TRANSPORT FOR LONDON

RIVER CROSSINGS: SILVERTOWN TUNNEL

SUPPORTING TECHNICAL DOCUMENTATION

BASE YEAR MODEL AUDIT

Steer Davies Gleave

October 2014

This report provides an independent review of TfL's 2012 base year assignment model. The main purpose of the review was to determine the suitability of the base year model in assessing the impacts of potential river crossing schemes in East and South East London.

This report is part of a wider suite of documents which outline our approach to traffic, environmental, optioneering and engineering disciplines, amongst others. We would like to know if you have any comments on our approach to this work. To give us your views, please respond to our consultation at www.tfl.gov.uk/silvertown-tunnel

Please note that consultation on the Silvertown Tunnel is running from October – December 2014.

River Crossings Modelling Review

Base Year Model Audit

Report

May 2014

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1 Introduction

1.1 In August 2013, Steer Davies Gleave responded to the brief from Transport for London (TfL) to review the suitability of the River Crossings Model in assessing the impacts of River Crossing options in East and south-east London.

1.2 Steer Davies Gleave was successfully appointed by Transport for London, together with the London Boroughs of Barking, Bexley, Greenwich, Newham and Tower Hamlets in October 2013 to carry out an **independent review** the River Crossings Model, primarily developed by Mott MacDonald.

Study Background

1.3 There has been a lot of development earmarked for south-east (and East) London by 2031. To support this growth, there has been substantial investment in Public Transport – including the extension and improved connectivity of the Docklands Light Railway (DLR); the construction of Crossrail stations extending to Woolwich Arsenal and Abbey Wood; the Emirates Airline; improvements in London Overground and river boat services.

1.4 However, investments in improving highway capacity have not kept up with demand. As a result, the increased congestion has impacted negatively on businesses and freight movement across London. The main river crossings – the Blackwall Tunnel, Rotherhithe Tunnel, the Woolwich Ferry and Dartford Crossing are operating at or close to capacity.

1.5 The **Dartford Crossing** (also known as the Queen Elizabeth II Bridge) connects Dartford in the south to Thurrock in the North. The crossing forms part of the M25 orbital and currently operates as a tolled crossing. The crossing is managed by an appointed agency on behalf of the Highways Agency.

1.6 The **Blackwall Tunnel** is a tunnelled crossing underneath the River Thames linking the Royal Borough of Greenwich with the London Borough of Tower Hamlets. The tunnel currently operates as a free crossing for traffic, and connects Central London to the south-east. The tunnel suffers severe tidal congestion, particularly in the peak periods on weekdays with queues on the northbound approach in the morning peak and vice versa in the evening peak periods. The tunnel forms part of the Transport for London Road Network (TLRN) and is managed by TfL.

1.7 The **Woolwich Ferry**, opened in 1889, is a free boat service linking Woolwich and North Woolwich. It provides a useful connection linking the North and South Circular. The ferry provides a useful alternative to the Blackwall Tunnel, particularly for Lorries, as the tunnel has restrictions on vehicle height. In addition, Woolwich Ferry is the only crossing to the east of Tower Bridge that vehicles carrying hazardous loads are permitted to use. The Woolwich Ferry is in the later stages of its life cycle.

Objectives of this Study

1.8 The Mayor has set out proposals to improve the connectivity of River Crossings in London. The proposals include:

- Constructing a new tolled tunnelled crossing linking Silvertown to the Greenwich Peninsula,
- Introducing a new user charge at Blackwall Tunnel, and
- Implementing a new toll crossing to replace the Woolwich Ferry.

1.9 Each of these options will have a significant impact on both the local and more strategic highway movements across the East London boroughs, particularly in Tower Hamlets, Newham, Greenwich, Barking and Bexley which are in immediate vicinity of the existing and proposed crossings. Clearly each of the boroughs have significant stake in understanding and evaluating what these options would mean for their residents.

1.10 TfL has developed a River Crossings model to assess the impacts of the proposed river crossings on the highway network. The SATURN model is based on the East London Highway Assignment Model (ELHAM). The model has been developed for the morning, inter-peak and evening peak periods.

1.11 The objectives of this study are to:

- Review the **robustness of the River Crossings model** to forecasting demand across the crossings,
- Review the **reliability and scope of count data** collected for use in calibrating and validating the model, and
- Provide an **independent audit** to assure the affected boroughs that the model developed is fit for purpose and has been developed in accordance with standard industry guidance and best practice.

Phased Audit

1.12 The model review was intended to be undertaken in two sub-phases:

- **Phase 1a** – Review of the Base Year Model
- **Phase 1b** – Review of the Future Year Reference Case Model

1.13 This report documents our review of the base year model – i.e. **for Phase 1a ONLY**.

1.14 This document comprises five chapters of which this chapter is the introduction. The remaining chapters are as follows:

- **Chapter Two** sets out our summary and comment on model development;
- **Chapter Three** sets out our review of base year model calibration and validation;
- **Chapter Four** discusses general model performance; and
- **Chapter Five** concludes our review of the suitability of the base year River Crossings model to be used as the basis for assessment of future options.

2 Model Development

2.1 The model development and validation for the base year has been documented in a report published by Mott MacDonald in February 2014 titled "*Base Year Development and Validation Report*" (Mott MacDonald, February 2014). Steer Davies Gleave has also received the full model files for the River Crossings Model.

East London Highway Assignment Model (ELHAM)

2.2 The 2009 ELHAM Base Year model (Production Version 2) was used as a starting point in developing the River Crossings Base Year. Development of ELHAM prior to Product Version 2 has not been considered as part of the current model audit.

2.3 This model was updated to a 2012 base for the River Crossings model and included the following steps:

- Updates to the model network to include schemes in the East London area which had been delivered since 2009. A list of changes is provided in Table 5.9 of the Model Validation Report (MVR) and consists of changes to junction operation rather than major new route opportunities.
- Updates to the demand matrices to include trips associated with housing and employment developments, completed since 2009. Forecasts of trip generation have been derived from a total of 10,167 new dwellings, spread over 23 sites ranging from 2,821 new dwellings at Isle of Dogs down to just 14 new homes at Euston. Similarly, trips have been added for different types of employment development, across 36 sites. In both cases, trip generation rates have been derived using TRAVL.
- Introduction of an adjustment to the modelled capacity of existing river crossings to match observed data. Constraints on capacity are applied to Blackwall Tunnel, Rotherhithe Tunnel, Woolwich Ferry, Dartford Crossing and Tower Bridge.
- Significant enhancements have been made to the original ELHAM matrices resulting in an increase from 1,471 zones to 2,448 zones. The main enhancements related to the reliability of trips with an origin within an enclosure when compared to LTS highway assignment matrices.
- External to external trips, with both an origin and destination outside the M25, are taken from the assignment trip matrices of the Highways Agency M25 Assignment Model.
- The resulting prior matrices were then put through a matrix estimation process, for each vehicle type separately, using all counts at all screenlines and enclosures, including the River Thames screenline.

2.4 It is worth noting that no background growth has been applied to the prior matrices between 2009 and 2012. This decision was based on observed counts at 16 sites (detailed in Table 6.10 of the MVR).

Model Parameters

Peak Periods

2.5 The model time periods used are consistent with time periods for all highway assignment models developed by TfL. The time periods in the model are:

- Morning Peak - 08:00–09:00h
- Inter-peak – average hour 10:00h–16:00h
- Evening Peak – 17:00–18:00h

2.6 There is no evidence provided to support that the AM and PM peaks are represented by the hours identified above, but there is no reason to doubt their suitability given the consistency with other HAMs.

User Class Definitions

2.7 There are five user classes in the River Crossings model. These are consistent with the user class definitions in ELHAM. These are:

- Cars – in work time (IWT)
- Cars – out of work time (OWT)
- Taxis
- Light Goods Vehicles (LGVs)
- Ordinary Goods Vehicles (OGVs)

2.8 The OWT user class includes the commute trip.

2.9 All user classes except OGVs have a PCU value of 1; OGVs have a PCU value of 2. Buses were assigned as fixed flows on set routes in the model.

Generalised Cost Parameters & Values of Time

The generalised cost parameters for distance (measured in pence per kilometre, PPK) and time (measured in pence per minute, PPM) are summarised in

2.10 Table 2.1. The generalised cost parameters are based on WebTAG values, but adjusted according to guidance to account for local vehicle occupancy and trip purpose data taken from the HAM roadside interviews, and local average speeds.

2.11 Having reviewed the process for adjusting values for local conditions[1], we conclude that these parameters are appropriate for the River Crossings model.

[1] MVA Technical Note 64, TfL Common Approach to Gravity Modelling – Generalised Cost Parameter Values (19 April 2013)

TABLE 2.1 GENERALISED COST PARAMETERS (2009 PRICES, 2012 VALUES)

	AM Peak		Inter-peak		Evening peak	
	PPM	PPK	PPM	PPK	PPM	PPK
UC 1	13.49	8.51	14.41	8.06	14.64	8.51
UC 2	54.58	15.22	55.56	14.70	56.54	15.48
UC 3	54.58	8.06	55.56	7.67	56.54	8.06
UC 4	21.75	17.55	21.38	16.88	22.73	17.28
UC 5	36.26	39.25	36.26	38.43	36.26	38.70

Tolls on the Dartford Crossing

2.12 Since November 2008, local residents who most likely need to use the Dartford Crossing on a regular basis have been able to register for reduced toll charges. An up-front annual charge (currently £10) pays for the first 50 crossings, and also allows additional crossings to be made in the same calendar year for a reduced fee (currently 20p).

2.13 In addition, there are regular users who receive discounts through the DART-Tag system and some users are exempt. Furthermore, the difference in charges between light and heavy goods vehicles is not entirely consistent with the modelled user class definitions.

2.14 Each of these issues has been taken into account to derive adjustments to advertised toll values to apply to the model. These are indicated in Table 2.2.

TABLE 2.2 DARTFORD CROSSING TOLLS (2009 PRICES, 2012 VALUES)

		Cars	Vans	Goods Vehicles
Full Advertised Toll	2012	£2.00	£2.50	£5.00
DART-Tag	2012	£1.33	£2.19	£4.33
Modelled Values		£1.56	£2.12	£3.66

Central London Congestion Charge

2.15 The following table shows the Congestion Charge values applied across the day.

TABLE 2.3 CONGESTION CHARGE

User Class	Charge
UC1 – Cars IWT	£1.35
UC2 – Cars OWT	£1.35
UC3 – Taxis	0
UC4 – LGVs	£2.03
UC5 - OGVs	£2.14

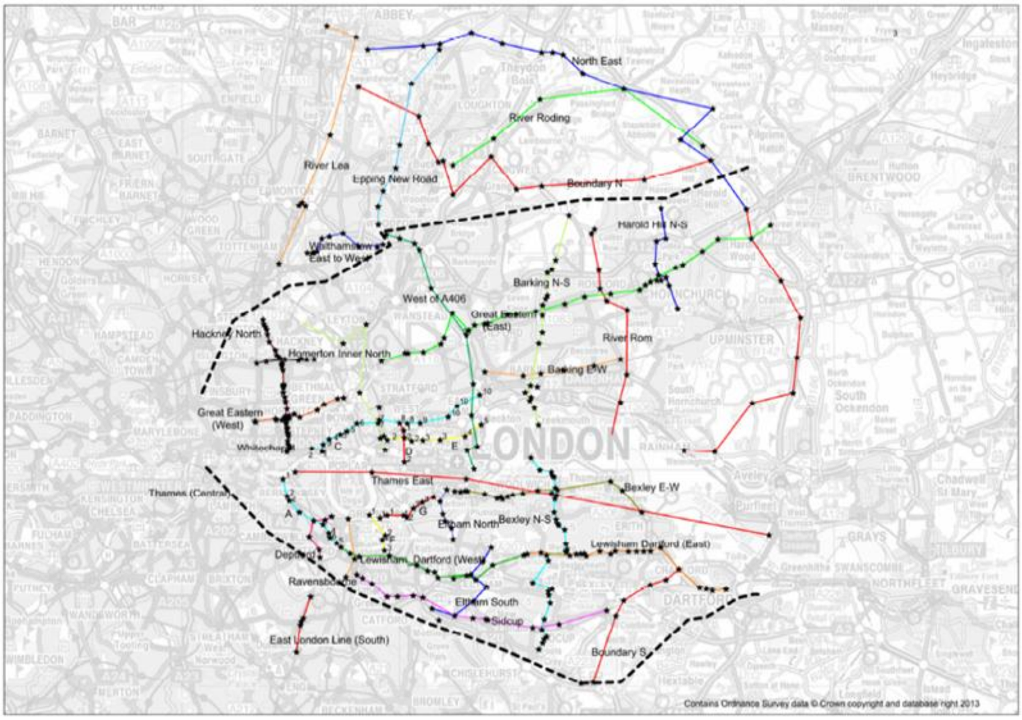
Count Data

Count Sites

2.16 A significant amount of traffic count data has been made available for the model update, providing a comprehensive coverage of routes within East London. Counts data was collected in either 2009 or 2012, and analysis of data from long term continuous automatic counters was used to conclude that there is no reason to apply growth to the 2009 data to reflect 2012 conditions.

2.17 There are 28 separate screenlines, with counts in each direction, providing observed data for 627 individual links. The geographical spread of screenlines is illustrated in Figure 2.1

FIGURE 2.1 TRAFFIC COUNT DATA – SCREENLINE LOCATIONS



2.18 These data are supplemented by a further 11 enclosures, again in both directions, providing count data at an additional 525 locations. Enclosures form part of the Continuous Roadside Interview Survey Programme (CRISP).

2.19 These data have been used for matrix estimation, and matrix updates are carried out separately for cars, taxis, lgvs and ogvs.

2.20 Initially, it was the intention to hold back the River Screenline from the matrix estimation process, to use in flow validation. However, resulting comparison of River Screenline flows was poor, particularly at Rotherhithe, and it was subsequently agreed to include all data for matrix estimation, at the expense of retaining data for independent validation.

Additional Counts – "Borough Counts"

2.21 The coverage of data provided by the screenlines and enclosures was reviewed by TfL and the London Boroughs, resulting in the collection of data at a number of additional locations, referred to as 'Borough Counts'. These reflect 'gap' locations where the Boroughs identified important sections of route not already included as part of the screenline/enclosure data sets.

2.22 This added data for a further 52 location, by direction, given a total of 104 additional link counts for use in the matrix estimation.

2.23 A plan showing the location of all screenline and Borough Count sites, as well as enclosure definitions, is provided at Appendix A.

3 Model Calibration & Validation

Matrix Estimation

3.1 As discussed briefly above, all screenline, enclosure and Borough counts were used for matrix estimation. The change in prior and post matrix estimation matrix totals is +1% across the AM peak and +4% in the Interpeak and PM peak. Table 3.1 provides a summary of numbers of trips by each user class and for each model time period.

TABLE 3.1 MATRIX ESTIMATION - CHANGE IN TRIP MATRIX TOTALS

	Car OWT	Car IWT	Taxi	LGV	OGV	Total
AM Peak						
Prior	4,574,260	789,316	27,340	113,158	92,168	5,596,241
Post	4,604,306	794,439	25,520	118,703	91,220	5,634,189
%Diff	1%	1%	-7%	5%	-1%	1%
Interpeak						
Prior	3,200,063	805,462	36,676	119,191	106,586	4,267978
Post	3,317,029	836,540	37,160	126,788	104,505	4,422,022
%Diff	4%	4%	1%	6%	-2%	4%
PM Peak						
Prior	4,488,779	615,329	41,921	104,922	59,278	5,310,230
Post	4,673,400	641,295	41,082	111,550	54,667	5,521,994
%Diff	4%	4%	-2%	6%	-8%	4%

3.2 At an individual level, we see a 7% reduction in AM peak taxi trips following matrix estimation, but it should be noted that taxis represent less than 0.05% of all vehicle trips.

3.3 In the PM peak, we get a similarly large percentage reduction in OGV trips, but it is again noted that OGVs form less than 1% of total vehicle trips.

3.4 As well as matrix totals the change in trip length distributions following matrix estimation is also considered. Tables 4 to 6 in Appendix I of the MVR provide a summary of changes in mean and standard deviation of trip length, for each time period and each user class. The tables are repeated below.

3.5 All changes are generally within 5% for both mean trip distance and standard deviation, and changes of this size are not considered significant.

TABLE 3.2 AM PEAK COMPARISON OF TRIP LENGTH DISTRIBUTIONS

	Car OWT	Car IWT	Taxi	LGV	OGV	Total
Prior						
Mean	9.80	9.98	4.86	10.28	10.52	9.82
Standard Dev	3.13	3.16	2.21	3.21	3.24	3.13
Post						
Mean	9.52	9.69	4.37	10.17	10.32	9.55
Standard Dev	3.08	3.11	2.09	3.19	3.21	3.09
%Diff						
Mean	-2.9%	-2.9%	-10.2%	-1.1%	-1.9%	-2.7%
Standard Dev	-1.5%	-1.5%	-5.2%	-0.5%	-1.0%	-1.4%

TABLE 3.3 INTERPEAK COMPARISON OF TRIP LENGTH DISTRIBUTIONS

	Car OWT	Car IWT	Taxi	LGV	OGV	Total
Prior						
Mean	8.55	8.47	4.27	9.55	10.05	8.63
Standard Dev	2.92	2.91	2.07	3.09	3.17	2.94
Post						
Mean	8.29	8.29	4.09	9.52	19.77	8.41
Standard Dev	2.8	2.88	2.02	3.08	3.13	2.90
%Diff						
Mean	-3.0%	-2.1%	-4.2%	-0.4%	-2.8%	-2.6%
Standard Dev	-1.5%	-1.1%	-2.1%	-0.2%	-1.4%	-1.3%

TABLE 3.4 PM PEAK COMPARISON OF TRIP LENGTH DISTRIBUTIONS

	Car OWT	Car IWT	Taxi	LGV	OGV	Total
Prior						
Mean	9.84	10.02	4.30	10.56	9.30	9.73
Standard Dev	3.14	3.17	2.07	3.25	3.05	3.12
Post						
Mean	9.61	9.77	3.93	10.48	9.37	9.53
Standard Dev	3.10	3.13	1.98	3.24	3.06	3.09
%Diff						
Mean	-2.3%	-2.4%	-8.7%	-0.7%	-0.7%	-2.0%
Standard Dev	-1.2%	-1.2%	-4.4%	-0.4%	-0.3%	-1.0%

3.6 The greatest changes are seen for AM peak taxis, which reflect the change on matrix totals for this user class in Table 3.1. Although Table 3.1 also identified a significant change in OGV trips in the PM peak, average trip lengths and standard deviations retain a close relationship for this user class.

3.7 The change in the numbers of trips and trip length distributions as a result of the matrix estimation process is reasonable and offers no cause for concern.

Model Validation Criteria

3.8 At the time of the model update, flow validation criteria were defined in WebTAG unit 3.19, which was replaced in October 2013 by TAG Unit M3.1. The criteria are repeated below for link flows, screenline totals and journey time comparisons and it is noted that paragraph 3.2.7 of Unit M3.1 states that "link flows that meet either criterion should be regarded as satisfactory".

TABLE 3.5 LINK FLOW VALIDATION CRITERIA AND ACCEPTABILITY GUIDELINES

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h Individual flows within 15% of counts for flows from 700 to 2,700 veh/h Individual flows within 400 veh/h of counts for flows more than 2.700 veh/h	>85% of cases
2	GEH <5 for individual flows	>85% cases

TABLE 3.6 SCREENLINE FLOW VALIDATION CRITERION AND ACCEPTABILITY GUIDELINE

Criteria	Acceptability Guideline
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines

TABLE 3.7 JOURNEY TIME VALIDATION CRITERION AND ACCEPTABILITY GUIDELINE

Criteria	Acceptability Guideline
Modelled times along routes should be 15% of surveyed times (or 1 minute, if higher)	>85% of routes

3.9 WebTAG notes that the acceptability guidelines should be applied to both link flow and turning counts, but acknowledges that guidelines may be difficult to achieve for turning movements.

Model Flow Calibration

3.10 The MVR provides comparisons of modelled flows to screenlines/ enclosure/ Borough count locations for both the scenario where the River Thames screenline was included or excluded from matrix estimation. It is understood that the final version of the model agreed with TfL reflects the results with all counts, including the River Thames screenline, and it is that version that is reported here.

3.11 Link flow comparisons are reported in section 10.3.2 of the MVR, and particularly in Table 10.8 which is repeated in Appendix B.

3.12 A summary of the link flow comparisons is shown in Table 3.8, along with calculation of the overall results for all link count locations.

TABLE 3.8 SUMMARY OF LINK FLOW CALIBRATION RESULTS

Count Type	No. of sites	AM		IP		PM	
		Flow criteria	GEH	Flow criteria	GEH	Flow criteria	GEH
Screenline	513	73%	67%	82%	78%	68%	65%
Enclosure	466	76%	59%	86%	67%	72%	55%
Borough	104	82%	83%	88%	85%	77%	73%
All	1083	75%	65%	84%	74%	71%	61%

3.13 It is seen that results are strongest for the Borough Count locations, with relatively similar results displayed for screenline and enclosure count locations.

3.14 Across all screenlines, the percentage of screenline flow comparisons achieving the WebTAG acceptability guideline is as follows:

- AM Peak 62%
- Interpeak 89%
- PM Peak 74%

3.15 It is clear that the results outlined above do not meet the acceptability guidelines contained in TAG Unit M3.1. However, it could be argued that the results are as good as we might expect for a model of this size and complexity.

3.16 The results have been benchmarked against the results achieved for four out of the other 5 HAMs for which information is available. The comparison is shown below. It can be seen that compliance with WebTAG acceptability guidelines is rarely achieved across any of the HAMs and it is also noted that the River Crossing model results generally represent an improvement on the ELHAM results from which it has been derived.

3.17 For this reason, it is concluded that calibration of link flow is acceptable.

TABLE 3.9 COMPARISON OF LINK FLOW CALIBRATION TO OTHER HAMS

	CLoHAM	WeLHAM	SoLHAM	ELHAM	River Crossing
Number of Screenlines	66	62	68	64	
Number of Counts	1031	906	1169	792	1083
AM Peak					
Links – WebTAG Flow Criteria	84%	69%	63%	61%	75%
Links – GEH<5	82%	68%	57%	60%	65%
Screenline – Flow Diff <5%	52%	77%	69%	86%	62%
Enclosure – Flow Diff <5%	39%	75%	68%	73%	
Interpeak					
Links – WebTAG Flow Criteria	84%	80%	73%	62%	84%
Links – GEH<5	81%	74%	66%	59%	74%
Screenline – Flow Diff <5%	48%	63%	79%	78%	89%
Enclosure – Flow Diff <5%	39%	56%	71%	55%	
PM Peak					
Links – WebTAG Flow Criteria	85%	68%	66%	54%	71%
Links – GEH<5	82%	64%	60%	53%	61%
Screenline – Flow Diff <5%	45%	77%	75%	88%	74%
Enclosure – Flow Diff <5%	29%	81%	61%	68%	

Journey Time Validation

3.18 A comparison of modelled and observed journey times has been made across a total of 62 key routes, which are illustrated in Figure 3.1.

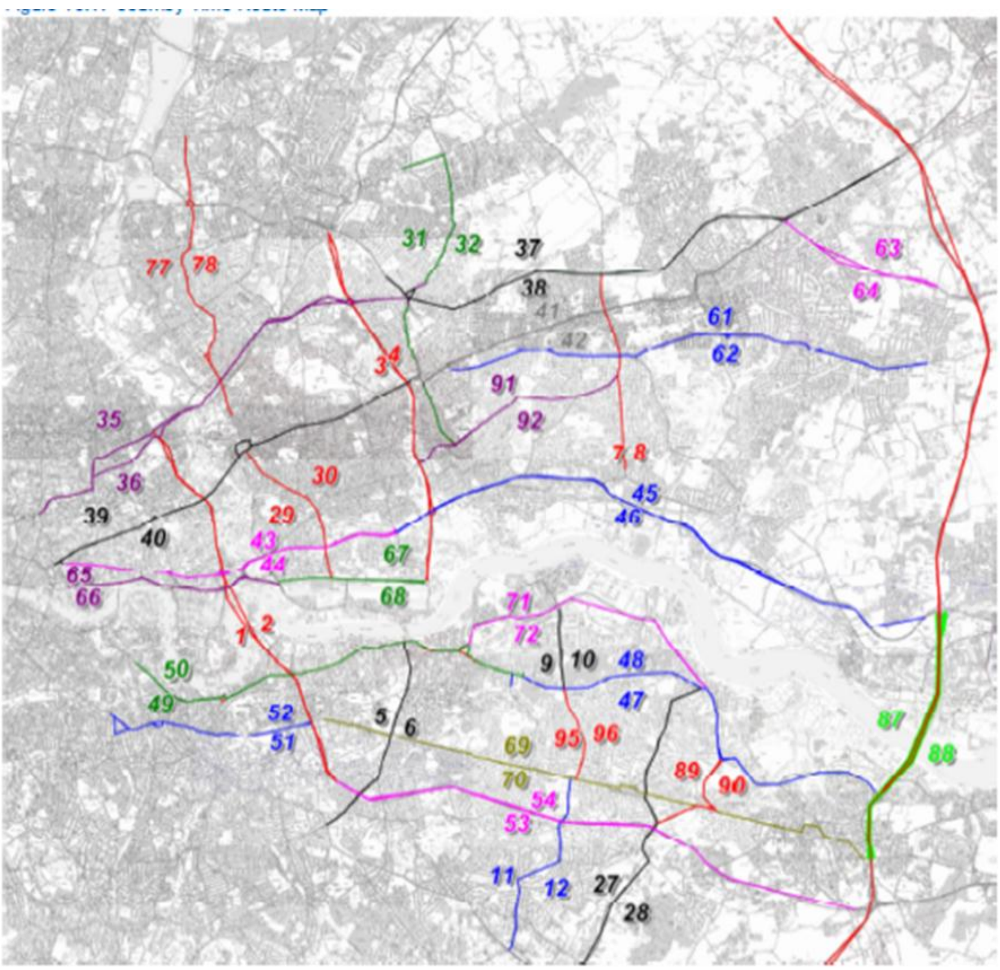
3.19 Observed journey times along each route have been derived from TrafficMaster data. The data represents 2011 conditions and there is no reason to discount the conclusion that similar conditions would be observed in 2012, on the basis that there had been no growth in traffic levels between 2009 and 2012.

3.20 Key routes in relation to any study of new river crossings are Blackwall Tunnel (Routes 1&2) and Dartford Crossing (Routes 87&88). No data has been derived for cross river routes using Rotherhithe Tunnel.

3.21 A validation of TrafficMaster data has been carried out against Moving Car Observer (MCO) surveys along the Blackwall Tunnel routes. It is reported that correlation is good except in the PM peak in the northbound direction. As a result, the TrafficMaster data was replaced with MCO records for this particular PM northbound route.

3.22 Further evidence that TrafficMaster data is robust and is fit for using in future HAM journey time validation has been provided[2], based on detailed analysis against MCO data for 16 routes in the South London HAM model area.

FIGURE 3.1 JOURNEY TIME ROUTES MAP



3.23 WebTAG guidelines for journey time acceptability state that modelled times across routes should be within 15% or one minute of observed times, or whichever is greater, for more than 85% of route comparisons.

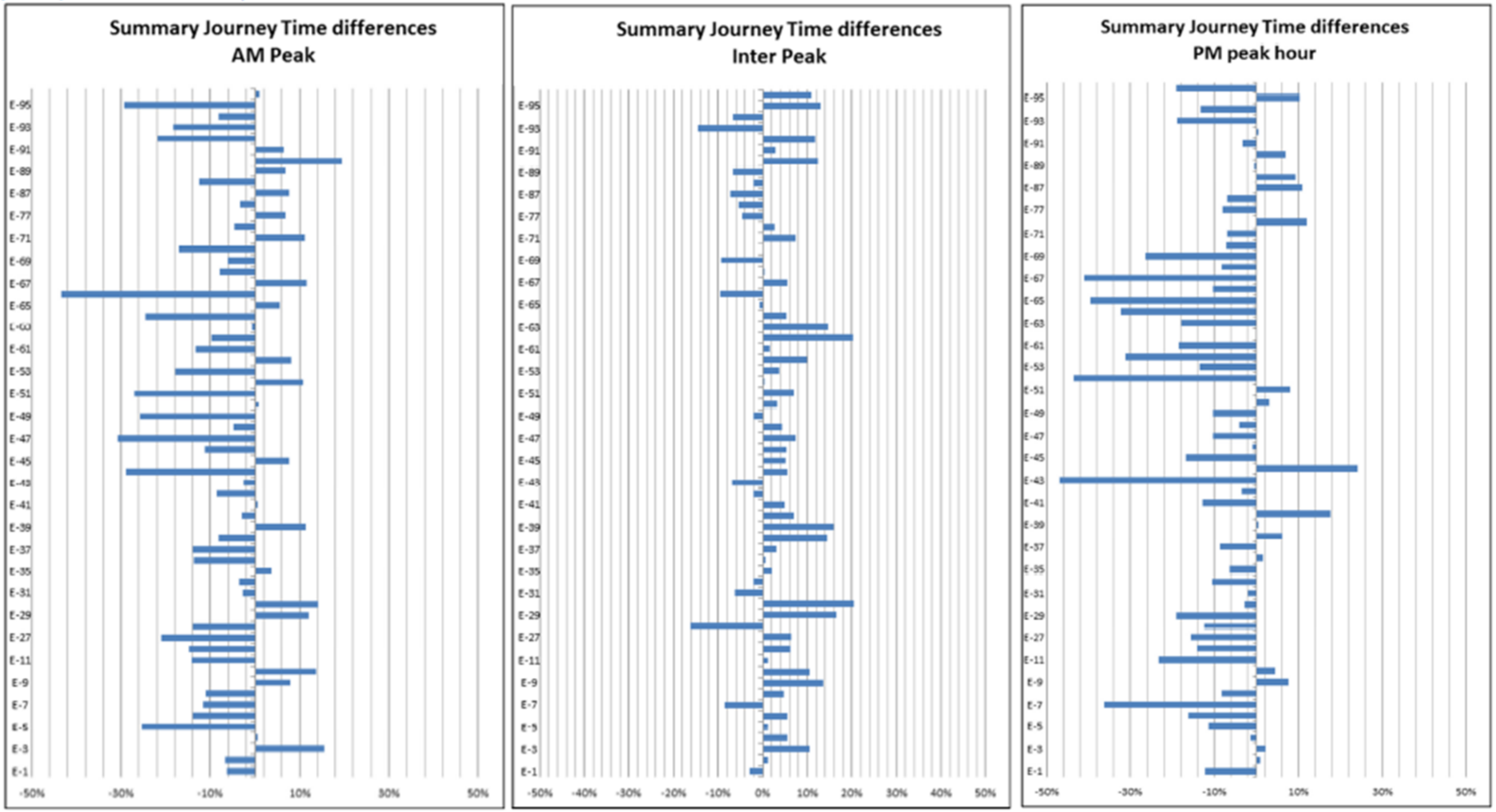
3.24 Validation results are shown in Figure 3.2 for each of the AM Peak, Interpeak and PM Peak.

3.25 Although 90% of routes achieve the acceptability criteria in the interpeak, the results are lower for the AM peak (76%) and PM peak (68%).

3.26 Having said that, the key Blackwall Tunnel and Dartford Crossing routes both meet the criteria in each direction and for each peak.

[2] Comparison between TrafficMaster and Moving Car Observer Journey Time, Discussion Note – TfL Planning Strategic Analysis

FIGURE 3.2 VALIDATION RESULTS – JOURNEY TIME COMPARISONS



3.27 Plots showing the comparison of modelled times against observed times for the Blackwall Tunnel and Dartford Crossing routes are provided in Appendix L2 of the MVR, and repeated here at Appendix C.

3.28 For Blackwall Tunnel the match of end-to-end results is very good. Northbound, the modelled times are slightly lower throughout, but much closer in the southbound direction.

3.29 In the PM peak, the model appears slower for much of the southbound route, but this is a result of a specific delay early in the route, beyond which point the model is then relatively faster to the extent that the end-to-end comparison is very close.

3.30 A very similar pattern of results is observed for the Dartford Crossing route, even to the extent that there is a delay along the route shown in the southbound direction in the PM peak.

Independent Flow Validation

3.31 Independent turning count data at major junction locations show in Figure 3.3 have been used as an additional check on model flow validation. Counts were taken on a single day and factored to an average week day using 5-day November 2012 counts on adjacent links.

3.32 It had been planned to include more than the 12 counts shown but as a result of camera malfunctions or other similar incidents, numerous sites had to be re-surveyed and could no longer be factored to 5-day weekday averages as planned.

3.33 The relatively small sample still provides a relatively good coverage of approach roads to the main crossing points, however there are no validation turn counts either side of Rotherhithe, nor on the main southern approach to Blackwall Tunnel. These locations, shown as dotted circles on Figure 3.3, would have been nice to have, and would have strengthened the results.

3.34 Traffic counts were undertaken on the southern approach to Blackwall Tunnel but, unfortunately, these needed to be resurveyed due to reasons described in 3.32 above, and could not be consistently factored to November 2012 values.

FIGURE 3.3 TRAFFIC COUNTS FOR VALIDATION

3.35 The WebTAG acceptability criteria has been applied to turning counts as shown in Table 3.10

TABLE 3.10 TURNING FLOW VALIDATION

	AM		IP		PM	
	Flow criteria	GEH	Flow criteria	GEH	Flow criteria	GEH
Turning Flows	85%	56%	88%	55%	81%	45%

3.36 Comparisons of absolute flow values are good, but the results are poor when comparing against GEH<5. Given that TAG Unit M3.1 states that the “two measures (flow differences and GAH) are broadly consistent and link flows that meet either criterion should be regarded as satisfactory”, these results are considered acceptable.

4 Model Performance

4.1 One key feature of a robust model is how it represents routing in the base year model in comparison to existing conditions, particularly along key corridors. Steer Davies Gleave has reviewed the routings of trips along the main river crossings in East London.

4.2 TfL has provided Road Side Interview (RSI) plots showing the origin and destination of trips using Blackwall Tunnel and Woolwich Ferry for all time periods, but in the northbound direction only. These have been used to inform and sense-check routing in the base model. It is noted that he plots represent survey responses over a 3-hour period. They are not expanded to counts and we are advised that the sample would be small if restricted to the peak hour. As such, the plots are used as a general check against distribution patterns, rather than actual numbers of trips.

Blackwall Tunnel

4.3 The Blackwall Tunnel has been modelled with a capacity of 3,236pcu/hour in the northbound direction for all time periods. Southbound capacity is higher and has small variations between time periods. The southbound capacity is modelled as 3,842 pcu/hour, 3,839 pcu/hour and 3,719 pcu/hour in the AM, Interpeak and PM respectively.

4.4 The modelled capacities reflect observed conditions, derived from 5–day manual classified counts (MCC) taken in November 2012. This approach is sound, and is preferable to simple application of generic capacities.

4.5 Table 4.1 shows that cars (user classes 1 and 2) make up the largest proportion of vehicles using the tunnel. The distribution of user classes across time periods is relatively consistent, although we see a higher proportion of cars northbound in the PM peak and fewer OGVs in the PM peak in each direction.

4.6 The main areas of congestion are northbound in the AM peak and southbound in the PM peak where demand flows are significantly higher than both actual flows and modelled capacity. This is broadly consistent with observed conditions through the Tunnel.

4.7 Related to this, the model shows large flows left over from the pre-peak in the northbound morning peak and southbound evening peak. This is to be expected because of tidal flows and the level of congestion in the tunnel during these time periods.

4.8 Bus Route 108 from Lewisham to Stratford the currently the only bus route to use the tunnel. The base year model shows bus flows in the southbound direction, but bus flows are missing in the northbound direction of the tunnel. Northbound bus flows need to be added to future model versions.

TABLE 4.1 MODEL DEMAND AND ACTUAL FLOW THROUGH BLACKWALL TUNNEL (PCUS)

	AM Peak			Interpeak			PM Peak		
	Demand	Actual	% Demand	Demand	Actual	% Demand	Demand	Actual	% Demand
Northbound									
Fixed	533	409	12.6%	17	17	0.6%	105	99	3.4%
UC1	1966	1507	46.6%	1466	1460	50.0%	1934	1824	62.5%
UC2	568	436	13.5%	250	249	8.5%	390	368	12.6%
UC3	15	12	0.4%	75	75	2.6%	66	63	2.1%
UC4	641	492	15.2%	527	525	18.0%	398	375	12.9%
UC5	496	380	11.8%	599	597	20.4%	201	189	6.5%
Total	**4220**	**3236**	**100.0%**	**2933**	**2923**	**100.0%**	**3094**	**2919**	**100.0%**
Southbound									
Fixed	134	123	4.3%	53	53	1.7%	1000	704	18.9%
UC1	1480	1364	48.0%	1395	1383	44.3%	2551	1798	48.3%
UC2	356	328	11.6%	336	333	10.7%	625	441	11.8%
UC3	5	5	0.2%	35	35	1.1%	29	21	0.5%
UC4	528	487	17.1%	641	636	20.3%	793	559	15.0%
UC5	578	533	18.8%	691	685	21.9%	279	197	5.3%
Total	**3081**	**2840**	**100.0%**	**3152**	**3125**	**100.0%**	**5278**	**3719**	**100.0%**

4.9 Figures 4.1 to 4.6 show the RSI OD plots and select link analysis for each time period for cars (user class 1) which makes up the largest proportion of trips in the matrix. The flow/routing pattern across the tunnel in the northbound direction is considered reasonable across all time periods.

4.10 However, it is worth noting that the RSI plots show that the Isle of Dogs is a significant destination in the AM and interpeak, and although the select link plots show 18% of trips to the Isle of Dogs this is not easily reflected when shown as a bandwidth in Figure 4.2. In general the pattern of observed trips through Blackwall Tunnel is best matched in the PM peak model.

FIGURE 4.1 AM PEAK RSI DATA FOR BLACKWALL TUNNEL

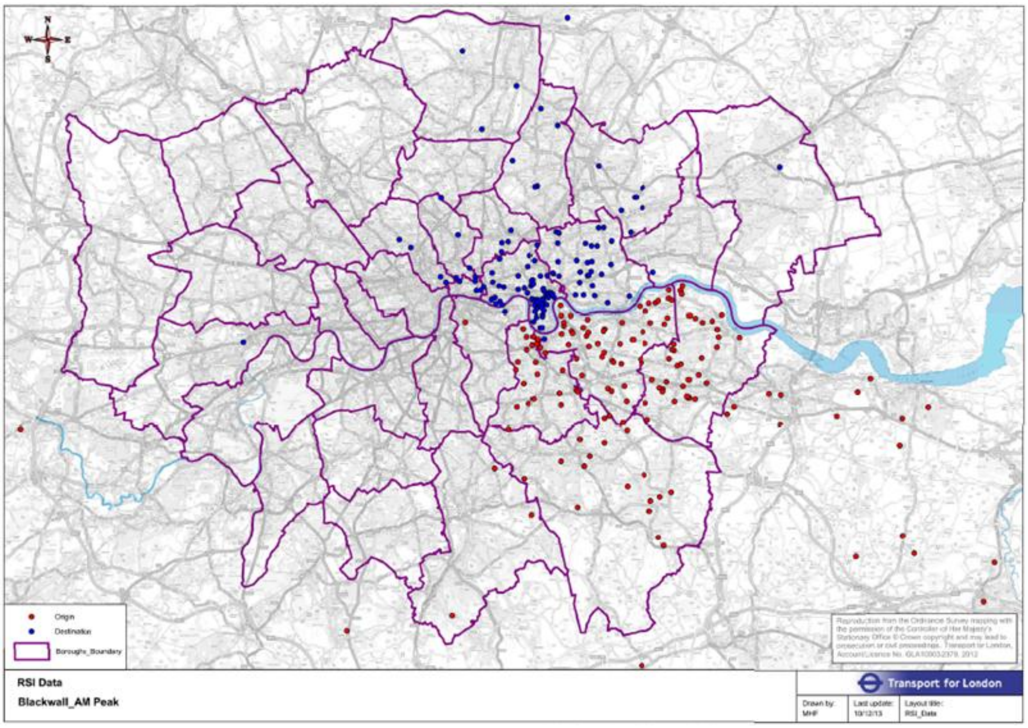


FIGURE 4.2 AM PEAK SELECT LINK ANALYSIS FOR BLACKWALL TUNNEL (NORTHBOUND)

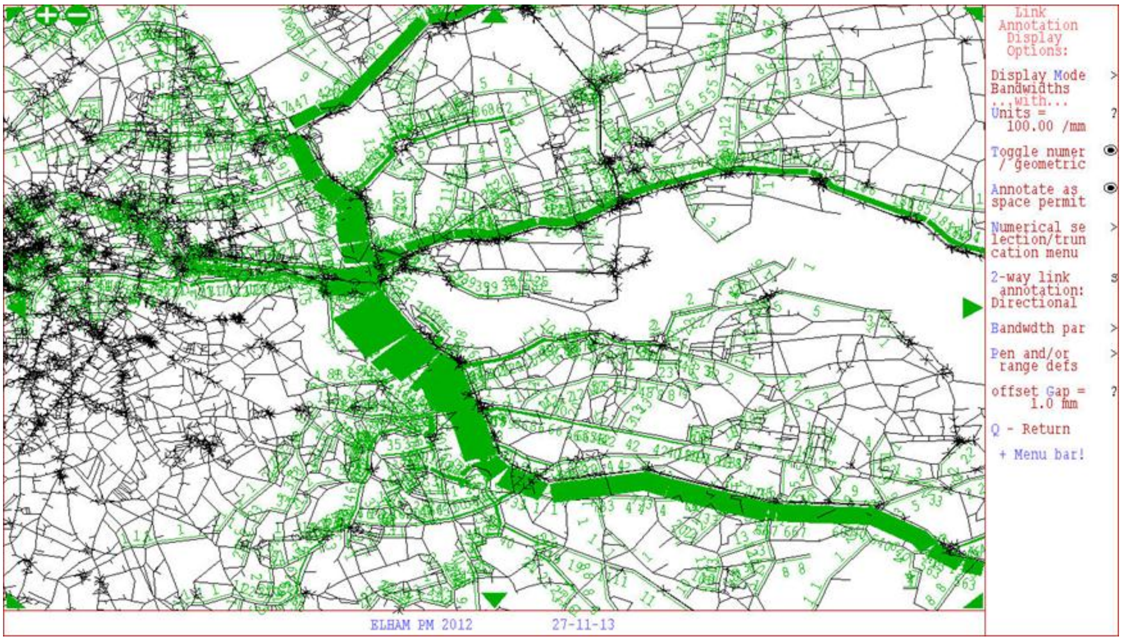


FIGURE 4.3 INTERPEAK RSI DATA OR BLACKWALL TUNNEL

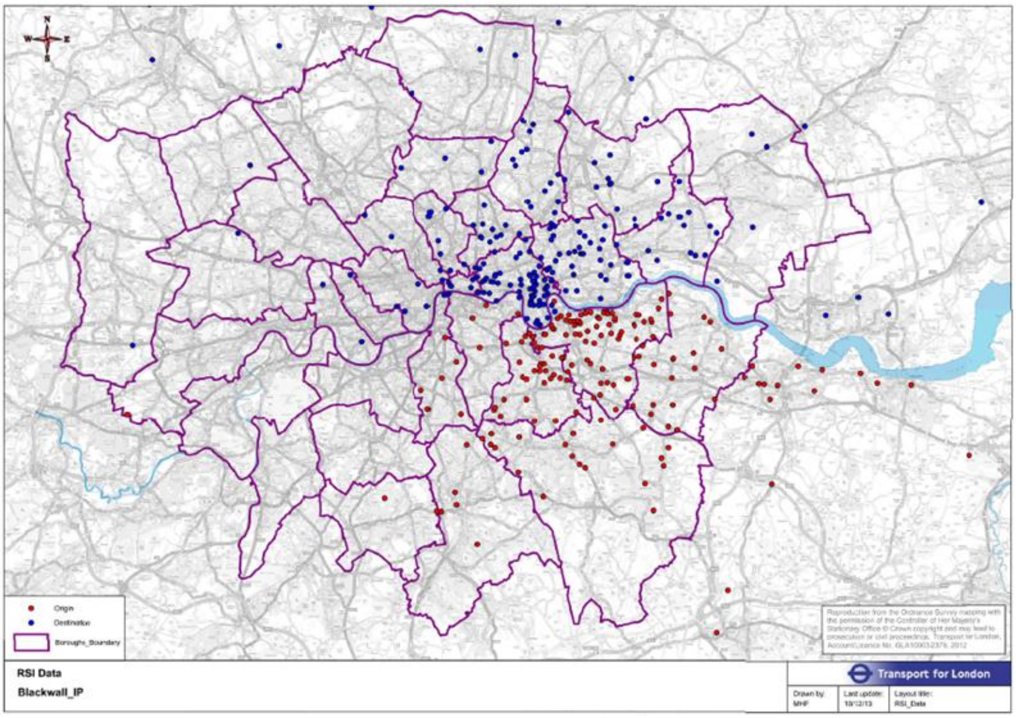


FIGURE 4.4 INTERPEAK SELECT LILNK ANALYSIS FOR BLACKWALL TUNNEL (NORTHBOUND)

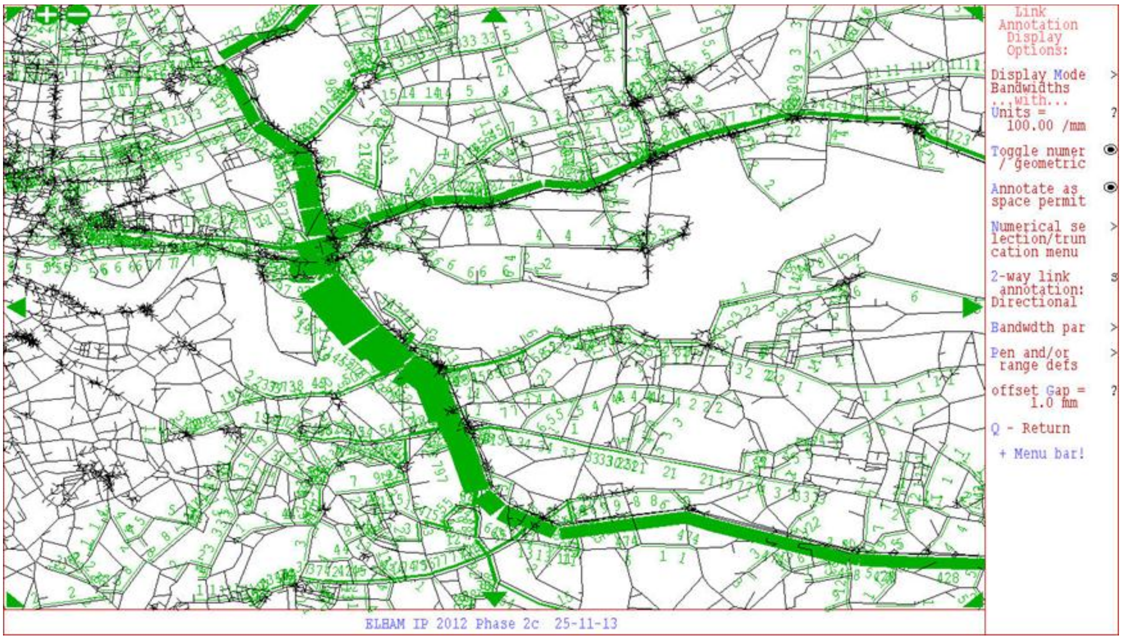


FIGURE 4.5 PM PEAK RSI DATA FOR BLACKWALL TUNNEL

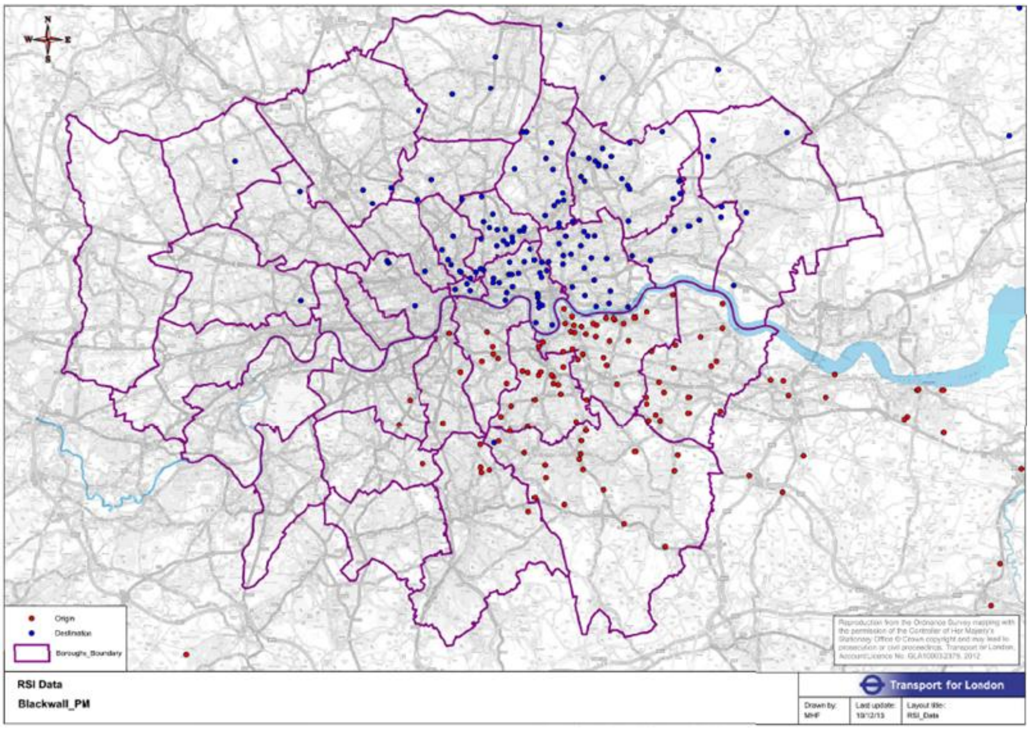
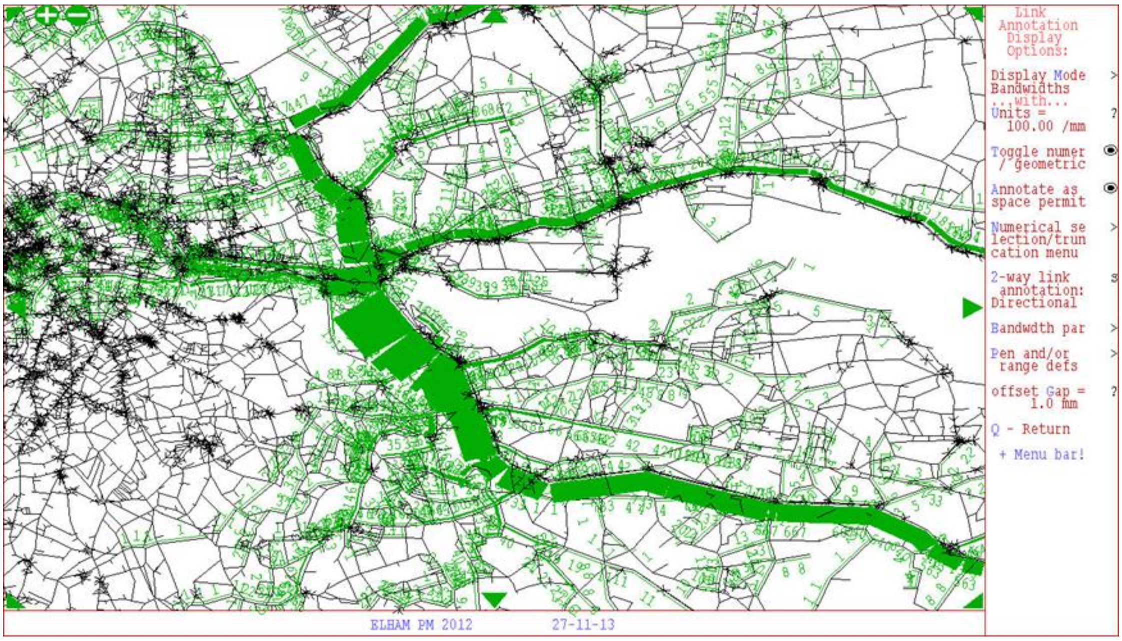


FIGURE 4.6 PM PEAK SELECT LINK ANALYSIS FOR BLACKWALL TUNNEL (NORTHBOUND)



Woolwich Ferry

4.11 The capacity on the Woolwich Ferry is constrained to the physical capacity of the ferry, and takes account of differing numbers of goods vehicles using the ferry during different time periods. Again, these reflect observed capacities and are higher in the PM peak. The ferry provides a crucial alternative to the Blackwall Tunnel, which has restrictions on vehicle type and height.

4.12 Morning peak flows across the ferry are dominated by goods vehicles, particularly in the northbound direction, whereas we see more car trips in the evening peak. The tunnel is shown to be operating at or close to capacity throughout the day and in each direction, but particularly during peak hours.

4.13 As expected, there are very few taxis or cars in work time, using the ferry.

4.14 There are no bus routes across the ferry and the base year model shows no flows in either direction on the Woolwich Ferry.

TABLE 4.2 MODEL DEMAND AND ACTUAL FLOW ACROSS WOOLWICH FERRY (PCUS)

	AM Peak			Interpeak			PM Peak		
	Demand	Actual	% Demand	Demand	Actual	% Demand	Demand	Actual	% Demand
Northbound									
Fixed	21	17	10.0%	0	0	0.0%	2	2	1.5%
UC1	42	33	20.1%	72	72	51.1%	93	91	70.5%
UC2	7	5	3.3%	1	1	0.7%	17	16	12.9%
UC3	3	3	1.4%	1	1	0.7%	1	1	0.8%
UC4	15	12	7.2%	18	18	12.8%	6	6	4.5%
UC5	121	95	57.9%	49	49	34.8%	13	13	9.8%
Total	**209**	**165**	**100.0%**	**141**	**141**	**100.0%**	**132**	**129**	**100.0%**
Southbound									
Fixed	4	4	2.5%	1	0	0.7%	34	24	11.9%
UC1	61	58	38.4%	52	52	38.2%	167	120	58.4%
UC2	2	2	1.3%	2	2	1.5%	17	12	5.9%
UC3	3	3	1.9%	1	1	0.7%	5	4	1.7%
UC4	30	28	18.9%	24	24	17.6%	31	22	10.8%
UC5	59	56	37.1%	56	56	41.2%	32	23	11.2%
Total	**159**	**151**	**100.0%**	**136**	**135**	**100.0%**	**286**	**205**	**100.0%**

4.15 Figures 4.7 to 4.12 show the RSI plots and select link analysis for the morning, evening and inter peak periods. As expected, the RSI data shows that the origin and destination of trips using the ferry are more constrained to the local area and that the ferry caters mostly for trips between the south-east and north-east of the crossing. This observation is also reflected in the select link analysis for all time periods.

FIGURE 4.7 AM PEAK RSI DATA FOR WOOLWICH FERRY

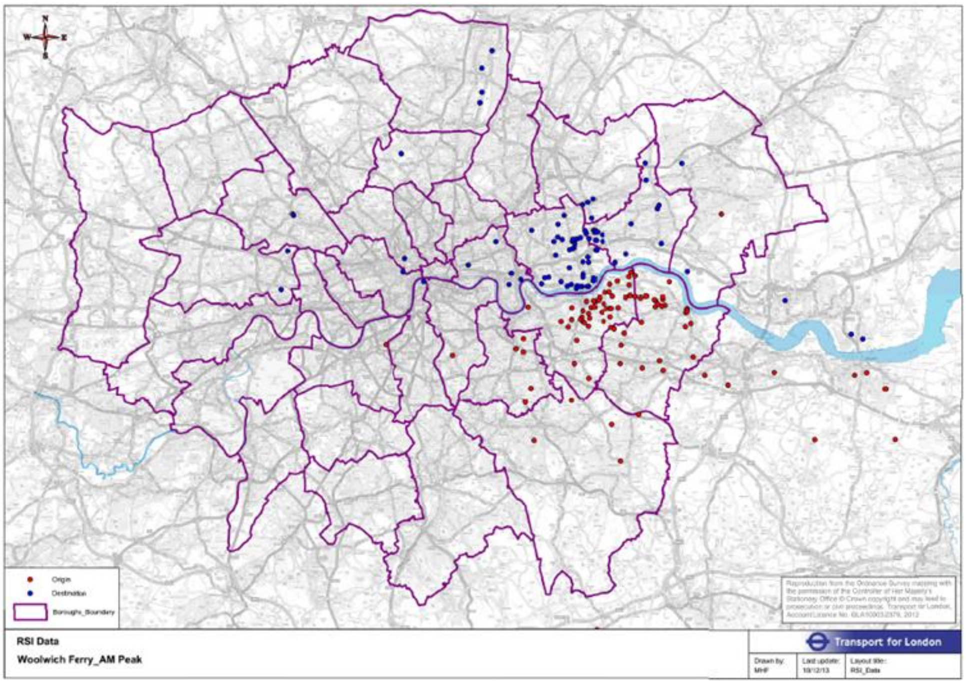


FIGURE 4.8 AM PEAK SELECT LINK ANALYIS FOR WOOLWICH FERRY (NORTHBOUND)

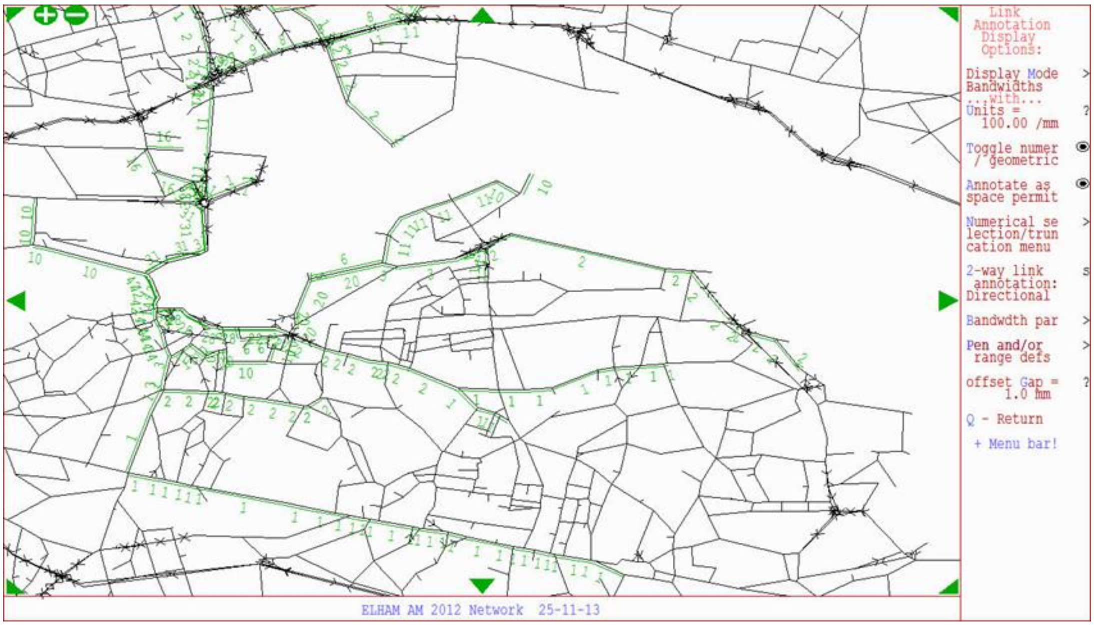


FIGURE 4.9 INTERPEAK RSI DATA FOR WOOLWICH FERRY

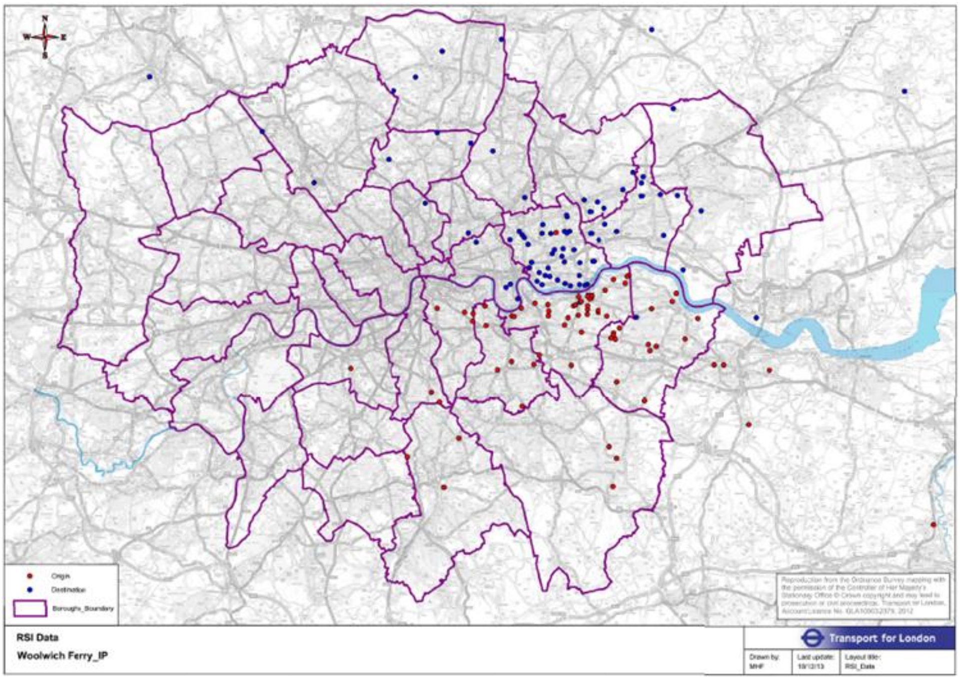


FIGURE 4.10 INTERPEAK SELECT LINK ANALYSIS FOR WOOLWICH FERRY (NORTHBOUND)

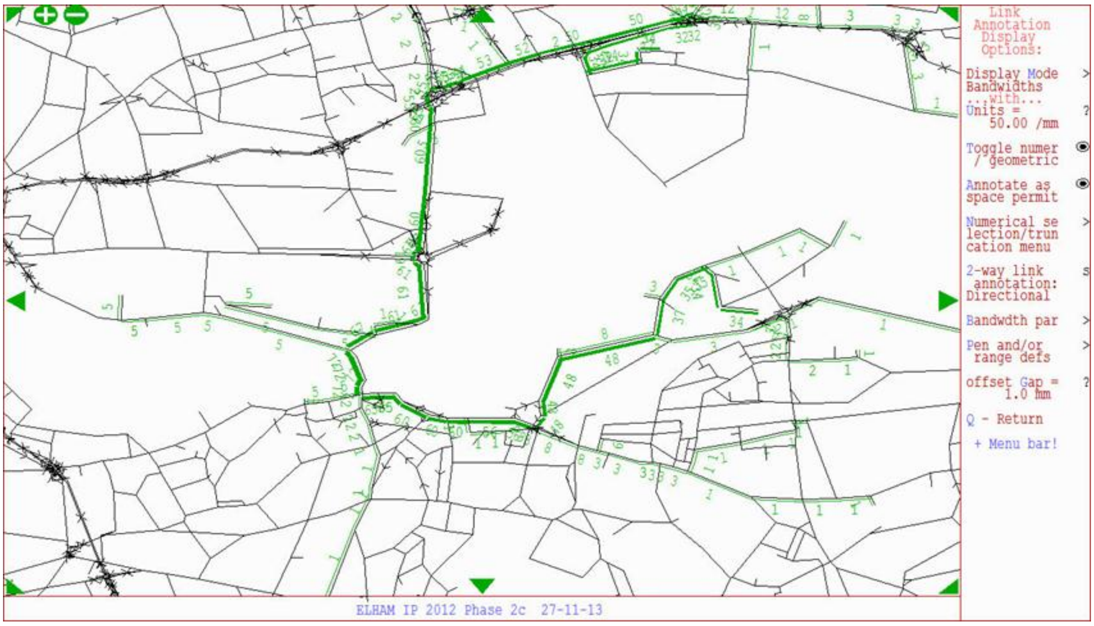


FIGURE 4.11 PM PEAK RSI DATA FOR WOOLWICH FERRY

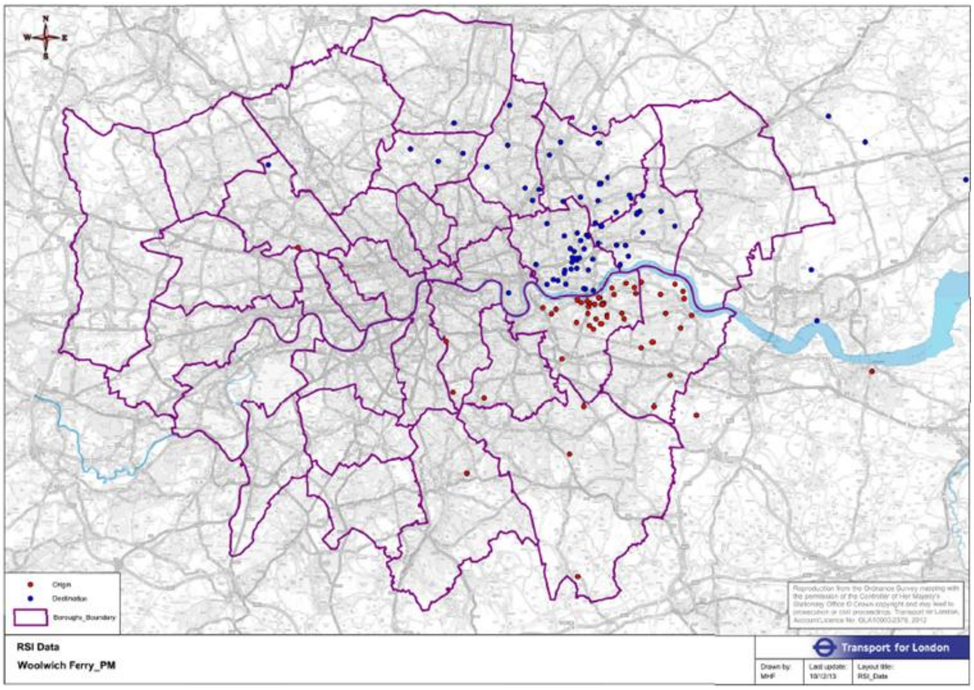
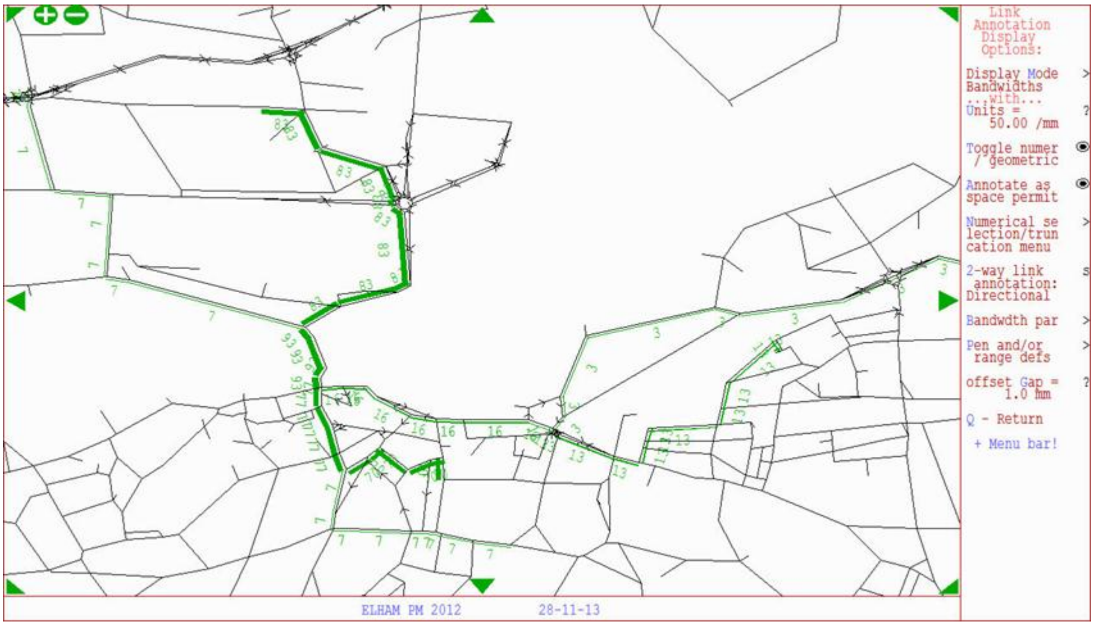


FIGURE 4.12 PM PEAK SELECT LINK ANALYSIS FOR WOOLWICH FERRY (NORTHBOUND)



Dartford Crossing

4.16 The capacity of the crossing ranges from 4,800pcu/hour in the inter peak to 5,400 and 5,500pcu/hour in the morning and evening peak period respectively. As with other crossings, these capacities are based on observed records.

4.17 The model shows the crossing operating at capacity in all peaks. In fact, model flows (actual and demand) are above capacity in the PM peak. Table 4.3 shows the demand and actual flow across the Dartford Crossing.

4.18 The distribution of traffic by user class is very similar between the AM and interpeak hours. However, the PM peak shows a higher proportion of traffic made up of cars (OWT), largely at the expense of reduced OGVs.

4.19 The River Crossings base year model does not show any bus flow on the Dartford Crossing.

TABLE 4.3 MODEL DEMAND AND ACTUAL FLOW ACROSS DARTFORD CROSSINGS (PCUS)

	AM Peak			Interpeak			PM Peak		
	Demand	Actual	% Demand	Demand	Actual	% Demand	Demand	Actual	% Demand
Northbound									
Fixed	12	12	0.2%	20	20	0.4%	122	115	2.1%
UC1	2549	2537	47.9%	1991	1983	41.3%	3159	2984	55.2%
UC2	685	682	12.9%	577	575	12.0%	562	530	9.8%
UC3	4	4	0.1%	2	2	0.0%	2	2	0.0%
UC4	539	536	10.1%	479	477	9.9%	590	557	10.3%
UC5	1536	1529	28.9%	1750	1743	36.3%	1283	1212	22.4%
Total	**5324**	**5299**	**100.0%**	**4819**	**4800**	**100.0%**	**5718**	**5400**	**100.0%**
Southbound									
Fixed	24	24	0.4%	17	17	0.4%	84	82	1.3%
UC1	2384	2356	43.1%	1947	1941	40.6%	3501	3430	56.1%
UC2	559	552	10.1%	601	599	12.5%	728	714	11.7%
UC3	1	1	0.0%	1	1	0.0%	26	25	0.4%
UC4	719	711	13.0%	491	490	10.2%	650	637	10.4%
UC5	1838	1816	33.3%	1742	1737	36.3%	1249	1224	20.0%
Total	**5526**	**5460**	**100.0%**	**4799**	**4785**	**100.0%**	**6239**	**6113**	**100.0%**

Rotherhithe Tunnel

4.20 It is worth noting that the River Crossings is a large model with a wide coverage area (and over 2,400 zones). In the model, the Rotherhithe tunnel is at the boundary of the simulation area and model outputs would need to be interpreted with some caution.

4.21 The capacity in both north and southbound directions is 1210pcu/hour and maintained for all time periods. With the exception of the PM peak in the southbound direction, flows through Rotherhithe are within capacity. It is also noted that the difference between demand flows and actual flows is slight.

4.22 Anecdotal evidence suggests a high level of queuing on approaches to the tunnel, particularly on the southern side at the Jamaica Road junction, and a greater level of difference between demand and actual flows might therefore have been expected. However, further analysis has been undertaken by Mott MacDonald of journey time routes along Jamaica Road. These indicate that although modelled times are generally faster than observed, comparisons along the route pass the validation criterion in all cases except eastbound in the PM peak.

4.23 The demand and actual flows for the Rotherhithe Tunnel are shown in Table 4.4.

4.24 Vehicles wider than 1.98m are restricted from using Rotherhithe tunnel. In the model, this is reflected by the banning of OGVs (user class 5) through the use of time penalties (9999 seconds) in both directions. There is no modelled restriction for wider LGVs. This represents a sensible approach, particularly given the model’s inability to distinguish between vehicles of different widths.

4.25 There are no bus services operating through Rotherhithe tunnel.

TABLE 4.4 MODEL DEMAND AND ACTUAL FLOW THROUGH ROTHERHITHE TUNNEL (PCUS)

	AM Peak			Interpeak			PM Peak		
	Demand	Actual	% Demand	Demand	Actual	% Demand	Demand	Actual	% Demand
Northbound									
Fixed	11	11	1.1%	7	7	0.9%	16	16	1.5%
UC1	591	574	58.2%	413	408	53.7%	650	624	59.0%
UC2	237	230	23.3%	114	112	14.8%	164	157	14.9%
UC3	6	6	0.6%	27	27	3.5%	21	21	1.9%
UC4	170	165	16.7%	207	204	26.9%	251	241	22.8%
UC5	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total	**1015**	**986**	**100.0%**	**769**	**758**	**100.0%**	**1102**	**1059**	**100.0%**
Southbound									
Fixed	26	24	3.1%	7	7	1.2%	13	12	1.0%
UC1	450	423	53.4%	326	323	56.6%	818	767	63.4%
UC2	108	101	12.8%	90	89	15.6%	257	241	19.9%
UC3	9	8	1.1%	16	15	2.8%	17	16	1.3%
UC4	249	234	29.6%	137	136	23.8%	186	175	14.4%
UC5	0	0	0.0%	0	0	0.0%	0	0	0.0%
Total	**842**	**790**	**100.0%**	**576**	**570**	**100.0%**	**1291**	**1210**	**100.0%**

5 Study Conclusions

5.1 The update from ELHAM Production Version 2 to the Base Year 2012 River Crossings Model follows sound methodology.

5.2 The resulting flow validation does not meet WebTAG acceptability guidelines, but we consider both that the results are in improvement on the ELHAM model from which the new model is based, that the results compare favourably to the other HAMs for which results are available, and that the results are as good as might be expected for a model of this size and complexity.

5.3 Similarly, journey time validation does not meet the WebTAG guidelines (85% of routes should be within 15% of surveyed times), but key routes using existing crossings – Blackwall Tunnel and Dartford Crossing – validate well.

5.4 Considering both link flow and journey time validation together, it could be argued that the AM and Interpeak models are more reliable than the PM peak model.

5.5 The select link analysis compares well to the pattern of trips indicated by the RSI data for Blackwall Tunnel and Woolwich Ferry. Further select link analysis shows that there is little difference between patterns of trips for each user class at these sites.

Future use of the model

5.6 It has been noted and agreed that there is a need to include code for northbound bus routes through Blackwall Tunnel.

5.7 Users of the model should be aware that delays on approaches to Rotherhithe Tunnel do not seem to be particularly well represented in the evening peak. Further analysis of journey time routes along Jamaica Road has been undertaken by Mott MacDonald and shows that modelled times are faster than observed in the eastbound direction in the PM peak. However, there is no specific agreement to ‘fix’ this issue in future versions of the model.

5.8 Our overall conclusion is that the model is fit for the purpose of identifying changes in strategic movements in and around East London should a new crossing be introduced or, for example, if charges for use of existing crossings were to be imposed. However, we do recommend that sensitivity tests are carried out on ‘scheme’ findings, to give comfort that the model is reacting to change in a defendable manner.

5.9 Furthermore, if future models are to be used to assess impacts at individual junctions, or groups of junctions, it is recommended that the focus should be on changes in model flows between given scenarios, rather than basing operational analyses directly on model output flows. This is consistent with approach used elsewhere in London based on other HAMs.

APPENDIX

A

COUNT SITE LOCATIONS

A1 APPENDIX 1

Appendix 2

A1.1 Appendix list number

APPENDIX

B

LINK FLOW CALIBRATION RESULTS (MVR TABLE 10.8)

B1 LINK FLOW CALOBRATION SUMMARY

Copy of Table 10.8 of the Model Validation Report

Screenline	Direction	No of Sites	AM		IP		PM	
			Within % / abs	Within GEH<5	Within % / abs	Within GEH<5	Within % / abs	Within GEH<5
Barking E-W	NB	6	50%	83%	83%	83%	67%	67%
Barking E-W	SB	6	100%	100%	100%	100%	50%	67%
Barking N-S	WB	12	75%	50%	75%	75%	67%	58%
Barking N-S	EB	12	92%	75%	92%	100%	75%	75%
Bexley E-W	NB	9	100%	89%	78%	67%	78%	78%
Bexley E-W	SB	10	80%	80%	60%	70%	60%	30%
Bexley N-S	WB	15	73%	67%	87%	73%	80%	80%
Bexley N-S	EB	15	73%	60%	87%	73%	60%	67%
Deptford	WB	5	60%	60%	100%	100%	60%	40%
Deptford	EB	5	60%	60%	80%	80%	20%	20%
Eltham North	WB	6	100%	83%	67%	67%	83%	83%
Eltham North	EB	6	50%	83%	100%	83%	50%	50%
Eltham South	WB	7	43%	57%	71%	71%	43%	43%
Eltham South	EB	7	57%	71%	100%	100%	43%	43%
GreatEastern (east)	NB	25	60%	56%	76%	64%	56%	52%
GreatEastern (east)	SB	25	64%	68%	80%	68%	72%	64%
GreatEastern (east) except Mways	NB	24	58%	54%	75%	63%	54%	50%
GreatEastern (east) except Mways	SB	24	63%	67%	79%	67%	71%	67%
GreatEastern (west)	NB	14	79%	64%	93%	86%	64%	64%
GreatEastern (west)	SB	15	73%	53%	87%	67%	73%	60%
Hackney North	WB	11	82%	55%	73%	45%	100%	82%
Hackney North	EB	10	90%	70%	100%	80%	70%	60%
HaroldHillN-S	WB	7	43%	43%	71%	71%	57%	57%
HaroldHillN-S	EB	7	43%	43%	71%	71%	57%	43%
Homerton	NB	6	67%	50%	67%	67%	50%	67%
Homerton	SB	6	50%	33%	50%	33%	67%	67%
Inner North	WB	6	83%	67%	83%	83%	67%	67%
Inner North	EB	6	83%	83%	83%	83%	50%	50%
LewishamDartford (east)	NB	14	50%	64%	93%	93%	86%	93%
LewishamDartford (east)	SB	14	64%	57%	79%	71%	71%	71%
LewishamDartford	NB	11	73%	64%	64%	91%	55%	55%

(west)								
LewishamDartford (west)	SB	11	91%	82%	73%	91%	91%	91%
Ravensbourne	WB	4	75%	75%	75%	75%	100%	100%
Ravensbourne	EB	4	100%	100%	100%	100%	100%	75%
River Screenline	NB	7	86%	86%	100%	100%	100%	86%
River Screenline	SB	7	100%	100%	100%	100%	43%	43%
RiverRom	WB	10	60%	60%	100%	90%	100%	90%
RiverRom	EB	9	67%	78%	89%	89%	89%	89%
Screenline A	EB	9	67%	67%	100%	100%	22%	33%
Screenline A	WB	9	67%	56%	56%	44%	78%	78%
Screenline C	NB	15	87%	73%	87%	80%	80%	60%
Screenline C	SB	15	87%	87%	100%	100%	60%	60%
Screenline D	EB	2	100%	100%	100%	100%	100%	50%
Screenline D	WB	2	100%	100%	100%	100%	100%	100%
Screenline E	NB	7	100%	57%	86%	86%	71%	71%
Screenline E	SB	7	86%	71%	86%	71%	71%	57%
Screenline F	EB	4	100%	100%	100%	100%	75%	75%
Screenline F	WB	4	75%	75%	100%	100%	100%	100%
Screenline G	NB	7	71%	57%	100%	86%	100%	86%
Screenline G	SB	7	100%	86%	100%	86%	100%	86%
Sidcup	NB	11	64%	64%	64%	73%	73%	64%
Sidcup	SB	11	36%	36%	45%	45%	55%	45%
West of A406	WB	11	64%	64%	73%	73%	36%	45%
West of A406	EB	11	55%	55%	82%	82%	45%	36%
Whitechapel	WB	9	78%	78%	89%	78%	78%	78%
Whitechapel	EB	8	100%	75%	75%	75%	63%	75%
Boundary S	NB	7	71%	71%	57%	57%	71%	71%
Boundary Sl	SB	7	86%	86%	86%	86%	57%	57%
Total Screenline count sites (by direction)		**513**	**73%**	**67%**	**82%**	**78%**	**68%**	**65%**

Enclosure	Direction	No of Sites	AM		IP		PM	
			Within % / abs	Within GEH<5	Within % / abs	Within GEH<5	Within % / abs	Within GEH<5
Barking	In	28	82%	64%	89%	82%	71%	36%
Barking	Out	29	76%	55%	83%	62%	72%	55%
Barkingside	In	27	59%	41%	81%	63%	56%	56%
Barkingside	Out	27	67%	52%	89%	63%	81%	56%
Bexley	In	11	55%	64%	82%	73%	64%	55%

Bexley	Out	11	64%	55%	91%	73%	55%	55%
Canary Wharf	In	6	67%	50%	67%	67%	17%	33%
Canary Wharf	Out	6	33%	33%	50%	33%	50%	33%
Harold Hill	In	16	56%	50%	88%	69%	56%	38%
Harold Hill	Out	16	63%	56%	81%	75%	75%	69%
Hornchurch	In	14	64%	64%	79%	79%	64%	64%
Hornchurch	Out	14	79%	71%	86%	79%	64%	64%
Lewisham	In	41	83%	59%	93%	73%	66%	56%
Lewisham	Out	40	78%	68%	83%	63%	75%	58%
Stepney	In	34	85%	62%	88%	44%	79%	44%
Stepney	Out	35	94%	60%	91%	63%	80%	54%
Stratford	In	19	63%	53%	74%	63%	74%	53%
Stratford	Out	19	84%	68%	74%	58%	79%	63%
Swanley	In	13	77%	62%	92%	69%	85%	54%
Swanley	Out	13	92%	69%	100%	69%	85%	69%
Woolwich	In	23	96%	74%	91%	78%	78%	61%
Woolwich	Out	24	67%	50%	96%	75%	83%	75%
Total Enclosure count sites (by direction)		**466**	**76%**	**59%**	**86%**	**67%**	**72%**	**55%**

		No of Sites	AM		IP		PM	
			Within % / abs	Within GEH<5	Within % / abs	Within GEH<5	Within % / abs	Within GEH<5
Total Borough Counts (by direction)		**104**	**82%**	**83%**	**88%**	**85%**	**77%**	**73%**

APPENDIX

C

VALIDATION RESULTS – JOURNEY TIME SURVEYS – EXISTING RIVER CROSSINGS

C1 JOURNEY TIME VALIDATION GRAPHS

Blackwall Tunnel (northbound)

Figure L.13: AM Route 01: ELHAM Route 01 N (includes Blackwall tunnel) Northbound

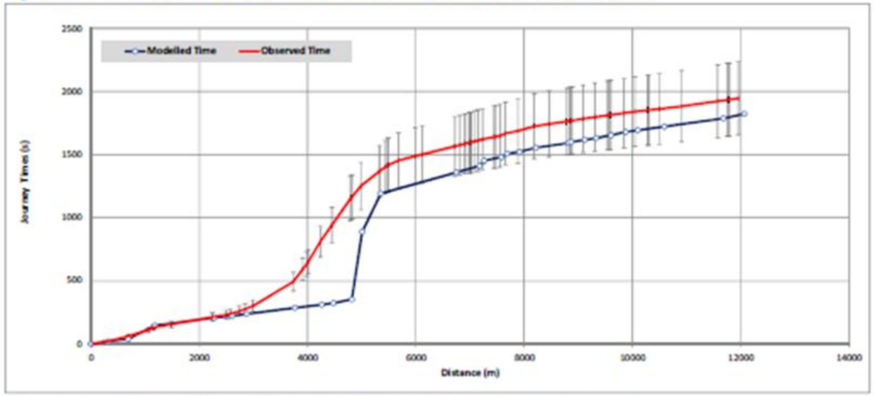


Figure L.15: PM Route 01: ELHAM Route 01 N (includes Blackwall tunnel) Northbound

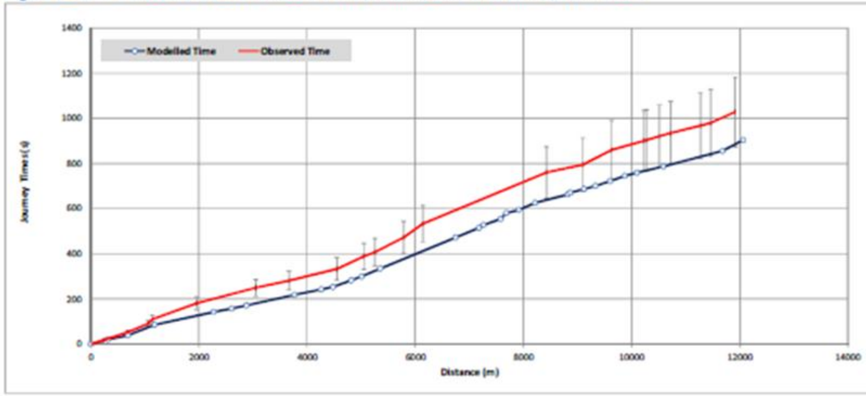
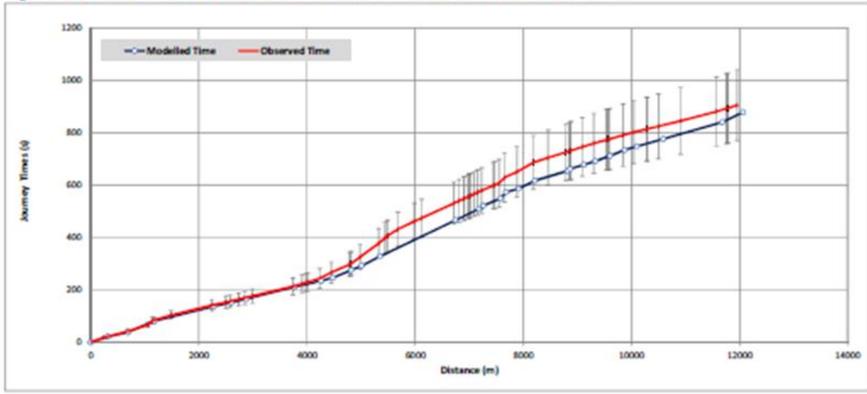


Figure L.14: IP Route 01: ELHAM Route 01 N (includes Blackwall tunnel) Northbound



Blackwall Tunnel (southbound)

Figure L.16: AM Route 02: ELHAM Route 01 S (includes Blackwall tunnel) Southbound

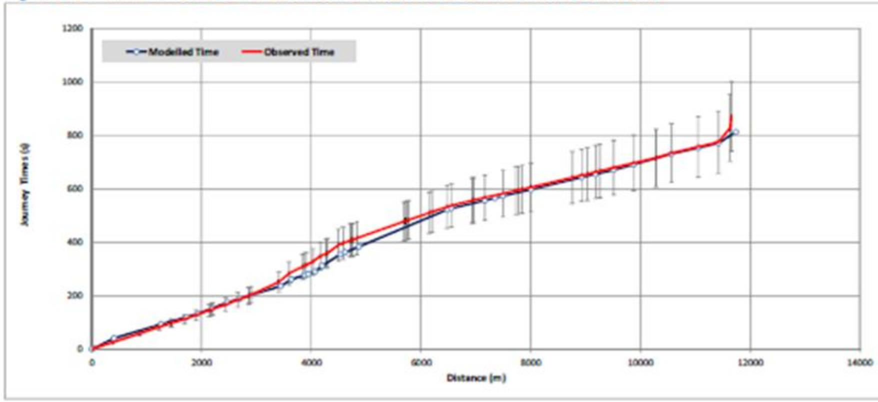


Figure L.18: PM Route 02: ELHAM Route 01 S (includes Blackwall tunnel) Southbound

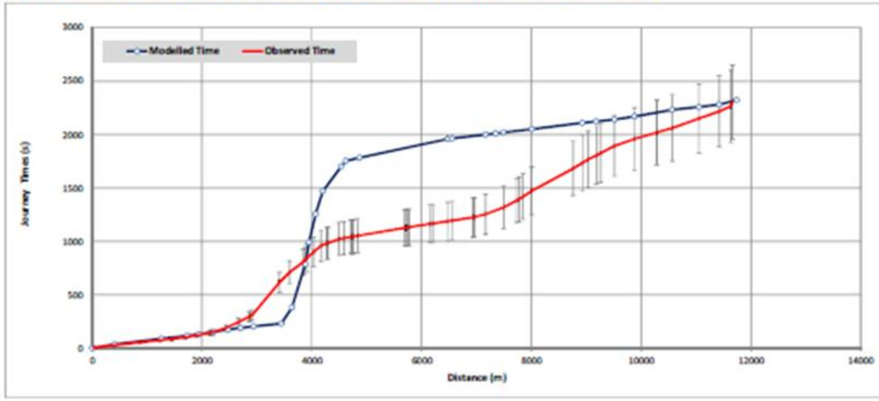
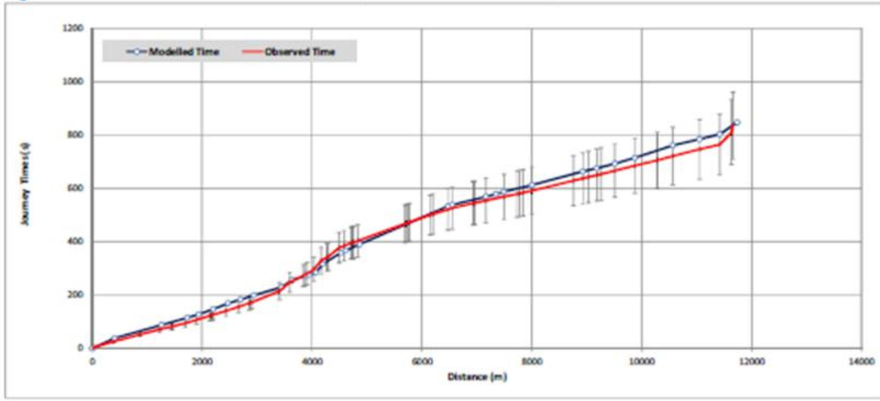


Figure L.17: IP Route 02: ELHAM Route 01 S (includes Blackwall tunnel) Southbound



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Dartford Crossing (northbound)

Figure L.19: AM: Route 87: M25 Route 20 A (includes Dartford Crossing) Northbound

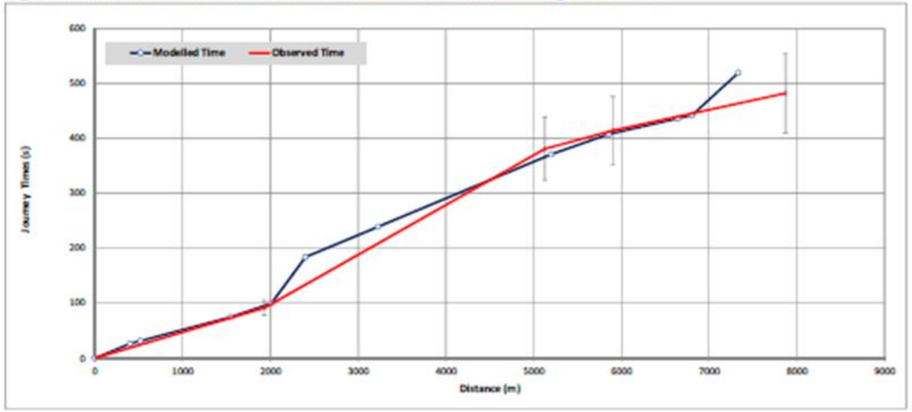


Figure L.20: IP: Route 87: M25 Route 20 A (includes Dartford Crossing) Northbound

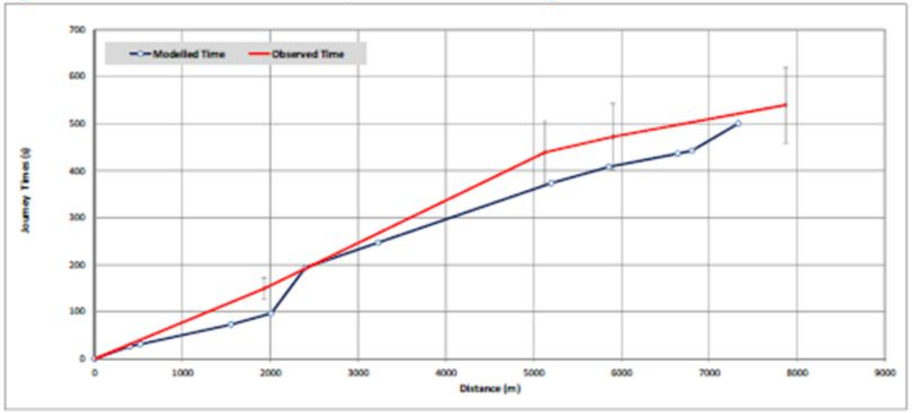
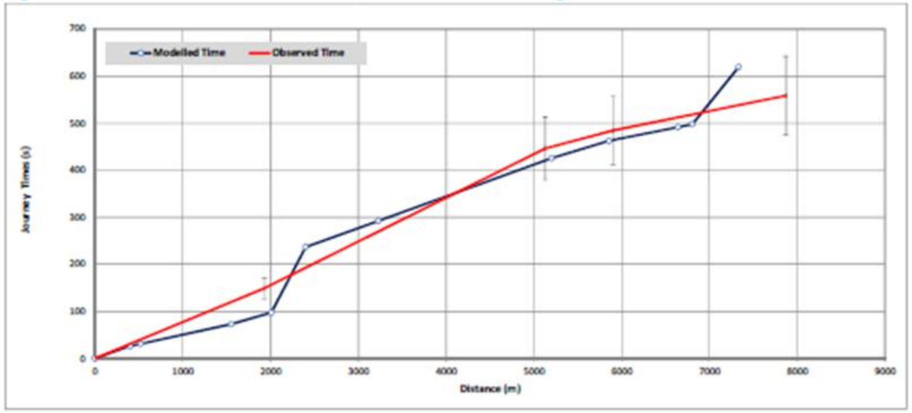


Figure L.21: PM: Route 87: M25 Route 20 A (includes Dartford Crossing) Northbound



Dartford Crossing (southbound)

Figure L.22: AM: Route 88: M25 Route 20 C (includes Dartford Crossing) Southbound

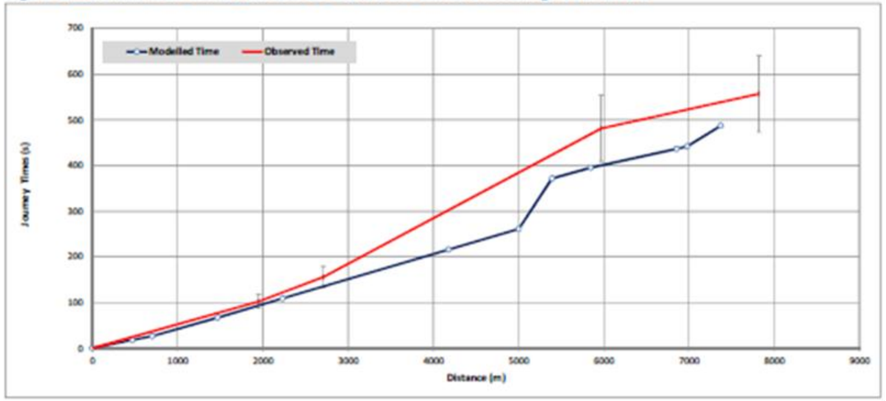


Figure L.24: PM: Route 88: M25 Route 20 C (includes Dartford Crossing) Southbound

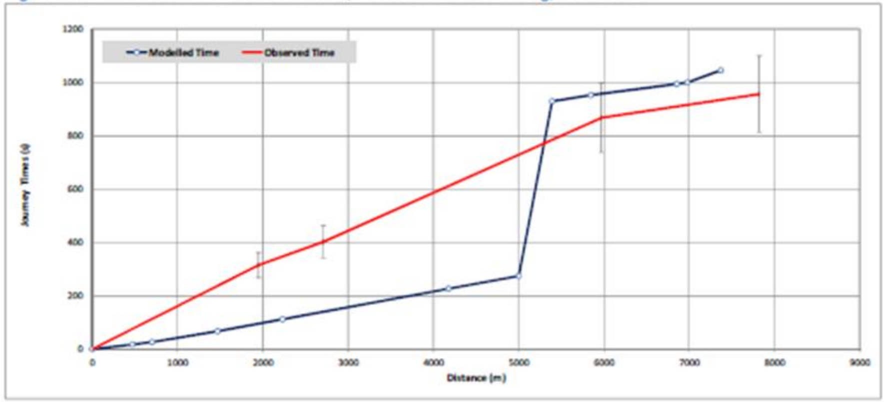
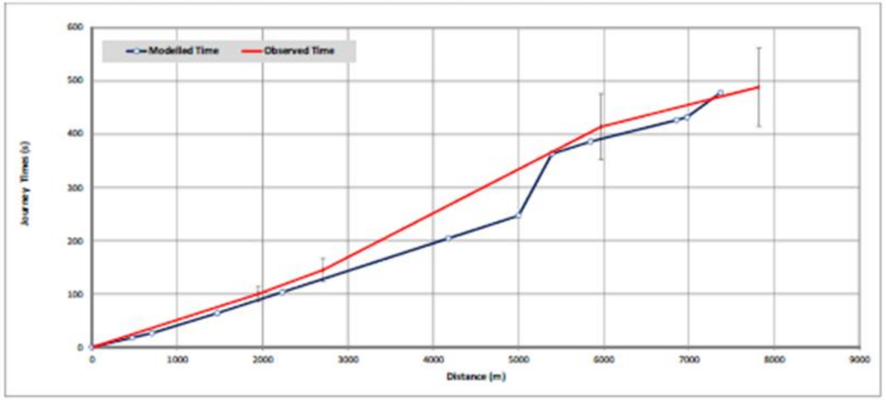


Figure L.23: IP: Route 88: M25 Route 20 C (includes Dartford Crossing) Southbound



CONTROL SHEET

Project/Proposal Name	River Crossings Modelling Review
Document Title	Base Year Model Audit
Client Contract/Project No.	3100627222
SDG Project/Proposal No.	22621001

ISSUE HISTORY

Issue No.	Date	Details
2	20 May 2014	Final

REVIEW

Originator	Seyram Kumapley
Other Contributors	Steve Oliver
Review by:	Print
Steve Oliver	Sign

DISTRIBUTION

Client:	Transport for London
Steer Davies Gleave:	

DNV UKAS QUALITY MANAGEMENT 013

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