April 2013

Review of Lower Thames Crossing Options: Model Capability Report

Prepared by: .... Andrew Currall, Senior Consultants

Checked by: .... Mark Dazeley, Associate Director

Approved by: .... Paul Hanson / Ian Burrows, Regional Directors

Review of Lower Thames Crossing Options:

Rev No	Comments	Checked by	Approved by	Date
1	Issue 1 – Chapters 4,5,6,7 only	MJD	PAH	2012-06-22
2	Issue 2 – Chapters 1-8	MJD	MJD	2012-07-04
3	Issue 3 – Chapters 1-9	MJD	PAH	2012-07-05
4	Issue 4 – Final version following client comments	AC	IOB	2012-07-20
5	Issue 5 – Revised final version following client comments	MJD	IOB	2012-07-26
6	Issue 6 – Minor revisions	MJD	IOB	2013-05-13

AECOM House, 63-77 Victoria Street, St Albans, Hertfordshire, AL1 3ER
Telephone: 01727 535000 Website: http://www.aecom.com

Job No 60249197 Reference Model Capability Report Date Created April 201

Table of Contents

1 Introduction

1 Introduction

1.1 Purpose of Report

1.1.1 This report is the first of a series of technical documents produced as part of the 'Review of Lower Thames Crossing Capacity Options' study, commissioned by the Department for Transport in 2012. The report documents the work undertaken to establish the transport modelling tool and to verify that the outputs are plausible and suitable for the study requirement. It covers existing transport models and data sources that have been considered, and details the application of the models and data for use in this study.

1.2 Background

1.2.1 AECOM has been appointed by the Department for Transport (DfT) to undertake a study to provide strategic outline business cases for three location options (including a variant) for providing additional river crossing capacity in the Lower Thames area. These options were identified as a result of previous analysis set out in, the 'Dartford River Crossing Study (2009)'[1].

1.2.2 The first Dartford Thurrock River crossing, the A282, was in the form of a single bore tunnel which opened in 1963. In line with growth in demand, a second bore tunnel was completed 1980 and the Queen Elizabeth II Bridge opened in 1991.

1.2.3 As reported in the 'Dartford River Crossing Study', the existing crossing provision suffers from significant congestion; the study identified the issues caused by these constraints as well as proposing both short-term (the use of technology and changes to the toll plaza locations) and long-term (three options for additional crossing capacity) mitigation measures.

1.2.4 As part of the Government's Comprehensive Spending Review (CSR) 2010, the DfT committed to both short and medium term measures to address congestion as well as to review the longer term capacity options. The focus of this study is to address and develop the longer-term capacity options.

1.2.5 The aim of the Study is to provide strategic outline business cases for the potential locations identified by the Dartford River Crossing Study for additional river crossing highway capacity in the Lower Thames area, and a comparison between the location options and the Do Minimum option.

1.2.6 The Study objectives are:

- to ensure that the assessment of potential locations is underpinned by a robust evidence base, based on a proportionate approach to meeting the DfT's WebTAG guidance;
- to use the five case model set out in DfT Transport Business Case guidance to assess the alternative viable locations, with:
    - AECOM assessing the case for change ('strategic case'), value for money ('economic case' which includes consideration of environmental, economic, social and distributional factors) and achievability ('management case'); and
    - DfT assessing commercial viability ('commercial case') and financial affordability ('financial case') and these should be adopted into, and be recognised in, the summary of the overall business cases.

1.2.7 In order to meet these Study objectives, transport models are required to generate an evidence base to act as the basis of the appraisal and assessment. In clarifying the methodology to be used, account has been taken of DfT guidance on the need for a proportionate approach (refer to guidance in WebTAG Unit 2.1.2C). There are models and data that can be used to create a new model that makes best use of existing information within a relatively short timeframe commensurate with this early stage of developing proposals for a new crossing. The Highways Agency's M25 Model in particular, was identified as the starting point for developing modelling capability for the purpose of this study.

[1] Dartford River Crossing Study into Capacity Requirements (April 2009), prepared by Parsons Brinckerhoff for DfT. Available at: http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/about/strategy/capacityrequirements/dartfordrivercrossing/

1.2.8 The model development effort has resulted in the derivation of the Lower Thames Crossing Model (LTCM), consisting of:

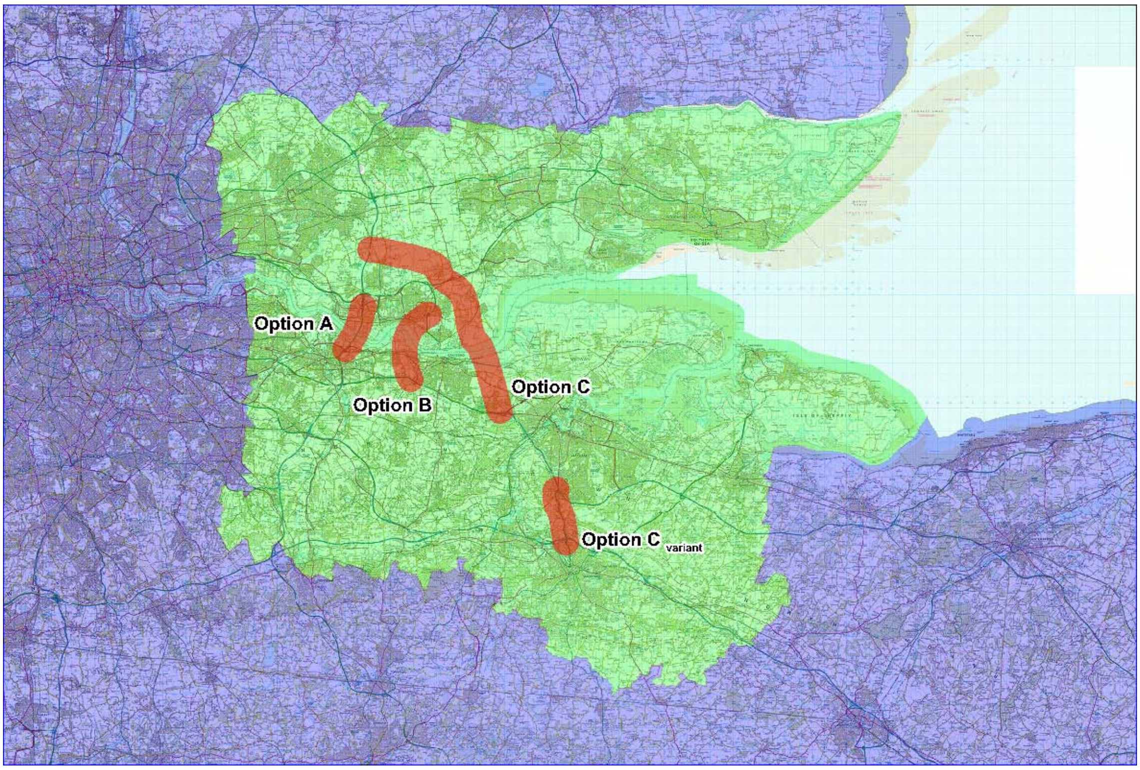
- the Lower Thames Crossing Demand Model (LTC_{DM}), a variable demand forecasting model, developed using EMME software; and
- the Lower Thames Crossing Highway Assignment Model (LTC_{HAM}), developed using SATURN software.

1.3 Study Area

1.3.1 A Study Area has been defined, namely an area that has the greatest model detail, and an area that has received the greatest attention when preparing the models for use in the assessment of additional crossing capacity in the Lower Thames area.

1.3.2 This Study Area is shown in green in Figure 1.1, as well as indicative locations for the additional crossing options to be tested and appraised.

Figure 1.1: Study Area and Indicative Location Options



1.4 Report Structure

1.4.1 This Model Capability Report documents existing models and data sources that have been considered for use in this Study, and details how they have been incorporated into the existing M25 Model, resulting in the new LTC_{DM} and LTC_{HAM}. The main enhancements are the refinement of the spatial detail of the model, and an extension of their capability (primarily enhancements aimed at improving the way that travellers perceive tolls).

1.4.2 The report then considers how the revised models perform in the 2009 base year, comparing modelled traffic flows with observed data, and comparing how sensitive the models are to changes in input assumptions; these are compared with empirical data and the DfT's WebTAG guidance. Finally the report comments on the suitability of the model for forecasting and appraisal purposes.

1.4.3 Following this introduction, this report is structured as follows:

- Chapter 2: Existing Models and Data;

- Chapter 3: Data Sources for Model Enhancement;
- Chapter 4: Spatial Refinement;
- Chapter 5: Approach to Toll Modelling;
- Chapter 6: Base Year Highway Model ;
- Chapter 7: Demand Model Realism Tests;
- Chapter 8: Demonstration Testing;
- Chapter 9: Suitability of the Model for Forecasting and Appraisal.

Appendices then provide supporting information to this report, as follows::

- Appendix A: Model Status Report
- Appendix B: Appraisal Methodology Report
- Appendix C: Identification of Significant Links
- Appendix D: Routeing Verification Plots
- Appendix E: Analysis of Matrix Estimation Impacts

2 Existing Models and Data

2 Existing Models and Data

2.1 Introduction

2.1.1 The LTCM requirement is for a model that makes best use of existing models and data, and can support a strategic outline business case for each of the three crossing options, shown in Figure 1.1. The model does not need to support detailed design, but should be sufficiently robust to estimate the scale of user benefit from each option, and critically, to distinguish between the relative merits of each of the options.

2.1.2 It is with this requirement in mind that this chapter reviews the existing models and data to establish the availability of models and data that can be used to develop the LTCM.

2.2 Suitable Models and Data Available to the Study

2.2.1 The following models and data sources have been reviewed for use in this Study:

- the M25 model;
- the Thames Gateway South Essex Model;
- the Kent Thameside Model;
- the Medway Traffic Model;
- the East London Highway Assignment Model;
- the M25-A13 Corridor Relieving Congestion Scheme Model;
- the Base Year Freight Matrices (BYFM); and
- the Freight in London Model (FiLM).

These models are discussed individually in the following sections.

2.3 M25 Model

2.3.1 The M25 Model has been developed and maintained for the Highways Agency since 2005. The model has undergone significant investment since its inception and has been used to support the Highways Agency's ongoing M25 widening programme, as well as for applications relating to Heathrow Airport and the 2012 Olympics.

2.3.2 The M25 Model was also used for the previous Option A assessment undertaken by Halcrow/Hyder, and has recently been refined by Hyder for use in the modelling of free-flow tolling options.

2.3.3 In considering this pedigree and the alternative existing models available, the M25 Model is the obvious starting point with which to develop a model with the sole focus of the assessment of Lower Thames crossing options.

2.3.4 The M25 Model was developed to assess the transport impacts of forecast traffic growth and for the assessment of transport interventions within and around London, with specific reference to the demand management strategies on and around the M25, requiring consideration of:

- the potential range of developments across the region and the consequential travel demands;
- the scale of development at Heathrow, Gatwick and Stansted Airports and the possible breadth of impacts on the regional transport infrastructure; and
- the credibility and robustness of the modelling suite to withstand detailed examination at Public Inquiry.

2.3.5 Recognising the then existing capabilities of modelling software and methods, a suite of linked models was developed, with each focused on specific issues. The key components of this M25 Model are:

- an M25 Assignment Model, M25AM, developed by Hyder Consulting from the existing M25 North of Thames Assignment Model (NoTAM) SATURN model, incorporating travel demand data derived from the 2001 London Area Travel Survey (LATS) data;
- a multi-modal M25 Demand Model (M25DM), developed by AECOM, providing demand model capability, covering trip generation and trip frequency, time period, mode and destination choice; and

2.3.6 Of relevance to this study, the M25 Model has been used in the recent past to assess Option A (HyderHalcrow JV) and is currently being used to assess free flow tolling on the existing Dartford Crossing. The most recent version of the model, the B602 version, has been enhanced to incorporate improved representation of the river crossings for the A282 at Dartford and the A210 Blackwall Tunnel, incorporating new speed-flow curves and coding at the crossings.

2.3.7 The detailed simulation model network covers the South East region and the southern parts of the East of England region. Away from these areas, the network provides more skeletal coverage of the rest of Great Britain, represented through the use of less detailed buffer-style network coding. The simulation network covers an area broadly from Reading in the west to just east of Medway and Rochester in the east, and from Stevenage in the north to Gatwick Airport in the south. With reference to the South East, which is to be the primary focus of this study, the network extends to Junction 5 on the M2 at Sittingbourne, some 20 miles west of Canterbury, and to Junction 8 of the M20 some 20 miles north-west of Ashford.

2.3.8 The M25 highway model has the following dimensions:

- 1,417 zones;
- 48,910 network links, of which 34,359 are simulation and 14,551 are buffer.
- 18,533 nodes, of which 14,841 are in simulation network and 3,692 are in buffer.
- 6 user-classes (low/medium/high income (non-work), employers' business, LGV, HGV); and
- 3 time-periods (AM peak, interpeak, PM peak); no pre-peak (PASSQ) assignments;

2.3.9 The M25 demand model has the following dimensions:

- 1417 zones;
- 5 demand segments (commuting, other, employers' business, LGV, HGV);
- 2 types of car availability (car and no-car available); and
- 4 time periods (AM period, interpeak period, PM period, off peak period).

2.3.10 The highway demand matrices used in the M25 Model were developed from LATS roadside interview data collected in 2001 and 2004 traffic count data. The age of these data add some uncertainty to the trip patterns, but there is no more recent comparable data set providing the scope and coverage of the 2001 LATS data.

2.3.11 The M25 Model demand matrices were rebuilt by AECOM during 2008, incorporating greater coverage of RSI survey data than previously used in the NoTAM donor model, the focus of which was to the north of the Thames. Synthetic demand data were used to represent unobserved trip movements and merged with observed data using variance-weighting techniques (essentially giving greater weight to data that has greater statistical confidence).

2.3.12 It should be noted that although the M25 Model uses 1417 zones, the highway demand matrices were developed in 2532 zones (NAOMI zoning), before being aggregated to M25 Model zones. These more disaggregate demand data will be of potential use if the disaggregation of M25 Model zones is considered necessary; this is discussed in Chapter 4. The NAOMI zones are particularly disaggregate to the south of the Thames Estuary.

2.3.13 The public transport demand matrices were developed synthetically, calibrated to TEMRPO trip ends and trip length profiles from the National Travel Survey.

2.3.14 Given the provenance of the model, its data and its structure, it is clear that the M25 Model is the most suitable basis with which to develop the strategic outline business cases for the crossing variants.

2.3.15 The M25 Model is documented in three key documents:

- a technical note detailing the highway matrix development;
- a Local Model Validation report (LMVR) for the highway model; and
- a Model Development and Validation Report (MDVR) for the demand model.

Thames Gateway South Essex Model

2.3.16 The Thames Gateway South Essex model (TGSE) consists of an upper-tier land-use, economic and transport interaction model (SETLUM), a middle-tier network assignment model coded in Omnitrans software and a lower-suite of operational models.

2.3.17 The TGSE covers the majority of the Thames Gateway region, extending 40 miles along the River Thames from the London Docklands in the west to Southend-on-Sea in the east. The model is broadly bounded by the A12 in the north and the River Thames in the south, and from the River Crouch in the east and the M25 in the west.

2.3.18 The model is comprised of 380 zones, 249 of which cover the internal study area to a relatively fine level of detail. These zones are broadly aligned with 2001 Census geographical and administrative boundaries.

2.3.19 The highway demand matrices were developed by AECOM using a similar methodology used to develop the M25 Model matrices. Roadside interview data came from two sources: local RSIs undertaken in 2006 and LATS RSIs undertaken in 2001.

Kent Thameside Model

2.3.20 The Kent Thameside Model (KTS) is multi-modal transport model that has been developed for the purpose of predicting the impact effects of development in the KTS area. The detailed model simulation area covers the highway network stretching from the boundary of the London Borough of Bexley in the east to Gravesend in the west, and bound by the River Thames in the north and the A2 in the south. Less detailed buffer network covers most of Greater London and Kent.

2.3.21 The KTS model consists of 590 zones, the majority of which are located within the Kent Thameside area, with a good level of detailed zoning in south Essex and the remainder of Kent, and the remaining zones becoming progressively more aggregate away from the study area. The zones are broadly based upon 2001 Census boundaries, although there are some instances of more disaggregate zoning that crossed the 2001 Census Output Areas boundaries.

2.3.22 The highway matrices are primarily based upon observed data used in the original model build in 1993; a subset of these data were enhanced in a model update to a 2005 base-year, making use of 2001 LATS survey data to replace the river crossing information only (Rotherhithe Tunnel, A102 Blackwall Tunnel and A282 Dartford Crossing) and use of some limited 2002 RSIs undertaken in the London Borough of Bexley.

Medway Traffic Model

2.3.23 The Medway Traffic Model (MTM) covers a relatively restricted set of network and zone definitions primarily within the urban areas of Chatham, Gillingham and Rochester, bound to the south by the M2 motorway, with links to Gravesend in the west and the A249 in the east. Some detail of the A228 and on the Isle of Grain has also been included to the north.

2.3.24 There is little detail in either the network or zone structure outside Medway, in recognition that sufficient data were not available in order to model traffic movements outside the district. The trip matrices in the MTM have been created primarily from synthetic data, making use of pre-existing synthetic matrices and with no new roadside interview surveys undertaken.

2.3.25 Unlike the M25 Model, the Medway Transport Model zones are not built from aggregations of output areas or larger-aggregated recognised boundary datasets, with zone boundaries frequently bisecting those from the 2001 Census geography. This is inconsistent with the M25 Model and WebTAG guidance (3.19C).

East London Highway Assignment Model

2.3.26 The East London Highway Assignment Model (ELHAM) is one of five highway assignment models developed by TfL covering the Greater London area. These, together with the London Regional Demand Model (LoRDM) and Regional Railplan form the basis of TfL's London regional modelling capability. This model is subject to on-going improvements, but the version available at the time is a 2009 validated model, released in early 2011.

2.3.27 ELHAM covers 10 boroughs as part of its area of detailed modelling, with parts of the M25 falling within the Study Area. Outside these 10 boroughs there is a detailed representation of network, albeit in buffer network coding in some cases, particularly in North, Central and parts of South London. In order to accurately represent this level of detailed network coding, the model contains a significant number of zones; in total there are 1,471 zones, of which 1,103 are within the area of detailed modelling. These zone boundaries are defined based on administrative boundaries in line with WebTAG guidance.

2.3.28 The prior matrices for this model were developed using a large number of RSI locations. The first set of data was from the Continuous Roadside Interview Survey Programme (CRISP) from 2008 / 2009 which focuses on RSI surveys for cordons, or enclosures, or areas within London. In addition to this there is a Thames Screenline of RSI surveys that has been used in the development of the prior matrices.

2.3.29 As part of the calibration / validation of the highway model, there is a good coverage of both counts and journey times within the East London area. In terms of counts, there are cordons for each of the matrix build enclosures and a number of screenlines inside the M25, including a Thames Screenline. In terms of journey times all significant routes within the area are covered by observed data. This includes the A12, A13, A2 and A20, as well as the M25, including the Dartford Crossing, and a route passing through the Blackwall Tunnel.

M25-A13 Corridor Relieving Congestion Scheme Model

2.3.30 The incomplete M25-A13 Corridor study has a data collection report and associated data available for use in the development of the LTCM. These have been provided, consisting of ANPR (Automated Number Plate Recognition) data, ATC (Automatic Traffic Count) and MCC (Manual Traffic Count) count data and HATRIS journey time data extracts.

Freight Data (BYFM and FiLM)

2.3.31 We have reviewed the representation of freight demand in the existing M25 Model, and alternative potential data sources.

2.3.32 Due to the evolution of recent travel patterns, the updated 2001-based LGV and HGV matrices in current use in the M25 Model are not guaranteed to be an accurate representation of the current pattern of goods vehicle movements at the existing Dartford Crossing.

2.3.33 The use of a single roadside interview (RSI) survey at the Crossing would in principle be an excellent and cost effective way of obtaining data on the current pattern of goods vehicle movements. However, the timescales and practical problems associated with this work preclude any surveys. Other RSI surveys located away from the Crossing itself are highly unlikely to be a cost-effective approach to collection of adequate data on HGV movements.

2.3.34 We have therefore reviewed the suitability of using the existing Base Year Freight Matrices (BYFM) developed for the DfT and of using data from the Freight in London Model (FiLM) which was developed for TfL by refining the BYFM matrices.

2.4 Summary of Review Results

2.4.1 The review of the M25 Model (and other models and data discussed in Section 2.2), is set out in detail in Appendix A (the Model Status Report) of this document. This also sets out the recommended enhancements required to update the M25 Model to the LTCM.

2.4.2 The review concluded the following:

- By examining the available models, the M25 Model is clearly the best starting point for the development of a model suitable for assessing the Lower Thames Crossing options, and that most of the other local models are not useful, for various reasons (wrong focus, wrong software, zoning not consistent), but that the Thames Gateway model would be useful in defining more disaggregate zoning in Thurrock and north of the existing and proposed crossings, and the Medway Traffic Model may contain some useful network coding that can be adopted in the area of the M2.

- The existing M25 highway assignment model is generally suitable for assessing the impacts of proposed capacity enhancement schemes in the Lower Thames area. The broad network coverage and extent of the simulation network is good, with all major routes covered. Some arterial routes within the Study Area were identified for enhancement, and the review and update of centroid connector loading, and the representation of economic parameters (generalised costs) and tolls in the model was proposed.
- Following examination it was concluded that the zoning in the existing M25 Model required some disaggregation in the north Kent and south Essex areas, either due to the high trip densities that currently exist or based upon the analysis of the river crossing trip movements in the existing model. In addition, the existing M25 Model zoning is overly detailed for the purposes of testing Lower Thames Crossing options, with significant unnecessary detail to the west of London. Sensitivity tests indicated that there would not be an adverse effect on the model by aggregating zones in these areas.
- The existing M25 demand model was reviewed and concluded to be generally suitable for the Study and compliant with WebTAG guidance, provided that the modelling of traveller response to tolls was improved, for example via income segmentation.
- The existing method of representing tolls in the M25 Model was reviewed, concluding that refinement of the disaggregation of the demand matrices by income group was required, and that income-segmentation of the demand model matrices, to improve representation of demand-model responses would also be beneficial.

2.5 Representing Tolling in the Model

2.5.1 The existing M25 Model contains a global three-way division of demand into “willingness to pay” categories, split by household income. This is applied only in the highway assignment model, not the demand model.

2.5.2 We have considered potential refinements to this process, as discussed in Chapter 8 of the Model Status Report, and concluded that a pre-assignment choice (logit) model that divides travellers into “pay toll” and “don’t pay toll” categories is the most appropriate way to model route choice associated with one or more tolls.

2.5.3 This approach is commonly used in European studies, where traffic and revenue forecasting for tolled infrastructure is well established. AECOM has forecast and audited other consultants’ traffic and revenue forecasts using this methodology in Ireland, France, Spain, Portugal, Germany and Croatia. This logit approach was also used for the M6 Toll forecasts in the UK.

2.5.4 We also believe that income-segmentation of the demand model matrices, to improve representation of demand-model responses (mainly redistribution and mode-choice) to tolls, is also likely to be beneficial.

2.5.5 The existing division of demand into income bands is quite simple, involving global factors applied to the matrices. We intend to refine this if we do decide to split by income, including at least a representation of the increased length of trips made by persons in higher-income households.

2.6 Scope of Enhancements Required

2.6.1 Following the review of existing models and data, as documented in the Model Status Report in Appendix A, and summarised in this chapter, the concluded scope of enhancement is as follows.

- to use the M25 Model as the basis of the LTCM;
- to introduce a toll choice model within LTC_{DM};
- to incorporate network data from local models, most notably ELHAM;
- to incorporate demand data from TGSE and the original (more disaggregate) M25/NAOMI matrix build;
- to incorporate count data from the local models and Highways Agency sources; and
- to incorporate journey time data from the local models and Highways Agency sources.

2.6.2 The data sources used for enhancement are discussed in Chapter 3.

2.7 Modelling Standards

2.7.1 The enhancement of the existing models and data has been undertaken in accordance with WebTAG guidance; most notably:

- Unit 3.5.6D: Values of Time and Operating Costs – Draft (May 2012);
- Unit 3.10.4: Variable Demand Modelling - Convergence Realism and Sensitivity (April 2011); and
- Unit 3.19D: Highway Assignment Modelling (November 2011).

2.7.2 The latter, Unit 3.19D, supersedes the use of DMRB for guidance relating to the development of highway assignment models, and has been referred to during the refinement of the highway model, and in its reporting.

3 Data Sources for Model Enhancement

3 Data Sources for Model Enhancement

3.1 Introduction

3.1.1 The existing M25 Model has a base year of 2004, and its demand data were derived from 2001 LATS roadside interview surveys and traffic counts, with the matrix uplifted to 2004 levels using matrix estimation techniques.

3.1.2 These data used to develop the model are therefore aging, beyond the age recommended in WebTAG and should therefore be enhanced where possible, within available data, resource and time constraints.

3.1.3 This chapter discusses the various data sources used to enhance the existing M25 Model to form the LTCM. Some of the sources of data for model enhancement were discussed in Chapter 2, primarily existing models of which some use can be made of demand data. These, and other sources of data, are discussed in the sections below.

3.2 Network Data

3.2.1 In updating and enhancing the LTC_{HAM} a programme of network recoding was undertaken, using first principles to provide a better representation of links and junctions within the Study Area; a fuller explanation of these is provided in Chapter 4. As part of the network enhancements, coding was also extracted and used from two of the local and sub-regional models as discussed above, namely ELHAM and the Medway Traffic Model (MTM).

3.2.2 Data from the MTM were used to enhance and supplement coding of the M2 in the vicinity of the borough of Medway. Junction layouts between Rochester (Junction 1) and Sittingbourne (Junction 5) were updated to match those of the MTM where they did not in the existing M25 Model. Speed-flow curve data were not imported and, instead, the closest proxy speed-flow curve within the default definitions within LTC_{HAM} was instead used, as reasonable curve definitions for strategic motorways already existed.

3.2.3 TfL's ELHAM model was used to enhance a number of routes inside the M25, where corridor coding within the donor M25 Model was particularly unrepresentative, especially with regard to signal timings. This included the route of the A127 between the A12 and the M25, the A124 between Ilford and Hornchurch and parts of the A2 south of Dartford. For these links, speed-flow curves were also used where they differed from those in LTC_{HAM}, unlike with the MTM coding; this was due to the fact that local conditions within London were much more likely to be better represented within ELHAM than the M25 Model. Junction coding, including saturation flows, signal timings and lane allocations were also adopted from ELHAM.

3.2.4 Additionally, the M25 Model networks were recoded to be consistent with the latest versions of the ELHAM network for both the A282 Dartford Crossing and the A102 Blackwall Tunnel, with speed-flow relationships and capacities in particular changing as a result of this. As such, the recoded LTC_{HAM} contains the latest assumptions as to network coding for the two key Thames crossings on the eastern side of London.

3.2.5 Following the network recoding and assimilation of ELHAM and MTM data, the LTC_{HAM} consisted of an enhanced model of network coding within the Study Area, along the key corridors. The quality of this coding is deemed appropriate for the areas of network likely to be influenced by the study objectives, particularly with regard to the strategic road network. ELHAM coding has been through a significant amount of revision and checking since its inception, with networks currently in the process of being enhanced for a third major update – as such, the corridor coding on aforementioned sections of the A127, A124 and A2 can be assumed to be of sufficient quality. Likewise, the latest version of the ELHAM model for which coding has been standardised with at the A282 Dartford Crossing and A102 Blackwall Tunnel has been the focus of a recent study and recoding exercise, meaning that LTC_{HAM} contains the latest research and assumptions for these two key locations.

3.2.6 All strategic routes have been checked or recoded from first principles to ensure that they are consistent and reflect actual layouts. Within the Study Area but away from the strategic road network, the networks have been subject to some checks, although not to the same level of interrogation. Significant errors/warnings have been checked and amended where necessary and the topography of the networks is reasonable; however, saturation flows, input junction assumptions and speed-flow curve usage have not all been reviewed and some issues could therefore still persist. Any such issues however, are likely to be peripheral on routes which will only have a slight impact, if any, on the existing Dartford Crossing or the proposed crossing schemes.

3.2.7 Outside the Study Area, focussed spot checks have been undertaken; any significant network errors or warnings highlighted by the software have been examined and recoded as necessary. It is known that within the central London area, blanket use of speed-flow curves and unlimited capacity junctions exist, although these are not expected to impact on the assignment within Essex or north Kent. The M25 coding should be reasonable, given that it has undergone significant checking as part of previous applications and revisions of the M25 Model. Away from the M25 however, the quality of the local road networks outside Essex and Kent is unknown: again, these areas of the model are not likely to be impacted by the schemes or exert any significant influence over routing to or from them. As such, the highway networks are deemed suitable for the purposes of the study.

3.3 Demand Data

3.3.1 As specified in Chapter 9 in the Model Status Report, the 2009 demand matrices have been enhanced to make best use of available local data. The process adopted is discussed in Section 4.4 of this report, drawing on data from the following sources:

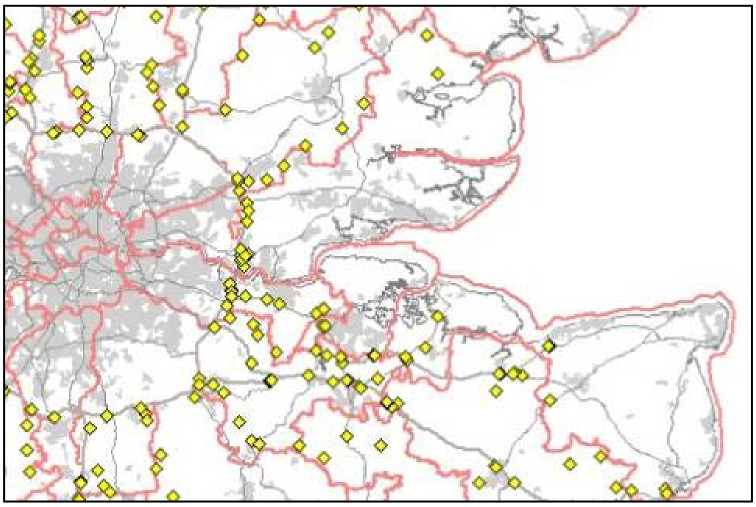
- 2009 forecasts from the existing M25 Model, which have been used to for the bass of the LTCM 2009 demand;
- trip ends from TGSE and the original M25/NAOMI matrix build have been used to disaggregate zones; and
- the TGSE demand matrix for movements within south Essex have been used to replace the M25 Model forecasts.

3.3.2 The use of Base Year Freight Matrices (BYFM) freight demand data was considered for use in the base year LTCM model. A comparison was undertaken whereby the BYFM HGV matrices were assigned within the M25 highway model, and compared with the M25 highway model freight matrices. The performance, in terms of strategic freight flows was found to be similar, with BYFM performing marginally worse. It was therefore concluded that BYFM data should be considered for us in the LTCM forecasting process, but that the M25 Model base year freight matrices should be retained- BYFM data was not used in creating the 2009 freight demand.

Data Quality

3.3.3 The M25 Model matrices were derived from 2001 LATS data, and are therefore an ageing, though strategically comprehensive data set. The roadside interview (RSI) surveys that formed the LATS data set will have intercepted strategic movements crossing the LATS cordons - see Figure 3.1 below – the cordons are shown in red.

Figure 3.1: LATS Sites and M25 Model Matrix Build Sectors in South Essex and North Kent



Reproduced from Figure 9.1 in the Model Status Report

3.3.4 The M25 Model matrices should provide a reasonable representation of longer distance trip movements, and are the best available representation of strategic movements

3.3.5 A potential weakness of the M25 Model matrices is that any trip movement with both trip ends within the red bordered sectors will not have been observed in the RSI surveys, and so will have been synthesised using travel cost data from the M25 Model and fitted to trip length profiles derived from the observed data.

3.3.6 To address this issue, demand data derived from a similar methodology, but using more local observed data have been taken from the TGSE model in south Essex, providing greater confidence in localised movements in this part of the model.

3.3.7 Of particular relevance to the LTCM, there remains particular uncertainty in the unobserved demand within the LATS sectors in north Kent; no local data were available to enhance the LTCM in this part of the model.

3.3.8 These uncertainties in the demand data should be borne in mind in when using the LTCM in forecasting mode; effects upon local demand, especially south of the river, should be treated with caution.

3.4 Count Data

3.4.1 Traffic count data have been obtained from five separate sources: ELHAM, KTS and TGSE models and from the HATRIS TRADS database and the DfT Open Data release. The age of the data and the type of count undertaken at sites is presented in Table 3.1.

Table 3.1: Traffic Count Data Summary

Source	Year of Survey	Count Type	Classification
ELHAM	2009	ATC (2-week)	Fully classified
KTS	2005	ATC	Total vehicles only
TGSE	2006	ATC and MCC	Total vehicles only
HATRIS TRADS	2009	ATC (4-week)	Light vehicles and HGVs (>6.6m axle)
DfT Open Release	2009	MCC	Fully classified

3.4.2 As the above table demonstrates, traffic count data available for the study is of varying age and quality. ELHAM and HATRIS traffic count data used are of the highest quality, being automatic traffic count data from the correct base-year for the model update and from neutral months surveyed over at least a two-week survey period. Similarly, these data have been provided split by light vehicles and HGVs; HATRIS data have been based on a 6.6m split, deemed sufficiently accurate in WebTAG 3.19D §4.2. The majority of traffic count data used within the M25 has come from ELHAM, whilst HATRIS has been used for all traffic count data on the M25 itself.

3.4.3 The DfT Open Data Release data are also from 2009, although it is acknowledged that these data, whilst having site-specific vehicle proportions, are obtained solely from single-day MCC records, and thus have lower confidence intervals associated with them. These counts are subject to the daily variation and individual events and no account for these will be taken. DfT Open Release Data counts have only been used at one location within the model, the A129, which is at the edge of the Study Area.

3.4.4 Data from the KTS and TGSE models were originally collected in 2005 and 2006 respectively. These data are 3-4 years prior to the 2009 base-year local recalibration of the LTC_{HAM}. Travel patterns may have changed within the KTS area since the survey date, particularly following the widening schemes on the A2 and the introduction of infrastructure in the vicinity of Ebbsfleet International Station. It is likely that such schemes may have had some impact upon traffic patterns within the north Kent area.

3.4.5 Data obtained from the TGSE and KTS models were supplied at a total vehicle level only, with no disaggregation by user-class. In order to estimate traffic counts for HGVs on these links, analyses of the DfT Open Release Data within the Thurrock, Essex and Kent regions was undertaken, in order to calculate the average vehicle proportions across all sites for Motorways, Trunk Roads and Non-Trunk Road classifications. These average proportions were then applied to the total vehicle counts in order to obtain proxy HGV traffic count data. This method was considered appropriate given that no other data were available, with the DfT Open Release Data providing an extensive dataset of traffic counts within each of the regions, but there is clearly uncertainty associated with this method.

3.4.6 Following this analysis and collation of traffic count data, they were arranged into screenlines for the calibration and validation of the LTC_{HAM}. This process and the final screenline definitions are discussed further in Chapter **Error! Reference source not found.**.

3.5 Journey Time data

3.5.1 As with the traffic count data, observed journey times have been obtained from a number of sources, both from the HATRIS database and from the local and regional models. The model sources and the age of the data are presented in Table 3.2.

Table 3.2: Journey Time data summary

Source	Year of Survey	Survey type
ELHAM	2009	Trafficmaster GPS
KTS	2005	In-car vehicle surveys
TGSE	2006	In-car vehicle surveys
HATRIS TRADS	2009	Trafficmaster GPS, ITIS, MIDAS data

3.5.2 All journey time survey data used in the validation of LTC_{HAM} that have been obtained from existing models have been provided as end-to-end data only, with no section-by-section information available. HATRIS data have been extracted on a section-by-section (junction to junction) basis.

3.5.3 Whilst data from ELHAM and the HATRIS database have been obtained for the model base-year (2009), data from the KTS and TGSE models are from 2005 and 2006 respectively and are therefore likely to be of lower quality, as they are subject to uncertainty resulting from local and regional development and infrastructure changes between the date of survey and the base-year. This was most apparent in the use of journey time data from the TGSE model, where we have been unable to use journey time data for the A127 due to speed-limit restrictions along eastern sections of the route imposed in early 2009.

3.5.4 Whilst we have not had access to the raw data, we are aware that the Trafficmaster GPS data used for ELHAM have previously been deemed to be reasonable for an end-to-end type assessment, of the nature to be used in LTC_{HAM}. For the KTS and TGSE journey time data, no assessment of COBA confidence levels surrounding the in-vehicle surveys has been presented in the respective LMVRs.

3.5.5 Further information regarding the final journey time routes used as part of the LTC_{HAM} validation exercise is presented in Chapter **Error! Reference source not found.**.

3.6 Toll Sensitivity Data

3.6.1 Sensitivity parameters from other toll and route-choice models analogous to the LTC_{DM} have been reviewed. We have obtained input parameters from the M6 Toll study (undertaken by AECOM), which used information from stated preference surveys for calibration and was based upon a logit route choice model, as used in LTCM. These parameters are reproduced in Table 3.3, with the sensitivity parameters emboldened and highlighted.

Table 3.3: Input Parameters from M6 Toll Model

Parameter	Class 1, Cars Commuting	Class 2, Cars Social	Class 3, Cars Employers Business	Class 4, Vans (LGVs)	Class 5, Coaches	Class 6, HGV Logistics	Class 7, HGV General Haulage	Class 8, Cars international	Class 9, vans international	Class 10, HGV international
time coefficient (min^{-1})	**-0.15**	**-0.06**	**-0.08**	**-0.12**	**-0.10**	**-0.10**	**-0.10**	**-0.15**	**-0.12**	**-0.10**
toll transaction delay	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
route constant (mins)	3.00	25.00	20.00	10.00						
toll (mins)	22.50	15.00	12.70	25.50	28.00	28.00	28.00	15.00	21.80	24.00
toll (£)	3.50	3.50	3.50	7.00	7.00	7.00	7.00	2.50	6.00	6.00
VOT (£/hour)	9.40	14.00	16.50	16.50	15.00	15.00	15.00	10.00	16.50	15.00

3.6.2 Following a literature review, logit route choice sensitivity parameters from various sources, not all related to tolls, have been examined and are summarised in Table 3.4. Parameters vary from -0.04 to -0.15 min^{-1}. The sensitivity parameter adopted in LTCM is -0.128 $mins^{-1}$, the least sensitive parameter possible in the model for reasons discussed in Section 5.7.

Table 3.4: Toll Sensitivity Parameters from M6 Toll and Literature Review

Source	Lambdas ($mins^{-1}$)	Reference
M6 Toll sensitivity parameters	-0.06 to -0.15	M6 Toll Study
A Modified Route Choice Model Overcoming Path Overlapping Problems, Cascetta et al	Around -0.05	http://www.alkox.informatik.hu-berlin.de/lehre/lvws0809/verkehr/logit.pdf
Capturing Correlation in Route Choice Models using Subnetworks, Frejinger and Bierlaire	-0.07	http://www.strc.ch/conferences/2006/Frejinger_laire_STRC_2006.pdf
The role of personality factors in repeated route choice behaviour: behavioural economics perspective, Albert, Toledo and Ben-Zion	-0.11	http://www.istiee.org/te/papers/N48/48D_Alber edoBenZion.pdf
The impacts of road pricing on route and mode choice behaviour, Vtric et al	-0.04	http://www.jocm.org.uk/index.php/JOCM/article wFile/14/41

3.7 Income / Value of Time Data

3.7.1 The methodology adopted to split travel demand by income band is discussed in Section 8.3 of Appendix A (Model Status Report). In order to implement this approach, data have been collated to enable a estimate of the proportions of demand in each of three “willingness to pay” bands based on household income. These collated data are summarised below:

1. National Travel Survey (NTS) data;
2. assigned distances between zones from the LTC_{HAM};

3. households by household income[2] and car ownership in NTEM[3] zoning from NatCOP[4]; and
4. WebTAG guidance (Unit 3.12.2, Annex A) regarding elasticities of value of time to household income and length of trip.

3.7.2 Sources 1 to 3 were used to split the demand matrices; sources 3 and 4 to derive estimates of behavioural values of time by income band. The methodology is discussed further in this report in Section 5.2.

3.8 Dartford Crossing Transaction Data

3.8.1 Transaction data for the Dartford Crossing have been obtained, consisting of, post September 2009, vehicles counted travelling in either direction over the crossing by day, hour, vehicle class and payment type (cash, Dart TAG, LRDS TAG, no payment). Night-time traffic, outside charging hours, is not differentiated by vehicle type.

3.8.2 Data for some years prior to September 2009 were also provided with less detail (segmentation by vehicle class and payment type was not available simultaneously).

3.8.3 These transaction data have been used to derive counts on the crossing for use in the highway model, as well as to derive average monetary tolls actually paid in each modelled time period, used in both LTC_{HAM} and LTC_{DM}.

3.8.4 In addition to this, various statistics have been made available from reports, including number of TAGs and LRDS TAGs in circulation, and excess revenue made from currency exchanges and overpaid cash tolls. These will be taken into account when forecasting and deriving toll revenue streams using data from the model.

3.9 WebTAG 3.5.6D Economic Parameters

3.9.1 LTCM requires economic parameters in order to model the relative weight travellers place upon travel time, travel distance, and monetary costs (i.e. tolls). These are taken from WebTAG 3.5.6D, as of June 2012. This is in-draft guidance, due to become live in August 2012, which includes amongst other updates estimates of electric vehicle proportions and operating costs.

3.9.2 Inputs are required both for LTC_{HAM} and LTC_{DM}. The former requires weights for time, distance and money by assignment user class. The latter uses a slightly more complicated formulation whereby fuel consumption (and hence distance-weight) is dependent upon a trip’s average speed.

3.9.3 The derivation of each quantity is summarised in Table 3.5. All calculations and model values are expressed in 2010 prices. Where it is necessary to convert between price bases (as for application of Dartford tolls and public transport fares), the overall Consumer Price Index (CPI) is used, in-line with WebTAG 3.5.6D.

3.9.4 In calculating fuel consumption for LTC_{HAM}, a single average speed was required for use in the WebTAG functions. Given the interurban trunk-road focus of the project, a value of 80 kph has been adopted (the outturn parameters are fairly insensitive to any reasonable average speed assumption).

3.9.5 The final base year economic parameters are shown in Table 3.6 and Table 3.7.

[2] The household income data from NatCOP are originally sourced from CACI household income estimates.
[3] NTEM, the National Trip End Model, used to forecast the trip ends that are published in the DfT’s TEMPRO software
[4] NatCOP, the National Car Ownership Program, used to forecast car ownership which are an input to NTEM

Table 3.5: WebTAG Inputs, Summary of Derivation

Parameter	WebTAG Tables	Notes
Person Values of Time	Tables 1,2 and 3b	Further adjusted by income- See Section 5.4.
Vehicle Occupancies	Table 6	Derived from surveys in 2004, Table 6 used to apply adjustments over time and for freight values.
Vehicle Values of Time	Tables 1, 2, 3b, 4, 5, and 6	Table 9 is not used.
Fuel Consumption	Tables 10, 11a, 11b and 13	Initial calculation is separately by fuel type. In demand model, calculation is by average speed using a,b,c,d parameters.
Fleet Composition	Table 12	Used to average fuel consumption and non-fuel costs over fuel type.
Non-fuel Costs	Table 15	Table 16 not used (calculation is by fuel type). Applied to business trips only.

Table 3.6: Economic Parameters, 2009 values , 2010 prices

Parameter	Value	Units
Car Fuel Usage Petrol	1.014	litres/km, relative to 2010
Car Fuel Usage Diesel	1.016	litres/km, relative to 2010
LGV Fuel Usage Petrol	1.003	litres/km, relative to 2010
LGV Fuel Usage Diesel	1.018	litres/km, relative to 2010
Car Petrol Proportion	62%	proportion
Car Diesel Proportion	38%	proportion
Car Electric Proportion	0%	proportion
LGV Petrol Proportion	7%	proportion
LGV Diesel Proportion	93%	proportion
Business Petrol price	89	pence/litre
Business Diesel price	93	pence/litre
Business Electricity price	-	pence/kWh
Consumer Petrol price	102	pence/litre
Consumer Diesel price	107	pence/litre
Consumer Electricity price	-	pence/kWh
Value of Time, HBWork, Low	7.382	pence/minute
Value of Time, HBWork, Med	10.185	pence/minute
Value of Time, HBWork, High	12.929	pence/minute
Value of Time, HBBusiness	44.548	pence/minute
Value of Time, HBOther, Low	8.332	pence/minute
Value of Time, HBOther, Med	9.59	pence/minute
Value of Time, HBOther, High	10.644	pence/minute
Value of Time, NHBBusiness	44.548	pence/minute
Value of Time, NHBOther, Low	8.332	pence/minute
Value of Time, NHBOther, Med	9.59	pence/minute
Value of Time, NHBOther, High	10.644	pence/minute
Value of Time, LGV	16.782	pence/minute
Value of Time, HGV	41.366	pence/minute

Table 3.7: Fuel Consumption and Non-Fuel Function Parameters, 2009, litres/km

Parameter	a	b	c	d	Units
Car Petrol Fuel Consumption	0.964	0.0414	-0.0000454	0.00000201	litres/km
Car Diesel Fuel Consumption	0.437	0.0586	-0.000525	0.00000413	litres/km
Car Electric Fuel Consumption	0	0.126	0	0	litres/km
LGV Petrol Fuel Consumption	1.56	0.0643	-0.000744	0.0000101	litres/km
LGV Diesel Fuel Consumption	1.05	0.0579	-0.000433	0.00000803	litres/km
HGV Fuel Consumption	2.32	0.311	-0.00404	0.0000330	litres/km
Car Business Non-Fuel Cost	4.966	135.946	-	-	pence/km
LGV Non-Fuel Cost	6.34744	41.45944	-	-	pence/km
HGV Non-Fuel Cost	9.51519	371.81671	-	-	pence/km

4 Spatial Refinement to the Model

4 Spatial Refinement to the Model

4.1 Introduction

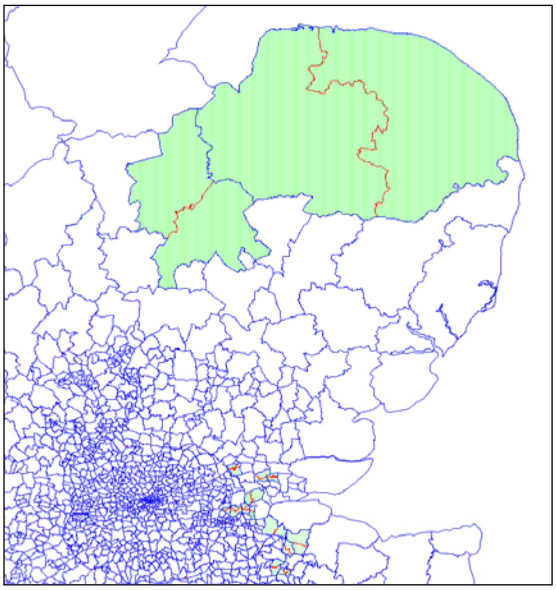
4.1.1 The zoning for the LTCM has been derived from the existing M25 Model zoning with changes made to improve the suitability of the LTCM for use in modelling additional river crossing capacity in the Lower Thames area. This chapter outlines the changes made to zoning, consisting of:

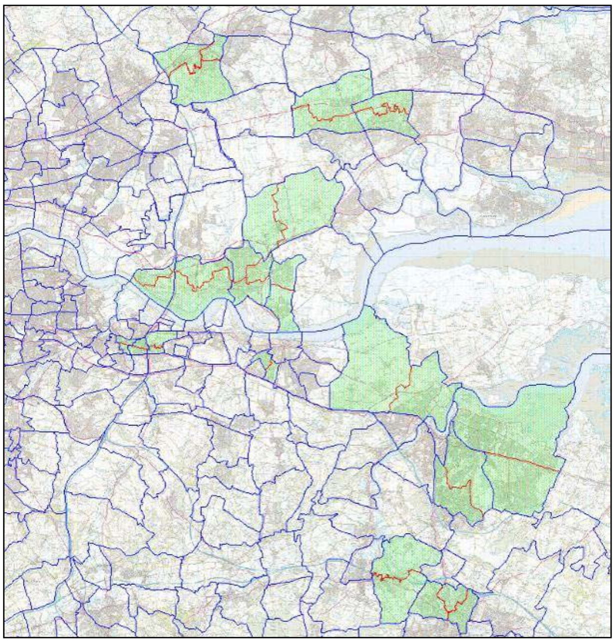
- disaggregation, whereby 19 zones in the Study Area have been disaggregated to increase the level of spatial detail in the model, and
- the aggregation of around 300 zones, mostly in the west of the M25 Model simulation area, which have been aggregated to reduce run times and file sizes.

4.2 Zone Disaggregation

4.2.1 The disaggregated zones are illustrated in green shading in Figure 4.1. Most have been split into two new zones; a few have been split into three. The disaggregated zone boundaries are shown in red; the existing M25 Model boundaries in blue. The disaggregated zones have been identified as being worth disaggregating due to either an obvious choice of strategic routeing, which may vary depending on where within a zone a trip originates/destinates, or a high level of travel activity to/from them.

Figure 4.1: Disaggregated Zones

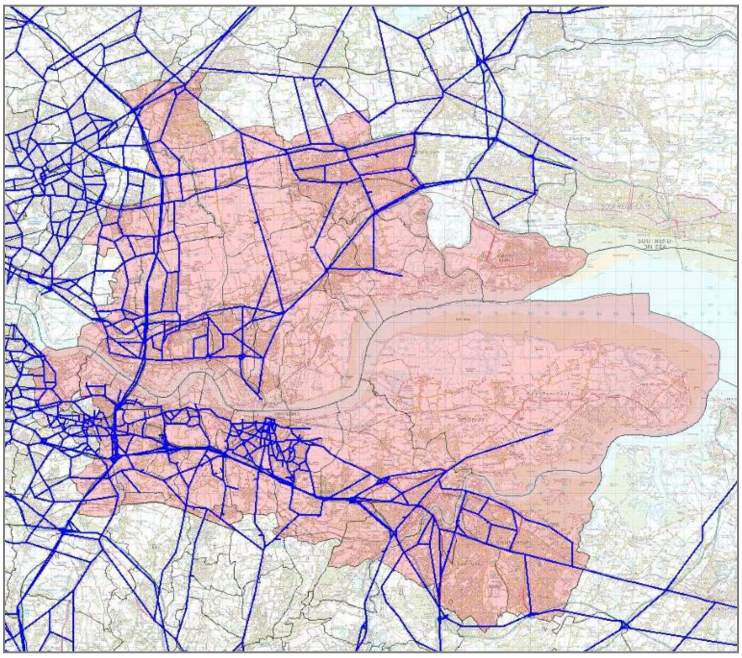




Contains Ordnance Survey data © Crown copyright and database right 2012

4.2.2 All zones in the shaded area in Figure 4.2 were considered for disaggregation, with appropriate justification for those zones it was not considered necessary to disaggregate. A zone-by-zone consideration of disaggregation candidates was reported in Appendix A of the Model Status Report.

Figure 4.2: Area of Detailed Consideration of Zone Disaggregation Candidates



Contains Ordnance Survey data © Crown copyright and database right 2012

4.2.3 The volume of trips loading on the highway network by zone was also analysed, with large values in the Study Area considered for disaggregation, in accordance with WebTAG 3.19D §2.3. Finally, select-link analysis has been performed on the Dartford Crossing to identify the origins and destinations of trips using the Crossing; two zones in Norfolk were added to the disaggregation list based on relatively high levels of Crossing traffic and clear strategic routing choices (using either the Crossing or routeing around the M25 west of London).

4.3 Zone Aggregation

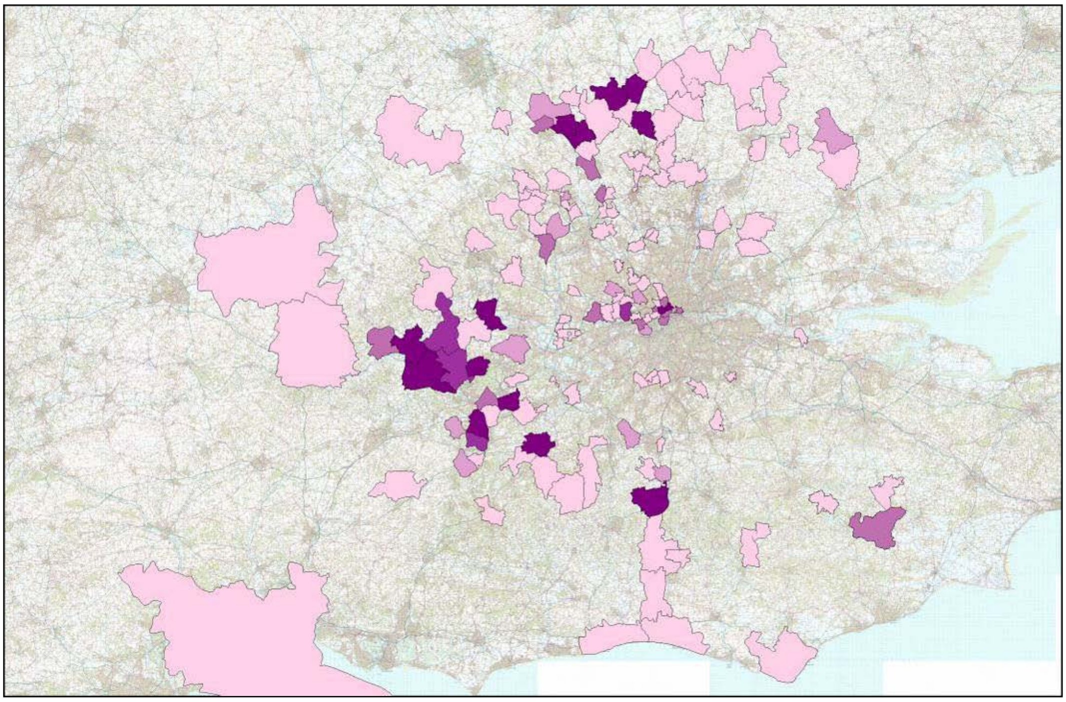
4.3.1 The existing M25 Model uses a zone system with 1417 zones, with unnecessary detail in areas distant from the Study Area. In order to reduce the size, and hence data storage and run time requirements of the LTCM, a review of the zoning was undertaken with the intention of aggregating selected zones.

4.3.2 The whole zone system was considered for aggregation, but the focus of the process was within the 'Fully Modelled Area' to the west, north-west, and south-west of London. East of London is the Study Area, so this was generally avoided. There appeared some scope for aggregation in central London also, but this was kept fairly minimal, since the effect on routing was unpredictable and routing through parts of central London is potentially important from the point of view of the river crossings west of Dartford.

4.3.3 Testing using the existing M25 Model was undertaken to identify the likely impact of aggregating zones.

4.3.4 The extent of the aggregation is illustrated in Figure 4.3, with more intense colours representing greater aggregation. Zones have generally been aggregated where they are distant from the Study Area, and either the loading onto the strategic network is very similar or one or more of the aggregated zones has negligible demand. A small number of zones closer to the Study Area with very low demand (fewer than 10 Passenger Car Units), have also been aggregated with neighbouring zones.

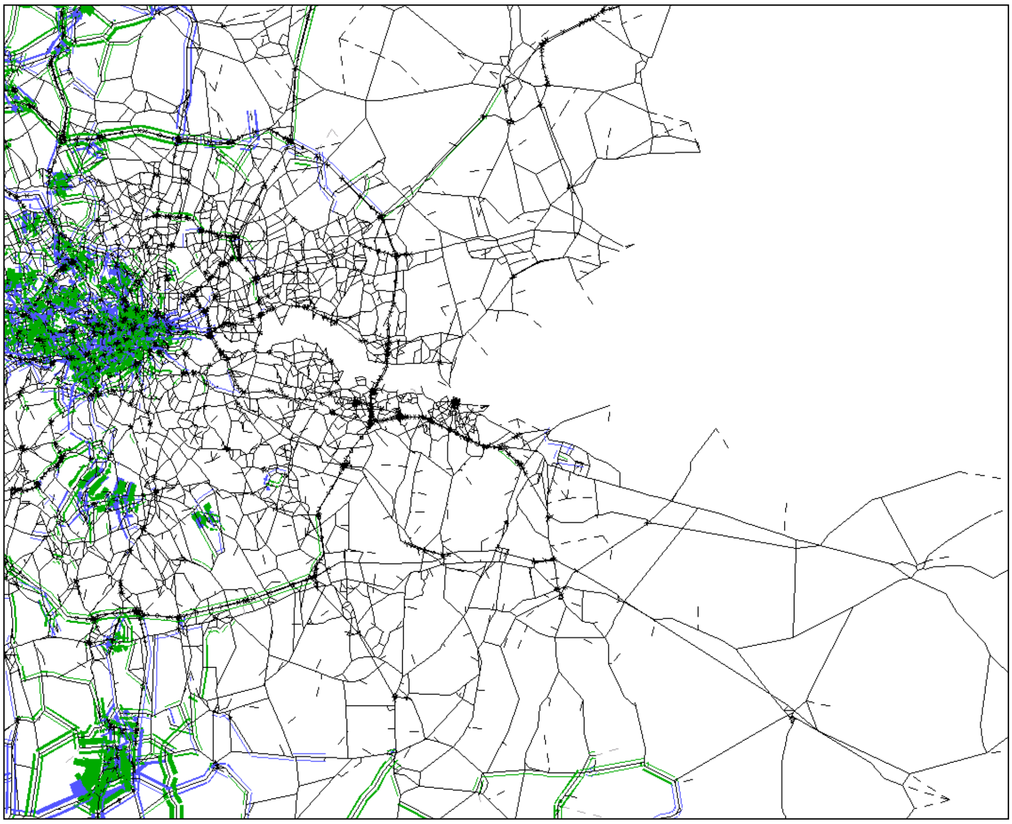
Figure 4.3: Location of Aggregated Zones



4.3.5 The effect of the zone aggregation on assigned network flows was considered through a series of sensitivity tests; the final results of which are illustrated in Figure 4.4, showing the difference in flows between a model with the original M25 Model zoning and one with the revised aggregated zoning; the same demand has been assigned in each. The scale on the north section of the M25 between the A1(M) and A10, is around 150 PCUs/hour. All differences in the Study Area are negligible (less than 10 PCUs/hour), and there are no changes anywhere on the M25 in excess of 250 PCUs/hour.

4.3.6 Aggregating zones has a distinctly positive effect on model runtimes, with around 300 zones removed in all. LTC_{DM} model runtimes and most model file sizes have been reduced by 38%. The effect on SATURN assignment times is smaller; around 25%. Further reductions in the latter could have been achieved by recoding some of the simulation network in SATURN to the west of London as buffer network, but timescales precluded this.

Figure 4.4: Effect of Zone Aggregation on Assigned Flows



4.4 Infilling and Refining of Prior Trip Matrices

4.4.1 Trip matrices were prepared for LTCM for use in calibrating the highway model through iterations of matrix estimation and network refinement; this process is discussed in Chapter 6.

4.4.2 The starting point for the new LTCMHW demand matrices was 2009 forecast production-attraction demand from the existing 1417 zone M25 Model. This 2009 demand was derived by applying trip-end growth from TEMPRO to the 2004 base M25 Model demand, using the established methodology developed as part of the M25 Model.

4.4.3 The forecast 2009 M25 Model demand was then converted to the new LTCM zoning system as discussed above. Where zones had been disaggregated, data were used to apportion the demand in the following order of priority:

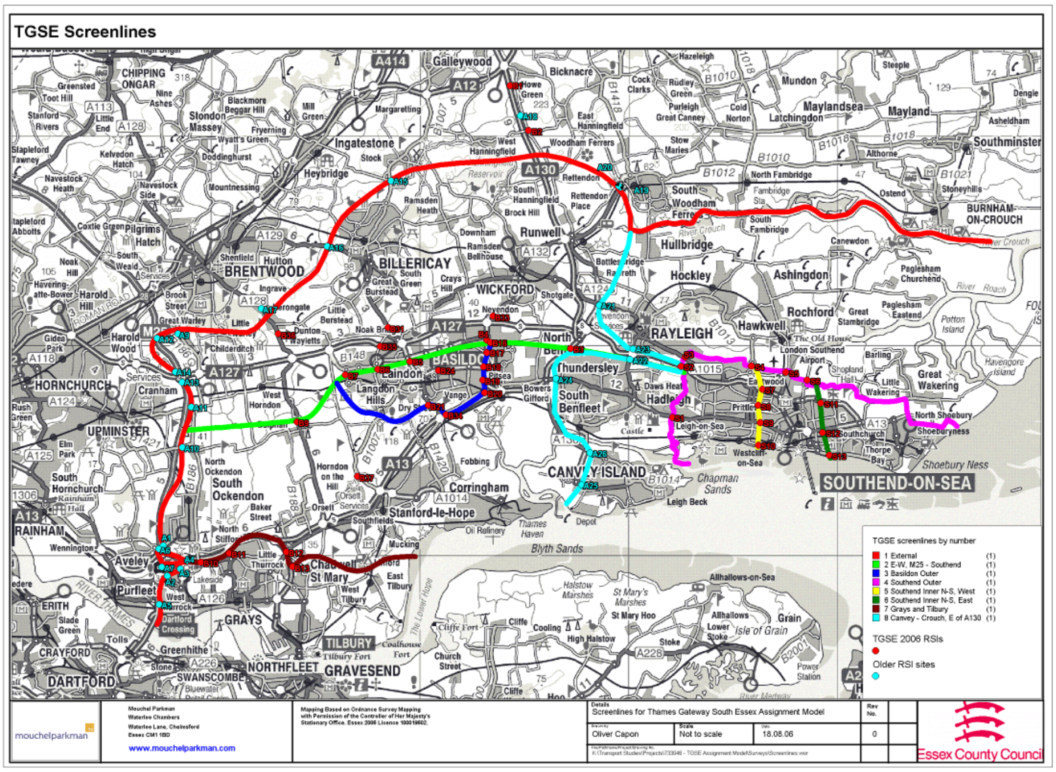
1. Trip-ends from the base year (2006) Thames Gateway South Essex (TGSE) model, within the Thames Gateway modelled area (south Essex).
2. Trip-ends from the original NAOMI matrices, where the NAOMI zoning is sufficiently disaggregate.
3. Numbers of postcodes from code-point data.

4.4.4 Within the local area of the TGSE model, illustrated within the red boundary in Figure 4.5, no roadside interview data were used in the original NAOMI matrix-building process, which formed the basis of the M25 Model demand. Accordingly, it was considered beneficial to adopt the demand from the TGSE model for trips wholly internal to this area, as this was derived from several RSI cordons and screenlines, as shown in Figure 4.5. Both the NAOMI and TGSE matrix builds used the same 2001 LATS cordon (red boundary), so the M25 Model demand was retained for internal to external and external to internal trips.

4.4.5 The TGSE demand was converted directly to the new LTCM zoning system. As this involved only aggregations, no disaggregation factors were required. This demand was then used to overwrite demand within the LTCM south Essex LATS cordon as defined in Figure 4.5 (red boundary).

4.4.6 Vehicle demand was used for this conversion, and the occupancy factors from the M25 Model were retained and used to generate person demand for use in the LTC_{DM}, because the TGSE model contains only single global estimates of vehicle occupancy.

Figure 4.5: Thames Gateway Roadside Interview Sites and South Essex LATS Cordon



Reproduced from TGSE Matrix Development Technical Note

4.5 Income Segmentation of the Prior Trip Matrices

4.5.1 The demand matrices for non-business trips were divided into willingness-to-pay bands based upon household income using a process discussed in detail in Chapter 5. These were then converted to assignment level (origin to destination, vehicles, assignment user-classes) to be used as an input to matrix estimation.

4.6 Quality of Prior Trip Matrices

4.6.1 The resulting traveller demand in the Study Area is unlikely to be as high-quality as might be obtained with data obtained from an extensive data collection exercise. The main deficiencies with the prior demand are that:

- The survey data is of variable age, with the most recent dating to 2006, and the LATS data used for much of the matrix development dating to 2001. Demand over the Dartford Crossing pre-dates changes to toll levels in 2008, and demand in London pre-dates the introduction of the congestion charge.
- Travel wholly within Kent is based upon wholly synthetic data, placing a heavy emphasis on trip-end data from TEMPRO being correct (and TEMPRO uses trip-rates that are themselves old and not very disaggregate), although the planning data are reasonably current. Within Essex, and between Kent and Essex, matrices containing observed data have been used.

4.7 Verification of Prior Trip Matrices

4.7.1 A number of high-level checks have been carried out on the new prior matrices, largely to ensure correct processing and that no gross errors have been introduced. Further and more local verification of the matrix quality is provided by the analysis of the impact of matrix estimation, discussed in Chapter 6. Details and verification of the income splitting of the non-work matrices is discussed in Chapter 5.

4.7.2 Matrix totals are provided in Table 4.1 by demand model segment (willingness to pay excluded), in the three areas of key interest to the modelling and for Great Britain.

Table 4.1: LTC_{DM} Trip Totals (Person Trip Productions)

LTC_{DM}	HBW	HBEB	HBO	NHBEB	NHBO	All Car	LGV	HGV
GB	30,783,273	4,134,294	66,056,628	3,194,411	10,925,970	115,094,575	1,663,133	1,866,463
Essex	834,504	132,745	1,788,430	105,822	310,886	3,172,386	182,376	169,853
London	3,098,417	650,660	7,964,267	468,408	1,263,441	13,445,193	764,100	771,030
Kent	912,922	120,596	1,924,244	103,531	369,109	3,430,402	80,318	119,074

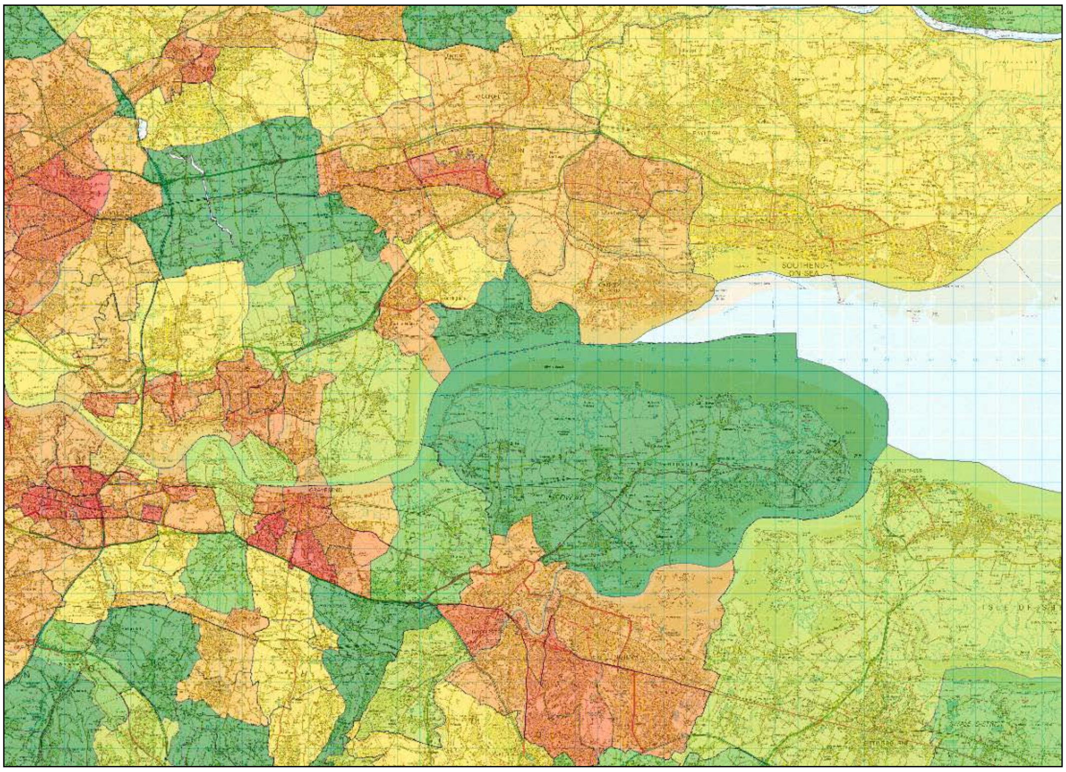
4.7.3 The car demand has been compared with TEMPRO 6.2, and found to demonstrate reasonable consistency, as shown in Table 4.2. There is some evidence that the prior matrices are somewhat low in Essex and Kent overall, and that they may have a somewhat high proportion of business trips, especially in London.

Table 4.2: LTC_{DM} Demand vs. TEMPRO 6.2

Difference	HBW	HBEB	HBO	NHBEB	NHBO	All Car
GB	-1%	9%	-3%	14%	3%	-1%
Essex	-14%	11%	-15%	30%	5%	-11%
London	1%	43%	10%	45%	10%	10%
Kent	-6%	1%	-6%	12%	5%	-4%

4.7.4 Production and attraction densities (numbers of trip ends per unit area) have been calculated by LTCM zone, and examined to demonstrate that the areas of high trip density are also dense urban areas. This is illustrated graphically in Figure 4.6 for productions densities. Redder areas tend to be urban centres, greener areas are either wholly rural or contain large rural expanses.

Figure 4.6: Zonal Production Density



4.7.5 Trip rates have also been examined per capita of 2001 Census population, and unusually low and high values inspected. There are no real outlier low trip rates on this measure, with the lowest values being more than half the median, but there are a few zones with unusually high trip rates per person (around 10 times the median). These are all zones with very low population, generally dominated by industrial or commercial use, which could easily have had significant housing development since 2001 (relative to 2001).

4.7.6 Finally, trip length distributions and average trip lengths have been checked, and the latter compared with National Travel Survey (NTS) figures for Great Britain and Base Year Freight Matrix (BYFM) data, as shown in Table 4.3. Trip lengths were extracted from the model for internal productions for all columns except NTS. Intrazonal trips have been included with infilled trip-lengths based on half row-minima, again for all columns except NTS. NTS data are not mappable to model zoning, as they are classified at a regional level.

Table 4.3: Average Trip Length, Models and Survey Data, Study Area, kilometres

Purpose	LTCM	NTS	BYFM	LTCM, NoTGSE	M25 2009	LTCM vs. NTS/BYFM	LTCM vs. M25 2009
Business	20.83	32.28	-	21.74	22.28	-35%	-7%
Commuting	11.37	15.44	-	10.48	10.24	-26%	11%
Other	10.47	13.31	-	10.15	10.24	-21%	2%
LGV	15.87	-	-	23.10	23.52	-	-33%
HGV	25.85	-	45.95	33.97	33.22	-44%	-22%

Column Headers:

LTCM:	Lower Thames Crossing Model
NTS:	2008 National NTS data covering Great Britain
BYFM:	2006 Base Year Freight Matrices
LTCM, NoTGSE:	Lower Thames Crossing Model, without the TGSE demand infilled (retaining M25 Model demand)
M25 2009:	M25 Model 2009 forecasts
LTCM vs. NTS/BYFM:	LTCM compared with NTS (BYFM for HGV)
LTCM vs. M25 2009:	LTCM compared with M25 Model 2009 forecasts

4.7.7 Model (LTCM) trip lengths are substantially shorter than those reported in the National Travel Survey and developed for BYFM, especially in the case of business trips. The LTCM figures compare quite well with the 2009 M25 Model forecast matrices used as their source.

4.7.8 The exception is for freight trips. The “LTCM NoTGSE” column demonstrates that differences here, especially freight, are due to the infilling of demand from the TGSE model in south Essex, which has tended to reduce trip lengths.

4.8 Network Refinement

4.8.1 Prior to undertaking any matrix refinement processes, network coding in the south Essex, north Kent and east London areas have been refined in order to ensure that the LTC_{HAM} networks were suitable for the purposes of assessing additional crossing capacity in the Lower Thames area.

4.8.2 At a global level, general network parameters were reviewed to ensure that they were consistent with the latest guidance and advances in modelling techniques, including the latest WebTAG 3.6.6D economic parameters presented in Table 3.6. The SATURN software version was updated to version 10.9.24, the then current version, in order to allow for the modelling to take advantage of the latest modelling advances including multi-core and SPIDER networks in order to reduce model run times. The UFC109 parameter has also been adopted so that the model can store more extensive path information in order to provide more accurate inputs into economic assessments at a later date.

4.8.3 Network coding enhancements were all undertaken in-line with a standardised junction coding note, ensuring that any new coding was implemented in a consistent fashion. The primary focus of network recoding was the strategic routes within the south Essex and north Kent areas, outside the M25 boundaries. Existing M25 coding within these sub-regions was found to be inconsistent, containing simplified coding of junctions on the strategic road network, a large number of ‘dummy nodes’ allowing unlimited capacity through junctions as well as some missing road linkage and incorrect network speeds. The core focus of these changes was on the following routes:

- A13: between the M25 and the A176;
- A127: between the M25 and the A132;
- A1089: full route between the Tilbury docks and the A13;
- A229: between the M2 and the M20;
- A2: between the M25 and the M2;
- M20: between the M25 and the A249; and
- M26: between the M25 and the M20.

4.8.4 Existing regional and local models were also used for enhancing the network coding along other routes whereby the extra detail contained within them was applicable for and easily translatable to the LTC_{HAM}. Two such models were used as 'donor models' for network coding.

4.8.5 Firstly, the Medway Traffic Model was used to enhance and supplement coding of the M2 in the borough of Medway between Junctions 1 and 5. Junction layouts and link distances were incorporated where applicable.

4.8.6 Secondly, the East London Highway Assignment Model (ELHAM) was used to enhance a number of routes inside the M25, where corridor coding within the donor M25 Model was particularly unrepresentative, especially with regard to signal timings. This included the route of the A127 between the A12 and the M25, the A124 between Ilford and Hornchurch and parts of the A2 south of Dartford. Additionally, the M25 Model coding was recoded to be consistent with the latest development versions of the ELHAM network for both the A282 Dartford Crossing and the A102 Blackwall Tunnel, with speed-flow relationships and capacities in particular changing as a result of this. As such, the recoded LTC_{HAM} is consistent with the latest coding assumptions for the two key Thames crossings on the eastern side of London.

4.8.7 Within the M25 Model, there were a number of buffer links sporadically contained within the simulation network in the north Kent area, particularly around the Bluewater and Gravesend areas. These links were fully recoded into the simulation network in order that link capacities and junction delays were better represented within the updated LTC_{HAM}.

4.8.8 Away from the strategic road network, a number of network coding changes have also been made to more local and rural routes as part of the network calibration process, incorporating B-roads as well as urban routes through Basildon and Thurrock. Changes have also involved the relocation of centroid connectors in a number of locations to ensure better compatibility with the network density and structure as well as for the land-uses and geography within each zone.

4.8.9 In total, 114 'dummy nodes' have been removed from the LTC_{HAM} network, and 326 new nodes have been coded, consisting of 297 new priority nodes, 2 new roundabout nodes and 27 new signalised junctions. This represents a significant enhancement of the networks within the south Essex, north Kent and east London areas.

4.9 Verification of Updates

4.9.1 Following updates to the highway models, the networks were built in order that they could be checked prior to any calibration processes being undertaken. Given the size and scope of the M25 Model, only those areas of enhanced or new coding were assessed directly against the standard network checking procedures detailed in WebTAG 3.19D §5.3.2; as defined, these enhanced portions of the network were checked as follows:

- that appropriate junction types were used in the new coding;
- that entry lanes coded at junctions reflected aerial photography;
- that two-way and one-way links had been coded where appropriate;
- for consistency in the application of link lengths, cruise speeds and speed-flow relationships;
- that new junctions were coded in accordance with the standardised network coding note and that speed-flow relationships used were consistent with the rest of the M25 Model.

4.9.2 Following the network build process, checks were also undertaken on the network by assessing the network errors and warnings within the Study Area; these warnings were viewed spatially within the SATURN software. Errors and warnings within the Study Area were assessed based on severity, ‘non-fatal errors’ first, followed by ‘serious warnings’ and subsequently ‘warnings’. Junctions that were highlighted were checked to see if a network edit was necessary or whether the issue was more cosmetic. Generally errors and warnings outside the Study Area were not assessed due to the volume of data involved and taking into account the geographical focus of the LTCM.

4.9.3 Once the topography, coding and network build checks were undertaken, the prior matrix was assigned to the network in order to ensure that the network was correctly connected. This test ensured that there were no origins or destinations within the network that were unreachable, ensuring that all demand could be assigned without issue.

5 Approach to Toll Modelling

5 Approach to Toll Modelling

5.1 Introduction

5.1.1 This chapter presents the approach to the toll modelling adopted within the LTCM. The following sections are structured to explain:

- the approach to and results of income segmentation;
- values of time derived for use in the LTC_{HAM} and LTC_{DM};
- the toll modelling methodology and the toll choice model sensitivity parameter; and
- the derivation of the tolls to be used in LTC_{HAM} and LTC_{DM}.

5.2 Approach to Income Segmentation

5.2.1 Because this study involves consideration of one or more tolled stretches of road, it is considered necessary, as discussed in WebTAG 3.10.2, §1.7, to incorporate some segmentation of demand by value of time, or "willingness to pay", beyond that provided by the existing segmentation by purpose. This has been done by dividing travellers into three groups based on the gross annual income of the household they belong to, and then estimating average value of time for travellers in each group.

5.2.2 Income segmentation has been applied only to non-work car trips. Business trips already have very high values of time, meaning they will generally pay any toll, so additional segmentation was not considered warranted. Freight trips also have reasonably assumed high values of time, and represent a significantly smaller proportion of total demand than car trips; freight is thus also not income-segmented.

5.2.3 The National Travel Survey has been used as the primary basis for deriving income and travel distance distributions and hence willingness-to pay segmentation. Three income bands have been defined as shown in Table 5.1, segmenting households into three segments with broadly similar total traffic levels in each. These bands and thresholds are based on NTS household income bands, inflated to 2010 prices (consistent with the new price base in WebTAG 3.5.6D). The derivation of values of time in the table is discussed later, in Section 5.4.

Table 5.1: Income Bands, Gross Household Income, 2010 prices

	Thresholds (Household Income)			Value of Time (p/min), 2009 values	
Band	**Lower**	**Upper**	**Mean**	**Commuting**	**Other**
Low	£0	£26,023	£15,195	7.382	8.332
Medium	£26,023	£52,047	£37,255	10.185	9.590
High	£52,047	£∞	£72,454	12.929	10.644

5.2.4 Car trip rates have been derived from NTS data by purpose and income-band. In addition, proportions of trips made by persons in each of three income bands have been derived by distance-band and by purpose. Finally, numbers of persons in a car-owning household by income band and number of adults in household were extracted. These tabulations are shown in Table 5.2 and Table 5.3 below.

Table 5.2: NTS Trip Rate and Household Size Data by Income Band, Great Britain

	Car Trip Rates Per Person (Mon-Fri)			Persons Per household		
Income	**Commuting**	**Other**	**Business**	**1 adult**	**2 adults**	**3+ adults**
Low	1.598	9.409	0.286	1.256	2.472	3.883
Medium	2.709	9.149	0.571	1.136	2.738	3.840
High	2.691	9.363	0.778	1.067	2.757	3.920

Table 5.3: NTS Car Trip Proportions by Income Band and Distance Band

	Commuting			Other		
Trip Lengths	**Low**	**Med**	**High**	**Low**	**Med**	**High**
Under 1 mile	37%	43%	20%	43%	37%	20%
1 to under 2 miles	32%	46%	22%	41%	37%	22%
2 to under 3 miles	32%	43%	25%	40%	38%	22%
3 to under 5 miles	29%	47%	24%	40%	38%	23%
5 to under 10 miles	27%	46%	27%	39%	37%	24%
10 to under 15 miles	22%	46%	31%	37%	38%	25%
15 to under 25 miles	20%	46%	34%	37%	38%	25%
25 to under 35 miles	15%	45%	40%	36%	37%	27%
35 to under 50 miles	13%	42%	44%	35%	37%	29%

5.2.5 The number of households by income-band, car-ownership, number of adults in household and TEMPRO zone, were extracted from the National Car Ownership Program (NatCOP) which produces the car ownership forecasts used in TEMPRO. These data (based on CACI household income estimates) were extracted using the same income bands as above, adjusted for price base, for 2006 and 2011. 2009 values were calculated by interpolation.

5.2.6 From the above sources, total production trips were derivable by model zone (TEMPRO zones were aggregated where appropriate and disaggregated by Census population where appropriate), purpose and income band, by multiplying number of households (NatCOP) by persons in household (NTS), and by trip rates (NTS). These were used proportionally to split the demand by income at a production zone level.

5.2.7 This split was then refined by production-attraction movement to control to trip proportions by distance band from NTS. Only proportions up to 50 miles were used, as sample sizes from NTS became low beyond this point and spurious results were found to appear in the data. Beyond 50 miles, the fitted functions were extrapolated. Table 5.3 shows that incomes tend to rise with trip distance, more markedly for commuting and slightly less so for other non-business trips.

5.2.8 Business trips are not segmented by income.

5.3 Results of Income Segmentation

5.3.1 Several checks have been done on the resulting matrices by income band to verify the income segmentation process. The total demand across all three income bands has been checked to ensure the outputs are equal to the total demand prior to income segmentation, for every purpose, time period and production-attraction movement. Some summary totals are shown in Table 5.4:

Table 5.4: Income Segmentation: Summary of Results within GB and Study Area (DSA)

		Totals			Proportions		
		Low	Medium	High	Low	Medium	High
Population (GB), '000s	Households	13,766	7,626	3,683	54.9%	30.4%	14.7%
	People	27,828	23,466	12,807	43.4%	36.6%	20.0%
Trips (DSA), '000s	Commuting	286	452	246	29.0%	46.0%	25.0%
	Home Based Other	854	872	513	38.2%	38.9%	22.9%
	Non-HB Other	162	166	98	38.0%	38.9%	23.1%
Person km (DSA), 000s	Commuting	1,584	4,964	3,300	16.1%	50.4%	33.5%
	Home Based Other	7,155	7,813	5,228	35.4%	38.7%	25.9%
	Non-HB Other	1,814	2,042	1,387	34.6%	38.9%	26.5%
Mean Trip Length, km (DSA)	Commuting	5.5	11.0	13.4	-	-	-
	Home Based Other	8.4	9.0	10.2	-	-	-
	Non-HB Other	11.2	12.3	14.1	-	-	-

5.3.2 It is worth noting that nationally the split into income bands at the household level looks uneven, with less than 15% of households being in the highest income category and more than 50% in the lowest. However, due to a number of factors the proportions of person km in the South-East are roughly divided three ways because:

- higher income households tend to contain more people on average;
- the South-East, the focus of the Study Area, has a higher income than average;
- people with higher incomes make slightly more trips than average; and
- people with higher incomes make significantly longer trips than average.

5.3.3 Average trip lengths by income band have also been calculated to demonstrate the variation in trip length with income. These are presented at the bottom of Table 5.4. Average trip lengths increase markedly with income, as expected, especially for commuting trips.

5.4 Values of Time

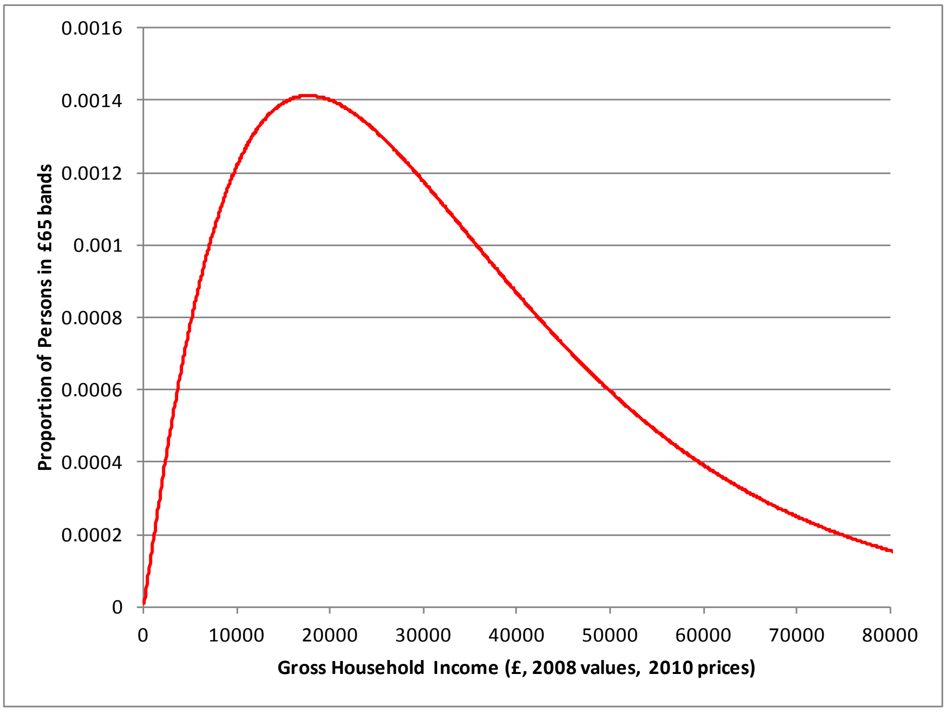
5.4.1 Values of time for each of the three income bands have been calculated using advice in WebTAG 3.12.2C, Annex A, which provides cross-sectional elasticities of value of time with respect to income. It also provides elasticities with respect to trip length, which have been used in the existing M25 Model and are retained in LTCM; these are not accounted for here to avoid double-counting.

5.4.2 Application of these elasticities requires an estimate of the average income in each income band. This has been obtained by assuming a gamma distribution of income, with P as number of people, I as income, and k and θ as parameters:

$$P = I^{k-1} e^{-I/\theta}$$

5.4.3 With k and θ fitted to reproduce the proportions of persons from the NatCOP data, a distribution of income has thus been estimated, shown in Figure 5.1 below, which allows the mean income in each band to be calculated.

Figure 5.1: Fitted Gamma Distribution of Income



5.4.4 These average incomes, shown in Table 5.1, have been used along with the WebTAG elasticities to calculate ratios of low income and high income values of time to medium income values of time. Keeping these ratios fixed, the value of time for the medium income band has then been adjusted to ensure that the average value of time across all three bands remains at the central value in WebTAG 3.5.6D. For both commuting and other purposes, this leaves the average value of time within a few percent of the medium income value.

5.5 Toll Choice Procedure Methodology

5.5.1 Before the main highway assignment in SATURN, in which trips are allocated to routes through the highway networks, is run, an external logit model has been adopted to allow travellers to choose to pay or not to pay the river-crossing toll. This model is the subject of this section. This ensures a “smoother” response to changes in tolls and the introduction of new toll roads, as discussed in Section 2.5, as compared with allowing the SATURN assignment itself to allocate trips to the toll roads or untolled alternatives.

5.5.2 This approach also removes the need to apply willingness-to-pay (household income) segmentation in the SATURN assignment model, since the choice of whether to pay the toll is not made in SATURN. Income segmentation is used in the demand and toll-choice models, though, as discussed in Section 5.2 above.

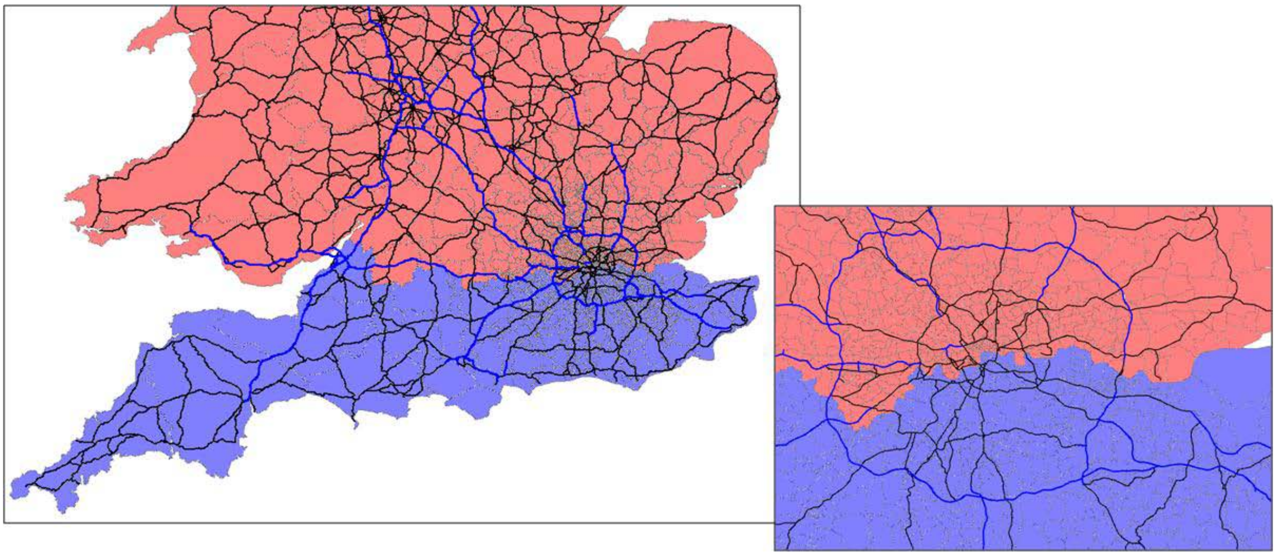
5.5.3 This pre-assignment logit model takes the non-work assignment demand and allocates demand to “pay” and “don’t’ pay” options. The “don’t pay” demand is then banned from using any tolled Thames crossings, whereas the “pay” demand has only tolled Thames crossings available. In cases where there is more than one tolled Thames crossing, a further logit model is available to allocate “pay” demand between toll options, and therefore to a specific crossing point. This additional choice model is only used when modelling differential tolls for use of different crossings.

5.5.4 This allocation from the pre-assignment logit model is implemented in the SATURN highway model through the addition of multiple non-work SATURN user classes. One represents the “don’t pay” demand, and then a further non-work assignment user class for (each) tolled Thames crossing in a given scenario is used. A series of banned links in the SATURN model across southern England ensure that these non-work assignment groups use only the crossing points they have been allocated through the pre-assignment logit model.

5.5.5 For freight and business assignment demand, the choice of crossing point, in terms of location and between tolled and non-tolled options, is undertaken in a conventional way within the SATURN assignment itself. The pre-assignment logit model is thus only applied to non-work car demand.

5.5.6 As part of the setup of the SATURN model to represent the crossing choices, a series of links stretching east-west following the Thames and continuing west along the M4 corridor has been defined. It is these links which are available to different "pay" and "don't pay" options discussed in Paragraph 5.5.4. Trips with both an origin and destination to the north of this screenline, or to the south, are excluded from the pre-assignment logit process and automatically added to the "don't pay" category. This screenline is shown in Figure 5.2

Figure 5.2: Thames River / M4 Corridor Screenline

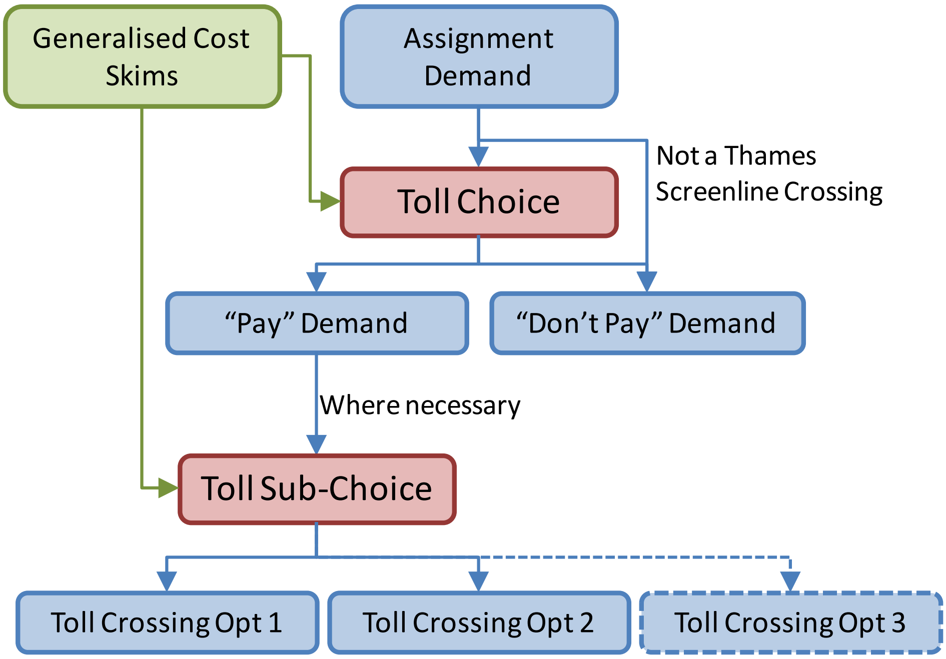


5.5.7 In summary, the procedure is as follows:

- Demand with origin and destination either both to the north or both to the south of the Thames Crossing Screenline is allocated directly to the "don't pay" category.
- An absolute logit model is run for the remainder of demand based on the highway assignment skimmed costs to allocate non-work between "don't pay" and "pay" categories.
- Where there is more than one tolled Thames crossing option, a further absolute logit model is available to distinguish between the available toll options.
- Demand is then reassigned onto the highway network, producing revised cost skims. This feeds into a further round of demand model choice calculations, producing revised assignment demand for the toll choice model.

5.5.8 This process is repeated until the demand and supply models are fully converged. The convergence is measured in accordance with the demand-supply %Gap as defined in WebTAG 3.10.4. The structure is illustrated in Figure 5.3.

Figure 5.3: Toll Choice Model Flow Diagram



5.5.9 The remainder of the demand model, i.e. mode choice, time period choice, etc, is applied based on composite costs over toll options, and between "pay" and "don't pay". The toll choice model itself is performed after these main demand model processes, prior to the assignment.

5.5.10 The toll choice process is an absolute logit model, based upon absolute costs rather than changes from existing base year costs, as it is necessary that the model be able to deal with new toll options that do not exist in the base year. It is therefore necessary to iterate the base year model to convergence, by running the toll choice model; this was not previously required in the M25 Model.

5.6 Derivation of Base Year Tolls for the Models

5.6.1 Tolls have been calculated for the demand and highway models. For freight and business trips, a toll is applied within the highway network, which is skimmed from SATURN and read into the demand model along with times and distances. For non-work travel, the toll-choice process supersedes this, and the toll is applied directly in the demand model. Home-based trips produced in the Local Residents' Discount Area are assigned a lower toll to account for the effect of the Local Residents' Discount.

5.6.2 Base year (2009) tolls on the crossing are as follows, expressed in 2009 prices.

Table 5.5: 2009 Dartford Tolls, 2009 prices

	Cash	TAG	Local
Car	£1.50	£1.00	£0.20
LGV	£2.00	£1.75	-
HGV	£3.70	£3.20	-

5.6.3 Deriving appropriate tolls for the LTCM involved two main steps: inflating these tolls to 2010 prices, as 2010 is used as the price base for the model (in accordance with WebTAG 3.5.6D), and calculating average tolls across all four payment types (including no payment).

5.6.4 The Consumer Price Index 2009-2010 has been used as the basis of the price-base adjustment.

5.6.5 Dartford Crossing transaction data have been used to derive payment type proportions, as shown in Table 5.6. For freight vehicles, proportions were found to be quite consistent across time periods. There was some variation for cars, with TAG and Local Residents (LR) take-up being higher in the peaks, especially the morning peak. However this made relatively little difference to the final tolls (the largest variation was around

8%), and in the interests of avoiding counter-intuitive time-period choice responses the same tolls were used for the three validated time periods (AM peak, interpeak, and PM Peak).

Table 5.6: 2009 Dartford Payment Type Proportions

	TAG	Local Residents	Cash	No Pay
Car	22.9%	4.9%	70.9%	1.2%
LGV	41.0%	0.0%	58.3%	0.7%
HGV	70.7%	0.0%	29.0%	0.3%

5.6.6 For the off-peak period, a much higher proportion of users do not pay a toll, as the Crossing is not charged between 10pm and 6am. The transaction data were used to derive this proportion (45.4% of off-peak users did not pay), and lower tolls were applied in the off-peak in the model. The data provided were not sufficient to derive the off-peak no-pay proportion by vehicle type.

5.6.7 An additional adjustment was made for Heavy Goods Vehicles (HGVs). The model definitions of “HGV” and “LGV” differs from the distinction made in the tolling system on the Crossing. The former is based upon vehicle weight, with vehicles weighing more than 3.5 tonnes being classified as HGVs, while the latter is based upon numbers of axles. Consequently, 21% (derived from DfT MCC data on either side of the crossing) of modelled HGVs pay the 2 axle tariff rather than the 3 axle tariff.

5.6.8 Finally, the local residents’ toll was estimated using two values that no direct observed data were available to substantiate: the proportion of trips based in the local-resident’s discount area using the Crossing that actually have an Local Residents’ tag (some will be occasional users that have none and pay the cash toll), and the average number (treating any value in excess of 50 as 50) of crossings made by a Local Residents’ TAG owner in one year (making fewer will increase the effective cost per trip, since a minimum £10 annual fee is charged.

5.6.9 The assumed values for these figures are 60% and 25 trips, respectively. Depending on the values assumed, the actual average paid toll for LR trips could vary between £0.21 (if all local residents who ever use the crossing have an LR TAG and use it 50 or more times per year) and £1.37 (if the LR TAG take-up is negligible). The proportion of trips using the crossing that are affected by this figure, however, is small; less than 5%.

5.6.10 The final tolls used in the model are presented in Table 5.7, below. These are in 2010 prices for consistency with the values of time and WebTAG 3.5.6D. In the demand model, the “LR” values are applied to home-based non-work car trips with a production in Dartford or Thurrock and the “Base” values to all other non-work car trips.

Table 5.7: Final Modelled Tolls (2010 prices, 2009 values)

Model	Segment	12hr	Off-peak
Highway	Business	£1.346	£0.735
	LGV	£1.947	£1.063
	HGV	£3.131	£1.711
Demand	Non-work, Base	£1.374	£0.774
	Non-work, LR	£0.868	£0.474

5.7 Toll Choice Model Sensitivity Parameters

5.7.1 Parameters are required for the toll-choice process. This means:

- a sensitivity “lambda”, in units of inverse time, which controls the scale of response of “pay” and “don’t pay” proportions to any change in cost;
- a choice-constant, in units of time, which calibrates the base level of toll paying, applied to toll-payers without loss of generality; and
- in principle, a second choice-constant used to calibrate the choice between two tolls, assumed zero.

5.7.2 We lack any strong or local evidence about what suitable parameters should be. A review of other models (see Section 3.6) identifies sensitivity lambdas calibrated between -0.05 and -0.15 inverse minutes.

WebTAG guidance would suggest that route choice, such as the choice of whether to use a toll road or not, is more sensitive than trip distribution. In the M25 Model, the most sensitive trip distribution lambda is -0.128 mins^{-1}.

5.7.3 By retaining the distribution lambdas in the M25 Model and by assuming same toll choice lambda is used for all demand segments, the toll choice lambda must be less than -0.128 mins^{-1}. Since the literature review suggests this is towards the upper end of sensible values, this value of -0.128 mins^{-1} has been adopted.

5.7.4 Testing shows that the volume of traffic using the crossing is not very sensitive to the lambda value, changing by only 20-30 PCUs as the toll choice lambda is varied between -0.1 and -0.2. There is therefore no compelling argument for refining the lambda better to reproduce observed flows..

5.7.5 Whilst research on toll roads identifies differences such as journey ambience and reliability between toll roads and untolled alternatives, we would not judge that there are such qualitative differences between the Dartford Crossing and other Thames crossings. Accordingly, we have assumed a choice-constant of zero.

5.8 Summary and Verification of Process

5.8.1 The process of dividing the demand matrices into willingness to pay bands has been checked thoroughly; total demand is unchanged, numbers of trips by income band are of a sensible order and trips lengths vary as expected. These figures are provided in Section 5.3. The distribution of trips by income and distance is consistent with NTS data.

5.8.2 The toll choice model has been checked to confirm that the composite costs generated are of sensible order (between minimum and maximum input values), that the process produces reasonable splits of demand, and that all non-river-crossing demand is allocated to “don’t pay”. It has been confirmed that the flow of non-work car traffic on the Dartford Crossing is very close to the total of the “pay” matrix, so that no demand is using the Crossing where it has been allocated to “don’t pay”, or, more likely, not using the Crossing where it has been allocated to “pay”.

5.8.3 Further verification and validation of the toll-choice process is provided by the results of the sensitivity tests in Chapter 8.

6 Base Year Highway Model Calibration and Validation

6 Base Year Highway Model Calibration and Validation

6.1 Introduction

6.1.1 This chapter documents the calibration and validation of the highway model, LTC_{HAM}, describing the approach adopted in refining the model within the Study Area, and examining the effect of the calibration on the highway demand matrices, and reporting how the modelled flows and journey times compare with observed data.

6.2 Identification of Significant Links in the Model

6.2.1 As previously discussed in Chapter 3, observed traffic data have been obtained from a number of different sources, incorporating traffic count databases such as the Highways Agency's Traffic Information System (HATRIS) and the Department for Transport's Open Data release, as well as from existing traffic models – both strategic and local in context.

6.2.2 The focus of the LTCM will be on corridors within the Study Area that are of most significance to the strategic assessment of potential impacts by provision of additional crossing capacity in the Lower Thames area. The locations of the proposed crossing capacity enhancement options are detailed in Chapter 1.

6.2.3 In order to identify these significant corridors, three separate fixed base year demand tests were undertaken using an interim version of the LTCM. These fixed demand tests were early approximations of the three scheme options to be tested: Options A, B and C. These tests assumed likely routes of each of the schemes with assumptions made as to the road standards, capacities and speed-flow relationships of the new infrastructure.

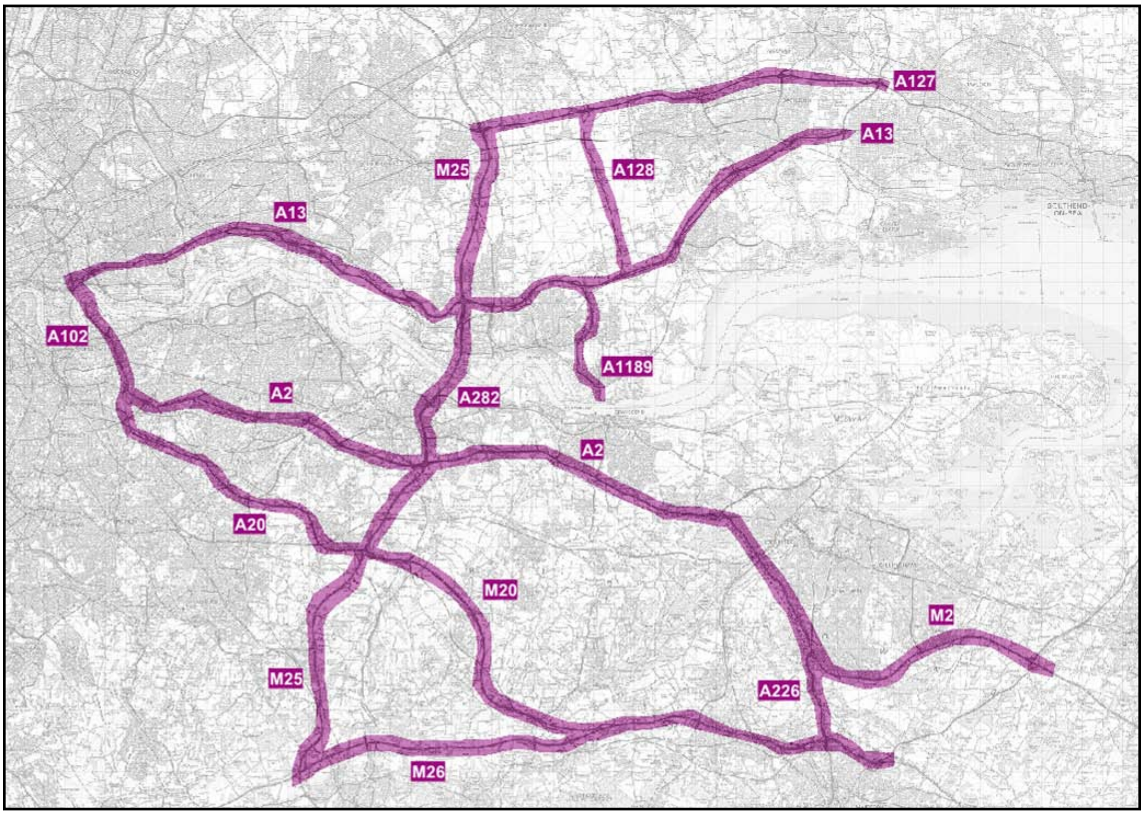
6.2.4 It was ensured that capacities on the new infrastructure were sufficient that the schemes would not generate significant delay either along their route nor at new junctions in order that all trips likely to be within the scope of the new schemes were captured.

6.2.5 The assignments of the fixed demand options A, B and C networks provided an indication as to both the geographical scope of trips likely to be affected by the introduction of further crossing capacity but also, and more importantly, the links within the model that were most likely to be affected as a result of traffic re-routeing.

6.2.6 In order to identify the links on which there is a significant change in flow as a result of the introduction of one of the crossing options, a set of flow change criteria was applied to identify where modelled traffic flow on a link changes by greater than ±2% or more, and by more than ±100 trips. Flow difference plots are included in Appendix C.

6.2.7 The broad definition of the identified links is shown in Figure 6.1. As can be seen this identification shows that the key corridors encompass the A2, M2, A13, A127, M20, M25, and M26 amongst others.

Figure 6.1: Key Corridors Identified



6.3 Definition of Screenlines

6.3.1 The availability of local models and suitable data sources for model enhancement was discussed in Chapters 2 and 3 respectively.

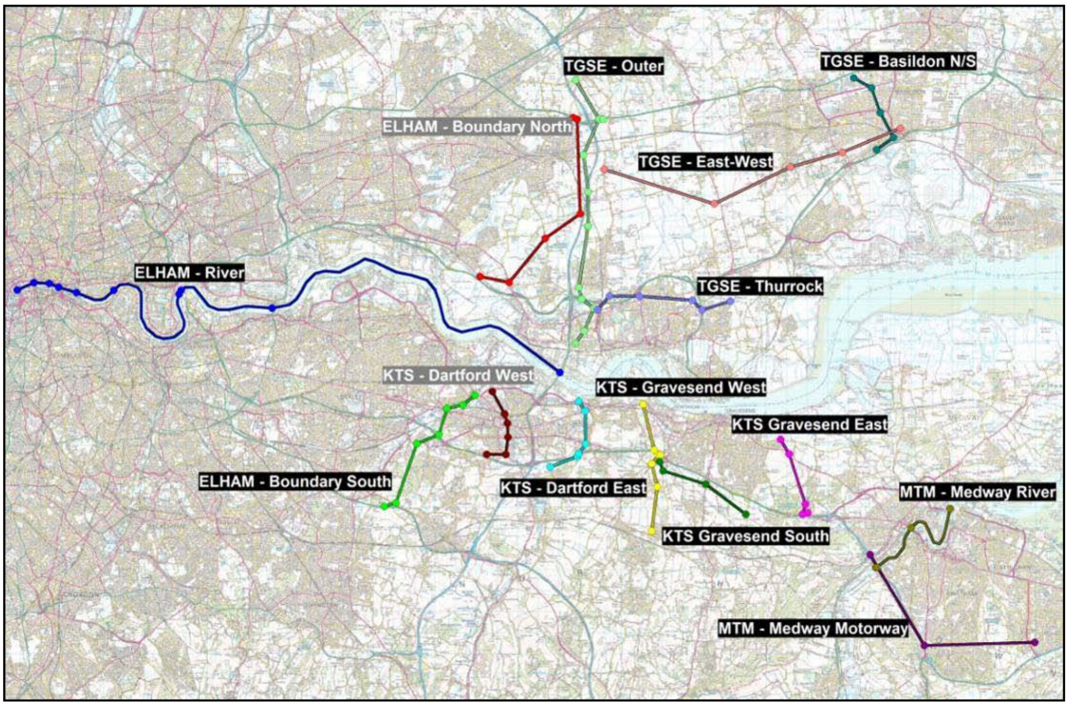
6.3.2 Available traffic count data have been arranged into a series of screenlines for the purposes of our assessment. A screenline represents a water-tight grouping of traffic count data across a number of adjacent links (normally 5 links or more) allowing for the identification of traffic across these parallel corridors, thus identifying sub-regional movements as a whole.

6.3.3 The count data from the local models, and the screenlines that have been derived, have been reviewed for their suitability for use in the calibration and validation of the LTC_{HAM}. The available screenlines have been assembled with the following in mind:

- to capture trip movements likely to use the existing Dartford Crossing and Options A, B and C, using traffic flow differences resulting from the fixed demand base year Option testing discussed above;
- to take account of the location of urban areas relative to these crossing locations;
- to take account of the known quality of the demand matrix throughout the Study Area; and
- to minimise the impact of matrix estimation on strategic traffic movements, as these have been estimated within the existing M25 Model.

6.3.4 The resulting screenlines are shown in Figure 6.2, with calibration screenlines indentified with black boxes and validation screenlines with grey boxes. The screenlines presented were based upon the data available to us from existing regional and local models; as a result there were some limitations in their selection as the donor regional and local model were not developed with assessment of additional Thames crossing capacity in mind. Nevertheless, the resultant screenlines do present a reasonable coverage of the Study Area, picking up the majority of the key sub-regional movements. It should be noted that these limitations have resulted in two screenlines being available for independent validation.

Figure 6.2: Calibration and validation screenlines selected for LTC_{HAM}



6.3.5 With these screenlines identified, 'mini-screenlines' have been defined for the calibration screenlines, sub-dividing the screenlines for direct use in the matrix estimation; this procedure is in-line with the guidance set out in WebTAG 3.19D §2.4. The counts on the mini-screenlines are grouped and used as a combined constraint, hence increasing confidence in them, rather than allowing matrix estimation to adjust the prior demand matrix on the basis of individual link counts alone.

6.3.6 Mini-screenlines were already defined in ELHAM, and these have been retained within the LTC_{HAM} calibration data set (ELHAM River and ELHAM Boundary South screenlines). For all other screenlines, mini-screenlines have been developed, taking into account routeing options and disparity of traffic flows using different roads crossing the screenline.

6.4 Further Calibration Traffic Count Data

6.4.1 Whilst the majority of the observed traffic count data contained were obtained from pre-existing models and arranged into the screenlines detailed above, some up-to-date traffic counts for the strategic road network were extracted from the Highways Agency's TRADS system for October 2009.

6.4.2 These TRADS counts were extracted for the M25 within the vicinity of the existing A282 crossing and incorporated into the calibration dataset. In total 9 counts at four locations were identified from the Highways Agency's database. The resultant calibration dataset is presented spatially in Figure 6.3, with screenline counts highlighted purple and TRADS counts shown in blue.

Figure 6.3: Location of All Counts Used for LTC_{HAM} Calibration

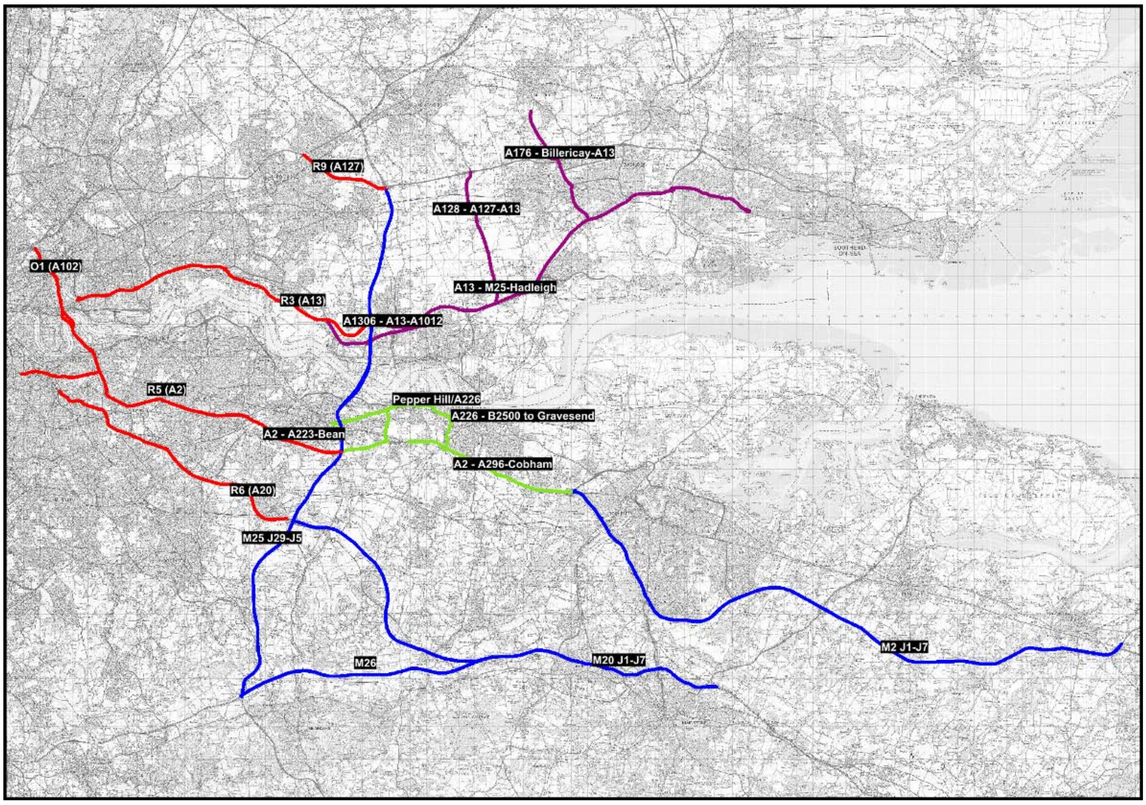
6.5 Definition of Journey Time Routes

6.5.1 As with screenlines, the journey time routes available in the local models have been considered for use in the validation of the LTC_{HAM}. To supplement these, journey time routes available in HATRIS have also been reviewed.

6.5.2 Before deciding on the journey time routes to use for the validation of the LTC_{HAM}, the routes used by existing Dartford Crossing traffic and those likely to be used following the introduction of Options A, B and C have been assessed, using the preliminary tests discussed in Section 6.2 above. Routes that carry significant traffic for the Dartford Crossing or local competing crossings (e.g. Blackwall Tunnel), or are forecast to carry significant traffic for Options A, B and C have relevance in the reporting of the validation of the model for the study purposes.

6.5.3 The resulting journey time routes are shown in Figure 6.4.Those coloured red have been derived from ELHAM, Purple from TGSE, green from the KTS model and blue from HATRIS.

Figure 6.4: Journey Time Routes Used for LTC$_{HAM}$ Validation



6.6 Network Calibration and Validation

6.6.1 Prior to undertaking matrix estimation, a round of network calibration was undertaken, making use of the prior matrices, in order to undertake an initial assignment. This round of network calibration complies with the guidance set out in WebTAG 3.19D §6, which states that highway networks need to be 'debugged before being used to adjust the trip matrices', in order that matrix adjustments are not made which compensate for issues within the networks and not the matrices.

6.6.2 Network calibration was undertaken primarily on a corridor basis, with a focus on the strategic regional routes within south Essex, north Kent and eastern London just within the M25. Whilst any network enhancement coding had been undertaken to a consistent set of guidelines, network adjustments to measurable topographical features such as link distances and cruise speeds were made where required to the network that had been inherited from the original base M25 Model. A review of warning messages generated by SATNET, the network build process, was also undertaken for the Study Area with changes made to the networks as required.

6.6.3 As discussed in WebTAG 3.19D §6, network connectivity was also assessed as part of the initial round of network calibration, with checks undertaken in areas where zonal aggregation and disaggregation had been undertaken (discussed in Chapter 4). Connectivity of the zone system to the network where no disaggregation or aggregation was carried out was not initially undertaken; an assumption that the M25 Model would have a reasonable representation of connectivity; any further changes to connectivity were undertaken in an iterative process where matrix estimation exposed network deficiencies which were subsequently reviewed and amended as necessary.

6.6.4 As WebTAG discusses, network validation is difficult due to a lack of available data. However, from the prior matrix assignment a preliminary comparison of observed and modelled journey time was undertaken for the routes that observed data had been obtained from other models as discussed in Section 6.5. This process showed a number of journey time routes within the M25 for which observed data had been obtained from TfL's ELHAM model that were particularly poor-performing in the donor M25 Model. As a result of this a review of coding was undertaken against that of ELHAM, leading ultimately to the incorporation of ELHAM coding for the A124, A127 and sections of the A2 to the west of the M25. This process ensured an enhanced representation of network coding along these routes, particularly with respect to junction capacities and signal timings.

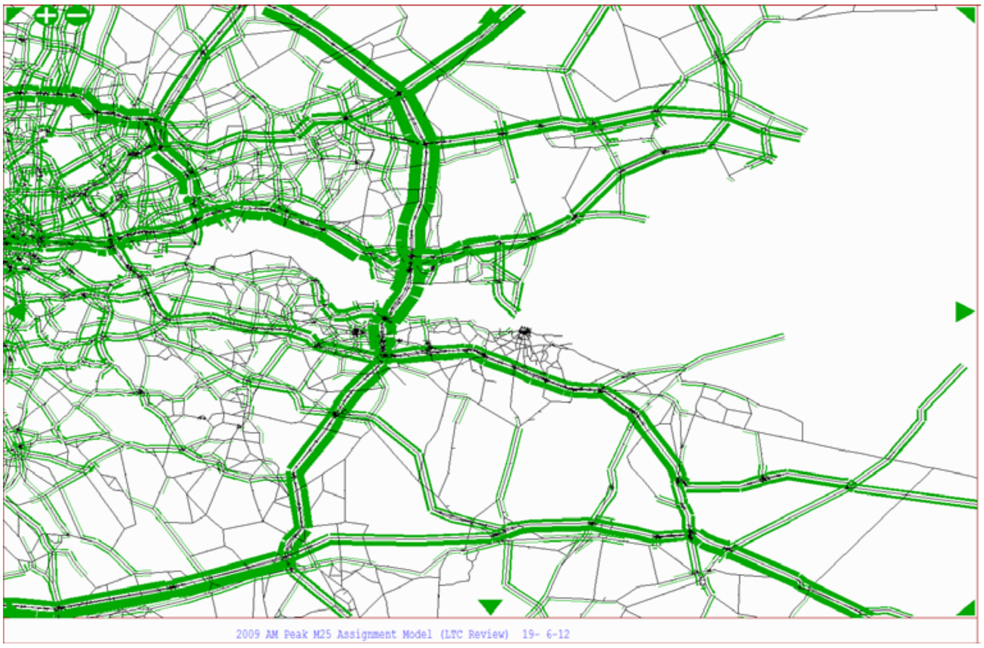
6.7 Route Choice Calibration and Validation

6.7.1 WebTAG 3.19D §7 states that the accuracy of a modelled assignment is dependent not only on the accuracy of the network coding and trip matrices, but also on the realism of the modelled routes throughout the highway assignment model. The guidance states that the plausibility of modelled routes should be checked at various stages of the model development process. For the purposes of the LTC_{HAM} model enhancement, routeing was checked before and during the trip matrix calibration process.

6.7.2 In accordance with WebTAG 3.19D §2.8, §7.2, generalised cost coefficients have not been adjusted during model calibration process. The values were derived from WebTAG 3.5.6D; the derivation of these coefficients is explained in Section 3.7 of this report.

6.7.3 As part of the assignment procedure however, we have retained the use of a KNOBS penalty file[5] in order to ensure that the routeing of HGVs takes better account of the attractiveness of motorways and key regional routes and trunk roads throughout the Study Area and the rest of the Fully Modelled Area. Figure 6.5 demonstrates HGV flows in the morning peak hour, showing that HGVs predominantly make use of strategic routes through the network as opposed to shorter distance but less suitable minor roads.

Figure 6.5: HGV Flows: 2009, AM Peak Hour



6.7.4 With regards to route-choice validation, a number of zone-to-zone paths have been extracted from the final post matrix estimation assignments demonstrating the route choice between zone pairs along key routes. These zone pairs have been chosen based on the criteria specified in WebTAG 3.19D §7.3, essentially being that they relate to links likely to be affected by the schemes to be tested and coincide with routes used as part of journey time validation. Plots are presented in Appendix D; each demonstrating that the model is allocating plausible route-choices.

6.8 Trip Matrix Calibration and Validation

6.8.1 As previously discussed, the starting point for the trip matrices used for the base-year calibration are the existing 2009 forecast matrices from the B602 version of the M25 Model which have been refined as discussed in Section 4.4, forming the 'prior' matrices for LTC_{HAM}.

[5] The KNOBS penalty procedure was favoured by Hyder Consulting during the development of the M25 Model over the use of HGV-specific speed-flow curves in order to provide consistency with previous modelling work and due to the impracticability of the timescales involved in the development of HGV-specific curves throughout the model.

6.8.2 Initial validation of the prior trip matrices against both the defined calibration and validation screenlines demonstrated the need for further matrix refinement; analyses of the trip ends from the 'prior' matrices demonstrated unrealistically high trip ends within one of the zones in the Gillingham urban area – as a result, an adjustment was made to this zone in order to reduce the activity to/from this zone. The 'prior' trips were then subsequently refined through use of matrix estimation, a process discussed in WebTAG 3.19D §8.3.

6.8.3 In-line with WebTAG 3.19D §8.3.5, count constraints during matrix estimation have been applied at a screenline level where appropriate. The use of some individual sites in the estimation process as previously described was limited and applied only at a few spot-points on the M25 where it was not possible to extend screenline definitions. Use of these individual counts is in-line with the guidance in WebTAG 3.19D §4.4.6 that states that counts of cars may be used in matrix estimation at the individual link level providing they are of sufficient quality. Traffic count data used in this study has been previously discussed in Chapter 3.

6.8.4 In-line with the WebTAG 3.19D §8.3.12, assignment convergence standards used in the estimation process were relaxed from the standards to be used in the final assignment models; a relaxed %GAP value of 0.05% was used in preference to the 0.02% used by the final assignments, well within the 0.1% tolerance set out in WebTAG.

Effect of matrix estimation on the prior matrix

6.8.5 In order to monitor the effect of matrix estimation and to ensure that the changes being implemented as a result of the process are not significant, matrix estimation has been monitored according to the criteria provided in WebTAG 3.19D §8.3.15, reproduced in Table 6.1.

Table 6.1: WebTAG Matrix Estimation Measures and Criteria

Table 5 Significance of Matrix Estimation Changes

Measure	Benchmark Criteria
Matrix zonal cell values	Slope within 0.98 and 1.02 Intercept near zero R^2 in excess of 0.95
Matrix zonal trip ends	Slope within 0.99 and 1.01 Intercept near zero R^2 in excess of 0.98
Trip length distributions	Means within 5% Standard deviations within 5%
Sector to sector level matrices	Differences within 5%

6.8.6 The guidance has been applied for each measure to each of the modelled time periods (AM peak, interpeak, PM peak).

6.8.7 Results from matrix estimation against the criteria are quoted in Table 6.2. Figures demonstrating the goodness of fit of the trip length frequency and zonal trip ends are presented in Appendix E. All matrix estimation results presented herein are for trips that have at least one trip-end in the Study Area. This is the area of the matrix that is likely to change the greatest and also corresponds to where traffic count data have been used in the matrix estimation process. Changes to the matrix outside this area are expected to be small and are analysed later in this chapter.

Table 6.2: Final Matrix Estimation Results

Measure	Criteria	AM	IP	PM
Matrix zonal cell values				
All cells	Slope	0.96	0.97	0.98
	Intercept	0.01	0.01	0.01
	R^2	0.92	0.95	0.91
Matrix zonal trip ends				
Origins	Slope	1.02	1.00	0.99
	Intercept	-27.38	-2.94	18.56
	R^2	0.99	1.00	0.99
Destinations	Slope	0.98	1.01	1.04
	Intercept	14.98	-7.38	-49.13
	R^2	1.00	1.00	0.99
Trip Length Distributions				
	Mean	-0.2%	0.9%	1.1%
	Standard Deviation	-0.7%	1.3%	0.2%

6.8.8 The matrix zonal cell value changes show that overall the matrix is changing by only a small degree within the Study Area as a result of the estimation process. Slope values for the morning and evening peak are just outside of the WebTAG criteria, but demonstrate very little change, whilst the evening peak hour changes meet the criteria. Intercept values are 0.01 in each time period, easily being in accordance with the guidance. For the R^2 values, the interpeak shows a value of 0.95, in-line with guidance. The morning and evening peak hours demonstrate values of 0.92 and 0.91 respectively, which are just outside the guidance criteria; these suggest that the estimation process is invoking some slightly larger changes to individual cells than would be expected in a traditional 'prior' to post matrix comparison.

6.8.9 An analysis of the 50 largest cell-to-cell demand changes across the AM peak, interpeak and PM peak periods as a result of matrix estimation has been undertaken. This shows that most changes are for localised movements within the Study Area, usually not affecting traffic in the close vicinity of the existing Crossing or Options A, B and C. Of the 50 movements examined, none crossed the River Thames. Detail of this analysis can be found in Appendix E.

6.8.10 With regard to matrix zonal trip end changes, the analyses demonstrate that for origins and destinations across each of the three modelled time periods, the resultant regression statistics tend to be within the criteria specified in WebTAG 3.19D. The only instance where the model fails to meet the criteria is in the PM peak hour where the slope of the destination trip ends is 1.04, only just exceeding the 1.02 criteria specified. Analyses of the trip ends for the PM peak however, demonstrate that the overall change in trip ends appears reasonable, demonstrating a good fit between the prior and post-estimation matrices.

6.8.11 Analysis of the outliers from the matrix zonal trips ends has been undertaken; these outliers have been identified as the largest outliers across each of the three time periods. In general, the changes at these zones as a result of estimation show that the effects are largely localised, not affecting traffic in the vicinity of the existing Dartford Crossing or proposed options. As with the cell-to-cell demand change analyses, none of the large trip end changes affect movements crossing the River Thames. A discussion of the key changes is provided below:

- Zone 28099 (Basildon East): The largest changes in trip ends from this zone are due to a reduction in trips to three other zones within Basildon and to Southend-on-Sea. For destinations, the largest changes are again due to a reduction in trips from other Basildon zones. These analyses suggest that the prior matrix may have contained an overestimate of demand within the Basildon urban area. These is a reasonable assumption as there is more confidence in the traffic counts used in matrix estimation than in the planning data used to derive the demand matrices (i.e. TEMPRO).

- Zone 28915 (Basildon central): The largest changes in trip ends at this zone, as per zone 28099, are reductions to/from other zones within Basildon, as well as a reduction in trips to Southend-on-Sea, again suggesting that the initial matrix may have contained an overestimate of demand for local trip movements.
- Zone 28014 (Southend-on-Sea): The largest changes in trip ends to/from Southend consist of reductions in trips from the Basildon area, as previously identified, suggesting that the local movements within the matrix are over-represented. Analyses does however, also show a corresponding increase in trips to a number of other zones within the Essex area and to eastern areas of London. The analyses indicate that traffic in the vicinity of the Dartford Crossing and crossing options is unlikely to be affected.
- Zone 20910 (Rochester, Medway): The change in trip ends at this zone is primarily due to the large increases in traffic between zones within Medway borough, to Gillingham, Rainham and Chatham. The analyses suggest that the prior matrices have an underestimate of trips within Medway and that counts in the estimation process within Medway itself are causing the increase. The movements contributing the majority of the trip end change are all localised within the borough boundary and will have little or no impact on the crossing options or cross-river traffic.

6.8.12 Analysis of the change in trip length distributions between the prior and post-estimation assignments demonstrates changes in the mean trip length and standard deviation that are well within the 5% criterion specified within WebTAG. Changes in the mean across all user-classes range from -0.2% to 1.1%, whilst changes in the standard deviation range from -0.7% to 1.3%. Further analyses have also demonstrated that, at an individual user-class level the estimation process is also compliant with the guidance: LGVs and HGVs tend to exhibit the largest change in trip lengths, with changes in the mean trip length for LGVs ranging from 1.5% in the interpeak to 4.0% in the evening peak, whilst the corresponding range for HGVs is between -0.6% and 2.0%. Changes in the standard deviation for these user-classes also fall within the 5% criteria stipulated in WebTAG 3.19D. Overall, the matrix estimation process can be shown to be having only a very slight effect on trip lengths for those trips with a trip-end in the Study Area.

6.8.13 Sector-to-sector analyses for the matrix estimation process are contained within Appendix E of this document, showing the percentage change in total trip ends by sector, where the inter-sector total is greater than 2000 trips. A threshold of 2000 trips has been selected in order to ensure that only significant changes in trips are identified through the analyses. In the morning peak hour, the results indicate that there are very few significant percentage changes observed in inter-sector movements: the two largest changes identified are between Basildon and Southend (-23%) and Southend to Basildon (-8%), which correspond to changes identified in the trip end changes, suggesting too many trips were contained within the demand matrices between these sectors. The only other notable inter-sector change in the morning peak is a reduction of 6% in trips between the Rest of Great Britain (south) and Maidstone/Mid-Kent.

6.8.14 In the interpeak, both Basildon to Southend (5%) and Southend to Basildon (-7%) show in the largest changes, the other notable change being the East of England to North East London (7%) where an increase in trips is demonstrated, with trips from either side of the A127 corridor being the uplifted. The evening peak again shows a similar collection of inter-sector movements: the matrix issues in the vicinity of Basildon are illustrated by the reduction in trips between the East of England and Basildon (-10%) and Southend and Basildon (-20%), whilst trips from Basildon to Southend witness an increase of 10%. Trips from South East London to Gravesend are shown to increase by 19% in the evening peak.

6.8.15 Overall, the sector-to-sector analyses demonstrate that for the majority of inter-sector movements there are only small changes to the matrix taking place, allowing only for modest changes to the underlying information contained within the initial 2009 prior matrices. Analogous to the other matrix estimation analyses undertaken, the sector-to-sector movements identify an overestimation of trips in the Basildon area of the matrices, with the general trend educing trips between Basildon and Southend. With the exception of the Basildon changes, the majority of the changes in inter-sector movements for prior matrix sectors with greater than 2000 trips are within the 5% criteria specified within WebTAG 3.19D.

Performance of the pre-matrix estimation trip matrices

6.8.16 Prior to undertaking matrix estimation, the prior matrix was assigned in order to understand the quality of the matrices within the Study Area prior to interpreting any change brought about by the matrix estimation process. Screenline totals are presented in Table 6.3 for both the calibration and independent validation screenlines at a total vehicle level.

6.8.17 As the table demonstrates, the performance of the prior matrix against the observed data is not compliant with the WebTAG criteria. Performance on the London boundary screenlines tends to be reasonable, although it is noted that the River Thames screenline in particular demonstrates modelled flows in excess of the observed. Similarly, performance throughout the Thames Gateway and Kent areas is mixed, with modelled flows being both higher and lower than the observed across each of the areas and time periods.

6.8.18 Prior to undertaking the model enhancement, the model performance within the Thames Gateway sub-region was known to be poor, with traffic flows tending to be under-represented. As a result, internal-internal movements throughout the sub-region were replaced with those from the TGSE prior matrices which should have a better representation of internal traffic movements.

6.8.19 The north Kent (KTS) area is shown to have poor compliance at the screenline level. As previously mentioned, the matrix in the north Kent area as taken from the original M25 Model is comprised almost entirely of synthetic data which have then been subject to matrix estimation. The matrices in the north Kent area in the prior matrix are not particularly representative of observed traffic volumes, with estimation of the original model having occurred only on the strategic routes.

6.8.20 As mentioned above, the screenline totals show that modelled flows across the River Thames screenline are in excess of the observed values, by between 14 and 29%; this is thought to be an effect of the Central London Congestion Charge Scheme (CLoCCS). The original matrices made use of observed data from 2001 LATS surveys, subsequently growthed and estimated to 2004 traffic data, both years of which are pre-CLoCCS implementation. With CLoCCS being implemented in 2003, traffic volumes across the central London area were reduced.

6.8.21 TfL's 5th annual impacts monitoring report (2007) suggested that of chargeable vehicles, up to a 30% decline in trips within the centre were observed, with a 16% reduction in all traffic. This is broadly consistent with the higher modelled flows across the screenline that are demonstrated, with the majority of the higher flows on the screenline occurring in central London, and with eastern locations on the screenline (Blackwall Tunnel, Woolwich, Dartford Crossing) being relatively well represented.

6.8.22 As well as the screenline totals, individual link flows on the M25 have been included in Table 6.4 for the AM peak, interpeak and PM peak periods. Flows on the M25 have been shown as this was the original focus of the B602 model, from which are prior matrices have been derived. These comparisons show that in general, the validation of the prior matrix assignment against M25 flows in the vicinity of Dartford Crossing is good, with the majority of sites between J29 and J5 meeting WebTAG 3.19D flow criteria in the morning and interpeak, and three of the sites meeting the requirements in the evening peak hour. This shows that the prior matrices are reasonable with regards to the level of trips making use of the strategic M25 routes within the model.

Table 6.3: Prior Matrix Screenline Calibration / Validation – Total PCUs

						25%					33%					13%
Calibration		**AM Peak**					**Interpeak**					**PM Peak**				
Screenline	**Direction**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**
ELHAM - River	Northbound	13,701	15,593	1,893	14%	FAIL	12,395	14,551	2,157	17%	FAIL	13,626	15,634	2,008	15%	FAIL
ELHAM - River	Southbound	12,740	15,925	3,185	25%	FAIL	12,549	15,732	3,182	25%	FAIL	13,951	16,967	3,017	22%	FAIL
ELHAM - Boundary South	Westbound	11,017	10,717	-300	-3%	PASS	7,784	7,601	-183	-2%	PASS	9,833	11,154	1,320	13%	FAIL
ELHAM - Boundary South	Eastbound	8,968	9,357	388	4%	PASS	8,520	8,362	-158	-2%	PASS	12,191	10,337	-1,854	-15%	FAIL
TGSE - Thurrock	Eastbound	6,091	7,713	1,621	27%	FAIL	6,794	7,547	753	11%	FAIL	7,064	8,999	1,935	27%	FAIL
TGSE - Thurrock	Westbound	5,595	7,406	1,811	32%	FAIL	6,597	6,394	-203	-3%	PASS	7,449	7,811	363	5%	PASS
TGSE - Basildon N/S	Eastbound	6,829	8,903	2,074	30%	FAIL	7,702	7,498	-205	-3%	PASS	10,329	8,941	-1,388	-13%	FAIL
TGSE - Basildon N/S	Westbound	9,818	9,359	-459	-5%	PASS	6,953	7,488	535	8%	FAIL	7,435	9,025	1,591	21%	FAIL
TGSE - Outer	Eastbound	11,171	9,276	-1,895	-17%	FAIL	9,728	8,188	-1,540	-16%	FAIL	11,285	9,613	-1,673	-15%	FAIL
TGSE - Outer	Westbound	10,147	9,661	-486	-5%	PASS	9,732	7,358	-2,374	-24%	FAIL	11,521	9,617	-1,904	-17%	FAIL
TGSE - East-West	Northbound	3,808	4,917	1,109	29%	FAIL	2,724	4,418	1,695	62%	FAIL	2,946	5,071	2,125	72%	FAIL
TGSE - East-West	Southbound	2,900	4,886	1,986	68%	FAIL	2,979	4,553	1,574	53%	FAIL	3,937	4,835	898	23%	FAIL
KTS - Gravesend East	Westbound	5,258	5,886	628	12%	FAIL	3,593	4,727	1,134	32%	FAIL	4,259	6,278	2,020	47%	FAIL
KTS - Gravesend East	Eastbound	3,858	6,108	2,249	58%	FAIL	3,869	5,445	1,576	41%	FAIL	6,044	6,454	410	7%	FAIL
KTS - Gravesend West	Westbound	7,183	5,896	-1,288	-18%	FAIL	4,869	5,042	173	4%	PASS	5,342	6,368	1,026	19%	FAIL
KTS - Gravesend West	Eastbound	4,688	5,810	1,123	24%	FAIL	5,168	6,312	1,145	22%	FAIL	7,903	6,758	-1,146	-14%	FAIL
KTS - Dartford East	Westbound	8,737	7,812	-925	-11%	FAIL	6,229	6,374	146	2%	PASS	6,533	8,106	1,573	24%	FAIL
KTS - Dartford East	Eastbound	5,504	7,711	2,206	40%	FAIL	6,653	7,607	954	14%	FAIL	9,233	8,490	-743	-8%	FAIL
KTS - Gravesend South	Westbound	1,630	1,532	-98	-6%	FAIL	1,171	1,105	-66	-6%	FAIL	1,365	1,427	62	5%	PASS
KTS - Gravesend South	Eastbound	1,122	1,221	99	9%	FAIL	1,139	1,105	-34	-3%	PASS	1,579	1,246	-333	-21%	FAIL
MTM - Medway River	Westbound	7,923	5,833	-2,090	-26%	FAIL	4,997	4,480	-517	-10%	FAIL	6,913	6,341	-572	-8%	FAIL
MTM - Medway River	Eastbound	7,163	5,764	-1,399	-20%	FAIL	4,813	4,979	165	3%	PASS	8,622	6,423	-2,199	-26%	FAIL
MTM - Medway Motorway	Northbound	3,675	3,606	-69	-2%	PASS	2,088	2,651	563	27%	FAIL	3,659	3,553	-106	-3%	PASS
MTM - Medway Motorway	Northbound	3,327	3,428	101	3%	PASS	2,092	2,573	481	23%	FAIL	3,311	3,796	485	15%	FAIL

						25%					50%					0%
Independent Validation		**AM Peak**					**Interpeak**					**PM Peak**				
Screenline	**Direction**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**
ELHAM - Boundary North	Westbound	8,144	6,882	-1,263	-16%	FAIL	5,510	4,855	-655	-12%	FAIL	6,731	6,363	-368	-5%	FAIL
ELHAM - Boundary North	Eastbound	5,709	5,860	151	3%	PASS	6,213	5,312	-901	-14%	FAIL	8,351	6,065	-2,286	-27%	FAIL
KTS - Dartford West	Westbound	8,446	7,935	-512	-6%	FAIL	5,995	5,771	-223	-4%	PASS	6,923	8,224	1,301	19%	FAIL
KTS - Dartford West	Eastbound	6,440	7,712	1,272	20%	FAIL	6,722	6,651	-71	-1%	PASS	9,336	7,858	-1,477	-16%	FAIL

Table 6.4: Prior Matrix, M25 validation

AM Peak

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	4,979	3,981	998	4,967	4,200	766	-12	0%	0.17	PASS
M25 J4-5: Clockwise	3,995	3,110	886	4,065	3,404	661	70	1%	1.10	PASS
M25 J4-5: Anti-Clockwise	4,115	3,457	658	4,399	3,691	708	284	6%	4.35	PASS
M25 J29-30: Clockwise	4,306	3,031	1,275	4,549	3,449	1,100	243	5%	3.65	PASS
M25 J29-30: Anti-Clockwise	4,396	3,013	1,383	5,021	3,813	1,208	625	14%	9.11	FAIL
M25 (within J29): Anti-Clockwise	3,262	2,043	1,219	3,435	2,446	989	173	5%	3.00	PASS
M25 (within J29): Clockwise	3,364	2,275	1,089	3,380	2,422	958	16	0%	0.27	PASS
A282 Dartford Crossing: Northbound	5,240	4,072	1,168	5,223	3,766	1,457	-17	-0%	0.24	PASS
A282 Dartford Crossing: Southbound	5,325	4,154	1,171	5,664	3,933	1,730	338	6%	4.57	PASS

Interpeak

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	3,597	2,801	797	3,552	2,886	667	-45	-1%	0.75	PASS
M25 J4-5: Clockwise	3,386	2,594	792	3,266	2,675	592	-120	-3%	2.08	PASS
M25 J4-5: Anti-Clockwise	3,784	2,796	988	3,686	2,866	820	-98	-2%	1.61	PASS
M25 J29-30: Clockwise	4,335	2,745	1,590	4,244	2,888	1,356	-90	-2%	1.38	PASS
M25 J29-30: Anti-Clockwise	4,345	2,755	1,591	4,786	3,183	1,604	441	10%	6.53	FAIL
M25 (within J29): Anti-Clockwise	3,441	1,993	1,449	3,441	2,012	1,429	-1	0%	0.01	PASS
M25 (within J29): Clockwise	3,483	2,055	1,428	3,213	2,045	1,168	-270	-7%	4.67	PASS
A282 Dartford Crossing: Northbound	5,018	3,687	1,330	5,102	3,300	1,801	84	2%	1.18	PASS
A282 Dartford Crossing: Southbound	4,734	3,556	1,178	5,128	3,476	1,653	394	8%	5.61	PASS

PM Peak

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	4,410	3,997	413	3,945	3,657	288	-465	-10%	7.19	FAIL
M25 J4-5: Clockwise	4,059	3,629	431	4,098	3,855	243	39	0%	0.61	PASS
M25 J4-5: Anti-Clockwise	4,327	3,833	494	4,730	4,149	581	403	9%	5.99	FAIL
M25 J29-30: Clockwise	4,046	2,993	1,054	5,296	4,370	926	1,250	30%	18.28	FAIL
M25 J29-30: Anti-Clockwise	4,874	3,803	1,072	4,812	3,750	1,062	-62	-1%	0.89	PASS
M25 (within J29): Anti-Clockwise	3,633	2,624	1,009	3,319	2,354	964	-314	-8%	5.32	PASS
M25 (within J29): Clockwise	3,283	2,280	1,003	4,071	3,226	845	788	24%	13.00	FAIL
A282 Dartford Crossing: Northbound	5,565	4,721	844	5,891	4,487	1,405	326	6%	4.31	PASS
A282 Dartford Crossing: Southbound	5,579	4,723	855	6,247	4,994	1,253	668	12%	8.69	FAIL

Validation of the post-matrix estimation trip matrices

6.8.23 Following matrix estimation, trip matrices have been validated at the total screenline level against both the calibration screenlines (those which have been used in applying constraints in the estimation process) and against the independent validation screenlines. This follows the suggested validation method in WebTAG 3.19D §8.

6.8.24 As per the prior matrix analyses, key M25 link calibration statistics are presented in Table 6.5. Screenline totals are presented in Table 6.6 for calibration screenlines and validation screenlines at a total vehicles level, whilst Table 6.7 presents the same analyses for HGVs only, in response to WebTAG guidance. The tables display the total observed count across all links contained on the screenline along with the total modelled flow across the screenline; the absolute and percentage difference between these figures is also presented. A separate column indicates the compliance with WebTAG 3.19D guidance set out in §3.2, specifically that differences between modelled and observed flows should be less than 5% of the observed count.

6.8.25 The results indicate that there is a general trend of the model slightly underestimating traffic flows across the screenlines in all time periods; this underestimation is modest with respect to WebTAG criteria however, being less than 5% difference from observed flows. All of the calibration screenlines with the exception of the TGSE Outer screenline in the eastbound direction in the morning peak hour meet the WebTAG criteria, indicating a 96% compliance rate in the AM peak and a 100% compliance in the interpeak and evening peak.

6.8.26 The TGSE Outer screenline failure to meet the WebTAG criterion in the morning peak hour in the eastbound direction is only slight, with the modelled flows being under-represented by 7%, just outside of the tolerance levels specified within WebTAG. Overall the matrix is demonstrated as being consistent with observed screenline counts, with the WebTAG 3.19D criterion being met in accordance with acceptability guidelines in almost all instances. As such, the model can be said to be broadly representing observed movements within the Study Area.

6.8.27 With regards to the independent validation screenlines, modelled traffic volumes on the ELHAM Boundary North screenline perform well against observed traffic counts across all time periods with respect to the flow criterion. The KTS Dartford-West screenline meets the criterion in the evening peak (both directions) and in the morning peak and interpeak (westbound); however, where the screenline fails to meet the criteria in the morning peak and the interpeak (eastbound), the differences are modest, with failures of +8% and -9% respectively. Overall, the matrix can be shown to present a reasonable validation against the independent traffic count data, further information as to the performance of the key strategic links is provided later in this chapter.

6.8.28 The general trend of total traffic volumes being slightly underestimated can also be seen in the HGV-only vehicle results. The results demonstrate that HGVs perform slightly worse compared with total traffic volumes, with 63%, 88% and 75% of calibration screenlines meeting the WebTAG criterion in the AM peak, interpeak and PM peak hours respectively, whilst for independent validation screenlines the KTS Dartford-West screenline fails to meet the criteria in all three time periods.

6.8.29 As with total vehicles, the morning peak validation is poor on the TGSE Outer screenline in the eastbound direction, with a difference of 17%, whilst the Medway River screenline also tends to underestimate HGV movements in both directions. In the interpeak, the Medway River screenline is the only calibration screenline that fails to meet the criteria in both directions, although this failure is only just outside of the specified tolerance levels at -6% and -7%. One other screenlines in the interpeak fails to meet the criteria, the KTS – Gravesend East screenline, only just failing to do so, reporting a total screenline difference of 6%.

6.8.30 For the evening peak, the majority of the failures are only just outside of the WebTAG criteria: this is particularly the case with the ELHAM River (northbound), TGSE Thurrock (westbound), TGSE East-West (southbound) and KTS Gravesend South (Eastbound) screenlines, all of which report a percentage difference of just 7%, only slightly in excess of the WebTAG screenline criterion.

6.8.31 Overall, the screenline validation for HGVs is considered to be acceptable: the majority of failures against the criterion in the morning and evening peak hours are only slight, with percentage differences only just in excess of the 5% threshold allowed in the guidelines. There is clearly an issue with the representation of HGV traffic in the west Dartford area as demonstrated by the results for the Dartford West independent validation screenline suggesting that the HGV matrix in this area of the model is light on trips. However, the majority of the Dartford West screenline is contained within the Dartford urban area, without much in the way of strategic relevance to the modelling and testing at hand, and so is unlikely to impact particularly on the schemes to be tested.

6.8.32 Overall, the matrix screenline validation suggests that the matrices are broadly in-line with observed levels of HGVs and should represent their movements reasonably at a strategic level.

Table 6.5: Post Estimation, M25 calibration

AM Peak

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	4,979	3,981	998	5,018	4,016	1,003	40	0%	0.56	PASS
M25 J4-5: Clockwise	3,995	3,110	886	4,024	3,136	888	29	0%	0.46	PASS
M25 J4-5: Anti-Clockwise	4,115	3,457	658	4,158	3,496	662	43	1%	0.67	PASS
M25 J29-30: Clockwise	4,306	3,031	1,275	4,443	3,164	1,279	137	3%	2.08	PASS
M25 J29-30: Anti-Clockwise	4,396	3,013	1,383	4,419	2,956	1,463	23	0%	0.35	PASS
M25 (within J29): Anti-Clockwise	3,262	2,043	1,219	3,359	2,156	1,203	98	3%	1.70	PASS
M25 (within J29): Clockwise	3,364	2,275	1,089	3,450	2,359	1,090	86	2%	1.48	PASS
A282 Dartford Crossing: Northbound	5,240	4,072	1,168	5,640	4,165	1,475	399	8%	5.42	PASS
A282 Dartford Crossing: Southbound	5,325	4,154	1,171	4,656	3,202	1,454	-670	-13%	9.48	FAIL

Interpeak

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	3,597	2,801	797	3,643	2,838	805	46	1%	0.77	PASS
M25 J4-5: Clockwise	3,386	2,594	792	3,415	2,619	796	29	0%	0.49	PASS
M25 J4-5: Anti-Clockwise	3,784	2,796	988	3,829	2,834	995	45	1%	0.73	PASS
M25 J29-30: Clockwise	4,335	2,745	1,590	4,381	2,773	1,608	46	1%	0.70	PASS
M25 J29-30: Anti-Clockwise	4,345	2,755	1,591	4,377	2,727	1,649	32	0%	0.48	PASS
M25 (within J29): Anti-Clockwise	3,441	1,993	1,449	3,524	2,112	1,412	83	2%	1.40	PASS
M25 (within J29): Clockwise	3,483	2,055	1,428	3,515	2,083	1,433	33	0%	0.55	PASS
A282 Dartford Crossing: Northbound	5,018	3,687	1,330	4,981	3,401	1,580	-37	-1%	0.52	PASS
A282 Dartford Crossing: Southbound	4,734	3,556	1,178	5,138	3,475	1,663	404	9%	5.75	FAIL

PM Peak

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	4,410	3,997	413	4,457	4,042	416	48	1%	0.72	PASS
M25 J4-5: Clockwise	4,059	3,629	431	4,081	3,647	434	22	0%	0.34	PASS
M25 J4-5: Anti-Clockwise	4,327	3,833	494	4,345	3,848	497	18	0%	0.27	PASS
M25 J29-30: Clockwise	4,046	2,993	1,054	4,201	3,124	1,078	155	3%	2.42	PASS
M25 J29-30: Anti-Clockwise	4,874	3,803	1,072	4,898	3,744	1,154	24	0%	0.34	PASS
M25 (within J29): Anti-Clockwise	3,633	2,624	1,009	3,746	2,798	947	113	3%	1.86	PASS
M25 (within J29): Clockwise	3,283	2,280	1,003	3,382	2,366	1,016	99	3%	1.72	PASS
A282 Dartford Crossing: Northbound	5,565	4,721	844	5,545	4,523	1,022	-20	-0%	0.27	PASS
A282 Dartford Crossing: Southbound	5,579	4,723	855	5,901	4,894	1,007	322	6%	4.25	PASS

Table 6.6: Screenline Calibration / Validation – Total PCUs

						96%					100%					100%
Calibration		**AM Peak**					**Interpeak**					**PM Peak**				
Screenline	**Direction**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**
ELHAM - River	Northbound	13,701	13,560	-141	-1%	PASS	12,395	12,355	-40	-0%	PASS	13,626	13,637	11	0%	PASS
ELHAM - River	Southbound	12,740	12,752	12	0%	PASS	12,549	12,600	50	0%	PASS	13,951	13,937	-14	-0%	PASS
ELHAM - Boundary South	Westbound	11,017	11,096	79	1%	PASS	7,784	7,782	-2	-0%	PASS	9,833	9,795	-38	-0%	PASS
ELHAM - Boundary South	Eastbound	8,968	8,812	-156	-2%	PASS	8,520	8,512	-8	-0%	PASS	12,191	12,136	-55	-0%	PASS
TGSE - Thurrock	Eastbound	6,091	6,228	136	2%	PASS	6,794	6,740	-54	-1%	PASS	7,064	7,028	-36	-1%	PASS
TGSE - Thurrock	Westbound	5,595	5,521	-74	-1%	PASS	6,597	6,551	-46	-1%	PASS	7,449	7,438	-11	-0%	PASS
TGSE - Basildon N/S	Eastbound	6,829	6,830	1	0%	PASS	7,702	7,719	17	0%	PASS	10,329	10,265	-64	-1%	PASS
TGSE - Basildon N/S	Westbound	9,818	9,844	26	0%	PASS	6,953	6,954	1	0%	PASS	7,435	7,429	-6	-0%	PASS
TGSE - Outer	Eastbound	11,171	10,394	-777	-7%	FAIL	9,728	9,676	-52	-1%	PASS	11,285	11,147	-139	-1%	PASS
TGSE - Outer	Westbound	10,147	9,701	-446	-4%	PASS	9,732	9,631	-101	-1%	PASS	11,521	11,298	-224	-2%	PASS
TGSE - East-West	Northbound	3,808	3,797	-11	-0%	PASS	2,724	2,716	-8	-0%	PASS	2,946	2,952	6	0%	PASS
TGSE - East-West	Southbound	2,900	2,812	-88	-3%	PASS	2,979	2,966	-13	-0%	PASS	3,937	3,893	-45	-1%	PASS
KTS - Gravesend East	Westbound	5,258	5,369	111	2%	PASS	3,593	3,652	59	2%	PASS	4,259	4,251	-7	-0%	PASS
KTS - Gravesend East	Eastbound	3,858	3,878	19	1%	PASS	3,869	3,868	-1	-0%	PASS	6,044	6,023	-22	-0%	PASS
KTS - Gravesend West	Westbound	7,183	7,130	-54	-1%	PASS	4,869	4,855	-14	-0%	PASS	5,342	5,295	-47	-1%	PASS
KTS - Gravesend West	Eastbound	4,688	4,880	192	4%	PASS	5,168	5,314	146	3%	PASS	7,903	8,199	296	4%	PASS
KTS - Dartford East	Westbound	8,737	8,544	-193	-2%	PASS	6,229	6,227	-2	-0%	PASS	6,533	6,525	-8	-0%	PASS
KTS - Dartford East	Eastbound	5,504	5,502	-2	-0%	PASS	6,653	6,648	-4	-0%	PASS	9,233	9,215	-18	-0%	PASS
KTS - Gravesend South	Westbound	1,630	1,633	3	0%	PASS	1,171	1,172	1	0%	PASS	1,365	1,383	17	1%	PASS
KTS - Gravesend South	Eastbound	1,122	1,118	-4	-0%	PASS	1,139	1,136	-3	-0%	PASS	1,579	1,565	-14	-1%	PASS
MTM - Medway River	Westbound	7,923	7,818	-106	-1%	PASS	4,997	4,956	-41	-1%	PASS	6,913	6,911	-2	-0%	PASS
MTM - Medway River	Eastbound	7,163	6,990	-172	-2%	PASS	4,813	4,748	-65	-1%	PASS	8,622	8,631	10	0%	PASS
MTM - Medway Motorway	Northbound	3,675	3,634	-41	-1%	PASS	2,088	2,092	4	0%	PASS	3,659	3,660	0	0%	PASS
MTM - Medway Motorway	Northbound	3,327	3,257	-70	-2%	PASS	2,092	2,093	1	0%	PASS	3,311	3,296	-16	-0%	PASS

						75%					75%					100%
Independent Validation		**AM Peak**					**Interpeak**					**PM Peak**				
Screenline	**Direction**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**
ELHAM - Boundary North	Westbound	8,144	8,154	10	0%	PASS	5,510	5,634	124	2%	PASS	6,731	7,015	283	4%	PASS
ELHAM - Boundary North	Eastbound	5,709	5,835	126	2%	PASS	6,213	6,306	93	2%	PASS	8,351	8,513	161	2%	PASS
KTS - Dartford West	Westbound	8,446	8,221	-225	-3%	PASS	5,995	5,895	-100	-2%	PASS	6,923	7,000	77	1%	PASS
KTS - Dartford West	Eastbound	6,440	6,925	485	8%	FAIL	6,722	6,129	-593	-9%	FAIL	9,336	8,970	-366	-4%	PASS

Table 6.7: Screenline Calibration / Validation – HGVs (PCUs)

						63%					88%					75%
Calibration		**AM Peak**					**Interpeak**					**PM Peak**				
Screenline	**Direction**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**
ELHAM - River	Northbound	2,353	2,301	-51	-2%	PASS	2,663	2,625	-37	-1%	PASS	1,366	1,464	98	7%	FAIL
ELHAM - River	Southbound	2,520	2,459	-61	-2%	PASS	2,649	2,589	-60	-2%	PASS	1,374	1,366	-8	-1%	PASS
ELHAM - Boundary South	Westbound	1,520	1,510	-10	-1%	PASS	1,380	1,373	-8	-1%	PASS	749	752	3	0%	PASS
ELHAM - Boundary South	Eastbound	1,641	1,519	-122	-7%	FAIL	1,613	1,610	-2	-0%	PASS	799	811	13	2%	PASS
TGSE - Thurrock	Eastbound	986	1,183	198	20%	FAIL	1,407	1,399	-8	-1%	PASS	612	587	-24	-4%	PASS
TGSE - Thurrock	Westbound	933	944	10	1%	PASS	1,367	1,363	-4	-0%	PASS	638	675	37	6%	FAIL
TGSE - Basildon N/S	Eastbound	997	995	-1	-0%	PASS	1,477	1,463	-14	-1%	PASS	948	942	-6	-1%	PASS
TGSE - Basildon N/S	Westbound	1,443	1,437	-6	-0%	PASS	1,345	1,349	3	0%	PASS	665	654	-11	-2%	PASS
TGSE - Outer	Eastbound	2,305	1,961	-344	-15%	FAIL	2,438	2,434	-4	-0%	PASS	1,135	1,129	-6	-1%	PASS
TGSE - Outer	Westbound	1,924	1,894	-30	-2%	PASS	2,488	2,484	-3	-0%	PASS	1,213	1,068	-145	-12%	FAIL
TGSE - East-West	Northbound	344	320	-24	-7%	FAIL	331	330	-1	-0%	PASS	125	163	38	30%	FAIL
TGSE - East-West	Southbound	262	243	-19	-7%	FAIL	362	370	8	2%	PASS	167	145	-22	-13%	FAIL
KTS - Gravesend East	Westbound	752	855	103	14%	FAIL	747	791	44	6%	FAIL	471	470	-1	-0%	PASS
KTS - Gravesend East	Eastbound	567	566	-1	-0%	PASS	799	797	-2	-0%	PASS	669	666	-2	-0%	PASS
KTS - Gravesend West	Westbound	1,015	972	-43	-4%	PASS	951	945	-6	-1%	PASS	593	591	-1	-0%	PASS
KTS - Gravesend West	Eastbound	600	598	-2	-0%	PASS	939	941	2	0%	PASS	879	883	4	0%	PASS
KTS - Dartford East	Westbound	1,096	1,033	-63	-6%	FAIL	1,082	1,076	-6	-1%	PASS	728	726	-2	-0%	PASS
KTS - Dartford East	Eastbound	724	719	-5	-1%	PASS	1,195	1,190	-5	-0%	PASS	1,028	1,020	-8	-1%	PASS
KTS - Gravesend South	Westbound	129	130	1	1%	PASS	116	116	0	0%	PASS	155	156	1	0%	PASS
KTS - Gravesend South	Eastbound	89	90	1	1%	PASS	112	111	-2	-2%	PASS	179	167	-12	-7%	FAIL
MTM - Medway River	Westbound	1,056	950	-106	-10%	FAIL	913	856	-57	-6%	FAIL	455	453	-2	-0%	PASS
MTM - Medway River	Eastbound	917	741	-177	-19%	FAIL	887	821	-67	-7%	FAIL	578	580	2	0%	PASS
MTM - Medway Motorway	Northbound	278	276	-3	-1%	PASS	220	223	3	1%	PASS	108	108	-0	-0%	PASS
MTM - Medway Motorway	Northbound	252	249	-3	-1%	PASS	221	222	1	0%	PASS	98	98	-0	-0%	PASS

						50%					50%					25%
Independent Validation		**AM Peak**					**Interpeak**					**PM Peak**				
Screenline	**Direction**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**	**Observed**	**Modelled**	**Abs Diff (M-O)**	**% Difference**	**WebTAG**
ELHAM - Boundary North	Westbound	2,002	2,010	7	0%	PASS	1,379	1,375	-4	-0%	PASS	533	584	51	9%	FAIL
ELHAM - Boundary North	Eastbound	1,026	1,019	-7	-1%	PASS	1,726	1,717	-9	-1%	PASS	939	929	-10	-1%	PASS
KTS - Dartford West	Westbound	1,020	1,272	252	25%	FAIL	953	1,107	154	16%	FAIL	774	570	-204	-26%	FAIL
KTS - Dartford West	Eastbound	779	1,342	563	72%	FAIL	1,078	1,196	118	11%	FAIL	1,043	711	-332	-32%	FAIL

6.9 Assignment Calibration and Validation

6.9.1 Following the validation of the trip matrices at a screenline level, the assignments have also been interrogated to ensure that the assignment model is reproducing realistic routeing at the link level. In order to validate this, two primary forms of validation have been undertaken in accordance with WebTAG 3.19D §9 guidance:

- traffic flows on individual links; and
- journey times along defined routes.

Traffic flows on links

6.9.2 Modelled flows on links have been compared for each of the calibration (constraints used in estimation) and independent validation screenlines, in-line with the guidance provided in WebTAG 3.19D §9.3 and §3.2. Whilst we have already demonstrated that the matrix totals are reasonable compared with observed trip totals, analyses of the individual link data help to provide confidence in the overall network coding and routeing being inferred by the highway assignment model. The acceptability guidelines given in WebTAG 3.19D §3.2 for individual link counts are presented in Table 6.8.

Table 6.8: WebTAG Link Flow Validation Criteria

Table 2 Link Flow and Turning Movement Validation Criteria and Acceptability Guidelines

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases
2	GEH < 5 for individual flows	> 85% of cases

6.9.3 Rather than present individual link flow validation results against all links across a screenline, results are presented herein for the key links of relevance to the study objectives.

6.9.4 The individual links that are presented have been selected through use of the significant link identification process outlined in Section 6.2 and followed by a process of determining the key links that are likely to have the most relevance to the three options to be assessed; generally, these are also the links that have the highest flows of any of the links on the screenline and thus represent the key movements through that particular area. The selected link flow validation is presented in Table 6.9 to Table 6.11 for the calibration constraint links and in Table 6.12 to Table 6.14 for the independent validation links.

Table 6.9: Significant Link Flow Validation; Calibration Screenlines: AM Peak

ELHAM River - Northbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A102 Blackwall Tunnel	3,317	2,812	505	2,995	2,781	214	-322	-9%	5.73	PASS
Woolwich Ferry	129	85	43	95	67	28	-34	-26%	3.17	PASS
A282 Dartford Crossing	5,240	4,072	1,168	5,640	4,165	1,475	399	7%	5.42	PASS
Rest of Screenline	5,015	4,378	636	4,830	4,245	585	-185	-3%		PASS
Total Screenline	**13,701**	**11,348**	**2,353**	**13,560**	**11,258**	**2,301**	**-141**	**-1%**		**PASS**

ELHAM River - Southbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A102 Blackwall Tunnel	2,788	2,130	658	3,483	3,097	386	695	24%	12.41	FAIL
Woolwich Ferry	143	102	41	149	109	40	6	4%	0.49	PASS
A282 Dartford Crossing	5,325	4,154	1,171	4,656	3,202	1,454	-670	-12%	9.48	FAIL
Rest of Screenline	4,484	3,833	650	4,464	3,885	579	-20	0%		PASS
Total Screenline	**12,740**	**10,220**	**2,520**	**12,752**	**10,293**	**2,459**	**12**	**0%**		**PASS**

ELHAM Boundary South - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2	4,281	3,767	514	4,283	3,781	501	2	0%	0.03	PASS
A20	2,804	2,485	319	2,895	2,611	284	90	3%	1.69	PASS
Rest of Screenline	3,932	3,245	687	3,919	3,194	725	-13	0%		PASS
Total Screenline	**11,017**	**9,497**	**1,520**	**11,096**	**9,586**	**1,510**	**79**	**0%**		**PASS**

ELHAM Boundary South - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2	3,565	2,983	582	3,521	2,991	530	-43	-1%	0.73	PASS
A20	1,625	1,413	212	1,707	1,557	149	82	5%	2.00	PASS
Rest of Screenline	3,779	2,931	847	3,584	2,744	840	-195	-5%		PASS
Total Screenline	**8,968**	**7,327**	**1,641**	**8,812**	**7,293**	**1,519**	**-156**	**-1%**		**PASS**

TGSE Thurrock - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A1089 Dock Approach Rd	909	653	256	880	642	239	-28	-3%	0.95	PASS
Rest of Screenline	5,182	4,453	730	5,347	4,403	945	165	3%		PASS
Total Screenline	**6,091**	**5,105**	**986**	**6,228**	**5,044**	**1,183**	**136**	**2%**		**PASS**

TGSE Thurrock - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A1089 Dock Approach Rd	1,032	741	291	1,017	726	291	-16	-1%	0.49	PASS
Rest of Screenline	4,563	3,920	643	4,504	3,851	653	-59	-1%		PASS
Total Screenline	**5,595**	**4,662**	**933**	**5,521**	**4,577**	**944**	**-74**	**-1%**		**PASS**

TGSE Basildon N/S - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between A176 and A132	2,782	2,313	469	2,797	2,315	483	15	0%	0.29	PASS
A13 between A132 and A176	1,972	1,640	333	1,987	1,649	337	14	0%	0.32	PASS
Rest of Screenline	2,075	1,880	195	2,046	1,870	176	-29	-1%		PASS
Total Screenline	**6,829**	**5,833**	**997**	**6,830**	**5,835**	**995**	**1**	**0%**		**PASS**

TGSE Basildon N/S - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between A176 and A132	3,661	3,043	617	3,847	3,206	641	186	5%	3.03	PASS
A13 between A132 and A176	3,363	2,796	567	2,985	2,403	583	-378	-11%	6.71	PASS
Rest of Screenline	2,794	2,536	258	3,013	2,799	213	218	7%		FAIL
Total Screenline	**9,818**	**8,375**	**1,443**	**9,844**	**8,408**	**1,437**	**26**	**0%**		**PASS**

TGSE Outer - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between M25 and B186	3,043	2,530	513	3,257	2,743	514	213	7%	3.80	PASS
A13	5,062	3,616	1,445	4,064	3,149	915	-997	-19%	14.77	FAIL
Rest of Screenline	3,066	2,719	347	3,073	2,541	532	7	0%		PASS
Total Screenline	**11,171**	**8,866**	**2,305**	**10,394**	**8,433**	**1,961**	**-777**	**-6%**		**FAIL**

TGSE Outer - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between M25 and B186	3,671	3,052	619	3,766	3,161	605	95	2%	1.56	PASS
A13	3,307	2,363	944	3,246	2,304	941	-62	-1%	1.07	PASS
Rest of Screenline	3,169	2,809	360	2,689	2,342	347	-480	-15%		FAIL
Total Screenline	**10,147**	**8,223**	**1,924**	**9,701**	**7,807**	**1,894**	**-446**	**-4%**		**PASS**

TGSE East-West - Northbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A128 Tilbury Rd	846	770	76	502	460	41	-345	-40%	13.28	FAIL
Rest of Screenline	2,962	2,694	268	3,295	3,016	279	333	11%		FAIL
Total Screenline	**3,808**	**3,464**	**344**	**3,797**	**3,476**	**320**	**-11**	**0%**		**PASS**

TGSE East-West - Southbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A128 Tilbury Rd	793	722	72	453	406	47	-340	-42%	13.63	FAIL
Rest of Screenline	2,107	1,917	190	2,359	2,163	196	252	11%		FAIL
Total Screenline	**2,900**	**2,638**	**262**	**2,812**	**2,569**	**243**	**-88**	**-3%**		**PASS**

Table 6.9: Significant Link Flow Validation; Calibration Screenlines: AM Peak (continued)

KTS Gravesend East - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Watling Street Strood	4,217	3,548	669	4,934	4,102	831	717	16%	10.60	FAIL
Rest of Screenline	1,041	959	83	435	411	24	-606	-58%	FAIL	
Total Screenline	**5,258**	**4,507**	**752**	**5,369**	**4,514**	**855**	**111**	**2%**	**PASS**	

KTS Gravesend East - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Watling Street Strood	3,285	2,764	521	3,593	3,047	546	308	9%	5.24	PASS
Rest of Screenline	573	528	45	285	265	20	-288	-50%	FAIL	
Total Screenline	**3,858**	**3,292**	**567**	**3,878**	**3,312**	**566**	**19**	**0%**	**PASS**	

KTS Gravesend West - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Pepperhill	5,608	4,718	890	5,606	4,759	846	-2	0%	0.03	PASS
Rest of Screenline	1,576	1,451	125	1,524	1,399	126	-51	-3%	PASS	
Total Screenline	**7,183**	**6,169**	**1,015**	**7,130**	**6,158**	**972**	**-54**	**0%**	**PASS**	

KTS Gravesend West - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Pepperhill	2,875	2,419	456	3,402	2,918	484	527	18%	9.40	FAIL
Rest of Screenline	1,812	1,668	144	1,478	1,364	114	-334	-18%	FAIL	
Total Screenline	**4,688**	**4,087**	**600**	**4,880**	**4,282**	**598**	**192**	**4%**	**PASS**	

KTS Dartford East - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Bean to M25 J2	5,081	4,274	806	5,071	4,261	810	-10	0%	0.14	PASS
Rest of Screenline	3,656	3,366	290	3,473	3,250	223	-184	-5%	PASS	
Total Screenline	**8,737**	**7,641**	**1,096**	**8,544**	**7,511**	**1,033**	**-193**	**-2%**	**PASS**	

KTS Dartford East - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Bean to M25 J2	3,621	3,046	575	3,618	3,046	573	-2	0%	0.04	PASS
Rest of Screenline	1,884	1,734	150	1,884	1,737	146	-0	0%	PASS	
Total Screenline	**5,504**	**4,780**	**724**	**5,502**	**4,783**	**719**	**-2**	**0%**	**PASS**	

Medway River - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M2 Junction 2 to 3	4,286	3,506	780	4,284	3,502	782	-2	0%	0.04	PASS
Rest of Screenline	3,637	3,361	276	3,534	3,366	168	-103	-2%	PASS	
Total Screenline	**7,923**	**6,867**	**1,056**	**7,818**	**6,868**	**950**	**-106**	**-1%**	**PASS**	

Medway River - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M2 Junction 2 to 3	3,524	2,882	642	3,473	2,879	594	-51	-1%	0.86	PASS
Rest of Screenline	3,639	3,363	276	3,517	3,370	147	-122	-3%	PASS	
Total Screenline	**7,163**	**6,245**	**917**	**6,990**	**6,250**	**741**	**-172**	**-2%**	**PASS**	

Medway Motorway - Northbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A229 Maidstone Rd	961	888	73	939	870	69	-22	-2%	0.71	PASS
Rest of Screenline	2,714	2,508	206	2,695	2,488	207	-19	0%	PASS	
Total Screenline	**3,675**	**3,397**	**278**	**3,634**	**3,358**	**276**	**-41**	**-1%**	**PASS**	

Medway Motorway - Northbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A229 Maidstone Rd	933	862	71	899	829	70	-34	-3%	1.13	PASS
Rest of Screenline	2,394	2,213	181	2,358	2,179	179	-36	-1%	PASS	
Total Screenline	**3,327**	**3,075**	**252**	**3,257**	**3,008**	**249**	**-70**	**-2%**	**PASS**	

Non-Screenline SRN Counts

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	4,979	3,981	998	5,018	4,016	1,003	40	0%	0.56	PASS
M25 J4-5: Clockwise	3,995	3,110	886	4,024	3,136	888	29	0%	0.46	PASS
M25 J4-5: Anti-Clockwise	4,115	3,457	658	4,158	3,496	662	43	1%	0.67	PASS
M25 J29-30: Clockwise	4,306	3,031	1,275	4,443	3,164	1,279	137	3%	2.08	PASS
M25 J29-30: Anti-Clockwise	4,396	3,013	1,383	4,419	2,956	1,463	23	0%	0.35	PASS
M25 (within J29): Anti-Clockwise	3,262	2,043	1,219	3,359	2,156	1,203	98	3%	1.70	PASS
M25 (within J29): Clockwise	3,364	2,275	1,089	3,450	2,359	1,090	86	2%	1.48	PASS

Table 6.10: Significant Link flow validation; Calibration Screenlines – Interpeak

ELHAM River - Northbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A102 Blackwall Tunnel	2,786	2,139	647	2,966	2,552	415	181	6%	3.37	PASS
Woolwich Ferry	134	73	61	76	47	29	-58	-43%	5.64	PASS
A282 Dartford Crossing	5,018	3,687	1,330	4,981	3,401	1,580	-37	0%	0.52	PASS
Rest of Screenline	4,458	3,833	625	4,332	3,730	602	-126	-2%	PASS	
Total Screenline	**12,395**	**9,732**	**2,663**	**12,355**	**9,729**	**2,625**	**-40**	**0%**	**PASS**	

ELHAM River - Southbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A102 Blackwall Tunnel	3,116	2,319	796	2,847	2,518	329	-269	-8%	4.93	PASS
Woolwich Ferry	148	106	42	68	29	39	-80	-53%	7.70	PASS
A282 Dartford Crossing	4,734	3,556	1,178	5,138	3,475	1,663	404	8%	5.75	FAIL
Rest of Screenline	4,551	3,919	632	4,547	3,988	559	-4	0%	PASS	
Total Screenline	**12,549**	**9,900**	**2,649**	**12,600**	**10,010**	**2,589**	**50**	**0%**	**PASS**	

ELHAM Boundary South - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2	2,780	2,322	458	2,786	2,337	449	6	0%	0.12	PASS
A20	1,515	1,267	248	1,881	1,656	224	365	24%	8.87	FAIL
Rest of Screenline	3,489	2,815	673	3,115	2,415	699	-374	-10%	FAIL	
Total Screenline	**7,784**	**6,404**	**1,380**	**7,782**	**6,409**	**1,373**	**-2**	**0%**	**PASS**	

ELHAM Boundary South - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2	3,545	2,867	678	3,483	2,841	642	-63	-1%	1.05	PASS
A20	1,630	1,354	276	1,422	1,195	227	-208	-12%	5.32	PASS
Rest of Screenline	3,344	2,686	658	3,607	2,866	741	263	7%	FAIL	
Total Screenline	**8,520**	**6,907**	**1,613**	**8,512**	**6,902**	**1,610**	**-8**	**0%**	**PASS**	

TGSE Thurrock - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A1089 Dock Approach Rd	1,055	688	367	985	644	341	-70	-6%	2.20	PASS
Rest of Screenline	5,739	4,699	1,041	5,755	4,697	1,058	16	0%	PASS	
Total Screenline	**6,794**	**5,387**	**1,407**	**6,740**	**5,341**	**1,399**	**-54**	**0%**	**PASS**	

TGSE Thurrock - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A1089 Dock Approach Rd	1,028	671	358	979	633	346	-49	-4%	1.55	PASS
Rest of Screenline	5,568	4,558	1,010	5,571	4,555	1,017	3	0%	PASS	
Total Screenline	**6,597**	**5,229**	**1,367**	**6,551**	**5,188**	**1,363**	**-46**	**0%**	**PASS**	

TGSE Basildon N/S - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between A176 and A132	2,910	2,240	669	2,947	2,295	652	38	1%	0.69	PASS
A13 between A132 and A176	2,200	1,694	506	2,192	1,659	534	-8	0%	0.16	PASS
Rest of Screenline	2,593	2,291	302	2,580	2,303	277	-13	0%	PASS	
Total Screenline	**7,702**	**6,225**	**1,477**	**7,719**	**6,257**	**1,463**	**17**	**0%**	**PASS**	

TGSE Basildon N/S - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between A176 and A132	2,625	2,021	604	2,763	2,139	624	138	5%	2.66	PASS
A13 between A132 and A176	1,984	1,527	456	1,933	1,448	485	-50	-2%	1.14	PASS
Rest of Screenline	2,344	2,059	285	2,257	2,018	240	-87	-3%	PASS	
Total Screenline	**6,953**	**5,608**	**1,345**	**6,954**	**5,605**	**1,349**	**1**	**0%**	**PASS**	

TGSE Outer - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between M25 and B186	2,573	1,981	592	2,477	1,904	573	-96	-3%	1.91	PASS
A13	3,793	2,458	1,334	3,871	2,492	1,378	78	2%	1.26	PASS
Rest of Screenline	3,362	2,851	512	3,328	2,846	482	-34	-1%	PASS	
Total Screenline	**9,728**	**7,290**	**2,438**	**9,676**	**7,242**	**2,434**	**-52**	**0%**	**PASS**	

TGSE Outer - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between M25 and B186	2,386	1,837	549	2,551	2,000	551	166	6%	3.33	PASS
A13	4,129	2,676	1,453	4,126	2,648	1,478	-3	0%	0.05	PASS
Rest of Screenline	3,218	2,731	486	2,954	2,498	456	-264	-8%	FAIL	
Total Screenline	**9,732**	**7,244**	**2,488**	**9,631**	**7,146**	**2,484**	**-101**	**-1%**	**PASS**	

TGSE East-West - Northbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A128 Tilbury Rd	584	513	71	346	322	25	-238	-40%	11.03	FAIL
Rest of Screenline	2,139	1,879	260	2,369	2,065	305	230	10%	FAIL	
Total Screenline	**2,724**	**2,393**	**331**	**2,716**	**2,386**	**330**	**-8**	**0%**	**PASS**	

TGSE East-West - Southbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A128 Tilbury Rd	665	584	81	533	464	69	-132	-19%	5.41	FAIL
Rest of Screenline	2,314	2,033	281	2,433	2,133	301	120	5%	PASS	
Total Screenline	**2,979**	**2,617**	**362**	**2,966**	**2,596**	**370**	**-13**	**0%**	**PASS**	

Table 6.10: Significant Link flow validation; Calibration Screenlines – Interpeak (continued)

KTS Gravesend East - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Watling Street Strood	3,011	2,321	690	3,248	2,475	773	237	7%	4.24	PASS
Rest of Screenline	582	524	57	405	386	18	-177	-30%		FAIL
Total Screenline	**3,593**	**2,846**	**747**	**3,652**	**2,861**	**791**	**59**	**1%**		**PASS**

KTS Gravesend East - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Watling Street Strood	3,197	2,465	732	3,453	2,690	762	255	7%	4.43	PASS
Rest of Screenline	671	605	66	415	381	35	-256	-38%		FAIL
Total Screenline	**3,869**	**3,070**	**799**	**3,868**	**3,071**	**797**	**-1**	**0%**		**PASS**

KTS Gravesend West - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Pepperhill	3,611	2,784	827	3,690	2,886	804	79	2%	1.32	PASS
Rest of Screenline	1,258	1,134	124	1,165	1,024	141	-93	-7%		FAIL
Total Screenline	**4,869**	**3,918**	**951**	**4,855**	**3,910**	**945**	**-14**	**0%**		**PASS**

KTS Gravesend West - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Pepperhill	3,292	2,538	754	3,757	2,972	786	466	14%	7.85	FAIL
Rest of Screenline	1,876	1,691	185	1,556	1,401	156	-320	-17%		FAIL
Total Screenline	**5,168**	**4,228**	**939**	**5,314**	**4,372**	**941**	**146**	**2%**		**PASS**

KTS Dartford East - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Bean to M25 J2	3,583	2,762	821	3,591	2,776	815	8	0%	0.13	PASS
Rest of Screenline	2,646	2,384	261	2,637	2,375	261	-9	0%		PASS
Total Screenline	**6,229**	**5,147**	**1,082**	**6,227**	**5,151**	**1,076**	**-2**	**0%**		**PASS**

KTS Dartford East - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 Bean to M25 J2	4,128	3,183	945	4,123	3,179	944	-5	0%	0.08	PASS
Rest of Screenline	2,524	2,275	249	2,525	2,280	246	1	0%		PASS
Total Screenline	**6,653**	**5,458**	**1,195**	**6,648**	**5,459**	**1,190**	**-4**	**0%**		**PASS**

Medway River - Westbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M2 Junction 2 to 3	2,611	1,949	662	2,621	1,964	657	10	0%	0.20	PASS
Rest of Screenline	2,386	2,135	252	2,335	2,136	199	-52	-2%		PASS
Total Screenline	**4,997**	**4,084**	**913**	**4,956**	**4,100**	**856**	**-41**	**0%**		**PASS**

Medway River - Eastbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M2 Junction 2 to 3	2,566	1,916	650	2,562	1,913	648	-4	0%	0.08	PASS
Rest of Screenline	2,248	2,010	237	2,187	2,014	173	-61	-2%		PASS
Total Screenline	**4,813**	**3,926**	**887**	**4,748**	**3,927**	**821**	**-65**	**-1%**		**PASS**

Medway Motorway - Northbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A229 Maidstone Rd	396	354	42	396	352	44	-0	0%	0.01	PASS
Rest of Screenline	1,692	1,513	179	1,696	1,517	179	4	0%		PASS
Total Screenline	**2,088**	**1,868**	**220**	**2,092**	**1,869**	**223**	**4**	**0%**		**PASS**

Medway Motorway - Northbound

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A229 Maidstone Rd	436	390	46	439	392	47	2	0%	0.10	PASS
Rest of Screenline	1,656	1,481	175	1,655	1,480	175	-1	0%		PASS
Total Screenline	**2,092**	**1,871**	**221**	**2,093**	**1,871**	**222**	**1**	**0%**		**PASS**

Non-Screenline SRN Counts

Description	Observed Total	Observed Lights	Observed Heavies	Modelled Total	Modelled Lights	Modelled Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M25 J3-4: Clockwise	3,597	2,801	797	3,643	2,838	805	46	1%	0.77	PASS
M25 J4-5: Clockwise	3,386	2,594	792	3,415	2,619	796	29	0%	0.49	PASS
M25 J4-5: Anti-Clockwise	3,784	2,796	988	3,829	2,834	995	45	1%	0.73	PASS
M25 J29-30: Clockwise	4,335	2,745	1,590	4,381	2,773	1,608	46	1%	0.70	PASS
M25 J29-30: Anti-Clockwise	4,345	2,755	1,591	4,377	2,727	1,649	32	0%	0.48	PASS
M25 (within J29): Anti-Clockwise	3,441	1,993	1,449	3,524	2,112	1,412	83	2%	1.40	PASS
M25 (within J29): Clockwise	3,483	2,055	1,428	3,515	2,083	1,433	33	0%	0.55	PASS

Table 6.11: Significant Link flow validation; Calibration Screenlines – PM Peak

ELHAM River - Northbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A102 Blackwall Tunnel	3,366	3,044	322	3,475	3,318	157	109	3%	1.86	PASS
Woolwich Ferry	155	136	20	192	160	31	36	23%	2.77	PASS
A282 Dartford Crossing	5,565	4,721	844	5,545	4,523	1,022	-20	0%	0.27	PASS
Rest of Screenline	4,539	4,359	181	4,426	4,172	253	-114	-2%		PASS
Total Screenline	**13,626**	**12,260**	**1,366**	**13,637**	**12,173**	**1,464**	**11**	**0%**		**PASS**

ELHAM River - Southbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A102 Blackwall Tunnel	3,294	3,009	286	3,104	2,969	135	-191	-5%	3.37	PASS
Woolwich Ferry	136	119	18	77	64	14	-59	-43%	5.71	PASS
A282 Dartford Crossing	5,579	4,723	855	5,901	4,894	1,007	322	5%	4.25	PASS
Rest of Screenline	4,941	4,726	215	4,855	4,644	210	-87	-1%		PASS
Total Screenline	**13,951**	**12,577**	**1,374**	**13,937**	**12,571**	**1,366**	**-14**	**0%**		**PASS**

ELHAM Boundary South - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2	3,912	3,648	263	3,893	3,634	259	-19	0%	0.30	PASS
A20	1,977	1,875	102	2,704	2,622	82	728	36%	15.04	FAIL
Rest of Screenline	3,945	3,561	384	3,198	2,787	411	-747	-18%		FAIL
Total Screenline	**9,833**	**9,084**	**749**	**9,795**	**9,043**	**752**	**-38**	**0%**		**PASS**

ELHAM Boundary South - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2	5,498	5,192	307	5,407	5,090	316	-92	-1%	1.24	PASS
A20	2,733	2,582	150	2,566	2,463	103	-166	-6%	3.23	PASS
Rest of Screenline	3,960	3,618	342	4,163	3,771	392	202	5%		PASS
Total Screenline	**12,191**	**11,393**	**799**	**12,136**	**11,324**	**811**	**-55**	**0%**		**PASS**

TGSE Thurrock - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A1089 Dock Approach Rd	1,206	1,053	152	1,163	1,019	144	-43	-3%	1.24	PASS
Rest of Screenline	5,858	5,398	459	5,865	5,421	444	7	0%		PASS
Total Screenline	**7,064**	**6,452**	**612**	**7,028**	**6,440**	**587**	**-36**	**0%**		**PASS**

TGSE Thurrock - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A1089 Dock Approach Rd	1,124	982	142	1,159	931	228	35	3%	1.05	PASS
Rest of Screenline	6,325	5,829	496	6,279	5,831	447	-46	0%		PASS
Total Screenline	**7,449**	**6,811**	**638**	**7,438**	**6,763**	**675**	**-11**	**0%**		**PASS**

TGSE Basildon N/S - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between A176 and A132	4,269	3,784	485	4,062	3,602	459	-208	-4%	3.22	PASS
A13 between A132 and A176	3,060	2,713	347	3,199	2,852	347	139	4%	2.48	PASS
Rest of Screenline	3,000	2,884	116	3,005	2,870	135	5	0%		PASS
Total Screenline	**10,329**	**9,381**	**948**	**10,265**	**9,324**	**942**	**-64**	**0%**		**PASS**

TGSE Basildon N/S - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between A176 and A132	2,919	2,588	331	3,170	2,825	345	251	8%	4.54	PASS
A13 between A132 and A176	1,863	1,651	211	1,854	1,655	200	-8	0%	0.20	PASS
Rest of Screenline	2,653	2,530	122	2,404	2,295	110	-248	-9%		FAIL
Total Screenline	**7,435**	**6,770**	**665**	**7,429**	**6,775**	**654**	**-6**	**0%**		**PASS**

TGSE Outer - Westbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between M25 and B186	3,593	3,185	408	3,336	2,925	411	-256	-7%	4.35	PASS
A13	3,927	3,423	505	3,893	3,390	503	-35	0%	0.55	PASS
Rest of Screenline	3,765	3,543	222	3,918	3,703	214	152	4%		PASS
Total Screenline	**11,285**	**10,151**	**1,135**	**11,147**	**10,018**	**1,129**	**-139**	**-1%**		**PASS**

TGSE Outer - Eastbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 between M25 and B186	2,897	2,568	329	3,270	2,939	331	374	12%	6.73	PASS
A13	5,136	4,476	660	4,395	3,906	489	-741	-14%	10.73	FAIL
Rest of Screenline	3,488	3,264	224	3,632	3,384	248	144	4%		PASS
Total Screenline	**11,521**	**10,308**	**1,213**	**11,298**	**10,229**	**1,068**	**-224**	**-1%**		**PASS**

TGSE East-West - Northbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A128 Tilbury Rd	695	665	29	463	444	20	-231	-33%	9.61	FAIL
Rest of Screenline	2,251	2,155	96	2,489	2,345	144	238	10%		FAIL
Total Screenline	**2,946**	**2,821**	**125**	**2,952**	**2,789**	**163**	**6**	**0%**		**PASS**

TGSE East-West - Southbound

	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A128 Tilbury Rd	953	912	40	690	655	34	-263	-27%	9.18	FAIL
Rest of Screenline	2,985	2,858	127	3,203	3,092	111	218	7%		FAIL
Total Screenline	**3,937**	**3,770**	**167**	**3,893**	**3,748**	**145**	**-45**	**-1%**		**PASS**

Table 6.11: Significant Link flow validation; Calibration Screenlines – PM Peak (continued)

KTS Gravesend East - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 Watling Street Strood	3,603	3,207	397	3,889	3,433	456	286	7%	4.68	PASS
Rest of Screenline	655	581	74	362	348	13	-294	-44%	FAIL	
Total Screenline	**4,259**	**3,787**	**471**	**4,251**	**3,781**	**470**	**-7**	**0%**	**PASS**	

KTS Gravesend East - Eastbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 Watling Street Strood	5,082	4,523	559	5,549	4,917	632	467	9%	6.41	FAIL
Rest of Screenline	962	853	109	474	439	35	-488	-50%	FAIL	
Total Screenline	**6,044**	**5,375**	**669**	**6,023**	**5,356**	**666**	**-22**	**0%**	**PASS**	

KTS Gravesend West - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 Pepperhill	4,000	3,560	440	4,125	3,636	489	124	3%	1.95	PASS
Rest of Screenline	1,342	1,189	152	1,170	1,067	103	-172	-12%	FAIL	
Total Screenline	**5,342**	**4,749**	**593**	**5,295**	**4,703**	**591**	**-47**	**0%**	**PASS**	

KTS Gravesend West - Eastbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 Pepperhill	5,317	4,732	585	6,002	5,333	669	685	12%	9.11	FAIL
Rest of Screenline	2,586	2,292	294	2,196	1,982	214	-389	-15%	FAIL	
Total Screenline	**7,903**	**7,024**	**879**	**8,199**	**7,316**	**883**	**296**	**3%**	**PASS**	

KTS Dartford East - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 Bean to M25 J2	3,985	3,547	439	3,990	3,554	435	4	0%	0.07	PASS
Rest of Screenline	2,547	2,258	289	2,535	2,245	290	-12	0%	PASS	
Total Screenline	**6,533**	**5,804**	**728**	**6,525**	**5,799**	**726**	**-8**	**0%**	**PASS**	

KTS Dartford East - Eastbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 Bean to M25 J2	5,909	5,259	650	5,979	5,316	663	70	1%	0.90	PASS
Rest of Screenline	3,324	2,946	378	3,236	2,878	358	-88	-2%	PASS	
Total Screenline	**9,233**	**8,205**	**1,028**	**9,215**	**8,194**	**1,020**	**-18**	**0%**	**PASS**	

Medway River - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
M2 Junction 2 to 3	3,667	3,308	359	3,663	3,306	358	-4	0%	0.07	PASS
Rest of Screenline	3,246	3,150	96	3,248	3,152	95	2	0%	PASS	
Total Screenline	**6,913**	**6,458**	**455**	**6,911**	**6,458**	**453**	**-2**	**0%**	**PASS**	

Medway River - Eastbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
M2 Junction 2 to 3	4,728	4,265	463	4,743	4,278	465	15	0%	0.22	PASS
Rest of Screenline	3,893	3,778	115	3,888	3,773	115	-5	0%	PASS	
Total Screenline	**8,622**	**8,044**	**578**	**8,631**	**8,051**	**580**	**10**	**0%**	**PASS**	

Medway Motorway - Northbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A229 Maidstone Rd	823	799	24	824	800	24	1	0%	0.03	PASS
Rest of Screenline	2,837	2,753	84	2,836	2,752	84	-1	0%	PASS	
Total Screenline	**3,659**	**3,551**	**108**	**3,660**	**3,552**	**108**	**0**	**0%**	**PASS**	

Medway Motorway - Northbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A229 Maidstone Rd	901	874	27	890	862	28	-11	-1%	0.36	PASS
Rest of Screenline	2,411	2,339	71	2,406	2,336	70	-5	0%	PASS	
Total Screenline	**3,311**	**3,213**	**98**	**3,296**	**3,198**	**98**	**-16**	**0%**	**PASS**	

Non-Screenline SRN Counts	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
M25 J3-4: Clockwise	4,410	3,997	413	4,457	4,042	416	48	1%	0.72	PASS
M25 J4-5: Clockwise	4,059	3,629	431	4,081	3,647	434	22	0%	0.34	PASS
M25 J4-5: Anti-Clockwise	4,327	3,833	494	4,345	3,848	497	18	0%	0.27	PASS
M25 J29-30: Clockwise	4,046	2,993	1,054	4,201	3,124	1,078	155	3%	2.42	PASS
M25 J29-30: Anti-Clockwise	4,874	3,803	1,072	4,898	3,744	1,154	24	0%	0.34	PASS
M25 (within J29): Anti-Clockwise	3,633	2,624	1,009	3,746	2,798	947	113	3%	1.86	PASS
M25 (within J29): Clockwise	3,283	2,280	1,003	3,382	2,366	1,016	99	3%	1.72	PASS

6.9.5 Overall, a total of 37 of the 145 calibration links have been identified as being significant links with regards to movements likely to be affected by the introduction of one of the capacity enhancement schemes. Of these links, 81% of meet the DMRB link flow requirements in the morning peak hour, 86% in the average interpeak hour and 84% in the evening peak hour. This demonstrates an acceptable level of performance of the strategic highway network in the Lower Thames area which, whilst not quite meeting the 85% of cases quoted in the WebTAG 3.19D acceptability guidelines for the AM and PM peak hours, shows that the majority of links represent traffic flows across the sub-region to a reasonable degree.

6.9.6 With regards to the **ELHAM River Screenline**, the key links are all shown to have good validation in the interpeak and evening peak hours, with northbound movements also sufficiently well represented in the morning peak. For southbound movements in the morning peak hour it is noted that whilst the representation of trips crossing the river at a screenline level is good, there is a clear discrepancy between trips crossing the river at the A102 Blackwall Tunnel and the A282 Dartford Crossing. It should be noted that, for both of these crossings, network coding is consistent with that of the latest studies and ongoing work within the area, with recent updates to TfL’s ELHAM having been reflected and used within our improved M25 Model networks.

6.9.7 On the **ELHAM Boundary South Screenline**, the key link of the A2 meets the WebTAG criteria in all time periods and directions. For the A20 in the westbound direction however, the route appears to be too attractive in the interpeak and evening peak hours, with the route carrying a higher volume of traffic than observed. The screenline totals as a whole match very closely across all time periods being well within the WebTAG criteria, whilst the ‘rest of screenline’ links have a lower volume than observed due to the increased amount of traffic making use of the A20 instead.

6.9.8 For the **TGSE Basildon N/S Screenline**, the two key routes of the A127 and A13 exhibit good flow validation in all time periods. .

6.9.9 The **TGSE Outer Screenline** generally shows reasonable levels of validation, although it is notable as the only calibration constraint screenline which fails to meet WebTAG criteria as a whole in one direction, with traffic flows underrepresented by 7% in the morning peak hour westbound, primarily due to the under-modelling of traffic flows on the A13.

6.9.10 The **TGSE East-West Screenline** as a whole represents good levels of validation in all time periods suggesting that the matrix across the screenline is broadly sufficient. The A128 which has been identified as a link significant to the proposed schemes is shown to be light on modelled traffic across each of the time periods and directions, whilst the combination of all sites that make up the rest of the screenline are shown to have too much traffic by the corresponding amount. The networks and zone-loading within the area have been scrutinised to a good degree and appear reasonable, matching adopted coding conventions, whilst modelled journey times on the A128 validate well against observed data. As a result, it would appear that whilst the matrices in the area are broadly plausible, trip-ends by individual zone may not match planning data or the geographical features of the zones entirely accurately. Traffic use of the A128 will need to be borne-in-mind during forecasting work and any re-routing along it will need to be scrutinised in-light of the likely available capacity, which is being overestimated by the base year model.

6.9.11 At the **KTS Gravesend East Screenline**, the A2 has been selected as the significant link with regards to the proposed schemes. Modelled flows on the A2 validate well in the interpeak and in the peak hours in the non-peak directions. For the AM peak (westbound) and the PM peak (eastbound), the A2 is shown as over-representing traffic flows; these absolute differences correspond with the under-representation of traffic flows across the rest of the screenline. The rest of the counts on this screenline are situated on lower flow more rural routes including the A226 to the east of Gravesend. It is acknowledged that within Gravesend there is an over-complex network given the zone system that exists for the strategic model; it is possible that the mismatch between zone system and network is leading to the routeing of traffic via the A2 in preference to more rural routes. In general however, the issues are not considered significant. Further west, data for the M2shows that traffic flows into the Study Area validate well and none of the links on the KTS Gravesend East screenline have been identified as significant with regards to flow changes expected by the introduction of the scheme options. As a result, the peak flow over-estimation of flows on the A2 at this location is not expected to have a significant and detrimental impact upon the strategic assessment of the Thames crossing options, although this should be borne in mind, for Option B in particular.

6.9.12 All of the other screenlines and individual links (Strategic Road Network in the Lower Thames area) that have been included in the calibration constraints exhibit good levels of validation. Given that the majority of locations that have been designated as being significant with regards to the scheme options to be tested, it is not considered that the screenline issues reported above will have a significantly detrimental effect on any strategic assessments to be made, particularly given the likely use-case for the model as an initial identification and sifting tool for the three schemes as opposed to a detailed design and assessment tool.

6.9.13 Tables demonstrating the link flow validation for the independent validation screenlines are presented in Table 6.12 to Table 6.14 for all three time periods. The data that are provided are shown in the same format as for the calibration constraint screenlines, with routes significant to the proposed scheme options in the Lower Thames area highlighted.

6.9.14 On the **ELHAM Boundary North Screenline**, both the key routes of the A127 and the A13 tend to exhibit good validation. The A13 fails to meet the validation criterion in the morning peak hour eastbound and in the evening peak hour westbound, overestimating traffic flows by around 20%.

6.9.15 For the **KTS Dartford West Screenline**, the A2 tends to demonstrate good validation, meeting the WebTAG requirements in most time periods and directions, failing to meet the criteria only eastbound in the PM peak, although this is only a slight failure with a GEH value of 7.7 calculated. The 'rest of the screenline' categorised counts fail to meet the criteria in both directions in the interpeak and in the eastbound direction in the evening peak. For the PM at least, this is partially due to the fact that in LTC_{HAM} the A2 is modelled with more traffic than observed. The main likely cause however, is the modelling of the urban area within Dartford, for which the majority of the counts cover routes in the centre; the network coding within the urban area itself is reasonable, although signal timings do not necessarily reflect the on-ground situation in October 2009 and capacities are generally based on more strategic specifications and will not be as junction-specific as normally required for the urban area. In the interpeak particularly, the results also suggest that there is not enough demand within the matrices for the central Dartford area, given the low modelled flows across the rest of the screenline.

Table 6.12: Significant Link flow validation; Calibration Screenlines – AM Peak

ELHAM Boundary North - Westbound	Observed			Modelled						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A127 Southend Arterial Road	1,867	1,613	253	2,025	1,750	275	158	8%	3.59	PASS
A13	4,010	2,546	1,464	4,155	2,874	1,281	144	3%	2.26	PASS
Rest of Screenline	2,267	1,983	285	1,974	1,520	454	-293	-12%	FAIL	
Total Screenline	**8,144**	**6,142**	**2,002**	**8,154**	**6,144**	**2,010**	**10**	**0%**	**PASS**	

ELHAM Boundary North - Eastbound	Observed			Modelled						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A127 Southend Arterial Road	1,450	1,287	163	1,572	1,433	139	122	8%	3.13	PASS
A13	2,401	1,759	642	2,963	2,303	660	562	23%	10.86	FAIL
Rest of Screenline	1,858	1,637	221	1,300	1,080	221	-558	-30%	FAIL	
Total Screenline	**5,709**	**4,683**	**1,026**	**5,835**	**4,816**	**1,019**	**126**	**2%**	**PASS**	

KTS Dartford West - Westbound	Observed			Modelled						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 West of J2	4,408	3,708	699	4,054	3,613	441	-354	-8%	5.44	PASS
Rest of Screenline	4,039	3,718	321	4,167	3,336	831	129	3%	PASS	
Total Screenline	**8,446**	**7,427**	**1,020**	**8,221**	**6,949**	**1,272**	**-225**	**-2%**	**PASS**	

KTS Dartford West - Westbound	Observed			Modelled						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 West of J2	3,382	2,846	537	3,732	3,183	548	349	10%	5.85	PASS
Rest of Screenline	3,057	2,815	243	3,193	2,400	794	136	4%	PASS	
Total Screenline	**6,440**	**5,660**	**779**	**6,925**	**5,583**	**1,342**	**485**	**7%**	**FAIL**	

Non-Screenline SRN counts	Observed			Modelled						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
M20 J2-3: Eastbound	2,504	1,851	653	980	871	109	-1,524	-60%	36.51	FAIL
M20 J3-4: Westbound	4,968	3,518	1,450	4,830	4,008	823	-138	-2%	1.97	PASS
M20 J3-4: Eastbound	4,000	3,096	905	3,071	2,662	410	-929	-23%	15.62	FAIL
M20 J5-6: Eastbound	2,798	2,151	647	2,491	2,099	391	-307	-10%	5.97	PASS
M20 J5-6: Westbound	3,685	2,693	992	3,064	2,619	446	-621	-16%	10.68	FAIL
M20 J6-7: Eastbound	4,517	3,585	932	4,140	3,453	687	-376	-8%	5.72	PASS
M20 J6-7: Westbound	5,782	4,548	1,235	5,178	4,185	994	-604	-10%	8.15	FAIL
M25 J8-9: Clockwise	6,144	4,898	1,246	5,660	4,403	1,257	-484	-7%	6.30	FAIL
M25 J8-9: Anti-Clockwise	5,378	4,320	1,058	5,884	4,876	1,008	506	9%	6.74	FAIL
M25 J13-J14 : Clockwise	8,185	6,929	1,256	7,858	6,895	963	-327	-3%	3.65	PASS
M25 J13-J14 : Anti-Clockwise	7,873	6,673	1,200	7,669	6,689	980	-204	-2%	2.32	PASS
M25 Within J20: Clockwise	4,055	3,223	832	4,295	3,667	628	240	5%	3.71	PASS
M25 J20 Offslip: Clockwise	474	418	56	742	596	146	268	56%	10.88	FAIL
M25 Within J20: Anti-Clockwis	2,570	1,886	684	3,428	2,926	503	858	33%	15.67	FAIL
M25 J20 Offslip: Anti-Clockwis	749	591	158	1,083	953	130	334	44%	11.03	FAIL
M25 J25-26: Clockwise	4,353	3,135	1,218	4,723	4,071	652	370	8%	5.49	PASS
M25 J25-26: Anti-Clockwise	4,907	3,675	1,232	4,534	3,899	636	-373	-7%	5.42	PASS
M26 J2a-3: Eastbound	1,487	1,102	385	2,091	1,791	300	605	40%	14.30	FAIL

Table 6.13: Significant Link flow validation; Calibration Screenlines – Interpeak

ELHAM Boundary North - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A127 Southend Arterial Road	1,270	1,088	182	1,308	1,140	167	38	2%	1.06	PASS
A13	2,783	1,800	983	3,091	2,080	1,011	308	11%	5.69	PASS
Rest of Screenline	1,457	1,243	214	1,235	1,039	196	-222	-15%		FAIL
Total Screenline	**5,510**	**4,131**	**1,379**	**5,634**	**4,259**	**1,375**	**124**	**2%**		**PASS**

ELHAM Boundary North - Eastbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A127 Southend Arterial Road	1,251	1,070	181	1,236	1,090	145	-15	-1%	0.44	PASS
A13	3,416	2,095	1,321	3,639	2,333	1,306	223	6%	3.75	PASS
Rest of Screenline	1,546	1,321	225	1,431	1,166	266	-114	-7%		FAIL
Total Screenline	**6,213**	**4,486**	**1,726**	**6,306**	**4,589**	**1,717**	**93**	**1%**		**PASS**

KTS Dartford West - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 West of J2	2,771	2,136	635	2,880	2,496	384	109	3%	2.05	PASS
Rest of Screenline	3,224	2,905	318	3,015	2,292	723	-209	-6%		FAIL
Total Screenline	**5,995**	**5,042**	**953**	**5,895**	**4,788**	**1,107**	**-100**	**-1%**		**PASS**

KTS Dartford West - Westbound	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
A2 West of J2	3,179	2,451	728	3,427	2,810	617	248	7%	4.31	PASS
Rest of Screenline	3,542	3,193	350	2,702	2,123	579	-840	-23%		FAIL
Total Screenline	**6,722**	**5,644**	**1,078**	**6,129**	**4,933**	**1,196**	**-593**	**-8%**		**FAIL**

Non-Screenline SRN counts	**Observed**			**Modelled**						
Description	**Total**	**Lights**	**Heavies**	**Total**	**Lights**	**Heavies**	**Abs Diff (M-O)**	**% Difference**	**GEH**	**DMRB**
M20 J2-3: Eastbound	1,513	952	562	872	723	149	-641	-42%	18.56	FAIL
M20 J3-4: Westbound	3,261	2,048	1,213	2,577	1,961	616	-684	-20%	12.66	FAIL
M20 J3-4: Eastbound	3,662	2,380	1,282	2,780	2,133	646	-882	-24%	15.55	FAIL
M20 J5-6: Eastbound	2,638	1,718	920	2,041	1,505	536	-597	-22%	12.34	FAIL
M20 J5-6: Westbound	2,502	1,597	905	1,203	1,203	0	-1,299	-51%	30.17	FAIL
M20 J6-7: Eastbound	3,861	2,680	1,181	3,460	2,607	853	-401	-10%	6.62	FAIL
M20 J6-7: Westbound	3,546	2,412	1,134	3,267	2,387	880	-279	-7%	4.78	PASS
M25 J8-9: Clockwise	5,557	4,146	1,411	5,132	3,701	1,431	-425	-7%	5.82	FAIL
M25 J8-9: Anti-Clockwise	5,592	4,211	1,382	5,666	4,208	1,458	74	1%	0.98	PASS
M25 J13-J14 : Clockwise	7,276	5,505	1,771	6,252	4,966	1,286	-1,024	-14%	12.45	FAIL
M25 J13-J14 : Anti-Clockwise	7,095	5,763	1,332	6,389	5,274	1,114	-706	-9%	8.60	FAIL
M25 Within J20: Clockwise	4,336	3,111	1,225	3,985	3,189	796	-351	-8%	5.44	PASS
M25 J20 Offslip: Clockwise	451	369	82	576	407	169	126	27%	5.54	FAIL
M25 Within J20: Anti-Clockwis	3,936	2,921	1,014	3,954	3,298	656	19	0%	0.30	PASS
M25 J20 Offslip: Anti-Clockwise	753	616	136	622	462	160	-130	-17%	4.97	FAIL
M25 J25-26: Clockwise	4,537	3,004	1,533	4,799	3,849	950	262	5%	3.84	PASS
M25 J25-26: Anti-Clockwise	4,403	2,971	1,432	4,095	3,240	856	-308	-6%	4.72	PASS
M26 J2a-3: Eastbound	1,662	1,004	657	1,907	1,410	497	246	14%	5.81	PASS

Table 6.14: Significant Link flow validation; Calibration Screenlines – PM Peak

ELHAM Boundary North - Westbound	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 Southend Arterial Road	1,846	1,787	59	2,072	1,949	123	226	12%	5.11	PASS
A13	2,972	2,612	360	3,696	3,377	319	724	24%	12.54	FAIL
Rest of Screenline	1,913	1,799	114	1,246	1,104	142	-667	-34%	FAIL	
Total Screenline	**6,731**	**6,198**	**533**	**7,015**	**6,431**	**584**	**283**	**4%**	**PASS**	

ELHAM Boundary North - Eastbound	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A127 Southend Arterial Road	1,608	1,514	94	1,488	1,399	89	-120	-7%	3.05	PASS
A13	4,684	3,942	741	4,884	4,200	684	200	4%	2.89	PASS
Rest of Screenline	2,059	1,956	103	2,140	1,985	155	81	3%	PASS	
Total Screenline	**8,351**	**7,413**	**939**	**8,513**	**7,583**	**929**	**161**	**1%**	**PASS**	

KTS Dartford West - Westbound	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 West of J2	3,582	3,188	394	3,675	3,502	174	93	2%	1.54	PASS
Rest of Screenline	3,340	2,961	380	3,325	2,928	396	-16	0%	PASS	
Total Screenline	**6,923**	**6,149**	**774**	**7,000**	**6,430**	**570**	**77**	**1%**	**PASS**	

KTS Dartford West - Westbound	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
A2 West of J2	4,929	4,386	543	5,489	5,158	330	560	11%	7.75	FAIL
Rest of Screenline	4,407	3,906	501	3,482	3,101	381	-925	-20%	FAIL	
Total Screenline	**9,336**	**8,293**	**1,043**	**8,970**	**8,259**	**711**	**-366**	**-3%**	**PASS**	

Non-Screenline SRN counts	Observed			Modelled						
Description	Total	Lights	Heavies	Total	Lights	Heavies	Abs Diff (M-O)	% Difference	GEH	DMRB
M20 J2-3: Eastbound	1,733	1,389	344	2,001	1,914	86	267	15%	6.19	FAIL
M20 J3-4: Westbound	3,529	2,650	880	3,847	3,378	469	318	9%	5.24	PASS
M20 J3-4: Eastbound	5,848	4,873	975	4,229	3,822	407	-1,619	-27%	22.80	FAIL
M20 J5-6: Eastbound	4,091	3,327	765	2,981	2,681	300	-1,110	-27%	18.67	FAIL
M20 J5-6: Westbound	2,690	2,100	590	2,404	2,404	0	-286	-10%	5.67	PASS
M20 J6-7: Eastbound	6,240	5,318	922	4,507	3,957	549	-1,733	-27%	23.64	FAIL
M20 J6-7: Westbound	4,249	3,483	766	4,594	4,053	541	346	8%	5.20	PASS
M25 J8-9: Clockwise	5,270	4,420	850	5,804	4,801	1,004	534	10%	7.18	FAIL
M25 J8-9: Anti-Clockwise	6,578	5,738	840	6,297	5,495	801	-281	-4%	3.51	PASS
M25 J13-J14 : Clockwise	6,272	5,244	1,028	6,920	6,076	844	648	10%	7.98	FAIL
M25 J13-J14 : Anti-Clockwise	7,457	6,681	776	7,566	6,938	628	109	1%	1.25	PASS
M25 Within J20: Clockwise	3,814	3,292	522	4,140	3,542	598	326	8%	5.17	PASS
M25 J20 Offslip: Clockwise	630	590	40	764	665	99	134	21%	5.08	FAIL
M25 Within J20: Anti-Clockwise	3,760	3,172	588	4,306	3,819	487	546	14%	8.60	FAIL
M25 J20 Offslip: Anti-Clockwise	882	802	80	888	844	44	6	0%	0.20	PASS
M25 J25-26: Clockwise	4,666	3,842	824	5,001	4,321	680	335	7%	4.82	PASS
M25 J25-26: Anti-Clockwise	4,608	3,712	896	4,214	3,721	493	-394	-8%	5.94	PASS
M26 J2a-3: Eastbound	2,175	1,648	527	2,229	1,908	321	54	2%	1.16	PASS

Journey times along routes

6.9.16 Modelled journey times have been compared with observed journey time data that have been obtained from other models within the Study Area, as well as from HATRIS where relevant. Observed journey time data have only been presented as end-to-end surveys due to the limitations of the data obtained from other models, and as such it has not been possible to extract or produce journey time graphs for individual route sections as WebTAG suggests. The criteria with which modelled journey time data have been compared with observed data are provided in Table 6.15, reproduced from Table 3 in WebTAG 3.19D.

Table 6.15: Journey time validation acceptability criteria

Table 3 Journey Time Validation Criterion and Acceptability Guideline	
Criteria	**Acceptability Guideline**
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher)	> 85% of routes

6.9.17 Modelled journey times are presented in Table 6.16 for each of the three modelled time periods, with appropriate comparisons against the observed data. Spatial representation of the journey time routes has been provided previously in Section 6.5 of this report, whilst text descriptions are given in the presented tables. The journey time data presented is the average across all modelled vehicle types.

6.9.18 As the validation table shows, journey time validation is reasonable across all time periods, meeting the WebTAG criteria for 76% of routes in the AM peak, 88% of routes in the interpeak and 83% of routes in the PM peak. Whilst the figures for the AM and PM peaks are slightly less than the 85% of routes acceptability guidelines specified in WebTAG there are a number of factors that will be impacting upon this.

6.9.19 Modelled journey times compared with observed data acquired from ELHAM are the poorest performing of all of the journey time routes in the AM and PM peak hours, accounting for the majority of failures to meet WebTAG criteria. Indeed, for the other routes, the model performance would exceed the WebTAG acceptability guidelines in all three time periods. The journey time routes from ELHAM extend up to 30 kilometres to the west of the M25, with a number of the routes terminating/beginning well within the extents of the north and south-circular routes.

6.9.20 The donor M25 Model was developed as a strategic model primarily to appraise widening schemes on the M25 and, whilst the model covers the London urban area, the representation of accurate delays and speeds within London itself have not been the primary focus of the model. Coding within the bounds of the M25 tends to be reasonable in order to ensure that traffic routes to the correct motorway junctions, however, with increasing distance from the M25 towards central London, the network coding is relatively coarse, resulting in the modelled speeds throughout the central London network being higher than observed; this is most apparent in the AM peak hour.

6.9.21 Apart from the routes in London, the journey time validation tends to be very good, with the majority of routes meeting the criteria stipulated in WebTAG. The notable routes that do not meet the criteria are the M25 between junctions 29-5 clockwise in the AM peak and anti-clockwise for the same section in the evening peak.

6.9.22 The M25 route is noted as being modelled too fast in the AM peak (clockwise) and PM peak (anti-clockwise). Analyses of journey time data suggest that whilst the crossing is reasonably well represented through the coding obtained from ELHAM, the use of a speed-flow curve to represent toll booth delays does not invoke a blocking back response within the model. These specific toll plaza delays cause blocking back (particularly anti-clockwise through junction 1a toward junction 1b) that the model under-represents. Whilst causing the journey times to exceed the criteria in the base, the introduction of free-flow tolling in the future should remove this blocking back, meaning that times are likely to be better represented in forecast models.

6.9.23 Overall, the model can be said to be replicating observed journey times across the Study Area well, with a mixture of strategic and more local routes meeting the specifications set out within WebTAG 3.19D. There is an issue of journey times being under-represented within London, particularly in the AM peak, although given the quality of the coding close to the M25 which is of better quality than that within the central London area, it is not expected that the underestimate of journey times is having a material impact on the routeing of traffic to the M25 and other strategic routes within the Study Area.

Table 6.16: Journey Time Validation, All User-Classes

							76%					88%					83%
Model Source	Route	Direction	AM Peak Observed (mins)	AM Peak Modelled (mins)	AM Peak Difference	AM Peak % Diff	AM Peak Result	Inter-Peak Observed (mins)	Inter-Peak Modelled (mins)	Inter-Peak Difference	Inter-Peak % Diff	Inter-Peak Result	PM Peak Observed (mins)	PM Peak Modelled (mins)	PM Peak Difference	PM Peak % Diff	PM Peak Result
ELHAM	O1	Northbound	25.30	9.15	-16.15	-64%	×	10.80	9.46	-1.34	-12%	✓	12.50	15.32	2.82	23%	×
		Southbound	12.10	11.00	-1.10	-9%	✓	12.50	8.92	-3.58	-29%	×	25.50	9.64	-15.86	-62%	×
ELHAM	R3	Eastbound	49.60	27.74	-21.86	-44%	×	31.10	33.21	2.11	7%	✓	36.90	37.45	0.55	1%	✓
		Westbound	49.90	35.36	-14.54	-29%	×	31.30	30.86	-0.44	-1%	✓	37.30	36.44	-0.86	-2%	✓
ELHAM	R5	Eastbound	26.70	32.08	5.38	20%	×	27.50	33.85	6.35	23%	×	37.40	40.50	3.10	8%	✓
		Westbound	40.30	38.36	-1.94	-5%	✓	25.60	28.78	3.18	12%	✓	26.20	29.75	3.55	14%	✓
ELHAM	R6	Eastbound	25.20	23.19	-2.01	-8%	✓	25.00	22.91	-2.09	-8%	✓	30.00	26.42	-3.58	-12%	✓
		Westbound	39.30	26.29	-13.01	-33%	×	24.60	22.98	-1.62	-7%	✓	29.10	24.42	-4.68	-16%	×
ELHAM	R9	Eastbound	6.10	5.66	-0.44	-7%	✓	5.40	4.95	-0.45	-8%	✓	5.40	5.51	0.11	2%	✓
		Westbound	9.00	7.82	-1.18	-13%	✓	5.80	5.86	0.06	1%	✓	6.80	7.12	0.32	5%	✓
TGSE	A13: A1306 to London Road, Hadleigh	Eastbound	25.68	23.41	-2.27	-9%	✓	26.03	23.96	-2.08	-8%	✓	NO DATA	27.82			
		Westbound	33.93	32.59	-1.35	-4%	✓	24.98	23.30	-1.68	-7%	✓	24.15	27.98	3.83	16%	×
TGSE	A128: A127 to A13	Northbound	6.67	7.27	0.60	9%	✓	6.53	6.91	0.38	6%	✓	6.62	7.17	0.56	8%	✓
		Southbound	7.27	7.25	-0.01	-0%	✓	7.03	7.52	0.49	7%	✓	NO DATA	7.72			
TGSE	A176: Billericay to A13	Northbound	NO DATA	12.35				10.53	10.09	-0.45	-4%	✓	NO DATA	12.01			
		Southbound	10.43	11.61	1.17	11%	✓	9.98	12.10	2.11	21%	×	11.00	11.63	0.63	6%	✓
TGSE	A1306 (Old A13): A13 to A1012	Eastbound	10.40	8.25	-2.15	-21%	×	9.68	8.38	-1.30	-13%	✓	NO DATA	8.88			
		Westbound	9.52	9.06	-0.46	-5%	✓	9.45	8.81	-0.64	-7%	✓	10.03	9.33	-0.70	-7%	✓
KTS	A2 (East): A296 to Cobham	Eastbound	6.15	7.42	1.27	21%	×	7.95	7.47	-0.48	-6%	✓	9.03	8.17	-0.87	-10%	✓
		Westbound	8.13	8.17	0.04	0%	✓	6.42	7.74	1.33	21%	×	7.45	7.85	0.40	5%	✓
KTS	A2 (West): A2 WB slip (Bean) to A223	Eastbound	6.20	5.73	-0.47	-8%	✓	6.28	5.69	-0.60	-9%	✓	7.17	6.42	-0.75	-10%	✓
		Westbound	7.40	6.93	-0.47	-6%	✓	6.00	6.57	0.57	10%	✓	6.08	6.78	0.70	11%	✓
KTS	A226: Bath Street, Gravesend to B2500	Eastbound	14.22	13.38	-0.83	-6%	✓	15.10	13.75	-1.35	-9%	✓	15.45	14.38	-1.07	-7%	✓
		Westbound	14.27	14.91	0.64	4%	✓	13.73	14.13	0.40	3%	✓	14.97	13.96	-1.01	-7%	✓
KTS	Pepper Hill/A226/Bluewater	Eastbound	12.85	11.71	-1.14	-9%	✓	13.03	11.85	-1.18	-9%	✓	14.55	12.45	-2.10	-14%	✓
		Westbound	11.82	12.02	0.20	2%	✓	11.68	11.66	-0.02	-0%	✓	11.73	11.95	0.22	2%	✓
HATRIS	M26: M25 to M20	Eastbound	8.29	9.27	0.98	12%	✓	8.65	9.28	0.63	7%	✓	8.88	9.37	0.49	6%	✓
		Westbound	8.66	8.83	0.17	2%	✓	8.42	8.61	0.19	2%	✓	8.21	8.68	0.47	6%	✓
HATRIS	M20: J1-J7	Eastbound	16.18	18.50	2.33	14%	✓	16.47	18.21	1.74	11%	✓	17.78	19.33	1.54	9%	✓
		Westbound	17.79	19.43	1.65	9%	✓	16.81	17.75	0.94	6%	✓	17.08	18.65	1.57	9%	✓
HATRIS	M2: J1-J7	Eastbound	23.08	23.21	0.13	1%	✓	21.89	23.04	1.15	5%	✓	22.74	23.83	1.08	5%	✓
		Westbound	23.48	24.59	1.11	5%	✓	22.23	23.63	1.40	6%	✓	21.79	23.96	2.17	10%	✓
HATRIS	M25: J29-J5 (inc. A282)	Clockwise	30.11	23.38	-6.73	-22%	×	22.60	22.91	0.31	1%	✓	26.13	23.99	-2.14	-8%	✓
		Anti-Clockwise	24.44	25.45	1.00	4%	✓	25.59	24.13	-1.46	-6%	✓	33.31	25.63	-7.68	-23%	×

6.10 Summary

6.10.1 This chapter has documented the calibration and validation of the LTC_{HAM}, documenting the approach adopted in refining the model within the Study Area. Links with particular relevance to the study aims have been identified through preliminary option testing and the calibration has been tailored to these areas and corridors within the model.

6.10.2 Observed traffic and journey time data have been obtained from a number of different models within the region, with some strategic road network data having been extracted from HATRIS. This has produced a reasonable dataset for the purposes of calibration and validation, with a good coverage of the study area. It should be noted that the differing data sources do result in observed data having been used from earlier years, meaning that annualisation and seasonality factors have been applied. Results should be viewed in this light, although the dataset can be considered to be reasonably robust.

6.10.3 Network updates within the Study Area have been verified and checked against calibration guidance within WebTAG 3.19D. Network calibration was undertaken on a corridor basis and the model coding deemed satisfactory for the purposes of the study in most cases; notably, this process led to the adoption of some coding from ELHAM within the M25, from which coding was more refined than the donor M25 model. Checks on routeing of traffic through the networks showed satisfactory and plausible route choice; analyses of HGVs have also shown that continued use of a KNOBS penalty ensures that goods vehicle movements (which tend to seek to minimise distance) tend towards strategic routes.

6.10.4 Assignment of the prior matrices demonstrated that, for the M25 and for the A282 Dartford and A102 Blackwall crossings, the level of demand within the matrices was broadly consistent with the count data, with the network demonstrating sufficient routing that performance of the prior matrix against WebTAG criteria – at least for these key links – was reasonable. For the rest of the model, total screenline results demonstrated that the prior matrix was deficient in the TGSE and KTS areas. These areas had previously been identified as having less certain levels of demand. The TGSE area has therefore been enhanced through the use of TGSE model prior matrices to enhance internal trip representation in LTCM. The KTS area was known to be primarily composed of synthetic trips within the prior matrix obtained from Hyder and was known to need improvement through matrix estimation, given the lack of available higher quality observed data to improve it beforehand.

6.10.5 Validation of the post matrix estimation matrices, undertaken at a screenline level, shows the post-estimation matrices to be broadly representing observed movements within the Study Area, with screenline totals for the calibration screenlines demonstrating compliance against WebTAG 3.19D criteria with results of 96%, 100% and 100% for the AM, IP and PM respectively, well within the acceptability criteria guidelines.

6.10.6 Calibration screenlines have also been assessed at the link level for key strategic routes and links with significance to the crossing schemes, in order to demonstrate the model calibration and validation at the assignment level. Overall, 81% of these links meet WebTAG 3.19D criteria in the AM, 86% in the IP and 84% in the PM, demonstrating a good level of calibration at the assignment level. It is acknowledged that there are some significant links which do not meet the WebTAG criteria, being the A128 on the TGSE East-West screenline, the A13 on the TGSE Outer Screenline, the A2 on the KTS Gravesend East screenline and the A20 on the ELHAM Boundary South screenline. Traffic use of these routes and any impacts on them shown during forecasting work will need to be carefully scrutinised in-light of the likely available capacities being demonstrated on them.

6.10.7 It is therefore suggested that, with reference to the screenlines used in the calibration constraint process, the model represents a reasonably accurate representation of traffic flows within the Study Area and is suitable for use as scheme identification and sifting tool. The model calibration can be deemed as fit-for-purpose for assessing the strategic road network and the significant links within the study area, although further scrutiny of effects on more local routes will be required, and the known weaknesses in the demand matrices also taken into account.

7 Demand Model Realism Tests

7 Demand Model Realism Tests

7.1 Introduction

7.1.1 This chapter considers the realism tests undertaken using the model, comparing the output from these against the recommended ranges of acceptable values for model sensitivity contained in WebTAG 3.10.4. A number of realism tests have been undertaken to demonstrate that the modelled demand responses are plausible, both in the direction and scale of change.

7.2 Scope and Role of Sensitivity Tests

7.2.1 The Lower Thames Crossing Demand Model (LTC_{DM}) is largely (toll choice model excepted) an incremental model that uses cost changes to estimate changes in demand from a base year or reference matrix[6]. The LTC_{DM} is derived from the M25 Demand Model; the model structure and sensitivity parameters have been retained (though the model has been rezoned and the toll choice mechanism has been incorporated). In developing the LTC_{DM} and producing the realism tests the model calibration parameters are unchanged, and the outturn model sensitivities are largely consistent with the donor M25 Model.

7.2.2 Within this section, where elasticities are discussed, these are based on changes in either vehicle-kilometres or trips with respect to changes in some element of cost, such as fuel cost or journey times. When considering vehicle-kilometres, this is calculated via the following arc-elasticity formula:

$$\text{elasticity} = \frac{\log_e\left(\frac{km_t}{km_b}\right)}{\log_e\left(\frac{v_t}{v_b}\right)}$$

where:

- km_t is the vehicle kilometres in the test case;
- km_b is the vehicle kilometres in the base case;
- v_b is the base value of the variable for which the elasticity is being calculated (fuel cost, rail fares, journey time, etc.); and
- v_t is the test value of that variable.

7.2.3 In the case of a trip elasticity, the value is calculated using a similar formula, but considering trips instead of vehicle-kilometres. This formulation is given below:

$$\text{elasticity} = \frac{\log_e\left(\frac{t_t}{t_b}\right)}{\log_e\left(\frac{v_t}{v_b}\right)}$$

where:

[6] The toll choice model is an exception, formed as an absolute model, as discussed in Section 5.5.

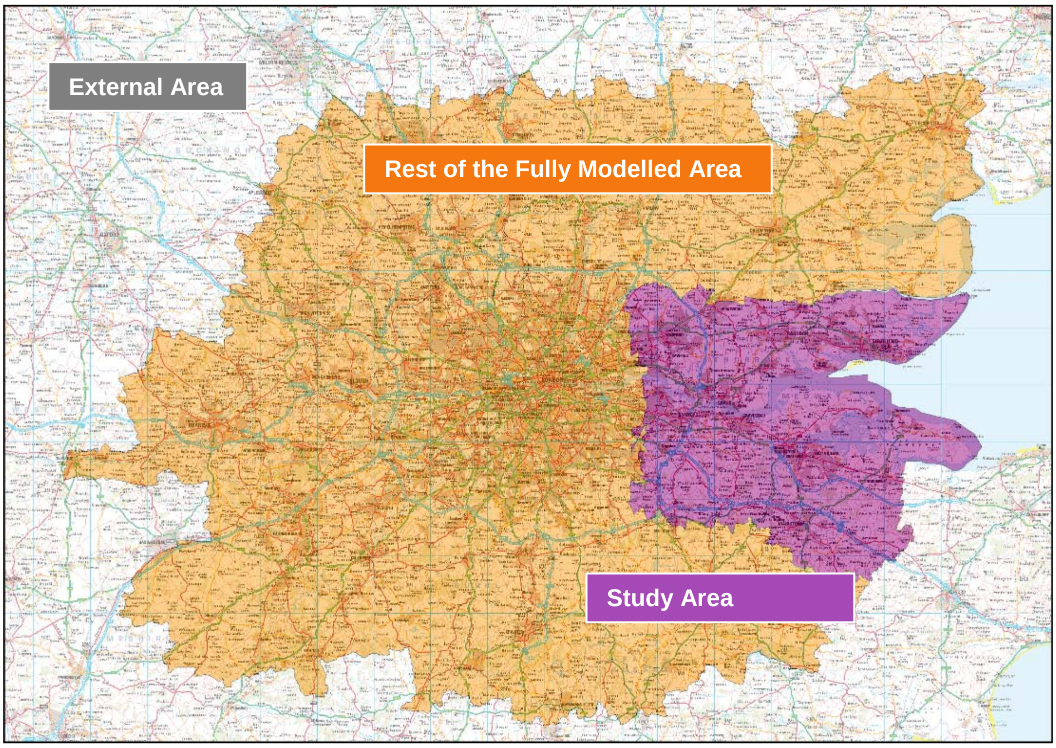
- t_t is the total trips in the test case; and
- t_b the total trips in the base case.

7.2.4 Elasticities have been calculated in two ways, in accordance with WebTAG 3.10.4 guidance:

- Firstly, at a matrix level, using demand matrices and distance skims, including only demand produced in the Study Area (some data have been produced for the Fully Modelled Area too, for comparison). This ensures that a complete range of trip lengths is included in the calculation but that wholly external demand, which is of little interest, is excluded.
- Secondly, at a network level, using link flows and link distances, including only links in the simulation area of the highway model. The simulation area extends over the whole M25 area and about 30km outside of it. This is much larger than the Study Area, but easier to calculate over.

7.2.5 The Study Area is a significantly smaller area than that covered by the simulation network coding within the highway model, and focuses on area around the existing Dartford Crossing. These areas are shown in Figure 7.1, with the simulation area being the combination of both the Study Area and the rest of the Fully Modelled Area.

Figure 7.1: Extent of Detailed Modelled Area Classifications



7.2.6 WebTAG guidance states that elasticities should ideally represent the average elasticity for the whole year. In order to calculate annualisation factors for this purpose, TEMPRO (v6.2) data have been used for the South-East, East of England and London to estimate suitable annualisation factors.

7.2.7 The AM Peak and PM Peak periods are simply factored by the average number of working days in the year. For the interpeak and off-peak periods, these are also factored by the number of working days, but are also factored to include Saturdays, Sundays and bank holidays. This process considers the relative number of interpeak and off-peak period trips, and allocates weekend trips to either the interpeak or off-peak based on these proportions.

7.2.8 The process results in the annualisation factors given in Table 7.1.

Table 7.1: TEMPRO-Derived Elasticity Annualisation Factors

	AM	IP	PM	OP
Commuting	252.9	381.1	252.9	317.0
Home Based Business	252.9	369.9	252.9	311.4
Home Based Other	252.9	550.8	252.9	401.9
Non-Home Based Business	252.9	276.9	252.9	264.9
Non-Home Based Other	252.9	413.2	252.9	333.0

7.3 Fuel Cost Elasticity

7.3.1 The main measure of the model highway sensitivity is the change in car vehicle-kilometres with respect to a change in car fuel cost. Car fuel cost has been increased by 10% in the 2009 base year model, with the resulting change in car vehicle kilometres measured, and elasticities calculated.

7.3.2 WebTAG 3.10.4 provides guidance on the modelling of, and expected values of, car fuel cost elasticities. They are expected to be in the range of -0.25 to -0.35, at a plausible level given the characteristics of the modelled area relative to the UK as a whole. As the Dartford Crossing is relatively congested and likely to have a higher than average proportion of business travel, the expectation is to see elasticities towards the lower end of this range.

7.3.3 Fuel cost elasticities from the LTC_{DM} would therefore be expected to be around -0.25 to -0.30, with variation by journey purpose that should show lower elasticities for business trips compared with discretionary trips such as leisure and shopping (i.e. other). It is also expected that elasticities should be lower in higher income bands and vice versa.

7.3.4 Table 7.2 shows the car fuel cost vehicle-kilometre elasticities for all trips produced within the Study Area, derived from a test that increased car fuel cost by 10%.

Table 7.2: LTC_{DM} Car Fuel Cost Elasticities (matrix-based vehicle km), Study Area

	AM	IP	PM	OP	Annual
Commuting Low Income	-0.401	-0.421	-0.497	-0.581	**-0.465**
Commuting Medium Income	-0.307	-0.298	-0.289	-0.420	**-0.316**
Commuting High Income	-0.229	-0.238	-0.201	-0.345	**-0.240**
Home Based Business	-0.106	-0.162	-0.047	-0.217	**-0.129**
Home Based Other Low Income	-0.338	-0.371	-0.301	-0.402	**-0.362**
Home Based Other Medium Income	-0.281	-0.305	-0.234	-0.347	**-0.300**
Home Based Other High Income	-0.249	-0.267	-0.193	-0.316	**-0.263**
Non-Home Based Business	-0.099	-0.129	-0.017	-0.178	**-0.108**
Non-Home Based Other Low Income	-0.320	-0.290	-0.287	-0.299	**-0.294**
Non-Home Based Other Medium Income	-0.268	-0.250	-0.234	-0.266	**-0.251**
Non-Home Based Other High Income	-0.232	-0.224	-0.198	-0.246	**-0.223**
All Car	**-0.263**	**-0.288**	**-0.237**	**-0.354**	**-0.284**

7.3.5 Table 7.2 demonstrates that the car fuel cost sensitivity of the LTC_{DM} is consistent with current research and guidance. Interpeak and off-peak model sensitivity is higher than peak period sensitivity, reflecting lower levels of highway congestion which constrain the effects of the fuel cost change in the peak periods.

7.3.6 Table 7.2 also demonstrates the expected variation in elasticity by trip purpose and income band. Business trips have a lower fuel cost elasticity than other, discretionary trips, and elasticities reduce as income increases.

7.3.7 Table 7.3 shows the car fuel cost elasticities when calculated from the assigned LTCM highway networks. These data are for all simulation links, and provide an alternative measure of the demand response to car fuel cost changes within the model. The area covered by the simulation area is, however, significantly larger than that considered for the matrix-based analysis above (see Figure 7.1).

7.3.8 Aside from the different definitions of area, differences between these two measures include the absence of intrazonal demand, and the inclusion of through traffic, in the network data.

Table 7.3: LTC_{DM} Fuel Cost Elasticities (network-based vehicle-kilometres)

	AM	IP	PM	OP	Annual
Business	-0.02	-0.11	-0.00	-0.11	**-0.04**
Non-work – No Toll	-0.31	-0.36	-0.30	-0.42	**-0.32**
Non-work – Dartford Crossing	-0.47	-0.46	-0.32	-0.80	**-0.42**
All Car	**-0.25**	**-0.29**	**-0.24**	**-0.37**	**-0.26**

7.3.9 Overall, the network-based results are not substantially different from the matrix-based assessment and show the same general pattern. Dartford Crossing trips have a higher elasticity than “don’t pay” trips, because they are longer than average. This effect is slightly damped in the AM and PM periods by them also having higher incomes than average, due to the toll,, but in the off-peak, where the average toll paid is much lower, a high elasticity is observed due to the trip-length effect.

7.3.10 Finally, matrix-based elasticities have been calculated for the much larger Fully Modelled Area; these are shown in Table 7.4 and demonstrate similar, though generally slightly higher, values than the statistics for the Study Area.

Table 7.4: LTC_{DM} Car Fuel Cost Elasticities (matrix-based vehicle km), Fully Modelled Area

	AM	IP	PM	OP	Annual
Commuting Low Income	-0.458	-0.498	-0.488	-0.598	**-0.498**
Commuting Medium Income	-0.303	-0.347	-0.306	-0.432	**-0.333**
Commuting High Income	-0.211	-0.262	-0.208	-0.342	**-0.241**
Home Based Business	-0.133	-0.186	-0.110	-0.233	**-0.163**
Home Based Other Low Income	-0.378	-0.419	-0.362	-0.436	**-0.409**
Home Based Other Medium Income	-0.293	-0.334	-0.264	-0.354	**-0.324**
Home Based Other High Income	-0.243	-0.282	-0.201	-0.307	**-0.272**
Non-Home Based Business	-0.095	-0.144	-0.048	-0.178	**-0.121**
Non-Home Based Other Low Income	-0.337	-0.312	-0.295	-0.321	**-0.313**
Non-Home Based Other Medium Income	-0.282	-0.267	-0.248	-0.282	**-0.267**
Non-Home Based Other High Income	-0.242	-0.237	-0.214	-0.256	**-0.236**
All Car	**-0.274**	**-0.312**	**-0.258**	**-0.361**	**-0.304**

7.3.11 The LTC_{DM}, as discussed in previous chapters, includes “cost damping” functions that reduce the sensitivity of long distance trips to absolute cost changes from that found in a pure logit model. This methodology is supported by WebTAG, but it is suggested that the need for such mechanisms be demonstrated.

7.3.12 Accordingly, the LTC_{DM} has been run in the absence of either cost-damping mechanism (value of time variation and generalised cost factoring) for the same 10% increase in car fuel costs as reported in Table 7.2 and Table 7.3 . This yielded highly implausible elasticities, as shown in Table 7.5, demonstrating the need for some form of cost damping.

Table 7.5: LTC_{DM} Car Fuel Cost Elasticities without Cost Damping (matrix-based vehicle-km), DSA

	AM	IP	PM	OP	Annual
Commuting Low Income	-2.874	-3.472	-5.046	-5.422	**-4.096**
Commuting Medium Income	-3.169	-3.174	-3.546	-4.690	**-3.499**
Commuting High Income	-2.885	-3.172	-3.012	-4.293	**-3.186**
Home Based Business	0.829	0.440	1.681	-0.699	**0.709**
Home Based Other Low Income	-2.184	-2.909	-2.401	-2.704	**-2.719**
Home Based Other Medium Income	-1.986	-2.527	-1.907	-2.405	**-2.356**
Home Based Other High Income	-1.995	-2.420	-1.691	-2.337	**-2.253**
Non-Home Based Business	1.163	0.417	1.527	-0.487	**0.706**
Non-Home Based Other Low Income	-2.880	-2.599	-2.591	-2.404	**-2.615**
Non-Home Based Other Medium Income	-2.698	-2.521	-2.373	-2.309	**-2.496**
Non-Home Based Other High Income	-2.667	-2.581	-2.288	-2.333	**-2.514**
All Car	**-1.911**	**-2.235**	**-1.971**	**-2.723**	**-2.199**

7.4 Journey Time Elasticity

7.4.1 WebTAG also requires calculation of elasticity of car demand (at a trip level, not vehicle-kilometres) to changes in journey times. Here the requirement is that the elasticity is negative and does not exceed 2 in magnitude. Journey times were increased by 10% for this test, and the demand and supply models were not iterated to convergence but run for a single iteration only, as advised in WebTAG 3.10.4.

7.4.2 Table 7.6 shows the resultant elasticities for this test in which car journey times were increased by 10%. As stated above, these elasticities are based on trips rather than vehicle-kilometres, and are for productions from the Study Area. The overall elasticity of -0.105 is within the range specified by WebTAG.

Table 7.6: LTC_{DM} Car Journey Time Elasticities (matrix-based trips), Study Area

	AM	IP	PM	OP	Annual
Commuting Low Income	-0.062	-0.006	-0.099	-0.059	**-0.058**
Commuting Medium Income	-0.182	-0.033	-0.198	-0.114	**-0.139**
Commuting High Income	-0.225	-0.060	-0.244	-0.167	**-0.180**
Home Based Business	-0.066	0.013	-0.060	0.017	**-0.022**
Home Based Other Low Income	-0.127	-0.095	-0.153	-0.067	**-0.102**
Home Based Other Medium Income	-0.141	-0.108	-0.169	-0.074	**-0.114**
Home Based Other High Income	-0.160	-0.125	-0.192	-0.087	**-0.132**
Non-Home Based Business	-0.075	0.001	-0.039	0.111	**-0.013**
Non-Home Based Other Low Income	-0.130	-0.043	-0.135	0.002	**-0.063**
Non-Home Based Other Medium Income	-0.142	-0.047	-0.146	0.003	**-0.069**
Non-Home Based Other High Income	-0.159	-0.054	-0.161	0.000	**-0.078**
All Car	**-0.142**	**-0.085**	**-0.161**	**-0.071**	**-0.105**

7.4.3 It must be appreciated that these values are not representative of the general sensitivity of the demand model. The overall values in the table above are driven largely by trip-frequency, which is the least sensitive choice model and the one for which there is least guidance in WebTAG about sensible sensitivities. Trip distribution, the main driver of fuel cost elasticity, has no effect on the elasticity to trips, which is what is required to be reported for this test. Mode choice, the other process that has some effect on trip elasticities, is fairly weak for car trips, as car is the dominant mode.

7.4.4 These factors are especially noticeable for business trips, for which the trip journey time elasticity is almost zero, as there is no trip-frequency response modelled (according with WebTAG guidance) and for which there is relatively little public transport demand. Commuting elasticity is highest due mainly to substantial rail mode-share.

7.4.5 There is significant variation in elasticities by time period. This is a result of time period choice. The more congested periods (AM and PM) have high elasticities, while the less congested periods, especially the off-peak, have much lower elasticities. This is because the heavily congested periods have higher average trip durations (due to speeds being lower), so the 10% increase in journey times has greater effect upon them and results in a shift out of the peaks towards the interpeak and off-peak periods.

7.4.6 To illustrate the situation further, journey time elasticities to vehicle kilometres are presented below in Table 7.7 (not a WebTAG requirement). These show a more intuitive breakdown by purpose (commuting trips are now less sensitive than average, as they respond less strongly to trip distribution due to the double-constraint in the model; business trips are of a broadly similar magnitude to other purposes), and variation by time period that is in roughly the same order, but at a much smaller scale.

Table 7.7: LTC_{DM} Car Journey Time Elasticities (matrix-based vehicle-km), Study Area

	AM	IP	PM	OP	Annual
Commuting Low Income	-0.826	-0.810	-1.136	-0.847	**-0.935**
Commuting Medium Income	-0.966	-0.830	-1.049	-0.813	**-0.941**
Commuting High Income	-1.014	-0.908	-1.097	-0.845	**-0.992**
Home Based Business	-0.970	-1.073	-0.966	-0.761	**-0.986**
Home Based Other Low Income	-1.104	-1.124	-1.224	-0.881	**-1.095**
Home Based Other Medium Income	-1.111	-1.085	-1.177	-0.852	**-1.061**
Home Based Other High Income	-1.146	-1.087	-1.175	-0.855	**-1.067**
Non-Home Based Business	-1.171	-0.918	-0.992	-0.640	**-0.966**
Non-Home Based Other Low Income	-0.936	-0.787	-0.973	-0.581	**-0.819**
Non-Home Based Other Medium Income	-0.951	-0.806	-0.983	-0.591	**-0.836**
Non-Home Based Other High Income	-0.968	-0.833	-0.993	-0.608	**-0.858**
All Car	**-1.031**	**-1.026**	**-1.103**	**-0.826**	**-1.012**

7.5 Summary

7.5.1 LTC_{DM} is a fully functioning variable demand model, designed to be compliant with WebTAG 3.5.6D and 3.10. Economic parameters from the M25 Demand Model have been updated, and a toll choice model has been added to the model structure.

7.5.2 The sensitivity of LTC_{DM} is consistent with WebTAG guidance; sensitivities have been calculated using both network and matrix statistics. The demand elasticities of the model to changes in car fuel cost and journey time are plausible and within the expected ranges, varying by demand purpose, income band and time of day.

7.5.3 The car fuel cost sensitivity of LTC_{DM} is consistent with current research and guidance. Interpeak and off-peak model sensitivity is highest, reflecting lower levels of highway congestion which constrain the effects of the fuel cost change in the peak periods. The car journey time elasticity of LTC_{DM} is also consistent with WebTAG guidance, within the range of the values suggested for low to high modal competition.

7.5.4 Sensitivity tests, variants of the fuel cost elasticities, have been calculated without cost damping, as required in WebTAG 3.10.4. These demonstrate a need for the incorporation of the cost damping mechanism in the model (this has always been required throughout the development of the donor M25 Model).

8 Demonstration Testing

8 Demonstration Testing

8.1 Introduction

8.1.1 This chapter summarises the initial ‘demonstration tests’ that have been run in the new LTCM. These are designed to demonstrate that the model works, and to identify any major issues that might be encountered at an early stage, allowing them to be addressed. The tests also allow the suitability of LTCM to be judged in the forecasting context in which it will be applied. They are distinguished from ’realism tests’ reported in the previous chapter, as the realism tests are to show specifically that the demand model is appropriately calibrated in the base year. Demonstration tests are tests of the model in a forecasting context, designed simply to show that outputs are plausible.

8.2 Scope and Purpose of Demonstration Tests

8.2.1 To evaluate the performance of the LTCM for the assessment of additional Lower Thames crossing capacity, a range of demonstration tests have been undertaken. These include approximate representations of Options A, B and C, and testing of different toll levels.

8.2.2 No attempt has been made at this stage to construct a plausible future year core scenario in accordance with WebTAG 3.15 in advance of verification of the base year model performance. The highway networks used are unchanged from the base year model, with the exceptions of the illustrative schemes being tested; they are effectively ‘Do Nothing’ scenario networks, without the inclusion, for example of free flow tolling. The demand used was generated by applying TEMPRO 6.2 growth to the base 2009 demand. All tests were run for the indicative year 2041, this being the latest forecast year for which the model is expected to be used.

8.2.3 The complete list of demonstration tests run is as follows:

1. A ‘Do Nothing’, with inflated 2041 demand on the base 2009 network
2. As 1, but with a simplistic representation of Option A.
3. As 1, but with a simplistic representation of Option B.
4. As 1, but with a simplistic representation of Option C.
5. As 1, but with 50% higher tolls.
6. As 2, but with 50% higher tolls.

8.3 2041 Do Nothing Scenario

8.3.1 As noted above, no network changes from with the base year have been made, so the demonstration tests will tend to overstate congestion, as future highway schemes to relieve congestion have not been accounted for in the modelling at this stage.

8.3.2 Economic parameters (values of time, fuel prices and vehicle efficiency) have been derived from the latest WebTAG 3.5.6D guidance, as of June 2012.

8.3.3 Changes in total trips in the Do Nothing scenario, both as a result of the application of TEMPRO growth (‘Reference’ demand, which includes only the effect of land-use and car ownership changes) and then generated by the demand model responses (Do Nothing demand, which also includes the effect of changing economics and increasing congestion over time), are presented in Table 8.1. The TEMPRO growth implies increases in car trips of a little over 20%. Freight growth is derived from the National Transport Model (NTM) forecasts, ultimately from the Great Britain Freight Model (GBFM), and is significantly higher.

8.3.4 The LTCM demand model is structured so as not to permit the adjustment of freight demand in ‘without intervention’ tests such as this one; this is because the NTM freight forecasts are already incorporate the demand responses to economic trends that the LTC_{DM} introduces when forecasting between modelled years.

8.3.5 Consequently the Reference to Do Nothing effect is zero for freight traffic. Small adjustments, generally suppressing travel slightly, more so in the fully-modelled and Study Areas, are forecast for car (person) trips. This is primarily due to the effect of increasing congestion over time.

8.3.6 Changes in forecast vehicle kilometres over time are presented in Table 8.2 for both the whole network at the 24-hour level, and for the simulation area (Fully Modelled Area), by modelled time period.

Table 8.1: Forecast Changes in Highway Person Trip Totals, 2009-2041, '000s

Area	Purpose	Base (2009)	Reference	Do Nothing	Ref-Base	DN-Ref
Entire Network	Commuting	30,550	35,324	35,422	16%	0.3%
	Business	7,432	8,877	8,853	19%	-0.3%
	Other	76,945	98,063	98,015	27%	-0.1%
	LGV	1,684	3,657	3,657	117%	0.0%
	HGV	1,851	3,063	3,063	65%	0.0%
Fully Modelled Area	Commuting	6,825	8,084	7,815	18%	-3.3%
	Business	2,398	2,918	2,902	22%	-0.6%
	Other	18,968	24,729	24,021	30%	-2.9%
	LGV	1,426	3,097	3,097	117%	0.0%
	HGV	1,405	2,324	2,324	65%	0.0%
Detailed Study Area	Commuting	944	1,088	1,064	15%	-2.2%
	Business	308	368	366	19%	-0.4%
	Other	2,619	3,462	3,399	32%	-1.8%
	LGV	282	612	612	117%	0.0%
	HGV	258	427	427	65%	0.0%

Note: Reference excludes effects of congestion and fuel cost, reflecting only exogenous changes in planning data and economic growth

Table 8.2: Forecast Changes in Highway Vehicle Kilometres, 2009-2041, '000s

Period and Area	Purpose	Base (2009)	Reference	Do Nothing	Ref-Base	DN-Ref
Entire Network (24 Hour)	Business	122,687	147,254	220,420	20%	49.7%
	Other	461,529	591,997	672,421	28%	13.6%
	LGV	34,482	71,370	73,896	107%	3.5%
	HGV	75,652	120,723	123,349	60%	2.2%
	All	694,349	931,344	1090,086	34%	17.0%
Fully Modelled Area (AM Peak)	Business	3,108	3,407	3,513	10%	3.1%
	Other	11,751	13,837	12,680	18%	-8.4%
	LGV	1,469	2,886	3,069	96%	6.3%
	HGV	2,719	4,023	4,259	48%	5.9%
	All	19,046	24,154	23,521	**27%**	**-2.6%**
Fully Modelled Area (Interpeak)	Business	3,139	3,690	3,803	18%	3.1%
	Other	7,415	9,626	8,787	30%	-8.7%
	LGV	1,460	3,001	3,121	106%	4.0%
	HGV	3,030	4,678	4,844	54%	3.5%
	All	15,043	20,995	20,555	**40%**	**-2.1%**
Fully Modelled Area (PM Peak)	Business	3,142	3,507	3,595	12%	2.5%
	Other	12,476	14,752	13,548	18%	-8.2%
	LGV	1,583	3,111	3,315	96%	6.5%
	HGV	1,806	2,653	2,825	47%	6.5%
	All	19,008	24,022	23,283	**26%**	**-3.1%**
Fully Modelled Area (Off-Peak)	Business	1,049	1,346	1,533	28%	13.9%
	Other	4,253	5,757	6,486	35%	12.7%
	LGV	315	694	694	120%	-0.1%
	HGV	767	1,277	1,276	67%	-0.1%
	All	6,383	9,074	9,989	**42%**	**10.1%**

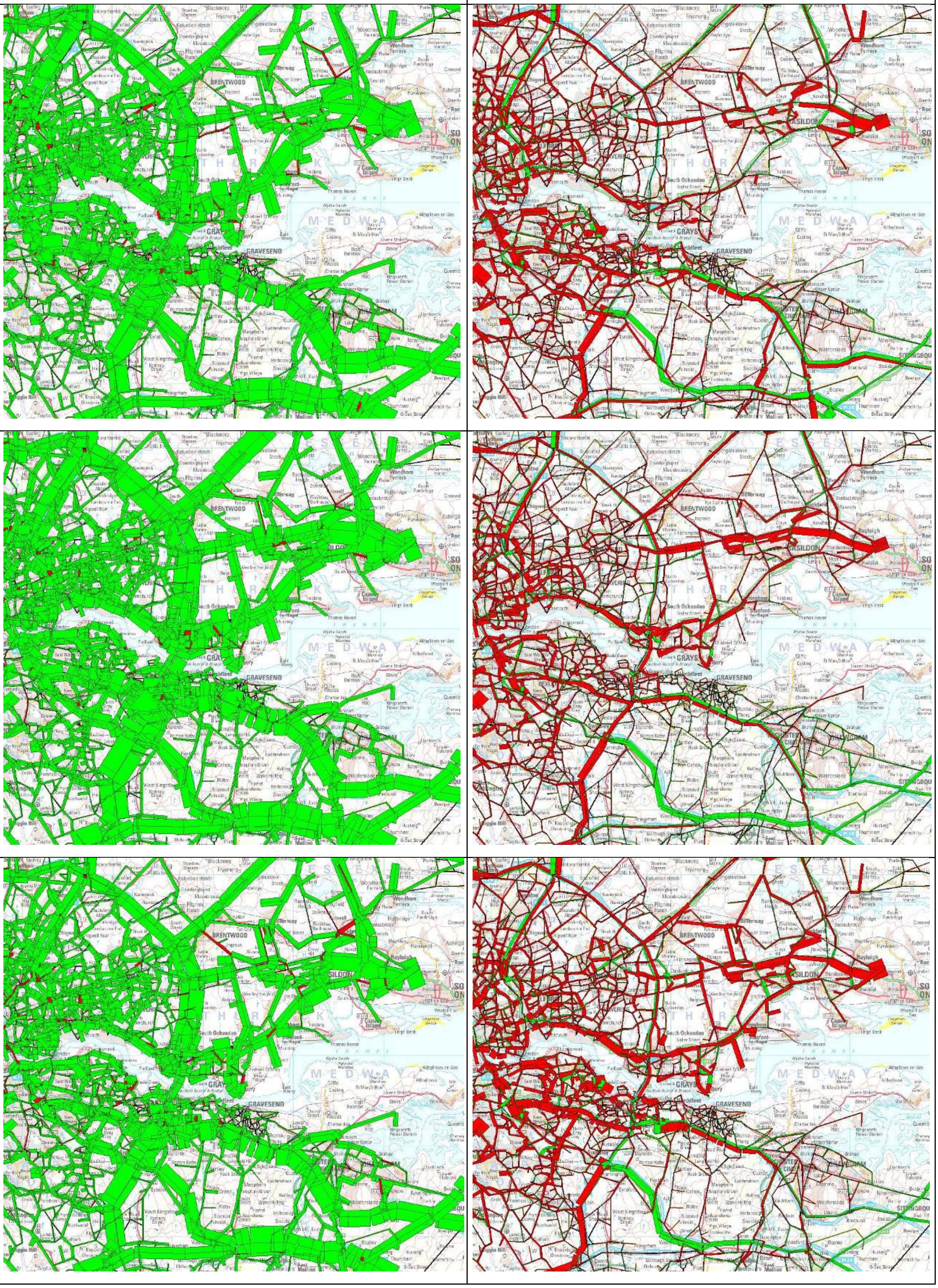
Note: Reference excludes effects of congestion and fuel cost, reflecting only exogenous changes in planning data and economic growth

8.3.7 Overall, the demand model suppresses vehicle kilometres in the Fully Modelled Area, except in the off-peak, where there is relatively little congestion to act as a constraint. However, this results from a significant suppression of car other travel, accompanied by small increases in business and freight travel. Freight travel, as noted above, is not affected directly by the demand model, so changes here result from changes in assignment routeing of freight trips as a result of varying congestion levels.

8.3.8 The overall increase in forecast vehicle kilometres between 2009 and 2041, across the whole model is 51% (summing the 34% and 17% in Table 8.2). Reflecting the longer forecast period (2009 to 2041), this is consistent with NTM forecasts of around 44% growth in total traffic from 2010 to 2035. Overall growth in the Fully Modelled Area is much lower, at around 25-30%, except in the off-peak, where it is 53%. This constrained forecast traffic growth is predominantly due to high levels of congestion in the Fully Modelled Area within the model; partly due to higher levels of congestion in and around London, and partly due to the way that this area of the network is represented in the SATURN model, using simulation network coding.

8.3.9 Flow changes on the network between 2009 and Do Nothing and between 2041 Reference and Do Nothing scenarios are presented in Figure 8.1. Increases in traffic flow are shown in green, while decreases are red. All plots show flow changes on the same scale, with modest increases in flow on the northbound Dartford Crossing and more significant increases in the southbound direction in the AM peak and interpeak hours of around 1500 PCUs. This additional traffic takes the southbound crossing traffic to capacity, with the toll plaza providing the key capacity constraint.

Figure 8.1: 2041 Do Nothing Scenario versus 2009 Base and 2041 Reference (PCUs/hr)

	Do Nothing versus Base	Do Nothing versus Reference
AM Peak		
Interpeak		
PM Peak		

8.3.10 It is noted that capacity restraints on the Dartford Crossing northbound prevent any significant increases in traffic from 2009 to 2041 (the northbound tunnels result in lower capacity northbound compared with the southbound Crossing, but the primary constraint is the toll plaza which is modelled as having a 96% volume to capacity (V/C) ratio in the base year. Small increases can be seen in the interpeak, but in the peaks, there is negligible change, because the road is at capacity and it is not possible for any more traffic to get access to it.

8.3.11 The demand model generally suppresses traffic in the Study Area, as expected.

8.3.12 Flows on the Dartford Crossing from 2009 through to Reference and Do Nothing scenarios, are presented in Table 8.3.

Table 8.3: Flows on the Dartford Crossing, 2009 to 2041 (Vehicles/hr)

		AM Peak			Interpeak			PM Peak		
Direction	**User Class**	**2009**	**2041 Ref**	**2041 DN**	**2009**	**2041 Ref**	**2041 DN**	**2009**	**2041 Ref**	**2041 DN**
North-bound	**HGV**	737	876	987	790	1,023	1,200	511	608	741
	LGV	371	589	686	372	653	765	452	796	913
	Business	1,103	931	861	1,133	1,101	1,070	1,041	974	926
	Non-work	2,690	2,625	2,372	1,895	2,095	1,655	3,029	2,912	2,575
	All Traffic	**4,900**	**5,020**	**4,906**	**4,190**	**4,871**	**4,690**	**5,034**	**5,290**	**5,155**
South-bound	**HGV**	726	1,129	1,194	832	1,159	1,240	502	655	738
	LGV	330	691	732	384	765	836	374	700	798
	Business	808	911	874	1,022	1,155	1,156	934	909	929
	Non-work	2,061	2,348	2,135	2,070	2,463	1,874	3,577	3,721	3,139
	All Traffic	**3,926**	**5,079**	**4,935**	**4,308**	**5,541**	**5,105**	**5,387**	**5,985**	**5,604**

8.3.13 Changes in Dartford Crossing flows are shown in Table 8.4. The main pattern is one of freight traffic being substituted for car traffic. Non-work car trips generally reduce between 2009 and 2041. Freight traffic universally increases in all time periods and directions.

8.3.14 This effect is partly due to the NTM forecasts predicting large increases in freight travel which displace some of the car trips (“Base to Reference” effect). However, following the demand model interaction, freight travel further increases at the expense of car (“Reference to Do Nothing” effect). This is because freight travel is not adjusted by the demand model in a “without scheme” test, but car trips are. Due to the relatively high congestion levels, many car trips redistribute to other destinations (or modes), leaving some spare capacity that is filled in by re-routeing freight trips. It is noted that such a lack of a freight response may not be entirely realistic, but also that evidence for likely scale of such an effect is lacking.

Table 8.4: Changes in Flows on the Dartford Crossing, 2009 to 2041 (Vehicles/hr)

		AM Peak			Interpeak			PM Peak		
Direction	**User Class**	**Base-DN**	**Base-Ref**	**Ref-DN**	**Base-DN**	**Base-Ref**	**Ref-DN**	**Base-DN**	**Base-Ref**	**Ref-DN**
North-bound	**HGV**	250	139	111	411	233	178	230	97	134
	LGV	315	218	97	393	280	113	461	344	117
	Business	-242	-173	-69	-63	-32	-31	-115	-67	-47
	Non-work	-317	-64	-253	-240	200	-440	-455	-118	-337
	All Traffic	**6**	**120**	**-114**	**500**	**681**	**-181**	**122**	**256**	**-134**
South-bound	**HGV**	467	403	64	407	327	81	236	152	84
	LGV	402	361	41	452	381	71	424	326	98
	Business	66	103	-37	134	133	1	-5	-26	20
	Non-work	**74**	**287**	**-213**	**-197**	**392**	**-589**	**-438**	**145**	**-582**
	All Traffic	**1,010**	**1,154**	**-144**	**797**	**1,233**	**-436**	**217**	**597**	**-380**

8.4 Effect of Additional Crossing Capacity

8.4.1 Three tests have been run with additional crossing capacity, one representing each of Options A, B and C.

8.4.2 Flows on each tolled river crossing and the Blackwall Tunnel and Woolwich Ferry are presented in Table 8.5, and changes in these flows from the Do Nothing scenario are in Table 8.6.

8.4.3 Changes in flows on the Blackwall Tunnel and the Woolwich Ferry are very small, as expected as they are some distance from the schemes. This is consistent with both previous LTCM model testing and ELHAM analysis undertaken by TfL.

8.4.4 However, there is a general tendency for these flows to reduce due to the addition of an extra crossing, as expected. This is not universally true; in the AM peak southbound there are mostly increases; this may be a complex second-order effect.

8.4.5 On the Dartford Crossing, likewise, flows tend to reduce with the addition of an extra crossing (less so northbound because the route is already over-capacity and so reductions tend to be filled back in with newly induced traffic due to large improvements in journey time). Option B northbound appears to produce small increases in the flow on the Dartford Crossing. This is likely related to the northbound crossing toll plaza being very close to capacity. As expected, Option A has a larger effect on the Dartford Crossing flows than either of the other two options.

Table 8.5: Flows on the Crossings, Options A, B and C (Vehicles/hr)

		AM Peak				Interpeak				PM Peak			
Dir.	**Crossing**	**DN**	**OptA**	**OptB**	**OptC**	**DN**	**OptA**	**OptB**	**OptC**	**DN**	**OptA**	**OptB**	**OptC**
	Blackwall	3,291	3,288	3,281	3,286	3,122	3,129	3,116	3,125	3,368	3,367	3,367	3,368
	Woolwich	143	142	139	139	134	128	130	125	186	186	186	186
North	**Dartford**	4,906	5,583	5,000	4,853	4,690	5,338	4,701	4,677	5,155	5,888	5,178	5,272
	Opt ABC	0		1,932	2,531	0		1,675	2,004	0		1,677	2,158
	Screenline	**8,340**	**9,012**	**10,352**	**10,810**	**7,946**	**8,595**	**9,622**	**9,931**	**8,710**	**9,441**	**10,409**	**10,985**
	Blackwall	3,358	3,383	3,367	3,358	2,878	2,871	2,870	2,831	2,839	2,827	2,797	2,774
	Woolwich	133	133	133	133	81	82	82	80	65	63	61	58
South	**Dartford**	4,935	5,361	4,712	4,544	5,105	5,548	4,742	4,377	5,604	6,017	4,965	4,594
	Opt ABC	0		990	1,421	0		1,699	2,188	0		1,976	2,703
	Screenline	**8,426**	**8,876**	**9,201**	**9,457**	**8,064**	**8,500**	**9,393**	**9,476**	**8,508**	**8,907**	**9,800**	**10,130**

Table 8.6: Changes in Flows (vs. Do Nothing) on the Crossings, Options A, B, and C (Vehicles/hr)

		AM Peak			Interpeak			PM Peak		
Dir.	**Crossing**	**OptA**	**OptB**	**OptC**	**OptA**	**OptB**	**OptC**	**OptA**	**OptB**	**OptC**
	Blackwall	-3	-10	-5	7	-6	3	-1	-1	0
	Woolwich	-1	-3	-3	-6	-4	-9	0	-0	-0
North	**Dartford**	676	93	-53	647	11	-13	732	22	117
	Opt ABC		1,932	2,531		1,675	2,004		1,677	2,158
	Screenline	**672**	**2,012**	**2,470**	**649**	**1,676**	**1,985**	**731**	**1,699**	**2,275**
	Blackwall	25	9	-0	-7	-8	-47	-12	-41	-65
	Woolwich	-0	0	1	1	1	-1	-2	-5	-7
South	**Dartford**	426	-223	-391	443	-363	-728	413	-639	-1,010
	Opt ABC		990	1,421		1,699	2,188		1,976	2,703
	Screenline	**451**	**775**	**1,031**	**436**	**1,329**	**1,412**	**399**	**1,291**	**1,621**

8.4.6 Options B and C produce higher river crossing screenline totals than Option A, as Option A is simply giving more capacity to the existing Dartford Crossing, whilst Options B and C provide new connectivity to south Essex, north Kent and transit traffic.

8.4.7 Modelled flow changes from the Do-Nothing scenario are shown on network plots on Figure 8.2 and Figure 8.3. Increases in traffic are in green and decreases in red. All plots are to the same scale. All three options increase long-distance traffic on the M25, M2, A12 and A13, even some distance from the schemes.

Figure 8.2: 2041 Flow Effect of Options A and B (PCUs/hr)

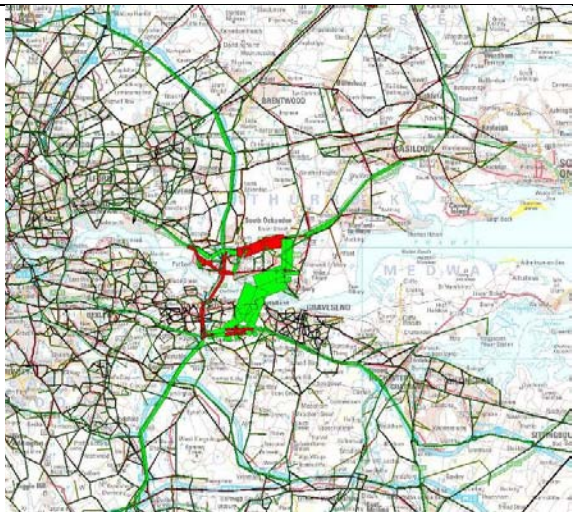
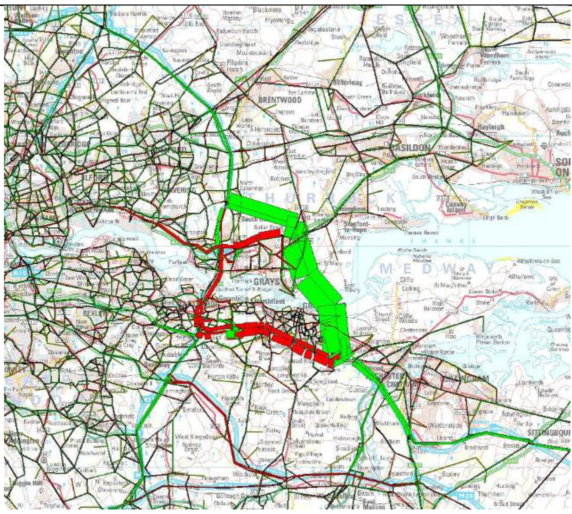
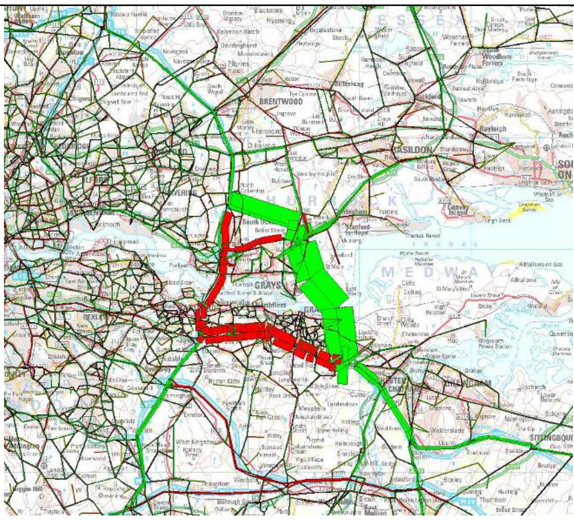
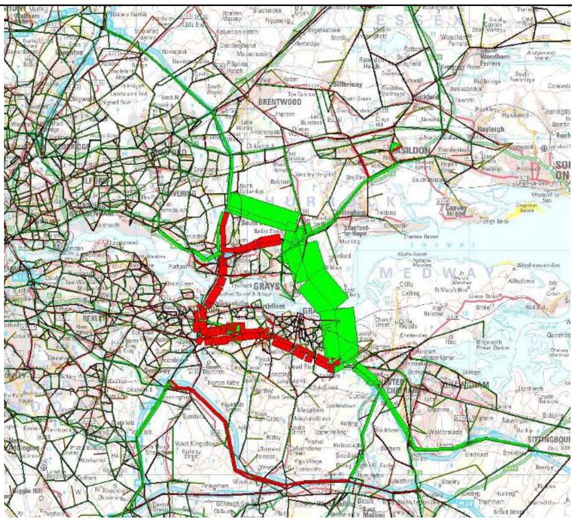
	Option A	Option B
AM Peak		
Interpeak		
PM Peak		

Figure 8.3: 2041 Flow Effect of Option C (PCUs/hr)

	Option C
AM Peak	
Interpeak	
PM Peak	

8.5 Summary

8.5.1 The demonstration tests have been run and examined; we are confident that the general model setup is free from significant errors, as the results are plausible, with modelled effects and impacts on crossing traffic in the expected direction and with credible scale of change.

8.5.2 The model is able to be run for the year 2041 with no significant problems, convergence or otherwise, and the overall changes in traffic flows are plausible and consistent with other sources (NTS).

8.5.3 It must, however, be appreciated, that the demonstration tests reported in this chapter do not represent robust forecasts per se, as they were designed solely to demonstrate the general suitability of the model, not for any further analysis. In forecasting, considerably more care will be taken to define model assumptions, especially with regard to changes in the highway network and planning data over time; that is in defining a 'core' scenario, and in defining crossing option schemes that are more refined and consistent with the highway engineering outcomes form Output 2.

9 Suitability of the Model for Forecasting and Appraisal

9 Suitability of the Model for Forecasting and Appraisal

9.1 Introduction

9.1.1 This chapter summarises and comments upon the approach to be taken to deriving reasonable future year scenarios in the LTCM and to using the model to appraise the scheme options.

9.2 Forecasting Approach

9.2.1 The forecasting approach to be taken in using the LTCM is summarised as follows:

- The calibrated base year (2009) highway and demand models (LTC_{HAM} and LTC_{DM}) will be used as the basis for the model forecasts.
- The model will be used to forecast for 2025 and 2041; model inputs will therefore be required for these two modelled years. These forecasting input assumptions are set out in Table 9.1.
- Planning data, by zone, will be used to derive trip ends. These trip ends will then be used to add growth to the base year demand matrices, using a Furness matrix-balancing technique. This will result in a 'Reference' scenario.
- Freight growth assumptions will be forecast exogenously and apply to the base year freight matrices.
- Economic forecasting assumptions, primarily derived from WebTAG 3.5.6D, will be input to the LTC_{HAM} routeing parameters and the demand model. Toll tariff assumptions will also be implemented.
- The LTCM will be used to derive a 'Core' scenario, which will adjust from the 'Reference' scenario to take account of changes in transport infrastructure, congestion and travellers' valuation of time, and the changes in vehicle operating costs, public transport fares and tolls (excluding new Lower Thames crossings).
- The LTCM will then be used to derive 'With Intervention' forecasts, pivoting off the 'Core' scenario, introducing the new Lower Thames crossing options.

9.3 Forecasting Assumptions

9.3.1 The key forecasting assumptions that will be defined are summarised in Table 9.1, with some commentary on their derivation.

Table 9.1: Forecasting Assumptions and Derivation

Forecasting Element	Approach
Planning Data	Forecast planning data (households, population and employment) will be collated, by model zone, for authorities in the vicinity of the crossing options. Further afield, TEMPRO planning data will be used, apportioned to LTCM zoning. The National Trip End Model (NTEM) will be applied using the planning data, together with the National Car Ownership Model (NatCOP) to derive person trip ends by purpose and mode.
Trip Ends	Great Britain Freight Model (GBFM) and relevant port forecasts will be used to forecast freight growth (GBFM forecasts feed into the DfT's National Transport Model (NTM) forecasts.
Highway networks	A list of expected network changes will be assembled, both strategic and local. These will then be considered against WebTAG 3.15.5 likelihood criteria to define a list of schemes that will form the 'core' scenario.
River crossing	The network assumptions and charges for river crossing options will be defined, including routes for

networks	new crossing options, the way in which free-flow tolling is represented in the model and the associated capacities for free-flow tolling infrastructure.
Economic assumptions	Assumptions relating to travellers' values of time and vehicle operating costs will be derived from WebTAG 3.5.6D. These are shown in Table 9.2 below. Public transport fares assumptions will also be defined.
Toll assumptions	Assumptions of the tolls to be used for all crossings will be assembled. These may, subject to TfL views, include Blackwall Tunnel, Silvertown Crossing, Dartford Crossing and the new crossing options. Effective tolls will need to be calculated, taking into account any discounts for local residents, TAG users etc.

9.3.2 Economic parameters (values of time, fuel prices and vehicle efficiency) for the 2025 and 2041 forecast years have largely been derived from WebTAG 3.5.6D, as of June 2012, incorporating new assumptions relating to electric vehicle fleet mix. These are shown in Table 9.2.

Table 9.2: Change in Economic Parameters over Time

Parameter	2009	2025	2041	2025 Change	2041 Change	Units
Car Fuel Usage Petrol	1.014	0.619	0.536	-39%	-47%	litres/km, relative to 2010
Car Fuel Usage Diesel	1.016	0.718	0.615	-29%	-39%	litres/km, relative to 2010
LGV Fuel Usage Petrol	1.003	0.772	0.637	-23%	-37%	litres/km, relative to 2010
LGV Fuel Usage Diesel	1.018	0.716	0.652	-30%	-36%	litres/km, relative to 2010
Car Petrol Proportion	62%	44%	44%	-28%	-28%	proportion
Car Diesel Proportion	38%	53%	50%	38%	31%	proportion
Car Electric Proportion	0%	3%	5%	-	-	proportion
LGV Petrol Proportion	7%	1%	1%	-85%	-88%	proportion
LGV Diesel Proportion	93%	99%	99%	6%	6%	proportion
Business Petrol price	89	123	154	38%	72%	pence/litre
Business Diesel price	93	130	162	39%	74%	pence/litre
Business Electricity price	-	20	19	-	-	pence/kWh
Consumer Petrol price	102	147	184	44%	80%	pence/litre
Consumer Diesel price	107	155	195	45%	82%	pence/litre
Consumer Electricity price	-	21	20	-	-	pence/kWh
Value of Time, HBWork, Low	7.382	9.024	11.642	22%	58%	pence/minute
Value of Time, HBWork, Med	10.185	12.45	16.06	22%	58%	pence/minute
Value of Time, HBWork, High	12.929	15.805	20.389	22%	58%	pence/minute
Value of Time, HBBusiness	44.548	57.421	79.085	29%	78%	pence/minute
Value of Time, HBOther, Low	8.332	10.185	13.138	22%	58%	pence/minute
Value of Time, HBOther, Med	9.59	11.722	15.122	22%	58%	pence/minute
Value of Time, HBOther, High	10.644	13.011	16.784	22%	58%	pence/minute
Value of Time, NHBBusiness	44.548	57.421	79.085	29%	78%	pence/minute
Value of Time, NHBOther, Low	8.332	10.185	13.138	22%	58%	pence/minute
Value of Time, NHBOther, Med	9.59	11.722	15.122	22%	58%	pence/minute
Value of Time, NHBOther, High	10.644	13.011	16.784	22%	58%	pence/minute
Value of Time, LGV	16.782	21.569	29.65	29%	77%	pence/minute
Value of Time, HGV	41.366	53.166	73.085	29%	77%	pence/minute

9.3.3 Our exploratory testing reported in Chapter 8 demonstrated that the model forecast, in response to these economic inputs resulted in a plausible increase in traffic, ranging between about 25% in the peaks to nearly 40% in the interpeak period. Similarly the forecast growth in demand across the Lower Thames was, plausibly of a comparable scale. These tests thus confirmed the ability of the model to respond plausibly to forecasting assumptions of the scale and nature of those that will be applied.

9.4 Suitability of Model for Appraisal

9.4.1 The model outputs will be applied in the appraisal of the impacts of new crossing capacity. This is set out in detail in Appendix B (Appraisal Methodology Report). In the following paragraphs we review the quality of the model and associated forecasting uncertainties in considering specific appraisal metrics that draw upon the model outputs.

Financial and Economic

9.4.2 Economic benefits are derived from the changes in travel time, costs and how these affect demand. The model network has been reviewed and verified demonstrating a reasonable reproduction of journey times along the strategic road network and indicative tests undertaken that confirmed that, as might be expected, modelled flow changes were focused on these key routes. The key uncertainties in the assessment of benefits thus relate to:

- the ageing source of demand data used, particularly for trips starting or finishing in North Kent along the south side of the Thames; in this regard initial actions should based analysis to review the proportion of benefits derived from these trips; and
- representation of delays (southbound in the morning and northbound in the evening) were comparatively poor in the base year validation, and the representation of capacity and delays with the free-flow operation will be critical to understanding the time savings provided by additional crossing capacity.

9.4.3 Revenues are estimated from traffic forecasts and the charges assumed. The demand forecast will in part be sensitive to the assumptions on capacity and associated journey time improvements delivered by additional crossing capacity. In addition, given the different charges for different vehicle types the forecasts of freight traffic growth, which are subject to greater uncertainty than car traffic growth, will be of relevance.

9.4.4 Assessments will, in addition, be made of ‘wider impacts’, or the economic growth stimulated by the improved accessibility provided by additional crossing capacity. Given the main traffic changes should be confined to the key routes for which the model performance has been validated, measures of accessibility change which drive these assessments should be satisfactory for this purpose.

Environmental

9.4.5 Noise and Air Quality changes are assessed based on the forecast changes in traffic flow and speeds. As noted above the model validation specifically considered performance along the busy corridors likely to be affected by the new crossings providing assurance that the model outputs will be satisfactory. These corridors are most likely to be affected by the options in terms of changes air quality and noise as they would have the biggest change in traffic.

9.4.6 Other minor local roads are included in the model but the model outputs were not reviewed for these. However, these roads are likely to be less affected by the options as most of the traffic affected will be strategic and travelling on the major roads.

9.4.7 For air quality, emissions will be calculated for all of the roads where traffic data is available. The assessment will be carried out at a strategic level so the change in emissions will be looked at over an area using the DMRB regional impact assessment tool. The DMRB local air quality predictions will be carried out for major links only. Likewise for noise, changes in levels of annoyance will be calculated for major links only.

9.4.8 Air quality can be poor on minor roads if the roads are congested and there are properties very close to the edge of the road. However, changes in traffic flows on these roads are likely to be small as traffic is unlikely to divert from strategic roads to congested roads through towns and villages. To ensure that significant issues are not overlooked, the traffic data will be reviewed to check whether any minor roads are predicted to have a large increase in flows and whether these are in an AQMA. Likewise, for noise, traffic data for minor roads will be reviewed to ensure that significant issues are not overlooked.

Social

9.4.9 Accidents are estimated from forecast traffic flows using different types of road. The key distinction being that the accident rate is appreciably lower on motorway / similar standard road, relative to other rural roads and to urban roads. The change in demand and routeing between the strategic and other routes was the focus of the model validation, providing assurance that the outputs will be appropriate for use in assessing accidents.

SDI

9.4.10 Particular care was taken in the model development to segment demand between low, medium and high income groups. This will provide the level of segmentation needed to indicate differentials in impacts.

9.5 Review of Model Suitability and Forecasting Risks

9.5.1 Chapter 6 sets out the performance of the LTC_{HAM} highway model, demonstrating the acceptable model validation, in terms of screenline and link flows for significant links. Similarly the journey time validation is also reasonable, and the analysis undertaken demonstrates that model calibration has not significantly distorted the prior demand matrices.

9.5.2 Chapter 7 sets out the performance of the LTC_{DM} demand model, demonstrating that the LTC_{DM} demand responses are as expected and consistent with WebTAG 3.10.4 guidance, with plausible differentials in outturn model sensitivity across time periods and journey purposes.

9.5.3 Chapter 8 documents the headline results of demonstration testing, identifying how the LTCM reacts to the inclusion of new Lower Thames crossing options, and to the introduction of higher tolls. These model responses are plausible both in terms of magnitude and sign, given the proportionate level of analysis that has been undertaken on these indicative tests.

9.5.4 Together these assessments indicate that the LTC model is suitable for strategic assessment of Lower Thames crossing options. Section 9.4 then reviewed the risks in using the model outputs for developing the specific appraisal metrics that will be used, confirming the need to focus on impacts associated with the strategic rather than local network and highlighting risks associated with demand patterns and capacity assumptions regarding the existing crossing (with free-flow) that may require specific consideration. Nevertheless the review confirmed that the evidence on model performance indicates that it will be a suitable tool to establish the appraisal metrics

9.5.5 The overall model performance is therefore considered to be suitable for use in the strategic assessment of additional Lower Thames crossing capacity.

Appendices

Appendix A: Model Status Report

Appendix B: Appraisal Methodology Report

Appendix C: Identification of Significant Links

C.1. This appendix contains SATURN outputs from three separate fixed base year demand tests undertaken using an interim version of LTCHAM. These assignments were variants of the 2009 base-year network with indicative coding of each of the identified Lower Thames crossing capacity enhancement schemes added in.

C.2. The plots contained within this appendix show comparisons of the morning peak hour assignments with the interim base-year model, demonstrating the links that experience a significant change in traffic flow as a result of the introduction of each of the capacity enhancement options. These plots, along with each of criteria set out in Section 6.2 of the report were used to identify the significant strategic links/corridors within the model.

Figure C.1: Option A –vs- interim 2009 base-year assignment

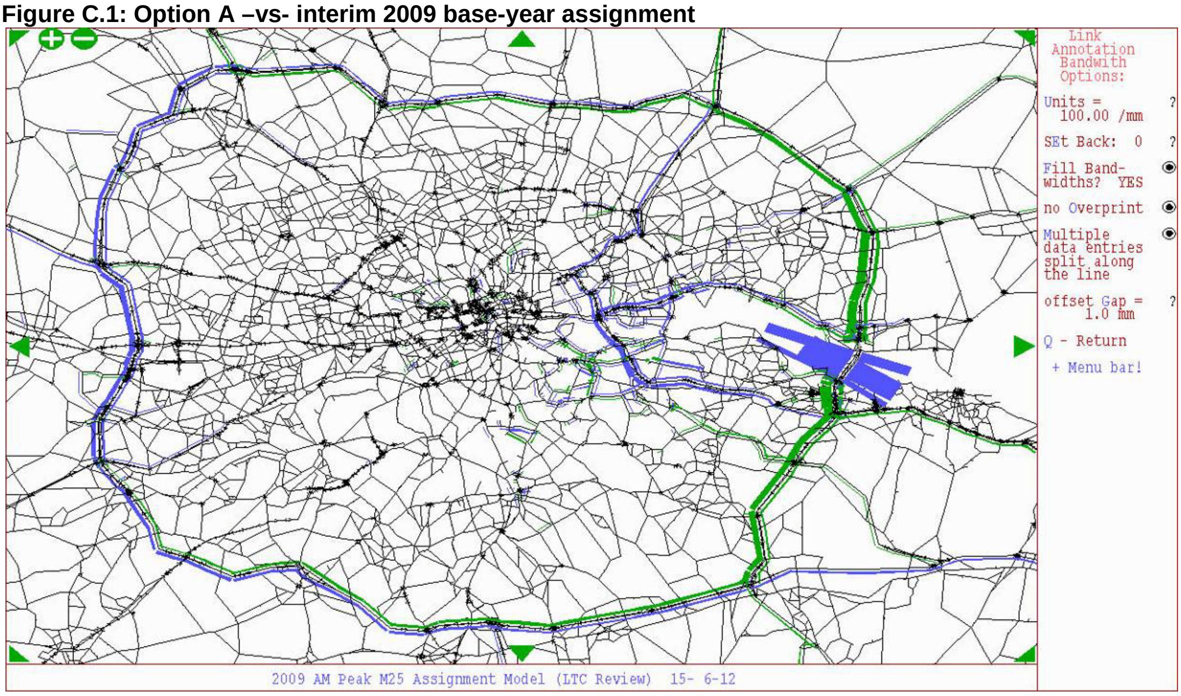


Figure C.2: Option B –vs- interim 2009 base-year assignment

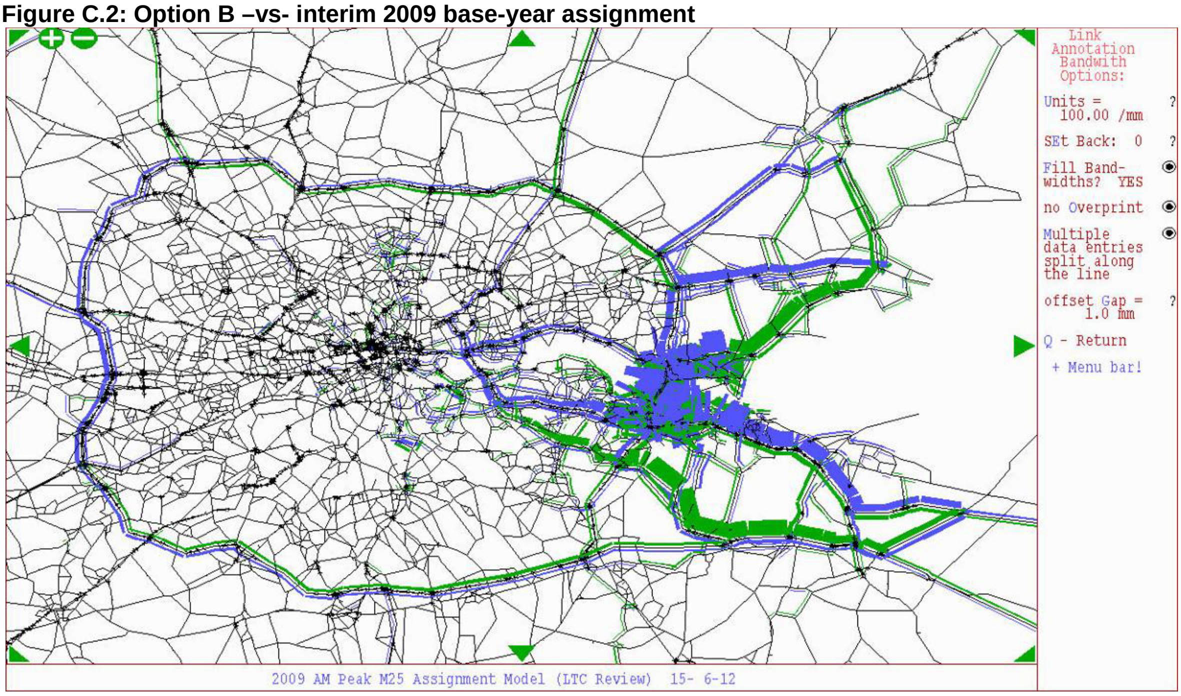


Figure C.3: Option B –vs- interim 2009 base-year assignment (Lower Thames area)

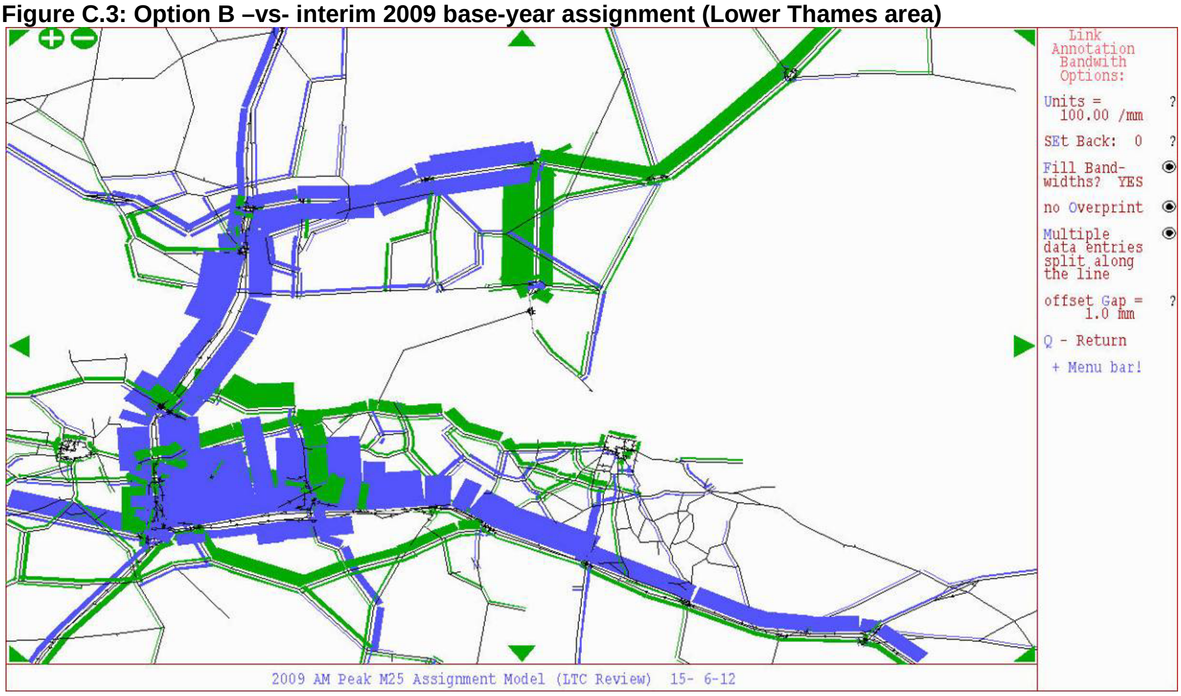


Figure C.4: Option C –vs- interim 2009 base-year assignment

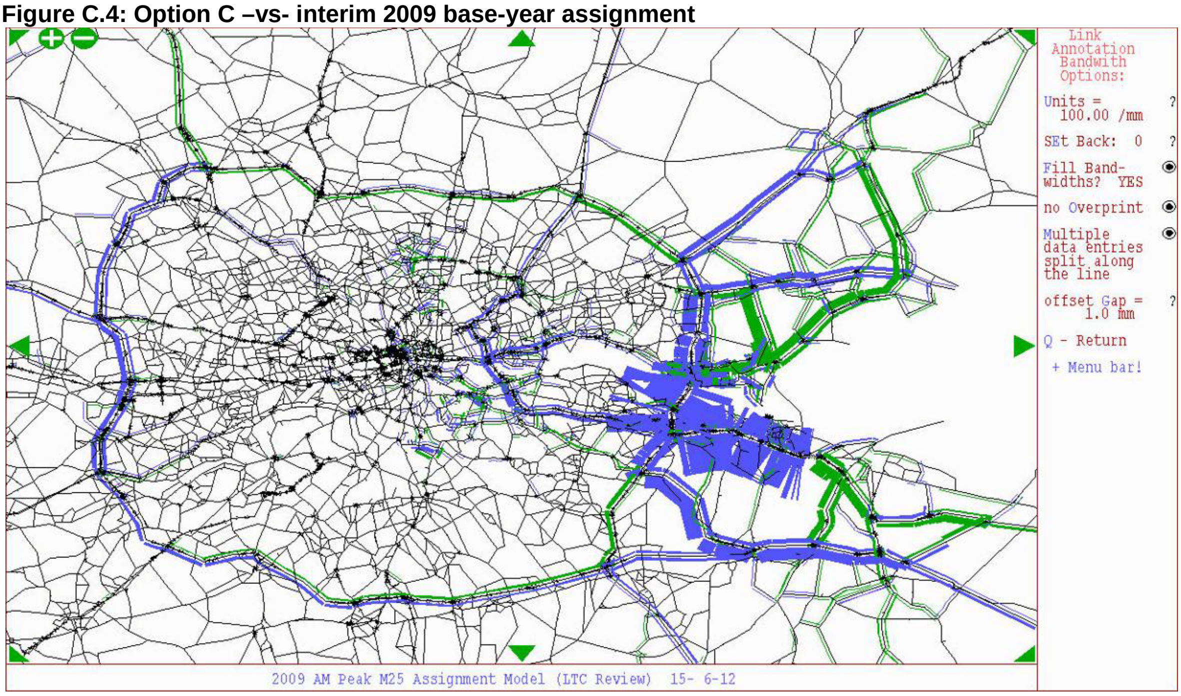
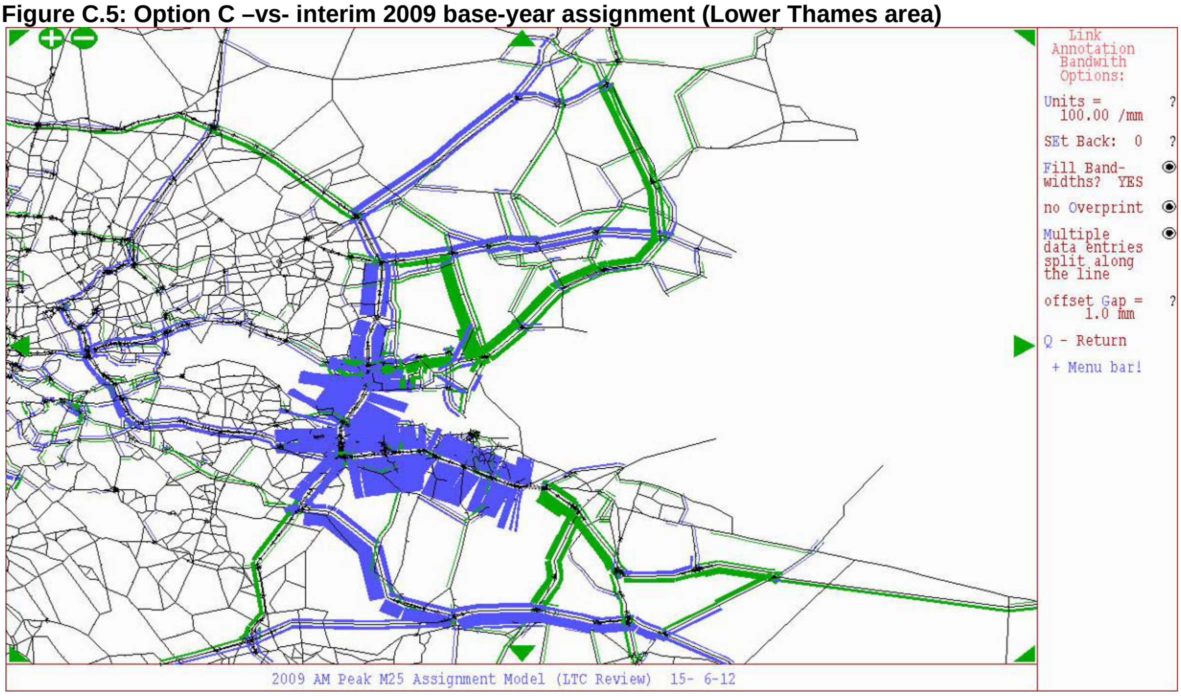
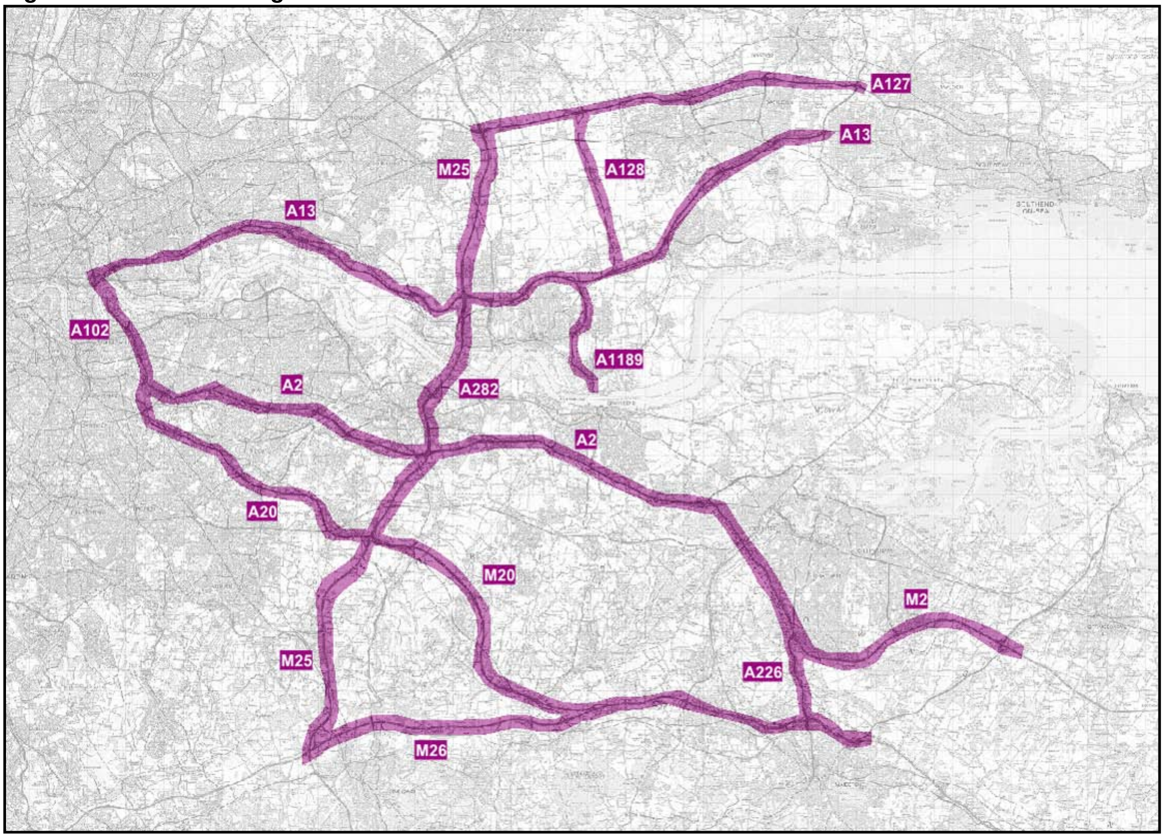


Figure C.5: Option C –vs- interim 2009 base-year assignment (Lower Thames area)



C.3. The links that have been identified as significant based on the above plots are presented on a corridor basis in Figure C.6. This forms the basis of further analyses contained within the main report document.

Figure C.6: Identified Significant Links



Appendix D: Routeing Verification Plots

D.1. Appendix D provides plots demonstrating routeing within the LTC_{HAM} base-year model. The plots shown represent the minimum-cost paths through the network and are demonstrated along significant routes that have been previously identified. The plots demonstrate that routeing through the network appears to be logical.

Figure D.1: Brentwood Hills to Gravesend East

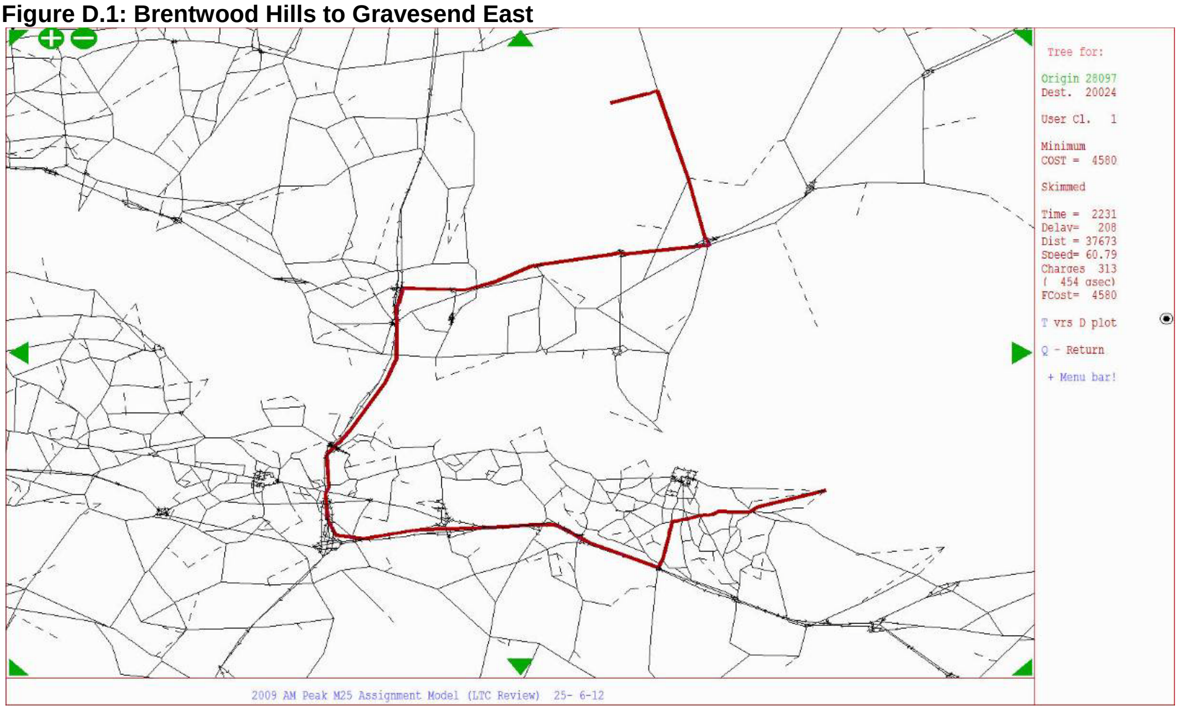


Figure D.2: Warley to Orpington

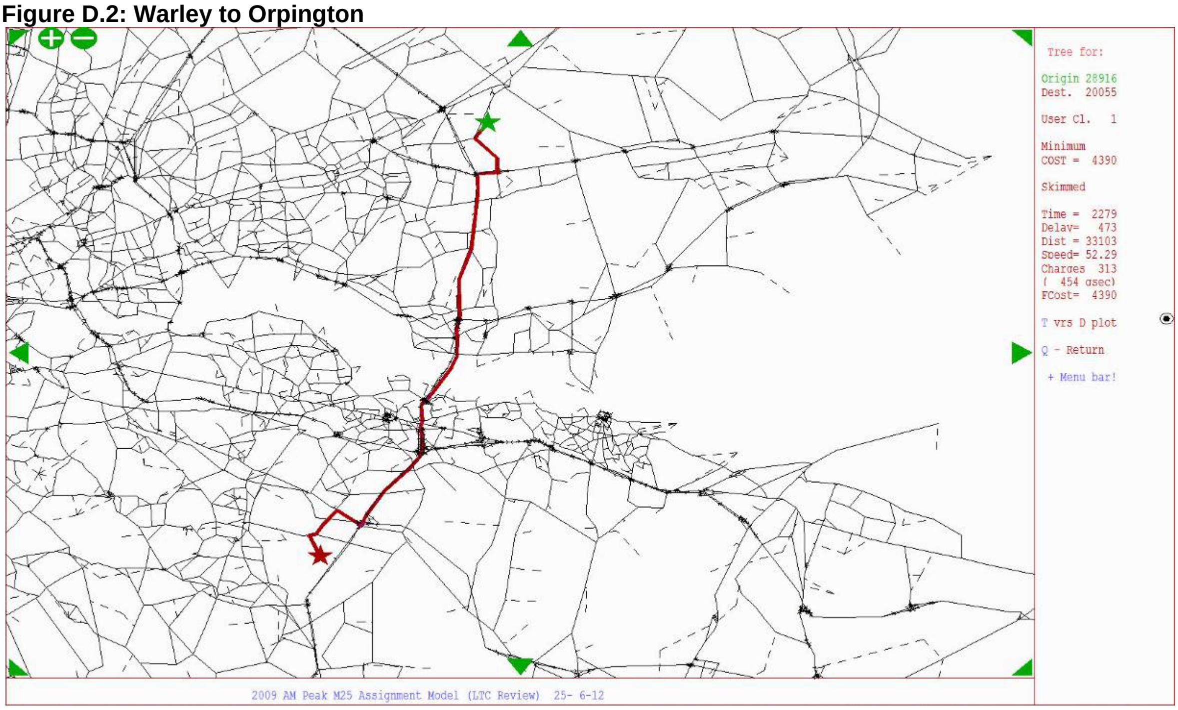


Figure D.3: Hainault to New Ash Green

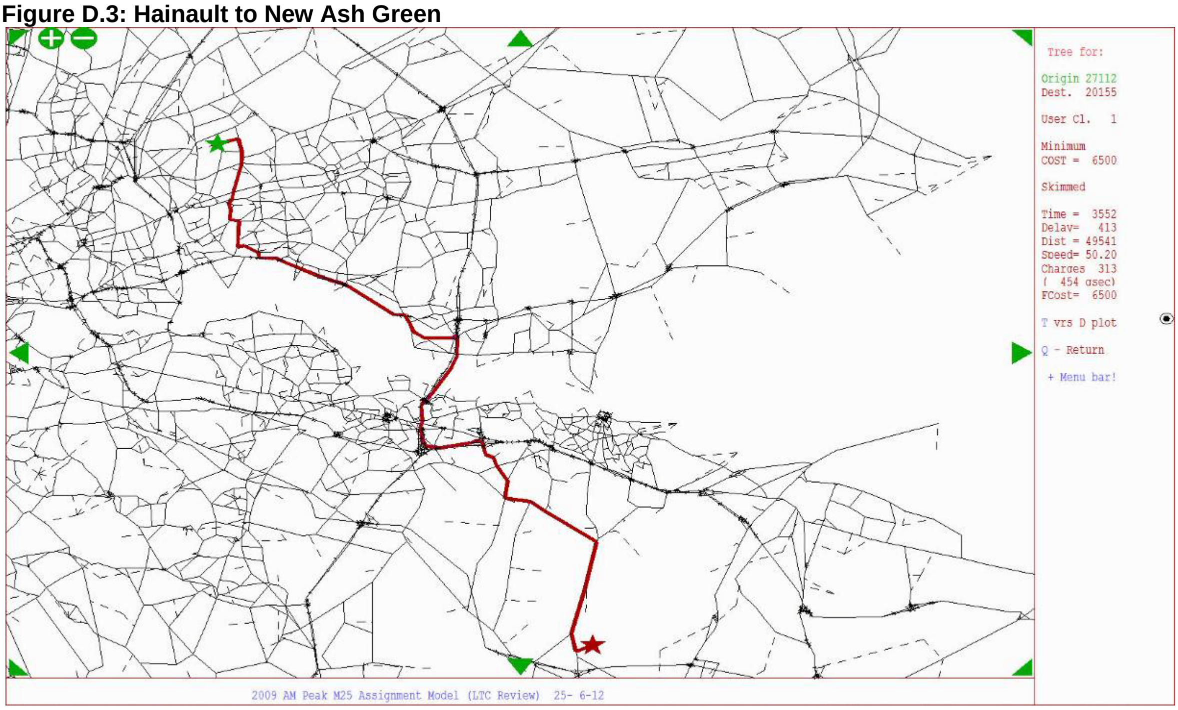


Figure D.4: Hainault to Biggin Hill

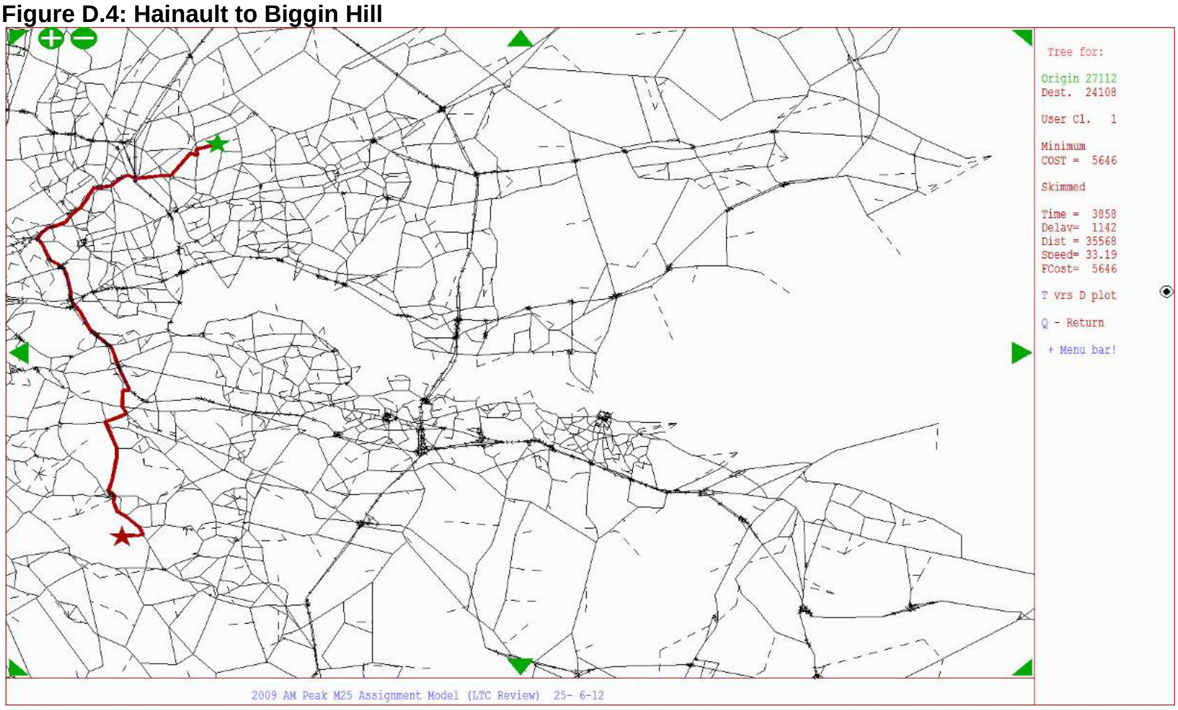


Figure D.5: West Dartford to Snodland

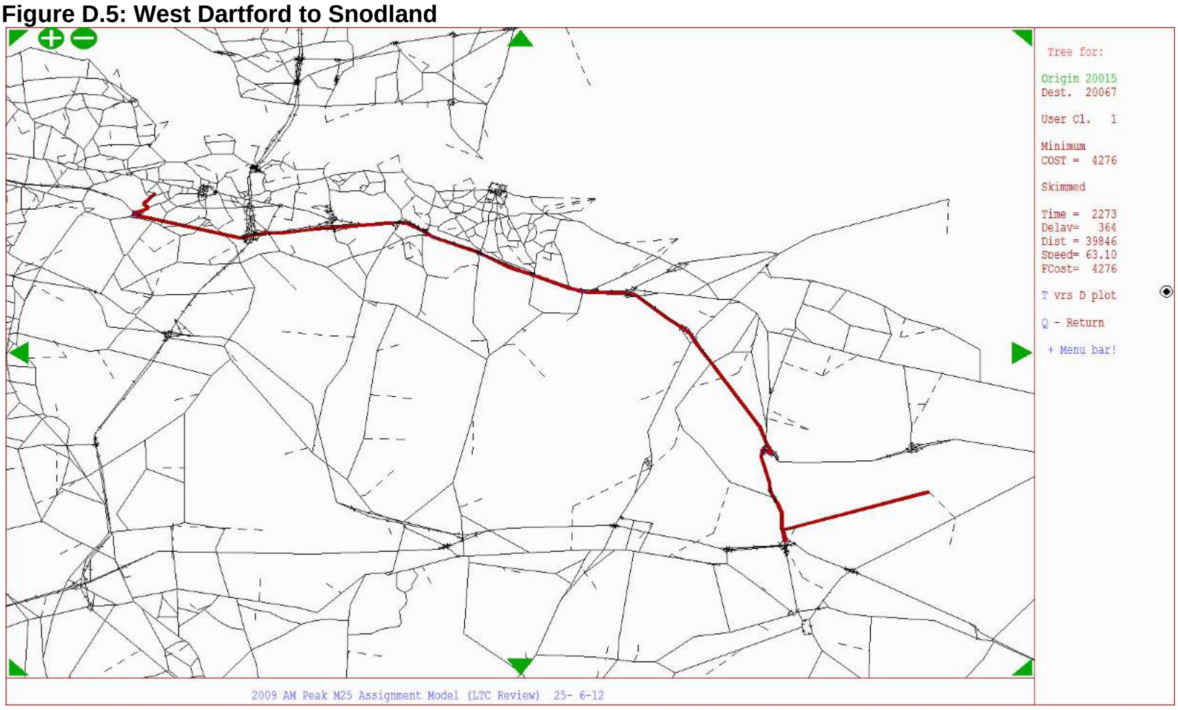


Figure D.6: East Dartford to Stratford

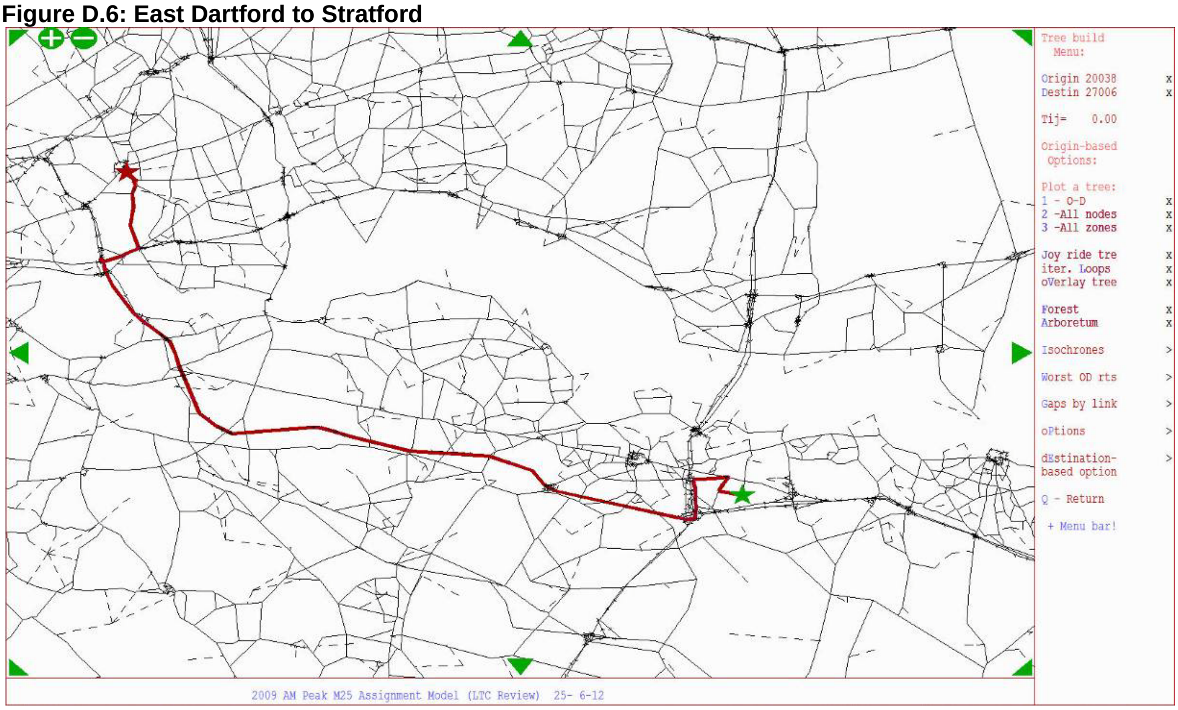


Figure D.7: Southend-on-Sea to Stratford

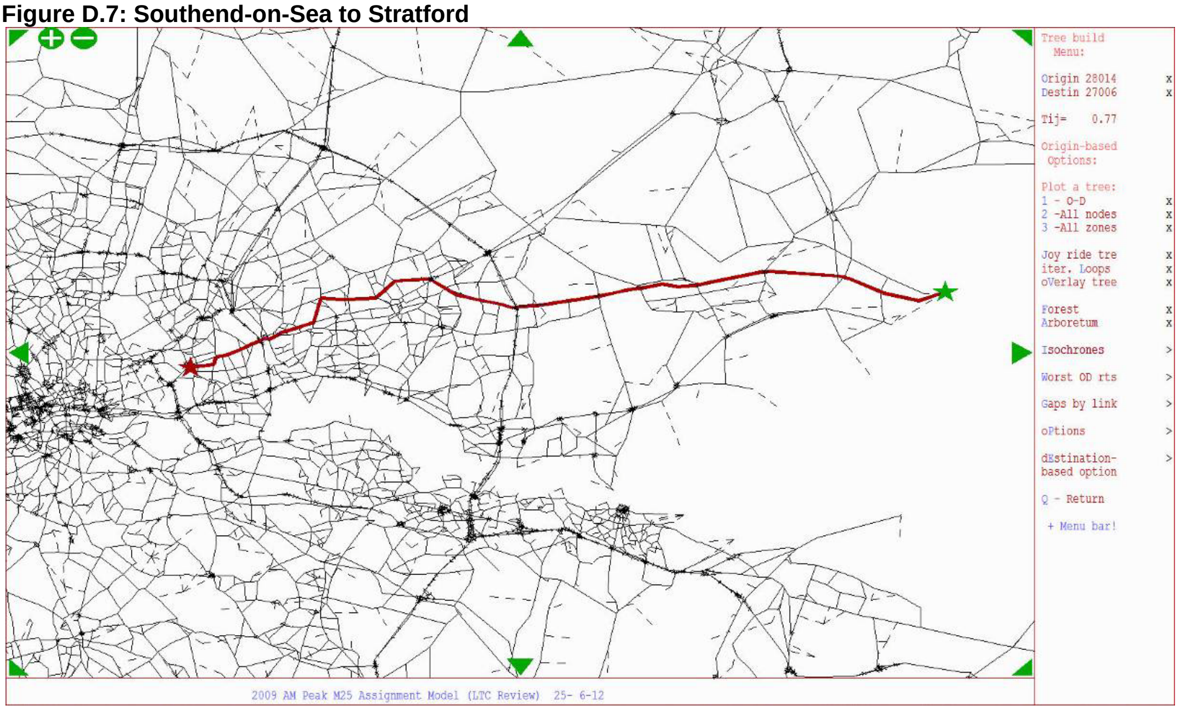
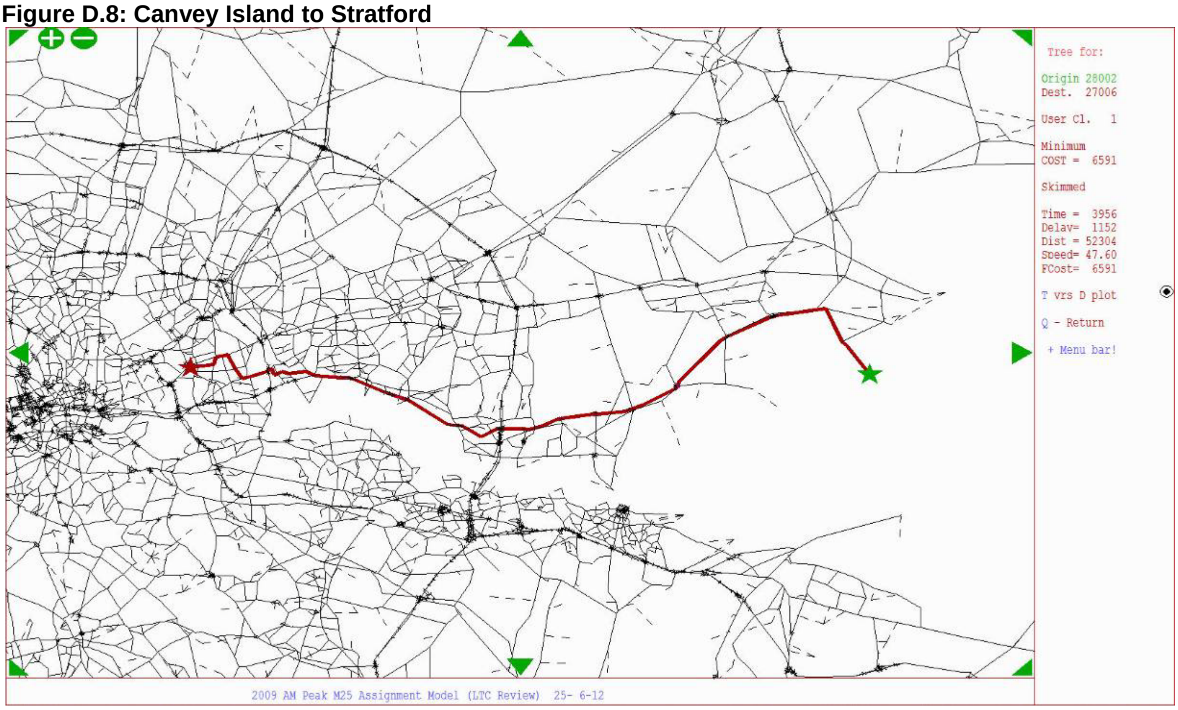


Figure D.8: Canvey Island to Stratford

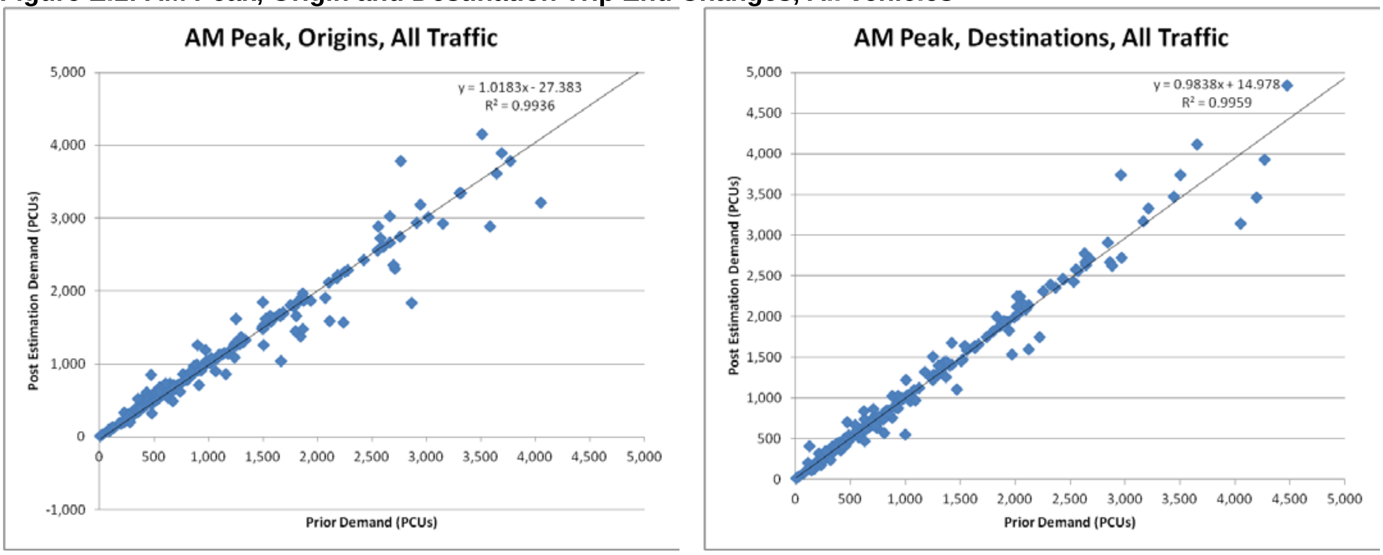


Appendix E: Analysis of Matrix Estimation Impacts

E.1. Appendix E provides plots demonstrating the impact of matrix estimation on the prior matrices. The plots shown represent the change between the prior matrix and post-estimation matrices, with analyses for zonal trip end changes, trip length distribution changes and sector-to-sector changes.

E.1. Zonal trip end changes

Figure E.1: AM Peak, Origin and Destination Trip End Changes, All vehicles



Capabilities on project:
Error! Reference source not found.

Figure E.2: Interpeak, Origin and Destination Trip End Changes, All vehicles

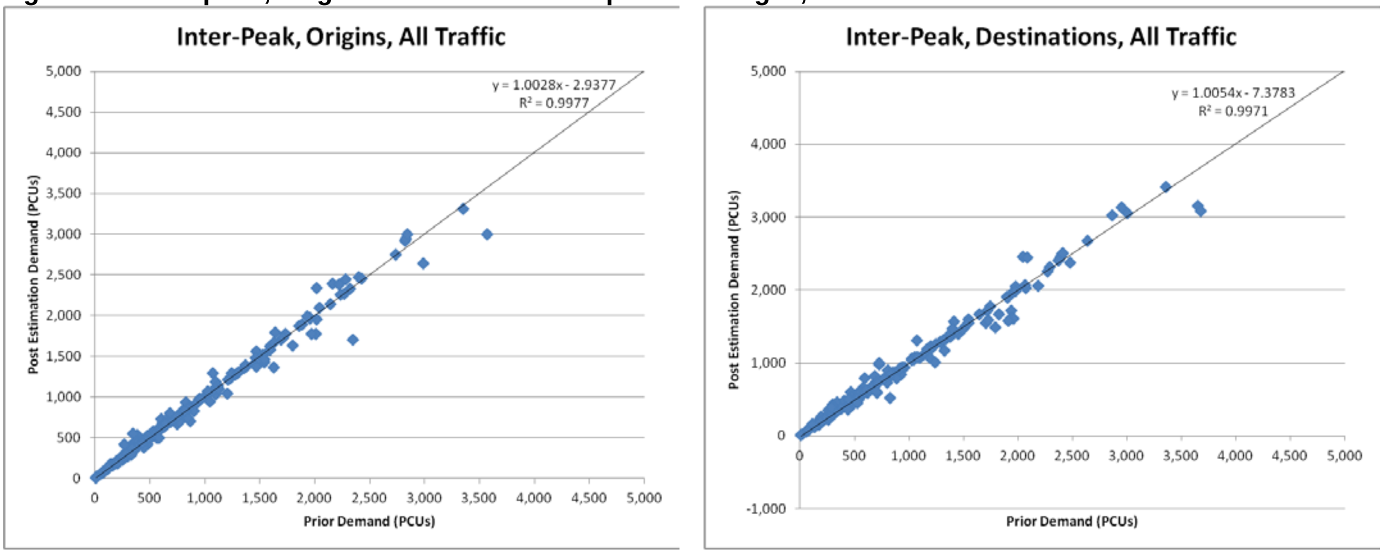
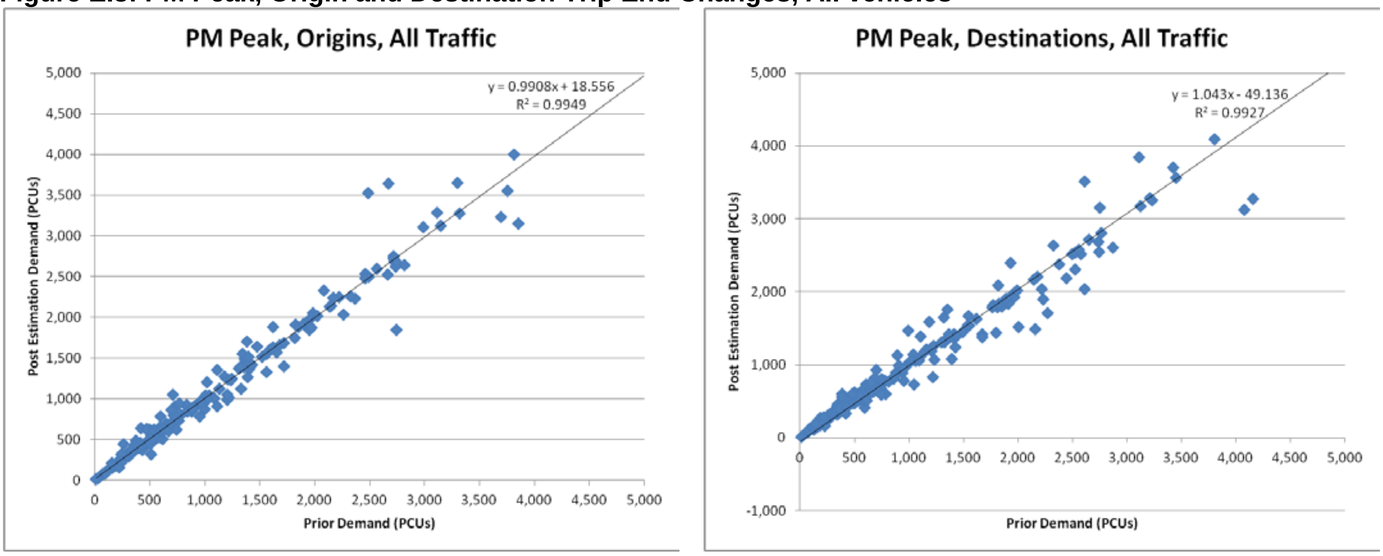


Figure E.3: PM Peak, Origin and Destination Trip End Changes, All vehicles



Capabilities on project:
Error! Reference source not found.

E.2. Trip Length Distribution Changes

Figure E.4: AM Peak, All vehicles

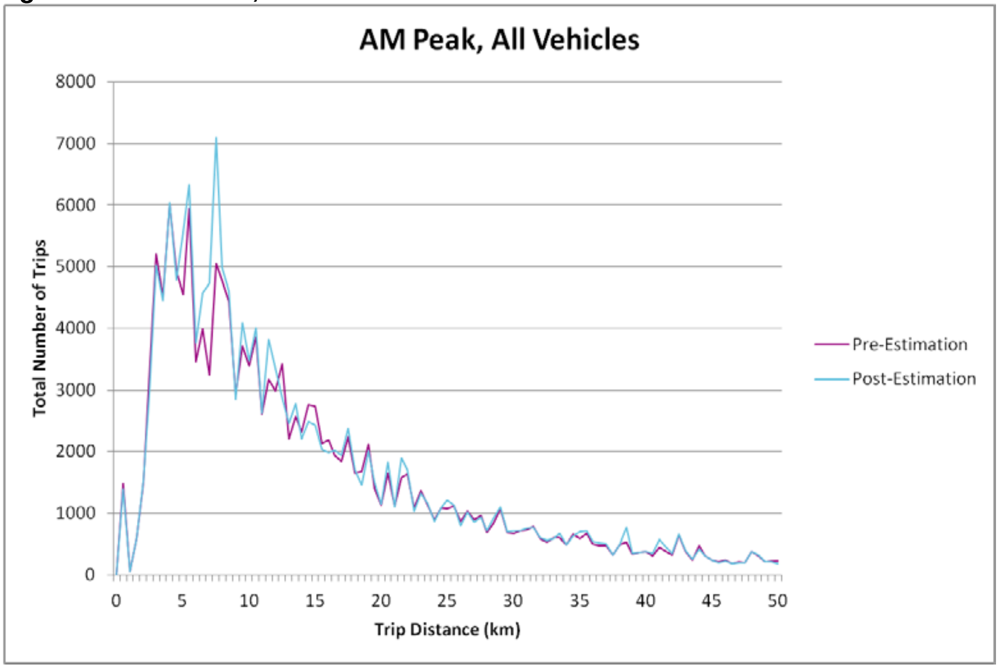


Figure E.5: Interpeak, All vehicles

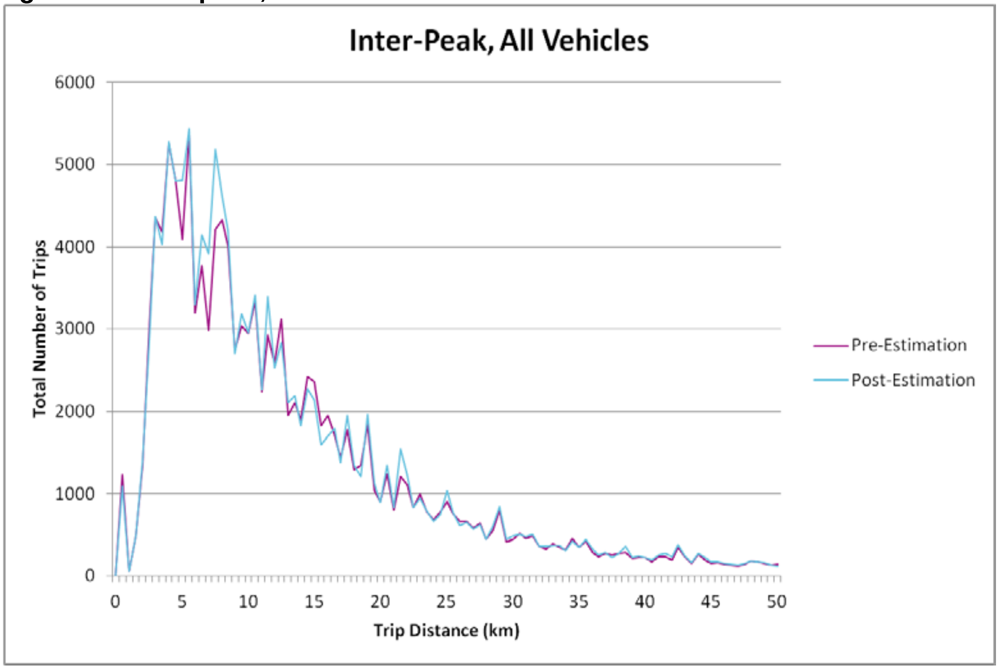
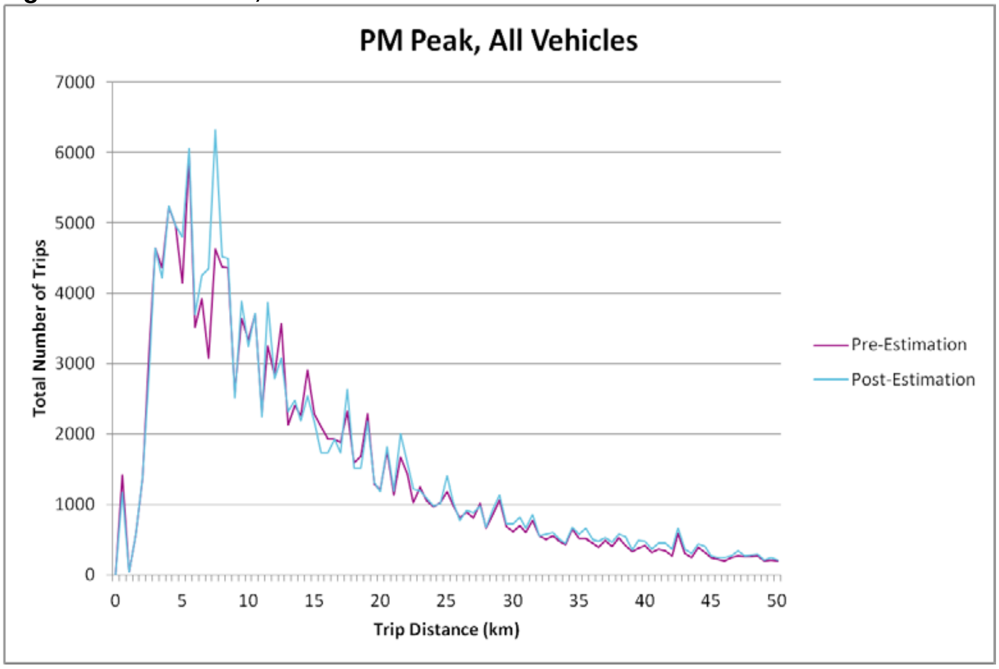


Figure E.6: PM Peak, All vehicles



Capabilities on project:
Error! Reference source not found.

E.3. Sector-to-Sector Changes

Figure E.7: AM Peak, All vehicles

Sector	Basildon/Mid Essex	EastEngland	Gravesend	Grays	Maidstone/Mid Kent	Medway/NE Kent	NE London	RoGB_North	RoGB_South	SE London	SEEngland	Southend
Basildon/Mid Essex	-0%											-23%
EastEngland	0%	0%					2%	0%				3%
Gravesend			13%									
Grays				-15%								
Maidstone/Mid Kent					0%	8%			4%	4%	0%	
Medway/NE Kent						10%						
NE London		6%					0%	4%				
RoGB_North		-0%					-2%	-0%	-4%			
RoGB_South					-6%			-5%	-0%	1%	-0%	
SE London			-3%						2%	3%		
SEEngland					0%				0%		-0%	
Southend	-8%	-2%										-3%

Figure E.8: Interpeak, All vehicles

Sector	Basildon/Mid Essex	EastEngland	Gravesend	Grays	Maidstone/Mid Kent	Medway/NE Kent	NE London	RoGB_North	RoGB_South	SE London	SEEngland	Southend
Basildon/Mid Essex	0%											5%
EastEngland		0%					7%	0%				
Gravesend			14%									
Grays				-13%								
Maidstone/Mid Kent					0%						-0%	
Medway/NE Kent						5%						
NE London		3%					0%	-2%				
RoGB_North		0%					1%	-0%	-6%			
RoGB_South								-4%	-0%	4%	0%	
SE London									0%	1%		
SEEngland					-0%				1%		0%	
Southend	-7%											-3%

Figure E.9: PM Peak, All vehicles

Sector	Basildon/Mid Essex	EastEngland	Gravesend	Grays	Maidstone/Mid Kent	Medway/NE Kent	NE London	RoGB_North	RoGB_South	SE London	SEEngland	Southend
Basildon/Mid Essex	-0%											10%
EastEngland	-10%	0%					5%	0%				-0%
Gravesend			15%							-9%		
Grays				-17%								
Maidstone/Mid Kent					-0%				-1%		0%	
Medway/NE Kent						11%					-3%	
NE London		7%					0%	-1%				
RoGB_North		0%					3%	-0%	-5%			
RoGB_South					-5%			-4%	-0%	4%	-1%	
SE London			19%						1%	4%		
SEEngland					-1%	-1%			-1%		-0%	
Southend	-20%	-2%										-3%