8. Network Calibration and Validation

8.1. Network Calibration

The SBL highway network was developed from the earlier GBATS SBL 2009 v2 HAM model and updated to a 2012 base year, as described in Section 6. A number of checks were undertaken on the network coding including:

- reviewing the warnings produced by SATNET, the SATURN network building software;
- the coded link distances versus crow-fly distances;
- coded link speeds and speed-flow curves; and
- coded junction saturation flows.

Link distances were compared to crow-fly link lengths and those greater than 1.3 times the crow-fly distance were inspected. Excluding the links that represent centroid connector stubs, those links representing expanded junctions and those with a difference of less than 10 metres (to account for any loss of accuracy when assigning co-ordinates to a node) 3% of links in South Bristol are outside of the criteria.

During the model calibration, there were a large number of changes undertaken principally at the individual junction level to improve the overall performance of the model. These included the following:

- **Counts in excess of capacity** – where an observed count was noticeably higher than the coded network capacity the capacities where checked and amended if necessary;
- **Excessive junction delays** – the largest overall delays, and the largest differences between the link travel times and the moving car observer data were checked and junction coding checked;
- **Low flows** – where the modelled flow was substantially below that counted; this revealed locations where traffic was either restricted at an upstream junction or where a competing route was more attractive; and
- **Poor reproduction of observed travel times** - detailed comparisons of modelled travel times against the observed journey time routes revealed locations where additional modifications to signal settings were necessary in order to replicate the observed levels of delay.

8.2. Route Choice Calibration and Validation

The accuracy of the assignment depends on the network structure, the trip matrix and the realism of modelled routes. Checks undertaken on the model prior to assignment to confirm the network was suitable for the matrix development.

8.2.1. Route Choice Calibration

The ability of model to robustly represent route choice within the network depends on:

- correct zone sizing and definition, network structure and the realism of the zone connections to the modelled network (centroid connectors);
- the accuracy of the network coding and the appropriateness of the simplifications adopted;
- the accuracy with which delays at junctions and link cruise speeds are modelled, which in turn is dependent not only on data and/or coding accuracy but also on the appropriateness of the approximations inherent in the junction flow/delay and link speed/flow relationships; and
- how accurately the trip matrices have been built, which, when assigned, will impact on the route choice process (via the flow/delay and speed/flow relationships).

During the route choice calibration process, any issues such as these, which arose from incorrect or doubtful route choices, were examined in detail, and where appropriate corrections/changes to the junction coding are implemented.

8.2.2. Route Choice Validation

No specific criterion exists for validating route choices within a modelled network. However, it is common practice to undertake to review the routing chosen by the model between key locations and TAG Unit 3.19 suggests that the number of routs (OD pairs) should be estimated as:

$$\text{Number of OD pairs} = (\text{number of zones})^{0.25} \times \text{the number of user classes}$$

This equates to approximately 15 routes (five routes for each time period). The analysis of the routes selected did not highlight any errors in the underlying network coding. Further information may be found in Appendix C .

9. Trip Matrix Calibration

9.1. Case for Matrix Estimation

TAG Unit 3.19 advises that the primary purpose of matrix estimation is to refine estimates of trips not intercepted in surveys which have been synthesised, usually by means of a gravity model. The development of the prior matrix was described in the previous section and the modelled flows were compared to the observed counts for the calibration cordons and screenlines to determine whether further matrix calibration was required using matrix estimation.

The comparison of the observed and modelled flows across the screenlines is summarised in Table 36 and showed that the replication of the observed cordon and screenline flows was outside the TAG Unit 3.19 targets (as defined in Table 1 for total screenline flow) for all three time periods. As such, matrix estimation was applied to the prior trip matrix to improve the matrix calibration and the following principles were adopted:

- the effects of matrix estimation were minimised;
- count constraints were usually grouped and applied at the short screenline level;
- counts used as constraints in matrix estimation were usually derived from two-week ATCs; and
- constraints were applied at the car, LGV and HGV level.

9.2. Application of Matrix Estimation

The SATURN modules SATME2 and SATPIJA are used for matrix estimation and in combination attempt to match assigned link flows in the model with observed traffic counts. Checks were made to ensure that the overall trip distribution of the original trip matrix was maintained.

The matrix estimation process forms part of the calibration process and is designed to modify the origin-destination volumes by reference to the observed traffic counts. Trips are adjusted in the matrix to produce the estimated matrix, which is most likely to be consistent with the traffic counts. The equation used was:

$$T_{ij} = tij \prod_a X_a^{Pija}$$

where:

- T_{ij} is the output matrix of OD pairs ij;
- tij is the prior matrix of OD pairs ij;
- $\prod_a$ is the product over all counted links a;
- X_a is the balancing factor associated with counted link;
- ^{Pija} is the fraction of trips from i to j using link a.

The changes brought about by matrix estimation should be monitored by the following means:

- scatter plots of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R2 values);
- scatter plots of zonal trip ends, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R2 values);
- trip length distributions, prior to and post matrix estimation, with means and standard deviations; and
- sector to sector level matrices, prior to and post matrix estimation, with absolute and percentage changes.

The matrix estimation process was examined to ensure that the estimated matrix converged to a stable solution. The post matrix should reflect more closely the pattern of observed traffic on the network and, as such, provide an improved representation of travel patterns in the area.

The key advice in TAG Unit 3.19, shown in Table 4, is that the changes brought about by matrix estimation should not be significant and that all exceedances of these criteria should be examined and assessed for their importance for the accuracy of the matrices in the FMA or the area of influence of the scheme to be assessed.

Table 36. Summary of Cordon and Screenline Validation (Prior Matrix)

Screenline		Direction	AM				IP				PM			
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total
RSI Cordon	Inner Cordon	Inbound	9%	0%	-14%	6%	2%	3%	-3%	1%	-2%	0%	-15%	-2%
		Outbound	0%	2%	-18%	-1%	1%	4%	-3%	0%	1%	1%	-13%	0%
	Outer Cordon	Inbound	2%	2%	-3%	1%	2%	2%	1%	1%	0%	3%	-3%	0%
		Outbound	1%	3%	-2%	1%	1%	3%	-8%	0%	1%	3%	-4%	0%
Matrix Estimation Screenline	Central (S2)	Westbound	-7%	0%	17%	-6%	2%	8%	35%	3%	-6%	3%	21%	-5%
		Eastbound	13%	8%	23%	12%	5%	10%	38%	6%	6%	25%	25%	8%
	River	Northbound	-3%	-9%	3%	-3%	5%	5%	1%	5%	-4%	7%	-1%	-2%
		Southbound	-1%	-1%	-2%	-1%	-5%	-4%	4%	-4%	-12%	-9%	-1%	-12%
	Bishopsworth	Northbound	-7%	-27%	87%	-8%	-18%	-26%	96%	-16%	-38%	-44%	47%	-37%
		Southbound	2%	-11%	114%	3%	-11%	2%	64%	-6%	-17%	-24%	91%	-16%
	Hengrove	Northbound	-3%	-9%	40%	-2%	1%	-13%	44%	0%	21%	4%	40%	20%
		Southbound	-1%	-18%	62%	-2%	-6%	-19%	50%	-7%	-9%	-26%	31%	-10%
	Pidgeonhouse	Westbound	4%	-6%	10%	2%	-11%	-3%	50%	-8%	-2%	-3%	2%	-2%
		Eastbound	-19%	-32%	37%	-20%	-27%	-37%	33%	-27%	-37%	-39%	85%	-36%
	Highridge	Westbound	-23%	-32%	-25%	-24%	-26%	-23%	-9%	-25%	-13%	-19%	-68%	-14%
		Eastbound	8%	-15%	-60%	3%	-4%	-11%	-65%	-7%	-7%	-8%	-54%	-7%
	Long Ashton	Inbound	-7%	-5%	0%	-7%	-4%	1%	8%	-3%	-11%	-10%	-18%	-11%
		Outbound	-8%	0%	-43%	-9%	0%	6%	-2%	0%	-8%	-4%	3%	-8%

9.3. Changes due to Matrix Estimation

9.3.1. Matrix Totals

A comparison of the total number of trips before and after application of the matrix estimation process is shown in Table 37. The matrix estimation process typically changed the overall number of trips in the car and light goods vehicle matrices by less than +2% in all three time periods. The HGV matrix has changed by up to - 2% in the two peak hour models and reduced by 2% (<100 pcus/h) in the Inter-peak matrix.

Table 37. Comparison of Matrix Totals - Prior versus Post ME2

Time Period	Car			LGV			HGV		
	Prior	Post ME2	% Change	Prior	Post ME2	% Change	Prior	Post ME2	% Change
AM	96,104	96,722	0.6%	15,387	15,546	1.0%	13,389	13,197	-1.4%
IP	74,619	75,131	0.7%	13,704	13,765	0.4%	14,806	14,486	-2.2%
PM	98,063	99,521	1.5%	11,154	11,330	1.6%	7,403	7,314	-1.2%

Units: pcu/h

9.3.2. Matrix Zonal Cell Values

The changes are the matrix zonal level are summarised below in Table 38 whilst Figure 22 to Figure 23 show the scatter plots, for all vehicles combined. The analysis is presented for the whole geographic area of the matrix and also for all trips to, from and through south Bristol but excluding those trips that are between zones that are north of the River Avon. The analysis shows that in all but a very few instances the impact of matrix estimation at a cell to cell level across the whole matrix is within benchmark criteria. Considering a matrix that excludes trips exclusively in north Bristol reveals that the matrix meets slope and intercept whilst narrowly missing the R^2>0.95 criteria in the morning and evening peaks.

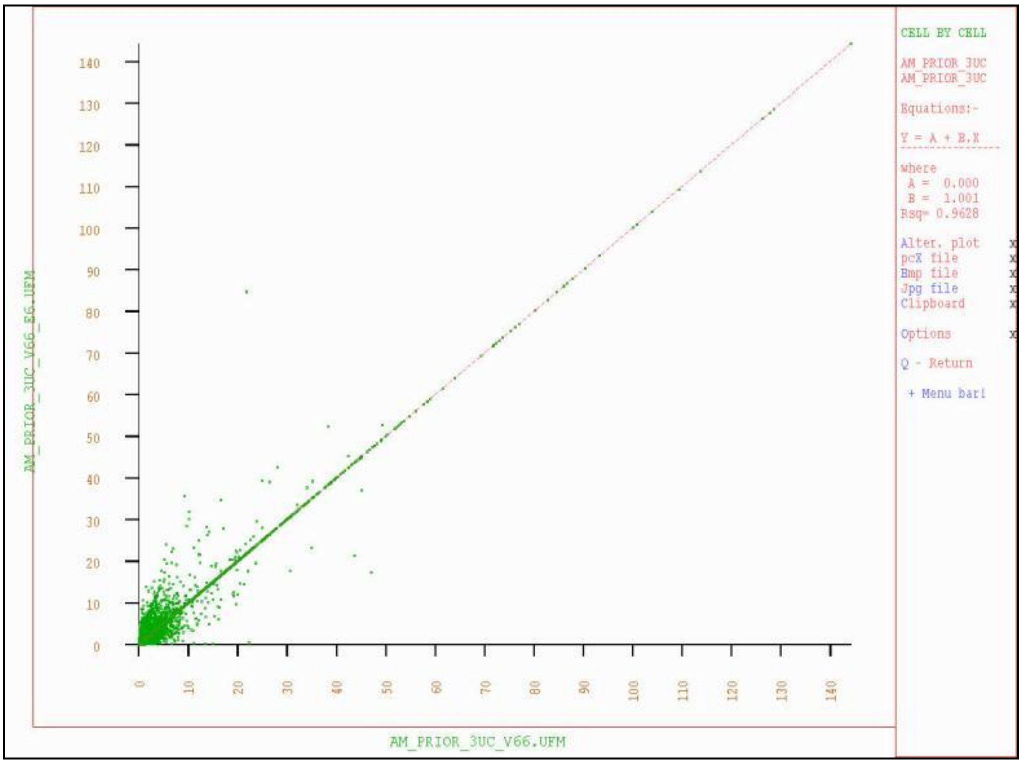
Table 38. Matrix Zonal Cell Regression Analysis

Time	Matrix	Significance criteria		Total	Car	LGV	HGV
Morning peak (08:00-09:00)	Whole Matrix	Slope	0.98<Slope<1.02	1.00	1.01	0.99	0.98
		Intercept	near 0	0.00	0.00	0.00	0.00
		R^2	>0.95	0.96	0.96	0.93	0.97
	Matrix excluding trips exclusively in the north of Bristol	Slope	0.98<Slope<1.02	1.00	1.01	0.99	0.98
		Intercept	near 0	0.00	0.00	0.00	0.00
		R^2	>0.95	0.94	0.93	0.90	0.96
Inter-peak (ave hr 10:00-16:00)	Whole Matrix	Slope	0.98<Slope<1.02	1.00	1.01	1.00	0.99
		Intercept	near 0	0.00	0.00	0.00	0.00
		R^2	>0.95	0.98	0.98	0.97	0.96
	Matrix excluding trips exclusively in the north of Bristol	Slope	0.98<Slope<1.02	1.00	1.01	1.01	0.99
		Intercept	near 0	0.00	0.00	0.00	0.00
		R^2	>0.95	0.97	0.98	0.95	0.95

Time	Matrix	Significance criteria		Total	Car	LGV	HGV
Evening peak (17:00-18:00)	Whole Matrix	Slope	0.98<Slope<1.02	1.00	1.00	1.00	0.99
		Intercept	near 0	0.00	0.00	0.00	0.00
		R^2	>0.95	0.96	0.95	0.90	0.99
	Matrix excluding trips exclusively in the north of Bristol	Slope	0.98<Slope<1.02	1.00	1.01	1.00	0.99
		Intercept	near 0	0.00	0.00	0.00	0.00
		R^2	>0.95	0.93	0.93	0.85	0.98

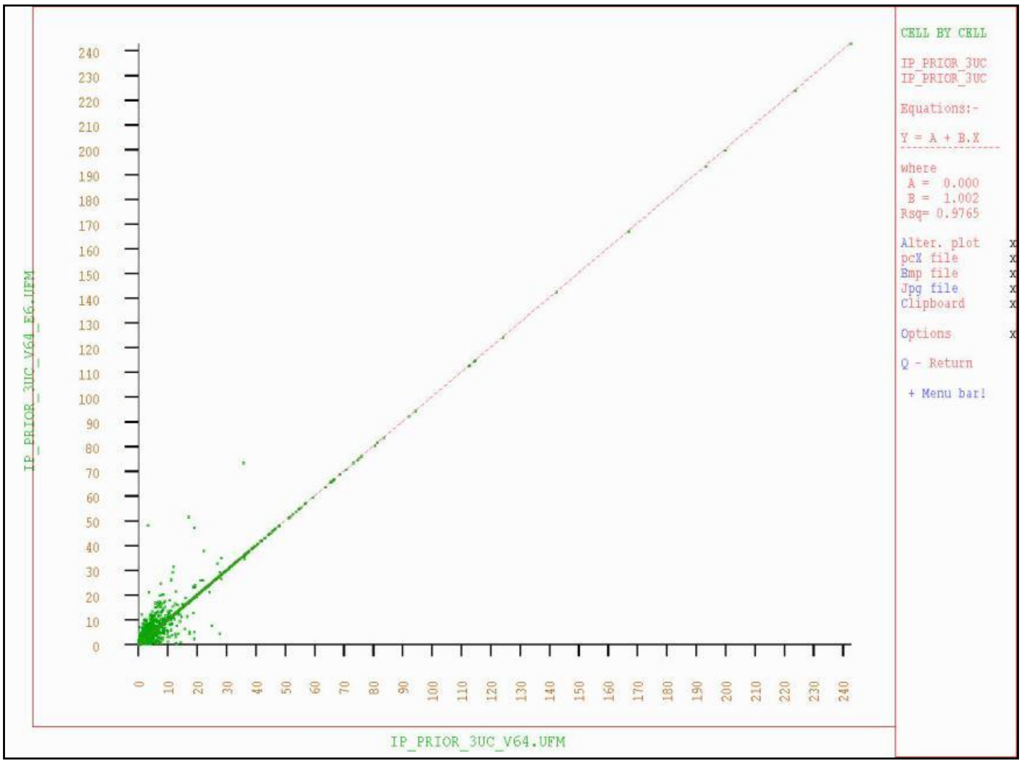
Note: Near zero assumed to be <5 considering mean trip end is 61

Figure 22. Matrix Zonal Cell Scatter Plot - Morning Peak (All Vehicles)



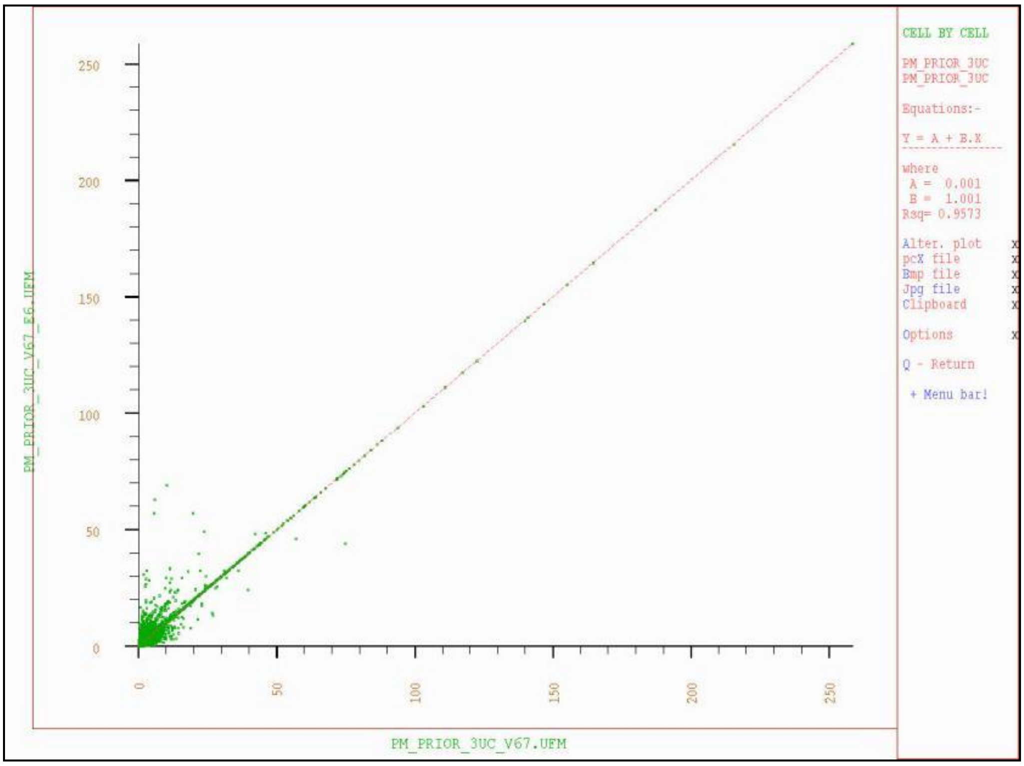
Units: pcu/h

Figure 23. Matrix Zonal Cell Scatter Plot - Inter Peak (All Vehicles)



Units: pcu/h

Figure 24. Matrix Zonal Cell Scatter Plot – Evening Peak (All Vehicles)



Units: pcu/h

9.3.3. Matrix Zonal Trip Ends

The changes are the matrix zonal trip end level are summarised below in Table 39 whilst Figure 25 to Figure 27 shows the scatter plots, for all vehicles combined. The analysis is presented for the whole geographic area of the matrix and also for all trips to, from and through south Bristol but excluding those trips that are between zones that are north of the River Avon. The analysis is also presented for all vehicle types.

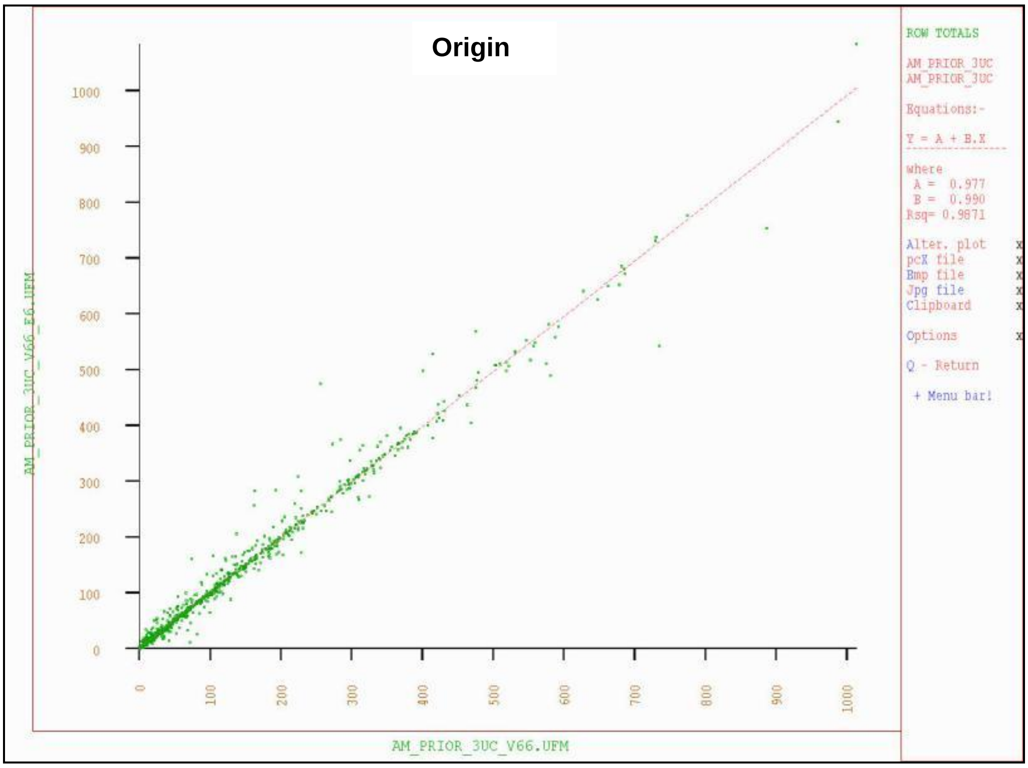
The analysis shows that in all but a very few instances the impact of matrix estimation at a zonal trip end level across the whole matrix and, specifically to SBL, a matrix excluding trips exclusively in the north of Bristol is within benchmark criteria.

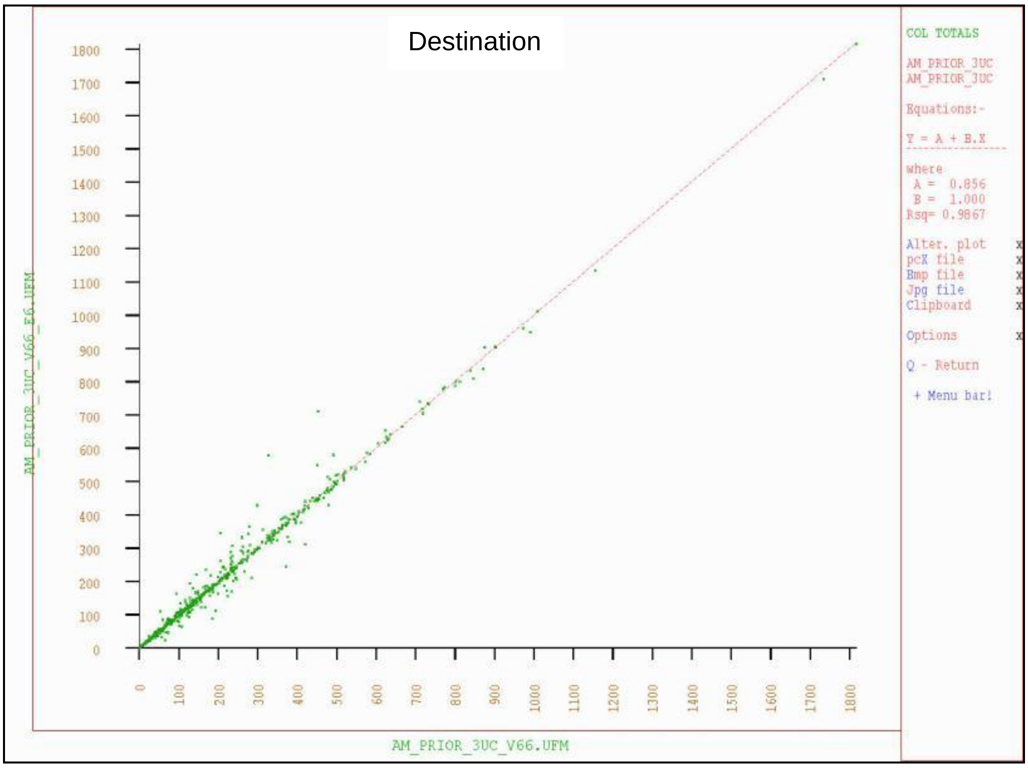
Table 39. Trip End Level Regression Analysis

Time	All or part of matrix		Significance criteria		Total	Car	LGV	HGV
Morning peak (08:00-09:00)	Whole Matrix	Origin	Slope	0.99<Slope<1.01	0.99	0.98	1.00	1.00
			Intercept	near 0	0.98	3.86	0.38	-0.25
			R^2	>0.98	0.99	0.98	0.98	0.99
		Destination	Slope	0.99<Slope<1.01	1.00	1.00	1.00	1.00
			Intercept	near 0	0.86	1.32	0.30	-0.23
			R^2	>0.98	0.99	0.98	0.98	0.99
	Matrix excluding trips exclusively in the north of Bristol	Origin	Slope	0.99<Slope<1.01	0.99	0.98	1.00	0.99
			Intercept	near 0	0.76	2.57	0.30	-0.17
			R^2	>0.98	0.98	0.97	0.97	0.99
		Destination	Slope	0.99<Slope<1.01	1.01	1.01	1.01	0.99
			Intercept	near 0	-0.09	0.06	0.17	-0.16
			R^2	>0.98	0.98	0.97	0.95	0.99
Inter-Peak (ave hr 10:00-16:00)	Whole Matrix	Origin	Slope	0.99<Slope<1.01	1.00	1.00	0.99	0.99
			Intercept	near 0	0.00	0.78	0.24	-0.51
			R^2	>0.98	0.99	0.99	0.98	0.99
		Destination	Slope	0.99<Slope<1.01	1.00	1.01	1.00	0.99
			Intercept	near 0	-0.15	-0.04	0.16	-0.29
			R^2	>0.98	0.99	0.98	0.98	0.99
	Matrix excluding trips exclusively in the north of Bristol	Origin	Slope	0.99<Slope<1.01	1.00	1.00	0.99	1.00
			Intercept	near 0	0.00	0.60	0.24	-0.49
			R^2	>0.98	0.99	0.99	0.98	0.99
		Destination	Slope	0.99<Slope<1.01	1.01	1.01	1.01	0.99
			Intercept	near 0	-0.18	-0.30	0.03	-0.33
			R^2	>0.98	0.99	0.98	0.96	0.99

Time	All or part of matrix		Significance criteria		Total	Car	LGV	HGV
Evening peak (17:00-18:00)	Whole Matrix	Origin	Slope	0.99<Slope<1.01	1.00	0.99	0.98	1.00
			Intercept	near 0	0.96	3.95	0.63	-0.16
			R^2	>0.98	0.99	0.98	0.97	1.00
		Destination	Slope	0.99<Slope<1.01	1.02	1.02	1.00	1.00
			Intercept	near 0	-0.66	-0.73	0.24	-0.15
			R^2	>0.98	0.98	0.98	0.96	1.00
	Matrix excluding trips exclusively in the north of Bristol	Origin	Slope	0.99<Slope<1.01	1.00	1.00	0.99	1.00
			Intercept	near 0	0.81	3.07	0.41	-0.14
			R^2	>0.98	0.98	0.97	0.95	1.00
		Destination	Slope	0.99<Slope<1.01	1.04	1.04	1.02	1.00
			Intercept	near 0	-1.50	-1.71	0.11	-0.12
			R^2	>0.98	0.97	0.97	0.94	1.00

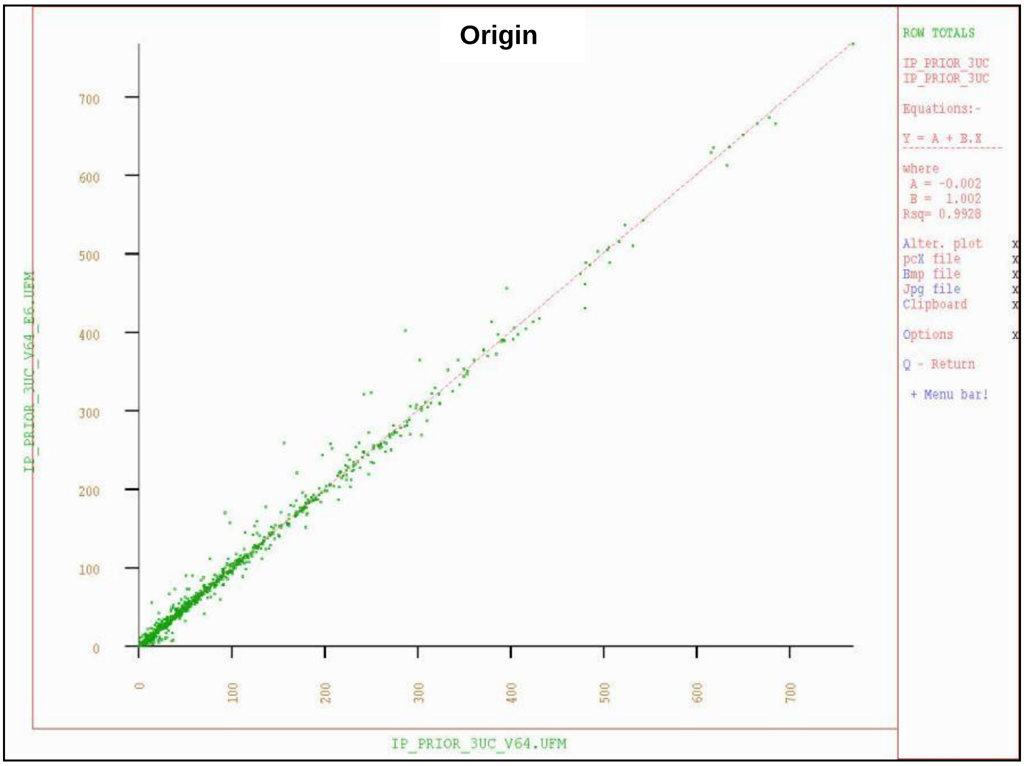
Figure 25. Origin / Destination Trip End Scatter Plot - Morning Peak (All Vehicles)

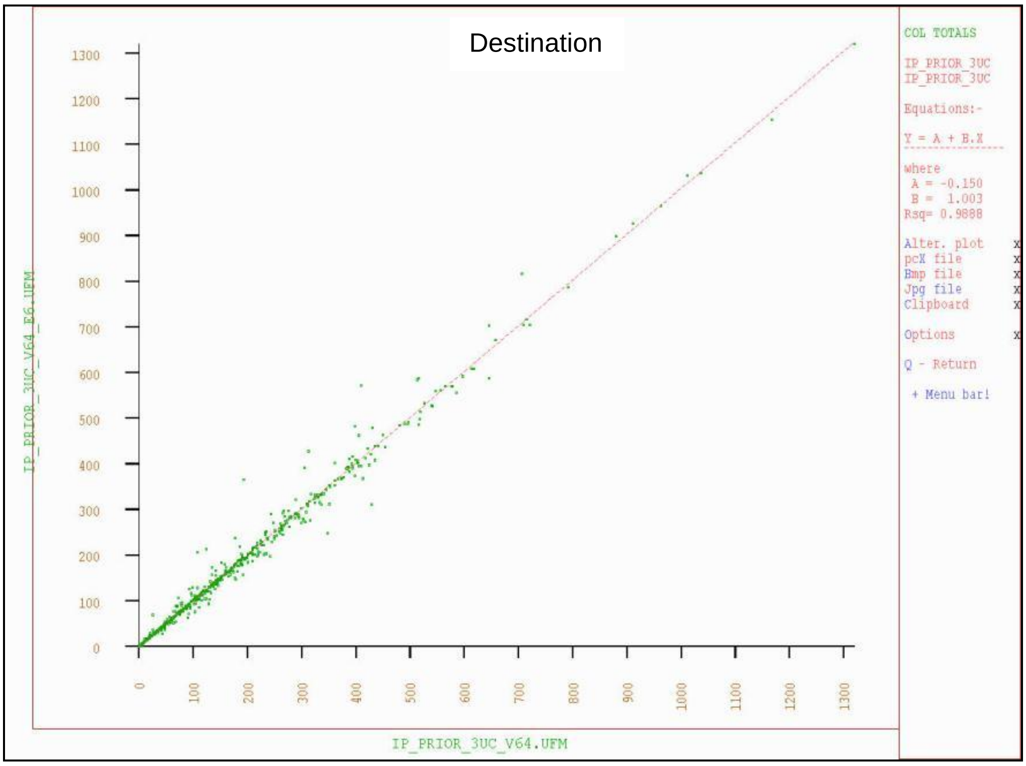




Units: pcu/h

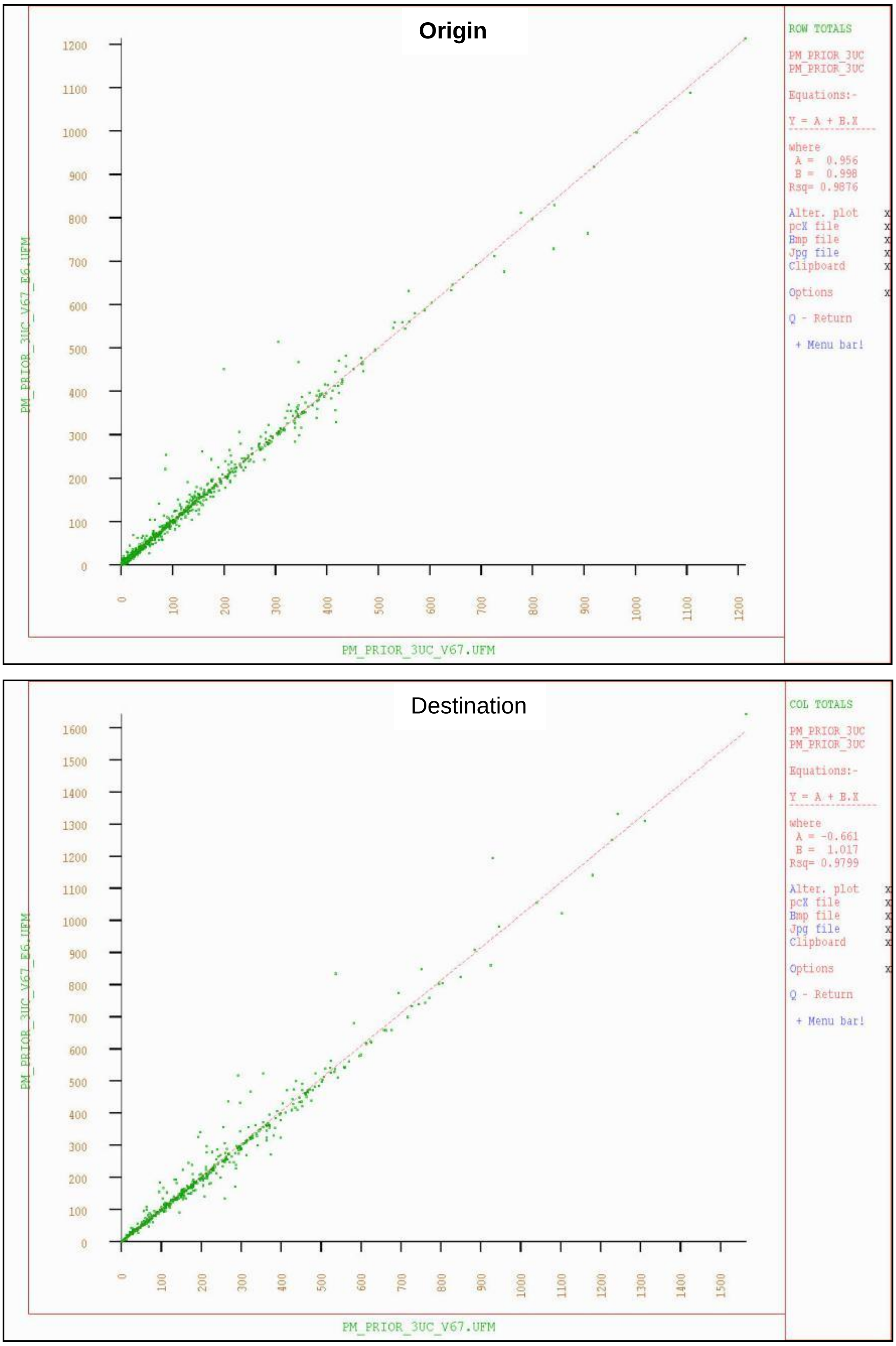
Figure 26. Origin / Destination Trip End Scatter Plot - Inter-Peak (All Vehicles)





Units: pcu/h

Figure 27. Origin / Destination Trip End Scatter Plot – Evening Peak (All Vehicles)



Units: pcu/h

9.3.4. Trip Length Distribution

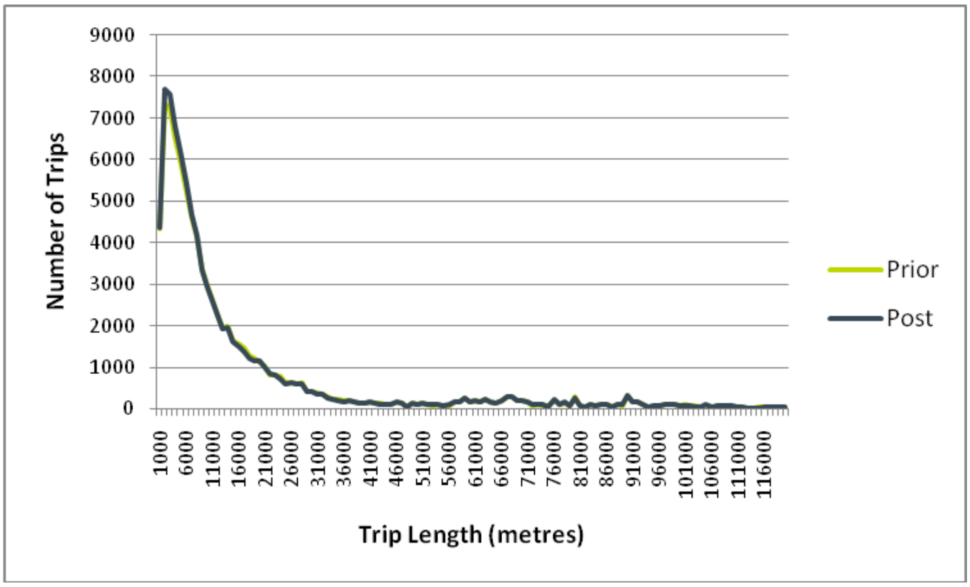
The changes in the average trip length distribution resulting from matrix estimation by time period and user class is summarised below in Table 40 whilst Figure 28 to Figure 36 compare the trip length distributions for the pre and post matrix estimation matrices for each time period and vehicle class.

The analysis shows that in all cases the impact of matrix estimation on trip length distribution is within benchmark criteria.

Table 40. Comparison of Trip Length Distributions - Prior versus Post ME2

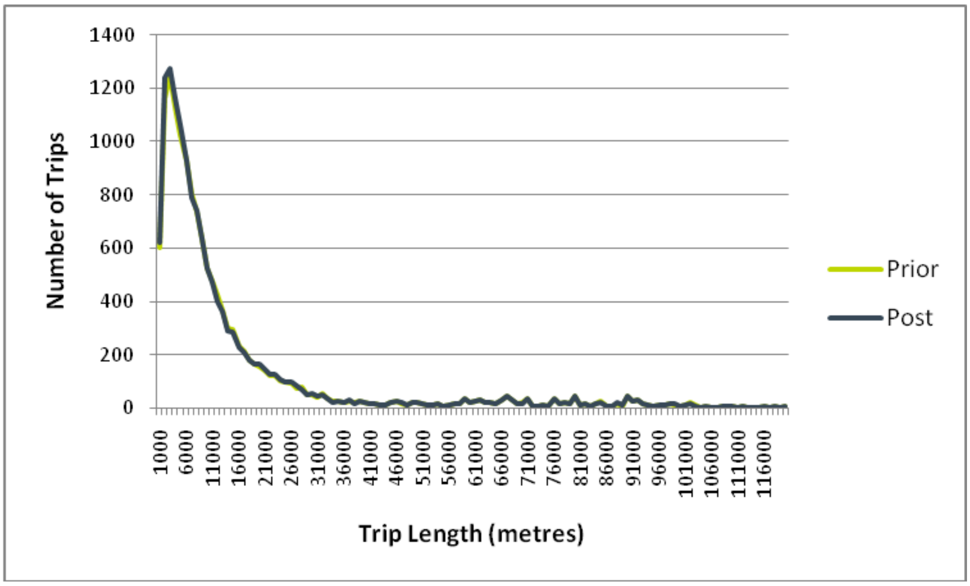
Time	Significance criteria		Car	LGV	HGV
Morning peak (08:00-09:00)	Difference in means	<5%	-1.8%	-1.0%	1.5%
	Difference in standard deviation	<5%	-0.5%	-0.4%	0.3%
Inter-peak (ave hr 10:00-16:00)	Difference in means	<5%	-0.8%	-1.1%	2.1%
	Difference in standard deviation	<5%	-0.3%	0.0%	0.2%
Evening peak (17:00-18:00)	Difference in means	<5%	-1.0%	-1.5%	1.8%
	Difference in standard deviation	<5%	-0.4%	-0.4%	0.2%

Figure 28. Trip Length Distribution for Morning Peak (UC1 Car)



Units: pcu/h

Figure 29. Trip Length Distribution for Morning Peak (UC2 LGV)



Units: pcu/h

Figure 30. Trip Length Distribution for Morning Peak (UC3 HGV)

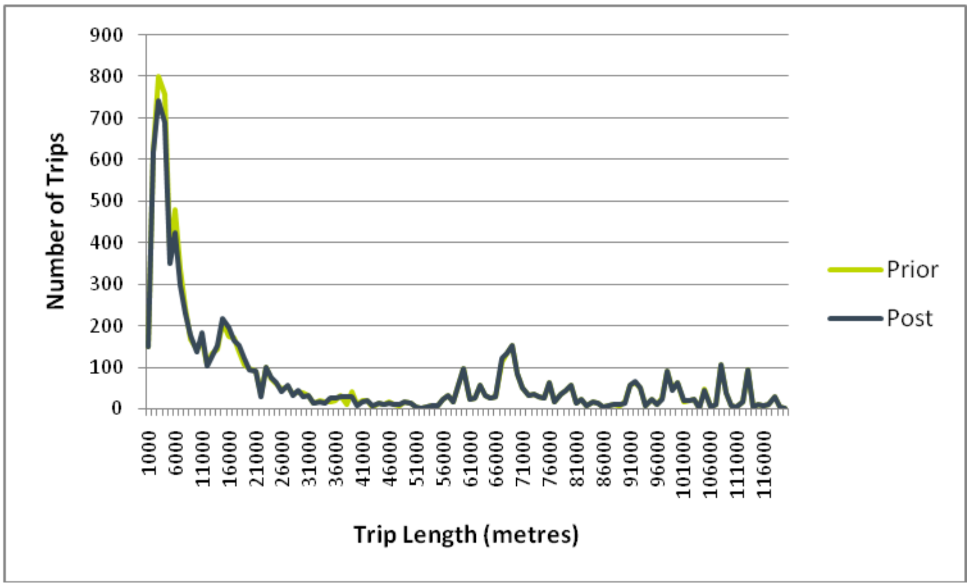


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Figure 31. Trip Length Distribution for Inter-Peak (UC1 Car)

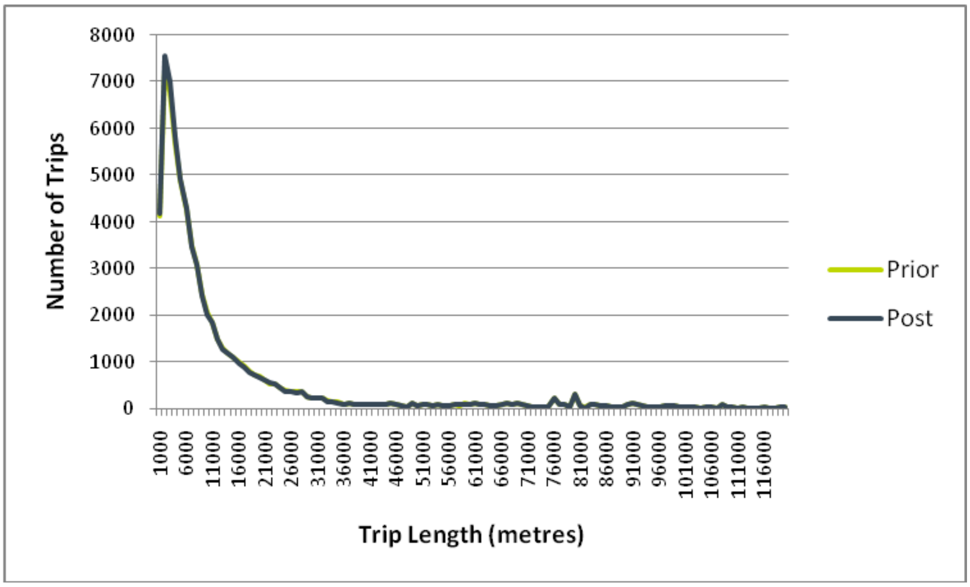

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Figure 32. Trip Length Distribution for Inter-Peak (UC2 LGV)

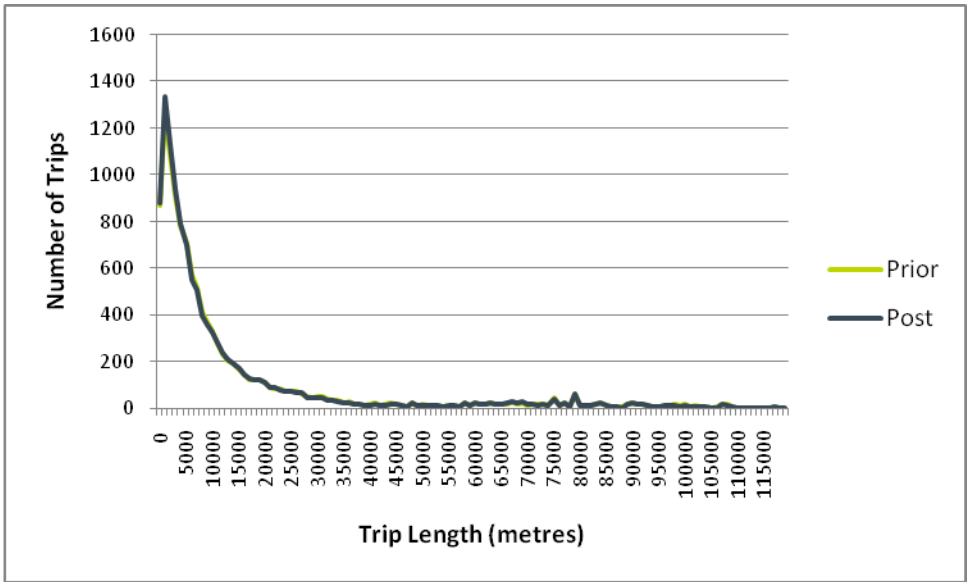

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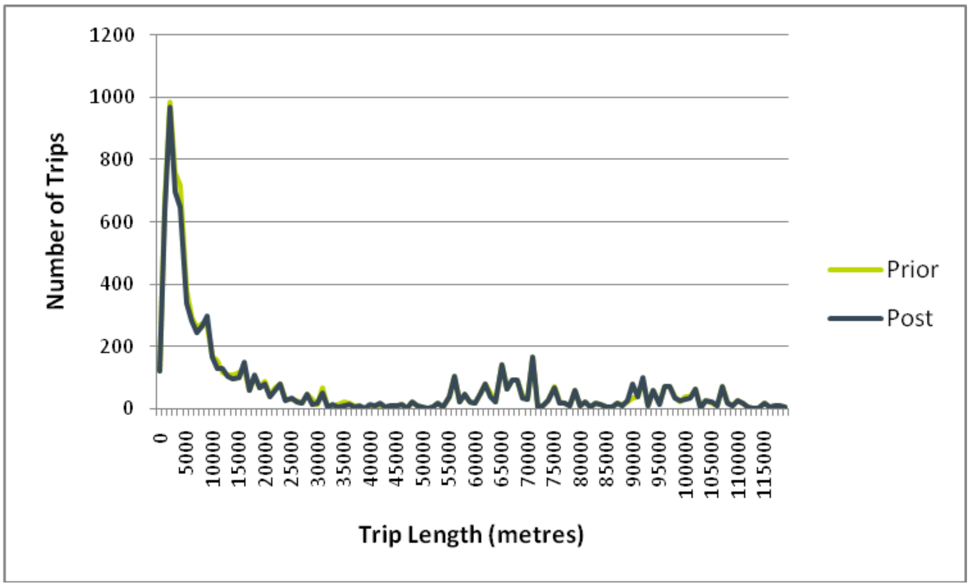
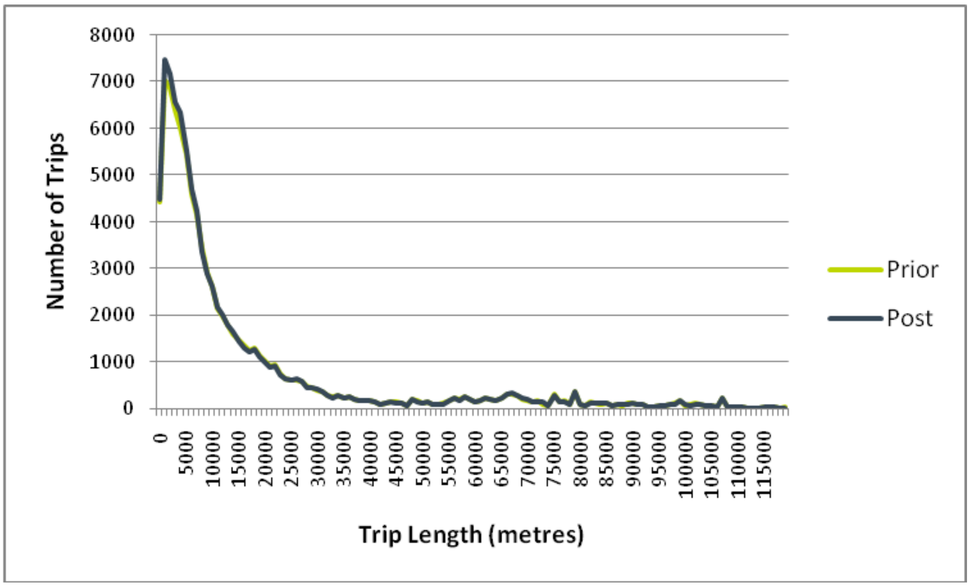
Figure 33. Trip Length Distribution for Inter-Peak (UC3 HGV)



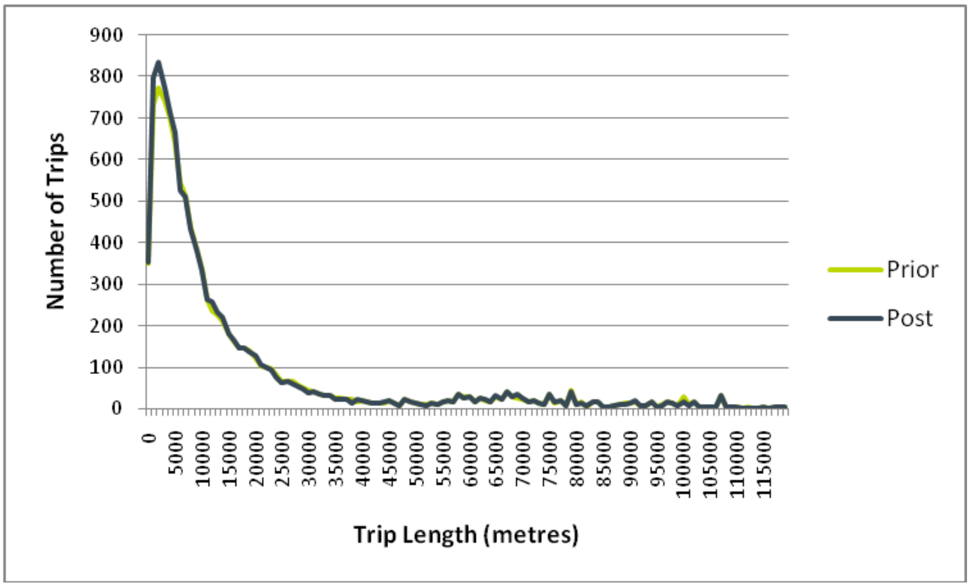
Units: pcu/h

Figure 34. Trip Length Distribution for Evening Peak (UC1 Car)



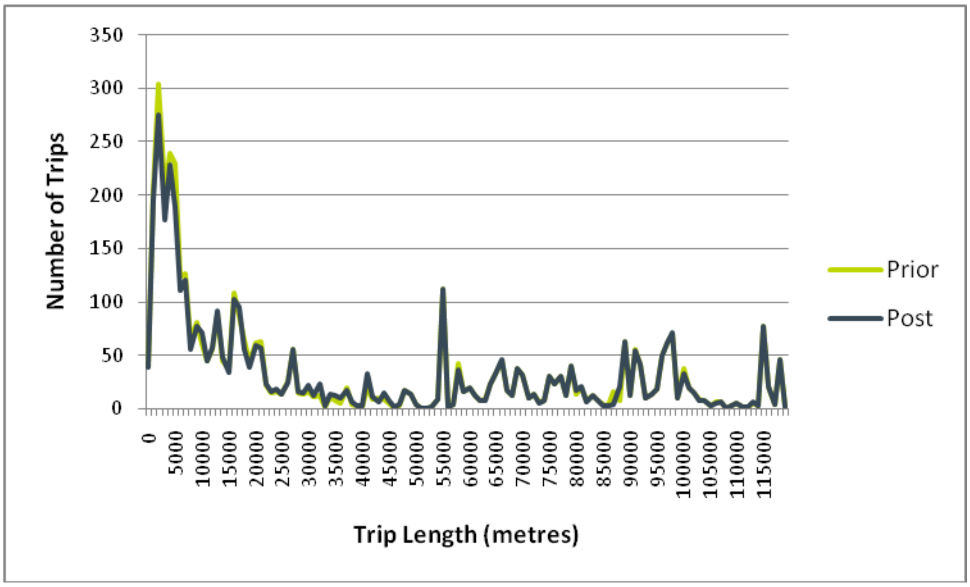
Units: pcu/h

Figure 35. Trip Length Distribution for Evening Peak (UC2 LGV)



Units: pcu/h

Figure 36. Trip Length Distribution for Evening Peak (UC3 HGV)



Units: pcu/h

9.3.5. Sector-to-Sector Changes

The matrix changes made by matrix estimation at the sector level are tabulated in more detail as part of Appendix D. The changes are presented by time period, and by user class (i.e. Car, LGV and HGV and All Vehicles), showing the absolute values, differences and percentage differences.

The analysis shows a number of sectors where the changes are greater than 5%. To put the impact of matrix estimation into context, our analysis focuses on those sectors that contained more than 1% of the total prior matrix for each vehicle type and time period. By focusing upon those sectors that contained at least 1% of the total prior matrix (960 car trips in the Morning Peak, 750 car trips in the Inter-Peak and 980 car trips in the Evening Peak) the analysis typically includes only 25% of the 64 sector to sector movements (i.e. 75% of the sectors have less than 1% of the matrix total). The number and location of each exceedance by time period and vehicle type is presented below:

- Morning peak hour – cars
  - Sector 1 to sector 1 – 12% change – within inner cordon so no observed movements
  - Sector 3 to sector 3 – 18% change – within outer cordon so limited observed movements
  - Sector 8 to sector 4 – 12% change – external to within outer cordon – Highridge screenline westbound in the prior had a shortage of trips
  - Sectors 6-8, 7-6 and 8-6 – maximum change of 8% – limited observed movements
- Morning peak hour –LGV
  - Sector 1 to sector 1 – 25% change – within inner cordon so no observed movements
  - Sector 3 to sector 3 – 30% change – within outer cordon so limited observed movements
  - Sector 5 to sector 5 – 6% change – within outer cordon so limited observed movements
  - Sector 6 to sector 3 – 9% change – external to within outer cordon – Hengrove screenline southbound in the prior had a shortage of trips
  - Sector 8 to sector 5 – 14% change – external to within outer cordon – Outer cordon inbound in the prior needs a reduction in trips
  - Sector 8-6 – 10% change – external movements so limited observed movements
- Morning peak hour – HGV
  - Sector 4 to sector 7 – 8% change – external to outer cordon – Pidgeonhouse screenline eastbound had too many trips in the prior

  - Sector 8-7 and8-8 – maximum change 9% – external movements so limited observed movements

- Inter-peak hour – cars
  - Sector 1 to sector 1 – 22% change – within inner cordon so no observed movements
  - Sector 3 to sector 3 – 6% change – within outer cordon so limited observed movements
  - Sector 6 to sector 4 – 6% change – external to within outer cordon – Inner cordon inbound and Central (S2) had too many trips in the prior
- Inter-peak hour –LGV
  - Sector 1 to sector 1 – 29% change – within outer cordon so limited observed movements
  - Sector 3 to sector 3 – 12% change – within outer cordon so limited observed movements
  - Sector 6 to sector 3 – 16% change – external to within outer cordon – Hengrove screenline southbound had a shortage of trips in the prior
  - Sector 6-8– 6% change – external movements so limited observed movements
- Inter-peak hour – HGV
  - Sector 4 to sector 5 – 35% change – within outer cordon so limited observed movements
  - Sector 5 to sector 5 – 43% change – within outer cordon so limited observed movements
  - Sector 7-8– 9 % change – external movements so limited observed movements

- Evening peak hour – cars
  - Sector 1 to sector 1 – 12% change – within inner cordon so no observed movements
  - Sector 3 to sector 3 – 11% change – within outer cordon so limited observed movements
  - Sector 4 to sector 8 – 32% change –within outer cordon to external– Pidgeonhouse screenline eastbound had a shortage of trips in the prior
  - Sector 7 to sector 4 – 8% change – external to within outer cordon
- Evening peak hour –LGV
  - Sector 3 to sector 3 – 26% change – within outer cordon so limited observed movements
  - Sector 5 to sector 5 – 12% change – within outer cordon so limited observed movements
  - Sector 7 to sector 3 – 14% change – external movements so limited observed movements
  - Sector 7 to sector 4 – 13% change – external to within outer cordon – Pidgeonhouse screenline westbound and river screenline southbound had too few trips in the prior
  - Sector 4 to sector 8 – 7% change –within outer cordon to external– Pidgeonhouse screenline eastbound had too few trips in the prior
- Evening peak hour – HGV
  - Sector 7 to sector 8 – 6% change – external movements so limited observed movements

The incidence of exceedances of the benchmark criteria at a sector to sector level is a result of small changes at a cell to cell level combining to form larger change at a sector level. Furthermore, the screenlines used in matrix estimation are close together and likely to include a number of incidences of one vehicle trip making multiple crossings of screenlines. Such incidences would be unknown in the matrix estimation process and consequently, matrix estimation could have resulted in generating more, shorter trips rather than one longer one. This would result in a greater change in the number of trips generated by matrix estimation than would actually be the case.

9.4. Trip Matrix Validation

9.4.1. Traffic flow

Validation of the post matrix estimation matrices was undertaken by comparing total screenline and cordon modelled flows and counts by vehicle type and time period. The assessment criteria follows those defined in TAG Unit 3.19 Table 1, which states that differences between modelled flows and counts should be less than 5% of the counts for all or nearly all screenlines. The focus of the validation effort was on cars and all vehicles as cars represent typically 80% to 90% of flow on roads in the area of detailed modelling. The results of this assessment are shown in Table 41 and are summarised below.

- In the morning peak
  - all of the roadside interview cordons meet acceptability guidelines
  - all 14 of the matrix estimation screenlines (seven screenlines in two directions) meet acceptability guidelines
  - two of the four validation screenlines (two screenlines in two directions) meet acceptability guidelines. .
- In the inter-peak:
  - all of the roadside interview cordons meet acceptability guidelines
  - all of the matrix estimation screenlines meet acceptability guidelines
  - all of the validation screenlines meet acceptability guidelines for cars and three out of four meet acceptability guidelines for all vehicles and the one that fails has a 6% difference for all vehicles
- In the evening peak:
  - all of the roadside interview cordons meet acceptability guidelines
  - 12 out of 14 of the matrix estimation screenlines meet acceptability guidelines
  - two of the four validation screenlines (two screenlines in two directions) meet acceptability guidelines; with one of those failing doing so marginally with a difference of 5.1%.

Table 36 presented the validation of the prior trip matrices and that showed that whilst the roadside interview cordons met acceptability guidelines, matrix estimation was required to improve the validation of the prior matrix against screenlines. The impact of matrix estimation has improved trip matrix validation with all or nearly all of the roadside interview cordons and matrix estimation screenlines meeting acceptability guidelines.

The performance of the post matrix estimation trip matrices against independent validation screenlines is more mixed, with the inter-peak performing much better than the peak periods. The performance of the validation screenlines in the morning and evening peaks was a compromise between achieving a screenline and link flow calibration and validation whilst minimising the impact of matrix estimation.

The two validation screenlines have different geographic scopes. The central validation screenline intersects east-west movements across the scheme alignment in south Bristol whilst the railway screenline intersects north-south movements across the whole of area of detailed modelling.

The performance of central independent validation screenline was the hardest to achieve an acceptable validation standard, with adjacent screenlines and routing across multiple screenlines causing a particular problem. Whilst the performance varies from a -9% difference in the morning peak to a 16% difference in the evening peak for total vehicle the actual difference in all vehicle flow is quite small, ranging from 36pcu to 190pcu. In deciding to accept the performance of the central independent validation screenline the high level of performance of the adjacent Highridge and Pigeonhouse matrix estimation screenlines, in which cars and all vehicle met acceptability guidelines, provided reassurance that the right level of traffic was travelling east-west at two other locations in south Bristol in the scheme corridor.

The performance of the railway independent validation screenline meets acceptability guidelines for flow for cars and all vehicles in both directions the inter-peak, the flow is within 6% difference for cars and all vehicles in both directions the evening peak and meets acceptability guidelines for cars and all vehicles southbound in morning peak. The main exception is therefore northbound movements in the morning peak, which have a -10% difference for cars and -7% difference for all vehicles. The locations where the difference is greatest are Cattle Market Road and St John's Lane both of which are not a concern for SBL.

Table 41. Summary of Cordon and Screenline Validation (Post Matrix Estimation Matrix)

Screenline		Direction	Morning Peak				Inter-Peak				Evening Peak			
			Car	LGV	HGV	Total	Car	LGV	HGV	Total	Car	LGV	HGV	Total
RSI Cordon	Inner Cordon	Inbound	2%	2%	-22%	0%	1%	0%	-3%	0%	1%	2%	-16%	0%
		Outbound	-1%	-2%	-15%	-2%	-1%	1%	-4%	-2%	-1%	-3%	-16%	-2%
	Outer Cordon	Inbound	0%	1%	-1%	0%	0%	0%	0%	0%	-1%	1%	-1%	-1%
		Outbound	0%	0%	0%	0%	0%	1%	-7%	0%	0%	1%	-3%	0%
Matrix Estimation Screenline	Central (S2)	Westbound	0%	-1%	0%	-1%	0%	1%	0%	-1%	-1%	2%	7%	-1%
		Eastbound	1%	-2%	21%	0%	0%	0%	1%	-1%	1%	9%	-4%	1%
	River	Northbound	-2%	-10%	6%	-3%	-1%	4%	-10%	0%	-2%	15%	0%	0%
		Southbound	-1%	-10%	-17%	-3%	0%	-8%	-11%	-2%	0%	-12%	-4%	-2%
	Bishopsworth	Northbound	-6%	0%	-21%	-5%	0%	0%	-9%	1%	0%	-1%	11%	1%
		Southbound	0%	0%	-32%	1%	0%	0%	-1%	1%	-1%	1%	-18%	-1%
	Hengrove	Northbound	-2%	0%	6%	-1%	0%	0%	0%	0%	0%	-2%	21%	0%
		Southbound	0%	7%	9%	2%	0%	0%	1%	0%	-2%	-2%	2%	-2%
	Pidgeonhouse	Westbound	0%	-3%	-2%	-1%	0%	1%	0%	0%	-1%	3%	8%	0%
		Eastbound	0%	-5%	13%	-1%	0%	0%	1%	0%	-1%	-4%	25%	-1%
	Highridge	Westbound	-1%	0%	-23%	-1%	0%	-1%	-1%	0%	-5%	-13%	-24%	-6%
		Eastbound	0%	0%	-5%	0%	0%	-2%	-17%	-1%	0%	1%	-1%	1%
	Long Ashton	Inbound	0%	0%	-1%	-1%	0%	0%	1%	0%	1%	3%	3%	1%
		Outbound	0%	1%	-17%	-1%	0%	0%	0%	-1%	-7%	3%	9%	-6%
Validation	Central (S1)	Westbound	-11%	-7%	21%	-9%	3%	10%	5%	6%	10%	47%	2%	16%
		Eastbound	-5%	5%	22%	-2%	3%	9%	-39%	4%	-8%	2%	62%	-5%
	Railway	Northbound	-10%	9%	27%	-7%	-1%	3%	10%	-1%	-6%	10%	-3%	-4%
		Southbound	4%	13%	-7%	5%	-1%	7%	-1%	0%	4%	12%	10%	5%

10. Assignment Calibration and Validation

10.1. Overview

The assignment calibration and validation was undertaken in conjunction with the matrix estimation process previously described in section 9. An iterative process was undertaken whereby the validation of the model was assessed using comparisons of the modelled and observed data as discussed below. Adjustments were made to the model to reduce the differences between the modelled and observed data. These adjustments were undertaken as part of the model calibration and were described earlier in this report and included:

- revisions to the network coding (as described in section 6 and 8) including local revisions to the junction coding, typically focussed on the signal timings; and
- revisions to the demand matrices (as described in Section 9).

The model was validated by means of the following comparisons:

- modelled and observed traffic flows on links compared by cars and all vehicles and by time period; and
- modelled and observed journey times along routes, as a check on the quality of the network and the assignment.

Each of these validations is presented in separate sections below. The final section presents the levels of model convergence achieved.

10.2. Traffic Flows on Links

Assignment validation was undertaken by comparing modelled flows and counts on individual links by vehicle type and time period. The assessment criterion follows those defined in TAG Unit 3.19 Table 2, which states that 85% of the criteria should meet acceptability guidelines for flow criteria and GEH criteria.

The focus of the validation effort was on cars and all vehicles as cars represent typically 80% to 90% of flow on roads in the ADM. The counts of LGVs and HGVs are not sufficiently accurate for validation of individual link flows.

The assessment of traffic flows on links was undertaken at a range of geographic levels:

- within sector 1 – the urban area of south Bristol surrounding the scheme;
- south of the River Avon (excluding Long Ashton) – the ADM;
- within sectors 1 or 2 – the area covered by RSI surveys, including the city centre to the north of the river; and
- all links – the area within sectors 1 or 2 and counts around Long Ashton

The results need to be considered in the context that traffic counts were predominantly entered into matrix estimation as mini-screenlines, as TAG Unit 3.19 advises, and seldom as individual link counts. This controls the application of matrix estimation but limits the ability of matrix estimation to match individual links counts. As such, the TAG Unit 3.19 acceptability guidelines are very challenging at a link level.

10.2.1. Morning Peak

Morning peak link flow validation is shown in Table 42. Link flow validation with sector 1, the urban area of south Bristol immediately around the scheme, meets acceptability guidelines for TAG flow criteria for cars and all vehicles and meets acceptability guidelines for TAG GEH criteria for cars whilst just missing the acceptability guidelines for TAG criteria for all vehicles.

South of the River Avon covers the ADM and link flow validation almost meets acceptability guidelines for TAG flow criteria for cars (84%) and all vehicles (78%) but falls short of the acceptability guidelines for GEH criteria.

The link flow validation of independent validation counts demonstrates that 85% of links meet the TAG acceptability guidelines.

Table 42. Morning Peak Link Flow Validation

Count source	Location	Number of counts	Flow criteria (% pass)		GEH criteria	
			Car	Total	Car	Total
RSI and Matrix Estimation Links	Within sector 1	64	98%	92%	83%	80%
	South of the River Avon	115	84%	78%	76%	71%
	Within sectors 1 or 2	155	79%	73%	72%	66%
	All links	163	80%	74%	72%	67%
Validation	Total	26	85%	81%	73%	81%
Total	Total	189	81%	75%	72%	69%

Inter-peak link flow validation is shown in Table 43. Link flow validation with sector 1, the urban area of south Bristol immediately around the scheme, meets acceptability guidelines for TAG flow and GEH criteria for cars and all vehicles South of the River Avon covers the area of detailed modelling and link flow validation also meets acceptability guidelines for TAG flow and GEH criteria for cars and all vehicles.

The link flow validation of independent validation counts meets acceptability guidelines for TAG flow and GEH criteria.

Table 43. Inter-Peak Link Flow Validation

Count source	Location	Number of counts	Flow criteria (% pass)		GEH criteria	
			Car	Total	Car	Total
Calibration	Within sector 1	64	100%	94%	83%	86%
	South of the River Avon	115	94%	89%	81%	77%
	Within sectors 1 or 2	155	86%	80%	75%	71%
	All links	163	87%	80%	77%	72%
Validation	Total	26	96%	85%	92%	88%
Total	Total	189	88%	81%	79%	74%

Evening peak link flow validation is shown in Table 44. Link flow validation with sector 1, the urban area of south Bristol immediately around the scheme, meets acceptability guidelines for TAG flow criteria for cars and all vehicles and almost meets acceptability guidelines for TAG GEH criteria for cars and all vehicles. South of the River Avon covers the area of detailed modelling and link flow validation almost meets acceptability guidelines for TAG flow criteria for cars (83%) and all vehicles (79%) but falls short of the acceptability guidelines for GEH criteria.

The validation at the independent counts sites does not meet the TAG acceptability guidelines in all models. In deciding to accept this level of independent link flow validation the performance of the model at a screenline level was considered suitable and, analysis did reveal that combining the counts into mini-screenlines improved validation of the independent validation counts although this was not considered in the final matrix as this is against WebTAG 3.19 advice.

Sensitivity tests based upon the final forecasts will be undertaken to further support this argument.

Table 44. Evening Peak Link Flow Validation

Count source	Location	Number of counts	Flow criteria (% pass)		GEH criteria	
			Car	Total	Car	Total
Calibration	Within sector 1	64	92%	91%	83%	81%
	South of the River Avon	115	83%	79%	77%	73%
	Within sectors 1 or 2	155	77%	73%	72%	68%
	All links	163	76%	72%	71%	67%
Validation	Total	26	73%	69%	58%	46%
Total	Total	189	76%	71%	69%	65%

10.3. Journey Time Validation

10.3.1. 2011 Dataset

The modelled journey time values were compared with the TomTom derived journey times representing 2011. Section 5.5 describes how these data were checked for consistency between 2011 and 2012 on the A370 between Long Ashton and the River Avon. Summaries of the overall modelled and observed journey time comparisons for each route in the three modelled time periods are provided below in Table 45 to Table 47. The detailed representation of individual route sections, which highlights any outlying observed and modelled times, is provided in Appendix E.

10.3.2. Morning Peak

Table 45 shows that 93% (13/14) of the journey time routes in the morning peak hour model routes are within +/- 15% of the observed journey times.

Route 1 northbound fails to meet the criteria for the last 1 km of the route (on the approach to Parson Street gyratory). The count on Bridgewater Road shows that the assigned flow was 3% (28 vehicles) less than the count which is within acceptable limits. The use of route specific cruise speeds would have enabled a better match to the journey time data but this was not the basis on which the model was built. As the flow validation in the area is good the failure of the journey time route is not of concern.

Overall the model performs well, replicating the observed journey times to TAG Unit 3.19 standards.

Table 45. Comparison of Observed and Modelled Journey Time - Morning Peak

Route No.	Route Description	Morning Peak (08:00 - 09:00)					
		Direction	Route Journey Time		Diff in seconds	% Diff	Within 15% (or 60secs if higher)
			Observed (mean)	Modelled			
Route 1	A38 Corridor	NB	00:07:46	00:06:12	-94	-20%	×
		SB	00:05:37	00:05:43	6	2%	✓
Route 2	Barrow Gurney Corridor	NB	00:04:37	00:05:07	30	11%	✓
		SB	00:05:04	00:04:58	-6	-2%	✓
Route 3	Long Ashton Corridor	NB	00:10:02	00:08:44	-78	-13%	✓
		SB	00:07:10	00:06:41	-29	-7%	✓
Route 4	A370 Corridor	NB	00:10:02	00:08:44	-78	-13%	✓
		SB	00:05:11	00:05:28	17	5%	✓
Route 5	Winterstoke Road	SB	00:03:47	00:03:22	-25	-11%	✓
		NB	00:06:57	00:06:26	-31	-7%	✓
Route 6	Headley Park	CW	00:14:38	00:12:59	-99	-11%	✓
Route 7		ACW	00:12:47	00:11:06	-101	-13%	✓
Route 8	Hengrove	CW	00:16:47	00:15:44	-63	-6%	✓
Route 9		ACW	00:16:32	00:16:59	27	3%	✓

10.3.3. Inter Peak

Table 46 shows that 93% (13/14) of the journey time routes in the inter-peak hour model are within +/- 15% of the observed journey times.

The route which fails to meet the criterion is Route 5 northbound. The main delay occurs at the superstore entrance.. The flows on Winterstoke Road show a deficit of traffic of 4% (39 vehicles) so the exceedance of the journey time validation criterion along this stretch of the journey time route is not of concern.

Table 46. Comparison of Observed and Modelled Journey Time – Inter-Peak

Route No.	Route Description	Inter-Peak (10:00-16:00)					
		Direction	Route Journey Time		Diff in seconds	% Diff	Within 15% (or 60secs if higher)
			Observed (mean)	Modelled			
Route 1	A38 Corridor	NB	00:05:44	00:06:04	20	6%	✓
		SB	00:05:34	05:45	11	3%	✓
Route 2	Barrow Gurney Corridor	NB	00:04:02	00:04:11	9	4%	✓
		SB	00:04:30	00:04:52	22	8%	✓
Route 3	Long Ashton Corridor	NB	00:06:55	00:06:21	-34	-8%	✓
		SB	00:06:42	00:06:38	-4	-1%	✓
Route 4	A370 Corridor	NB	00:06:19	00:06:36	17	4%	✓
		SB	00:05:11	00:05:30	19	6%	✓
Route 5	Winterstoke Road	SB	00:03:22	00:03:23	1	0%	✓
		NB	00:04:12	00:05:21	69	27%	×
Route 6	Headley Park	CW	00:12:27	00:13:34	67	9%	✓
Route 7		ACW	00:10:21	00:11:06	45	7%	✓
Route 8	Hengrove	CW	00:15:03	00:14:49	-14	-2%	✓
Route 9		ACW	00:14:29	00:14:30	1	0%	✓

10.3.4. Evening Peak

Table 47 shows that 93% (13/14) of the journey time routes in the evening peak hour model are within +/-15% of the observed journey times. The one that fails (route 5 northbound) is slightly too quick but the difference is less than 60 seconds.

The route which fails to meet the criterion is Route 5 northbound, the approach to the superstore entrance is missing 20 seconds of delay, due to the positioning of the connectors.. The flows along Winterstoke Road are -3% (-29 vehicles) when compared to the counts which suggests the exceedance of the journey time validation criterion is not of concern.

Table 47. Comparisons of Observed and Modelled Journey Times – Evening Peak

Route No.	Route Description	Evening Peak (17:00 - 18:00)					
		Direction	Route Journey Time		Diff in seconds	% Diff	Within 15% (or 60secs if higher)
			Observed (mean)	Modelled			
Route 1	A38 Corridor	NB	00:06:35	00:06:25	-10	-3%	✓
		SB	00:06:11	05:54	-17	-5%	✓
Route 2	Barrow Gurney Corridor	NB	00:04:59	00:04:15	-44	-15%	✓
		SB	00:06:07	00:06:30	23	6%	✓
Route 3	Long Ashton Corridor	NB	00:06:57	00:06:29	-28	-7%	✓
		SB	00:06:56	00:07:12	16	4%	✓
Route 4	A370 Corridor	NB	00:06:23	00:06:43	20	5%	✓
		SB	00:05:34	00:05:52	18	5%	✓
Route 5	Winterstoke Road	SB	00:04:15	00:03:36	-39	-15%	✓
		NB	00:05:48	00:04:52	-56	-16%	×
Route 6	Headley Park	CW	00:14:54	00:14:42	-12	-1%	✓
Route 7		ACW	00:12:16	00:12:30	14	2%	✓
Route 8	Hengrove	CW	00:18:12	00:15:56	-136	-12%	✓
Route 9		ACW	00:18:22	00:16:14	-128	-12%	✓

10.4. Model Convergence

The convergence for each model period is summarised in Table 48 below and shows that the three models have achieved a high level of convergence. They are stable for at least four consecutive assignment-simulation loops and the delta values (as reported by the %GAP statistic in SATURN) comfortably exceed the targets specified in the TAG Unit 3.19.

Table 48. Model Convergence

Time Period	Assignment - Simulation Loop	Delta (%)* (δ)	% Flow Change (P within +/-1%)
Morning Peak	37	0.01%	98.7%
	38	0.01%	98.8%
	39	0.01%	98.7%
	40	0.02%	98.6%
Inter-Peak	15	0.01%	98.7%
	16	0.01%	98.8%
	17	0.01%	98.7%
	18	0.00%	99.2%
Evening Peak	12	0.05%	98.7 %
	13	0.05%	98.9%
	14	0.04%	99.1%
	15	0.04%	99.2%

Note: * as measured by the SATURN %GAP measures

11. Conclusion

The model has been validated using the measures and criteria recommended in TAG Unit 3.19. The following comparisons between modelled and observed data have been reported:

- total flows for cordons and screenlines (counts on which were used as constraints in the matrix estimation – calibration counts);
- flows on individual links which did not feature in the matrix estimation (independent counts); and
- journey times in the SBL corridor.

The models have been built following best practice and have adopted processes that have ensured that the matrix has retained its integrity with the observed data and that matrix estimation has been applied in a controlled and limited way.

The analysis shows that the three models:

- either meet, or are very close to, the acceptability guidelines regarding the impact of matrix estimation at a cell, trip and matrix level, although not at a sector level;
- either meet, or are very close to, the acceptability guidelines at the cordon and screenline level at the individual calibration sites, and at the independent validation sites; and
- the models either meet, or are very close to, the acceptability guidelines for journey times.

All three models are stable and achieve acceptable levels of convergence.

Sensitivity tests will be undertaken to confirm model fitness for purpose

Appendices

Appendix A. Matrix Development

A.1. Expansion of RSI data

Source data

Four sets of RSI data have been used in building the partial matrices for the GBATS3 SBL 2012 HAM model.

- 2001 RSIs forming a wider Bristol (outer) cordon
- 2006 RSIs to provide data for M32, Hengrove Way and the A370 Long Ashton bypass
- 2009 RSIs to supplement 2012 data to form a South Bristol (inner) cordon
- 2012 RSIs to complete a South Bristol (inner) cordon

Each of these RSIs had accompanying manually classified counts (MCCs) at the same site on the same day. In addition the 2001 surveys have MCCs carried out at on a different day. There were also automatic traffic counts (ATCs) at the RSIs from the original survey year, plus new ATC data collected in 2012.

Issues / variations

The 2001 RSI data was previously[4] processed for two hour peak periods – the peak hour plus 30 minute shoulders each side (07:30 – 09:30, 16:30-18:30).

The MCC data collected on the RSI survey day was only collected in the interview direction and is available for one hour periods (07:00-08:00, 08:00-09:00 etc). Thus this MCC data is not readily available for time periods consistent with the processed RSI data. Additional MCC data is also available for a non survey day in both the interview and non-interview direction. This is summarised in 30 minute periods however there is no distinction between cars and LGVs. The RSI data for the additional half hours was found and added to the 2001 RSI data set (at the BATS1 zone level).

The 2001 RSI data was only available in zone, not OS Grid Reference (OSGR) format. It was converted from BATS1 zones to BATS3 zones then to GBATS3 SBL 2012 HAM zones before an expansion process. This zone conversion process resulted in an RSI dataset with a large number of records (> 50,000) containing small fractions of trips. The interview dataset (prior to expansion) was therefore filtered to retain only those records where the trip volume was >0.1. This eliminated more than 30,000 records and lost just under 1000 trips (~9% of the data), prior to expansion.

The 2006, 2009 and 2012 RSI data were available with OSGRs on the origins and destinations. This RSI data was thus zoned to the SBL3 zones by overlaying the co-ordinates with the zone boundaries.

Both the SBL and SGCS models have excluded motorcycles and buses when building the matrices so the same process will be adopted for the reprocessing of 2001 and 2006/09 RSI data and the processing of the 2012 RSI data.

Three of the 2001 RSI sites were not located on the cordons so filtering of the records was required to eliminate trips for zone pairs which would not (or would be unlikely) to cross the cordon. For the A4 Portway records which had a destination in the Stoke Bishop and Sneyd Park area were removed from the dataset as they would not cross the cordon. The survey conducted on A4 Bath Road was located east of the Bath road and St Phillips Causeway split whilst the cordon crossed the two individual roads. This meant that records from the Bath Road site were filtered so that trips that would not logically use Bath Road were removed. This was done because there was another RSI on St Phillips Causeway at the cordon crossing point and using both datasets risked double counting, and the use of St Phillips Causeway captured trips crossing the cordon point and hence was more accurate. Therefore trips which had destinations to zones to the north and east of A4320 St Phillips Causeway and bounded by the river and A38 Gloucester road were excluded, as were long distance trips which would most certainly use the A4320 rather than go into the city centre and back out again. For the Callington Road site any trips with a destination in the zone representing Callington Road Hospital and Tesco supermarket were removed because they would not cross the cordon.

In all three cases the count being used to expand the filtered RSI dataset was located on the cordon so the two datasets are consistent.

[4] For earlier versions of the Bristol model

The 2001 RSI data has no information (or at least none available) on the number of occupants in each vehicle. This information is not required for the HAM base matrices but is required to define person trip to vehicle trip conversions for the interface between the BATS demand model and the HAM. Occupancies for 2001 were estimated from the 2006, 2009 and 2012 RSI data for each time period, trip purpose (including purpose direction: from / to home and NHB). Having taken these dimensions into account little variation was found to exist between the vehicles crossing the cordons inbound and outbound. If the purpose profile varies by RSI site, then the occupancies will also vary. Similarly if a particular zone generates or attracts mainly one purpose of journey (e.g. education or commuting) this will be taken into account. No other spatial variation was considered possible from the data available.

A.2. Estimation of missing cordon data

Flow Volumes

The RSI data necessarily excludes a number of the routes crossing the cordons. In the majority of cases, the volume of trips crossing the cordons will be available from ATC data. In a few cases the volumes need to be estimated for the three assignment hours (08:00-09:00, average hour 10:00-16:00 and 17:00-18:00). Only two sites on the inner cordon are missing volumes (Goodwin Drive and Vale Lane). Goodwin Drive is not explicitly represented in the SATURN highway network. Traffic on this route would be represented in the model as movements on Longway Avenue. Vale Lane is the only modelled link on the Inner cordon where a flow estimate is required. There were several sites on the outer cordon where volumes were estimated some with links in the model, others not explicitly represented.

Where the link crossing the cordon is in the SATURN network the flow could be taken from the previous version of the model. In cases where the link is not explicitly in the SATURN network the traffic using this route should be on other modelled links thereby increasing their flow. Estimates of the flow for missing links are either based on estimates of residential activity for residential distributor roads, or from nearby roads of a similar nature where count data does exist.

Where data has been inferred from a neighbouring road / link, the vehicle split has also been taken from that site. Where a GBATS3 SBL 2009 v2 HAM link flow has been used the numbers of HGVs are taken directly and the light vehicles from the GBATS3 SBL 2009 v2 HAM model split into cars and LGVs using the average split by time period derived from the RSI data. Where the flow has been estimated on the basis of trip generation, and in cases where the roads are very minor and a nominal flow has been assumed; it has also been assumed that there will be no HGVs and the car/LGV split will again be the average from the RSI data collected.

The table below shows the approach adopted for the roads without count data.

Table 1: Source of flow volumes for cordon roads not counted

Cordon	Road	Link in model	Source of flow estimate
Inner	Vale Lane	Yes	Flow = 50% Headley Lane flow.
Inner & Outer	Goodwin Drive	No	50% of Longway Ave (same vehicle split)
Outer	Kersteman Road	Yes	GBATS3 SBL 2009 v2 HAM link Generic LGV / car split by time period 0% HGVs
Outer	Elton Road	No	50% of Kersteman Road (same vehicle split)
Outer	North Road	No	Use Chesterfield Road flows
Outer	Mina Road	No	Commercial – estimate from Gazetteer and trip rates. Generic LGV / car split by time period. 0% HGVs
Outer	St Marks Road	No	Nominal 100 per hour. Generic LGV / car split by time period 0% HGVs
Outer	All Hallows Road	No	Low – nominal 50 per hour. Generic LGV / car split by time period. 0% HGVs
Outer	Hazelbury Road	No	Gazetteer and trip generation rates, Generic LGV / car split by time period. 0% HGVs
Outer	Kinsale Road	No	50% of Hazelbury Road (same vehicle split)

Appendix B. Accuracy of Partial Matrix

B.1. Accuracy of partial matrices at sector level (Step 5)

The partial matrices created are not statistically reliable on a cell by cell basis at zone level for trips segmented into various purposes. It was necessary to look at how the partial matrices could be aggregated both spatially and across demand segments to provide statistically reliable sector level matrices for use in the gravity modelling. This applies to car and LGV trips to produce constraints for the gravity modelling. For HGVs this process was used to determine at what level of detail the partial trip matrices can be reliably used to adjust / constrain the HGV matrices from the GBATS3 SBL 2009 v2 HAM model.

There are two sources of error introduced: errors as a result of sampling only a fraction of the trips taking place, and errors associated with the way in which the data was collected and then adjusted to provide estimates of the trips taking place. The variance associated with these two sources of error are referred to as sampling variance and non sampling variance. The way these are measured is described for each in turn.

Sampling Variance

The formula used to calculate the sampling variance of a matrix cell estimate, using the simplified formulation from the DfT's MATVAL program and set out in the ERICA 5 Manual (and reproduced here) is:

$$\mathrm{var}(N) = \frac{Q(Q-q)}{q^2}x \qquad or \qquad \mathrm{var}(N) = \frac{Q}{q}\left(\frac{Q}{q}-1\right)x$$

Where:

- Q is the counted flow within a period,
- q is the number of vehicles interviewed,
- x is the number of vehicles in the category of interest (i.e. with a particular purpose, origin & destination).
- N is the estimate of trips in this category over the period.

This is linear in x, with the consequence that the variance of any pooled set of trips is equal to the sum of the variances associated with each individual observed trip (case x=1). This sampling variance is a simple function of the sample fraction q/Q.

When working with individual interview records the sampling variance associated with each cordon crossing location (with an expansion factor) can be calculated as:

$$\mathrm{var}(N) = \frac{Q}{q}\left(\frac{Q}{q}-1\right) \text{ or } \mathrm{var}(N) = f\left(f-1\right)$$

Where *f* is the expansion factor from the RSI time period (3 or 6 hour) to the count period (3 or 6 hour).

There were a number of cordon crossing sites without RSI data. For these the OD flow volumes are estimated based on either select link analysis (SLA) from an earlier model combined with new count data, or from a sample of RSI records for adjacent sites factored to count data.

In these instances, there is in theory no sampling so the sampling variance should be zero. In practice the sampling variance was calculated using the expansion factors obtained to scale from the SLA volumes to the base year counts.

Non sampling variance

This relates to variations introduced specific to the way the data has been collected and adjusted (scaled) in order to estimate the partial matrices. Every adjustment (scaling) applied introduced further error and hence increased the variance.

The TAM and ERICA manuals identify a number of sources of error including:

- Day-to-day variation in flow – use of single day v week v two week surveys

- Mechanical/Human counter error
- The assumption of reversibility if the wrong direction was surveyed
- The age of the data
- Seasonal variation.

In addition data has been estimated from select link analyses of earlier model runs and in filled data by assuming records from the RSI sites available can be transferred to a nearby non-interviewed site.

The possible values of C (coefficient of variation) to be used to estimate the non sampling, site specific variances obtained from the TAM and ERICA manuals are shown in Table 49 below, together with the assumptions proposed for use in determining the variance for ODs in the GBATS3 SBL 2012 HAM partial matrices.

Table 49. Site specific variance factors

ID	**Source of error**	**C (TAM)**	**$1000C^2$ (ERICA)**	**$1000C^2$ GBATS3 SBL 2012 HAM**
a1	If interviews have been factored to a manual classified count - for cars - for LGVs - for HGVs	 0.05 0.12 0.14	 2.5 - -	 2.5 14.4 19.6
a2	If interviews have been factored to an automatic traffic count (ATC	0.025	0.5	0.625
b1	if total site flow is based on a 1-day count		1	1
b2	if total site flow based on a 1-week count		0.5	0.5
b3	if total site flow based on 2 weeks or more of data		0	0
c1	if the survey day-of-week to average weekday factor (which may be equal to 1.0) is based on national or regional data		1.5	01.5
c2	if the survey day-of-week to average weekday factor is based on local data		0	0
d1	if a regional or national factor (which may be equal to 1.0) has been applied to convert to a different month		2.5	2.5
d2	if the data was collected in the correct month or a local conversion factor is available		0	0
e1	for every year between RSI data collection and model base, if a regional or national growth factor (which may be equal to 1.0) has been applied		6	6
e2	if a local growth factor is available		0	2
f1	if reversibility has been assumed		10	10
f2	if interviews are factored to a reverse direction count		5	5
f3	for the interviewed direction		0	0
g1	For every year between RSI data collection and model base			2
h1	Where no RSI available and OD data estimated			32*

*Majority of the sites where this value would apply filtered 2001 RSI data or SLA were used, the data used is therefore 11 years old and in terms of the other factors this would mean a factor of 22 (from g1) giving a minimum accepted value, a factor of 10 was also applied to account for the transferring of data. This then largely gives a site specific variance which is greater than those where OD data is known reflecting the potential errors in the data set.

For SBL, the adjustments made which impact on the variance of the estimates include:

- Transposing RSI data and scaling using the reverse direction counts

- Using old RSI data (from 2001, 2006 and 2009)
- Seasonal and annual growth adjustments to counts to the March 2012 base month
- Scaling RSIs to both MCCs (for veh types) and ATCs (for volumes)
- To account for infilling / where no count data was available

All these adjustments are applied and the results added together so the non sampling variance is equal to the sum of the C^2 values.

Variance and Confidence Intervals for OD estimates

Having estimated both the sampling and non sampling variance of the site (cordon crossing) estimates of OD flows passing through these sites, these were combined to give an estimate of the variance for each OD pair based on the flow contributions from the different cordon crossing sites. Adopting the approach used in ERICA, it was assumed that the OD flows from different sites are independent (no correlation).

The variance of the estimated flow then becomes:

$$Var(N) = f(f-1)x + QfxC^2 + \textit{product term (neglected)}$$

Where: f=Q/q (the expansion factor for the period) as defined above

Q is the traffic count (by vehicle type) within the period

C^2 is the non sample variance (site specific) calculated using the factors defined in Table 49 above.

x is the number of vehicles in the category of interest (i.e. with a particular purpose, origin & destination

The variance of the OD pair was calculated as the sum of the variances of the different sources of trips contributing to the volume of that OD pair. Similarly the variance of sector to sector matrices was the sum of the variances of the zone pairs within the sector pair. The 95% confidence intervals for sector pairs were then calculated from the sector to sector volumes and variances. This enabled the definition of sectors such that the 95% confidence intervals for the flows for all sector pairs are between 20% and 30% of the flow volumes (for cars and LGVs).

Definition of these sectors began from an examination of the 3x3 sector system used within the partial matrix build, looking at total car trips and splitting into car work and car non work, this led to the ratios shown in Table 50 to Table 52 below.

In each case the Intra sector movements (1-1 etc) were not of interest since there was only partial information and the inter sector cells are shaded based on the value of the ratio of the 95% confidence interval to the number of trips. The shading is as follows:

Shade	Value of ratio	Interpretation
(blue)	< 0.2	Data could be further disaggregated
(red)	> 0.3	Pushing limits of data reliability – too much disaggregation
(green)	between 0.2 and 0.3	Ratio within desired bounds

Table 50. 3x3 sector definition for all car trips

Origin Sector	AM			IP			PM		
	1	2	3	1	2	3	1	2	3
1 Inside Inner	0.38	0.13	0.04	0.21	0.10	0.03	0.35	0.06	0.02
2 Between cordons	0.13	0.05	0.01	0.12	0.05	0.01	0.15	0.06	0.01
3 Outside Outer	0.03	0.00	0.00	0.03	0.01	0.00	0.03	0.01	0.00

Table 51. 3x3 for Non Work car trips

Origin Sector	AM			IP			PM		
	1	2	3	1	2	3	1	2	3
1 Inside Inner	0.48	0.23	0.05	4.62	0.31	0.11	0.70	0.23	0.04
2 Between cordons	0.25	0.06	0.02	0.68	0.22	0.03	0.38	0.14	0.01
3 Outside Outer	0.04	0.01	0.00	0.11	0.03	0.02	0.07	0.02	0.01

Table 52. 3x3 for Work car trips

Origin Sector	AM			IP			PM		
	1	2	3	1	2	3	1	2	3
1 Inside Inner		3.47	1.00	1.34	1.12	0.35		4.37	0.37
2 Between cordons	3.03	0.53	0.16	1.16	0.40	0.04	2.26	0.69	0.07
3 Outside Outer	0.34	0.03	0.05	0.28	0.04	0.02	0.95	0.12	0.05

This process demonstrated that it was difficult to find a detailed sector system using any purpose segmentation since even the non work (commuting + other) trips have ratios higher than desired for the movements between sectors 1 and 2 in the inter peak. Since more weight is attached to the spatial detail only the vehicle types (car and LGV) were considered for gravity modelling. Since the ratios for the 3x3 sectors without any purpose disaggregation shown in Table 50 are sufficiently small it should be possible to disaggregate to additional sectors while still retaining confidence in the sector to sector movements.

The process adopted for further disaggregation was to take each of the initial 3 sectors above in turn and consider splitting them into two or three sub sectors – while leaving the other sectors as they were. This process aimed to demonstrate the bounds of the level of detail possible and for cars suggested that:

- Sector 1 (within Inner cordon) could be split into 2 sub sectors but using 3 generated ratios larger than 0.3 in a few cases (particularly for movements to / from sector 2) suggesting that when combined with sub divisions of the outer areas this would stretch the data too far.
- Sector 2 (between cordons) could just about be split into 4 sectors without disaggregation of sectors 1 and 3. A division into two areas (north and south of the river) retained good confidence in the data.
- Sector 3 could be sub divided into around 6 areas and retain confidence in the data for movements for sector 2. However for movements to sector 1 a division into two or three areas was the best that could be achieved.

The resulting ratios of the 95% confidence interval to the number of car trips for each time period are shown in Table 53 to Table 55 below, using the 12 sector shown in Figure 15. The same shading by ratio range is adopted as shown above. In this case the values in the pink cells (denoting the data is being stretched) are generally (but not always) only slightly greatly than 0.3 and hence deemed acceptable.

Table 53. Ratio of 95% Confidence Interval / Trips – Car trips AM peak

95% CI / TRIPS		Inner		Outer				External					
		1	4	2	6	5	9	3	8	10	7	11	12
Inner	1			0.13		0.26		0.24	0.26	0.29	0.20		
	4			0.29		0.33		0.41	0.40	0.28	0.34		
Outer	2	0.32	0.25					0.31	0.20	0.29	0.26	0.05	0.53
	6							0.26	0.97	0.12	0.11	0.13	0.48
	5	0.51	0.32					1.12	0.42	1.01	0.27	0.12	0.18
	9							0.41	0.27	0.09	0.03	0.05	0.44
External	3	0.19	0.30	0.09	0.18	0.06	0.13						
	8	0.21	0.39	0.13	0.50	0.07	0.15						
	10	0.20	0.12	0.23	0.09	0.05	0.05						
	7	0.15	0.10	0.29	0.28	0.03	0.07						
	11			0.35	0.31	0.05	0.02						
	12			0.20	0.25	0.02	0.10						

Table 54. Ratio of 95% Confidence Interval / Trips – Car trips Inter Peak

95% CI / TRIPS		Inner		Outer				External					
		1	4	2	6	5	9	3	8	10	7	11	12
Inner	1			0.11		0.29		0.19	0.38	0.36	0.20		
	4			0.24		0.23		0.20	0.28	0.21	0.13		
Outer	2	0.25	0.25					0.15	0.21	0.23	0.39	0.30	0.22
	6							0.41	0.71	0.11	0.44	0.24	0.57
	5	0.44	0.31					0.18	0.09	0.20	0.13	0.10	0.05
	9							0.29	0.17	0.10	0.17	0.03	0.30
External	3	0.22	0.17	0.17	0.25	0.13	0.22						
	8	0.42	0.30	0.25	0.47	0.09	0.22						
	10	0.32	0.15	0.16	0.10	0.14	0.07						
	7	0.23	0.15	0.35	0.15	0.07	0.20						
	11			0.33	0.24	0.07	0.05						
	12			0.43	0.44	0.06	0.15						

Table 55. Ratio of 95% Confidence Interval / Trips – Car trips PM peak

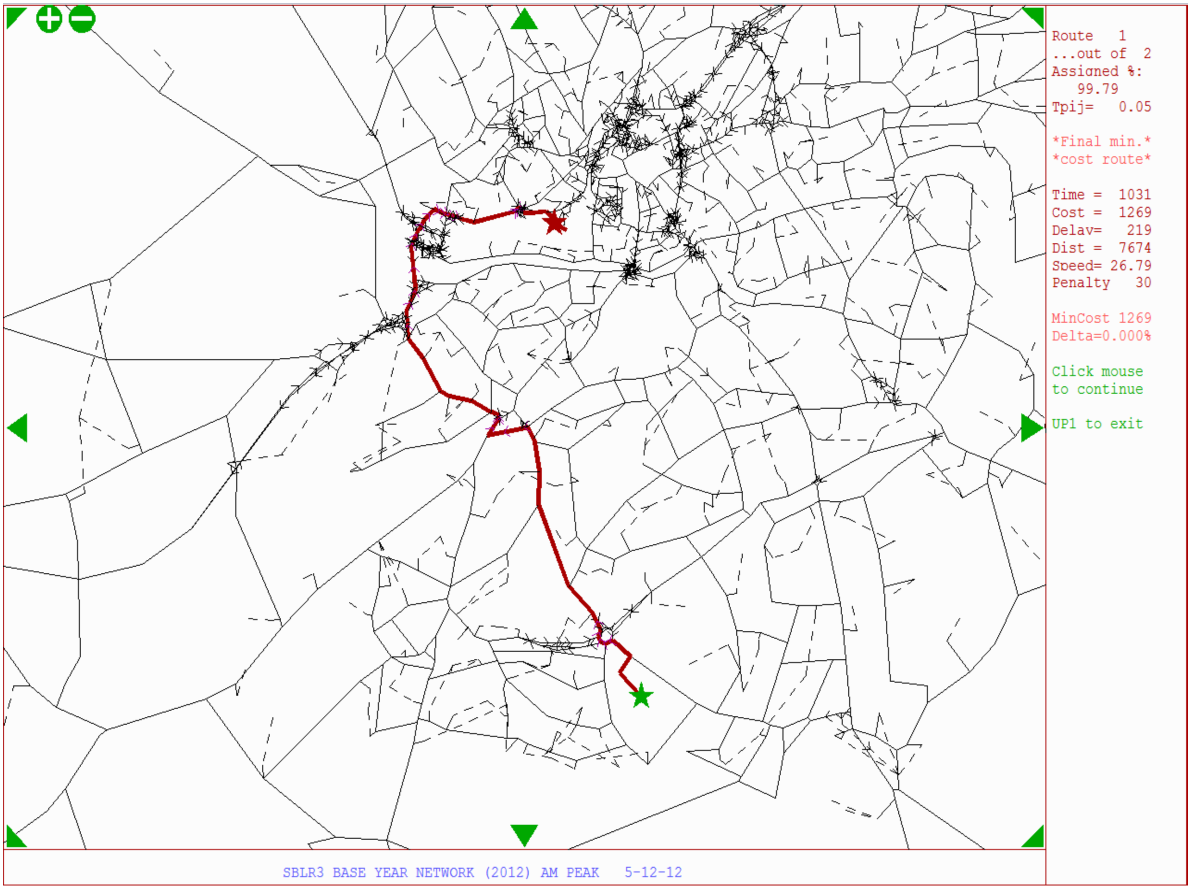
<table>
<tr><th colspan="2" rowspan="2">95% CI / TRIPS</th><th colspan="2">Inner</th><th colspan="4">Outer</th><th colspan="6">External</th></tr>
<tr><th>1</th><th>4</th><th>2</th><th>6</th><th>5</th><th>9</th><th>3</th><th>8</th><th>10</th><th>7</th><th>11</th><th>12</th></tr>
<tr><td rowspan="2">Inner</td><td>1</td><td></td><td></td><td colspan="2">0.21</td><td colspan="2">0.30</td><td>0.19</td><td>0.24</td><td>0.28</td><td colspan="3">0.15</td></tr>
<tr><td>4</td><td></td><td></td><td colspan="2">0.13</td><td colspan="2">0.20</td><td>0.16</td><td>0.39</td><td>0.16</td><td colspan="3">0.13</td></tr>
<tr><td rowspan="4">Outer</td><td>2</td><td rowspan="2">0.13</td><td rowspan="2">0.31</td><td></td><td></td><td></td><td></td><td>0.18</td><td>0.22</td><td>0.30</td><td>0.41</td><td>0.30</td><td>0.30</td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td><td>0.24</td><td>0.36</td><td>0.13</td><td>0.15</td><td>0.38</td><td>0.09</td></tr>
<tr><td>5</td><td rowspan="2">0.30</td><td rowspan="2">0.21</td><td></td><td></td><td></td><td></td><td>0.12</td><td>0.07</td><td>0.08</td><td>0.03</td><td>0.06</td><td>0.02</td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td><td>0.21</td><td>0.15</td><td>0.06</td><td>0.12</td><td>0.04</td><td>0.40</td></tr>
<tr><td rowspan="6">External</td><td>3</td><td>0.18</td><td>0.17</td><td>0.11</td><td>0.30</td><td>0.27</td><td>0.33</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td>0.26</td><td>0.30</td><td>0.13</td><td>0.42</td><td>0.24</td><td>0.18</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td>0.22</td><td>0.29</td><td>0.13</td><td>0.10</td><td>0.27</td><td>0.06</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td rowspan="3">0.29</td><td rowspan="3">0.29</td><td>0.10</td><td>0.11</td><td>0.12</td><td>0.04</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>11</td><td>0.08</td><td>0.14</td><td>0.07</td><td>0.07</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>0.26</td><td>0.52</td><td>0.08</td><td>0.26</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

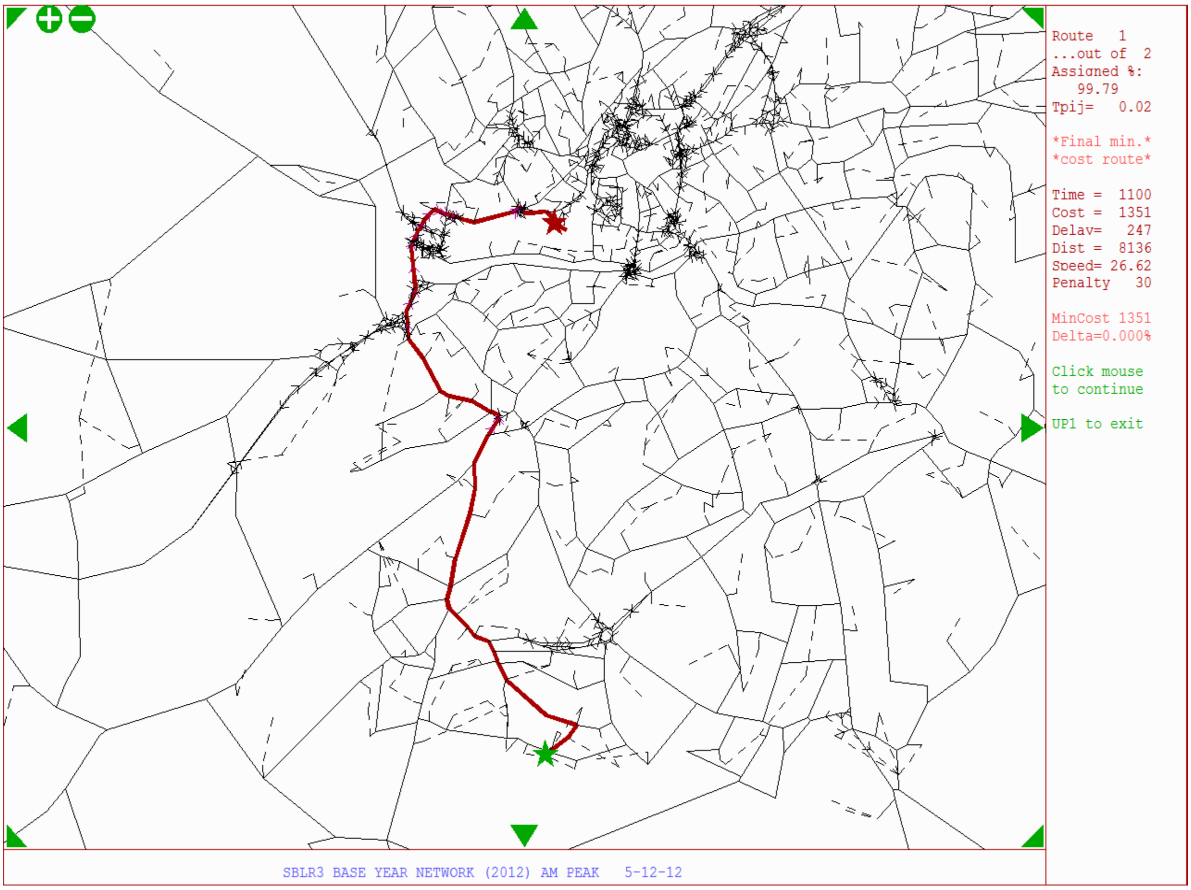
Appendix C. Route Choice Validation

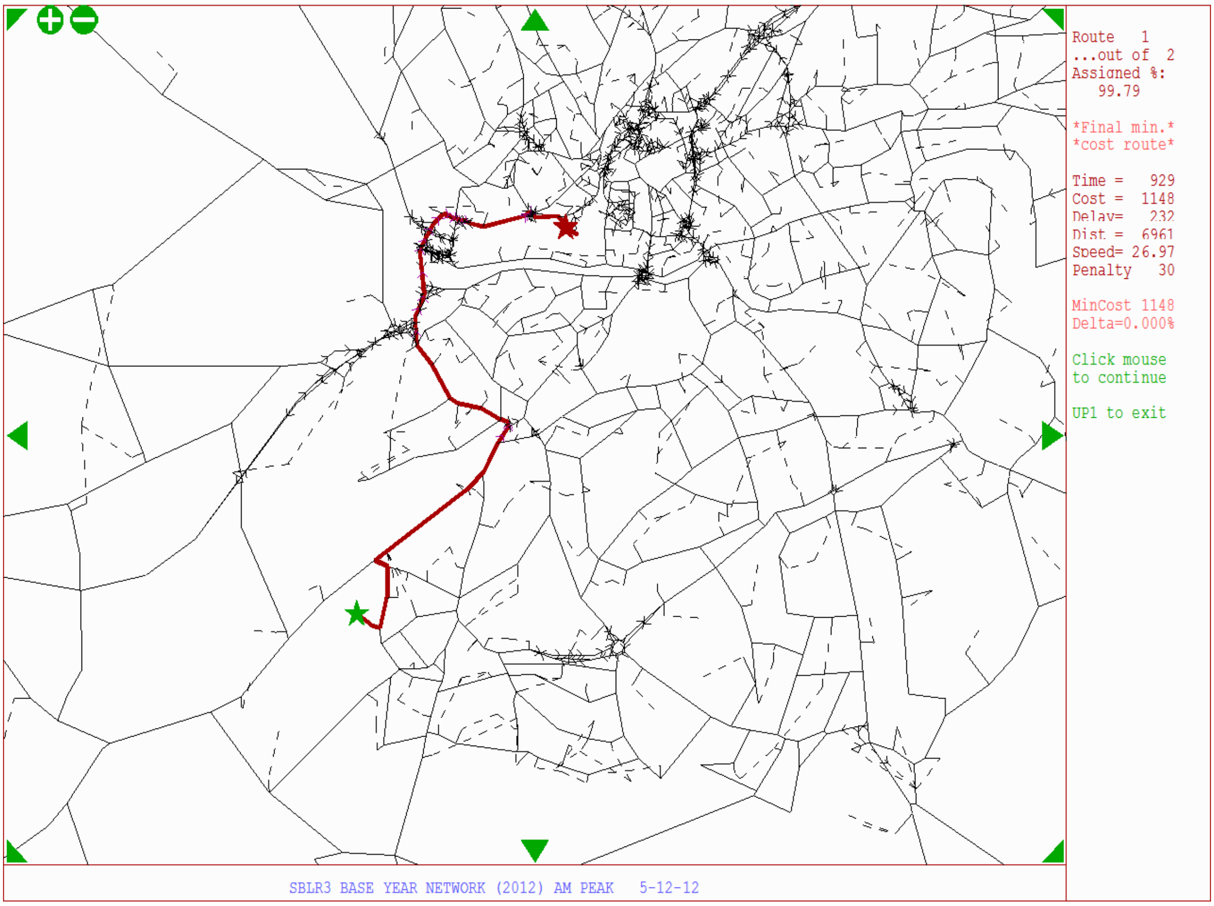
Route choice plots are presented below between a range of origin and destination pairs.

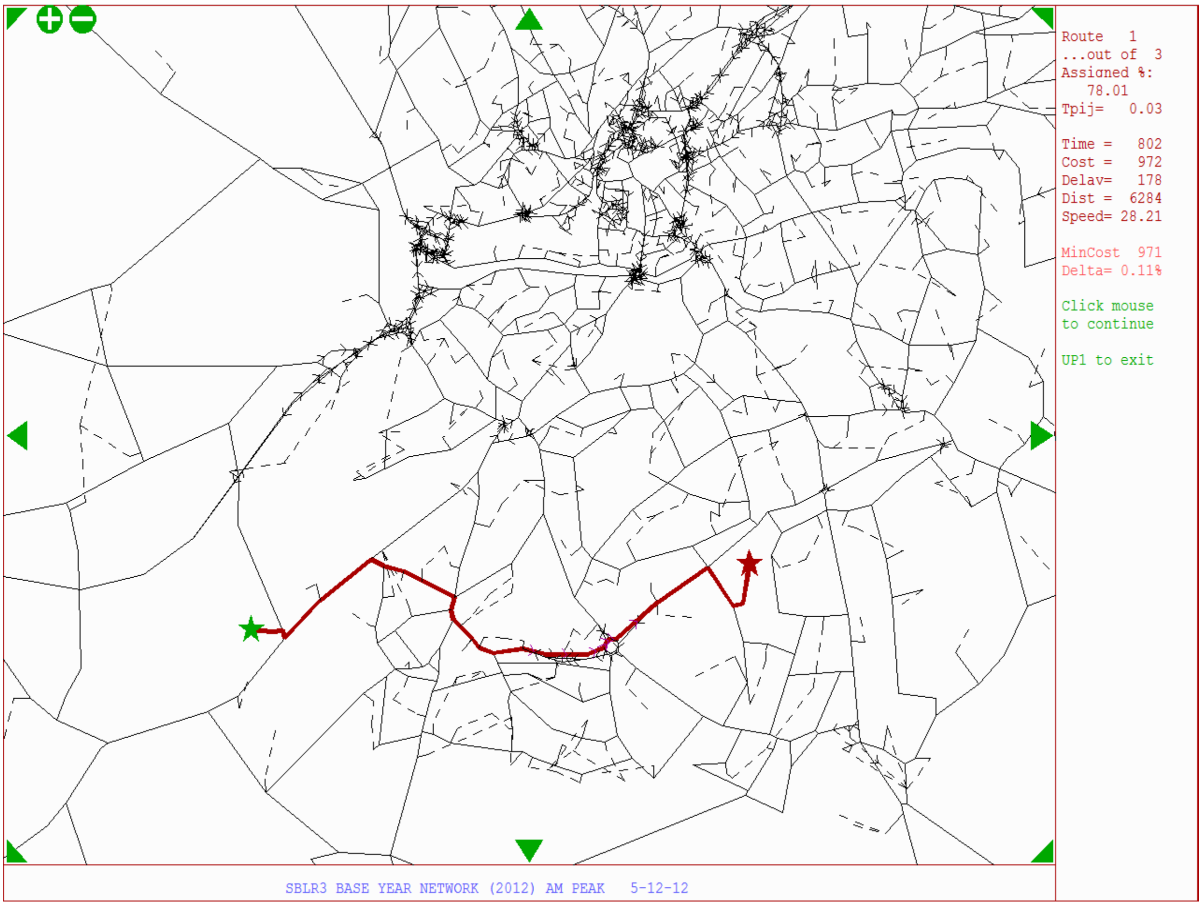
C.1. Prior Assignment

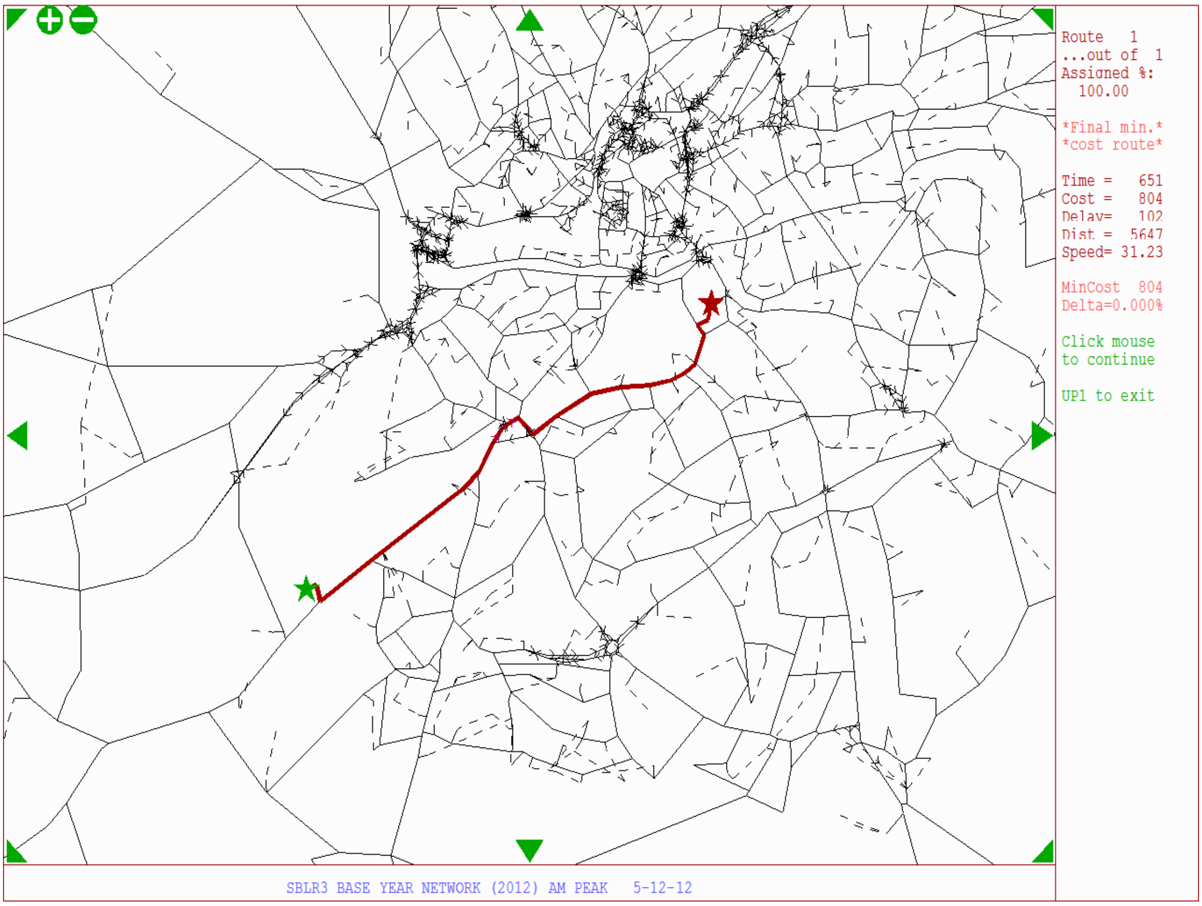
C.1.1. Morning Peak



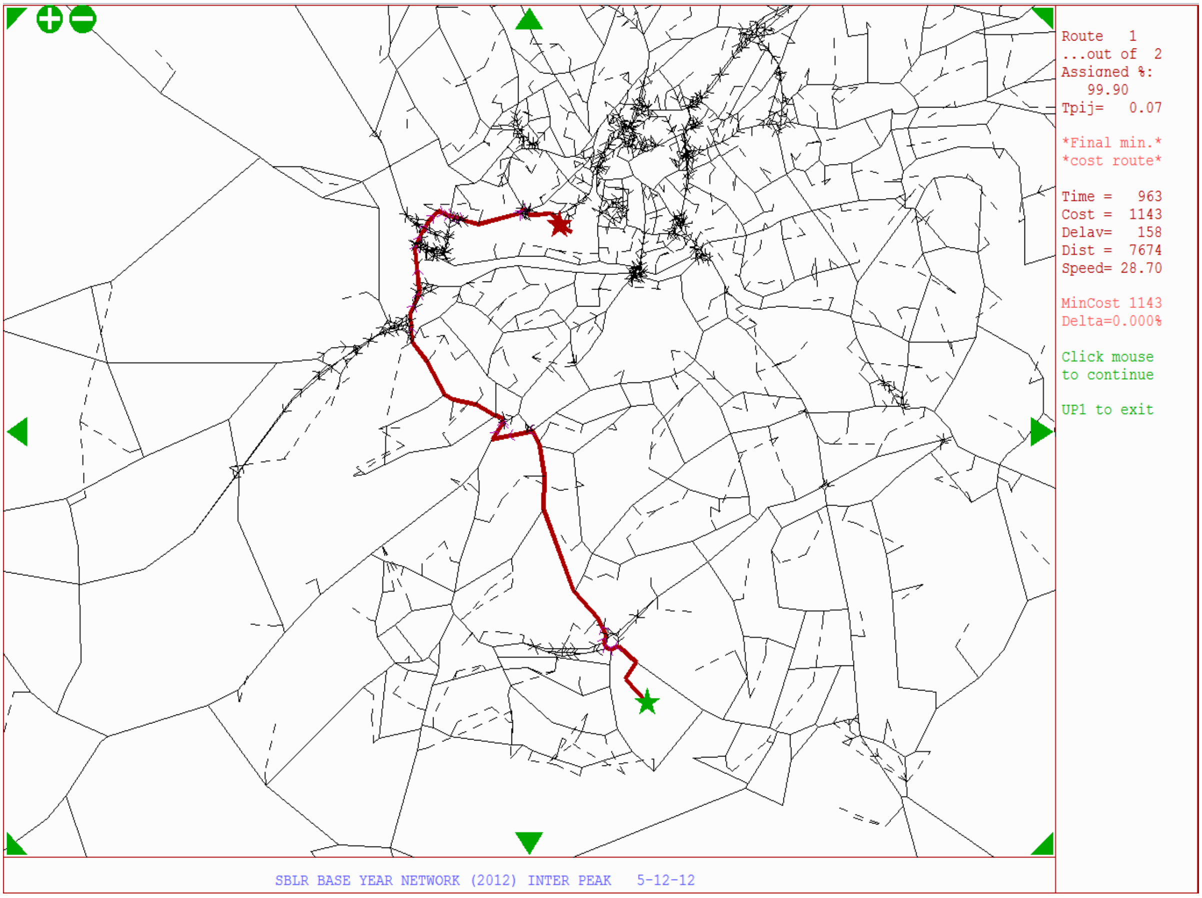

Route 1
...out of 2
Assigned %:
99.79
Tpij= 0.02
Final min.
cost route
Time = 1100
Cost = 1351
Delay= 247
Dist = 8136
Speed= 26.62
Penalty 30
MinCost 1351
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

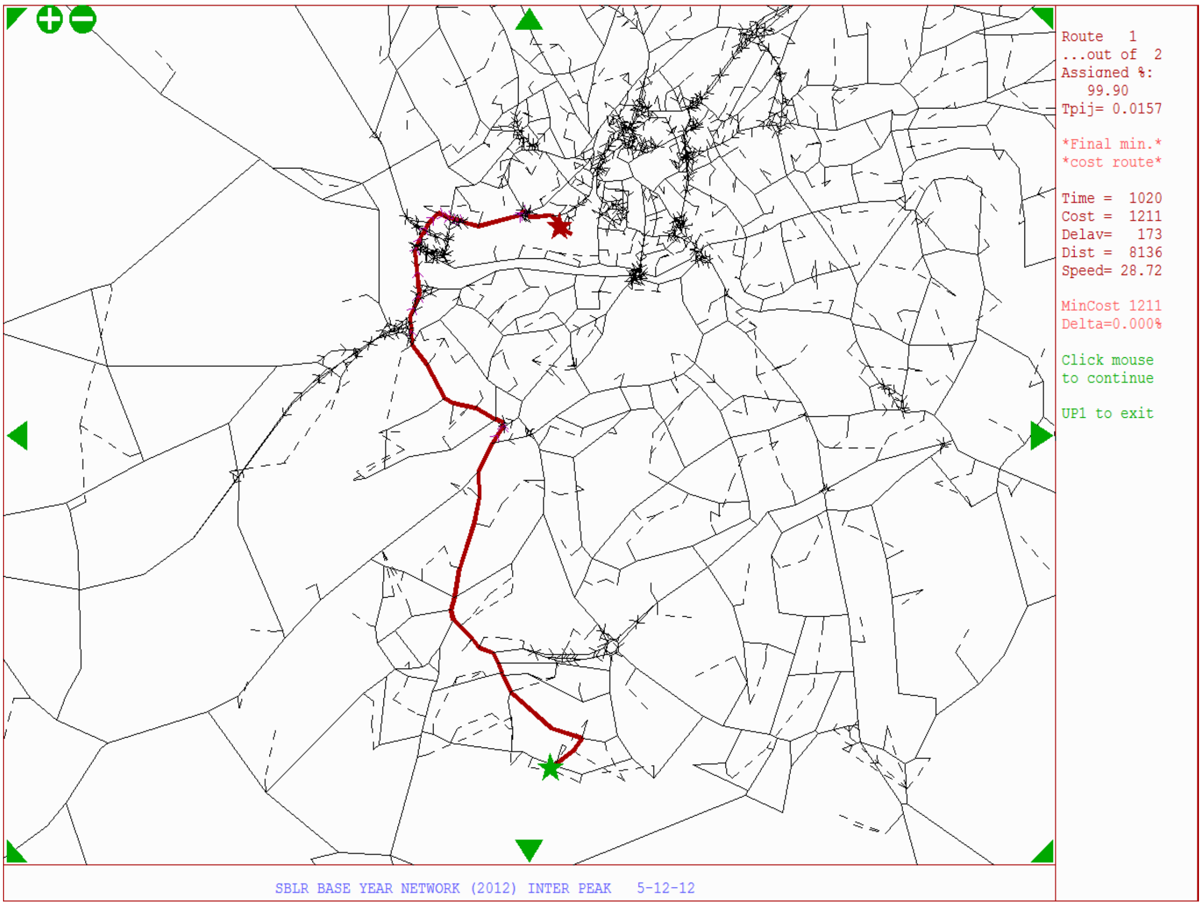

Route 1
...out of 2
Assigned %:
99.79
Final min.
cost route
Time = 929
Cost = 1148
Delay= 232
Dist = 6961
Speed= 26.97
Penalty 30
MinCost 1148
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

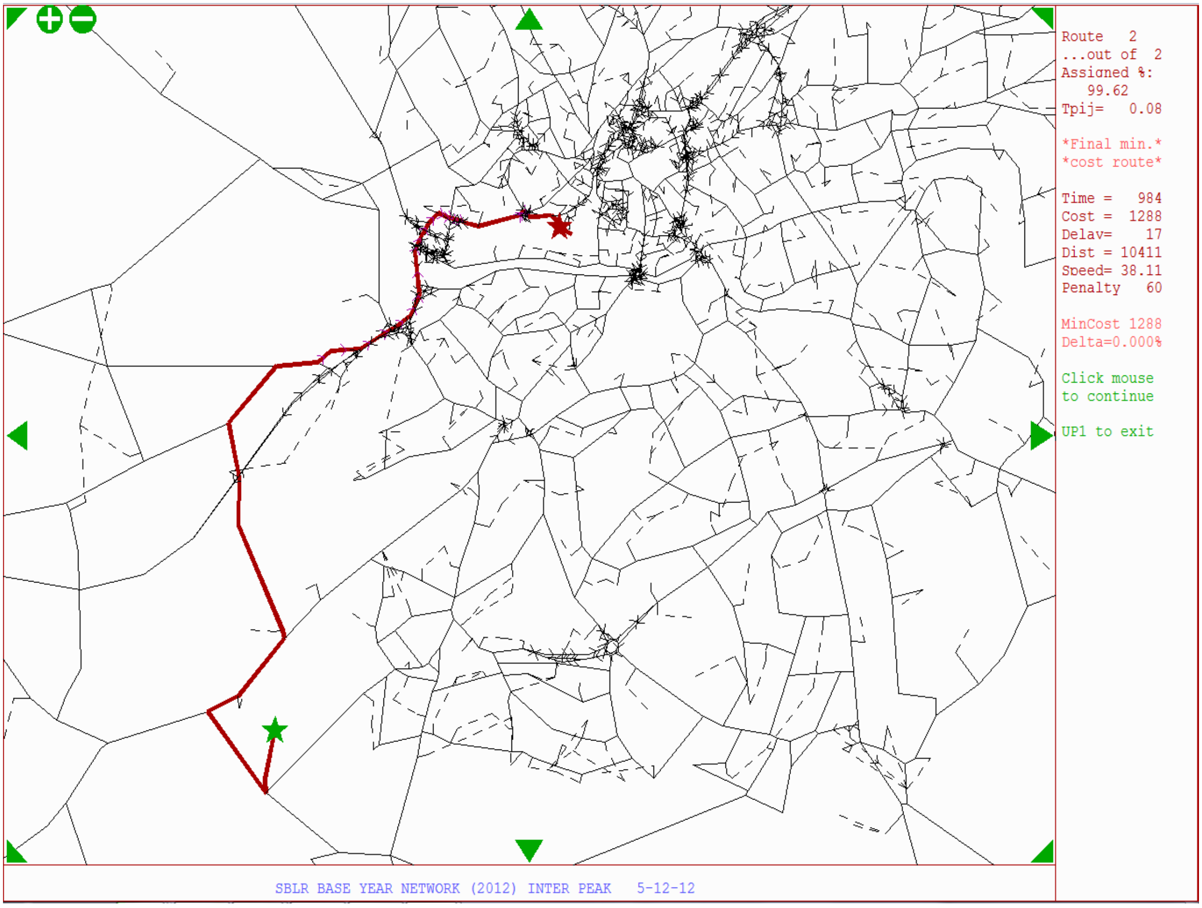

Route 1
...out of 3
Assigned %:
78.01
Tpij= 0.03
Time = 802
Cost = 972
Delav= 178
Dist = 6284
Speed= 28.21
MinCost 971
Delta= 0.11%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

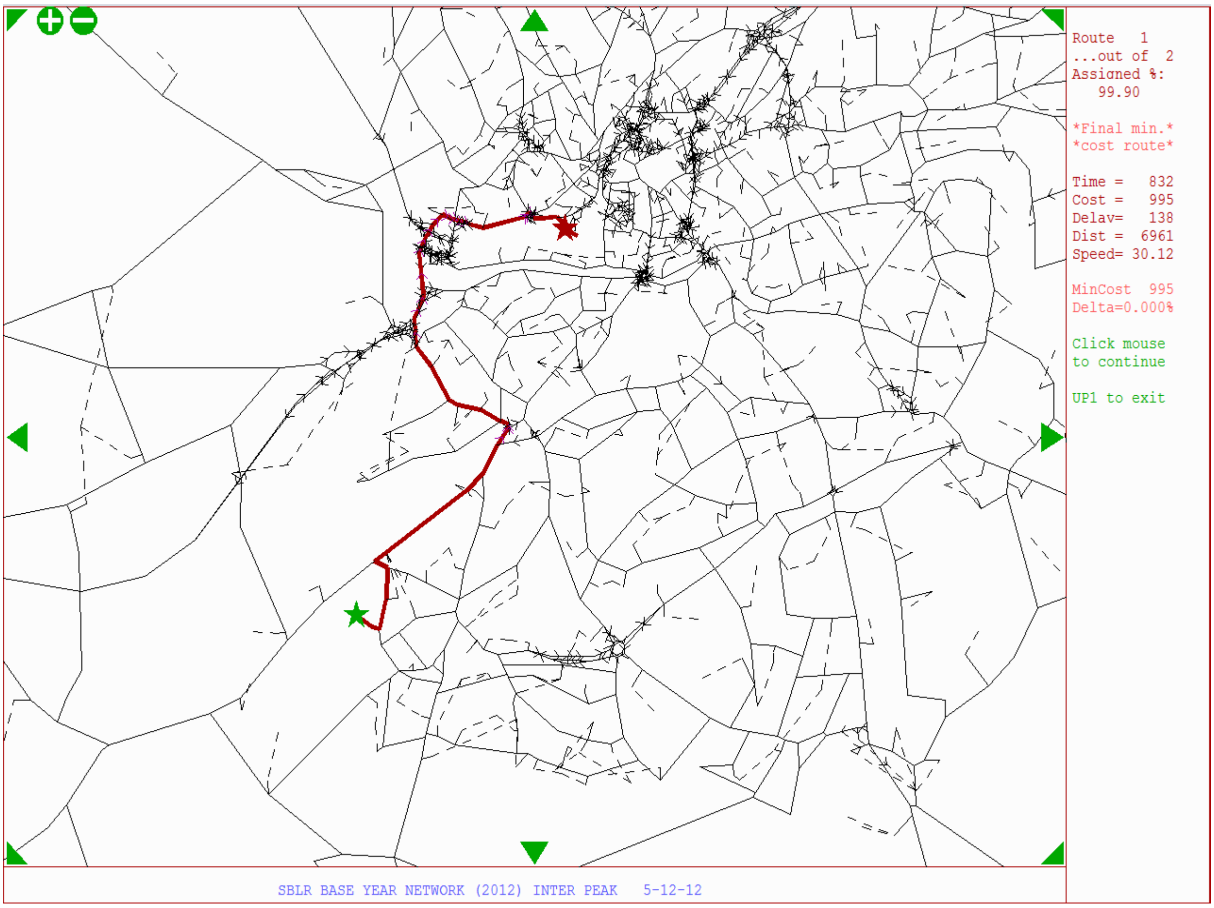

Route 1
...out of 1
Assigned %:
100.00
Final min.
cost route
Time = 651
Cost = 804
Delav= 102
Dist = 5647
Speed= 31.23
MinCost 804
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

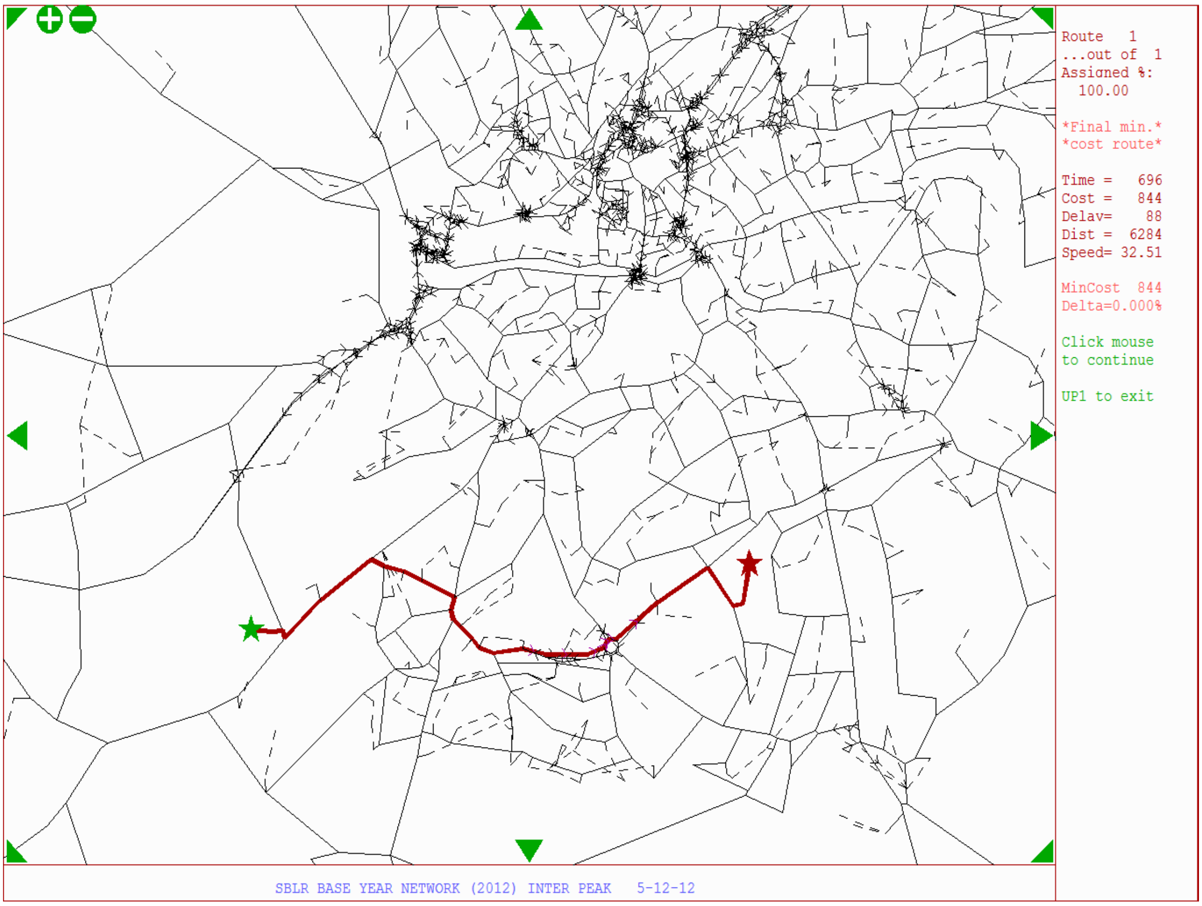
C.1.2. Inter-Peak

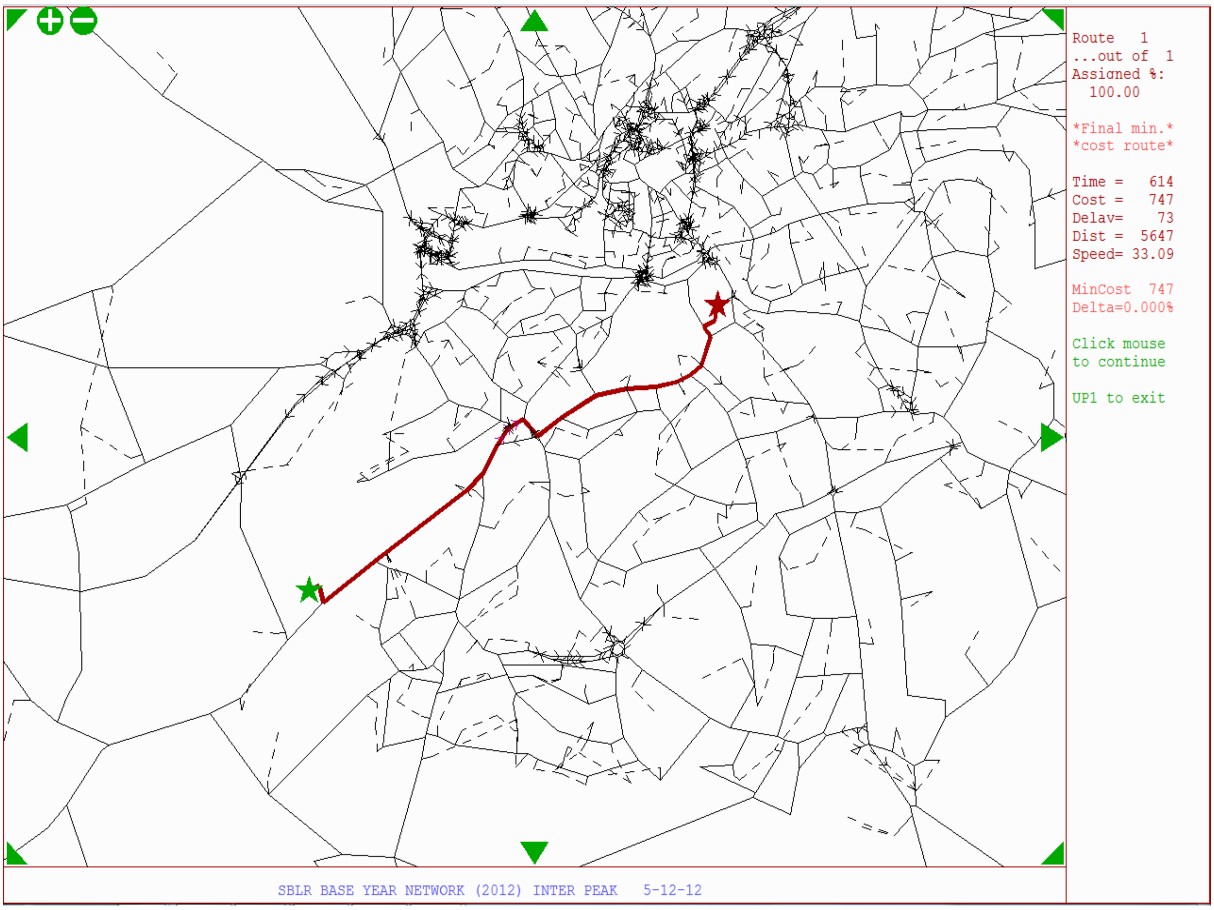




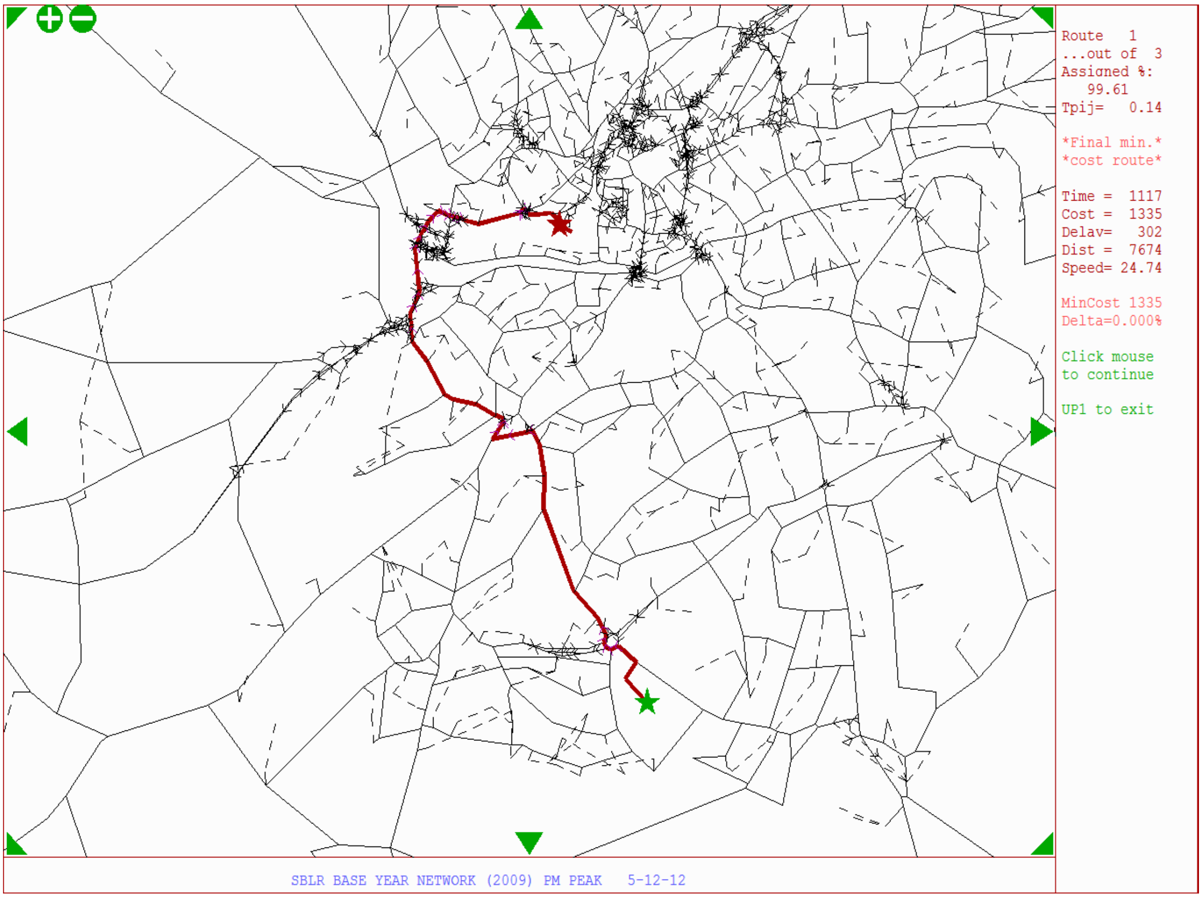

Route 2
...out of 2
Assigned %:
99.62
Tpij= 0.08
Final min.
cost route
Time = 984
Cost = 1288
Delav= 17
Dist = 10411
Speed= 38.11
Penalty 60
MinCost 1288
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

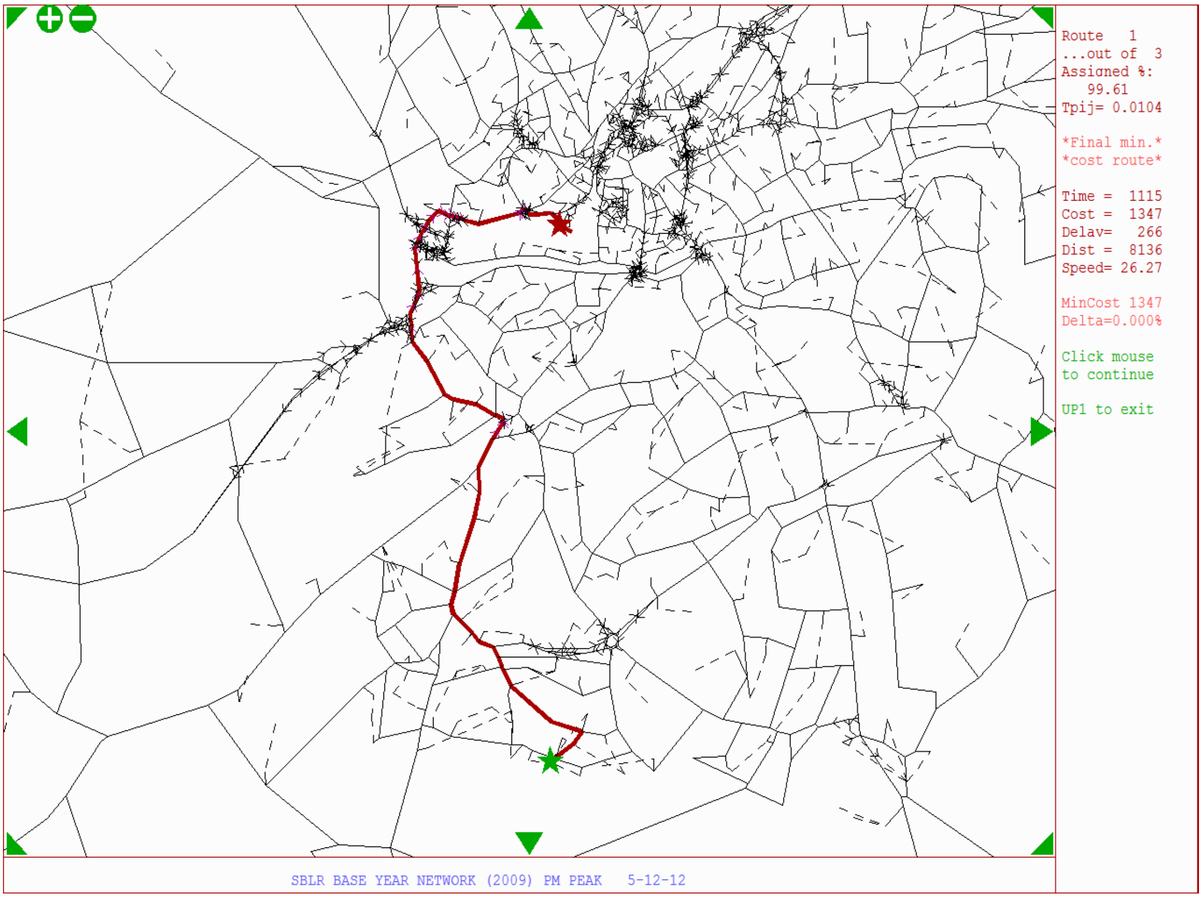

Route 1
...out of 2
Assigned %:
99.90
Final min.
cost route
Time = 832
Cost = 995
Delav= 138
Dist = 6961
Speed= 30.12
MinCost 995
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

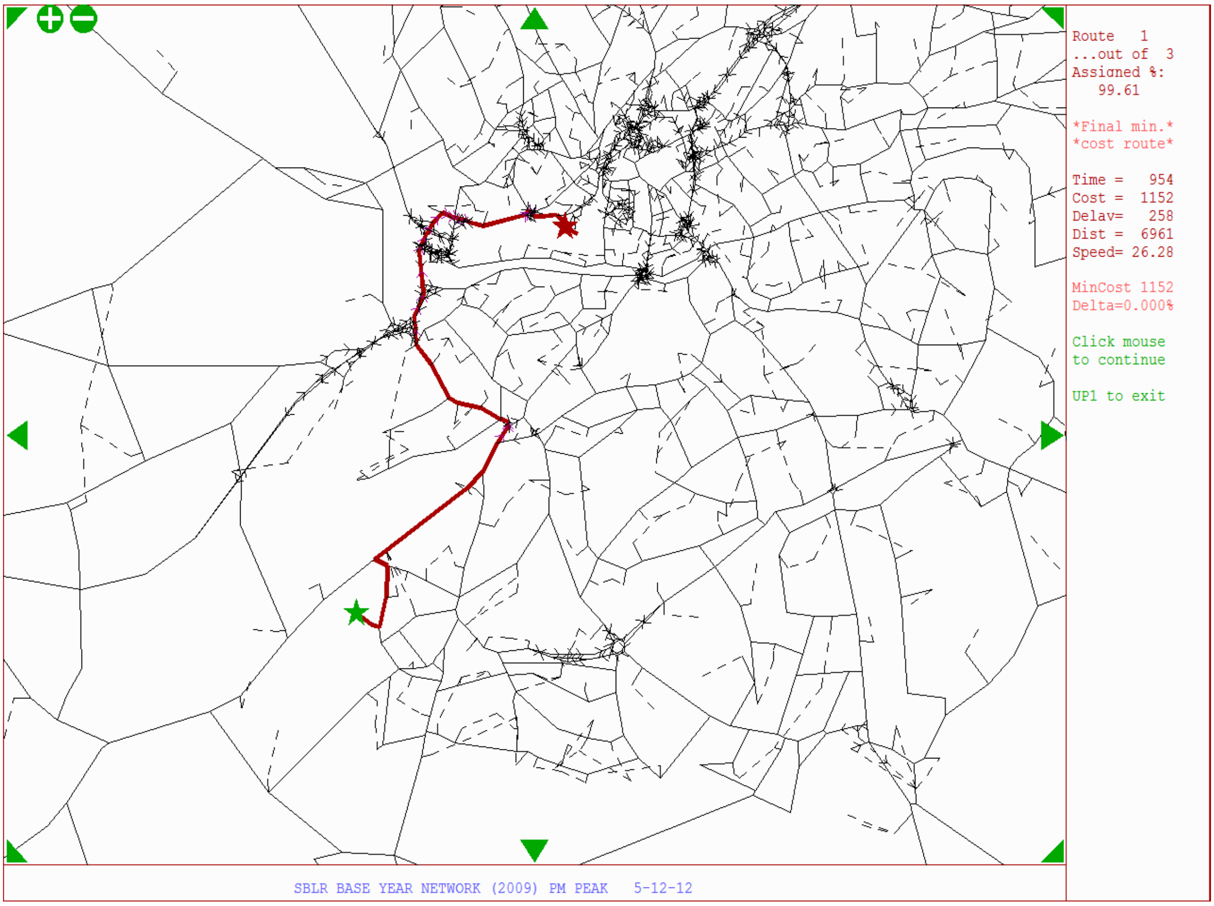

Route 1
...out of 1
Assigned %:
100.00
Final min.
cost route
Time = 696
Cost = 844
Delay= 88
Dist = 6284
Speed= 32.51
MinCost 844
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

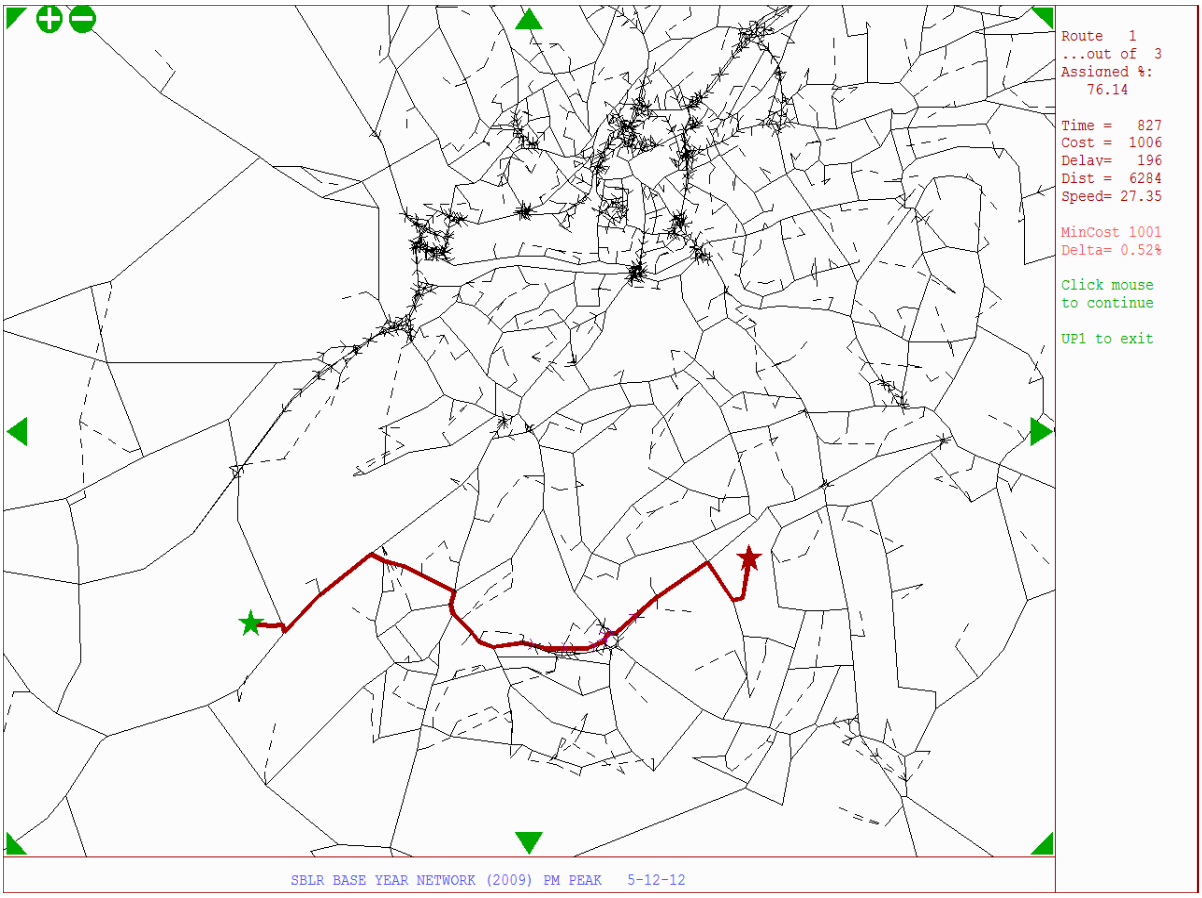

Route 1
...out of 1
Assigned %:
100.00
Final min.
cost route
Time = 614
Cost = 747
Delay= 73
Dist = 5647
Speed= 33.09
MinCost 747
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

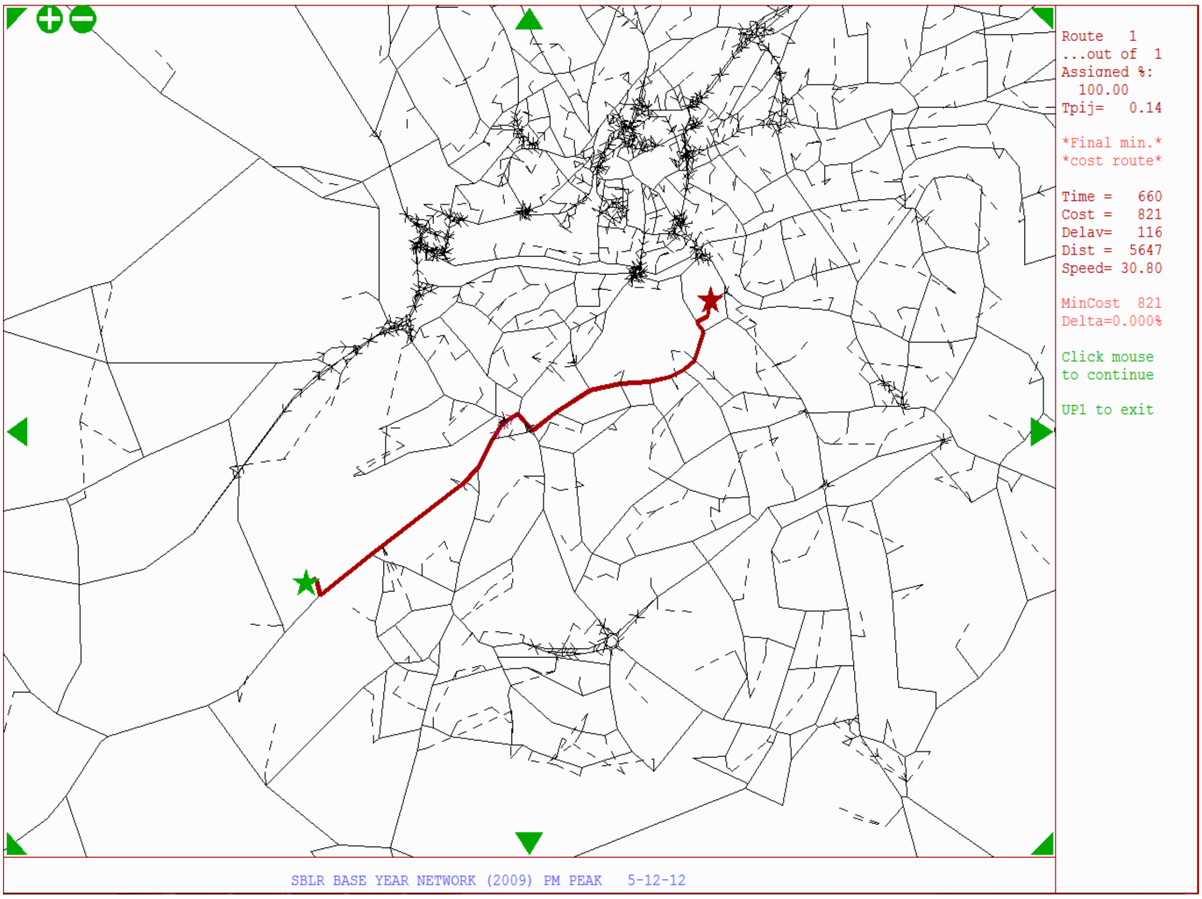
C.1.3. Evening Peak





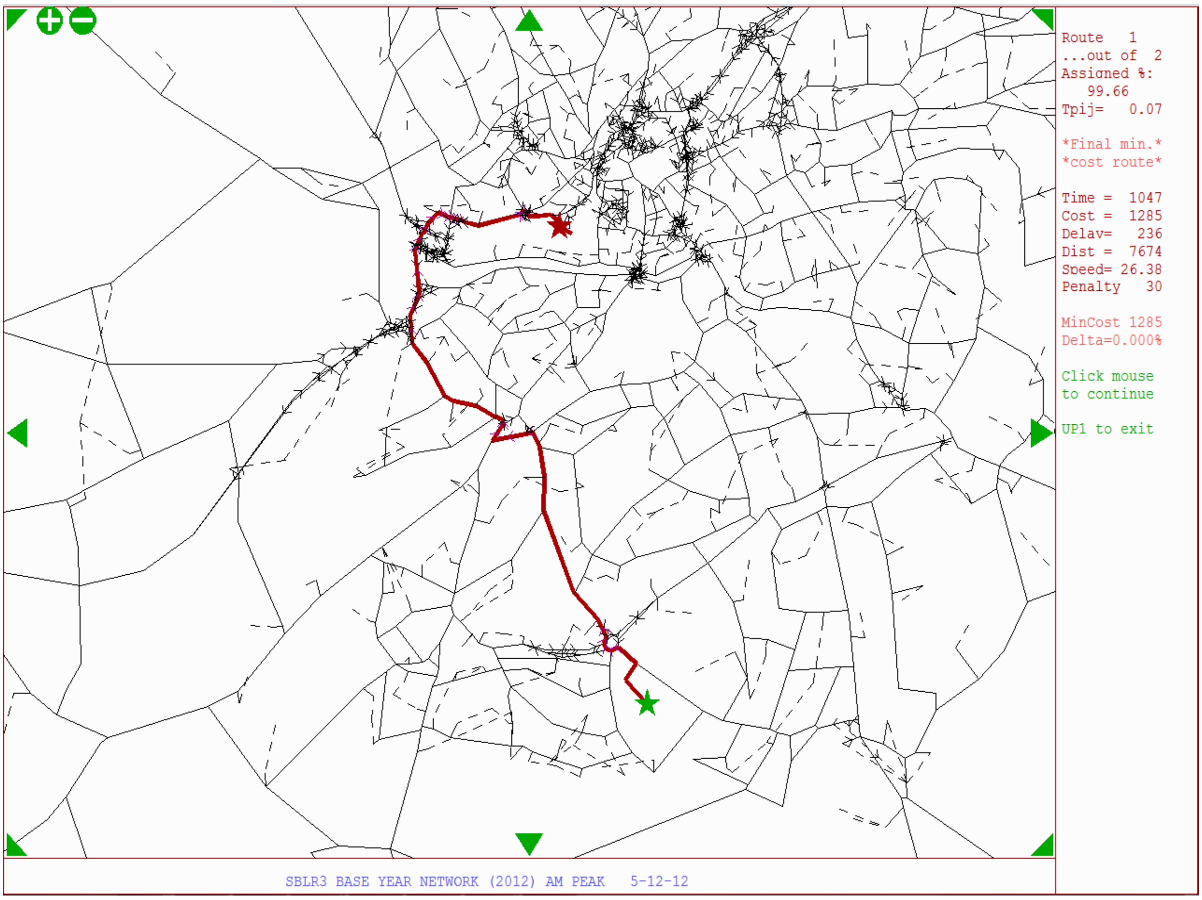

Route 1
...out of 3
Assigned %:
99.61
Final min.
cost route
Time = 954
Cost = 1152
Delav= 258
Dist = 6961
Speed= 26.28
MinCost 1152
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2009) PM PEAK 5-12-12

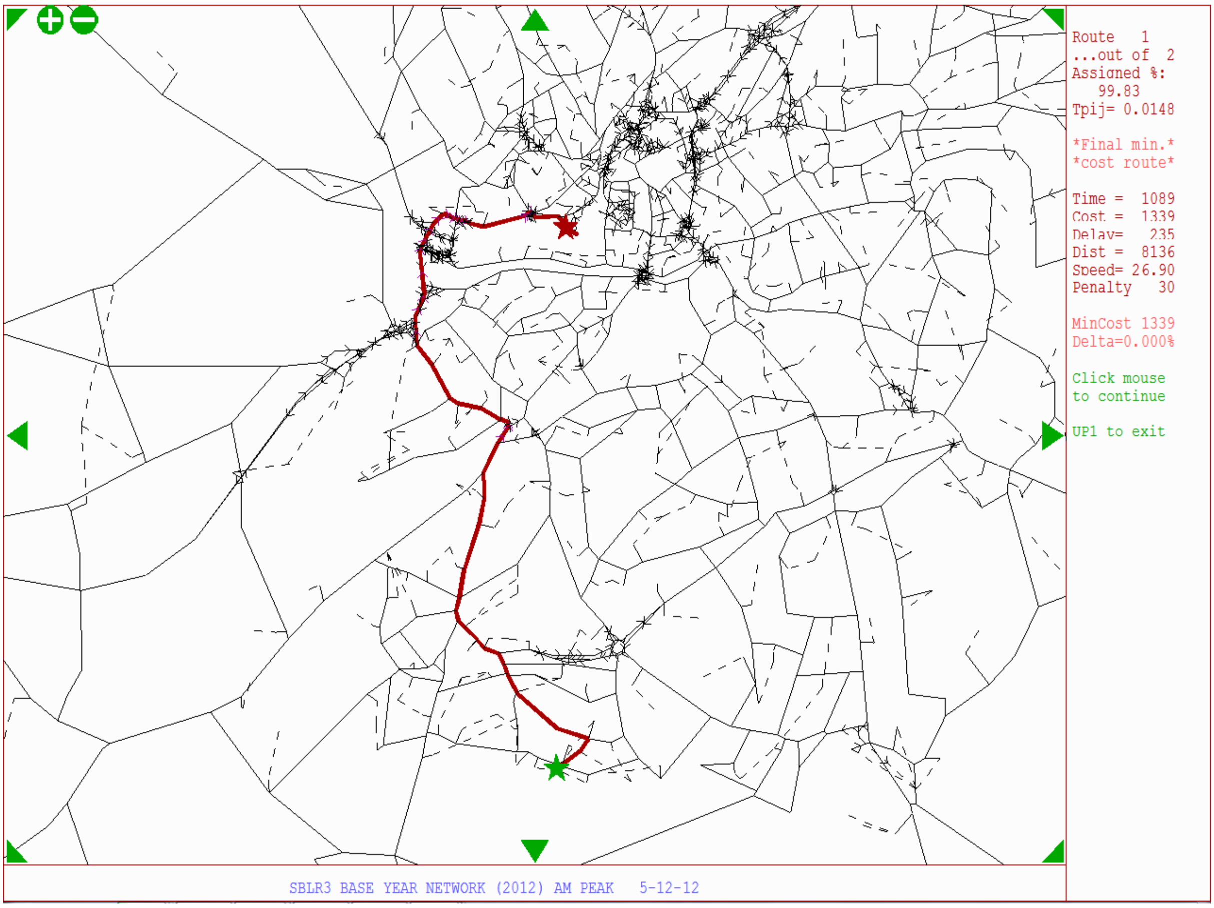

Route 1
...out of 3
Assigned %:
76.14
Time = 827
Cost = 1006
Delav= 196
Dist = 6284
Speed= 27.35
MinCost 1001
Delta= 0.52%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2009) PM PEAK 5-12-12

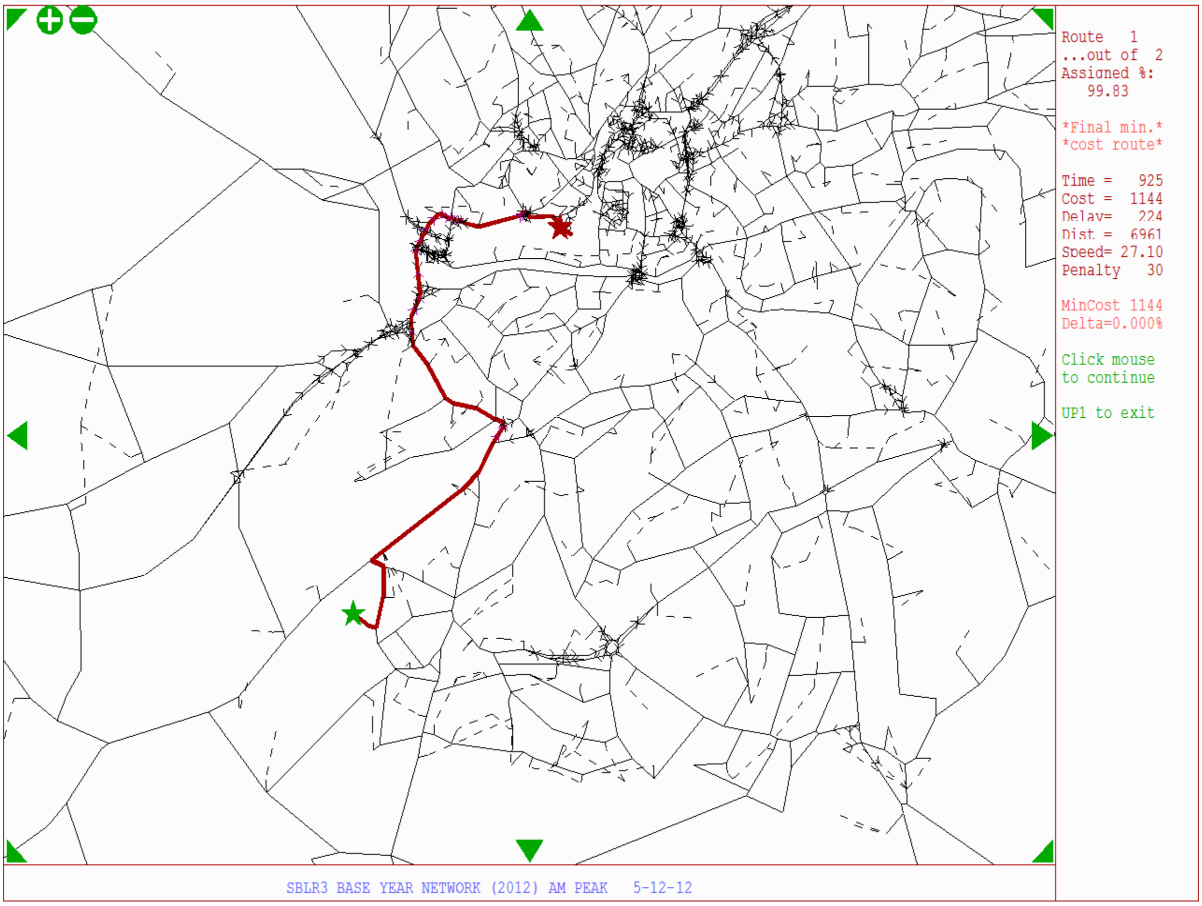

Route 1
...out of 1
Assigned %:
100.00
Tpij= 0.14
Final min.
cost route
Time = 660
Cost = 821
Delav= 116
Dist = 5647
Speed= 30.80
MinCost 821
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2009) PM PEAK 5-12-12

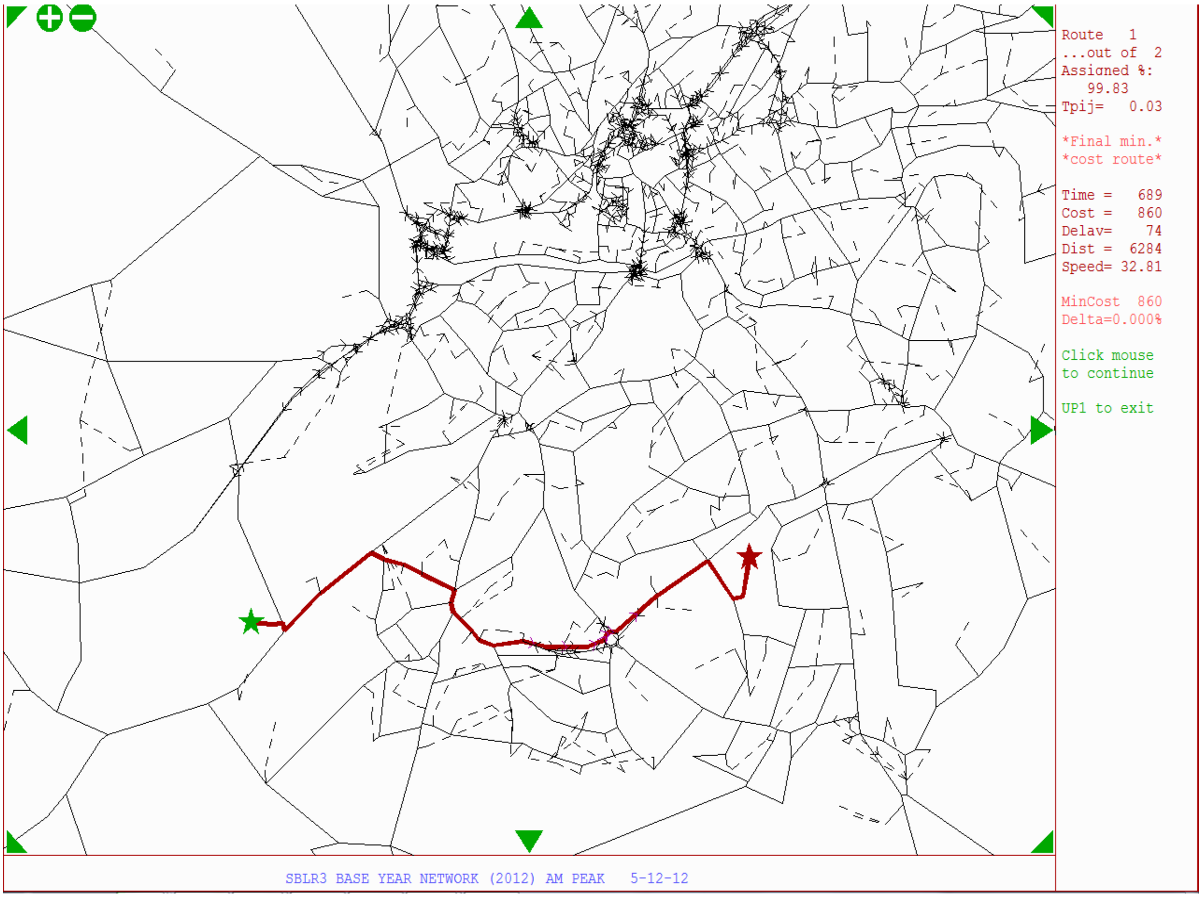
C.2. Post ME Assignment

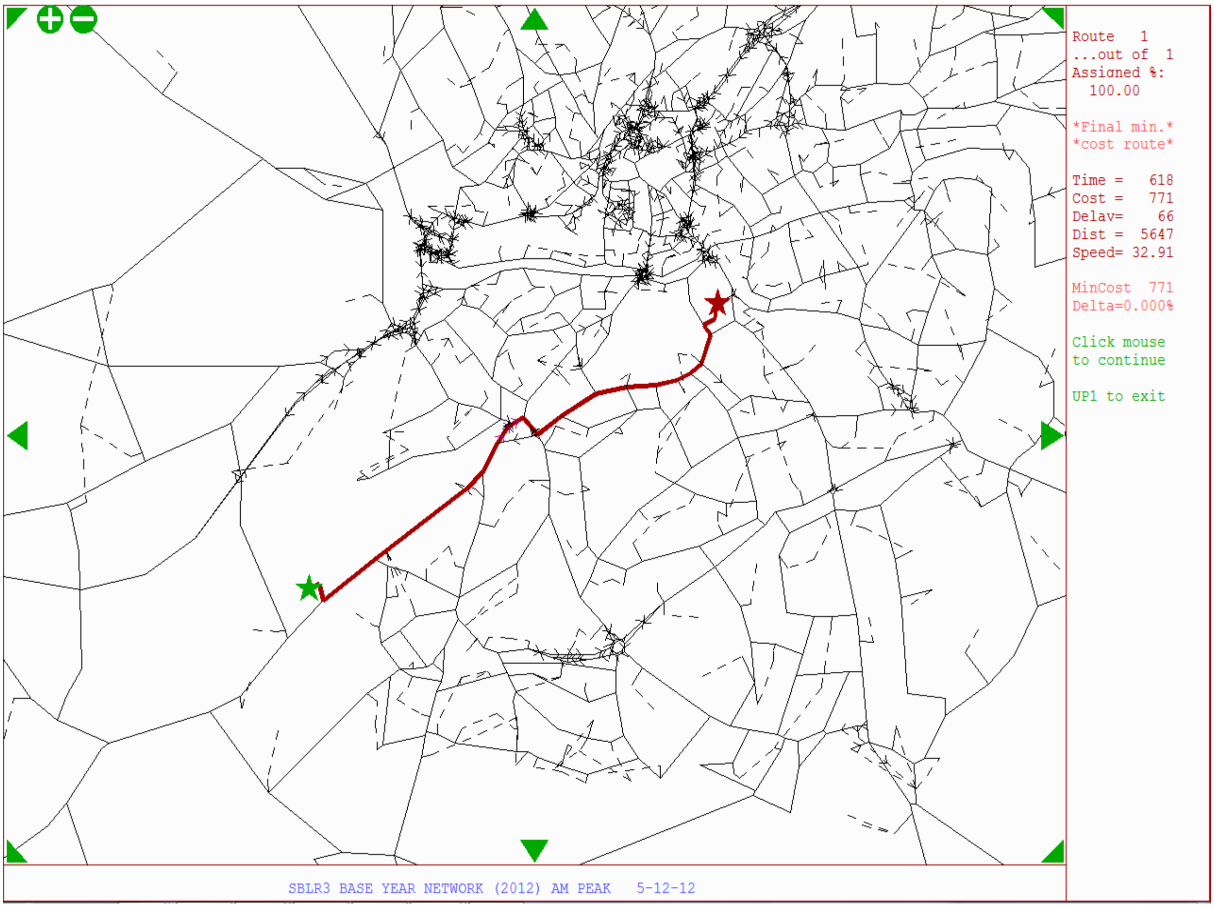
C.2.1. Morning Peak



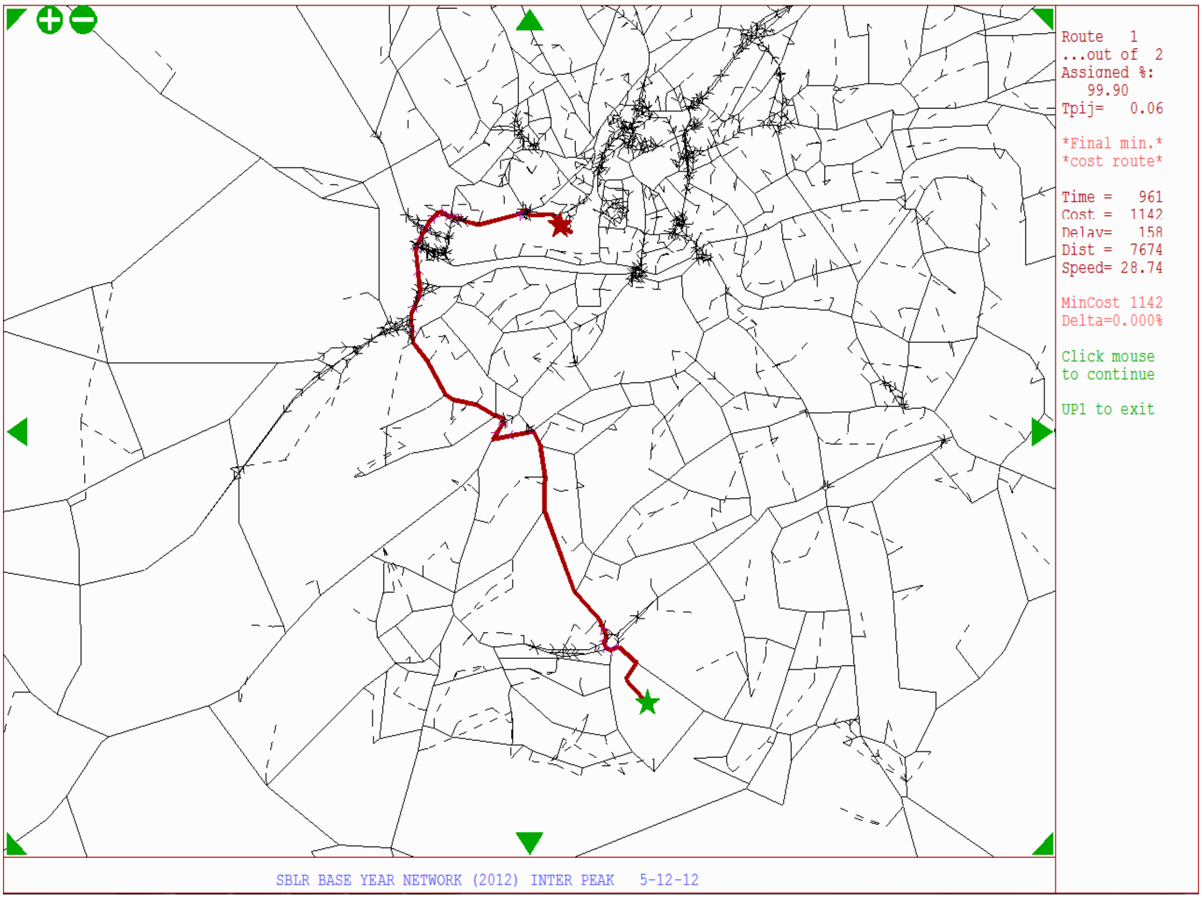

Route 1
...out of 2
Assigned %:
99.83
Tpij= 0.0148
Final min.
cost route
Time = 1089
Cost = 1339
Delay= 235
Dist = 8136
Speed= 26.90
Penalty 30
MinCost 1339
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

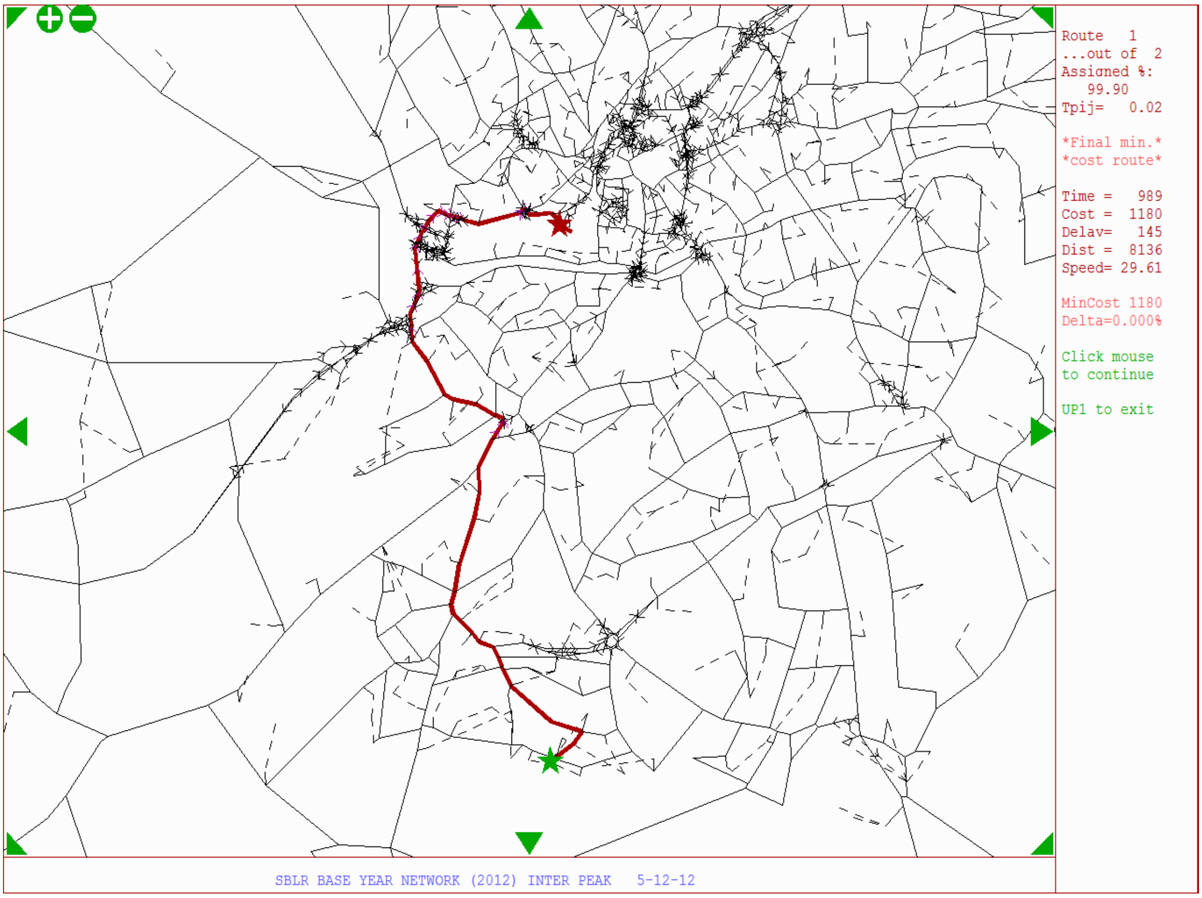

Route 1
...out of 2
Assigned %:
99.83
Final min.
cost route
Time = 925
Cost = 1144
Delay= 224
Dist = 6961
Speed= 27.10
Penalty 30
MinCost 1144
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

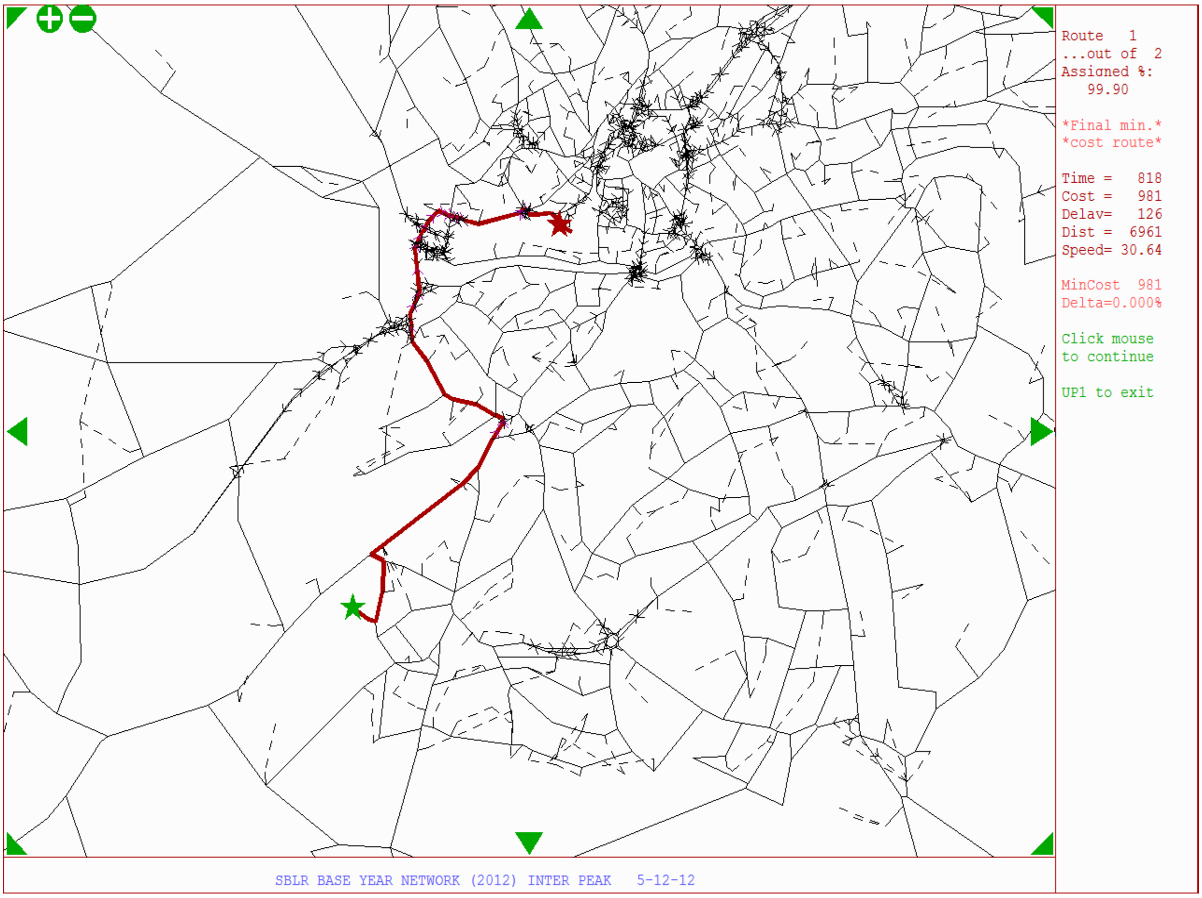

Route 1
...out of 2
Assigned %:
99.83
Tpij= 0.03
Final min.
cost route
Time = 689
Cost = 860
Delay= 74
Dist = 6284
Speed= 32.81
MinCost 860
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR3 BASE YEAR NETWORK (2012) AM PEAK 5-12-12

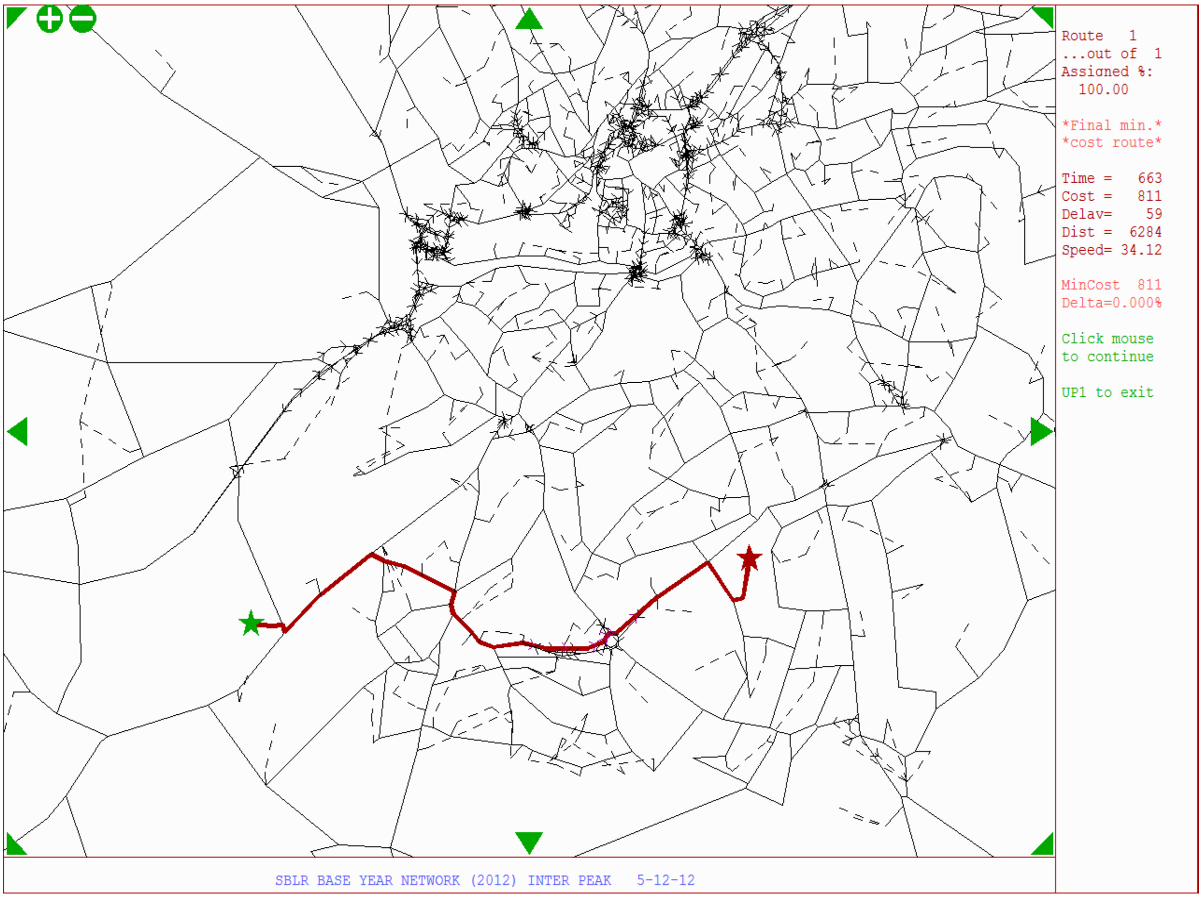


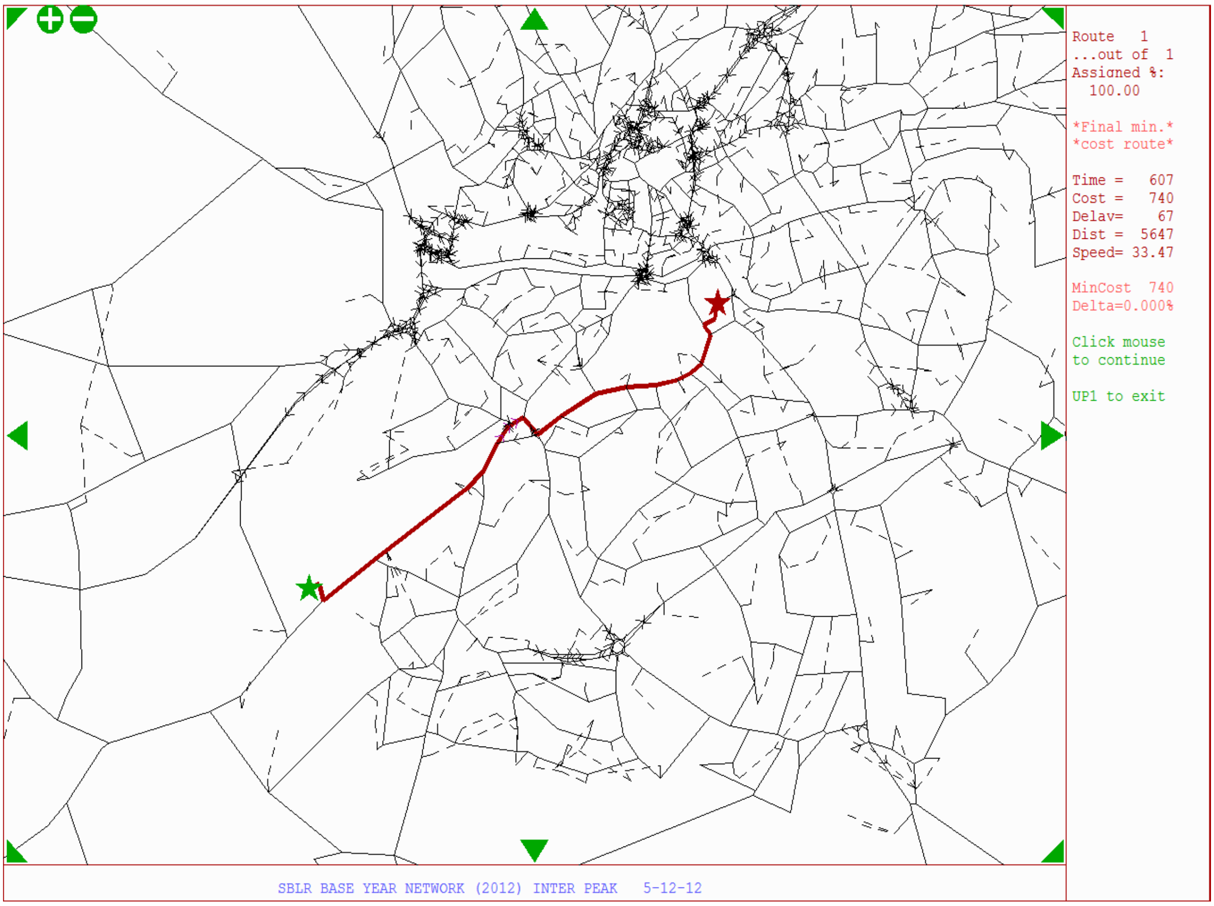
C.2.2. Inter-Peak



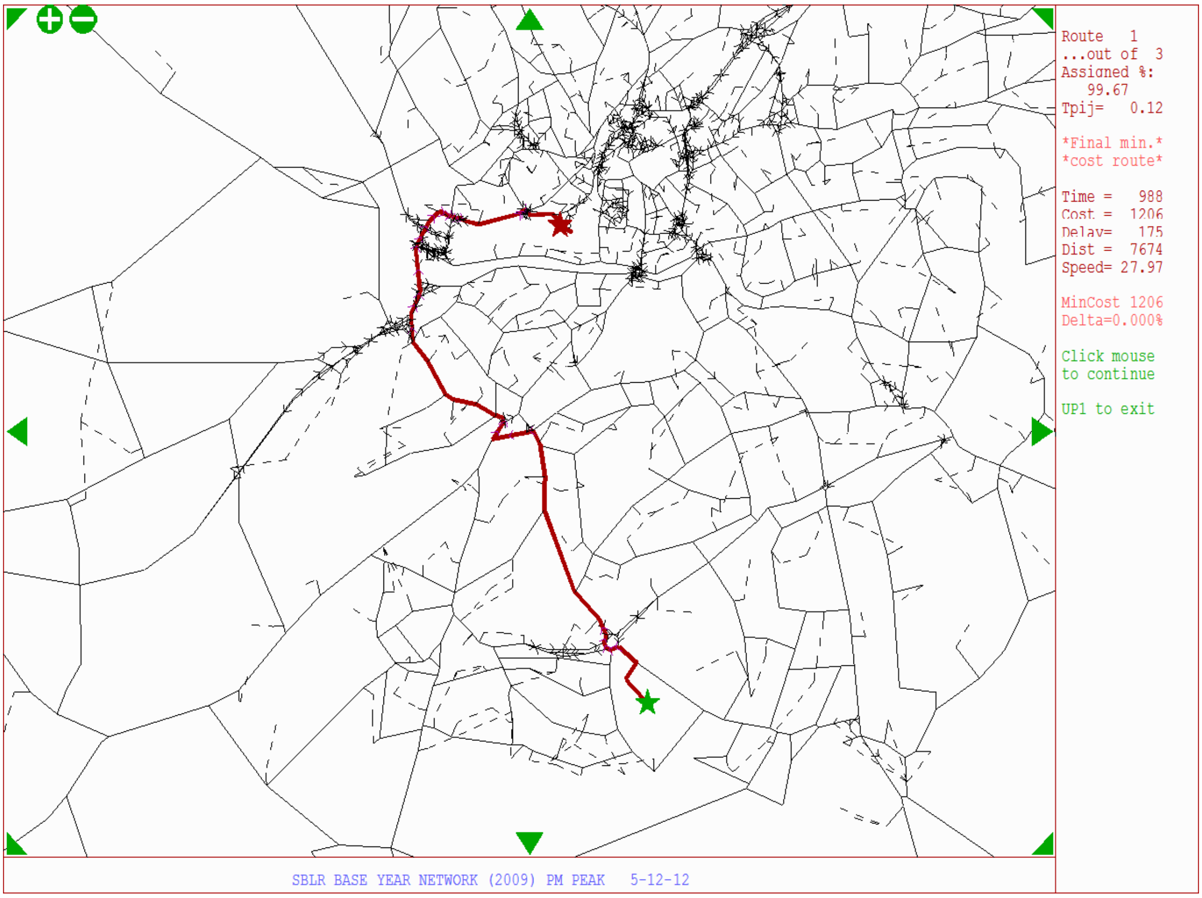

Route 1
...out of 2
Assigned %:
99.90
Tpij= 0.02
Final min.
cost route
Time = 989
Cost = 1180
Delav= 145
Dist = 8136
Speed= 29.61
MinCost 1180
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

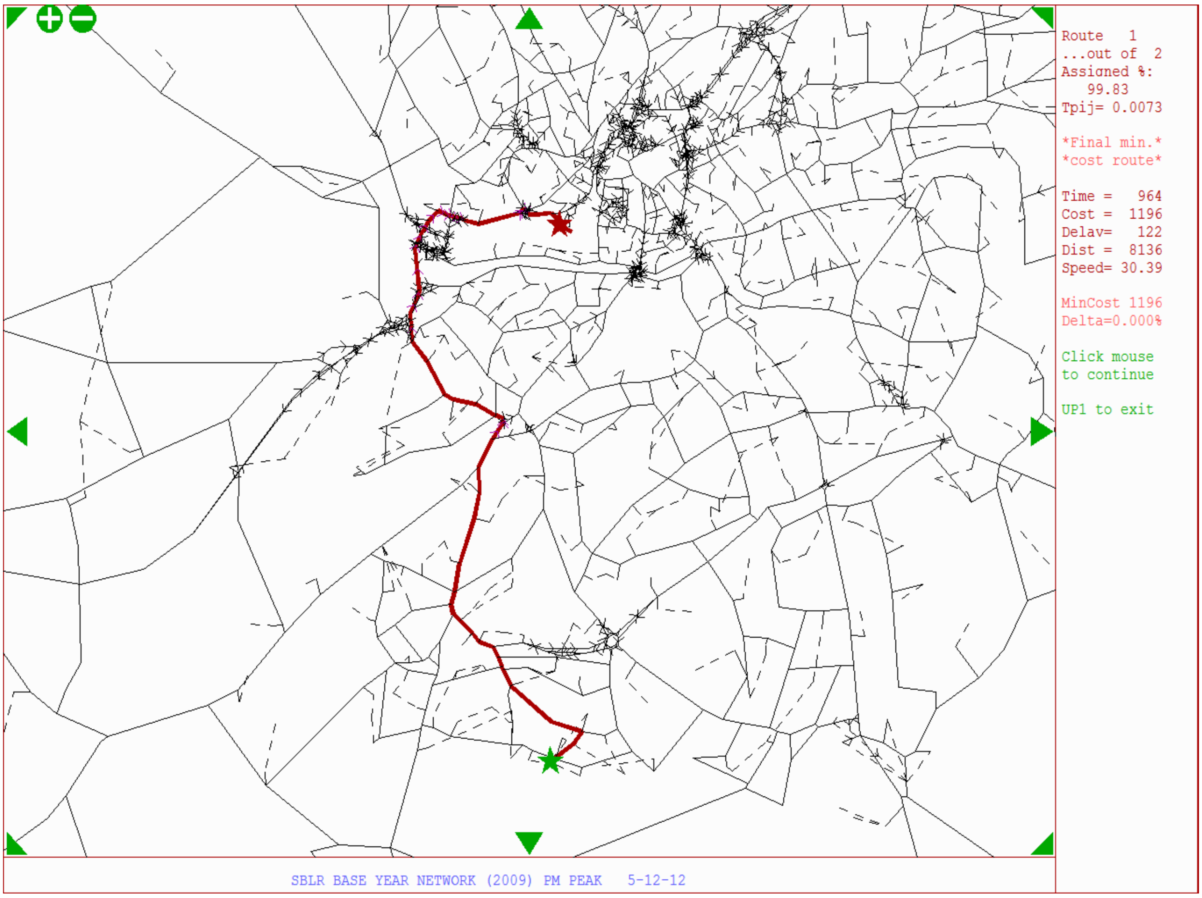

Route 1
...out of 2
Assigned %:
99.90
Final min.
cost route
Time = 818
Cost = 981
Delav= 126
Dist = 6961
Speed= 30.64
MinCost 981
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

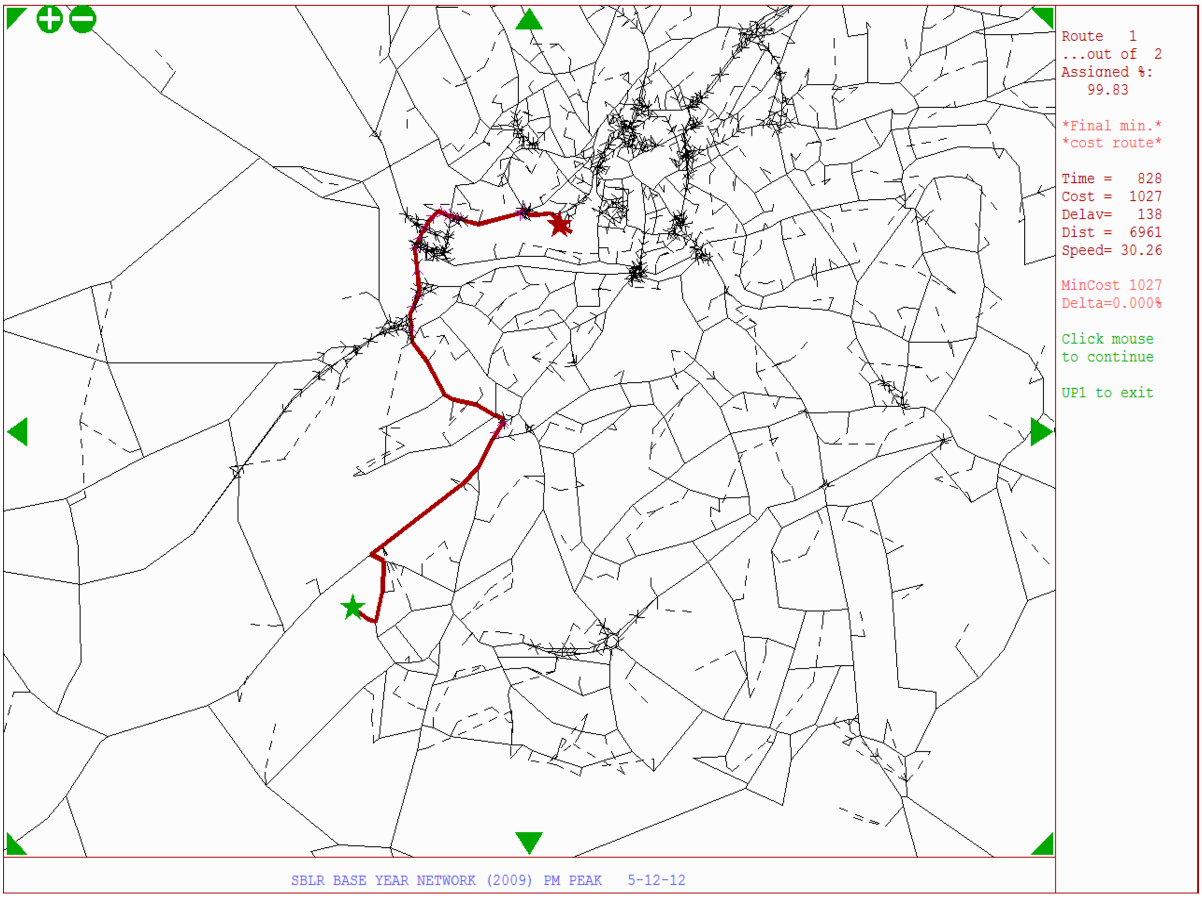

Route 1
...out of 1
Assigned %:
100.00
Final min.
cost route
Time = 663
Cost = 811
Delav= 59
Dist = 6284
Speed= 34.12
MinCost 811
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

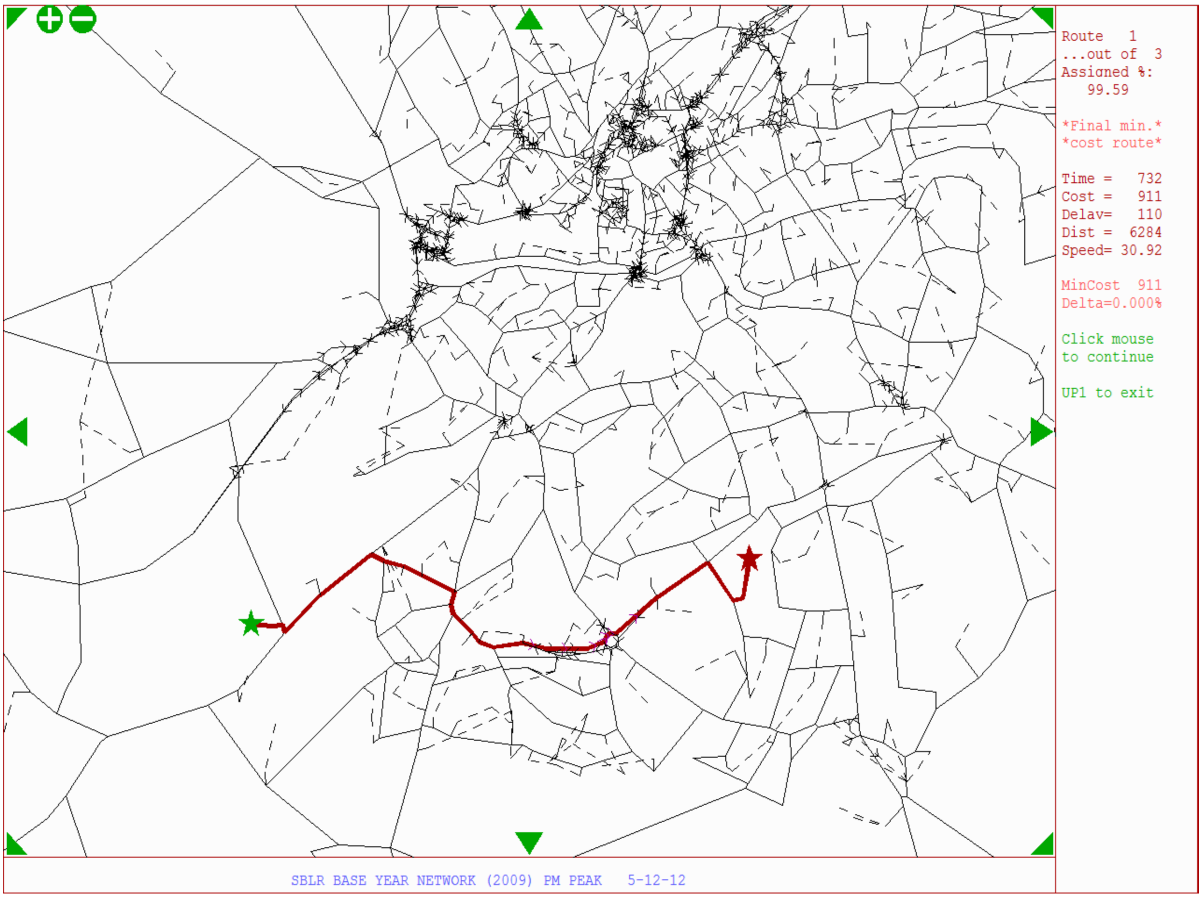

Route 1
...out of 1
Assigned %:
100.00
Final min.
cost route
Time = 607
Cost = 740
Delav= 67
Dist = 5647
Speed= 33.47
MinCost 740
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2012) INTER PEAK 5-12-12

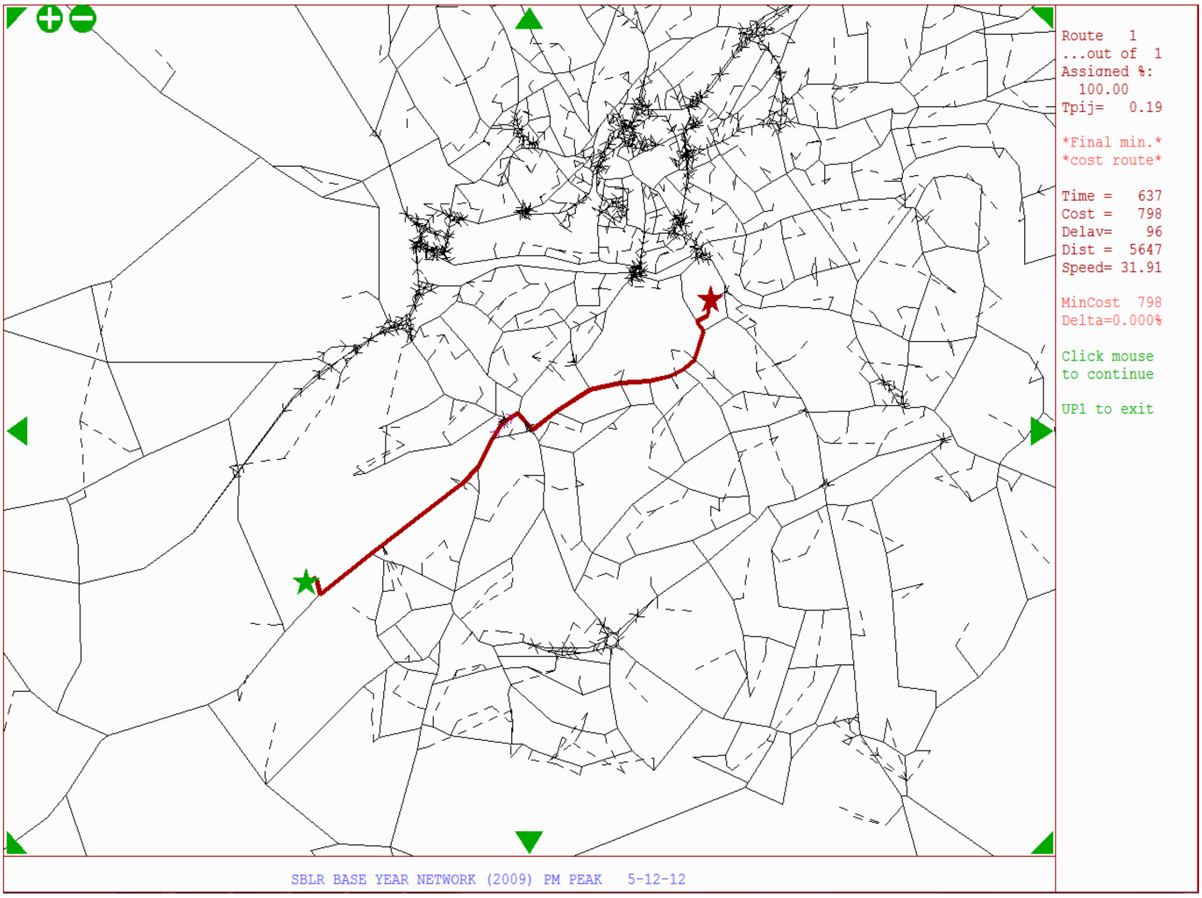
C.2.3. Evening Peak






Route 1
...out of 2
Assigned %:
99.83
Final min.
cost route
Time = 828
Cost = 1027
Delav= 138
Dist = 6961
Speed= 30.26
MinCost 1027
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2009) PM PEAK 5-12-12


Route 1
...out of 3
Assigned %:
99.59
Final min.
cost route
Time = 732
Cost = 911
Delav= 110
Dist = 6284
Speed= 30.92
MinCost 911
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2009) PM PEAK 5-12-12


Route 1
...out of 1
Assigned %:
100.00
Tpij= 0.19
Final min.
cost route
Time = 637
Cost = 798
Delav= 96
Dist = 5647
Speed= 31.91
MinCost 798
Delta=0.000%
Click mouse
to continue
UP1 to exit
SBLR BASE YEAR NETWORK (2009) PM PEAK 5-12-12

Appendix D. Matrix Estimation Changes

The impacts of matrix estimation at a sectored level are shown in the tables below. Trips with limited observed movements (because they do not cross an RSI cordon) are shaded and those movements where more than 1% of the matrix performs the movement are shown in bold.

Whilst movements from sectors 1 & 2 to sectors 3-8 were observed these form a small part of the matrix. So in the morning peak only movement 8-4 would be a significant change on a sector to sector movement that was partially observed and had >1% of the matrix. In all other cases the changes were to sectors with a small proportion of the matrix or cells that were not partially observed and it is in these locations that matrix estimation is required.

Table 56. AM Sector Changes

Cars	1	2	3	4	5	6	7	8
1	**12%**	21%	16%	-25%	-18%	38%	-27%	-30%
2	-15%	19%	45%	-18%	-17%	17%	-25%	4%
3	39%	-13%	**18%**	-27%	22%	22%	-19%	17%
4	-1%	-23%	31%	**0%**	33%	-18%	-3%	9%
5	8%	0%	21%	26%	5%	-13%	20%	0%
6	-12%	-33%	**1%**	8%	-24%	**-1%**	**2%**	**-5%**
7	1%	-32%	12%	**-1%**	14%	**-7%**	**0%**	**-2%**
8	-11%	-6%	8%	**12%**	-2%	**-8%**	**-1%**	**1%**
LGV								
1	25%	49%	17%	19%	26%	46%	7%	10%
2	6%	19%	22%	-27%	-22%	-24%	-30%	9%
3	85%	-22%	**30%**	9%	20%	27%	5%	20%
4	45%	-39%	7%	**-1%**	-5%	-18%	**-1%**	-20%
5	171%	28%	59%	-3%	**6%**	-7%	-12%	-20%
6	15%	-42%	**9%**	10%	12%	**-2%**	**0%**	**1%**
7	35%	-34%	26%	**1%**	-12%	**-4%**	**0%**	**-3%**
8	70%	3%	13%	20%	**-14%**	**-10%**	**0%**	**1%**
HGV								
1	-89%	-85%	-79%	-35%	-28%	25%	29%	-74%
2	-29%	-39%	43%	-29%	-91%	6%	-89%	-36%
3	-79%	-79%	-5%	1%	29%	12%	22%	-34%
4	-73%	-35%	-11%	**-4%**	-48%	-11%	**-8%**	8%
5	-42%	-23%	-24%	-27%	38%	16%	28%	17%
6	-70%	25%	-22%	10%	2%	**2%**	**1%**	**2%**
7	-18%	-98%	3%	**4%**	61%	**-1%**	**0%**	**-3%**
8	0%	0%	17%	-10%	-1%	**-1%**	**9%**	**6%**

Table 57. IP Sector Changes

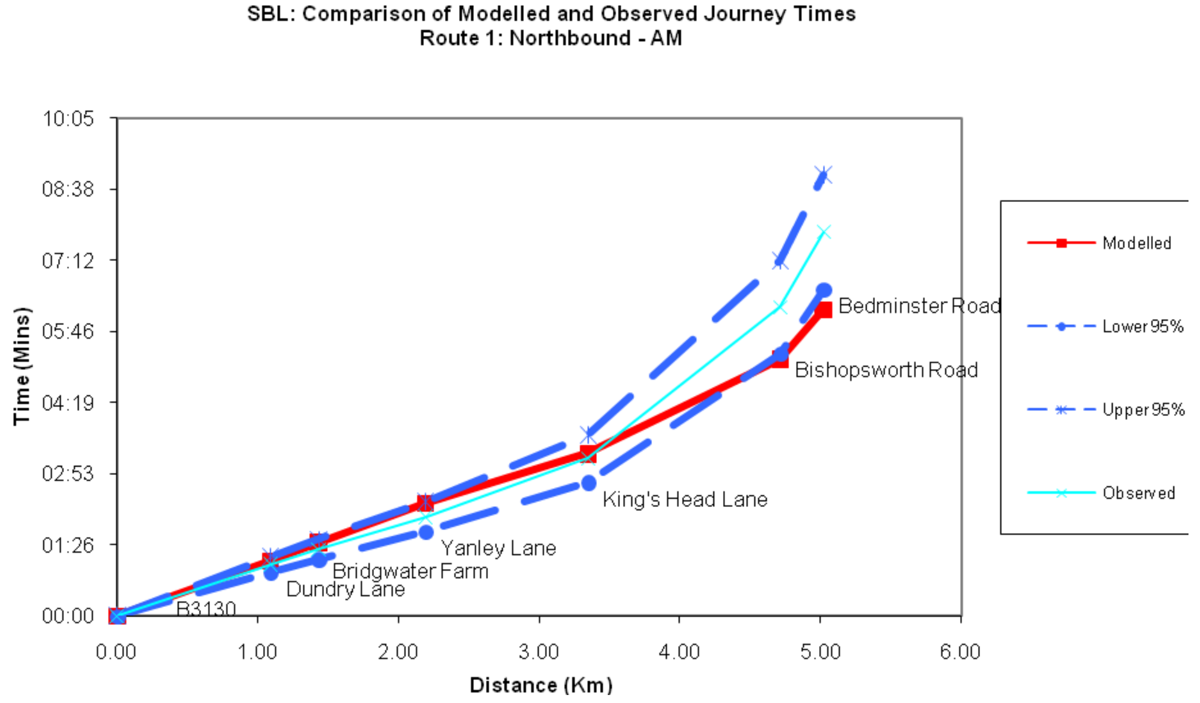
Cars	1	2	3	4	5	6	7	8
1	**22%**	15%	13%	0%	13%	22%	18%	-21%
2	19%	13%	3%	-23%	-14%	-7%	-9%	9%
3	19%	-6%	**6%**	-14%	12%	**4%**	-6%	9%
4	31%	6%	28%	**0%**	-2%	**-2%**	**-1%**	12%
5	36%	4%	28%	-12%	**10%**	1%	-5%	-4%
6	3%	-19%	**4%**	**-6%**	-10%	**-1%**	**1%**	**-4%**
7	2%	-15%	14%	**0%**	-3%	**-1%**	**0%**	**-1%**
8	15%	11%	19%	3%	-22%	**-4%**	**-2%**	**0%**
LGV								
1	**29%**	34%	1%	14%	32%	13%	34%	4%
2	36%	3%	-4%	-16%	-11%	-18%	0%	-2%
3	18%	-16%	**12%**	-1%	5%	37%	9%	-4%
4	21%	-18%	3%	**-1%**	-17%	-14%	**-5%**	-2%
5	124%	32%	9%	-9%	**2%**	11%	5%	3%
6	-13%	-26%	**16%**	-5%	-13%	**-1%**	**0%**	**-6%**
7	16%	-8%	13%	**4%**	-10%	**-2%**	**0%**	**-1%**
8	48%	19%	13%	-3%	-29%	**-2%**	**-2%**	**0%**
HGV								
1	-78%	-43%	-49%	-15%	-57%	-31%	-68%	-58%
2	-60%	-43%	40%	164%	-46%	-20%	-21%	0%
3	-2%	-80%	-10%	20%	9%	-28%	73%	-35%
4	-25%	13%	3%	**1%**	**-35%**	-13%	**3%**	-7%
5	-26%	-48%	76%	-56%	**-43%**	-71%	-45%	-2%
6	126%	-46%	-4%	2%	-8%	**-1%**	**0%**	**0%**
7	-13%	-26%	39%	**-3%**	-34%	**-2%**	**0%**	**9%**
8	-7%	69%	-5%	-36%	-27%	**3%**	**0%**	**1%**

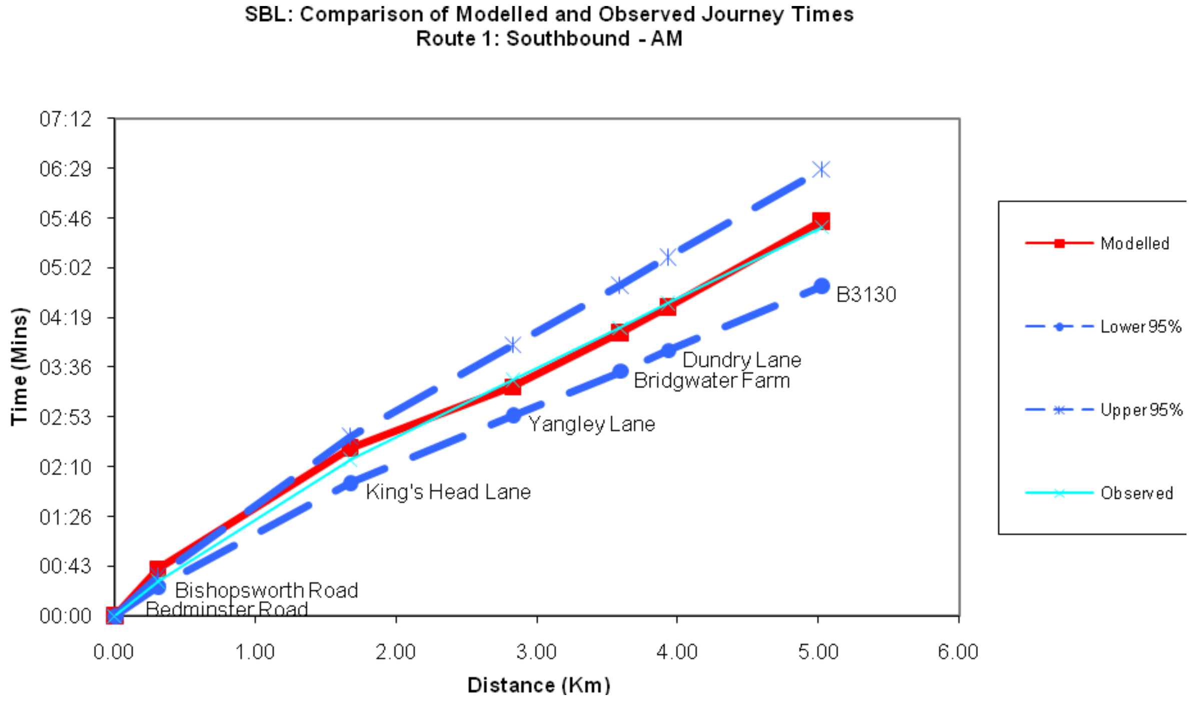
Table 58. PM Sector Changes

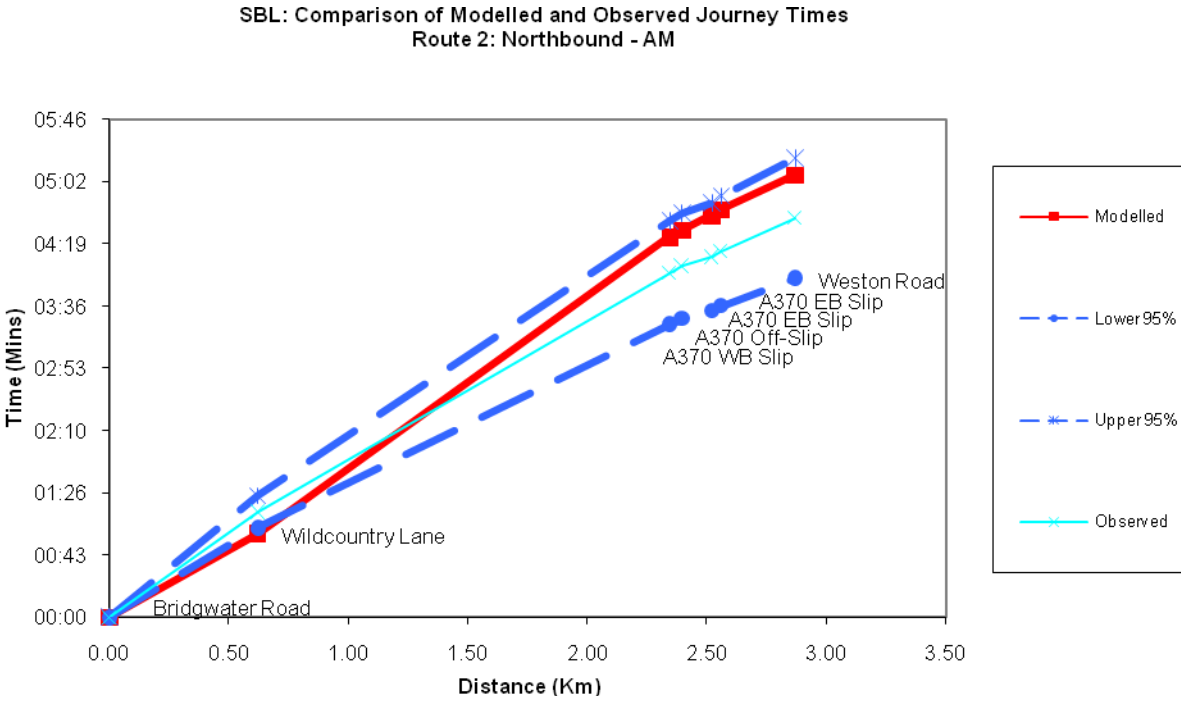
Cars	1	2	3	4	5	6	7	8
1	**12%**	113%	36%	-14%	7%	14%	-12%	9%
2	45%	56%	21%	-23%	-17%	6%	-29%	15%
3	34%	1%	**11%**	-16%	11%	-11%	-27%	-3%
4	44%	20%	42%	**2%**	43%	**3%**	**-2%**	**32%**
5	151%	44%	32%	4%	**4%**	17%	-2%	-15%
6	23%	-16%	14%	**2%**	-9%	**-2%**	**4%**	**-9%**
7	19%	-17%	15%	**-8%**	-7%	**6%**	**-1%**	**-1%**
8	-8%	29%	-6%	28%	-29%	**-3%**	**-2%**	**1%**
LGV								
1	42%	227%	43%	24%	13%	25%	46%	128%
2	46%	55%	7%	-31%	-43%	0%	-27%	-13%
3	66%	**-1%**	**26%**	3%	-6%	12%	18%	-17%
4	41%	-16%	15%	**2%**	-22%	-11%	**-3%**	**8%**
5	436%	89%	46%	0%	**12%**	79%	30%	2%
6	21%	-13%	15%	1%	-34%	**-2%**	**2%**	**-5%**
7	47%	-27%	**14%**	**13%**	-37%	**-2%**	**-1%**	**-1%**
8	11%	34%	-4%	24%	-46%	**1%**	**-2%**	**0%**
HGV								
1	-89%	-7%	-77%	-39%	-36%	-14%	30%	0%
2	-86%	-89%	-35%	-85%	-75%	-17%	-88%	0%
3	-85%	-88%	18%	13%	-17%	-19%	13%	131%
4	-86%	-92%	-3%	**0%**	-18%	-3%	**0%**	-11%
5	-68%	-91%	-10%	6%	-36%	-48%	-26%	-28%
6	9%	-60%	-14%	-16%	-9%	**-1%**	**0%**	**2%**
7	66%	80%	23%	**-3%**	-37%	**-1%**	**-1%**	**6%**
8	0%	0%	-26%	-14%	2%	**5%**	**2%**	**1%**

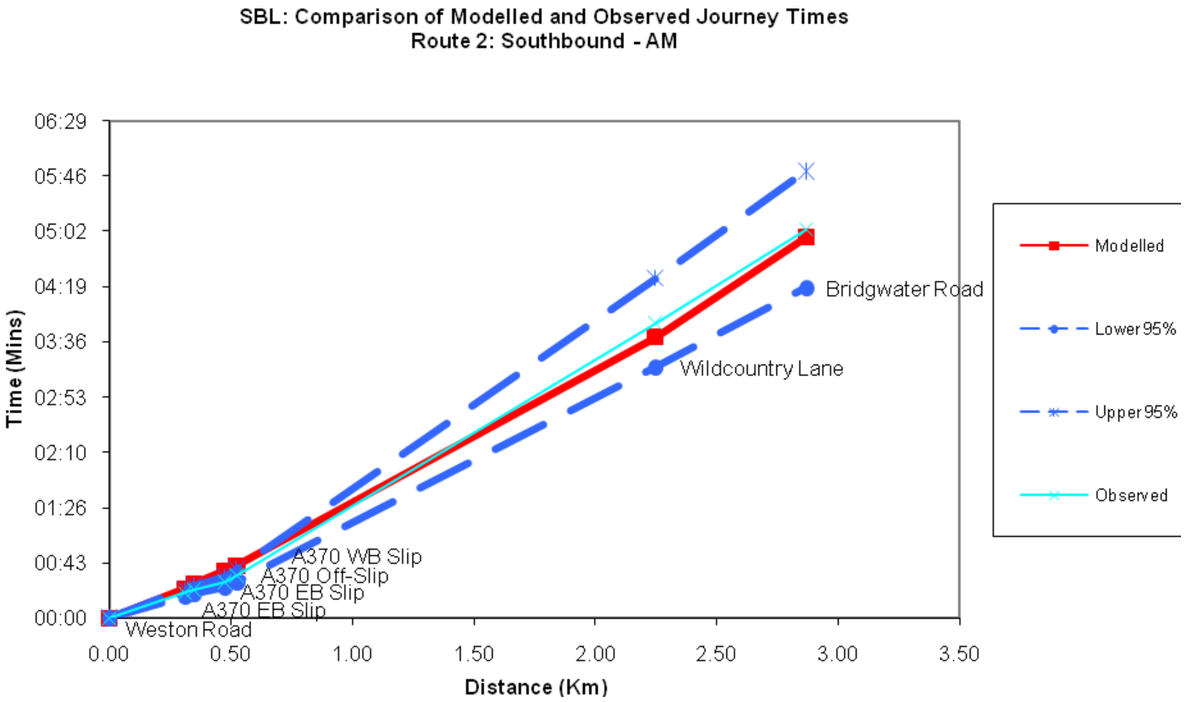
Appendix E. Journey Time Routes

E.1. AM peak

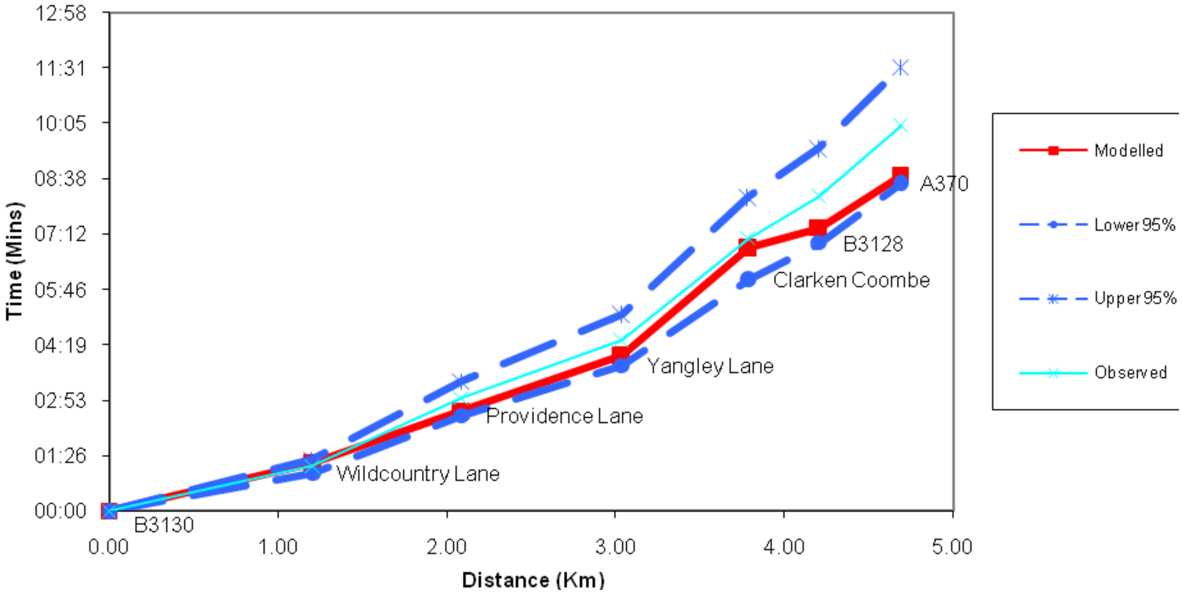




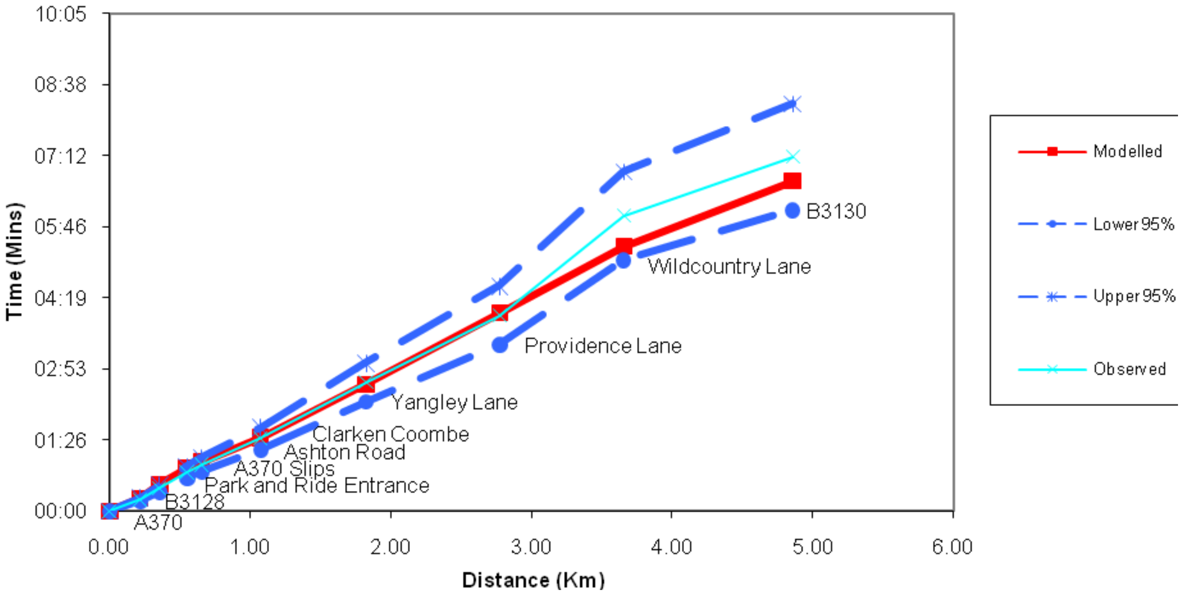

SBL: Comparison of Modelled and Observed Journey Times
Route 2: Northbound - AM
Time (Mins)
Distance (Km)
Bridgwater Road
Wildcountry Lane
Weston Road
A370 EB Slip
A370 EB Slip
A370 Off-Slip
A370 WB Slip
Modelled
Lower 95%
Upper 95%
Observed

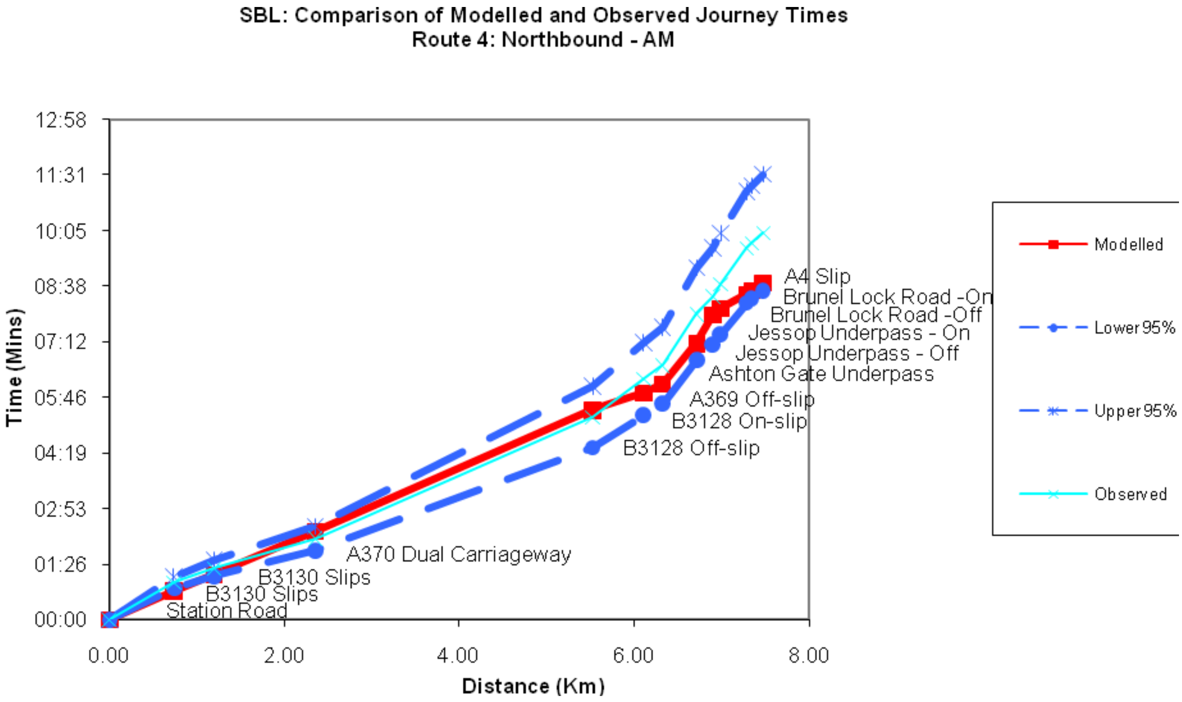

SBL: Comparison of Modelled and Observed Journey Times
Route 2: Southbound - AM
Time (Mins)
Distance (Km)
Bridgwater Road
Wildcountry Lane
A370 WB Slip
A370 Off-Slip
A370 EB Slip
A370 EB Slip
Weston Road
Modelled
Lower 95%
Upper 95%
Observed

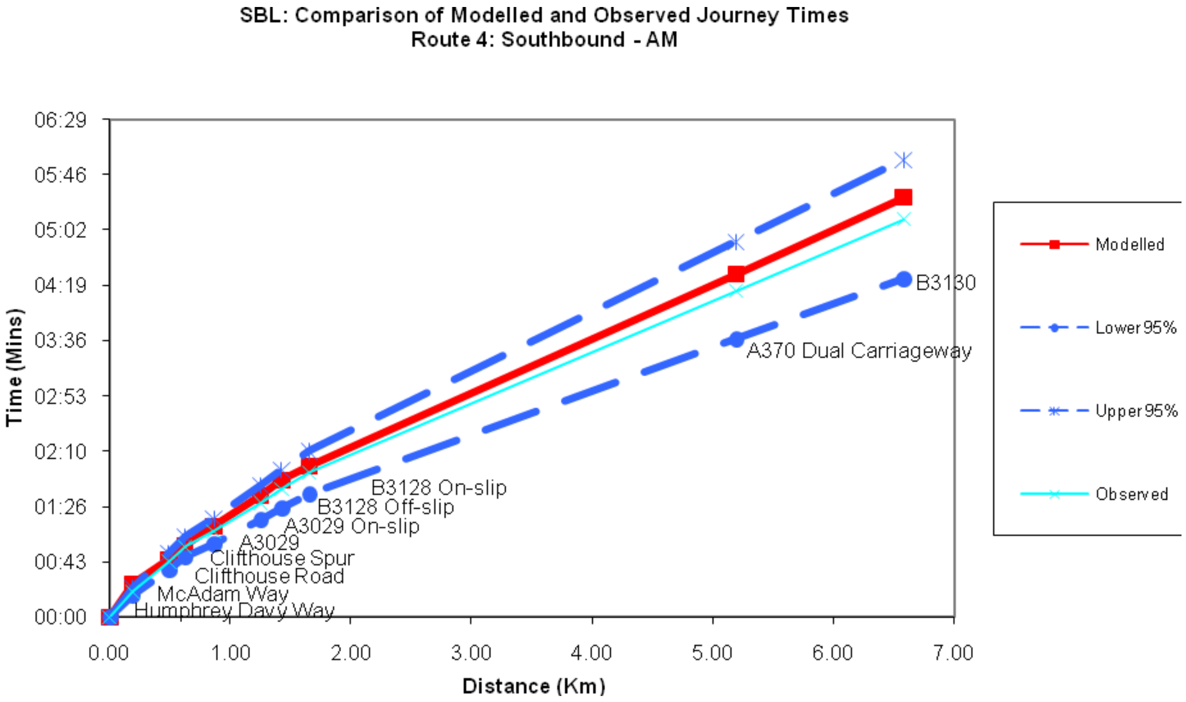
SBL: Comparison of Modelled and Observed Journey Times
Route 3: Northbound - AM

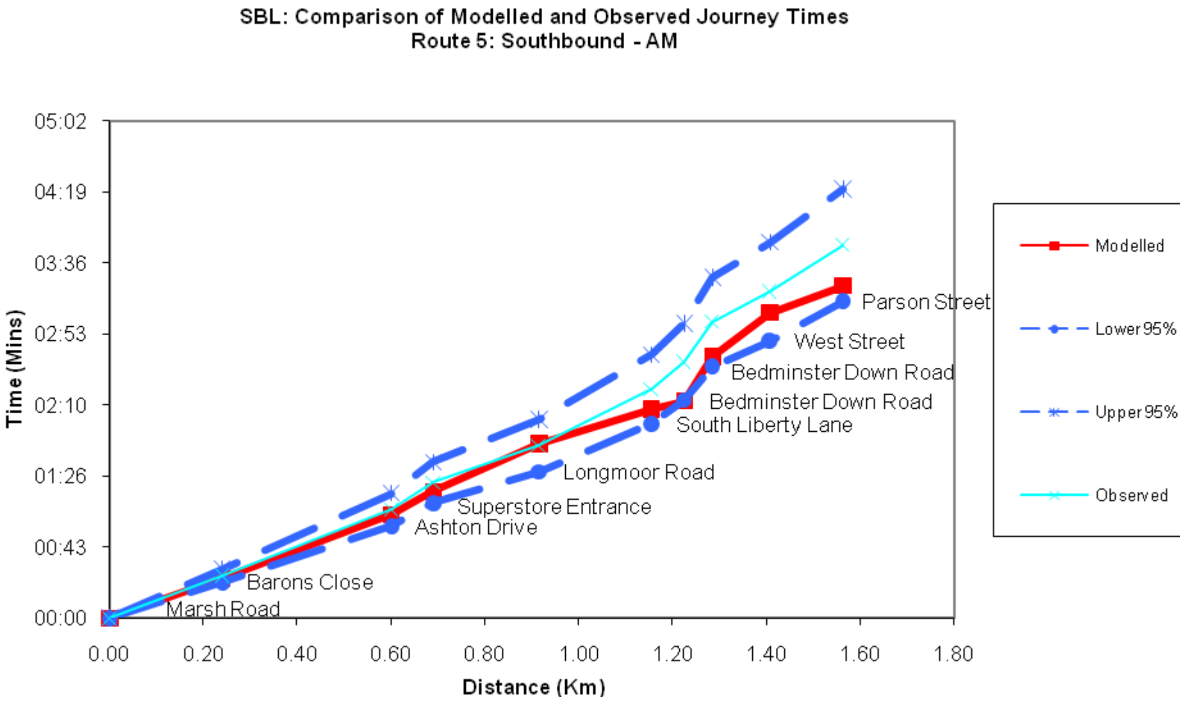


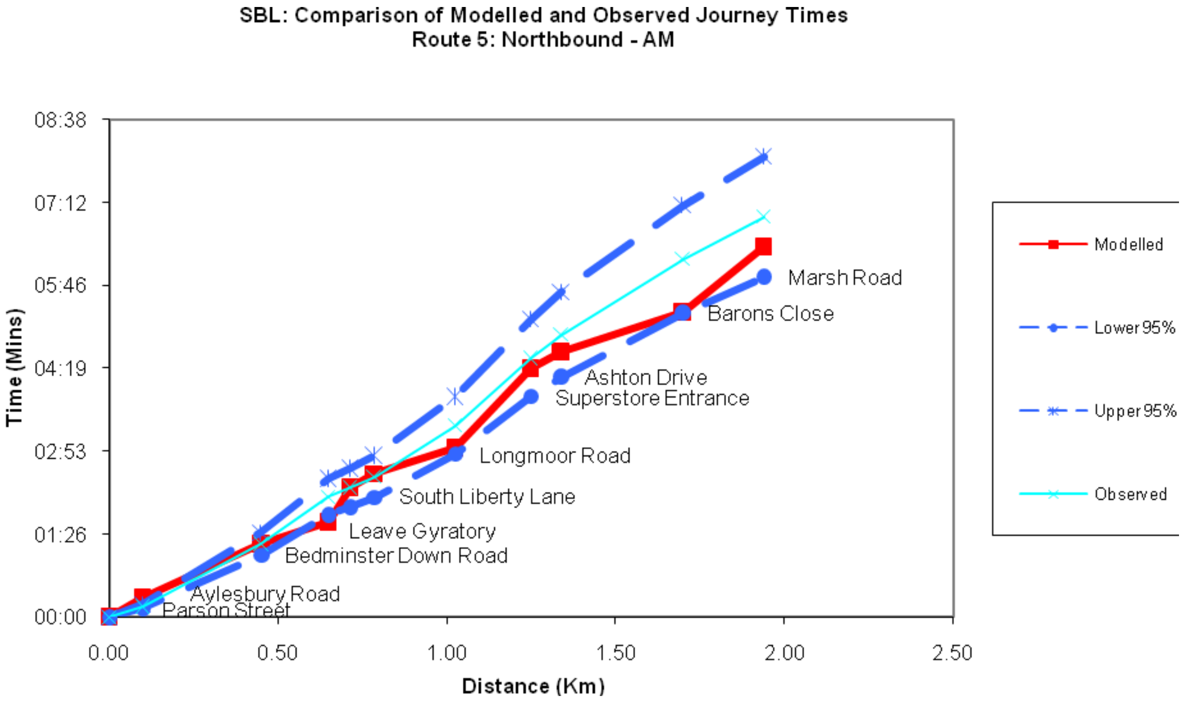
SBL: Comparison of Modelled and Observed Journey Times
Route 3: Southbound - AM

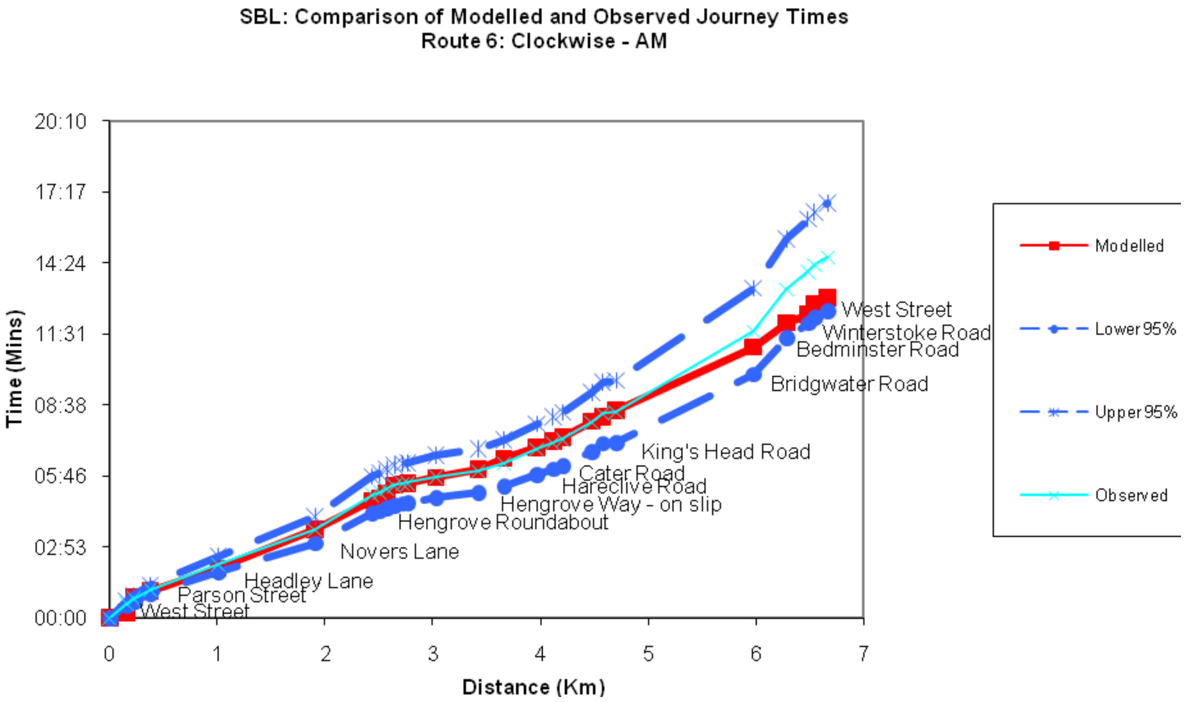


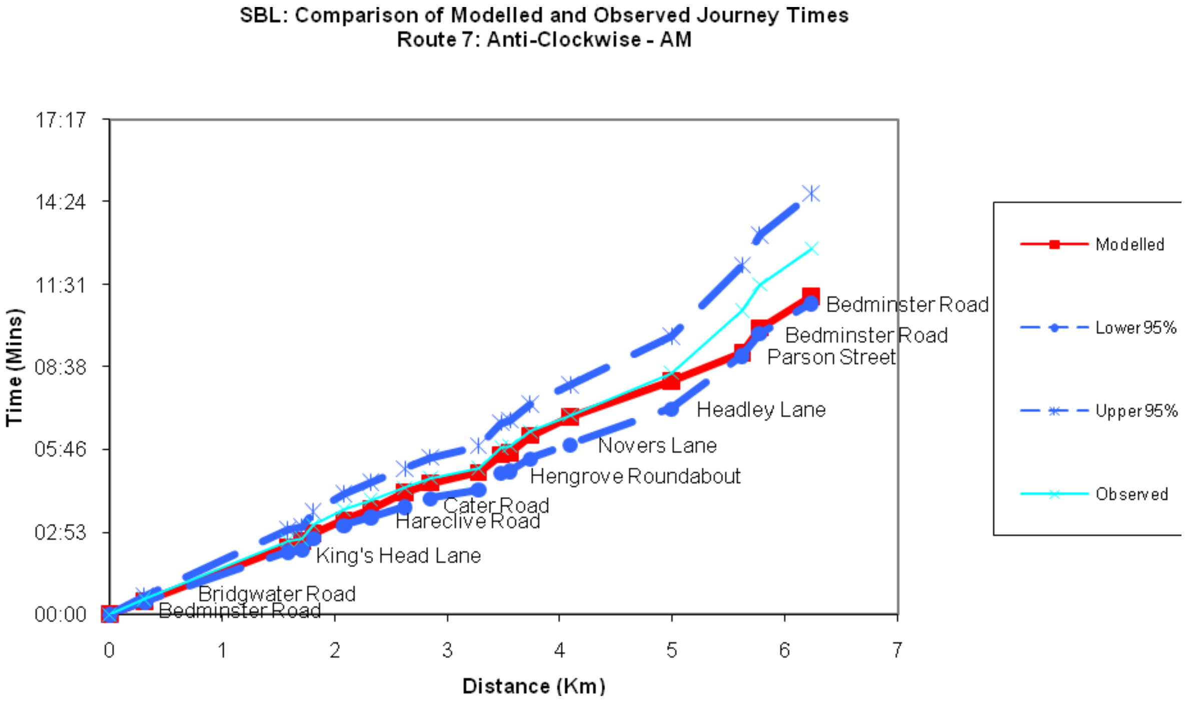

SBL: Comparison of Modelled and Observed Journey Times
Route 4: Northbound - AM
Time (Mins)
12:58
11:31
10:05
08:38
07:12
05:46
04:19
02:53
01:26
00:00
Distance (Km)
0.00
2.00
4.00
6.00
8.00
A4 Slip
Brunel Lock Road -On
Brunel Lock Road -Off
Jessop Underpass - On
Jessop Underpass - Off
Ashton Gate Underpass
A369 Off-slip
B3128 On-slip
B3128 Off-slip
A370 Dual Carriageway
B3130 Slips
B3130 Slips
Station Road
Modelled
Lower 95%
Upper 95%
Observed

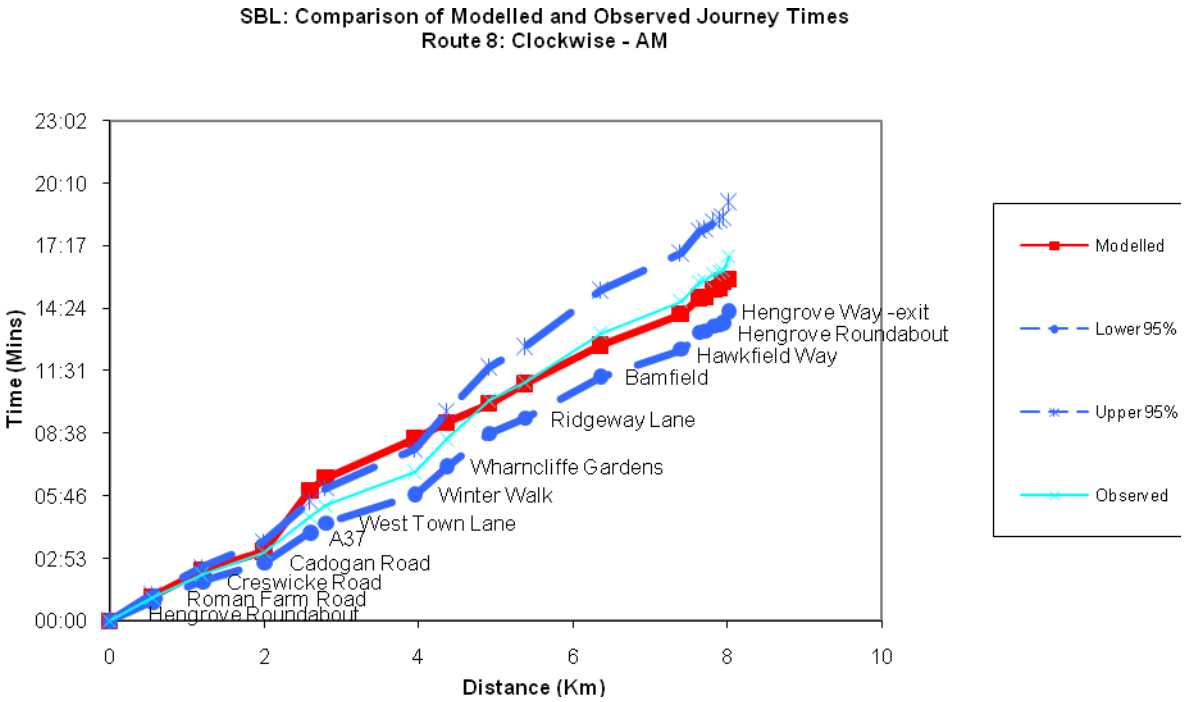

SBL: Comparison of Modelled and Observed Journey Times
Route 4: Southbound - AM
Time (Mins)
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
Distance (Km)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
B3130
A370 Dual Carriageway
B3128 On-slip
B3128 Off-slip
A3029 On-slip
A3029
Clifthouse Spur
Clifthouse Road
McAdam Way
Humphrey Davy Way
Modelled
Lower 95%
Upper 95%
Observed

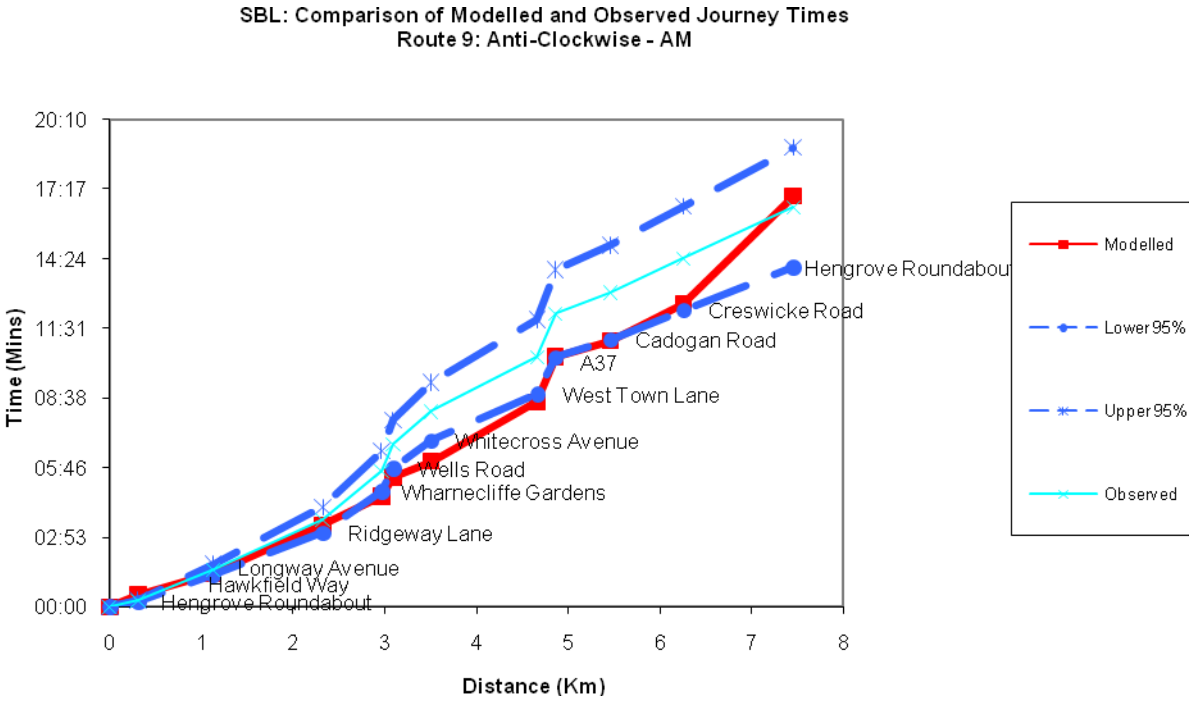

SBL: Comparison of Modelled and Observed Journey Times
Route 5: Southbound - AM
Time (Mins)
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
Distance (Km)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
Parson Street
West Street
Bedminster Down Road
Bedminster Down Road
South Liberty Lane
Longmoor Road
Superstore Entrance
Ashton Drive
Barons Close
Marsh Road
Modelled
Lower 95%
Upper 95%
Observed


SBL: Comparison of Modelled and Observed Journey Times
Route 5: Northbound - AM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
0.50
1.00
1.50
2.00
2.50
Distance (Km)
Marsh Road
Barons Close
Ashton Drive
Superstore Entrance
Longmoor Road
South Liberty Lane
Leave Gyratory
Bedminster Down Road
Aylesbury Road
Parson Street
Modelled
Lower 95%
Upper 95%
Observed

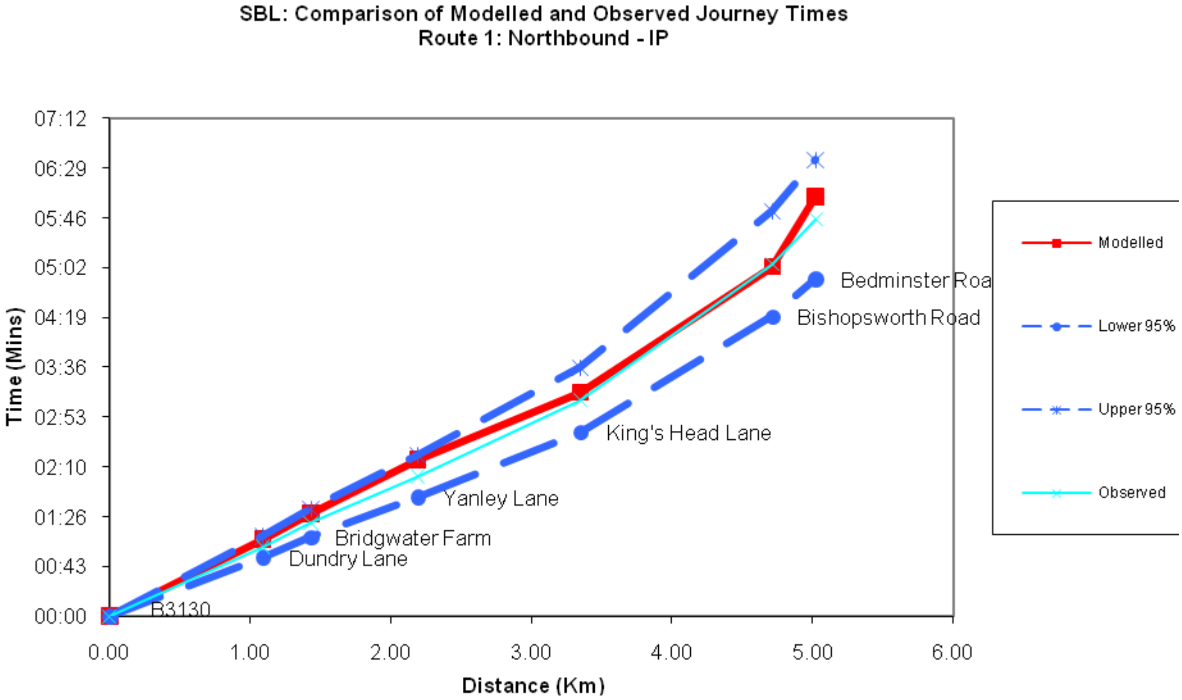

SBL: Comparison of Modelled and Observed Journey Times
Route 6: Clockwise - AM
Time (Mins)
20:10
17:17
14:24
11:31
08:38
05:46
02:53
00:00
0
1
2
3
4
5
6
7
Distance (Km)
West Street
Winterstoke Road
Bedminster Road
Bridgwater Road
King's Head Road
Cater Road
Hareclive Road
Hengrove Way - on slip
Hengrove Roundabout
Novers Lane
Headley Lane
Parson Street
West Street
Modelled
Lower 95%
Upper 95%
Observed

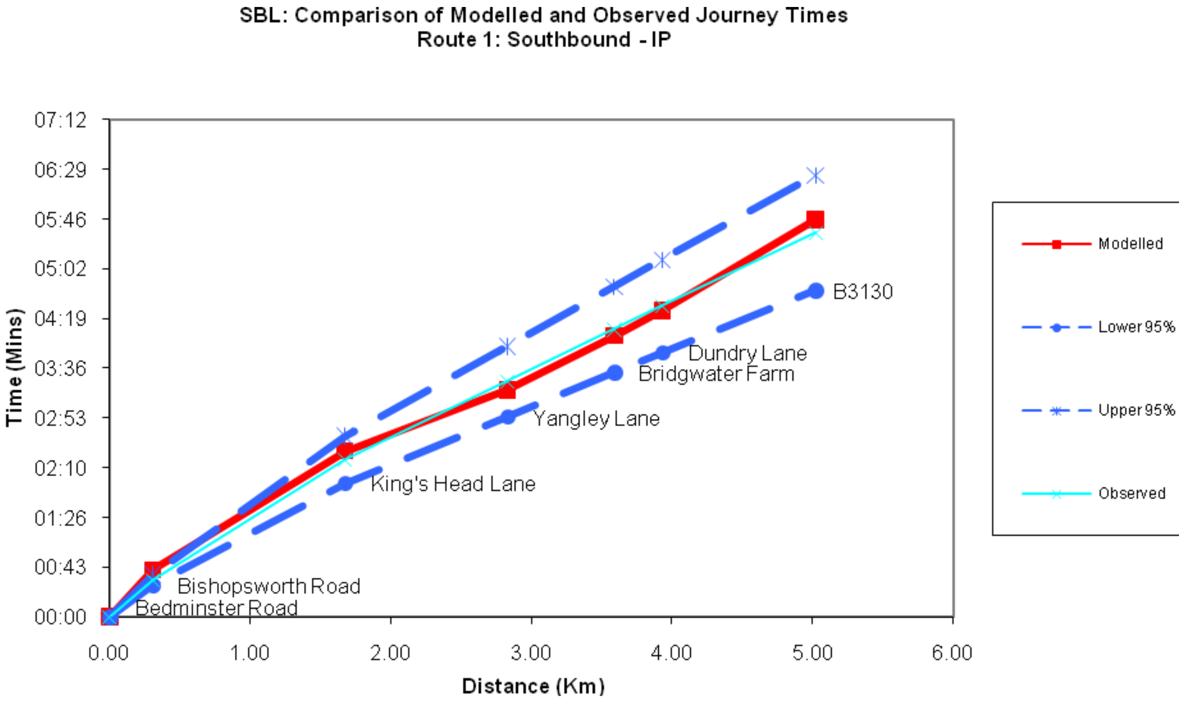

SBL: Comparison of Modelled and Observed Journey Times
Route 7: Anti-Clockwise - AM
Time (Mins)
17:17
14:24
11:31
08:38
05:46
02:53
00:00
Distance (Km)
Bedminster Road
Bedminster Road
Parson Street
Headley Lane
Novers Lane
Hengrove Roundabout
Cater Road
Hareclive Road
King's Head Lane
Bridgwater Road
Bedminster Road
Modelled
Lower 95%
Upper 95%
Observed

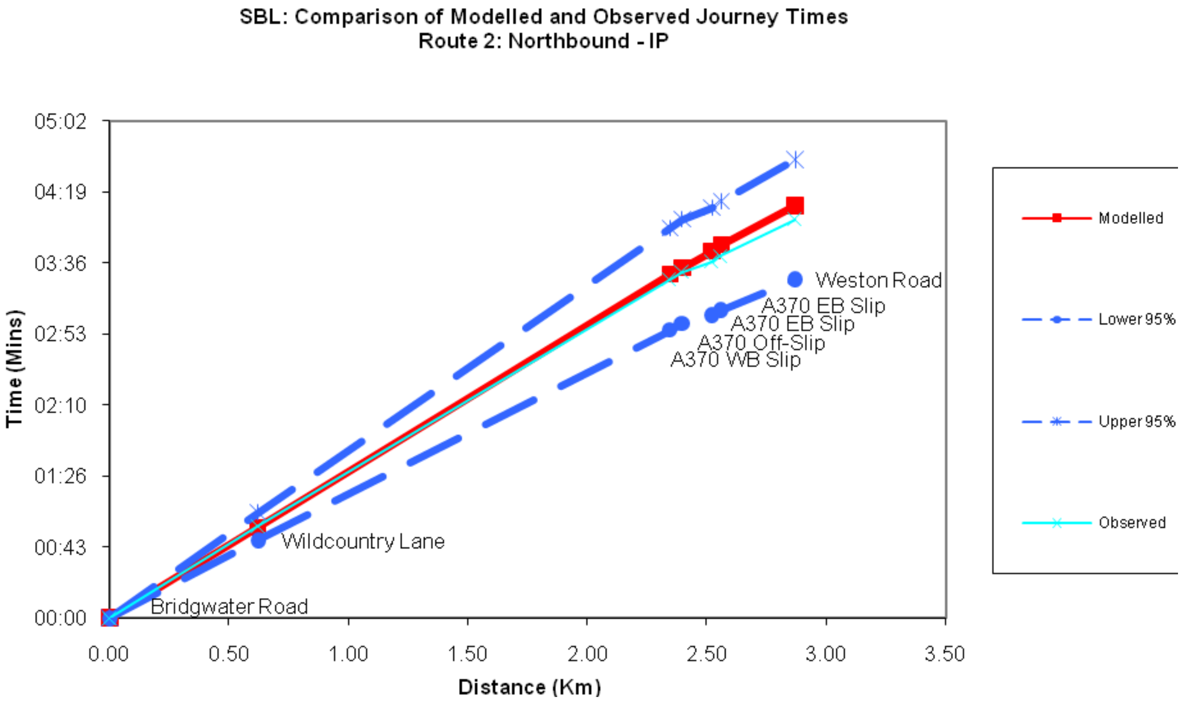

SBL: Comparison of Modelled and Observed Journey Times
Route 8: Clockwise - AM
Time (Mins)
23:02
20:10
17:17
14:24
11:31
08:38
05:46
02:53
00:00
Distance (Km)
Hengrove Way -exit
Hengrove Roundabout
Hawkfield Way
Bamfield
Ridgeway Lane
Wharncliffe Gardens
Winter Walk
West Town Lane
A37
Cadogan Road
Creswicke Road
Roman Farm Road
Hengrove Roundabout
Modelled
Lower 95%
Upper 95%
Observed

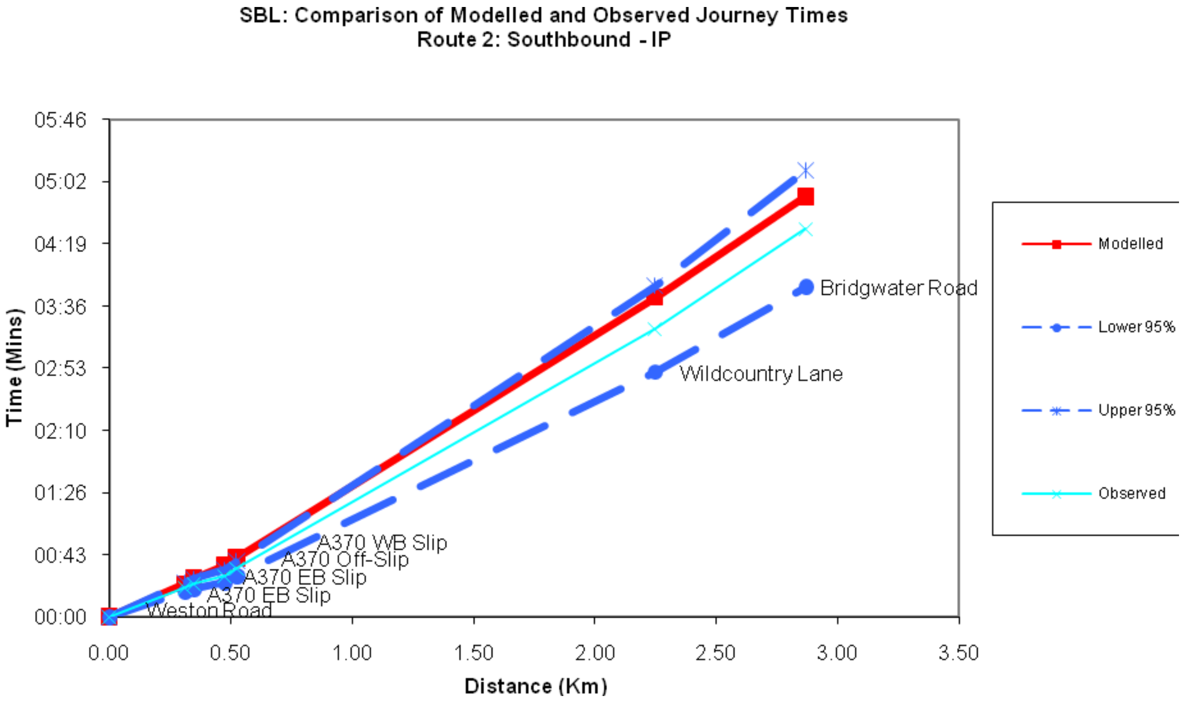


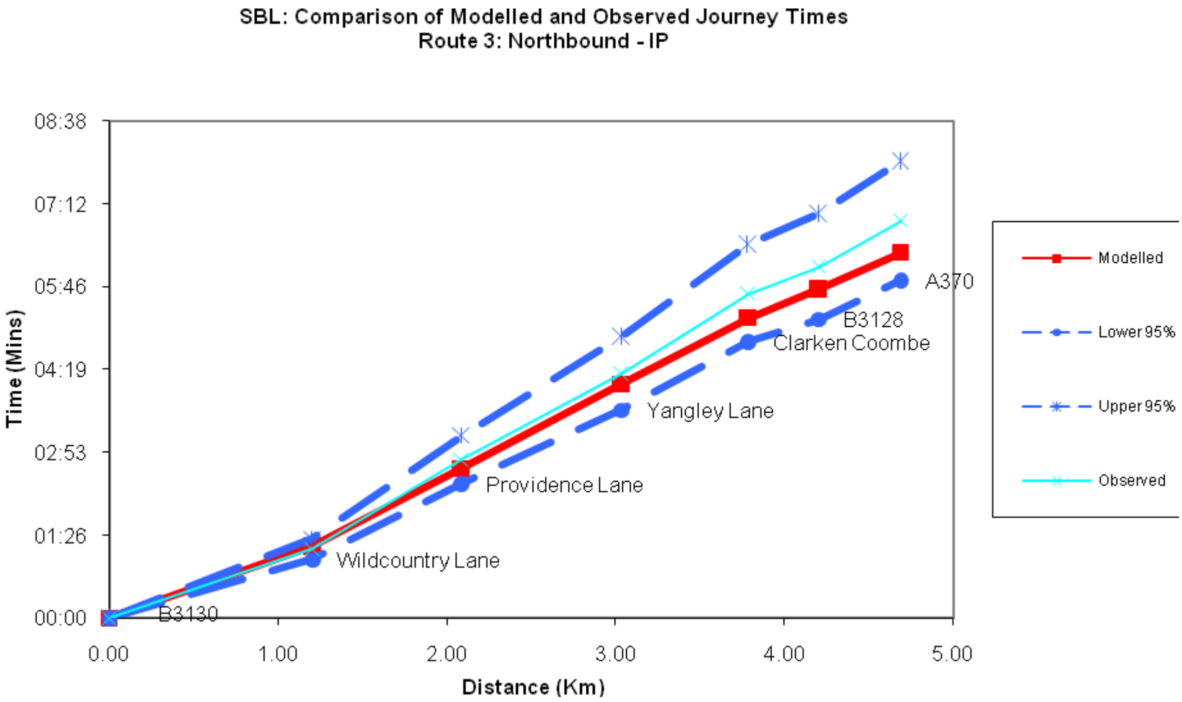
E.2. Inter peak

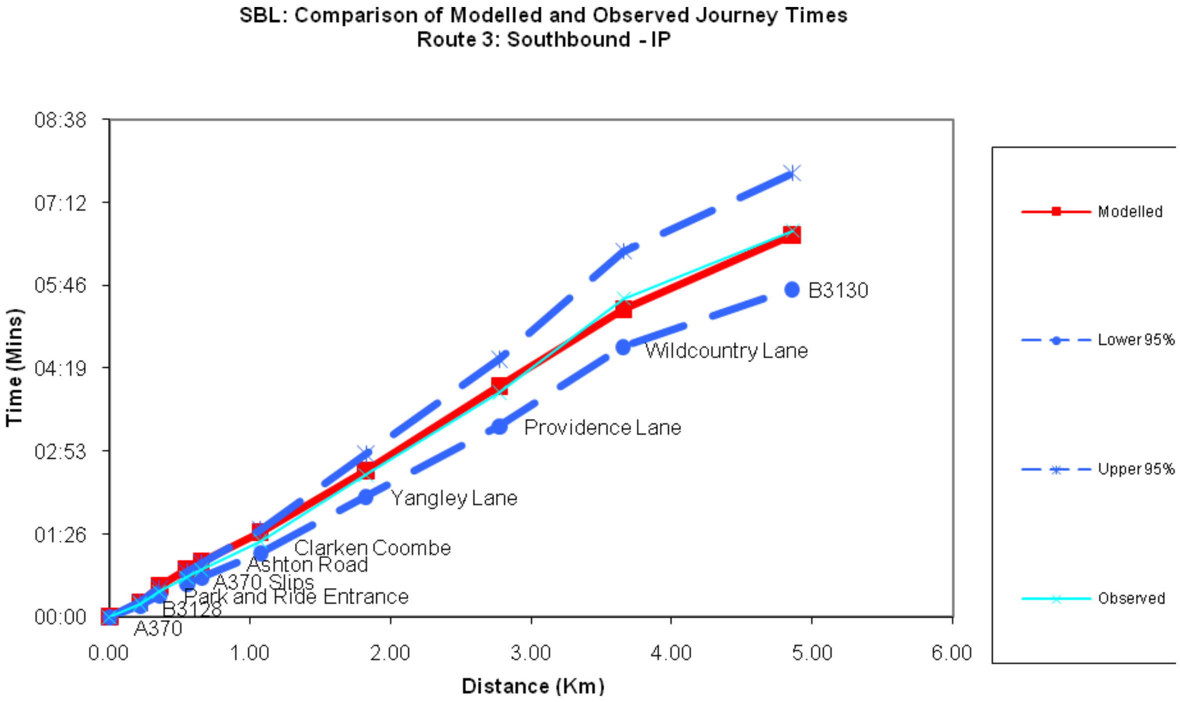


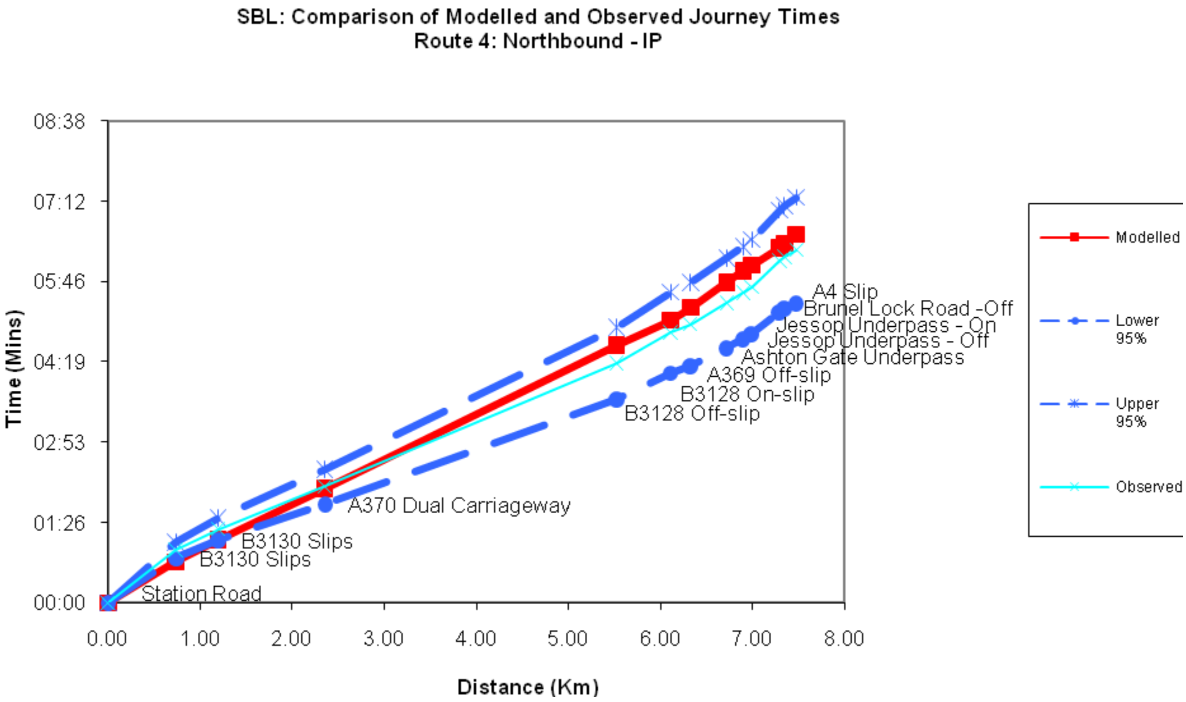

SBL: Comparison of Modelled and Observed Journey Times
Route 1: Southbound - IP
Time (Mins)
07:12
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Km)
B3130
Dundry Lane
Bridgwater Farm
Yangley Lane
King's Head Lane
Bishopsworth Road
Bedminster Road
Modelled
Lower 95%
Upper 95%
Observed

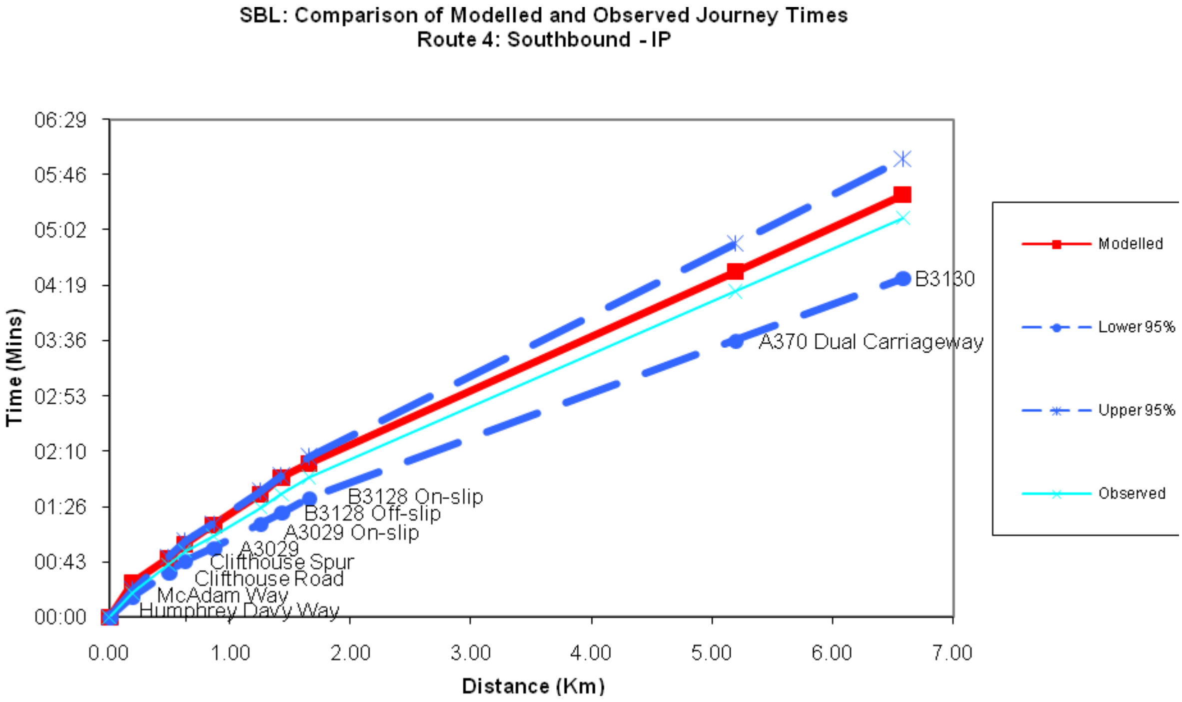

SBL: Comparison of Modelled and Observed Journey Times
Route 2: Northbound - IP
Time (Mins)
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Distance (Km)
Weston Road
A370 EB Slip
A370 EB Slip
A370 Off-Slip
A370 WB Slip
Wildcountry Lane
Bridgwater Road
Modelled
Lower 95%
Upper 95%
Observed

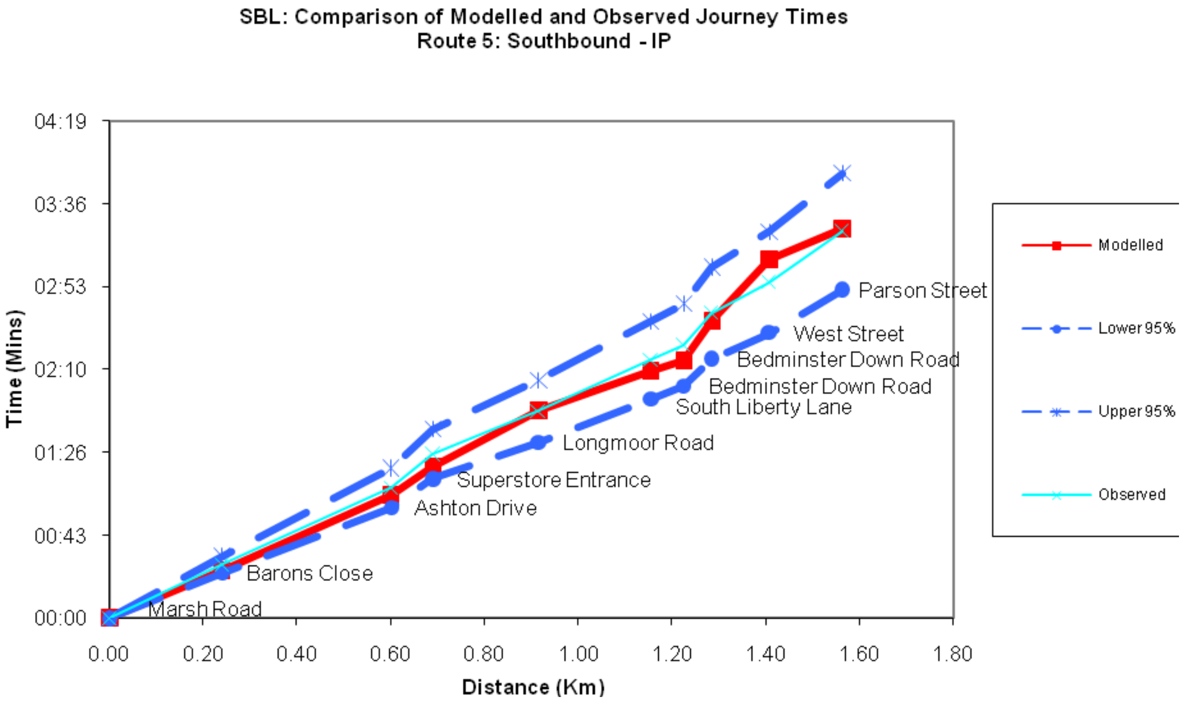

SBL: Comparison of Modelled and Observed Journey Times
Route 2: Southbound - IP
Time (Mins)
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Distance (Km)
Bridgwater Road
Wildcountry Lane
A370 WB Slip
A370 Off-Slip
A370 EB Slip
A370 EB Slip
Weston Road
Modelled
Lower 95%
Upper 95%
Observed

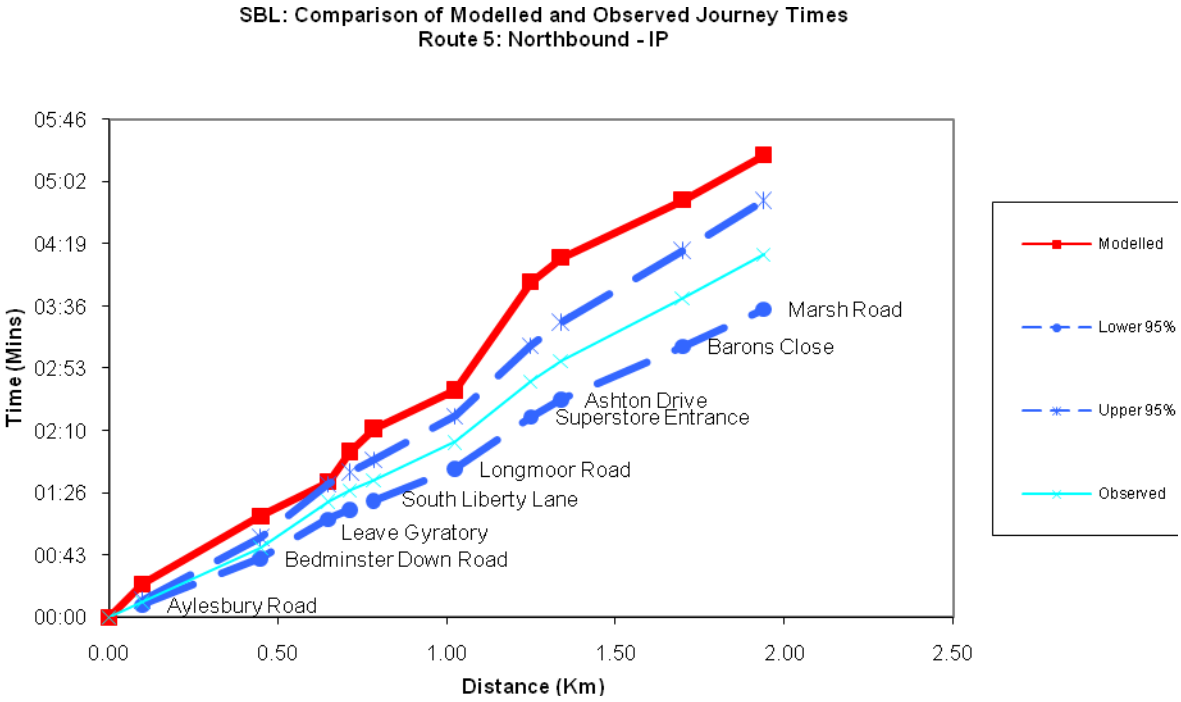

SBL: Comparison of Modelled and Observed Journey Times
Route 3: Northbound - IP
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
Distance (Km)
A370
B3128
Clarken Coombe
Yangley Lane
Providence Lane
Wildcountry Lane
B3130
Modelled
Lower 95%
Upper 95%
Observed

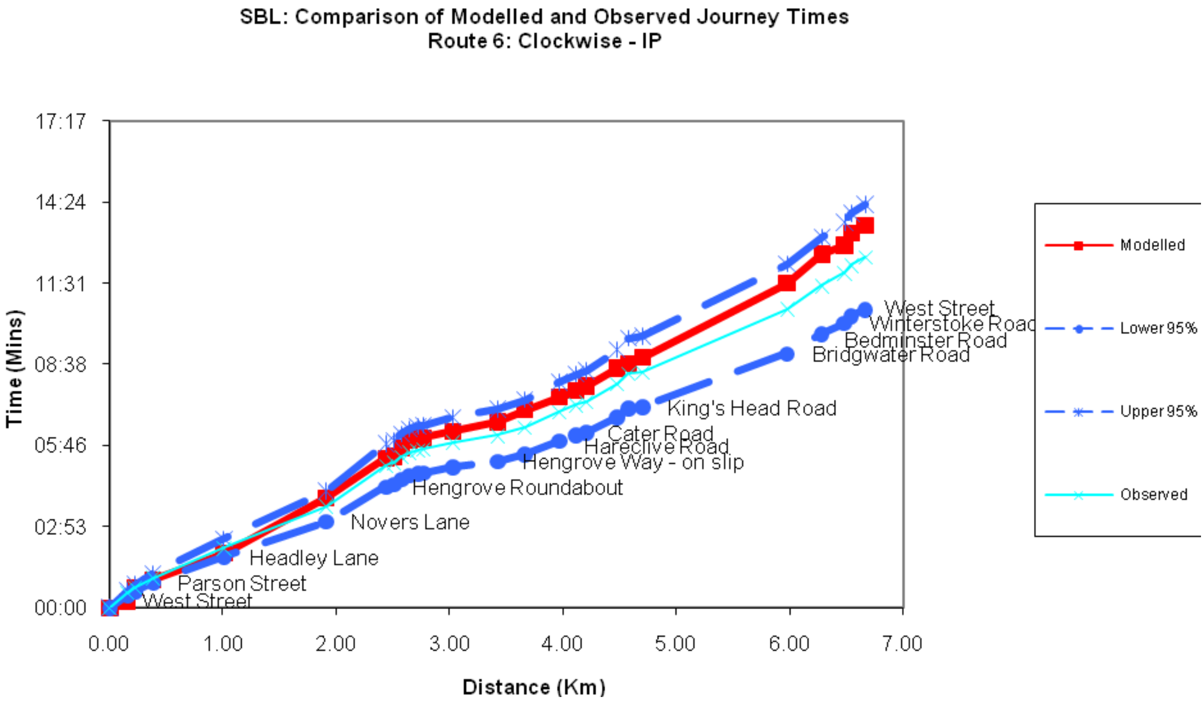

SBL: Comparison of Modelled and Observed Journey Times
Route 3: Southbound - IP
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Km)
B3130
Wildcountry Lane
Providence Lane
Yangley Lane
Clarken Coombe
Ashton Road
A370 Slips
Park and Ride Entrance
B3128
A370
Modelled
Lower 95%
Upper 95%
Observed

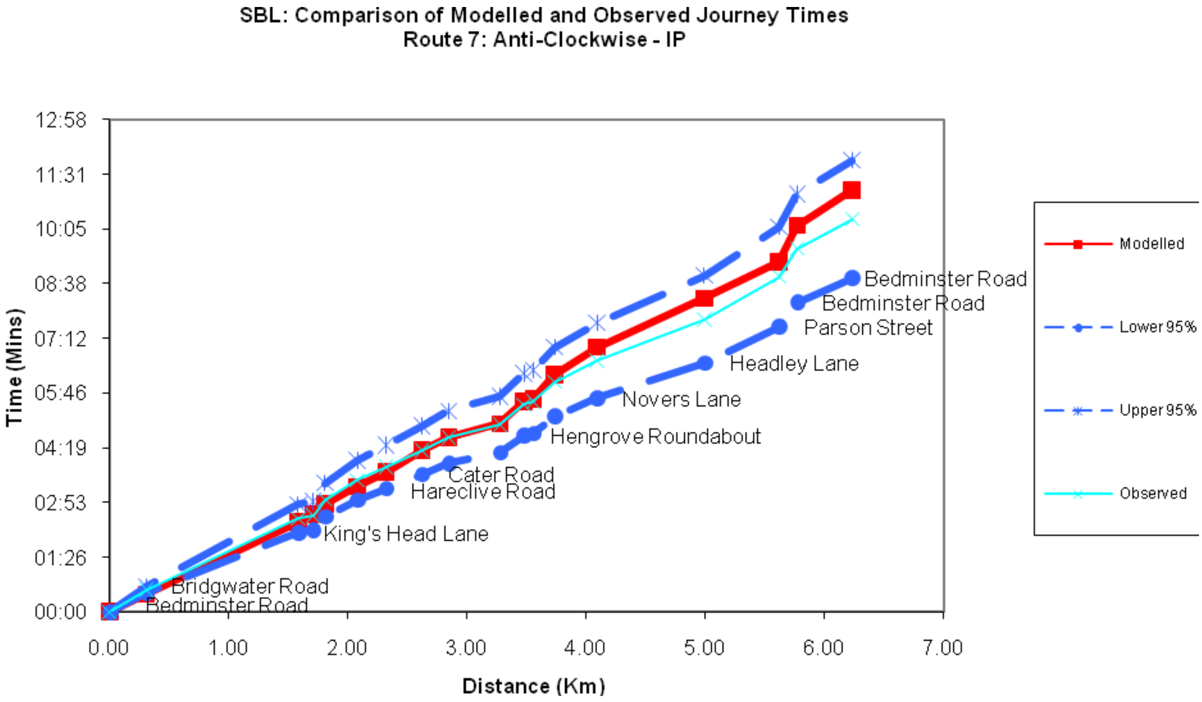

SBL: Comparison of Modelled and Observed Journey Times
Route 4: Northbound - IP
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Distance (Km)
A4 Slip
Brunel Lock Road -Off
Jessop Underpass - On
Jessop Underpass - Off
Ashton Gate Underpass
A369 Off-slip
B3128 On-slip
B3128 Off-slip
A370 Dual Carriageway
B3130 Slips
B3130 Slips
Station Road
Modelled
Lower 95%
Upper 95%
Observed

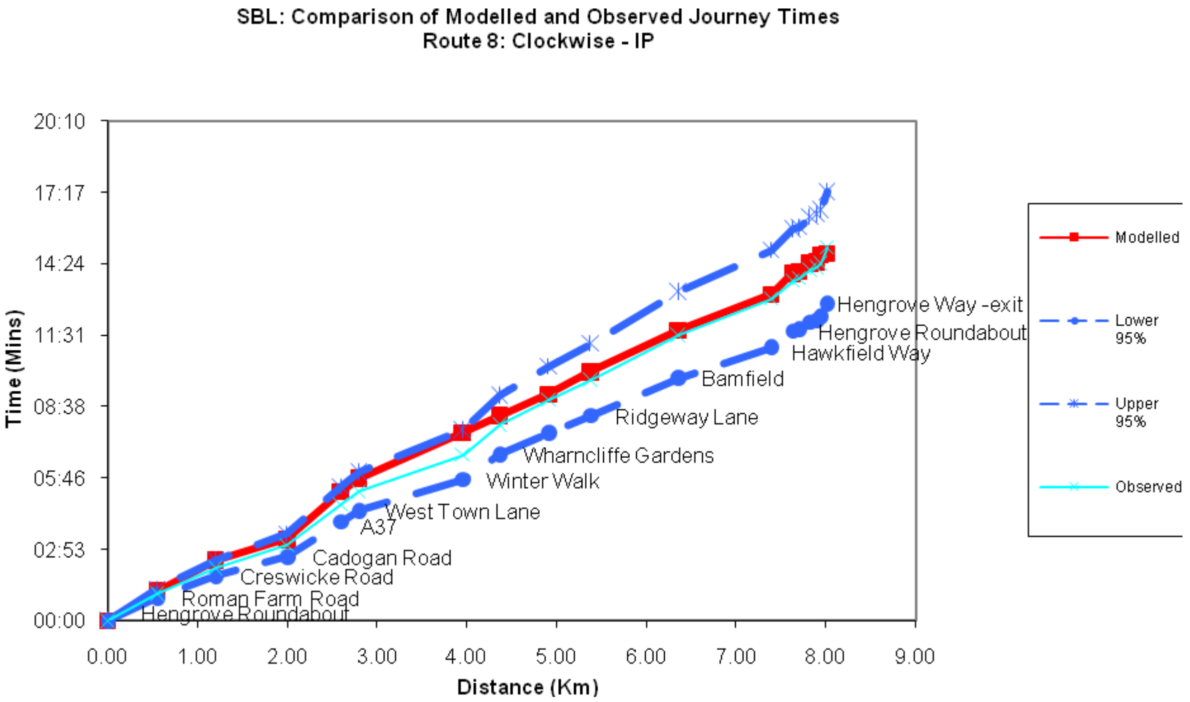

SBL: Comparison of Modelled and Observed Journey Times
Route 4: Southbound - IP
Time (Mins)
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
Distance (Km)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
B3130
A370 Dual Carriageway
B3128 On-slip
B3128 Off-slip
A3029 On-slip
A3029
Clifthouse Spur
Clifthouse Road
McAdam Way
Humphrey Davy Way
Modelled
Lower 95%
Upper 95%
Observed

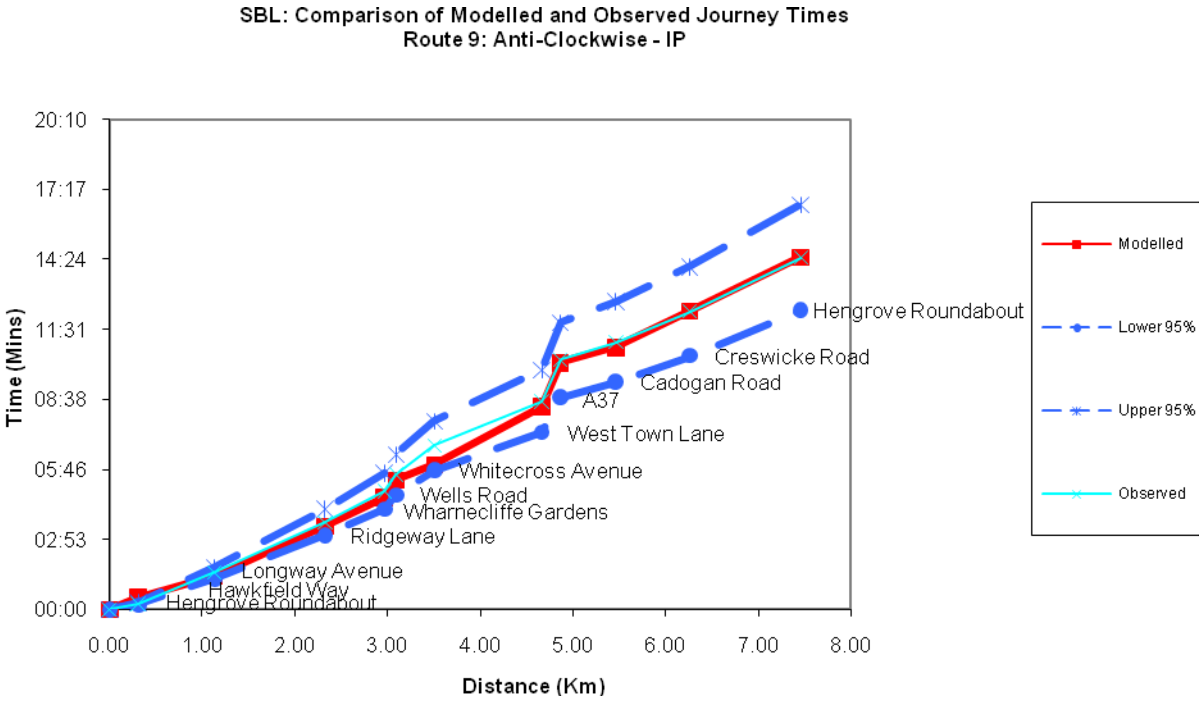

SBL: Comparison of Modelled and Observed Journey Times
Route 5: Southbound - IP
Time (Mins)
04:19
03:36
02:53
02:10
01:26
00:43
00:00
Distance (Km)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
Parson Street
West Street
Bedminster Down Road
Bedminster Down Road
South Liberty Lane
Longmoor Road
Superstore Entrance
Ashton Drive
Barons Close
Marsh Road
Modelled
Lower 95%
Upper 95%
Observed


SBL: Comparison of Modelled and Observed Journey Times
Route 5: Northbound - IP
Time (Mins)
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
2.50
Distance (Km)
Marsh Road
Barons Close
Ashton Drive
Superstore Entrance
Longmoor Road
South Liberty Lane
Leave Gyratory
Bedminster Down Road
Aylesbury Road
Modelled
Lower 95%
Upper 95%
Observed

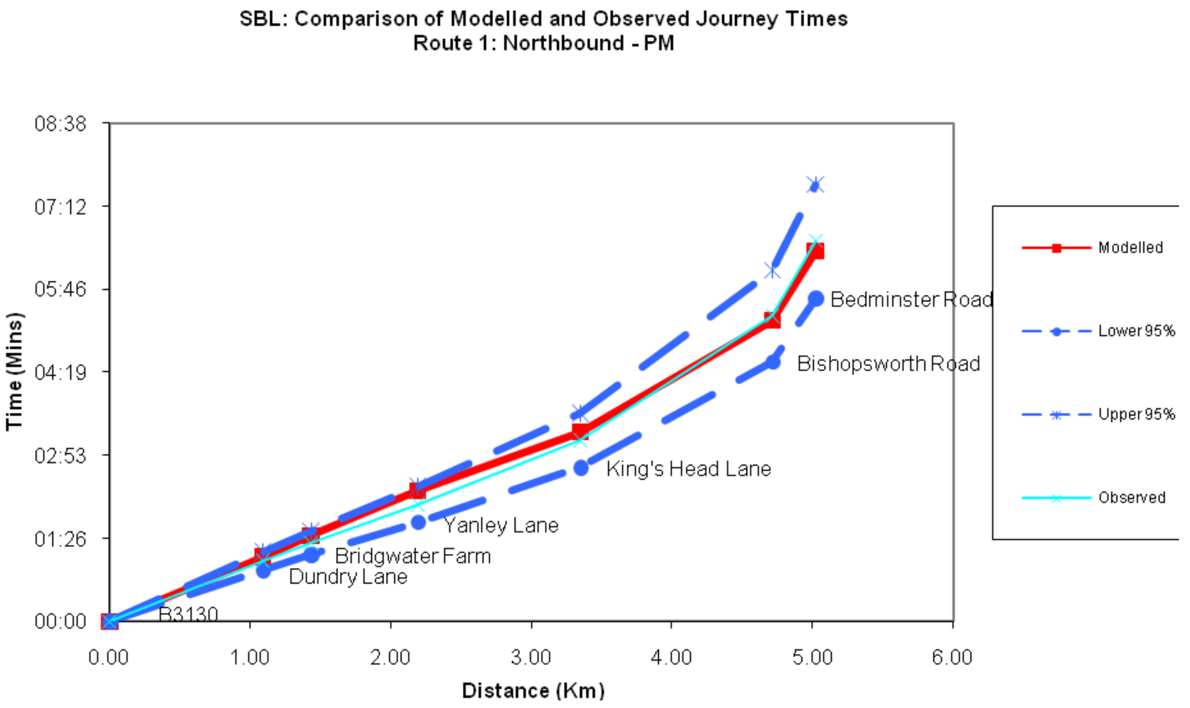

SBL: Comparison of Modelled and Observed Journey Times
Route 6: Clockwise - IP
Time (Mins)
17:17
14:24
11:31
08:38
05:46
02:53
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Distance (Km)
West Street
Winterstoke Road
Bedminster Road
Bridgwater Road
King's Head Road
Cater Road
Hareclive Road
Hengrove Way - on slip
Hengrove Roundabout
Novers Lane
Headley Lane
Parson Street
West Street
Modelled
Lower 95%
Upper 95%
Observed

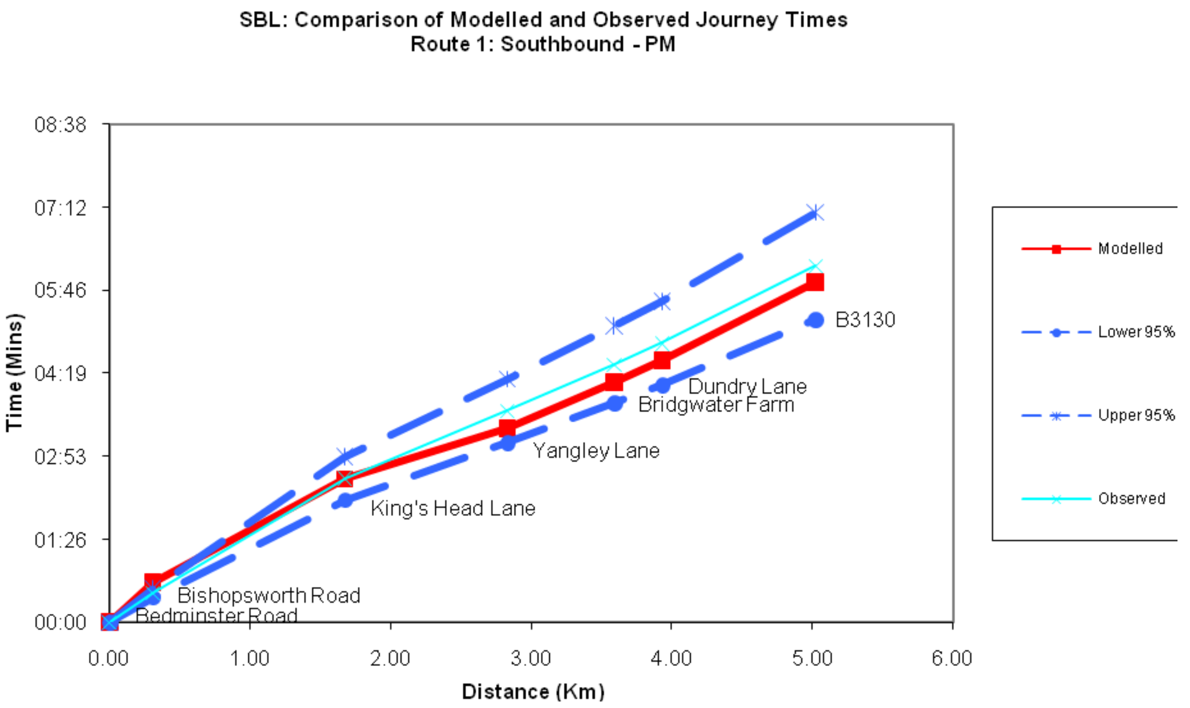

SBL: Comparison of Modelled and Observed Journey Times
Route 7: Anti-Clockwise - IP
Time (Mins)
12:58
11:31
10:05
08:38
07:12
05:46
04:19
02:53
01:26
00:00
Distance (Km)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Bedminster Road
Bedminster Road
Parson Street
Headley Lane
Novers Lane
Hengrove Roundabout
Cater Road
Hareclive Road
King's Head Lane
Bridgwater Road
Bedminster Road
Modelled
Lower 95%
Upper 95%
Observed

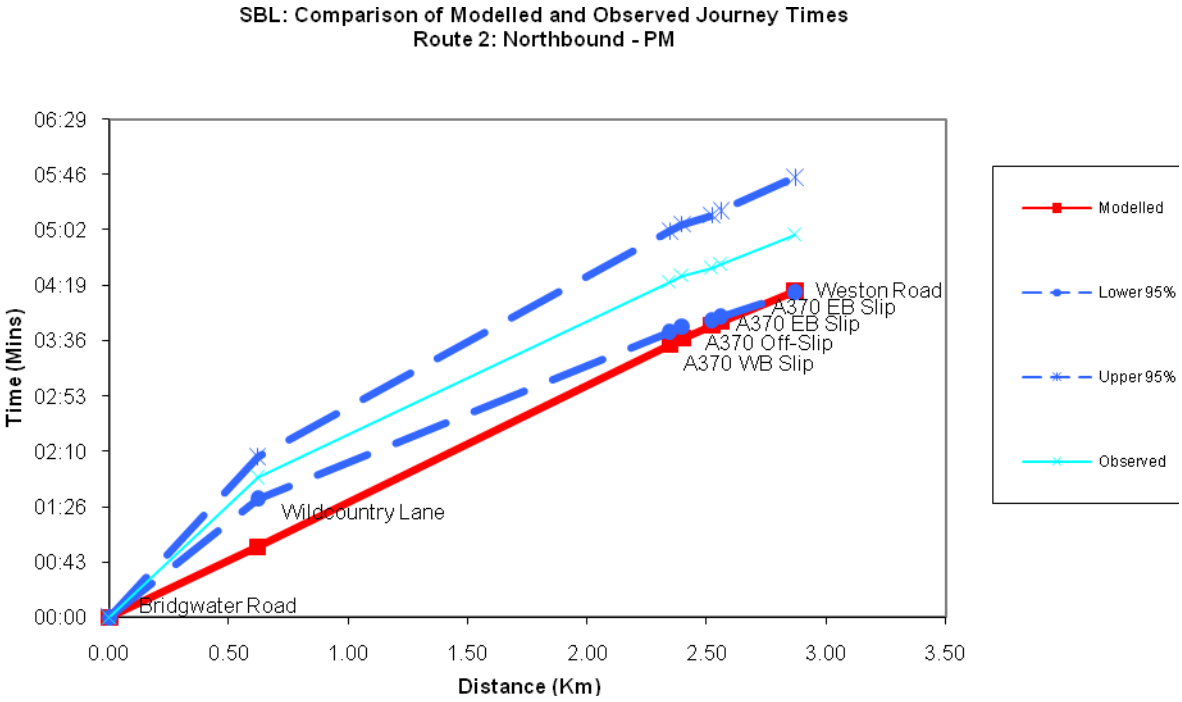

SBL: Comparison of Modelled and Observed Journey Times
Route 8: Clockwise - IP
Time (Mins)
20:10
17:17
14:24
11:31
08:38
05:46
02:53
00:00
Distance (Km)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Hengrove Way -exit
Hengrove Roundabout
Hawkfield Way
Bamfield
Ridgeway Lane
Wharncliffe Gardens
Winter Walk
West Town Lane
A37
Cadogan Road
Creswicke Road
Roman Farm Road
Hengrove Roundabout
Modelled
Lower 95%
Upper 95%
Observed

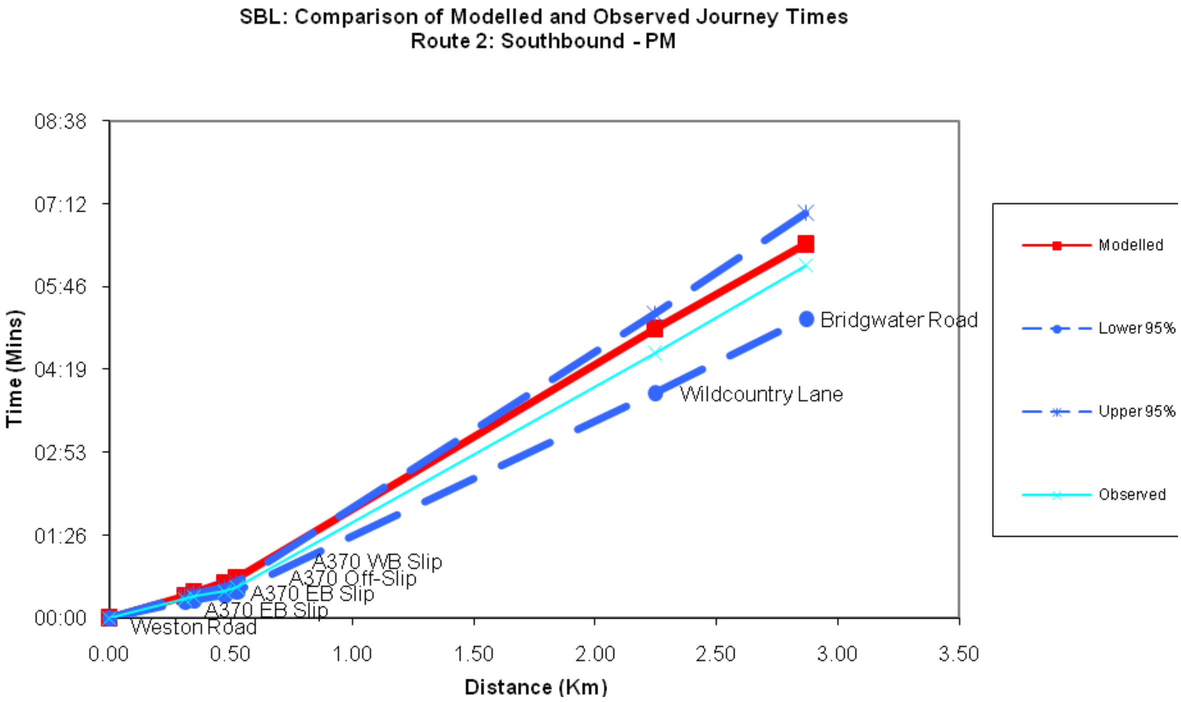

SBL: Comparison of Modelled and Observed Journey Times
Route 9: Anti-Clockwise - IP
20:10
17:17
14:24
11:31
08:38
05:46
02:53
00:00
Time (Mins)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Distance (Km)
Hengrove Roundabout
Creswicke Road
Cadogan Road
A37
West Town Lane
Whitecross Avenue
Wells Road
Wharnecliffe Gardens
Ridgeway Lane
Longway Avenue
Hawkfield Way
Hengrove Roundabout
Modelled
Lower 95%
Upper 95%
Observed

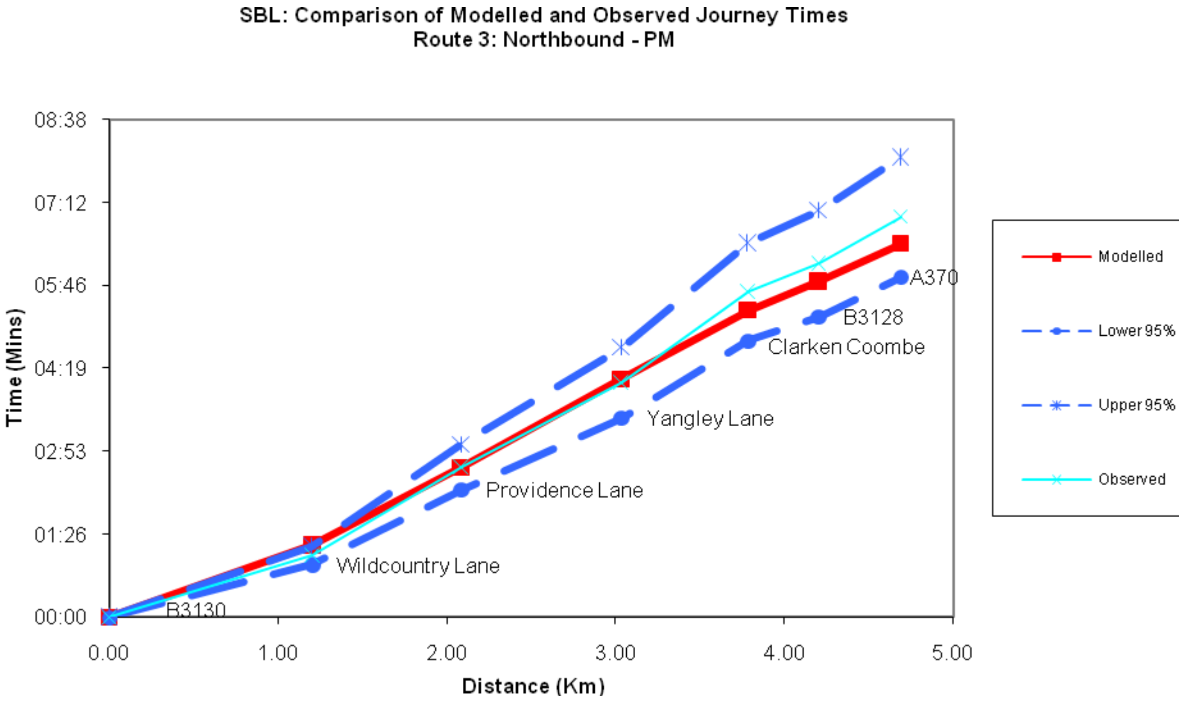
E.3. PM peak

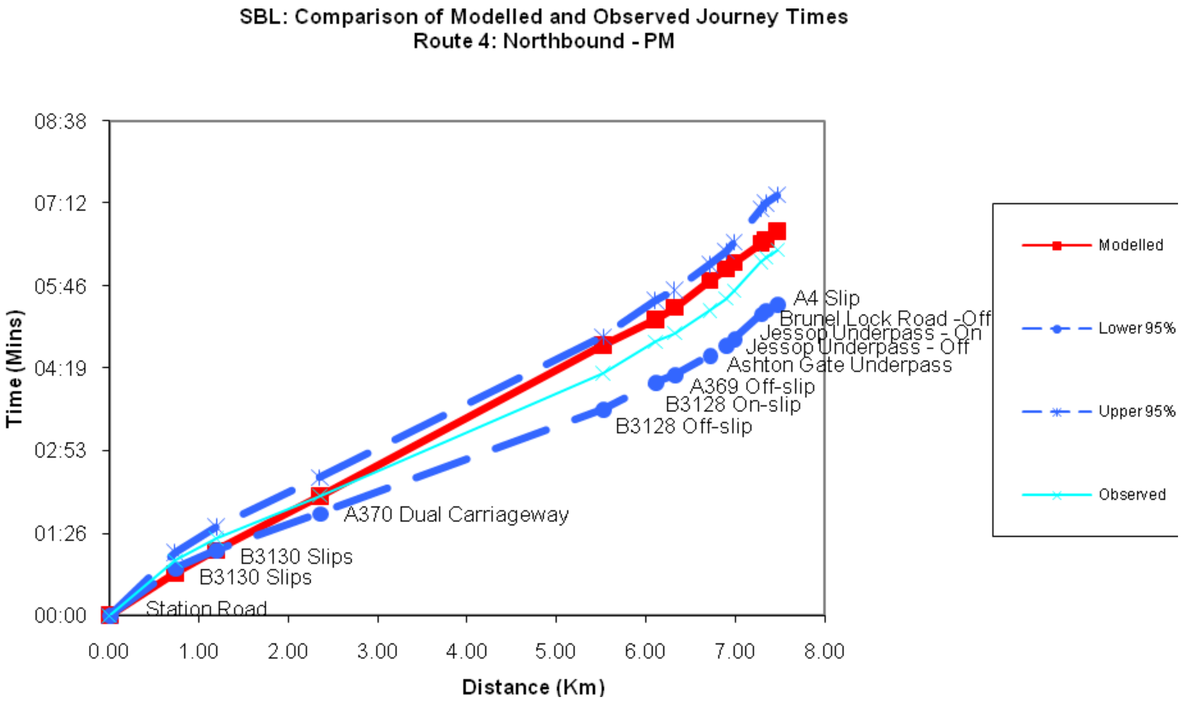

SBL: Comparison of Modelled and Observed Journey Times
Route 1: Northbound - PM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Km)
B3130
Dundry Lane
Bridgwater Farm
Yanley Lane
King's Head Lane
Bishopsworth Road
Bedminster Road
Modelled
Lower 95%
Upper 95%
Observed

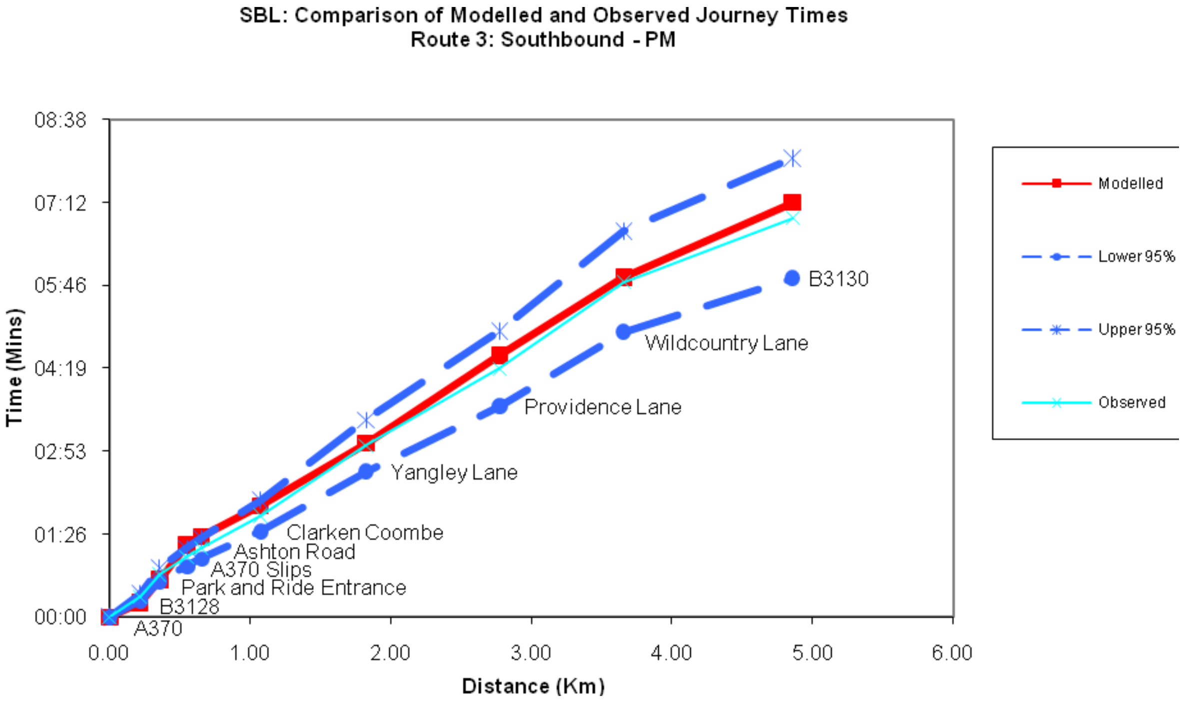

SBL: Comparison of Modelled and Observed Journey Times
Route 1: Southbound - PM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Km)
Bedminster Road
Bishopsworth Road
King's Head Lane
Yangley Lane
Bridgwater Farm
Dundry Lane
B3130
Modelled
Lower 95%
Upper 95%
Observed

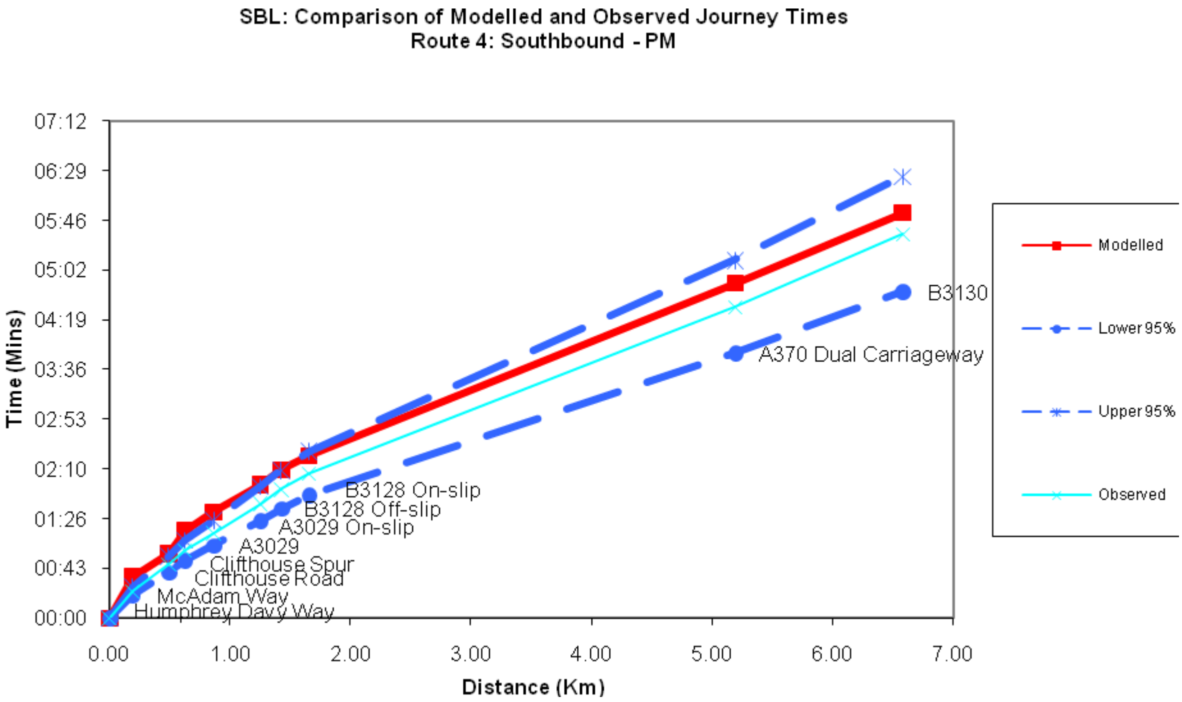

SBL: Comparison of Modelled and Observed Journey Times
Route 2: Northbound - PM
Time (Mins)
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Distance (Km)
Weston Road
A370 EB Slip
A370 EB Slip
A370 Off-Slip
A370 WB Slip
Wildcountry Lane
Bridgwater Road
Modelled
Lower 95%
Upper 95%
Observed

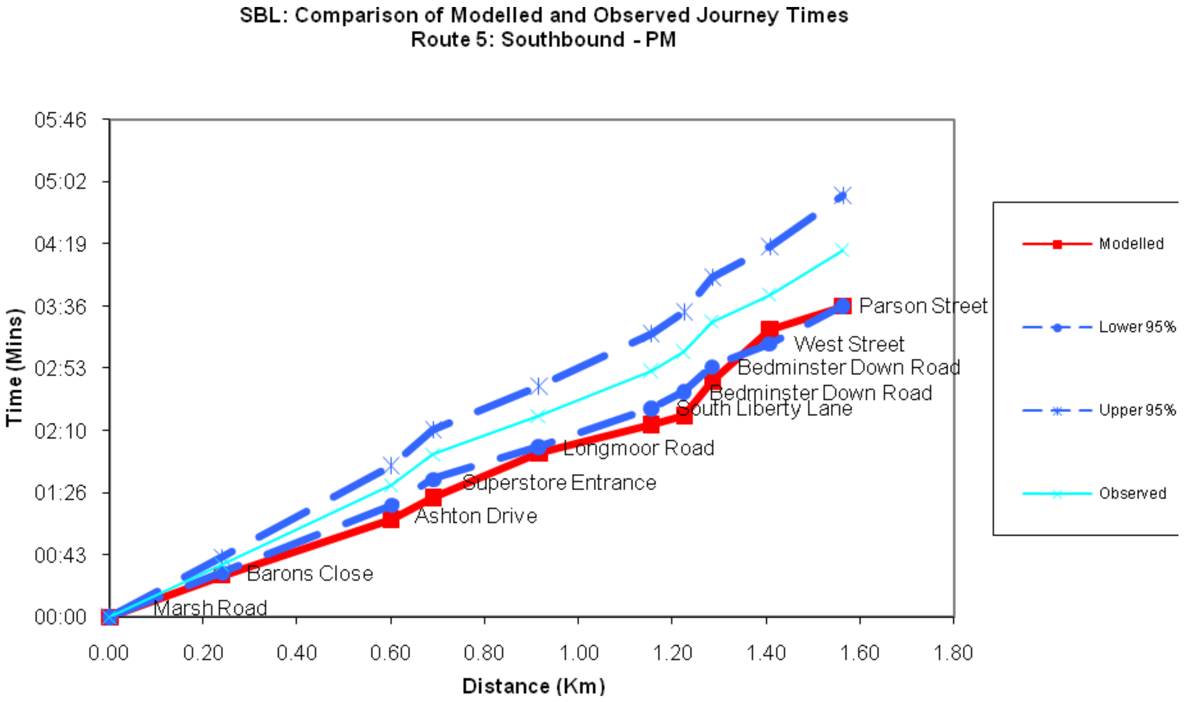

SBL: Comparison of Modelled and Observed Journey Times
Route 2: Southbound - PM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
Distance (Km)
Bridgwater Road
Wildcountry Lane
A370 WB Slip
A370 Off-Slip
A370 EB Slip
A370 EB Slip
Weston Road
Modelled
Lower 95%
Upper 95%
Observed

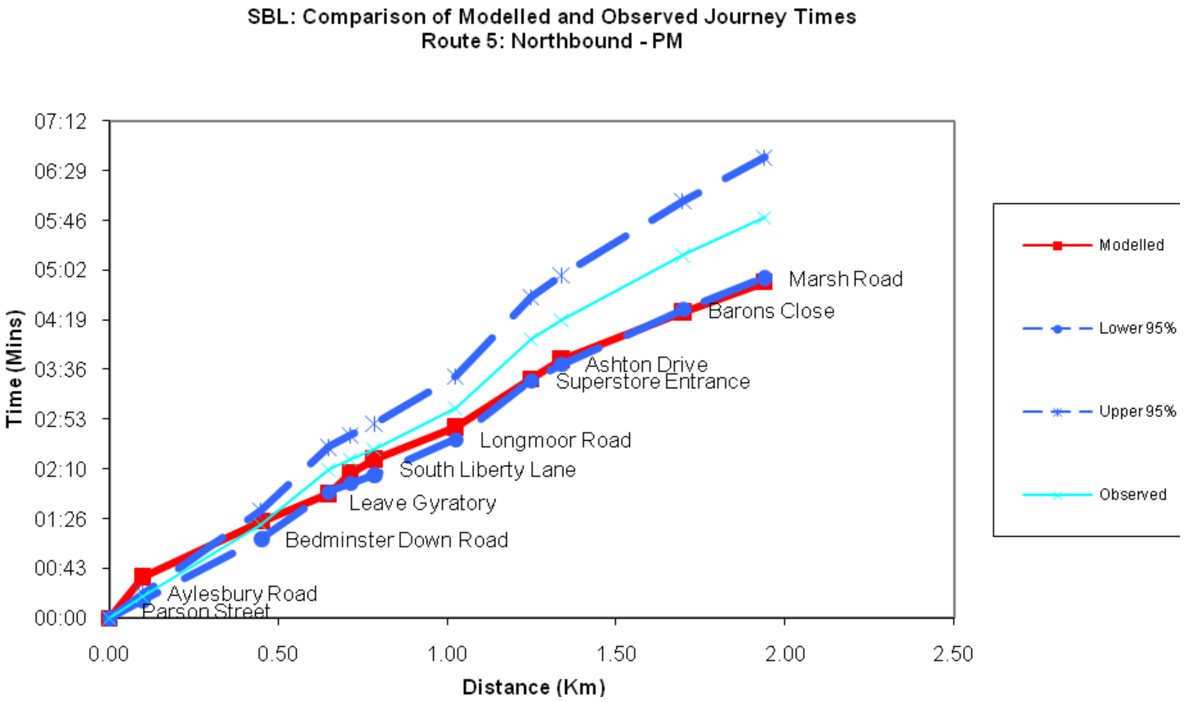

SBL: Comparison of Modelled and Observed Journey Times
Route 3: Northbound - PM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
Distance (Km)
A370
B3128
Clarken Coombe
Yangley Lane
Providence Lane
Wildcountry Lane
B3130
Modelled
Lower 95%
Upper 95%
Observed

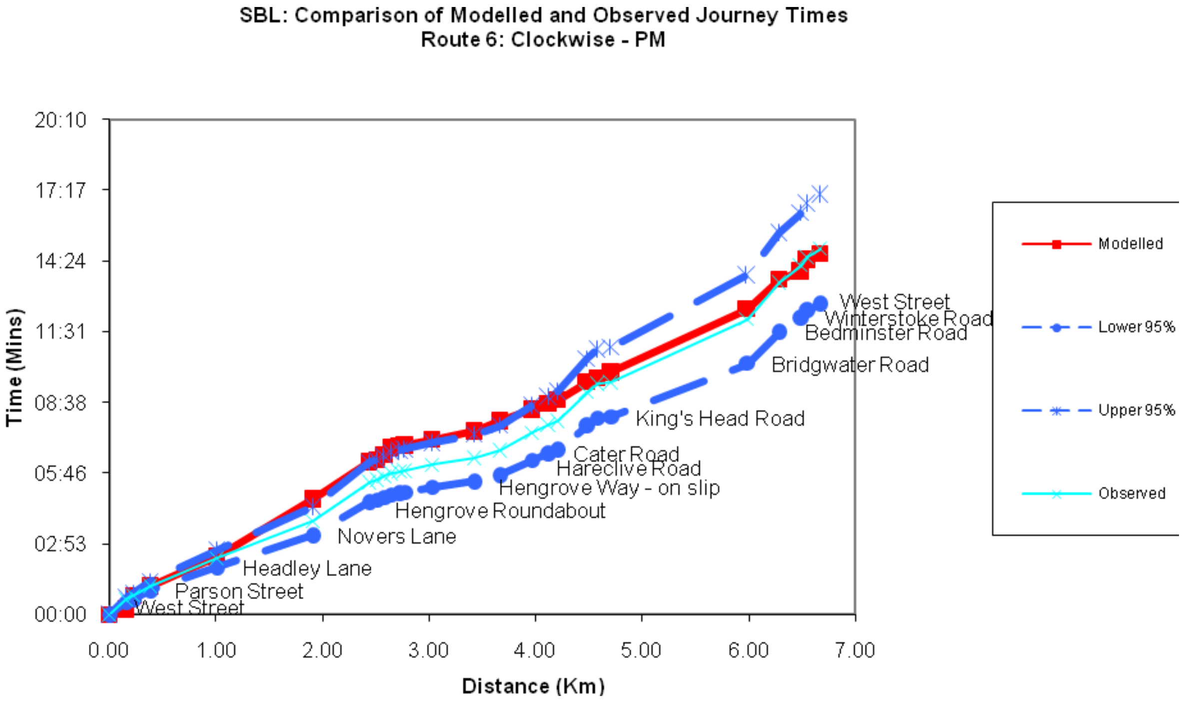

SBL: Comparison of Modelled and Observed Journey Times
Route 4: Northbound - PM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Distance (Km)
A4 Slip
Brunel Lock Road -Off
Jessop Underpass - On
Jessop Underpass - Off
Ashton Gate Underpass
A369 Off-slip
B3128 On-slip
B3128 Off-slip
A370 Dual Carriageway
B3130 Slips
B3130 Slips
Station Road
Modelled
Lower 95%
Upper 95%
Observed

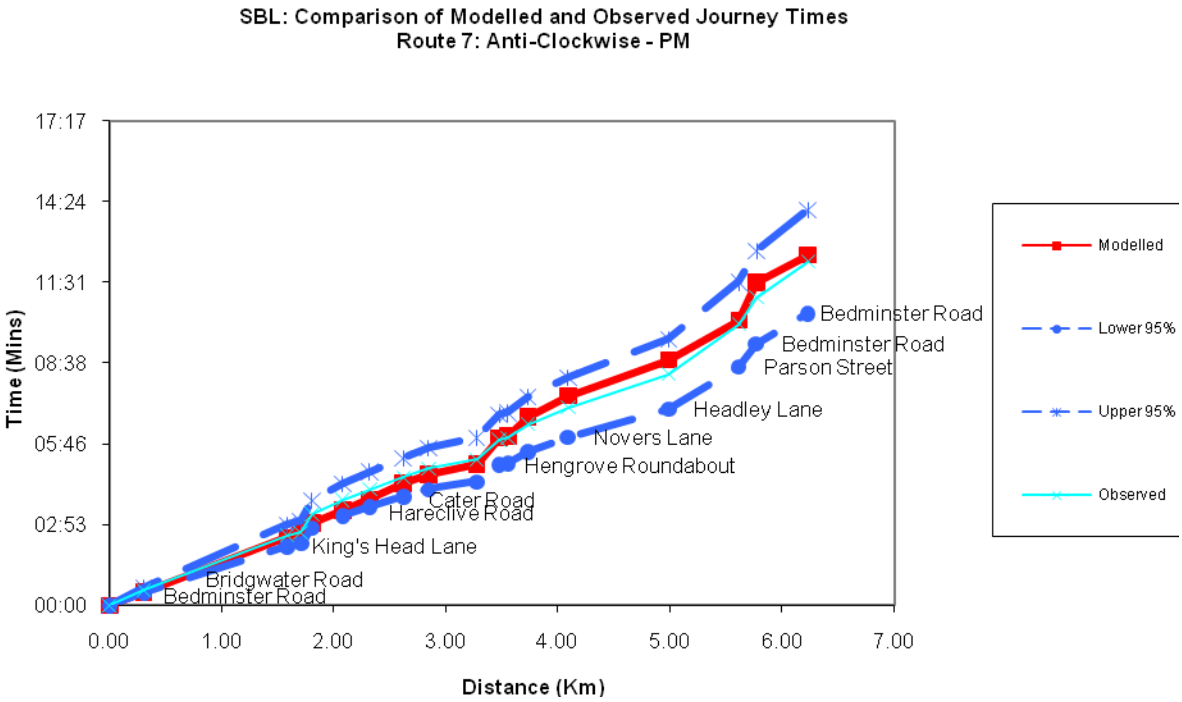

SBL: Comparison of Modelled and Observed Journey Times
Route 3: Southbound - PM
Time (Mins)
08:38
07:12
05:46
04:19
02:53
01:26
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Km)
B3130
Wildcountry Lane
Providence Lane
Yangley Lane
Clarken Coombe
Ashton Road
A370 Slips
Park and Ride Entrance
B3128
A370
Modelled
Lower 95%
Upper 95%
Observed


SBL: Comparison of Modelled and Observed Journey Times
Route 4: Southbound - PM
Time (Mins)
07:12
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Distance (Km)
B3130
A370 Dual Carriageway
B3128 On-slip
B3128 Off-slip
A3029 On-slip
A3029
Clifthouse Spur
Clifthouse Road
McAdam Way
Humphrey Davy Way
Modelled
Lower 95%
Upper 95%
Observed

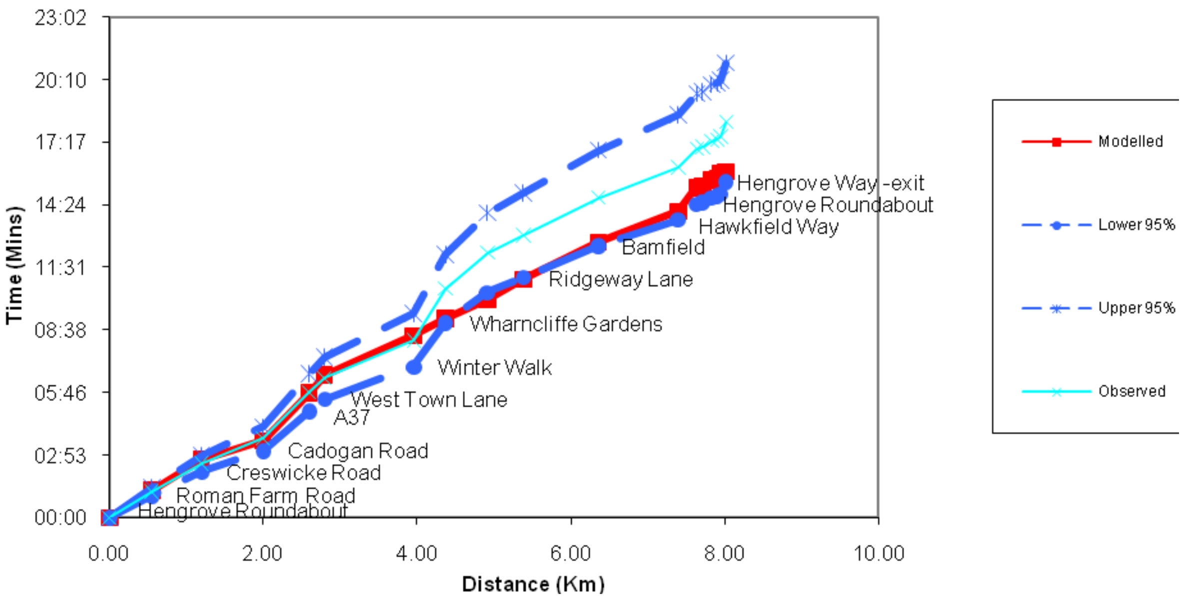

SBL: Comparison of Modelled and Observed Journey Times
Route 5: Southbound - PM
Time (Mins)
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
Distance (Km)
Parson Street
West Street
Bedminster Down Road
Bedminster Down Road
South Liberty Lane
Longmoor Road
Superstore Entrance
Ashton Drive
Barons Close
Marsh Road
Modelled
Lower 95%
Upper 95%
Observed


SBL: Comparison of Modelled and Observed Journey Times
Route 5: Northbound - PM
Time (Mins)
07:12
06:29
05:46
05:02
04:19
03:36
02:53
02:10
01:26
00:43
00:00
0.00
0.50
1.00
1.50
2.00
2.50
Distance (Km)
Marsh Road
Barons Close
Ashton Drive
Superstore Entrance
Longmoor Road
South Liberty Lane
Leave Gyratory
Bedminster Down Road
Aylesbury Road
Parson Street
Modelled
Lower 95%
Upper 95%
Observed

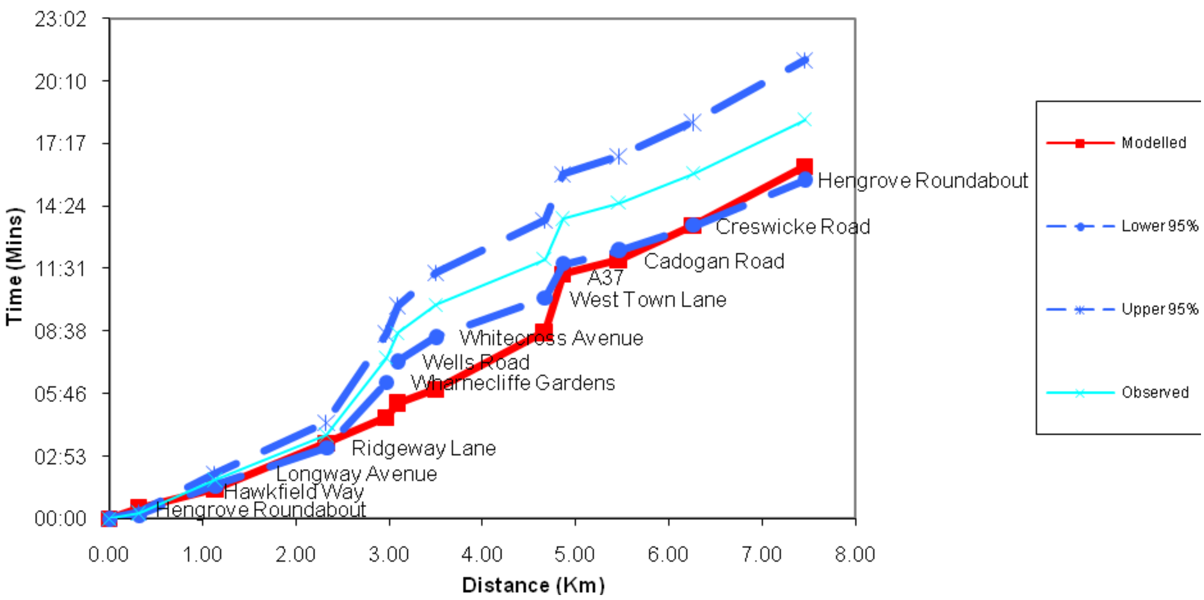

SBL: Comparison of Modelled and Observed Journey Times
Route 6: Clockwise - PM
Time (Mins)
20:10
17:17
14:24
11:31
08:38
05:46
02:53
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Distance (Km)
West Street
Winterstoke Road
Bedminster Road
Bridgwater Road
King's Head Road
Cater Road
Hareclive Road
Hengrove Way - on slip
Hengrove Roundabout
Novers Lane
Headley Lane
Parson Street
West Street
Modelled
Lower 95%
Upper 95%
Observed


SBL: Comparison of Modelled and Observed Journey Times
Route 7: Anti-Clockwise - PM
Time (Mins)
17:17
14:24
11:31
08:38
05:46
02:53
00:00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Distance (Km)
Bedminster Road
Bedminster Road
Parson Street
Headley Lane
Novers Lane
Hengrove Roundabout
Cater Road
Hareclive Road
King's Head Lane
Bridgwater Road
Bedminster Road
Modelled
Lower 95%
Upper 95%
Observed

SBL: Comparison of Modelled and Observed Journey Times
Route 8: Clockwise - PM



SBL: Comparison of Modelled and Observed Journey Times
Route 9: Anti-Clockwise - PM



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