A89/ A8 Corridor – Public Transport Improvement Study

Prepared by: .... Checked by: ....

Paul Cameron / Colin Hardie — Iain Henderson

Regional Director / Principal Consultant — Principal Consultant

Approved by: ....

Paul Cameron

Regional Director

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1 Tanfield, Edinburgh, EH3 5DA
Telephone: 0131 301 8600 Website: http://www.aecom.com

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Executive Summary

This is the outcome of a public transport study for the A89/ A8 between the Kilpunt Roundabout in Broxburn and Maybury Road Junction in Edinburgh. Through a robust option appraisal process it was demonstrated that bus lanes/ priority measures and high quality active travel infrastructure will need to be invested in to ensure the future needs of all road users using the corridor are considered. It is estimated that the indicative cost to deliver these measures would be around £11 million in the next 5 to 10 years (medium term).

The Forth Replacement Crossing Public Transport Strategy (FRCPTS) was published in January 2010 by Transport Scotland, in conjunction with the South East Scotland Regional Transport Partnership (SEStran), The City of Edinburgh and West Lothian Councils. A refreshed Strategy was produced in August 2012 with a purpose to support the Forth Replacement Crossing by delivering effective public transport facilities, and to ensure that levels of service provided for all transport modes is at least equal to that which was provided in 2006. Its investigation identified the implementation of a range of schemes and measures would be required to deliver this target. This included public transport improvements at the Newbridge Interchange, along with bus lanes on the A89 and A8 as well as the installation of traffic signals on the A8/ Station Road. These intervention measures are also contained within other strategies such as the West Edinburgh Transport Appraisal (WETA) and the Transport Infrastructure for West Edinburgh Phase 1 (TISWEP) studies.

This study takes full account of these strategies and others by developing strategically aligned intervention measures and then testing them through rigorous traffic micro simulation modelling. A subsidiary aim of the study was to ensure that provision for walking and cycling along the corridor were investigated to identify any gaps in service provision that could encourage a shift away from the car.

When assessing against the various transport strategies and deliverability (including public acceptability through stakeholder engagement meetings), a number of the justifiable intervention measures were taken forward to the option appraisal and development stages.

This allowed the rationalisation of the traffic modelling work into three distinct traffic models (excluding the base models):

- Near sided bus lane using the existing road space which resulted in significant congestion issues;
- The construction of a bus lane through local road widening, which yielded the best results; and
- The addition of traffic signals at Station Road which had a negative impact on the network performance.

Results

The aim of this study was to identify the intervention measures required to aid public transport movement along the A89/ A8 corridor and thus improve bus journey times. The most pragmatic way of achieving this is through bus lanes and potentially by intelligent bus priority measures.

To support public transport enhancements, active travel improvements can also offer a credible alternative to the car. To capitalise further on the existing strategic walking and cycle network along the A8 corridor the active travel audit carried out identifies further design work that would be required to establish the cycling/ walking investment required to do so.

Bus priority measures assist buses through traffic with more consistent journey times helping deliver timetable reliability. In addition to quality and frequency, reliability is the most important issue in attracting and maintaining public transport usage. In almost every survey about bus services, reliability is one of the most important issues for bus users. Motorists cite reliable bus services as a pre-requisite for leaving their car at home. Through the scheme evaluation work, increasing road space through the introduction of bus lanes is the only way to ensure this without creating detriment to other traffic. This requires design development of the identified measures to establish costs and the land needed to allow this to happen. The introduction of Intelligent Transport Systems (ITS) based bus priority solutions would strengthen further bus reliability but would require a detailed investigation as part of an ITS strategy for the SEStran region.

One of the objectives of the FRCPTS is the provision of traffic signal at Station Road however the traffic modelling work has shown a decrease in network performance and so further investigation is required to look at alternatives such as a stand-alone controlled crossing facility.

Introduction

1 Introduction

1.1 Study Background

AECOM have been appointed to undertake a Public Transport Study on the A89/ A8 corridor between Broxburn, and the Maybury Road Junction, Edinburgh. The commission is a joint initiative between Transport Scotland, SEStran, West Lothian Council and The City of Edinburgh Council (CEC). CEC have agreed to take the lead role in the delivery of this study on behalf of the project partners.

1.2 Commission Objective

The Forth Replacement Crossing Public Transport Strategy (FRCPTS) was published in January 2010 by Transport Scotland, in conjunction with the South East Scotland Regional Transport Partnership (SEStran) and the relevant local authorities. A refreshed Strategy was prepared in August 2012 by Transport Scotland (TS), SEStran, The City of Edinburgh, Fife and West Lothian Councils, Scotrail, Lothian Buses, Stagecoach, First Bus and the Confederation of Passenger Transport. The FRCPTS's purpose is to support the Forth Replacement Crossing (FRC) by delivering effective public transport facilities, and to ensure that levels of service provided for all transport modes after the opening of the Forth Replacement Bridge Crossing, which has now been named the "Queensferry Crossing", is at least equal to that which was provided in 2006.

This study takes full account of this and focuses on improving the flow of public transport on the A89/ A8 corridor, ideally without creating detriment to general traffic. A subsidiary aim of the study is to ensure that provision for walking and cycling on the corridor is improved.

1.3 Study Approach

As per the Scope of Service, this is a feasibility design study that does not require a full Scottish Transport Appraisal Guidance (STAG). The options being considered, however, match the methodology set out in it in order to make an informed choice of the most appropriate option(s) for design development.

1.4 Structure of Report

Following this introductory chapter, the remainder of this report is set out as follows:

- Chapter 2 – Background & Policy Context;
- Chapter 3 – Route Appraisal;
- Chapter 4 – Stakeholder Consultation;
- Chapter 5 – Option Development;
- Chapter 6 – Option Appraisal;
- Chapter 7 – Traffic Model Calibration & Validation;
- Chapter 8 – Traffic Model Analysis; and
- Chapter 9 – Summary & Conclusion

Background and Policy Context

2 Background & Policy Context

2.1 Study Area

The study area, as shown in Figure 2.1, comprises a distance of nearly 10km along the A89/ A8 corridor; from the Kilpunt Roundabout in Broxburn, West Lothian, and eastwards to the Maybury Road Junction in Edinburgh. There are several key junctions along this route, including the Newbridge Interchange, Gogar Roundabout and Maybury Junction, all of which can result in considerable delays to public transport and general traffic during the peak traffic periods.

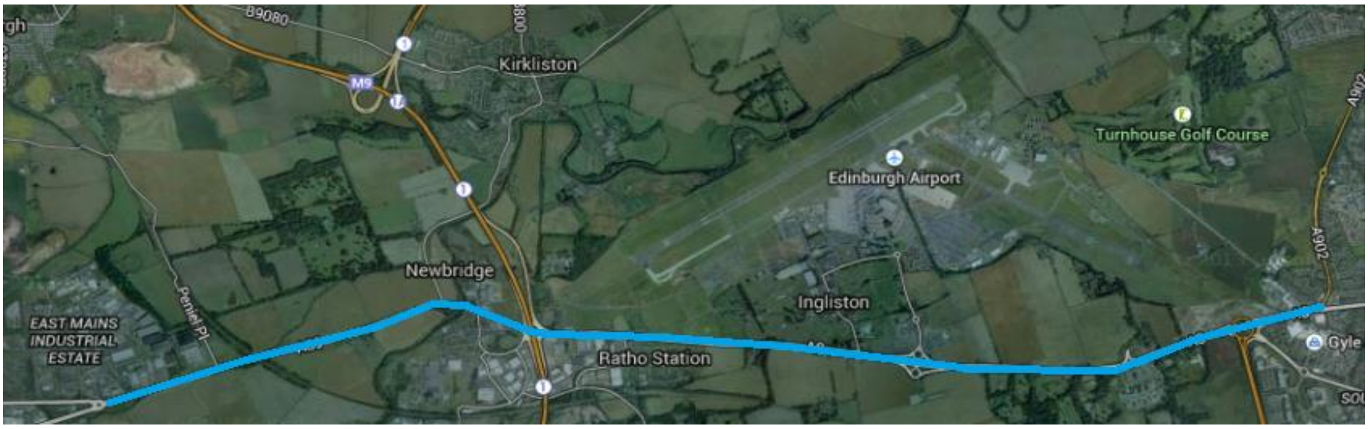


Figure 2.1: Corridor Extent

2.2 Study Background

The FRCPTS was published to support the FRC by delivering effective public transport facilities, and to ensure that levels of service provided for all transport modes after the opening of the FRC are at least equal to that which was provided in 2006, after the opening of the Queensferry Crossing.

The FRCPTS provides full detail of the analysis undertaken of cross-Forth demand and the subsequent analysis techniques used to develop the strategy. The study was informed by actual and forecast origin and destination analysis, local authority land-use plans and information on a number of committed and proposed transport interventions throughout the area.

Demand for travel across the Forth currently exceeds capacity in the peak hours. Looking to the future, the adopted and emerging land use plans of the adjacent local authorities indicate a continued increase in the demand for travel across the Forth in both directions.

The analysis shows that the future origins and destinations remain broadly similar to those at present. However, considerable growth forecast at some of these sites (including Edinburgh Airport and west Edinburgh), as well as land releases at Winchburgh and West Lothian, mean the level of transport demand at these locations is predicted to increase substantially along the A89/ A8 corridor.

The analysis that accompanied the FRCPTS demonstrated that implementation of a range of measures are required to deliver the level of service outlined in the strategy. This study was appointed to take account of the content of the FRCPTS and focus on improving the flow of public transport in the vicinity of Newbridge Junction and along the A89/ A8 towards Edinburgh. The existing Public Transport Strategy already identifies bus lanes on the A8 westbound and A89 eastbound and improvements to Newbridge Roundabout, for short to medium term delivery. These are:

- Eastbound bus lane on the A89 from Broxburn eastwards for approximately 2.1 kilometres;
- Eastbound bus lanes on the A8 from Eastfield Road eastwards for approximately 2.5 kilometres;
- Westbound bus lane on the A8 from Station Road westwards for approximately 500 metres; and
- Provision of traffic signals at Station Road, Ratho.

2.3 Study Aim

The focus of this study is to develop and test preliminary designs for public transport infrastructure improvements for the A89/ A8 Newbridge Interchange Corridor and demonstrate how these design options are likely to improve public transport journey times. The key problem on the corridor is associated with travel through the Newbridge Interchange which is currently being tackled by making the existing traffic signal operational times a more efficient form of control, able to deliver substantially reduced traffic delays.

The designs will take into account The Equalities Act 2010 and focus on either developing additional public transport capacity through land acquisition or making use of the existing infrastructure through lane allocation and/or Intelligent Transport Systems-based solutions. The designs should consider localised queue jumps as well as a more strategic corridor-based approach. The extents of any bus lanes should be determined as part of the study and be fully justified through rigorous model testing. Bus passenger infrastructure should also be audited with improvements highlighted that may increase the level of service to the travelling public. A subsidiary aim of the study is to ensure that provision for walking and cycling on the corridor is improved, which should include a Toucan crossing on the A89 east of (and preferably near to) the minor road which joins the A89 from the south.

The aim of this study is to identify the intervention measures required to aid public transport movement along the A89/ A8 corridor and thus improve bus journey times. These improvements are to complement the proposals set out in the Forth Replacement Crossing Public Transport Strategy (FRCPTS) and other relevant strategies.

The following study objectives are required to be met in order to meet the study aim:

- To identify existing problems in the corridor, by reviewing previous studies and documents;
- To develop appropriate designs for public transport infrastructure improvements in the corridor;
- To undertake microsimulation modelling of the designs, and to interpret results obtained;
- To identify the design that best meets the aim of the study, and to evaluate its estimated cost;
- To identify gaps in bus passenger infrastructure;
- To provide an active travel audit; and
- To undertake the preliminary design for a pedestrian/ cyclist (Toucan) crossing on the A89 near the railway viaduct.

2.4 Policy Context

A review of existing documents was undertaken, which helped to understand the history, philosophy, and operation of the existing corridor within a strategic context. Such an approach provided a behind-the-scenes look at the corridor that would not be directly observable from a site assessment and highlight issues not noted by other means.

Committed and future development proposals along the route corridor were also considered. Looking to the future, the adopted and emerging land use plans of the adjacent local authorities indicate a continued increase in demand for travel which will considerably affect the study corridor. First of all, a comprehensive review of current and emerging policies and action plans at national, regional and local levels was undertaken to provide a basis in which to develop the most aligned proposals.

2.4.1 The Scottish Government – Strategic Objectives

These are contained in five objectives that underpin the Scottish Government's core purpose to 'create a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth'.[1]

- **Wealthier and fairer** by providing opportunities for everyone and not just car owners;
- **Safer and stronger** by providing dedicated shared use facilities including crossing facilities along the route;
- **Greener** buses can reduce congestion, carbon emissions by maximising use of road space;
- **Smarter** by linking people with workplaces, retail and business; and
- **Healthier** through improvements that encourage active travel that could help towards reducing obesity.

2.4.2 The National Transport Strategy

The National Transport Strategy (NTS), produced by the Scottish Government and published in 2006, considers Scotland's transport needs and the needs of travellers over the medium to long term. It sets the framework for the Strategic Transport Project Review (STPR) and will determine the Government's future infrastructure investment. Three key strategic outcomes are identified within the NTS:[2]

- **Improve journey times and connections** between our cities and towns and our global markets to tackle congestion and provide access to key markets;
- **Reduce emissions** to tackle climate change; and
- **Improve quality, accessibility and affordability** of transport, to give people the choice of public transport and real alternatives to the car.

These outcomes feed directly into the five strategic objectives above and will set the context for transport policy making and inform in the decision making process.

[1] http://www.gov.scot/About/Performance/Strategic-Objectives
[2] http://www.gov.scot/Resource/Doc/157751/0042649.pdf

2.4.3 SEStran Regional Transport Strategy Refresh

SEStran's Regional Transport Strategy (RTS) lays out the vision for the strategic development of transport in SE Scotland up to 2025 and includes a particular focus on links to and from Edinburgh, as the economic hub of the region.[3] First produced in 2008, the RTS has undergone a thorough update and refresh of the objectives which are:

- **Economy** - to ensure transport facilitates economic growth, regional prosperity and vitality in a sustainable manner;
- **Accessibility** - to improve accessibility for those with limited transport choice (including disabled people) or no access to a car, particularly those who live in rural areas;
- **Environment** - To ensure that development is achieved in an environmentally sustainable manner; and
- **Safety and Health** - To promote a healthier and more active SEStran area population.

Like the NTS, these objectives have been mapped to the high level objectives of the Scottish Government and set the policy framework that will guide effective transport provision over the cross-boundary areas. Of particular reference to this study are:

- Improvements to Newbridge Roundabout;
- Bus lanes on the A89/A8; and
- Queue relocation near Newbridge Roundabout from Ratho and around Station Road.

2.4.4 Forth Replacement Crossing Public Transport Strategy

The Forth Replacement Crossing Public Transport Strategy (FRCPTS) was published in January 2010, with the main purpose of supporting the FRC project.[4] The report identifies various public transport improvements for the A89/ A8 corridor. These are:

- Improvements to Newbridge Roundabout;
- Bus lane on the A89 eastbound from Broxburn to Newbridge;
- Bus lane on the A8 from Eastfield Road at Edinburgh Airport eastwards to Gogar Roundabout;
- Bus lane on the A8 westbound bus lane from Station Road to Newbridge Roundabout;
- Traffic signals at Station Road Ratho on A8, incorporating queue relocation towards Newbridge Roundabout; and
- Queue relocation near Newbridge Roundabout from Ratho and around Station Road.

[3] http://www.sestran.gov.uk/files/Regional%20Transport%20Strategy.pdf
[4] http://www.sestran.gov.uk/uploads/frc_-_pts_-_forth_replacement_crossing_-_public_transport_strategy_-_the_refreshed_strategy_-_1_august_2012.pdf

This Strategy will also complement the impact of the Edinburgh International Implementation Plan to create an International Business Gateway around Edinburgh Airport. The transport appraisal undertaken for the Business Gateway has developed transport requirements based on achieving a 50% mode share for travel to the west of Edinburgh area by public transport, cycling and walking. This appraisal has identified that there is a need to deliver bus priority on the M8, A8 and the A89. These measures complement this Public Transport Strategy by proposing the following intervention measures:

- Reconstruction of the junction of the A8 with Eastfield Road which runs towards Edinburgh Airport;
- Upgrading of Gogar Roundabout by providing an additional lane on the inside of the roundabout (separate study);
- Upgrading at Newbridge Roundabout to enhance its capacity;
- Public transport priority on the A89; and
- A8 widening in both directions between Eastfield Road and Newbridge Roundabout to incorporate bus lanes.

2.4.5 SESplan Strategic Development Plan and Supplementary Guidance

SESplan's Strategic Development Plan (SDP) recognises existing development commitments and promotes a sustainable pattern of growth.[5] The strategy includes proposals for the development of strategic transport and infrastructure networks to support growth and to meet the needs of communities. These are:

- Improvements to the A89;
- Bus priority in approaches to Newbridge; and
- Upgrades at Newbridge Interchange.

2.4.6 Transport Infrastructure Study for West Edinburgh Phase 1

In May 2008, the Scottish Government published the West Edinburgh Planning Framework (WEPF), which sets out the long term vision for the area. The WEPF required an appraisal of transport interventions to support its implementation. The subsequent appraisal was the West Edinburgh Transport Appraisal (WETA) which set out the results needed to assist choosing the policies and interventions required to be taken forward.

Following the WETA study, changing economic conditions required the developers to consider reduced levels of development to 2021. It was considered by some stakeholders that the reduced development activity may not require the same levels of infrastructure interventions developed under WETA and a reappraisal was required. In order to address this, the Transport Infrastructure Study for West Edinburgh Phase 1 study (TISWEP) was produced in February 2010, which identified what infrastructure interventions were needed to service the additional travel demand associated with the revised development proposals in 2021. These included:

- Implementation of the infrastructure interventions as detailed in the report (improvements to Gogar Roundabout, Newbridge Roundabout and the dumbbells roundabout underneath the A8 at the south of Eastfield Road); and
- A review of the performance of Newbridge Roundabout when the quantum of development exceeds the levels considered by the report for 2017 (this recommendation is subject to the ongoing review of Newbridge Roundabout).

[5] http://www.sesplan.gov.uk/assets/assets/files/docs.pdf

2.4.7 The City of Edinburgh Local Transport Strategy 2014 – 2019

Edinburgh's Local Transport Strategy (LTS) sets out the transport policies and actions for the next five years that will contribute to the Council's vision of Edinburgh as a thriving, successful and sustainable capital city.[6] These include:

- To support the economic vitality of the city centre, traditional centres and local shops;
- To support development in the growth areas of the city through facilitating provision of necessary transport infrastructure;
- To help improve quality of life in Edinburgh's residential areas; and
- To minimise the need for car use.

Again, these chart the regional and national transport strategies which are linked into the Scottish Governments five key objectives. Key future projects include:

- Edinburgh Gateway Station, a new pedestrian/ cycle bridge linking the station to housing at Maybury and Cammo, and other cycle and walking network improvements;
- Improving Newbridge Interchange – incorporating bus priority measures, and bus priority on the A8 and A89;
- Upgrading the A8/ Eastfield Road Junction and Gogar Roundabout;
- Widening Eastfield Road to four lanes and devoting the extra space to bus priority;
- Upgrading Maybury and Barnton junctions in association with housing developments in the Maybury and Cammo areas, incorporating bus priority; and
- Extending the Tram beyond Edinburgh Airport to Newbridge (for which the Council has Parliamentary powers) and possibly further, which is outwith the scope of this work.

2.4.8 Transport Appraisal and Modelling West Lothian Local Development Plan: Background Paper

West Lothian Council published its Local Transport Strategy (WLLTS) in 2000. Although this has not been updated, the three key objectives running through the LTS remain pertinent:

- To maximise accessibility for all and minimise the need for travel, especially by car;
- To ensure adequate means of access, including by public transport; and
- To enhance the provision of non-private car travel, by public transport/ cycling/ foot.

The Transport Appraisal and Modelling West Lothian Local Development Plan is a background paper for the West Lothian Local Development Plan to help plan future transport network improvements through identifying congested junctions and identifying solutions until a new LTS is produced.[7] Contained within it are the following interventions measures:

- Bus lanes on the approach from Newbridge commencing at Kilpunt, East Broxburn to Newbridge Roundabout;
- Improved capacity of Newbridge Roundabout through improved traffic signal operation (MOVA);
- Delivery of park and ride site at Kilpunt; and
- Bus priority and cycle/ walking network.

[6] http://www.edinburgh.gov.uk/downloads/file/3525/local_transport_strategy
[7] http://www.westlothian.gov.uk/Transport-appraisal-and-model.pdf

2.4.9 The City of Edinburgh Council Active Travel Action Plan

The City of Edinburgh Council is promoting the benefits of walking and cycling which include better health, better road safety, a better environment, benefits to businesses and wider economic benefits. The Council identified some of the following improvements:

- Improve conditions on the existing cycle network, both on road and off-road;
- Extend the coverage of the city's cycle network;
- Improve cycle access, cycle safety and cycle priority; and
- Support innovative cycling schemes.

The Active Travel Action Plan identifies some key corridors within the network that require upgrading for cycle provisions. The A8 was one of the corridors identified which is mirrored within the scope of works of this study.

2.5 Future Major Development

As part of the Scope of Work for this study, it was specified that any potential intervention measures should reflect the wider transportation aspects such as future demand generated by major developments along the route. As highlighted in the FRCPTS, the analysis work carried out shows considerable growth forecast at some of these sites, such as land releases at both West Lothian and the west end of Edinburgh.

2.5.1 West Craigs & Cammo Developments - Maybury Road area

A Planning Permission in Principle application was submitted to The City of Edinburgh Council at the beginning of September 2014 for a new residential development of up to 250 new homes on land at West Craigs, Maybury Road, Edinburgh.

The application was refused in March 2015 and an appeal against the decision has been submitted to the Scottish Government. The application site constitutes the eastern part of the Maybury housing allocation in the proposed Edinburgh Local Development Plan (LDP), which has an overall estimated capacity of up to 2000 houses. The applicants have submitted a Traffic Statement which identifies actions including, but not limited to, a new signalised junction at Maybury Road/Craigs Road and a proposed junction design at Glasgow Road/ Turnhouse Road/ Maybury Road to include the removal of the right turn from Turnhouse Road.

2.5.2 Edinburgh International Business Gateway

The International Business Gateway (IBG) is the working title of a long term strategic reserve of land (circa 85 hectares) located between Edinburgh Airport and the Royal Bank of Scotland Headquarters building at Gogar. The site has long term physical development capacity to accommodate up to circa 500,000 sqm, and is currently safeguarded in planning policy of WEPF. Part of a long-term vision for the commercial development of the IBG, which is designated as a site of national importance by the Scottish Government, is the delivery of a sustainable transport access strategy.[8] High quality public transport options are a top priority, with a strategy which promotes sustainability, reduces congestion, cuts journey times and minimises car use with a target in place of 50% of all trips to be made by public transport.

A new £37 million rail interchange station at Gogar, which is currently under construction, will enhance access to the area from across Scotland and beyond, incorporating a high quality public transport interchange to the Edinburgh

[8] http://www.scotlandsglobalhub.com

tram system. A number of road enhancements have been identified and are contained within TISWEP, such as enhancements to the Gogar Roundabout.

2.5.3 Winchburgh/East Broxburn/ Uphall Core Development Area

The West Lothian Local Plan adopted in 2009 provides guidance on the location of development across West Lothian, based on meeting the requirements set by the approved Edinburgh & Lothians Structure Plan 2015. In order to meet new housing requirements as part of the Core Development Area, land has been identified for 5000 new houses. Meeting the new housing requirements is a key driver of the land use policies of this Local Plan, which will have an impact on existing traffic demand on the A89. Identified intervention measures include a Park and Ride site at the Kilpunt Roundabout and bus lanes on the approach to Newbridge Interchange.

2.6 Conclusion

In line with the Scope of Work for this study, as well as developing a strategic business case, any potential intervention measures must take into account national and regional transport, planning and economic development policies. They also need to be fully integrated with CEC’s wider objectives and outcomes, and with other Council strategies, especially the Local Development Plans. In addition to these documents, a range of other strategy documents were reviewed as part of this exercise, such as the West Edinburgh Planning Framework.

The transport intervention measures obtained from this process are summarised in Table 2.1, overleaf, and have been taken forward to the route appraisal stage in the next chapter.

Table 2.1: Summary of Potential Intervention Measures

No	Intervention	RTS	FRCPTS	SDP	TISWEP	LTS	TAMWL LDP	ATAP
1	Improvements to Newbridge Roundabout (MOVA)	√	√	√		√	√	
2	Bus lane on the A89 eastbound from Broxburn to Newbridge.	√	√	√			√	
3	Bus lane on the A8 from Eastfield Road at Edinburgh Airport eastwards to Gogar Roundabout.	√	√	√				
4	Bus lane on the A8 westbound from Station Road to Newbridge Roundabout.	√	√	√				
5	Traffic signals at Station Road Ratho on A8, incorporating queue relocation towards Newbridge Roundabout.		√					
6	Queue relocation near Newbridge Roundabout from Ratho and around Station Road.	√	√	√		√		
7	Public transport priority on the A89/ A8	√	√	√			√	
8	A8 widening in both directions between Eastfield Road and Newbridge Roundabout to incorporate bus lanes.		√					
9	Installation of MOVA on Gogar Roundabout				√			
10	Upgrading Maybury and Barnton junctions in association with housing developments in the Maybury and Cammo areas.					√		
11	Improved cycling facilities on the A89/A8 corridor					√	√	√

Route Appraisal

3 Route Appraisal

3.1 Introduction

High quality road-based public transport services are vital to achieve maximum effectiveness from the road network and to offer an acceptable alternative to the private car. Buses can transport large numbers of people while occupying relatively little road space. The basic approach to bus priority scheme planning involves a standard approach of feasibility, consultation, detailed design and implementation.

In order to form the basis of the feasibility element, a thorough understanding of the road network is required; including a detailed appraisal of the existing conditions through site assessments and surveys. This chapter sets out the tasks undertaken to gain this knowledge and details the results of the surveys undertaken.

3.2 Network Assessments

There is no substitute for direct experience of the existing traffic conditions and in order to gain a greater appreciation and familiarity a number of site assessments were carried out at the start of the assessment. Four overview plans were created (**Appendix A**) to highlight the existing infrastructure across the following key areas:

- Public Transport (Drawing 1);
- Active Travel (Drawing 2);
- General Traffic Control (Drawing 3); and
- Land-use (Drawing 4).

3.2.1 Traffic Assessments

Site visits were undertaken during the AM and PM peak hours, as well as the inter peak and early evening, to ensure that the project team had the complete understanding of the operation of the entire route. Observations were recorded to capture network delays/ hot spots as well as journey time assessments and queue length surveys.

Figure 3.1, below, highlights the network hotspots as observed on site and these are highlighted further in Drawing 5 in **Appendix A**.

Figure 3.1: Corridor Hotspots

The journey time and queue length surveys were supplemented further with a series of comprehensive surveys in late August 2015 to provide a metric for validation and calibration of the VISSIM traffic model. These are discussed further in section 7.3.3, with results presented in Table 7.5 and Table 7.6 in section 7.5.4. The journey time results from the initial site visits are presented in Table 3.1, with the measurement locations shown in Figure 3.2.

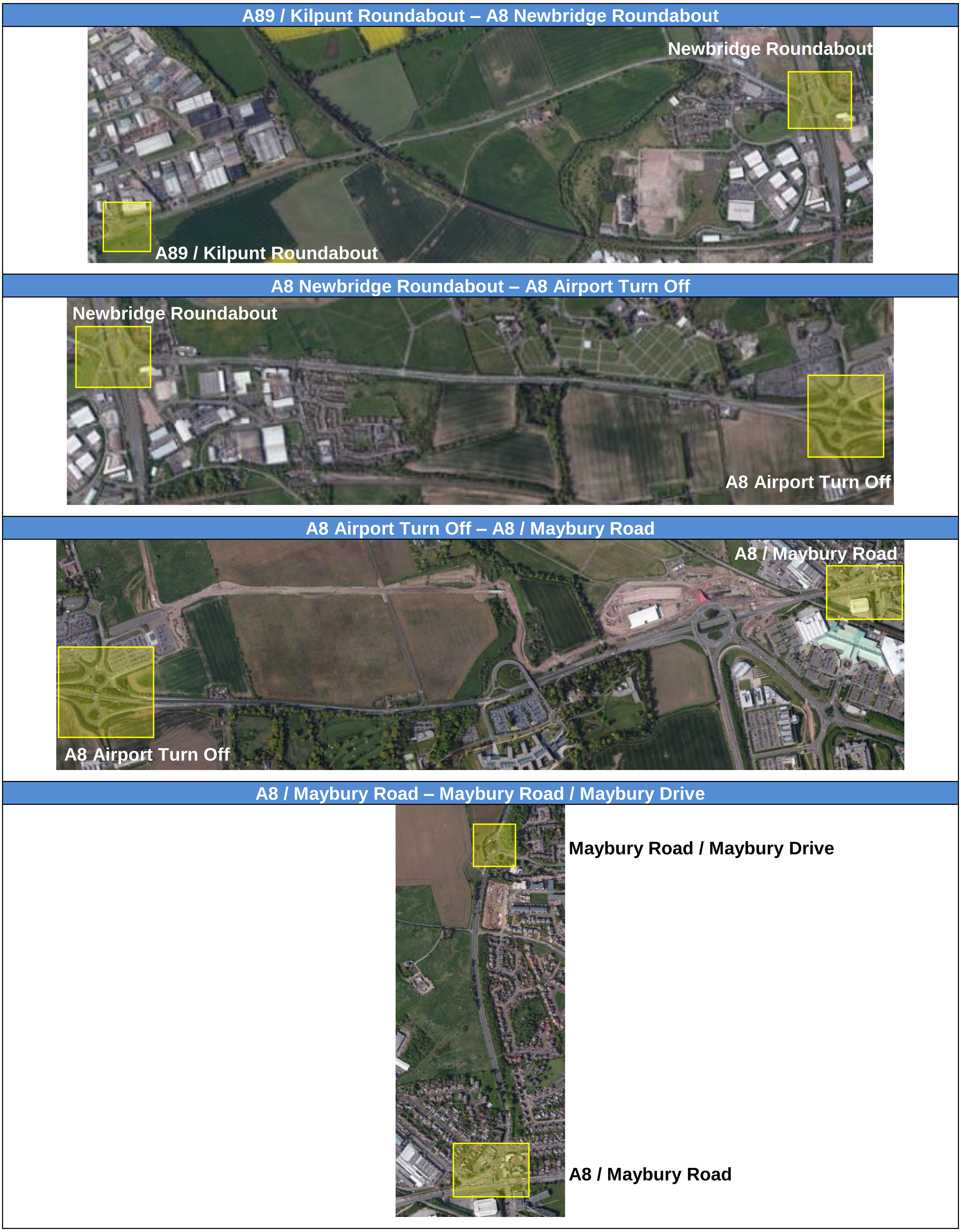


Figure 3.2: Journey Time Measurement Locations

Table 3.1: Observed Vehicle Journey Times (mm:ss)

		Period	AM					PM			
		Start time	07:20	07:45	08:20	08:45	Average	16:37	17:08	17:50	Average
	From	To									
Westbound	Maybury Rd/Maybury Drive	A8/Maybury Rd Junction	01:52	07:51	07:18	06:51	05:58	01:15	01:25	00:59	01:13
Westbound	A8/Maybury Rd Junction	A8 Airport turnoff	02:47	02:32	02:26	02:35	02:35	02:51	02:39	02:19	02:36
Westbound	A8 Airport turnoff	A8 Newbridge Roundabout	02:05	01:58	02:35	02:15	02:16	05:38	13:40	05:34	08:17
Westbound	A8 Newbridge Roundabout	A89/Kilpunt Roundabout	04:03	04:38	04:35	03:14	04:09	06:20	05:57	05:04	05:47
Westbound	**Total journey time**		**10.47**	**16:59**	**16.54**	**14:15**	**14:43**	**18:04**	**23:51**	**13:56**	**18:37**
Eastbound	Eastwards Kilpunt Roundabout	A8 Newbridge Roundabout	06:30	07:51	06:40	05:14	06:35	04:31	03:44	03:59	04:04
Eastbound	A8 Newbridge Roundabout	A8 Airport turnoff	02:30	02:47	02:37	02:09	02:31	02:13	02:15	01:52	02:06
Eastbound	A8 Airport turnoff	A8/Maybury Rd	02:22	03:20	05:10	03:53	04:08	07:32	09:50	05:31	07:37
Eastbound	A8/Maybury Rd	Maybury Rd/Maybury Drive	00:58	01:02	01:06	01:17	01:11	Not surveyed due to congestion on Maybury Rd in the PM peak period, because Maybury Road is not directly on the corridor, and because undertaking journey times on this section would have reduced the number of overall runs that could have been undertaken			
Eastbound	**Total journey time**		**12:20**	**15:00**	**15:23**	**12:33**	**13:49**	**14:16***	**15:49***	**11:22***	**13:49***
								***PM eastbound journey times measured from Kilpunt Roundabout to A8 / Maybury Rd**			

3.2.2 Public Transport Journey Times

Buses can be flexible in operation and can respond rapidly to changing patterns and levels of demand, but are adversely affected by urban traffic congestion. To identify exactly where the delays to public transport are being experienced, AECOM undertook a number of journey time surveys.

The surveys were undertaken on Tuesday 13 January 2015 between 07:45 and 10:00, and 16:00 to 18:00. The weather conditions were fair and there were no adverse road conditions, such as traffic management or accidents, which impacted on the survey results.

To identify the journey time of the bus between stops, and thus to allow a speed to be calculated, the surveyor used a stopwatch to determine the travel time between adjacent stops. Dwell time at stops were not recorded, as the intention was to calculate vehicle speeds in order that areas of low speed and high journey time could be used to support the identification of network hot spots. The results from the bus journey surveys are detailed in **Appendix B** and Drawing 6 in **Appendix A**, with a summary in Table 3.2 and 3.3.

Table 3.2: Observed Bus Journey Times – Westbound

Bus No.		22		22		20		X21	
Start Time		07:53		09:24		16:12		17:16	
Ref. No.	Stop Name	Split Time (mm:ss)	Av. Speed (mph)	Split Time (mm:ss)	Av. Speed (mph)	Split Time (mm:ss)	Av. Speed (mph)	Split Time (mm:ss)	Av. Speed (mph)
1	Marriot Hotel	00:00	-	00:00	-	00:00	-	00:00	-
2	Gogar Roundabout	01:05	31.2	00:50	40.5	01:18	26.0	00:55	36.8
3	RBS Gogarburn	00:43	43.6	00:40	46.9	00:59	31.8	01:04	29.3
4	Gogarstone Road	00:52	36.8	00:42	45.5	00:55	34.8	00:58	33.0
5	Airport Roundabout	00:22	37.6	00:18	46.0	00:30	27.6	01:25	9.7
6	Ingliston Road	00:32	41.9	00:27	49.6	00:45	29.8	03:53	5.8
7	Ingliston Showground	00:21	43.5	00:20	45.6	00:24	38.0	01:08	13.4
8	Station Road	01:05	34.5	00:51	44.0	01:02	36.2	04:31	8.3
9	Newbridge Roundabout	00:44	26.0	00:37	31.0	01:59	9.6	02:28	7.7
10	Old Liston Road	-	-	-	-	01:53	11.8	-	-
-	Cliftonhall Road	00:58	18.4	01:15	14.3	-	-	02:08	8.4
-	Bridge Street	01:13	14.7	01:20	13.4	-	-	01:45	10.2
11	Glenmorangie	04:45	18.1	03:06	27.7	03:07	27.5	02:53	29.8
Total Travel Time (excl. Dwell times)		**12:40**		**10:26**		**12:52**		**23:08**	
End Time		08:06		09:37		16:27		17:41	

Table 3.3: Observed Bus Journey Times – Eastbound

Bus No.		20		21		22		21	
Start Time		08:32		09:50		16:56		17:50	
Ref. No.	Stop Name	Split Time (mm:ss)	Av. Speed (mph)	Split Time (mm:ss)	Av. Speed (mph)	Split Time (mm:ss)	Av. Speed (mph)	Split Time (mm:ss)	Av. Speed (mph)
11	Glenmorangie	00:00	-	00:00	-	00:00	-	00:00	-
10	Old Liston Road	04:53	15.5	-	-	-	-	-	-
-	Bridge Street	-	-	02:50	26.5	03:33	21.1	03:25	22.0
-	Bowling Club	-	-	00:18	12.0	00:19	15.4	00:22	13.3
9	Newbridge Roundabout	04:22	7.9	02:52	29.5	04:16	8.1	06:07	5.6
8	Station Road	00:43	24.7	00:36	52.4	00:37	28.7	00:34	31.2
7	Ingliston Showground	03:17	11.7	00:44	52.4	01:01	37.8	00:54	42.7
6	Ingliston Road	01:41	10.8	00:20	54.7	00:26	42.1	00:29	37.7
5	Airport Roundabout	00:56	16.3	00:20	45.5	00:16	56.9	00:26	35.0
4	Gogarstone Road	02:35	8.5	00:24	55.2	00:27	49.0	00:33	40.1
3	RBS Gogarburn	09:51	5.1	01:02	48.2	01:05	46.0	01:15	39.9
2	Gogar Roundabout	00:40	14.3	00:12	47.5	00:31	18.4	00:15	38.0
1	Marriot Hotel	01:31	22.5	01:37	21.1	04:51	7.0	02:22	14.4
Total Travel Time (excl. Dwell times)		**30:29**		**11:15**		**17:22**		**16:42**	
End Time		09:06		10:02		17:14		18:07	

As may be expected, the results indicate a clear tidal pattern, with low speeds eastbound into Edinburgh during the AM peak and then westbound to Newbridge during the PM peak. During the AM peak, vehicle speeds were low along the entire corridor, with speeds below 10mph from the airport to Gogar. The top speed in the AM peak was approximately 25mph. The reverse was evident in the PM peak, whilst speeds of around 37mph were achieved leaving the Marriot Hotel stop and out under the Gogar underpass, traffic congestion soon slowed buses to around 10mph from Gogarburn through to Broxburn.

As was the case for the traffic assessments (section 3.2.1), further bus journey time data was collected in late August 2015, after the summer holidays had ended. This produced a larger pool of data, which was used in the calibration and validation of the VISSIM traffic models. A summary of the data is provided in Table 3.4, overleaf.

Table 3.4: Additional Bus Journey Time Data Collected

Direction	Section	AM		PM	
		Journey time	Cumulative	Journey time	Cumulative
Westbound	Maybury-Airport	04:00	04:00	03:44	03:44
	Airport-Newbridge	04:33	08:33	10:34	14:18
	Newbridge-A89	07:07	15:40	06:30	20:48
	Total	**15:40**		**20:48**	
Eastbound	A89-Newbridge	13:27	13:27	10:27	10:27
	Newbridge-Airport	04:25	17:52	04:23	14:50
	Airport-Maybury	05:47	23:39	06:05	20:55
	Total	**23:39**		**20:55**	

The data in Table 3.4 again highlights the tidal nature of the traffic flows between Edinburgh and Newbridge. Westbound bus journey times increase significantly in the PM compared to the AM (by around 5 minutes), while the same is true in the eastbound direction in the AM compared to the PM (an increase of around 3 minutes).

3.2.3 Public Transport Infrastructure Audit

An audit of each the bus stop was undertaken using the following criteria:

- Presence of bus stop flag & pole;
- Presence of a shelter;
- Availability of passenger information;
- Presence of Real Time Passenger Information (RTPI);
- Kerb height i.e.125mm; and
- Bus lay-by.

The bus stop infrastructure was generally found to be of a reasonable level. The findings of the audit are summarised below, with the full audit presented in **Appendix C.**

Westbound

- Bus stop flags, shelters and passenger information are present at 10 of the 11 bus stops on the A8 in the westbound direction. The exception is the stop at the Glenmorangie factory in Broxburn, which doesn't currently have a shelter or passenger information.
- RTPI is only available at one stop – the Marriot Hotel at Maybury.
- Bus Boarder kerbs are only available at one stop – RBS Gogarburn.
- Lay-bys are available at 9 of the 11 bus stops.

Eastbound

- Bus stop flags, shelters and passenger information are present at 10 of the 11 bus stops on the A8 in the eastbound direction, as was the case westbound. The exception is the stop at the Glenmorangie factory in Broxburn, which only has a bus stop flag.
- RTPI is only available at one stop – the Marriot Hotel, Maybury.
- Bus Boarder kerbs are only provided opposite RBS Gogarburn.
- Lay-bys are available at 9 of 11 the bus stops.

The corridor could benefit from an upgrade and general modernisation to provide high quality bus infrastructure in accordance with current good practice. Whilst most stops do incorporate a shelter, they are of varying styles, age and quality. High quality bus shelters should be considered to enhance the passenger experience, although five of these bus shelters with advertisement panels will be replaced shortly as part of the new bus shelter contract arrangements with the Council.

Only one bus stop incorporates the recommended/standard kerb height of 125mm, which helps buses to stop close to the kerb without any damage to tyres and aid the movement of mobility impaired passengers. In recent years, service providers have developed improvements in bus technology with both low floor and kneel down buses covering many routes. As a result of these improvements the need for the installation of bus stop access kerbs needs to be considered on a case by case basis.

Buses can experience delay in re-entering the traffic stream when leaving a lay-by but they can be useful to allow buses to pass other buses if they are not accessing the same stop. They can also provide benefit on strategic corridors as they keep general traffic moving. Research undertaken by TfL has shown that in-filling a lay-by and replacing it with a kerbside stop will:

- Make it easier for the bus to stop adjacent to the kerb;
- Make it easier and quicker for passengers to board/ alight; and
- Reduce delays to buses by between 2 and 4 seconds per bus.

These types of improvement can enhance the image and public perception of the service in a way that could encourage higher patronage figures and hence a transfer from other modes. The impact of introducing bus lanes was to be tested and as these would subsume the existing bus lay–bys along the corridor there was no need to test the impact of bus lay-bys removal.

3.2.4 Active Travel Audit

A site assessment was carried out on Tuesday 13 January 2015 between the hours of 13:00 and 16:00. The weather was mixed with sunshine, rain & snow. The corridor has a complete traffic-free walking/cycling route from east to west. The corridor is dominated by the A89 single carriageway and A8 dual carriageway roads, around which cycling/ walking provision has been accommodated with varying degrees of success.

The route is essentially flat with gradients restricted to bridges over/ under the main road.

The route is generally suitable for walking, in terms of surfacing and path width. There are a number of narrow points and obstructions in the path (bus shelters, sign posts, lighting columns), however, which will be challenging for wheelchair users or those with pushchairs. The path is generally set back from the carriageway edge. Many side road and access crossings lack provision for pedestrian crossing. The results of the active travel audit are described in more detail in **Appendix D**.

3.3 Development Constraints

Both a desk-top and site assessment was carried out to identify possible constraints along the route and this is detailed within Drawing 7 in **Appendix E**.

The key development constraints include:

- Bridge across railway at Maybury;
- Bridge across A8 at RBS Gogarburn;
- Pedestrian bridge at Ratho Station;
- Pedestrian bridge at Newbridge;
- Bridge across the River Almond on the A89;
- Railway viaduct on the A89;
- Proximity of Edinburgh Airport;
- Existing street furniture such as lighting columns and communications cabinets;
- Existing junctions; and
- Existing housing and land ownership issues.

3.4 Route Appraisal Summary

A thorough appraisal of the existing corridor was undertaken which considered both the network operation and physical infrastructure. The information collated will support the development of the design solution for public transport improvements along the corridor.

Several aspects have been identified for further consideration in the outline proposals, relating to bus, cycle and pedestrian facilities. These aspects will be considered further in the following sections, ensuring that the infrastructure and facilities provided for all road users are robust, appropriate and of a high standard.

Following the development of potential design improvements several further site visits occurred to ensure the options proposed could be physically constructed.

Stakeholder Consultation

4 Stakeholder Consultation

4.1 Introduction

Consultation is a key part of the development of any transport study. It allows the stakeholders to engage with the study team and highlight the issues which matter most to them, and it can improve decision making and accountability.

Furthermore, nobody is likely to know any particular area as well as those who use it every day; not only are these users well aware of the problems, but they will often have their own views about what kind of solutions might be appropriate. Therefore early involvement to fully appreciate their concerns is vital and will often lead to a shared ownership of the solutions.

4.2 Stakeholder Working Group

AECOM held a Stakeholder Working Group at their Edinburgh Office on Tuesday 10 February 2015 to discuss the progress of the project to date and receive valuable input from the major bus companies operating on the route. Representatives from Transport Scotland, The City of Edinburgh Council, West Lothian Council, SEStran, Stagecoach, Lothian Buses and First Group were present.

AECOM presented journey time observations from site visits highlighting the problematic locations along the route, which include:

- Major delays at Newbridge, Gogar and Maybury;
- Delays coming from M9 Spur Slip Road to A8; and
- Kirkliston Junction to Ratho Station (congested), Ratho Station to RBS (free moving traffic) and RBS to Maybury (congested).

The bus companies were in agreement with the bus journey times observed by AECOM and the proposed intervention measures being developed. The bus service providers were in agreement that the proposed improvements were acceptable and any improvement to bus journey times along the route would be beneficial.

4.3 Open Stakeholder Workshop

An Open Stakeholder Workshop was held on Friday 13 March 2015 at The City of Edinburgh Council's City Chambers to present AECOM's proposals to a wider stakeholder group, previously agreed with the client and listed in Table 4.1. In addition to the proposals already being developed, there were a number of new ideas raised, including:

- Improvements to cycle routes from the west to complete any routes on A8 itself. For example Union Canal. As this was out with the study area this was passed to WLC;
- Look at the possibility of making the M9 off slip bus lane continuous past Newbridge roundabout by increasing the number of lanes on the A8 eastbound by narrowing the A8 centre reserve to the east of Newbridge roundabout. As part of the trunk road network this would need to be taken addressed by Transport Scotland;
- Continuous cycle path from Kilpunt to South Gyle already exists but requires upgrading at parts which are addressed in the Active Travel Audit in **Appendix D**;
- Bus priority through Newbridge to tie in with bus provision from Forth Bridge which is being pursued as part of the Forth Replacement Crossing Strategy;

- Additional lane existing M9 onto A8, improve flow onto A8 and improve the priority from the M9. This would be achieved by an initial 3 lane section along the A8 (or one bus lane access from roundabout and a dedicated lane off the M9) which is one of the potential intervention measures;
- Interaction with new train station at Gogar. Impact the additional generation;
- Increasing the capacity at Maybury Junction and ensuring the route 9 cycle route is accommodated. These will be incorporated within the Maybury road development;
- Development at International Business Gateway, how will this link into public and active travel network? Presents opportunity for direct link avoiding 2 uncontrolled crossings. Active travel improvements will be developed as part of the IBG transport assessment,
- The proposal for traffic signals at Station Road is better than current footbridge but the crossing should be a toucan which would be investigated as part of a future study;
- Allow for cycling provisions at Maybury through toucan crossing and cycling lane facilities. This is already being considered by The City of Edinburgh Council (CEC);
- Yellow box markings on Gogar Roundabout to prevent traffic from blocking the A8 merge, allowing free flow from Gyle Centre. This is already being considered by CEC;
- The feasibility of an additional east-bound traffic lane across the Edinburgh-Queensferry railway over-bridge on the A8 from the end of Gogar Roundabout to the identified option for an additional traffic lane east of this and through the Maybury Junction onto Maybury Road should be examined;
- Options should be examined as to how cyclists using the proposed Cammo to Maybury cycle route (LDP and Maybury proposals) may safely cross the A8 to gain access to the Gyle and other routes southwards; and
- The potential re-designation of little used sections of the Maybury Road footway to enable shared use by cyclists and walkers should be examined, as cyclists currently have little option other than to use the footway illegally if they wish to cycle safely in this vicinity. (Cramond and Barnton Community Council).

Table 4.1: List of Key Stakeholders

Organisation		
Almond Neighbourhood Partnership	SPOKES (cycling)	Gyle Shopping Centre
Broxburn Community Council	Stagecoach	Kirkliston Community Council
Corstorphine Community Council	The City of Edinburgh Council	Lothian Buses/Transport for Edinburgh
Edinburgh Airport	Transport Scotland	Police Scotland
Fire Scotland	West Lothian Council	Ratho and District Community Council
First Bus	SEStran	Gyle Shopping Centre
Kirkliston Community Council	Lothian Buses/Transport for Edinburgh	Police Scotland
Royal Bank of Scotland (Gogarburn)	Royal Highland Showground	Local councillors
Scottish Citylink	SESPLAN	Winchburgh Community Council
SEStran		

Option Development

5 Option Development

5.1 Introduction

As indicated in Chapter 2, potential intervention measures for improving traffic and transport systems should be developed within the context of local and national transport strategies and development plans, in order that they can be brought forward as part of the planning of the area as a whole and that their objectives are compatible with such plans. The planning process may identify parts of the transport network where new investment in roads or public transport or traffic management would be beneficial on economic, traffic, road safety or environmental grounds. This study has predominately been undertaken in response to the FRCPTS, and seeks to deliver on the opportunities identified whilst also taking cognisance of the considerable development proposals along the corridor.

All improvement proposals developed are in line with the objectives summarised in Chapter 2 as a whole, and will be broadly appraised against a robust, objective-led assessment framework.

5.2 Option Development

The primary aim of this study is to improve the flow of public transport along the A89/ A8 corridor and thus reduce journey times and improve service reliability. If the inherent advantages of a quality bus system are to be realised and the objectives of the study delivered, then buses must have a good on-street operating environment. There is a strong case within this study for providing buses with priority over, or complete segregation from, other road users, to protect bus services from the effects of congestion and to improve service times and reliability. To address the development of these options the following three key category headings have been used:

1. Bus Priority Measures;
2. Traffic Control Measures; and
3. Active Travel Improvements.

5.3 Bus Priority Measures

Bus priority measures aim to reduce journey times and improve the reliability of bus services. They include: segregation (i.e. dedicated bus lanes); traffic management; traffic signal control; and bus stop improvements. Effective bus priority measures can achieve mode shift from car, and in so doing, reduce delays for both bus users and general traffic. They are particularly effective wherever bus journey times and reliability are affected by traffic congestion.

5.3.1 Bus Lanes

In general, bus priority measures have several aims:

- To reduce delays to buses arising from traffic congestion and thus saving passengers' travel time, bus operating costs and bus fleet requirements;
- To improve the reliability of bus services so as to make bus travel more attractive;
- To increase the mobility for those who do not own or have use of a car;
- To increase accessibility to major traffic generators like shopping centres; and
- Better management of traffic congestion, by the provision of efficient and high quality alternative services.

Bus priority measures combining physical traffic management measures such as bus lanes and bus advance areas are most successful when implemented along bus route corridors and are linked to other improvements such as passenger information, improved waiting facilities, bus stop clearways and easily accessible buses.

Potential locations to be considered for introducing new bus lanes are detailed in Table 5.1, below:

Table 5.1: Potential Introduction of Bus Lanes

New Bus Lanes	
1	Bus lane under Gogar Roundabout to allow queue jump.
2	New 3.65m wide eastbound bus lane from Broxburn to Newbridge Roundabout
3	New westbound 3.65m wide bus lane immediately adjacent to the nearside lane up to Station Road, which is 500m from Newbridge Roundabout.
4	New eastbound 3.65m wide bus lane from Airport Roundabout to Maybury Junction bus lane.
5	Partial bus lane on Maybury Road.

As per the scope, any potential designs may focus on either developing additional public transport capacity through land acquisition or by making use of the existing infrastructure through lane allocation. The traffic modelling of the bus lanes presented in Table 5.1 will thus consider two design scenarios:

1. Reallocation of existing road space; and
2. Developing additional capacity through land acquisition.

5.3.2 Bus Priority Using Traffic Signals

Traffic signal control offers huge benefits to bus priority when used in combination with other measures such as bus lanes. A ‘Bus-Advance Area’ is a traffic management technique which allows buses to advance into an area of road, clear of traffic before a signal control junction. Pre-signals, located in advance of the junction, control entry to the advanced area, with a bus lane provided up to the pre-signal. The objective of the pre-signals is to re-order vehicles so that buses get priority into the advanced area to reach the junction first.

Metering or queue relocation involves the linking of two sets of traffic signals and a system for measuring congestion in the critical section of road between those signals. Traffic signal timings are adjusted through the detection of flow/queue at the upstream signals to control traffic flow into the congested section. Providing a bus lane to the upstream stop line allows buses to overtake traffic queues on the approach to the upstream signals.

5.3.3 Intelligent Transport Solutions

Intelligent Transport Solutions (ITS) such as Selective Vehicle Detection (SVD) can provide bus priority within traffic control strategies, such as vehicle actuation (VA) and fixed/real time Urban Traffic Control (UTC).

Buses can be given priority at traffic signals by making traffic signals respond to the arrival of a bus utilising an SVD system as follows:

- Buses fitted with a transponder are able to communicate with the traffic signal controller;
- Buses are detected as they approach the signals, and the traffic signal timings are called in their favour;
- Either the green time for the approaching bus is extended, or, if the bus is approaching a red signal, the other stages in the cycle are shortened or omitted to bring forward a green signal for the bus.

These systems only exhibit considerable benefits if the bus can approach the traffic signals in an unrestricted manner, and therefore must be included as a package of bus priority measures.

This review of the main aspects of bus priority/ITS have shown some of the tools that are available, but the appropriateness of using such technologies depends on various factors such as:

- Legacy traffic control systems (e.g. UTC, VA);
- Any existing infrastructure (e.g. detection, communication);
- Bus operational method (e.g. headway/timetable, scale of bus operation);
- Integration with other applications (e.g. RTPI, fleet management); and
- Joint venture agreements.

Based on these factors, a requirements specification would needs to be developed for each one to select the best-suited bus priority architecture for a particular situation. For instance, at Maybury Junction we would need to know basic requirements such as vehicle location accuracy and priority determination, i.e. which bus gets priority?

Given the complexity of determining the appropriateness of installing the correct technology along the corridor it was decided that this could not be explored as part of this study. This would need to be investigated separately as part of a larger ITS strategy for the region.

5.4 Traffic Control Measures

Traffic signal control measures provide an efficient way of controlling traffic movements and can deliver improvements in congestion, road safety and support specific strategies, such as bus priority. There are a number of junctions along the corridor (both traffic signal controlled and priority) that could benefit from a review and upgrade, namely:

1. Newbridge Interchange;
2. Gogar Roundabout;
3. Maybury Junction; and
4. New traffic signals at A8/ Station Road.

The following sections detail the possible improvements at the first three junctions listed, which are all currently signal controlled, and also considers the introduction of new traffic signals at the A8/ Station Road Junction:

5.4.1 Newbridge Interchange

The Newbridge Interchange is a grade separated signalised roundabout incorporating a dual underpass for the M9 trunk road where the traffic signals operate on fixed time plans. To improve current traffic signal operational times and improve efficiency, The City of Edinburgh Council is currently installing the MOVA system (Microprocessor Optimised Vehicle Actuation) which should be completed by spring 2016.

The introduction of MOVA is the result of the Newbridge Air Quality Improvement Study, which was carried out in 2014. This study provided options for delivering substantial reductions in queuing on the westbound A8, which included simple re-timing of the fixed sequence and adaptive traffic signal controls such as MOVA. As MOVA is a control method for isolated, heavily loaded traffic signal junctions and is widely used across the UK, particularly on the trunk road network, this is considered to be the ideal strategy. As per the report, the implementation of MOVA predicts a saving of 87% in average delay, resulting in an average delay of 23 seconds per vehicle including buses on the A8 during the PM peak period.

5.4.2 Gogar Roundabout

The Gogar Roundabout is a grade separated signalised roundabout incorporating a dual underpass for the A8.

The traffic signals operate under cablelessly linked fixed time plans. This approach is ideal when traffic flows remain constant, but not if there are fluctuations in road traffic. Here, traffic-adaptive signal control would offer a lot more flexibility, as it's based on the current demand where cycle time, green period, number of stages and stage sequence can be set individually.

It is well documented that this approach is ideal for controlling traffic at intersections with daily fluctuations, as well as for implementing public transport priority schemes. Again, there may be merit in reviewing the current time plans in the short term, although MOVA traffic control could be considered. A separate study is currently underway to improve capacity through additional lanes and the installation of MOVA.

5.4.3 Maybury Junction

Maybury Junction operates under fixed time plans and is cablelessly linked to the adjacent pedestrian crossing at the Marriott Hotel, so as to control the coordination of vehicles passing through both sets of traffic signals. There would be a low cost benefit by modifying the existing traffic signal plans, but adaptive traffic control would be a more efficient and flexible approach.

A medium term solution would be to coordinate the traffic signals and incorporate them into CEC's existing Urban Traffic Management Control (UTMC) system. These systems are designed to allow the different applications used within modern traffic management systems such as Automatic Number Plate Recognition (ANPR) cameras, Variable Message Signs (VMS), car parks, traffic signals and air quality monitoring stations to communicate and share information with each other. The idea behind it is to maximise road network potential to create a more robust and intelligent system that can be used to meet current and future management requirements. A traffic adaptive system such as SCOOT (Split Cycle and Offset Optimisation Technique), which CEC already use, would be extended to continually assess the traffic flow data, to control the traffic signal timings in order to try to keep traffic congestion to a minimum and to allow bus priority implementation. The traffic signal equipment at the three locations would need to be completely modernised, with more efficient and sustainable Extra Low Voltage (ELV) traffic signal equipment such as LED signal heads and traffic controllers being installed. Again, given the complexity of determining the best control strategy this would need to be investigated separately as part of an urban traffic control strategy for the whole of the A8 corridor.

5.4.4 A8 Station Road

At present, this junction is currently under priority control with a 'left-in/ left-out' arrangement. As a result, all exiting eastbound traffic from Ratho must head west to the Newbridge Interchange, turn and head back eastwards towards Edinburgh. As a result, unnecessary traffic movements are generated on an already congested junction. Whilst the actual number of vehicles doing this movement cannot be quantified (in the absence of origin-destination data), it can be assumed that given the 'attractors' on the west side of Edinburgh, such as schools, a shopping centre, business park and an industrial estate, this could be a significant volume. Furthermore, the A8 forms a key arterial route into Edinburgh city centre. The signalisation of the A8/ Station Road Junction is in line with the FRCPTS and would:

- Permit all vehicle movements and thus reduce u-turning traffic at the Newbridge Interchange;
- To provide inclusive mobility facilities;
- To manage queuing and support bus priority; and
- To improve safety by influencing vehicle speeds along this section of the A8.

5.5 Active Travel Improvements

Active travel is a hugely important element of any transport strategy and offers health, environmental and economic benefits. It is suitable for many local trips and could be used in conjunction with public transport for longer trips.

Given the distances involved, walking along the A89/ A8 corridor is likely to be limited to shorter trips and for accessing bus stops, but cycling offers a realistic alternative to the private car. To achieve this, cyclists require routes that are safe, convenient and suitable for use.

Following a review of walking and cycling infrastructure along the A89/ A8 corridor, it is proposed that the following options should be taken forward for consideration:

- Upgrade all shared use sections to a minimum width of 3m, plus clearance to adjacent features and carriageway;
- Ensure the path is clear of obstructions and street furniture is appropriately positioned;
- Consider providing additional width and providing fully segregated two-way cycling;
- Review all side roads and accesses to promote cyclist/ pedestrian priority;
- Comprehensive signing review to ensure consistent and thorough directional signing, shared use signing, and markings/ symbols to illustrate route continuity;
- Wheeling channels/ other improvements at Ratho Station bridge;
- Improved connections through Maybury and Gogar junctions in all directions; and
- Consider cycle parking at bus stops, where other roads meet the A89/ A8 corridor, to support bike-and-ride journeys.

The scope of works includes consideration of a pedestrian/ cycle crossing of the A89 at its junction with the Birdsmill minor road, east of the railway viaduct. The location of the A89/ Birdsmill Road Junction is shown Figure 5.1.

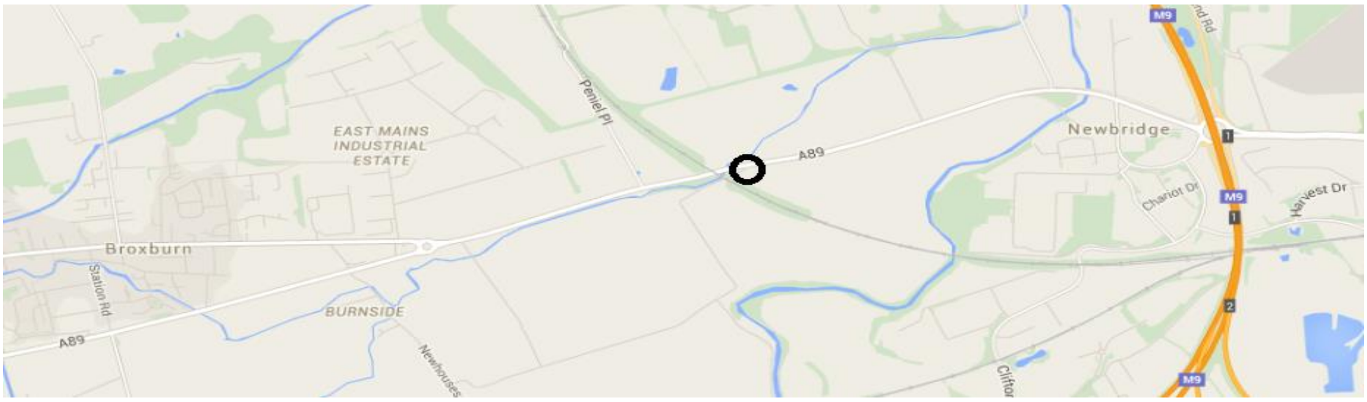


Figure 5.1: Toucan Crossing on the A89/ Birdsmill Road

The A89 is a single carriageway road with a speed limit of 50mph at this point, with relatively high traffic flows. There is space on both sides of the A89 to form path approaches and visibility is generally good, with slight restrictions for traffic eastbound on the A89 resulting from the viaduct piers.

It is recommended that a Toucan crossing is located east of Birdsmill and the speed limit is reduced or serious consideration should be given to speed reduction measures as per national guidance.

Option Appraisal

6 Option Appraisal

6.1 Introduction

To this stage, the emphasis of the study has been on developing broad options for consideration and testing. These have included options involving significant capital expenditure on infrastructure and land acquisition and lower cost options such as priorities for public transport through traffic management and reallocation of existing road space. All design proposals need to be assessed against each other, as well as against the current situation, or in other words, a 'do nothing' baseline situation.

This chapter aims to set out a broad brush style of appraisal against a common set of objectives. The methodology adopted is as follows:

- Identify appropriate objectives by which to appraise the options;
- Identify suitable performance indicators by which each objective is to be measured;
- Measure the performance of each option using the chosen set of indicators;
- Score each option against each indicator;
- Define an appropriate weighting to be applied to each indicator; and
- Sum the weighted scores across all objectives to give an overall assessment.

6.2 Setting Appraisal Criteria

As previously stated in section 2.3, the overall aim of this study is to identify the intervention measures required to aid public transport movement along the A89/ A8 corridor and thus improve bus journey times

The criteria for appraisal have been defined using an objective-led assessment framework used to develop and test preliminary designs for the corridor and demonstrate how these design options are likely to improve public transport journeys.

These options focus on additional road capacity through land acquisition or making use of the existing infrastructure through lane allocation and ITS-based solutions.

Bus passenger infrastructure and the provision of effective walking and cycling connections were also considered in the option appraisal process.

The appraisal criteria have been defined as follows:

- Technical feasibility/ buildability;
- Impact on bus journey times;
- Impact on queues and delays for all modes;
- Impact on road safety;
- Impact on pedestrians;
- Impact on cyclists;
- Public acceptability;
- Environmental impact; and
- Cost.

For each criterion, the impacts of the various options were assessed using the seven-point scale which matches the methodology set out in Transport Scotland's Scottish Transport Appraisal Guidance (STAG) as specified within Table 6.1.

Table 6.1: Assessment Scoring

Impact	Description
Major Beneficial (+3)	These are benefits or positive impacts which, depending on the scale of benefit or severity of impact, should be a principal consideration when appraising an option.
Moderate Beneficial (+2)	The option is anticipated to have only a moderate benefit or positive impact, and although they would not be taken in isolation, these scores may be a key consideration in the overall appraisal of an option when considered alongside other factors.
Minor Beneficial (+1)	The option is anticipated to have only a small benefit or positive impact. Small benefits or impacts are those which are worth noting, but are not likely to contribute materially to determining whether an option is taken forward.
Neutral (0)	The option is anticipated to have no or negligible benefit or negative impact.
Minor Negative (-1)	The option is anticipated to have only a small negative impact. Small impacts are those which are worth noting, but are not likely to contribute materially to determining whether an option is taken forward.
Moderate Negative (-2)	The option is anticipated to have only a moderate negative impact, and although they would not be taken in isolation these scores may be a key consideration in the overall appraisal of an option when considered alongside other factors.
Major Negative (-3)	These are negative impacts which, depending on the severity of impact, should be a principal consideration when appraising an option.

6.3 Option Appraisal Results

In line with the study objectives aims, the options that would be taken forward for microscopic traffic simulation in the next chapter were the ones that looked at using the existing road space as well as road widening to accommodate bus lanes and to allow localised queue jumps.

The full results of the option appraisal can be found in **Appendix F,** with Table 6.2, below, highlighting the ones to be used in the three traffic model tests.

Table 6.2: Potential Intervention Measures

Test 1	Test 2	Test 3
Bus lane under Gogar Roundabout to allow queue jump.	Bus lane under Gogar Roundabout to allow queue jump.	Bus lane under Gogar Roundabout to allow queue jump.
Increase capacity to 2 lanes at traffic lights to Maybury road.	Increase capacity to 2 lanes at traffic lights to Maybury road.	Increase capacity to 2 lanes at traffic lights to Maybury road.
A89: 3.65m wide eastbound bus/ lane from Broxburn to Newbridge Roundabout - using existing road.	A89: 3.65m wide eastbound bus/ lane from Broxburn to Newbridge Roundabout - through land acquisition.	A89: 3.65m wide eastbound bus/ lane from Broxburn to Newbridge Roundabout - through land acquisition.
A8: 3.65m wide westbound bus lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout - using existing road.	A8: 3.65m wide westbound bus lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout - through land acquisition.	A8: 3.65m wide westbound bus/ lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout - through land acquisition.
A8: 3.65m wide eastbound bus/ lane from Airport Roundabout to Maybury Junction - using existing road.	A8: 3.65m wide eastbound bus/ lane from Airport Roundabout to Maybury Junction - through land acquisition.	A8: 3.65m wide eastbound bus/ lane from Airport Roundabout to Maybury Junction - through land acquisition.
Bus lane – using existing road space.	Bus lane – through road widening	Bus lane – through road widening
		Signalisation of Station Road Junction.

Traffic Model Calibration & Validation

7 Traffic Model Calibration & Validation

7.1 Introduction

In order to assess the impact of the proposed bus priority measures it was agreed that a VISSIM micro-simulation model of the network would be developed which could then take cognisance of the network operation; including items such as:

- Existing public transport operations, e.g. bus schedule, stops, dwell times;
- Full study period analysis;
- Peak period flow profiles; and
- Detailed traffic signal timings.

The extents of the model needed to include suitable entry/ exit points and the various elements which affect flow and operation. The model network therefore extends from Kilpunt Roundabout on the A89 east of Broxburn in the west, to the A8/ A902 Maybury Junction in the east. The modelled network is shown in Figure 7.1, below:

Figure 7.1: VISSIM Model Network Extents

The model adopted VISSIM 7.00-05 as the platform, which meant that the network was directly linked to Microsoft Bing mapping. While this is not totally up to date it provided sufficient detail to ensure that the model network developed would be a very good representation of the existing road network. Where necessary, additional new detail was captured from site visits or supplied plans.

7.2 Model Assignment

The model was developed using static vehicle routes. This involved two inputs: firstly vehicle demands and secondly routeing decision markers to proportion the demand correctly through each junction. The vehicle inputs were included in the model using intervals of 15 minutes to replicate the current demand profiles.

7.3 Model Inputs

7.3.1 Traffic Flows and Turning Count Proportions

A proportionate approach was taken to data collection making best use of existing resources to ensure a baseline data set was available that was suitable for this study. The strategic data was taken from the JRC VISUM model which has been recently updated but was not available in time for this report.

Data from Automatic Traffic Count (ATC) sites were supplied, as well as a detailed turning count/queue length survey for Newbridge Junction that was undertaken in December 2013 as part of a separate study.

Traffic counts for the peak hours were supplied for Maybury Junction, part of the West Craig Development Study (2012).

In order to have updated traffic counts at the Airport Junction, AECOM carried out a traffic survey on Thursday 23 April 2015, during both the AM and PM peak periods.

No data was available at the Royal Bank of Scotland Junction and at Gogar Roundabout. Subsequent discussion identified that another model had been developed which included the area in question and that it could be supplied to provide the necessary information. This transpired to be a 2006 model that was interrogated for morning and evening traffic counts proportion at the aforementioned junctions.

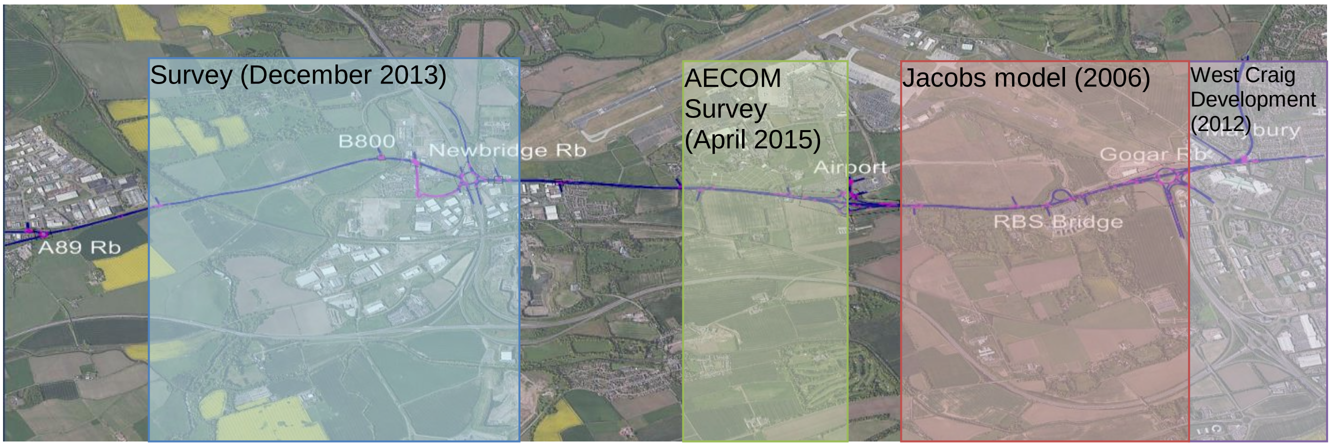


Figure 7.2: Traffic Data Sources

The Scottish Roads Traffic Database (SRTDb) provided flow data for the survey days and for the entire year. This was utilised to assess seasonal variations and whether our survey days were representing traffic conditions on a “typical day”. Figure 7.3, overleaf, shows the locations of the available flow data within the studied area.

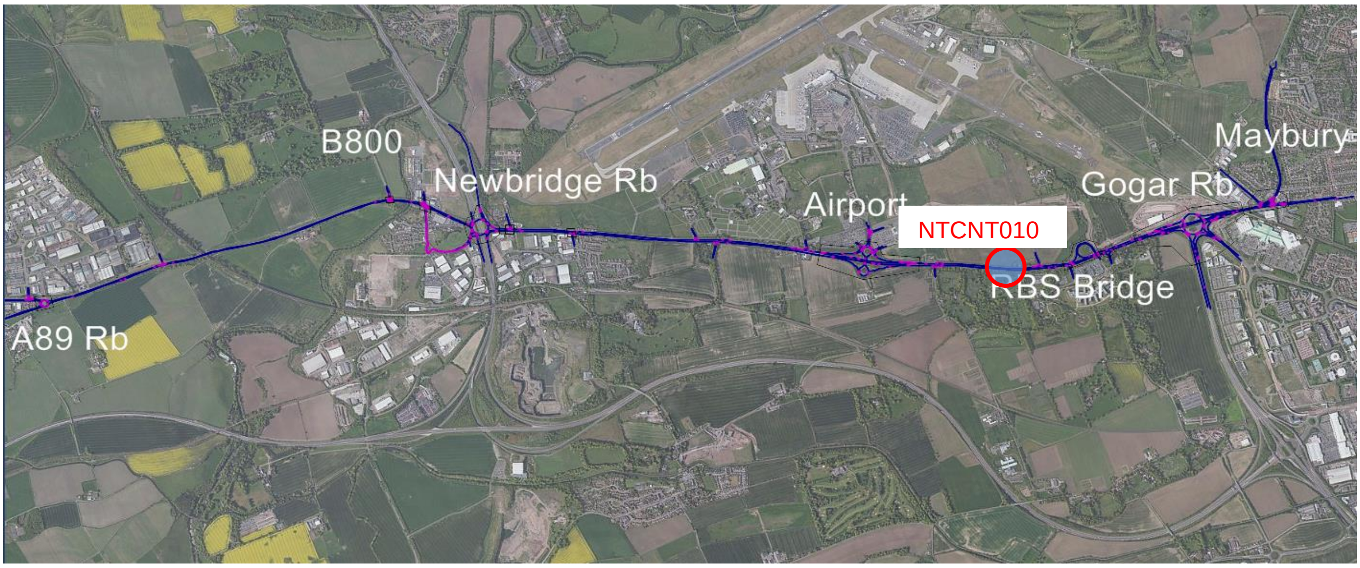


Figure 7.3: Scottish Road Traffic Database Location

7.3.2 2015 Traffic Flows

As mentioned in section 7.3.1, the data provided was from a range of sources and years. It was thus necessary to factor up the demand to a 2015 demand.

The factors that were utilised were in line with the National Road Traffic Central forecasts. This approach was taken due to the fact that during the construction of the infrastructure associated with the Edinburgh Tram project, from 2007 to 2013, there were significant road works in the study area, particularly centred on Gogar Roundabout. Construction of a tunnel under the roundabout as well as associated tram infrastructure led to the capacity being reduced at the roundabout during the construction periods. It was thus decided that any data that could be obtained from the automatic traffic count site on the A8, between Gogar Roundabout and the Airport 'dumbbells' (as shown in Figure 7.3), may not be representative of average site conditions.

The growth factors that were applied are shown in Table 7.1, below:

Table 7.1: Growth Factors Applied

Traffic Flow Year	Factor Applied
2006	1.144
2012	1.045
2013	1.030
2015	1.000

Incorporating the factors in Table 7.1, the model represents a 2015 base year, however it should be noted that due to the validation of journey times being undertaken during August, the model is seen to be more in line with end of summer conditions, then a neutral month.

7.3.3 Journey Time Information

Bus and car journey times were recorded during a survey carried out by AECOM staff on Thursday 20 August 2015, shortly after the schools returned from their summer holidays.

Bus journey times were calculated by recording the time, service and registration number of each bus when passing the survey locations, as shown in Figure 7.4. This information was used to determine the exact journey time for each service.

Car journey times were recorded by driving along the corridors six times during the morning and afternoon peak periods.

In order to check the confidence on the journey times recorded during the surveys, the traffic flow during that day was compared with the traffic flow on an average day of a neutral month, using the SRTDb at the location NTCNT010 (see Figure 7.3). The difference in traffic flows were within 1% in the AM period and 6% during the PM period.

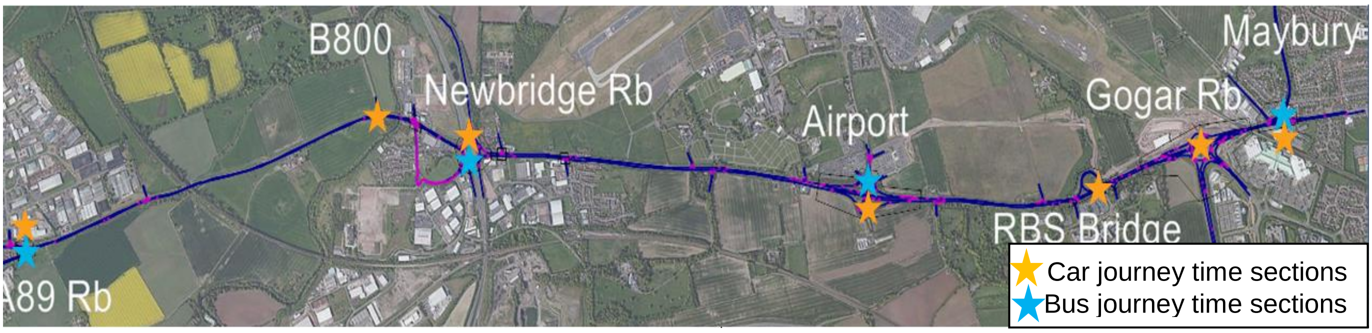


Figure 7.4: Journey Time Sections

7.3.4 Queue Lengths

Queue length information was also collected during the site visit carried out on Thursday 20 August 2015. Figure 7.5, overleaf, highlights those areas where traffic queue issues were observed.

During the AM peak period congestion issues and traffic queue lengths were observed at the western approach to Newbridge. There were intermittent traffic queues at the western approach to Maybury Junction.

The main congestion problems that were observed during the PM peak period were for westbound traffic approaching Maybury Junction, and for the eastbound traffic at Maybury Junction.

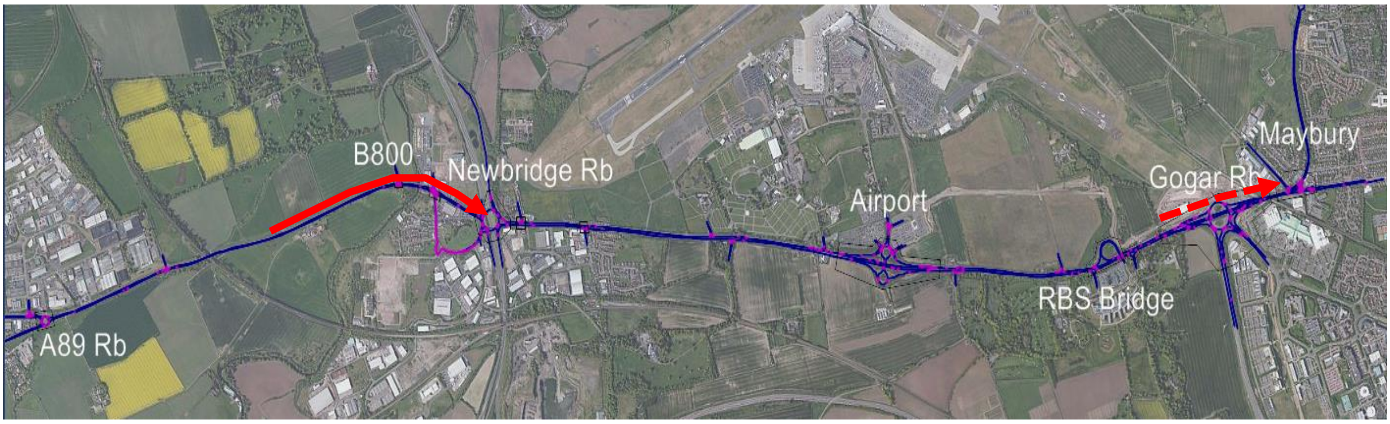


Figure 7.5: AM Peak Conditions

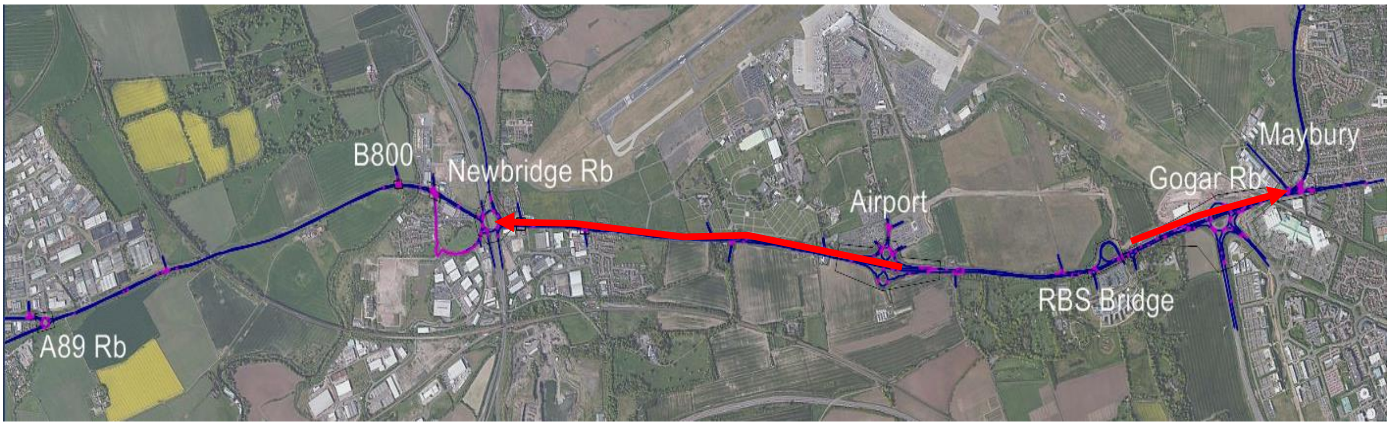


Figure 7.6: PM Peak Conditions

7.3.5 Public Transport Information

The public transport information was obtained from the service provider websites and site visits. The model includes 37 bus routes and 28 bus stops along the corridor.

7.3.6 Traffic Signal Timings

The traffic signal plan data was supplied by the Traffic Signal team at The City of Edinburgh Council. After the site visits it was deemed necessary to update the signal timings at Maybury Junction in the AM period, and Newbridge Junction in the PM period. This was due to the supplied signal timings not being representative of the timings observed on site.

7.3.7 Peak Periods

A review of the traffic data identified the following peak periods:

- AM period 07:00 - 09:30; and
- PM period 16:00 - 18:30.

In each case a 30 minute 'build-up' period prior to the times shown above was included to ensure the network was suitably populated prior to the assessment periods.

The peak hours were estimated using the surveyed turning counts at Newbridge Roundabout (December 2013). Figure 7.7 shows the traffic flow at this roundabout and the peak hours.

- AM Peak 07:45 - 08:45; and
- PM Peak 16:45 - 17:45.

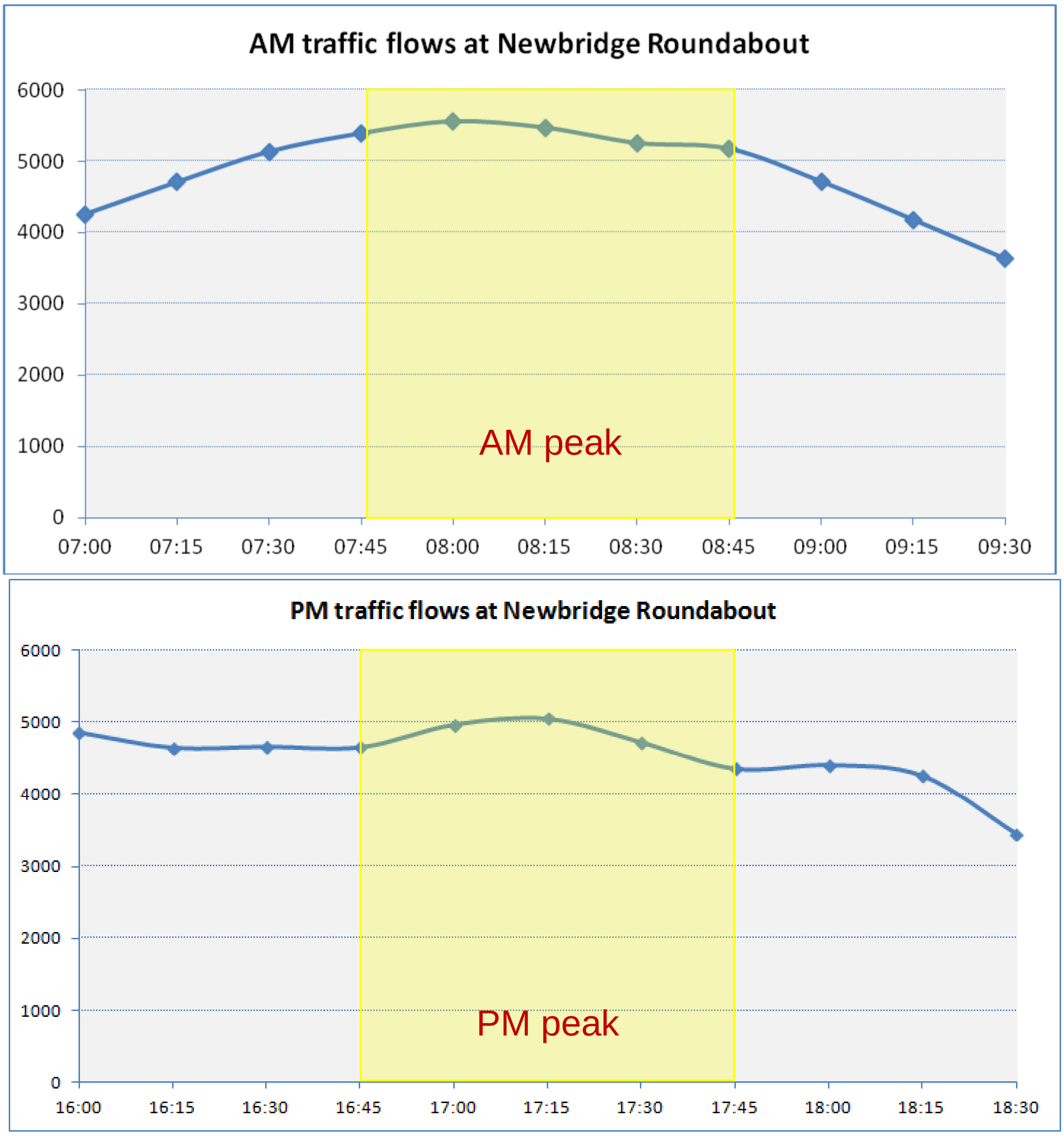


Figure 7.7: Surveyed Traffic Flows at Newbridge Roundabout

7.4 Model Calibration

For the purposes of calibration, link flow data at each of the junctions was used. In order to check the calibration level, the model was run using 20 different random seeds, starting with random seed 12 and utilising a random seed increment of 10. This introduces variability to the model by varying factors such as the discharge of vehicles, their assigned speeds and acceleration. The assigned flows from each run are then averaged and compared to the observed data for evaluation.

7.4.1 Calibration Process

The purpose of model calibration is to ensure that the model represents existing traffic conditions. In order to correctly model on-site behaviour, a number of factors have been considered, as listed below:

- Modelled flows at key junctions reflect those in the area;
- Appropriate traffic flow levels are getting through the network and equally, the right levels are being suppressed; and
- Traffic volumes on side roads and alternative routes are modelled adequately.

Calibration is an iterative process in which the model is continually revised to ensure that it ultimately provides a fair representation of base year conditions. This includes:

- Checking the coding of network elements; and
- Refining and adjustment of the trip data.

7.4.2 Network and Driver Behaviour Calibration Checks

The network and driver behaviour calibration checks that were undertaken for each model period are detailed below:

- **Coding of the Network**

The addition of the traffic flows into the base models allows a visual check of the model to be undertaken. This allows the construction of the network to be checked, as well as highlighting any program error files that may require addressing.

- **Driver Behaviours**

VISSIM has a default set of driving behaviour parameters which can be edited to more accurately reflect site specific conditions. These parameters affect the car following and lane change models of vehicles, lateral behaviour and vehicular reaction to traffic signals. The default driver behaviour parameters were changed at the A8/Maybury Junction, western approach, to allow more cooperative driver behaviour, as it was observed on site.

7.5 Validation

Following calibration of the model, the VISSIM model was taken forward for model validation. This process involves comparing model outputs against independent data to ensure that the model achieves a satisfactory level of validation.

7.5.1 Model Validation Criteria

The following paragraphs summarize the validation of the A89/ A8 VISSIM model which has been undertaken to comply with current guidance and recommendations.

Network validation has been carried out in accordance with DMRB Volume 12, Section 2 Part 1 Chapter 4. Current advice on micro-simulation modelling is also contained in Interim Advice Note 36-01 'The Use and Application of Micro-Simulation Models'. A summary of the acceptable criteria is listed in Table 7.2.

Table 7.2: Summary of Assignment Validation Acceptability Guidelines

Criteria and Measures	Acceptability Guideline
Assigned Hourly Flows * compared with observed flows. 1. Individual flows within 15% for flows 700-2700 vph 2. Individual flows within 100 vph for flows < 700 vph 3. Individual flows within 400 vph for flows >2700 vph 4. Total screenline flows (normally >5 links) to be within 5% 5. GEH statistic i. Individual flows: GEH <5 ii. Screenline (+) totals: GEH <4 Notes: + Screenlines containing high flow routes such as motorways should be provided both including and excluding such routing * Link flows or turning movements	All (or nearly all) screen lines Greater than 85% of all cases
Modelled journey times compared with observed times. 6. Times within 15% (or 1 minute if higher)	> 85% of routes

To demonstrate that the developed model provides a robust platform for future testing, the following validation checks were carried out:

- Traffic Flow Validation – Individual Flows and GEH Statistic; and
- Average Journey Time Validation.

7.5.2 Traffic Flow Comparison

The observed and modelled flows were compared for key turning counts in accordance with the criteria above. The permissible difference was then calculated for each value (based on the observed figure) and compared to that which had been produced in the model. The results are summarized in Table 7.3, with a more detailed breakdown presented in **Appendix G**.

Table 7.3: Summary of Traffic Flow Validation – Total Vehicles

DMRB Criteria	Result Achieved	
Modelled Flows against the Observed flows satisfying DMRB criteria (DMRB Target > 85%)	AM peak (07:45 - 08:45)	PM peak (16:45 - 17:45)
Number of counts	72	72
Individual flows within 100 vph for flows < 700 vph	100%	100%
Individual flows within 15% for flows 700-2700 vph	100%	100%
Individual flows within 400vph for flows > 2700vph	100%	100%

From Table 7.3 and Figure 7.8 it can be seen that both the AM and PM peak model correlate with the observed traffic flows.

AM PM

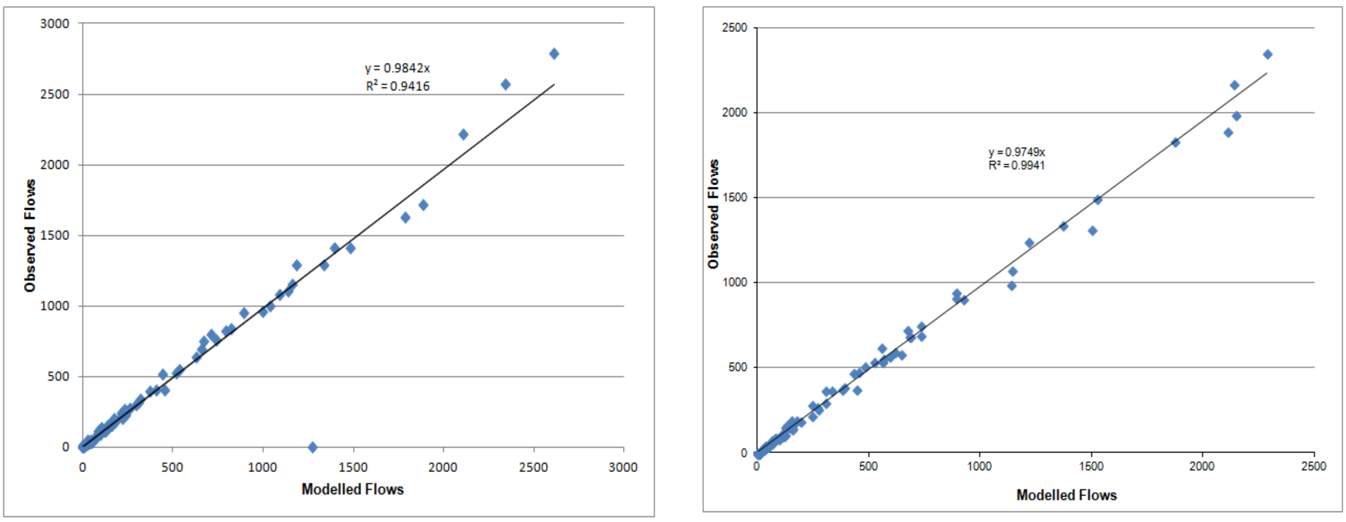


Figure 7.8: Correlation between Observed and Modelled Traffic Flows

7.5.3 GEH Statistic

The percentage difference between observed and modelled datasets can prove to be misleading given the relative value of the difference. The standard method used to compare modelled values against observations on a link therefore involves the calculation of the Geoff Havers (GEH) statistic, which is a form of the Chi-squared statistic, incorporating both the relative and the absolute errors.

The GEH statistic is defined as:

Equation 7.1

$$GEHStat = \sqrt{\frac{\{O - M\}^2}{\frac{1}{2}\{O + M\}}}$$

Where O and M are observed flows and modelled flows respectively.

As a general rule, when comparing assigned volumes with observed volumes, a GEH value of 5 or less indicates an acceptable fit, whilst a value greater than 10 requires closer attention. The objective is to get at least 85% of GEH values below a value of 5.

The calculated GEH statistic from the observed and modelled flows was considered for the turning counts in accordance with the above criteria. The results are summarized below in Table 7.4 for the turning counts and are taken from the average of the random seeds. A more detailed breakdown can be found in **Appendix G**.

Table 7.4: Summary of GEH Traffic Flow Validation – Total Vehicles

DMRB Criteria	Result Achieved	
Modelled Flows against the Observed flows satisfying DMRB criteria (DMRB Target > 85%)	AM peak (07:45 - 08:45)	PM peak (16:45 - 17:45)
Number of counts	72	72
Percentage of sites meeting GEH <5	97.2%	97.2%
Percentage of sites meeting GEH <10	100%	100%
Average GEH	1.10	1.17

From Table 7.4 it can be seen that the traffic flow validation for the turning counts during both the AM and PM peak periods are within the required GEH criteria. This indicates that the VISSIM models for both the AM and PM peak periods provide a fair representation of the observed data.

7.5.4 Average Journey Time Validation

The previous journey time survey described in 3.2.2 was used to identify hotspots within the corridor, but did not contain sufficient detailed information on journey time sections in order to develop a robust model. It was therefore deemed necessary to gather further information on bus and private vehicle journey times to strengthen the model's robustness. The methodology for journey time collection was as follows:

- Bus Transport Journey Time Survey – Surveyors placed along the corridor at key locations e.g. Newbridge, Maybury etc., to record the bus arrival time, service number and licence plate. Each surveyor synchronised their clocks in order to remove any discrepancies between timing locations. This method greatly increases the number of buses being monitored over other methods such as a "ride on board" survey.
- Private Transport Journey Time Survey – Two cars were used to collect journey time data, with each car starting at opposite ends of the corridor. A floating car method was adopted whereby the survey vehicle must pass as many cars as it is passed by. There are limitations to this method, such as maintaining a floating behaviour within congested conditions, however all efforts were made to maintain this behaviour. In addition, the survey car passenger was able to collect queue data and observations during the survey which aided the development of the model.

The two journey time surveys were carried out between 07:00 to 09:30 in the morning, and 16:00 to 18:30 in the evening. In terms of the bus journey times, the corridor was split into 6 sections, whereas the car journey times were split into 14 sections. Both eastbound and westbound directions were monitored. In total 6 journey time runs were completed in each direction in each period by the survey car. In terms of bus journey times, 66 and 58 buses were monitored during the AM and PM periods respectively.

For the journey time validation the sections are the same as those identified during the site visit (see Figure 7.4).

The observed average journey times for these routes have been compared to the modelled average journey times in accordance with the criteria outlined in Table 7.2. The permissible difference was then calculated for each value (based on the observed figure) and compared to that which had been produced in the model.

It can be seen from Table 7.5, overleaf, that during the AM peak period, the modelled journey times for cars along the corridor are very similar to the observed journey times. The difference between observed and modelled journey times is less than 1 minute for all the sections and about 30 seconds for the whole route (3-4%).

Table 7.5: Observed and Modelled Journey Times for Cars – AM peak

	Section	Observed		Modelled		Comparison	
		Journey time	Cumulative	Journey time	Cumulative	Differences	%
Westbound	Maybury Rd SB	02:03	02:03	01:52	01:52	00:11	
	Maybury-Gogar	00:41	02:44	00:37	02:29	00:04	
	Gogar-RBS	00:52	03:37	00:49	03:18	00:03	
	RBS-Airport	01:16	04:52	01:45	05:03	00:29	
	Airport-Newbridge	02:15	07:08	02:50	07:53	00:35	
	Newbridge-B800	01:31	08:39	01:23	09:16	00:08	
	B800-A89 Rb	02:19	10:58	02:12	11:28	00:07	
	Total	**10:58**		**11:28**		**00:30**	**4%**
Eastbound	A89 Rb-B800	03:58	03:58	03:04	03:04	00:54	
	B800-Newbridge	06:19	10:16	06:36	09:40	00:17	
	Newbridge-Airport	02:36	12:53	02:21	12:01	00:15	
	Airport-RBS	01:27	14:19	01:40	13:41	00:13	
	RBS-Gogar	00:40	14:59	00:59	14:40	00:19	
	Gogar-Maybury	01:17	16:16	01:37	16:17	00:20	
	Maybury Rd NB	01:03	17:19	01:00	17:17	00:03	
	Total	**17:19**		**17:17**		**00:02**	**0%**

The graphs presented overleaf display the cumulative observed (blue line) and modelled (red line) journey times along the A8 and A89 roads. The vertical axis shows the journey times (in the format mm:ss) and the horizontal axe shows the distances in metres, from Maybury Road to the A89. The graphs are reproduced in **Appendix H**, with the variability of the observed journey times shown as dashed lines.

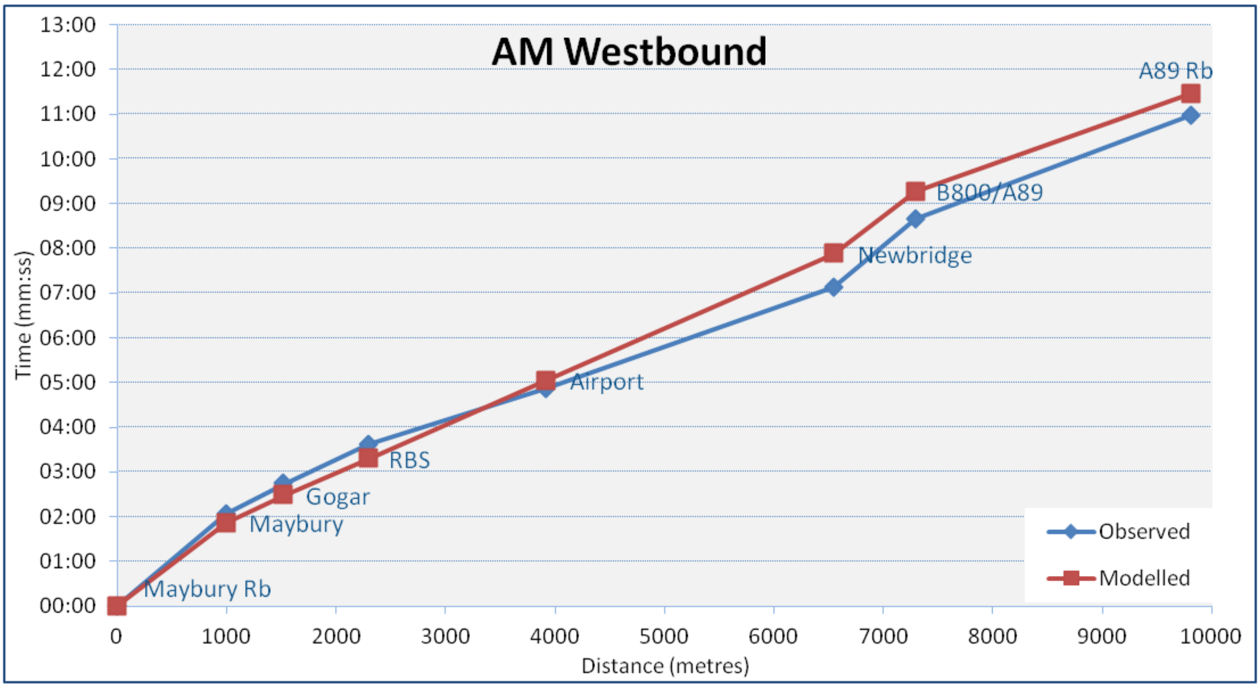


Figure 7.9: Modelled and Observed Journey Times for Cars – AM peak - Westbound

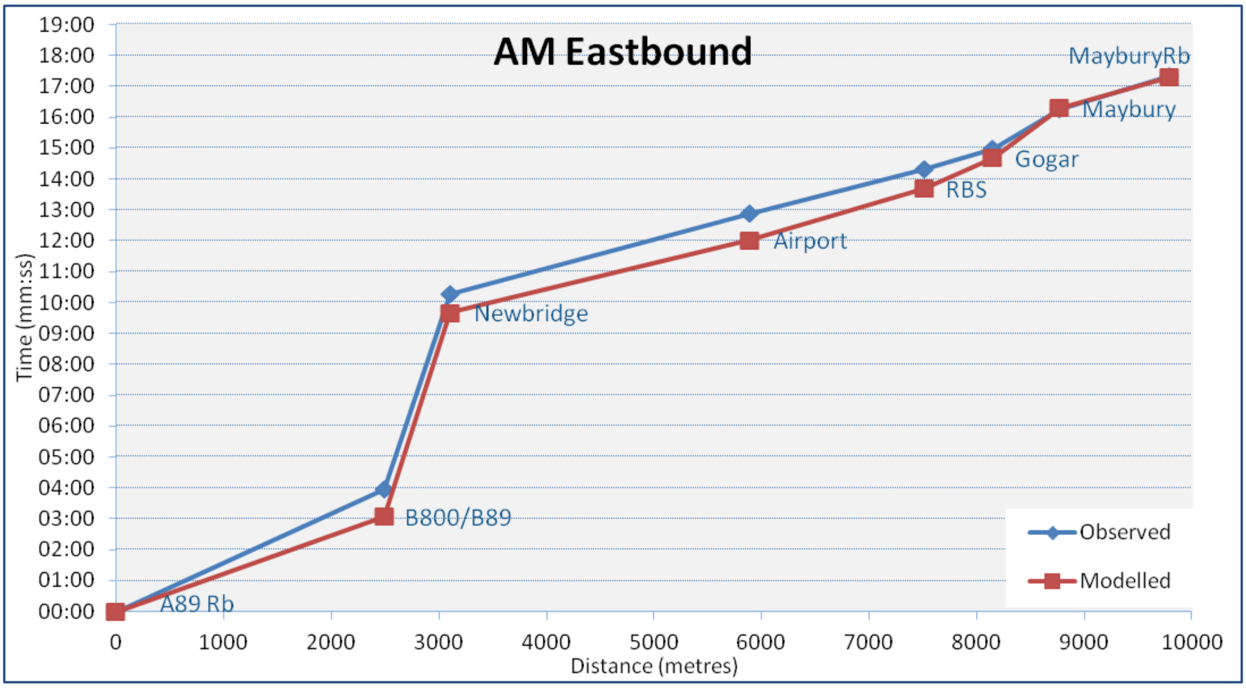


Figure 7.10: Modelled and Observed Journey Times for Cars – AM peak - Eastbound

Table 7.6 and Figures 7.11 and 7.12 show the observed and modelled journey times for cars during the PM peak period along the corridor. The modelled journey times are within 1 minute of the observed journey times for all the sections, except for the westbound traffic between Newbridge Roundabout and the A89/B800 junction where the observed journey times are slightly higher than the modelled journey times. This might be due to the fact that high variability in journey times was observed at this section during the site visit (see Figure 7.12).

Overall, the modelled journey times during the PM peak period replicates the observed journey times to a high degree, with a difference of 7 seconds along the westbound route and 1 second along the eastbound route.

Table 7.6: Observed and Modelled Journey Times for Cars – PM Peak

	Section	Observed		Modelled		Comparison	
		Journey time	Cumulative	Journey time	Cumulative	Differences	%
Westbound	Maybury Rd SB	06:11	06:11	06:14	06:14	00:03	
	Maybury-Gogar	00:40	06:51	00:36	06:50	00:04	
	Gogar-RBS	00:39	07:30	00:49	07:39	00:10	
	RBS-Airport	01:30	09:00	02:14	09:53	00:44	
	Airport-Newbridge	10:23	19:23	10:46	20:39	00:23	
	Newbridge-B800	02:35	21:58	01:30	22:09	01:05	
	B800-A89 Rb	02:19	24:18	02:15	24:24	00:04	
	Total	**24:18**		**24:24**		**00:07**	**0%**
Eastbound	A89 Rb-B800	02:33	02:33	02:12	02:12	00:21	
	B800-Newbridge	02:12	04:45	02:00	04:12	00:12	
	Newbridge-Airport	02:23	07:08	02:43	06:55	00:20	
	Airport-RBS	03:05	10:13	02:34	09:29	00:31	
	RBS-Gogar	02:14	12:27	02:07	11:36	00:07	
	Gogar-Maybury	02:07	14:34	02:49	14:25	00:42	
	Maybury Rd NB	00:58	15:33	01:03	15:28	00:05	
	Total	**15:33**		**15:28**		**00:05**	**1%**

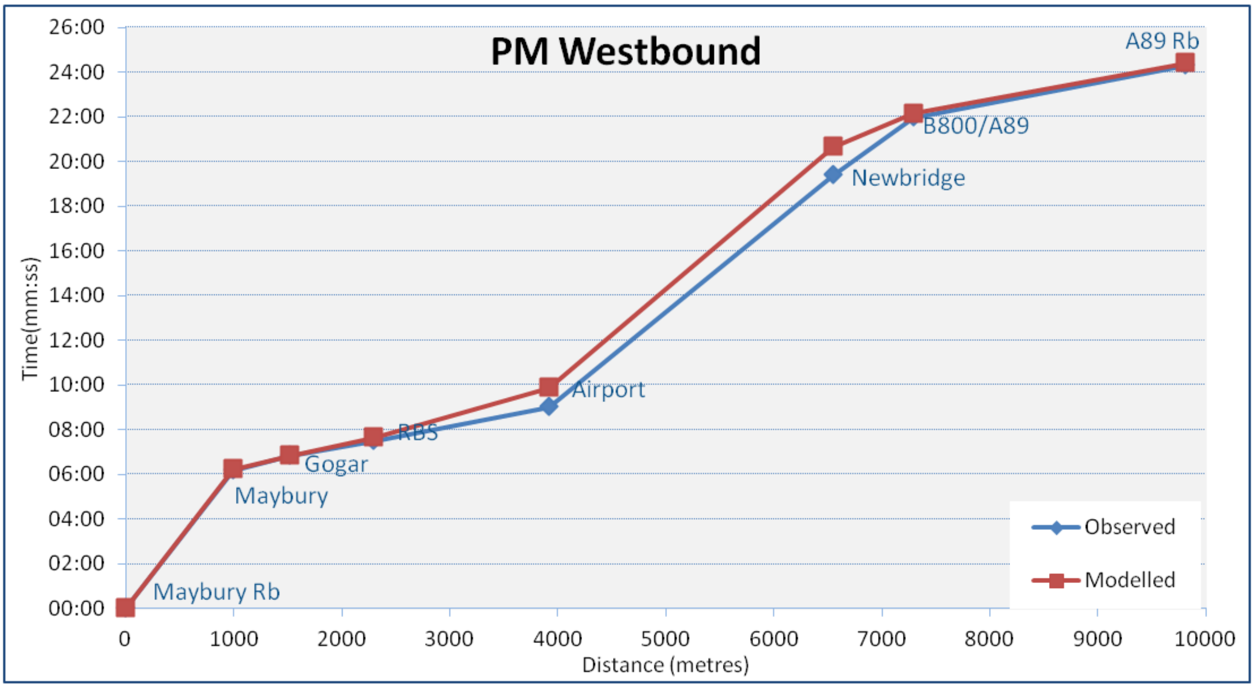


Figure 7.11: Modelled and Observed Journey Times for Cars – PM Peak - Westbound

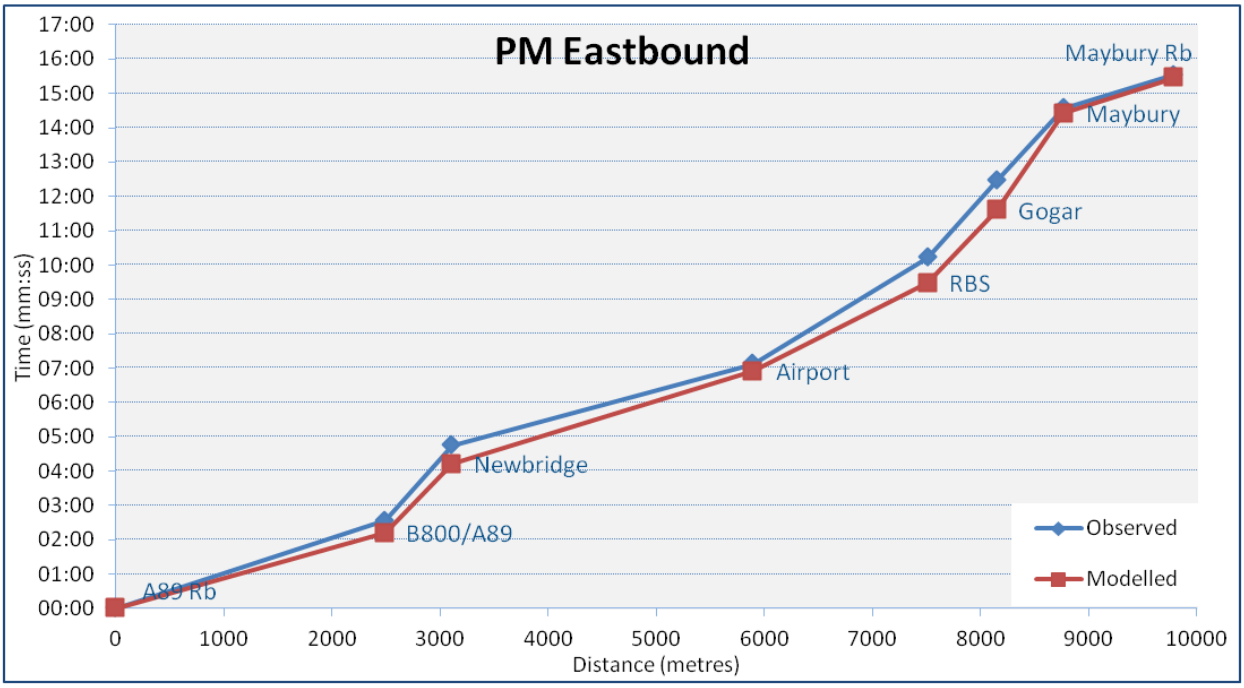


Figure 7.12: Modelled and Observed Journey Times for cars – PM Peak - Eastbound

The following tables and figures show the observed and modelled journey times for buses.

Table 7.7 and Figures 7.13 and 7.14 show the journey times for buses during the AM peak hour. The modelled journey times are less than 1 minute for all the sections along the corridor except for the western section between the A89 Roundabout and Newbridge Roundabout. In this case, the modelled bus journey times are slightly slower than the observed journey times. This could be due to the sample size, as only 2 buses were observed during the AM peak period along this section.

Table 7.7: Observed and Modelled Journey Times for Buses – AM Peak

	Section	Observed		Modelled		Comparison	
		Journey time	Cumulative	Journey time	Cumulative	Differences	%
Westbound	Maybury-Airport	04:00	04:00	04:40	04:40	00:40	
	Airport-Newbridge	04:33	08:33	05:07	09:47	00:34	
	Newbridge-A89	07:07	15:40	07:03	16:50	00:04	
	Total	**15:40**		**16:50**		**01:10**	**7%**
Eastbound	A89-Newbridge	13:27	13:27	11:58	11:58	01:29	
	Newbridge-Airport	04:25	17:52	05:20	17:18	00:55	
	Airport-Maybury	05:47	23:39	05:47	23:05	00:00	
	Total	**23:39**		**23:05**		**00:34**	**2%**

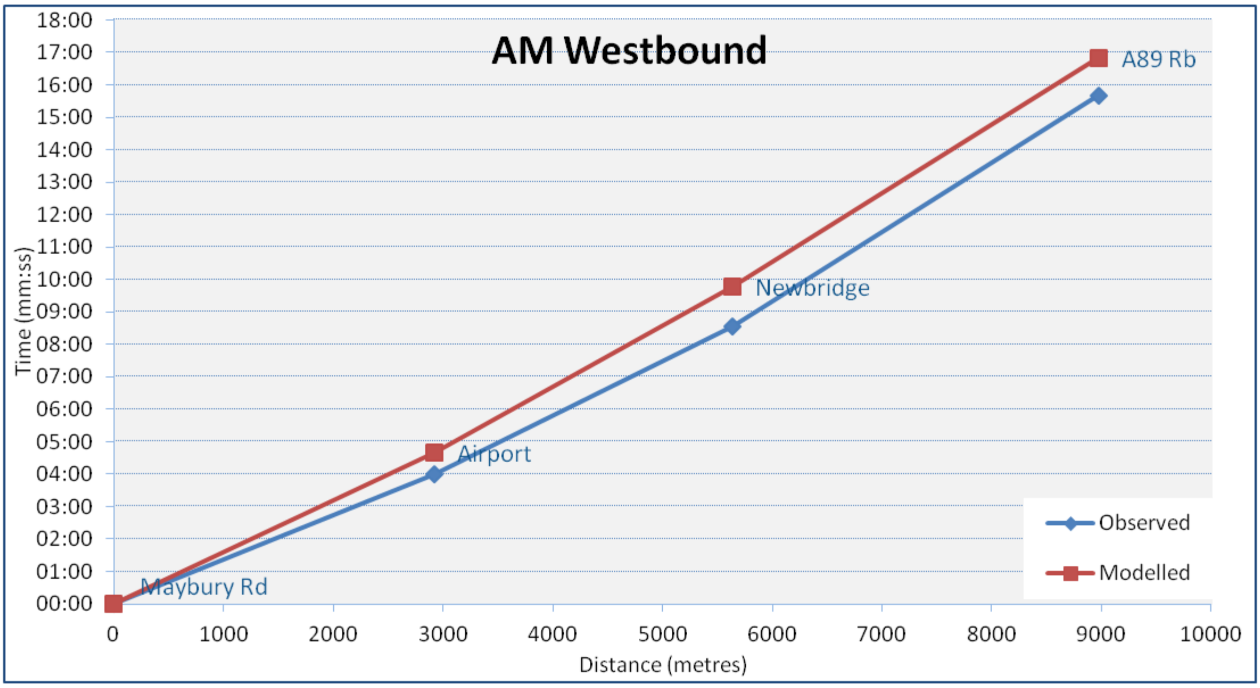


Figure 7.13: Modelled and Observed Journey Times for Buses – AM Peak - Westbound

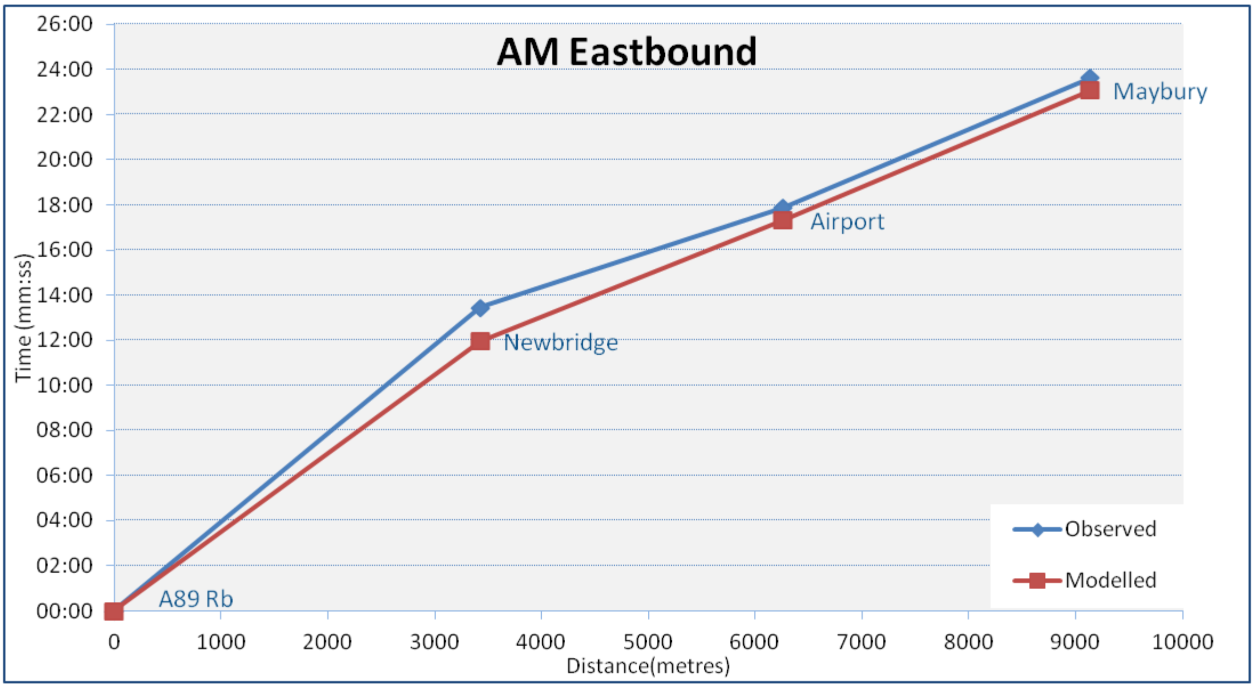


Figure 7.14: Modelled and Observed Journey Times for Buses – AM Peak – Eastbound

During the PM peak period, the bus journey times fulfil the DMRB criteria that the modelled journey times along both routes are within 15% of the observed journey times. It has to be noted that between the Airport and Newbridge Roundabout the modelled journey times for buses are about 3 minutes higher than the observed journey times. However, big variability in journey times was observed at this section during the site visit. Modelled journey times replicates the highest observed journey time. It can be seen in Figure 7.15 that the slope of the line for modelled journey times between the Airport and Newbridge is the same that the slope of the line for the maximum observed journey time.

Table 7.8: Observed and Modelled Journey Times for Buses – PM peak

	Section	Observed		Modelled		Comparison	
		Journey time	Cumulative	Journey time	Cumulative	Differences	%
Westbound	Maybury-Airport	03:44	03:44	04:32	04:32	00:48	
	Airport-Newbridge	10:34	14:18	13:13	17:45	02:39	
	Newbridge-A89	06:30	20:48	05:51	23:36	00:39	
	Total	**20:48**		**23:36**		**02:48**	**13%**
Eastbound	A89-Newbridge	10:27	10:27	10:10	10:10	00:17	
	Newbridge-Airport	04:23	14:50	04:51	15:01	00:28	
	Airport-Maybury	06:05	20:55	08:12	23:13	02:07	
	Total	**20:55**		**23:13**		**02:18**	**11%**

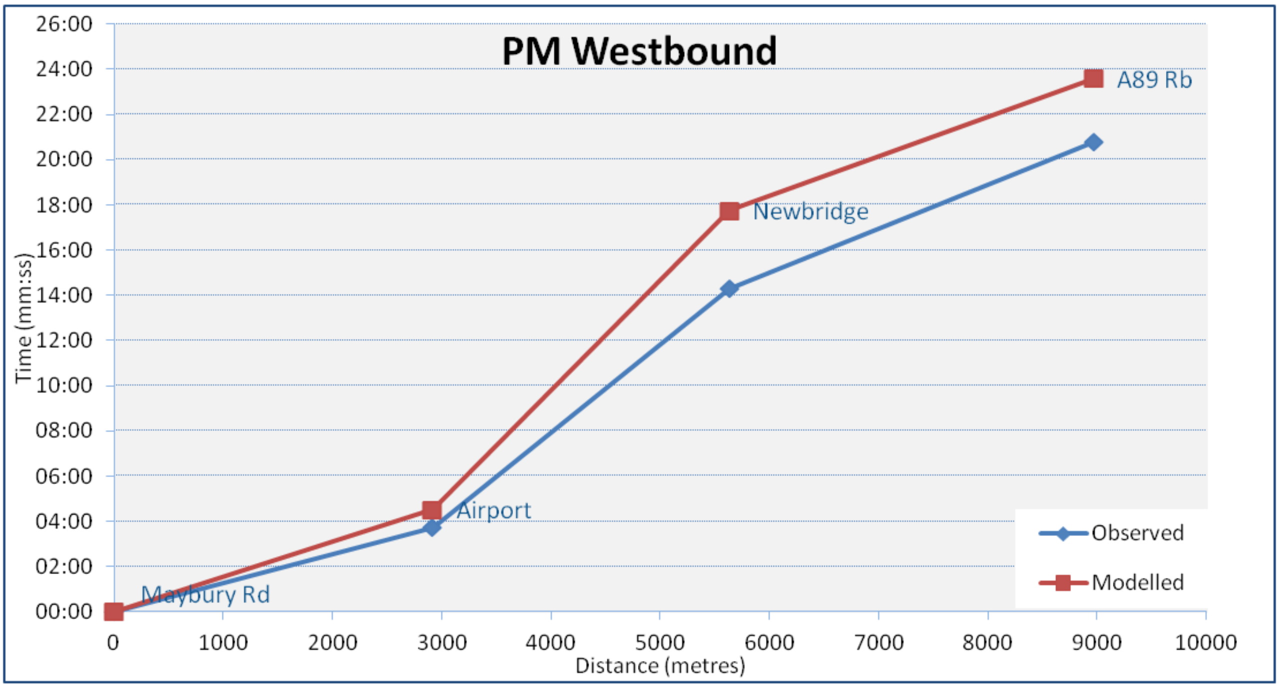


Figure 7.15: Modelled and Observed Journey Times for Buses – PM Peak - Westbound

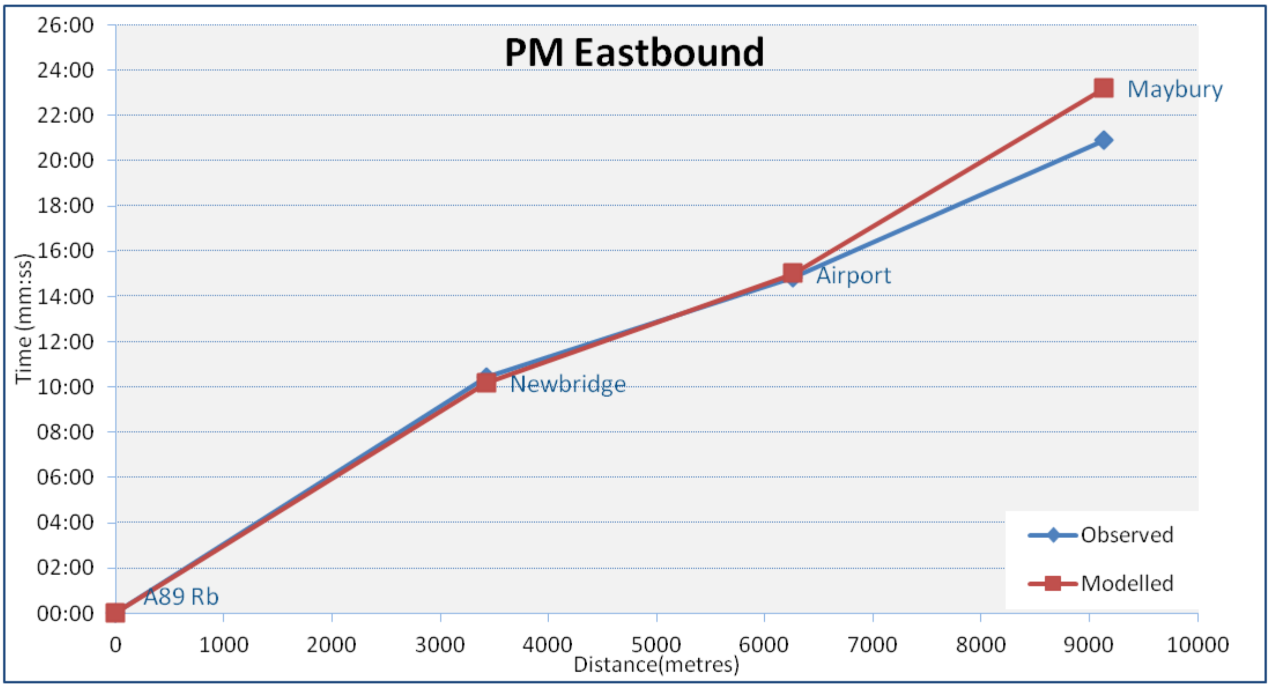


Figure 7.16: Modelled and Observed Journey Times for Buses – PM Peak - Eastbound

Table 7.9 and Table 7.10 summarise the journey time validation results. The DMRB criteria were fulfilled during the AM and PM peak periods for cars and buses. The average journey time was within 15% of the observed values (or 1 minute if higher) in all the cases.

Table 7.9: Summary of DMRB Journey Time Validation – Cars

DMRB Criteria	Result Achieved	
(DMRB Target > 85%)	AM peak (07:45 - 08:45)	PM peak (16:45 - 17:45)
Number of routes validated	2 routes (14 sections)	2 routes (14 sections)
Modelled journey times within 15% (or 1 minute if higher)	100%	100%

Table 7.10: Summary of DMRB Journey Time Validation – Buses

DMRB Criteria	Result Achieved	
(DMRB Target > 85%)	AM peak (07:45 - 08:45)	PM peak (16:45 - 17:45)
Number of routes validated	2 routes (6 sections)	2 routes (6 sections)
Modelled journey times within 15% (or 1 minute if higher)	100%	100%

7.5.5 Queue Lengths

A check of the available surveyed queue information against the modelled queues was undertaken as part of the validation of the model. Since no criteria exist to assess surveyed and modelled queue lengths, the appraisal that was undertaken took the form of inspection of the results.

No queue length surveys were undertaken by a survey company as part of this study. As previously mentioned in section 7.3.4, spot checks of queue lengths were collected during the site surveys that AECOM undertook in August 2015. This data was compared against the outputs from the VISSIM models to ensure that the models are representative. The models were shown to stakeholders and it was agreed that they provide a fair representation of the base network.

7.6 Overall Conclusion

Overall, the AM and PM models validate to DMRB standards against the traffic flows and journey time available data and are considered a robust tool to test the public transport proposals detailed in previous sections. However, it should be acknowledged that the model has limitations and these need to be considered when reviewing and formulating conclusions. The following limitations should be considered:

- The traffic count data used in the development of the model is a combination of survey data from different years and data extracted from other models within this area;
- During the survey there were roadworks along the underpass at Gogar junction which restricted the number of lanes to one in both directions;
- The signal data provided was dated and did not correspond to that observed on site. Although every effort was made to replicate the current on-site signal timings and offsets it is acknowledged that the model timings might differ from those on-site; and
- Factoring method for aligning the data to a 2015 baseline was reliant on NRTF rather than observed data such as ATCs.

Traffic Modelling Analysis

8 Traffic Modelling Analysis

8.1 Introduction

Having achieved a satisfactory level of validation for both periods, it was possible to include the various bus priority measures to assess their impact on public transport and general traffic in the network.

The measures included are shown in Table 8.1 below.

Table 8.1: Proposed Measures

Link	Section
Broxburn – Newbridge	A89: 3.65m eastbound bus lane from Broxburn to Newbridge Roundabout
Edinburgh Airport – Maybury Junction	3.65m eastbound bus lane from Airport Roundabout to Maybury Junction;
Edinburgh Airport – Newbridge	3.65m westbound bus lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout
Gogar Roundabout	Bus lane under Gogar Roundabout to allow queue jump
Maybury Junction	Remodelling of Maybury Junction to provide 2 northbound lanes onto Maybury Rd
Maybury Road	3.65m partial bus/ lane
Station Road	Introduction of traffic signals at A8/Station Road junction.

8.2 Option Testing

8.2.1 Description of the Tests

The measures above were grouped into three tests as described in Table 8.2. Test 1 looks at bus improvements that could be adopted in the short term, whereas Tests 2 and 3 consider bus improvements that could be adopted in the medium to long term, as they require land acquisition/ reallocation.

Table 8.2: Proposed Measures Included in Each Test

Test 1	Test 2	Test 3
Bus lane under Gogar Roundabout to allow queue jump.	Bus lane under Gogar Roundabout to allow queue jump.	Bus lane under Gogar Roundabout to allow queue jump.
Increase capacity to 2 lanes at traffic lights to Maybury road.	Increase capacity to 2 lanes at traffic lights to Maybury road.	Increase capacity to 2 lanes at traffic lights to Maybury road.
A89: 3.65m eastbound bus lane from Broxburn to Newbridge Roundabout - using existing road.	A89: 3.65m eastbound bus lane from Broxburn to Newbridge Roundabout - through land acquisition.	A89: 3.65m eastbound bus lane from Broxburn to Newbridge Roundabout - through land acquisition.
A8: 3.65m westbound bus lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout - using existing road.	A8: 3.65m westbound bus/ lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout - through land acquisition.	A8: 3.65m westbound bus/ lane immediately adjacent to the nearside lane up to Station Road which is 500 metres from Newbridge Roundabout - through land acquisition.
A8: 3.65m eastbound bus/ lane from Airport Roundabout to Maybury Junction - using existing road.	A8: 3.65m eastbound bus/ lane from Airport Roundabout to Maybury Junction - through land acquisition.	A8: 3.65m eastbound bus lane from Airport Roundabout to Maybury Junction - through land acquisition.
3.65m Partial bus lane - using existing road.	3.65m Partial bus lane - through land acquisition.	3.65m Partial bus lane - through land acquisition.
		Signalisation of Station Road Junction.

These tests have been assessed using two demand scenarios:

- 2015 scenario – This scenario includes the current traffic demand and all the tests have been compared against the validated 2015 base model; and
- 2027 scenario – The 2027 scenario includes a new design for Maybury Junction (provided by Jacobs) and it incorporates 2027 demand.

8.2.2 Assumptions for Station Road Junction

The following assumptions have been made for Test 3:

- Signals at Station Road have been coded to optimise the green time at all the approaches during the AM and PM peak periods;
- Due to the lack of data for the eastbound traffic turning right into Station Road, the green time assigned to this stage has been limited to 5 seconds; and
- An estimate of vehicles that previously turned left from Station Road and performed a U-turn at Newbridge Roundabout to travel eastbound along the A8, are now assigned to the right turn from Station Road in Test 3.

8.2.3 2027 Scenario

Jacobs provided AECOM with 2014 and 2027 demand matrices from their VISUM models. The 2027 development demand was extensive and was estimated by subtracting the 2014 demand from the 2027 demand.

The 2027 demand includes the following larger developments:

- The International Business Gateway (IBG development);
- Edinburgh Airport development; and
- The Royal Highland Showground development.

Note: a full list of developments included in the 2027 models is provided in **Appendix I**.

The development demand represents about 25% of the 2015 demand for the AM peak period and about 44% for the PM period. This level of additional demand is significant considering the congestion levels currently experienced within the modelled area. The additional demand may result in changes in mode choice, peak spreading or changes in origin/destination, which are not considered by the VISUM model. Therefore caution should be taken when interpreting the model results.

Table 8.3 and Table 8.4, overleaf, indicate the increase in demand by area and time period (only increases greater than 100 vehicle per hour have been presented). The tables illustrate that during the AM peak the M9 North generates the largest increase in demand, whereas during the PM peak there are a number of locations where demand is significantly increased, including The City of Edinburgh Bypass and South Gyle Broadway.

Table 8.3: AM Peak, Demand difference between 2027 and 2014

Origin / Destination	Lochend Rd	A8 West	S Gyle Broadway	Edinburgh Bypass	RB S	M9 South	Lochside Cres	Ingliston P&R
A89 West	202			113				
M9 North		325	425		138		213	385
Maybury Rd		114						
A8 West				131		182		310
Edinburgh Bypass								388
M9 South								174
Ingliston P&R		113						

Table 8.4: PM Peak, Demand difference between 2027 and 2014

Origin / Destination	A89 West	M9 North	Lochend Rd	Maybury Rd	A8 West	S Gyle Broadway	Edinburgh Bypass	M9 South	Ingliston P&R
A89 West		177	147						
Ingliston P&R		155						153	
A8 West								630	134
S Gyle Broadway							985	312	
Edinburgh Bypass				172	596	145			103
M9 South	110								101
Lochside Cres							358		
Lochside Ave							358		
Ingliston P&R		255			143		239	191	

8.2.4 Evaluation Outputs

The schemes were assessed in terms of:

- Network performance, the attributes selected to evaluate the network performance;
- Average delay – public transport and general traffic;
- Average speed – public transport and general traffic;
- Total travel time – public transport and general traffic; and
- Journey time – public transport and general traffic.

8.2.5 Confidence Level and Intervals

As explained in section 7.4, the random seed affects the realization of the stochastic quantities in VISSIM, such as inlet flows and vehicle capabilities. Models should be run using several different “seed” values, with average figures taken for output evaluation. The number of random seeds that should be used, and hence the number of times that the model should be run to obtain the average figures, depends on the complexity and stability of the model.

The stability of the models has been checked using the average delay per vehicle during the AM and PM peak period, which is assumed to be normally distributed. After calculating the mean and standard deviation for a sample of 30 values, a 90% confidence level that the true mean lies in the interval ±15 seconds was achieved.

Therefore, the models have been run using 30 different random seed values, from random seed 12 to random seed 302 with random seed increments of 10.

8.2.6 Risks and Assumptions

The following assumptions have been made through the modelling exercise and, therefore, should be considered in case of further studies:

- The reliance on the VISUM model in providing forecast matrices is a high risk. The growth being calculated by the VISUM model indicates significant growth within the corridor. Behavioural reactions such as modal shift, changing journey departure times etc. have not been considered. Furthermore, there is an assumption that the additional demands will pass through the corridor during the model period. These might be held back due to pinch points external to the network, however, such as the Forth Road Bridge, The City of Edinburgh Bypass and the Queensferry Crossing;
- The available traffic data in the study area was provided from different sources and were collected in different years. The homogenisation process has some risks associated like the utilisation of the most appropriate traffic growth factors. Moreover, the traffic data provided by Jacobs, and used at RBS and Gogar Roundabout, was obtained from a VISSIM model without consideration of any behavioural change;
- Microprocessor Optimised Vehicle Actuation (MOVA) has not been included into any of the models due to time and budget constraints;
- Station Road traffic signals have been improved using VISSIM. It is considered that a better optimisation might be achieved through the utilisation of a more accurate signal software, i.e. LinSig;
- As explained in section 7.3.2, since there was not traffic demand information at Station Road Junction, no traffic demand has been assigned for the right turn into Station Road in Test 3; and
- A key feature of any test will be the need for close coordination of adjacent signals on each junction. This was particularly evident at Newbridge and Station Road in Test 3 where the difference in cycle times was causing

the loss of green time for the westbound traffic at Newbridge Roundabout. Accordingly, it is recommended that further detailed signal design/assessment is undertaken. This is discussed in the Chapter 9.

8.3 Results

The overall aim of the study is to reduce bus journey times between Kilpunt Roundabout and Maybury Road junction. This section compares all of the 2015 tests against the 2015 validated Base model, and all of the 2027 tests against the 2027 Do-minimum model. This includes a comparison of journey times, the key indicator as to whether the option tested meets the overall aim of the study, as well as other indicators, including queue lengths, network performance and levels of suppressed demand.

After assessing Test 1 in the 2015 scenario, it was considered that the there was insufficient road capacity to build a new bus lane along the corridor without causing significant delays to the general traffic. Incorporating a bus lane using the existing road capacity would result in highly increased delays (+184%) and travel times (+65%), as shown in Table 8.1. Thus, Test 1 was not assessed in the 2027 scenario.

The modelling results are presented as follows:

- 2015 results – section 8.3.1; and
- 2027 results – section 8.3.2.

The following tables and figures are provided to illustrate the results:

- Table showing the network performance for buses and all vehicles;
- Table showing the journey times for buses;
- Table showing the journey time for all vehicles;
- Figures comparing the queue lengths at key junctions; and
- Table presenting the suppressed demand;

Additional data is presented in the appendices

- Graph illustrating the journey time comparison for buses between the Base and option tests – **Appendix J**; and
- Graph illustrating the journey time comparison for cars between the Base and option tests – **Appendix J**.

8.3.1 2015 Results

Table 8.5 and Table 8.6 present the journey time and network performance indicator results for the AM and PM periods respectively. The differences against the Base and the Do-minimum scenario are highlighted in the tables as follows:

(yellow)	Marginal: differences less than 5% (network performance) or 30 seconds (travel time)
(red)	Detriment: Test performs worse than the Base model
(green)	Improvement: Test performs better than the Base model

Table 8.7 presents average queue length comparison figures for four junctions:

- Newbridge Roundabout;
- A8 / Airport Accesses;
- Gogar Roundabout; and
- A8 / Maybury Road Junction.

In this table the numerical values in the figures are the test results minus the Base results. This means that a positive value indicates an increase in average queue length, while a negative value indicates a decrease. All values are in metres.

Table 8.5: Results AM Peak 2015

Network Performance Results

Test 1 indicates a significant increase in bus delays and with average bus delays increasing by around 6 minutes. The network performance and journey times are similar for both Test 2 and Test 3. Average delay and total travel time were reduced for cars and buses therefore leading to an increase in average speed. However

	Average delay_All vehicles (minutes)	Average delay_Buses (minutes)	Average speed_All vehicles (km/h)	Average speed_Buses (km/h)	Total travel time_All vehicles (hours)	Total travel time_Buses (hours)
Base	2.5	3.5	22.3	17.2	1106.0	13.7
Test 1	7.0	9.4	11.0	9.4	1824.1	23.2
Test 2	2.4	3.2	36.3	29.3	1095.5	12.9
Test 3	2.5	3.2	35.7	29.0	1109.6	13.0
Difference (Test 1 - Base)	4.5 (184%)	5.9 (167%)	-11.3 (-51%)	-7.8 (-45%)	718.2 (65%)	9.6 (70%)
Difference (Test 2 - Base)	-0.1 (-2%)	-0.3 (-9%)	14.0 (63%)	12.1 (70%)	-10.4 (-1%)	-0.7 (-5%)
Difference (Test 3 - Base)	0.0 (1%)	-0.3 (-8%)	13.4 (60%)	11.8 (68%)	3.6 (0%)	-0.7 (-5%)

Bus Journey Time Results

Significant delays are experienced in Test 1, with overall journey times in the eastbound direction increasing by over 20 minutes. Journey times remained similar for the westbound direction, however the eastbound direction indicates a reduction of 3 minutes along the A89 in both Test 2 and 3.

	Sections		Journey Times (mm:ss)				Differences		
	From	**To**	**Base**	**Test 1**	**Test 2**	**Test 3**	**Test 1**	**Test 2**	**Test 3**
WB	A8/Maybury	A8/Airport	04:41	04:38	04:40	04:38	00:03 (-1%)	00:01 (0%)	00:03 (-1%)
	A8/Airport	A8/Newbridge	05:07	04:55	04:56	05:08	00:12 (-4%)	00:11 (-4%)	00:01 (0%)
	A8/Newbridge	A89/Kilpunt	07:01	06:59	06:58	07:04	00:02 (0%)	00:03 (-1%)	00:03 (1%)
EB	A89/Kilpunt	A8/Newbridge	11:52	39:14	08:58	08:59	03:22 (231%)	02:54 (-24%)	02:53 (-24%)
	A8/Newbridge	A8/Airport	05:20	23:01	05:23	05:30	17:41 (332%)	00:03 (1%)	00:10 (3%)
	A8/Airport	A8/Maybury	05:54	08:06	05:21	05:22	02:12 (37%)	00:33 (-9%)	00:32 (-9%)

Private Vehicle Journey Time Results

Test 1 generally presents a disbenefit to private vehicles, with the exception of section between the B800 and Newbridge Roundabout and Gogar and Maybury. The improvements in journey times at these sections are a result of capacity restraints which allows fewer vehicles to pass through, therefore limiting the effect of congestion downstream. Test 2 and 3 present similar results to that observed within the base scenario, therefore the introduction of the additional lane for buses have had little impact on private vehicles.

	Sections		Journey Times (mm:ss)						
	From	**To**	**Base**	**Test 1**	**Test 2**	**Test 3**	**Test 1**	**Test 2**	**Test 3**
Westbound	Maybury Rb	Maybury/A8	01:53	05:11	01:53	01:47	03:18 (175%)	00:00 (0%)	00:06 (-5%)
	Maybury	Gogar	00:37	00:36	00:37	00:37	00:01 (-3%)	00:00 (0%)	00:00 (0%)
	Gogar	RBS	00:49	00:49	00:49	00:49	00:00 (0%)	00:00 (0%)	00:00 (0%)
	RBS	Airport	01:47	01:47	01:47	01:46	00:00 (0%)	00:00 (0%)	00:01 (-1%)
	Airport	Newbridge	02:52	03:02	02:52	03:03	00:10 (6%)	00:00 (0%)	00:11 (6%)
	Newbridge	B800	01:28	01:27	01:29	01:29	00:01 (-1%)	00:01 (1%)	00:01 (1%)
	B800	A89 Rb	02:12	02:12	02:12	02:12	00:00 (0%)	00:00 (0%)	00:00 (0%)
Eastbound	A89 Rb	B800	03:00	13:28	02:49	02:51	10:28 (349%)	00:11 (-6%)	00:09 (-5%)
	B800	Newbridge	06:23	02:46	06:12	06:09	03:37 (-57%)	00:11 (-3%)	00:14 (-4%)
	Newbridge	Airport	02:24	18:48	02:24	02:36	16:24 (683%)	00:00 (0%)	00:12 (8%)
	Airport	RBS	01:41	04:28	01:37	01:38	02:47 (165%)	00:04 (-4%)	00:03 (-3%)
	RBS	Gogar	01:01	00:41	00:52	00:54	00:20 (-33%)	00:09 (-15%)	00:07 (-11%)
	Gogar	Maybury	01:39	00:46	01:33	01:38	00:53 (-54%)	00:06 (-6%)	00:01 (-1%)
	Maybury	Maybury Rb	01:00	01:01	01:01	01:01	00:01 (2%)	00:01 (2%)	00:01 (2%)

Table 8.6: Results PM Peak 2015

Network Performance Results

Test 1 presents significant disbenefit to the network, with both private and bus vehicle types displaying higher delays and lower average speeds. .Comparing Test 2 and 3 against the base model, delays and travel times were reduced for private vehicles and buses, with an increase in average speeds, especially for buses.

	Average delay_All vehicles (minutes)	Average delay_Buses (minutes)	Average speed_All vehicles (km/h)	Average speed_Buses (km/h)	Total travel time_All vehicles (hours)	Total travel time_Buses (hours)
Base	5.0	6.1	23.8	21.0	1587.5	14.0
Test 1	8.8	10.6	14.8	12.8	2125.2	20.5
Test 2	4.5	4.2	25.2	26.5	1497.5	11.4
Test 3	4.8	4.6	24.1	25.2	1567.7	11.9
Difference (Test 1 - Base)	3.9 (78%)	4.5 (74%)	-9.0 (-38%)	-8.3 (-39%)	537.7 (34%)	6.5 (46%)
Difference (Test 2 - Base)	-0.5 (-9%)	-1.9 (-31%)	1.5 (6%)	5.5 (26%)	-90.0 (-6%)	-2.5 (-18%)
Difference (Test 3 - Base)	-0.1 (-3%)	-1.5 (-25%)	0.3 (1%)	4.2 (20%)	-19.8 (-1%)	-2.1 (-15%)

Bus Journey Time Results

Test 1 produced a significant reduction in journey times between the Airport and Newbridge. Reviewing of the model showed that once passed the bottle neck at the Airport, where the road narrows from 3 lanes to 1 lane for general traffic, cars go considerably faster along this road section. The one lane section avoids the weaving behaviour and vehicles can increase their speed. Eastbound there is a significant delay passing the Airport; this is a result of merging traffic from the Airport eastbound on slip, combined with the mainline traffic merging in to one lane due to the downstream, bus lane For both Test 2 and 3, Journey times for buses were significantly reduced westbound between the Airport and Newbridge, however delays slightly increased between Maybury and the Airport. This slight increase in delay is a result of bus priority measures on the approach to Newbridge, and the introduction of the Station Road signals (Test 3 only), which extends the queuing into the Maybury to Airport section.

	Sections		Journey Times (mm:ss)				Differences		
	From	**To**	**Base**	**Test 1**	**Test 2**	**Test 3**	**Test 1**	**Test 2**	**Test 3**
WB	A8/Maybury	A8/Airport	04:41	23:29	05:21	07:08	18:48 (401%)	00:40 (14%)	02:27 (52%)
	A8/Airport	A8/Newbridge	14:04	06:42	07:47	07:55	07:22 (-52%)	06:17 (-45%)	06:09 (-44%)
	A8/Newbridge	A89/Kilpunt	05:58	06:20	06:27	06:16	00:22 (6%)	00:29 (8%)	00:18 (5%)
EB	A89/Kilpunt	A8/Newbridge	10:44	10:41	10:35	10:18	00:03 (0%)	00:09 (-1%)	00:26 (-4%)
	A8/Newbridge	A8/Airport	04:51	11:26	04:49	04:47	06:35 (136%)	00:02 (-1%)	00:04 (-1%)
	A8/Airport	A8/Maybury	08:03	09:58	06:14	06:02	01:55 (24%)	01:49 (-23%)	02:01 (-25%)

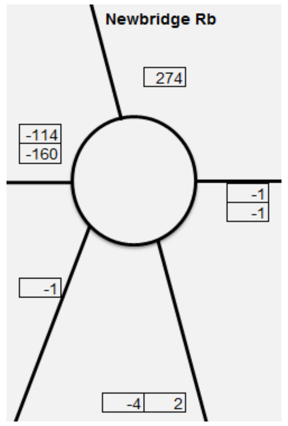
Private Vehicle Journey Time Results

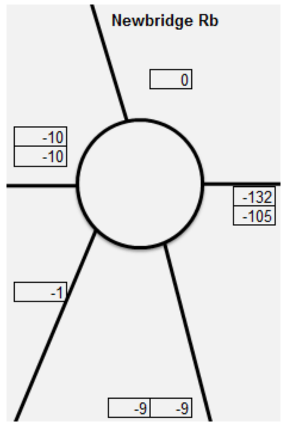
Test 1 indicates significant delays in the westbound direction due to the reduction in capacity. The eastbound direction suffers from the issues experienced at the Airport on slip merge as per the AM peak.

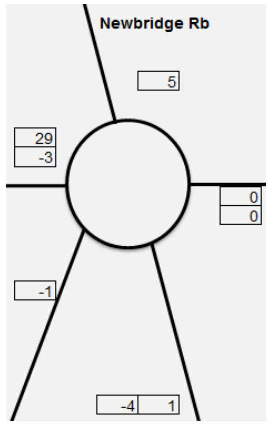
Both Test 2 and 3 present improvements in the eastbound direction, however the westbound direction indicates increased delays between the RBS and Airport, with queues extending back due to bus priority on the approach to Newbridge. Test 3 experiences further delays with the introduction of the Station Road signals.

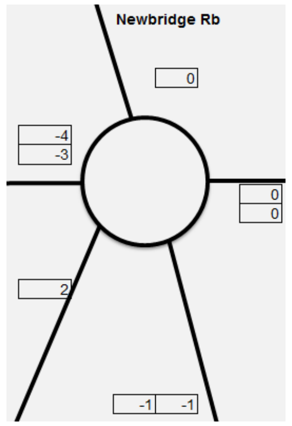
	Sections		Journey Times (mm:ss)						
	From	**To**	**Base**	**Test 1**	**Test 2**	**Test 3**	**Test 1**	**Test 2**	**Test 3**
Westbound	Maybury Rb	Maybury/A8	06:13	17:19	05:50	05:50	11:06 (179%)	00:23 (-6%)	00:23 (-6%)
	Maybury	Gogar	00:36	04:51	00:36	00:36	04:15 (708%)	00:00 (0%)	00:00 (0%)
	Gogar	RBS	00:49	08:12	00:50	00:59	07:23 (904%)	00:01 (2%)	00:10 (20%)
	RBS	Airport	02:23	12:07	03:08	04:49	09:44 (408%)	00:45 (31%)	02:26 (102%)
	Airport	Newbridge	10:51	07:35	11:17	12:11	03:16 (-30%)	00:26 (4%)	01:20 (12%)
	Newbridge	B800	01:32	01:29	01:32	01:32	00:03 (-3%)	00:00 (0%)	00:00 (0%)
	B800	A89 Rb	02:15	02:14	02:15	02:15	00:01 (-1%)	00:00 (0%)	00:00 (0%)
Eastbound	A89 Rb	B800	02:12	02:15	02:12	02:12	00:03 (2%)	00:00 (0%)	00:00 (0%)
	B800	Newbridge	01:56	01:35	01:52	02:02	00:21 (-18%)	00:04 (-3%)	00:06 (5%)
	Newbridge	Airport	02:45	08:44	02:45	02:45	05:59 (218%)	00:00 (0%)	00:00 (0%)
	Airport	RBS	02:27	06:13	01:51	01:53	03:46 (154%)	00:36 (-24%)	00:34 (-23%)
	RBS	Gogar	02:03	00:41	01:29	01:28	01:22 (-67%)	00:34 (-28%)	00:35 (-28%)
	Gogar	Maybury	02:47	00:57	02:30	02:24	01:50 (-66%)	00:17 (-10%)	00:23 (-14%)
	Maybury	Maybury Rb	01:03	01:04	01:05	01:04	00:01 (2%)	00:02 (3%)	00:01 (2%)

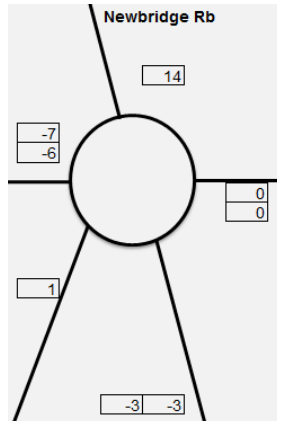
Table 8.7: Queue Length Comparison (Test – Base) 2015 [numbers in metres]

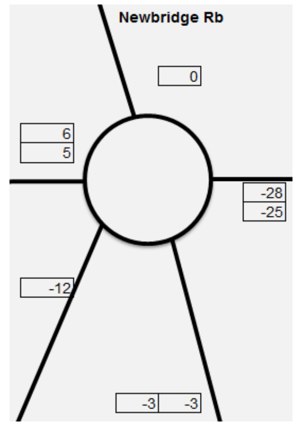
<table>
<tr><th rowspan="2">Test</th><th colspan="2">Test 1</th><th colspan="2">Test 2</th><th colspan="2">Test 3</th></tr>
<tr><th>AM</th><th>PM</th><th>AM</th><th>PM</th><th>AM</th><th>PM</th></tr>
<tr>
<td>Newbridge Roundabout</td>
<td>

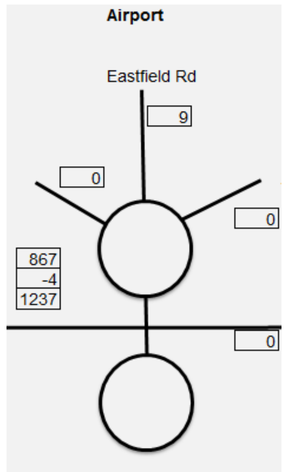
Reduction in queue on western approach to Newbridge, but this reduction is smaller than the increase in queue on the M9 approach</td>
<td>

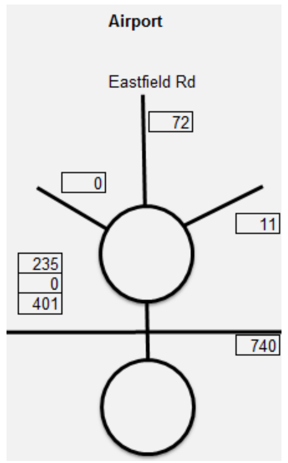
Large reduction in queue length on the eastern approach to Newbridge. This is caused by the fact that the nearside lane on the two lane westbound section between west of the Airport Accesses and Station Road, Ratho, is for use by buses only. This causes severe congestion problems prior to the merge point.</td>
<td>

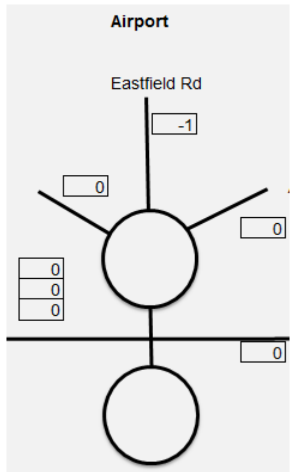
Small increase in average queue on western approach.</td>
<td>

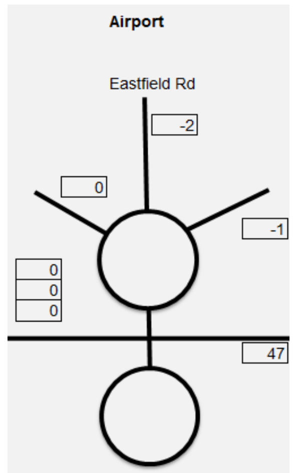
Relatively small change in Base queues at Newbridge Roundabout.</td>
<td>

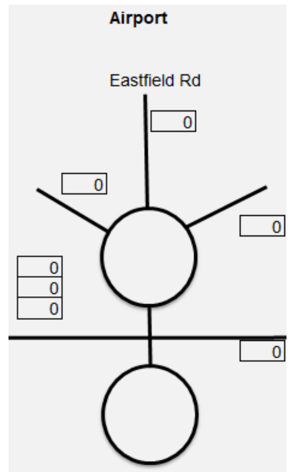
Relatively small changes in average queue length when compared with those in the Base model.</td>
<td>

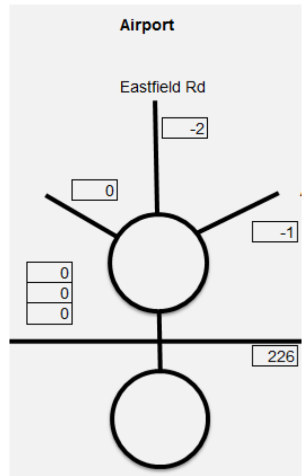
The westbound queues stretch back to the Airport ‘dumbbells’, further than in the Base Model, as shown in the row below. The remaining approaches all have comparable queues to those in the Base Model.</td>
</tr>
<tr>
<td>A8 / Airport Accesses</td>
<td>

Large increase in queue on western approach, stretching back from the merge point with the EB airport traffic.</td>
<td>

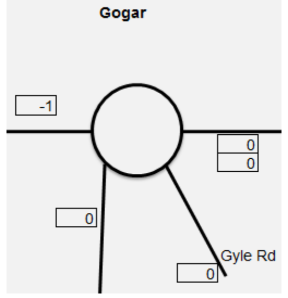
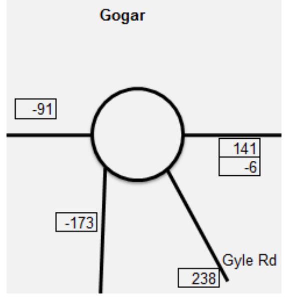
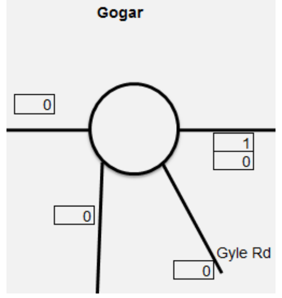
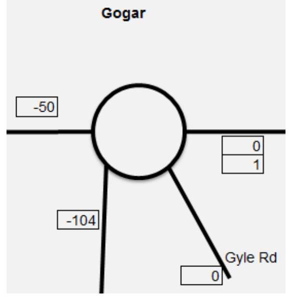
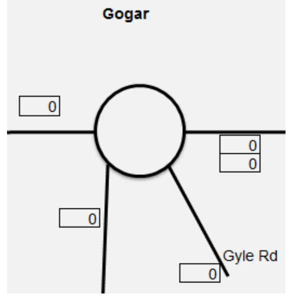
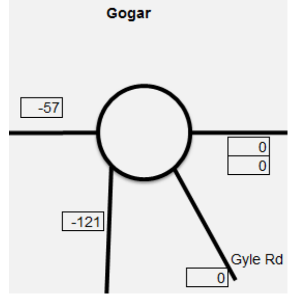
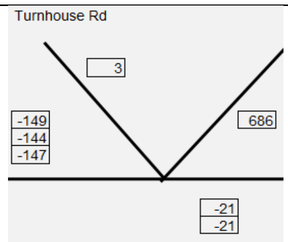
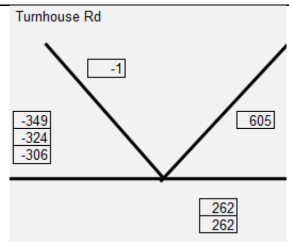
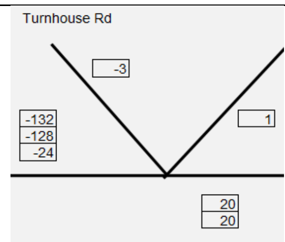
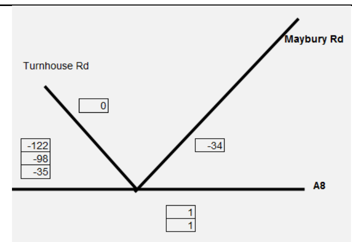
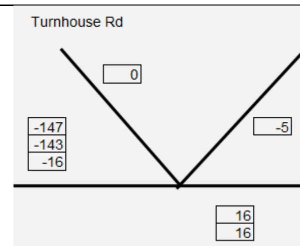
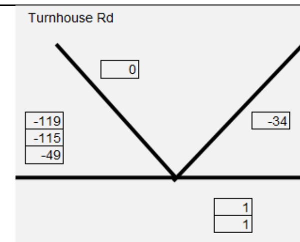
Large increase in average queue length on both the eastern and western approaches.
In the EB direction, queues stretch back from the merge point with the EB airport traffic.
In the WB direction, queues stretch right back onto the approaches to Maybury Junction. The queue lengths in the WB direction are thus increased significantly in the WB direction, much larger than 740m, which is the distance to the downstream node.</td>
<td>

Relatively small change in Base queues at Airport Accesses.</td>
<td>

Small increase in average queue on the eastern approach. Remaining queues are similar to that presented in the Base model.</td>
<td>

No change in Base queues at Airport Accesses</td>
<td>

As described above, the queues in the westbound direction increases in the Test 3 model, compared to the Base.
The queues on the remaining approaches are comparable to those in the Base Model.</td>
</tr>
</table>

		Also a large increase in queue length on Eastfield Road.					
Gogar Roundabout	 Similar queueing to that of the Base model.	 Large increase in average queue lengths at Gogar Roundabout on the A8 WB and on Gyle Road. Large reductions in average queue lengths are observed on the A8 EB and on The City of Edinburgh Bypass. As previously mentioned, queueing in the WB direction begins upstream of Gogar Roundabout, and queues back onto the approaches to Maybury Junction.	 Similar queueing to that of the Base model.	 Large reduction in average queue length on The City of Edinburgh Bypass, with a reduction also seen on the western approach to Gogar.	 No change in Base queues at Gogar Roundabout	 Large reduction in average queue length on The City of Edinburgh Bypass, with a reduction also seen on the western approach to Gogar. Similar effects to what is observed when the Test 2 model is compared to the Base.
A8 / Maybury Road Junction	 Large average queue length increase on Maybury Road approach, but reduction in queues on A8 WB and EB. The queue reduction on the A8 WB can be attributed to the addition of the second short lane for traffic turning onto Maybury Road.	 Large increases in queue length are observed on the northeast and eastern approaches to the junction. This is caused by congestion in the westbound direction, stretching back to Maybury from west of the Airport. In the eastbound direction, average queues are reduced significantly. This can be attributed to the addition of the second short lane for traffic turning onto Maybury Road.	 Large reduction in average queue length on the western approach on the A8. This can be attributed to the addition of the second short lane for traffic turning onto Maybury Road. Small increase in average queue length on the A8 eastern approach.	 In both the base and Test 2 models the EB queue stretches back onto Gogar Roundabout, although it is reduced in the Test 2 model. There is also a slight reduction in queue length on Maybury Road. This can be attributed to the addition of the second short lane for traffic turning onto Maybury Road.	 Large reduction in average queue length on the western approach on the A8. This can be attributed to the addition of the second short lane for traffic turning onto Maybury Road. Small increase in average queue length on the A8 eastern approach.	 Large reduction in average queue length on the western approach, while a reduction is also observed on Maybury Road. The WB queue is reduced to the point that it doesn’t stretch back onto Gogar Roundabout. This can be attributed to the addition of the second short lane for traffic turning onto Maybury Road.

The suppressed demand in the 2015 models at the end of the modelled periods is presented in Table 8.8, below:

Table 8.8: Suppressed Demand - 2015 Models

Location	Test							
	Base		1		2		3	
	AM	PM	AM	PM	AM	PM	AM	PM
A89 West	0	0	446	0	1	0	0	0
M9 North	0	0	1696	0	0	0	0	0
B7030	0	0	0	4	0	0	0	0
Ratho North	0	0	214	0	0	0	0	0
Eastfield Rd	0	3	41	1003	0	0	0	1
A8 East	35	0	0	370	0	0	33	0
Turnhouse Rd	9	0	36	0	59	0	2	0
Maybury Rd	0	0	0	191	0	0	0	0
Ingliston Rd	0	0	247	259	0	0	0	0
Total	**44**	**3**	**2680**	**1827**	**60**	**0**	**35**	**1**

As shown in Table 8.8, there is very little suppressed demand in the Base, Test 2 and Test 3 models. Regarding the suppressed demand in the Test 1 model, the majority is located on the M9 northbound and on the A89 westbound in the AM period. In the PM peak the majority (54%) is located on Eastfield Road, with large numbers of vehicles also not able to enter the network on the A8 eastbound and on Ingliston Road.

8.3.2 2027 Results

As discussed in section 8.2.3, the growth in traffic between the 2014 and 2027 is significant. This increase in traffic results in suppressed demand; traffic demand that is unable to enter the network due to extensive queuing. A review of the suppressed demand conducted after running the models showed that a significant number of vehicles could not access the network during the AM and PM evaluation periods. The current road capacity within the studied area is unable to accommodate the high traffic demands being generated in 2027.

The suppressed demand at the end of the modelled periods is shown in Table 8.9, overleaf.

Table 8.9: Suppressed Demand – 2027 Models

Location	Do-Minimum		2		3	
	AM	PM	AM	PM	AM	PM
A89 West	294	0	319	0	98	0
M9 North	2682	0	2641	0	2173	0
M9 South	99	119	131	120	85	55
Eastfield Rd	0	17	4	13	0	18
Ingliston P&R	0	1732	2	1584	0	1350
Bypass	0	1	0	0	0	0
S Gyle Broadway	0	2143	0	2159	0	2097
A8 East	0	0	0	0	0	395
Maybury Rd	108	0	0	0	23	0
Edinburgh Bypass	0	1227	0	1183	0	762
Total	**3183**	**5239**	**3097**	**5059**	**2379**	**4677**

As shown in the table above, all of the models have large volumes of vehicles that are not able to enter the network. The Test 3 models perform best in terms of getting traffic onto the network, while the Test 2 model does not show a great deal of improvement from the Do-minimum scenario. In the AM period, the largest volumes of suppressed demand are found on the M9 northbound (between 84% and 92% of the total figure), while in the PM period South Gyle Broadway is the biggest contributor to the total suppressed demand figure (around 40% of the total). Ingliston Park & Ride and Edinburgh Bypass also have large suppressed demands waiting to enter the network.

Table 8.10 and Table 8.11 present the 2027 journey time and network performance indicator results for the AM and PM periods respectively. The differences against the Do-minimum scenario are highlighted in the tables as follows:

(yellow)	Marginal: differences less than 5% (network performance) or 30 seconds (travel time)
(red)	Detriment: Test performs worse than the Do-minimum model
(green)	Improvement: Test performs better than the Do-minimum model

Table 8.12 presents the average queue length comparison figures for the same four junctions that were considered in the 2015 results (Table 8.7):

- Newbridge Roundabout;
- A8/ Airport Accesses;
- Gogar Roundabout; and
- A8/ Maybury Road Junction.

As was the case for the 2015 results, in this table the numerical values in the figures are the test results minus the Do-minimum results. This means that a positive value indicates an increase in average queue length, while a negative value indicates a decrease. All values are in metres.

Table 8.10: Results AM Peak 2027

Network Performance Results

Comparing Test 2 against the Do Minimum scenario, average delays and total travel times were reduced for cars and buses. Vehicles speed slightly increased.

Test 3 showed better network performance and journey times than the Do Minimum scenario, although the improvements were less significant than the ones showed for Test 2.

	Average delay_All vehicles (minutes)	Average delay_Buses (minutes)	Average speed_All vehicles (km/h)	Average speed_ Buses (km/h)	Total travel time_All vehicles (hours)	Total travel time_Buses (hours)	Latent demand
Do Minimum	3.6	4.9	29.4	23.5	1510.5	15.4	2426
Test 2	3.6	3.7	29.4	27.3	1503.8	13.8	2450
Test 3	3.7	3.8	29.0	27.0	1524.7	14.0	2420
Test 2 - Do Min	0.0 (0%)	-1.3 (-26%)	0.0 (0%)	3.8 (16%)	-6.7 (0%)	-1.6 (-10%)	24(1%)
Test 3 - Do Min	0.1 (2%)	-1.2 (-23%)	-0.3 (-1%)	3.5 (15%)	14.1 (1%)	-1.4 (-9%)	-6.1 (0%)

Bus Journey Time Results

Fort both Test 2 and Test 3, Journey times remained similar for buses travelling westbound. However, significant reductions in journey times were seen for the eastbound traffic, mainly along the A89.

These results are in line with what could be expected from the increase in capacity. The additional bus lane allowed buses to pass the traffic queues on the approach to Newbridge Roundabout.

	Sections		Journey Times (mm:ss)			Differences	
	From	To	Do Minimum	Test 2	Test 3	Test 2	Test 3
WB	A8/Maybury Rd	A8/Airport	04:49	04:51	04:43	00:02 (1%)	00:06 (-2%)
WB	A8/Airport	A8/Newbridge Rb	05:16	05:03	05:14	00:13 (-4%)	00:02 (-1%)
WB	A8/Newbridge Rb	A89/Kilpunt Rb	07:00	06:56	07:00	00:04 (-1%)	00:00 (0%)
EB	A89/Kilpunt Rb	A8/Newbridge Rb	25:13	10:36	10:26	14:37 (-58%)	14:47 (-59%)
EB	A8/Newbridge Rb	A8/Airport	05:23	05:28	05:36	00:05 (2%)	00:13 (4%)
EB	A8/Airport	A8/Maybury Rd	05:19	05:10	05:07	00:09 (-3%)	00:12 (-4%)

Private Vehicle Journey Time Results

Car journey times were very similar for Test 2 and 3 than for the Do Minimum scenario and the differences were marginal.

	Sections		Journey Times (mm:ss)			Differences	
	From	To	Do Minimum	Test 2	Test 3	Test 2	Test 3
Westbound	Maybury Rb	Maybury/A8	05:28	05:00	05:19	00:28 (-9%)	00:09 (-3%)
Westbound	Maybury	Gogar	00:44	00:44	00:44	00:00 (0%)	00:00 (0%)
Westbound	Gogar	RBS	00:53	00:53	00:53	00:00 (0%)	00:00 (0%)
Westbound	RBS	Airport	01:47	01:47	01:47	00:00 (0%)	00:00 (0%)
Westbound	Airport	Newbridge	02:54	02:53	03:05	00:01 (-1%)	00:11 (6%)
Westbound	Newbridge	B800	01:33	01:33	01:33	00:00 (0%)	00:00 (0%)
Westbound	B800	A89 Rb	02:12	02:12	02:12	00:00 (0%)	00:00 (0%)
Eastbound	A89 Rb	B800	09:03	09:23	08:59	00:20 (4%)	00:04 (-1%)
Eastbound	B800	Newbridge	07:45	08:02	07:51	00:17 (4%)	00:06 (1%)
Eastbound	Newbridge	Airport	02:40	02:41	02:54	00:01 (1%)	00:14 (9%)
Eastbound	Airport	RBS	01:40	01:39	01:40	00:01 (-1%)	00:00 (0%)
Eastbound	RBS	Gogar	00:52	00:47	00:45	00:05 (-10%)	00:07 (-13%)
Eastbound	Gogar	Maybury	01:15	01:14	01:15	00:01 (-1%)	00:00 (0%)
Eastbound	Maybury	Maybury Rb	01:01	01:01	01:01	00:00 (0%)	00:00 (0%)

Table 8.11: Results PM Peak 2027

Network Performance Results

Test 2 showed reduced average delays and total travel times for buses comparing against the Do Minimum. On the other hand, the network performance was marginally worse for cars with an increase in average delays and total travel times and a reduction in the average speed.

Test 3 performed worse than Test 2, showing increased delays and journey times for both private and bus vehicles types.

	Average delay_All vehicles (minutes)	Average delay_Buses (minutes)	Average speed_All vehicles (km/h)	Average speed_Buses (km/h)	Total travel time_All vehicles (hours)	Total travel time_Buses (hours)	Latent demand
Do Minimum	4.8	5.7	24.1	21.8	1884.1	12.9	4284
Test 2	5.2	5.2	22.8	22.4	1967.3	12.0	4275
Test 3	7.0	7.4	18.1	17.4	2325.9	15.0	4818
Test 2 - Do Min	0.4 (8%)	-0.5 (-8%)	-1.3 (-5%)	0.6 (3%)	83.1 (4%)	-0.9 (-7%)	-9 (0%)
Test 3 - Do Min	2.1 (45%)	1.8 (31%)	-6.0 (-25%)	-4.3 (-20%)	441.7 (23%)	2.1 (17%)	534 (12%)

Bus Journey Time Results

Test 2 showed very similar journey times for the eastbound traffic flow. The westbound traffic flow had increased journey times between Maybury and the Airport. This increase, as explained for the 2015 PM scenario, has been attributed to the delays produced when cars give priority to buses on the approach to Newbridge. A significant reduction in journey times was observed between the Airport and Newbridge as expected with the addition of the bus lane.

Test 3 however has the additional delays due to the introduction of the Station Road signals which extends the queueing further along the A8, resulting in buses being delays prior to entering the bus lane.

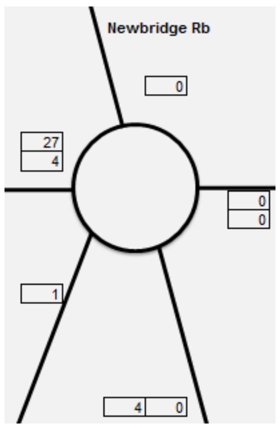
	Sections		Journey Times (mm:ss)			Differences	
	From	To	Do Minimum	Test 2	Test 3	Test 2	Test 3
WB	A8/Maybury Rd	A8/Airport	05:51	07:29	14:39	01:38 (28%)	08:48(150%)
WB	A8/Airport	A8/Newbridge Rb	11:32	07:21	07:06	04:11 (-36%)	04:26 (-38%)
WB	A8/Newbridge Rb	A89/Kilpunt Rb	06:24	06:08	06:10	00:16 (-4%)	00:14 (-4%)
EB	A89/Kilpunt Rb	A8/Newbridge Rb	07:50	07:38	07:39	00:12 (-3%)	00:11 (-2%)
EB	A8/Newbridge Rb	A8/Airport	04:49	04:48	04:39	00:01 (0%)	00:10 (-3%)
EB	A8/Airport	A8/Maybury Rd	05:27	05:16	05:17	00:11 (-3%)	00:10 (-3%)

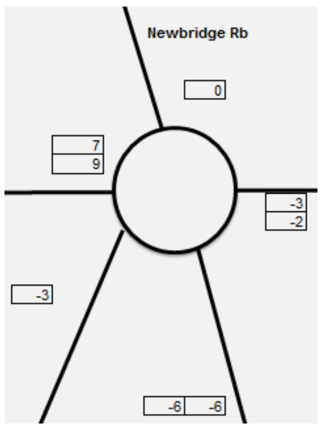
Private Vehicle Journey Time Results

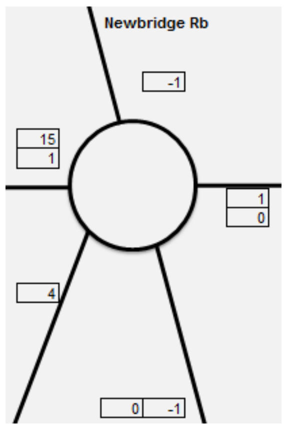
Both Test 2 and Test 3 present similar journey times for the eastbound traffic flow when compared to the Do Minimum scenario. The westbound traffic flow had increased journey times between RBS and Newbridge, it is clear from the delays that the introduction of the Station Road signals have extended the queuing into the beyond RBS, with delays from Maybury Road to RBS increasing by around 13 minutes.

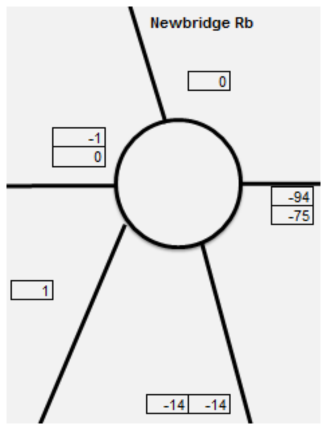
	Sections		Journey Times (mm:ss)			Differences	
	From	To	Do Minimum	Test 2	Test 3	Test 2	Test 3
Westbound	Maybury Rb	Maybury/A8	03:34	03:42	10:57	00:08 (4%)	07:23(207%)
Westbound	Maybury	Gogar	00:43	00:51	02:42	00:08 (19%)	01:59(277%)
Westbound	Gogar	RBS	01:29	01:55	04:48	00:26 (29%)	03:19(224%)
Westbound	RBS	Airport	02:49	04:11	07:46	01:22 (49%)	04:57(176%)
Westbound	Airport	Newbridge	08:18	09:14	10:04	00:56 (11%)	01:46 (21%)
Westbound	Newbridge	B800	01:34	01:33	01:30	00:01 (-1%)	00:04 (-4%)
Westbound	B800	A89 Rb	02:16	02:16	02:16	00:00 (0%)	00:00 (0%)
Eastbound	A89 Rb	B800	02:18	02:18	02:19	00:00 (0%)	00:01 (1%)
Eastbound	B800	Newbridge	02:57	03:05	02:57	00:08 (5%)	00:00 (0%)
Eastbound	Newbridge	Airport	02:57	02:56	03:05	00:01 (-1%)	00:08 (5%)
Eastbound	Airport	RBS	01:41	01:41	01:41	00:00 (0%)	00:00 (0%)
Eastbound	RBS	Gogar	01:00	00:55	00:55	00:05 (-8%)	00:05 (-8%)
Eastbound	Gogar	Maybury	01:34	01:36	01:35	00:02 (2%)	00:01 (1%)
Eastbound	Maybury	Maybury Rb	01:04	01:04	01:04	00:00 (0%)	00:00 (0%)

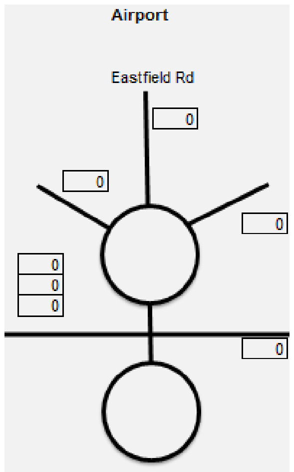
Table 8.12: Queue Length Comparison (Test – Do Minimum) 2027

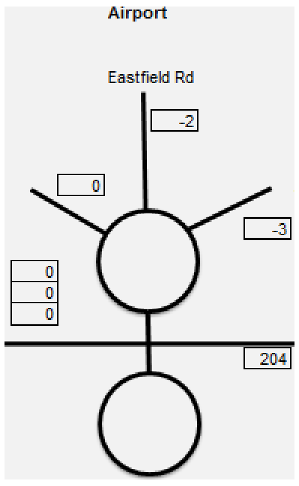
<table>
<tr><th rowspan="2">Test</th><th colspan="2">Test 2</th><th colspan="2">Test 3</th></tr>
<tr><th>AM</th><th>PM</th><th>AM</th><th>PM</th></tr>
<tr><td>Newbridge Roundabout</td>
<td>

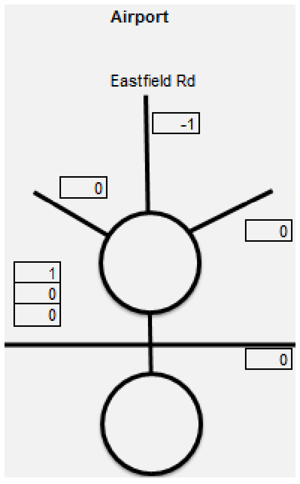
Very little change in Do-Minimum queues at Newbridge Roundabout. There is a slight increase in average queue length on the western approach.</td>
<td>

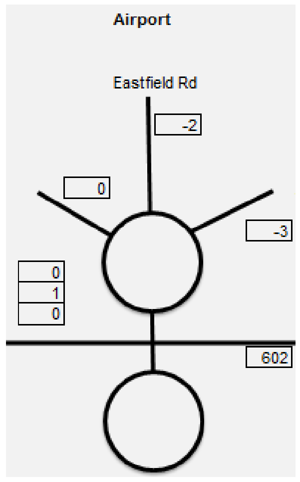
Very little change in Do-Minimum queues at Newbridge Roundabout.</td>
<td>

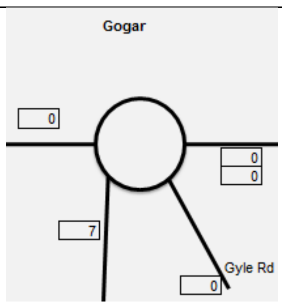
Slight increase in queue length on the western approach, as was the case for the Test 2 model. The remaining approaches are all comparable to the average queue lengths in the Do-Minimum model.</td>
<td>

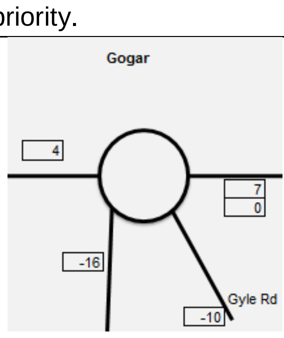
Benefits are observed at Newbridge Roundabout on the eastern approach, as well as on the M9 southern approach.</td></tr>
<tr><td>A8 / Airport Accesses</td>
<td>

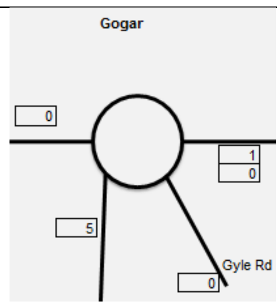
No change in Do-Minimum queues at Airport Accesses.</td>
<td>

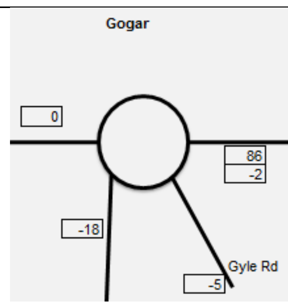
A large increase in average queue length is observed on the eastern approach in the Test 2 model compared to the Do-Minimum model. This is caused by displacement of traffic due to bus priority.</td>
<td>

No change in Do-Minimum queues at Airport Accesses.</td>
<td>

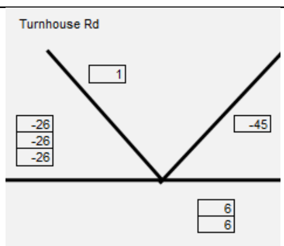
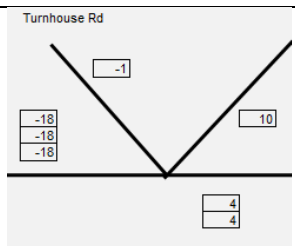
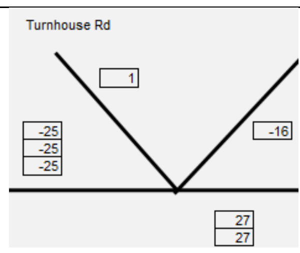
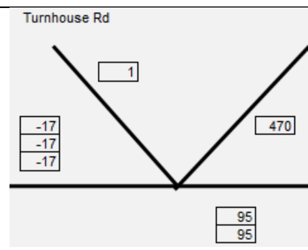
A large increase in average queue length is observed on the eastern approach, which stretches back to the approaches to Maybury Junction.</td></tr>
<tr><td>Gogar Roundabout</td>
<td>

Little change in Do-Minimum queues at Gogar Roundabout.</td>
<td>

Average queues at Gogar Roundabout are observed to be relatively similar in the Test 2 and Do-Minimum models. In both models, queues stretch back from Maybury onto Gogar Roundabout, and the western approach to the roundabout.</td>
<td>

Little change in Do-Minimum queues at Gogar Roundabout.</td>
<td>

An increase in average queue length is observed in the WB direction on the A8 eastern approach. This is caused by congestion upstream of the junction.</td></tr>
</table>

A8 / Maybury Road Junction	 Benefits in average queue length are observed in the Test 2 Model with respect to the Do-Minimum model on the western approach, and on Maybury Road. Benefits in the EB direction are relatively small, due to the fact that the same junction is modelled in the Do-minimum models and the Test 2 models.	 Little change in Do-Minimum queues at Maybury. There is a slight decrease in average queue length on the western approach, although in both the Base and Test 2 models queues on this approach are observed to stretch back onto Gogar Roundabout, as previously mentioned. Benefits in the EB direction are relatively small, due to the fact that the same junction is modelled in the Do-minimum models and the Test 2 models.	 Benefits in average queue length are observed in the Test 3 Model with respect to the Do-Minimum model on the western approach, and on Maybury Road. These benefits are not as great as in the Test 2 model, however. Additionally, an increase in average queue length in observed on the eastern approach to Maybury. Benefits in the EB direction are relatively small, due to the fact that the same junction is modelled in the Do-minimum models and the Test 2 models.	 A large increase in average queue length is observed on the northeastern and eastern approaches to Maybury Junction, but particularly on Maybury Road (northeast). This is due to blocking back from the signals at RBS and at Station Road. Slight benefits are observed on the A8 EB, although queues still back up onto Gogar Roundabout and it's approaches. Benefits in the EB direction are relatively small, due to the fact that the same junction is modelled in the Do-minimum models and the Test 2 models.

8.4 Summary

The following table summarises the main findings from the traffic modelling work carried out:

Table 8.13: Modelling results

Test	Description	2015	2027
1	No intervention measures	• Increased journey times along the corridor, for buses and general traffic, during both peak periods. • Large increases in queue lengths, particularly during the PM peak period. • The existing capacity is insufficient to accommodate the proposed bus lanes, resulting in long queues and significant congestion in both AM and PM periods. Consequently, Test 1 was not assessed for the 2027 scenario.	Not assessed due to congestion in the network
2	Bus lanes along the A89/ A8 in both directions	• Improved network performance compared with the Base models, especially for buses. Delays were reduced by 9% and 31% during the AM and PM peak periods, respectively. • During the AM peak period, journey times showed marginal differences against the Do-Minimum model along the westbound route, however they were significantly reduced for the eastbound route with bus journey times improving by approximately 3 minutes along the A89 and 40 seconds along the A8. • During the PM period, the bus journey times were reduced by approximately 6 minutes in the westbound direction, with the majority of the improvements being experienced between the Airport and Newbridge Roundabout. In the	• Results showed a similar network performance for Test 2 than for the Do-Minimum in the AM peak. Whereas the PM peak indicated that buses would experience less delay, however private vehicles would see an increase in delay. • During the AM peak period, journey times remained similar for the westbound traffic. For the eastbound direction, journey times were reduced by approximately 15 minutes for buses, with the majority of the benefits being experienced along the A89. • During the PM peak period, bus journey times increased between Maybury and the Airport, due to increased queuing, however were more than compensated once they accessed the bus lane between the Airport and Newbridge. Private vehicles also experience the added

		eastbound direction the benefits were approximately 2 minutes within the section between the Airport and Maybury Junction. • Overall, queuing is similar to as in the Base models, although there are slight increases in the westbound direction in the PM peak due to displacement.	delays on the approach to the Airport, however these delays continued on towards Newbridge. In the eastbound direction, the difference in journey times against the Do-Minimum model was marginal. • Queue lengths are observed to increase in the PM peak in the westbound direction with respect to the Do-minimum model. This is due to displacement caused by bus priority.
3	Bus lanes + traffic signals at Station Road	Similar to Test 2	• During the AM peak Test 3 results remains similar to that extracted from Test 2. However the PM peak indicates significantly greater delays for both bus and private vehicles due to the introduction of the Station Road Junction and its impact on the westbound queue on the A8. • Queue results are similar to Test 2 queues. Some benefits are observed at Newbridge in the PM peak.

The aim of the study is to develop and test designs for public transport infrastructure improvements on the A89/ A8 that will improve bus journey times between the Kilpunt Roundabout in Broxburn and Maybury Road Junction in Edinburgh. These improvements are to complement the proposals set out in the Forth Replacement Crossing Public Transport Strategy (FRCPTS) and other relevant strategies.

From the traffic modelling results test 2 yields the best improved bus journey times along the corridor which consisted of the following intervention measures:

- Bus lane under Gogar Roundabout to allow queue jump;
- Increased road capacity at the Maybury Road Junction through additional lanes;
- A 3.65m wide bus lane on the A89 eastbound from Broxburn to Newbridge Roundabout;
- A 3.65m wide bus lane on the A8 westbound from Station Road to the Newbridge Interchange;
- A 3.65m wide bus lane on the A8 from the airport merge lane eastbound to the Maybury Junction; and
- A 3.25m wide bus lane on Maybury Road on the approach to the Maybury Junction.

Summary and Conclusion

9 Summary and Conclusion

9.1 Study Aim

The aim of this study was to identify the intervention measures required to aid public transport movement along the A89/ A8 corridor and thus improve bus journey times. These improvements are to complement the proposals set out in the Forth Replacement Crossing Public Transport Strategy (FRCPTS) and other relevant strategies.

The key problem on the corridor is associated with travel through the Newbridge Interchange, which is currently being tackled by making the existing traffic signal operational times a more efficient form of control, able to deliver substantially reduced traffic delays.

A subsidiary aim of the study was to ensure that provision for walking and cycling on the corridor is improved. A new pedestrian/ cyclist (Toucan) crossing is to be introduced across the A89 and opportunities to link into the wider family network of cycle paths are to be considered where possible.

9.2 Summary

The first part of the process saw the generation of a list of potential transport intervention measures and a review of them against the supporting policies and land use plans that address the transport accessibility requirements for the A89/A8. When assessing against the various transport strategies and deliverability (including public acceptability), several of the options were removed from any further appraisal (e.g. a flyover at the Newbridge Interchange which would be cost prohibitive).

The next stage involved a route appraisal of the existing corridor which considered both the network operation and existing infrastructure along the route. The information collated was then used to support the development of the design solution for public transport and active travel improvements along the corridor. An active travel and public transport audit was produced, which highlighted a number of gap provisions that should be addressed to support the public transport improvements.

To ensure shared ownership of the potential intervention measures two stakeholder engagement meetings were held which allowed the participants to highlight the issues which mattered most to them. This helped to minimise negative and maximising positive impacts by the potential intervention measures developed through the process. One of the key messages coming out of the feedback was support for bus lanes along the corridor.

In addition to bus lanes, the most pragmatic way of delivering faster bus journey times is through bus priority measures utilising traffic control and other technologies. It was decided, however, through the option development process, that without the requirement specifications for the whole corridor this could not be explored as part of the study. This would need to be investigated as part of a larger ITS strategy of the area.

The identified proposals were then broadly appraised against a robust, objective-led assessment framework based on the methodology of the STAG appraisal framework. The outcome of this allowed the potential intervention measures required to improve the flow of public transport along the A89/ A8 corridor to be taken forward and rationalised into three traffic models, excluding the base model.

Test 1

The provision of a near sided bus lane using the existing road space resulted in significant traffic congestion issues. The existing capacity is insufficient to accommodate the proposed bus lanes, resulting in long queues and significant congestion in both AM and PM periods. Consequently there was no need to assess it for the 2027 scenario.

Test 2

The construction of a bus lane through local road widening improved network performance and reduced bus journey times along the corridor.

Year / Results	2015	2027
Network Performance Indicators	Bus delays reduced by 9% and 31% during the AM and PM peak periods, respectively.	Similar network performance for Test 2 than for the Do-Minimum in the AM peak. PM peak indicates decrease in bus delays but increase in general traffic delays.
Journey Times – AM Peak	Marginal differences against the Do-Minimum model along the westbound route. Improved bus journey times eastbound by approximately 3 minutes along the A89 and 40 seconds along the A8.	Journey times remained similar for the westbound traffic. Reduced bus journey times eastbound by approximately 15 minutes with the majority of the benefits being experienced along the A89.
Journey Times – PM Peak	Improved bus journey times by around 6 minutes westbound with the majority of the improvements being experienced between the Airport and Newbridge Roundabout. Improved eastbound bus journey times around 2 minutes between the Airport and Maybury Junction.	Increased bus journey times between Maybury and the Airport, due to increased queuing, however were more than compensated once they accessed the bus lane between the Airport and Newbridge. Private vehicles also experience the added delays on the approach to the Airport. However, these delays continued on towards Newbridge. In the eastbound direction, the difference in journey times against the Do-Minimum model was marginal.

Test 3

The addition of traffic signals at Station Road to the Test 2 models resulted in slightly worse network performance and journey times particularly in the 2027 scenario, although there are benefits to both pedestrian and cycling safety.

Year	2015	2027
Results	Results were found to be broadly similar to those in Test 2.	AM peak – results were found to be broadly similar to those in Test 2. PM peak - greater delays for both bus and private vehicles due to the introduction of the Station Road Junction and its impact on the westbound queue on the A8.

From the traffic modelling results it is clear that Test 2 yields the best improved bus journey times along the corridor and consisted of the following intervention measures:

- Bus lane under Gogar Roundabout to allow queue jump;
- Increased road capacity at the Maybury Road Junction through additional lanes;
- A 3.65m wide bus lane on the A89 eastbound from Broxburn to Newbridge Roundabout;
- A 3.65m wide bus lane on the A8 westbound from Station Road to the Newbridge Interchange;
- A 3.65m wide bus lane on the A8 from the airport merge eastbound to the Maybury Junction; and
- A 3.25m wide bus lane on Maybury Road on the approach to the Maybury Junction.

With the preferred improvements identified this allowed preliminary designs to be developed, which are shown in **Appendix K**. The high level costs associated with such work are shown in Table 9.1 and is based on based on unit costs rates from 'SPON's Civil Engineering and Highway Pricing Guide 2016'. An optimisation bias of 44% as per the STAG, Technical Database, 2014, has been applied.

Table 9.1: Estimated Costs

Proposed Measures	Total Cost	Land ownership/reallocation
Bus lane under Gogar Roundabout to allow queue jump.	£12,000	Road markings and coloured surfacing on existing carriageway.
Increased road capacity at the Maybury Road Junction through additional lanes.	£1,300,000	Road widening within Council land. It is anticipated that delivery would be through developer contributions.
A 3.65m wide bus lane eastwards from Broxburn to Newbridge roundabout.	£4,600,000	The verge is part of the adopted road network.
A 3.65m wide bus lane on the A8 westbound from Station Road to the Newbridge Interchange.	£2,200,000	The verge and central reservation are part of the adopted road network. Although the central reservation is reserved for the future tram expansion.
A 3.65m wide bus lane on the A8 from the airport merge lane eastbound to the Maybury Junction.	£2,300,000	The verge and central reservation are part of the adopted road network.
A 3.25m wide bus lane on Maybury Road on the approach to the Maybury Junction	£900,000	Private

9.3 Conclusion

The overall objective of this study was to develop and test preliminary designs for public transport infrastructure improvements for the A89/ A8 Newbridge Interchange Corridor and demonstrate how these improvements are likely to improve public transport journey times. These improvements were to complement the proposals set out in the Forth Replacement Crossing Public Transport Strategy (FRCPTS) and other relevant strategies.

Through the scheme evaluation work including rigorous model testing this report shows that the above intervention measures are required to allow bus priority along this corridor, without creating detriment to other traffic. To increase the attractiveness of bus based transport the existing bus passenger infrastructure was audited and found that investment in high quality shelters including real time passenger information was required.

A subsidiary aim of the study is to ensure that provision for walking and cycling on the corridor is improved. An active travel audit of the corridor highlighted a number of gap provisions that should be addressed to support the public transport improvements.

The A89/ A8 need to move people and goods efficiently to ensure the social and economic wellbeing of communities it supports. Buses have a vital role to play in this as they can make excellent use of limited road space, carrying many more passengers than a private car. However, the potential benefits of the bus can be stifled by traffic congestion and it can be seen from this study, as well as others, that traffic congestion will continue to increase along this corridor. Therefore a ‘do nothing’ or ‘do minimum’ scenario is not an option.

The provision of high quality public transport options are a top priority for taking forward the Edinburgh International Business Gateway, which promotes sustainability, reduced congestion and minimising car use. Their target is for 50% of all trips to be by public transport and active travel. While this is an ambitious target it is perhaps one that should be aspired for the whole of the A89/ A8 corridor.

9.4 Further work

To continue to develop and test the proposed intervention measures consideration should be given to:

- Taking the feasibility study forward to outline design to establish costs and safeguard the land needed to allow bus lane construction;
- To investigate the benefits from investing into ITS based bus priority solutions would require a detailed investigation as part of an ITS strategy for the entire SEStran region;
- One of the objectives of the FRCPTS is the provision of traffic signal at Station Road (estimated cost £1.1. million) however the traffic modelling work has shown a decrease in network performance. Further design work could be carried out to investigate the possibility of a stand-alone controlled crossing facility instead; and
- Design development of the bus and active travel infrastructure required along the corridor.

Appendices

Appendix A – Network Assessment

Appendix B – Bus Journey Times

Appendix C – Existing Bus stop Infrastructure

Appendix D – Active Travel Audit

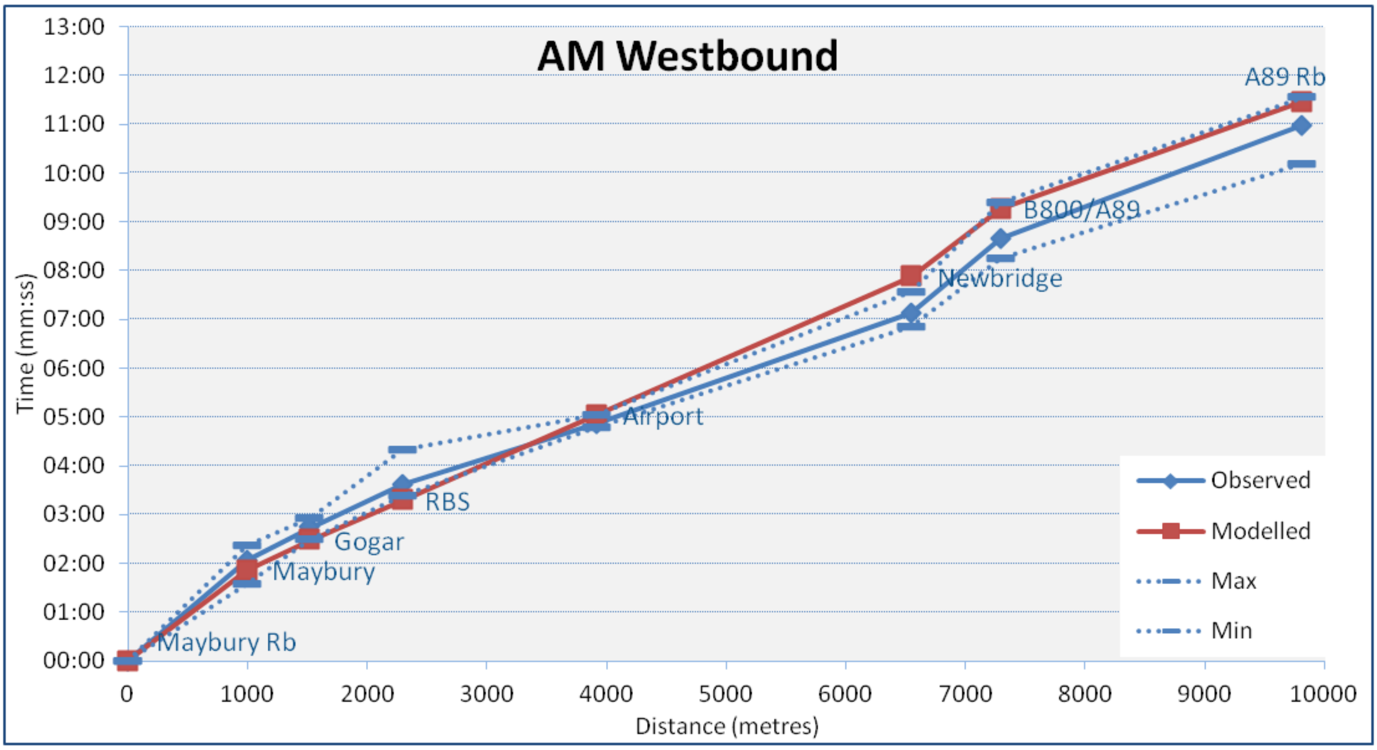
Appendix E – Corridor Constraints

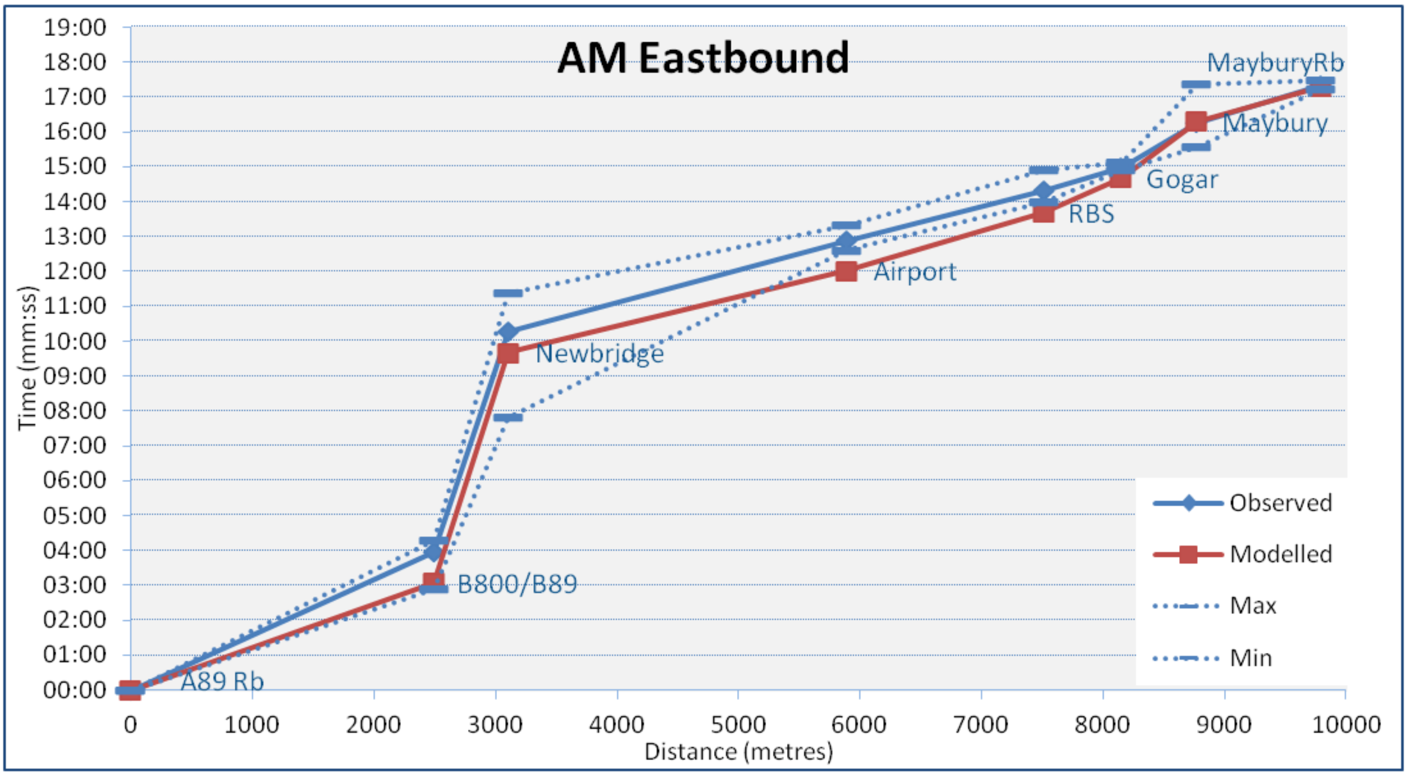
Appendix F – Option Appraisal

Appendix G – Validation Results

Appendix H – Journey Times

Cars

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Airport
RBS
Gogar
Maybury
MayburyRb
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Modelled
Max
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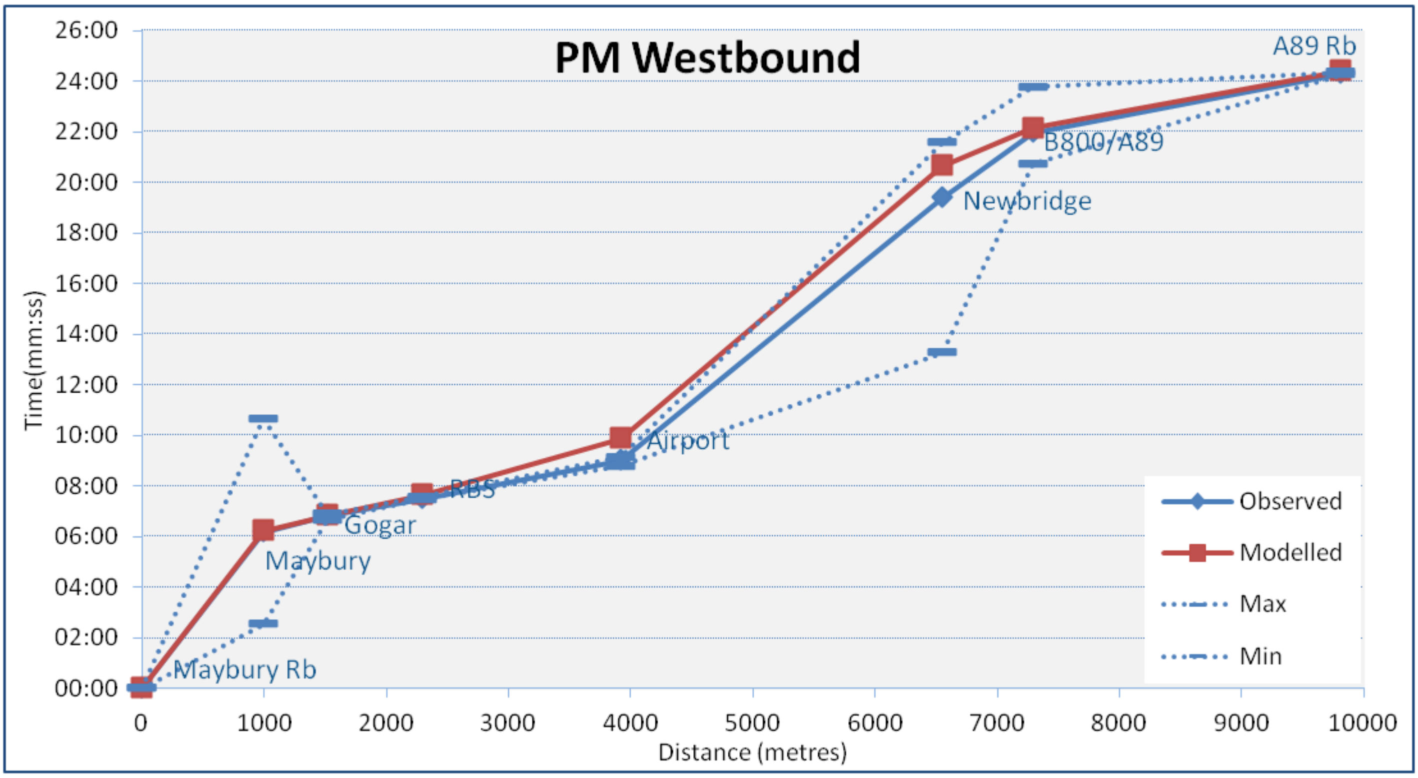
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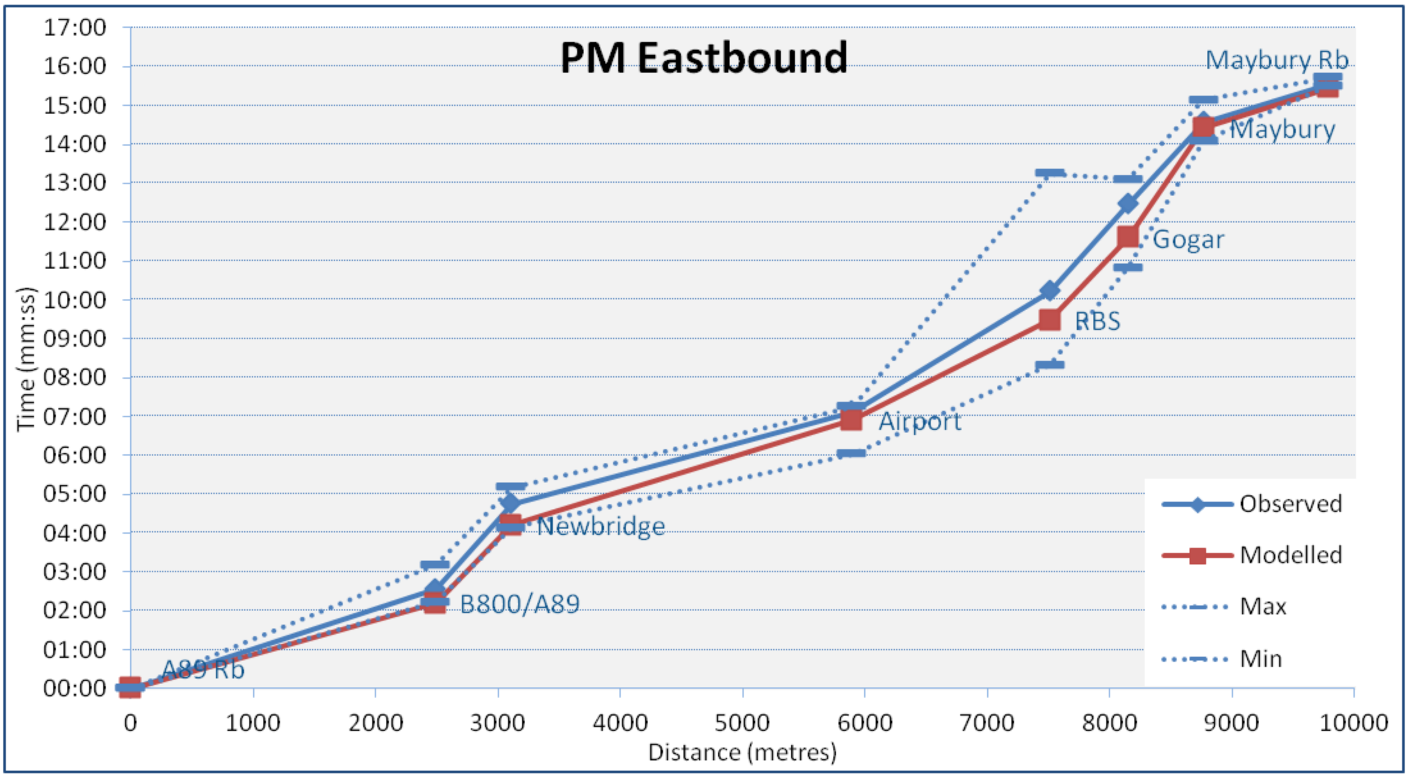
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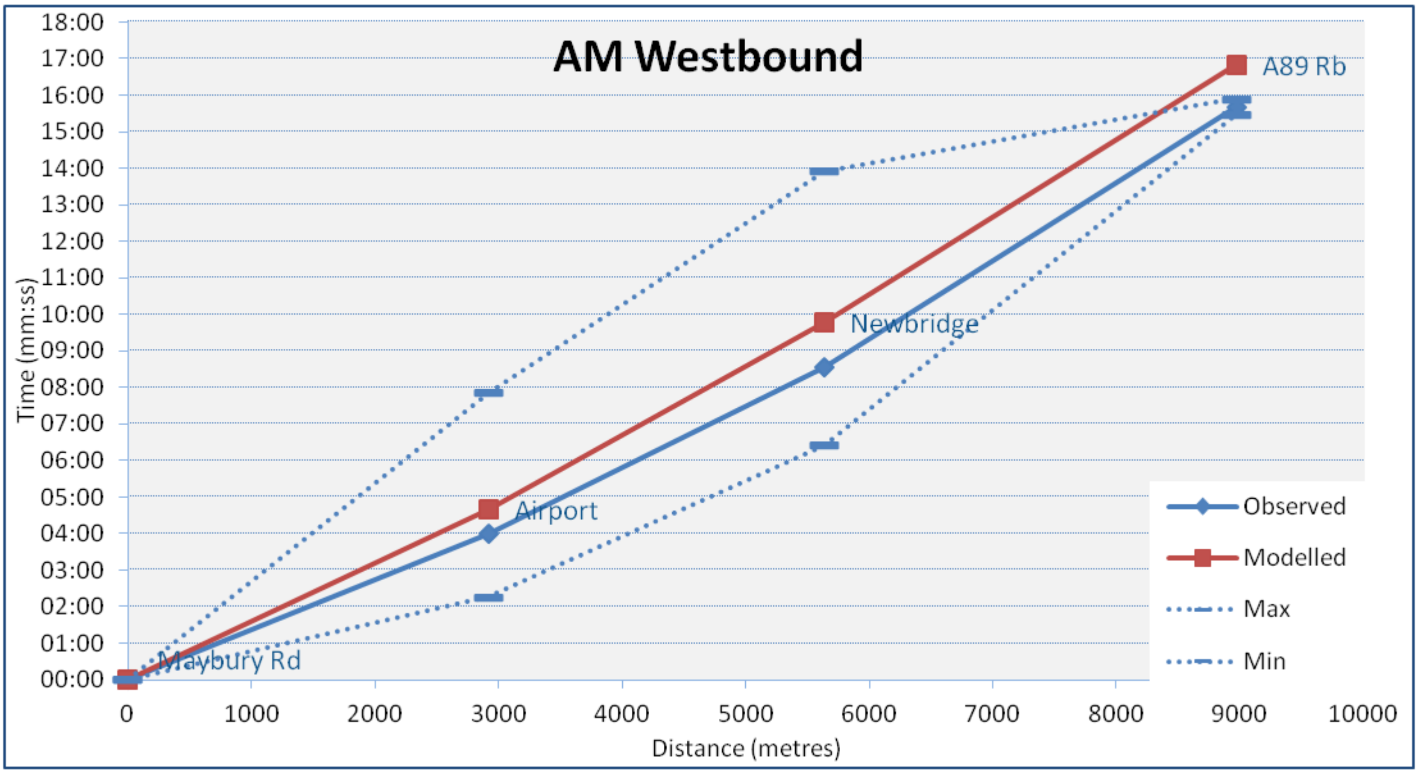
Buses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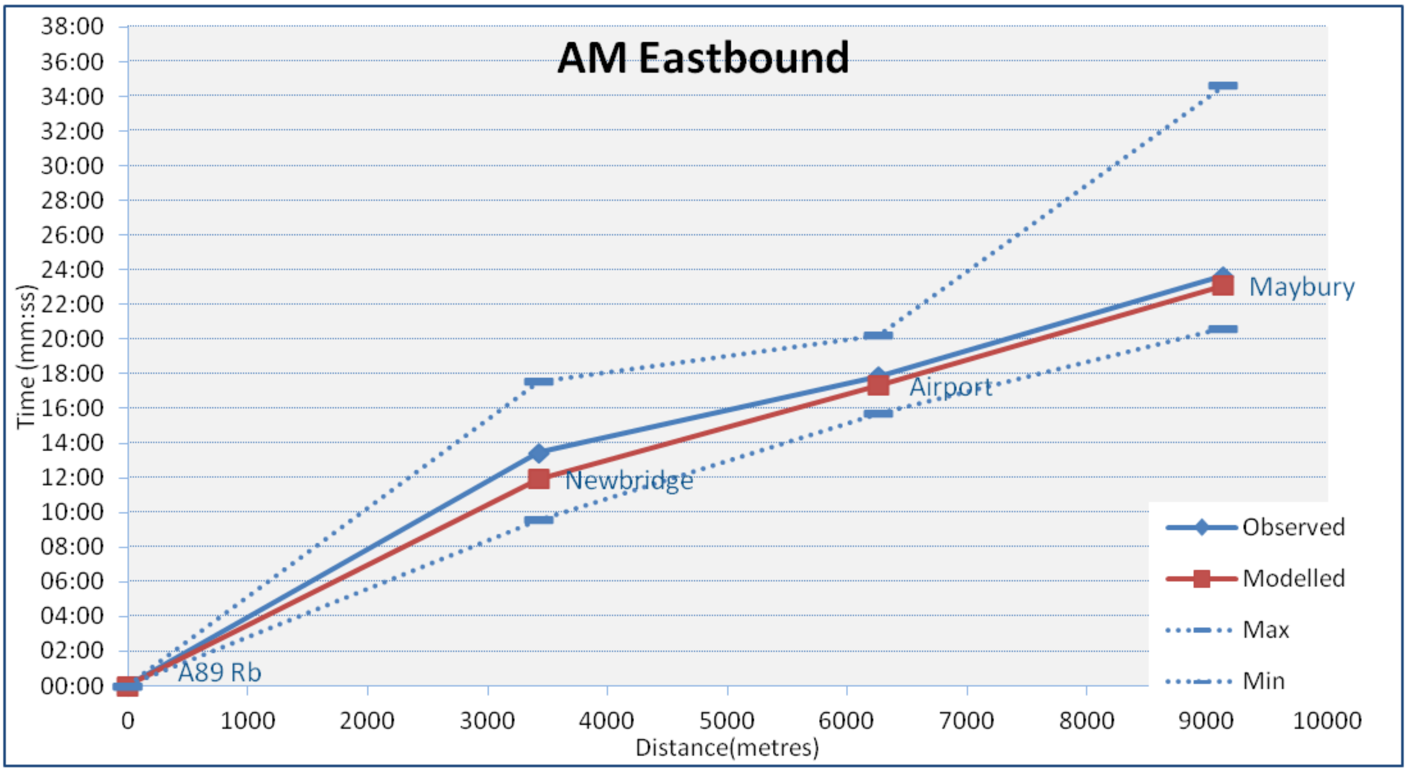
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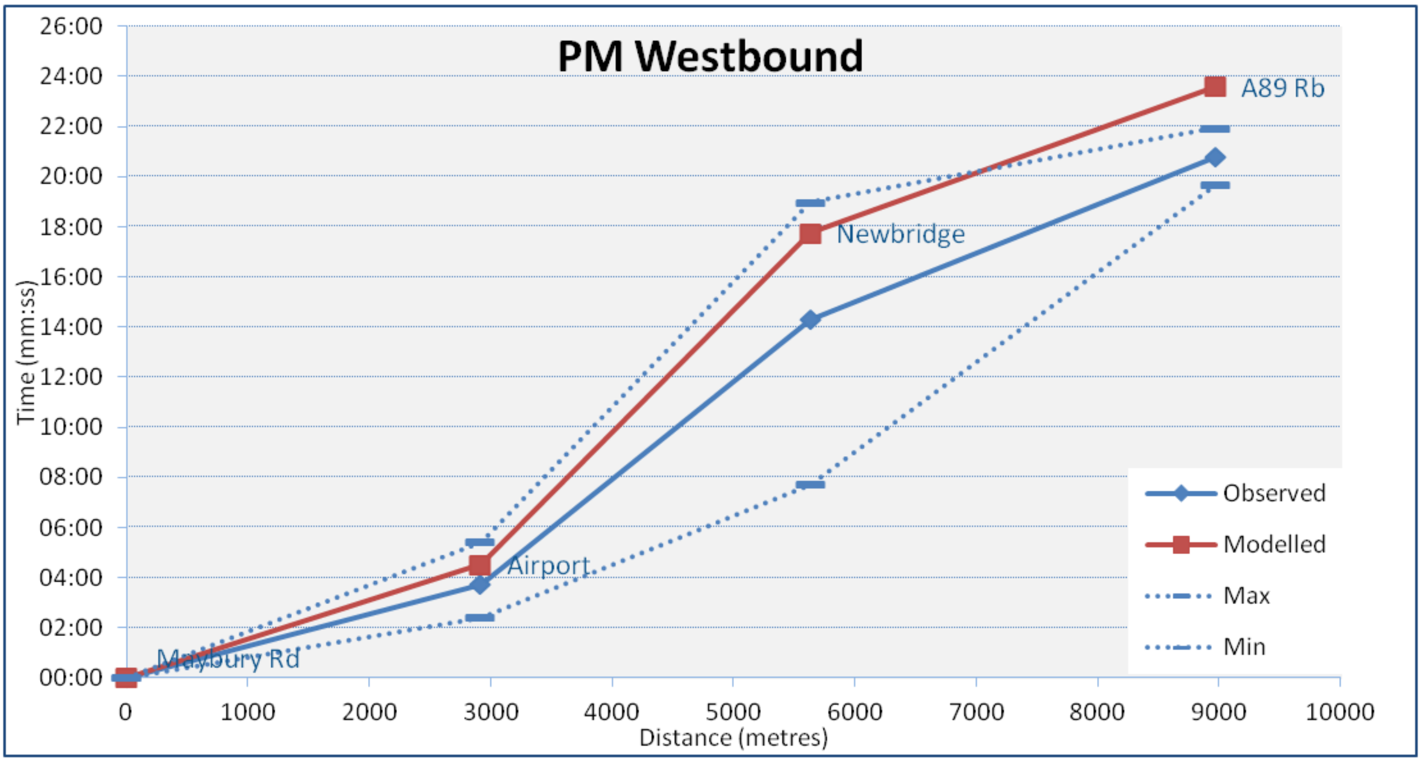
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Distance (metres)
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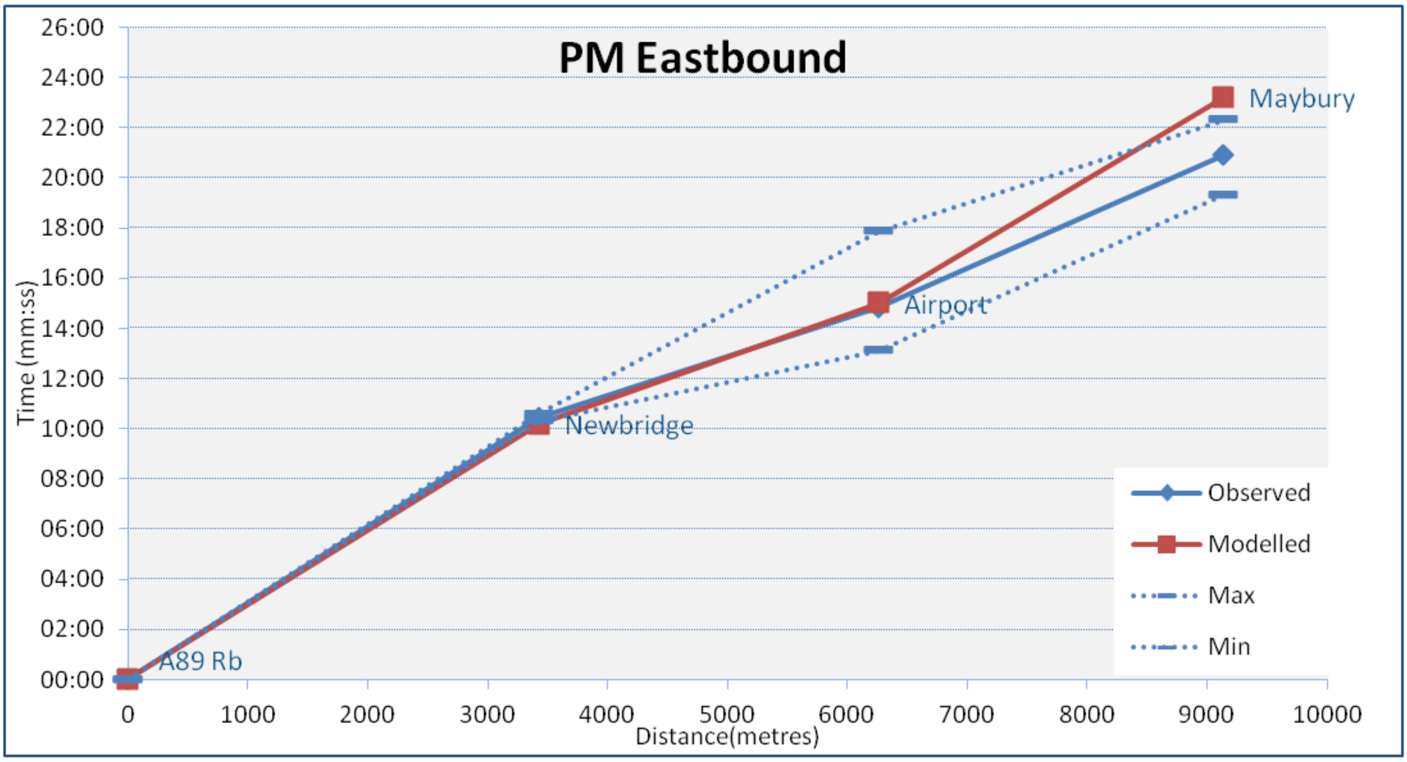
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4000
5000
6000
7000
8000
9000
10000
Distance(metres)
A89 Rb
Newbridge
Airport
Maybury
Observed
Modelled
Max
Min

Appendix I – Developments Included in 2027 Tests

Appendix J – Journey Time Comparison

Appendix K – Preliminary Options