Transportation Department for Transport January 2012

Local Model Validation Report

This report has been prepared under contract to WSP on behalf of the WSP-PB led consortium for Lot 4 of the DfT Framework for Transport – Related Technical Advice and Research (Contract PPRO 4/45/4).

Prepared by: .... Laura Appleton / Ian Taylor
Consultant / Associate Director

Checked by: .... Ian Taylor
Associate Director

Approved by: Frank Mohan
Associate Director

Local Model Validation Report

Rev No	Comments	Checked by	Approved by	Date
5	Final Version	OB/IT	FM	10/02/12
4	Final Version – Client Issue	OB/IT	FM	18/01/12
3	Final draft following client comments	OB/IT	FM	
2	Draft for WSP/DfT Review	OB/LA	FM	23/12/10
1	Initial draft for WSP Review	OB/FM		
0	Initial structure	FM		

1 New York Street, Manchester, M1 4HD
Telephone: 0161 601 1700 Website: http://www.aecom.com

Job No 60155880 Reference M001.010 Date Created January 2012

f:\projects\transport planning - humber bridge model - dft\outgoing documents\reports - working\04_lmvr\lmvr_v16_10.02.2012.docx

Table of Contents

1 Introduction

1 Introduction

1.1 Background

The Humber Estuary Transport Model (HETM) has been developed by AECOM to investigate travel patterns in and around the Humber Estuary area with a view to considering the changes that may occur to those patterns in response to changes in toll levels on the Humber Bridge.

1.2 Context

Any transportation model represents a simplified version of reality; the structure and level of detail required for a particular application is determined by a consideration of the ultimate use of the model. As models serve a variety of functions, the nature of models is similarly varied, ranging from highly detailed urban situations to more strategic regional and inter urban contexts.

In this instance the model has been designed to cover a necessarily wide area given the sphere of influence of the Bridge. Detailed route choice within the urban centres included in the model area is less important than the route choice between those centres, whether by the Bridge or alternative routes. The validation of the model reflects this with a focus on ensuring that the following are adequately replicated by the model:

- Existing total flows across the Bridge;
- Existing vehicle types across the Bridge;
- Route choice between key settlements around and across the Estuary;
- Traffic flows on major links / routes around the Estuary; and
- Existing travel times on the network.

1.3 Purpose of this Report

The Local Model Validation Report (LMVR) is intended to summarise all aspects of the development of the base year model and demonstrate that the model has been calibrated and validated to a level commensurate with its intended use for future year demand forecasting.

The production of an LMVR is a requirement of the Design Manual for Roads and Bridges (DMRB) and the contents are determined by those standards and the guidance provided by the Department for Transport (DfT) via WebTAG.

It is intended that the LMVR is a free standing document that covers all aspects of the model development. However, more detail on many aspects of the process can be found in the appropriate Reports and Technical Notes prepared during the course of the study. In such cases, where additional information is available, this is indicated in the text of this report.

1.4 Related Reports

The reports which have already been produced, and approved by the DfT, which are of direct relevance to this document are:

- Model Scoping Report;
- Traffic Survey Report; and the
- Network Development Report.

2 Model Description

2 Model Description

2.1 Description of the Highway Model

The HETM has been developed as a study tool to reflect existing traffic flows on the Humber Bridge and the surrounding area and to investigate the potential responses in trip making as a consequence of changes to toll levels on the Bridge. It is a highway only model that covers the area deemed to fall within the area of influence of the Bridge. This has been defined as the areas of England for which the Bridge represents a sensible option for travel and the areas for which traffic flows are affected by routing to and from the Bridge.

The scope of the model has been drawn carefully to ensure that it is wide enough to enable all aspects of Bridge operation to be considered, whilst not over complicating the processes involved.

In particular the aspects that were considered before developing the model were:

- The need to include public transport trips within the model;
- The geographical coverage of the model;
- The level of segmentation of demand within the model;
- The time periods to be considered by the model; and the
- Choice of software platform.

The assessment undertaken and the decisions made with respect to each are discussed in this section.

2.2 Geographical coverage

A review of the sphere of influence was undertaken using route choice software which displays the best routes between pairs of towns. The area determined to fall within the scope of the Bridge is shown in **Figure 1**.

There is a skeletal network outside of the area illustrated sufficient to allow connectivity for longer distance trips. Within the modelled area the network representation includes all significant A roads and significant B roads in areas closer to the Bridge.

2.3 Need for Public Transport Modelling

Transport models are built for a wide variety of purposes and can incorporate a range of features. The decision as to what should be included in any particular model needs to be based on a consideration of the purpose of the model (what it is to be used for) and the nature of the study area in transport terms.

The need to include Public Transport trips within the model was considered, and the assessment is reported in detail in ‘Technical Note 6 – Public Transport Assessment’. AECOM undertook a specific occupancy check on bus services in the morning peak and the average number of passengers per hour was 44 (in the busiest direction). Given that the typical flow of cars is of the order of 650 for the same period, adopting the standard WebTAG guidance for vehicle occupancy in the morning indicates a mode share for bus of less than 5%. This figure excludes any allowance for vans etc. which would reduce the proportion still further.

This study is considering, amongst other things, whether or not reductions in toll levels would alter trip patterns in the area. As public transport is a relatively unattractive option for cross-Humber trips, for the reasons described earlier, it would be reasonable to assume that any reduction in toll would have the effect of reducing public transport mode share even further. That is to say, the most likely response would be a shift from bus to car. This is then only a material consideration if the volume of bus trips is so high, and the number shifting to car would be so significant, as to alter the journey times experienced by existing car users. The available information suggests this is not the case. As we have identified 44 passengers in the morning peak, even if all of these were to switch to being individual car drivers then the relative impact of highway flows would be negligible. In reality, a proportion of these passengers, probably do not have access to a car and therefore could not make such a switch.

Based upon a review of public transport in the vicinity of the Humber Bridge, it is clear that the difference between bus and car travel times, even for those areas comparatively well served by bus services, is considerable. Based purely on in-vehicle travel time, bus journey times are considerably longer than car (the Scunthorpe to Hull bus trip takes over 30 minutes longer than by car, the Cleethorpes to Hull equivalent is over an hour longer).

AECOM therefore concluded that the impacts of public transport would be excluded from the model for the following reasons:

- Bus services using the bridge are low frequency and have relatively low patronage;
- The absolute numbers of bus users is low (less than 50 in the morning peak hour);
- There are no direct rail services crossing the Humber Estuary in close proximity to the bridge;
- A reduction of the tolling regime on the bridge would not offer the required significant improvement in generalised cost to result in significant modal transfer; and
- Accessibility to bus services that cross the Humber are only located in and between the key centres of Hull, Scunthorpe, and Grimsby & Cleethorpes.

It is also worth noting that the inclusion of public transport modelling would have added significantly to the cost of what is already a complex model without bringing any benefits in terms of improved model accuracy given the reasons outlined above.

2.4 Demand Segmentation

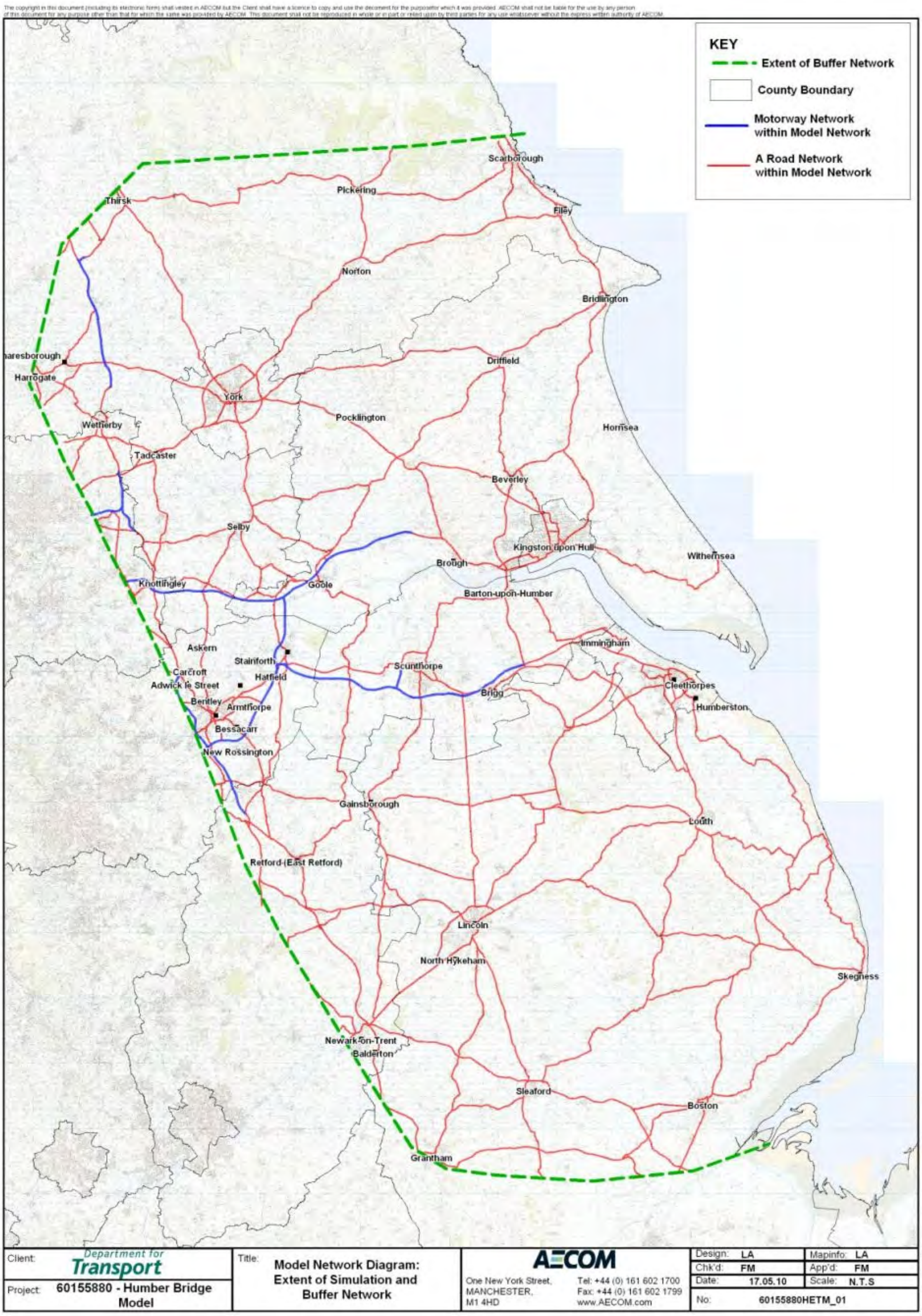
Trips within a transport model are grouped into what is referred to as demand segments. These seek to reflect the typical characteristics of users of the transport system and consider issues like vehicle type and the nature of the journey being made.

There are a number of factors which have influenced the choice of demand segmentation within the model. These include:

- Existing toll classifications on the Bridge;
- Standard modelling ‘best practice’; and
- The need to reflect income segmentation as part of toll response.

Capabilities on project:
Transportation

Figure 1 Study Area - Within the Scope of the Bridge



2.4.1 Humber Bridge Toll Classifications

The existing vehicle classifications on the Bridge are as shown in **Table 1**.

Table 1 Humber Bridge - Toll Classifications

Class	Description
1	Motor Cycles
2	Cars and Goods vehicles having a maximum weight not exceeding 3.5 tonnes including Motor Caravans
3	Goods vehicles having a maximum gross vehicle weight exceeding 3.5 tonnes but not exceeding 7.5 tonnes. Vehicles within Class 2 above, with trailers. Small buses (with seating for 9-16 passengers)
4	Goods vehicles having a maximum gross vehicle weight exceeding 7.5 tonnes with 2 axles. Large buses (with seating for 17 or more passengers
5	Goods vehicles having a maximum gross vehicle weight exceeding 7.5 tonnes with 3 axles
6	Goods vehicles having a maximum gross vehicle weight exceeding 7.5 tonnes with 4 or more axles

It is not usual to model motorcycles within studies of this type since sufficient supporting data is very rarely available and would not be cost effective to collect. The final HETM structure explicitly represents the remaining five toll classes but excludes motorcycles.

2.4.2 Trip Purpose

To reflect the potential for variation in response to toll changes by trip purpose and also the differential changes in demand over time by purpose, the demand model segments the observed travel patterns by five trip purposes:

- Commuting;
- Home based employers business;
- Home based other;
- Non home based employers business; and
- Non home based other.

2.4.3 Income Group

Further disaggregation by income segmentation (into low, medium and high income bands in accordance with the guidance provided by WebTAG) is provided for the home based trips not associated with employers business. The definition of what constitutes low, medium and high income has been informed by the income questions from the new RSI data together with available socio-economic data for the area.

2.4.4 Summary

The level of trip matrix definition adopted is summarised in **Table 2**.

Table 2 Trip Matrix Definition

Vehicle Type	Journey Purpose	Income Segmentation
Cars & Light Vans	Commuting	Low Income
		Medium Income
		High Income
Cars & Light Vans	Home Based Employers Business	All(1)
Cars & Light Vans	Home Based Other	Low Income
		Medium Income
		High Income
Cars & Light Vans	Non Home Based Employers Business	All(1)
Cars & Light Vans	Non Home Based Other	All
Goods Vehicles 3.5t to 7.5t	All	All
Goods Vehicles > 7.5t (2 axles)	All	All
Goods Vehicles > 7.5t (3axles)	All	All
Goods Vehicles > 7.5t (4+ axles)	All	All

Notes:

(1) Responses for employers business trips are assumed not to vary by income.

2.5 Modelled Periods

The trip matrices have been developed in Production-Attraction (P/A) format at the 12-hour level (07:00 to 19:00) and in Origin-Destination (OD) format covering three time periods as follows:

- Average AM peak hour;
- Average inter peak hour; and
- Average PM peak hour.

The model periods have been determined by an analysis of long term monitoring sites on the Bridge itself and on the surrounding strategic network in the immediate vicinity of the estuary. The AM peak is an average of the two hours between 07:00 and 09:00 and the PM Peak is the average of the hours between 16:00 and 18:00. The interpeak period is an average of the period 10:00 to 15:00. In terms of calibration and validation, all of the model outputs are compared to traffic count data which has been collated in an identical manner (e.g. the average of 07:00 to 09:00 for the morning peak). In principle, two hour assignments could have been run for the peak periods (rather than an average hour) but the analysis of count profiles in the area showed the flow pattern to be suitably consistent for the selected hours. We do not believe significant differences would have resulted.

As the primary data collection took place in June, the base period for the model is an average weekday, June 2010.

2.6 Software Used and Model Structure

The A63 Castle Street model, which provided the basis for the present model, was constructed using the SATURN traffic modelling package. A review of software was undertaken and it was concluded that there would be no advantage in any other platform and that SATURN was an appropriate tool for the HETM. The version of SATURN used for this model is 10.8.22.

SATURN is probably the most commonly used assignment package in the UK. The way in which networks are coded and manipulated is one of the properties that distinguish SATURN from other assignment models.

SATURN networks may be coded at two levels of detail:

- A simulation network in which considerable junction-based data in addition to road-based data must be provided; and
- A buffer network, normally surrounding the simulation network, which only requires data to describe the roads as opposed to the junctions.

Typically the simulation network is used to describe networks at the centre of, for example, a traffic management scheme where the impacts are crucial and large, while the buffer network is used to describe, for example, the inter-urban roads surrounding a town where the impacts of traffic management schemes are less critical.

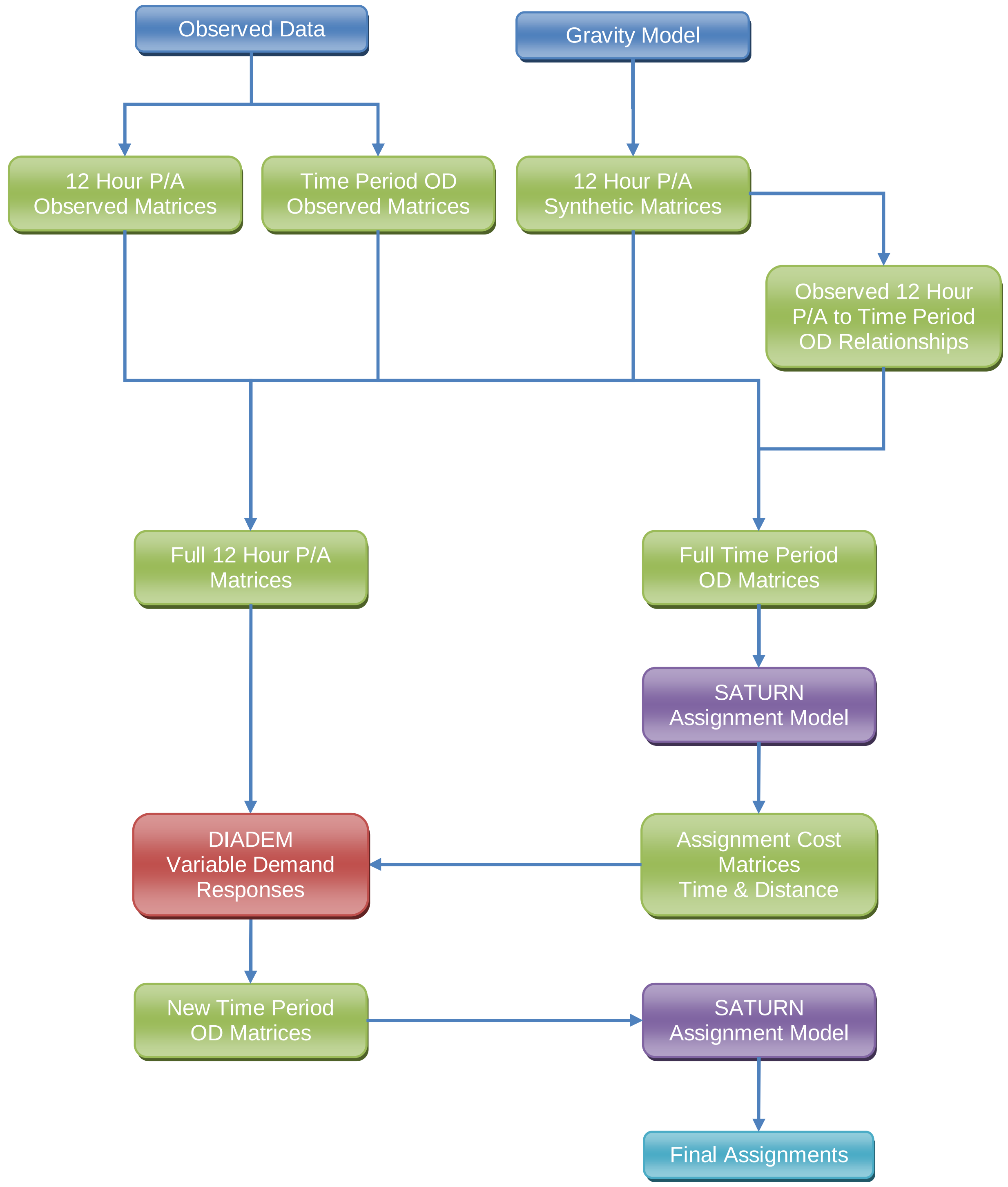
Within the buffer area of the model, the network characteristics are represented by speed flow curves. These provide a simplified representation of how traffic speeds alter on a link in reaction to changing levels of flow on the link. Within the simulation area speed flow curves have been applied to a number of links and, where used, are consistent with those used in the buffer network. Most commonly used in the simulation area is the coding of fixed speeds on links and the use of junction modelling is adopted to reflect the operational characteristics and delays of the network (description of the speed flow curves is provided in Section 4.3.4).

There are a number of behavioural responses, in addition to change of route, which are collectively known as variable demand responses. These are dealt with in HETM by the use of DIADEM, which stands for Dynamic Integrated Assignment and DEmand Modelling, and is the software developed by the DfT to enable practitioners to easily set up variable demand models that are consistent with the advice in WebTAG. The version of DIADEM used for this model is 3.1.13.

The overall model structure is illustrated in **Figure 2.**

As discussed earlier, SATURN models comprise two levels of detail: buffer and simulation. The extent to which simulation is required was determined by a review of journey time / delay data provided by the Dft. The various areas of the model is illustrated in level of definition in **Figure 3**.

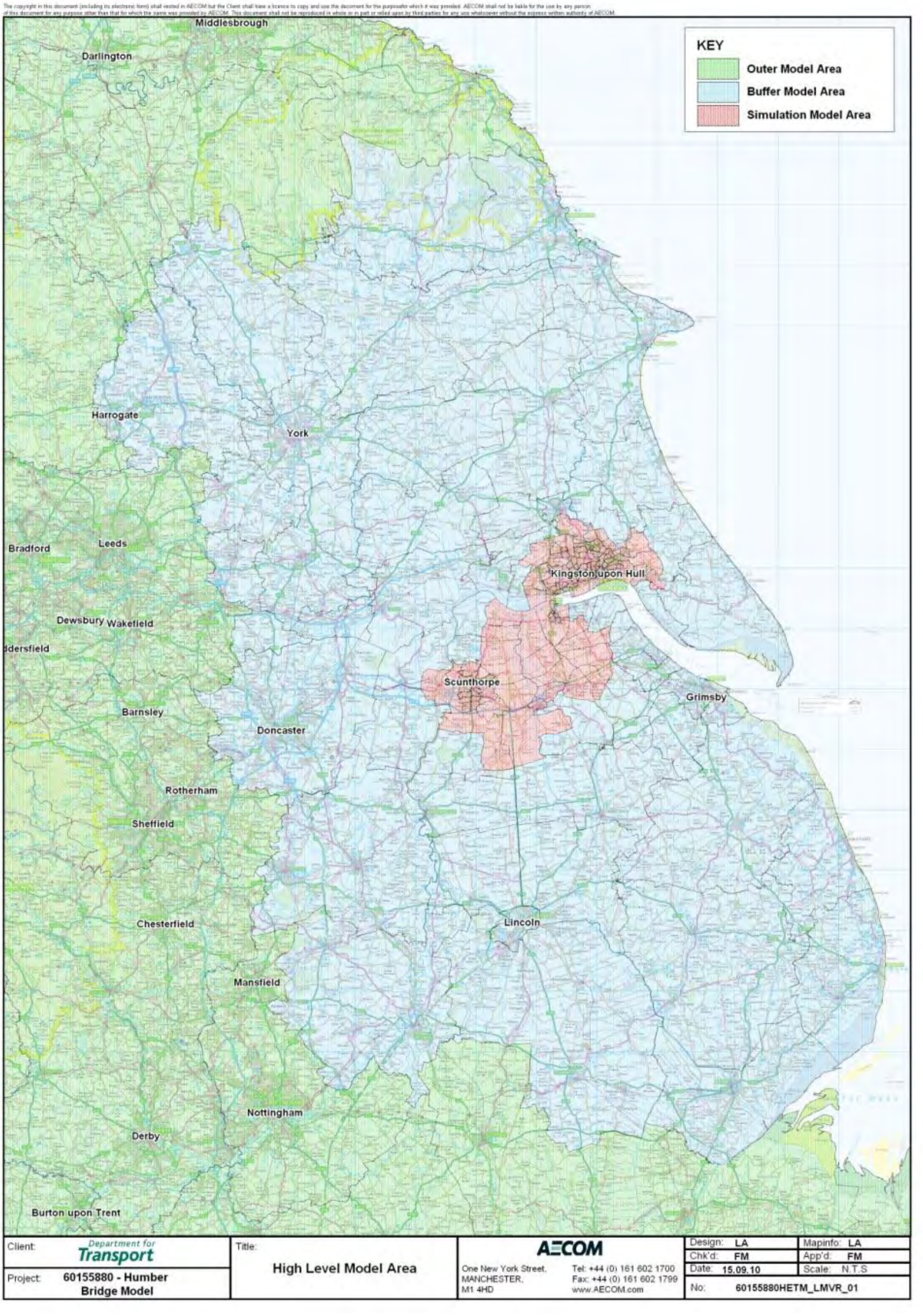
Figure 2 Model Structure



Note: This is a simplified representation designed to illustrate the interaction between the demand data, the assignment model and the variable demand response. In reality an iterative approach is adopted to ensure convergence.

Capabilities on project:
Transportation

Figure 3 Model Area



3 Summary of Data Collection

3 Summary of Data Collection

3.1 Overview

This section outlines the survey data that was available for model development. Survey data includes:

- Roadside interview (RSI) origin – destination data;
- Traffic counts; and
- Travel time data.

A great deal of data used for the study was already available from previous studies. Additional new data was also collected specifically for this study in June 2010. All of the data collected is described in detail in the Traffic Survey Report.

3.2 Origin Destination Data

3.2.1 New Data Collection

In June 2010 a number of new RSI surveys were undertaken specifically for the development of the HETM. This was to rectify an identified gap in RSI data to the south of the Humber Estuary in North Lincolnshire. Five RSIs were undertaken at the following locations to capture trips heading to/from the Humber Bridge and parallel to the Humber:

- A180 east of the A15;
- A18 east of M181 in Scunthorpe;
- A1077 north of A18 in Scunthorpe;
- A161 south of the M180; and
- A18 in the vicinity of Humberside Airport.

Each survey was undertaken in one direction for a single 12-hour day (07:00 to 19:00); each site was also covered by a two-way manual classified 12-hour count and a two-way, two-week automatic traffic count (ATC). The new RSI locations are shown in overview in **Figure 4.**

Figure 4 New HETM RSI Locations

3.2.2 Data from Other Studies

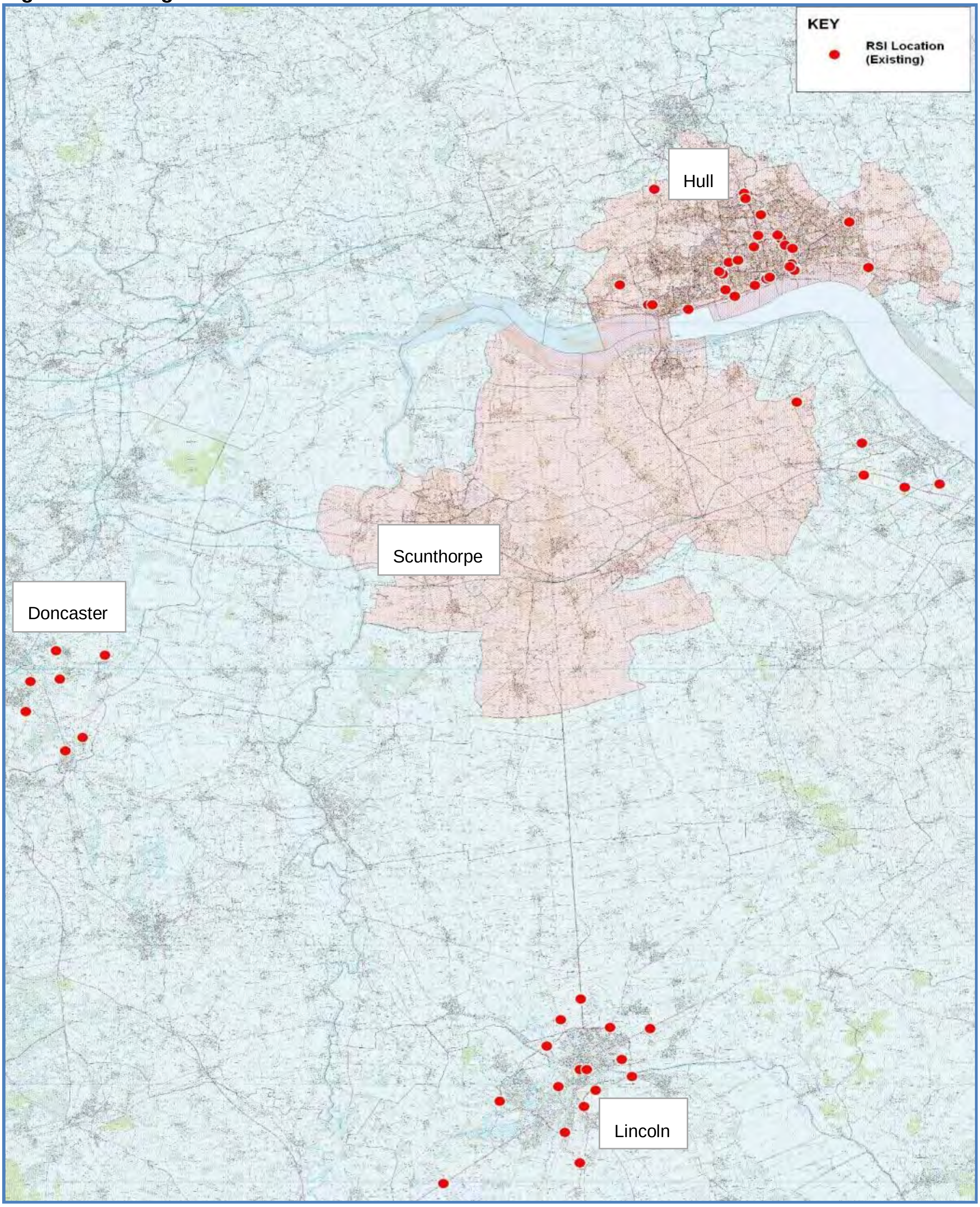
There was already a considerable amount of roadside interview (RSI) data available from models that had been developed in the area. These included:

- A63 Castle Street Improvements 2008;
- A160/A180 Improvements (Immingham Model) 2008;
- Lincoln Model 2008; and
- Doncaster Model 2009.

The datasets were reviewed with regard to the value they could add to the development of HETM bearing in mind the critical movements to be considered, likely route choice and the model zoning system.

The locations of the RSIs used in the development of the HETM are illustrated in overview in **Figure 5**.

Figure 5 Existing RSI Locations



3.3 Traffic Counts

In addition to the traffic counts associated with the roadside interview surveys, additional traffic count data for model calibration and validation was sought across the network.

The following local authorities were approached for traffic count data in the model area:

- North East Lincolnshire
- East Riding of Yorkshire;
- Hull City Council ;
- North Lincolnshire;
- North Yorkshire; and
- Lincolnshire.

Additionally, data has also been obtained from the Highways Agency's continual automatic traffic count (ATC) sites via their TRADS website.

The location of all count data received is shown in **Figure 6.**

Figure 7 illustrates the use each count site has been put to. The traffic count data is used for:

- Matrix building;
- Matrix infilling; and
- Validation.

It is important to ensure that the data used for model validation is independent of that used for developing the model. **Figure 7** shows how the data items input to the various model building processes have been separated and therefore kept independent.

3.4 Travel Time Data

Travel time data was required for the HETM for two distinct purposes:

- To help defining the extent of simulation modelling required (see Chapter 4 for details of what simulation modelling entails); and
- To enable checks to be made on how well the model was performing in terms of replicating observed travel times.

Travel time data is traditionally obtained by undertaking a series of journey time surveys across defined routes using survey staff in vehicles. In this instance, however, we were able to make use of the Department's existing contract with TrafficMaster[1] to provide journey time data in relation to performance monitoring of the network.

The layer files provided to AECOM include all road network links within the study area. The TrafficMaster journey time data is calculated using anonymised data from around 50,000 probe vehicles equipped with global positioning system devices. These devices record speed and location information which is collated digitally mapped and matched to the ITN[2]. Any link that has been traversed by a TrafficMaster vehicle within each 15 minute time period within the day will have a TrafficMaster record. Separate records are created for each vehicle class.

---

[1] This traffic model has been commissioned by DfT on the understanding that AECOM are to undertake traffic modelling using data and/or information prepared by a third party (TrafficMaster in this instance). The commission requires AECOM to undertake a brief desktop review of this data / information merely to establish if it appears suitable for modelling, and then to prepare a model that is based and reliant on this data/ information if it is. For the avoidance of doubt, AECOM have not been commissioned to check, validate or in any other way endorse as correct or accurate the data/information supplied to them. Necessarily, all AECOM modelling work has therefore been based on the assumption that the data and/or information that has been supplied to them is both correct, accurate and current, and AECOM disclaim any liability to whomsoever if this assumption is subsequently proven to be incorrect

[2] The Ordnance Survey Integrated Transport Network (ITN) represents all navigable roads across Great Britain, from motorways to alleyways.

3.5 Other Data Sets Used

3.5.1 National Trip End Model

The National Trip End Model (NTEM) provides a systematic means of comparing the national consequences of alternative national transport policies or widely-applied local transport policies, against a range of background scenarios which take into account the major factors affecting future patterns of travel.

NTEM provides forecasts of population, employment, households by car ownership, trip ends and simple traffic growth factors based on data from the National Transport Model (NTM).

NTEM is subject to a programme of continuous improvement and as a consequence the NTEM datasets (formerly known as TEMPRO) are regularly reviewed. The current guidance within WebTAG is to use NTEM version 5.4 but there is also a (currently) draft version known as 6.1 which incorporates the effects of the recession.

At the current time it is not possible for the Department to say when version 6.1 will become definitive. The relevance of these points is that NTEM is used to derive trip ends for elements of the model in the base case and also in forecasting.

For the purposes of defining trips ends, in the base case (2010), for the buffer area of the model, NTEM 6.1 has been adopted as it is likely to be a better reflection of the actual state of play currently in the region.

For forecasting purposes, in order to maintain consistency with current guidance, NTEM 5.4 has been adopted.

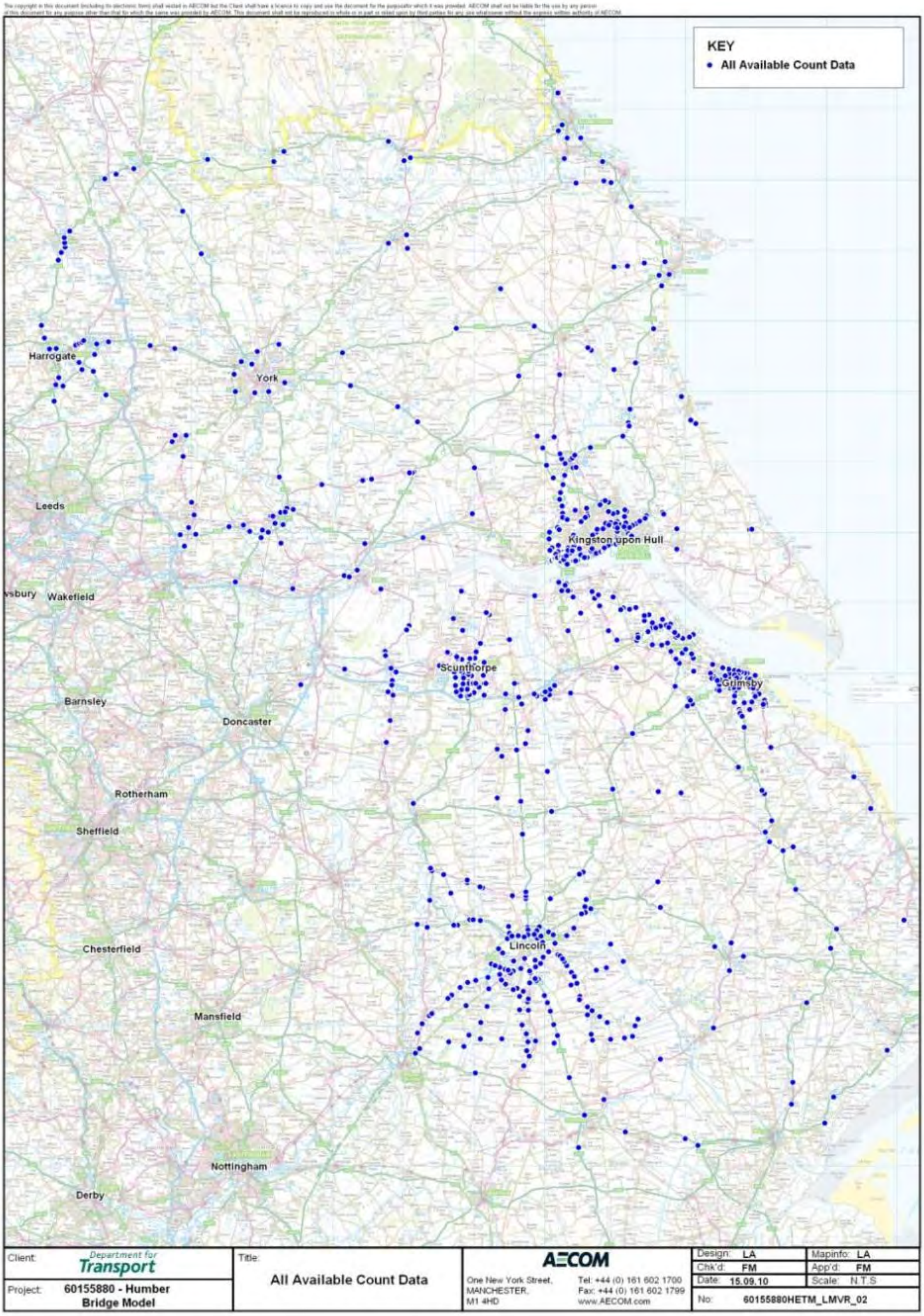
3.5.2 National Traffic Statistics

Within the external areas of the model (see Chapter 4 for more information on what this relates to), it is necessary to indentify appropriate fixed speeds to be applied to links in the network. For this purpose, the Department's statistics website has been interrogated and information extracted for speeds on the strategic road network for 2009; the latest data available.

3.5.3 Income Data

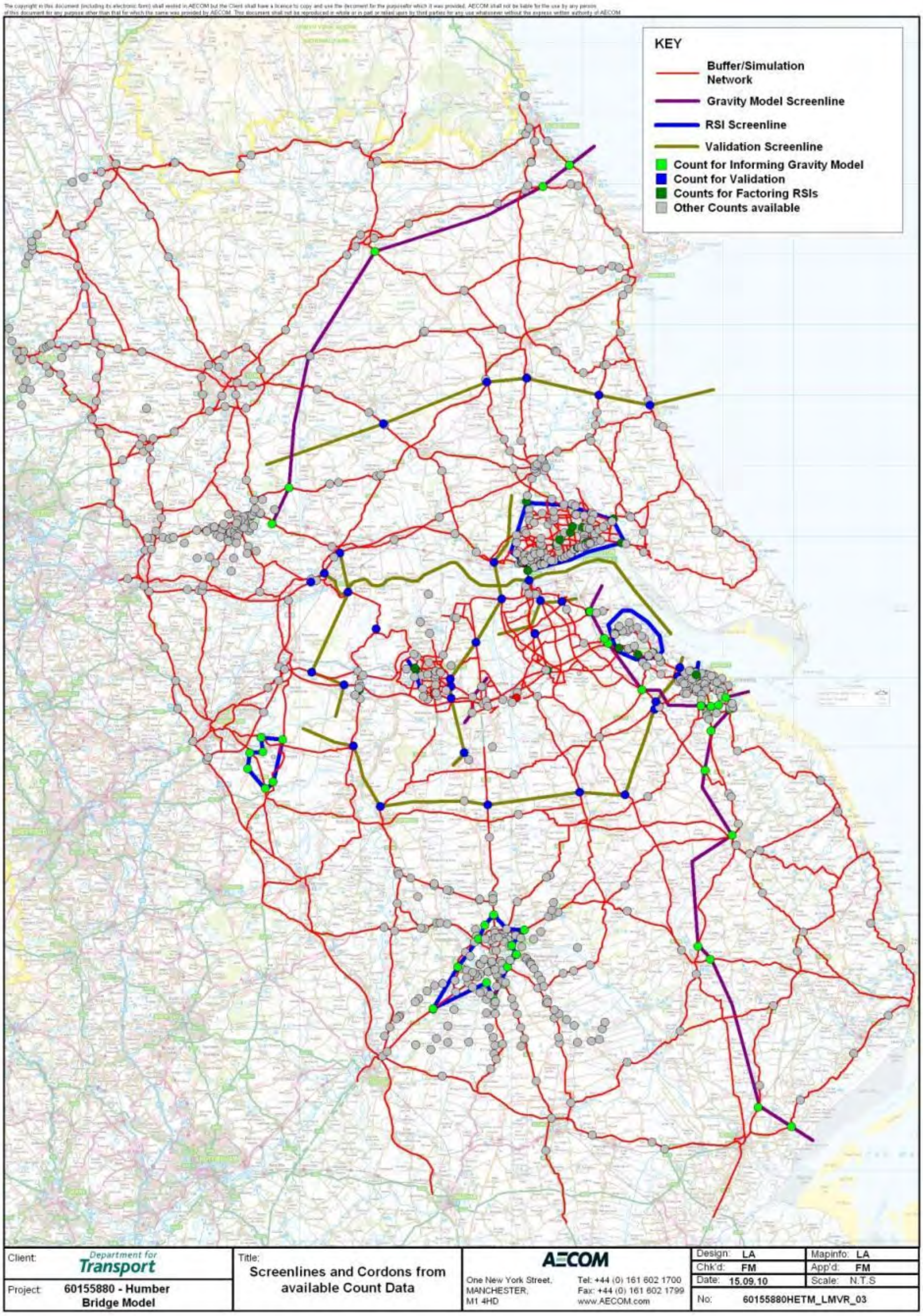
As this study involves the impact of tolls, the income distribution of trips is also relevant. AECOM were assisted by Yorkshire Forward in this regard who were able to supply the results of data analysis undertaken for them by Acxiom. Their analysis provided the number of households in each of five income bands (based upon gross household income). The data was provided at Census Super Output Area (CSOA) level.

Figure 6 All Available Count Data



Capabilities on project:
Transportation

Figure 7 Use of Count Data



4 Model Development - Network

4 Model Development - Network

4.1 Overview of Structure

The development of the model network has been described fully in the Network Development Report for this study. For completeness, this section reproduces some of the key sections of that report.

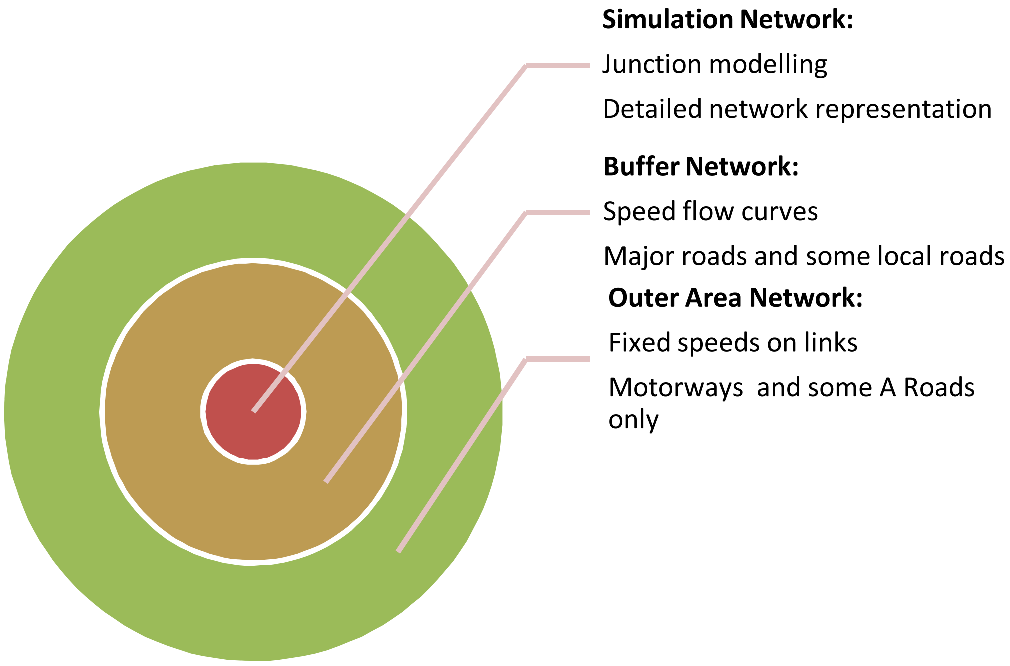
The SATURN assignment software has two levels of network representation, namely buffer and simulation. In the context of this model, there are effectively three levels of network, which mirror the zone structure discussed later in this report:

- Outer area skeletal network (serving the outer area zones);
- Buffer network (serving the buffer area zones); and
- Simulation network (serving the simulation area).

The definition of the boundary between the outer and buffer areas was determined based upon a consideration of the sphere of influence of the Bridge. The definition of the boundary between the buffer and simulation area is based upon an analysis of the extent to which delay/congestion is likely to impact upon route choice (in relation to the Bridge). This analysis makes use of TrafficMaster data supplied to AECOM for this study as part of the Department's wider contract with this journey time data supplier.

The overall structure and purpose of the network is illustrated conceptually in **Figure 8.**

Figure 8 Overall Network Structure Concept



The extents of the three levels of network are illustrated in separate figures within Appendix A.

4.2 Outer Area Network

4.2.1 Function

The function of the outer area network is to ensure that traffic enters in to the HETM area along the correct strategic routes. This part of the network will not reflect actual traffic volumes on these links as not all trips within the area are being modelled in this study.

As an example, there needs to be a representation of the M62 from Liverpool via Manchester towards the HETM area. However, the only trips along the route will be those which have a destination within the HETM area relevant to the use of the Bridge. For this reason, trips between say, Liverpool and

Manchester, will not be represented.

4.2.2 Network Coding Requirements

As not all of the traffic using these links will be present in the model, it is not appropriate to use speed flow curves. Instead, fixed speeds are applied which are generally representative of conditions in the relevant time period.

The requirement of the network is therefore relatively simple; the links need to be representative of actual link distances travelled and the speeds should be appropriate to the time period under consideration. The link characteristics, such as carriageway standard, number of lanes etc. are not relevant as we will not be modelling congestion in this area.

4.2.3 Network Build

The network links have been identified from the Ordnance Survey Meridian data set which is a data layer within GIS database which has been used throughout the HETM model development process. The links required for the external network are mainly motorway links although there are some ‘A’ roads needed to provide sufficient connectivity for the outer zones.

Initially all motorway and ‘A’ roads were included as links, with surplus links being removed as part of an iterative process. This process takes account of the zoning system which is overlayed on the network throughout to ensure consistency of route choice and sufficient connectivity to the rest of the model.

The Meridian data set accurately reflects link length throughout the country and no further corrections or modifications are required.

4.2.4 Determination of Fixed Speeds

The external network covers a wide area of the UK road network, albeit at a very coarse level. In order to determine the appropriate fixed speeds to apply, national statistics from the DfT have been reviewed. The relevant information is presented in **Table 3** and **Table 4.**

The speeds to be used in the HETM network are based upon the national time of day figures from **Table 4** but adjusted to reflect the regional differences evident from **Table 3**

Table 3. The resulting numbers are presented in **Table 5.**

Table 3 Average Road Speeds for 2009 by Government Office Region

Government Office Region	Trunk 'A' roads (carriageways)			Motorways	SRN(2)
	Single	Dual	All	All	All
East Midlands	47.2	53.7	51.1	57.8	54.0
Eastern	45.0	56.4	53.3	53.7	53.5
North West	42.6	59.3	48.7	59.5	57.9
North East	44.4	50.6	49.3	59.9	51.7
South East[1]	48.7	52.1	51.7	58.3	56.3
South West	47.2	56.9	51.1	66.2	59.3
West Midlands	41.1	52.0	48.3	57.7	55.2
Yorkshire & Humber	49.2	54.5	53.0	59.6	57.6
England	45.8	53.9	51.4	58.8	55.9

Source: Dft Statistics website, Table 4.6 Average traffic speeds on the SRN by GO, England: 2009

Notes: (1) Includes the small length of SRN in the London region
(2) SRN = Strategic Road Network
(3) Speeds are in miles per hour.

Table 4 Average Road Speeds for 2009 by Time of Day and Day Type

Time Period	Trunk 'A' Roads (Carriageways)(2)		Motorways(2)		SRN
	Single	Dual	All	All	All
Weekdays:					
AM peak (7am-10am)	44.5	51.4	49.3	55.9	53.3
Off-peak (10am-4pm)	45.2	54.1	51.1	59.5	56.2
PM peak (4pm-7pm)	44.1	51.4	49.1	54.6	52.5
All day (6am - 8pm)	45.1	53.0	50.5	57.6	54.8
Weekends:					
All day (6am - 8pm)	48.5	57.3	54.4	63.2	59.8
All week(1):					
All day (Mon-Sun, 6am - 8pm)	45.8	53.9	51.3	58.8	55.9
Public holidays:					
All day (6am - 8pm)	46.9	56.7	53.4	63.1	59.3

Source: Dft Statistics website, Table 4.5 Average traffic speeds on the SRN by time period and day type, England: 2009

Notes: (1) Not including public holidays.
(2) Speed limits vary by road category.
(3) SRN = Strategic Road Network.
(4) Speeds are in miles per hour.

Table 5 HETM Outer Area Network Fixed Speeds

Government Office Region	Motorways			Trunk - Dual			Trunk - Single		
	AM	Inter Peak	PM Peak	AM	Inter Peak	PM Peak	AM	Inter Peak	PM Peak
East Midlands	55.0	58.5	53.7	50.5	53.2	50.5	43.7	44.4	43.4
Eastern	51.1	54.3	49.9	46.9	49.4	46.9	40.6	41.2	40.3
North West	56.6	60.2	55.3	52.0	54.8	52.0	45.0	45.7	44.7
North East	56.9	60.6	55.6	52.3	55.1	52.3	45.3	46.0	44.9
South East	55.5	59.0	54.2	51.0	53.7	50.9	44.1	44.8	43.8
South West	63.0	67.0	61.5	57.9	60.9	57.8	50.1	50.9	49.7
West Midlands	54.9	58.3	53.6	50.4	53.1	50.4	43.6	44.3	43.3
Yorkshire & Humber	56.7	60.3	55.4	52.1	54.9	52.1	45.1	45.8	44.7

Notes: (1) Speeds are in miles per hour.

4.3 Buffer Network

4.3.1 Function

The buffer network needs to provide sufficient connectivity to enable travel patterns to be adequately represented within the model. It needs to reflect the time and distance of competing routes and be responsive to traffic conditions i.e. to reflect how traffic speeds alter in relation to traffic volumes.

It is assumed that within the buffer area, route choice is not significantly affected by individual junction conditions, as may be the case in an urban area. Whilst it is acknowledged that there may be locations where junction delay is significant, in local terms, this does not affect route choice between settlements.

4.3.2 Network Coding Requirements

The buffer network needs to reflect:

- Link length;
- Link type;
- Capacity; and
- Speed flow relationship.

As with the external network, the relevant links have been identified from the Ordnance Survey Meridian data set which is a data layer within GIS database which has been used throughout the HETM model development process. All motorway, ‘A’ roads and ‘B’ roads were initially included as links, with surplus links being removed as part of an iterative process. This process takes account of the zoning system which is overlaid on the network throughout to ensure consistency of route choice and sufficient connectivity to the rest of the model.

The Meridian data set accurately reflects link length throughout the country and no further corrections or modifications to this are required. However the Meridian data set contains no information on the link type i.e. what the standard of the carriageway is (single or dual), the number of lanes or the prevailing environment (urban, rural etc.).

For this study AECOM have also received a copy of the relevant sections of the Ordnance Survey ITN layer. This includes, inter alia, information on:

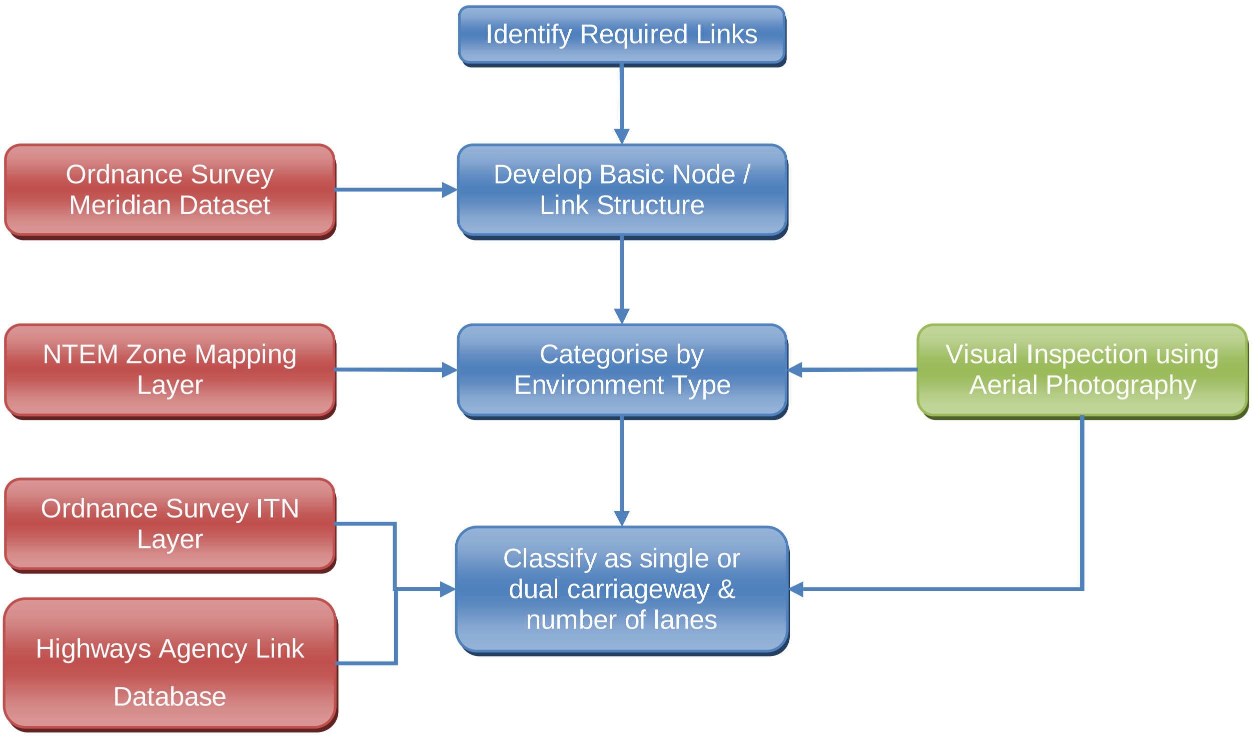
- Designation (i.e. A road, B road);
- Nature (single carriageway, dual carriageway, junction); and
- Road name and number (e.g. Clive Sullivan Way, A63).

In order to determine the appropriate environment category, an initial assessment has been made by overlaying the NTEM zone structure, within the overall GIS database, which includes a differential between rural and urban categories. The final refinement of the network, which includes the identification of additional environment definition (suburban, small town etc.) and the appropriate number of lanes, has largely been determined by visual inspection of freely available internet based aerial photography. However, we have also been able to utilise a previous study for the Highways Agency which includes a description of the number of lanes for any links that form part of the trunk road network.

4.3.3 Network Build

The network build has been undertaken within the GIS database to ensure accuracy, consistency and traceability of data. The build process is illustrated in **Figure 9.**

Figure 9 Network Build Process



4.3.4 Speed Flow Curves

The final element of the buffer network definition is the determination of the appropriate speed flow relationship for the link. This is a simplified mathematical representation of how speeds on the link will alter in response to changes in traffic flow.

The Department of Transport's COBA user manual (currently part of the Design Manual for Roads and Bridges, DMRB, Volume 13) provides a set of relationships for different road types as follows:

- Rural single carriageway;
- Rural all-purpose dual carriageway;
- Motorway;
- Urban non-central;
- Urban central;
- Small town; and
- Suburban.

Further distinctions are provided according to the number of lanes and the vehicle type ('light' or 'heavy' vehicle).

The relationships take the form of single or dual slope linear curves up to capacity. Within the COBA software, which is used for economic appraisal, the speed beyond capacity has a minimum value dependant on the type of link.

The SATURN software uses continuous power curves and there is therefore a need to identify a 'best fit' version of the power curve to the equivalent COBA linear formulation. SATURN curves take the following form up to capacity:

$$t = t_0 + aV^n$$

Where t = link travel time
t_o = free flow link time
V = flow
'a' and 'n' are user defined parameters

Beyond capacity, we are following current best practice and adopting the Department of Transport's 'Advice Note 1A' curves which use the following formulation:

$$V = \frac{V_c}{1 + \frac{V_c}{8L}(E - 1)}$$

Where V = speed at demand flow Q which is greater than Q_c
V_c = speed at limiting capacity
L = link length
E = Q / Q_c where Q is the demand flow and Q_c is demand at capacity

AECOM have had discussions with the Highways Agency's TAME team who have kindly provided SATURN equivalent COBA speed curves based upon typical assumptions for the parameters determining the relationship for each link type. The assumptions for each link type are set out in Appendix B together with illustrative charts of the relationships. The relationships illustrated in Appendix B represent the speeds for light vehicles based upon assumptions about the likely goods vehicle content for a given stretch of road. As this SATURN model operates in passenger car units (PCUs), rather than vehicles, there is an assumption throughout that the PCU factor for all HGVs is 2.5.

In order to differentiate between goods vehicles relative to cars in terms of their free flow speeds, we have used the "CLICKS" parameter in SATURN. This parameter represents a method with which to model any vehicle class at a lower speed than cars (whether due to speed restrictions or to vehicle characteristics – or both).

CLICKS, only has an impact on road links (i.e., buffer and/or simulation roads, not simulation turns and not centroid connectors) whose free-flow speed is in excess of the input value(s) of CLICKS. In modelling terms it is represented by a fixed time penalty per user class equal to the difference in time between a vehicle travelling at the input free-flow speed and at CLICKS; if the free-flow speed is less than or equal to CLICKS then the time penalty is zero.

The effect in practical terms is to adjust the speed flow curve for the affected user class such that that user's correct free flow speed is modelled and the remaining points on the curve are consistent with that adjustment.

4.4 Simulation Network

4.4.1 Function

The simulation network area represents the part of the network with the most detailed coding in the model. Within the simulation area, all junctions are modelled explicitly and it is assumed that junction performance, and associated delay at busy periods, is critical in determining users' routes through the network.

The identification of the extent of the simulation area has been informed by a consideration of TrafficMaster journey time data which has been made available to AECOM by the DfT for use in this study. Within the simulation area, all network junctions have been modelled.

4.4.2 Network Coding Requirements

In addition to the standard network requirements described earlier for the buffer network, the simulation area also requires a representation of each junction. This needs to include:

- Junction type (e.g. signal controlled, priority etc.);
- Signal timings where appropriate;
- Lane allocations;
- Priorities; and
- Movement capacities.

The vast majority of the simulation area in this model has been already prepared for use in the A63 Castle Street (SATURN) model which was made available to AECOM by the Highways Agency for use in this project.

Traffic signals within the Hull City area operate using a SCOOT system which allows continually varying signal timings to be generated in response to variations in demand. SATURN does not have the ability to replicate SCOOT operation but it is not alone in this respect. Only micro simulation techniques can currently offer this level of sophistication. Instead, SATURN uses fixed times but can incorporate optimisation techniques to generate the best set of times for a given level of demand. This approach has been used within HETM for those junctions where preliminary assignments showed junction delay to be a cause for concern.

The existing A63 model was focused on a particular scheme in the Hull urban area and models the whole of that urban area in considerable detail, far more than is required for the purposes of this study. AECOM have therefore reviewed the existing network representation, in the context of the HETM zoning system, and removed unnecessary link detail. This has typically involved the following:

- Remove non strategic residential streets and local access;
- Removal of some local roads which are currently used to feed the detailed A63 Castle Street zoning system; and
- Areas to the north and East of the A63 model e.g. Bransholme have seen a number of minor roads removed as changes to the tolling on the Humber Bridge will not have a significant impact on local routing in this area (e.g. Noodle Hill Way).

A higher level of detail on areas closer to the Bridge e.g. Hessle and Willerby has been retained as these could be affected more directly by any changes to the Bridge.

The coding of the retained network has been checked to ensure that no changes to the network have occurred since the base year A63 model was developed.

The minor urban junctions and those across the wider network were simulated with saturation flows estimated (based on TRL Research Reports) using the following guidance for priority junctions:

- Unopposed straight on 1,700 to 1,800 PCUs/hour;
- Unopposed left turn 1,500 to 1,700 PCUs/hour;
- Opposed major right turn to minor road 550 to 650 PCUs/hour;
- Opposed left turn minor to major give way 550 to 650 PCUs/hour; and
- Opposed right turn minor to major give way 450 to 550 PCUs/hour.

The model network coding has been specially designed to accommodate the tolling on the Humber Bridge within the base model. The following key network coding has been undertaken:

- The bridge tolls have been introduced in the model as a toll charge for each user class in monetary values which are equal to the current charges on the bridge. It has been assumed that the toll will be the same throughout the day; and
- To simulate the presence of the toll booths and the consequent impact on journey times, the links on the approach to the toll booths initially had minor speed reductions introduced to represent the deceleration and acceleration into and out of the toll plaza. However the outturn journey times were then checked against independent travel time data and it was determined that no such adjustments were required.

4.4.3 Simulation Network Link Speeds

The simulation link speeds within the model were based on those defined within the existing A63 Model which formed a large proportion of the simulation network, these are shown in

Table 6.

Table 6 HETM Outer Area Network Fixed Speeds

Link Type	AM Peak free flow speed (kph)
Minor road – Non strategic (generally residential in nature) and 20mph roads	32kph
Main road network and local strategic network of 30mph speed limit	45 - 48kph
Main road network and local strategic network of higher speed	60 – 64kph
Major strategic network at higher speeds (including HA network)	65 – 125kph*

These are typical values which have been used in the A63 model, however it was necessary to adjust a small number of the free flow speeds based on local conditions; these were assessed on a case by case basis whilst reviewing the model validation.

5 Model Development - Matrices

5 Model Development - Matrices

5.1 Overview

As described previously, the overall structure of the HETM has been designed to investigate the impact of toll changes on the Humber Bridge. Three distinct time periods are modelled within the SATURN assignment process on an origin-destination (OD) basis:

- Average AM peak hour based on the period 07:00 to 09:00;
- Average Inter Peak hour based on the period 10:00 to 15:00; and
- Average PM Peak hour based on the period 16:00 to 18:00.

However, in order to model variable demand responses accurately, it is necessary to maintain a linkage between the trip patterns in each model period. As an example it would be incorrect to have a model which suggested an increase in commuting trips to Hull in the morning peak without a corresponding increase in commuting trips out of Hull in the evening peak.

Although this is easy to understand in principle, it is relatively complex to implement in transport models. The accepted process is to incorporate demand matrices which are defined in 12-hour terms (07:00 to 19:00) in what is referred to as production-attraction (P/A) format.

The distinction between P/A and O/D matrices can be illustrated using the earlier example of commuting trips. In O/D terms, a commuter from, say Barton, with a workplace in Hull completes one trip from Barton to Hull in the morning and one trip from Hull to Barton in the evening. In P/A terms, Barton 'generates' two commuter trips (there and back) and Hull 'attracts' two commuter trips.

Trip matrices can be built in either P/A or O/D format. The former is required for variable demand and the latter for assignment.

Within the HETM model, the available RSI records have been used to develop both 12-hour P/A and time period O/D matrices directly. Both have required infilling (for unobserved movements) from the bespoke gravity model that has been created. This approach maintains consistency between the two matrix sets.

5.2 Zone Structure

5.2.1 Overview

The zone structure determines the way in which trips, or transport demand, are assigned to the network. In general, the zone structure is more detailed and the zone sizes smaller towards the core area of interest of a model. Zone sizes then increase as the distance from the focus, or key link(s) within the model, increases.

This in turn has an impact upon the way in which the network is developed. The core area of interest of the model needs to be sufficiently detailed to provide connectivity for all of the zones and be appropriate to any requirement for junction or simulation coding. In the wider or buffer area, the network definition will inevitably be less detailed with only significant roads needing to be represented.

5.2.2 Approach to Definition of the Zone System

The initial intention for the HETM was to adopt the A63 Castle Street Model as the basis for the zoning system albeit a simplified version as that model included considerably more detail within the Hull urban area than was required for this study.

After a review of the existing zone system however, it was discovered that the zone boundaries do not follow any other accepted geographical boundary. As modelling work inevitably makes use of demographic data based upon census information, local authority datasets, NTEM etc., AECOM's standard modelling approach is to ensure that any model's zone system is built up from one of these 'standard' representations. Census output area boundaries are coincident with local authority districts and NTEM zones and are therefore an ideal building block for model zone systems. It would be difficult to relate any of the standard demographic datasets to the A63 zones given these discrepancies.

A bespoke zoning system has therefore been developed for the HETM, using census output areas as the smallest element. It has been developed in such a way that the zones can be aggregated to local authority, district, and county boundaries. As NTEM zones also share the common building block of Census Output Areas (COAs), this approach allows for the creation of correspondence tables between any of these systems.

The network zoning varies in size between the simulation, buffer and external network. Census boundaries have been used for zones within the centre of the simulation network to provide the most detailed local zones. As the zones increase in size with greater distance from the centre of the simulation network, district, county, and government office region boundaries have been used to divide the zones. Also, where possible, the development of each of these zones has focused on maintaining consistency with NTEM zones to ensure accuracy when forecasting future year growth.

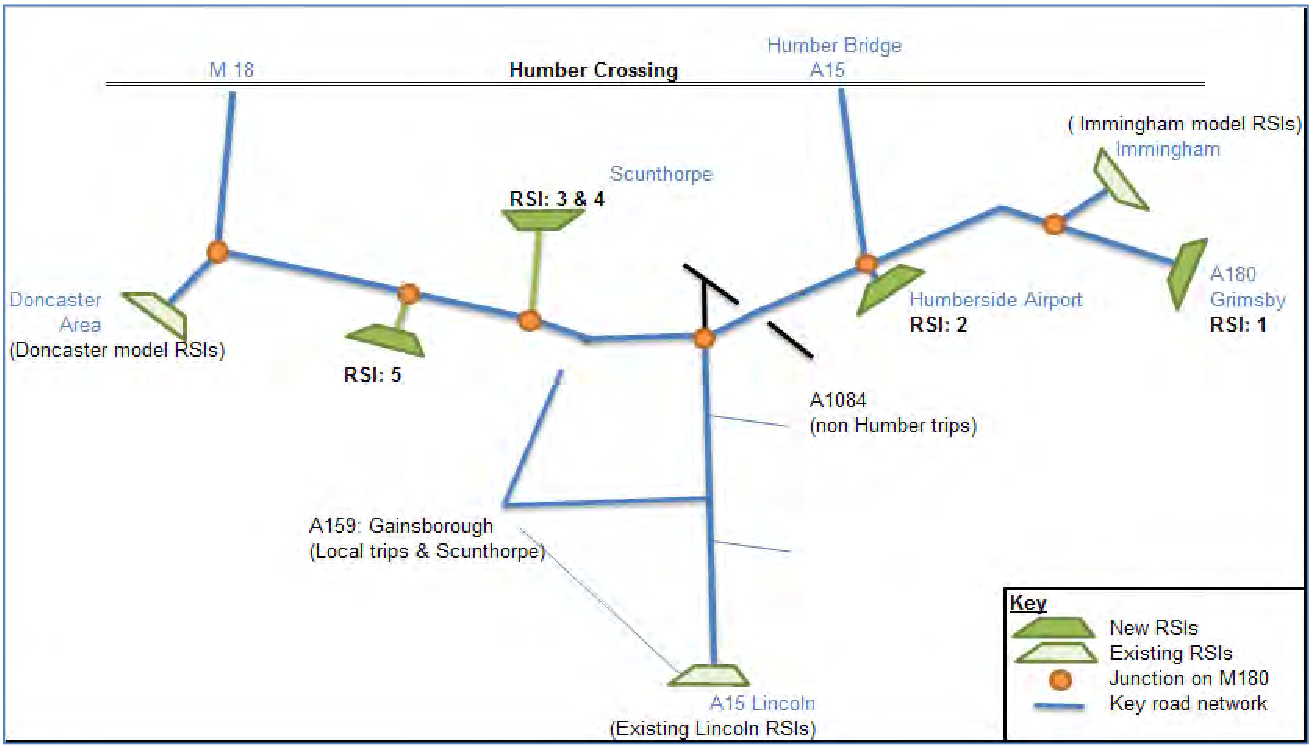
5.2.3 Zone / Sector System in Context of Demand Matrix Development

It is important that there is a high level of observed data for particular movements throughout the model area. These should be focused on capturing trips of Cross Humber, parallel to Humber and trips to/from key urban centres through the model area. **Figure 5**, within section 3.2 shows the locations of all RSI data used in the development of the HETM.

Since the primary purpose of the model is to assess the demands for traffic crossing the Humber estuary, the key intention in developing the survey programme was to ensure that cross Humber demands, either over the Humber Bridge, or on other routes, were captured.

Figure 10 below provides a schematic of the M180/A180 corridor showing key junctions and the locations of nearby RSIs to ensure all key movements are captured.

Figure 10 Schematic of RSI Locations



This diagram shows that the majority of the strategic network is covered by RSI and should identify the majority of Cross Humber and M180/A180 traffic movements.

5.2.4 Sectoring of Model Zones

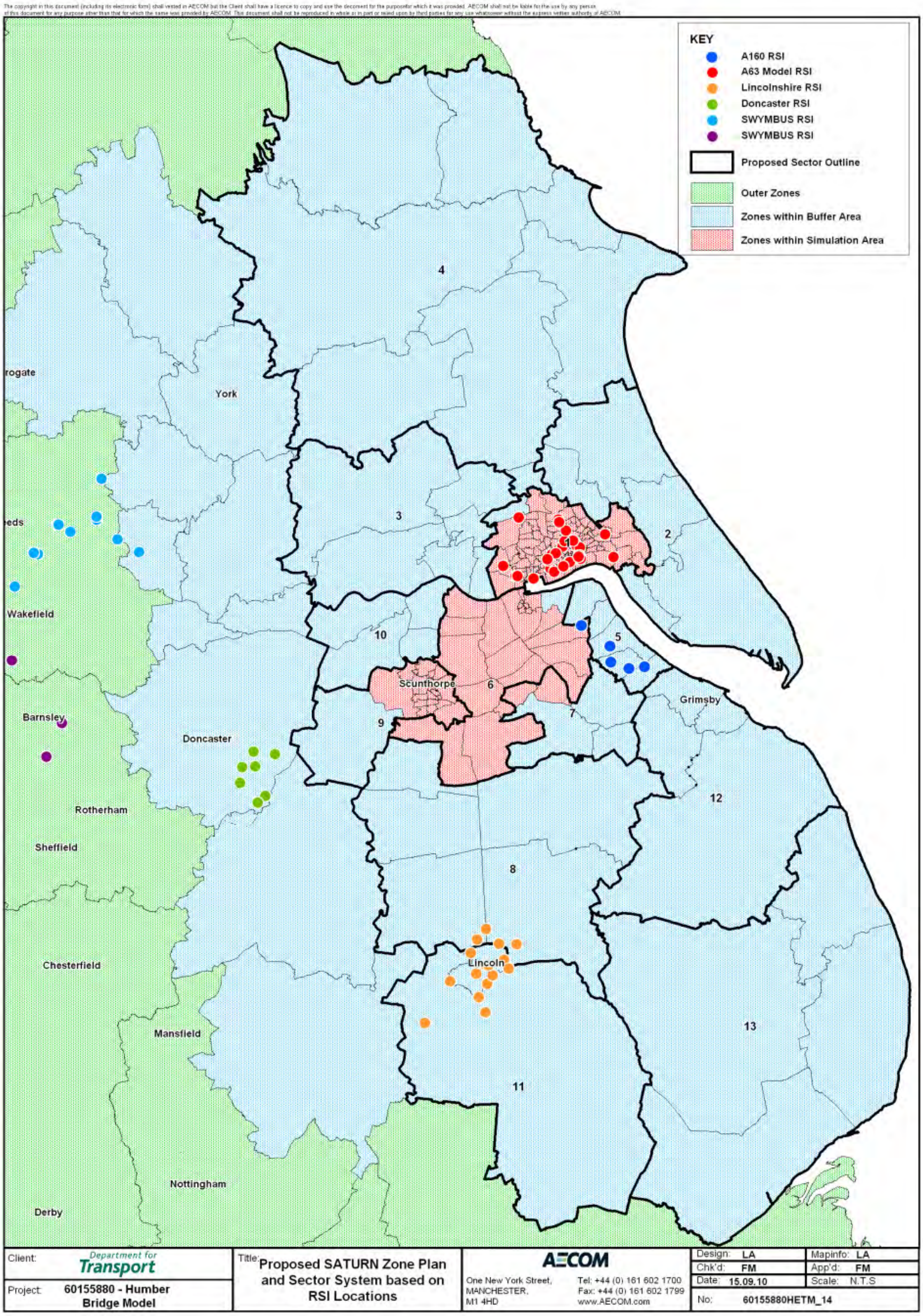
In order to identify if there is a suitable level of zone to zone movements covered by the RSI data, it was necessary to sector the model zones into wider areas that represent key parts of the model and fit with the RSI sites. A total of 13 sectors were identified, with 4 to the north of the Humber focusing on Hull and the surrounding area.

Table 7 summarises the area of coverage of each sector and the rationale behind its definition. The sectors are also illustrated in **Figure 11.**

Table 7 Sector Definition

Sector	Definition of Area	Rationale for Extent
1	Hull	Location of A63 Model RSIs and extent of Hull urban area
2	Hornsea, Withernsea & Hedon	Location of A63 Model RSIs plus land use and network connectivity
3	South Cave & Market Weighton	North of Estuary and location of A63 Model RSIs
4	Bridlington, Scarborough & Norton-on-Derwent	Northern extent of buffer area, relationship to Hull
5	Immingham	Immingham Model & location of RSIs
6	Barton-upon-Humber & South of Bridge	South of Estuary, Immingham Model RSIs and new HETM RSIs
7	Brigg and Caistor	Location of new HETM RSIs and Immingham data
8	North of Lincoln	Location of Lincoln RSIs
9	Scunthorpe	Location of new HETM RSIs
10	Crowle/Selby	Location of new HETM RSIs
11	South of Lincoln	Location of Lincoln RSIs, Southern extent of Buffer Network
12	Grimsby, Cleethorpes & Louth	Location of new HETM RSIs and existing Immingham data
13	Skegness & Boston	Location of Lincoln RSIs, South east extent of Buffer network

Figure 11 Zone Sector System



The final zone system is illustrated in a series of plans in Appendix C.

5.3 Observed Matrix Development

5.3.1 Data Sources

As outlined in Chapter 3, a number of origin-destination datasets were available from transport models that have been developed over recent years across the study area. These comprise the following:

- A63 Castle Street Improvements 2008;
- A160/A180 Improvements (Immingham Model) 2008;
- Lincoln Model 2006; and
- Doncaster Model 2009.

The following three tables present summary comparisons of the type of data available from each of these sources and from the new surveys undertaken specifically for the development of HETM.

Table 8 Comparison of RSI Data

RSI Question Asked	Existing Data Sources				New HETM
	A63 Model	Immingham Model	Lincoln Model	Doncaster Model	
Time/Date & location of survey	✓	✓	✓	✓	✓
Vehicle Type	✓	✓	✓	✓	✓
Vehicle Occupancy	✓	✓	✓	✓	✓
Origin (Full Address/Postcode)	✓	✓	✓	✓	✓
Origin Purpose	✓	✓	✓	✓	✓
Destination (where park)	✓	✗	✗	✓	✗
Did you have to pay to park	✓	✗	✗	✓	✗
Cost of parking	✓	✗	✗	✓	✗
Walk time (from Car park)	✗	✗	✗	✓	✗
Destination (Final after parking)	✓	✓	✓	✓	✓
Destination Journey purpose	✓	✓	✓	✓	✓
Contact Details	✓	✗	✓	✗	✗
Gender	✗	✗	✗	✓	✗
Age Group	✗	✗	✗	✓	✗
Number of vehicles	✗	✗	✗	✓	✗
Income Data	✗	✗	✓	✗	✓
Will you be using the Humber Bridge	✗	✗	✗	✗	✓(1)
Direction of survey (one /two way)	One Way	Two Way	One Way	One Way	One Way
Length of Survey	12hr	12hr	12hr	12hr	12hr

Notes: (1) Except postcard site (A180 near Grimsby).

Table 9 Comparison of Vehicle Type Category

Categories	Existing Model RSI Data				New HETM
	A63 Model	Immingham Model	Lincoln Model	Doncaster Model	
Motorcycle	✓	✓	✓	✗	✓
Car	✗	✗	✓	✓	✗
Taxi	✗	✗	✓	✓	✗
Car & Taxi	✓	✓	✗		✓
Light Goods	✓	✓	✓	✓	✓
HGV1	✓	✗	✗	✓	✗
HGV2	✓	✗	✗	✓	✗
Van > 3.5 tonnes	✗	✓	✗	✗	✓
2 Axle Rigid	✗	✓	✗	✗	✗
3 Axles Rigid	✗	✓	✗	✗	✗
4+ Axles Rigid	✗	✓	✗	✗	✗
3 Axles Artic	✗	✓	✗	✗	✗
4+ Axles Artic	✗	✓	✗	✗	✗
Van >3.5t but <7.5t	✗	✗	✗	✗	✓
HGV 2 axle	✗	✗	✓	✗	✓
HGV 3 axle	✗	✗	✗	✗	✓
HGV 4+ axles	✗	✗	✓	✗	✓
Bus	✗	✗	✓	✓	✗

Table 10 Comparison of Journey Purpose

Categories	Existing Model RSI Data				New HETM
	A63 Model	Immingham Model	Lincoln Model	Doncaster Model	
Permanent Home	✓	✓	✓	✓	✓
Holiday Home	✓	✓	✓	✓	✓
Place of Work	✓	✓	✓	✓	✓
Employers Business	✓	✓	✓	✓	✓
Personal Business	✓	✓	✓	✓	✓
Shopping	✓	✓	✓	✓	✓
Education	✓	✓	✓	✓	✓
Recreation	✓	✓	✗	✓	✓
Other	✗	✗	✗	✓	✓
Visit Friends	✗	✗	✓	✓	✓
Meet/Accompany	✗	✗	✗	✓	✗
Hospital/Doctor	✗	✗	✗	✓	✗
Airport Pickup / drop off	✗	✗	✗	✓	✗

In order to develop matrices from the RSIs, it was necessary to disaggregate the data into a number of categories which were required for inclusion into the model; the remainder of this section identifies the modelled time periods and trip purposes.

5.3.2 Modelled Periods

The trip matrices have been developed in Production-Attraction (P/A) format at the 12-hour level (07:00 to 19:00) but are assigned as Origin-Destination (OD) matrices covering three time periods as follows:

- AM average peak hour (07:00 to 09:00);
- Average inter peak hour (10:00 to 15:00); and
- PM average peak hour (16:00 to 18:00).

The definition of these time periods was determined by an analysis of long term monitoring sites on the Bridge and on the surrounding strategic network in the immediate vicinity of the estuary.

As the primary data collection took place in June, the base period for the model is an average weekday, June 2010.

The model area benefits from continuous monitoring count sites on the Bridge and at a number of Highways Agency locations. We have investigated the variability of count data by day / month at these longer term monitoring sites and used that to inform the factoring process which is required when combining the various data sets involved and also when considering how to factor from model output to, for example, annual averages.

5.3.3 Trip Purposes

The HETM adopts the following five standard journey type definitions within the demand segmentation:

- Commuting;
- Home based employers business;
- Home based other;
- Non home based employers business; and
- Non home based other.

Further disaggregation by income segmentation (into low, medium and high income bands in accordance with WebTAG) is provided for the home based trips not associated with employers business. The level of trip matrix definition is summarised in **Table 11**.

Table 11 Trip Matrix Definition

Vehicle Type	Journey Purpose	Income Segmentation
Cars & Light Vans	Commuting	Low Income
		Medium Income
		High Income
Cars & Light Vans	Home Based Employers Business	All(1)
Cars & Light Vans	Home Based Other	Low Income
		Medium Income
		High Income
Cars & Light Vans	Non Home Based Employers Business	All(1)
Cars & Light Vans	Non Home Based Other	All
Goods Vehicles 3.5t to 7.5t	All	All
Goods Vehicles > 7.5t (2 axles)	All	All
Goods Vehicles > 7.5t (3axles)	All	All
Goods Vehicles > 7.5t (4+ axles)	All	All

Notes:
(1) Employers business trips are assumed to be not responsive to income.

5.3.4 Matrix Building Process

A number of basic processes were involved prior to combining the various sources of data and these are described in outline here.

The survey data sets were provided in various different formats. Code numbers for vehicle types, journey purposes etc were different in each set, and therefore the trip information was made consistent over all the data sets. Also, the data has generally been supplied with survey sites numbered from ‘Site 1’. To avoid confusion, each data set was assigned a prefix such as ‘HU’ for Hull, ‘IM’ for Immingham or ‘LN’ for Lincoln.

A process of data cleaning was undertaken to ensure that all data has been inputted correctly and ensured the capture of correct postcodes. This was done by:

- Using MapInfo to create a ‘postcode to model zone’ lookup table which was exported to Microsoft Access;
- This was then used to assign the trip origin and destination postcodes to model zones;

- Where only a partial postcode was provided, the trip was randomly allocated to one of the zones that fits that postcode; and
- Where no postcode was provided the survey record was deleted.

Prior to calculating expansion factors and creating trip matrices from the RSI surveys, the data was scrutinised to determine whether the trips recorded were actually logical. The trips from all RSIs were plotted in Mapinfo to ensure that the post codes were correct and that the survey data was providing sensible OD movements. Trip patterns for each survey site were analysed to show whether any origin or destinations (or both) appeared to be illogical. For example, for a site where the survey was carried out on northbound traffic, a trip in a southbound direction may have been recorded incorrectly. Illogical trip records were either corrected or deleted.

5.3.5 Sample Rates

The absolute sampling rate required to achieve an acceptable degree of accuracy when developing a traffic model depends on a number of factors which are dependent on the characteristics of the traffic stream. However, in general practice a minimum of 10% is required to produce a reliable model.

It is common for heavy goods vehicles to be under-represented in surveys, but it is good practice to obtain a good sample of these vehicles. When surveys are carried out by the distribution of pre-paid postcards rather than interviewing, the surveyors have no control over response rate. In such cases very low returns from goods vehicles are common and inevitable.

The development of this model has utilised data previously collected from other studies as well as bespoke data for the HETM. Clearly this means the project team have not had control over the collection of a substantial amount of the origin-destination data but nevertheless, it has all been checked to ensure that sample rates are reasonable.

Sample rates have been assessed over each model time period by vehicle type:

- AM average peak hour (07:00 to 09:00);
- Average inter peak hour (10:00 to 15:00);
- PM average peak hour (16:00 to 18:00); and
- The overall survey period (07:00 to 19:00).

Appendix D contains sample rate analysis for each RSI location by time period grouped according to the data source i.e. new HETM surveys first followed by A63 Castle Street etc. The section below provides a brief commentary of the sample rates for each of the data sets.

HETM 2010 Surveys

A review of the sample rate obtained at each RSI relative to the MCC counts was undertaken. Generally to ensure an RSI provides a representative sample, a minimum of a 10% is considered desirable. **Table 12** provides an overview of the sample rate for each of the sites.

Table 12 HETM Summary Sample Rates

Site No	Description	Date Of RSI	Number of RSI Records	No. of Vehicles during (MCC)	Sample Rate
1	A180 Westbound, Grimsby	16/06/10	1,559	13,982	**11%**
2	A18, South of M180 Junction 5	15/06/10	855	6,071	**14%**
3	A1077, Crosby (Scunthorpe)	14/06/10	786	5,873	**13%**
4	A18, Doncaster Road, Scunthorpe	14/06/10	1,014	8,743	**12%**
5	A161, High Street, Belton (South of M180)	15/06/10	1,054	4,188	**25%**
TOTAL			**5,268**	**38,857**	**14%**

Site 1 was undertaken using a postcard survey due to physical constraints which limited the ability of the survey team to stop vehicles without causing significant traffic congestion along the route. As a result there were initial concerns over the likely sample rates achieved at this site. However despite these worries, a reasonable sample was obtained.

A63 Castle Street Improvements (Model Hull City Region) 2008

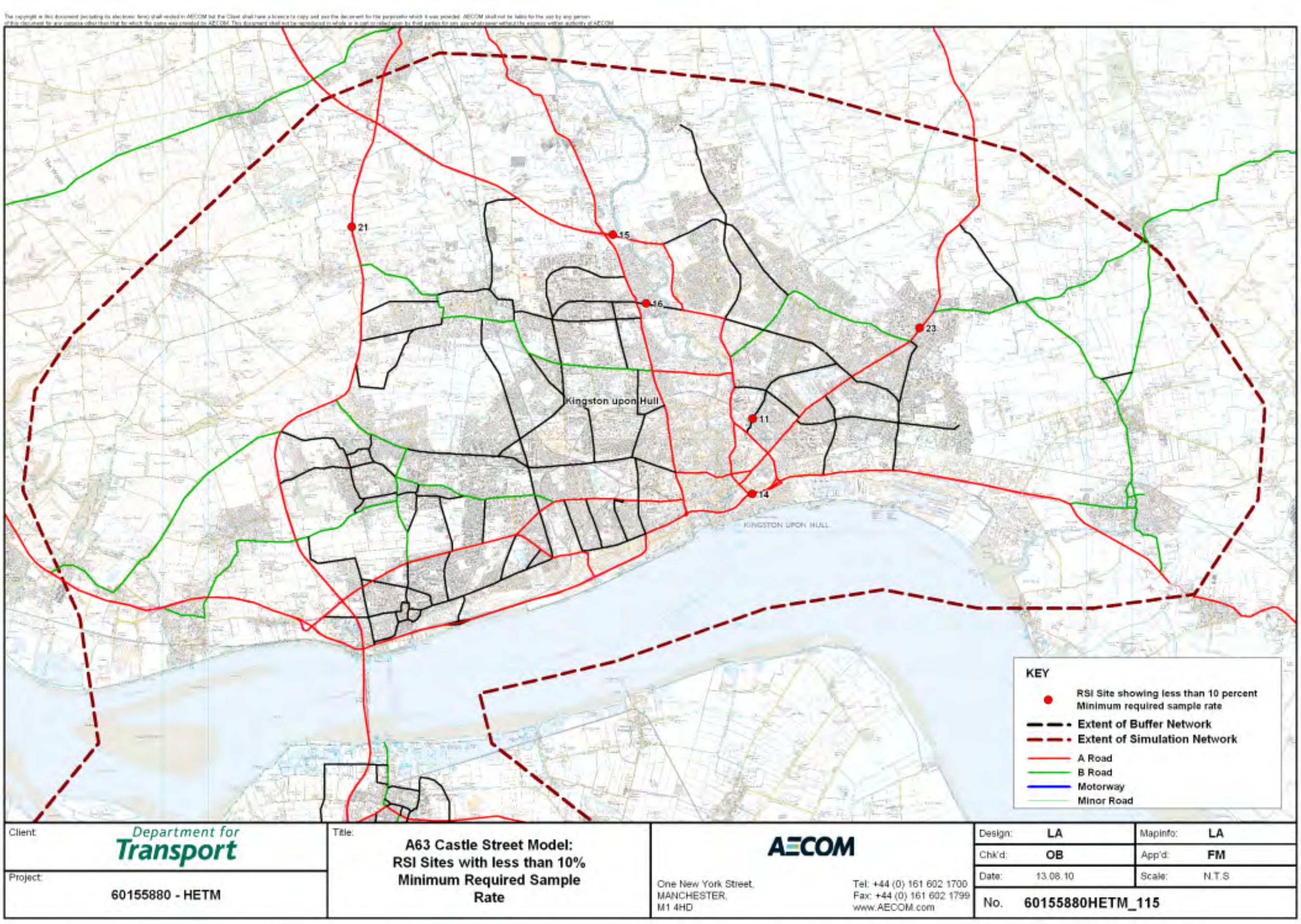
A total of 28 sites have been selected with existing RSI data and ATC counts to assist with the development of the matrices. The data was obtained through a mix of road side interviews and postcard forms. The locations of the surveys are detailed in **Table 13**, alongside the interview methodology and the percentage of vehicles surveyed.

Table 13 A63 Model Summary Sample Rates

Site Number	Description	Date Of RSI	Number of RSI Records	Number of Vehicles during RSI survey (MCC)	Sample Rate
1	A63 Hessle Road at Mytongate junction (1X)	08 & 10/08	2,196	18,645	12%
2	A1166 Hessle Road east of Sunningdale Rd	09-Aug	1,335	8,880	15%
3	Boothferry Road to the west of Kempton Rd	09-Aug	931	4,707	20%
4	Anlaby Road east of Hamlyn Avenue	09-Aug	1,115	4,886	23%
5	Spring Bank West (De La Pole Avenue)	09-Aug	833	7,435	11%
6	Chanterlands Avenue (Cemetery Entrance)	09-Aug	1,270	6,404	20%
7	Queens Road after Newland Avenue	09-Aug	976	4,269	23%
8	Beverley Road south of the Clough Road	09-Aug	950	7,455	13%
9	Bankside located at approach to roundabout	09-Aug	564	5,859	10%
10	Stoneferry Road south of the railway bridge	09-Aug	1,285	10,032	13%
11	James Reckitt Avenue	09-Aug	468	5,764	8%
12	Witham west of the Holderness Road	09-Aug	965	4,957	19%
13	Hedon Road west of the Merrick Street	09-Aug	335	1,847	18%
14	Garrison Road (Plimsoll Way roundabout)	08 &09/08	1,355	15,000	9%
15	Raich Carter Way to, east of Beverley High Road roundabout	09 &10/08	777	11,407	7%
16	Sutton Road west of Welwyn Park Avenue	09-Aug	709	7,699	9%
17	Clough Road before the Reservoir Road	09-Aug	1,381	7,700	18%
18	Boothferry Road before the A164 roundabout	09-Aug	1,130	10,867	10%
19	Tranby Lane Old Hill and Humber View	09-Aug	866	2,445	35%
20	A15 North of the Humber Bridge	09-Aug	1,201	7,779	15%
21	A164 south of Dunflat Road	09-Aug	1,002	10,936	9%
22	Beverley Road prior to Evergreen Drive	09-Aug	1,499	9,201	16%
23	Holderness Road opposite Parkhurst Close	09-Aug	878	10,075	9%
24	Hedon Road opposite Tower House Lane	09-Aug	1,142	10,865	11%
25	A63 slip road to Brighton Street junction	09-Aug	682	4,834	14%
26	Madeley Street north of Fishermans Walk	09-Aug	1,253	7,069	18%
27	Clarence Street west of Alma Street junction	09-Aug	789	2,676	29%
28	A63 slip road to Priory Way junction	09-Aug	661	2,996	22%
TOTAL			**28,548**	**212,689**	**13%**

Table 13 indicates that there are 6 out of the 28 sites surveyed that fall below the minimum required 10% threshold. These sites are displayed on **Figure 12**. In order to improve the sample rate and make the data useable in the matrix build phase, a process of merging adjacent time periods or by using records for similar types of vehicles in the same or neighbouring time periods was undertaken to represent trips in the under sampled band.

Figure 12 A63 Model RSI Data not Achieving a 10% Sample Rate



A160/A180 Improvements (Immingham Model) 2008

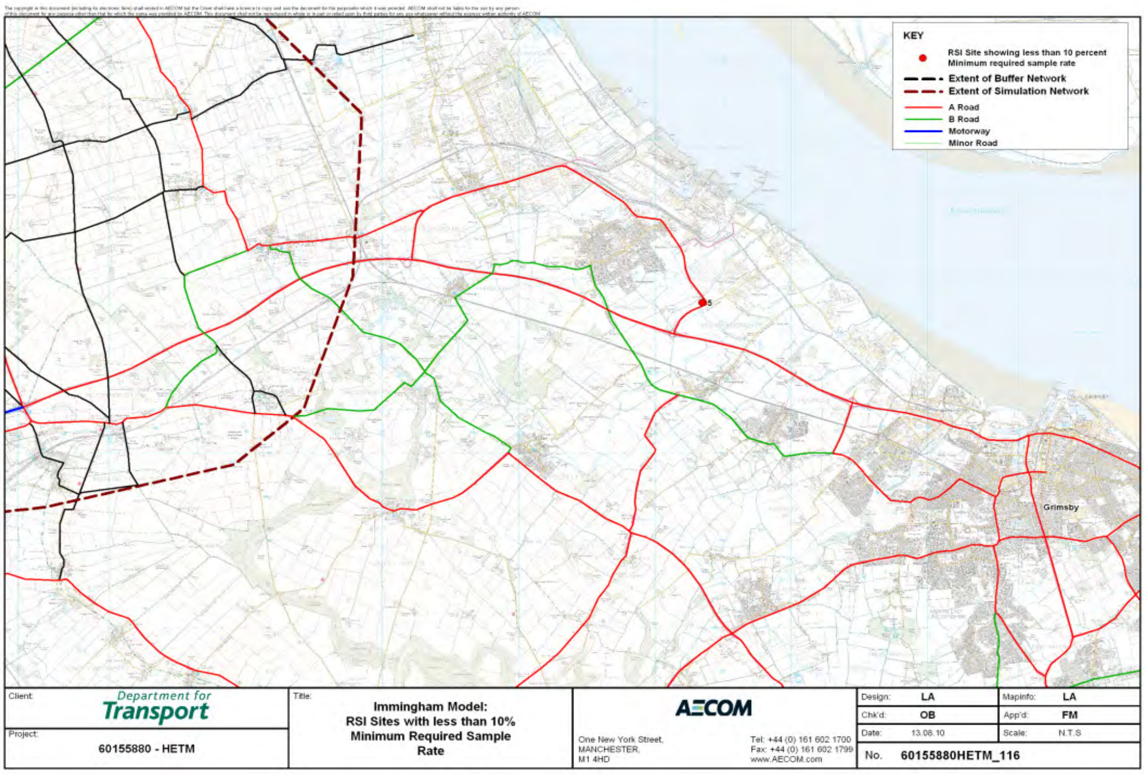
The locations of the surveys are detailed below alongside the percentage of vehicles surveyed.

Table 14 Existing RSI Sites, Immingham Model - Survey Day Sample Rate

SITE Number	Description	Date Of RSI	No. of RSI Records	MCC totals	Sample Rate
1EB	College Road, East Halton	25-Jun	660	1,320	50%
1WB		24-Jun	568	1,324	43%
2EB	A160 Humber Road, east of Top Road Roundabout	26-Jun	1083	5,661	19%
2WB		30-Jun	1,102	5,223	21%
3NB	B1210 Station Road, Habrough	25-Jun	895	1,428	63%
3SB		24-Jun	888	1,428	62%
4NB	B1210 Stallingborough Road, South of Immingham	25-Jun	1,508	2,971	51%
4SB		24-Jun	928	2,908	32%
5EB	A1173, between A180 and Kiln Lane Roundabout	30-Jun	389	5,953	7%
5WB		26-Jun	437	6,136	7%
TOTAL			**8,458**	**34,352**	**25%**

Table 14 indicates that only one of the sites surveyed falls below the minimum required 10% threshold. Site 5 is displayed on **Figure 13**. In order to improve the sample rate and make the data useable in the matrix build phase, a process of merging adjacent time periods or by using records for similar types of vehicles in the same or neighbouring time periods was undertaken to represent trips in the under sampled band.

Figure 13 Immingham Model Sites That Fall Below Minimum Required 10% Sample Rate Threshold



Doncaster Model 2009

Table 15 shows no site surveyed falling below the minimum required 10% threshold.

Table 15 Existing Road Side Interview Doncaster Model – Survey Day Sample Rate

Site Number	Description	Date Of RSI	Number of RSI Records	Number of Vehicles during RSI survey (MCC)	Sample Rate
1N	A614, High Street, Austerfield	Jun 09	924	2,029	46%
2N	A638, Great North Road, Bawtry	Jun 09	1,387	4,322	32%
3S	A614, Thorne Road, Blaxton	Jun 09	925	2,972	31%
4S	B1396, New Road, Auckley	Jun 09	1,555	4,758	33%
5S	Hurst Lane, Hayfield Green	Jun 09	1405	4,978	28%
6N	B6463, Sheep Bridge Lane, Rossington	Jun 09	1,506	5,820	26%
7N	B6463, Stripe Road, New Rossington	Jun 09	904	3,421	26%
TOTAL			**8,606**	**28,300**	**30%**

Lincoln Model 2006

Table 16 indicates that 6 sites fall below the minimum required 10% threshold. In order to improve the sample rate and make the data useable in the matrix build phase, a process of merging adjacent time periods or by using records for similar types of vehicles in the same or neighbouring time periods was undertaken to represent trips in the under sampled band. As the Lincoln data set is on the periphery of the model network, the RSI data will be considered less important than the HETM sites as the majority of Lincoln based trips are unlikely to be influenced by changes to the Humber Crossing, except for those trips crossing the Humber. The key sites likely to be affected by Humber trips are those to the north of Lincoln which have all achieved the minimum sample rate of 10%.

Table 16 Existing Road Side Interview Lincoln Model – Survey Day Sample Rate

Site Number	Description	Date Of RSI	Number of RSI Records	Number of Vehicles during RSI survey (MCC)	Sample Rate
1	B1398 – Middle Street	Oct 06	590	2,975	20%
2	A15 – North of Lincoln (Showground)	Oct 06	888	6,765	13%
3	A46 – Nettleham Road	Oct 06	948	7,721	12%
4	A57 – Saxiby Road	Oct 06	912	7,111	13%
5	B1190 – Lincoln Road	Oct 06	469	3,022	16%
6	A46 – South of Lincoln (Swinderby)	Oct 06	578	13,148	4%
7	Greetwell Road	Oct 06	439	2,943	15%
8	B1190 - Washingborough	Oct 06	587	3,788	15%
9	B1188 – Canwick Hill	Oct 06	887	8,287	11%
10	A15 – Cross O'Cliff Hill	Oct 06	807	5,372	15%
11	Brant Road, Lincoln	Oct 06	522	3,297	16%
11a	Station Road, Waddington	Oct 06	658	1,601	41%
12	A158 – Wragby Road	Oct 06	577	7,906	7%
13N	Wigford Way, Lincoln	Oct 06	533	6,597	8%
13S	Wigford Way, Lincoln	Oct 06	641	4,219	15%
14N	Pelham Bridge	Oct 06	1108	12,163	9%
14S	Pelham Bridge	Oct 06	756	17,859	4%
Site 16	B1003 – Tritton Road	Oct 06	615	9,209	7%
TOTAL			**12515**	**123,983**	**10%**

5.3.6 Expansion Factors

As it is not possible to survey all vehicles passing the RSI site, this data represent a sample of the total vehicles passing the location. As a result, the sampled number of vehicles at any RSI site must be factored up to represent the total traffic passing through the site, by use of expansion factors. These are linked directly to the sample rate, and are calculated separately for cars, LGVs and OGVs, and for each time period. Expansion factors have been calculated for each data set using Access and Excel.

During the RSI surveys and for a period of two weeks around the survey period, a series of ATCs have been undertaken to monitor trip volumes using the route. This data records all vehicles passing the RSI site and so can be used to factor trips up to the required levels.

Where ATC counts are available, the average weekday count has been calculated for each time period (half hour) using the following correction factor:

*(Ave 5 Day ATC / ATC on Survey Day) * Manual Count for Vehicle Type*

This is used because on the day of the survey, it is possible that the flow will be different to the average weekday flow, as it may be that the delay caused by the survey may result in fewer than usual trips using the corridor. As a result it is inappropriate to use just the count data from the day of the survey.

By having a longer data set of, for example, 2 weeks or more, it has been possible to derive an average weekday flow that represents the day of the survey. The RSI sample surveys were then factored up to the value of the average weekday flow for that site to represent all trips passing the RSI point.

This adjustment ensures that an accurate average daily weekday count is obtained and the result is not influenced by drivers avoiding the survey site on the day of the survey.

Where there were no ATC counts such as the Doncaster data set, the average weekday count for cars, LGVs and OGVs has been calculated directly from the manual counts.

Expansion factors have been calculated for each model period, by vehicle type (see 5.3.2) and also for the 12 hour period. As part of the process, factors have also been calculated for each individual hour within the 12-hour period which, although not used directly, have been helpful in identifying any problems with the data.

Where large expansion factors are calculated for some vehicle types for some time periods it is standard to smooth the data by reducing the expansion factors. This has been achieved by merging adjacent time periods or by using records for similar types of vehicles in the same or neighbouring time periods to represent trips in the under sampled band. For example, where there was a low sample rate reported for HGVs in the A63 dataset for the AM peak hour 7-8am, neighbouring records from the time period 8-9am were used.

5.3.7 Reverse Direction

As some RSI surveys were only undertaken in one direction, it was necessary to synthesise trip records for the non-interview direction. AECOM adopted the standard process of using the morning peak interview direction trips to represent the evening peak non-interview direction trips, and vice versa. When doing this the recorded trip purposes are retained, but the origin and destination zones are transposed.

New expansion factors have then been calculated using the average weekday counts for the reverse direction at each site which were obtained using the MCCs and ATCs.

To account for differences in trip purpose split between the morning and evening peaks an additional factor was included for the reverse direction trips. Each set of data was pooled to derive local trip rates. The proportions of trips in the interview direction were calculated for each period and the proportions in the assumed non interview direction were adjusted to match.

5.3.8 Scaling to 2010

Not all of the survey data was obtained in 2010; for example the A63 and A160/A180 improvements models were created in 2008. As a result, it was necessary to factor the data from these RSI sites to June 2010 levels, this was undertaken by reviewing nearby long term ATC counts which show annual changes in traffic growth on the route.

5.3.9 Matrix Development

Matrices were developed separately for each model time period from the origin destination data pertaining to that period. The process was also used to develop 12 hour PA matrices for input to the demand model.

The five separate data sets were combined to form the demand matrices for the model. The matrix building process was incremental, starting with the A63 Hull data, as this model formed the basis for the new model and as it best represents the traffic demands in the immediate vicinity of the Bridge. Further data sets were then added in a step wise process according to their age and their proximity to the study area. Thus the matrices were combined in the following sequence:

1. A63 Hull Model
2. New HETM Survey data
3. Immingham Model

4. Doncaster Model
5. Lincoln Model

At each step in the process the potential for double counting was investigated to ensure that the inclusion of new data did not reproduce trip patterns already in the matrices. Possible double counting was identified by examining the movements within each data set on a sector to sector basis and also by carrying out select link analyses on the network to identify routing patterns between zone pairs.

Critical in the building process was the assessment of trip patterns across the Humber screenline where route options are limited to a small number of crossing points, including the Humber Bridge. Particular attention was paid to examining these trips in the model to identify the locations of break points where the primary route switched from one bridge to the next and areas where the model identified more than one route between the two sides of the Estuary. Through this process a detailed representation of which movements would be double counted in both the A63 data set and either the new HETM or Immingham data sets was developed.

The analysis identified that there was very limited scope for multi routing across the estuary. This was borne out in similar assessments using route planning software and off line evaluation of costs, since the distance and thus additional costs involved in avoiding the toll Bridge for many trips significantly outweighs the tolls. In the majority of cases cross Humber movements were restricted to a single link, at least on the river crossing section. The design of the surveys also minimised the risks of partial observation for cross Humber trips, since given that the A63 surveys fully captured traffic on the Humber Bridge itself, the new surveys were designed to capture cross estuary traffic on the alternative routes. For movements parallel to the estuary the locations of the survey sites were such that the majority of major movements were captured, so whilst double counting was an issue, partial observation was minimised.

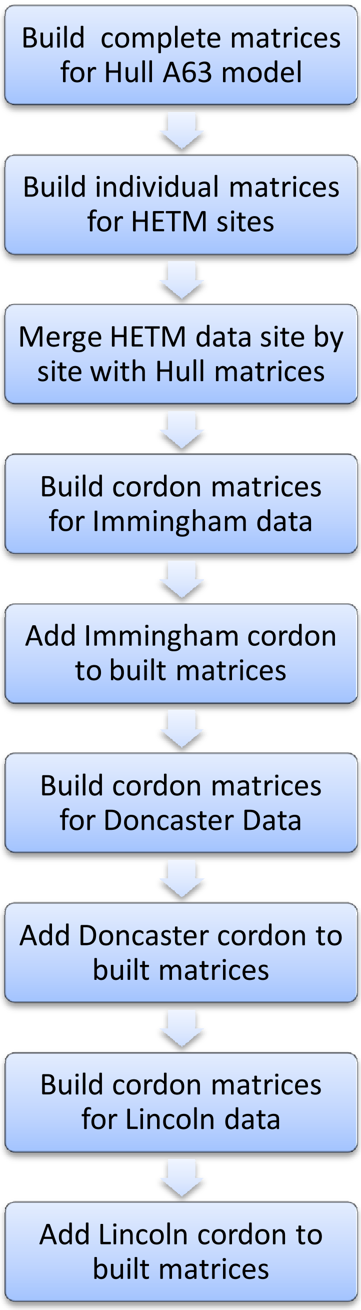
For movements where double counting was identified the demands were computed using a weighted average between the study matrices existing at that stage in the process and the new data to be added. Weightings were calculated on the basis of sample variances.

The matrix building process was developed using purpose written macros using the emme transport modelling software. Emme was chosen particularly for its capabilities in matrix handling, which was important given the large number of input matrices involved in the process, when considering time periods, trip purposes and income segments. The macro command language also offers the ability to create reproducible processes to speed up the handling of repetitive processes for successive time periods.

The Lincoln data set, being that collected most distant from the Humber, was also the oldest data. The majority of this data related to local trips within the south of the model, and very few trips to areas north of the Humber were found in the data set. This data was used primarily to infill movements in the Lincolnshire area, and longer distance trips that would also have been identified in the other data sets were discounted.

The sequence of data processing is shown in **Figure 14**.

Figure 14 Matrix Development Process



5.4 Matrix Infilling

5.4.1 Gravity Model Requirement

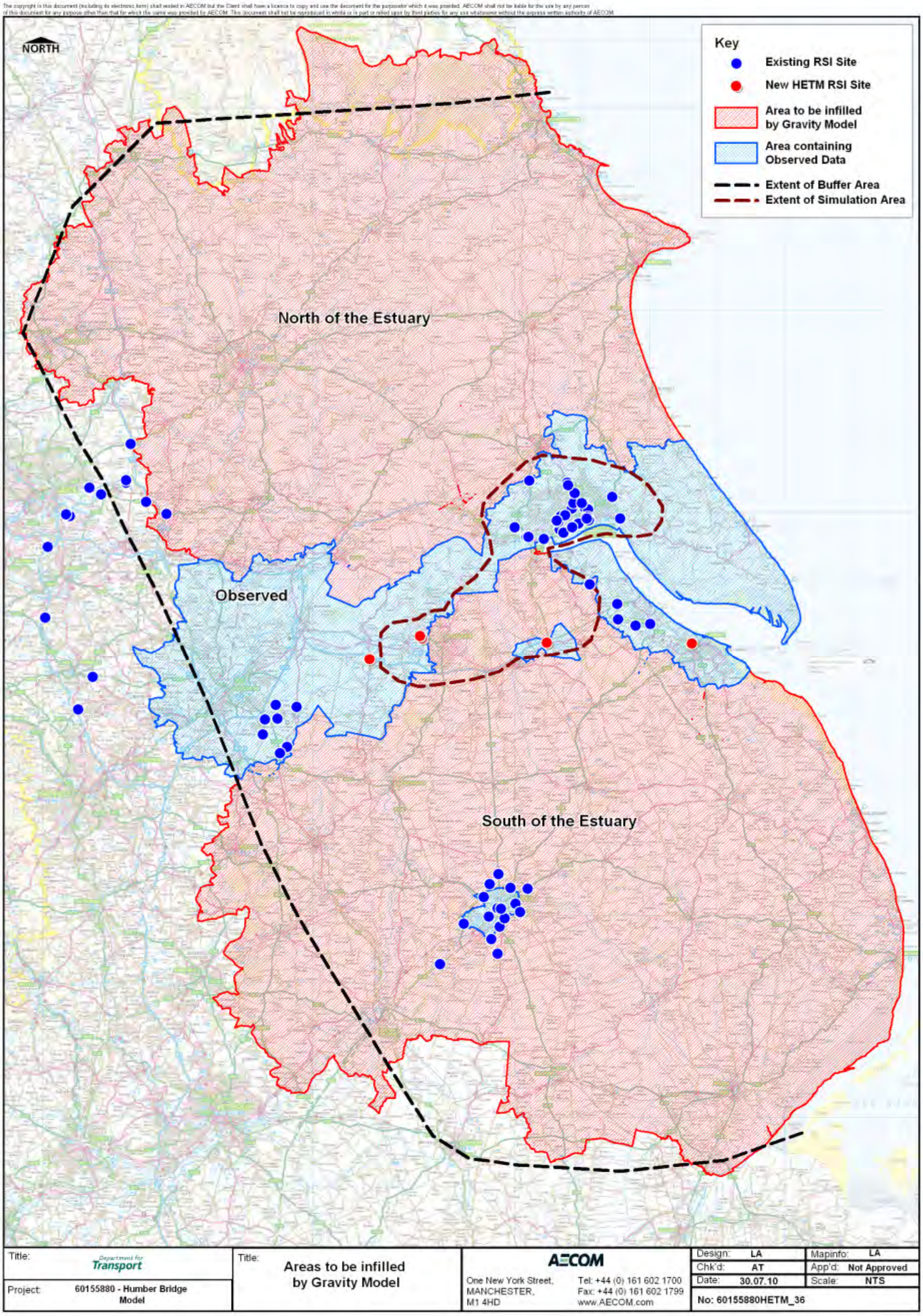
The new and existing and surveys ensured that the majority of trips between the major areas of employment and population were observed, however that left some gaps which it was necessary to infill.

The overall modelled area is split into 236 zones, of these, 108 (45%) are within the Hull cordon and a further 60 are in the area south of the Humber between Scunthorpe and Grimsby. This area represents over 70% of the modelled zones and the majority of the heavily populated zones within the study area. Cross Humber trips into Hull are fully observed since the RSIs around Hull form a closed cordon. The majority of cross Humber trips between the regions to the north and south of the Humber in this area are also fully observed from the RSI on the Humber bridge access road.

Consequently the need to infill applies to trips between the remaining 30% of zones more distant from the bridge. These zones are generally more sparsely populated, indeed the major population areas such as

Lincoln and Doncaster are covered by RSIs. The area requiring infill is illustrated in **Figure 15**.

Figure 15 Areas Requiring Infilling



5.4.2 Gravity Model Process

The gravity model is used to infill the 12 hour production attraction matrices of person trips for the demand model. These are then converted to origin – destination matrices for the assignment model for each time period using factors based on observed proportions of trips for each trip purpose and time period. HGV matrices have also been broken down into the separate vehicle types used for assignment, according to the fleet make-up observed in the new surveys.

Separate gravity models have been run for each of six trip purposes/vehicle types:

- Home based work;
- Home based employers business;
- Home based other;
- Non home based employers business;
- Non home based other; and
- HGVs.

5.4.3 Gravity Model Approach

The model was developed using the CUBE MVESTM program. This is a widely used commercial package developed for matrix estimation.

There are a number of ways of formulating the gravity model. The standard form within MVESTM is:

$$T_{ij} = a_i b_j c_{ij}^{-} \; e^{- \; C_{ij}}$$

Where a_i and b_j are factors that are calculated to satisfy the constraints

$$\sum_j T_{ij} = P_i$$

$$\sum_i T_{ij} = A_j$$

Where: T_{ij} is the estimated number of trips from zone *i* to zone *j*;

C_{ij} is the cost (in generalised minutes) of travelling from zone *i* to zone *j*;

a is the power term in the function;

β is the exponential term;

P_i is total trips produced from zone *i*; and

A_j is total trips attracted to zone *j.*

Matrix outputs from SATURN and other data may be readily formatted for input to the CUBE processes.

5.4.4 Development of Synthetic Trip Ends

The NTEM dataset has been used to derive total trip productions and attractions by trip purpose and time period for each NTEM zone.

Although the version 5.4 dataset remains the approved version for forecasting, after discussion with DfT it was agreed that the 6.1 version would be most appropriate for setting the base year trip ends.

To create zonal trip ends for ‘car driver and passenger’ (i.e. accepting the NTEM mode split) for input to the gravity model the trip ends at the NTEM zone level was disaggregated using demographic data for each zone as follows.

Table 17 Criteria Used in Splitting NTEM Zones

	Productions	Attractions
HBW and HBEB	Workers	Jobs
Other HB	Population	Population, jobs(1)
Non home based	Jobs, population(1)	Jobs, population(1)

Notes:
(1) A 50:50 weighting of the two values was used in these cases.

5.4.5 Derivation of zonal trip costs

The SATURN model was used to derive travel costs for input to the demand model. Travel costs were skimmed from the model and converted to units of generalised time to represent the whole cost of the journey, according to tolls and WebTAG values of time and operating costs.

Since the gravity model is run at a twelve hour level it was necessary to use appropriate costs for each trip purpose, the model for commuting trips uses costs skimmed from the peak hour model, whilst trips for other purposes use costs from the inter peak model.

5.4.6 Intra Zonal Costs

For the generalised cost of travel a traffic model can provide estimates of the inter-zonal costs, but not the intra zonal costs. Nevertheless, intra-zonal costs are needed to generate the full synthetic trip matrix to reflect the allocation of total trips produced in each zone as some trips produced in a zone will also have an attraction in the same zone. As such, for the buffer and simulation networks, intra-zonal costs were assumed to be half the cost of the shortest inter-zonal trip from each zone.

5.4.7 Gravity Model Calibration Results

The best fit between the observed and fitted data was obtained using the parameters shown in **Table 18**, in which the power parameter was fixed to 1. The fit between modelled and observed trip costs for the trips used to calibrate the gravity model are shown in **Table 19**.

Table 18 - Gravity Model Fitted Parameters

Purpose	X1	X2
HBW	1	-0.040
HBEB	1	-0.030
HBO	1	-0.040
NHBEB	1	-0.035
NHBO	1	-0.050

Table 19 – Comparison of Trip Lengths

Purpose	Observed		Modelled	
	Mean	SD	Mean	SD
HBW	87.3	57	87.1	53
HBEB	114.4	82	114.5	82
HBO	83.3	65	83.2	57
NHBEB	104.7	91	104.7	86
NHBO	84.9	78	85.0	72

Table 19 demonstrates a close fit between the observed data used to calibrate the gravity model and the trip distribution produced by the application of the gravity model.

5.4.8 Merging Observed and Synthetic Matrices

Table 20 Infilled Movements

Sector		1	2	3	4	5	6	7	8	9	10	11	12	13
Hull City Region	1													
Hornsea	2		■		■									
Market Weighton	3			■	■				■		■	■		■
North Yorkshire	4		■	■	■				■		■	■		■
Immingham	5													
North Lincs (Barton)	6						■		■	■	■			■
West of Grimsby	7							■	■			■	■	■
North of Lincoln	8			■	■		■	■	■	■	■	■	■	■
Scunthorpe	9						■		■	■				■
Goole	10			■	■		■		■		■			■
Lincoln & S of Lincoln	11			■	■			■	■				■	■
Grimsby	12							■	■			■	■	■
Skegness & Boston	13			■	■		■	■	■	■	■	■	■	■

Two options were considered for merging the synthetic and observed matrices. The first was to fix the observed cells for movements which are fully observed and to use cells from the synthetic matrices for other movements. The advantage of this is that it maintains the integrity of the observed data, and the use of the synthetic matrices is restricted to the unobserved portions of the matrix.

The alternative was to create a weighted average of the two matrices, weighting to take account of the relative variability of the two sets of matrices. This approach reduces the use of observed data and introduces synthetic data in the observed sections of the matrices. It has an advantage in that it smoothes out some of the lumpiness that may occur within the observed matrices due to sampling rates and that partial counting may be reduced.

The former method was adopted, and synthetic data was introduced into the matrix for all movements indicated in **Table 20** the locations of the sectors being shown in **Figure 11**. In developing the profile of the segments to be infilled the numbers of trips in the observed and synthetic trips making each sector to sector movement were considered to determine whether any trip patterns in the synthesised matrices were not reflected within the observed matrices

The only location where additional trips were included from the gravity model from otherwise observed segments were from zones in the south and the west of the Grimsby sector, where it was concluded that trips to and from West of Grimsby and North of Lincoln would be unobserved.

An assessment was made of the degree to which movements could have been partially observed by the roadside interview programme. This was carried out by select link analysis and by use of SATURNs capabilities of displaying route forests. It was concluded that for all the key cross Humber movements trips could be assumed to be either fully observed, or for a few localised movements at the west of the study are fully unobserved by the roadside interview programme. There was minimal scope for partial observation. Similarly, for non cross Humber movements, since the majority of survey data was derived from cordon studies the scope for partial observation was minimised. Where it was concluded that there was a possibility of partial counting, which applied mainly to the south Grimsby area, additional trips were included from the synthetic matrix, the total being controlled to count data. This approach was considered sufficiently accurate, since these trips were included only to ensure correct volumes on the Lincolnshire network, and would not be affected by the schemes under consideration. A summary of this analysis is presented in Appendix J comparing the routings through the AM Peak base model.

In addition, the gravity model fitted trips between the outer sectors and the areas outside the yellow cordon in **Figure 11** representing trips leaving and entering the main buffer model area.

The following figures, (**Figure 16** to **Figure 21**) provide a comparison in trip lengths between the observed data and the synthetic trips added from the gravity model. These show that the patterns of trip length between the modelled and synthetic trips is very similar, in some cases the trips added to the overall matrices from the gravity model are slightly longer than those in the observed matrix, however this reflects the larger zoning and more rural nature of many of the movements extracted from the gravity model.

Table 21 shows a comparison of the trip costs in the observed and synthesised portions of the matrix, this too demonstrates a high degree of similarity between the observed and synthesised trips.

Table 21 – Comparison of Trip Lengths

Purpose	Observed		Modelled	
	Mean	SD	Mean	SD
HBW	67	55	68	47
HBEB	93	77	89	57
HBO	61	58	65	47
NHBEB	78	71	73	51
NHBO	54	56	60	45
HGV	120	89	129	72

Figure 16 – Trip Length Distributions (HBW)

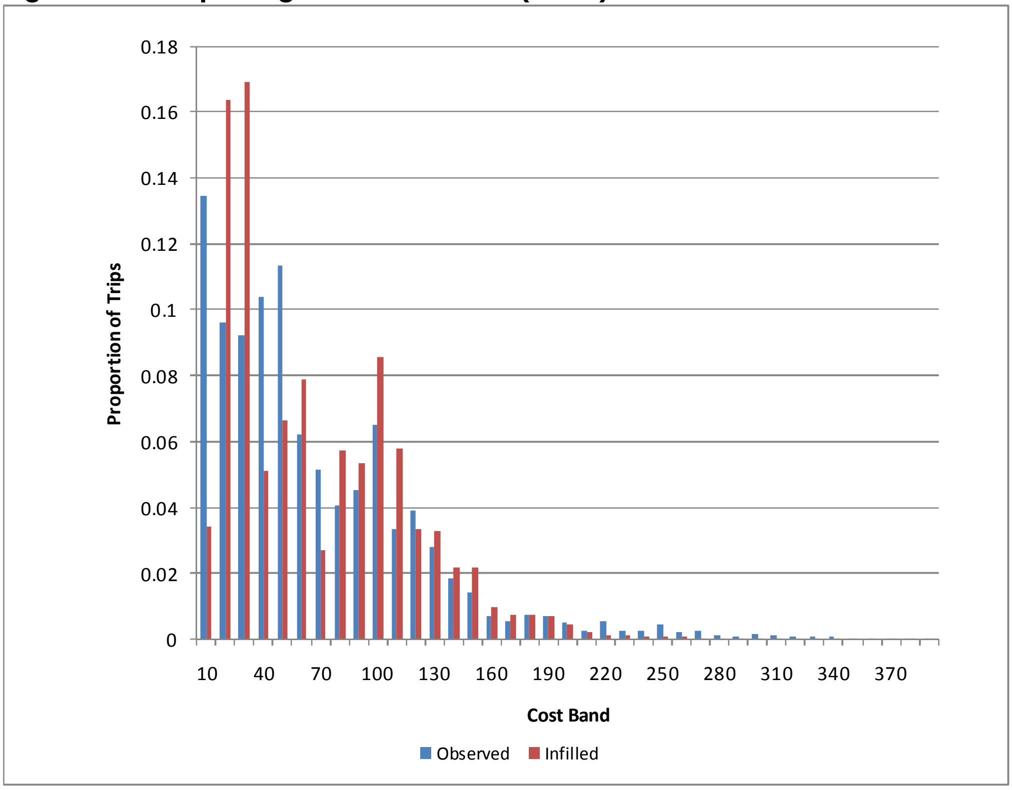


Figure 17 – Trip Length Distributions (HBEB)

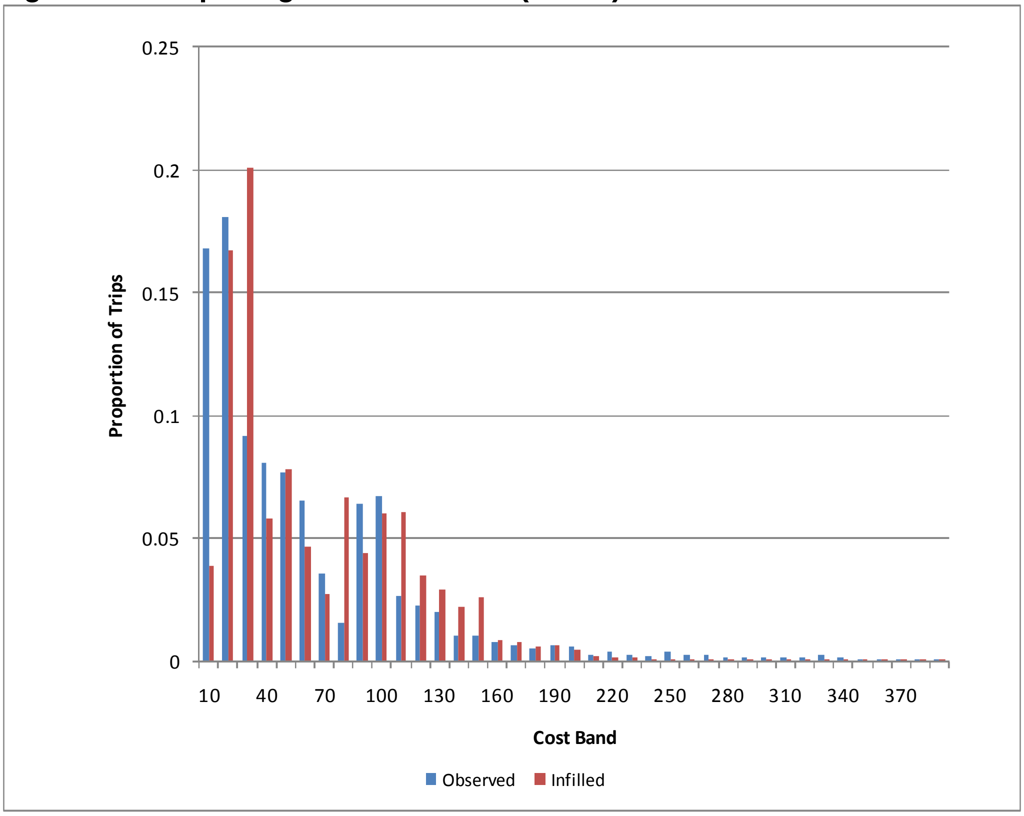


Figure 18 – Trip Length Distributions - HBO

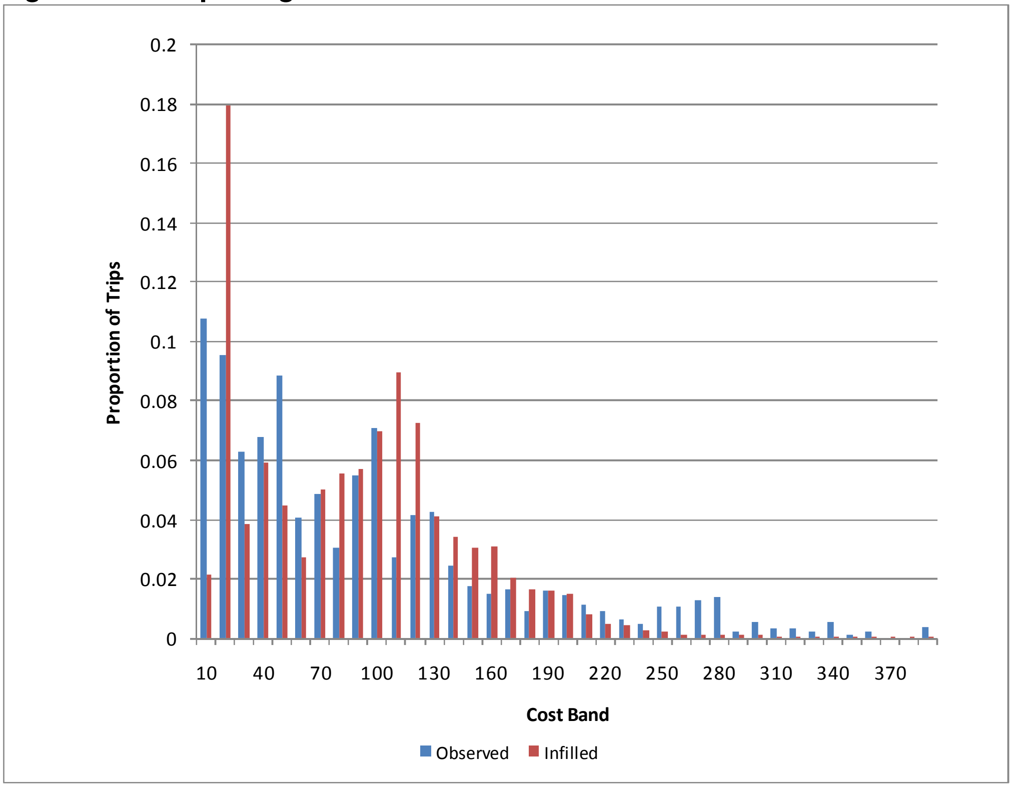


Figure 19 – Trip Length Distributions - NHBEB

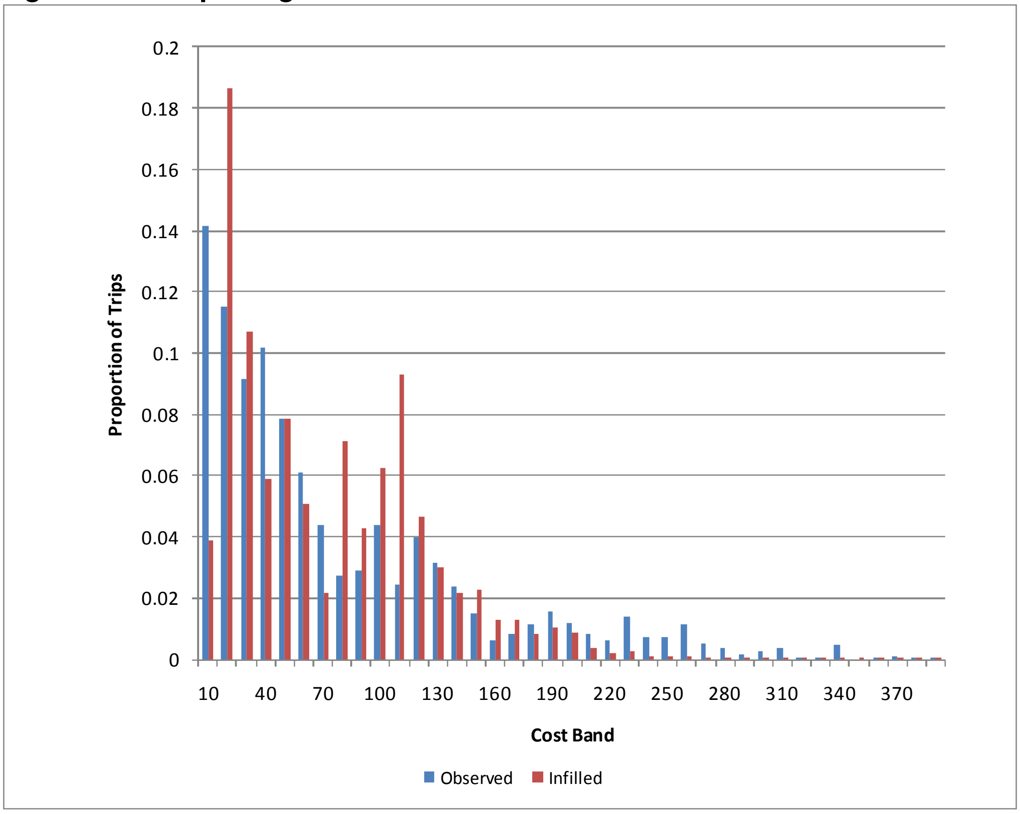


Figure 20 – Trip Length Distributions - NHBO

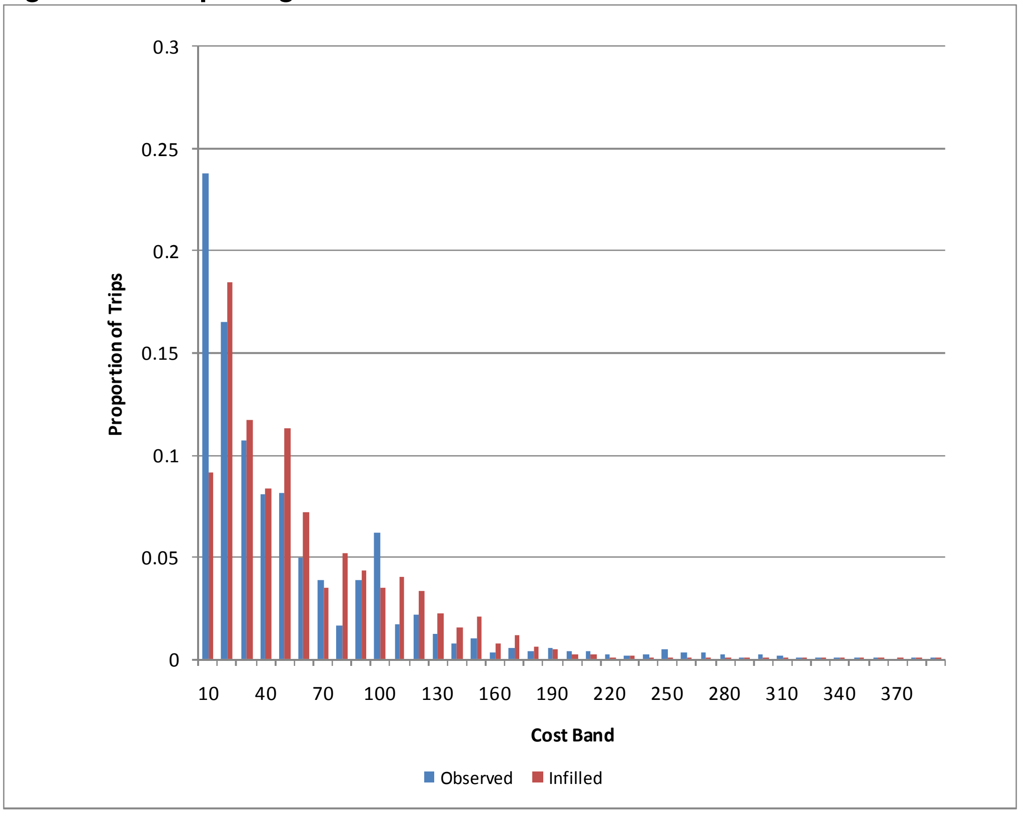
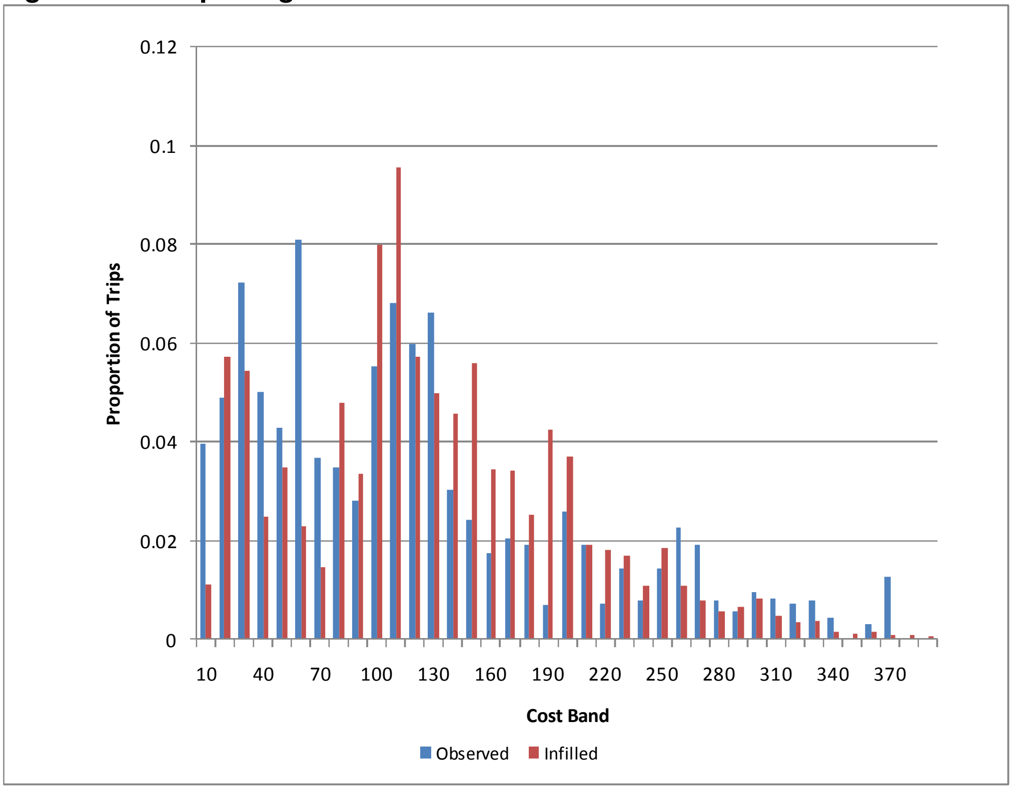


Figure 21 – Trip Length Distribution - HGV



5.4.9 Matrix Estimation

Matrices Estimation has not been used to develop the base model.

5.5 Income Segmentation

As set out in **Table 11**, the home based work and home based other trips have been segmented according to income. An analysis of the HETM RSI data was undertaken which identified that for home based work trips, there a correlation between the length of trip and the relative proportion of trips in each income band; this was not the case for home based other trips. These results aligned with current thinking which suggests that those on the highest incomes will tend to have the longest commuting distance.

It was decided to adopt three distance and three income bands for the demand matrix development. The distance bands were developed based upon an analysis of the HETM RIS data with boundary values chosen such that there were roughly equal numbers of trips in each group. The final bands were as follows:

- Less than 10.5 miles (31.8% of all trips);
- 10.5 to 28 miles (34.4%); and
- Greater than 28 miles (33.7%).

Yorkshire Forward kindly provided household income data to the project team which had been collected on their behalf by Acxiom. This identified the number of households in each census output area by gross household income in £5,000 increments up to £50,000 (i.e. <£5k, £5k-£10k etc) then for £50,000 to £75,000 and over £75,000. Whilst this is an extremely useful dataset, it was felt that the distribution of household incomes might not reflect car availability. The information was therefore adjusted using NATCOP, the Department's national car ownership model.

The final income bands used were then:

- Less than £20,000;
- Between £20,000 and £33,000;
- Greater than £33,000.

5.5.1 HBO Segmentation

As HBO trips were only segmented on the basis of income (i.e. no distance element), the relevant matrices were therefore simply split according to the production (home end) of the trip taking account of the identified income levels in that model zone.

5.5.2 HBW Segmentation

To accommodate the additional complication of distance bands for commuting trips, a distance skim, based upon an AM peak assignment, was used to identify which trip movements fall into which of the defined bands.

A process was then undertaken which ensured that the final split of HBW trips in each band reflected both the household (corrected by NATCOP) income and the relevant distance for the movement being considered.

5.6 Final Matrices

The following tables provide summary statistics of trip numbers by vehicles for a 12 hour period, identifying the proportion of observed and infilled trips in each instance. A comparison for each modelled time period can be found in Appendix G. **Table 23** represents the observed trips, **Table 24** represents synthesised trips and **Table 22 Final Matrix - Combined 12 Hour Matrices (Vehicles)Table 22** all trips (i.e the sum of observed and synthesised).

Table 22 Final Matrix - Combined 12 Hour Matrices (Vehicles)

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	142,553	8,736	10,346	15,393	1,156	2,260	262	379	1,492	50	201	2,042	239	7,357	**192,467**
2	16,811	8,463	710	8,034	94	170	30	0	221	14	6	253	0	733	**35,538**
3	15,376	492	8,013	4721	248	429	63	33	405	272	11	417	0	15,481	**45,961**
4	22,920	8,207	4,905	144,021	284	382	38	30	224	109	62	378	38	29,184	**210,784**
5	811	29	94	143	2,619	2,454	598	193	838	76	109	9,996	145	3,117	**21,225**
6	3,552	119	126	122	5,130	11,467	985	2,004	8,731	97	110	4,069	213	1,191	**37,916**
7	389	6	66	10	2,133	1,040	1,701	1,238	2,726	67	94	6,590	534	290	**16,884**
8	257	43	0	137	746	2,061	1,241	10,334	4,162	451	7,526	2,441	2,605	3,643	**35,648**
9	1,200	14	239	53	1,519	8,684	2,382	4,101	6,377	941	253	3,246	303	3,098	**32,411**
10	84	4	496	144	302	22	46	451	893	165	4	133	68	950	**3,763**
11	300	0	14	46	122	140	155	8,490	212	12	76,407	904	8,624	7,262	**102,689**
12	2,070	95	232	228	18,596	3,451	5,979	2,355	2,818	306	791	58,441	6,526	1,510	**103,398**
13	126	13	22	26	192	200	656	2,637	310	15	8,945	6,733	86,256	6,742	**112,873**
14	11,114	546	16,243	28,893	2,927	1,230	287	2,061	5,775	539	5,201	1,438	6,604	467,966	**550,824**
Total	**217,564**	**26,769**	**41,508**	**201,970**	**36,070**	**33,990**	**14,423**	**34,308**	**35,183**	**3,116**	**99,720**	**97,082**	**112,155**	**548,524**	**1,502,381**

Table 23 Final Matrix - Observed 12hr Matrices (Vehicles)

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	142,553	8,736	10,346	15,393	1,156	2,260	262	379	1,492	50	201	2,042	239	7,357	**192,467**
2	16,811	32	537	153	94	170	30	0	221	14	6	253	0	439	**18,758**
3	15,376	320	145	160	248	429	63	33	405	11	11	417	0	311	**17,929**
4	22,920	258	175	45	284	382	38	30	224	20	62	378	38	279	**25,132**
5	811	29	94	143	2,508	1,496	598	193	838	76	109	9,996	145	3,117	**20,155**
6	3,552	119	126	122	3,997	911	423	26	887	97	110	2,294	23	654	**13,341**
7	389	6	66	10	2,133	459	0	0	714	67	94	1,109	0	154	**5,201**
8	257	43	0	137	746	59	0	443	184	40	5,161	217	28	1,559	**8,874**
9	1,200	14	239	53	1,519	784	388	143	4,101	941	253	1,689	42	3,098	**14,465**
10	84	4	0	42	302	22	46	44	893	33	4	90	53	441	**2,058**
11	300	0	14	46	122	140	155	6,166	212	12	76,407	515	698	3,984	**88,772**
12	2,070	95	232	228	18,596	1,636	544	123	1,934	185	395	13,305	19	1,401	**40,763**
13	126	13	22	26	192	6	14	27	49	0	804	98	98	173	**1,647**
14	11,114	380	166	205	2,927	913	206	771	5,775	196	3,188	1,332	150	37,289	**64,611**
Total	**217,564**	**10,049**	**12,163**	**16,763**	**34,825**	**9,667**	**2,767**	**8,379**	**17,928**	**1,742**	**86,805**	**33,735**	**1,534**	**60,254**	514,174

Table 24 Final Matrix - Gravity Model 12hr Matrices (Vehicles)

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2	0	8,432	173	7,882	0	0	0	0	0	0	0	0	0	294	**16,780**
3	0	173	7,868	4,561	0	0	0	0	0	261	0	0	0	15,169	**28,031**
4	0	7,949	4,731	143,976	0	0	0	0	0	90	0	0	0	28,905	**185,651**
5	0	0	0	0	111	959	0	0	0	0	0	0	0	0	**1,070**
6	0	0	0	0	1,134	10,556	562	1,978	7,844	0	0	1,775	190	537	**24,575**
7	0	0	0	0	0	580	1,701	1,238	2,012	0	0	5,481	534	137	**11,683**
8	0	0	0	0	0	2,002	1,241	9,892	3,978	411	2,364	2,225	2,577	2,084	**26,774**
9	0	0	0	0	0	7,899	1,994	3,958	2,276	0	0	1,557	261	0	**17,946**
10	0	0	496	101	0	0	0	408	0	132	0	43	15	510	**1,706**
11	0	0	0	0	0	0	0	2,324	0	0	0	388	7,927	3,278	**13,916**
12	0	0	0	0	0	1,815	5,435	2,232	884	121	396	45,136	6,506	109	**62,635**
13	0	0	0	0	0	194	643	2,610	262	15	8,141	6,634	86,158	6,569	**111,226**
14	0	167	16,077	28,688	0	318	81	1,290	0	344	2,013	106	6,453	430,677	**486,213**
Total	**0**	**16,720**	**29,345**	**185,207**	**1,245**	**24,323**	**11,656**	**25,929**	**17,255**	**1,374**	**12,915**	**63,347**	**110,621**	**488,270**	**988,207**

6 Model Development – Assignment Process

6 Model Development – Assignment Process

6.1 Overview

Highway trips have been assigned to the highway network using the SATALL module in SATURN. Three time periods are modelled, each an average hour, covering the following hours:

- AM Peak (07:00 to 09:00);
- Inter Peak (10:00 to 15:00); and
- PM Peak (16:00 to 18:00).

6.2 Modelling Assumptions

6.2.1 Generalised Cost

Assignment routings are derived from comparing the generalised cost of the various options to determine the least cost route for each movement. The model then uses a standard equilibrium type assignment to distribute trips over routes.

The generalised cost takes account of the costs of making a journey in terms of travel time and operating costs, which includes toll charges.

6.2.2 Values of Time and Operating Costs

The values of time for non home based purposes and home based employers business have been derived from WebTAG unit 3.5.6 (April 2011) corrected to 2010 values. For home based work and home based other, the approach outlined in Section 11.4 of Annex A of the currently consultation WebTAG Unit 3.12.2 has been followed. The values of time used in the model are shown in **Table 25**.

Table 25 Base Model Values of Time Per Vehicle

Vehicle Type / Purpose	Pence per minute
Car – HBW – Low Income	6.38
Car – HBW – Med Income	9.24
Car – HBW – High Income	13.18
Car – HBEB	68.20
Car – HBO – Low Income	10.63
Car – HBO – Med Income	12.08
Car – HBO – High Income	13.83
Car – NHBEB	67.93
Car – NHBO	18.09
Goods 1	23.80
Goods 2	23.80
Goods 3	23.80
Goods 4	23.80

Operating costs take account of fuel costs on the network. Fuel consumption varies with speed, so to derive an average cost per mile, an average speed of 50 mph has been used to derive fuel costs. The values used for the model are shown in **Table 26**.

Table 26 Base Model Vehicle Operating Costs

Vehicle Type / Purpose	Pence per mile
Car – HBW – Low Income	5.47
Car – HBW – Med Income	5.47
Car – HBW – High Income	5.47
Car – HBEB	10.12
Car – HBO – Low Income	5.47
Car – HBO – Med Income	5.47
Car – HBO – High Income	5.47
Car – NHBEB	10.12
Car – NHBO	5.47
Goods 1	25.07
Goods 2	25.07
Goods 3	44.47
Goods 4	44.47

Below is a worked example of the generalised cost calculations for values of time and vehicle operating costs.

Value of Time Calculation 2010 (e.g. HBW)

$$= \left(\left(GDPxKx \left(\frac{bt}{bc} \right) x \left(\left(\frac{income}{inc0\ x\ k} \right)^{income\ elasticity} \right) x \left(\left(\frac{distance}{Do} \right)^{distance\ elasticity} \right) \right) \right) xoccupancy$$

Where:

GDP = 1.230131905 (webTAG 3.12.2c)

K (factor to allow for differences between base year 1994 income and data year) = 1.482998 (webTAG 3.12.2c)

bt (time coefficient) = -0.10098 (webTAG 3.12.2c Table A6)

bc (distance coefficient) = -0.024729 (webTAG 3.12.2c Table A6)

income = Average Income from RSI survey

inc0 (base income value, 1994) = 35

income elasticity = 0.358773 (webTAG 3.12.2c Table A6)

distance = Average Distance from RSI survey

Do = 7.58 (webTAG 3.12.2c Table A6)

Distance elasticity = 0.421305 (webTAG 3.12.2c Table A6)

Occupancy = 1.08 (Car occupancy 2010 – Non Work (webTAG 3.5.6))

Vehicle Operating Cost Calculation 2010 (e.g. HBW)

$$= \left(\left(\frac{\% \ Petrol}{100} \right) x (Petrol\ fuel\ Consumption\ x\ (Petrol\ resourceCost + Duty) x \left(1 + \frac{VAT}{100} \right) \right)$$

$$+ \left(\left(\frac{\% Diesel}{100} \right) x (Diesel\ fuel\ consumption\ x\ (Diesel\ resourceCost + Duty) x \left(1 + \frac{VAT}{100} \right) \right)$$

Where:

% Petrol = 59.8 (% of Petrol Cars 2010)

% Diesel = 40.2 (% of Diesel Cars 2010)

Petrol Fuel Consumption = 0.063 (2010)

Diesel Fuel Consumption = 0.048 (2010)

Petrol Resource Cost =34.6 (2010

Diesel Resource Cost =36 (2010)

Duty = 46.45 (2010)

VAT = 17.5 (2010)

(Source: webTAG 3.5.6)

6.2.3 Tolls

Tolls are added as a link penalty applied to all vehicles crossing the bridge. Tolls are expressed in terms of pence and relate to the current toll schedule on the bridge. For consistency with the price base for other elements of the modelling it was necessary to convert 2010 toll levels to 2002 prices by dividing actual tolls by the change in RPI between 2002 and 2010. Current toll levels , which is shown in **Table 27** (Numbers quoted at 2010 values and 2002 prices).

Table 27 Base Model Humber Bridge Toll Levels

Class	Description	Actual toll in 2010 prices and values	Model toll value 2010 values 2002 prices
1	Motor Cycles	not modelled	not modelled
2	Cars and Goods vehicles having a maximum weight not exceeding 3.5 tonnes including Motor Caravans	270	213
3	Goods vehicles having a maximum gross vehicle weight exceeding 3.5 tonnes but not exceeding 7.5 tonnes. Vehicles within Class 2 above, with trailers. Small buses (with seating for 9-16 passengers)	490	386
4	Goods vehicles having a maximum gross vehicle weight exceeding 7.5 tonnes with 2 axles. Large buses (with seating for 17 or	1090	859

	more passengers)		
5	Goods vehicles having a maximum gross vehicle weight exceeding 7.5 tonnes with 3 axles	1460	1150
6	Goods vehicles having a maximum gross vehicle weight exceeding 7.5 tonnes with 4 or more axles	1830	1442

6.2.4 Convergence Criteria

Whilst standard practice for SATURN model convergence has previously involved the monitoring of the percentage of links on which flow changes by less than 5% on consecutive iterations, the more recent trend has been towards measuring the level of convergence by assessment of the duality gap value. Indeed the gap value has a sound theoretical basis and SATURN guidance states that the gap value should be viewed as the most important indication of overall convergence. DMRB Volume 12 states that *'the duality gap expresses the flow-weighted difference between current total cost estimates on the network, as determined by the present flow pattern and the speed/flow curves, and the costs if all traffic would use minimum cost routes (as calculated by the next all-or-nothing assignment).'*

DMRB states that the value should be less than 1% but that values of typically less than 0.1% are preferred.

Within the HETM, the STPGAP value in the model is set to 0.05 so that the model continues to run until this is achieved. In Saturn, STPGAP represents the critical gap value (%) used to terminate the assignment-simulation loops, and represents the difference between the current total vehicle costs on the assigned routes and the total vehicle costs if all drivers were to use minimum cost routes with the costs fixed.

In addition to achieving the necessary duality gap value, DMRB recommends that percentage flow change on links should also be monitored, with 95% of links having flows changing by less than 5% on consecutive iterations.

Upon completion of the validation of the model, the convergence of the model achieved the required levels, these are summarised in **Table 28**.

Table 28 Summary of Model Convergence

Peak	Number of Assignment Loops	% Flow	% Delay	% Gap
AM Peak	19	99.3%	99.7%	0.024%
Interpeak	12	99.0%	99.7%	0.017%
PM Peak*	49	98.9%	99.4%	0.036%

***The PM Peak achieves a gap values of around 0.07% after 24 iterations, however takes a total of 49 iterations to achieve consecutive iterations below a % gap of 0.05

7 Model Calibration

7 Model Calibration

7.1 Overview

This section describes the calibration of the traffic model. This stage, along with validation in the subsequent chapter, represents the fine tuning of the model inputs and parameters, and the processes involved in ensuring and demonstrating that the base year model is accurately defined and thus a suitable tool for testing and forecasting.

7.2 Network Structure

Traditionally the checking of networks for large transport models was a very time consuming process however the emergence of GIS techniques over the recent past has greatly improved the efficient checking of large scale networks.

Various aspects of the HETM model (network, zone structure, count data etc.) have been developed with reference to an underlying GIS structure and there has therefore been a considerable element of in-built cross checking throughout the development process.

But as a final check on the network development process, the following have been undertaken:

- Path check within the SATURN assignment to ensure that all zones can reach all other zones and that there are no missing links;
- Comparison between model link lengths and crow fly distances based on node co-ordinates;
- Comparison between model link lengths and GIS mapped link lengths (see section 4.2.3 and 4.3.2); and
- Visual inspection of location of urban versus rural etc. link types.

7.3 Link Speeds and Delays

The availability of TrafficMaster data on this project enabled a comprehensive check to be made on journey times across a wider range of routes than would normally be expected for a transport model. These are reported on in detail in Chapter 8. This chapter also includes a report on model journey times between various key settlements.

7.4 Use of Matrix Estimation

Matrix Estimation has not been used in the development of HETM.

7.5 Calibration Screenlines

Existing RSI data from the model area was used to provide as much observed coverage of the network as possible, these comprise of a number of separate data sets covering the core areas of the model, and these include:

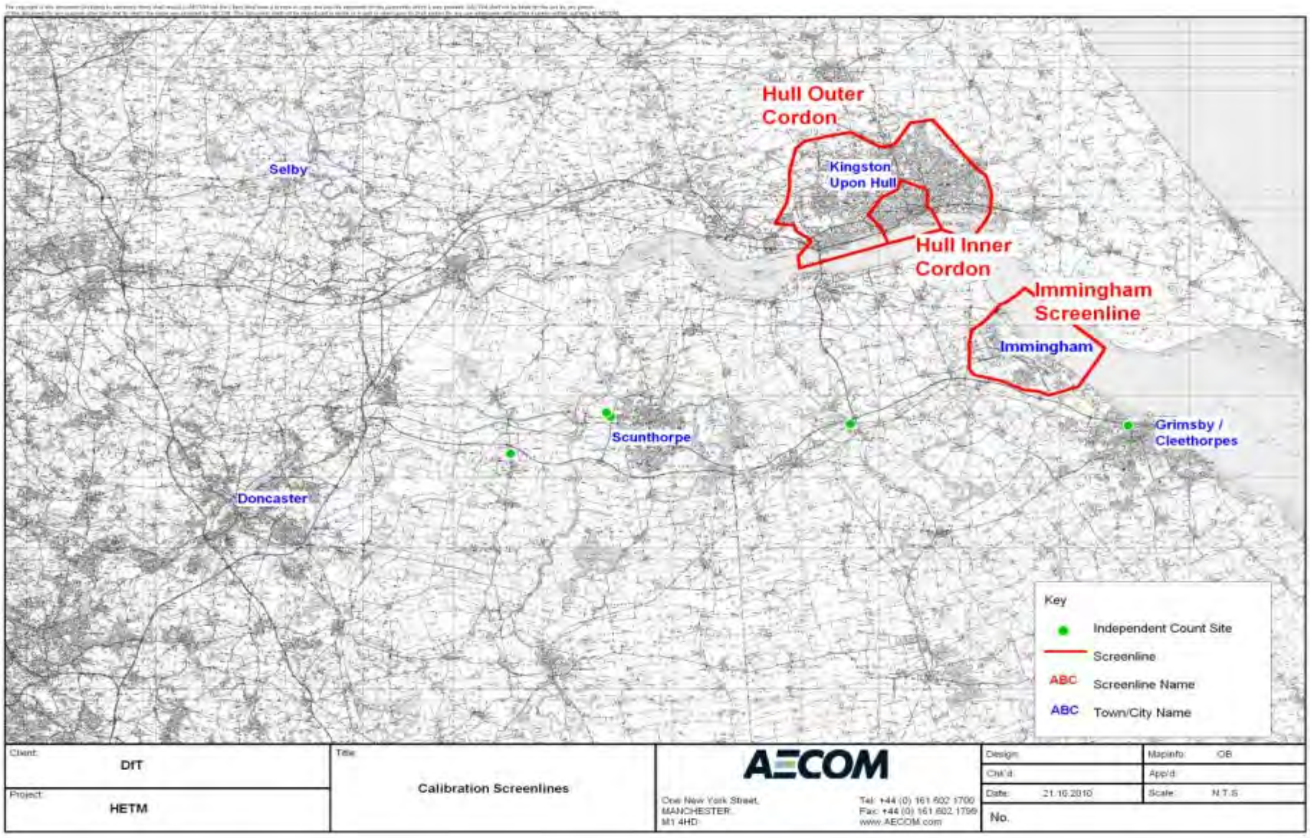
- Hull City Region;
- Immingham;
- HETM Independent sites;
- Lincoln, and;
- Doncaster

A number of these sites form screenlines and cordons which have enabled a robust calibration of the model, these key sites used for calibration are:

- Hull Outer cordon – cordon surrounding the Hull City Region providing a water tight cordon;
- Hull Inner Partial Cordon – A cordon within central Hull providing counts on all major radials and most minor routes; and
- Immingham cordon – provides a water tight cordon around the Immingham area.

A plan showing the locations of these screenlines is provided in **Figure 22**.

Figure 22 Calibration Screenlines



For the Hull Inner Cordon, this site was calibrated at the cordon level, as at the individual site by site levels there are some variations between radial routes. This is due to a less detailed model zoning and network structure within Hull. However in terms of impacts on the Humber Bridge and hence this study, we would expect should have a minimal impact on flows using the Humber Bridge. This is because the observed matrices was developed using RSI sites at both the Humber Bridge and on radials into Hull and so within the model these journeys will still be represented at the strategic level, however due to the reduced network detail in central Hull some localised routing may have been diverted onto alternative radial route. As a result, this is only reported at the screenline level.

Whilst the other observed data sets of Lincoln and Doncaster has been used to inform the observed trips within the model, it has not been possible to calibrate these data sets for the following reasons:

- The locations of Lincoln and Doncaster are on the periphery of the buffer network area;
- As a result the level of model zoning is less detailed, resulting in difficulties providing water tight cordons and screenlines around these data sets;
- The network structure is less detailed, providing a small number of routes, these will lead to difficulties in the capture of some data sites
- Due to the course zoning around these data sets, the intra-zonal trips (within Lincoln or within Doncaster areas) will not be captured, in some cases these trips may cross the cordons and so would not be shown within the model.

Whilst it has not been possible to calibrate these data sets, the core longer distance trips have been included within the model to ensure a robust set of data for trips within the Humber Estuary. As a number of the localised trips are on the periphery of the network, these are considered less relevant in terms of the purpose of the uses of the HETM model.

7.6 Calibration Results

This section presents a review of the level of calibration of the model.

There are three calibration screenlines: Hull Outer, Hull Inner and Immingham as illustrated above.

In the morning peak, only the Hull Outer screenline in the outbound direction fails to meet the criteria with a flow difference of 5% and a GEH of 4.5. The outbound direction is the less critical one in the morning peak as the balance of flow is towards Hull and we feel the level of calibration achieved is satisfactory.

In the interpeak, the Hull Outer screenline in the outbound direction just fails on GEH and flow criteria with a value of GEH 5.7 and percentage flow difference of 6%. The Immingham screenline is fine in GEH terms but has percentage differences of 6% (Inbound) and 8% Outbound). As the flows involved here are relatively low, we feel this is acceptable.

In the evening peak, the Immingham screenline just fails at 6% but is fine in GEH terms. The Hull outer screenline, again only in the less critical (inbound) direction just misses the criteria.

Overall we feel the fit of the model is acceptable.

Table 29 Calibration Screenline Summary

Description							
Screenline	**Direction**	**Model**	**Obs**	**%**	**GEH**	**GEH PASS**	**Pass Flow Criteria**
AM PEAK							
Hull Outer	Inbound	12110	12316	-2%	1.9	YES	YES
	Outbound	9298	9742	-5%	4.5	NO	YES
Hull Inner	Inbound	15334	15676	-2%	2.7	YES	YES
	Outbound	10953	11284	-3%	3.1	YES	YES
Immingham	Inbound	3496	3581	-2%	1.4	YES	YES
	Outbound	1858	1934	-4%	1.7	YES	YES
INTERPEAK							
Hull Outer	Inbound	8204	8428	-3%	2.5	YES	YES
	Outbound	9202	8663	6%	5.7	NO	NO
Hull Inner	Inbound	12867	12872	0%	0.0	YES	YES
	Outbound	13823	13439	3%	3.3	YES	YES
Immingham	Inbound	1922.3	1807	6%	2.7	YES	NO
	Outbound	1769.9	1929	-8%	3.7	YES	NO
PM PEAK							
Hull Outer	Inbound	9912	10593	-6%	6.7	NO	NO
	Outbound	13406	13420	0%	0.1	YES	YES
Hull Inner	Inbound	11130	11320	-2%	1.8	YES	YES
	Outbound	15363	15336	0%	0.2	YES	YES
Immingham	Inbound	1954	1844	6%	2.5	YES	NO
	Outbound	3393	3214	6%	3.1	YES	NO

The calibration of observed data on an individual site by site basis can be found in **Table 30**, a more detailed breakdown on of this data is provided in Appendix E.

Table 30 Calibration Summary - Individual Sites

Description	AM Peak		Interpeak		PM Peak	
Screenline	No. of sites meeting GEH	No. of sites meeting flow criteria	No. of sites meeting GEH	No. of sites meeting flow criteria	No. of sites meeting GEH	No. of sites meeting flow criteria
Calibration Sites						
All sites	29	31	22	21	27	27
% meeting Criteria	76%	82%	58%	55%	71%	71%

Whilst not a defined target within DMRB, it was agreed with the client group that a suitable target value for goods vehicle representation was to be 25% at the screenline level. This was achieved in all instances in the morning peak and evening peaks and in five out of six cases in the Interpeak which we feel is a very strong performance.

Table 31 HGV Screenline Summary

Description					
Screenline	**Direction**	**Modelled**	**Observed**	**Percentage difference**	**PASS**
AM PEAK					
Hull Outer	Inbound	2,369	1,926	23%	YES
	Outbound	2,575	2,369	9%	YES
Hull Inner	Inbound	2,436	2,364	3%	YES
	Outbound	2,478	2,198	13%	YES
Immingham	Inbound	907	842	8%	YES
	Outbound	1,279	1,125	14%	YES
INTERPEAK					
Hull Outer	Inbound	2,265	1,915	18%	YES
	Outbound	3,390	2,058	65%	NO
Hull Inner	Inbound	2,337	2,125	10%	YES
	Outbound	2,879	2,401	20%	YES
Immingham	Inbound	1,136	1,005	13%	YES
	Outbound	1,068	1,043	2%	YES
PM PEAK					
Hull Outer	Inbound	1,653	1,548	7%	YES
	Outbound	1,931	1,719	12%	YES
Hull Inner	Inbound	1,447	1,223	18%	YES
	Outbound	1,690	1,627	4%	YES
Immingham	Inbound	1,078	891	21%	YES
	Outbound	807	781	3%	YES

8 Model Validation

8 Model Validation

8.1 Overview

The model has been validated according to the method recommended in the Design Manual for Roads and Bridges, Volume 12.2.1. This involved comparing, for each time period and for each vehicle type assigned separately, the following:

- Total assigned and counted flows on roads crossing screenlines and cordons, as a check on the matrices;
- Assigned and counted flows on individual links;
- Assigned and counted flows making turning movements at key junctions (subject to accuracy of the data used); and
- Modelled and observed journey time along routes.

The relevant criteria and acceptability guidelines are reproduced below.

Table 32 DMRB Validation Criteria

Criteria and Measures	Acceptability Guideline
<u>Assigned hourly flows* compared with observed flows</u>	
1. Individual flows within 15% for flows 700 – 2,700 vph 2. Individual flows within 100vph for flows < 700 vph 3. Individual flows within 400 vph for flows > 2,700 vph	)) 85% of cases)
4. Total screenline flows (normally > 5 links) to be within 5%	All (or nearly all) screenlines
5. GEH statistic **: i) individual flows: GEH < 5 ii) screenline (+) totals: GEH < 4	 > 85% of cases All (or nearly all) screenlines
Notes: + Screenlines containing high flow routes such as Motorways should be presented both including and excluding such routes. * links and turning movements (but see paragraph 4.4.37 in DMRB 12.2.1) ** See paragraph 4.4.2 in DMRB 12.2.1	
<u>Modelled journey times compared with observed times</u>	
6. Times within 15% (or 1 minute, if higher)	> 85% of routes

8.2 Assignment Flow Validation Overview

In accordance with modelling best practice, a large number of count sites have been kept back from the model development process to provide an independent test on the ability of the model to replicate observed flows. A total of 58 count sites have been used for this purpose, spread across the model area and grouped into screenlines.

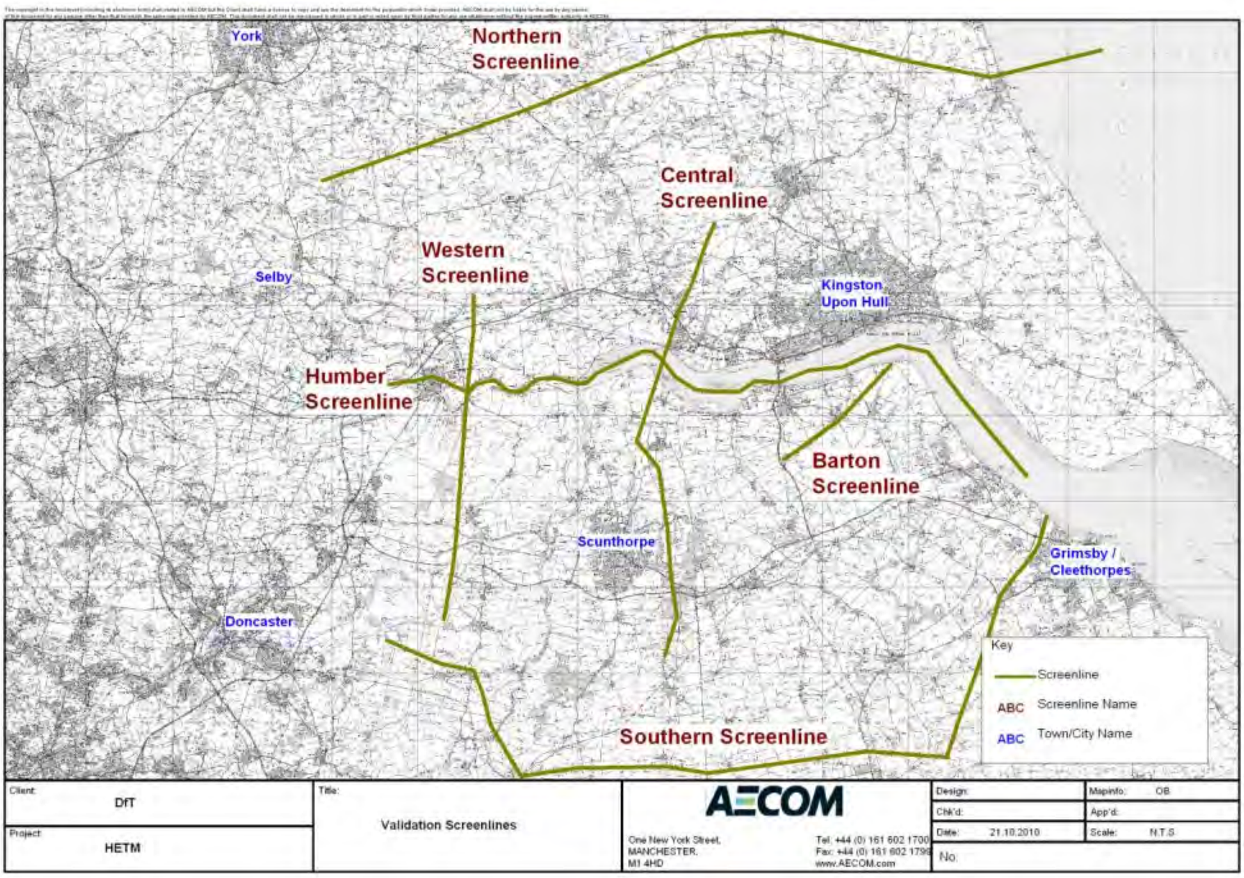
The screenlines are illustrated in **Figure 23**, and the results are discussed in the following sections.

8.3 Screenline Performance

The target validation criteria for screenlines is a GEH value of 4 or within 5% overall. In terms of GEH, the screenlines perform well with ten out of twelve passing in the morning and interpeak and all passing in the evening peak.

In percentage terms eight out of twelve meet the criteria in the morning and interpeak and ten out of twelve in the evening. For the morning, two of those screenlines are on the low flow Barton screenline and the remaining two are only just outside at 6%. In the interpeak, apart from one low flow screenline, the missing elements are again very close at 6% and 7%. A very similar result is observed in the PM.

Figure 23 Location of the Validation Screenlines



8.4 Individual Flows

The DMRB Target in this case is for 85% of the sites to be within the required criteria. Again, two measures are available, the first based on GEH and the second on a combination of absolute and percentage flow difference depending on the scale of the count.

The performance of the HETM is very strong in both terms, with the AM and PM peak marginally outside the GEH target, at 84% and 81%, and the inter peak slightly further off at 74%. The performance against flow is even stronger with the AM exceeding, at 88%, the PM again only marginally under at 83% and the inter peak not far behind at 78%.

A full validation breakdown of individual link flows are presented in Appendix E.

8.5 Flow Summary

Whilst not strictly meeting the DMRB target criteria, the performance needs to be viewed in the context that the model development has not involved any use of matrix estimation (ME). This technique is typically used by modellers to get a better fit between observed and model flows by using algorithms within the assignment software to adjust the base matrices. As this model was operating with a high degree of demand segmentation and also incorporating P/A as well as O/D representations of demand, this approach was not used as it would have been very difficult to maintain the consistency of demand across the various model segments. The lack of ME has placed additional demands on the skills of the modellers developing the HETM but has resulted in a more robust tool overall.

It is also worth reiterating that a significant dataset (58 count sites) were held back for independent validation and therefore the validation is a significant and comprehensive test of the model's performance.

Furthermore, the need to ensure network consistency between time periods, in order to enable the 12 hour P/A model to function on a theoretically sound basis, has meant that no time period specific network corrections have been undertaken. This necessitated a balancing of performance between the periods but the final results reflect very well on the model's ability given this issue and the lack of any use of ME as referred to previously.

Table 33 Validation Summary - Screenlines

Criteria	Time Period	Validation Fit		Calibration Fit	
		No. of screenlines meeting criteria	Number of screenlines	No. of screenlines meeting criteria	Number of screenlines
Flow Screenlines					
GEH	AM Peak	10	12	5	6
	Interpeak	10		5	
	PM Peak	12		5	
Criteria Assessed against:		GEH < 4		GEH < 4	
Flow Criteria	AM Peak	8	12	6	6
	Interpeak	8		3	
	PM Peak	10		3	
Criteria Assessed against:		Screenline flows < 5%			

(1) No DMRB standard for HGV percentages, criteria of 25% was advised by DfT

Table 34 Validation Summary – Individual Sites

Criteria	Time Period	Validation Fit			Calibration Fit		
		No. of sites meet criteria	Number of sites	% Meet DMRB	No. of sites meet criteria	Number of sites	% Meet DMRB
Validation Fit – Individual flows							
GEH	AM Peak	49	58	84%	29	38	76%
	Interpeak	43		74%	22		58%
	PM Peak	47		81%	27		71%
Criteria Assessed against:		GEH < 5					
Flow Criteria	AM Peak	51	58	88%	31	38	82%
	Interpeak	45		78%	21		55%
	PM Peak	48		83%	27		71%
Criteria Assessed against:		< 700 = within 100vph / 700 - 2700 vph			within 15% . > 2700 within 400vph		

Table 35 Validation Summary – Journey Time Routes

Criteria	Time Period	Validation Fit		
		No. of sites meet criteria	Number of sites	% Meet DMRB
Journey Time Validation				
Time (mins)	AM Peak	19	20	95%
	Interpeak	20		100%
	PM Peak	16		80%
Criteria Assessed against:		Route End to End time within 15%		

Table 36 Validation Summary – HGV Percentages

Criteria	Time Period	Validation Fit			Calibration Fit		
		No. of sites meet criteria	Number of sites	% Meet DMRB	No. of sites meet criteria	Number of sites	% Meet DMRB
HGV Percentages (1)							
Flow Criteria	AM Peak	8	12	67%	6	6	100%
	Interpeak	8		67%	5		83%
	PM Peak	8		67%	6		100%
Criteria Assessed against:		Screenline HGV flow within 25%					

Table 37 Individual Flow Summary Table

Description	AM Peak		Interpeak		PM Peak	
Screenline	**No. of sites meeting GEH**	**No. of sites meeting flow criteria**	**Number of sites meeting GEH Criteria**	**Number of sites meeting flow criteria**	**Number of sites meeting GEH Criteria**	**Number of sites meeting flow criteria**
Validation Sites						
All sites	49	51	43	45	47	48
% meeting Criteria	84%	88%	74%	78%	81%	83%
Calibration Sites						
All sites	29	31	22	21	27	27
% meeting Criteria	76%	82%	58%	55%	71%	71%
Combined (Validation & Calibration sites)						
All sites	78	82	65	66	74	75
% meeting Criteria	81%	85%	68%	69%	77%	78%

Table 38 Screenline Summary Table

Description		AM Peak						Interpeak						PM Peak					
Screenline	Direction	Model	Obs	%	GEH	GEH PASS	Pass Flow Criteria	Model	Obs	%	GEH	GEH PASS (1)	Pass Flow Criteria	Model	Obs	%	GEH	GEH PASS	Pass Flow Criteria
North / South	**Screenline**																		
Northern Screenline	Northbound	2330	2384	-2%	1.1	YES	YES	2185	2283	-4%	2.1	YES	YES	2619	2628	0%	0.2	YES	YES
	Southbound	2569	2487	3%	1.6	YES	YES	2136	2050	4%	1.9	YES	YES	2654	2823	-6%	3.2	YES	NO
Southern Screenline	Northbound	5110	4810	6%	4.3	NO	NO	3769	3712	2%	0.9	YES	YES	4818	4570	5%	3.6	YES	YES
	Southbound	4444	4339	2%	1.6	YES	YES	3775	3706	2%	1.1	YES	YES	5079	5108	-1%	0.4	YES	YES
Humber Screenline	Northbound	4054	4052	0%	0.0	YES	YES	2865	3039	-6%	3.2	YES	NO	4024	4213	-4%	3.0	YES	YES
	Southbound	4294	4121	4%	2.7	YES	YES	2944	3033	-3%	1.6	YES	YES	4034	4039	0%	0.1	YES	YES
East / West	**Screenline**																		
Western Screenline	Eastbound	4494	4463	1%	0.5	YES	YES	3440	3169	9%	4.7	NO	NO	4282	4222	1%	0.9	YES	YES
	Westbound	4009	4243	-6%	3.7	YES	NO	3313	3378	-2%	1.1	YES	YES	4508	4246	6%	4.0	YES	NO
Central Screenline	Eastbound	5179	5082	2%	1.4	YES	YES	4097	4160	-2%	1.0	YES	YES	5727	5454	5%	3.7	YES	YES
	Westbound	6330	6038	5%	3.7	YES	YES	4856	4478	8%	5.5	NO	NO	6176	5963	4%	2.7	YES	YES
Barton Screenline	Westbound	525	608	-14%	3.5	YES	NO	398	366	9%	1.7	YES	NO	551	525	5%	1.1	YES	YES
(low flow Screenline)	Eastbound	519	421	23%	4.5	NO	NO	344	355	-3%	0.6	YES	YES	581	594	-2%	0.6	YES	YES
Calibration - Hull	**Cordon**																		
Hull Outer Cordon	Inbound	12110	12316	-2%	1.9	YES	YES	8204	8428	-3%	2.5	YES	YES	9912	10593	-6%	6.7	NO	NO
	Outbound	9298	9742	-5%	4.5	NO	YES	9202	8663	6%	5.7	NO	NO	13406	13420	0%	0.1	YES	YES
Hull Inner Cordon (Partial)	Inbound	15334	15676	-2%	2.7	YES	YES	12867	12872	0%	0.0	YES	YES	11130	11320	-2%	1.8	YES	YES
	Outbound	10953	11284	-3%	3.1	YES	YES	13823	13439	3%	3.3	YES	YES	15363	15336	0%	0.2	YES	YES
Calibration - Immingham	**Cordon**																		
	Inbound	3496	3581	-2%	1.4	YES	YES	1922.3	1807	6%	2.7	YES	NO	1954	1844	6%	2.5	YES	NO
	Outbound	1858	1934	-4%	1.7	YES	YES	1769.9	1929	-8%	3.7	YES	NO	3393	3214	6%	3.1	YES	NO

Table 39 HGV Screenline Table

Description		AM Peak (pcus)				Interpeak (pcus)				PM Peak (pcus)			
Screenline	Direction	Modelled	Observed	Percentage difference	PASS	Modelled	Observed	Percentage difference	PASS	Modelled	Observed	Percentage difference	PASS
North / South Screenlines													
Northern Screenline	Northbound	467	434	8%	YES	628	497	26%	NO	279	264	6%	YES
	Southbound	565	337	68%	NO	543	470	16%	YES	344	297	16%	YES
Southern Screenline	Northbound	832	791	5%	YES	1,118	998	12%	YES	824	565	46%	NO
	Southbound	1,199	949	26%	NO	1,221	948	29%	NO	608	608	0%	YES
Humber Screenline	Northbound	1,127	1,421	-21%	YES	928	1,326	-30%	NO	785	1,400	-44%	NO
	Southbound	1,367	1,545	-11%	YES	1,273	1,332	-4%	YES	1,042	1,245	-16%	YES
East / West Screenlines													
Western Screenline	Eastbound	1,858	1,686	10%	YES	1,870	1,530	22%	YES	1,408	1,586	-11%	YES
	Westbound	1,701	1,660	2%	YES	1,606	1,540	4%	YES	1,201	1,538	-22%	YES
Central Screenline	Eastbound	1,592	1,952	-18%	YES	1,702	1,711	-1%	YES	1,447	1,605	-10%	YES
	Westbound	2,051	1,945	5%	YES	2,182	1,956	12%	YES	1,203	1,752	-31%	NO
Barton Screenline	Westbound	153	95	61%	NO	131	94	40%	NO	86	62	38%	NO
(Low flow Screenline)	Eastbound	204	80	157%	NO	89	96	-8%	YES	47	51	-8%	YES

8.6 Journey Time Validation Results

The use of TrafficMaster data has enabled a large number of journey time routes (10 in total) to be assessed which is greater than would normally be expected. The model has been evaluated in each time period and in each direction for all ten routes and the DMRB criteria have been met in all cases.

This means that the model is reflecting the travel times, and therefore travel costs, accurately across the day and across the model area. This is an area of model validation which is sometimes not given due weight by modellers, but in this instance is of particular importance as the model needs to able to represent the trade-offs between time and toll charge that users make when selecting their route. The very strong performance of the model in this regard gives added confidence to the process and the subsequent economic analysis that will be undertaken

Tables 28 - 30 provide a summary comparison of end to end journey times. Diagrams of each Journey Time route and a full section by section breakdown for each route can be found in Appendix F.

Table 40 AM Peak End to End Journey Time Comparison

Route No.	Route	Base Time (mins)	Base Length (miles)	Model Time (mins)	Model Length (miles)	Time %	Length %
Forward Direction							
1	Lincoln to Hull	62.85	45	59.20	45	-5.8%	1%
2	Grimsby to Hull	50.57	34	53.50	35	5.8%	1%
3	Immingham to Hull	45.80	24	42.40	24	-7.4%	1%
4	Thorne to Hull	50.83	43	48.20	43	-5.2%	0%
5	Scunthorpe to Hull (north route)	50.79	28	42.00	27	-17.3%	-1%
6	Scunthorpe to Hull (south route)	44.36	29	40.00	30	-9.8%	2%
7	Thorne to Hull	47.29	39	42.20	37	-10.8%	-4%
8	York to Grimsby	77.68	60	85.30	60	9.8%	0%
9	Drifield to Lincoln	85.60	60	85.40	60	-0.2%	0%
10	York to Hull via Thorne	94.16	64	85.70	62	-9.0%	-2%
Reverse Direction							
1	Hull to Lincoln	60.80	45	55.70	46	-8.4%	2%
2	Hull to Grimsby	46.42	34	50.00	35	7.7%	2%
3	Hull to Immingham	40.37	24	44.30	25	9.7%	2%
4	Hull to Thorne	46.91	43	45.20	43	-3.6%	1%
5	Hull to Scunthorpe (north route)	44.73	27	40.40	28	-9.7%	5%
6	Hull to Scunthorpe (south route)	39.49	29	36.80	30	-6.8%	4%
7	Hull to Thorne	41.64	38	38.10	37	-8.5%	-2%

8	Grimsby to York	81.95	60	86.10	61	5.1%	1%
9	Lincoln to Drifield	87.22	60	81.90	60	-6.1%	0%
10	Hull to York via Thorne	87.19	63	81.90	62	-6.1%	-2%

- 9 forward routes are within 15% validation criteria, 1 routes outside 15% threshold
- All reverse routes are within 15% validation criteria

Figure 24 End to End Route Times for AM "Forward" Direction Routes

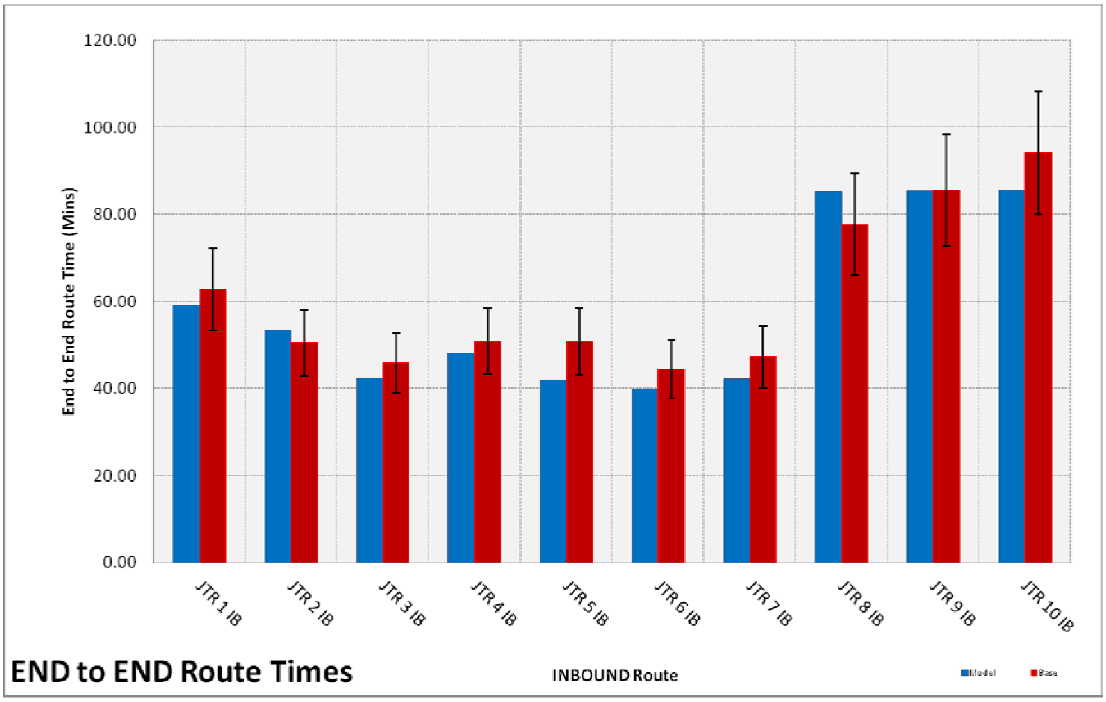


Figure 25 End to End Route Times for AM "Reverse" Direction Routes

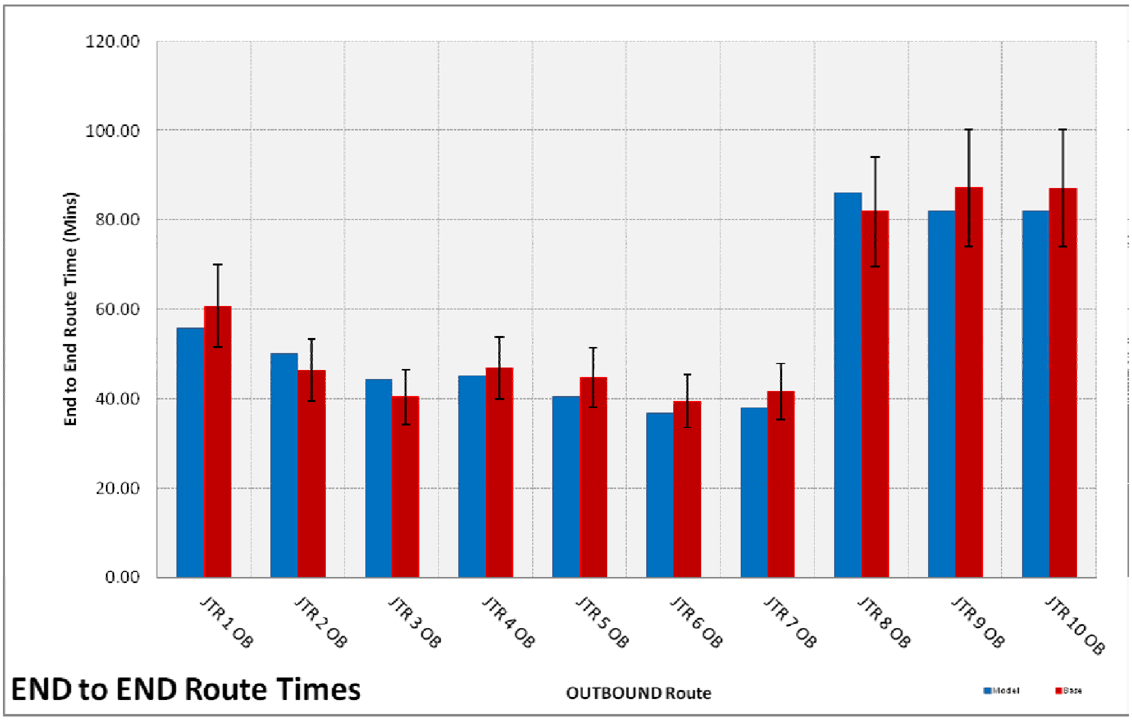


Table 41 Inter-Peak End to End Journey Time Comparison

Route No.	Route	Base Time (mins)	Base Length (miles)	Model Time (mins)	Model Length (miles)	Time %	Length %
Forward Direction							
1	Lincoln to Hull	56.74	45	55.60	45	-2.0%	1%
2	Grimsby to Hull	45.06	34	50.10	35	11.2%	1%
3	Immingham to Hull	40.09	24	39.30	24	-2.0%	1%
4	Thorne to Hull	44.06	43	45.40	43	3.0%	0%
5	Scunthorpe to Hull (north route)	43.92	28	38.80	27	-11.7%	-1%
6	Scunthorpe to Hull (south route)	38.03	29	36.80	30	-3.2%	2%
7	Thorne to Hull	40.44	39	39.20	37	-3.1%	-4%
8	York to Grimsby	76.88	60	82.20	60	6.9%	0%
9	Drifield to Lincoln	84.88	60	80.90	60	-4.7%	0%
10	York to Hull via Thorne	86.44	64	79.60	62	-7.9%	-2%
Reverse Direction							
1	Hull to Lincoln	56.16	45	54.80	46	-2.4%	2%
2	Hull to Grimsby	45.00	34	48.70	35	8.2%	2%
3	Hull to Immingham	39.39	24	37.50	25	-4.8%	2%
4	Hull to Thorne	44.43	43	44.50	43	0.2%	1%
5	Hull to Scunthorpe (north route)	42.39	27	37.90	28	-10.6%	5%
6	Hull to Scunthorpe (south route)	36.95	29	35.50	30	-3.9%	4%
7	Hull to Thorne	39.38	38	37.80	37	-4.0%	-2%
8	Grimsby to York	78.98	60	82.80	61	4.8%	1%
9	Lincoln to Drifield	83.93	60	80.20	60	-4.4%	0%
10	Hull to York via Thorne	89.13	63	78.20	62	-12.3%	-2%

- All 20 routes are within 15% validation criteria

Figure 26 End to End Route Times for IP "Forward" Direction Routes

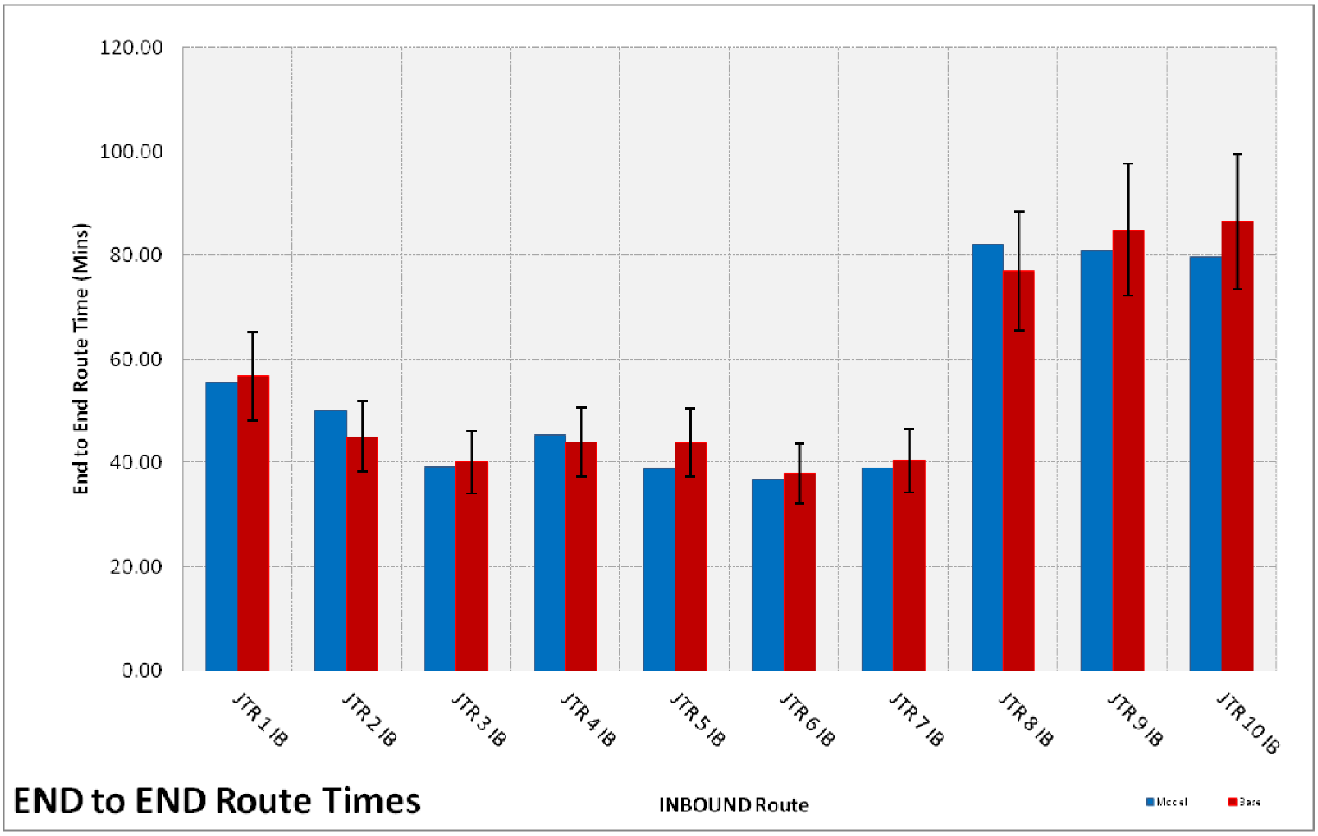


Figure 27 End to End Route Times for IP "Reverse" Direction Routes

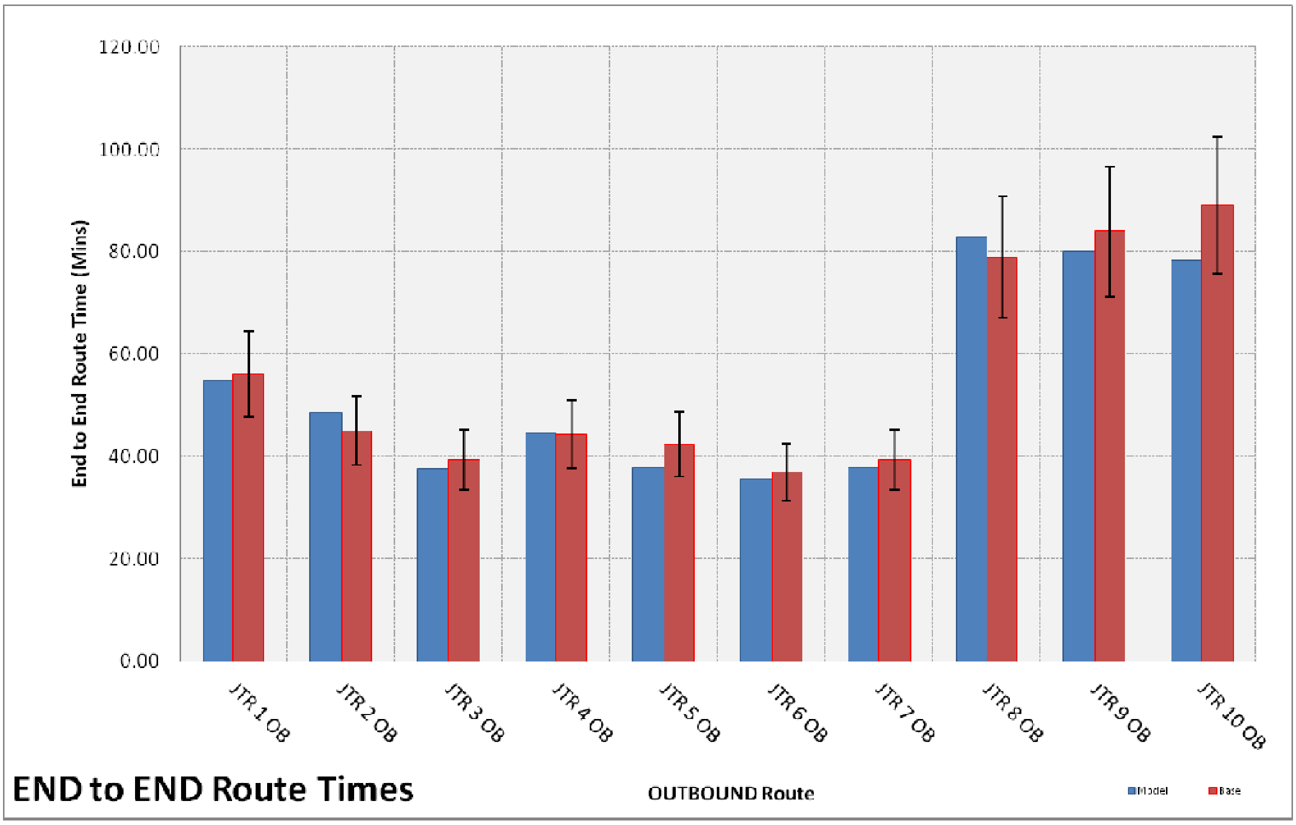


Table 42 PM Peak End to End Journey Time Comparison

Route No.	Route	Base Time (mins)	Base Length (miles)	Model Time (mins)	Model Length (miles)	Time %	Length %
Forward Direction							
1	Lincoln to Hull	54.01	45	60.10	45	11.3%	1%
2	Grimsby to Hull	42.71	34	54.00	35	26.4%	1%
3	Immingham to Hull	37.83	24	45.70	24	20.8%	1%
4	Thorne to Hull	42.09	43	49.00	43	16.4%	0%
5	Scunthorpe to Hull (north route)	41.42	28	45.30	27	9.4%	-1%
6	Scunthorpe to Hull (south route)	35.90	29	40.90	30	13.9%	2%
7	Thorne to Hull	38.60	39	42.60	37	10.4%	-4%
8	York to Grimsby	74.67	60	87.70	60	17.5%	0%
9	Drifield to Lincoln	83.03	60	86.70	60	4.4%	0%
10	York to Hull via Thorne	79.55	64	87.00	62	9.4%	-2%
Reverse Direction							
1	Hull to Lincoln	58.19	45	56.80	46	-2.4%	2%
2	Hull to Grimsby	44.87	34	51.20	35	14.1%	2%
3	Hull to Immingham	40.76	24	39.60	25	-2.8%	2%
4	Hull to Thorne	45.87	43	46.10	43	0.5%	1%
5	Hull to Scunthorpe (north route)	42.71	27	40.00	28	-6.3%	5%
6	Hull to Scunthorpe (south route)	38.05	29	37.30	30	-2.0%	4%
7	Hull to Thorne	40.78	38	39.80	37	-2.4%	-2%
8	Grimsby to York	75.93	60	87.00	61	14.6%	1%
9	Lincoln to Drifield	80.60	60	88.80	60	10.2%	0%
10	Hull to York via Thorne	87.78	63	82.90	62	-5.6%	-2%

- 6 forward routes are within 15% validation criteria, 4 routes outside 15% threshold
- All reverse routes are within 15% validation criteria

Figure 28 End to End Route Times for PM "Forward" Direction Routes

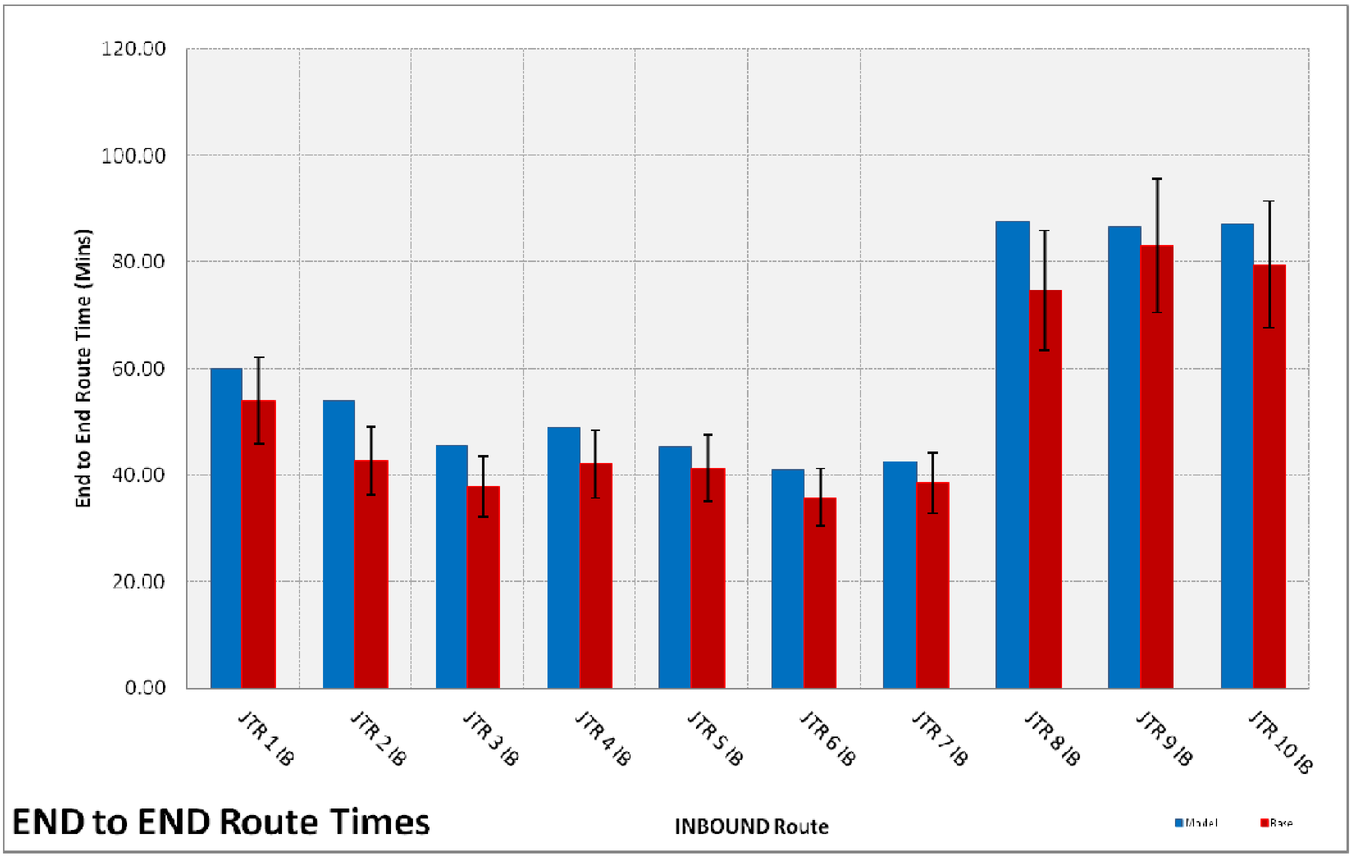
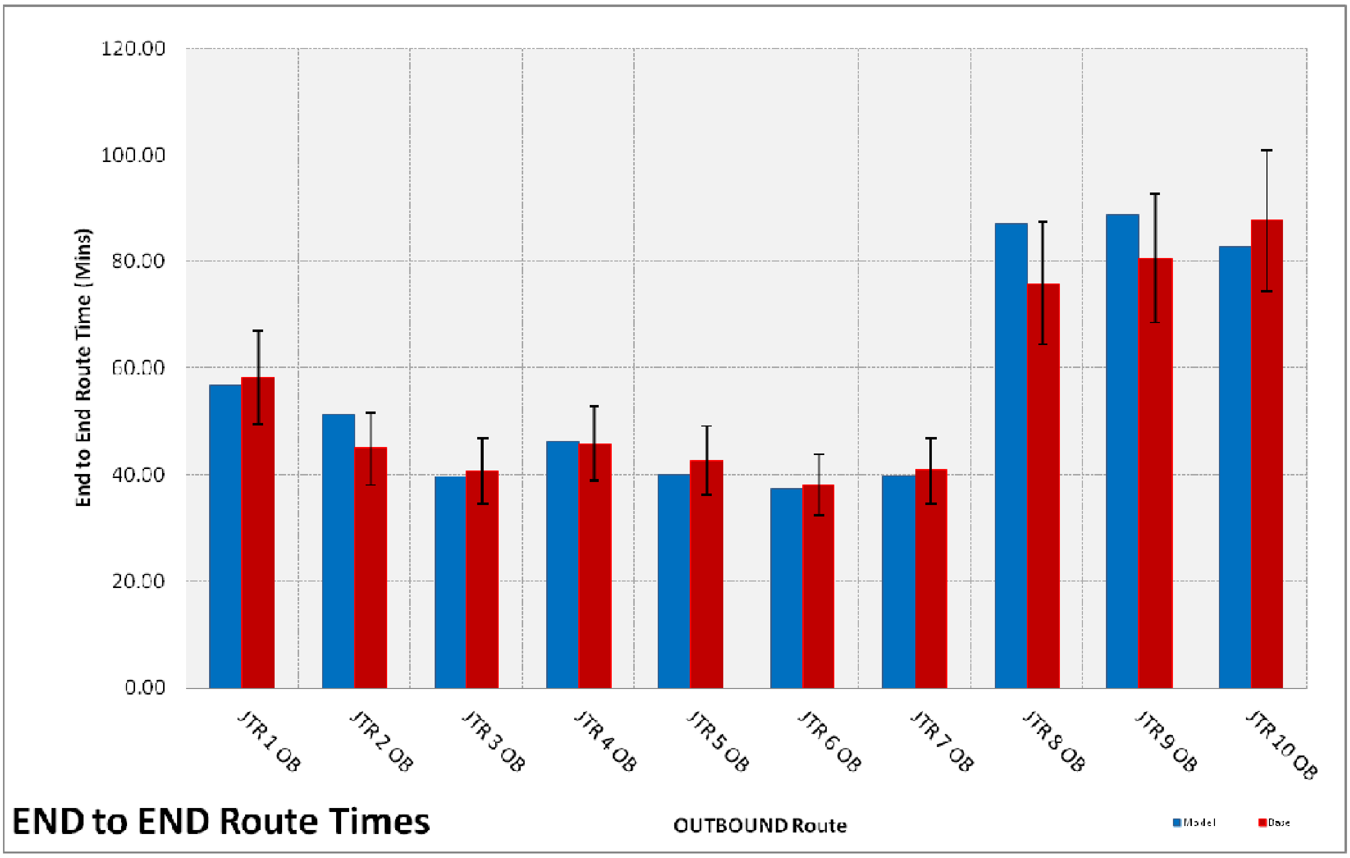


Figure 29 End to End Route Times for PM "Reverse" Direction Routes



9 Conclusions

9 Conclusions

9.1 Overview

The HETM has been designed to provide a robust modelling platform on which to investigate the economic impacts of potential changes to tolls on the Humber Bridge. The model has been designed with reference to current best practice guidance as set out in the Department for Transport's WebTAG site.

The model structure incorporates production / attraction (P/A) and origin / destination (O/D) modelling in order to ensure a consistency of trip making response throughout the day. The 12-hour (07:00 to 19:00) P/A demand modelling uses composite costs from the time period O/D assignments in order to determine the response to the various toll scenarios.

The assignment model time periods are:

- Average AM Peak Hour (07:00 to 09:00);
- Average Inter Peak Hour (10:00 to 15:00); and
- Average PM Peak Hour (16:00 to 18:00).

The assignment model uses SATURN which is probably the most commonly used assignment package in the UK. It enables two levels of network detail to be applied, simulation which incorporates detailed junction modelling, and buffer which relies on link based speed flow curves. This structure is useful for the HETM area where there are two significant urban areas (Hull and Scunthorpe) but also large areas of quite rural network.

Responses other than reassignment will be assessed using DIADEM, which is the Department's own software that has been designed to link to assignment packages such as SATURN. The responses that will be assessed during the forecasting process include:

- Trip Frequency; and
- Trip Redistribution.

The representation of demand in the model is highly detailed, incorporating income segmentation for home based trips (excluding those related to employers business) as well as the more traditional car based journey purposes:

- Home Based Work (commuting);
- Home Based Employers Business;
- Home Based Other;
- Non home Based Employers Business; and
- Non Home Based Other.

Normally, the goods vehicles would be grouped into a single class but in this instance, the goods vehicles groups reflect the existing toll structure on the Bridge, namely:

- 3.5t to 7.5t;
- Greater than 7.5t (2 axles);
- Greater than 7.5t (3 axles); and
- Greater than 7.5t (4 or more axles).

9.2 Model Validation Performance

9.2.1 Criteria

The performance of the model has been assessed in three key areas: the ability to reflect observed travel patterns on the Bridge; the ability to replicate traffic flows either at screenline or link level across the model area and the ability to reflect observed travel times (which in turn reflect travel costs).

It is worth noting again at this point that the model development has not involved any use of matrix estimation (ME). This technique is typically used by modellers to get a better fit between observed and model flows by using algorithms within the assignment software to adjust the base matrices. As this model was operating with a high degree of demand segmentation and also incorporating P/A as well as O/D representations of demand, this approach was not used as it would have been very difficult to maintain the consistency of demand across the various model segments. The lack of ME has placed additional demands on the skills of the modellers developing the HETM but has resulted in a more robust tool overall.

9.2.2 Travel Patterns on the Bridge

The model reflects existing travel movements across the Bridge very well across all three model time periods. In summary, the difference between model and observed flow in each period for all vehicles (goods vehicles in brackets) is as follows:

- AM Peak Northbound +2% (-6%);
- AM Peak Southbound +6% (+15%);
- Inter Peak Northbound +3% (-12%);
- Inter Peak Southbound +14% (-2%);
- PM Peak Northbound 0% (-4%); and
- PM Peak Southbound -3% (-26%).

DMRB provides criteria in terms of flow difference (either absolute, percentage or GEH[3]) for individual links; the HETM meets this performance criteria for the Bridge in both directions across all time periods.

As well as looking at total volumes, the pattern, or distribution of trips, has also been compared and this shows a very strong correlation between the model and the observed situation.

9.2.3 Flow Validation

In accordance with modelling best practise, a large number of count sites (58 in each time period) have been held back from the model development process to act as independent validation sites across the model area.

DMRB suggests that models should meet the flow difference criteria (either absolute, percentage or GEH3) in 85% of cases for those independent validation sites. In the case of HETM, the need to ensure network consistency between time periods, in order to enable the 12 hour P/A model to function on a theoretically sound basis, has meant that no time period specific network corrections may be undertaken. This necessitates a balancing of performance between the periods but the final results reflect very well on the model’s ability given this issue and the lack of any use of ME as referred to previously. The performance by time period is as follows in terms of flow and GEH (in brackets):

- AM Peak – 84% (84%);
- Inter Peak – 79% (78%); and
- PM Peak – 88% (84%).

Whist the model falls just outside of the ideal in the morning peak (by 1%) and the inter peak (by 6%), we believe the results are very impressive given the complexity of demand segmentation that has been included, the maintenance of network integrity between the three time periods, the scale of the model area and the lack of use of ME as a ‘quick fix’ to improve performance.

9.2.4 Journey Time Validation

In addition to reflecting traffic flows, an equally important aspect of any model is to represent observed travel times and therefore costs. This is of even greater importance in the context of HETM as the model needs to reflect the potential trade-offs between travel time and toll.

As with flow, DMRB provides performance criteria for transport models in respect of journey time.

[3] GEH = Geoffrey Edward Havers statistic that reflects absolute and percentage difference.

Typically this is measured against a few routes; in the case of HETM, the use of TrafficMaster data has enabled the model to be tested against ten routes by direction in each time period.

The HETM meets the performance requirements in all time periods for all routes in both directions; a very strong performance given the scale of the model and the number of routes compared to.

9.3 Summary

The HETM has been designed in accordance with current modelling best practice and is at the forefront of model development in terms of its representation of demand and the use of P/A aand O/D modelling techniques.

The model represents traffic patterns on the existing Bridge very well; the validation against truly independent count sites is very strong and the representation of existing trips costs (travel times) is excellent.

We believe the information presented in this LMVR proves that the model is a robust and reliable modelling tool on which to base the trip forecasting and subsequent economic appraisal required for this study.

Appendix A – Extent of Model Network

Appendix A – Extent of Model Network

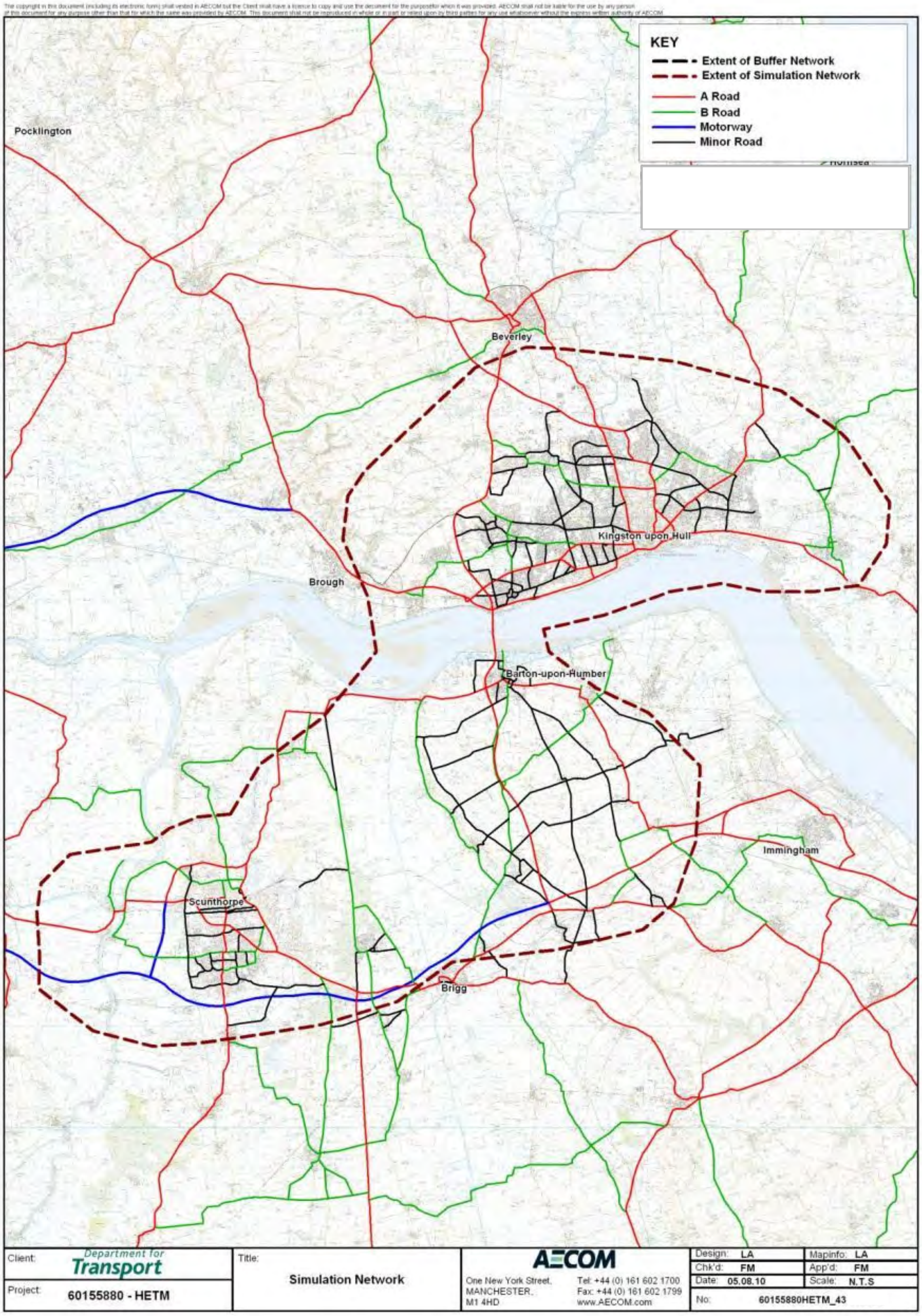
A- 1 Extent of Skeletal Network

Capabilities on project:
Transportation

A- 2 Extent of Buffer Network

Capabilities on project:
Transportation

A- 3 Extent of Simulation Network



Appendix B – SATURN/COBA Speed Flow Curves

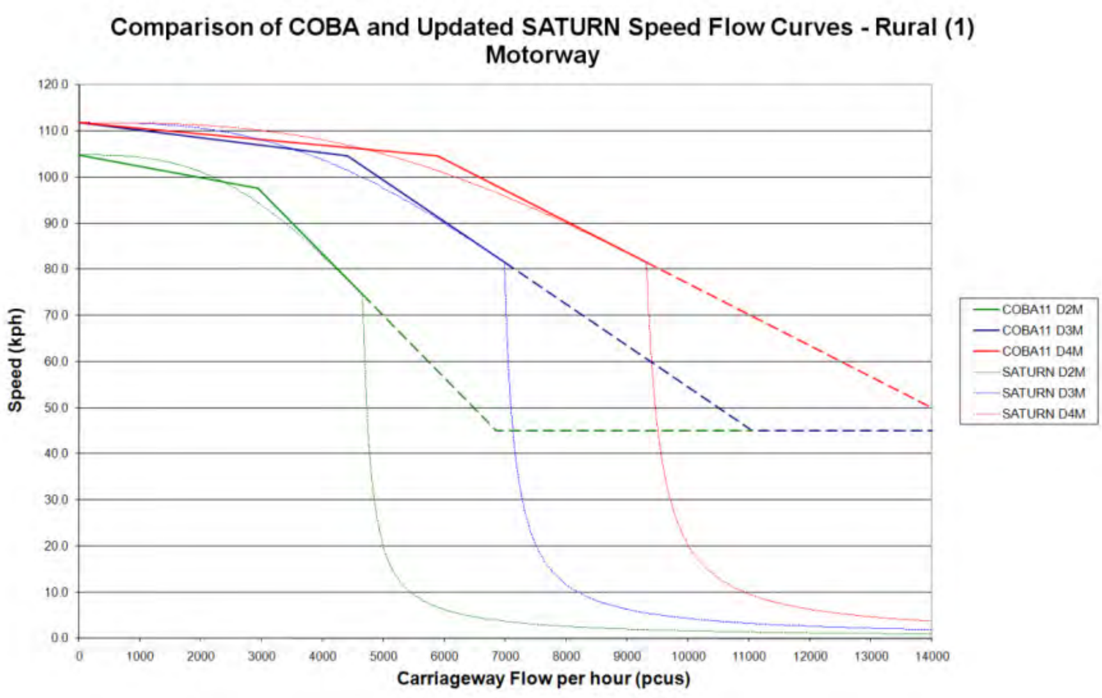
Appendix B – SATURN/COBA Speed Flow Curves

Table B1 COBA Speed Flow Curve Parameter Assumptions

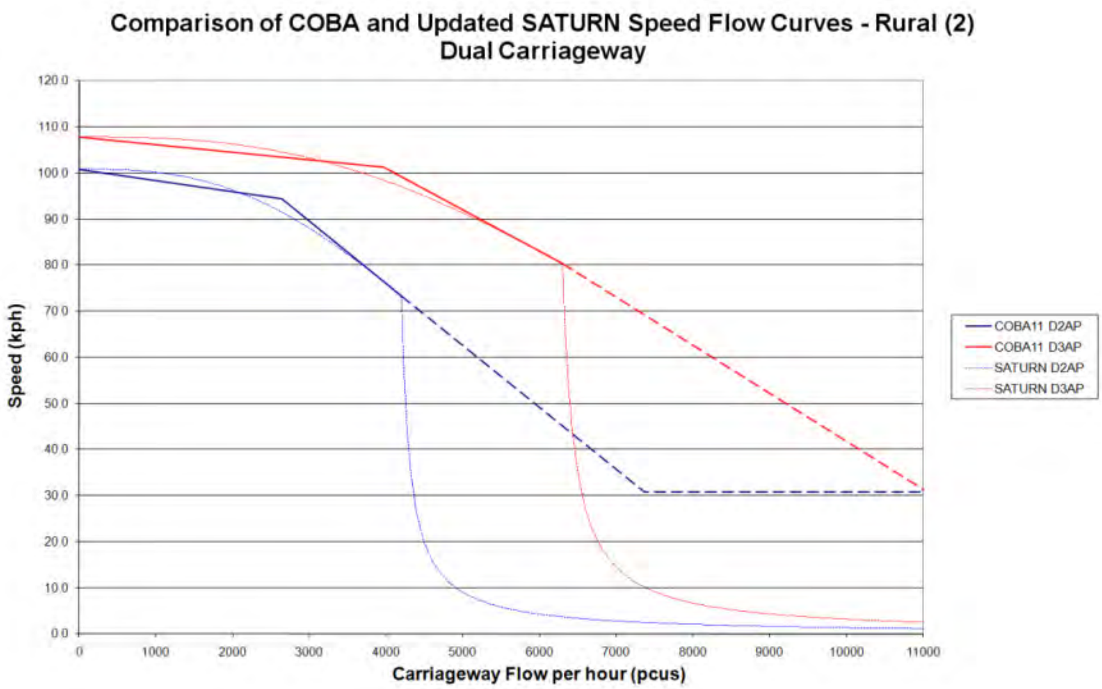
Parameter	**Link Type**		
	Rural Motorway (D2M, D3M & D4M)		
BEND (bendiness in deg / km)	20		
H_R (sum of rises and falls in m / km)	15		
HGV% (proportion of goods vehicles)	15		
	Rural Dual Carriageway		
BEND (bendiness in deg / km)	30		
H_R (sum of rises and falls in m / km)	15		
HGV% (proportion of goods vehicles)	15		
	Rural Single Carriageway		
	Wide Single	Good	Typical
CWID (average carriageway width in m)	10	7.3	7.3
Hills (sum of rises and falls in m/km)	15	15	15
Bend (bendiness in deg / km)	75	75	75
SWID (average width of hard strip in m)	1	1	Negligible
VWID (average verge width in m)	4	4	1
Junc (number of side roads per km)	0.6	0.6	2
Visi (average sight distance in m)	400	400	300
HGV% (proportion of goods vehicles)	15	15	15
	Urban (Central)		
	Good	Typical	Poor
INT (number of intersections per km)	2	4.5	9
HGV% (proportion of goods vehicles)	12	12	12
Capacity per lane (vehicles per hour)	800	800	800
	Urban (Non-Central)		
	Good	Typical	Poor
DEVEL (% of network with frontage)	50	80	90
HGV% (proportion of goods vehicles)	12	12	12
Capacity per lane (vehicles per hour)	800	800	800
	Small Town		
	Light Dev	Typical Dev	Heavy Dev
DEVEL (% of network with frontage)	35	60	90
P30 (% of route subject to 30 mph limit)	20	50	100

HGV% (proportion of goods vehicles)	12	12	12
Capacity per lane (vehicles per hour)	1200	1200	1200
	Suburban Single / Dual		
	Good	Typical	Poor
INT (number of major intersections per km)	0.4	0.8	1.2
AXS (number of minor intersections per km)	15	30	40
HGV% (proportion of goods vehicles)	12	12	12
Capacity per lane (vehicles per hour)	1500	1500	1500

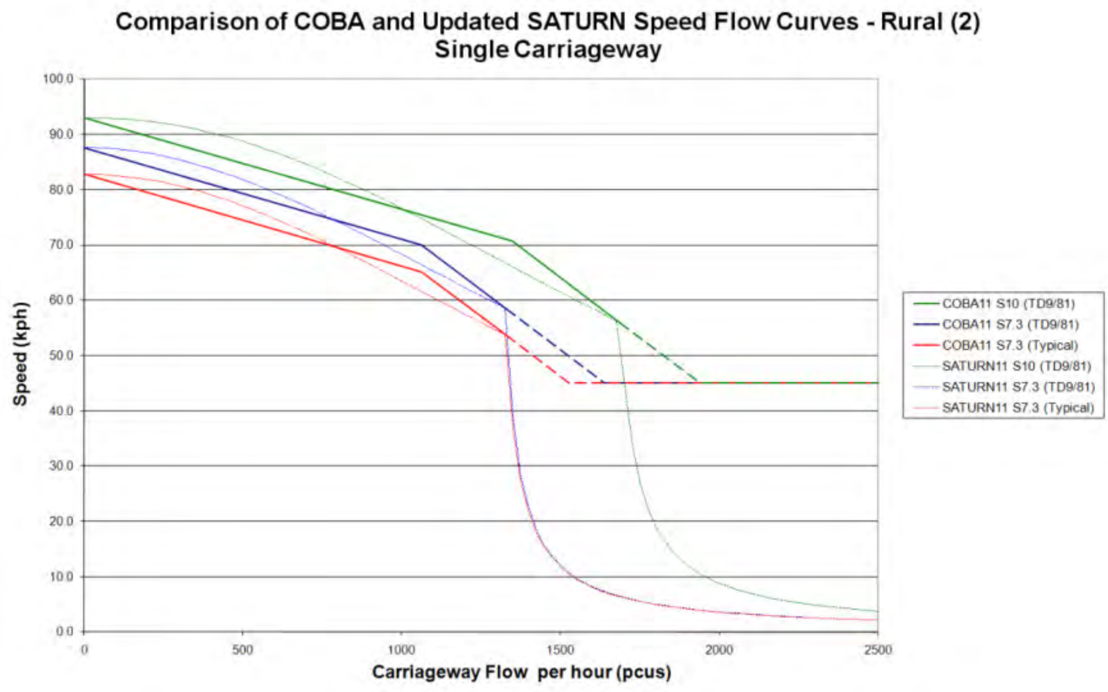
B -1 Motorway



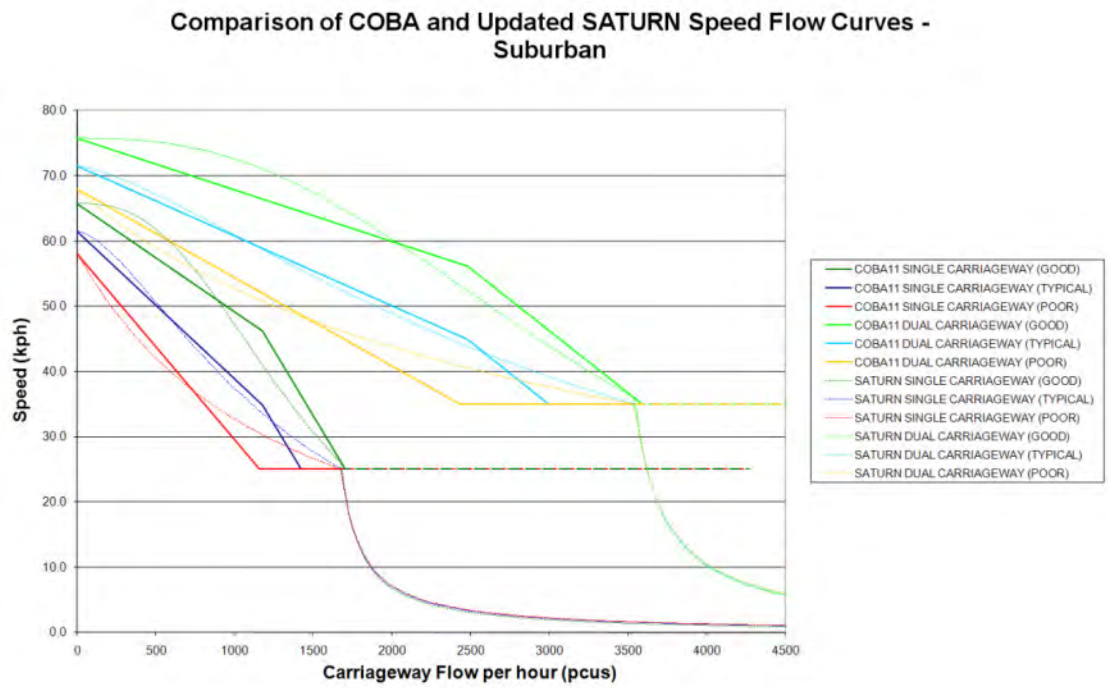
B -2 Dual Carriageway



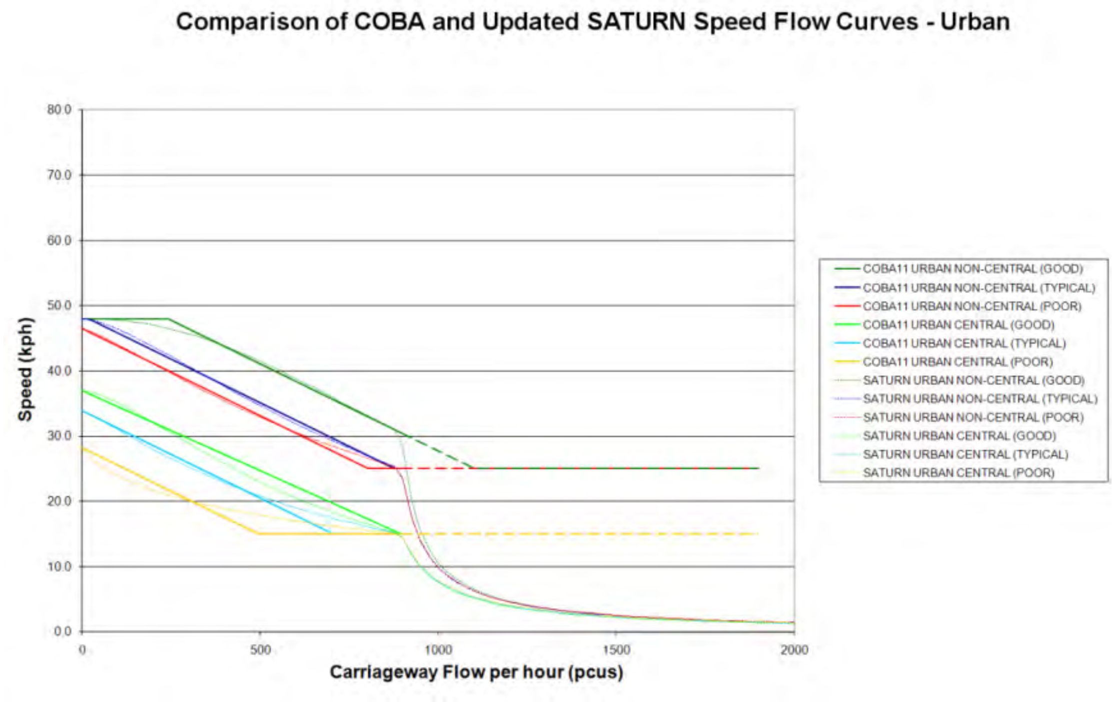
B -3 Single Carriageway



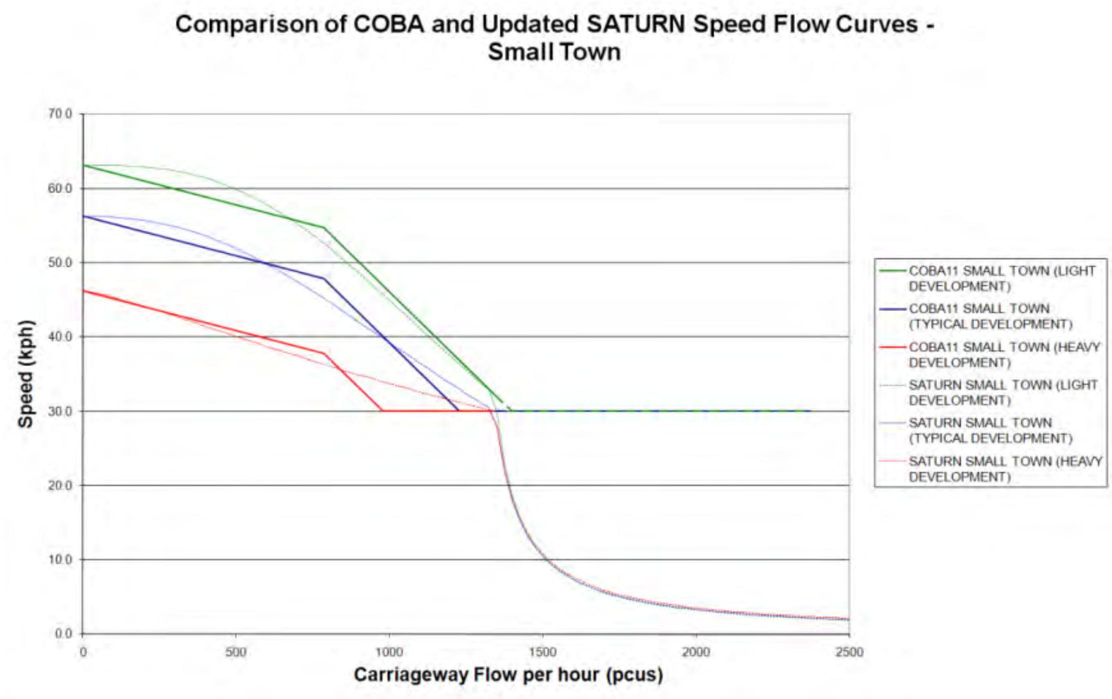
B -4 Suburban



B -5 Urban



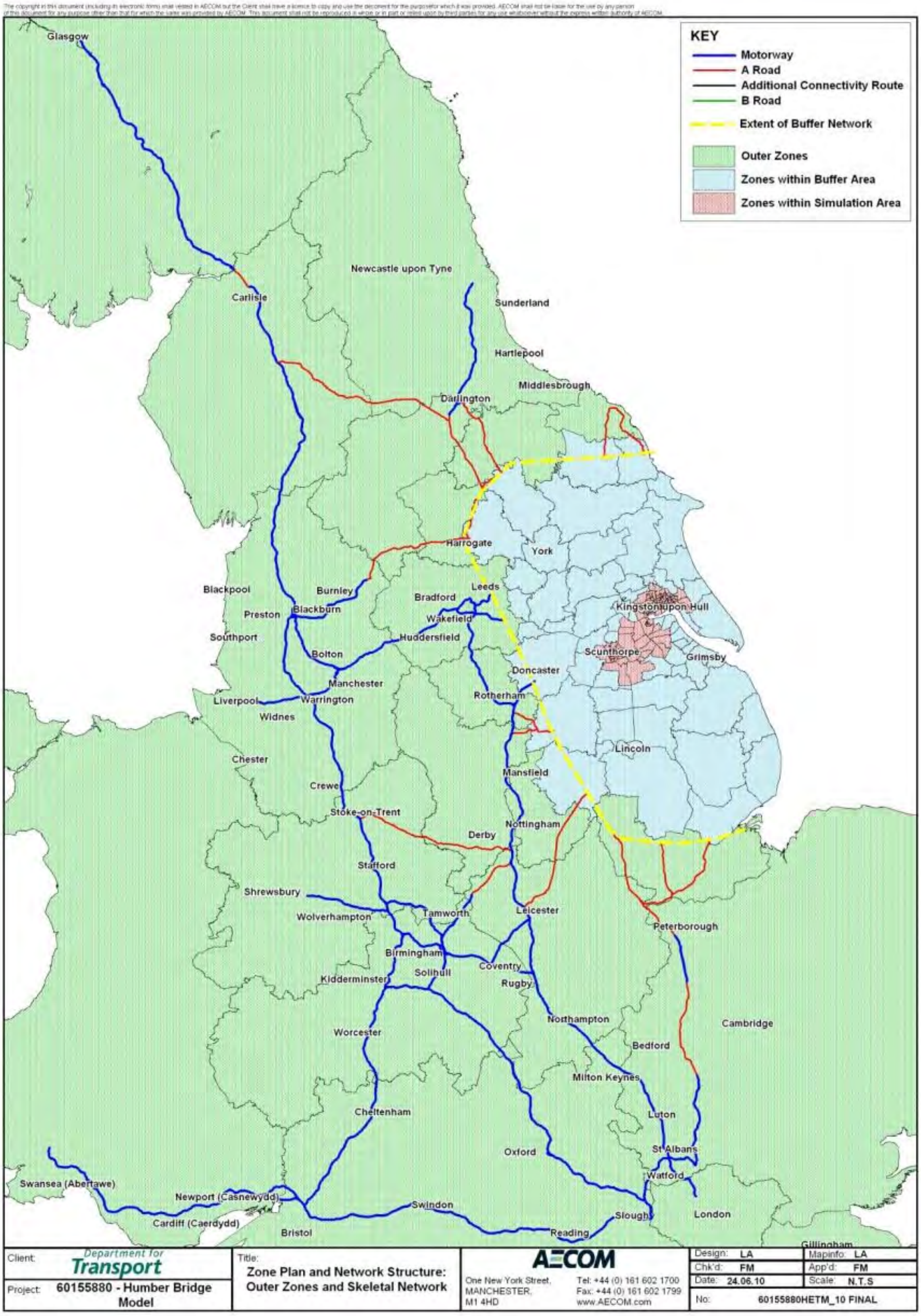
B -6 Small Town



Appendix C – Zone Plan and Network Structure

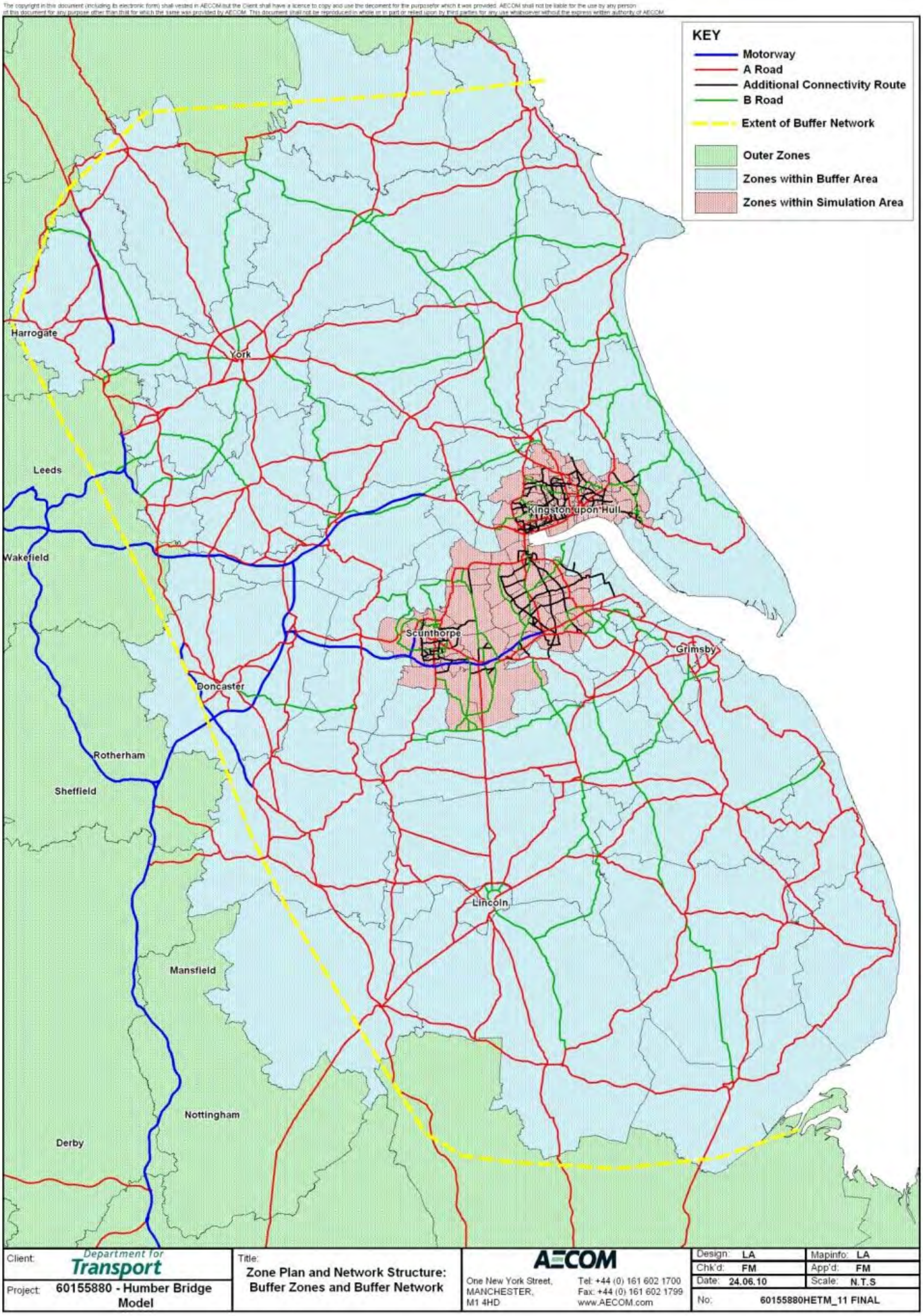
Appendix C – Zone Plan and Network Structure

C – 1 Outer Zones and Skeletal Network

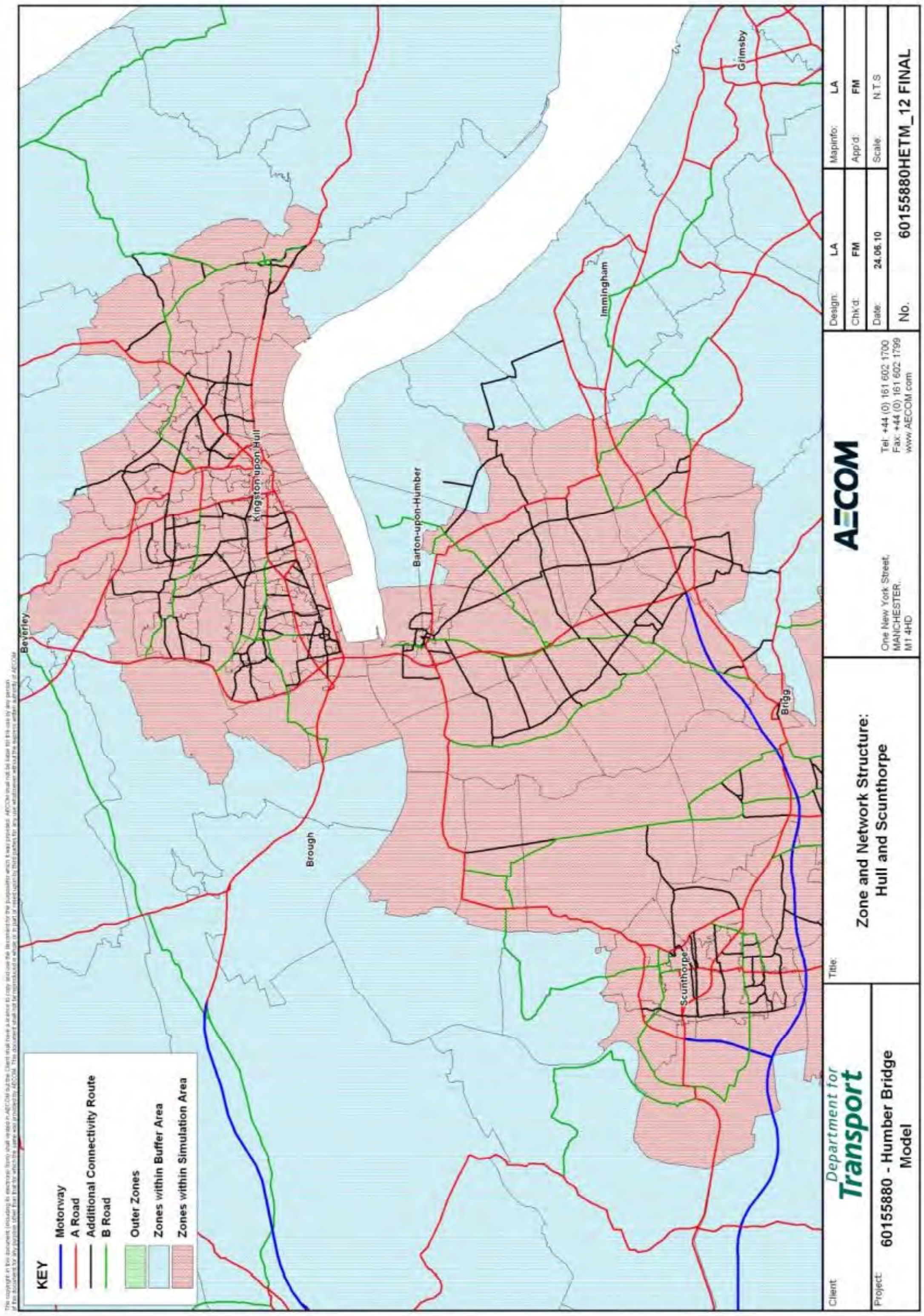


Capabilities on project:
Transportation

C – 2 Buffer Zones and Buffer Network



C – 3 Outer Zones and Skeletal Network



Appendix D – RSI Sample Rates

Appendix D – RSI Sample Rates

Table D - 1 Existing Road Side Interview A63 Castle Street Model – Hourly RSI Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
1	154	352	260	183	155	150	144	169	148	172	179	129	2,195	506	801	351
2	85	163	81	127	99	128	96	137	92	130	91	106	1,335	248	587	221
3	17	135	88	110	47	92	53	106	51	85	67	80	931	152	408	152
4	94	74	121	84	116	93	100	79	84	83	107	80	1,115	168	472	190
5	66	112	97	78	51	77	77	62	48	45	66	54	833	178	345	111
6	121	107	129	90	113	106	102	95	118	101	118	70	1,270	228	506	219
7	64	136	84	100	77	109	86	85	86	0	74	75	976	200	457	74
8	56	79	98	79	91	77	89	71	95	62	76	77	950	135	407	138
9	96	103	62	32	47	35	26	42	21	48	30	22	564	199	182	78
10	72	126	126	126	119	103	120	107	102	101	128	55	1,285	198	575	229
11	68	81	72	34	18	39	36	19	38	26	17	20	468	149	146	43
12	90	63	68	55	108	88	74	72	95	77	104	71	965	153	397	181
13	68	105	76	0	15	15	13	7	9	7	11	9	335	173	50	18
14	101	117	112	113	123	100	124	106	111	116	125	107	1,355	218	566	241
15	0	57	89	46	91	120	78	101	115	80	0	0	777	57	436	80
16	123	56	57	61	61	59	62	44	63	59	32	32	709	179	287	91
17	94	124	101	118	94	139	109	124	117	141	113	107	1,381	218	584	254
18	66	83	78	86	102	97	95	88	118	103	119	95	1,130	149	468	222
19	79	70	72	74	66	62	78	65	77	72	73	78	866	149	345	145
20	117	89	99	91	111	88	106	89	115	97	127	72	1,201	206	485	224
21	98	72	70	72	115	69	129	76	103	108	9	81	1,002	170	461	117
22	96	131	139	112	136	108	131	131	118	138	149	110	1,499	227	618	287
23	100	55	0	0	66	104	96	96	95	106	107	53	878	155	362	213
24	105	45	0	43	122	137	124	109	127	126	123	81	1,142	150	535	249
25	57	153	100	56	50	49	41	34	46	33	32	31	682	210	230	65
26	103	125	110	108	98	68	116	112	91	117	131	74	1,253	228	502	248
27	75	82	39	66	68	71	48	67	79	78	75	41	789	157	320	153
28	55	160	89	85	45	27	44	44	30	36	32	14	661	215	245	68
TOTAL	**2,320**	**3,055**	**2,517**	**2,229**	**2,404**	**2,410**	**2,397**	**2,337**	**2,392**	**2,347**	**2,315**	**1,824**	**28,547**	**5,375**	**11,777**	**4,662**

Table D - 2 Existing Road Side Interview A63 Castle Street Model – Hourly MCC Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
1	1,776	1,871	1,636	1,450	1,382	1,386	1,461	1,471	1,474	1,654	1,651	1,433	**18,645**	**3,647**	**7,150**	**3,305**
2	962	1,130	860	637	849	829	782	698	661	625	508	339	**8,880**	**2,092**	**3,795**	**1,133**
3	423	630	474	390	321	320	333	302	321	412	449	332	**4,707**	**1,053**	**1,666**	**861**
4	375	467	447	351	442	407	421	399	388	425	412	352	**4,886**	**842**	**2,020**	**837**
5	745	772	728	494	497	619	641	461	521	504	737	716	**7,435**	**1,517**	**2,712**	**1,241**
6	634	895	662	407	448	461	521	405	466	504	621	380	**6,404**	**1,529**	**2,242**	**1,125**
7	181	490	307	338	364	332	363	385	466	428	313	302	**4,269**	**671**	**1,782**	**741**
8	639	739	677	676	612	600	653	646	549	598	528	538	**7,455**	**1,378**	**3,187**	**1,126**
9	505	792	547	469	432	452	456	536	522	521	391	236	**5,859**	**1,297**	**2,345**	**912**
10	798	771	554	793	863	898	801	723	869	1,175	1,242	545	**10,032**	**1,569**	**4,078**	**2,417**
11	783	766	649	399	376	442	449	360	535	345	309	351	**5,764**	**1,549**	**2,026**	**654**
12	514	595	478	364	328	362	453	325	341	377	508	312	**4,957**	**1,109**	**1,832**	**885**
13	209	406	174	93	141	178	150	130	127	102	96	41	**1,847**	**615**	**692**	**198**
14	1,675	1,399	1,133	1,203	1,329	1,250	1,037	1,185	1,296	1,471	1,043	979	**15,000**	**3,074**	**6,004**	**2,514**
15	1,023	1,228	860	706	730	772	845	769	889	1,223	1,347	1,015	**11,407**	**2,251**	**3,822**	**2,570**
16	698	781	639	533	553	585	639	605	674	719	762	511	**7,699**	**1,479**	**2,915**	**1,481**
17	672	645	540	578	574	662	704	654	760	681	677	553	**7,700**	**1,317**	**3,172**	**1,358**
18	1,311	1,128	759	652	710	673	734	766	921	1,269	1,265	679	**10,867**	**2,439**	**3,535**	**2,534**
19	227	450	271	183	133	142	155	136	224	200	175	149	**2,445**	**677**	**749**	**375**
20	908	941	685	506	471	453	548	525	520	761	862	599	**7,779**	**1,849**	**2,503**	**1,623**
21	1,149	1,171	908	505	683	884	838	725	922	1,199	1,251	701	**10,936**	**2,320**	**3,635**	**2,450**
22	994	1,104	763	590	570	655	620	716	635	961	944	649	**9,201**	**2,098**	**3,151**	**1,905**
23	977	1,208	1,419	795	741	722	607	725	742	851	791	497	**10,075**	**2,185**	**3,590**	**1,642**
24	1,229	1,211	1,397	847	775	783	940	554	769	949	804	607	**10,865**	**2,440**	**3,899**	**1,753**
25	299	658	590	426	382	396	413	417	345	359	279	270	**4,834**	**957**	**2,034**	**638**
26	630	1,024	742	541	485	583	592	515	442	525	561	429	**7,069**	**1,654**	**2,716**	**1,086**
27	233	571	258	164	145	211	189	165	186	214	242	98	**2,676**	**804**	**874**	**456**
28	281	476	364	281	199	205	228	253	180	202	227	100	**2,996**	**757**	**1,166**	**429**
Total	**20,850**	**24,319**	**19,521**	**15,371**	**15,535**	**16,262**	**16,573**	**15,551**	**16,745**	**19,254**	**18,995**	**13,713**	**212,689**	**45,169**	**79,292**	**38,249**

Table D - 3 Existing Road Side Interview A63 Castle Street Model – Hourly Sample Rates

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
1	9%	19%	16%	13%	11%	11%	10%	11%	10%	10%	11%	9%	12%	14%	11%	11%
2	9%	14%	9%	20%	12%	15%	12%	20%	14%	21%	18%	31%	15%	12%	15%	20%
3	4%	21%	19%	28%	15%	29%	16%	35%	16%	21%	15%	24%	20%	14%	24%	18%
4	25%	16%	27%	24%	26%	23%	24%	20%	22%	20%	26%	23%	23%	20%	23%	23%
5	9%	15%	13%	16%	10%	12%	12%	13%	9%	9%	9%	8%	11%	12%	13%	9%
6	19%	12%	19%	22%	25%	23%	20%	23%	25%	20%	19%	18%	20%	15%	23%	19%
7	35%	28%	27%	30%	21%	33%	24%	22%	18%	0%	24%	25%	23%	30%	26%	10%
8	9%	11%	14%	12%	15%	13%	14%	11%	17%	10%	14%	14%	13%	10%	13%	12%
9	19%	13%	11%	7%	11%	8%	6%	8%	4%	9%	8%	9%	10%	15%	8%	9%
10	9%	16%	23%	16%	14%	11%	15%	15%	12%	9%	10%	10%	13%	13%	14%	9%
11	9%	11%	11%	9%	5%	9%	8%	5%	7%	8%	6%	6%	8%	10%	7%	7%
12	18%	11%	14%	15%	33%	24%	16%	22%	28%	20%	20%	23%	19%	14%	22%	20%
13	33%	26%	44%	0%	11%	8%	9%	5%	7%	7%	11%	22%	18%	28%	7%	9%
14	6%	8%	10%	9%	9%	8%	12%	9%	9%	8%	12%	11%	9%	7%	9%	10%
15	0%	5%	10%	7%	12%	16%	9%	13%	13%	7%	0%	0%	7%	3%	11%	3%
16	18%	7%	9%	11%	11%	10%	10%	7%	9%	8%	4%	6%	9%	12%	10%	6%
17	14%	19%	19%	20%	16%	21%	15%	19%	15%	21%	17%	19%	18%	17%	18%	19%
18	5%	7%	10%	13%	14%	14%	13%	11%	13%	8%	9%	14%	10%	6%	13%	9%
19	35%	16%	27%	40%	50%	44%	50%	48%	34%	36%	42%	52%	35%	22%	46%	39%
20	13%	9%	14%	18%	24%	19%	19%	17%	22%	13%	15%	12%	15%	11%	19%	14%
21	9%	6%	8%	14%	17%	8%	15%	10%	11%	9%	1%	12%	9%	7%	13%	5%
22	10%	12%	18%	19%	24%	16%	21%	18%	19%	14%	16%	17%	16%	11%	20%	15%
23	10%	5%	0%	0%	9%	14%	16%	13%	13%	12%	14%	11%	9%	7%	10%	13%
24	9%	4%	0%	5%	16%	17%	13%	20%	17%	13%	15%	13%	11%	6%	14%	14%
25	19%	23%	17%	13%	13%	12%	10%	8%	13%	9%	11%	11%	14%	22%	11%	10%
26	16%	12%	15%	20%	20%	12%	20%	22%	21%	22%	23%	17%	18%	14%	18%	23%
27	32%	14%	15%	40%	47%	34%	25%	41%	42%	36%	31%	42%	29%	20%	37%	34%
28	20%	34%	24%	30%	23%	13%	19%	17%	17%	18%	14%	14%	22%	28%	21%	16%
TOTAL	11%	13%	13%	15%	15%	15%	14%	15%	14%	12%	12%	13%	13%	12%	15%	12%

Table D - 4 Existing Road Side Interview A63 Castle Street Model – RSI Totals by Vehicle Type

Site Number	1 - Motorcycle	2 - Car & Taxis	3 - Light Goods	4 - OGV1	5 - OGV2	Total Car	Total LGV	Total HGV
1	29	1,868	190	36	72	1,897	190	108
2	15	1,130	164	25	1	1,145	164	26
3	21	798	97	15	0	819	97	15
4	19	959	132	5	0	978	132	5
5	10	773	27	3	20	783	27	23
6	9	1,136	125	0	0	1,145	125	0
7	3	870	101	1	1	873	101	2
8	6	817	122	5	0	823	122	5
9	9	515	32	5	3	524	32	8
10	4	1,034	229	18	0	1,038	229	18
11	4	447	17	0	0	451	17	0
12	40	770	136	18	1	810	136	19
13	3	279	44	7	2	282	44	9
14	17	1,082	216	29	11	1,099	216	40
15	6	645	99	19	8	651	99	27
16	9	644	51	2	3	653	51	5
17	14	1,081	238	46	2	1,095	238	48
18	13	903	171	36	7	916	171	43
19	5	784	68	9	0	789	68	9
20	8	903	183	46	61	911	183	107
21	14	839	108	21	20	853	108	41
22	20	1,269	181	27	2	1,289	181	29
23	10	764	92	10	2	774	92	12
24	11	868	178	32	53	879	178	85
25	2	612	46	8	14	614	46	22
26	6	1,042	167	18	20	1,048	167	38
27	8	638	132	11	0	646	132	11
28	11	600	31	11	8	611	31	19
TOTAL	326	24,070	3,377	463	311	24,396	3,377	774

Table D - 5 Existing Road Side Interview A63 Castle Street Model – MCC Totals by Vehicle Type

Site Number	1 - Motorcycle	2 - Car & Taxis	3 - Light Goods	4 - OGV1	5 - OGV2	Total Car	Total LGV	Total HGV
1	204	12,954	2,552	1,155	1,780	13,158	2,552	2,935
2	129	7,327	1,171	168	85	7,456	1,171	253
3	64	4,008	540	77	18	4,072	540	95
4	77	4,043	687	67	12	4,120	687	79
5	92	6,304	898	120	21	6,396	898	141
6	109	5,520	646	89	40	5,629	646	129
7	67	3,650	496	49	7	3,717	496	56
8	136	6,146	893	198	82	6,282	893	280
9	50	4,749	817	182	61	4,799	817	243
10	176	6,861	1,919	696	380	7,037	1,919	1,076
11	108	4,966	629	57	4	5,074	629	61
12	112	4,067	636	120	22	4,179	636	142
13	38	1,364	311	62	72	1,402	311	134
14	192	10,805	1,787	742	1,474	10,997	1,787	2,216
15	111	9,391	1,258	432	215	9,502	1,258	647
16	123	6,252	1,055	226	43	6,375	1,055	269
17	142	5,873	1,264	330	91	6,015	1,264	421
18	96	8,337	1,542	411	481	8,433	1,542	892
19	14	2,217	170	40	4	2,231	170	44
20	75	5,706	1,214	339	445	5,781	1,214	784
21	152	9,421	958	221	184	9,573	958	405
22	141	7,674	984	305	97	7,815	984	402
23	145	8,487	1,087	211	145	8,632	1,087	356
24	148	8,393	1,415	385	524	8,541	1,415	909
25	21	3,597	701	277	238	3,618	701	515
26	54	5,772	949	184	110	5,826	949	294
27	37	2,154	358	93	34	2,191	358	127
28	9	2,437	267	145	138	2,446	267	283
TOTAL	2,822	168,475	27,204	7,381	6,807	171,297	27,204	14,188

Table D - 6 Existing Road Side Interview A63 Castle Street Model – Sample Rates by Vehicle Type

Site Number	1 - Motorcycle	2 - Car & Taxis	3 - Light Goods	4 - OGV1	5 - OGV2	Total Car	Total LGV	Total HGV
1	14%	14%	7%	3%	4%	14%	7%	4%
2	12%	15%	14%	15%	1%	15%	14%	10%
3	33%	20%	18%	19%	0%	20%	18%	16%
4	25%	24%	19%	7%	0%	24%	19%	6%
5	11%	12%	3%	3%	95%	12%	3%	16%
6	8%	21%	19%	0%	0%	20%	19%	0%
7	4%	24%	20%	2%	14%	23%	20%	4%
8	4%	13%	14%	3%	0%	13%	14%	2%
9	18%	11%	4%	3%	5%	11%	4%	3%
10	2%	15%	12%	3%	0%	15%	12%	2%
11	4%	9%	3%	0%	0%	9%	3%	0%
12	36%	19%	21%	15%	5%	19%	21%	13%
13	8%	20%	14%	11%	3%	20%	14%	7%
14	9%	10%	12%	4%	1%	10%	12%	2%
15	5%	7%	8%	4%	4%	7%	8%	4%
16	7%	10%	5%	1%	7%	10%	5%	2%
17	10%	18%	19%	14%	2%	18%	19%	11%
18	14%	11%	11%	9%	1%	11%	11%	5%
19	36%	35%	40%	23%	0%	35%	40%	20%
20	11%	16%	15%	14%	14%	16%	15%	14%
21	9%	9%	11%	10%	11%	9%	11%	10%
22	14%	17%	18%	9%	2%	16%	18%	7%
23	7%	9%	8%	5%	1%	9%	8%	3%
24	7%	10%	13%	8%	10%	10%	13%	9%
25	10%	17%	7%	3%	6%	17%	7%	4%
26	11%	18%	18%	10%	18%	18%	18%	13%
27	22%	30%	37%	12%	0%	29%	37%	9%
28	122%	25%	12%	8%	6%	25%	12%	7%
TOTAL	12%	14%	12%	6%	5%	14%	12%	5%

Table D - 7 Existing Road Side Interview Immingham Model – Hourly RSI Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
1EB	72	92	50	35	46	38	55	51	51	52	68	50	**660**	**164**	**225**	**120**
1WB	27	50	55	40	35	39	59	60	52	70	29	52	**568**	**77**	**233**	**99**
2EB	107	122	93	89	82	103	94	103	92	70	71	57	**1,083**	**229**	**471**	**141**
2WB	71	90	88	91	83	101	72	93	92	109	127	85	**1,102**	**161**	**440**	**236**
3NB	111	150	87	58	45	47	78	74	87	59	70	29	**895**	**261**	**302**	**129**
3SB	44	57	48	65	75	76	62	91	107	122	83	58	**888**	**101**	**369**	**205**
4NB	114	144	121	118	126	129	90	146	116	162	143	99	**1,508**	**258**	**609**	**305**
4SB	61	77	65	67	74	80	74	77	84	100	102	67	**928**	**138**	**372**	**202**
5EB	17	55	0	3	34	53	50	41	28	35	45	28	**389**	**72**	**181**	**80**
5WB	57	70	41	44	50	33	39	39	41	22	1	0	**437**	**127**	**205**	**23**
TOTAL	**681**	**907**	**648**	**610**	**650**	**699**	**673**	**775**	**750**	**801**	**739**	**525**	**8,458**	**1,588**	**3,407**	**1,540**

Table D - 8 Existing Road Side Interview Immingham Model – Hourly MCC Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
1EB	355	189	83	59	81	67	72	63	84	106	101	60	**1,320**	**544**	**342**	**207**
1WB	41	55	60	47	58	60	71	79	139	271	275	168	**1,324**	**96**	**315**	**546**
2EB	1,158	704	403	344	368	375	406	504	422	380	365	232	**5,661**	**1,862**	**1,997**	**745**
2WB	367	397	314	364	285	341	354	412	432	798	747	412	**5,223**	**764**	**1,756**	**1,545**
3NB	345	269	89	71	70	69	91	102	91	66	88	77	**1,428**	**614**	**403**	**154**
3SB	62	85	68	71	93	87	77	98	120	258	275	134	**1,428**	**147**	**426**	**533**
4NB	530	361	189	176	195	197	191	200	255	260	255	162	**2,971**	**891**	**959**	**515**
4SB	179	218	181	192	170	198	217	223	235	380	437	278	**2,908**	**397**	**1,000**	**817**
5EB	1,192	878	453	348	344	395	395	456	413	399	424	256	**5,953**	**2,070**	**1,938**	**823**
5WB	337	413	335	375	341	345	432	537	575	974	958	514	**6,136**	**750**	**2,030**	**1,932**
TOTAL	**4,566**	**3,569**	**2,175**	**2,047**	**2,005**	**2,134**	**2,306**	**2,674**	**2,766**	**3,892**	**3,925**	**2,293**	**34,352**	**8,135**	**11,166**	**7,817**

Table D - 9 Existing Road Side Interview Immingham Model – Hourly Sample Rates

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
1EB	20%	49%	60%	59%	57%	57%	76%	81%	61%	49%	67%	83%	50%	30%	66%	58%
1WB	66%	91%	92%	85%	60%	65%	83%	76%	37%	26%	11%	31%	43%	80%	74%	18%
2EB	9%	17%	23%	26%	22%	27%	23%	20%	22%	18%	19%	25%	19%	12%	24%	19%
2WB	19%	23%	28%	25%	29%	30%	20%	23%	21%	14%	17%	21%	21%	21%	25%	15%
3NB	32%	56%	98%	82%	64%	68%	86%	73%	96%	89%	80%	38%	63%	43%	75%	84%
3SB	71%	67%	71%	92%	81%	87%	81%	93%	89%	47%	30%	43%	62%	69%	87%	38%
4NB	22%	40%	64%	67%	65%	65%	47%	73%	45%	62%	56%	61%	51%	29%	64%	59%
4SB	34%	35%	36%	35%	44%	40%	34%	35%	36%	26%	23%	24%	32%	35%	37%	25%
5EB	1%	6%	0%	1%	10%	13%	13%	9%	7%	9%	11%	11%	7%	3%	9%	10%
5WB	17%	17%	12%	12%	15%	10%	9%	7%	7%	2%	0%	0%	7%	17%	10%	1%
TOTAL	15%	25%	30%	30%	32%	33%	29%	29%	27%	21%	19%	23%	25%	20%	31%	20%

Table D - 10 Existing Road Side Interview Immingham Model – RSI Totals by Vehicle Type

Site Number	Motorcycle	Car and Taxis	Light Goods	Van > 3.5 Tonnes	2 Axle Rigid	3 Axles Rigid	4+ Axles Rigid	3 Axles Artic	4+ Axles Artic	Total Car	Total LGV	Total HGV
1EB	11	584	54	8	3	0	0	0	0	**595**	**54**	**11**
1WB	20	456	61	25	6	0	0	0	0	**476**	**61**	**31**
2EB	7	471	108	11	32	14	90	11	339	**478**	**108**	**497**
2WB	16	487	104	12	18	6	91	16	352	**503**	**104**	**495**
3NB	17	715	108	6	4	6	2	2	35	**732**	**108**	**55**
3SB	25	691	94	21	12	7	3	2	33	**716**	**94**	**78**
4NB	24	1,256	116	33	14	15	12	8	30	**1,280**	**116**	**112**
4SB	19	734	89	25	14	14	4	4	24	**753**	**89**	**85**
5EB	0	317	34	4	4	3	1	8	18	**317**	**34**	**38**
5WB	0	342	42	5	11	4	4	6	23	**342**	**42**	**53**
TOTAL	**139**	**6,053**	**810**	**150**	**118**	**69**	**207**	**57**	**854**	**6,192**	**810**	**1,455**

Table D - 11 Existing Road Side Interview Immingham Model – MCC Totals by Vehicle Type

Site Number	Motorcycle	Car and Taxis	Light Goods	Van > 3.5 Tonnes	2 Axle Rigid	3 Axles Rigid	4+ Axles Rigid	3 Axles Artic	4+ Axles Artic	Total Car	Total LGV	Total HGV
1EB	35	1,056	188	6	25	7	1	0	2	**1,091**	**188**	**41**
1WB	36	1,066	183	12	22	1	3	0	1	**1,102**	**183**	**39**
2EB	33	2,243	534	116	134	127	156	9	2,309	**2,276**	**534**	**2,851**
2WB	39	2,137	320	218	164	65	115	73	2,092	**2,176**	**320**	**2,727**
3NB	24	1,167	134	34	13	7	2	1	46	**1,191**	**134**	**103**
3SB	30	1,165	126	20	30	12	4	1	40	**1,195**	**126**	**107**
4NB	53	2,426	328	37	26	21	12	1	67	**2,479**	**328**	**164**
4SB	62	2,348	312	28	54	21	36	2	45	**2,410**	**312**	**186**
5EB	75	3,991	775	124	169	109	64	17	629	**4,066**	**775**	**1,112**
5WB	55	4,119	919	47	196	88	148	34	530	**4,174**	**919**	**1,043**
TOTAL	**442**	**21,718**	**3,819**	**642**	**833**	**458**	**541**	**138**	**5,761**	**22,160**	**3,819**	**8,373**

Table D - 12 Existing Road Side Interview Immingham Model – Sample Rates by Vehicle Type

Site Number	Motorcycle	Car and Taxis	Light Goods	Van > 3.5 Tonnes	2 Axle Rigid	3 Axles Rigid	4+ Axles Rigid	3 Axles Artic	4+ Axles Artic	Total Car	Total LGV	Total HGV
1EB	31%	55%	29%	133%	12%	0%	0%	0%	0%	55%	29%	27%
1WB	56%	43%	33%	208%	27%	0%	0%	0%	0%	43%	33%	79%
2EB	21%	21%	20%	9%	24%	11%	58%	122%	15%	21%	20%	17%
2WB	41%	23%	33%	6%	11%	9%	79%	22%	17%	23%	33%	18%
3NB	71%	61%	81%	18%	31%	86%	100%	200%	76%	61%	81%	53%
3SB	83%	59%	75%	105%	40%	58%	75%	200%	83%	60%	75%	73%
4NB	45%	52%	35%	89%	54%	71%	100%	800%	45%	52%	35%	68%
4SB	31%	31%	29%	89%	26%	67%	11%	200%	53%	31%	29%	46%
5EB	0%	8%	4%	3%	2%	3%	2%	47%	3%	8%	4%	3%
5WB	0%	8%	5%	11%	6%	5%	3%	18%	4%	8%	5%	5%
TOTAL	31%	28%	21%	23%	14%	15%	38%	41%	15%	28%	21%	17%

Table D - 13 Existing Road Side Interview Doncaster Model – Hourly RSI Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1N	81	64	78	73	81	84	63	70	81	76	101	72	**924**	**145**	**371**	**177**
Site 2N	132	142	119	125	120	101	110	112	98	107	114	107	**1,387**	**274**	**568**	**221**
Site 3S	87	92	69	67	77	81	62	68	74	91	83	74	**925**	**179**	**355**	**174**
Site 4S	134	138	143	136	151	137	202	62	128	113	98	113	**1,555**	**272**	**688**	**211**
Site 5S	125	135	120	110	103	101	98	103	114	127	141	128	**1,405**	**260**	**515**	**268**
Site 6N	132	148	144	138	125	131	123	103	105	118	129	110	**1,506**	**280**	**620**	**247**
Site 7N	64	85	84	62	75	75	69	74	83	71	94	68	**904**	**149**	**355**	**165**
TOTAL	**755**	**804**	**757**	**711**	**732**	**710**	**727**	**592**	**683**	**703**	**760**	**672**	**8,606**	**1,559**	**3,472**	**1,463**

Table D - 14 Existing Road Side Interview Doncaster Model – Hourly MCC Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1N	209	184	160	140	168	155	140	132	208	180	195	140	**2,011**	**393**	**735**	**375**
Site 2N	348	437	296	287	287	315	359	331	396	434	417	331	**4,238**	**785**	**1,579**	**851**
Site 3S	215	310	204	167	191	250	215	216	243	374	329	236	**2,950**	**525**	**1,039**	**703**
Site 4S	264	417	266	251	290	355	307	349	523	551	599	493	**4,665**	**681**	**1,552**	**1,150**
Site 5S	386	523	316	296	347	321	418	355	472	491	539	403	**4,867**	**909**	**1,737**	**1,030**
Site 6N	622	595	467	466	408	430	449	469	495	462	542	362	**5,767**	**1,217**	**2,222**	**1,004**
Site 7N	240	286	206	199	220	228	237	280	366	394	460	288	**3,404**	**526**	**1,164**	**854**
TOTAL	**2,284**	**2,752**	**1,915**	**1,806**	**1,911**	**2,054**	**2,125**	**2,132**	**2,703**	**2,886**	**3,081**	**2,253**	**27,902**	**5,036**	**10,028**	**5,967**

Table D - 15 Existing Road Side Interview Doncaster Model – Hourly Sample Rate

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1N	39%	35%	49%	52%	48%	54%	45%	53%	39%	42%	52%	51%	46%	37%	50%	47%
Site 2N	38%	32%	40%	44%	42%	32%	31%	34%	25%	25%	27%	32%	33%	35%	36%	26%
Site 3S	40%	30%	34%	40%	40%	32%	29%	31%	30%	24%	25%	31%	31%	34%	34%	25%
Site 4S	51%	33%	54%	54%	52%	39%	66%	18%	24%	21%	16%	23%	33%	40%	44%	18%
Site 5S	32%	26%	38%	37%	30%	31%	23%	29%	24%	26%	26%	32%	29%	29%	30%	26%
Site 6N	21%	25%	31%	30%	31%	30%	27%	22%	21%	26%	24%	30%	26%	23%	28%	25%
Site 7N	27%	30%	41%	31%	34%	33%	29%	26%	23%	18%	20%	24%	27%	28%	30%	19%
TOTAL	33%	29%	40%	39%	38%	35%	34%	28%	25%	24%	25%	30%	31%	31%	35%	25%

Table D - 16 Existing Road Side Interview Doncaster Model – RSI Totals by Vehicle Type

Site Number	Car	LGV	OGV 1	OGV 2	Total Car	Total LGV	Total HGV
Site 1N	727	125	27	43	**729**	**125**	**70**
Site 2N	1,176	137	38	24	**1,187**	**137**	**62**
Site 3S	750	104	31	38	**752**	**104**	**69**
Site 4S	1,386	121	35	7	**1,392**	**121**	**42**
Site 5S	1,205	156	32	4	**1,210**	**156**	**36**
Site 6N	1,325	116	33	14	**1,340**	**116**	**47**
Site 7N	758	118	18	6	**761**	**118**	**24**
TOTAL	**7,327**	**877**	**214**	**136**	**7,371**	**877**	**350**

Table D - 17 Existing Road Side Interview Doncaster Model – MCC Totals by Vehicle Type

Site Number	Car	LGV	OGV 1	OGV 2	Total Car	Total LGV	Total HGV
Site 1N	1,539	283	64	109	**1,822**	**283**	**173**
Site 2N	3,567	485	87	61	**3,567**	**485**	**148**
Site 3S	2,314	407	73	138	**2,314**	**407**	**211**
Site 4S	4,058	485	64	36	**4,058**	**485**	**100**
Site 5S	4,107	619	117	24	**4,107**	**619**	**141**
Site 6N	4,958	556	184	17	**4,958**	**556**	**201**
Site 7N	2,869	417	78	20	**2,869**	**417**	**98**
TOTAL	**23,412**	**3,252**	**667**	**405**	**23,695**	**3,252**	**1,072**

Table D - 18 Existing Road Side Interview Doncaster Model – Sample Rates by Vehicle Type

Site Number	Car	LGV	OGV 1	OGV 2	Total Car	Total LGV	Total HGV
Site 1N	47%	44%	42%	39%	40%	44%	40%
Site 2N	33%	28%	44%	39%	33%	28%	42%
Site 3S	32%	26%	42%	28%	32%	26%	33%
Site 4S	34%	25%	55%	19%	34%	25%	42%
Site 5S	29%	25%	27%	17%	29%	25%	26%
Site 6N	27%	21%	18%	82%	27%	21%	23%
Site 7N	26%	28%	23%	30%	27%	28%	24%
TOTAL	47%	44%	42%	39%	40%	44%	40%

Table D - 19 Existing Road Side Interview Lincoln Model – Hourly RSI Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1	84	116	79	43	27	19	16	37	43	42	56	24	**586**	**200**	**142**	**98**
Site 2	121	135	98	65	42	67	60	51	58	59	80	47	**883**	**256**	**285**	**139**
Site 3	82	147	58	79	95	61	65	71	71	86	88	41	**944**	**229**	**371**	**174**
Site 4	90	97	90	59	64	60	70	71	58	74	93	81	**907**	**187**	**324**	**167**
Site 5	0	23	47	51	38	39	38	39	38	43	52	57	**465**	**23**	**205**	**95**
Site 6	27	33	41	34	25	67	95	50	88	48	45	25	**578**	**60**	**271**	**93**
Site 7	86	113	61	30	34	17	8	18	19	26	15	11	**438**	**199**	**107**	**41**
Site 8	1	71	158	58	88	34	42	20	13	37	47	15	**584**	**72**	**242**	**84**
Site 9	4	165	139	143	90	18	70	21	162	9	2	53	**876**	**169**	**342**	**11**
Site 10	71	112	126	93	59	61	54	44	111	30	44	0	**805**	**183**	**311**	**74**
Site 11	63	81	26	41	23	30	39	25	26	28	68	72	**522**	**144**	**158**	**96**
Site 11a	29	58	43	32	38	51	66	56	62	119	50	49	**653**	**87**	**243**	**169**
Site 12	70	85	57	40	43	38	33	34	36	42	38	60	**576**	**155**	**188**	**80**
Site 13N	65	44	79	73	29	15	30	44	22	79	42	6	**528**	**109**	**191**	**121**
Site 13S	64	79	105	34	36	30	48	31	65	77	48	17	**634**	**143**	**179**	**125**
Site 14N	153	251	69	87	71	81	74	41	98	76	107	2	**1,110**	**404**	**354**	**183**
Site 14S	44	87	95	38	58	45	61	67	103	62	57	27	**744**	**131**	**269**	**119**
Site 16	53	85	48	53	60	34	41	50	41	63	39	47	**614**	**138**	**238**	**102**
TOTAL	**1,107**	**1,782**	**1,419**	**1,053**	**920**	**767**	**910**	**770**	**1,114**	**1,000**	**971**	**634**	**12,447**	**2,889**	**4,420**	**1,971**

Table D - 20 Existing Road Side Interview Lincoln Model – Hourly MCC Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1	479	513	273	213	149	162	170	163	180	236	280	157	**2,975**	**992**	**857**	**516**
Site 2	704	886	637	500	450	501	427	478	521	562	654	445	**6,765**	**1,590**	**2,356**	**1,216**
Site 3	872	996	764	593	495	525	536	557	566	637	595	585	**7,721**	**1,868**	**2,706**	**1,232**
Site 4	601	565	740	572	548	512	547	526	510	677	738	575	**7,111**	**1,166**	**2,705**	**1,415**
Site 5	327	409	247	188	189	162	211	219	233	319	270	248	**3,022**	**736**	**969**	**589**
Site 6	1,079	1,405	987	854	843	868	937	989	1,084	1,338	1,604	1,160	**13,148**	**2,484**	**4,491**	**2,942**
Site 7	334	691	321	217	183	181	175	162	205	175	141	158	**2,943**	**1,025**	**918**	**316**
Site 8	436	463	337	298	367	300	278	273	297	268	212	259	**3,788**	**899**	**1,516**	**480**
Site 9	994	1,053	803	639	593	570	649	609	522	580	626	649	**8,287**	**2,047**	**3,060**	**1,206**
Site 10	575	568	465	364	397	402	417	421	450	497	452	364	**5,372**	**1,143**	**2,001**	**949**
Site 11	218	354	253	145	237	201	229	218	271	456	425	290	**3,297**	**572**	**1,030**	**881**
Site 11a	113	158	111	91	99	97	123	136	118	221	213	121	**1,601**	**271**	**546**	**434**
Site 12	806	939	776	703	625	563	613	612	581	588	587	513	**7,906**	**1,745**	**3,116**	**1,175**
Site 13N	509	699	566	434	479	543	558	520	566	615	657	451	**6,597**	**1,208**	**2,534**	**1,272**
Site 13S	347	430	454	336	339	306	357	328	313	409	363	237	**4,219**	**777**	**1,666**	**772**
Site 14N	999	1,340	1,089	858	1,049	886	981	973	1,027	1,070	1,111	780	**12,163**	**2,339**	**4,747**	**2,181**
Site 14S	1,182	1,557	1,281	1,347	1,312	1,471	1,443	1,509	1,738	1,987	1,752	1,280	**17,859**	**2,739**	**7,082**	**3,739**
Site 16	753	1,084	885	841	740	826	756	770	673	672	633	576	**9,209**	**1,837**	**3,933**	**1,305**
TOTAL	**11,328**	**14,110**	**10,989**	**9,193**	**9,094**	**9,076**	**9,407**	**9,463**	**9,855**	**11,307**	**11,313**	**8,848**	**123,983**	**25,438**	**46,233**	**22,620**

Table D - 21 Existing Road Side Interview Lincoln Model – Hourly Sample Rate

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1	18%	23%	29%	20%	18%	12%	9%	23%	24%	18%	20%	15%	20%	20%	17%	19%
Site 2	17%	15%	15%	13%	9%	13%	14%	11%	11%	10%	12%	11%	13%	16%	12%	11%
Site 3	9%	15%	8%	13%	19%	12%	12%	13%	13%	14%	15%	7%	12%	12%	14%	14%
Site 4	15%	17%	12%	10%	12%	12%	13%	13%	11%	11%	13%	14%	13%	16%	12%	12%
Site 5	0%	6%	19%	27%	20%	24%	18%	18%	16%	13%	19%	23%	15%	3%	21%	16%
Site 6	3%	2%	4%	4%	3%	8%	10%	5%	8%	4%	3%	2%	4%	2%	6%	3%
Site 7	26%	16%	19%	14%	19%	9%	5%	11%	9%	15%	11%	7%	15%	19%	12%	13%
Site 8	0%	15%	47%	19%	24%	11%	15%	7%	4%	14%	22%	6%	15%	8%	16%	18%
Site 9	0%	16%	17%	22%	15%	3%	11%	3%	31%	2%	0%	8%	11%	8%	11%	1%
Site 10	12%	20%	27%	26%	15%	15%	13%	10%	25%	6%	10%	0%	15%	16%	16%	8%
Site 11	29%	23%	10%	28%	10%	15%	17%	11%	10%	6%	16%	25%	16%	25%	15%	11%
Site 11a	26%	37%	39%	35%	38%	53%	54%	41%	53%	54%	23%	40%	41%	32%	45%	39%
Site 12	9%	9%	7%	6%	7%	7%	5%	6%	6%	7%	6%	12%	7%	9%	6%	7%
Site 13N	13%	6%	14%	17%	6%	3%	5%	8%	4%	13%	6%	1%	8%	9%	8%	10%
Site 13S	18%	18%	23%	10%	11%	10%	13%	9%	21%	19%	13%	7%	15%	18%	11%	16%
Site 14N	15%	19%	6%	10%	7%	9%	8%	4%	10%	7%	10%	0%	9%	17%	7%	8%
Site 14S	4%	6%	7%	3%	4%	3%	4%	4%	6%	3%	3%	2%	4%	5%	4%	3%
Site 16	7%	8%	5%	6%	8%	4%	5%	6%	6%	9%	6%	8%	7%	8%	6%	8%
TOTAL	**10%**	**13%**	**13%**	**11%**	**10%**	**8%**	**10%**	**8%**	**11%**	**9%**	**9%**	**7%**	**10%**	**11%**	**10%**	**9%**

Table D - 22 Existing Road Side Interview Lincoln Model – RSI Totals by Vehicle Type

Site Number	Car	LGV	OGV 1	OGV 2	Total Car	Total LGV	Total HGV
Site 1	556	25	3	0	556	25	3
Site 2	779	86	6	11	779	86	17
Site 3	892	35	6	9	892	35	15
Site 4	853	40	4	5	853	40	9
Site 5	410	40	5	6	410	40	11
Site 6	508	34	10	24	508	34	34
Site 7	419	18	0	1	419	18	1
Site 8	557	23	3	1	557	23	4
Site 9	853	24	2	5	853	24	7
Site 10	767	28	8	1	767	28	9
Site 11	507	14	1	0	507	14	1
Site 11a	627	27	2	1	627	27	3
Site 12	535	19	4	14	535	19	18
Site 13N	492	26	3	4	492	26	7
Site 13S	600	26	3	3	600	26	6
Site 14N	1,076	33	0	1	1,076	33	1
Site 14S	691	45	3	5	691	45	8
Site 16	590	20	3	0	590	20	3
TOTAL	11,712	563	66	91	11,712	563	157

Table D - 23 Existing Road Side Interview Lincoln Model – MCC Totals by Vehicle Type

Site Number	Car	LGV	OGV 1	OGV 2	Total Car	Total LGV	Total HGV
Site 1	2594	322	44	15	**2594**	**322**	**59**
Site 2	4892	926	243	704	**4892**	**926**	**947**
Site 3	6615	871	161	74	**6615**	**871**	**235**
Site 4	5756	967	203	185	**5756**	**967**	**388**
Site 5	2312	549	99	62	**2312**	**549**	**161**
Site 6	9816	1694	809	829	**9816**	**1694**	**1638**
Site 7	2586	322	28	7	**2586**	**322**	**35**
Site 8	3097	574	67	50	**3097**	**574**	**117**
Site 9	7229	818	159	81	**7229**	**818**	**240**
Site 10	4600	493	145	134	**4600**	**493**	**279**
Site 11	2853	357	73	14	**2853**	**357**	**87**
Site 11a	1236	264	76	25	**1236**	**264**	**101**
Site 12	6173	1139	381	213	**6173**	**1139**	**594**
Site 13N	5518	834	184	61	**5518**	**834**	**245**
Site 13S	3596	486	89	48	**3596**	**486**	**137**
Site 14N	10003	1745	290	125	**10003**	**1745**	**415**
Site 14S	14836	2183	667	173	**14836**	**2183**	**840**
Site 16	7825	1086	223	75	**7825**	**1086**	**298**
TOTAL	**101537**	**15630**	**3941**	**2875**	**101537**	**15630**	**6816**

Table D - 24 Existing Road Side Interview Lincoln Model – Sample Rates by Vehicle Type

Site Number	Car	LGV	OGV 1	OGV 2	Total Car	Total LGV	Total HGV
Site 1	21%	8%	7%	0%	21%	8%	5%
Site 2	16%	9%	2%	2%	16%	9%	2%
Site 3	13%	4%	4%	12%	13%	4%	6%
Site 4	15%	4%	2%	3%	15%	4%	2%
Site 5	18%	7%	5%	10%	18%	7%	7%
Site 6	5%	2%	1%	3%	5%	2%	2%
Site 7	16%	6%	0%	14%	16%	6%	3%
Site 8	18%	4%	4%	2%	18%	4%	3%
Site 9	12%	3%	1%	6%	12%	3%	3%
Site 10	17%	6%	6%	1%	17%	6%	3%
Site 11	18%	4%	1%	0%	18%	4%	1%
Site 11a	51%	10%	3%	4%	51%	10%	3%
Site 12	9%	2%	1%	7%	9%	2%	3%
Site 13N	9%	3%	2%	7%	9%	3%	3%
Site 13S	17%	5%	3%	6%	17%	5%	4%
Site 14N	11%	2%	0%	1%	11%	2%	0%
Site 14S	5%	2%	0%	3%	5%	2%	1%
Site 16	8%	2%	1%	0%	8%	2%	1%
TOTAL	12%	4%	2%	3%	12%	4%	2%

Table D - 25 New HETM RSI Surveys – Hourly RSI Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1WB	75	180	116	113	117	135	119	117	134	147	187	119	**1,559**	**255**	**601**	**334**
Site 2NB	65	85	66	50	76	69	72	73	70	82	81	66	**855**	**150**	**340**	**163**
Site 3SB	60	80	59	68	61	61	63	63	62	79	62	68	**786**	**140**	**316**	**141**
Site 4WB	62	74	87	71	64	103	73	114	88	86	114	78	**1,014**	**136**	**425**	**200**
Site 5NB	105	119	102	80	80	75	84	76	79	84	97	73	**1,054**	**224**	**395**	**181**
TOTAL	**367**	**538**	**430**	**382**	**398**	**443**	**411**	**443**	**433**	**478**	**541**	**404**	**4,870**	**905**	**1,679**	**1,019**

Table D - 26 New HETM RSI Surveys – Hourly MCC Totals

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1WB	1,698	1,415	939	934	1,016	1,097	1,182	1,144	1,241	1,242	1,211	863	**13,982**	**3,113**	**5,373**	**2,453**
Site 2NB	696	798	546	440	426	390	425	392	444	558	579	377	**6,071**	**1,494**	**2,073**	**1,137**
Site 3SB	292	373	374	428	452	522	490	526	558	739	748	371	**5,873**	**665**	**2,418**	**1,487**
Site 4WB	750	575	590	586	678	740	750	745	800	994	939	596	**8,743**	**1,325**	**3,499**	**1,933**
Site 5NB	547	587	383	293	299	303	283	251	287	338	377	240	**4,188**	**1,134**	**1,429**	**715**
TOTAL	**3,983**	**3,748**	**2,832**	**2,681**	**2,871**	**3,052**	**3,130**	**3,058**	**3,330**	**3,871**	**3,854**	**2,447**	**38,857**	**7,731**	**14,792**	**7,725**

Table D - 27 New HETM RSI Surveys – Hourly Sample Rate

Site Number	0700 to 0800	0800 to 0900	0900 to 1000	1000 to 1100	1100 to 1200	1200 to 1300	1300 to 1400	1400 to 1500	1500 to 1600	1600 to 1700	1700 to 1800	1800 to 1900	12hr Total	AM Peak	Inter Peak	PM Peak
Site 1WB	4%	13%	12%	12%	12%	12%	10%	10%	11%	12%	15%	14%	**11%**	**8%**	**11%**	**14%**
Site 2NB	9%	11%	12%	11%	18%	18%	17%	19%	16%	15%	14%	18%	**14%**	**10%**	**16%**	**14%**
Site 3SB	21%	21%	16%	16%	13%	12%	13%	12%	11%	11%	8%	18%	**13%**	**21%**	**13%**	**9%**
Site 4WB	8%	13%	15%	12%	9%	14%	10%	15%	11%	9%	12%	13%	**12%**	**10%**	**12%**	**10%**
Site 5NB	19%	20%	27%	27%	27%	25%	30%	30%	28%	25%	26%	30%	**25%**	**20%**	**28%**	**25%**
TOTAL	**9%**	**14%**	**15%**	**14%**	**14%**	**15%**	**13%**	**14%**	**13%**	**12%**	**14%**	**17%**	**13%**	**12%**	**11%**	**13%**

Table D - 28 New HETM RSI Surveys – RSI Totals by Vehicle Type

Site Number	Motorcycle	Car / Taxi	Van not over 3.5T	Van >3.5T but <7.5T	HGV 2 axle	HGV 3 axle	HGV 4+ axles	Total Car	Total LGV	Total HGV
Site 1WB	17	1,397	95	21	4	7	18	**1,492**	**21**	**29**
Site 2NB	7	655	108	19	12	6	48	**763**	**19**	**66**
Site 3SB	4	540	91	29	18	5	99	**631**	**29**	**122**
Site 4WB	9	802	130	20	14	12	27	**932**	**20**	**53**
Site 5NB	11	829	146	37	16	3	12	**975**	**37**	**31**
TOTAL	**48**	**4,223**	**570**	**126**	**64**	**33**	**204**	**4,793**	**126**	**301**

Table D - 29 New HETM RSI Surveys – MCC Totals by Vehicle Type

Site Number	Motorcycle	Car / Taxi	Van not over 3.5T	Van >3.5T but <7.5T	HGV 2 axle	HGV 3 axle	HGV 4+ axles	Total Car	Total LGV	Total HGV
Site 1WB	139	10,397	2,132	544	172	123	475	**12,529**	**544**	**770**
Site 2NB	36	4,350	870	214	184	64	353	**5,220**	**214**	**601**
Site 3SB	26	3,952	701	181	75	60	878	**4,653**	**181**	**1,013**
Site 4WB	55	6,940	1,028	236	132	56	296	**7,968**	**236**	**484**
Site 5NB	19	3,370	574	115	47	18	45	**3,944**	**115**	**110**
TOTAL	**275**	**29,009**	**5,305**	**1,290**	**610**	**321**	**2,047**	**34,314**	**1,290**	**2,978**

Table D - 30 New HETM RSI Surveys – Sample Rates by Vehicle Type

Site Number	Motorcycle	Car / Taxi	Van not over 3.5T	Van >3.5T but <7.5T	HGV 2 axle	HGV 3 axle	HGV 4+ axles	Total Car	Total LGV	Total HGV
Site 1WB	12%	13%	4%	4%	2%	6%	4%	**12%**	**4%**	**4%**
Site 2NB	19%	15%	12%	9%	7%	9%	14%	**15%**	**9%**	**11%**
Site 3SB	15%	14%	13%	16%	24%	8%	11%	**14%**	**16%**	**12%**
Site 4WB	16%	12%	13%	8%	11%	21%	9%	**12%**	**8%**	**11%**
Site 5NB	58%	25%	25%	32%	34%	17%	27%	**25%**	**32%**	**28%**
TOTAL	**17%**	**15%**	**11%**	**10%**	**10%**	**10%**	**10%**	**14%**	**10%**	**10%**

Appendix E – Detailed Validation Breakdown

Appendix E – Detailed Validation Breakdown

Table E - 1 AM Validation Sites

Description			AM PEAK					
Screenline	**Link Description**	**Dir**	**Modelled**	**Observed**	**%**	**GEH**	**GEH**	**Flow**
NORTHERN SCREENLINE								
	B1242 Atwick Road	NB	230	192	20%	2.6	YES	YES
	A165 Bridlington Road	NB	576	445	29%	5.8	NO	NO
	A164 Beverley-Driffield	NB	330	299	10%	1.8	YES	YES
	B1248 Station Road	NB	467	498	-6%	1.4	YES	YES
	A1079 Crosshills	NWB	727	951	-24%	7.7	NO	NO
NB Combined			2330	2384	-2%	1.1		
	B1242 Atwick Road	SB	223	149	49%	5.4	NO	YES
	A165 Bridlington Road	SB	557	487	15%	3.1	YES	YES
	A164 Beverley-Driffield	SB	441	534	-17%	4.2	YES	YES
	B1248 Station Road	SB	627	596	5%	1.3	YES	YES
	A1079 Crosshills	SEB	720	722	0%	0.1	YES	YES
SB Combined			2569	2487	3%	1.6		
SOUTHERN SCREENLINE								
	A161 Haxey	NB	366	322	14%	2.4	YES	YES
	A159, Gainsborough	NB	292	221	32%	4.5	YES	YES
	A15, Spital-in-the-Street	NB	464	462	1%	0.1	YES	YES
	A46 Claxby Moor-Walesby Moor	NB	388	416	-7%	1.4	YES	YES
	B1225, Stainton le Vale	NWB	163	126	29%	3.0	YES	YES
	A46 Irby upon Humber	WB	373	293	27%	4.4	YES	YES
	A18 Barton Street	NB	828	856	-3%	1.0	YES	YES
	A1136 Great Coates Road	NWB	537	488	10%	2.2	YES	YES
	A180, Europarc	WB	1697	1625	4%	1.8	YES	YES
NB Combined			5110	4810	6%	4.3		
	A161 Haxey	SB	223	224	0%	0.0	YES	YES
	A159, Gainsborough	SB	371	317	17%	2.9	YES	YES
	A15, Spital-in-the-Street	SB	509	507	0%	0.1	YES	YES
	A46 Claxby Moor-Walesby Moor	SB	396	364	9%	1.6	YES	YES
	B1225, Stainton le Vale	SEB	159	132	21%	2.3	YES	YES
	A46 Irby upon Humber	EB	431	377	14%	2.7	YES	YES
	A18 Barton Street	SB	585	480	22%	4.6	YES	NO
	A1136 Great Coates Road	SEB	342	686	-50%	15.2	NO	NO
	A180, Europarc	EB	1429	1253	14%	4.8	YES	YES
SB Combined			4444	4339	2%	1.6		
HUMBER SCREENLINE								
	M62 J35-36	NEB	2358	2457	-4%	2.0	YES	YES
	A614 N Goole	NB	525	424	24%	4.6	YES	NO
	A15 South Humber Bridge	NB	1171	1171	0%	0.0	YES	YES
NB Combined			4054	4052	0%	0.0		
	M62 J35-36	SWB	2582	2514	3%	1.4	YES	YES
	A614 N Goole	SB	490	504	-3%	0.6	YES	YES
	A15 South Humber Bridge	SB	1221	1103	11%	3.5	YES	YES
SB Combined			4294	4121	4%	2.7		
WESTERN SCREENLINE								
	M62 J37-38	NEB	1868	1851	1%	0.4	YES	YES
	A161 Swinefleet Road	SEB	111	72	54%	4.1	YES	YES
	A18 Doncaster Road - Gunness	EB	749	691	8%	2.2	YES	YES
	M180 J1-2	EB	1766	1849	-4%	1.9	YES	YES
EB Combined			4494	4463	1%	0.5		
	M62 J37-38	WB	1812	1936	-6%	2.9	YES	YES
	A161 Swinefleet Road	WB	63	53	19%	1.3	YES	YES
	A18 Doncaster Road - Gunness	WB	472	306	54%	8.4	NO	NO
	M180 J1-2	WB	1662	1948	-15%	6.7	NO	YES
WB Combined			4009	4243	-6%	3.7		
CENTRAL SCREENLINE								
	M180 (jct 3 - 4)	EB	1251	1325	-6%	2.1	YES	YES
	A18 - Queensway	EB	1337	1193	12%	4.1	YES	YES
	A1077	NB	133	202	-34%	5.3	NO	YES
	Thealby Lane	EB	47	74	-37%	3.5	YES	YES
	A63 (S Cave - N Ferriby)	EB	2410	2287	5%	2.5	YES	YES
EB Combined			5179	5082	2%	1.4		
	M180 (jct 4 - 5)	WB	2010	1879	7%	3.0	YES	YES
	A18 - Queensway	WB	1997	1703	17%	6.8	NO	NO
	A1077	SB	351	367	-4%	0.9	YES	YES
	Thealby Lane	WB	140	132	6%	0.7	YES	YES
	A63 (S Cave - N Ferriby)	WB	1833	1957	-6%	2.9	YES	YES
WB Combined			6330	6038	5%	3.7		
BARTON SCREENLINE								
	A1077 Barrow Road	WB	382	417	-8%	1.7	YES	YES
	Burnham Road	NB	0	10	-100%	4.4	YES	YES
	B1206 (A15)	WB	143	182	-21%	3.0	YES	YES
WB Combined			525	608	-14%	3.5		
	A1077 Barrow Road	EB	420	321	31%	5.2	NO	YES
	Burnham Road	SB	28	15	82%	2.7	YES	YES
	B1206 (A15)	EB	71	85	-16%	1.5	YES	YES
EB Combined			519	421	23%	4.5		

Table E - 2 AM Calibration sites

Description			AM PEAK					
Screenline	**Link Description**	**Dir**	**Modelled**	**Observed**	**%**	**GEH**	**GEH**	**Flow**
Hull City Region - Outer Cordon A63 Model								
	·A164 south of Dunflat Road	SB	1370	1413	-3%	1.1	YES	YES
	·Beverley Road prior to junction with Evergreen Drive	SB	1415	1187	19%	6.3	NO	NO
	Raich Carter Way east of the Beverley High Road	EB	1232	1214	1%	0.5	YES	YES
	Holderness Road opposite Parkhurst Close	WB	1277	1395	-8%	3.2	YES	YES
	Hedon Road opposite Tower House Lane	WB	1596	1777	-10%	4.4	YES	YES
	A63 (Under the Humber Bridge)	EB	2891	3091	-6%	3.7	YES	YES
	A15 North of the Humber Bridge	NB	1171	1127	4%	1.3	YES	YES
	Boothferry Road before the A164 roundabout junction	NB	953	872	9%	2.7	YES	YES
	Tranby Lane junction with Old Hill and Humber View	EB	206	239	-14%	2.2	YES	YES
Hull Outer Inbound Combined			12110	12316	-2%	1.9		
	·A164 south of Dunflat Road	NB	961	1099	-13%	4.3	YES	YES
	·Beverley Road prior to junction with Evergreen Drive	SB	837	802	4%	1.2	YES	YES
	Raich Carter Way east of the Beverley High Road	EB	1301	1343	-3%	1.2	YES	YES
	Holderness Road opposite Parkhurst Close	EB	710	666	7%	1.7	YES	YES
	Hedon Road opposite Tower House Lane	EB	1050	1034	1%	0.5	YES	YES
	A63 (Under the Humber Bridge)	WB	1661	1868	-11%	4.9	YES	YES
	A15 North of the Humber Bridge	SB	1221	1103	11%	3.5	YES	YES
	Boothferry Road before the A164 roundabout junction	SB	1380	1642	-16%	6.7	NO	NO
	Tranby Lane junction with Old Hill and Humber View	WB	176	184	-4%	0.6	YES	YES
Hull Outer Outbound Combined			9298	9742	-5%	4.5		
Hull City Region - Inner Cordon A63 Model								
	A63 Clive Sulavan Way (Hull) West of Ferensway	IB	3117	2180	43%	18.2	NO	NO
	Madeley Street (slip)	IB	863	1068	-19%	6.6	NO	NO
	Brighton Road (slip)	IB	366	569	-36%	9.4	NO	NO
	A1166 Hessle Road to the east of Sunningdale Road	EB	1221	1183	3%	1.1	YES	YES
	Boothferry Road to the west of Kempton Road	EB	511	557	-8%	2.0	YES	YES
	Anlaby Road east of Hamlyn Avenue	EB	673	393	71%	12.1	NO	NO
	Spring Bank West opposite De La Pole Avenue	EB	1281	1230	4%	1.4	YES	YES
	Chanterlands Avenue prior to the Cemetery Entrance	SB	955	825	16%	4.4	YES	NO
	Queens Road after the turn for Newland Avenue	EB	268	327	-18%	3.4	YES	YES
	Beverley Road south of the Clough Road junction	SB	874	749	17%	4.4	YES	NO
	Bankside located approach to roundabout	SB	809	883	-8%	2.5	YES	YES
	Stoneferry Road south of the railway bridge	SB	1414	1573	-10%	4.1	YES	YES
	James Reckitt Avenue south of Dunscombe Park	SB	728	1011	-28%	9.6	NO	NO
	Witham west of the Holderness Road junction	WB	392	640	-39%	10.9	NO	NO
	·Clarence Street west of Alma Street junction	WB	179	490	-63%	17.0	NO	NO
	Hedon Road west of the Merrick Street junction	WB	391	425	-8%	1.7	YES	YES
	·Garrison Road, approach to Plimsoll Way roundabout	WB	1292	1571	-18%	7.4	NO	NO
Hull Inner Cordon Combined (Inbound)			15334	15676	-2%	2.7		
	A63 Clive Sulavan Way (Hull) West of Ferensway	OB	2010	2457	-18%	9.4	NO	NO
	Madeley Street (slip)	OB	520	438	19%	3.8	YES	YES
	Brighton Road (slip)	OB	116	189	-38%	5.9	NO	YES
	A1166 Hessle Road to the east of Sunningdale Road	WB	644	960	-33%	11.2	NO	NO
	Boothferry Road to the west of Kempton Road	WB	254	317	-20%	3.7	YES	YES
	Anlaby Road east of Hamlyn Avenue	EB	409	326	26%	4.3	YES	YES
	Spring Bank West opposite De La Pole Avenue	WB	779	828	-6%	1.7	YES	YES
	Chanterlands Avenue prior to the Cemetery Entrance	NB	692	583	19%	4.3	YES	NO
	Queens Road after the turn for Newland Avenue	WB	313	324	-3%	0.6	YES	YES
	Beverley Road south of the Clough Road junction	NB	749	649	15%	3.8	YES	NO
	Bankside located approach to roundabout	NB	586	429	37%	7.0	NO	NO
	Stoneferry Road south of the railway bridge	NB	795	1135	-30%	10.9	NO	NO
	James Reckitt Avenue south of Dunscombe Park	NB	362	180	101%	11.1	NO	NO
	Witham west of the Holderness Road junction	EB	432	408	6%	1.2	YES	YES
	·Clarence Street west of Alma Street junction	EB	290	307	-5%	1.0	YES	YES
	Hedon Road west of the Merrick Street junction	EB	25	214	-88%	17.3	NO	NO
	·Garrison Road, approach to Plimsoll Way roundabout	EB	1975	1544	28%	10.3	NO	NO
Hull Inner Cordon Combined			10953	11284	-3%	3.1		
Immingham Cordon								
	Thornly Station	EB	209	294	-29%	5.3	NO	YES
	A160 - Humber Road	EB	1275	1243	3%	0.9	YES	YES
	B1210 W	NB	357	322	11%	1.9	YES	YES
	B1210 E	NB	460	497	-7%	1.7	YES	YES
	A1173	EB	1194	1225	-3%	0.9	YES	YES
Immingham Inbound Combined			3496	3581	-2%	1.4		
	Thornly Station	WB	106	85	25%	2.1	YES	YES
	A160 - Humber Road	WB	914	860	6%	1.8	YES	YES
	B1210 W	SB	23	93	-75%	9.2	NO	YES
	B1210 E	SB	282	236	19%	2.8	YES	YES
	A1173	WB	533	660	-19%	5.2	NO	NO
Immingham Outbound Combined			1858	1934	-4%	1.7		
RSI COUNTS - HETM								
	A180 Grimbsy	WB	1697	1590	7%	2.6	YES	YES
	A18 Brigg	NB	942	879	7%	2.1	YES	YES
	A1077 Scunthorpe	SB	574	500	15%	3.2	YES	YES
	A18 Scunthorpe	WB	837	843	-1%	0.2	YES	YES
	A161	NB	748	571	31%	6.9	NO	NO
HETM NB Combined			4798	4384	9%	6.1		
	A180 Grimbsy	EB	1429	1226	17%	5.6	NO	NO
	A18 Brigg	SB	748	597	25%	5.8	NO	NO
	A1077 Scunthorpe	NB	835	916	-9%	2.8	YES	YES
	A18 Scunthorpe	EB	1242	1096	13%	4.3	YES	YES
	A161	SB	500	330	51%	8.3	NO	NO
HETM SB Combined			4753	4166	14%	8.8		

Table E - 3 IP Validation Sites

Description			AM PEAK					
Screenline	**Link Description**	**Dir**	**Modelled**	**Observed**	**%**	**GEH**	**GEH**	**Flow**
NORTHERN SCREENLINE								
	B1242 Atwick Road	NB	181	305	-41%	8.0	NO	NO
	A165 Bridlington Road	NB	530	431	23%	4.5	YES	YES
	A164 Beverley-Driffield	NB	337	323	4%	0.7	YES	YES
	B1248 Station Road	NB	456	620	-27%	7.1	NO	NO
	A1079 Crosshills	NWB	681	603	13%	3.1	YES	YES
NB Combined			2185	2283	-4%	2.1		
	B1242 Atwick Road	SB	210	299	-30%	5.5	NO	YES
	A165 Bridlington Road	SB	513	361	42%	7.3	NO	NO
	A164 Beverley-Driffield	SB	296	337	-12%	2.3	YES	YES
	B1248 Station Road	SB	445	464	-4%	0.9	YES	YES
	A1079 Crosshills	SEB	671	590	14%	3.3	YES	YES
SB Combined			2136	2050	4%	1.9		
SOUTHERN SCREENLINE								
	A161 Haxey	NB	350	208	68%	8.5	NO	NO
	A159, Gainsborough	NB	246	237	4%	0.6	YES	YES
	A15, Spital-in-the-Street	NB	435	428	1%	0.3	YES	YES
	A46 Claxby Moor-Walesby Moor	NB	324	282	15%	2.4	YES	YES
	B1225, Stainton le Vale	NWB	117	109	7%	0.7	YES	YES
	A46 Irby upon Humber	WB	329	247	34%	4.9	YES	YES
	A18 Barton Street	NB	465	398	17%	3.2	YES	YES
	A1136 Great Coates Road	NWB	247	420	-41%	9.4	NO	NO
	A180, Europarc	WB	1255	1383	-9%	3.5	YES	YES
NB Combined			3769	3712	2%	0.9		
	A161 Haxey	SB	166	191	-13%	1.9	YES	YES
	A159, Gainsborough	SB	263	246	7%	1.1	YES	YES
	A15, Spital-in-the-Street	SB	504	447	13%	2.6	YES	YES
	A46 Claxby Moor-Walesby Moor	SB	324	249	30%	4.4	YES	YES
	B1225, Stainton le Vale	SEB	151	92	64%	5.3	NO	YES
	A46 Irby upon Humber	EB	328	254	29%	4.3	YES	YES
	A18 Barton Street	SB	529	373	42%	7.3	NO	NO
	A1136 Great Coates Road	SEB	284	396	-28%	6.1	NO	NO
	A180, Europarc	EB	1226	1458	-16%	6.3	NO	NO
SB Combined			3775	3706	2%	1.1		
HUMBER SCREENLINE								
	M62 J35-36	NEB	1733	1850	-6%	2.7	YES	YES
	A614 N Goole	NB	360	462	-22%	5.0	NO	NO
	A15 South Humber Bridge	NB	771	728	6%	1.6	YES	YES
NB Combined			2865	3039	-6%	3.2		
	M62 J35-36	SWB	1732	1882	-8%	3.5	YES	YES
	A614 N Goole	SB	377	449	-16%	3.5	YES	YES
	A15 South Humber Bridge	SB	836	703	19%	4.8	YES	NO
SB Combined			2944	3033	-3%	1.6		
WESTERN SCREENLINE								
	M62 J37-38	NEB	1296	1267	2%	0.8	YES	YES
	A161 Swinefleet Road	SEB	67	50	35%	2.3	YES	YES
	A18 Doncaster Road - Gunness	EB	537	472	14%	2.9	YES	YES
	M180 J1-2	EB	1539	1380	12%	4.2	YES	YES
EB Combined			3440	3169	9%	4.7		
	M62 J37-38	WB	1526	1343	14%	4.8	YES	YES
	A161 Swinefleet Road	WB	72	49	47%	3.0	YES	YES
	A18 Doncaster Road - Gunness	WB	443	465	-5%	1.0	YES	YES
	M180 J1-2	WB	1271	1521	-16%	6.7	NO	NO
WB Combined			3313	3378	-2%	1.1		
CENTRAL SCREENLINE								
	M180 (jct 3 - 4)	EB	1057	1062	0%	0.2	YES	YES
	A18 - Queensway	EB	1198	1406	-15%	5.8	NO	YES
	A1077	NB	174	227	-24%	3.8	YES	YES
	Thealby Lane	EB	47	80	-42%	4.2	YES	YES
	A63 (S Cave - N Ferriby)	EB	1621	1384	17%	6.1	NO	NO
EB Combined			4097	4160	-2%	1.0		
	M180 (jct 4 - 5)	WB	1646	1372	20%	7.1	NO	NO
	A18 - Queensway	WB	1079	1143	-6%	1.9	YES	YES
	A1077	SB	210	203	3%	0.5	YES	YES
	Thealby Lane	WB	82	59	39%	2.8	YES	YES
	A63 (S Cave - N Ferriby)	WB	1838	1701	8%	3.3	YES	YES
WB Combined			4856	4478	8%	5.5		
BARTON SCREENLINE								
	A1077 Barrow Road	WB	327	247	32%	4.7	YES	YES
	Burnham Road	NB	0	7	-100%	3.8	YES	YES
	B1206 (A15)	WB	71	111	-36%	4.2	YES	YES
WB Combined			398	366	9%	1.7		
	A1077 Barrow Road	EB	274	250	10%	1.5	YES	YES
	Burnham Road	SB	7	9	-15%	0.5	YES	YES
	B1206 (A15)	EB	62	96	-35%	3.8	YES	YES
EB Combined			344	355	-3%	0.6		

Table E - 4 IP Calibration

Description			INTERPEAK					
Screenline	**Link Description**	**Dir**	**Modelled**	**Observed**	**%**	**GEH**	**GEH**	**Flow**
Hull City Region - Outer Cordon A63 Model								
	·A164 south of Dunflat Road	SB	985	964	2%	0.7	YES	YES
	·Beverley Road prior to junction with Evergreen Drive	SB	841	817	3%	0.8	YES	YES
	Raich Carter Way east of the Beverley High Road	EB	1225	993	23%	7.0	NO	NO
	Holderness Road opposite Parkhurst Close	WB	729	907	-20%	6.2	NO	NO
	Hedon Road opposite Tower House Lane	WB	811	1073	-24%	8.6	NO	NO
	A63 (Under the Humber Bridge)	EB	2003	1909	5%	2.1	YES	YES
	A15 North of the Humber Bridge	NB	771	728	6%	1.6	YES	YES
	Boothferry Road before the A164 roundabout junction	NB	689	888	-22%	7.1	NO	NO
	Tranby Lane junction with Old Hill and Humber View	EB	150	148	1%	0.1	YES	YES
Hull Outer Inbound Combined			8204	8428	-3%	2.5		
	·A164 south of Dunflat Road	NB	954	999	-5%	1.4	YES	YES
	·Beverley Road prior to junction with Evergreen Drive	SB	995	814	22%	6.0	NO	NO
	Raich Carter Way east of the Beverley High Road	EB	1209	1059	14%	4.4	YES	YES
	Holderness Road opposite Parkhurst Close	EB	1096	880	24%	6.9	NO	NO
	Hedon Road opposite Tower House Lane	EB	987	1047	-6%	1.9	YES	YES
	A63 (Under the Humber Bridge)	WB	1910	1914	0%	0.1	YES	YES
	A15 North of the Humber Bridge	SB	836	703	19%	4.8	YES	NO
	Boothferry Road before the A164 roundabout junction	SB	872	1086	-20%	6.8	NO	NO
	Tranby Lane junction with Old Hill and Humber View	WB	345	162	113%	11.5	NO	NO
Hull Outer Outbound Combined			9202	8663	6%	5.7		
Hull City Region - Inner Cordon A63 Model								
	A63 Clive Sulavan Way (Hull) West of Ferensway	IB	2610	2310	13%	6.0	NO	YES
	Madeley Street (slip)	IB	678	729	-7%	1.9	YES	YES
	Brighton Road (slip)	IB	392	539	-27%	6.8	NO	NO
	A1166 Hessle Road to the east of Sunningdale Road	EB	772	859	-10%	3.0	YES	YES
	Boothferry Road to the west of Kempton Road	EB	213	424	-50%	11.8	NO	NO
	Anlaby Road east of Hamlyn Avenue	EB	671	444	51%	9.6	NO	NO
	Spring Bank West opposite De La Pole Avenue	EB	930	852	9%	2.6	YES	YES
	Chanterlands Avenue prior to the Cemetery Entrance	SB	641	643	0%	0.1	YES	YES
	Queens Road after the turn for Newland Avenue	EB	382	381	0%	0.0	YES	YES
	Beverley Road south of the Clough Road junction	SB	758	850	-11%	3.2	YES	YES
	Bankside located approach to roundabout	SB	799	572	40%	8.7	NO	NO
	Stoneferry Road south of the railway bridge	SB	1212	1185	2%	0.8	YES	YES
	James Reckitt Avenue south of Dunscombe Park	SB	397	401	-1%	0.2	YES	YES
	Witham west of the Holderness Road junction	WB	268	506	-47%	12.1	NO	NO
	·Clarence Street west of Alma Street junction	WB	170	278	-39%	7.3	NO	NO
	Hedon Road west of the Merrick Street junction	WB	145	213	-32%	5.1	NO	YES
	·Garrison Road, approach to Plimsoll Way roundabout	WB	1829	1685	9%	3.4	YES	YES
Hull Inner Cordon Combined (Inbound)			**12867**	**12872**	**0%**	**0.0**		
	A63 Clive Sulavan Way (Hull) West of Ferensway	OB	2145	2310	-7%	3.5	YES	YES
	Madeley Street (slip)	OB	458	745	-39%	11.7	NO	NO
	Brighton Road (slip)	OB	385	580	-34%	8.9	NO	NO
	A1166 Hessle Road to the east of Sunningdale Road	WB	1044	1083	-4%	1.2	YES	YES
	Boothferry Road to the west of Kempton Road	WB	308	406	-24%	5.2	NO	YES
	Anlaby Road east of Hamlyn Avenue	EB	655	359	83%	13.2	NO	NO
	Spring Bank West opposite De La Pole Avenue	WB	1008	970	4%	1.2	YES	YES
	Chanterlands Avenue prior to the Cemetery Entrance	NB	894	674	33%	7.9	NO	NO
	Queens Road after the turn for Newland Avenue	WB	285	416	-31%	7.0	NO	NO
	Beverley Road south of the Clough Road junction	NB	811	909	-11%	3.3	YES	YES
	Bankside located approach to roundabout	NB	784	526	49%	10.1	NO	NO
	Stoneferry Road south of the railway bridge	NB	1560	1224	27%	9.0	NO	NO
	James Reckitt Avenue south of Dunscombe Park	NB	503	418	20%	4.0	YES	YES
	Witham west of the Holderness Road junction	EB	348	531	-34%	8.7	NO	NO
	Clarence Street west of Alma Street junction	EB	151	300	-50%	10.0	NO	NO
	Hedon Road west of the Merrick Street junction	EB	72	269	-73%	15.1	NO	NO
	Garrison Road, approach to Plimsoll Way roundabout	EB	2412	1720	40%	15.2	NO	NO
Hull Inner Cordon Combined			**13823**	**13439**	**3%**	**3.3**		
Immingham Cordon								
	Thornly Station	EB	82	76	8%	0.7	YES	YES
	A160 - Humber Road	EB	908	798	14%	3.8	YES	YES
	B1210 W	NB	62	108	-42%	4.9	YES	YES
	B1210 E	NB	195	259	-25%	4.3	YES	YES
	A1173	EB	675	566	19%	4.4	YES	NO
Immingham Inbound Combined			**1922**	**1807**	**6%**	**2.7**		
	Thornly Station	WB	101	90	12%	1.1	YES	YES
	A160 - Humber Road	WB	906	832	9%	2.5	YES	YES
	B1210 W	SB	58	109	-47%	5.6	NO	YES
	B1210 E	SB	175	232	-24%	3.9	YES	YES
	A1173	WB	530	666	-20%	5.5	NO	NO
Immingham Outbound Combined			**1770**	**1929**	**-8%**	**3.7**		
RSI COUNTS - HETM								
	A180 Grimbsy	WB	1255	1353	-7%	2.7	YES	YES
	A18 Brigg	NB	706	605	17%	4.0	YES	NO
	A1077 Scunthorpe	SB	584	778	-25%	7.4	NO	NO
	A18 Scunthorpe	WB	902	974	-7%	2.4	YES	YES
	A161	NB	470	333	41%	6.8	NO	NO
HETM NB Combined			**3917**	**4043**	**-3%**	**2.0**		
	A180 Grimbsy	EB	1226	1427	-14%	5.5	NO	YES
	A18 Brigg	SB	765	590	30%	6.7	NO	NO
	A1077 Scunthorpe	NB	597	762	-22%	6.4	NO	NO
	A18 Scunthorpe	EB	1005	980	3%	0.8	YES	YES
	A161	SB	563	333	69%	10.9	NO	NO
HETM SB Combined			**4156**	**4093**	**2%**	**1.0**		

Table E - 5 PM Validation

Description			PMPEAK					
Screenline	**Link Description**	**Dir**	**Modelled**	**Observed**	**%**	**GEH**	**GEH**	**Flow**
NORTHERN SCREENLINE								
	B1242 Atwick Road	NB	195	251	-22%	3.8	YES	YES
	A165 Bridlington Road	NB	489	631	-22%	6.0	NO	NO
	A164 Beverley-Driffield	NB	518	493	5%	1.1	YES	YES
	B1248 Station Road	NB	628	592	6%	1.5	YES	YES
	A1079 Crosshills	NWB	789	661	19%	4.8	YES	NO
NB Combined			**2619**	**2628**	**0%**	**0.2**		
	B1242 Atwick Road	SB	263	290	-10%	1.7	YES	YES
	A165 Bridlington Road	SB	604	356	70%	11.3	NO	NO
	A164 Beverley-Driffield	SB	391	308	27%	4.4	YES	YES
	B1248 Station Road	SB	603	765	-21%	6.2	NO	NO
	A1079 Crosshills	SEB	793	1104	-28%	10.1	NO	NO
SB Combined			**2654**	**2823**	**-6%**	**3.2**		
SOUTHERN SCREENLINE								
	A161 Haxey	NB	614	233	164%	18.5	NO	NO
	A159, Gainsborough	NB	348	361	-3%	0.6	YES	YES
	A15, Spital-in-the-Street	NB	529	525	1%	0.2	YES	YES
	A46 Claxby Moor-Walesby Moor	NB	475	372	28%	5.0	NO	NO
	B1225, Stainton le Vale	NWB	135	122	11%	1.2	YES	YES
	A46 Irby upon Humber	WB	433	385	13%	2.4	YES	YES
	A18 Barton Street	NB	510	522	-2%	0.5	YES	YES
	A1136 Great Coates Road	NWB	454	760	-40%	12.4	NO	NO
	A180, Europarc	WB	1318	1291	2%	0.7	YES	YES
NB Combined			**4818**	**4570**	**5%**	**3.6**		
Screenline 10 -	A161 Haxey	SB	235	326	-28%	5.4	NO	YES
Screenline 10 -	A159, Gainsborough	SB	267	277	-4%	0.6	YES	YES
Screenline 10 -	A15, Spital-in-the-Street	SB	444	495	-10%	2.3	YES	YES
Screenline 10 -	A46 Claxby Moor-Walesby Moor	SB	470	383	23%	4.2	YES	YES
Screenline 10 -	B1225, Stainton le Vale	SEB	142	127	12%	1.3	YES	YES
Screenline 10 -	A46 Irby upon Humber	EB	431	370	16%	3.0	YES	YES
Screenline 10 -	A18 Barton Street	SB	850	877	-3%	0.9	YES	YES
Screenline 10 -	A1136 Great Coates Road	SEB	549	518	6%	1.4	YES	YES
Screenline 10 -	A180, Europarc	EB	1690	1734	-3%	1.1	YES	YES
SB Combined			**5079**	**5108**	**-1%**	**0.4**		
HUMBER								
Screenline 4 -	M62 J35-36	NEB	2510	2638	-5%	2.5	YES	YES
Screenline 4 -	A614 N Goole	NB	462	540	-14%	3.5	YES	YES
Screenline 4 -	A15 South Humber Bridge	NB	1052	1035	2%	0.5	YES	YES
NB Combined			**4024**	**4213**	**-4%**	**3.0**		
Screenline 4 -	M62 J35-36	SWB	2357	2441	-3%	1.7	YES	YES
Screenline 4 -	A614 N Goole	SB	573	500	15%	3.1	YES	YES
Screenline 4 -	A15 South Humber Bridge	SB	1104	1098	1%	0.2	YES	YES
SB Combined			**4034**	**4039**	**0%**	**0.1**		
WESTERN								
Screenline 5 -	M62 J37-38	NEB	1796	1866	-4%	1.6	YES	YES
Screenline 5 -	A161 Swinefleet Road	SEB	78	74	6%	0.5	YES	YES
Screenline 5 -	A18 Doncaster Road - Gunness	EB	400	445	-10%	2.2	YES	YES
Screenline 5 -	M180 J1-2	EB	2008	1838	9%	3.9	YES	YES
EB Combined			**4282**	**4222**	**1%**	**0.9**		
Screenline 5 -	M62 J37-38	WB	2120	1661	28%	10.5	NO	NO
Screenline 5 -	A161 Swinefleet Road	WB	72	80	-11%	1.0	YES	YES
Screenline 5 -	A18 Doncaster Road - Gunness	WB	529	725	-27%	7.8	NO	NO
Screenline 5 -	M180 J1-2	WB	1788	1779	0%	0.2	YES	YES
WB Combined			**4508**	**4246**	**6%**	**4.0**		
CENTRAL								
Screenline 6 -	M180 (jct 3 - 4)	EB	1409	1375	2%	0.9	YES	YES
Scunthorpe East	A18 - Queensway	EB	1886	1759	7%	3.0	YES	YES
Screenline 6 -	A1077	NB	373	351	6%	1.1	YES	YES
Screenline 6 -	Thealby Lane	EB	94	123	-24%	2.8	YES	YES
Screenline 6 -	A63 (S Cave - N Ferriby)	EB	1966	1847	6%	2.7	YES	YES
EB Combined			**5727**	**5454**	**5%**	**3.7**		
Screenline 6 -	M180 (jct 4 - 5)	WB	1945	1858	5%	2.0	YES	YES
Scunthorpe East	A18 - Queensway	WB	1362	1289	6%	2.0	YES	YES
Screenline 6 -	A1077	SB	176	179	-2%	0.2	YES	YES
Screenline 6 -	Thealby Lane	WB	44	133	-67%	9.5	NO	YES
Screenline 6 -	A63 (S Cave - N Ferriby)	WB	2650	2504	6%	2.9	YES	YES
WB Combined			**6176**	**5963**	**4%**	**2.7**		
BARTON								
Screenline 7 -	A1077 Barrow Road	WB	418	429	-2%	0.5	YES	YES
Screenline 7 -	Burnham Road	NB	0	12	-100%	4.9	YES	YES
Screenline 7 -	B1206 (A15)	WB	132	84	58%	4.7	YES	YES
WB Combined			**551**	**525**	**5%**	**1.1**		
Screenline 7 -	A1077 Barrow Road	EB	415	438	-5%	1.1	YES	YES
Screenline 7 -	Burnham Road	SB	18	12	48%	1.5	YES	YES
Screenline 7 -	B1206 (A15)	EB	148	144	3%	0.3	YES	YES
EB Combined			**581**	**594**	**-2%**	**0.6**		

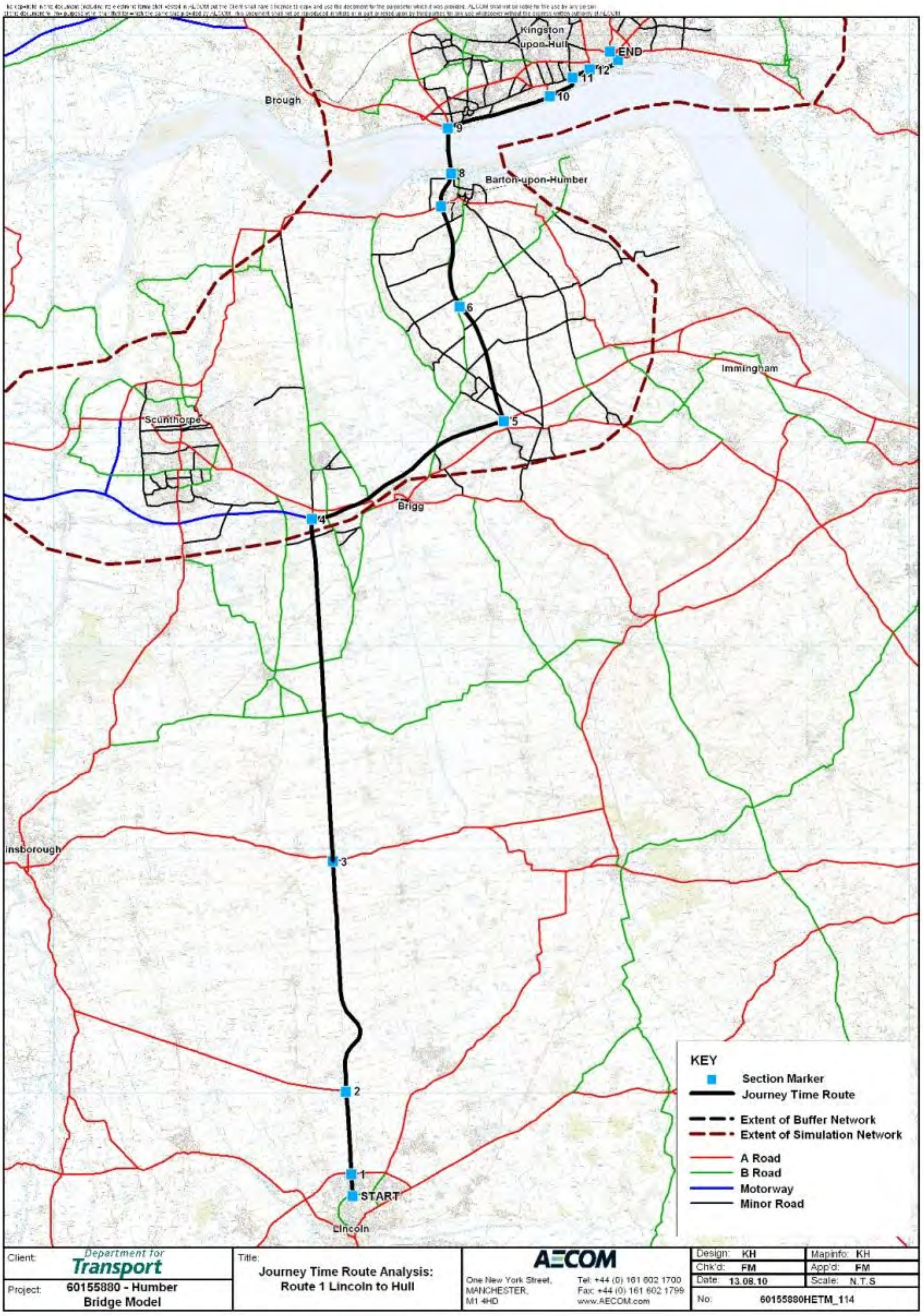
Table E - 6 PM Calibration

Description			PMPEAK					
Screenline	Link Description	Dir	Modelled	Observed	%	GEH	GEH	Flow
Hull City Region								
RSI - A63	·A164 south of Dunflat Road, north of Skidby roundabout	SB	1369	1244	10%	3.5	YES	YES
RSI - A63	·Beverley Road prior to junction with Evergreen Drive	SB	1001	1064	-6%	2.0	YES	YES
RSI - A63	Raich Carter Way to the east of the Beverley High Road	EB	1504	1640	-8%	3.4	YES	YES
RSI - A63	Holderness Road opposite Parkhurst Close	WB	755	1034	-27%	9.3	NO	NO
RSI - A63	Hedon Road opposite Tower House Lane	WB	880	991	-11%	3.6	YES	YES
TRADS	A63 (Under the Humber Bridge)	EB	1999	2065	-3%	1.5	YES	YES
RSI - A63	A15 North of the Humber Bridge	NB	1052	1035	2%	0.5	YES	YES
RSI - A63	Boothferry Road before the A164 roundabout junction	NB	1164	1347	-14%	5.2	NO	YES
RSI - A63	Tranby Lane before the junction with Old Hill and Humber	EB	187	173	8%	1.1	YES	YES
Hull Outer			**9912**	**10593**	**-6%**	**6.7**		
RSI - A63	·A164 south of Dunflat Road, north of Skidby roundabout	NB	1709	1554	10%	3.8	YES	YES
RSI - A63	·Beverley Road prior to junction with Evergreen Drive	SB	1394	1270	10%	3.4	YES	YES
RSI - A63	Raich Carter Way to the east of the Beverley High Road	EB	1648	1448	14%	5.1	NO	YES
RSI - A63	Holderness Road opposite Parkhurst Close	EB	1696	1506	13%	4.8	YES	YES
RSI - A63	Hedon Road opposite Tower House Lane	EB	1978	1878	5%	2.3	YES	YES
TRADS	A63	WB	2562	3243	-21%	12.6	NO	NO
RSI - A63	A15 North of the Humber Bridge	SB	1104	1098	1%	0.2	YES	YES
RSI - A63	Boothferry Road before the A164 roundabout junction	SB	1055	1163	-9%	3.2	YES	YES
RSI - A63	Tranby Lane before the junction with Old Hill and Humber	WB	260	260	0%	0.0	YES	YES
Hull Outer			**13406**	**13420**	**0%**	**0.1**		
Hull City Region								
RSI - A60	A63 Clive Sulavan Way (Hull) West of Ferensway	IB	2804	2176	29%	12.6	NO	NO
RSI - A61	Madeley Street (slip)	IB	654	734	-11%	3.0	YES	YES
RSI - A62	Brighton Road (slip)	IB	235	394	-40%	9.0	NO	NO
RSI - A63	A1166 Hessle Road to the east of Sunningdale Road	EB	546	641	-15%	3.9	YES	YES
RSI - A63	Boothferry Road to the west of Kempton Road	EB	253	503	-50%	12.9	NO	NO
RSI - A63	Anlaby Road east of Hamlyn Avenue	EB	537	410	31%	5.8	NO	NO
RSI - A63	Spring Bank West opposite De La Pole Avenue	EB	732	792	-8%	2.2	YES	YES
RSI - A63	Chanterlands Avenue prior to the Cemetery Entrance	SB	542	539	1%	0.1	YES	YES
RSI - A63	Queens Road after the turn for Newland Avenue	EB	522	458	14%	2.9	YES	YES
RSI - A63	Beverley Road south of the Clough Road junction	SB	595	626	-5%	1.3	YES	YES
RSI - A63	Bankside located at the approach to the new mini-	SB	523	524	0%	0.0	YES	YES
RSI - A63	Stoneferry Road south of the railway bridge	SB	937	785	19%	5.2	NO	NO
RSI - A63	James Reckitt Avenue south of Dunscombe Park junction	SB	239	289	-17%	3.1	YES	YES
RSI - A63	Witham west of the Holderness Road junction	WB	146	522	-72%	20.6	NO	NO
RSI - A63	·Clarence Street west of Alma Street junction	WB	152	337	-55%	11.8	NO	NO
RSI - A63	Hedon Road west of the Merrick Street junction	WB	34	228	-85%	16.9	NO	NO
RSI - A63	·Garrison Road, split site at approach to the Plimsoll Way	WB	1678	1361	23%	8.1	NO	NO
Hull Inner			1678	1361	23%	8.1		
RSI - A60	A63 Clive Sulavan Way (Hull) West of Ferensway	OB	2166	2516	-14%	7.3	NO	YES
RSI - A61	Madeley Street (slip)	OB	734	759	-3%	0.9	YES	YES
RSI - A62	Brighton Road (slip)	OB	425	654	-35%	9.9	NO	NO
RSI - A63	A1166 Hessle Road to the east of Sunningdale Road	WB	1015	1080	-6%	2.0	YES	YES
RSI - A63	Boothferry Road to the west of Kempton Road	WB	351	533	-34%	8.6	NO	NO
RSI - A63	Anlaby Road east of Hamlyn Avenue	EB	721	524	38%	7.9	NO	NO
RSI - A63	Spring Bank West opposite De La Pole Avenue	WB	974	429	127%	20.6	NO	NO
RSI - A63	Chanterlands Avenue prior to the Cemetery Entrance	NB	1030	897	15%	4.3	YES	YES
RSI - A63	Queens Road after the turn for Newland Avenue	WB	261	509	-49%	12.6	NO	NO
RSI - A63	Beverley Road south of the Clough Road junction	NB	910	803	13%	3.6	YES	YES
RSI - A63	Bankside located at the approach to the new mini-	NB	778	759	3%	0.7	YES	YES
RSI - A63	Stoneferry Road south of the railway bridge	NB	1638	1134	44%	13.5	NO	NO
RSI - A63	James Reckitt Avenue south of Dunscombe Park junction	NB	795	965	-18%	5.7	NO	NO
RSI - A63	Witham west of the Holderness Road junction	EB	370	562	-34%	8.9	NO	NO
RSI - A63	Clarence Street west of Alma Street junction	EB	315	463	-32%	7.5	NO	NO
RSI - A63	Hedon Road west of the Merrick Street junction	EB	166	371	-55%	12.5	NO	NO
RSI - A63	Garrison Road, split site at approach to the Plimsoll Way	EB	2714	2378	14%	6.7	NO	YES
Hull Inner			**15363**	**15336**	**0%**	**0.2**		
Immingham								
RSI - Immingham	Thornly Station	EB	78	94	-17%	1.7	YES	YES
RSI - Immingham	A160 - Humber Road	EB	956	789	21%	5.6	NO	NO
RSI - Immingham	B1210 W	NB	61	103	-41%	4.6	YES	YES
RSI - Immingham	B1210 E	NB	210	311	-32%	6.3	NO	NO
RSI - Immingham	A1173	EB	649	547	19%	4.2	YES	NO
Immingham			**1954**	**1844**	**6%**	**2.5**		
RSI - Immingham	Thornly Station	WB	189	297	-36%	6.9	NO	NO
RSI - Immingham	A160 - Humber Road	WB	1323	994	33%	9.7	NO	NO
RSI - Immingham	B1210 W	SB	266	315	-16%	2.9	YES	YES
RSI - Immingham	B1210 E	SB	435	445	-2%	0.5	YES	YES
RSI - Immingham	A1173	WB	1181	1162	2%	0.5	YES	YES
Immingham			**3393**	**3214**	**6%**	**3.1**		
RSI COUNTS -								
RSI - HETM	A180 Grimbsy	WB	1318	1264	4%	1.5	YES	YES
RSI - HETM	A18 Brigg	NB	699	635	10%	2.5	YES	YES
RSI - HETM	A1077 Scunthorpe	SB	799	963	-17%	5.5	NO	NO
RSI - HETM	A18 Scunthorpe	WB	1243	1101	13%	4.2	YES	YES
RSI - HETM	A161	NB	518	395	31%	5.7	NO	NO
HETM NB			**4577**	**4358**	**5%**	**3.3**		
RSI - HETM	A180 Grimbsy	EB	1690	1697	0%	0.2	YES	YES
RSI - HETM	A18 Brigg	SB	913	906	1%	0.2	YES	YES
RSI - HETM	A1077 Scunthorpe	NB	440	541	-19%	4.5	YES	NO
RSI - HETM	A18 Scunthorpe	EB	974	1046	-7%	2.3	YES	YES
RSI - HETM	A161	SB	877	540	63%	12.7	NO	NO
HETM SB			**4894**	**4729**	**3%**	**2.4**		

Appendix F – Detailed Journey Time Routes

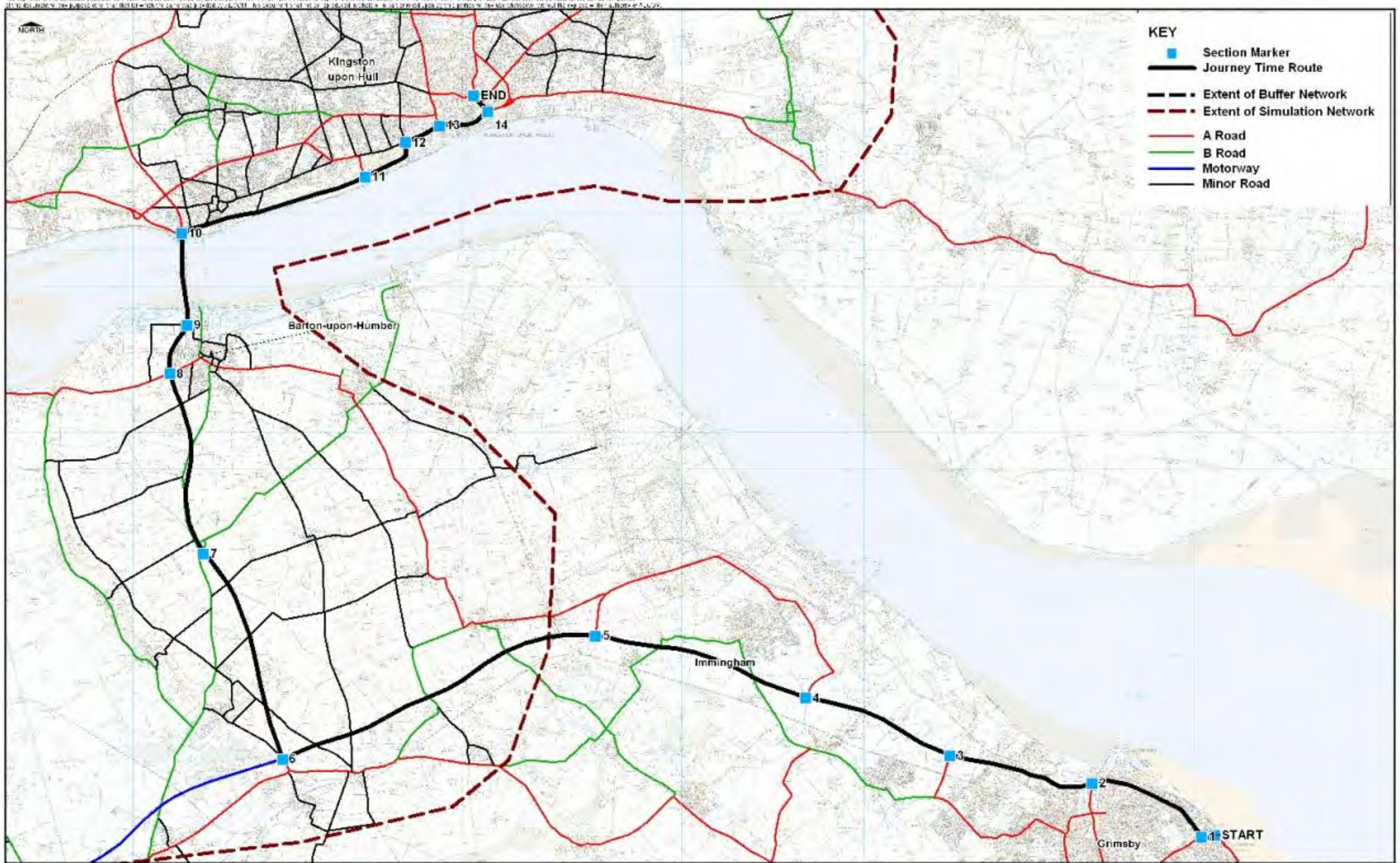
Appendix F – Detailed Journey Time Routes

F – 1 Journey Time Route 1 – Lincoln to Hull



Capabilities on project:
Transportation

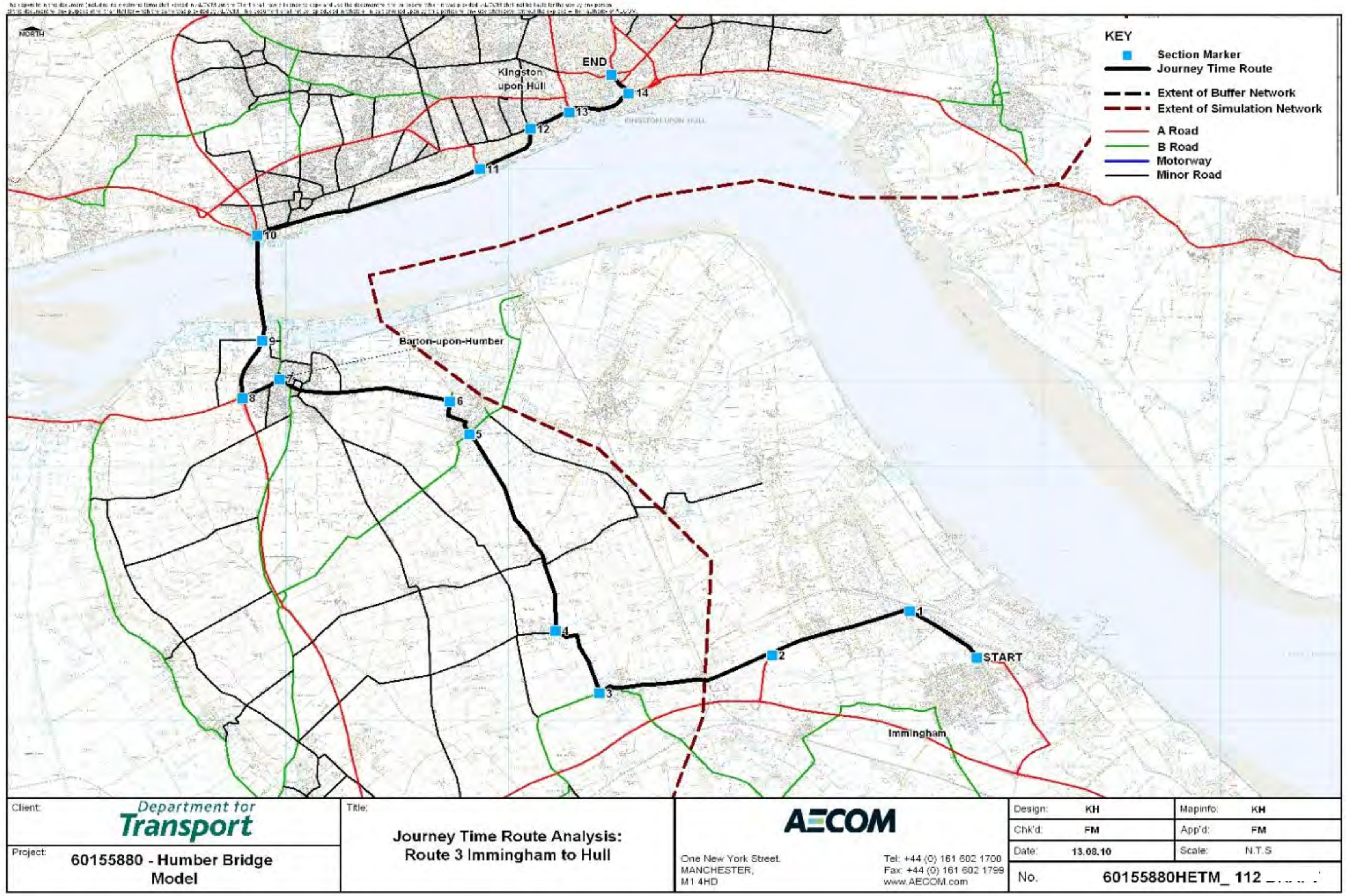
F – 2 Journey Time Route 2 – Grimsby to Hull



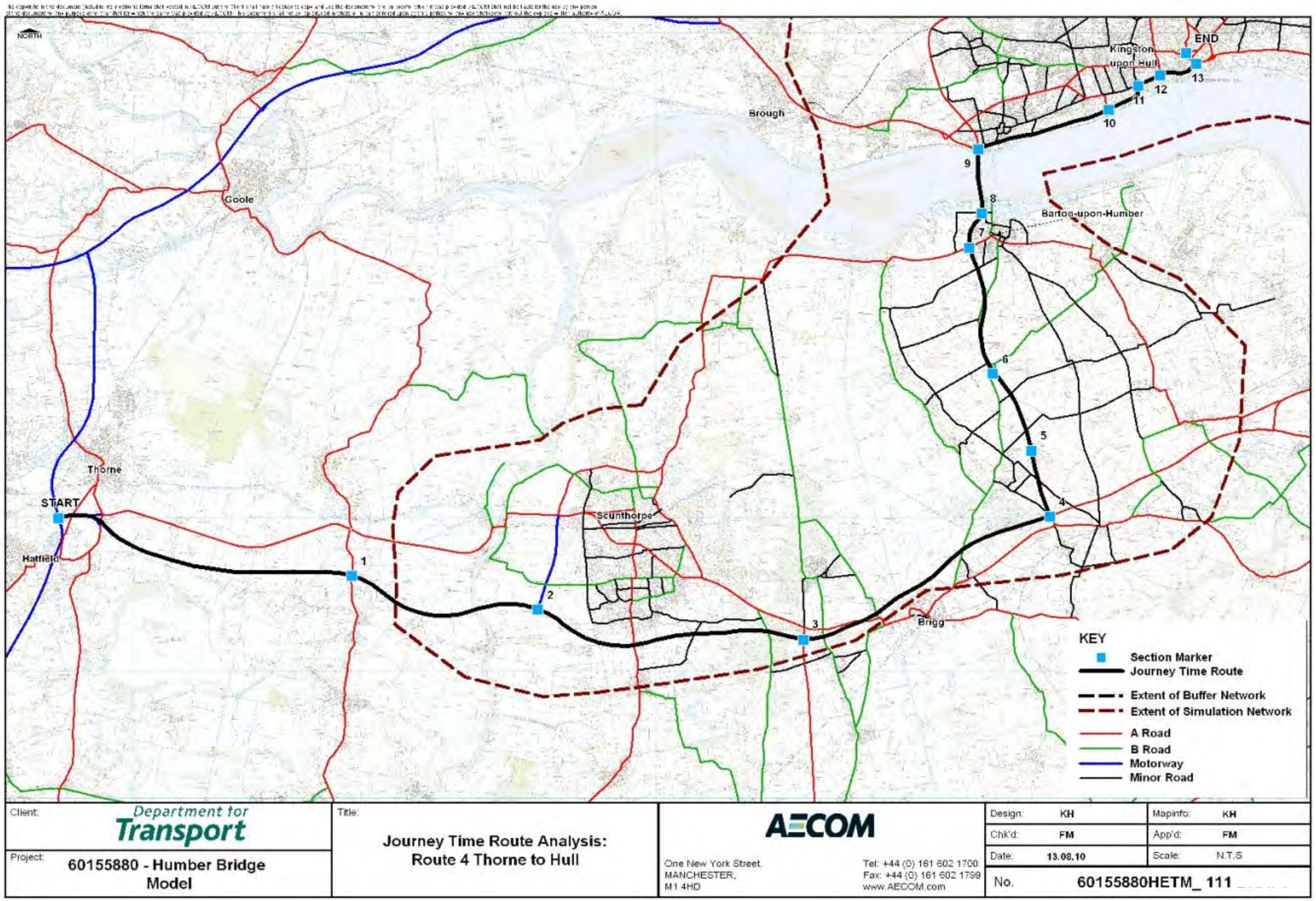
Client: Department for Transport	Title: Journey Time Route Analysis: Route 2 Grimsby to Hull	AECOM One New York Street, MANCHESTER, M1 4HD Tel: +44 (0) 161 602 1700 Fax: +44 (0) 161 602 1799 www.AECOM.com	Design: KH; Mapinfo: KH Chk'd: FM; App'd: FM Date: 13.08.10; Scale: N.T.S No. 60155880HETM_113
Project: 60155880 - Humber Bridge Model			

Capabilities on project:
Transportation

F – 3 Journey Time Route 3 – Immingham to Hull

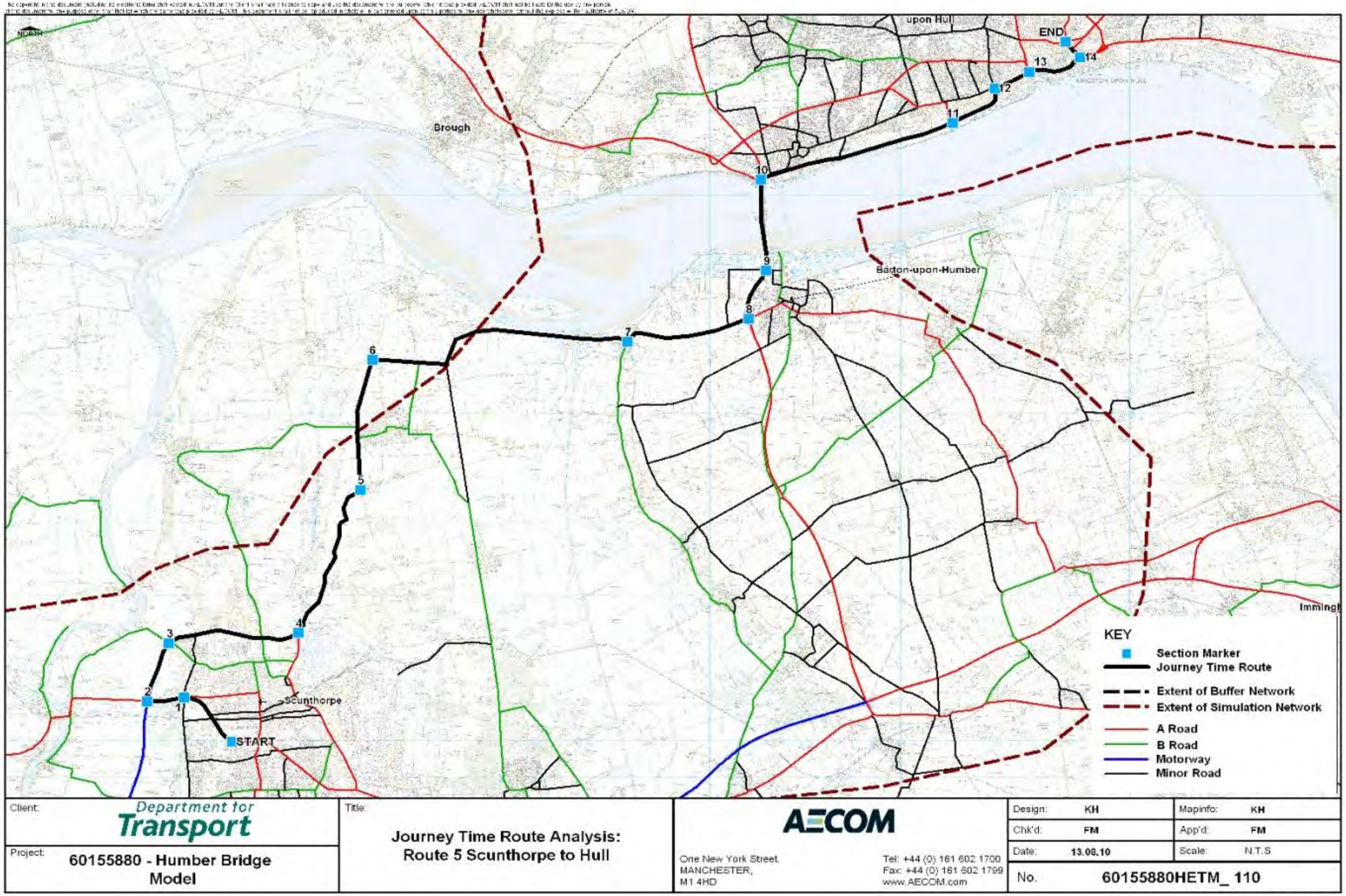


F – 4 Journey Time Route 4 – Thorne to Hull



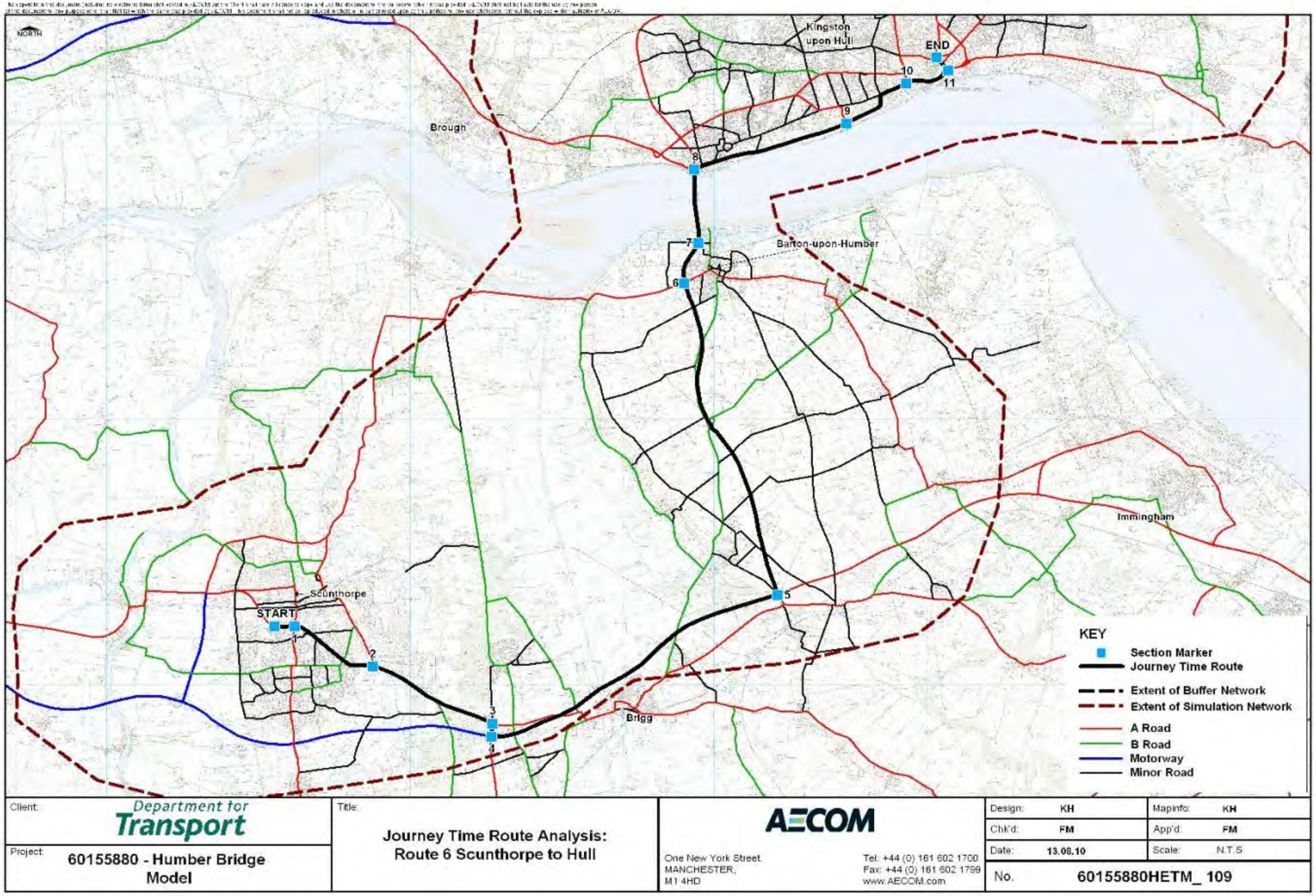
Capabilities on project:
Transportation

F – 5 Journey Time Route 5 – Scunthorpe (1) to Hull



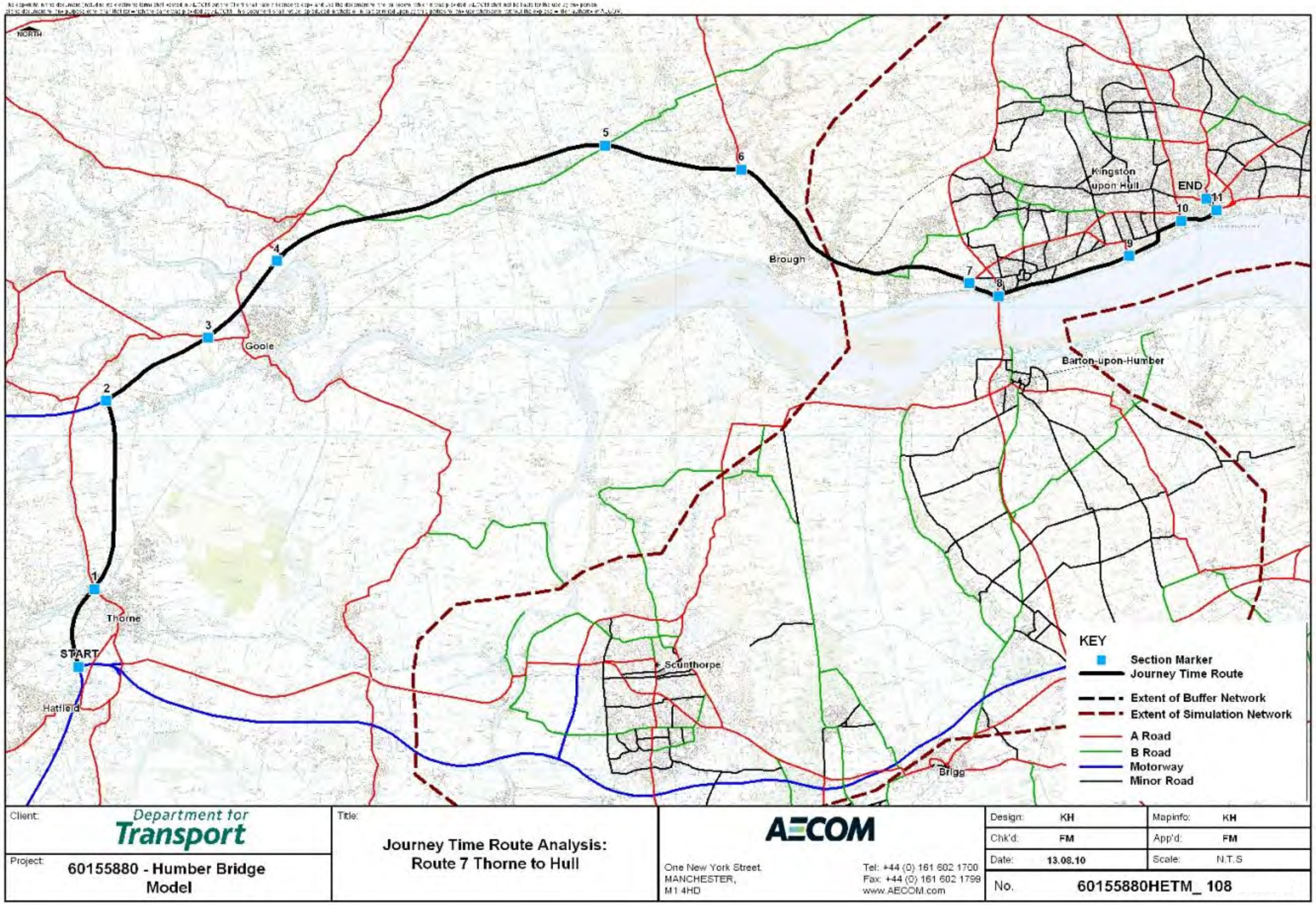
Capabilities on project:
Transportation

F – 6 Journey Time Route 6 – Scunthorpe (2) to Hull



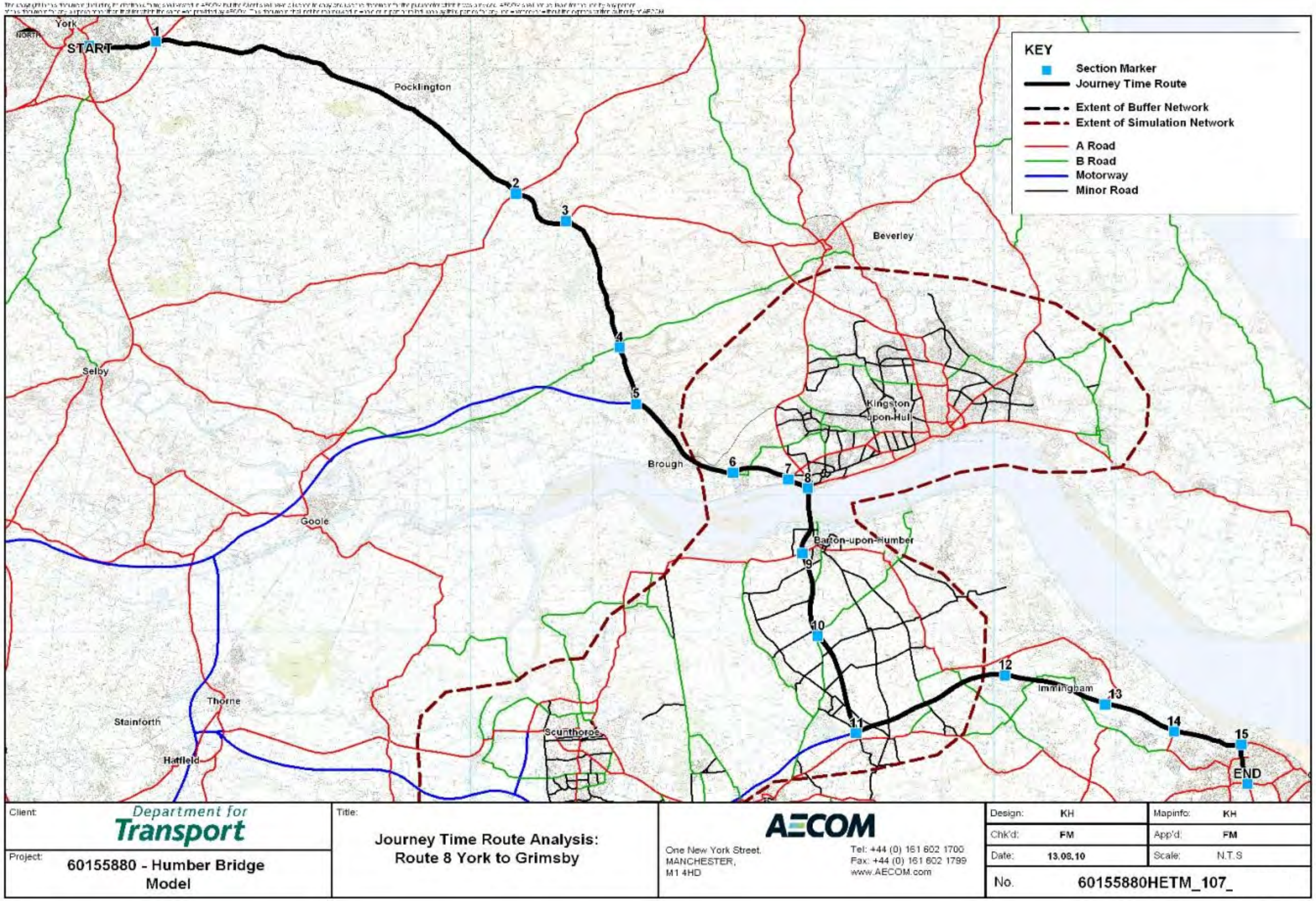
Capabilities on project:
Transportation

F – 7 Journey Time Route 7 – Thorne to Hull

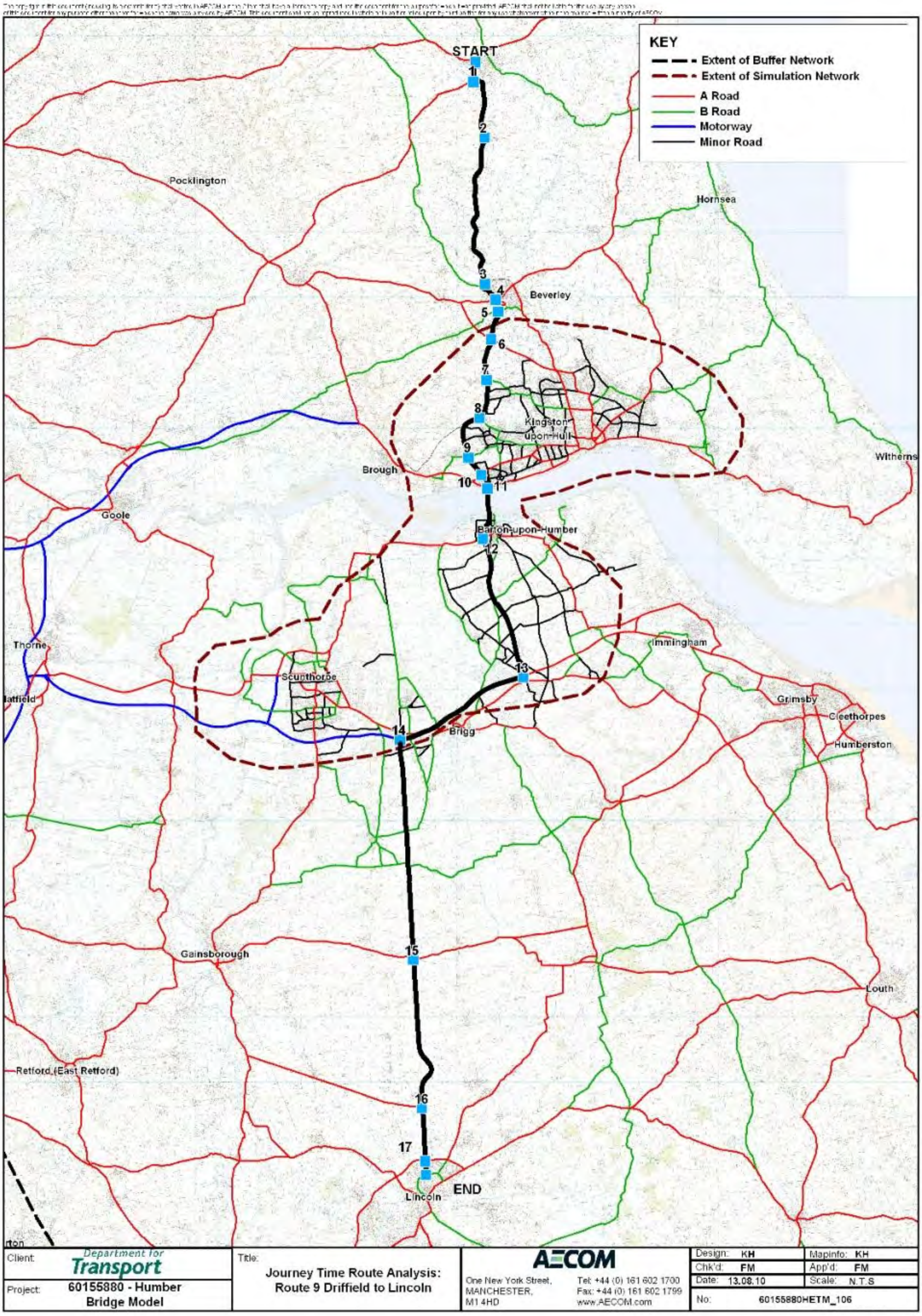


Capabilities on project:
Transportation

F – 8 Journey Time Route 8 – York to Grimsby

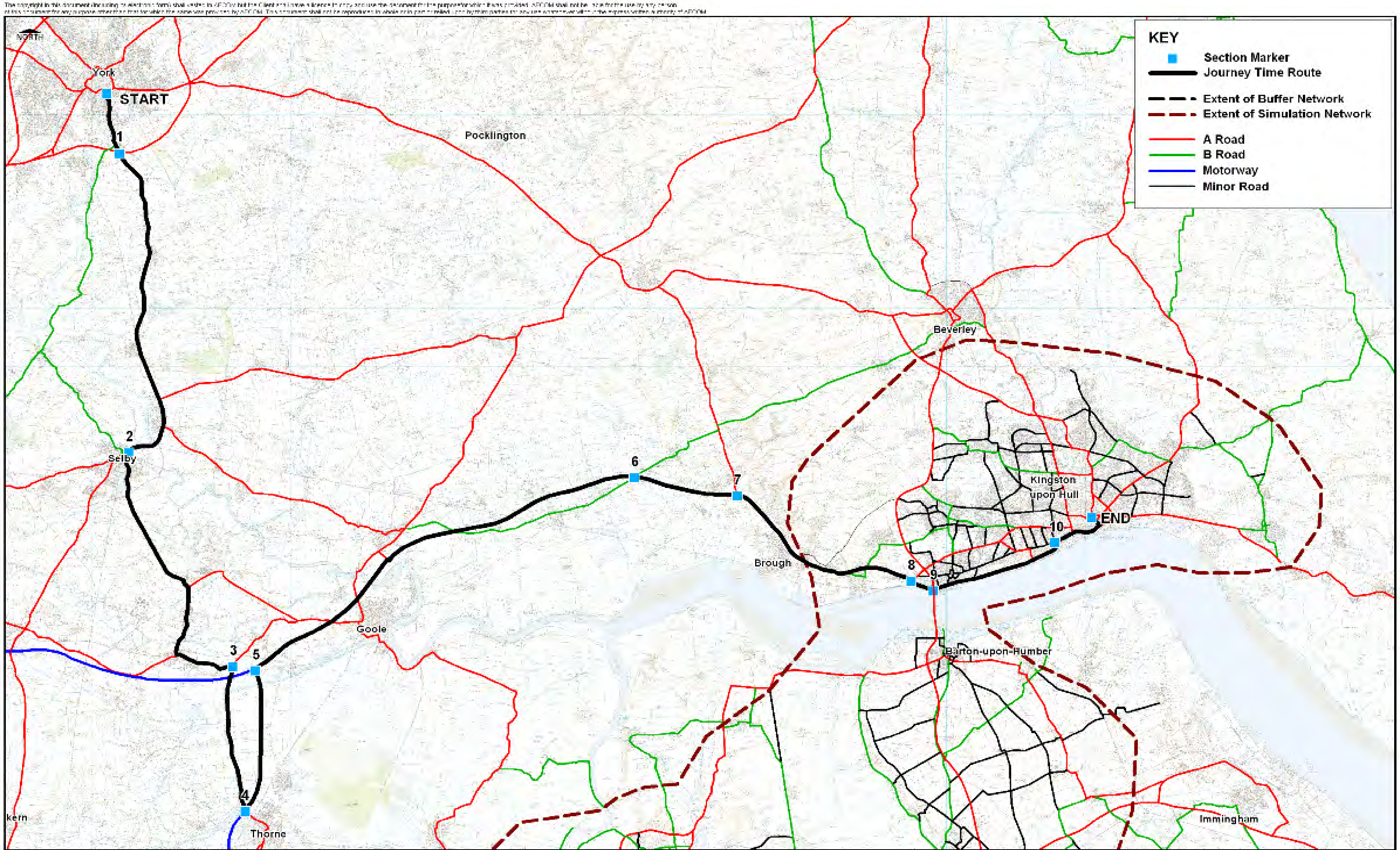


F – 9 Journey Time Route 9 – Drifield to Lincoln



Capabilities on project:
Transportation

F – 10 Journey Time Route 10 – York to Hull Via Thorne

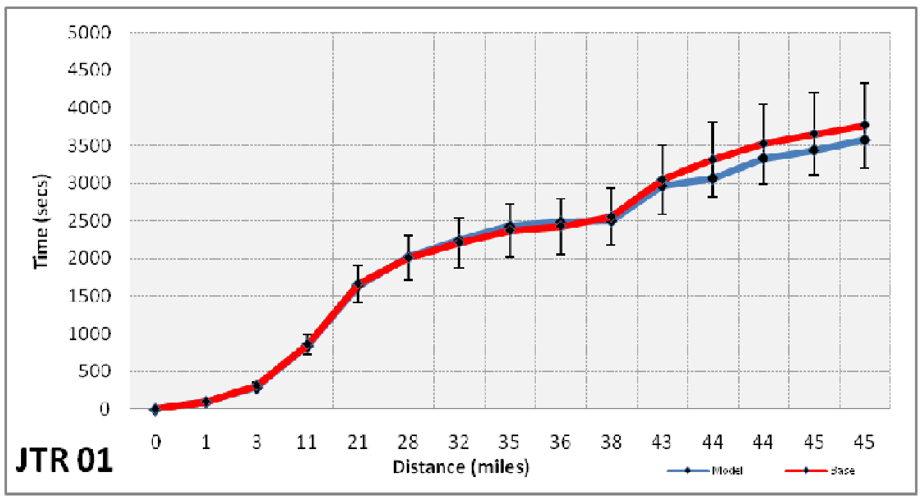


Client: Department for Transport	Title:	AECOM	Design: LA / Mapinfo: LA
Project: 60155880 - Humber Bridge Model	Journey Time Route Analysis: Route 10 York to Hull via Thorne	One New York Street, MANCHESTER M1 4HD — Tel: +44 (0) 161 602 1700 Fax: +44 (0) 161 602 1799 www.AECOM.com	Chk'd: FM / App'd: FM
			Date: 13.08.10 / Scale: N.T.S
			No. 60155880HETM_ 105

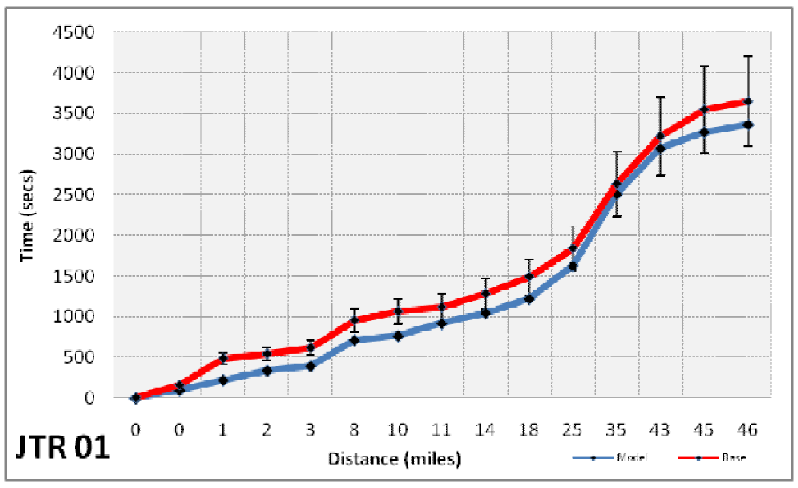
Journey Time Review

AM PEAK

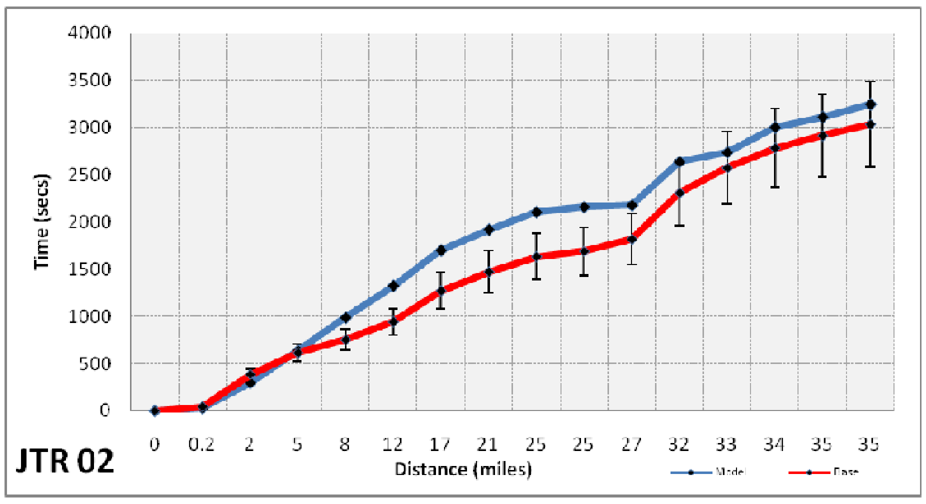
Route 1: Lincoln to Hull



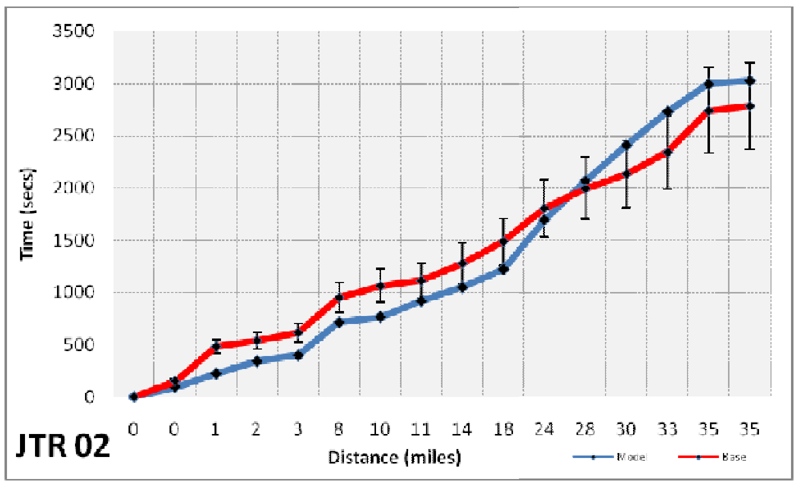
Route 1: Hull to Lincoln



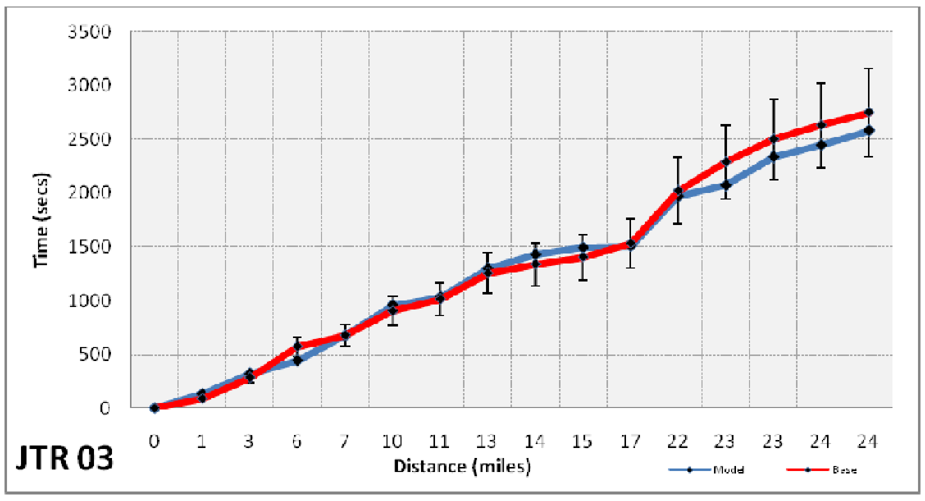
Route 2: Grimsby to Hull



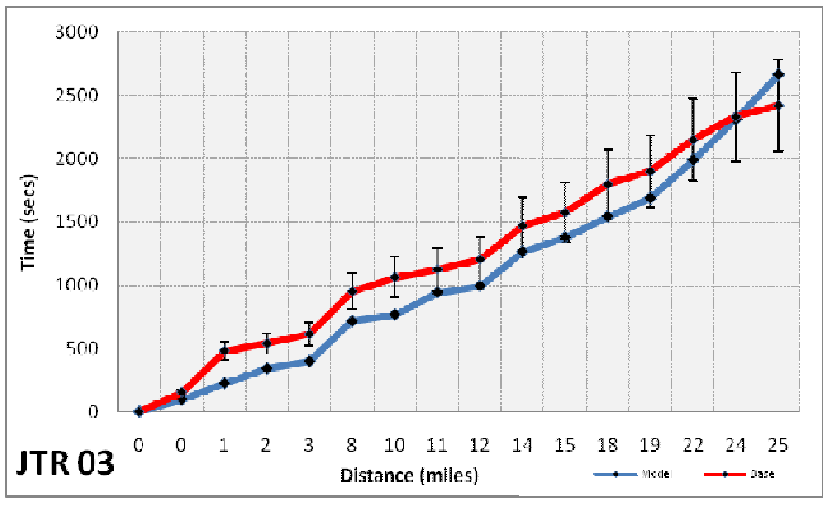
Route 2: Hull to Grimsby



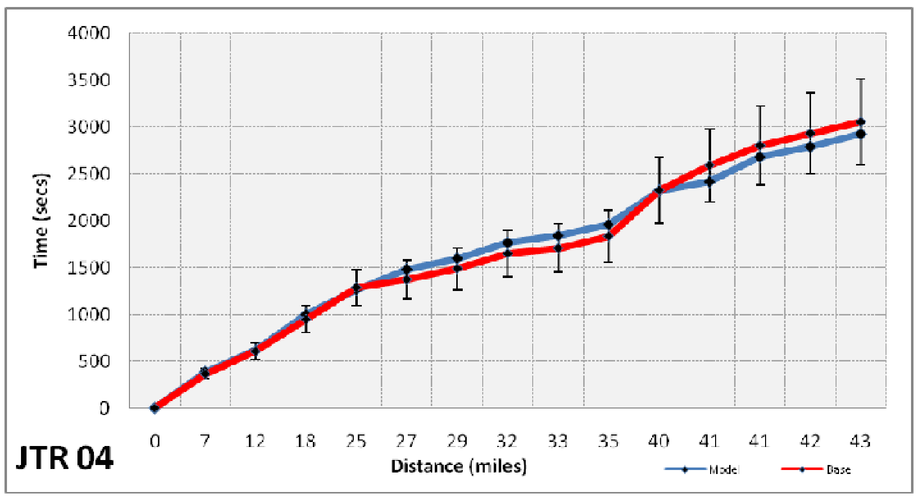
Route 3: Immingham to Hull



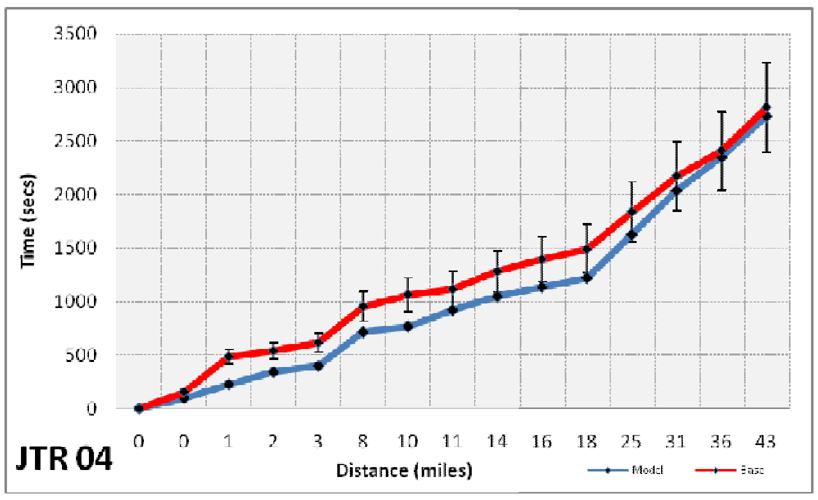
Route 3: Hull to Immingham



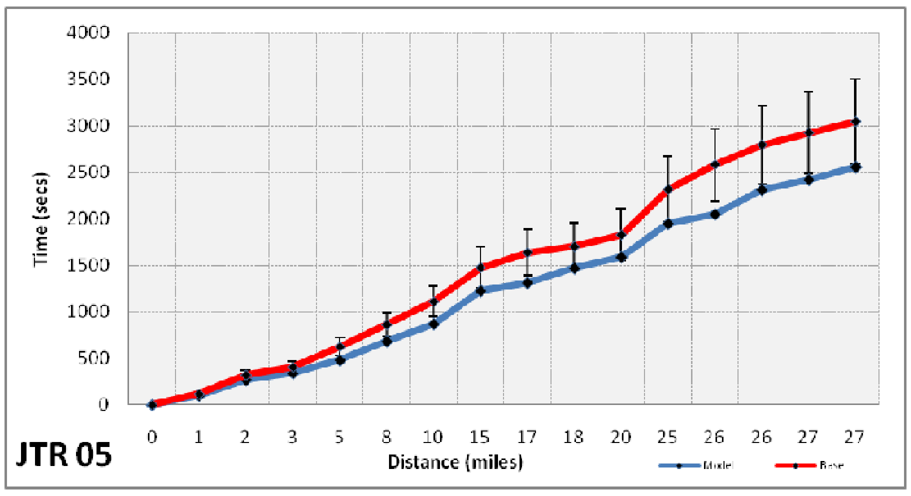
Route 4: Thorne to Hull



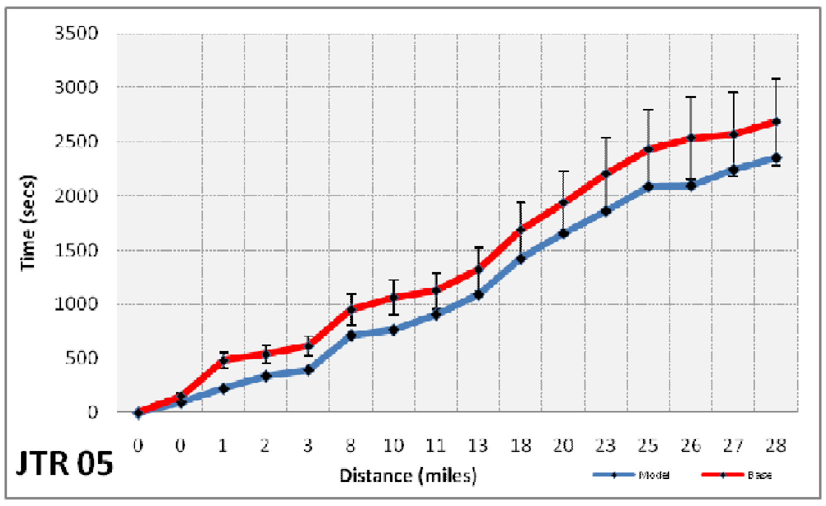
Route 4: Hull to Thorne



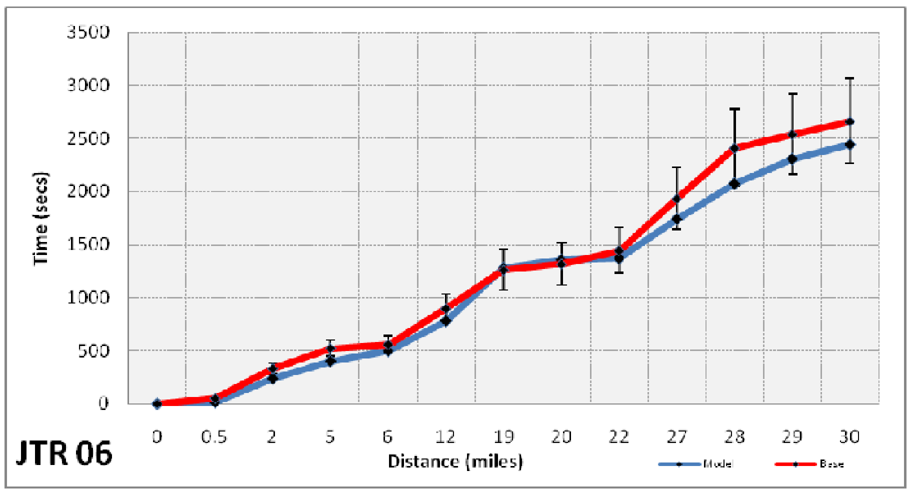
Route 5: Scunthorpe to Hull (Northern Route)



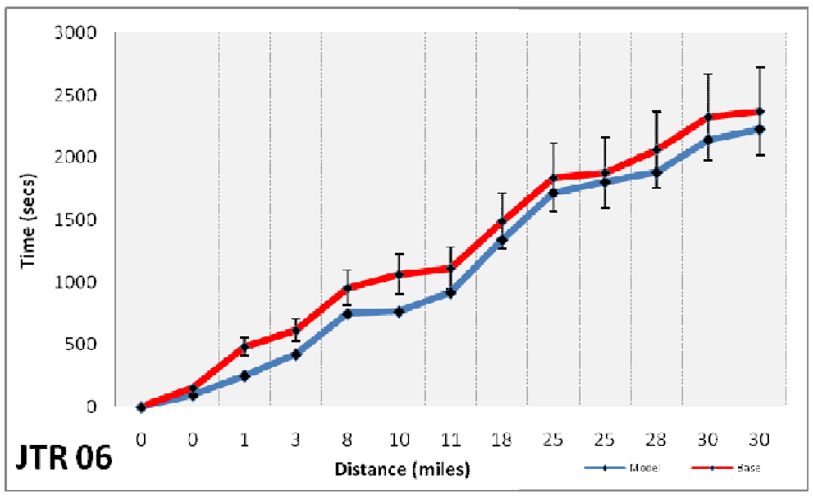
Route 5: Hull to Scunthorpe (Northern Route)



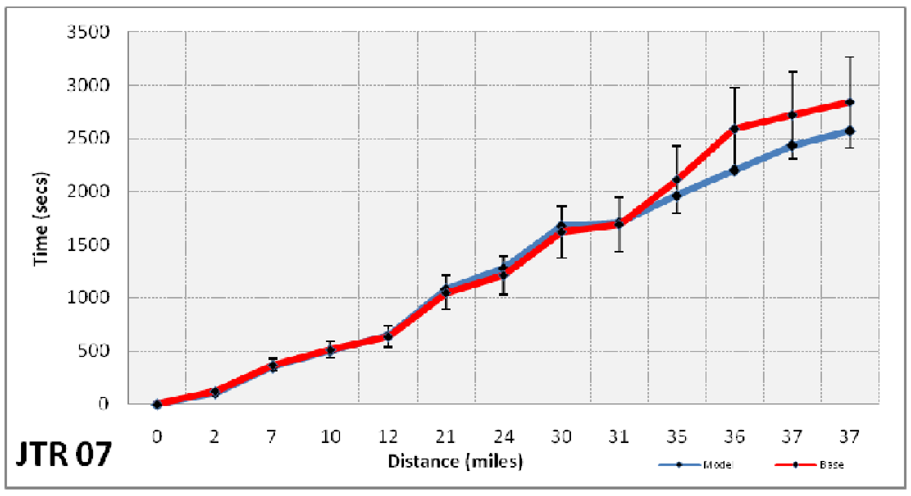
Route 6: Scunthorpe to Hull (Southern Route)



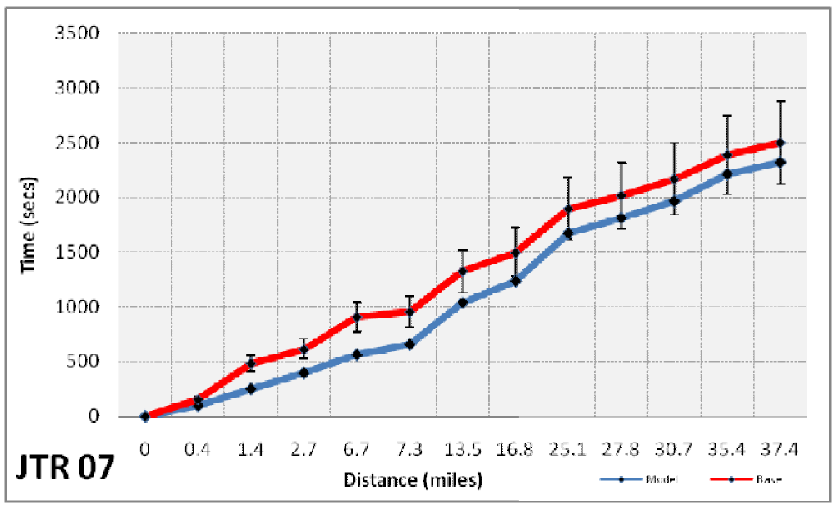
Route 6: Hull to Scunthorpe (Southern Route)



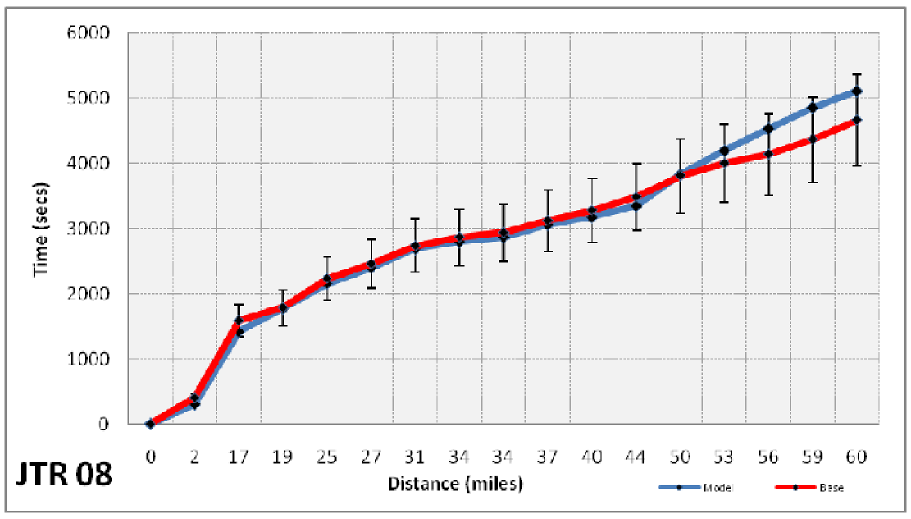
Route 7: Thorne to Hull



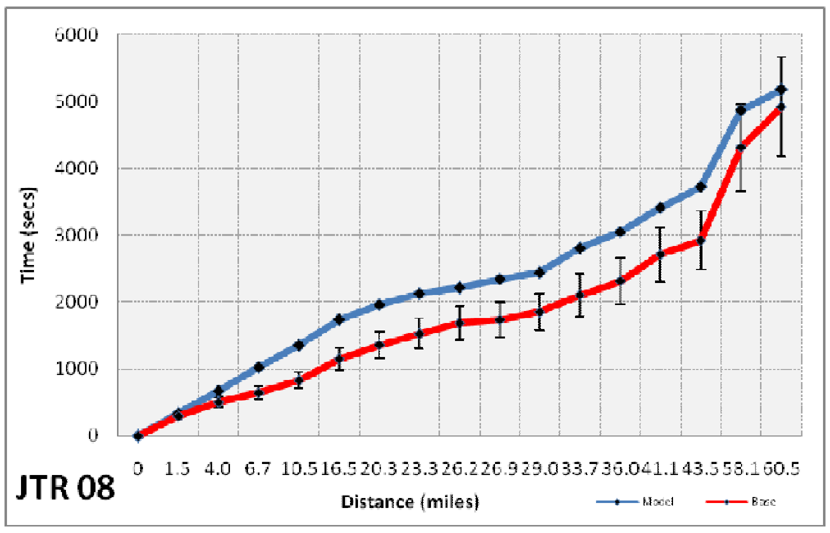
Route 7: Hull to Thorne



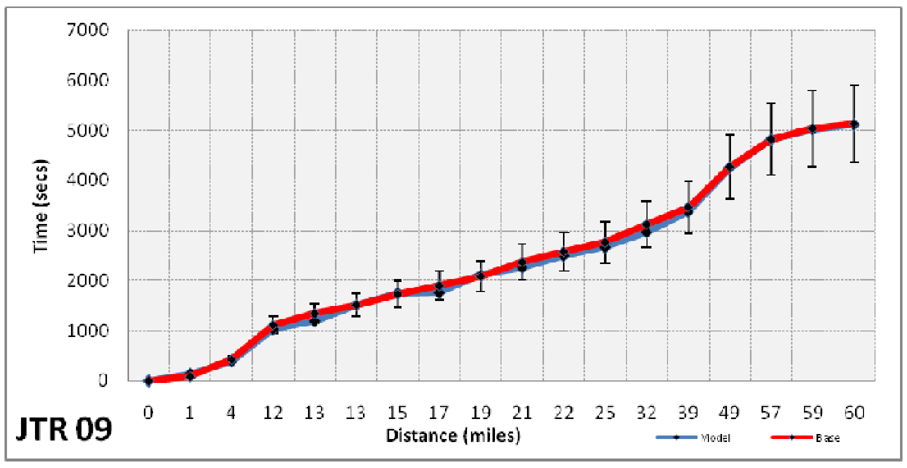
Route 8: York to Grimsby



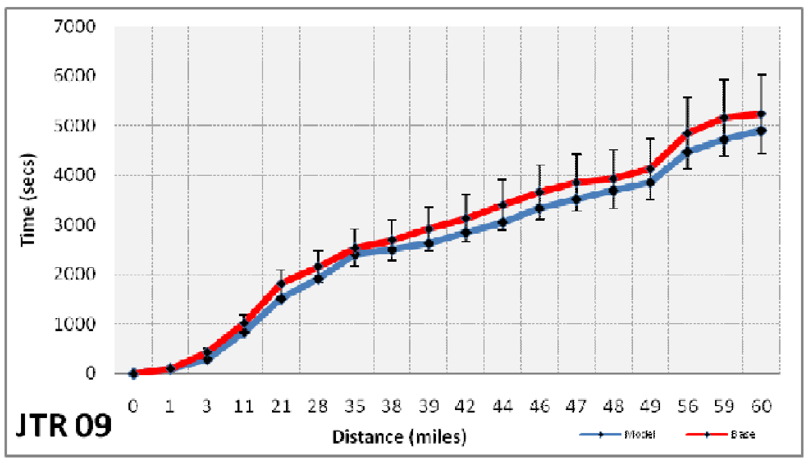
Route 8: Grimsby to York



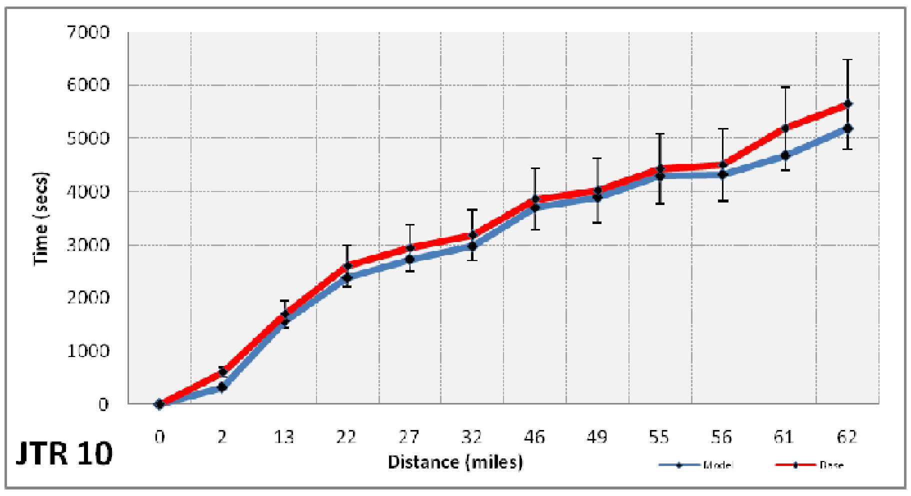
Route 9: Driffield to Lincoln



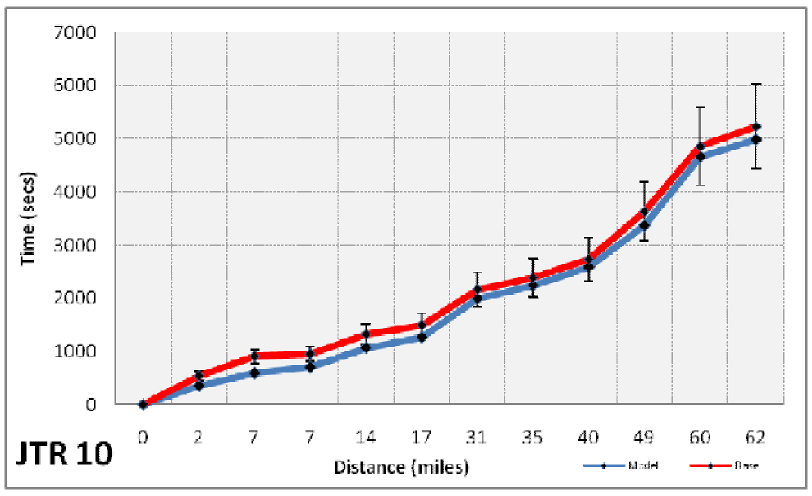
Route 9: Lincoln to Driffield



Route 10: York to Hull (via Thorne)



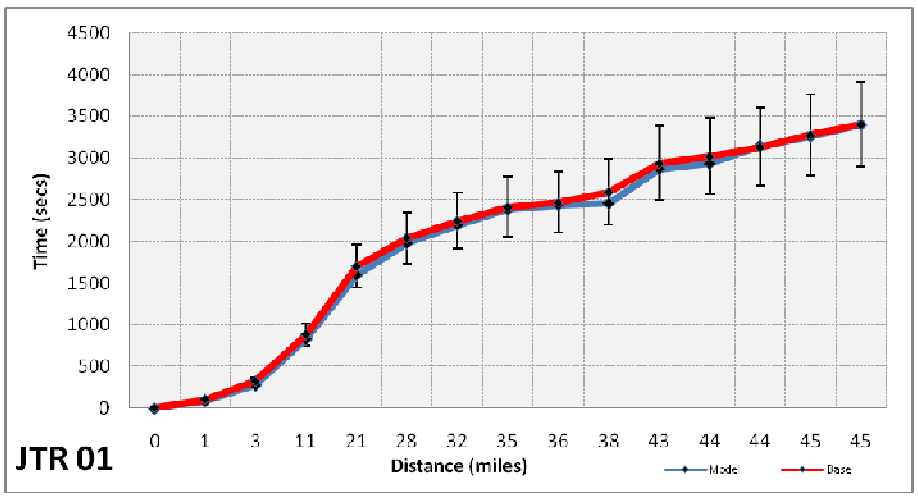
Route 10: Hull to York (via Thorne)



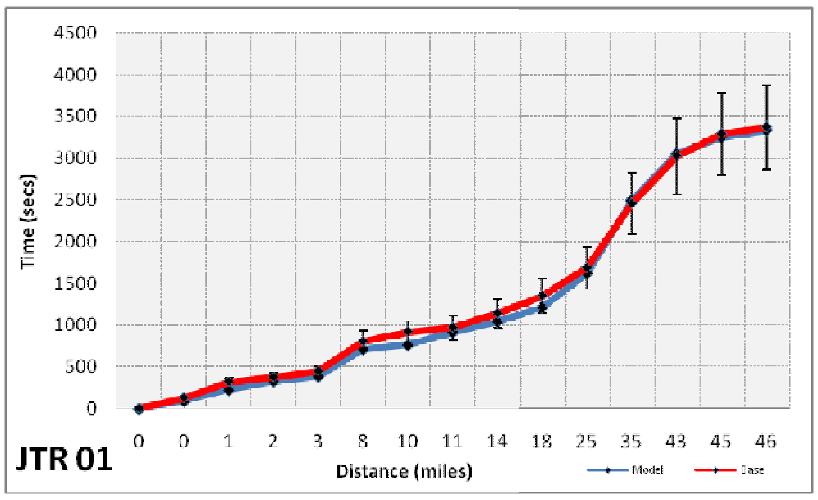
Journey Time Review

INTER PEAK

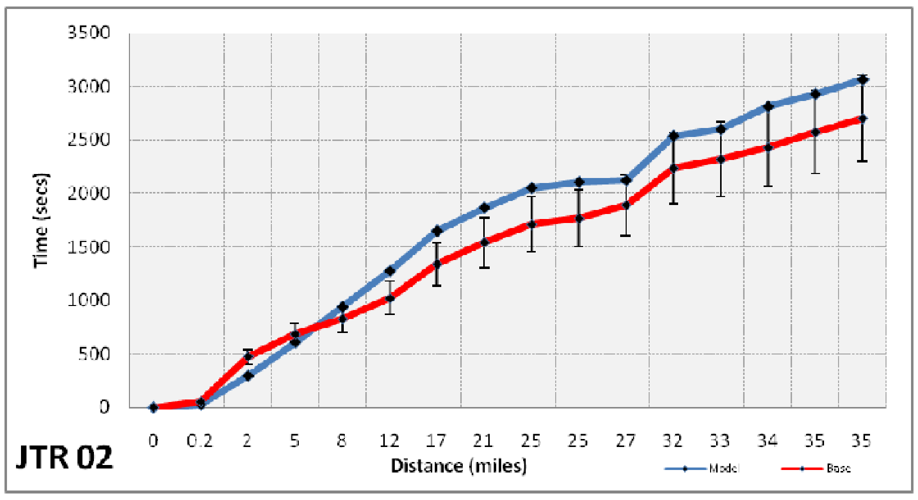
Route 1: Lincoln to Hull



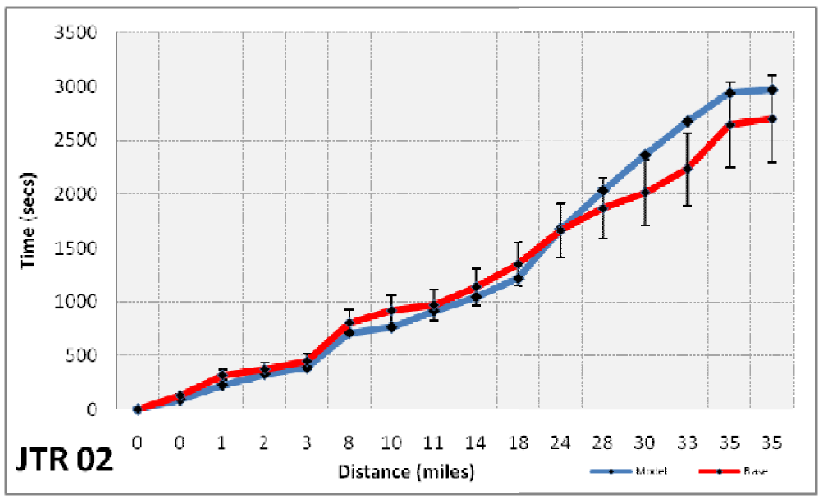
Route 1: Hull to Lincoln



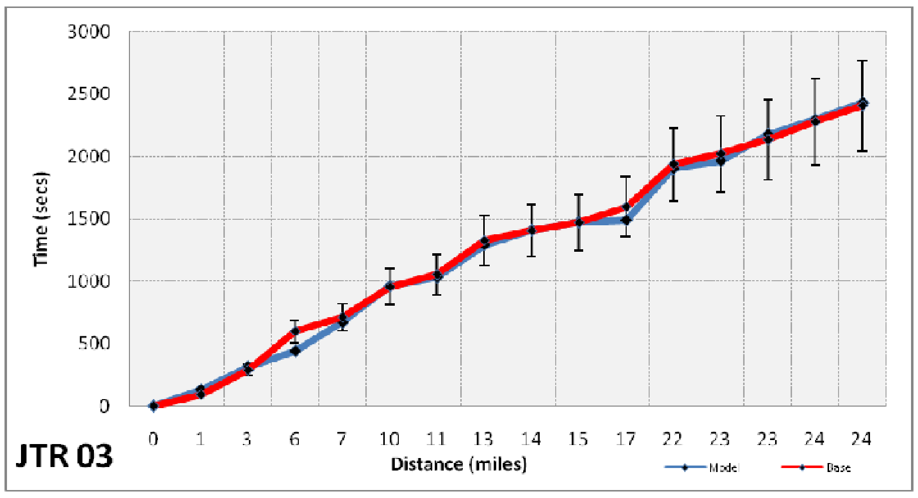
Route 2: Grimsby to Hull



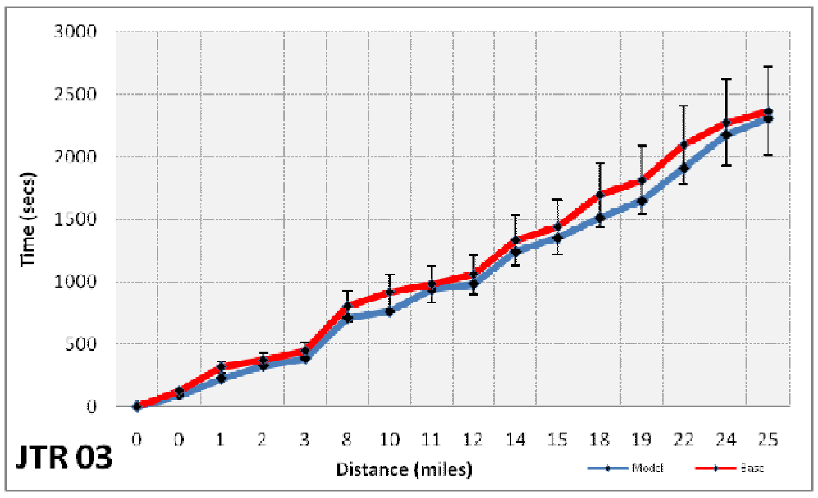
Route 2: Hull to Grimsby



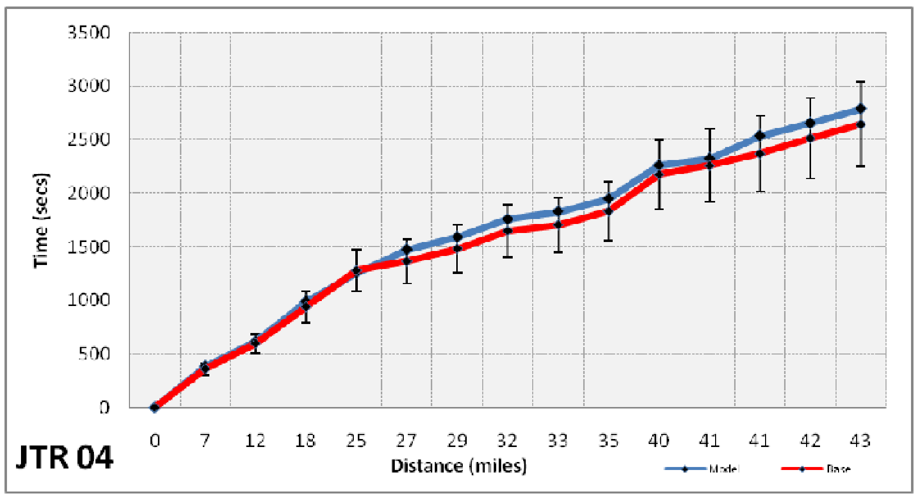
Route 3: Immingham to Hull



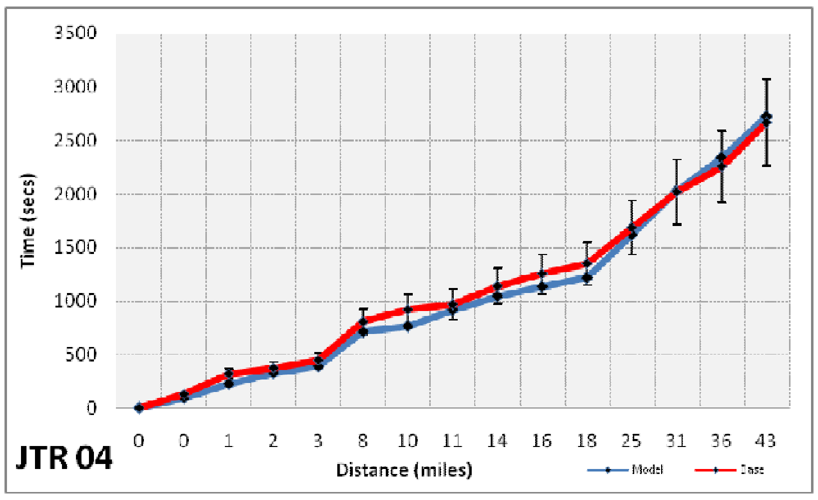
Route 3: Hull to Immingham



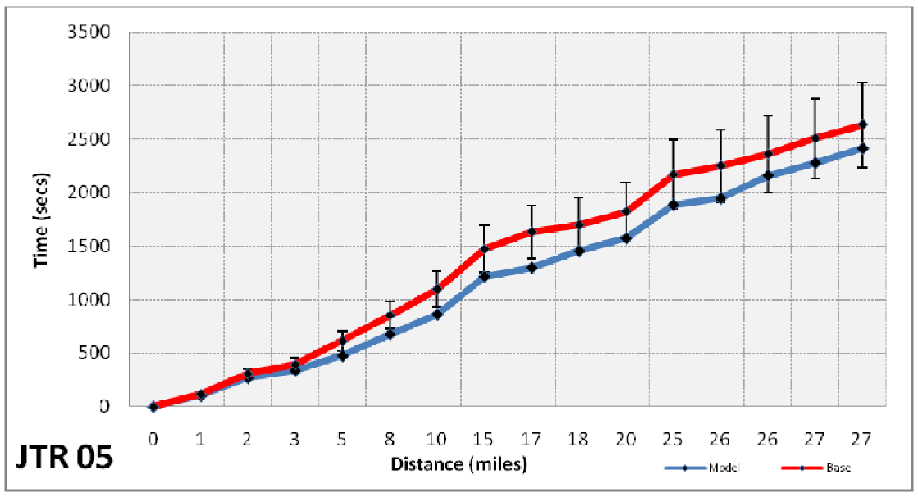
Route 4: Thorne to Hull



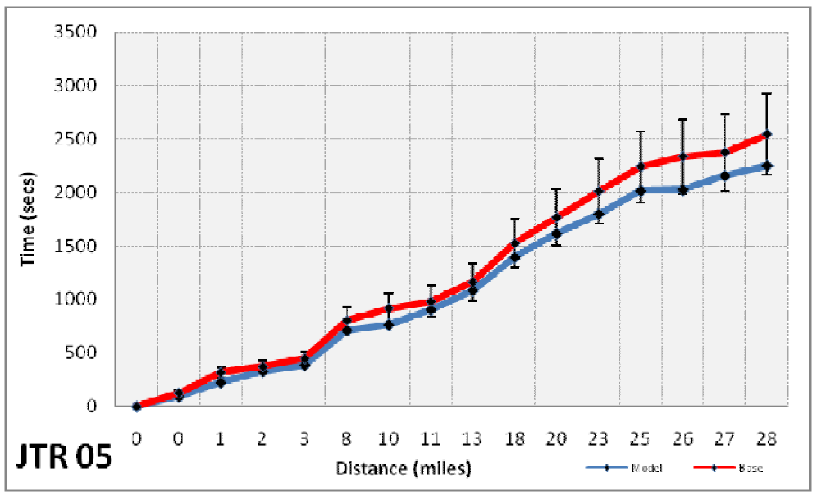
Route 4: Hull to Thorne



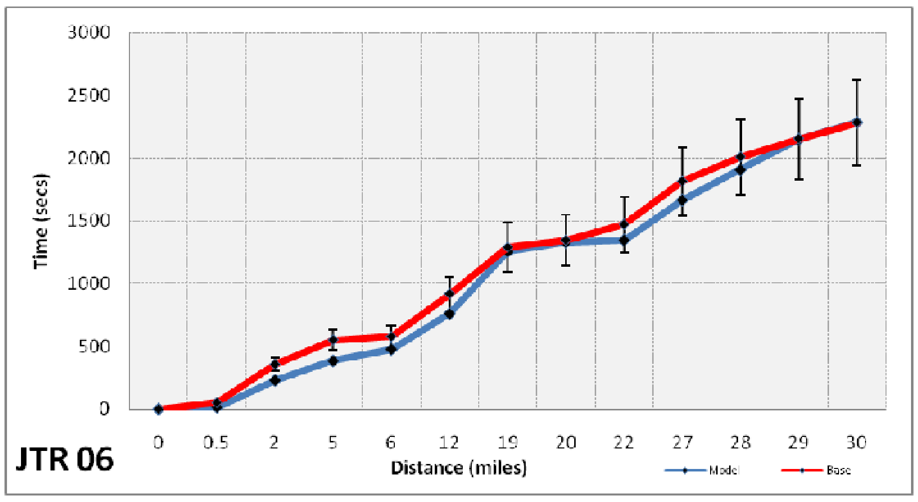
Route 5: Scunthorpe to Hull (Northern Route)



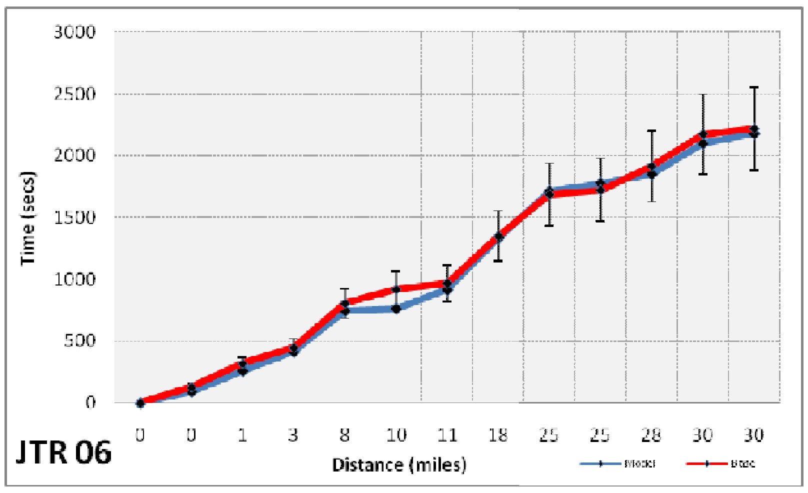
Route 5: Hull to Scunthorpe (Northern Route)



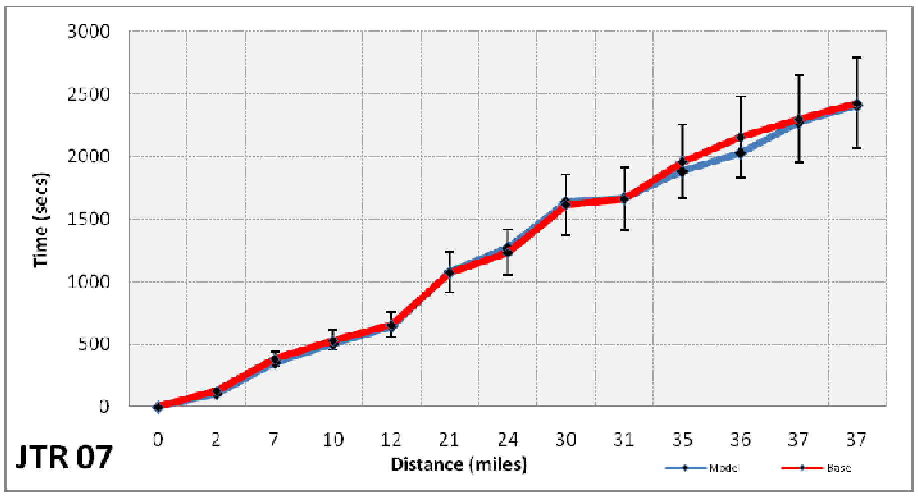
Route 6: Scunthorpe to Hull (Southern Route)



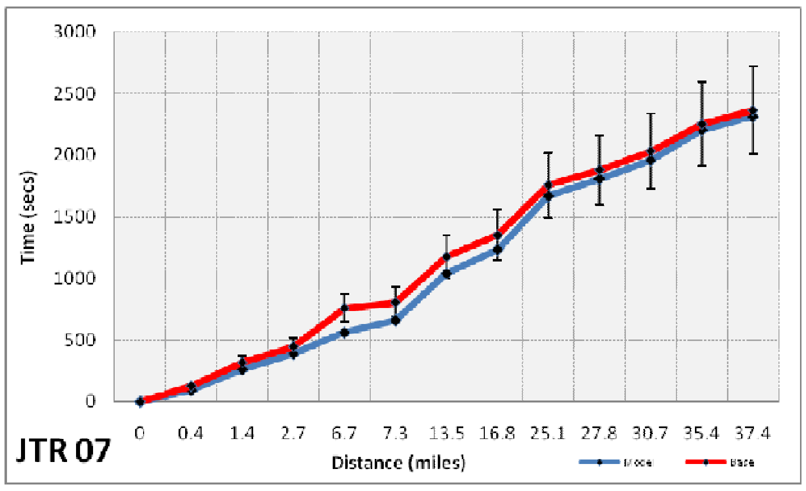
Route 6: Hull to Scunthorpe (Southern Route)



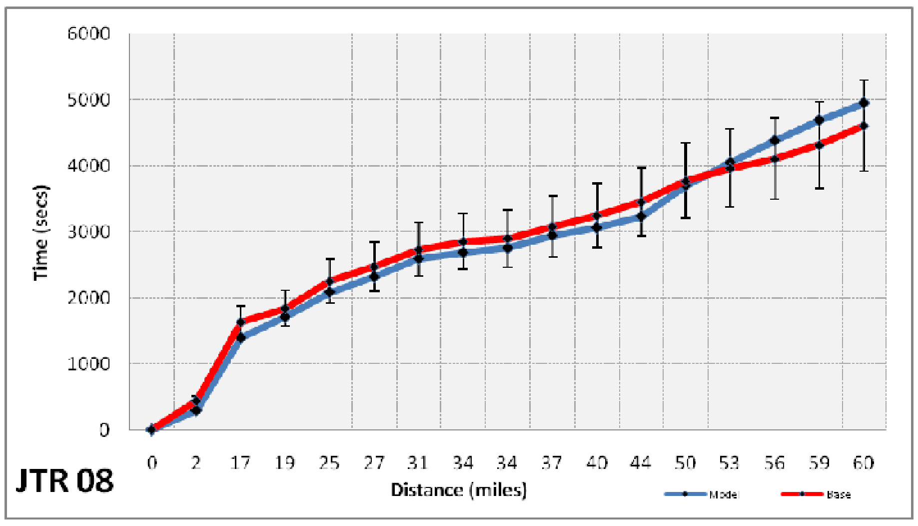
Route 7: Thorne to Hull



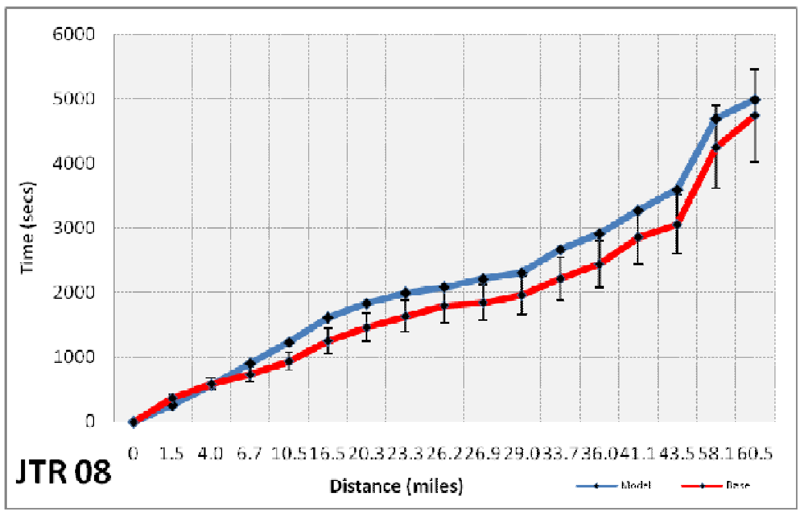
Route 7: Hull to Thorne



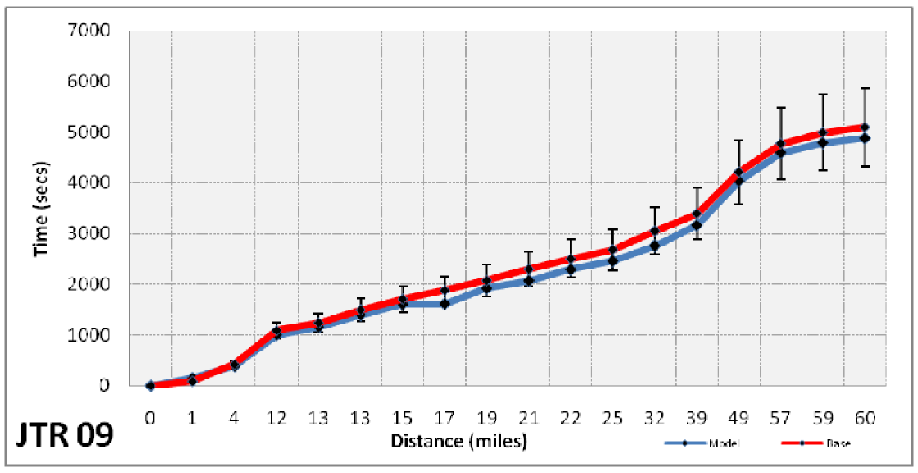
Route 8: York to Grimsby



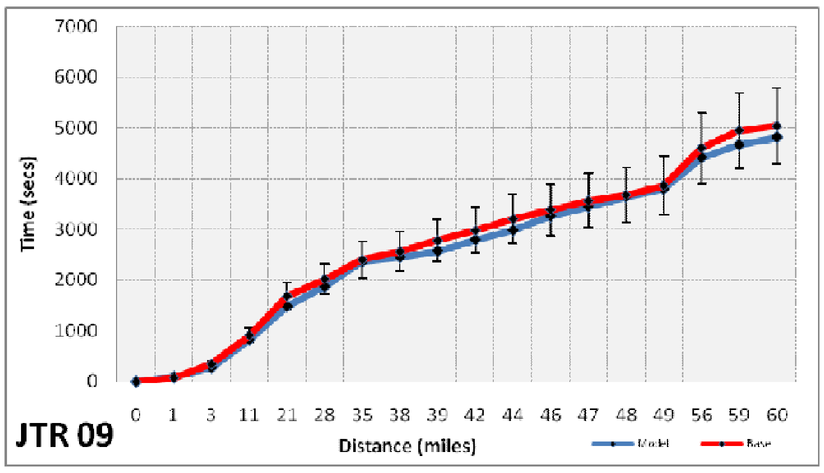
Route 8: Grimsby to York



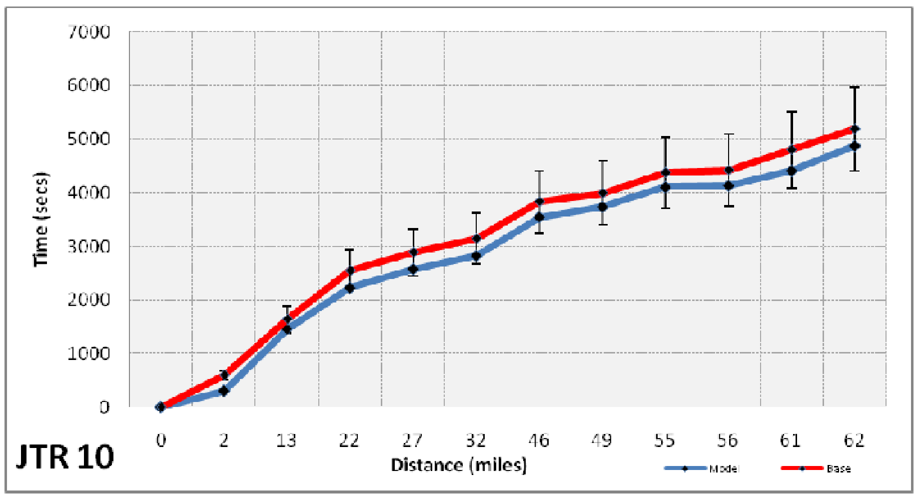
Route 9: Driffield to Lincoln



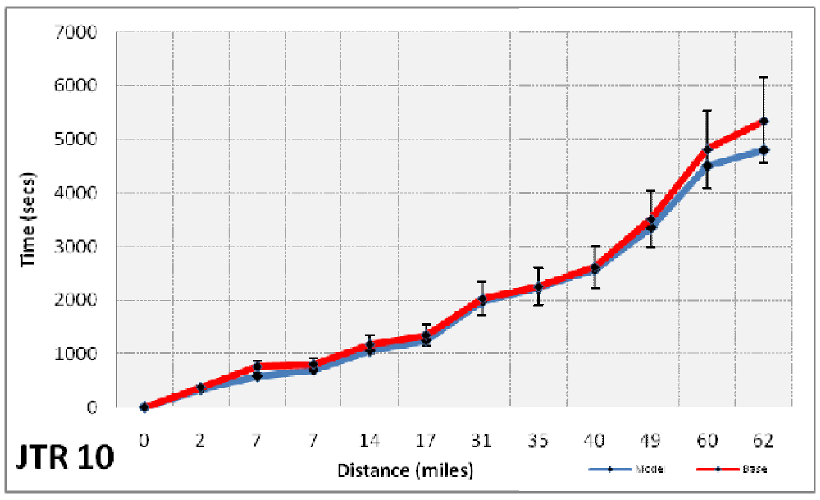
Route 9: Lincoln to Driffield



Route 10: York to Hull (via Thorne)



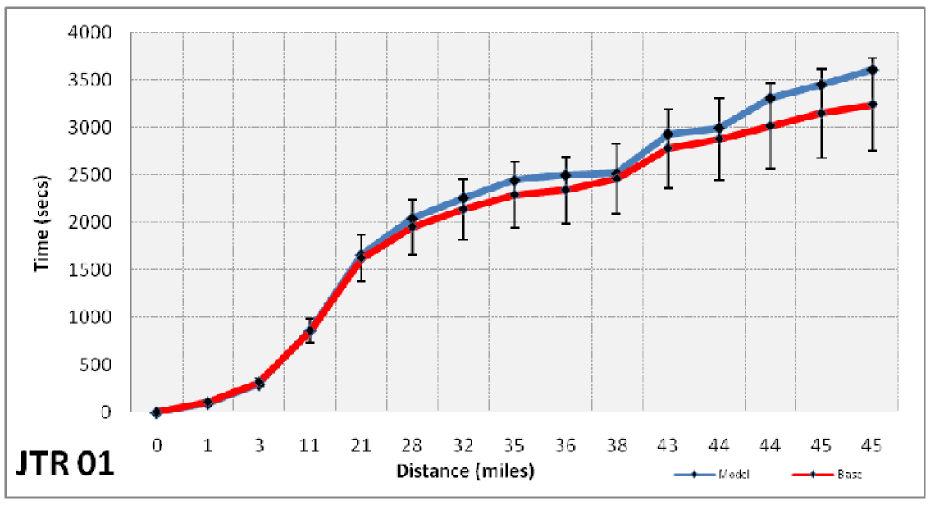
Route 10: Hull to York (via Thorne)



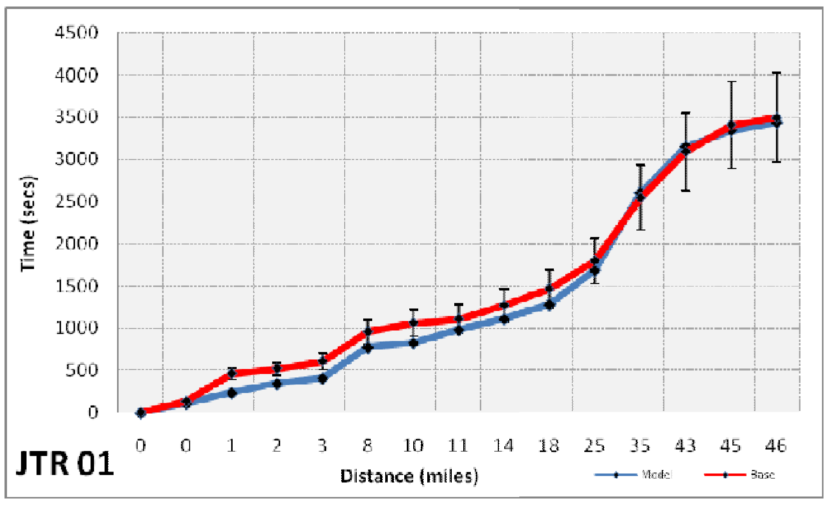
Journey Time Review

PM PEAK

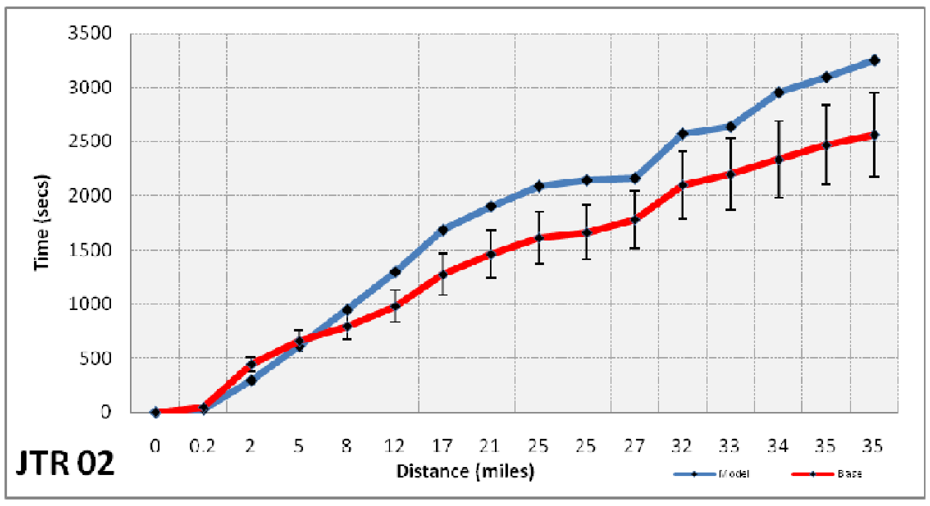
Route 1: Lincoln to Hull



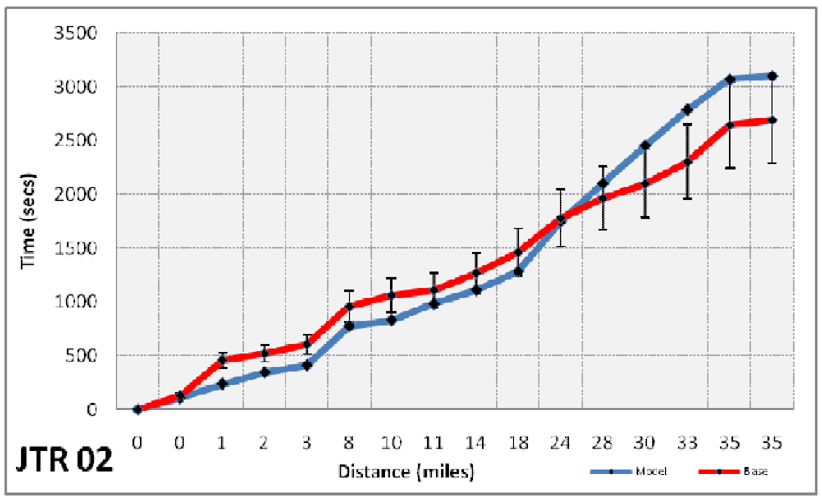
Route 1: Hull to Lincoln



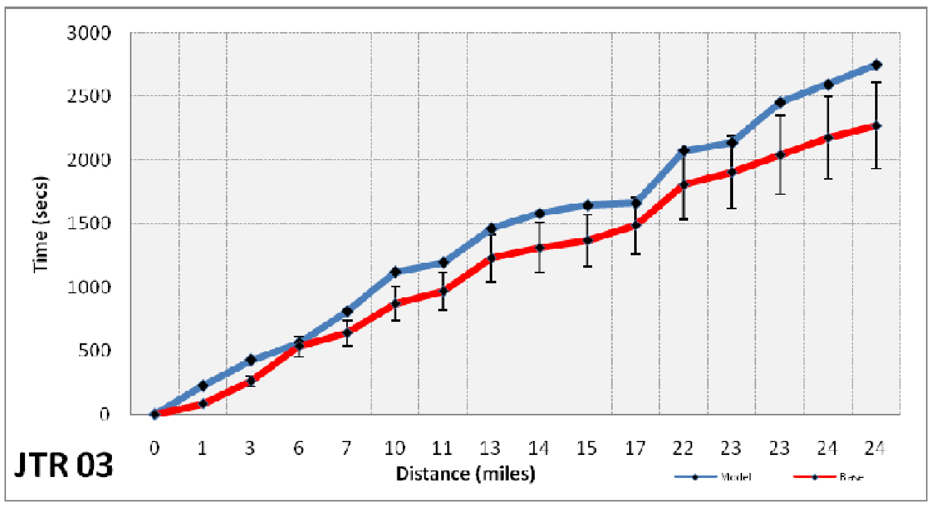
Route 2: Grimsby to Hull



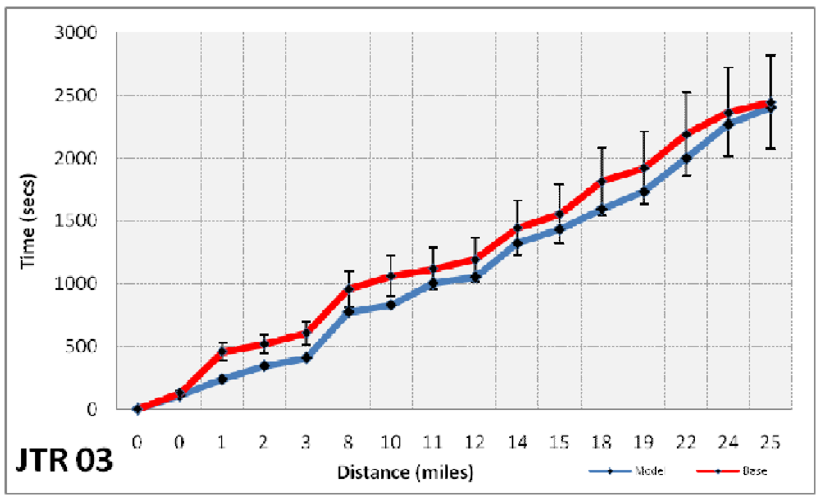
Route 2: Hull to Grimsby



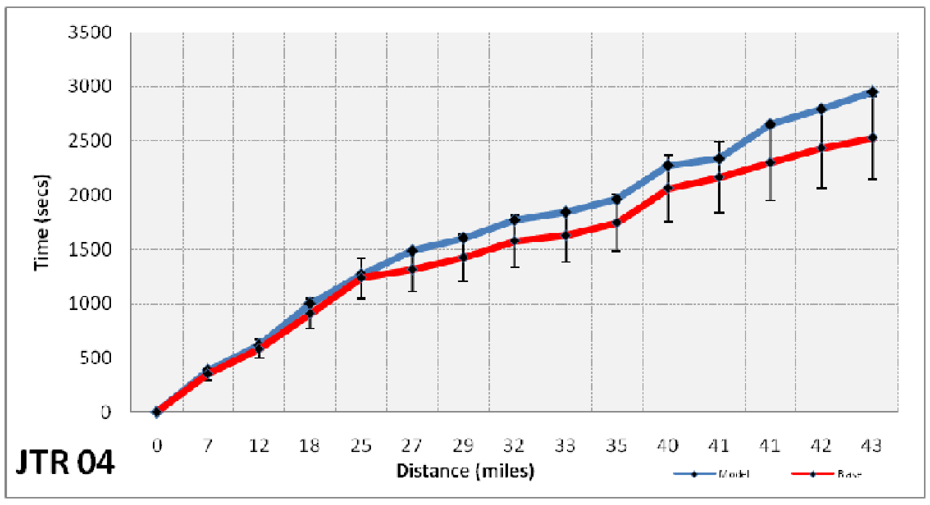
Route 3: Immingham to Hull



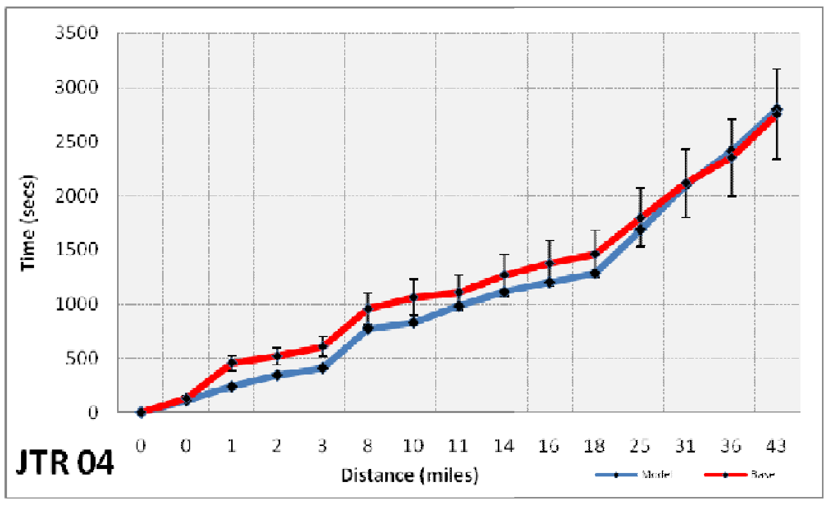
Route 3: Hull to Immingham



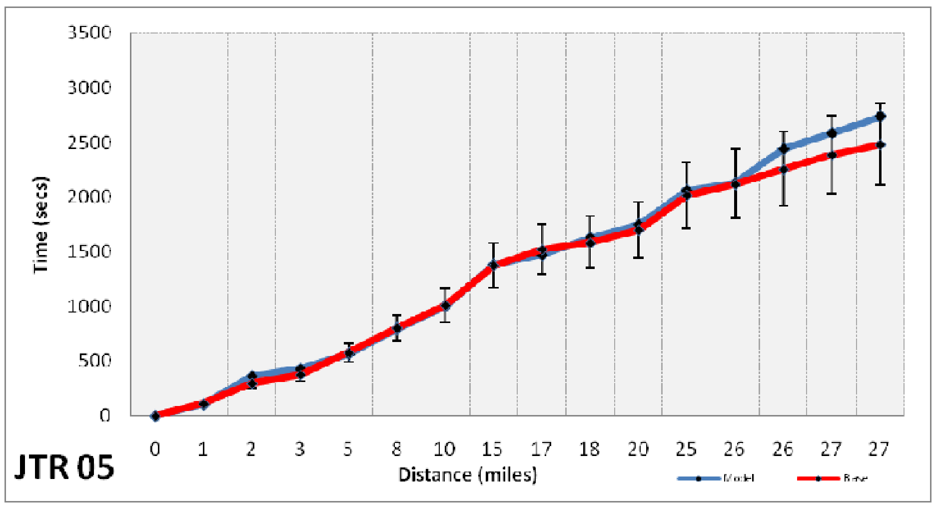
Route 4: Thorne to Hull



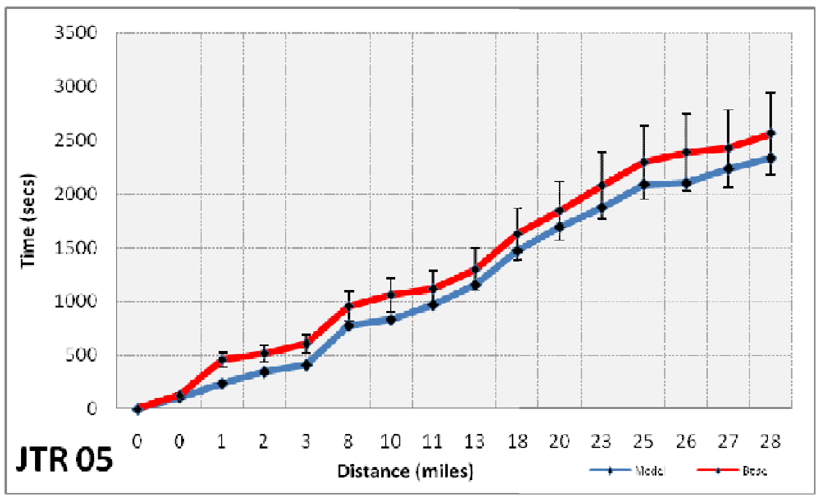
Route 4: Hull to Thorne



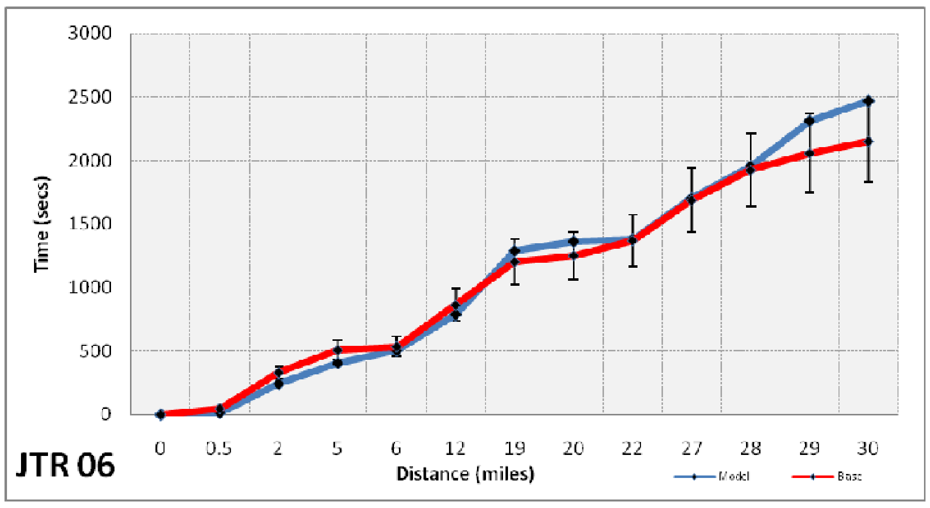
Route 5: Scunthorpe to Hull (Northern Route)



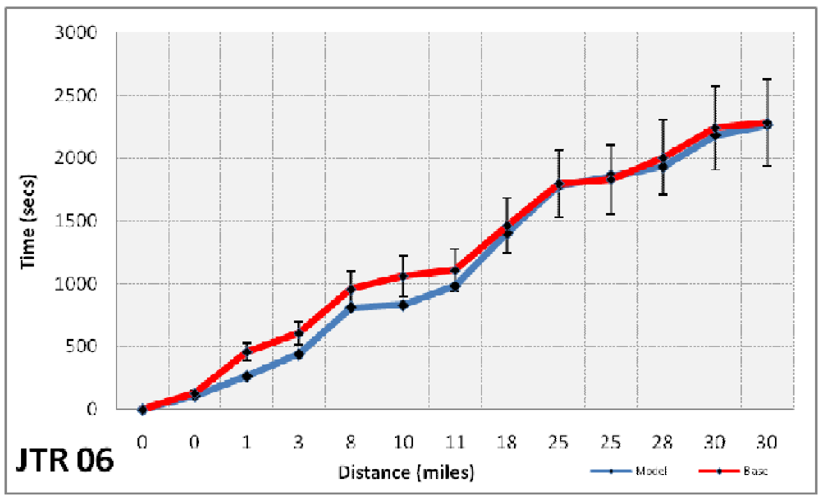
Route 5: Hull to Scunthorpe (Northern Route)



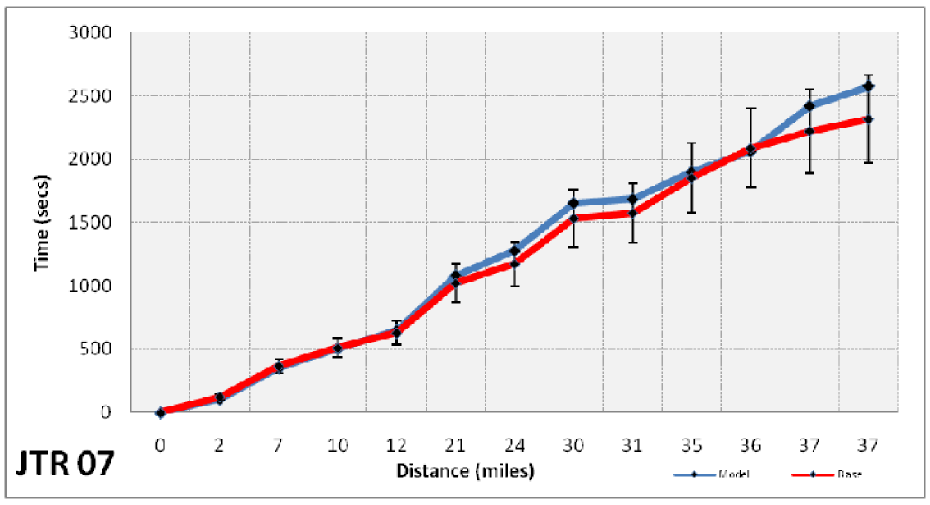
Route 6: Scunthorpe to Hull (Southern Route)



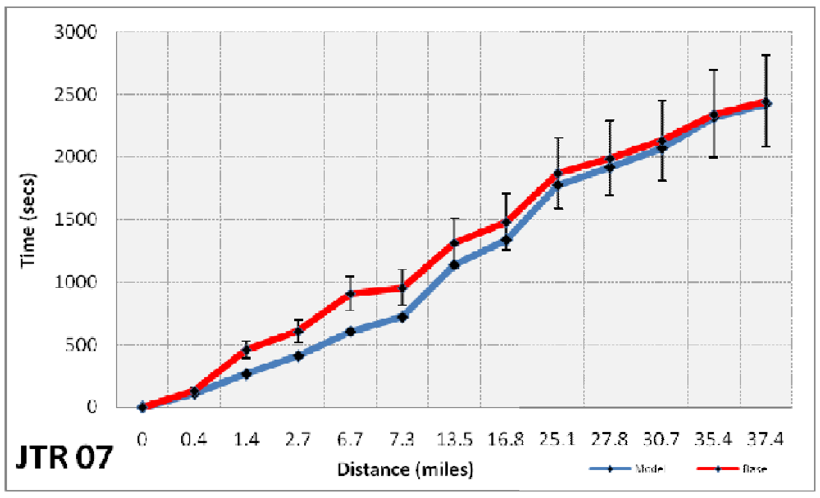
Route 6: Hull to Scunthorpe (Southern Route)



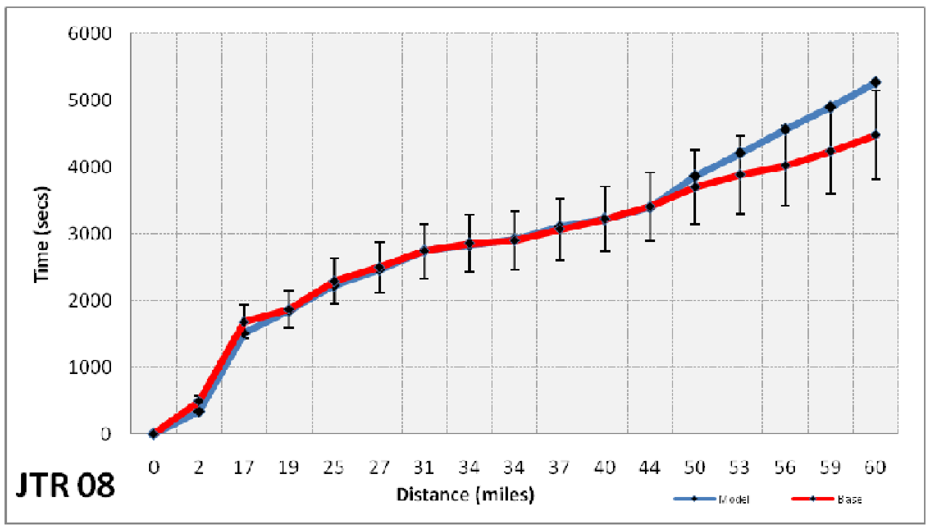
Route 7: Thorne to Hull



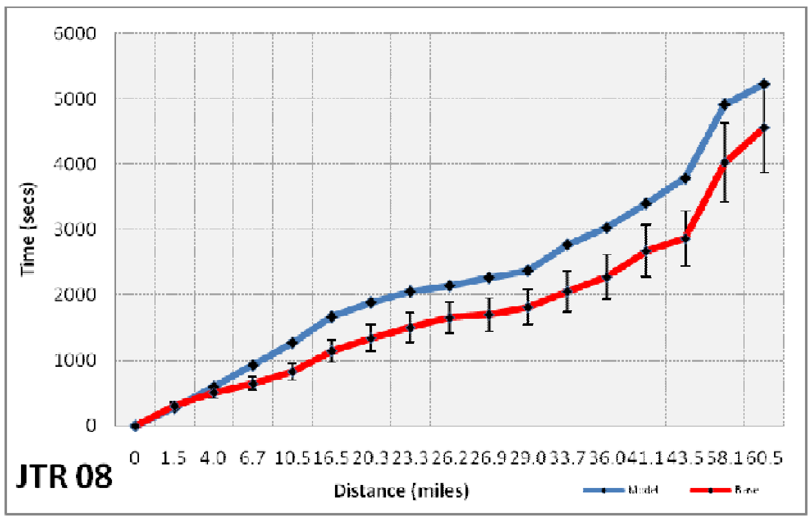
Route 7: Hull to Thorne



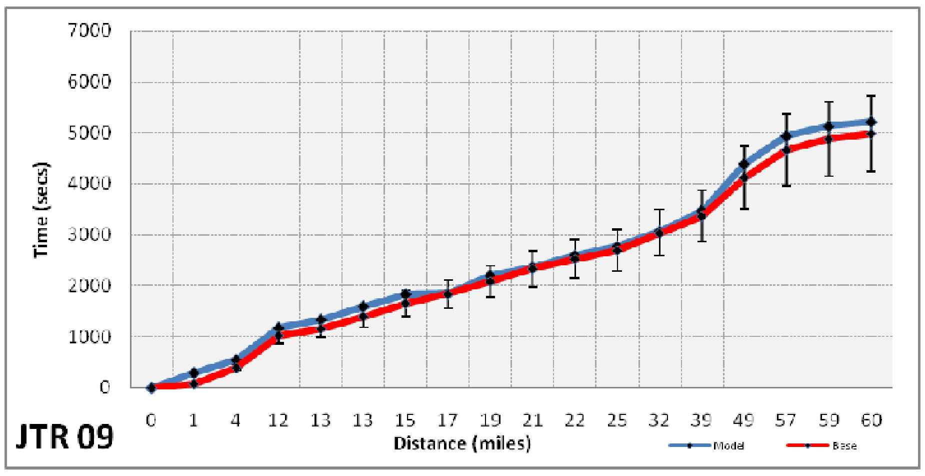
Route 8: York to Grimsby



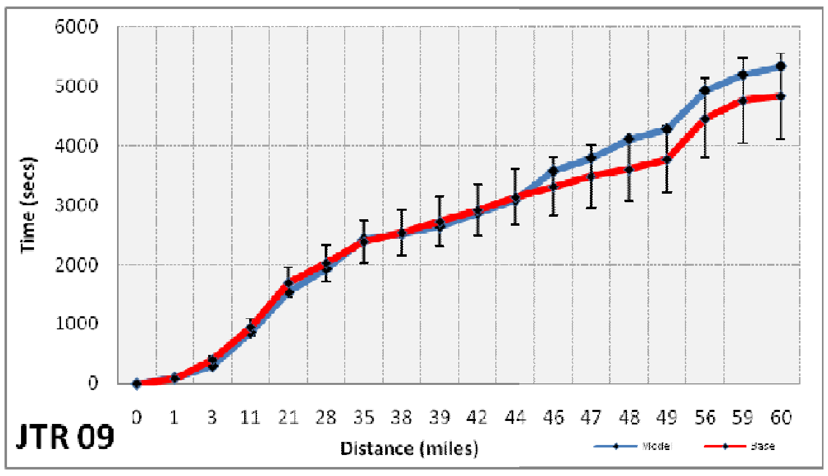
Route 8: Grimsby to York



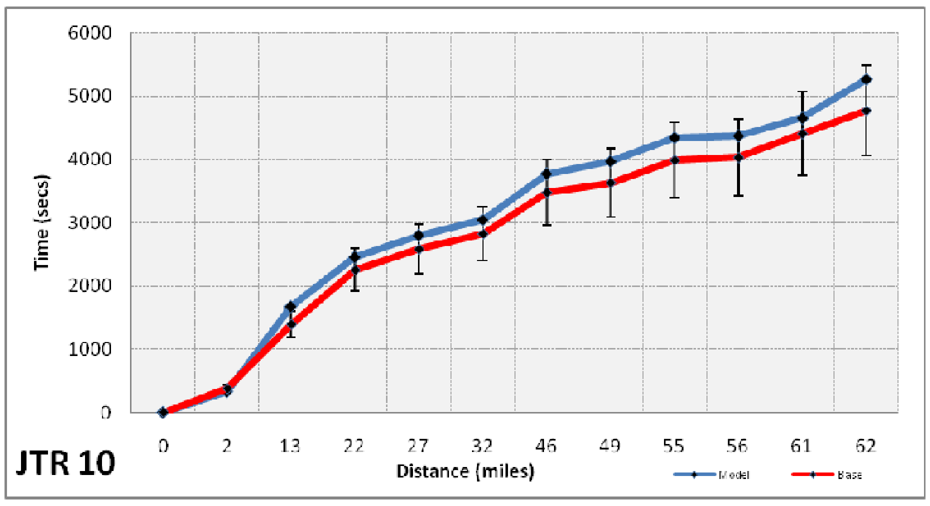
Route 9: Driffield to Lincoln



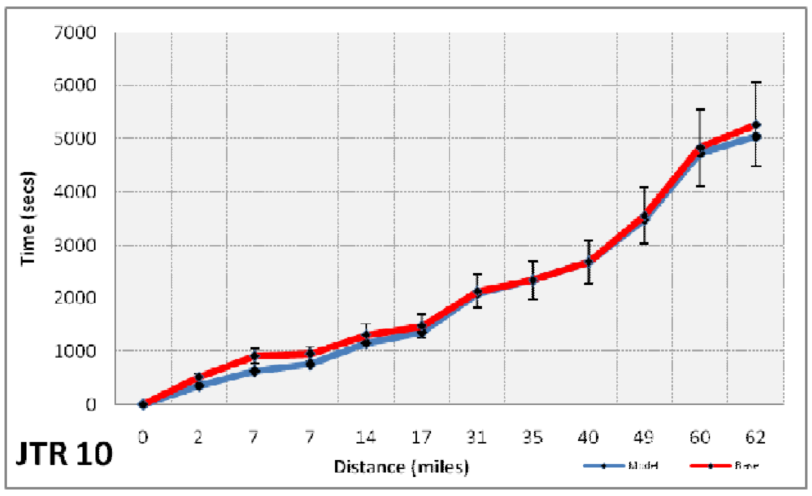
Route 9: Lincoln to Driffield



Route 10: York to Hull (via Thorne)



Route 10: Hull to York (via Thorne)



Appendix G Summary Matrix Totals Observed Vs. Gravity Model

Appendix G Summary Matrix Totals Observed Vs. Gravity Model

Table G – 1 AM Peak Hour Observed (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	1718	545	993	1144	81	144	7	25	135	1	16	101	28	814	21220
2	1580	3	54	14	33	15	10	0	11	7	0	19	0	63	1810
3	1327	16	3	3	69	40	3	5	71	0	1	51	0	39	1629
4	1953	33	14	4	28	32	5	2	11	7	9	25	2	31	2156
5	67	0	2	13	200	78	29	10	75	14	7	506	10	324	1335
6	314	9	7	10	381	70	35	2	173	16	9	194	2	101	1324
7	63	0	7	0	201	34	0	0	95	14	9	95	0	22	539
8	30	2	0	7	65	5	0	41	32	12	439	14	3	130	781
9	107	0	46	2	172	124	22	12	943	143	26	119	3	626	2345
10	7	0	0	2	32	11	3	8	270	5	2	2	5	65	412
11	42	0	1	2	10	10	7	509	20	3	6750	29	55	338	7777
12	194	8	18	11	1754	104	38	7	188	19	24	1064	1	132	3562
13	5	0	5	8	16	0	2	3	5	0	75	7	6	17	149
14	990	30	8	22	282	72	15	65	933	26	277	212	13	3014	5959
Total	2386	646	1159	1243	3323	739	177	691	2962	266	7644	2439	128	5717	50998

Table G – 2 AM Peak Hour Gravity Model (Vehicles)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2	0	663	20	740	0	0	0	0	0	0	0	0	0	36	**1459**
3	0	19	649	449	0	0	0	0	0	34	0	0	0	1847	**2998**
4	0	616	402	1370	0	0	0	0	0	10	0	0	0	3163	**17894**
5	0	0	0	0	0	35	0	0	0	0	0	0	0	0	**35**
6	0	0	0	0	70	799	146	253	1522	0	0	189	23	76	**3078**
7	0	0	0	0	0	102	174	142	241	0	0	570	68	18	**1315**
8	0	0	0	0	0	142	108	950	310	29	216	203	248	368	**2574**
9	0	0	0	0	0	582	178	416	261	0	0	183	27	0	**1646**
10	0	0	50	13	0	0	0	53	0	11	0	13	2	67	**209**
11	0	0	0	0	0	0	0	234	0	0	0	39	798	638	**1709**
12	0	0	0	0	0	134	471	248	145	8	44	3643	657	14	**5363**
13	0	0	0	0	0	16	54	267	29	1	740	573	7463	503	**9646**
14	0	15	1600	2911	0	49	14	205	0	44	276	11	358	4318	**48667**
Total	**0**	**1313**	**2721**	**1781**	**70**	**1859**	**1143**	**2768**	**2508**	**137**	**1276**	**5423**	**9644**	**4991**	**96592**

Table G – 3 AM Peak Combined Matrices (Vehicles)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Total**
1	1718	545	993	1144	81	144	7	25	135	1	16	101	28	814	**21220**
2	1580	665	74	754	33	15	10	0	11	7	0	19	0	99	**3268**
3	1327	35	652	452	69	40	3	5	71	34	1	51	0	1886	**4627**
4	1953	650	416	1370	28	32	5	2	11	17	9	25	2	3194	**20050**
5	67	0	2	13	200	113	29	10	75	14	7	506	10	324	**1370**
6	314	9	7	10	451	869	181	255	1695	16	9	383	25	177	**4402**
7	63	0	7	0	201	137	174	142	336	14	9	665	68	39	**1854**
8	30	2	0	7	65	147	108	991	342	41	655	217	250	499	**3354**
9	107	0	46	2	172	706	200	428	1204	143	26	301	30	626	**3992**
10	7	0	50	15	32	11	3	61	270	16	2	15	7	133	**622**
11	42	0	1	2	10	10	7	743	20	3	6750	68	853	975	**9486**
12	194	8	18	11	1754	238	508	255	333	26	68	4707	658	146	**8924**
13	5	0	5	8	16	16	56	270	34	1	815	580	7469	520	**9795**
14	990	44	1609	2933	282	121	29	270	933	70	553	223	371	4620	**54627**
Total	**2386**	**1959**	**3880**	**1906**	**3393**	**2598**	**1320**	**3458**	**5469**	**403**	**8919**	**7862**	**9772**	**5563**	**14759**

Table G – 4 IP hour Observed Matrices (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	8838	475	620	1015	116	182	18	34	118	0	12	182	16	400	**12027**
2	1508	3	40	7	3	15	0	0	24	0	0	23	0	31	**1655**
3	1289	16	6	15	11	33	6	0	15	0	1	32	0	22	**1445**
4	1919	20	9	2	26	32	3	0	23	0	3	36	0	24	**2099**
5	52	0	5	8	194	78	27	10	52	2	6	696	10	227	**1367**
6	312	9	9	9	373	73	34	1	39	5	5	195	2	42	**1110**
7	30	0	5	0	196	34	0	0	57	5	9	105	0	10	**451**
8	19	5	0	14	64	5	0	40	13	0	427	22	2	106	**716**
9	85	0	0	0	127	14	23	0	2	0	23	128	2	20	**425**
10	8	0	0	5	27	0	5	0	0	0	0	4	5	20	**73**
11	24	0	1	5	10	12	7	491	18	0	6567	32	53	329	**7548**
12	180	8	17	19	1719	125	37	7	149	14	23	1072	1	87	**3460**
13	8	0	0	0	15	0	1	3	2	0	73	7	5	11	**125**
14	867	24	8	11	199	63	13	57	205	3	268	63	7	2891	**4677**
Total	**1514**	**561**	**721**	**1110**	**3080**	**667**	**174**	**642**	**716**	**29**	**7417**	**2598**	**104**	**4219**	**37179**

Table G – 5 IP hour Gravity Model Matrices (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2	0	661	13	640	0	0	0	0	0	0	0	0	0	22	**1335**
3	0	13	602	344	0	0	0	0	0	8	0	0	0	1088	**2056**
4	0	640	345	1053	0	0	0	0	0	6	0	0	0	2020	**13546**
5	0	0	0	0	10	80	0	0	0	0	0	0	0	0	**90**
6	0	0	0	0	80	793	3	143	425	0	0	131	15	36	**1625**
7	0	0	0	0	0	3	115	88	133	0	0	396	35	9	**779**
8	0	0	0	0	0	143	88	723	293	30	175	168	193	119	**1933**
9	0	0	0	0	0	425	133	293	145	0	0	147	19	0	**1161**
10	0	0	38	7	0	0	0	30	0	10	0	0	1	36	**123**
11	0	0	0	0	0	0	0	176	0	0	0	30	595	174	**976**
12	0	0	0	0	0	131	396	168	73	9	30	3494	502	7	**4812**
13	0	0	0	0	0	15	47	193	19	1	596	503	6595	524	**8492**
14	0	13	1149	2029	0	10	2	21	0	16	12	7	524	2978	**33570**
Total	**0**	**1327**	**2147**	**1355**	**90**	**1599**	**784**	**1836**	**1087**	**81**	**814**	**4877**	**8479**	**3382**	**70498**

Table G – 6 IP hour Combined Matrices (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	8838	475	620	1015	116	182	18	34	118	0	12	182	16	400	**12027**
2	1508	664	53	647	3	15	0	0	24	0	0	23	0	53	**2990**
3	1289	29	608	359	11	33	6	0	15	8	1	32	0	1110	**3501**
4	1919	661	354	1053	26	32	3	0	23	6	3	36	0	2044	**15645**
5	52	0	5	8	204	158	27	10	52	2	6	696	10	227	**1457**
6	312	9	9	9	453	866	37	144	464	5	5	327	17	78	**2735**
7	30	0	5	0	196	37	115	88	189	5	9	502	35	19	**1230**
8	19	5	0	14	64	148	88	763	306	30	602	190	196	225	**2649**
9	85	0	0	0	127	439	156	293	147	0	23	275	21	20	**1586**
10	8	0	38	12	27	0	5	30	0	10	0	4	6	56	**196**
11	24	0	1	5	10	12	7	666	18	0	6567	62	649	503	**8524**
12	180	8	17	19	1719	257	433	175	222	24	54	4566	503	94	**8272**
13	8	0	0	0	15	15	48	195	21	1	669	510	6600	534	**8617**
14	867	37	1157	2040	199	73	15	78	205	19	280	70	530	3267	**38247**
Total	**1514**	**1888**	**2868**	**1466**	**3170**	**2265**	**958**	**2478**	**1803**	**110**	**8232**	**7475**	**8584**	**3804**	**10767**

Table G – 7 PM Peak hour observed matrices (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	1825	1896	1666	2435	27	249	51	27	132	24	35	181	27	1242	**26245**
2	709	0	51	34	0	10	5	0	3	0	3	13	0	29	**856**
3	1135	79	45	16	9	41	6	11	72	6	0	28	0	27	**1475**
4	1724	13	36	9	9	30	0	13	10	3	8	19	17	11	**1901**
5	125	15	26	27	267	353	162	46	133	15	22	1670	22	315	**3198**
6	196	13	18	13	105	88	39	6	112	13	24	160	0	57	**845**
7	10	3	7	5	69	57	0	0	31	0	4	32	0	16	**234**
8	23	0	0	5	50	3	0	18	8	8	410	7	2	220	**754**
9	147	7	73	24	73	212	79	60	1097	327	8	207	9	842	**3165**
10	4	2	0	0	11	0	0	13	177	12	0	26	0	75	**320**
11	10	0	0	2	12	12	41	585	11	3	4826	100	78	321	**6001**
12	110	6	29	27	573	205	83	25	176	15	79	1240	5	214	**2790**
13	25	6	6	5	19	3	0	0	12	0	31	12	21	26	**167**
14	1053	63	41	36	375	128	37	90	1123	60	232	199	36	3907	**7380**
Total	**2352**	**2103**	**2000**	**2637**	**1600**	**1391**	**501**	**894**	**3099**	**485**	**5681**	**3895**	**216**	**7303**	**55330**

Table G – 8 PM Peak hour gravity model matrices (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
2	0	873	15	606	0	0	0	0	0	0	0	0	0	24	**1518**
3	0	16	842	436	0	0	0	0	0	62	0	0	0	1325	**2682**
4	0	762	563	1556	0	0	0	0	0	10	0	0	0	3099	**20002**
5	0	0	0	0	15	120	0	0	0	0	0	0	0	0	**135**
6	0	0	0	0	173	1265	124	157	678	0	0	166	12	47	**2620**
7	0	0	0	0	0	176	211	119	227	0	0	564	57	14	**1369**
8	0	0	0	0	0	280	155	1063	490	54	255	228	257	192	**2973**
9	0	0	0	0	0	1646	282	374	291	0	0	0	26	0	**2618**
10	0	0	45	8	0	0	0	29	0	13	0	9	1	42	**146**
11	0	0	0	0	0	0	0	214	0	0	0	32	752	294	**1292**
12	0	0	0	0	0	241	641	186	0	16	30	4757	559	11	**6442**
13	0	0	0	0	0	21	77	256	25	2	913	705	8873	659	**11531**
14	0	16	1780	3205	0	71	16	355	0	64	681	14	746	5136	**58314**
Total	**0**	**1667**	**3246**	**1982**	**188**	**3820**	**1505**	**2754**	**1711**	**222**	**1879**	**6474**	**1128**	**5707**	**11164**

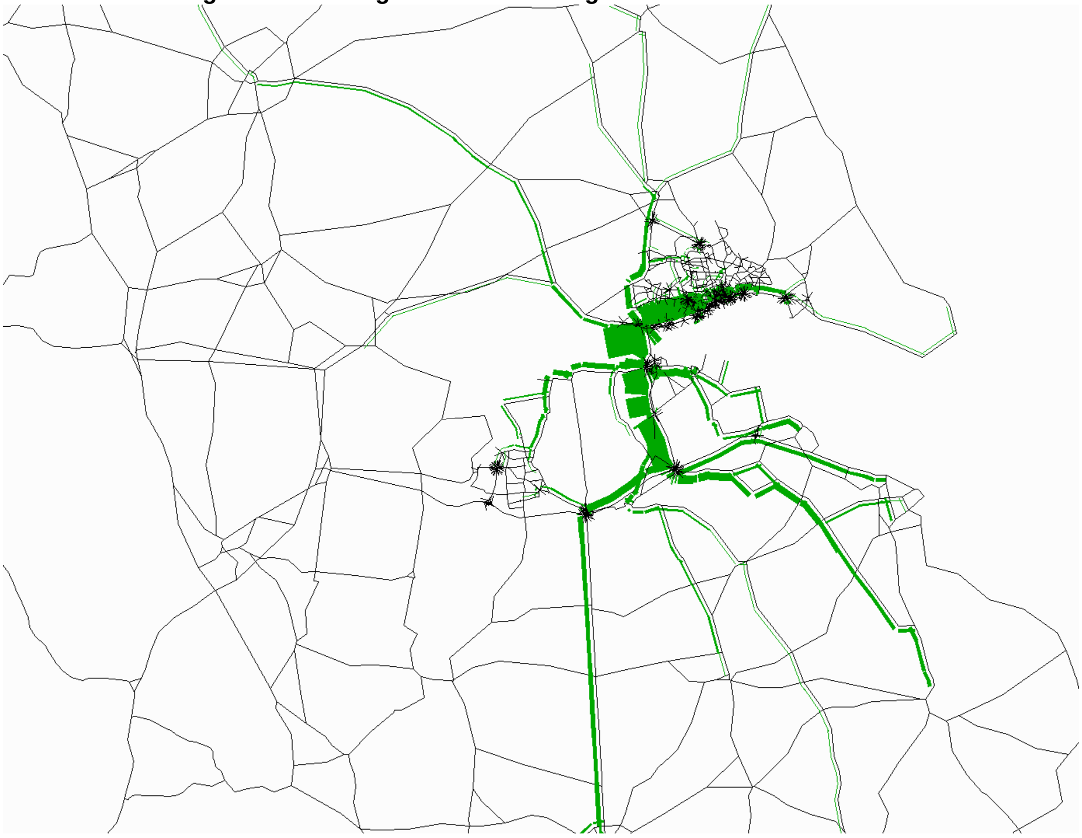
Table G – 9 PM Peak hour combined matrices (Vehicles)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	1825	1896	1666	2435	27	249	51	27	132	24	35	181	27	1242	**26245**
2	709	873	66	640	0	10	5	0	3	0	3	13	0	53	**2374**
3	1135	95	887	452	9	41	6	11	72	68	0	28	0	1352	**4156**
4	1724	776	600	1557	9	30	0	13	10	13	8	19	17	3110	**21903**
5	125	15	26	27	282	473	162	46	133	15	22	1670	22	315	**3333**
6	196	13	18	13	277	1353	162	163	790	13	24	326	12	103	**3464**
7	10	3	7	5	69	233	211	119	258	0	4	596	57	30	**1602**
8	23	0	0	5	50	283	155	1081	498	62	664	234	259	412	**3727**
9	147	7	73	24	73	1858	360	434	1388	327	8	207	35	842	**5783**
10	4	2	45	8	11	0	0	42	177	25	0	34	1	117	**466**
11	10	0	0	2	12	12	41	799	11	3	4826	132	829	616	**7292**
12	110	6	29	27	573	447	724	211	176	31	110	5998	564	226	**9232**
13	25	6	6	5	19	24	77	256	37	2	943	717	8894	685	**11698**
14	1053	79	1821	3241	375	199	53	445	1123	124	913	212	782	5527	**65694**
Total	**2352**	**3770**	**5246**	**2245**	**1787**	**5211**	**2006**	**3648**	**4809**	**707**	**7560**	**1036**	**1149**	**6437**	**16697**

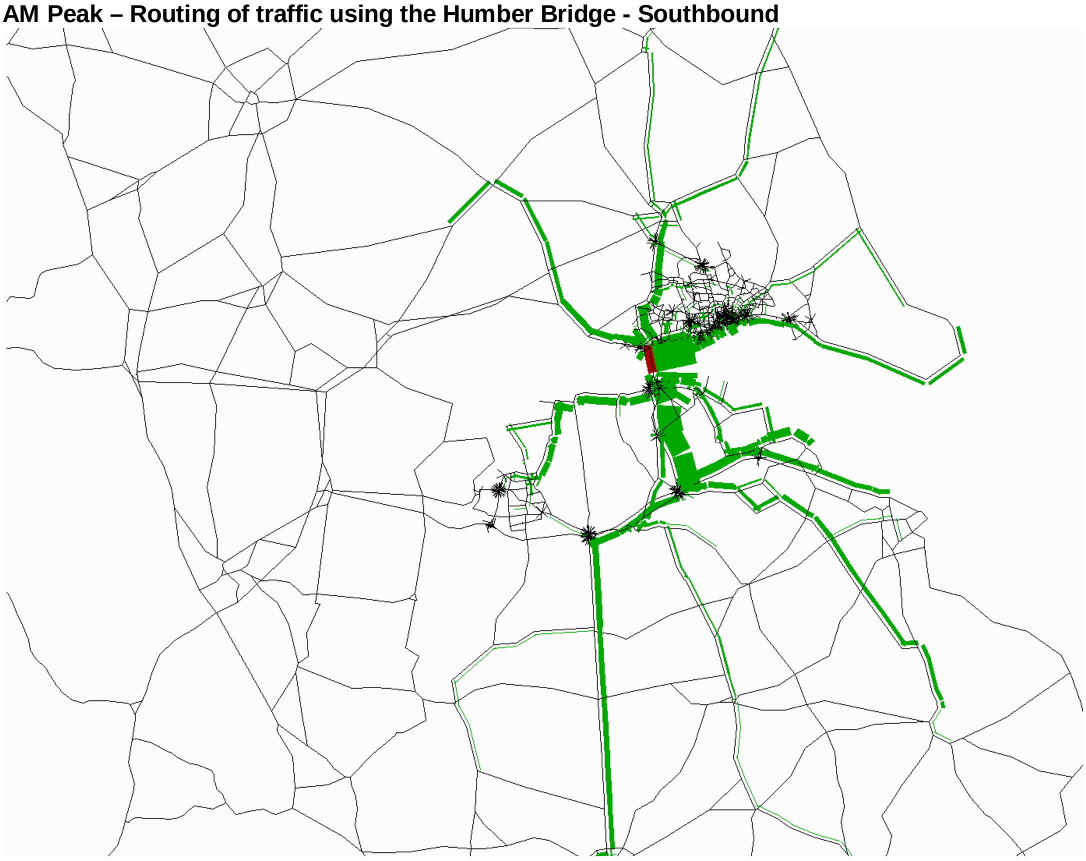
Appendix H – Observed Trips on the Bridge

Appendix H – Observed Trips on the Bridge

AM Peak – Routing of traffic using the Humber Bridge - Northbound



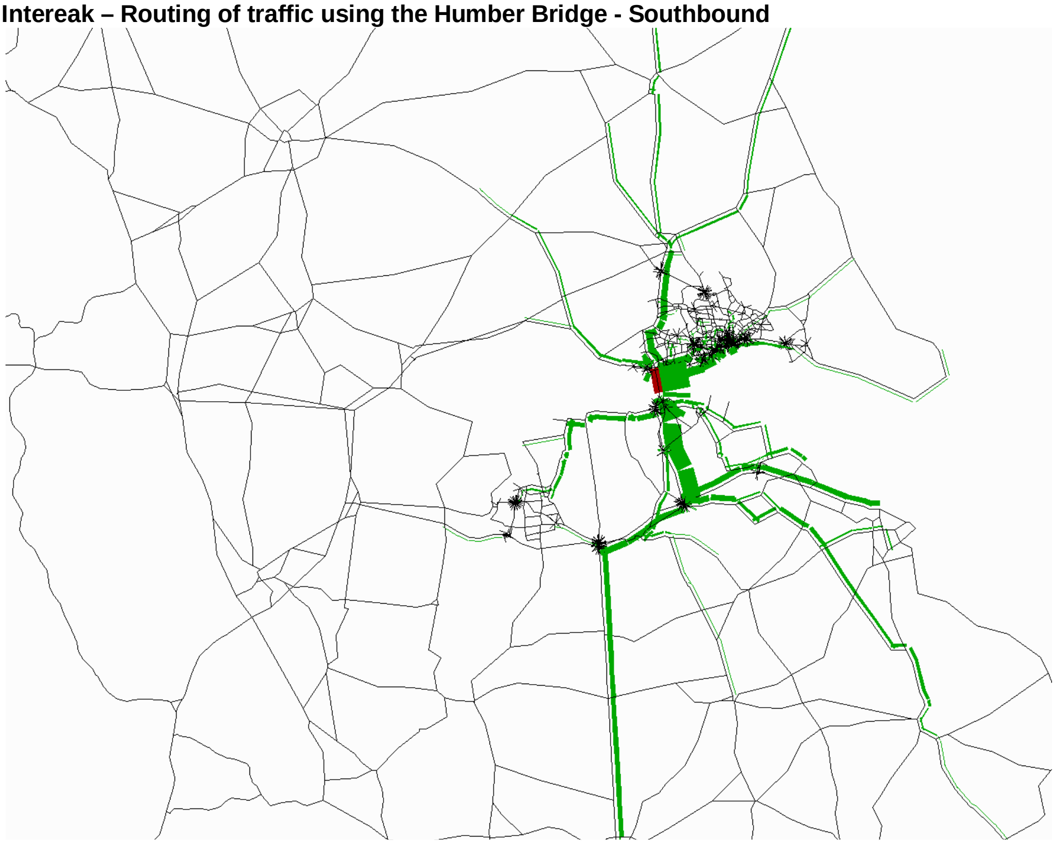
AM Peak – Routing of traffic using the Humber Bridge - Southbound



Capabilities on project:
Transportation

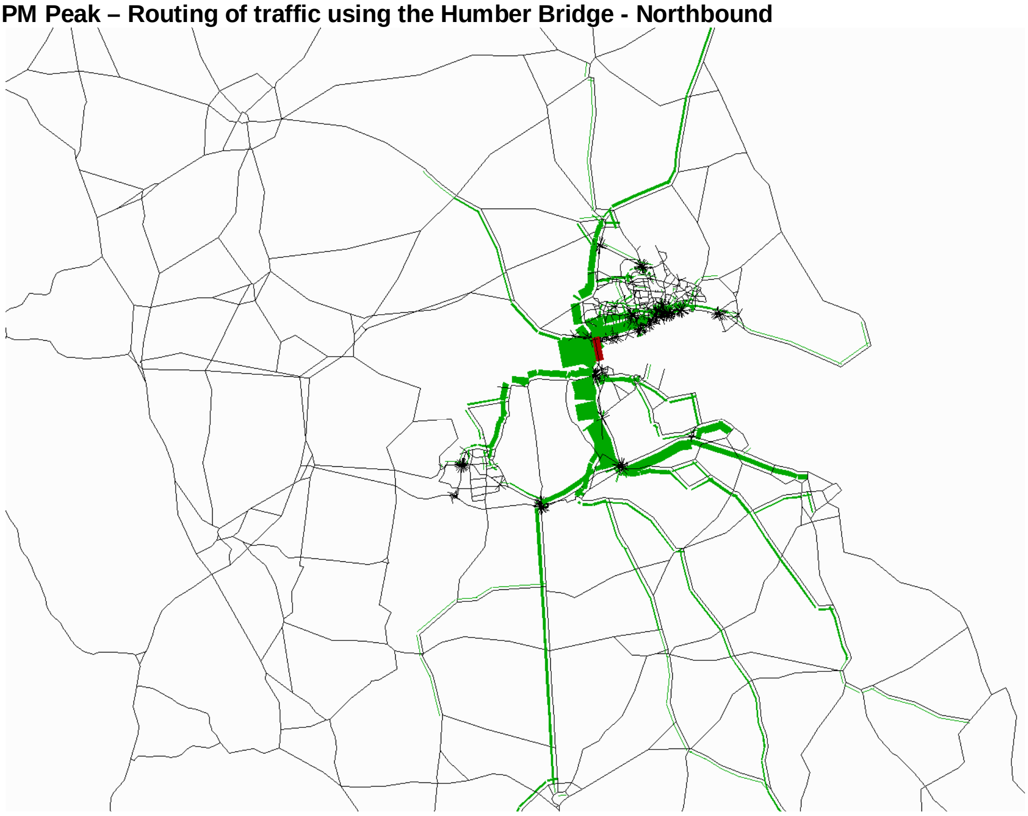
InterPeak – Routing of traffic using the Humber Bridge - northbound

Intereak – Routing of traffic using the Humber Bridge - Southbound

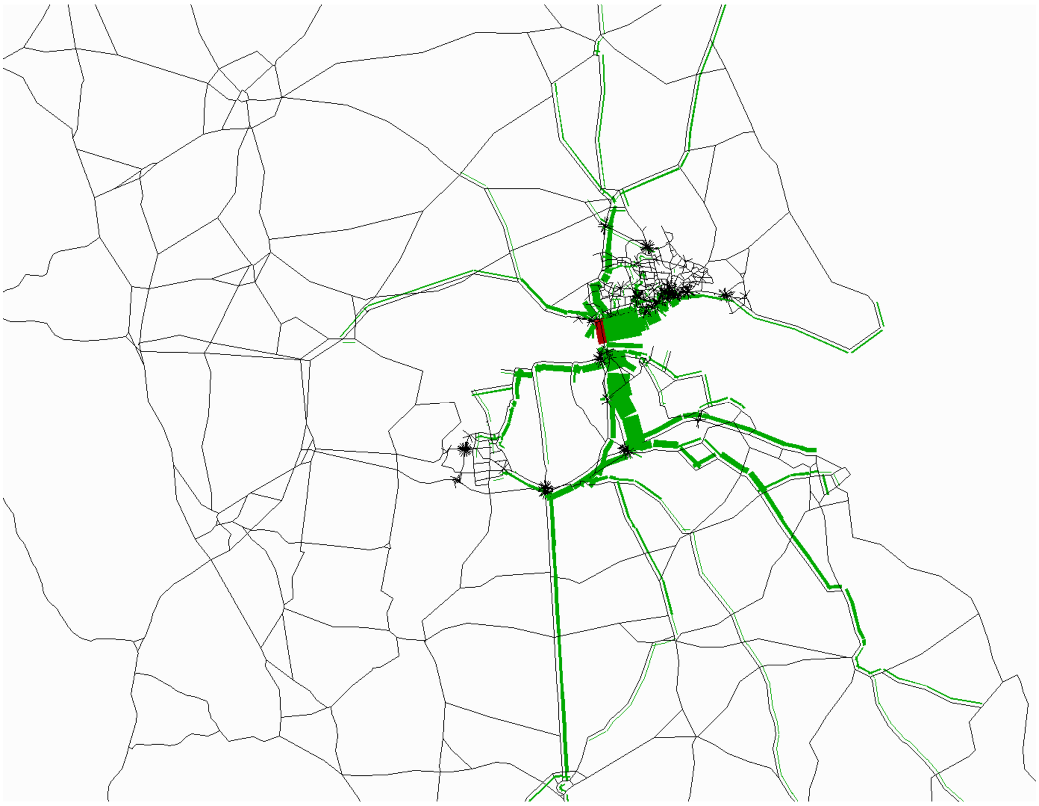


Capabilities on project:
Transportation

PM Peak – Routing of traffic using the Humber Bridge - Northbound



PM Peak – Routing of traffic using the Humber Bridge - Southbound



Appendix I – Supporting Information, Demand Model Calibration

Appendix I – Supporting Information, Demand Model Calibration

The Calibration of the Demand Model

The demand model has been implemented using the DIADEM 5 software and has been calibrated in accordance with the methodology laid out in WebTAG Unit 3.10.4.

The process of demand calibration involves adjusting the model parameters, in accordance with the range of values outlined in WebTAG Unit 3.10.3 until plausible results were produced from the realism testing. This appendix sets out the parameters used and discusses the results of the realism testing using these parameters..

To ensure robustness in calibration, tests have been carried out to examine the effects of a 10% increase in fuel costs and a 10% increase in journey times. The convergence parameter in DIADEM was set to 0.15% which was generally achieved after about 15 iterations of the DIADEM process.

The demand model is run in DIADEM using all 13 matrix segments; although the demands within the goods vehicle segments were not allowed to be changed by the variable demand model, Table I1, below shows the costs used in the model..

Table I1 – Value of Time and Operating Costs (per vehicle in 2010 values)

Vehicle Type	Journey Purpose	Income segmentation	VoT (p per min)	Op costs (p per km)
Cars and light vans	Commuting	Low	6.38	5.47
		Medium	9.24	5.47
		High	13.18	5.47
Cars and light vans	Home based employers business	All	68.20	10.12
Cars and light vans	Home based other	Low	10.63	5.47
		Medium	12.08	5.47
		High	13.83	5.47
Cars and light vans	Non home based employers business	All	67.93	10.12
Cars and light vans	Non home based other	All	13.83	5.47
Goods vehicles 3.5t – 7.5t	All	All	23.80	25.07
Goods vehicles >7.5t 2 axles	All	All	23.80	25.07
Goods vehicles >7.5t 3 axles	All	All	23.80	44.47
Goods vehicles >7.5t 4+ axles	All	All	23.80	44.47

Note Operating costs relate to fuel costs for own business trips (including commuting) and to fuel plus other operating costs for employers business trips.

DIADEM has the ability to model the full set of responses indicated in WEBTAG, namely mode choice, trip distribution, trip frequency and macro time of day. A review of alternative modes, referred to in Chapter 2, concluded that change of mode was not anticipated to be an important response to the tests under consideration, and consequently mode choice was not included in the DIADEM model. Time of day change was also omitted from the process.

Model Parameters

Parameters

DIADEM requires that model parameters are defined for each of the selected responses. For logit based models the spread (dispersion) parameter λ must be defined for the choice at the bottom of the hierarchy and for choices above the bottom the scaling parameter θ is required.

WebTAG Unit 3.10.3 provides some typical values for λ and θ which should be used as starting points for the model. These can be varied, within bounds provided by WebTAG during calibration to ensure that the model performs sensibly.

Table I2 – WebTAG Destination Choice Parameters

Trip Purpose	Minimum	Median	Maximum
Home based work	0.054	0.065	0.113
Home based employers business	0.038	0.067	0.106
Home based other	0.074	0.090	0.160
Non home based employers business	0.069	0.081	0.107
Non home based other	0.073	0.077	0.105

Currently there is no guidance in WebTAG regarding parameter values for trip frequency. Evidence is scarce on the impacts of changing costs on trip frequency. Recently, for other models, AECOM have used the following θ values for trip frequency. Both of these models incorporate main mode choice. In principle therefore, one would expect the θ values to be higher in HETM (where no mode choice is modelled) but this will be offset by the relative lack of mode choice for cross-Humber trips. We note the content of WebTAG Unit 3.10.3 (June 2006 and unchanged in Consultation Version dated 13 October 2009):

"1.11.10 Some models include trip frequency but the evidence on the appropriate sensitivity parameter value is limited and as a result we do not currently have any suitable recommended values."

Table I3 – Theta Values for Trip Frequency

Purpose	East of England Model	M25 Model
HBW	0.28	0.16
HBEB	0	0
HBO	0.28	0.16
NHBEB	0	0
NHBO	0.20	0.12

DIADEM also allows cost damping procedures as outlined in WebTAG 3.10.2. After initial tests without cost damping, it was agreed that a cost damping process was required for the HETM model. The method used was damping by a power function of cost. This process includes two new parameters to calibrate, μ and β in the damping formula:

$$\textit{damped cost} = \mu \cdot \left(60 \cdot \left(t + \frac{c}{VOT}\right)\right)^{\beta}$$

WebTAG (Unit 3.10.2, para 1.11.13) states that:
In some applications, β has been set at values ranging from 0.65 to 0.9 and then μ has been defined as

to set g=(t + c/v) at a specific generalised cost such as the mean generalised cost.

For this model beta was set at 0.8 and mu varied to examine the sensitivity of the results to different values. The final choice of mu was made in conjunction with the choice of lambda and theta in assessing the realism test results.

A complete list of the calibrated DIADEM parameters are shown in table I4 below

Table I4 - DIADEM Input Parameters

Trip Purpose	**Destination choice**	**Trip frequency**	**Cost Damping**	
	λ	θ	β	μ
Home based work	0.065	0.16	0.8	1.3
Home based employers business	0.067	-	0.8	1.3
Home based other	0.090	0.16	0.8	1.3
Non home based employers business	0.081	-	0.8	1.3
Non home based other	0.077	0.12	0.8	1.3

Response to Fuel Cost Change

Elasticity – Matrix Based

The model was run to investigate the demand responses to a 10% increase in fuel costs. For business trips the increase has been applied only to the fuel element of the overall vehicle operating costs.

Table I5 shows the summary (12 hour) elasticities with regard to a 10% increase in fuel costs. A full summary, by time period, is given in Table I8. The calculation for the matrix based assessment is carried out for all trips produced in the core study area. Trips produced in the outer buffer area are excluded from the analysis, as are trips with destinations in the external zones representing Southern and Western England, Scotland and Wales since the definition of costs for long distance external trips will be less well defined.

WebTAG guidelines (Unit 3.10.4, paras. 1.6.14-1.6.16) suggest

- The annual average fuel cost elasticity should lie within the range -0.25 to -0.35.
- The annual average elasticities for employers business trips should be near to -0.1
- The annual average elasticities for discretionary trips should be nearer -0.4

The results show that:

- High income band trips are less elastic to fuel cost changes than low income bands;
- Employers business trips are least elastic to changes in fuel cost; and
- Discretionary trips are most elastic to changes in fuel cost.

These findings are in line with a priori expectations in terms of both income effects and trip purpose effects. The results are all in line with the WebTAG requirements for matrix based elasticities.

Table I5 – Matrix Based Elasticities (wrt fuel costs)

Time	Purpose	Income	Elasticity
12 Hour Average	HBW	Low	-0.42
		Medium	-0.30
		High	-0.22
		Average	**-0.29**
	HBEB	**All**	**-0.05**
	HBO	Low	-0.52
		Medium	-0.46
		High	-0.40
		Average	**-0.47**
	NHBEB	**All**	**-0.13**
	NHBO	**All**	**-0.44**
	All	**Average**	**-0.33**

Fuel Costs - Network Based

The network based calculation uses data from the whole network, all buffer and simulation links although it excludes centroid connectors. The results are shown in Table I6. The results show a similar pattern to those for the matrix based assessment with the overall elasticity -0.30. Business trips show a lower elasticity and discretionary trips generally higher than commuting trips.

Table I6 - Network Based Elasticities (with respect to fuel costs)

Time	Purpose	Income	Elasticity
12 Hour Average	**HBW**	Low	-0.52
		Medium	-0.36
		High	-0.27
		Average	**-0.34**
	HBEB	**All**	**-0.13**
	HBO	Low	-0.48
		Medium	-0.33
		High	-0.32
		Average	**-0.38**
	NHBEB	**All**	**0.05**
	NHBO	**All**	**-0.31**
	All	**Average**	**-0.30**

Response to Change in Travel Times

In line with WebTAG guidance a test was carried out to examine the response to a 10% increase in travel time. This is carried out in DIADEM by increasing the demand model value of time parameters by 10% and running a single iteration of the DIADEM process rather than running it to convergence. The results of this test are shown in Table H7.

Journey time elasticities are calculated on a single iteration of DIADEM. WebTAG 3.10.4 (para 1.6.30) states that journey time elasticities should be no stronger than -2.0. The elasticities are generally low and considerably less than -2.0. Elasticity for discretionary trips is higher than for non discretionary

Table I7 Elasticity With Respect to Travel Time Increase

Time	Purpose	Income	Elasticity
12 Hour Average	HBW	Low	-0.43
		Medium	-0.44
		High	-0.44
		Average	-0.44
	HBEB	**All**	-0.26
	HBO	Low	-0.84
		Medium	-0.80
		High	-0.84
		Average	-0.83
	NHBEB	**All**	-0.61
	NHBO	**All**	-1.03
	All	**Average**	**-0.63**

Table I8 Matrix Based Outturn Elasticities (with respect to fuel costs)

Time	Purpose	Income	Elasticity
AM	HBW	Low	-0.40
		Medium	-0.29
		High	-0.20
		Average	**-0.27**
	HBEB	All	**-0.07**
	HBO	Low	-0.47
		Medium	-0.43
		High	-0.37
		Average	**-0.43**
	NHBEB	All	**-0.08**
	NHBO	All	**-0.40**
	All	Average	**-0.27**
Inter Peak	HBW	Low	-0.42
		Medium	-0.31
		High	-0.23
		Average	**-0.30**
	HBEB	All	**-0.04**
	HBO	Low	-0.56
		Medium	-0.48
		High	-0.43
		Average	**-0.50**
	NHBEB	All	**-0.13**
	NHBO	All	**-0.43**
	All	Average	**-0.36**
PM Peak	HBW	Low	-0.43
		Medium	-0.32
		High	-0.23
		Average	**-0.30**
	HBEB	All	**-0.04**
	HBO	Low	-0.47
		Medium	-0.42
		High	-0.36
		Average	**-0.43**
	NHBEB	All	**-0.14**
	NHBO	All	**-0.51**
	All	Average	**-0.33**
12 Hour	HBW	Low	-0.42
		Medium	-0.30
		High	-0.22
		Average	**-0.29**
	HBEB	All	**-0.05**
	HBO	Low	-0.52
		Medium	-0.46
		High	-0.40
		Average	**-0.47**
	NHBEB	All	**-0.13**
	NHBO	All	**-0.44**
	All	Average	**-0.33**

Appendix J – Analysis of traffic routings through the Model

Appendix J – Analysis of Traffic Routings through the model

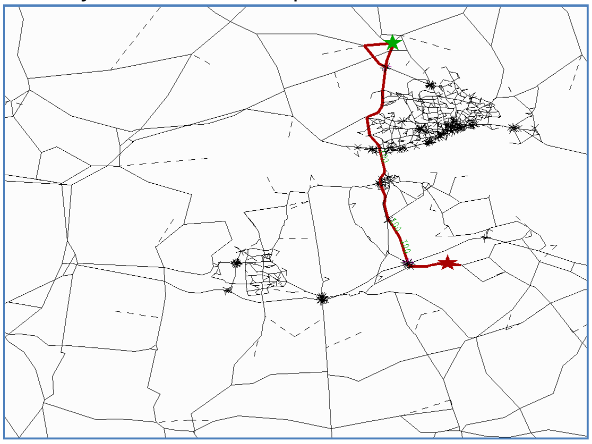
A series of forest plots were produced to analyse the routings of traffic for key cross Humber and non Cross Humber journeys to examine whether there may be significant partial observations at the model RSI sites. Origins and destinations were chosen to represent locations where there might be a split between two or more movements across the estuary such that some avoided survey sites.

The sample presented below are based on the AM Peak Base Model.

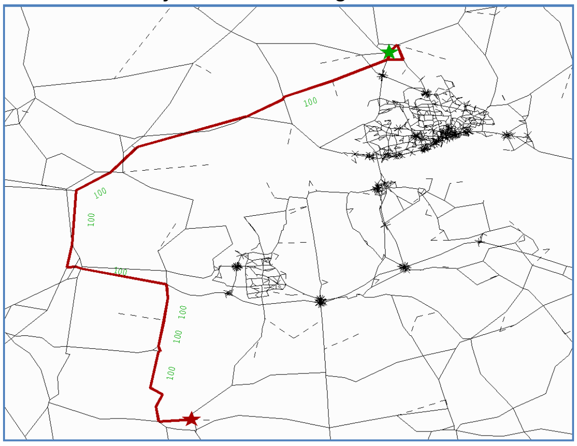
Cross Humber Movements

Trips from Beverley

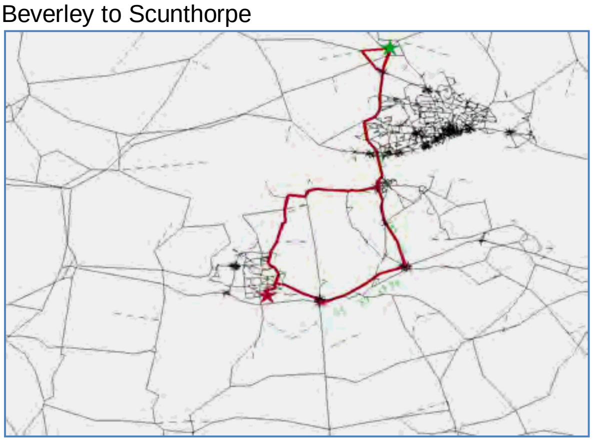
Beverley to Humberside Airport



Beverley to Gainsborough



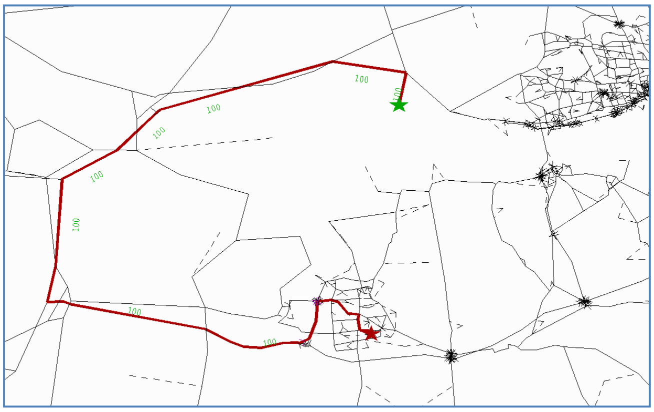
Beverley to Scunthorpe



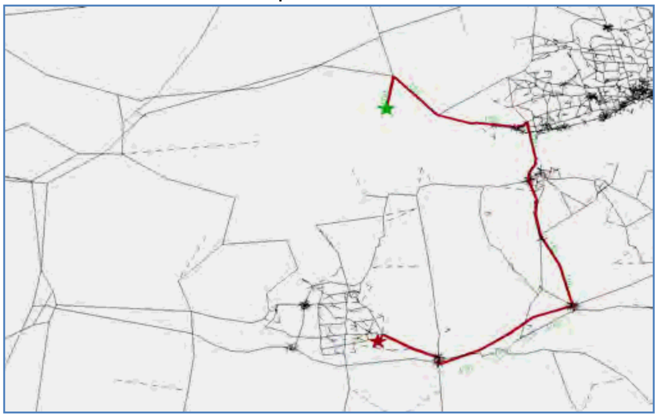
Capabilities on project:
Transportation

Trips from South Cave

South Cave to Scunthorpe

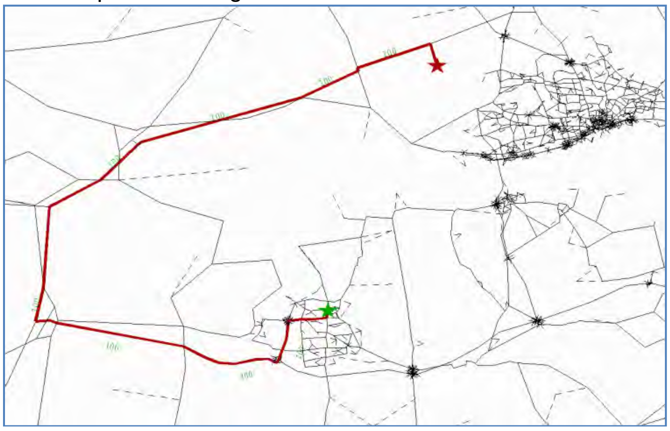


South Cave to Scunthorpe

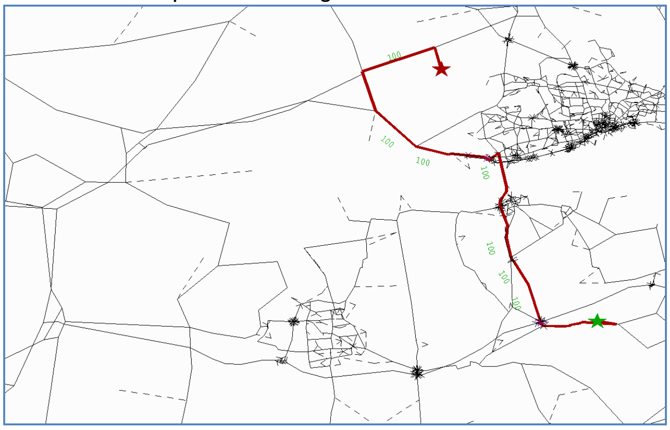


Trips to Walkington

Scunthorpe to Walkington

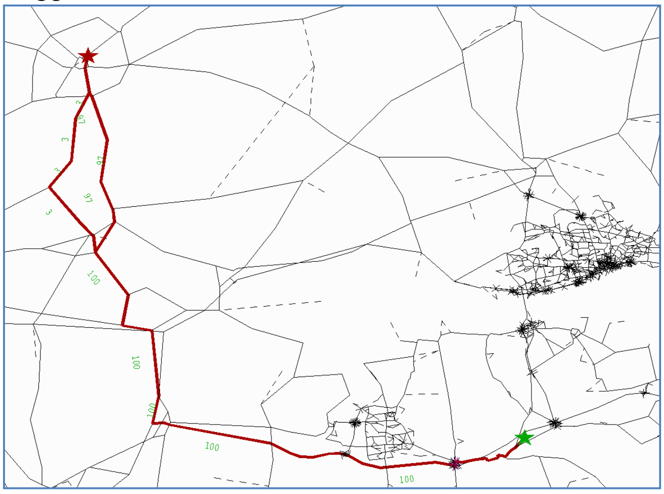


Humberside Airport to Walkington

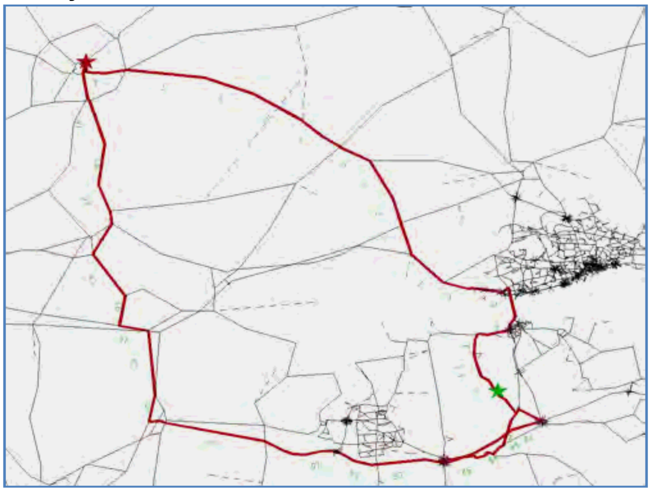


Trips to York

Brigg to York

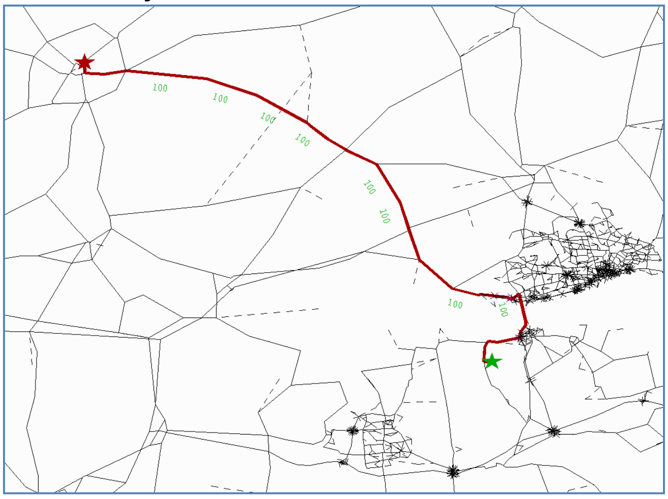


Saxby Road B1204 to York



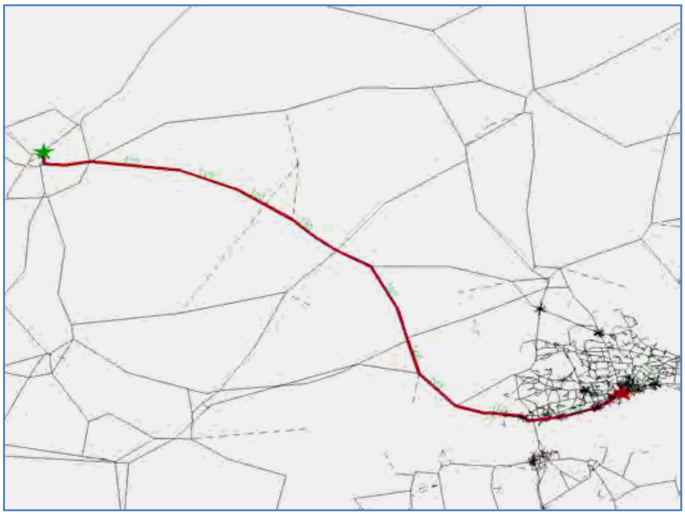
Capabilities on project:
Transportation

South Ferriby to York

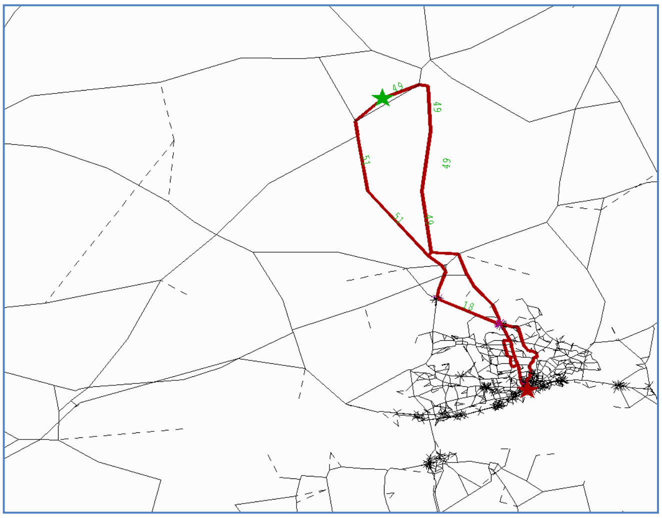


Non Cross Humber Movements

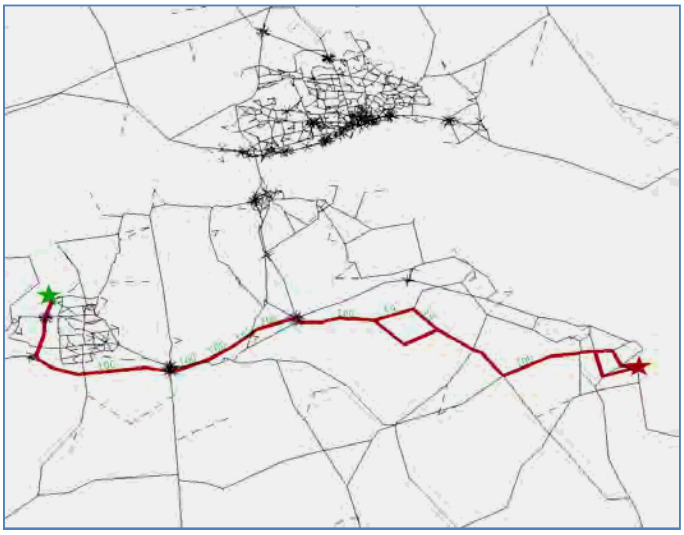
York to Hull



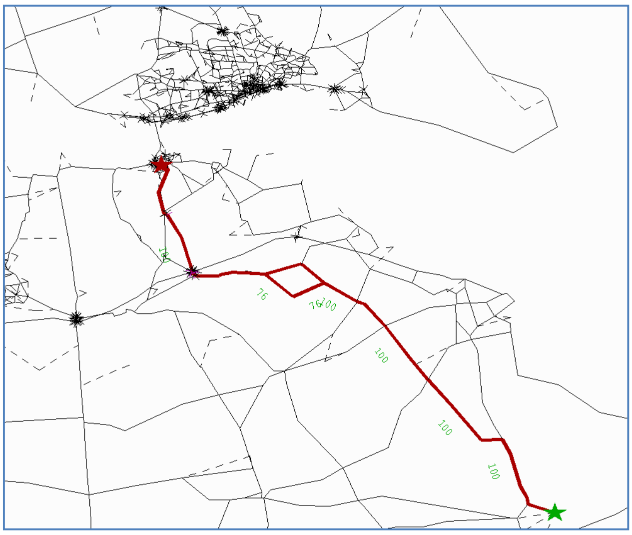
Driffield to Hull



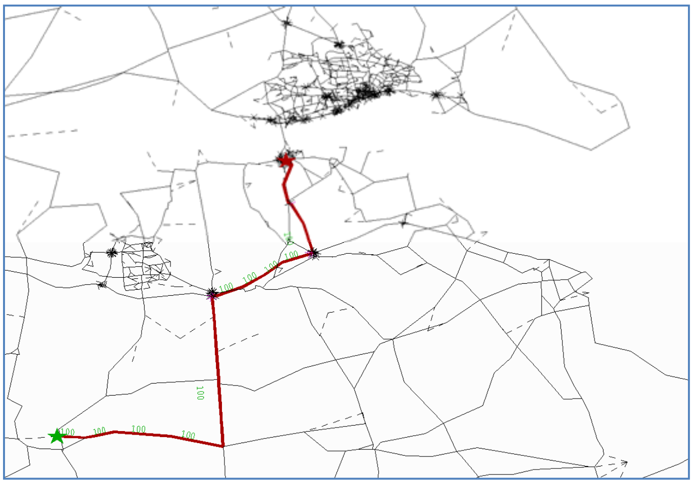
Scunthorpe to Cleethorpes



Louth to Barton Upon Humber



Gainsborough to Barton Upon Humber



Capabilities on project:
Transportation