ATKINS

Wisbech Area Transport Study

Local Model Validation Report

May 2009

Notice

This report was produced by Atkins Transport Planning for Fenland District Council and Cambridgeshire County Council for the specific purpose of the Wisbech Area Transport Study.

This report may not be used by any person other than Fenland District Council and Cambridgeshire County Council without Fenland District Council and Cambridgeshire County Council's express permission. In any event, Atkins accepts no liability for any costs, liabilities or losses arising as a result of the use of or reliance upon the contents of this report by any person other than Fenland District Council and Cambridgeshire County Council.

Document History

JOB NUMBER: 5071158			DOCUMENT REF: WATS LMVR v8.doc			
4	Re-calibration of A47/B1187 junction	SA/NP	KB	PDE	PDE	11/05/09
3	IP Count Data Corrections	SA	NP	NP	PDE	17/04/09
2	Final version	NP/SA/KB	NP/SA	KB	PDE	09/04/09
1	Draft for comments	NP/SA/KB	KB	PDE	PDE	23/03/09
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Contents

Section **Page**

1.	**Introduction**	**8**
	Background	8
	Study Scope	8
	This Report	8
2.	**Overview of Modelling Framework**	**9**
	Study Area	9
	Zone and Sector Plans	9
	Modelled Base Year	15
3.	**Data Usage**	**16**
	Roadside Interview Surveys	18
	Manual Classified Turning Counts	18
	Journey Time Surveys	18
	Car Park Interview Surveys	18
	National Census Journey to Work Data	18
	Education Trips Data	20
	Bus Route and Timetable Information	20
	CCC Traffic Signal Data	20
	Highway Network Inventory Surveys	20
	The East of England Regional Model	20
	Highways Agency TRADS Data	20
4.	**Local Highway Model – General Parameters**	**21**
	Introduction	21
	Passenger Car Unit Factors	21
	Modelled Time Periods	21
	User Classes	21
	Time and Distance Costs	22
5.	**Local Highway Model – Network Development**	**32**
	Network Coverage	32
	Network Coding	32
	Car Parks	35
	Bus Routes	36
6.	**Local Highway Model – Matrix Development**	**37**
	Introduction	37
	Data Utilised	37
	Building the Observed Matrices	37
	Building the Synthetic Matrices	48
	Compiling the Full Prior Matrices	56
7.	**Local Highway Model – Calibration and Validation Procedures**	**61**
	Data Utilised	61
	Calibration Counts	61

Assignment Parameters 61
Model Convergence Guidelines 61
Calibration Procedure 62
Speed Flow Curves 62
Model Validation 62
Validation Count List 64
Analysis of Journey Time Survey Data 65
8. Local Highway Model – Calibration and Validation Results 67
Prior Assignment Summary 67
Post ME2 Assignment Summary 71
Model Convergence 81
9. Conclusions 83

List of Tables

Table 2.1 – Observed Sector Movements 15
Table 3.1 – Travel Modes (2001 Census Data) 19
Table 4.1 – Values of Working Time per Person (£/hr) 22
Table 4.2 – Values of Non-Working Time per Person (£/hr) 22
Table 4.3 – Vehicle Occupancy per Trip (including driver) 23
Table 4.4 – Proportion of Vehicles Travelling for Each Purpose 23
Table 4.5 – Proportion of Vehicles in Each User Class 24
Table 4.6 – Perceived Values of Time per Vehicle in 2002 24
Table 4.7 – Forecast Growth in the Working and Non-Working Values of Time 25
Table 4.8 – Perceived Values of Time per Vehicle in 2008 25
Table 4.9 – 2008 Values of Time (PPM) Used in Model 26
Table 4.10 – Fuel Element Formula Parameter Values (in litres per kilometre) 26
Table 4.11 – 2002 Fuel Efficiency Values (litres per kilometre) 27
Table 4.12 – Vehicle Fuel Efficiency Improvements 27
Table 4.13 – 2008 Fuel Efficiency Values (litres per kilometre) 27
Table 4.14 – 2008 Fuel Costs (pence per litre) 28
Table 4.15 – Fuel Element of VOC (pence per kilometre) 28
Table 4.16 – Non-Fuel Element Formula Parameter Values 29
Table 4.17 – Non-Fuel Element of VOC (pence per kilometre) 29
Table 4.18 – Total VOC for Each Vehicle 30
Table 4.19 – 2008 Vehicle Operating Costs (PPK) Used in Model 30
Table 4.20 – AM Peak PPM and PPK Parameters 31
Table 4.21 – Inter Peak PPM and PPK Parameters 31
Table 4.22 – PM Peak PPM and PPK Parameters 31
Table 5.1 – Speed Flow Curve Classification 32
Table 6.1 – RSI Origin/Destination Purpose Definitions 38
Table 6.2 – Conversion to Trip Purposes 38
Table 6.3 – Matrix of Movements that have been taken from Site 7 Data 42
Table 6.4 – RSI Data Checks: Inbound Factored Interviews 43
Table 6.5 – RSI Data Checks: Outbound Factored Interviews 43
Table 6.6 – RSI Data Checks: Combined Interviews 43
Table 6.7 – RSI Data Checks: Double Counting 43

Table 6.8 – RSI Data Checks: AM Geographical Sector Matrix With and Without Double Counting (Difference) 44
Table 6.9 – RSI Data Checks: IP Geographical Sector Matrix With and Without Double Counting (Difference) 44
Table 6.10 – RSI Data Checks: PM Geographical Sector Matrix With and Without Double Counting (Difference) 44
Table 6.11 – Car Park Data Checks: Inbound Factored Interviews 45
Table 6.12 – Car Park Data Checks: Outbound Factored Interviews 45
Table 6.13 – Car Park Data Checks: Combined Interviews 45
Table 6.14 – Data Checks: Final Combined Matrices 46
Table 6.15 – Peak Hour Totals for Funnelled and Factored RSI Surveys (Inbound) 47
Table 6.16 – Matrix Totals 50
Table 6.17 – AM Factored Unobserved Census Matrix Geographical Sector Movements 51
Table 6.18 – AM Unobserved Deficit Matrix Geographical Sector Movements 51
Table 6.19 – AM Furnessed Matrix Geographical Sector Movements 51
Table 6.20 – AM Final Synthetic Matrix Sector Movements 52
Table 6.21 – IP Factored Unobserved Census Matrix Sector Movements 52
Table 6.22 – IP Unobserved Deficit Matrix Sector Movements 52
Table 6.23 – IP Furnessed Matrix Sector Movements 53
Table 6.24 – IP Final Synthetic Matrix Sector Movements 53
Table 6.25 – PM Factored Unobserved Census Matrix Sector Movements 53
Table 6.26 – PM Unobserved Deficit Matrix Sector Movements 54
Table 6.27 – PM Furnessed Matrix Sector Movements 54
Table 6.28 – PM Final Synthetic Matrix Sector Movements 54
Table 6.29 – AM Peak Hour Final Synthetic Matrix Observation Sector Movements 55
Table 6.30 – IP Hour Final Synthetic Matrix Observation Sector Movements 55
Table 6.31 – PM Peak Hour Final Synthetic Matrix Observation Sector Movements 56
Table 6.32 – Annualisation Factor Calculation 57
Table 6.33 – Eastbound A141/A47 Seeding 58
Table 6.34 – Westbound A141/SA47 Seeding 58
Table 6.35 – Prior Matrix Compilation Checks 58
Table 6.36 – Prior Matrix Zone Splitting Checks 59
Table 6.37 – Prior Matrix Annualisation Checks 59
Table 6.38 – Prior Matrix OGV2 Trip Addition Checks 59
Table 6.39 – Seeding Combination 60
Table 7.1 – DMRB Assignment Acceptability Guidelines 63
Table 7.2 – WATS Validation Counts 64
Table 7.3 – Number of Journey Times Used 65
Table 8.1 – AM Peak Hour Prior Assignment Screenline Flows 67
Table 8.2 – Inter Peak Hour Prior Assignment Screenline Flows 68
Table 8.3 – PM Peak Hour Prior Assignment Screenline Flows 68
Table 8.4 – AM Peak Hour Prior Assignment Journey Time Summary 69
Table 8.5 – Inter Peak Hour Prior Assignment Journey Time Summary 70
Table 8.6 – PM Peak Hour Prior Assignment Journey Time Summary 71
Table 8.7 – AM Peak Hour Final Assignment Screenline Summary 72
Table 8.8 – AM Peak Hour Count Validation Summary 72
Table 8.9 – Inter Peak Hour Final Assignment Screenline Summary 73
Table 8.10 – Inter Peak Hour Count Validation Summary 73
Table 8.11 – PM Peak Hour Final Assignment Screenline Summary 73
Table 8.12 – PM Peak Hour Count Validation Summary 73
Table 8.13 – AM Peak Hour Final Assignment Journey Time Summary 75

Table 8.14 – Inter Peak Hour Final Assignment Journey Time Summary 76
Table 8.15 – PM Peak Hour Final Assignment Journey Time Summary 77
Table 8.16 – Pre and Post-ME2 Matrix Total Comparison 78
Table 8.17 – AM Peak Hour Observation Sector Prior and Post ME2 Matrix Difference 78
Table 8.18 – Inter Peak Hour Observation Sector Prior and Post ME2 Matrix Difference 79
Table 8.19 – PM Peak Hour Observation Sector Prior and Post ME2 Matrix Difference 79
Table 8.20 – AM Peak Hour Model Convergence Criteria 81
Table 8.21 – Inter Peak Hour Model Convergence Criteria 81
Table 8.22 – PM Peak Hour Model Convergence Criteria 82

List of Figures

Figure 2.1 – Wisbech Study Area 9
Figure 2.2 – Zone Plan Overview 10
Figure 2.3 – Zone Plan Wisbech 11
Figure 2.4 – Geographical Sectors 12
Figure 2.5 – Observation Sectors 13
Figure 3.1 – All Count Data 17
Figure 5.1 – Urban Area Classification 34
Figure 5.2 – Locations of Car Parks within Wisbech 35
Figure 5.3 – 2008 Base Year Bus Routes 36
Figure 6.1 – Calibration of the Logit Function for AM OTP 50
Figure 7.1 – Validation Count Locations 65
Figure 7.2 – Inter Peak Hour Journey Time Results with Anomalous Data 66
Figure 7.3 - Inter Peak Hour Journey Time Results without Anomalous Data 66
Figure 8.1 – AM Peak Hour Prior Assignment Journey Time Summary 69
Figure 8.2 – Inter Peak Hour Prior Assignment Journey Time Summary 70
Figure 8.3 – PM Peak Hour Prior Assignment Journey Time Summary 71
Figure 8.4 – AM Peak Hour Final Assignment Journey Time Summary 75
Figure 8.5 – Inter Peak Hour Final Assignment Journey Time Summary 76
Figure 8.6 – PM Peak Hour Final Assignment Journey Time Summary 77
Figure 8.7 – AM Peak Hour Trip Length Distribution Changes 80
Figure 8.8 – Inter Peak Hour Trip Length Distribution Changes 80
Figure 8.9 – PM Peak Hour Trip Length Distribution Changes 81

Appendices

Appendix A **84**
A.1 AM Peak Hour 85
A.2 Inter Peak Hour 100
A.3 PM Peak Hour 115

List of Tables

Table A.1 – AM Peak Hour Screenline Results 85
Table A.2 – AM Peak Hour Validation Count Results 88
Table A.3 – Inter Peak Hour Screenline Results 100
Table A.4 – Inter Peak Hour Validation Count Results 103
Table A.5 – PM Peak Hour Screenline Results 115
Table A.6 – PM Peak Hour Validation Count Results 118

List of Figures

Figure A.1 – Route 1 Southbound, AM Peak Hour 92
Figure A.2 – Route 1 Northbound, AM Peak Hour 93
Figure A.3 – Route 2 Northbound, AM Peak Hour 94
Figure A.4 – Route 2 Southbound, AM Peak Hour 95
Figure A.5 – Route 3 Northbound, AM Peak Hour 96
Figure A.6 – Route 3 Southbound, AM Peak Hour 97
Figure A.7 – Route 4 Eastbound, AM Peak Hour 98
Figure A.8 – Route 4 Westbound, AM Peak Hour 99
Figure A.9 – Route 1 Southbound, Inter Peak Hour 107
Figure A.10 – Route 1 Northbound, Inter Peak Hour 108
Figure A.11 – Route 2 Northbound, Inter Peak Hour 109
Figure A.12 – Route 2 Southbound, Inter Peak Hour 110
Figure A.13 – Route 3 Northbound, Inter Peak Hour 111
Figure A.14 – Route 3 Southbound, Inter Peak Hour 112
Figure A.15 – Route 4 Eastbound, Inter Peak Hour 113
Figure A.16 – Route 4 Westbound, Inter Peak Hour 114
Figure A.17 – Route 1 Southbound, PM Peak Hour 122
Figure A.18 – Route 1 Northbound, PM Peak Hour 123
Figure A.19 – Route 2 Northbound, PM Peak Hour 124
Figure A.20 – Route 3 Southbound, PM Peak Hour 125
Figure A.21 – Route 3 Northbound, PM Peak Hour 126
Figure A.22 – Route 3 Southbound, PM Peak Hour 127
Figure A.23 – Route 4 Eastbound, PM Peak Hour 128
Figure A.24 – Route 4 Westbound, PM Peak Hour 129

Glossary of Abbreviations Used in the Report

Automatic Traffic Count	ATC
Average Weekday Traffic	AWT
Cambridgeshire County Council	CCC
Design Manual for Roads and Bridges	DMRB
Employer’s Business	EB
East of England Regional Model	EERM
Fenland District Council	FDC
Geoffrey E Havers	GEH
Geographical Information System	GIS
Highways Agency	HA
Home Based Education	HBEd
Home Based Work	HBW
Journey From Work	JFW
Journey To Work	JTW
Local Development Framework	LDF
Local Model Validation Report	LMVR
Manual Classified Count	MCC
Manual Classified Turning Count	MCTC
Matrix Estimation by Maximum Entropy	ME2
Maximum Walking Distance	MWD
Medium Goods Vehicles	OGV1
Heavy Goods Vehicles	OGV2
Ordnance Survey	OS
Other Trip Purpose	OTP
Passenger Car Unit	PCU
Pence Per Kilometre	PPK
Pence Per Minute	PPM
Roadside Interview	RSI
Simulation and Assignment of Traffic in Urban Road Networks	SATURN
User Class One	UC1
User Class Two	UC2
User Class Three	UC3
User Class Four	UC4
User Class Five	UC5
User Class Six	UC6
Vehicle Operating Cost	VOC
Vehicles per Hour	vph
Web Transport Analysis Guidance	WebTAG
Wisbech Area Transport Study	WATS

1. Introduction

Background

1.1 Atkins Transport Planning was commissioned by Cambridgeshire County Council (CCC) and Fenland District Council (FDC) in January 2008 to produce a transport model for FDC. The model should provide forecasts for the future land use planning of Wisbech and its surrounding area and therefore inform their Local Development Framework (LDF).

Study Scope

1.2 The scope of the Wisbech Area Transport Study (WATS) was to provide a transport model for Fenland District Council, to inform their LDF.

This Report

1.3 This document is the Local Model Validation Report (LMVR). It represents the culmination of the base year highway model development, and hence is the basis for future modelling work in Wisbech. It covers the AM Peak, Inter Peak and PM Peak hours.

1.4 The report is arranged in 9 chapters and an Appendix following this introduction:

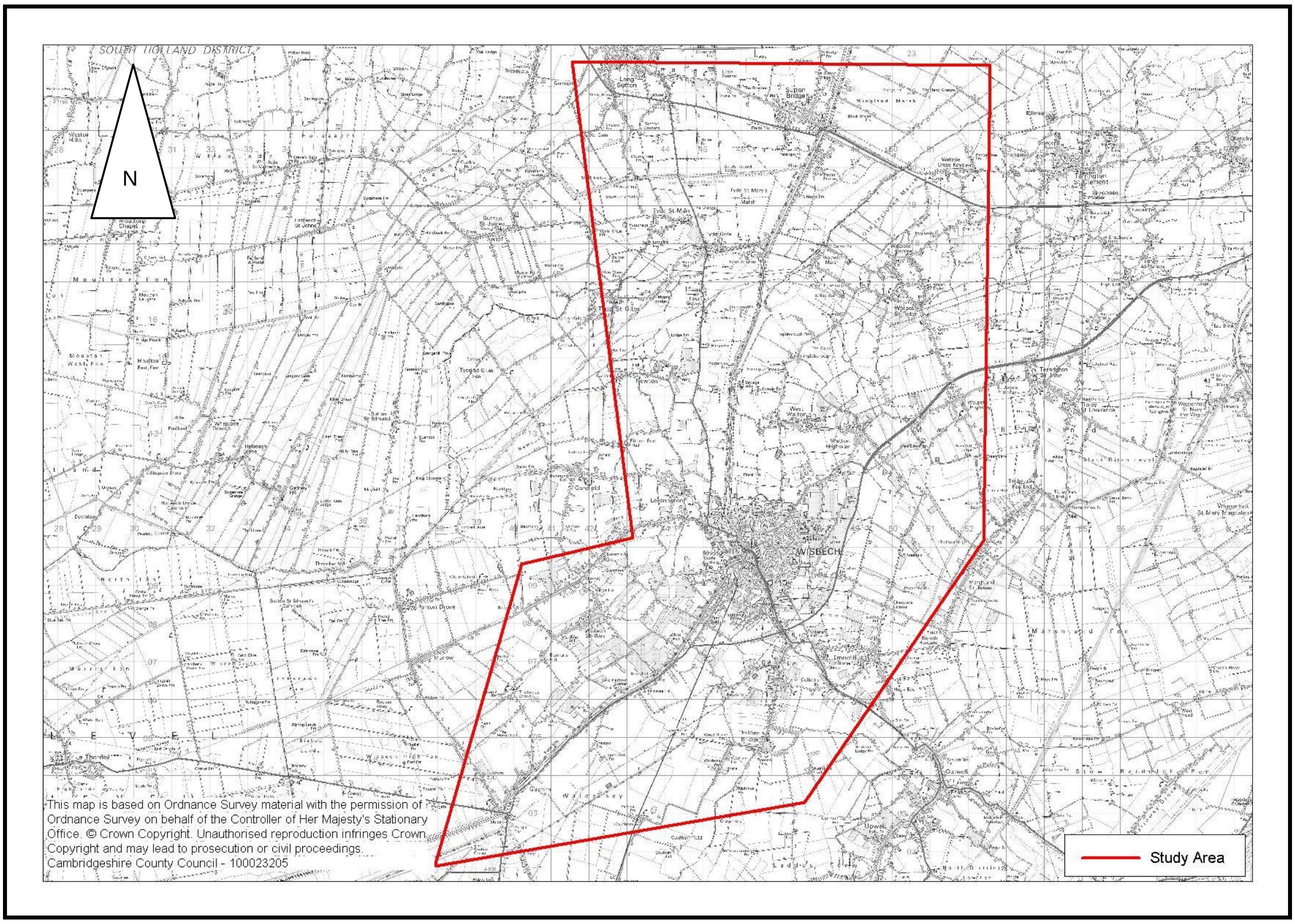
- Chapter 2 gives an overview of the modelling framework;
- Chapter 3 describes all of the data that was used during the development and validation of the model;
- Chapter 4 details the general parameters that were used within the model;
- Chapter 5 sets out the development of the local highway networks;
- Chapter 6 describes the development of the local highway model demand matrices
- Chapter 7 describes the model calibration and validation procedures;
- Chapter 8 provides a commentary of the model calibration and validation results;
- Chapter 9 draws together the conclusions of the model calibration and validation exercise; and
- Appendix A which gives detailed tables and graphs of validation results.

2. Overview of Modelling Framework

Study Area

2.1 Broadly speaking, the WATS Study Area covers Wisbech and its surrounding area, reaching to Long Sutton and the A17 to the north in Lincolnshire, Outwell in Norfolk to the south-east, the A605 in the south west, Parson Drove in the west and Walton Highway in the east. Figure 2.1 shows the context of the Study Area.

Figure 2.1 – Wisbech Study Area



Zone and Sector Plans

2.2 A zone plan for this study has been devised to give a fine level of detail in central Wisbech, growing coarser further away from the town, ultimately covering the whole of England, Scotland and Wales in 112 zones. Zone boundaries are based on existing divisions such as ward, parish, district and county boundaries. Compatibility with the East of England Regional Model (EERM) zone plan has also been borne in mind. Some zones with the same geographical boundary have been separated according to the destinations of their trips (or, in the case of observed data, the location at which they were observed), in order to eliminate any large-scale re-routing from the model in the forecast years. (This is because such re-routing should already have been simulated by the EERM, from which the Wisbech Area Transport Study (WATS) forecast year matrices are to be derived.) The resulting zone plan is shown in Figure 2.2 and Figure 2.3.

Figure 2.2 – Zone Plan Overview

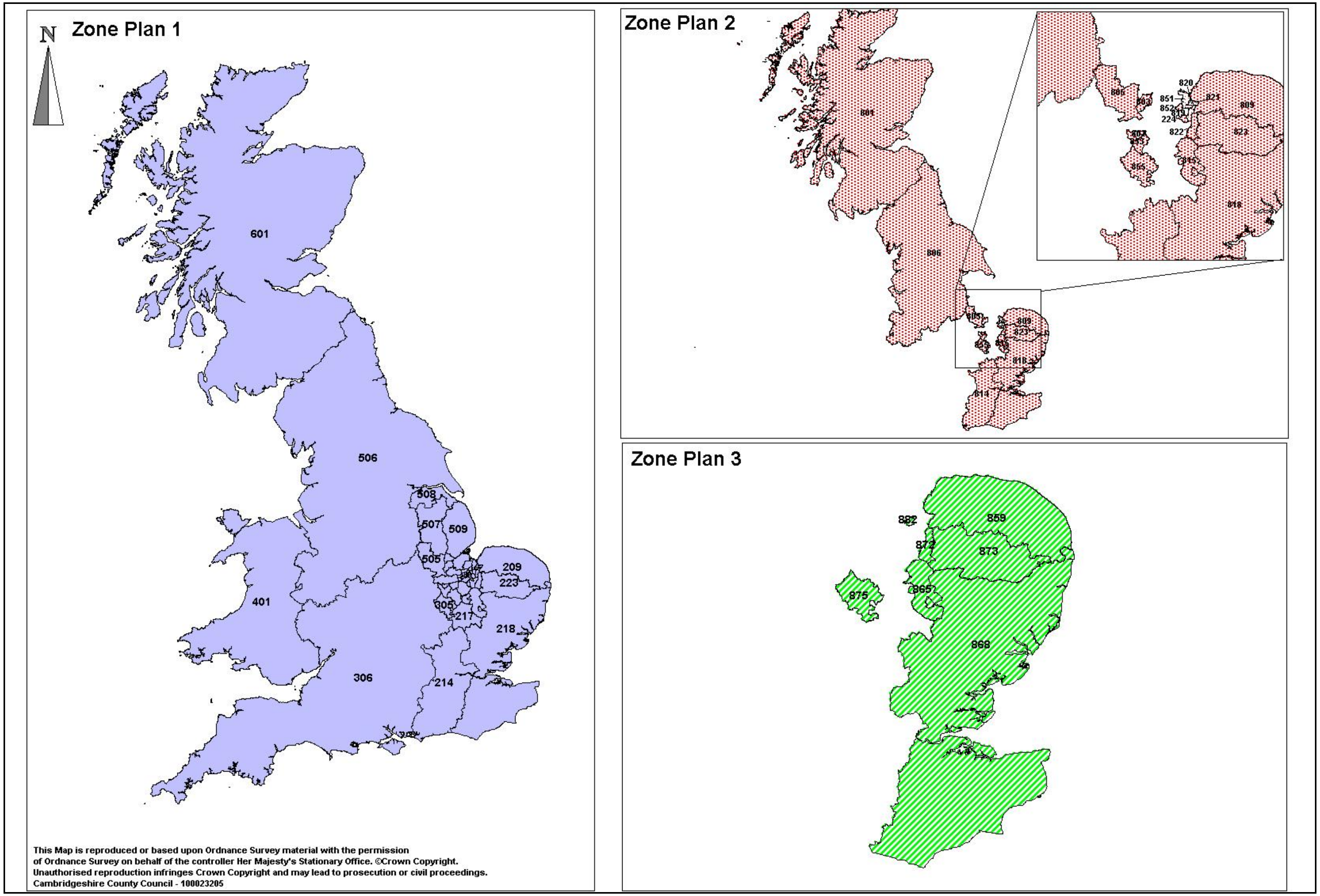


Figure 2.3 – Zone Plan Wisbech

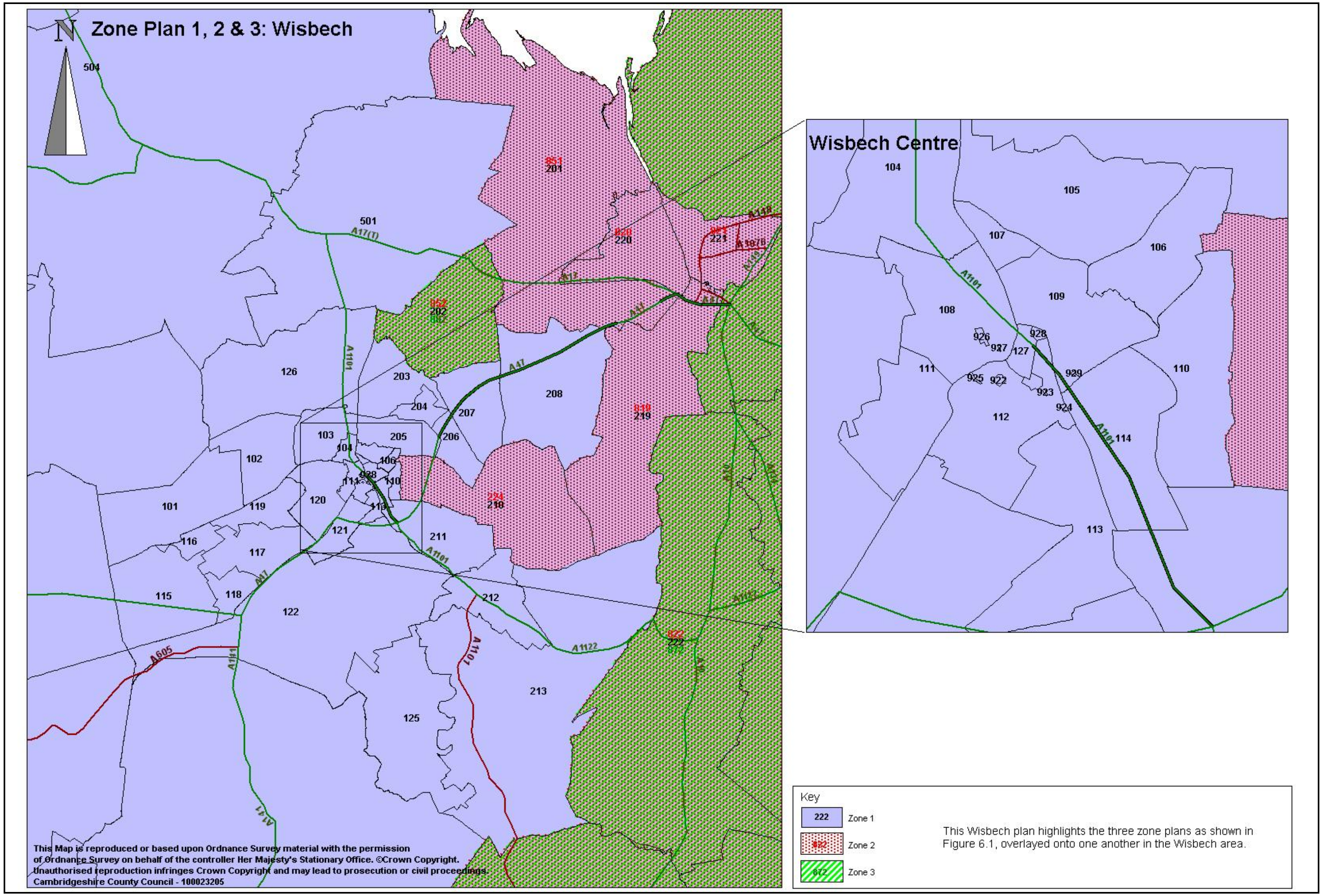


Figure 2.4 – Geographical Sectors

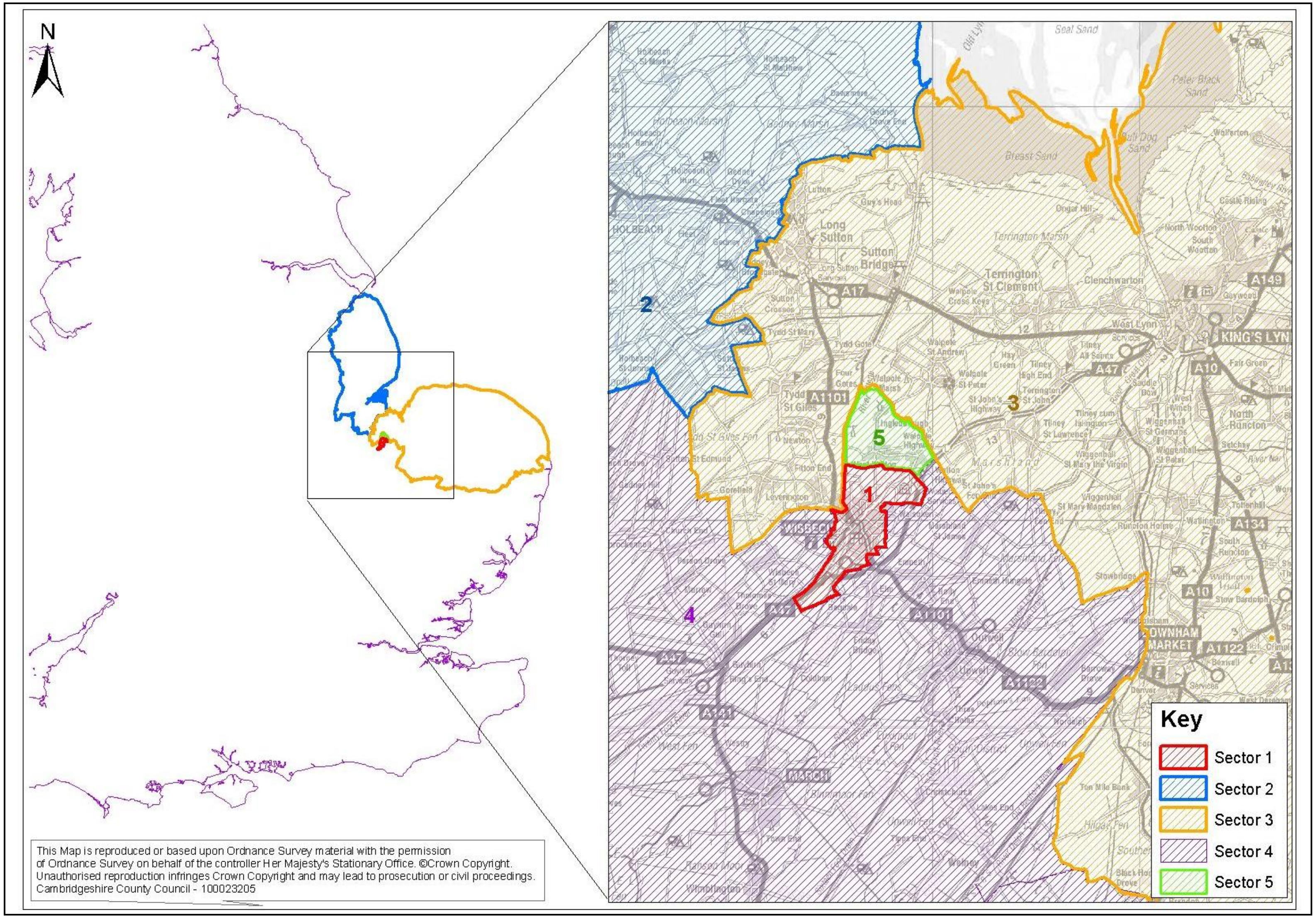
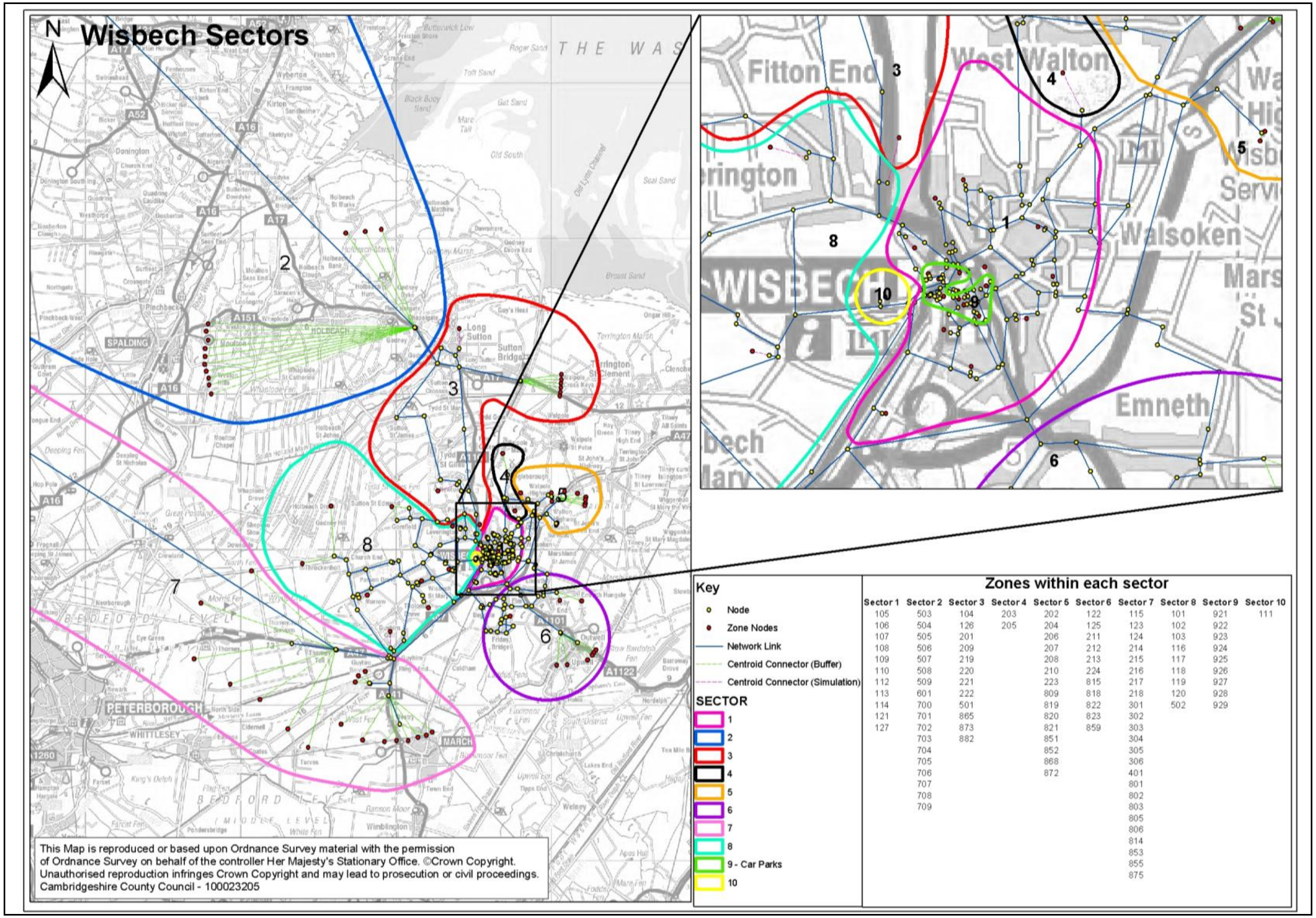


Figure 2.5 – Observation Sectors



Zones within each sector

Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Sector 8	Sector 9	Sector 10
105	503	104	203	202	122	115	101	921	111
106	504	126	205	204	125	123	102	922	
107	505	201		206	211	124	103	923	
108	506	209		207	212	214	116	924	
109	507	219		208	213	215	117	925	
110	508	220		210	224	216	118	926	
112	509	221		223	815	217	119	927	
113	601	222		809	818	218	120	928	
114	700	501		819	822	301	502	929	
121	701	865		820	823	302			
127	702	873		821	859	303			
	703	882		851		304			
	704			852		305			
	705			868		306			
	706			872		401			
	707					801			
	708					802			
	709					803			
						805			
						806			
						814			
						853			
						855			
						875			

2.3 Each zone within the model is connected via a single point, therefore not enabling any route choice to take place at a centroid connector level. The only exceptions to this are certain car parks which have multiple exits. In this instance the zone is connected to both exits, with the individual exits modelled accordingly.

2.4 The zone plan has also been aggregated into two sets of sectors: one set of "Observation Sectors" representing collections of zones that connect to the network in the same locations relative to the observation points (Road Side Interview (RSI) sites), and the other "Geographical Sectors" representing broad regions of the model. These sectors are shown in Figure 2.4 and Figure 2.5.

2.5 The Geographical Sectors are used simply as a means of keeping track of the basic movements around the model (for example, the number of people travelling into Wisbech town centre). Briefly, the sectors can be described as follows:

- Sector 1 – Wisbech town centre, within the RSI cordon;
- Sector 2 – East Lincolnshire;
- Sector 3 – Norfolk;
- Sector 4 – the rest of the country (including West Lincolnshire, most of Cambridgeshire and all other counties); and
- Sector 5 – Walton Highway, West Walton and Ingleborough.

2.6 The Observation Sectors are more difficult to visualise, as they were created to keep track of the routing of vehicles through the RSI sites. A description of each sector is provided below.

- Sector 1 – Wisbech town centre, within the RSI cordon.
- Sector 2 – North-western zones connecting onto the A17.
- Sector 3 – Northern zones joining the model on the A1101 north of Wisbech, or from the A17 in the east.
- Sector 4 – Zones in the West Walton area, straddling RSI Site 4.
- Sector 5 – Eastern zones joining the model east of RSI Sites 1 and 4, mostly on the A47.
- Sector 6 – Southern zones connecting on the A1101 south of RSI Site 6.
- Sector 7 – South-western zones connecting on the A141 and A47.
- Sector 8 – Villages immediately west of Wisbech and north of the River Nene (for example, Leverington, Gorefield and Wisbech St Mary), extending as far as Crowland.
- Sector 9 – Car Parks.
- Sector 10 – A single zone on North Brink immediately west of RSI Site 5.

2.7 In terms of observations, these sectors (shown in Figure 2.5) interact as follows:

- Movements between zones within each sector are unobserved.
- Sector 1 is contained within the RSI cordon, so movements to and from all other sectors are observed, except for Sector 4 (which straddles RSI Site 4) and Sector 6 (which could be accessed via Broad End Road or Redmoor Lane).
- Sector 2 contains all zones west of RSI Site 7, so movements to/from all other sectors must pass through that RSI site and are therefore observed.
- Trips from Sector 3 must pass through either RSI Site 3 or RSI Site 7 to access any other sector, except for Sector 8 which can be accessed via the B1169 north of RSI Site 3.

- Since Sector 4 straddles RSI Site 4, it can access sectors 1 and 5 without necessarily being observed. Sector 6 can also be accessed unobserved (via Broad End Road or Redmoor Lane). Movements to all other sectors from Sector 4 are observed.
- Movements to/from Sector 5 would be observed at RSI Sites 1 or 4, unless they were travelling to/from Sector 4.
- As discussed above, Sector 6 can be accessed via Redmoor Lane or Broad End Road, as well as the observed movements on the A1101, and is therefore not 'watertight'. However, movements to/from sectors 2, 3, 5, 7 and 8 are observed at other RSI sites, leaving only movements to/from sectors 1 and 4 being partially observed.
- Sector 7 can access Sectors 8 and 10 without being observed, but all other movements are observed.
- Sector 8 can access Sectors 3, 7 and 10 without being observed, but all other movements are observed.
- All movements to/from car parks (Sector 9) are fully observed.
- Sector 10 can access Sectors 7 and 8 without being observed, but all other movements are observed.

2.8 The observed movements within these Observation Sectors are shown in Table 2.1 below:

Table 2.1 – Observed Sector Movements

Sector	1	2	3	4	5	6	7	8	9	10
1	✘	✓	✓	✘	✓	✘	✓	✓	✓	✓
2	✓	✘	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✘	✓	✓	✓	✓	✘	✓	✓
4	✘	✓	✓	✘	✘	✘	✓	✓	✓	✓
5	✓	✓	✓	✘	✘	✓	✓	✓	✓	✓
6	✘	✓	✓	✘	✓	✘	✓	✓	✓	✓
7	✓	✓	✓	✓	✓	✓	✘	✘	✓	✘
8	✓	✓	✘	✓	✓	✓	✘	✘	✓	✘
9	✓	✓	✓	✓	✓	✓	✓	✓	✘	✓
10	✓	✓	✓	✓	✓	✓	✘	✘	✓	✘

(✘ = Unobserved Movement, ✓ = Observed Movement)

Modelled Base Year

2.9 The base year for the WATS model is 2008, with all count data factored to this date accordingly.

3. Data Usage

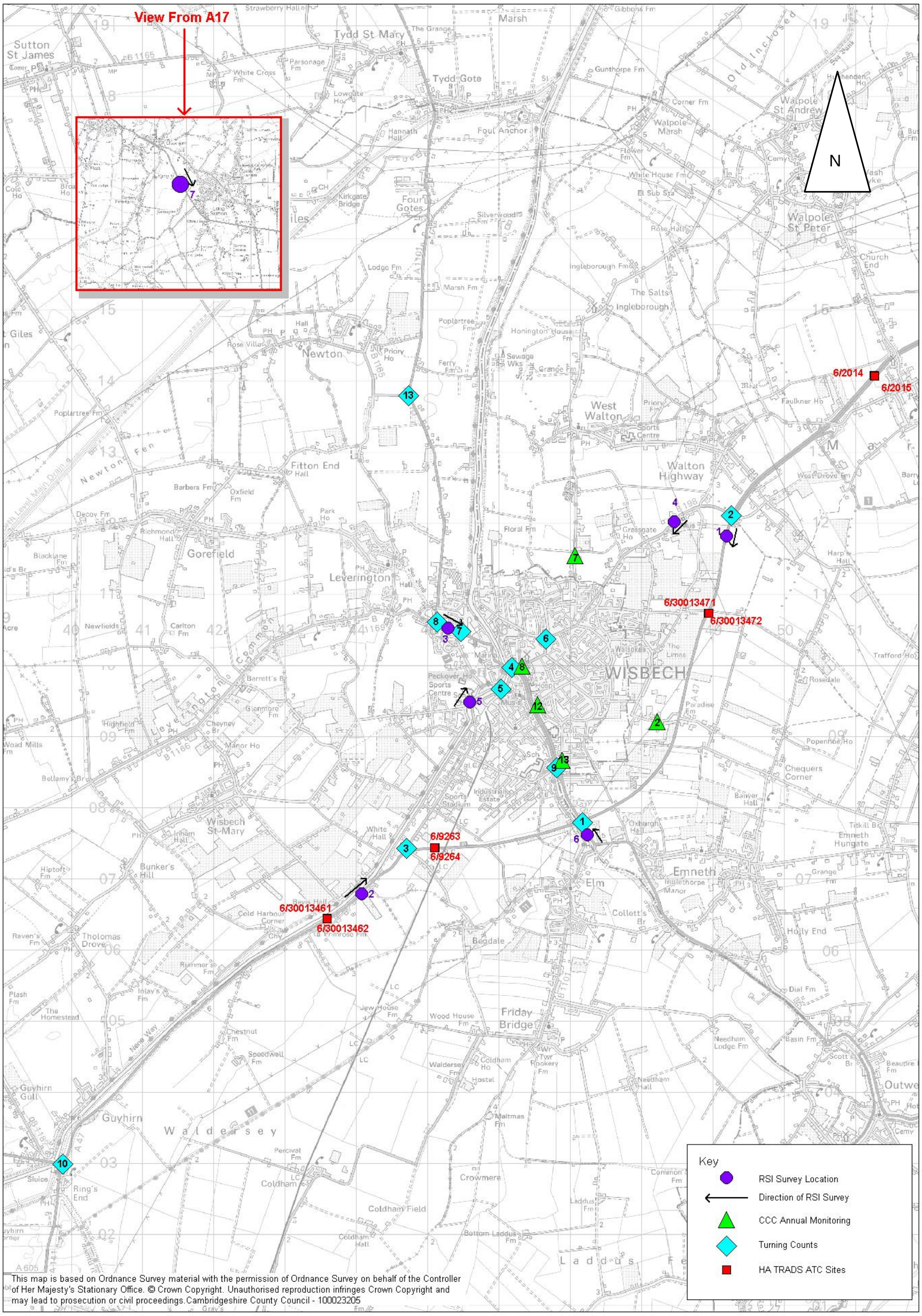
3.1 A variety of data was collected to enable the most accurate understanding of trip patterns in and around Wisbech to be built up. The majority of this data was collected by Atkins specifically for this project; a small number of Manual Classified Counts (MCCs) from CCC's Annual Monitoring programme have also been used for calibration of the model and matrix.

3.2 A complete list of the data that has been collected is presented below; further discussion on the use of each dataset can be found in the following sections of this report. Full details of the surveys and a summary of the data have been presented in the Data Collection Report.

- RSI Surveys (with associated MCCs and Automatic Traffic Counts (ATCs));
- Manual Classified Turning Counts (MCTCs);
- Journey Time Surveys;
- Car Park Interview Surveys (with associated MCCs);
- 2001 National Census Journey to Work (JTW) Data;
- Education Trips Data;
- Bus Route and Timetable Information;
- CCC Traffic Signal Data;
- Highway Network Inventory Surveys
- The EERM; and
- Highways Agency (HA) TRADS Data.

3.3 Figure 3.1 shows the locations of all count data listed above.

Figure 3.1 – All Count Data



Roadside Interview Surveys

3.4 Seven RSI sites were chosen around Wisbech; six forming a cordon on the radial routes into the town and a seventh isolated site on the A17 passing to the north of Wisbech. These surveys provide 12-hour interview data in an inbound direction (and eastbound on the A17), along with bi-directional Manual Classified Counts (MCCs) on the survey day and two-week bi-directional Automatic Traffic Counts (ATCs) at each site.

3.5 This data enables inbound and (by transposition) outbound trip matrices to be compiled for all vehicles travelling into and out of Wisbech on a typical day. These trips give the full representation of External-to-Internal (E-I) and (by transposition) Internal-to-External (I-E) movements, and a partial representation of External-to-External (E-E) movements. However, Internal-to-Internal (I-I) movements are completely unobserved by these surveys and E-E movements will also need supplementing by other types of data.

Manual Classified Turning Counts

3.6 Thirteen sites in and around Wisbech were selected for MCTCs. Twelve of these surveys do not directly form part of the matrix, but will be used in the calibration and validation stages of the model building. One site has been used to inform the splitting of some zones (see paragraphs 6.78 and 6.79).

Journey Time Surveys

3.7 A number of journey time surveys were carried out across the study area, passing through Wisbech. The detailed journey time data is key to understanding present conditions and is integral to the development and validation of the local highway traffic model.

Car Park Interview Surveys

3.8 Surveys were undertaken in nine car parks in Wisbech town centre, on 18th and 19th June 2008. The capacity of each car park was noted, along with counts of vehicles entering and leaving each car park (broken down into 15-minute time slots between 07:00 and 19:00), origins of the journeys destinating in each car park and the origin and destination purpose of each, the length of each stay and some limited demographic data about each driver.

3.9 Some of this information will be used in the matrix building process, providing a full representation of all trips to and (by transposition) from the nine car parks. Some of these trips will also pass through RSI sites; this has been accounted for during the matrix build process.

National Census Journey to Work Data

3.10 An origin-destination matrix based on the 2001 JTW Census Data was produced to assist the infilling of the traffic movements that are not captured by the Roadside Interview Surveys (for example, internal movements within Wisbech).

3.11 A database of the JTW trips between all output areas within England and Wales by mode from the 2001 Census has been made available for this study. Table 3.1 below shows the modes that are included in the 2001 Census database. For the Wisbech Census matrix, it was assumed that car driver trips are equivalent to vehicle trips.

3.12 Graphical Information System (GIS) software (MapInfo) was used to identify the output areas that are within each individual WATS traffic model zone. The WATS zone plan generally follows the boundaries of the output areas, except four zones within Wisbech which cut through the output areas. For these output areas, area proportion was calculated and used to split the trips from the Census Data.

Table 3.1 – Travel Modes (2001 Census Data)

Modes
Work From Home
Underground
Train
Bus
Taxi
Car Driver
Car Passenger
Motorcycle
Pedal Cycle
Walk
Other

3.13 By setting up Microsoft Access Queries with the 2001 Census Data and the zone correspondence list produced from MapInfo, a Census matrix based on the Wisbech model zone plan was generated. For the zones that do not follow the output areas, adjustments were made manually based on the area proportion as discussed above.

3.14 This 24-hour Census JTW matrix was factored from 2001 to June 2008 in the following way:

- From the Wisbech annual monitoring counts (collected by CCC), a factor of 1.08 was derived to convert the data from November 2001 to November 2007; and
- HA TRADS data provided a further factor of 1.01 from November 2007 to June 2008, in line with the other surveys that were undertaken for this project.
- These multiply together to give a total factor of 1.09 from November 2001 to June 2008.

3.15 From this 2008 24-hour JTW matrix, AM Peak, Inter Peak and PM Peak bi-directional matrices have been calculated, describing trip patterns to and from work. The method for this is detailed below.

- Take the RSI data and calculate the proportion of the total trips per period that are journeys to work (i.e. origin purpose 1 (home) to destination purpose 3 (work)).
- Multiply the full (24-hour) census matrix by these JTW proportions, to provide JTW matrices per period.
- Take the RSI data and calculate the proportion of the total trips per period that are journeys from work (i.e. origin purpose 3 (work) to destination purpose 1 (home).
- Transpose the full (24-hour) census matrix to provide Journey from Work (JFW) information.
- Multiply the transposed full (24-hour) census matrix by these JFW proportions, to provide JFW matrices per period.
- For each period, add the JTW and JFW census matrices to provide full bi-directional infill data for journeys to and from work, per period.

Education Trips Data

3.16 Data has been obtained from CCC, giving journey-to-school data for state funded primary and secondary schools in Wisbech. This data comprises the total number of pupils at each school, and their mode of transport to school.

3.17 This information has been used to estimate some internal trips within Wisbech during the AM peak hour, alongside the synthetic data (see paragraph 6.51).

Bus Route and Timetable Information

3.18 Bus timetables were obtained from the relevant bus operators within Wisbech, and the routes derived from these timetables. The timetables also allowed the number of buses per hour to be calculated.

CCC Traffic Signal Data

3.19 Signal timing and phasing data was obtained from CCC to allow the accurate representation of all signalised junctions within the model.

Highway Network Inventory Surveys

3.20 The local highway network model has been developed using Ordnance Survey (OS) mapping as a basis. This was used to find the co-ordinates of junctions, to build up the basic structure of the network.

3.21 Online aerial photography was used to ascertain the majority of junction layouts (which arms have priority, number of lanes for each turn, etc.) and any additional information was obtained through site visits as required.

3.22 Extensive site visits were undertaken to enable the modellers to understand the operation and speed limit of each road, visibility at junctions, operation of traffic signals, and any other issues that may be apparent, as well as checking the details of the junction layouts. Many photographs were taken, and their locations documented, to enable junctions to be reviewed again at a later date.

The East of England Regional Model

3.23 Data was extracted from the EERM to provide information about heavy vehicle movements along the A17, to supplement the data collected at RSI Site 7. This has been used during the matrix build process, as described in further detail in paragraphs 6.81 and 6.82

Highways Agency TRADS Data

3.24 Data from the HA TRADS database has been used to calculate an annualisation factor, to convert the June 2008 surveys into figures representing an average year (see paragraph 6.80).

4. Local Highway Model – General Parameters

Introduction

4.1 This Chapter gives all of the general parameters that have been used throughout the WATS Local Highway Model, including a detailed derivation of the time and distance costs.

Passenger Car Unit Factors

4.2 Standard factors to convert each vehicle type into Passenger Car Units (PCUs) have been taken from Transport in the Urban Environment (Institution of Highways and Transportation, 1997). These are:

- Motorcycle = 0.4 PCU;
- Car or Light Goods Vehicle (LGV) = 1.0 PCU;
- Medium goods vehicle (OGV1) = 1.5 PCU;
- Heavy goods vehicle (OGV2) = 2.3 PCU; and
- Bus or coach = 2.0 PCU.

Modelled Time Periods

4.3 Three time periods have been chosen for the WATS, as defined below:

- AM Peak Hour (08:00-09:00);
- Inter Peak Hour (14:00-15:00); and
- PM Peak Hour (17:00-18:00).

4.4 For all traffic counts, the data from these single-hour periods have been used.

4.5 However, to improve the accuracy of the RSI and car park data that is input into the model, interviews have been ‘funnelled’ in the following way.

- AM Peak: interviews between 07:00 and 10:00 are scaled to the 08:00-09:00 count;
- Inter Peak: interviews between 10:00 and 16:00 are scaled to the 14:00-15:00 count; and
- PM Peak: interviews between 16:00 and 19:00 are scaled to the 17:00-18:00 count.

User Classes

4.6 The WATS SATURN model comprises six user classes:

- User Class 1 (UC1) – Cars and LGVs, Home-Based Work (HBW) purpose;
- User Class 2 (UC2) – Cars and LGVs, Home-Based Education (HBEd) purpose;
- User Class 3 (UC3) – Cars and LGVs, Employers’ Business (EB) purpose;
- User Class 4 (UC4) – Cars and LGVs, Other Trip Purposes (OTP);
- User Class 5 (UC5) – OGV1, all purposes; and
- User Class 6 (UC6) – OGV2, all purposes.

Time and Distance Costs

4.7 Two important parameters that are input to SATURN models are called Pence Per Minute (PPM) and Pence Per Kilometre (PPK). These represent the travellers' concept of their values of time and distance for each journey, and the ratio between them. The interaction of these parameters has a huge effect on route choice: if time is highly valued but distance is not, then the quickest route will be chosen no matter how far it is; conversely, if distance is highly valued but time is not, then the shortest route would be chosen no matter how slow it is. Usually, the route choice is a fine balance between the relative importance of time and distance to the traveller.

Time Costs: Pence per Minute

4.8 The PPM model parameter was calculated based on time costs from WebTAG 3.5.6 (dated December 2008).

4.9 WebTAG Table 1 provides market-based Values of Working Time, expressed in 2002 prices in pounds per hour. These values are given in Table 4.1. These have been applied to the EB trip purpose for cars and LGVs, and to all OGVs.

Table 4.1 – Values of Working Time per Person (£/hr)

Vehicle Occupant	Resource Cost	Perceived Cost	Market Price
Car driver	21.86	21.86	26.43
Car passenger	15.66	15.66	18.94
LGV (driver or passenger)	8.42	8.42	10.18
OGV (driver or passenger)	8.42	8.42	10.18

4.10 WebTAG Table 2 provides market-based Values of Non-Working Time, expressed in 2002 prices in pounds per hour. These values are given in Table 4.2. “Commuting” values have been applied to HBW and HBEd trip purposes; “other” values have been applied to all other purposes for light vehicles.

Table 4.2 – Values of Non-Working Time per Person (£/hr)

Purpose	Resource Cost	Perceived Cost	Market Price
Commuting	4.17	5.04	5.04
Other	3.68	4.46	4.46

4.11 Vehicle occupancies (Table 4.3), proportion of travel for each purpose (Table 4.4) and proportions of vehicles making up each user class (Table 4.5) have all been calculated from the 2008 Roadside Interview data that was collected in Wisbech for this study.

Table 4.3 – Vehicle Occupancy per Trip (including driver)

Vehicle Type and Journey Purpose	8am-9am	2pm-3pm	5pm-6pm
Car (HBW)	1.09	1.26	1.18
Car (EB)	1.33	1.23	1.45
Car (HBEd)	2.16	1.4	1.5
Car (OTP)	1.48	1.67	1.72
LGV (HBW)	1.23	1.44	1.25
LGV (EB)	1.55	1.09	1.47
LGV (HBEd)	1.5	-	-
LGV (OTP)	1.75	2	1.38
OGV1 (Work)	1.21	1.22	1.00
OGV2 (Work)	1.06	1.09	1.00

NB: No occupancies are specified for LGVs with purpose HBEd because none were observed. Consequently, these values are not used in the final calculation.

Table 4.4 – Proportion of Vehicles Travelling for Each Purpose

Vehicle Type and Journey Purpose	8am-9am	2pm-3pm	5pm-6pm
Car (HBW)	60%	21%	52%
Car (EB)	4%	12%	5%
Car (HBEd)	14%	5%	1%
Car (OTP)	22%	62%	41%
LGV (HBW)	47%	24%	62%
LGV (EB)	40%	61%	22%
LGV (HBEd)	4%	0%	0%
LGV (OTP)	8%	16%	17%
OGV1 (Work)	100%	100%	100%
OGV2 (Work)	100%	100%	100%

Table 4.5 – Proportion of Vehicles in Each User Class

User Class	Mode / Vehicle Type	8am-9am	2pm-3pm	5pm-6pm
UC1	Car	87.26%	84.35%	86.01%
	LGV	12.74%	15.65%	13.99%
UC2	Car	94.81%	100.00%	100.00%
	LGV	5.19%	0.00%	0.00%
UC3	Car	37.50%	55.34%	63.04%
	LGV	62.50%	44.66%	36.96%
UC4	Car	93.55%	96.08%	94.65%
	LGV	6.45%	3.92%	5.35%
UC5	OGV1	100.00%	100.00%	100.00%
UC6	OGV2	100.00%	100.00%	100.00%

4.12 The time costs for each vehicle type and journey purpose (car, LGV, OGV1 and OGV2; HBW, HBEd, EB and OTP) were combined in the relevant proportions of occupancy (Table 4.3) and purpose (Table 4.4) to derive the values of time cost in 2008 (at 2002 prices), given in Table 4.6.

Table 4.6 – Perceived Values of Time per Vehicle in 2002

Vehicle Type	Journey Purpose	8am-9am	2pm-3pm	5pm-6pm
Car	HBW	5.51	6.34	5.96
	EB	27.08	25.43	28.88
	HBEd	10.91	7.06	7.56
	OTP	6.61	7.43	7.68
	Average Car	2.65	7.68	4.63
LGV	HBW	6.22	7.28	6.30
	EB	13.05	9.15	12.38
	HBEd	7.56	-	-
	OTP	7.81	8.92	6.18
	Average LGV	2.65	7.68	4.63
OGV1	Work	10.19	10.29	8.42
OGV2	Work	8.92	9.15	8.42

NB: No values of time are specified for LGVs with purpose HBEd because none were observed. Consequently, these values are not used in the final calculation.

4.13 WebTAG 3.5.6 Table 3 provides the forecast growth in the values of time for 2002 onwards, which have been used to calculate growth factors from 2002 to 2008:

Table 4.7 – Forecast Growth in the Working and Non-Working Values of Time

Range of Years	GDP Growth (%pa)	Population Growth (%pa)	Work VOT Growth (%pa)	Non-Work VOT Growth (%pa)
2002-2003	2.25	0.27	1.98	1.58
2003-2004	2.5	0.27	2.22	1.78
2004-2005	3.5	0.28	3.21	2.57
2005-2006	3.25	0.28	2.96	2.37
2006-2007	2.75	0.28	2.46	1.97
2007-2008	2.5	0.29	2.2	1.76
2002-2008			**1.16**	**1.13**

4.14 The 2002 values of time (Table 4.6) were combined with the 2002-2008 factor (Table 4.7) to give the 2008 values of time, in pounds per hour (Table 4.8).

Table 4.8 – Perceived Values of Time per Vehicle in 2008

Vehicle Type	Journey Purpose	8am-9am	2pm-3pm	5pm-6pm
Car	HBW	6.21	7.14	6.72
	EB	31.41	29.50	33.50
	HBEd	12.29	7.95	8.52
	OTP	7.45	8.37	8.65
	Average Car	2.98	8.66	5.22
LGV	HBW	7.01	8.20	7.10
	EB	15.14	10.62	14.36
	HBEd	8.52	-	-
	OTP	8.79	10.05	6.96
	Average LGV	2.98	8.66	5.22
OGV1	Work	11.82	11.94	9.77
OGV2	Work	10.34	10.62	9.77

NB: No values of time are specified for LGVs with purpose HBEd because none were observed. Consequently, these values are not used in the final calculation.

4.15 The 2008 values of time were converted from vehicle type to user classes using the proportions given in Table 4.5. The PPM parameter was established by converting these values of time in pounds per hour to pence per minute. The values used within the model are shown in Table 4.9.

Table 4.9 – 2008 Values of Time (PPM) Used in Model

User Class	Value of Time	8am-9am	2pm-3pm	5pm-6pm
UC1	£/hr	6.31	7.31	6.77
	ppm	10.51	12.18	11.28
UC2	£/hr	12.09	7.95	8.52
	ppm	20.15	13.25	14.19
UC3	£/hr	21.24	21.07	26.43
	ppm	35.40	35.11	44.05
UC4	£/hr	7.54	8.44	8.56
	ppm	12.56	14.06	14.27
UC5	£/hr	11.82	11.94	9.77
	ppm	19.71	19.90	16.28
UC6	£/hr	10.34	10.62	9.77
	ppm	17.24	17.69	16.28

Distance Costs: Pence per Kilometre

4.16 The PPK value (also known as Vehicle Operating Costs (VOC)) is partially based on speed. These speeds were obtained in two stages: for initial calculations, they were set to 60 mph; this was used to generate initial values of PPM and PPK, which were fed into the model and assigned to give better estimates of the average speeds in the network; these speeds were then fed back into the PPK calculations to give final values for the model. These speeds were 59.6, 64.6 and 58.9 kph for the AM Peak, Inter Peak and PM Peak models respectively.

4.17 WebTAG 3.5.6 gives details on the calculations required to produce the VOC, which are composed of a Fuel element and Non-Fuel element.

Fuel Element

4.18 WebTAG 3.5.6 Table 10 gives the values of the four parameters that are used to calculate fuel efficiency: these are reproduced in Table 4.10.

Table 4.10 – Fuel Element Formula Parameter Values (in litres per kilometre)

Vehicle Category	Parameter			
	a	b	c	d
Average Car	0.178	-0.0041	0.000046	-0.00000015
Average LGV	0.196	-0.0030	0.000017	0.00000006
OGV1	0.768	-0.0226	0.000318	-0.00000135
OGV2	1.024	-0.0302	0.000443	-0.00000201

4.19 These parameters, along with the average speed (V) for each time period, are used to calculate the fuel efficiency for each model using the following formula. The results are shown in Table 4.11.

$$Efficiency = a + bV + cV^2 + dV^3$$

Table 4.11 – 2002 Fuel Efficiency Values (litres per kilometre)

Vehicle Category	AM Average Speed	AM Efficiency	IP Average Speed	IP Efficiency	PM Average Speed	PM Efficiency
Average Car	59.60	0.07	64.60	0.07	58.90	0.07
Average LGV	59.60	0.09	64.60	0.09	58.90	0.09
OGV1	59.60	0.26	64.60	0.27	58.90	0.26
OGV2	59.60	0.37	64.60	0.38	58.90	0.37

4.20 In order to factor these 2002 fuel efficiency values to 2008 levels, WebTAG 3.5.6 Table 13 can be used (Table 4.12).

Table 4.12 – Vehicle Fuel Efficiency Improvements

Vehicle Category	2002-2003 (actual) (%)	2003-2004 (actual) (%)	2004-2005 (assumed) (%)	2005-2006 (assumed) (%)	2006-2007 (assumed) (%)	2007-2008 (assumed) (%)	2002-2008 (calculated)
Average Car	-1.08	-1.1	-1.11	-1.33	-1.33	-1.33	1.0750
Average LGV	0.64	-1.42	-1.78	-1.49	-1.49	-1.49	1.0722
OGV1	0.46	0	0	-1.23	-1.23	-1.23	1.0326
OGV2	-0.17	0	0	-1.23	-1.23	-1.23	1.0391

4.21 Multiplying these factors (Table 4.12) by the 2002 efficiency values (Table 4.11) gives the 2008 fuel efficiency values (Table 4.13).

Table 4.13 – 2008 Fuel Efficiency Values (litres per kilometre)

Vehicle Category	AM Efficiency	IP Efficiency	PM Efficiency
Average Car	0.07	0.07	0.07
Average LGV	0.09	0.09	0.10
OGV1	0.27	0.28	0.27
OGV2	0.39	0.39	0.39

4.22 WebTAG 3.5.6 Table 11 gives the 2007 resource costs for fuel and Table 14 gives the forecast growth for future years. These have been combined to give the 2008 fuel costs shown in Table 4.14.

Table 4.14 – 2008 Fuel Costs (pence per litre)

Vehicle Category	Fuel	Duty (2008)	Tax	pence/litre
Car (work)	28.93	44.00		72.93
Car (non-work)	28.93	44.00	17.50	85.69
LGV (work)	30.37	44.00		74.37
LGV (non-work)	30.37	44.00	17.50	87.38
OGV1	30.79	44.00		74.79
OGV2	30.79	44.00		74.79

4.23 These fuel costs (Table 4.14) can be multiplied by the fuel efficiency values (Table 4.13) to produce the Fuel element of the VOC (Table 4.15).

Table 4.15 – Fuel Element of VOC (pence per kilometre)

Vehicle Category	AM Litre/km	AM pence/km	IP Litre/km	IP pence/km	PM Litre/km	PM pence/km
Car (work)	0.074	5.37	0.073	5.35	0.074	5.38
Car (non-work)	0.074	6.31	0.073	6.29	0.074	6.31
LGV (work)	0.095	7.04	0.093	6.93	0.095	7.07
LGV (non-work)	0.095	8.27	0.093	8.15	0.095	8.30
OGV1	0.273	20.44	0.279	20.90	0.273	20.39
OGV2	0.386	28.90	0.395	29.51	0.386	28.84

Non-Fuel Element

4.24 WebTAG 3.5.6 paragraph 1.3.16 gives a formula for calculating the non-fuel element of VOC (in pence per kilometre), which includes expenses such as oil, tyres, maintenance and depreciation for all vehicles, along with a vehicle capital saving for vehicles in working time only.

$$Cost = a1 + \frac{b1}{V}$$

4.25 WebTAG 3.5.6 Table 15 gives the values of parameters a1 and b1 for input to this formula, reproduced in Table 4.16.

Table 4.16 – Non-Fuel Element Formula Parameter Values

Vehicle Category	Perceived Cost Parameters	
	a1	b1
Car (work)	4.1	111.4
Car (non-work)	3.2	-
LGV (work)	5.9	38.6
LGV (non-work)	5.9	-
OGV1	5.5	216.2
OGV2	10.7	416.7

4.26 Using the average speeds for each model, the non-fuel element of the VOC can be calculated for each hour (Table 4.17).

Table 4.17 – Non-Fuel Element of VOC (pence per kilometre)

Vehicle Category	AM Average Speed	AM NF VOC	IP Average Speed	IP NF VOC	PM Average Speed	PM NF VOC
Car (work)	59.60	5.94	64.60	5.79	58.90	5.96
Car (non-work)	59.60	3.15	64.60	3.15	58.90	3.15
LGV (work)	59.60	6.56	64.60	6.51	58.90	6.57
LGV (non-work)	59.60	5.91	64.60	5.91	58.90	5.91
OGV1	59.60	9.13	64.60	8.85	58.90	9.17
OGV2	59.60	17.69	64.60	17.15	58.90	17.78

Total VOC

4.27 The fuel and non-fuel elements of VOC are summed to give the total VOC for each vehicle category for each time hour in Table 4.18.

Table 4.18 – Total VOC for Each Vehicle

Vehicle	AM			IP			PM		
	F VOC	NF VOC	Total VOC	F VOC	NF VOC	Total VOC	F VOC	NF VOC	Total VOC
Car (work)	5.37	5.94	11.31	5.35	5.79	11.14	5.38	5.96	11.34
Car (non-work)	6.31	3.15	9.46	6.29	3.15	9.44	6.32	3.15	9.47
LGV (work)	7.04	6.56	13.60	6.93	6.51	13.44	7.07	6.57	13.63
LGV (non-work)	8.27	5.91	14.18	8.15	5.91	14.06	8.30	5.91	14.21
OGV1	20.44	9.13	29.56	20.90	8.85	29.75	20.39	9.17	29.56
OGV2	28.90	17.69	46.59	29.51	17.15	46.66	28.84	17.78	46.61

4.28 Using the proportions of vehicles given in Table 4.5, the PPK values for each user class can be derived – these are shown in Table 4.19.

Table 4.19 – 2008 Vehicle Operating Costs (PPK) Used in Model

	AM	IP	PM
UC1	10.06	10.16	10.13
UC2	9.71	9.44	9.47
UC3	12.74	12.17	12.19
UC4	9.77	9.62	9.72
UC5	29.56	29.75	29.56
UC6	46.59	46.66	46.61

PPM and PPK Parameters: Final Values

4.29 When input into the model, the PPM and PPK are given as a ratio, rather than absolute values. The final parameters for the AM Peak are given in Table 4.20; Inter Peak in Table 4.21 and PM Peak in Table 4.22.

Table 4.20 – AM Peak PPM and PPK Parameters

User Class	PPM	PPK	PPM=1	PPK=
UC1	10.51	10.06	**1.00**	**0.96**
UC2	20.15	9.71	**1.00**	**0.48**
UC3	35.40	12.74	**1.00**	**0.36**
UC4	12.56	9.77	**1.00**	**0.78**
UC5	19.71	29.56	**1.00**	**1.50**
UC6	17.24	46.59	**1.00**	**2.70**

Table 4.21 – Inter Peak PPM and PPK Parameters

User Class	PPM	PPK	PPM=1	PPK=
UC1	12.18	10.16	**1.00**	**0.83**
UC2	13.25	9.44	**1.00**	**0.71**
UC3	35.11	12.17	**1.00**	**0.35**
UC4	14.06	9.62	**1.00**	**0.68**
UC5	19.90	29.75	**1.00**	**1.50**
UC6	17.69	46.66	**1.00**	**2.64**

Table 4.22 – PM Peak PPM and PPK Parameters

User Class	PPM	PPK	PPM=1	PPK=
UC1	11.28	10.13	**1.00**	**0.90**
UC2	14.19	9.47	**1.00**	**0.67**
UC3	44.05	12.19	**1.00**	**0.28**
UC4	14.27	9.72	**1.00**	**0.68**
UC5	16.28	29.56	**1.00**	**1.82**
UC6	16.28	46.61	**1.00**	**2.86**

5. Local Highway Model – Network Development

Network Coverage

5.1 The network covers all key links within the study area, with a greater emphasis on the centre of Wisbech. The model stretches from the A17 at Long Sutton in the north to the A605 and Outwell in the south and from Walton Highway in the east to Parson Drove in the west.

Network Coding

5.2 The network coding has been carried out in line with the SATURN manual and The Design Manual for Roads and Bridges (DMRB) guidance. Alterations to the network were coded in stages so that any modelling errors could easily be traced and amended.

5.3 The network is coded entirely in simulation. Traffic signals are modelled using data acquired from CCC for the actual signal timings at each location. Initially maximum timings were used throughout, although these may be subsequently altered to any value within the given limits during the calibration and validation of the model.

5.4 Speed flow curves were allocated to all extra-urban links longer than 200m. Figure 5.1 provides the classification of inter and extra-urban areas of Wisbech. Table 5.1 lists the speed flow curves and shows how they differ for rural, suburban and urban roads.

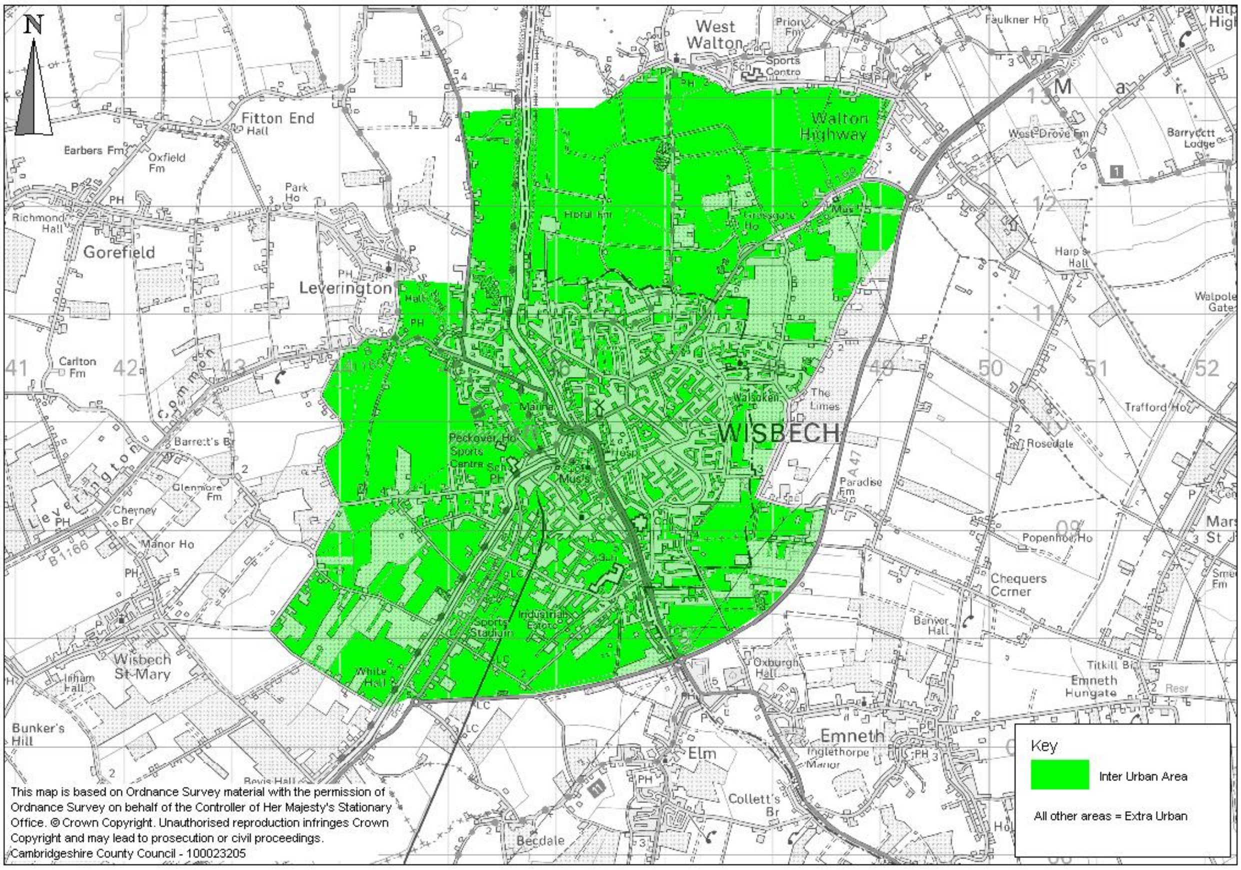
Table 5.1 – Speed Flow Curve Classification

Ref	S0	S1	C	N	Description
Rural Link De Restricted					
71	116	55	9320	3.5	D4 Motorway
72	116	72	6990	3.5	D3 Motorway
73	109	55	4660	4.0	D2 Motorway
61	112	72	6300	3.5	D3 AP
62	105	65	4200	3.5	D2 AP
63	93	49	1753	3.5	10m All Purpose high quality road with metre strips
64	87	52	1590	3.5	7.3m Modern Type "A" road
65	80	45	1380	3.5	7.3m Older Type "A" Road
66	71	40	1210	3.5	6.5m "B" Class Road
67	69	42	1081	3.5	6.0m "C" class poor quality hilly or bendy road
68	50	42	300	3.5	"C" class poor quality hilly or bendy road, with passing places
682	69	21	600	2.1	"C" class poor quality road with passing places
683	55	15	600	2.1	"C" class poor quality hilly or bendy road, with passing places and low visibility
684	55	15	300	2.1	"C" class poor quality hilly or bendy road, with passing places and very low visibility

Ref	S0	S1	C	N	Description
Rural Link (50 mph)					
51	80	67	6300	6.0	D3 AP
52	80	63	4200	6.0	D2 AP
53	80	48	1753	5.0	10m All Purpose high quality road with metre strips
54	80	51	1380	3.5	7.3m All Purpose high quality road with metre strips
55	80	45	1380	3.5	7.3m Typical Good quality road (B type road)
Urban Link (40 mph)					
42	64	41	3600	6.0	Dual Carriageway
43	64	38	3200	6.0	Dual Carriageway
44	64	35	1590	5.5	Primary radial route
45	62	31	1463	4.0	Secondary radial route
Urban Link (30 mph)					
32	48	41	3600	5.5	High standard dual carriageway with limited access
33	48	38	3200	5.0	Average standard dual carriageway with frontage access
34	48	35	1590	5.0	High standard 7.3m with limited access
35	48	31	1463	5.0	Good standard 7.3m with frontage access
36	48	28	1304	5.0	Variable standard 7.3m with frontage access and parking
37	48	28	1145	5.0	Variable standard 7.3m with frontage activity and parking
38	48	28	950	4.0	Variable standard 6.75m with frontage activity and parking
382	37	28	950	3.0	Variable standard and width with frontage activity and parking
39	48	28	733	4.0	Variable standard 6.1m with frontage activity and parking
Suburban Link (20 mph)					
26	32	28	1304	6.0	Variable standard 7.3m with frontage access and parking
27	32	28	1145	6.0	Variable standard 7.3m with frontage activity and parking
28	32	28	950	6.0	Variable standard 6.75m with frontage activity and parking
29	32	28	733	6.0	Variable standard 6.1m with frontage activity and parking

where S0 = Free Flow Speed; S1 = Speed at Capacity; C = Link Capacity; and N = N Factor.

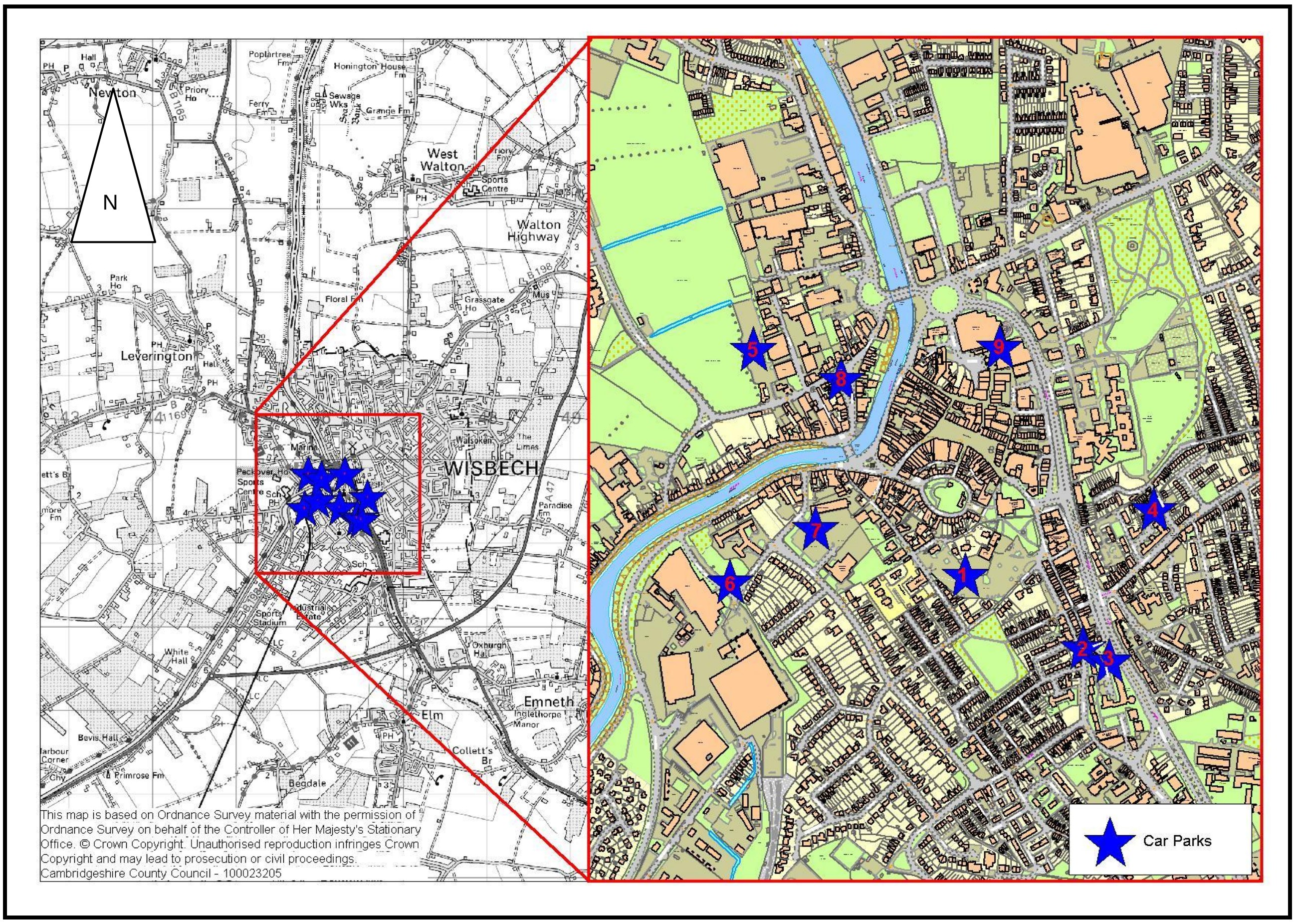
Figure 5.1 – Urban Area Classification



Car Parks

5.5 Significant long and short term car parks within Wisbech Town Centre have been included as freestanding traffic zones in the model. Where the car park has individual entry and exits, these have been modelled explicitly. These entrances and exits have been modelled as priority junctions, with speeds on the links connecting the car park zones to the junctions being set at 30 kph.

Figure 5.2 – Locations of Car Parks within Wisbech



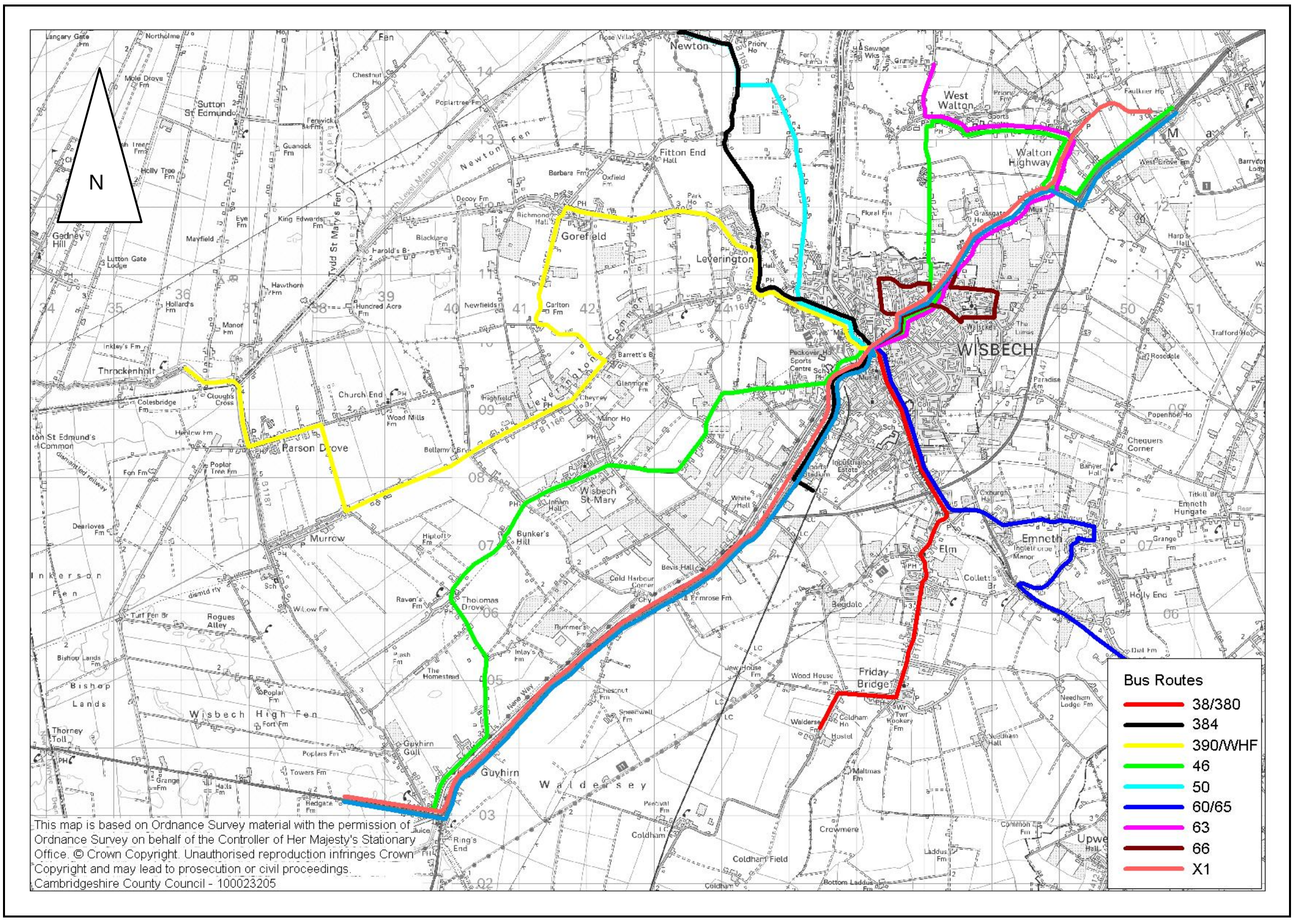
5.6 The locations above correlate to the following Car Parks:

1) Church Terrace/Alexandra Road
2) West Street
3) Onyx Court
4) Park Street
5) Chapel Road
6) Coalwharf Road
7) Queen Street
8) Old Market
9) Horsefair

Bus Routes

5.7 A full review of the base year public transport provision was carried out and all bus routes that operated within, or pass through Wisbech in June 2008 were coded into the model. Stagecoach have since amended their routes, but the June 2008 data was used to be consistent with the base year of the model, and other surveyed data. These routes are shown below in Figure 5.3. Details of the exact routes and number of buses per peak hour on each route can be found within the Data Collection Report.

Figure 5.3 – 2008 Base Year Bus Routes



6. Local Highway Model – Matrix Development

Introduction

6.1 This chapter gives details on the full process of generating trip matrices for the base year SATURN models for the WATS, for AM Peak, Inter Peak and PM Peak hours.

Data Utilised

6.2 Many different data sources were incorporated into the matrix building process. The list below details the data used during the matrix development. Full details of this data can be found within Chapter 2.

- RSI Surveys (with associated MCCs and ATCs);
- Car Park Interview Surveys (with associated MCCs);
- 2001 National Census JTW Data;
- Education Trips Data;
- The EERM; and
- HA TRADS Data.

Building the Observed Matrices

6.3 Observed trip matrices were built using only data collected in the RSI and Car Park surveys. As discussed in paragraphs 3.4 and 3.5 of this report, this data provides a complete picture of E-I movements and, by transposition, I-E movements, along with a partial record of E-E movements and all movements to/from car park zones. The exact process used to generate inbound matrices from this data is described below.

Cleaning and Geo-coding

6.4 Raw RSI and Car Park survey data is supplied as a simple table for each survey site with columns containing the following information:

- The time at which the vehicle passed through the RSI site or arrived at the car park;
- Vehicle type (Car / LGV / OGV1 / OGV2 / Motorcycle);
- Vehicle occupancy;
- The address, postcode and purpose for the origin; and
- The address, postcode and purpose for the destination (or the name of the car park, in the case of Car Park surveys).

6.5 This data was geo-coded and plotted using GIS software, to enable illogical trips to be removed. This was achieved by plotting each origin and destination point (joined by a line) for each RSI site and car park, and analysing the visual output in detail to ascertain whether or not each trip would logically have passed through that survey site. A route planner was used to check any alternative routes, as this enables time and distance comparisons of different routes between any given start and end points.

6.6 After the data had been cleaned of illogical trips, each origin and destination was assigned to a zone in the model, according to the geographical location of its postcode or the zone number of the car park.

Purpose Identification

6.7 The survey data was collected with a purpose for each origin and destination; however, the matrices only require one purpose per trip. The RSI purposes are shown in Table 6.1; the modelled purposes are HBW, HBEd, EB and OTP (as defined above in paragraph 4.6). The conversions shown in Table 6.2 allow a single purpose to be assigned to each trip.

Table 6.1 – RSI Origin/Destination Purpose Definitions

ID	Description
1	Home
2	Tourism
3	Work
4	Employers’ Business
5	Education
6	Shopping
7	Personal Business
8	Visit Friends/Family
9	Recreation/Leisure

Table 6.2 – Conversion to Trip Purposes

Trip Purpose	RSI O/D Purposes
HBW	1-3, 3-1
HBEd	1-5, 5-1
EB	4-*, *-4
OTP	All other combinations

Transposition

6.8 As previously mentioned in paragraph 6.3 of this report, outbound matrices can be generated from inbound interviews by transposition. This applies to both RSIs and Car Park Interviews.

6.9 In this process, the inbound interviews from the AM period (07:00-10:00) are transposed to provide outbound information for the PM Peak hour; inter peak interviews are transposed for the inter peak; and PM period interviews (16:00-19:00) are transposed for the AM Peak hour.

Factoring – Car Park Surveys

6.10 During the Car Park Interviews, only a subset of the cars entering each car park was interviewed. At the same time, an MCC was carried out at each entrance to each car park – this recorded the total number of people entering and leaving each car park.

6.11 In order to scale up the interviews to the total count, a factor was calculated for each car park. Where a car park had more than one entrance, the in/out counts at each entrance were added together, since the interview data did not differentiate between which entrance was used.

6.12 As discussed in paragraph 4.5 of this report, the interview data was funnelled, so the MCCs referenced below are single-hour counts, whereas the “No. of interviews” are collected over a greater length of time.

6.13 The inbound factor was equal to

$$F = \frac{MCC}{No.ofInterviews}$$

6.14 Outbound factors, to apply to the transposed interviews described above, are generated in a similar way, using the outbound counts and the number of transposed interviews.

Factoring – RSI Surveys

6.15 In the same way as the Car Park Interviews, since RSI surveys only interview a subset of the traffic passing through each site, it is necessary to factor the number of interviews up to the observed traffic flow at the site. This was carried out as a two-stage process. Prior to this factoring taking place, the factored number of Car Park Interviews passing through each RSI site was calculated, and the MCC at each RSI site was reduced accordingly.

6.16 As discussed in paragraph 4.5 of this report, the interview data was funnelled, so the MCCs and ATCs referenced below are single-hour counts, whereas the “No. of interviews” are collected over a greater length of time.

6.17 Firstly, a factor was calculated for each time period for each vehicle type at each site, according to the inbound (interview direction) MCC that had been recorded during the RSI surveys. This factor was equal to

$$F_1 = \frac{MCC}{No.ofInterviews}$$

6.18 Secondly, an Inbound Factor was calculated for each time period at each site, to scale the MCC data to the ATC value for the same direction. This is because the MCC was only carried out on the day of the survey and observed traffic flows might have been affected by the fact that RSI surveys were being carried out. The ATC data was recorded continuously for a fortnight: for this purpose, we took an average of the week that *didn't* include the RSI surveys. This factor was equal to

$$F_2 = \frac{ATC}{MCC}$$

6.19 These factors were combined into a single Inbound Factor, which was applied to each survey record to scale the interviews up to the average observed ATC.

$$F = F_1 \times F_2$$

6.20 At the same time, an Outbound Factor was calculated to enable transposed matrices to be derived. This was calculated in the same way as the Inbound Factor, except that each MCC and ATC was replaced with the equivalent count in the opposite direction, and the number of interviews replaced with the number of transposed interviews.

6.21 The ATC factors, F_2, were only calculated for survey sites with a low proportion of heavy vehicles (i.e. excluding Sites 1, 2 and 6). This is because the automatic counting equipment does not function accurately with heavy vehicles (or any vehicle with more than two axles), so counts with a high proportion of heavy vehicles become heavily skewed. This claim has been verified by comparing the RSI site MCC counts with independent turning counts that incorporate the same links.

Squaring

6.22 At the end of the above processes, the RSI data is still in the same table but with seven additional columns:

- Origin Zone;
- Destination Zone;
- Trip Purpose;
- Inbound Time Period;
- Outbound Time Period;
- Inbound Factor; and
- Outbound Factor.

6.23 In order to use this information in the model, it has to be in the form of a square matrix. This is achieved for the inbound matrices by using a spreadsheet Pivot Table for each Inbound Time Period, with Origin Zones as the row headings, Destination Zones as the column headings and a Sum of Inbound Factors as the data.

6.24 Similarly, for the outbound matrices, a Pivot Table for each Outbound Time Period with Destination Zones as the row headings, Origin Zones as the column headings and a Sum of Outbound Factors as the data is used.

6.25 To ensure that all origin and destination zones are included in the matrix, a list of 'dummy' records was added to the data table, with a complete list of origins and destinations. In this way, square matrices can be produced for each direction, time period, user class and RSI Site / Car Park.

Compiling the Full Observed Matrices

6.26 Using the process described above, 96 matrices were created as CSV files from Excel. These consisted of 24 Car Park matrices (3 Time Periods x 4 light-vehicle User Classes x 2 Directions) and 72 RSI matrices (3 Time Periods x 6 User Classes x 2 Directions, with Site 7 output separately to Sites 1-6).

6.27 The full Observed Matrices were compiled from the 96 CSV files using a batch file that carried out the following steps:

- For each Time Period and User Class, add together the Inbound and Outbound matrices for the Car Parks (resulting in 12 files), RSI Sites 1-6 (18 files) and RSI Site 7 (18 files).
- Multiply the site 7 matrices by the mask described below (paragraph 6.28).
- Remove double counting (see paragraphs 6.29 to 6.31).
- Add together the three different sources (car park, RSI 1-6 and RSI 7) to create 18 matrices (3 Time Periods x 6 User Classes)
- Stack the 6 User Classes for each time period to create three final Observed Matrices.

Treatment of RSI Site 7

6.28 As previously noted, RSI Site 7 does not form part of the cordon around Wisbech, but is an isolated site on the A17 to the north of the town. The catchment area of trips through this site overlaps with those in the cordon, particularly Site 3. Furthermore, no vehicles of class OGV2 were interviewed at Site 7 at any time during the day, so the data from this site is incomplete. Therefore, this site has been treated separately: only trips that would not pass through any other

RSI site (e.g. travelling from Boston to King's Lynn) have been used and all others have been discarded. The complete list of O-D zone pairs that have been used can be found in Table 6.3

Removal of Double Counting

6.29 Due to the way in which the transposed components of the matrices were created, some long distance External-to-External trips will have been included in the Observed Matrices twice. For example, a trip from Peterborough to King's Lynn may have been observed at RSI Site 1 (eastbound on the A47), and a trip from King's Lynn to Peterborough may have been observed at RSI Site 2 (westbound on the A47). The interviews at each RSI site have been factored up to the number of vehicles counted passing through that site such that, from the inbound matrices alone, all 'inbound' trips (including, for example, eastbound at Site 1 and westbound at site 2) have been accounted for. However, when the transposed matrices were created (and also factored up to the full number of vehicles that were counted at each site), trips such as the two described above would replicate each other and would therefore be double-counted in the matrix.

6.30 The barrier method of removing double counting has been employed for this WATS model. This means that, for each Origin-Destination pair, the number of RSI sites that a trip would have passed through was counted – so, for example, trips between Peterborough and King's Lynn pass through two sites. This information is used to build up a matrix containing 1 for any movement that passes through 0 or 1 RSI sites, and 2 for any movement that passes through 2 RSI sites. Due to the locations of the RSI sites, and the treatment of RSI Site 7, no movements were counted more than twice. The observed matrices were then divided by this 'divisor' matrix, to remove double counting effectively by taking an average of the trips observed at each site.

6.31 Double counting of the data was not an issue with the Car Park data, so this did not have to be considered at this stage.

Table 6.3 – Matrix of Movements that have been taken from Site 7 Data

	104	126	201	209	219	220	221	222	501	503	504	505	506	507	508	509	601	865	873	882
104										✓	✓	✓	✓	✓	✓	✓	✓			
126										✓	✓	✓	✓	✓	✓	✓	✓			
201										✓	✓	✓	✓	✓	✓	✓	✓			
209										✓	✓	✓	✓	✓	✓	✓	✓			
219										✓	✓	✓	✓	✓	✓	✓	✓			
220										✓	✓	✓	✓	✓	✓	✓	✓			
221										✓	✓	✓	✓	✓	✓	✓	✓			
222										✓	✓	✓	✓	✓	✓	✓	✓			
501										✓	✓	✓	✓	✓	✓	✓	✓			
503	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
504	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
505	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
506	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
507	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
508	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
509	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
601	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓
865										✓	✓	✓	✓	✓	✓	✓	✓			
873										✓	✓	✓	✓	✓	✓	✓	✓			
882										✓	✓	✓	✓	✓	✓	✓	✓			

Checking the Observed Matrices

General Checks – RSI Surveys

6.32 Table 6.4 shows the factored number of inbound Roadside interviews that were recorded (i.e. the sum of all interviews multiplied by their expansion factors (see paragraphs 6.15 to 6.21)), alongside the number of trips in the initial RSI matrix (i.e. before RSI Site 7 has been processed or double counting has been removed). Table 6.5 shows the same information for the outbound interviews and Table 6.6 shows the summary for inbound and outbound combined.

Table 6.4 – RSI Data Checks: Inbound Factored Interviews

Period	RSI Interviews Inbound	RSI Matrix Inbound	Difference
AM Peak Hour	4123	4123	0
IP Peak Hour	3481	3481	0
PM Peak Hour	4018	4018	0

Table 6.5 – RSI Data Checks: Outbound Factored Interviews

Period	RSI Interviews Outbound	RSI Matrix Outbound	Difference
AM Peak Hour	3654	3654	0
IP Peak Hour	3651	3651	0
PM Peak Hour	4674	4674	0

Table 6.6 – RSI Data Checks: Combined Interviews

Period	RSI Interviews	RSI Matrix	Difference
AM Peak Hour	7777	7777	0
IP Peak Hour	7133	7133	0
PM Peak Hour	8728	8692	0

6.33 These tables show that the first stages of the Observed Matrix build are operating as expected, since the factored number of interviews is exactly equal to the size of the matrix in all cases.

6.34 Table 6.7 shows how many trips were removed during the processing of double counting. This processing was completed in two stages: trips recorded at RSI Site 7 that would also have been recorded at RSI Site 3 were masked out by destination zone (see paragraph 6.28); and any trips that would have passed through two sites of the RSI cordon were divided by two (see paragraph 6.30). Logically, we would expect to remove less than half the total matrix, since trips either passed through one or two RSI sites, so some trips were divided by one and others by two.

Table 6.7 – RSI Data Checks: Double Counting

Period	With Double Counting	Without Double Counting	Difference
AM Peak Hour	7777	5778	26%
IP Peak Hour	7133	5273	26%
PM Peak Hour	8728	6490	26%

6.35 As expected, we have removed less than half the total matrix: in fact, we have removed around a quarter in each time period.

6.36 Table 6.8 shows the difference between the AM Peak Geographical Sector matrices before and after double counting was removed. Table 6.9 shows the same for the Inter Peak and Table 6.10 for the PM Peak. We would expect the movements into Wisbech town centre not to be affected much (except for the removal of trips recorded at RSI Site 7); most of the movements that were affected by the processing of double counting were through trips (i.e. external-to-external).

Table 6.8 – RSI Data Checks: AM Geographical Sector Matrix With and Without Double Counting (Difference)

	1	2	3	4	5
1	-8	-43	9	24	-6
2	-8	-2	-6	-95	-11
3	23	0	-87	-656	-2
4	-4	-38	-603	-334	-26
5	0	0	-2	-52	0

Table 6.9 – RSI Data Checks: IP Geographical Sector Matrix With and Without Double Counting (Difference)

	1	2	3	4	5
1	-2	-53	0	-17	0
2	-50	-2	-8	-79	-3
3	0	-7	-88	-612	-2
4	-15	-79	-554	-260	-12
5	0	-3	-2	-12	0

Table 6.10 – RSI Data Checks: PM Geographical Sector Matrix With and Without Double Counting (Difference)

	1	2	3	4	5
1	-9	-32	26	-10	0
2	-51	-2	0	-45	0
3	9	-7	-101	-677	-4
4	10	-82	-686	-359	-64
5	-3	-5	-3	-32	0

6.37 The above tables show that, in all time periods, the majority of the trips that were removed due to double counting were between Geographical Sectors 3 and 4, and within Sector 4. This is as expected, since Sector 3 is Norfolk (i.e. to the east of Wisbech) and Sector 4 is mostly to the west of Wisbech, so these sectors will contain the majority of double-counted movements along the A47.

6.38 A relatively large number of trips are removed from Geographical Sector 4 to/from all other sectors, simply because Sector 4 is the largest sector.

6.39 Movements between Geographical Sectors 1 and 2 have been reduced due to the removal of double counting at Site 7.

6.40 These reductions are in line with our expectations, so the removal of double counting has therefore been successful.

General Checks – Car Park Surveys

6.41 Table 6.11 shows the factored number of inbound Car Park interviews that were recorded (i.e. the sum of all interviews multiplied by their expansion factors (see paragraphs 6.15 to 6.21)), alongside the number of trips in Car Park matrix. Table 6.12 shows the same information for the outbound interviews and Table 6.13 shows the summary for inbound and outbound combined.

Table 6.11 – Car Park Data Checks: Inbound Factored Interviews

Period	Car Park Interviews Inbound	Car Park Matrix Inbound	Difference
AM Peak Hour	695	695	0
IP Peak Hour	424	424	0
PM Peak Hour	230	230	0

Table 6.12 – Car Park Data Checks: Outbound Factored Interviews

Period	Car Park Interviews Outbound	Car Park Matrix Outbound	Difference
AM Peak Hour	133	133	0
IP Peak Hour	512	512	0
PM Peak Hour	586	586	0

Table 6.13 – Car Park Data Checks: Combined Interviews

Period	Car Park Interviews	Car Park Matrix	Difference
AM Peak Hour	827	827	0
IP Peak Hour	936	936	0
PM Peak Hour	816	816	0

6.42 These tables show that Car Park matrix build is operating as expected, since the factored number of interviews is exactly equal to the size of the matrix in all cases.

General Checked – Combined Observed Matrices

6.43 Table 6.14 shows a final check that the total factored number of interviews (both Car Park and Roadside, minus double counting) is equal to the size of each observed matrix that has been built.

Table 6.14 – Data Checks: Final Combined Matrices

Period	RSI + Car Park From Tables Above	Full Observed Matrix	Difference
AM Peak Hour	6606	6606	0
IP Peak Hour	6209	6209	0
PM Peak Hour	7307	7307	0

6.44 Again, the differences are all zero, showing that the building of the Observed Matrix has operated as expected, with the correct results.

Detailed Checks

6.45 In addition to the above checks, some more detailed checks were made on the expanded inbound RSI data. For this purpose, separate matrices were produced for each RSI site.

6.46 Each matrix was assigned to the network in turn, and checks were undertaken to make sure that each trip either passed through the RSI site or along a neighbouring parallel link. (Ultimately, the trips will be required to pass through the RSI site and not along a neighbouring parallel link, but until the network is fully loaded with all trips, this cannot be expected.)

6.47 Checks were also made on the expansion factors: the total number of trips in the expanded RSI matrices should (and generally did) equal the total number of vehicles counted. The exceptions to this were when no interviews had been conducted on the relevant vehicle type, so nothing could be factored up to the count. A total of 284 vehicles were 'lost' (not included in the matrix) due to errors of this kind – most of these (219) were OGV2 vehicles at Site 7. Table 6.15 shows the peak period totals for each site and each vehicle type.

ATKINS

Table 6.15 – Peak Hour Totals for Funnelled and Factored RSI Surveys (Inbound)

Site	Peak Hour	Source	Vehicle Type					Total Vehicles
			Car	LGV	OGV1	OGV2	M/C	
1	AM	MCC	461	118	29	37	3	648
		RSI+CP	461	118	29	37	**0**	**645**
	IP	MCC	343	105	26	50	6	530
		RSI+CP	343	105	26	50	6	530
	PM	MCC	465	87	8	27	2	589
		RSI+CP	465	87	8	27	**0**	**587**
2	AM	MCC	676	152	37	56	5	926
		RSI+CP	676	152	37	56	5	926
	IP	MCC	424	120	36	76	7	663
		RSI+CP	424	120	36	76	7	663
	PM	MCC	760	163	28	39	17	1007
		RSI+CP	760	163	28	39	17	1007
3	AM	MCC	444	60	20	26	4	554
		RSI+CP	444	60	20	26	4	554
	IP	MCC	410	88	15	29	2	544
		RSI+CP	410	88	15	29	2	544
	PM	MCC	436	68	9	13	6	532
		RSI+CP	436	68	9	13	6	532
4	AM	MCC	268	49	6	9	3	335
		RSI+CP	268	49	6	**0**	**0**	**323**
	IP	MCC	146	27	5	7	2	187
		RSI+CP	146	27	5	**0**	2	**180**
	PM	MCC	250	36	1	8	2	297
		RSI+CP	250	36	1	**0**	**0**	**287**
5	AM	MCC	257	31	4	0	3	295
		RSI+CP	257	31	4	0	3	295
	IP	MCC	143	28	4	0	3	178
		RSI+CP	143	28	4	0	3	178

Site	Peak Hour	Source	Vehicle Type					Total Vehicles
			Car	LGV	OGV1	OGV2	M/C	
	PM	MCC	158	32	0	1	1	192
		RSI+CP	158	32	0	**0**	1	**191**
6	AM	MCC	588	115	12	12	15	742
		RSI+CP	588	115	12	12	**0**	**727**
	IP	MCC	483	85	28	28	11	635
		RSI+CP	483	85	28	28	11	635
	PM	MCC	567	111	10	16	18	722
		RSI+CP	567	111	10	16	18	722
7[1]	AM	MCC	402	118	41	77	0	638
		RSI+CP	402	118	41	**0**	0	**561**
	IP	MCC	288	95	30	85	1	499
		RSI+CP	288	95	30	**0**	1	**414**
	PM	MCC	380	85	15	57	7	544
		RSI+CP	380	85	**0**	**0**	7	**472**
		MCC	Grand total					11387
		RSI+CP	Grand total					**11103**

[1] For the purpose of this table, full data from site 7 has been used, before trips that would have passed through other RSI sites have been discarded.

6.48 These initial checks on the inbound RSI matrices proved the majority of the data used at this stage of the matrix building process to be robust (i.e. not 'lose' any trips inexplicably).

6.49 The missing heavy vehicle data at Site 7 has been infilled using data from the 2008 EERM, as described in paragraphs 6.81 and 6.82.

Building the Synthetic Matrices

6.50 Due to the lack of availability of other data, the synthetic matrices for all User Classes are based upon the 2001 National Census JTW data, except for HBEd in the AM Peak (for which additional data was supplied by CCC). The initial processing of this Census data was described in paragraphs 3.10 to 3.15, resulting in bi-directional 2008 Journey to Work matrices for the AM Peak, Inter Peak and PM Peak.

6.51 Synthetic data was generated only for the partially observed and unobserved movements in the matrix, as the observed movements are already included in the Observed Matrices. The process used to create these synthetic matrices was as follows:

a) Calculate factors that describe each user class as a proportion of HBW, using the observed data for each time period.

b) Multiply the census matrix by each of these factors, to create a starting point for the synthetic matrices for each user class. Also multiply these matrices by the ‘partially observed and unobserved’ mask, to strip out data for any movements that have already been fully observed.

c) For each user class and time period, calculate the difference between the processed census matrix and the corresponding observed matrix, resetting any negative differences to zero. This will leave the ‘missing’ trips – i.e. the unobserved movements and the unobserved portions of the partially observed movements.

d) Calculate the row and column totals for the above difference matrices – these provide the Trip Ends to be synthesised for each time period and user class.

e) From the RSI data, calculate the observed trip length distributions for each time period and user class. Plot each distribution on a graph.

f) Generate a logit function to replicate the trip length distribution for each time period and user class. (See paragraphs 6.52 to 6.58 for details.) Calibrate the logit function by changing the values of the parameters until the graph of the function matches the observed trip length distributions as closely as possible.

g) From the SATURN model (assigned to the Observed Matrix), take a distance skim to create a matrix of the average observed distances between each Origin-Destination pair.

h) Using the logit functions and distance skims, for each time period and user class, generate a matrix of the distribution of trip ends across the whole matrix. Multiply this by the ‘partially observed and unobserved’ mask, to generate a trip distribution only for the required parts of the matrix. Each cell of this matrix contains a value between 0 and 1, describing the probability of a trip between that origin and destination occurring (“propensity to travel”).

i) Feed the trip ends (step **d**) and the trip distribution matrices (step **h**) into a Furness process, to distribute the required trip ends according to the calculated distribution, creating a synthetic matrix of the partially observed and unobserved movements.

j) AM Peak Hour Only: additional information was available from CCC for Education trips in the AM Peak Hour. This information was used to estimate some specific movements that are made to schools during the AM Peak – these trips are then masked down to the unobserved (i.e. Internal-to-Internal) movements and added on to the matrix in place of the synthetic data for these cells.

Gravity Models and Logit Functions

6.52 A gravity model can be used to describe the propensity for a journey to be made between an origin and a destination, based on the costs associated with the travel between these locations. These costs could, for example, be based on time, distance or a combination of the two.

6.53 Gravity models attempt to describe a trip distribution based on very limited data – they do not provide an accurate trip matrix, but the information can be used to inform a prior matrix that provides a good starting point for the Matrix Estimation process that takes observed traffic counts into account.

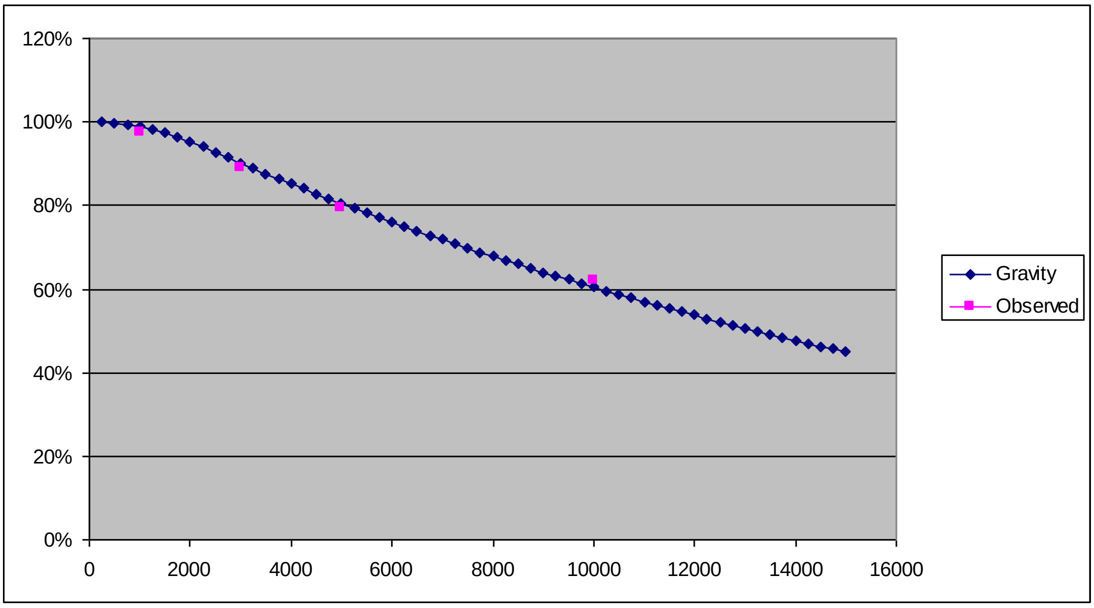
6.54 For this study, a gravity model has been developed for each user class based on distance costs. A profile of the lengths of car trips in the Study Area was ascertained from the RSI data, and this was used to inform a gravity model. In this case, the gravity model used the logit function

$$Gravity \quad \begin{cases} dist \le MWD \rightarrow & e^{-MWD \times disutility} \times \dfrac{dist}{MWD} \\ dist > MWD \rightarrow & e^{-dist \times disutility} \end{cases}$$

6.55 In this function, *MWD* refers to the Maximum Walk Distance. Research has shown this distance to be approximately 2 km, which has been used as a starting point for calibration in this study. (Clearly, longer distances would be expected for User Classes 5 and 6 (which are heavy vehicles).) The *disutility* is a value that is calibrated to achieve the best fit between the logit function and the observed trip length distribution, for each user class.

6.56 In graphical terms, the logit function developed for OTP in the AM Peak is shown in Figure 6.1.

Figure 6.1 – Calibration of the Logit Function for AM OTP



6.57 This graph shows that 100% of light vehicle trips are greater than 0 km (as expected); approximately 80% are greater than 5 km; etc.

6.58 Similar logit functions were developed for the other user classes and time periods.

Checking the Synthetic Matrices

6.59 As described in paragraph 6.51, the census matrices were processed in nine steps **a** to **i**. Table 6.16 shows the synthetic matrix totals at several stages: the "Factored Census Matrix" describes the matrix produced in steps **a** and **b**; the "Unobserved Deficit Matrix" is produced by step **c**; the "Furnessed Matrix" arises from steps **d** to **i**; and the "Final Synthetic Matrix" is the outcome of step **j**. The matrix total is expected to change between the first two columns, but after that only the distribution should change, except in the AM (see step **j**).

Table 6.16 – Matrix Totals

Period	Factored Census Matrix Total	Unobserved Deficit Matrix Total	Furnessed Matrix Total	Final Synthetic Matrix Total
AM Peak Hour	2304	2265	2265	2978
IP Peak Hour	2447	2702	2702	2702
PM Peak Hour	3045	2989	2989	2989

6.60 Table 6.16 shows the changes in matrix totals that we would expect, indicating that the synthetic matrix build has worked correctly. Further checks have been carried out below using the Geographical Sectors, to make sure that the distribution of trips is as we would expect at each of the four key stages.

Table 6.17 – AM Factored Unobserved Census Matrix Geographical Sector Movements

	1	2	3	4	5
1	1216	0	0	2	9
2	0	0	0	0	0
3	6	0	99	183	42
4	8	0	69	560	12
5	56	0	32	4	6

6.61 Table 6.17 above shows the movements that arise from the initial processing of the JTW Census within the synthetic matrix build as described in steps **a** and **b** in paragraph 6.51. Therefore the distribution shown above relates to that of the Census data, and is not representative of the combination of each user class.

Table 6.18 – AM Unobserved Deficit Matrix Geographical Sector Movements

	1	2	3	4	5
1	1209	0	0	2	8
2	0	0	0	0	0
3	5	0	97	169	42
4	6	0	67	551	12
5	54	0	32	4	6

6.62 Table 6.18 highlights the changes in the movements once the deficit from the observed data has been calculated for each user class as described in step **c** of paragraph 6.51. The reduction in numbers relates to occurrences where small quantities of unobserved data appear within the observed data, and therefore do not need to be synthesised as well. This could occur when a vehicle has taken an unusual route on its journey, or if a specific zone has parts of it either side of an RSI site.

Table 6.19 – AM Furnessed Matrix Geographical Sector Movements

	1	2	3	4	5
1	1205	0	1	2	11
2	0	0	0	0	0
3	4	0	76	190	44
4	8	0	93	527	5
5	57	0	27	5	8

6.63 Table 6.19 shows that while the matrix totals remain identical, the distribution of trips is clearly different after the Furness process has been undertaken. This is due to the fact that the distribution of trips is now based upon a logit function that represents each specific user class individually, whereas previously the whole distribution has been that of the Census matrix, only being representative of the HBW user class. This represents the process of steps **d** to **i** described in paragraph 6.51.

Table 6.20 – AM Final Synthetic Matrix Sector Movements

	1	2	3	4	5
1	1725	0	1	2	54
2	0	0	0	0	0
3	4	0	92	190	81
4	8	0	93	557	18
5	57	0	27	5	64

6.64 Uniquely to the AM Peak Hour, there is a further change in the matrix during the final processing of the synthetic data, and this is shown in Table 6.20. This arises from the addition of educational trips data as in step **j** in paragraph 6.51. The green cells highlight where these additions have taken place. It should be noted that as the education data was masked down to unobserved movements only, the changes that have taken place are largely intra-sectoral, with the exception of sector 5 as this contains Marshland High School which also has additional trips.

Table 6.21 – IP Factored Unobserved Census Matrix Sector Movements

	1	2	3	4	5
1	1491	0	6	7	52
2	0	0	0	0	0
3	2	0	98	108	57
4	4	0	189	685	8
5	27	0	39	11	8

6.65 Similarly to the AM Peak Hour, Table 6.21 above shows the movements that arise from the initial processing of the JTW Census within the synthetic matrix build as described in steps **a** and **b** in paragraph 6.51. Therefore the distribution shown above relates to that of the Census data, and is not representative of the combination of each user class.

Table 6.22 – IP Unobserved Deficit Matrix Sector Movements

	1	2	3	4	5
1	1472	0	3	7	38
2	0	0	0	0	0
3	1	0	90	98	56
4	4	0	178	674	8
5	17	0	39	11	8

6.66 Table 6.22 highlights the changes in the movements once the deficit from the observed data has been calculated for each user class as described in step **c** of paragraph 6.51. The reduction in numbers relates to occurrences where small quantities of unobserved data appear within the observed data, and therefore do not need to be synthesised as well. This could occur when a vehicle has taken an unusual route on its journey, or if a specific zone has parts of it either side of an RSI site.

Table 6.23 – IP Furnessed Matrix Sector Movements

	1	2	3	4	5
1	1464	0	3	7	45
2	0	0	0	0	0
3	1	0	68	124	51
4	3	0	200	652	7
5	25	0	38	5	7

6.67 Table 6.23 shows that while the matrix totals remain identical, the distribution of trips is clearly different after the Furness process has been undertaken. This is due to the fact that the distribution of trips is now based upon a logit function that represents each specific user class individually, whereas previously the whole distribution has been that of the Census matrix, only being representative of the HBW user class. This represents the process of steps **d** to **i** described in paragraph 6.51.

Table 6.24 – IP Final Synthetic Matrix Sector Movements

	1	2	3	4	5
1	1464	0	3	7	45
2	0	0	0	0	0
3	1	0	68	124	51
4	3	0	200	652	7
5	25	0	38	5	7

6.68 Unlike the AM Peak Hour, there are no further changes in the matrix during the final processing of the synthetic data, and this is shown in Table 6.24.

Table 6.25 – PM Factored Unobserved Census Matrix Sector Movements

	1	2	3	4	5
1	1634	0	8	10	70
2	0	0	0	0	0
3	1	0	100	82	63
4	3	0	239	748	7
5	17	0	42	13	9

6.69 As for both the AM and Inter Peak Hours, Table 6.25 shows the movements that arise from the initial processing of the JTW Census within the synthetic matrix build as described in steps **a** and **b** in paragraph 6.51 Therefore the distribution shown above relates to that of the Census data, and is not representative of the combination of each user class.

Table 6.26 – PM Unobserved Deficit Matrix Sector Movements

	1	2	3	4	5
1	1623	0	6	8	67
2	0	0	0	0	0
3	0	0	97	79	63
4	3	0	222	736	7
5	13	0	42	13	9

6.70 Table 6.26 highlights the changes in the movements once the deficit from the observed data has been calculated for each user class as described in step **c** of paragraph 6.51. The reduction in numbers relates to occurrences where small quantities of unobserved data appear within the observed data, and therefore do not need to be synthesised as well. This could occur when a vehicle has taken an unusual route on its journey, or if a specific zone has parts of it either side of an RSI site.

Table 6.27 – PM Furnessed Matrix Sector Movements

	1	2	3	4	5
1	1617	0	4	9	73
2	0	0	0	0	0
3	1	0	68	115	55
4	3	0	251	706	8
5	20	0	43	5	9

6.71 Table 6.27 shows that while the matrix totals remain identical, the distribution of trips is clearly different after the Furness process has been undertaken. This is due to the fact that the distribution of trips is now based upon a logit function that represents each specific user class individually, whereas previously the whole distribution ahs been that of the Census matrix, only being representative of the HBW user class. This represents the process of steps **d** to **i** described in paragraph 6.51.

Table 6.28 – PM Final Synthetic Matrix Sector Movements

	1	2	3	4	5
1	1617	0	4	9	73
2	0	0	0	0	0
3	1	0	68	115	55
4	3	0	251	706	8
5	20	0	43	5	9

6.72 Similarly to the Inter Peak Hour, there are no further changes in the matrix during the final processing of the synthetic data, and this is shown in Table 6.28.

6.73 It should be noted that there is no deviation in any of the three periods between the input trip ends and the output trip ends after the Furness process for any zone. This shows that the Furness process was able to accurately distribute the trips as desired.

6.74 By using the Observation Sectors, it can be shown clearly that there is no synthetic data in the observed areas of the matrix. These are shown below, where highlighted cells indicate observed movements:

Table 6.29 – AM Peak Hour Final Synthetic Matrix Observation Sector Movements

	1	2	3	4	5	6	7	8	9	10
1	1684	0	0	72	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	27	0	0	0	0	51	0	0
4	64	0	0	15	19	0	0	0	0	0
5	0	0	0	109	86	0	0	0	0	0
6	0	0	0	0	0	50	0	0	0	0
7	0	0	0	0	0	0	67	25	0	0
8	0	0	88	0	0	0	463	143	0	11
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	2	0	0

Table 6.30 – IP Hour Final Synthetic Matrix Observation Sector Movements

	1	2	3	4	5	6	7	8	9	10
1	1419	0	0	61	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	17	0	0	0	0	58	0	0
4	53	0	0	1	5	0	0	0	0	0
5	0	0	0	21	103	0	0	0	0	0
6	0	0	0	0	0	57	0	0	0	0
7	0	0	0	0	0	0	143	361	0	0
8	0	0	64	0	0	0	121	201	0	5
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	10	0	0

Table 6.31 – PM Peak Hour Final Synthetic Matrix Observation Sector Movements

	1	2	3	4	5	6	7	8	9	10
1	1563	0	0	84	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	19	0	0	0	0	70	0	0
4	61	0	0	2	3	0	0	0	0	0
5	0	0	0	32	109	0	0	0	0	0
6	0	0	0	0	0	66	0	0	0	0
7	0	0	0	0	0	0	111	553	0	0
8	0	0	59	0	0	0	62	176	0	4
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	14	0	0

6.75 The above tables clearly demonstrate that there have been no trips synthesised over observed movements, therefore showing that the synthetic and observed data does not overlap and can be simply added to form a total matrix.

Compiling the Full Prior Matrices

6.76 Paragraphs 6.3 to 6.75 above describe the steps that were taken to generate the observed and synthetic matrices for each user class and time period. As has been noted, these matrices have been created in such a way that the observed matrices contain only the observed movements and a portion of the partially observed movements, and the synthetic matrices contain only the unobserved movements and the other portion of the partially observed movements. Therefore the two components can simply be added together to produce the Full Matrices.

6.77 After the matrices had been compiled, there were four more stages to the matrix build process: splitting the last few zones according to their entry point onto the network, applying an annualisation factor, including the OGV2 matrices at RSI Site 7 from the EERM, and applying seeding to the south-western peripheral part of the network.

Splitting Zones

6.78 As explained in paragraph 2.3, no route choice is available at the centroid connector level – every zone is connected to a single point on the network. This means that some geographical zones have been split according to the point at which they entered the network – or, more specifically, the point at which they were observed on the network.

6.79 In most cases, the point at which a trip was observed on the network is enough identification to determine where it entered the network, but in four cases, this information was not enough. Consequently, these four zones (214, 302, 303 and 305) have been split using turning count data to determine the proportion that entered along each route, for each user class and time period.

Annualisation

6.80 The penultimate stage in the matrix building process was to factor each matrix to an average day. All new data collected for this project was dated June 2008; all other data was factored to this level during previous stages of the processing. This final stage is to factor the matrices to an Annual Average Day, using TRADS data to calculate a factor. The chosen year is September

2007 to August 2008, as this is the latest full year for which data was available. Table 6.32 details the figures used for the calculation of the factor.

Table 6.32 – Annualisation Factor Calculation

	12 Hour AWT
June 2008	61,982
September 2007 to August 2008 Average	59,661
Factor	0.962062

Adding the Site 7 OGV2s

6.81 The final stage was to add the EERM data for OGV2s on the A17, provided by Faber Maunsell.

6.82 The data was supplied in the form of Select Link trip matrices from the EERM zone plan, selected at RSI Site 7. One matrix was supplied for each time period and each direction. The following steps were taken to process the data:

- The matrices were converted to the WATS zone plan, by using MapInfo to calculate the conversion factors between each zone of the two zone plans, and using SATURN to apply the conversion.
- The total size of each individual matrix was analysed and a factor calculated to convert the matrix size to be equal to the count at RSI Site 7 for the OGV2 user class only (UC6).
- These new factored matrices were then individually assigned to the network.
- Select nodes were then undertaken on each individual assignment to select through trips only. This was done by selecting all four nodes that form the A17 in the model, in the relevant eastbound or westbound direction to obtain the final trips making that full movement.
- These select link results were then converted to matrices to give final OGV2 matrices for through trips along the A17 in both Eastbound and Westbound directions.
- Finally, these matrices were added directly to the main matrix during the final stage of the matrix build to account for the missing interview data.

A141/A47 Seeding

6.83 The calibration of the gravity model is based on willingness to travel a particular distance between zones, irrespective of the nature and location of the origin and destination. For the majority of the gravity model, this matches its purpose and so generates the appropriate levels of trips. However, in the south-western corner of the model, this means that the synthetic matrix contains a relatively large number of trips making the movement between zones connected on the A141 (representing the area surrounding March) and the Guyhirn / Gull Road area and a relatively small number making the long distance trips from March to Peterborough and beyond.

6.84 In order to correct the balance between short- and long-distance trips in this area of the network, trips from the A141 to the A47W (and vice versa) have been seeded into the prior matrices.

6.85 The methodology that has been adopted to apply the seeding is as follows:

- Assign the prior matrix to the network and calculate the deficits in vehicles making the required movements (A47W to A141, referred to as "eastbound", and A141 to A47W, referred to as "westbound") at the A141/A47W roundabout.
- Within SATURN, carry out a "select node" on the series of nodes between Hobbs Lots and the western extreme of the modelled A47 in both directions, and save these results to a matrix per direction.

- Factor these matrices so that their totals are equal to the deficits calculated in step (a).
- Add these factored matrices to the existing prior matrix, to seed trips in proportion to the existing trips making the required movements, to the levels indicated by the traffic count.

6.86 The following tables show the values that were calculated from the above process.

Table 6.33 – Eastbound A141/A47 Seeding

Period	Deficit	Select Link Matrix Total	Factor
AM	108	15.32	7.05
IP	121	55.23	2.19
PM	196	56.78	3.45

Table 6.34 – Westbound A141/SA47 Seeding

Period	Deficit	Select Link Matrix Total	Factor
AM	235	41.14	5.71
IP	No Deficit	N/A	N/A
PM	3	29.61	0.10

Checking the Prior Matrices

6.87 The majority of checks undertaken on the prior matrices were conducted when in separate observed and synthetic states. The first check that should be undertaken on the full prior matrix is to ensure that no data was lost during the combination of the observed data and synthetic data. The table below shows the matrix totals of the final observed, synthetic and prior matrices:

Table 6.35 – Prior Matrix Compilation Checks

Peak Hour	Observed Matrix Total	Synthetic Matrix Total	Sum of Observed and Synthetic Matrices	Prior Matrix Total
AM	6606	2978	9584	9584
IP	6209	2702	8911	8911
PM	7306	2989	10296	10296

6.88 Table 6.35 shows that there have been no occurrences of lost trips during the compilation of the observed and synthetic data.

6.89 The next check has been to ensure that during the zone splitting process there is no loss of data. Table 6.36 therefore compares the matrix totals before and after the zone splitting process.

Table 6.36 – Prior Matrix Zone Splitting Checks

Peak Hour	Matrix Total Pre Zone Splitting	Matrix Total Post Zone Splitting
AM	9584	9584
IP	8911	8911
PM	10296	10296

6.90 Once more it has been shown that no trips are lost during this stage of the process. The next check has been undertaken to ensure that the relative change in matrix total due to annualisation is of the same factor as the calculated annualisation factor. Table 6.37 below shows these changes:

Table 6.37 – Prior Matrix Annualisation Checks

Peak Hour	Pre Annualisation Matrix Total	Post Annualisation Matrix Total	Actual Factor Change	Annualisation Factor
AM	9584	9225	0.962602	0.962602
IP	8911	8577	0.962602	0.962602
PM	10296	9911	0.962602	0.962602

6.91 It has been clearly shown that the matrix totals have changed in line with the annualisation factors that were intended to be applied to the matrix, therefore ensuring that the desired result was obtained.

6.92 The penultimate check that has been undertaken is to ensure that the addition of the OGV2 trips derived from the EERM select links provided by Faber Maunsell has only increased the matrix consistently with the size of the additional trips to be added. This is in Table 6.38 detailed below:

Table 6.38 – Prior Matrix OGV2 Trip Addition Checks

Peak Hour	Pre OGV2 Trip Addition Matrix Total	OGV2 Trips to be Added	Sum of Pre OGV2 Trips and Additional OGV2 Trips	Post Annualisation Matrix Total
AM	9225	183	9408	9408
IP	8577	214	8791	8791
PM	9911	145	10056	10056

6.93 This table shows that the addition has been carried out satisfactorily.

6.94 The final check was to make sure that the seeded trips were added correctly – i.e. that the factored “select node” matrices plus the annualised prior matrix equals the desired totals. Table 6.39 confirms that this is the case, completing the process of checking the prior matrices.

Table 6.39 – Seeding Combination

Period	Eastbound to be Seeded	Westbound to be Seeded	Total to be Seeded	Post Annualisation Matrix Total	Post Annualisation Plus Seeding Total	Final Prior Matrix Total
AM	108	235	343	9408	9751	9751
IP	121	0	121	8791	8912	8912
PM	196	3	199	10056	10255	10255

7. Local Highway Model – Calibration and Validation Procedures

7.1 Model calibration refers to the process of adjusting and confirming values of the various parameters in the network, and correcting origin-destination movements in the trip matrices, as necessary to improve the performance of the model. This is achieved by making use of the various data collected during the study.

7.2 Model validation seeks to demonstrate that the calibrated model correctly reproduces observed conditions when applied in the base year situation. Ideally, it should make use of data which is not used directly in the model calibration.

Data Utilised

7.3 During the calibration and validation of the model, the following data sources were used:

- RSI Location MCCs;
- MCTCs;
- Journey Time Surveys;
- Car Park Interview entrance and exit counts;
- CCC Traffic Signal Data;
- Highway Network Inventory Surveys.

Calibration Counts

7.4 All counts that had not been designated as Validation counts were used within the Matrix Estimation by Maximum Entropy (ME2) process to calibrate the model, by inclusion in the SATURN 77777 card. Count data was factored to an annual average weekday for 2008 (in the same way as any data included in the matrix build was factored), and PCU factors were applied to the relevant vehicle classifications to ensure consistency with the matrix build.

Assignment Parameters

7.5 Model assignments were carried out using a Wardrop User Equilibrium procedure, which seeks to minimise travel costs for all vehicles in the network. The assignment is based on minimum generalised cost routes where the generalised cost is defined as a linear combination of time and distance:

$$\text{Generalised cost} = \beta \times \text{time} + \alpha \times \text{distance}$$

7.6 Full details of these parameters can be found in paragraphs 4.7 to 4.29

Model Convergence Guidelines

7.7 The following guidance was applied to control the convergence of the model:

7.8 “Current guidance suggests that the %GAP value should be less than 0.1% for a model to be considered converged. However, given the size of the model we would recommend a value much lower than this to be used, aiming for a value of 0.02%.”

7.9 The Traffic Appraisal in Urban Areas (DMRB Vol. 12.2.1.4) defines ‘Gap’ as the measure of convergence between the final SATASS / SATSIM loop. It is the difference between costs on the assigned routes and those along the minimum cost routes, as a percentage of the cost routes.

7.10 In addition to this, DMRB advice recommends the following criteria for Wardrop User Equilibrium assignment to ensure a satisfactory model convergence:

- ‘Delta’ is the measure of convergence of the final assignment to ensure that the alternative routes used in the assignment process do not differ significantly from the final minimum cost. It is the difference between costs on the various multiple assigned routes and those along the final minimum cost routes, as a percentage of the minimum cost routes. Its value should be less than 1%.
- Flow Change Stability (P) is the measure of convergence of assignment-simulation loops. It is the percentage of links where assigned flows change by less than 5% between successive assignment simulation loops. Assignment model iterations should continue until at least four successive values of ‘P’ greater than 90% have been obtained.

Calibration Procedure

7.11 The calibration procedure involved a number of tasks, all of which were designed to ensure that the model adequately reproduced observed traffic flows and travel times in the study area. These tasks included:

- The verification of speed flow curves in the model to represent the operation conditions of the local road network;
- Checking junction capacities and gap acceptance values to represent typical operating conditions;
- Ensuring that traffic counts that were used within the model were valid, did not conflict with neighbouring counts, and were representative of normal traffic conditions;
- Correlating the locations of traffic signals with the journey time graphs, to check that the observed delays being caused by the traffic signals are replicated correctly within the model; and
- Use of a matrix estimation process (ME2) to best ‘fit’ the prior trip matrices to observed traffic flows on the study area cordon and observed link and turning flows within the study area.

Speed Flow Curves

7.12 In SATURN, delays and queues in the simulation network occur at junctions. However, speed flow curves can also be allocated to simulation links in order to represent delays due to road conditions. In the buffer network, delays and queues result only from speed flow curves assigned to the links. The speed flow curves that have been used in this model are presented in Chapter 5 in Table 5.1.

Model Validation

7.13 During the latter stages of the model development, both the calibration and validation checks were also incorporated into the processing of the model output data. This primarily consisted of comparing observed and assigned link flows, and journey times along the specified routes. The calibration and validation comparison criteria used the guidelines as set out in the DMRB.

Assignment Acceptability Guidelines

7.14 The assignment acceptability guidelines are set out in the DMRB. These are reproduced in Table 7.1.

7.15 The observed flow and screenline flow criteria in Table 7.1 relate to total link flows, i.e. all vehicles, and should not be used when comparing partial link flows, e.g. heavy vehicles.

Table 7.1 – DMRB Assignment Acceptability Guidelines

Criteria and Measures	Acceptability Guideline
Assigned hourly flows compared with observed flows	
Individual flows within 100 vehicles per hour (vph) for flows < 700 vph	At least 85% of cases
Individual flows within 15% for flows 700-2,700 vph	At least 85% of cases
Individual flows within 400 vph for flows > 2,700 vph	At least 85% of cases
Total Screenline flows (normally > 5 links) to be within 5%	All (or nearly all) Screenlines
GEH Statistic: Individual flows GEH < 5	At least 85% of cases
GEH Statistic: Screenline totals GEH < 4	All (or nearly all) Screenlines
Modelled journey times compared with observed times	
Times within 15% (or 1 minute if higher)	At least 85% of routes

The GEH Statistic

7.16 The GEH (Geoffrey E Havers) Statistic included in Table 7.1 above is a generally accepted value used as an indicator of 'goodness of fit', i.e. the extent to which modelled flows match corresponding observed values. The GEH Statistic is a form of the chi-squared statistic. It is described in Traffic Appraisal in Urban Areas - Chapter 4 (DMRB Vol. 12a). It is defined as:

$$GEH = \sqrt{\frac{(M-C)^2}{1/2(M+C)}}$$

where M = modelled flow;

C = observed flow (or count).

7.17 Based on DMRB guidance, a GEH value of less than 5 per link indicates a satisfactory fit between independent observed counts and modelled flows, if achieved for 85% of individual links. For screenlines or other combinations of links, a GEH value of 4 or less per screenline is required in all or nearly all cases.

Validation Count List

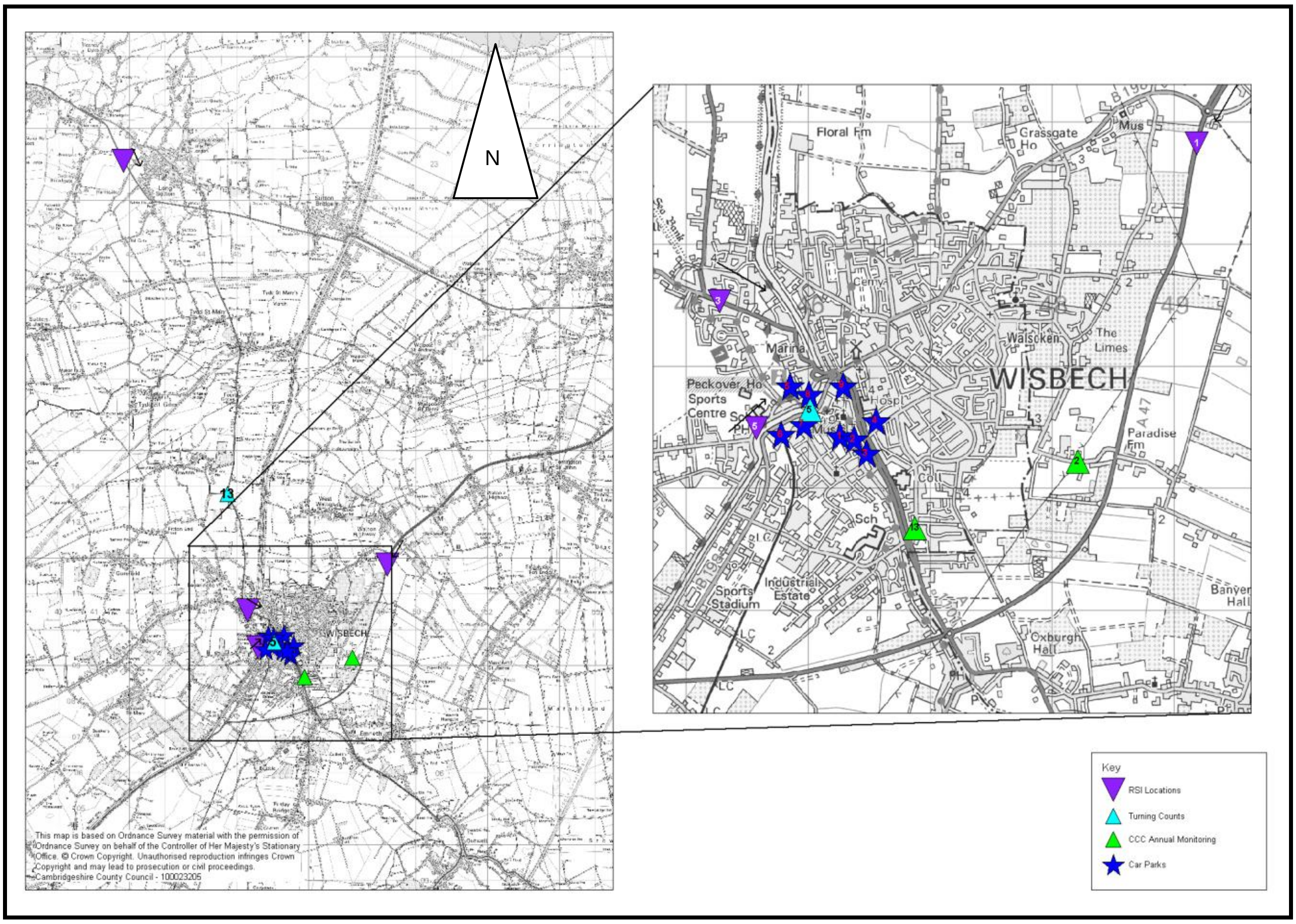
7.18 A set of counts were used as an independent validation check of the model. These counts did not form part of the SATURN 77777 card. The table below lists the counts that were identified as validation counts:

Table 7.2 – WATS Validation Counts

Count Name	Count Location
RSI Site 1	A47 between B198 Lynn Road and Broad End Road
RSI Site 2	A47 between B198 Cromwell Road and A47/A141 Junction
RSI Site 3	A1101 Leverington Road between Dowgate Road and Harecroft Road
RSI Site 5	North brink between Barton Road and Chapel Road
RSI Site 7	A17 between Gedney and Long Sutton
Annual Monitoring Count 2	Broad End Road, West of the A47
Annual Monitoring Count 13	Ramnoth Road
Turning Count 5	Town Bridge
Turning Count 13	A1101 Sutton Road/Little Ramper Junction
Car Park 1 Entrance and Exit Count	Church Terrace/Alexandra Road
Car Park 2 Entrance and Exit Count	West Street
Car Park 3 Entrance and Exit Count	Onyx Court
Car Park 4 Entrance and Exit Count	Park Street
Car Park 5 Entrance and Exit Count	Chapel Road
Car Park 6 Entrance and Exit Count	Coalwharf Road
Car Park 7 Entrance and Exit Count	Queen Street
Car Park 8 Entrance and Exit Count	Old Market
Car Park 9 Entrance and Exit Count	Horsefair

7.19 These locations are also shown in Figure 7.1.

Figure 7.1 – Validation Count Locations



Analysis of Journey Time Survey Data

7.20 A series of Journey Time Surveys were undertaken for this study, as described in Chapter 2. The table below highlights the number of observed runs that were used to obtain the average journey time to compare against the modelled journey time. Surveys undertaken between 07:00 and 10:00 were used for the AM Peak Hour, 10:00 to 16:00 for the Inter Peak Hour and 16:00 to 19:00 for the PM Peak Hour. Anomalous results were removed along with any data that was surveyed outside of the time frames mentioned above.

Table 7.3 – Number of Journey Times Used

Journey Time	AM	IP	PM
Route 1: SB	6	7	6
Route 1: NB	5	7	6
Route 2: NB	5	7	6
Route 2: SB	4	6	6
Route 3: NB	9	7	7
Route 3: SB	8	9	7
Route 4: SB	6	8	7
Route 4: NB	6	8	7

7.21 It is important to check the data and discard anomalous runs as these can have a significant effect on the calculated average value, as demonstrated in Figure 7.2. Once the two anomalous runs (Run 3 and Run 9) have been removed from the calculations, the average journey time reduces from a total of 11:11 to 10:42, and the reduced variability can clearly be seen in Figure 7.3.

Figure 7.2 – Inter Peak Hour Journey Time Results with Anomalous Data

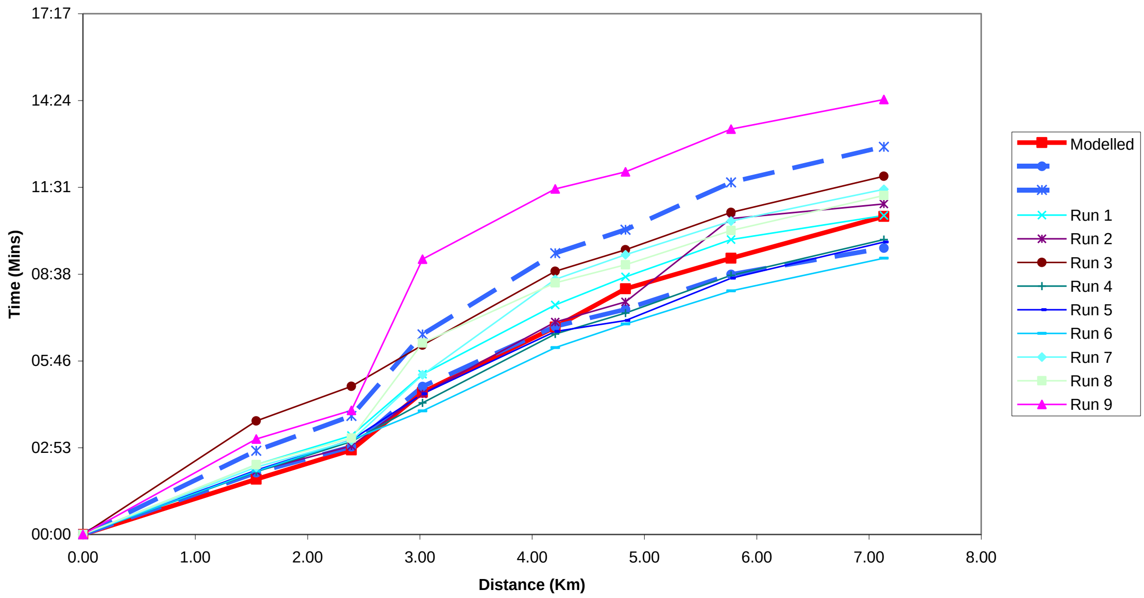
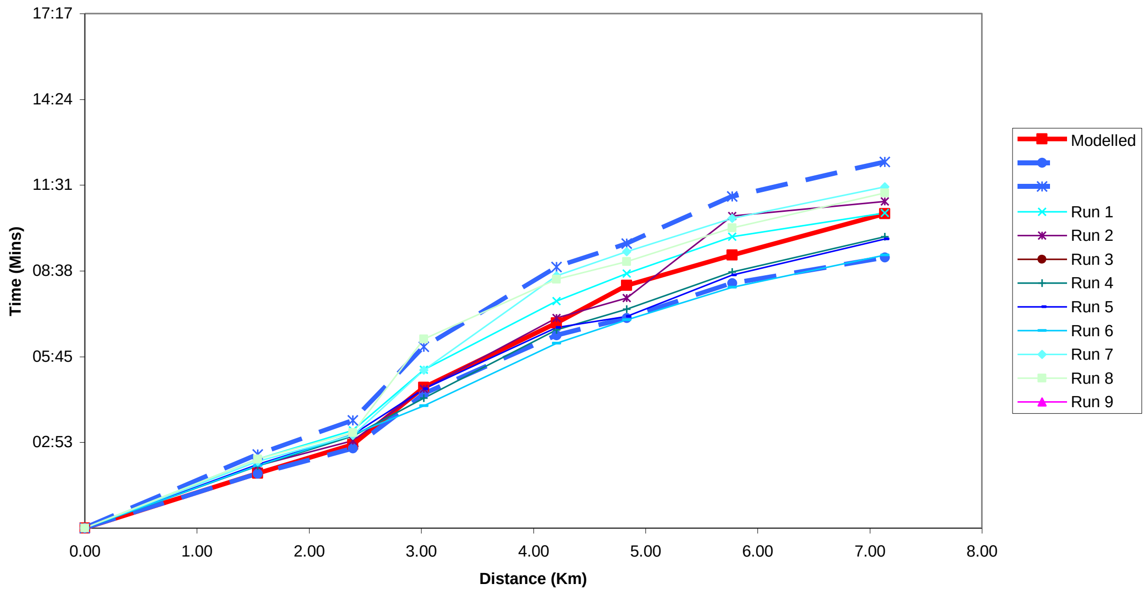


Figure 7.3 – Inter Peak Hour Journey Time Results without Anomalous Data



8. Local Highway Model – Calibration and Validation Results

8.1 This chapter presents the results of the calibration and validation exercises undertaken for each of the three modelled time periods: AM Peak Hour, Inter Peak Hour and PM Peak Hour. The performance of each model has been assessed against a number of benchmarks.

Prior Assignment Summary

8.2 Initial assignments of the matrices were undertaken without running the ME2 process. A check against the DMRB Assignment Acceptability Guidelines indicated that the assignment had 84%, 87% and 85% of validation counts with a GEH of less than 5 in the AM Peak, Inter Peak and PM Peak models respectively, whilst 98%, 98% and 97% of validation counts in the AM Peak, Inter Peak and PM Peak models passed the DMRB flow criteria test. The Journey Times met the validation criteria in 8, 7 and 8 cases (out of 8 in total) in the AM Peak, Inter Peak and PM Peak models respectively.

8.3 The guidelines suggest that 85% of links should have a GEH of less than 5, and that 85% of the Journey Times should pass.

8.4 Table 8.1 to Table 8.3 show the summary of the screenline flows from the prior assignment. The screenlines are composed of a mixture of Validation and Calibration counts, and have more stringent passing criteria than individual counts. Therefore, although the validation summaries of individual counts given in paragraph 8.2 are very good, the screenlines do not necessarily follow suit.

8.5 Table 8.4 to Table 8.6 and Figure 8.1 to Figure 8.3 give a summary of the Journey Time validation of the prior assignment.

Table 8.1 – AM Peak Hour Prior Assignment Screenline Flows

Screenline	Total Screenline Flow from Count Data	Prior Assignment Total	Difference	Percentage Difference	GEH	DMRB Flow	DMRB GEH
Central Screenline	2932	2446	487	17%	9.4	✘	✘
Northern Screenline	1910	1618	292	15%	7.0	✘	✘
Outer Southern Screenline	4470	4335	135	3%	2.0	✓	✓
Western Screenline	1969	1896	72	4%	1.6	✓	✓
Cordon	7473	7009	464	6%	5.5	✘	✘

Table 8.2 – Inter Peak Hour Prior Assignment Screenline Flows

Screenline	Total Screenline Flow from Count Data	Prior Assignment Total	Difference	Percentage Difference	GEH	DMRB Flow	DMRB GEH
Central Screenline	2507	1996	512	20%	10.8	✘	✘
Northern Screenline	1592	1467	125	8%	3.2	✘	✓
Outer Southern Screenline	4018	3901	116	3%	1.8	✓	✓
Western Screenline	1830	1662	168	9%	4.0	✘	✘
Cordon	6705	6216	489	7%	6.1	✘	✘

Table 8.3 – PM Peak Hour Prior Assignment Screenline Flows

Screenline	Total Screenline Flow from Count Data	Prior Assignment Total	Difference	Percentage Difference	GEH	DMRB Flow	DMRB GEH
Central Screenline	2921	2465	456	16%	8.8	✘	✘
Northern Screenline	1998	1686	312	16%	7.3	✘	✘
Outer Southern Screenline	4978	4795	183	4%	2.6	✓	✓
Western Screenline	1853	1832	20	1%	0.5	✓	✓
Cordon	7873	7454	419	5%	4.8	✘	✘

Figure 8.1 – AM Peak Hour Prior Assignment Journey Time Summary

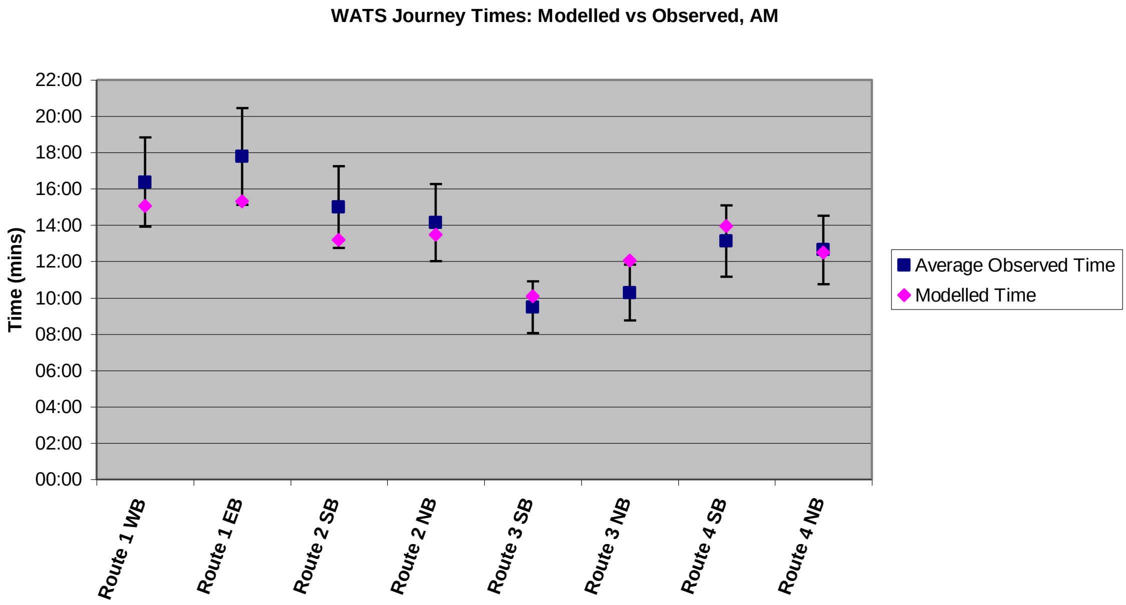


Table 8.4 – AM Peak Hour Prior Assignment Journey Time Summary

Route	Modelled Time	Mean Observed Time	Difference	Percentage Difference	Pass or Fail DMRB Criteria
Route 1: SB	00:15:03	00:16:22	00:01:19	8%	✓
Route 1: NB	00:15:19	00:17:47	00:02:28	14%	✓
Route 2: NB	00:13:11	00:15:01	00:01:50	12%	✓
Route 2: SB	00:13:28	00:14:09	00:00:41	5%	✓
Route 3: NB	00:10:05	00:09:29	00:00:36	-6%	✓
Route 3: SB	00:12:03	00:10:17	00:01:46	-17%	✗
Route 4: SB	00:13:56	00:13:07	00:00:49	-6%	✓
Route 4: NB	00:12:30	00:12:38	00:00:08	1%	✓

Figure 8.2 – Inter Peak Hour Prior Assignment Journey Time Summary

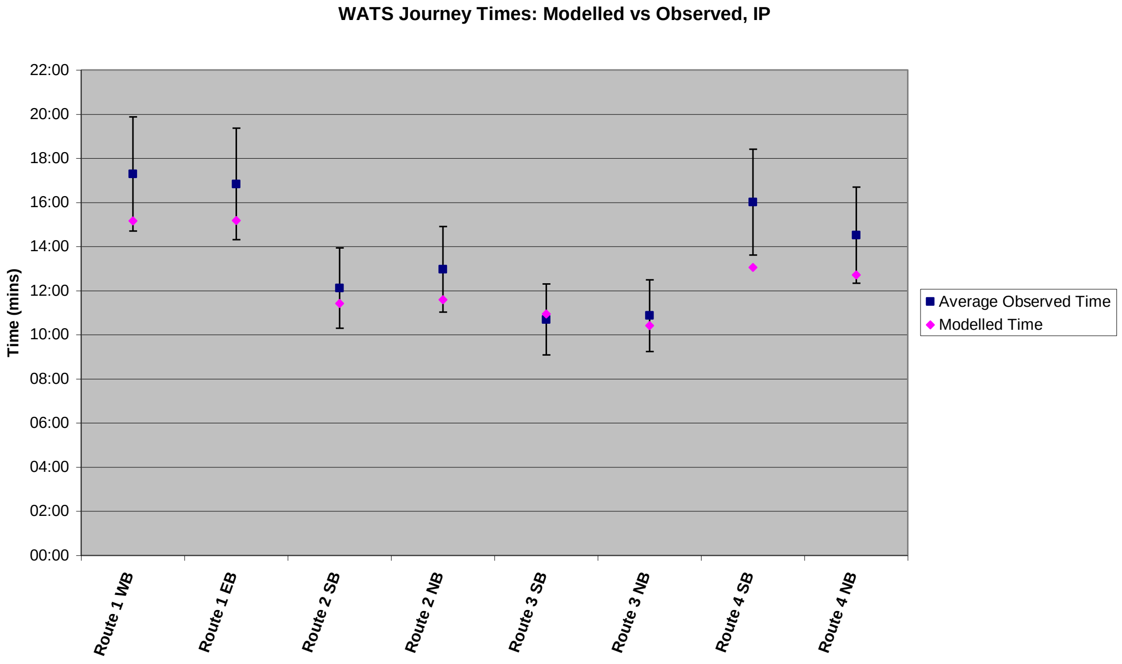


Table 8.5 – Inter Peak Hour Prior Assignment Journey Time Summary

Route	Modelled Time	Mean Observed Time	Difference	Percentage Difference	Pass or Fail DMRB Criteria
Route 1: SB	00:15:10	00:17:18	00:02:08	12%	✓
Route 1: NB	00:15:11	00:16:52	00:01:41	10%	✓
Route 2: NB	00:11:25	00:12:07	00:00:42	6%	✓
Route 2: SB	00:11:35	00:12:59	00:01:24	11%	✓
Route 3: NB	00:10:56	00:10:43	00:00:13	-2%	✓
Route 3: SB	00:10:25	00:10:53	00:00:28	4%	✓
Route 4: SB	00:13:03	00:16:00	00:02:57	18%	✗
Route 4: NB	00:12:43	00:14:30	00:01:47	12%	✓

Figure 8.3 – PM Peak Hour Prior Assignment Journey Time Summary

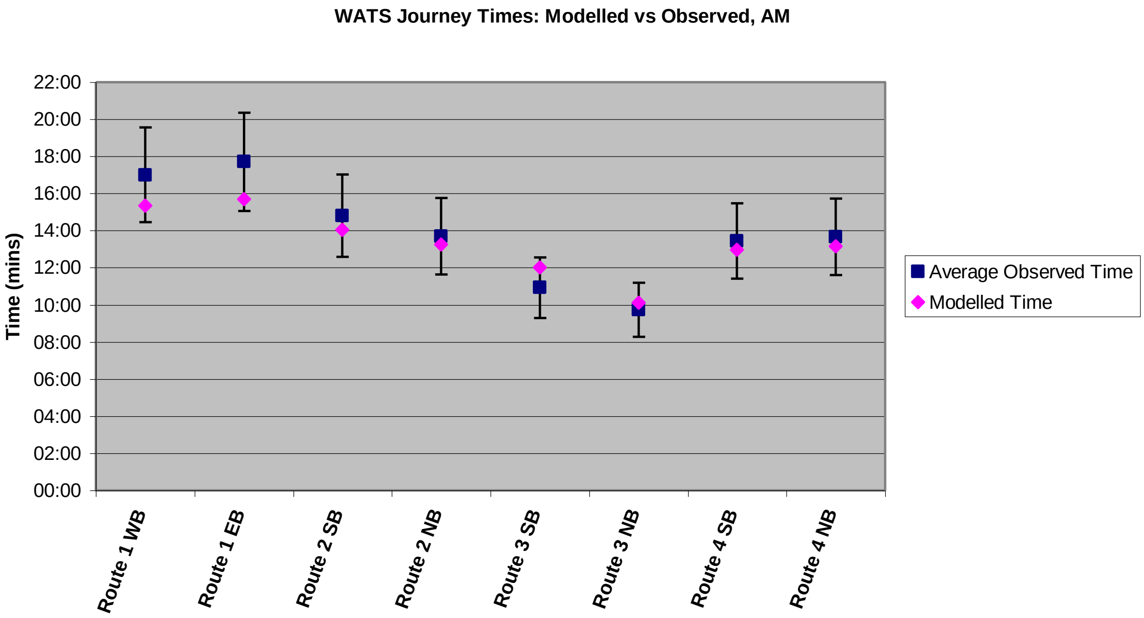


Table 8.6 – PM Peak Hour Prior Assignment Journey Time Summary

Route	Modelled Time	Mean Observed Time	Difference	Percentage Difference	Pass or Fail DMRB Criteria
Route 1: SB	00:15:21	00:16:59	00:01:38	10%	✓
Route 1: NB	00:15:41	00:17:42	00:02:01	11%	✓
Route 2: NB	00:14:02	00:14:47	00:00:45	5%	✓
Route 2: SB	00:13:15	00:13:42	00:00:27	3%	✓
Route 3: NB	00:12:00	00:10:56	00:01:04	-10%	✓
Route 3: SB	00:10:07	00:09:46	00:00:21	-4%	✓
Route 4: SB	00:12:58	00:13:27	00:00:29	4%	✓
Route 4: NB	00:13:10	00:13:40	00:00:30	4%	✓

Post ME2 Assignment Summary

8.6 Chapter 6 of this report has described the process of building the Prior matrices, from observed and synthetic data. Whilst every effort has been made to ensure these are as accurate as possible, it is acknowledged that data was not available to inform all movements, and the synthetic data is only an 'initial guess'. Therefore, the ME2 procedure has been used within SATURN to better inform the synthetic parts of the matrix, using count data as a basis. During this procedure, the observed parts of the matrix have been 'frozen', and therefore will not be altered.

8.7 The SATURN matrix estimation process has been set up to complete four iterations of the SATPIJA, SATME2 and assignment loop. Within each iteration, SATPIJA and SATME2 are run on each user class separately – for this purpose, the count data had to be split into each user class. Proportions from the observed RSI data were used to factor the count data down to each user class, where the vehicle split information from the count was not sufficient. Further details on the calibration and validation procedures are given in Chapter 0.

Observed and Assigned Traffic Flow Comparisons

8.8 The final validation assignment was compared with observed flows at all sites along the four screenlines and one cordon. The modelled flows were generated using SATURN version 10.8.21.

8.9 A summary of the output for the screenlines and cordon in each time period is presented below; full details can be found in Appendix A.

8.10 A check against the DMRB Assignment Acceptability Guidelines indicated that in the final validation assignment, out of all the Validation Counts, all three time periods exceeded the targets of 85% of links having a GEH value of less than 5 and 85% of links passing the DMRB flow criteria check.

8.11 In the AM Peak, 100% of links have a GEH value of less than 5, with 90% of links passing the DMRB flow criteria test. In the Inter Peak, 100% of links have a GEH value of less than 5, and 92% of links passed the DMRB flow criteria test. Finally, in the PM Peak, 98% of links have a GEH value of less than 5, and 89% of links passed the DMRB flow criteria test.

Table 8.7 – AM Peak Hour Final Assignment Screenline Summary

Screenline	Total Screenline Flow from Count Data	Prior Assignment Total	Difference	Percentage Difference	GEH	DMRB Flow	DMRB GEH
Central Screenline	2932	2811	122	4%	2.3	✓	✓
Northern Screenline	1910	1746	165	9%	3.9	✗	✓
Outer Southern Screenline	4470	4480	-10	0%	0.1	✓	✓
Western Screenline	1969	1792	176	9%	4.1	✗	✗
Cordon	7473	7173	300	4%	3.5	✓	✓

Table 8.8 – AM Peak Hour Count Validation Summary

No. of Validation Counts	No. Passing DMRB Flow	% Passing	No. Passing DMRB GEH	% Passing	DMRB Flow	DMRB GEH
63	63	100%	57	90%	✓	✓

Table 8.9 – Inter Peak Hour Final Assignment Screenline Summary

Screenline	Total Screenline Flow from Count Data	Prior Assignment Total	Difference	Percentage Difference	GEH	DMRB Flow	DMRB GEH
Central Screenline	2507	2402	106	4%	2.1	✓	✓
Northern Screenline	1592	1493	100	6%	2.5	✗	✓
Outer Southern Screenline	4018	4177	-159	-4%	2.5	✓	✓
Western Screenline	1830	1658	172	9%	4.1	✗	✗
Cordon	6996	6537	168	3%	2.1	✓	✓

Table 8.10 – Inter Peak Hour Count Validation Summary

No. of Validation Counts	No. Passing DMRB Flow	% Passing	No. Passing DMRB GEH	% Passing	DMRB Flow	DMRB GEH
62	62	100%	57	92%	✓	✓

Table 8.11 – PM Peak Hour Final Assignment Screenline Summary

Screenline	Total Screenline Flow from Count Data	Prior Assignment Total	Difference	Percentage Difference	GEH	DMRB Flow	DMRB GEH
Central Screenline	2921	2941	-20	-1%	0.4	✓	✓
Northern Screenline	1998	1720	277	14%	6.4	✗	✗
Outer Southern Screenline	4978	5113	-135	-3%	1.9	✓	✓
Western Screenline	1853	1807	45	2%	1.1	✓	✓
Cordon	7873	7796	78	1%	0.9	✓	✓

Table 8.12 – PM Peak Hour Count Validation Summary

No. of Validation Counts	No. Passing DMRB Flow	% Passing	No. Passing DMRB GEH	% Passing	DMRB Flow	DMRB GEH
62	61	98%	55	89%	✓	✓

Journey Time Comparisons

8.12 A graphical summary of the overall modelled and observed journey time comparison for each route in the AM Peak, along with ± 15% indicators, is shown in Figure 8.4. Similarly, Figure 8.5 shows a summary of the Inter Peak journey time results and Figure 8.6 shows the PM Peak. Detailed comparisons of the observed and modelled journey times of all three periods against the upper and lower 95% confidence limits of the observed times are also provided in Appendix A.

8.13 The results in Table 8.13 to Table 8.15 indicate that the modelled journey times in all three time periods meet the DMRB validation criteria, with at least 7 out of 8 (88%) modelled journey times being within ± 15% or ± 1 minute of the mean observed time.

8.14 The only routes that fail validation are Route 3 southbound in the AM Peak Hour and Route 4 eastbound in the Inter Peak: the latter was highlighted in the Data Collection Report as being an unexpected observation, since it is unusual for the Inter Peak journey time to be slower than the AM Peak or PM Peak. It was hypothesised in the Data Collection Report that the reason for the slow observation was unfamiliarity with the roads – this is something that cannot be modelled within SATURN, and so this route cannot be expected to validate in the Inter Peak period.

Figure 8.4 – AM Peak Hour Final Assignment Journey Time Summary

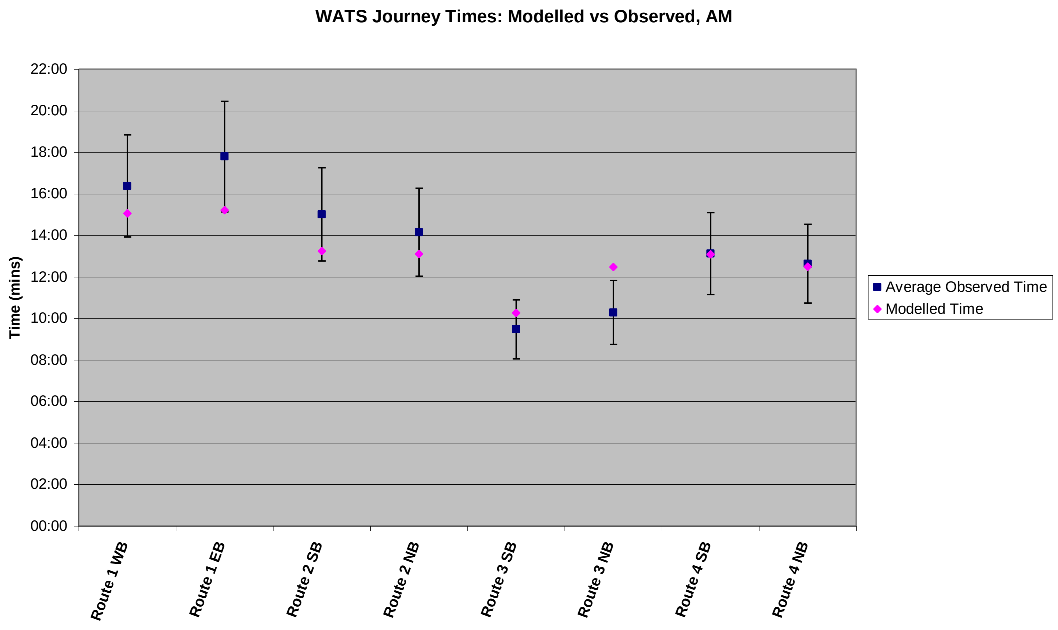


Table 8.13 – AM Peak Hour Final Assignment Journey Time Summary

Route	Modelled Time	Mean Observed Time	Difference	Percentage Difference	Pass or Fail DMRB Criteria
Route 1: SB	00:15:03	00:16:22	00:01:19	8%	✓
Route 1: NB	00:15:13	00:17:47	00:02:34	14%	✓
Route 2: NB	00:13:14	00:15:01	00:01:47	12%	✓
Route 2: SB	00:13:06	00:14:09	00:01:03	7%	✓
Route 3: NB	00:10:16	00:09:29	00:00:47	-8%	✓
Route 3: SB	00:12:28	00:10:17	00:02:11	-21%	✗
Route 4: SB	00:13:05	00:13:07	00:00:02	0%	✓
Route 4: NB	00:12:29	00:12:38	00:00:09	1%	✓

Figure 8.5 – Inter Peak Hour Final Assignment Journey Time Summary

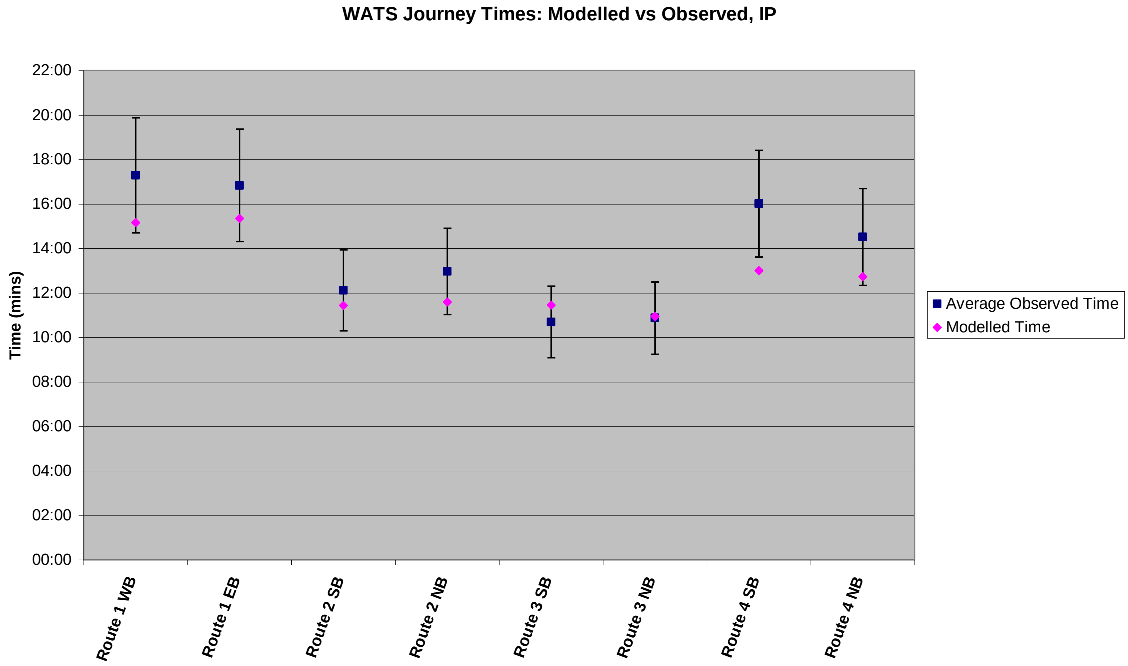


Table 8.14 – Inter Peak Hour Final Assignment Journey Time Summary

Route	Modelled Time	Mean Observed Time	Difference	Percentage Difference	Pass or Fail DMRB Criteria
Route 1: SB	00:15:10	00:17:18	00:02:08	12%	✓
Route 1: NB	00:15:21	00:16:52	00:01:31	9%	✓
Route 2: NB	00:11:26	00:12:07	00:00:41	6%	✓
Route 2: SB	00:11:35	00:12:59	00:01:24	11%	✓
Route 3: NB	00:11:27	00:10:43	00:00:44	-7%	✓
Route 3: SB	00:10:56	00:10:53	00:00:03	0%	✓
Route 4: SB	00:13:00	00:16:00	00:03:00	19%	✗
Route 4: NB	00:12:44	00:14:30	00:01:46	12%	✓

Figure 8.6 – PM Peak Hour Final Assignment Journey Time Summary

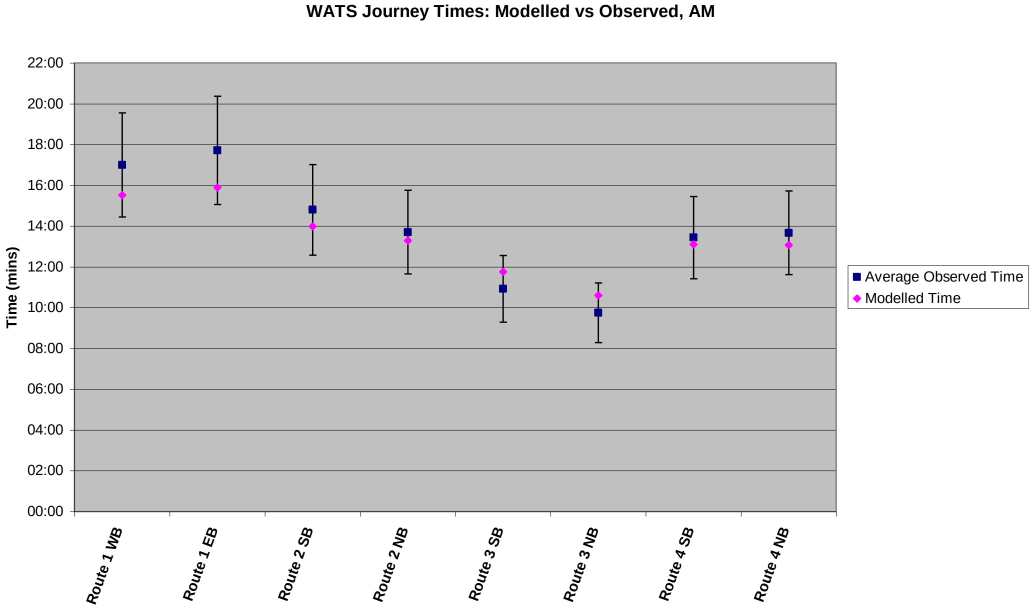


Table 8.15 – PM Peak Hour Final Assignment Journey Time Summary

Route	Modelled Time	Mean Observed Time	Difference	Percentage Difference	Pass or Fail DMRB Criteria
Route 1: SB	00:15:31	00:16:59	00:01:28	9%	✓
Route 1: NB	00:15:53	00:17:42	00:01:49	10%	✓
Route 2: NB	00:13:59	00:14:47	00:00:48	5%	✓
Route 2: SB	00:13:17	00:13:42	00:00:25	3%	✓
Route 3: NB	00:11:45	00:10:56	00:00:49	-7%	✓
Route 3: SB	00:10:36	00:09:46	00:00:50	-9%	✓
Route 4: SB	00:13:06	00:13:27	00:00:21	3%	✓
Route 4: NB	00:13:04	00:13:40	00:00:36	4%	✓

Prior and Post ME2 Matrix Comparisons

8.15 At the end of the matrix estimation procedure, the Prior and Post-ME2 matrices have been compared, and it has been verified that the observed movements of the matrix have not changed.

8.16 Table 8.16 below shows the change in total matrix size between the Prior and Post-ME2 matrices:

Table 8.16 – Pre and Post-ME2 Matrix Total Comparison

Peak Hour	Prior Matrix Total	Post ME2 Matrix Total	Difference
AM	9751	10459	708
IP	8912	9830	918
PM	10255	11289	1034

8.17 The use of a Frozen Cells Mask enabled the observed portions of the matrix to be kept constant. This would ensure the preservation of the observed data's integrity. Table 8.17 to Table 8.19 show the difference between the Prior matrix and Post ME2 matrix in Observation Sector-to-Sector format. The highlighted cells show the sector to sector movements that are observed, and therefore frozen within the ME2 process.

Table 8.17 – AM Peak Hour Observation Sector Prior and Post ME2 Matrix Difference

	1	2	3	4	5	6	7	8	9	10
1	265.5	0	0	103.8	0	60.45	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	27.22	0	0	0	0	-1.2	0	0
4	68.58	0	0	1.034	23.85	25.25	0	0	0	0
5	0	0	0	-21.8	82.17	0	0	0	0	0
6	152.5	0	0	11.69	0	0	0	0	0	0
7	0	0	0	0	0	0	37.32	54.25	0	6.33
8	0	0	-11.7	0	0	0	-136	-39.2	0	0.255
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	-3.37	0.994	0	0

Table 8.18 – Inter Peak Hour Observation Sector Prior and Post ME2 Matrix Difference

	1	2	3	4	5	6	7	8	9	10
1	311.6	0	0	55.72	0	166.2	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	22.41	0	0	0	0	-5.22	0	0
4	91.22	0	0	9.765	8.354	2.489	0	0	0	0
5	0	0	0	5.537	17.21	0	0	0	0	0
6	157.3	0	0	8.244	0	0	0	0	0	0
7	0	0	0	0	0	0	-44	36.41	0	-0.3
8	0	0	-13.1	0	0	0	111.8	-36.5	0	0.753
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	11.15	1.08	0	0

Table 8.19 – PM Peak Hour Observation Sector Prior and Post ME2 Matrix Difference

	1	2	3	4	5	6	7	8	9	10
1	457.7	0	0	24.12	0	206.2	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	27.55	0	0	0	0	-27.1	0	0
4	96.17	0	0	5.524	5.465	30.68	0	0	0	0
5	0	0	0	31.75	65.76	0	0	0	0	0
6	155.7	0	0	13.61	0	0	0	0	0	0
7	0	0	0	0	0	0	-28	-97.5	0	0.24
8	0	0	-10.4	0	0	0	74.26	0	0	0.047
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	2.363	-0.22	0	0

8.18 These tables show that, in all three time periods, the Observation Sector-to-Sector movement that has the biggest single increase is 1-1. This contains the movements that are internal to Wisbech, and therefore the highest proportion of synthetic data. Many link counts and turning counts were available in this area to inform the matrix estimation, so it is to be expected that this part of the matrix would be affected the most.

8.19 The only movements that were consistently reduced across all three time periods were Observation Sectors 3-8 and 8-3; this movement is partially observed and sparsely populated: two factors which make it unsurprising that the synthetic data has overestimated the trips between these sectors.

8.20 It can be seen that the highlighted cells show a zero difference between the Prior and Post ME2 matrices. This therefore confirms that the ME2 process was modifying the synthetic data only.

Trip Length Distribution

8.21 The figures below show the change in trip length distribution between the Prior and Post ME2 assignments.

8.22 These graphs indicate that the proportion of trips in each distance band remains very stable between the prior and final matrix In all three time periods, with a correlation of 99.8% in the AM Peak, 99.8% in the Inter Peak and 99.7% in the PM Peak.

Figure 8.7 – AM Peak Hour Trip Length Distribution Changes

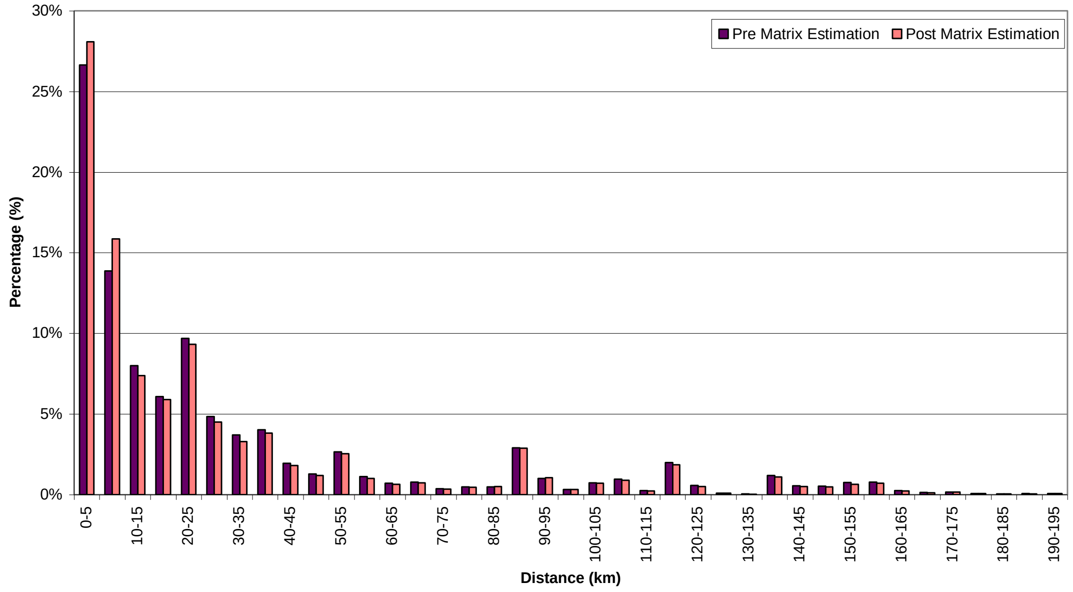


Figure 8.8 – Inter Peak Hour Trip Length Distribution Changes

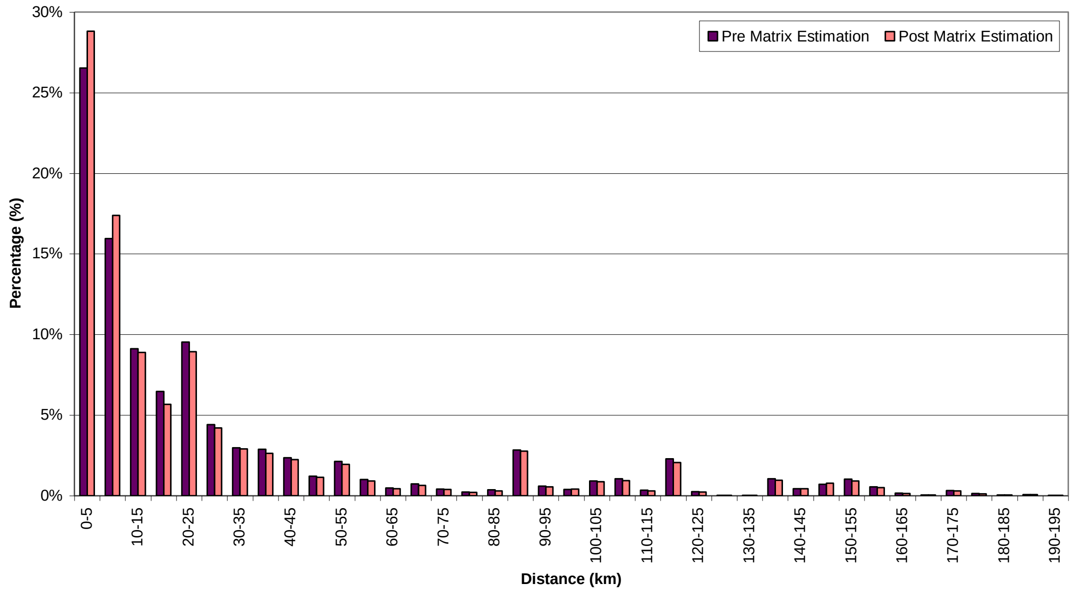
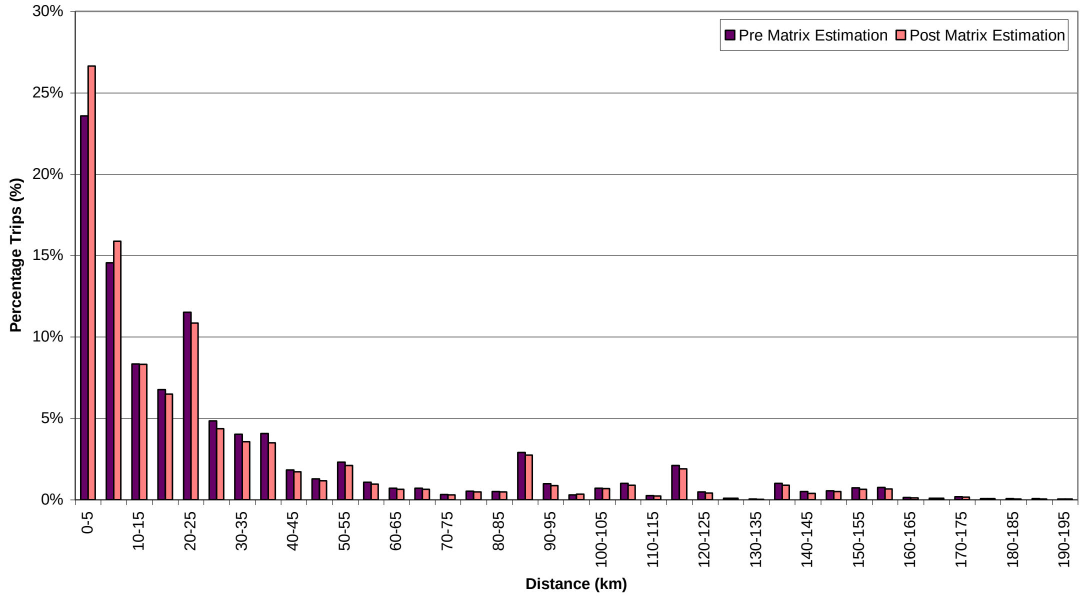


Figure 8.9 – PM Peak Hour Trip Length Distribution Changes



Model Convergence

8.23 The following tables show the convergence criteria for the final 5 loops of the convergence process, monitoring all of the criteria mentioned in paragraphs 7.7 to 7.10:

Table 8.20 – AM Peak Hour Model Convergence Criteria

Loop	Gap (%)	Delta (% / Number of Loops)	Flow Change Stability (%)
26	0.023	0.033/3	100.0
27	0.019	0.036/3	100.0
28	0.019	0.036/3	100.0
29	0.019	0.036/3	100.0
30	0.018	0.033/3	100.0

Table 8.21 – Inter Peak Hour Model Convergence Criteria

Loop	Gap (%)	Delta (% / Number of Loops)	Flow Change Stability (%)
6	0.021	0.023/3	97.4
7	0.016	0.018/3	99.0
8	0.014	0.017/3	97.7
9	0.012	0.016/3	97.4
10	0.010	0.013/3	99.3

Table 8.22 – PM Peak Hour Model Convergence Criteria

Loop	Gap (%)	Delta (% / Number of Loops)	Flow Change Stability (%)
17	0.023	0.023/3	99.9
18	0.017	0.025/3	99.8
19	0.018	0.024/3	99.8
20	0.014	0.024/3	100.0
21	0.016	0.022/3	100.0

8.24 The tables above show that the convergence criteria set out within the DMRB have been met in all three modelled periods.

9. Conclusions

9.1 The overall objective of this exercise has been to build a 2008 Wisbech Area Transport Model. It is intended that the base models produced by this exercise are then used to forecast local traffic flows in Wisbech and the neighbouring area.

9.2 The performance of the model in terms of convergence targets falls well within the DMRB validation criteria for a study of this nature.

9.3 The indicators of model performance set out within this report demonstrate that the model is capable of a good representation of base year (2008) traffic levels and patterns. Modelled flows at individual locations and along cordons around the local area closely match corresponding observed values. Modelled journey times along four routes of interest in the WATS Study Area further demonstrate a good match with the observed situation.

9.4 The results of this calibration and validation exercise for each analysed time period indicate a good correlation between observed and modelled flows, throughout the study area. As such they represent a robust basis from which to forecast local traffic flows in Wisbech and in the neighbouring area.

Appendix A
Screenline, Validation Count and Journey Time Results

A.1 AM Peak Hour

Screenline Results

Table A.1 – AM Peak Hour Screenline Results

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
Cordon							
RSI Site 1: Interview Direction	682.3	710.9	-28.6	0.0	1.1	✓	✓
RSI Site 1: Non-Interview Direction	568.9	530.3	38.6	0.1	1.6	✓	✓
RSI Site 2: Interview Direction	976.4	938.9	37.4	0.0	1.2	✓	✓
RSI Site 2: Non-Interview Direction	909.6	969.1	-59.5	-0.1	1.9	✓	✓
RSI Site 3: Interview Direction	927.9	823.4	104.5	0.1	3.5	✓	✓
RSI Site 3: Non-Interview Direction	547.0	459.9	87.2	0.2	3.9	✓	✓
RSI Site 4: Interview Direction	392.8	295.6	97.3	0.2	5.2	✓	×
RSI Site 4: Non-Interview Direction	380.7	348.6	32.1	0.1	1.7	✓	✓
RSI Site 5: Interview Direction	289.1	315.4	-26.3	-0.1	1.5	✓	✓
RSI Site 5: Non-Interview Direction	204.7	193.6	11.2	0.1	0.8	✓	✓
RSI Site 6: Interview Direction	726.4	731.7	-5.3	0.0	0.2	✓	✓
RSI Site 6: Non-Interview Direction	606.2	598.9	7.4	0.0	0.3	✓	✓
AnnMon7: NB	103.9	112.0	-8.1	-0.1	0.8	✓	✓
AnnMon7: SB	157.4	145.2	12.2	0.1	1.0	✓	✓
Cordon Total	**7473.3**	**7173.2**	**300.1**	**0.0**	**3.5**	✓	✓
Central Screenline							
AnnMon8: EB	713.0	620.9	92.1	0.1	3.6	✓	✓
AnnMon8: WB	846.4	861.1	-14.7	0.0	0.5	✓	✓
AnnMon12: EB	296.1	283.3	12.8	0.0	0.8	✓	✓
AnnMon12: WB	503.7	499.6	4.1	0.0	0.2	✓	✓
AnnMon13: SB	325.1	338.5	-13.4	0.0	0.7	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
AnnMon13: NB	248.1	207.4	40.7	0.2	2.7	✓	✓
Central Screenline Total	**2932.4**	**2810.7**	**121.7**	**0.0**	**2.3**	✓	✓
Northern Screenline							
AnnMon7: NB	103.9	112.0	-8.1	-0.1	0.8	✓	✓
AnnMon7: SB	157.4	145.2	12.2	0.1	1.0	✓	✓
RSI Site 4: Interview Direction	392.8	295.6	97.3	0.2	5.2	✓	✗
RSI Site 4: Non-Interview Direction	380.7	348.6	32.1	0.1	1.7	✓	✓
TC13 link count: from A1101 Sutton Road S	368.2	329.7	38.5	0.1	2.1	✓	✓
TC13 link count: to A1101 Sutton Road S	507.1	514.5	-7.4	0.0	0.3	✓	✓
Northern Screenline Total	**1910.2**	**1745.5**	**164.6**	**0.1**	**3.9**	✗	✓
Outer Southern Screenline							
RSI Site 1: Interview Direction	682.3	710.9	-28.6	0.0	1.1	✓	✓
RSI Site 1: Non-Interview Direction	568.9	530.3	38.6	0.1	1.6	✓	✓
RSI Site 2: Interview Direction	976.4	938.9	37.4	0.0	1.2	✓	✓
RSI Site 2: Non-Interview Direction	909.6	969.1	-59.5	-0.1	1.9	✓	✓
RSI Site 6: Interview Direction	726.4	731.7	-5.3	0.0	0.2	✓	✓
RSI Site 6: Non-Interview Direction	606.2	598.9	7.4	0.0	0.3	✓	✓
Outer Southern Screenline Total	**4469.7**	**4479.7**	**-9.9**	**0.0**	**0.1**	✓	✓
Western Screenline							
RSI Site 3: Interview Direction	927.9	823.4	104.5	0.1	3.5	✓	✓
RSI Site 3: Non-Interview Direction	547.0	459.9	87.2	0.2	3.9	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
RSI Site 5: Interview Direction	289.1	315.4	-26.3	-0.1	1.5	✓	✓
RSI Site 5: Non-Interview Direction	204.7	193.6	11.2	0.1	0.8	✓	✓
Western Screenline Total	**1968.7**	**1792.2**	**176.5**	**0.1**	**4.1**	✗	✗

Validation Count Results

Table A.2 – AM Peak Hour Validation Count Results

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
RSI Site 1: Interview Direction	682.3	710.9	-28.6	0.0	1.1	✓	✓
RSI Site 1: Non-Interview Direction	568.9	530.3	38.6	0.1	1.6	✓	✓
RSI Site 2: Interview Direction	976.4	938.9	37.4	0.0	1.2	✓	✓
RSI Site 2: Non-Interview Direction	909.6	969.1	-59.5	-0.1	1.9	✓	✓
RSI Site 3: Interview Direction	927.9	823.4	104.5	0.1	3.5	✓	✓
RSI Site 3: Non-Interview Direction	547.0	459.9	87.2	0.2	3.9	✓	✓
RSI Site 5: Interview Direction	289.1	315.4	-26.3	-0.1	1.5	✓	✓
RSI Site 5: Non-Interview Direction	204.7	193.6	11.2	0.1	0.8	✓	✓
RSI Site 7: Interview Direction	752.6	739.1	13.5	0.0	0.5	✓	✓
RSI Site 7: Non-Interview Direction	662.7	580.5	82.2	0.1	3.3	✓	✓
AnnMon2: EB	99.6	109.3	-9.6	-0.1	0.9	✓	✓
AnnMon2: WB	171.5	109.8	61.7	0.4	5.2	✓	×
AnnMon13: SB	325.1	338.5	-13.4	0.0	0.7	✓	✓
AnnMon13: NB	248.1	207.4	40.7	0.2	2.7	✓	✓
TC5: B198 South Brink to Town Bridge at Town Bridge Jct	172.6	148.1	24.5	0.1	1.9	✓	✓
TC5: B198 South Brink to B198 Nene Quay at Town Bridge Jct	236.0	240.6	-4.6	0.0	0.3	✓	✓
TC5: B198 South Brink to Bridge St at Town Bridge Jct	25.0	10.5	14.5	0.6	3.4	✓	✓
TC5: Town Bridge to B198 South Brink at Town Bridge Jct	355.0	306.8	48.2	0.1	2.7	✓	✓
TC5: Town Bridge to B198 Nene Quay at Town Bridge Jct	15.4	22.3	-6.9	-0.5	1.6	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
TC5: Town Bridge to Bridge St at Town Bridge Jct	54.9	98.1	-43.2	-0.8	4.9	✓	✓
TC5: B198 Nene Quay to B198 South Brink at Town Bridge Jct	335.3	341.4	-6.2	0.0	0.3	✓	✓
TC5: B198 Nene Quay to Town Bridge at Town Bridge Jct	25.2	0.0	25.2	1.0	7.1	✓	×
TC5: Bridge St to B198 South Brink at Town Bridge Jct	21.2	21.4	-0.2	0.0	0.0	✓	✓
TC5: Bridge St to Town Bridge at Town Bridge Jct	18.3	11.4	6.9	0.4	1.8	✓	✓
TC5: Bridge St to B198 Nene Quay at Town Bridge Jct	34.7	17.4	17.2	0.5	3.4	✓	✓
TC5: Alexandra Rd to B198 South Brink at Town Bridge Jct	14.0	2.5	11.4	0.8	4.0	✓	✓
TC5: Alexandra Rd to Town Bridge at Town Bridge Jct	53.9	6.3	47.6	0.9	8.7	✓	×
TC5: Alexandra Rd to B198 Nene Quay at Town Bridge Jct	27.4	9.6	17.9	0.7	4.2	✓	✓
TC5: Alexandra Rd to Bridge St at Town Bridge Jct	5.8	0.0	5.8	1.0	3.4	✓	✓
TC5: Old Market to Town Bridge at Town Bridge Jct	423.4	427.2	-3.9	0.0	0.2	✓	✓
TC5: Old Market to North Brink at Town Bridge Jct	43.3	1.8	41.5	1.0	8.7	✓	×
TC5: Town Bridge to Old Market at Town Bridge Jct	136.6	107.4	29.2	0.2	2.6	✓	✓
TC5: Town Bridge to North Brink at Town Bridge Jct	133.2	58.5	74.7	0.6	7.6	✓	×
TC5: North Brink to Old Market at Town Bridge Jct	1.0	0.0	1.0	1.0	1.4	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
TC5: North Brink to Town Bridge at Town Bridge Jct	1.9	0.0	1.9	1.0	2.0	✓	✓
TC13: A1101 Sutton Rd N to A1101 Sutton Rd S at A1101/Little Ramper Jct	425.8	443.8	-18.0	0.0	0.9	✓	✓
TC13: A1101 Sutton Rd N to Little Ramper at A1101/Little Ramper Jct	12.5	11.0	1.5	0.1	0.4	✓	✓
TC13: A1101 Sutton Rd S to A1101 Sutton Rd N at A1101/Little Ramper Jct	321.0	297.4	23.6	0.1	1.3	✓	✓
TC13: A1101 Sutton Rd S to Little Ramper at A1101/Little Ramper Jct	47.2	32.3	14.9	0.3	2.4	✓	✓
TC13: Little Ramper to A1101 Sutton Rd N at A1101/Little Ramper Jct	15.4	54.7	-39.2	-2.5	6.6	✓	×
TC13: Little Ramper to A1101 Sutton Rd S at A1101/Little Ramper Jct	81.3	70.8	10.6	0.1	1.2	✓	✓
CP1 921 Kingswalk in	177.1	151.5	25.7	0.1	2.0	✓	✓
CP1 921 Kingswalk out	41.4	57.4	-16.0	-0.4	2.3	✓	✓
CP1 921 Alexandra Road in	78.9	109.8	-30.9	-0.4	3.2	✓	✓
CP1 921 Alexandra Road out	33.7	17.7	16.0	0.5	3.2	✓	✓
CP2 923 in	4.8	3.9	1.0	0.2	0.5	✓	✓
CP2 923 out	1.9	2.4	-0.5	-0.3	0.3	✓	✓
CP3 924 in	17.3	17.3	0.0	0.0	0.0	✓	✓
CP3 924 out	1.9	1.9	0.0	0.0	0.0	✓	✓
CP4 929 in	1.0	4.8	-3.8	-4.0	2.3	✓	✓
CP4 929 out	1.9	1.9	0.0	0.0	0.0	✓	✓
CP5 926 in	124.2	106.7	17.5	0.1	1.6	✓	✓
CP5 926 out	11.6	11.6	0.0	0.0	0.0	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
CP6 925 in	1.9	3.4	-1.4	-0.7	0.9	✓	✓
CP6 925 out	1.4	0.0	1.4	1.0	1.7	✓	✓
CP7 922 Somers Road in	83.7	71.4	12.3	0.1	1.4	✓	✓
CP7 922 Somers Road out	3.9	0.1	3.8	1.0	2.7	✓	✓
CP7 922 Queens Road in	100.1	106.5	-6.4	-0.1	0.6	✓	✓
CP7 922 Queens Road out	3.4	7.1	-3.7	-1.1	1.6	✓	✓
CP8 927 in	27.0	19.7	7.2	0.3	1.5	✓	✓
CP8 927 out	7.2	7.2	0.0	0.0	0.0	✓	✓
CP9 928 in	54.9	93.0	-38.2	-0.7	4.4	✓	✓
CP9 928 out	20.2	34.2	-14.0	-0.7	2.7	✓	✓
Overall Validation Count Results						**100%**	**90%**

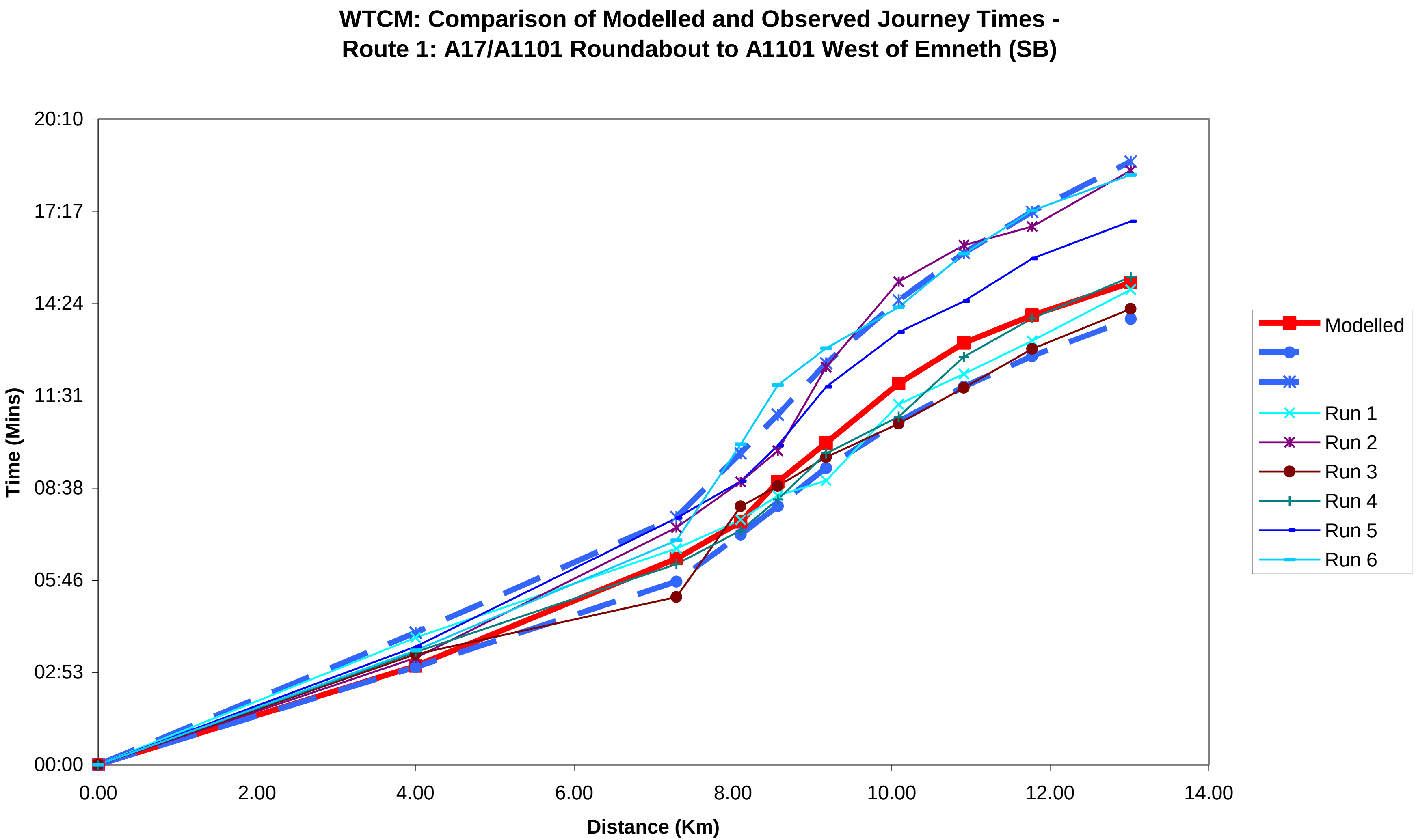


Figure A.1 – Route 1 Southbound, AM Peak Hour

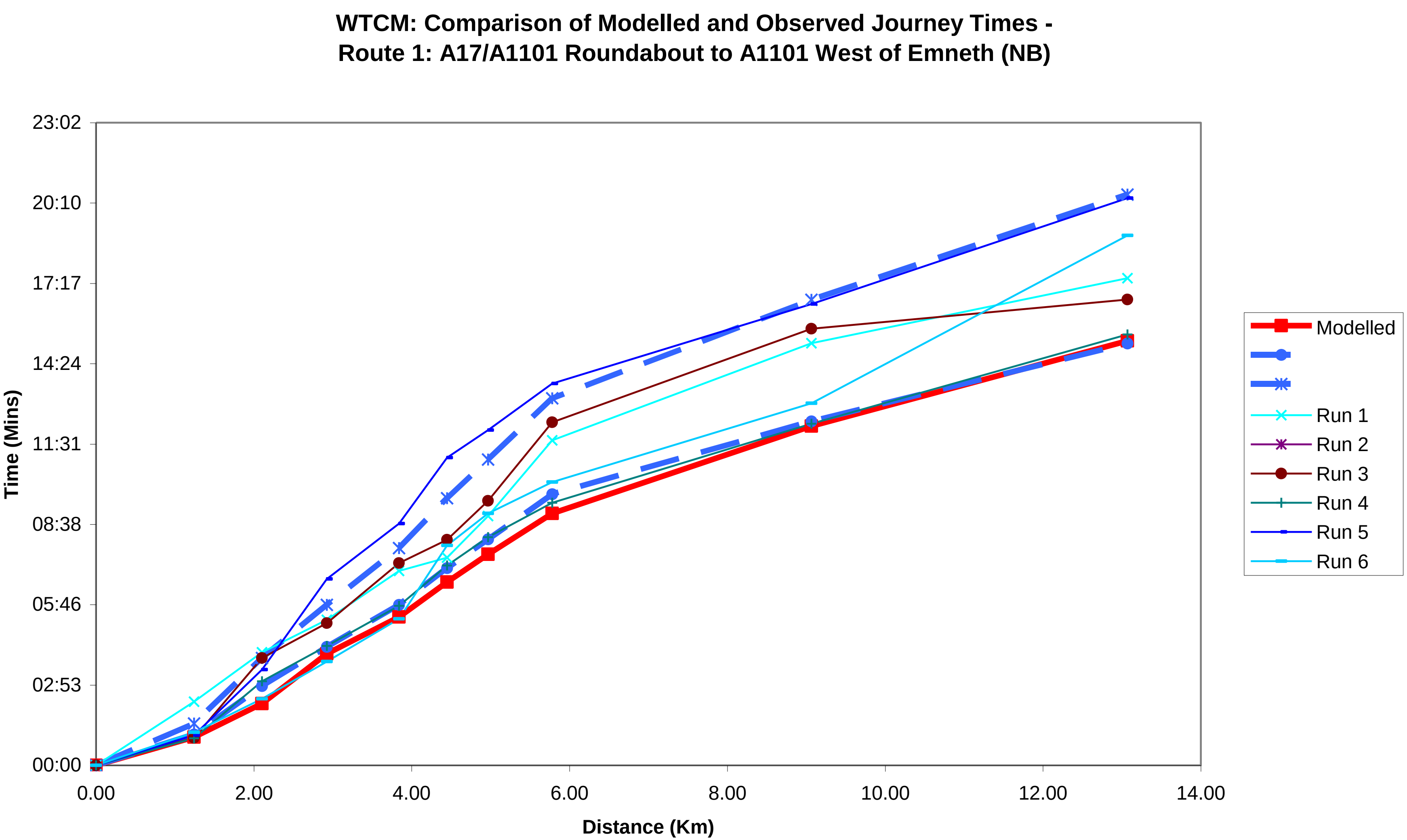


Figure A.2 – Route 1 Northbound, AM Peak Hour

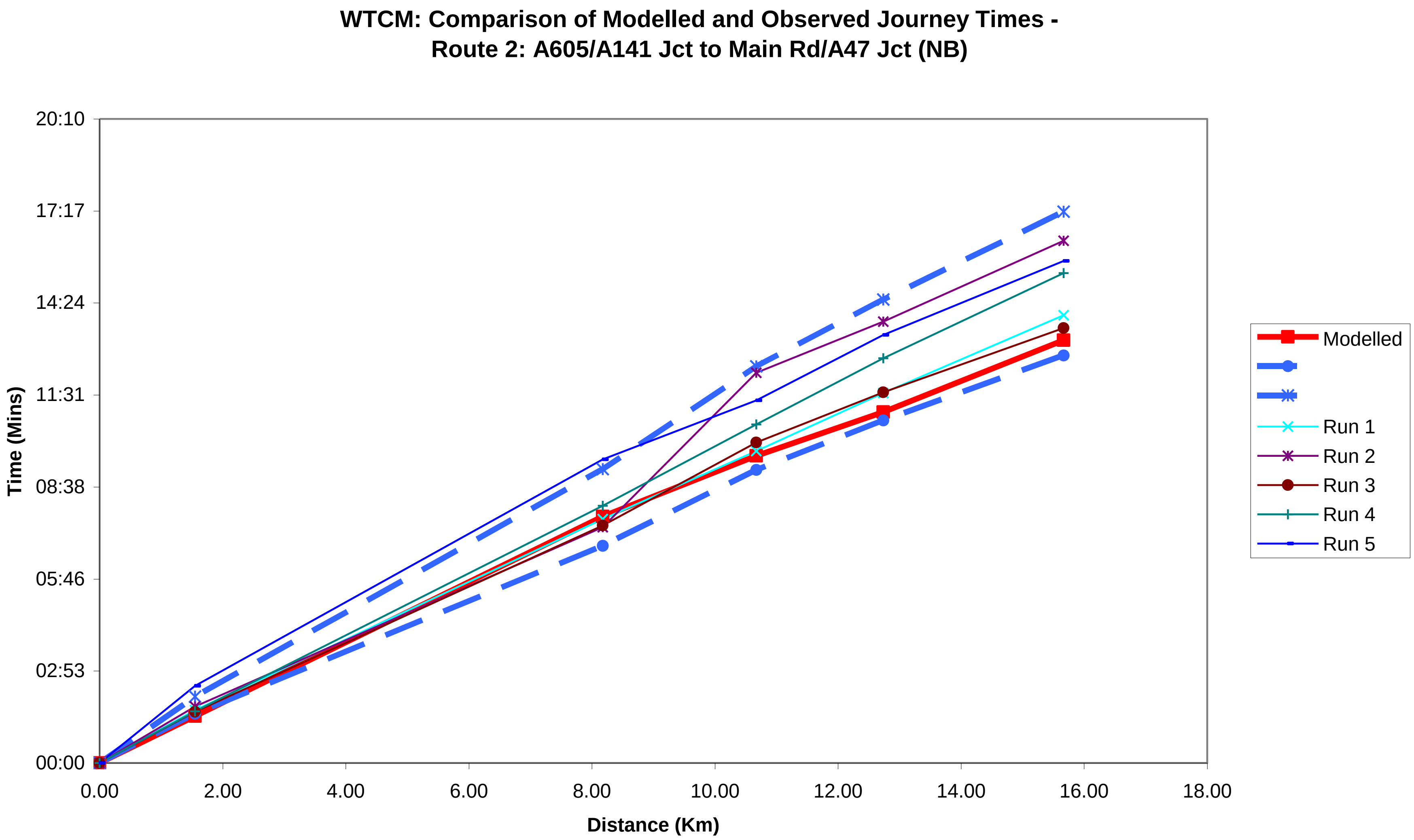


Figure A.3 – Route 2 Northbound, AM Peak Hour

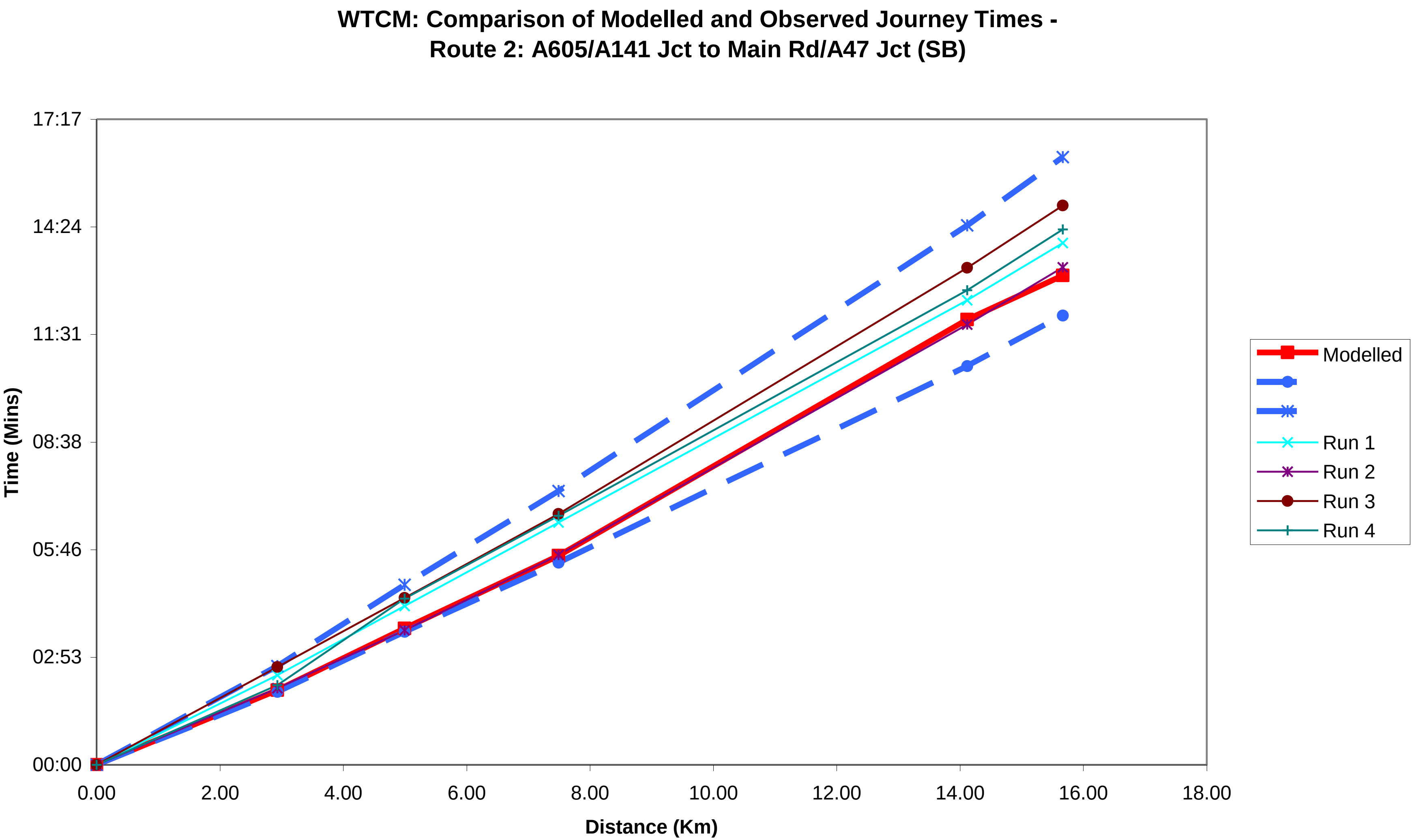


Figure A.4 – Route 2 Southbound, AM Peak Hour

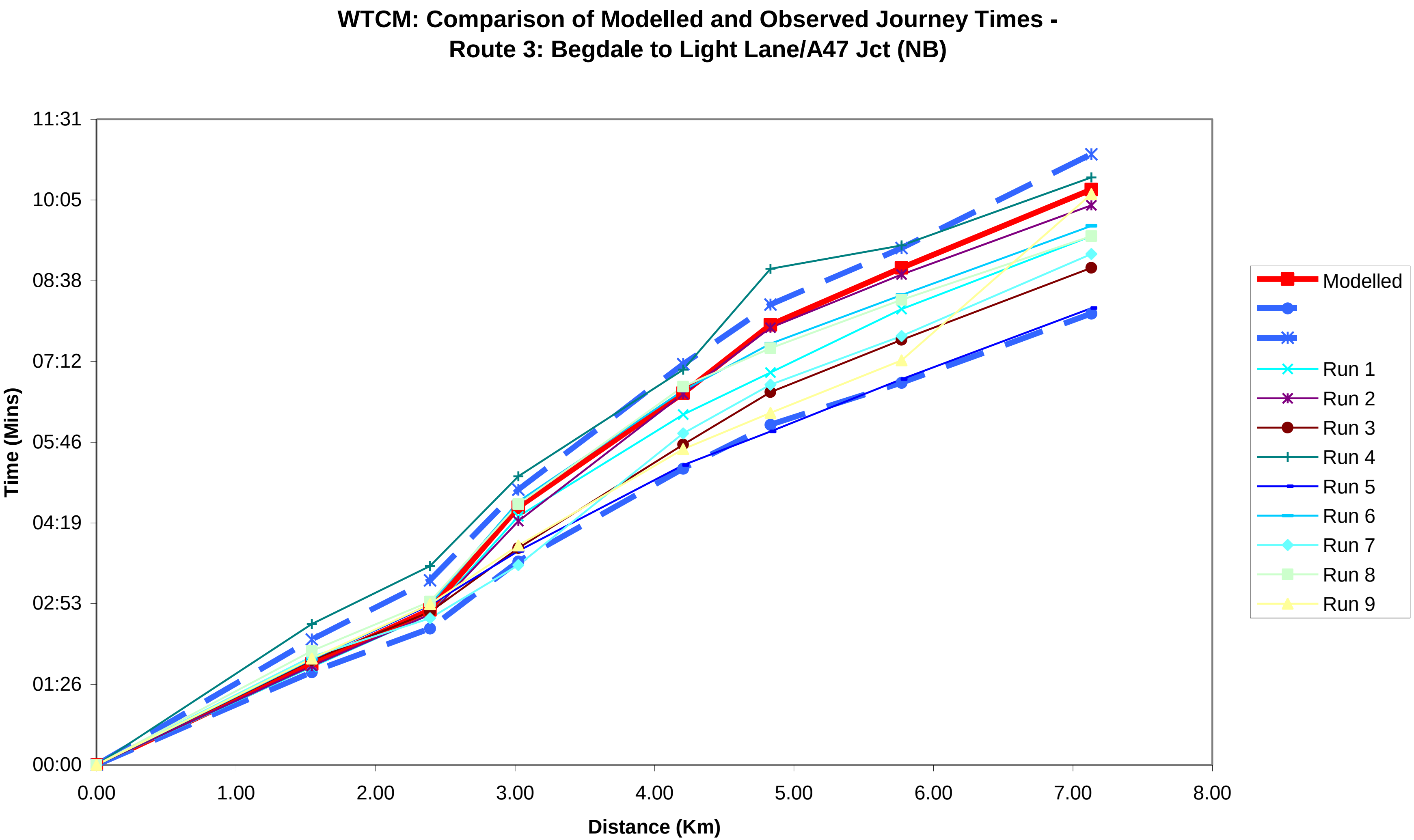


Figure A.5 – Route 3 Northbound, AM Peak Hour

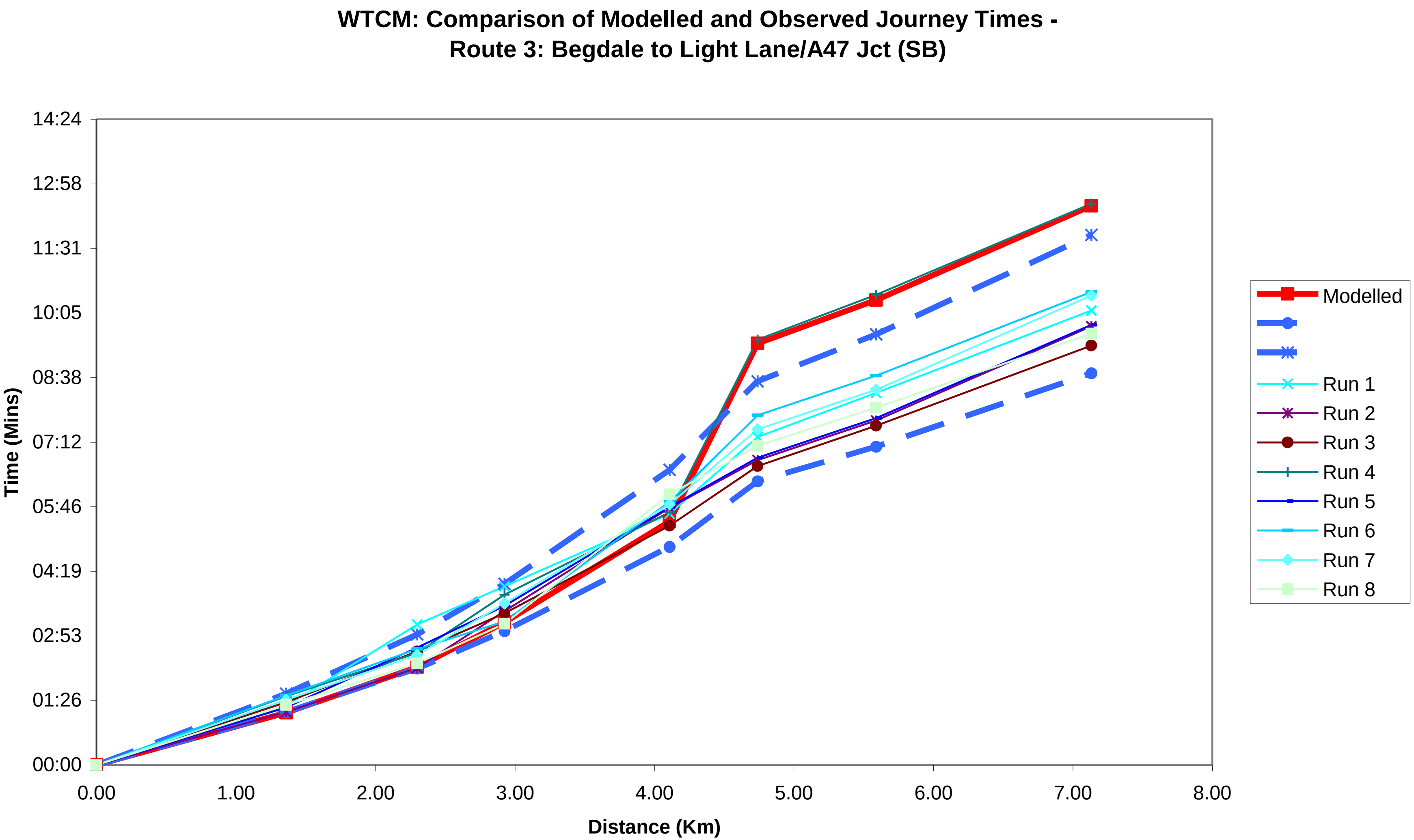


Figure A.6 – Route 3 Southbound, AM Peak Hour

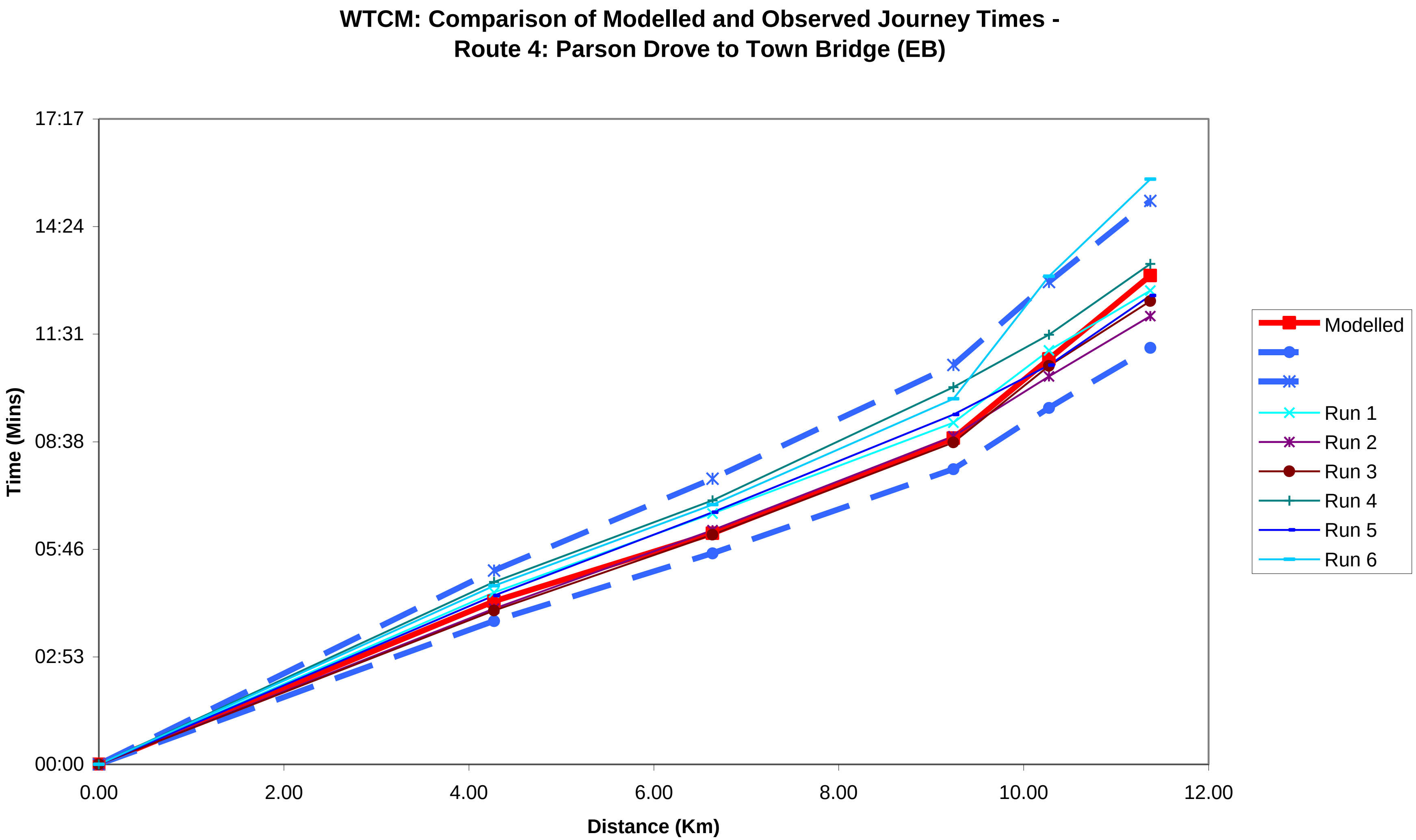


Figure A.7 – Route 4 Eastbound, AM Peak Hour

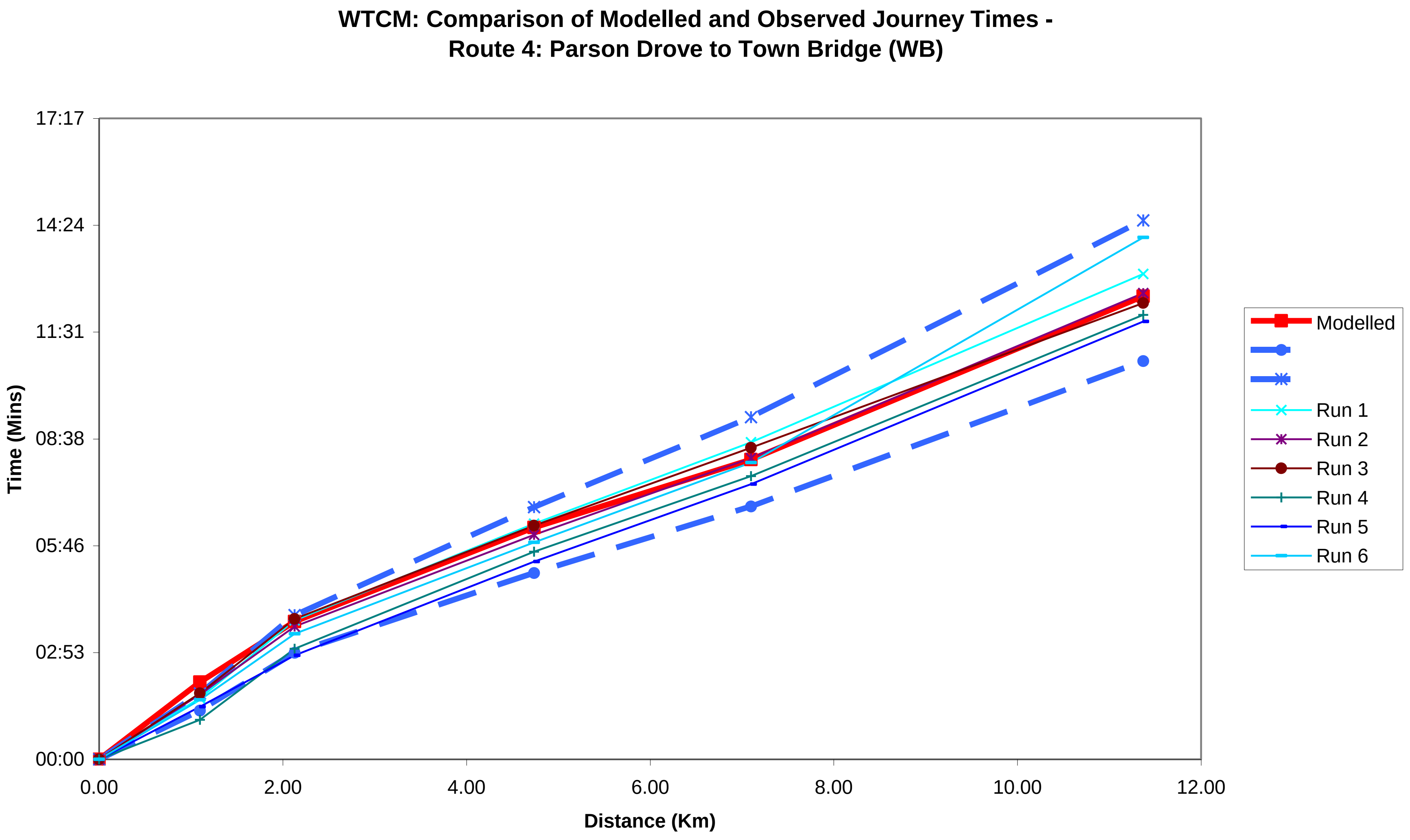


Figure A.8 – Route 4 Westbound, AM Peak Hour

A.2 Inter Peak Hour

Screenline Results

Table A.3 – Inter Peak Hour Screenline Results

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
Cordon							
RSI Site 1: Interview Direction	588.1	557.6	30.6	0.1	1.3	✓	✓
RSI Site 1: Non-Interview Direction	523.9	519.9	4.0	0.0	0.2	✓	✓
RSI Site 2: Interview Direction	754.7	837.1	-82.3	-0.1	2.9	✓	✓
RSI Site 2: Non-Interview Direction	811.5	918.5	-107.0	-0.1	3.6	✓	✓
RSI Site 3: Interview Direction	723.1	629.0	94.2	0.1	3.6	✓	✓
RSI Site 3: Non-Interview Direction	716.2	645.6	70.6	0.1	2.7	✓	✓
RSI Site 4: Interview Direction	320.1	248.6	71.5	0.2	4.2	✓	✓
RSI Site 4: Non-Interview Direction	394.5	304.3	90.2	0.2	4.8	✓	✓
RSI Site 5: Interview Direction	196.0	188.5	7.5	0.0	0.5	✓	✓
RSI Site 5: Non-Interview Direction	194.7	194.7	0.0	0.0	0.0	✓	✓
RSI Site 6: Interview Direction	660.5	664.5	-3.9	0.0	0.2	✓	✓
RSI Site 6: Non-Interview Direction	678.9	679.1	-0.2	0.0	0.0	✓	✓
AnnMon7: NB	77.7	86.7	-9.0	-0.1	1.0	✓	✓
AnnMon7: SB	64.9	63.0	1.9	0.0	0.2	✓	✓
Cordon Total	**6212.4**	**6536.9**	**168.0**	**0.0**	**2.1**	**✓**	**✓**
Central Screenline							
AnnMon8: EB	791.7	784.4	7.4	0.0	0.3	✓	✓
AnnMon8: WB	845.1	694.1	151.0	0.2	5.4	×	×
AnnMon12: EB	283.9	318.7	-34.8	-0.1	2.0	✓	✓
AnnMon12: WB	236.5	255.1	-18.6	-0.1	1.2	✓	✓
AnnMon13: SB	192.5	188.7	3.8	0.0	0.3	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
AnnMon13: NB	157.5	160.7	-3.1	0.0	0.2	✓	✓
Central Screenline Total	**2507.1**	**2401.6**	**105.6**	**0.0**	**2.1**	✗	✓
Northern Screenline							
AnnMon7: NB	77.7	86.7	-9.0	-0.1	1.0	✓	✓
AnnMon7: SB	64.9	63.0	1.9	0.0	0.2	✓	✓
RSI Site 4: Interview Direction	320.1	248.6	71.5	0.2	4.2	✓	✓
RSI Site 4: Non-Interview Direction	394.5	304.3	90.2	0.2	4.8	✓	✓
TC13 link count: from A1101 Sutton Road S	355.2	395.1	-39.9	-0.1	2.1	✓	✓
TC13 link count: to A1101 Sutton Road S	379.7	394.8	-15.2	0.0	0.8	✓	✓
Northern Screenline Total	**1592.0**	**1492.5**	**99.5**	**0.1**	**2.5**	✗	✓
Outer Southern Screenline							
RSI Site 1: Interview Direction	588.1	557.6	30.6	0.1	1.3	✓	✓
RSI Site 1: Non-Interview Direction	523.9	519.9	4.0	0.0	0.2	✓	✓
RSI Site 2: Interview Direction	754.7	837.1	-82.3	-0.1	2.9	✓	✓
RSI Site 2: Non-Interview Direction	811.5	918.5	-107.0	-0.1	3.6	✓	✓
RSI Site 6: Interview Direction	660.5	664.5	-3.9	0.0	0.2	✓	✓
RSI Site 6: Non-Interview Direction	678.9	679.1	-0.2	0.0	0.0	✓	✓
Outer Southern Screenline Total	**4017.7**	**4176.7**	**-159.0**	**0.0**	**2.5**	✓	✓
Western Screenline							
RSI Site 3: Interview Direction	723.1	629.0	94.2	0.1	3.6	✓	✓
RSI Site 3: Non-Interview Direction	716.2	645.6	70.6	0.1	2.7	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
RSI Site 5: Interview Direction	196.0	188.5	7.5	0.0	0.5	✓	✓
RSI Site 5: Non-Interview Direction	194.7	194.7	0.0	0.0	0.0	✓	✓
Western Screenline Total	**1830.0**	**1657.7**	**172.3**	**0.1**	**4.1**	✗	✗

Validation Count Results

Table A.4 – Inter Peak Hour Validation Count Results

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
RSI Site 1: Interview Direction	588.1	557.6	30.6	0.1	1.3	✓	✓
RSI Site 1: Non-Interview Direction	523.9	519.9	4.0	0.0	0.2	✓	✓
RSI Site 2: Interview Direction	754.7	837.1	-82.3	-0.1	2.9	✓	✓
RSI Site 2: Non-Interview Direction	811.5	918.5	-107.0	-0.1	3.6	✓	✓
RSI Site 3: Interview Direction	723.1	629.0	94.2	0.1	3.6	✓	✓
RSI Site 3: Non-Interview Direction	716.2	645.6	70.6	0.1	2.7	✓	✓
RSI Site 5: Interview Direction	196.0	188.5	7.5	0.0	0.5	✓	✓
RSI Site 5: Non-Interview Direction	194.7	194.7	0.0	0.0	0.0	✓	✓
RSI Site 7: Interview Direction	698.9	656.6	42.4	0.1	1.6	✓	✓
RSI Site 7: Non-Interview Direction	720.0	645.3	74.7	0.1	2.9	✓	✓
AnnMon2: EB	58.9	68.5	-9.6	-0.2	1.2	✓	✓
AnnMon2: WB	102.8	87.6	15.1	0.1	1.6	✓	✓
AnnMon13: SB	192.5	188.7	3.8	0.0	0.3	✓	✓
AnnMon13: NB	157.5	160.7	-3.1	0.0	0.2	✓	✓
TC5: B198 South Brink to Town Bridge at Town Bridge Jct	178.3	188.8	-10.5	-0.1	0.8	✓	✓
TC5: B198 South Brink to B198 Nene Quay at Town Bridge Jct	287.0	332.9	-46.0	-0.2	2.6	✓	✓
TC5: B198 South Brink to Bridge St at Town Bridge Jct	31.6	24.2	7.4	0.2	1.4	✓	✓
TC5: Town Bridge to B198 South Brink at Town Bridge Jct	207.3	161.9	45.5	0.2	3.3	✓	✓
TC5: Town Bridge to B198 Nene Quay at Town Bridge Jct	30.2	38.9	-8.7	-0.3	1.5	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
TC5: Town Bridge to Bridge St at Town Bridge Jct	42.4	30.9	11.4	0.3	1.9	✓	✓
TC5: B198 Nene Quay to B198 South Brink at Town Bridge Jct	268.8	327.2	-58.4	-0.2	3.4	✓	✓
TC5: B198 Nene Quay to Town Bridge at Town Bridge Jct	36.8	0.0	36.8	1.0	8.6	✓	×
TC5: Bridge St to B198 South Brink at Town Bridge Jct	55.3	29.1	26.1	0.5	4.0	✓	✓
TC5: Bridge St to Town Bridge at Town Bridge Jct	29.8	53.8	-23.9	-0.8	3.7	✓	✓
TC5: Bridge St to B198 Nene Quay at Town Bridge Jct	68.6	66.2	2.4	0.0	0.3	✓	✓
TC5: Alexandra Rd to B198 South Brink at Town Bridge Jct	15.4	0.5	14.9	1.0	5.3	✓	×
TC5: Alexandra Rd to Town Bridge at Town Bridge Jct	4.8	20.6	-15.8	-3.3	4.4	✓	✓
TC5: Alexandra Rd to B198 Nene Quay at Town Bridge Jct	35.1	18.0	17.2	0.5	3.3	✓	✓
TC5: Alexandra Rd to Bridge St at Town Bridge Jct	4.8	0.0	4.8	1.0	3.1	✓	✓
TC5: Old Market to Town Bridge at Town Bridge Jct	286.8	231.7	55.1	0.2	3.4	✓	✓
TC5: Old Market to North Brink at Town Bridge Jct	73.6	3.0	70.7	1.0	11.4	✓	×
TC5: Town Bridge to Old Market at Town Bridge Jct	163.3	180.8	-17.6	-0.1	1.3	✓	✓
TC5: Town Bridge to North Brink at Town Bridge Jct	133.6	82.4	51.2	0.4	4.9	✓	✓
TC5: North Brink to Town Bridge at Town Bridge Jct	1.9	0.0	1.9	1.0	2.0	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
TC13: A1101 Sutton Rd N to A1101 Sutton Rd S at A1101/Little Ramper Jct	326.7	331.9	-5.2	0.0	0.3	✓	✓
TC13: A1101 Sutton Rd N to Little Ramper at A1101/Little Ramper Jct	6.7	23.9	-17.1	-2.5	4.4	✓	✓
TC13: A1101 Sutton Rd S to A1101 Sutton Rd N at A1101/Little Ramper Jct	303.2	331.3	-28.2	-0.1	1.6	✓	✓
TC13: A1101 Sutton Rd S to Little Ramper at A1101/Little Ramper Jct	52.0	63.8	-11.8	-0.2	1.6	✓	✓
TC13: Little Ramper to A1101 Sutton Rd N at A1101/Little Ramper Jct	8.0	31.0	-23.1	-2.9	5.2	✓	×
TC13: Little Ramper to A1101 Sutton Rd S at A1101/Little Ramper Jct	52.9	62.9	-10.0	-0.2	1.3	✓	✓
CP1 921 Kingswalk in	108.8	77.4	31.9	0.3	3.3	✓	✓
CP1 921 Kingswalk out	116.0	120.5	-4.6	0.0	0.4	✓	✓
CP1 921 Alexandra Road in	37.5	60.7	-23.7	-0.6	3.4	✓	✓
CP1 921 Alexandra Road out	52.5	47.9	4.6	0.1	0.7	✓	✓
CP2 923 in	1.9	1.9	0.0	0.0	0.0	✓	✓
CP2 923 out	2.9	2.9	0.0	0.0	0.0	✓	✓
CP3 924 in	6.7	6.3	0.5	0.1	0.2	✓	✓
CP3 924 out	9.6	9.6	0.0	0.0	0.0	✓	✓
CP4 929 in	3.9	2.4	1.4	0.4	0.8	✓	✓
CP4 929 out	2.9	2.9	0.0	0.0	0.0	✓	✓
CP5 926 in	44.3	35.6	8.7	0.2	1.4	✓	✓
CP5 926 out	51.0	51.0	0.0	0.0	0.0	✓	✓
CP6 925 in	1.9	1.0	1.0	0.5	0.8	✓	✓
CP6 925 out	2.9	2.9	0.0	0.0	0.0	✓	✓

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
CP7 922 Somers Road in	14.4	19.5	-5.1	-0.4	1.2	✓	✓
CP7 922 Somers Road out	17.8	0.2	17.6	1.0	5.9	✓	×
CP7 922 Queens Road in	36.6	33.9	2.7	0.1	0.4	✓	✓
CP7 922 Queens Road out	43.8	61.4	-17.6	-0.4	2.4	✓	✓
CP8 927 in	27.0	17.8	9.1	0.3	1.9	✓	✓
CP8 927 out	19.7	19.7	0.0	0.0	0.0	✓	✓
CP9 928 in	141.5	173.5	-32.1	-0.2	2.6	✓	✓
CP9 928 out	173.7	189.8	-16.0	-0.1	1.2	✓	✓
Overall Validation Count Results						**100%**	**92%**

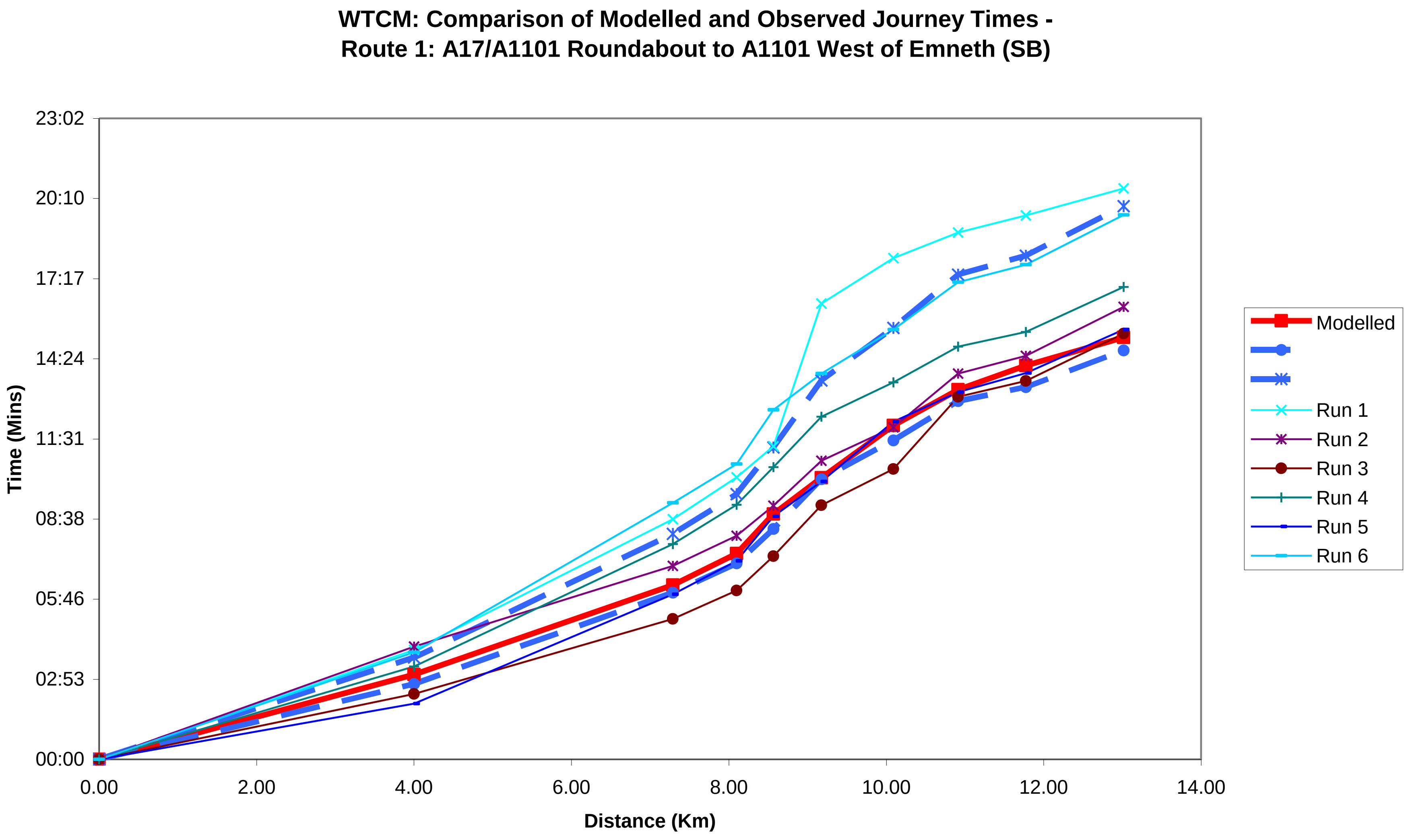


Figure A.9 – Route 1 Southbound, Inter Peak Hour

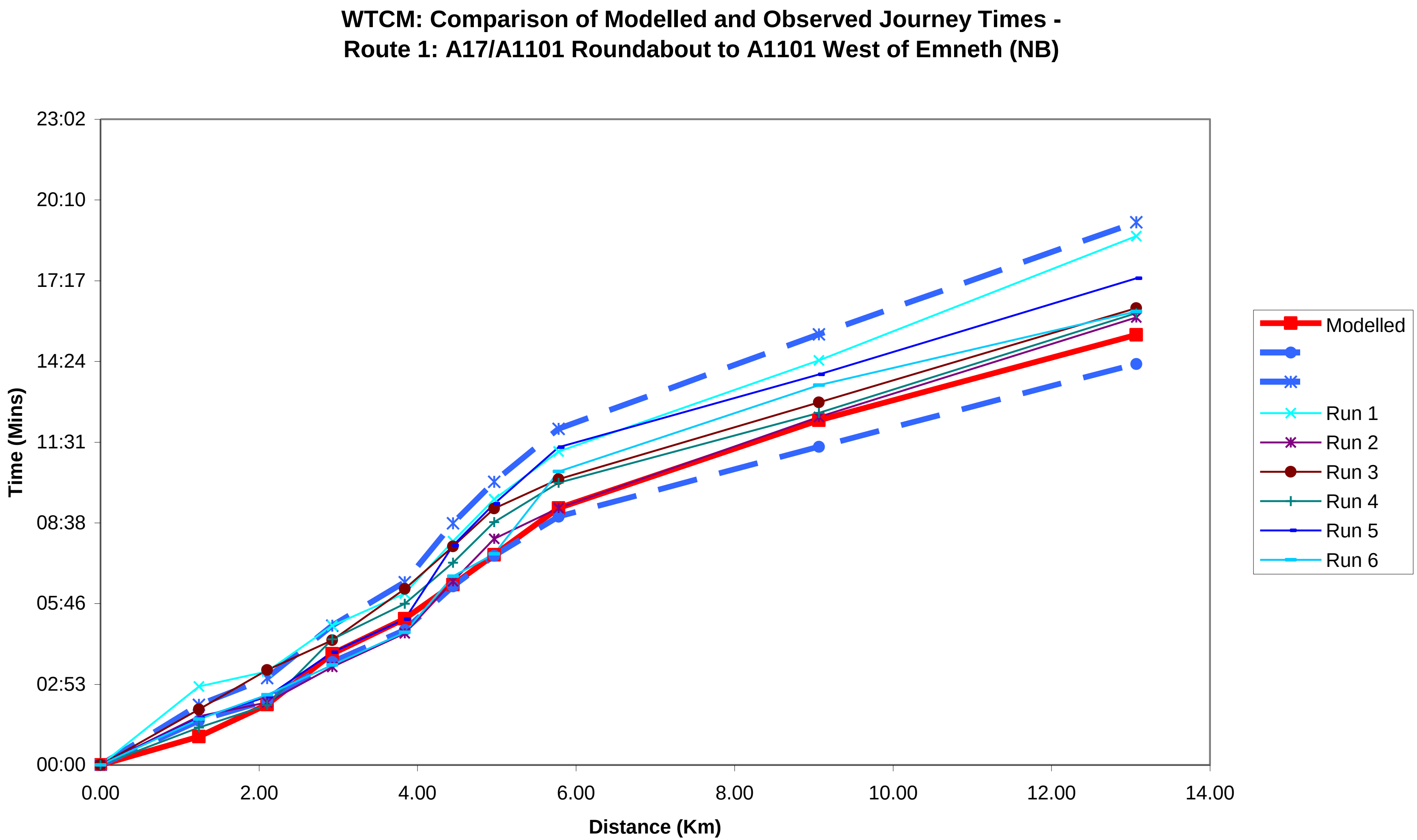


Figure A.10 – Route 1 Northbound, Inter Peak Hour

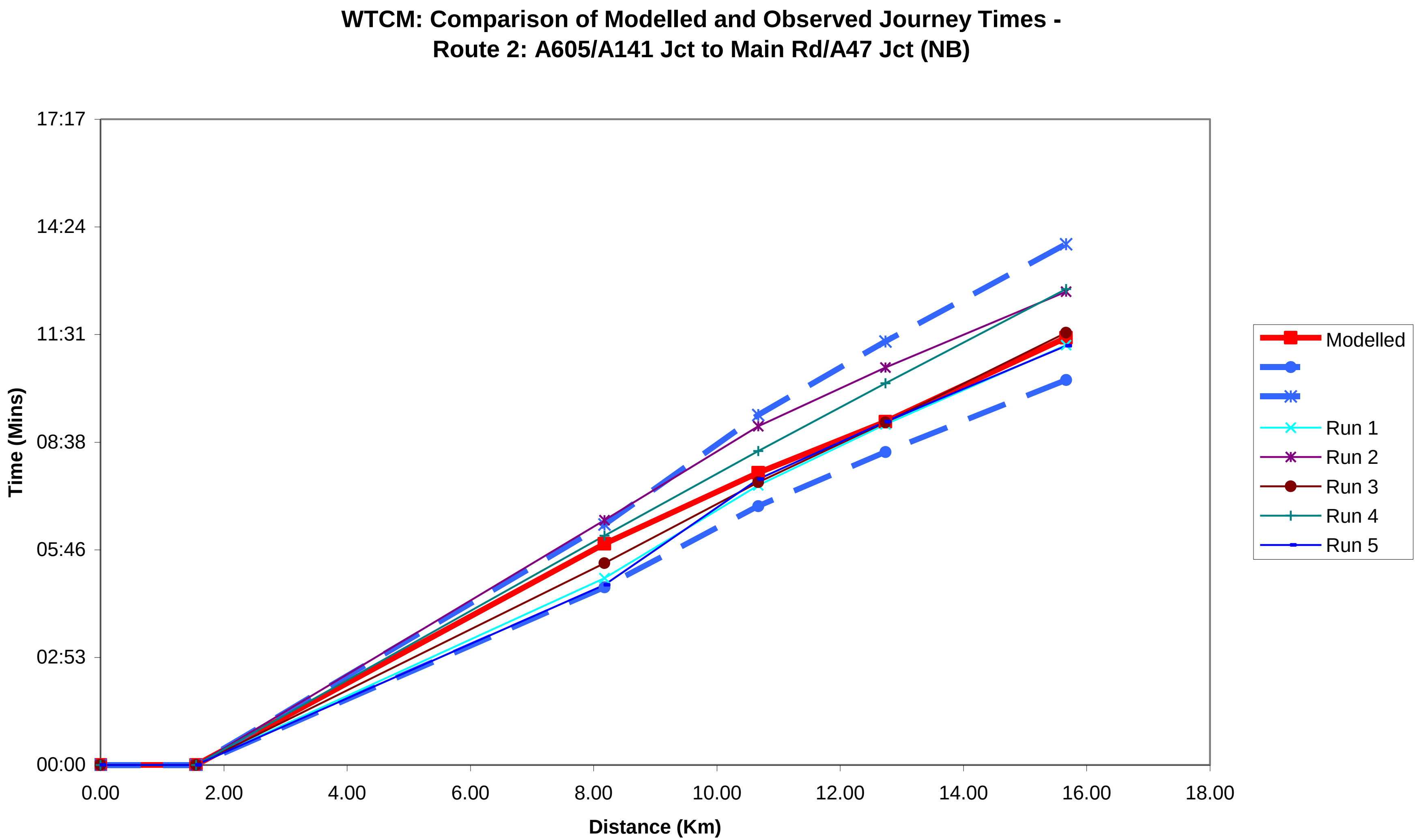


Figure A.11 – Route 2 Northbound, Inter Peak Hour

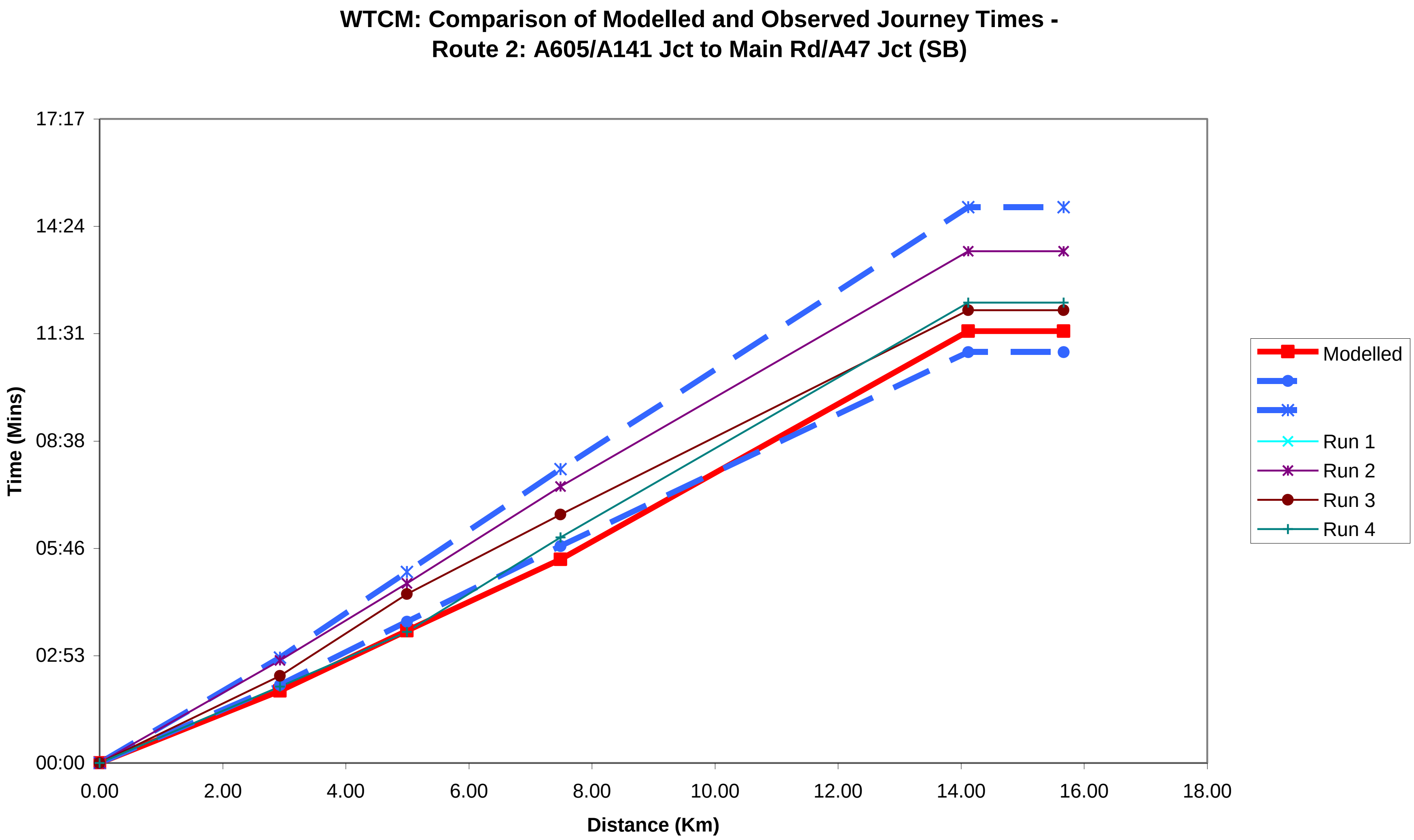


Figure A.12 – Route 2 Southbound, Inter Peak Hour

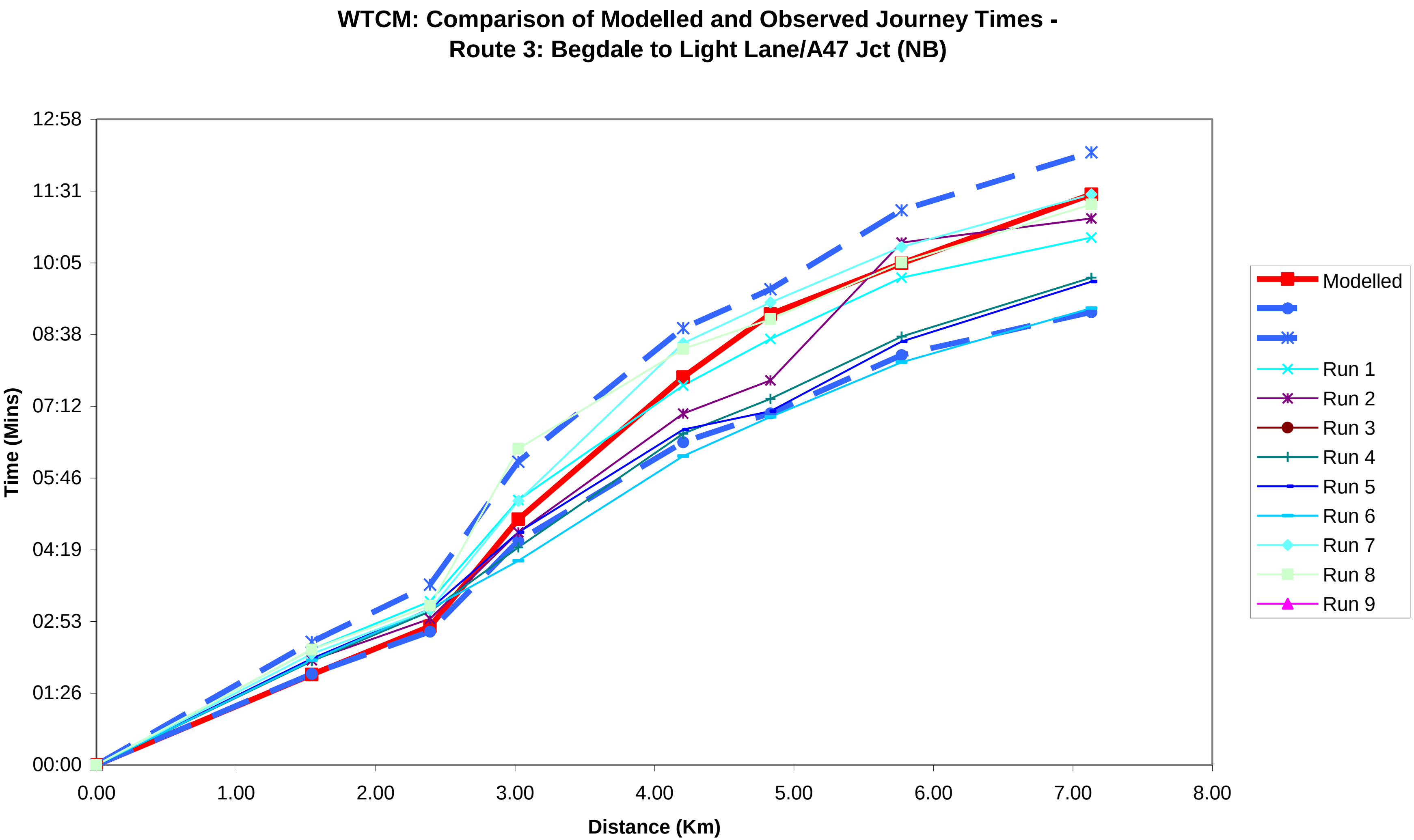


Figure A.13 – Route 3 Northbound, Inter Peak Hour

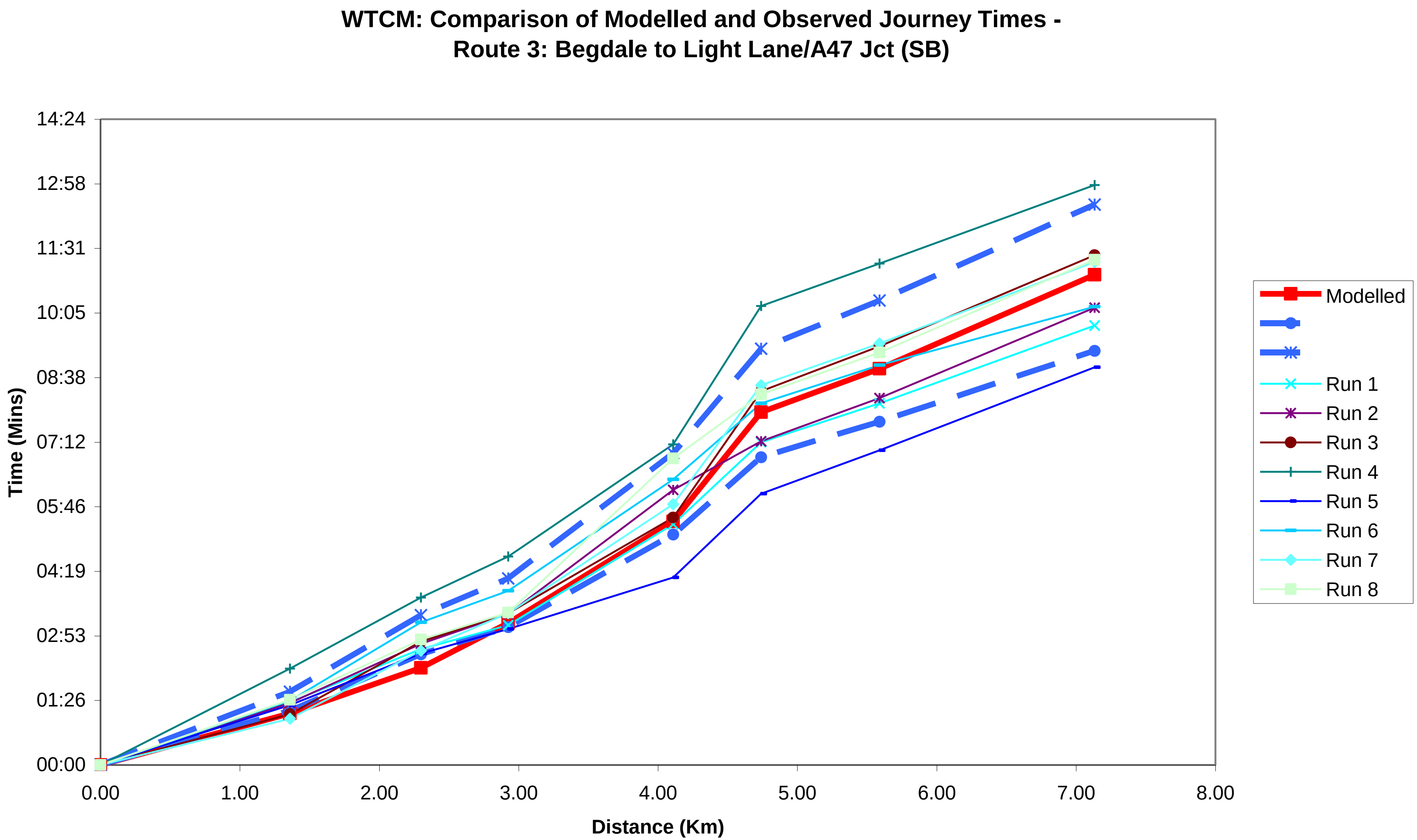


Figure A.14 – Route 3 Southbound, Inter Peak Hour

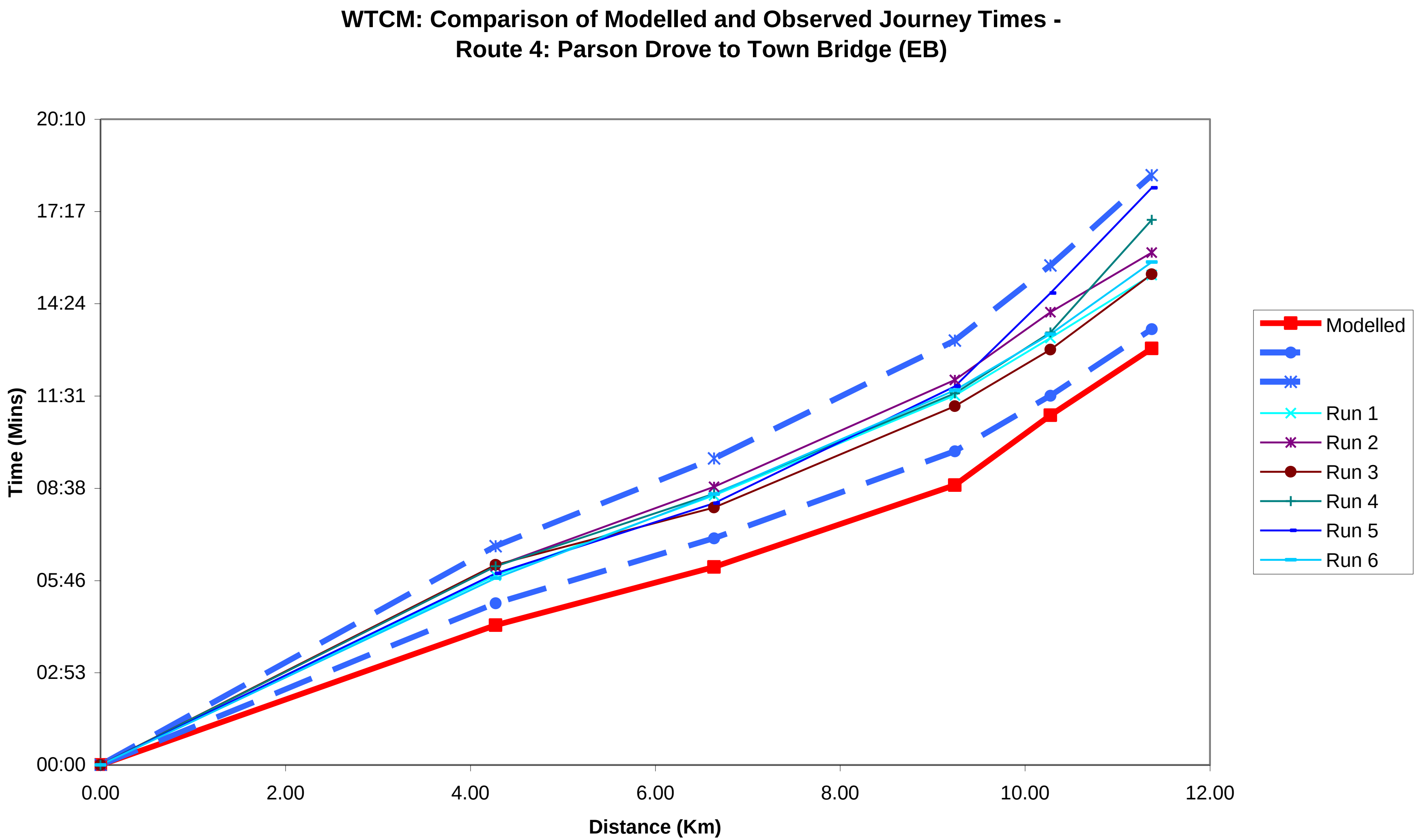


Figure A.15 – Route 4 Eastbound, Inter Peak Hour

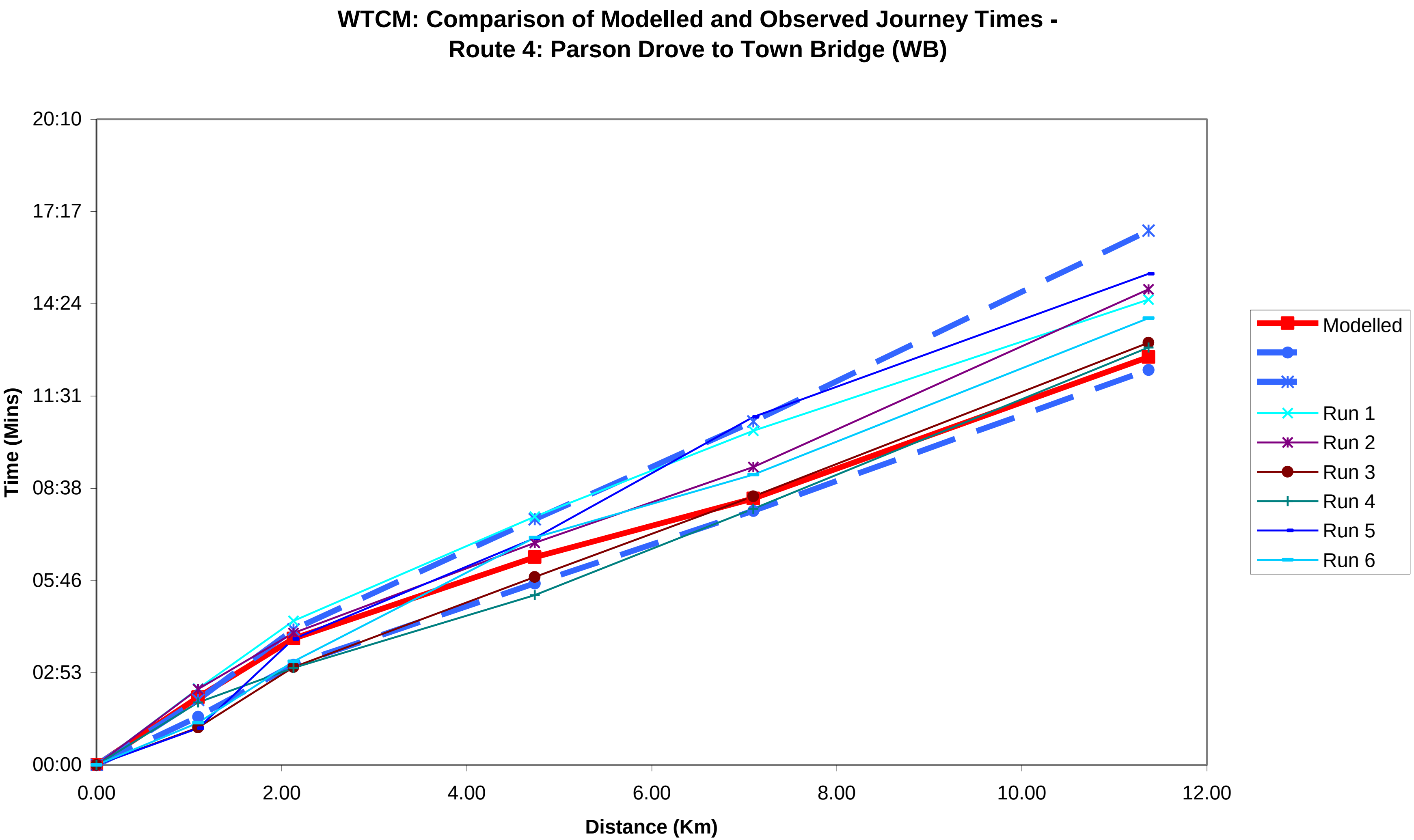


Figure A.16 – Route 4 Westbound, Inter Peak Hour

A.3 PM Peak Hour

Screenline Results

Table A.5 – PM Peak Hour Screenline Results

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
Cordon							
RSI Site 1: Interview Direction	603.5	650.3	-46.8	-0.1	1.9	✓	✓
RSI Site 1: Non-Interview Direction	743.7	758.8	-15.1	0.0	0.6	✓	✓
RSI Site 2: Interview Direction	1021.8	1037.7	-15.9	0.0	0.5	✓	✓
RSI Site 2: Non-Interview Direction	980.0	1022.0	-42.0	0.0	1.3	✓	✓
RSI Site 3: Interview Direction	502.3	462.1	40.2	0.1	1.8	✓	✓
RSI Site 3: Non-Interview Direction	843.8	757.6	86.2	0.1	3.0	✓	✓
RSI Site 4: Interview Direction	459.1	367.7	91.4	0.2	4.5	✓	✓
RSI Site 4: Non-Interview Direction	439.0	352.8	86.2	0.2	4.3	✓	✓
RSI Site 5: Interview Direction	211.9	201.0	10.9	0.1	0.8	✓	✓
RSI Site 5: Non-Interview Direction	294.6	386.6	-91.9	-0.3	5.0	✓	✓
RSI Site 6: Interview Direction	709.4	721.6	-12.1	0.0	0.5	✓	✓
RSI Site 6: Non-Interview Direction	920.0	922.9	-3.0	0.0	0.1	✓	✓
AnnMon7: NB	85.0	85.5	-0.5	0.0	0.0	✓	✓
AnnMon7: SB	59.4	69.3	-9.9	-0.2	1.2	✓	✓
Cordon Total	**7873.4**	**7795.8**	**77.7**	**0.0**	**0.9**	✓	✓
Central Screenline							
AnnMon8: EB	874.2	908.3	-34.2	0.0	1.1	✓	✓
AnnMon8: WB	750.8	758.7	-8.0	0.0	0.3	✓	✓
AnnMon12: EB	506.6	439.7	66.9	0.1	3.1	✓	✓
AnnMon12: WB	278.9	264.2	14.7	0.1	0.9	✓	✓
AnnMon13: SB	210.8	240.9	-30.1	-0.1	2.0	✓	✓

AnnMon13: NB	299.5	329.0	-29.5	-0.1	1.7	✓	✓
Central Screenline Total	**2920.7**	**2940.8**	**-20.1**	**0.0**	**0.4**	✓	✓
Northern Screenline							
AnnMon7: NB	85.0	85.5	-0.5	0.0	0.0	✓	✓
AnnMon7: SB	59.4	69.3	-9.9	-0.2	1.2	✓	✓
RSI Site 4: Interview Direction	459.1	367.7	91.4	0.2	4.5	✓	✓
RSI Site 4: Non-Interview Direction	439.0	352.8	86.2	0.2	4.3	✓	✓
TC13 link count: from A1101 Sutton Road S	582.6	527.8	54.8	0.1	2.3	✓	✓
TC13 link count: to A1101 Sutton Road S	372.5	317.1	55.4	0.1	3.0	✓	✓
Northern Screenline Total	**1997.5**	**1720.2**	**277.4**	**0.1**	**6.4**	✗	✗
Outer Southern Screenline							
RSI Site 1: Interview Direction	603.5	650.3	-46.8	-0.1	1.9	✓	✓
RSI Site 1: Non-Interview Direction	743.7	758.8	-15.1	0.0	0.6	✓	✓
RSI Site 2: Interview Direction	1021.8	1037.7	-15.9	0.0	0.5	✓	✓
RSI Site 2: Non-Interview Direction	980.0	1022.0	-42.0	0.0	1.3	✓	✓
RSI Site 6: Interview Direction	709.4	721.6	-12.1	0.0	0.5	✓	✓
RSI Site 6: Non-Interview Direction	920.0	922.9	-3.0	0.0	0.1	✓	✓
Outer Southern Screenline Total	**4978.4**	**5113.3**	**-134.9**	**0.0**	**1.9**	✓	✓
Western Screenline							
RSI Site 3: Interview Direction	502.3	462.1	40.2	0.1	1.8	✓	✓
RSI Site 3: Non-Interview Direction	843.8	757.6	86.2	0.1	3.0	✓	✓
RSI Site 5: Interview Direction	211.9	201.0	10.9	0.1	0.8	✓	✓

RSI Site 5: Non-Interview Direction	294.6	386.6	-91.9	-0.3	5.0	✓	✓
Western Screenline Total	**1852.6**	**1807.2**	**45.4**	**0.0**	**1.1**	✓	✓

ATKINS

Validation Count Results

Table A.6 – PM Peak Hour Validation Count Results

Description	Observed Flow	Modelled Flow	Diff	% Diff	GEH	DMRB Flow	DMRB GEH
RSI Site 1: Interview Direction	603.5	650.3	-46.8	-0.1	1.9	✓	✓
RSI Site 1: Non-Interview Direction	743.7	758.8	-15.1	0.0	0.6	✓	✓
RSI Site 2: Interview Direction	1021.8	1037.7	-15.9	0.0	0.5	✓	✓
RSI Site 2: Non-Interview Direction	980.0	1022.0	-42.0	0.0	1.3	✓	✓
RSI Site 3: Interview Direction	502.3	462.1	40.2	0.1	1.8	✓	✓
RSI Site 3: Non-Interview Direction	843.8	757.6	86.2	0.1	3.0	✓	✓
RSI Site 5: Interview Direction	211.9	201.0	10.9	0.1	0.8	✓	✓
RSI Site 5: Non-Interview Direction	294.6	386.6	-91.9	-0.3	5.0	✓	✓
RSI Site 7: Interview Direction	692.7	639.8	53.0	0.1	2.1	✓	✓
RSI Site 7: Non-Interview Direction	767.6	688.0	79.6	0.1	2.9	✓	✓
AnnMon2: EB	95.3	79.4	15.9	0.2	1.7	✓	✓
AnnMon2: WB	125.9	178.2	-52.3	-0.4	4.2	✓	✓
AnnMon13: SB	210.8	240.9	-30.1	-0.1	2.0	✓	✓
AnnMon13: NB	299.5	329.0	-29.5	-0.1	1.7	✓	✓
TC5: B198 South Brink to Town Bridge at Town Bridge Jct	241.0	273.4	-32.3	-0.1	2.0	✓	✓
TC5: B198 South Brink to B198 Nene Quay at Town Bridge Jct	304.9	379.0	-74.2	-0.2	4.0	✓	✓
TC5: B198 South Brink to Bridge St at Town Bridge Jct	19.3	27.3	-8.1	-0.4	1.7	✓	✓
TC5: Town Bridge to B198 South Brink at Town Bridge Jct	226.3	173.6	52.7	0.2	3.7	✓	✓
TC5: Town Bridge to B198 Nene Quay at Town Bridge Jct	31.8	82.9	-51.1	-1.6	6.8	✓	×

TC5: Town Bridge to Bridge St at Town Bridge Jct	36.6	11.1	25.5	0.7	5.2	✓	×
TC5: B198 Nene Quay to B198 South Brink at Town Bridge Jct	288.1	302.7	-14.6	-0.1	0.9	✓	✓
TC5: B198 Nene Quay to Town Bridge at Town Bridge Jct	19.3	0.0	19.3	1.0	6.2	✓	×
TC5: Bridge St to B198 South Brink at Town Bridge Jct	37.1	17.2	19.9	0.5	3.8	✓	✓
TC5: Bridge St to Town Bridge at Town Bridge Jct	23.7	62.0	-38.3	-1.6	5.9	✓	×
TC5: Bridge St to B198 Nene Quay at Town Bridge Jct	63.0	39.6	23.3	0.4	3.3	✓	✓
TC5: Alexandra Rd to B198 South Brink at Town Bridge Jct	27.0	0.0	26.9	1.0	7.3	✓	×
TC5: Alexandra Rd to Town Bridge at Town Bridge Jct	180.8	51.6	129.1	0.7	12.0	×	×
TC5: Alexandra Rd to B198 Nene Quay at Town Bridge Jct	39.5	30.9	8.6	0.2	1.4	✓	✓
TC5: Alexandra Rd to Bridge St at Town Bridge Jct	5.8	0.0	5.8	1.0	3.4	✓	✓
TC5: Old Market to Town Bridge at Town Bridge Jct	291.8	267.6	24.2	0.1	1.4	✓	✓
TC5: Old Market to North Brink at Town Bridge Jct	37.5	0.9	36.7	1.0	8.4	✓	×
TC5: Town Bridge to Old Market at Town Bridge Jct	284.6	250.0	34.7	0.1	2.1	✓	✓
TC5: Town Bridge to North Brink at Town Bridge Jct	181.0	137.0	43.9	0.2	3.5	✓	✓
TC5: North Brink to Old Market at Town Bridge Jct	1.0	0.0	1.0	1.0	1.4	✓	✓
TC5: North Brink to Town Bridge at Town Bridge Jct	2.9	0.0	2.9	1.0	2.4	✓	✓

TC13: A1101 Sutton Rd N to A1101 Sutton Rd S at A1101/Little Ramper Jct	329.2	282.2	47.0	0.1	2.7	✓	✓
TC13: A1101 Sutton Rd N to Little Ramper at A1101/Little Ramper Jct	15.9	37.8	-22.0	-1.4	4.2	✓	✓
TC13: A1101 Sutton Rd S to A1101 Sutton Rd N at A1101/Little Ramper Jct	489.2	454.5	34.7	0.1	1.6	✓	✓
TC13: A1101 Sutton Rd S to Little Ramper at A1101/Little Ramper Jct	93.4	73.3	20.1	0.2	2.2	✓	✓
TC13: Little Ramper to A1101 Sutton Rd N at A1101/Little Ramper Jct	16.8	31.8	-15.0	-0.9	3.0	✓	✓
TC13: Little Ramper to A1101 Sutton Rd S at A1101/Little Ramper Jct	43.3	35.0	8.4	0.2	1.3	✓	✓
CP1 921 Kingswalk in	65.5	54.6	10.9	0.2	1.4	✓	✓
CP1 921 Kingswalk out	133.8	107.4	26.4	0.2	2.4	✓	✓
CP1 921 Alexandra Road in	44.3	56.0	-11.7	-0.3	1.7	✓	✓
CP1 921 Alexandra Road out	91.0	117.4	-26.4	-0.3	2.6	✓	✓
CP2 923 in	8.7	6.6	2.1	0.2	0.7	✓	✓
CP2 923 out	10.6	10.6	0.0	0.0	0.0	✓	✓
CP3 924 in	4.8	7.2	-2.4	-0.5	1.0	✓	✓
CP3 924 out	14.0	14.0	0.0	0.0	0.0	✓	✓
CP4 929 in	1.9	3.9	-1.9	-1.0	1.1	✓	✓
CP4 929 out	4.8	4.8	0.0	0.0	0.0	✓	✓
CP5 926 in	10.6	9.1	1.4	0.1	0.5	✓	✓
CP5 926 out	56.3	56.3	0.0	0.0	0.0	✓	✓
CP6 925 out	4.8	4.8	0.0	0.0	0.0	✓	✓
CP7 922 Somers Road in	11.6	9.8	1.7	0.1	0.5	✓	✓
CP7 922 Somers Road out	55.8	58.8	-3.0	-0.1	0.4	✓	✓

CP7 922 Queens Road in	12.0	11.3	0.7	0.1	0.2	✓	✓
CP7 922 Queens Road out	76.5	73.6	3.0	0.0	0.3	✓	✓
CP8 927 in	20.2	14.9	5.3	0.3	1.3	✓	✓
CP8 927 out	17.8	17.8	0.0	0.0	0.0	✓	✓
CP9 928 in	54.9	70.0	-15.1	-0.3	1.9	✓	✓
CP9 928 out	98.7	118.7	-20.0	-0.2	1.9	✓	✓
Overall Validation Count Results						**98%**	**89%**

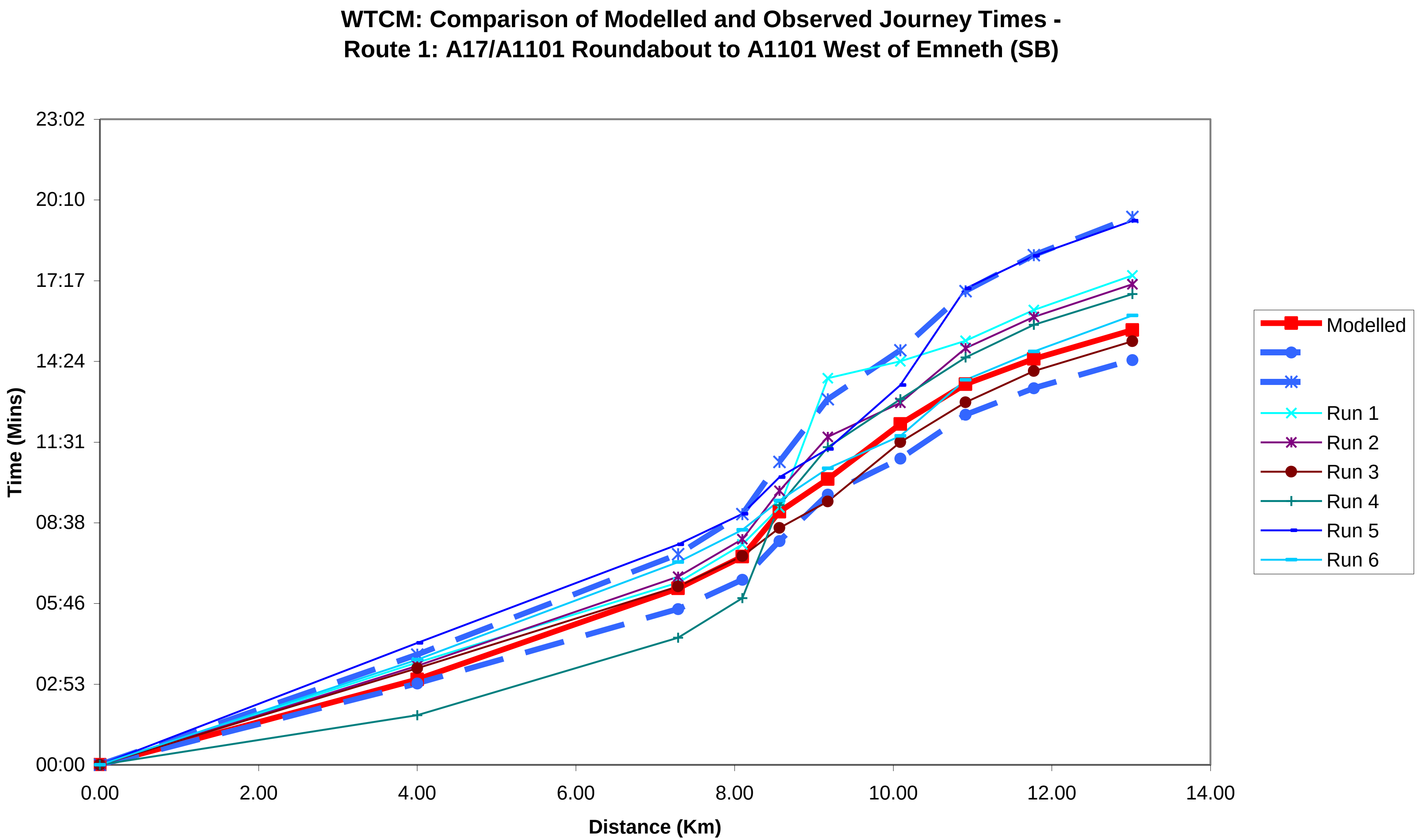


Figure A.17 – Route 1 Southbound, PM Peak Hour

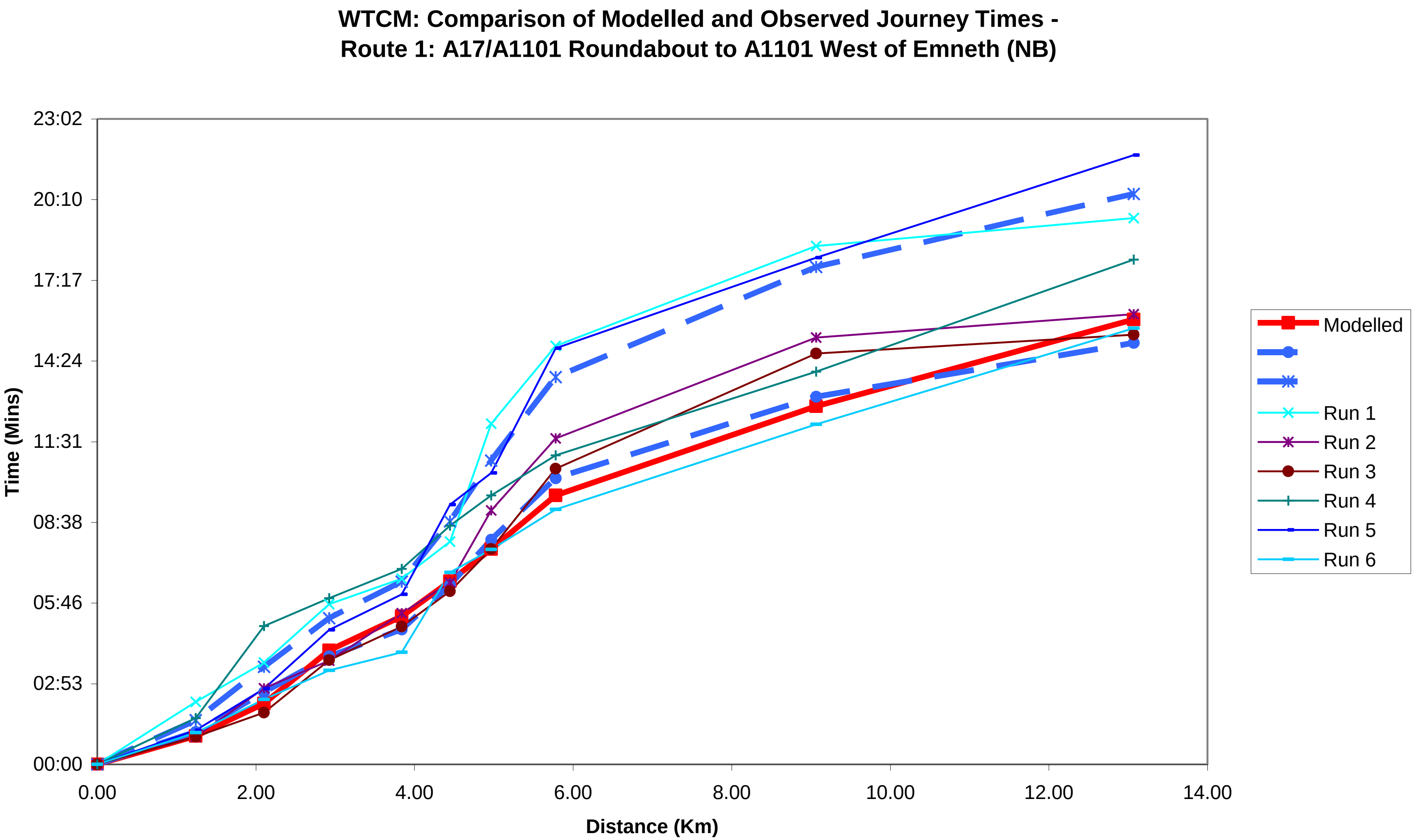


Figure A.18 – Route 1 Northbound, PM Peak Hour

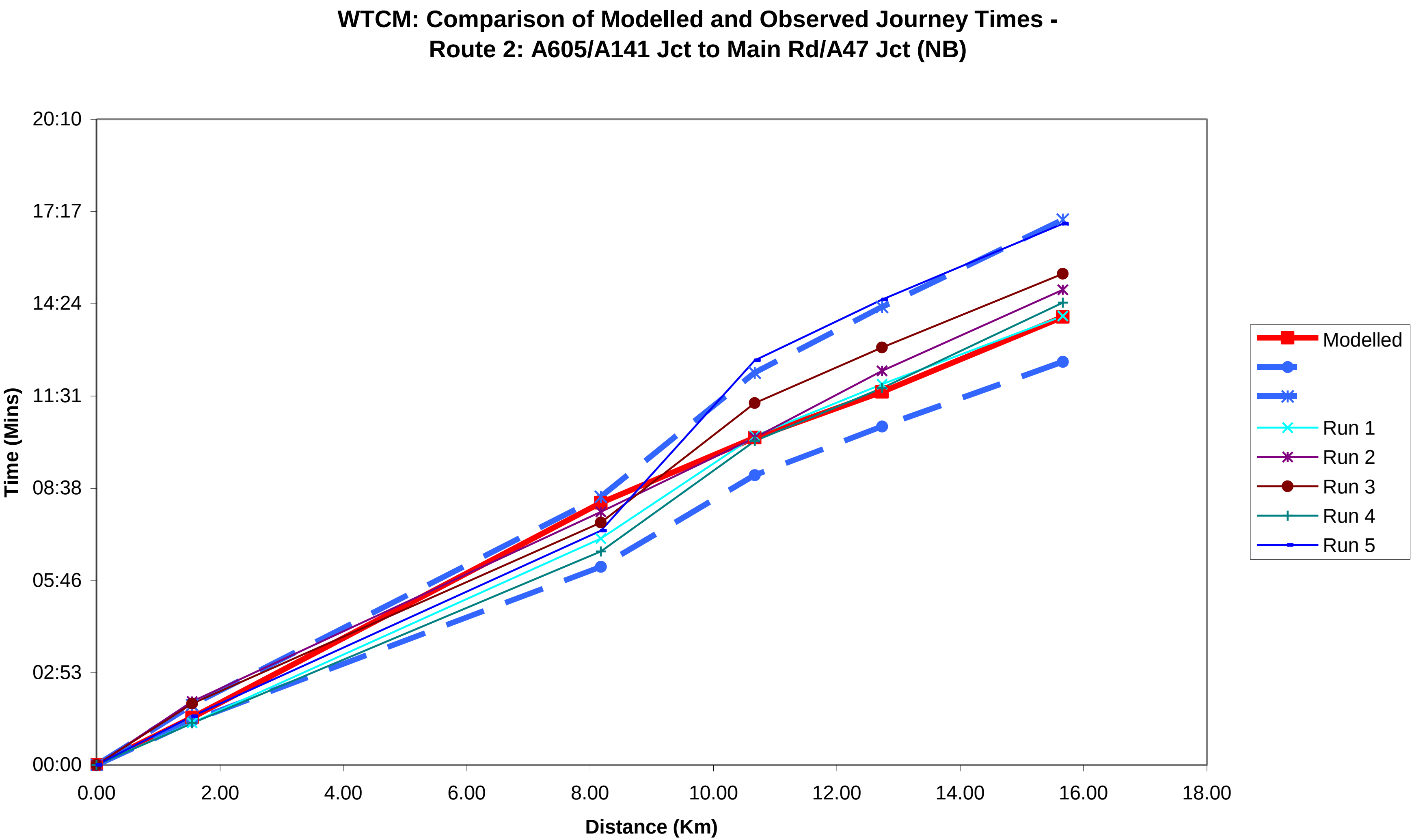


Figure A.19 – Route 2 Northbound, PM Peak Hour

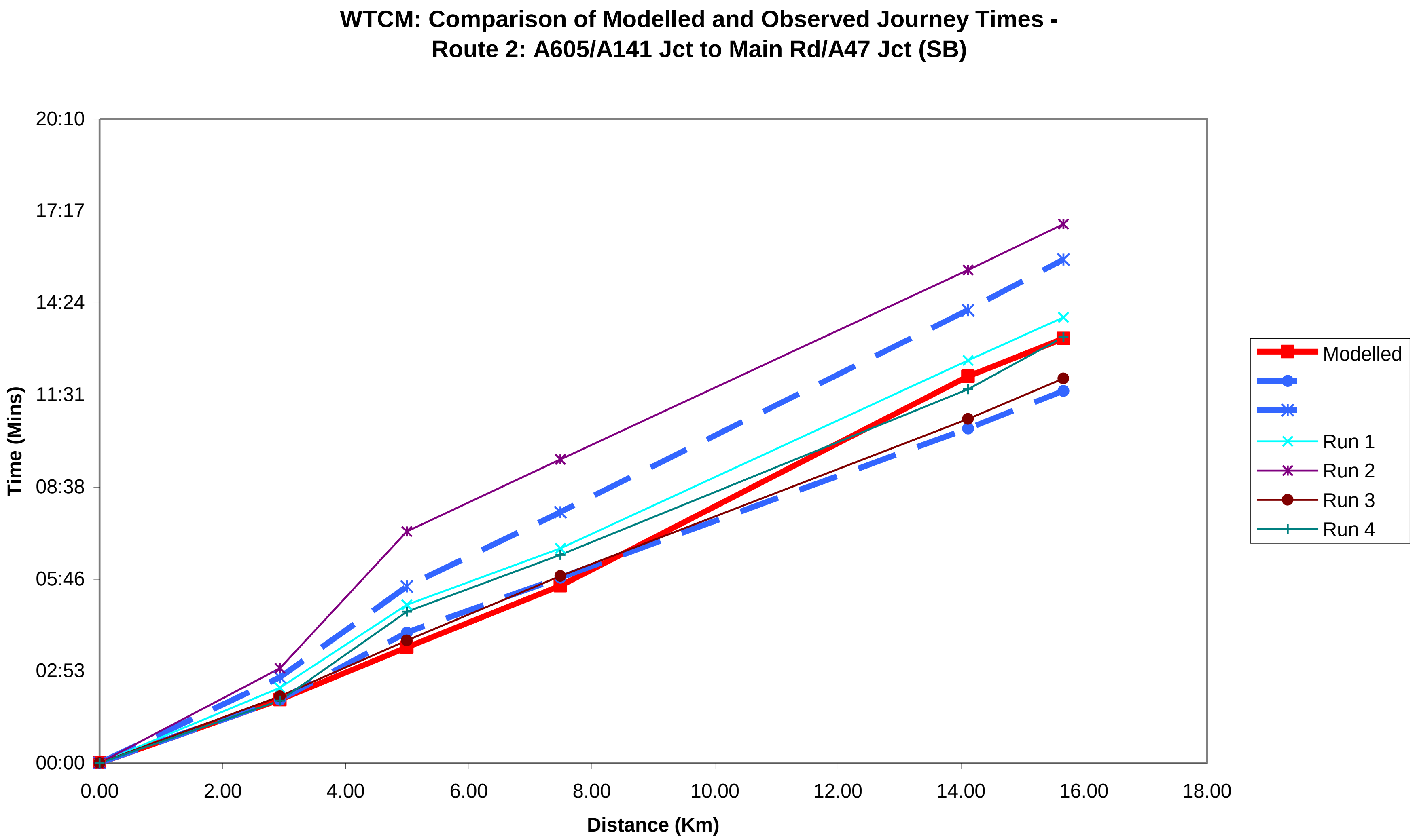


Figure A.20 – Route 3 Southbound, PM Peak Hour

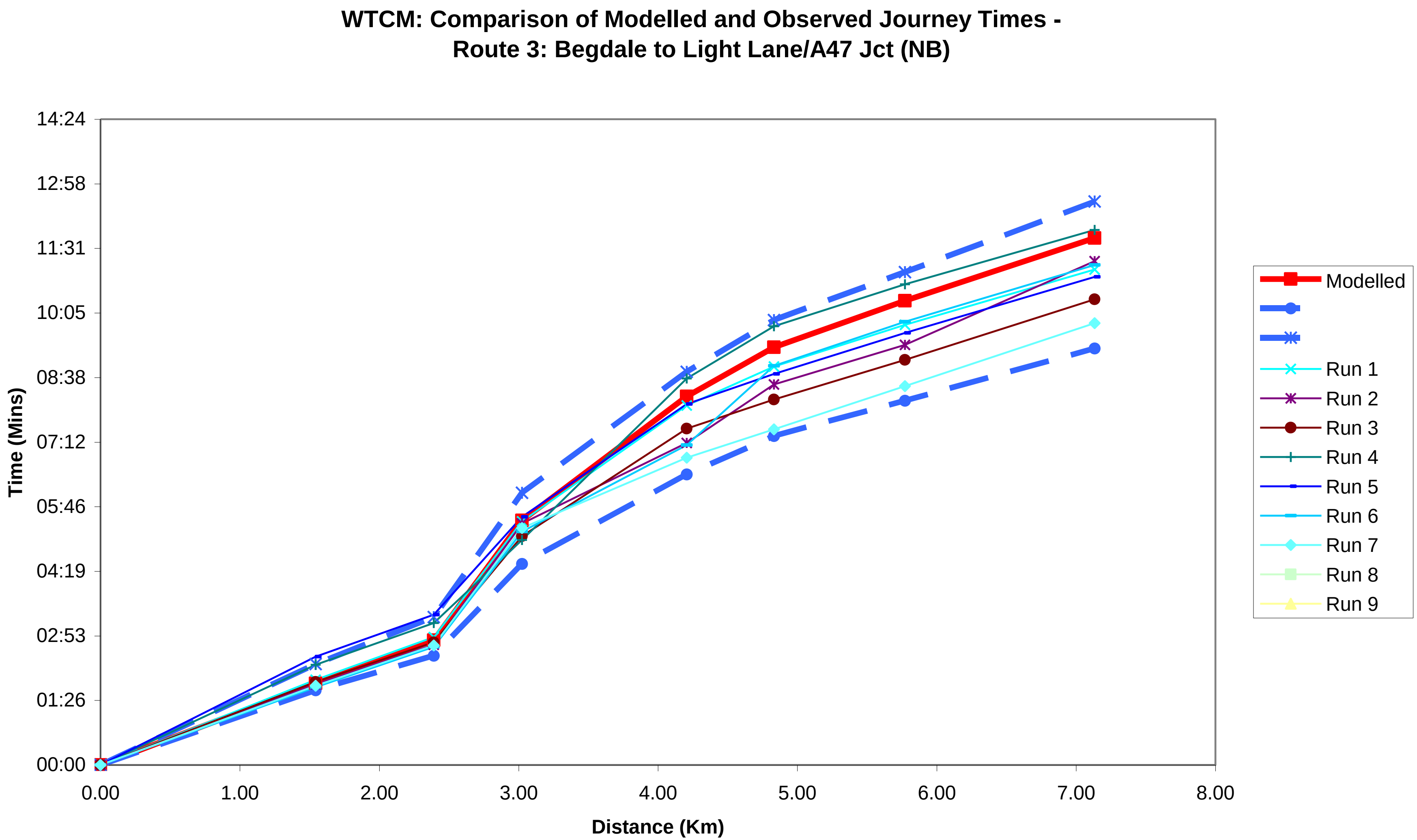


Figure A.21 – Route 3 Northbound, PM Peak Hour

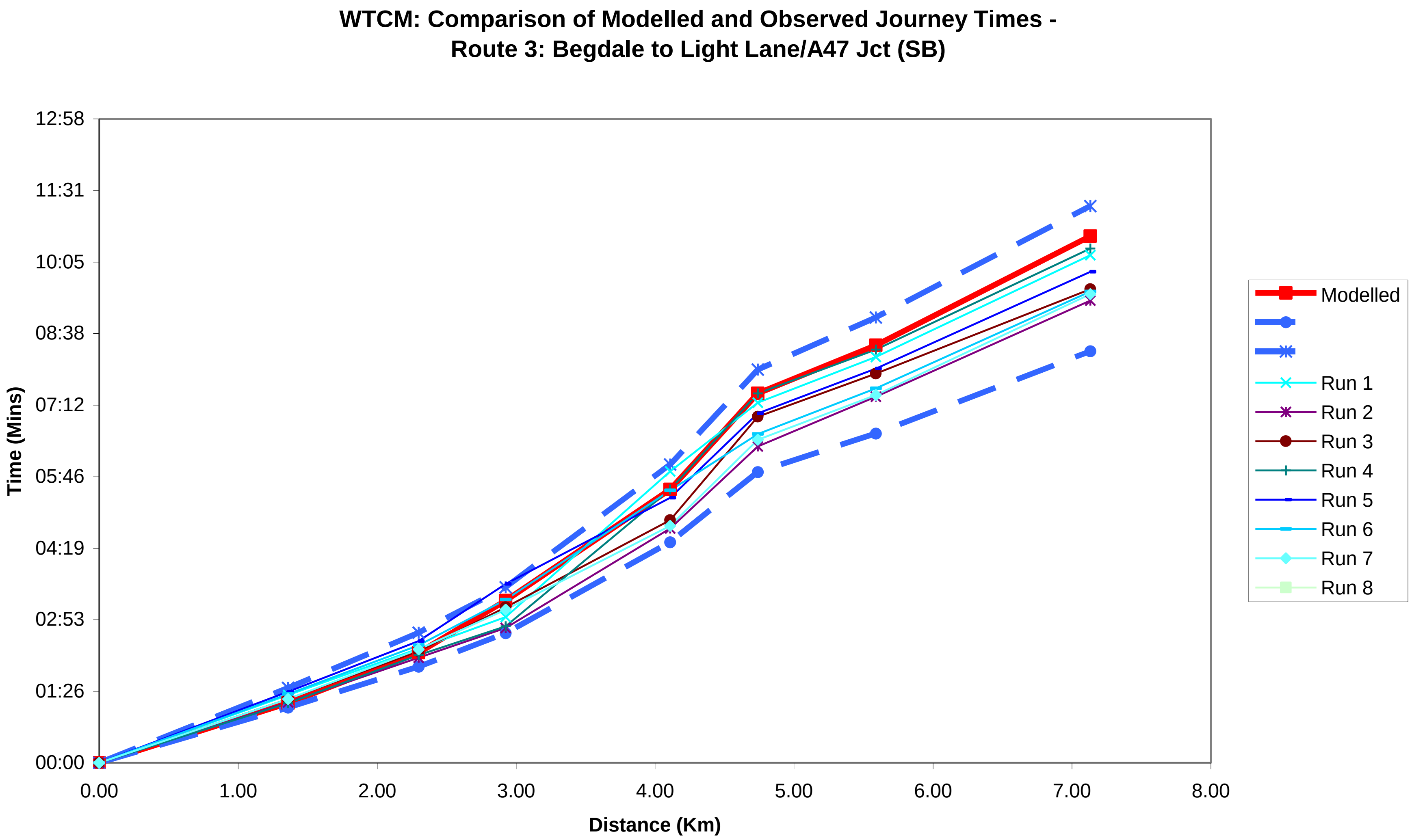


Figure A.22 – Route 3 Southbound, PM Peak Hour

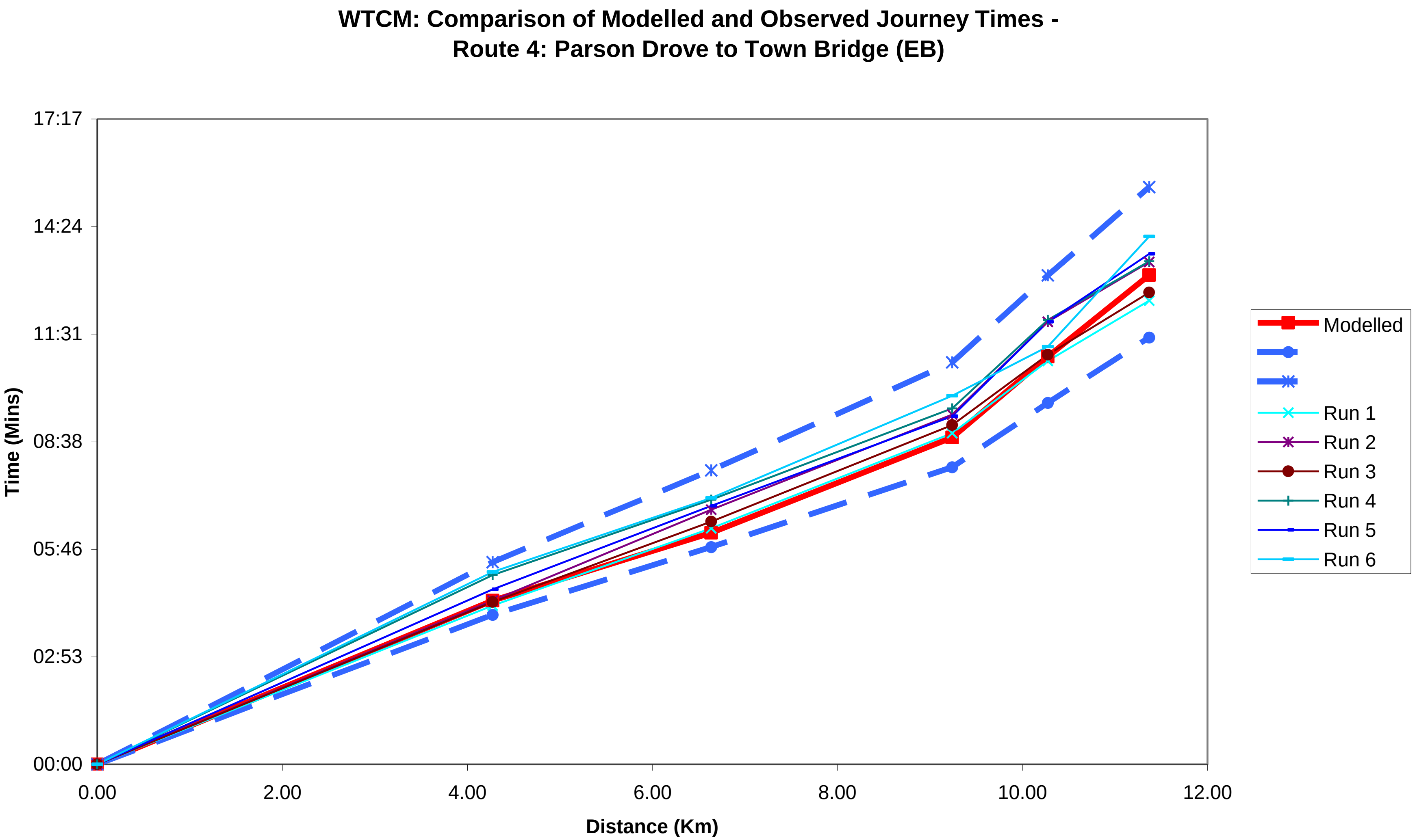


Figure A.23 – Route 4 Eastbound, PM Peak Hour

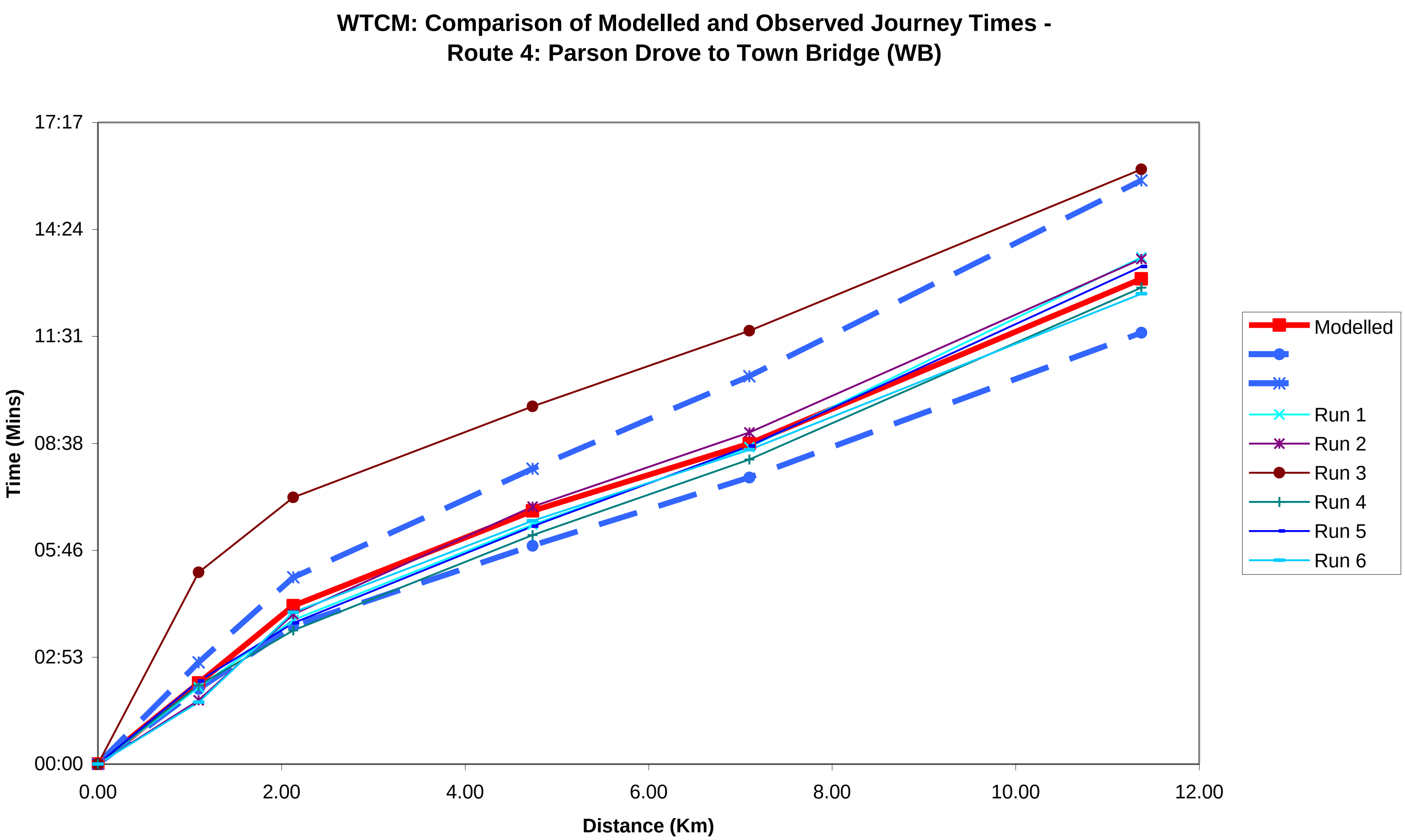


Figure A.24 – Route 4 Westbound, PM Peak Hour