006 to Saxby Road (via Ankle Hill) Westbound - Interpeak

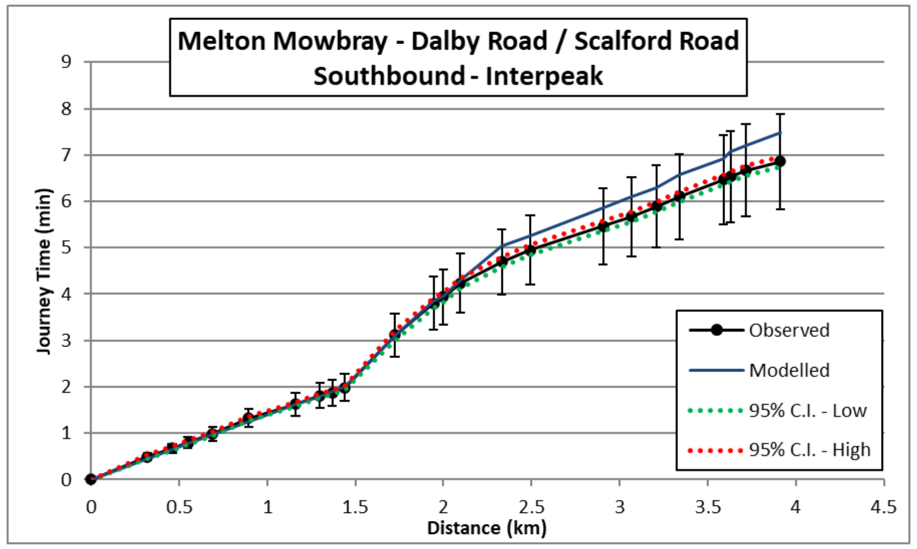

Melton Mowbray - A6006 to Saxby Road (via Ankle Hill) Westbound - PM Peak

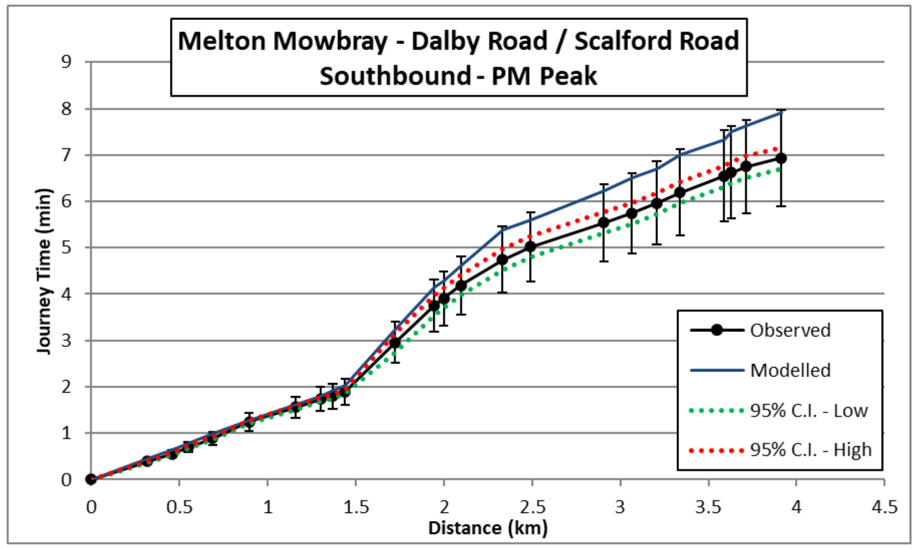

Melton Mowbray - Dalby Road / Scalford Road
Northbound - AM Peak
Journey Time (min)
0
2
4
6
8
10
12
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High

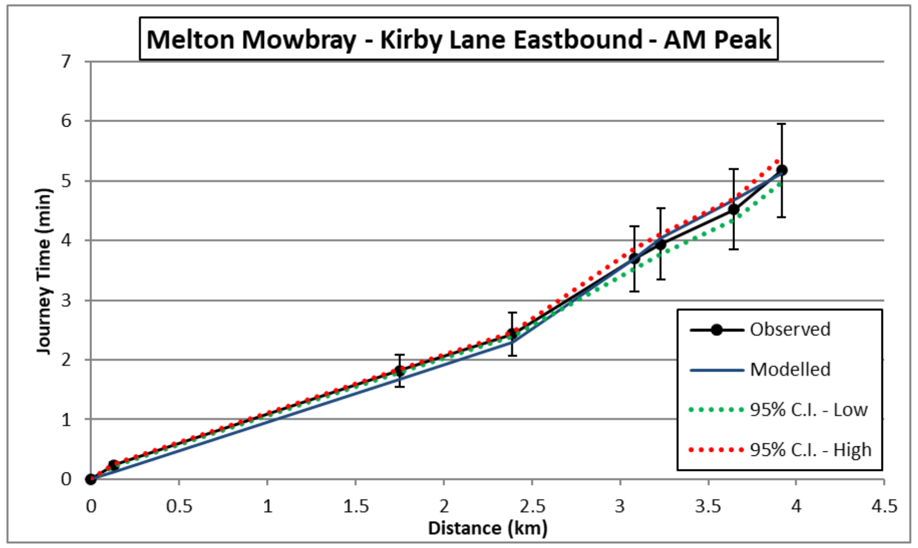

Melton Mowbray - Dalby Road / Scalford Road
Northbound - Interpeak
Journey Time (min)
0
1
2
3
4
5
6
7
8
9
10
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High

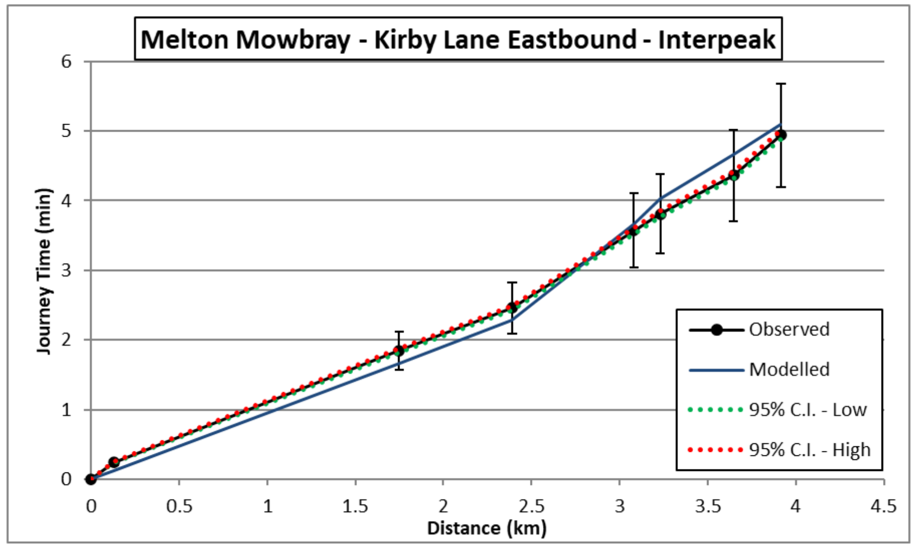

Melton Mowbray - Dalby Road / Scalford Road
Northbound - PM Peak
Journey Time (min)
0
2
4
6
8
10
12
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High

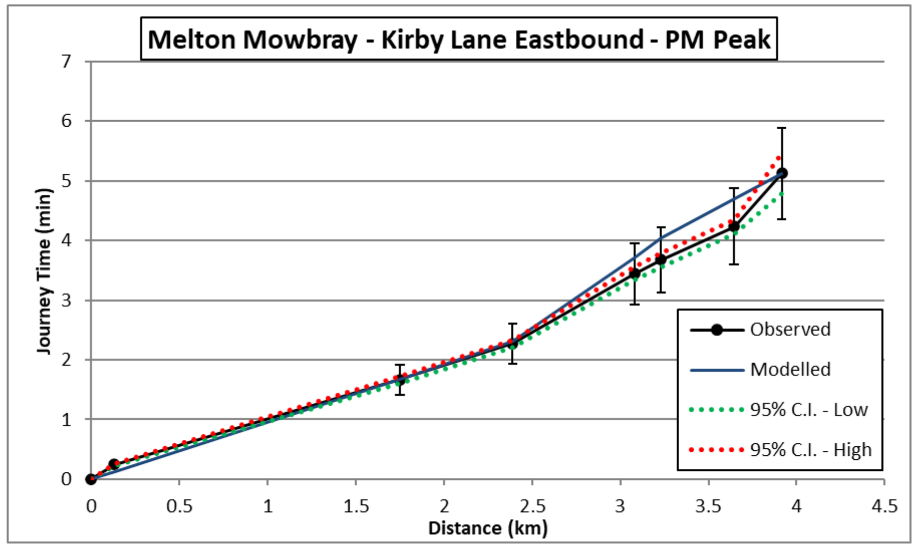

Melton Mowbray - Dalby Road / Scalford Road
Southbound - AM Peak
Journey Time (min)
0
1
2
3
4
5
6
7
8
9
10
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High

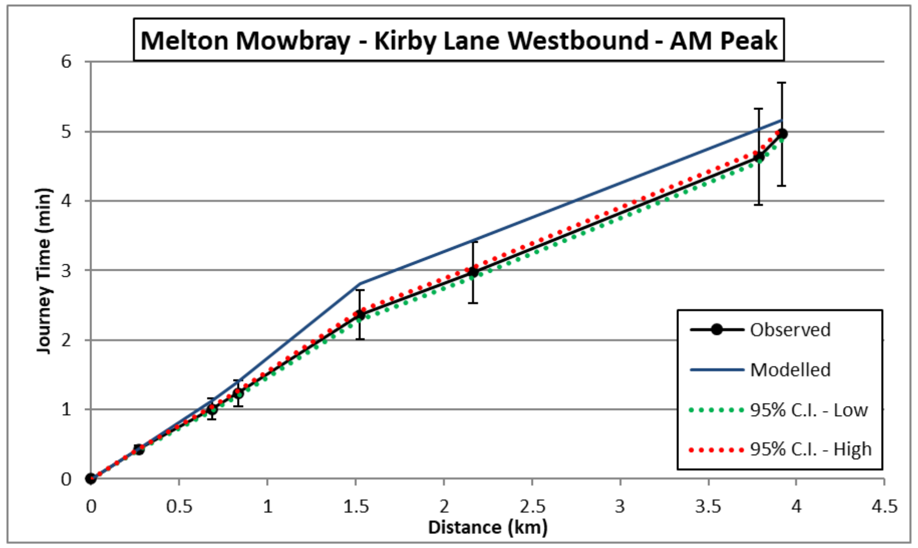

Melton Mowbray - Dalby Road / Scalford Road
Southbound - Interpeak
Journey Time (min)
0
1
2
3
4
5
6
7
8
9
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Dalby Road / Scalford Road
Southbound - PM Peak
Journey Time (min)
0
1
2
3
4
5
6
7
8
9
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High

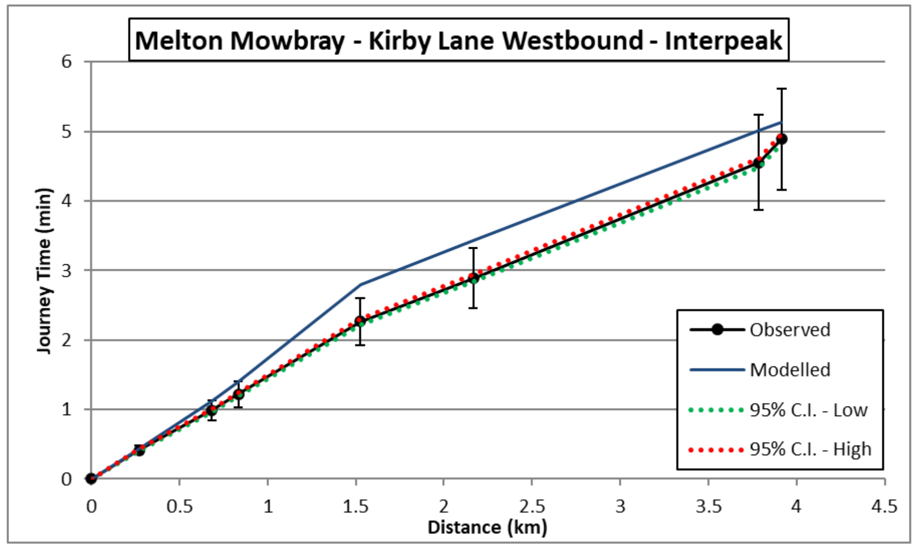

Melton Mowbray - Kirby Lane Eastbound - AM Peak
Journey Time (min)
0
1
2
3
4
5
6
7
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High


Melton Mowbray - Kirby Lane Eastbound - Interpeak
Journey Time (min)
0
1
2
3
4
5
6
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High

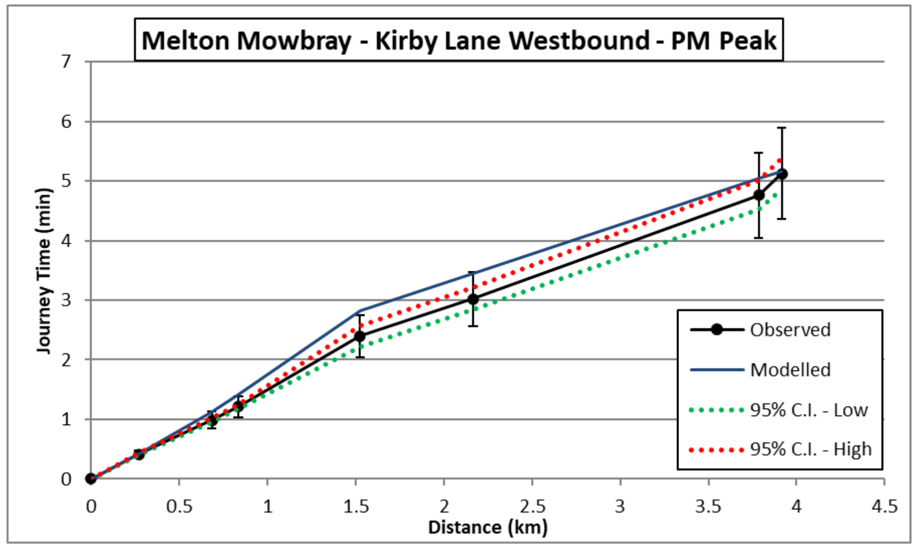

Melton Mowbray - Kirby Lane Eastbound - PM Peak
Journey Time (min)
0
1
2
3
4
5
6
7
Distance (km)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Observed
Modelled
95% C.I. - Low
95% C.I. - High



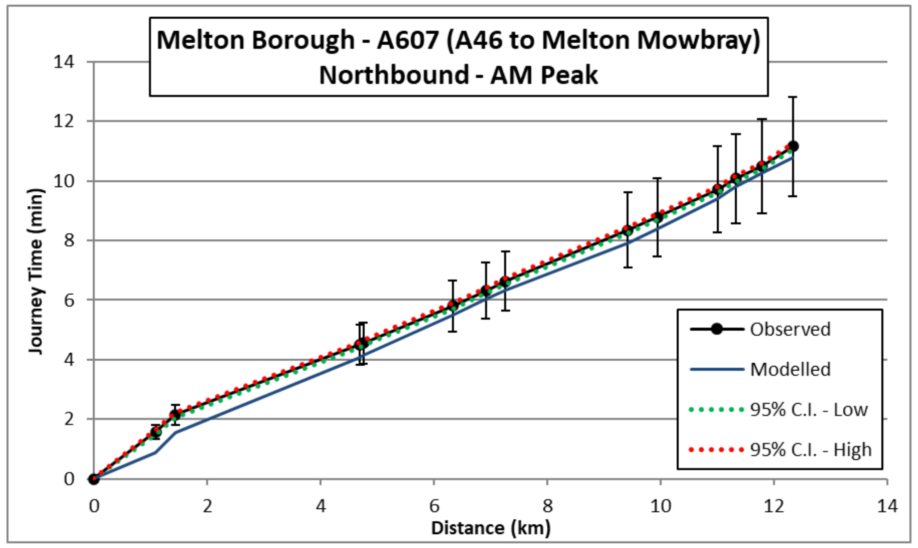
Melton Mowbray - Kirby Lane Westbound - AM Peak



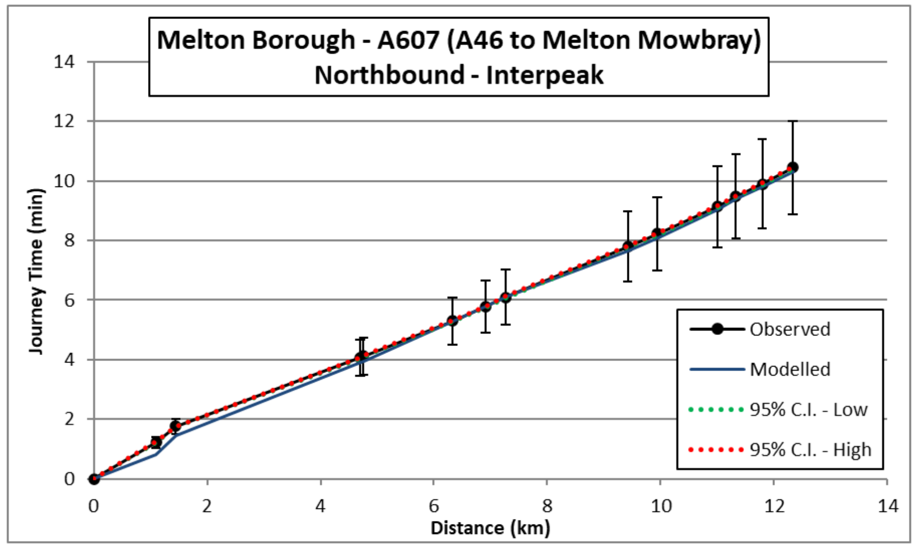
Melton Mowbray - Kirby Lane Westbound - Interpeak



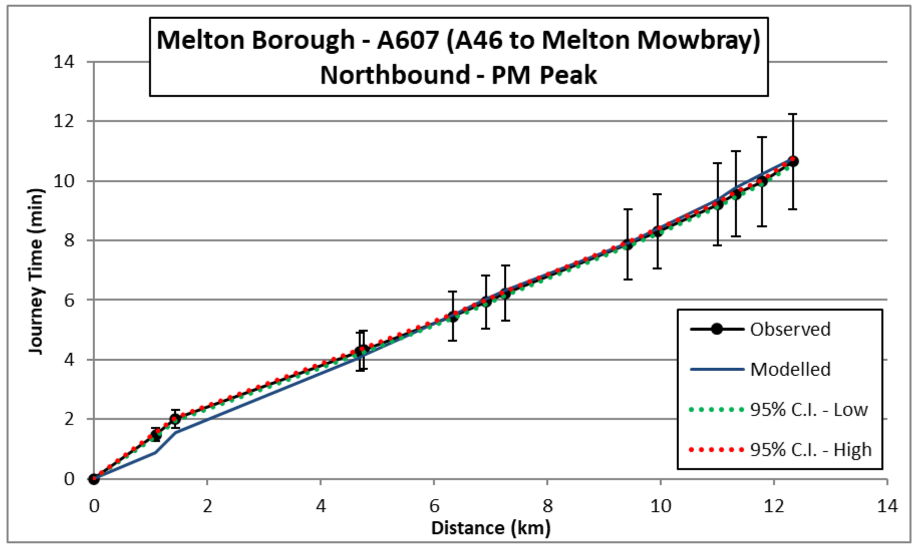
Melton Mowbray - Kirby Lane Westbound - PM Peak



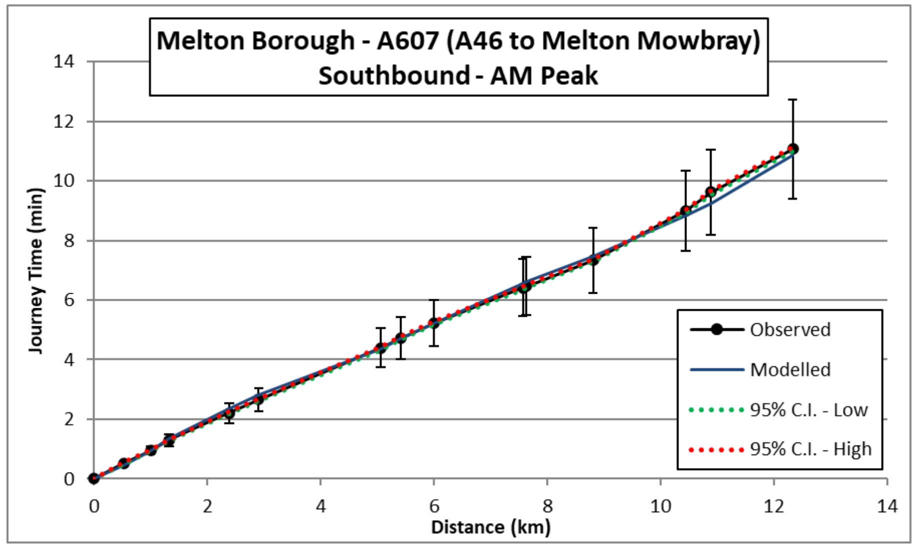
Melton Borough - A607 (A46 to Melton Mowbray) Northbound - AM Peak



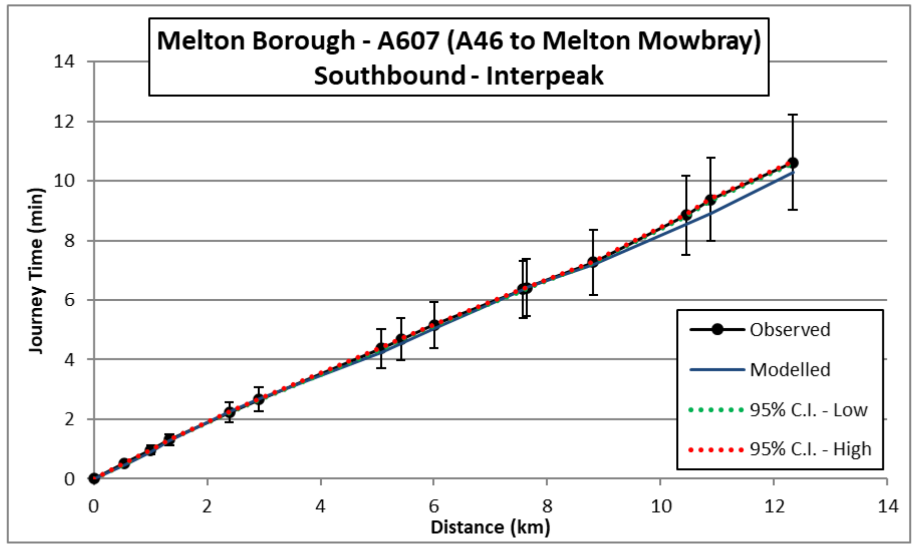
Melton Borough - A607 (A46 to Melton Mowbray) Northbound - Interpeak



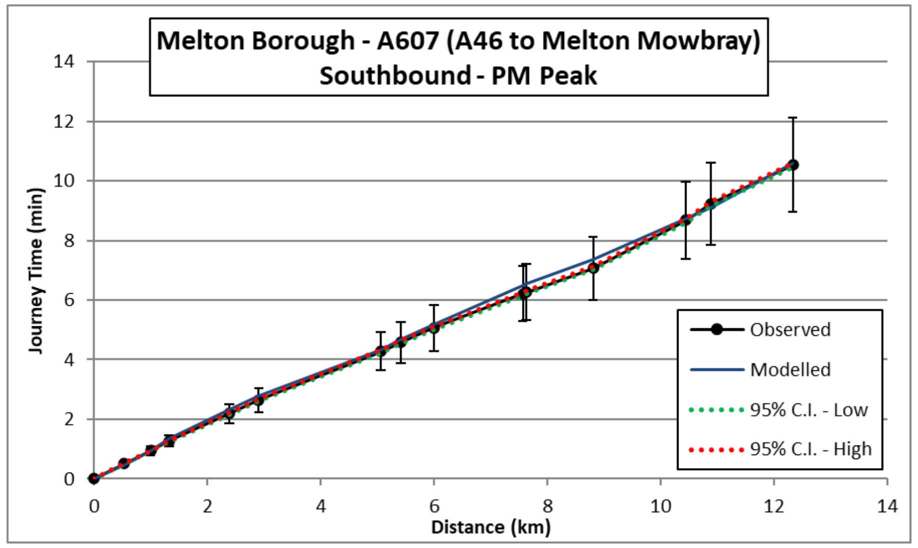
Melton Borough - A607 (A46 to Melton Mowbray) Northbound - PM Peak



Melton Borough - A607 (A46 to Melton Mowbray) Southbound - AM Peak



Melton Borough - A607 (A46 to Melton Mowbray) Southbound - Interpeak



Melton Borough - A607 (A46 to Melton Mowbray) Southbound - PM Peak

3.4 Additional Count Data – Validation Performance

3.4.1 As discussed in Paragraph 3.1.2, additional count data were provided within Melton Mowbray, and from this additional dataset 15 counts were identified and processed for use in validation of the modelled flows in the base year highway model. Two of these counts were subsequently removed due to inconsistencies between count data leaving 13 additional counts. These counts were not used as part of the original model development and use of these counts is over and above the requirements contained in TAG.

3.4.2 We would not expect, given that the counts were not used in the model development, that 85% of these locations meet TAG criteria. The local nature of these counts also introduces potential inconsistencies with the defined model zone system, whereby the counts are not located near zone boundaries and therefore the location of the centroid connector can have a significant impact on the apparent model performance.

3.4.3 It should also be recognised that these counts were undertaken during October and November 2016 and were adjusted using long-term count data to represent flows in April, May and June 2014. This adjustment will add uncertainty to the observed flows, and therefore there is an argument for relaxing the TAG criteria to account for this greater uncertainty within the observed data.

3.4.4 Therefore, based on the above comments, any comparison of modelled flows against counts should be viewed as an indication of the model’s performance and not as a measure of whether the model meets TAG guidelines or not.

3.4.5 Table 3.11, Figure 3-2, Figure 3-3, and Figure 3-4 provide a summary on the performance of the modelled flows against the additional count locations within Melton Mowbray by time period for total vehicle flows. The pass rate is 81% in the AM Peak hour, 85% in the interpeak hour and 81% in the PM Peak hour. This equates to five locations in the AM Peak hour, four locations in the interpeak hour and five locations in the PM Peak hour out of the 26 count locations which do not meet TAG criteria for individual link counts.

3.4.6 However, given comments above regarding the uncertainty surrounding this additional count data and the fact that these data were not used in the model development, this analysis does not contradict the good performance of the model against observed data presented elsewhere within this section.

3.4.7 A summary of the locations where modelled flows differ most significantly from observed counts (GEH > 7.5) is provided below.

- AM Peak, Interpeak and PM Peak: Asfordby Road, West of Nottingham Road, Westbound
    - The model underestimates flows here by approximately 125 vehicles in the AM Peak, 140 vehicles in the Interpeak, and 170 vehicles in the PM Peak. There are, however, other counts on Asfordby Road (one on the Melton Mowbray cordon to the west of the built-up area, and one near West Avenue in the town) where flows meet TAG criteria.
    - There is a relatively high level of modelled delay at the Nottingham Road / Asfordby Road signalised junction which may encourage modelled rat-running through Staveley Road and Dorothy Avenue for traffic travelling from Nottingham Road and Asfordby Road, thereby not using the affected modelled link.
- PM Peak: Nottingham Road, North of Norman Way, Southbound
    - The model underestimates flows here by approximately 220 vehicles in the PM Peak. There is another count on Nottingham Road (on the Melton Mowbray cordon) at the northern edge of the built-up area (just south of St Bartholomew’s Way) where flows meet TAG criteria. Further in towards the town centre (just south of The Crescent), however, there is another count (on the Melton Mowbray East-West Screenline (North)) where modelled flows are also approximately 220 vehicles below observed levels.
    - The underestimation is likely to at least partially be a routeing issue, the evidence for which can be seen when considering nearby counts on routes joining Nottingham Road between the aforementioned cordon count (TAG pass) and screenline count (TAG fail). In the aggregate, there is an overestimation of 80 vehicles routeing away from Nottingham

    Road on these routes, and an underestimation of approximately 60 vehicles routeing towards Nottingham Road.

- PM Peak: Scalford Road, North of Norman Way, Southbound
    - The model overestimates flows here by approximately 340 vehicles in the PM Peak. There are four further sources of count data on Scalford Road, two of which are from the “additional” count dataset, the other two of which are from the main calibration / validation dataset. From north to south, these counts are located: south of The Crescent, south of Wymondham Way, by John Ferneley College, and by Framlands Farm.
    - In the PM Peak southbound direction, all of the four further count sites meet TAG criteria apart from the one just south of The Crescent. This suggests that demand along is corridor is generally correct, however, is pushed out of TAG criteria limits in its southern section.
    - Whilst the underrepresentation along the parallel Nottingham Road (220 vehicles) is not equal in magnitude, it suggests that the discrepancy along Scalford Road is due to a misrepresentation of the relative attractiveness of these routes.
- PM Peak: Asfordby Road, West of Nottingham Road, Eastbound
    - The model underestimates flows here by approximately 215 vehicles in the PM Peak. There are, however, other counts on Asfordby Road (one on the Melton Mowbray cordon to the west of the built-up area, and one near West Avenue in the town) where flows meet TAG criteria.
    - There is a relatively high level of modelled delay at the Nottingham Road / Asfordby Road signalised junction which may encourage modelled rat-running through Staveley Road and Dorothy Avenue for traffic travelling from Nottingham Road and Asfordby Road, thereby not using the affected modelled link.

3.4.8 Whilst still recognising the observations at the start of this section about the appropriateness of the additional count data, the following relates to the implications of these validation results on scheme appraisal:

- The most significant misrepresentations of vehicle flow are focused on the central part of Melton Mowbray (particularly links leading to the Nottingham Road / Norman Way junction). The density of the road network in the town means that driver route choice can be more difficult to accurately model, particularly considering parallel competing routes with elevated levels of modelled delay. Given the nature and location of the scheme and the knowledge that the Melton Mowbray cordon meets TAG criteria in all time periods and directions, correct representation of town centre routing is less critical.
- The overall trend across the additional independent validation counts is that the model tends to underrepresent traffic in each time period for these counts, in particular within Melton Mowbray town centre. However, this should be considered in the context that these are independent validation counts with high pass rates (between 81% and 85%) as discussed in Paragraphs 3.4.5 and 3.4.6.

Figure 3-2: Additional Counts Performance – AM Peak Hour

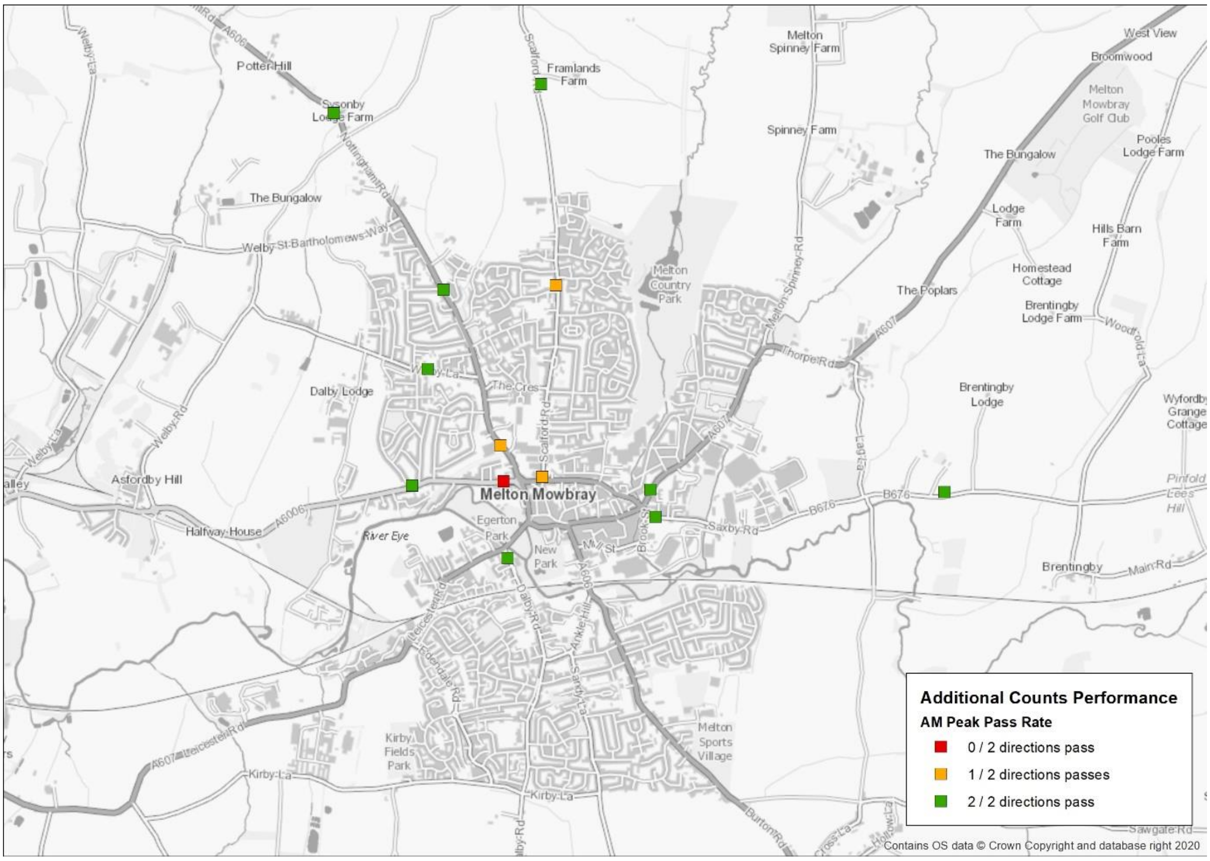


Figure 3-3: Additional Counts Performance – Interpeak Hour

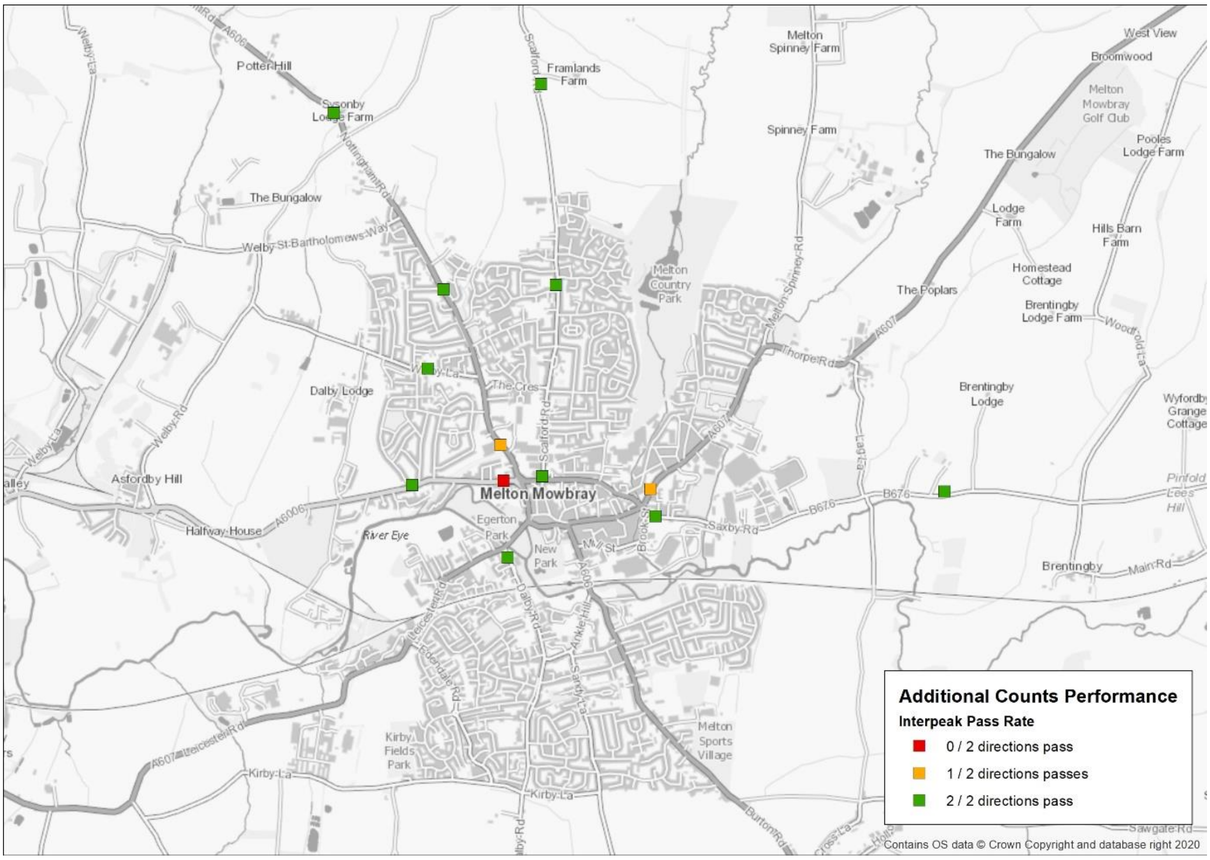


Figure 3-4: Additional Counts Performance – PM Peak Hour

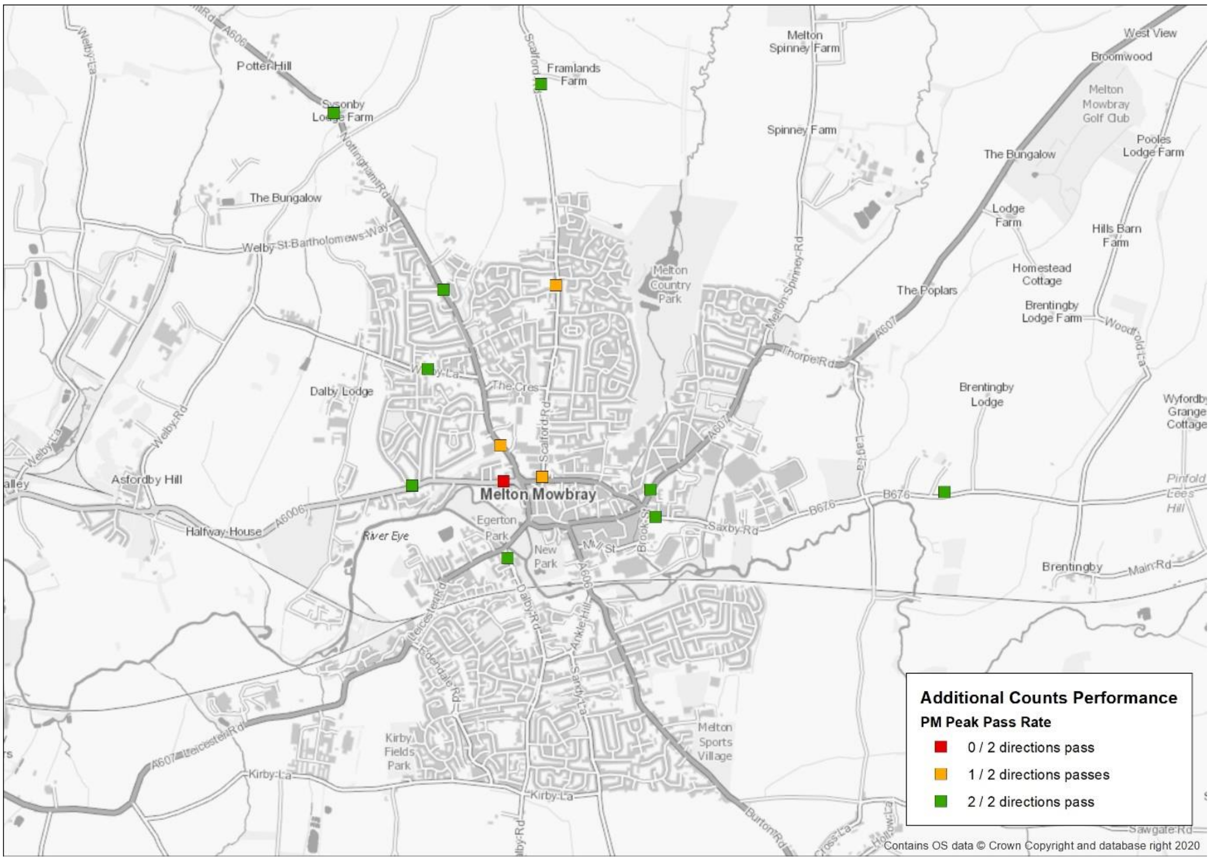


Table 3.11: FBC Model – Flow Performance against Additional Counts (Total Flows)

	AM Peak					Interpeak					PM Peak				
	Obs.	Mod.	Diff	GEH	Pass	Obs.	Mod.	Diff	GEH	Pass	Obs.	Mod.	Diff	GEH	Pass
Nottingham Road, North of St Bartholomew's Way, Northbound	402	408	6	0.3	✓	306	298	-9	0.5	✓	369	429	60	3.0	✓
Tooting Nottingham Road, South of Lynton Road, Northbound	448	366	-82	4.1	✓	359	310	-49	2.7	✓	442	454	12	0.6	✓
Nottingham Road, North of Norman Way, Northbound	473	447	-27	1.2	✓	546	453	-93	4.2	✓	692	724	32	1.2	✓
Nottingham Road, North of St Bartholomew's Way, Southbound	355	394	39	2.0	✓	294	265	-30	1.8	✓	490	506	16	0.7	✓
Nottingham Road, South of Lynton Road, Southbound	427	450	23	1.1	✓	344	325	-19	1.0	✓	548	467	-81	3.6	✓
Nottingham Road, North of Norman Way, Southbound	512	375	-137	6.5	×	455	339	-116	5.8	×	523	305	-219	10.8	×
Scalford Road, near Framland Farm, Northbound	126	112	-14	1.3	✓	85	72	-13	1.5	✓	125	76	-49	4.9	✓
Scalford Road, South of Wymondham Way, Northbound	287	251	-35	2.2	✓	218	218	0	0.0	✓	409	299	-110	5.8	×
Scalford Road, North of Norman Way, Northbound	276	351	75	4.2	✓	391	406	14	0.7	✓	581	551	-30	1.2	✓
Scalford Road, near Framland Farm, Southbound	119	131	12	1.0	✓	95	68	-27	3.0	✓	144	108	-35	3.2	✓
Scalford Road, South of Wymondham Way, Southbound	455	328	-127	6.4	×	227	220	-7	0.5	✓	336	325	-11	0.6	✓
Scalford Road, North of Norman Way, Southbound	610	809	199	7.5	×	458	506	48	2.2	✓	467	805	338	13.4	×
Thorpe Road, North of hospital, Northbound	404	330	-74	3.9	✓	460	338	-122	6.1	×	559	494	-65	2.8	✓
Thorpe Road, North of hospital, Southbound	492	492	-1	0.0	✓	447	381	-67	3.3	✓	546	467	-80	3.5	✓
Saxby Road, East of Lag Lane, Eastbound	195	151	-43	3.3	✓	147	110	-36	3.2	✓	209	185	-24	1.7	✓
Saxby Road, West of Brook Street, Eastbound	317	373	56	3.0	✓	240	286	46	2.8	✓	331	377	46	2.5	✓
Saxby Road, East of Lag Lane, Westbound	232	210	-22	1.5	✓	159	125	-33	2.8	✓	189	120	-68	5.5	✓
Saxby Road, West of Brook Street, Westbound	310	287	-23	1.3	✓	230	256	26	1.7	✓	248	270	22	1.4	✓
Dalby Road, South of Leicester Road, Northbound	300	237	-63	3.8	✓	225	143	-83	6.1	✓	288	192	-96	6.2	✓
Dalby Road, South of Leicester Road, Southbound	339	392	53	2.8	✓	327	386	59	3.1	✓	499	536	37	1.6	✓
Asfordby Road, near West Avenue, Eastbound	443	412	-31	1.5	✓	325	277	-48	2.8	✓	419	334	-85	4.4	✓
Asfordby Road, West of Nottingham Road, Eastbound	530	408	-122	5.6	×	380	256	-123	6.9	×	460	245	-215	11.4	×
Asfordby Road, near West Avenue, Westbound	312	268	-44	2.6	✓	318	255	-63	3.7	✓	450	383	-67	3.3	✓
Asfordby Road, West of Nottingham Road, Westbound	332	208	-124	7.6	×	350	208	-142	8.5	×	480	308	-172	8.7	×
Welby Road, East of Sysonby Street, Eastbound	91	69	-22	2.4	✓	95	60	-35	4.0	✓	138	66	-72	7.1	✓
Welby Road, East of Sysonby Street, Westbound	96	59	-37	4.2	✓	70	67	-3	0.3	✓	101	78	-23	2.4	✓

Section 4 – Conclusions

4.1.1 AECOM has refined and updated the LLITM 2014 Base OBC model to create a version that is suitable for supporting the scheme's Full Business Case. Specifically, this has involved:

- investigation of local routeing in Melton Mowbray (see Section 2.1);
- reviewing, analysing and debugging forecasting highway convergence issues (see Section 2.2);
- implementing the latest (July 2021) TAG data book values (see Section 2.3); and
- implementing the highway network updates (see Section 2.4).

4.1.2 The performance of the model against observed flow and journey time data in Leicestershire meets TAG guidelines for screenline flows, individual flows and journey times. Within North-East Leicestershire (largely Melton Borough) the percentage of screenlines meeting TAG criteria in a time period is at or above 93%, and the percentage of individual links meeting TAG criteria in a time period is at or above 88%. All journey time routes within North-East Leicestershire meet TAG criteria in all three time periods.

4.1.3 Given the performance of the highway model against the flow and journey time criteria contained within TAG, it is considered that the model is suitable for use in underpinning the forthcoming Full Business Case.

Appendix A – Model Wide Calibration/Validation Performance

Table A1: Screenline Performance

Screenline	AM Peak					Interpeak					PM Peak				
	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)
Leicestershire Cordon Inbound	*35,925*	*36,248*	*323*	*0.5%*	✓	*24,754*	*24,949*	*196*	*0.4%*	✓	*37,884*	*38,123*	*239*	*0.5%*	✓
Leicestershire Cordon Inbound (exc SRN counts)	*17,043*	*17,138*	*95*	*0.8%*	✓	*10,352*	*10,414*	*62*	*0.5%*	✓	*17,733*	*17,887*	*155*	*0.8%*	✓
Leicestershire Cordon Outbound	*35,926*	*35,857*	*-70*	*0.5%*	✓	*24,714*	*24,754*	*39*	*0.5%*	✓	*38,420*	*38,628*	*208*	*0.6%*	✓
Leicestershire Cordon Outbound (exc SRN counts)	*16,741*	*16,702*	*-39*	*0.8%*	✓	*10,420*	*10,405*	*-15*	*0.6%*	✓	*18,264*	*18,367*	*104*	*0.8%*	✓
Leicestershire T-Line Northbound	*22,052*	*22,340*	*288*	*1.0%*	✓	*15,901*	*16,057*	*156*	*0.8%*	✓	*21,715*	*21,425*	*-290*	*1.4%*	✓
Leicestershire T-Line Northbound (exc SRN counts)	*16,611*	*16,475*	*-136*	*1.3%*	✓	*11,535*	*11,643*	*108*	*0.9%*	✓	*15,100*	*14,949*	*-151*	*1.8%*	✓
Leicestershire T-Line Southbound	*21,829*	*21,747*	*-82*	*1.1%*	✓	*15,214*	*15,238*	*24*	*1.0%*	✓	*21,690*	*22,073*	*383*	*1.6%*	✓
Leicestershire T-Line Southbound (exc SRN counts)	*15,573*	*15,702*	*129*	*1.5%*	✓	*10,966*	*10,928*	*-38*	*1.3%*	✓	*16,127*	*16,048*	*-79*	*2.1%*	✓
Leicestershire S-Line Eastbound	*21,657*	*21,758*	*101*	*0.6%*	✓	*15,288*	*15,343*	*55*	*0.6%*	✓	*21,366*	*21,217*	*-149*	*0.9%*	✓
Leicestershire S-Line Eastbound (exc SRN counts)	*14,609*	*14,571*	*-37*	*0.6%*	✓	*10,606*	*10,688*	*82*	*0.7%*	✓	*14,527*	*14,390*	*-137*	*0.6%*	✓
Leicestershire S-Line Westbound	*21,277*	*20,764*	*-513*	*0.6%*	✓	*15,774*	*15,784*	*10*	*0.6%*	✓	*22,802*	*23,099*	*298*	*0.6%*	✓
Leicestershire S-Line Westbound (exc SRN counts)	*14,463*	*13,970*	*-494*	*0.7%*	✓	*10,901*	*10,899*	*-1*	*0.7%*	✓	*15,318*	*15,478*	*160*	*0.8%*	✓
M1 Screenline Eastbound	*23,498*	*23,458*	*-40*	*1.0%*	✓	*14,747*	*14,811*	*65*	*0.8%*	✓	*24,247*	*24,209*	*-38*	*1.0%*	✓
M1 Screenline Eastbound (exc SRN counts)	*18,933*	*18,922*	*-12*	*1.2%*	✓	*11,180*	*11,222*	*42*	*1.0%*	✓	*18,547*	*18,376*	*-171*	*1.2%*	✓
M1 Screenline Westbound	*23,081*	*23,289*	*208*	*1.0%*	✓	*14,995*	*15,049*	*54*	*0.7%*	✓	*23,635*	*23,936*	*301*	*0.8%*	✓
M1 Screenline Westbound (exc SRN counts)	*17,548*	*17,713*	*165*	*1.3%*	✓	*11,276*	*11,314*	*38*	*1.0%*	✓	*18,849*	*19,112*	*263*	*0.9%*	✓
Leicester City Inner Cordon Inbound	4,293	4,245	-48	2.0%	✓	3,114	3,208	93	1.3%	✓	3,469	3,473	4	1.5%	✓
Leicester City Inner Cordon Outbound	3,301	3,094	-208	0.8%	×	3,454	3,439	-15	0.6%	✓	4,358	4,498	140	1.2%	✓
Leicester City Middle Cordon (A563) Inbound	22,749	22,856	107	1.4%	✓	15,966	16,025	59	0.6%	✓	19,385	19,260	-126	1.2%	✓
Leicester City Middle Cordon (A563) Outbound	19,449	19,464	15	0.8%	✓	16,222	16,247	25	0.8%	✓	22,403	22,663	260	0.8%	✓
Leicester City Outer Cordon Inbound	30,400	29,990	-410	0.6%	✓	19,025	19,087	62	0.5%	✓	27,528	27,549	21	0.7%	✓
Leicester City Outer Cordon Inbound (exc SRN counts)	*18,191*	*17,785*	*-406*	*0.8%*	✓	*10,060*	*10,092*	*32*	*0.7%*	✓	*14,808*	*14,711*	*-97*	*0.8%*	✓
Leicester City Outer Cordon Outbound	25,830	26,250	420	0.5%	✓	19,191	19,299	108	0.8%	✓	30,721	30,655	-66	0.7%	✓
Leicester City Outer Cordon Outbound (exc SRN counts)	*13,553*	*13,864*	*311*	*0.7%*	✓	*10,285*	*10,358*	*73*	*1.3%*	✓	*17,851*	*17,751*	*-100*	*0.7%*	✓
Leicester City North-South Screenline (Beaumont Leys) Eastbound	2,969	2,974	5	8.5%	✓	2,834	2,835	1	2.9%	✓	3,850	3,858	8	2.6%	✓
Leicester City North-South Screenline (Beaumont Leys) Westbound	4,293	4,245	-48	6.9%	✓	2,817	2,825	8	4.7%	✓	3,392	3,362	-30	3.1%	✓
Leicester City North-South Screenline (Railway) Eastbound	2,200	2,187	-14	3.8%	✓	1,838	1,845	7	2.7%	✓	2,527	2,463	-64	1.2%	✓
Leicester City North-South Screenline (Railway) Westbound	2,412	2,339	-72	1.7%	✓	1,826	1,833	7	1.8%	✓	2,074	2,091	18	2.0%	✓
Loughborough Cordon Inbound	6,742	6,738	-4	1.4%	✓	3,441	3,457	16	1.2%	✓	4,529	4,575	46	1.3%	✓

Screenline	**AM Peak**					**Interpeak**					**PM Peak**				
	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)
Loughborough Cordon Outbound	4,123	4,158	35	1.6%	✓	3,543	3,544	1	1.5%	✓	6,317	6,343	26	1.0%	✓
Loughborough North-South Screenline (Epinal Way) Eastbound	3,728	3,691	-37	1.7%	✓	2,419	2,398	-21	1.2%	✓	2,674	2,649	-25	4.2%	✓
Loughborough North-South Screenline (Epinal Way) Westbound	2,562	2,587	25	2.3%	✓	2,492	2,487	-6	1.5%	✓	3,062	3,080	18	3.9%	✓
Loughborough North-South Screenline (A6) Eastbound	3,483	3,396	-88	1.6%	✓	2,342	2,411	69	2.2%	✓	2,620	2,787	167	2.9%	✗
Loughborough North-South Screenline (A6) Westbound	2,769	2,828	59	2.2%	✓	2,578	2,636	58	1.8%	✓	3,837	3,904	67	1.6%	✓
Loughborough East-West Screenline (Ashby Road) Northbound	2,449	2,495	46	2.8%	✓	2,135	2,208	73	1.3%	✓	2,693	2,862	169	1.6%	✗
Loughborough East-West Screenline (Ashby Road) Southbound	2,971	3,285	314	1.4%	✗	2,136	2,327	191	1.0%	✗	2,792	2,929	137	1.9%	✓
Shepshed Cordon Inbound	1,075	1,079	4	2.2%	✓	933	936	3	2.6%	✓	1,451	1,456	5	2.4%	✓
Shepshed Cordon Outbound	1,298	1,305	7	1.9%	✓	909	913	4	1.6%	✓	1,220	1,220	-1	2.2%	✓
Melton Mowbray Cordon Inbound	3,235	3,179	-56	1.9%	✓	2,125	2,137	12	1.4%	✓	3,184	3,099	-85	1.7%	✓
Melton Mowbray Cordon Outbound	3,054	2,949	-105	1.5%	✓	2,200	2,202	2	1.4%	✓	2,920	2,864	-56	1.6%	✓
Melton Mowbray North-South Screenline (Nottingham Road) Eastbound	1,044	1,267	224	3.2%	✗	930	1,028	97	1.4%	✓	1,266	1,344	78	1.8%	✓
Melton Mowbray North-South Screenline (Nottingham Road) Westbound	1,430	1,489	58	2.9%	✓	1,231	1,252	22	1.7%	✓	1,556	1,576	20	1.5%	✓
Melton Mowbray North-South Screenline (Dalby Road) Eastbound	1,107	1,112	5	2.7%	✓	756	758	1	2.0%	✓	1,054	1,047	-7	2.0%	✓
Melton Mowbray North-South Screenline (Dalby Road) Westbound	944	961	17	1.8%	✓	792	795	2	2.1%	✓	1,049	1,063	14	2.8%	✓
Melton Mowbray East-West Screenline (River) Northbound	1,554	1,667	113	8.7%	✓	1,192	1,237	46	1.9%	✓	1,526	1,486	-40	3.1%	✓
Melton Mowbray East-West Screenline (River) Southbound	1,494	1,476	-18	5.4%	✓	1,301	1,333	31	2.0%	✓	1,686	1,761	75	4.4%	✓
Melton Mowbray East-West Screenline (South) Northbound	1,846	1,752	-94	2.7%	✓	1,277	1,231	-47	2.2%	✓	1,830	1,784	-46	3.1%	✓
Melton Mowbray East-West Screenline (South) Southbound	1,716	1,697	-19	2.0%	✓	1,333	1,319	-13	2.0%	✓	1,788	1,741	-47	2.7%	✓
Melton Mowbray East-West Screenline (North) Northbound	1,031	1,014	-17	2.4%	✓	1,138	1,122	-16	2.4%	✓	1,728	1,680	-48	1.7%	✓
Melton Mowbray East-West Screenline (North) Southbound	1,759	1,712	-47	1.7%	✓	1,092	1,081	-11	1.5%	✓	1,451	1,438	-14	3.0%	✓
Market Harborough Cordon Inbound	2,724	2,724	-0	0.8%	✓	1,882	1,788	-94	0.9%	✓	2,748	2,543	-205	0.9%	✗
Market Harborough Cordon Outbound	2,425	2,211	-213	0.9%	✗	1,904	1,838	-66	0.9%	✓	3,000	2,955	-44	0.9%	✓
Market Harborough North-South Screenline (Leicester Road) Eastbound	1,730	1,677	-53	1.5%	✓	1,408	1,330	-78	0.9%	✓	1,765	1,758	-7	1.5%	✓
Market Harborough North-South Screenline (Leicester Road) Westbound	1,538	1,468	-70	2.1%	✓	1,234	1,115	-119	1.4%	✗	1,533	1,444	-89	2.1%	✓
Market Harborough North-South Screenline (Railway) Eastbound	826	918	92	12.9%	✓	651	756	105	1.8%	✗	1,011	1,105	94	4.7%	✓
Market Harborough North-South Screenline (Railway) Westbound	795	878	83	10.0%	✓	641	696	55	1.8%	✓	862	939	77	6.6%	✓
Market Harborough East-West Screenline (A4304) Northbound	1,351	1,343	-8	9.9%	✓	1,154	1,151	-4	1.4%	✓	1,532	1,519	-13	5.8%	✓
Market Harborough East-West Screenline (A4304) Southbound	1,239	1,231	-8	5.1%	✓	980	972	-9	2.4%	✓	1,250	1,238	-12	2.6%	✓
Lutterworth Cordon Inbound	4,108	4,190	82	2.3%	✓	2,487	2,466	-21	2.5%	✓	3,920	3,899	-21	2.1%	✓
Lutterworth Cordon Outbound	3,813	3,716	-97	1.9%	✓	2,442	2,431	-11	2.1%	✓	4,107	4,106	-1	1.4%	✓
Lutterworth North-South Screenline Eastbound	970	969	-1	1.8%	✓	644	658	14	2.4%	✓	1,002	1,000	-2	2.8%	✓
Lutterworth North-South Screenline Westbound	923	939	16	1.5%	✓	630	641	11	2.3%	✓	1,040	1,034	-6	2.5%	✓
Lutterworth East-West Screenline Northbound	1,067	1,125	59	1.2%	✓	818	870	52	2.6%	✓	1,557	1,447	-111	4.5%	✓
Lutterworth East-West Screenline Southbound	1,385	1,373	-12	1.4%	✓	738	770	33	1.3%	✓	1,001	1,096	94	1.8%	✓

Screenline	**AM Peak**					**Interpeak**					**PM Peak**				
	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)
Hinckley Outer Cordon Inbound	5,342	5,333	-9	1.3%	✓	3,886	3,869	-17	1.2%	✓	6,384	6,389	5	1.3%	✓
Hinckley Outer Cordon Outbound	5,485	5,483	-2	1.4%	✓	3,782	3,780	-3	1.0%	✓	5,312	5,337	26	1.1%	✓
Hinckley Inner Cordon Inbound	4,591	4,733	141	1.5%	✓	3,193	3,222	29	1.0%	✓	3,892	3,919	27	1.9%	✓
Hinckley Inner Cordon Outbound	3,235	3,324	89	2.2%	✓	3,187	3,220	32	1.2%	✓	4,420	4,546	126	2.4%	✓
Hinckley North-South Screenline (South) Eastbound	821	766	-55	2.5%	✓	581	623	42	2.0%	✓	913	1,099	187	3.1%	✗
Hinckley North-South Screenline (South) Westbound	820	875	55	2.3%	✓	567	500	-67	1.8%	✓	907	898	-9	1.8%	✓
Hinckley East-West Screenline (South) Northbound	1,492	1,494	2	1.7%	✓	1,083	1,086	3	2.8%	✓	1,910	1,945	35	2.3%	✓
Hinckley East-West Screenline (South) Southbound	1,710	1,714	4	2.6%	✓	1,044	1,050	5	1.5%	✓	1,608	1,603	-5	2.1%	✓
Barwell Cordon Inbound	1,477	1,404	-74	2.0%	✓	1,388	1,356	-32	1.6%	✓	2,176	2,127	-48	1.3%	✓
Barwell Cordon Outbound	1,901	1,877	-23	1.8%	✓	1,355	1,317	-38	1.0%	✓	1,750	1,657	-93	1.5%	✓
Earl Shilton Cordon Inbound	907	890	-17	2.8%	✓	880	878	-2	2.1%	✓	1,539	1,612	73	2.6%	✓
Earl Shilton Cordon Outbound	1,361	1,345	-16	2.3%	✓	853	853	0	1.4%	✓	1,093	1,065	-28	2.6%	✓
Coalville-Whitwick Cordon Inbound	7,160	7,136	-24	1.0%	✓	4,096	4,069	-27	1.5%	✓	6,541	6,526	-15	1.0%	✓
Coalville-Whitwick Cordon Outbound	5,888	5,875	-13	1.1%	✓	4,153	4,130	-22	1.4%	✓	7,252	7,222	-30	0.9%	✓
Coalville Inner Cordon Inbound	2,128	2,121	-7	1.9%	✓	1,862	1,851	-11	1.3%	✓	2,418	2,403	-14	1.9%	✓
Coalville Inner Cordon Outbound	2,176	2,168	-8	1.7%	✓	1,865	1,856	-9	1.1%	✓	2,212	2,196	-15	1.6%	✓
Coalville East-West Screenline (A511) Northbound	1,353	1,332	-22	1.5%	✓	1,178	1,088	-90	1.9%	✓	1,869	1,853	-17	1.5%	✓
Coalville East-West Screenline (A511) Southbound	1,742	1,744	2	1.8%	✓	1,125	1,093	-32	1.9%	✓	1,353	1,359	6	2.6%	✓
Ibstock Cordon Inbound	1,673	1,667	-5	1.8%	✓	1,098	1,092	-5	2.8%	✓	2,095	2,079	-17	2.5%	✓
Ibstock Cordon Outbound	1,992	1,989	-3	1.8%	✓	1,067	1,061	-6	2.0%	✓	1,853	1,835	-17	1.9%	✓
Ashby Cordon Inbound	2,355	2,361	6	0.9%	✓	1,486	1,489	3	1.2%	✓	2,429	2,437	8	1.3%	✓
Ashby Cordon Outbound	2,211	2,219	8	0.9%	✓	1,514	1,517	3	1.2%	✓	2,295	2,300	5	1.2%	✓
Ashby North-South Screenline (Smisby Road) Eastbound	1,441	1,443	2	3.0%	✓	925	930	4	1.7%	✓	1,156	1,166	10	2.4%	✓
Ashby North-South Screenline (Smisby Road) Westbound	1,002	1,003	1	4.5%	✓	846	845	-1	2.0%	✓	1,506	1,490	-16	2.7%	✓
Ashby East-West Screenline (Burton Road) Northbound	308	335	27	4.8%	✓	232	251	19	3.7%	✓	444	458	13	5.1%	✓
Ashby East-West Screenline (Burton Road) Southbound	426	442	16	3.3%	✓	234	257	24	3.1%	✓	426	467	41	5.8%	✓
Ashby East-West Screenline (Railway) Northbound	1,092	969	-123	3.0%	✗	564	520	-44	4.3%	✓	959	816	-143	5.0%	✗
Ashby East-West Screenline (Railway) Southbound	846	722	-125	2.0%	✗	588	543	-46	3.4%	✓	1,055	967	-87	4.0%	✓
Melton Borough A606 Screenline North-Eastbound	1,280	1,185	-95	2.9%	✓	808	806	-3	2.1%	✓	1,107	1,078	-29	3.3%	✓
Melton Borough A606 Screenline South-Westbound	1,180	1,155	-25	2.9%	✓	799	785	-14	2.5%	✓	1,248	1,187	-60	3.8%	✓
Melton-Charnwood North-South Screenline Eastbound	4,335	4,128	-207	1.4%	✓	2,720	2,667	-53	1.2%	✓	4,899	4,647	-252	2.1%	✗
Melton-Charnwood North-South Screenline Eastbound (exc SRN counts)	*2,989*	*2,744*	*-245*	*1.5%*	*✗*	*1,798*	*1,727*	*-72*	*1.4%*	*✓*	*2,994*	*2,731*	*-263*	*1.6%*	*✗*
Melton-Charnwood North-South Screenline Westbound	4,788	4,445	-342	1.3%	✗	2,737	2,717	-20	1.0%	✓	4,351	4,281	-70	1.1%	✓
Melton-Charnwood North-South Screenline Westbound (exc SRN counts)	*2,900*	*2,665*	*-235*	*1.4%*	*✗*	*1,860*	*1,799*	*-62*	*1.3%*	*✓*	*2,950*	*2,748*	*-202*	*1.5%*	*✗*
Harborough District North-South Screenline (A5199) Eastbound	1,306	1,096	-210	3.4%	✗	785	792	7	2.9%	✓	1,663	1,483	-180	2.4%	✗
Harborough District North-South Screenline (A5199) Westbound	1,844	1,646	-198	2.0%	✗	785	805	20	4.0%	✓	1,267	1,176	-91	2.5%	✓

Screenline	**AM Peak**					**Interpeak**					**PM Peak**				
	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)
Harborough District North-South Screenline (Great Glen) Eastbound	1,165	1,202	38	1.7%	✓	696	714	18	2.1%	✓	1,175	1,188	13	2.0%	✓
Harborough District North-South Screenline (Great Glen) Westbound	1,189	1,206	17	2.3%	✓	726	745	19	2.4%	✓	1,268	1,285	17	1.9%	✓
Harborough District East-West Screenline Northbound	9,990	9,831	-159	0.7%	✓	7,233	7,228	-5	1.0%	✓	11,629	11,799	170	1.2%	✓
Harborough District East-West Screenline Northbound (exc SRN counts)	*4,255*	*4,274*	*19*	*1.4%*	✓	*2,789*	*2,807*	*18*	*1.6%*	✓	*5,300*	*5,439*	*139*	*1.7%*	✓
Harborough District East-West Screenline Southbound	10,668	10,902	234	0.9%	✓	6,942	6,999	57	0.8%	✓	10,220	10,234	14	1.1%	✓
Harborough District East-West Screenline Southbound (exc SRN counts)	*4,602*	*4,609*	*7*	*1.4%*	✓	*2,682*	*2,694*	*11*	*1.4%*	✓	*4,290*	*4,268*	*-22*	*1.6%*	✓
Hinckley-NW Leics Screenline North-Eastbound	3,736	3,777	40	2.5%	✓	2,806	2,845	39	2.5%	✓	4,246	4,309	63	3.2%	✓
Hinckley-NW Leics Screenline North-Eastbound (exc SRN counts)	*1,433*	*1,428*	*-4*	*3.1%*	✓	*985*	*991*	*6*	*3.1%*	✓	*1,938*	*1,973*	*35*	*2.1%*	✓
Hinckley-NW Leics Screenline South-Westbound	3,939	3,986	47	1.6%	✓	2,703	2,770	68	1.1%	✓	3,745	3,764	20	1.9%	✓
Hinckley-NW Leics Screenline South-Westbound (exc SRN counts)	*1,857*	*1,859*	*2*	*2.1%*	✓	*955*	*962*	*7*	*2.1%*	✓	*1,452*	*1,472*	*21*	*3.6%*	✓
Nuneaton Cordon Inbound	5,887	5,898	11	1.8%	✓	4,527	4,532	5	1.5%	✓	8,037	8,061	24	1.5%	✓
Nuneaton Cordon Outbound	6,670	6,688	18	1.7%	✓	4,435	4,451	16	1.1%	✓	5,796	5,878	82	2.1%	✓
Northern Rugby Screenline Northbound	2,244	2,230	-13	2.1%	✓	1,428	1,434	6	2.8%	✓	2,594	2,511	-83	1.5%	✓
Northern Rugby Screenline Southbound	2,612	2,615	3	2.1%	✓	1,370	1,362	-8	1.9%	✓	2,282	2,235	-47	2.4%	✓
Tamworth Counts Northbound	672	683	10	2.1%	✓	535	521	-14	4.1%	✓	1,330	1,305	-25	3.4%	✓
Tamworth Counts Southbound	1,234	1,133	-102	3.7%	✓	525	520	-5	2.6%	✓	807	801	-6	7.9%	✓
Burton Counts Eastbound	1,267	1,276	9	1.9%	✓	1,168	1,169	2	2.9%	✓	1,689	1,680	-9	4.7%	✓
Burton Counts Westbound	1,519	1,505	-13	2.8%	✓	1,163	1,165	1	1.7%	✓	1,641	1,652	11	5.3%	✓
Nottingham Counts Northbound	3,868	4,023	155	1.4%	✓	2,977	3,016	39	1.2%	✓	4,698	4,743	45	1.2%	✓
Nottingham Counts Southbound	4,213	4,249	36	1.3%	✓	2,990	3,007	17	1.9%	✓	4,766	5,078	311	1.1%	✓
M1 Calibration Northbound	18,149	18,004	-146	0.4%	✓	15,370	15,356	-14	0.9%	✓	20,495	20,666	171	1.0%	✓
M1 Calibration Southbound	19,536	19,998	462	0.8%	✓	14,746	14,909	163	0.5%	✓	18,669	18,567	-102	0.9%	✓
M1 Validation Northbound	17,759	18,686	927	0.5%	✓	14,980	15,525	545	0.9%	✓	20,121	20,556	434	1.1%	✓
M1 Validation Southbound	19,499	19,827	327	0.8%	✓	14,751	15,142	392	0.6%	✓	18,879	19,113	234	1.0%	✓
M69 Calibration Northbound	4,259	4,292	33	0.8%	✓	3,410	3,482	72	1.0%	✓	5,940	5,852	-88	1.5%	✓
M69 Calibration Southbound	5,684	5,674	-10	1.0%	✓	3,250	3,285	35	0.8%	✓	4,894	4,951	57	1.0%	✓
M69 Validation Northbound	1,970	2,053	83	1.3%	✓	1,534	1,534	-0	1.7%	✓	2,521	2,245	-275	1.9%	✓
M69 Validation Southbound	2,495	2,294	-201	1.7%	✓	1,470	1,422	-49	1.1%	✓	2,127	2,079	-49	1.6%	✓
M42-A42 Calibration Northbound	6,739	6,882	143	1.4%	✓	5,452	5,586	134	1.5%	✓	6,983	7,086	103	2.1%	✓
M42-A42 Calibration Southbound	6,506	6,551	44	1.4%	✓	5,266	5,378	112	0.7%	✓	6,769	6,703	-66	1.2%	✓
M42-A42 Validation Northbound	7,241	7,307	66	0.7%	✓	5,895	6,062	168	1.2%	✓	7,900	7,670	-231	1.4%	✓
M42-A42 Validation Southbound	6,867	6,900	33	1.6%	✓	5,612	5,861	249	0.6%	✓	7,071	6,873	-198	1.2%	✓
A46 Calibration Northbound	7,425	7,310	-116	0.9%	✓	4,977	4,987	10	1.2%	✓	9,753	9,817	63	1.8%	✓
A46 Calibration Southbound	9,269	9,455	186	1.0%	✓	4,930	5,017	87	0.7%	✓	7,577	7,771	194	0.8%	✓
A46 Validation Northbound	5,875	6,079	204	1.1%	✓	4,051	4,185	134	1.5%	✓	8,049	8,091	42	2.0%	✓
A46 Validation Southbound	7,780	7,795	15	1.2%	✓	3,888	4,096	208	0.7%	✓	5,970	6,273	303	0.7%	✓
A5 Calibration North-Westbound	4,764	4,734	-30	0.7%	✓	3,424	3,410	-14	0.9%	✓	5,369	5,345	-24	0.8%	✓

Screenline	**AM Peak**					**Interpeak**					**PM Peak**				
	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)	Observed	Modelled	Diff.	ScnLine 95% C.I.	ScnLine (inc 95% C.I.)
A5 Calibration South-Eastbound	4,903	4,869	-34	0.9%	✓	3,322	3,086	-236	0.9%	✓	5,008	5,004	-4	0.7%	✓
A5 Validation North-Westbound	2,537	2,584	47	0.8%	✓	1,787	1,819	32	0.9%	✓	2,779	2,724	-56	0.8%	✓
A5 Validation South-Eastbound	2,679	2,619	-61	0.7%	✓	1,751	1,716	-35	0.9%	✓	2,624	2,717	93	0.8%	✓
A453 Calibration North-Eastbound	1,476	1,450	-25	2.7%	✓	1,371	1,368	-3	2.1%	✓	1,943	1,717	-225	3.6%	✓
A453 Calibration South-Westbound	1,186	1,162	-24	1.4%	✓	1,072	1,071	-1	1.1%	✓	931	937	5	2.2%	✓
M6 Calibration Northbound	3,375	3,726	351	1.6%	✓	2,712	2,919	207	1.3%	✓	3,295	3,386	90	2.3%	✓
M6 Calibration Southbound	3,071	2,993	-79	2.2%	✓	2,574	2,706	132	1.6%	✓	3,397	3,558	162	1.7%	✓
A50 Calibration North-Westbound	2,941	2,918	-23	1.0%	✓	1,806	1,798	-8	2.0%	✓	3,261	3,258	-3	1.9%	✓
A50 Calibration South-Eastbound	2,752	2,744	-8	1.1%	✓	1,702	1,682	-20	1.6%	✓	2,656	2,659	2	1.2%	✓
A14 Calibration Eastbound	3,437	3,431	-6	1.9%	✓	2,742	2,750	9	1.1%	✓	3,642	3,658	16	1.7%	✓
A14 Calibration Westbound	3,474	3,546	72	1.6%	✓	2,792	2,815	24	1.2%	✓	3,328	3,360	32	2.0%	✓
A52 Calibration Eastbound	891	894	3	1.5%	✓	830	822	-8	1.7%	✓	1,273	1,423	150	0.9%	✓
A52 Calibration Westbound	1,003	1,011	8	1.2%	✓	828	829	1	0.7%	✓	1,051	1,046	-6	2.1%	✓

Table A2: Journey Time Route Performance

		AM Peak					Interpeak					PM Peak				
Location	**Route**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**
Leicester City	A47 Thurnby Inbound	15:03	13:12	-01:52	-12.4%	✓	12:03	12:26	00:22	3.1%	✓	12:15	12:52	00:37	5.1%	✓
Leicester City	A47 Thurnby Outbound	13:03	13:45	00:42	5.3%	✓	12:34	13:10	00:36	4.7%	✓	16:00	15:11	-00:49	-5.1%	✓
Leicester City	A607 Thurmaston Inbound	13:27	15:01	01:34	11.6%	✓	12:41	12:00	-00:41	-5.4%	✓	12:57	13:28	00:31	4.0%	✓
Leicester City	A607 Thurmaston Outbound	11:47	12:48	01:01	8.6%	✓	12:19	12:03	-00:16	-2.2%	✓	14:36	14:32	-00:04	-0.4%	✓
Leicester City	A6 Birstall Inbound	15:14	14:44	-00:30	-3.3%	✓	10:30	11:03	00:32	5.2%	✓	11:33	12:30	00:57	8.2%	✓
Leicester City	A6 Birstall Outbound	10:47	10:58	00:11	1.6%	✓	09:50	10:47	00:57	9.7%	✓	12:37	13:04	00:28	3.6%	✓
Leicester City	B5327 Anstey Inbound	10:17	08:45	-01:32	-15.0%	✓	05:50	06:46	00:56	16.0%	✓	06:22	07:19	00:57	14.9%	✓
Leicester City	B5327 Anstey Outbound	06:15	06:39	00:24	6.3%	✓	06:03	06:28	00:25	6.8%	✓	07:59	07:40	-00:19	-4.0%	✓
Leicester City	A50 Groby Inbound	15:18	10:27	-04:51	-31.7%	×	08:31	08:48	00:17	3.3%	✓	11:29	09:53	-01:37	-14.0%	✓
Leicester City	A50 Groby Outbound	08:24	09:37	01:13	14.4%	✓	08:01	08:46	00:45	9.3%	✓	12:13	10:15	-01:58	-16.1%	×
Leicester City	A47 Leicester Forest East Inbound	17:38	15:44	-01:54	-10.8%	✓	11:04	12:21	01:17	11.7%	✓	13:46	14:24	00:39	4.7%	✓
Leicester City	A47 Leicester Forest East Outbound	13:09	16:06	02:57	22.4%	×	11:34	12:10	00:35	5.1%	✓	15:37	17:16	01:39	10.6%	✓
Leicester City	A5460 Enderby Inbound	18:29	14:57	-03:31	-19.1%	×	11:48	13:02	01:13	10.4%	✓	13:28	13:53	00:25	3.2%	✓
Leicester City	A5460 Enderby Outbound	15:00	14:13	-00:47	-5.2%	✓	11:28	12:43	01:15	10.9%	✓	15:45	13:29	-02:17	-14.4%	✓
Leicester City	A426 Blaby Inbound	18:09	16:12	-01:57	-10.7%	✓	10:01	13:05	03:04	30.5%	×	12:34	11:32	-01:02	-8.2%	✓
Leicester City	A426 Blaby Outbound	13:04	13:56	00:52	6.6%	✓	10:41	13:41	03:01	28.2%	×	16:10	15:47	-00:23	-2.4%	✓
Leicester City	Saffron Lane Inbound	11:43	11:44	00:01	0.2%	✓	07:53	08:55	01:02	13.0%	✓	08:32	09:13	00:41	8.0%	✓
Leicester City	Saffron Lane Outbound	09:52	09:43	-00:09	-1.5%	✓	08:27	09:26	00:59	11.6%	✓	12:21	10:35	-01:46	-14.4%	✓
Leicester City	A5199 Wigston Inbound	12:23	14:09	01:46	14.3%	✓	08:44	09:37	00:53	10.0%	✓	09:34	10:11	00:37	6.5%	✓
Leicester City	A5199 Wigston Outbound	09:48	09:54	00:06	1.0%	✓	09:10	09:40	00:30	5.5%	✓	11:05	12:29	01:23	12.5%	✓
Leicester City	A6 Oadby Inbound	18:29	19:07	00:39	3.5%	✓	12:45	13:44	00:59	7.7%	✓	15:10	14:39	-00:32	-3.5%	✓
Leicester City	A6 Oadby Outbound	12:24	13:43	01:19	10.6%	✓	11:52	12:55	01:02	8.8%	✓	15:56	16:06	00:09	1.0%	✓
Leicester City	A594 IRR Clockwise	15:31	15:28	-00:03	-0.3%	✓	12:44	14:11	01:27	11.5%	✓	15:59	15:01	-00:58	-6.1%	✓
Leicester City	A594 IRR Anti-Clockwise	12:29	12:21	-00:08	-1.1%	✓	10:20	11:09	00:50	8.0%	✓	12:43	11:54	-00:49	-6.5%	✓
Leicester City	A563 ORR1 Clockwise	18:33	18:03	-00:31	-2.7%	✓	11:25	15:06	03:41	32.3%	×	13:42	15:55	02:13	16.2%	×
Leicester City	A563 ORR1 Anti-Clockwise	16:07	16:07	00:01	0.1%	✓	11:12	14:14	03:03	27.2%	×	21:30	17:26	-04:04	-18.9%	×
Leicester City	A563 ORR2 Clockwise	14:45	13:14	-01:31	-10.3%	✓	11:53	12:59	01:06	9.3%	✓	15:24	14:07	-01:17	-8.3%	✓
Leicester City	A563 ORR2 Anti-Clockwise	14:08	14:42	00:34	4.0%	✓	10:52	12:14	01:22	12.5%	✓	12:47	13:44	00:56	7.4%	✓
Leicester City	A563 ORR3 Clockwise	12:53	13:21	00:28	3.6%	✓	11:15	12:30	01:15	11.1%	✓	15:46	14:30	-01:17	-8.1%	✓
Leicester City	A563 ORR3 Anti-Clockwise	13:05	14:42	01:38	12.4%	✓	11:07	13:08	02:01	18.1%	×	11:28	13:19	01:51	16.1%	×
Leicester City	Fullhurst Clockwise	17:16	16:44	-00:32	-3.1%	✓	13:47	15:35	01:48	13.1%	✓	16:01	17:38	01:38	10.2%	✓
Leicester City	Fullhurst Anti-Clockwise	15:51	17:37	01:46	11.1%	✓	13:52	15:27	01:35	11.4%	✓	18:18	18:08	-00:11	-1.0%	✓
Loughborough	A512 Ashby Road Eastbound	11:57	11:09	-00:48	-6.6%	✓	08:58	09:46	00:47	8.8%	✓	11:23	10:13	-01:10	-10.3%	✓
Loughborough	A512 Ashby Road Westbound	09:36	10:02	00:26	4.6%	✓	09:02	10:48	01:46	19.5%	×	12:43	11:40	-01:04	-8.3%	✓
Loughborough	Old Ashby Road / Alan Moss Road Eastbound	08:55	09:53	00:58	10.8%	✓	08:13	09:12	00:59	12.1%	✓	12:04	10:57	-01:07	-9.2%	✓
Loughborough	Old Ashby Road / Alan Moss Road Westbound	09:18	09:00	-00:18	-3.2%	✓	07:46	08:48	01:02	13.3%	✓	08:25	10:48	02:23	28.4%	×
Loughborough	Forest Road Eastbound	10:27	08:55	-01:31	-14.6%	✓	06:56	07:28	00:32	7.7%	✓	07:04	07:53	00:49	11.5%	✓
Loughborough	Forest Road Westbound	07:23	07:40	00:17	3.8%	✓	06:08	06:59	00:51	13.9%	✓	09:31	08:56	-00:35	-6.2%	✓
Loughborough	A6 north of Inner Relief Road Northbound	04:37	05:10	00:33	12.1%	✓	04:47	04:53	00:07	2.3%	✓	05:51	05:03	-00:49	-13.9%	✓
Loughborough	A6 north of Inner Relief Road Southbound	05:26	05:59	00:33	10.1%	✓	04:36	04:40	00:05	1.7%	✓	04:55	05:39	00:44	15.0%	✓
Loughborough	A6 south of Inner Relief Road Northbound	06:08	05:34	-00:34	-9.3%	✓	03:39	04:33	00:54	24.7%	✓	04:04	04:09	00:06	2.3%	✓
Loughborough	A6 south of Inner Relief Road Southbound	03:49	03:52	00:02	1.1%	✓	03:22	03:37	00:15	7.6%	✓	04:28	04:31	00:03	1.1%	✓
Loughborough	A6004 Epinal Way Northbound	11:26	09:31	-01:55	-16.8%	×	08:38	08:43	00:06	1.1%	✓	09:56	09:39	-00:17	-2.9%	✓
Loughborough	A6004 Epinal Way Southbound	09:13	09:32	00:19	3.4%	✓	08:15	08:02	-00:13	-2.7%	✓	11:23	09:44	-01:38	-14.4%	✓

		AM Peak					Interpeak					PM Peak				
Location	**Route**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**
Loughborough	New King Street / Queen's Road Eastbound	04:31	05:17	00:46	16.8%	✓	04:08	04:48	00:40	16.1%	✓	04:59	07:00	02:01	40.5%	×
Loughborough	New King Street / Queen's Road Westbound	06:16	08:03	01:47	28.5%	×	04:26	05:23	00:56	21.2%	✓	05:23	06:00	00:37	11.4%	✓
Charnwood	A6 (A46 to Loughborough) Northbound	05:56	05:50	-00:06	-1.6%	✓	05:40	05:43	00:03	0.7%	✓	05:36	05:54	00:19	5.5%	✓
Charnwood	A6 (A46 to Loughborough) Southbound	06:05	05:53	-00:11	-3.1%	✓	05:53	05:41	-00:12	-3.4%	✓	05:30	05:49	00:19	5.8%	✓
Charnwood	A6 (Loughborough to M1) Northbound	12:08	11:57	-00:11	-1.5%	✓	10:27	10:15	-00:12	-1.9%	✓	17:43	14:52	-02:52	-16.1%	×
Charnwood	A6 (Loughborough to M1) Southbound	11:28	11:39	00:12	1.7%	✓	09:40	10:01	00:21	3.7%	✓	10:42	11:01	00:18	2.9%	✓
Melton Mowbray	A606 Nottingham Road / Burton Road Northbound	09:04	08:52	-00:13	-2.3%	✓	08:30	08:13	-00:17	-3.3%	✓	09:52	10:05	00:13	2.2%	✓
Melton Mowbray	A606 Nottingham Road / Burton Road Southbound	11:05	11:51	00:47	7.0%	✓	10:28	11:11	00:42	6.7%	✓	11:24	11:32	00:08	1.2%	✓
Melton Mowbray	A607 Leicester Road / Thorpe Road Northbound	11:02	10:41	-00:20	-3.0%	✓	10:13	10:42	00:28	4.6%	✓	11:04	11:18	00:15	2.2%	✓
Melton Mowbray	A607 Leicester Road / Thorpe Road Southbound	10:31	09:42	-00:49	-7.7%	✓	09:08	09:10	00:02	0.4%	✓	09:50	10:32	00:42	7.0%	✓
Melton Mowbray	A6006 to Saxby Road (via Ankle Hill) Eastbound	14:53	13:21	-01:33	-10.4%	✓	12:51	13:05	00:15	1.9%	✓	14:43	13:14	-01:30	-10.1%	✓
Melton Mowbray	A6006 to Saxby Road (via Ankle Hill) Westbound	13:37	12:45	-00:52	-6.3%	✓	12:42	12:34	-00:08	-1.0%	✓	14:11	12:44	-01:28	-10.3%	✓
Melton Mowbray	Dalby Road / Scalford Road Northbound	09:41	08:38	-01:03	-10.9%	✓	07:50	08:15	00:25	5.4%	✓	09:25	09:16	-00:09	-1.6%	✓
Melton Mowbray	Dalby Road / Scalford Road Southbound	07:44	07:47	00:03	0.6%	✓	06:52	07:29	00:37	9.0%	✓	06:56	07:55	00:59	14.3%	✓
Melton Mowbray	Kirby Lane Eastbound	05:10	05:07	-00:03	-0.9%	✓	04:57	05:06	00:09	3.1%	✓	05:07	05:08	00:00	0.1%	✓
Melton Mowbray	Kirby Lane Westbound	04:58	05:09	00:12	3.9%	✓	04:53	05:08	00:15	5.1%	✓	05:08	05:10	00:02	0.7%	✓
Melton Borough	A607 (A46 to Melton Mowbray) Northbound	11:09	10:46	-00:23	-3.4%	✓	10:27	10:18	-00:09	-1.5%	✓	10:39	10:44	00:05	0.8%	✓
Melton Borough	A607 (A46 to Melton Mowbray) Southbound	11:04	10:51	-00:13	-2.0%	✓	10:37	10:18	-00:19	-3.0%	✓	10:32	10:36	00:04	0.7%	✓
Market Harborough	A4303 (Rockingham Road / Lubenham Hill) Eastbound	10:40	11:18	00:37	5.9%	✓	10:26	10:49	00:23	3.6%	✓	10:59	13:00	02:01	18.4%	×
Market Harborough	A4303 (Rockingham Road / Lubenham Hill) Westbound	09:37	11:03	01:26	14.8%	✓	09:43	10:26	00:43	7.4%	✓	11:45	10:48	-00:57	-8.1%	✓
Market Harborough	Leicester Road / Northampton Road Northbound	08:14	08:55	00:42	8.4%	✓	08:41	08:12	-00:29	-5.5%	✓	09:08	08:39	-00:30	-5.4%	✓
Market Harborough	Leicester Road / Northampton Road Southbound	08:48	08:35	-00:13	-2.5%	✓	09:06	08:07	-00:59	-10.8%	✓	08:43	08:19	-00:23	-4.4%	✓
Market Harborough	Rockingham Road / Welland Park Road Eastbound	08:31	09:33	01:02	12.1%	✓	07:53	08:53	01:00	12.6%	✓	09:39	11:09	01:30	15.6%	×
Market Harborough	Rockingham Road / Welland Park Road Westbound	08:32	09:23	00:50	9.8%	✓	07:51	08:29	00:39	8.2%	✓	09:37	08:53	-00:44	-7.6%	✓
Lutterworth	A426 Leicester Road Northbound	07:00	06:07	-00:53	-12.7%	✓	05:48	05:46	-00:03	-0.7%	✓	06:14	06:38	00:24	6.4%	✓
Lutterworth	A426 Leicester Road Southbound	06:18	06:58	00:40	10.6%	✓	05:48	05:43	-00:05	-1.4%	✓	07:46	06:07	-01:39	-21.2%	×
Lutterworth	A4303 (M1 to A5) Eastbound	03:48	03:13	-00:35	-15.5%	✓	03:39	03:10	-00:29	-13.0%	✓	03:53	03:14	-00:38	-16.5%	✓
Lutterworth	A4303 (M1 to A5) Westbound	03:47	03:32	-00:15	-6.6%	✓	03:35	03:23	-00:12	-5.8%	✓	03:40	03:25	-00:15	-6.8%	✓
Lutterworth	Western Bypass (Brookfield Way) Northbound	03:27	03:25	-00:02	-1.0%	✓	03:25	03:25	00:00	0.0%	✓	03:27	03:41	00:14	6.7%	✓
Lutterworth	Western Bypass (Brookfield Way) Southbound	03:26	03:59	00:33	16.2%	✓	03:24	03:41	00:17	8.5%	✓	03:20	03:45	00:25	12.6%	✓
Harborough	A6 (Market Harborough to Leicester) Northbound	14:44	14:37	-00:07	-0.8%	✓	14:06	13:45	-00:20	-2.4%	✓	14:34	15:48	01:14	8.5%	✓
Harborough	A6 (Market Harborough to Leicester) Southbound	14:45	15:15	00:30	3.4%	✓	13:45	13:23	-00:22	-2.7%	✓	13:29	14:27	00:57	7.1%	✓
Harborough	A4304 (M1 to Lubenham) Eastbound	15:03	14:24	-00:40	-4.4%	✓	14:44	14:25	-00:19	-2.2%	✓	14:34	14:55	00:21	2.4%	✓
Harborough	A4304 (M1 to Lubenham) Westbound	15:26	15:25	-00:01	-0.1%	✓	14:56	14:24	-00:32	-3.6%	✓	14:41	14:38	-00:03	-0.4%	✓

		AM Peak					Interpeak					PM Peak				
Location	**Route**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**
Harborough	A47 (Thurnby to Belton-in-Rutland) Eastbound	13:25	12:36	-00:49	-6.1%	✓	13:31	12:23	-01:08	-8.4%	✓	13:08	12:34	-00:34	-4.3%	✓
Harborough	A47 (Thurnby to Belton-in-Rutland) Westbound	13:25	12:41	-00:44	-5.4%	✓	13:26	12:25	-01:01	-7.6%	✓	12:48	12:40	-00:08	-1.0%	✓
Hinckley	A47 Normandy Way Eastbound	07:38	08:11	00:34	7.3%	✓	07:31	08:03	00:32	7.2%	✓	08:03	09:05	01:02	12.9%	✓
Hinckley	A47 Normandy Way Westbound	10:42	09:43	-01:00	-9.3%	✓	07:53	08:07	00:14	3.0%	✓	08:54	08:27	-00:28	-5.2%	✓
Hinckley	Coventry Road / Leicester Road Eastbound	11:19	12:33	01:14	10.9%	✓	10:16	12:16	02:00	19.4%	×	10:28	13:08	02:40	25.5%	×
Hinckley	Coventry Road / Leicester Road Westbound	12:23	11:58	-00:25	-3.3%	✓	10:25	10:54	00:29	4.6%	✓	12:52	11:43	-01:09	-9.0%	✓
Hinckley	HollyCroft / Sapcote Road Eastbound	12:25	11:47	-00:39	-5.2%	✓	10:03	10:28	00:26	4.3%	✓	10:22	11:14	00:52	8.3%	✓
Hinckley	HollyCroft / Sapcote Road Westbound	12:40	15:24	02:44	21.5%	×	11:15	13:19	02:03	18.2%	×	14:07	17:44	03:37	25.7%	×
Hinckley	Rugby Road / Ashby Road Northbound	13:46	13:28	-00:18	-2.2%	✓	09:33	10:48	01:14	12.9%	✓	15:52	15:08	-00:44	-4.7%	✓
Hinckley	Rugby Road / Ashby Road Southbound	10:04	11:26	01:22	13.5%	✓	09:22	10:20	00:59	10.4%	✓	09:50	11:01	01:12	12.1%	✓
Hinckley	Hinckley Road / Southfield Road / Nutts Lane Eastbound	14:36	14:21	-00:15	-1.7%	✓	12:32	13:29	00:56	7.5%	✓	15:04	14:43	-00:21	-2.3%	✓
Hinckley	Hinckley Road / Southfield Road / Nutts Lane Westbound	13:41	15:45	02:05	15.2%	×	12:01	13:15	01:15	10.3%	✓	16:01	17:36	01:35	9.9%	✓
Barwell / Earl Shilton	Earl Shilton Bypass Eastbound	04:06	04:32	00:25	10.3%	✓	03:49	04:25	00:36	15.5%	✓	03:53	04:42	00:49	21.1%	✓
Barwell / Earl Shilton	Earl Shilton Bypass Westbound	04:11	04:45	00:33	13.3%	✓	03:57	04:29	00:31	13.1%	✓	04:02	04:46	00:44	18.0%	✓
Barwell / Earl Shilton	Leicester Road Northbound	05:25	06:10	00:45	13.7%	✓	05:37	06:05	00:28	8.2%	✓	05:24	06:14	00:50	15.5%	✓
Barwell / Earl Shilton	Leicester Road Southbound	05:52	06:22	00:30	8.4%	✓	05:46	06:17	00:31	9.1%	✓	05:38	06:26	00:48	14.3%	✓
Barwell / Earl Shilton	Station Road / Heath Lane / The Common Clockwise	08:37	09:17	00:40	7.6%	✓	08:24	09:00	00:36	7.2%	✓	08:22	09:13	00:51	10.2%	✓
Barwell / Earl Shilton	Station Road / Heath Lane / The Common Anti-Clockwise	08:07	09:09	01:02	12.7%	✓	08:02	08:54	00:52	10.7%	✓	08:46	09:10	00:24	4.5%	✓
Barwell / Earl Shilton	Mill Street / Shilton Road Eastbound	04:14	04:22	00:08	3.1%	✓	04:09	04:22	00:13	5.3%	✓	04:12	04:25	00:13	5.1%	✓
Barwell / Earl Shilton	Mill Street / Shilton Road Westbound	04:15	04:23	00:07	2.9%	✓	04:08	04:21	00:13	5.3%	✓	04:05	04:22	00:17	6.9%	✓
Hinckley Borough	A47 (Leicester Forest East to Earl Shilton) Eastbound	06:36	07:30	00:54	13.7%	✓	05:38	06:27	00:49	14.4%	✓	06:50	06:49	-00:01	-0.2%	✓
Hinckley Borough	A47 (Leicester Forest East to Earl Shilton) Westbound	05:39	06:02	00:23	6.9%	✓	05:23	05:45	00:21	6.6%	✓	05:30	06:02	00:33	9.9%	✓
Hinckley Borough	A447 (A47 to A511) Northbound	22:11	21:21	-00:50	-3.8%	✓	21:06	20:29	-00:37	-2.9%	✓	21:28	21:18	-00:11	-0.8%	✓
Hinckley Borough	A447 (A47 to A511) Southbound	22:24	21:35	-00:49	-3.7%	✓	21:48	20:27	-01:22	-6.2%	✓	21:45	21:17	-00:28	-2.1%	✓
Hinckley Borough	A50 (A46 to M1) Northbound	06:37	05:51	-00:46	-11.7%	✓	05:57	05:37	-00:20	-5.6%	✓	06:04	06:06	00:02	0.5%	✓
Hinckley Borough	A50 (A46 to M1) Southbound	06:43	06:16	-00:26	-6.6%	✓	05:57	05:51	-00:06	-1.6%	✓	05:51	06:12	00:21	6.0%	✓
Coalville	Ashby Road / London Road Eastbound	06:53	06:11	-00:42	-10.1%	✓	06:28	06:07	-00:22	-5.5%	✓	07:58	06:48	-01:11	-14.8%	✓
Coalville	Ashby Road / London Road Westbound	06:14	06:52	00:38	10.2%	✓	06:33	06:34	00:01	0.2%	✓	09:05	08:14	-00:51	-9.3%	✓
Coalville	Forest Road / Meadow Lane Eastbound	09:06	07:39	-01:28	-16.0%	×	07:11	07:27	00:16	3.6%	✓	07:38	07:49	00:11	2.4%	✓
Coalville	Forest Road / Meadow Lane Westbound	08:47	07:49	-00:58	-11.0%	✓	07:13	07:35	00:22	5.2%	✓	08:21	07:55	-00:26	-5.2%	✓
Coalville	Belvoir Road / Thornborough Road Northbound	07:26	07:01	-00:25	-5.6%	✓	07:00	06:55	-00:05	-1.2%	✓	08:06	07:07	-00:59	-12.1%	✓
Coalville	Belvoir Road / Thornborough Road Southbound	07:23	07:13	-00:10	-2.3%	✓	07:51	07:04	-00:47	-10.0%	✓	07:00	07:04	00:03	0.8%	✓
Coalville	Whitwick Road / North Street Northbound	05:21	05:01	-00:20	-6.2%	✓	05:14	05:00	-00:14	-4.3%	✓	05:51	05:11	-00:40	-11.5%	✓
Coalville	Whitwick Road / North Street Southbound	05:04	05:15	00:11	3.6%	✓	05:02	05:06	00:03	1.2%	✓	05:16	05:07	-00:08	-2.7%	✓
Coalville	Grange Road / Standard Hill Eastbound	06:25	05:59	-00:25	-6.6%	✓	05:31	05:36	00:05	1.5%	✓	06:09	05:44	-00:25	-6.8%	✓

		AM Peak					Interpeak					PM Peak				
Location	**Route**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**	**Observed**	**Modelled**	**Diff.**	**%**	**TAG**
Coalville	Grange Road / Standard Hill Westbound	07:04	06:42	-00:22	-5.2%	✓	05:30	06:05	00:35	10.5%	✓	06:52	07:40	00:47	11.5%	✓
Ashby	Lower Packington Road / Burton Road Northbound	12:01	10:29	-01:32	-12.8%	✓	09:39	10:17	00:38	6.6%	✓	12:27	10:38	-01:48	-14.5%	✓
Ashby	Lower Packington Road / Burton Road Southbound	08:43	08:32	-00:10	-2.0%	✓	07:55	08:19	00:24	5.1%	✓	07:24	08:31	01:08	15.3%	×
Ashby	Station Road / Smisby Road Northbound	04:50	04:52	00:02	0.8%	✓	04:32	04:43	00:11	4.1%	✓	05:35	04:58	-00:37	-11.0%	✓
Ashby	Station Road / Smisby Road Southbound	04:38	04:42	00:05	1.6%	✓	04:09	04:32	00:23	9.4%	✓	04:18	04:45	00:27	10.4%	✓
Ashby	Moira Road / Nottingham Road Eastbound	07:51	07:42	-00:10	-2.0%	✓	07:12	07:31	00:18	4.2%	✓	08:38	07:37	-01:01	-11.7%	✓
Ashby	Moira Road / Nottingham Road Westbound	07:17	07:19	00:02	0.5%	✓	07:01	07:18	00:17	4.1%	✓	07:30	07:30	00:00	0.0%	✓
Ashby	A511 (A42 to Smisby Road) Northbound	02:29	02:37	00:07	4.9%	✓	02:26	02:30	00:03	2.2%	✓	02:29	02:59	00:30	20.2%	✓
Ashby	A511 (A42 to Smisby Road) Southbound	02:46	02:44	-00:01	-0.7%	✓	02:30	02:20	-00:10	-6.5%	✓	02:45	02:29	-00:16	-9.6%	✓
NW Leics	A511 (M1 to Bardon Road) Eastbound	08:25	06:33	-01:52	-22.2%	×	05:37	05:28	-00:09	-2.6%	✓	07:32	06:06	-01:26	-19.1%	×
NW Leics	A511 (M1 to Bardon Road) Westbound	06:08	06:37	00:29	7.9%	✓	05:33	05:35	00:03	0.8%	✓	05:46	06:47	01:01	17.7%	×
NW Leics	A511 (Bardon Road to A42) Eastbound	09:48	09:11	-00:37	-6.2%	✓	08:18	08:12	-00:05	-1.1%	✓	09:36	08:41	-00:55	-9.6%	✓
NW Leics	A511 (Bardon Road to A42) Westbound	10:07	09:01	-01:06	-10.9%	✓	08:27	08:23	-00:03	-0.7%	✓	10:46	09:54	-00:52	-8.1%	✓
NW Leics	A512 (A42 to Shepshed) Eastbound	12:58	12:43	-00:15	-1.9%	✓	11:35	10:45	-00:49	-7.1%	✓	12:18	11:49	-00:29	-3.9%	✓
NW Leics	A512 (A42 to Shepshed) Westbound	12:37	11:28	-01:09	-9.1%	✓	11:17	10:20	-00:58	-8.5%	✓	12:17	12:16	-00:01	-0.1%	✓
SRN	M1 (Jn16 to Jn26) Northbound	51:39	56:33	04:54	9.5%	✓	53:29	55:22	01:53	3.5%	✓	00:08	59:18	-00:50	-1.4%	✓
SRN	M1 (Jn16 to Jn26) Southbound	59:46	01:39	01:53	3.1%	✓	52:48	55:17	02:30	4.7%	✓	52:49	57:18	04:29	8.5%	✓
SRN	M69 (M6 to M1) Northbound	17:57	14:36	-03:21	-18.7%	×	14:25	14:19	-00:07	-0.8%	✓	17:03	14:54	-02:09	-12.6%	✓
SRN	M69 (M6 to M1) Southbound	14:26	14:46	00:20	2.3%	✓	14:28	14:17	-00:11	-1.3%	✓	14:15	14:34	00:19	2.2%	✓
SRN	M42 / A42 (Jn10 to M1) Northbound	20:48	23:44	02:56	14.1%	✓	20:53	22:40	01:47	8.5%	✓	20:37	23:26	02:49	13.6%	✓
SRN	M42 / A42 (Jn10 to M1) Southbound	21:09	22:55	01:46	8.4%	✓	20:32	22:11	01:39	8.0%	✓	20:08	22:49	02:40	13.2%	✓
SRN	M6 (M1 to Jn2) Eastbound	11:34	11:35	00:01	0.2%	✓	10:56	11:37	00:41	6.2%	✓	13:19	11:52	-01:27	-10.9%	✓
SRN	M6 (M1 to Jn2) Westbound	10:04	11:41	01:37	16.1%	×	10:11	11:05	00:54	8.9%	✓	10:04	11:09	01:04	10.6%	✓
SRN	A46 (M1 to A52) Northbound	25:17	26:46	01:29	5.9%	✓	24:21	25:25	01:04	4.4%	✓	28:33	30:31	01:58	6.9%	✓
SRN	A46 (M1 to A52) Southbound	27:25	30:12	02:48	10.2%	✓	24:35	25:46	01:11	4.8%	✓	24:13	27:03	02:49	11.6%	✓
SRN	A5 (M1 to M42) Eastbound	42:40	42:47	00:08	0.3%	✓	38:23	38:11	-00:11	-0.5%	✓	40:32	42:40	02:08	5.3%	✓
SRN	A5 (M1 to M42) Westbound	41:23	44:04	02:41	6.5%	✓	39:35	38:56	-00:39	-1.6%	✓	46:43	44:44	-01:59	-4.3%	✓
SRN	A453 (M1 Jn23a to A52) Northbound	20:32	16:57	-03:35	-17.4%	×	16:23	16:21	-00:02	-0.2%	✓	17:30	17:42	00:12	1.1%	✓
SRN	A453 (M1 Jn23a to A52) Southbound	16:21	17:33	01:12	7.3%	✓	15:54	16:44	00:50	5.3%	✓	21:11	17:44	-03:27	-16.3%	×
SRN	A50 (A38 to M1) Eastbound	14:09	13:44	-00:25	-2.9%	✓	11:52	13:21	01:29	12.5%	✓	12:43	13:40	00:57	7.5%	✓
SRN	A50 (A38 to M1) Westbound	11:47	12:31	00:43	6.1%	✓	11:37	12:07	00:31	4.4%	✓	12:06	12:38	00:32	4.4%	✓
SRN	A52 (A5111 to A1) Eastbound	00:46	57:24	-03:23	-5.6%	✓	48:20	49:57	01:36	3.3%	✓	56:19	01:20	05:01	8.9%	✓
SRN	A52 (A5111 to A1) Westbound	56:10	54:11	-01:58	-3.5%	✓	48:58	50:06	01:07	2.3%	✓	54:46	55:14	00:28	0.9%	✓
SRN	A1 (A14 to A52) Northbound	42:20	41:41	-00:39	-1.5%	✓	43:21	42:48	-00:33	-1.3%	✓	43:01	42:35	-00:26	-1.0%	✓
SRN	A1 (A14 to A52) Southbound	44:19	43:34	-00:45	-1.7%	✓	43:02	42:34	-00:29	-1.1%	✓	41:46	41:21	-00:24	-1.0%	✓
SRN	A14 (A1 to M1) Eastbound	39:47	42:19	02:31	6.3%	✓	39:34	41:19	01:44	4.4%	✓	38:49	41:27	02:39	6.8%	✓
SRN	A14 (A1 to M1) Westbound	42:15	42:36	00:21	0.8%	✓	40:52	42:01	01:10	2.8%	✓	40:27	42:11	01:45	4.3%	✓

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LLITM 2014 Base

North & East Melton Mowbray Distributor Road Full Business Case

Public Transport LMVR

Leicestershire County Council

April 2022

Quality information

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Revision History

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Executive Summary

E1 Introduction

E1.1. The first Leicester and Leicestershire Integrated Transport Model (LLITM) public transport model was developed during 2009 and early 2010 with a base year of 2008. It represents bus and rail travel across Leicestershire and Leicester, containing a detailed representation of all bus and rail services in the area, and with suitably detailed train frequencies for rail corridors outside Leicestershire. It is a strategic model, and does not model bus travellers precisely down to the level of individual bus stops.

E1.2. Between 2014 and 2016, a new LLITM 2014 Base model was developed, including a new public transport model. This uses entirely new demand patterns based on ticket sales data from the rail industry's LENNON database and nine bus operators in Leicestershire. The representation of public transport service patterns is also new, based primarily on Traveline National Data Set (TNDS) bus timetable data.

E1.3. These model updates have been undertaken in-line with TAG guidance, and in particular with reference to TAG Unit M3-2 on the subject of public transport assignment modelling.

E2 Model Updates and Enhancements

E1.4. New passenger count data were available for LLITM 2014; including:

- Passenger counts, conducted via on-board bus surveys, in both directions for radial roads surrounding each of the seven market towns. These were carried out in 2013 and 2014.
- Passenger counts around Leicester City carried out annually for 2009, 2013 and 2014. Counts at these sites had been available in earlier versions of LLITM, but not always in both directions; all sites in the 2014 survey contained data for both directions.
- Aggregate patronage data obtained from bus companies.
- Boarding and alighting counts at rail stations in Leicestershire, collected in July 2015.
- Boarding and alighting counts at bus stops in urban centres around Leicestershire, collected as part of a passenger interview programme in 2014.
- All of these data were used in development of the LLITM 2014 public transport model.

E3 Comparison with Previous Model

E1.5. The LLITM 2014 public transport model demand has been developed almost entirely from ticket sales data. Comparison against passenger counts demonstrates that this has generated a significantly more robust representation of bus passenger demand than previous versions of LLITM. This has resulted in a model that both validates better against passenger count data, and has been developed with less adjustment of the "prior" demand (from input ticket data) to improve the match against counts than previous versions.

E4 Model Performance Summary

E1.6. The updated public transport model has been assessed in terms of its ability to reproduce observed public transport patronage, against the acceptability guidelines contained within TAG Unit M3-2. Meeting these guidelines, or indeed not meeting these guidelines, does not automatically result in a model being fit, or not fit, for its intended purpose. The suitability of the model should be assessed in light of the objectives of each application and the performance of the model in the area of influence of a given scheme or proposed development.

E1.7. The model achieves a high standard of bus link count calibration, with well over 90% of road links in the model with significant (more than 30 passengers per hour) passenger flow achieving a match against observed flows within 25%, compliant with TAG. Furthermore, the validation at a high level of number of passenger boardings across the county and city against bus operator patronage data are very close, within 3%.

E1.8. The validation in terms of passenger boardings is good within Leicester, with modelled flows within 10-30% of observed. Within other market towns the model demonstrates boardings of the same order as the observed data, but does not generally match as closely. Following investigation, these discrepancies appear to relate to inconsistencies between the boarding count data and the link counts rather than the model per se.

E1.9. Rail travel matches observed data well at an overall level and around the largest stations of Leicester and Loughborough, with some discrepancies for the smaller stations.

1. Introduction

1.1 Background

1.1.1 Leicestershire County Council (LCC) originally commissioned the development of highway and public transport assignment models as components of a Leicestershire and Leicester Integrated Transport and Land-Use Model (LLITM) in 2008. AECOM was appointed to update the public transport model in 2012, when it rebuilt the modelled network and validated and calibrated the new model.

1.1.2 A new LLITM public transport model has been developed by AECOM as part of the development of the LLITM 2014 model, with a new 2014 base year. The LLITM 2014 model, the subject of this report, uses entirely new data for both public transport demand and public transport supply.

1.1.3 LLITM is a suite of models, which comprises:

- a highway traffic assignment model;
- a public transport assignment model, the subject of this document;
- a demand model covering trip generation, trip frequency, time period choice, mode choice and trip distribution; and
- a land-use model interacting with the transport model.

1.1.4 The LLITM 2014 model was developed in consultation with staff at Leicestershire County Council, who were involved in scoping the update, verifying the service patterns, and discussing the model performance. Through LCC, other stakeholders (including Leicester City Council) were involved, for example, in the collation of new count and bus service data.

1.2 Purpose

1.2.1 This report sets out the development and validation of the public transport model. The model has been developed in Emme software, and thus interfaces easily with the LLITM 2014 demand model, which is also built in Emme.

1.2.2 The public transport model covers Leicestershire in full, and has sufficient coverage of adjacent areas to determine the transport impacts of policy interventions within Leicestershire. It may be used to test a broad range of transportation and development related interventions, including:

- changes to service frequencies (bus and rail);
- new routes and route extensions (bus and rail);
- infrastructure improvements (new rail lines, new bus links, new bus lanes);
- interchange and stop/station upgrades (bus and rail);
- fare changes (bus and rail);
- qualitative changes to service provision (such as smart ticketing);
- general policy initiatives promoting use of public transport (’Smarter Choices); and
- land-use developments affecting use of public transport.

1.3 Structure

1.3.1 Following this introduction, the report is set out as follows :

- Chapter 2 summarises the scope of the model and the data used to develop it;
- Chapter 3 discusses the assignment model development;
- Chapter 4 discusses the demand matrix development;

- Chapter 5 reports on the model calibration;
- Chapter 6 reports on the model validation;
- Chapter 7 sets out our conclusions;
- Appendix A discusses in some technical detail the matrix estimation algorithm used; and
- Appendix B contains the detailed link flow calibration data.

2. Model Overview

2.1 Coverage and Scope

2.1.1 The model has been specified to cover the whole of Leicester and Leicestershire at a sufficient level of detail to assess significant policy interventions in the local transport market. The network detail has been focussed on service routes, with representation of routeing sufficiently accurate to provide realistic walk and travel times (by bus and rail) for public transport travellers and to provide impacts of bus flows on highway capacity. However, it is not constructed in sufficient detail to reliably study individual bus stops.

2.1.2 Outside Leicestershire, modelling is less detailed. Bus services that do not enter Leicestershire have not been included; if a service intercepts Leicestershire then it is modelled in full. Rail travel is modelled in less detail outside the county, with suitably accurate travel times and frequencies modelled on main rail corridors, without detailed representation of stopping pattern differences between services. Immediately outside Leicestershire (around Derby, Nottingham, Nuneaton and Tamworth), care has been taken with the rail services to ensure that undesired boundary effects do not occur. This approach to public transport modelling is typical for the modelling of external networks.

2.1.3 The development of the model networks is discussed in Chapter 3. The development of the representation of public transport passenger demand is described in Chapter 4.

2.2 Modelled Year and Time Periods

2.2.1 The model represents an average weekday in a neutral week (one without public holidays) in the period April to June 2014. All data used directly in modelling demand and supply representation were collected in and for Spring-Summer 2014. Some count data collected in 2013 and 2015 have been used for validation.

2.2.2 Three time periods have been developed; an AM period representing 07:00 to 10:00, an interpeak period representing 10:00 to 16:00 and a PM period representing 16:00 to 19:00. Data are generally represented at an hourly level; that is, demand and flows are divided by the number of hours in the period (3, 6 and 3 respectively).

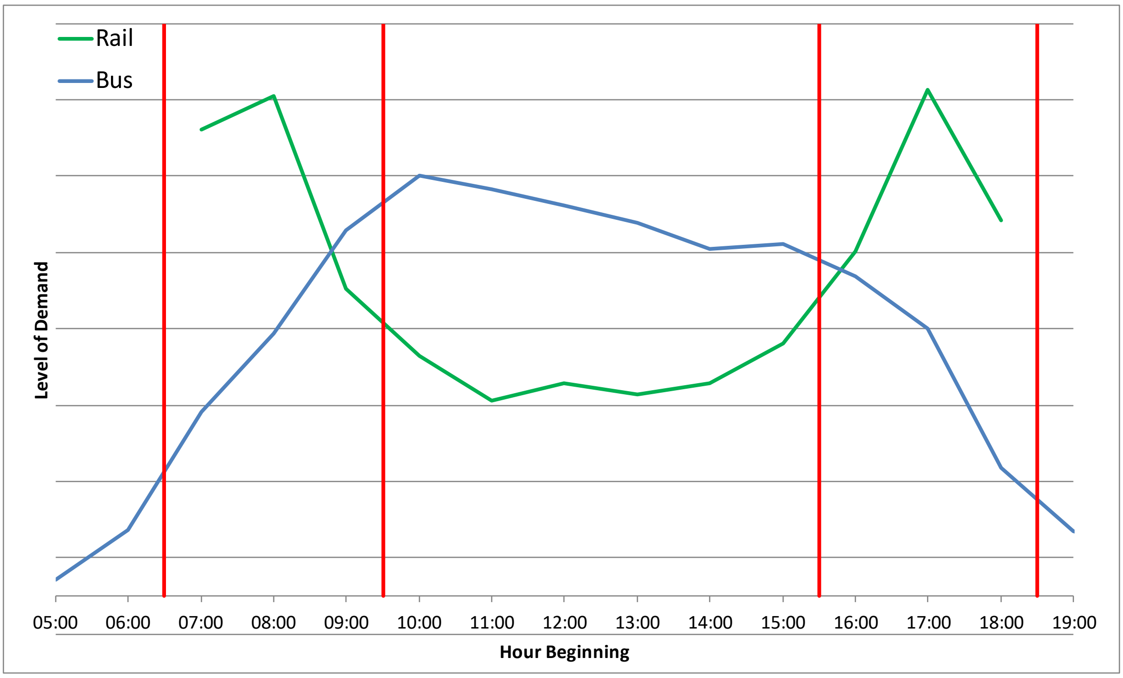
2.2.3 These time periods are consistent with the demand and highway models in LLITM 2014. The profile of public transport passenger demand derived from bus Electronic Ticket Machine (ETM) data demonstrates that the actual peak of bus passenger usage occurs in the interpeak period, as shown below, with the AM and PM time-periods highlighted as red and green bands.

2.2.4 The data used to derive this profile represent most, but not all, regular scheduled bus usage (excluding school buses) in Leicester and Leicestershire. Data were not available from all operators. The (linear, zero-based) scale has been omitted because the data are not complete and therefore do not represent a meaningful total. However, the profile is considered fairly robust.

2.2.5 In both the AM and PM periods (identified using red lines), the average of the period demand is similar to the demand in the middle hour of the period, as there are steep rising/falling patterns in each. Generally the overall pattern is one of build-up to a peak around 10:00 and then a fall. However, there is a much smaller PM Peak between 15:00 and 16:00, probably relating to school travel. Although dedicated school buses are not included in the model, education travel on public buses is.

2.2.6 Similar time-profile data for rail travel are available only from the rail boarding alighting counts; these are also shown on the graph. The rail profile is very different, with clear morning and evening peaks and a significant ‘valley’ in the middle of the day. The rail data are available only from 07:00 to 19:00.

Figure 2.1: Passenger Demand Profiles, Leicester and Leicestershire, Average Weekday



2.3 Data Sources

2.3.1 Data used in building the model are summarised below.

2.3.2 Several data sets were used in developing the representation of public transport service patterns and timetables:

- Traveline National Dataset (TNDS) data in TransXChange format for bus travel in Leicestershire and surrounding counties.
- National Coach Services Database (NCSD) data in TransXChange format for coach travel in Leicestershire and surrounding counties.
- The database underlying National Rail Enquiries for national rail travel across Great Britain.
- The LLITM 2014 highway model road network, discussed in *PR101: LLITM Highway LMVR*.
- Meridian Geographic Information System (GIS) layers from the Ordnance Survey of the UK rail network and stations.

2.3.3 Several data sets were used in developing the representation of public transport passenger demand:

- Electronic Ticket Machine (ETM) data from the nine largest bus operators in Leicester and Leicestershire: Arriva, First, Kinchbus, Centrebus, Stagecoach, Roberts Coaches, Paul S Winson Coaches, Nottingham City Transport and Macpherson Coaches; together, these account for about 99% of public, scheduled, local bus travel within the model area;
- LENNON rail ticket sales data for Great Britain, for the month of March 2014;
- origin / destination surveys conducted on bus passengers boarding in the centre of Leicester and the Leicestershire market towns in 2014;

- boarding and alighting counts for passengers at the bus stops above;
- National Travel Survey (NTS) data for 2002-2012, for the whole of Great Britain;
- National Rail Travel Survey (NRTS) data for 2005; and
- the LLITM 2014 land-use and trip-end models, the latter based on the DfT's National Trip-End Model (NTEM).

2.3.4 Some data were used to validate the model, but not as part of the "prior" demand development:

- bus passenger count volumes, collected across Leicester City annually as part of the LTP monitoring programme: most of the data used are from the 2014 survey; some counts from earlier years not available in 2014 have been adjusted and used;
- bus passenger volumes on cordons around the seven market towns of Ashby-de-la-Zouch, Coalville, Hinckley, Loughborough, Lutterworth, Market Harborough and Melton Mowbray, collected in Spring 2013 using on-board counts; and
- boarding and alighting counts for passengers at rail stations collected in 2015.

2.3.5 Matrix development is discussed in Chapter 4 and calibration count data in Section 6.2.

2.4 Guidance and Principles

2.4.1 In January 2014 the DfT issued TAG 2, a re-structured set of transport modelling and appraisal guidance. Unit M3.2 of TAG discusses public transport modelling.

2.4.2 The advice in this unit has been followed where reasonably practical. The guidance focuses on development of a public transport model for a specific major public transport scheme; this is not the primary focus of the LLITM model. However, much of the advice remains applicable. The report attempts to highlight areas of consistency with, and departure from, TAG. One area of uncertainty in the TAG advice relates to the proximity of model and observed flows when volumes are low; this is discussed in Section 7.2.

2.4.3 A coding manual has been developed for the LLITM 2014 public transport networks and services; this is TN207: LLITM 2014 Base Public Transport Coding Manual. This discusses how networks and services are coded in Emme, in detail, both for the base 2014 model and for forecasting transport interventions.

3. Network Model Development

3.1 Context

3.1.1 Base year (2014) public transport networks were constructed initially from the LLITM highway model network topography. Bus routes, rail network, rail services, access, egress and interchange walk links were then incorporated. Travel times and speeds from the LLITM highway network are not used in the public transport model, as timetables are used to define public transport travel times[1].

3.1.2 Following the importing of the highway model network to Emme (this was achieved using an automatic conversion process), bus services were generated. These were based on TNDS data for services in the region.

3.2 Zoning Structure

3.2.1 The LLITM zone system, which is the same across all model components; highway, public transport, demand and land-use models; is based on 2011 Census output areas, ensuring compatibility with Census household data. In total there are 1347 zones within LLITM; the Leicester City area contains 288 zones. Beyond Leicester City suitably fine zonal definition is included within the County market towns, with reduced definition for intermediate rural areas.

3.2.2 Zoning beyond the county becomes increasingly coarse, at a sub-district level for adjacent towns and cities, and a district and county level across the Midlands. Regions beyond the Midlands are aggregated into larger geographical areas.

3.2.3 Figure 3.2 and Figure 3.3 show the detail of the zoning system in the Leicestershire and Central Leicestershire areas. Figure 3.4 shows the zoning that is defined for much of England and Wales.

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[1] The effects of changing levels of highway congestion are reflected in LLITM when forecasting, through a matrix-based adjustment to bus travel times within the LLITM demand model.

Figure 3.2: LLITM Zoning (Leicester)

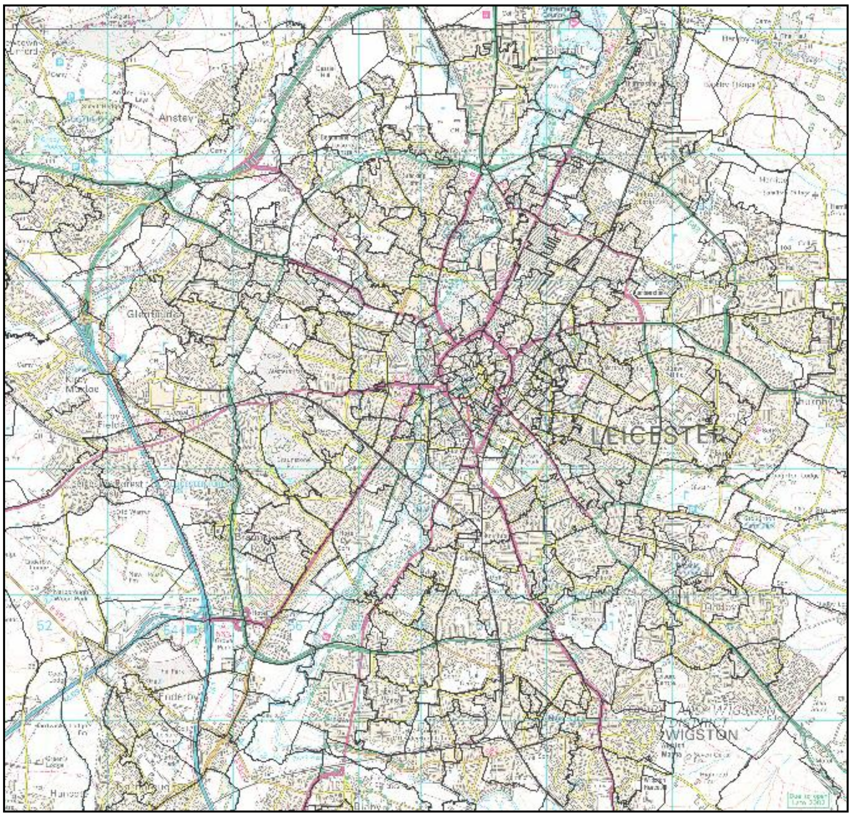

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Figure 3.3: LLITM Zoning (Leicestershire)

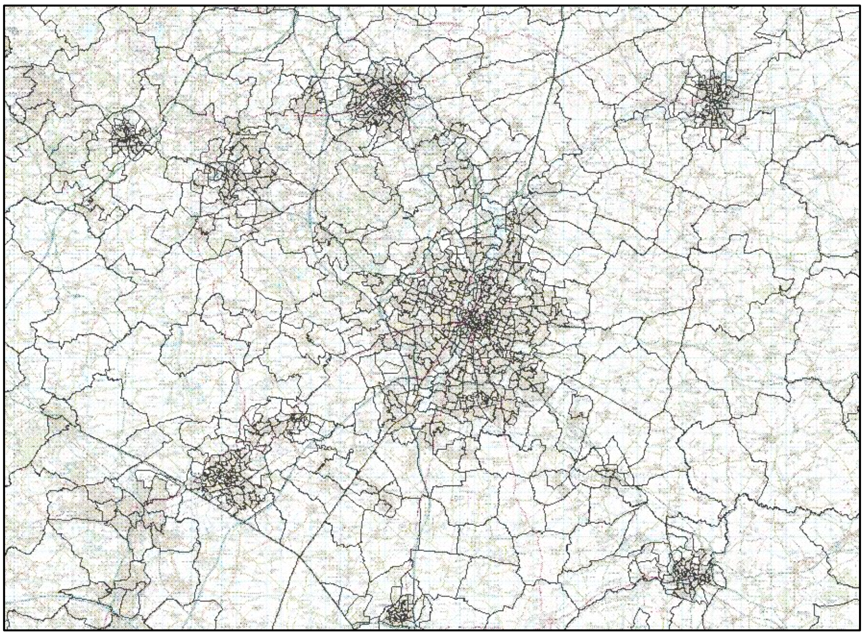

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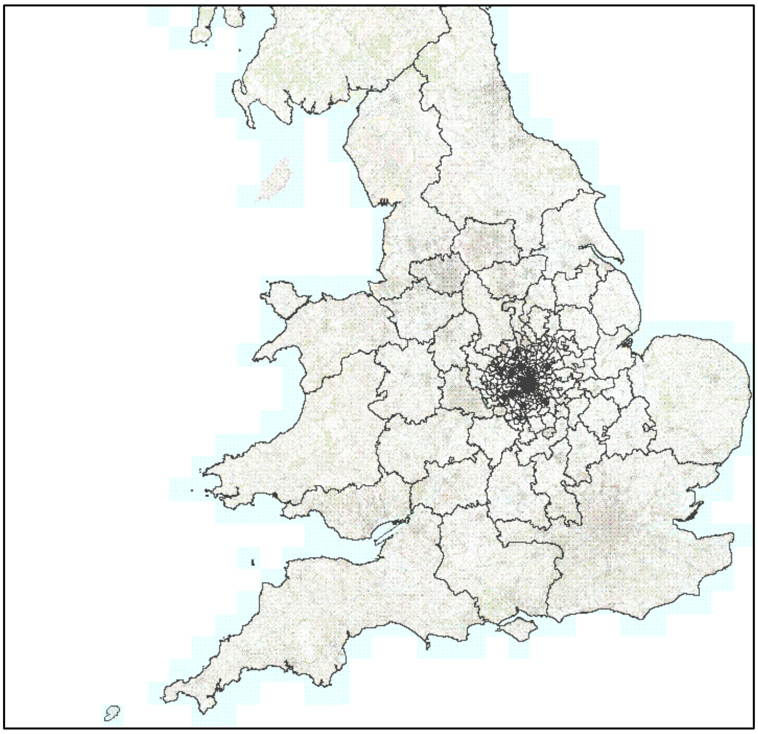
Figure 3.4: LLITM Zoning (England and Wales)



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3.3 Highway Network Data

3.3.1 The public transport model road network, in terms of both its topology and node numbers, is derived from the LLITM highway model. Development of this SATURN highway model is discussed in 'PR101 - LLITM Highway Model LMVR'. Junction characteristics were discarded for the public transport model, as this information is not relevant to bus assignment. Link speed-flow information is also not used by the public transport model, but the process converts these data anyway, as they may be useful in the future.

3.3.2 Bus lanes and bus-only links are coded in the highway model, so it was not necessary to add these explicitly.

3.3.3 The rail network, walk links to connect the rail and highway networks and to model pedestrian routes in town centres, and centroid connectors to allow access to and egress from the rail and bus networks, were all added to the highway network for public transport modelling. Station access links were coded to adjacent bus stops and walk catchment zones.

3.3.4 Centroid connectors in the highway model were not retained for the public transport model, as they do not necessarily represent the way pedestrians would walk to bus stops and railway stations, being designed for modelling movement of highway demand. Instead, a single centroid connector per zone was used to connect each zone to the closest point on the highway network.

3.4 Bus Transit Timetable Data

3.4.1 Bus service data were extracted from the Traveline National Dataset (TNDS) in the TransXChange file format, for 2014. This file format is used for the interchange of timetable information.

3.4.2 The TNDS data cover all publicly accessible bus and coach services that are operational in the Leicestershire area, with details of the origin and destination for each service, each bus stop at which the services stop and the times that each service is scheduled to call at each stop. It should be noted that detailed routes between stops are not included in these data.

3.4.3 The data give detailed information about each bus stop as location records. This record assigns each stop a unique identifier, and provides a description of each location, along with the grid reference, the NaPTAN (National Public Transport Access Node) code and the type of bus stop. All stops within the county are included, together with stops outside Leicestershire that are used by services that intersect Leicestershire.

3.4.4 Bus routes in the TransXChange file were specified by their service number and direction and include a list of each bus stop that the service passes along on route. Each stop the bus passes has scheduled arrival and departure times and defined the activity at each stop (i.e. pick up only, set down only, both pick up and set down or neither (as in the case of express services).

3.4.5 Days of the week and other special days (e.g. bank holidays, school term time) that the journey operates are recorded in the data, as are the first and last dates of operation of the journey.

3.4.6 The service frequencies for LLITM were derived for the whole of each 3 or 6 hour modelled period; i.e. the AM service headway was calculated by dividing 180 minutes by the total number of buses departing between 07:00 and 09:59 inclusive.

3.4.7 Link travel times for the public transport model were taken directly from the coded timetable times from the TransXChange data.

3.5 Rail Transit Timetable Data

3.5.1 The extent of national rail service representation was governed by the scale of the peripheral zone system. The zones include detail at a district level for areas immediately adjacent to Leicestershire and at a county level for the greater part of the Midlands (extending into Yorkshire, the North-West, East of England and the South East. Localities beyond this extent are zoned at a regional level.

3.5.2 All rail services passing through Leicestershire were coded with their stopping patterns represented in full, using service headways, as for bus routes.

3.5.3 Beyond Leicestershire, more approximate frequencies and travel times for each line have been coded, with no attempt to represent precise variations in stopping patterns, which in any case usually could not be represented fully given the large size of external zones.

3.5.4 National Rail Enquiries was used as the primary source of data for rail network coding.

3.6 Assignment Parameters and User Classes

3.6.1 Modes within the public transport model are defined as listed below; park-and-ride services are assigned to the bus mode.

Table 3.1: Modelled Modes

Mode	Name	Notes
b	Bus	Bus services
r	Rail	Rail, local & national
w	Walk	Non-transit connection legs
m	Motorised	Access to rail for car-owning households
e	External	Access to external zones

3.6.2 The LLITM 2014 public transport model has three assignment user classes, as follows. Interchange penalties were calibrated as part of the model validation and calibration process.

Table 3.2: Assignment User Classes

Name	Permitted Modes	Interchange Penalties
Bus Travellers	wbe	6 mins
Car-Owning Rail Travellers	wemr	2 mins
Non-Car-Owning Rail Travellers	webr	2 mins rail / 20 mins bus

3.6.3 Previous versions of LLITM have modelled only a single user class; the LLITM 2014 approach allows more robust modelling of passenger choice between bus and rail modes, which will make certain kinds of scheme (such as new rail routes) easier to assess in LLITM 2014.

3.6.4 As public transport generalised cost is built up from individual elements of the journey, the individual cost components need to be weighted to reflect user preferences. The following factors have been applied in respect of aggregate cost weighting.

- in-vehicle time = 1.0
- wait time factor = 2.0
- walk time factor = 2.0
- value of time = 11.973 pence/minute (2014 base year)

3.6.5 The in-vehicle time factor of 1.0 implies that all other parameters are scaled relative to in-vehicle time. No variations by mode were applied; there was an assumption that bus, rail and coach modes are equally perceived. No crowding factor is applied to in-vehicle times to represent over-crowded vehicles or services; this is not an uncommon practice in the context of urban bus models.

3.6.6 The wait value of 2.0 implies a perception of double the disutility of in-vehicle time. This is within the expected range. TAG Unit M3.2 suggests 1.5-2.5; the LLITM value is in the middle of this range.

3.6.7 Wait times in LLITM are estimated using an increasing function of headway with decreasing slope. That is to say, where services are very frequent, half of the service headway is assumed as the wait time, but as services become less frequent, the wait time factor is assumed to decrease from 0.5, although wait times continue to increase as headway does. The function is derived from the Passenger Demand Forecasting Handbook (PDFH) advice, and is discussed in Appendix A, Section 2.5.

3.6.8 The walk factor of 2.0 is a standard public transport model value; TAG Unit M3.2 suggests 1.5-2.0.

3.6.9 Fares are modelled at an assignment (as well as demand) level in LLITM 2014. This is in contrast to previous versions of LLITM, in which fares were included only in demand model responses. The change was made possible through the use of separate user classes for rail and bus travellers, and should ensure better consistency between the demand and public transport models.

3.6.10 Variations of all of these parameters were tested in the calibration, and some adjustments made to improve the model performance (both in terms of plausible routes being assigned for individual journeys and in terms of model validation against count data), particularly to boarding penalties by user class.

3.7 Fares Data

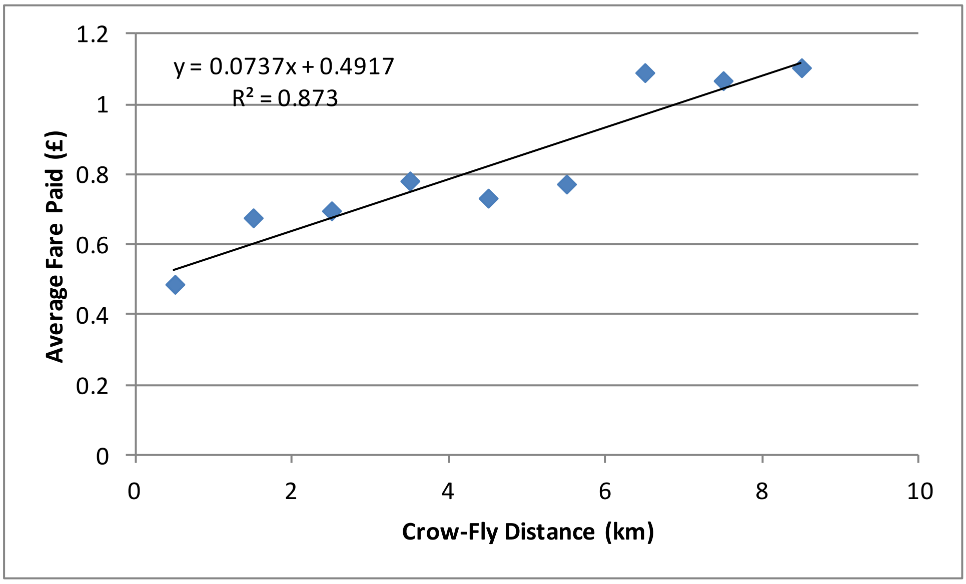
Bus Fares

3.7.1 The bus fare function in LLITM 2014 has been developed by summarising ticket sales data from six operators: Stagecoach, Kinchbus, Centrebus, First, Winsons and Roberts Coaches. Unfortunately, Arriva, the largest operator, did not provide any fare data; Arriva tickets sales received for LLITM cover only patronage.

3.7.2 Journeys were summarised by crow-fly distance of the trip (this could be calculated as fare stages had already been assigned to model zones to develop the demand matrices), and the total journeys and total receipts calculated.

3.7.3 This allowed average fare paid to be calculated as a function of distance, with some assurance that the fare represented the average actually paid, including all discounts and concessions.

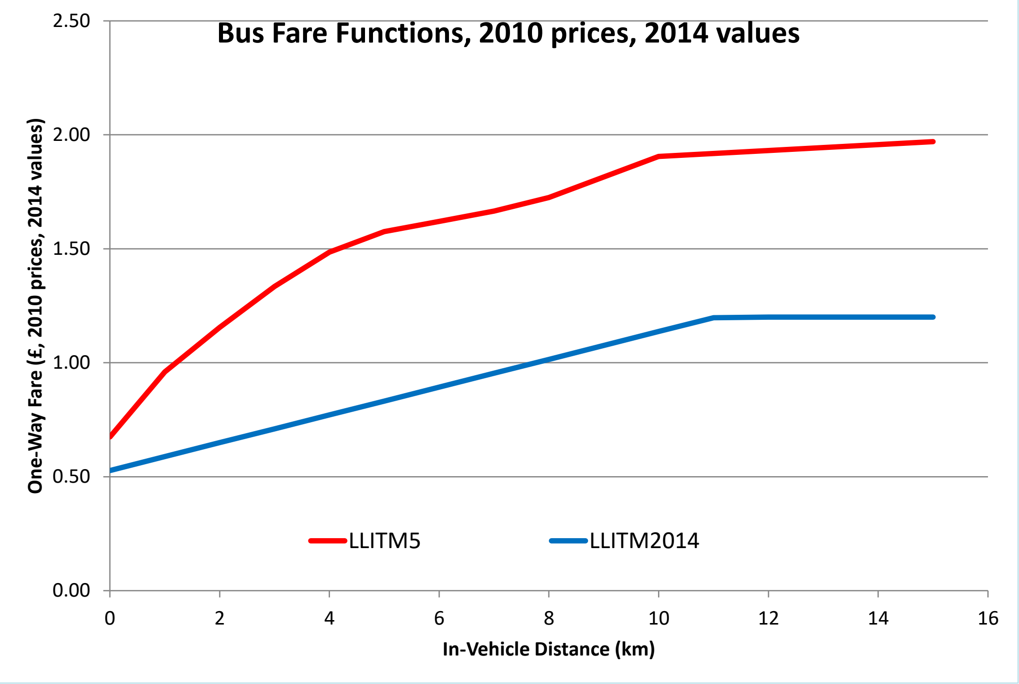
Table 3.3: Observed Bus Fare Data, with Fitted Function



3.7.4 The function as applied in LLITM is shown below, with crow-fly distance converted to assigned distance using a factor of 1.3, derived directly from the model. The function also includes an additional factor of 1.15 on top of the fitted function. We became concerned that the ticket sales data were generating unreasonably low fares due to tickets sold other than on buses (e.g. online or at ticket offices) not always being included, although the corresponding passenger boardings were. Some analysis of published fare tables resulted in the 1.15 factor.

3.7.5 The function used in LLITM v5.0, fitted in 2008 for the original LLITM model, is also illustrated for comparison; this was considerably higher.

Table 3.4: LLITM Bus Fare Functions, LLITM 2014 and LLITM v5.0



3.7.6 The bus fare function in previous versions of LLITM was too high. It was fitted based on full, adult, single fares (which represent only a fairly small proportion of journeys; probably less than 10%). While a discount factor was applied, this was based on a previous, unreferenced study, which may not have been particularly applicable to Leicestershire. The discount factor of 23.5% used was certainly too low, as concessionary travellers (who pay nothing) alone account for over a third of trips. A rough calculation based on ticket type data from operators suggest that the correct factor would have been closer to 50%.

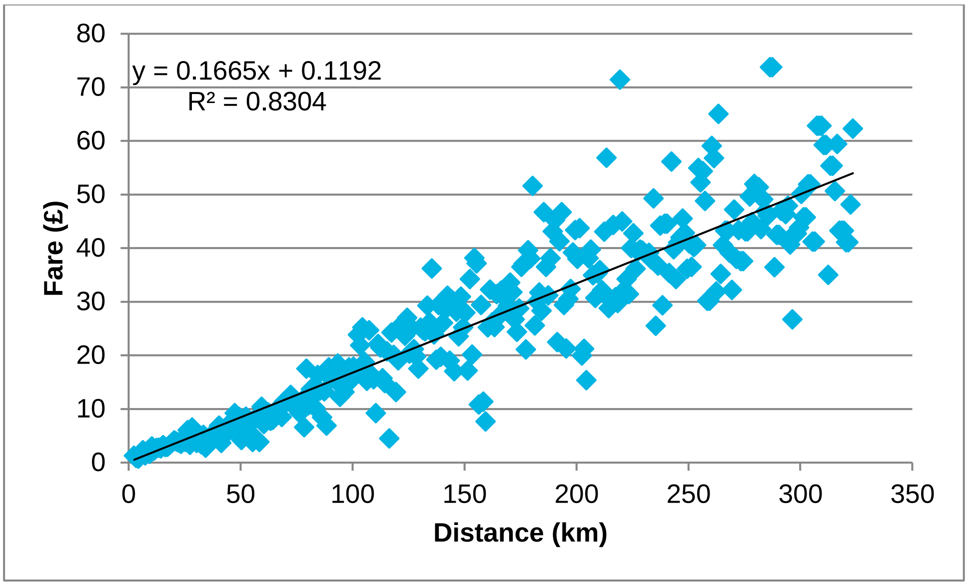
3.7.7 We thus have greater confidence in the LLITM 2014 function.

3.7.8 A different function is used for the three park-and-ride buses in Leicestershire. Here a flat fare of £1.08 for a single journey is used, based on the fare tables for these routes and proportions of concessionary and season ticket holders.

Rail Fares

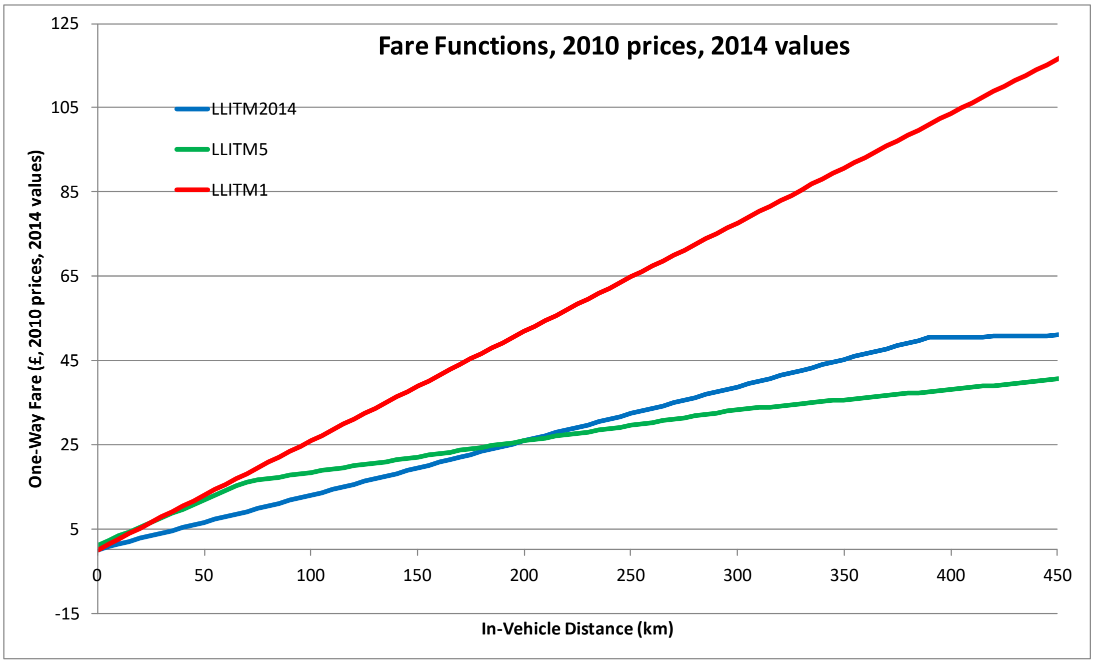
3.7.9 The rail fare function has been fitted in an analogous fashion to the bus using LENNON ticket sales data, shown below. There was no evidence of any distance dependence for fares beyond 300km. As with bus fares, the function was fitted to crow-fly distance and adjusted to on-track distance using a factor of 1.2, based on skims from the model.

Table 3.5: Observed Rail Fare Data, with Fitted Function



3.7.10 The function used in LLITM 2014 is plotted below, with comparisons against both LLITM v5 and LLITM v1. The first version of LLITM had large rail fares for long distance trips. This was found to generate implausible demand responses, and for LLITM v5 a revised function for fares beyond 100km was fitted using LENNON data. The whole function has been re-fitted for LLITM 2014; it looks similar to LLITM v5 for long-distance trips (as expected, since they were fitted from LENNON data in a similar way), but is significantly lower (about 40%) for short distance trips up to 60km.

Table 3.6: LLITM Rail Fare Functions, LLITM 2014, LLITM v5 and LLITM v1



4. Demand Matrix Development

4.1 Context

4.1.1 The public transport travel demand has been developed from a variety of sources, listed in Section 2.3.3, and has been processed to provide compatibility with the assignment models whilst adhering to the principles required by the demand model.

4.1.2 Demand represents travel on scheduled public bus services and national rail. It does not include travel on dedicated school buses, travel on non-scheduled coaches or travel on heritage railway lines.

4.1.3 Production-attraction matrices, representing person trips made between LLITM 2014 Base geographic zones, have been generated. Each contains an estimate of numbers of trips between every pair of zones, except external-external bus trips, which have not been estimated. Rail external-external trips are included.

4.1.4 Matrices are segmented in several ways: by time period, by purpose of travel, by rail / bus, by income-band and car-availability of traveller and by tour-status (see below). Each valid combination of these dimensions is stored in a separate matrix.

4.1.5 The demand matrices have been developed as two-legged tour matrices for home-based purposes (stored in production-attraction (PA) format) and as trip matrices for non-home-based purposes. A “tour” is assumed to be a pair of journeys, from home and then back to home again, linked together within the time period pair demand matrices.

4.1.6 In reality not all home-based travel forms two-legged tours, and some non-home-based travel does form two-legged sub-tours (albeit as part of larger home-based tours). The model simplification is adopted to reduce data storage and processing requirements, and is reasonably well supported by evidence from NTS data. Approximately 70% of home-based bus trips in reality form two-legged tours, while only 25% of non-home-based trips do. Around 8% of bus trips are non-home-based.

4.1.7 The tour matrices are formed of 15 time period pairs defining the time of the from-home and to-home legs of the tour constituting a 24-hour average neutral weekday in 2014. Table 4.1 shows the time period pairs modelled based on the assumption that a to-home leg will not occur in an earlier time period than the from-home leg; thus the return leg is assumed to occur within the same day. This assumption is based on NTS evidence that only ~4% of trips return earlier (in a later day) than they depart.

Table 4.1: Time Period Pairs for Matrix Building

Outbound \ Return	Off-Peak$_{Early}$	AM Peak	Interpeak	PM Peak	Off-Peak$_{Late}$
Off-Peak$_{Early}$	✓	✓	✓	✓	✓
AM Peak	×	✓	✓	✓	✓
Interpeak	×	×	✓	✓	✓
PM Peak	×	×	×	✓	✓
Off-Peak$_{Late}$	×	×	×	×	✓

4.2 LLITM Land-Use and Trip-End Models

4.2.1 Some use has been made of the base year LLITM land-use and trip-end models in estimating public transport demand at a zonal level. As these models will be used in forecasting changes in demand over time in LLITM 2014, it is desirable that the base demand be consistent with the LLITM trip-end model where possible.

4.2.2 The LLITM land-use model is documented elsewhere. It is based on 2011 Census and other recent data on population and employment at a fine geographic level. Only the 2014 base land-use scenario has been used in the base matrix development.

4.2.3 The LLITM trip-end model is documented in PR103 – Demand Model Development Report. It is based on the latest National Trip-End Model (NTEM), version 7.0, and the CTripEnd software that runs NTEM. It uses NTEM population and employment data outside the LLITM land-use model area (Leicestershire and all adjacent counties, broadly), but replaces this with data from the LLITM land-use model within the model area. It uses NTEM trip-rates, in terms of trips per person and trips per job, combined with the land-use population and employment data, to calculate trip productions and attractions (and thus origins and destinations) by zone.

4.2.4 The trip-end model is thus well-grounded in actual, recent land-use, and is capable of providing reasonable estimates of trip-making at a detailed model zonal level, which is much more precise than most available data sources.

4.2.5 However, the trip-rates in NTEM (and thus the LLITM trip-end model) are not very finely disaggregated by area or area type. The latter is a particular concern for public transport, because the model does not take account of level of, for example, bus accessibility in estimating bus trips by zone. Accordingly, we believe the trip-rates in NTEM over-estimate bus travel in Leicestershire by approximately 50%, and this overstatement exists broadly in all forecast years. It is not primarily the result of a failure to correctly forecast reductions in bus trip rates over time; although this is a (more minor) issue also.

4.2.6 Because of these weaknesses, the trip-end model data have not been used to derive absolute levels of trip-making anywhere in the matrix development process, but have been used to calculate local splits from larger geographic areas to model zones and to split purposes, directions of travel, and home-basis. These are discussed in the matrix build specification below at the appropriate points.

4.3 Rail Demand Matrices

4.3.1 Rail matrices were developed using LENNON data for the whole of the UK for March 2014. The data were then disaggregated by purpose and time period using data from the LLITM 2014 trip-end model and National Travel Survey (NTS) data from 2009-2012. Income splits were subsequently also derived from NTS data.

4.3.2 The process for constructing observed rail demand was as follows:

- create origin-station to destination-station rail matrices for the whole country using LENNON data;
- use a gravity model to disaggregate demand among ultimate origin and ultimate destinations based upon the stations used; and
- apply trip-end model data to derive splits by purpose, and then apply NTS data to derive splits by time period and time period pair.

LENNON Data

4.3.3 LENNON ticket data for the whole country for March 2014 were available. These comprised 4.2 million records and 50 million ticket sales. These were a complete representation of all national rail tickets sold in the UK and were used as the starting point for matrix development.

4.3.4 LENNON data represent ticket sales rather than journeys made. Estimates of total trips made per ticket issued, by ticket type, were required to create matrices of trips. For each ticket type in the LENNON database a decision was made on whether this related to a single trip or a tour, and the number of trips that the ticket entitles the customer to over the duration of its validity. Most of these estimates were acquired from databases that were already at our disposal but some had to be filled in logically.

4.3.5 Table 4.2 shows the trips that were assigned to the most frequently used ticket types in the LENNON dataset, along with the number of tickets of that type sold in Leicestershire. These represent about 87% of Leicestershire rail journeys. Expansion factors and tour flag were, however, estimated for all ticket types in LENNON.

Table 4.2: Breakdown of Ticket Sales by Common Ticket Types, Leicester and Leicestershire

Ticket	Tour?	Expansion	Sales	Implied Journeys
STANDARD DY RTN 2BAF	Yes	1	47,468	94,936
SEASONS VB 1 2MTA	Yes	20	1,593	63,720
SAVER RETURN HI 2BFP	Yes	1	30,982	61,964
CHEAP DY RTN HI 2BDY	Yes	1	25,103	50,206
7 DAY SEASON 2MQA	Yes	4.5	4,844	43,596
ANYTIME RETURN STANDARD 2BUA	Yes	1	12,135	24,270
SUPER OFF PK SSR 2BSO	Yes	1	11,518	23,036
STANDARD SINGLE 2AAA	No	1	22,372	22,372
SEASONS VB 3 2MTW	Yes	240	42	20,160
STD CHEAP SNGL 2ADA	No	1	13,063	13,063
REDUCED SINGLE2 2AGH	No	1	4,802	4,802

4.3.6 In order to produce average weekday trip and tour rail demand matrices, it was necessary to allocate stations to model zones before tabulating the data. This was done initially by looking up LENNON stations against the Ordnance Survey Meridian2 layer to return coordinates. This resulted in matches for about half of LENNON stations, but differences in the precise wording of station names meant that some had to be matched manually.

4.3.7 A detailed search was made for all stations in and in the vicinity of Leicestershire, to ensure these were matched correctly. Other stations were sorted by patronage, and stations with at least 7,000 passengers per months were all matched. Given the large number of stations (roughly 5,000), however, this was not extended to all stations. Consequently, about 0.1% of total Great Britain ticket sales, all well outside the model internal area, were not matched to a model zone and thus not included in the demand matrices.

4.3.8 East Midlands Parkway and Corby stations were found to be missing entirely from the Meridian2 layer, as these are new stations in the vicinity of the LLITM area, both having opened in 2009. Both were matched to model zones.

4.3.9 Trips allocated to “tours” were assumed to be “home-based”, for consistency with LLITM 2014 assumptions. Likewise, trips allocated to “trips” were assumed to be “non-home-based”. Although this is a simplifying assumption, the allocation produced home-based proportions broadly consistent with estimates from the trip-end model.

Access/ Egress Gravity Model

4.3.10 As LENNON data represent trips from station to station, and the demand matrices must represent travellers' ultimate origins and destinations (and productions and attractions), it was necessary to distribute demand over access/egress zones. A gravity model was constructed to distribute trip-ends, taking the following form:

$$D_{ijab} = D_{ab} k_{ab} P_i A_j d_{ia}^{(\lambda_{l1}-1)} e^{\mu_{l1} d_{ia}} d_{jb}^{(\lambda_{l2}-1)} e^{\mu_{l2} d_{jb}}$$

where :

i = origin zone ;

j = destination zone ;

a = origin station zone (from LENNON data) ;

b = destination station zone (from LENNON data);

D_{ab} = demand (from LENNON data);

P_i , A_j = production and attraction factors, derived from the trip-end model supplied with land-use model data.

d_{ia} = distance from origin zone i to origin station a;

λ_{l1} , μ_{l1} = calibrated parameters for access, by trip length (from a to b) band l;

λ_{l2} , μ_{l2} = calibrated parameters for egress, by trip length (from a to b) band l; and

k_{ab} = factor to control total demand from a to b to the total in the LENNON matrix.

4.3.11 Demand was then aggregated over a and b: the final demand matrices were not stored by origin and destination station; but only by ultimate origin and destination zone, so:

$$D_{ij} = \sum_{ab} D_{ijab}$$

4.3.12 Finally, i and j were considered for a given a and b only if they fell into a defined "catchment area" for each station. In the case of most external stations, a station's catchment area was its own zone only; in the case of Leicestershire stations and a number of stations close enough to Leicestershire to reside in a detailed LLITM zoning area, it was a larger area around the station; generally slightly larger than the urban area in which the station is located.

Table 4.3: Stations for which Access/Egress Gravity Model Was Applied

Main Leics. Stations	Minor Leics. Stations	External Stations
Hinckley	Barrow-Upon-Soar	Long Eaton
Leicester	Sileby	Rugby
Loughborough	South Wigston	Bedworth
Market Harborough	Syston	Attenborough
Melton Mowbray		East Midlands Parkway
Narborough		Nuneaton

4.3.13 Bottesford was the only station within the county for which a gravity model was **not** applied, as the LLITM 2014 zoning around this (very minor) station is not sufficiently detailed that the station is likely to capture much demand outside its own zone.

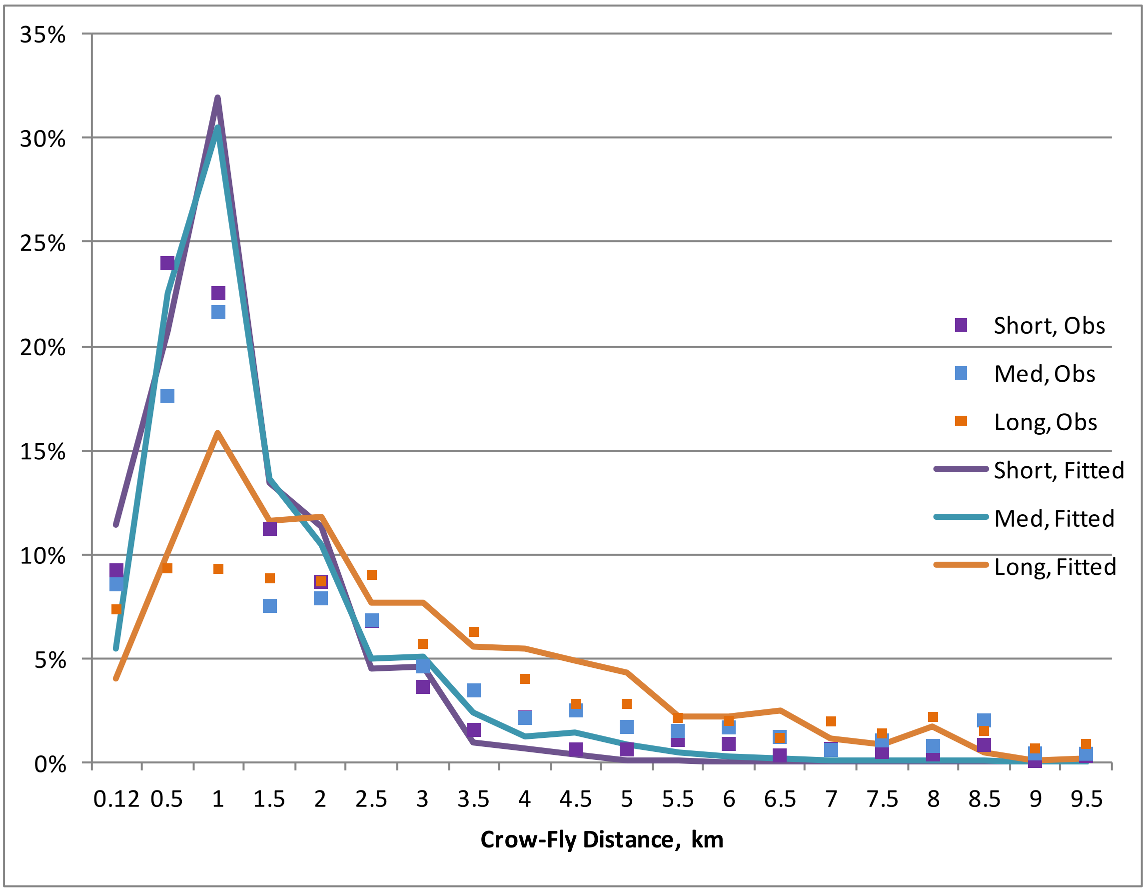
4.3.14 λ and μ parameters for distance were calibrated, by length of rail trip, using NRTS data (discussed below). Longer trips, as expected, had longer access/egress profiles, i.e. travellers were more likely to travel some distance to a railway station if their rail trip was itself long. The calibrated parameters are shown in Table 4.4.

Table 4.4: Calibrated Gravity Model Parameters

Distance Band	0-35 km	35-100km	100km+
Lambda (λ)	0	-0.1493	0
Mu (μ)	-0.7508	-0.1986	0.25

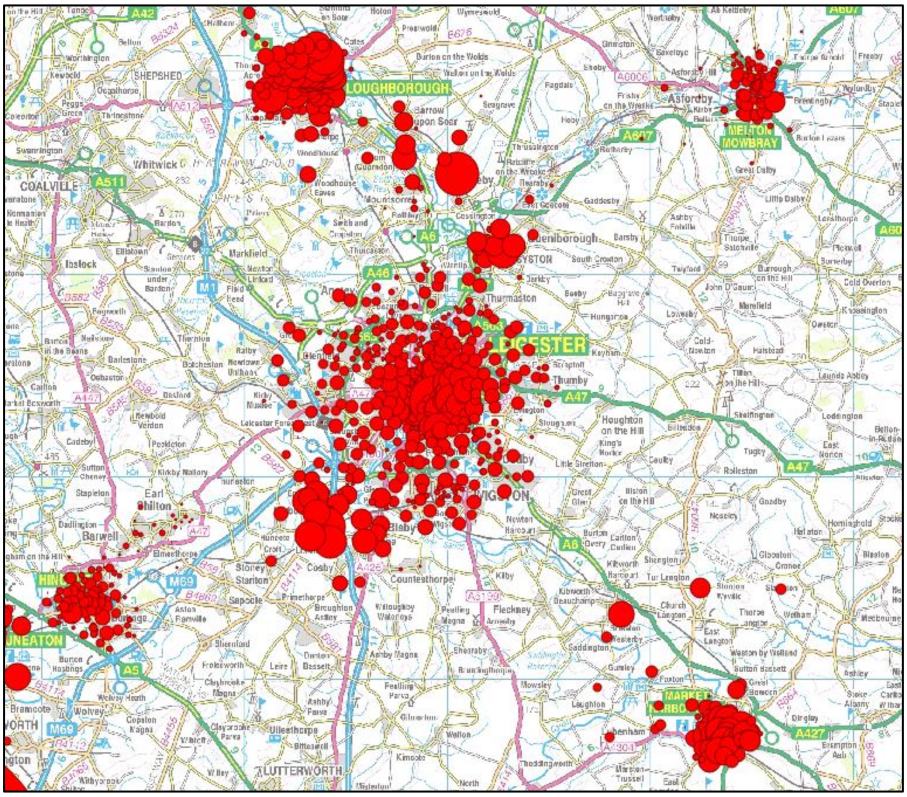
4.3.15 Figure 4.1 illustrates the trip-length distribution for the observed NRTS data, against the output of the gravity model, for all three distance bands.

Figure 4.1: Access-Egress Distance Functions, NRTS against Fitted Functions



4.3.16 Figure 4.2 shows origins over an average weekday within Leicestershire, following the application of the access/egress gravity model:

Figure 4.2: Leicestershire Origins after Trip End Disaggregation, All Purposes



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4.3.17 Note that the gravity model was only used to disaggregate the observed LENNON rail demand from stations to modelled zones. The LENNON dataset provides what is in principle a full observed matrix, and so the derivation of purely synthetic demand was not required.

Splitting Demand by Purpose

4.3.18 LENNON data contain tickets sold by type, issuing station, origin station and destination station but lack some information that we require to construct rail matrices, among them trip purpose (reason for travelling).

4.3.19 A number of possible sources of data were considered for splitting data by purpose, as follows:

- National Rail Travel Survey (NRTS) dataset from 2004. This covers the whole country, has a sample of about 12,000 interviews for Leicestershire stations, but is not bias-corrected and is 10+ years old.
- Leicester and Leicestershire rail passenger interviews conducted at railway stations in 2003 and 2008 for the first LLITM model. These comprise around 3,000 interviews, again are not bias-corrected, and are quite old (especially the Leicester data, which are from 2003).
- The National Travel Survey (NTS). This is a household survey of travel over a week, carried out on a rolling basis. The complete sample of rail trips from 2002-2012 across Britain is around 10,000, but most of these are either or both of quite old and not relating to the model area. Recent data for the East Midlands can be extracted, but these amount to only a few hundred records. The NTS data are bias-corrected using demographic data, and they are available for 2012, which is relatively recent; however the sample size is low relative to other sources and unlike NRTS and the LLITM interviews, they have no geographic detail below the regional level.
- The National Trip-End Model (NTEM) 6.2. This is based on NTS person trip-rates from the late 1990s), and population and employment data from the 2001 Census. These

represent very old data; however unlike the interview sources they do provide reasonable estimates at a zonal level, based on the land-use in the zone (employment, school, shops, etc.).

- The LLITM trip-end model, as discussed in Section 4.2. This is closely related to NTEM, but is based on 2011 Census and other more recent land-use data (it still relies on late 90s NTS trip rates, however).

4.3.20 Data were extracted from all of these sources for comparison and validation; however the primary source was the LLITM trip-end model. None of the interview data sources had sufficient sample sizes to reliably estimate purpose splits by production and attraction zone (NTS also lacks the geographic detail to do this), and this is felt to be important for the proper functioning of the mode-choice and trip-end forecasting models.

4.3.21 In addition to this, purpose splits by trip-length were extracted from (ageing) NRTS data for Leicestershire. This resulted in three estimates of purpose splits for each production-attraction movement; one from the origin (trip-end model), one from the destination (trip-end model) and one from the trip-length (NRTS). These were averaged for each movement and purpose, the purpose proportions renormalised to 1 for each movement, and the process applied to the whole matrix.

4.3.22 Purpose proportions for aggregate areas are shown from various sources below. “MA” is “Model Area”, that is Leicester and Leicestershire combined. “EM” is the East Midlands region.

Table 4.5: Rail Purpose Proportions, Various Sources

Area	**City**	**Leics.**	**EM**	**GB**	**MA**	**MA**	**GB**	**MA**	**GB**
Year	2003	2008	2002-12	2002-12	2005	2001	2001	2014	2014
Source	Interview	Interview	NTS	NTS	NRTS	NTEM	NTEM	Model	Model
HB Work	25%	34%	32%	46%	44%	38%	50%	34%	45%
HB Business	6%	8%	10%	7%	17%	5%	3%	6%	3%
HB Education	19%	15%	9%	10%	10%	10%	8%	15%	6%
HB Shopping	9%	6%	10%	8%	5%	7%	7%	8%	6%
HB Other	27%	25%	28%	20%	17%	15%	13%	17%	10%
NHB Business	3%	3%	3%	2%	3%	4%	3%	6%	9%
NHB Other	10%	10%	7%	7%	5%	20%	15%	14%	22%

4.3.23 The green-shaded columns on the right represent the final LLITM 2014 model matrices. Overall we consider these good estimates of purpose split, based on the available evidence.

4.3.24 There is much broad agreement between data sources, but also some sometimes substantial differences. A few obvious things are notable from the data relating to the whole of Great Britain relative to that relating to Leicestershire or the East Midlands; for example, the commuting proportion is significantly higher in the GB data. The business proportions are generally notably lower in the GB data.

4.3.25 NRTS has a number of oddities relative to most other data sources; it has a much higher commuting proportion (closer to the GB figures despite the data being for the model area), and an unusually high home-based business proportion also. We are uncertain why this is; it appears from these figures that the NRTS may have over-sampled longer-distance trips (i.e. those travelling between Leicester and London or Birmingham).

4.3.26 Most of the data sources agree on a non-home-based proportion of around 10%. NTEM is an exception; it suggests around 20%. This is consistent with the LENNON split into trips and tours based on ticket types; the model matrices thus accord best with NTEM. Given NTEM's weaknesses (little geographic variation), it appears likely the model has a little too much non-home-based demand and somewhat too little home-based (this is true for both "business" and "other" trips). However, this is not considered a major issue, as behavioural parameters will be similar and the non-home-base proportion remains relatively low.

4.3.27 The only other noteworthy discrepancy between the model area matrices in LLITM 2014 and the evidence is that a significantly higher education proportion is returned than most sources report. However, this is consistent with the 2003/2008 LLITM model rail interviews.

4.3.28 Purpose splits by trip length were extracted from NRTS data, and used to fit functions of distance to each purpose proportion. These resulted in average trip lengths by purpose for trips produced in Leicester and Leicestershire as follows, compared against NTS for the East Midlands and NRTS for Leicestershire and Leicester.

4.3.29 Generally the model reproduces the NRTS distances used to fit it fairly well, and is broadly consistent with the NTS figures also, although the comparison is less clear due to the difference in definition of distance; we would expect the NTS in-vehicle distances to be higher than crow-fly distances, and indeed they are.

Table 4.6: Average Trip Lengths by Purpose, Rail, kilometres

	Model (crow-fly)	NTS (In-vehicle)	NRTS (crow-fly)
HB Work	50.9	67.9	44.4
HB Employers' Business	102.5	152.6	99.9
HB Education	48.5	41.4	49.2
HB Shopping	35.2	37.7	33.4
HB Other	104.3	126.1	90.0
NHB Employers' Business	120.7	152.6	81.0
NHB Other	106.8	126.1	78.3

Splitting Demand by Time Periods

4.3.30 LENNON data do not contain any time of day information, so the split of demand to time of day had to be carried out post-processing. Time of day proportions, at a tour-level (both outbound and return times) for home-based trips, and at a trip-level (time of trip only) for non-home-based trips, have been extracted from the National Travel Survey. NRTS might have been preferred, but NRTS contains no data for individuals, making it hard to link trips into tours and thus derive tour proportions.

4.3.31 Time of day splits have been derived by purpose, and the split into time periods applied after the split into purposes. This, combined with most tickets being represented as tours, enables tidality (direction of travel in morning and evening peaks, for example), to be captured in the matrices. Commuting into the centre of Leicester, for example, will tend to be outbound in the AM and returning in the PM, because the centre of Leicester has high employment (and thus high attraction factors and lower production factors in the trip-end model), and because sales of return and season tickets will tend to be made at the production stations (e.g. Narborough or Syston), meaning the tours generated will generally be in the appropriate direction.

4.3.32 It should be noted, however, that some people do buy season tickets at the "employment" end of their trip, leading to incorrect allocation in the model. This is a weakness in LENNON data that is difficult to correct for; the tidality in the matrices may therefore be slightly understated.

4.3.33 Time period pair splits are shown for each purpose in the table below.

Table 4.7: Rail Time Period Pair Split Factors for Commuting

		Return Leg				
	%	OP Early	AM Peak	Interpeak	PM Peak	OP Late
Outward Leg	OP Early	0%	0%	3%	22%	2%
	AM Peak		0%	4%	57%	6%
	Interpeak			0%	1%	3%
	PM Peak				0%	1%
	OP Late					0%

Table 4.8: Rail Time Period Pair Split Factors for Business

		Return Leg				
	%	OP Early	AM Peak	Interpeak	PM Peak	OP Late
Outward Leg	OP Early	0%	0%	7%	15%	2%
	AM Peak		0%	20%	38%	3%
	Interpeak			4%	7%	5%
	PM Peak				0%	0%
	OP Late					0%

Table 4.9: Rail Time Period Pair Split Factors for Education

		Return Leg				
	%	OP Early	AM Peak	Interpeak	PM Peak	OP Late
Outward Leg	OP Early	0%	0%	0%	1%	0%
	AM Peak		3%	48%	31%	3%
	Interpeak			8%	5%	1%
	PM Peak				0%	0%
	OP Late					0%

Table 4.10: Rail Time Period Pair Split Factors for Shopping

		Return Leg				
	%	OP Early	AM Peak	Interpeak	PM Peak	OP Late
Outward Leg	OP Early	0%	0%	0%	0%	0%
	AM Peak		0%	28%	7%	2%
	Interpeak			32%	25%	3%
	PM Peak				0%	2%
	OP Late					0%

Table 4.11: Rail Time Period Pair Split Factors for Other

		Return Leg				
	%	OP Early	AM Peak	Interpeak	PM Peak	OP Late
Outward Leg	OP Early	0%	0%	1%	2%	0%
	AM Peak		0%	18%	11%	3%
	Interpeak			19%	16%	9%
	PM Peak				1%	15%
	OP Late					4%

Matrix Validation

4.3.34 The matrix has been validated for the 11 Leicestershire stations and East Midlands Parkway against the published Office of Rail and Road (ORR) station entry figures and the NRTS dataset. Note that this is strictly a validation of the prior matrix; the demand is at a matrix zonal level and will not precisely match network boardings in the assignment, which are considered in Chapter 5. A summary of the comparison is given in Table 4.12 below.

Table 4.12: LENNON vs. others, Rail Passengers Beginning Their Journey, Weekday, Prior Demand

Station	ORR Annual	ORR Weekday	LENNON Model Demand	Diff	NRTS 2005
Barrow-Upon-Soar	44,687	150	149	-1%	78
Bottesford	23,711	74	67	-9%	-
East Midlands Parkway	164,223	511	485	-5%	-
Hinckley	143,326	446	394	-12%	631
Leicester	2,426,954	7,550	7,504	-1%	8,482
Loughborough	620,623	1,931	1,975	2%	2,736
Market Harborough	398,945	1,241	1,153	-7%	1,033
Melton Mowbray	120,573	375	344	-8%	572
Narborough	195,141	607	629	4%	363
Sileby	55,739	187	193	3%	133
South Wigston	33,329	104	101	-3%	86
Syston	87,805	295	306	4%	267
Totals	**4,315,056**	**13,471**	**13,300**	**-1%**	**14,381**

4.3.35 The ORR data are for annual trips. They have been corrected to weekday using the numbers of days in a year combined with a weekend correction factor derived from NTS. The average weekend day has 63% of the rail demand of an average weekday; this has been used for all stations except Sileby, Syston and Barrow-upon-Soar. These stations have no Sunday service; for them a weekend factor equal to the average Saturday relative to average weekday (86%), divided by two (43%), was used as there will be no Sunday traffic at all.

4.3.36 The comparison against ORR is extremely good; this confirms that the LENNON data have been interpreted and processed correctly. However, the ORR statistics are based ultimately on LENNON also, so this is not an independent validation of LENNON itself.

4.3.37 The NRTS data does not compare so well; however there is still a good broad correlation and the NRTS data are 11 years old. Generally the NRTS data are higher than other sources. There are no NRTS data available for East Midlands Parkway (which did not exist in 2004/5), or Bottesford (which was omitted from the original NRTS data request as minor and not on a Leicestershire railway line).

4.3.38 Consideration was given to any bias introduced by fraudulent (non-fare-paying) rail trips, as these would not be recorded in LENNON data. Leicester, Loughborough, Market Harborough and East Midlands Parkway have ticket gates and can be expected to have low levels of fare-evasion. There is no evidence, above, relative to NRTS and count data, of a significantly worse validation for the un-gated stations, so no correction was applied.

4.3.39 The ticket data were inspected to confirm proportions of (paid) journeys between two un-gated stations. Only 5% of ticket sales wholly within Leicestershire are between two un-gated stations; these are mostly between Barrow and Sileby and among Narborough, Hinckley and South Wigston.

4.3.40 Interchanging passengers are not included in the above; these are considered in assignment validation in Chapter 5. ORR figures report that interchanging passengers are equal to roughly 15% of the entries at Loughborough and East Midlands Parkway and approximately 5% at Leicester. All other stations have no interchanging passengers.

Assignment Matrices

4.3.41 Once the trips/tours data had been split by purpose and time period to create a total of 85 demand matrices (15 time period pair matrices for the five home-based purposes and five time period matrices for the two non-home-based purposes), assignment matrices were created by combining the outbound and return trips, across all purposes, for the AM, interpeak and PM.

4.3.42 The final rail matrix totals are summarised in Table 4.13. It should be noted that the Leicestershire/Leicester total is not quite the same as that reported in Table 4.12. This is because Table 4.12 reports passengers beginning their rail journey at a Leicestershire/Leicester station or East Midlands Parkway, while Table 4.13 reports passengers beginning their overall journey at an address in Leicestershire or Leicester. However, the two figures are very close.

Table 4.13: Rail Demand Totals, By Period, Weekday

Time Period	Full Matrix	Leics. Origins
AM Peak	1,302,250	4,132
Interpeak	1,125,279	3,659
PM Peak	1,402,433	3,521
Off-Peak	612,434	1,646
Daily	**4,442,396**	**13,148**

4.4 Bus Demand Matrices

Passenger Interview Data

4.4.1 Around 16,000 interviews of bus passengers were carried out in 2014 in urban centres in Leicester and Leicestershire. These recorded ultimate origin and destination information for the passengers' journeys, as well as travel purpose, household car ownership and times of day, including information on returning times for outbound trips. Associated boarding and alighting counts were collected to allow these interviews to be expanded.

Table 4.14: Interview Locations

Town	Bus Stops	Survey Date
Ashby	Market Street 1, 2 & 3	22/05/2014
Coalville	Ashby Road 1	04/06/2014
	Marlborough Square 6 & 7	04/06/2014
	High Street, opp. FP Centre	04/06/2014
	Memorial Square 1 & 2	22/05/2014
	Memorial Square 5	04/06/2014
Hinckley	Regent Street R1 to R4	05/06/2014
	Bus Station W1 to W5	05/06/2014
Loughborough	Centre, Stands A,D-G,K-L,N-Q	15/05/2014 to 12/06/2014
	High Street C1,C2,B1,B	05/06/2014
	Railway Station, Stand R	12/06/2014
	University	12/06/2014
Lutterworth	George Street	22/05/2014
	High Street 1 & 2	10/06/2014
	Magna Park	10/06/2014
Market Harborough	Market Square 1 to 4	22/05/2014 to 10/06/2014
	Market Hall Bus Station	10/06/2014
Melton Mowbray	St Mary’s Way S1 to S4	11/06/2014
	Wilton Road	11/06/2014
	Windsor Street W1 to W4	22/05/2014 to 11/06/2014
Leicester	Beaumont Leys, 1 to 7	20/05/2014
	Fosse Park	15/05/2014 to 24/06/2014
	All within Inner Ring Road (99)	06/05/2014 to 25/06/2014

4.4.2 These data were used both to supply purpose, car ownership and travel time information for the demand matrices, and to validate and compare against the geographical distributions implied by the Electronic Ticket Machine (ETM) data.

Table 4.15: Number of Interviews

Town	Interviews
Leicester	12,541
Market Harborough	304
Melton Mowbray	581
Loughborough	1,231
Lutterworth	158
Ashby-de-la-Zouch	338
Coalville	454
Hinckley	443

4.4.3 Generally the interviewers did not interview under-16s. This means that the surveys understate school pupils using public buses.

4.4.4 The data are precise to variable levels of geographic detail. Some respondents gave actual postcodes, and their origins / destinations are thus correct to a high level of precision. However, many records were allocated roughly to a “central” postcode by the surveyors based on a vague description by the interviewee (e.g. “shopping in the centre of Leicester”), meaning that the data are not precise at a zonal level. Due to the way the data have been coded, it is not possible to determine with certainty how precise any given record is, although general patterns can be identified.

4.4.5 About 20% of records are missing either origin or destination information altogether, and about 2% are missing both.

4.4.6 A question regarding time of day in which a reverse-direction trip was made was asked. This appeared to return reasonable results for passengers interviewed travelling from home, but not for passengers travelling to home; the question does not seem to have been correctly interpreted for returning passengers.

Electronic Ticket Machine (ETM) Data

4.4.7 Electronic ticket machine (ETM) data have been collected from nine bus operators in Leicestershire. Between them, they cover an estimated 99% of public scheduled local bus services that operate in Leicester or Leicestershire. The missing data are primarily from two operators, Midland Classic and Travel De Courcey (about 1% in total), that each operate a few bus journeys per day into Leicestershire from outside the county.

4.4.8 The coach operators, National Express and Megabus, were also not approached for data. Coach journeys represent about 1% of total scheduled bus journeys in the county.

4.4.9 The data are summarised below. “Daily Journeys” refers to vehicle trips, not number of passengers.

Table 4.16: ETM Data – Data Collected by Bus Operator

Operator	Services Operated	Daily Journeys	Operating Area	Total Passenger Records
Arriva	68	2,823	Leicester and Leicestershire	4,906,481
First	19	1,406	Leicester only	2,847,370
Centrebus	33	790	Leicester, Melton, Market Harborough	776,921
Kinchbus	7	597	Loughborough	881,211
Stagecoach	4	583	Hinckley, Leicester, Inter-town	486,572
Roberts Coaches	7	268	Park-and-Ride, Inter-town	188,647
Paul S Winson	5	124	Loughborough	70,191
NCT	1	84	Nottingham - Loughborough	272,865
Macpherson Coaches	3	33	Ashby-de-la-Zouch	43,473
Totals	**149**	**6,708**	-	**10,473,731**

4.4.10 Although there is variation in the format of data provided, the bus operators have generally provided record-based data, containing one passenger boarding or other event per record. This generally covers most of the following:

- bus service number;
- bus journey departure time;
- boarding event time;
- ticket type;
- fare paid;
- boarding stage identifier; and
- alighting stage identifier (certain ticket types only).

4.4.11 The data in principle cover all passenger boardings, including concessions, use of return tickets, and use of smartcards and other passes, as well as actual ticket sales. Comparison with other data sources suggests that the substantial majority of boardings are included (at least 90%), but it is possible there is limited non-recording of boardings where no ticket sale occurs.

4.4.12 Two operators, Kinchbus and Nottingham City Transport (NCT), provided boarding information by NaPTAN[2] bus stop code. All other operators used only their own fare stage codes which identify a group of bus stops in the same general area (such as “Loughborough University”).

4.4.13 Four operators provided significantly different data:

- Macpherson Coaches provided only total passengers and fare by a few ticket types, with no bus service number or geographic information.
- Centrebus, Paul S Winson and Roberts Coaches provided matrix-based boarding / alighting data by service, containing total passengers by origin fare stage and destination fare stage. These data lack travel times, day of week, and breakdown into ticket types. Centrebus and Paul S Winson in addition provided separate summary tables containing passengers by service, date, and time of day, but without geographic data. Roberts provided no additional data.

4.4.14 With the exception of Centrebus, these are relatively minor operators with only a few services.

Bus Journey Stage Allocation

4.4.15 The stages provided by operators had to be converted to LLITM 2014 Base zones. Stage information was generally in the form of a numeric ID, followed by a text description, for example, “22004 Nicklaus Rd (Turning Circle)”.

4.4.16 This allocation was carried out by service, using MapInfo GIS software. Information regarding bus routes, NaPTAN bus stops, the LLITM 2014 Base zone system and a street plan were used to allocate a list of one or more model zones to each fare stage. These were chosen on the assumption that travellers will generally not walk much more than 500m to a bus stop, that they will choose the closest bus stop on the service in question and will choose the most convenient bus corridor where there is a choice. More zones were required per fare stage within urban centres where zones are smaller.

4.4.17 The mapping for Kinchbus and NCT, the data for which include NaPTAN stop codes, was carried out by automatically mapping each stage to a set of NaPTAN bus stops using the data themselves. Then each NaPTAN stop was manually allocated to one or more LLITM 2014 Base zones. This enabled slightly greater geographic precision than for other ETM data.

4.4.18 An example of the process as applied to one (Kinchbus) service in Loughborough is illustrated in Figure 4.3. Stops on this service are shown as coloured circles, coloured according to their coded stage. A mapping of the red stage to zones is shown in red cross-hatch (the zone layer is in green). All zones containing one of the stops are included, as are two more remote zones within easy walking distance of the route. Zones south of the A512 are not included, as travellers are considered more likely to use a different bus corridor than cross this road.

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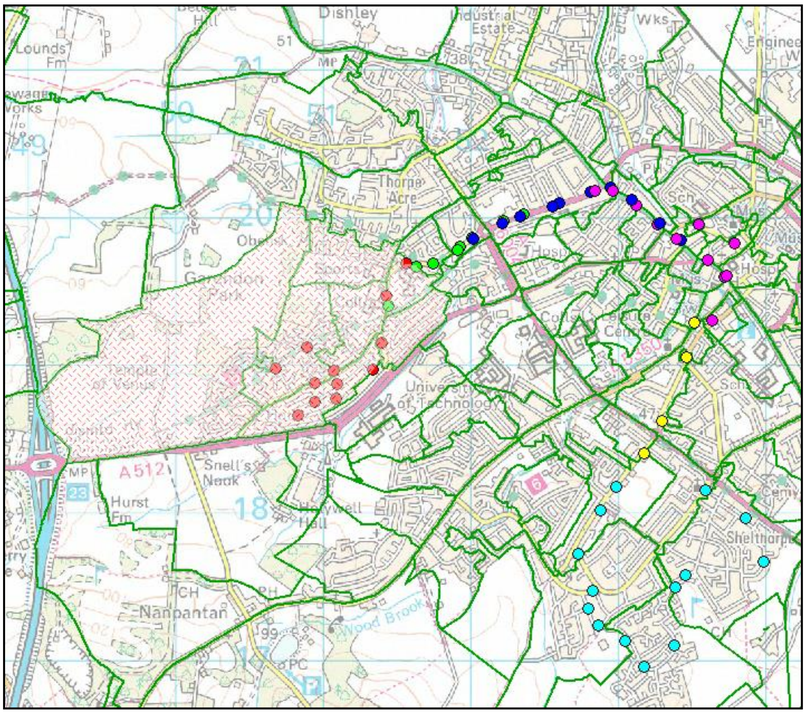
[2] National Public Transport Access Node (NaPTAN)

Figure 4.3: Example Stop / Stage to Zone Allocation



4.4.19 For most operators, the precise stop-to-stage correspondence was not available, and the process of mapping stages to model zones relied on text descriptions coupled with route trajectories and street plans. The locations of bus stops on the route trajectories was considered; however, it was not always possible to tell with certainty between adjacent fare stages which stops were covered by which stages, except for the Kinchbus and NTS data.

Travel Times and Periods

4.4.20 Most operators provided boarding event dates and times, enabling the data to be built by time period and weekends and holidays to be excluded from the data. Given the short length of most journeys, trips were allocated to time periods by their initial boarding time. Data were built for the night-time off-peak (19:00 to 07:00) period as well as the three public transport model periods. The off-peak demand is required for the demand model.

4.4.21 Centrebus and Paul S Winson data was not supplied in detail by boarding date and time. They were split into time periods and corrected to remove weekend data using the summary statistics provided with the matrix data in the form of total boardings by time, date and service. The form of the data allowed most services to be split separately by direction of travel, ensuring tidality; however for a few services this was not available.

4.4.22 Roberts Coaches provided no time period or date information at all. A weekend correction factor, derived from the Centrebus data, of 0.86, was applied to the data to obtain 3-month weekday travel from 3-month total travel. Data were split into time periods using factors generated by service from the boarding and alighting counts associated with the passenger interview data. No off-peak travel was assumed; in general Roberts services do not operate at night.

4.4.23 Roberts coaches provided data for July as well as the April-June period requested. This was not used. Roberts also provided data for the 103, 203 and 303 park-and-ride buses. The park-and-ride demand was not incorporated into the bus passenger matrix; this is because the parking model forecasts this demand separately from the rest of bus passenger demand.

Alighting Points

4.4.24 Although most of the ETM data contain alighting stage information, these data are accurate only for certain kinds of ticket; generally singles and returns. For concessionary fares, multi-day tickets, season tickets and other passes, these data are generally either missing or coded arbitrarily (either to the same point as the boarding or to the last calling point of the service). Between 5% and 70% of passengers detailed in the ETM data have associated alighting information, depending on service and operator.

4.4.25 Accordingly, it was necessary to estimate alighting points where these data are not available. For most operators it was possible to clearly identify which data needed to be infilled. For some, the data are simply missing or blank; for others the ticket types with incorrect alighting points were identified.

4.4.26 For Centrebus missing alighting data were coded as if the alighting and boarding points were the same. It was necessary to assume that all trips whose boarding and alighting points were the same needed to be corrected. This will not be true for absolutely all trips, but there will be relatively few trips short enough to remain within a single stage for their entire journey.

4.4.27 There are three possible sources of data that might inform alighting points:

- the alighting points available for the single and return tickets, from the same service, given the same boarding point, direction of travel, and time of day;
- the passenger interview data, which are a sample of trips which board within urban centres; and
- the distribution of boarding points for the same service, since the substantial majority of passengers will make a similar return trip on the same service and so at an all-day level the total boardings and alightings should be very similar.

4.4.28 The boarding points, the third source, are unsuitable without other assumptions, because they lack information concerning the typical length distribution of trips. Simply distributing the alighting points for a service in the same proportions as the boardings, across all journeys, would distort trip lengths by failing to take account of the boarding point in determining the alighting. They are also unlikely to be robust at a stop level, as passengers often tend to alight at different stops to those used for boarding. At a fare stage level, they should be fairly accurate.

4.4.29 Both of the other sources are potentially biased. The ETM alighting points are biased towards journey patterns for less frequent travel (which are more likely to use singles and returns), while the interview data are both biased towards travellers with more time available to answer interviews, and less useful for boardings other than in the town centres (they also suffer from low sample sizes relative to other data).

4.4.30 We primarily used the available ETM alighting information as a starting point, due to the fact that it both encompasses a larger sample than the interview data and is applicable to all trips. For one operator, First, the alighting information was invalid for almost all trips and thus did not represent a large or representative enough sample to be used. Accordingly, the boarding points were used to distribute the alighting points, with allocation by direction of travel used to ensure broadly logical trip lengths.

Creation of Zonal Trip Matrices by Purpose

4.4.31 Following the above process, trip-based zonal matrices were created by time period, service and direction of travel.

4.4.32 Zone-based matrices were created by splitting each record among the zones allocated to the boarding and alighting stages using estimates from the LLITM trip-end model. Given the relatively short distances and small numbers of zones involved, we did not construct a full gravity model to take account of the relative distances to the bus stops from model zones.

4.4.33 Records not referring to passenger boardings were ignored as part of this process. These include bus start times, fare stage changes, incidents and refunds; not all operators use each or any of these. Records referring to a cancellation of a ticket issued in error were considered as negative trips, as these cancel out an earlier (mis-sold) ticket which will also have been included in the dataset.

4.4.34 Data were aggregated by origin and destination zone following this process.

4.4.35 Purpose splits were then applied to the matrices. As with the rail demand, there were a number of possible sources of data for purpose splits:

- The LLITM passenger interviews, with a sample size of 16,000. However, this is still not sufficient to estimate purpose splits at a zonal level, and the data do contain some, possibly significant, biases.
- The National Travel Survey (NTS). This is a household survey of travel over a week, carried out on a rolling basis. The NTS data are bias-corrected using demographic data, and they are available for 2012, which is relatively recent; however the sample size is low relative to other sources and unlike NRTS and the LLITM interviews, have no geographic detail below the regional level.
- The National Trip-End Model (NTEM). This is based on NTS person trip-rates from the late 90s, and population and employment data from the 2001 Census. These represent very old data; however. Unlike the interview sources they do provide reasonable estimates (with known weaknesses) at a zonal level, based on the land-use in the zone (employment, school, shops, etc.).
- The LLITM trip-end model, as discussed in Section 4.2. This is closely related to NTEM, but is based on 2011 Census and other more recent land-use data (it still relies on late 90s NTS trip rates, however).

4.4.36 Sample size, age, and geographic detail preclude the use of either NTS or NTEM as a primary source. In principle, the passenger interview data would be the better source, as they are up-to-date, actual counts of traveller purpose, compared with the trip-end model data which are estimates based on recent land-use data and old trip-rate data.

4.4.37 However, the passenger interview data sample size is low for the purpose of extracting zonal data. With roughly 24,000 trip-ends in the data, on average there are around 24 trips per zone, 12 in each direction of travel. This is too low to extract robust purpose proportions. Furthermore, a high proportion (at least 50%) of the interview data are not sufficiently geographically precise to be of use in extracting zonal proportions anyway.

4.4.38 For the public transport model itself, the purpose split has little value. Business travel on buses is negligible, and all other purposes have similar values of time and behavioural parameters. The purpose split is required for the mode choice model, and for forecasting future year trips via the land-use and trip-end models. For both of these, a good match between the model matrices and the land-use/trip-end data are important, and getting the production zone correct is particularly important. For these reasons, the LLITM trip-end model data were used as the primary purpose split source, as with the rail data.

4.4.39 All four sources, however, were compared at a global level with the resulting model purpose split, as shown below. The 2008 LLITM model is also shown for comparison.

Table 4.17: Bus Purpose Proportions, Various Sources

Area Year Source	Leics+City 2014 LLITM Model	Leics+City 2014 Interviews	Leics+City Pre-2001 NTEM	EM 2010-12 NTS	Leics+City 2008 Old LLITM
HB Work	24%	24%	22%	17%	27%
HB Business	1%	1%	1%	1%	1%
HB Education	15%	11%	27%	17%	15%
HB Shopping	26%	32%	18%	33%	17%
HB Other	23%	18%	25%	25%	35%
NHB Business	1%	1%	0%	0%	1%
NHB Other	10%	13%	6%	7%	5%

4.4.40 The modelled proportions compare very well with the interviews. The main difference is a notably higher education proportion in the model; this is expected as the interviewers were unable to interview unaccompanied children (note that sixth form, college and university students would in general have been interviewed, however). There is also evidence of a somewhat lower shopping proportion; the interviews probably have a bias towards shopping trips as they were undertaken mainly in urban centres and retail parks.

4.4.41 The model also compares quite well with NTS; here the main difference is that NTS has a lower commuting proportion. As all the sources other than NTS agree, it may be that the commuting proportion is higher in Leicestershire than the East Midlands as a whole.

4.4.42 NTEM is the least consistent of the sources; this is probably expected as it based on data more than a decade old. In particular, it has a much higher education proportion; however NTEM trips are thought to include travel on dedicated school buses.

Missing Services

4.4.43 A number of bus services in the county were missing from the detailed ETM data:

- Travel De Courcey service X6 between Leicester and Coventry.
- Midland Classic services 19 and 19A between Ashby and Burton.
- Macpherson Coaches services 1, 2 and 3 in Ashby. Macpherson coaches did provide ticket data, but unfortunately they represented only total tickets sold, without breakdown by boarding or alighting point or even service.
- First service 17 in Leicester. Again, First did provide ticket data, but in the case of service 17 they were coded with only a single fare stage; so no geographic data could be deduced.
- All Megabus and National Express coaches, all dedicated school buses, and non-scheduled and non-public services (e.g. coach excursions).

4.4.44 Demand for coaches and school buses was not estimated; the model therefore does not contain passengers for these services.

4.4.45 Demand for the other missing services was estimated by direct use of the passenger interviews. In the case of Macpherson and First, the passenger interview data were expanded to the ticket sales totals supplied by the operator. In the case of De Courcey and Midland Classic, no operator data was requested, and so the counts collected with the interviews were used for expansion; they were inflated by the boarding counts attached to the time period and bus stop they were recorded in.

4.4.46 Interview matrices were built by origin-destination movement, purpose, time period and direction of travel.

Tours

4.4.47 The above process created zone-based trip matrices for bus travel. Tours matrices are required for home-based purposes: two “legs” in opposite directions of travel (from-home and to-home) joined together to create a single tour. Unlike the rail ticket sales data, the bus ETM data does not allow tour matrices to be constructed directly as linkage between travellers’ journey legs is not generally available. The passenger interview data does; however return time information was missing for a substantial proportion of records, so these data were only used at an aggregate level.

4.4.48 Every journey allocated to “home-based” by the purpose split process was reversed to create a trip in the reverse direction. Proportions to split the unobserved direction trip by time period were derived primarily from the passenger interviews, for “from-home” trips only because the relevant interview question was answered poorly for “to-home” trips. However these lacked data for trips outbound in the off-peak, so proportions for these were filled in using NTS data for the East Midlands.

4.4.49 The purpose split process divided home-based trips into “from-home” and “to-home” using the trip-end model totals. The observed direction trip’s time period was known from the ETM data, so the interview/NTS proportions were used to divide this trip proportionally among the possible reverse-direction time periods (assuming all trips return later than they set out, as discussed in Section 4.1.7).

Table 4.18: Bus Time Period Pair Split Factors for Commuting

		Return Leg				
	%	**OP Early**	**AM Peak**	**Interpeak**	**PM Peak**	**OP Late**
Outward Leg	**OP Early**	0%	1%	6%	8%	2%
	AM Peak		0%	16%	40%	3%
	Interpeak			5%	7%	6%
	PM Peak				2%	3%
	OP Late					0%

Table 4.19: Bus Time Period Pair Split Factors for Business

		Return Leg				
	%	**OP Early**	**AM Peak**	**Interpeak**	**PM Peak**	**OP Late**
Outward Leg	**OP Early**	0%	0%	3%	5%	2%
	AM Peak		1%	27%	25%	3%
	Interpeak			12%	10%	4%
	PM Peak				1%	5%
	OP Late					1%

Table 4.20: Bus Time Period Pair Split Factors for Education

		Return Leg				
	%	**OP Early**	**AM Peak**	**Interpeak**	**PM Peak**	**OP Late**
Outward Leg	**OP Early**	0%	0%	0%	0%	0%
	AM Peak		1%	43%	16%	2%
	Interpeak			18%	11%	6%
	PM Peak				1%	2%
	OP Late					0%

Table 4.21: Bus Time Period Pair Split Factors for Shopping

		Return Leg				
	%	**OP Early**	**AM Peak**	**Interpeak**	**PM Peak**	**OP Late**
Outward Leg	**OP Early**	0%	0%	0%	0%	0%
	AM Peak		1%	20%	3%	1%
	Interpeak			57%	15%	1%
	PM Peak				1%	1%
	OP Late					0%

Table 4.22: Bus Time Period Pair Split Factors for Other

		Return Leg				
	%	**OP Early**	**AM Peak**	**Interpeak**	**PM Peak**	**OP Late**
Outward Leg	**OP Early**	0%	0%	0%	0%	0%
	AM Peak		2%	20%	6%	3%
	Interpeak			35%	13%	10%
	PM Peak				4%	4%
	OP Late					4%

4.4.50 It should be acknowledged that there is a potential bias in the passenger interviews for these splits, as the data include only trips boarding in an urban centre. Since for most bus services the majority of trips have one trip-end within an urban centre this is thought not to be a major issue.

4.4.51 Purpose proportions were compared across the passenger interviews, NTS and the 2009 LLITM household survey. All three sources suffered from some low sample sizes in places; the passenger interviews cover the largest sample and the household interview the smallest.

4.4.52 In the main there was broad agreement between NTS and the passenger interviews. NTS had much higher probabilities of off-peak return for a PM Peak outbound journey for most purposes than the interviews; it is not clear why this is, but the NTS proportions appeared implausibly high relative to scale of post-19:00 bus service provision in the county and city, so the interview data were used.

4.4.53 One interview figure displayed an opposite pattern. The interview data displayed a high off-peak return proportion of 22% for shopping trips outbound in the interpeak. NTS has a much lower value of 1%. Here the interview proportion was considered implausible, and this section (the interpeak outbound row) of the shopping proportion matrix was replaced with NTS data.

4.4.54 The tour factors above were used as a starting point for splitting demand. However, for each origin-destination movement, the tour-factor matrices were “Furnessed” (balanced) so that their row and column totals matched those observed for that movement in the ticket data. This avoided distorting the matrix any more than necessary.

4.4.55 Because the ETM data contain all trips made, in both directions, on the services they cover, the process of reversing every trip results in twice as many trips as observed. Assuming the premise that every trip has a reverse-direction trip is correct, this was resolved by dividing the resulting tour matrices by two, thus in effect averaging two “samples” of each movement; one from the movement itself, and one from trips making the opposite direction movement.

4.4.56 The tour-generation process therefore altered the observed matrix by forcing the trips into tours. The degree of change induced by this was studied, and is summarised below.

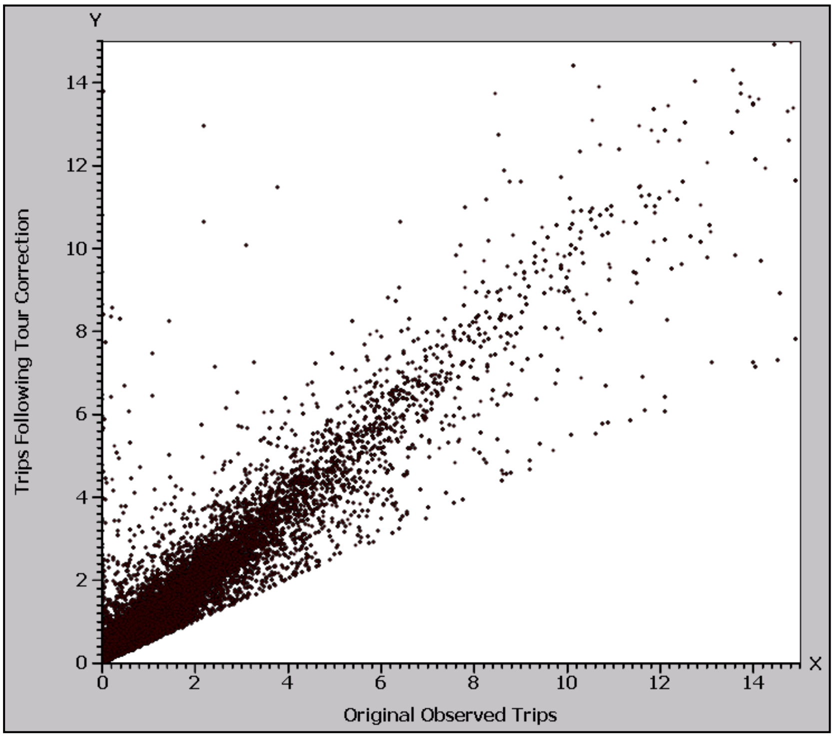
Table 4.23: Effect of Converting Observed Demand to Tours, Trip Totals, Home-Based Only

Time Period	Demand, Observed	Demand, Tours	Difference
AM Peak	30,223	29,985	-0.8%
Interpeak	61,036	60,129	-1.5%
PM Peak	23,891	23,605	-1.2%
Off-Peak	9,403	10,829	15.2%
All Day	**124,553**	**124,549**	**0.0%**

4.4.57 Although the off-peak demand increases noticeably, the breakdown by time period is otherwise very close and the all-day demand changes only by rounding errors. As the off-peak is of least significance to the modelling (the off-peak model is not validated and used only to provide time-period choice), this was not considered concerning.

4.4.58 The matrices have also been inspected at a cell level to determine the degree of change. 75% of the demand is unchanged by the process. The trip-end and cell level scatter-plots are shown below. Linear functions have been fitted to the plots; at the cell level the matrices compare with an r^2 of 0.91 and at the production level they compare with an r^2 of 0.98; in both cases the slopes are close to 1 and the intercepts close to zero.

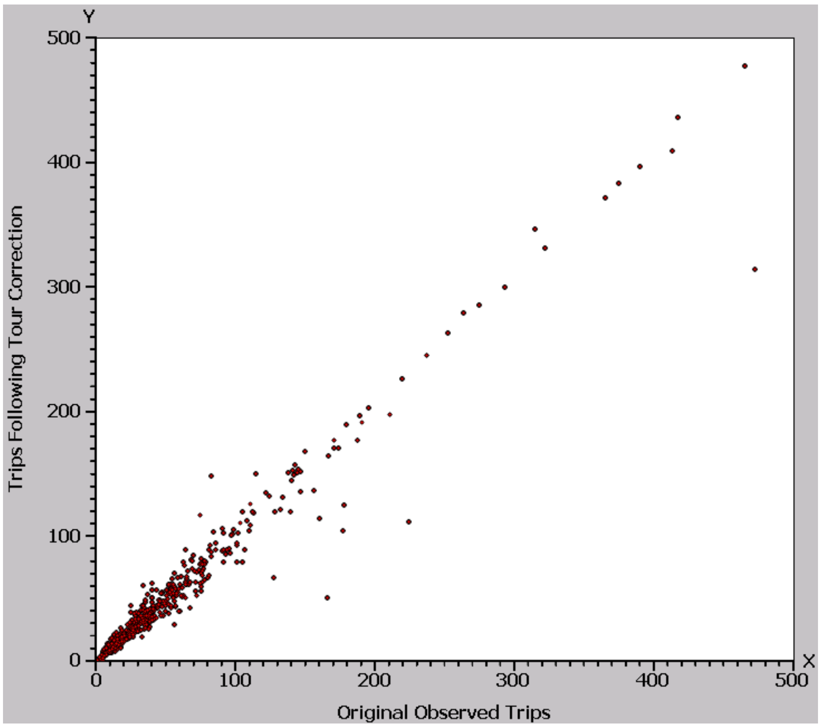
Table 4.24: Effect of Tour Correction, All Day Demand, Origin-Destination Movements



4.4.59 It will be noted at the cell level that no cell is reduced by more than 50%. This is because the process averages each estimate of demand with another (the reverse direction one); in the limit where the reverse direction estimate is zero, the demand cannot be reduced by more than half.

4.4.60 In the other direction, there is no limit; the process can increase demand by any level, if the reverse-direction estimate is large enough. Very large increases are, however, rare.

Table 4.25: Effect of Tour Correction, All Day Demand, Trip Productions



Income and Car Availability

4.4.61 LLITM 2014 Base requires matrices to be segmented by both household income and household car-ownership. Neither the ETM nor the passenger interview data contain any representation of income.

4.4.62 Segmentation was carried out using trip rates from the National Travel Survey (NTS) for the East Midlands and household type segmentation from the land-use model. Trip rates were derived by three income bands, car-owning / non-car-owning households, purpose and mode of travel. These were applied to the base year planning data, with household types having been allocated to income bands within the land-use model, to derive expected trips produced in each zone by income band and car-ownership category.

4.4.63 Trip length distributions for trips by income band were also applied to ensure the effect of higher-income persons making longer trips is captured. These are derived from NTS data.

4.4.64 Car ownership proportions were controlled at a global level to those observed in the passenger interviews, as follows:

Table 4.26: Household Car Ownership, Interview Data, By Crow-Fly Trip Distance

Distance (km)	Car Ownership
0	41%
1	40%
2	46%
3	47%
4	50%
5	52%
10	54%
15	48%
20	54%
30	55%
50	69%

Table 4.27: Household Car Ownership, Interview Data, By Purpose

Distance (km)	Car Ownership
Commuting	51%
Business	69%
Education	57%
Shopping	44%
Other	46%

4.4.65 The zonal and trip-length splits were applied to the matrices iteratively using a balancing process until the split matrices converged.

Multi-Leg Bus Trips

4.4.66 The use of bus ticket data generally carries with it an implicit assumption that a bus boarding and a bus / public transport trip are the same thing. Multi-leg trips, either using more than one bus service or using both bus and rail, are not explicitly considered. A small proportion of multi-leg trips are correctly captured, because some of the ticket data includes through tickets that involve interchanging onto another bus, but this occurs only where the journey can be made using a single ticket and the same operator runs both services.

4.4.67 National Travel Survey (NTS) data suggest that about 10% of bus trips in Leicestershire involve more than one bus boarding. This is sufficiently low that we do expect that no significant forecasting or demand interaction issues will arise through treating most of these multi-leg journeys as separated trips, as has been done. We lack any data that could reasonably be used to calculate trip-chaining.

Matrix Validation

4.4.68 The validation of the public transport demand and assignment is discussed in Chapter 5. However, some broad, high-level checks of the demand matrices against other sources were conducted prior to the assignment, and these are discussed here.

4.4.69 Total demand by town of origin in the model matrices has been compared with the total number of boardings and alightings in that town counted by the interview surveys. Note that these will not in general be equal; inter-town trips will add boardings/alightings to two different towns, and the boarding/alighting counts will not include trips not visiting urban centres. However, they should agree in broad scale of demand.

4.4.70 Off-peak demand was excluded from the model matrices for this comparison for consistency with the surveys. It should be noted that some demand in the matrices does not originate in a market town or Leicester, so the total for the model matrices is greater than the sum of the town values.

Table 4.28: Trips by Town, Interviews versus Model Matrices, 07:00 to 19:00 Average Weekday

Town	Interview Counts, Boardings	Interview Counts, Alightings	Model Matrices, Origins
Ashby	550	466	424
Coalville	1,171	736	1,484
Hinckley	1,194	662	2,445
Loughborough	6,414	4,909	9,618
Lutterworth	217	122	336
Market Harborough	962	639	931
Melton Mowbray	1,287	494	1,955
Leicester	42,998	40,171	76,419
All	**54,794**	**48,199**	**126,715**

4.4.71 There is a good general correlation between the scales of numbers in the two datasets, as expected.

4.4.72 In principle the boardings from the interviews should always be less than the model matrix origins. This is true for all but Ashby and Market Harborough, and here the values are close.

4.4.73 We would generally expect boardings plus alightings to be within about 35% of the model matrix, allowing for some intra-town travel. This is true for all except Ashby and Market Harborough.

4.4.74 The total boardings plus alightings would be expected to be less than the model matrix total, since inter-town trips counted twice are probably fewer in number than trips not intercepted at all. This is indeed the case; the model matrices total roughly 20% more than the boardings plus alightings.

4.4.75 Alightings should roughly equal boardings, unless a lot of off-peak travel is expected. This is true overall, and for Leicester, but for some towns this is a long way off, particularly Lutterworth and Melton. We suspect the survey methodology in some towns may have missed some major alighting stops in town centres. The same issue (alightings sometimes significantly less than boardings) was observed in the original 2008 LLITM model surveys. It can be noted that boardings exceed alightings for all towns. This has implications for assignment validation, as the differential in Lutterworth or Melton is not credible as a representation of actual behaviour.

4.4.76 Bus average trip lengths are shown below for the model against the interview data and NTS. The model and interview data are based on crow-fly distance; NTS on in-vehicle distance travelled on the road.

Table 4.29: Bus Trip Lengths by Purpose, Various Sources

Purpose	NTS In-vehicle	Interview Crow-Fly	Model Crow-Fly
HB Work	4.4	9.0	4.3
HB Business	4.4	10.8	4.7
HB Education	6.6	11.2	4.0
HB Shopping	4.4	7.5	4.3
HB Other	6.6	9.8	4.3
NHB Business	5.9	7.0	4.1
NHB Other	5.2	10.6	4.1
All	**5.4**	**9.3**	**4.2**

4.4.77 Overall the model is very consistent with NTS, with the figures implying a plausible ratio of in-vehicle to crow-fly distance of around 30%. However, the interview data display much higher trip lengths. There are a number of reasons for this:

- The interview data are derived from an intercept survey. Because they “intercept” travellers at a point (bus stops), they are more likely to capture longer trips than shorter ones. This is estimated to account for roughly half of the discrepancy: the interview data tend to omit the shortest trips (those that get on and off the bus outside the urban centre), and count the longest trips (the inter-town ones) twice.
- The interview data contain a small number of extremely long trips. About 1% of the journeys in the data are longer than 100km. Since coach services were explicitly excluded from interviews, these clearly do not represent majority-mode bus trips and thus do not properly belong in the matrices[3]. Excluding this 1% reduces the average trip lengths by around 2km, and thus accounts for over a third of the discrepancy. The average home-based business trip length reduces from 10.8km to 8.5km when a single trip 160km long is excluded; this represents quite neatly one drawback to the mean as a measure of average.
- There is likely to be some response bias in the interview data towards longer trips. Passengers travelling further will generally allow more time at the bus stop, leading to them being more likely to be interviewed. It is noticeable that the interviews do appear to have over-sampled non-home-based other trips, which tend to be longer than average. This could account for up to around a fifth of the discrepancy, though it is not thought to be the major influence because the purpose split recorded by the interviews is generally reasonably consistent with other sources.
- Access and egress distances are likely to be slightly understated in the model matrices because fare stages have been allocated to zone using relatively short (few hundred metre) “catchment areas”. While most trips will indeed not walk long distances to and from bus stops, there will be a minority walking longer distances, which would be captured in the interviews. Because the model data are quite consistent with NTS, this is unlikely to be a major component of the discrepancy, but it could have some influence.
- Multi-leg bus trips, as discussed above, will be understated in the model matrices due to the use of ticket sales to build trips. These will tend to be longer than average. As with the access and egress distances, this is unlikely to be a major influence because of the consistency with NTS data.

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[3] About a quarter of these trips appear to be bus travellers changing to rail. The remainder must be park-and-ride trips, coding errors, or interviewees misunderstanding the questions or wilfully misreporting. None of these should be retained in the model matrices.

5. Network and Assignment Validation

5.1 Context

5.1.1 Following the development of the public transport network and services and the accompanying public transport demand matrices, a calibration and validation exercise has been undertaken to improve and assess the robustness and fitness for purpose of the resulting model.

5.1.2 The calibration process was carried out in-line with current guidance as set out in TAG Unit M3.2, and consisted of the following steps :

- network and service validation;
- passenger routeing validation;
- validation of the trip matrix;
- assignment parameter calibration; and
- matrix estimation.

5.1.3 These aspects are covered in subsequent sections of the report.

5.2 Network and Service Validation

5.2.1 The validation of the public transport network was an ongoing process during the development of the model. During the development of the highway network a series of checks on the links and nodes that make up the SATURN model were performed to ensure accurate representation of the Leicestershire public transport network. The SATURN network was then converted into an Emme network fully inclusive of all links and nodes required for accurate representation of the bus network. Additional network to represent rail and walk travel, including railway lines, pedestrian routes in urban centres and connections between highway and rail network was added.

5.2.2 The model was reviewed in terms of bus services represented, both by AECOM internally and by LCC who undertook detailed checks on all service routes and frequencies. The LCC checks were reviewed in full by AECOM, and about half of the comments resulted in corrections to the model. 6 services out of around 180 were found to have incorrectly coded frequencies; around 20 had minor problems with their route coding.

5.3 Passenger Routeing Validation

5.3.1 To ensure that the model is producing sensible routeing outputs, a number of random journeys with an origin and destination within the modelled area were selected. These were interrogated in LLITM 2014 and outputs were compared with the recommendations given by online journey planners. Key information analysed included:

- transit (in vehicle) time;
- service frequencies; and
- service numbers (for bus).

5.3.2 Traveline (East Midlands) and National Rail Enquiries were used for bus and rail journeys respectively.

5.3.3 The model gave consistent routes and services used for each origin-destination pair, with largely accurate in-vehicle journey time estimates compared with estimates given by journey planners. Minor coding changes to transit lines were made where required. A representative set of these comparisons is summarised below, for rail and bus journeys. It should be noted that the journey planners themselves are not 100% accurate, and that, as the validation was done in 2016, there are two years' of changes to service patterns between the model and journey planners.

5.3.4 For rail travel there is generally very good validation between service frequencies and modelled transit time. The larger discrepancies are between stations intermediate to Loughborough and Leicester where significant service changes have occurred since 2014. There is now a more regular Leicester to Lincoln service in the PM Peak.

5.3.5 For bus travel, the validation is slightly less good but still strong. This is partly due to the increased complexity of bus routeing, especially where interchanges are involved. There have also been, in some locations, considerable service changes between 2014 and 2016.

Table 5.1: Modelled & Journey Planner Transit Times and Frequencies, Rail

Origin	Destination	Period	Transit Time, mins (Modelled)	Transit Time, mins (Planner)	Frequency (Modelled)	Frequency (Planner)
Leicester	Peterborough	AM	60	56	1 per hour	1 per hour
Syston	Barrow-Upon-Soar	AM	9	10	1 per hour	1 per hour
Derby	Leicester	AM	26	28	2 per hour	2 per hour
Loughborough	Nottingham	IP	24	23	2 per hour	2 per hour
Hinckley	Leicester	IP	19	21	1 per hour	1 per hour
Melton Mowbray	Hinckley	IP	36	33	1 per hour	1 per hour
Sileby	South Wigston	PM	25	21	1 per hour	1 per hour
Market Harborough	East Midlands Parkway	PM	34	31	1 per hour	1 per hour
Leicester	St Pancras (London)	PM	71	75	4 per hour	5 per hour

Table 5.2: Modelled & Journey Planner Transit Times and Frequencies, Bus

Origin	Destination	Period	Transit Time, mins (Modelled)	Transit Time, mins (Planner)	Frequency (Modelled)	Frequency (Planner)
Leicester (Centre)	Wigston	AM	18	22	3 per hour	3 per hour
Syston	Loughborough	AM	32	31	1 per hour	1 per hour
Leicester (Station)	Leicester (Hospital)	AM	15	18	2 per hour	2 per hour
Birstall (P&R)	Leicester (Centre)	IP	17	17	4 per hour	4 per hour
Hinckley	Lutterworth	IP	45	42	1 per hour	1 per hour
Shepshed	Loughborough (Station)	IP	36	33	5 per hour	5 per hour
Coalville	Ashby	PM	17	20	2 per hour	1.5 per hour
Oadby	Leicester (University)	PM	16	16	4 per hour	4 per hour
Market Harborough	Oadby	PM	30	38	3 per hour	3 per hour

5.4 Assignment Parameter Calibration

5.4.1 The assignment calibration was also an ongoing process during the construction of the model. It refers to analysis of how the assignment algorithm is behaving and what modes, services and routes it allocates travellers to, and inspection of these for plausibility and consistency with count data. As part of this process, various assignment parameters and procedures were adjusted to improve the quality of routeing.

5.4.2 Initial and final values of model parameters are summarised below. Some further discussion surrounding these parameters can be found in Section 3.6.

5.4.3 It was noted that a significant proportion of trips were interchanging at larger stations to make marginal time savings on long distance trips (for instance to London) leading to poor validation of rail boardings. This was particularly evident at Leicester where East Midlands trains travelling south call at varying numbers of intermediate stations en-route to London. Therefore, an additional station boarding penalty of 8 minutes was added at Leicester, Loughborough and East Midlands Parkway stations (the only stations with a significant number of interchanges in the model) to discourage unnecessary boarding as much as possible.

Table 5.3: Assignment Parameters, Initial and Calibrated

Parameter	Initial Parameters	Calibrated Parameters
Boarding Penalty – bus (bus only trips)	6 minutes	6 minutes
Boarding penalty – bus (main mode rail)	6 minutes	25 minutes
Boarding penalty – train (car available trips)	6 minutes	2 minutes
Boarding penalty – train (no-car available	6 minutes	2 minutes
Additional Interchange boarding penalty	None	8 minutes (see Section 5.4.3)
Wait time weight	2.0	2.0
Threshold for Long Waits	5 mins	5 mins
Long Wait time factor	0.25	0.25
Walk time weight	2.0	2.0
Value of time (per hour) (2010 prices)	£11.97	£11.97
In-Vehicle time weight	1.0	1.0
Motorised access speed	22 kph	15 kph
External access speed	50 kph	22 kph
Walk access speed	4 kph	4 kph

5.4.4 The 25 minute boarding penalty for bus (with main mode of rail) is applied to trips already identified as “rail” boarding a bus. This is to prevent (almost) any rail trips using a bus to complete the main part of their journey instead of a train. This parameter value could almost be 9999 minutes, but we prefer to allow bus to be used to access rail if the access distance is wholly impractical for walking so we have used a high but plausible value in the calibration. (The initial parameter was 6 minutes only because the initial model set all boarding penalties to 6 before starting to consider the different user classes’ requirements).

6. Prior Demand Validation

6.1 Context

Following the development of the public transport network and services and a series of checks on the accuracy of both the coded networks and the representation of demand, the “prior” demand matrix so developed was assigned on the networks and the resulting flows and boarding levels compared with observed data. This comparison is presented in this chapter.

6.2 Passenger Flow Calibration Data

6.2.1 Bus and rail patronage count data were obtained from a number of sources, as follows;

- Platform count surveys at all railway stations in Leicestershire (excluding Bottesford) plus East Midlands Parkway, conducted in Summer 2015.
- Leicester City LTP monitoring site data for 2014. These consist of link counts of bus passengers, conducted via a mixture of on-board and road-side surveys, around cordons and screenlines in the city. 2014 data were used where possible; some directions for some sites were only surveyed in 2013 or 2009.
- Bus passenger volumes counted in cordons around the seven market towns in 2013. These were conducted via on-board surveys. A few holes in these cordons were infilled with data collected in 2014.
- Bus boarding and alighting volumes collected as part of the LLITM 2014 bus passenger interview surveys in urban centres, collected in 2014.
- Bus patronage data obtained from bus operators. This was available only at a very aggregate level, and was used as an overall check on total patronage.

6.2.2 Almost all the data used were from 2013, 2014, or 2015. A very small number of Leicester City cordon counts had to be taken from 2009 data, but this only affected a few small sites. Bus data not from 2014 were factored to 2014 values using bus patronage data obtained via LCC from bus operator passenger data. The adjustment factors are shown below. Loughborough is unusual in that bus patronage appears to have risen slightly since 2009; Hinckley on the other hand has seen a particularly large fall; the general trend has been for lower bus patronage post-2008, which is attributed to significant real growth in bus fares. Data were not available by town for the smaller market towns.

Table 6.1: Bus Passenger Flows, Adjustment Factors to 2014 Values

Area	2009	2013
Loughborough	0.9973	1.0135
Coalville	0.8842	0.9689
Ashby	0.8842	0.9689
Lutterworth	0.8842	0.9689
Melton Mowbray	0.8842	0.9689
Hinckley	0.7834	0.9391
Market Harborough	0.8842	0.9689
Leicester	1.0515	0.9441

6.2.3 Count locations, derived from the LTP and bespoke survey data, are illustrated in the figures below. Stars represent boarding and alighting counts at bus stops, while circles and squares represent link counts, the former in Leicester City (a combination of on-board and roadside surveys) and the latter in the market towns (all on-board).

6.2.4 Link counts are labelled with IDs, used in reporting later in this chapter. Boardings and alightings are only reported by urban area, and so are not individually identified. Boarding surveys are identified with one star per bus stop cluster rather than one star per bus stop.

Figure 6.1: Leicester Cordons, Screenlines and Boarding Surveys, City Centre

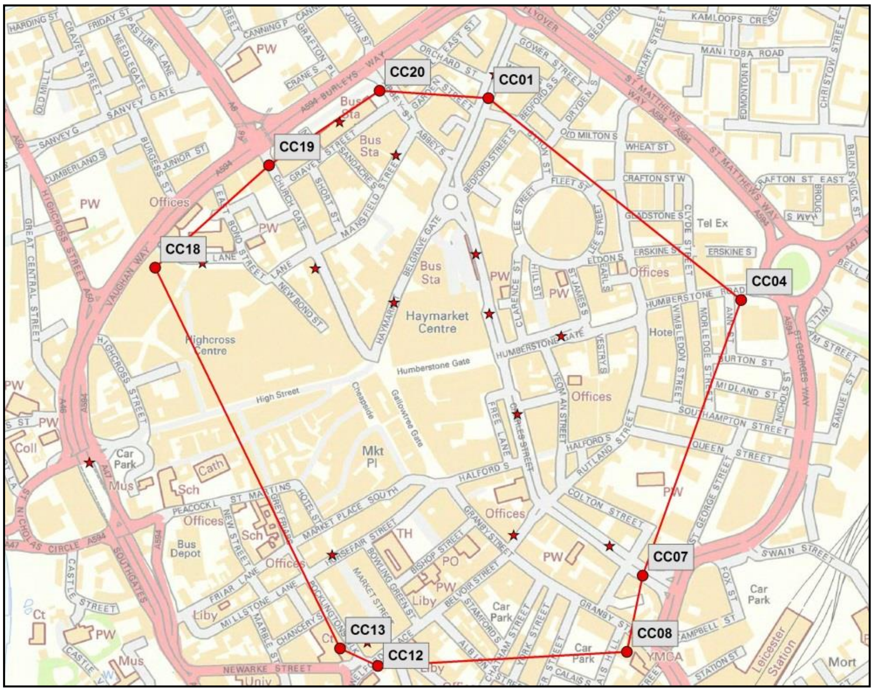

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Figure 6.2: Leicester Cordons, Screenlines and Boarding Surveys, Inner

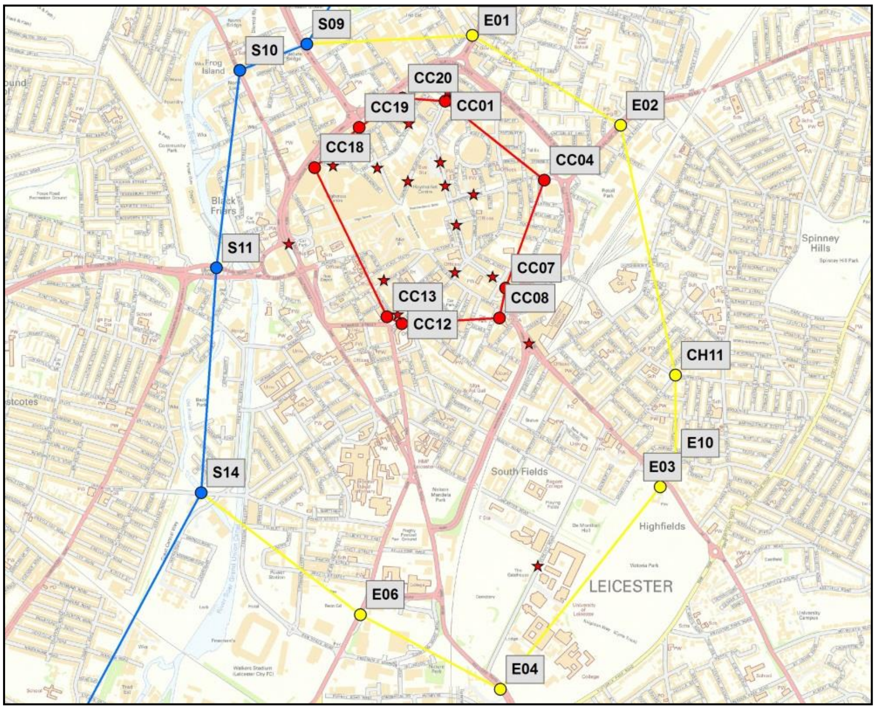

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Figure 6.3: Leicester Cordons and Screenlines, Outer

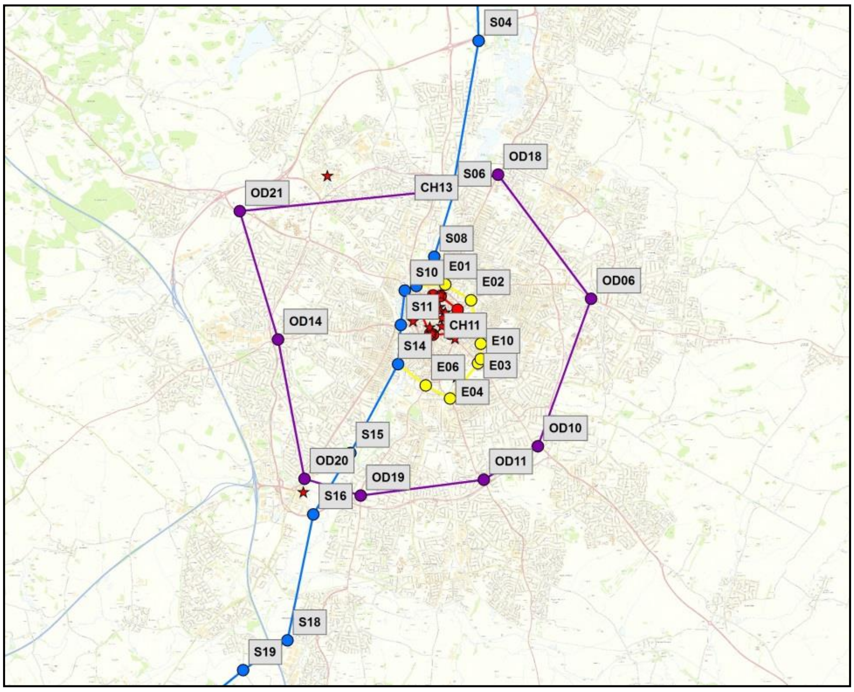

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Figure 6.4: Loughborough Cordon and Boarding Surveys

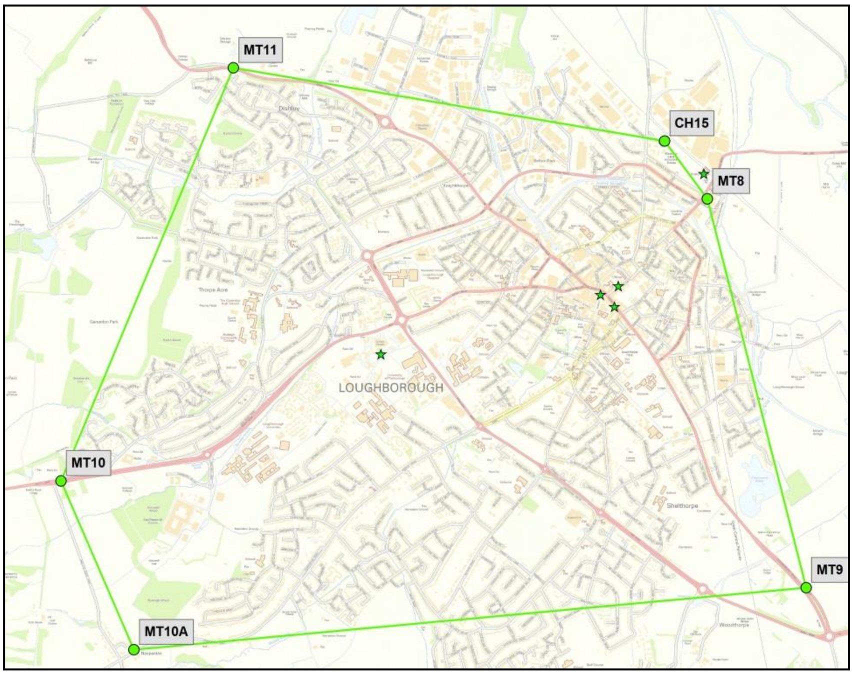

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Figure 6.5: Melton Mowbray Cordon and Boarding Surveys

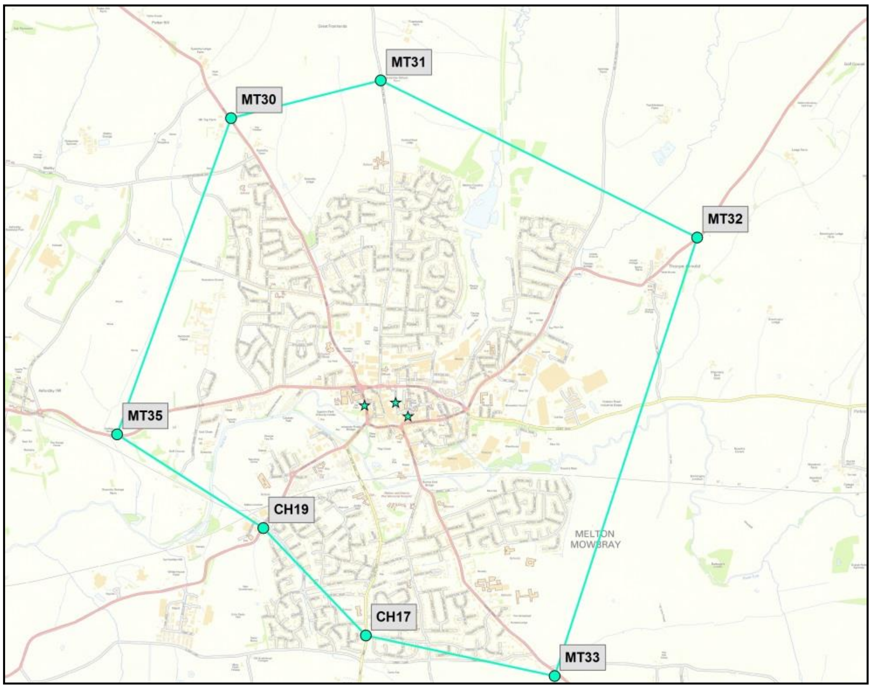

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Figure 6.6: Market Harborough Cordon and Boarding Surveys

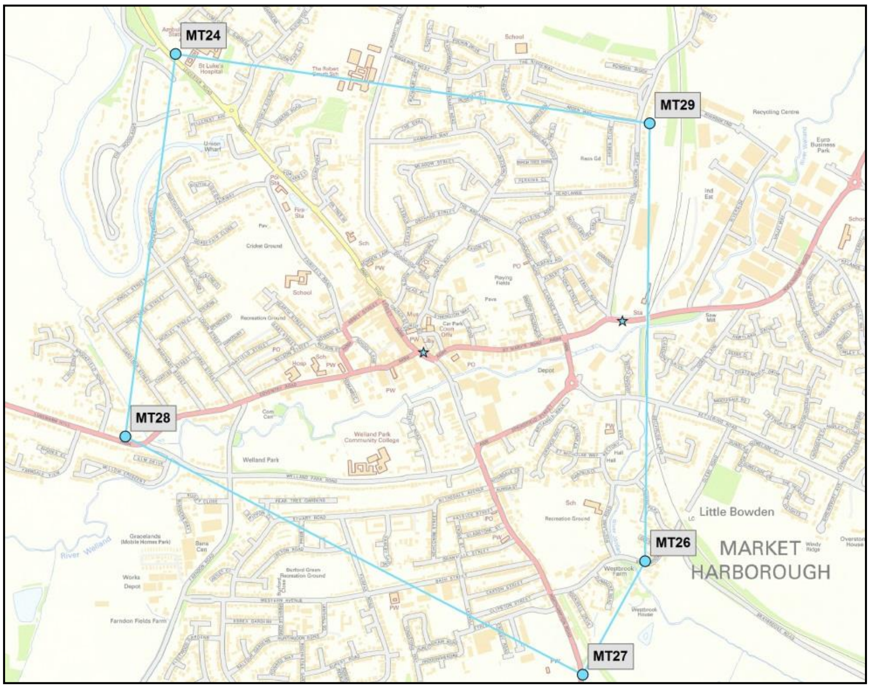

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Figure 6.7: Lutterworth Cordon and Boarding Surveys

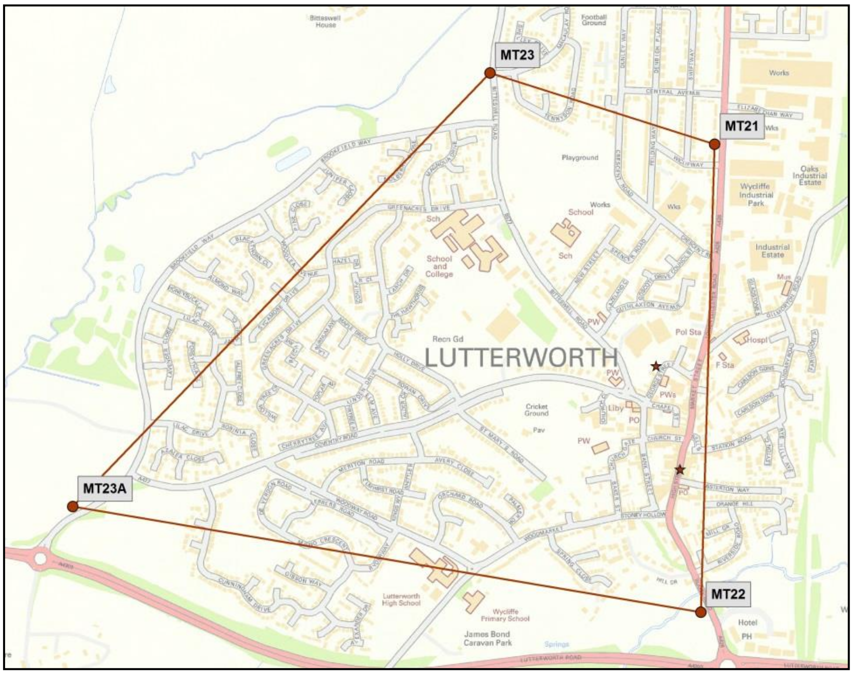

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Figure 6.8: Hinckley Cordon and Boarding Surveys

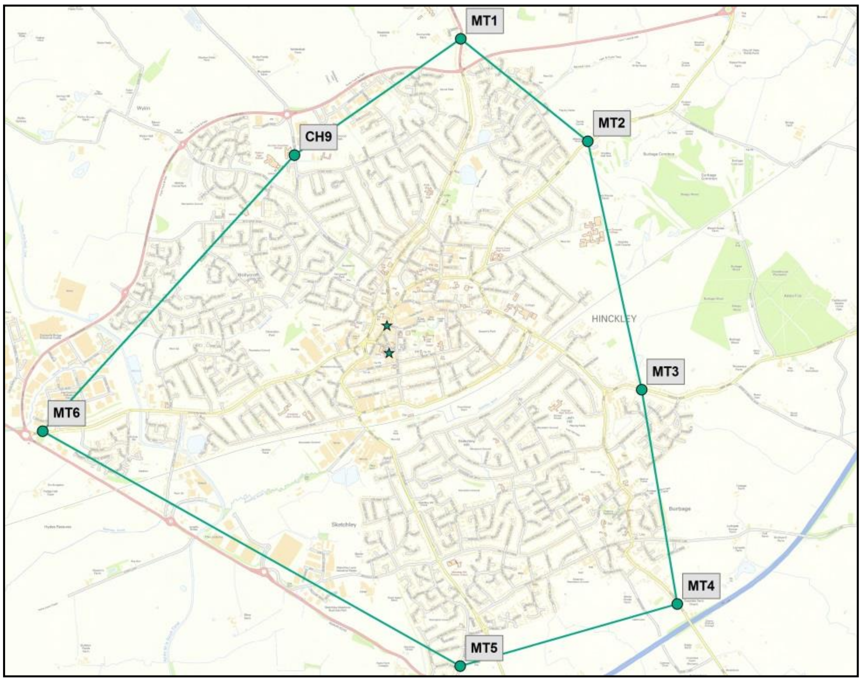

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Figure 6.9: Coalville Cordon and Boarding Surveys

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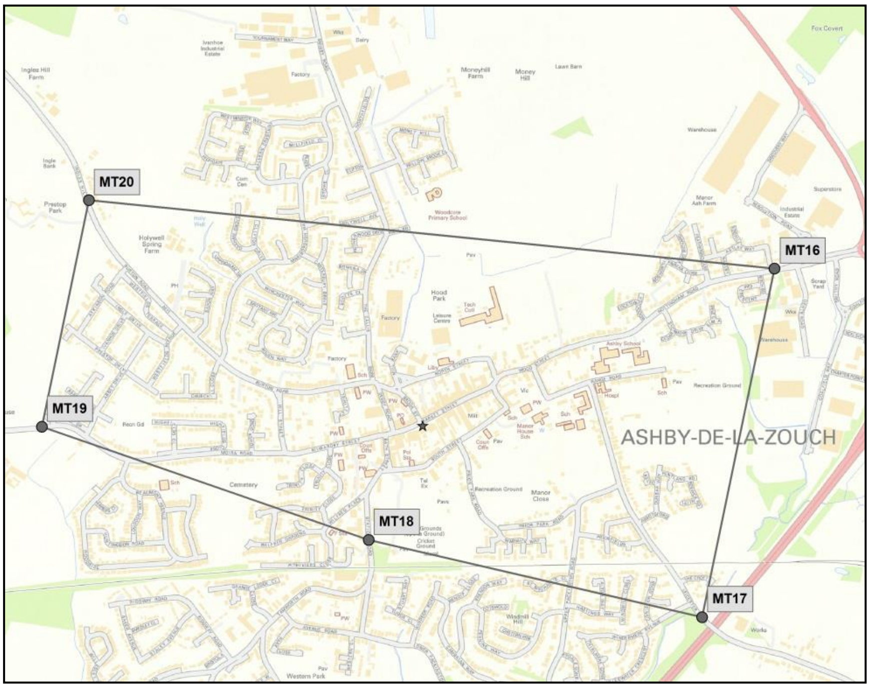
Figure 6.10: Ashby-de-la-Zouch Cordon and Boarding Surveys



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6.3 Prior Assignment Results

6.3.1 Before running “matrix estimation” procedures to improve the modelled flows’ reproduction of observed flows, evaluation of the quality of the starting “prior” matrix was undertaken. Table 6.2 details the position at a screenline level before any matrix adjustments were made.

6.3.2 In the prior, pre-estimated model, demand is very slightly under-represented across all time periods, though this is not universal; Loughborough and Coalville in the PM Peak as examples. As expected from a prior matrix, the comparison at a detailed level is not precise, but almost all screenlines are modelled with flows of the right order of magnitude. In Leicester all screenlines are, prior to estimation, within 35% of the observed flow, and the majority of them are within 20%. There is particularly good validation in the interpeak period. This is reassuring evidence that the prior matrix contains a broadly sensible level of bus travel and with broadly sensible distributions. The validation in Leicester is particularly good, probably because sample sizes on observed data are inevitably higher.

6.3.3 The larger proportional discrepancies, such as Lutterworth inbound in the AM, tend to be screenlines with low overall flows; this is as expected.

6.3.4 LLITM 2014 also features observed passenger boarding data for all rail stations in Leicestershire (excluding Bottesford) and the comparison of modelled and observed boardings and alightings are shown in Table 6.3 and Table 6.4.

6.3.5 TAG guidance for flow validation and calibration is that flows should match within 25%, except where the flow is less than 150 passengers an hour. This is generally met prior to matrix estimation although there is considerable variation across stations and peak periods. The boardings and alightings at Leicester station are generally overstated and this is primarily attributable to additional modelled interchanges as mentioned in Section 5.3. All other links within over 150 passengers pass this threshold prior to estimation.

Table 6.2: Matrix Comparison by Screenline Prior to Matrix Estimation, Bus Flows

Screenline	Direction	AM Peak				Interpeak				PM Peak			
		Observed	Modelled	Diff	Change	Observed	Modelled	Diff	Change	Observed	Modelled	Diff	Change
Central Transport	Inbound	3,058	2,809	-248	-8.1%	2,068	2,387	320	15.5%	1,257	1,354	97	7.7%
Central Transport	Outbound	1,345	1,365	20	1.5%	2,386	2,294	-92	-3.9%	3,117	2,424	-694	-22.2%
City Centre	Inbound	2,893	3,103	210	7.3%	2,907	2,868	-39	-1.4%	1,442	1,733	291	20.2%
City Centre	Outbound	1,479	1,921	442	29.9%	2,960	2,992	32	1.1%	3,575	2,952	-623	-17.4%
N-S Screenline	Eastbound	1,875	1,538	-337	-18.0%	1,497	1,401	-96	-6.4%	840	897	57	6.8%
N-S Screenline	Westbound	828	828	0	0.0%	1,473	1,390	-83	-5.6%	1,624	1,410	-213	-13.1%
Outer Ring Road	Inbound	1,276	1,148	-128	-10.0%	1,031	927	-104	-10.1%	819	577	-242	-29.6%
Outer Ring Road	Outbound	863	566	-297	-34.4%	988	866	-122	-12.3%	1,304	926	-378	-29.0%
Hinckley	Inbound	181	164	-16	-9.1%	154	171	17	10.8%	112	93	-19	-16.8%
Hinckley	Outbound	156	96	-60	-38.7%	165	167	2	1.2%	180	120	-60	-33.4%
Loughborough	Inbound	524	402	-122	-23.3%	346	359	13	3.8%	161	284	123	76.5%
Loughborough	Outbound	362	342	-20	-5.6%	397	424	28	7.0%	287	373	86	29.9%
Coalville	Inbound	176	111	-66	-37.3%	118	120	2	1.7%	69	80	11	16.3%
Coalville	Outbound	110	90	-20	-18.5%	125	133	8	6.1%	113	101	-12	-10.6%
Ashby	Inbound	73	56	-17	-23.4%	47	53	6	12.0%	49	34	-15	-30.2%
Ashby	Outbound	93	41	-52	-56.0%	65	57	-8	-12.3%	58	40	-19	-32.2%
Lutterworth	Inbound	62	33	-29	-46.6%	27	34	6	22.8%	23	21	-2	-10.4%
Lutterworth	Outbound	33	29	-4	-12.1%	57	39	-18	-31.1%	25	20	-5	-19.9%
Market Harborough	Inbound	95	63	-32	-34.1%	88	72	-16	-17.9%	59	56	-3	-5.0%
Market Harborough	Outbound	62	64	2	3.3%	85	79	-6	-7.3%	58	56	-2	-3.2%
Melton Mowbray	Inbound	120	102	-18	-15.2%	96	118	22	22.7%	91	86	-5	-5.1%
Melton Mowbray	Outbound	131	122	-9	-6.5%	108	124	16	14.7%	69	71	2	3.3%
	All	**15,794**	**14,991**		**-5.1%**	**17,190**	**17,076**		**-0.7%**	**15,332**	**13,708**		**-10.6%**

Table 6.3: Rail Station Boardings Prior to Matrix Estimation

Boardings	AM			IP			PM		
Rail station	Obs.	Model	% Diff	Obs.	Model	% Diff	Obs.	Model	% Diff
Barrow upon Soar	23	10	-57%	5	4	-11%	2	3	51%
East Midlands Parkway	115	38	-67%	51	29	-43%	50	40	-19%
Hinckley	74	71	-4%	24	25	5%	28	33	20%
Loughborough	186	209	12%	83	119	43%	119	142	19%
Market Harborough	226	207	-8%	72	57	-20%	51	65	27%
Melton Mowbray	54	51	-5%	30	22	-27%	30	26	-13%
Narborough	55	120	117%	16	33	103%	21	37	77%
Sileby	36	19	-46%	10	10	-3%	7	4	-42%
South Wigston	13	28	110%	3	4	50%	2	19	708%
Syston	51	40	-22%	14	19	31%	14	8	-45%
Leicester	732	741	1%	339	483	43%	621	1032	66%
Bottesford	N/A	8	0%	N/A	2	0%	N/A	3	0%

Table 6.4: Rail Station Alightings Prior to Matrix Estimation

Alightings	AM			IP			PM		
Rail station	Obs.	Model	% Diff	Obs.	Model	% Diff	Obs.	Model	% Diff
Barrow upon Soar	2	3	72%	6	4	-32%	22	8	-66%
East Midlands Parkway	33	24	-27%	45	30	-33%	93	51	-45%
Hinckley	26	28	8%	17	27	60%	71	68	-3%
Loughborough	118	148	25%	71	123	74%	163	195	19%
Market Harborough	84	86	2%	50	54	8%	160	164	2%
Melton Mowbray	16	27	64%	25	23	-7%	52	49	-6%
Narborough	15	28	85%	13	30	133%	59	104	76%
Sileby	7	5	-26%	8	12	63%	37	12	-66%
South Wigston	10	9	-9%	3	2	-23%	31	25	-18%
Syston	16	11	-30%	16	19	21%	45	33	-26%
Leicester	615	957	56%	364	490	35%	650	821	26%
Bottesford	N/A	3	0%	N/A	4	0%	N/A	10	0%

7. Matrix Estimation

7.1 Matrix Estimation

Context

7.1.1 Matrix estimation is a process designed to incorporate count data in building traveller demand matrices by calculating origin-destination movements that travel through count sites and adjusting the demand for those movements to better reflect the observed count.

7.1.2 Matrix estimation is generally considered to work best when it is used to make relatively minor changes to a matrix that is already reasonably good. It is not suitable for building matrices alone. It is also vital to ensure that the assignment routeing is sound before attempting matrix estimation, since the process assumes any discrepancies between model and observed data are due to the matrix itself.

7.1.3 The count data used in matrix estimation consist of:

- all link counts shown in Figure 6.1 to Figure 6.10; that is the cordons around the seven market towns surveyed in 2013 and the four cordons/screenlines in Leicester from the LTP programme; and
- station patronage statistics from the Office of Rail and Road; factored to represent an average weekday.

7.1.4 Bus boarding and alighting data were not used in matrix estimation; neither were the rail station counts collected in Summer 2015. These data were reserved for validation.

7.1.5 Matrix estimation was carried out using the ‘gradient method’ documented in “A Gradient Approach for the O-D Matrix Adjustment Problem”, Spiess, 1990. The process was adapted for LLITM to operate on two-leg tours rather than one-leg trips, because the Leicester demand model operates at a tour-level.

7.1.6 The algorithm is discussed in more detail in Appendix B.

Matrix Changes

7.1.7 It is important to consider the extent to which the matrix estimation algorithm changes the prior matrices, as this should ideally not be very large. Current TAG guidance contains no explicit suggestions as to how to do this for a public transport model; in the absence of such guidance, we have considered similar statistics to those advised for highway model estimation processes.

7.1.8 There was some concern in previous LLITM models that the changes were larger than ideal, and accordingly we have compared the performance of the two models where data are available.

7.1.9 We have examined and reported statistics for trips produced within Leicestershire, the majority of which are likely to be adjusted by matrix estimation. The effect of matrix estimation in LLITM 2014 has been compared with the LLITM v1.0 and LLITM v5.0 models below.

7.1.10 Changes by district are detailed in Tables 7.1 to Tables 7.3 below.

Table 7.1: Matrix Estimation Changes, Two-Way Trips, AM Peak, LLITM v1.0 and LLITM v5.0

AM Trips					
District	**Prior**	**Post**	**LLITM 2014**	*LLITM v5*	*LLITM v1*
Leicester City	**6120**	**6808**	**11%**	**1%**	**-4%**
Blaby	608	736	21%	-13%	-29%
Charnwood	1727	1815	5%	-8%	-34%
Harborough	415	465	12%	16%	-31%
Hinckley & Bosworth	484	555	15%	25%	-40%
Melton	276	286	3%	-9%	-47%
NW Leicestershire	397	521	31%	-18%	-9%
Oadby and Wigston	545	549	1%	10%	-25%
Leicestershire	**4452**	**4927**	**11%**	**-2%**	**-30%**

Table 7.2: Matrix Estimation Changes, Two-Way Trips, Interpeak, LLITM v1.0 and LLITM v5.0

IP Trips					
District	**Prior**	**Post**	**LLITM 2014**	*LLITM v5*	*LLITM v1*
Leicester City	**7371**	**7293**	**-1%**	**20%**	**8%**
Blaby	436	468	7%	-16%	-22%
Charnwood	1710	1683	-2%	-1%	-24%
Harborough	300	335	11%	24%	-21%
Hinckley & Bosworth	515	505	-2%	22%	-37%
Melton	278	252	-9%	-6%	-43%
NW Leicestershire	488	490	0%	-22%	-7%
Oadby and Wigston	488	456	-7%	17%	-15%
Leicestershire	**4217**	**4189**	**-1%**	**1%**	**-23%**

Table 7.3: Matrix Estimation Changes, Two-Way Trips, PM Peak, LLITM v1.0 and LLITM v5.0

PM Trips					
District	**Prior**	**Post**	**LLITM 2014**	*LLITM v5*	*LLITM v1*
Leicester City	**6401**	**7000**	**9%**	**27%**	**18%**
Blaby	331	372	12%	2%	-15%
Charnwood	1145	1170	2%	-2%	-13%
Harborough	180	172	-5%	10%	-19%
Hinckley & Bosworth	292	361	24%	55%	-39%
Melton	162	168	4%	10%	-40%
NW Leicestershire	302	316	5%	-7%	-6%
Oadby and Wigston	276	287	4%	26%	-7%
Leicestershire	**2688**	**2847**	**6%**	**10%**	**-17%**

7.1.11 The overall position is improved over previous versions of LLITM. The interpeak is particularly good; the AM itself is a little worse than LLITM v5. The changes by district, and especially the overall change across Leicestershire, are generally smaller in scale than in LLITM v5 and considerably less than LLITM v1. The changes in the AM Peak are slightly more significant than in LLITM v5; there has been a clear upward bias to the matrix estimation results in the AM. With the exception of the AM Peak the changes in Leicester City are much improved, probably largely because the demand matrices were developed from fully-observed ticket data rather than smaller and potentially biased interview samples. All but one of the Leicestershire districts across all time periods remains within 25%

7.1.12 Trip-length distribution plots are shown below, demonstrating how the trip-lengths have changed as a result of matrix estimation. As demonstrated in Figure 7.1 to Figure 7.6 the process tends to reduce bus trip-lengths slightly; this is a usual effect, as matrix estimation tends to add short trips to a matrix. There is also a tendency for very short trips (under 2 km), which are less likely to pass through observed screenlines/cordons, to be reduced, whilst medium length trips (2-10km) increase, and very long trips (10km+) reduce, because they are likely to pass through more than one site. However, generally, the trip length distribution does not change significantly.

7.1.13 The rail trip-length distribution is less good and there is considerable variation between peaks; in the AM Peak matrix estimation has reduced trips of less than 50km and significantly increased long-distance trips whilst in the PM a significant increase in shorter rail trips is shown. Journeys to London and Birmingham have been particularly expanded in the AM and interpeak periods, whilst in the PM Peak these journeys have been reduced. This is likely due to estimation having an increased impact on the more substantial commuter flows that travel to these destinations.

Figure 7.1: AM Bus Trip Length Distribution Change, Orange (Prior), Green (Post)

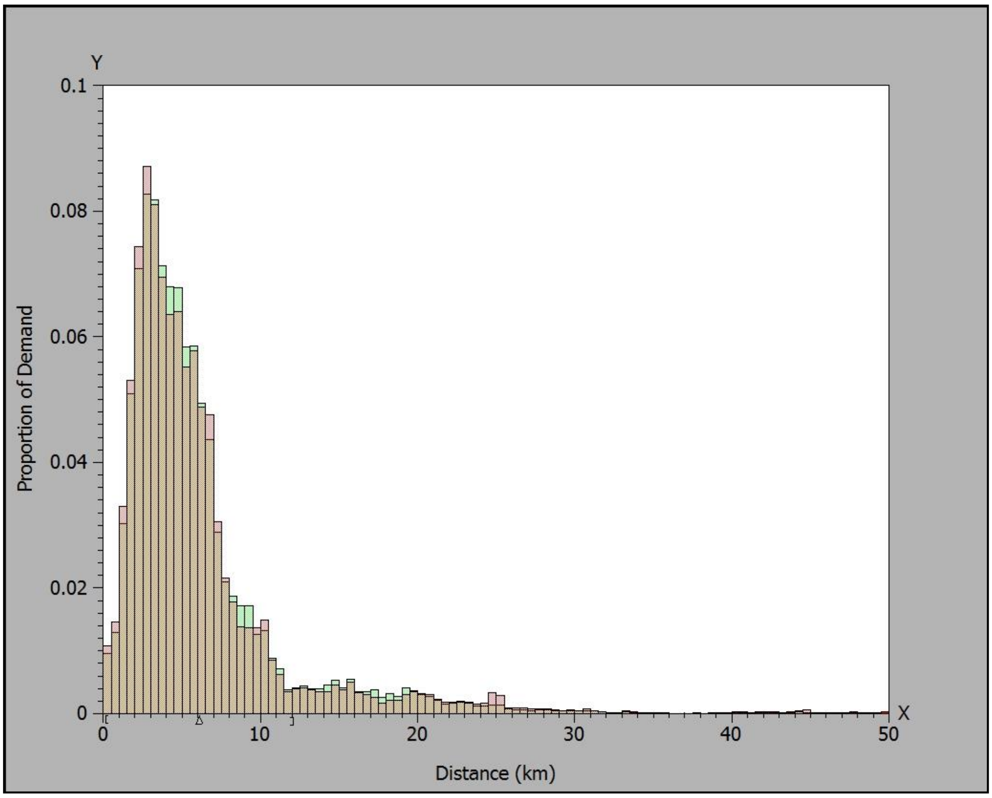


Figure 7.2: AM Rail Trip Length Distribution Change, Orange (Prior), Green (Post)

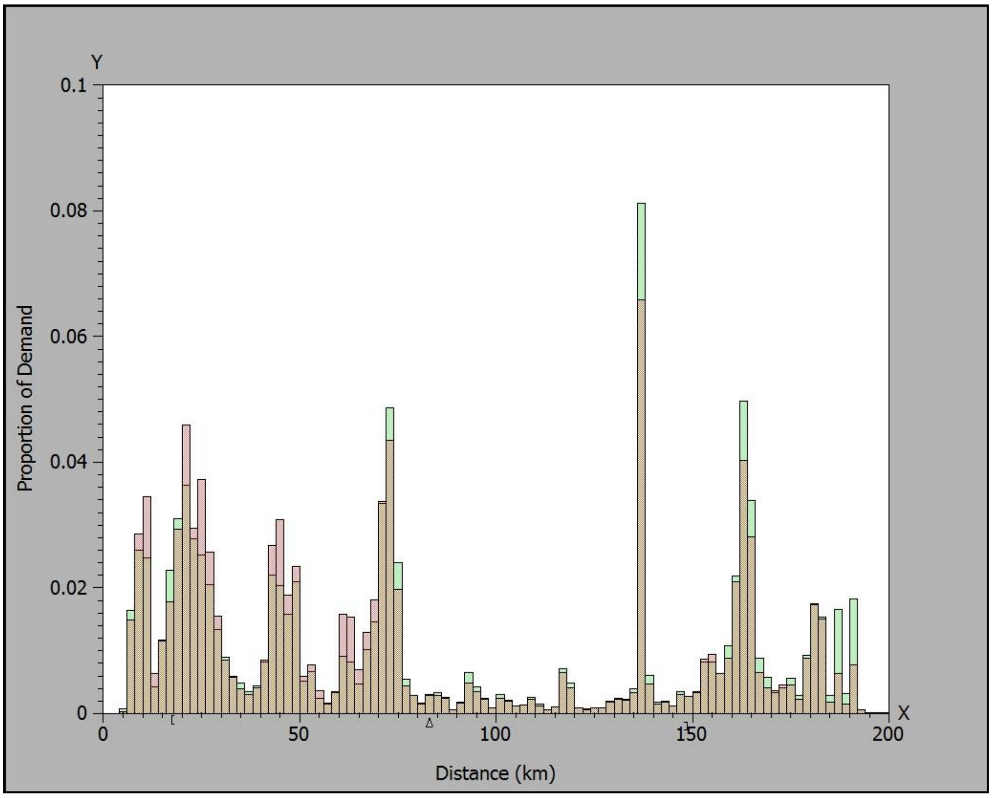


Figure 7.3: Interpeak Bus Trip Length Distribution Change, Orange (Prior), Green (Post)

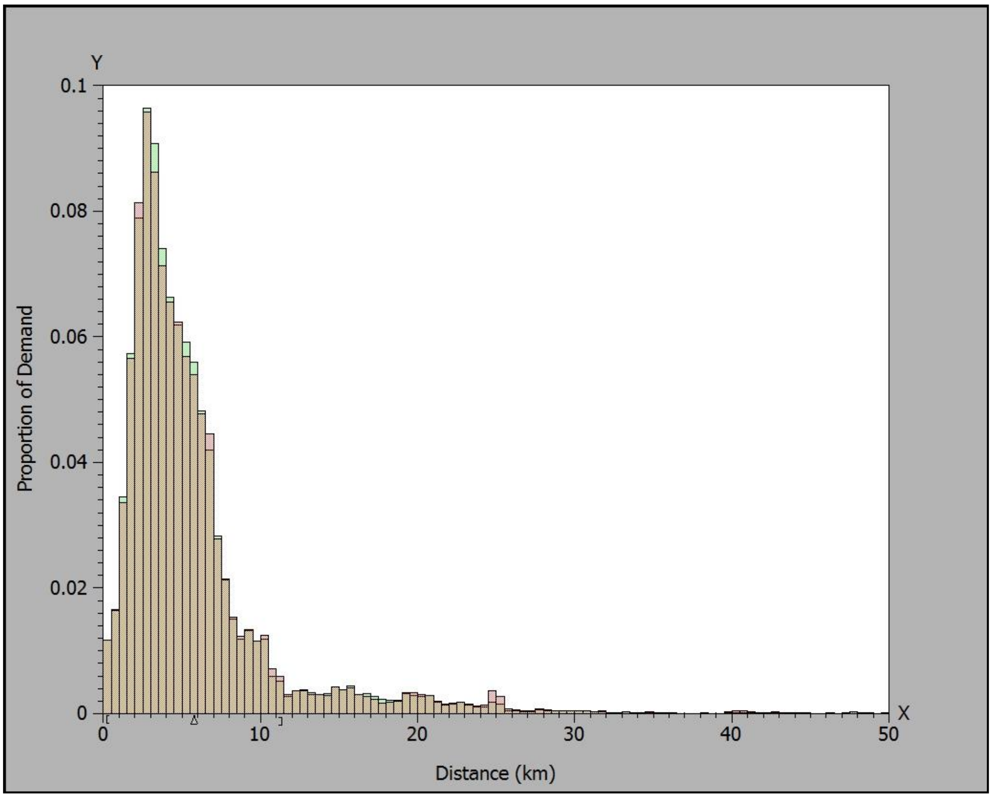


Figure 7.4: Interpeak Rail Trip Length Distribution Change, Orange (Prior), Green (Post)

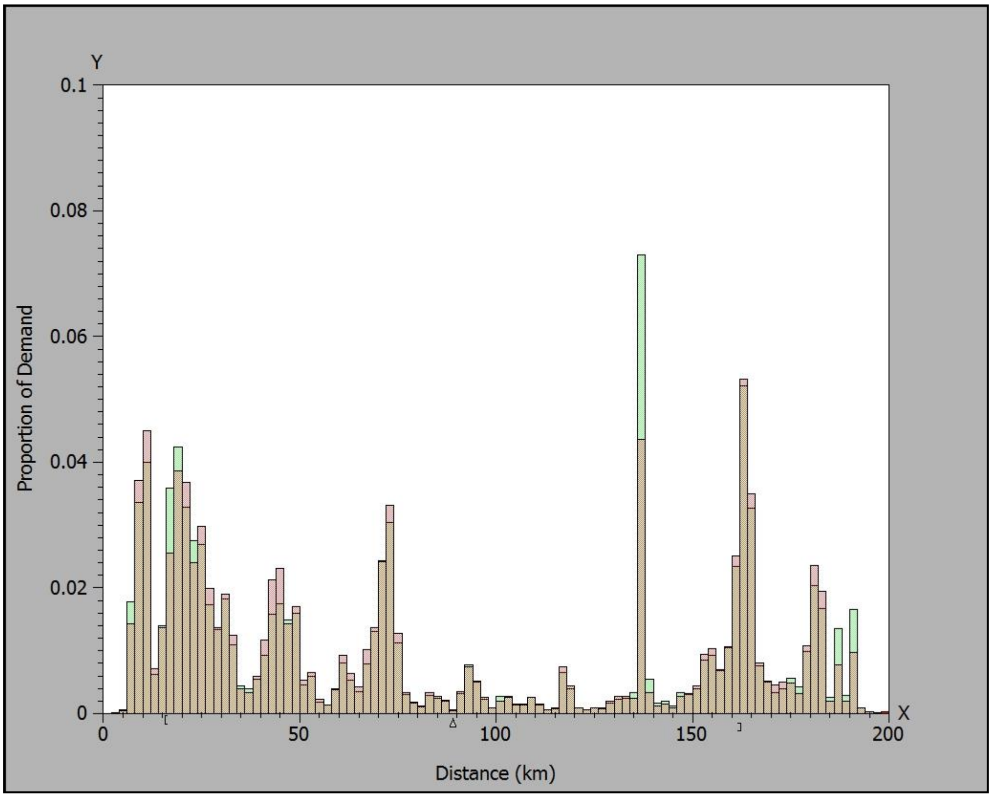


Figure 7.5: PM Bus Trip Length Distribution Change, Orange (Prior), Green (Post)

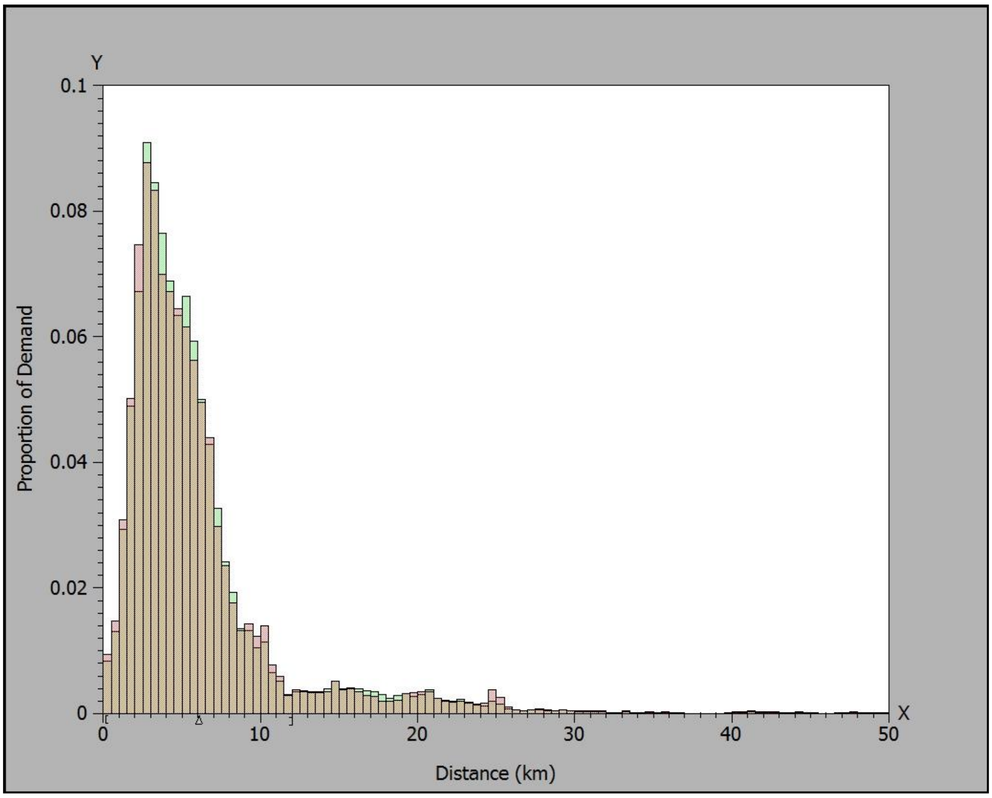
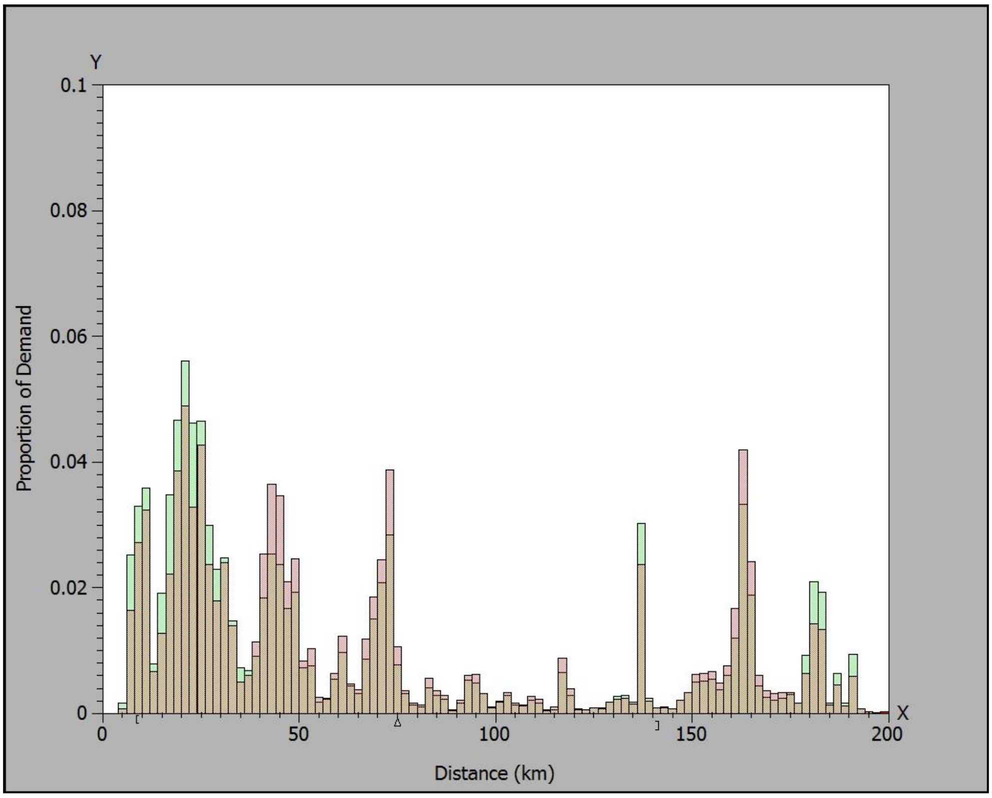


Figure 7.6: PM Rail Trip Length Distribution Change, Orange (Prior), Green (Post)



7.1.14 The estimation process has overall altered the public transport matrix significantly less than in earlier versions of LLITM and within the expected uncertainty of the prior matrix data and the count data.

7.2 Post Estimation Flow Calibration

7.2.1 The public transport calibration guidelines in TAG Unit M3-2 state that “across modelled screenlines, modelled flows should, in total, be within 15% of the observed values. On individual links in the network, modelled flows should be within 25% of the counts, except where observed flows are particularly low (less than 150)”.

7.2.2 We have generally adopted this as a measure of performance; however in the market towns almost no observed link flows are greater than 150 passengers per hour, meaning that no links would be considered relevant by the above criterion. Accordingly, we have used a lower threshold of 30 passengers per hour for market towns (as used by AECOM, SYSTRA and WSP elsewhere for similar sizes of urban area). This is more stringent than the TAG advice.

7.2.3 Calibration and validation results are presented below for the cordons and screenlines, both at a screenline level, and a summary of the performance at the link level (full link level performance can be found in Appendix C). The boarding and alighting calibration for rail stations is also presented, as are boardings for bus services.

7.2.4 We have used the TAG threshold of 15% for screenlines.

7.2.5 All but five of the screenlines, directions and periods pass this test and each is within 35% of the observed flow. All but one of the failures are below the 150 passenger per hour threshold suggested in TAG for link counts. Within market towns, all screenlines are within an absolute difference of 40 passengers and the vast majority also achieve the much more stringent criteria of being within 15% considering there are small numbers overall. The totals across all cordons and screenlines match very well. This suggests that there is no bias in either direction for the matrix as a whole.

7.2.6 For most foreseeable modelling purposes, these results indicate that model users can be confident in the demand and flow estimates.

7.2.7 The performance, across all screenlines, is at a very similar level to, and indeed slightly better than, that exhibited in LLITM v5, despite the smaller changes applied by matrix estimation, which should be interpreted as reassuring.

Table 7.4: Final Matrix Comparison by Screenline After Estimation

Screenline	Direction	AM Peak				Interpeak				PM Peak			
		Observed	Modelled	Diff	Change	Observed	Modelled	Diff	Change	Observed	Modelled	Diff	Change
Central Transport	Inbound	3,058	3,101	43	1.4%	2,068	2,096	28	1.4%	1,257	1,267	10	0.8%
Central Transport	Outbound	1,345	1,319	-26	-1.9%	2,386	2,377	-9	-0.4%	3,117	3,137	20	0.6%
City Centre	Inbound	2,893	2,967	74	2.6%	2,907	2,867	-40	-1.4%	1,442	1,438	-4	-0.3%
City Centre	Outbound	1,479	1,430	-49	-3.3%	2,960	2,926	-34	-1.1%	3,575	3,587	11	0.3%
N-S Screenline	Eastbound	1,875	1,970	94	5.0%	1,497	1,457	-40	-2.7%	840	900	61	7.2%
N-S Screenline	Westbound	828	912	85	10.2%	1,473	1,499	25	1.7%	1,624	1,755	132	8.1%
Outer Ring Road	Inbound	1,444	1,538	94	6.5%	1,142	1,094	-48	-4.2%	881	935	54	6.1%
Outer Ring Road	Outbound	923	1,059	136	14.7%	1,077	1,116	39	3.7%	1,437	1,498	61	4.2%
Hinckley	Inbound	181	175	-5	-2.9%	154	146	-8	-5.2%	112	114	2	1.7%
Hinckley	Outbound	156	117	-39	-25.2%	165	145	-20	-12.2%	180	154	-26	-14.4%
Loughborough	Inbound	524	522	-2	-0.5%	346	343	-3	-0.9%	161	184	23	14.2%
Loughborough	Outbound	362	392	30	8.2%	397	402	5	1.4%	287	302	15	5.2%
Coalville	Inbound	176	186	10	5.5%	118	120	2	1.6%	69	70	1	1.0%
Coalville	Outbound	110	101	-10	-8.9%	125	134	8	6.7%	113	125	13	11.1%
Ashby	Inbound	73	98	25	34.8%	47	51	4	7.7%	49	44	-4	-9.0%
Ashby	Outbound	93	79	-14	-15.2%	65	58	-7	-10.4%	58	51	-7	-12.8%
Lutterworth	Inbound	62	70	8	12.8%	27	30	3	11.1%	23	20	-3	-12.1%
Lutterworth	Outbound	33	31	-2	-5.4%	57	52	-5	-9.0%	25	22	-3	-12.9%
Market Harborough	Inbound	95	75	-20	-20.8%	88	75	-13	-15.0%	59	51	-9	-14.5%
Market Harborough	Outbound	62	73	11	18.3%	85	76	-9	-10.9%	58	53	-5	-8.9%
Melton Mowbray	Inbound	120	117	-3	-2.4%	96	101	5	5.5%	91	85	-5	-5.9%
Melton Mowbray	Outbound	131	128	-3	-2.0%	108	107	-1	-1.0%	69	74	5	7.3%
	All	**16,022**	**16,460**	**439**	**2.7%**	**17,390**	**17,273**	**-117**	**-0.7%**	**15,527**	**15,866**	**339**	**2.2%**

7.2.8 A summary of the performance by individual link is shown below. ‘All Flows’ refers to all link flows for which observed data have been used in the model, including some with very low (few passengers per hour or even zero) flows.

7.2.9 Within Leicester, only one link out of 100 fails to meet TAG criteria, and, even if ‘high’ is interpreted as only over 30 passengers per hour in Leicester, the vast majority of links pass the test (i.e. are within 25% of the observed count). Within Leicester, around four-fifths of all flows of any size, are with 25% as well. In market towns, around 50% of all links pass. Furthermore, most of these small discrepancies are extremely low flow links, and thus largely irrelevant, with zero to five passengers per hour being common. The detailed breakdown by individual link can be found in Appendix C.

7.2.10 All market town sites with flows in excess of 150 passengers per hour (the TAG threshold) pass in all periods, however there are only two such sites out of 84; hence our preference for the lower 30 passenger threshold in market towns. Using this threshold shows that over 90% of links pass across all time periods.

Table 7.5: Final Matrix Calibration by Link, Bus Flows, Leicester, Summary

	High Flows (>150)			High Flows (>30)			All Flows		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Number of Sites	33	36	31	56	59	51	77	77	77
Pass Rate	97%	100%	100%	90%	95%	86%	82%	86%	77%

Table 7.6: Final Matrix Calibration by Link, Bus Flows, Market Towns, Summary

	High Flows (>150)			High Flows (>30)			All Flows		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Number of Sites	2	2	2	20	22	14	84	84	84
Pass Rate	100%	100%	100%	95%	96%	93%	52%	62%	48%

7.2.11 The rail station boardings and alightings calibration is shown below. TAG guidance for flow validation and calibration is that flows should match within 25%, except where the flow is less than 150 passengers an hour. Although this is not explicitly extended to passenger boardings, applying the same criteria to the rail boardings and alightings results in a 100% pass rate, since all large (>150) boarding counts are within 25%.

Table 7.7: Calibration Rail Station Boardings, Model versus ORR, Average Weekday

Boardings	Boardings			Alightings		
Rail station	**ORR**	**Model**	**% Diff**	**ORR**	**Model**	**% Diff**
Barrow upon Soar	150	*124*	-17%	150	*125*	-17%
East Midlands Parkway	511	*511*	0%	511	*514*	1%
Hinckley	446	*507*	14%	446	*509*	14%
Loughborough	1,931	*2,118*	10%	1,931	*2,128*	10%
Market Harborough	1,241	*1,207*	-3%	1,241	*1,194*	-4%
Melton Mowbray	375	*377*	1%	375	*411*	10%
Narborough	607	*679*	12%	607	*650*	7%
Sileby	187	*183*	-2%	187	*192*	3%
South Wigston	104	*140*	35%	104	*113*	9%
Syston	295	*299*	2%	295	*317*	8%
Leicester	7,550	*7,056*	-7%	7,550	*7,049*	-7%
Bottesford	74	*49*	-34%	74	*64*	-13%

8. Model Validation

8.1 Boardings and Alightings

8.1.1 The model validation consisted of comparison of modelled flows against two sources of count data not used in matrix estimation; boardings by bus stop and patronage data from bus operators.

8.1.2 Alighting data were also available from the same source. However, we have not presented a validation against these. Analysis of the data suggests that the observations missed a significant proportion of alighters, at least in the market towns, because the total boarders and alighters do not accord at all well across the day. This is illustrated below.

Table 8.1: Observed Daily Bus Stop Boardings and Alightings, 2014

Town	Boarding	Alighting	Difference
Ashby	550	466	-15%
Coalville	1,171	736	-37%
Hinckley	1,194	662	-45%
Loughborough	6,414	4,909	-23%
Lutterworth	210	115	-45%
Market Harborough	962	639	-34%
Melton Mowbray	1,287	494	-62%
Leicester	41,417	38,747	-6%

8.1.3 All towns show fewer alightings than boardings, and several of them (Hinckley, Lutterworth and Melton Mowbray) show very substantially fewer; with only around half the alightings compared with boardings. The problem is less stark in Leicester. Clearly we would expect most bus trips to be accompanied by a return trip in the opposite direction, so the two should broadly correspond at a daily level.

8.1.4 It is unclear exactly why the alightings are consistently lower; however identical issues were seen in the in dataset used LLITM v5. One potential cause is that the surveys were principally conducted to interview boarding passengers, with the alighting counts being secondary. It is possible that those stops at which passengers generally or exclusively alighted rather than boarded were not surveyed or were surveyed incompletely.

8.1.5 Table 6.2 confirms that the model represents strategic bus flows reasonably well, including in the low-flow Melton Mowbray cordon. Whilst the boarding validation performance is significantly worse; the model is correct to within an order-of-magnitude and correlates well with the observed data but does not “validate” at the individual urban centre boarding level.

8.1.6 It is also possible that in reality there is more of a tendency for passengers to alight from stops a little outside the town centres, especially if there is significant road congestion; but that when returning they prefer to board at the main central bus stops, especially if buses wait at these for a short period. This would also explain the issue, and since the Leicester surveys were more complete and covered a larger area, this would also explain the reduced scale of the problem in Leicester. Accordingly, the comparison of the model against observed alightings is considered to be unreliable. The validation against boardings is presented below. Generally there is a good correlation and order-of-magnitude agreement, but the correspondence at a town level is not very strong (partly due to lower flows at these locations). Particular discrepancies are significantly higher and lower boardings in Coalville and Melton Mowbray respectively.

8.1.7 The model has been inspected to ensure that the majority of boardings and alightings in and round the urban centre do occur at the surveyed bus stop clusters, and not at nearby ones, and this is generally the case.

8.1.8 The Leicester boardings compare quite well, as do the market towns at an overall level. Leicester and overall totals are assessed against a 25% criterion. Lower flow locations in the market towns are assessed against an absolute 30 passengers per hour criterion. TAG has no explicit guidance on appropriate thresholds for boardings counts; the link flow tests used above (Section 7.2.4) have therefore been adopted.

8.1.9 The validation for the smaller urban areas, while generally within TAG thresholds, is not particularly good. There are a number of reasons for this:

- Where the counts are low, the sample error on the observed data will be large and there will be significant day-to-day variability.
- The evidence from the cordon counts in Chapter 6, and from the operator patronage data below, is that the model broadly represents the total amount of demand and all strategic flows, but precision is lost at an individual stop level; as a strategic model LLITM 2014 does not precisely model correct boarding and alighting points. This explains why the comparison is better for Leicester, where all stops in a wide area across the centre were surveyed.

Table 8.2: Bus Stop Boarding Validation, Passengers per hour

Area	**AM**			**IP**			**PM**		
	Obs	**Mod**	**Diff**	**Obs**	**Mod**	**Diff**	**Obs**	**Mod**	**Diff**
Ashby (Market Street)	36	32	-3	58	38	-20	32	31	-1
Coalville	60	106	46	123	167	44	84	143	59
Hinckley	45	26	-19	138	68	-70	77	53	-24
Loughborough (Centre)	216	319	48%	631	444	-30%	413	297	-28%
Loughborough (University)	33	8	-25	45	17	-28	22	18	-4
Loughborough (Railway)	30	1	-29	25	1	-24	21	2	-19
Lutterworth	16	26	10	22	26	4	10	13	3
Lutterworth (Magna Park)	0	0	0	1	3	3	1	5	4
Market Harborough (Centre)	58	70	12	102	75	-27	58	56	-2
Melton Mowbray	74	37	-37	137	60	-77	80	48	-32
Leicester (Centre)	2246	1646	-27%	3507	3113	-11%	3438	3878	13%
Leicester (Fosse Park)	5	26	21	37	40	4	33	39	6
Leicester (Beaumont Leys)	74	36	-37	116	38	-78	100	43	-58
Leicester (Station)	35	101	66	52	115	63	94	176	82
Leicester (University)	1	0	0	43	1	-41	38	3	-35
Leicester (Hospital)	44	39	-6	63	37	-26	63	46	-17

8.1.10 Whilst a highway-focussed measure of model fit, the difference column has been substituted with GEH statistics in the table below, provided for context.

Table 8.3: Bus Stop Boarding Validation, Passengers per hour (with GEH statistics)

Area	AM			IP			PM		
	Obs	Mod	GEH	Obs	Mod	GEH	Obs	Mod	GEH
Ashby (Market Street)	36	32	0.7	58	38	2.9	32	31	0.2
Coalville	60	106	5.0	123	167	3.7	84	143	5.5
Hinckley	45	26	3.2	138	68	6.9	77	53	3.0
Loughborough (Centre)	216	319	6.3	631	444	8.1	413	297	6.2
Loughborough (University)	33	8	5.5	45	17	5.0	22	18	0.9
Loughborough (Railway)	30	1	7.4	25	1	6.7	21	2	5.6
Lutterworth	16	26	2.2	22	26	0.8	10	13	0.9
Lutterworth (Magna Park)	0	0	-	1	3	1.4	1	5	2.3
Market Harborough (Centre)	58	70	1.5	102	75	2.9	58	56	0.3
Melton Mowbray	74	37	5.0	137	60	7.8	80	48	4.0
Leicester (Centre)	2246	1646	13.6	3507	3113	6.8	3438	3878	7.3
Leicester (Fosse Park)	5	26	5.3	37	40	0.5	33	39	1.0
Leicester (Beaumont Leys)	74	36	5.1	116	38	8.9	100	43	6.7
Leicester (Station)	35	101	8.0	52	115	6.9	94	176	7.1
Leicester (University)	1	0	-	43	1	9.0	38	3	7.7
Leicester (Hospital)	44	39	0.8	63	37	3.7	63	46	2.3

8.2 Rail Boardings and Alightings

8.2.1 The rail model calibration was undertaken to ORR data. This has made it possible to use the boarding and alighting counts collected for the LLITM 2014 project in Summer 2015 as an independent validation for rail.

8.2.2 This validation is shown in Table 8.4 and Table 8.6. There is generally a good validation at the larger stations, with Leicester and Market Harborough validating well, and a strong correlation between modelled and observed data. It should be noted that the validation sites are the same as the calibration sites, with different data, so the discrepancies largely relate to differences between the two observed data sources rather than weaknesses in the model per se. See Table 7.7 for the calibration results.

8.2.3 Loughborough in particular is significantly higher in ORR than in the observed counts; there is good evidence that the counts may be substantially low. Station staff on the survey day noted that the stations were unusually quiet on the survey day and this may account for the general downward bias of the count data compared with the model/ORR. Comparison of the count at Loughborough with a similar survey conducted in 2008 implies a 30% fall in station patronage since 2008, which is considered unlikely.

8.2.4 While both observed sources have their strengths and weaknesses, our overall view favoured trusting the ORR data more. The boardings/alightings are single-day, manual counts, and there is good evidence that the day was in general light on rail patronage. The most obvious weakness of the ORR data would be a failure to include illegal passengers (as ORR is largely ticket-based), but the ORR seems generally higher than the boardings and alightings. Accordingly, we calibrated the model to ORR and used the boarding and alightings as an independent check.

Table 8.4: Validation Rail Station Boardings

Boardings	AM			IP			PM		
Rail station	**Obs**	**Model**	**% Diff**	**Obs**	**Model**	**% Diff**	**Obs**	**Model**	**% Diff**
Barrow upon Soar	23	25	11%	5	5	-6%	2	3	47%
East Midlands Parkway	115	82	-29%	51	26	-48%	50	21	-58%
Hinckley	74	74	1%	24	23	-2%	28	32	17%
Loughborough	186	261	40%	83	108	30%	119	164	38%
Market Harborough	226	176	-22%	72	71	-1%	51	48	-6%
Melton Mowbray	54	47	-12%	30	21	-29%	30	24	-18%
Narborough	55	105	90%	16	31	94%	21	38	81%
Sileby	36	30	-17%	10	10	0%	7	5	-29%
South Wigston	13	25	85%	3	4	44%	2	11	355%
Syston	51	51	0%	14	13	-8%	14	14	-4%
Leicester	732	838	14%	339	349	3%	621	601	-3%

8.2.5 Whilst a highway-focussed measure of model fit, the difference column has been substituted with GEH statistics in the table below, provided for context.

Table 8.5: Validation Rail Station Boardings (with GEH statistics)

Boardings	AM			IP			PM		
Rail station	**Obs**	**Model**	**GEH**	**Obs**	**Model**	**GEH**	**Obs**	**Model**	**GEH**
Barrow upon Soar	23	25	0.4	5	5	0.0	2	3	0.6
East Midlands Parkway	115	82	3.3	51	26	4.0	50	21	4.9
Hinckley	74	74	0.0	24	23	0.2	28	32	0.7
Loughborough	186	261	5.0	83	108	2.6	119	164	3.8
Market Harborough	226	176	3.5	72	71	0.1	51	48	0.4
Melton Mowbray	54	47	1.0	30	21	1.8	30	24	1.2
Narborough	55	105	5.6	16	31	3.1	21	38	3.1
Sileby	36	30	1.0	10	10	0.0	7	5	0.8
South Wigston	13	25	2.8	3	4	0.5	2	11	3.5
Syston	51	51	0.0	14	13	0.3	14	14	0.0
Leicester	732	838	3.8	339	349	0.5	621	601	0.8

Table 8.6: Validation Rail Station Alightings

Alightings	AM			IP			PM		
Rail station	Obs	Model	% Diff	Obs	Model	% Diff	Obs	Model	% Diff
Barrow upon Soar	2	4	118%	6	7	9%	22	21	-6%
East Midlands Parkway	33	26	-22%	45	31	-30%	93	68	-27%
Hinckley	26	29	11%	17	24	37%	71	78	11%
Loughborough	118	183	55%	71	103	45%	163	256	57%
Market Harborough	84	54	-36%	50	60	20%	160	188	18%
Melton Mowbray	16	22	37%	25	25	1%	52	53	1%
Narborough	15	30	100%	13	25	90%	59	117	98%
Sileby	7	9	36%	8	13	74%	37	22	-39%
South Wigston	10	7	-27%	3	2	-24%	31	22	-27%
Syston	16	18	14%	16	17	10%	45	44	-4%
Leicester	615	682	11%	364	397	9%	650	660	2%

8.2.6 Whilst a highway-focussed measure of model fit, the difference column has been substituted with GEH statistics in the table below, provided for context.

Table 8.7: Validation Rail Station Alightings (with GEH Statistics)

Alightings	AM			IP			PM		
Rail station	Obs	Model	GEH	Obs	Model	GEH	Obs	Model	GEH
Barrow upon Soar	2	4	1.2	6	7	0.4	22	21	0.2
East Midlands Parkway	33	26	1.3	45	31	2.3	93	68	2.8
Hinckley	26	29	0.6	17	24	1.5	71	78	0.8
Loughborough	118	183	5.3	71	103	3.4	163	256	6.4
Market Harborough	84	54	3.6	50	60	1.3	160	188	2.1
Melton Mowbray	16	22	1.4	25	25	0.0	52	53	0.1
Narborough	15	30	3.2	13	25	2.8	59	117	6.2
Sileby	7	9	0.7	8	13	1.5	37	22	2.8
South Wigston	10	7	1.0	3	2	0.6	31	22	1.7
Syston	16	18	0.5	16	17	0.2	45	44	0.1
Leicester	615	682	2.6	364	397	1.7	650	660	0.4

8.3 Patronage

8.3.1 TAG recommends that wherever possible, a check should be made between the patronage derived from the model and the patronage derived from the operator from revenue records. This has been obtained and compared against the model by town of boarding, as shown below.

8.3.2 It has been necessary to estimate a factor to convert annual patronage data to an average 12 hour weekday. Conversion factors from 24 to 12 hours were derived from the model itself; to go from annual to an average weekday. 253 working days per year were assumed, with average public transport patronage of 41% of weekday patronage on a non-working day, derived from the National Travel Survey.

Table 8.8: Bus Model Validation against Patronage Data, 2014

Sector	Annual Operator Data	Model (12h)	Model (Annualised)	Difference
Leicester City	27,212,782	87,745	28,165,989	4%
LTP Area	5,098,817	14,434	4,633,243	-9%
Loughborough	3,567,450	10,166	3,263,352	-9%
Hinckley	452,219	2,472	793,462	75%
Other Leicestershire	4,690,667	18,882	6,061,019	29%
All	**41,021,936**	**133,698**	**42,917,066**	**5%**

8.3.3 This is an independent validation; these data were not used directly at any point of the matrix build (they were used to derive factors with which to correct count data, but only the change over time was relevant), and no changes to any aspect of the model were made after extracting the comparison. Generally the comparison is good; the only significant discrepancy is Hinckley, where the model has overstated the demand. It is not entirely clear why; however some relevant points can be made.

8.3.4 Hinckley was also overstated in this comparison in LLITM v5, and by a larger factor (150%).

8.3.5 It is likely that the conversion factor used to convert the model data from 12 hour to annual is not accurate. Hinckley, like most of the market towns besides Loughborough, has a very poor Sunday and evening service (about 10% of the weekday service, contrasted with 33% in Loughborough), and so the modelled annualised patronage is probably a little lower than that quoted above, meaning that the real error in the model is may well be somewhat less than the quoted 75%. This does not, however, explain the entire discrepancy for Hinckley. The same argument probably accounts for most of the 29% overstatement in other parts of Leicestershire.

8.4 Model Summary Statistics

8.4.1 Some summary statistics for the base year public transport model are presented below. These represent a single hour of the model within each time period and it should be noted that these cover a slightly larger area than just Leicestershire. The average bus speed of 22 kph includes stops to pick up and set down passengers; it is the average speed experienced by a traveller as long as they are on the bus. It is also dominated by the high volumes of passengers in central Leicester, where speeds are lower. Therefore, this seems realistic.

8.4.2 Average trip length has not been reported for rail as the computation of this would include through rail trips that do not board in the modelled area (for instance Sheffield to London) and would therefore be a non-meaningfully high value.

Table 8.9: Summary Public Transport Statistics, LLITM 2014 Base, Leicestershire and surroundings

Period	Mode	Passenger Kilometres	Passenger Hours	Passenger Boardings	Average speed (kph)	Average trip length (km)
AM	Bus & Coach	71,623	3,220	12,052	22	5.9
AM	Rail	102,376	948	1,422	108	
IP	Bus & Coach	67,813	3,043	12,028	22	5.6
IP	Rail	65,849	586	583	112	
PM	Bus & Coach	59,551	2,650	10,135	22	5.9
PM	Rail	94,465	870	901	109	

9. Conclusions

9.1 Introduction

9.1.1 The preceding sections of this report detail the development of the public transport model, the definition and derivation of the observed data used to build and validate the model, the calibration process adopted, and the results of the calibration process assessed against standards defined in TAG. This section summarises these process and results, and assesses the model performance in light of the known and expected applications of the model.

9.2 Review of Development

9.2.1 This version of the LLITM public transport model is a complete re-build from previous versions of LLITM. No network or demand data at all were taken from earlier models, although in some cases similar processes were used.

9.2.2 The network and service representation of buses in Leicester and Leicestershire has been completely revised, with data taken from the Traveline National Dataset. Substantial validation and checking of these data suggest that, interpreted sensibly, they contain a highly accurate representation of bus vehicle travel. The service coding has been reviewed by LCC to add further confidence in the model coding.

9.2.3 Bus and rail matrices were developed for 2014 from new ticket sales data. In the case of bus travel, this represents a new matrix building methodology, not used in previous versions of the model.

9.2.4 The new public transport model has been calibrated to new count data available across Leicester and Leicestershire, all rebased to 2014 levels.

9.3 Model Performance Summary

9.3.1 The LLITM 2014 public transport model achieves a high standard of bus link count calibration, with well over 90% of links with significant (more than 30 passengers per hour) flow achieving a match compliant with TAG of within 25%. Furthermore, the validation at a high level of the number of passenger boardings across the county and city is very close, within 5%, as shown in Table 8.8.

9.3.2 The validation in terms of boardings in town centres is slightly weaker; within Leicester it is reasonable with modelled boardings generally within 10-20% of observed. Within other market towns the model demonstrates boardings of the same order as the observed data, but does not match as closely. These discrepancies appear to relate primarily to inconsistencies between the boarding count data and the link counts rather than to deficiencies in the model, although it is true that the model does not represent boardings and alightings at a bus stop level; it has a strategic focus.

9.3.3 Rail travel matches ORR data well (see Table 7.7.)

9.4 Model Uses and Suitability

9.4.1 There are some specific types of application envisioned for the public transport model:

- Strategic urban studies, reviewing travel within the larger Leicester urban area and study into the effectiveness of various measures to improve travel and encourage sustainable use.

- Various development assessments, including Sustainable Urban Extensions (SUEs) and elements of Area Action Plans and Core Strategies, including proposed new bus services to the sites.
- Fare policy testing (such as area-based fare reductions).
- Early stage assessment of bus service frequency variations.
- Park-and-ride assessment (changes to existing services and new sites).

9.4.2 We regard the new public transport model as a *good* starting point for *all of* these kinds of assessments (not necessarily an exhaustive list). *It remains a relatively strategic model; it is not suitable for operational planning of bus services, to the level of bus stop positions.*

Appendix A Matrix Estimation Methodology

1.2 Matrix Estimation

1.2.1 The standard transport modelling technique for using count data to improve assignment demand matrices is called "matrix estimation". This involves repeatedly assigning the transport demand, identifying movements that pass through count sites, and making adjustments to those movements to improve the modelled flows relative to the observed counts.

1.2.2 It is important to ensure that any differences between modelled and observed flows are primarily due to the demand matrix, and not to the network and services or assignment methodology, before allowing matrix estimation to adjust the matrices. This is not discussed in detail here; this note is concerned with the algorithms used to perform estimation, rather than surrounding principles.

1.2.3 It is also preferable, if significant problems with the matrix are identified, to consider why, and ideally to change the original matrix building process to address the problems. This way, issues can be corrected directly; the matrix estimation may otherwise reproduce appropriate counts without addressing the underlying problems with the matrix. Again, this is not discussed in any further detail here.

1.3 Gradient Method

1.3.1 An accepted algorithm for adjusting matrices to reflect counts is the "gradient method", documented in "A Gradient Approach For The O-D Matrix Adjustment Problem", Spiess, 1990. This is the standard approach taken in the Emme software in which LLITM-PT is built. It is not the only well-used matrix estimation, algorithm, however algorithms generally share two basic principles:

- The revised matrix should reproduce the observed flows as well as possible.
- The revised matrix should resemble the original matrix as well as possible.

1.3.2 Algorithms differ in the relative weights they place on the two points, as well as in how "as well as possible" is defined for each and whether some counts and/or origin-destination pairs are weighted more highly than others.

1.3.3 The gradient method aims at each step to make minimal adjustments to the matrix to achieve a given improvement in flow comparison by seeking the path of steepest descent. The full algorithm is as follows:

1. A single standard assignment is performed to generate flows. All following network calculations are performed ***only*** on links/nodes/segments that actually have counts; other links are ignored.
2. The "gradient" is calculated for each link, segment or node with a count, using the following function:

   $$G = \lambda(ObservedCount - ModelFlow)$$

   where λ is a chosen small number; 0.01 is used in LLITM-PT.
3. The "objective function" Z is calculated for the network as a whole, as

   $$Z = \sum \lambda(ModelFlow - ObservedCount)^2$$

   where λ is the same number as before. This is not used in the rest of the process but is a measure of convergence.
4. A "gradient matrix" is computed, skimming the sum of G across all boardings and segments on each journey. This matrix gradient is called g.
5. The gradient matrix is multiplied by demand to get a demand adjustment. A new assignment of this demand **adjustment** is performed to produce new flows. This assignment uses the same routes as 1, with only the demand by zone-pair changed. It does *not* recalculate congestion and re-evaluate routes. Note that this step requires the assignment of negative demand, since the adjustments will sometimes be negative.

6. The maximum absolute ratio of adjusted to new demand is calculated by matrix cell, that is to say, the maximum matrix-level gradient is calculated. Negatives become positive.
7. The “optimal step length” is calculated as a network calculation as follows, using the maximum G calculated in step 6. The flows used here are those derived from step 5, not the current “real” assignment flows.

$$StepLength = \sum \left(\frac{G}{\lambda} \frac{Flow}{\sum Flow^2} \right) Max(|g|)$$

8. If the step length is greater than 1, it is set to 1.
9. A new demand matrix is calculated as follows:

$$NewDemand = PreviousDemand \left(1 + StepLength \left(\frac{g}{Max(|g|)} \right) \right)$$

10. A decision is made on whether to stop or not (based on number of iterations, value of objective function, or some other convergence measure). If the process is not halted, it goes back to step 1, using the new demand matrix calculated in step 9 in place of the original matrix.

1.4 Tours

1.4.1 LLITM is a tour-based model. This means that instead of considering the basic unit of travel to be the “trip”, where a trip has an origin and a destination; it instead largely considers two-leg “tours”, where a tour has a production and an attraction, and over the course of the day makes two trips, one outbound from the production to the attraction, and one returning from the attraction to the production.

1.4.2 This has previously created some problems with respect to matrix estimation. Standard matrix estimation algorithms such as the one laid out in Section 2.1 adjust trip matrices. This leads to a problem of reconciling the adjusted trip matrices with the original tour matrices, as it straightforward to calculate trips given tours, but not vice-versa.

1.4.3 In previous versions of the model, the problem was addressed by having additive adjustment matrices applied to the public transport assignment matrices prior to assignment; these being based on the effect of the matrix estimation. The original tour matrices were left unchanged by the matrix estimation process. This approach is somewhat undesirable, as it creates a discrepancy between the assignment and demand-level matrices, and the additive adjustments are essentially modelled as unresponsive to transport cost.

1.4.4 Accordingly, an alternative approach has been investigated, whereby the matrix estimation algorithm adjusts the tour matrices directly. The revised algorithm is as follows. Note that while previously the algorithm adjusted a single time-period at a time, the tour-based algorithm must adjust all three time periods together.

1. Three standard assignments, for the AM Peak, interpeak, and PM Peak, are performed to generate flows. Assignment demand is calculated by summing appropriate tour-based matrices and converting to a single hour. All following network calculations are performed ***only*** on links/nodes/segments that actually have counts; other links are ignored.
2. The “gradient" is calculated for each link, segment or node with a count, using the following function:

$$G = \lambda(ObservedCount - ModelFlow)$$

where λ is a chosen small number; 0.01 is used in LLITM-PT.

3. The “objective function” Z is calculated across the three networks, as

$$Z = \sum \lambda(ModelFlow - ObservedCount)^2$$

where λ is the same number as before. This is not used in the rest of the process but is a measure of convergence.

4. “Gradient matrices” are computed, skimming the sum of G across all boardings and segments on each journey, for all three time periods.
5. Tour-based matrix gradients are calculated by summing appropriate pairs of time period matrices, transposing where appropriate. For example, the gradient matrix for the AM

outbound, interpeak return period-pair is the sum of the AM skim and the transport of the interpeak skim. These matrix gradients are called g.

6. The gradient matrices is multiplied by demand to get a demand adjustment. This is converted to assignment level by summing the appropriate tour matrices and converting to a single hour. New assignments of this demand adjustment are performed to produce new flows. These assignment use the same routes as 1, with only the demand by zone-pair changed. They do *not* recalculate congestion and re-evaluate routes.
7. The maximum absolute ratio of adjusted to new demand is calculated by matrix cell across all time period pairs, that is to say, the maximum matrix-level gradient is calculated. Negatives become positive.
8. The "optimal step length" is calculated as a network calculation as follows, using the maximum G calculated in step 6. The flows used here are those derived from step 6, not the current "real" assignment flows. The sums are across all three time periods.

$$StepLength = \sum \left(\frac{G}{\lambda} \frac{Flow}{\sum Flow^2} \right) Max(|g|)$$

9. If the step length is greater than 1, it is set to 1.
10. New demand matrices are calculated at the tour level as follows:

$$NewDemand = PreviousDemand\left(1 + StepLength\left(\frac{g}{Max(|g|)}\right)\right)$$

11. A decision is made on whether to stop or not (based on number of iterations, value of objective function, or some other convergence measure). If the process is not halted, it goes back to step 1, using the new demand matrix calculated in step 10 in place of the original matrix.

1.4.5 The algorithm is conceptually identical to the trip-based one; it is simply a generalisation of the process.

Appendix B Flow Calibration Performance by Link

Table B1.1: Flow Calibration Performance by Link

Cordon	ID	Road Name	Direction	AM Obs	AM Mod	AM Diff	IP Obs	IP Mod	IP Diff	PM Obs	PM Mod	PM Diff
Central Transport	E01	Belgrave Road	Inbound	1,745	1,522	-13%	916	869	-5%	664	518	-22%
Central Transport	E02	Humberstone Road	Inbound	1,051	941	-10%	691	632	-8%	336	270	-20%
Central Transport	E03	London Road	Inbound	732	710	-3%	530	506	-4%	240	253	6%
Central Transport	E04	Welford Road	Inbound	514	488	-5%	205	199	-3%	119	139	17%
Central Transport	E06	Aylestone Road	Inbound	1,109	1,017	-8%	677	595	-12%	308	254	-18%
Central Transport	E10	Evington Road	Inbound	353	392	11%	344	350	2%	127	169	32%
Central Transport	E01	Belgrave Road	Outbound	576	656	14%	1045	1,008	-4%	1,391	1,323	-5%
Central Transport	E02	Humberstone Road	Outbound	289	318	10%	541	559	3%	834	894	7%
Central Transport	E03	London Road	Outbound	347	340	-2%	335	352	5%	707	643	-9%
Central Transport	E04	Welford Road	Outbound	173	172	0%	174	200	15%	328	331	1%
Central Transport	E06	Aylestone Road	Outbound	241	303	26%	522	544	4%	1,000	1,007	1%
City Centre	CC01	Belgrave Gate	Inbound	1,264	1,303	3%	860	862	0%	511	516	1%
City Centre	CC04	Humberstone Road	Inbound	903	961	6%	664	684	3%	262	304	16%
City Centre	CC07	Charles Street	Inbound	788	767	-3%	803	770	-4%	527	486	-8%
City Centre	CC08	Granby Street	Inbound	57	0	-100%	74	0	-100%	44	0	-100%
City Centre	CC13	Pocklingtons Walk	Inbound	853	875	3%	750	779	4%	422	481	14%
City Centre	CC18	Causeway Lane	Inbound	884	866	-2%	581	587	1%	344	376	9%
City Centre	CC19	Church Gate	Inbound	448	456	2%	302	281	-7%	185	165	-11%
City Centre	CC20	Abbey Street	Inbound	90	212	135%	65	143	120%	0	71	100%
City Centre	CC01	Belgrave Gate	Outbound	539	436	-19%	744	674	-9%	909	875	-4%
City Centre	CC04	Humberstone Road	Outbound	486	365	-25%	686	588	-14%	1,263	1,114	-12%
City Centre	CC07	Charles Street	Outbound	754	678	-10%	747	730	-2%	1,030	983	-5%
City Centre	CC12	Welford Place	Outbound	1,017	924	-9%	903	779	-14%	1,127	1,048	-7%
City Centre	CC18	Causeway Lane	Outbound	332	287	-14%	721	599	-17%	746	676	-9%

Cordon	ID	Road Name	Direction	AM Obs	AM Mod	AM Diff	IP Obs	IP Mod	IP Diff	PM Obs	PM Mod	PM Diff
City Centre	CC20	Abbey Street	Outbound	1,115	885	-21%	883	828	-6%	832	817	-2%
N-S Screenline	S01	Barrow Road	Eastbound	29	30	3%	44	54	21%	47	22	-53%
N-S Screenline	S03	Syston Road	Eastbound	18	17	-2%	18	19	4%	12	26	126%
N-S Screenline	S04	Rectory Road	Eastbound	0	28	100%	0	12	100%	0	5	100%
N-S Screenline	S06	Loughborough Road	Eastbound	210	266	27%	149	166	11%	85	78	-9%
N-S Screenline	S08	Abbey Park Road	Eastbound	467	457	-2%	382	377	-1%	169	176	4%
N-S Screenline	S09	St Margarets Way	Eastbound	125	200	59%	104	126	20%	75	86	15%
N-S Screenline	S10	Frog Island	Eastbound	589	581	-1%	375	346	-8%	233	187	-20%
N-S Screenline	S11	St Augustines Road	Eastbound	1,142	1,197	5%	744	735	-1%	366	347	-5%
N-S Screenline	S14	Upperton Road	Eastbound	94	147	57%	42	84	100%	4	54	1180%
N-S Screenline	S15	Braunstone Lane East	Eastbound	10	40	316%	7	18	161%	5	16	209%
N-S Screenline	S16	Soar Valley Way	Eastbound	28	20	-29%	23	17	-27%	37	9	-74%
N-S Screenline	S18	Warwick Road	Eastbound	0	9	100%	7	6	-18%	16	4	-72%
N-S Screenline	S19	Cosby Road	Eastbound	42	24	-44%	6	21	230%	13	37	190%
N-S Screenline	S21	Coventry Road	Eastbound	0	1	100%	0	0	0%	0	0	0%
N-S Screenline	S01	Barrow Road	Westbound	66	67	2%	32	37	18%	11	14	30%
N-S Screenline	S03	Syston Road	Westbound	93	37	-60%	11	17	62%	11	11	8%
N-S Screenline	S04	Rectory Road	Westbound	0	0	0%	0	0	0%	0	0	0%
N-S Screenline	S06	Loughborough Road	Westbound	151	171	13%	144	192	33%	210	231	10%
N-S Screenline	S08	Abbey Park Road	Westbound	211	198	-6%	366	354	-3%	544	524	-4%
N-S Screenline	S09	St Margarets Way	Westbound	134	233	74%	129	151	17%	139	104	-25%
N-S Screenline	S10	Frog Island	Westbound	216	280	29%	420	442	5%	644	562	-13%
N-S Screenline	S11	St Augustines Road	Westbound	329	325	-1%	788	752	-5%	1,217	1,164	-4%
N-S Screenline	S14	Upperton Road	Westbound	9	48	410%	37	55	50%	48	104	114%
N-S Screenline	S15	Braunstone Lane East	Westbound	0	11	100%	12	14	16%	5	8	42%
N-S Screenline	S16	Soar Valley Way	Westbound	27	38	38%	13	15	23%	6	12	88%
N-S Screenline	S18	Warwick Road	Westbound	18	7	-60%	4	6	35%	0	4	100%

Cordon	ID	Road Name	Direction	AM Obs	AM Mod	AM Diff	IP Obs	IP Mod	IP Diff	PM Obs	PM Mod	PM Diff
N-S Screenline	S19	Cosby Road	Westbound	16	35	123%	14	23	66%	3	21	569%
N-S Screenline	S21	Coventry Road	Westbound	0	0	0%	0	0	100%	0	0	0%
Outer Ring Road	OD01	North Abbey Lane	Inbound	72	48	-33%	34	58	73%	14	55	306%
Outer Ring Road	OD02	Loughborough Road	Inbound	210	266	27%	149	166	11%	85	78	-9%
Outer Ring Road	OD06	A47 - East Uppingham Road	Inbound	211	214	1%	126	130	3%	38	36	-4%
Outer Ring Road	OD10	London Road	Inbound	558	534	-4%	423	384	-9%	240	196	-18%
Outer Ring Road	OD11	Welford Road	Inbound	300	271	-10%	161	129	-20%	162	96	-41%
Outer Ring Road	OD14	A47 - Hinckley Road	Inbound	434	532	23%	230	237	3%	119	161	36%
Outer Ring Road	OD18	Melton Road	Inbound	331	293	-11%	188	170	-10%	239	203	-15%
Outer Ring Road	OD19	Aylestone Road	Inbound	377	369	-2%	165	184	11%	122	97	-21%
Outer Ring Road	OD20	Narborough Road	Inbound	81	93	15%	44	77	75%	55	81	49%
Outer Ring Road	OD21	A50 - North Groby Road	Inbound	193	181	-6%	168	127	-24%	157	72	-54%
Outer Ring Road	OD01	North Abbey Lane	Outbound	76	106	40%	93	43	-54%	134	58	-57%
Outer Ring Road	OD02	Loughborough Road	Outbound	175	171	-3%	153	192	26%	226	231	2%
Outer Ring Road	OD06	A47 - East Uppingham Road	Outbound	64	72	12%	161	166	3%	184	175	-5%
Outer Ring Road	OD10	London Road	Outbound	284	269	-5%	292	307	5%	442	444	0%
Outer Ring Road	OD11	Welford Road	Outbound	57	90	58%	111	133	20%	171	187	9%
Outer Ring Road	OD14	A47 - Hinckley Road	Outbound	167	155	-7%	239	239	0%	370	421	14%
Outer Ring Road	OD18	Melton Road	Outbound	212	168	-21%	163	133	-18%	269	234	-13%
Outer Ring Road	OD19	Aylestone Road	Outbound	137	146	7%	115	129	12%	313	310	-1%
Outer Ring Road	OD20	Narborough Road	Outbound	269	212	-21%	92	86	-6%	139	127	-9%
Outer Ring Road	OD21	A50 - North Groby Road	Outbound	316	92	-71%	189	121	-36%	357	252	-29%
Ashby	MT16	Nottingham Road	Inbound	0	9	100%	11	13	17%	35	35	0%
Ashby	MT17	Leicester Road	Inbound	21	22	5%	18	20	13%	8	11	34%

Cordon	ID	Road Name	Direction	AM Obs	AM Mod	AM Diff	IP Obs	IP Mod	IP Diff	PM Obs	PM Mod	PM Diff
Ashby	MT18	Station Road	Inbound	60	58	-3%	4	6	55%	1	4	248%
Ashby	MT19	Moira Road	Inbound	50	52	4%	19	22	16%	27	24	-9%
Ashby	MT20	Burton Road	Inbound	3	0	-93%	5	1	-87%	0	0	100%
Ashby	MT16	Nottingham Road	Outbound	25	33	31%	14	14	-6%	0	9	100%
Ashby	MT17	Leicester Road	Outbound	53	39	-26%	14	9	-37%	17	13	-23%
Ashby	MT18	Station Road	Outbound	2	7	215%	15	21	45%	10	14	33%
Ashby	MT19	Moira Road	Outbound	30	26	-13%	31	30	-5%	50	48	-4%
Ashby	MT20	Burton Road	Outbound	0	0	100%	4	0	-88%	7	0	-93%
Coalville	MT12	Talbot Street	Inbound	35	36	4%	37	39	6%	10	16	53%
Coalville	MT13	Shaw Lane	Inbound	9	12	30%	29	29	-1%	57	57	1%
Coalville	MT14	Station Road	Inbound	94	97	3%	47	48	2%	9	10	10%
Coalville	MT15	Ashby Road	Inbound	73	70	-3%	28	28	2%	23	20	-12%
Coalville	MT12	Talbot Street	Outbound	54	49	-10%	22	21	-4%	42	41	-2%
Coalville	MT13	Shaw Lane	Outbound	29	29	-1%	26	25	-6%	13	13	3%
Coalville	MT14	Station Road	Outbound	22	22	0%	59	56	-6%	68	63	-8%
Coalville	MT15	Ashby Road	Outbound	27	26	-2%	43	42	-1%	40	42	5%
Hinckley	MT1	Ashby Road	Inbound	111	108	-3%	79	66	-17%	122	99	-19%
Hinckley	MT2	Leicester Road	Inbound	91	88	-3%	17	18	7%	3	8	140%
Hinckley	MT3	Sapcote Road	Inbound	17	7	-61%	3	9	212%	0	2	100%
Hinckley	MT4	Lutterworth Road	Inbound	3	5	52%	6	6	12%	13	10	-19%
Hinckley	MT5	Welvey Road	Inbound	0	9	100%	27	26	-3%	38	42	9%
Hinckley	MT6	Coventry Road	Inbound	75	77	3%	107	108	1%	51	54	7%
Hinckley	MT1	Ashby Road	Outbound	221	177	-20%	97	74	-23%	169	128	-24%
Hinckley	MT2	Leicester Road	Outbound	16	17	6%	47	48	3%	19	19	1%
Hinckley	MT3	Sapcote Road	Outbound	0	10	100%	7	15	112%	14	16	13%
Hinckley	MT4	Lutterworth Road	Outbound	8	6	-21%	6	6	0%	6	3	-45%
Hinckley	MT5	Welvey Road	Outbound	45	44	-1%	24	0	-100%	40	36	-9%

Cordon	ID	Road Name	Direction	AM Obs	AM Mod	AM Diff	IP Obs	IP Mod	IP Diff	PM Obs	PM Mod	PM Diff
Hinckley	MT6	Coventry Road	Outbound	118	112	-4%	83	80	-4%	114	110	-4%
Loughborough	MT10	Ashby Road	Inbound	95	95	0%	41	42	2%	39	39	0%
Loughborough	MT10A	Nanpanton Road	Inbound	13	19	41%	1	6	289%	2	2	-18%
Loughborough	MT11	Derby Road	Inbound	48	43	-10%	39	31	-21%	10	10	-7%
Loughborough	MT8	Nottingham Road	Inbound	36	38	4%	37	34	-6%	41	42	2%
Loughborough	MT9	Leicester Road	Inbound	288	260	-9%	167	153	-9%	68	62	-9%
Loughborough	MT10	Ashby Road	Outbound	20	20	2%	60	57	-4%	96	94	-2%
Loughborough	MT10A	Nanpanton Road	Outbound	1	1	-33%	7	4	-37%	0	1	100%
Loughborough	MT11	Derby Road	Outbound	26	23	-10%	48	45	-7%	24	22	-7%
Loughborough	MT8	Nottingham Road	Outbound	23	21	-7%	37	32	-14%	46	43	-5%
Loughborough	MT9	Leicester Road	Outbound	253	207	-18%	190	170	-11%	152	133	-12%
Lutterworth	MT21	Lower Leicester Road	Inbound	67	65	-3%	8	11	42%	3	5	35%
Lutterworth	MT22	Rugby Road	Inbound	7	6	-7%	11	11	5%	20	20	1%
Lutterworth	MT23	Bitteswell Road	Inbound	0	3	100%	8	7	-14%	7	4	-36%
Lutterworth	MT23A	Coventry Road	Inbound	0	10	100%	6	8	44%	3	7	98%
Lutterworth	MT21	Lower Leicester Road	Outbound	8	3	-60%	35	28	-21%	3	5	36%
Lutterworth	MT22	Rugby Road	Outbound	21	22	4%	12	10	-15%	2	5	120%
Lutterworth	MT23	Bitteswell Road	Outbound	5	8	70%	7	6	-8%	6	8	37%
Lutterworth	MT23A	Coventry Road	Outbound	6	7	18%	14	15	3%	24	19	-22%
Market Harborough	MT24	Harborough Road	Inbound	54	42	-22%	66	53	-21%	61	49	-20%
Market Harborough	MT26	Scotland Road	Inbound	0	0	100%	8	0	-99%	3	0	-98%
Market Harborough	MT27	Northampton Road	Inbound	17	2	-88%	15	5	-69%	17	3	-83%
Market Harborough	MT28	Lubenham Hill	Inbound	23	25	10%	9	12	38%	3	5	49%
Market Harborough	MT29	Great Bowden Road	Inbound	19	19	3%	7	9	23%	0	3	100%

Cordon	ID	Road Name	Direction	AM Obs	AM Mod	AM Diff	IP Obs	IP Mod	IP Diff	PM Obs	PM Mod	PM Diff
Market Harborough	MT24	Harborough Road	Outbound	74	64	-13%	45	39	-13%	36	38	6%
Market Harborough	MT26	Scotland Road	Outbound	0	0	100%	15	0	-98%	5	0	-99%
Market Harborough	MT27	Northampton Road	Outbound	0	0	100%	22	1	-97%	16	0	-98%
Market Harborough	MT28	Lubenham Hill	Outbound	0	3	100%	12	11	-13%	13	12	-4%
Market Harborough	MT29	Great Bowden Road	Outbound	0	4	100%	7	8	21%	14	17	20%
Melton Mowbray	MT30	Nottingham Road	Inbound	22	16	-27%	20	15	-27%	25	15	-42%
Melton Mowbray	MT31	Scalford Road	Inbound	2	2	2%	3	2	-22%	0	2	100%
Melton Mowbray	MT32	Thorpe Road	Inbound	8	10	28%	8	9	24%	20	21	8%
Melton Mowbray	MT33	Burton Road	Inbound	22	22	0%	12	11	-8%	15	11	-28%
Melton Mowbray	MT35	Ashfordby Road	Inbound	79	58	-26%	48	31	-34%	44	33	-25%
Melton Mowbray	MT30	Nottingham Road	Outbound	19	20	10%	19	20	3%	6	8	36%
Melton Mowbray	MT31	Scalford Road	Outbound	2	4	59%	5	5	3%	1	3	190%
Melton Mowbray	MT32	Thorpe Road	Outbound	0	2	100%	10	5	-45%	17	6	-67%
Melton Mowbray	MT33	Burton Road	Outbound	27	20	-24%	16	9	-42%	7	4	-42%
Melton Mowbray	MT35	Ashfordby Road	Outbound	76	44	-42%	54	40	-26%	59	53	-10%

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LLITM 2014 Base

North & East Melton Mowbray Distributor Road
Full Business Case

Demand Model Development Report

Leicestershire County Council

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Quality information

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Revision History

Revision	**Revision date**	**Details**	**Authorised**	**Name**	**Position**
v1	2017-06-28	v1 for issue	Yes	Mark Dazeley	Regional Director
v2	2018-05-11	Responding to comments from LCC	Yes	Mark Dazeley	Regional Director
v3	2019-02-11	Update for revised base year and economic parameters	Yes	Mark Dazeley	Regional Director
v4	2022-04-19	Update for NEMMDR FBC	Yes	Mark Dazeley	Regional Director
v5	2022-11-15	Addressing DfT Comments	Yes	Mark Dazeley	Regional Director

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Figures

Tables

1. Overview

1.1 Introduction

1.1.1 This report discusses the specification, implementation and verification of the variable demand model used in the Leicester and Leicestershire Integrated Transport Model (LLITM 2014 Base), referred from here on as LLITM-DM.

1.1.2 The LLITM 2014 Base model consists of four key components, namely:

- a highway supply model (LLITM-HW), developed in SATURN;
- a public transport supply model (LLITM-PT), developed in Emme;
- a variable demand model (LLITM-DM), the subject of this report, built in Emme; and
- a trip-end model (LLITM-TEM), developed in MS Access, using the code from the DfT's National Trip End Model (NTEM).

1.2 Role of LLITM-DM within LLITM 2014 Base

1.2.1 The purpose of the demand model is to estimate the pattern of trips made in Leicester and Leicestershire, including their origins, destinations, mode and time of day, reflecting journey purpose, income and car-availability, for a given forecasting scenario comprising scheme highway and public transport networks, land-use assumptions, economic assumptions, and transport policies. LLITM-DM takes base year land-use assumptions from LLITM-TEM and economic assumptions from the November 2021 version of the TAG data book (the latest available version at the time of model forecasting).

1.2.2 A set of base year matrices exists for LLITM, the preparation of which is discussed in the highway and public transport Local Model Validation Reports (LMVRs). Thus the demand model, as discussed in this document, is concerned with incrementally adjusting these base matrices in response to changes in land-use and travel costs rather than seeking to estimate the entire matrix through the application of an absolute demand model. This incremental method is the preferred approach in TAG.

1.2.3 The demand matrix outputs from the LLITM-DM are used by the LLITM-HW and LLITM-PT in assignments, and in the economic evaluation of schemes. The LLITM-DM itself requires inputs taken from LLITM-TEM, discussed in Chapter 8.

1.3 Demand Model Structure

1.3.1 The LLITM-DM contains a number of components that work together. The model is primarily implemented using Emme transport planning software. These components are:

- A trip end model, implemented in MS Access and based on the CTripEnd software that the DfT uses to establish National Trip-End Model (NTEM) forecasts, which takes input population, car ownership and employment forecasts, applies trip rates and derives production and attraction trip ends.
- A set of Emme databanks designed to hold the demand and cost matrices needed to operate the demand model and in which the core logit choice models are run.
- A collection of DOS batch files, executables, and Emme macros that control the creation of reference demand (including a parking model), operation of the demand model, interface with land-use and supply models, and outputs and reporting. Most of the process is handled by Emme macros: batch files and executables are used to control the overall model processes and for some interfacing tasks.

1.4 Report Structure

1.4.1 Following this introduction, this report contains the following chapters:

- **Chapter 2** explains how the demand used in the LLITM-DM is stored, how travellers are segmented, and what the model is designed to do.
- **Chapter 3** discusses the inputs required for the demand model, other than the base matrices and the land-use data, including economic assumptions and model sensitivities.
- **Chapter 4** explains how the planning data are derived, how the trip end model works, and how forecast ‘reference’ matrices are generated.
- **Chapter 5** discusses how the assignment (supply) models link to the demand model.
- **Chapter 6** discusses the choice models in the LLITM-DM, and explains their formulation and how generalised costs are calculated for use in them.
- **Chapter 7** presents data on base year LLITM-DM realism testing sensitivities, including fuel cost sensitivity and public transport fare sensitivities, and explains how the LLITM-DM was calibrated.
- **Chapter 8** explains how the LLITM-DM is used to generate estimates of demand for a scenario to be tested.

2. Scope and Segmentation

2.1 Time Periods and Tours Modelling

2.1.1 LLITM-DM is a tour-based model. This means that it stores demand as two-legged ’tours’, which have both an outgoing and a return leg, each with a (different or similar) time period. Demand matrices therefore must be stored by time-period-pairs. LLITM-DM models five time periods:

early off-peak period (E):	00:00-07:00;
AM Peak period (A):	07:00-10:00;
interpeak period (I):	10:00-16:00;
PM Peak period (P):	16:00-19:00; and
late off-peak period (L):	19:00-00:00.

2.1.2 Demand is stored by pairs as shown in Table 2.1 (the numbers simply labelling each combination):

Table 2.1: Time Period Pairs used for Modelling of Tours

Period	OP (early)	AM	IP	PM	OP (late)
OP (early)	1	2	3	4	5
AM		6	7	8	9
IP			10	11	12
PM				13	14
OP (late)					15

2.1.3 Note that for simplicity, and to reduce the number of matrices required, it is assumed that all trips must return later in the day than they set out. This is not, of course, universally true, as a traveller may return in a different day from that in which they set out, but it is true for around 95% of tours, as confirmed by an inspection of National Travel Survey (NTS) / NTEM data.

2.1.4 There are therefore 15 time-period pairs, and each requires a separate set of demand matrices.

2.1.5 We also make the assumption that all tours have two legs only, an outgoing and a return segment. More complex tours are represented by the approximation of non-home-based trips: single trips with no tour-linkage. Non-home-based trips constitute a small proportion of overall travel (around 15% in NTEM).

2.1.6 The tour-based approach is both theoretically and practically preferable to a trip-based approach (consideration of demand on the basis of single-leg ’trips’), permitting more complex interaction between the outbound and return legs of a trip. It allows the model to better represent a wider range of policy measures. The main drawbacks are an increase in model run times and storage space required, and the complexities involved in developing the demand matrices.

2.2 Demand Segmentation

2.2.1 The demand model considers the following demand segments, each of which are separate from the point of view of the demand model itself and do not interact with one another. In the supply models, of course, they do interact, and the generalised costs that feed into the demand model for any given segment will naturally depend upon the demand for all segments.

2.2.2 The LLITM-DM demand segmentation is shown below (the numbers label each purpose and segment combination represented). Segments 1 to 17 relate to personal travel and Segments 18 and 19 to freight demand.

Table 2.2: Demand Model Segmentation

	Income Segmentation		
Purpose	**Low**	**Medium**	**High**
Commuting	1	2	3
Education	4	5	6
Shopping	7	8	9
Home-Based Employers' Business		10	
Home-Based Other	11	12	13
Non-Home-Based Employers' Business		14	
Non-Home-Based Other	15	16	17
Light Goods Vehicles (LGV)		18	
Other Goods Vehicles (HGV)		19	

2.2.3 The public transport model uses a single person category, combining all the above segments (except freight, which is not used in the public transport model) together. The highway model has nine user classes, combining Education, Shopping, HB Other and NHB Other together, and similarly combining HB Business and NHB Business, as shown below.

Table 2.3: Demand Model Segments, Highway Model User Class Number

	Highway Model User Class #		
Purpose	**Low**	**Medium**	**High**
Commuting	7	8	9
Education	4	5	6
Shopping	4	5	6
Home-Based Employers' Business		3	
Home-Based Other	4	5	6
Non-Home-Based Employers' Business		3	
Non-Home-Based Other	4	5	6
Light Goods Vehicles (LGV)		2	
Other Goods Vehicles (HGV)		1	

2.2.4 In addition to the segmentation above, the mode-choice model operates with demand segmented by car-ownership, namely:

- persons in non-car-owning households; and

- persons in car-owning households.

2.2.5 This car ownership segmentation (in terms of proportional splits) is assumed to be constant across the day, i.e. it does not vary by time-period of outgoing or return trip. It does vary by segment, mode and production zone.

2.2.6 We assume that car travellers cannot be non-car-owning. This is not absolutely true in itself, but inspection of household survey data in Leicester and Leicestershire has confirmed that less than 1% of car trips are made by non-car-owning households, so we consider this a reasonable approximation.

2.2.7 In developing the trip matrices, demand was disaggregated by income and car availability through the application of variations in planning data (an aggregation of the household types assembled and represented in DELTA) and through application of trip rates derived from NTS data and through the application of differential trip length distributions, also based on NTS data. This processing results in different trip patterns by segment.

2.3 Zoning

2.3.1 LLITM-DM uses the same zoning system as the highway model LLITM-HW, the public transport model LLITM-PT and the trip-end model LLITM-TEM.

2.3.2 There are 1347 zones in LLITM 2014 Base, as illustrated in Figure 2.1 which shows an overview of the model zoning for Leicestershire and the immediate surrounding area, and Figure 2.2 showing an example of the zone detail within urban areas within Leicestershire, namely for Leicester City. Figure 2.3 shows the model zoning for Great Britain and shows the detail of the external zone system outside Leicestershire.

Figure 2.1: Model Zone System - Leicestershire

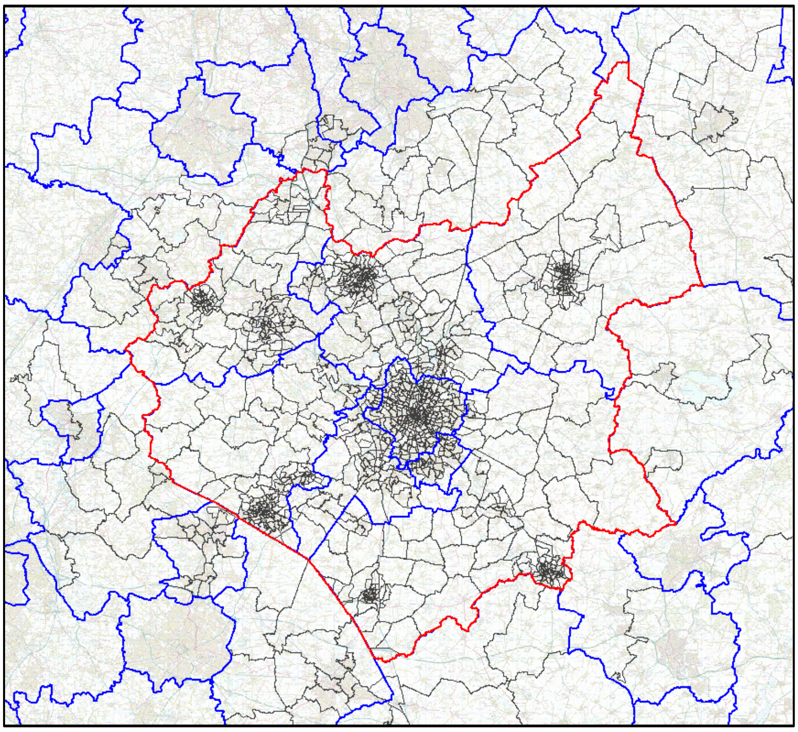

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Figure 2.2: Model Zone System – Leicester City

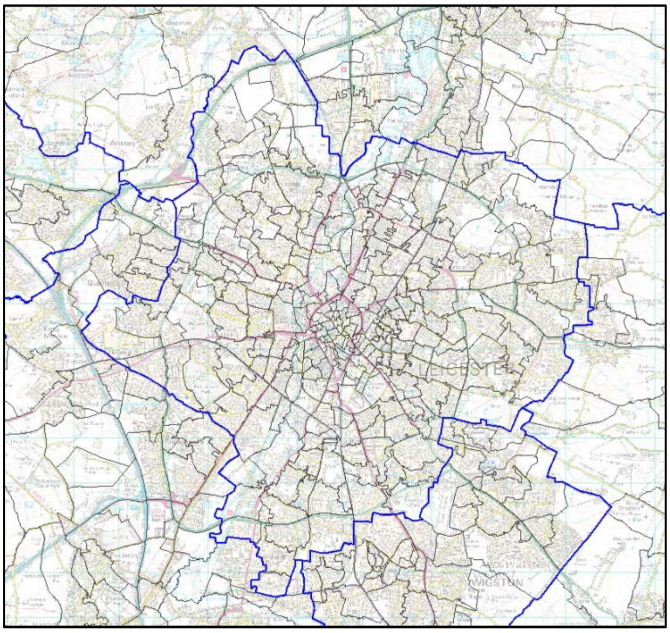

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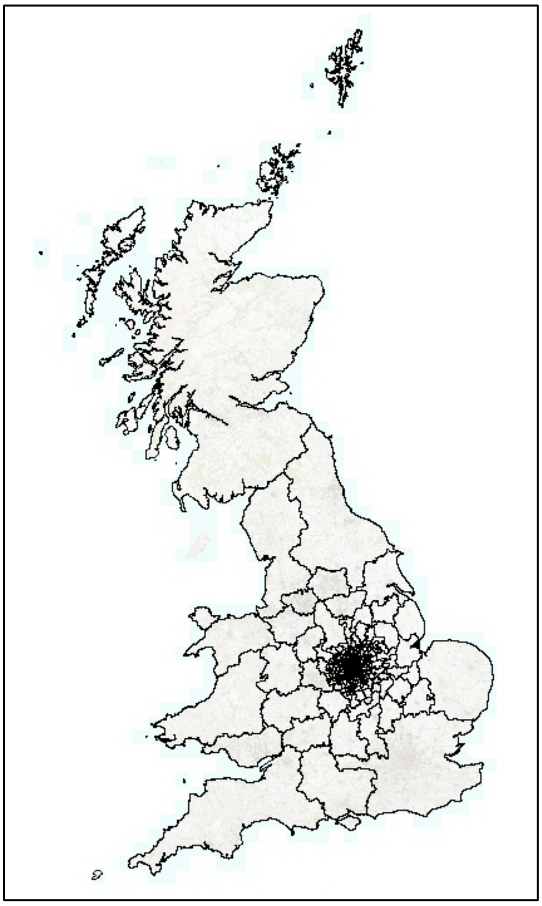
Figure 2.3: Model Zone System – Great Britain



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3. Data Sources

3.1 Introduction

3.1.1 This chapter discusses source data that complement the information available from the highway and public transport network models in developing estimates of the generalised cost of travel. Travel time and distance are taken directly from the network models, as are public transport fares. The following sections first discuss car related costs, and values of time. These are interpreted in a consistent but more aggregate form in the highway network model, reflecting the more aggregate segmentation of demand.

3.2 Cost of Travel

3.2.1 The demand model requires generalised costs for each trip movement, by purpose, mode, and income-band. The use of these data is explained in detail in Chapter 6. The calculation requires economic data, as summarised below:

- Fuel prices for car and freight travel, pence per litre.
- Fuel usage for each vehicle type, litres per kilometre.
- Non-fuel vehicle operating costs (including maintenance and vehicle depreciation), pence per kilometre. These are considered only for business travellers: we assume that non-work travellers do not take these costs into account in their decisions.

3.2.2 These data are taken directly from the TAG data book (November 2021).

3.2.3 Fuel and non-fuel vehicle operating costs are calculated using the following expressions.

$$\text{Monetary Fuel Costs} = M_F = p_F * l * i * \frac{\left(f_a + f_b * v + f_c * v^2 + f_d * v^3\right)}{v}$$

$$\text{Monetary Non - Fuel Costs} = M_O = l * \left(n_a + \frac{n_b}{v}\right)$$

for business and freight trips

$$\text{Monetary Non - Fuel Costs} = M_O = 0$$

for non-business trips

where:

M_F	monetary cost of fuel;
M_O	monetary non-fuel vehicle operating cost;
M_T	monetary value of all charges, including parking charges and public transport fares;
p_F	fuel price (pence per litre);
l	assigned distance;
i	fuel efficiency improvement factor, which reduces fuel consumption over time;
$f_{a/b/c/d}$	fuel cost parameters- see table below;

v average assigned speed for the matrix cell (kph); and

$n_{a/b}$ non-fuel cost parameters- see table below.

3.2.4 The base year (2014) vehicle operating cost economic parameters taken from TAG are summarised in Table 3.1, expressed in 2010 prices.

Table 3.1: Base Year (2014) Fuel Cost Parameters (2010 Prices)

Parameter Description	VOC Parameters by Fuel Type		
	Petrol	Diesel	Electric
Car Fuel Type Proportions	51.5%	48.4%	0.1%
HGV Fuel Type Proportions	0.0%	100.0%	0.0%
LGV Fuel Type Proportions	2.4%	97.5%	0.1%
Car Fuel VOC A-Factor, litres/km	0.45195	0.48191	-
Car Fuel VOC B-Factor, litres/km	0.09605	0.06909	0.21911
Car Fuel VOC C-Factor, litres/km	-0.00109	-0.00066	-
Car Fuel VOC D-Factor, litres/km	0.00001	0.00001	-
HGV Fuel VOC A-Factor, litres/km	-	4.61561	-
HGV Fuel VOC B-Factor, litres/km	-	0.24077	-
HGV Fuel VOC C-Factor, litres/km	-	-0.00163	-
HGV Fuel VOC D-Factor, litres/km	-	0.00001	-
LGV Fuel VOC A-Factor, litres/km	0.34435	0.46348	-
LGV Fuel VOC B-Factor, litres/km	0.19309	0.11328	0.23347
LGV Fuel VOC C-Factor, litres/km	-0.00303	-0.00163	-
LGV Fuel VOC D-Factor, litres/km	0.00002	0.00001	-
Car Fuel Efficiency Adjustment	0.97268	0.96338	1.01610
LGV Fuel Efficiency Adjustment	1.01289	0.99193	1.00042
HGV Fuel Efficiency Adjustment	1.00946	1.00946	1.00946
Business Fuel Price, pence/litre, kWh	99.17	103.52	13.78
Consumer Fuel Price, pence/litre, kWh	119.00	124.22	16.53

Source: TAG data book, November 2021

Table 3.2: Base Year (2014) Work Non-Fuel Operating Cost Parameters (2010 prices)

Parameter Description	Non Fuel Parameters by Vehicle Type		
	Car	LGV	HGV
Non-Fuel Cost A Parameter, pence/km	4.966	7.213	10.817
Non-Fuel Cost B Parameter, pence/km	135.946	47.113	421.993

Source: TAG data book, November 2021

3.3 Value of Time

3.3.1 Values of time (VoT), in pence per minute, by purpose and income-band are taken from the November 2021 TAG data book except that values of time have been disaggregated by income band using advice in TAG and base year LLITM-LUM[1] data. Base year values of time and factors used for income segmentation are provided in Table 3.3 and Table 3.4. Business and freight values of time do not vary by income band.

Table 3.3: Base Year (2014) Values of Time (2010 Prices)

Purpose	Value of Time; Pence per Minute		
	Low Income	Medium Income	High Income
Commuting	13.54	17.40	22.10
Business	25.99	25.99	25.99
Shopping	7.12	7.94	8.82
Education	7.12	7.94	8.82
Other	7.12	7.94	8.82
LGV	17.30	17.30	17.30
HGV	42.42	42.42	42.42

3.3.2 The same values of time apply to home-based and non-home-based trips, to all modelled modes, and to each of the car-availability levels. The proportions of travellers by income-band, however, vary by mode and car-availability.

3.3.3 Central values of time are taken directly from the TAG data book. However, values of time in LLITM-DM vary by both income-band (there are three income bands), and by length of journey.

3.3.4 This variation has been developed with reference to TAG Unit M2.1, Appendix B. We have derived average incomes for each of our three income-bands using data from LLITM-LUM, and adjusted values of time using the elasticities below.

Table 3.4: Value of Time Income Segmentation (2010 Prices)

Income Band	Household Income	Average Household Income	Value of Time Factor		
			Commuting	Other	All Non Work
1	0-£25,000	£17,009	0.778	0.896	0.856
2	£25,000-£50,000	£37,520	1.000	1.000	1.000
3	£50,000 +	£63,711	1.270	1.110	1.160

Source: TAG Unit M2.1, LLITM-LUM

3.3.5 In addition, we vary value of time by trip distance using a function of the form:

$$\text{Value of Time} = \max\left(\mathrm{VoT}_c \left(\frac{D}{D_0} \right)^{\eta_s}, \mathrm{VoT}_c \left(\frac{D_C}{D_0} \right)^{\eta_s} \right)$$

where:

VoT value of time used by the model;

---

[1] LLITM-LUM is a DELTA land-use model that can be used as part of LLITM, but has not been used for the NEMMDR FBC

VoT_c central value of time as given in Table 3.3;

D length of trip in kilometres; and

D_0, D_C and η_s are parameters.

3.3.6 This is a function of the form given in TAG Unit M2.1, Appendix C, except that it contains a lower-cap, below which values of time do not decrease further. We have found the lower-cap necessary to avoid excessive generalised cost changes for very short-distance trips, with associated high sensitivity, which results from using the very low value of time implied by the uncapped function. The parameters used are given in the table below.

Table 3.5: Value of Time Distance Variation

Parameter	Commuting Value	Other Value
D_0	5 km	5 km
D_C	27 km	22 km
η_s	0.248	0.315

3.4 Sensitivity Parameters

3.4.1 Parameters are taken from TAG Unit M2.1. As LLITM is a tour-based model, sensitivities for home-based purposes, for which the generalised costs in the model are tour costs, have been divided by two.

3.4.2 Active mode distribution sensitivities, not available from TAG, have been taken from the previous LLITM v5.2 model, as they were fitted using analysis of the 2009 LLITM household interview survey. Because this is now significantly out-of-date, and TAG generalised cost parameters have changed significantly since then, the highway and public transport parameters from this fitting process have not been used in LLITM 2014 Base. However, the active mode values have been retained as no other estimates are available and as there are no monetary elements to active mode cost, the 2009 research should remain broadly valid.

Table 3.6: LLITM 2014 Destination Choice Sensitivity (lambda)

Purpose	Highway	Public Transport	Active Modes
Home-Based Commuting	0.0325	0.0165	0.0232
Home-Based Business	0.0335	0.018	0.044
Home-Based Education	0.045	0.018	0.0443
Home-Based Shopping	0.045	0.018	0.0563
Home-Based Other	0.045	0.018	0.0423
Non-Home-Based Business	0.081	0.042	0.088
Non-Home-Based Other	0.077	0.033	0.07
LGV[1]	0.0300	-	-
HGV[1]	0.0300	-	-

[1] Freight sensitivities were derived from analysis of the synthetic gravity models

Table 3.7: LLITM 2014 Time Period/Mode Choice Sensitivity (lambda)

Purpose	Highway	Public Transport	Active Modes
Home-Based Commuting	0.0221	0.0112	0.0158
Home-Based Business	0.0151	0.0081	0.0198
Home-Based Education	0.0239	0.0095	0.0235
Home-Based Shopping	0.0239	0.0095	0.0299
Home-Based Other	0.0239	0.0095	0.0224
Non-Home-Based Business	0.0591	0.0307	0.0642
Non-Home-Based Other	0.0624	0.0267	0.0567
LGV	1.000	-	-
HGV	1.000	-	-

3.4.3 The LLITM-DM, in common with any model representing the whole of Great Britain (albeit coarser outside the area of detailed modelling), contains a wide range of trip lengths, from less than 1 kilometre to over 1,000 kilometres. The sensitivity of response to a ten-minute change would be expected in reality to be larger for a 30-minute journey than a six-hour journey, but in a pure logit model this ten-minute change would result in a similar demand response irrespective of trip length. Furthermore, testing has demonstrated that in the absence of any adjustment here, the model exhibits substantial over-sensitivity overall, driven by large responses for long-distance trips. The following formulation has therefore been developed to reflect the variation in response sensitivity to trip length:

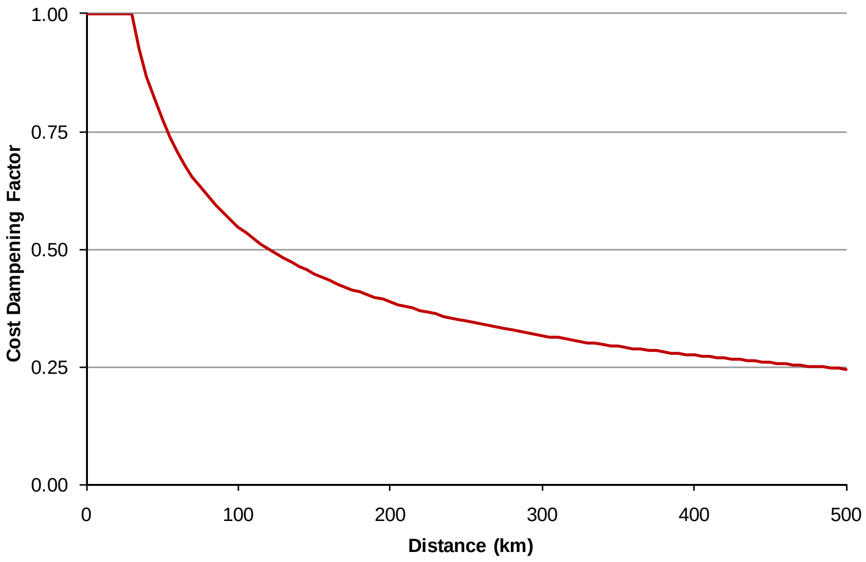
$$CostDampeningFactor = \min\left(\frac{\sqrt{d_1}}{\sqrt{\text{distance}}}, 1\right)$$

where d_1 is a calibrated parameter, set to 30km in the LLITM demand model. The cost damping function is consistent with advice in TAG Unit M2.

3.4.4 The function is plotted in Figure 3.1. Cumulative generalised cost changes that are used within the demand model are multiplied by the factor implied by this function. The distance used for each movement is the assigned distance on an uncongested base year highway network. This distance matrix remains constant and is used for all modelled years.

3.4.5 The cost damping function is applied to all personal travel and to all three modes: highway, public transport and active mode.

Figure 3.1: Cost Damping Function



3.5 Demand Data

3.5.1 The base year demand data, including factors relating highway person to vehicle trips (vehicle occupancies), peak hours to periods, and production-attraction to origin-destination factors have been developed as part of the LLITM 2014 Base model development. Detailed documentation on these processes is available in the highway and public transport model Local Model Validation Reports (LMVRs).

3.5.2 Synthetic active mode (walk and cycle) demand has been developed for the mode choice model. This is based on trip length profiles from the National Travel Survey (NTS), along with trip-ends from the LLITM 2014 Base trip-end model. Gravity functions have been calibrated to the NTS trip length profiles and matrices balanced to the trip-ends. These active mode matrices are suitable for mode choice; they are not validated representations of walk and cycle demand at an origin-destination level.

Relationship between Demand Model and Assignment Model Matrices

3.5.3 To provide a link between the demand used within the demand model, and the estimated assignment matrices in the highway model, delta matrices[2] have been developed. The following steps detail the process by which the matrix estimated demand is reconstituted to time period pairs, and how delta matrices have been derived to account for any remaining inconsistencies.

1. The prior, tour-based production-attraction demand is converted to an origin-destination assignment format using vehicle occupancies and peak-period factors developed as part of the matrix build process.
2. The assignment demand calculated in Step 1 is compared with the calibrated assignment demand from the matrix estimation process and proportional changes calculated.
3. The PA tour matrices are multiplied by the proportional adjustment calculated for their outbound legs. No adjustment is applied for off-peak-outbound trips. Non-home-based and freight trips are simply adjusted at a trip-level.
4. The adjusted PA demand is converted again to origin-destination level.

---

[2] These delta matrices represent the differences between the estimated highway assignment demand and the reconstituted demand model matrices and are not related to the land-use model LLITM-LUM (which operates in DELTA software).

5. Again, the assignment demand calculated in Step 4 is compared with the calibrated matrices and proportional adjustments calculated.
6. The PA tour matrices from Step 3 are multiplied by the adjustment calculated for their returning legs. No adjustment is applied for off-peak-returning trips. Non-home-based and freight trips will need no further adjustment.
7. Go back to Step 1 until the process converges.

Delta Matrices

3.5.4 Although this process produces PA matrices that are highly compatible with the estimated OD matrices, some residual differences remain, as a balancing process such as the above will never converge perfectly. The decision was made that (multiplicative) delta matrices would be introduced to account for the remaining differences that could not be reconciled through the reconstitution process.

4. Planning Data and Trip Ends

4.1 Derivation of Planning Data

4.1.1 LLITM-LUM, the DELTA-based land-use model for LLITM, provides forecasts of land-use relating to residential, retail, commercial, industrial and other activities. The land-use model is concerned with more than just land-use, providing forecasts of future levels of population (in total and for sub-sections of the resident population), households, employment levels and car ownership at a detailed zonal level.

4.1.2 A detailed description of the LLITM-LUM land-use model and its calibration can be found in the '*Land-Use Model Development Report*'.

4.1.3 LLITM-LUM is used to provide base year (2014) population and employment for the LLITM trip-end model, reflecting the collated data from local authorities, and hence the demand model.

4.1.4 For the purposes of the North and East Melton Mowbray Distributor Road Full Business Case (NEMMDR FBC), LLITM forecasting has not used LLITM-LUM to derive for forecast population and employment, instead compiling estimates from local plan data concerning developments and planning permission directly as inputs to the trip-end model, LLITM-TEM. LLITM-LUM has not been maintained in the last few years and significant time and budget would have been required to make use of it; it was felt that the cost was unnecessary and would not materially affect the case for the scheme.

4.2 Derivation of Trip Ends

Personal Trip Ends

4.2.1 The demand model (LLITM-DM) requires a means with which to estimate trip ends, both for the base year (2014) during matrix development and for forecast years. Forecast planning assumptions are taken from envisaged local development plans of the local planning authorities, with constraint to NTEM.

4.2.2 The demand model (LLITM-DM) thus derives its trip ends by taking planning and car ownership data and inputting to the DfT's trip end model software (CTripEnd), which has been customised for use in LLITM 2014 Base, forming LLITM-TEM. The trip rates within NTEM were verified to be consistent with the household survey data and are thus applied to the planning data to estimate trip ends by purpose, income segment and mode. These were used for base year matrix development and are also used for forecasting, being applied to the base year matrices to derive reference demand.

Freight Trip Ends

4.2.3 NTEM does not provide freight-based trip ends as it is focussed on the forecasting of personal travel. Data from TRICS (a database of trip-rate surveys owned by six county councils in the south of England, but covering the whole UK) were used to estimate freight trip rates per job by employment type. These trip rates were applied to the planning data to estimate freight trip making. This has been done to link the number of freight trips with the 2014 employment data in the land-use model, to derive an estimate of base year (2014) freight demand.

5. Supply Modelling

5.1 Highway Model Integration

5.1.1 Validated SATURN models for morning and evening peak hours and for an average interpeak hour have been developed, documented fully in the Highway LMVR. In LLITM-DM, generalised costs for the AM and PM periods are derived by assigning an average hour in each of the corresponding full three-hour periods, rather than the peak hours themselves, to ensure that the time period choice model is unbiased (as it represents demand for the periods, not the peak hours). The final assignment of demand, however, are the validated peak hours.

5.2 Public Transport

5.2.1 The public transport model has been developed using Emme software and is discussed in detail in the Public Transport LMVR. This model has been embedded within LLITM 2014 Base in its validated form, with public transport demand matrices being passed to it, and cost matrices taken from it for use in the demand model.

5.2.2 The public transport model is specified to assign public transport demand on a public transport network that includes all services (rail and bus) with appropriate access and egress links and modes. The cost matrices that are used in the demand model are thus for public transport (representing both modes).

5.3 Active Modes

5.3.1 There is no validated active modes (walk & cycle) model within LLITM 2014 Base, but synthetic active-mode demand matrices have been developed as discussed in Section 3.5.

5.3.2 The interpeak highway network from the public transport model is used as a starting point for the active mode costs, with all one-way links being converted into two-way links; some walk links have then been added in the centre of Leicester and Loughborough. No links are removed from the network. Removal of trunk roads, where walking and cycling are unlikely was considered, but due to the methodology used in the active mode matrix build, which only allows for intra-urban demand, these links are unlikely to be used in the assignment.

5.3.3 This assignment is carried out as an Emme highway assignment algorithm, with no speed-flow curves, to identify the shortest path (distance) between origin and destination. The travel times generated by this assignment are derived assuming an average speed of 4kph and are only used in the demand model.

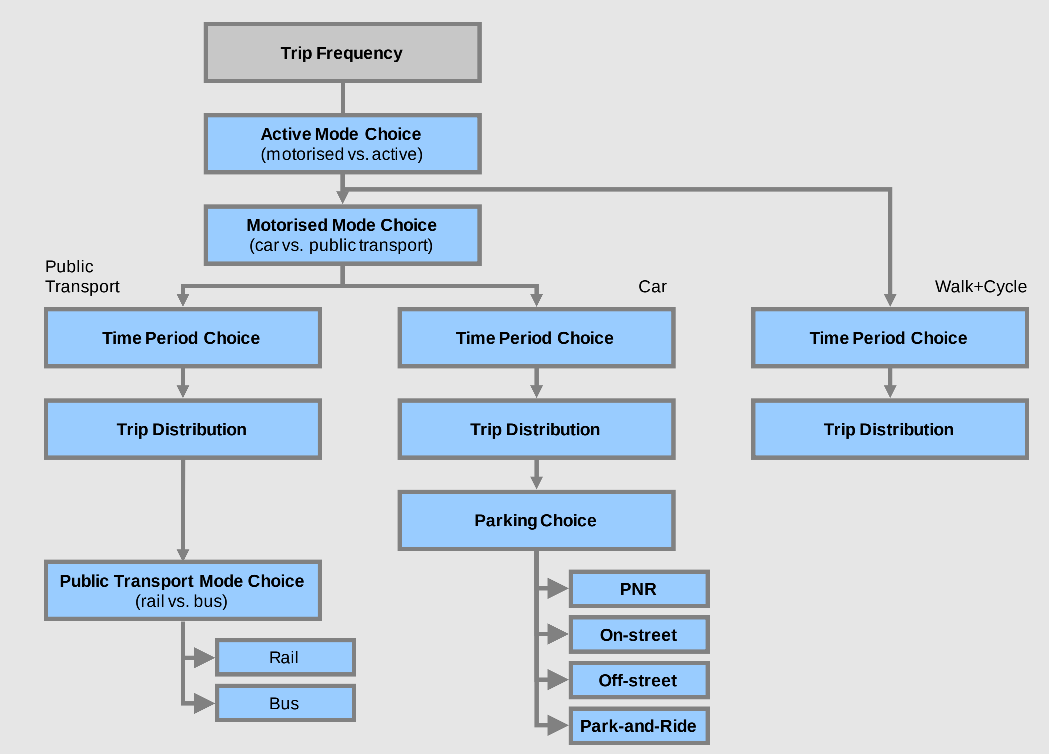
6. Choice Modelling

6.1 Choice Model Structure

6.1.1 LLITM-DM is a hierarchical logit model, and thus contains several different modules that deal with different aspects of traveller choice. They are implemented in increasing order of sensitivity, least sensitive choices first; this structure is necessary to ensure that higher-level modules use composite costs and are consistent with those from lower levels and is in accordance with guidance in TAG Unit M2.1 Section 4.5.

6.1.2 The choice structure used in the LLITM-DM is illustrated below. This is applicable to car-owning trips. Non-car-owning and freight demand segments have simplified choice structures, discussed below. Analysis of the 2009 local household survey has confirmed TAG guidance that destination choice should be more sensitive than mode choice in the hierarchy.

Figure 6.1: Choice Model Structure



6.1.3 Firstly, the trip frequency module adjusts overall trip-making, then the active mode choice module allocates demand into motorised and active travellers, then the motorised-mode-choice module allocates motorised travellers into car and public transport, and so on.

6.1.4 It should be noted that, while a trip frequency module has been coded (and is illustrated above), it is currently not used (i.e. the sensitivity is zero), as TAG guidance suggests that trip frequency is not required where active-modes are fully represented.

6.1.5 We consider two categories of car-ownership as discussed in Section 2.2. For non-car-owning trips, ‘car’ is not a valid mode option. The motorised mode choice model is therefore skipped, with all motorised travel being by public transport.

6.1.6 Freight demand uses only the time period choice and trip distribution modules.

6.2 Generalised Cost Formulation

6.2.1 LLITM-DM responds to changes in generalised cost. This is a representation of all the costs to the traveller associated with travel, including the following, where applicable:

- travel time;
- fuel and other vehicle operating costs;
- public transport fares;
- tolls and congestion charges;
- parking charges;
- search time for parking spaces;
- waiting time for public transport services;
- inconvenience associated with interchanging between public transport services; and
- access / egress time to/from public transport services (including walking and motorised modes).

6.2.2 The expressions used to derive generalised costs for highway, active-mode and public transport trips are shown below. Note that for mixed-mode (i.e. park-and-ride) trips, the sum of the relevant highway and public transport costs is used, that is, the highway cost to the park-and-ride site (including parking search time) is added to the bus/rail cost from the site to destination.

$$\mathrm{GenCost}_{\mathrm{Highway}} = t_t + t_s + \left(\frac{\mathrm{M}_F + \mathrm{M}_O + \mathrm{M}_T}{\mathrm{V} * \mathrm{O}} \right)$$

$$\mathrm{GenCost}_{\mathrm{Active}} = t_a$$

$$\mathrm{GenCost}_{\mathrm{PT}} = t_t + t_h + f_w t_w + f_a t_a + \left(\frac{\mathrm{M}_T}{\mathrm{V}} \right)$$

where:

M_F	monetary cost of fuel;
M_O	monetary non-fuel vehicle operating cost;
M_T	monetary value of all charges, including parking charges and public transport fares;
t_t	travel time (timetabled in-vehicle time for public transport);
t_s	search time for a parking space;
f_a	weighting for active mode legs of public transport trips, initially assumed to be 2;
t_a	walk time;
t_h	delay time due to (non-timetabled) highway congestion for bus and coach trips;
f_w	weighting for waiting time for public transport trips, initially assumed to be 2;
t_w	waiting time for public transport services;

V value of time, pence per minute; and

O vehicle occupancy.

6.2.3 Monetary costs for car travel are calculated based on TAG advice; with values of time varying by segment as detailed in Chapter 3.

6.2.4 Where demand is represented in tours (for home-based person travel), the costs used are tour-costs, i.e. the total cost for both legs of a tour, with cost data taken from the appropriate time periods.

6.2.5 The component cost (time, distance, fares and toll) matrices are derived from the LLITM 2014 base supply models. LLITM-HW assigns nine user classes, and LLITM-PT assigns three; these are used to generate component costs for all segments. In each case it is necessary to combine costs resulting from different assignment paths:

- for the highway model, component cost matrices are averages over all paths used; and
- for the public transport model, component cost matrices are averages over all routeing options, combining bus and rail as appropriate.

6.2.6 To represent the effects of highway congestion on the public transport assigned times a simplified feedback process has been adopted. This feedback effect is performed at a matrix level and adds the difference between the current highway times and the base highway times to the current public transport times.

6.3 Demand Sensitivity of Longer Distance Demand Movements

6.3.1 LLITM-DM represents a wide range of trip lengths, from less than one kilometre to several hundred kilometres. The sensitivity of response to a 10-minute change would be expected to be larger for a 30-minute journey than a six-hour journey, but in a standard logit model, which is based upon absolute cost changes, in the absence of any intervention this ten-minute change would result in a similar demand response, irrespective of trip length. This, we have verified, produces extremely large growth in future years in long-distance trips, generating 100,000+ vehicles along some external motorway links.

6.3.2 Cost damping has therefore been used in LLITM 2014 Base. The form of the cost-damping function was tested as part of the model calibration as discussed in Chapter 7, and thus is retained in the demand model for consistency. In addition to this, the variation in value of time for non-work trips to trip distance was also tested as part of the model calibration as discussed in Section 3.3.

6.4 Logit Equations

6.4.1 The following sections describe in detail the equations used by LLITM-DM to determine traveller choices. The expressions manipulate input travel demand, travel costs and cost changes, and output travel demand. These are represented as follows:

Input (reference, except freight-scheme test, where Core Scenario) demand: D_{pmtuij}

Output demand: $\hat{D}_{pmtuij}$

Generalised cost: C_{pmtuij} (the calculation of which was discussed in Section 6.2)

Generalised cost change (test minus base): ΔC_{pmtuij}

6.4.2 The subscripts refer to the following:

p : demand model segment, including both purpose and income, and including car-availability for the first two choice models (active mode choice and motorised mode choice). Choice models below motorised mode are aggregate across car-ownership levels.

m : mode (H: highway (car and freight), P: public transport, A: active modes);

t : time period of outgoing leg of tour, or time period of trip for non-home-based trips;

u : time period of return leg of tour, not used for non-home-based trips;

i : production zone of trip ('home'), or origin for a non-home-based trip; and

j : attraction zone of trip, or destination for a non-home-based trip.

6.4.3 Where lowercase letters are used as subscripts, the expression is intended to be applied separately for each instance of the subscript. Where capital letters are used, the expression refers to a specific instance of the subscript (see the designators for modes above). Where an asterisk (*) is used, the expression refers to a sum (for demand) or a composite average (for cost) over all instances of the subscript.

6.4.4 Note that costs and cost changes refer to the cost for a complete tour (outgoing and return trip combined) for home-based tours, and that they include costs of all journey stages (car and public transport) for park-and-ride trips.

Trip Frequency

6.4.5 Trip frequency is not modelled because of the presence of active-mode choice as discussed above, though it has been coded so that it could easily be enabled if necessary.

Active Mode Choice

6.4.6 Active mode choice is forecast as a function of cost change for all non-freight demand, by segment and production zone:

$$\hat{D}_{pA{*}{*}i*} = D_{p{*}{*}{*}i*} \frac{D_{pA{*}{*}i*} e^{\theta_a \Delta C_{pA{*}{*}i*}}}{\left(D_{pP{*}{*}i*} + D_{pH{*}{*}i*}\right) e^{\theta_a \Delta C_{pM{*}{*}i*}} + D_{pA{*}{*}i*} e^{\theta_a \Delta C_{pA{*}{*}i*}}}$$

$$\hat{D}_{pM{*}{*}i*} = D_{p{*}{*}{*}i*} \frac{\left(D_{pP{*}{*}i*} + D_{pH{*}{*}i*}\right) e^{\theta_a \Delta C_{pM{*}{*}i*}}}{\left(D_{pP{*}{*}i*} + D_{pH{*}{*}i*}\right) e^{\theta_a \Delta C_{pM{*}{*}i*}} + D_{pA{*}{*}i*} e^{\theta_a \Delta C_{pA{*}{*}i*}}}$$

6.4.7 An M as the mode subscript is used to indicate a sum (for demand) or composite weighted average (for cost change) over the public transport and highway (i.e. motorised) modes only. The definitions of composite costs are given below:

$$\Delta C_{pA**i*} = \theta_m \log_e\left(\frac{\sum_{tu}\left(D_{pAtui*}e^{\theta_t \Delta C_{pAtui*}}\right)}{\sum_{tu} D_{pAtui*}}\right)$$

$$\Delta C_{pM**i*} = \log_e\left(\frac{D_{pH**i*}e^{\theta_m \Delta C_{pH**i*}} + D_{pP**i*}e^{\theta_m \Delta C_{pP**i*}}}{D_{pH**i*} + D_{pP**i*}}\right)$$

6.4.8 The theta values are sensitivity parameters.

Motorised Mode Choice

6.4.9 Main mode choice (highway versus public transport) is forecast as a function of cost change for non-active mode, non-freight demand only, by segment and production zone.

$$\hat{D}_{pH**i*} = \hat{D}_{pM**i*}\frac{D_{pH**i*}e^{\theta_m \Delta C_{pH**i*}}}{D_{pH**i*}e^{\theta_m \Delta C_{pH**i*}} + D_{pP**i*}e^{\theta_m \Delta C_{pP**i*}}}$$

$$\hat{D}_{pP**i*} = \hat{D}_{pM**i*}\frac{D_{pP**i*}e^{\theta_m \Delta C_{pP**i*}}}{D_{pH**i*}e^{\theta_m \Delta C_{pH**i*}} + D_{pP**i*}e^{\theta_m \Delta C_{pP**i*}}}$$

with:

$$\Delta C_{pH**i*} = \log_e\left(\frac{\sum_{tu}\left(D_{pHtui*}e^{\theta_t \Delta C_{pHtui*}}\right)}{\sum_{tu} D_{pHtui*}}\right)$$

$$\Delta C_{pP**i*} = \log_e\left(\frac{\sum_{tu}\left(D_{pPtui*}e^{\theta_t \Delta C_{pPtui*}}\right)}{\sum_{tu} D_{pPtui*}}\right)$$

Time Period Choice

6.4.10 Time period choice is forecast as a function of cost change for all trips, by segment, mode and production zone.

$$\hat{D}_{pmtui*} = \hat{D}_{pm**i*}\frac{D_{pmtui*}e^{\theta_t \Delta C_{pmtui*}}}{\sum_{tu}\left(D_{pmtui*}e^{\theta_t \Delta C_{pmtui*}}\right)}$$

with:

$$\Delta C_{pmtui*} = \log_e \left(\frac{\sum_j D_{pmtuij} e^{-\lambda_d \Delta C_{ptmuij}}}{\sum_j D_{pmtuij}} \right)$$

where the lambda value is another sensitivity parameter.

6.4.11 For non-home-based trips, the expression is the same, except that there is only one subscript, t, to consider, rather than two (t and u), as the trip has only one time period associated with it. The sums over t and u are therefore only over t for non-home-based trips.

6.4.12 It should be noted that the above time-period choice mechanism treats all pairs of time-periods as essentially equivalent (with different costs and demand, of course). A trip changing from AM Peak out, PM Peak return to AM Peak out, late off-peak return is therefore as likely (subject to costs and demand) as one changing from AM Peak out, PM Peak return to late off-peak out, late off-peak return. This is regarded as reasonable given the incremental structure of the model (which reflects the prevalence of certain time-period pairs for each purpose through the base year demand), and the lack of evidence concerning different sensitivities for different movements within time-period choice.

Trip Distribution

6.4.13 Trip distribution is forecast as a function of cost change:

$$\hat{D}_{pmtuij} = \hat{D}_{pmtui*} \frac{D_{pmtuij} e^{-\lambda_d \Delta C_{pmtuij}}}{\sum_j D_{pmtuij} e^{-\lambda_d \Delta C_{pmtuij}}}$$

where ΔC_{pmtuij} are generalised tour cost differences.

6.4.14 ΔC_{pmtuij} may be composite costs over different parking/access strategies for certain movements and for the car mode. This is discussed further below.

6.4.15 For commuting and education trips, the trip distribution model is complicated by the fact that such trips are doubly-constrained, meaning that their attraction totals as well as production totals are fixed.

6.4.16 Double constraint is handled by means of a Furness of demand over all modes, time period pairs, income bands and car ownership levels, to constrain the demand generated by the (singly-constrained) distribution equation above to desired total productions and attractions. This total Furnessed matrix is then split back down by modes, time period pairs, income levels and car ownership using movement-specific proportions in the singly constrained demand.

Parking Choice

6.4.17 LLITM-DM contains a parking choice model that uses an absolute formulation, distinct from the incremental model form used in the wider demand model. This is the more helpful formulation for modelling new park-and-ride sites that did not exist in the base year. In addition, we lack suitable data to create an incremental model.

6.4.18 The parking model is applied only for car demand, and is only applied within Leicester and Loughborough, and so has no material influence on the NEMMDR FBC forecasts.

6.4.19 In applying parking choice, the first step is to decide which ends of which trips, if any, need to make a parking decision. The criteria are as follows:

- escort trips are not considered within the parking model; factors to extract escort trips from total car demand are derived from the Leicestershire household survey.
- any home-based trip is assumed to have access to residential parking at its production end i.e. at home; non-home-based trips are assumed to have on-site parking for their origin; thus only attractions (or destinations for non-home-based trips) are included in the parking choice;
- any trip end that is located outside the Leicester/Loughborough urban centres is assumed to have access to readily available parking at the attraction/destination end; therefore parking is not modelled outside the urban centres of Leicester and Loughborough; and
- freight demand (LGV and HGV) is assumed to have access to on-site parking at both ends of their trips, and so freight parking is not modelled.

6.4.20 Following the application of these rules, vehicle trip ends requiring consideration within the parking model are identified, and so the second stage of the parking model is used to allocate this demand to available PNR (private non-residential) parking provision.

6.4.21 For commuting and business trips we have assumed that a specified number of spaces are available in Leicester and Loughborough. This number of trips is allocated PNR parking, as appropriate; we assume that commuting and business and home-based and non-home-based trips will share the available PNR demand proportionally.

6.4.22 The effect of this rule is to make work PNR parking a function of availability rather than traveller choice. We assume that any traveller with access to work PNR parking will use it (subject to any restricting capacity thresholds), and that the available spaces are limited.

6.4.23 The third stage of the parking model is then used to determine a parking decision for non-PNR trips, one which requires the identification of parking type. There are four available parking types other than PNR: on-street, off-street, park-and-ride and ‘ring-zone’. The last option is intended to represent parking outside the urban centres and walking to the attraction of the trip.

6.4.24 From the valid parking options, a logit model (absolute formulation) is applied to determine the choice of type. The parking choice model is applied as follows:

$$\hat{D}_{ikj} = \hat{D}_{ij} \frac{e^{-\lambda\ \left(C_{ikj} + K_k\right)}}{\sum_k e^{-\lambda\ \left(C_{ikj} + K_k\right)}}$$

where:

k : parking type

K_k : constant cost associated with each parking type (different values are used for Leicester and Loughborough), used to calibrate the response; and

λ : parking sensitivity parameter.

6.4.25 Note that we have omitted time period and purpose subscripts here for simplicity. The expression should be understood to be applied to all time periods and purposes individually.

6.4.26 It is also important to appreciate that the costs used here include costs derived for highway and public transport stages of the journey. For park-and-ride trips, the total cost is given as:

$$C_{ikj} = C_{Cik} + C_{Pkj}$$

6.4.27 For park-and-ride trips, a further logit model (with an identical structure and sensitivity) is applied to distribute trips between actual park-and-ride site (there are three in the base model: Birstall, Enderby and Meynell's Gorse).

6.4.28 The assignment matrices calculated by the wider demand model are adjusted to take account of the park-and-ride choices, ensuring that the car leg of each journey is assigned in the highway model, while the public transport leg is assigned on the public transport networks. Non-park-and-ride trips are not adjusted; car trips drive to their attraction zone in the highway model.

6.4.29 Because the parking model causes the overall cost for a car trip to be different from the costs produced by the assignment models, it is necessary to create composite costs for the other choice functions in the wider demand model for car trips, to take account of parking. The expression for this is as follows:

$$\Delta C_{pmtuij} = \frac{1}{\lambda}\log_e\left(\sum\nolimits_k e^{\lambda C^{T}{}_{ptmuikj}}\right) - \frac{1}{\lambda}\log_e\left(\sum\nolimits_k e^{\lambda C^{B}{}_{ptmuikj}}\right)$$

The 'T' and 'B' superscripts refer to base and test cost respectively.

6.4.30 This cost change is for trips using public parking (i.e. not PNR). The costs provided to the distribution models is a demand-weighted average of this composite cost change and the cost change for commuting/business PNR trips, as the split of demand into PNR and other parking options is based upon availability rather than cost.

Public Transport Mode Choice

6.4.31 As with parking choice, the choice between rail and bus public transport modes is an absolute, not an incremental model. While it would have been possible to construct an incremental model (and indeed this would probably have improved the validation of the base model), this would have made it impossible to model new public transport routes, especially new passenger rail lines, because the base demand would be zero.

$$\hat{D}_{pRtuij} = \hat{D}_{pPtuij}\,\frac{e^{\lambda_p C_{pRtuij}}}{e^{\lambda_p C_{pRtuij}} + e^{\lambda_p C_{pBtuij}}}$$

$$\hat{D}_{pBtuij} = \hat{D}_{pPtuij}\,\frac{e^{\lambda_p C_{pBtuij}}}{e^{\lambda_p C_{pRtuij}} + e^{\lambda_p C_{pBtuij}}}$$

6.4.32 No alternative specific constants were required to calibrate the model; the costs used are as produced by the public transport model skims.

6.4.33 Composite costs across bus and rail travel, for all public transport, are required by the rest of the demand model. These are calculated as follows.

$$\Delta C_{pPtuij} = \frac{1}{\lambda_p}\log_e\left(\sum\nolimits_m e^{\lambda_p C^{T}{}_{ptmuij}}\right) - \frac{1}{\lambda}\log_e\left(\sum\nolimits_m e^{\lambda_P C^{B}{}_{ptmuij}}\right)$$

7. Calibration and Validation

7.1 Summary

7.1.1 We have calibrated and validated LLITM-DM following advice in TAG Unit M2.1 such that its response to cost changes is at an acceptable and reasonable level. In particular, we examined the following:

- the elasticity of car vehicle kilometres with respect to car fuel cost;
- the elasticity of car trips with respect to car journey time; and
- the elasticity of public transport trips with respect to fare.

7.1.2 Elasticities represent a measure of how rapidly one dependent variable (trips or vehicle kilometres in this context) changes with respect to an independent one, and are defined by the following expression:

$$\text{elasticity} = \frac{\log_e\left(\frac{d_t}{d_b}\right)}{\log_e\left(\frac{i_t}{i_b}\right)}$$

where:

d_t is the test value of the dependent variable, d_b is the base value of the dependent variable, i_t is the test value of the independent variable, and i_b is the base value of the independent variable.

7.1.3 In calculating elasticities, we have chosen not to use the entire demand in the model, as most of this is external to Leicestershire, much of it in intrazonal movements. This demand is modelled approximately and is not representative of the internal area of interest. Accordingly, matrix calculations have been performed on only demand produced within Leicestershire, and highway network calculations only traffic on the highway network within Leicestershire.

7.1.4 The calibration process is as follows. The model was set up with TAG parameters and structure as outlined in Chapter 6. The realism tests described in TAG unit M2.1 were then run. The outturn model elasticities were then inspected and compared with the targets in M2.1 and previous experience and expectation. We would then have adjusted distribution lambdas and/or cost damping curves to improve the elasticities if this had been necessary. As it happens, the outturn model elasticities were considered reasonable on first inspection, so no further adjustments were made to the model.

7.2 Fuel Cost Sensitivity

7.2.1 TAG advises that an elasticity of car vehicle kilometres with respect to fuel cost of around -0.30 is realistic, allowing for a range between -0.25 and -0.35. The guidance indicates that where incomes are higher than national average or where trip lengths are relatively short or where there is a high proportion of business, travel elasticities would be expected towards the lower half of this range, and vice-versa.

7.2.2 We have calculated this elasticity in LLITM 2014 Base, both at a matrix level (multiplying trips by distance skims) and a network level (multiplying vehicle flows by link lengths). A fully converged test run with a 10% increase in the total cost of fuel, applied at a matrix level in the demand model only, was used. The results are shown in Table 7.1, by purpose and time period. Note that the fuel costs for HGV and LGV are not changed as part of this test.

Table 7.1: Matrix-Based Fuel Cost Elasticities - Leicestershire Productions

Demand Segment	OP	AM	IP	PM	Annual
Commuting Low	-0.36	-0.33	-0.32	-0.38	-0.35
Commuting Med	-0.26	-0.25	-0.22	-0.24	-0.24
Commuting High	-0.18	-0.17	-0.15	-0.15	-0.16
Education Low	-0.43	-0.45	-0.71	-0.64	-0.61
Education Med	-0.36	-0.38	-0.58	-0.52	-0.50
Education High	-0.33	-0.40	-0.56	-0.44	-0.48
Home-Based Other Low	-0.50	-0.63	-0.61	-0.52	-0.56
Home-Based Other Med	-0.44	-0.56	-0.54	-0.45	-0.50
Home-Based Other High	-0.39	-0.51	-0.48	-0.40	-0.44
Non-Home-Based Other Low	-0.83	-0.61	-0.56	-0.74	-0.65
Non-Home-Based Other Med	-0.74	-0.56	-0.51	-0.65	-0.59
Non-Home-Based Other High	-0.66	-0.51	-0.46	-0.58	-0.53
Shopping Low	-0.40	-0.47	-0.40	-0.43	-0.41
Shopping Med	-0.36	-0.42	-0.35	-0.38	-0.37
Shopping High	-0.32	-0.37	-0.31	-0.33	-0.32
Home-Based Business	-0.25	-0.22	-0.28	-0.23	-0.25
Non-Home-Based Business	-0.30	-0.26	-0.32	-0.24	-0.29
All Car	**-0.33**	**-0.28**	**-0.37**	**-0.31**	**-0.33**
LGV	0.00	0.00	0.00	0.00	0.00
HGV	0.00	0.00	0.00	0.00	0.00
All Vehicles	**-0.24**	**-0.22**	**-0.28**	**-0.26**	**-0.25**

7.2.3 The blue highlighted cell (-0.33) is the overall car elasticity, for direct comparison with the TAG target range of -0.25 to -0.35. Given the consistency with national average elasticities, no adjustments were therefore made to the calibrated model sensitivity parameters. We regard this as reassuring evidence that our model structure and parameters are realistic and internally consistent.

7.2.4 The breakdown of elasticities by purpose and time period is also plausible. Interpeak elasticities are higher, due to lack of congestion and predominance of non-business, non-commuting trips. Peak elasticities are lower, as expected.

7.2.5 Freight elasticities are effectively zero. This is not because freight is not responsive to fuel changes in the model (in normal scheme forecasting there is a modelled freight response), but because this test involved increasing only car (not freight) fuel costs, as required by TAG.

7.2.6 We have also calculated elasticities at a network level using link flows and lengths. These are very similar to the matrix values and are shown in Table 7.2. Education and shopping trips are included in “other” in assignment, and home-based and non-home-based trips are combined, so there are fewer distinct segments in these figures.

Table 7.2: Network-Based Fuel Cost Elasticities, Simulation Area

User Class	OP	AM	IP	PM	All Day
Commuting Low Income	-0.38	-0.37	-0.33	-0.35	-0.36
Commuting Medium Income	-0.29	-0.25	-0.24	-0.25	-0.25
Commuting High Income	-0.20	-0.17	-0.17	-0.16	-0.17
Other Low Income	-0.62	-0.59	-0.60	-0.57	-0.60
Other Medium Income	-0.56	-0.52	-0.54	-0.54	-0.54
Other High Income	-0.50	-0.44	-0.49	-0.47	-0.48
Business	-0.30	-0.19	-0.30	-0.15	-0.24
All Car	**-0.39**	**-0.28**	**-0.40**	**-0.28**	**-0.34**
LGV	0.00	0.01	0.01	0.02	0.01
HGV	0.00	0.08	0.00	0.00	0.02
All Vehicles	-0.27	-0.18	-0.25	-0.22	-0.23

7.3 Journey Time Sensitivity

7.3.1 TAG advises that the elasticity of car trips with respect to car journey times should be (intuitively) negative, and not have a magnitude in excess of 2. We have calculated this elasticity in LLITM 2014 Base, at a matrix level only.

7.3.2 A test run with a 10% increase in the car journey times (excluding parking search times and walk times), applied at a matrix level in the demand model only, and with only a single demand-supply iteration, was used. The results are shown below, by purpose and time period.

Table 7.3: Matrix-Based Car Journey Time Elasticities, Leicestershire Productions

Demand Segment	OP	AM	IP	PM	Annual
Commuting Low	-0.10	-0.11	-0.05	-0.15	-0.10
Commuting Med	-0.12	-0.13	-0.07	-0.16	-0.12
Commuting High	-0.10	-0.13	-0.06	-0.13	-0.10
Education Low	-0.19	-0.15	-0.15	-0.25	-0.16
Education Med	-0.20	-0.17	-0.16	-0.26	-0.18
Education High	-0.17	-0.15	-0.14	-0.25	-0.16
Home-Based Other Low	-0.10	-0.15	-0.11	-0.14	-0.12
Home-Based Other Med	-0.11	-0.16	-0.12	-0.15	-0.12
Home-Based Other High	-0.10	-0.15	-0.10	-0.14	-0.11
Non-Home-Based Other Low	-0.44	-0.09	-0.10	-0.39	-0.20
Non-Home-Based Other Med	-0.46	-0.11	-0.12	-0.43	-0.22
Non-Home-Based Other High	-0.46	-0.10	-0.12	-0.43	-0.22
Shopping Low	-0.09	-0.12	-0.08	-0.12	-0.09
Shopping Med	-0.09	-0.12	-0.08	-0.12	-0.09
Shopping High	-0.07	-0.11	-0.06	-0.11	-0.08
Home-Based Business	-0.11	-0.06	-0.16	-0.07	-0.11
Non-Home-Based Business	-0.30	-0.20	-0.01	-0.41	-0.12
All Car	**-0.12**	**-0.13**	**-0.09**	**-0.17**	**-0.12**
HGV	0.00	0.00	0.00	0.00	0.00
LGV	0.00	0.00	0.00	0.00	0.00
All	-0.10	-0.11	-0.08	-0.15	-0.10

7.3.3 The overall elasticity is within the required range. Commuting elasticities are lower than average, due in part to doubly-constrained trip distribution.

7.3.4 Non-home-based elasticities are higher than home-based ones. This is partly because non-home-based trips are slightly longer than home-based ones in the model, and partly because they have a higher public transport and active mode share.

7.3.5 There is no particularly strong pattern of journey time elasticity variation with income. This is plausible, since income would not be expected to have a strong influence on sensitivity to *time*, only to monetary elements of cost, such as fuel prices.

7.4 Public Transport Fare Sensitivity

7.4.1 TAG advises that the elasticity of public transport trips with respect to public transport fares should be in the range -0.2 to -0.9, and only likely to lie very close to the lower end of this range where there is a particularly high proportion of concessionary fares. We have calculated this elasticity in LLITM 2014 Base, at a matrix level only. A fully converged test run with a 10% increase in the public transport fares, for all public transport modes, applied at a matrix level in the demand model only, was used. The results (trip elasticities) are shown in Table 7.4, by purpose and time period.

Table 7.4: Matrix-Based Public Transport Fare Elasticities, Leicestershire Productions

Demand Segment	OP	AM	IP	PM	Annual
Commuting Low	-0.12	-0.12	-0.11	-0.13	-0.12
Commuting Med	-0.10	-0.10	-0.08	-0.10	-0.10
Commuting High	-0.11	-0.10	-0.07	-0.10	-0.09
Education Low	-0.23	-0.25	-0.24	-0.25	-0.24
Education Med	-0.22	-0.23	-0.23	-0.25	-0.23
Education High	-0.27	-0.27	-0.25	-0.28	-0.26
Home-Based Other Low	-0.28	-0.32	-0.28	-0.28	-0.28
Home-Based Other Med	-0.30	-0.40	-0.31	-0.32	-0.32
Home-Based Other High	-0.35	-0.49	-0.34	-0.35	-0.36
Non-Home-Based Other Low	-0.37	-0.42	-0.31	-0.33	-0.33
Non-Home-Based Other Med	-0.45	-0.51	-0.35	-0.38	-0.38
Non-Home-Based Other High	-0.47	-0.54	-0.35	-0.38	-0.38
Shopping Low	-0.24	-0.27	-0.24	-0.24	-0.25
Shopping Med	-0.24	-0.30	-0.25	-0.25	-0.26
Shopping High	-0.24	-0.34	-0.25	-0.25	-0.26
Home-Based Business	-0.26	-0.25	-0.28	-0.25	-0.26
Non-Home-Based Business	-0.30	-0.46	-0.39	-0.34	-0.39
All	**-0.22**	**-0.23**	**-0.26**	**-0.21**	**-0.24**

7.4.2 The overall elasticity is within the range given in TAG of between -0.2 and -0.9, albeit at the lower end. The elasticity is also notably lower than in earlier versions of LLITM, in which it was around –0.3. This is partly due to the reduction of long-distance rail fares to account for non-full-fare-paying passengers, and partly due to the way that internal-external bus trips were dealt with pre LLITM v5.

7.4.3 The pattern of elasticities shows much lower values for commuting trips, as expected, since these trips are doubly-constrained. However, there is not a strong relationship between elasticities and value of time; higher income trips do not produce consistently lower elasticities. Furthermore, business elasticities are actually towards the higher end, despite this purpose's high value of time. There are a number of factors influencing this. Firstly, with respect to income, the base year trip matrices represent the variation in trip lengths, and these tend to be longer for higher income segments and especially long for business trips. Therefore average fares vary by income group and given the longer trip length, higher income segments have a higher public transport fare.

7.4.4 In addition, higher income groups and business trips are much more likely to use rail rather than bus, with associated higher fares, while lower income groups tend to use bus rather than rail.

7.4.5 The average fares paid by demand segment are given in Table 7.5 to illustrate this.

Table 7.5: Average Public Transport Fare (pence), Leicestershire Origins (2010 prices)

Demand Segment	OP	AM	IP	PM	24hr
Commuting Low	118	103	90	108	104
Commuting Med	143	129	93	110	117
Commuting High	233	208	112	144	173
Education Low	108	102	93	100	98
Education Med	117	108	98	106	104
Education High	178	188	130	135	159
Home-Based Other Low	113	125	98	102	104
Home-Based Other Med	151	245	137	138	153
Home-Based Other High	196	359	179	179	207
Non-Home-Based Other Low	162	188	104	119	118
Non-Home-Based Other Med	285	341	149	189	185
Non-Home-Based Other High	368	442	185	239	236
Shopping Low	85	88	83	84	84
Shopping Med	88	102	90	89	91
Shopping High	91	108	94	92	95
Home-Based Business	834	920	526	403	673
Non-Home-Based Business	554	934	769	645	773

8. Forecasting

8.1 Derivation of Reference Demand and Core Scenarios

Reference Demand

8.1.1 It is necessary, prior to application of the demand model for any future year, to estimate changes in trip patterns over time due to GDP, population and employment changes. These are fed by local plan data on population and employment growth which provide planning inputs for the trip end model, discussed in Chapter 4. The trip end model provides ‘reference’ trip ends for future-year forecasting. These will be exclusive of the direct effect of changing costs of travel, which is applied by the demand model. In other words, these trip ends will represent unconstrained travel demand growth.

8.1.2 Trip end changes are applied to the base year demand through a matrix-balancing procedure (Furnessing). This involves factoring matrix rows so that production totals match, then factoring columns so that attraction totals match and repeating until convergence is achieved, whereby both production and attraction totals match the input trip ends, within a specified tolerance for error.

Development Zones

8.1.3 The LLITM 2014 Base model has 40 ‘development zones’ allocated whereby there is zero demand in the base year. In these cases where the base year demand for a production or attraction zone is zero (for example, the location of a future year ‘green-field’ development), this Furnessing process will not be appropriate, as it is a factor-based procedure, and hence cannot be used to generate information for production or attraction zones that have zero (or virtually zero) demand. An alternative procedure is therefore required.

8.1.4 For this alternative procedure it is necessary to create an initial estimate of the trip distribution to/from a development zone. This initial estimate of the trip distribution to/from development zones could be derived from the use of ‘parent’ zones. For each development zone used in a forecast scenario, one or more ‘parent’ zones (to a limit of 5) are defined from which the trip distribution, 24 hour-to-period factors and base cost data are taken. The trip distribution from the ‘parent’ zone(s) is then factored to the absolute trip total from the trip-end model.

8.1.5 An alternative methodology is to use a gravity model to derive the trip distributions for development zones. Both options can be used in LLITM 2014 Base.

8.1.6 An average trip-rate per job for HGV and LGV (derived from analysis of the TRICS database) is applied to the employment within a development zone to derive an estimate of the trip ends for freight.

8.2 Pivoting

8.2.1 LLITM-DM is a pivot-point incremental model that estimates changes in trip patterns relative to a reference[3] matrix derived from detailed observation of travellers. The predicted relative changes are applied to the reference matrix, so that the characteristics of the reference matrix are reflected. The parking and public-transport sub-mode models are exceptions to this rule: they are absolute models calibrated to reproduce observed base scenarios with suitable accuracy.

8.2.2 In forecasting, the model pivots from the base year 2014 model, calculating the difference in generalised cost of travel between the forecast and base years.

8.3 LLITM-DM Iterative Process

Demand-Supply Iterations

8.3.1 The SATURN highway supply model, the Emme public transport model, and the demand model are run in sequence iteratively until LLITM-DM is deemed to have converged (discussed below). The costs from the supply models and functions are fed into the demand calculations, with the resulting demand used to recalculate the costs. Highway congestion is reflected in the public transport times at a matrix level using the change in highway time from the base as a proxy for the change in public transport times.

8.3.2 This process continues until model convergence has been achieved.

8.3.3 As crowding is not modelled in the Emme public transport model, the costs data extracted are independent of the assignment demand. The public transport model is therefore only run in the first and last iterations of the transport model.

Smoothing of Demand

8.3.4 Demand smoothing is used to ensure that LLITM-DM and the network models reach a convergent state. LLITM-DM demand matrices are assigned in the LLITM 2014 Base supply models, which generate costs to be used in LLITM-DM. Following choice model calculations, new demand is calculated, from which the %Gap is calculated prior to the averaging process which is then applied to the demand matrices before they are reassigned in the supply models in the next iteration of the overall LLITM 2014 Base suite.

8.3.5 The demand smoothing uses the following function, a variation of the method of successive averages (MSA) algorithm that we have used in existing demand models:

$$\hat{D}_{(\mathrm{X}+1)} = \frac{2 * D_{\mathrm{X}}}{(X-1)} + \frac{(X-3)\hat{D}_{\mathrm{X}}}{(X-1)}$$

where:

X : the current iteration of LLITM;

$\hat{D}_X$: the averaged demand matrix used as input to the supply models in iteration X .

D_X : the demand matrix produced by the demand model in iteration X

---

[3] The term ‘reference’ refers to the demand that the model pivots from. This could be reference demand in the commonly used sense (i.e. unconstrained trip end growth), or in the case of scheme testing, the ‘Do Minimum’ demand from which a scheme is being pivoted and compared.

8.3.6 This algorithm is a less aggressive form of the standard MSA algorithm that we have used when developing other TAG-compliant variable demand models. Model testing has demonstrated that this variant of the standard MSA algorithm intervenes less in the demand smoothing process, and produces better overall model convergence, as it gives more weight to the demand calculated within the more recent demand-supply iterations. The algorithm is of course only applied when X is 4 or greater; for the first three iterations, no smoothing is applied.

%Gap Demand-Supply Convergence

8.3.7 Our measure of convergence of the demand and supply models is the demand-supply gap, as defined in TAG Unit M2.1. The %Gap is calculated as follows:

$$G = \frac{\sum_{pmtuij} C(D_{pmtuij}).\left| D_{pmtuij} - D(C(D_{pmtuij})) \right| * 100}{\sum_{pmtuij} C(D_{pmtuij}).D_{pmtuij}}$$

where

D_{pmtuij} : OD demand used as input to the supply models;

$C(D_{i_{pmtuij}})$: generalised OD cost generated by the assignment of D_{pmtuij} on the network;

$D(C(D_{pmtuij}))$: OD demand generated by the demand model in response to cost changes created from $C(D_{pmtuij})$ prior to application of smoothing.

8.3.8 The %Gap is calculated by LLITM-DM across all of the LLITM-DM person demand segments, as well as LGV and HGV, for each of the time periods and for all modes. The threshold for convergence was set at 0.15 for the previous NEMMDR OBC modelling. By expending effort in improving the convergence of the highway models to refine the appraisal of the scheme, we have been able to reduce this convergence gap for the NEMMDR FBC modelling to 0.075, which represents tighter convergence than that required by TAG Unit M2.1.

8.3.9 We evaluate the convergence gap for a subset of the demand matrix, as required by TAG M2.1. Previous experience suggests that it is quite common for the external demand (which will constitute most of the total demand, the matrix representing the whole country as it does) to stabilise very quickly, leading to a very low convergence gap, while the demand in the modelled area (which is what is really of concern) has not yet reached a reasonable level of convergence. We have previously used demand with a production end in the internal area as a sub-matrix for evaluation of convergence and adopt this approach in LLITM-DM where the convergence criterion is applied to all trips produced in Leicestershire.

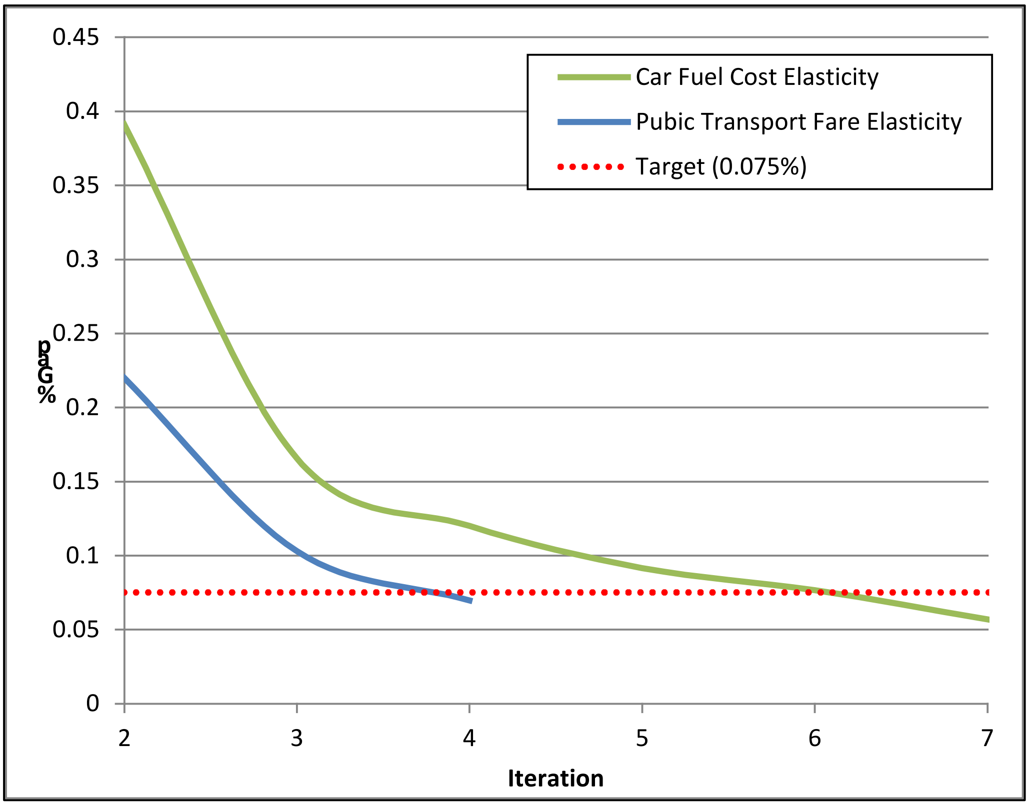
8.4 Realism Test Demand Model Convergence

8.4.1 The convergence statistics from the demand model realism tests are presented in Table 8.1 and Figure 8.1, demonstrating that the LLITM-DM is a well converged model, exceeding TAG guidance, which is beneficial when forecasting, particular when undertaking economic appraisal. Due to the journey time realism test being run for a single demand-supply iteration, the convergence statistics from this model run are not provided.

Table 8.1: Demand Model Convergence for Realism Tests

Iteration	Car Fuel Cost	Public Transport Fare
2	0.391	0.220
3	0.166	0.103
4	0.120	0.070
5	0.092	
6	0.077	
7	0.057	

Figure 8.1: Demand Model Convergence for Realism Tests



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LLITM 2014 Base

North and East Melton Mowbray Distributor Road Full Business Case

Forecasting Report

Leicestershire County Council

November 2022

Quality Information

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Section 1 – Overview

1.1 Introduction

1.1.1 The Leicester and Leicestershire Integrated Transport Model (LLITM 2014 Base) was commissioned by Leicestershire County Council (LCC) and is a suite of models containing highway and public transport assignment models and a variable demand model.

1.1.2 LLITM 2014 Base draws on and augments previous versions of the model suite, extending the coverage of the detailed model area beyond Leicestershire, creating demand matrices to reflect 2011 Census data, incorporating significant new observed data (highway roadside interview surveys and counts, and public transport counts), and making best use of electronic ticketing and mobile phone data. NTEM 7.2 has also been incorporated in LLITM 2014 Base.

1.1.3 This report discusses the forecasting assumptions and processes used in LLITM 2014 Base for the purposes of the assessment and appraisal of the proposed North and East Melton Mowbray Distributor Road (NEMMDR). This includes the assumptions adopted within this set of forecasts, and the results of these forecasts for the Core Scenario (i.e. without the NEMMDR) and the NEMMDR Scenario (i.e. with the proposed scheme). This report also includes details on the Department for Transport (DfT) Transport Analysis Guidance (TAG) high and low growth scenarios undertaken as part of the assessment of the NEMMDR.

1.1.4 The Scheme assessment is relatively complex due to the inclusion of other schemes that form the distributor road to the east of Melton Mowbray. There are three separate elements that form the distributor road, these being:

1. The Southern Link Road (SLR)
2. The North MMDR
3. The East MMDR

1.1.5 Although the schemes being appraised are the North and East MMDR, only the East section is a unique part of the 'Do Something' scenario as the North section would come forward is part of the 'Do Minimum' scenario, although at a later date (2040 rather than 2025). The SLR is a development led scheme completed in stages between 2030 and 2040. Table 1.1 summarises the assumed timeframe of these local road schemes in Melton between 2025 and 2040 for the Do Minimum and Do Something scenarios.

Table 1.1: Local Infrastructure within Do Minimum and Do Something Scenarios

Year	Do Minimum (Without Scheme)	Do Something (With Scheme)
2025	-	North & East MMDR
2030	SLR Phase 1: A607 Leicester Road to Kirby Lane	North & East MMDR SLR Phase 1
2035	SLR Phase 1 & Phase 2: A606 Burton Road to Dalby Road	North & East MMDR SLR Phase 1 & Phase 2
2040	North MMDR SLR Phase 1 & Phase 2 & Phase 3: Dalby Road to Kirby Lane	North & East MMDR SLR Phase 1 & Phase 2 & Phase 3

1.1.6 The economic appraisal of the scheme has been undertaken using forecasts up to and including a forecast year of 2051.

1.1.7 Note that forecasts have been undertaken for six modelled years: 2025, 2030, 2035, 2039, 2040 and 2051. All but 2035 and 2039 have been reported in this Forecasting Report; these forecast years have been introduced to better represent infrastructure change when interpolating economic benefits, and their inclusion is unlikely to add understanding to this report, and hence they are not reported.

1.2 Report Structure

1.2.1 This forecasting report contains the following sections, in addition to this introduction:

- Section 2 – Forecasting Processes: this section provides an overview of the forecasting processes adopted within LLITM 2014 Base.
- Section 3 – Forecasting Assumptions: this section details the forecast assumptions used to generate the Core Scenario and their sources, and provides details of the NEMMDR.
- Section 4 – Core Scenario Forecasts: this section details the forecast results from the Core Scenario using the defined forecasting processes and assumptions. This includes the forecast land-use data, how these drive forecast demand, and the performance of the highway network in forecast years.
- Section 5 – NEMMDR Scenario Forecasts: this section details the change from the Core Scenario due to the inclusion of the NEMMDR, primarily in terms of the changes to the forecast highway network performance and flows.
- Section 6 – TAG High and Low Traffic Growth Sensitivity Testing: this section details the methodology adopted to implement the TAG high / low growth scenarios, and also details the forecast demand and highway network performance in these sensitivity tests.
- Section 7: this section provides a summary of the forecasts detailed within this forecasting report for the NEMMDR Full Business Case.

1.2.2 In addition to these sections, this forecasting report also includes the following appendices:

- Appendix A – Location of Key Developments in Melton Mowbray
- Appendix B – Core Scenario Forecast Vehicle Flows
- Appendix C – Core Scenario Forecast Volume-Capacity Ratios
- Appendix D – Core Scenario Forecast Junction Delays
- Appendix E – NEMMDR Scenario Forecast Vehicle Flow Changes
- Appendix F – NEMMDR Scenario Forecast Volume-Capacity Ratio Changes
- Appendix G – NEMMDR Scenario Forecast Change in Average Delay at Junctions

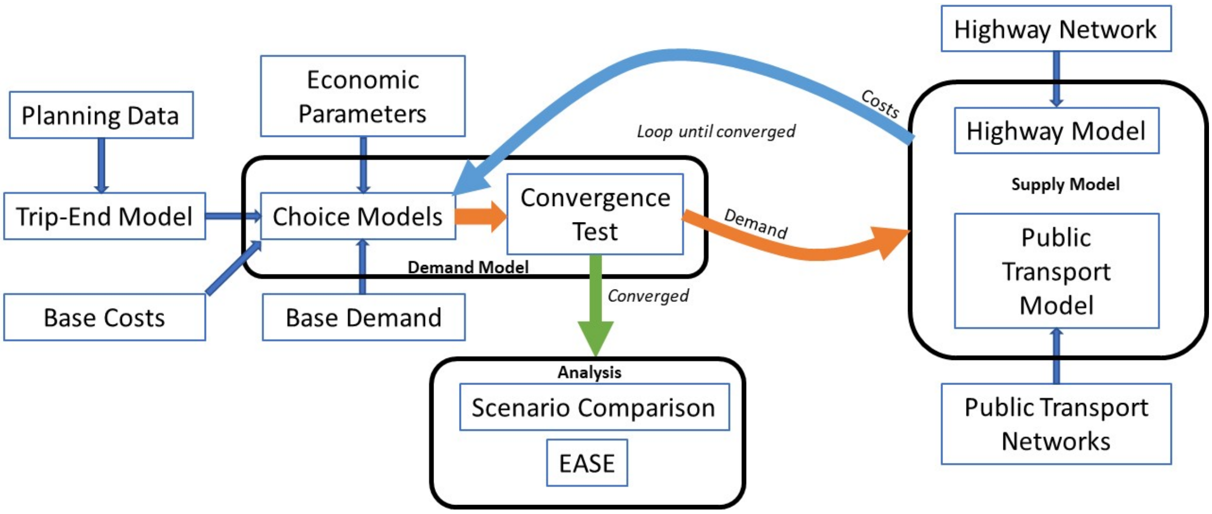
Section 2 – Forecasting Processes

2.1 Introduction

2.1.1 This section outlines the forecast processes contained within LLITM 2014 Base, drawing on information contained within the demand model development report. The demand model report *'NEMMDR FBC - Demand Model Development Report'* contains detailed commentary on the assumptions and processes used in the demand model.

2.1.2 Figure 2-1 shows an outline of the flow of information and data within LLITM 2014 Base when forecasting. A spreadsheet approach is used to produce planning data inputs that are fed into the trip-end model. The outturn trip-end forecasts, along with the highway and public transport network assumptions and various economic assumptions, are used within the variable demand model to produce forecast future year demand.

Figure 2-1: Overview of Data Flow within LLITM 2014 Base



2.1.3 The following sections detail some of the processes contained within the main elements of LLITM 2014 and give references to other reports and technical notes where applicable.

2.2 Supply Models

2.2.1 LLITM 2014 Base contains both highway and public transport assignment models. The validation report for each of these elements can be found in *'NEMMDR FBC - Local Highway LMVR'* and *'NEMMDR FBC - Public Transport LMVR '* respectively. Further information on the performance of the base year highway model in the vicinity of the NEMMDR is detailed in *"NEMMDR FBC - Local Highway LMVR Addendum"*.

2.2.2 In addition to these two assignment models there is also an active mode (walking and cycling) assignment, which uses the public transport network as a proxy for the active mode network.

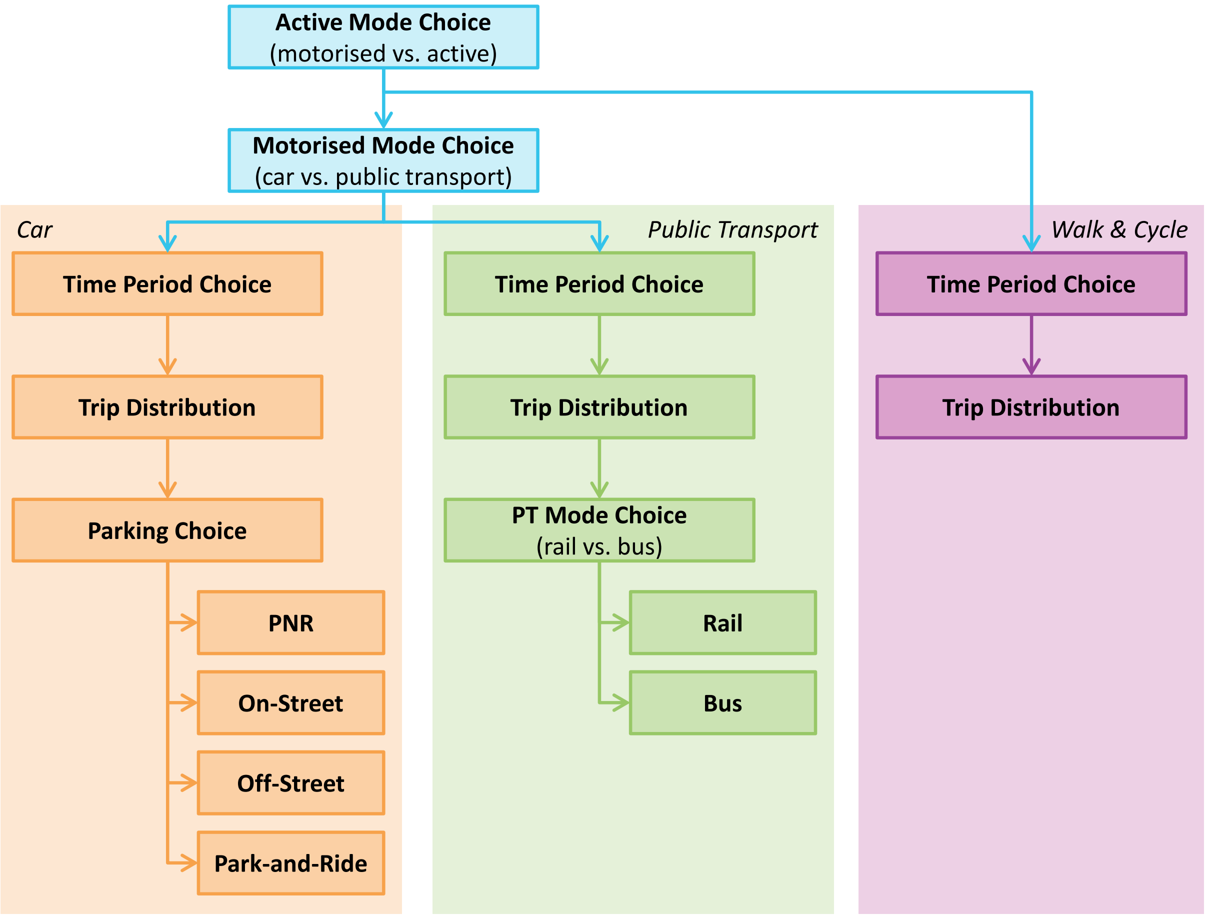
2.2.3 Potential transport schemes have been categorised, following the advice in TAG, as one of 'near certain', 'more than likely', 'reasonably foreseeable' or 'hypothetical'. Schemes considered to be either 'near certain' or 'more than likely' are included in the Core Scenario. These Core Scenario schemes are listed in

2.2.4 Table 3.3 and Table 3.4 for the highway and public transport assignment models respectively. Similarly, Table 3.5 gives the Core Scenario schemes for the active mode network.

2.3 Demand Model

2.3.1 LLITM 2014 Base contains a TAG-compliant variable demand model, which is detailed in *'NEMMDR FBC - Demand Model Development Report'*. Central to the demand model is the choice structure defining how forecast demand is derived. Figure 2-2 shows this choice structure for a car-available, non-freight trip purpose. The choices available to some other segments of demand differ slightly from this. For example, no-car available demand does not have the choice of 'car' as a mode, and so chooses only between public transport and active mode.

Figure 2-2: Typical LLITM 2014 Base Choice Model Structure



2.3.2 These choices are based on the composite costs at each choice level, which are derived from the costs from the assignment models and the parking model, along with the economic parameters assumed in a given forecast year. The economic assumptions used in the Core Scenario can be found in Table 3.2. Sensitivity parameters for these choice models are based on the DfT's TAG advice.

2.3.3 Results of model sensitivity and realism tests for the demand model are reported in *'NEMMDR FBC - Demand Model Development Report'*.

Section 3 – Forecasting Assumptions

3.1 Introduction

3.1.1 This section details the forecasting assumptions used within the model forecasts for the assessment of the proposed NEMMDR. This includes the assumptions underpinning the Core Scenario (i.e. without the NEMMDR), including highway and public transport infrastructure changes from the base year and economic assumptions, and also the assumptions adopted for the modelling of the proposed Distributor Road.

3.2 Core Scenario Assumptions

3.2.1 There are a number of assumptions required when running the integrated model in forecasting mode. These include planning data, network inputs for highway and public transport and economic assumptions such as values of time and fuel costs.

3.2.2 In accordance with TAG Unit M4, information regarding potential future land-use and transport developments has been considered together with their likelihoods. For transport schemes, Leicestershire County Council's latest scheme list (from the late-2021 PRTM 2.2 model) was used. This was compiled from ongoing consultation with Leicestershire County Council and Leicestershire district councils, including Melton Borough Council; Leicester City Council, LCC Highways Development Management (for developer-led schemes within Leicestershire) and National Highways. Scheme details, plans, and certainty were developed from agreement between these parties.

3.2.3 For future development (i.e. land-use) information, the process of developing the uncertainty log has involved the use of both national guidance, and detailed input, stakeholder engagement and review by planners at Melton Borough Council. This has been done to ensure suitable, accurate and contemporary inputs to the uncertainty log development, and thus also model forecasting.

3.2.4 Following TAG, it is important that national and local sources of uncertainty are assessed as part of the model forecasting approach. At a national level, uncertainty in forecasting can typically relate to:

- national uncertainty in travel demand;
- national uncertainty in travel cost; and
- other modelled / nationally based forecast parameter errors.

At a local level, such sources of uncertainty typically include:

- local uncertainty (within the vicinity of the scheme) in travel demand, including uncertainty surrounding whether proposed developments are built; and
- local uncertainty (within the vicinity of the scheme) in travel supply, which includes whether other transport infrastructure projects materialise.

3.2.5 The development of the model forecasts for the NEMMDR scheme has followed the same structure.

3.2.6 The assumptions adopted within the Core Scenario are set out in Table 3.2 which lists the assumptions used in forecasting, excluding the network assumptions for the highway, public transport, and walk / cycle networks, which are detailed in

3.2.7 Table 3.3, Table 3.4 and Table 3.5 respectively.

3.2.8 Table 3.3 and Table 3.4 include schemes which were considered as part of this review but were not included within the Core Scenario based on their likelihood of proceeding.

3.2.9 Aside from new or amended signalised junctions as part of the adopted highway schemes detailed in

3.2.10 Table 3.3, no alterations have been made to signal timings from those included in the base year network.

3.2.11 Table 3.6 and Table 3.7 show the assumptions used in the trip-end model for the residential and employment development in and around Melton Mowbray respectively. Maps of these development sites within Melton Mowbray are provided in Appendix A. Table 3.8 provides details of residential developments within the remainder of Melton Borough.

3.2.12 Across both the trip-end and transport model assumptions for the Core Scenario, the classifications detailed in Table A2 of TAG Unit M4 have been adopted. These classifications are reproduced in Table 3.1.

Table 3.1: TAG Unit M4 (Table A2)

Probability of the input	Status	Core Scenario Assumption
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.	This should form part of the Core Scenario
More than likely: the outcome is likely to happen, but there is come uncertainty	Submission of planning or consent application imminent. Development application within the consent process.	This could form part of the Core Scenario
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 the transport strategy / scheme proceeding. Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty.	These should be excluded from the Core Scenario, but may form part of the alternative scenarios
Hypothetical: there is considerable uncertainty whether this outcome will ever happen	Conjecture based upon currently available information. Discussed on a conceptual basis. One of a number of possible inputs in an initial consultation process. A policy aspiration.	These should be excluded from the Core Scenario, but may form part of the alternative scenarios

3.2.13 Specific attention has been paid to the uncertainty log to justify the level of TAG certainty allocated, and importantly to directly cross-reference the latest planning approvals and planning application references to those sites that are ‘near certain’ or ‘more than likely’. This has been done to provide up-to-date information and proof on the planning status of each development, and to support the inclusion of any specific development sites in the modelling.

3.2.14 For sites where the status of planning developments is not clear, the local knowledge of Melton Borough Council planners was used to best define the level of certainty. In general, TAG certainty for housing developments was based on the planning status apparent in the public domain as per TAG guidance. Employment TAG certainty, other than for very recent applications, is based on Melton Borough Council’s 2021 on-site audit of employment developments. In all cases, unless a planning application has been submitted to Melton Borough Council, the development is not included in the Core Scenario.

3.2.15 Any sites categorised as ‘reasonably foreseeable’ or ‘hypothetical’ have been excluded from the modelling. Importantly, this means that some dwellings and employment in the South Sustainable Neighbourhood (SSN) are still excluded from the Core Scenario model forecasts.

3.2.16 In addition to the quantum of development included / excluded in the Core Scenario, the uncertainty log also provides details of which year the development is likely to be in place. The phasing of development, where included in the Core Scenario, has been included in the modelling as per that detailed in either the planning application or the Local Plan. Both sources are informed by developers’ own timing and forecast build out rates.

3.2.17 It is also of note that the uncertainty log has taken account of windfalls and small sites in a cumulative manner. Whilst these are individually very minor, their cumulative effect may be a material consideration, and thus these sites form a specific item in the uncertainty log. The ‘near certain’ categorisation is evidenced by similar levels of delivery of windfall sites in recent years, and their expectation of such sites continuing to come forward as per previous years.

3.2.18 It is important to note that the trip end model operates to an overall NTEM constraint (v7.2) at the Leicestershire level. Thus, whilst the local uncertainty log inputs on the basis of planning applications and consented development in Melton may be different to NTEM local forecasts, over a wider spatial area growth is constrained to the latest DfT forecasts; those being the latest version of NTEM (v7.2) for the Core Scenario. Further details on the constraint applied to the trip-end model forecasts is given in Section 4.2.

Table 3.2: Core Scenario Forecasting Assumptions

Input	Assumption / Source
Economic Growth **(GDP growth, value of time)**	Information on changes in GDP and values of time are taken from DfT advice (TAG data book, November 2021[1]). Values of time used within the demand model are assumed to be constant across modes[2], time periods, productions and attractions, and vary only by purpose, income segment and length of trip.
Public Transport Fares	All public transport fares are assumed to grow 1% per annum in real terms. This is consistent with recent government policy on rail fares, and consistent with previous trend data across the county for bus fares.
Vehicle Operating Costs	Changes in fuel prices, vehicle fuel efficiency, and non-fuel vehicle operating costs (VOCs) have been taken from the TAG data book, November 2021.
Parking Charges	Parking charges are assumed to grow in line with inflation, i.e. 0% real growth.
Parking Capacities	Zonal capacities of private non-residential parking (PNR) increase and decrease in relation to the changes in employment within each zone. Other parking capacities are unchanged over time.
Land-use: Population and Employment Forecasts	Detailed information on planning policy (land allocated by development type) has been collated from individual districts and used in the trip-end model. Growth in trips across Leicestershire has been constrained to NTEM 7.2 forecasts.
Car Ownership	Car ownership forecasts are derived from NTEM 7.2. forecasts.
Car Occupancy	Global changes in car occupancy over time are assumed to be zero, in line with current TAG guidance. However, changes are assumed relating to the workplace and school travel planning schemes in Loughborough, Coalville, Shepshed, Hinckley and parts of Leicester (see below under ‘Smarter Choices’).
Trip rates	Trip rates are assumed to be constant over time (as in NTEM 7.2). Demand growth is applied at a 24-hour level, so ‘reference demand’ time period proportions by purpose are also assumed to be constant over time. Outturn modelled proportions and trip rates by mode may vary due to the variable demand model (time period and mode choice). Trip rates from NTEM 7.2 have been applied to all model zones; however, adjustment factors have been applied to the trip rates applied to the sustainable neighbourhood developments to the north and south of Melton Mowbray (see Table 4.5 for details on the growth assumed for these developments) which are important to the assessment of the

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[1] This version of the TAG data book was the latest available version at the start of this assessment of the proposed NEMMDR.

[2] Non-working values of time do not vary by mode within TAG; however, values of time do vary by mode for employers’ business trips. The functions for distance-based values of time for employers’ business are different for rail trips over 100km. Given the location and focus of the model not representing this variation is not considered material to the model forecasts.

Input	Assumption / Source
	NEMMDR. For these sites, the modelled trip rate has been approved by LCC as part of the approved planning applications.
Highway Congestion Changes **(for external buffer network)**	The external buffer network is coded with fixed speeds within the highway model, and these are varied over time in-line with expected changes in journey times. RTF18 forecasts of average speeds on inter-urban strategic roads have been used within LLITM 2014 Base to determine the changes in external buffer network speeds.
Active Mode Costs	Changes to walk and cycle costs are represented as part of the representation of the LSTF Smarter Choices funding within Loughborough, Coalville, Hinckley and Leicester. These changes are detailed in Table 3.5.
Smarter Choices	Three Smarter Choices schemes have been modelled within the LLITM 2014 Base Core Scenario, following TAG guidance (documented in *'TN119 - Modelling of Smarter Choices within LLITM'*). These are the LSTF schemes in Loughborough, Coalville and Shepshed, and the LSTF2 schemes in the Leicester City area and Hinckley. The derivation of the target car driver reductions and the results of the calibration process are detailed in TN119. These measures also include changes to the average car occupancies within the model for workplace and school travel plans, which are also detailed in TN119. However, in summary, the following impacts of Smarter Choices have been calibrated in 2016[3]: • **Loughborough, Coalville and Shepshed LSTF Scheme:** o 0.9% reduction in commuting car drivers to Loughborough, Coalville and Shepshed o 3.4% reduction in education car drivers to Loughborough and Coalville o 2.6% reduction in all car drivers from Loughborough and Coalville • **Leicester City LSTF2 Scheme:** o 1.7% reduction in commuting car drivers to Narborough Road / NW Leicester City area • **Hinckley LSTF2 Scheme:** o 1.8% reduction in commuting car drivers to Hinckley o 1.0% reduction in education car drivers to Hinckley

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[3] These reductions in car drivers are after a converged 2016 model run, whereas the effects of Smarter Choices measures are calibrated after a single iteration of the demand model. It is also worth noting that these reductions are based on the network and planning forecast assumptions in the initial version of the LLITM 2014 Base Core Scenario (developed in Spring 2017). No significant changes have been made to the forecast assumptions for 2016 since this model run, and so the calibration exercise has not been repeated.

Input	Assumption / Source
	o 0.8% reduction in all car drivers from Hinckley
Freight Growth	Freight demand is forecast by using trip rates derived from TRICS, applied on a per-employee basis to the employment data derived from the land-use model such that freight growth is responsive to land-use change and is adjusted to be consistent at an overall level with the RTF18 forecasts from the DfT's National Transport Model (NTM).

Table 3.3: Core Scenario Highway Network Scheme Assumptions

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Melton Mowbray (NEMMDR relevant)	Highway improvements for new development • Phase 1: Leicester Road to Kirby Lane • Phase 2: As Phase 1, plus Burton Road and Dalby Road • Phase 3: As Phase 2, plus Dalby Road to Kirby Lane	More than likely	2026-2040	Phase 1 2030 Phase 2 2035 Phase 3 2040	Infrastructure is linked to developments in the Melton South Sustainable Neighbourhood, which is identified in the Melton Local Plan. Planning applications are submitted and further applications are imminent.
Melton Mowbray (NEMMDR relevant)	Highway improvements for new development • Nottingham Road to Melton Spinney Road	More than likely	2040	2040	Infrastructure is linked to developments in the Melton North Sustainable Neighbourhood, which is identified in the Melton Local Plan. Some sites are being build and all applications are submitted or approved.
Melton Mowbray (NEMMDR relevant)	Gladman's Site Access (Leicester Road and Kirby Lane)	Near certain	2021 onwards	2021	Linked to development in the Melton South Sustainable Neighbourhood, which is identified in the Melton Local Plan. First phase under construction and other parts related to Kirby Lane access have submitted or approved planning applications (after modelling commenced, the final application was approved).

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Blaby	Leicester North West Project Phase 1	Complete	2015-2016	2016	Leicestershire County Council / Leicester City Council Highways scheme.
Blaby	Glenfield Park / Optimus Point S278 works	Complete	2014-2016	2016	Developer Scheme (Blaby Local Plan). Infrastructure is linked to the Glenfield Park/Optimus Point development which has Secretary of State approval.
Charnwood	A6 Loughborough Road Bus Lane and Parking Controls	Complete	2016	2016	Leicestershire County Council Highways Scheme. Infrastructure is linked to the Hallam Fields Development (Birstall) which has planning permission.
Charnwood	North of Birstall SUE (Broadnook)	Near Certain	2021-2026	2026	Leicestershire County Council Highways Scheme. Infrastructure is linked to the Broadnook Garden Suburb which has planning permission.
Cotes	A60 Nottingham Road/Loughborough reduction of speed limit	Complete	2016	2016	Leicestershire County Council Highways scheme.
Daventry	DIRFT III - Daventry International Rail Freight Terminal	Complete	2016	2016	National Highways Committed Scheme Linked to the DIRFT III development which is under construction
Hinckley & Bosworth	RGF/MIRA, A5 Redgate Junction @ A444 to Higham Lane Junction.	Complete	Jan-2015	2015	National Highways Committed scheme
Hinckley & Bosworth	A5 Dodwells and Longshoot junctions	Complete	2015	2016	National Highways Committed scheme
Kegworth	M1 J24	Complete	Oct-2014	2016	National Highways Committed scheme
Leicester City	Removal of Belgrave Flyover	Complete	2014-2015	2016	Leicester City Council scheme
Leicester City	Saffron Lane - Old Velodrome Improvements	Complete	2016	2016	Leicester City Council scheme
Leicester City	Closure of Hotel Street and St Martins to traffic	Complete	2016	2016	Leicester City Council scheme
Leicester City	Haymarket / Charles Street bus station development	Complete	Sep-2015	2016	Leicester City Council scheme

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Leicester City	Existing and additional 20mph zones	Complete	2012-2016	2016	Leicester City Council scheme
Leicester City	St Nicholas Circle	Complete	2015	2016	Leicester City Council scheme
Leicester City	Traffic calming schemes	Complete	2016	2016	Leicester City Council scheme
Leicester City	Mansfield Street & Church Gate	Complete	2021	2021	Leicester City Council scheme
Leicester City	Ashton Green	Complete	2021	2021	Leicester City Council scheme
Leicester City	LNW2 Ravensbridge Drive / Blackbird Road	Complete	2020	2020	Leicester City Council scheme
Leicester City	Beaumont Leys Anstey Lane Improvements	Complete	2021	2021	Leicester City Council scheme
Leicester City	Putney Road West Improvement	Near Certain	2026	2026	Leicester City Council scheme
Loughborough	Loughborough Integrated Transport Scheme (closure of old A6 and junction improvements)	Complete	2013	2016	Leicestershire County Council Highways scheme
North West Leicestershire	M1 Junction 22	Complete	Mar-2016	2016	Leicestershire County Council Highways Scheme, partially LEP funded Infrastructure is linked to the Coalville Growth Corridor
Nottingham	A453 upgrade - Including removal of temp 40mph speed limit	Complete	Sep-2015	2016	National Highways committed scheme
Rugby	Rugby Radio Station	Near certain	2016-2019	2016	Developer Scheme (Rugby Local Plan) Infrastructure is associated with the Rugby SUE development which has planning permission
Blaby	Desford Crossroads	More than likely	2026	2026	Leicestershire County Council Highways scheme The infrastructure is linked to several development in the area
Castle Donington	Western Link Road from Back Lane to Tops Hill, NWLDC package of measures to help mitigate growth planned	Complete	2020	2021	Developer Scheme (North West Leicestershire Local Plan) Infrastructure associated with the Park Lane Development which has planning permission

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Catthorpe	M1 Junction 19	Complete	2016-2017	2017	National Highways committed scheme
Charnwood	Mountsorrel Lane, Rothley Link Road	Complete	2021	2021	Developer Scheme (Charnwood Local Plan) Linked to development in Rothley which has been granted planning permission
Charnwood	A512 junction improvements	Complete	2016-2019	2021	Included in the Charnwood Local Plan Infrastructure Schedule, linked to West of Loughborough SUE which has been granted planning permission
Coalville	Bardon Road Link: Southern Section	Near Certain	2021-2024	2024	Developer Scheme (North West Leicestershire Local Plan). Under Construction.
Harborough	Harborough Strategic Development Area	Near Certain	2021	2021	Developer Scheme (Harborough Local Plan) Infrastructure associated with the Market Harborough East Development, which has been granted planning permission
Hinckley	Hinckley Area Project Phase 1-3	Complete	2014-2017	2021	Leicestershire County Council Highways scheme
Hinckley	Rugby Road Corridor Improvements – Phase 4	Near certain	2022-2026	2026	Leicestershire County Council Highways scheme
Kegworth	Kegworth Bypass	Complete	2019	2019	East Midlands Gateway scheme
Leicester City	East of Hamilton Development Improvements	Complete	2016	2017	Linked to the East of Hamilton development which has planning permission and is under construction
Leicester City	Welford Road	Complete	2018	2021	Leicester City Council scheme

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Loughborough	A512 widening B591 to M1 J23, improvements to J23 and completion of dualling thereafter to either Snell's Nook Lane or Epinal Way junction	More than likely	2016-2021	2021	Developer Scheme (Charnwood Local Plan) Infrastructure is included in the Charnwood Local Plan's Infrastructure schedule, with an 'essential' status to improve access to the West of Loughborough growth areas
Lubbesthorpe	Access arrangements for SUE including strategic traffic link to the A563 Lubbesthorpe Way	Complete	2015-2017	2021	Blaby Local Plan Planning permission for the Lubbesthorpe SUE has been granted and the infrastructure is associated with this development
North West Leicestershire	A42 Junction 13	Complete	2017	2018	Leicestershire County Council Highways Scheme, partially LEP funded Infrastructure is linked to the Coalville Growth Corridor
Nottingham	M1 Junction 23a - 25 SMART motorway	Complete	2017	2019	National Highways committed scheme
SRFI	Southern Access for new development	Complete	2017-2020	2019	East Midlands Gateway Scheme Development included at the same certainty, therefore the transport scheme is also included
SRFI	Highway improvements for new development	Complete	2016-2021	2021	East Midlands Gateway Scheme Development included at the same certainty, therefore the transport scheme is also included
Various	M1 Junctions 16-19	Complete	2019	2019	National Highways committed scheme
Warwickshire	M6 Junctions 2-4 Smart Motorway	Complete	2017-2020	2021	National Highways committed scheme
Lubbesthorpe	Link across M69 to join North and South of Lubbesthorpe development	Near Certain	2018-2023	2026	Developer Scheme (Blaby Local Plan) Infrastructure is linked to the Lubbesthorpe SUE development which has planning permission

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Coalville	Bardon Road Link: Southern section only	Near Certain	2019-2024	2024	Developer Scheme (North West Leicestershire Local Plan) Infrastructure associated with the South East Coalville Development which has planning permission
Earl Shilton	Access arrangements for SUE / Highway improvements for SUE	Near Certain	2026	2026	Infrastructure is linked to the Earl Shilton SUE which is included in the Hinckley & Bosworth Local Plan Planning application has been submitted
Barwell	Access arrangements for SUE / Highway improvements for SUE	Near Certain	2019-2035	2026	Infrastructure is linked to the Barwell SUE which is included in the Hinckley & Bosworth Local Plan Planning application has been submitted
Leicester City	Waterside Development	More than likely	mid-2020s	2026	Developer Scheme (Leicester City) Infrastructure associated with the Waterside development which has been granted planning permission
Loughborough	West of Loughborough SUE	More than likely	2021-2026	2026	Developer Scheme (Charnwood Local Plan) Infrastructure is linked to the West of Loughborough SUE which is included in the Charnwood Local Plan and has been granted planning permission
Lubbesthorpe	Highway improvements for SUE	Near Certain	2017-2023	2026	Developer Scheme (Blaby Local Plan) Infrastructure is linked to the Lubbesthorpe SUE development which has planning permission
North of East Leicester	North of East Leicester Development Network	Near Certain	2026/2036	2026/2036	Developer Scheme (Charnwood Local Plan) Infrastructure is linked to the Thorpebury SUE which has planning permission

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Lutterworth	Frank Whittle Roundabout approaches	Complete	2018-2020	2020	Leicestershire County Council Highways scheme
Lutterworth	Lutterworth East Development Network	More than likely	2021-2026	2026	Lutterworth Strategic Development Area
Nuneaton and Bedworth Borough	Coton Arches	More than likely	2021	2021	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	A4254 Eastboro Way P1	Near Certain	2021	2021	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	Nuneaton Northern Sites Link Road	Near Certain	2031	2031	Warwickshire County Council scheme
Rugby Borough	A5 Northern Access to DIRFT III	More than likely	2021	2021	Warwickshire County Council scheme
Rugby Borough	A5/A428 Halfway House Roundabout	Near Certain	2026	2026	Warwickshire County Council scheme
Rugby Borough	M1 Junction 18	More than likely	2031	2031	Warwickshire County Council scheme
Rugby Borough	M6 to Coton House	Near Certain	2031	2031	Warwickshire County Council scheme
Rugby Borough	A5 Southern Access to DIRFT III	Complete	2021	2021	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	College Street / A444	Near Certain	2023	2023	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	Transforming Nuneaton	More than likely	2026	2026	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	Croft Road/Greenmoor Road Priority	More than likely	2031	2031	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	A47 Old Hinckley Road	Near Certain	2023/2024	2024	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	Coventry Road / Gipsy Lane	More than likely	2026	2026	Warwickshire County Council scheme
Nuneaton and Bedworth Borough	A4254 / B4114/Eastboro Way	Near certain	2021	2021	Warwickshire County Council scheme
North Warwickshire	B5000 Market Street/Bridge St Signals	More than likely	2026	2026	Warwickshire County Council scheme
Rugby Borough	A426/A4071 Avon Mill Roundabout/Newbold Road/Hunters Lane Priority Junction	Near Certain	2026	2026	Warwickshire County Council scheme

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Rugby Borough	Ashlawn Road/Hillmorton Road	Near Certain	2021	2021	Warwickshire County Council scheme
North Warwickshire	A5 dualling Grendon to Atherstone	More than likely	2031	2031	Warwickshire County Council scheme
Leicester City	Belgrave Gate South	Complete	2019	2020	Segregated cycle ways and revised bus lane
Leicester City	Belvoir Street	Complete	2017	2018	Revised traffic arrangements and cycle lane
Leicester City	King St	Complete	2018	2018	Traffic reversal
Leicester City	York Road/Bonners Lane/Grange Road	Complete	2019	2019	Pedestrianisation
Leicester City	Lancaster Road	Complete	2020	2020	Segregated cycle lane and removal of junction movements to facilitate
Leicester City	SMBS Access to Burleys Way	Complete	2019	2021	Access from St Margaret’s Bus Station to Burleys Way
Leicester City	Vaughan Way	Complete	2019	2020	Vaughan Way Supercrossing and Highway widening (additional lane)
Leicester City	London Road	Complete	2019	2020	New Segregated Cycleways. Granby Street to Mayfield Roundabout.
Bardon Hill	Interlink Way East junction	Complete	2016	2016	Developer Scheme creating additional through route capacity at Bardon Hill
Granby Street	Granby Street/Halford Street Improvements	Complete	2017	2018	Leicester City Council scheme.
Loughborough	Alan Moss Road	Complete	2017	2018	Leicestershire County Council Highways scheme. Realignment of A6 junction.
Hinckley	DPD A5 Access	Complete	2021	2021	Developer Led. Access to DPD Site East of M69 Junction 1
Leicester Forest East	Ratby Lane/Wembley Road junction	Complete	2017/2018	2019	LCC scheme.
Coalville	Flying Horse Roundabout	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Fieldhead Roundabout	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Hoo Ash Roundabout	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Coalville	Thornborough Road Roundabout	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Dual Carriageway from Thornborough Rd to Whitwick Road	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Whitwick Road Roundabout	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Broom Leys Road Junction	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Bardon Link Road	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Coalville	Bardon Link Road Junction	More than likely	2024	2024	Leicestershire County Council A511 MRN Growth Corridor scheme
Melton	SSN employment	More than likely	2026	2026	Developer scheme identified in latest Melton Mowbray SSN Masterplan. Leicester Road (Davidsons) access

Table 3.4: Core Scenario Public Transport Network Scheme Assumptions

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Lubbesthorpe	Sustainable Urban Extension services	Complete	2013-2016	2021	Blaby Local Plan
North of East Leicester	Sustainable Urban Extension services	Complete	2013-2016	2016	Charnwood Local Plan
Garendon	New service for Garendon	More than likely	2022-2026	2026	Developer scheme (Charnwood Local Plan)
Hinckley	Hinckley Area Project Phases 1 to 3	Complete	2016	2016	Leicestershire County Council scheme
Kegworth	East Midlands Gateway Strategic Rail Freight Interchange (not represented)	Near Certain	2017-2020	2021	Bus interchange agreed
Charnwood	A6 Loughborough Road Bus Lane and Parking Controls	Complete	2016	2016	Leicestershire County Council scheme
Aston Green	New services to accommodate development	More than Likely	2013-2016	2016	Developer Funding (Leicester City)
National	High Speed 2 (not represented[4])	More than likely	Late-2026	2031	Central Government proposal

Table 3.5: Core Scenario Active Mode Network Scheme Assumptions

Location	Scheme Name	Certainty	Timescale	Included from	Comment
Coalville / Loughborough	LSTF package of measures	Complete	2012-2015	2016	Leicestershire County Council scheme
Hinckley	Hinckley Area Project Phases 1 to 3	Complete	Apr 2016	2016	Leicestershire County Council scheme
Leicester City	Cycling Ambition funding	Complete	2016	2016	Leicester City Council scheme

Table 3.6: Core Scenario Melton Mowbray Residential Development Assumptions

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
1		2021-2026	200	Near certain	Planning application 19/00208/REM Taylor Wimpey Melton Spinney Road. Permitted. Build underway.

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[4] Due to the uncertainties regarding the schemes which might be brought forward to provide access to / from Leicestershire and the proposed HS2 station at Toton and the expected limited impact of HS2 on traffic flows through Melton Mowbray, this scheme has not been represented within the model forecasts.

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
	Melton North Sustainable Neighbourhood	2026-2036	480	More than likely	Planning application 21/01198/OUT Taylor Wimpey Melton Spinney Road Remainder. Pending Consideration.
		2024-2030	290	Near Certain	Planning application 18/00359/OUT LCC Land Sysonby Farm Nottingham Road. Permitted.
		2025-2033	575	More than likely	Planning application 21/00973/OUT Barwood Land. Pending Consideration.
		2025-2028	175	More than likely	Planning application 21/00989/OUT William Davis Land. Pending Consideration
		2024-2035	400	Near certain	Planning application 18/00769/OUT Richborough Estates land North of John Ferneley College Scalford Road
2	Melton South Sustainable Neighbourhood	2023-2024	56	Near Certain	Planning application 19/00376/FUL Field OS 0002 Leicester Road (Gladman’s land). Permitted.
		2023-2028	249	Near Certain	Planning application 19/00245/REM Field OS 0002 Leicester Road (Gladman’s land). Permitted.
		2022-2026	266	Near Certain	Planning application 19/00377/REM Field OS 0002 Leicester Road (Gladman’s land). Permitted.
		2026-2036	1500	Near Certain	Planning application 16/00515/OUT currently represents the SSN housing identified in the adopted masterplan. Will either be determined or replaced by updated application depending on Southern Link Road progress.
3	War Memorial Hospital, Ankle Hill	2017-2021	85	Near certain	07/00733/FUL. Planning Permission.
4	Field No. 3310, Scalford Road	2015-2017	91	Complete	13/00497/FUL. Planning Permission.
5	Field Numbers 5855 And 6071 Nottingham Road	2019-2021	85	Near certain	14/00078/OUT. Planning Permission.
6	Field No. 3310, Scalford Road	2017-2018	77	Complete	15/00178/FUL. Planning Permission.
7	Land West Of Bowling Green, Leicester Road	2018-2020	97	Complete	16/00290/FUL. Planning Permission.
8	King Edward Vii Upper School, Burton Road	2022-2025	120	Near Certain	13/00877/OUT. Planning Permission.
9	Catherine Dalley House, Scalford Road	2022-2023	56	Near Certain	18/00518/FUL. Planning Permission.

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
10	St Marys Hospital, Thorpe Road	2024-2025	46	Near Certain	19/00909/OUT. Planning Permission.
11	Land At South Of Hill Top Farm, St Bartholomews Way	2022-2023	60	Near Certain	19/00342/FUL. Planning Permission.
12	Field 4100, Lake Terrace	2022-2025	90	Near Certain	17/01500/OUT. Planning Permission.
13	Jeld Wen Snow Hill Melton Mowbray LE13 1 PD	2026-2035	313	More than likely	21/00405/FUL. Pending Consideration.

Threshold of 30 dwellings has been applied for inclusion within the Uncertainty Log reproduced here

Table 3.7: Core Scenario Melton Mowbray Employment Development Assumptions

Ref. No.	Description	Timescale	Jobs	Certainty	Comment
1	Change of use from B8 to B2 Green Bank	2015	-22	Complete	12/00483/COU
2	Change of use from B8 to B2 Green Bank	2015	82	Complete	12/00483/COU
3	Redevelopment of the site for a new foodstore with associated car parking, access highway works, landscaping and servicing. Nottingham Road.	2015	320	Complete	10/00178/FUL
4	Change of use of former Abattoir site to car parking. Nottingham Road.	2015	-144	Complete	12/00889/COU
5	Construction of new two storey reduced eaves height respite care centre with 1st floor staff and administrative suite with parking provision. Dalby Road.	2015	49	Complete	11/00551/FUL
6	Extension to Offices & new fenstration (windows) to existing warehouse. Green Bank.	2015	27	Complete	13/00229/FUL Office

Ref. No.	Description	Timescale	Jobs	Certainty	Comment
7	Extension to Offices & new fenstration (windows) to existing warehouse. Green Bank.	2015	5	Complete	13/00229/FUL Warehousing
8	Construction of a single-storey despatch extension and packaging store, with car parking. Pate Road.	2015	32	Complete	13/00135/FUL
9	Construction of new Lidl (UK) Foodstore. 50-52 Scalford Road	2015	96	Complete	14/00133/FUL Retail
10	Construction of new Lidl (UK) Foodstore 50-52 Scalford Road	2015	-152	Complete	14/00133/FUL Office
11	Erection of Class A1 food retail store (Aldi) with associated access and parking. Ambulance Station Leicester Road.	2018	94	Complete	15/00476/FUL
12	Change of use to storage and businesses. Airfield Farm Dalby Road.	2018	13	Complete	11/00916/COU Industry
13	Change of use to storage and businesses. Airfield Farm Dalby Road.	2018	28	Complete	11/00916/COU Warehousing
14	Erection of 4 Chill stores to South Elevation. Melton Foods, 3 Samworthy Way.	2018	3	Complete	14/00177/FUL Office
15	Erection of 4 Chill stores to South Elevation. Melton Foods, 3 Samworthy Way.	2018	30	Complete	14/00177/FUL Industry
16	Erection of 4 Chill stores to South Elevation. Melton Foods, 3 Samworthy Way.	2018	2	Complete	14/00177/FUL Warehousing
17	Extension of an existing food production facility to provide additional despatch store space with relocated HGV docks. Kettleby Foods, 2 Samworthy Way.	2018	31	Complete	14/00407/FUL

Ref. No.	Description	Timescale	Jobs	Certainty	Comment
18	single storey production extension and associated chilled, frozen and ambient storage areas. Melton Foods, 3 Samworthy Way.	2018	41	Complete	15/00029/FUL
19	new offices and amenities Melton Foods, 3 Samworthy Way.	2018	34	Complete	15/00336/FUL Office
20	new offices and amenities Melton Foods, 3 Samworthy Way.	2018	4	Complete	15/00336/FUL Industry
21	Erection of two industrial buildings. Land At Rear Of MasterFoods 2-8, Hudson Road.	2021	49	Complete	16/00449/FUL Industry
22	Erection of two industrial buildings. Land At Rear Of MasterFoods 2-8, Hudson Road.	2021	7	Complete	16/00449/FUL Warehousing
23	Change of use of part of the site for the storage of fifty-four freight containers. Land adjacent to Wendover Dalby.	2021	60	Complete	17/00353/FUL
24	Erection of an ambient storage warehouse and associated hard-standing. Kettleby Foods, 2 Samworthy Way.	2022	6	Certain	20/01111/FUL
25	Change of use from "Sui generis" (previously used as a youth club) to F1(a) dance school. 22 North Street.	2022	6	Certain	20/01284/FUL
26	Demolition of Industrial Buildings and creation of 313 dwelling development. Jeld Wen Snow Hill.	2024	-396	More than Likely	21/00405/FUL
27	Transfer of Jeld Wen jobs to Thorpe Road Site & Site upgrade	2024	396	More than Likely	18/01203/FUL
28	Employment Allocation: 20 hectares of employment land, located off Leicester Road, as part of the South Melton Mowbray Sustainable Neighbourhood	2026-2031	549	More than Likely	21/01280/OUT Industry

Ref. No.	Description	Timescale	Jobs	Certainty	Comment
29	Employment Allocation: 20 hectares of employment land, located off Leicester Road, as part of the South Melton Mowbray Sustainable Neighbourhood	2026-2031	119	More than Likely	21/01280/OUT Warehousing

Table 3.8: Core Scenario Wider Area Residential Development Assumptions

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
1	Outline residential development up to 56 dwellings, including 22 affordable 2 and 3 bedroom dwellings, together with site access and entrance road, service utilities infrastructure including pumping stations, and associated open space on land to the rear (east) of 33-51 Belvoir Road, Bottesford, Leicestershire. Land Adjoining Belvoir Road And Green Lane, Belvoir Road.	2017	56	Complete	12/00123/OUT
2	Outline application for residential development (up to 100 dwellings) and associated infrastructure (all matters except access reserved for subsequent approval). Field No 0070.	2021	91	Near Certain	14/00980/OUT
3	Residential development of up to 45 new dwellings, together with new areas of public open space, access, landscaping and drainage infrastructure. Field 1357 Melton Road.	2021	32	Near Certain	15/01011/OUT
4	Outline application for residential development with associated landscaping, open space,	2021	53	Near Certain	16/00491/OUT

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
	drainage infrastructure and vehicular and pedestrian access. Additional Information: density of development and provision of pedestrian facilities (Please note the additional information will be available on line from Monday 19th December 2016). Land Off Great Lane.				
5	Outline application, with all matters other than access to be reserved for future approval, for residential development with associated access, community uses, landscaping, open space, drainage infrastructure and surface carpark.. OS Fields 8456 7946 And 9744 Normanton Lane Bottesford.	2021	46	Near Certain	17/00641/OUT
6	Small sites <25 dwellings, agglomerated to PRTM zone. Harby.	2021	32	Complete	Cluster of small sites & Windfalls
7	Melton local plan 2022>. Land Around Sherbrook House And Millway Foods.	2026	50	Near Certain	16/00318/OUT
8	Melton local plan 2022>. Millway Foods Ltd, Colston Lane.	2027	53	Near Certain	15/00673/OUT
9	Melton local plan 2022>. Land West Of Marquis Road And North Of Station Road.	2024	39	Near Certain	15/00017/OUT
10	Melton local plan 2022>. Spinney Campus - Brooksby Melton College, Melton Road.	2025	70	Near Certain	20/01388/REM
11	Melton local plan 2022>. Birleys Garage, 1 Waltham Lane.	2029	45	Near Certain	16/00560/OUT

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
12	Melton local plan 2022>. Land South Of Frisby On The Wreake, Leicester Road.	2025	48	Near Certain	16/00704/OUT
13	Melton local plan 2022>. Land Opposite 1 And 10, Station Lane.	2026	72	Near Certain	17/00397/OUT
14	Melton local plan 2022>. Fair Farm 33 Melton Road.	2023	31	Near Certain	16/00847/OUT
15	Melton local plan 2022>. Field No 0070, Hoby Road.	2025	70	Near Certain	16/00570/OUT
16	Melton local plan 2022>. The Old Clay Pit, Grantham Road.	2023	40	Near Certain	17/01577/OUT
17	Melton local plan 2022>. Field 6967 Grantham Road.	2025	60	Near Certain	18/00632/OUT
18	Melton local plan 2022>. Field OS 6260, Canal Lane.	2025	34	Near Certain	19/00859/OUT
19	Melton local plan 2022>. OS 4240, Burdetts Close.	2025	35	Near Certain	18/00721/OUT
20	Melton local plan 2022>. Normanton Lane.	2030	51	Near Certain	17/00641/OUT
21	Melton local plan 2022>. Grange Farm House, Harby Lane.	2025	35	Near Certain	18/00500/OUT
22	Melton local plan 2022>. Land known as Brickyard Lane.	2030	34	More than Likely	WYM3
23	Melton local plan 2022>. Field OS 3300, Oakham Road.	2025	31	Near Certain	16/00100/OUT (20/00452/REM (31 PCO))
24	Melton local plan 2022>. Field OS 6934, Bypass Road.	2024	55	Near Certain	16/00539/OUT
25	Melton local plan 2022>. Land Rear Of 1 To 3, Hickling Lane.	2025	31	Near Certain	16/00810/OUT (31) (PERS106)
26	Melton local plan 2022>. Land Rear Of Daybells Farms, Grantham Road.	2024	41	Near Certain	17/00250/OUT (Part - PCO 18)
27	Melton local plan 2022>. Land West Of Saltby Road And South Of Mill Lane, Saltby Road.	2026	39	More than Likely	17/00299/OUT (PCO)

Ref. No.	Description	Timescale	Dwellings	Certainty	Comment
28	Melton local plan 2022>. Land west of Main Street.	2030	72	More than Likely	19/01302/FUL (PCO 74)
29	Melton local plan 2022>. Land West Of Rectory Farm.	2028	215	More than Likely	20/00388/OUT (PCO 215)

* A threshold of 30 dwellings has been applied for inclusion within these Forecasting Report tables; smaller developments are also included in the model as appropriate

3.2.19 As shown in

3.2.20 Table 3.3, there are two highway network schemes included in the Core Scenario within Melton Mowbray. These are a new Southern Link Road between the A607 Leicester Road and A606 Burton Road to the south of Melton Mowbray (built in three phases between 2030 and 2040), and the northern section of the MMDR between the A606 Nottingham Road and Melton Spinney Road (represented in the Core Scenario from 2040).

3.2.21 Both of these schemes are related to urban extensions to the north and south of Melton Mowbray included in Table 3.2, and are therefore developer-led schemes which are included in the Core Scenario (i.e. excluding the NEMMDR).

3.2.22 The proposed NEMMDR scheme (discussed in detail in Section 3.3) also includes the northern section of the MMDR but brings forward the delivery from 2040 to 2025.

3.2.23 The Southern Link Road is unaffected by the inclusion of the NEMMDR scheme.

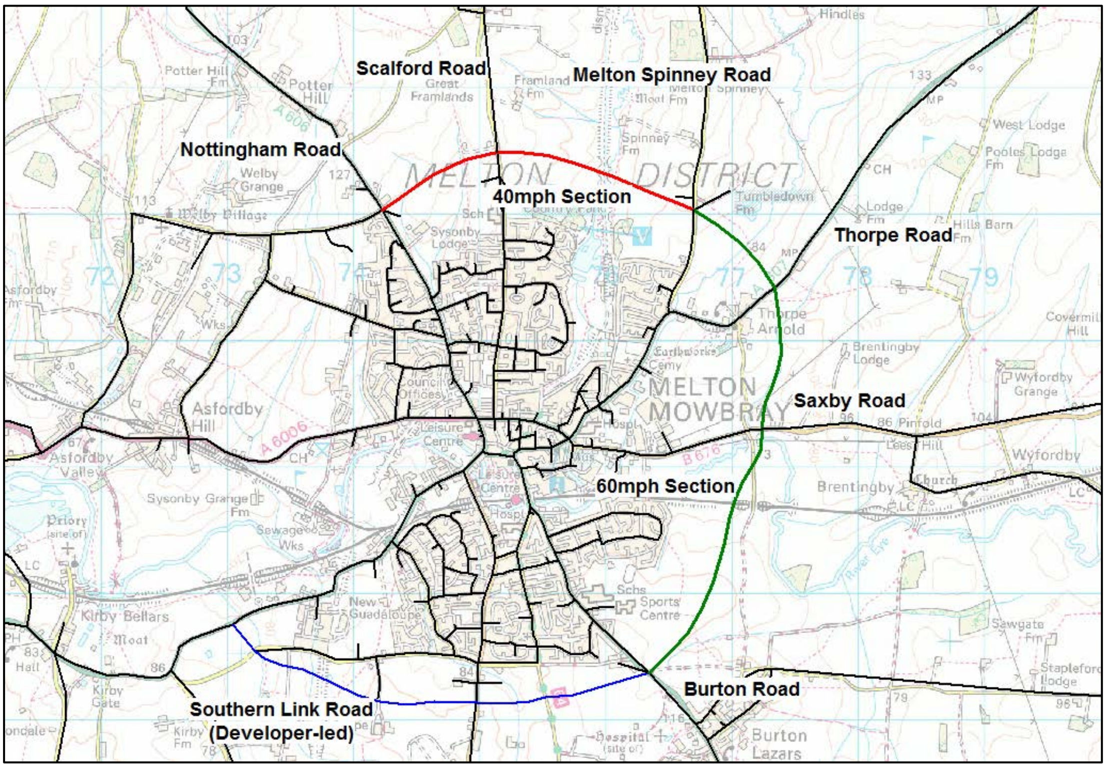
3.3 Scheme Assumptions

3.3.1 The assumptions detailed in Section 3.2 define the Core Scenario, which are the forecast assumptions excluding the proposed NEMMDR. This section details the incremental changes to these assumptions in the NEMMDR Scenario.

3.3.2 The first modelled year in which the NEMMDR is represented is 2025. The NEMMDR brings forward the delivery of the Northern Link Road (shown in red in Figure 3-1), providing a continuous link around the north and east of Melton Mowbray from Nottingham Road in the north and Burton Road in the south.

3.3.3 The NEMMDR is assumed to be a single carriageway route with a 40mph speed limit between Nottingham Road and Melton Spinney Road, and a 60mph limit for the remainder of the route. The route of the proposed NEMMDR is shown in Figure 3-1 in red (North) and green (East). The route of the Southern Link Road included in the Core Scenario is also shown in blue.

Figure 3-1: Proposed North and East Melton Mowbray Distributor Road



Map contains Ordnance Survey data © Crown copyright and database right 2022

3.3.4 This proposed route, including the section between Nottingham Road and Melton Spinney Road, creates a number of new junctions and amends some existing junctions. The following details the assumptions adopted for each of these junctions:

- **A606 Nottingham Road:** the existing priority junction of Nottingham Road and St Bartholomew's Way is converted to a five-arm roundabout with flared approaches, including the Northern Link Road and an access to the proposed Melton North Sustainable Neighbourhood.
- **Scalford Road:** a new four-arm roundabout with flared approaches. (Access to / from the Melton North Sustainable Neighbourhood is assumed to be via an additional roundabout to south of this junction.)
- **Melton Spinney Road:** a new five-arm roundabout with flared approaches, including a relocated Twinlakes Park access.
- **A607 Thorpe Road:** a new four-arm roundabout with flared approaches.
- **B676 Saxby Road:** a new four-arm roundabout with flared approaches.
- **A606 Burton Road:** a new five-arm roundabout including a connection to the Southern Link Road and an access to the proposed Melton South Sustainable Neighbourhood development.

Section 4 – Core Scenario Forecasts

4.1 Introduction

4.1.1 This section details the LLITM 2014 Base forecasts for the Core Scenario, i.e. the scenario excluding the proposed NEMMDR.

4.1.2 This section firstly discusses the planning data forecasts, and then discusses how these are used the derive forecast year demand estimates within the transport model. This section also details the highway model forecasts in the vicinity of the scheme, based on the changes in demand from the validated base year model driven by the land-use assumptions and trip-end forecasts.

4.2 Planning Data Forecasts

4.2.1 The first element of the Core Scenario forecasts is the planning data provided by the Leicestershire district authorities. Figure 4-1 and Figure 4-2 show the forecast growth in households and employment respectively by district within Leicestershire from the 2014 base year to 2051.

4.2.2 Figure 4-1 shows that Melton Borough is forecast to have a 37% increase in population from 2014 to 2040, largely driven by the Melton Borough Local Plan[5] policies which incorporate the delivery of two sustainable neighbourhoods for Melton Mowbray, to the north and the south of the existing urban area.

4.2.3 In terms of employment, Figure 4-2 shows that Harborough, North West Leicestershire and Hinckley and Bosworth expect to see significant employment growth over the forecasting period. In the case of Harborough, this is driven by large sites such as Magna Park[6], Symmetry Park[7] and Compass Point Business Park. The large growth in North West Leicestershire, is driven by the Strategic Rail Freight Interchange[8] development adjacent to East Midlands Airport and by Mercia Park. The largest growth in Hinckley and Bosworth is expected to be at Hinckley Park[9] and at the MIRA Technology Park[10] on the A5.

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[5] https://www.meltonplan.co.uk/

[6] https://eu.glp.com/property/magna-park-lutterworth/?gclid=EAIaIQobChMI_MG61eST-gIV2t_tCh0aYgUpEAAYASAAEgIvp_D_BwE

[7] https://tritaxsymmetry.com/projects/symmetry-park-leicester/

[8] https://www.slp-emg.com/

[9] https://hinckleypark.co.uk/

[10] https://www.miratechnologypark.com/

Figure 4-1: Household Growth Forecasts from Planning Data by District

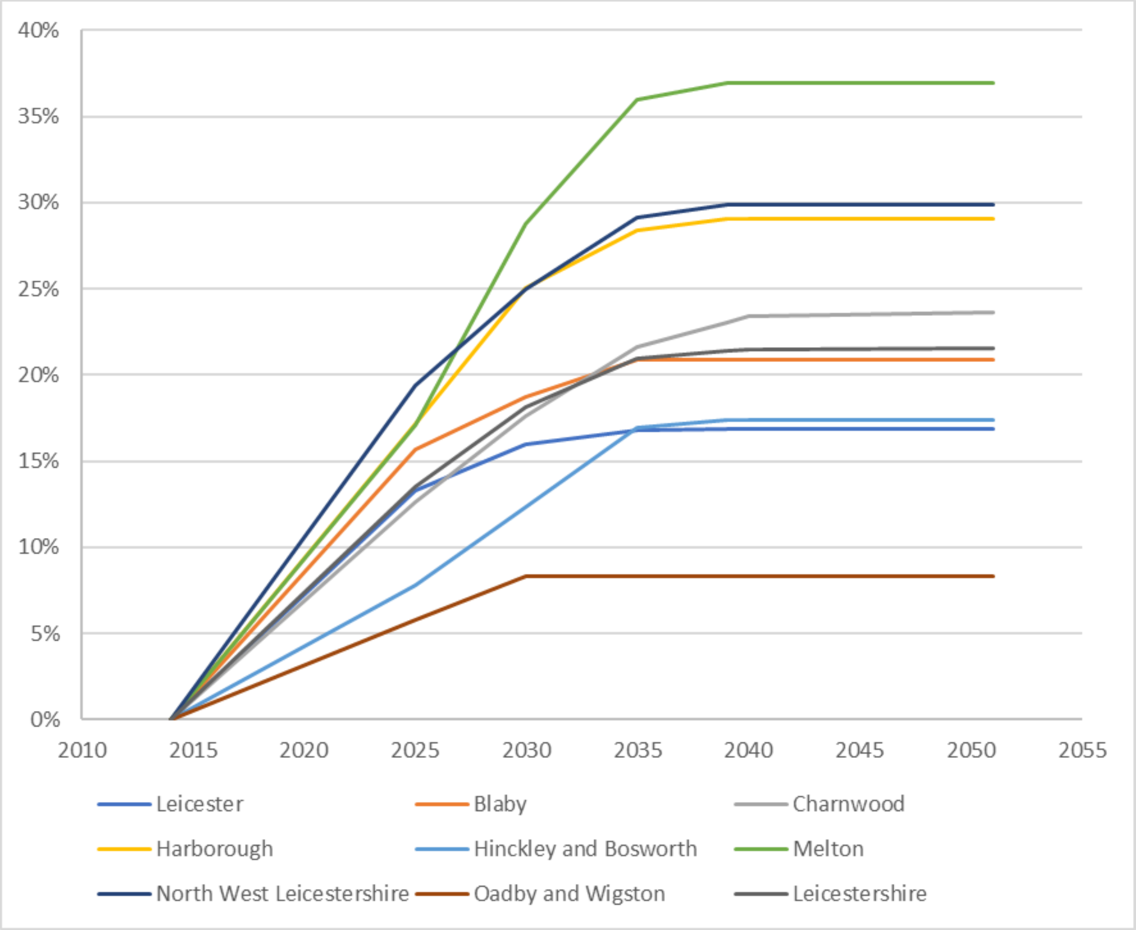
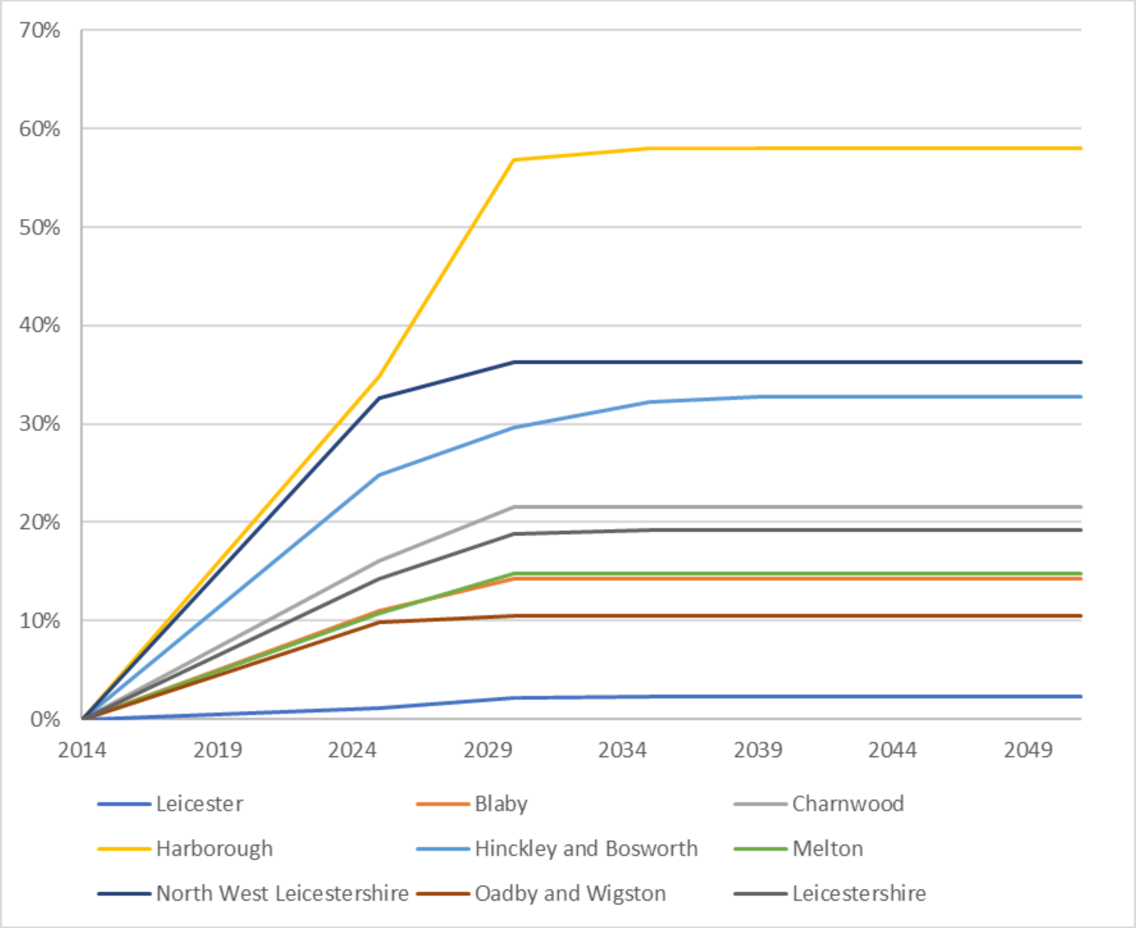


Figure 4-2: Employment Growth Forecasts from Planning Data by District



4.2.4 Table 4.1 and Table 4.2 provide more detail on the planning data household and employment forecasts by Leicestershire district.

Table 4.1: Household Forecasts from Planning Data by District

	2014	2025	2030	2035	2039	2040	2051
Leicester	125,112	141,748	145,096	146,161	146,245	146,245	146,245
Blaby	40,043	46,324	47,538	48,402	48,402	48,402	48,402
Charnwood	69,476	78,266	81,705	84,504	85,474	85,716	85,886
Harborough	36,311	42,543	45,402	46,614	46,853	46,853	46,853
Hinckley and Bosworth	46,860	50,523	52,627	54,810	55,004	55,004	55,004
Melton	22,137	25,921	28,509	30,107	30,316	30,316	30,316
North West Leicestershire	40,045	47,804	50,056	51,702	52,008	52,008	52,008
Oadby and Wigston	21,837	23,094	23,647	23,647	23,647	23,647	23,647
Leicestershire	**401,821**	**456,224**	**474,581**	**485,946**	**487,948**	**488,190**	**488,360**

Table 4.2: Employment Forecasts by District

	2014	2025	2030	2035	2039	2040	2051
Leicester	164,028	165,962	167,639	167,904	167,904	167,904	167,904
Blaby	58,556	65,011	66,885	66,885	66,885	66,885	66,885
Charnwood	67,423	78,264	81,943	81,943	81,943	81,943	81,943
Harborough	41,099	55,399	64,474	64,948	64,948	64,948	64,948
Hinckley and Bosworth	43,338	54,088	56,152	57,333	57,551	57,551	57,551
Melton	21,695	24,030	24,894	24,894	24,894	24,894	24,894
North West Leicestershire	58,042	76,979	79,111	79,111	79,111	79,111	79,111
Oadby and Wigston	20,304	22,312	22,431	22,431	22,431	22,431	22,431
Leicestershire	**474,484**	**542,046**	**563,530**	**565,451**	**565,668**	**565,668**	**565,668**

4.2.5 Table 4.3 and

	2025		2030		2035		2039		2040		2051	
District	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**
Leicester	13%	9%	16%	13%	17%	17%	17%	20%	17%	21%	17%	30%
Blaby	16%	8%	19%	11%	21%	14%	21%	17%	21%	18%	21%	25%
Charnwood	13%	12%	18%	18%	22%	23%	23%	27%	23%	28%	24%	39%
Harborough	17%	7%	25%	16%	28%	20%	29%	23%	29%	24%	29%	34%
Hinckley and Bosworth	8%	10%	12%	14%	17%	17%	17%	20%	17%	21%	17%	30%
Melton	17%	5%	29%	7%	36%	8%	37%	9%	37%	9%	37%	11%
North West Leicestershire	19%	6%	25%	8%	29%	10%	30%	12%	30%	13%	30%	19%
Oadby and Wigston	6%	3%	8%	5%	8%	7%	8%	9%	8%	10%	8%	16%
Leicestershire	**14%**	**9%**	**18%**	**13%**	**21%**	**16%**	**21%**	**19%**	**21%**	**20%**	**22%**	**28%**

4.2.7 Table 4.4 provide information on the local planning data-derived growth in households and employment by district and compare these growth forecasts with NTEM 7.2.

4.2.8 In terms of household growth to the design year of 2040 (beyond which there is little change due to lack of forward visibility in the planning data), the local planning data predict growth of 21% across Leicestershire (compared with 21% growth in NTEM 7.2), and growth of 37% within Melton Borough (compared with 9% in NTEM). This significant difference in terms of household growth within Melton Borough is due to the inclusion of the planning applications and planning status of significant developments within the district forecasts, which are not reflected in the NTEM 7.2 forecasts.

4.2.9 In terms of employment growth, the growth from 2014 to 2040 across Leicestershire is forecast to be 19%, compared with 10% employment growth in NTEM 7.2. Within Melton Borough, planning data forecasts employment growth to 2040 of 15%, which compares to 10% in NTEM. The NTEM employment growth is evenly distributed across districts within Leicestershire, whereas the LLITM 2014 Base forecasts vary significantly by district, reflecting the expected location of growth within the county (see Section 4.2.3).

Table 4.3: Household Forecast Growth from 2014 by District Compared to NTEM

	2025		2030		2035		2039		2040		2051	
District	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**
Leicester	13%	9%	16%	13%	17%	17%	17%	20%	17%	21%	17%	30%
Blaby	16%	8%	19%	11%	21%	14%	21%	17%	21%	18%	21%	25%
Charnwood	13%	12%	18%	18%	22%	23%	23%	27%	23%	28%	24%	39%
Harborough	17%	7%	25%	16%	28%	20%	29%	23%	29%	24%	29%	34%
Hinckley and Bosworth	8%	10%	12%	14%	17%	17%	17%	20%	17%	21%	17%	30%
Melton	17%	5%	29%	7%	36%	8%	37%	9%	37%	9%	37%	11%
North West Leicestershire	19%	6%	25%	8%	29%	10%	30%	12%	30%	13%	30%	19%
Oadby and Wigston	6%	3%	8%	5%	8%	7%	8%	9%	8%	10%	8%	16%
Leicestershire	**14%**	**9%**	**18%**	**13%**	**21%**	**16%**	**21%**	**19%**	**21%**	**20%**	**22%**	**28%**

Table 4.4: Employment Forecast Growth from 2014 by District Compared to NTEM

	2025		**2030**		**2035**		**2039**		**2040**		**2051**	
District	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**
Leicester	1%	6%	2%	7%	2%	9%	2%	10%	2%	10%	2%	14%
Blaby	11%	6%	14%	8%	14%	9%	14%	10%	14%	11%	14%	15%
Charnwood	16%	5%	22%	7%	22%	8%	22%	10%	22%	10%	22%	14%
Harborough	35%	6%	57%	7%	58%	9%	58%	10%	58%	10%	58%	14%
Hinckley and Bosworth	25%	6%	30%	7%	32%	9%	33%	10%	33%	10%	33%	14%
Melton	11%	6%	15%	7%	15%	9%	15%	10%	15%	10%	15%	14%
North West Leicestershire	33%	6%	36%	7%	36%	9%	36%	10%	36%	10%	36%	14%
Oadby and Wigston	10%	6%	10%	7%	10%	9%	10%	10%	10%	10%	10%	14%
Leicestershire	**14%**	**6%**	**19%**	**7%**	**19%**	**9%**	**19%**	**10%**	**19%**	**10%**	**19%**	**14%**

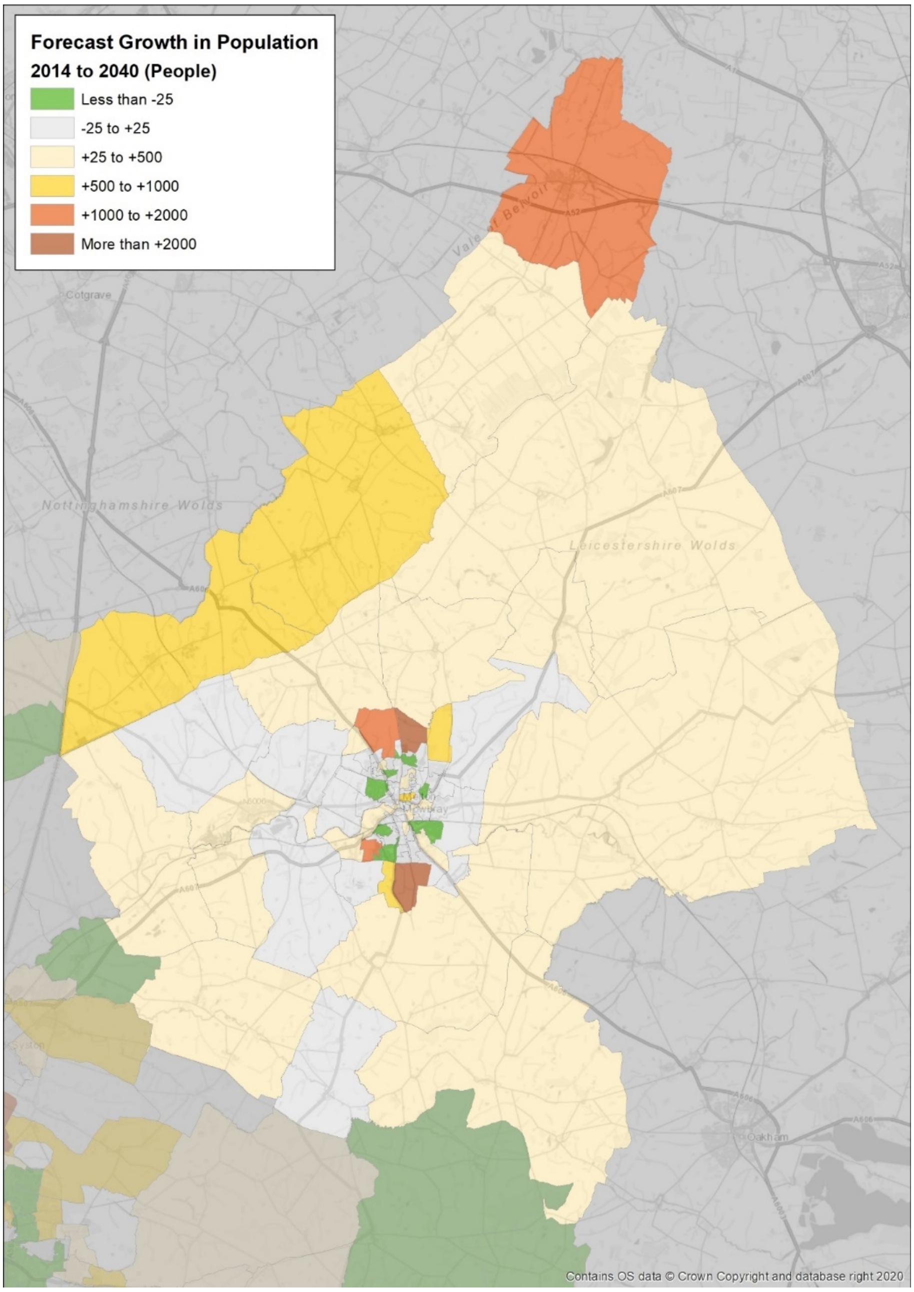
4.2.10 Figure 4-3 shows the forecast growth in households for Melton Borough from 2014 to 2040 by LLITM 2014 Base zone. In this figure the significant growth in households to the north and south of the existing Melton Mowbray urban area can be seen due to the North and South Sustainable Neighbourhoods. Figure 4-4 shows the same information for employment growth. This shows that most of the employment growth is focussed to the south-west of Melton Mowbray as part of the Southern Sustainable Neighbourhood as well as in the villages of Old Dalby and Bottesford.

4.2.11 Table 4.5 shows the forecast households for the two sustainable neighbourhoods. These are large developments that are close to, and will be affected by, the NEMMDR scheme.

Table 4.5: Forecast Households in Melton Mowbray North and South Urban Extensions

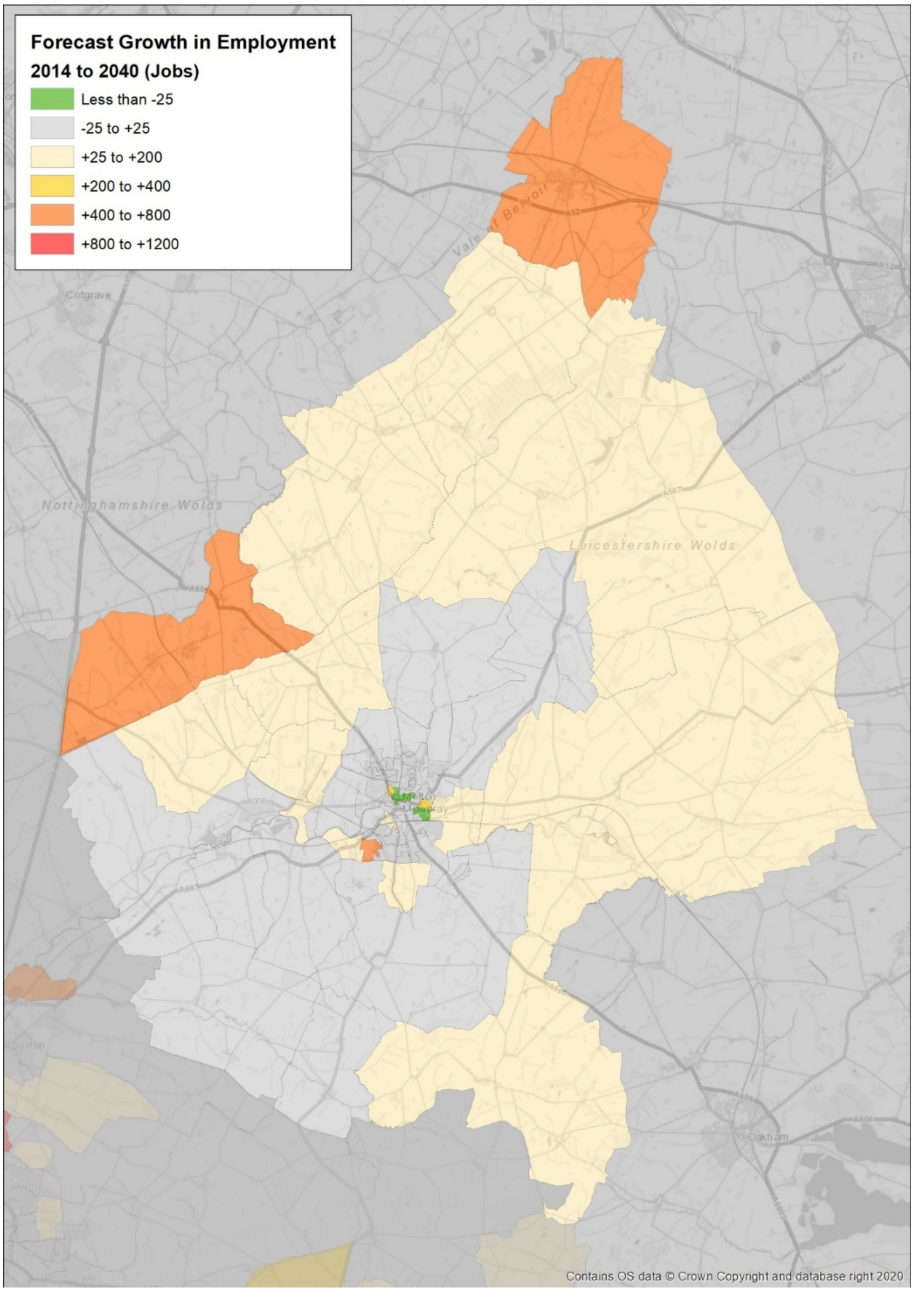
	2014	2025	2030	2040	2051
North	0	353	1,481	2,120	2,120
South	0	439	1,207	2,071	2,071

Figure 4-3: Population Growth from 2014 to 2040 in Melton Borough



Contains OS data © Crown Copyright and database right 2020

Figure 4-4: Employment Growth from 2014 to 2040 in Melton Borough



4.2.12 Prior to the trip-end model being run to generate trip-ends, population and car-ownership forecasts are calculated for each model zone based on NTEM 7.2 projections.

4.3 Population Forecasts

4.3.1 Figure 4-5 shows the forecast population by Leicestershire district and for the whole county including the city. Forecast growth is largest in Harborough and North West Leicestershire and smallest in Oadby and Wigston with Melton being close to the Leicestershire average.

4.3.2 The decline in population beyond the current forward visibility of planning data (Figure 4-1) is due to lower household sizes being forecast in NTEM 7.2 as shown in Figure 4-6. Melton is anomalous in this respect, with a much smaller decline in population being apparent in the NTEM 7.2 forecast. For all Leicestershire districts apart from Melton, the NTEM 7.2 forecast change between 2014 and 2051 is around 8%. For Melton the equivalent change is around half of that forecast for the other districts..

4.3.3 The population forecasts derived from the local planning data (Figure 4-5) have different characteristics to the rather bland NTEM 7.2 forecasts, which assume almost linear growth extrapolated beyond the planning data horizon (Figure 4-7; note that again Melton is anomalous in terms of growth rate beyond

2030). Once the trip-end model has constrained the forecast trip ends to NTEM trip-end growth from 2014 for Leicestershire, the differences in 2014 populations and the pattern of population growth compared to NTEM will produce a different distribution of personal demand to NTEM within Leicestershire. This has two consequences: firstly, demand growth in Melton will be like the county average; and secondly comparisons of trip-ends between NTEM trip-ends and the trip-end model output are unlikely to be meaningful at district level.

4.3.4 Table 4.6 and Table 4.7 give details of the population forecasts and a comparison of growth to NTEM 7.2 respectively.

Figure 4-5: Forecast Population Growth by Leicestershire District

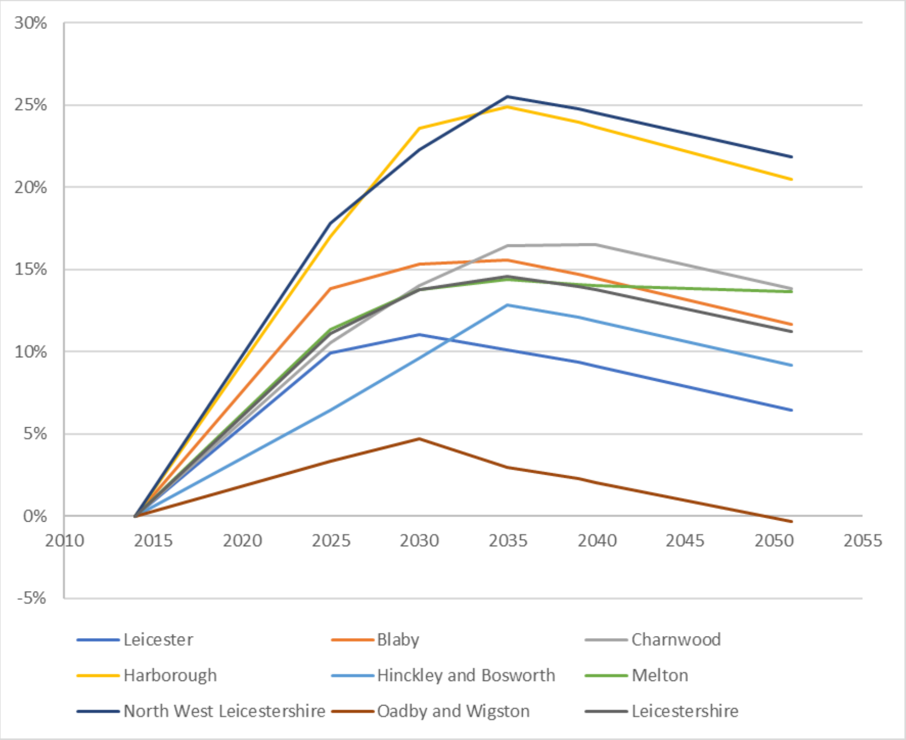


Figure 4-6: Forecast Change in Household Size by Leicestershire District from NTEM

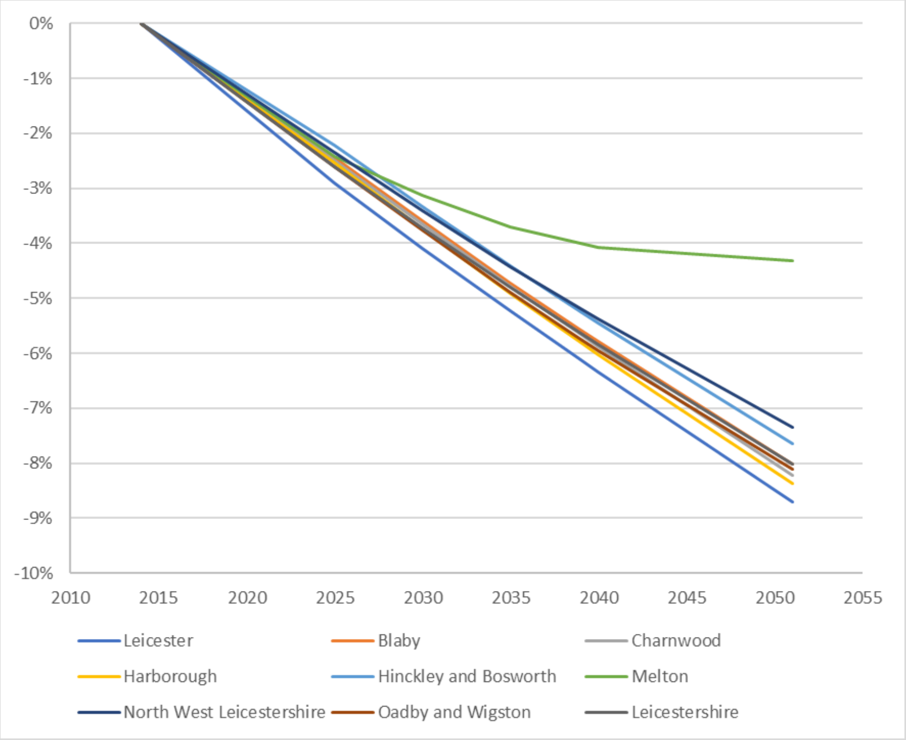


Figure 4-7: Forecast Population Growth by Leicestershire District from NTEM

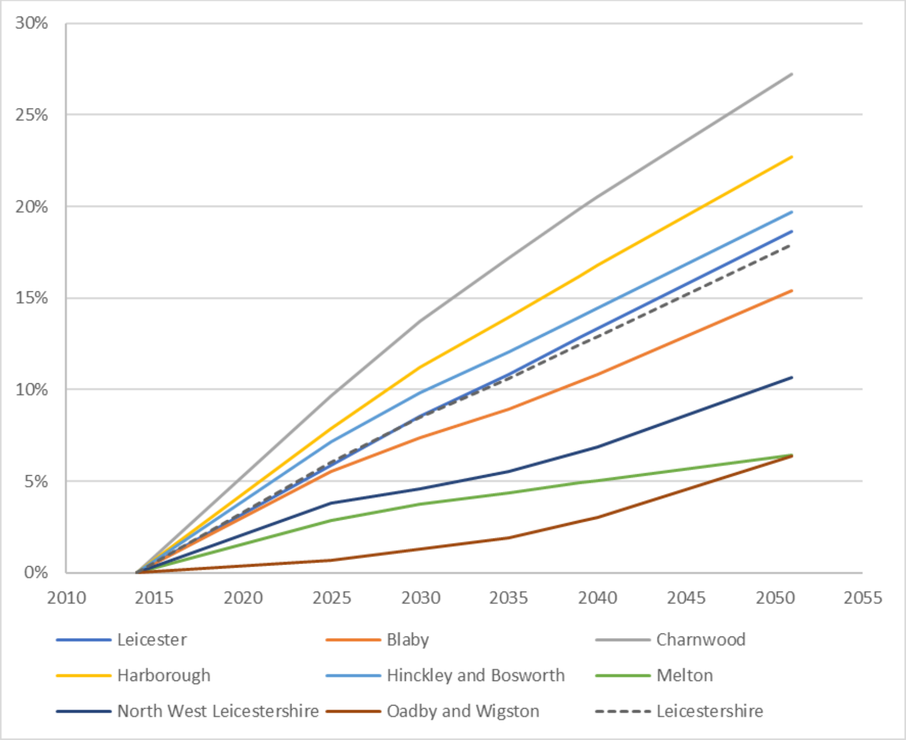


Table 4.6:Population Forecasts by District

District	2014	2025	2030	2035	2039	2040	2051
Leicester	330,474	363,364	366,981	363,908	361,430	360,627	351,831
Blaby	95,711	108,964	110,370	110,600	109,820	109,566	106,905
Charnwood	173,771	192,140	198,179	202,354	202,465	202,514	197,832
Harborough	86,760	101,530	107,206	108,365	107,563	107,304	104,553
Hinckley and Bosworth	107,655	114,582	118,000	121,499	120,663	120,391	117,521
Melton	51,154	56,957	58,208	58,513	58,376	58,331	58,144
North West Leicestershire	94,798	111,713	115,954	119,020	118,285	118,045	115,532
Oadby and Wigston	57,591	59,505	60,319	59,294	58,901	58,772	57,417
Leicestershire	**997,912**	**1,108,755**	**1,135,218**	**1,143,554**	**1,137,503**	**1,135,549**	**1,109,737**

Table 4.7: Population Forecast Growth from 2014 by District Compared to NTEM

	2025		2030		2035		2039		2040		2051	
District	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**
Leicester	10%	6%	11%	9%	10%	11%	9%	13%	9%	13%	6%	19%
Blaby	14%	6%	15%	7%	16%	9%	15%	10%	14%	11%	12%	15%
Charnwood	11%	10%	14%	14%	16%	17%	17%	20%	17%	21%	14%	27%
Harborough	17%	8%	24%	11%	25%	14%	24%	16%	24%	17%	21%	23%
Hinckley and Bosworth	6%	7%	10%	10%	13%	12%	12%	14%	12%	14%	9%	20%
Melton	11%	3%	14%	4%	14%	4%	14%	5%	14%	5%	14%	6%
North West Leicestershire	18%	4%	22%	5%	26%	6%	25%	7%	25%	7%	22%	11%
Oadby and Wigston	3%	1%	5%	1%	3%	2%	2%	3%	2%	3%	0%	6%
Leicestershire	**11%**	**6%**	**14%**	**8%**	**15%**	**11%**	**14%**	**12%**	**14%**	**13%**	**11%**	**18%**

4.4 Car Ownership Forecasts

4.4.1 Figure 4-8 shows the change (forecast minus base) in the proportion of households with car availability by Leicestershire district between 2014 and 2051. This shows a modest gain of 2-4% in districts outside Leicester where the levels of car ownership are already high and a higher 9% gain in Leicester City where the levels of car ownership are relatively low.

4.4.2 The equivalent change (forecast minus base) in the proportion of households with car availability is derived from NTEM 7.2 projections and is shown in Figure 4-9.

4.4.3 Table 4.8 and Table 4.9 provide further detail on the proportion of households with car availability and a comparison of change in percentage point (forecast minus base) compared to NTEM 7.2 respectively.

Figure 4-8: Forecast Change in Car Availability by District

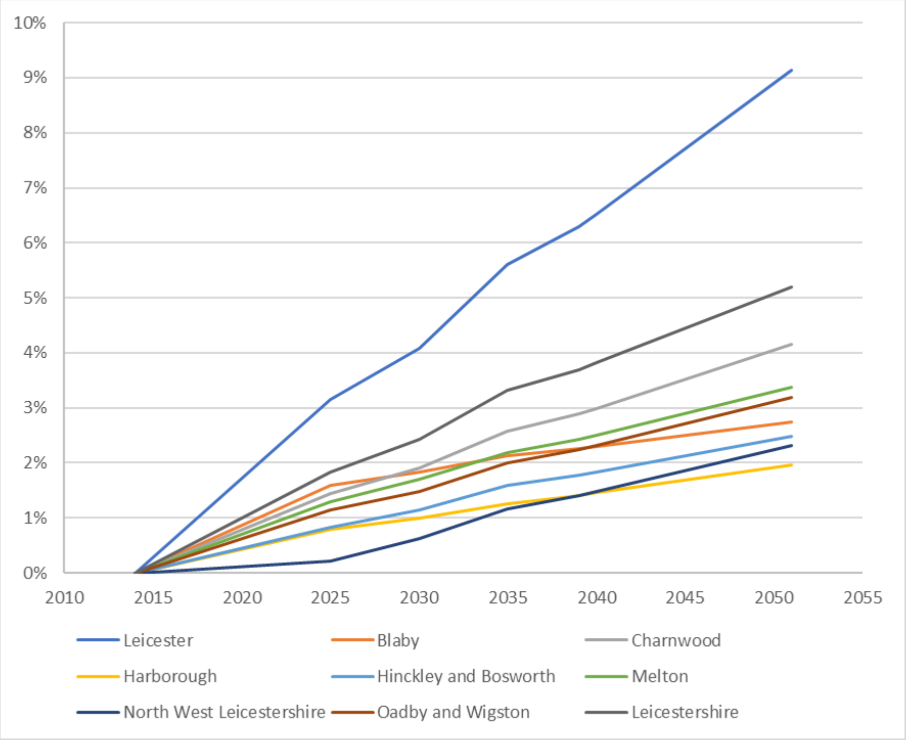


Figure 4-9: Forecast Change in Car Availability by District from NTEM

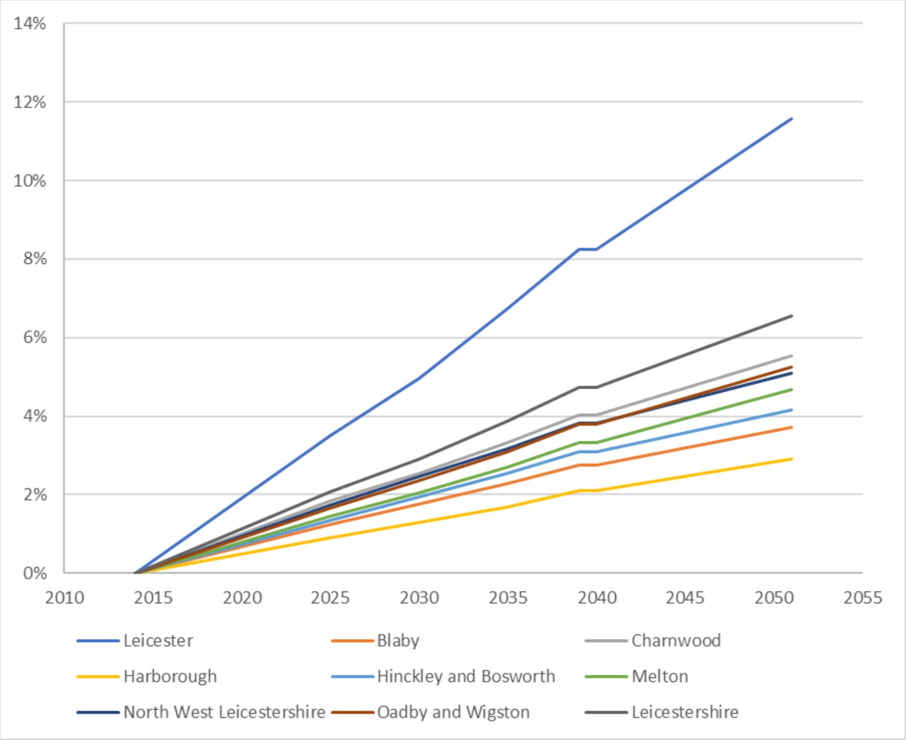


Table 4.8: Forecast Proportion of Households with Car Availability District

	2014	2025	2030	2035	2039	2040	2051
Leicester	73%	76%	77%	78%	79%	79%	82%
Charnwood	93%	95%	95%	95%	95%	95%	96%
Melton	88%	89%	90%	90%	91%	91%	92%
Harborough	93%	94%	94%	94%	95%	95%	95%
Oadby and Wigston	92%	92%	93%	93%	93%	93%	94%
Blaby	90%	92%	92%	93%	93%	93%	94%
Hinckley and Bosworth	91%	92%	92%	93%	93%	93%	94%
North West Leicestershire	90%	92%	92%	92%	93%	93%	94%
Leicestershire	**85%**	**87%**	**87%**	**88%**	**88%**	**89%**	**90%**

Table 4.9: Forecast Change in Car Availability Compared to NTEM 7.2

	2025		2030		2035		2039		2040		2051	
District	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**	**LLITM**	**NTEM**
Leicester	3%	3%	4%	5%	6%	7%	6%	8%	7%	8%	9%	12%
Blaby	2%	1%	2%	2%	2%	2%	2%	3%	2%	3%	3%	4%
Charnwood	1%	2%	2%	3%	3%	3%	3%	4%	3%	4%	4%	6%
Harborough	1%	1%	1%	1%	1%	2%	1%	2%	1%	2%	2%	3%
Hinckley and Bosworth	1%	1%	1%	2%	2%	3%	2%	3%	2%	3%	2%	4%
Melton	1%	1%	2%	2%	2%	3%	2%	3%	3%	3%	3%	5%
North West Leicestershire	0%	2%	1%	2%	1%	3%	1%	4%	1%	4%	2%	5%
Oadby and Wigston	1%	2%	1%	2%	2%	3%	2%	4%	2%	4%	3%	5%
Leicestershire	2%	2%	2%	3%	3%	4%	4%	5%	4%	5%	5%	7%

4.5 Demand Forecasts

Personal Demand Forecasts

4.5.1 The population, employment and car-ownership forecasts derived as described above are used by the trip-end model to produce the reference demand forecasts for an average weekday for each modelled year. The trip-end model calculates trip-ends for personal travel, constrained to NTEM 7.2 trip-end growth for Leicestershire.

4.5.2 Freight trip ends are calculated by applying TRICS trip rates to the employment data, except that for the SRFI and DIRFT developments which use externally derived demand estimates. Overall freight trip-ends are then controlled to RTF18 forecasts.

4.5.3 The planning forecasts are therefore one of the key drivers of demand change from the base year to future years, along with changes in values of time and travel costs (such as fuel costs, public transport fares and congestion). The assumptions for these variables are detailed in Table 3.2.

4.5.4 Figure 4-10 shows the forecast growth in 24-hour trip productions for personal demand across all modes by Leicestershire district. Figure 4-11 shows the equivalent trip production growth forecasts for highway demand only. The highway trip productions within Leicestershire are higher than the all-modes trip productions since there are forecasts of increases in car availability and a decline in public transport trip productions over time as shown in Figure 4-8 and Figure 4-13. Active mode trip production growth forecasts are shown in Figure 4-12, which shows that productions forecast within Leicestershire vary little over time.

4.5.5 The change in highway mode share is shown in Figure 4-14. For the outlying districts where car ownership is already high the increase is 2-4% between 2014 and 2051. For Leicester City where car availability is forecast to increase most (Figure 4-8) the increase is 6%. Figure 4-15 shows the mode share forecast through time for Melton Borough. There is very little change with a 2% increase in highway mode share which leads to a 1% decrease in active mode and PT mode share respectively. provides further detail of mode share in Melton Borough.

4.5.6 The constraint to NTEM trip end growth across Leicestershire is demonstrated for personal demand in Figure 4-16. There is a strong correlation with a gradient of 0.87 and R^2 of 1 compared to NTEM average weekday trip end growth. This equates to a maximum absolute difference of 2% which occurs in the in the 2051 model. The gradient below 1 is due to the constraint being applied to the trip-end model output which will have a different number of trips to NTEM. This variation between LLITM and NTEM is due to difference in the methodology used to apply growth to the base year demand to produce forecast year demand, and then additional constraints on growth by purpose and mode within the overall trip-end constraint process.

4.5.7 As stated before, in Section 4.3.3, the pattern of demand growth within Leicestershire by district will differ from NTEM due to the population growth assumptions being based on local planning data rather than NTEM forecasts.

Figure 4-10: Core Scenario Forecast Growth in 24-hour Trip Productions by District (All Modes Personal Demand)

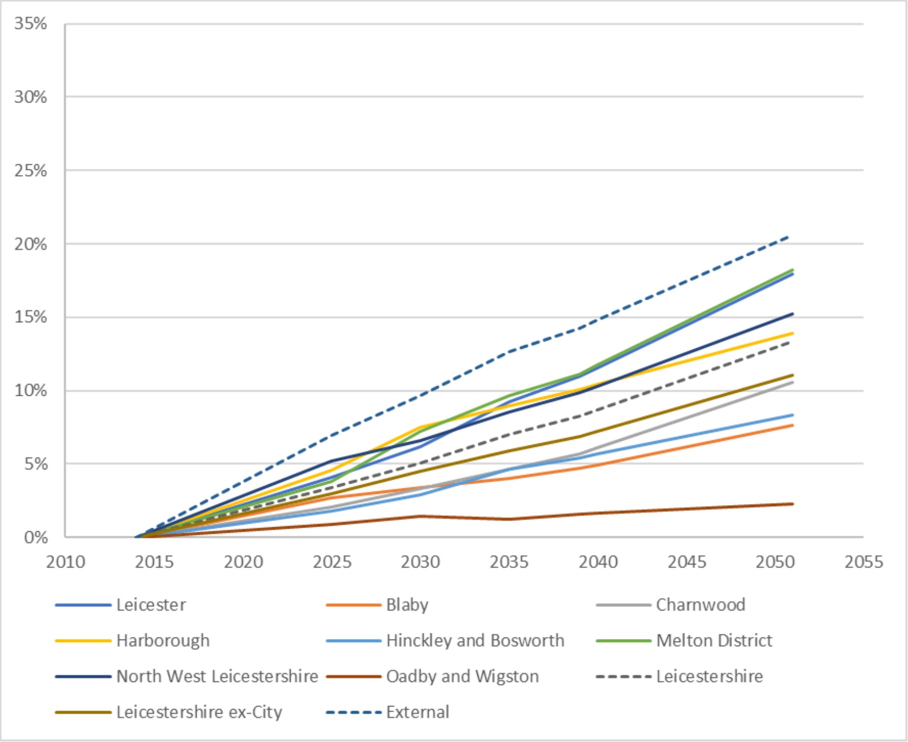


Figure 4-11: Core Scenario Forecast Growth in 24-hour Trip Productions by District (Highway Personal Demand)

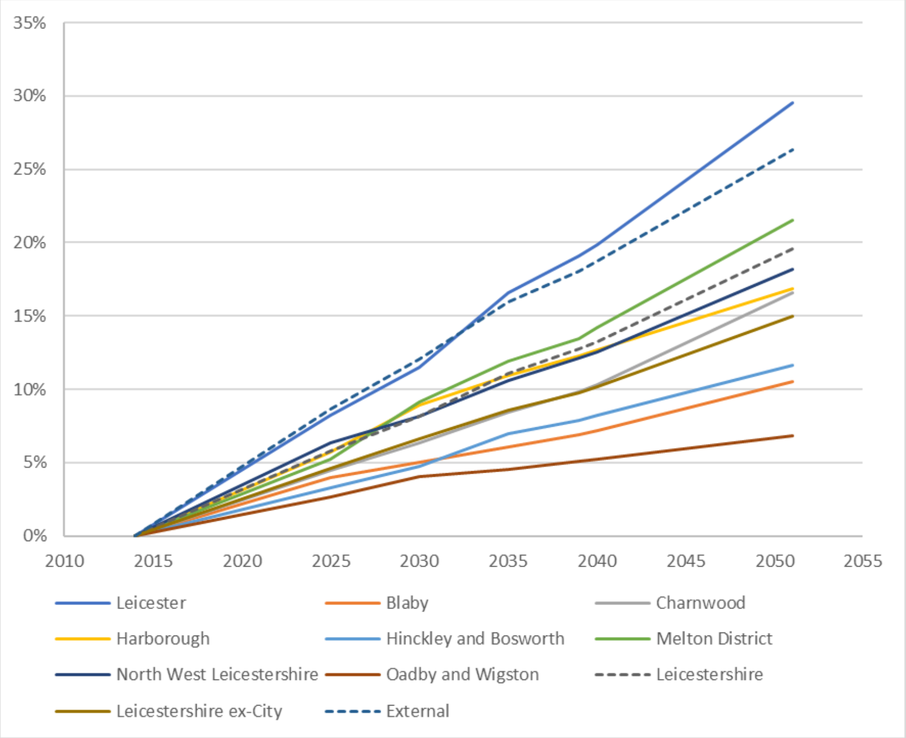


Figure 4-12: Core Scenario Forecast Growth in 24-hour Trip Productions by District (Active Modes Personal Demand)

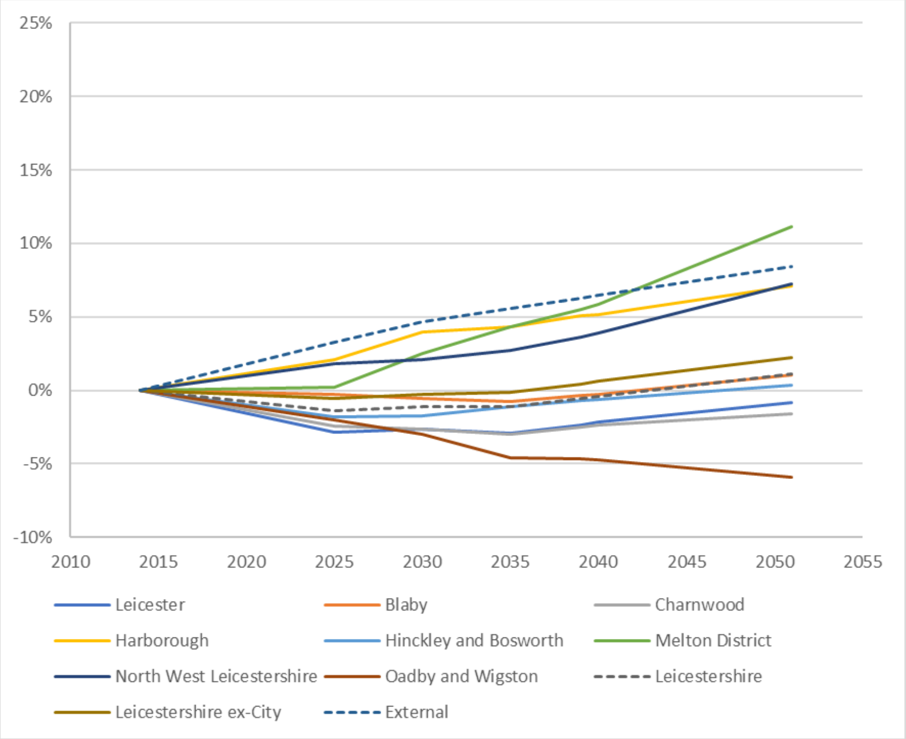


Figure 4-13: Core Scenario Forecast Growth in 24-hour Trip Productions by District (Public Transport Modes Personal Demand)

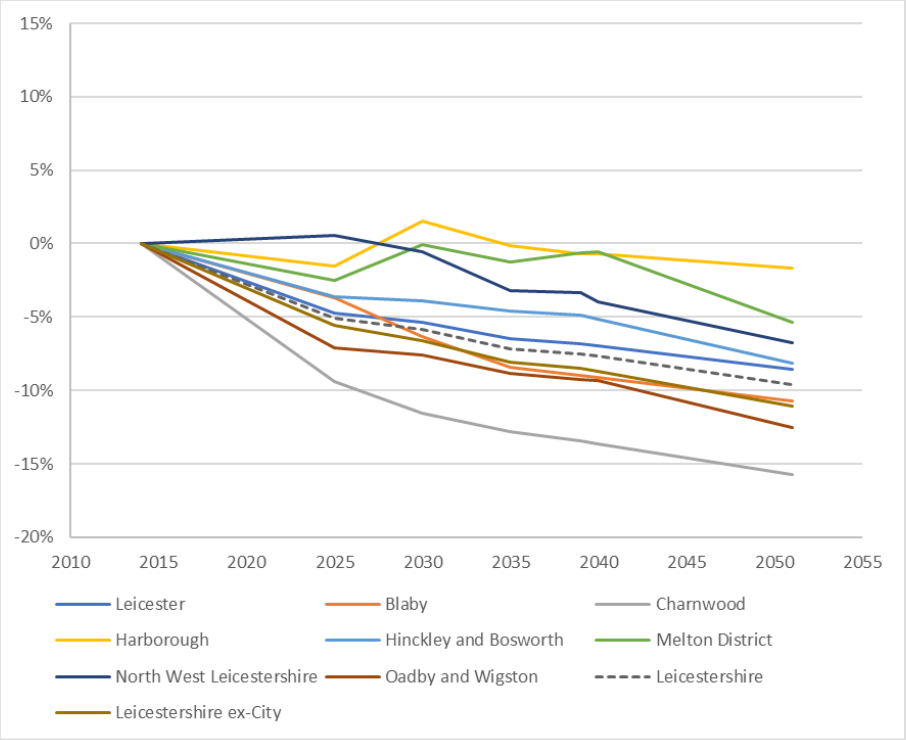


Figure 4-14: Forecast Highway Mode Share by District

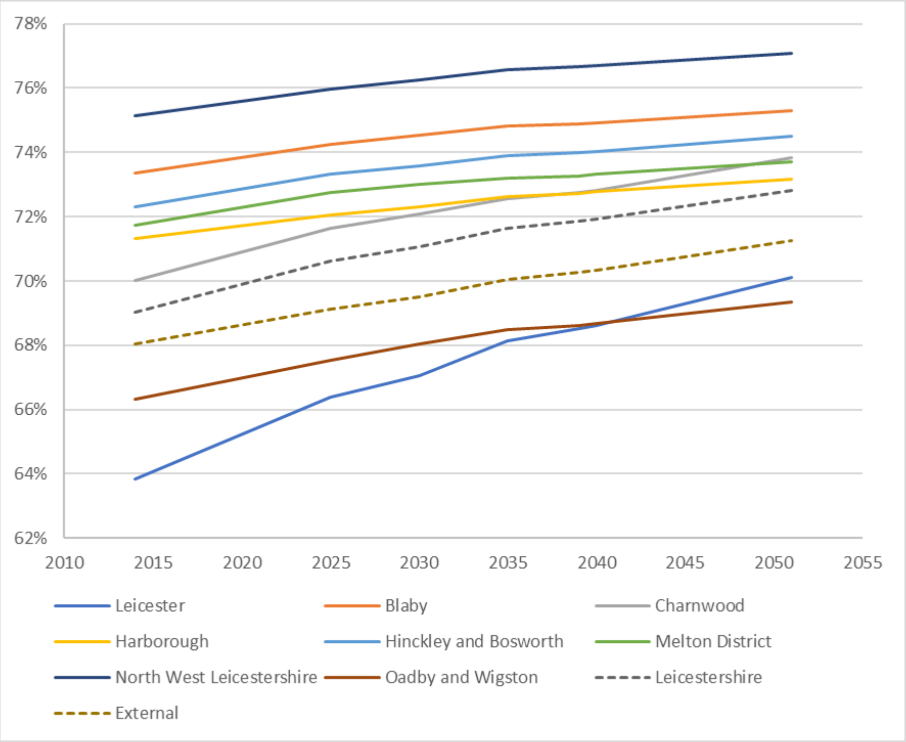


Figure 4-15: Melton Borough Mode Share Forecast

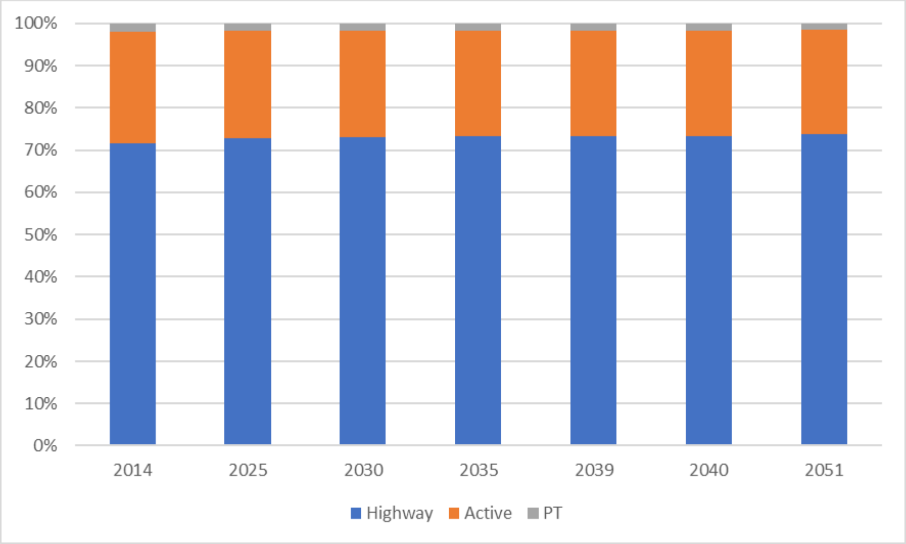
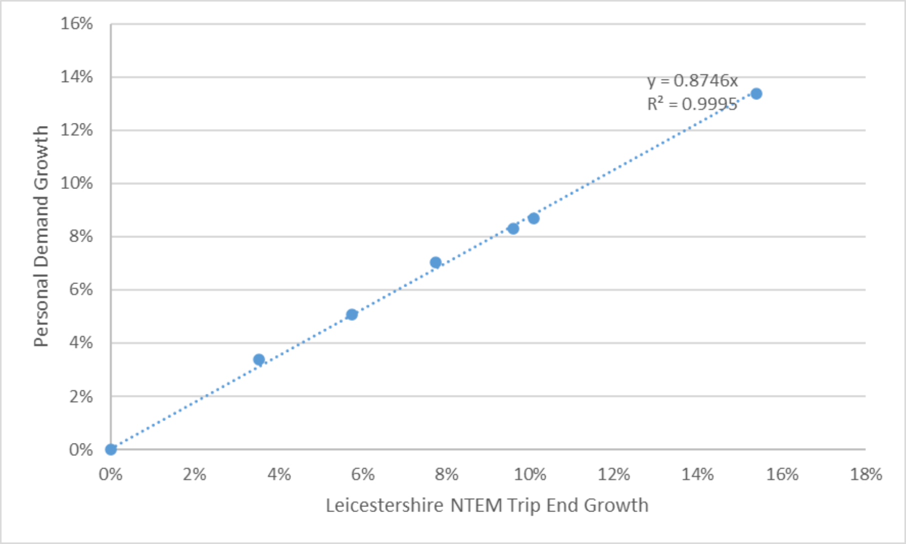


Figure 4-16: Personal Demand Growth Constraint to NTEM Trip End Growth



4.5.8 Table 4.10 shows additional detail of the demand forecasts by district for personal demand across all modes. Table 4.11 shows additional detail of the forecast demand growth by district for personal demand across all modes. Where appropriate, this is compared to NTEM 7.2 trip-end growth. Both Leicestershire and External growth are close to NTEM 7.2 forecasts.

4.5.9 Table 4.12 shows additional detail of the demand forecasts by district for personal highway demand. Table 4.13 shows additional detail of the forecast demand growth by district for personal highway demand. Where appropriate, this is compared to NTEM 7.2 trip-end growth. Both Leicestershire and External growth are close to NTEM 7.2 forecasts.

4.5.10 provides additional detail on the forecast 24-hour mode shares for trips produced within Melton Borough. This table shows that the mode share for highway trips is forecast to increase from 75% in 2014 to 77% in 2040, with the mode share for active mode trips forecast to reduce marginally from 19% in 2014 to 18% in 2040. The mode share for public transport trips (both bus and rail) is also not forecast to change significantly over time, staying at around 5% to 6% of trips produced within the district.

Table 4.10: Core Scenario Forecast in 24-hour Trip Productions (Personal Demand All Modes) from 2014 by District

	2014	2025	2030	2035	2039	2040	2051
Leicester	643,034	669,326	682,768	702,620	713,721	717,180	758,441
Blaby	174,661	179,421	180,554	181,695	182,911	183,327	188,008
Charnwood	334,059	341,096	345,069	349,529	353,038	354,427	369,363
Harborough	161,965	169,431	174,073	176,459	178,278	178,842	184,504
Hinckley and Bosworth	192,531	196,005	198,154	201,491	202,994	203,452	208,610
Melton District	97,122	100,793	104,113	106,518	107,904	108,502	114,843
North West Leicestershire	196,511	206,753	209,467	213,319	215,914	216,725	226,438
Oadby and Wigston	84,765	85,491	86,017	85,821	86,090	86,166	86,675
Leicestershire	**1,884,647**	**1,948,316**	**1,980,214**	**2,017,450**	**2,040,850**	**2,048,622**	**2,136,883**
External (‘000)	**98,596**	**105,412**	**108,145**	**111,071**	**112,667**	**113,200**	**118,903**

Table 4.11: Core Scenario Forecast Growth in 24-hour Trip Productions (Personal Demand All Modes) from 2014 by District

	2025	2030	2035	2039	2040	2051
Leicester	4%	6%	9%	11%	12%	18%
Blaby	3%	3%	4%	5%	5%	8%
Charnwood	2%	3%	5%	6%	6%	11%
Harborough	5%	7%	9%	10%	10%	14%
Hinckley and Bosworth	2%	3%	5%	5%	6%	8%
Melton District	4%	7%	10%	11%	12%	18%
North West Leicestershire	5%	7%	9%	10%	10%	15%
Oadby and Wigston	1%	1%	1%	2%	2%	2%
Leicestershire	**3%**	**5%**	**7%**	**8%**	**9%**	**13%**
Leicestershire (NTEM)	**4%**	**6%**	**8%**	**10%**	**10%**	**15%**
External	**7%**	**10%**	**13%**	**14%**	**15%**	**21%**
External (NTEM)	**5%**	**7%**	**9%**	**11%**	**12%**	**17%**

Table 4.12: Core Scenario Forecast in 24-hour Trip Productions (Personal Highway Demand) from 2014 by District

	2014	2025	2030	2035	2039	2040	2051
Leicester	410,518	444,376	457,826	478,735	488,992	492,157	531,856
Blaby	128,134	133,205	134,582	135,921	136,985	137,363	141,584
Charnwood	233,907	244,333	248,761	253,669	256,848	258,120	272,698
Harborough	115,506	122,104	125,851	128,131	129,644	130,167	135,010
Hinckley and Bosworth	139,181	143,709	145,804	148,865	150,191	150,604	155,417
Melton District	69,665	73,334	76,011	77,977	79,053	79,551	84,637
North West Leicestershire	147,679	157,065	159,702	163,348	165,549	166,249	174,539
Oadby and Wigston	56,230	57,736	58,523	58,775	59,079	59,168	60,094
Leicestershire	**1,300,821**	**1,375,860**	**1,407,060**	**1,445,420**	**1,466,342**	**1,473,380**	**1,555,834**
External (‘000)	**67,075**	**72,861**	**75,159**	**77,790**	**79,171**	**79,63**	**84,719**

Table 4.13: Core Scenario Forecast Growth in 24-hour Trip Productions (Personal Highway Demand) from 2014 by District

	2025	2030	2035	2039	2040	2051
Leicester	8%	12%	17%	19%	20%	30%
Blaby	4%	5%	6%	7%	7%	10%
Charnwood	4%	6%	8%	10%	10%	17%
Harborough	6%	9%	11%	12%	13%	17%
Hinckley and Bosworth	3%	5%	7%	8%	8%	12%
Melton District	5%	9%	12%	13%	14%	21%
North West Leicestershire	6%	8%	11%	12%	13%	18%
Oadby and Wigston	3%	4%	5%	5%	5%	7%
Leicestershire	**6%**	**8%**	**11%**	**13%**	**13%**	**20%**
Leicestershire (NTEM)	**6%**	**9%**	**12%**	**15%**	**15%**	**23%**
External	**9%**	**12%**	**16%**	**18%**	**19%**	**26%**
External (NTEM)	**7%**	**11%**	**14%**	**17%**	**17%**	**25%**

Table 4.14: Core Scenario Forecast 24-hour Mode Share within Melton Borough

	2014	2025	2030	2035	2039	2040	2051
Highway (excluding freight)	72%	73%	73%	73%	73%	73%	74%
Active Mode	26%	25%	25%	25%	25%	25%	25%
Public Transport	2%	2%	2%	2%	2%	2%	1%

Freight Demand Forecasts

4.5.11 For freight demand, the HGV and LGV productions are derived by applying a series of trip rate assumptions to the employment planning data. This is the local planning data in Leicestershire and NTEM 7.2 data in external areas. The variable demand model is not applied to freight demand, so the forecast demand represents the assignment demand. SRFI[8] and DIRFT[11] use externally modelled HGV demand distributions.

4.5.12 HGV and LGV productions are then dynamically controlled to RTF18 growth across the whole model. These relationships are illustrated in Figure 4-17 for internal Leicestershire productions and external productions. External productions for LGV and HGV follow slightly below the RTF18 forecasts since both the external area and RTF18 are based on NTEM employment growth and Leicestershire has above average growth.

4.5.13 Internal freight production growth is based on local employment planning data growth and externally modelled trip-ends for SRFI and DIRFT. The locally high growth in employment associated with distribution centres (warehousing and industry; Section 4.2.3) produces the significantly above RTF18 average HGV trip-end growth evident in Figure 4-17.

4.5.14 Table 4.15 and Table 4.16 contain further information on the freight demand and freight demand growth by district. For Melton Borough, base demand is at the low end of the range and the growth between 2014 and 2051 is greater than 50%, closer to the districts with large developments (Section 4.2.3).

Figure 4-17: RTF18 Constrained Freight Demand Forecasts

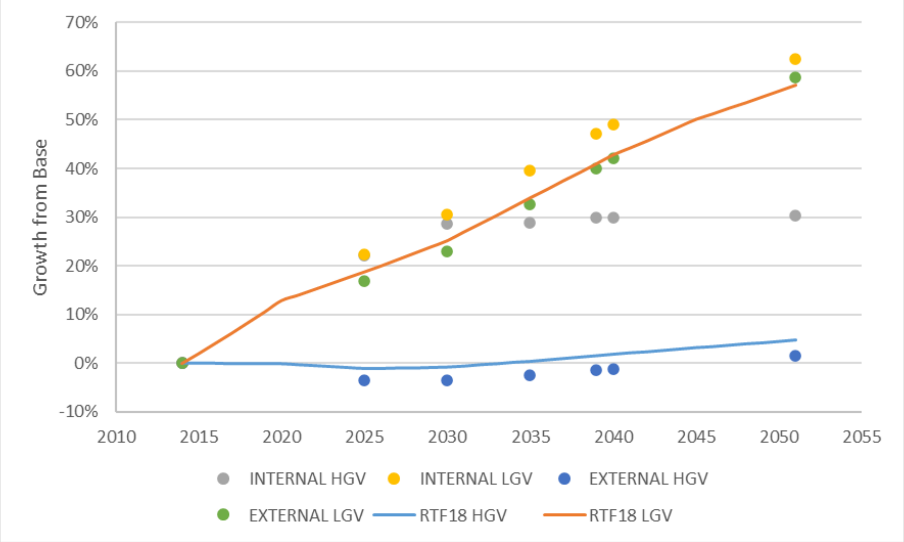


Table 4.15: Core Scenario Forecast in 24-hour Trip Productions (Freight Demand) from 2014 by District

	2014	2025	2030	2035	2039	2040	2051
Leicester	83,285	89,186	92,337	97,107	101,106	102,094	109,324
Blaby	35,043	39,923	41,923	44,026	45,823	46,266	49,502
Charnwood	52,853	60,371	63,270	66,145	68,662	69,279	73,757
Harborough	30,606	40,025	45,307	47,375	49,005	49,401	52,234
Hinckley and Bosworth	34,929	42,565	44,906	47,568	49,376	49,820	53,037
Melton District	14,573	17,505	18,600	19,524	20,314	20,509	21,935
North West Leicestershire	47,643	62,691	65,094	67,698	70,007	70,568	74,605
Oadby and Wigston	14,192	16,628	17,136	17,974	18,696	18,874	20,175
Leicestershire	**313,124**	**368,894**	**388,574**	**407,417**	**422,989**	**426,812**	**454,570**
External (‘000)	**89,415**	**98,414**	**101,885**	**106,429**	**109,310**	**110,166**	**118,600**

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[11] https://prologis.co.uk/our-parks/prologis-rfi-dirft/?gclid=EAIaIQobChMIws6e1aaU-gIVToFQBh2QtwbtEAAYASAAEgIkxfD_BwE

Table 4.16: Core Scenario Forecast Growth in 24-hour Trip Productions (Freight Demand) from 2014 by District

	2025	2030	2035	2039	2040	2051
Leicester	7%	11%	17%	21%	23%	31%
Blaby	14%	20%	26%	31%	32%	41%
Charnwood	14%	20%	25%	30%	31%	40%
Harborough	31%	48%	55%	60%	61%	71%
Hinckley and Bosworth	22%	29%	36%	41%	43%	52%
Melton District	20%	28%	34%	39%	41%	51%
North West Leicestershire	32%	37%	42%	47%	48%	57%
Oadby and Wigston	17%	21%	27%	32%	33%	42%
Leicestershire	**18%**	**24%**	**30%**	**35%**	**36%**	**45%**
External	**10%**	**14%**	**19%**	**22%**	**23%**	**33%**
RTF18 HGV	**-1%**	**-1%**	**0%**	**2%**	**2%**	**5%**
RTF18 LGV	**19%**	**25%**	**34%**	**41%**	**43%**	**57%**

4.6 Demand Model Convergence

4.6.1 The variable demand model iterates between the assignment models (highway and public transport) and the demand choice calculations, and a measure of convergence based on the change in forecast demand between two iterations is calculated in line with TAG. This approach is detailed in *'NEMMDR FBC - Demand Model Development Report'*.

4.6.2 The target convergence level for a $\%Gap$ of 0.075% has been adopted within LLITM 2014 Base for the NEMMDR FBC forecasts, exceeding TAG requirements[12], and Table 4.17 details the demand model convergence by iteration for the 2025, 2030, 2040 and 2051 Core Scenario model runs.

4.6.3 Table 4.17 shows that in all forecast years the target $\%Gap$ value is reached, with the number of iterations required to attain this target generally increasing in later forecast years. The convergence of the demand model by iteration in the Core Scenario is also shown in Figure 4-18.

Table 4.17: Core Scenario Demand Model Convergence

Iteration	2025	2030	2040	2051
2	1.09	1.37	2.10	2.48
3	0.50	0.59	1.00	1.29
4	0.33	0.39	0.62	0.86
5	0.14	0.14	0.21	0.31
6	0.08	0.07	0.08	0.12
7	0.07		0.10	0.10
8			0.07	0.09
9				0.08
10				0.07

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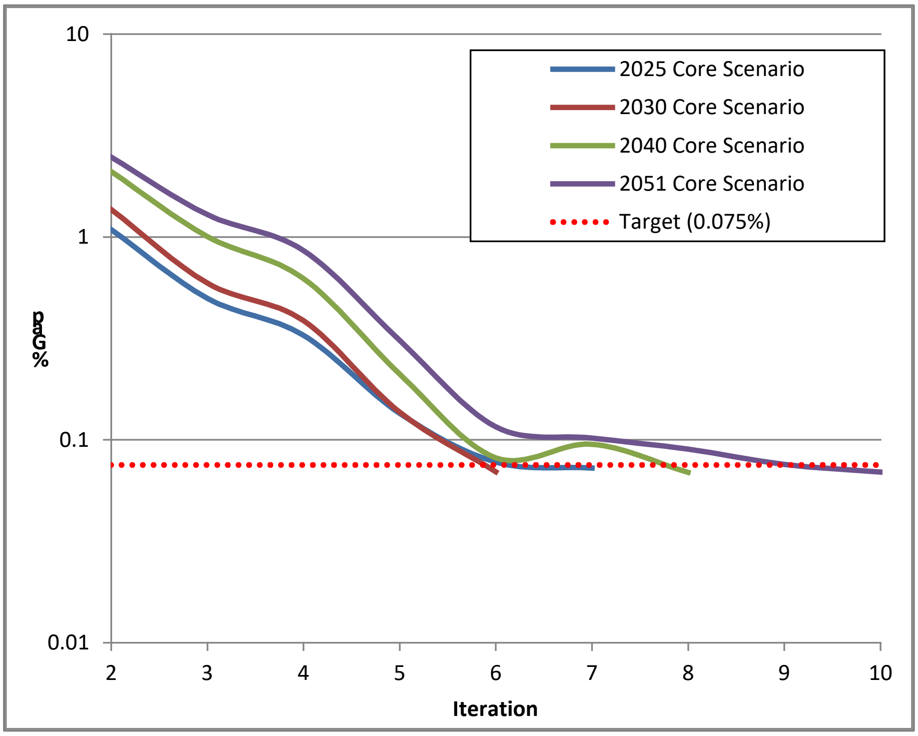
[12] TAG Unit M2 §6.3.8 states that a $\%Gap$ value of 0.1% can be achieved in many cases, but that remedial action is only required if the $\%Gap$ value is not below 0.2%.

Figure 4-18: Core Scenario Demand Model Convergence



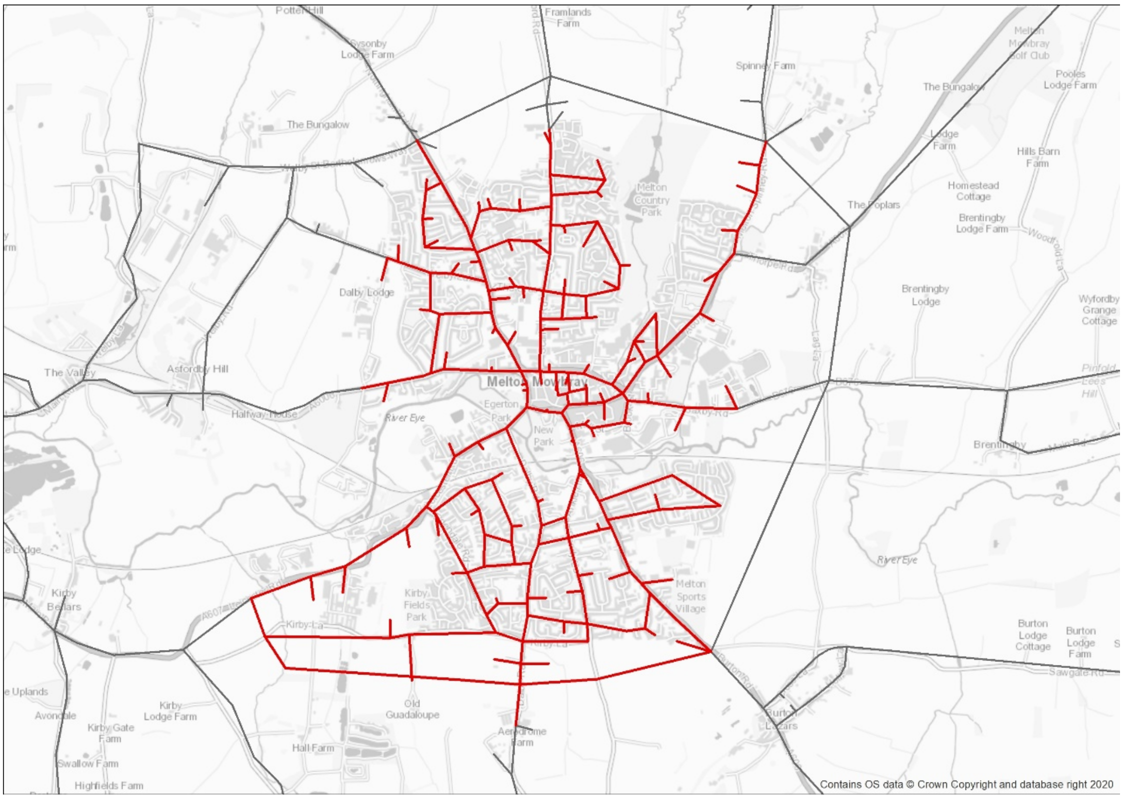
4.7 Highway Assignment Forecasts

4.7.1 Taking the demand forecasts from the demand model, the forecast highway demand is assigned on the highway network. This network is the validated base year network with the addition of the defined highway schemes (detailed in

4.7.2 Table 3.3) based on the given forecast year. This section details some of the forecasts produced by the assignment of the forecast demand on the highway network.

4.7.3 The first set of forecasts from the highway model is a series of network performance indicators. These provide forecasts of the amount of traffic on the network (measured in vehicle distance), the delay on the network (measured both in terms of vehicle delay and delay per kilometre), and the average speed on the network. For this analysis, the links within Melton Borough and Melton Mowbray have been identified. The links selected as being within Melton Mowbray are shown in Figure 4-19, and includes links within the urban area, excluding the proposed distributor road.

Figure 4-19: Links Selected as being within Melton Mowbray



4.7.4 Table 4.18 provides more detail on the network performance forecasts for Melton Borough in the three modelled hours, with Table 4.19 showing the change in these indicators compared with the 2014 base year. Considering the change between 2014 and 2040, traffic on the Melton Borough network is forecast to increase by 37% in the AM Peak hour, 49% in the interpeak hour, and 39% in the PM Peak hour. This increase in traffic on the network results in a forecast reduction in average speeds within Melton Borough of 2% in the AM Peak and 2% in the PM Peak (the Interpeak sees a negligible change).

4.7.5 Table 4.20 and Table 4.21 show the same analysis, but for links identified as being within Melton Mowbray rather than Melton Borough. This analysis shows that traffic within Melton Mowbray is forecast to increase by 17% in the AM Peak, 27% in the interpeak and 18% in the PM Peak between 2014 and 2040. As a result of the additional traffic, average network speeds are forecast to decrease from 2014 to 2040 by between 1% and 2%. A larger reduction in average speeds is seen when comparing 2014 with 2030 as most of the Southern Link Road and the Northern Link Road, which provide congestion relief, do not exist in 2030.

4.7.6 Figure 4-20 shows the forecast change in the network performance indicators over time for both Melton Borough and Melton Mowbray in the AM Peak and PM Peak hours. This figure shows that within both the district and the urban area, and within both peak hours, there is forecast to be an increase in the traffic on the network (measured in vehicle distance) over time.

4.7.7 In terms of delay at the Melton Borough level (both in terms of vehicle delay and delay per kilometre), there is a general upward trend in both time periods, however, the rate of increase reduces beyond 2030. The smaller growth in delays beyond 2030 reflects the additional capacity generated by the Southern Link Road (completed in phases from 2030 to 2040) and the Northern Link Road completed in 2040,. At the Melton Mowbray level, delay per kilometre rises most sharply between 2025 and 2030, beyond which the build out of the Southern Link Road and Northern Link Road have a decongesting effect and there is a consequent increase in average speed.

Table 4.18: Core Scenario Forecast Network Performance within Melton Borough

		2014	2025	2030	2040	2051
AM Peak	Vehicle Distance (veh-km)	112,382	129,354	139,815	154,452	163,005
	Vehicle Delay-Time (veh-hours)	266	314	381	430	461
	Average Speed (kph)	56.3	55.9	55.0	55.3	55.2
	Vehicle Delay/Vehicle Distance (min/km)	0.14	0.15	0.16	0.17	0.17
Interpeak	Vehicle Distance (veh-km)	76,361	91,433	100,484	113,955	121,308
	Vehicle Delay-Time (veh-hours)	169	209	246	274	291
	Average Speed (kph)	55.9	55.7	55.2	56.0	56.2
	Vehicle Delay/Vehicle Distance (min/km)	0.13	0.14	0.15	0.14	0.14
PM Peak	Vehicle Distance (veh-km)	116,378	133,674	144,756	162,212	173,383
	Vehicle Delay-Time (veh-hours)	306	364	425	478	509
	Average Speed (kph)	55.5	55.0	54.3	54.8	54.9
	Vehicle Delay/Vehicle Distance (min/km)	0.16	0.16	0.18	0.18	0.18

Table 4.19: Core Scenario Forecast Change from 2014 in Network Performance within Melton Borough

		2025	2030	2040	2051
AM Peak	Vehicle Distance (veh-km)	15%	24%	37%	45%
	Vehicle Delay-Time (veh-hours)	18%	43%	62%	73%
	Average Speed (kph)	-1%	-2%	-2%	-2%
	Vehicle Delay/Vehicle Distance (min/km)	7%	14%	21%	21%
Interpeak	Vehicle Distance (veh-km)	20%	32%	49%	59%
	Vehicle Delay-Time (veh-hours)	24%	46%	62%	72%
	Average Speed (kph)	0%	-1%	0%	1%
	Vehicle Delay/Vehicle Distance (min/km)	8%	15%	8%	8%
PM Peak	Vehicle Distance (veh-km)	15%	24%	39%	49%
	Vehicle Delay-Time (veh-hours)	19%	39%	56%	66%
	Average Speed (kph)	-1%	-2%	-1%	-1%
	Vehicle Delay/Vehicle Distance (min/km)	0%	13%	13%	13%

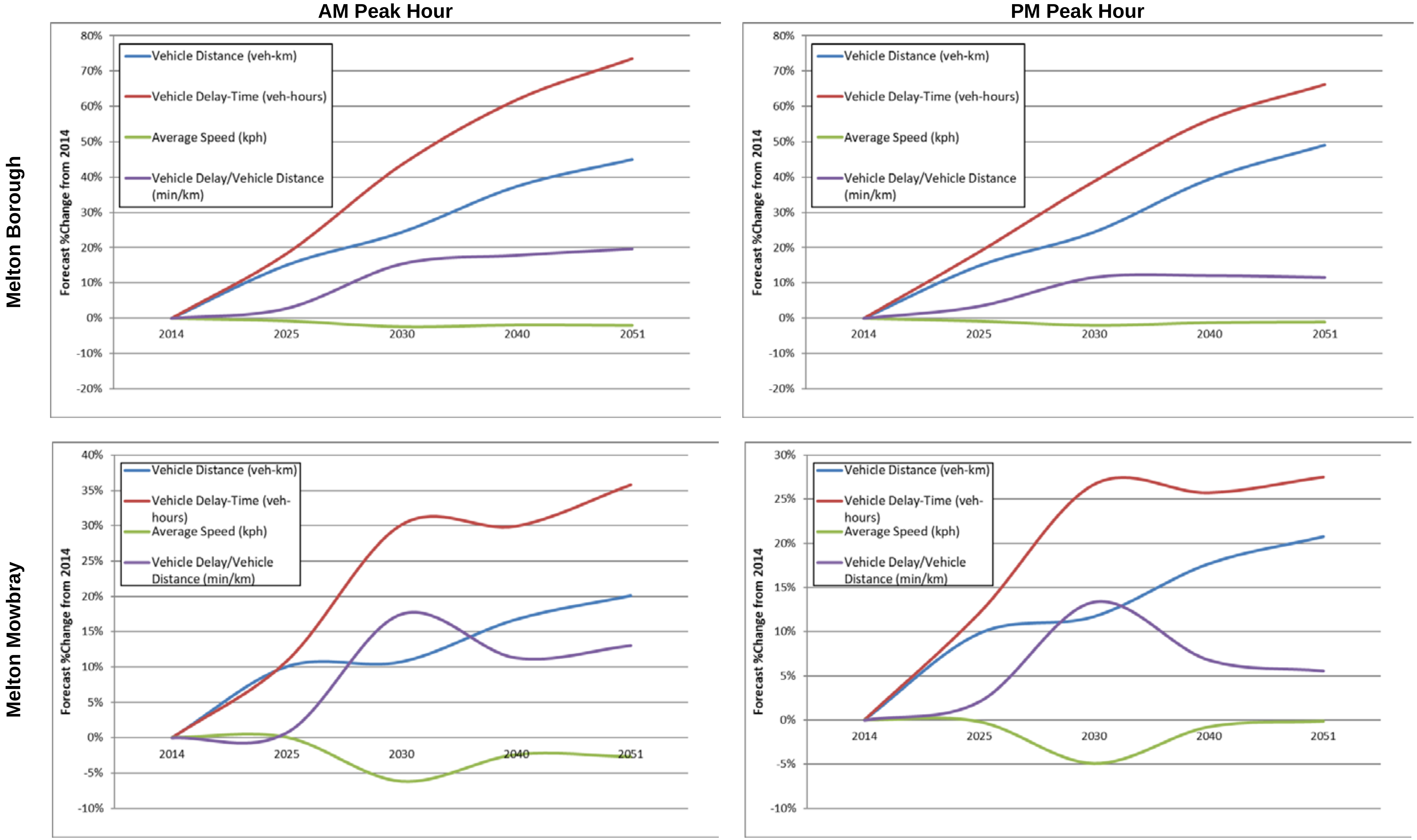
Table 4.20: Core Scenario Forecast Network Performance within Melton Mowbray

		2014	2025	2030	2040	2051
AM Peak	Vehicle Distance (veh-km)	20,119	22,141	22,277	23,482	24,156
	Vehicle Delay-Time (veh-hours)	192	212	249	249	260
	Average Speed (kph)	30.9	30.9	29.0	30.2	30.1
	Vehicle Delay/Vehicle Distance (min/km)	0.57	0.58	0.67	0.64	0.65
Interpeak	Vehicle Distance (veh-km)	15,121	17,283	18,055	19,234	19,629
	Vehicle Delay-Time (veh-hours)	131	156	178	182	187
	Average Speed (kph)	31.4	31.3	30.1	31.1	31.1
	Vehicle Delay/Vehicle Distance (min/km)	0.52	0.54	0.59	0.57	0.57
PM Peak	Vehicle Distance (veh-km)	21,002	23,059	23,461	24,717	25,363
	Vehicle Delay-Time (veh-hours)	224	251	284	282	286
	Average Speed (kph)	29.6	29.6	28.2	29.4	29.6
	Vehicle Delay/Vehicle Distance (min/km)	0.64	0.65	0.73	0.68	0.68

Table 4.21: Core Scenario Forecast Change from 2014 in Network Performance within Melton Mowbray

		2025	2030	2040	2051
AM Peak Hour	Vehicle Distance (veh-km)	10%	11%	17%	20%
	Vehicle Delay-Time (veh-hours)	11%	30%	30%	36%
	Average Speed (kph)	0%	-6%	-2%	-3%
	Vehicle Delay/Vehicle Distance (min/km)	1%	17%	11%	13%
Interpeak Hour	Vehicle Distance (veh-km)	14%	19%	27%	30%
	Vehicle Delay-Time (veh-hours)	18%	35%	38%	42%
	Average Speed (kph)	0%	-4%	-1%	-1%
	Vehicle Delay/Vehicle Distance (min/km)	4%	13%	9%	10%
PM Peak Hour	Vehicle Distance (veh-km)	10%	12%	18%	21%
	Vehicle Delay-Time (veh-hours)	12%	27%	26%	28%
	Average Speed (kph)	0%	-5%	-1%	0%
	Vehicle Delay/Vehicle Distance (min/km)	2%	13%	7%	6%

Figure 4-20: Core Scenario Forecast Change in Network Performance within Melton Borough and Melton Mowbray within AM Peak and PM Peak Hours



4.7.8 In addition to the network performance forecasts, Figure 4-21 to Figure 4-24 show the forecast traffic volumes within Melton Mowbray in the 2014 base year and 2040 forecast year for the AM Peak and PM Peak hours. The corresponding plots for 2014, 2025, 2030, 2040 and 2051 for all three modelled time periods are given in Appendix B.

4.7.9 These plots show that there are forecast to be more links within the higher flow categories (shown in orange and red) in 2040 than in 2014 within the two peak hours. These higher forecast flows are generally located within the town centre, and along parts of the town’s radial routes

4.7.10 In addition to the forecast vehicle flows, Figure 4-25 to Figure 4-28 show the forecast volume-capacity ratios on the network in the 2014 base year and 2040 forecast year for the AM Peak and PM Peak hours. The corresponding forecasts for other forecast years and time periods can be found in Appendix C.

4.7.11 As with the forecast flow plots, the analysis of volume-capacity ratios shows that there are forecast to be more locations within Melton Mowbray town centre, in particular on approaches to the inner ring road, which are in the higher categories of volume-capacity ratio (i.e. where flows are at 80% or more of capacity).

4.7.12 In addition to the forecast flows and volume-capacity ratios, Figure 4-29 to Figure 4-32 show the forecast average junction delays within Melton Mowbray in the 2014 base year and 2040 forecast year for the AM Peak and PM Peak hours. The corresponding figures for other modelled years and time periods can be found in Appendix D.

4.7.13 The forecast delay plots show the locations of the significant delays within Melton Mowbray, generally around the inner ring road, in the two peak hours. These plots, along with those contained within Appendix D, show that there are no locations within Melton Mowbray where the forecast junction delay increases significantly and beyond plausible levels.

4.7.14 As discussed with the network performance forecasts, the introduction of the Southern Link Road between the A607 Leicester Road and the A606 Burton Road provides additional capacity to the network which is forecast to increase average speeds within Melton Mowbray. In addition to this, the introduction of this link road affects the forecast routeing of traffic through Melton Mowbray.

Figure 4-21: Core Scenario Forecast Highway Vehicle Flows – 2014 AM Peak

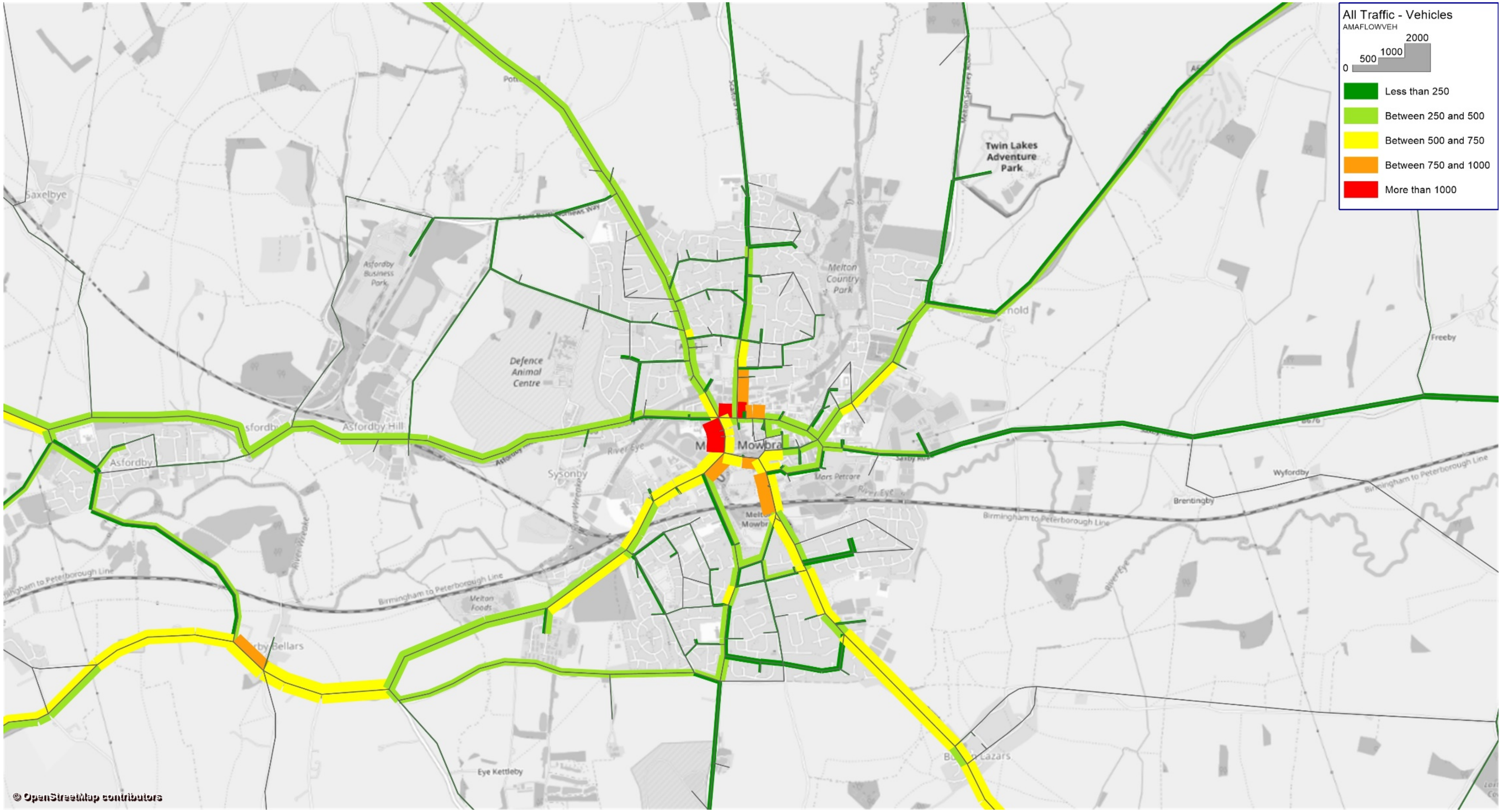


Figure 4-22: Core Scenario Forecast Highway Vehicle Flows – 2040 AM Peak

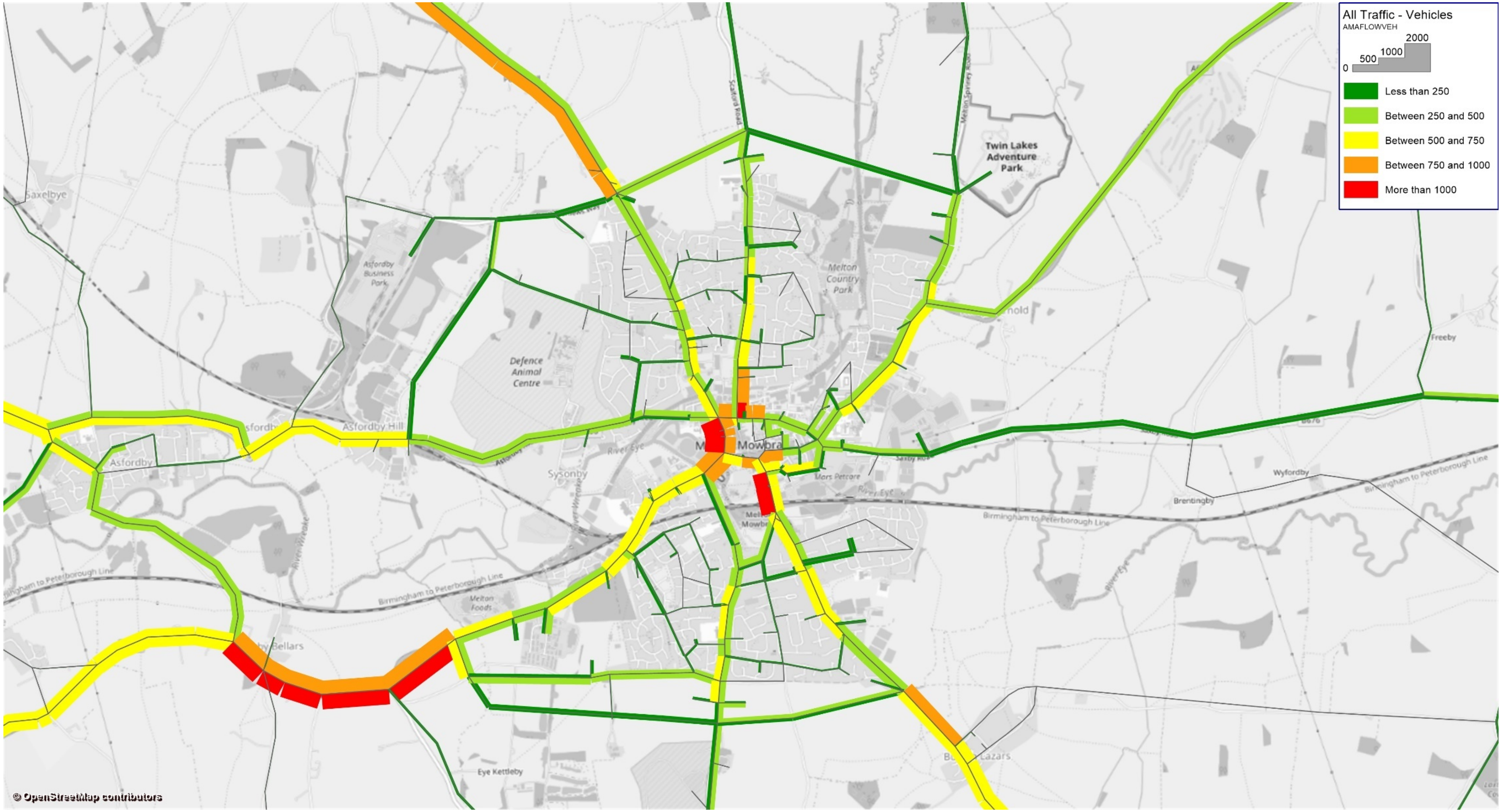


Figure 4-23: Core Scenario Forecast Highway Vehicle Flows – 2014 PM Peak

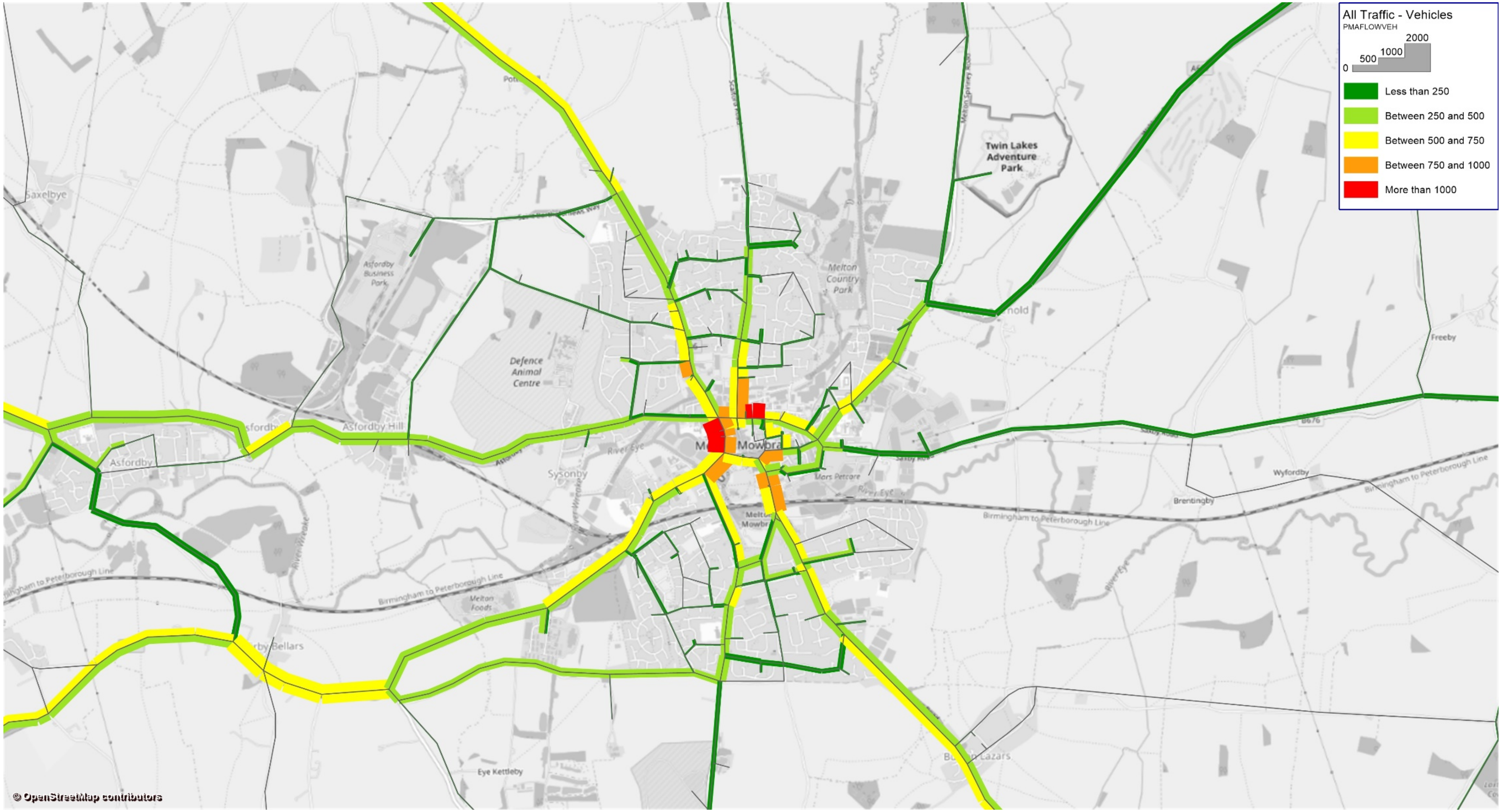


Figure 4-24: Core Scenario Forecast Highway Vehicle Flows – 2040 PM Peak

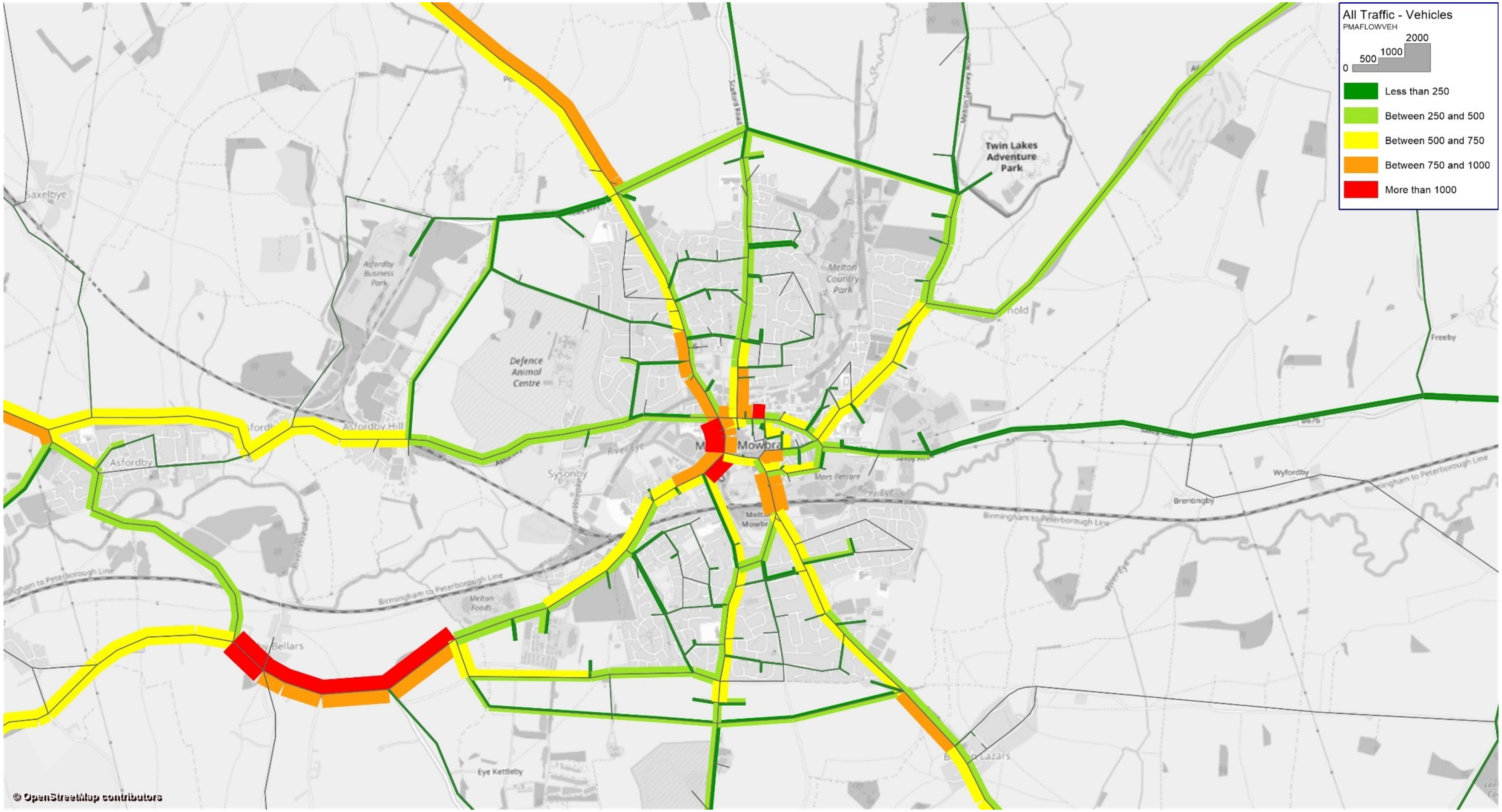


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Figure 4-25: Core Scenario Forecast Highway Volume-Capacity Ratio – 2014 AM Peak

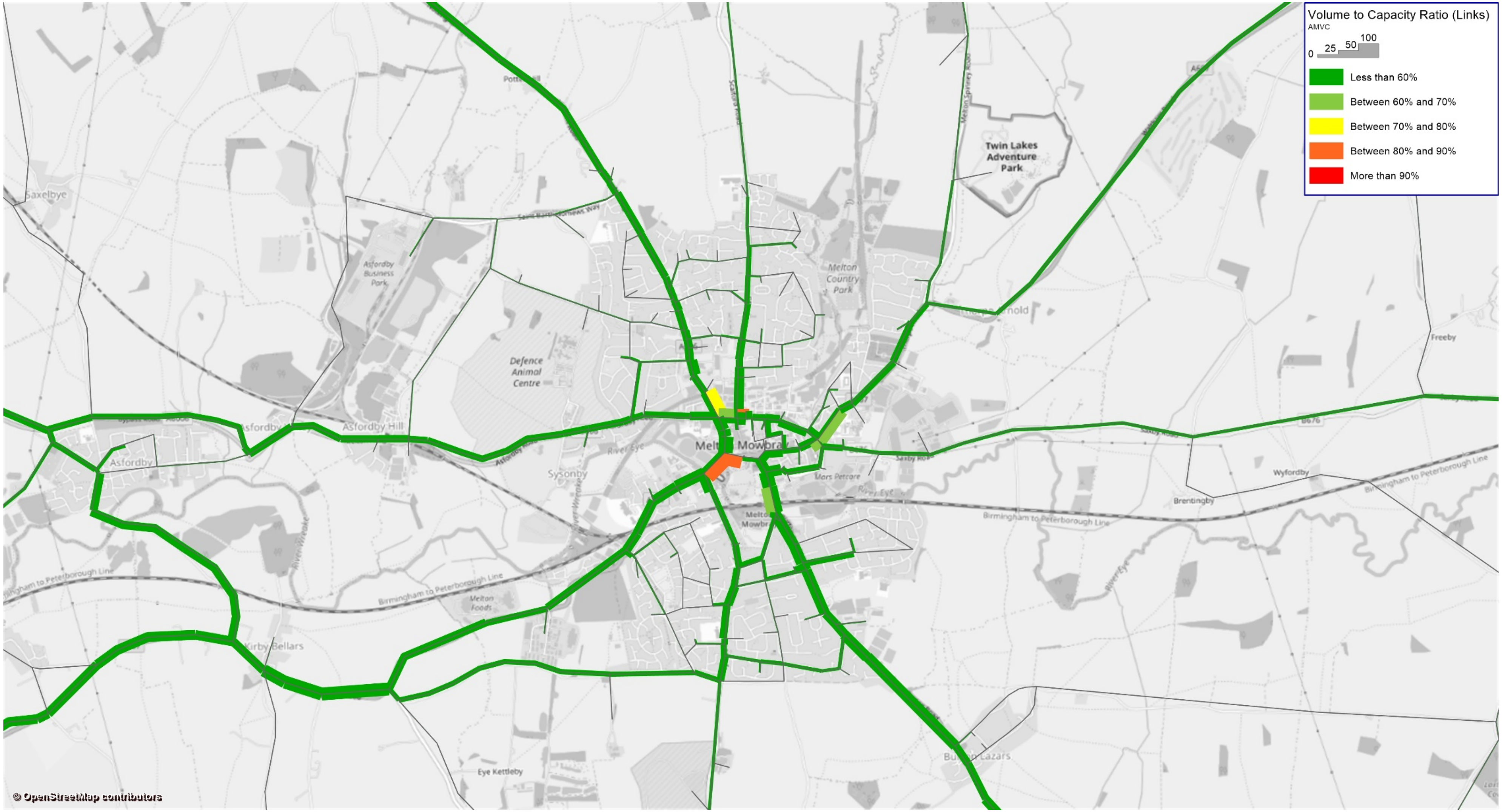


Figure 4-26: Core Scenario Forecast Highway Volume-Capacity Ratio – 2040 AM Peak

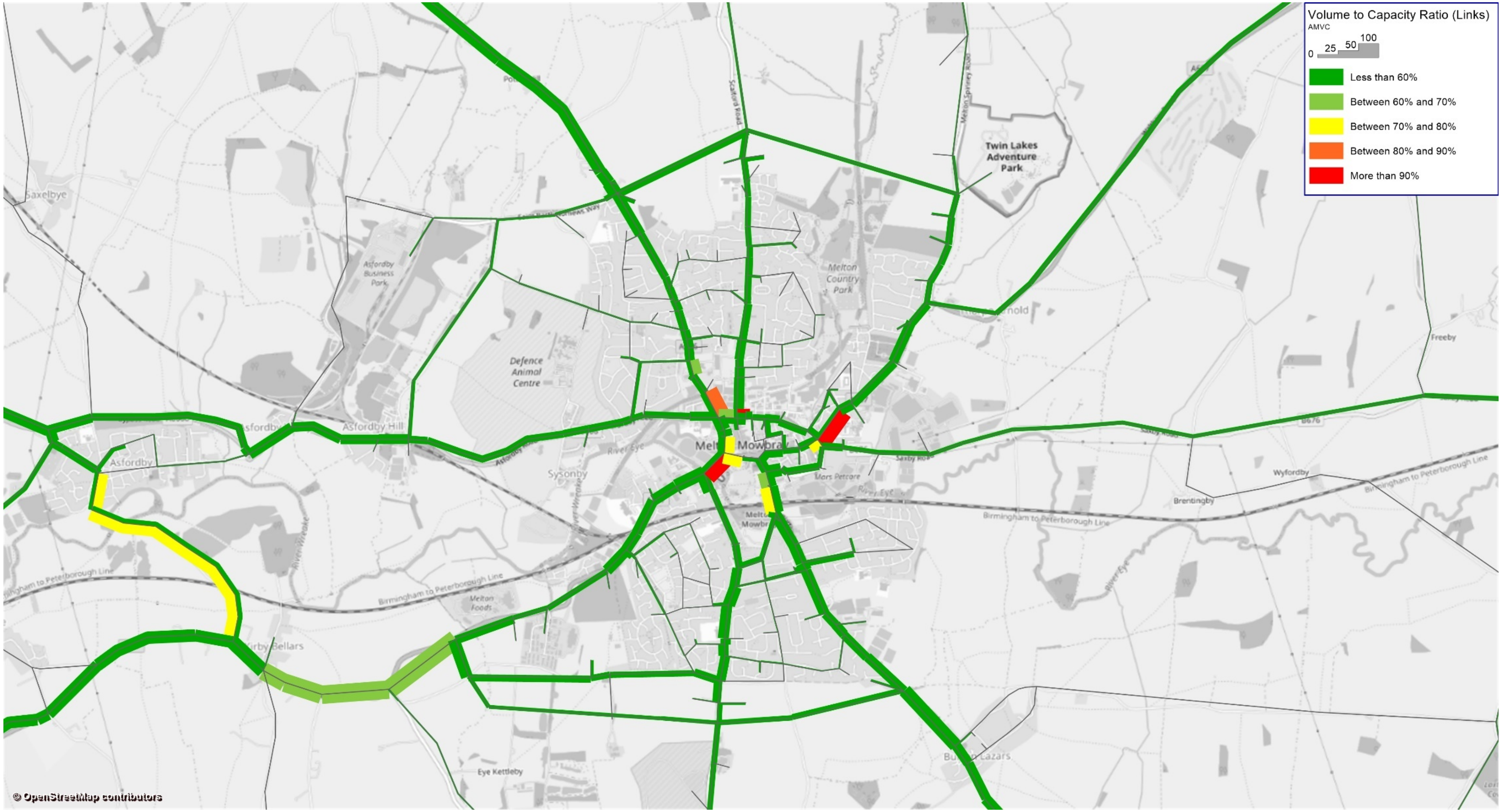


Figure 4-27: Core Scenario Forecast Highway Volume-Capacity Ratio – 2014 PM Peak

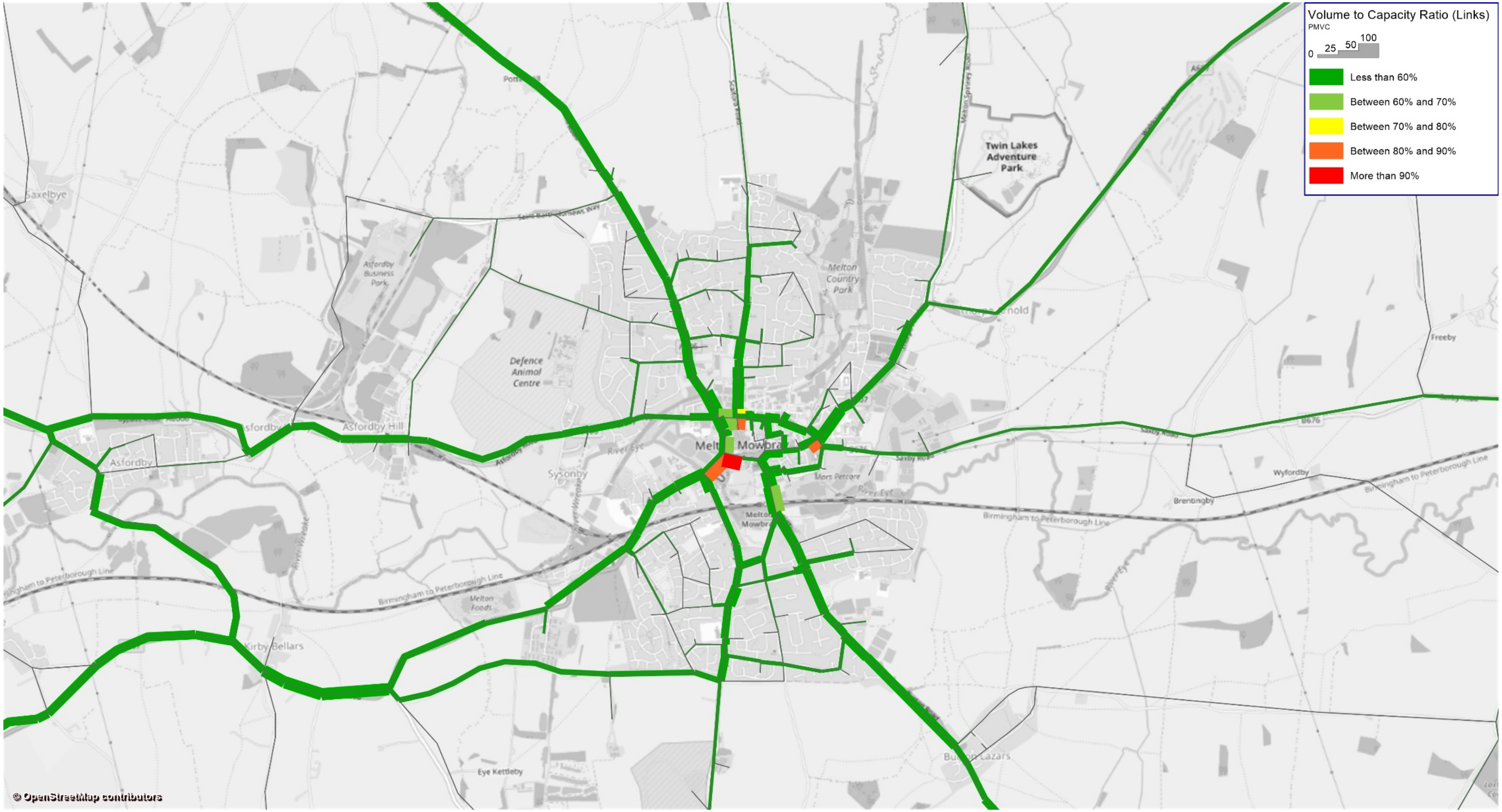


Figure 4-28: Core Scenario Forecast Highway Volume-Capacity Ratio – 2040 PM Peak

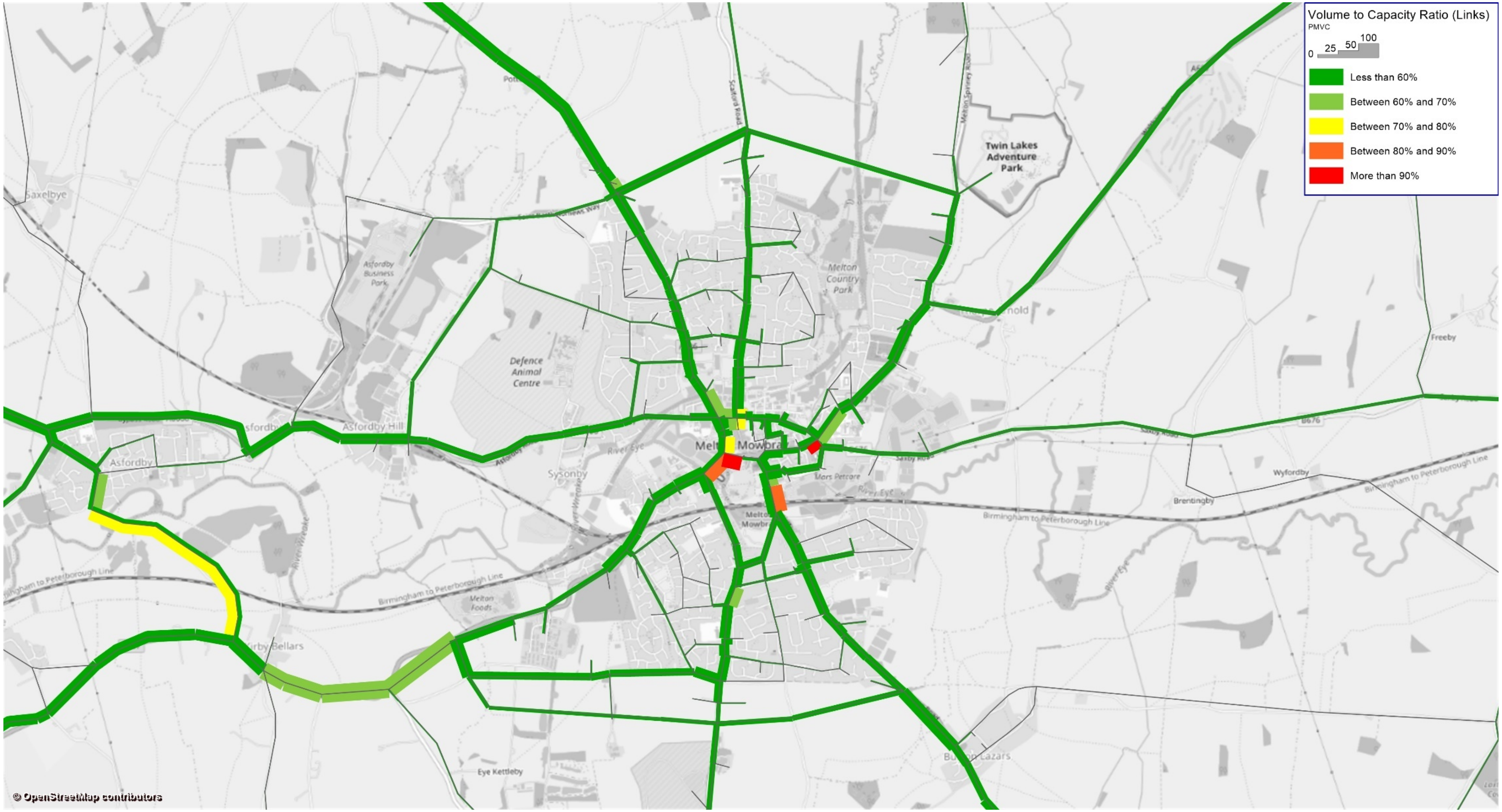


Figure 4-29: Core Scenario Forecast Highway Junction Delay – 2014 AM Peak

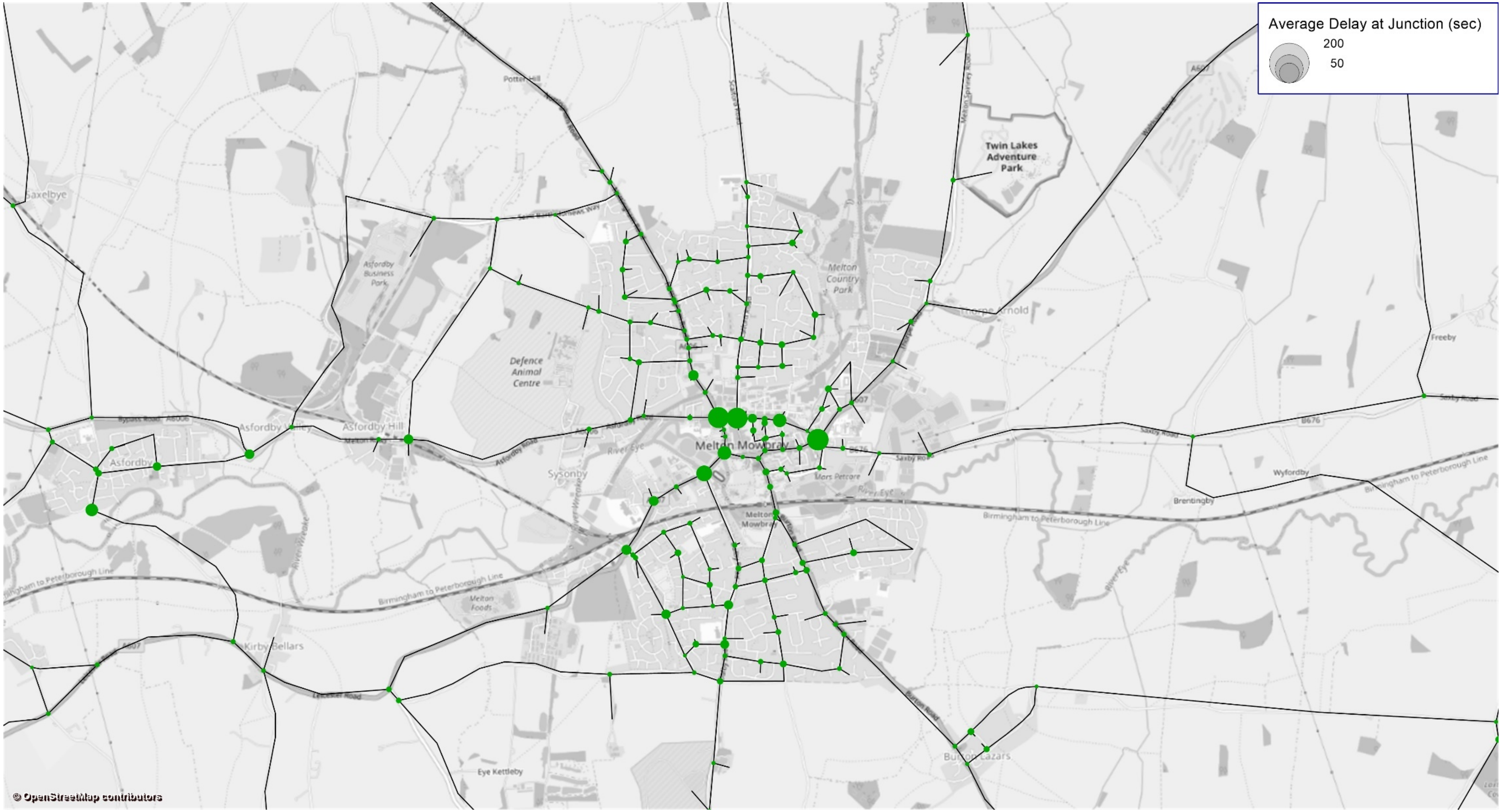


Figure 4-30: Core Scenario Forecast Highway Junction Delay – 2040 AM Peak

Figure 4-31: Core Scenario Forecast Highway Junction Delay – 2014 PM Peak

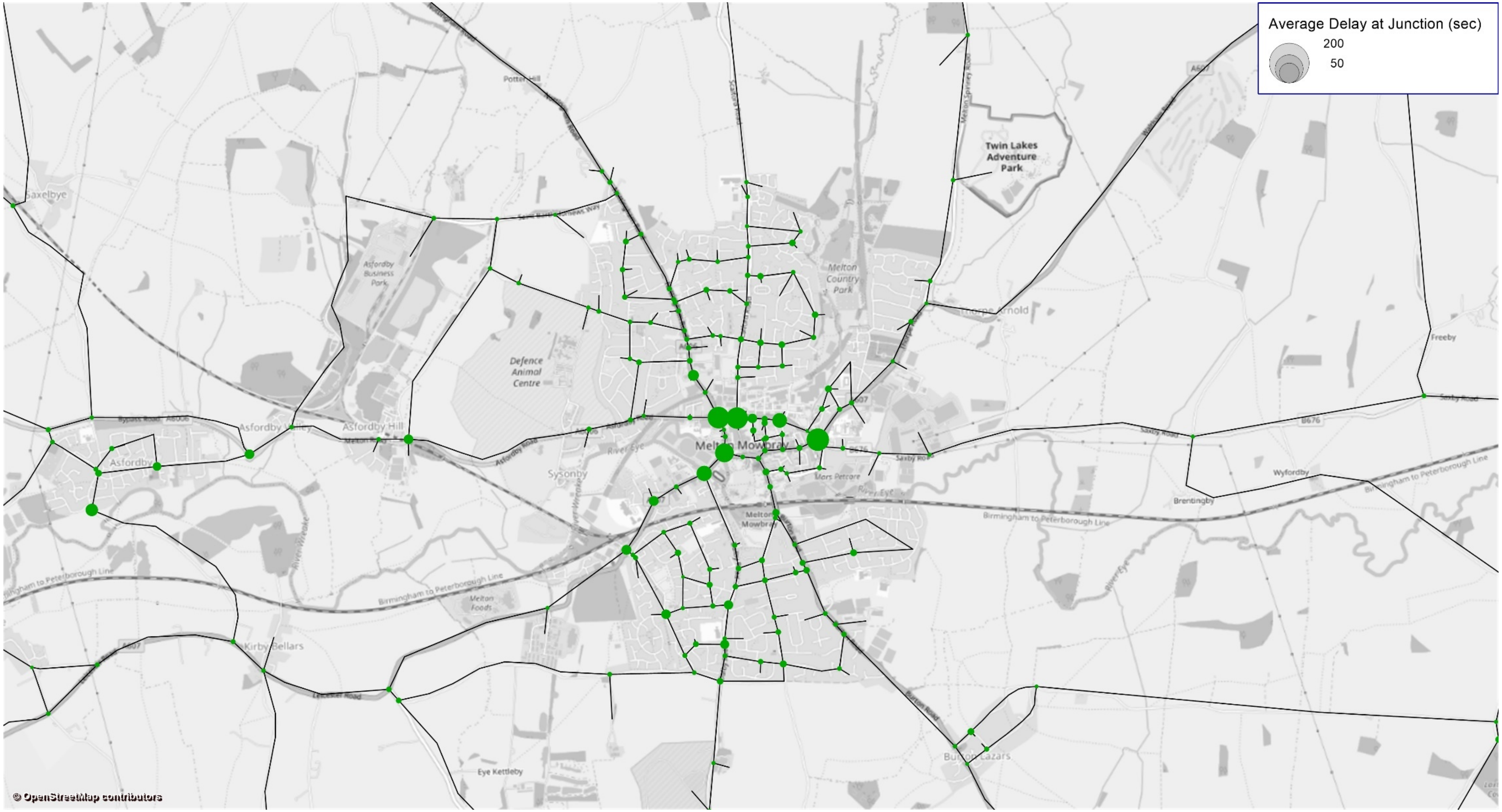


Figure 4-32: Core Scenario Forecast Highway Junction Delay – 2040 PM Peak

Section 5 – NEMMDR Scenario Forecasts

5.1 Introduction

5.1.1 Based on the Core Scenario forecasts, from 2025 onwards LLITM 2014 Base forecasts have been undertaken with the addition of the NEMMDR scheme as defined in Section 3.2.19 to produce the NEMMDR Scenario. This section details the changes in the model forecasts as a result of implementing the NEMMDR in comparison with the Core Scenario forecasts detailed in Section 4.

5.2 Demand Model Convergence

5.2.1 As with the Core Scenario, the demand model has been run iteratively with the assignment models, with the convergence of the overall model assessed against a target of 0.075. Table 5.1 details the convergence statistics by iteration for the NEMMDR Scenario, which has been undertaken in 2025, 2030, 2040 and 2051.

5.2.2 The target convergence level for a $\%Gap$ of 0.075% has been adopted within LLITM 2014 Base for the NEMMDR FBC forecasts, exceeding TAG requirements[13], and Table 5.1 details the demand model convergence by iteration for the 2025, 2030, 2040 and 2051 NEMMDR Scenario model runs. Table 5.1 demonstrates that the demand model reaches the desired convergence level in all forecast years.

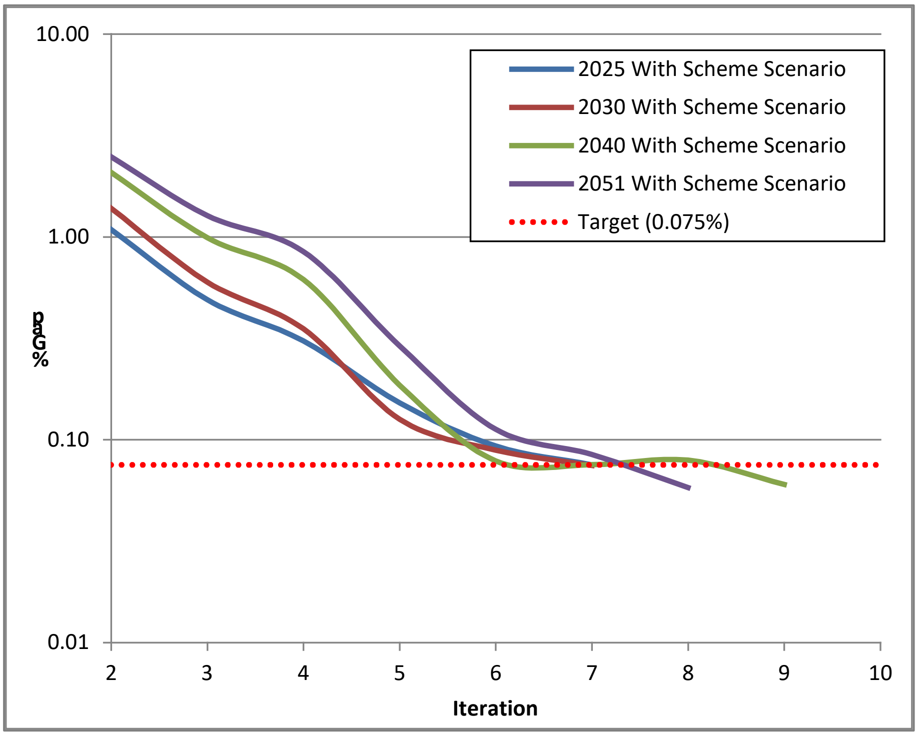
Table 5.1: NEMMDR Scenario Demand Model Convergence

Iteration	2025	2030	2040	2050
2	1.09	1.39	2.09	2.49
3	0.49	0.60	0.99	1.28
4	0.31	0.35	0.62	0.85
5	0.15	0.13	0.19	0.29
6	0.09	0.09	0.08	0.11
7	0.08	0.07	0.08	0.08
8			0.08	0.06
9			0.06	

---

[13] TAG Unit M2 §6.3.8 states that a $\%Gap$ value of 0.1% can be achieved in many cases, but that remedial action is only required if the $\%Gap$ value is not below 0.2%.

Figure 5-1: NEMMDR Scenario Demand Model Convergence



5.3 Highway Assignment Forecasts

5.3.1 Comparable network performance statistics to those detailed in Section 4.7 have been produced for the NEMMDR Scenario forecasts. Figure 5-2 provides a summary of the forecast network performance statistics within the AM Peak and PM Peak hours for the highway network within Melton Borough and Melton Mowbray. Figure 5-2 shows the forecast for these network performance indicators in the NEMMDR Scenario, with the corresponding forecasts from the Core Scenario (i.e. excluding the NEMMDR) shown as dotted lines within the plots.

5.3.2 In summary, Figure 5-2 shows that with the inclusion of the NEMMDR:

- there is a forecast increase in traffic (measured in vehicle-kilometres) within Melton Borough, with a forecast reduction in traffic within Melton Mowbray as traffic shifts onto the NEMMDR;
- there is a forecast reduction in vehicle-delays both within Melton Borough and Melton Mowbray; and
- there is a forecast increase in average network speeds within both Melton Borough and Melton Mowbray.

5.3.3 Table 5.2 and Table 5.4 provide further detail on the forecast network performance statistics for Melton Borough and Melton Mowbray respectively for the NEMMDR Scenario. The network statistics for 2014, which are prior to the assumed opening of the NEMMDR, are those detailed in Section 4.7 as part of the Core Scenario forecasts.

5.3.4 Table 5.3 and Table 5.5 show the forecast change in the highway network performance statistics from the Core Scenario forecasts with the introduction of the NEMMDR for Melton Borough and Melton Mowbray respectively. Taking the 2040 forecasts, Table 5.3 shows that there is forecast to be a ~4% increase in traffic (measured in vehicle-kilometres) within Melton Borough in all time periods, with between a 4% and 5% increase in average network speeds across the borough. Within Melton Mowbray in 2040 there is forecast to be around a ~13% reduction in traffic within the urban area, and between a 3% and 7% increase in average network speeds depending on the time period.

5.3.5 Figure 5-3 and Figure 5-4 show the forecast change in traffic levels within Melton Mowbray as a result of introducing the NEMMDR within the 2040 AM Peak hour and PM Peak hour models. Corresponding plots for all three time periods and for 2025, 2030, 2040 and 2051 are shown in Appendix E.

5.3.6 These forecasts for the two peak hours in 2040 show that with the inclusion of the NEMMDR there is forecast to be a reduction in traffic volumes within Melton Mowbray as trips reroute onto the new distributor road. The largest reductions in traffic levels are forecast on the A606 Burton Road to the south-east of the town centre, and on the A607 Thorpe Road and Melton Spinney Road to the north-east of the town centre.

5.3.7 In addition to the forecast flow changes with the introduction of the NEMMDR, Figure 5-5 and Figure 5-6 show the forecast change in the volume-capacity ratios from the Core Scenario to the NEMMDR Scenario in the 2040 forecasts for the AM Peak and PM Peak hours. The corresponding figures for 2025, 2030 and 2051 for the AM Peak, interpeak and PM Peak are given in Appendix F.

5.3.8 The forecast change in volume-capacity ratios follows a similar pattern as the forecast flow changes, with areas with higher forecast reductions in flow with the introduction of the scheme also forecast to see the largest reductions in volume-capacity ratios.

5.3.9 Table 5.6 to Table 5.8 provide a comparison of journey times in 2040 for the three modelled time periods across Melton between the without and with NEMMDR scenarios. Three routes have been selected, the A606 from the southeast to the northwest of Melton, the A607 from southwest to northeast and the third between the A606 (southeast) and the A607 (northeast). Due to the one-way system in Melton town centre A607 traffic travelling in the southbound direction has a longer route than northbound traffic which results in imbalances in journey times for the A607 routes.

5.3.10 Table 5.6 provides the comparison of journey times for the AM peak, for both the existing routes and those via the NEMMDR for the with scheme scenario. There are moderate reductions in journey times along existing routes due to reductions in through traffic as it transfers to the NEMMDR and Southern Link Road. For through traffic using the NEMMDR the reductions in journey times are significant, 18% (northbound) and 34% (southbound) for A606 traffic, around 20% for A607 traffic and around a 50% reduction for traffic travelling between the A606 and A607, or about 6 minutes per vehicle.

5.3.11 Table 5.7 provides the comparison of journey times for the interpeak. There are small reductions in journey times along existing routes due to reductions in through traffic as it transfers to the NEMMDR and Southern Link Road. For through traffic using the NEMMDR the reductions in journey times are significant, 16% (northbound) and 35% (southbound) for A606 traffic, around 20% for A607 traffic and almost a 50% reduction for traffic travelling between the A606 and A607, or 5 to 6 minutes per vehicle.

5.3.12 The largest reductions in journey times due to the NEMMDR occur in the PM peak as presented in Table 5.8. There are moderate reductions in journey times along existing routes due to reductions in through traffic as it transfers to the NEMMDR and Southern Link Road. For through traffic using the NEMMDR the reductions in journey times are significant, 26% (northbound) and 36% (southbound) for A606 traffic, around 25% for A607 traffic and a 50% reduction for traffic travelling between the A606 and A607, or about 7 minutes per vehicle, in the northbound direction, with a 5 minute reduction in opposite direction.

5.3.13 The NEMMDR is generally expected to have a beneficial impact on the Strategic Road Network (SRN) that is closest to the Melton area, these being the A46 to the west, A1 to the east and A52 to the north. As the NEMMDR provides an improved route around Melton for traffic using the A606 and A607 it results in some traffic transferring from using parts of the A46/A52 and A1/A52 routes to either the A606 or A607 routes. The highest reductions occur on the A46 between the A6006 and A606 junctions as traffic between Melton and the A46 re-routes from the former to the latter with the NEMMDR in place. On the A1 there are forecast reductions in traffic between the A606 junction at Stamford and the A52 junction at Grantham.

5.3.14 Figure 5-7 and Figure 5-8 present the forecast change in average delay at junctions for the 2040 AM and PM peaks respectively. There are forecast reductions in delay at a number of junctions in Melton Mowbray town centre of up to 30 seconds per vehicle. The inclusion of the NEMMDR does results in some additional delay at the new junctions but these are relatively small compared with the reductions at existing junctions. Appendix G contains figures with the forecast outcomes for the peak periods in other years and the interpeak time period.

Figure 5-2: NEMMDR Scenario Forecast Change in Network Performance within Melton Borough and Melton Mowbray within AM Peak and PM Peak Hours

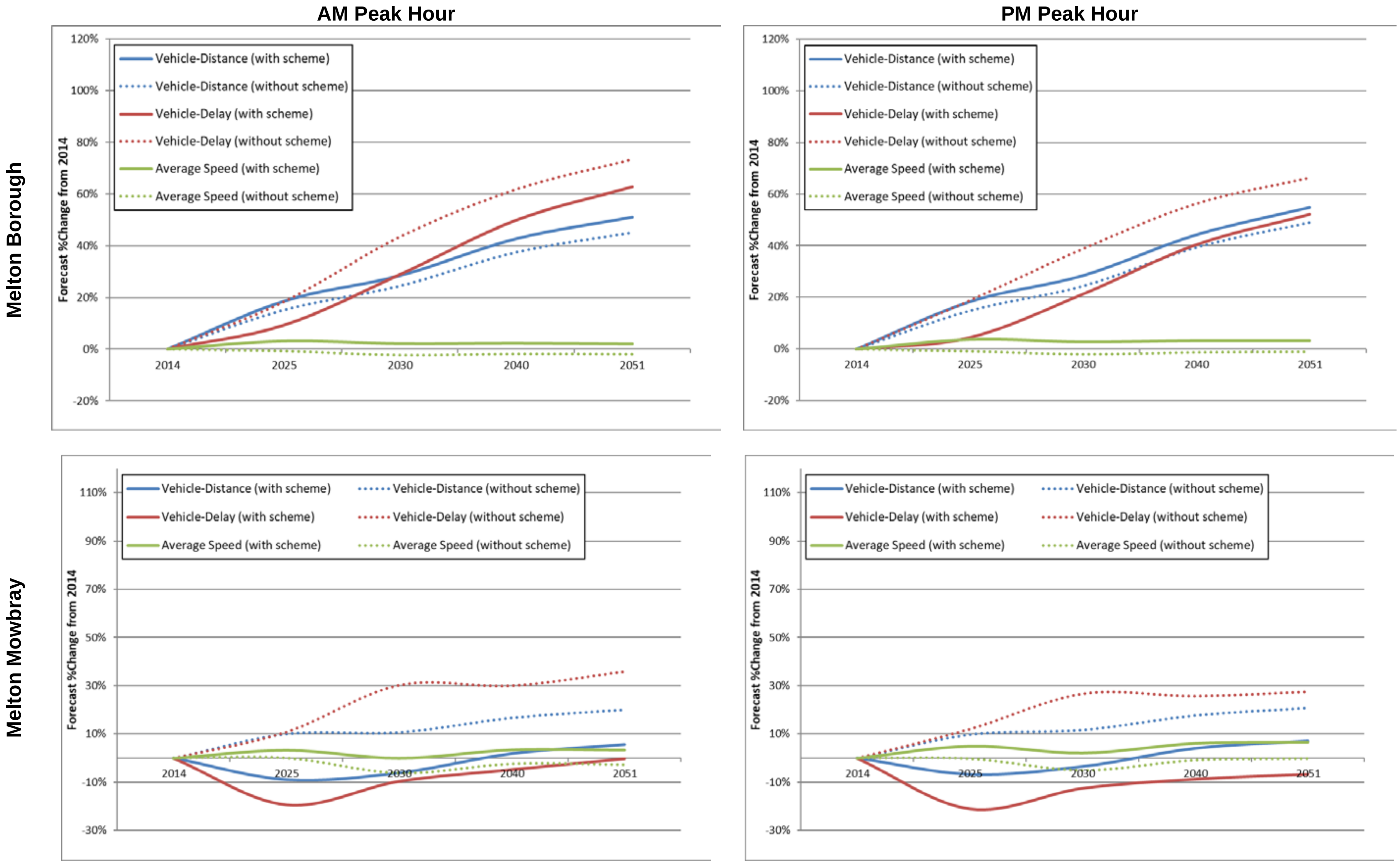


Table 5.2: NEMMDR Scenario Forecast Network Performance within Melton Borough

		2014	2025	2030	2040	2051
AM Peak Hour	Vehicle Distance (veh-km)	112,382	133,233	144,332	160,367	169,791
	Vehicle Delay-Time (veh-hours)	266	290	343	398	433
	Average Speed (kph)	56.3	58.1	57.5	57.6	57.5
	Vehicle Delay/Vehicle Distance (min/km)	0.14	0.13	0.14	0.15	0.15
Interpeak Hour	Vehicle Distance (veh-km)	76,361	94,683	104,291	118,366	126,792
	Vehicle Delay-Time (veh-hours)	169	189	221	254	274
	Average Speed (kph)	55.9	58.1	57.8	58.4	58.5
	Vehicle Delay/Vehicle Distance (min/km)	0.13	0.12	0.13	0.13	0.13
PM Peak Hour	Vehicle Distance (veh-km)	116,378	137,699	149,472	167,801	180,097
	Vehicle Delay-Time (veh-hours)	306	320	371	430	466
	Average Speed (kph)	55.5	57.5	57.0	57.3	57.3
	Vehicle Delay/Vehicle Distance (min/km)	0.16	0.14	0.15	0.15	0.16

Table 5.3: NEMMDR Scenario Forecast Change from Core Scenario in Network Performance within Melton Borough

		2025	2030	2040	2051
AM Peak Hour	Vehicle Distance (veh-km)	3%	3%	4%	4%
	Vehicle Delay-Time (veh-hours)	-8%	-10%	-7%	-6%
	Average Speed (kph)	4%	5%	4%	4%
	Vehicle Delay/Vehicle Distance (min/km)	-10%	-13%	-11%	-10%
Interpeak Hour	Vehicle Distance (veh-km)	4%	4%	4%	5%
	Vehicle Delay-Time (veh-hours)	-10%	-10%	-7%	-6%
	Average Speed (kph)	4%	5%	4%	4%
	Vehicle Delay/Vehicle Distance (min/km)	-13%	-14%	-11%	-10%
PM Peak Hour	Vehicle Distance (veh-km)	3%	3%	3%	4%
	Vehicle Delay-Time (veh-hours)	-12%	-13%	-10%	-8%
	Average Speed (kph)	4%	5%	5%	4%
	Vehicle Delay/Vehicle Distance (min/km)	-15%	-15%	-13%	-12%

Table 5.4: NEMMDR Scenario Forecast Network Performance within Melton Mowbray

		2014	2025	2030	2040	2051
AM Peak Hour	Vehicle Distance (veh-km)	20,119	18,332	18,888	20,480	21,233
	Vehicle Delay-Time (veh-hours)	192	155	173	183	191
	Average Speed (kph)	30.9	31.9	30.9	32.0	32.0
	Vehicle Delay/Vehicle Distance (min/km)	0.57	0.51	0.55	0.53	0.54
Interpeak Hour	Vehicle Distance (veh-km)	15,121	14,383	15,204	16,546	17,062
	Vehicle Delay-Time (veh-hours)	481	451	487	512	529
	Average Speed (kph)	31.4	31.9	31.2	32.3	32.3
	Vehicle Delay/Vehicle Distance (min/km)	0.52	0.49	0.52	0.51	0.52
PM Peak Hour	Vehicle Distance (veh-km)	21,002	19,583	20,257	21,835	22,466
	Vehicle Delay-Time (veh-hours)	709	630	669	695	712
	Average Speed (kph)	29.6	31.1	30.3	31.4	31.6
	Vehicle Delay/Vehicle Distance (min/km)	0.64	0.54	0.58	0.56	0.56

Table 5.5: NEMMDR Scenario Forecast Change from Core Scenario in Network Performance within Melton Mowbray

		2025	2030	2040	2051
AM Peak Hour	Vehicle Distance (veh-km)	-17%	-15%	-13%	-12%
	Vehicle Delay-Time (veh-hours)	-27%	-30%	-27%	-26%
	Average Speed (kph)	3%	7%	6%	6%
	Vehicle Delay/Vehicle Distance (min/km)	-12%	-18%	-16%	-16%
Interpeak Hour	Vehicle Distance (veh-km)	-17%	-16%	-14%	-13%
	Vehicle Delay-Time (veh-hours)	-24%	-26%	-22%	-22%
	Average Speed (kph)	2%	4%	4%	4%
	Vehicle Delay/Vehicle Distance (min/km)	-9%	-12%	-10%	-10%
PM Peak Hour	Vehicle Distance (veh-km)	-15%	-14%	-12%	-11%
	Vehicle Delay-Time (veh-hours)	-30%	-31%	-27%	-27%
	Average Speed (kph)	5%	7%	7%	7%
	Vehicle Delay/Vehicle Distance (min/km)	-17%	-20%	-18%	-17%

Table 5.6: 2040 AM peak – Impact of NEMMDR on Average Travel Times

	Without NEMMDR	With NEMMDR	NEMMDR Impact	
	(Mins)	(Mins)	(Mins)	% Change
A606 NB via existing route	10.7	10.2	-0.4	-4%
A606 SB via existing route	14.1	13.6	-0.6	-4%
A606 NB via NEMMDR	*10.7*	8.7	-1.9	-18%
A606 SB via NEMMDR	*14.1*	9.3	-4.9	-34%
A607 NB via existing route	15.6	15.5	-0.1	-1%
A607 SB via existing route	16.2	14.7	-1.5	-9%
A607 NB via NEMMDR	*15.6*	12.3	-3.3	-21%
A607 SB via NEMMDR	*16.2*	12.4	-3.8	-23%
A606(S)-A607(N) NB via existing route	12.7	12.1	-0.6	-5%
A607(N)-A606(S) SB via existing route	13.1	12.0	-1.1	-8%
A606(S)-A607(N) NB via NEMMDR	*12.7*	6.6	-6.1	-48%
A607(N)-A606(S) SB via NEMMDR	*13.1*	6.8	-6.3	-48%

Table 5.7: 2040 Inter peak – Impact of NEMMDR on Average Travel Times

	Without NEMMDR	With NEMMDR	NEMMDR Impact	
	(Mins)	(Mins)	(Mins)	% Change
A606 NB via existing route	10.1	9.8	-0.3	-3%
A606 SB via existing route	13.0	12.8	-0.1	-1%
A606 NB via NEMMDR	*10.1*	8.5	-1.6	-16%
A606 SB via NEMMDR	*13.0*	8.5	-4.5	-35%
A607 NB via existing route	15.5	15.4	-0.2	-1%
A606 SB via existing route	14.4	14.1	-0.3	-2%
A607 NB via NEMMDR	*15.5*	12.0	-3.5	-22%
A607 SB via NEMMDR	*14.4*	11.8	-2.6	-18%
A606(S)-A607(N) NB via existing route	13.0	12.0	-0.9	-7%
A607(N)-A606(S) SB via existing route	11.6	11.6	0.0	0%

A606(S)-A607(N) NB via NEMMDR	*13.0*	6.5	-6.5	-50%
A607(N)-A606(S) SB via NEMMDR	*11.6*	6.4	-5.2	-45%

Table 5.8: 2040 PM peak – Impact of NEMMDR on Average Travel Times

	Without NEMMDR	With NEMMDR	NEMMDR Impact	
	(Mins)	(Mins)	(Mins)	% Change
A606 NB via existing route	12.3	10.8	-1.5	-12%
A606 SB via existing route	13.4	13.2	-0.2	-2%
A606 NB via NEMMDR	*12.3*	9.1	-3.2	-26%
A606 SB via NEMMDR	*13.4*	8.6	-4.8	-36%
A607 NB via existing route	16.4	16.1	-0.3	-2%
A606 SB via existing route	16.2	14.5	-1.7	-10%
A607 NB via NEMMDR	*16.4*	12.5	-4.0	-24%
A607 SB via NEMMDR	*16.2*	12.2	-4.0	-25%
A606(S)-A607(N) NB via existing route	14.3	12.3	-2.0	-14%
A607(N)-A606(S) SB via existing route	11.9	11.7	-0.2	-2%
A606(S)-A607(N) NB via NEMMDR	*14.3*	7.0	-7.3	-51%
A607(N)-A606(S) SB via NEMMDR	*11.9*	6.9	-5.0	-42%

Figure 5-3: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2040 AM Peak

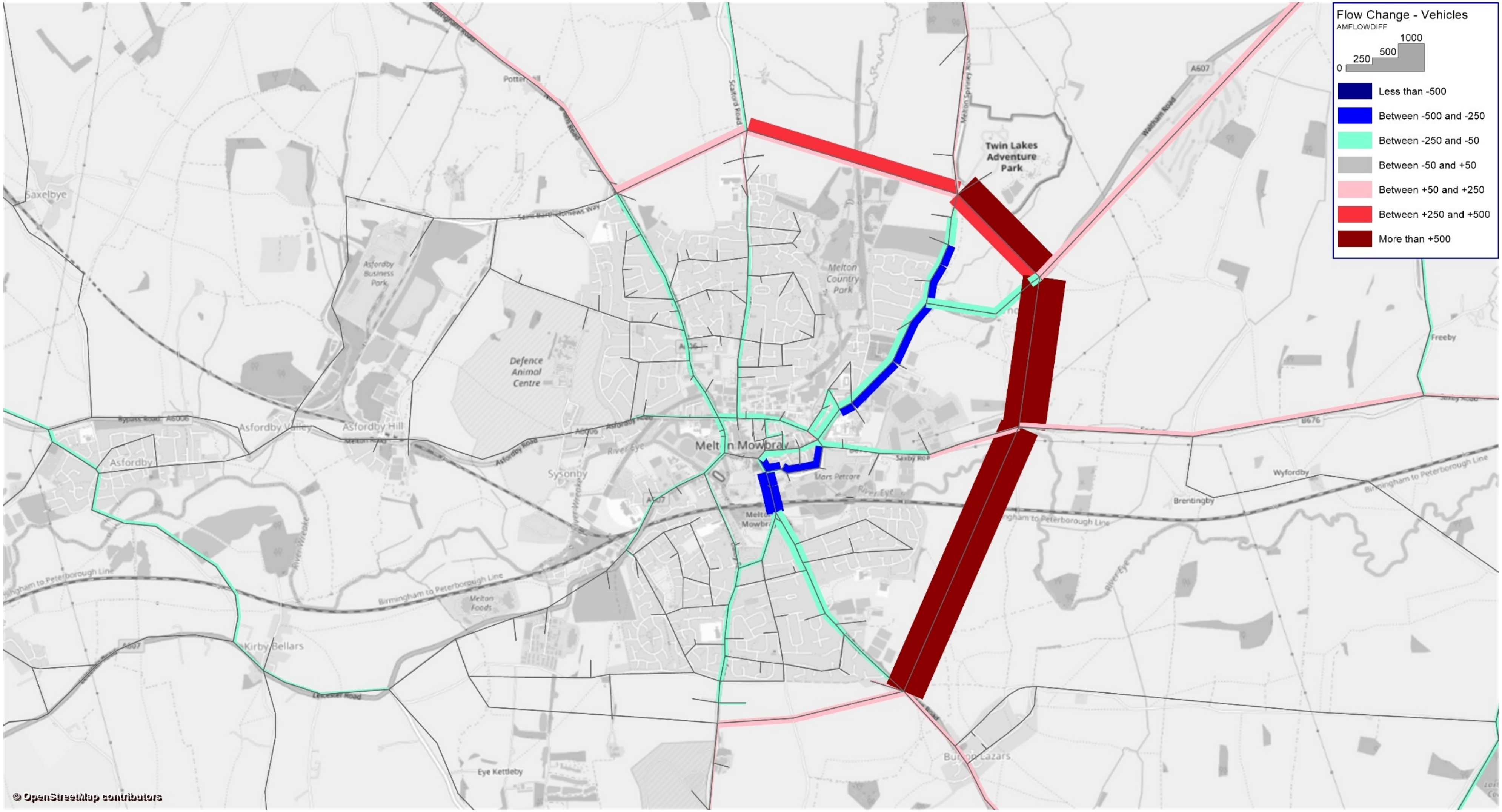


Figure 5-4: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2040 PM Peak

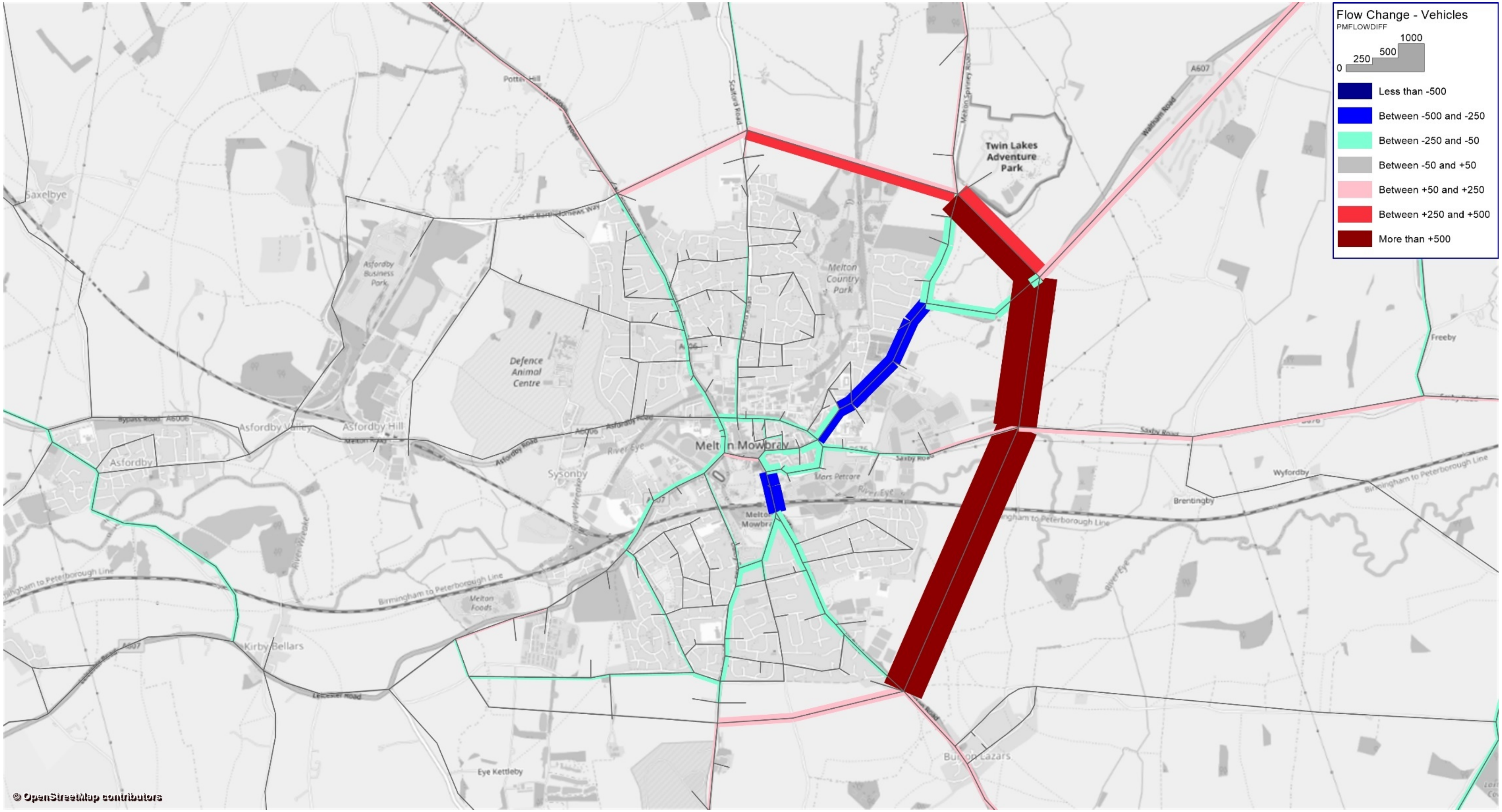


Figure 5-5: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2040 AM Peak

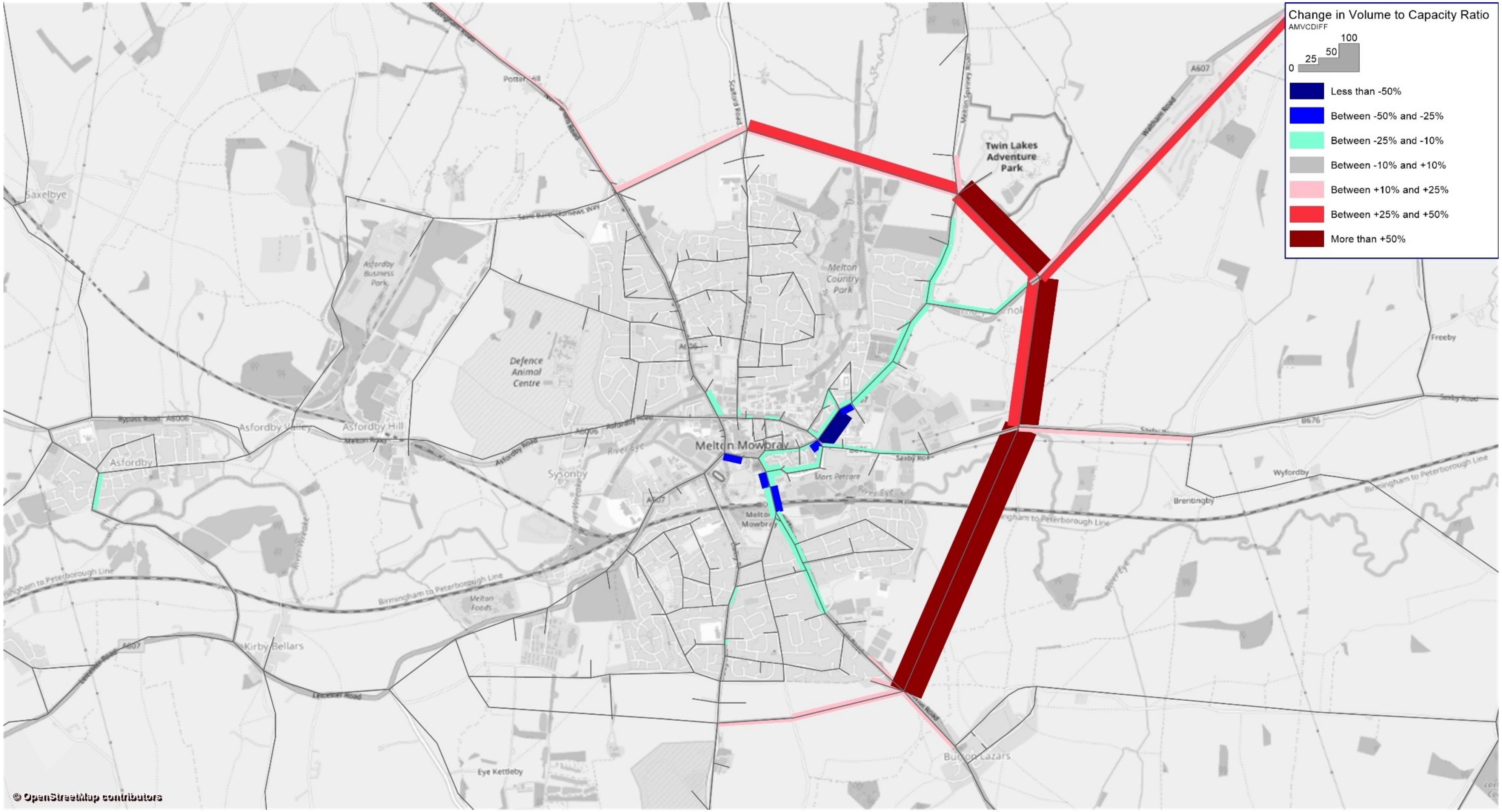


Figure 5-6: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2040 PM Peak

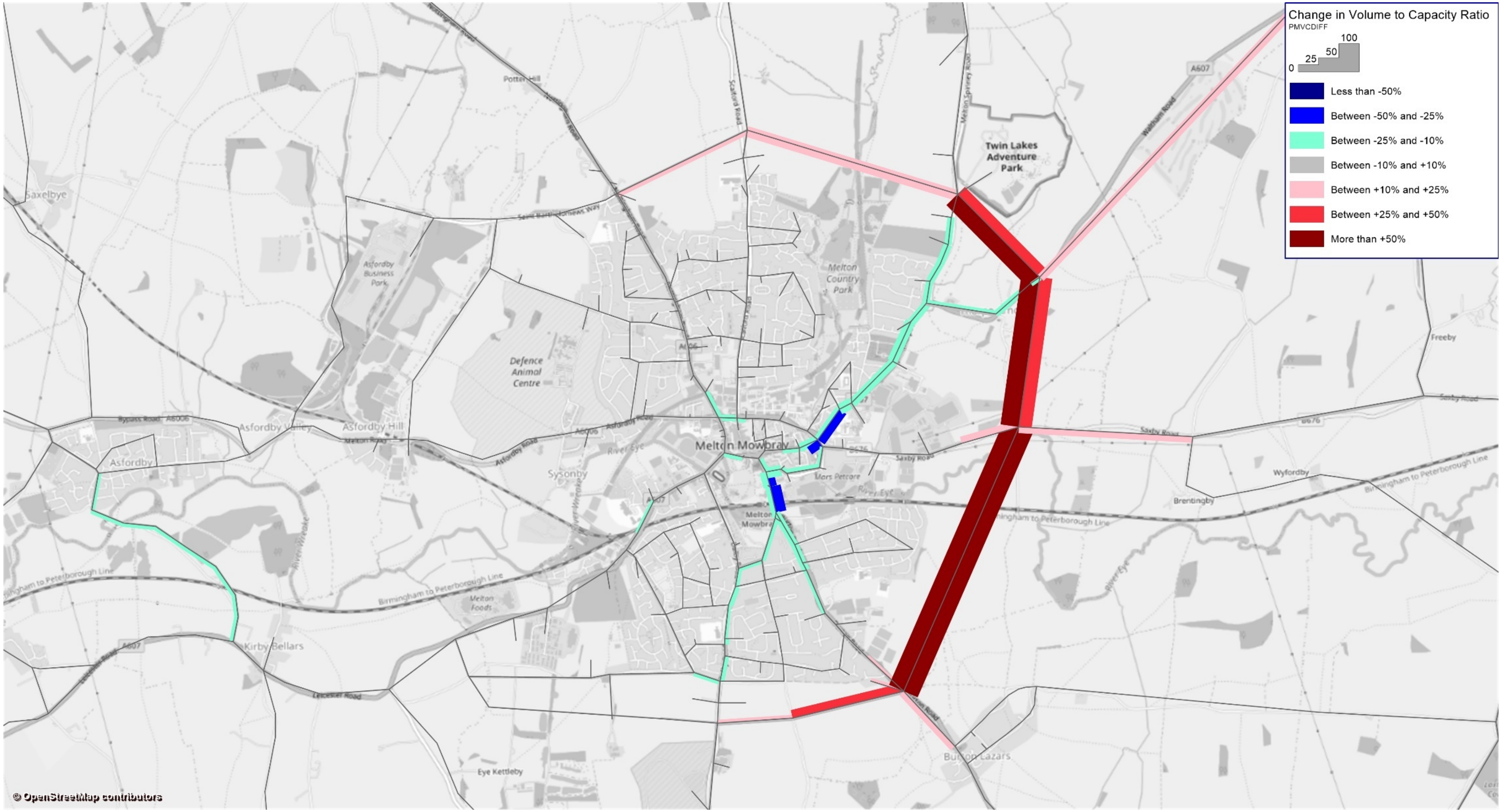


Figure 5-7: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2040 AM Peak

Figure 5-8: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2040 PM Peak

Section 6 – TAG High and Low Traffic Growth Sensitivity Testing

6.1 Introduction

6.1.1 Section 4 and Section 5 detail the central traffic growth forecasts for the Core Scenario and the NEMMDR Scenario based on the forecasting assumptions detailed in Section 3. To provide an indication of the uncertainty around these forecasts, high and low growth scenarios have been produced based on the guidance detailed in Section 4 of TAG Unit M4.

6.1.2 These high and low growth forecasts add or subtract a proportion of the base year demand based on the number of years between the given forecast year and the model's base year, and a factor which varies by mode of travel. This proportion of the base year demand is calculated as follows:

$$\min\left(\sqrt{\mathrm{FY}-2014},6\right) * \mathrm{p}$$

where p equals 2.5% for highway demand, and 1.5% for public transport (based on guidance regarding bus demand within TAG). For active modes, the same value of p as adopted for public transport has been assumed.

6.1.3 This adjustment to the forecast demand matrices has been applied to the 'reference' demand, which is that based on changes in land-use prior to the application of the variable demand model. This adjusted 'reference' demand is then used as the starting point for the demand model, responding to forecast changes in cost from the base year (including fuel costs and values of time).

6.1.4 The TAG high / low growth sensitivity tests have been run from 2025 onwards for the Core Scenario (i.e. excluding the NEMMDR) and the NEMMDR Scenario.

6.2 Demand Forecasts

6.2.1 Table 6.1 details the forecast "central" and high / low growth demand totals for 24-hour trip productions for all modes from Leicestershire for the Core Scenario. The percentage change in demand within the high / low growth scenarios compared with the "central" forecasts is given, along with the corresponding expected change based on the formula defined within TAG (see Paragraph 6.1.2).

6.2.2 For the high growth sensitivity test, the percentage change in demand from the "central" case is broadly consistent with the expectation from TAG for all forecast years, demonstrating that the sensitivity test has been applied correctly.

6.2.3 For the low growth scenario, the modelled difference in demand is generally smaller in magnitude than expected based on TAG. This is because a condition has been applied within the low growth scenario to ensure that no demand movement has a negative number of trips, limiting the proportion of the base year demand which could be subtracted for some movements.

6.2.4 Table 6.2 provides the corresponding demand forecasts for the high / low growth scenarios in the Core Scenario, but only for highway demand. Again, there is a good correspondence between the expected difference from TAG and the difference in demand forecasts between both the high and low growth scenarios and the central growth forecasts for highway demand; however, there is greater variation than for all modes demand. This is due to the effect of the mode choice component within the variable demand model, which reallocates demand between modes in response to travel costs.

6.2.5 Table 6.3 presents the same set of forecasts for 24-hour trip productions for all modes and highway demand, produced within Leicestershire and Melton Borough, for the NEMMDR Scenario. These tables present a similar pattern of demand changes in the high and low growth scenarios compared to the central growth forecasts as the changes occurring in the Core Scenario forecasts.

Table 6.1: High / Low Growth Core Scenario Forecast 24-hour Trip Productions (All Modes) for Leicestershire

	2025	2030	2040	2051
Central Forecast	2,769,242	2,805,192	2,886,136	2,994,879
Low Growth Scenario	2,577,749	2,575,064	2,594,845	2,653,162
%Difference	-7.1%	-8.5%	-10.7%	-12.6%
TAG Expectation	-7.1%	-8.6%	-11.0%	-13.3%
High Growth Scenario	2,961,927	3,037,123	3,180,859	3,341,266
%Difference	7.1%	8.5%	10.9%	12.8%
TAG Expectation	7.1%	8.6%	11.0%	13.3%

Table 6.2: High / Low Growth Core Scenario Forecast 24-hour Trip Productions (Highway) for Leicestershire

	2025	2030	2040	2051
Central Forecast	1,815,061	1,862,323	1,964,271	2,075,553
Low Growth Scenario	1,676,817	1,695,632	1,752,244	1,826,690
%Difference	-8.1%	-9.8%	-12.4%	-14.6%
TAG Expectation	-8.3%	-10.0%	-12.7%	-15.2%
High Growth Scenario	1,953,071	2,028,785	2,176,119	2,323,595
%Difference	8.1%	9.8%	12.4%	14.6%
TAG Expectation	8.3%	10.0%	12.7%	15.2%

Table 6.3: High / Low Growth NEMMDR Scenario Forecast 24-hour Trip Productions (All Modes) for Leicestershire

	2025	2030	2040	2051
Central Forecast	2,768,970	2,804,866	2,885,774	2,994,466
Low Growth Scenario	2,577,511	2,574,755	2,594,544	2,652,827
%Difference	-7.1%	-8.5%	-10.7%	-12.6%
TAG Expectation	-7.1%	-8.6%	-11.0%	-13.3%
High Growth Scenario	2,961,614	3,036,761	3,180,401	3,340,795
%Difference	7.1%	8.5%	10.9%	12.8%
TAG Expectation	7.1%	8.6%	11.0%	13.3%

Table 6.4: High / Low Growth NEMMDR Scenario Forecast 24-hour Trip Productions (Highway) for Leicestershire

	2025	2030	2040	2051
Central Forecast	1,815,059	1,862,324	1,964,255	2,075,427
Low Growth Scenario	1,676,812	1,695,638	1,752,191	1,826,601
%Difference	-8.1%	-9.8%	-12.4%	-14.6%
TAG Expectation	-8.3%	-10.0%	-12.7%	-15.2%
High Growth Scenario	1,953,158	2,028,821	2,176,016	2,323,510
%Difference	8.1%	9.8%	12.4%	14.6%
TAG Expectation	8.3%	10.0%	12.7%	15.2%

6.3 Demand Model Convergence

6.3.1 The convergence of the demand model is, in part, a function of the level of demand within a given forecast scenario. The higher the demand within a given model run, the higher the levels of forecast congestion, and therefore the greater instability in the travel costs from the supply models.

6.3.2 Table 6.5 summarises the number of iterations required to converge the variable demand model in the "central" forecast and the high / low growth sensitivity tests. This information has been summarised for the 2025, 2030, 2040 and 2050 forecasts (note that some forecast scenarios have reached the maximum number of iterations used for the NEMMDR FBC forecasting, namely 15 iterations.)

6.3.3 Table 6.5 shows that the low growth sensitivity tests generally take fewer iterations to converge than the "central" forecasts, and conversely the high growth sensitivity tests generally take additional iterations to converge compared with the "central" forecasts. This is in line with the expectation that the number of iterations to reach convergence is related to the level of demand assumed within a given model run.

Table 6.5: Demand Model Convergence Iterations – Summary

		2025	2030	2040	2051
Core Scenario	Low	6	6	6	7
	Central	7	6	8	10
	High	9	15	15	15
NEMMDR Scenario	Low	6	6	6	6
	Central	7	7	9	8
	High	8	11	15	15

6.3.4 Table 6.6 and Table 6.7 provide further detail on the demand model convergence within the high growth sensitivity tests for the Core Scenario and the NEMMDR Scenario forecasts respectively. Table 6.8 and Table 6.9 show the corresponding demand model convergence for the low growth sensitivity tests. Figure 6-1 also provides a summary of the convergence of the demand model in the central forecasts, and high and low growth sensitivity testing.

6.3.5 Not all modelled years/scenarios meet the low target $\%Gap$ value of 0.075 adopted for the NEMMDR FBC forecasts, but most are within the TAG target criterion of 0.1, and the worst converged model, 2051 High Growth Core Scenario is 0.13.

Table 6.6: High Growth Core Scenario Demand Model Convergence

Iteration	2025	2030	2040	2051
2	0.98	1.41	2.41	3.27
3	0.54	0.90	1.95	3.53
4	0.40	0.75	1.74	3.24
5	0.19	0.34	0.85	1.79
6	0.12	0.13	0.31	0.68
7	0.10	0.09	0.13	0.23
8	0.09	0.08	0.11	0.15
9	0.06	0.09	0.09	0.24
10		0.08	0.11	0.15
11		0.08	0.10	0.12
12		0.09	0.08	0.13
13		0.08	0.11	0.13
14		0.08	0.08	0.12
15		0.09	0.08	0.13

Table 6.7: High Growth NEMMDR Scenario Demand Model Convergence

Iteration	2025	2030	2040	2051
2	0.98	1.45	2.40	3.26
3	0.55	0.92	1.92	3.53
4	0.39	0.76	1.70	3.23
5	0.21	0.31	0.83	1.77
6	0.12	0.12	0.33	0.68
7	0.10	0.09	0.12	0.24
8	0.07	0.11	0.12	0.14
9		0.08	0.09	0.13
10		0.10	0.10	0.10
11		0.07	0.09	0.10
12			0.09	0.09
13			0.10	0.08
14			0.10	0.12
15			0.08	0.10

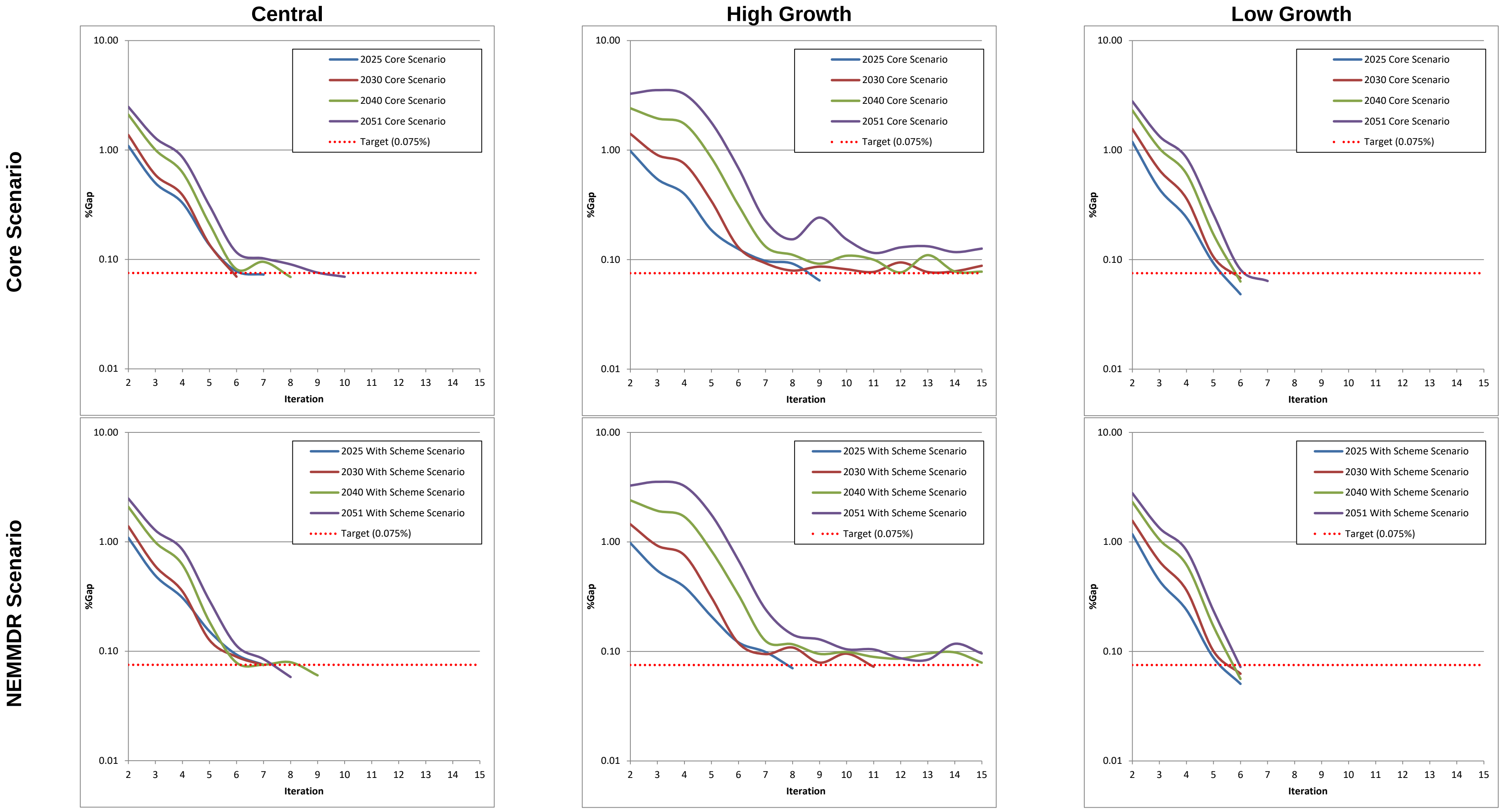
Table 6.8: Low Growth Core Scenario Demand Model Convergence

Iteration	2025	2030	2040	2051
2	1.19	1.56	2.31	2.78
3	0.44	0.66	1.04	1.34
4	0.24	0.36	0.61	0.85
5	0.09	0.11	0.17	0.26
6	0.05	0.07	0.06	0.08
7				0.06

Table 6.9: Low Growth NEMMDR Scenario Demand Model Convergence

Iteration	2025	2030	2040	2051
2	1.18	1.56	2.31	2.79
3	0.44	0.67	1.05	1.34
4	0.24	0.36	0.62	0.84
5	0.09	0.10	0.17	0.24
6	0.05	0.06	0.06	0.07
7				

Figure 6-1: Central, High and Low Growth Demand Model Convergence



6.4 Highway Assignment Forecasts

6.4.1 The high and low growth forecast demand matrices have been assigned within the highway model and the resulting forecast performance of the highway network in these two sensitivity tests has been analysed. As with the assessment of the highway network performance for the central growth scenario, statistics relating to the level of traffic on the network, the level of delay on the network and the average speed on the network have been calculated.

6.4.2 Table 6.13 to Table 6.13 provide the forecast highway network statistics in the high / low growth scenarios and comparing these with the corresponding “central” forecasts. This analysis has been undertaken for both the Melton Borough and Melton Mowbray network and for the Core Scenario and NEMMDR Scenarios.

Table 6.10: High Growth Forecast Network Performance within Melton Borough

		Core Scenario					With Scheme				With Scheme vs Core Scenario			
		2014	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**
AM	Vehicle Distance (veh-km)	112,382	138,215	150,875	168,388	180,288	142,607	156,303	175,442	187,823	3%	4%	4%	4%
	Vehicle Delay-Time (veh-hours)	266	359	435	508	573	326	389	472	525	-9%	-11%	-7%	-8%
	Average Speed (kph)	56	55	54	54	54	58	57	57	57	4%	5%	4%	5%
	Vehicle Delay/Vehicle Distance (min/km)	0.14	0.16	0.17	0.18	0.19	0.14	0.15	0.16	0.17	-12%	-14%	-11%	-12%
IP	Vehicle Distance (veh-km)	76,361	98,267	109,015	125,024	135,058	101,800	113,107	130,062	140,789	4%	4%	4%	4%
	Vehicle Delay-Time (veh-hours)	169	233	280	322	342	210	249	295	322	-10%	-11%	-8%	-6%
	Average Speed (kph)	56	55	55	55	56	58	58	58	58	4%	5%	5%	4%
	Vehicle Delay/Vehicle Distance (min/km)	0.13	0.14	0.15	0.15	0.15	0.12	0.13	0.14	0.14	-13%	-14%	-12%	-10%
PM	Vehicle Distance (veh-km)	116,378	143,153	156,272	177,725	190,911	147,706	161,304	184,357	198,392	3%	3%	4%	4%
	Vehicle Delay-Time (veh-hours)	306	411	489	559	611	357	430	509	559	-13%	-12%	-9%	-8%
	Average Speed (kph)	55	54	54	54	54	57	56	56	56	5%	5%	5%	5%
	Vehicle Delay/Vehicle Distance (min/km)	0.16	0.17	0.19	0.19	0.19	0.15	0.16	0.17	0.17	-16%	-15%	-12%	-12%

Table 6.11: High Growth Forecast Network Performance within Melton Mowbray

		Core Scenario					With Scheme				With Scheme vs Core Scenario			
		2014	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**
AM	Vehicle Distance (veh-km)	20,119	23,480	23,813	25,382	26,424	19,543	20,323	22,399	23,416	-17%	-15%	-12%	-11%
	Vehicle Delay-Time (veh-hours)	651	778	840	871	926	619	667	715	752	-20%	-21%	-18%	-19%
	Average Speed (kph)	31	30	28	29	29	32	30	31	31	5%	8%	8%	9%
	Vehicle Delay/Vehicle Distance (min/km)	0.57	0.62	0.72	0.70	0.74	0.52	0.58	0.57	0.58	-15%	-20%	-19%	-22%
IP	Vehicle Distance (veh-km)	15,121	18,491	19,395	20,847	21,445	15,387	16,387	18,046	18,824	-17%	-16%	-13%	-12%
	Vehicle Delay-Time (veh-hours)	481	598	657	686	704	486	530	567	594	-19%	-19%	-17%	-16%
	Average Speed (kph)	31	31	30	30	30	32	31	32	32	2%	5%	5%	4%
	Vehicle Delay/Vehicle Distance (min/km)	0.52	0.56	0.63	0.61	0.61	0.51	0.54	0.53	0.54	-10%	-14%	-13%	-11%
PM	Vehicle Distance (veh-km)	21,002	24,509	25,131	26,797	27,763	20,892	21,761	23,821	24,712	-15%	-13%	-11%	-11%
	Vehicle Delay-Time (veh-hours)	709	849	919	939	975	680	741	783	811	-20%	-19%	-17%	-17%
	Average Speed (kph)	30	29	27	29	28	31	29	30	30	6%	8%	7%	7%
	Vehicle Delay/Vehicle Distance (min/km)	0.64	0.70	0.79	0.74	0.75	0.56	0.64	0.62	0.62	-19%	-19%	-17%	-17%

Table 6.12: Low Growth Forecast Network Performance within Melton Borough

		Core Scenario					With Scheme				With Scheme vs Core Scenario			
		2014	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**
AM	Vehicle Distance (veh-km)	112,382	119,838	128,622	139,674	145,420	123,058	132,701	144,670	151,039	3%	3%	4%	4%
	Vehicle Delay-Time (veh-hours)	266	278	328	363	377	255	299	337	355	-8%	-9%	-7%	-6%
	Average Speed (kph)	56	56	56	56	56	58	58	58	58	4%	4%	4%	4%
	Vehicle Delay/Vehicle Distance (min/km)	0.14	0.14	0.15	0.16	0.16	0.12	0.14	0.14	0.14	-10%	-12%	-10%	-9%
IP	Vehicle Distance (veh-km)	76,361	84,755	92,250	102,670	108,346	87,666	95,624	106,558	112,852	3%	4%	4%	4%
	Vehicle Delay-Time (veh-hours)	169	186	216	234	243	169	194	217	229	-9%	-10%	-7%	-6%
	Average Speed (kph)	56	56	56	56	57	58	58	59	59	4%	5%	4%	4%
	Vehicle Delay/Vehicle Distance (min/km)	0.13	0.13	0.14	0.14	0.13	0.12	0.12	0.12	0.12	-12%	-13%	-10%	-10%
PM	Vehicle Distance (veh-km)	116,378	124,874	147,214	102,670	154,828	128,470	137,473	151,822	160,300	3%	-7%	48%	4%
	Vehicle Delay-Time (veh-hours)	306	326	406	234	416	286	324	364	385	-12%	-20%	56%	-7%
	Average Speed (kph)	55	55	56	56	56	58	58	58	58	4%	4%	3%	4%
	Vehicle Delay/Vehicle Distance (min/km)	0.16	0.16	0.17	0.14	0.16	0.13	0.14	0.14	0.14	-15%	-15%	5%	-10%

Table 6.13: Low Growth Forecast Network Performance within Melton Mowbray

		Core Scenario					With Scheme				With Scheme vs Core Scenario			
		2014	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**	**2025**	**2030**	**2040**	**2051**
AM	Vehicle Distance (veh-km)	20,119	20,660	20,642	21,524	21,792	17,065	17,494	18,555	18,917	-17%	-15%	-14%	-13%
	Vehicle Delay-Time (veh-hours)	651	658	694	692	699	528	557	569	579	-20%	-20%	-18%	-17%
	Average Speed (kph)	31	31	30	31	31	32	31	33	33	3%	6%	5%	5%
	Vehicle Delay/Vehicle Distance (min/km)	0.57	0.55	0.62	0.58	0.58	0.49	0.53	0.51	0.51	-12%	-16%	-13%	-13%
IP	Vehicle Distance (veh-km)	15,121	16,084	16,678	17,510	17,698	13,365	14,029	14,998	15,257	-17%	-16%	-14%	-14%
	Vehicle Delay-Time (veh-hours)	481	508	547	552	557	415	444	458	465	-18%	-19%	-17%	-17%
	Average Speed (kph)	31	32	31	32	32	32	32	33	33	2%	4%	3%	3%
	Vehicle Delay/Vehicle Distance (min/km)	0.52	0.52	0.57	0.54	0.54	0.48	0.51	0.49	0.49	-8%	-11%	-8%	-9%
PM	Vehicle Distance (veh-km)	21,002	21,612	22,573	17,510	22,784	18,257	18,720	19,773	20,083	-16%	-17%	13%	-12%
	Vehicle Delay-Time (veh-hours)	709	719	746	552	741	579	608	616	621	-19%	-18%	12%	-16%
	Average Speed (kph)	30	30	30	32	31	32	31	32	32	5%	2%	1%	5%
	Vehicle Delay/Vehicle Distance (min/km)	0.64	0.62	0.63	0.54	0.61	0.52	0.55	0.53	0.52	-17%	-13%	-1%	-14%

Section 7 – Summary of Forecasts

7.1 Summary of Forecasts

7.1.1 The preceding sections of this document detail the forecasting processes and assumptions adopted within LLITM 2014 Base to produce the forecasts detailed in this report, the results of this forecasting process for the "central" case both excluding and including the NEMMDR, and the forecast results in the TAG high / low growth sensitivity tests.

7.1.2 In terms of the forecasting process, LLITM 2014 Base includes both highway and public transport assignment models and a variable demand model. LLITM 2014 Base also incorporates the DfT's CTripEnd software to produce trip-end forecasts based on the planning forecasts collated from local authorities within Leicestershire.

7.1.3 To develop forecasts, assumptions on the changes to the highway and public transport networks have been collected from LCC, neighbouring authorities and National Highways, and information regarding the location and scale of proposed developments collated from planning applications as part of the Local Plan. In addition to these forecast assumptions, forecasts for a number of economic parameters (such as values of time and fuel prices) have been taken from TAG.

7.1.4 Using these forecast assumptions, LLITM 2014 Base forecasts a 32% increase in population between 2014 and 2040 within Melton Borough, with a 15% increase in employment over the same period. This forecast growth in population and employment drives growth in travel demand produced within Melton Borough. Total travel demand (excluding freight) produced within Melton Borough is forecast to grow by 16% between 2014 and 2040, with a forecast 18% growth in non-freight highway demand.

7.1.5 The forecast increase in highway demand over time results in additional traffic and delays both within Melton Borough and Melton Mowbray. Traffic levels within the district are forecast to increase from 2014 to 2040 by between around 37% and 49% depending on the time of day. This forecast increase in traffic results in increase in delay of between 56% and 62% and reductions in average speed of between 1% and 2% between 2014 and 2040.

7.1.6 Within Melton Mowbray, traffic growth of around 17% to 27% is forecast between 2014 and 2040 depending on the time period. Forecast delays increase by between 26% and 38% due to this increase in traffic, with average speeds forecast to change between no change and a 6% reduction. Reductions in average speeds are smaller in later forecast years due to the additional infrastructure relating to the northern and southern urban extensions included within the Core Scenario.

7.1.7 With the introduction of the NEMMDR, forecast levels of traffic within Melton Borough increase (in 2040 by around 4%), with levels of traffic within Melton Mowbray forecast to decrease (by around 13% in 2040). Average speeds within Melton Borough and Melton Mowbray are forecast to increase with the introduction of the NEMMDR, by between 4% and 5% across the borough and by between 2% and 7% within Melton Mowbray in 2040.

7.1.8 The introduction of the NEMMDR results in traffic routeing away from the Melton Mowbray urban area and onto the new road. Significant reductions in traffic volumes are forecast on Thorpe Road and Burton Road within Melton Mowbray as a result of the NEMMDR, with smaller reductions in flow forecast on Nottingham Road and Norman Way.

7.1.9 In addition to these "central" forecasts, high and low growth scenarios have been undertaken using the approach detailed within TAG Unit M4. These sensitivity tests result in a reduction in highway demand produced within Melton Borough of 8.5% from the "central" forecasts in the low growth scenario, and a corresponding 8.5% increase in highway demand in the high growth scenario. This forecast increase or decrease in highway demand results in corresponding increases and decreases in traffic both within Melton Borough and Melton Mowbray, with larger forecast reductions in average speed in the high growth scenario and smaller reductions in average speed in the low growth scenario.

Appendix A Location of Key Developments in Melton Mowbray

Figure A-1: Key Residential Developments within Melton Mowbray

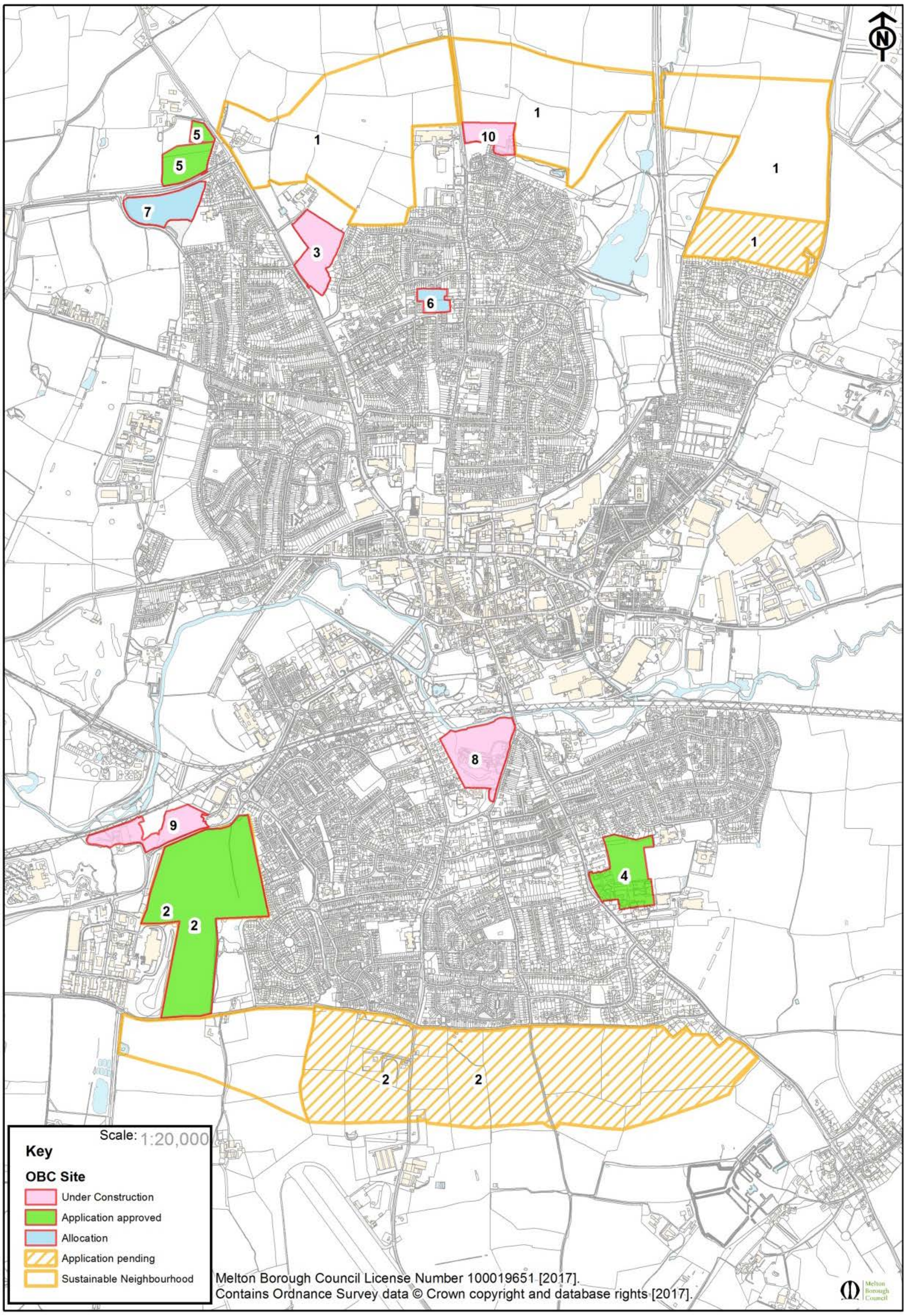


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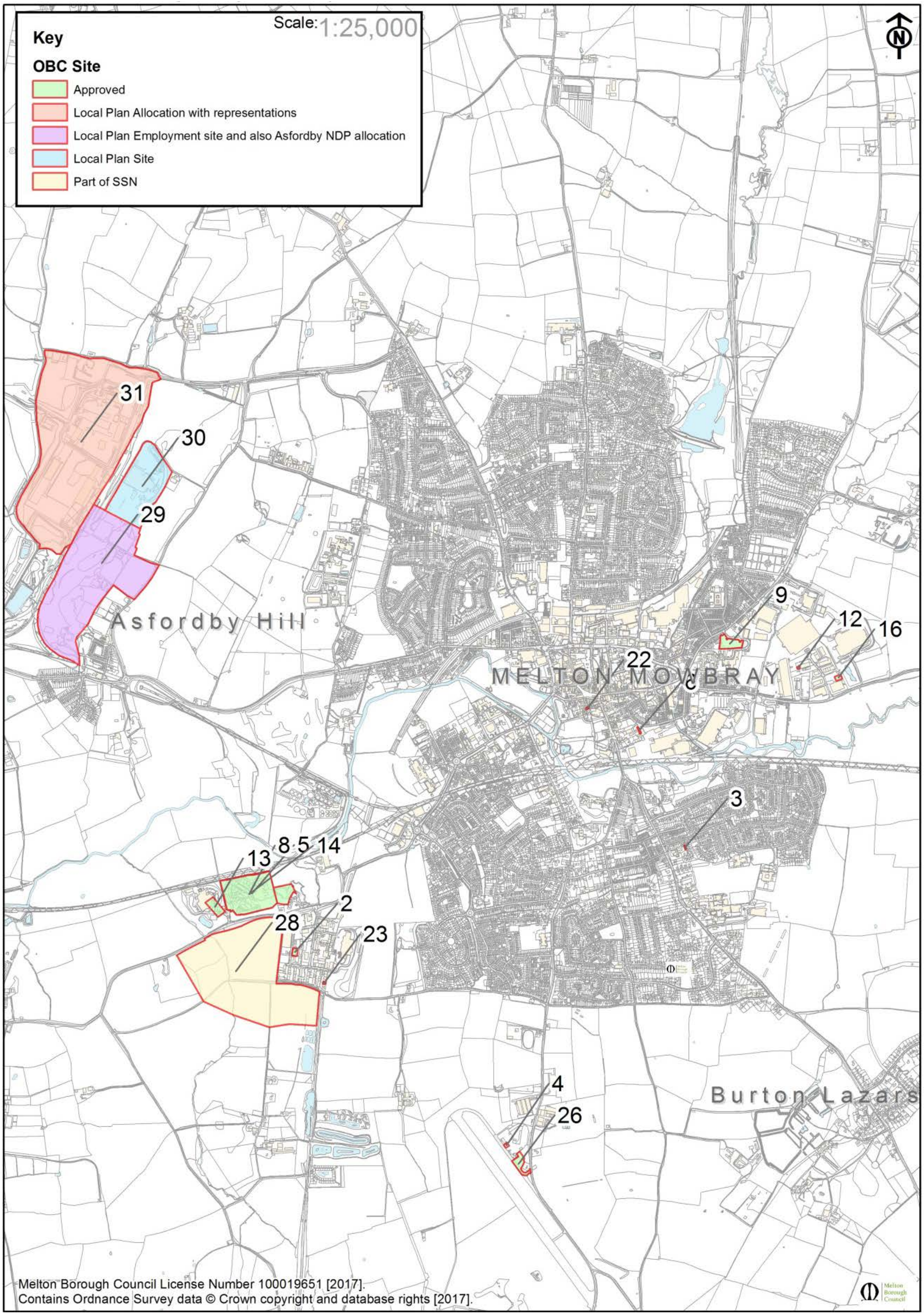
Figure A-2: Key Employment Developments within Melton Mowbray



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Appendix B Core Scenario Forecast Vehicle Flows

Figure B-1: Core Scenario Forecast Highway Vehicle Flows – 2014 AM Peak

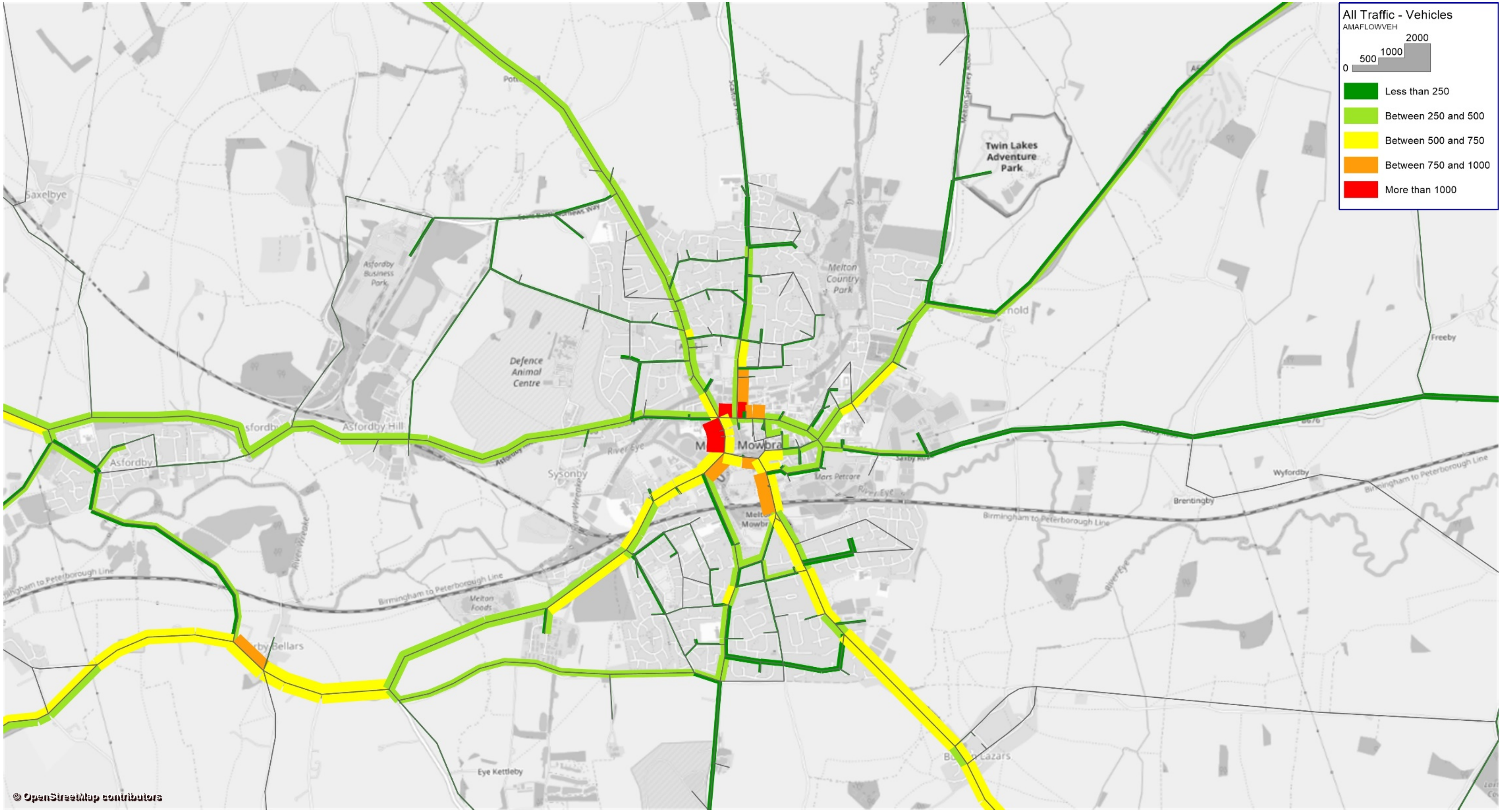

Figure B-2: Core Scenario Forecast Highway Vehicle Flows – 2014 Interpeak

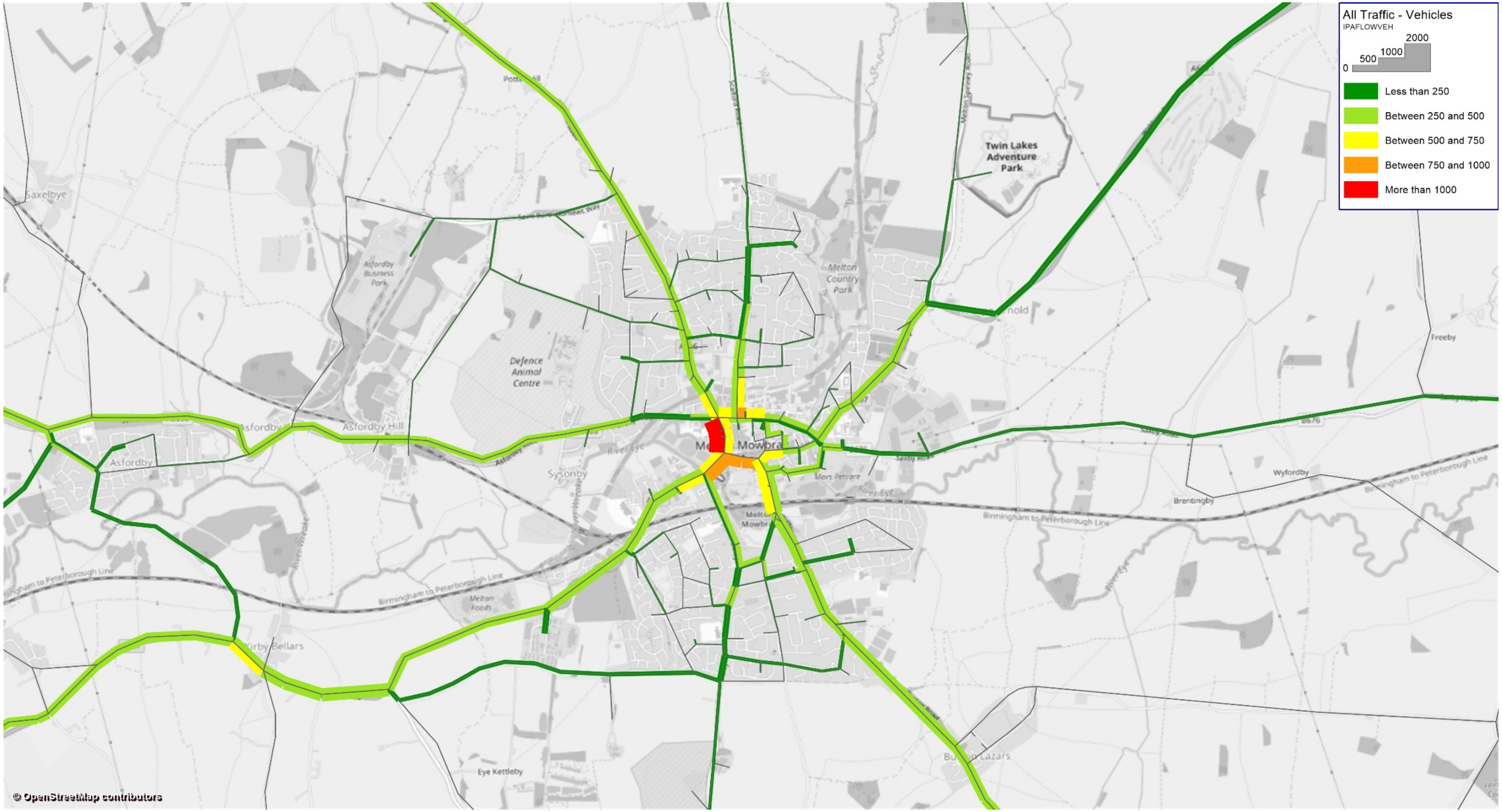

Figure B-3: Core Scenario Forecast Highway Vehicle Flows – 2014 PM Peak

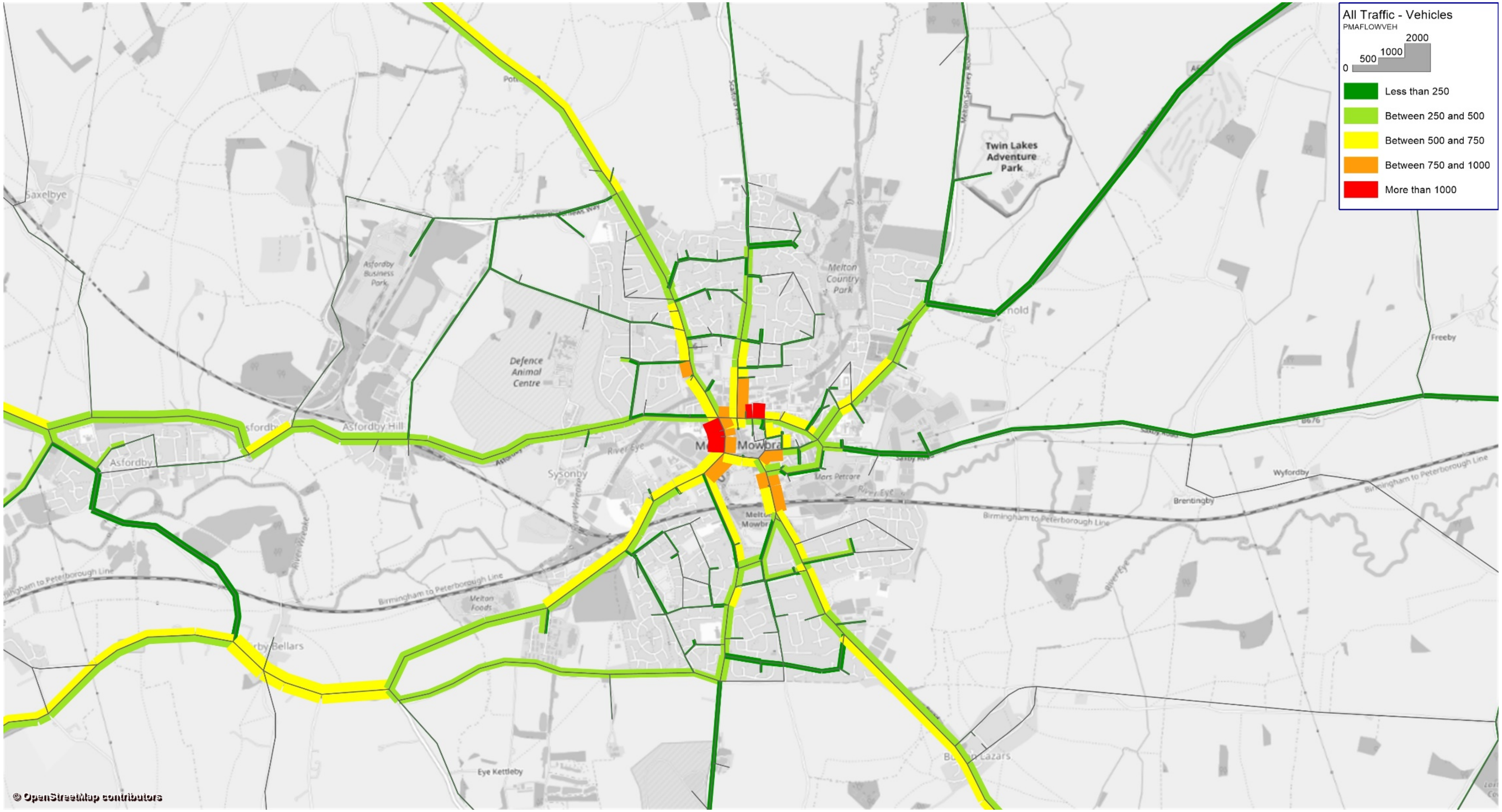

Figure B-4: Core Scenario Forecast Highway Vehicle Flows – 2025 AM Peak

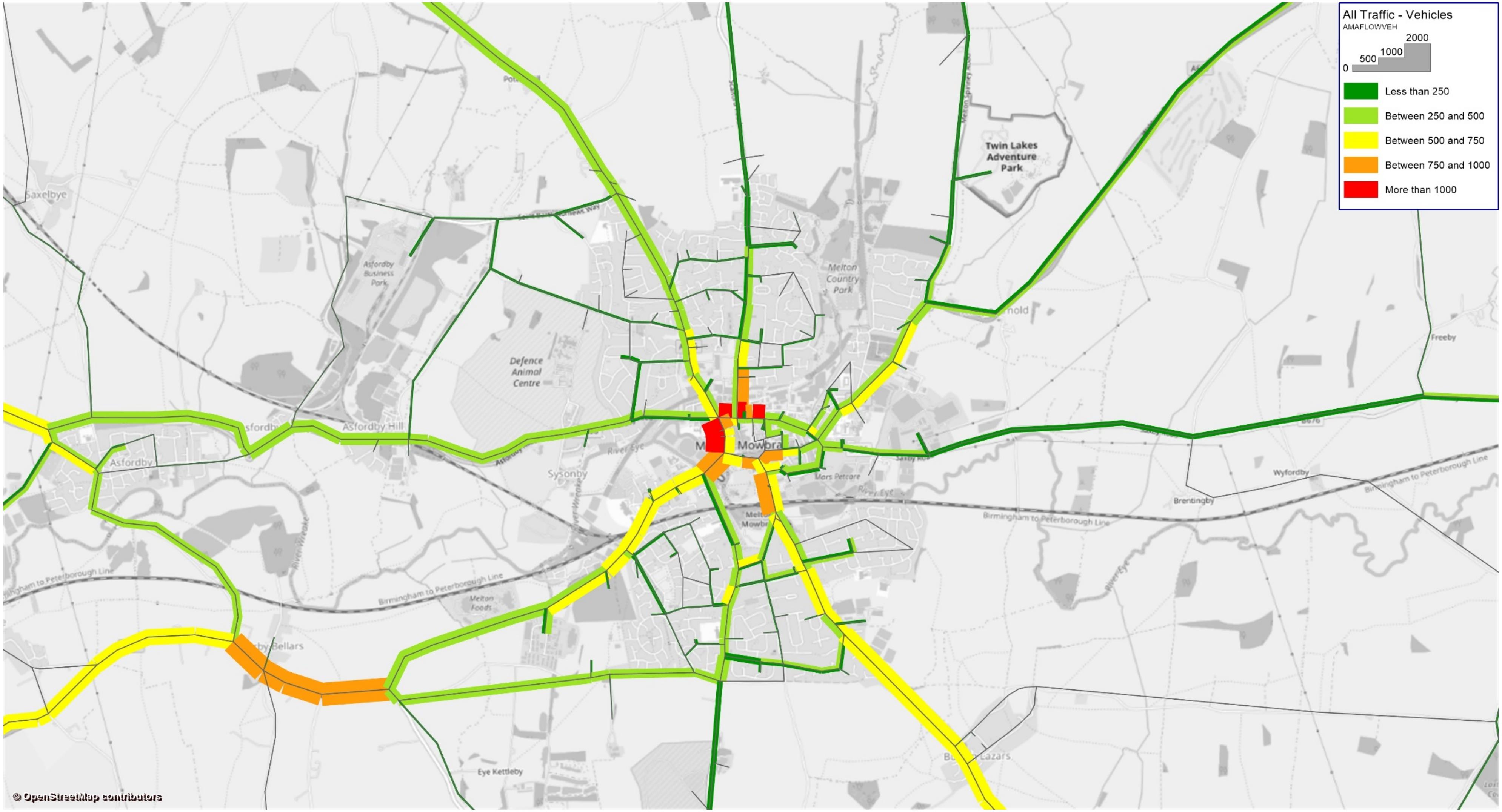

Figure B-5: Core Scenario Forecast Highway Vehicle Flows – 2025 Interpeak

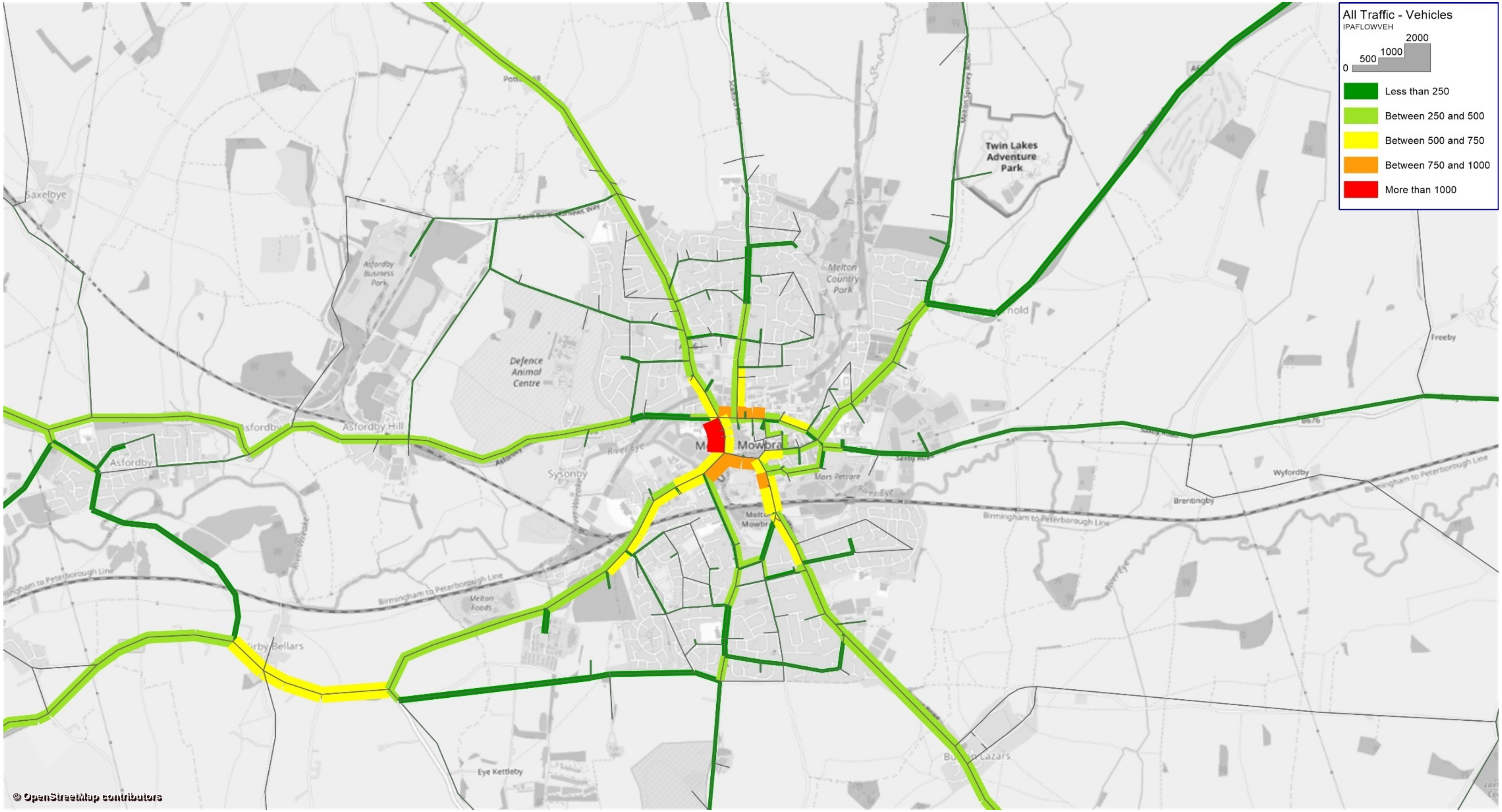

Figure B-6: Core Scenario Forecast Highway Vehicle Flows – 2025 PM Peak

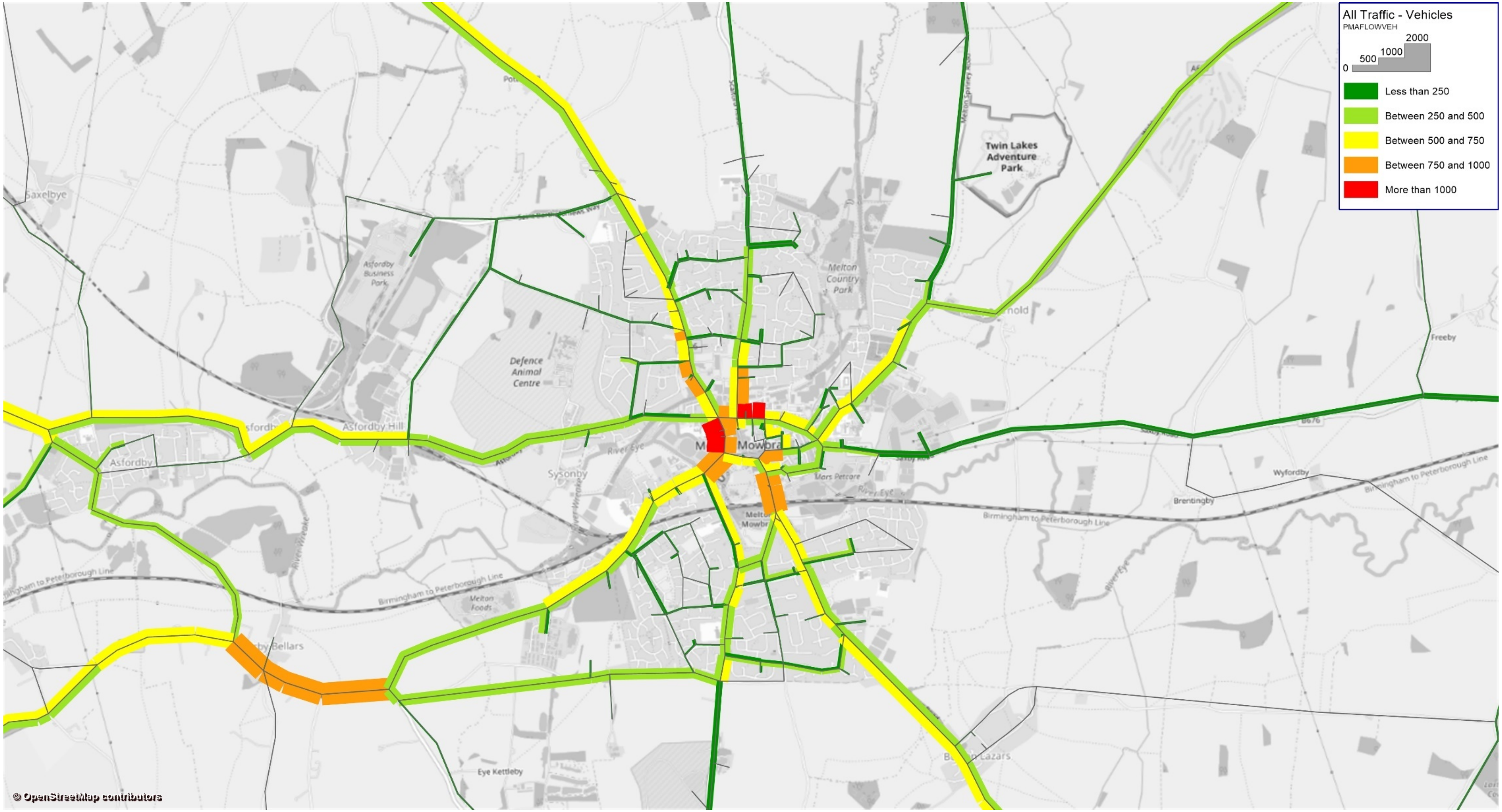

Figure B-7: Core Scenario Forecast Highway Vehicle Flows – 2030 AM Peak

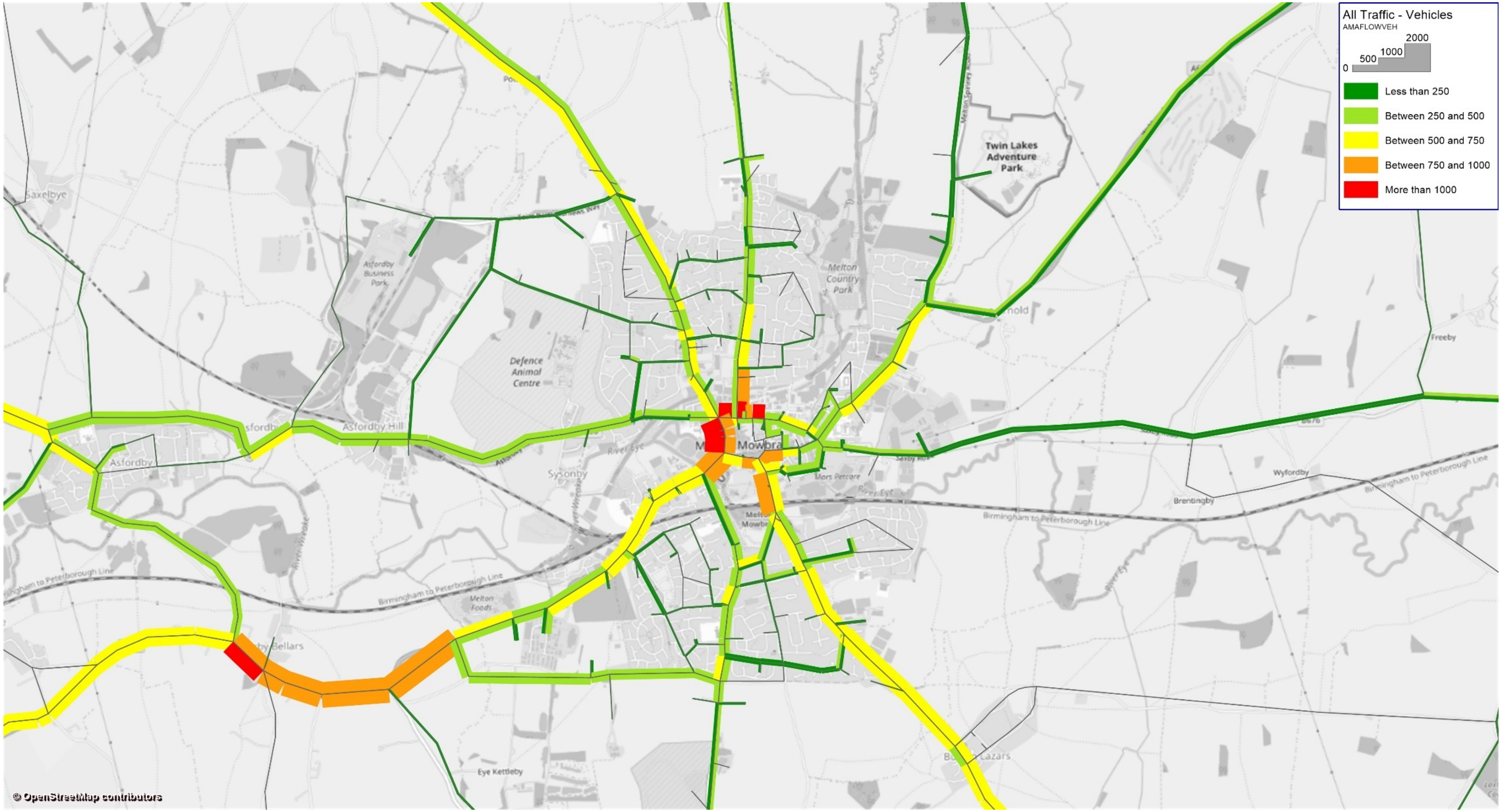

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Figure B-8: Core Scenario Forecast Highway Vehicle Flows – 2030 Interpeak

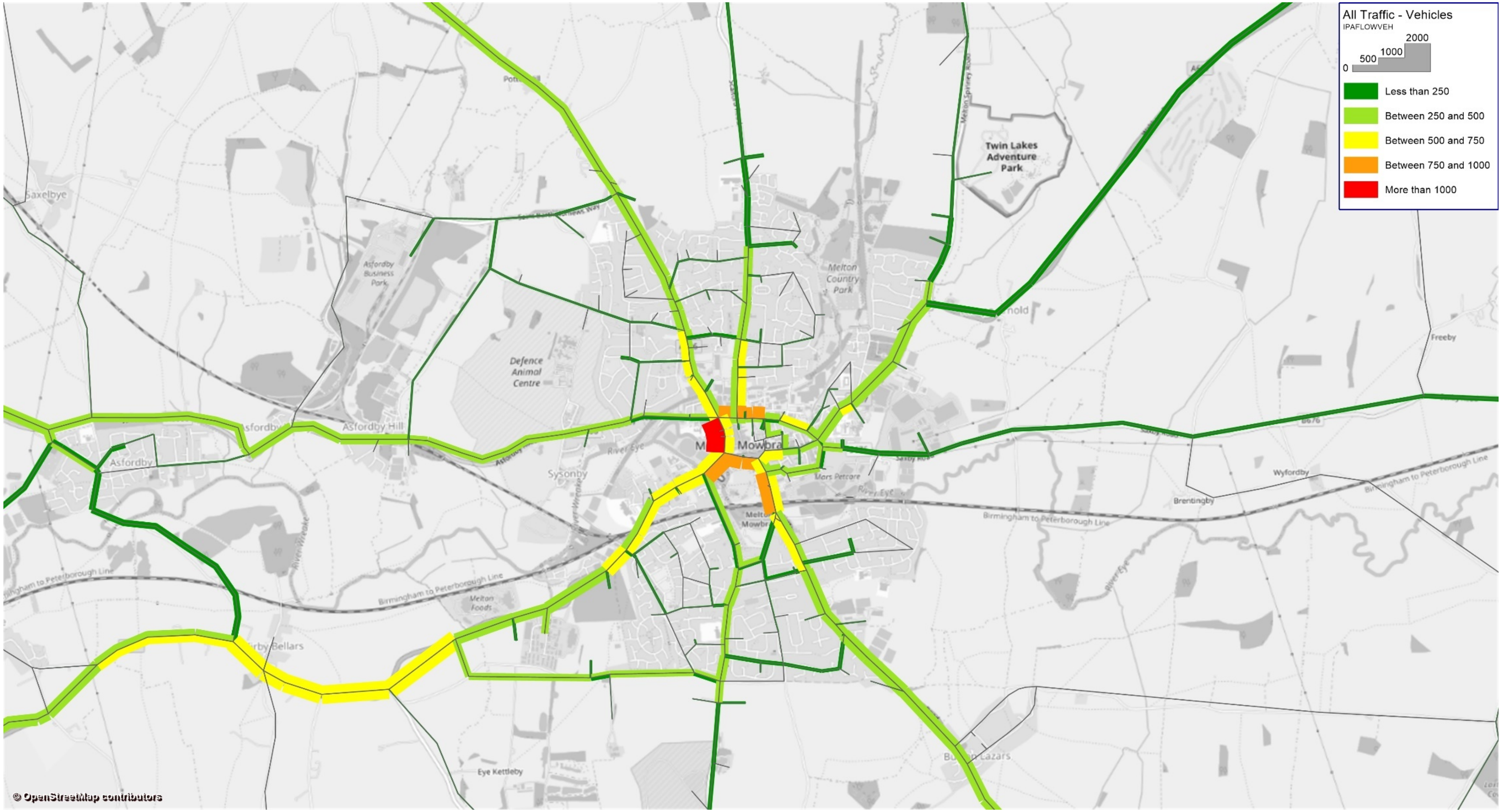

Figure B-9: Core Scenario Forecast Highway Vehicle Flows – 2030 PM Peak

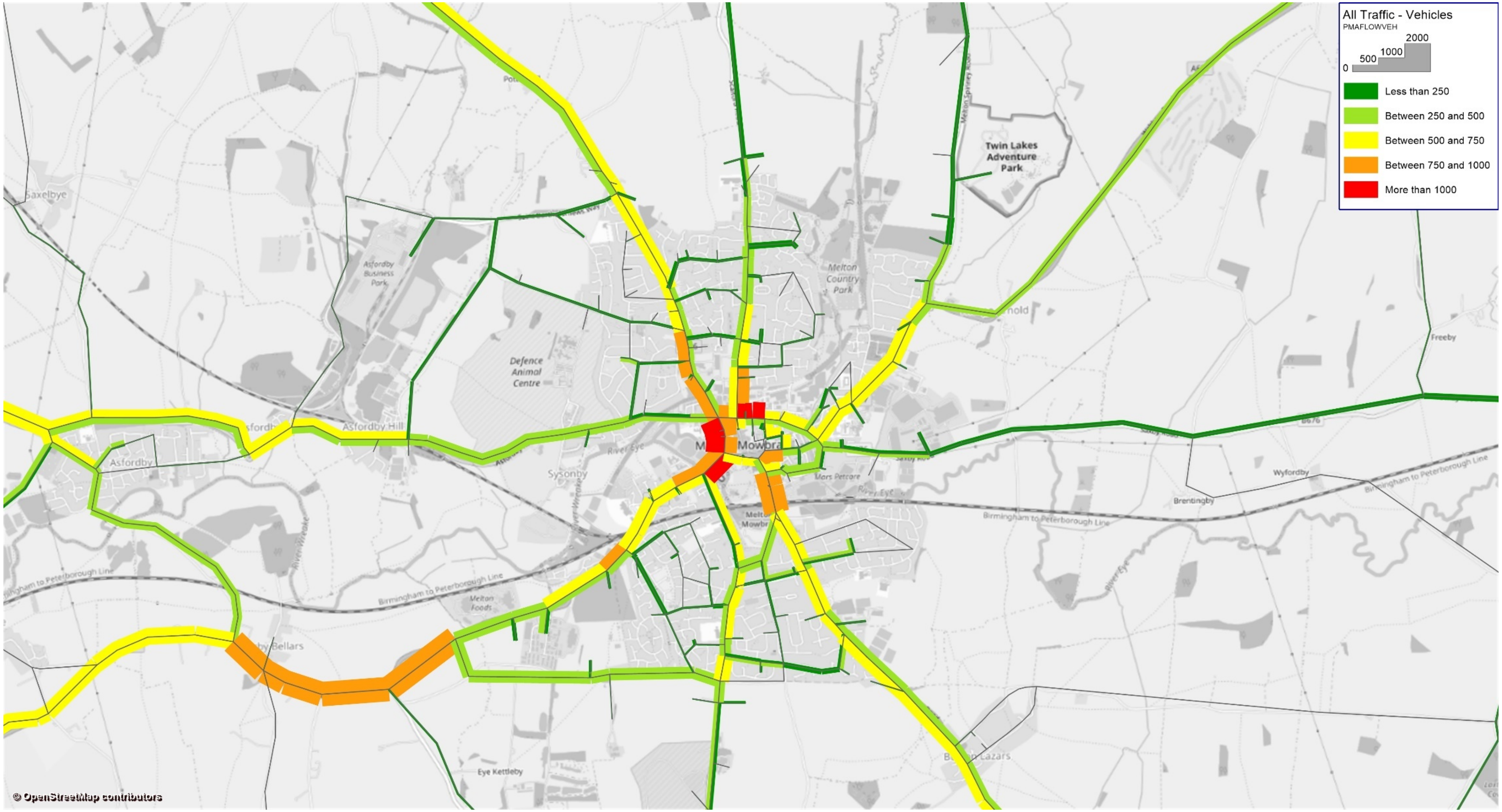

Figure B-10: Core Scenario Forecast Highway Vehicle Flows – 2040 AM Peak

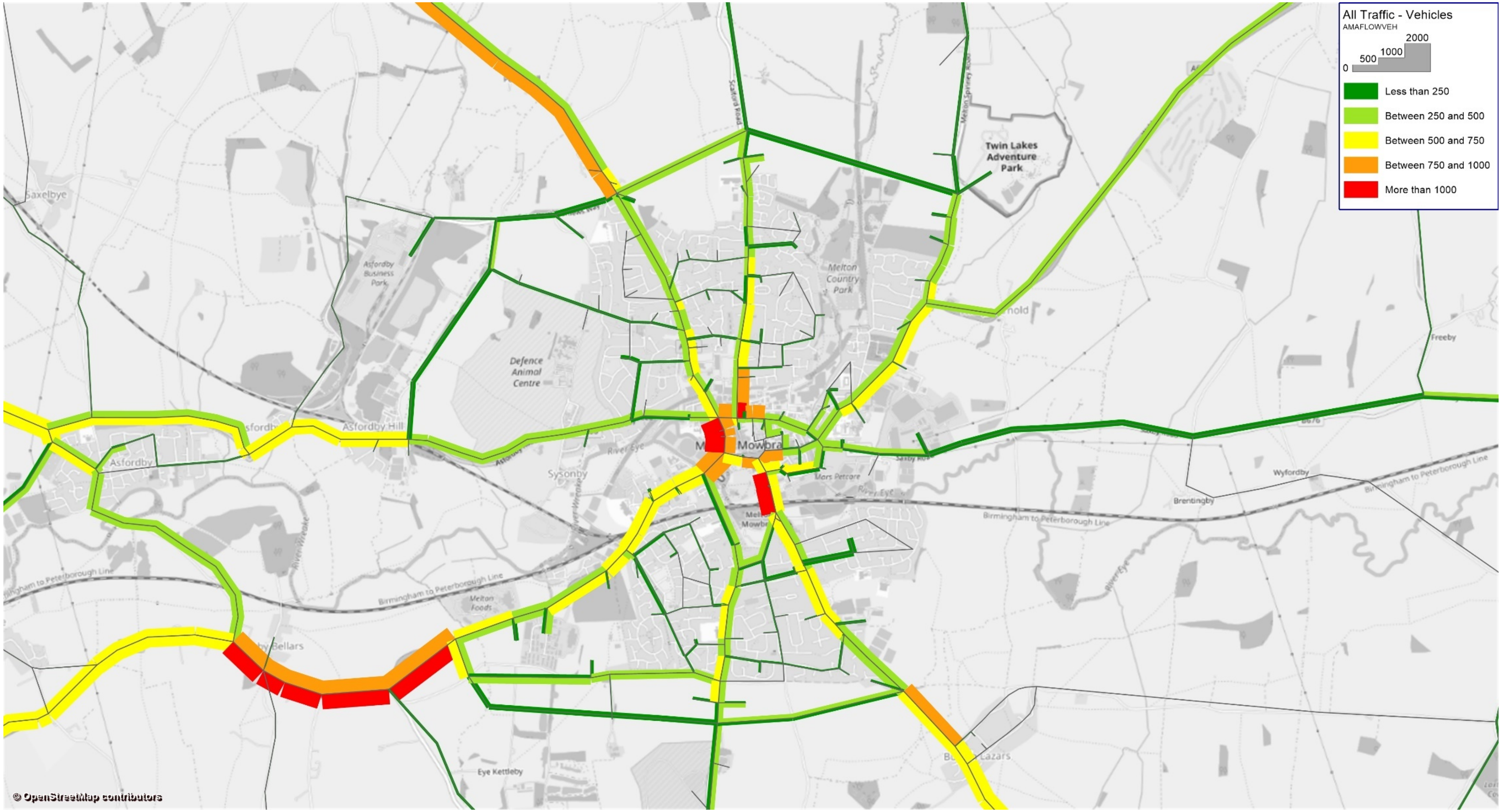

Figure B-11: Core Scenario Forecast Highway Vehicle Flows – 2040 Interpeak

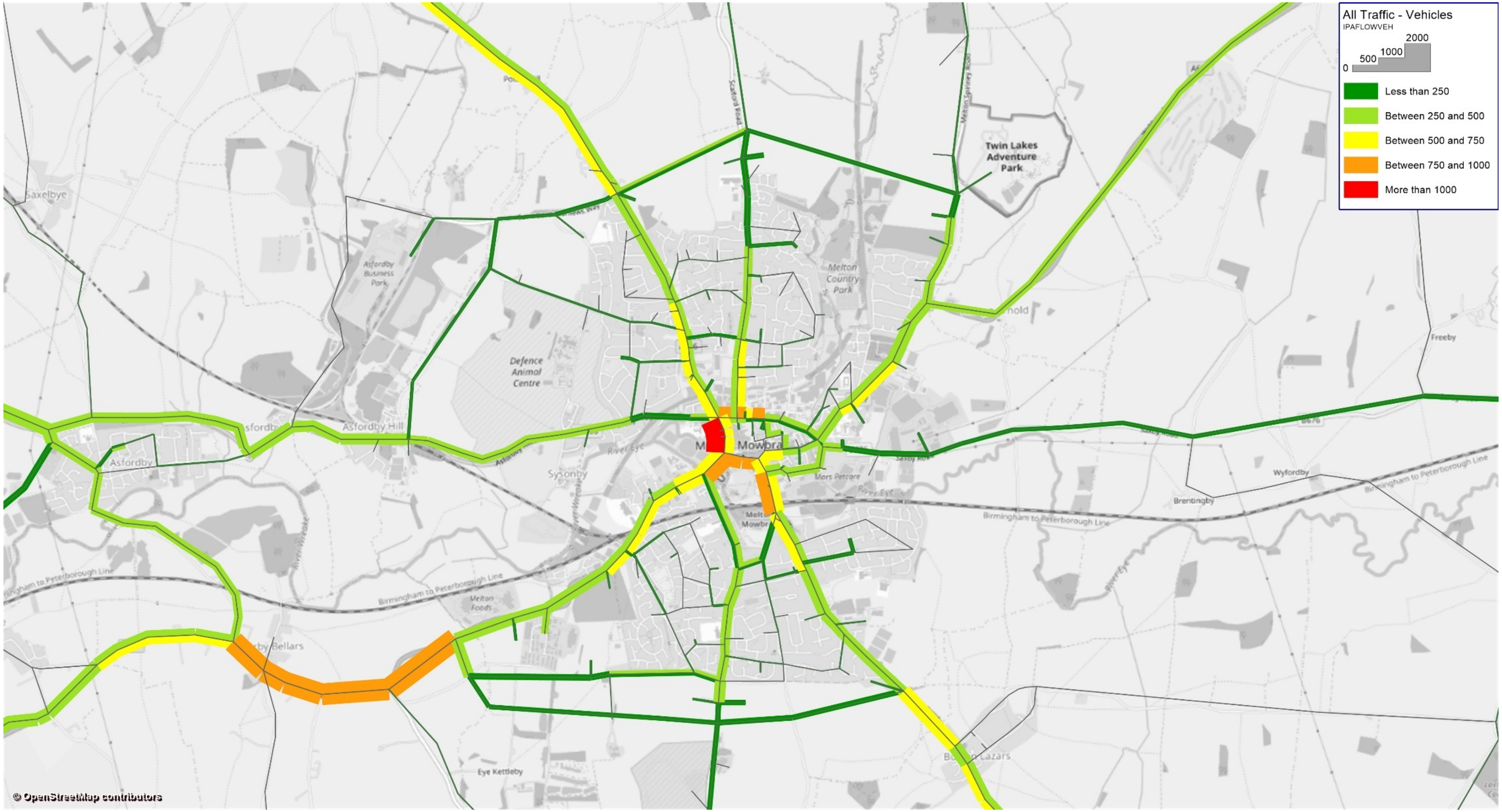

Figure B-12: Core Scenario Forecast Highway Vehicle Flows – 2040 PM Peak

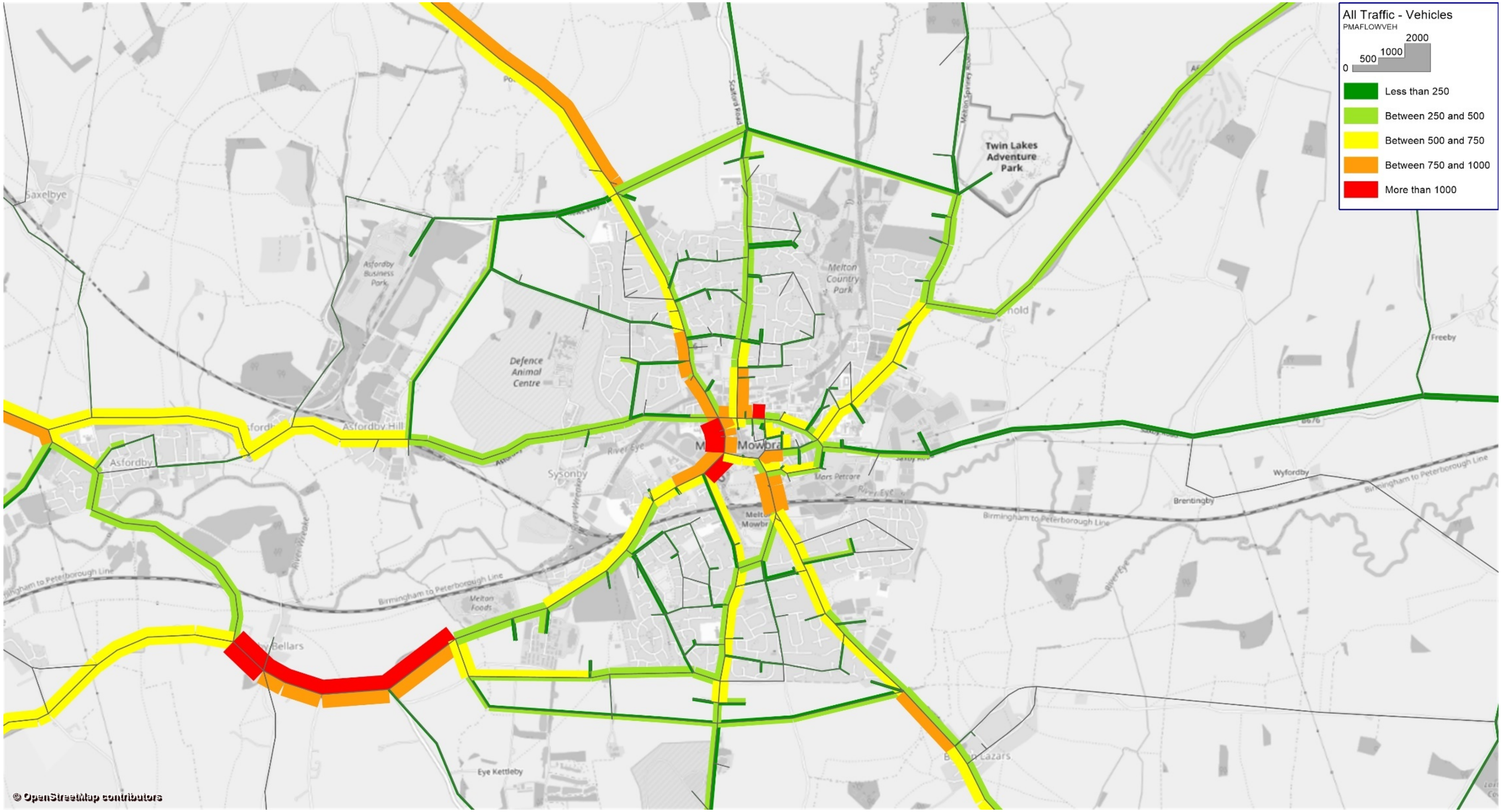

Figure B-13: Core Scenario Forecast Highway Vehicle Flows – 2051 AM Peak

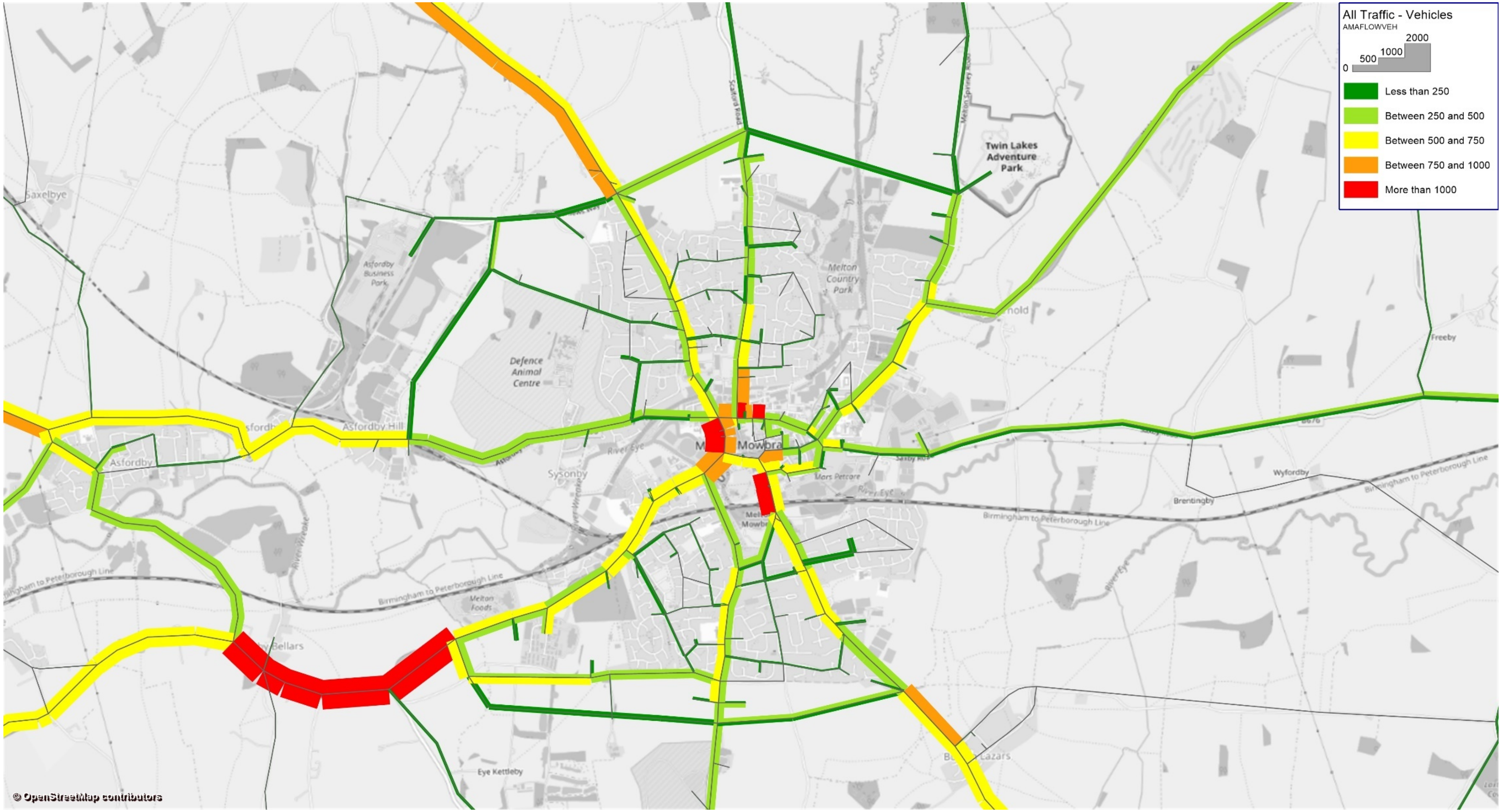

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Figure B-14: Core Scenario Forecast Highway Vehicle Flows – 2051 Interpeak

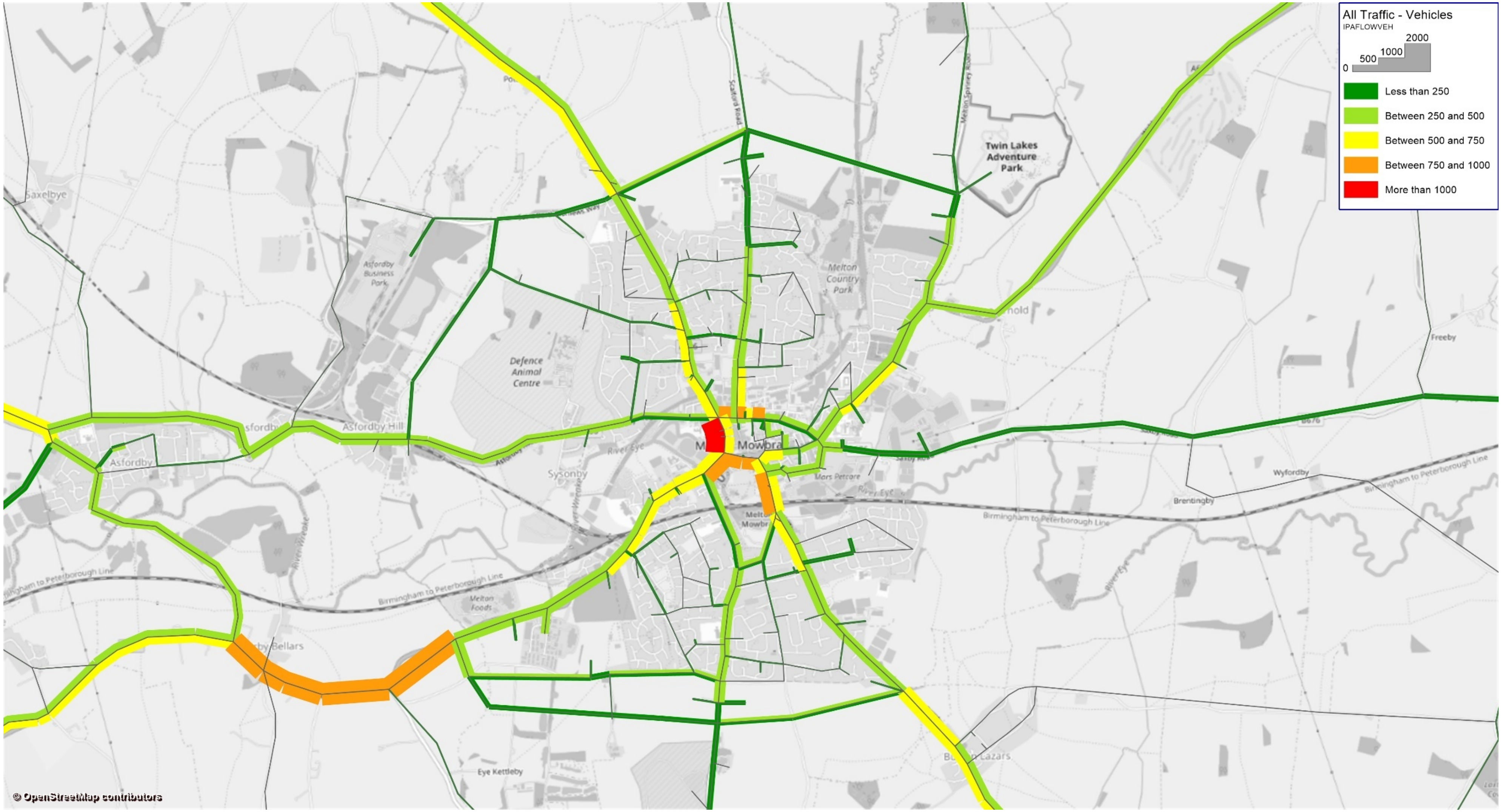
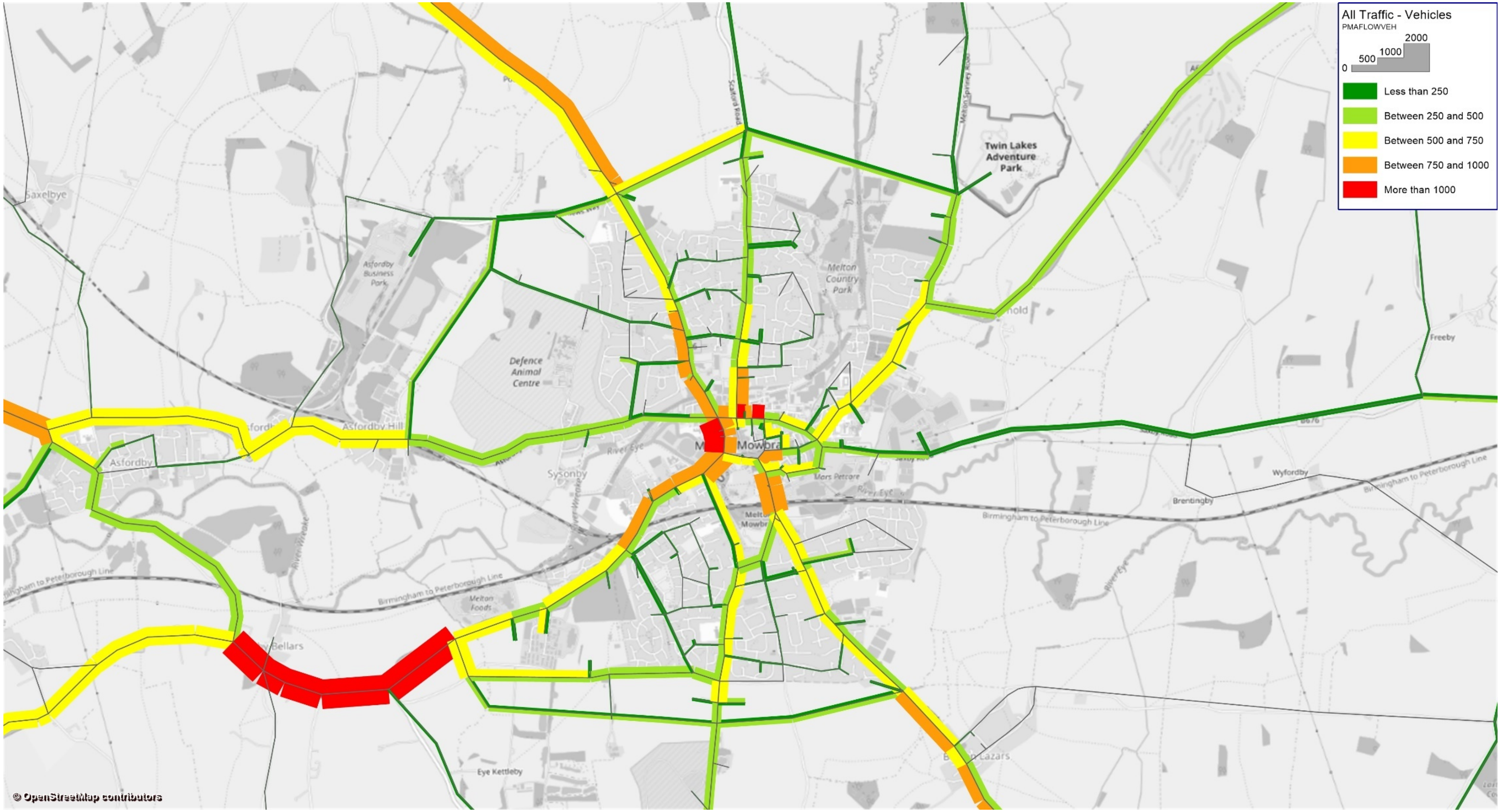


Figure B-15: Core Scenario Forecast Highway Vehicle Flows – 2051 PM Peak



Appendix C Core Scenario Forecast Volume-Capacity Ratios

Figure C-1: Core Scenario Forecast Highway Volume-Capacity Ratio – 2014 AM Peak

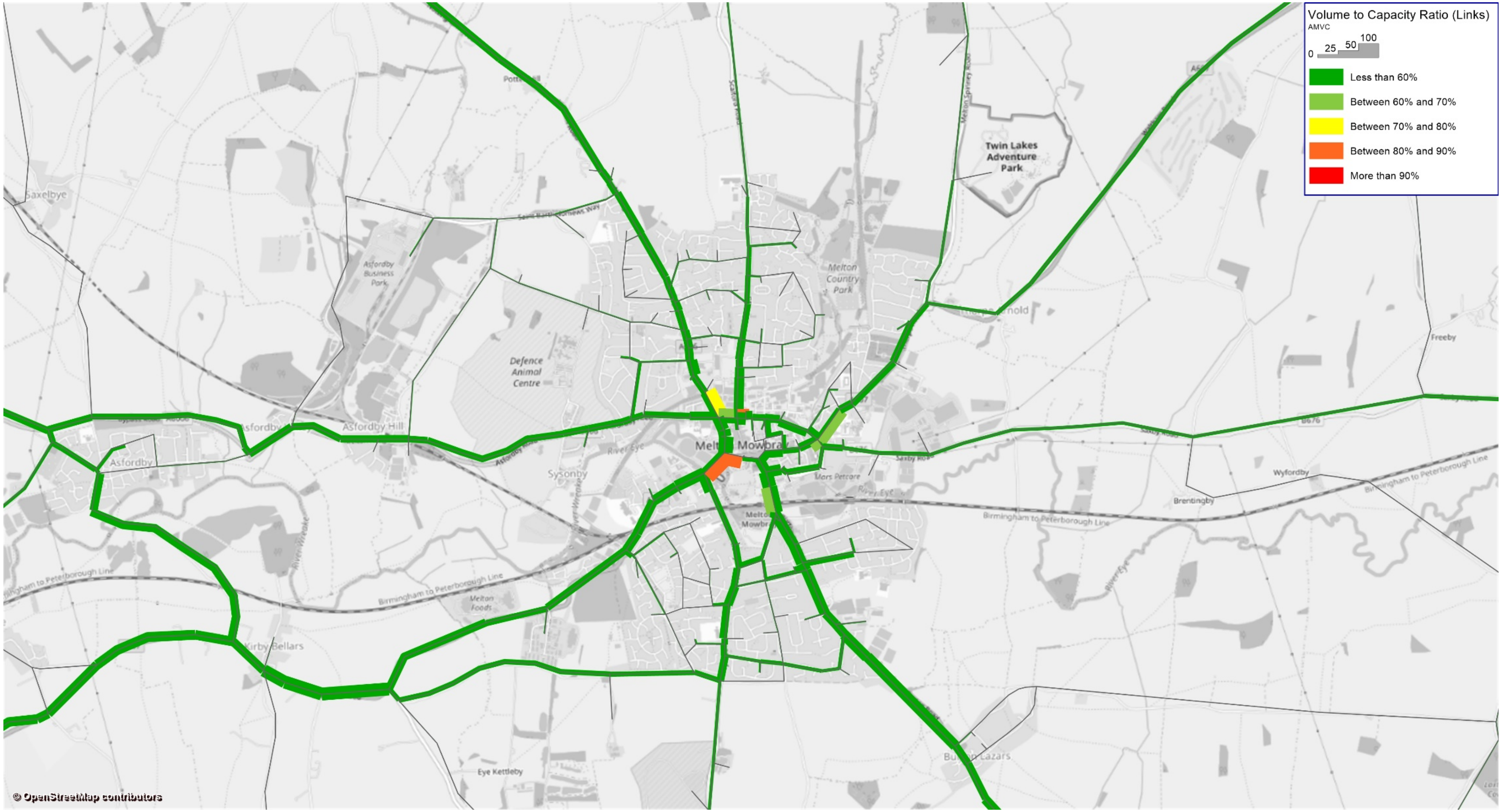


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Figure C-2: Core Scenario Forecast Highway Volume-Capacity Ratio – 2014 Interpeak

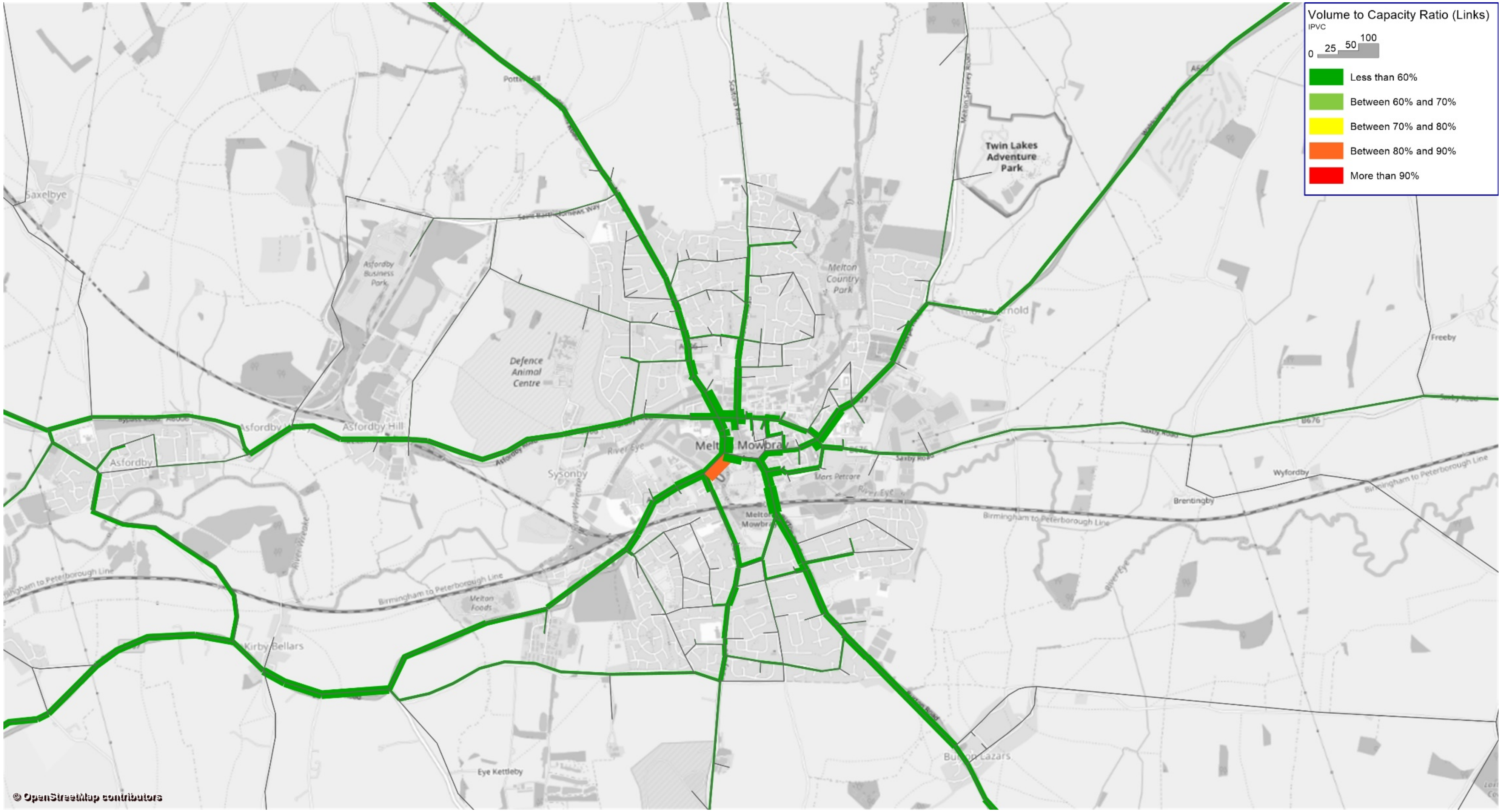

Figure C-3: Core Scenario Forecast Highway Volume-Capacity Ratio – 2014 PM Peak

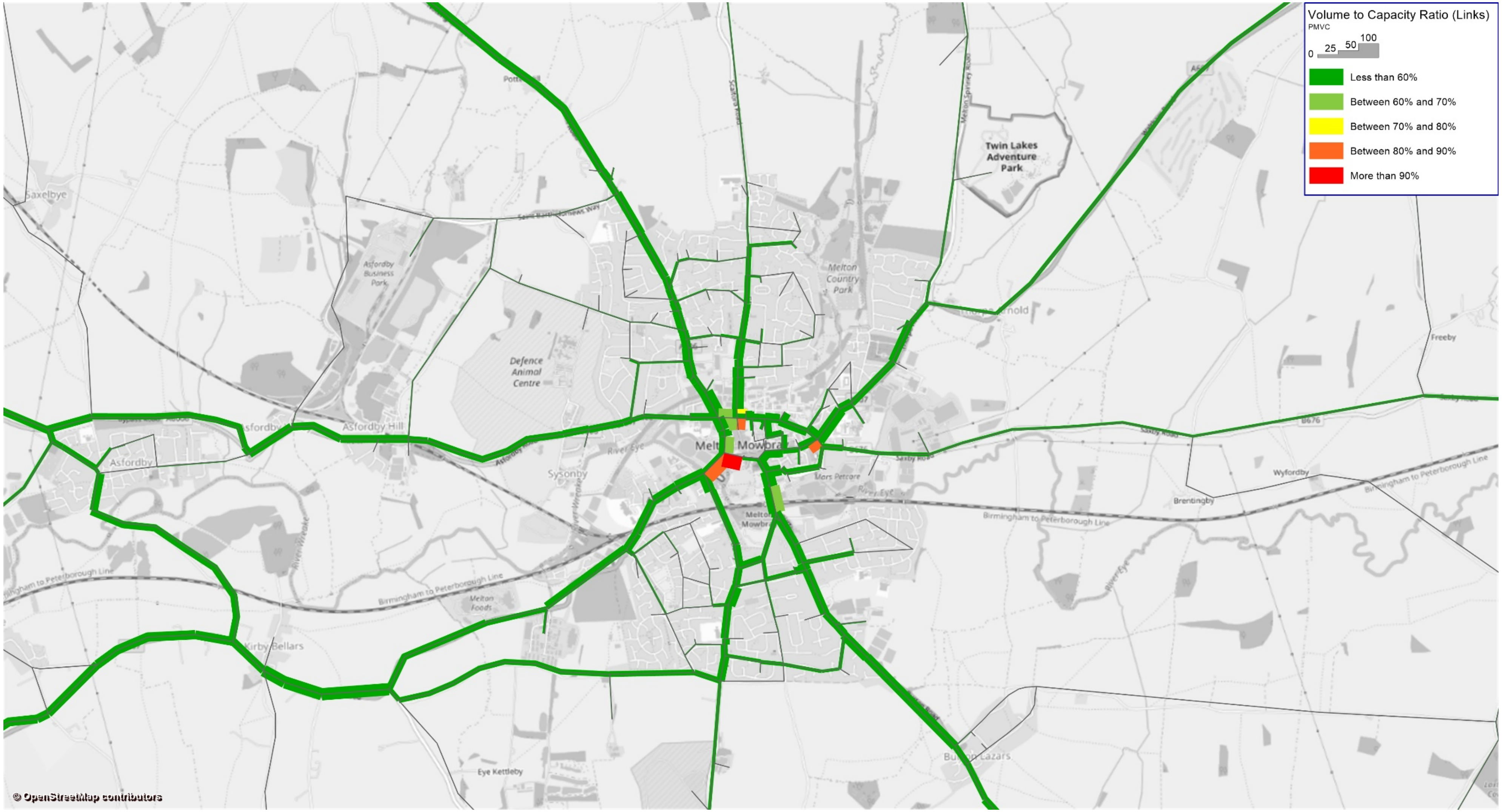

Figure C-4: Core Scenario Forecast Highway Volume-Capacity Ratio – 2025 AM Peak

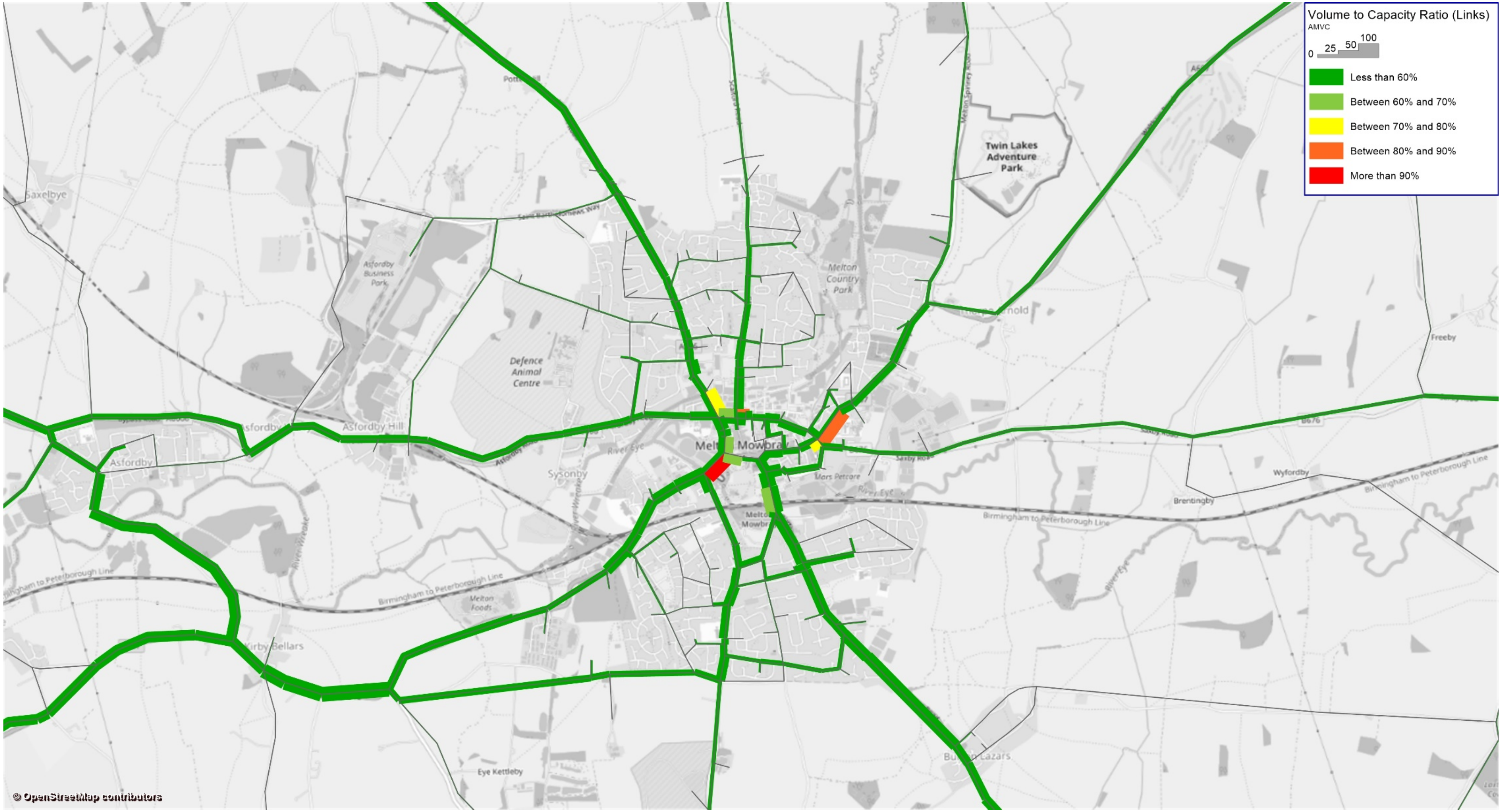

Figure C-5: Core Scenario Forecast Highway Volume-Capacity Ratio – 2025 Interpeak

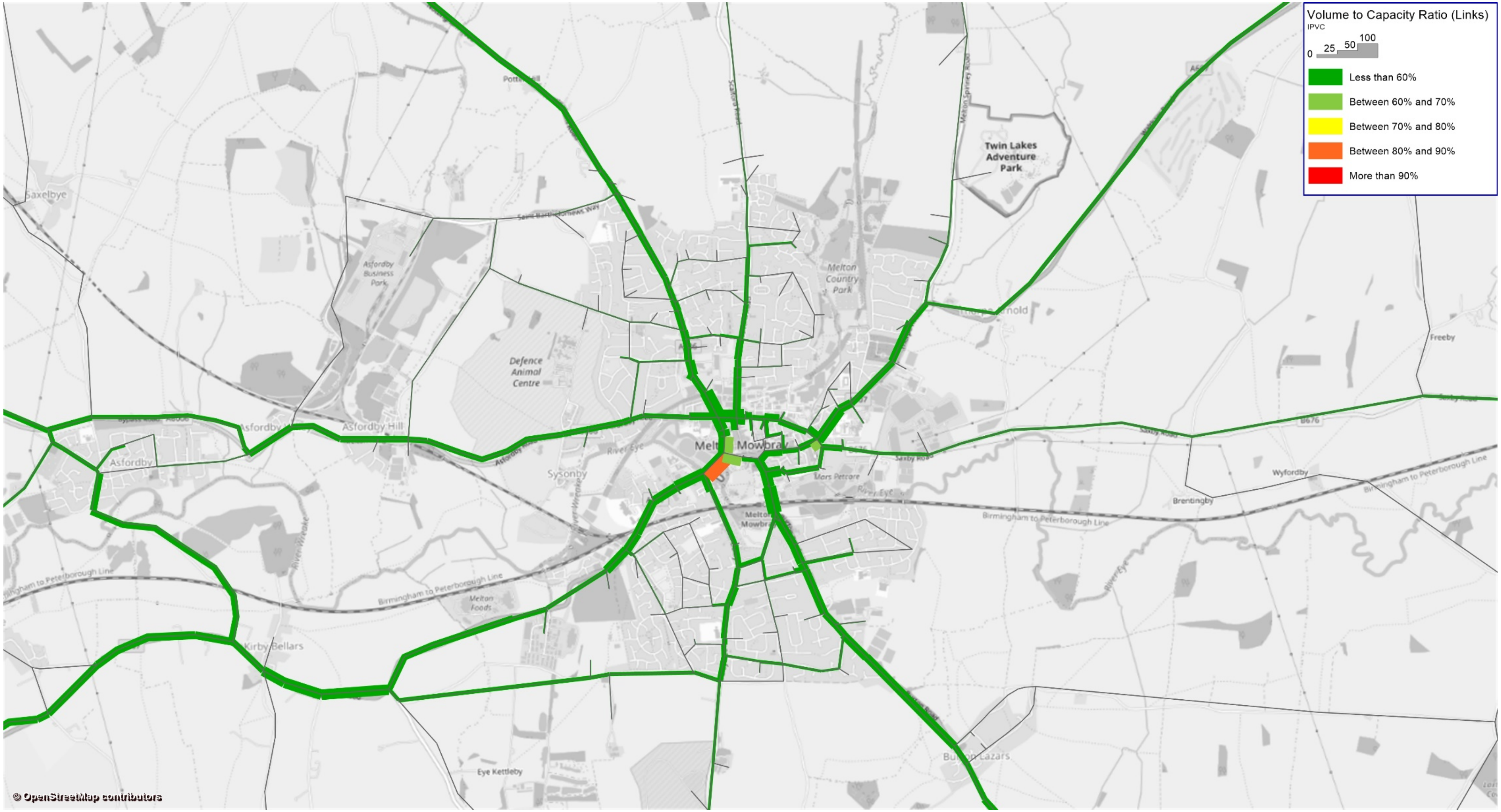

Figure C-6: Core Scenario Forecast Highway Volume-Capacity Ratio – 2025 PM Peak

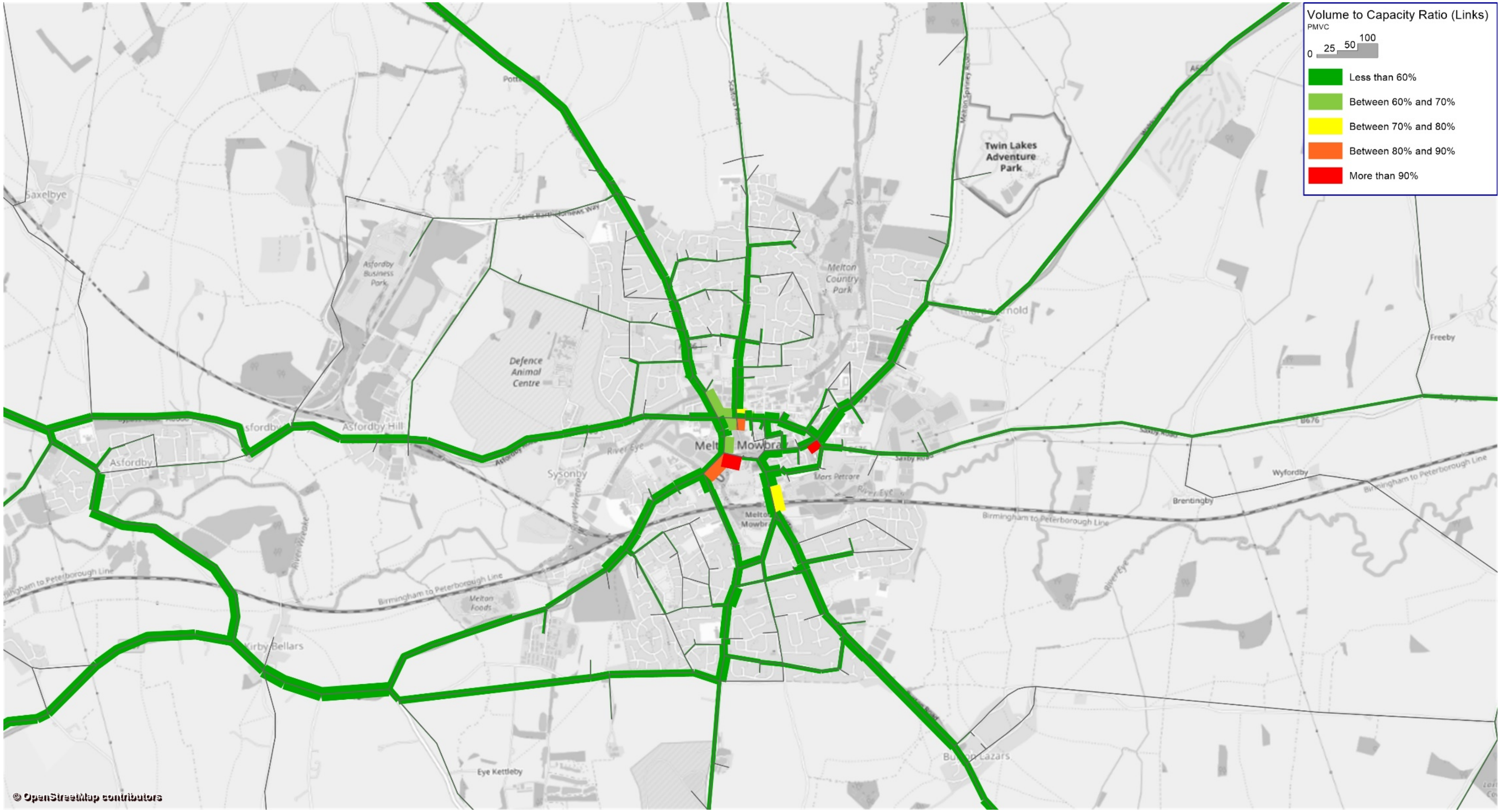

Figure C-7: Core Scenario Forecast Highway Volume-Capacity Ratio – 2030 AM Peak

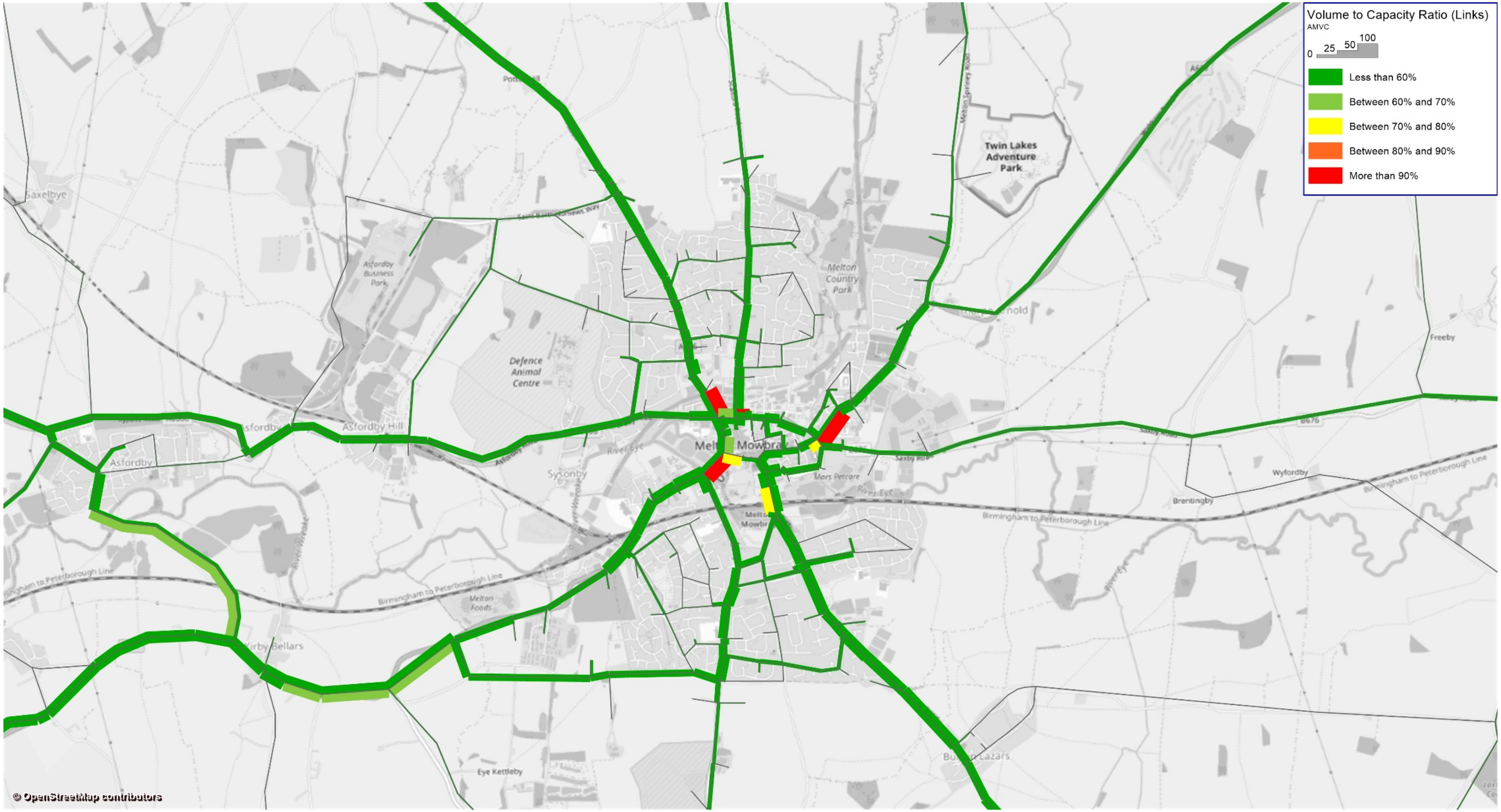

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Figure C-8: Core Scenario Forecast Highway Volume-Capacity Ratio – 2030 Interpeak

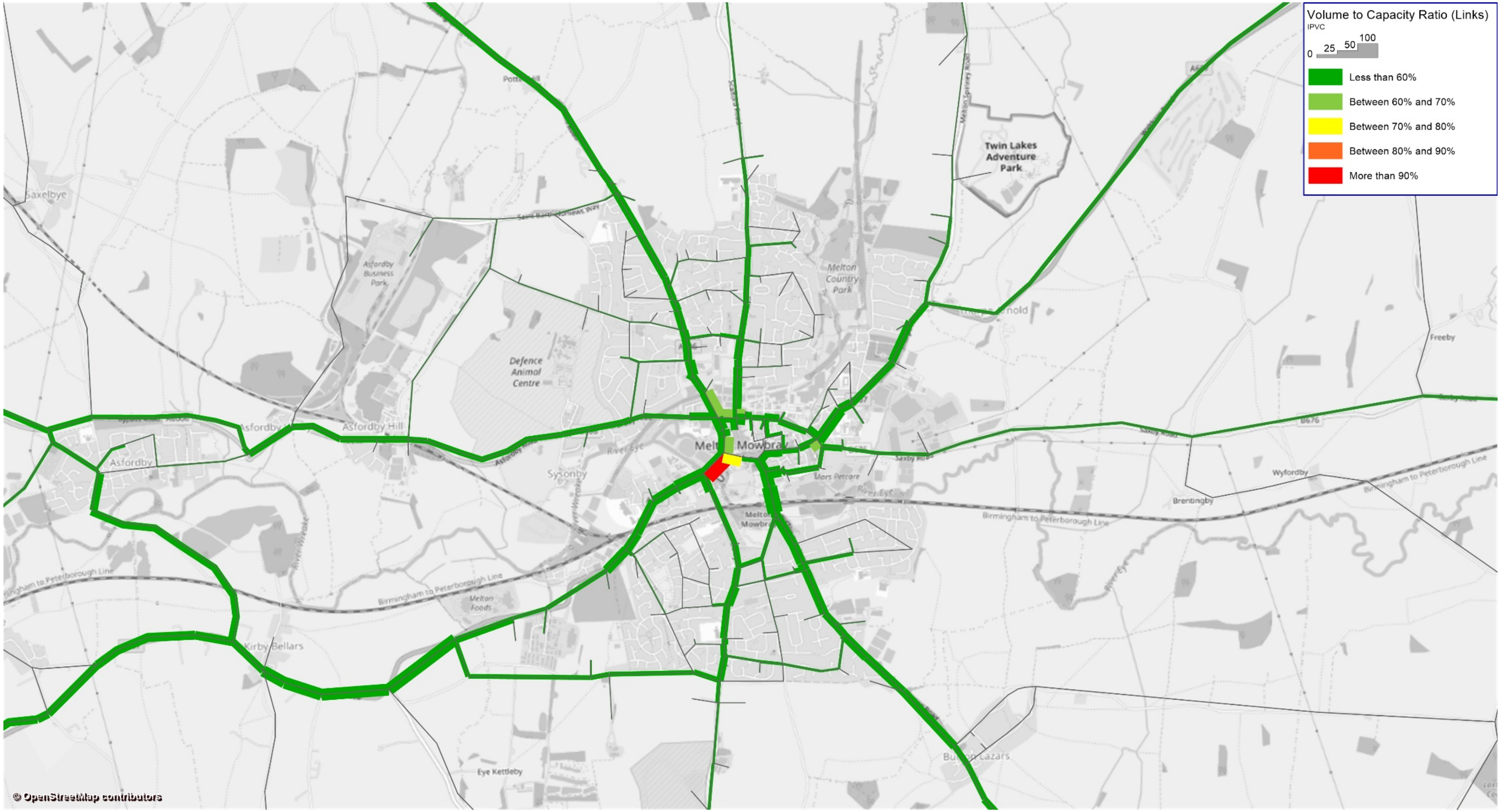


Figure C-9: Core Scenario Forecast Highway Volume-Capacity Ratio – 2030 PM Peak

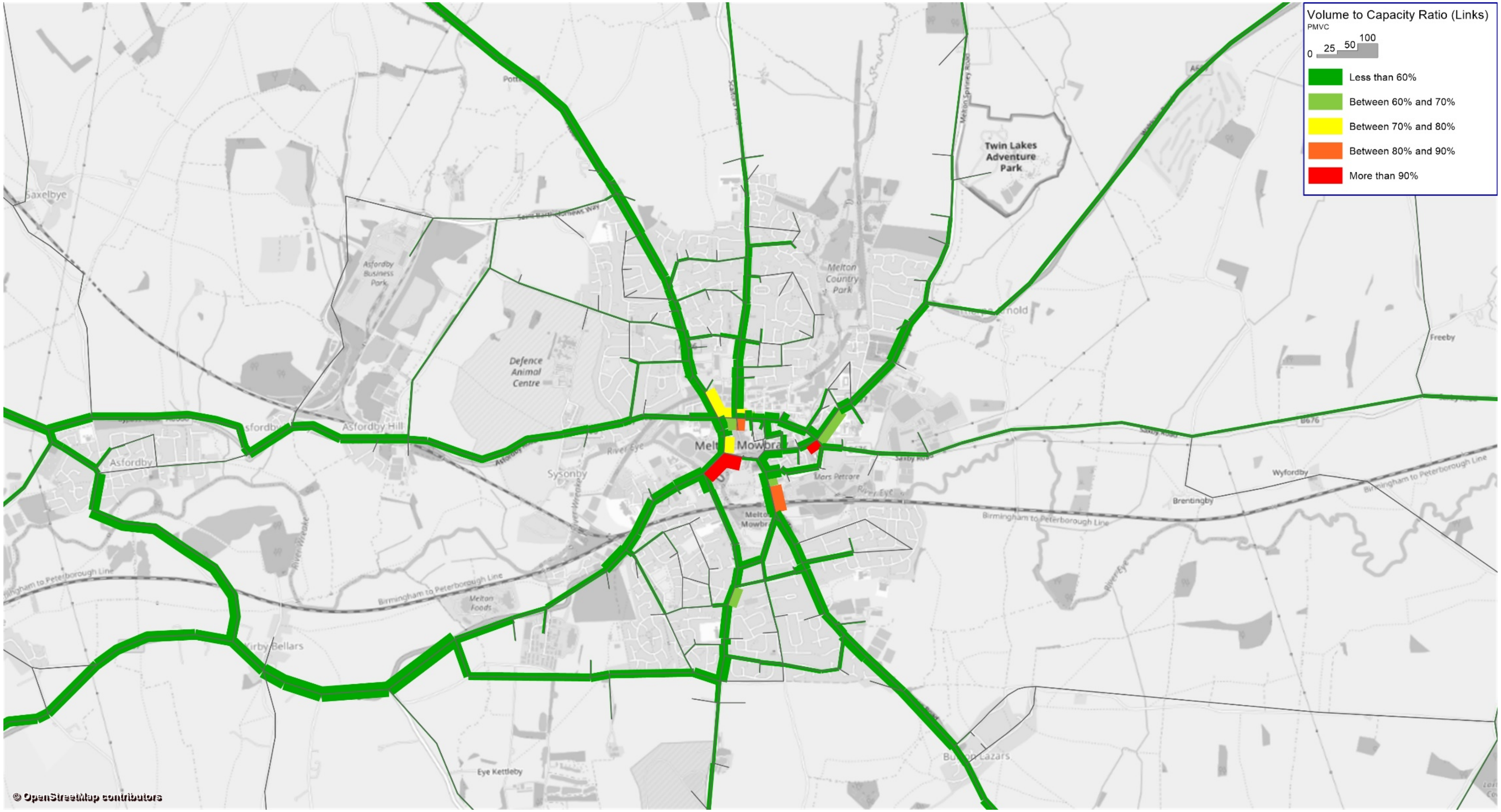


Figure C-10: Core Scenario Forecast Highway Volume-Capacity Ratio – 2040 AM Peak

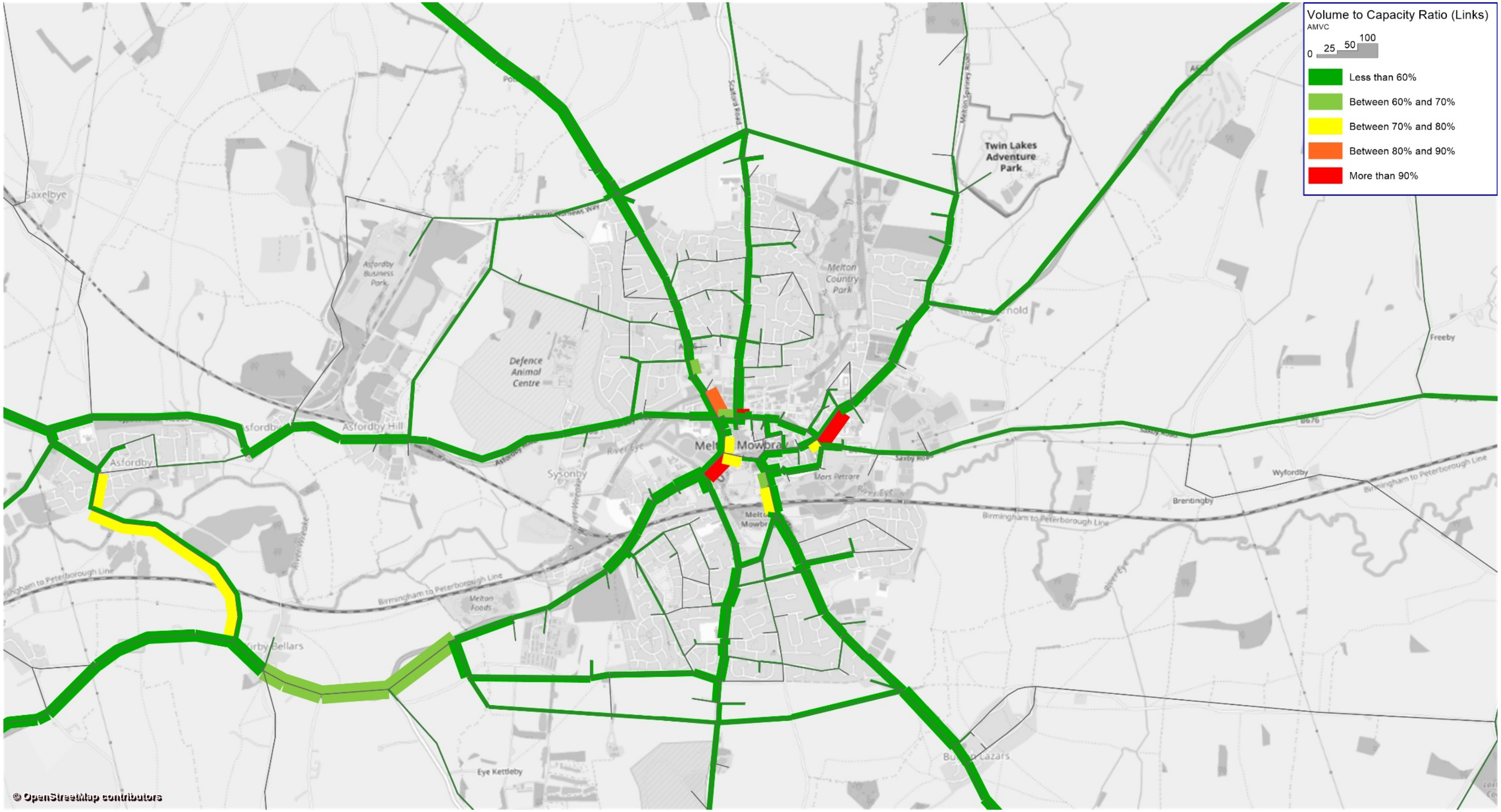


Figure C-11: Core Scenario Forecast Highway Volume-Capacity Ratio – 2040 Interpeak

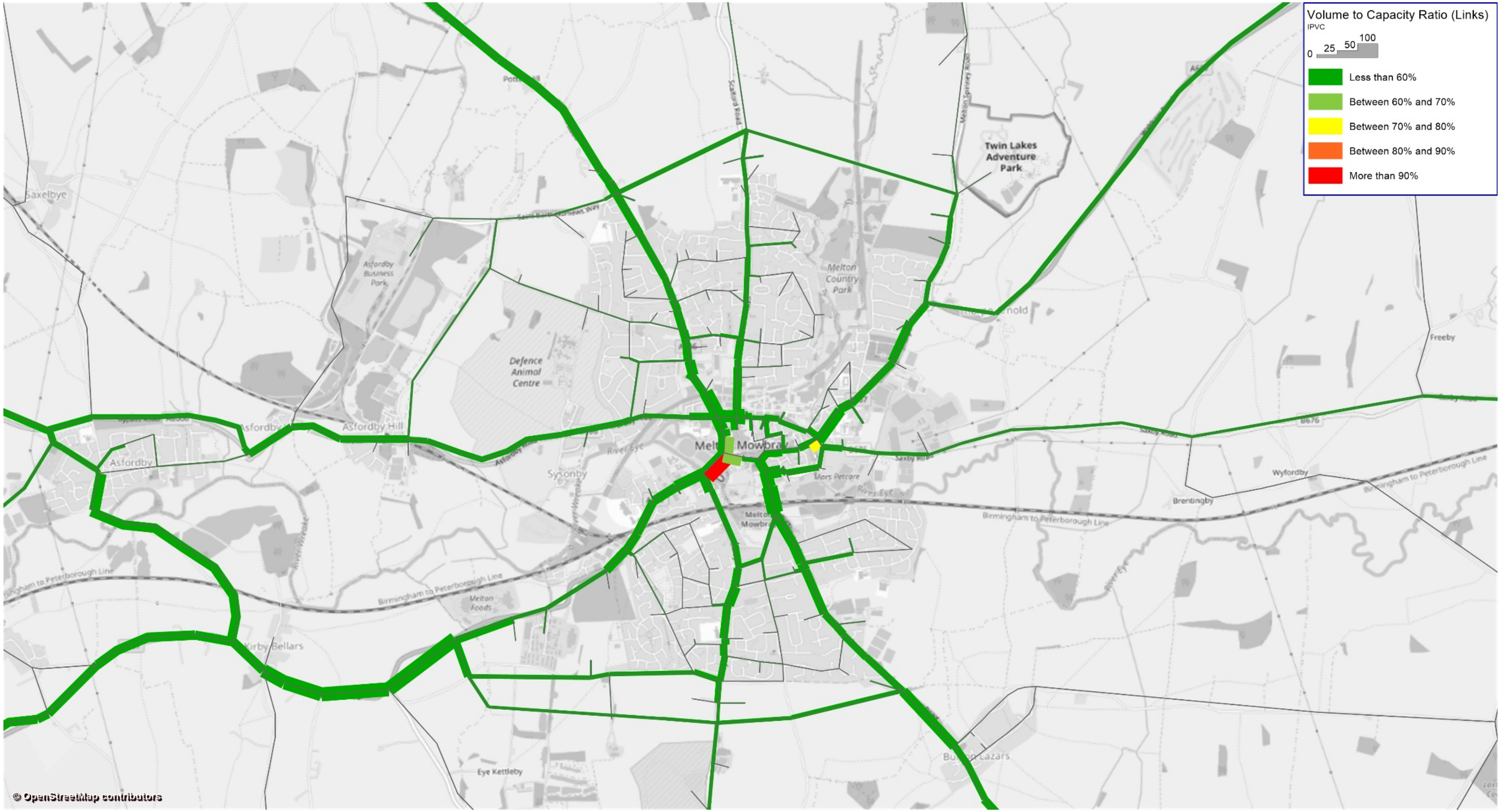


Figure C-12: Core Scenario Forecast Highway Volume-Capacity Ratio – 2040 PM Peak

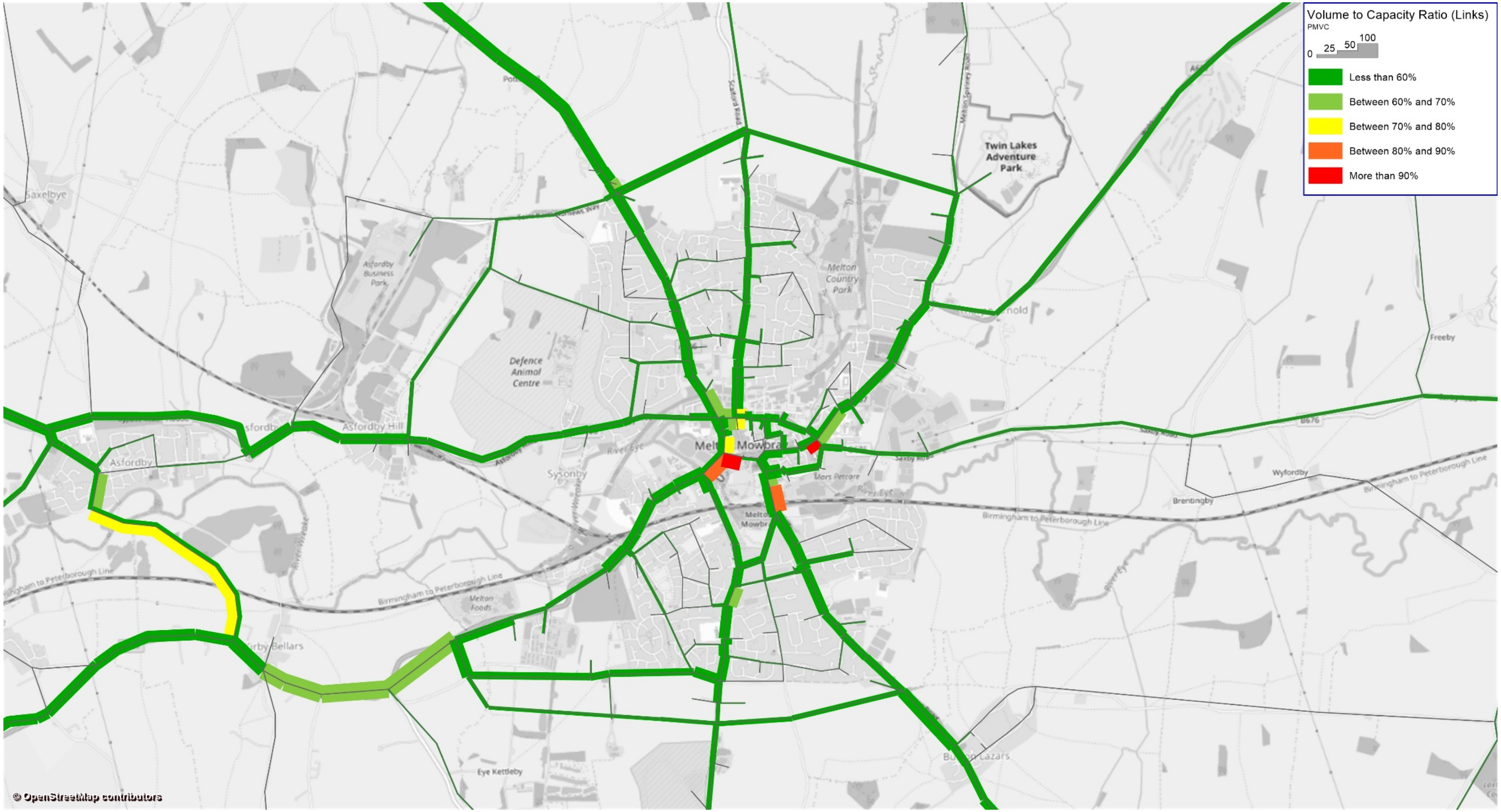


Figure C-13: Core Scenario Forecast Highway Volume-Capacity Ratio – 2051 AM Peak

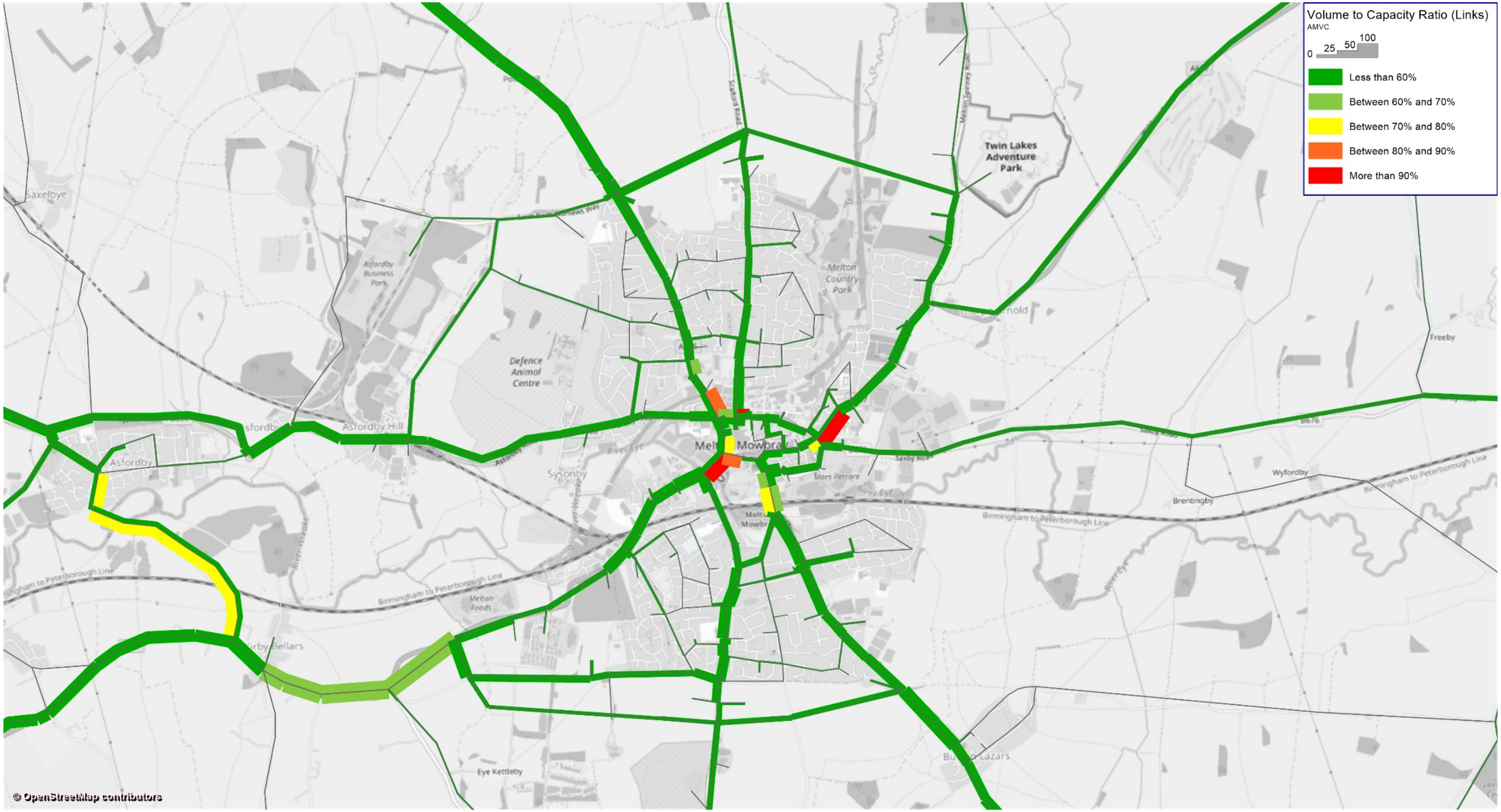


Figure C-14: Core Scenario Forecast Highway Volume-Capacity Ratio – 2051 Interpeak

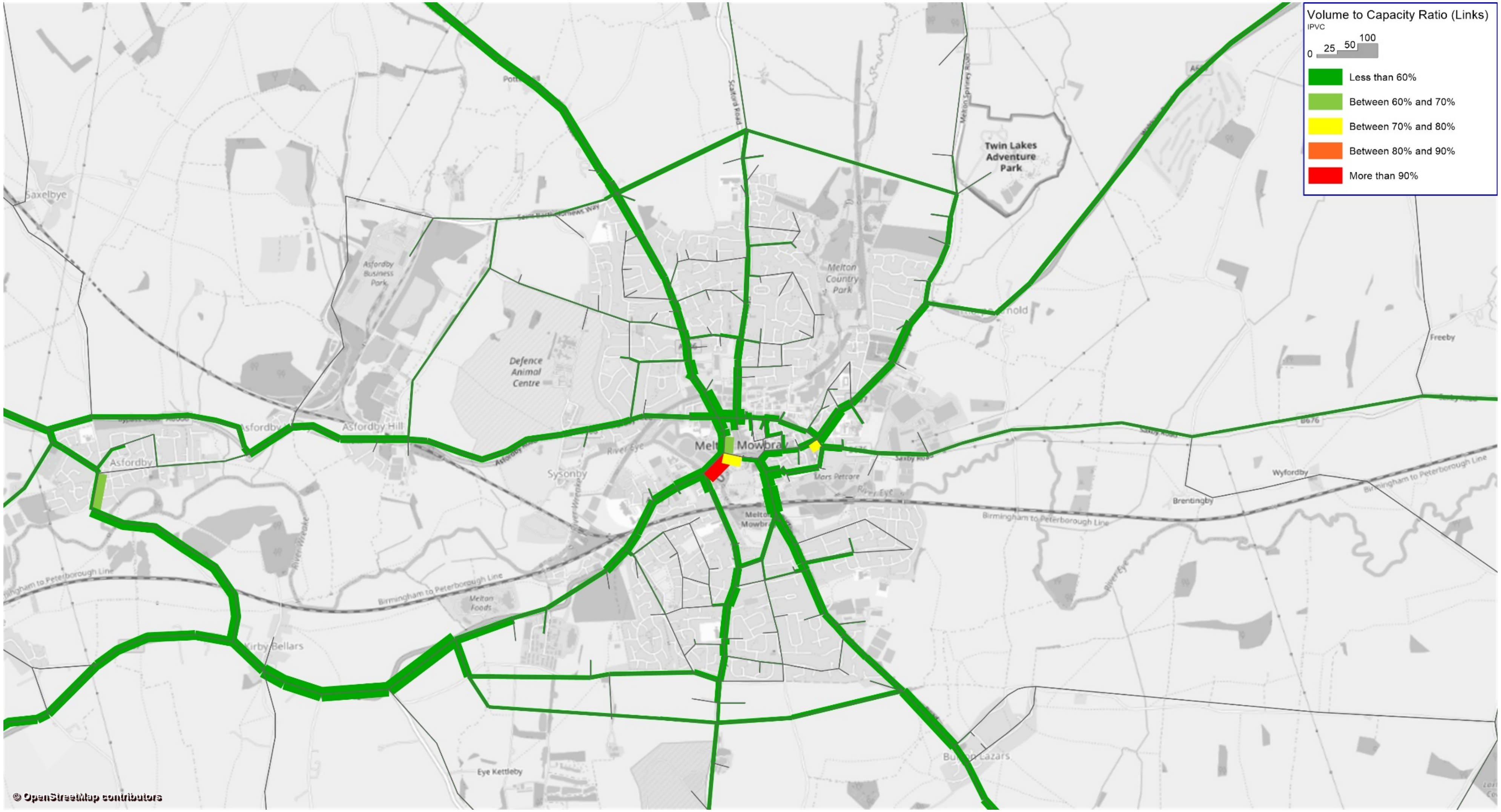
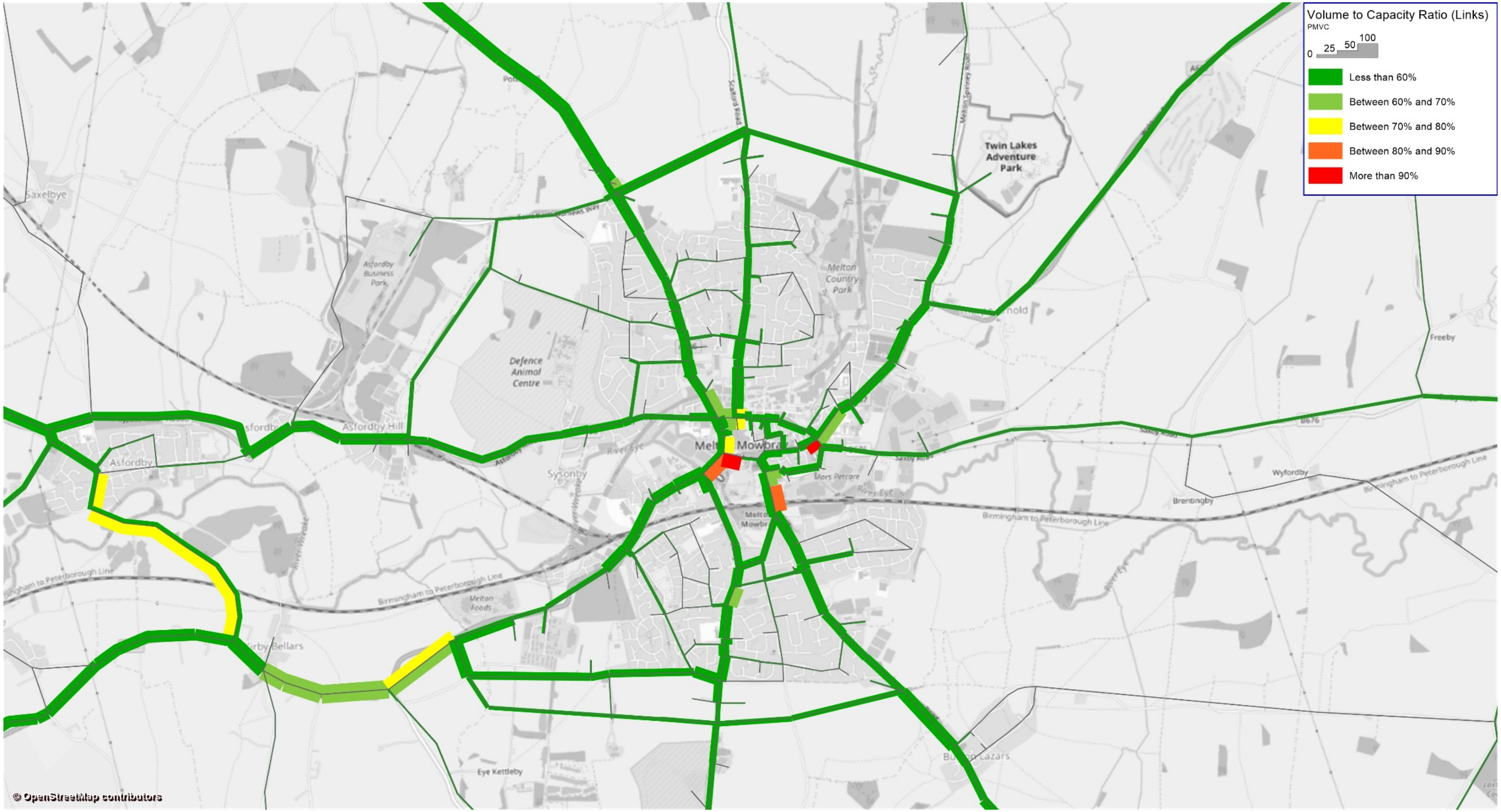


Figure C-15: Core Scenario Forecast Highway Volume-Capacity Ratio – 2051 PM Peak



Appendix D Core Scenario Forecast Junction Delays

Figure D-1: Core Scenario Forecast Highway Junction Delays – 2014 AM Peak

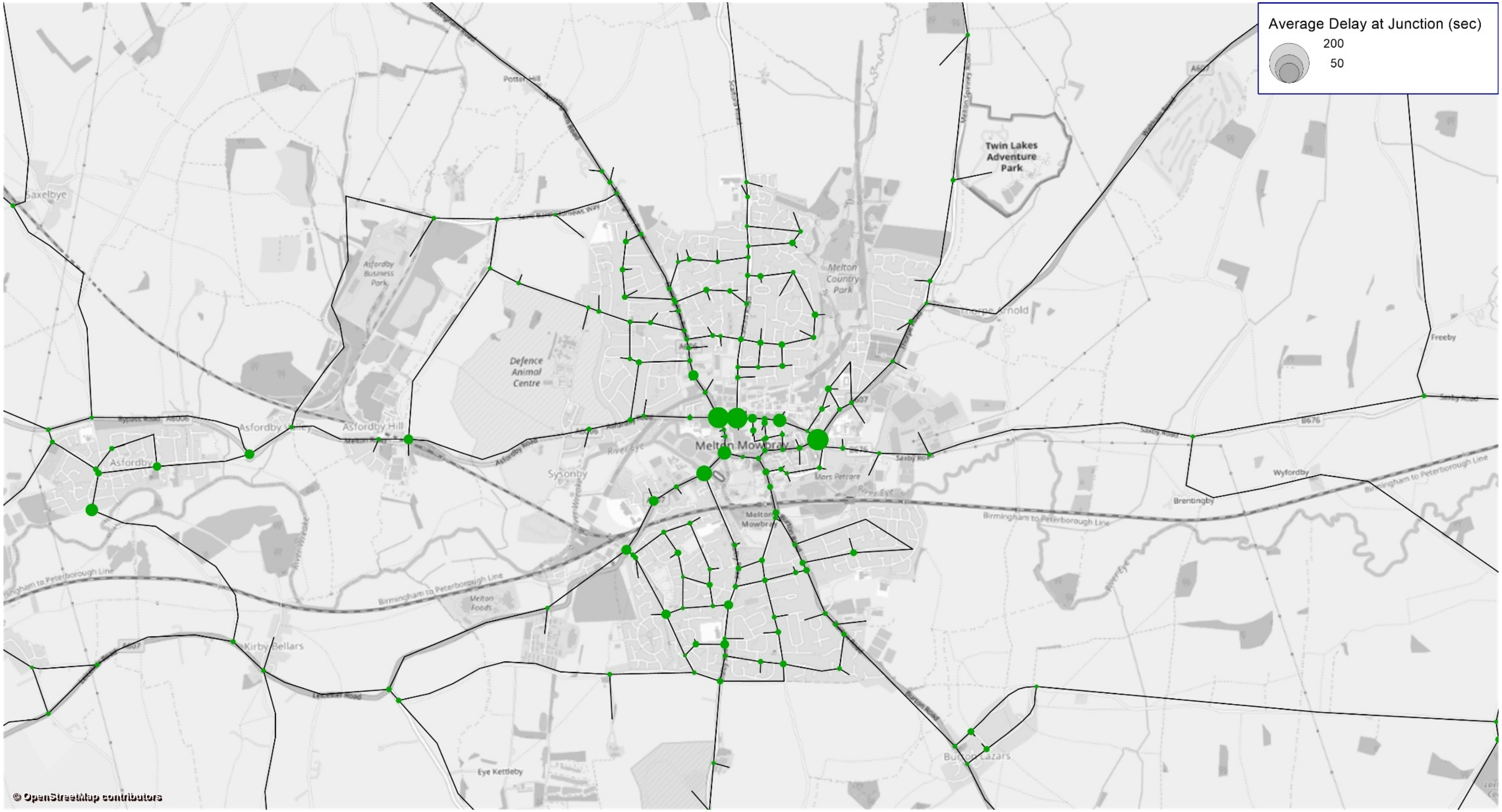


Figure D-2: Core Scenario Forecast Highway Junction Delays – 2014 Interpeak

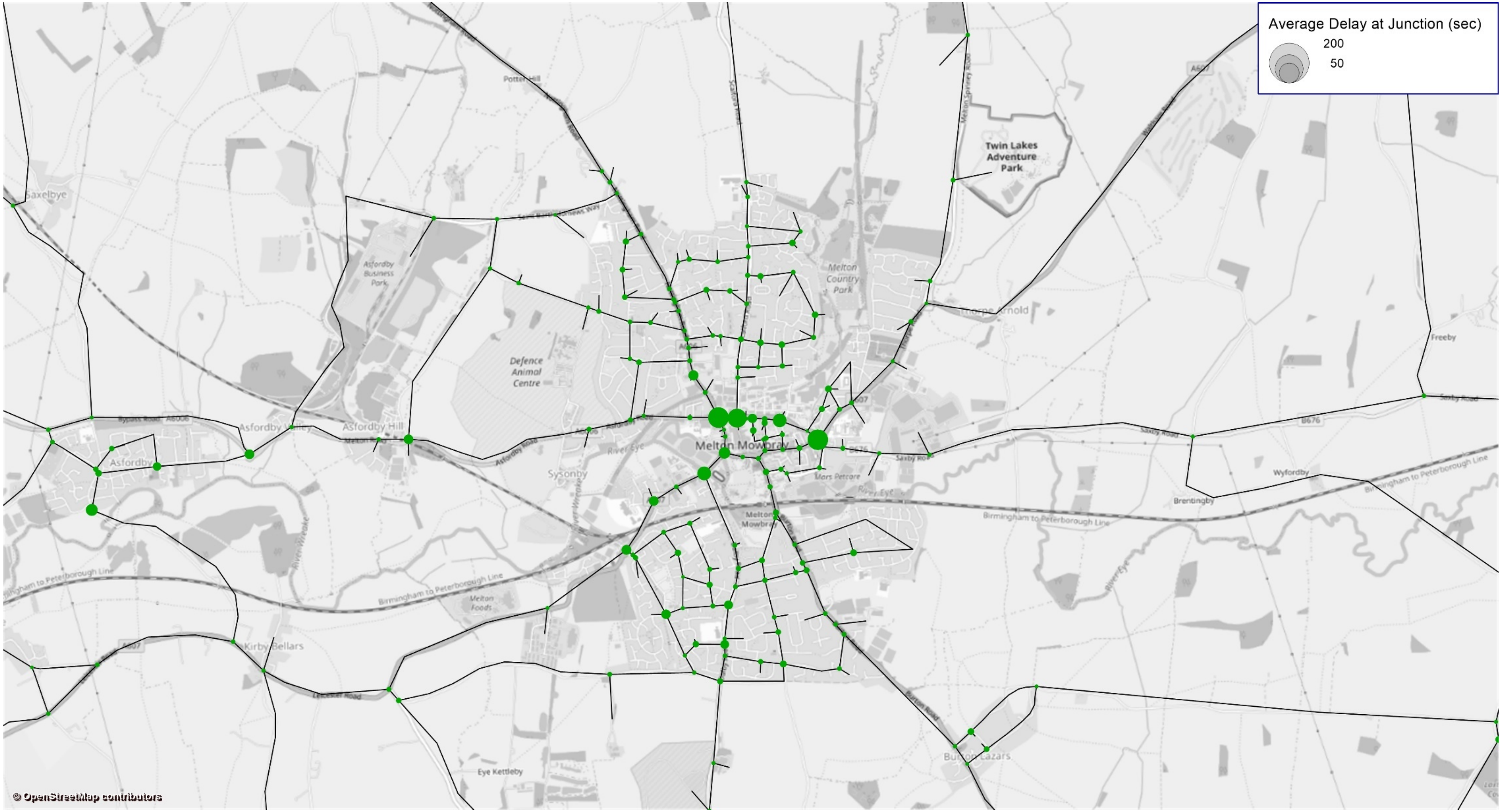


Figure D-3: Core Scenario Forecast Highway Junction Delays – 2014 PM Peak

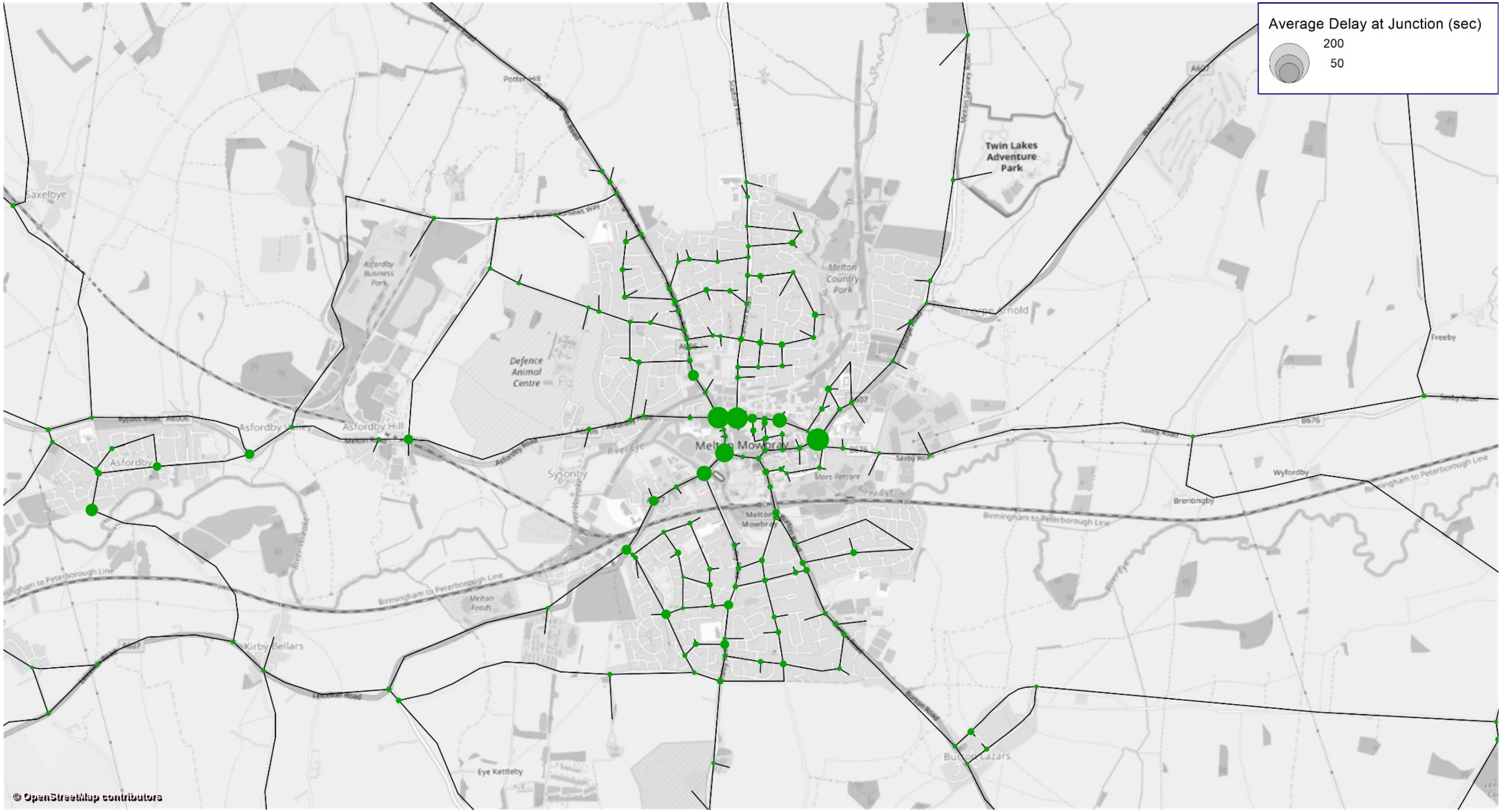


Figure D-4: Core Scenario Forecast Highway Junction Delays – 2025 AM Peak

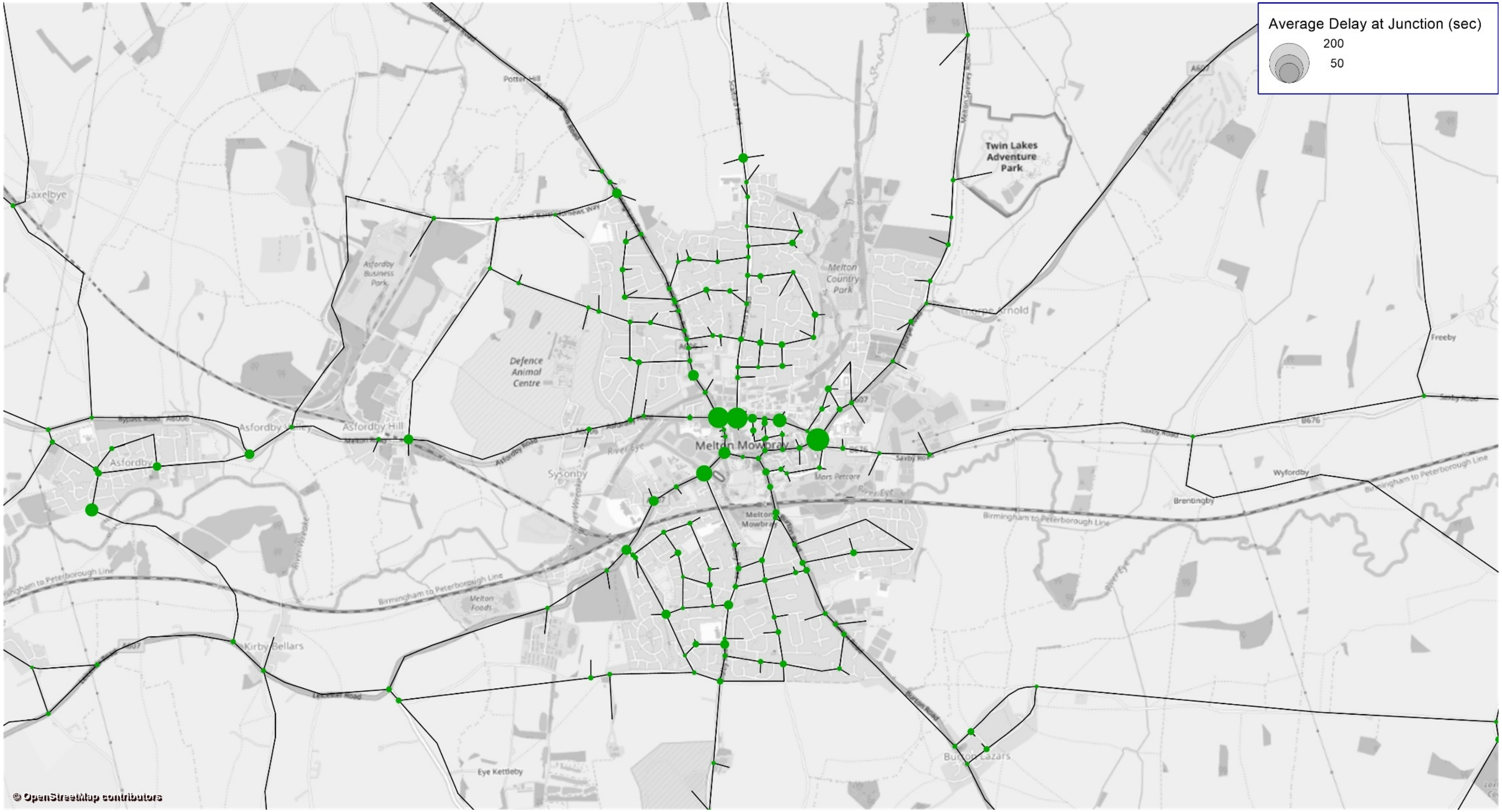


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Figure D-5: Core Scenario Forecast Highway Junction Delays – 2025 Interpeak

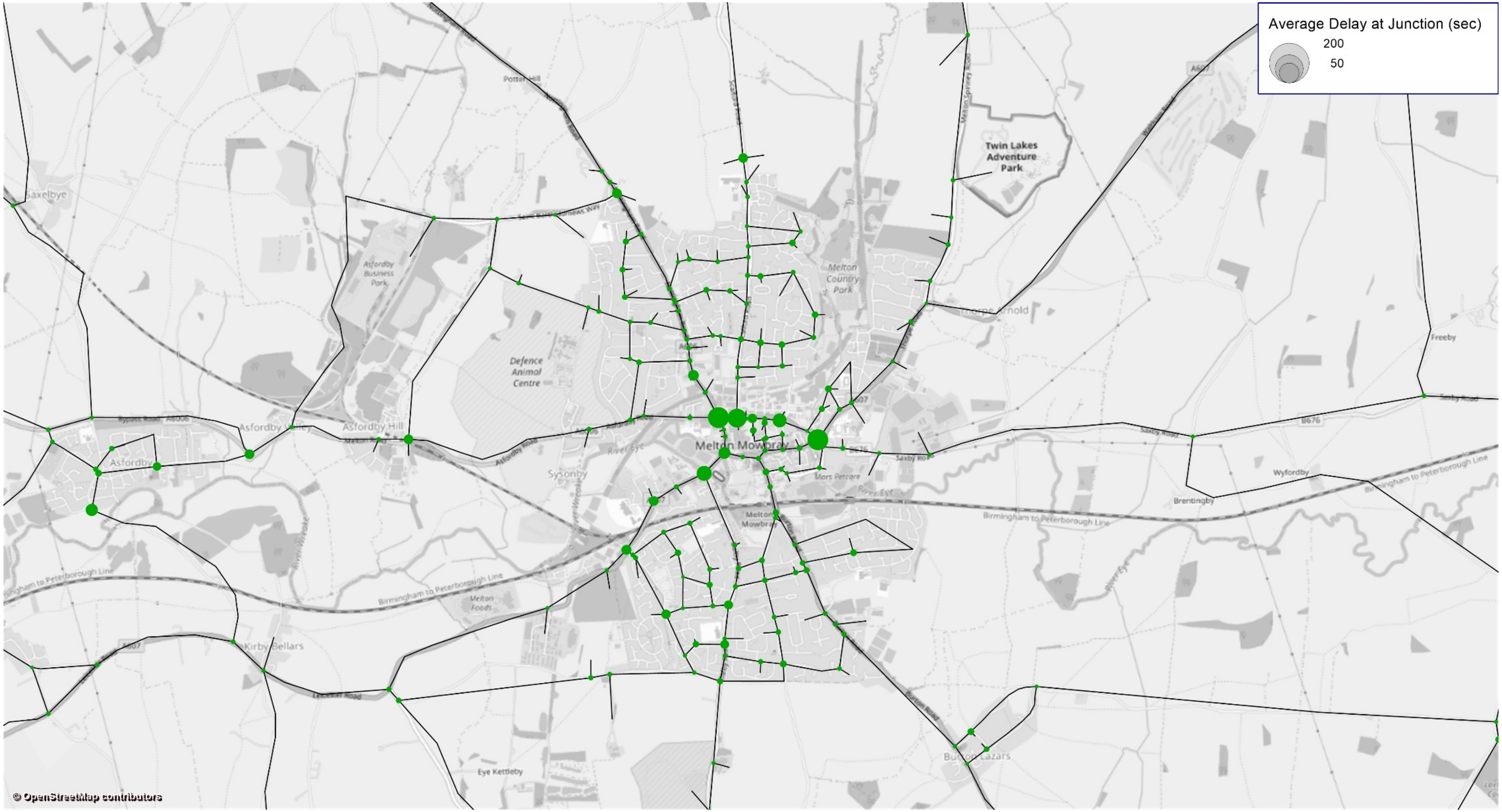

Figure D-6: Core Scenario Forecast Highway Junction Delays – 2025 PM Peak

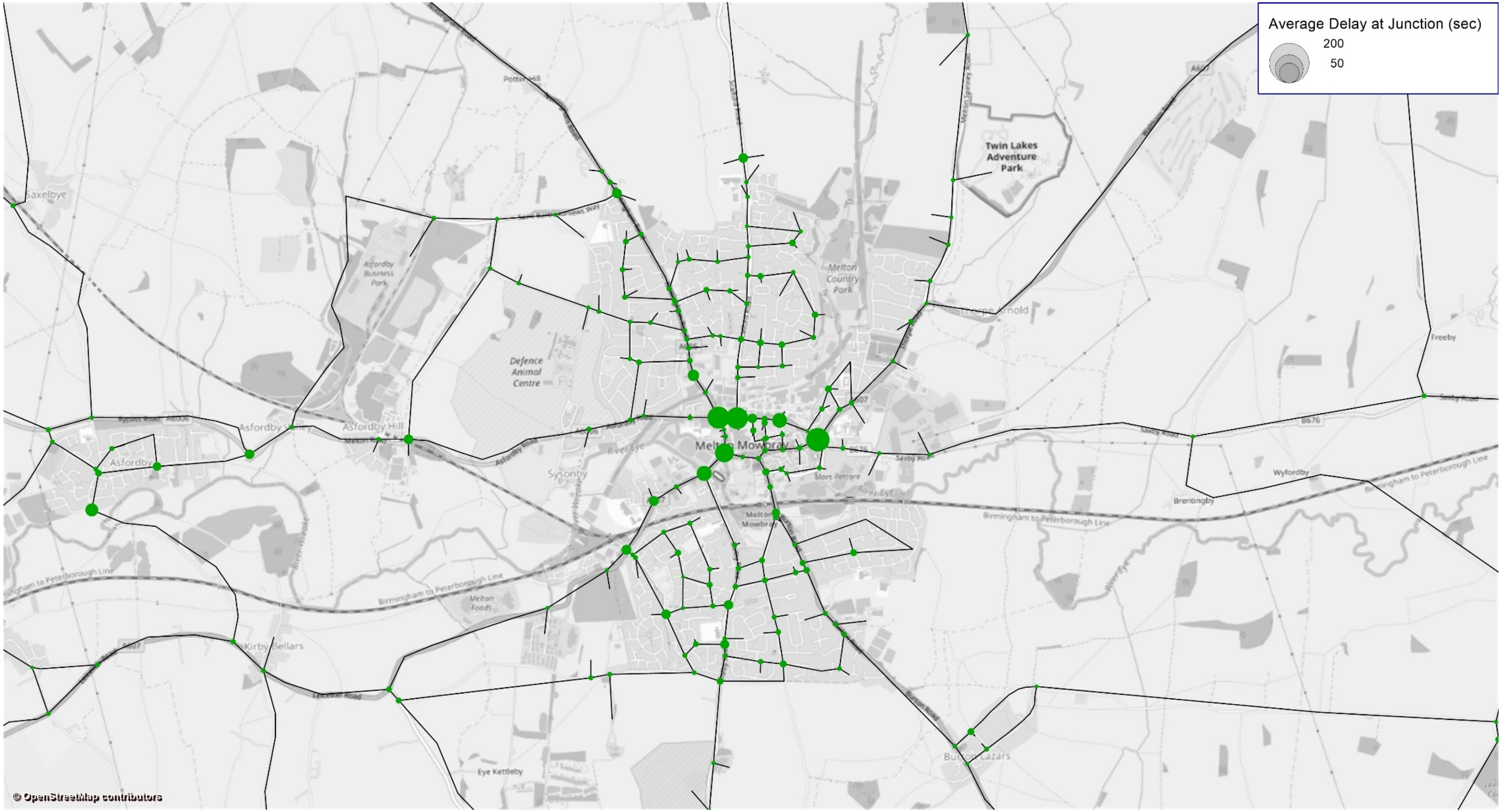

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Figure D-7: Core Scenario Forecast Highway Junction Delays – 2030 AM Peak

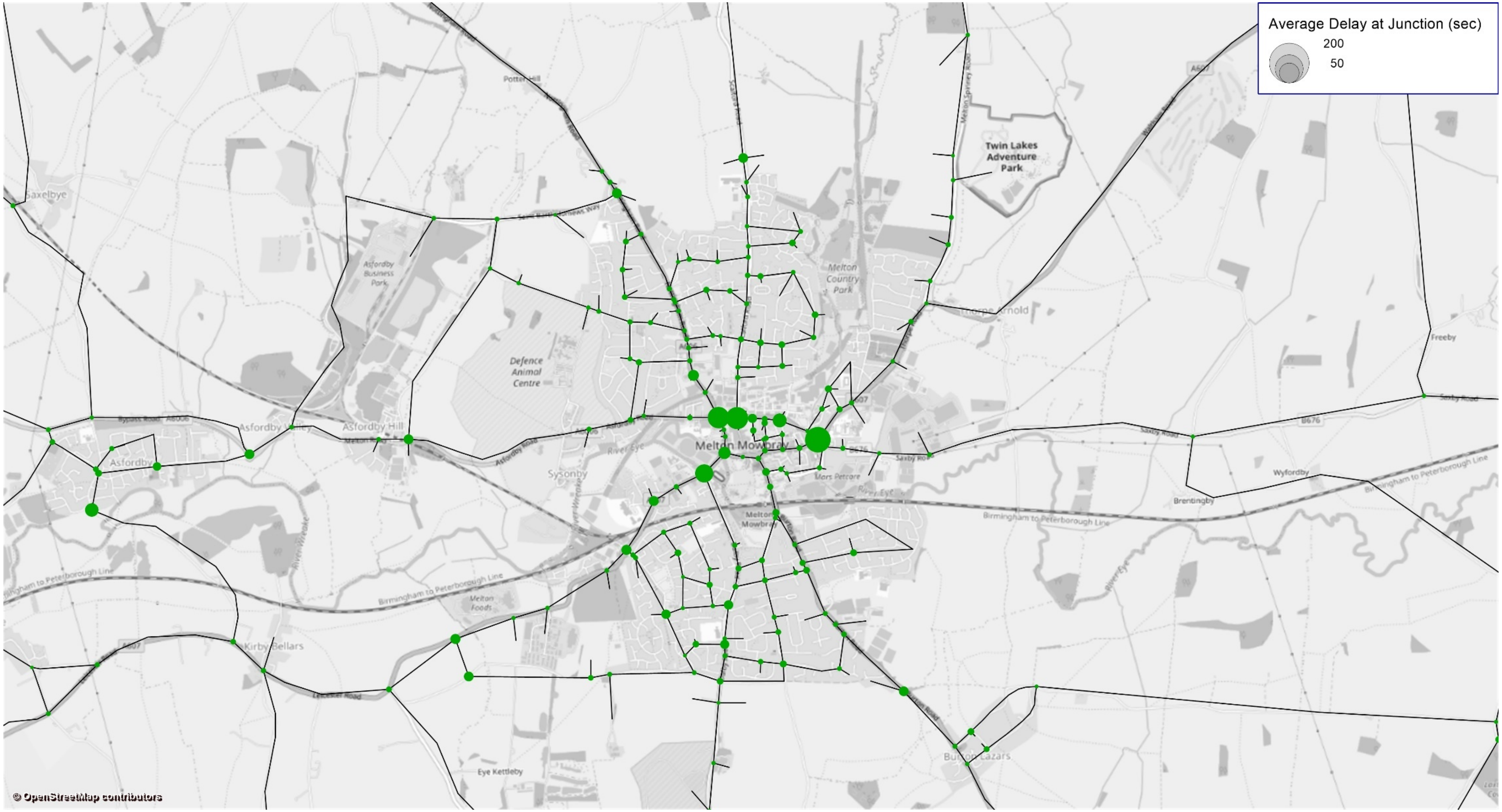

Figure D-8: Core Scenario Forecast Highway Junction Delays – 2030 Interpeak

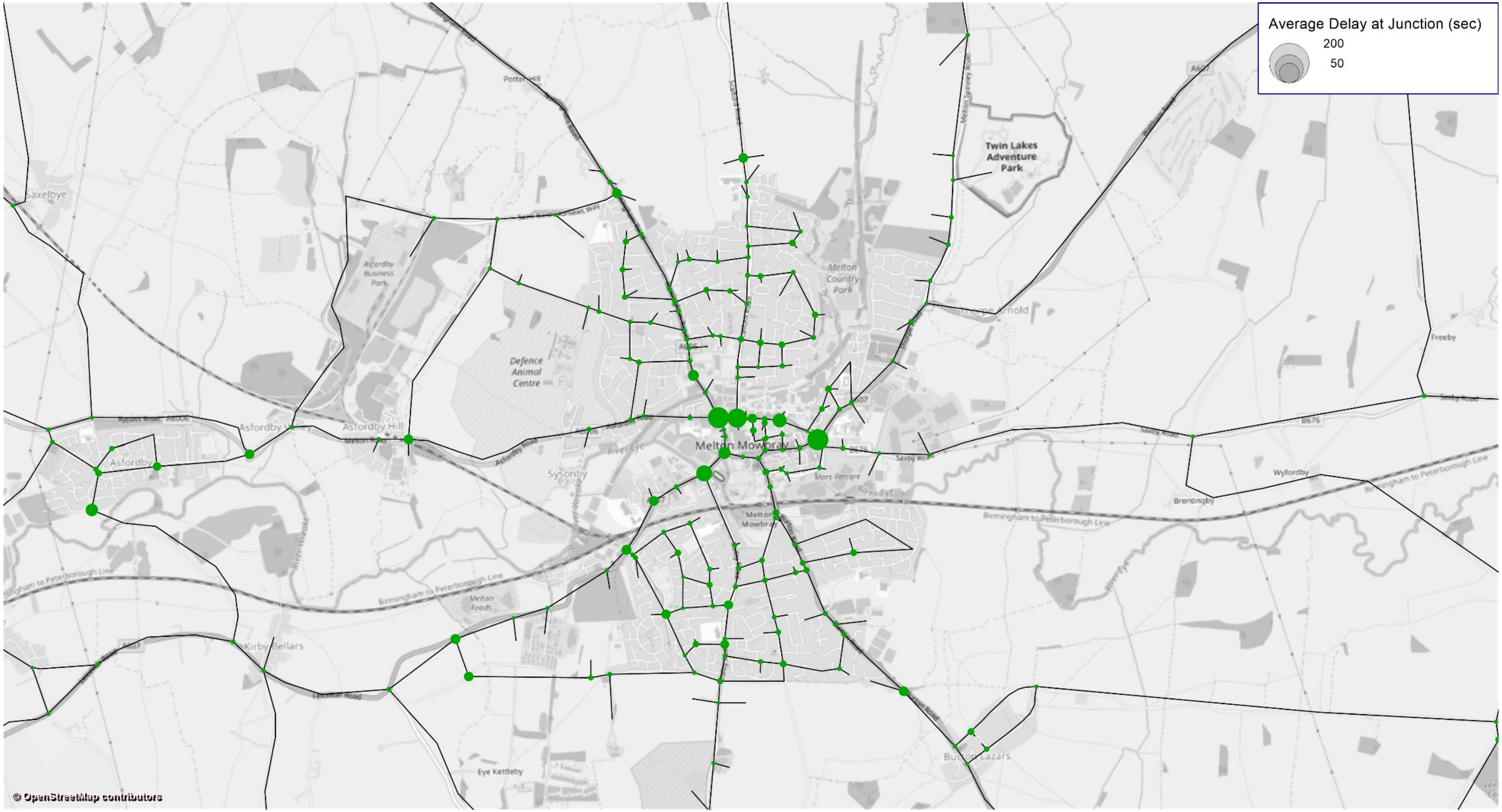

Figure D-9: Core Scenario Forecast Highway Junction Delays – 2030 PM Peak

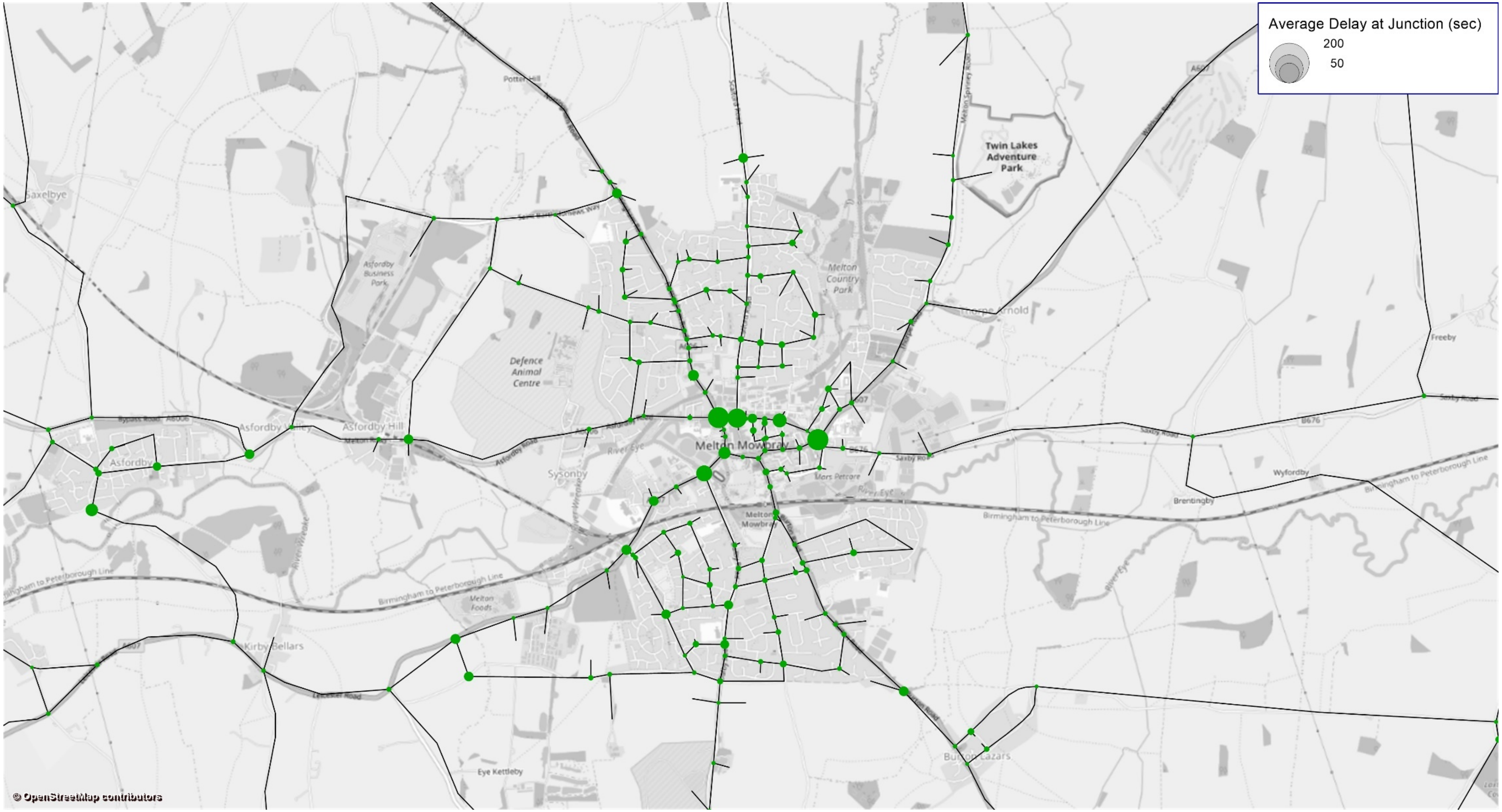

Figure D-10: Core Scenario Forecast Highway Junction Delays – 2040 AM Peak

Figure D-11: Core Scenario Forecast Highway Junction Delays – 2040 Interpeak

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Figure D-12: Core Scenario Forecast Highway Junction Delays – 2040 PM Peak

Figure D-13: Core Scenario Forecast Highway Junction Delays – 2051 AM Peak

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Figure D-14: Core Scenario Forecast Highway Junction Delays – 2051 Interpeak

Figure D-15: Core Scenario Forecast Highway Junction Delays – 2051 PM Peak

Appendix E NEMMDR Scenario Forecast Vehicle Flow Changes

Figure E-1: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2025 AM Peak

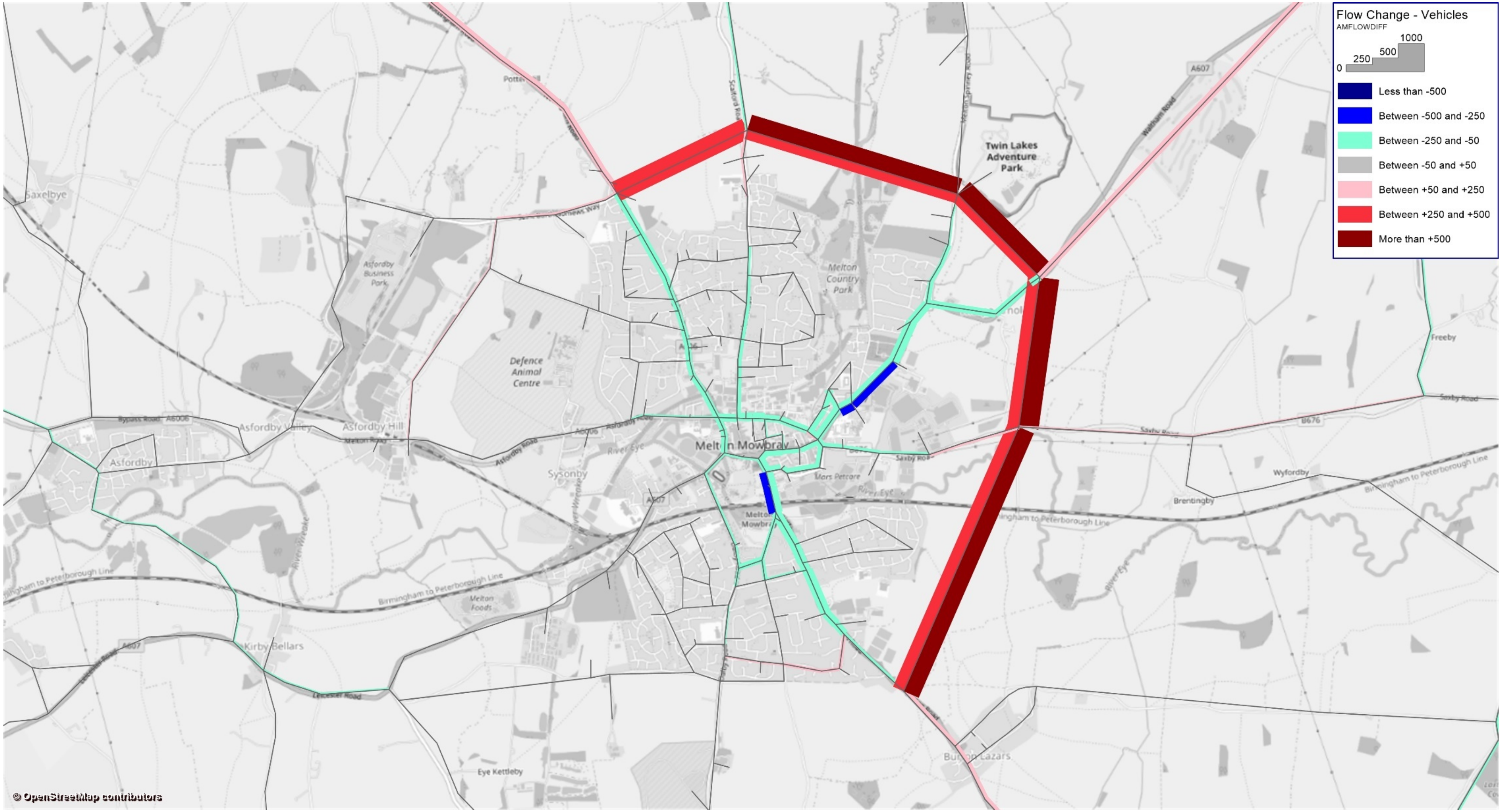

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Figure E-2: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2025 Interpeak

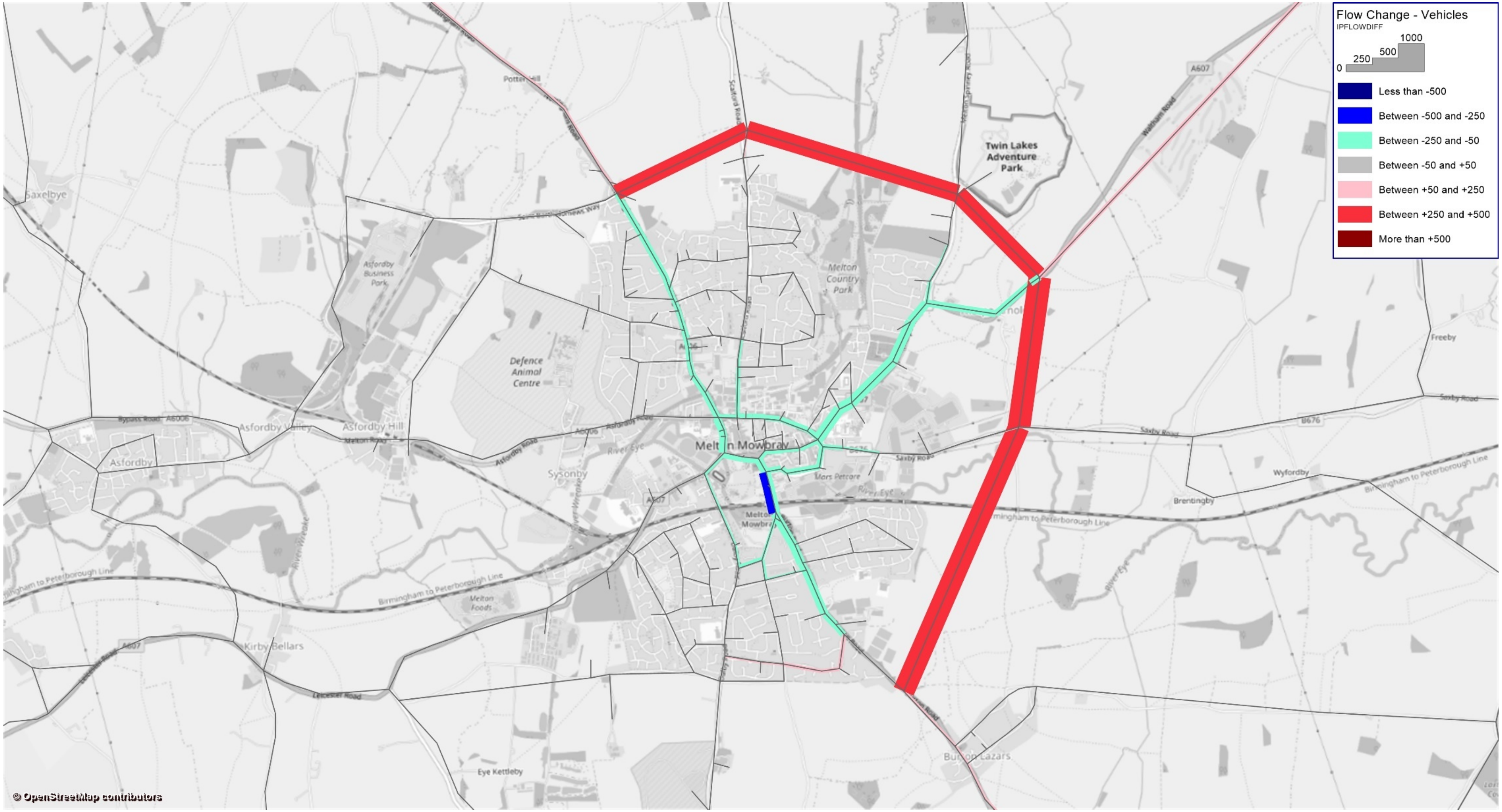


Figure E-3: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2025 PM Peak

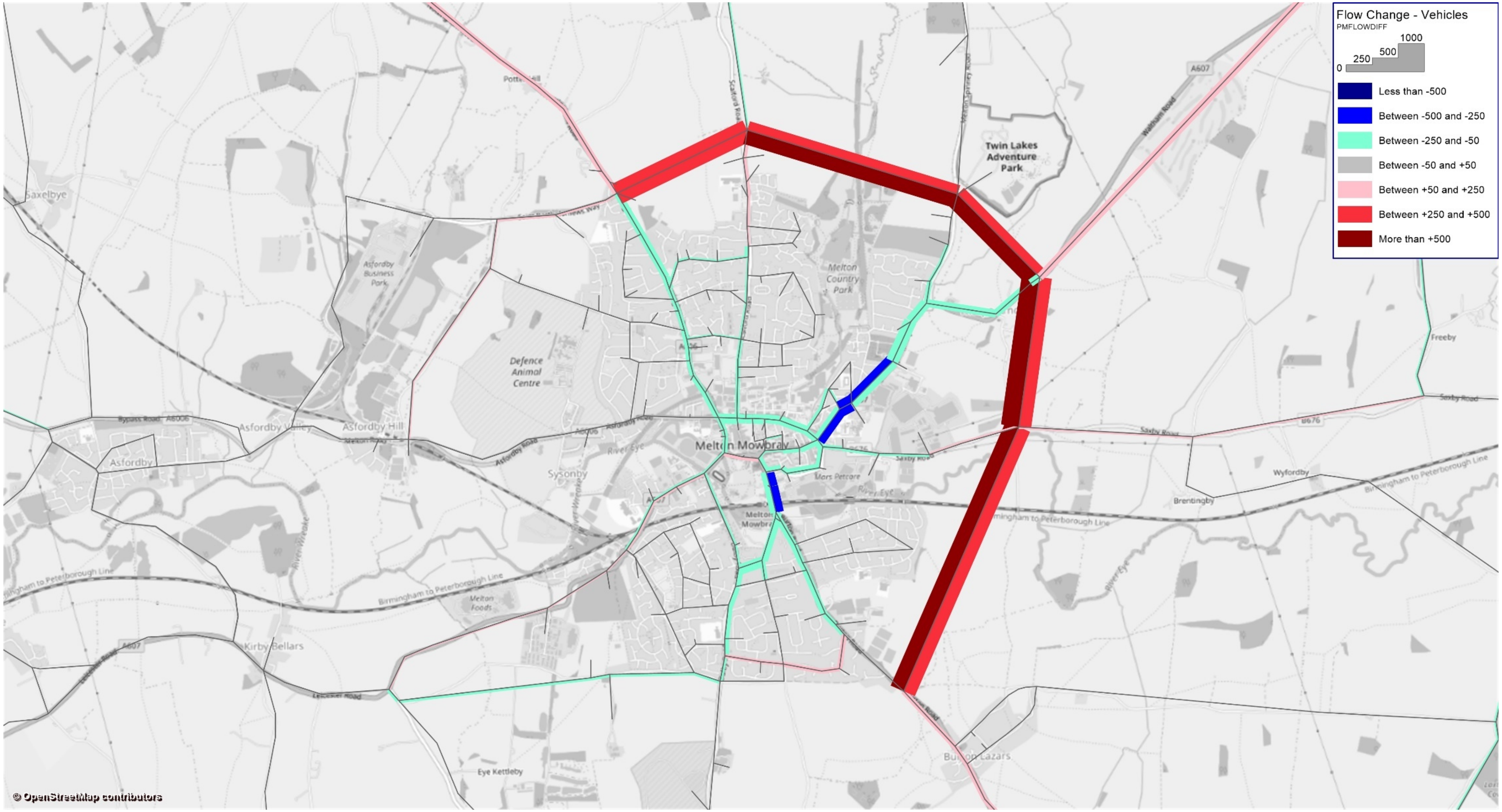


Figure E-4: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2030 AM Peak

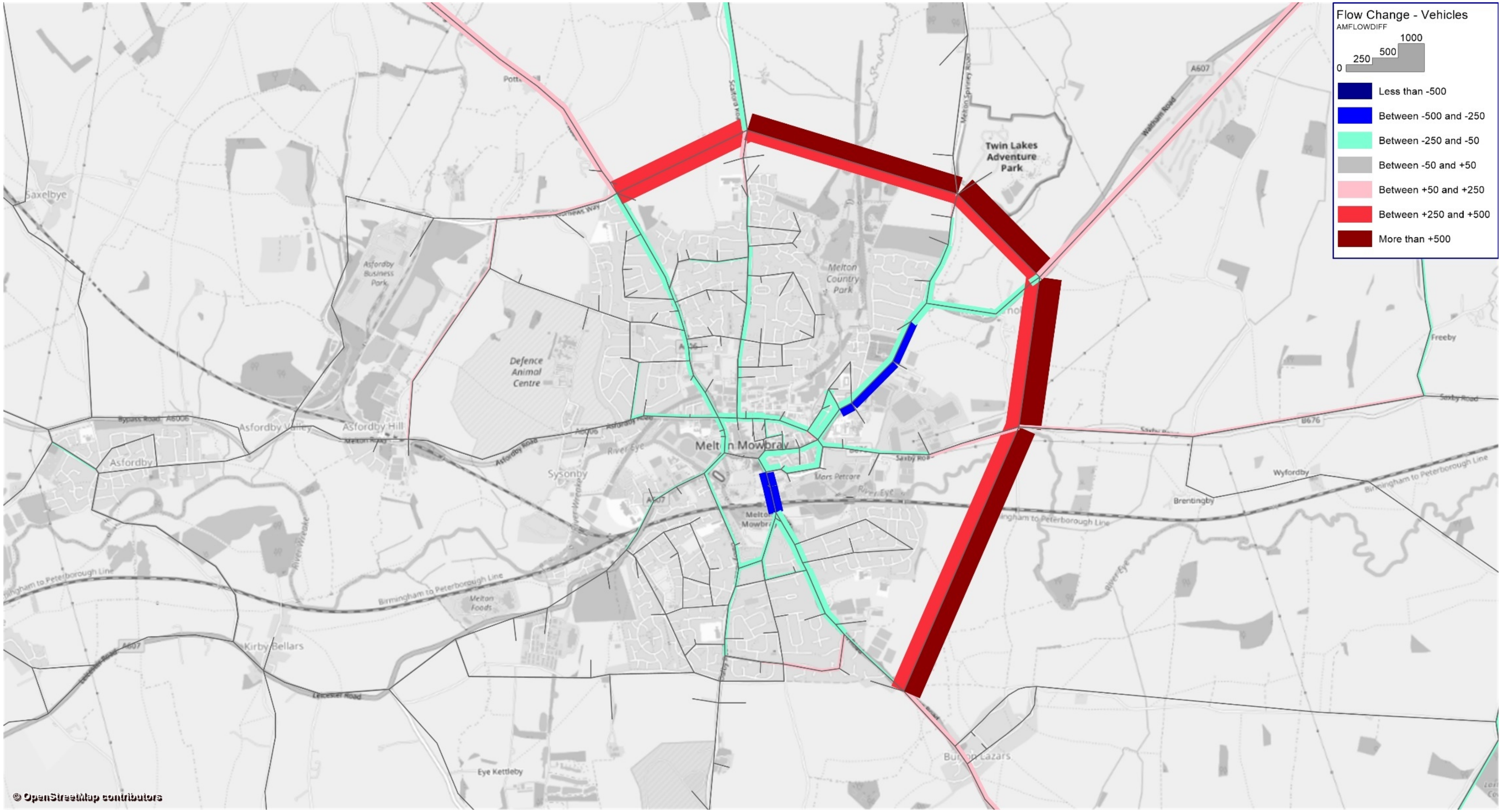


Figure E-5: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2030 Interpeak

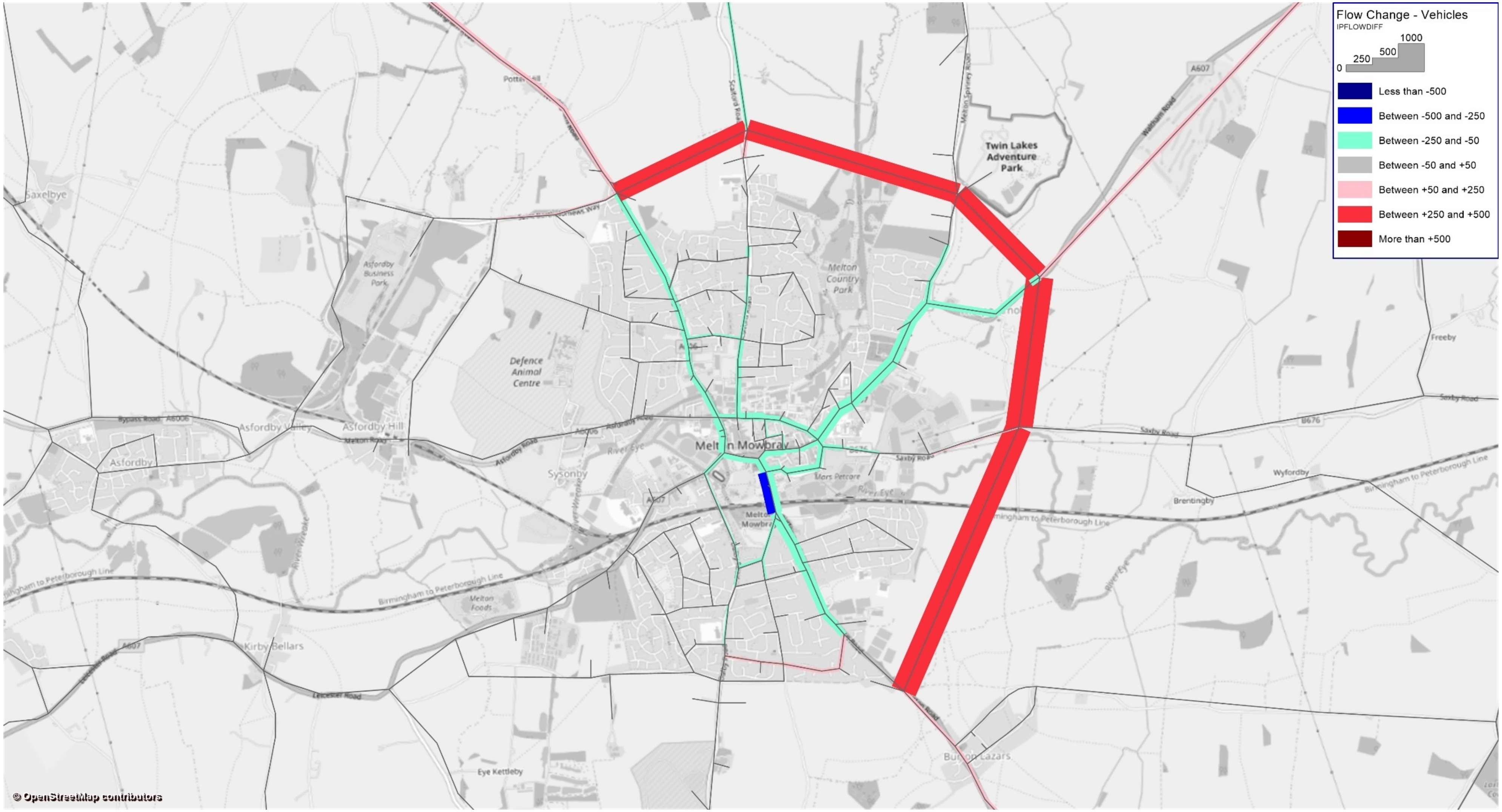


Figure E-6: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2030 PM Peak

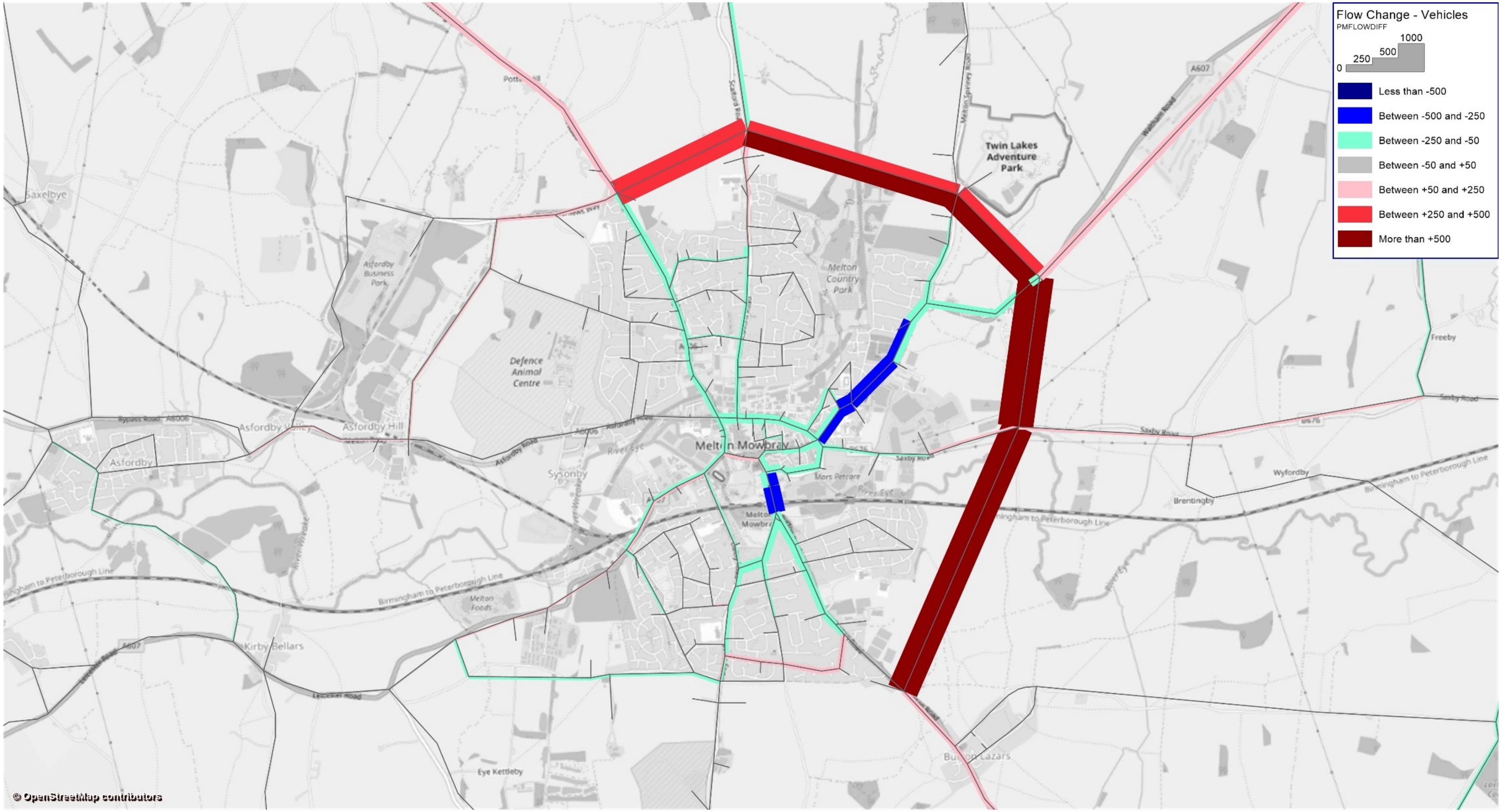


Figure E-7: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2040 AM Peak

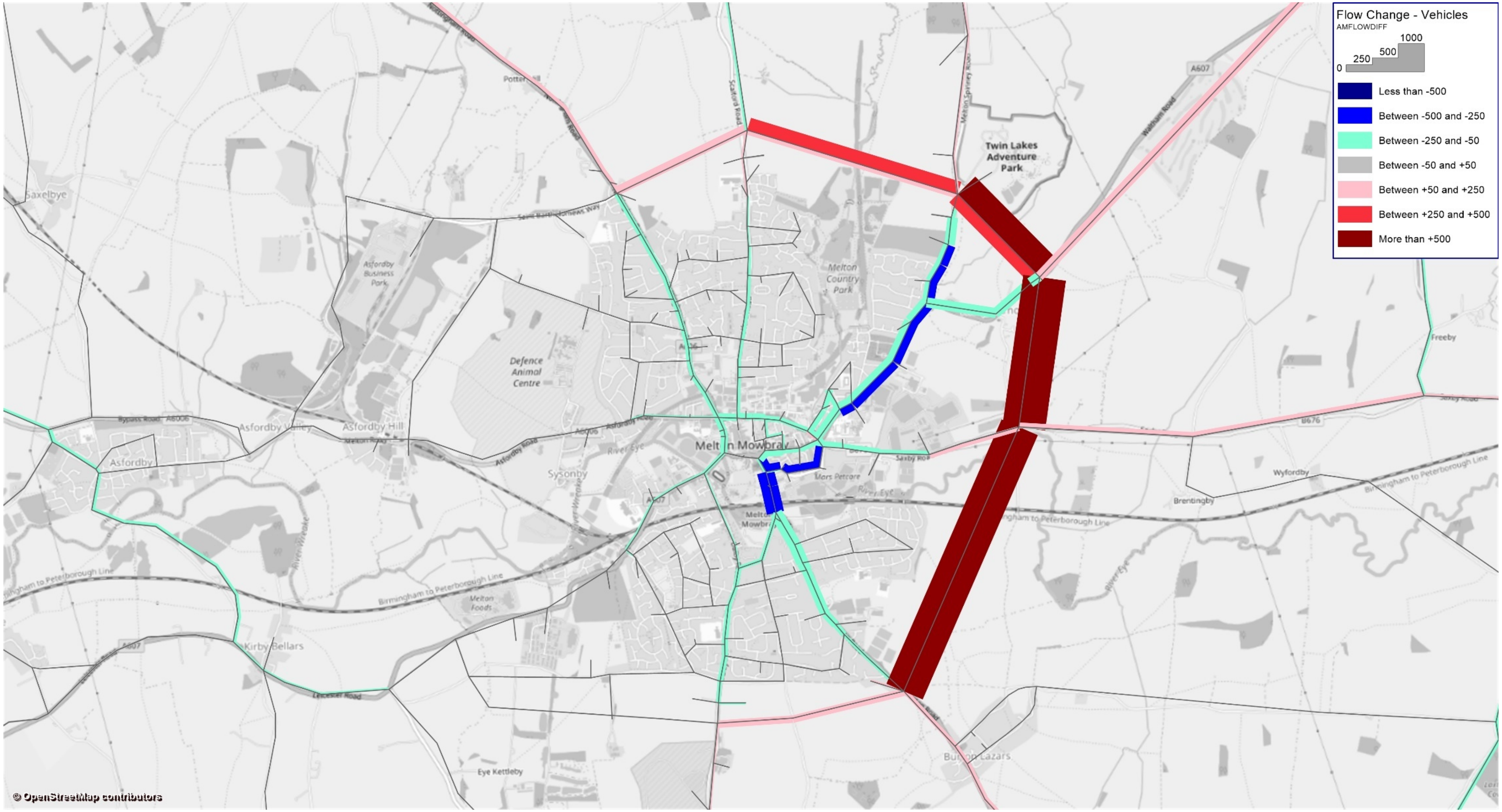


Figure E-8: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2040 Interpeak

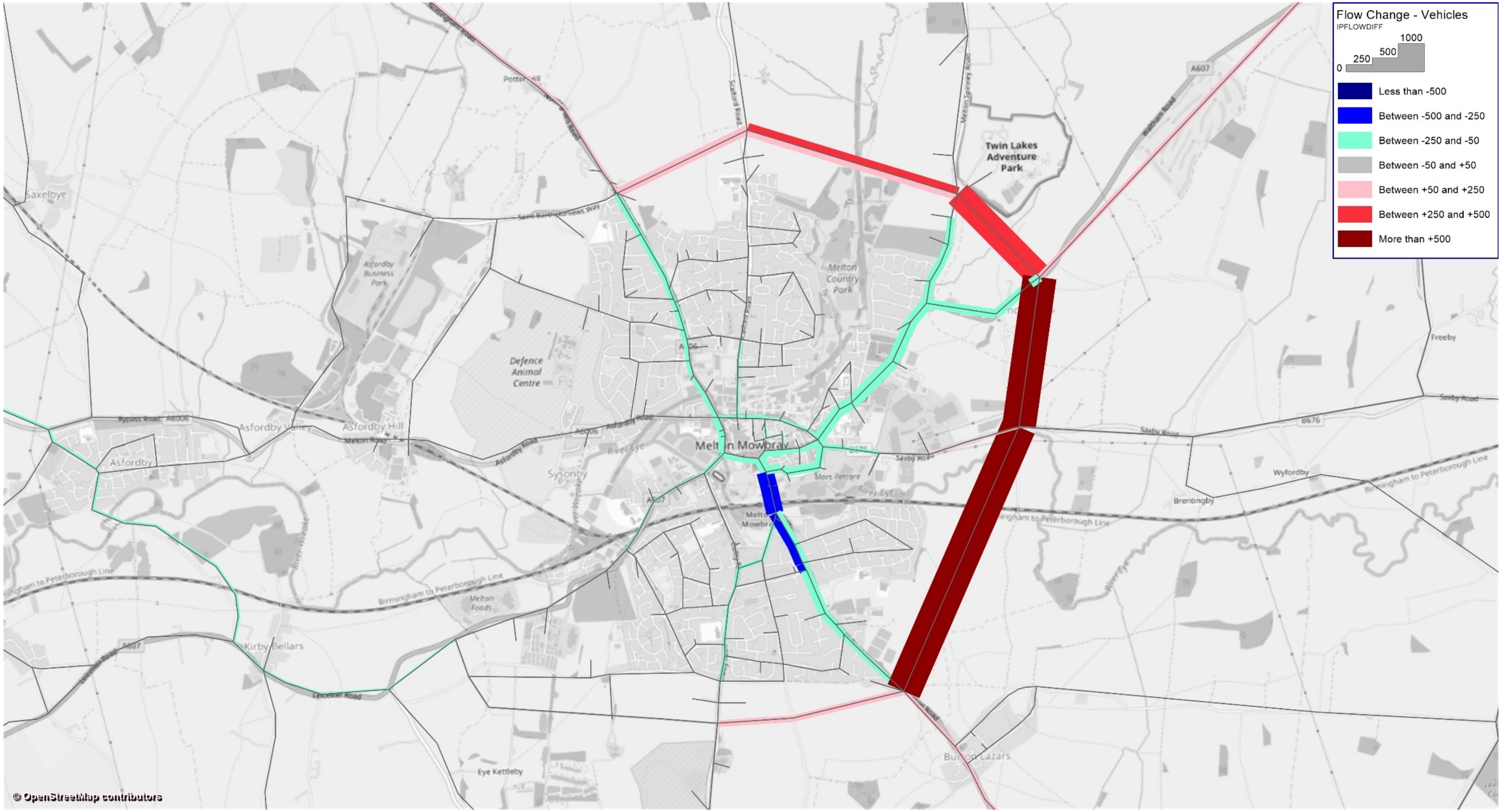


Figure E-9: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2040 PM Peak

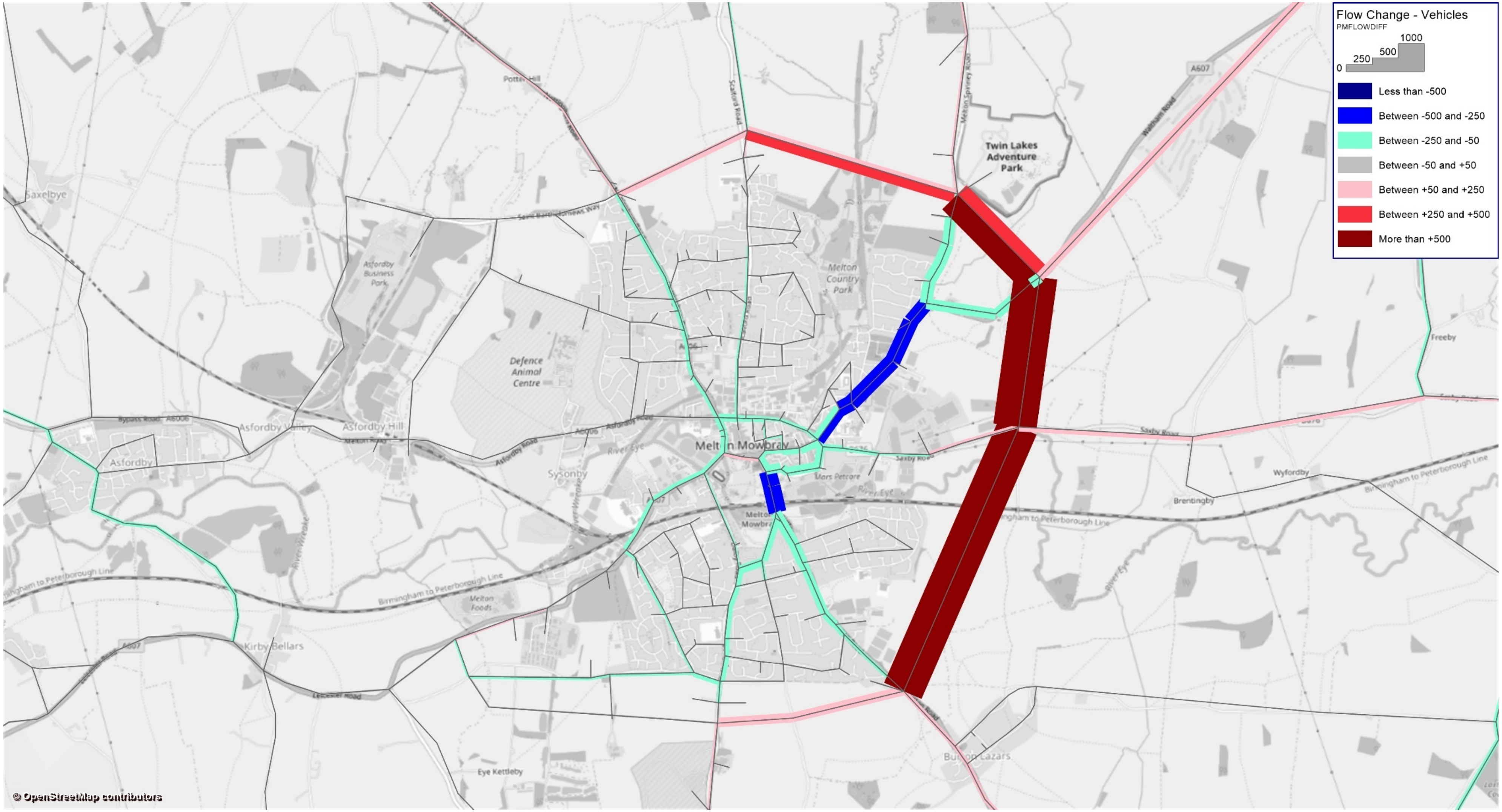


Figure E-10: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2051 AM Peak

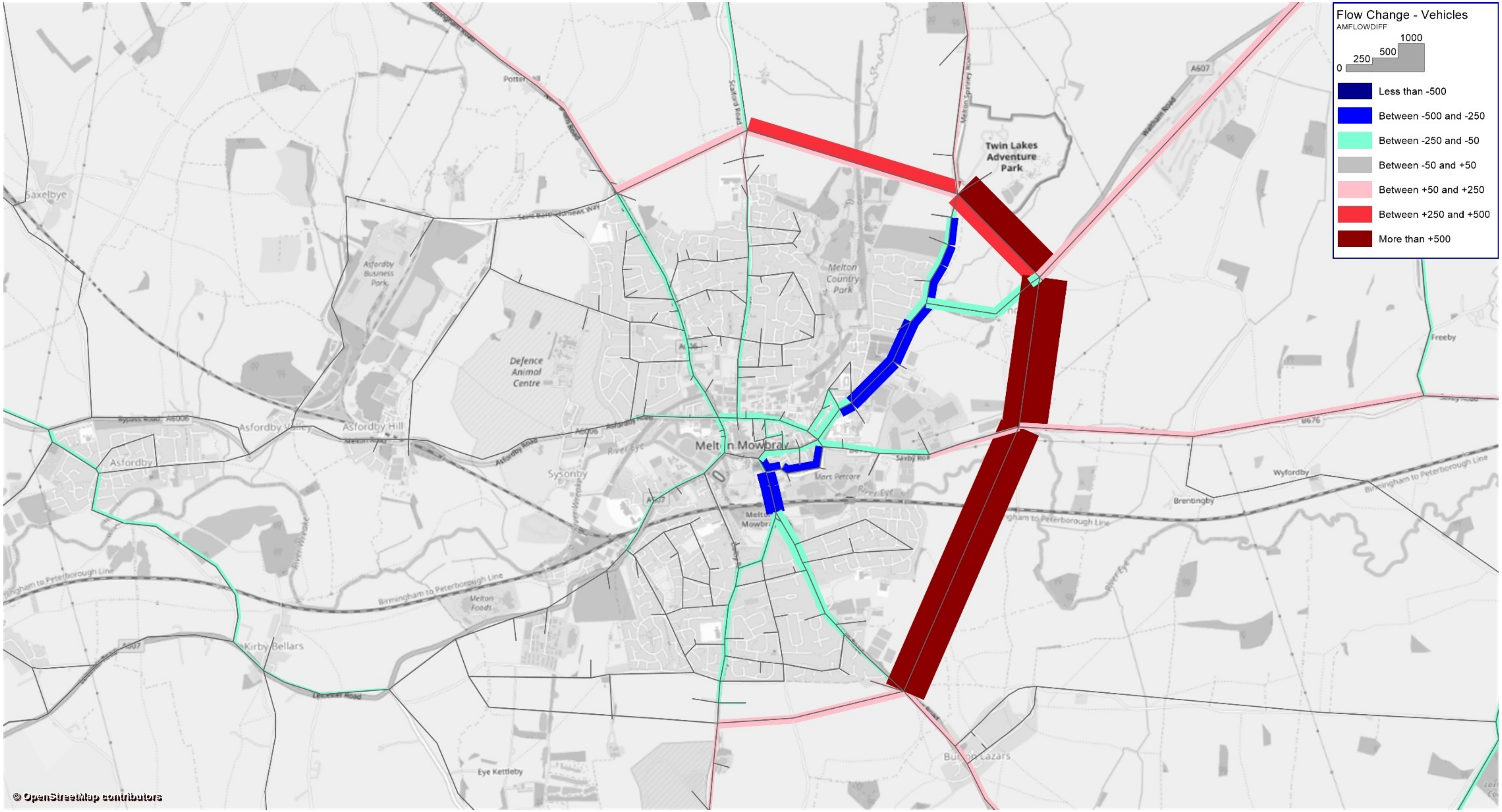


Figure E-11: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2051 Interpeak

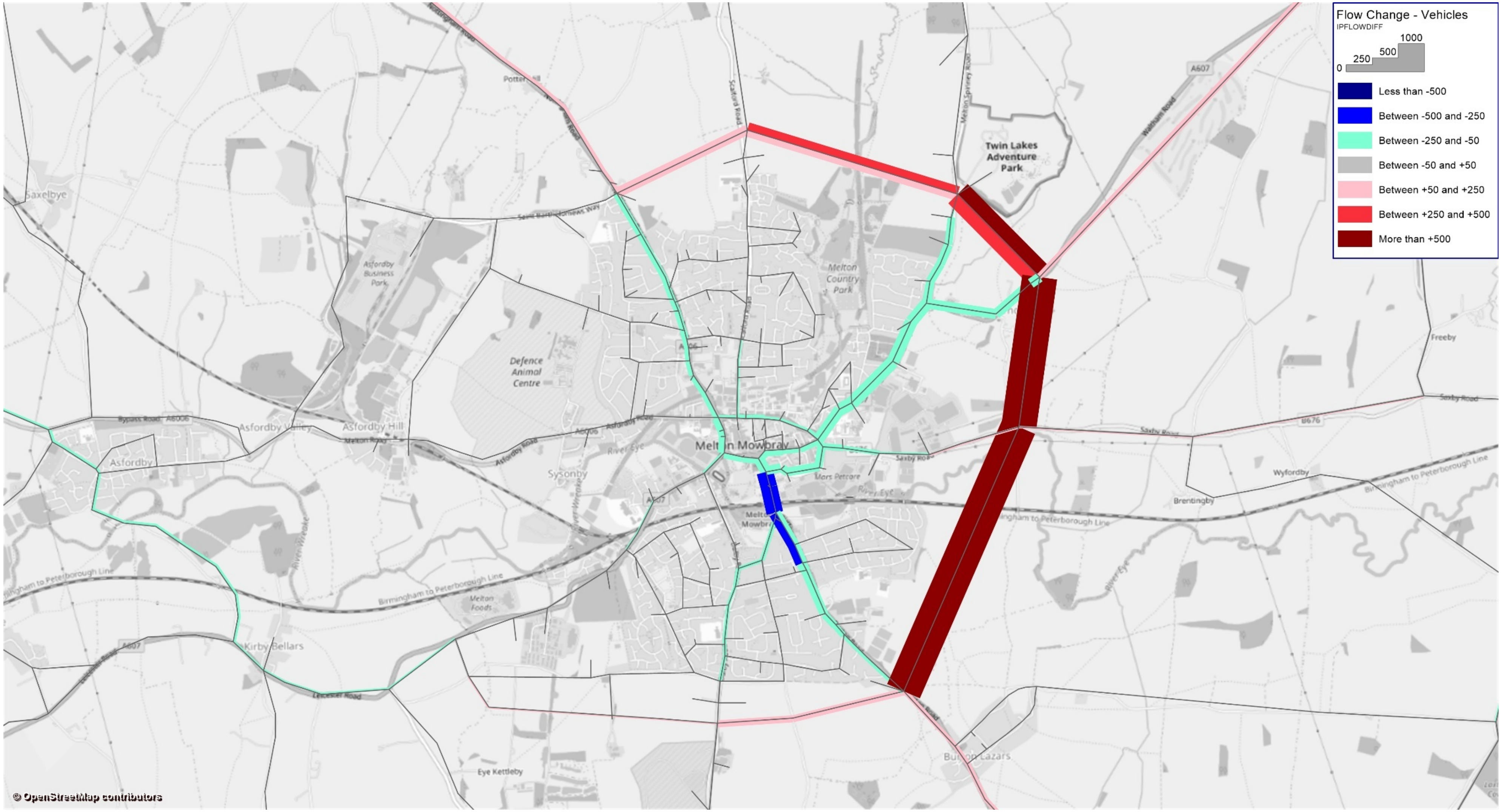
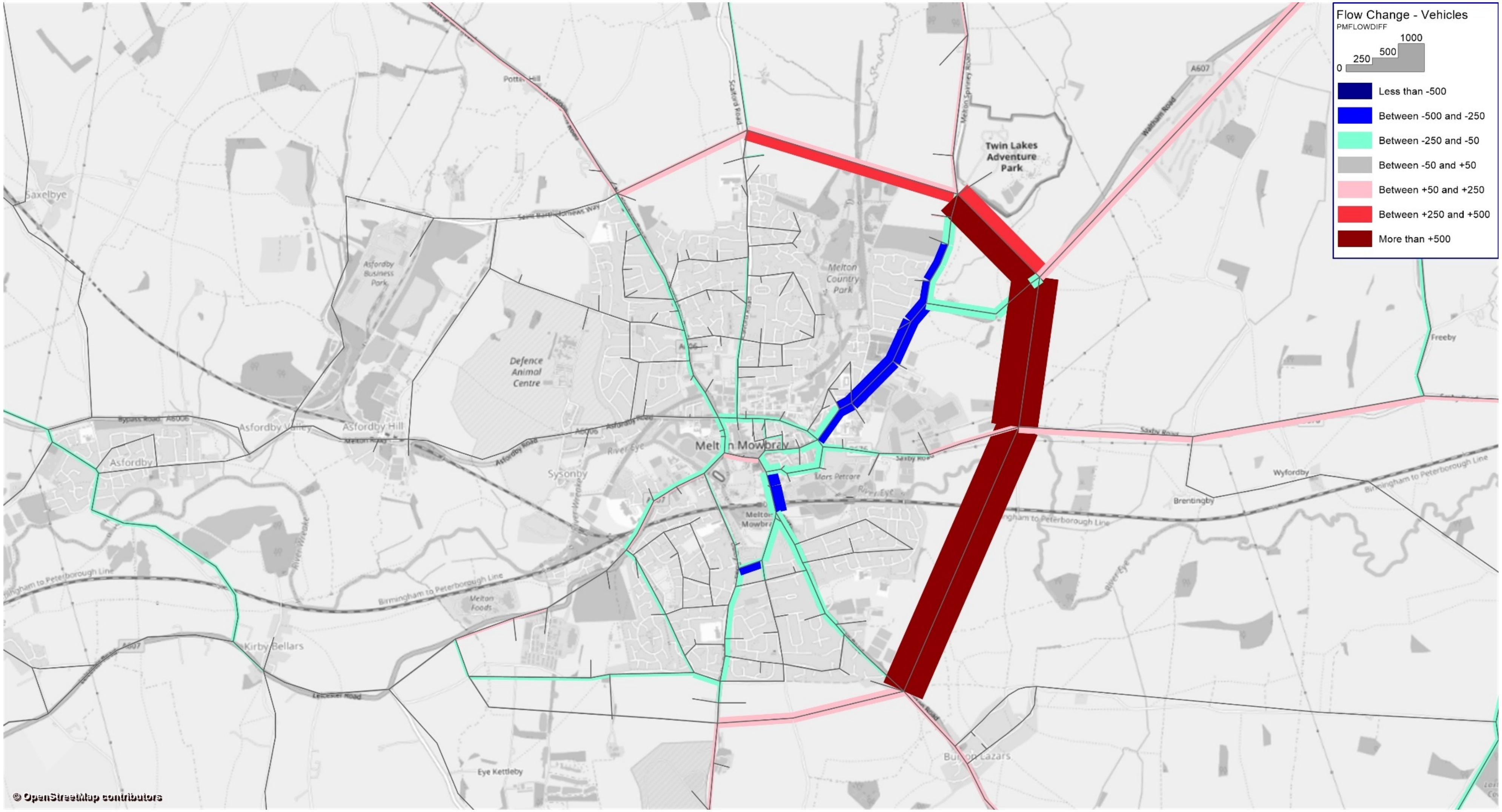


Figure E-12: Forecast Highway Vehicle Flow Changes from Core Scenario to NEMMDR Scenario – 2051 PM Peak



Appendix F NEMMDR Scenario Forecast Volume-Capacity Ratio Changes

Figure F-1: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2025 AM Peak

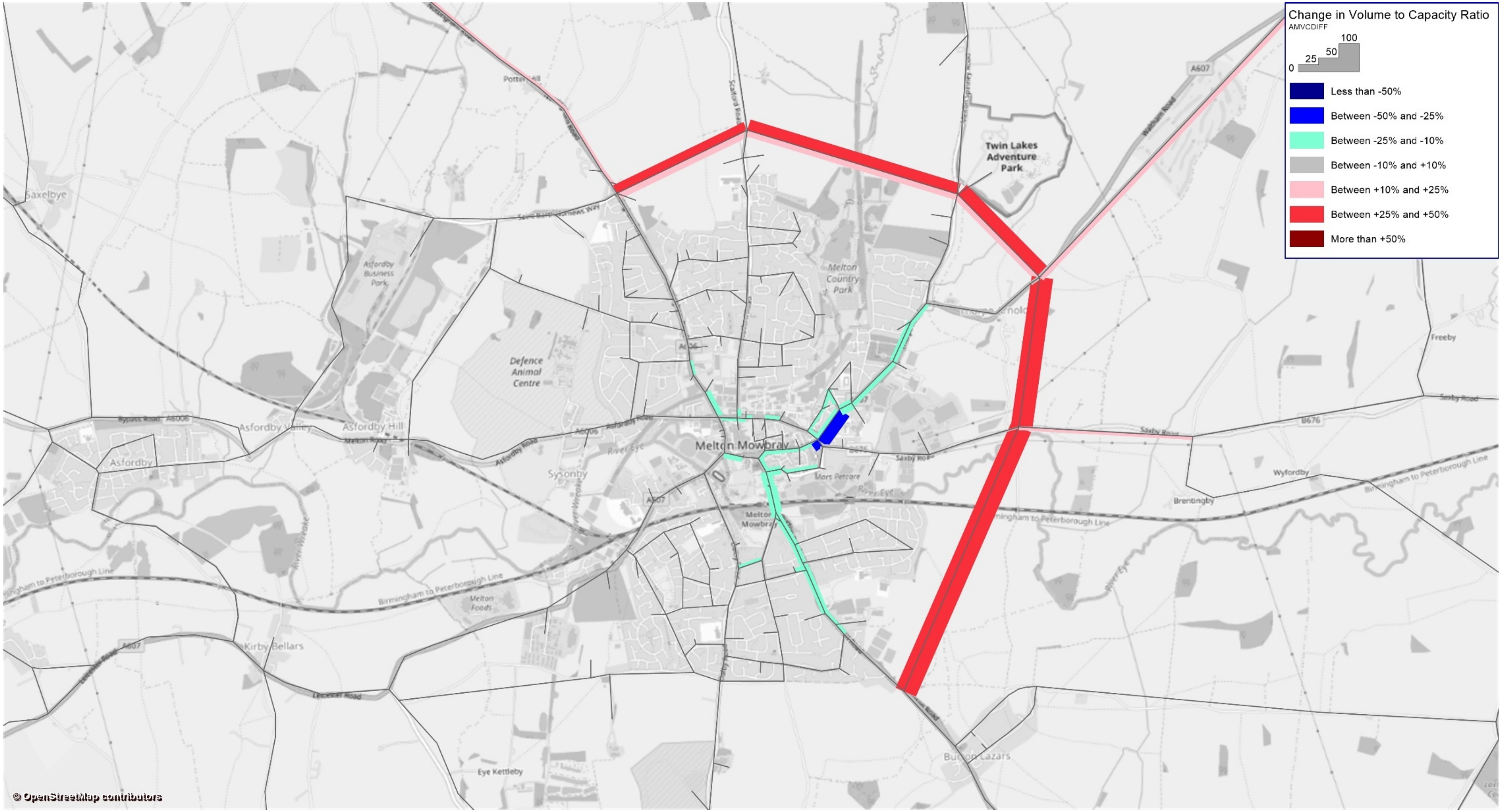


Figure F-2: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2025 Interpeak

Figure F-3: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2025 PM Peak

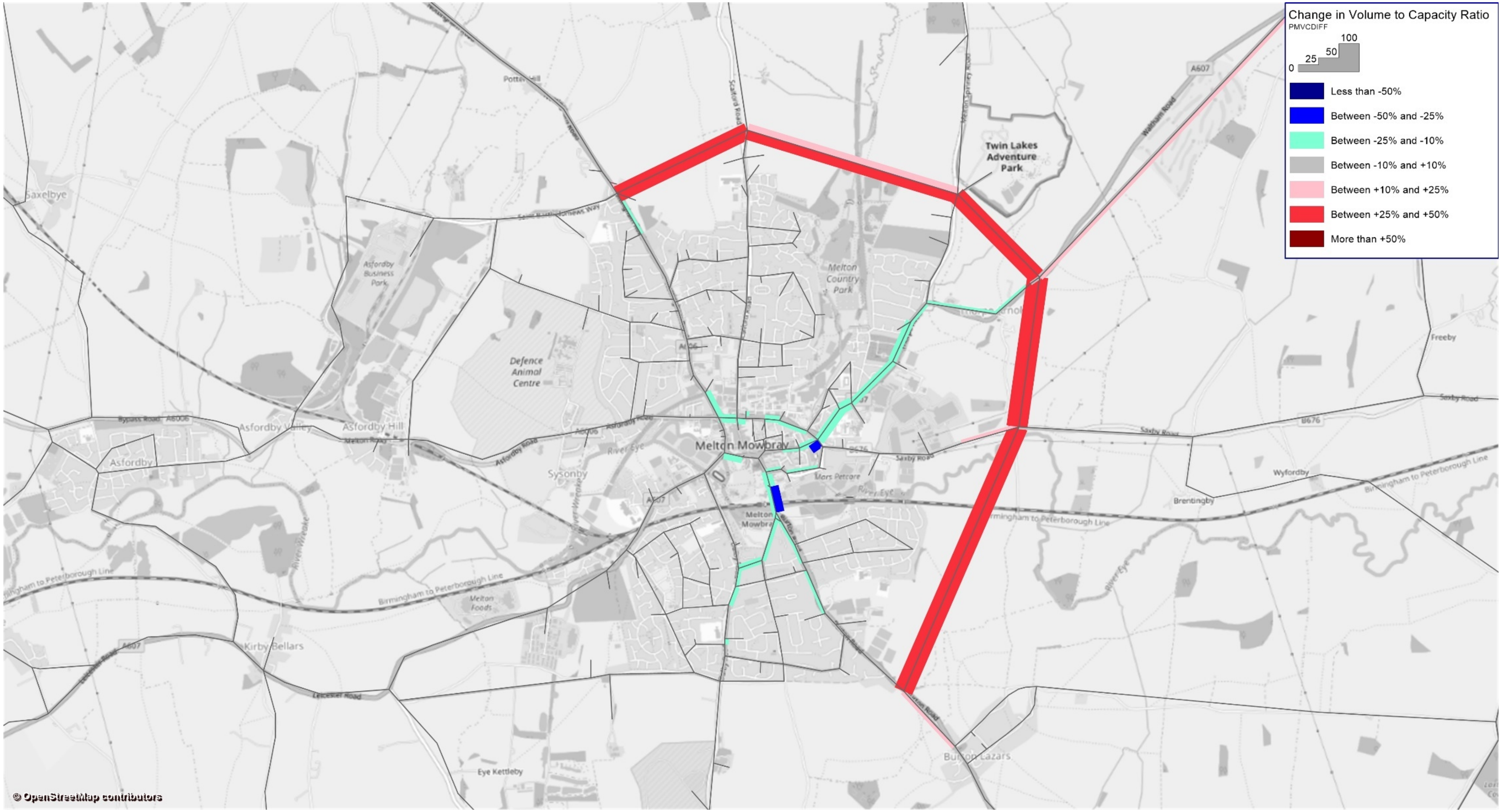


Figure F-4: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2030 AM Peak

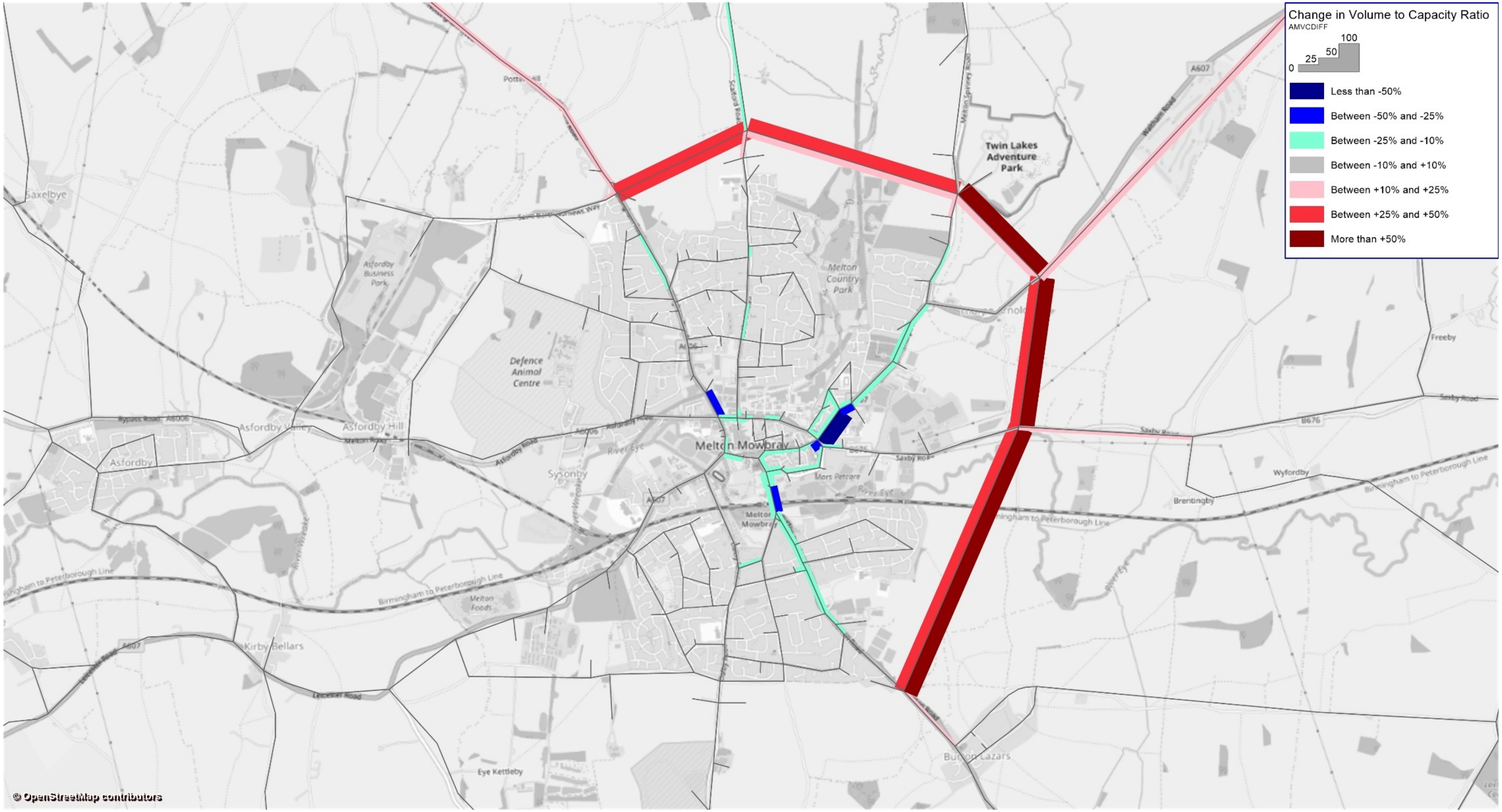


Figure F-5: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2030 Interpeak

Figure F-6: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2030 PM Peak

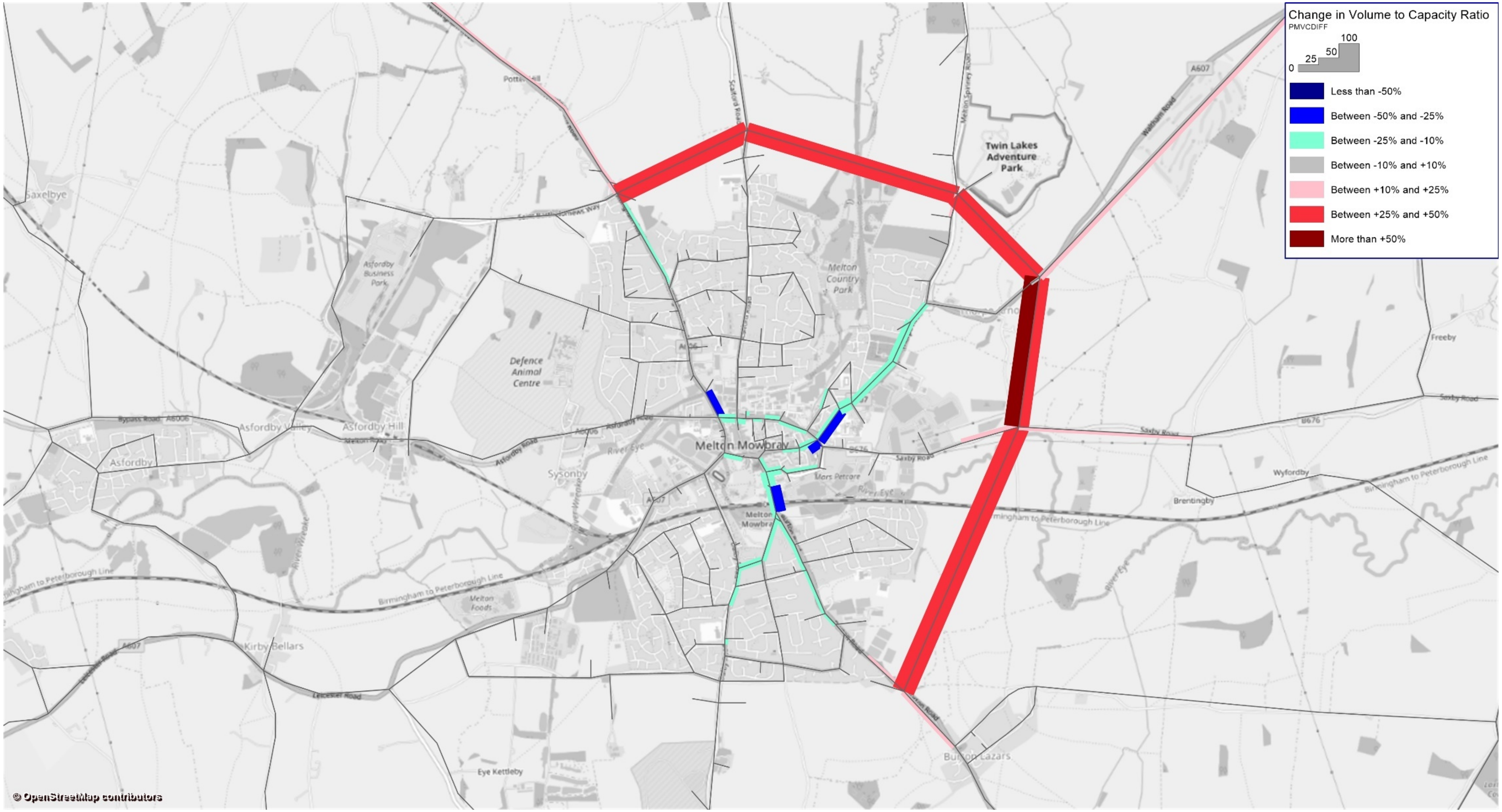


Figure F-7: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2040 AM Peak

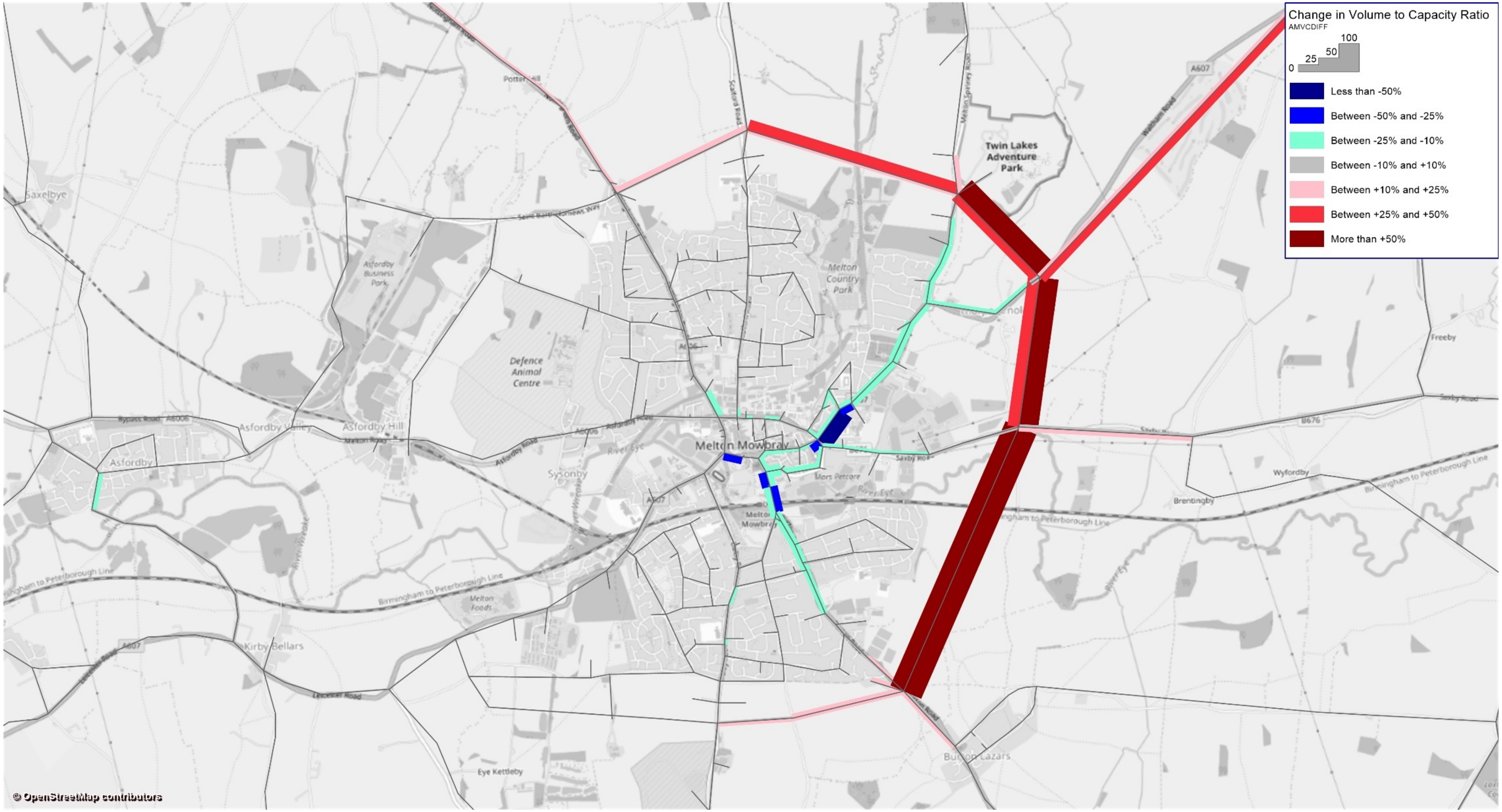


Figure F-8: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2040 Interpeak

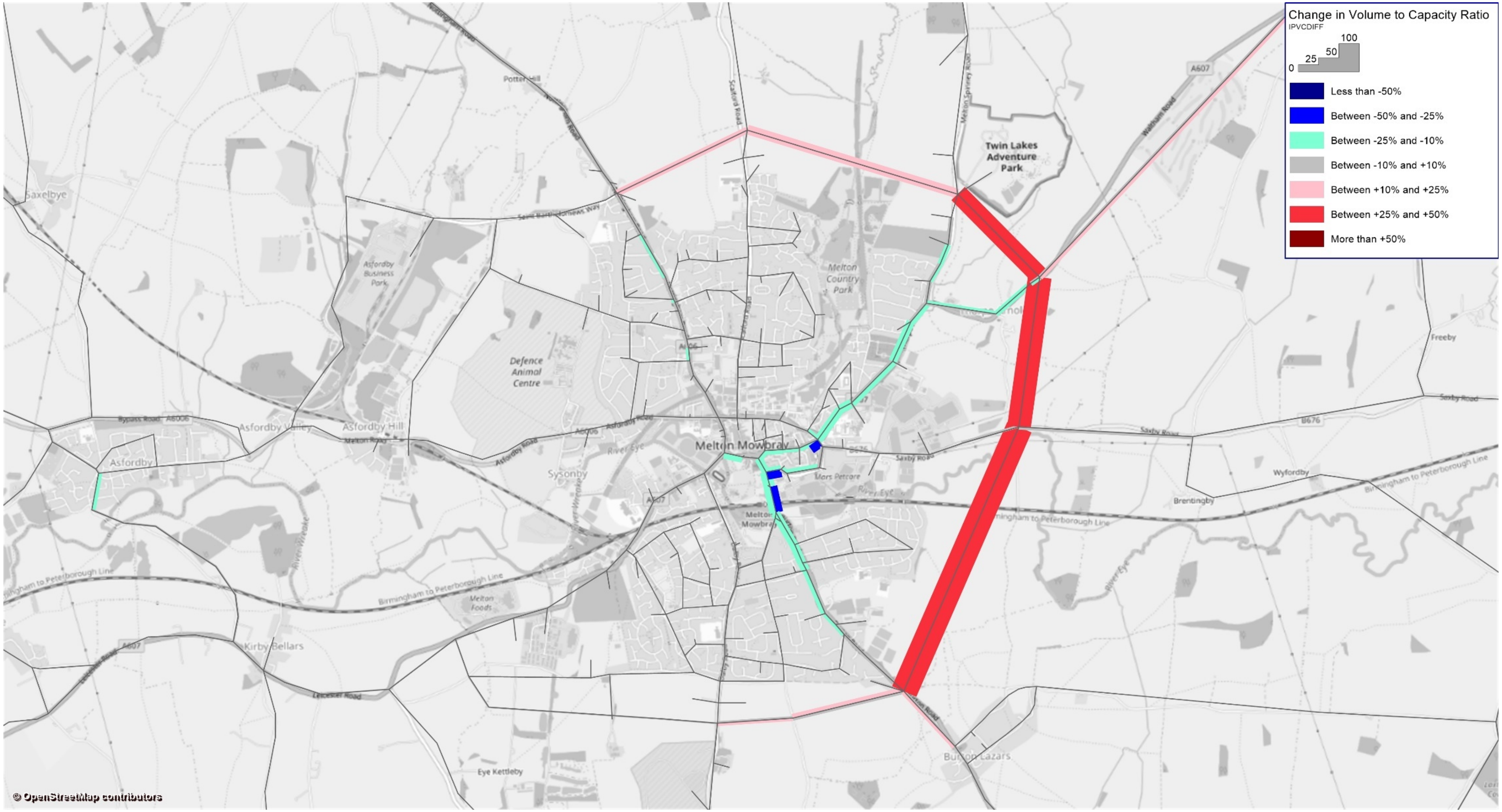


Figure F-9: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2040 PM Peak

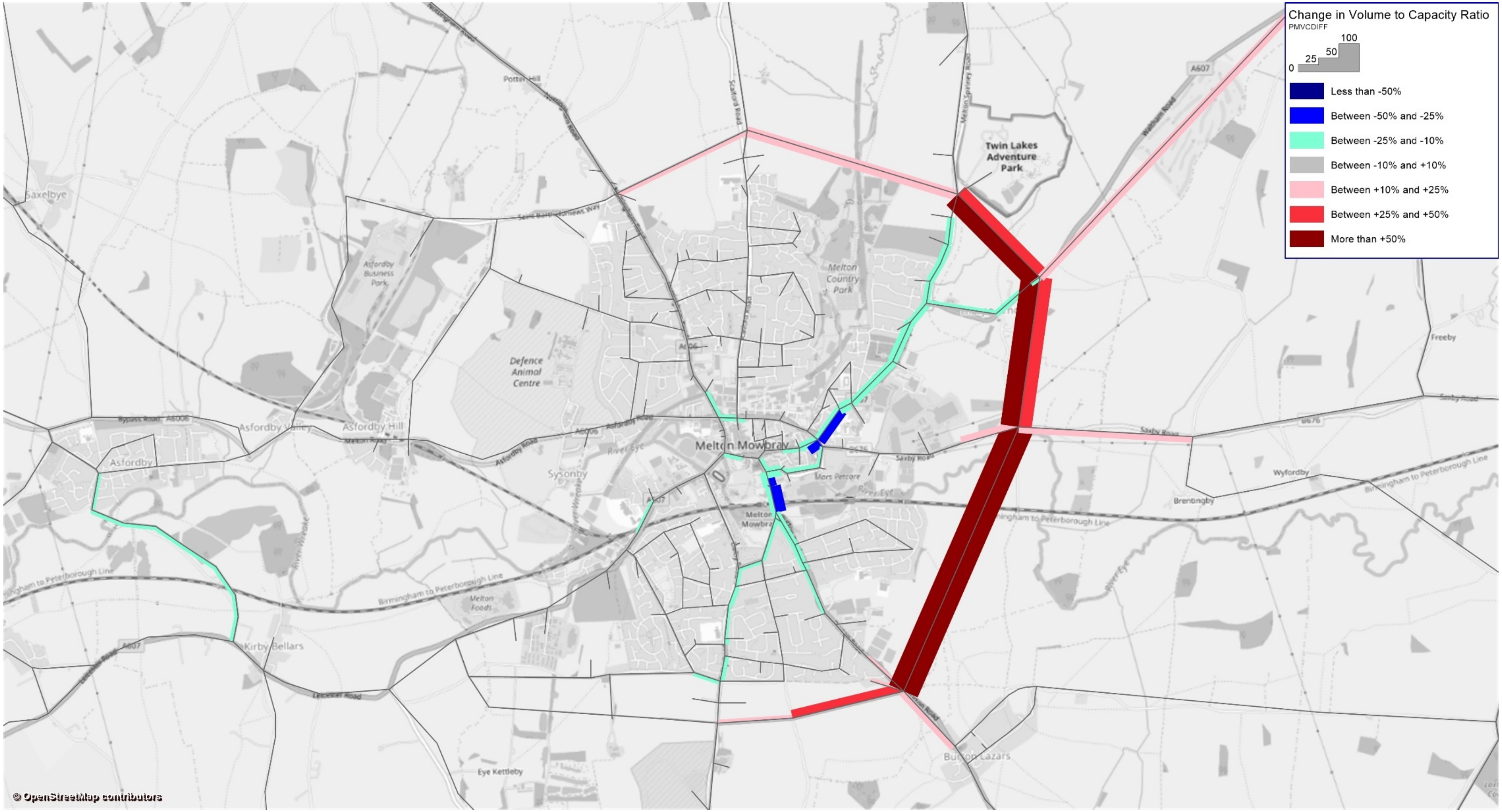


Figure F-10: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2051 AM Peak

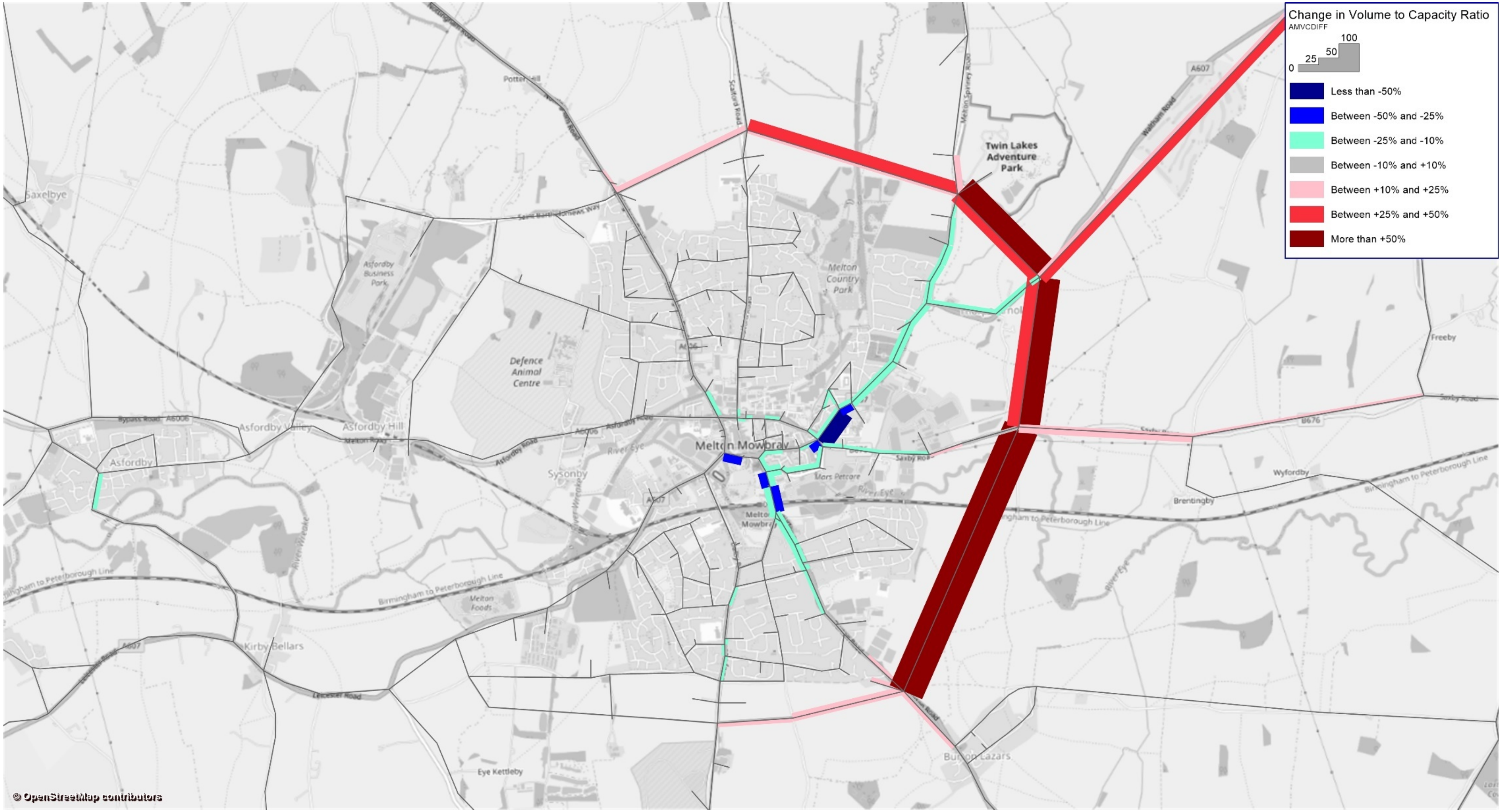
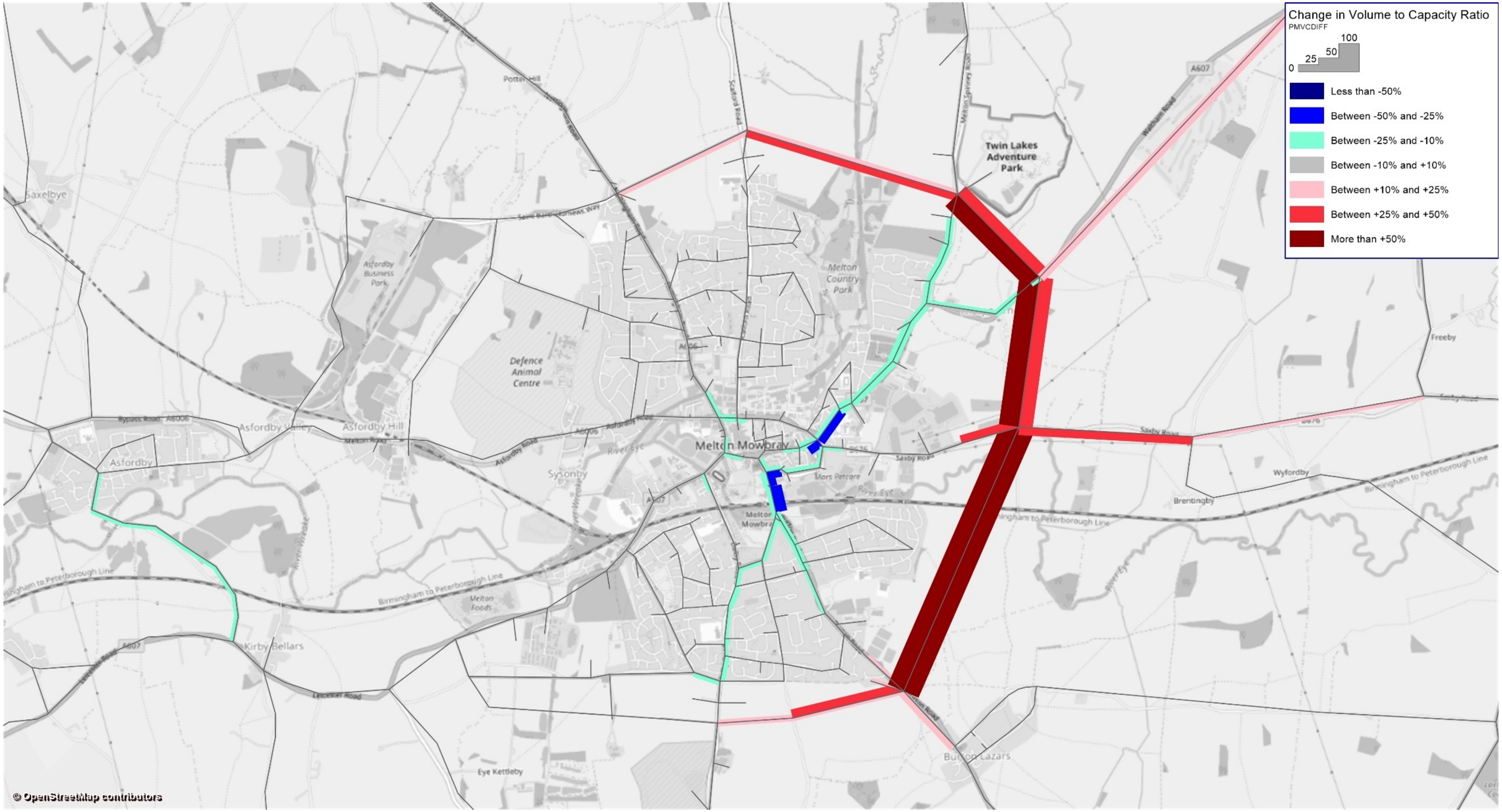


Figure F-11: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2051 Interpeak

Figure F-12: Forecast Highway Volume-Capacity Ratio Changes from Core Scenario to NEMMDR Scenario – 2051 PM Peak



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Appendix G NEMMDR Scenario Forecast Change in Average Delay at Junctions

Figure G-1: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2025 AM Peak

Figure G-2: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2025 Interpeak

Figure G-3: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2025 PM Peak

Figure G-4: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2030 AM Peak

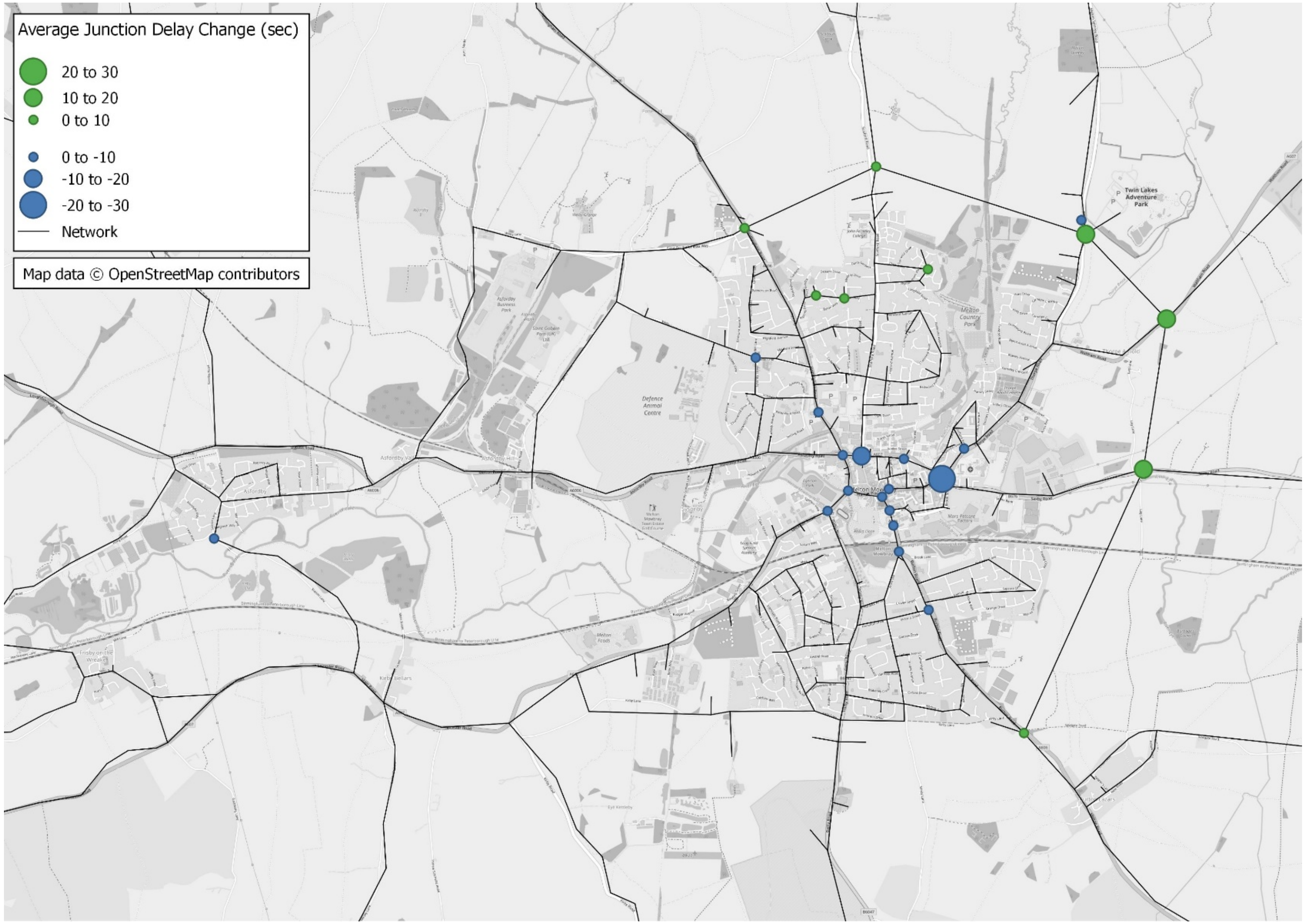

Figure G-5: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2030 Interpeak

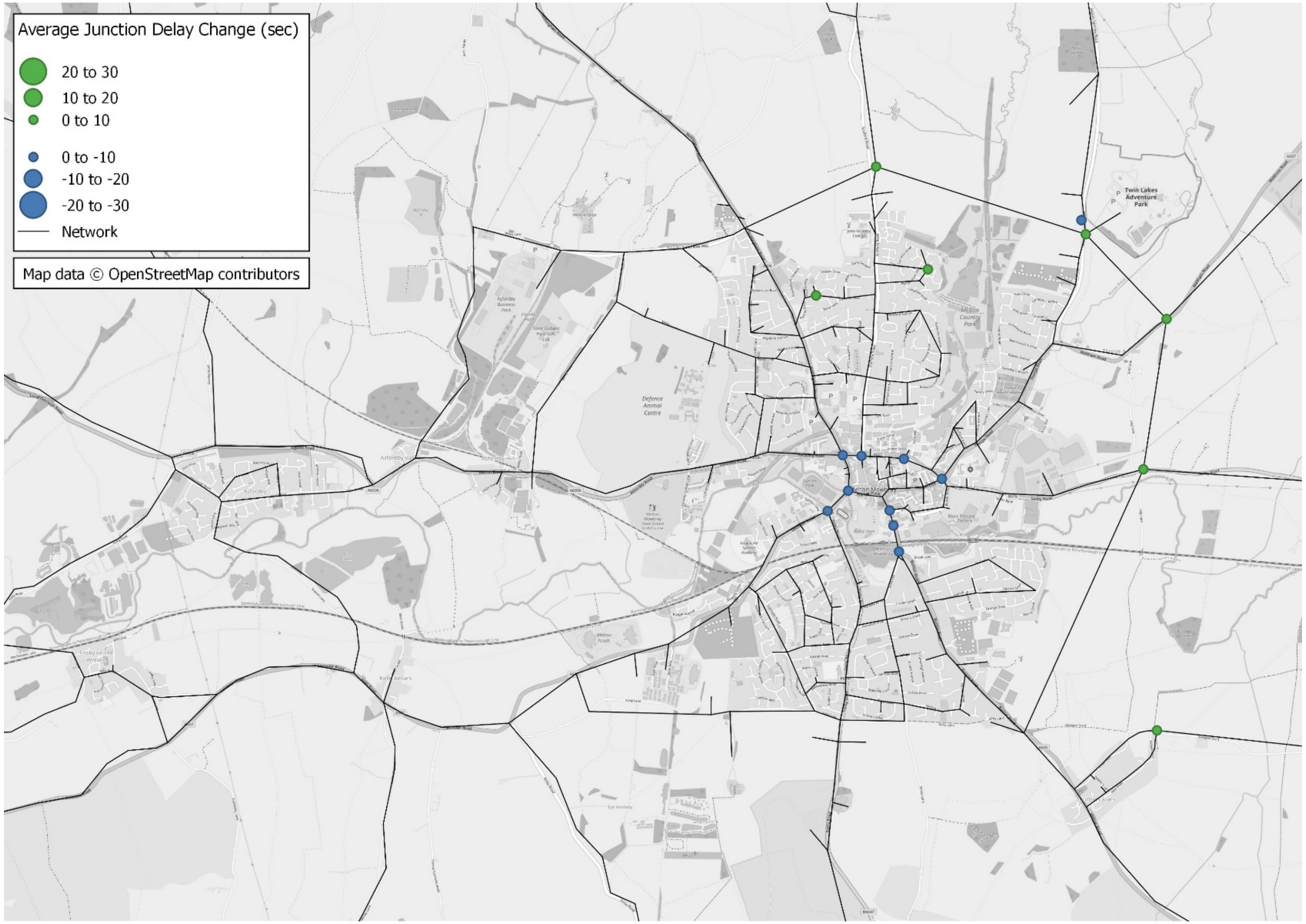

Figure G-6: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2030 PM Peak

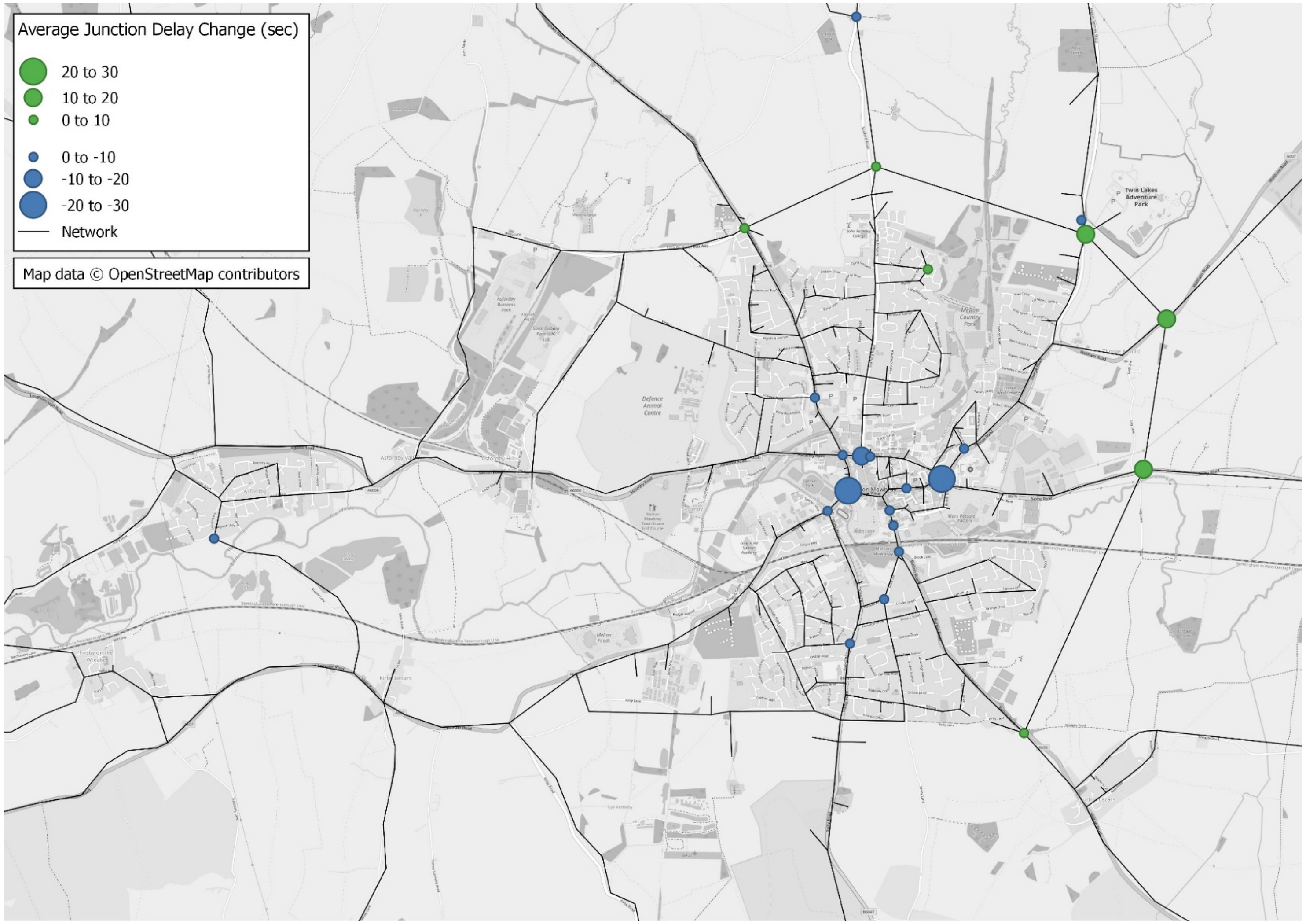

Figure G-7: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2040 AM Peak

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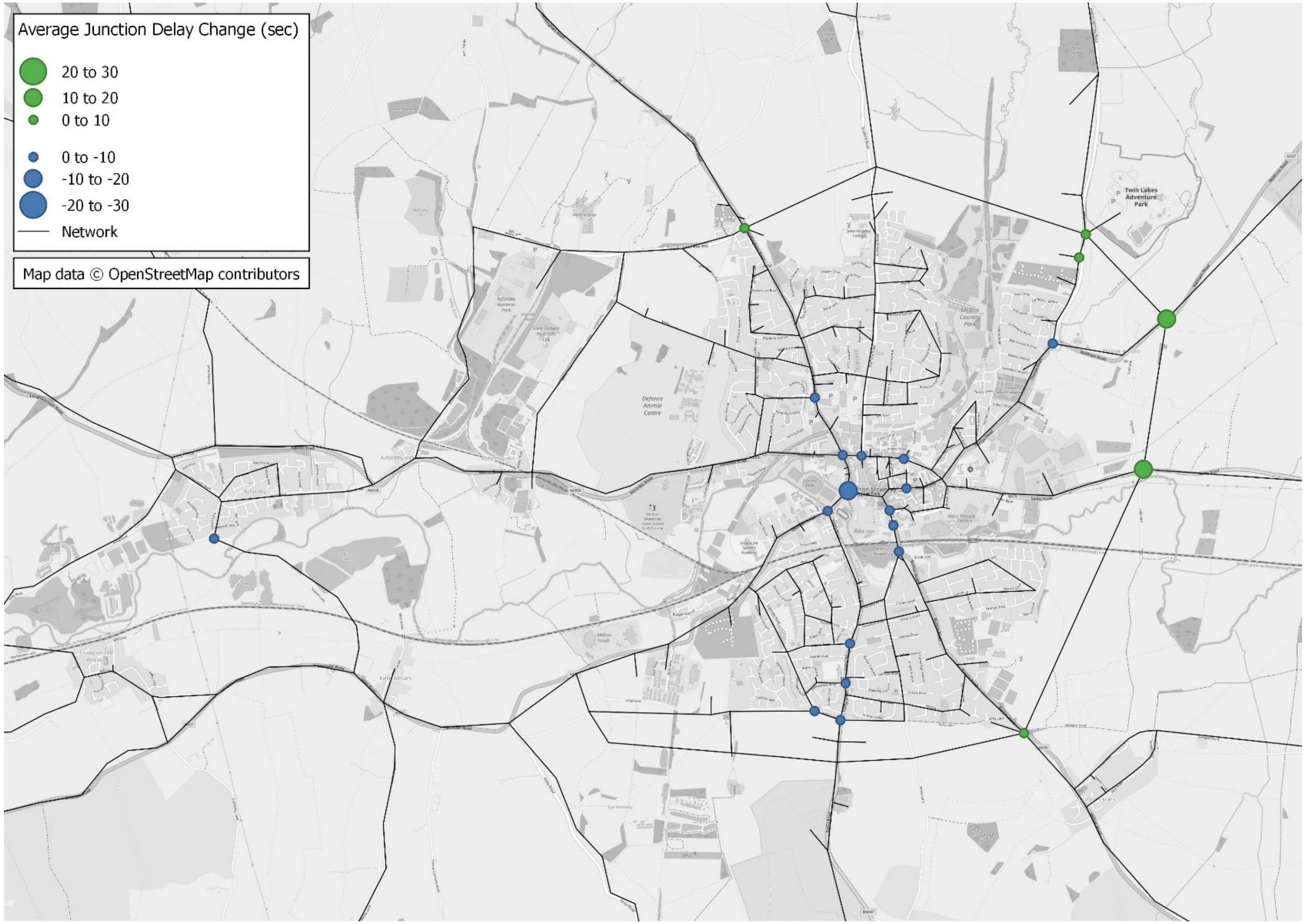
Figure G-12: Forecast Change in Average Delay at Junctions from Core Scenario to NEMMDR Scenario – 2051 PM Peak



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LLITM 2014 Base

North & East Melton Mowbray Distributor Road Full Business Case

Economic Assessment Report

Leicestershire County Council

November 2022

Quality information

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Revision History

Revision	Revision date	Details	Authorised	Name	Position
v1	2022-05-18	Update for NEMMDR FBC	Yes	Mark Dazeley	Regional Director
v1.01	2022-06-10	Minor internal updates	Yes	Mark Dazeley	Regional Director
v1.05	2022-11-25	Updated DI section in response to DfT queries Scheme costs section updated	Yes	Mark Dazeley	Regional Director
v1.05	2022-11-30	Minor changes to scheme costs	Yes	Mark Dazeley	Regional Director

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Section 1 – Overview

1.1 Introduction

1.1.1 The Leicester and Leicestershire Integrated Transport Model (LLITM 2014 Base) was commissioned by Leicestershire County Council (LCC) and is a suite of models containing highway and public transport assignment models; a variable demand model, which includes a parking model of Leicester City and Loughborough town centre; and a land-use model.

1.1.2 LLITM 2014 Base draws on and augments previous versions of the model suite, extending the coverage of the detailed model area beyond Leicestershire, creating demand matrices to reflect 2011 Census data, incorporating significant new observed data (highway RSIs and counts, and public transport counts), and making best use of electronic ticketing and mobile network data. NTEM 7.2 has also been incorporated in LLITM 2014 Base.

1.1.3 This report discusses the economic assessment of the proposed North and East Melton Mowbray Distributor Road (NEMMDR), based on the forecasts detailed in *'NEMMDR FBC - Forecasting Report'* and following the approach set out in the Appraisal Specification Report.

1.1.4 This economic assessment includes the appraisal of user benefits, including the TAG high / low growth sensitivity tests, the assessment of the impacts of the scheme on journey time reliability, physical activity and accidents, the environmental assessment of scheme impact on air quality and noise, and an assessment of the impacts of construction and maintenance of the NEMMDR. It also includes assessment of the scheme cost.

1.1.5 For calculating scheme costs the contractor has based future inflation estimates on the Building Cost Information Service (BCIS) forecasts for the construction period from 2022 to 2025. These inflation estimates have been applied at monthly intervals.

1.1.6 This Economic Assessment Report details the assessment of the forecast monetised impacts of the proposed NEMMDR; however, there are other objectives and impacts of the scheme which have not been monetised which form an important part of the decision-making process. These are discussed elsewhere within the Full Business Case for the NEMMDR.

1.2 Scheme Overview

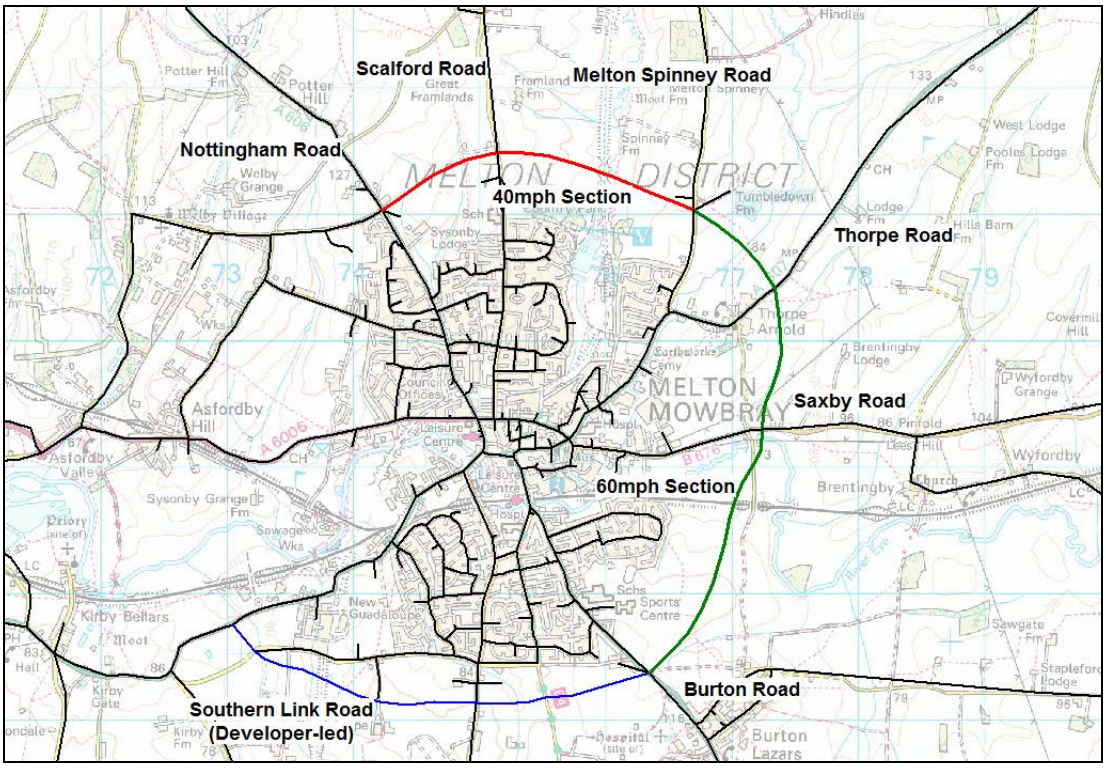
1.2.1 Figure 1-1 provides an overview of the proposed NEMMDR, which provides a new link road between Nottingham Road to the north-west of Melton Mowbray and Burton Road to the south-east of the town. This link between Nottingham Road and Burton Road is assumed to be a single carriageway route with a 40mph speed limit between Nottingham Road and Melton Spinney Road (shown in red), and a 60mph speed limit for the remainder of the route (shown in green).

1.2.2 The Core Scenario (without scheme) assumes that the Northern Link Road between Nottingham Road and Melton Spinney Road is open in 2040, and that the eastern section between Melton Spinney Road and Burton Road is not built.

1.2.3 The NEMMDR Scenario (with scheme) assumes that the Northern Link Road between Nottingham Road and Melton Spinney Road is accelerated to be open in 2025, and that the eastern section between Melton Spinney Road and Burton Road is also open in 2025.

1.2.4 The Southern Link Road, shown in blue, is not part of the NEMMDR, but will ultimately link with the NEMMDR. The Southern Link Road will be developer-funded, with an assumed completion date of 2040.

Figure 1-1: Proposed NEMMDR



Map contains Ordnance Survey data © Crown copyright and database right 2022

1.3 Report Structure

1.3.1 Following this introduction, this Economic Assessment Report contains the following sections:

- Section 2 – Estimation of Scheme Costs: this section details the derivation of the costs of construction and maintenance for the NEMMDR.
- Section 3 – Estimation of Benefits – TUBA: this section details the TUBA assessment to estimate the user benefits of the NEMMDR. This section also includes the results of sensitivity tests around the user benefits for high / low growth, the inclusion of 2051 forecasts, and the use of an alternative base year model.
- Section 4 – Estimation of Benefits – Accidents: this section details the application of the approach set out in CoBA-LT to assess the change in accidents with the introduction of the NEMMDR.
- Section 5 – Estimation of Benefits – Scheme Construction Delays: this section details the use of QUADRO to assess the delays associated with the construction and maintenance of the NEMMDR.
- Section 6 – Estimation of Benefits – Journey Time Reliability: this section details the assessment of the benefits due to improved journey time reliability through the inclusion of the NEMMDR.
- Section 7 – Local Noise Assessment: this section details the assessment of the impact of the scheme on local traffic noise levels through the inclusion of the NEMMDR.
- Section 8 – Local Air Quality Assessment: this section details the assessment of the impact of the scheme on local air quality levels with the inclusion of the NEMMDR.
- Section 9 – Assessment of Physical Activity: this section details the assessment of the impact of the NEMMDR on physical activity (i.e. walking and cycling).
- Section 10 – Wider Impacts Assessment: this section summarises the assessment of the forecast Wider Impacts of the NEMMDR.

- Section 11 – Assessment of Distributional Impacts: this section details the screening and assessment (where deemed necessary) of the distributional impacts of the NEMMDR in-line with the guidance set out in TAG Unit A4.2.
- Section 12 – TEE, Public Accounts and AMCB Tables: this section provides the TAG Transport Economic Efficiency (TEE), Public Accounts, and Analysis of Monetised Costs and Benefits (AMCB) tables required for the Full Business Case submission.

1.3.2 In addition to the section outlined above, accompanying this Economic Assessment Report are several stand-alone files. These include:

- the TUBA input (scheme and economics files) and output files;
- the CoBA-LT input and output files; and
- the TEE, PA and AMCB tables detailed in Section 12 in MS Excel format.

Section 2 – Estimation of Scheme Costs

2.1 Introduction

2.1.1 This section details the costs of construction and maintenance of the NEMMDR as used in the economic assessment. It also details the assumed developer contributions. In undertaking the assessment of costs it is important to note that the Northern Link Road (Nottingham Road to Melton Spinney Road) is also included in the Without Scheme (Core) Scenario although it is built at a later date in the Core Scenario, opening in 2040 rather than 2025.

2.2 With Scheme (NEMMDR) Scenario Construction Costs and Profile

2.2.1 The construction costs of the full NEMMDR have been estimated for land, construction and preparation costs over the financial years from 2018/19 to 2025/26. These costs have been provided in factor costs, based on 2022 prices. To these costs the BCIS inflation forecasts have been applied and the GDP deflator. Costs incurred prior to October 2022 are considered as 'sunk' costs and are excluded from the economic assessment. A summary of these costs is presented in Table 2.1

Table 2.1: Summary of NEMMDR Construction Costs (factor costs, including inflation)

Calendar Year	Land	Construction	Preparation	Supervision	Total (£)
2022	1,549,800	2,253,583	1,324,437	0	**5,127,820**
2023	516,600	33,481,644	1,491,377	0	**35,489,621**
2024	172,200	39,152,136	1,326,867	0	**40,651,203**
2025	57,400	16,358,595	463,688	0	**16,879,682**
Total	**2,296,000**	**91,245,958**	**4,606,368**	**0**	**98,148,326**

Note: Supervision costs are included as part of construction costs

2.2.2 These costs have been converted to market prices (by applying the indirect tax factor of 1.19). A Quantified Risk Assessment (QRA) has been undertaken, resulting in a risk estimate that was 6.12% of the scheme cost (P50). TAG Unit 2.1 has been updated from that used at the OBC stage and now either Risk or Optimism Bias are applied rather than both. As defined within Table 8 of TAG Unit A1.2, an optimism bias of 20% should be used based at Stage 3 (Full Business Case), this has been applied as it is more conservative than the calculated QRA value.

2.2.3 The construction costs, including optimism bias, have been converted to 2010 prices and discounted to 2010 values for the purposes of economic appraisal. A summary of these scheme costs is provided in which gives a total construction cost of £66.2M in 2010 prices discounted to 2010.

Table 2.2: Summary of NEMMDR Discounted Scheme Construction Costs (2010 market prices, including Optimism Bias, discounted to 2010)

Year	Cost (£)
2022	3,798,731
2023	24,824,710
2024	26,952,356
2025	10,606,412
Total	66,182,209

2.3 Monitoring and Evaluation, and Maintenance Costs and Profile

2.3.1 In addition to the costs of the scheme as detailed in Section 2.2, the costs of monitoring and evaluating the proposed scheme, and the costs of maintenance for the scheme have been estimated.

2.3.2 In terms of monitoring and evaluation, a budget of £240,000 (in 2022 factor prices) has been assumed to be spent between 2023 and 2030 (5 years after opening). This equates to a spend of about £50,000 in each year from 2023 (first year of construction) to 2026 (one year after opening) and a further £50,000 spent in the fifth year after opening (2030). These costs have been converted to market prices, and inflation of 2.1% per annum has been assumed.

2.3.3 Maintenance costs have been calculated using assumptions from the CoBA manual although these relate to operational maintenance only. Using Table 9.1 of the CoBA Manual, non-traffic related maintenance costs for the scheme have been assumed to be £7,400 per kilometre in 2002 prices. The length of the NEMMDR is 7.04km, and using a GDP inflation assumption, results in maintenance costs of £80,539 per annum in 2022 prices.

2.3.4 In-line with guidance, maintenance is assumed to commence in 2026, and continue annually until the end of the appraisal period in 2084.

2.3.5 Both the monitoring and evaluation, and the maintenance costs have been converted to 2010 prices and values, including optimism bias of 20%, to provide the following estimates for the economic assessment:

- Monitoring and Evaluation: £165,337
- Scheme Operational Costs: £1,988,846 (approximately 3% of the scheme construction costs)

2.4 Third Party Contributions

2.4.1 As part of the Melton Mowbray North Sustainable Neighbourhood (MMNSN) development included within the Core Scenario land-use assumptions, it is expected that the developers for this site will provide a contribution to the costs of the NEMMDR. These contributions are programmed to be provided between 2022 and 2035 for the With Scheme NEMMDR scenario.

2.4.2 Under the Core scenario assumptions the developers of the MMNSN will entirely fund the Northern Link Road which is expected to be completed by 2040. As these costs are funded by business, the Public Account costs for the Core scenario are zero. However, under the NEMMDR scenario these Core scenario business costs are not incurred and become an additional business benefit attributable to the NEMMDR scenario.

2.4.3 Currently, £14 million of developer funding has been identified by LCC. Some of these funds have already been received by LCC and it is currently forecast that the remaining contributions will be received between now and 2035. It is has been assumed that these payments will be in the price base of the year that they are received.

2.4.4 These developer contributions of £14 million in ‘factor’ prices have been converted to market prices, split across the expected build out of the MMNSN, and converted to 2010 prices and discounted to 2010. The result of this conversion is that the value of the developer contributions for the NEMMDR scenario will be £7.2 million in 2010 prices discounted to 2010.

2.5 NEMMDR Net Scheme Costs

2.5.1 The Present Value of Costs (PVC) of the NEMMDR is £68.34 million in 2010 prices discounted to 2010.

2.5.2 When including developer contributions of £7.2 million, the NEMMDR scheme costs reduce to £61.14 million.

2.5.3 The Northern Link Road is included in the Core (Without Scheme) scenario, and the cost of this has been calculated to be £18.7 million in 2010 prices discounted to 2010. As the Northern Link Road is wholly funded by the developers, under the NEMMDR scenario these funds are not incurred by the developers and hence become a business benefit.

2.5.4 As well as contributions from developers there will also be a contribution to the NEMMDR scheme costs by LCC and these are provided in Section 12.

2.6 Quantified Risk Assessment

2.6.1 Cost risk and uncertainty has been assessed using a Quantified Risk Assessment (QRA) which is then used to produce a risk-adjusted cost estimate, following TAG Unit A1.2 guidance.

2.6.2 Risks have been assessed for preparation, construction and supervision costs; the following methodology has been adopted, based on TAG Unit A1.2 §3.2.

Risk Identification

2.6.3 A comprehensive risk register has been developed listing identified risks (and their owners) that are likely to affect the delivery of the scheme. This risk register has been developed by AECOM and Galliford Try which is the ECI[1] contractor for the NEMMDR, consisting of preparation (design), construction and project risks. The risk register is shown in Appendix A .

2.6.4 The early involvement of Galliford Try has combined the complementary expertise of client, designer and contractor, and facilitated the early identification of project risks. This process has used the knowledge gained by the organisations and the individuals on the ECI team during the development and construction of many similar schemes.

Assessing the Impacts of Risk to Determine Possible Outcomes

2.6.5 For each risk, the minimum and maximum likely impacts have been monetised, using empirical evidence, previous experience on similar projects, or common-sense approximations as appropriate. For construction and project risks, these have been derived pre- and post-risk mitigation; the post-mitigation impacts have been used for the QRA assessment, which are the residual risks following mitigation spending, which has been treated as a fixed cost within the QRA.

2.6.6 Galliford Try has an established ECI and construction phase risk management process that was used to develop the project risk register. The project team identified the risks and impacts, with potential costs, associated with the project. These were further evaluated for the likelihood of occurrence resulting in a risk rating measure between ‘high’ and ‘low’. Mitigation measures identified were reviewed by the project team to give a revised risk rating with a residual cost impact on the project.

2.6.7 The use of this process allows the client to identify areas of more significant risk and their associated mitigation opportunities, enabling an informed decision to be made on the value of allocating upfront funds to provide options for alternative design or construction solutions. The overall benefit of this ECI risk management process is the lowering the potential outturn cost and / or budget uncertainty.

2.6.8 The established process used by the project team, working in collaboration, provides a realistic assessment of risks at this stage in the scheme’s development. The risk profile naturally alters as project scope, design details, and constraints change over time. The risk register has required periodic review and updating as the scheme develops to incorporate any new, mitigated, or revised risks.

Estimating the Likelihood of the Outcomes Occurring

2.6.9 The likelihood of each outcome occurring has been based on past experience on similar schemes. As recognised in TAG Unit A1.2 §3.2.14, defining the likelihood of each outcome occurring is not an exact science. The assumptions made are shown in Appendix A .

Deriving the Probability Distribution for the Costs of the Scheme

2.6.10 A QRA allows a probability distribution around the costs of the scheme to be derived and enables the expected risk-adjusted cost estimate to be obtained. This expected outcome, also known as the 'mean' or 'unbiased' outcome is the weighted average of all potential outcomes and associated probabilities. This is the (risk-adjusted) mean estimate of the cost of the scheme, and it is to this that optimism bias will be applied.

2.6.11 A Monte Carlo risk model has been developed using MS Excel and @RISK. Potential correlations between the individual risks have been considered, with no materially dependent variables identified. Sensitivity tests have been undertaken to assess the impact of unknown correlations being present; the impact on the output probability distribution is relatively small.

2.6.12 The Monte Carlo risk model has been run with 10,000 iterations, with the output probability distribution for the QRA shown in Figure 2-1.

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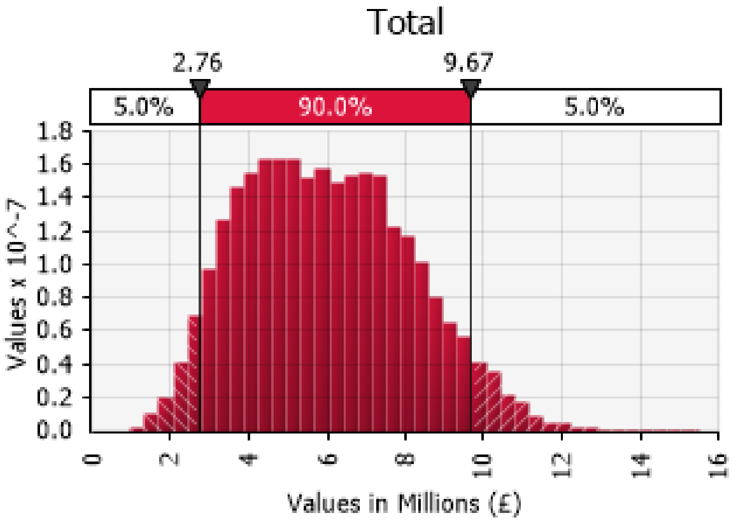
[1] Early Contractor Involvement

Figure 2-1: Probability Distribution for the Scheme Cost QRA



2.6.13 The resulting mean, P50 and P80 values from the output probability distributions are given in Table 2.3.

Table 2.3: Mean, P50 and P80 Values from the QRA

	Mean	P50	P80
QRA Assessment	£5,973,351	£5,856,401	£7,884,833

Section 3 – Estimation of Benefits – TUBA

3.1 Introduction

3.1.1 TUBA is the Department for Transport’s appraisal software used to estimate the transport user benefits (changes in time and vehicle operating costs), changes in indirect tax revenue and greenhouse gases as the result of a proposed scheme.

3.1.2 Using the forecast year models described within *‘NEMMDR FBC - Forecasting Report’*, the forecast demand, time and distance for the Core Scenario and NEMMDR Scenario have been used within the TUBA assessment.

3.1.3 This assessment has used forecast model data from 2025, 2030, 2035, 2039, 2040 and 2051.

3.1.4 A 60-year appraisal period has been adopted, in-line with TAG, from the assumed NEMMDR opening year of 2025 to a horizon year of 2084. The current year assumed within the assessment is 2022, with the benefits and costs given in 2010 prices and values. This assessment has used v1.9.17 of the TUBA software.

3.1.5 The TUBA input and output files are included as accompanying files to this Economic Assessment Report.

3.2 TUBA Economic Assumptions

3.2.1 The assessment of the proposed NEMMDR has made use of the standard TUBA economics file issued with v1.9.17 of the software; however, amendments have been made to the file to provide consistency with the user classes in the LLITM 2014 Base highway model.

3.2.2 For highway travel, the standard economics file contains assumptions for car, LGV (personal and freight) and for OGV1 and OGV2. Within LLITM 2014 Base, the highway model includes a single HGV user class, a single LGV user class, and seven car user classes representing business travel, commuting for three income bands, and other travel for three income bands.

3.2.3 To provide consistency with the LLITM 2014 Base user classes, the data within the standard economics file have been mapped to the LLITM 2014 Base user classes. The standard economic assumptions have been adopted throughout, with the following exceptions:

- OGV1 and OGV2 assumptions have been combined into a single HGV category. 40% of HGVs are assumed to be OGV1, with the remaining 60% assumed to be OGV2, based on DfT statistics on the mix of HGV vehicles[2].
- LGV Personal and LGV Freight have been combined into a single LGV category. 88% of LGV traffic is assumed to be freight, with 12% assumed to be personal, based on Table A1.3.4 within the TAG data book.

3.2.4 As prescribed within TAG Unit A1.3, Section 4.3.4, values of time for commuting and other travel have not been amended to reflect the different income levels adopted within the highway model. Whereas the highway assignment and variable demand model represents different values of time by income, central TUBA values of time have been used for low, medium and high-income bands within the assessment.

3.3 TUBA Annualisation Assumptions

3.3.1 The highway model contained within LLITM 2014 Base represents an AM Peak hour (08:00 to 09:00), an average interpeak hour (between 10:00 and 16:00), and a PM Peak hour (17:00 to 18:00). Using data from these three modelled hours, an estimate of benefits to road users for a year is estimated. The factors applied to the three modelled hours to estimate benefits for a year are annualisation factors.

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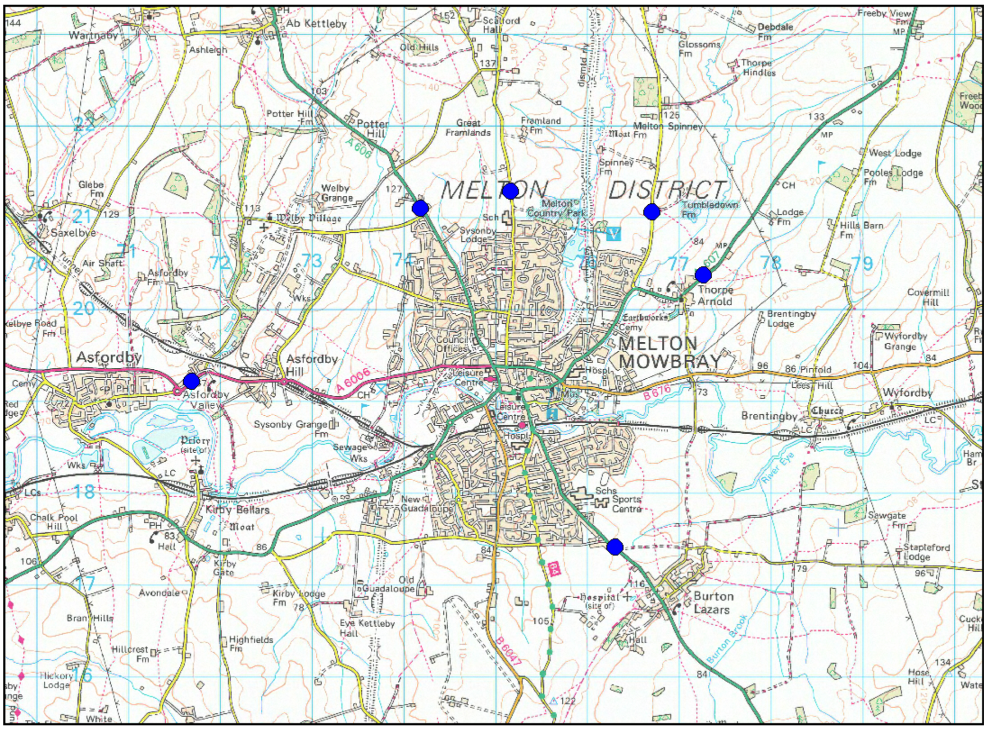
[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209004/tra3105.xls

Selected Count Data

3.3.2 Long-term automatic traffic count data have been provided for locations within Leicestershire between 2012 and early 2017. Within this data set, 18 count sites were found to be within Melton Borough, with 9 of these sites having complete count data for at least one year.

3.3.3 Analysis of these data revealed inconsistencies in the count data for some of these sites across a given year and between years of data, particularly for the data covering 2014. It was therefore concluded that annual count data for 6 sites between the start of November 2012 and the end of October 2013 should form the basis of annualisation calculations as this was the nearest complete year of reliable data to 2014. Figure 3-1 shows the location of these six counts.

Figure 3-1: Location of Count Sites Used in Annualisation Calculation

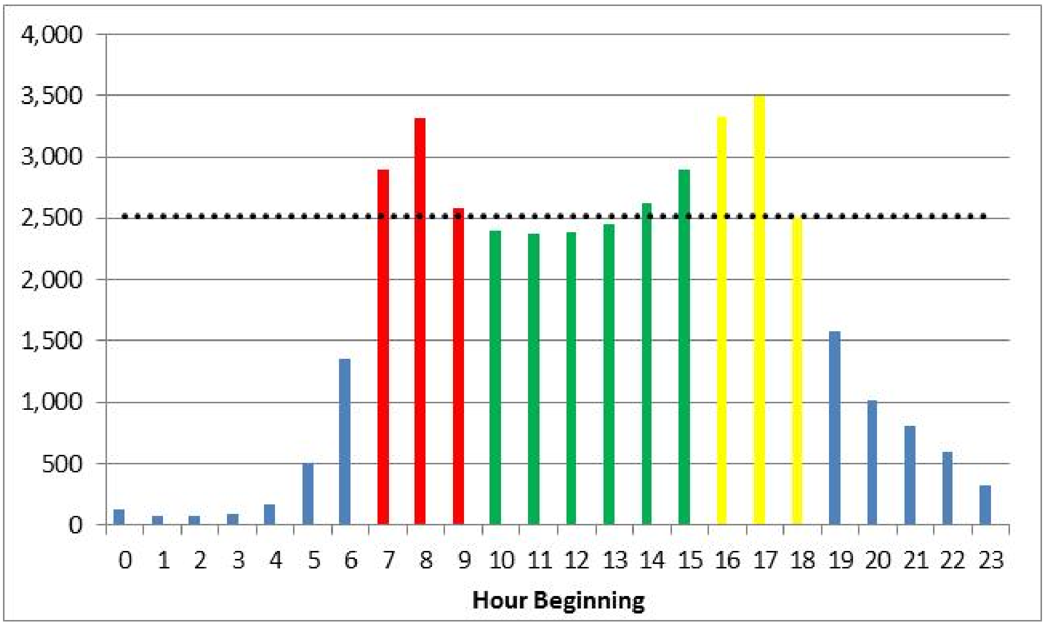


Map contains Ordnance Survey data © Crown copyright and database right 2022

Flow Profile (Weekdays)

3.3.4 Figure 3-2 shows the flow profile across the day for an average weekday within Melton Mowbray. This analysis uses sites shown in Figure 3-1, and these data have been aggregated by site and direction. The bars within Figure 3-2 have been colour-coded based on the traditional time period allocation: AM Period (0700 to 10:00); Interpeak Period (10:00 to 16:00); PM Period (16:00 to 19:00); and Off-Peak Period (19:00 to 07:00). The black dotted line within Figure 3-2 represents the average interpeak hour flow.

Figure 3-2: Aggregated Vehicle Flow Profile for Melton Mowbray (Weekdays)



3.3.5 This figure shows that for the 09:00 to 10:00 and 18:00 to 19:00 hours, which would normally be attributed to their peak periods, the traffic volumes in these hours are at an interpeak level. In addition to this, the 07:00 to 08:00 hour is below the peak hour in the AM Peak, and is marginally closer to the interpeak average than the AM Peak hour flows. (Conversely, the 16:00 to 17:00 flow is closer to the PM Peak hour than the interpeak average flow.)

3.3.6 Considering the 07:00 to 08:00 hour in more detail, a limited number of counts with data at fifteen minutes intervals were available. These data have been used to define a profile of demand within this hour, and the results of this analysis are shown in Table 3.1.

Table 3.1: 07:00 to 08:00 Estimated 15 Minute Vehicle Flows (Weekdays)

Time	Traffic Count	Proportion of Hourly Flow
07:00 – 07:15	550	19%
07:15 – 07:30	667	23%
07:30 – 07:45	804	28%
07:45 – 08:00	881	30%

3.3.7 Based on this analysis, for the purposes of the TUBA assessment, hours where the flow is closest to the average interpeak hour flow have been allocated benefits equivalent to those forecast from the interpeak hour model. The result of this allocation for 07:00 to 19:00 during an average weekday is given in Table 3.2.

Table 3.2: 12-hour Benefit Allocation

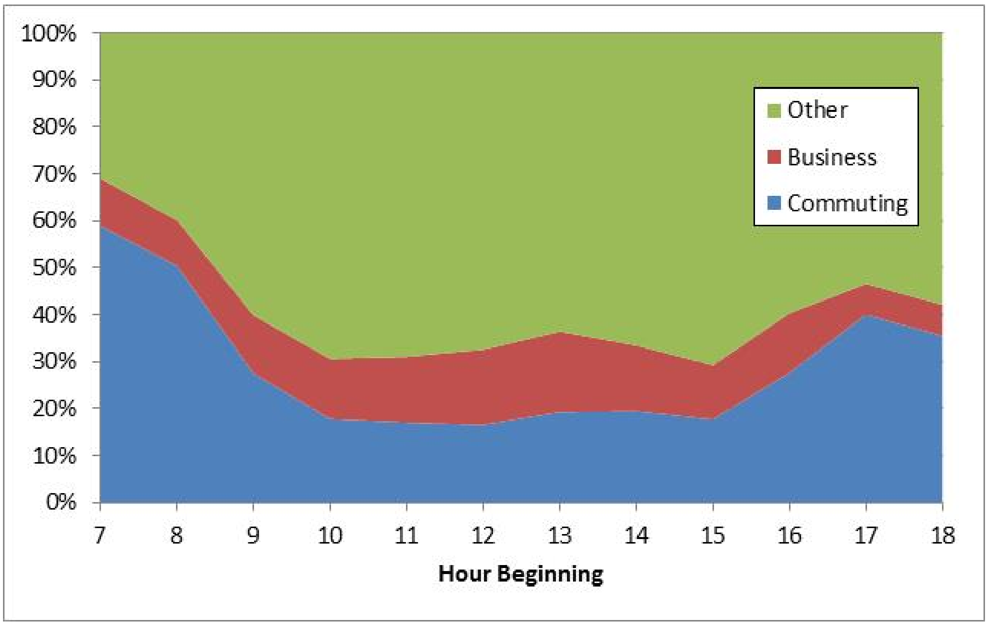
Hour	7		8	9	10	11	12	13	14	15	16	17	18
Benefits	IP	AM	AM	IP	IP	IP	IP	IP	IP	IP	PM	PM	IP

Purpose Splits (Weekdays)

3.3.8 Whilst, for example, the 18:00 to 19:00 hour has traffic volumes equivalent to the interpeak hour, and therefore is expected to see interpeak hour benefits, the demand within this hour may not have the same purpose split as that observed within the interpeak hour. The purpose split within the demand matrices influences the benefits calculated, and therefore needs to be considered within the assessment.

3.3.9 Using the 2014 RSI data for the Melton Mowbray cordon, the observed purpose splits have been calculated for inbound trips by hour across the 12-hour period of the survey. The results of this analysis are shown in Figure 3-3.

Figure 3-3: Observed Purpose Split at Melton Mowbray Cordon



3.3.10 This shows that, for example, the purpose split for 18:00 to 19:00 is closer to that observed within the PM Peak hour rather than that observed within the interpeak period. For the modelled hours within the two peak periods, each hour has been assigned to either the given peak period or the interpeak period based on the closest match in terms of purpose split. This allocation defines the demand matrices to be used within the economic assessment, and this is detailed in Table 3.3.

Table 3.3: 12-hour Benefit and Demand Allocation

Hour	7		8	9	10	11	12	13	14	15	16	17	18
Demand	AM		AM	IP	IP	IP	IP	IP	IP	IP	IP	PM	PM
Benefits	IP	AM	AM	IP	IP	IP	IP	IP	IP	IP	PM	PM	IP

3.3.11 This allocation results in six combinations of demand and cost skims to be provided to TUBA, and annualisation factors for each of these six combinations will be calculated based on the collated annual count data. These six combinations are:

- 07:00 to 07:30: AM Peak hour demand with interpeak hour costs;
- 07:30 to 09:00: AM Peak hour demand and costs;
- 09:00 to 16:00: interpeak hour demand and costs;
- 16:00 to 17:00: interpeak hour demand and PM Peak hour costs;
- 17:00 to 18:00: PM Peak hour demand and costs; and
- 18:00 to 19:00: PM Peak hour demand and interpeak hour costs.

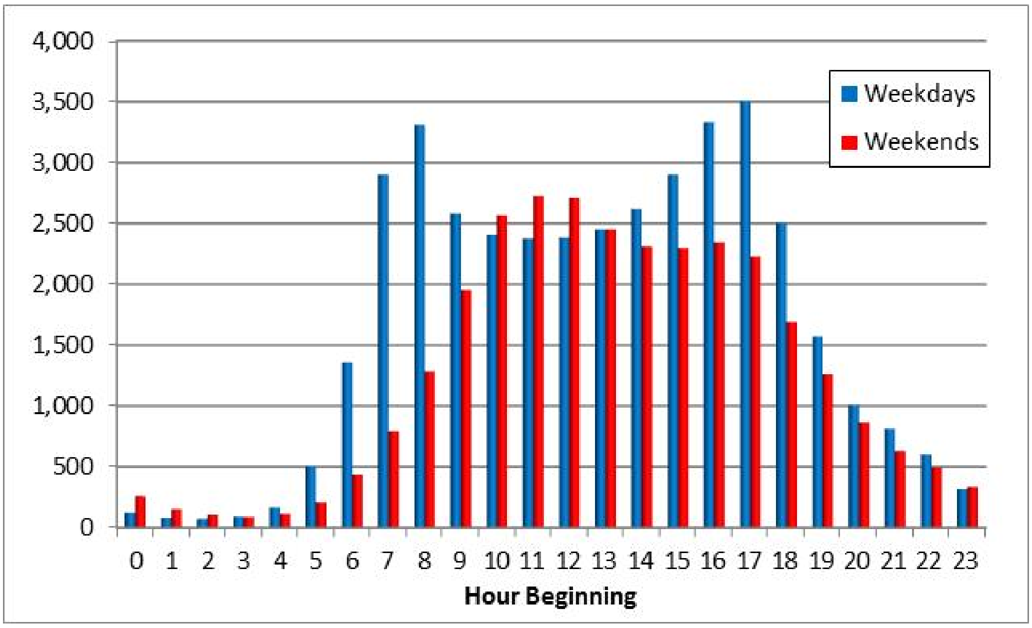
3.3.12 In addition to the 12 hours covered by the roadside interview data, the off-peak period (19:00 to 07:00) has also been included within the appraisal. Purpose split data are not available for the off-peak period from the roadside interview data, and therefore it has been assumed that this period will use both interpeak demand and costs within the TUBA assessment.

Flow Profile (Weekends)

3.3.13 In addition to weekdays, benefits during weekend periods need to be accounted for within the TUBA assessment. As with the weekday off-peak period, the roadside interview data do not cover weekends, so we do not have local purpose split information, and therefore have similarly assumed that weekends will use both demand and costs from the interpeak model within the appraisal.

3.3.14 In terms of the level of flow across an average day within a weekend, Figure 3-4 shows the flow profile for both an average weekday and average weekend day based on count data available at the locations shown in Figure 3-1. This shows that the interpeak and off-peak flows are comparable between weekdays and weekends, but that the weekends lack the morning and evening peak.

Figure 3-4: Aggregated Flow Profile for Melton Mowbray (Weekdays and Weekends)



Annualisation Factors

3.3.15 Using the definition of the time periods within the TUBA assessment, the observed flow for the modelled hours has been calculated, along with the annual flow for each assessment time period. Using these modelled and annual count data, annualisation factors have been calculated, as shown in Table 3.4:.

Table 3.4: Annualisation Factors

Period	Description	Demand	Costs	Model	Annual	Factor
1	07:00 to 07:30	AM	IP	3,426	302,270	88
2	07:30 to 09:00	AM	AM	3,426	1,241,055	362
3	09:00 to 16:00	IP	IP	2,537	4,490,608	1,770
4	16:00 to 17:00	IP	PM	2,537	838,705	331
5	17:00 to 18:00	PM	PM	3,619	880,676	243
6	18:00 to 19:00	PM	IP	3,619	628,887	174
7	19:00 to 07:00	IP	IP	2,537	1,683,133	664
8	Weekend	IP	IP	2,537	3,365,809	1,327

3.4 Masking of TUBA Forecasts

3.4.1 With any assignment model with the scale of LLITM 2014 Base, between any two assignments there can be ‘noise’ in the assignment results. This can manifest itself as changes in assigned volumes and

/ or travel costs between the “without scheme” and NEMMDR scenarios in areas of the model not thought to be impacted by the NEMMDR.

3.4.2 To remove this assignment noise from the economic assessment of the scheme, a sectoring system has been defined (largely based on districts within Leicestershire and counties surrounding Leicestershire), with benefits / disbenefits between sectors which are not thought to experience any change in travel costs as a result of the NEMMDR removed from the assessment.

3.4.3 Figure 3-5 shows the sector system adopted for the TUBA assessment of the NEMMDR, with Table 3.5 showing the movements which have been included (highlighted in blue) and excluded (shown in grey) from the assessment. In summary:

- all movements to / from Melton Borough have been included in the assessment; and
- for non-Melton Borough movements, only those which may pass through the Area of Influence of the scheme (such as Leicester City to / from Lincolnshire) have been included.

Figure 3-5: TUBA Assessment Sector System

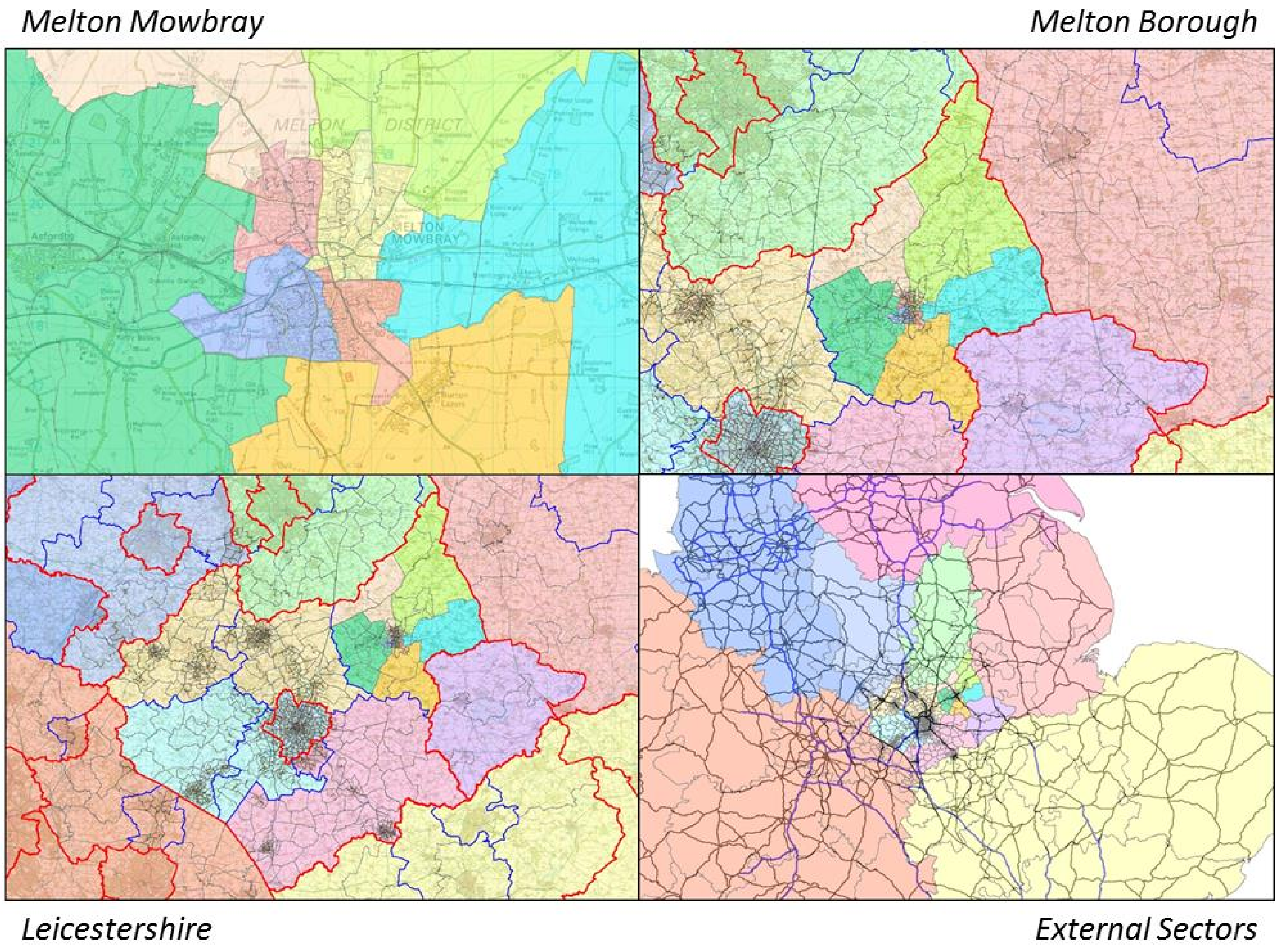


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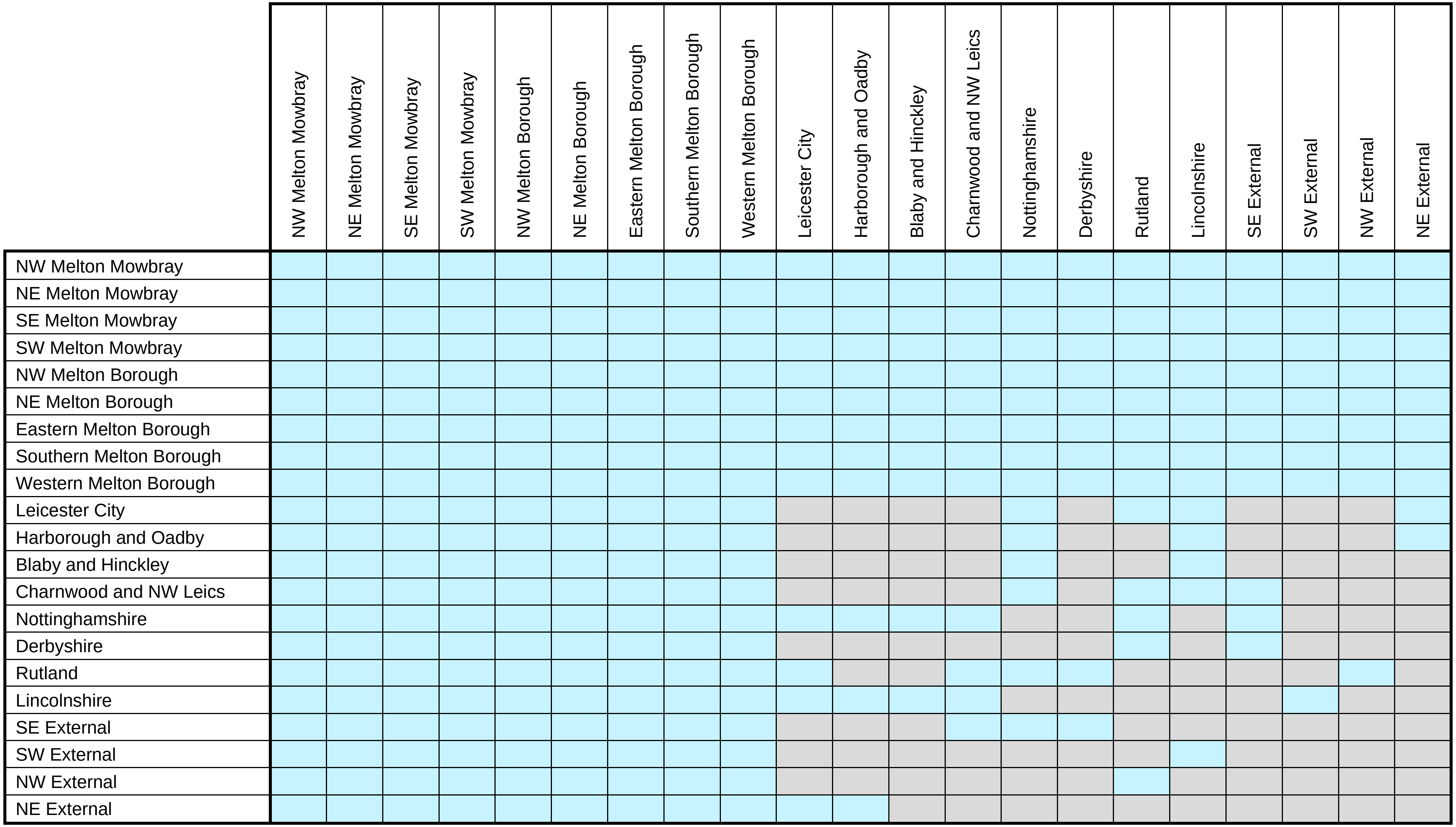
Table 3.5: Included Sector-to-sector Movements



	NW Melton Mowbray	NE Melton Mowbray	SE Melton Mowbray	SW Melton Mowbray	NW Melton Borough	NE Melton Borough	Eastern Melton Borough	Southern Melton Borough	Western Melton Borough	Leicester City	Harborough and Oadby	Blaby and Hinckley	Charnwood and NW Leics	Nottinghamshire	Derbyshire	Rutland	Lincolnshire	SE External	SW External	NW External	NE External
NW Melton Mowbray	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
NE Melton Mowbray	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
SE Melton Mowbray	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
SW Melton Mowbray	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
NW Melton Borough	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
NE Melton Borough	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Eastern Melton Borough	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Southern Melton Borough	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Western Melton Borough	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Leicester City	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	🟦	⬜	🟦	🟦	⬜	⬜	⬜	🟦
Harborough and Oadby	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	🟦	⬜	⬜	🟦	⬜	⬜	⬜	🟦
Blaby and Hinckley	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	🟦	⬜	⬜	🟦	⬜	⬜	⬜	⬜
Charnwood and NW Leics	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	🟦	⬜	🟦	🟦	🟦	⬜	⬜	⬜
Nottinghamshire	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	🟦	⬜	🟦	⬜	⬜	⬜
Derbyshire	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	🟦	⬜	⬜	⬜
Rutland	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	🟦	🟦	🟦	⬜	⬜	⬜	⬜	🟦	⬜
Lincolnshire	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜
SE External	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜
SW External	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜	⬜	⬜
NW External	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜	⬜	⬜	⬜
NE External	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜

3.5 Summary of TUBA Forecasts

3.5.1 Table 3.6 summarises the TUBA scheme benefits for the Central Growth scenario, i.e. the Central Forecasts as detailed within the NEMMDR FBC - Forecasting Report and including model forecasts for 2025 (scheme opening year), 2040 (scheme opening year plus 15 years), and 2051 (scheme horizon year). As there are network changes in 2030 and 2035 due to the Southern Link Road these two forecast years are also included in the TUBA assessment. 2039 is also included as an appraisal year as the Northern Link Road is not present in the Core Scenario until 2040 which results in a step change in NEMMDR benefit outcomes between these two years.

3.5.2 Table 3.6 also provides a breakdown of the scheme benefits by trip purpose, split by travel time savings and changes in vehicle operating costs, and for indirect tax revenues and greenhouse gases, as required within the TAG Transport Economic Efficiency (TEE) table.

3.5.3 Table 3.6 shows that for the Central Growth scenario the estimated present value of benefits from the TUBA assessment is £107.3m over the 60-year appraisal period. This includes forecasts of £107.8m in travel time benefits, £0.6m of vehicle operating cost disbenefits, a £2.9m increase in indirect tax revenues and £2.8m of greenhouse gas disbenefits.

3.5.4 Table 3.6 also shows that the NEMMDR results in significant journey time savings; however, due to its alignment, the scheme also is forecast to increase typical journey distances resulting in increases in fuel consumption, and therefore disbenefits for vehicle operating costs and greenhouse gases.

3.5.5 Further analysis of these forecast scheme benefits by modelled year, user class, time period and sector-based movements is given later in this section in Table 3.9 to Table 3.14. These tables exclude greenhouse gas (GHG) emissions following TUBA standard reporting practice as GHG is not included within the TEE benefits.

3.5.6 The TUBA output files provide statistics indicating the Scheme benefits as a proportion of overall transport costs. This is meant to provide an indication of whether convergence within the transport model is sufficient. The proportion of benefits to overall costs range from 0.12% to 0.20% which are more than 10 times greater than the assignment model convergence criteria of 0.01%. However, as the LLITM 2014 Base model has national coverage these values are not 10 times the demand/supply model convergence criteria of 0.075%.

Table 3.6: Summary of Discounted TUBA Benefits - Central Growth, 2010 prices and values

	Travel Time	**Vehicle Operating Costs**	**Total**
Non-Business: Commuting	£24,108,000	-£535,000	£23,573,000
Non-Business: Other	£39,665,000	-£4,607,000	£35,058,000
Business (Freight)	£23,976,000	£2,496,000	£26,472,000
Business (Personal)	£20,003,000	£2,051,000	£22,054,000
Total	*£107,752,000*	*-£595,000*	£107,157,000

Indirect Tax Revenues	£2,943,000
Greenhouse Gases	*-£2,753,000*
Present Value of Benefits	***£107,347,000***

Note: PVB consists of only those elements included in the table

3.5.7 As detailed within *'NEMMDR FBC - Forecasting Report'*, high and low growth sensitivity tests have been undertaken using the methodology detailed within TAG Unit M4, Section 4.

3.5.8 Using these alternative growth scenarios, TUBA assessments of the scheme benefits have been undertaken using high and low growth forecast for 2025, 2030, 2035, 2039, 2040 and 2051. The results of these sensitivity tests are detailed in Table 3.7 and Table 3.8 for the high and low growth scenarios respectively.

3.5.9 The Central Growth scenario forecasts TUBA benefits of around £107.3m and this is forecast to increase to £124.8m in the High Growth scenario, an increase of around 16%. In the Low Growth scenario, the forecast scheme benefits reduce to around £85.6m, a reduction of around 20%.

3.5.10 The majority of the difference in scheme benefits between the central, high and low growth scenarios is attributable to changes in the forecast travel time savings.

Table 3.7: Summary of Discounted TUBA Benefits - High Growth Sensitivity Test, 2010 prices and values

	Travel Time	**Vehicle Operating Costs**	**Total**
Non-Business: Commuting	£28,210,000	-£393,000	£27,817,000
Non-Business: Other	£44,425,000	-£4,557,000	£39,868,000
Business (Freight)	£29,904,000	£2,650,000	£32,554,000
Business (Personal)	£21,721,000	£2,597,000	£24,318,000
Total	*£124,260,000*	*£297,000*	£124,557,000

Indirect Tax Revenues	£3,214,000
Greenhouse Gases	*-£3,010,000*
Present Value of Benefits	***£124,761,000***

Note: PVB consists of only those elements included in the table

Table 3.8: Summary of Discounted TUBA Benefits - Low Growth Sensitivity Test, 2010 prices and values

	Travel Time	**Vehicle Operating Costs**	**Total**
Non-Business: Commuting	£19,510,000	-£686,000	£18,824,000
Non-Business: Other	£31,585,000	-£4,329,000	£27,256,000
Business (Freight)	£20,191,000	£1,388,000	£21,579,000
Business (Personal)	£16,155,000	£1,589,000	£17,744,000
Total	*£87,441,000*	*-£2,038,000*	£85,403,000

Indirect Tax Revenues	£2,919,000
Greenhouse Gases	*-£2,766,000*
Present Value of Benefits	***£85,556,000***

Note: PVB consists of only those elements included in the table

3.5.11 The following analysis provides further detail on the forecast scheme benefits detailed above. Table 3.9 provides a summary of the forecast scheme benefits in the three scheme assessments (Central Growth, High Growth and Low Growth scenarios) by modelled year.

3.5.12 The discounted forecast scheme benefits generally increase from 2025 to 2035, with a small reduction before 2039. Between 2039 and 2040 there is a more marked drop which reflects the Northern Link Road being included in the Core Scenario in the latter year which means that the additional infrastructure from 2040 onwards in the NEMMDR scenario is just the eastern section of the NEMMDR (i.e. Junctions 3 to 6). There is then a further, although more gradual, decline in benefits to 2051 reflecting the impact of discounting. In all years the Low Growth benefits are consistently the lowest and the High Growth benefits consistently the highest.

Table 3.9: Summary of Discounted TUBA Benefits (excluding greenhouse gasses) by Modelled Year, 2010 prices and values

Year	Central Growth	High Growth	Low Growth
2025	£2,112,000	£2,505,000	£1,905,000
2030	£2,529,000	£2,928,000	£2,185,000
2035	£2,732,000	£3,291,000	£2,398,000
2039	£2,646,000	£3,176,000	£2,250,000
2040	£2,125,000	£2,641,000	£1,820,000
2051	£1,869,000	£2,111,000	£1,392,000
60 year Total	**£110,099,000**	**£127,770,000**	**£88,322,000**

Note figures may not match those presented in Table 3.6 to Table 3.8 due to rounding within the TUBA output files

3.5.13 Table 3.10 provides a summary of the forecast scheme benefits by the user classes defined within the LLITM 2014 Base highway model. For non-business car user classes, which are segmented by income, the user benefits increase with income. Car business and LGV user classes provide the highest forecast benefits based on the user classes defined within LLITM 2014 Base.

3.5.14 Considering the Central Growth scenario in more detail, non-business user classes combined are forecast to constitute around 55% of total benefits, of which around 22% is attributable to commuting demand and 33% to ‘other’ demand. LGV and car business travel are forecast to contribute around 17% and 21% respectively to overall benefits, with HGV travel forecast to be around 7% or 8% of benefits, accounting for marginally higher proportions with higher traffic growth.

Table 3.10: Summary of Discounted TUBA Benefits (excluding greenhouse gasses) by User Class, 2010 prices and values

User Class	Central Growth	High Growth	Low Growth
HGV	£8,248,000	£10,435,000	£5,853,000
LGV	£18,701,000	£21,510,000	£15,386,000
Car Employers Business	£23,020,000	£25,430,000	£18,610,000
Car Other Low-income	£11,032,000	£12,870,000	£8,986,000
Car Other Medium-income	£12,110,000	£14,128,000	£9,781,000
Car Other High-income	£13,074,000	£15,245,000	£10,531,000
Car Commute Low-income	£4,614,000	£5,377,000	£3,733,000
Car Commute Medium-income	£8,508,000	£10,056,000	£6,787,000
Car Commute High-income	£10,792,000	£12,720,000	£8,655,000
Total	**£110,099,000**	**£127,771,000**	**£88,322,000**

Note figures may not match those presented in Table 3.6 to Table 3.8 due to rounding within the TUBA output files

3.5.15 Table 3.11 provides a breakdown in the forecast scheme benefits by the eight time periods included within the TUBA assessment. These eight time periods are: AM Peak Early (07:00 to 07:30); AM Peak (07:30 to 09:00); Interpeak (09:00 to 16:00); PM Peak Early (16:00 to 17:00); PM Peak (17:00 to 18:00); PM Peak Late (18:00 to 19:00); weekday off-peak (19:00 to 07:00); and weekends.

3.5.16 In terms of the Central Growth forecasts, Table 3.11 shows that around 31% of benefits are forecast to occur within the interpeak period, around 25% of benefits occur during the weekends, around 21% in the PM Peak time periods combined, around 12% in the AM Peak time periods combined, and around 11% in the off-peak.

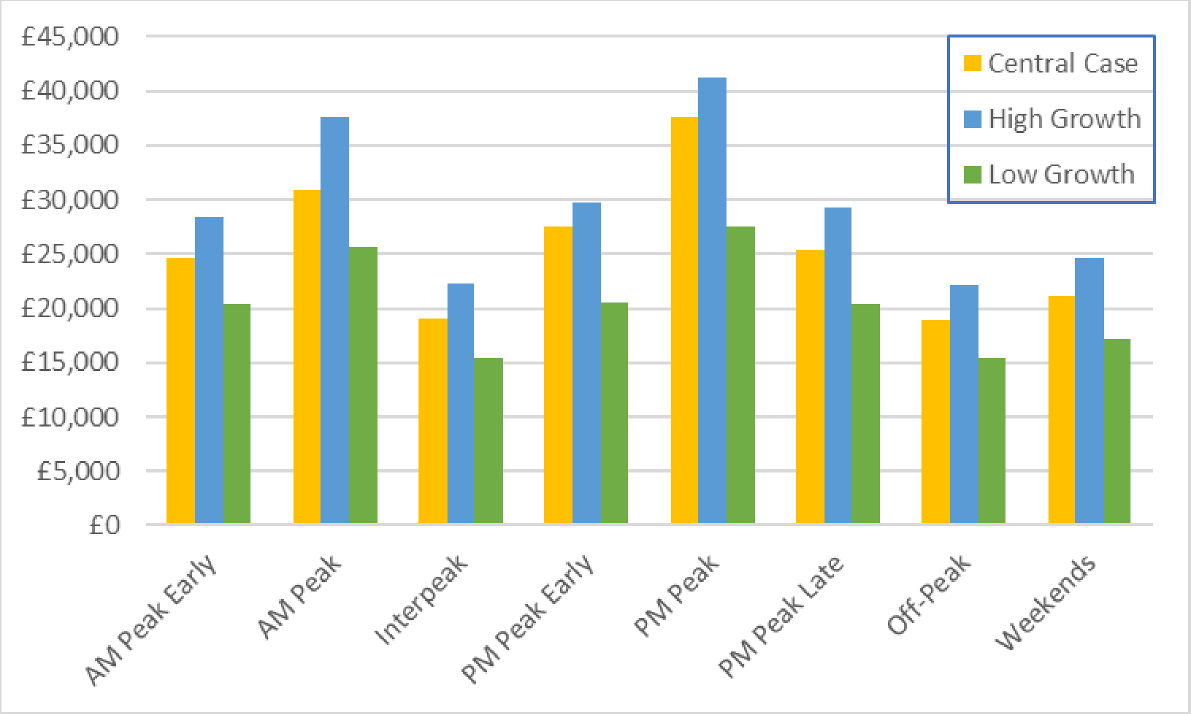
3.5.17 This analysis is, in part, influenced by the assumed annualisation factors, which are largest for the interpeak and weekend time periods. Figure 3-6 shows the forecast scheme benefits within the eight time periods per modelled hour, i.e. excluding the effects of annualisation. This figure shows that 60 year forecast scheme benefits per hour are forecast to be highest in the morning and evening peaks, with the lowest levels of scheme benefits per hour forecast during the interpeak, off-peak and weekends.

Table 3.11: Summary of Discounted TUBA Benefits (excluding greenhouse gasses) by Time Period, 2010 prices and values

Time Period	Central Growth	High Growth	Low Growth
AM Peak Early	£2,166,000	£2,505,000	£1,793,000
AM Peak	£11,187,000	£13,613,000	£9,268,000
Interpeak	£33,602,000	£39,343,000	£27,278,000
PM Peak Early	£9,122,000	£9,858,000	£6,813,000
PM Peak	£9,126,000	£10,013,000	£6,693,000
PM Peak Late	£4,404,000	£5,092,000	£3,556,000
Off-Peak	£12,546,000	£14,689,000	£10,183,000
Weekends	£27,946,000	£32,655,000	£22,737,000
Total	£110,099,000	£127,768,000	£88,321,000

Note figures may not match those presented in Table 3.6 to Table 3.8 due to rounding within the TUBA output files

Figure 3-6: Non-Annualised Discounted TUBA Benefits (excluding greenhouse gases) by Time Period per Hour, 2010 prices and values



3.5.18 Table 3.12 provides a geographical breakdown of the forecast benefits for trip origins and destinations in four broad sectors: Melton Mowbray; the rest of Melton Borough; the rest of Leicestershire (including Leicester City); and the rest of Great Britain.

3.5.19 Considering Central Growth, around 30% of the forecast scheme benefits are for trips which are to or from Melton Mowbray, with around 25% of the benefits attributable to trips with an origin or destination in the remainder of the borough. Trips to or from the remainder of Leicestershire receive between 6% and 10% forecast scheme benefits, with trips to / from zones outside Leicestershire accounting for around 36% of scheme benefits.

Table 3.12: Summary of Discounted TUBA Benefits (excluding greenhouse gasses) by Location, 2010 prices and values

	Sector	Central Growth	High Growth	Low Growth
Origin	Melton Mowbray	£33,702,774	£41,670,939	£27,089,701
	Rest of Melton Borough	£24,835,389	£28,689,047	£21,434,471
	Rest of Leicestershire	£10,920,722	£10,076,669	£6,515,036
	Rest of GB	£40,642,202	£47,333,237	£33,283,710
Destination	Melton Mowbray	£33,888,294	£42,134,606	£26,674,029
	Rest of Melton Borough	£25,730,191	£28,959,356	£21,755,268
	Rest of Leicestershire	£7,626,945	£9,301,283	£5,603,827
	Rest of GB	£42,855,656	£47,374,648	£34,289,794

3.5.20 Considering Central Growth in more detail, Table 3.13 details the forecast TUBA benefits for sector-to-sector movements using the sectors adopted above in Table 3.12, with Table 3.14 showing the percentage of forecast benefits in each sector-to-sector movement.

3.5.21 The movements with the highest proportion of forecast benefits are trips within Melton Mowbray and between areas outside Leicestershire (both with around 16% to 17% of benefits), and also between Melton Borough and zones outside Leicestershire (around 10% in both directions). Movements between Melton Mowbray and the rest of Melton Borough, and between Melton Mowbray and zones outside Leicestershire all are forecast to have around 5% to 7% of total benefits.

3.5.22 The share of forecast benefits within Table 3.14 corresponds with the likely movements that are expected to benefit from the NEMMDR. Through trips with an origin and destination outside Leicestershire are forecast to experience time savings due to the proposed new infrastructure, with trips within Melton Mowbray benefiting from the congestion relief within the urban area.

3.5.23 Given the location of the NEMMDR, trips between Melton Borough and other parts of Leicestershire are not forecast to significantly benefit from the scheme, and this is reflected in the TUBA assessment.

Table 3.13: Summary of Discounted Central Forecast TUBA Benefits (excluding greenhouse gasses) by Movement, 2010 prices and values

		Destination			
		Melton Mowbray	Rest of Melton Borough	Rest of Leicestershire	Rest of GB
Origin	Melton Mowbray	£17,281,276	£6,603,991	£2,220,282	£7,597,225
	Rest of Melton Borough	£6,249,656	£5,558,084	£2,414,277	£10,613,372
	Rest of Leicestershire	£2,223,842	£3,080,147	£0	£5,616,733
	Rest of GB	£8,133,521	£10,487,970	£2,992,386	£19,028,325

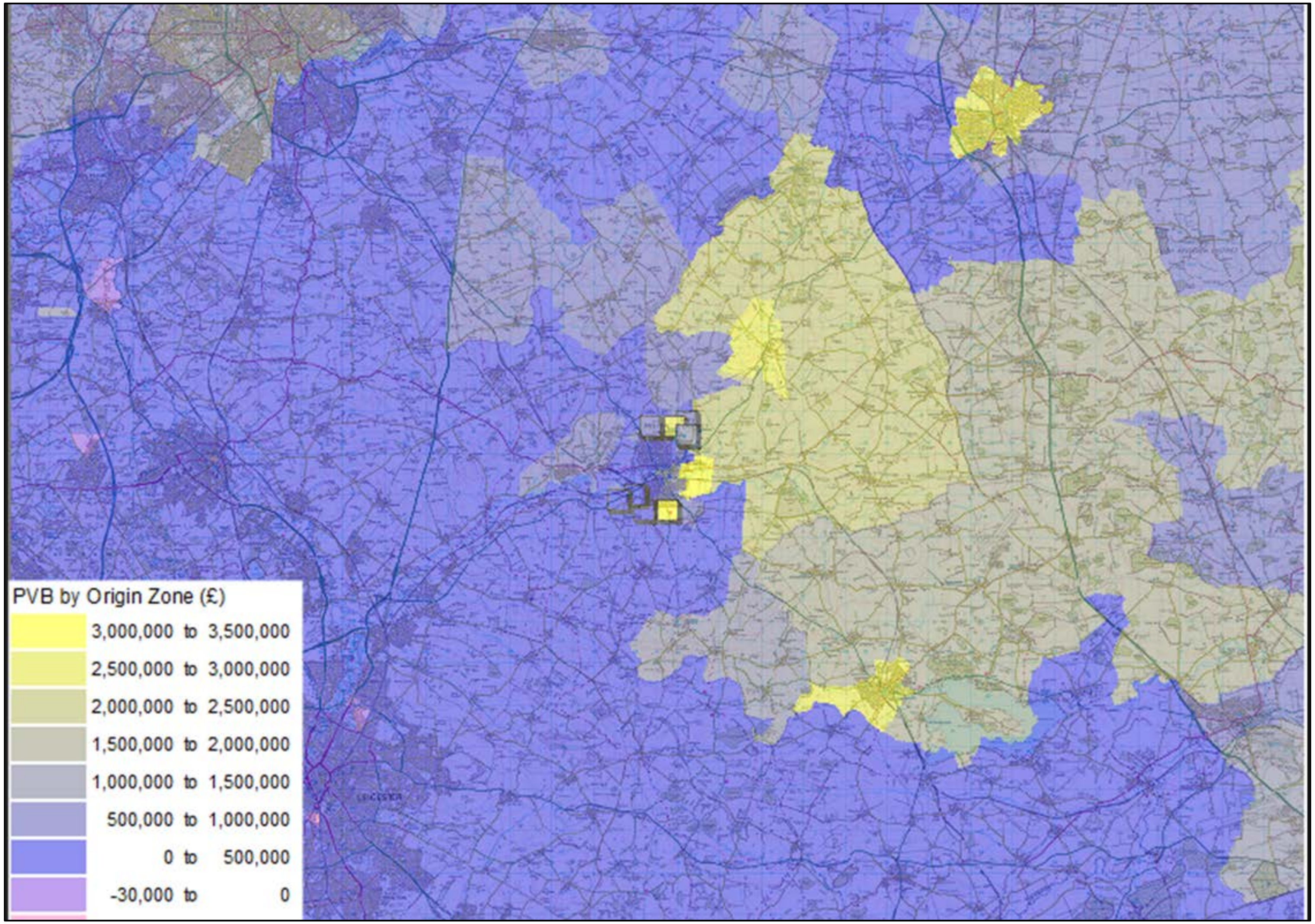
Table 3.14: Summary of Discounted Central Forecast TUBA Benefits (excluding greenhouse gasses) by Movement (Proportion of Benefits), 2010 prices and values

		Destination			
		Melton Mowbray	Rest of Melton Borough	Rest of Leicestershire	Rest of GB
Origin	Melton Mowbray	15.7%	6.0%	2.0%	6.9%
	Rest of Melton Borough	5.7%	5.0%	2.2%	9.6%
	Rest of Leicestershire	2.0%	2.8%	0.0%	5.1%
	Rest of GB	7.4%	9.5%	2.7%	17.3%

3.5.24 Figure 3-7 and Figure 3-8 show the forecast TUBA benefits (excluding greenhouse gases) for the Central Growth scenario by origin and destination zone respectively. Square symbols indicate development zones representing the Melton Mowbray Sustainable Neighbourhoods. These show that within Melton Mowbray there is forecast to be generally higher levels of benefit within the eastern half of the town for both trip origins and trip destinations, compared with the western half of Melton Mowbray.

3.5.25 In terms of the wider area, the benefits of the NEMMDR are concentrated along the axis of the scheme, with forecast benefits highest in Nottingham and Derby to the north-west of Melton Mowbray, and to the east of Melton Borough, Lincolnshire and Rutland to the east of Melton Mowbray. Generally, zones within Leicestershire, outside Melton Borough, are forecast to experience lower levels of benefit from the NEMMDR than those trips with an origin or destination in one of the aforementioned areas.

Figure 3-7: TUBA Benefits (excluding greenhouse gasses) for Central Growth by Origin Zone



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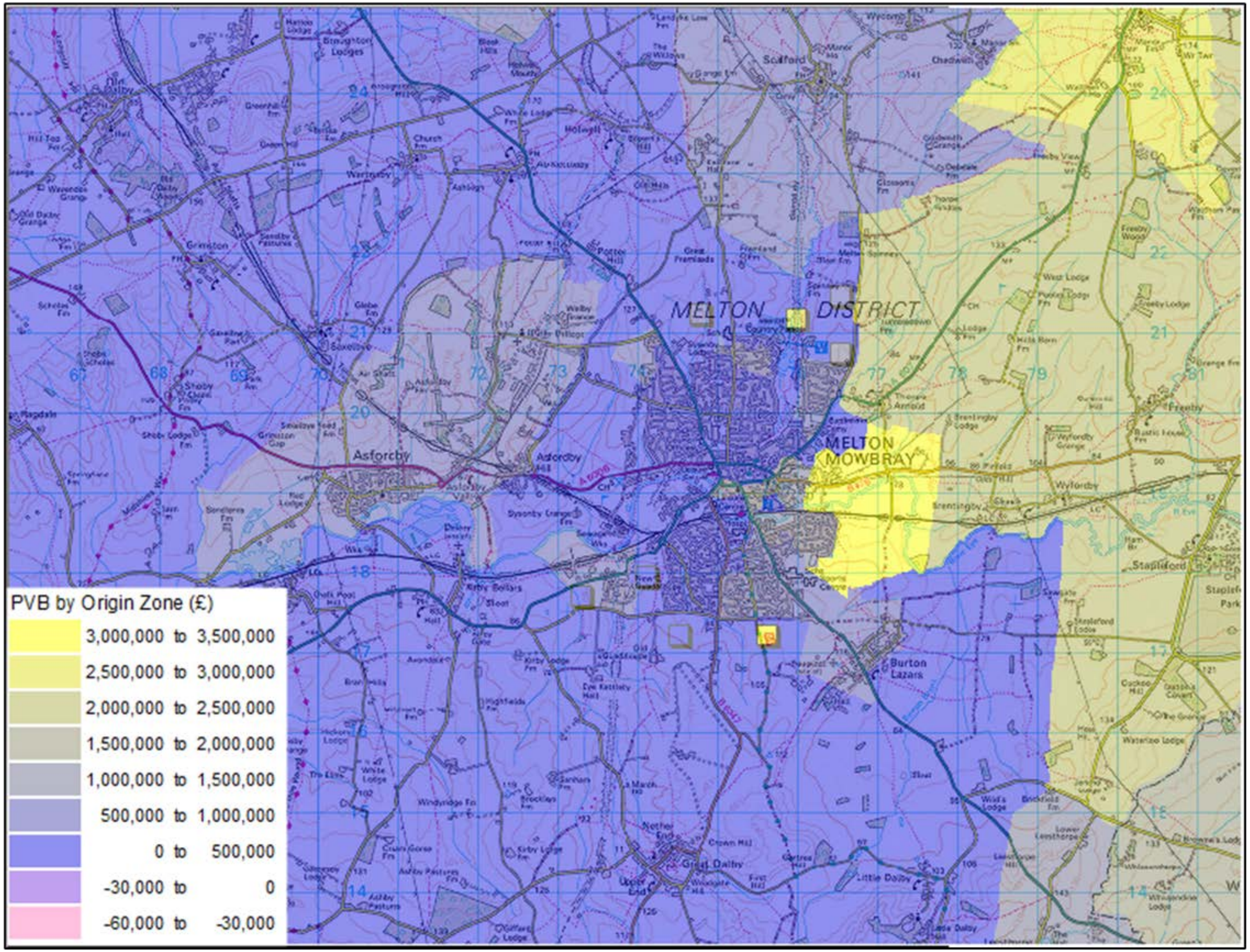

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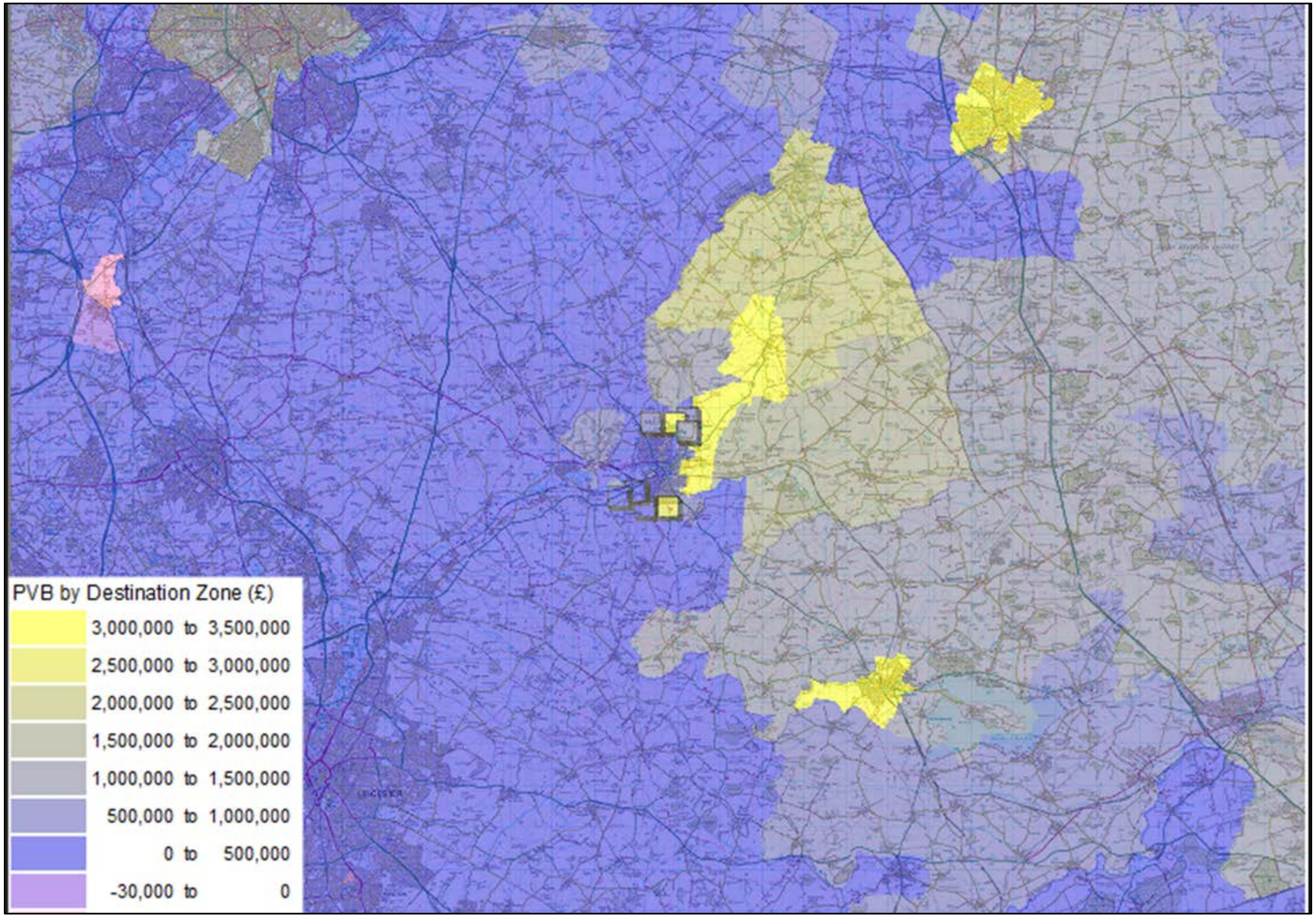
Figure 3-8: TUBA Benefits (excluding greenhouse gasses) for Central Growth by Destination Zone



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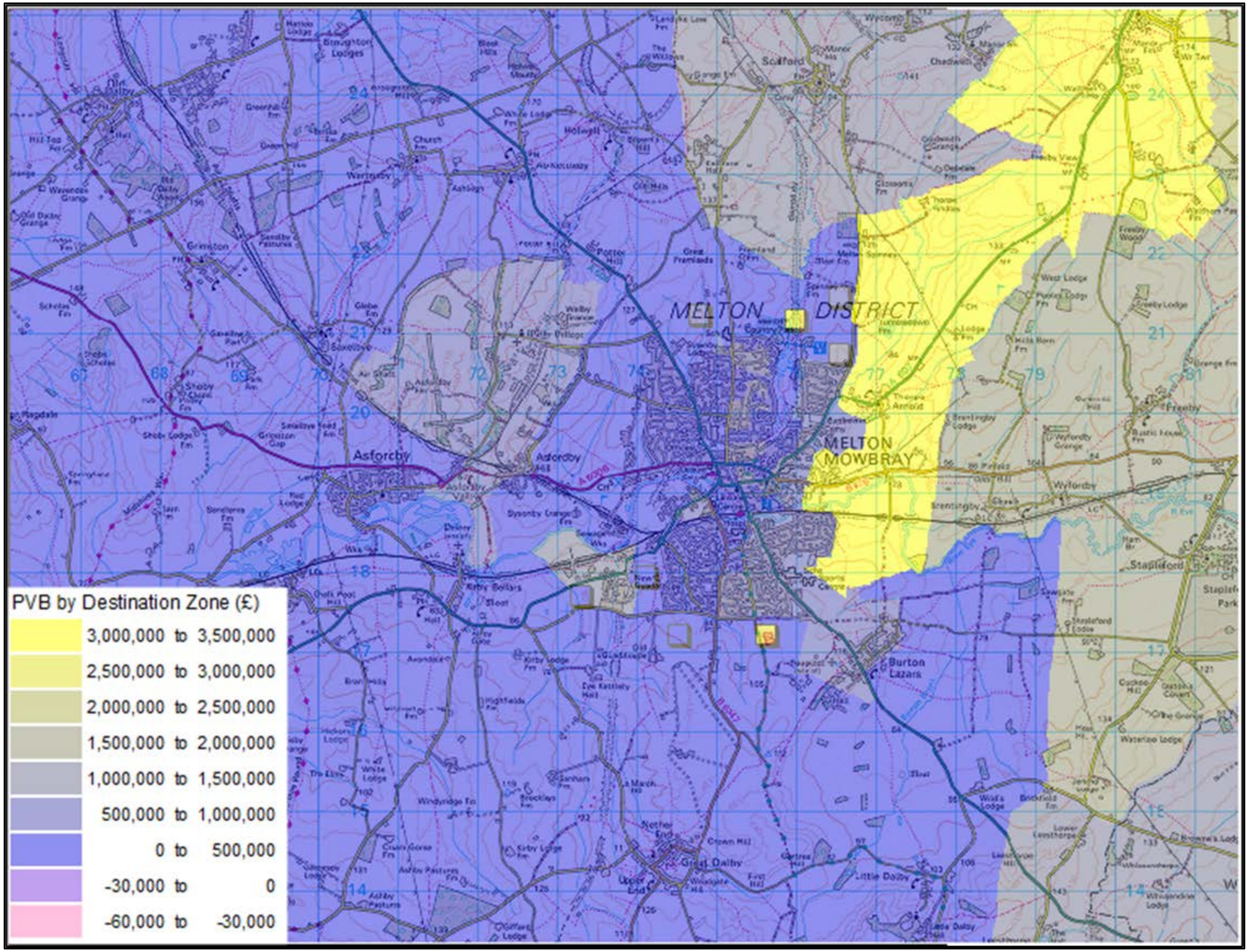

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3.6 Review of TUBA Warnings

3.6.1 In-line with the guidance given by the TUBA User Manual and associated guidance notes, warnings produced by the Central Growth scenario were investigated. It should be noted that the number of TUBA warnings is also affected by the number of modelled years, time periods and user classes. This can quite easily result in a large number of warnings but they are effectively repetitive due to there being 7 car user classes. The Central Growth scenario produced a total of 1.9 million warnings of which TUBA categorised just 3,372 (0.2%) as serious.

3.6.2 The TUBA User Manual Tables 5.2 to 5.4 outline the various limits used by TUBA to identify warnings. There is also information on how serious warnings are identified, which occur where the ratio of the Core Scenario and "with scheme" time or distance is above 3 or below 1/3. Table 3.15: briefly outlines the warnings produced by TUBA for this scheme assessment.

Table 3.15: Summary of TUBA Warnings

Warning	Description
DM speeds less than limit for the following	Forecast speeds in the Core Scenario are lower than the defined limit
DS speeds less than limit for the following	Forecast speeds in the NEMMDR Scenario are lower than the defined limit
Ratio of DM to DS travel distance lower than limit	The scheme has led to a large increase in forecast distance between the Core Scenario and the NEMMDR Scenario
Ratio of DM to DS travel distance higher than limit	The scheme has led to a large decrease in forecast distance between the Core Scenario and the NEMMDR Scenario
Ratio of DM to DS travel time lower than limit	The scheme has led to a large increase in forecast time between the Core Scenario and the NEMMDR Scenario
Ratio of DM to DS travel time higher than limit	The scheme has led to a large decrease in forecast time between the Core Scenario and the NEMMDR Scenario

3.6.3 Although there are a large number of warnings by far the majority are explained by two coding practices. About 1.25 million are due to where around 50 unused spare model zones have been connected to the network. These are at a single location in central Leicester and are connected into an area where net speeds are relatively low due low speed limits and the effects of junction delays. A further 450,000 are due to a cut-off speed of 85kph in the HGV vehicle operating cost calculations whereas HGV maximum speeds can be 96kph. This mostly occurs to and from zones in the 'Buffer' part of the assignment model network as model vehicle speeds are constant (although reduce over time) and they reflect the speed of all traffic rather than just HGVs.

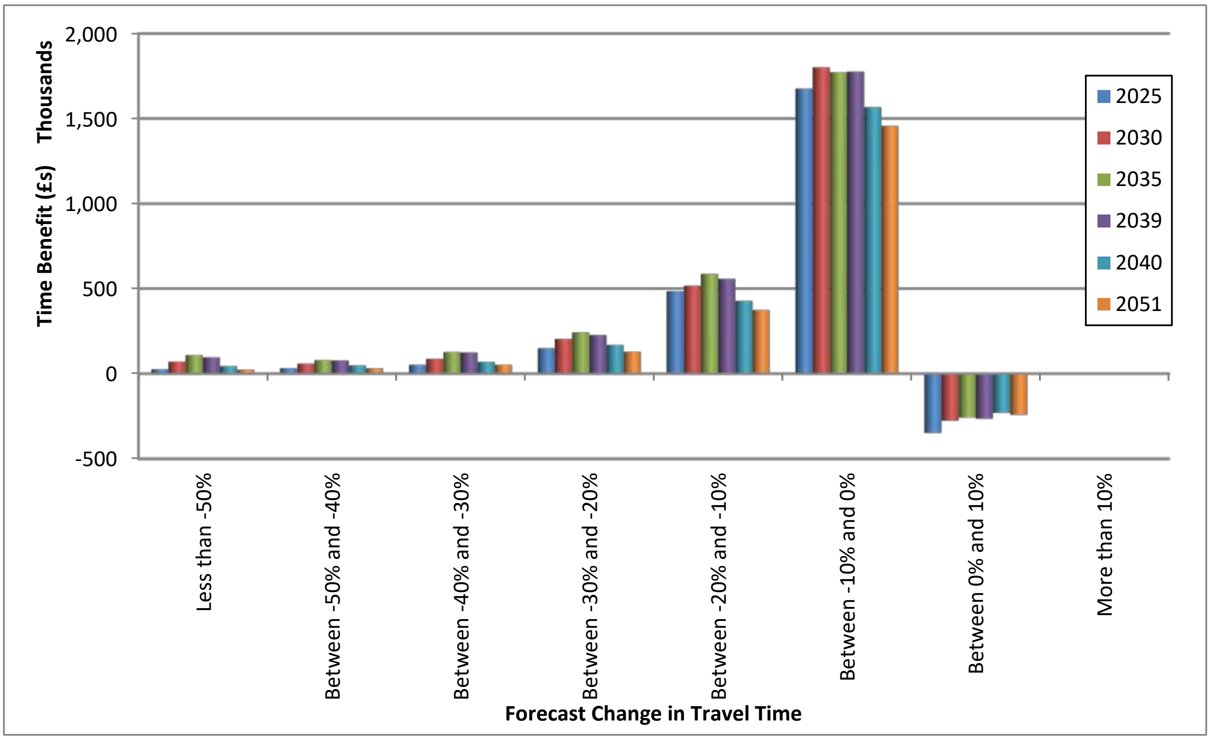
3.6.4 Following this, the remainder of warnings were investigated. It was found that the warnings were located within, or near, Melton Mowbray where the NEMMDR is located. This has led to large, localised changes in accessibility (both time and distance) between the Core Scenario and the NEMMDR Scenario.

3.6.5 Using the .tbn file produced by TUBA, the distribution of travel time benefits by the forecast change in travel time has been calculated, and this is shown in Figure 3-9. This shows that the majority of forecast travel time benefits occur where the change in forecast travel time is relatively small.

3.6.6 For example, 99% or more of the forecast time disbenefits occur where the forecast travel time change is between 0% and 10%. between 60% and 70% of the time benefits occur where the forecast travel time change is between 0% and -10%, with between 80% and 90% of the time benefits occurring where the forecast time change is between 0% and -20%.

3.6.7 The accuracy of the 'rule-of-a-half' applied within TUBA to estimate benefits reduces as the scale of the cost changes increases. The TUBA warnings detailed above, in part, seek to identify movements where the 'rule-of-a-half' approach may not be applicable. The analysis included in Figure 3-9 demonstrates that the majority of the forecast scheme benefits are accrued where the time changes are less than 20%, which suggests that any errors in the application of the 'rule-of-a-half' are unlikely to be material on the scheme appraisal.

Figure 3-9: Distribution of Discounted Travel Time Benefits by Forecast Change in Travel Time



3.7 Alternative Scenarios

3.7.1 Two alternative scenarios have been considered in the appraisal of the NEMMDR. These both represent scenarios where schemes with lower certainty, but which are being developed, are included.

Accelerated Southern Link Road Scenario

3.7.2 Significant work on planning and delivery of the developer-led southern section of the NEMMDR between Burton Road and Leicester Road has been undertaken by LCC, MBC and the associated developers, as part of the Southern Sustainable Neighbourhood (SSN). This has secured Homes England Housing Infrastructure Fund funding for the Southern Link Road and has also satisfied all parties that the road can be funded and mechanisms to facilitate funding from developer contributions are in place.

3.7.3 In the Core Scenario, the Southern Link Road is opened in three stages between 2025 and 2040 as the SSN is built out. The first section between Leicester Road to Kirby Lane is assumed to be open in 2030, the second section between Burton Road to Dalby Road by 2035 with the third and last section between Dalby Road to Kirby Lane completed in 2040. In the Accelerated Southern Link Road Scenario, the southern link is assumed to be open in its entirety by 2025.

Melton Mowbray Transport Strategy Scenario

3.7.4 The Melton Mowbray Transport Strategy is envisaged as an additional set of measures, dependent on the delivery of the NEMMDR, that are implemented in the centre of Melton Mowbray to further reduce the impact of traffic on the town. Currently these are at an early stage of development.

3.7.5 The most significant change from the Core Scenario is the introduction of further weight limits on the radial routes inside the NEMMDR to inhibit through-HGV traffic from passing through the town.

3.7.6 It is also envisaged that the A and B roads inside the NEMMDR will be declassified to further deter through-traffic from the town. Although this behavioural change cannot be modelled in the traffic model, the upgrade of Welby Road, Welby Lane and St Bartholomew’s Way to a standard commensurate with an A-Road is modelled as this route is likely to become part of the A6006, linking Asfordby Road with Nottingham Road and the NEMMDR at Roundabout 1.

3.7.7 The main change in the model forecasts compared with the Core Scenario is the reduction of HGVs in the town centre. HGVs that do access the town are forecast to route via the NEMMDR and the shortest route from the NEMMDR to their destination. HGVs on through routes use the NEMMDR where possible. The changes on the Welby Road – St Bartholomew's Way route are negligible as the preferred routeing from the east (Six Hills, Paddy's Lane A46 junctions) to the NEMMDR is via Six Hills Lane and Nottingham Road (A606) rather than the A6006.

TUBA Appraisal

3.7.8 The TUBA appraisal summarised in Table 3.6 has been rerun for the Alternative Scenarios, summarised in Table 3.16 and Table 3.17.

Table 3.16: Summary of Discounted TUBA Benefits – Accelerated Southern Link Road Alternative Scenario, 2010 prices and values

	Travel Time	**Vehicle Operating Costs**	**Total**
Non-Business: Commuting	£24,490,000	-£539,000	£23,952,000
Non-Business: Other	£40,108,000	-£4,416,000	£35,692,000
Business (Freight)	£25,167,000	£2,749,000	£27,916,000
Business (Personal)	£20,064,000	£2,274,000	£22,339,000
Total	£109,829,000	£68,000	£109,897,000

Indirect Tax Revenues	£2,840,000
Greenhouse Gases	*-£2,661,000*
Present Value of Benefits	***£110,077,000***

Note: PVB consists of only those elements included in the table

Table 3.17: Summary of Discounted TUBA Benefits – Melton Mowbray Transport Strategy Alternative Scenario, 2010 prices and values

	Travel Time	**Vehicle Operating Costs**	**Total**
Non-Business: Commuting	£24,086,000	-£446,000	£23,640,000
Non-Business: Other	£39,899,000	-£4,368,000	£35,531,000
Business (Freight)	£22,116,000	-£2,498,000	£19,617,000
Business (Personal)	£19,544,000	£2,055,000	£21,599,000
Total	£105,645,000	-£5,257,000	£100,387,000

Indirect Tax Revenues	£4,374,000
Greenhouse Gases	*-£4,271,000*
Present Value of Benefits	***£100,490,000***

Note: PVB consists of only those elements included in the table

3.7.9 Compared with the Central Growth scenario (Table 3.6), the Accelerated Southern Link Road Alternative Scenario shows a marginally higher PVB (£110m vs. £107.3m, reflecting the accelerated benefits of the Southern Link Road.

3.7.10 The Melton Mowbray Transport Strategy Alternative Scenario shows a disbenefit compared with the Central Growth scenario (£100.4m vs. £107.3m), a result of the partial nature of the strategy tested which primarily consists of HGV restrictions; this is reflected in the Business Freight segment, which experiences the most significant (negative) change.

Section 4 – Estimation of Benefits – Accidents

4.1 Introduction

4.1.1 CoBA-LT (Cost and Benefit to Accidents – Light Touch) is a cost-benefit analysis software package available from the DfT. It is used to forecast changes in the numbers of accidents and casualties associated with a change to the highway network, and to monetise these impacts.

4.2 Input Files

4.2.1 CoBA-LT v2.2 has been used, with default link and junction combined rates used throughout. The following parameters / dimensions are used in the CoBA-LT analysis:

- **CoBA-LT Parameter File**
  - '*COB22_CoBA-LT Parameters File - TAG data book v1.17.xls*' has been used without modification and is consistent with the November 2021 TAG Data Book.
- **CoBA-LT Input File**
  - Current Year: 2022
  - Base Year: 2014
  - Forecast Years: 2025, 2030, 2039, 2040 and 2051 (this is the maximum number if forecast years that can be specified in the software)
  - Scheme Opening Year: 2025
  - AADT traffic flow data have been calculated using the same long-term count data analysis used to calculate the TUBA annualisation factors

4.2.2 The CoBA-LT input / output files are provided as part of a package accompanying this Economic Assessment Report.

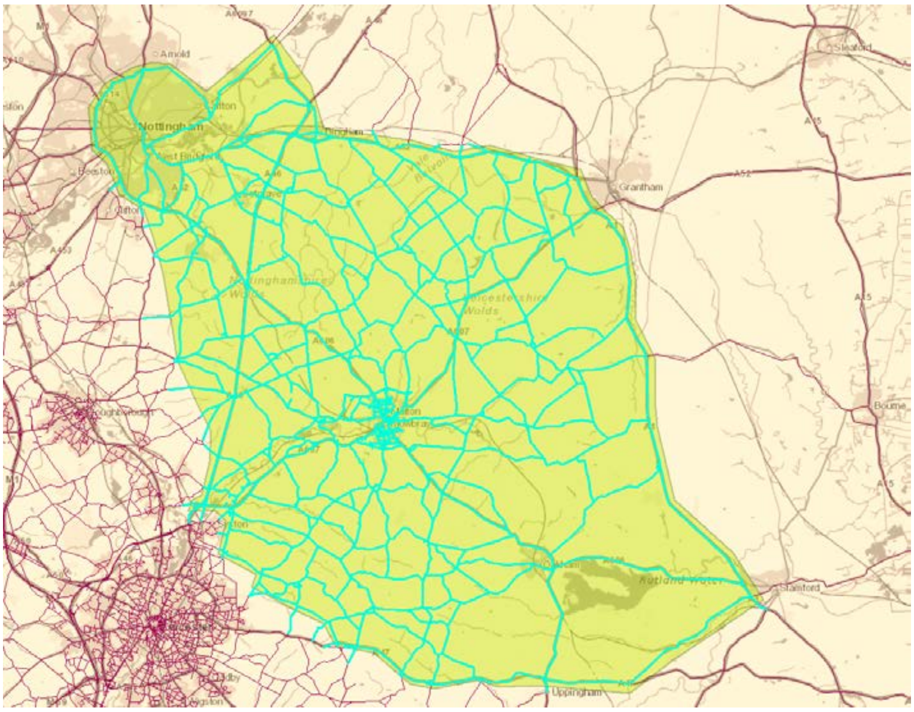
4.3 Accident Rates

4.3.1 The analysis has used standard national accident rates as incorporated in CoBA-LT rather than local accident rates calculated from STATS19 observed accident data. This follows best practice and avoids issues such as identifying suitable proxies for each part of the scheme and assumptions of direction from STATS19 data. For the OBC accident analysis the Oakham Bypass was identified as a proxy and used to estimate accident rates for the NEMMDR. The current design of the NEMMDR, in terms of speed and formation (narrower formation due to the lack of cycle/pedestrian route) is no longer envisaged as similar to the Oakham bypass.

4.4 Area of Influence

4.4.1 The LLITM 2014 Base traffic model covers an extensive area and incorporates almost 65,000 links. As the impact of the NEMMDR scheme on most of these links is very limited an Area of Influence (AoI) has been defined based on changes in traffic volumes as a result of the NEMMDR. This AoI is indicated in Figure 4-1 and is broadly bounded by the A1 in the east, A52 in the north, A46 in the west and the A47 to the south.

Figure 4-1: Defined Area of Influence for Accident Appraisal



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4.5 Estimated Accident Impact of the NEMMDR

4.5.1 Using the inputs specified in Section 4.2 CoBA-LT has been used to appraise the scheme over a 60-year period for the Central, Low and High Growth traffic forecasts.

4.5.2 The CoBA-LT summary results are in Table 4.1 for the Central Growth forecast with monetised values expressed in £000s, in 2010 prices and discounted to 2010. The scheme is thus forecast to generate accident disbenefits of £4.10 million, despite the NEMMDR itself having a relatively low accident rate and meeting one of its strategic aims of removing through-traffic from Melton Mowbray.

4.5.3 The main driver of this disbenefit is the additional traffic that is attracted into the AoI as a result of the improved connectivity provided by the NEMMDR. This increase is forecast to be 0.43%, 0.39% and 0.38% for 2025, 2040 and 2051 respectively. This is a result of traffic rerouteing, as well as an element of trip redistribution, and some very minor mode-choice effects, in the variable demand model.

4.5.4 The CoBA-LT links associated with the larger benefits/disbenefits have been sense-checked, and they have been found to be sensible, either directly related to the scheme (and its impact on localised traffic) or resulting from rerouteing across Melton Borough.

4.5.5 Table 4.2 presents the CoBA-LT summary for the Low and High Growth scenarios and these give credible results compared with the Central Growth outcomes as the Low Growth disbenefits are marginally lower at £2.96 million whereas the High Growth disbenefits are marginally greater at £5.69 million.

Table 4.1: Summary of Accident Assessment – Central Growth

Economic Summary
(£000s in 2010 prices and discounted to 2010)

Total without-scheme accident costs	£909,027.8
Total with-scheme accident costs	£913,127.4
Total accident benefits saved by the scheme	-£4,099.6

Accident Summary

Total without-scheme accidents	19215.4
Total with-scheme accidents	19229.0
Total accidents saved by the scheme	-13.6

Casualty Summary

Total without-scheme casualties	Fatal	346.6
	Serious	2892.3
	Slight	23763.0
Total with-scheme casualties	Fatal	350.5
	Serious	2905.5
	Slight	23807.9
Total casualties saved by the scheme	Fatal	-3.8
	Serious	-13.1
	Slight	-45.0

Table 4.2: Summary of Accident Assessment – Low and High Growth

Economic Summary
(£000s in 2010 prices and discounted to 2010)

	Low Growth	**High Growth**
Total without-scheme accident costs	£825,899.8	£988,752.3
Total with-scheme accident costs	£828,856.3	£994,440.2
Total accident benefits saved by the scheme	-£2,956.5	-£5,687.9

Accident Summary

Total without-scheme accidents	17411.1	20939.9
Total with-scheme accidents	17404.0	20983.5
Total accidents saved by the scheme	7.1	-43.6

Casualty Summary

Total without-scheme casualties	Fatal	314.0	378.0
	Serious	2621.4	3151.1
	Slight	21542.1	25885.8
Total with-scheme casualties	Fatal	317.3	382.6
	Serious	2630.7	3169.2
	Slight	21559.0	25970.5
Total casualties saved by the scheme	Fatal	-3.3	-4.5
	Serious	-9.4	-18.1
	Slight	-16.9	-84.7

4.6 Forecast Changes in Accident Costs

4.6.1 Figure 4-2 and Figure 4-3 show where there are forecast accident benefits (green) or disbenefits (blue) as a result of the Scheme compared with the Without Scheme scenario, with the bandwidth indicating the scale of the change. As the Scheme itself is a new road there are additional significant accident costs indicated on the NEMMDR as indicated in Figure 4-3, more so on the eastern section of the NEMMDR as this does not exist in the Without Scheme scenario whereas the Northern Link Road is present from 2040 onwards and hence accident cost differences are smaller. There is little impact on the Southern Link Road due to the Scheme as it causes a rerouteing of traffic with less reduced north-west to south-east traffic generally balanced by more south-west to north-east traffic. There are reductions in accident costs on most existing roads through Melton town centre as traffic switches from these routes to the NEMMDR.

4.6.2 There are also some increased accident costs along the A606 route as the Scheme results in traffic rerouteing to this road from alternative routes such as the A6006, west of Melton, along which accident costs are forecast to reduce.

Figure 4-2: Scheme Accident Benefits and Disbenefits – Area of Influence

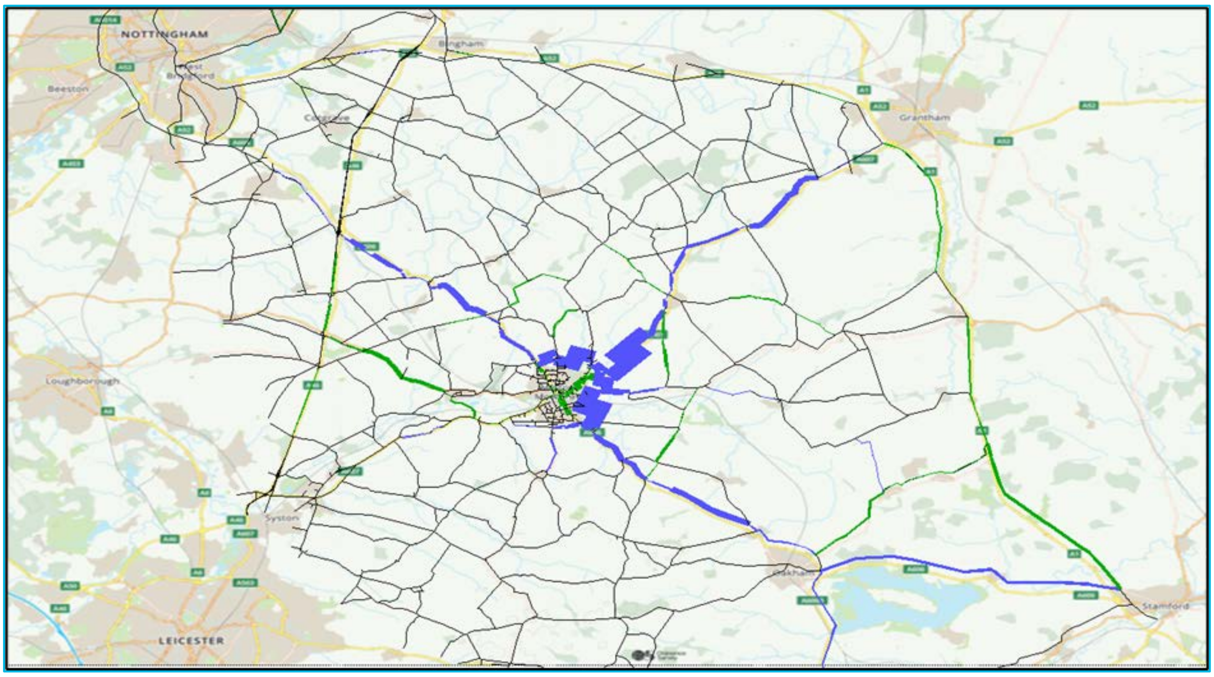
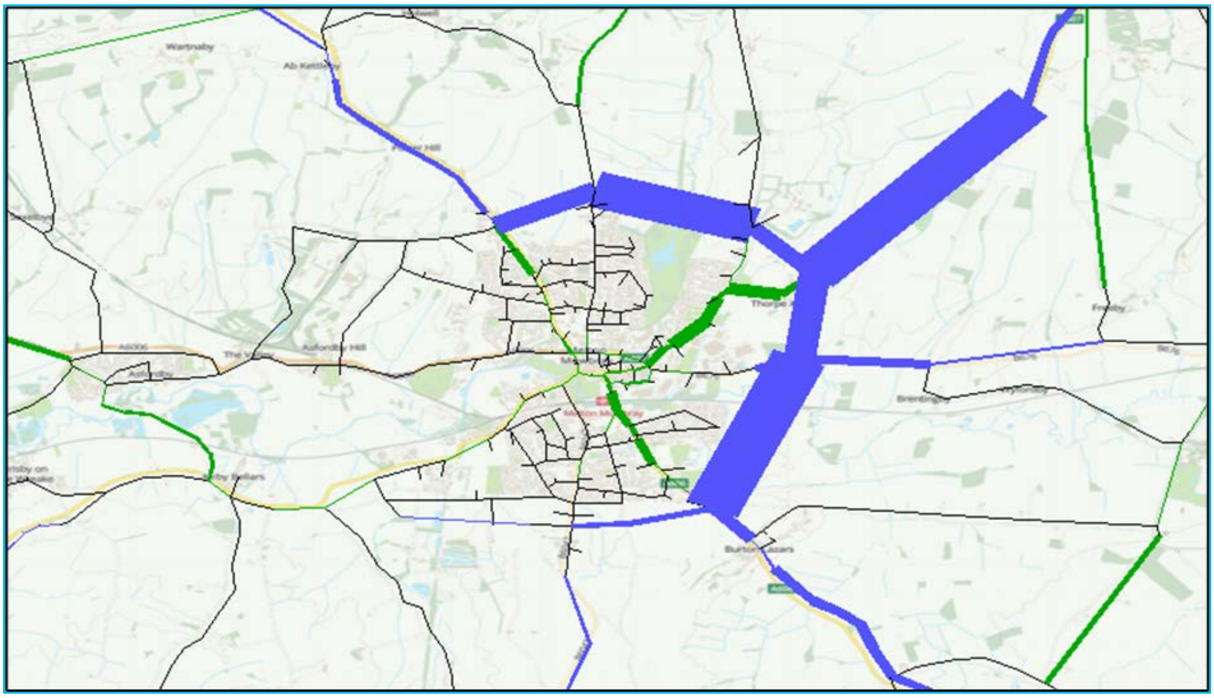


Figure 4-3: Scheme Accident Benefits and Disbenefits – Melton Mowbray Area



4.7 Use of May 2022 CoBA-LT Version

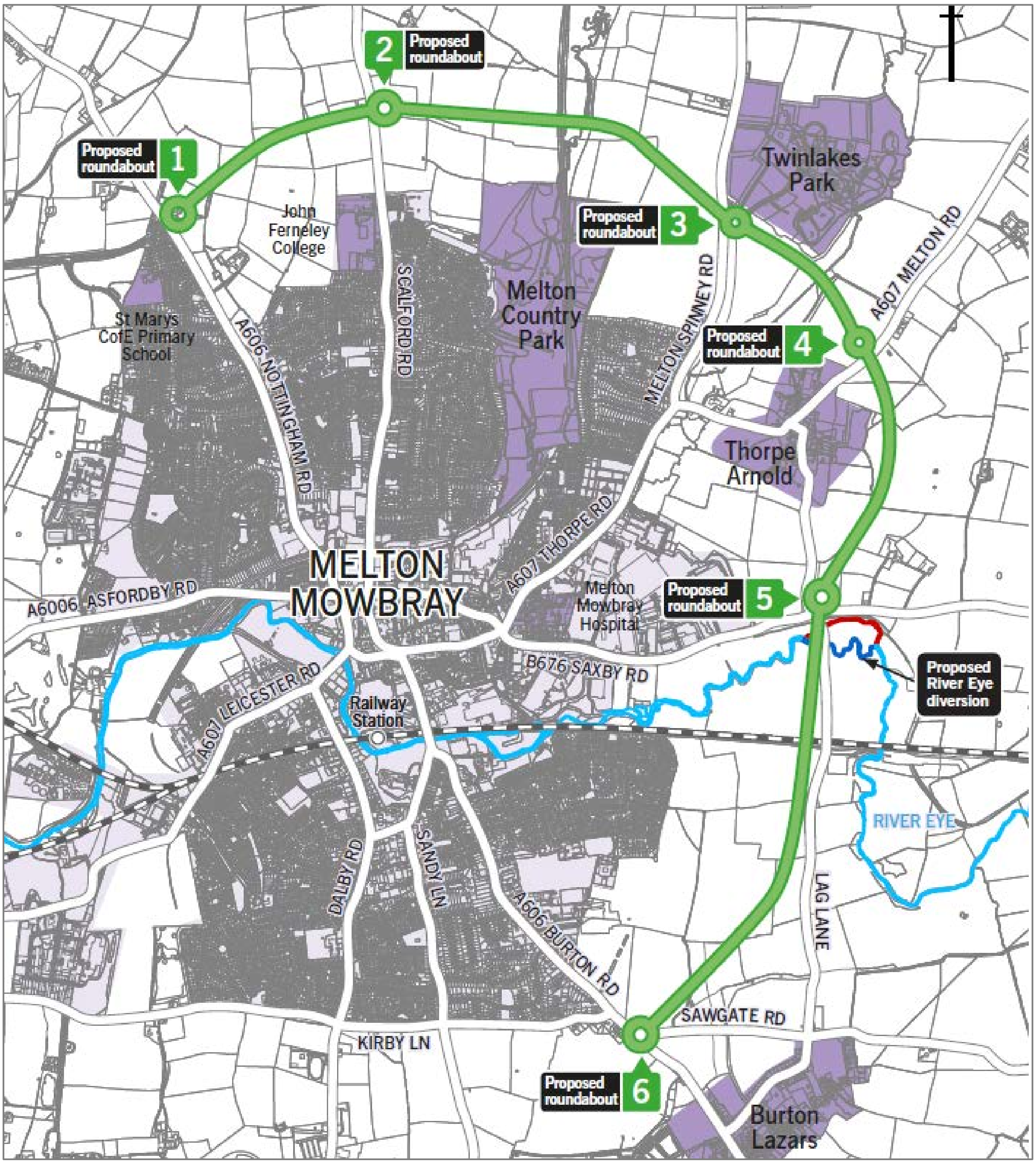
4.7.1 The DfT requested for a sensitivity test to be undertaken using the most recent version of CoBA-LT based on the May 2022 TAG Databook. Using CoBA-LT v2.3 gave a 60 year accident disbenefit of -£4.23 million or additional disbenefits of £0.13 million compared to those forecast using CoBA-LT v2.2.

Section 5 – Estimation of Benefits – Scheme Construction Delays

5.1 Introduction

5.1.1 This section details the assessment of the delays during construction of the proposed NEMMDR. The reason for this assessment is to capture the costs to road users during the construction of the junctions along the proposed route. Each junction will require periods of full road closure and periods of traffic management involving traffic lights, speed limits and narrow lanes. The locations of the six proposed junctions where the NEMMDR connects with existing roads are shown in Figure 5-1.

Figure 5-1: Location of Junctions along Proposed Route



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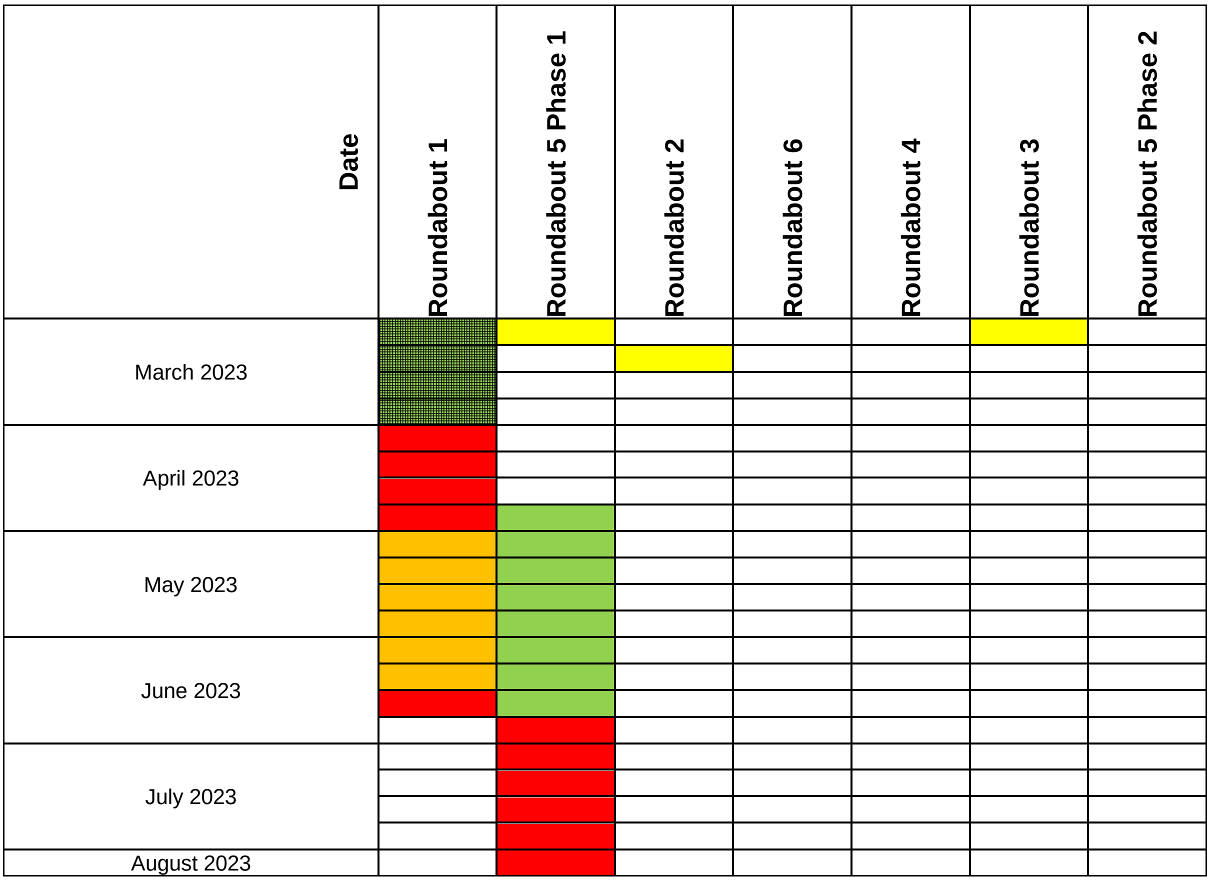
5.2 Construction Programme, Data and Assumptions

5.2.1 The scheme contractor, Galliford Try, has determined a construction programme that will require around two years from March 2023 to January 2025. Table 5.1 was provided by Galliford Try as an early outline estimate of the assumed time schedule for the phasing of junction construction. Each new roundabout is numbered 1 to 6 clockwise from Nottingham Road to Burton Road. Any works considered to be "off-line" or of short duration - "Full Closure (Plant Crossings)" - were excluded as they should have no significant impact on the calculation of construction delay disbenefits.

5.2.2 In comparison with general traffic, the number of construction vehicles would be expected to be relatively low and their impact on general traffic travel times also relatively small. These vehicles have therefore not been included in the assessment of construction delay.

Table 5.1: NEMMDR Junction Construction Schedule

▨	Offline works (Narrow lanes)
🟩	Offline Works (No TM)
🟥	Full closure (Arm Construction)
🟥	Full closure (Surfacing)
🟨	Full closure (Plant Crossings)
🟫	Temporary Signals (Offline Works)
🟧	Temporary Signals (Online Works)



Date	Roundabout 1	Roundabout 5 Phase 1	Roundabout 2	Roundabout 6	Roundabout 4	Roundabout 3	Roundabout 5 Phase 2
March 2023	▨	🟨				🟨	
	▨		🟨				
	▨						
	▨						
April 2023	🟥						
	🟥						
	🟥						
	🟥	🟩					
May 2023	🟧	🟩					
	🟧	🟩					
	🟧	🟩					
	🟧	🟩					
June 2023	🟧	🟩					
	🟧	🟩					
	🟥	🟩					
		🟥					
July 2023		🟥					
		🟥					
		🟥					
		🟥					
August 2023		🟥					

Date	Roundabout 1	Roundabout 5 Phase 1	Roundabout 2	Roundabout 6	Roundabout 4	Roundabout 3	Roundabout 5 Phase 2
			🟧				
			🟧				
			🟧				
September 2023			🟧				
			🟧				
			🟧				
			🟥				
October 2023			🟥				
			🟥				
			🟥				
			🟨				
November 2023			🟨				
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June 2024					▩		
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					🟥	🟩	
July 2024					🟥	🟩	
					🟨	🟩	
					🟨	🟩	
					🟨	🟩	
August 2024					🟨	🟩	
					🟨	🟩	
					🟨		
					🟥		
September 2024						🟥	
						🟥	
						🟥	
						🟥	
October 2024						🟥	
						🟥	
						🟨	
						🟨	
November 2024						🟨	
						🟨	

Date	Roundabout 1	Roundabout 5 Phase 1	Roundabout 2	Roundabout 6	Roundabout 4	Roundabout 3	Roundabout 5 Phase 2
						🟥	
							🟧
December 2024							🟧
							🟧
							🟧
							🟧
January 2025							🟧
							🟥

5.2.3 Coding the roadworks associated with the NEMMDR into the SATURN traffic models was based on the following data and assumptions:

- The affected section of existing roads was estimated to be in the region of 200m-400m. Detailed estimates were not available at the time of modelling and these estimates are broadly consistent with those used at the OBC stage.
- Galliford Try advised that it expects a 30mph limit to be adopted along the affected sections of road due to use of narrow lanes and prevalence of construction traffic.
- Traffic signals are assumed to be used for shuttle (one-way) working and timings have been set such that there are equal green times in each direction for the main-line. At Junction 1 on Nottingham Road 80% green time was assumed for the A606 and 20% for St Bartholomew’s Way.
- For full closure purposes it has been assumed that roads are fully closed between adjacent junctions or traffic zone loading points.
- At Roundabout 3 full closure was implemented with access to Twinlakes Park via Roundabout 4 and the NEMMDR.

5.2.4 For consistency with the transport modelling the assessment assumes that 2023 is the year in which construction work commences. For those junctions included within the Core Scenario network assumptions by 2035 and 2040, details of the construction programme have been assumed to be unchanged from those provided in Table 5.1, with only the year in which the works take place being updated.

5.2.5 Construction delay costs are usually much lower than the operational benefits generated by road schemes. Although they are incurred earlier, their duration is much shorter, generally over a few years rather than the 60 year period over which operational benefits are accrued. As construction programmes can also be complex some degree of simplification of traffic modelling is required.

5.2.6 To model the costs of construction delays the SATURN models used for scheme assessment purposes were modified to represent the construction phases at each junction on the proposed route. A with-construction intervention and an equivalent Core Scenario were prepared to provide inputs to TUBA for determining the costs of the expected delays. Assignments were run using the 2025 Core Scenario demand for 2023 and 2024 and assumed that demand is unchanged between the with and without construction scenarios. For the 2034 and 2039 construction scenarios the 2035 and 2040 Core Scenario demand were respectively used.

5.3 Delay Costs

5.3.1 TUBA, using the same economic assumptions as the user benefits appraisal, was then used to monetise the impact of building each junction on the proposed route separately. These results were added together to obtain a total cost for implementing the entire proposed NEMMDR. In this assessment, only the construction of the junctions was analysed as the offline construction of the distributor road will not itself significantly affect traffic.

5.3.2 Four of the six junctions required for the NEMMDR would be built for the Northern and Southern Link Roads associated with Sustainable Neighbourhood developments within Melton Mowbray, and are included in the Core Scenario network assumptions. The junctions associated with the Northern Link Road on A606 Nottingham Road, Scalford Road and Melton Spinney Road are scheduled to be completed by 2040 and the junction on A606 Burton Road (part if the Southern Link Road) is scheduled to be completed by 2035.

5.3.3 To account for this, the delay costs of construction of these junctions in their respective Core Scenario future years have been removed from the costs of construction in 2023-24, effectively evaluating the incremental cost of accelerating their construction.

5.3.4 For calculation of construction delay costs TUBA has been used although the process has been simplified with three rather than seven time periods incorporated. Weekday AM and PM Peak periods were assumed to be 3 hours each, from 0700-1000 and 1600-1900. The weekday standard interpeak period is 6 hours (1000-1600) and the weekday interpeak model is also used to represent the off-peak and weekend periods based on the relative traffic volumes during these periods compared with the weekday interpeak. This results in a combined weekly total of 69 equivalent interpeak hours. TUBA is usually set up to appraise outcomes at an annual level but as the construction periods being modelled are in durations of weeks the ‘annualisation factors are quite different to those used for the standard 60 year appraisal.

5.3.5 Table 5.2 shows the accumulated cost for the construction of each junction in 2023-24, followed by the equivalent cost in 2034 (J6) or 2039 (J1-J3), where appropriate. The net construction delay costs for the NEMMDR are the costs incurred constructing Junctions 1 to 6 in 2023-2024 less the cost of building Junction 6 in 2034 and Junctions 1 to 3 in 2039 which amounts to £379,000.

5.3.6 The construction delay cost of the two junctions (Junctions 4 and 5) unique to the NEMMDR is £298,000. The remaining £81,000 is the incremental cost of the other four junctions (1,2,3 and 6).

5.3.7 It might be expected that higher traffic levels and more congestion in later years would lead to higher costs in later years and a benefit for building earlier. In this case, there are small decreases in total delay costs on the local roads (Scalford Road and Melton Spinney Road) and increases in total delay costs at both A606 junctions in later construction years. On both Scalford Road and Melton Spinney Road traffic volumes are quite low and hence overall delays are relatively low and the impact of discounting will reduce the comparative delay costs.

Table 5.2: Summary of Discounted TUBA Benefits (excluding greenhouse gasses) by Junction, 2010 prices discounted to 2010.

Junction	Year	DS Disbenefit	Year	DM Disbenefit	Incremental DS
1 A606 Nottingham Road	2023	-£227,000	2039	-£187,000	-£40,000
2 Scalford Road	2023	-£65,000	2039	-£66,000	£1,000
3 Melton Spinney Road	2024	-£72,000	2039	-£80,000	£8,000
4 A607	2024	-£112,000		n/a	-£112,000
5 B676	2023/4	-£186,000		n/a	-£186,000
6 A606 Burton Road	2024	-£174,000	2034	-£124,000	-£50,000
Total		***-£836,000***		***-£457,000***	***-£379,000***

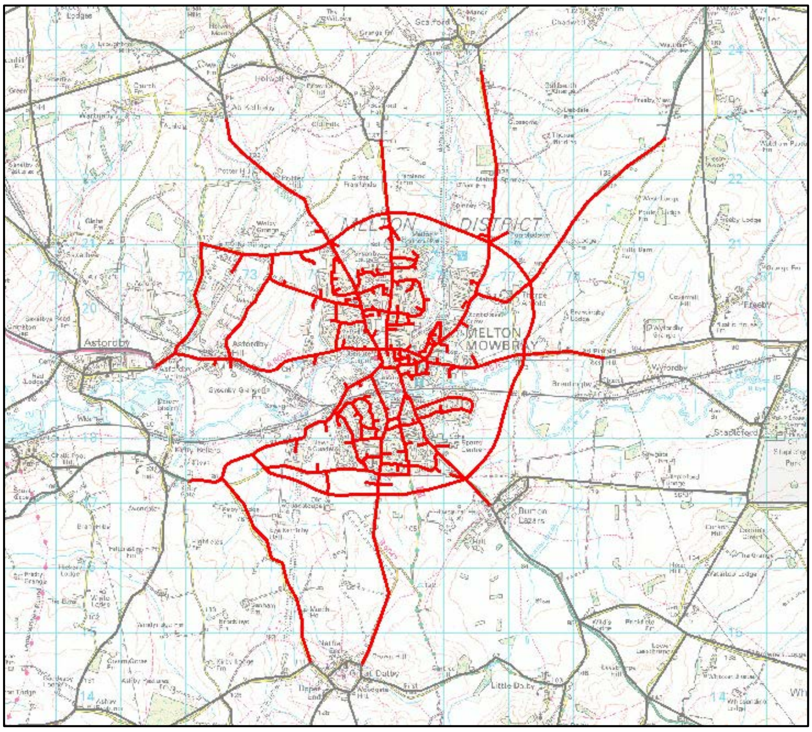
Section 6 – Estimation of Benefits – Journey Time Reliability

6.1 Introduction

6.1.1 The change in journey time reliability has been estimated based on the guidance contained within TAG Unit A1.3, Section 6.3 for urban roads. This approach considers the ratio of the assigned time within the highway model to the free-flow time as a measure of the standard deviation in journey times and monetises this using the same assumptions as adopted within the TUBA assessment of the forecast scheme impacts (see Section 3).

6.1.2 This analysis has used a cordon from the highway assignment model, which covers the Melton Mowbray urban area and includes the NEMMDR. The extent of this cordon model is shown in Figure 6-1, which includes links in Melton Mowbray that are forecast to have a significant flow, delay or volume-capacity ratio change due to the NEMMDR based on the analysis included within *'NEMMDR FBC - Forecasting Report'*.

Figure 6-1: Reliability Cordon Model



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6.2 Methodology

6.2.1 Using the cordon model defined in Figure 6-1, the assigned time and distance, and free-flow time, have been skimmed from the assignment for each time period. Using these outputs from the models, the following equation (defined in TAG A1.3, §C.3.3) has been applied to each time period for the Core Scenario and NEMMDR Scenario in the 2025, 2039, 2040 and 2051 forecast years:

$$\sigma = 0.4 * 0.16 * \left(\frac{Time_{Assigned}}{Time_{FreeFlow}}\right)^{1.02} * Dist^{-0.39} * Time_{Assigned}$$

6.2.2 The change in the forecast journey time variability (σ) between the Core Scenario and the NEMMDR Scenario has then been used in a standard 'rule-of-a-half' calculation using the assignment demand to estimate the journey time benefits. This has used the same periods and demand/cost combinations as defined for the TUBA assessment (see Table 3.3).

6.2.3 In order to monetise these benefits, firstly the results of the above calculation have been converted from vehicles (the units of the highway assignment model) to people (the units of the appraisal) using the standard vehicle occupancies as defined within TUBA v1.9.17. These have then been annualised based on the factors defined in Table 3.4:.

6.2.4 These savings have been applied to the modelled forecast years of 2025, 2039, 2040 and 2051, with linear interpolation applied between 2025 and 2039, and between 2040 and 2051 to estimate benefits between these years. The 2039 forecast is included within the assessment as this is the last year in which there is no Northern Link Road present within the Core Scenario network. As within TUBA, the benefits are assumed to be constant for all years after 2051 over the remaining part of the 60-year appraisal period to 2084. Based on this and using the values of time adopted within the TUBA assessment of the scheme, the journey time variability benefits have been converted to a monetary value.

6.2.5 Within the TUBA assessment, a value of time which varies by trip-length has been adopted for car business trips, but this approach cannot be applied within the journey time variability analysis, as the cordon model does not include information on the total trip-length for business trips. Therefore, the average business value of time, as defined within TUBA v1.9.17, has been applied for this trip purpose.

6.2.6 These monetary values have then been discounted to 2010 using the standard assumptions included within TAG.

6.3 Summary of Results

6.3.1 Applying the methodology outlined above to the Central Growth traffic forecasts for the four modelled years results in the reliability benefits presented in Table 6.1. The assessment forecasts that the journey time reliability benefits are £5.41m over 60 years, of which around 15% is attributable to LGV traffic, 16% to car business traffic, 39% to car ‘other’ traffic, and 23% to car commuting traffic with the remaining 7.5% of reliability benefits attributable to HGV traffic.

Table 6.1: Summary of Reliability Benefits by User Class

User Class	Benefit (£)
HGV	£405,096
LGV	£817,206
Car Employers Business	£861,244
Car Other - Low-income	£639,486
Car Other - Medium-income	£699,559
Car Other - High-income	£747,058
Car Commute - Low-income	£240,361
Car Commute - Medium-income	£447,940
Car Commute - High-income	£555,596
Total	***£5,413,546***

6.3.2 Whilst Table 6.1 monetises journey time benefits following the methodology defined within TAG, there are also non-monetised benefits of the scheme in terms of network resilience. Given the location of Melton Mowbray on both the A606 and A607, these routes can be used as alternative routes when there are incidents (such as accidents or roadworks) elsewhere on the network. For example, closures on the A1 between Stamford and Grantham can (and do) result in additional traffic routeing through Melton Mowbray.

6.3.3 The NEMMDR will help to minimise the impacts of these effects on the residents of Melton Mowbray, by providing a route for these movements which avoids the town centre. The proposed additional network would also provide an alternative route when there are incidents within Melton Mowbray itself, providing a measure of network resilience.

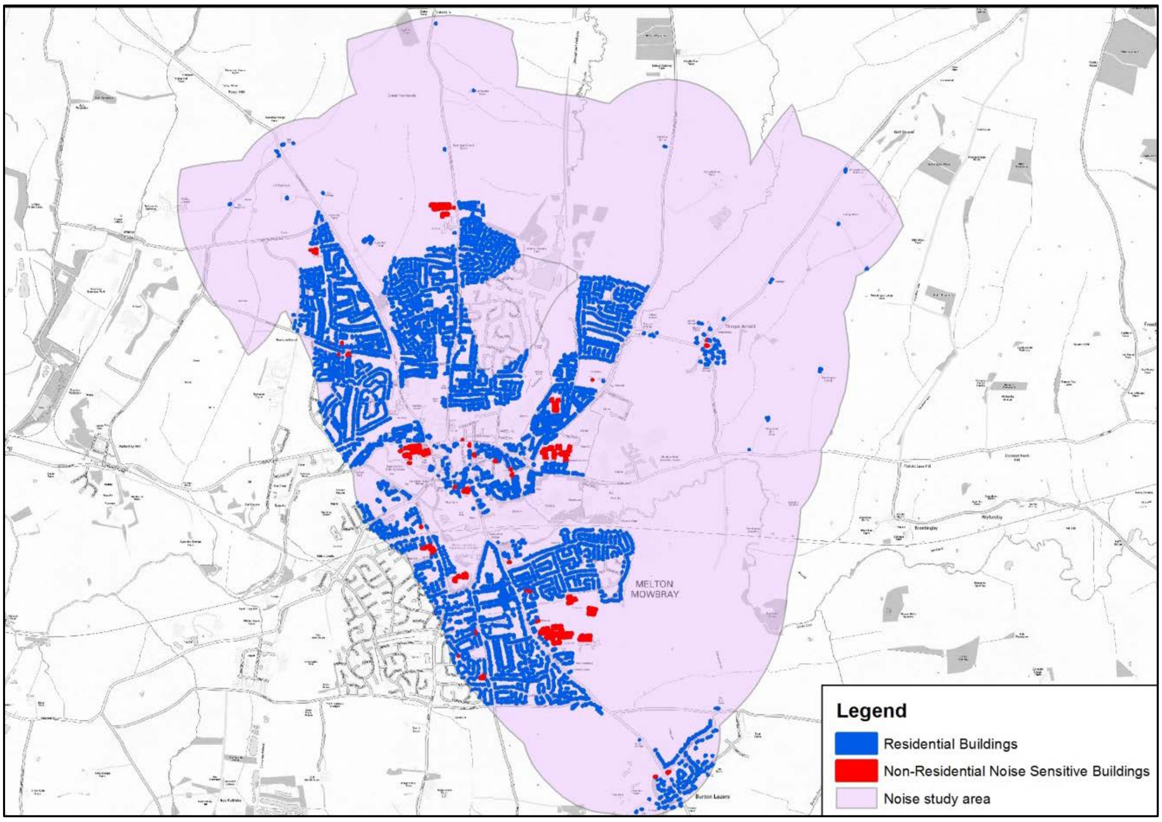
Section 7 – Local Noise Assessment

7.1 Introduction

7.1.1 As set out in the Appraisal Specification Report, the local noise assessment set out below relies on the analysis carried out for the OBC (which is aligned with TAG Unit A3 advice) as it was agreed to be disproportionate to carry out further analysis given their limited impact on the value for money case.

7.1.2 The NEMMDR will affect traffic noise levels as experienced by occupiers of residential properties, and sensitive receptors such as schools, places of worship, hospitals and other community facilities, in the vicinity of the NEMMDR, as well as other existing affected roads on the local road network, as shown in Figure 7-1.

Figure 7-1: Area of Impact for Noise



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7.2 The Study Area

7.2.1 The study area has been defined in accordance with guidance given in National Highways' Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 7, HD 213/11:

- The study area comprises the NEMMDR, existing roads through Melton Mowbray bypassed by the scheme and all surrounding existing roads that are predicted to be subject to a change in traffic noise level as a result of the NEMMDR of:
    - 1 dB(A) or more in the short-term (2021 opening year between the Core Scenario and the NEMMDR Scenario); or
    - 3 dB or more in the long-term (opening year of 2021 Core Scenario to the NEMMDR Scenario 15 years after opening), subject to a minimum change of 1 dB between the Core Scenario and NEMMDR Scenario 15 years after opening 2036.

These roads are defined as 'affected routes' and are identified by analysis of the forecast traffic data. The identification of affected routes considered all roads with 18-hour (06:00-00:00) weekday traffic flows above the 1,000 lower cut off of the Calculation of Road Traffic Noise (CRTN) prediction methodology in all scenarios.

- The study area for the detailed quantitative appraisal of noise impacts comprises a corridor 600m either side of the NEMMDR, 600m either side of the existing roads through Melton Mowbray which are bypassed by the NEMMDR, and a set of corridors 600m corridors either side of all affected routes within 1km of the NEMMDR and existing roads bypassed by the NEMMDR.

7.3 Operational Traffic Noise Prediction Methodology

7.3.1 Noise from road traffic is generated by both the vehicle engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as residents within a property, is influenced by a number of factors including traffic flow, speed, composition (percentage of heavy goods vehicles), gradient, type of road surface, distance from the road and the presence of any obstructions between the road and the receptor.

7.3.2 Noise from a stream of traffic is not constant, but to assess the noise impact a single figure estimate of the overall noise level is necessary. The index adopted by the Government in CRTN to assess traffic noise is $L_{A10,18h}$. This value is determined by taking the highest 10% of noise readings in each of the 18 one-hour periods between 06:00 and 00:00, and then calculating the arithmetic mean. As recorded in DMRB, a reasonably good correlation has been shown to exist between this index and the perception of traffic noise by residents over a wide range of noise exposures.

7.3.3 CRTN provides the standard methodology for predicting the $L_{A10,18h}$ road traffic noise level. Noise levels are predicted at a point measured 1m horizontally from the external façade of buildings. The monetisation process within TAG is based on the $L_{Aeq,16h}$[3] road traffic noise level. This is calculated in accordance with the guidance in TAG:

$$L_{Aeq,16h}\ (façade) = L_{A10,18h}(façade) - 2dB$$

7.3.4 TAG also requires an assessment of night-time (i.e. between 23:00 and 07:00) traffic noise levels ($L_{Aeq,8h}$ free-field). However, this parameter is not calculated by the standard CRTN methodology. DMRB refers to three methods for calculating night-time traffic noise levels developed by the Transport Research Laboratory (TRL). The most widely used is 'Method 3' which factors the night time $L_{Aew,8h}$ from the $L_{A10,18h}$, based on the typical diurnal pattern of traffic flows in the UK; this method has been used for this assessment.

7.3.5 Daytime and night-time traffic noise levels have been generated using the SoundPLAN (v8.0) noise modelling software. The software implements the standard CRTN methodology. The model is based on traffic data provided by the traffic model forecasts for the NEMMDR and surrounding area. The traffic flow and the proportion of HGVs forecasts are taken directly from the model. However, the traffic speeds are subject to a process called 'speed banding' which assigns one of four speeds to all non-motorway roads. The model also includes the ground topography, ground type and buildings to form a 3D representative of the study area. Residential and other potentially noise sensitive buildings such as schools have been identified using the OS AddressBase dataset.

7.3.6 Different floors and façades of the same building can experience different changes in traffic noise level depending on their orientation to the noise source. TAG does not specify which floor or façade should be used to characterise each receptor. Discussions with the National Highways Noise Advisor as part of the National Highways 'Peer-to-Peer' expert group have established a consensus to base the TAG appraisal on the façade which experiences the highest "with scheme" $L_{A10,18h}$ traffic noise level in the opening year. It should be noted that this is different to the requirements of an environmental impact assessment completed in accordance with DMRB, which is based on the façade with the worst-case change. Both TAG and DMRB are based on the top floor of each building.

7.3.7 The $L_{Aeq,16h}$ (façade) daytime and $L_{Aeq,8h}$ (free-field) night time noise levels for each residential receptor for the opening year 2021 and 15 years after opening 2036, for both the Core Scenario and the NEMMDR Scenario, have been inputted into the current TAG workbook. This calculates the monetised impacts with and without the scheme.

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[3] A-weighted, equivalent sound level

7.3.8 It should be noted that the TAG workbook is based on assigning each residential building in each scenario into a range of 3dB bands for the day time and night time. Therefore, for the TAG analysis, depending where the absolute traffic noise level falls within a band, a change of 0.1dB at one building may result in a change of band, and therefore the building being classed as experiencing an increase or decrease in noise. However, a change of 2.9dB at another building which does result in a change of band is classed as ‘no change’.

7.3.9 The TAG workbook is based on guidance produced by Defra on assessing the impacts of transport related noise from different sources, using an ‘impact pathway’ approach and covering a range of impacts on annoyance, sleep disturbance and health impacts. Dose-response functions for each impact pathway for road noise are used. These functions describe, at different noise levels, the percentage of the population affected, or the increased risk of adverse health outcomes. This information, combined with details of the number of residential buildings experiencing different traffic noise levels, is used to calculate the number of people affected under each impact pathway. The estimation of the population affected for each impact pathway is combined with monetary values for each impact pathway developed in the Defra research to provide the net present value of the change in traffic noise.

7.4 Limitations and Assumptions

7.4.1 Low noise surfacing has been assumed to be in place on the proposed Melton Mowbray Distribution Road. Based on the current DMRB guidance the additional 3dB benefit of the low noise surfacing can only be applied if speeds are at or above 75 km/hr. Based on the traffic data the speed-banded speed only exceeds this on the most southerly section of the scheme between Saxby Road and the A606.

7.4.2 No additional mitigation in terms of amendments to the horizontal or vertical alignment of the scheme or the use of noise barriers has been assumed at this stage. However, this is being considered as part of the ongoing work to support the planning application to reduce the magnitude of the impact of the scheme.

7.4.3 The area between the NEMMDR and the northern edge of Melton Mowbray is allocated in the Local Plan for future housing development. Plans for the first phase of this housing immediately to the east of the A606 are relatively advanced and an indicative masterplan is available. In the absence of the NEMMDR, a road on the same alignment as the scheme would be constructed by the developers between the A606 and Melton Spinney Road.

7.4.4 Therefore, this section of the proposed Distributor Road, and the housing development for which an indicative masterplan is available, have been assumed to be in place in the 2036 Core Scenario. The houses within the new development are not included in the assessment as they are only present in 2036, and they do not experience a change in traffic noise due to the scheme.

7.4.5 In addition to the assumed infrastructure to the north of Melton Mowbray relating to residential development in this area, a similar road scheme and development is located to the south of Melton Mowbray. This new link to the south of Melton is assumed to be in place in both the 2036 Core Scenario and NEMMDR Scenario.

7.5 Summary of Results

7.5.1 The net present value of the change in traffic noise calculated by the TAG workbook is £3,797,505 in 2010 prices and values.

7.5.2 No households are forecast to experience daytime traffic noise levels in excess of 80dB $L_{Aeq,16h}$ (façade) in the opening year (2021) or the forecast year (2036). Three households are identified as potentially qualifying under the Noise Insulation Regulations.

7.5.3 The scheme results in the transfer of traffic from the A606 through the centre of the town onto the distributor road. 8,312 residential households are located in the DMRB noise study area. Based on the facade of the property which experiences the worst-case change in the short-term (opening year), 35 are predicted to experience a major increase in traffic noise consisting of one individual property north of Saxby Road, two on the edge of Thorpe Arnold and 32 on the northern edge of the town east of Scalford Road.

7.5.4 3% of households experience a moderate increase in traffic noise in the short-term primarily on the north and east sides of Melton Mowbray closest to the NEMMDR, Thorpe Arnold and Burton Lazars, with 41% of households forecast to experience a minor or negligible increase. 8% of households experience no change in the short-term and 47% a negligible or minor reduction.

7.5.5 42 non-residential sensitive receptors have been identified in the study area. Based on the façade that experiences the worst-case change in the short-term, one school on the northern edge of Melton Mowbray, west of Scalford Road, experiences a moderate increase in traffic noise, 14 experience a negligible or minor increase, 4 experience no change, and 23 a negligible or minor reduction.

Section 8 – Local Air Quality Assessment

8.1 Introduction

8.1.1 As set out in the Appraisal Specification Report, the local air quality assessment set out below relies on the analysis carried out for the OBC (which is aligned with TAG Unit A3 advice) as it was agreed to be disproportionate to carry out further analysis given their limited impact on the value for money case.

8.1.2 This section details the methodology adopted to provide the air quality forecasts for use in the assessment of the proposed NEMMDR. This includes the plan level calculations and regional calculations that have been used in the air quality valuation and the air quality modelling and plan calculations used in the Distributional Impact Appraisal.

8.1.3 The key road traffic pollutants of oxides of nitrogen (NO_x), nitrogen dioxide (NO_2) and particulates (i.e. PM_{10}) have all been appraised for the NEMMDR.

8.2 Plan Level Calculations

8.2.1 The plan level TAG appraisal provides an indication of the overall change in operational air quality associated with the NEMMDR.

8.2.2 The plan level methodology within the TAG (Unit A3, Section 3: Air Quality Impacts) aims to quantify the change in exposure at properties in the opening year as a result of schemes, through the quantification of exposure for all DMRB local affected roads. The methodology follows a number of steps including:

- identification of the affected road network, which is the same as the DMRB HA207/07 (Volume 11, Section 3, Part 1) local air quality affected road network;
- quantification of the number of properties within 0-50m, 50-100m, 100-150m and 150-200m bands, from the affected roads;
- the calculation of concentrations within each band at 20m, 70m, 115m and 175m from the road centreline using the DMRB spreadsheet tool;
- calculation of property weighted NO_2 and PM_{10} concentrations;
- calculation of the total numbers of properties that improve, worsen or stay the same for each pollutant; and
- calculation of an overall assessment score for NO_2 and PM_{10}.

8.2.3 An overall positive score indicates an overall worsening and an overall negative score indicates an overall improvement in air quality.

8.3 Regional Calculations

8.3.1 The regional assessment considers changes in annual road transport emissions of oxides of nitrogen (NO_x) and PM_{10} that may be brought about by the NEMMDR in the opening year (2021) and the design year (i.e. 15 years after opening, 2036) at a regional level.

8.3.2 The latest Emission Factor Toolkit (version 8.0) spreadsheet has been used in the estimation of these emissions.

8.3.3 DMRB (HA207/07) regional scoping criteria have been applied to define the regional affected road network (which is different to that assessed for local air quality).

8.4 Air Quality Valuation

8.4.1 The TAG air quality valuation spreadsheet (dated July 2017) uses the findings from the plan level calculations for PM_{10} and the regional emissions of NO_x to calculate a monetary air quality valuation for the scheme.

8.5 Local Air Quality Modelling

8.5.1 In addition to the plan level calculations specific sensitive receptors have also been modelled using detailed air quality modelling techniques. This has been undertaken for 8 schools and hospitals within the air quality study area.

8.5.2 The detailed model used is the Cambridge Environmental Research Consultants (CERC) Atmospheric Dispersion Modelling Software (ADMS) Roads. The model uses hourly sequential meteorological data to disperse pollutants and in this case data from East Midlands Airport 2016 were used.

8.6 Summary of Results

8.6.1 For the TAG PM_{10} analysis, a 0.1 µg/m^3 threshold has been used to define “no change”. As it can be observed in Table 8.1, all scenarios are forecast to be better off with the NEMMDR compared with the Core Scenario, given that more households are forecast to see a decrease in PM_{10} as a result of the NEMMDR compared with those households forecast to see an increase in PM_{10}.

Table 8.1: Distribution of PM_{10} Impacts on Households

Air Quality Impact	2021 (PM_{10})	2036 (PM_{10})
Households with increased PM_{10}	327	75
Households with decreased PM_{10}	881	729
Households with no change in PM_{10}	4,922	5,326
Total number of Winner / Losers across all groups	544	654
Assessment	**Better off**	**Better off**

8.6.2 Similarly, for the TAG NO_2 analysis, a 0.1 µg/m^3 threshold has been used to define “no change”. As it can be observed in Table 8.2, all scenarios are forecast to be better off with the NEMMDR compared with the Core Scenario, given that more households are forecast to see a decrease in NO_2 as a result of the NEMMDR compared with those households forecast to see an increase in NO_2.

Table 8.2: Distribution of NO_2 Impacts on Households

Air Quality Impact	2021 (NO_2)	2036 (NO_2)
Households with increased NO_2	737	483
Households with decreased NO_2	2,584	2,119
Households with no change in NO_2	2,809	3,528
Total number of Winner / Losers across all groups	1,847	1,636
Assessment	**Better off**	**Better off**

8.6.3 In addition, the forecast PM_{10} and NO_2 impacts on non-residential receptors are shown in Table 8.3 and Table 8.4 for schools, nurseries and hospitals. For all the identified non-residential receptors, the forecast PM_{10} and NO_2 change is negligible or beneficial.

Table 8.3: Distribution of PM_{10} Impacts on Non-residential Sensitive Receptors (2021)

Description	Core PM_{10} ($\mu g/m^3$)	Scheme PM_{10} ($\mu g/m^3$)	Difference PM_{10} ($\mu g/m^3$)	Magnitude of impact
St Marys Church of England Primary School	14.0	14.0	<0.1	Negligible
The Beverley Robinson School	19.5	18.9	-0.6	Beneficial
The Grove CP School	15.5	15.4	-0.1	Negligible
Swallowdale CP School	15.2	15.2	<0.1	Negligible
Early Years Nursery LTD	18.7	18.3	-0.4	Negligible
Brownlow Primary School	16.5	16.4	-0.1	Negligible
Waltham on the Wolds Church of England School	13.5	13.5	0.1	Negligible
St Marys Hospital	17.4	17.0	-0.4	Negligible

Table 8.4: Distribution of NO_2 Impacts on Non-residential Sensitive Receptors (2021)

Description	Core NO_2 ($\mu g/m^3$)	Scheme NO_2 ($\mu g/m^3$)	Difference NO_2 ($\mu g/m^3$)	Magnitude of impact
St Marys Church of England Primary School	9.4	9.4	<0.1	Negligible
The Beverley Robinson School	31.4	28.7	-2.7	Beneficial
The Grove CP School	12.8	12.5	-0.3	Negligible
Swallowdale CP School	11.7	11.5	-0.1	Negligible
Early Years Nursery LTD	26.9	24.9	-2.0	Beneficial
Brownlow Primary School	13.9	13.6	-0.3	Negligible
Waltham on the Wolds Church of England School	9.5	9.9	0.4	Negligible
St Marys Hospital	19.7	17.7	-2.0	Beneficial

8.6.4 The TAG air quality valuation spreadsheet (dated July 2017) uses the findings from the plan level calculations for PM_{10} and the regional emissions of NO_x to calculate a monetary air quality valuation for the scheme. The air quality valuation is presented in Table 8.5. An overall positive value represents a net benefit for air quality.

Table 8.5: Air Quality Valuation (60-years, 2010 prices and values)

NO_x emissions	-£88,074
PM_{10} concentrations	£679,279
Total	***£591,206***

Section 9 – Assessment of Physical Activity

9.1 Introduction

9.1.1 The following section provides an estimate of the economic benefits of walking and cycling due to delivery of the NEMMDR and associated dedicated cycle facilities provided as part of the scheme. Further details on the methodology for this assessment, developed for the OBC, are found in *'20171207_MMDR_Cycle Appraisal Technical Note'*. Further details of the application of these methodologies to the FBC forecast scenarios can be found in *'Technical Note: North and East Melton Mowbray Distributor Road FBC – Active Mode Forecasting and Appraisal'* which is included in Appendix B .

9.1.2 Given the nature and location of the scheme outside Melton Mowbray it is anticipated the largest impact will be on cycle users and hence this is the focus of the analysis. Walking benefits are intrinsically linked to changes in severance detailed elsewhere. As a result of the orbital nature of the route, and travel distances between junctions, benefits to pedestrians were expected to be minimal and as such are not formally quantified.

9.2 Methodology

9.2.1 For this scheme appraisal, an elasticity approach linked to the sketch plan method in TAG has been used to provide inputs for the DfT Active Mode Appraisal Toolkit (AMAT).

9.2.2 The sketch plan method is one of the Department for Transport's TAG (Unit A5.1) suggested approaches to estimating the impact of a scheme on cycling demand.

9.2.3 The NEMMDR's potential trip generation for cyclists has been determined through a cycle elasticity estimate for the change in demand for cycling in an area, based on a change in the proportion of routes in Melton Mowbray that have dedicated facilities for cycle traffic (see TAG Unit A5.1 §2.4.4).

9.2.4 Cycle commuters and non-commuter cyclists were calculated from Census data and National Travel Survey information and adjusted according to TEMPro v7.2 growth forecasts for future years. Additional consideration was given to forthcoming housing growth in Melton Mowbray. This provided a cycling base year (2025) cycle demand for the opening year of the scheme as required by AMAT.

9.2.5 An elasticity methodology was then used to predict the impact of the new infrastructure on cycling in the area. For the NEMMDR Scenario, this resulted in an uplift in demand on base levels of cycling in Melton Mowbray of 2.95% due to the inclusion of the NEMMDR. This is below the 4.05% predicted for the OBC because the scheme now uses existing infrastructure along Lag Lane to provide a route between Saxby Road and Burton Road, reducing the length of new infrastructure from around 7km to 5km.

9.2.6 This uplift was applied to the base year estimates to produce figures for forecast With Scheme cycle trips and cyclists attracted to this travel mode in the area. Table 9.1 shows the result of these calculations.

Table 9.1: 2025 NEMMDR Scenario Forecast Daily Cycling Demand within Melton Mowbray

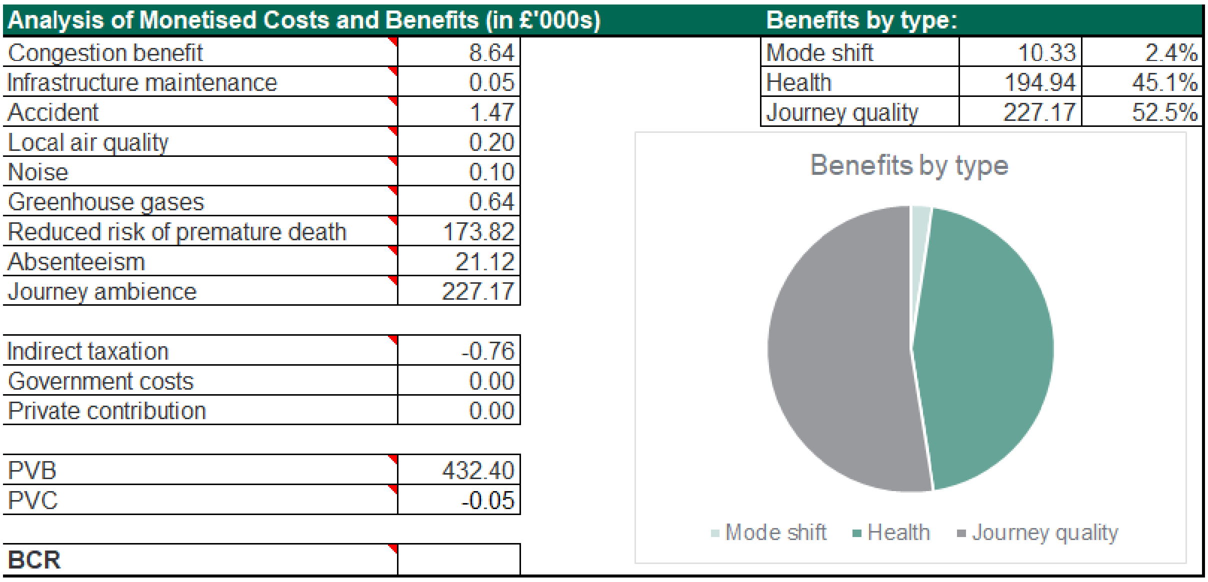
	Core Scenario		NEMMDR Impact		With NEMMDR	
Purpose	**Trips**	**Users**	**Trips**	**Users**	**Trips**	**Users**
Commuting	349	439	10	13	360	452
Leisure	698	3,318	21	98	718	3,416
Total	**1,047**	**3,758**	**31**	**111**	**1,078**	**3,869**

9.3 Summary of Results

9.3.1 The DfT Active Mode Appraisal Toolkit was then used to monetise the information in Table 9.1. Assumptions are that 5% of cycling trips are likely to use the radial route and that it is an off-road segregated cycle track to account for separation between the road and the cycleway for large sections in the latest design.

9.3.2 Table 9.2 below provides a summary of the monetised benefits of the cycle infrastructure created as part of the NEMMDR over a 20-year appraisal period, as recommended in the TAG Unit A4.1. These indicate a PVB of £432,400 for the NEMMDR Scenario.

Table 9.2: NEMMDR Scenario Monetised Cycle Benefits, 2010 Prices, Discounted to 2010



Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	8.64
Infrastructure maintenance	0.05
Accident	1.47
Local air quality	0.20
Noise	0.10
Greenhouse gases	0.64
Reduced risk of premature death	173.82
Absenteeism	21.12
Journey ambience	227.17
Indirect taxation	-0.76
Government costs	0.00
Private contribution	0.00
PVB	432.40
PVC	-0.05
BCR	

Benefits by type:		
Mode shift	10.33	2.4%
Health	194.94	45.1%
Journey quality	227.17	52.5%

9.3.3 Because cycling demand changes vary considerably between schemes, a sensitivity test was also undertaken using an alternative approach using outturn uplift from other similar UK schemes to provide a comparison. Comparable orbital routes were estimated to have given a minimum of 10% uplift for a purely orbital route. Table 9.3 shows the change in demand and users for 10% uplift and

9.3.4 Table 9.4 provides a summary of the monetary benefits. This test shows a higher PVB than the Core Scenario of £930,210 mainly due to a significant increase in health benefits.

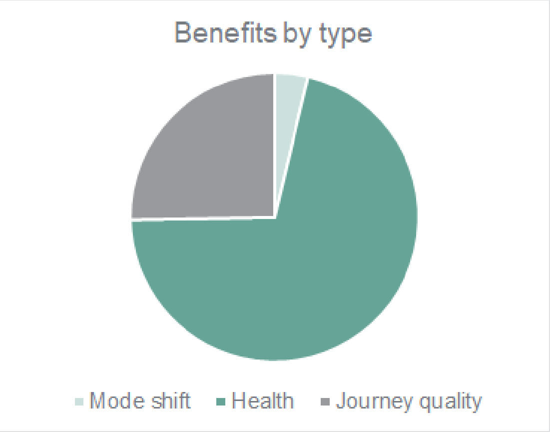
Table 9.3: 2025 NEMMDR Scenario Sensitivity Test (10% Uplift) Forecast Daily Cycling Demand within Melton Mowbray

	Core Scenario		NEMMDR Impact		With NEMMDR	
Purpose	**Trips**	**Users**	**Trips**	**Users**	**Trips**	**Users**
Commuting	349	439	35	44	384	483
Leisure	698	3,318	70	332	767	3,650
Total	**1,047**	**3,758**	**105**	**376**	**1,152**	**4,133**

Table 9.4: NEMMDR Scenario Sensitivity Test (10% Uplift) Monetised Cycle Benefits, 2010 Prices, Discounted to 2010

Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	29.27
Infrastructure maintenance	0.16
Accident	4.97
Local air quality	0.67
Noise	0.33
Greenhouse gases	2.17
Reduced risk of premature death	588.75
Absenteeism	71.54
Journey ambience	235.08
Indirect taxation	-2.58
Government costs	0.00
Private contribution	0.00
PVB	930.21
PVC	-0.16
BCR	

Benefits by type:		
Mode shift	34.99	3.8%
Health	660.30	71.0%
Journey quality	235.08	25.3%

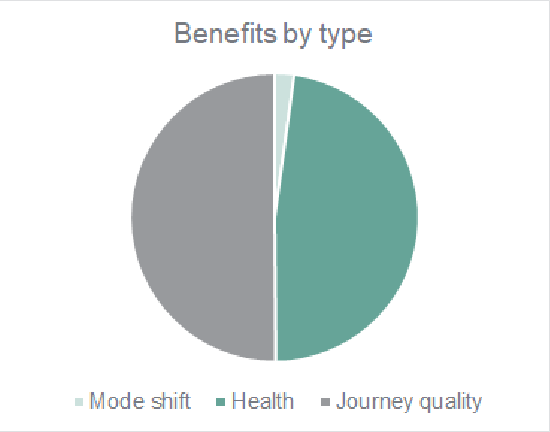


9.3.5 The NEMMDR infrastructure is designed with a life more than the 20 years assumed for the cycling appraisal, so a further sensitivity test was undertaken using the same assumptions and a 60-year appraisal. Table 9.5 gives a summary of the monetised benefits which produce a PVB of £1,037,080.

Table 9.5: NEMMDR Scenario Sensitivity Test (60-year Appraisal) Monetised Cycle Benefits, 2010 Prices, Discounted to 2010

Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	18.63
Infrastructure maintenance	0.10
Accident	3.01
Local air quality	0.39
Noise	0.20
Greenhouse gases	1.27
Reduced risk of premature death	446.78
Absenteeism	48.31
Journey ambience	519.61
Indirect taxation	-1.11
Government costs	0.00
Private contribution	0.00
PVB	1037.08
PVC	-0.10
BCR	

Benefits by type:		
Mode shift	22.47	2.2%
Health	495.09	47.7%
Journey quality	519.61	50.1%

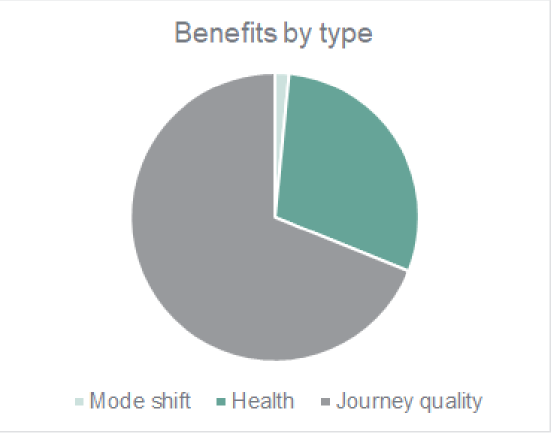


9.3.6 For the NEMMDR Scenario it was assumed that all commuter trips were on the radial routes across Melton Mowbray and that this results in 5% of total cycling trips using the new infrastructure. Assuming that some commuting trips might use the infrastructure (e.g. Northern Sustainable Neighbourhood to Asfordby Business Park) or that there is some behavioural change, a test was undertaken using the Core Scenario assumptions with 10% of cycling trips using the new infrastructure. Table 9.6 gives a summary of the monetised benefits which produce a higher PVB than the NEMMDR Scenario of £659,560 mainly due to better journey quality.

Table 9.6: Core Scenario Sensitivity Test (10% Usage) Monetised Cycle Benefits, 2010 Prices, Discounted to 2010

Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	8.64
Infrastructure maintenance	0.05
Accident	1.47
Local air quality	0.20
Noise	0.10
Greenhouse gases	0.64
Reduced risk of premature death	173.82
Absenteeism	21.12
Journey ambience	454.34
Indirect taxation	-0.76
Government costs	0.00
Private contribution	0.00
PVB	659.56
PVC	-0.05
BCR	

Benefits by type:		
Mode shift	10.33	1.6%
Health	194.94	29.6%
Journey quality	454.34	68.9%



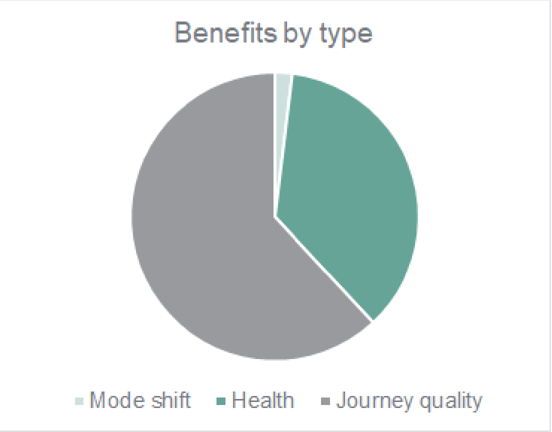
9.3.7 Two alternative scenarios are considered, one with the Southern Link Road being present in the opening year and one with additional, NEMMDR dependent, cycling infrastructure associated with the Melton Mowbray Transport Strategy being part of the With Scheme scenario.

9.3.8 The Southern Link Road Scenario uses the NEMMDR Scenario assumptions but produces a smaller demand uplift of 2.00% for the NEMMDR, as the it forms a smaller proportion of the total cycling infrastructure. The monetised benefits are summarised in Table 9.7 and produce a lower PVB than the Core Scenario of £365,120. This is due to the lower demand uplift (2.00% versus 2.95%) and the relative changes in PVB seen in the sensitivity tests for the Core Scenario are also applicable.

Table 9.7: Southern Link Road Alternative Scenario Monetised Cycle Benefits, 2010 Prices, Discounted to 2010

Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	5.85
Infrastructure maintenance	0.03
Accident	0.99
Local air quality	0.13
Noise	0.07
Greenhouse gases	0.43
Reduced risk of premature death	117.75
Absenteeism	14.31
Journey ambience	226.10
Indirect taxation	-0.52
Government costs	0.00
Private contribution	0.00
PVB	365.12
PVC	-0.03
BCR	

Benefits by type:		
Mode shift	7.00	1.9%
Health	132.06	36.2%
Journey quality	226.10	61.9%



9.3.9 The proposed Melton Mowbray Transport Strategy[4], consists of further mitigation across the town road network that is dependent on the NEMMDR and intended to complement the NEMMDR to help manage

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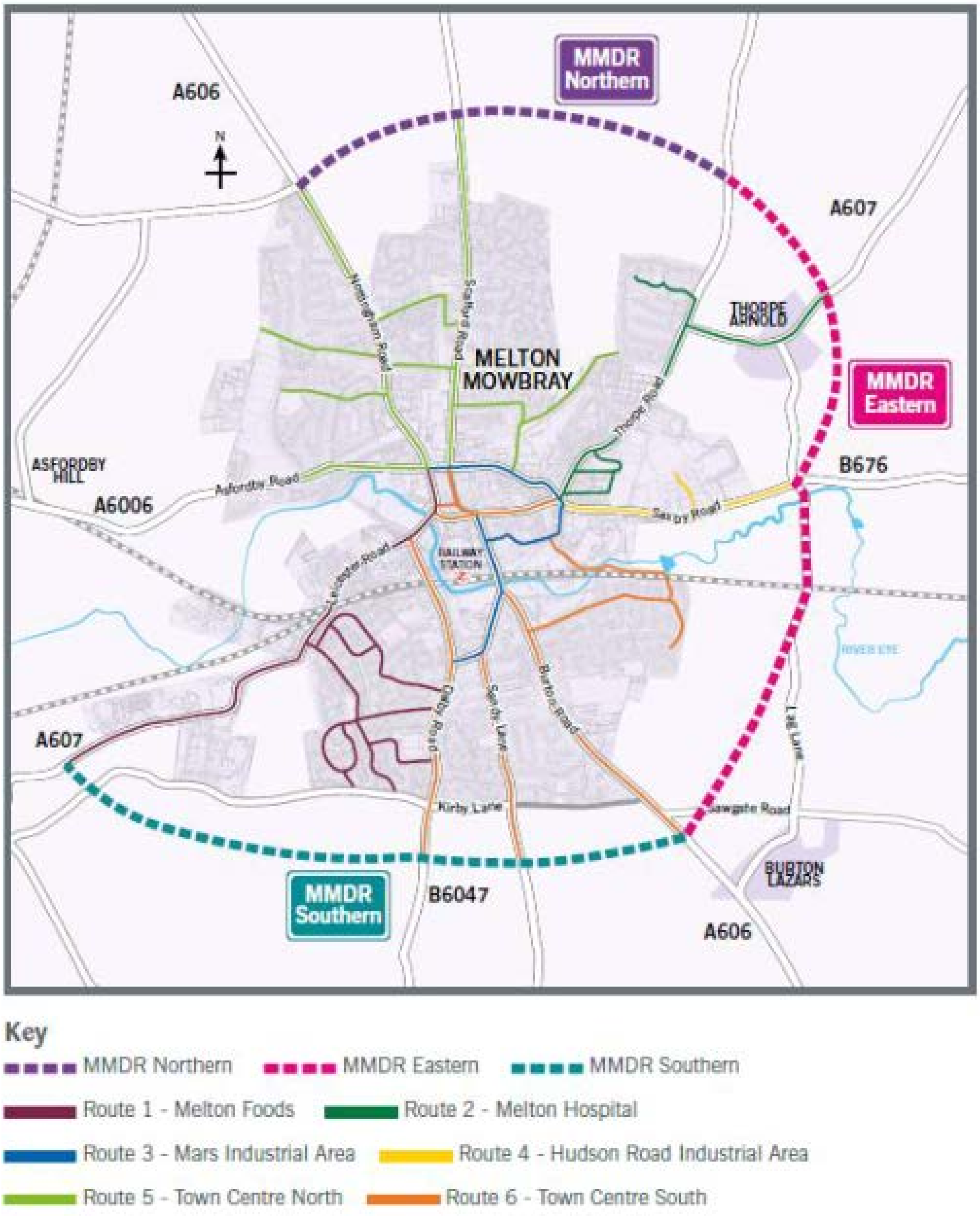
[4] https://www.leicestershire.gov.uk/sites/default/files/field/pdf/2021/7/27/Interim-Melton-Mowbray-transport-strategy.pdf

future traffic growth in the town centre. It is at an early stage of development and not part of the Core Scenario.

9.3.10 For cycling, the latest published version of the strategy, the Interim Melton Mowbray Transport Strategy[4], contains an aspirational cycling network as shown in Figure 9-1.

Figure 9-1: Interim Melton Mowbray Transport Strategy Aspirational Cycle Network.



Source: https://www.leicestershire.gov.uk/sites/default/files/field/pdf/2021/7/27/Interim-Melton-Mowbray-transport-strategy.pdf

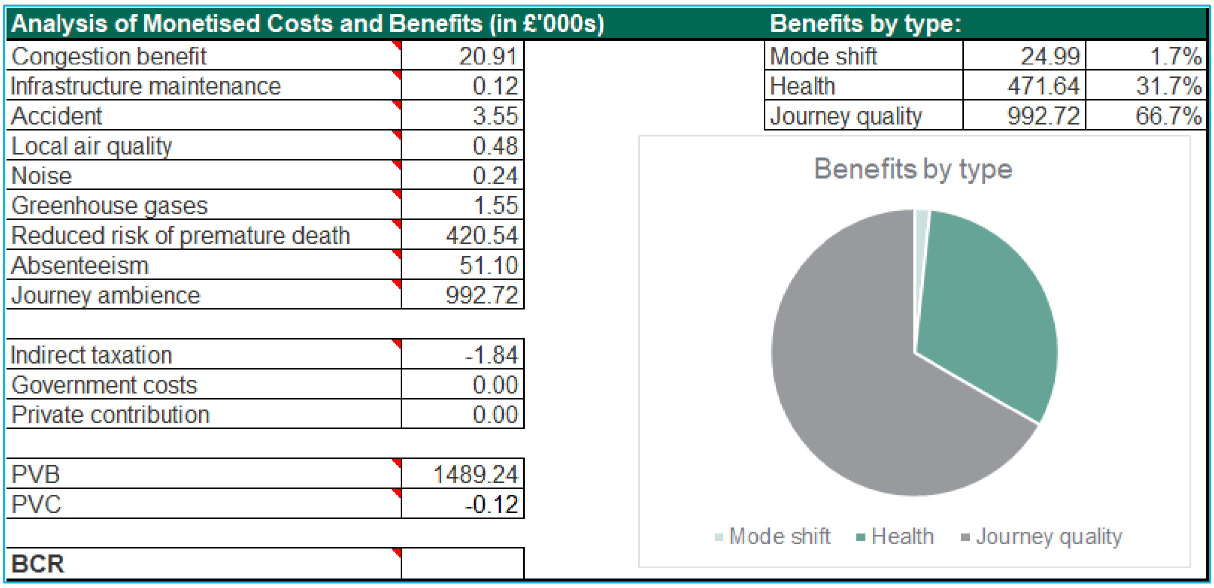
9.3.11 Assuming any new cycling infrastructure is concentrated on the main roads (an average of 1.7 km per route) in the demand elasticity calculations produces an uplift of 7.06% (Table 9.8). As this includes radial routes as well as the orbital route, usage is assumed to include both leisure and commuting trips. All trips are assumed to use one section of the scheme on the orbital route (leisure) and radial route (commuting) which produces an average usage of new facilities of 21%.

Table 9.8: MMTS Alternative Scenario Forecast Daily Cycling Demand within Melton Mowbray

	Core Scenario		NEMMDR Impact		With NEMMDR	
Purpose	**Trips**	**Users**	**Trips**	**Users**	**Trips**	**Users**
Commuting	356	448	25	32	382	480
Leisure	711	3,385	50	239	762	3,624
Total	**1,068**	**3,833**	**75**	**270**	**1,143**	**4,104**

9.3.12 Table 9.9 shows the monetised benefits for the MMTS alternative scenario which produce a PVB of £1,489,240 for a standard 20-year appraisal, significantly in excess of the NEMMDR Scenario PVB.

Table 9.9: MMTS Alternative Scenario Monetised Cycle Benefits, 2010 Prices, Discounted to 2010



Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	20.91
Infrastructure maintenance	0.12
Accident	3.55
Local air quality	0.48
Noise	0.24
Greenhouse gases	1.55
Reduced risk of premature death	420.54
Absenteeism	51.10
Journey ambience	992.72
Indirect taxation	-1.84
Government costs	0.00
Private contribution	0.00
PVB	1489.24
PVC	-0.12
BCR	

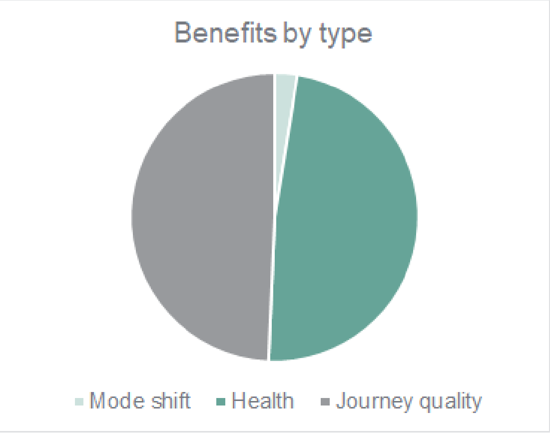
Benefits by type:		
Mode shift	24.99	1.7%
Health	471.64	31.7%
Journey quality	992.72	66.7%

9.3.13 For the NEMMDR Scenario a sensitivity test was undertaken using 10% demand uplift based on outturn uplift from previous comparable schemes. For this scenario, with both orbital and radial routes, 15% minimum uplift is observed for directly comparable schemes. The MMTS scenario was revised with 15% uplift and produces the monetised benefits shown in Table 9.10 giving a PVB of £2,090,120, which is significantly higher than the NEMMDR Scenario PVB.

Table 9.10: MMTS Alternative Scenario Sensitivity Test (15% uplift) Monetised Cycle Benefits, 2010 Prices, Discounted to 2010

Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	44.60
Infrastructure maintenance	0.25
Accident	7.57
Local air quality	1.02
Noise	0.50
Greenhouse gases	3.30
Reduced risk of premature death	897.15
Absenteeism	109.02
Journey ambience	1030.88
Indirect taxation	-3.93
Government costs	0.00
Private contribution	0.00
PVB	2090.12
PVC	-0.25
BCR	

Benefits by type:		
Mode shift	53.32	2.6%
Health	1006.17	48.1%
Journey quality	1030.88	49.3%



9.3.14 Table 9.11 provides a summary of results for the tested scenarios. The NEMMDR Scenario provides a PVB of £432,000. With the Southern Link Road present PVB is reduced to £365,000. The Transport Strategy Cycle Routes scenario (dependent on NEMMDR) has a PVB of £1.49m. Small changes in AMAT input parameters suggest that the assumptions made for the NEMMDR Scenario give a conservative estimate of benefits. Based on the MMTS tests, the NEMMDR unlocks the possibility of a cycling scheme with significantly larger benefits.

Table 9.11: Summary of Results for Tested Scenarios

Scenario	Test	% Usage	Increase in demand	PVB
NEMMDR	**-**	**5%**	**2.95%**	**£432,000**
NEMMDR	10% uplift	5%	10.00%	£930,000
NEMMDR	60-year appraisal	5%	2.95%	£1,037,000
NEMMDR	Higher usage	10%	2.95%	£660,000
Southern Link Road present	-	5%	2.00%	£365,000
Transport Strategy Cycle Routes	-	21%	7.06%	£1,490,000
Transport Strategy Cycle Routes	15% uplift	21%	15.00%	£2,090,000

9.3.15 This presents a potential range in terms of the benefits, but the elasticity methodology presented above has been used in the summary of benefits detailed in Section 12 as it is considered to provide a more robust appraisal.

Section 10 – Wider Impacts Assessment

10.1 Introduction

10.1.1 Wider economic impacts are supplementary to the conventional transport user benefits appraisal undertaken in TUBA software. Wider benefits are not therefore reported as part of the initial BCR. There are four types of wider impact which are appraised:

- Agglomeration impact – as discussed in TAG Unit A2.4, this relates to the concentration of economic activity across an area. By improving the accessibility of an area to a greater number of firms and workers, transport schemes can deliver increases in Gross Domestic Product (GDP). The primary influences on determining agglomeration impacts are changes in travel costs, the number and location of workers, and the productivity of those workers.
- Increased or decreased output in imperfectly competitive markets – as discussed in TAG Unit A2.2, this relates to the changes in the output of goods that use transport. Reductions in transport costs to business and/or freight allows for an increase in the production or output of goods or service markets.
- Labour market impacts from more/fewer people working – as discussed in TAG Unit 2.3, this is the impact of a transport scheme on labour supply and is based mainly on changes in commuting travel costs.
- Labour market impacts from the move to more/less productive jobs – as discussed in TAG Unit A2.3, a transport scheme may lead to a change in where people choose to work. Some jobs are more productive than others which can lead to changes in GDP.

10.1.2 The scheme is expected to improve journey times for the routes through Melton Mowbray, particularly along the A606, and also improve journey times between Melton Mowbray and destinations outside Melton Borough. This is likely to improve access to labour and reduce transport costs for businesses, increasing output, and reduce travel costs and make Melton Mowbray more desirable for commuters.

10.2 Methodology

10.2.1 To assess the wider impacts of the Scheme, the DfT's Wider Impacts in Transport Appraisal (WITA) computer software was used (v2.2). This is a change from the OBC when the DELTA land-use model (not used for the FBC transport modelling) was used to assess wider impacts.

10.2.2 WITA implements the calculations of wider impacts as described in TAG Unit A2.1 'Wider Economic Impacts Appraisal'. In all cases the WITA methodology seeks only to capture the part of the above impacts that is not already captured in conventional transport user benefit calculations.

10.2.3 The appraisal of wider impacts for the Scheme assumes that employment is consistent between the Without Scheme and With Scheme scenarios and does not include benefits arising from freight trips.

Forecast years, scenarios and appraisal period

10.2.4 The appraisal of wider impacts focusses on the Central Growth scenario and uses data derived from the six forecast year transport models as defined in the appraisal of conventional transport user benefits. Benefits calculated for each of the forecast years are similarly interpolated and extrapolated to cover the whole appraisal period.

10.2.5 Like the appraisal of conventional transport user benefits, a standard 60-year appraisal was undertaken.

Economic parameters

10.2.6 Economic data for each of the Local Authority Districts (LAD) in Great Britain have been derived from the latest version 3.3.0 of the TAG 'Wider Impacts Dataset' published by DfT in July 2021 [5]. These data detail the average wage per worker; index of labour productivity; and GDP per worker across the four industrial sectors as set out in TAG Unit A2.4 'Appraisal of Productivity Impacts'.

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[5] Wider Impacts Dataset Version 3.3.0 DfT. https://www.gov.uk/government/publications/tag-economic-impacts-worksheets

10.2.7 Forecast numbers of workers in each LAD have also been derived from the same dataset for each of the six modelled forecast years.

10.2.8 The conventional transport user benefit appraisal used an economic parameters file consistent with the November 2021 TAG Data book. The same economic file was used in WITA with minor format changes to be compatible with WITA v2.2.

User classes

10.2.9 The conventional transport user benefit appraisal, undertaken in TUBA, provides an assessment of benefits by journey purpose, split by vehicle type and has been undertaken for nine user classes, comprising:

- HGV;
- LGV;
- car business;
- car other (low household income);
- car other (medium household income);
- car other (high household income);
- car commuting (low household income);
- car commuting (medium household income); and
- car commuting (high household income);.

10.2.10 Wider economic impact assessment is only concerned with trips and travel costs made for non-freight purposes, therefore freight (HGV and LGV) user classes were omitted from the appraisal.

Input matrix data and annualisation

10.2.11 The same highway matrix data as used in the conventional transport user benefit analysis is input into the appraisal of wider economic impacts. This is detailed in Section 3.

10.2.12 Intra-zonal demand is included in the input to WITA; however, intra-zonal costs are not defined in the assignment model and are set to zero so that WITA uses the standard approximation of the greater of £2.50 or an intra-zonal cost proportion of 0.5.

10.2.13 The annualisation of the travel demand uses the same factors as the conventional transport user benefit appraisal as detailed in Section 3.3.

Masking

10.2.14 The masking applied is the same as the conventional transport user benefit appraisal as detailed in Section 3.3 and is applied to the input to WITA.

10.2.15 Results from WITA were output for Leicestershire districts and the external administrative areas surrounding Melton Borough: South Kesteven, Rushcliffe and Rutland. The three administrative areas outside Leicestershire are separated from the larger TUBA sectors so that the districts surrounding Melton, which are forecast to be directly affected by changes in traffic on the A606 and A607 due to the scheme, can be included with confidence.

10.2.16 South Kesteven, Rushcliffe and Rutland lie in the hinterland adjacent to Leicestershire which is modelled in sufficient detail to include a high proportion of intra-zonal demand. They are represented by 6, 21 and 4 zones respectively.

10.2.17 The TUBA sectors including South Kesteven, Rushcliffe and Rutland also include larger, more distant external zones which have a high proportion of intra-zonal demand for which generalised costs are estimated from a small number of inter-zonal movements with associated greater uncertainty for the WITA calculation.

10.3 Results

10.3.1 Results are included from Melton Borough and from Charnwood, Rushcliffe, South Kesteven and Rutland as their proximity to the scheme and links via the A606 and A607 give confidence in the generalised cost changes and in particular the estimates of intra-zonal generalised cost changes from inter-zonal movements affected by the scheme. Results are shown in Table 10.1 and given a total wider economic impacts benefit of £20 million over 60 years. Table 10.2 provides a breakdown by area for the areas included for the calculation of agglomeration and labour supply impact.

Table 10.1: Wider Economic Impacts Benefits, 2010 Prices and Values

Wider Impact Measure	**Benefit (£)**
Agglomeration - Manufacturing	1,459,000
Agglomeration - Construction	1,335,000
Agglomeration - Consumer Services	4,565,000
Agglomeration - Producer Services	7,118,000
Agglomeration - Total	*14,477,000*
Labour supply impact	673,000
Move to more / less productive jobs	-
Increase output in imperfectly competitive market	4,853,000
Total	*20,003,000*

Table 10.2: Summary of Agglomeration and Labour Supply Benefits by District, 2010 Prices and Values

	Agglomeration Manufacturing	**Agglomeration Construction**	**Agglomeration Consumer Services**	**Agglomeration Producer Services**	**Labour supply impact**	**District Total**
Melton	1,003,900	772,600	2,948,300	3,810,000	448,000	8,982,800
Rushcliffe	233,800	321,400	852,000	2,249,200	53,000	3,709,400
Rutland	88,900	80,300	303,300	317,100	105,300	894,900
Charnwood	89,500	120,400	354,800	613,700	19,700	1,198,100
South Kesteven	43,000	40,500	106,700	127,800	47,000	365,000
Total	*1,459,100*	*1,335,200*	*4,565,100*	*7,117,800*	*673,000*	*15,150,200*

10.3.2 Agglomeration benefits arise from improved labour market interactions, knowledge spill-over and linkages between suppliers and consumers. The Scheme reduces travel times and delay for users of the routes affected by the NEMMDR improving the connectivity and accessibility between suppliers and firms. Table 10.1 shows that there are positive agglomeration impacts realised from the Scheme providing around £14.5 million of benefits across the appraisal period.

10.3.3 The largest benefits realised due to increased agglomeration occur in Melton Borough, accounting for £8.5 million of the £14.5 million benefits across the appraisal period shown in Table 10.2. This shows that the reduction in travel costs has largest impact in the local area; however, there are benefits realised across the surrounding districts and for longer distance journeys that use the Scheme.

10.3.4 Transport costs are likely to affect the overall costs and benefits to an individual from working. In deciding whether to work, an individual will weigh travel costs against the wage rate of the job travelled to. A change in transport costs is therefore likely to affect the incentives of individuals to work and hence the overall level of labour supplied in the economy. As the Scheme reduces the cost of travel, through improved travel times and reliability, there will be a higher level of labour supplied in the economy because of its implementation. There is a positive impact on labour supply due to the Scheme, with total benefits in the region of £0.7 million realised across the appraisal period as shown in Table 10.1.

10.3.5 Output change in imperfectly competitive markets refers to changes in the level of economic activity because of transport investment. Reductions in generalised travel cost induce investment and hence increase output, providing benefits to business users. Because the market is not perfectly competitive, improved transport can increase productivity beyond the cost of delivering this increase. Melton Mowbray has a strong manufacturing base that relies heavily on road transport so is likely to benefit from the Scheme. Forecast benefits from this measure are £4.8 million across the appraisal period as shown in Table 10.1.

10.4 Alternative Scenarios

10.4.1 The two alternative scenarios being considered, delivery of the NEMMDR with an accelerated delivery of the Southern Link Road and delivery of the NEMMDR with the subsequent addition of measures related to the Interim Melton Mowbray Transport Strategy, are described in Section 3.7.

10.4.2 Wider impacts of the NEMMDR were calculated for both alternative scenarios in the same way as for the NEMMDR scenario.

10.4.3 The equivalent results for the Accelerated Southern Link Road Scenario are shown in Table 10.3 and Table 10.4 and show that this scenario very slightly increases the wider impacts for all measures and areas from the NEMMDR scenario producing a total increase of £392,000, or around 2%.

Table 10.3: Accelerated Southern Link Road Scenario Wider Economic Impacts Benefits, 2010 Prices and Values

Wider Impact Measure	Benefit (£)
Agglomeration - Manufacturing	1,490,000
Agglomeration - Construction	1,357,000
Agglomeration - Consumer Services	4,643,000
Agglomeration - Producer Services	7,197,000
Agglomeration - Total	*14,687,000*
Labour supply impact	682,000
Move to more / less productive jobs	-
Increase output in imperfectly competitive market	5,025,000
Total	*20,395,000*

Table 10.4: Accelerated Southern Link Road Scenario Summary of Agglomeration and Labour Supply Benefits by District, 2010 Prices and Values

	Agglomeration Manufacturing	Agglomeration Construction	Agglomeration Consumer Services	Agglomeration Producer Services	Labour supply impact	District Total
Melton	1,025,900	788,200	3,006,700	3,883,200	454,400	9,158,400
Rushcliffe	229,100	315,400	835,900	2,207,200	53,300	3,640,900
Rutland	88,900	80,600	304,800	318,600	104,300	897,200
Charnwood	94,000	124,800	367,200	634,900	21,400	1,242,300
South Kesteven	51,800	48,000	128,700	153,100	48,900	430,500
Total	*1,489,700*	*1,357,000*	*4,643,300*	*7,197,000*	*682,300*	*15,369,300*

10.4.4 The equivalent results for the Accelerated Southern Link Road Scenario are shown in Table 10.5 and Table 10.6 and show that this scenario slightly decreases the wider impacts for all measures and areas from the NEMMDR scenario producing a total decrease of £870,000, or around 4%. This is consistent with smaller agglomeration benefits due to increased distances for businesses caused by the extra measures to limit through traffic in Melton Mowbray.

Table 10.5: Accelerated Southern Link Road Scenario Wider Economic Impacts Benefits, 2010 Prices and Values

Wider Impact Measure	Benefit (£)
Agglomeration - Manufacturing	1,445,000
Agglomeration - Construction	1,318,000
Agglomeration - Consumer Services	4,527,000
Agglomeration - Producer Services	7,040,000
Agglomeration - Total	*14,330,000*
Labour supply impact	679,000
Move to more / less productive jobs	-
Increase output in imperfectly competitive market	4,125,000
Total	*19,133,000*

Table 10.6: Accelerated Southern Link Road Scenario Summary of Agglomeration and Labour Supply Benefits by District, 2010 Prices and Values

	Agglomeration Manufacturing	Agglomeration Construction	Agglomeration Consumer Services	Agglomeration Producer Services	Labour supply impact	District Total
Melton	1,001,200	772,000	2,953,900	3,813,500	454,200	8,994,800
Rushcliffe	231,500	318,800	847,300	2,234,800	52,700	3,685,100
Rutland	86,500	78,400	296,900	310,100	104,000	875,900
Charnwood	82,200	108,200	319,600	552,200	21,300	1,083,500
South Kesteven	43,200	40,600	108,800	129,500	46,800	368,900
Total	*1,444,600*	*1,318,000*	*4,526,500*	*7,040,100*	*679,000*	*15,008,200*

10.4.5 The three scenarios considered produce significant wider impact benefits of around £20m:

- NEMMDR Scenario - £20,003,095
- Accelerated Southern Link Road Scenario - £20,395,000
- Melton Mowbray Transport Strategy Scenario - £19,133,000

Section 11 – Assessment of Distributional Impacts

11.1 Introduction

11.1.1 This section details the methodology adopted for the Distributional Impact appraisal for the NEMMDR.

11.1.2 Distributional impacts consider the variance of transport intervention impacts across different social groups. Both the beneficial and / or adverse impacts are taken into consideration for the social and economic groups affected by each indicator of scheme impact.

11.1.3 Consideration of distributional impacts is undertaken where changes occur in user benefits (transport costs), noise, air quality, accidents, security, severance, accessibility and personal affordability. Not all social and economic groups are vulnerable to changes in each indicator and therefore it is only necessary to investigate affected groups. They are listed in TAG Unit A4.2 and reproduced in Table 11.1.

Table 11.1: Groups of People Considered for Each Indicator

Social Group	**User benefits**	**Noise**	**Air Quality**	**Accidents**	**Security**	**Severance**	**Accessibility**	**Affordability**
Income distribution	✓	✓	✓				✓	✓
Children: proportion of population aged <16		✓	✓	✓	✓	✓	✓	
Young adults: proportion of population aged 16-25				✓			✓	
Older people: proportion of population aged >70		✓		✓	✓	✓	✓	
Proportion of population with a disability					✓	✓	✓	
Proportion of population of Black and Minority Ethnic (BME) origin					✓		✓	
Proportion of households without access to a car						✓	✓	
Carers: proportion of households with dependent children							✓	

11.1.4 For each indicator listed in Table 11.1 a three-step approach was undertaken:

- **Step 1 - Screening Process:** Identify the likely impacts for each indicator in the different scenarios and whether appraisal is necessary. This step, covered in Section 11.2, is summarised in the TAG screening proforma.
- **Step 2 - Assessment:** Determine the area impacted by the transport intervention, identify the distribution of the social groups in the area and identify the local amenities in the area. This is covered in Section 11.3.
- **Step 3 - Appraisal of Impacts:** Core analysis of the impacts. This is covered in Section 11.3.12. This step is summarised in the Distributional Impacts Appraisal Matrix and the Appraisal Summary Table entry.

11.1.5 Typically, the indicators are assessed using the 7-point scale as shown in Table 11.2.

Table 11.2: General System for Grading of DIs (TAG A4.2 Table 5)

Impact	Assessment
Beneficial and the population impacted is significantly greater than the proportion of the group in the total population	Large Beneficial (✓✓✓)
Beneficial and the population impacted is broadly in-line with the proportion of the group in the total population (± 5%)	Moderate Beneficial (✓✓)
Beneficial and the population impacted is smaller than the proportion of the group in the total population	Slight Beneficial (✓)
There are no significant benefits or disbenefits experienced by the group for the specific benefit	Neutral
Adverse and the population impacted is smaller than the proportion of the group in the total population	Slight Adverse (×)
Adverse and the population impacted is broadly in-line with the proportion of the group in the total population (± 5%)	Moderate Adverse (××)
Adverse and the population impacted is significantly greater than the proportion of the group in the total population	Large Adverse (×××)

11.2 Screening

Context

11.2.1 Melton Mowbray is a rural market town with a population of around 27,000 according to the 2011 Census. It is the commercial and administrative centre of Melton Borough (51,000 population) and at least 13 miles from any of the surrounding towns or cities. As a rural area, car dependency is relatively high in Melton Borough and car usage within the town is also relatively high leading to congestion and poor conditions for active travel in the centre of the town.

11.2.2 Currently there are 5 radial routes (A606, A607, A6006, B676 and B6047) that meet in a partial gyratory in the centre of Melton Mowbray. This leads to congestion from a combination of through-traffic and local traffic that is forecast to increase in volume in the future as housing and employment developments are completed. The through-routes also form signed diversion routes for the A46 and A1, adding large volumes of traffic when disruption to the Strategic Road Network occurs.

11.2.3 A high volume of goods vehicles leads to an adverse impact on road safety, noise and air quality. Poor parking provision leads with difficulties for the disabled and those deterred by the high traffic levels that exist between the town-centre car parks and the town centre amenities. Other severance issues exist in relation to queuing traffic and narrow footpaths with limited separation from traffic. Cycling also suffers from poor perceived traffic conditions.

11.2.4 The NEMMDR aims to remove through-traffic (around 20% of all traffic) from the town centre to start to alleviate these issues. Other subsequent strategies such as the Melton Mowbray Transport Strategy, considered as an alternative scenario, aim to make infrastructure and routeing changes to further mitigate the specific issues in the town and town centre.

11.2.5 The observations noted above identify the local issues and are considered in the screening shown in the FBC screening proforma reproduced in Table 11.3

Table 11.3: NEMMDR FBC Distributional Impacts Screening Proforma

Indicator	Appraisal output criteria	Potential impact (yes / no, positive/negative if known)	Qualitative Comments	Proceed to Step 2
User benefits	The TUBA user benefit analysis software or an equivalent process has been used in the appraisal; and / or the value of user benefits Transport Economic Efficiency (TEE) table is non-zero.	Yes, positive	TUBA was used in the user benefit appraisal, so a full distributional impacts appraisal is required.	Yes
Noise	Any change in alignment of transport corridor or any links with significant changes (>25% or <-20%) in vehicle flow, speed or %HDV content. Also note comment in TAG Unit A3.	Yes	Noise impacts are likely to occur as the scheme results in changes to traffic flows and speeds.	Yes
Air quality	Any change in alignment of transport corridor or any links with significant changes in vehicle flow, speed or %HDV content: • Change in 24 hour AADT of 1000 vehicles or more • Change in 24 hour AADT of HDV of 200 HDV vehicles or more • Change in daily average speed of 10kph or more • Change in peak hour speed of 20kph or more • Change in road alignment of 5m or more	Yes,	Air quality impacts are likely to occur as the scheme results in changes to traffic flows or speeds.	Yes
Accidents	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network.	Yes,	The scheme is likely to change the alignment, flows, speeds, %HGV content. Changes in cyclist are likely to be <10%.	Yes

Security	Any change in public transport waiting/interchange facilities including pedestrian access expected to affect user perceptions of personal security.	No, not significant	There are no significant changes in public transport waiting facilities, pedestrian access, provision of lighting and visibility, landscaping or surveillance.	No
Severance	Introduction or removal of barriers to pedestrian movement, either through changes to road crossing provision, or through introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, %HGV content.	Yes	Changes in flow, speed and %HGV are likely to occur within Melton Mowbray because of the scheme.	Yes
Accessibility	Changes in routeings or timings of current public transport services, any changes to public transport provision, including routeing, frequencies, waiting facilities (bus stops / rail stations) and rolling stock, or any indirect impacts on accessibility to services (e.g. demolition & re-location of a school).	No, not significant	There are no significant changes in services, routeing or timings of current public transport services or change to waiting facilities available.	No
Affordability	In cases where the following charges would occur; parking charges (including where changes in the allocation of free or reduced fee spaces may occur); car fuel and non-fuel operating costs (where, for example, rerouteing or changes in journey speeds and congestion occur resulting in changes in costs); road user charges (including discounts and exemptions for different groups of travellers); public transport fare changes (where, for example, premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); or public transport concession availability (where, for example, concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority).	Yes	Car fuel and non-fuel operating costs are likely to change as the Distributor Road will affect north-east to south-west axis journey times and distances across Melton Mowbray and Melton Borough.	Yes

11.3 Assessment

11.3.1 Unless an indicator-specific area was derived for an assessment, the impact area is taken as Melton Borough, where most traffic changes will occur in response to the scheme. Melton Borough is contained within the traffic model Area of Detailed Modelling (AoDM) where the confidence in the model is considered highest.

11.3.2 The data describing social and economic groups are required for multiple indicator appraisals so are described in this section and the appraisals are described separately in the next section.

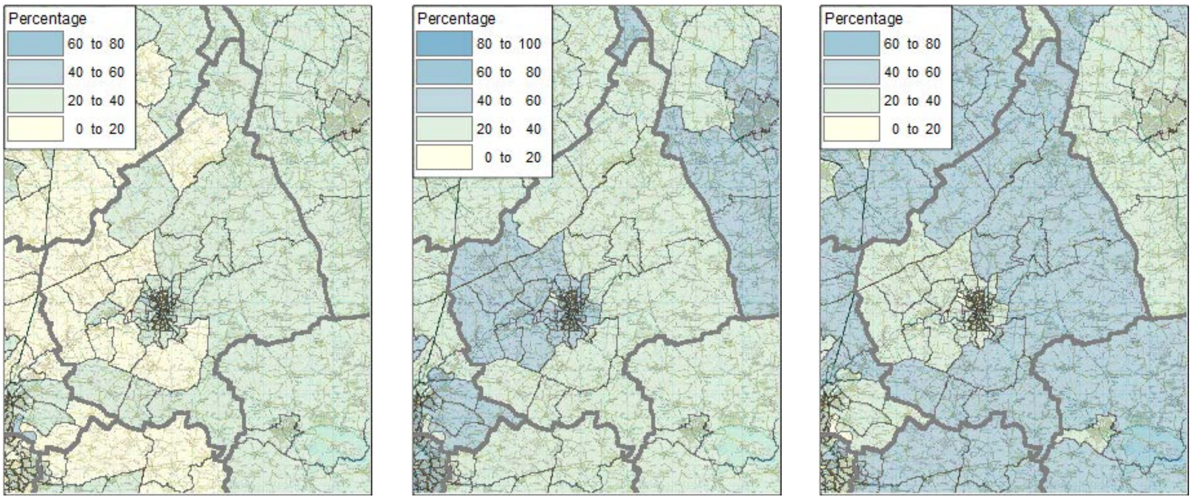
11.3.3 The groups identified in Table 11.1 for the indicators being assessed (Table 11.3) are mapped from appropriate data in this section. Data used to derive social groupings include the LLITM land-use model (ultimately derived from the 2011 Census), the 2011 Census and the 2019 English Indices of Deprivation.

11.3.4 The LLITM land-use model provides income estimates for all model zones in Leicestershire and a small surrounding area. The 33 household types in the LLITM land-use model were grouped into three income bands, as per the transport model, as shown in Table 11.4 and Figure 11-1. Within Melton Mowbray, the average population split is 24%, 45% 30%, low-middle-high and in the rural areas of Melton Borough the population split is 20%,39%,41% low-middle-high.

Table 11.4: Income Bands Modelled within LLITM, 2010 prices

Income Band	Gross Household Income
1 (Low)	£0 to £25,000
2 (Middle)	£25,000 to £50,000
3 (High)	Above £50,000

Figure 11-1: Percentages of Income Band by Model Zone in Melton Borough



Low-income (<£25,000 pa) **Middle (£25,000-£50,000 pa)** **High (>£50,000 pa)**

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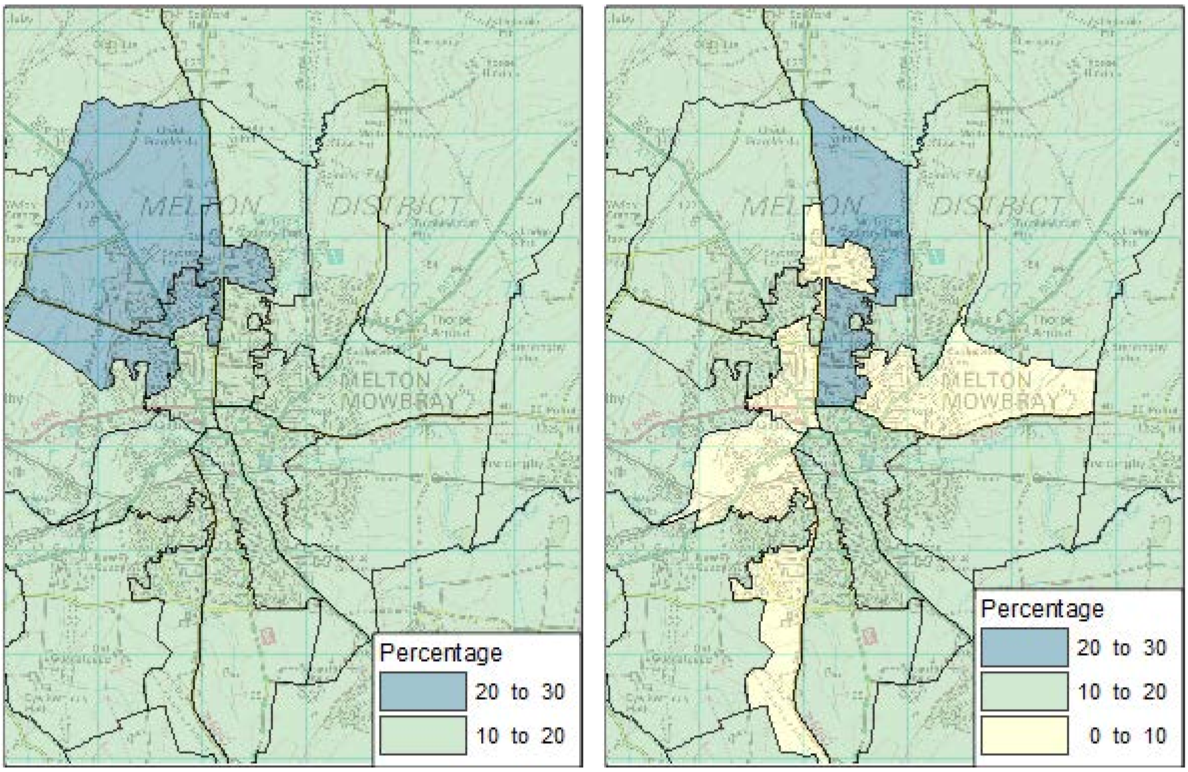
11.3.5 The 2011 Census was used to derive the population of other vulnerable groups used for distributional impacts assessment. The data relevant to the noise and air quality appraisal are shown mapped by census Lower Super Output Area (LSOA) in Figure 11-2. All LSOAs have a proportion of children between 10% and 20% of the population apart from three in north-west Melton Mowbray that are slightly higher. The proportion on older people in the population is in the 10% to 20% range with some variation in Melton Mowbray.

Figure 11-2: Vulnerable Groups for Air Quality and Noise Appraisal



Children (under 16 years)

Older People (over 69 years)

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11.3.6 For the appraisal of severance, the location and size of the population without access to a car and who are disabled is required. Both are derived at LSOA level from the 2011 Census. The census question around disability defines disability broadly and leads to a slightly higher percentage of disabled population than other sources. It is perceived disabled, rather than claiming specific benefits, and often corresponds with areas with an ageing population. The data are shown for Melton Borough and Melton Mowbray in Figure 11-3.

11.3.7 Households without access to a car are rare in the rural areas of Melton Borough and access to a car is variable within Melton Mowbray with some areas having between 40% and 50% of households without access to a car, reflecting that there is significant population employed within the town and that the short distances are conducive to active travel.

11.3.8 Perceived disability is relatively uniform across Melton Borough, with slightly higher levels in Melton Mowbray where there is a slightly higher proportion of older people in some LSOAs.

11.3.9 Melton Borough is largely rural with sparse amenities. Melton Mowbray is the commercial and administrative centre of the Borough. This is demonstrated in Figure 11-4 which show the results of Google's most common amenity map search terms plus schools[6]. Most of the amenities (shown as red tags) are concentrated in the centre of Melton Mowbray. Accessing amenities therefore requires journeys into Melton Mowbray from the surrounding rural areas or journeys into the centre of Melton Mowbray from the rest of the town. There are primary schools in some of the villages surrounding Melton Mowbray which will attract journeys for educational purposes in the rest of the district.

11.3.10 The weekly market in Melton Mowbray is well used, using a significant proportion if not all the parking provision. Public transport links are also centred in Melton Mowbray including bus and rail stations.

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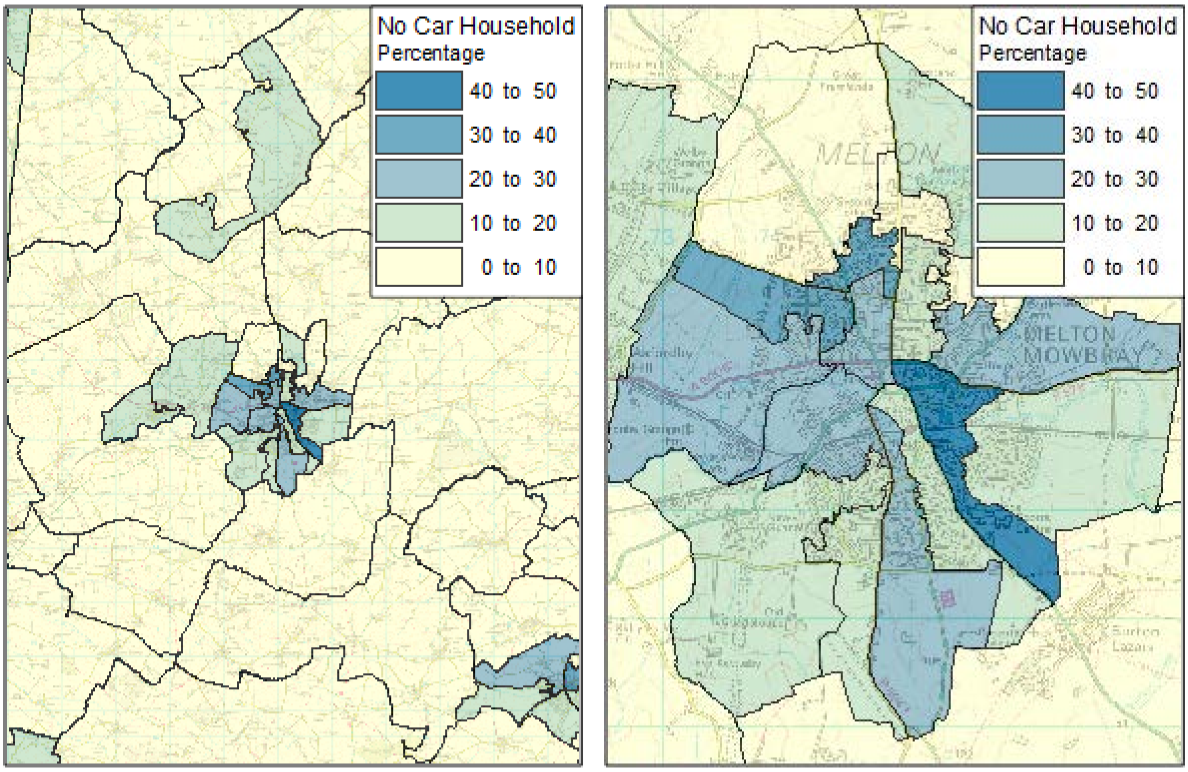
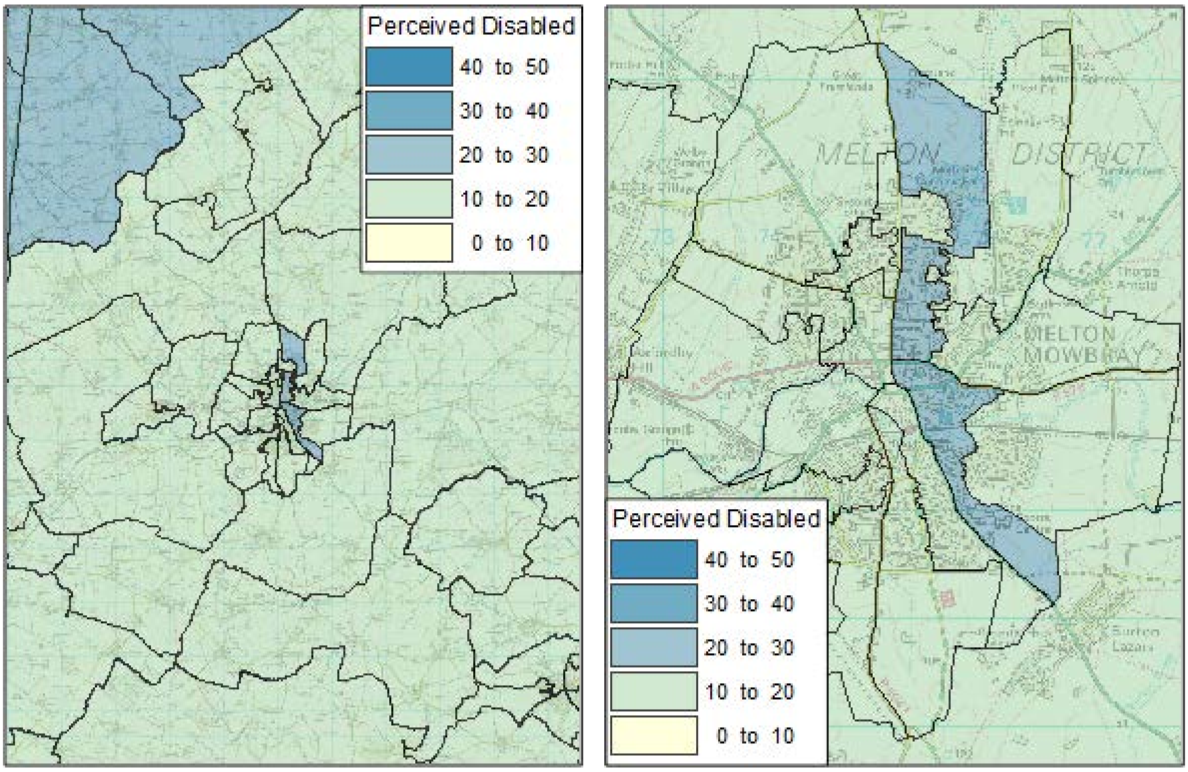
[6] https://www.google.co.uk/maps/search/schools/@52.770336,-0.9023254,12z/data=!4m2!2m1!6e6

Figure 11-3: Vulnerable Groups for Severance Appraisal



No Car Households

No Car Households in Melton Mowbray



Disabled Population

Disabled Population in Melton Mowbray

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Comparison of Social Groups with Local Authority Averages

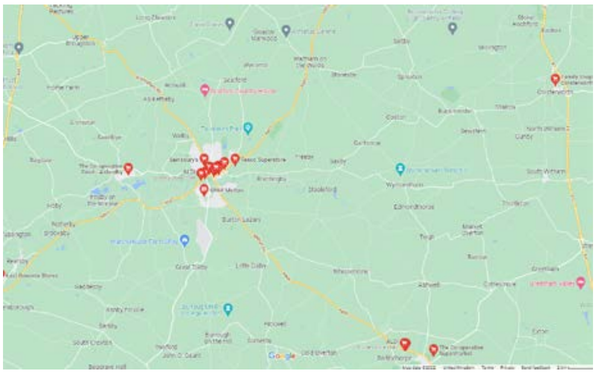
11.3.11 The social group proportions within the impact area for assessed indicators are compared to the proportions in the Local Authority (Melton Borough) in Table 11.5. Melton Borough is relatively affluent with no LSOAs in the least affluent Indices of Deprivation quintile, with 67% of LSOAs in the two most affluent quintiles. The chosen impact areas pick up a greater proportion of Quintile 2 LSOAs for Air Quality and Noise and a slightly greater proportion of no-car households for severance which in more Melton Mowbray-centred. Journeys within Melton Mowbray are relatively short compared to the surrounding rural areas and therefore more conducive to non-motorised travel. Other than these two small deviations, the proportions of groups being assessed are comparable to the Melton Borough averages.

Table 11.5: Social Group Proportions in the Local Authority and Indicator Impact Areas

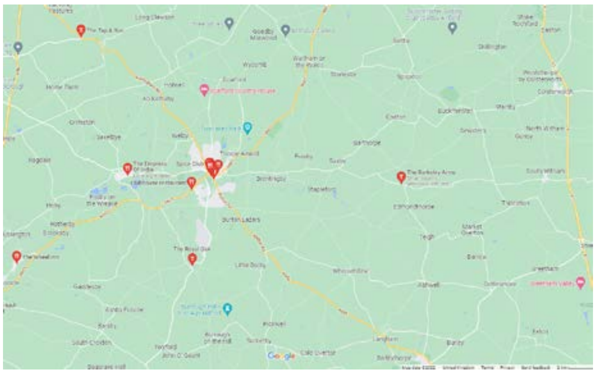
Group		Measure	User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability
Income Distribution (Indices of Deprivation Income Quintiles)	Melton Borough	1	0%	0%	0%					0%
		2	13%	13%	13%					13%
		3	20%	20%	20%					20%
		4	27%	27%	27%					27%
		5	40%	40%	40%					40%
	Impact Area	1	0%	0%	0%					0%
		2	13%	21%	21%					13%
		3	20%	16%	11%					20%
		4	27%	26%	32%					27%
		5	40%	37%	37%					40%
Children (<16)	Melton Borough	Proportion		17%	17%	17%		17%		
	Impact Area	Proportion		17%	17%	17%		17%		
Older People (>70)	Melton Borough	Proportion		13%		13%		13%		
	Impact Area	Proportion		13%		13%		13%		
No Car Available	Melton Borough	Proportion						15%		
	Impact Area	Proportion						16%		
Young People (16-25)	Melton Borough	Proportion				10%				
	Impact Area	Proportion				10%				
People with a Disability	Melton Borough	Proportion						17%		
	Impact Area	Proportion						17%		

Figure 11-4: Melton Borough Amenities

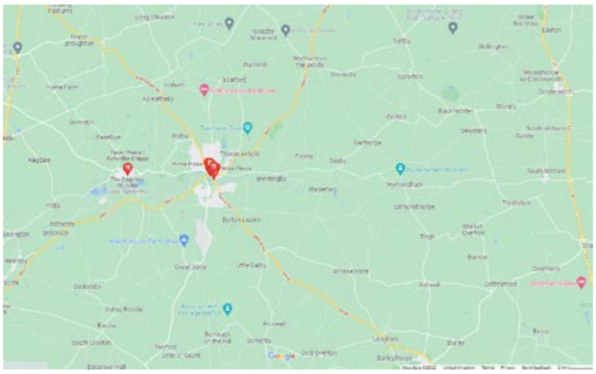
Groceries



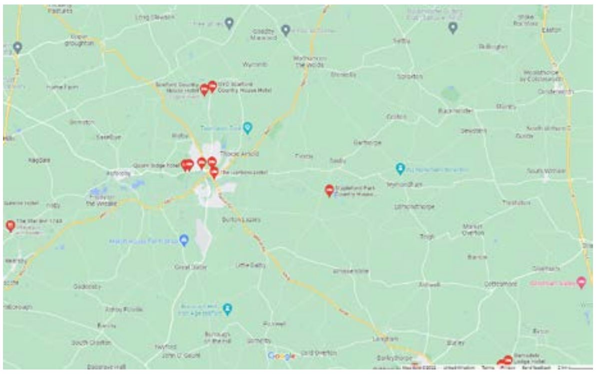
Restaurants



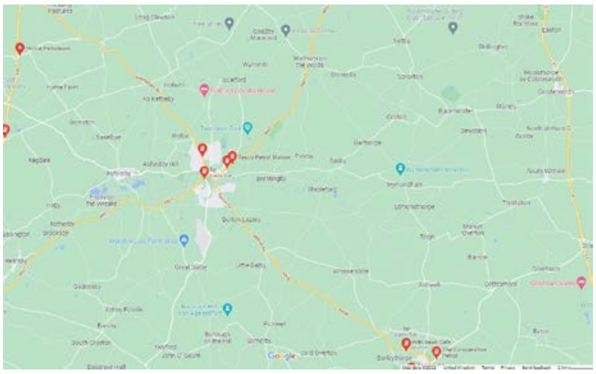
Takeaway



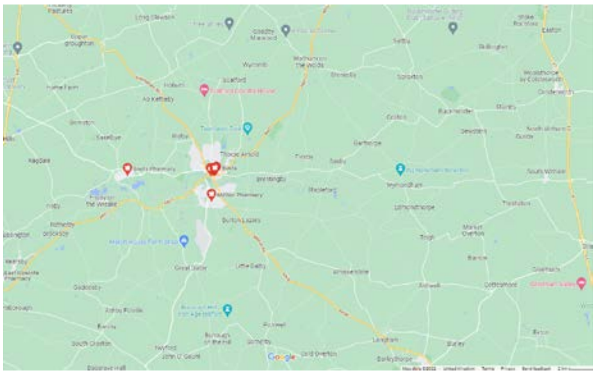
Hotels



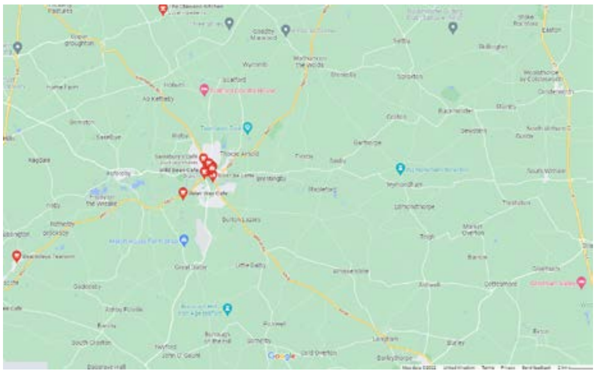
Petrol



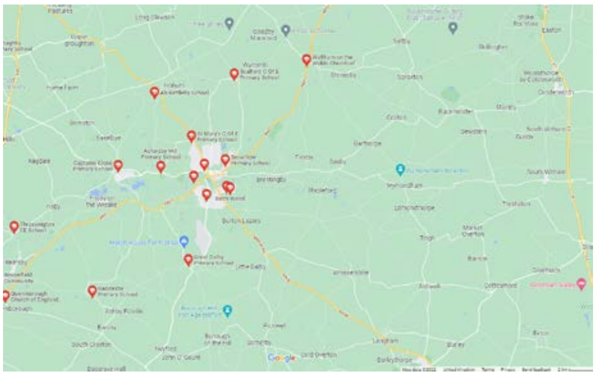
Chemists



Coffee

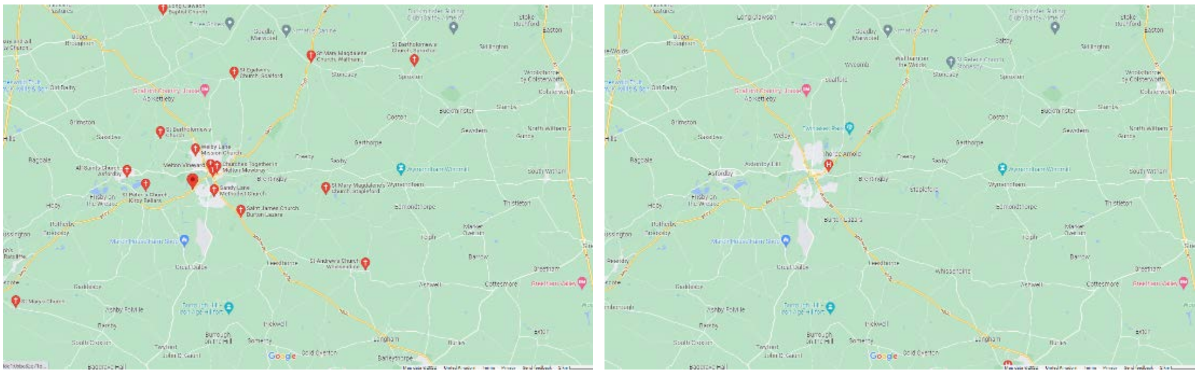


Schools



Churches

Hospitals



Nurseries

Community Centres

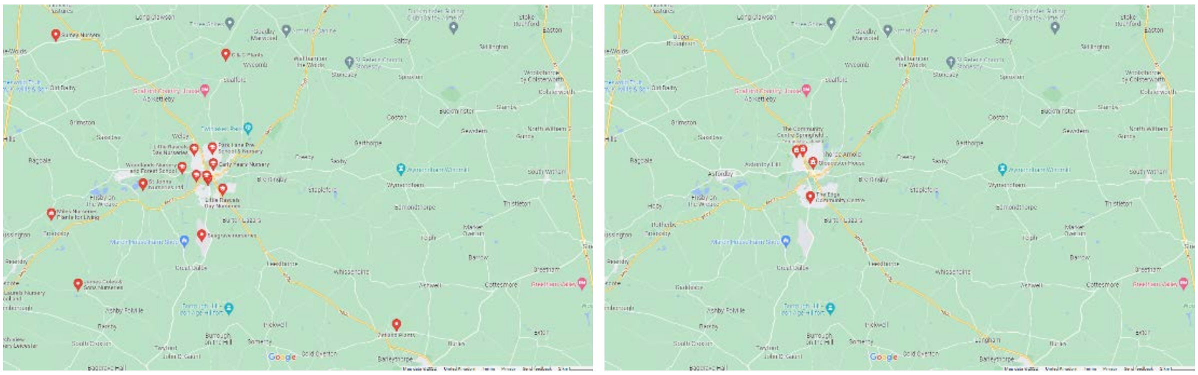
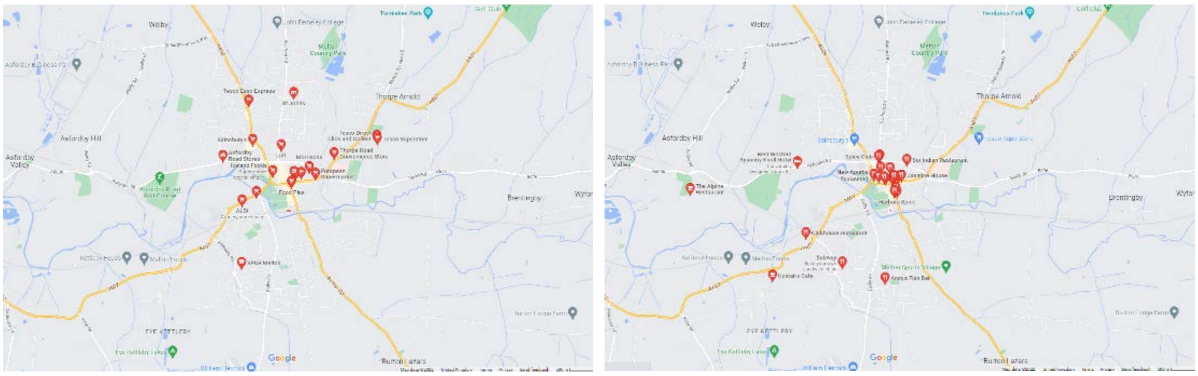


Figure 11-5: Melton Mowbray Amenities

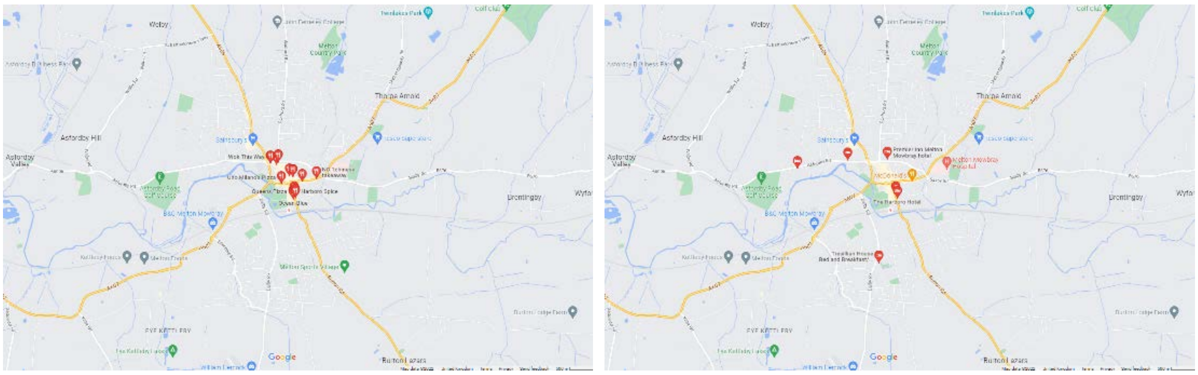
Groceries

Restaurants

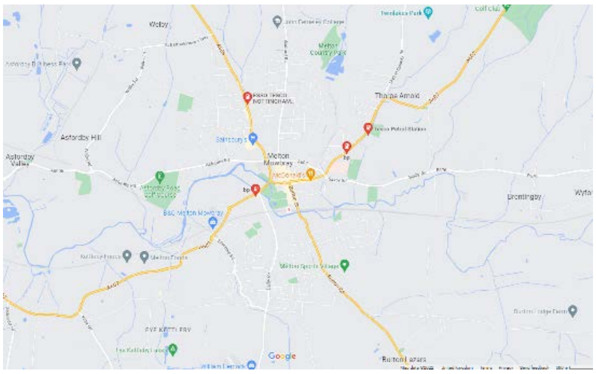


Takeaway

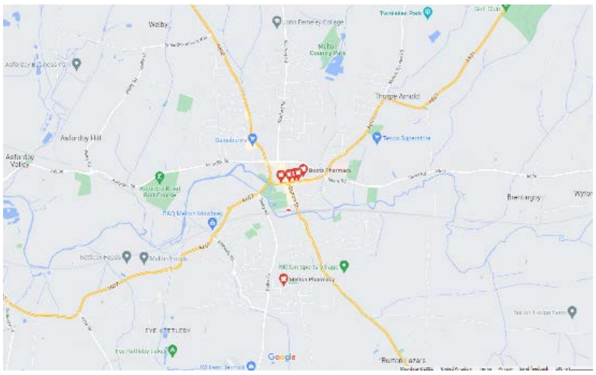
Hotels



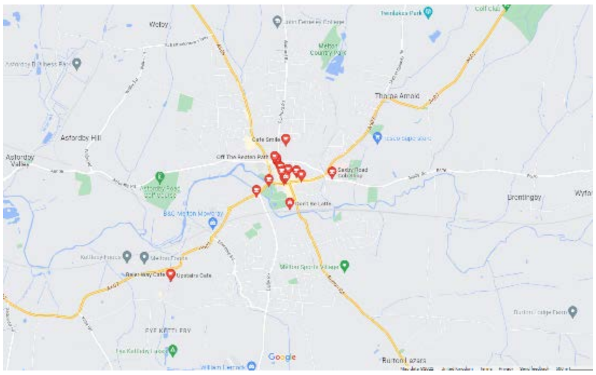
Petrol



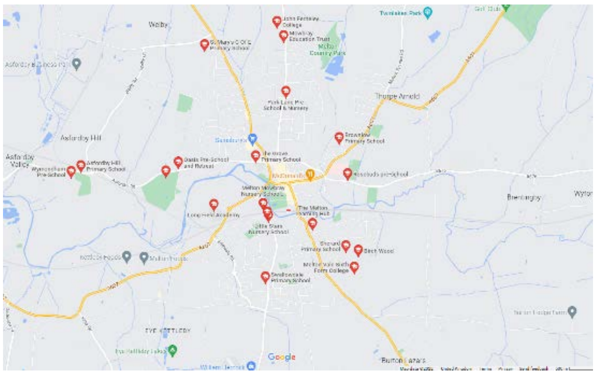
Chemists



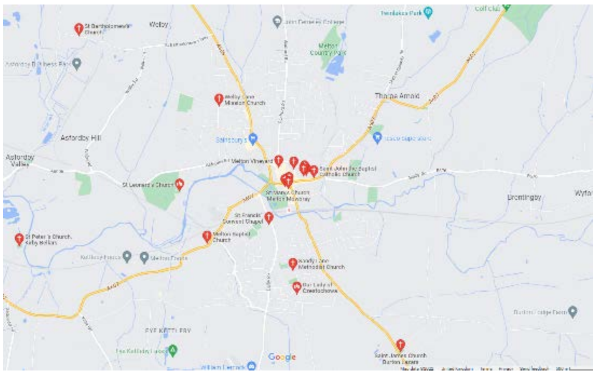
Coffee



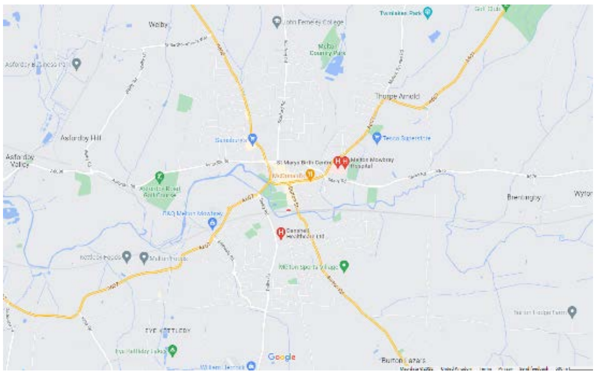
Schools



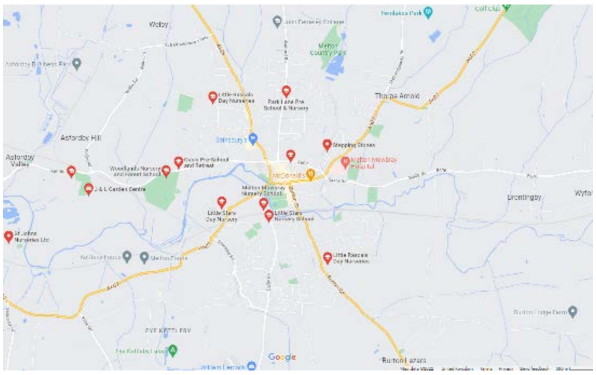
Churches



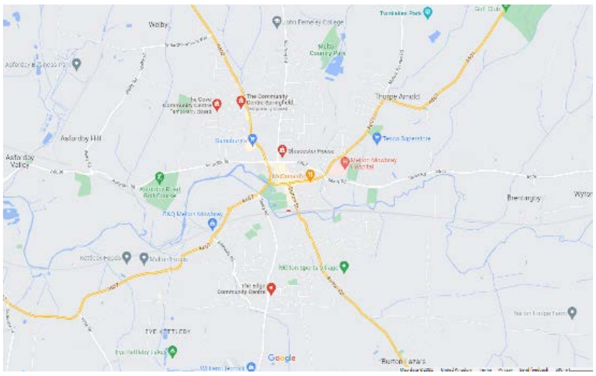
Hospitals



Nurseries



Community Centres



11.3.12 Table 11.6 provides a summary of outputs from Step 2, identifying the assessed social group proportions against local authority and national averages and identifying amenities in the impact area for each indicator.

Table 11.6: Step 2 Output Summary

Social Group			User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability	Local Authority	England
Resident population in the impact area	Income distribution quintiles	0-20%	0%	0%	0%					0%	0%	20%
		20%-40%	13%	21%	21%					13%	13%	20%
		40%-60%	20%	16%	11%					20%	20%	20%
		60%-80%	27%	26%	32%					27%	27%	20%
		80%-100%	40%	37%	37%					40%	40%	20%
	Children (<16)			17%	17%	17%		17%			17%	18%
	Young People					10%					10%	12%
	Older People (>70)			13%		13%		13%			13%	12%
	Disabled							17%			17%	18%
	Black Minority Ethnic											
	No Car Households							16%			15%	26%
	Indicator Population in the impact area		51k	32k	33k	51k		46k		51k	51k	55m
Amenities present within the impact area	Schools/Nurseries			✓	✓	✓	✓	✓	✓	✓	-	-
	Playgrounds			✓	✓	✓	✓	✓	✓	✓	-	-
	Parks and open spaces			✓	✓	✓	✓	✓	✓	✓	-	-
	Hospitals			✓	✓	✓	✓	✓	✓	✓	-	-
	Care homes/day centres			✓	✓	✓	✓	✓	✓	✓	-	-
	Community centre			✓	✓	✓	✓	✓	✓	✓	-	-

11.4 Distributional Impacts of User Benefits

11.4.1 The monetary transport user benefits of the NEMMDR are calculated using the Department for Transport’s TUBA software version 1.19.17 Released in December 2021. This is consistent with the November 2021 TAG Data book used to derive the economic parameters for the SATURN traffic model and variable demand model. User benefits are examined by income distribution (Table 11.1).

11.4.2 For distributional impact assessment, only the benefits resulting from non-business journeys were considered, to limit the appraisal to benefits experienced by individuals rather than businesses. The non-business trips in LLITM are segmented by income using the three income bands defined in Table 11.4.

11.4.3 The impacted area of the NEMMDR was assumed to be Melton Borough where most of the changes in flows due to the scheme are forecast by the traffic model. This is similar to the AoI for accidents shown in Figure 4-1.

11.4.4 The model base year (2014) population distribution by income (based on the 2011 Census) is illustrated in Figure 11-1.

11.4.5 Development populations modelled as development zones in LLITM are assumed to be split evenly between high-, medium- and low-income segments by the variable demand model. This applies to the zones relating the Melton Mowbray sustainable neighbourhoods which generate around a quarter of user benefits. Although the actual make-up of the development population is unknown, alternative assumptions could be made, based on the observed population. A sensitivity test is included to test the effect of this assumption.

11.4.6 The user benefits calculated by TUBA are filtered to only include trips which have an origin and / or destination inside Melton Borough. Benefits are related to the home end of trips by assigning AM benefits to origin zones, PM benefits to destination zones and splitting benefits from all other periods equally between origin and destination zones. The assessment includes the user benefits relating to changes in time and fuel / non-fuel operating costs. Benefits relating to changes in indirect taxation and greenhouse gases are excluded from this analysis.

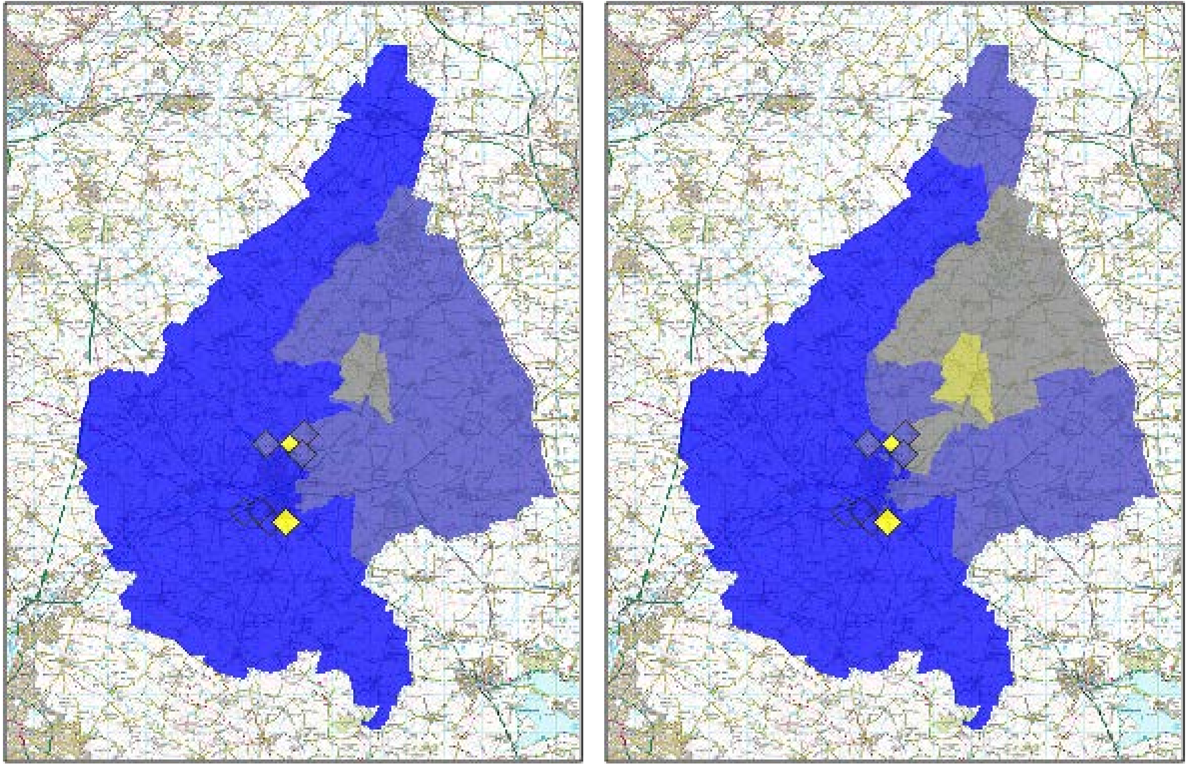
11.4.7 Table 11.7 contains the user benefits results which indicate a large beneficial impact for the low income group, a slight beneficial impact for the medium income group and a moderate beneficial impact for the high income group in Melton Borough.

Table 11.7: Distributional Impacts of User Benefits (£m)

	Income Bands			
	Low	**Middle**	**High**	**Total**
Net benefits	10.8	13.4	15.0	39.2
Net disbenefits	-	-	-	-
Gross benefits	10.8	13.4	15.0	39.2
Gross disbenefits	-	-	-	-
Share of benefits	28%	34%	38%	
Share of disbenefits	-	-	-	-
Share of population in income band	23%	42%	35%	
Assessment	✓✓✓	✓	✓✓	

11.4.8 Figure 11-6 shows the distribution of user benefits for each income band and total user benefits in Melton Borough, with development zones representing the Southern and Northern Sustainable Neighbourhoods (SSN, NSN) shown as diamonds. All zones have beneficial impacts. All income bands show a similar distribution of user benefits with the area to the east of Melton Mowbray, the NSN and the easternmost SSN having higher levels of user benefits. These are the areas closest to the NEMMDR and are likely to have trips that use sections of the NEMMDR.

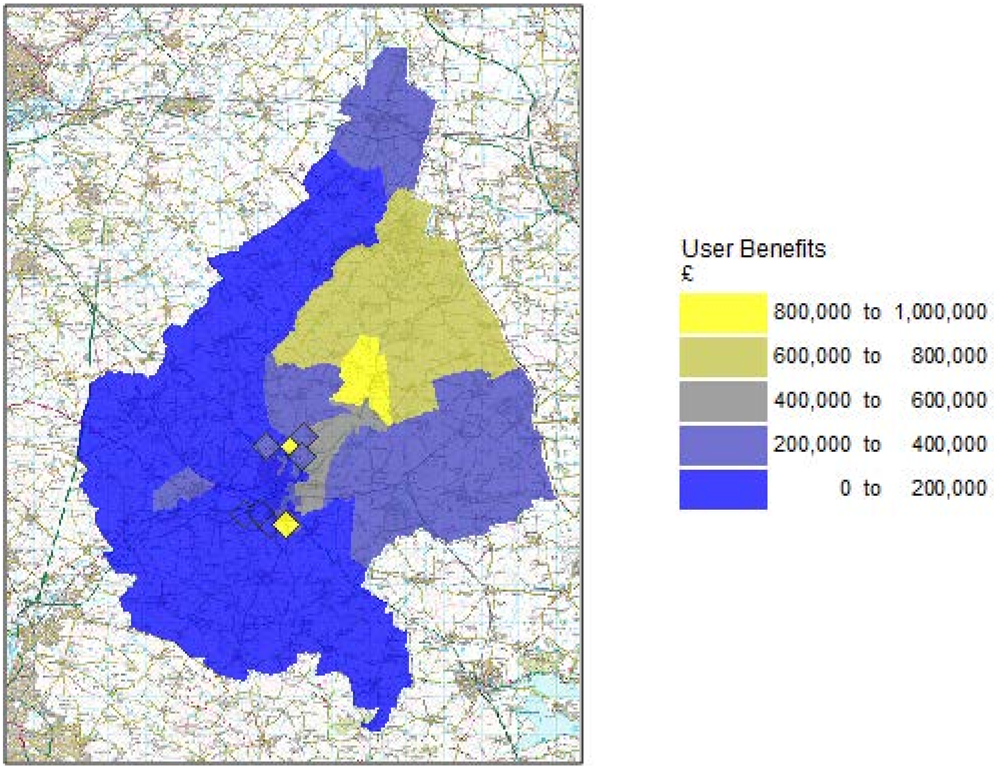
Figure 11-6: User Benefits Distribution by Zone



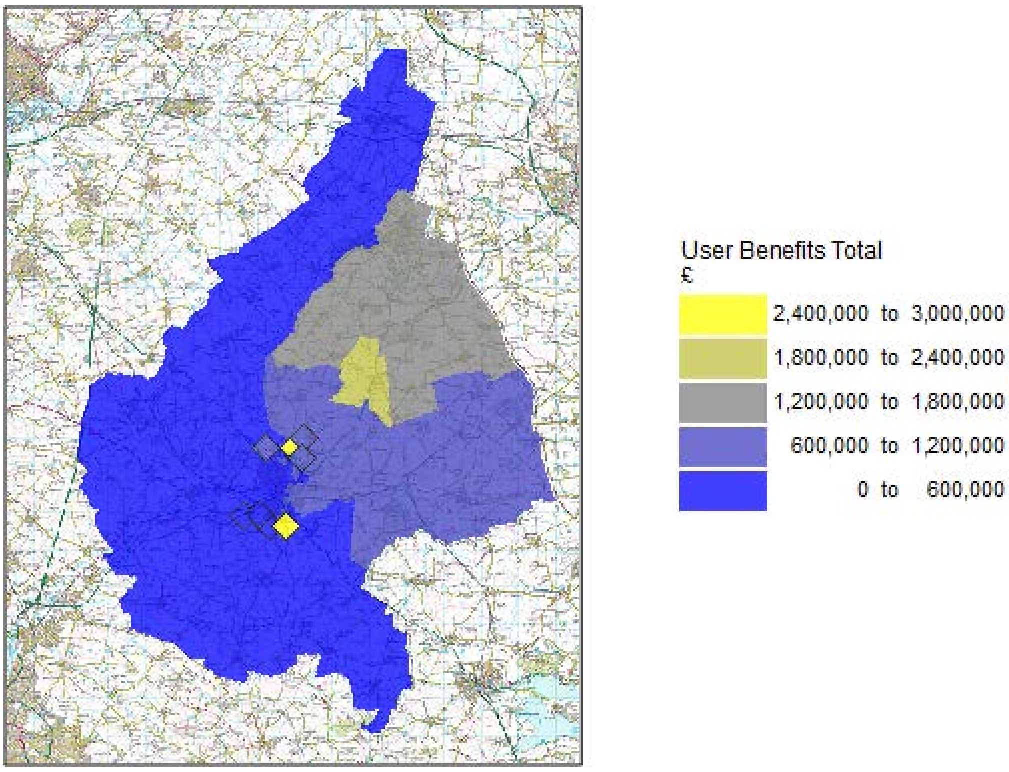
Low-Income Households

Middle-Income Households

High-Income Households



All Income Groups Combined



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11.4.9 A sensitivity test was undertaken to test whether the appraisal was sensitive to the assumptions made around the development zone population (Paragraph 11.4.5). The development zones as modelled have an even low-middle-high-income split, which is different from the observed population distribution (Melton Mowbray zones: 24%, 45%, 30%, low-middle-high). These zones contribute significant user benefits to the overall result. With the Melton Mowbray population distribution used in the development zones the estimated distribution of benefits is slightly more in-line with the population as shown in Table 11.8, but a significant (6.1%, where 5% is the cut-off for significance) lower level of beneficial impact for the middle-income group remains.

Table 11.8: User Benefits (£m) Sensitivity Test

	Income Bands			
	Low	Middle	High	Total
Net benefits	10.0	14.5	14.7	39.2
Net disbenefits	-	-	-	-
Gross benefits	10.0	14.5	14.7	39.2
Gross disbenefits	-	-	-	-
Share of benefits	25%	37%	38%	
Share of disbenefits	-	-	-	-
Share of population in income band	23%	43%	34%	
Assessment	✓✓	✓	✓✓	

11.4.10 The sensitivity test presented in Table 11.8 shows that the assessment is sensitive to the development zone population income split that is assumed. Given that the income data allows substitution of a non-arbitrary distribution based on a large sample (62 zones, ~27,000 population) and the resulting assessment is more conservative, we have more confidence in the sensitivity test result so that will be used in the AST entry.

11.5 Distributional Impacts of Noise

11.5.1 As set out in the Appraisal Specification Report, the local noise assessment set out in this document relies on the analysis carried out for the OBC (which is aligned with TAG Unit A3 advice) as it was agreed to be disproportionate to carry out further analysis given their limited impact on the value for money case. The distributional impacts assessment discussed below therefore draws on the OBC forecasts.

1.1 Noise is appraised for children and older people as they are most sensitive to noise, affecting their health. It is also known that people with a lower income are less able to afford mitigation against noise (strategic location, performant insulation and double glazing) and may experience noise disbenefits as a result while not receiving user benefits due to lower car ownership. Noise is also appraised against income distribution.

1.2 The assessment of noise is based on the OBC forecasting which generally had a higher level of traffic through higher growth assumptions and is considered a worse-case scenario compared with the current FBC traffic model.

1.3 The modelling and appraisal of noise impacts, including deriving the impacted area, are detailed in Section 7.

1.4 A total of 8,312 affected residential buildings were identified. The buildings and the resulting impact area are shown in Figure 7-1. The distributional impacts appraisal uses both daytime ($L_{Aeq,16\ hour}$, façade) and night-time traffic noise levels ($L_{Aeq,8\ hour}$, free-field).

1.5 The analysis is undertaken on the modelled future year as discussed in TAG Unit A4.2. The year used was the design year, 15 years after opening, which, for the OBC model used for this noise assessment, was 2036.

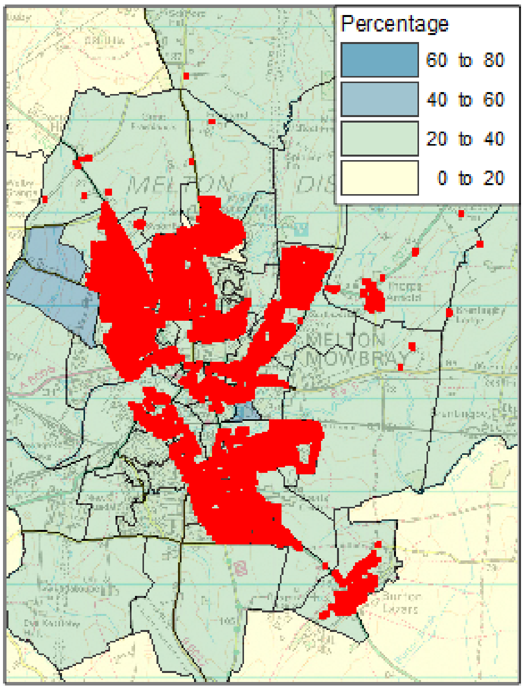
Noise Distributional Impacts by Income Distribution

11.5.2 The noise appraisal area includes most of Melton Mowbray and the rural areas of Burton Lazars and Thorpe Arnold. Most of the households are in Melton Mowbray which has a consistent 24%, 45% 30% (low, middle, high) income distribution.

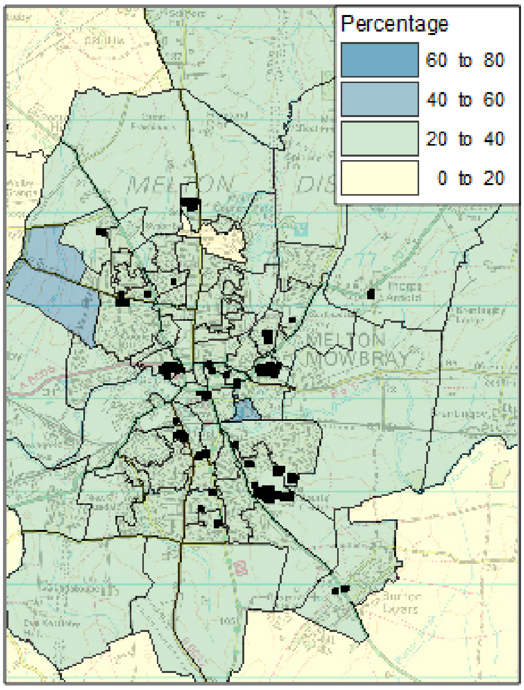
11.5.3 The income group data and the residential and non-residential receptors (locations where people tend to congregate away from the home) that were identified in the noise assessment are shown with the low- medium- and high-income household percentages in Figure 11-7. The non-residential receptors will also be represented in the amenities shown in Figure 11-5 (note that the data in Figure 11-5 are more recent that the assessment).

Figure 11-7: Noise Modelling Receptors and Income Distribution

Residential Receptors & Percentage of Low-Income Households



Amenities & Percentage of Low-Income Households



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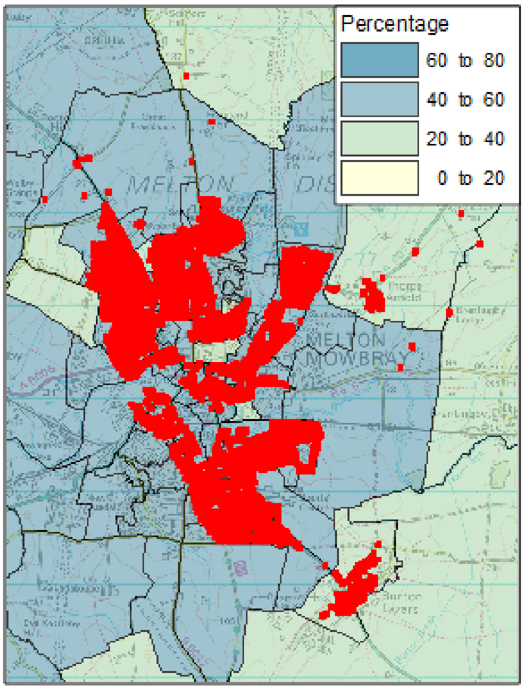
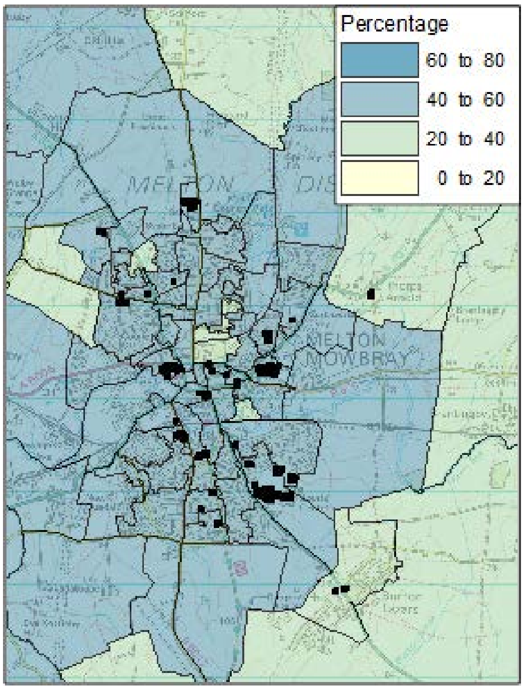
Residential Receptors & Percentage of Medium-Income Households



Amenities & Percentage of Medium-Income Households



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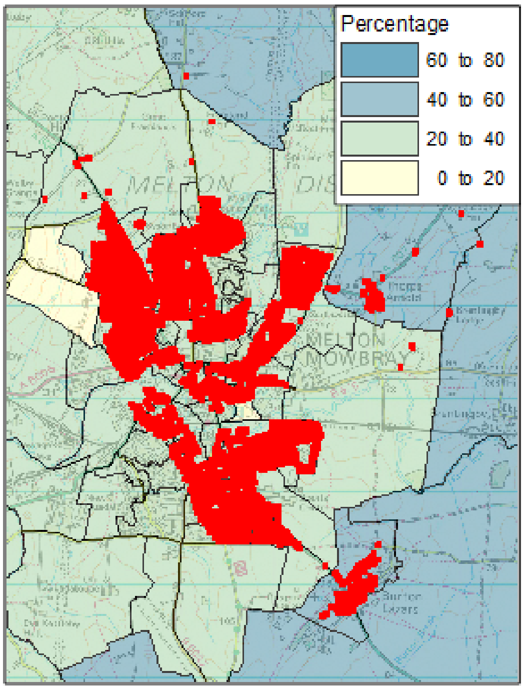
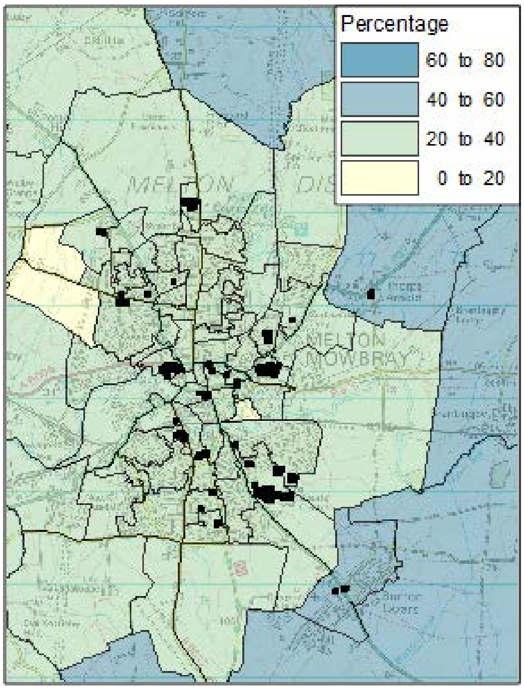
Residential Receptors & Percentage of High-Income Households



Amenities & Percentage of High-Income Households



11.5.4 Traffic noise data from the main noise appraisal were provided for this analysis for residential buildings for the Core and NEMMDR scenarios for the scheme design year (2036). The model zone containing each household location was identified.

11.5.5 The number of households in each model zone that would experience less noise (a reduction in traffic), no change (similar traffic), or more noise (an increase in traffic) were then counted. These were then split between income groups using the proportions from the land-use model for each zone.

11.5.6 So that the distributional impacts assessment is consistent with the noise modelling result in Section 7, a change in noise is defined in the same way, as a change in the 3db TAG noise bands defined in the TAG Noise workbook. It is noted that changes in noise less than 3db, but falling within a noise band, may not change the assessment of a receptor, whereas small changes in noise close to the limits of a noise band may change the assessment of a receptor.

11.5.7 Table 11.9 shows the forecast daytime noise impact and Table 11.10 shows the corresponding forecast night-time noise impacts.

11.5.8 The forecast has a change in daytime noise for 18% of people in the impacted area. 11% of people experience a decrease in noise and 7% of people experience an increase in noise. The impacts are beneficial and the proportion of impacts are in-line with the proportion of the income groups in the population.

11.5.9 The night-time forecast has a change in night-time noise for 5% of people. Almost all of the 5% experiencing a change in noise experience a decrease in noise and <1% of people experience an increase in noise. The impacts are beneficial and the proportion of impacts are in-line with the proportion of the income groups in the population.

11.5.10 The assessed impact is moderately beneficial for all income groups. None of the income groups are disproportionately affected by the scheme.

Table 11.9: Distributional Impacts of Daytime Noise on Households by Income Band

	Income Group			
	Low	Middle	High	Total
Population with an increase in noise	391	745	541	1,677
Population with a decrease in noise	616	1,104	785	2,505
Population with no change in noise	4,552	8,316	5,807	18,675
Net winners/losers	225	359	244	828
Percentage of winners/losers in the affected population	27%	43%	29%	
Percentage of the affected population	24%	44%	31%	
Assessment	✓✓	✓✓	✓✓	

Table 11.10: Distributional Impacts of Night-time Noise on Households by Income Band

	Income Group			
	Low	Middle	High	Total
Population with an increase in noise	16	28	22	66
Population with a decrease in noise	290	518	367	1,174
Population with no change in noise	5,254	9,620	6,744	21,617
Net winners/losers	274	490	345	1,108
Percentage of winners/losers in the affected population	25%	44%	31%	
Percentage of the affected population	24%	44%	31%	
Assessment	✓✓	✓✓	✓✓	

Noise Impacts on Vulnerable Groups

11.5.11 The groups that are vulnerable to noise impacts on their health are children and older people.

11.5.12 Population data from the 2011 Census were collated for the impacted area by Census Lower Super Output Area (LSOA). The population in each LSOA was split into 3 groups – children (under 16), working-age adults and older people (over 69).

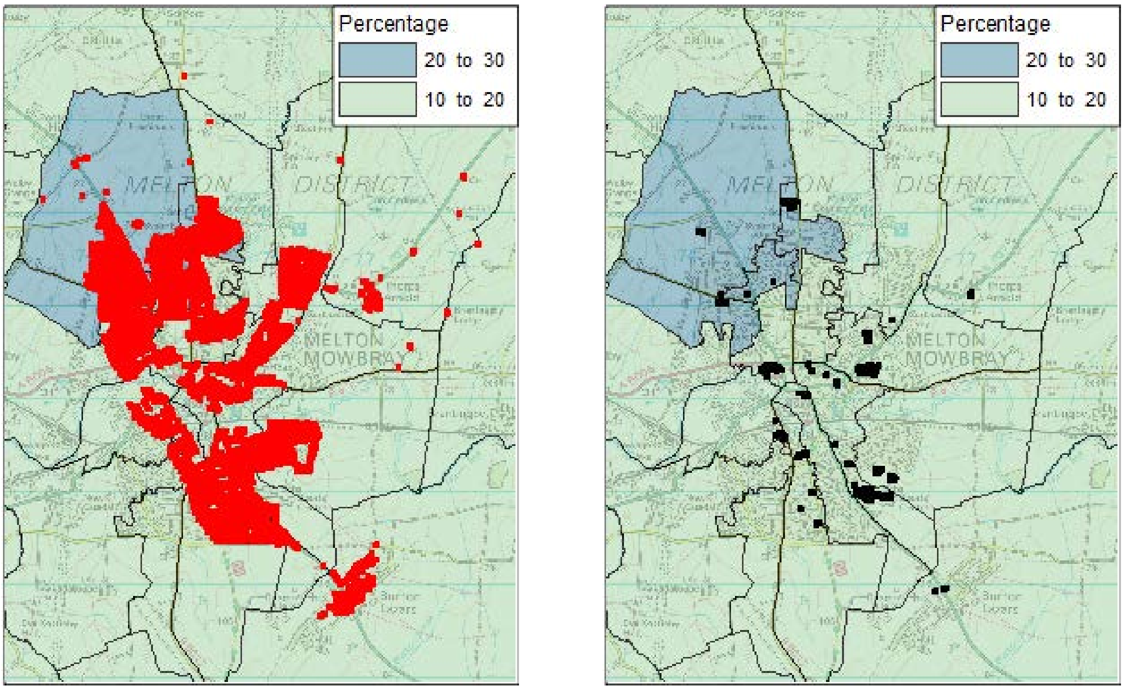
11.5.13 The proportion of each vulnerable group and the receptors used for modelling noise are shown in Figure 11-8. Apart from an area in the northwest of Melton Mowbray where it is slightly higher, the proportion of children where there are residential receptors is between 10% and 20%. Most residential receptors are in areas where there are between 10% and 20% of older people.

11.5.14 The 19 impacted LSOAs have a similar, predominantly working age (70%) population with smaller proportions of children (17%) and older people (13%).

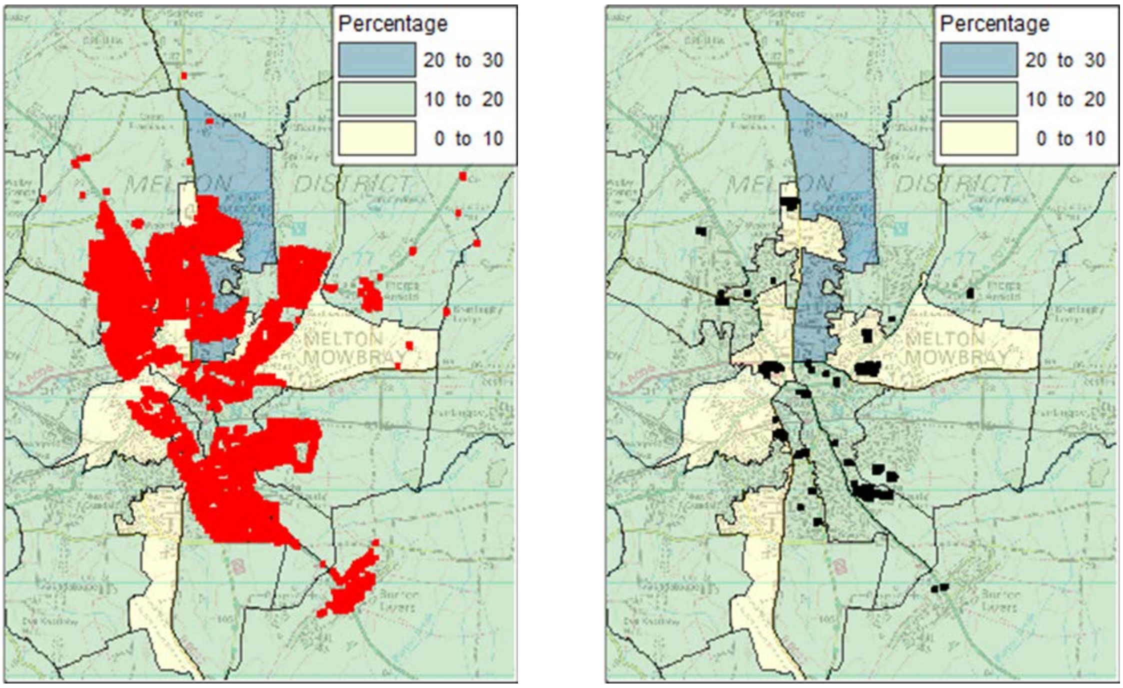
Figure 11-8: Noise Modelling Receptors and Vulnerable Groups

Residential Receptors | **Non-Residential Receptors**

Under 16s



Older People



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11.5.15 Traffic noise data were provided for this analysis for residential buildings for the Core and NEMMDR scenarios for the scheme design year (2036). The LSOA containing each household location was identified.

11.5.16 The number of households in each LSOA that would experience less noise (a reduction in traffic), no change (similar traffic) or more noise (an increase in traffic) were then counted. Impacted population was calculated by assuming 2.75 people per household and the population group proportions from 2011 Census in each LSOA.

11.5.17 The forecast shown in Table 11.11 has a change in daytime noise for 18% of children. 10% of children experience a decrease in noise and 7% experience an increase in noise. The impacts are beneficial and the proportion of impacts are in-line with the proportion of children in the population.

11.5.18 The forecast shown in Table 11.12 has a change in night-time noise for 5% of children. Almost 5% of children experience a decrease in noise and <1% experience an increase in noise. The impacts are beneficial and the proportion of impacts are in-line with the proportion of children in the population.

11.5.19 The forecast has a change in daytime noise for 20% of older people. 12% of older people experience a decrease in noise and 8% experience an increase in noise. The proportion of impacts are in-line with the proportion of older people in the population.

11.5.20 The forecast has a change in night-time noise for 6% of older people. Almost 6% of older people experience a decrease in noise and <1% experience an increase in noise. The proportion of impacts are in-line with the proportion of older people in the population.

11.5.21 The assessed impacts for both vulnerable groups are moderately beneficial. Neither vulnerable group is disproportionately affected.

Table 11.11: Distributional Impacts of Daytime Noise by Population Group

	Population Group			
	Children	**Working**	**Older**	**Total**
Population with an increase in noise	267	1,191	220	1,678
Population with a decrease in noise	395	1,746	364	2,505
Population with no change in noise	3,267	13,029	2,379	18,675
Net winners/losers	129	555	144	828
Percentage of winners/losers in the affected population	16%	67%	17%	
Percentage of the affected population	17%	70%	13%	
Assessment	✓✓	**n/a**	✓✓	

Table 11.12: Distributional Impacts of Night-time Noise by Population Group

	Population Group			
	Children	**Working**	**Older**	**Total**
Population with an increase in noise	10	44	12	66
Population with a decrease in noise	179	815	181	1,174
Population with no change in noise	3,740	15,107	2,770	21,618
Net winners/losers	169	770	169	1,108
Percentage of winners/losers in the affected population	15%	70%	15%	
Percentage of the affected population	17%	70%	13%	
Assessment	✓✓	**n/a**	✓✓	

Noise Impacts on Non-Residential Sensitive Receptors

11.5.22 These are specific locations where people, including those identified as belonging to vulnerable groups for noise, congregate during the daytime and could experience changes in noise due to the scheme. These are shown in Figure 11-7 and Figure 11-8.

11.5.23 At the non-residential sensitive receptors listed in Table 11.13 to Table 11.16, noise impacts in the design year are forecast to be negligible (i.e. less than 3dB change), and the in the majority of cases (33 out of 42) the forecast impact is a decrease in noise levels. As no locations and associated vulnerable group are impacted, the impact at non-residential sensitive receptors is neutral.

Table 11.13: Distribution of Noise Impacts on Non-residential Sensitive Receptors (Schools / Nurseries)

Description	2021				2036			
	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact
Birch Wood School, Melton Mowbray	45.2	46.9	1.7	Negligible	45.3	47.6	2.3	Negligible
Brooksby Melton College/Theatre	68.6	68.1	-0.5	Negligible	68.7	68.5	-0.2	Negligible
Brownlow Primary School, Melton Mowbray	45.5	45.6	0.1	Negligible	45.7	46.0	0.3	Negligible
Early Years Nursery Ltd, Melton Mowbray	70.8	69.8	-1.0	Negligible	70.7	70.2	-0.5	Negligible
John Ferneley College, Melton Mowbray	63.4	62.2	-1.2	Negligible	62.6	63.6	1.0	Negligible
King Edward VII School/Melton Post 16 Centre	61.2	59.7	-1.5	Negligible	61.1	59.7	-1.4	Negligible
Little Rascals Day Nursery, Melton Mowbray	59.3	59.2	-0.1	Negligible	60.9	60.2	-0.7	Negligible
Melton Learning Hub	61.2	59.7	-1.5	Negligible	61.4	60.0	-1.4	Negligible
Melton Mowbray College	57.3	56.6	-0.7	Negligible	58.0	57.5	-0.5	Negligible
Melton Nursery School	63.2	62.9	-0.3	Negligible	63.5	63.4	-0.1	Negligible
Riverside Day Nursery, Melton Mowbray	57.8	57.3	-0.5	Negligible	57.9	57.8	-0.1	Negligible
Sherrard School & Community Centre, Melton	49.3	49.5	0.2	Negligible	49.4	49.9	0.5	Negligible
St Francis Roman Catholic Primary School	66.8	66.5	-0.3	Negligible	67.1	67.0	-0.1	Negligible
St Marys Church of England Primary School	49.4	49.6	0.2	Negligible	49.9	50.1	0.2	Negligible
The Beverley Robinson School, Melton Mowbray	72.8	71.9	-0.9	Negligible	72.7	72.2	-0.5	Negligible
The Cove Children Centre	53.2	53.1	-0.1	Negligible	53.7	53.5	-0.2	Negligible
The Grove Primary School, Melton Mowbray	54.6	54.2	-0.4	Negligible	54.8	54.7	-0.1	Negligible

Table 11.14: Distribution of Noise Impacts on Non-residential Sensitive Receptors (Hospitals)

Description	2021				2036			
	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact
Burton Park Hospital, Warwick Lodge Bungalow	59.6	59.2	-0.4	Negligible	60.1	59.8	-0.3	Negligible
St Marys Hospital, Melton Mowbray	64.5	62.5	-2.0	Negligible	64.0	62.7	-1.3	Negligible

Table 11.15: Distribution of Noise Impacts on Non-residential Sensitive Receptors (Places of Worship)

Description	2021				2036			
	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact
Kingdom Hall, Melton Mowbray	44.3	44.2	-0.1	Negligible	45.0	44.9	-0.1	Negligible
Melton Mowbray United Reformed Church, Melton	67.4	66.7	-0.7	Negligible	68.1	67.7	-0.4	Negligible
Methodist Church, Melton Mowbray	54.6	54.4	-0.2	Negligible	55.3	54.8	-0.5	Negligible
Polish Church	55.1	55.3	0.2	Negligible	55.7	55.8	0.1	Negligible
Cemetery Chapel, Melton Mowbray	55.4	53.7	-1.7	Negligible	55.5	54.1	-1.4	Negligible
Roman Catholic Church, Melton Mowbray	55.6	55.6	0	Negligible	56.9	56.4	-0.5	Negligible
Sage Cross Methodist Church Melton Mowbray	68.3	67.6	-0.7	Negligible	69.1	68.7	-0.4	Negligible
St James Church, Burton Lazars	68.8	69.2	0.4	Negligible	69.3	69.7	0.4	Negligible
St John The Baptist Church	67.5	66.5	-1.0	Negligible	66.4	65.2	-1.2	Negligible
St Marys Church, Melton Mowbray	70.1	69.0	-1.1	Negligible	70.5	69.7	-0.8	Negligible
St Marys Church, Thorpe Arnold	62.8	60.3	-2.5	Negligible	63.3	60.6	-2.7	Negligible
Welby Lane Mission Church	56.9	56.8	-0.1	Negligible	58.5	57.9	-0.6	Negligible

Table 11.16: Distribution of Noise Impacts on Non-residential Sensitive Receptors (Community Centres)

Description	2021				2036			
	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact	Core (dB)	Scheme (dB)	Difference (dB)	Magnitude of impact
Fairmead Community Centre	47.5	46.9	-0.6	Negligible	47.7	47.4	-0.3	Negligible
Freemasons Hall, Melton Mowbray	58.3	57.0	-1.3	Negligible	58.3	57.0	-1.3	Negligible
Melton Carnegie Museum, Melton Mowbray	66.0	65.0	-1.0	Negligible	64.9	63.8	-1.1	Negligible
Melton Mowbray Library	71.3	70.9	-0.4	Negligible	71.4	71.1	-0.3	Negligible
Penman Spicer Community Hall, Melton Mowbray	51.2	50.9	-0.3	Negligible	51.3	51.2	-0.1	Negligible
Polish Club	54.4	54.6	0.2	Negligible	54.8	55.0	0.2	Negligible
Scout Group Headquarters, Melton Mowbray	53.6	53.2	-0.4	Negligible	53.6	53.5	-0.1	Negligible
Springfield Street Community Centre, Melton	46.2	45.6	-0.6	Negligible	46.6	46.3	-0.3	Negligible
Venture House Youth Centre, Melton Mowbray	63.8	63.3	-0.5	Negligible	63.9	63.8	-0.1	Negligible
Village Hall, Burton Lazars	60.0	60.5	0.5	Negligible	60.6	61.1	0.5	Negligible
Village Hall, Thorpe Arnold	70.9	68.2	-2.7	Negligible	71.3	68.4	-2.9	Negligible

11.6 Distributional Impacts of Air Quality

11.6.1 As set out in the Appraisal Specification Report, the air quality assessment set out in this document relies on the analysis carried out for the OBC (which is aligned with TAG Unit A3 advice) as it was agreed to be disproportionate to carry out further analysis given their limited impact on the value for money case. The distributional impacts assessment discussed below therefore draws on the OBC forecasts.

11.6.2 Children are considered more at risk from air pollution given that they may tend to spend more time outside and can therefore have the longest exposure. Appraisal of impacts on children and against income distribution are included (Table 11.1).

11.6.3 Although the centre of Melton Mowbray has had an Air Quality Management Area (AQMA) in the past (revoked 2005)[7] there are no current AQMAs in Melton Borough. Up to 2019, the monitoring location at the junction of Leicester Street and Wilton Road, at the convergence of the A606 and A607, had an increasing trend of average NO_2 concentrations ($34.5 \mu g/m^3$). Although this trend may have been interrupted by the COVID-19 19 pandemic, Melton Borough Council does not expect an improvement here until an intervention is made to add capacity or reduce traffic.

11.6.4 The distributional analysis of the air quality impacts was carried out using an assessment of NO_2 and PM_{10} concentrations that were modelled in 2017 for the OBC. Because modelled traffic levels were higher in the OBC model than the FBC model, this is considered as a worst-case.

11.6.5 The main change in the 2020 update of TAG Unit A4.2 was to align the distributional impacts appraisal with current practise of considering $PM_{2.5}$ rather than PM_{10} as required by the 2015 version used for the OBC. The November 2021 TAG Data book table A3.2.4 gives a conversion factor of 0.635 to convert PM_{10} concentration to $PM_{2.5}$ concentration for road transport. Since this is a linear conversion above 0.5, the result using the PM_{10} modelling will be the same as the result for $PM_{2.5}$ at the level of precision being used.

11.6.6 The affected road network links are those that see a change in traffic flows because of the scheme. In total around 6,130 affected residential receptors were identified in the air quality modelling.

11.6.7 The income data from the LLITM land-use model were used for the assessment by income group. Figure 11-9 shows the relationship between the air quality receptors and the distribution of the income groups. As the air quality model extends into the rural areas beyond Melton Mowbray along the A606 and A607 where the distribution of income groups is dissimilar to Melton Mowbray (20%,39%,41% low-medium high versus 24% 45% 30% in Melton Mowbray), some variation in impact could be expected depending on where changes in air quality occur.

11.6.8 The 2011 Census was used to derive the proportion of children in the population and this was used for the assessment by population group. Figure 11-10 shows the relationship between the air quality receptors and the proportion of children in the population. There is little variation across the impact area and the impact should be in-line with the population proportions.

11.6.9 The air quality appraisal uses the design year from the OBC (2036) modelling for which forecast data was supplied at an accuracy of $0.1 \mu g/m^3$.

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[7] https://www.melton.gov.uk/media/hzgno5zm/air-quality-annual-status-report-asr-2020.docx

Figure 11-9: Percentage of Households by Income Band and Air Quality Receptor Locations

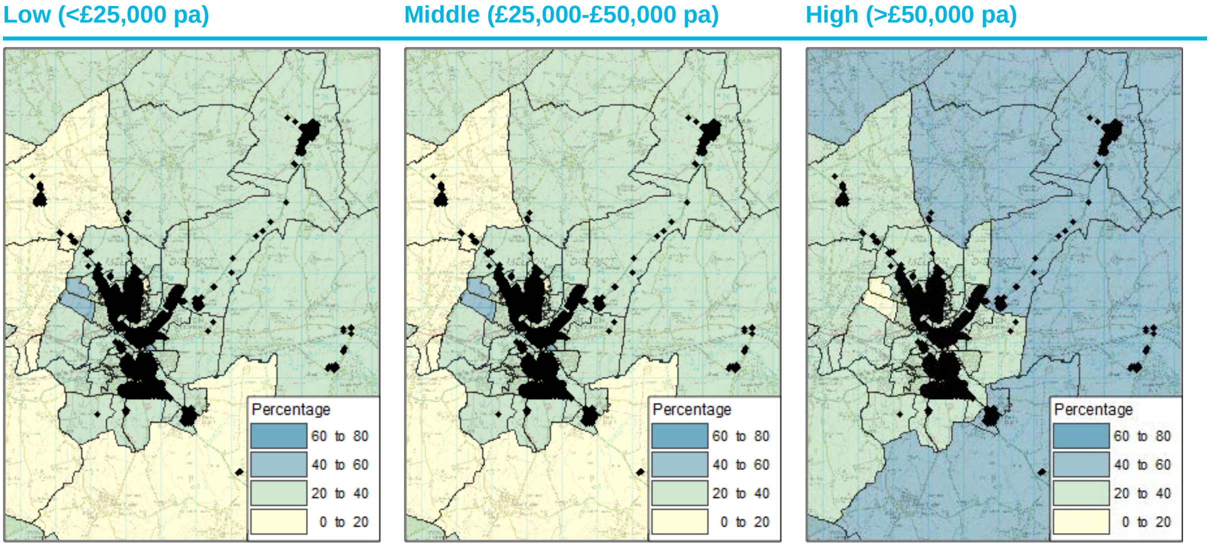
Low (<£25,000 pa) Middle (£25,000-£50,000 pa) High (>£50,000 pa)

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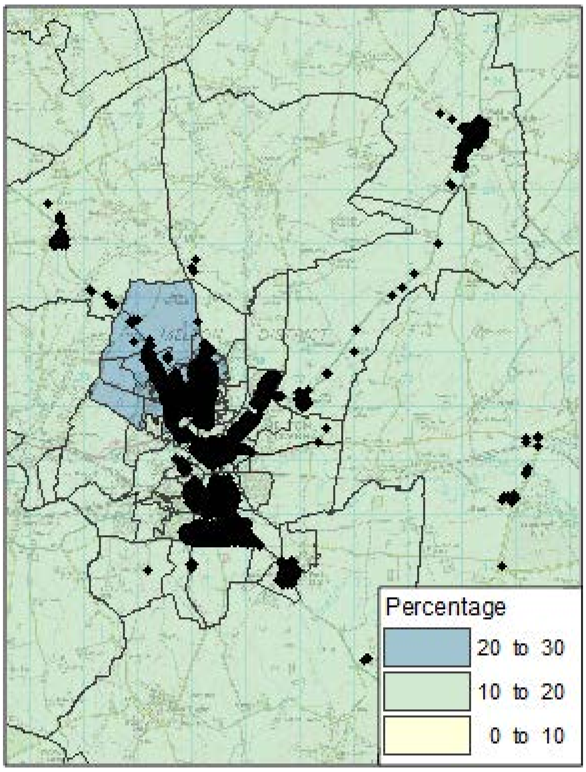
Figure 11-10: Percentage of Children in the Population and Air Quality Receptor Locations



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PM_{10} Impacts by Income Group

11.6.10 Figure 11-11 shows the location of the forecast changes in PM_{10}. Within Melton Mowbray the main radial routes that link into the NEMMDR have decreases in concentration and the surrounding residential areas have no change in PM_{10}. Outside the NEMMDR the radial routes from Melton Mowbray have increases along the road and no change in the surrounding residential areas. This pattern is linked to a decrease in traffic within Melton Mowbray and an increase in through-traffic induced by the scheme.

11.6.11 Table 11.17 shows the PM_{10} impacts in each of the three income bands. The slightly lower share of benefits experienced by the high-income households is related to the larger percentage of high-income households outside Melton Mowbray (Figure 11-9), where increases in concentration are forecast. In contrast the slightly higher share of benefits experienced by the low- and middle-income groups are related to their relatively high percentages in Melton Mowbray where decreases in concentration are forecast.

11.6.12 The differences between the share of benefit and proportions of each income group in the population are however <5% and broadly in-line with the population. The assessment for PM_{10} is therefore moderately beneficial for all income groups.

Figure 11-11: Forecast PM_{10} Changes

Red = Increase **Blue = Decrease** Grey = No Change

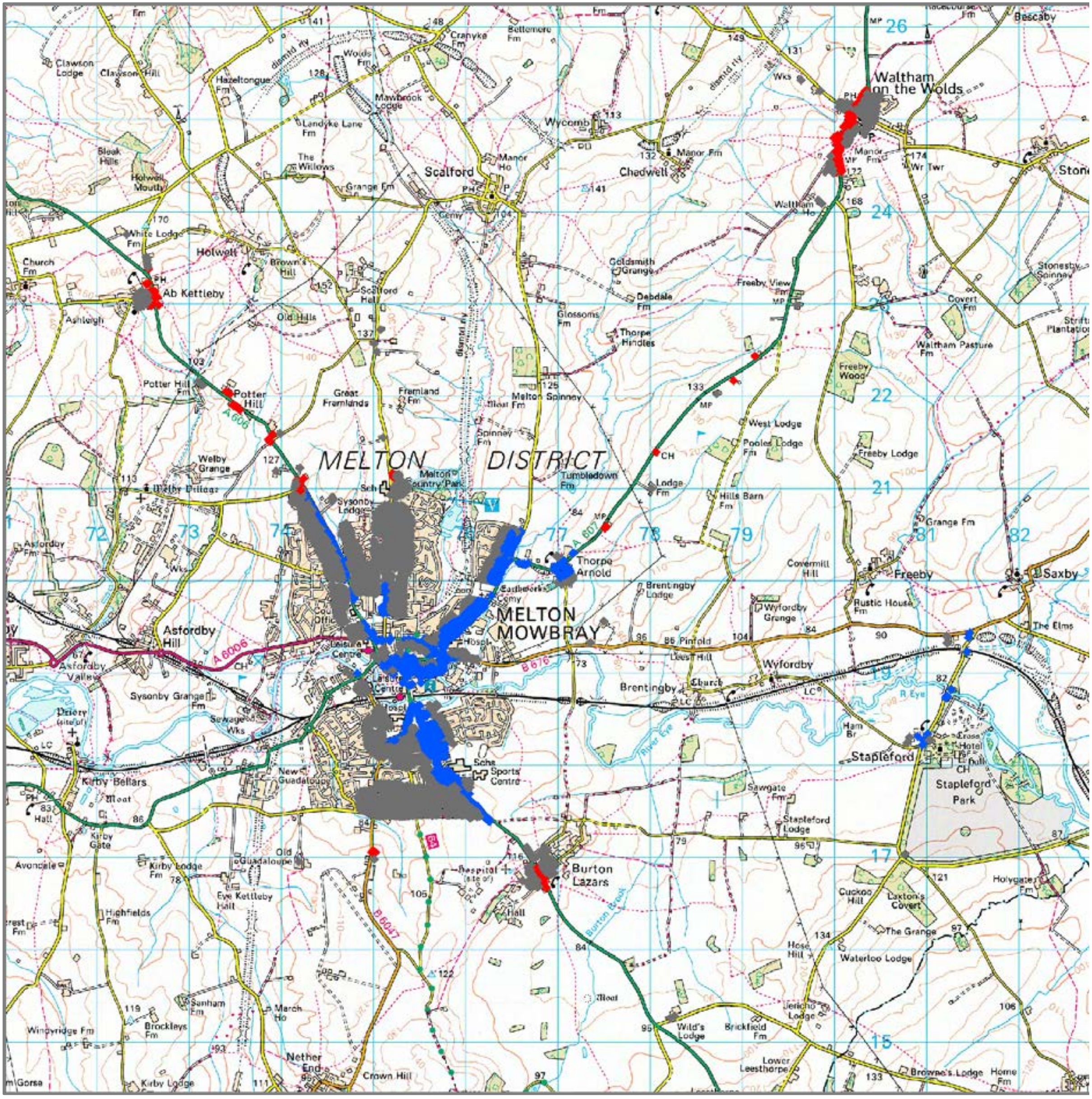

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Table 11.17: Distributional Impacts of PM_{10} on Households by Income Band

	Income Group			
	Low	Medium	High	Total
Households with increased PM_{10}	71	133	142	347
Households with decreased PM_{10}	357	632	466	1,455
Households with no change in PM_{10}	1,033	1,897	1,398	4,328
Net number of 'winners'	286	499	323	1,108
Proportion of net 'winners' by category	26%	45%	29%	
Share of population in income band	24%	43%	33%	
Assessment	✓✓	✓✓	✓✓	

NO_2 Impacts by Income Group

11.6.13 Figure 11-12 shows the location of the forecast changes in NO_2. Within Melton Mowbray the main radial routes that link into the NEMMDR have decreases in concentration and the surrounding residential areas mostly have no change in NO_2. Outside the NEMMDR the radial routes from Melton Mowbray have increases along the road and no change in the surrounding residential areas. This pattern is linked to a decrease in traffic within Melton Mowbray and an increase in through-traffic induced by the scheme.

11.6.14 Table 11.18 shows the NO_2 impacts in each of the three income bands. The slightly lower share of benefits experienced by the high-income households is, like PM_{10}, related to the larger percentage of high-income households outside Melton Mowbray, where the increases in concentration are forecast. In contrast the slightly higher share of benefits experienced by the low- and middle-income groups are related to their relatively high percentages in Melton Mowbray where decreases in concentration are forecast.

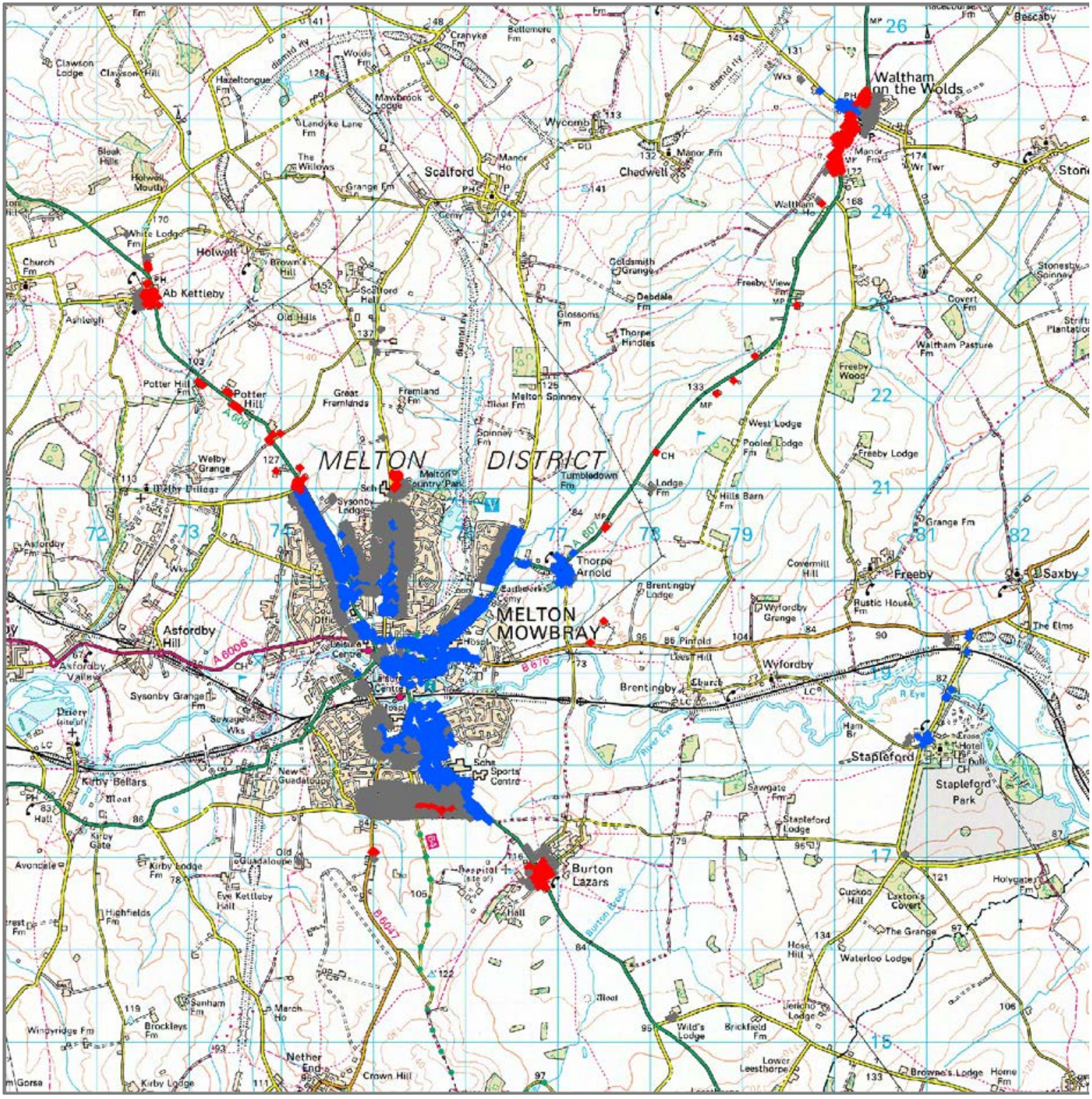
11.6.15 The differences between the share of benefit and proportions of each income group in the population are however <5% and broadly in-line with the population. The assessment is therefore moderately beneficial for all income groups.

Table 11.18: Distributional Impacts of NO_2 on Households by Income Band

	Income Band			
	Low	Medium	High	Total
Households with increased PM_{10}	127	235	235	597
Households with decreased PM_{10}	653	1,165	855	2,673
Households with no change in PM_{10}	682	1,263	915	2,860
Net number of 'winners'	526	930	620	2,076
Proportion of net 'winners' by category	25%	45%	30%	
Share of population in income band	24%	43%	33%	
Assessment	✓✓	✓✓	✓✓	

Figure 11-12: Forecast NO_2 Changes

Red = Increase **Blue = Decrease** **Grey = No Change**



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PM_{10} Impacts on Children

11.6.16 Figure 11-10 shows the percentage of children in the population and air quality receptor locations. There is only a small variation in the proportion of children in the population in the impact area so the proportion of net benefits should be close to the proportion of children in the population.

11.6.17 Table 11.19 shows that the scheme is beneficial and that the proportion of net benefits to children are in-line with the proportion of children in the population.

Table 11.19: Distributional Impacts of PM_{10} on Children

	Population Groups		
	Children	Adults	All
Population with PM_{10} increase	147	807	954
Population with PM_{10} decrease	608	3,393	401
Population with no change in PM_{10}	2,025	9,877	11,902
Net number of 'winners'	461	2,586	3,047
Proportion of net 'winners' by category	15%	85%	
Share of population in each group	16%	84%	
Assessment	✓✓	**n/a**	

NO_2 Impacts on Children

11.6.18 Table 11.20 shows that the scheme is beneficial and that the proportion of net benefits to children are in-line with the proportion of children in the population. The assessment is moderately beneficial.

Table 11.20: Distributional Impacts of NO_2 on Children

	Population Groups		
	Children	Adults	All
Population with NO_2 increase	254	1,388	1,642
Population with NO_2 decrease	1,162	6,188	7,351
Population with no change in NO_2	1,364	6,501	7,865
Net number of 'winners'	908	4,801	5,709
Proportion of net 'winners' by category	16%	84%	
Share of population in each group	16%	84%	
Assessment	✓✓	**n/a**	

Air Quality Impacts on Non-Residential Sensitive Receptors

11.6.19 A small number of non-residential sensitive receptors were identified as impacted for air quality. The impacts are listed for PM_{10} in Table 11.21 and NO_2 in Table 11.22. In both cases, the changes are small and mostly negligible, so the impact is assessed as neutral.

Table 11.21 Distribution of PM_{10} Impacts on Non-residential Sensitive Receptors

Description	Core PM_{10} (µg/m^3)	Scheme PM_{10} (µg/m^3)	Difference PM_{10} (µg/m^3)	Magnitude of impact
St Marys Church of England Primary School	14.0	14.0	<0.1	Negligible
The Beverley Robinson School	19.5	18.9	-0.6	Beneficial
The Grove CP School	15.5	15.4	-0.1	Negligible
Swallowdale CP School	15.2	15.2	<0.1	Negligible
Early Years Nursery LTD	18.7	18.3	-0.4	Negligible
Brownlow Primary School	16.5	16.4	-0.1	Negligible
Waltham on the Wolds Church of England School	13.5	13.5	0.1	Negligible
St Marys Hospital	17.4	17.0	-0.4	Negligible

Table 11.22: Distribution of NO_2 Impacts on Non-residential Sensitive Receptors

Description	Core NO_2 (µg/m^3)	Scheme NO_2 (µg/m^3)	Difference NO_2 (µg/m^3)	Magnitude of impact
St Marys Church of England Primary School	9.4	9.4	<0.1	Negligible
The Beverley Robinson School	31.4	28.7	-2.7	Beneficial
The Grove CP School	12.8	12.5	-0.3	Negligible
Swallowdale CP School	11.7	11.5	-0.1	Negligible
Early Years Nursery LTD	26.9	24.9	-2.0	Beneficial
Brownlow Primary School	13.9	13.6	-0.3	Negligible
Waltham on the Wolds Church of England School	9.5	9.9	0.4	Negligible
St Marys Hospital	19.7	17.7	-2.0	Beneficial

11.7 Distributional Impacts of Accidents

11.7.1 Most of the transport-related accidents occur on the road network. The vulnerable groups usually subject to above-average casualty rates are children and older people (both particularly as pedestrians). Potentially vulnerable groups are young male drivers, motorcyclists, cyclists and pedestrians. Deprivation is also important to consider as deprived areas typically have high road accident rates.

11.7.2 The impact area for accidents was selected as Melton Borough as this covers the area where the changes in traffic due to the scheme are significant and where CoBA-LT results were available from the main accident assessment (Section 4.4) to estimate the change in accidents.

Vulnerable Groups

11.7.3 Vulnerable social groups in the impact area are identified through analysis of the 2011 Census and STATS19 accident data for 2015-2019. These were used to identify concentrations of home locations and accident locations.

11.7.4 To put the observed accidents in Melton Borough into context, the same STATS19 dataset for 2015 to 2019 was used to generate equivalent statistics for Leicestershire (and Rutland, since Leicestershire Constabulary also polices Rutland) and the UK. In Table 11.23, vulnerable group casualties are expressed as percentages of the total casualties by area.

11.7.5 Apart from cyclist casualties, Table 11.23 shows that Melton Borough has typical Leicestershire and UK vulnerable group casualty statistics. Cyclist casualties are lower than typical.

Table 11.23: Vulnerable Group Casualty Statistics

		Vulnerable Group						
Area	Count	Child Pedestrians	Older Pedestrians	Older Drivers	Pedestrians	Cyclists	Motorcyclists	Young Male Drivers
Melton Borough	594	3%	2%	4%	12%	5%	9%	9%
Leicestershire	11,995	4%	1%	3%	13%	10%	8%	12%
UK	234,950	4%	1%	3%	14%	10%	10%	11%

11.7.6 The percentage of children in the population in Melton Borough is mostly between 10% and 20% as shown in Figure 11-13. Three LSOAs have populations with between 20% and 30% children. Child pedestrian casualties are concentrated in Melton Mowbray where most of the population and amenities such as school, nurseries and healthcare are concentrated, and more journeys are short and on foot.

11.7.7 Figure 11-13 also shows the locations of accidents with child pedestrian casualties in Melton Mowbray. There are no apparent clusters of accidents in the town, but is should be noted that all but two of the 16 accidents are on main roads, on which the scheme is expected to reduce traffic and the number of accidents.

11.7.8 The percentage of older people is mostly less than 20% in LSOAs in Melton Borough. The only exceptions are an LSOA in Bottesford and two LSOAs in Melton Mowbray which have 20% to 30% older people. There are accidents involving older people as casualties across Melton Borough with a slight concentration in Melton Mowbray where amenities and population are concentrated (Figure 11-13).

11.7.9 There are no accidents involving older pedestrian outside central Melton Mowbray. All accidents outside central Melton Mowbray that involve older people involve older drivers.

11.7.10 Within central Melton Mowbray, most accidents with older casualties involve pedestrians. These accidents are shown in Figure 11-13.

11.7.11 In addition to the vulnerable population groups – children and older people – certain road user groups may be more susceptible to accidents than others – pedestrians, cyclists, motorcyclists and young male drivers.

11.7.12 Apart from single casualties in Waltham on the Wolds, Belvoir and Shroby and two casualties in Asfordby Hill, all pedestrian casualties are all associated with accidents within Melton Mowbray. This reflects the lack of pedestrian journeys in the rural areas of Melton Borough. These are shown in Figure 11-14. As with the analysis for children and older people, most casualties are on the main roads or in the centre of Melton Mowbray within the ring road. These roads are areas likely to be affected by reductions in traffic due to the scheme.

11.7.13 Cyclist casualties are shown in Figure 11-14. As previously noted in discussing Table 11.23, there are relatively few cyclist casualties in Melton Borough. There is a slight concentration in Melton Mowbray where likely commuting journeys are shorter and more coercive to using bicycles.

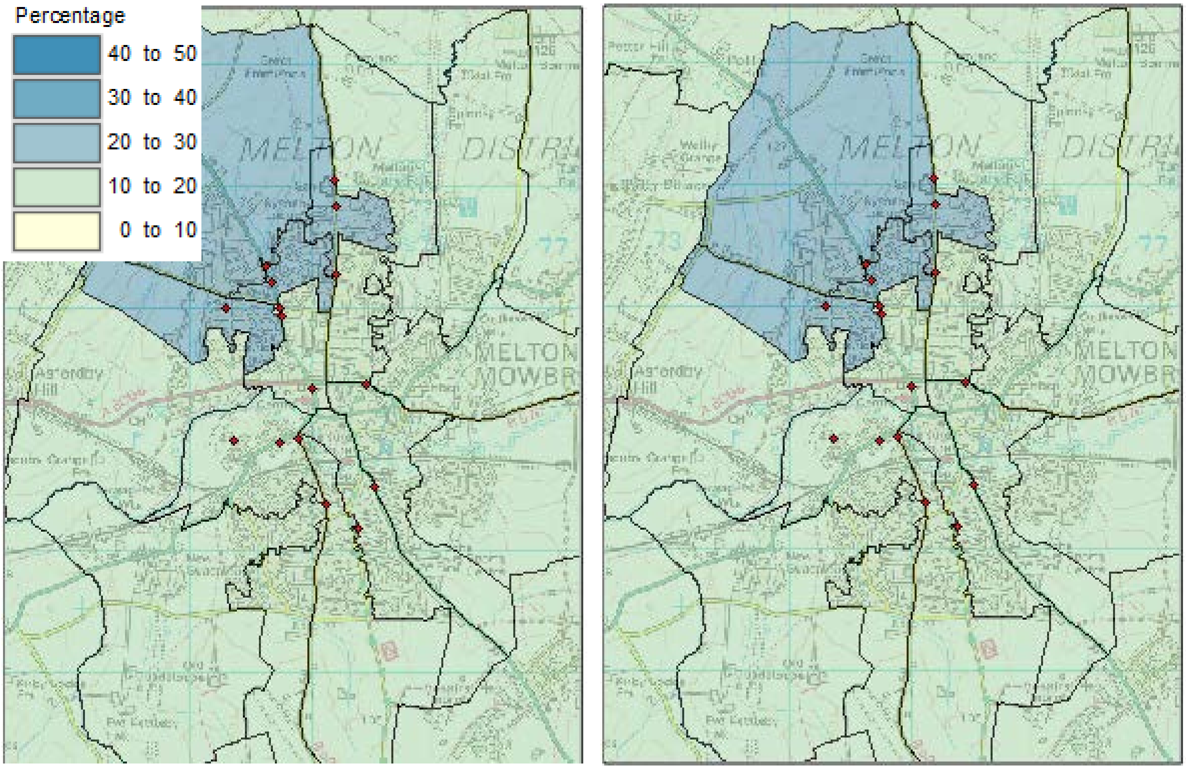
11.7.14 Motorcyclist casualties are shown in Figure 11-14. There is a slight concentration of casualties in Melton Mowbray and on the rural A roads and B roads

11.7.15 In Melton Borough, 9% of casualties were young male drivers (25 or younger) which is comparable with the percentage of motorcyclist casualties that will be included in the analysis; therefore, given the similar rate, young male drivers will also be included in the analysis. Figure 11-14 shows the distribution of accidents involving young male driver casualties. Like motorcyclists, these accidents are concentrated in Melton Mowbray and the rural A roads and B roads (there are individual accidents included in both categories).

Figure 11-13: Vulnerable Population Group Casualty Locations

Melton Borough **Melton Mowbray**

Children (under 16)



Older People

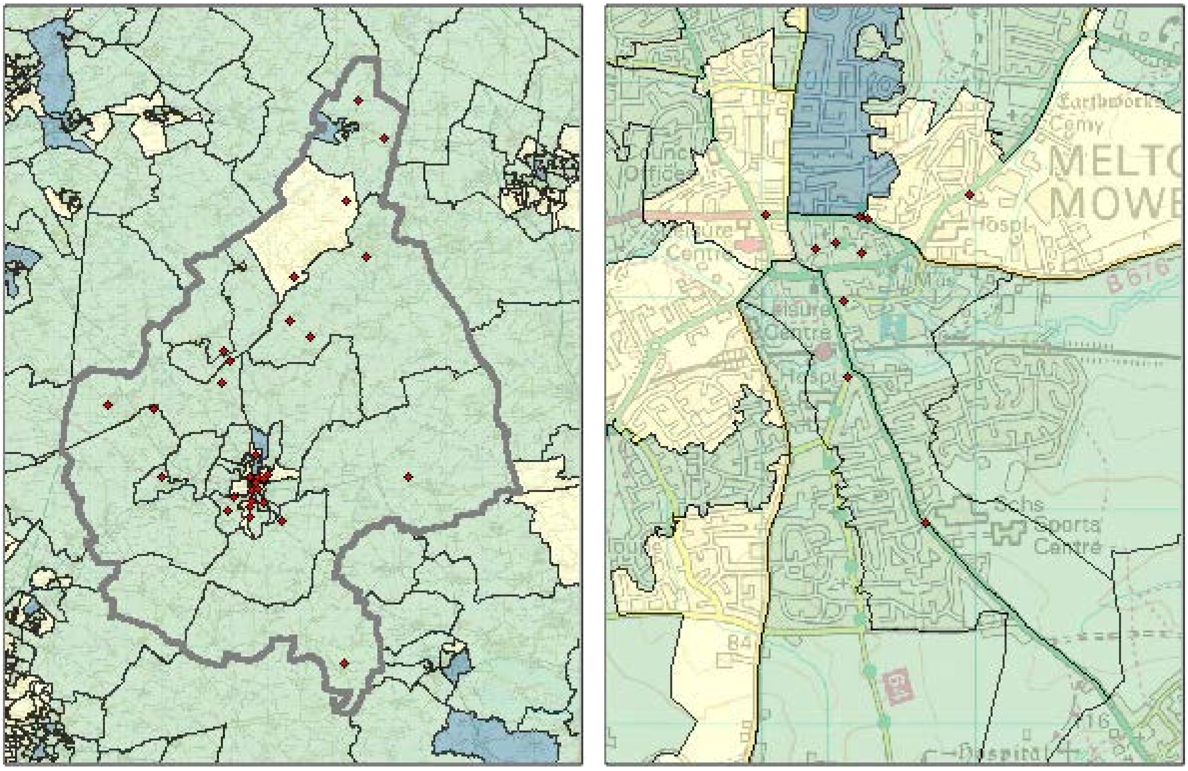


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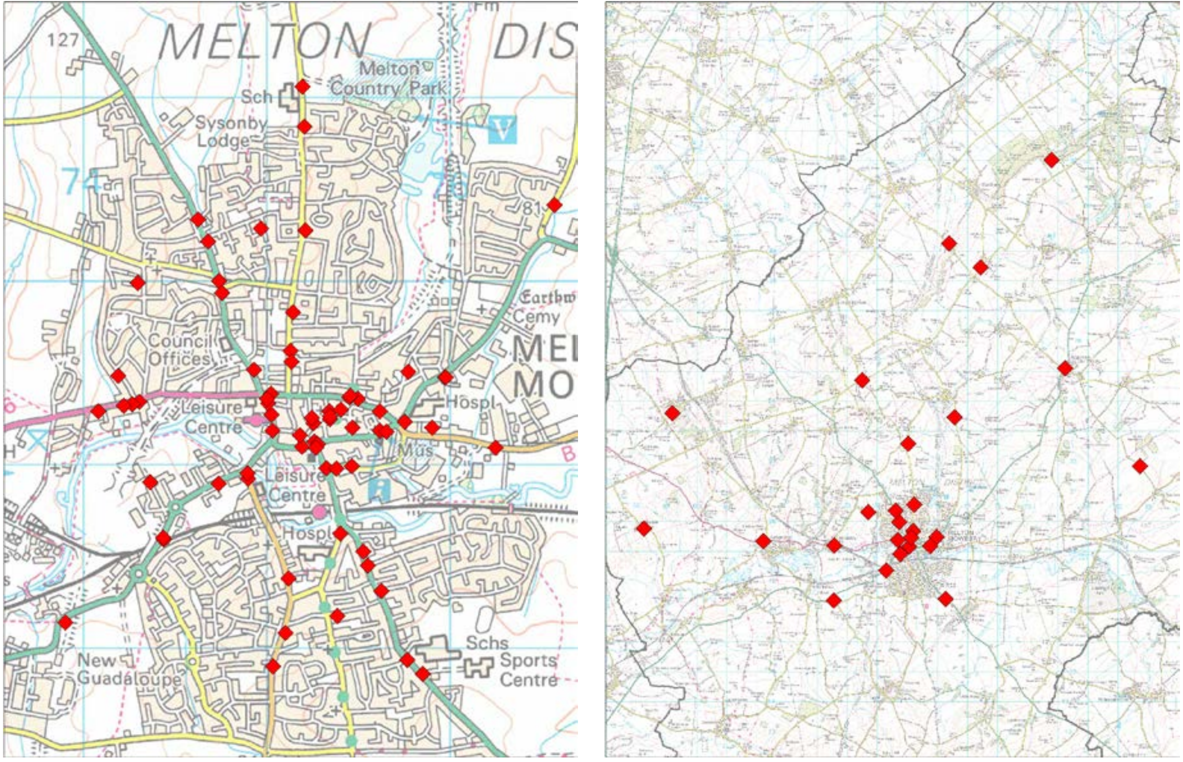
Figure 11-14: Vulnerable Road User Group Casualty Locations

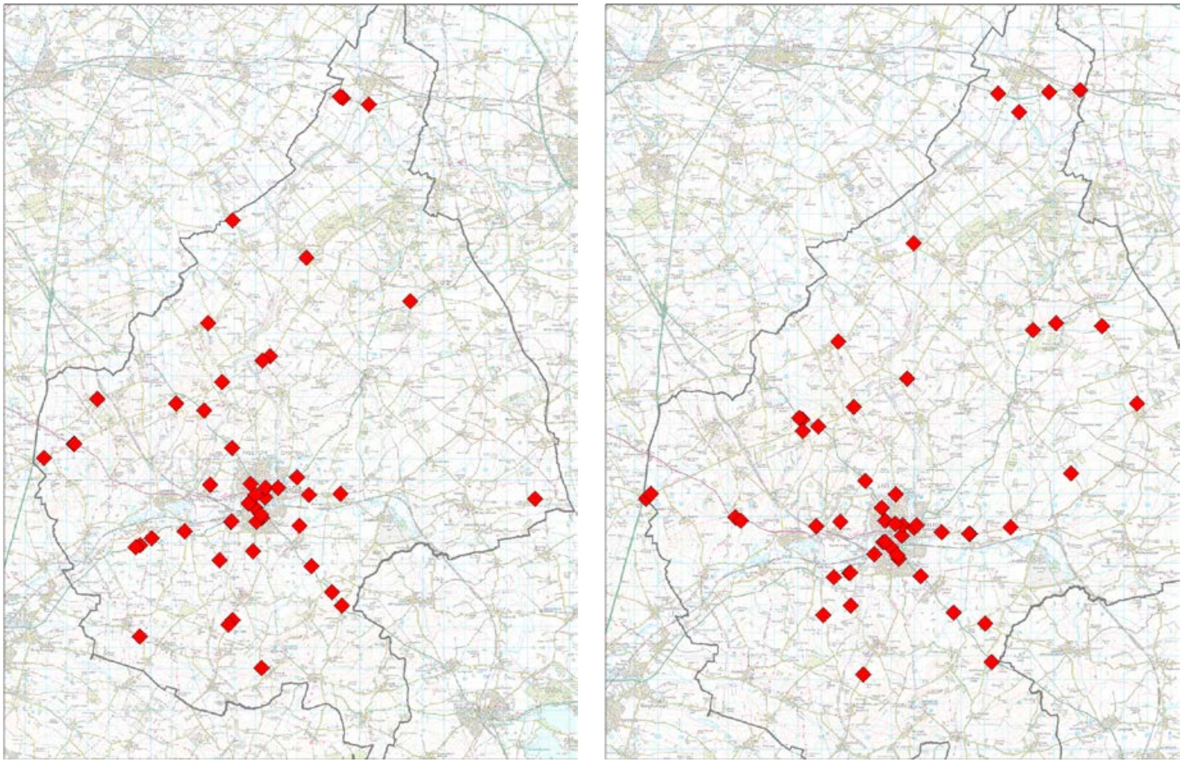


Pedestrians

Cyclists

Motorcyclists

Young Male Drivers



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Methodology

11.7.16 As there are more than 50 relevant casualties in the impact area over the 5 years being considered (2015-2019) a detailed appraisal was undertaken. This used spreadsheet and GIS methods to manipulate the casualty dataset as the number of affected model links (>200 with recorded casualties) was considered too big to assess individually. The change in total accidents produced by CoBA-LT in the NEMMDR scenario accident appraisal was used to forecast future accident rates on individual links.

11.7.17 The STATS19 data were used to classify links with accidents into six link types, broadly following the split in accident rates in CoBA-LT (30/40mph limit and >40mph limit) and splitting into urban and rural to pick up any differences between Melton Mowbray and the rest of Melton Borough. Six link types were defined as follows:

- A Roads - Urban - 30/40mph
- A Roads - Rural - 30/40mph
- A Roads - Rural - above 40mph
- B/C Roads - Urban - 30/40mph
- B/C Roads - Rural - 30/40mph
- B/C Roads - Rural - above 40mph

11.7.18 Casualty rates (per accident) were calculated for each combination of link type and vulnerable group using the 2015-2019 Melton Borough STATS19 accidents and casualties. These are shown in Table 11.24. The highest rates are for pedestrians in urban areas, i.e. Melton Mowbray, with motorcyclists and young male drivers having the highest rates of the other groups.

Table 11.24: Average Vulnerable Group Per Accident Casualty Rates by Road Type

	Vulnerable Group						
Road Type	**Child Pedestrians**	**Older Pedestrians**	**Older Drivers**	**Pedestrians**	**Cyclists**	**Motorcyclists**	**Under 25 Male Drivers**
Rural A Roads 30/40mph	0.07	0.00	0.07	0.15	0.07	0.22	0.04
Rural B/C Roads 30/40mph	0.00	0.00	0.04	0.04	0.12	0.12	0.08
Rural A Roads >40mph	0.00	0.00	0.01	0.01	0.02	0.13	0.14
Rural B/C Roads >40mph	0.01	0.00	0.12	0.01	0.05	0.13	0.15
Urban A Roads 30/40mph	0.12	0.06	0.03	0.49	0.09	0.07	0.13
Urban B/C Roads 30/40mph	0.19	0.00	0.15	0.41	0.15	0.11	0.07

11.7.19 Observed vulnerable casualty rates were calculated for the model links on which accidents involving people in vulnerable groups occurred. As per the TAG Distributional Impacts Worksheet, the observed casualty rates were compared with the corresponding average casualty rate for the road type (Table 11.24) and ranked as low, medium, or high. Low rates are more than 30% lower than average, medium rates are within 30% of average and high rates are more than 30% greater than average.

11.7.20 These rankings were compared with the change in total accidents output from CoBA-LT for each affected link as per the TAG Distributional Impacts Worksheet to calculate an impact on the 7-point scale for each affected link for each vulnerable group. The limits for assigning each of the 7 classes of impact are shown in Table 11.25.

Table 11.25: TAG Scale for Accident Impacts

Observed Casualty Rate	Change in Total Accidents (CoBA-LT output)	Impact
Low	>15% Reduction	Moderate Beneficial
Low	5% to 15% Reduction	Slight Beneficial
Low	5% Reduction to 5% Increase	Neutral
Low	5% to 15% Increase	Slight Adverse
Low	>15% Increase	Moderate Adverse
Medium	>15% Reduction	Moderate Beneficial
Medium	5% to 15% Reduction	Slight Beneficial
Medium	5% Reduction to 5% Increase	Neutral
Medium	5% to 15% Increase	Slight Adverse
Medium	>15% Increase	Moderate Adverse
High	>15% Reduction	Large Beneficial
High	5% to 15% Reduction	Moderate Beneficial
High	5% Reduction to 5% Increase	Neutral
High	5% to 15% Increase	Moderate Beneficial
High	>15% Increase	Large Adverse

11.7.21 Table 11.26 shows the results of the accident appraisal. All the vulnerable groups considered have assessed impacts that are either neutral or beneficial (highlighted). The vulnerable group with the highest observed casualty rate is pedestrians and the scheme has the largest impact for that group as a whole and child and older pedestrians. Similarly, cyclists also have a significant number of beneficial impacts although the more conservative neutral score is assigned.

11.7.22 The beneficial assessments relate to groups with concentrations of casualties in Melton Mowbray where traffic is reduced by the scheme as shown in Figure 11-15.

11.7.23 The neutral assessments relate to groups for which casualties are not concentrated in Melton Mowbray and spread across Melton Borough as shown in Figure 11-15. This leads the groups to experience the impacts of reduced forecast traffic in Melton Mowbray and increased forecast traffic on some of the rural A roads and B roads.

Qualitative Comment

11.7.24 The accident appraisal used STATS19 data from 2015 to 2019 to identify accidents within Melton Borough. From these accidents, vulnerable group casualties were identified and average casualty rates calculated for road types based on speed limits and urban or rural classification. Casualty rates for links with accidents involving vulnerable group casualties were compared to the average for the road type to identify links with high and low casualty rates. The percentage change of total accidents forecast by CoBA-LT was then used to assign impact on each assessed link for each group.

11.7.25 The scheme generally reduces traffic in Melton Mowbray but increases traffic, due to better connectivity, on some main roads in Melton Borough. Most of the vulnerable group casualties are within Melton Mowbray as it is the main town in the Borough, small enough to be amenable to pedestrian and cycle travel and where the scheme produces lower traffic flows and fewer accidents. This results in almost all pedestrian and cycling impacts being beneficial or neutral. The impacts for young male drivers and motorcyclists include beneficial impacts in Melton Mowbray, neutral impacts mainly on the main roads in Melton Borough where traffic and accidents are unaffected by the scheme, and adverse impacts on certain main roads in Melton Borough where traffic and accidents increase.

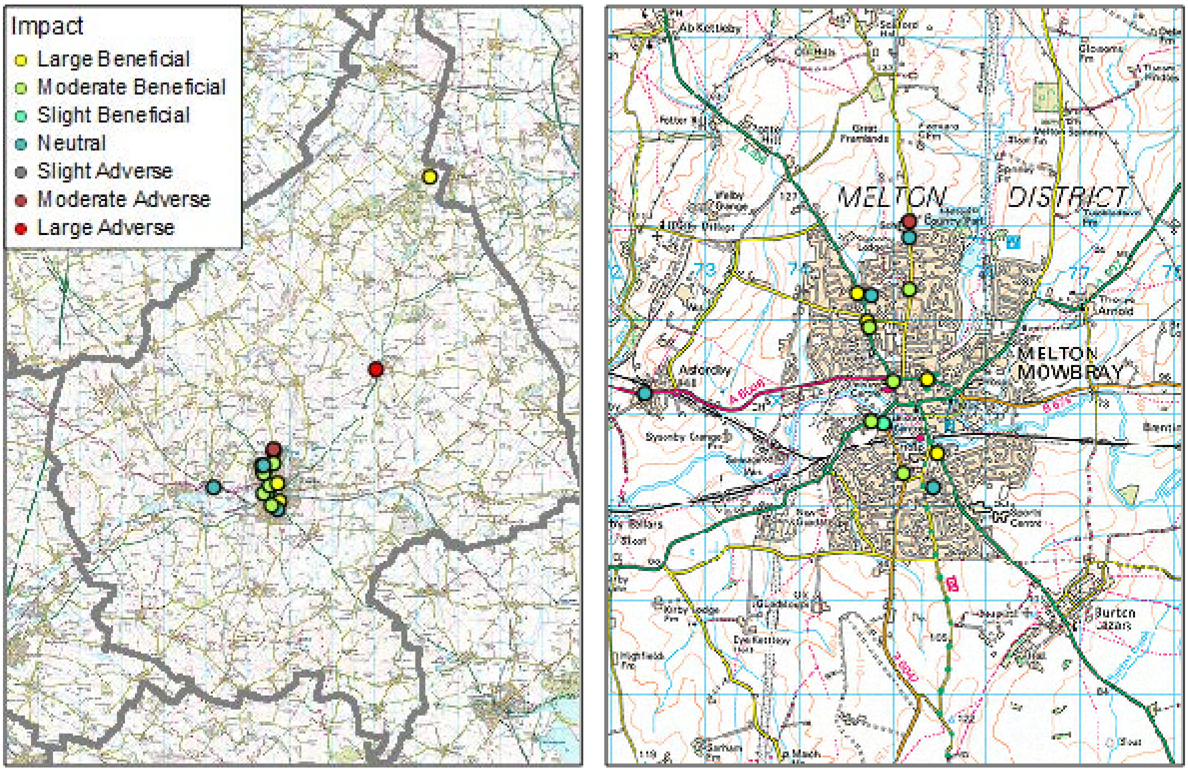
11.7.26 None of the vulnerable groups for accidents are adversely affected by the scheme and depending on how they distributed compared to the pattern of traffic flow change due to the scheme have mostly neutral or beneficial impacts. There are no especially deprived areas where the likelihood of accidents may be higher (such as Indices of Deprivation income Quintile 1 LSOAs) that are affected by the scheme.

Table 11.26: Summary of Distributional Impacts of Accidents (Number of Links)

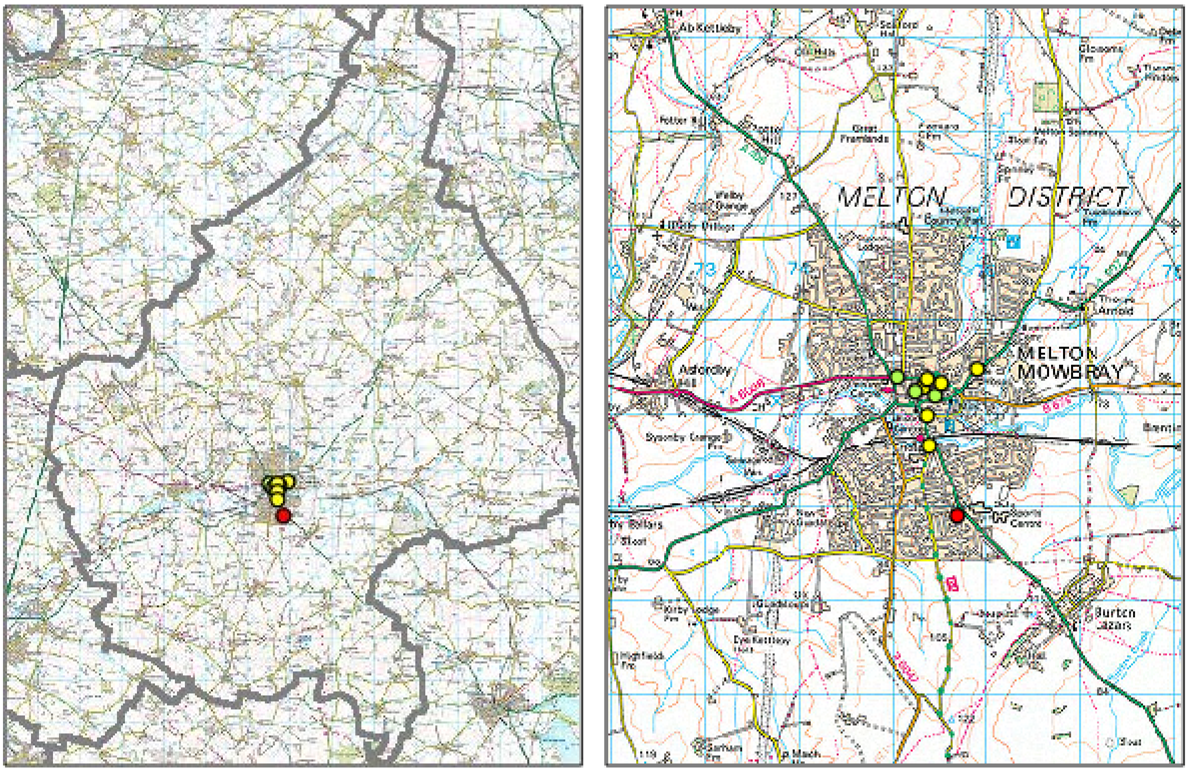
Impact	Child Pedestrians	Older Pedestrians	Older Drivers	Pedestrians	Cyclists	Motorcyclists	Young Male Drivers
Large Beneficial	5	6	4	18	4	4	4
Moderate Beneficial	5	3	5	11	9	11	9
Slight Beneficial	1	0	1	9	0	1	2
Neutral	4	0	8	10	9	14	18
Slight Adverse	0	0	0	0	0	2	1
Moderate Adverse	1	0	0	1	0	3	4
Large Adverse	1	1	2	2	2	5	3

Figure 11-15: Accident Distributional Impacts Appraisal Results

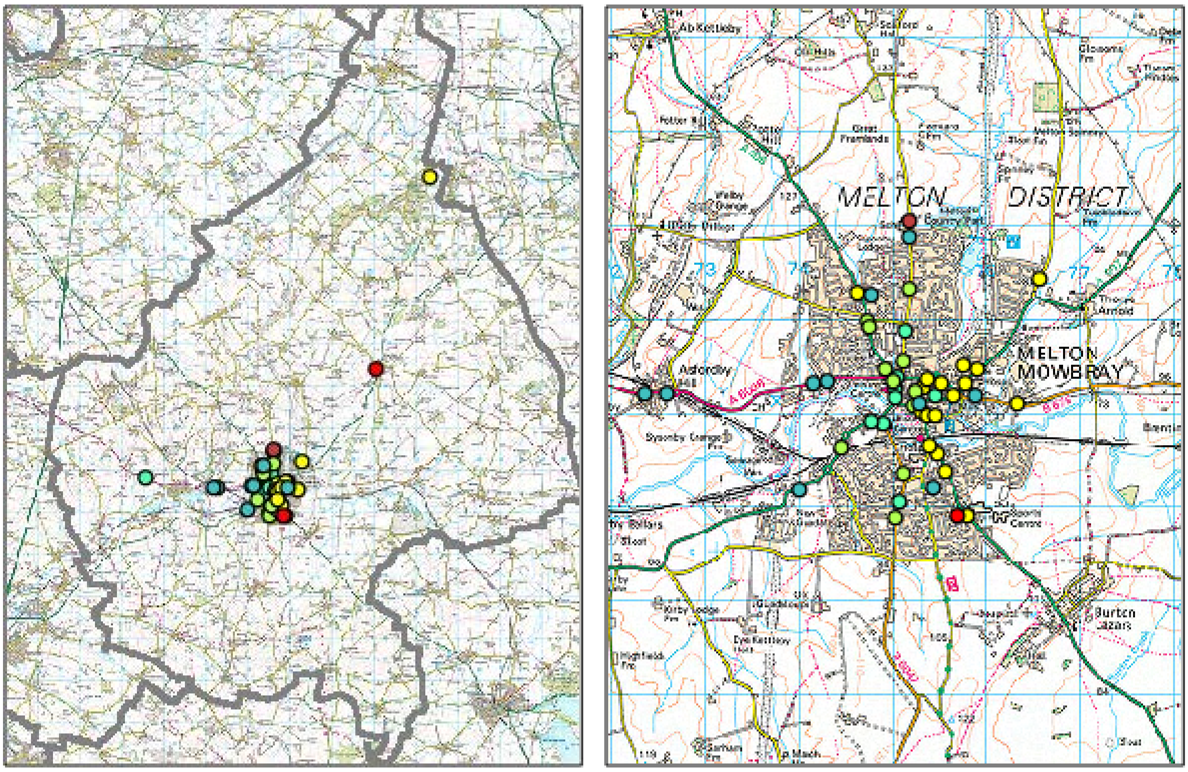
Child Pedestrians



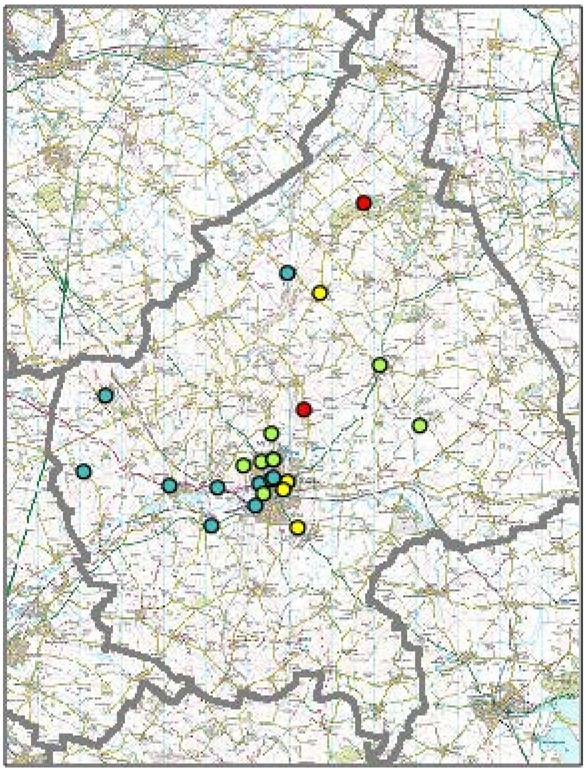
Older Pedestrians



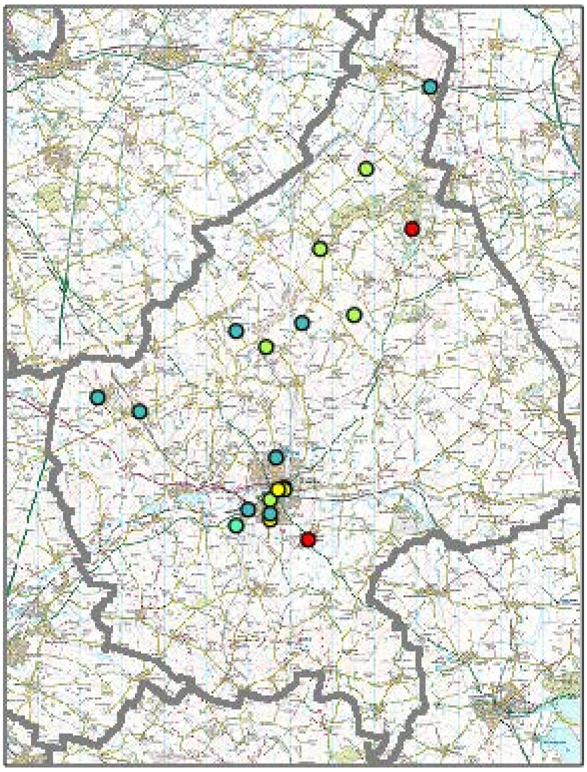
Pedestrians



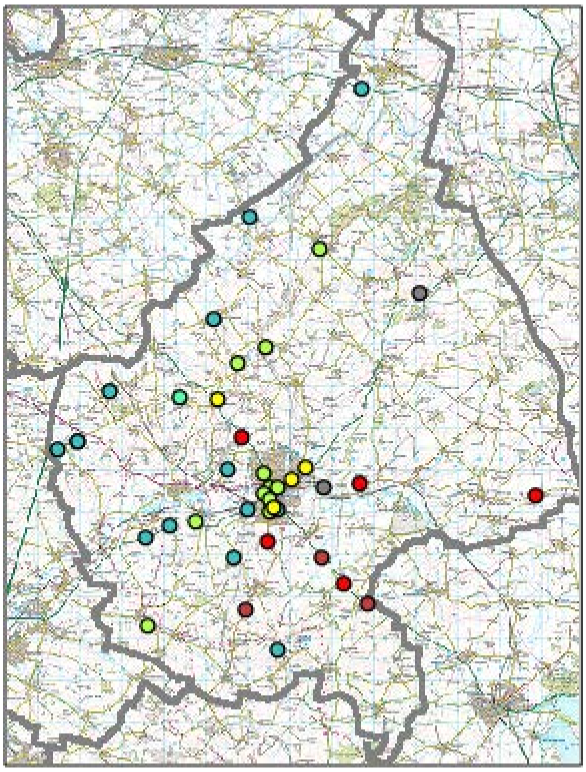
Cyclists



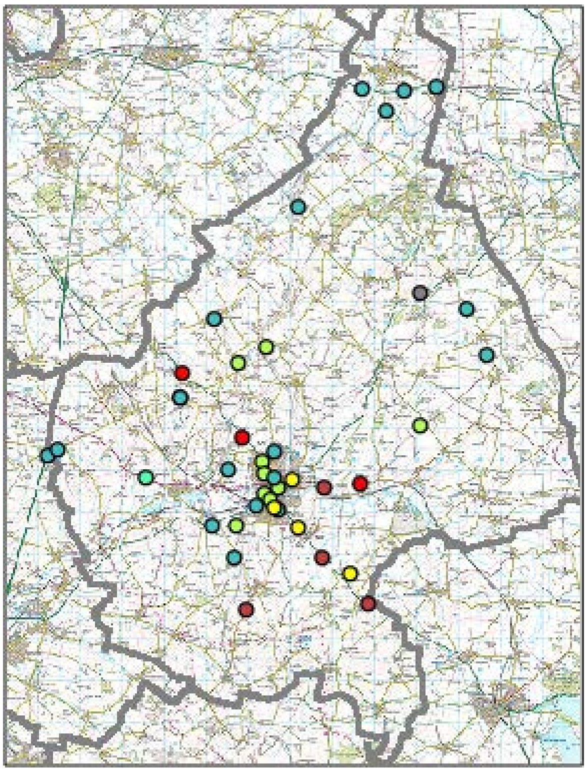
Older Drivers



Motorcyclists



Young Male Drivers



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11.8 Distributional Impacts of Security

11.8.1 Distributional impacts of security were screened out of the assessment and appraisal as shown in Table 11.3.

11.9 Distributional Impacts of Severance

11.9.1 This section presents the appraisal of severance generated by the NEMMDR. The social groups that are potentially vulnerable to the effects of severance because of changes in the transport network are those without access to cars, older people, people with disabilities, parents with pushchairs, and children. The adult population are included as severance or mitigation might result in longer journey times. Children are included, as they are potentially vulnerable to severance as they are more likely to cross the road at dangerous crossing points and find it difficult to judge the speed of traffic, hence putting themselves at risk of road accidents.

11.9.2 The impact area was initially defined as Melton Borough where most changes in traffic are expected. Severance impacts are expected from increases in traffic on some rural main roads and from decreases in traffic throughout Melton Mowbray.

11.9.3 The broad levels of severance defined in TAG Unit A4.1 are:

- **None** - Little or no hindrance to pedestrian movement.
- **Slight** - All people wishing to make pedestrian movements will be able to do so, but there will probably be some hindrance to movement.
- **Moderate** - Pedestrian journeys will be longer or less attractive; some people are likely to be dissuaded from making some journeys on foot.
- **Severe** - People are likely to be deterred from making pedestrian journeys to an extent sufficient to induce a reorganisation of their activities. In some cases, this could lead to a change in the location of centres of activity or to a permanent loss of access to certain facilities for a particular community. Those who do make journeys on foot will experience considerable hindrance.

Rural Areas

11.9.4 The rural areas of Melton Borough have relatively high car availability and relatively large distances between amenities so pedestrian journeys are a minor component of travel particularly on roads outside the villages which have few pedestrian facilities. The without scheme severance is therefore assessed as slight on rural routes.

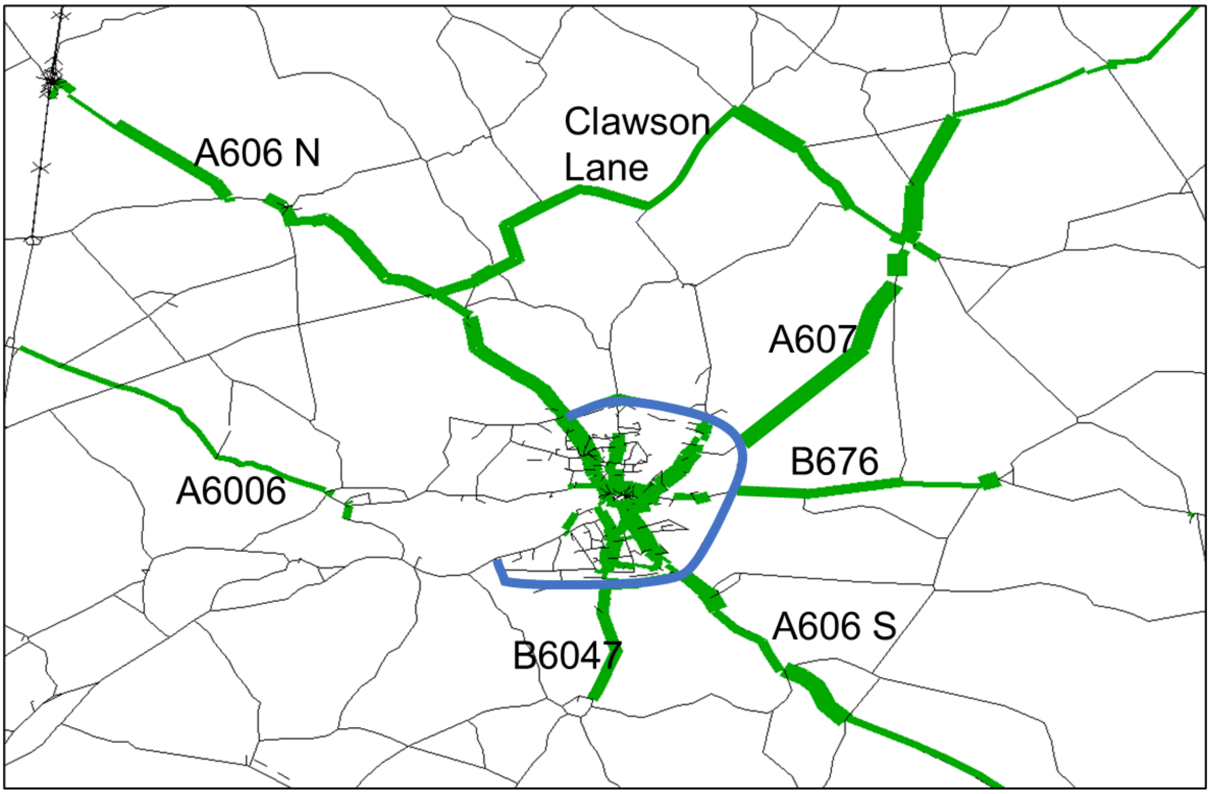
11.9.5 To identify where the scheme causes changes in flow, AADT flows were derived from the traffic model and links with >10% change from the Core Scenario were identified, subject to a 2000 PCU minimum in more than one of the modelled years, to remove links where small changes in traffic cause a high percentage change. The changes in AADT flow broadly represent changes in HGV and LGV flows.

11.9.6 Six affected routes, shown in Figure 11-16, were identified and the population within 800m of those routes was estimated from the 2011 Census and a postcode dataset.

11.9.7 On the identified rural links where flows are forecast to increase (A606N, A607, B676, A606S, B6047), the with-scheme severance assessment is increased to moderate, a slight increase. On the links on which flows are forecast to decrease (A6006, Clawson Lane) the severance will not be eliminated so the assessment remains slight. Since this is related to a general change in traffic that affects all groups, rather than a specific change in infrastructure or traffic management, the same level of change is applied to all vulnerable groups.

11.9.8 The severance scores for these routes are shown in Table 11.27 and are small for all vulnerable groups due to the small and affected population in the rural areas.

Figure 11-16: Rural Routes Identified for Severance Appraisal



Melton Mowbray

11.9.9 In contrast to the rural areas, Melton Mowbray is very compact and coercive to pedestrian journeys. The evidence base for the Interim Melton Mowbray Transport Strategy[8] brings together various up to date LCC and MBC strategic transport studies and details the current severance issues in Melton Mowbray.

11.9.10 In summary, the MMTS document describes the following relevant evidence:

- Congestion affects the central ‘ring-road’ and all approaches, leading to air pollution, queuing traffic and hindrance to pedestrian movement particularly in the AM and PM Peak periods as shown in Figure 11-17.
- Traffic volumes are very high on the northern and western sides of the ‘ring-road’.
- While present in AM and PM Peak periods in normal weekdays, the congestion extends to other periods on market days.
- Approximately 7,000 goods vehicles per day are using the centre of Melton Mowbray, 85% of which are through-traffic.
- Rat running to avoid congested main roads leads to traffic using suburban routes thereby degrading their character and dissuading pedestrians.
- Car parking provision is exceeded on market and event days causing additional on-street parking and obstruction to pedestrians.
- Having to cross the congested main roads to access the town centre from the main car parks is deterring usage (Wilton Road, Burton Street, Mill Street, Scalford Road, Cattle Market) as shown in Figure 11-18.
- Use of the more convenient car parks leaves the excess capacity concentrated at Scalford Road and the Cattle Market, from which pedestrian must cross the busiest part of the ring road to access the town centre as shown in Figure 11-17 and Figure 11-18.

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[8] https://www.leicestershire.gov.uk/sites/default/files/field/pdf/2021/7/27/Interim-Melton-Mowbray-transport-strategy.pdf

- The town centre has a perceived road safety issue related to HGV traffic, limited crossing infrastructure and narrow footways.
- One of the broad conclusions is that "*failure to address existing issues and alleviate the negative impacts of growth will also restrict opportunities to enhance the vitality and facilitate regeneration of the town centre through improvements to the public realm and pedestrian connectivity*".

11.9.11 This describes a situation where the poor environment and safety concerns are causing people to reorganise activities to avoid the issues in the town centre. The existing severance issues are considered severe for the centre of Melton Mowbray, moderate for the radial routes into the centre of Melton Mowbray and slight for the urban areas.

Figure 11-17: Melton Mowbray Traffic Volumes

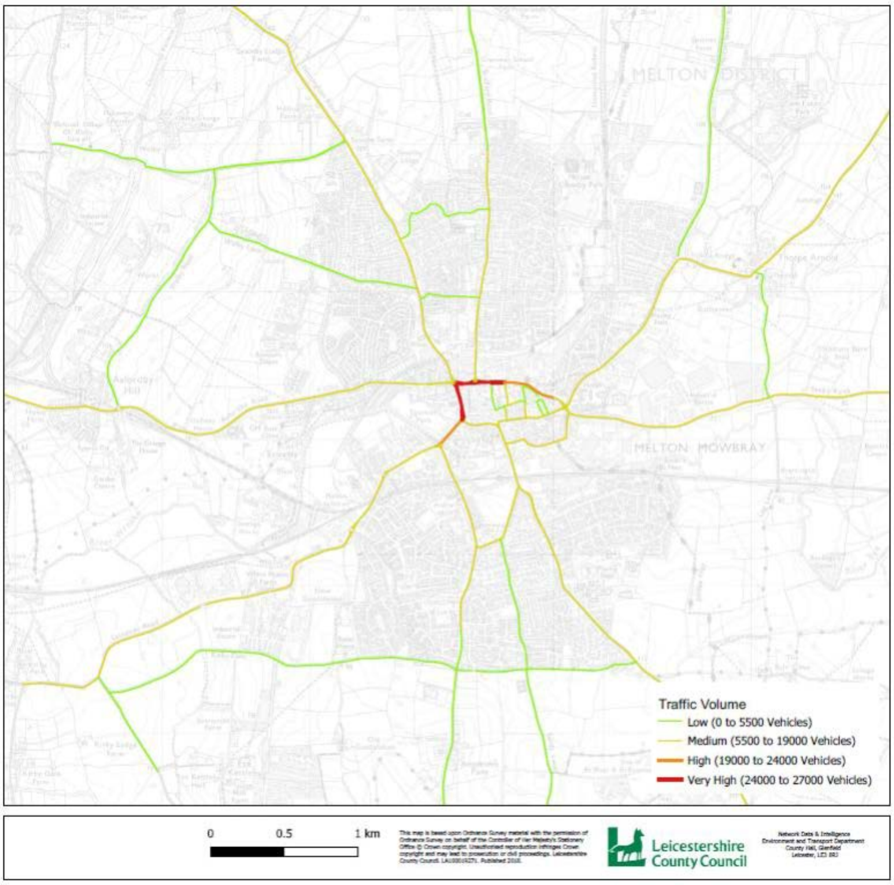
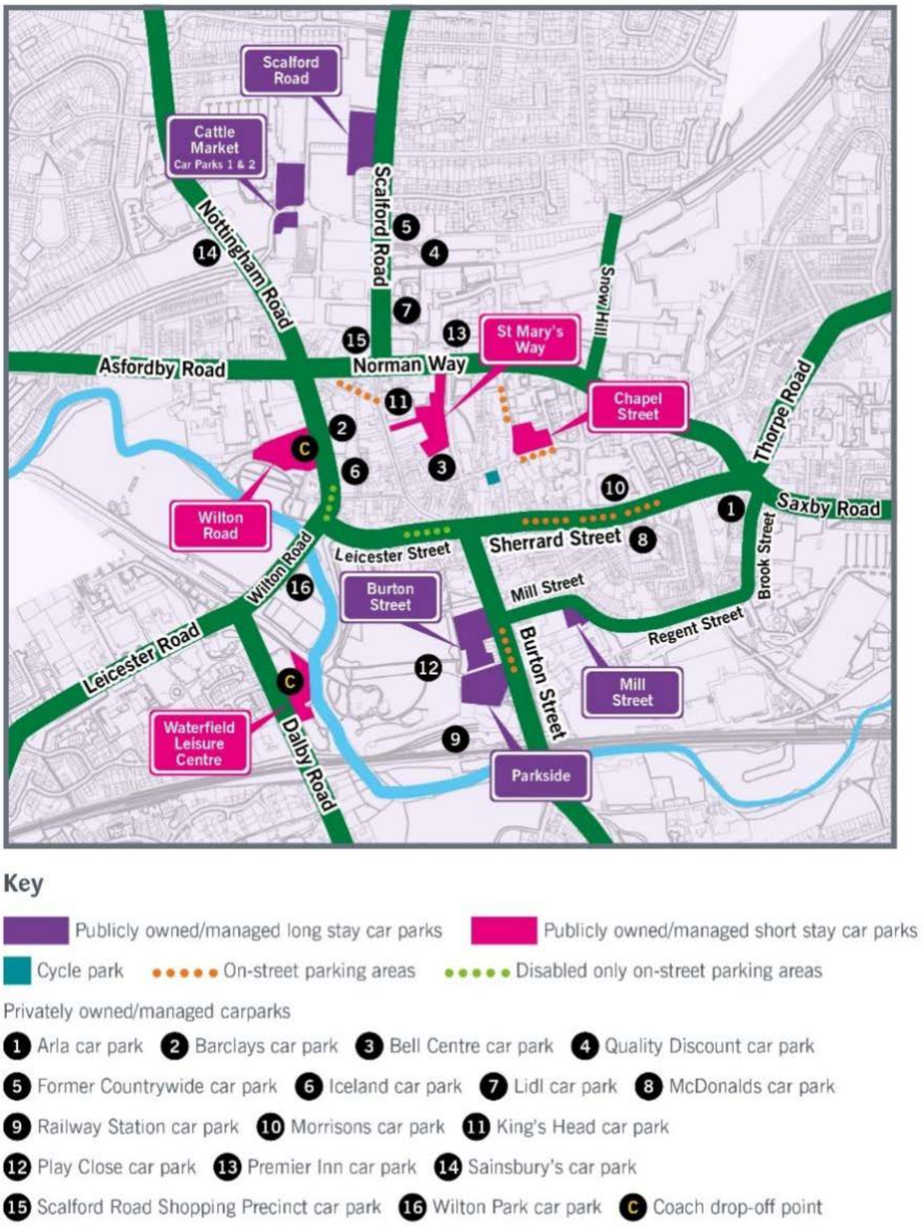


Figure 11-18: Melton Mowbray Parking



Source: Melton Mowbray Town Centre Car and Coach Parking Strategy (November 2015)

11.9.12 Analysis of postcode locations shows that approximately 14,000 people live within 800m of the town centre area where severance is interpreted as severe (Figure 11-19) and another 11,000 in the outer areas of Melton Mowbray where the radial routes have severance assessed as moderate and the suburban areas are assessed as slight.

11.9.13 Additionally, the Norfolk Drive - Queensway route is identified as this has an increase in traffic between 2030 until the Southern Link Road is fully open in 2040 (Figure 11-19)

11.9.14 Severance scores for the Melton Mowbray areas are shown in Table 11.27 and are overwhelmingly beneficial for the larger areas. The overall assessment is large beneficial for all groups as the scores in Melton Mowbray are an order of magnitude larger than the scores for the rural routes.

Figure 11-19: Levels of Severance in Melton Mowbray

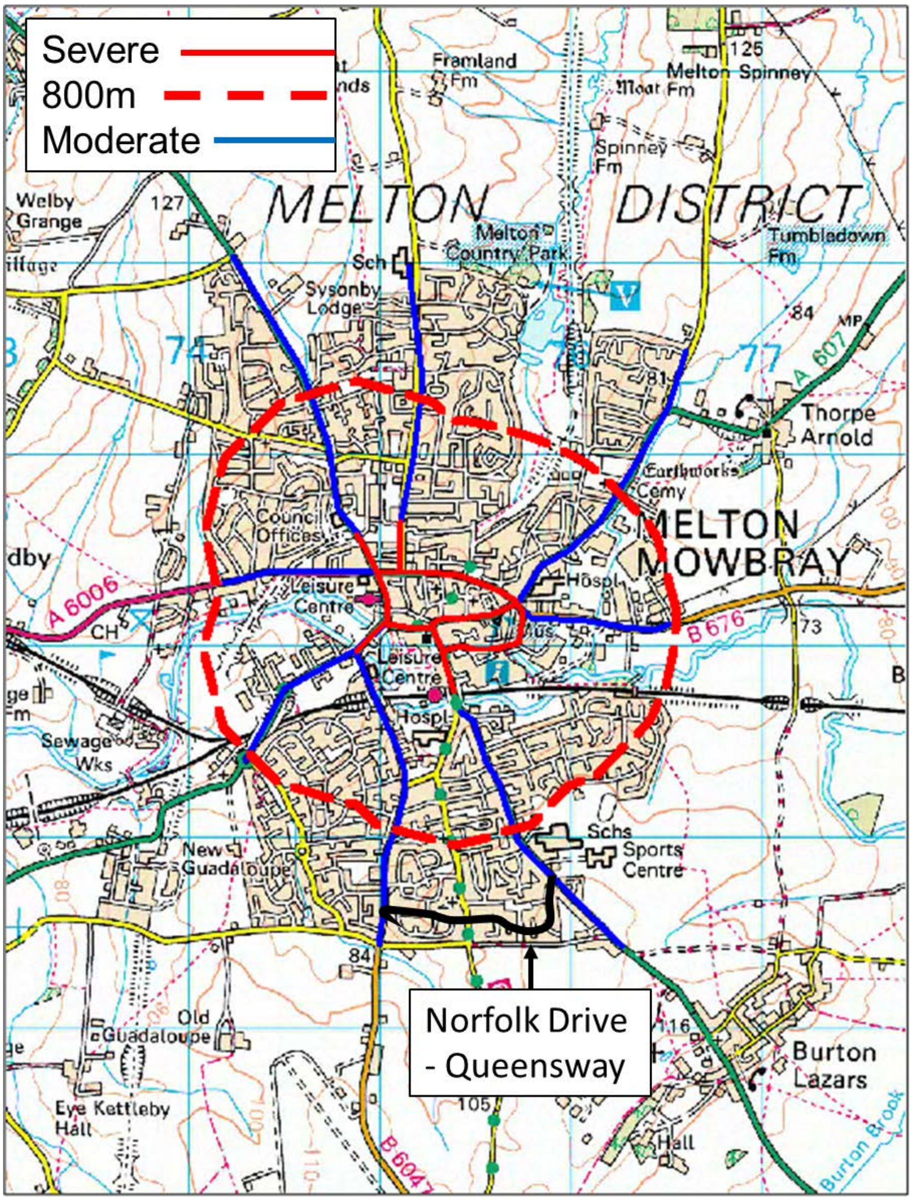


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Table 11.27: Distributional Impact of Severance Summary

		Severance			All		No-car		Young		Older		Disabled	
Location	**Area/Route**	**Core**	**NEMMDR**	**Change**	**People**	**Effect**	**People**	**Effect**	**People**	**Effect**	**People**	**Effect**	**People**	**Effect**
Town	Town Centre	severe	moderate	Slight +ve (+1)	13,700	**13,700**	1,250	**1,250**	2,200	**2,200**	1,750	**1,750**	2,250	**2,250**
Town	Melton Mowbray main roads	moderate	slight	Slight +ve (+1)	11,000	**11,000**	1,900	**1,900**	4,100	**4,100**	3,000	**3,000**	3,950	**3,950**
Town	Norfolk Drive - Queensway	slight	moderate*	Slight -ve (-1)	1,700	**-1,700**	300	**-300**	250	**-250**	200	**-200**	300	**-300**
Borough	A606 South	slight	moderate	Slight -ve (-1)	500	**-500**	0	**0**	50	**-50**	50	**-50**	50	**-50**
Borough	B676	slight	moderate	Slight -ve (-1)	200	**-200**	0	**0**	0	**0**	0	**0**	0	**0**
Borough	A607 North-east	slight	moderate	Slight -ve (-1)	1,100	**-1,100**	50	**-50**	150	**-150**	150	**-150**	200	**-200**
Borough	Waltham on the Wolds-Six Hills Lane	slight	slight	Neutral (0)	700	**0**	50	**0**	100	**0**	100	**0**	100	**0**
Borough	A606 North	slight	moderate	Slight -ve (-1)	1,300	**-1,300**	100	**-100**	200	**-200**	150	**-150**	250	**-250**
Borough	A6006	slight	slight	Neutral (0)	100	**0**	0	**0**	0	**0**	0	**0**	0	**0**
Total						**19,900**		**2,700**		**5,650**		**4,200**		**5,400**

*no impact once Southern Link Road is completed (2040)

11.10 Distributional Impacts of Accessibility

11.10.1 Distributional impacts of accessibility were screened out of the assessment and appraisal as shown in Table 11.3.

11.11 Distributional Impacts of Personal Affordability

11.11.1 Personal affordability focuses on the impact of an intervention on those for whom the minimum cost of travel affects their access to services. This includes low-income groups, young and old people, for example, for access to schools or doctors, and people with disabilities whose baseline costs may be higher due to limited transport choices.

11.11.2 For low-income groups whose main form of transport is by car and who do not have alternative modes of transport, small changes in the monetary costs of car travel can be significant for personal affordability. The value of time is lower for lower income groups than higher income groups.

11.11.3 The impact area for personal affordability is the same as that derived for user benefits, namely Melton Borough where most of the changes in traffic flow due to the scheme are forecast by the traffic model. This is like the AoI for accidents shown in Figure 4-1.

11.11.4 There are no low income (Quintile 1) LSOAs in the impact area (Table 11.5) so the personal affordability impacts are mainly the deviations from the population proportions in the personal affordability impacts rather than changes in baseline costs.

11.11.5 The scope of the personal affordability appraisal depends on the potential changes in the costs of travel across all modes, due to the scheme. These are summarised in Table 11.28. Since the scheme being assessed is a new road scheme (free at the point of use) the only cost changes are expected to be the car fuel and non-fuel costs that change in response to changes in routeing and journey time. The LLITM model used is income-segmented and differing values of time between income groups are represented, which produces subtle variations in routeing for each income group. TUBA is run with the income segmentation and captures the resulting changes in car fuel and non-fuel costs for each income group.

Table 11.28: Summary of Scope of Potential Changes in Travel Costs

Mode	Cost Change	Cost Change expected?	Change Captured in TUBA?	Quantified Impact (Benefit)
Car	Car fuel and non-fuel costs	Yes	Yes	-£2.3m
	Road User Charges	No		
	Public parking charges - management	No		
	Other car charge/costs	No		
Public Transport	Bus Fares	No		
	Rail	No		
	Fares	No		
	Rapid Transit Fares	No		
	Mode shift between PT modes due to change in supply	No		
	Ticket/interchange discounts	No		
	Concessionary fares	No		

Mode	Cost Change	Cost Change expected?	Change Captured in TUBA?	Quantified Impact (Benefit)
	Other public transport charges/costs	No		
Non-motorised Modes	Walking costs	No		
	Cycling costs	No		

11.11.6 The appraisal of impact uses the non-working time user benefits data (fuel and non-fuel operating costs) derived from the FBC TUBA forecasts, and the income data from the LLITM land-use model.

11.11.7 The personal affordability benefits and disbenefits, arising from increases in vehicle operating costs, are likely to result from a preponderance of journeys which are forecast to have different routes in the core and with-scheme scenarios in the transport model. Time rather than distance dominates the cost estimates used in choosing routes both in reality and in the transport model, and the personal affordability benefits is sensitive to the resulting change in distance via the fuel and non-fuel operating costs.

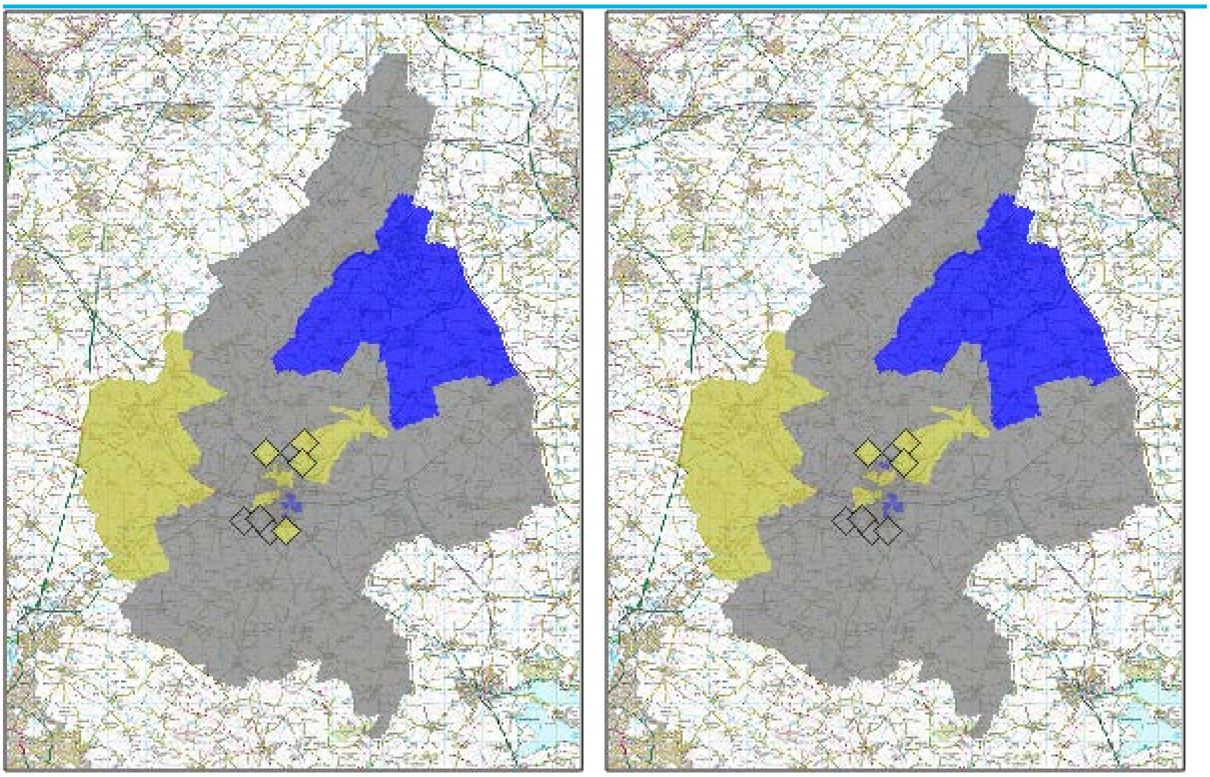
11.11.8 Figure 11-1 shows the income data used for the appraisal and Figure 11-20 shows the non-working time vehicle operating cost benefits in Melton Borough. Development zones representing the northern and southern sustainable neighbourhoods (NSN and SSN) are shown as diamonds. There is a mixture of benefits and disbenefits which represents journeys rerouteing onto shorter routes and longer routes respectively.

11.11.9 Table 11.29 shows that the share of disbenefits across the income groups are in-line with the population for low- and high-income groups and, by a small margin, slightly less for the middle-income group. The distribution is related to the location relative to the NEMMDR and the trip length and distribution of the income group. Absolute benefits and disbenefits over the 60-year appraisal are small (<£1 per person per annum).

11.11.10

11.11.11 Table 11.30 shows the equivalent sensitivity test to that undertaken in the user benefits appraisal involving modifying the NSN and SSN development zone benefits and population to be more representative of Melton Mowbray. The modified result shows that personal affordability impacts are not as sensitive to this change as the user benefits and the scores are the same as the NEMMDR scenario. However, to be consistent with the user benefits analysis, which found the alternative population in the sensitivity test to be a robust assumption, the sensitivity test version is used for the AST entry.

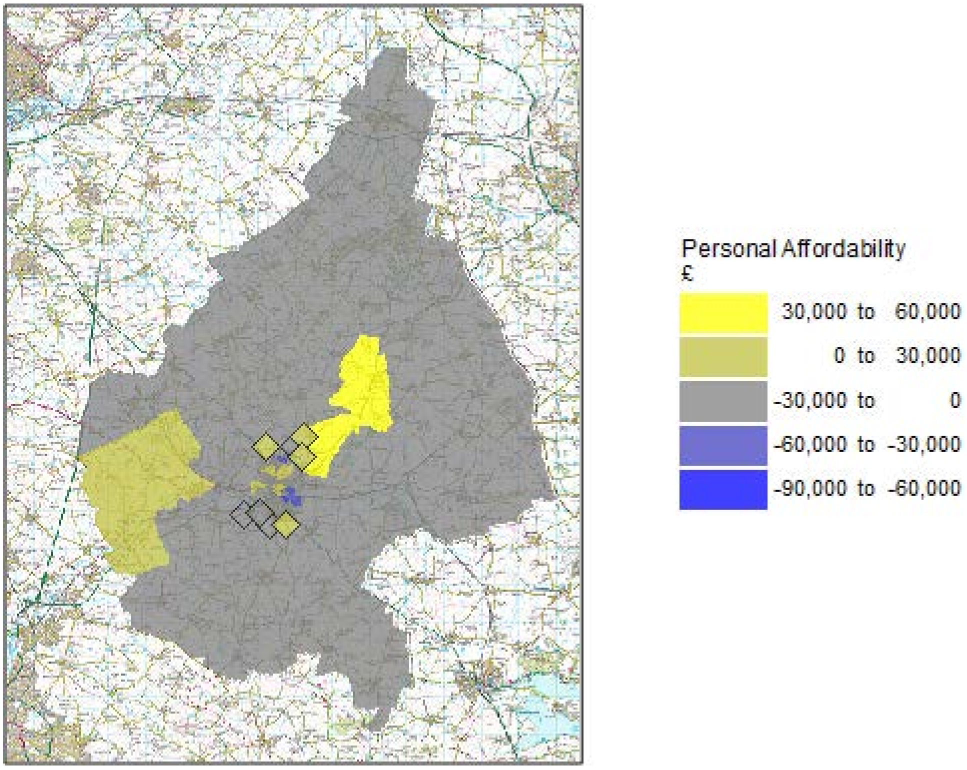
Figure 11-20: Forecast Personal Affordability Benefits



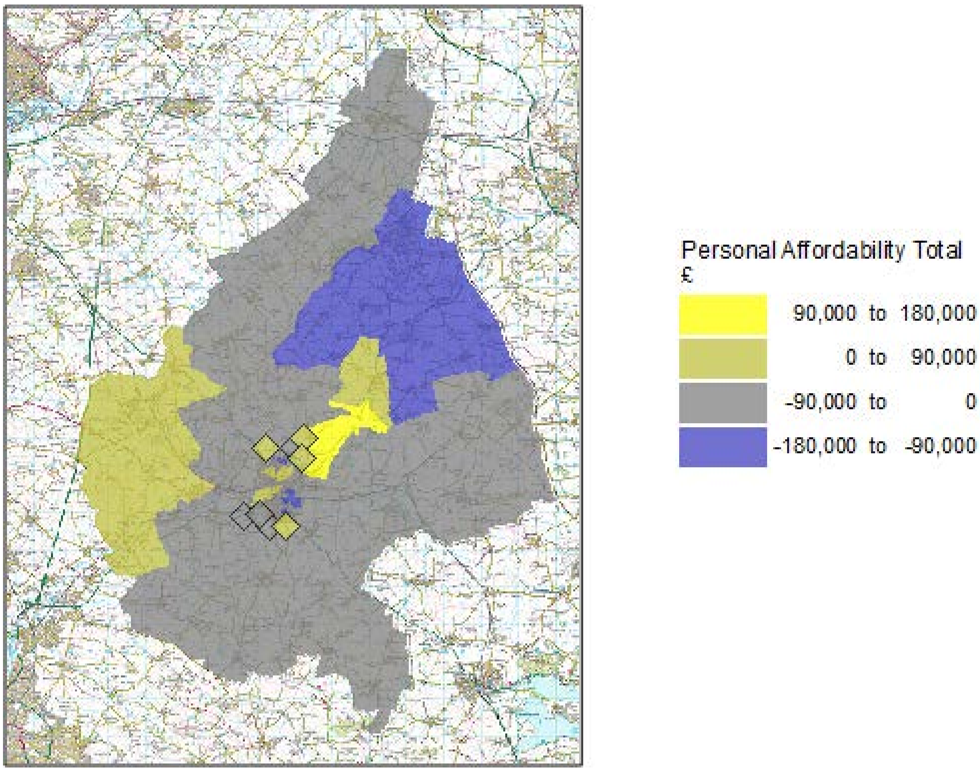
Low-Income Households

Medium-Income Households

High-Income Households



Whole Population Personal Affordability Benefits



Maps contain Ordnance Survey data © Crown copyright and database right 2022

Table 11.29: Summary of NEMMDR Scenario Personal Affordability Appraisal

	Income Bands			
	Low	Medium	High	Total
Net benefits	84,755	87,163	116,540	288,458
Net disbenefits	-671,117	-872,854	-1,003,242	-2,547,213
Gross benefits	-	-	-	-
Gross disbenefits	-586,362	-785,691	-886,702	-2,258,755
Share of benefits	-	-	-	
Share of disbenefits	26%	35%	39%	
Share of population in income band	22%	42%	35%	
Assessment	✗✗	✗	✗✗	

Table 11.30: Summary of NEMMDR Scenario Personal Affordability Appraisal Sensitivity Test

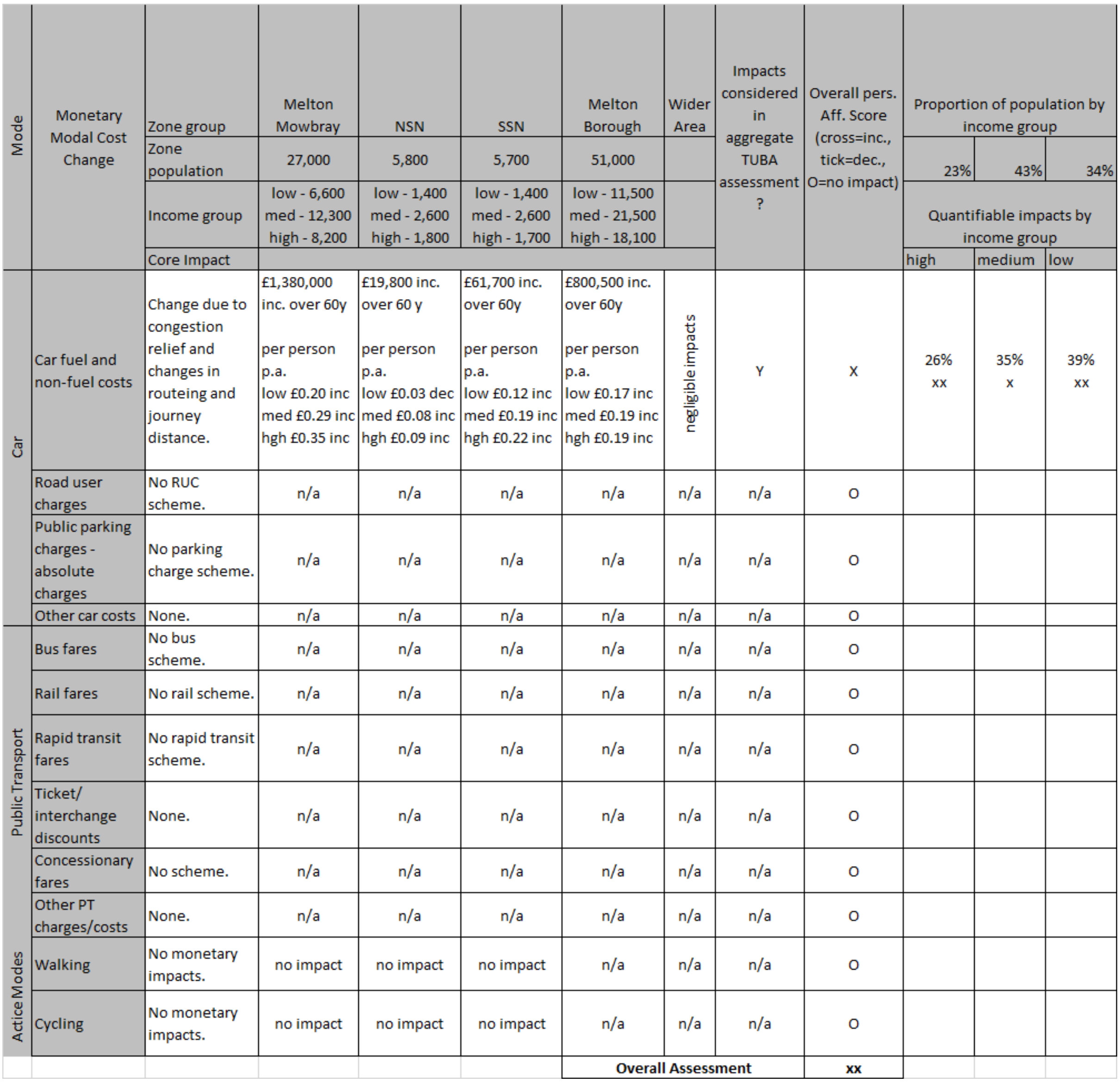
	Income Bands			
	Low	Medium	High	Total
Net benefits	78,523	90,470	115,732	284,724
Net disbenefits	-661,786	-887,567	-999,071	-2,548,424
Gross benefits	-	-	-	-
Gross disbenefits	-583,262	-797,097	-883,340	-2,263,700
Share of benefits	-	-	-	
Share of disbenefits	26%	35%	39%	
Share of population in income band	23%	43%	35%	
Assessment	✗✗	✗	✗✗	

11.11.12 Table 11.31 is the NEMMDR Personal Affordability Worksheet. This breaks down the identified changes in car fuel and non-fuel cost changes, monetised in TUBA, to show how they affect users of different income levels in the impact area (Melton Borough). All per person per year disbenefits are negligible and there are no Quintile 1 (lowest income) LSOAs in Melton Borough. The model zones covering Melton Mowbray contain a population of around 27,000.

11.11.13 The personal affordability disbenefits total £1.38 million and the disbenefit per person increases with income. The NSN and SSN development zones are treated separately and have relatively low personal affordability impacts compared to the Melton Mowbray zones. The NSN low-income group are forecast slight benefits. The rest of Melton Borough also has lower per person impacts than Melton Mowbray and disbenefit does not consistently increase with income level.

11.11.14 The overall assessment is moderate adverse since the quantifiable impacts are in line with the population percentages for two of the three income groups.

Table 11.31: NEMMDR Personal Affordability Worksheet



Mode	Monetary Modal Cost Change	Zone group	Melton Mowbray	NSN	SSN	Melton Borough	Wider Area	Impacts considered in aggregate TUBA assessment ?	Overall pers. Aff. Score (cross=inc., tick=dec., O=no impact)	Proportion of population by income group		
		Zone population	27,000	5,800	5,700	51,000				23%	43%	34%
		Income group	low - 6,600 med - 12,300 high - 8,200	low - 1,400 med - 2,600 high - 1,800	low - 1,400 med - 2,600 high - 1,700	low - 11,500 med - 21,500 high - 18,100				Quantifiable impacts by income group		
		Core Impact								high	medium	low
Car	Car fuel and non-fuel costs	Change due to congestion relief and changes in routeing and journey distance.	£1,380,000 inc. over 60y per person p.a. low £0.20 inc med £0.29 inc hgh £0.35 inc	£19,800 inc. over 60 y per person p.a. low £0.03 dec med £0.08 inc hgh £0.09 inc	£61,700 inc. over 60y per person p.a. low £0.12 inc med £0.19 inc hgh £0.22 inc	£800,500 inc. over 60y per person p.a. low £0.17 inc med £0.19 inc hgh £0.19 inc	negligible impacts	Y	X	26% xx	35% x	39% xx
	Road user charges	No RUC scheme.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Public parking charges - absolute charges	No parking charge scheme.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Other car costs	None.	n/a	n/a	n/a	n/a	n/a	n/a	O			
Public Transport	Bus fares	No bus scheme.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Rail fares	No rail scheme.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Rapid transit fares	No rapid transit scheme.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Ticket/ interchange discounts	None.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Concessionary fares	No scheme.	n/a	n/a	n/a	n/a	n/a	n/a	O			
	Other PT charges/costs	None.	n/a	n/a	n/a	n/a	n/a	n/a	O			
Actice Modes	Walking	No monetary impacts.	no impact	no impact	no impact	n/a	n/a	n/a	O			
	Cycling	No monetary impacts.	no impact	no impact	no impact	n/a	n/a	n/a	O			
						Overall Assessment			**xx**			

11.12 Distributional Impacts Appraisal Matrix

11.12.1 The results from the main (non-sensitivity test/alternative scenarios) assessments are included in the Appraisal Matrix reproduced below.

Table 11.32: Distributional Impacts Appraisal Matrix

Indicator	Distributional impact of income deprivation			Are the impacts distributed evenly?	Key impacts – Qualitative statements
	Low	Medium	High		
User Benefits	✓✓	✓	✓✓	n	User benefits impacts are beneficial and are felt by all groups. The medium income group a lesser share of benefits. The low- and high-income group benefits are in-line with the population.
Noise	✓✓	✓✓	✓✓	y	Noise impacts are beneficial and evenly distributed across income groups.
Air quality	✓✓	✓✓	✓✓	y	Air quality impacts are beneficial and evenly distributed across income groups.
Affordability	✗✗	✗	✗✗	n	Affordability impacts are adverse and insignificant in absolute terms. Adverse impacts are higher for low- and high-income groups compared to medium income groups.
Accessibility	n/a	n/a	n/a	n/a	Not assessed.

AST entry

Impact	Social groups						User Groups				
	Children & young people	Older people	Carers	Women	Disabled	BME	Pedestrians	Cyclists	Motor-cyclists	Young Male Drivers	Qualitative Statement
Noise	✓✓	✓✓									There are moderate beneficial noise impacts for all affected social groups due to the traffic reduction in Melton Mowbray where population is concentrated. Noise changes at amenities are negligible.
Air quality	✓✓										There are moderate beneficial air quality impacts for all affected social groups due to the traffic reduction in Melton Mowbray where population is concentrated. Noise changes at amenities are negligible.
Accidents	✓✓	✓✓					✓✓✓	n	n	n	There are large beneficial impacts for Pedestrians and neutral impacts for other user groups. This is due to pedestrians being concentrated in Melton Mowbray, where traffic is reduced by the scheme, and other user groups being spread more widely across Melton Borough where traffic change is more varied. Children, Young People and Older people experience both decreases in traffic in Melton Mowbray as pedestrians and neutral/increases in traffic in the rest of the Borough as drivers.
Security	n/a	n/a		n/a	n/a	n/a					Not Assessed.
Severance	✓✓✓	✓✓✓	✓✓✓		✓✓✓						There are large beneficial Severance impacts for all groups due to the reduction in traffic in Melton Mowbray where the impacted population is concentrated.
Accessibility	n/a	n/a	n/a	n/a	n/a	n/a					Not Assessed.

11.13 Mitigation

11.13.1 Mitigation was not considered based on the distributional impacts assessment. For user benefits and personal affordability there are only minor distributional effects; for noise, air quality and severance there are none; and for accidents there are none amongst population groups and effects aligned with the scheme aims across user groups.

11.14 Alternative Scenarios

11.14.1 Two alternative scenarios have been considered in the appraisal of the scheme. These both represent scenarios where schemes with lower certainty, but which are being developed, are included.

11.14.2 Not all indicators are likely to be affected by the changes between the core and alternative scenarios. Where there are changes, the likely effect on most indicators is described qualitatively unless additional modelling was undertaken for other parts of the appraisal.

Accelerated Southern Link Road Scenario

11.14.3 The details of this scenario are as described in Section 3.7.

11.14.4 For distributional impacts, these alternative assumptions are materially very similar to the Core Scenario as the only change is in timing of the Southern Link Road scheme.

11.14.5 For user benefits and personal affordability, the affected population is the same as in the Core Scenario and the proportion of the population in each income group is similar in most model zones in Melton Mowbray. There are no concentrations of a particular group in the south of the town, where traffic changes due to the earlier delivery of the southern link are concentrated, who would be differentially impacted by earlier delivery of the Southern Link Road.

11.14.6 Noise and air quality distributional impacts are appraised in the NEMMDR scheme design year and the changes between the with and without scheme models are identical in both scenarios (since the southern link in the Core Scenario is delivered in the design year).

11.14.7 The accident distributional impacts in the NEMMDR scenario appraisal follow a distinct pattern with beneficial impacts for pedestrian groups and cycling which are concentrated in Melton Mowbray where traffic is reduced and neutral impacts for vehicular groups that are spread more widely across Melton Borough.

11.14.8 The earlier delivery of the Southern Link Road will reduce east-west traffic on the southern side of Melton Mowbray and is considered likely to slightly reenforce the beneficial pattern of accident distributional impacts seen in Melton Mowbray in the NEMMDR scenario.

11.14.9 Changes to the Core Scenario severance appraisal will be limited to the routes in the south of Melton Mowbray where the Southern Link Road provides an alternative route between Leicester Road and Burton Road to the residential areas. The areas likely to benefit from reduced traffic, compared with the NEMMDR scenario, are Norfolk Drive, Dalby Road, Queensway, Valley Road, Edendale Road and Kirby Lane. The rating for the severance appraisal, over all the impacted area, is the same Large beneficial as the Core Scenario.

Melton Mowbray Transport Strategy Scenario

11.14.10 The details of this scenario are as described in Section 3.7.

11.14.11 User benefits and personal affordability are concerned with personal travel costs and the main change modelled in this scenario is a change in HGV access to the town which affects business travel. As the population is the same as the Core Scenario and all zones in Melton have a similar income distribution, it is unlikely that the minor routeing of car traffic in response to the changes in HGV traffic will change the Core Scenario appraisal results.

11.14.12 The removal of HGV traffic from the town centre, reductions in traffic flows and queuing are expected to benefit noise and air quality distributional impacts compared with the Core Scenario. Further noise modelling was not undertaken.

11.14.13 The accident impacts in the Core Scenario appraisal follow a distinct pattern with beneficial impacts for pedestrian groups and bicycling which are concentrated in Melton Mowbray where traffic is reduced and neutral impacts for vehicular groups that are spread more widely across Melton Borough. The MMTS is considered likely to significantly reenforce the beneficial pattern of impacts within Melton Mowbray seen in the Core Scenario.

Similarly, severance distributional impacts are adverse in the rural areas outside Melton Mowbray and beneficial within Melton Mowbray. The MMTS strategy will address some of the infrastructure issues and further reduce traffic level in the town centre which may further reduce the severance scores in the with-scheme scenario, leading to a larger change in severance than the NEMMDR scenario.

Section 12 – TEE, Public Accounts and AMCB Tables

12.1 Summary of Analysis

12.1.1 Using the monetised benefits described in the preceding sections of this Economic Assessment Report, this section brings those together to produce the Transport Economic Efficiency (TEE), Public Accounts (PA) and Analysis of Monetised Costs and Benefits (AMCB) tables defined within TAG. These are reproduced as Table 12.1, Table 12.2 and Table 12.3 below. The TEE Present Value of Benefits (PVB) has been calculated at £118.2 million and the overall Present Value of Costs (PVC), or Broad Transport Budget is calculated to be £61.1 million. Including environmental impacts, changes in costs of accidents and changes in physical activity results in the overall PVB increasing marginally to £119.1 million.

12.1.2 These tables are also included as stand-alone MS Excel files accompanying this Economic Assessment Report.

12.1.3 LCC is to make a local contribution to the scheme costs. This has included costs that have been spent to date and hence are considered ‘sunk’ plus further contributions. These further contributions have been calculated based on the expected funding of £49.472 million in 2020 prices. In 2010 prices discounted to 2010 the DfT contribution has been calculated to be £33.547 million which results in an LCC contribution of £27.591 million in 2010 prices discounted to 2010.

12.1.4 In terms of the outturn benefit-to-cost ratio (BCR) of the NEMMDR, two outcomes are provided, one excluding adjusted benefits and one including the adjusted benefits of journey time reliability and wider economic impacts. This results in BCRs of 1.95 and 2.36 for the unadjusted and adjusted outcomes respectively placing the NEMMDR scheme in the high value for money category.

Table 12.1: Transport Economic Efficiency (TEE) Table, Central Growth, 2010 prices and values

Non-Business: Commuting	*Total*
Travel time	£24,108,000
Vehicle operating costs	-£535,000
Construction	-£98,000
Total	***£23,475,000***

Non-Business: Other	*Total*
Travel time	£39,665,000
Vehicle operating costs	-£4,607,000
Construction	-£113,000
Total	***£34,945,000***

Business	*Total*	*Personal*	*Freight*
Travel time	£43,979,000	£20,003,000	£23,976,000
Vehicle operating costs	£4,547,000	£2,051,000	£2,496,000
Construction	-£234,000	-£80,000	-£154,000
Total	**£48,292,000**	**£21,974,000**	**£26,318,000**

Operating Costs	£458,000
Investment Costs	£18,218,000
Developer Contributions	-£7,201,000
Net Business Impact	***£59,767,000***

Present Value of Benefits	***£118,187,000***

Table 12.2: Public Accounts (PA) Table, 2010 prices and values

	Net Scheme Costs
Local Government Funding	
Investment Costs	£34,793,000
Developer Contributions	-£7,201,000
Net Impact	***£27,592,000***
Central Government Funding: Transport	
Investment Costs	£33,548,000
Net Impact	***£33,548,000***
Central Government Funding: Non-Transport	
Indirect Tax Revenues	-£2,943,000
Broad Transport Budget	***£61,140,000***
Wider Public Finances	***-£2,943,000***

Table 12.3: Analysis of Monetised Costs and Benefits (AMCB) Table, 2010 prices and values

Noise		£3,798,000
Local Air Quality		£591,000
Greenhouse Gases		-£2,753,000
Journey Quality		-
Physical Activity		£432,000
Accidents		-£4,100,000
Economic Efficiency: Consumer Users (Commuting)		£23,475,000
Economic Efficiency: Consumer Users (Other)		£34,945,000
Economic Efficiency: Business Users and Providers		£59,767,000
Wider Public Finances (Indirect Taxation Revenues)		£2,943,000
Journey Time Reliability		£5,414,000
Wider Impacts		£20,003,000
Present Value of Benefits (PVB)	Exc. adjusted benefits	**£119,098,000**
	Inc. adjusted benefits	**£144,515,000**
Present Value of Costs (PVC) [Broad Transport Budget]		**£61,140,000**
Initial outcome	**Net Present Value (NPV)**	**£57,958,000**
	Benefit-Cost Ratio (BCR)	**1.95**
Adjusted outcome	**Net Present Value (NPV)**	**£83,375,000**
	Benefit-Cost Ratio (BCR)	**2.36**

Appendix A Scheme Cost Risk Register

Table A1: Scheme Cost Risk Register

Master Category	Category	Risk	Likelihood	Min (£)	Most Likely (£)	Max (£)
Design	General & Staff Resources	Staff sickness affects progress of works.	5%	13	20	30
Design	General & Staff Resources	Coronavirus. Potential for delays due to issues including staff availability, the impact of remote working, restrictions to land access. Potential to miss a window for a survey or we have to stop part way through a survey. Ongoing issue in 2022 due to new strains which are more contagious & 2nd national lockdown plus potential stricter lockdown measures	5%	13	20	30
Design	General & Staff Resources	Potential for LCC to change scope of proposed VE works	50%	47	70	105
Design	Highways	Potential for abortive work associated with gradients of footways (This will impact construction more than design - potential to significantly reduce savings)	20%	33	50	75
Design	Highways	Potential for changes being required to the NEMMDR NMU design at the River Eye and Railway bridge in Section 5 due to changes to DfT design guidance, and possible increased conflict between NMU and livestock movements at the River Eye bridge, resulting from the Updated VE design proposals.	20%	67	100	150
Design	Highways	Potential for requirement to include signal controlled toucan crossings across mainline north of Roundabout 6 due to changes in DfT design guidance and to mitigate against future NEMMDR traffic growth which is partially contingent on completion of the Melton South scheme	10%	7	10	15
Design	Highways	Potential for requirement to include signal controlled toucan crossings at roundabouts 1-5 due to changes in DfT design guidance and to provide increased consistency with LTN 1/20 guidance introduced following completion of scheme design	5%	53	80	120
Design	Structures	Amendments to Lag Lane bridge to provide additional NMU fencing or similar	25%	7	10	15
Design	Structures	Risk of Network Rail objections to revised ground improvement proposals at Railway Bridge abutment locations, if they perceive greater risk to railway from construction operations	10%	33	50	75
Design	Structures	Risk of programme delays due to uncertain Network Rail review/approval periods.	20%	17	25	38
Design	Drainage	Potential for clashes between drainage and other proposed/existing infrastructure such as culverts/badger tunnels/existing & proposed utilities due to level changes required due to VE process	50%	20	30	45
Design	Drainage	Potential need for additional treatment measures and implications for all of the above. This is due to changes in the DMRB method for assessing water quality risks from highway runoff	10%	50	75	113

Master Category	Category	Risk	Likelihood	Min (£)	Most Likely (£)	Max (£)
Design	Drainage	Septic tank adjacent to Grammar School farm - potential objections by landowners to new sewage treatment facility, issues regarding land access rights and potential for new sewage treatment to require localised adjustments to earthworks, drainage and landscaping. VE design of earthworks increases cut in this location.	40%	13	20	30
Design	Geotechnics	Departure from standards needed to use Light Weight Aggregate within embankment. Risk that it will not be approved.	5%	67	100	150
Design	Environmental	Potential delays due to land access agreements for outstanding site surveys (excluding archaeology - see item 6.10)	10%	33	50	75
Design	Environmental	Potential for additional environmental / ecological surveys and mitigation in areas selected for site compounds or topsoil storage areas which are outside the extents of the permanent works and CPO boundary	10%	33	50	75
Design	Environmental	Potential for additional environmental / ecological surveys within 6 months prior to construction to satisfy LCC ecology interpretation of planning Condition 9	40%	33	50	75
Design	Environmental	Risks associated with Archaeological Trenching. Land access delays. Land drains affecting works.	10%	13	20	30
Design	Environmental	Significant archaeology discovered requiring additional trenching and /or full strip map and record and resulting in further cost/delay.	10%	20	30	45
Design	Environmental	Potential for discovery of greater number of land drains than anticipated during archaeological works leading to programme delay / additional repair costs. (10 days of repair costs allowed for)	40%	3	5	8
Design	Statutory Undertakers	Services required for the adjacent development areas impact programme & design.	20%	20	30	45
Design	Statutory Undertakers	Cadent IP Gas main at Twin lakes - detailed design for protection	50%	20	30	45
Design	Statutory Undertakers	Changes to proposed statutory undertakers diversions resulting from GT discussions with Utility Companies result in redesign and additional clashes/ programme delay.	50%	20	30	45
Design	Planning	Potential re-design & programme delays due to Public Enquiry Objections. Public inquiry and Objections now covered in CAR 68, 69 and 71 .	20%	13	20	30
Design	Planning	Section 73 applications associated with VE redesign: Potential for additional assessments required e.g. Environmental/Ecology to inform S73 application	20%	33	50	75
Design	Planning	S73 application - new planning conditions: There is a risk that additional work and / or re-design may be required following submission of the S73 application to satisfy new planning conditions imposed as part of the S73 application. (e.g. Rbt 2 redesign)	25%	33	50	75
Design	Planning	S73 application - there is a risk that the S73 application may be rejected, resulting in redesign and programme delay etc	5%	67	100	150
Design	Planning	Risk that deposition of excess material requires additional design and separate planning approval	50%	30	45	68
Design	Planning	Risk that deposition of excess material requires a further S73 application	50%	30	45	68
Construction	Statutory Undertakers	Discovery of uncharted statutory undertakers plant	30%	100	500	750
Construction	Statutory Undertakers	Statutory Undertakers diversions not commenced/completed as programmed	50%	25	400	700

Master Category	Category	Risk	Likelihood	Min (£)	Most Likely (£)	Max (£)
Construction	Statutory Undertakers	National Grid - working in vicinity of 132kv overhead cable and overly onerous conditions imposed	20%	50	375	563
Construction	Statutory Undertakers	Undertakers and statutory consultees are not fully engaged or responses are delaying programme	4%	25	150	225
Construction	Archaeology	Unplanned/additional archaeological investigation works	20%	100	800	1200
Construction	Archaeology	Additional works needed for compound/soil storage areas	50%	1200	2800	5040
Construction	Network rail	Cancellation of programmed Network Rail possessions at the Railway Bridge	10%	75	300	390
Construction	Network rail	Restricted availability of Network Rail possessions at Railway Bridge	10%	15	150	210
Construction	Network Rail	Delayed Network Rail approvals / sign-off for Temp bridge design of bridge over railway not in line with construction programme (Form 2 & 3)	5%	100	500	700
Construction	Weather	Flooding in the vicinity of the River Eye, Thorpe and Scalford Brooks, other watercourses	20%	70	600	900
Construction	Weather	Above 1 in 10 weather events disrupts earthworks or other Site Wide operations	25%	75	500	750
Construction	Weather	High winds for crane lifts (wind checks on site - include in works information)	60%	50	100	170
Construction	Design	Potential for general design changes during construction impacting construction cost.	12%	100	600	750
Construction	Design	LCC require a significant increase to the work/design scope due to compatibility with developer requirements including access or utilities	20%	20	250	325
Construction	Earthworks	A proportion of unacceptable (including contaminated) materials which cannot be reused on the project requiring disposal off-site to landfill.	10%	75	500	700
Construction	Earthworks	Additional settlement of embankments	10%	50	250	313
Construction	Earthworks	Potential for Unexploded Ordnance has been identified to the east of Nottingham Road.	15%	0	100	140
Construction	Earthworks	Shallow depth material with low CBR may require excavate and replace at very low cutting / embankment / transitions from cut to fill (soft spots)	5%	0	800	960
Construction	Environmental	Invasive species	40%	15	50	80
Construction	Environmental	Potential for additional environmental survey and mitigation and improvement measures in areas out of original scheme extents or where updated surveys are required due to expiry of original surveys.	10%	0	150	210
Construction	Ecology	Newt ponds creation / badgers/ bats missing ecology windows.	10%	50	400	560
Construction	Ecology	Ecology - unidentified issues	15%	10	75	101
Construction	Third parties	Local community and stakeholders impacted are challenging and have complex needs to manage (e.g. continuity of access)	30%	5	50	70
Construction	Third parties	Approvals and licences	15%	5	500	900
Construction	Operations	Poor existing carriageway construction leading to more extensive reconstruction.	30%	50	250	350

Master Category	Category	Risk	Likelihood	Min (£)	Most Likely (£)	Max (£)
Construction	Operations	Traffic impact of incident on A1. Levels of congestion in MM are particularly bad during incidents on the A1. Could also cause disruption to deliveries and access issues to site.	35%	10	200	350
Construction	Operations	Timely approval of traffic management layouts for construction of roundabouts.	5%	20	150	165
Construction	Operations	TM embargos on network.	40%	10	50	80
Construction	Measurement	The topographical survey may be incorrect (high or low)	15%	0	200	260
Construction	Cost	Key individuals leave employment of LCC and / or AECOM / GT, and this affects progress.	25%	50	100	150
Construction	Cost	Coronavirus. Potential for delays due to new outbreak during the construction phase. Issues including staff availability, the impact of site closing, restrictions to land access. Government instructions and advice to be followed.	5%	150	500	750
Construction	Network Rail	Claim from Network Rail for funding to enhance their GSM-R radio network in the vicinity of the NEMMDR Railway	25%	0	190	342
Construction	Structures	Amendments to Lag Lane bridge to increase parapet height or similar	40%	75	120	180
Construction	Environmental	Asbestos found (e.g. within footprint of old canal ML5)	3%	250	750	1245
Construction	Economy	Inflation - Steel	40%	50	200	350
Construction	Economy	Inflation - General Civils	75%	500	1000	1950
Construction	Statutory Undertakers	E.O. Inflation	30%	5	50	88
Construction	Earthworks	Risk of unsuitable material for embankment construction	20%	0	250	400
Construction	Ecology	Mitigated Ecology returning	15%	50	400	520
Construction	Statutory Undertakers	IP gas main protection Rbt 3 - requirement for piled protection slab.	55%	50	250	450
Construction	Drainage	Proposed drainage outfall locations not feasible due to lack of discharge consent or unworkable levels.	10%	30	100	150
Construction	Network Rail	NWR Insurances	60%	40	150	270
Construction	Ecology	Potential for Otters found on site	2%	125	1750	2275
Construction	Third parties	Difficulty of managing crossing frequency of 'The Hawleys' Livestock impacting works and/or PRoW.	20%	20	800	1440
Construction	Third parties	Scheme impacts private services	60%	20	100	180
Construction	Ecology	DLL GCN	100%	0	275	550
Construction	Structures	Resurfacing of carriageway post settlement	60%	20	80	160
Project	Project Management	Lack / change of Resource	10%	20	800	1280
Project	Funding	Funding may be delayed	25%	200	2000	2800
Project	Land	Additional Land negotiation costs	20%	10	1000	1500
Project	Land	Part 1 Claims	13%	10	800	1200

Appendix B Methodology for Physical Activity Forecasting and Appraisal

Appraisal History

In 2017 WSP produced an active mode demand forecast and economic appraisal[9] for the North and East Melton Mowbray Distributor Road Outline Business Case (NEMMDR OBC). This concentrated on cycling demand since the location of the scheme is more likely to make it used by cyclists rather than pedestrians. Since the OBC, the Department for Transport (DfT) has developed the Active Mode Appraisal Tool (AMAT) and there are updates to the scheme that affect the active mode appraisal.

This technical note describes the updates to the active mode (cycling) appraisal for the FBC using the AMAT and updated scheme and economic parameters. The main difference in methodology from the OBC appraisal is that the demand forecasts for AMAT requires daily productions rather than the annual trips used in the previous method. For the FBC, two additional scenarios are also being appraised in addition to the NEMMDR scenario considered at the OBC stage: one including the faster delivery of the developer-led Southern Link Road which forms the southern section of the NEMMDR and the other including the Melton Mowbray Transport Strategy (MMTS) cycling improvements which are dependent on completion of the NEMMDR.

As part of the latest design iteration, the cycling infrastructure has been relocated from alongside the road as assumed in the OBC to a route along the top of the NEMMDR cuttings, introducing separation of the cycle way from road traffic. Between Saxby Road and Burton Road, a right of way along the existing Lag Lane is used, rather than a route tied to the new NEMMDR.

This Note is intended to describe the updates to the OBC appraisal and as such will not repeat the description of methodology and discussion in the OBC technical note[9].

Assumptions

- the cycling demand model assumes that the utility of all modes except cycling remain unchanged;
- benefits are forecast for a 20-year appraisal period as per TAG guidance for active modes;
- the first full year of scheme benefits is assumed to be 2025; and
- all figures are presented in 2010 values and prices.

Revised Core Scenario Demand Forecasts

The FBC forecasts uses the same areal extent as the OBC forecasts (MSOAs Melton 002, Melton 004 and Melton 005) and the same 2011 Census journey to work data[10]. For AMAT calculations, the scheme is assumed to be in MSOA Melton 002. All three MSOAs are of the same ‘Other Urban’ type.

This section describes how the opening-year demand for the Central Growth Core scenario is derived using the OBC methodology, modified to produce daily outbound trip forecasts for AMAT.

Commuting Demand

Table 12.4 shows the 2011 Census journey to work data which were also used as the basis for the active mode assessment of the OBC and FBC forecasts.

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[9] Technical Note: Melton Mowbray Distributor Road – Active Mode Demand forecasting and economic appraisal (WSP 06/12/2017).

[10] WU03EW - Location of usual residence and place of work by method of travel to work (MSOA level).

Table 12.4: Cycle Commuters in the 2011 Census

Cycling to Work	Residents	Workplace	Internal	Total
E02005392: Melton 002	146	168	154	160
E02005394: Melton 004	150	143	115	178
E02005395: Melton 005	113	74	63	124
Total	**409**	**385**	**332**	**462**

Cycle trip end growth forecasts from 2011 to 2025 were extracted from the National Trip End Model (NTEM) version 7.2. The trip end factors are shown in Table 12.5: . The number of cycling commuters is estimated by applying the NTEM growth factors shown in Table 12.5: to the Census data shown in Table 12.4. The results are shown in Table 12.6 .

Table 12.5: NTEM Cycle Trip End Growth

MSOA	Production	Attraction
Melton 002	0.897	0.970
Melton 004	0.873	0.977
Melton 005	0.884	0.976

Table 12.6: 2025 Cycle Commuter Forecast (NTEM)

MSOA	Residents (Production)	Workplace (Attraction)	Workplace living in study area (Attraction)	Total
Melton 002	131	163	149	144
Melton 004	131	140	112	158
Melton 005	100	72	62	111
Total	**362**	**375**	**323**	**413**

From this section the FBC forecast will diverge from the OBC and will calculate daily outbound trip forecasts rather than annual trip forecasts to provide inputs in the correct form for AMAT.

The average number of daily trips made by these commuters was calculated using these assumptions:

- commuters cycle 40 weeks per year; this conservatively accounts for holidays, sick leave, working from home/away from the workplace;
- the average number of hours worked in Melton Mowbray is 38.8 hours per week 11 - assuming a 7.5 hour working day, this equals 5.2 days per week; and
- there is an outbound trip with the return applied in AMAT.

The estimated average daily number of outbound commuting trips are therefore:

413 Commuters x 40 Weeks x 5.2 days / (52 Weeks x 5 Days) = 329 outbound trips

This equates to a daily rate of 0.796 trips per day per commuter, or one commute every 1.256 days for each commuter.

Non-commuting Demand

Non-commuting demand was estimated by applying National Travel Survey 12 (NTS) trip proportions to the estimate of commuting demand. The updated NTS data from table NTS0409 (trip data by

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[11] ONS (2022) Annual Survey of Hours and Earnings, workplace analysis, 2019

[12] Department for Transport (2022) National Travel Survey. https://www.gov.uk/government/collections/national-travel-survey-statistics

purpose) and NTS0410 (distance data by purpose) are shown in Table 12.7. This shows that 33% of trips are made for a commuting purpose, 34% of trips are made for leisure and 33% of trips are made for other purposes.

Table 12.7: 2019 National Travel Survey Cycling Data

Purpose	Annual Trips	Miles	Miles/Trip	Km/Trip	% Total Trips
Commuting	5.4	17.25	3.19	5.14	33
Business	.47	1.49	3.17	5.1	3
Education	1.63	2.24	1.37	2.21	10
Shopping	2.02	3.25	1.61	2.59	12
Other escort	.17	.25	1.47	2.37	1
Personal Business	1.03	1.98	1.92	3.09	6
Leisure	5.46	26.35	4.83	7.77	34
All Purposes	**16.18**	**52.72**	**3.26**	**5.24**	**100**

Based on NTEM growth forecasts and the NTS trip proportions, the estimated average daily number of non-commuting outbound trips is 657 (329 x (1-0.33)/0.33) and the total (commuting + leisure) average daily number of outbound trips is 986 (657+329) trips.

To estimate the number of non-commuter cyclists NTS table 0313 is used. This reports frequency of cycle usage and is shown in Table 12.8. For the 3+ category, 5 days are used so that the daily trip rate (0.712) is comparable with the commuting trip rate (0.796) using the assumption that regular commuters are the most frequent cyclists. This produces an average rate of 0.21 productions per day, or a ride every 4.76 days.

Table 12.8: 2019 National Travel Survey Cycling Usage

Frequency	Annual	Daily	Percentage of Population	Volume
3+ days/week (5 days)	260	0.712	7%	0.050
1 or 2 days/week	78	0.214	7%	0.015
<1 day/week >1day/fortnight	39	0.107	6%	0.006
1 day/fortnight to 1 day/month	19	0.052	6%	0.003
1 day/month to 1 day/6 months	7	0.019	6%	0.001
1day/6months to 1 day per year	1.5	0.004	4%	0.0002
			Weighted Average	**0.210 productions/day**

The 657 non-commuting outbound trips therefore require 3,125 non-commuting cyclists (657*4.76) giving a total number of cyclists of 3,538.

Growth Adjustments

The planning data included in NTEM v7.2 provide a consistent growth forecast against which competing schemes, through constraint applied at district or county level, can be assessed. Active mode trips are relatively short and the growth driving changes in demand is relatively local to the scheme. The growth in NTEM may not therefore accurately represent the local growth close to the scheme. In the 3 MSOAs containing Melton Mowbray being considered for this appraisal, the NTEM housing growth between the model base year (2014) and scheme opening year (2025) is 664 dwellings.

Between 2014 and 2025, the planning dataset that was used in the FBC highway model (updated based on the latest planning data in early 2022) has growth of 1440 dwellings that meet TAG certainty criteria in the appraisal area. NTEM significantly underestimates the local short-term growth close to the scheme.

New dwellings are likely to be under-represented in the NTEM data so are explicitly modelled as extra dwellings, to avoid underestimating demand close to the scheme.

Assuming the trip rates for the development population are like those for the background population, the effect of adding the additional 776 dwellings is an additional 20 commuter trips and 41 leisure trips as shown in Table 12.9.

Table 12.9: Revised Trips (Including Local Housing Adjustment)

NTEM 2025 Dwellings	NTEM Commuting Trips	NTEM Non-commuting Trips	Commuting Trip Rate	Leisure Trip Rate	Extra Dwellings	Revised Commuting Trips	Revised Leisure Trips	Revised Total Trips
12,526	329	657	0.026	0.052	776	**349**	**698**	**1047**

1.6 Table 12.10 shows a summary of the daily outbound cycle demand estimated for 2025.

Table 12.10 Summary of Opening Year Average Daily Cycle Demand Without the Scheme

Scenario	Type	Trips	People
2025 Core	Commuter	349	439
	Non-Commuter	698	3,318
	Total	**1,047**	**3,758**

NEMMDR Scenario Demand Response

The sketch plan elasticity calculation used in the OBC appraisal is consistent with the current TAG Unit A5.1 and is also used for this appraisal. In the current design, the increase in cycling facilities is around 5km since Lag Lane, an existing route, is used for the section between Saxby Road and Burton Road. The NEMMDR increases the proportion of cycling facilities by 59% and an elasticity of 0.05 results in an increase in demand of 2.95%. For clarity the calculation is shown in Table 12.11.

Table 12.11: Infrastructure Elasticity Calculation for the NEMMDR Scenario

Description	Current	With NEMMDR
Length of Road Network (m)	108,119	113,110
Length of Cycle Facilities (m)	7,533	12,533
Proportion of cycle facilities	7%	11%
Increase in proportion		59%
Expected increase in trips (Increase in proportion of cycle facilities x0.05)		**2.95%**

Southern Link Road Scenario

The accelerated delivery of the Southern Link Road would introduce a significant increase in cycling infrastructure in both the With and Without NEMMDR scenarios, with 3.28km of segregated cycle path envisaged[13] alongside the Southern Link Road.

The opening year demand for this scenario would be identical to the NEMMDR scenario since none of the Southern Sustainable Neighbourhood developments that are included in the planning data begin before 2026. Only the link road cycle infrastructure is considered.

Uplift would be less than the NEMMDR Scenario, as the additional 3.28km of cycle path along the southern link increases the increase length of cycling facilities in the without-scheme case. The expected increase in trips due to the NEMMDR is 2.00% as shown in Table 12.12.

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[13] https://democracy.melton.gov.uk/documents/s9539/Item%206%20-%20Appendix%20A%20part%202%20-%20South%20Sustainable%20Neighbourhood%20Masterplan-PART%202.pdf

Table 12.12: Infrastructure Elasticity Calculation (Southern Link Road Scenario)

Description	Current With Southern Link	With NEMMDR and Southern Link
Length of Road Network (m)	111,399	116,390
Length of Cycle Facilities (m)	10,813	15,813
Proportion of cycle facilities	10%	14%
Increase in proportion	40%	
Expected increase in trips (Increase in proportion of cycle facilities x0.05)	**2.00%**	

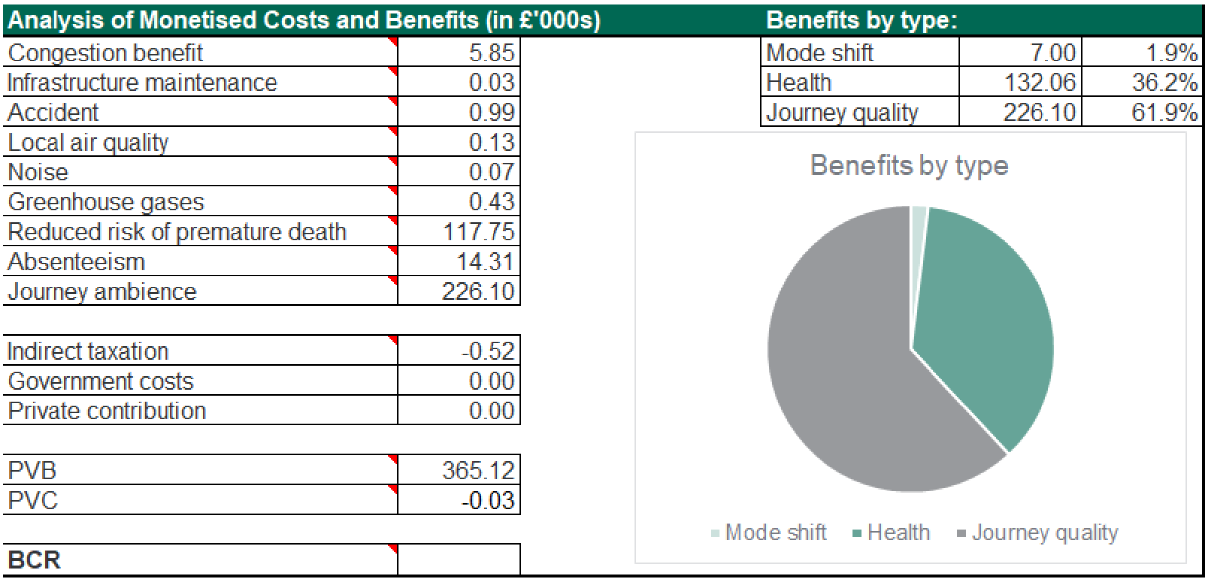
Table 12.13: Daily With-Scheme Demand (Southern Link Road Scenario)

Purpose	Trips Without NEMMDR	Users Without NEMMDR	New Trips	New Users	Trips with NEMMDR and Southern Link	Users with NEMMDR and Southern Link Users
Commuting	329	439	7	9	356	448
Non-Commuting	657	3,318	14	66	711	3,386
Total	**1,047**	**3,758**	**21**	**75**	**1,068**	**1,143**

With the smaller demand response compared to the NEMMDR Scenario, from having additional infrastructure in the without-scheme case, the Present Value of Benefits (PVB) for the NEMMDR cycling facilities drop to £365,000 as shown in Figure 12-1.

The sensitivity review results for the NEMMDR scenario are also applicable to this scenario and suggests that the forecast PVB for this alternative scenario is also conservative.

Figure 12-1: Southern Link Road Scenario AMCB Table



Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	5.85
Infrastructure maintenance	0.03
Accident	0.99
Local air quality	0.13
Noise	0.07
Greenhouse gases	0.43
Reduced risk of premature death	117.75
Absenteeism	14.31
Journey ambience	226.10
Indirect taxation	-0.52
Government costs	0.00
Private contribution	0.00
PVB	365.12
PVC	-0.03
BCR	

Benefits by type:		
Mode shift	7.00	1.9%
Health	132.06	36.2%
Journey quality	226.10	61.9%

Melton Mowbray Transport Strategy Scenario

The proposed Melton Mowbray Transport Strategy 14 (MMTS) consists of further mitigation on the town road network that is dependent on the NEMMDR and intended to complement the NEMMDR to help

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[14] https://www.leicestershire.gov.uk/sites/default/files/field/pdf/2021/7/27/Interim-Melton-Mowbray-transport-strategy.pdf

manage future traffic growth in the town centre. It is at an early stage of development and not part of the NEMMDR scenario.

The Interim Melton Mowbray Transport Strategy[4] highlights that there are perceived concerns for active mode travel in Melton Mowbray around the level of HGV and LGV traffic using the centre of the town, principally on the A607 and A606. For cycling, the perceived issues are safety and air quality/journey ambience and for walking they are severance and air quality.

Walking improvements in the MMTS are intrinsically linked to the proposed highway improvements (NEMMDR, road declassification and weight limits restricting HGVs) and the changes in perceived severance these will produce. These are best appraised in terms of a severance appraisal as part of the distributional impact appraisal.

Melton Mowbray is compact, with a large proportion of the population working within the town so there is potential to raise the level of walking and cycling significantly from the current ~2% of commuting trips. Current cycling infrastructure is piecemeal and will not link up with the infrastructure envisaged in the sustainable neighbourhoods where active modes will be prioritised.

For cycling, the Interim Melton Mowbray Transport Strategy[4] document contains an aspirational cycling network as shown in Figure 12-2.

The length of the routes shown in Figure 12-2 and the proportion of main roads are shown in Table 12.14.

It is assumed that the changes in facilities are concentrated on the main roads. The additional length of cycle facilities on the main roads has been added to the elasticity calculation in Table 12.15 giving an uplift in trips of 7.06%.

Most of the MMTS routes are on existing roads likely to be used by cyclists currently. For the AMAT calculation it is assumed that the infrastructure is on-road segregated cycle lanes, typical of main road interventions in mixed strategic cycle route schemes 15.

Table 12.17 illustrates the usage calculation for AMAT. It is assumed as previously that leisure trips use the orbital route and non-leisure trips use the radial routes improved by MMTS. Using the NTS trip lengths and average scheme lengths as assumed previously (one section per trip) produces a conservative estimated usage of new facilities during an average trip of 21%.

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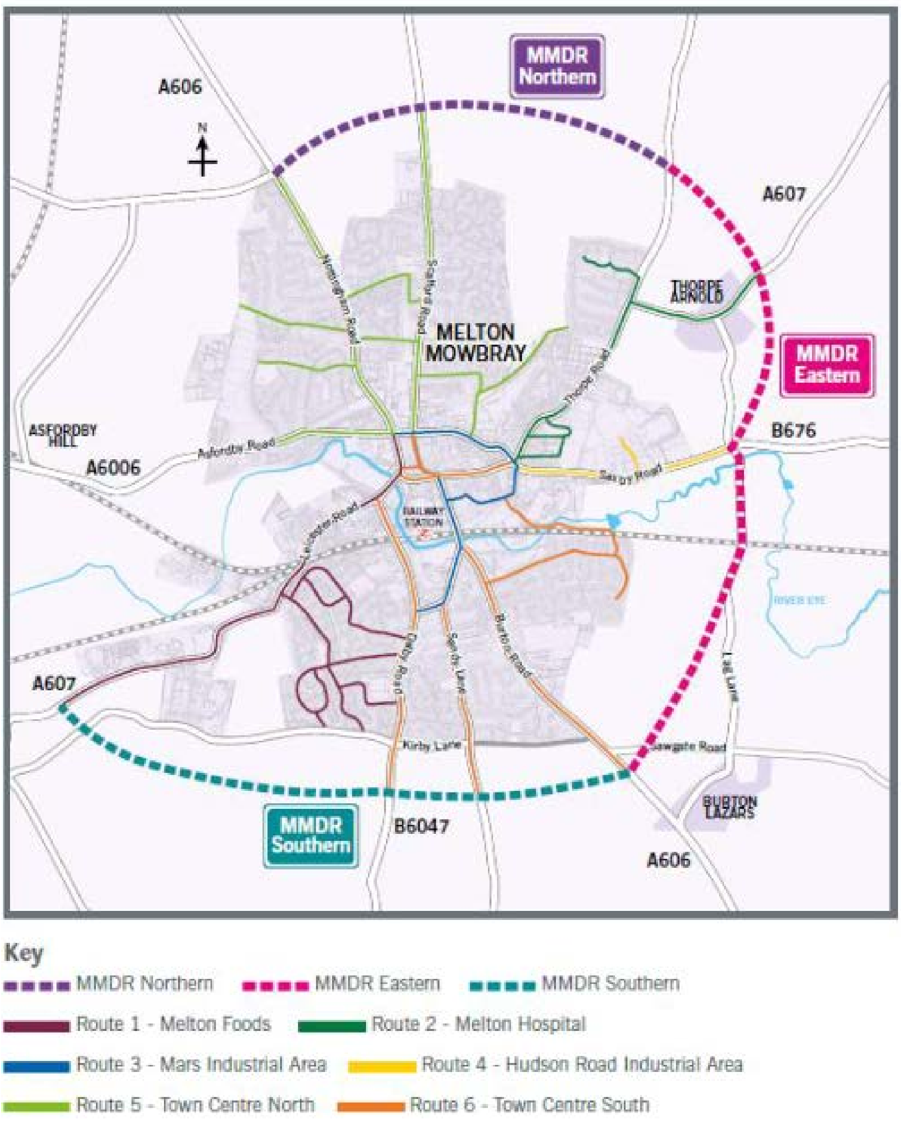
[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/742451/typical-costings-for-ambitious-cycling-schemes.pdf

Figure 12-2: Interim Melton Mowbray Transport Strategy Aspirational Cycle Network.



Source:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/742451/typical-costings-for-ambitious-cycling-schemes.pdf

Table 12.14: Proposed MMTS Cycle Route Lengths

Route	Kilometres	A Road Kilometres
1 – Melton Foods	7.2	1.6
2 – Melton Hospital	3.7	1.3
3 – Mars Industrial Area	2.6	0.8
4 – Hudson Road Industrial Area	1.6	0.9
5 – Town Centre North	8.5	1.1
6 – Town Centre South	8.0	1.2
Total	**31.7**	**11.9**
Average		**1.7**

Table 12.15: Infrastructure Elasticity Calculation (Melton Mowbray Transport Strategy Scenario)

Description	Current With Southern Link	With Southern Link, NEMMDR and MMTS Cycle Routes
Length of Road Network (m)	111,399	116,390
Length of Cycle Facilities (m)	10,813	27,720
Proportion of cycle facilities	10%	23%
Increase in proportion		141%
Expected increase in trips (Increase in proportion of cycle facilities x0.05)		**7.06%**

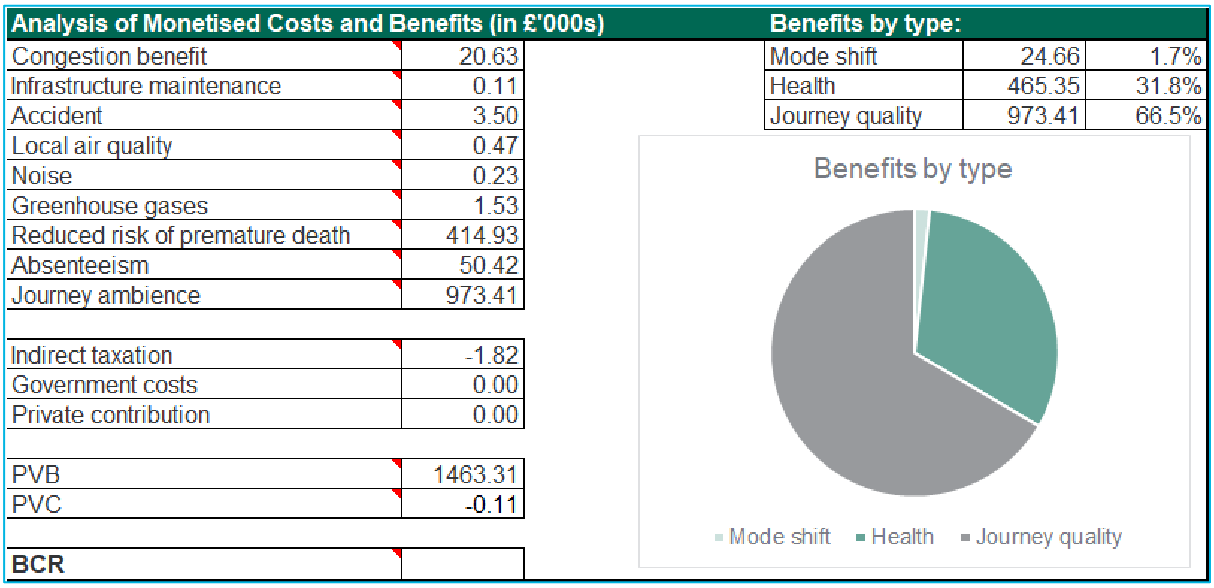
Table 12.16: Daily With-Scheme Demand (Melton Mowbray Transport Strategy Scenario)

Purpose	Trips Without NEMMDR	Users Without NEMMDR	New Trips	New Users	Trips with NEMMDR, Southern Link and MMTS Cycle Routes	Users with NEMMDR, Southern Link and MMTS Cycle Routes
Commuting	329	439	25	31	382	470
Non-Commuting	657	3,318	49	234	762	3,552
Total	**1,047**	**3,758**	**74**	**265**	**1,149**	**4,022**

Table 12.17: Usage Calculation for AMAT

	Orbital (Leisure only)	Radial (Non-Leisure)
Average trip length (km)	7.77	3.97
Average scheme length (km)	1.25	1.7
Proportion of trip	43%	16%
Percentage users	34%	66%
Weighted Average		**21% Usage**

Figure 12-3: Melton Mowbray Transport Strategy Scenario AMCB Table



Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	20.63
Infrastructure maintenance	0.11
Accident	3.50
Local air quality	0.47
Noise	0.23
Greenhouse gases	1.53
Reduced risk of premature death	414.93
Absenteeism	50.42
Journey ambience	973.41
Indirect taxation	-1.82
Government costs	0.00
Private contribution	0.00
PVB	1463.31
PVC	-0.11
BCR	

Benefits by type:		
Mode shift	24.66	1.7%
Health	465.35	31.8%
Journey quality	973.41	66.5%

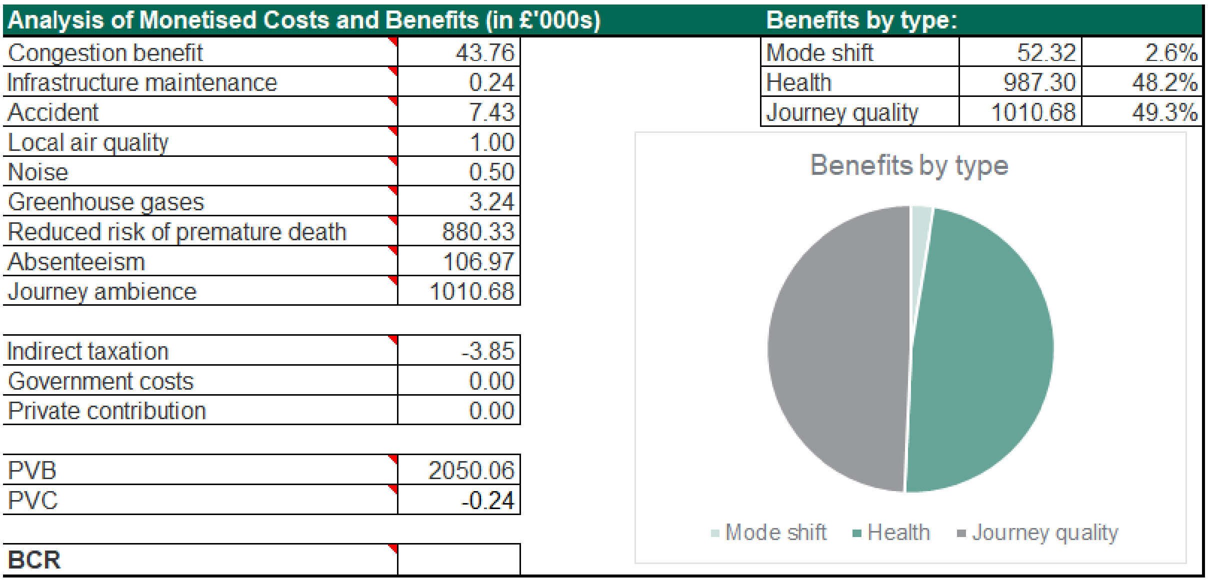
The PVB for the scenario in which the Melton Mowbray Transport Strategy Cycle scheme is £1.46m over a 20-year appraisal period from 2025. This includes the facilities on the NEMMDR and a conservative assumption of the town centre improvements (main roads only). This produces an uplift of 7.06% of cycling trips which is still significantly below the outturn uplift of comparable cycling infrastructure schemes detailed in the OBC active mode appraisal[9] (15% minimum uplift for orbital and radial cycle routes).

This analysis shows that even with a conservative uplift in cycling demand, the NEMMDR cycling facilities and the additional cycle scheme facilitated by the NEMMDR provide significant benefits.

Melton Mowbray Transport Strategy Sensitivity Review

In the OBC work[9], a comparable scheme with an uplift of 15% in demand, for the radial plus orbital route scenario, was identified. The MMTS scenario is equivalent to this scenario and a sensitivity test with a 15% uplift in demand was undertaken. This provides a PVB of £2.05m confirming that the main result is conservative.

Figure 12-4: Melton Mowbray Transport Strategy Scenario (15% uplift) AMCB Table



Analysis of Monetised Costs and Benefits (in £'000s)	
Congestion benefit	43.76
Infrastructure maintenance	0.24
Accident	7.43
Local air quality	1.00
Noise	0.50
Greenhouse gases	3.24
Reduced risk of premature death	880.33
Absenteeism	106.97
Journey ambience	1010.68
Indirect taxation	-3.85
Government costs	0.00
Private contribution	0.00
PVB	2050.06
PVC	-0.24
BCR	

Benefits by type:		
Mode shift	52.32	2.6%
Health	987.30	48.2%
Journey quality	1010.68	49.3%

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