highways england

POPE of LNMS

M54 Junction 2 Traffic Signals Evaluation Report

January 2016

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Glossary

Term	a.k.a.	Definition
Accessibility	-	Accessibility can be defined as 'ease of reaching'. The accessibility objective is concerned with increasing the ability with which people in different locations, and with differing availability of transport, can reach different types of facility
Annual Average Daily Traffic	**AADT**	The 24 hour total traffic flow for the average day of the year
Appraisal Summary Table	**AST**	This records the impacts of the scheme according to the Government's five key objects for transport, as defined in **DfT** guidance contained on its **Transport Analysis Guidance** web pages, **WebTAG**
Asset Support Contractor	**ASC**	Responsible for the operation, maintenance, and improvement of the motorway and trunk road network of a Highways England area. First appointed in 2012, these replace **MAC**s
Automatic Traffic Count	**ATC**	An automated method of recording the volume (and sometimes classification) of vehicles passing a particular point on a road
Average Daily Traffic	**ADT**	The 24 hour total traffic flow on an average day over a certain time period (Monday – Sunday)
Average Weekday Traffic	**AWT**	The 24 hour total traffic flow on an average weekday over a certain time period (Monday – Friday)
Benefit Cost Ratio	**BCR**	Benefit Cost Ratio is a ratio identifying the relationship between cost and benefits of a proposed project
Capitalisation	-	The process by which benefits for a scheme are factored to give an estimate for the appropriate appraisal period
Department for Transport	**DfT**	A Government department whose objective is to oversee the delivery of a reliable, safe and secure transport system that responds efficiently to the needs of individuals and business whilst safeguarding our environment
Discounting	-	A technique used to compare costs and benefits that occur in different time periods and is the process of adjusting future cash flows to their present values to reflect the time value of money, e.g. £1 worth of benefits now is worth more than £1 in the future. A standard base year needs to be used which is 2002 for the appraisal used in this report
Dis-benefit	-	A negative benefit or something that detracts from the performance

Evaluation Summary Table	**EST**	In **POPE** studies, this is a summary of the evaluations of the **TAG** objectives using a similar format to the forecasts in the **AST**
First Year Rate of Return	**FYRR**	First Year Rate of Return is the ratio of money gained on an investment relative to the amount of money invested
Highways England	**-**	An Government-owned company**,** responsible for operating, maintaining and improving the strategic road network in England
Killed or Seriously Injured	**KSI**	A term used to describe the number of people killed or seriously injured as a result of **PIC**s
Local Network Management Scheme	**LNMS**	LNMS are improvement schemes where total overall estimated cost (including design, land, works, supervision, risk and VAT) is less than £10 million. They are categorised by the Government under Safety, Economy, Severance, Environment, Non-Appraisable and Non-NATA
Managing Agent Contractor	**MAC**	Responsible for the operation, maintenance, and improvement of the motorway and trunk road network of a Highways England area. These are being replaced by **ASC**s, the first of which was appointed in 2012
Optimism Bias	**-**	Is a demonstrated systematic, tendency for project appraisers to be overly optimistic, and in effect, results in an underestimation of scheme costs. The base cost estimate is adjusted to account for optimism bias in order to obtain more accurate cost estimates
Project Appraisal Report	**PAR**	A key document summarising the need for a project, plus its costs and benefits (including those that cannot be quantified in monetary terms)
Personal Injury Collison	**PIC**	A term commonly used to refer to road accidents
Post-Opening Project Evaluation	**POPE**	Before and after monitoring of all highway schemes in England
Present Value of Costs	**PVC**	Present Value of Costs is a term used in cost-benefit analysis and project appraisal that refers to the discounted sum, or Present Value, of a stream of costs associated with a project or proposal
Risk Allowance	**-**	**Risk** refers to identifiable future situations that could result in an over spend or under spend occurring. The base cost estimate is adjusted to account for risk in order to obtain more accurate cost estimates
Severance	**-**	Community severance is the separation of adjacent areas by road or heavy traffic, causing negative impact on non-motorised users, particularly pedestrians
-	**STATS19**	A database of injury accident statistics recorded by police officers attending accidents

Traffic Database System	**TRADS**	Traffic count database developed by Highways England, to hold data from traffic monitoring sites on the strategic network
Web-based Transport Analysis Guidance	**WebTAG**	The Department for Transport's transport appraisal guidance and toolkit, first issued in 2003

1. Introduction

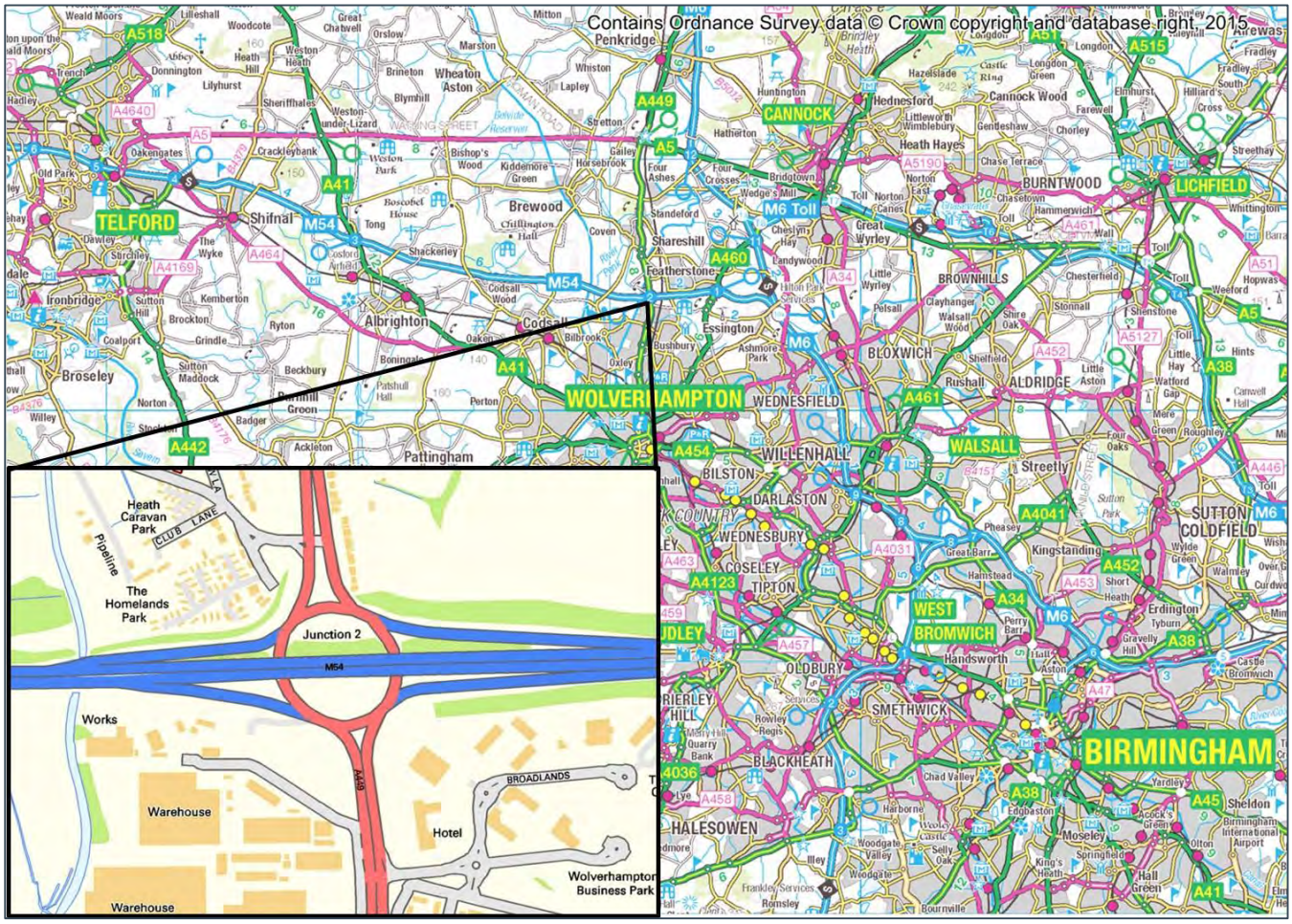
Background

1.1. This report is the Post-Opening Project Evaluation (POPE) of the M54 Junction 2 Signalisation Local Network Management Scheme (LNMS). This will be referred to throughout this report as M54 Junction 2 or “the scheme”.

1.2. Junction 2 of the M54 is located approximately 6km to the north of the centre of Wolverhampton in the West Midlands. The M54 runs east-west and provides connections to Telford to the west and the M6 to the east. The A449 provides access to Stafford to the north via Penkridge and to Wolverhampton City Centre to the south.

1.3. The location of the junction is presented in **Figure 1.1**.

Figure 1.1 – Location Plan



1.4. Before the scheme was implemented, the junction was a simple four arm roundabout with no signal controls. With this layout, a high level of accidents were recorded. In addition, it was reported that queuing could occur during the peak periods on the approaches to the junction.

1.5. The scheme was developed to address the safety issues, as well as to reduce the congestion observed during the peak periods.

Purpose of this report

1.6. As part of an ongoing programme, whereby Highways England (formerly the Highways Agency) evaluates the impacts of trunk road schemes, Atkins is commissioned to undertake post-opening evaluations of LNMS with an implementation cost of less than £10m.

1.7. This report sets out the results of the POPE of the M54 Junction 2 Signalisation LNMS. More specifically, this report examines the economic and safety impacts resulting from the improvements, with consideration also given to wider impacts on the environment and society.

1.8. The scheme was introduced prior to the construction of the i54 Business Park which is located to the immediate south-west of Junction 2. The LNMS scheme opened at the end of July 2010. From March 2013, works started to change the highway layout in the vicinity of M54 Junction 2, to provide access for the i54 Business Park. These works were completed in December 2014 when the new arrangement came into operation. The revised layout includes new sections of carriageway (named as the A4510) which now form the western approach and exit arms of the Junction 2 roundabout. The junction no longer directly links to the M54 on- and off-slip roads on the western side.

1.9. This POPE considers only the performance of the signalisation LNMS and does not consider any subsequent impacts which the scheme may have provided following the changes to the highway layout or when accommodating the additional traffic generated by the opening of i54. The information in the PAR indicates the LNMS was developed to address a safety issue, and there is no suggestion in the PAR or supporting documentation that the LNMS scheme was implemented to facilitate the development. The analysis presented in this report therefore does not consider any operating conditions after March 2013, meaning the impacts of the LNMS alone are isolated for analysis.

1.10. It is intended that the findings from this report will feed into a wider summary of the outcomes of POPE. This is a document (namely the LNMS Annual Evaluation Report) produced in the 4th quarter of each year outlining the key messages from the entire POPE of LNMS process.

2. Scheme Detail

Introduction

2.1. This section of the report outlines the pre-scheme and post-scheme layout of the roundabout, using photos, diagrams and site observations to illustrate the changes made to the highway network.

Background

2.2. The aim of the scheme was to reduce the number of accidents occurring at the junction, as well as the queues which built up on the approaches to the junction during peak times. The scheme involved installing traffic signals at the roundabout, with local widening undertaken for all four approaches to the junction, as well as sections of the circulatory carriageway.

2.3. **Table 2.1** summarises the scheme details.

Table 2.1 – Summary of M54 Junction 2 LNMS

Scheme name	M54 Junction 2 Signalisation
Area	9
Opening date	30th July 2010
Category	Safety
Reason for scheme	The junction experienced a high level of accidents, as well as queueing which occurred during the peak periods on the approaches to the junction.
Objectives	• To reduce the injury collision rate; and • To reduce queues on the approaches to the junction.
Alternative options	The PAR states a possible safety scheme without the widening of the approaches.

Location

2.4. The scheme is located at Junction 2 of the M54, to the north of Wolverhampton. The location of the scheme is shown in **Figure 1.1**. Junction 2 is a four arm roundabout with the M54 running east-west through the junction, which is grade separated. The A449 runs north-south through the junction, providing links to Stafford to the north and Wolverhampton City Centre to the south.

2.5. The junction is located directly to the north-east of i-54 Business Park; a new, large business park with occupiers which include Jaguar Land Rover.

Pre-Scheme Junction Layout

2.6. Prior to the opening of the scheme in July 2010, the roundabout at M54 Junction 2 was a simple four arm roundabout with no signal controls. There were no lane separation markings on the circulatory carriageway, and no lane destinations marked on the approach arms.

2.7. The A449 northbound approach to the junction consisted of two lanes, while the A449 southbound approach to the junction consisted of three lanes near to the junction. Similarly, the off-slips from the M54 eastbound and westbound were two lane approaches to the junction which widened to three lanes close to the junction. The layout of the junction before the scheme was implemented is shown in **Figure 2.1**.

Figure 2.1 – Pre-Scheme Junction Layout (Before January 2010)

2.8. With this layout, the PAR states that there were a high number of accidents which occurred at the junction and queues which formed during peak times.

Post-Scheme Junction Layout

2.9. Following the implementation of the scheme, the entire junction was signalised. Local widening was undertaken on each approach arm and new road markings were introduced across the junction indicating lane destination designations.

2.10. With the signalisation, new crossings were installed to enable pedestrians to access the footway which now runs around the middle of the circulatory carriageway and to access other crossing points around the junction. Guardrails have also been introduced along the footway at the crossing points. New signing

such as chevrons and traffic signal warnings was also installed. The post-scheme layout is shown in **Figure 2.2**.

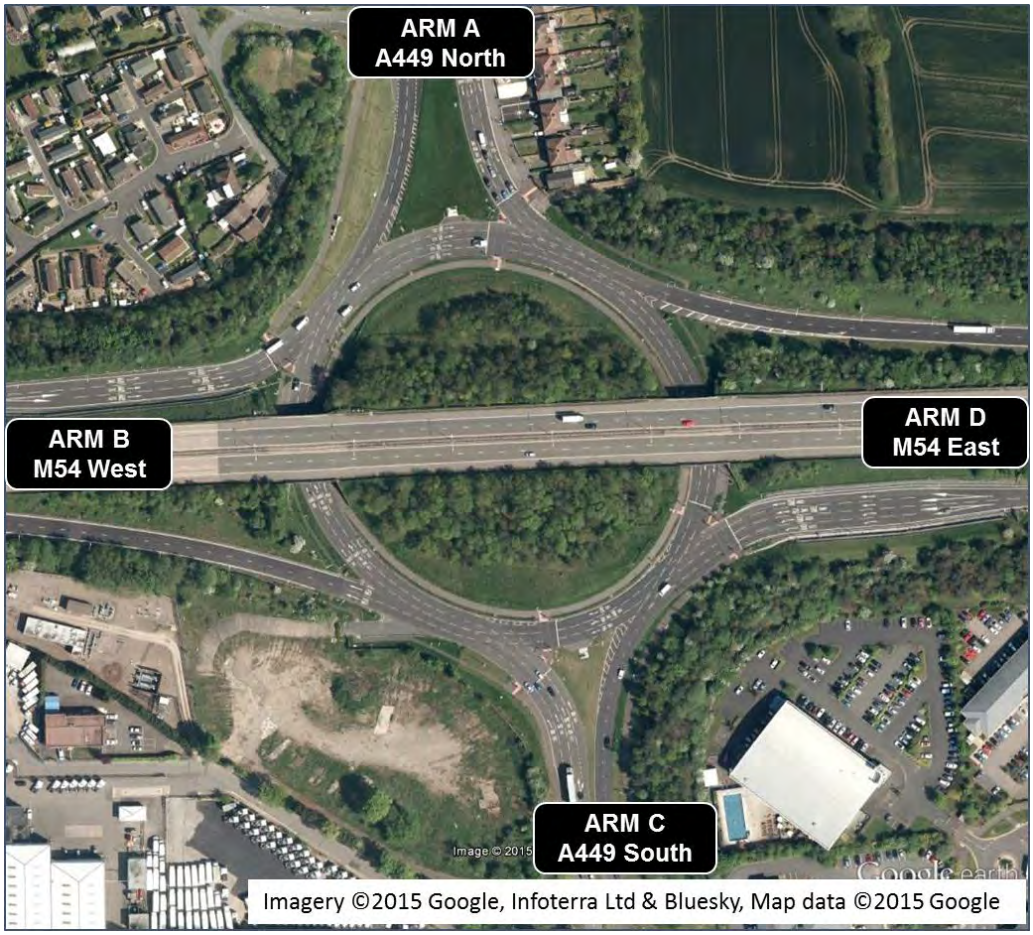
2.11. The A449 northbound approach to the junction was widened from two lanes to four; with the left lane marked for the M54 westbound, which is accessed via the A4510, the left of the two middle lanes marked for A449 northbound, the second of the middle lanes for A449 northbound and M54 eastbound and the right lane for M54 eastbound.

2.12. The A449 southbound approach to the junction was widened so that the nearside third lane was extended further back, away from the junction. The left lane is marked for the M54 eastbound, the middle lane for the A449 southbound and the right lane for the A449 southbound and the M54 westbound.

2.13. The M54 westbound approach to the roundabout was widened to provide four lanes. The left two of these were marked for A449 southbound, the right middle lane for the M54 westbound and the A449 northbound and the right lane for the A449 northbound.

2.14. The M54 eastbound approach to the junction now links to the A4510, which provides access to the junction. The A4510 approach (previously the M54 off-slip) was widened to provide three lanes, with the left lane marked for those travelling to the A449 northbound and the middle and right lanes marked for A449 southbound.

Figure 2.2 – Post-LNMS Junction Layout (August 2010-December 2014)



Subsequent Post-Scheme Junction Layout Change (i54 Business Park)

2.15. Following the implementation of the scheme (which opened on the 30th July 2010), the junction operated as a four arm signalised roundabout for approximately 31 months, until the start of construction of the i54 Business Park.

2.16. From March 2013, the highway layout in the vicinity of M54 Junction 2 was changed again to facilitate new access arrangements for i54. These changes included revising the motorway slip road layouts, meaning the approach and exits arms to the west of the Junction 2 roundabout no longer directly link to the M54.

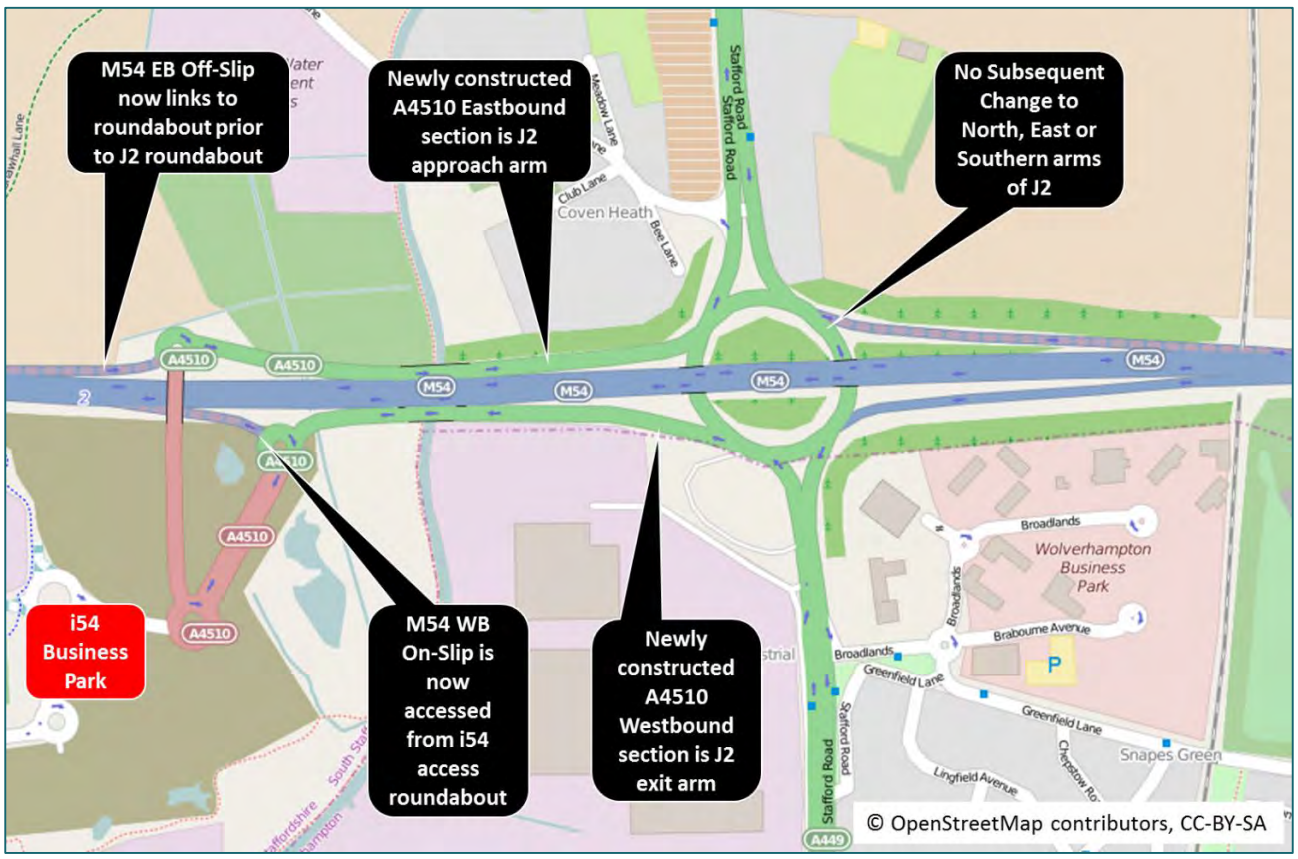
2.17. Traffic leaving the M54 eastbound at Junction 2 is routed to a new small roundabout and can either turn right and cross the overbridge to i54, or travel ahead and into the Junction 2 roundabout on the eastbound approach arm.

2.18. Traffic wanting to exit the Junction 2 roundabout and join the M54 westbound is now routed to a new small roundabout which either provides access to i54, or access to the M54 Junction 2 westbound on-slip road.

2.19. The Junction 2 roundabout itself, and the other three approach arms are unchanged from the post-scheme arrangement described previously and shown in **Figure 2.2.**

2.20. This new junction layout which has been operating since it opened in December 2014 is shown in **Figure 2.3**.

Figure 2.3 – Post-i54 Business Park Junction Layout (Since December 2014)



2.21. As such, the post-opening scheme described previously (as shown in **Figure 2.2**) no longer exists. **Figure 2.4** shows the A4510 eastbound carriageway running parallel to the motorway.

Figure 2.4 – A4510 Eastbound Approach to Junction 2 with Post-i54 Layout

2.22. In order to isolate the impacts of the M54 Junction 2 Signalisation LNMS, a clear assessment period has been identified which considers the operation of the junction after the signalisation, but before the subsequent changes were implemented. Any impacts relating the highway layout changes required to facilitate the i54 development are considered to be external to this LNMS post-opening evaluation.

Post-Scheme Site Observations

2.23. A site visit was undertaken on Monday 13th July 2015 during mid-morning. The conditions on the day of the site visit were considered to be normal, with no known special events or incidents occurring in the area. The weather was largely wet throughout the visit period.

2.24. The junction layout was as described above, with the highway layout reflecting the changes introduced since December 2014 to facilitate access to the i54 Business Park. Therefore, the conditions that were observed on-site are not exactly the same as the scheme which is being assessed in this post-opening evaluation report.

2.25. Most of the scheme elements were observed to be installed as described in the PAR, with the junction now signalised and the approaches widened and marked. The road markings were all clear and in good condition. The latest PAR available (Conception stage) stated that high-friction surfacing was planned to be installed with the scheme however none was observed on the site visit.

2.26. During the site visit, traffic conditions were fairly quiet, with traffic moving well. There was no queuing or residual traffic delay observed on any of the approaches to the junction. Driver movements appeared to be safe and consistent and vehicles did not appear to be making late lane-changes near to the junction stop line. The images in **Figure 2.5** to **Figure 2.8** demonstrate the conditions observed on site.

2.27. The scheme included the installation of new pedestrian crossing facilities although NMU activity was not observed during the site visit. It is considered that this may have been due to the weather. It was also observed that the wet weather did not appear to be causing any drainage issues.

Figure 2.5 – Layout from M54 West Approach

Figure 2.6 – Layout from A449 South Approach

Figure 2.7 – A449 South Approach

Figure 2.8 – Pedestrian Facilities at M54 West Approach

Stakeholder Feedback

2.28. While the analysis in this report can consider the quantifiable impact of this scheme based on empirical data, it is also important to consider the opinions of major stakeholders of the scheme. For example, a scheme may save journey times in practice, but if this saving isn't perceived, the scheme may not be as successful as first thought.

2.29. Highways England were contacted to express their views on the scheme but did not provide a reply.

3. Traffic Volumes

Introduction

3.1. This section of the report considers the impact that the M54 Junction 2 Large LNMS has had on traffic volumes.

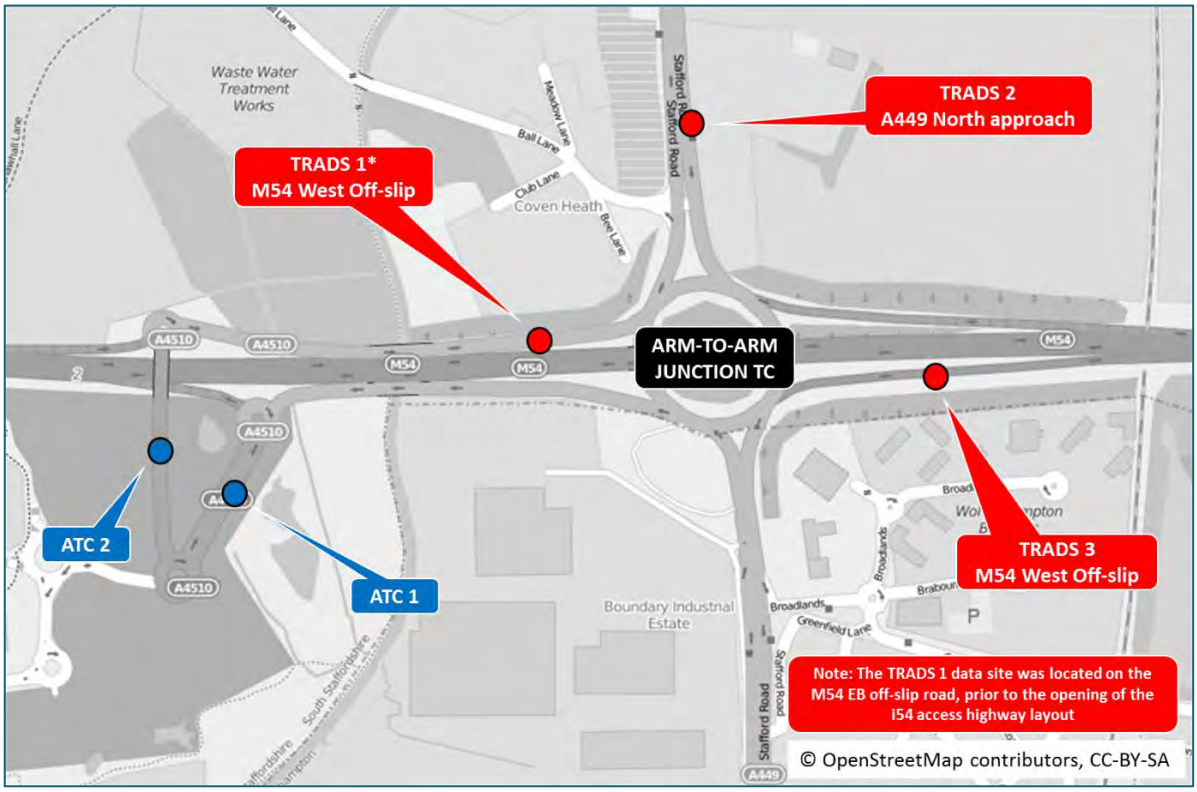
Data Sources

3.2. As scheme planning and construction is a process that takes a number of years, it is important to understand how traffic volumes have changed over time and whether this will impact the way the scheme performs. To understand this, traffic data from three sources has been assessed:

- Link-based count data provided on Highways England's TRADS database (with data used from 2007 to 2013). Three sites were identified with suitable data, as follows:
  - M54 east (westbound off-slip);
  - M54 west (eastbound off-slip); and
  - A449 north (southbound approach to junction).
- A turning count for the Junction 2 roundabout commissioned to support this post-opening evaluation report (collected in June 2015); and
- Two Automated Traffic Counts (ATCs) commissioned to support this post-opening evaluation report (collected in July 2015) to observe trips to/from i54.

3.3. The locations of the count sites are shown in **Figure 3.1**.

Figure 3.1 – Traffic Data Count Sites



Turning Count Manipulation

3.4. As outlined previously, a turning count for the junction was collected in June 2015. At this time, the junction has been amended since the completion of the LNMS to facilitate the i54 Business Park access arrangements

3.5. It is considered that the opening of i54 is likely to have attracted additional traffic to the junction, and as a result, the turning proportions observed in 2015 will have shifted from those which would have been observed immediately following the completion of the signalisation scheme.

3.6. The post-opening evaluation team has calculated the turning proportions which may have been observed at the junction prior to i54 opening by subtracting the development traffic from the western approach and exit arms of the junctions. During July 2015, two ATCs were placed for 7 days to identify the level of traffic entering and exiting the development.

3.7. Prior to the i54 scheme, all traffic entering the junction from the west was coming directly from the M54 eastbound. Firstly, all traffic observed travelling from the M54 west arm to the M54 east arm was deducted from the count as these are assumed to all be development-related trips. Previously this journey would have been a vehicle leaving the motorway and re-joining it in the same direction which is illogical. The flow is then adjusted based on the remaining northbound flow recorded at ATC2 (see **Figure 3.1**). It is assumed that the remaining pre-scheme traffic would have exited at the junction at the northern and southern arms in the same turning proportions as for the full observed count.

3.8. Similarly, prior to the i54 scheme, all traffic exiting the junction to the west would have been directly joining the M54 westbound. This exit now also provides the access route towards i54 and so will be carrying additional non-motorway traffic. Firstly, all traffic observed travelling from the M54 east arm to the M54 west arm was deducted from the count as these are assumed to all be development-related trips. Previously this journey would have been a vehicle leaving the motorway and re-joining it in the same direction, which is illogical. The flow is then adjusted based on the remaining southbound flow travelling towards i54 (ATC1 on **Figure 3.1**). It is assumed that the remaining pre-scheme traffic would have arrived at the junction from the northern and southern arms in the same turning proportions as for the full observed count.

3.9. These adjustments create a ‘calculated’ traffic turning count as a best-approximation of the traffic movements which were likely to have been using the junction during the post-LNMS period. There are no u-turning movements, and no movements east-west across the junction in either direction (i.e. re-joining the motorway in the same direction). These assumptions detailed above are applied for each hour (07:00 – 19:00) separately, and added together to create a 12-hour post-scheme calculated turning count.

3.10. This ‘calculated’ traffic turning count is used to support the analysis in this report.

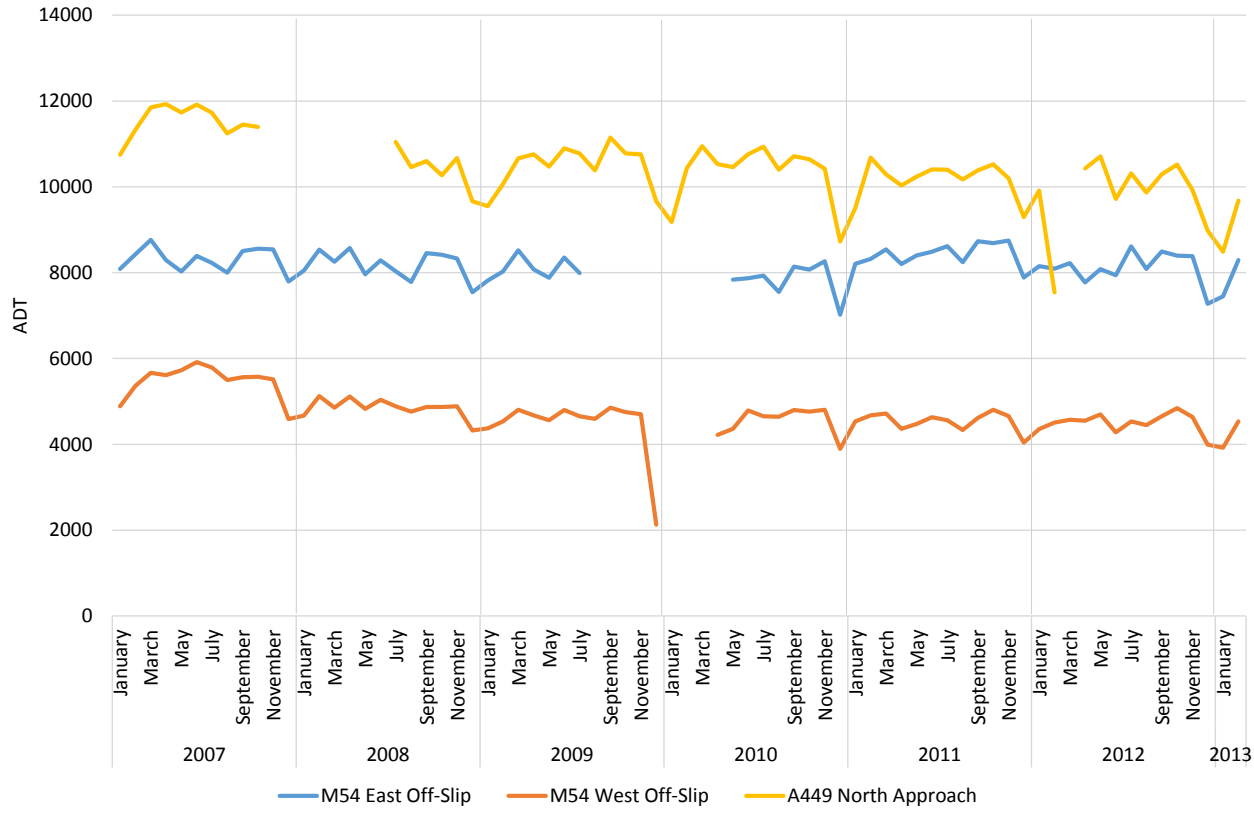
Traffic Volume

3.11. TRADS data for the three sites highlighted in **Figure 3.1** have been assessed for the period January 2007 – February 2013. This provides a view of traffic patterns during the period when the Junction 2 Signalisation LNMS was being developed,

during its construction and in the period after opening. The period does not include any of the period when the i54 access highway changes were being constructed or after they had opened.

3.12. The Average Daily Traffic (ADT) on a monthly basis is shown in **Figure 3.2**.

Figure 3.2 – Long-Term ADT Flows (2007 – 2013)



3.13. The key points from **Figure 3.2** are as follows:

- Traffic volumes for the M54 off-slips and A449 north approach to the junction gradually declined slightly across the pre-scheme and post-scheme period, although there has been no significant traffic growth in the period since the scheme opened; and
- The junction approaches are subject to a fairly typical seasonality in terms of traffic volumes, with troughs in winter. The graph does not generally show evidence of the junction being affected by local events or attractions above normal seasonality. There is a decline in traffic volumes during the winter in 2009 although these increase again in March 2010. On closer inspection, average traffic volumes increase by approximately 11% from the pre- to post-scheme period, not taking into consideration the construction period.

3.14. Traffic patterns since March 2013 are not considered as this period included the highway works related to the construction of the i54 development access highway layout, and the subsequent opening of the development. It is expected that the opening of the development may have attracted more traffic to the junction. However, these impacts are outside of the scope of this post-opening evaluation.

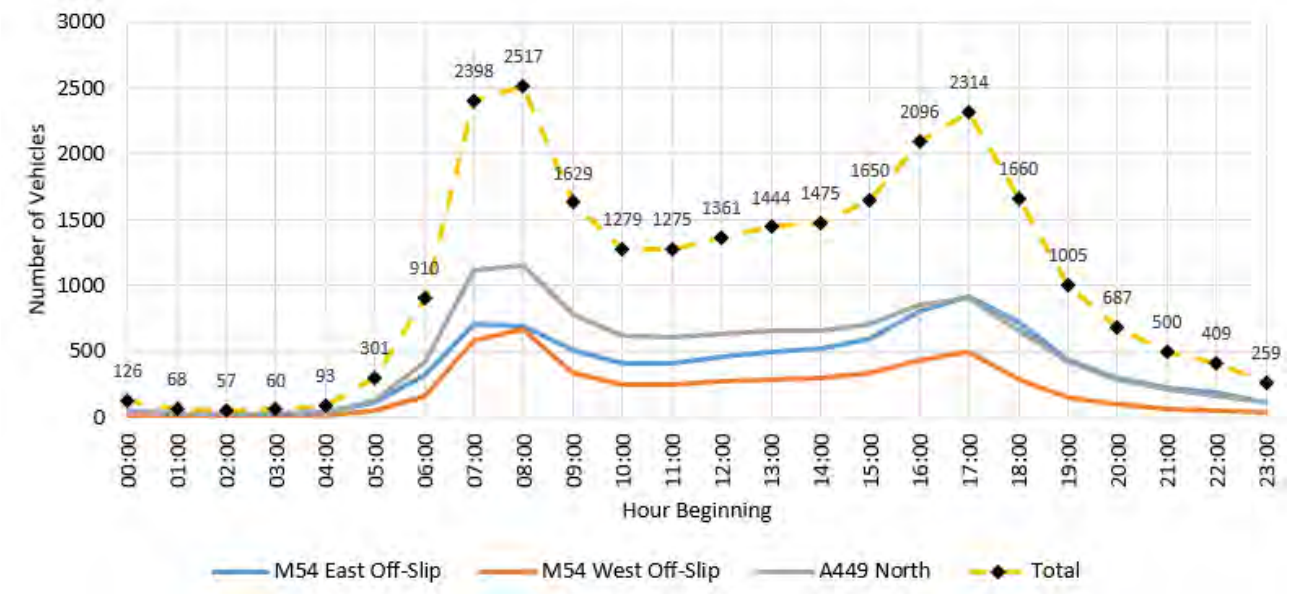
Daily Traffic Patterns

TRADS Data

3.15. TRADS data has also been analysed in the format of daily flows, in order to understand daily variation and to establish the profile of traffic and any tidal behaviour. Data was obtained for a one-year post-scheme period of 1st August 2010 – 31st July 2011. The relevant TRADS sites located on the junction have been used, although there is an absence of a site on the A449 south approach to the junction. The available data will be used to give an indication of the daily traffic profile at the junction as a whole.

3.16. **Figure 3.3** presents these daily flows and average values for an average weekday.

Figure 3.3 – Average Weekday Hourly Traffic Flow (August 2010 – July 2011)



3.17. The key points from **Figure 3.3** are as follows:

- The profile on weekdays is typical, with peak periods during the morning and early evening and lower flows during the inter peak;
- **AM peak traffic approaching the junction was experienced between 07:00 and 09:00** – The data demonstrates that the peak traffic at Junction 2 occurred across a two hour period, during which time an average of almost 2,500 vehicles per hour travelled along the three approach arms where TRADS data is collected. Flows are highest on the A449 north approach;
- **PM peak traffic approaching the junction was experienced between 16:00 and 18:00** – A PM peak is observed across two hours with the 17:00-18:00 hours being the busiest period. During this period, the flow approaching the junction from the A449 north and the M54 east approaches is very similar (around 850 vehicles per hour). Flow on the M54 west approach is lower; on average just less than 500 vehicles;
- Overall, the junction appears to be at its busiest during the AM peak (considering these three arms only). Flows between 11:00 and 12:00 are almost half the size of the morning peak flows. In the PM peak hour, the

average total flow across the three arms is around 85% of the volume observed during the AM peak hour; and

- All three approaches to the junction follow a similar pattern with two hour AM peak periods, lower flows throughout the inter peak period and a smaller rise to the PM peak. For the A449 north and the M54 west approaches, flow is higher in the AM peak than the PM peak. The opposite is observed for the M54 east approach where the PM peak flows are slightly larger than the morning levels.

3.18. Daily flows and average values for an average Saturday and Sunday are shown in **Figure 3.4** and **Figure 3.5** respectively.

Figure 3.4 – Average Saturday Hourly Traffic Flow (August 2010 – July 2011)

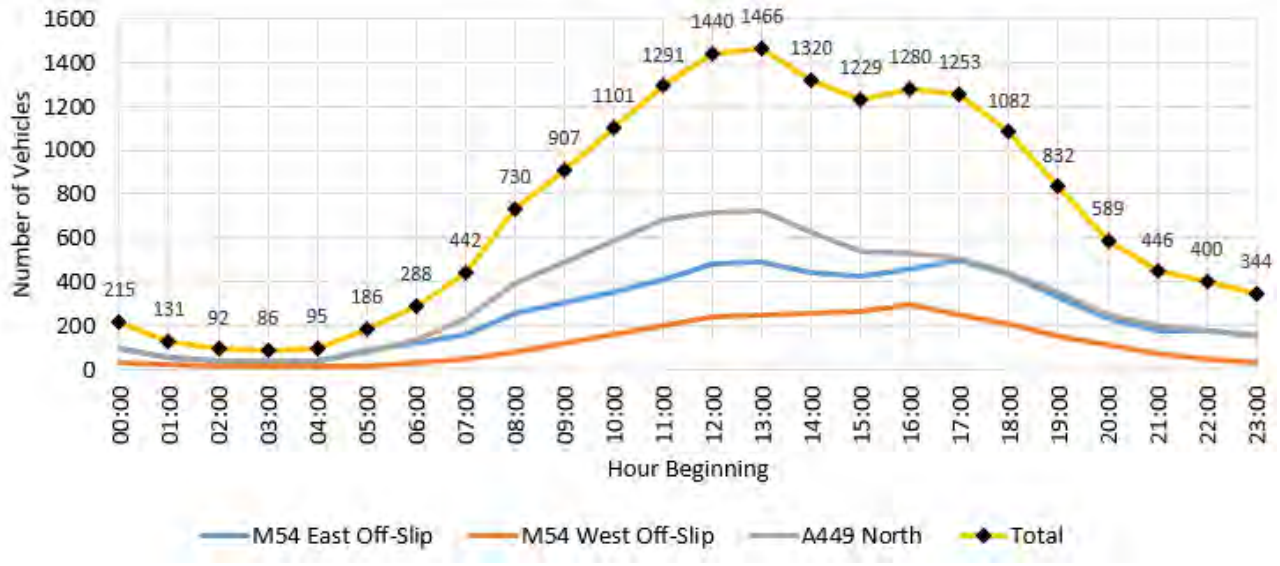
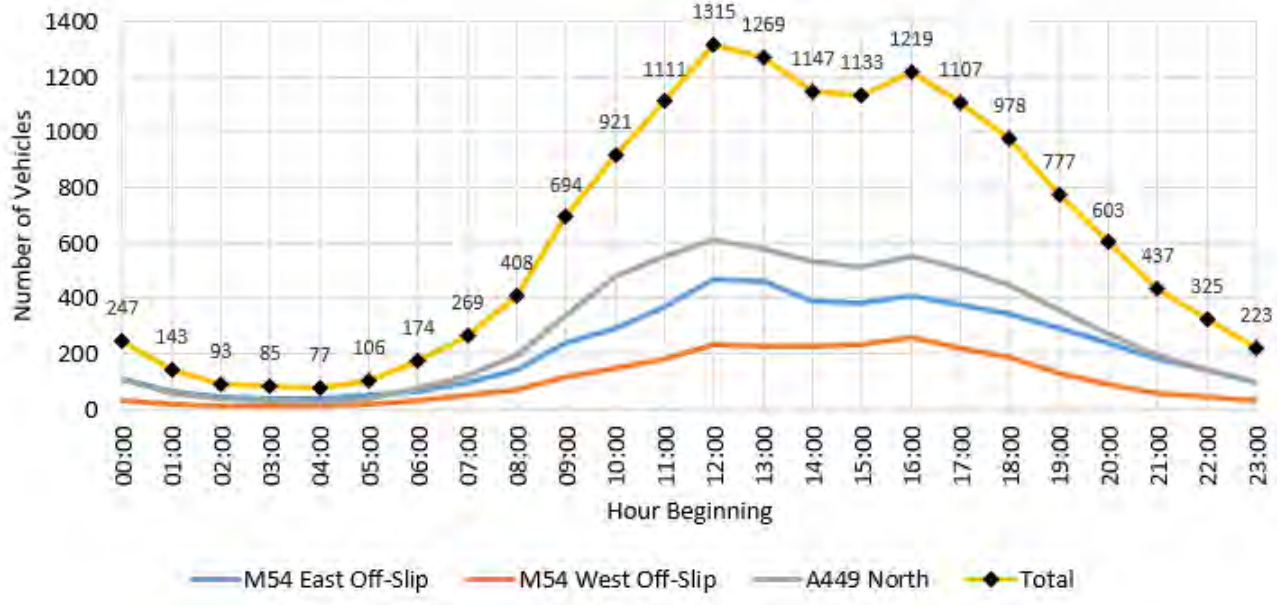


Figure 3.5 – Average Sunday Hourly Traffic Flow (August 2010 – July 2011)



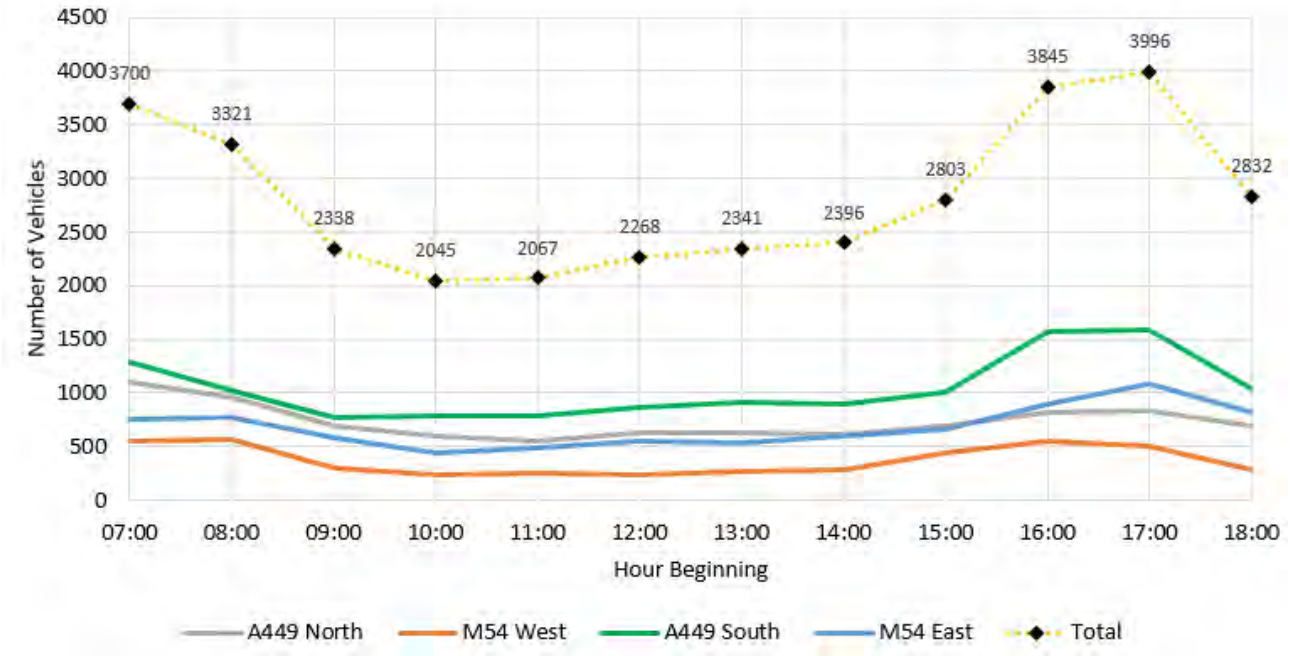
3.19. The key points to note from **Figure 3.4** and **Figure 3.5** are as follows:

- The flow profiles on Saturdays and Sundays are generally similar, with a gradual increase in traffic flows throughout the morning. Peak conditions for the combined flow of the three approach arms is experienced between 12:00 and 14:00;
- On both weekend days, there is a slight reduction in traffic flows through the afternoon before a slight increase again in the evening. Flows are slightly higher on the Saturday than the Sunday;
- Throughout the weekend days, the A449 north approach is the busiest of the three arms, and the M54 west off-slip carries the lowest flows; and
- During the busiest period over the weekend (13:00 to 14:00 on Saturdays – 1,466 vehicles), traffic flows on the three approach arms combined are around 58% of the flows experienced during the busiest period on a weekday (08:00 – 09:00). Generally, the weekend flow is of a similar scale to the weekday inter peak flow.

Post-LNMS Calculated Turning Count data

3.20. The 'calculated' turning count for the post-LNMS conditions has also been interrogated to review the daily traffic patterns approaching the junction. **Figure 3.6** shows the flow profile observed by this calculated count.

Figure 3.6 – ADT as Shown by the Calculated Post-LNMS Turning Count



3.21. **Figure 3.6** shows that more traffic passing through Junction 2 approaches via the A449 south arm than from the other arms. Traffic flows for the other three approaches are all consistent with the traffic profiles shown by the TRADS data, with peaks in the morning and evening. As suggested by the TRADS data, the M54 west approach was observed to carry the lowest flows into the junction on a weekday.

Traffic Turning Movements

3.22. As outlined previously, a turning count was collected for the junction during June 2015. The observed flows have been adjusted to account for the opening of the

i54 Business Park. The resulting 'calculated' turning count for the junction aims to estimate the conditions observed in the period after the LNMS scheme was completed, and before the i54 development changes took effect. The calculated post-LNMS 12 hour turning count is presented in **Table 3.1**.

Table 3.1 – Calculated Post-LNMS 12-Hour Junction Turning Count

12 Hour (07:00 – 19:00)	A449 North	A449 South	M54 East	M54 West	Total Flow From
A449 North	- -	6,160 *18%*	1,427 *4%*	1,216 *4%*	8,803 *26%*
M54 West	1,833 *5%*	2,633 *8%*	- -	- -	4,466 *13%*
A449 South	6,041 *18%*	- -	4,511 *13%*	1,974 *6%*	12,526 *37%*
M54 East	1,604 *5%*	6,554 *19%*	- -	- -	8,158 *24%*
Total Flow To	9,478 *28%*	15,347 *45%*	5,938 *17%*	3,190 *10%*	**33,953**

3.23. **Table 3.1** shows that most of the traffic travelling through the junction exits on the A449 South arm of the roundabout. Similarly, most of the traffic entering the junction does so on the A449 South approach arm. This is likely to be because it is the route to Wolverhampton City Centre. The largest individual movements are from the M54 East approach towards Wolverhampton. The other two movements with a similarly large flow are from the A449 North to the A449 South and from the A449 South to the A449 North. The quietest approach arm is the M54 West, which carries only 13% of the vehicle arrivals.

Summary

- Traffic volumes at Junction 2 of the M54 have remained fairly consistent over time, suggesting there has been no significant traffic growth in the period since the scheme opened;
- Junction 2 of the M54 follows a typical daily profile, with peaks during the morning (07:00 – 09:00) and early evening (16:00 – 18:00) on weekdays;
- The traffic profile over the weekend are of a similar volume to the weekday inter peak period. Flows increase slowly throughout the morning period reaching a peak at around midday on both Saturday and Sundays; and
- The calculated post-LNMS turning count indicates the A449 south is the busiest approach and exit arm.

4. Journey Time Analysis

Introduction

4.1. Although this scheme was developed as a safety scheme according to the PAR, it was predicted that the measures would also result in a change in journey times, with benefits predicted for all users. The signalisation of the roundabout was designed to improve journey times for vehicles moving through the junction during peak periods.

4.2. To assess the impact, this section of the report considers evidence from before and after the scheme to ascertain whether there has been a journey time benefit experienced due to the implementation of the scheme.

Data Source

4.3. For the journey time analysis, Sat Nav data has been used to inform pre- and post-scheme journey times. This data is available from some motorists who use satellite navigation devices and allow their data to be used anonymously for the purpose of generating travel statistics. This data can provide crucial intelligence on the operation of the highway network. The data also has the benefit of being historic, so that it is possible to retrieve pre-scheme journey time data after the scheme has opened.

4.4. In order to conduct the analysis, seven time periods have been defined using the diurnal flow profiles presented in Chapter 3 as a guide. The time periods have been defined to combine similar hours in terms of flow levels and trip purposes (commuting/leisure etc.). The seven time periods used are listed in **Table 4.1**.

Table 4.1 – Journey Time Analysis: Time Period Splits

Time Period	Monday – Friday	Saturday	Sunday
AM Peak	07:00 – 09:00	-	-
PM Peak	16:00 – 18:00	-	-
Inter Peak	09:00 – 15:00	-	-
PM Shoulder	15:00 – 16:00 and 18:00 – 19:00	-	-
Saturday Day	-	10:00 – 19:00	-
Sunday Day	-	-	11:00 – 19:00
Overnight	19:00 – 07:00	19:00 – 10:00	19:00 – 11:00

4.5. Sat Nav data has been acquired for these time periods over a one year period before and after the scheme. These periods are defined as:

- Pre-scheme: 1st February 2009 – 31st January 2010; and
- Post-scheme: 1st August 2010 – 31st July 2011.

4.6. The right-turn from each approach to the junction was used for journey time data collection. These routes were then cut down so that all movements from each approach were considered in the analysis. The data analysis considers only the road layout before the highway changes introduced to facilitate the i54 Business Park.

Journey Time Comparison

4.7. The impact of the scheme during each of these seven time periods has been considered separately.

4.8. **Table 4.2** presents the change in journey time between the pre-scheme and post-scheme periods for each movement and each time period. This demonstrates how the provision of the signals has affected the ease of vehicles getting into the junction. Negative values indicate a journey time saving and hence a benefit. As outlined previously, the movements between Arms B and D have not been assessed as this would have been trips leaving the motorway and immediately re-joining it in the same direction, which is illogical.

4.9. The arms have been referenced as follows:

- Arm A: A449 north;
- Arm B: M54 west;
- Arm C: A449 south; and
- Arm D: M54 east.

Table 4.2 – Difference in Before and After Journey Times (seconds per vehicle)

Arm From	Arm To	AM Peak	PM Peak	Inter Peak	PM Shoulder	Saturday Day	Sunday Day	Overnight
A – A449 North	**B**	28.8	25.1	22.9	23.3	20.6	21.3	17.6
	C	18.7	12.0	12.8	12.2	10.7	12.8	11.2
	D	11.0	6.9	8.1	7.5	6.1	8.5	7.3
B – M54 West	**A**	10.1	9.3	9.9	9.4	10.1	10.0	7.7
	C	28.8	23.5	23.5	22.6	23.0	22.4	17.4
C – A449 South	**A**	7.2	7.6	8.0	8.3	7.0	6.6	6.9
	B	3.6	3.9	5.0	5.1	4.4	4.0	5.0
	D	18.3	16.6	16.8	16.8	15.4	14.6	12.7
D – M54 East	**A**	25.0	25.0	23.9	23.0	22.5	20.0	16.0
	C	11.4	8.1	10.8	8.7	10.1	9.0	7.7

Positive values indicate an increase in journey time and hence a dis-benefit. Increases of > 20 seconds are highlighted in red.

4.10. **Table 4.2** shows that there were increases in journey times in all time periods for all movements. This impact was expected during some of the lower flow times due to the introduction of signals at the junction, but some benefits were predicted during the AM and PM peaks which have not materialised.

4.11. The largest increases in journey times were for trips from Arm A to B (from the A449 north to the M54 west) during the AM peak and from Arm B – C (from the M54 west to the A449 south), also during the AM peak. Indeed, throughout all of the time periods these movements are shown to have been the most severely impacted, except for the inter-peak period, when the most severely impacted period was from the M54 east approach to the A449 north arm.

4.12. Journey time increases were also fairly substantial during the overnight period.

Journey Time Reliability

4.13. The Sat Nav data also allows any change in journey time reliability to be quantified, by using the inter-quartile range journey times and the 5th to 95th percentile journey times. By considering how these ranges have changed from the pre-scheme year to the post-scheme year the reliability of journey times can be assessed.

4.14. The Sat Nav data has been extracted as a series of right turning arm-to-arm vehicle movements which take in the majority of the circulatory carriageway. It is possible to assess the change in journey time reliability for each of these vehicle movements to make a robust assessment of how reliability has been affected.

4.15. The graphs presented in **Appendix C** show the journey time reliability on the vehicle movements assessed:

- A449 North – M54 West;
- M54 East – A449 North;
- A449 South – M54 East; and
- M54 West – A449 South.

4.16. In summary, the reliability graphs show:

- Generally, journey times have become more unreliable since the implementation of the scheme. The graphs show an interquartile range which is either similar to or worse than the pre-scheme situation. The minimum journey times increase in all graphs also;
- Journey times look to have worsened significantly during the AM peak for all movements assessed. The 95th percentile journey times have increased from 123 seconds to 205 during the AM peak for those travelling from the M54 east to the A449 north arm. The 75th percentile journey time has also increased from 68 seconds to 118 seconds. For the turn from the M54 west to the A449 south arm, the 75th percentile journey time has increased in the AM peak from 95 seconds to 121 seconds, with the 95th percentile journey time over one minute larger (increase from 128 seconds to 196 seconds); and
- In the PM peak, there have been increases in 75th percentile and 95th percentile journey times for all movements. For trips from the A449 north to the M54 west, the 75th percentile journey time has increased from 59 seconds to 86 seconds (17 additional seconds). The 95th percentile journey time has increased by 59 seconds. For the movement from the M54 west arm to the A449 south arm, the 75th percentile journey time has increased by 21 seconds and the 95th percentile journey time has increased by 50 seconds.

Calculation of Annual Vehicle Hour Benefits

4.17. **Table 4.2**, presented earlier in this section, demonstrates how journey times have changed for certain movements and time periods before and after the scheme's construction. It is assumed that these changes are a result of the scheme measures. Therefore, it is necessary to calculate the number of vehicle hours saved in the opening year, in order to understand and quantify the overall impact for this evaluation.

4.18. Weekly vehicle movement matrices are presented in **Table 4.3**.

4.19. The vehicle movements are based on the post-LNMS calculated turning count, as described in the 'traffic turning movements' section in Chapter 3. In the absence of any observed turning count data, the weekend and overnight flows are based on the post-LNMS calculated count data but factored using the permanent TRADS counts data.

Table 4.3 – Total Weekly Arm-to-Arm Vehicle Flow Matrices by Period

Arm From	Arm To	AM Peak	PM Peak	Inter Peak	PM Shoulder	Saturday Day	Sunday Day	Overnight
A – A449 North	**B**	1,393	1,380	494	840	671	558	2,009
	C	6,820	5,795	2,639	4,990	3,590	2,986	10,741
	D	2,105	1,070	580	1,060	789	656	2,361
B – M54 West	**A**	1,985	2,415	665	1,440	905	753	2,707
	C	3,640	2,830	898	2,205	1,222	1,016	3,655
C – A449 South	**A**	5,680	7,695	2,406	4,800	3,273	2,723	9,793
	B	2,069	3,218	611	1,531	831	691	2,485
	D	3,830	4,890	1,984	3,915	2,699	2,245	8,075
D –M54 East	**A**	1,170	2,410	551	1,685	750	624	2,243
	C	6,415	7,500	2,629	5,710	3,576	2,975	10,700
Total		**37,675**	**35,107**	**39,203**	**13,456**	**28,176**	**18,306**	**15,227**

4.20. The arm-to-arm vehicle movements outlined in **Table 4.3** are multiplied by the differences in journey times outlined in **Table 4.2** to identify the total weekly vehicle hour savings.

4.21. Weekly vehicle hour savings are multiplied by 52 to calculate the annual vehicle hour savings. The annual resulting vehicle hour savings are summarised, by approach arm, in **Table 4.4**.

Table 4.4 – Annual Vehicle Hour Savings

Arm From	Arm To	AM Peak	PM Peak	Inter Peak	PM Shoulder	Saturday Day	Sunday Day	Overnight	Total
A – A449 North	B	579	500	164	282	199	172	511	2,407
	C	1,842	1,006	488	879	555	554	1,733	7,058
	D	335	106	68	114	70	80	248	1,021
B – M54 West	A	289	325	95	196	132	109	301	1,445
	C	1,516	960	304	721	406	328	918	5,153
C – A449 South	A	589	849	277	575	332	259	976	3,859
	B	108	179	44	113	53	40	179	716
	D	1,011	1,175	482	949	600	474	1,481	6,173
D – M54 East	A	422	869	190	559	244	180	519	2,984
	C	1,052	876	410	718	520	386	1,185	5,148
Total		7,743	6,846	2,523	5,107	3,110	2,583	8,051	35,964

4.22. **Table 4.4** demonstrates that there has been a net dis-benefit with longer journey times observed for all movements at the junction, during all times of the week. Once annualised, this results in a journey time dis-benefit of 35,964 vehicle hours in the opening year.

4.23. There has been a notable increase in vehicle hours during both the AM and PM peak periods. During the AM peak where there has been a net dis-benefit of 7,743 vehicle hours per annum. This is equivalent to 22% of the annual dis-benefits. The most affected movement has been the journey from the A449 north to the A449 south where 1,842 additional vehicle hours per year are experienced following the implementation of the scheme and a total of 7,058 annual vehicle hours are experienced across all time periods. The journey from the M54 west, turning towards the A449 south arm has also been negatively affected with 1,516 additional vehicle hours per annum during the AM peak hours.

4.24. During the PM peak, the most affected movement has been the right turn from the A449 south, to the M54 east. This journey is now required to pass through the traffic signals on approach, as well as signals on the circulatory carriageway. There are 1,175 additional vehicle hours experienced by vehicles making this turn. Overall, in the PM peak, there has been a net dis-benefit of 6,846 vehicle hours; equivalent to 19% of the annual dis-benefits.

4.25. The greatest journey time increases have been observed during the overnight period. This is an expected impact as the overnight hours are when the lowest vehicle flows are experienced. At these times, there was unlikely to have been congested conditions at the junction and so the addition of the traffic signals will have created additional delay. With the pre-scheme layout, traffic could flow freely through the junction.

4.26. The smallest changes in net journey times have been observed during Sunday daytimes and during the weekday inter peak period although these impacts were still adverse.

4.27. Considering the impacts by movement, it is observed that the most severely impacted movements are trips southbound through the junction (Arm A to C has a dis-benefit of 7,058 vehicle hours per annum) and right turning trips from Arm C to Arm D (6,173 additional vehicle hours per annum).

4.28. It is also noticeable that the movements turning to exit the junction on the A449 south are amongst the most badly impacted. In total, the three movements to exit via Arm C contribute 17,359 of the annual vehicle hour dis-benefit (48%). This may suggest an issue on the downstream carriageway which limits the capacity of the junction exit. There was however no obvious sign of this during the site visit.

4.29. **Table 4.5** presents a breakdown of the journey time savings (or dis-benefits in the case of this scheme), by the scale of the journey time impacts.

Table 4.5 – Annual Vehicle Hour Savings by Size of Impact

Change in JT (Secs per Veh)	Journey Time Benefits	Journey Time Dis-Benefits	Total Journey Time Impact
0 – 10	0	+12,706	+12,706
10 – 20	0	+17,350	+17,350
20+	0	+5,907	+5,907
Total	**0**	**+35,964**	**+35,964**

4.30. **Table 4.5** demonstrates that the majority of scheme dis-benefits are due to relatively small changes in journey time, with most changes being 10 – 20 seconds. The journey time data also shows that there were no changes greater than 30 seconds per vehicle being recorded across all movements and time periods. This suggests that although the scheme has clearly had a negative impact on congestion at the time of evaluation, the changes may not be perceivable to the majority of motorists.

Summary

- Although a safety scheme, the PAR stated that the measures were designed to help address issues with congestion during the AM and PM peak periods and included a forecast journey time saving;
- The observed data shows that journey times have actually increased across all movements at the junction, and in all periods during the week;
- Between them, the journey time increases in the AM and PM peaks have contributed 41% of the annual dis-benefits. The scheme has therefore not achieved the desired journey time savings;
- The largest journey time increases have been during the overnight period with 8,051 additional vehicle hours per annum. Signalisation would be expected to result in additional journey times during periods of low traffic flow,

where conditions would have travelled freely through the previous highway layout; and

- Journey time reliability has worsened in all time periods, with the most noticeable worsening during the peak periods.

5. Safety Impacts

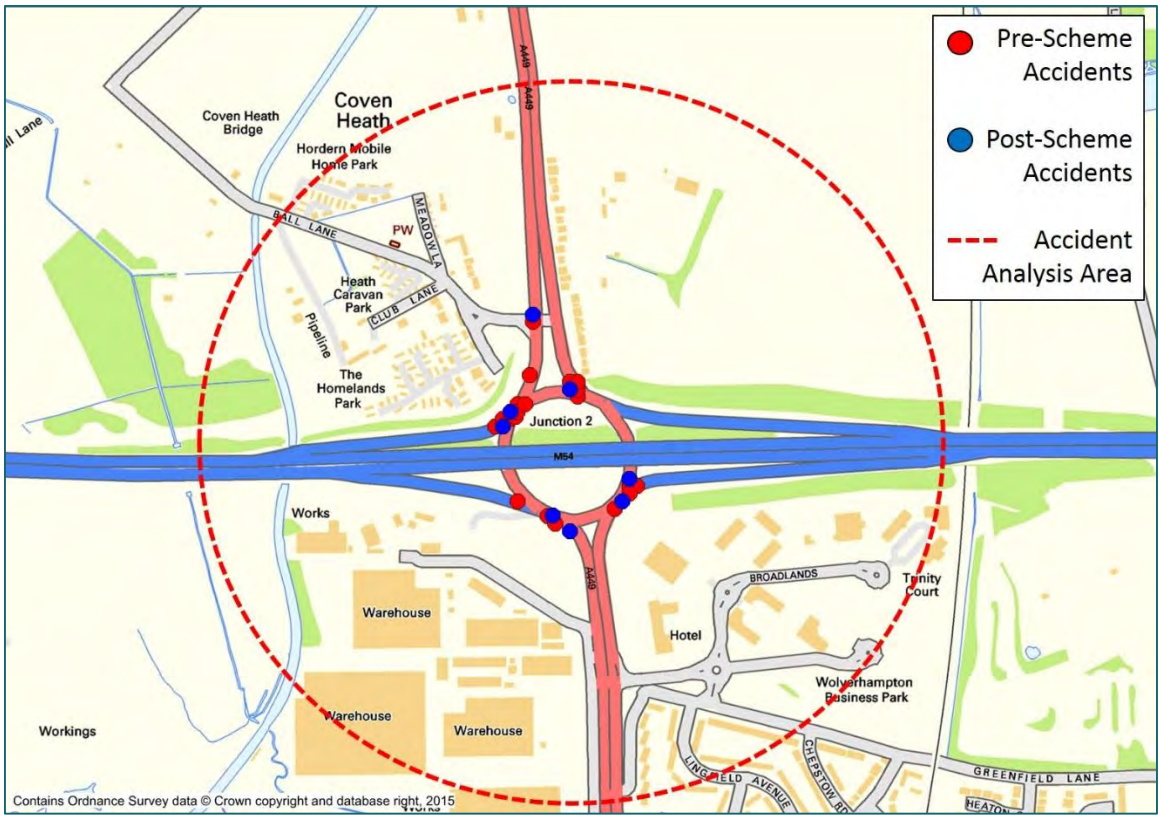
Introduction

5.1. A critical component of any highway scheme is safety. This scheme aimed to reduce the number of accidents occurring at the junction. This section examines the safety impacts associated with the scheme, and compares the pre- and post-scheme opening accident rates to determine whether the scheme has resulted in a post-opening safety benefit or dis-benefit.

Data Source

5.2. The PAR used accidents[1] from the five year period from 1st January 2004 as evidence for the pre-scheme conditions at the scheme site. The PAR stated that there had been 51 accidents during this period and that the scheme aimed to save 6.40 accidents in the opening year. The area over which accidents are considered includes the A449 and the M54, within a radius of 500 metres from the centre of the junction and is highlighted in **Figure 5.1**. The M54 mainline through the junction was not included. This area has been used to analyse accidents for this evaluation.

Figure 5.1 – Accident Analysis Area (including Pre- and Post- Scheme Accidents)



[1] All references to accidents in this report refer to Personal Injury Collisions (PICs).
The accident data referred to in this report has not necessarily been derived from the national validated accident statistics produced by Department for Transport (DfT). As such, the data may subsequently be found to be incomplete or contain inaccuracies. The requirement for up-to date information and site specific data was a consideration in the decision to use non-validated data and, as it is sourced from Local Processing Units through the Managing Agent Contractors or Asset Support Contractors, it is sufficiently robust for use in this context.

5.3. The PAR covers the evidence used to support the decision to proceed with the scheme, effectively outlining the business case. However, once a PAR has been completed and agreed, there can be a time delay before the start of scheme construction.

5.4. The delay between collecting evidence for a scheme and starting construction means the accident data used to evidence the situation before the scheme is often dated. As such, to understand just the impact of the scheme, a five year pre-construction accident analysis represents a better comparison to the outturn accident rate, and hence representation of scheme impacts.

5.5. For this scheme, the PAR used accident data from 1st January 2004 up to 31st December 2008. However, scheme construction did not begin until February 2010. Therefore, there are 13 months between the evidence and the scheme, during which time the accident rate could have changed.

5.6. As such, to understand just the impact of the scheme, accident data has been analysed for the same location for a period of five years directly before construction began (1st February 2005 – 31st January 2010).

5.7. The results are presented in **Table 5.1**, which shows that 47 accidents occurred during this pre-scheme period (which is an average of 9.40 per year). All of these accidents were slight in severity. The predicted opening year accident saving remains 6.40, as given in the PAR.

Table 5.1 – 5 Year Pre-Scheme Accident Rates

Accidents	Dates	Slight	Serious	Fatal	Rate	Severity Index
5 Years Pre-Construction	February 2005 to January 2010	47	0	0	9.40	0%

5.8. **Figure 5.1** shows that most of the pre-scheme accidents occurred near to the stop lines at the junction.

Construction

5.9. It is important to consider the effect of construction on accidents. While this is not typically monetised in LNMS evaluations, it is informative to consider whether the construction process introduces accidents to the road network.

5.10. For the M54 Junction 2 scheme, the construction period occurred from February 2010 until July 2010. During this period, 1 accident was recorded in the area affected by the scheme.

5.11. The description of the accident shows that this accident occurred as a result of driver error.

Post-Scheme

5.12. To understand the safety performance of the road network after the scheme was implemented, data has been collected for the period since the scheme opened. The scheme opened at the end of July 2010 and therefore data has been collected from August 2010. The post-scheme analysis period runs until the end of February 2013. This period avoids the impacts of the construction works of the

i54 Business Park access, which began in March 2013. Therefore, there are 31 months of post-opening data available to analyse.

5.13. The post-scheme accident data is summarised in **Table 5.2**.

Table 5.2 – Post-Scheme Accident Summary

Accidents	Dates	Slight	Serious	Fatal	Rate	Severity Ratio
Post-Scheme	August 2010 to February 2013	8	0	0	3.1	0%

5.14. **Table 5.2** shows that there have been 8 personal injury accidents since the scheme opened, all slight in severity. The post-scheme accident rate is therefore 3.10, which is a significant reduction on the five-year pre-scheme accident rate as well as the pre-scheme rate reported in the PAR.

5.15. Following the signalisation of the junction, fewer accidents have occurred. The analysis also shows that the location where accidents are occurring has not changed. **Figure 5.1** demonstrates that those that have occurred in the post-scheme period were near to the stop lines at the junction, and so are in similar sites to the pre-scheme accidents. The scheme does not appear to have introduced any new accident locations.

Accident Rate Change

5.16. The key changes in accidents that can result from a scheme are:

- Change in the frequency of accidents; and
- Change in the severity of accidents.

5.17. By understanding the impact the scheme has had on these metrics, it is possible to draw conclusions on the safety aspects of the M54 Junction 2 scheme.

5.18. **Table 5.3** compares the accident rate and severity index for the pre-scheme and post-scheme periods.

Table 5.3 – Impact of Scheme on Accident Rates

5 Year Pre-Construction Period		Post-Scheme Period		Accident Saving
Accident Rate	Severity Index	Accident Rate	Severity Index	
9.40	0%	3.10	0%	6.30

5.19. The table shows that the scheme has reduced the accident rate by 6.30 accidents per year. This is close to the forecast saving of 6.40 accidents per annum which was stated in the PAR and demonstrates an accurate forecast.

5.20. As no ‘serious’ or ‘fatal’ collisions have been recorded, the post-scheme severity index remains at 0%, showing that the scheme has not made the severity of accidents worse.

Accident Causation

5.21. STATS19 accident data provides a comprehensive record of the accidents that have occurred. This allows us to go beyond the frequency and severity of accidents and consider the reasons why accidents have been occurring, by analysing the 'contributory factors' recorded during accidents.

5.22. **Table 5.4** demonstrates the before and after frequency of the most common contributory factors. In the outturn column of these tables, accident savings are highlighted in green.

Table 5.4 – Impact on Contributory Factors to Accidents per Annum

Contributory Factor	5 Years Pre-Construction	Outturn
Failed to look properly	5.6	0.8
Failed to judge other person's speed	3.2	1.5
Careless/reckless/in a hurry	1.8	0.0
Following too close	1.4	0.0
Poor turn or manoeuvre	1.2	0.4
Junction restart	1.0	0.4

5.23. **Table 5.4** shows that before the scheme, most accidents were due to drivers 'failing to look properly' or 'failing to judge another person's speed'. In the post-scheme period, the frequency of accidents being caused where a driver has failed to look properly has decreased from 5.6 per annum 0.8 per annum. The introduction of traffic signals has helped to reduce the potential conflicts where drivers are required to make judgements on how other vehicles will proceed. Accidents involving careless or reckless driving have also been reduced with no instances recorded in the post-opening period, compared to 1.8 per annum in the pre-scheme period.

Summary

- The number of accidents has greatly reduced in the post-scheme period, with a saving of 6.30 accident per annum;
- This saving is in line with the prediction in the PAR, where it was forecast that the scheme would save 6.40 accidents per annum;
- The severity index is 0% in both the pre- and post-scheme periods. All accidents observed near the junction between February 2005 and February 2013 were of slight severity; and
- The scheme has notably reduced the number of accidents occurring due to drivers failing to look properly, failing to judge another person's speed or driving carelessly/recklessly. The introduction of traffic signals has helped to reduce the potential conflicts where drivers are required to make judgements on how other vehicles will proceed.

6. Economy Impacts

Introduction

6.1. This section of the report takes the journey time and safety impacts reported in Chapters 4 and 5, and considers the monetary value of these impacts. These monetised benefits are then compared to the cost of scheme construction to inform two measures of value for money:

- **First Year Rate of Return (FYRR):** This is a measure of the scheme's first year benefits as a proportion of the scheme cost. It is given as a percentage and informs the percentage of the scheme costs recouped in the opening year. The FYRR given is evidence based and a primary finding of this report; and
- **Benefit Cost Ratio (BCR):** This is a measure of all the benefits that the scheme is likely to accrue over its workable life divided by the scheme cost over its life. This can only be a prediction, as this is a one year after opening report and it is not known how the scheme will perform in the future. However, this forecast is revised from that provided in the PAR based on the first year evidence.

6.2. All monetised figures in this section are quoted in 2002 prices, discounted to opening year, unless otherwise specified.

PAR and Outturn Comparison

6.3. The evidence provided in this report has been analysed to evaluate the scheme costs and economic benefits of the scheme provided in the PAR and to calculate the outturn costs and scheme benefits.

6.4. The benefits calculated and discussed in this report can be monetised using standard value of time and accident values from WebTAG. A positive impact is considered to provide a monetary saving. Once monetised in this way, the economy and safety impacts of the scheme are usually offset against the scheme costs to inform the overall Value for Money of the scheme package in both an opening year, and over a longer scheme life period. In line with the PAR, the scheme has been evaluated against a scheme life of 60 years.

6.5. **Table 6.1** summarises this comparison, presenting the PAR and outturn costs and benefits of the scheme. It also includes opening year figures for both costs and benefits of the scheme.

Table 6.1 – PAR and Outturn Economy Comparison

		PAR	Outturn
Opening Year (2010)	Total Cost	£1,192,702	£3,374,647
	Opening Year Accident Saving (Number)	6.40	6.30
	Opening Year Accident Saving (£)	£470,336	£463,224
	Opening Year Journey Time Benefits (£)	£3,947,906	-£468,251
	FYRR	370%	0%
Scheme Life (60 years)	Costs	£1.193m	£3.375m
	Safety Benefits	£23.097m	£22.748m
	Journey Time Benefits	£156.149m	-£18.520m
	BCR	150.3	1.3

Summary

6.6. Overall, the scheme is shown to have been less successful than was predicted in the PAR and resulted in an almost neutral impact in monetary terms.

6.7. It was anticipated that the scheme would deliver an accident saving of 6.40 accidents per year and the post-scheme data indicates that a saving in line with this level of benefit has been achieved. There has been an outturn safety benefit of £0.463m per annum.

6.8. The PAR also predicted that the scheme would result in some journey time benefits in the peak periods and forecast a net journey time saving. The PAR did not consider any adverse impacts from signalising the junction during periods of lower traffic flow. Sat Nav data has provided evidence that journey times through the junction have in fact increased for all possible movements at the junction, and at all times of the week. There has been an outturn journey time dis-benefit of £0.468m per annum.

6.9. It is also noted that the outturn scheme costs were reported as being over two and a half times greater than those forecast in the PAR.

6.10. While the accident savings provide benefits to the scheme, the journey time increases have adversely affected the scheme performance and offset the safety benefits. The outturn scheme costs were also substantially higher than forecast by the PAR. As a result, the first year rate of return is 0%, while the overall BCR is 1.3.

7. Other Impacts

7.1. This section of the report presents information relating to the WebTAG objectives which are not related to journey times, reliability or safety, as set out in the PAR's AST (as these have already been discussed in previous chapters).

7.2. This information will be compared to the forecasts made in the AST (provided in **Appendix D**). These comparisons are used to score the scheme against WebTAG objectives based on the first year's observed findings and are recorded in the Evaluation Summary Table (EST). The EST can be found in **Appendix E**.

7.3. Other impacts from the AST which are not referred to in this section are considered to be 'not applicable'.

Landscape

7.4. The PAR stated that the impact on landscape would be neutral.

7.5. However, the installation of new traffic signalling equipment throughout the roundabout has resulted in a negative impact on the landscape. As such, this sub-objective has been scored as **adverse**.

Physical Fitness

7.6. The PAR stated that the scheme would have a beneficial impact on physical fitness.

7.7. The signalisation of the roundabout has led to improved facilities for non-motorised users, with crossings installed, thereby improving connectivity. This may have had a positive impact on the number of people walking or cycling through the junction. No non-motorised users were observed using the facilities, although this may have been due to the weather on the day of the site visit. While the facilities have been improved for non-motorised users, it is not considered that this warrants a beneficial impact of physical fitness, and hence a score of **neutral** has been awarded.

Journey Ambience

7.8. Journey ambience is related to traveller care, views and stress. The PAR considered the scheme would have a positive impact on journey ambience through a reduction of traveller stress due to the provision of destination signs and markings.

7.9. The introduction of traffic signals and the lining of the roundabout, including lane markings is likely to have had a positive impact on journey ambience as the layout of the roundabout is clearer. The safety analysis has shown that there has been a dramatic decrease in accidents with the introduction of the scheme, which is likely to have had a positive impact on journey ambience.

7.10. However, the journey time analysis indicates that travelling through the junction is now slower increasing driver frustration.

7.11. The outturn assessment is therefore **neutral**.

Severance

7.12. The scheme's PAR stated that the scheme would have a beneficial impact on severance as a result of the improved pedestrian and cycling facilities at the junction.

7.13. The site visit confirmed that the crossings have been implemented, with several crossings available on the junction. The signalisation of the junction has enabled safer crossing conditions for pedestrians, whereas previously pedestrians may have avoided crossing the junction. Therefore, the scheme is deemed to have had a **beneficial** impact on severance.

Other Government Policies

7.14. The scheme's PAR stated that there would be a positive impact on government policy, as the scheme meets policies on DDA issues, which can be seen through the introduction of crossing points.

7.15. The post-opening evaluation considers that the impact of the junction signalisation scheme on government policies has been **neutral**.

8. Conclusions and Recommendations

8.1. This report presents the POPE of the M54 Junction 2 LNMS, implemented by the Area 9 MAC in 2010. The scheme evaluation has considered all elements of the WebTAG criteria. The evaluation team have worked closely with the MAC to ensure the best data possible was used and the scheme thoroughly understood.

8.2. The purpose of this section is to:

- Summarise the key impacts of the scheme and how these compare to forecasts; and
- Consider the lessons learnt and make recommendations to improve future LNMS.

8.3. The M54 Junction 2 LNMS opened at the end of July 2010. The scheme involved signalising the roundabout junction with local widening undertaken on all approaches to provide additional capacity. The scheme was developed as a safety scheme in order to address the high number of accidents occurring. The scheme also hoped to reduce congestion and delays during the AM and PM peak periods.

8.4. Following the opening of the LNMS in July 2010, subsequent highway works have taken place in the local area which have revised the highway layout. The western approach and exit arms to the junction no longer directly connect to the M54, and are now also shared with highway access to the i54 Business Park which opened to the immediate south-west of the Motorway junction. The opening of this development has changed the traffic conditions in the area and the junction which now exists on the ground no longer resembles the junction as it was post-LNMS. This post-opening evaluation has been restricted to just assessing the operation of the junction before and after the LNMS scheme and does not account for any further changes made to facilitate access to i54.

8.5. Accident data shows that the number of accidents occurring at the junction has decreased by 6.30 accidents per year. The PAR predicted that the scheme would save 6.40 accidents per year, which shows that the outturn result is in line with this and that the PAR forecast was accurate. The accidents which occurred in the post-scheme period were located in broadly the same locations as those which occurred in the pre-scheme period.

8.6. Although presented as a safety scheme, the PAR also predicted a journey time saving based on congestion and queues which were experienced in the AM and PM peak periods. The PAR gave no consideration for any adverse impacts from the signalisation which may have been incurred during the periods of lower traffic flow. Analysis of Sat Nav data has shown that the scheme was unsuccessful in reducing journey times, with increases observed for all possible journey movements and at all times of the week.

8.7. The outturn first year rate of return is 0%, while the BCR is 1.3, as compared to the forecast of 370% and 150.3 respectively. This is related to the outturn costs being two and a half times greater than forecast through the PAR. While the accident savings provide benefits to the scheme, this is off-set by journey time increases which have adversely affected the scheme performance.

8.8. The upgrading of the junction has positive impacts for non-motorised users by providing new, safer crossing facilities across each arm of the junction.

8.9. Although the analysis indicates an increase in journey times, it is considered likely that the increased capacity provided by the signalisation will have enabled the junction to operate more effectively in the period since i54 has opened. Although not investigated by this post-opening evaluation, it is expected that the new Business Park will have attracted additional trips to the area and through the junction. Although not stated as an objective for the LNMS, the signalisation scheme may have eased this subsequent growth in traffic.

Scheme Specific Objectives

8.10. Drawing on information presented in this report, a summary of the scheme's success against the scheme specific objectives, listed in the introduction to this report, is provided in **Table 8.1**.

Table 8.1 – Scheme Specific Objectives

Objective	Evaluation Summary
To reduce the injury collision rate	The scheme has successfully reduced the injury collision rate, with an accident saving of 6.30 per year. ✓
To reduce queues on the approaches to the junction	Journey times have increased following the introduction of the scheme, for all possible movements and in all time periods during the week. ✗

Lessons Learned

8.11. During the course of this evaluation it was observed that the PAR forecasts for journey times predicted a saving as it was hoped that congestion and delays experienced during the peaks could be addressed. However, the PAR made no consideration for any adverse impacts which may have been caused by signalisation during periods of lower flow. Typically, introducing traffic signals can help the flow of vehicles during periods where a junction has high and competing flows. However, in conditions where flows are low, the junction would operate with near free-flow conditions. Therefore the addition of signals can slow down trips and create additional delay. It is recommended that if proposing traffic signals as a part of a scheme, the ASC reasonably consider the cumulative impacts of such measures and at least acknowledge the journey time dis-benefits which may be added overnight or during other periods of low flow.

Appendices

Appendix A. Pre-Scheme Journey Times

Arm From	Arm To	AM Peak	PM Peak	Inter Peak	PM Shoulder	Saturday Day	Sunday Day	Overnight	Average
A – A449 North	**B**	60	56	56	54	54	52	53	55
	C	53	48	48	46	47	44	45	47
	D	37	34	35	33	34	31	33	34
B – M54 West	**A**	67	69	66	65	63	63	63	65
	C	93	92	88	87	84	84	84	87
C – A449 South	**A**	77	82	73	74	70	68	62	72
	B	67	72	64	65	61	59	54	63
	D	86	91	82	83	78	77	71	81
D – M54 East	**A**	60	52	48	48	46	46	45	49
	C	44	34	31	31	30	30	29	33
Total		**644**	**631**	**591**	**586**	**567**	**554**	**539**	

Journey times are given in seconds

Note: The average value is a simple average, and is not weighted by volume of traffic

Appendix B. Post-Scheme Journey Times

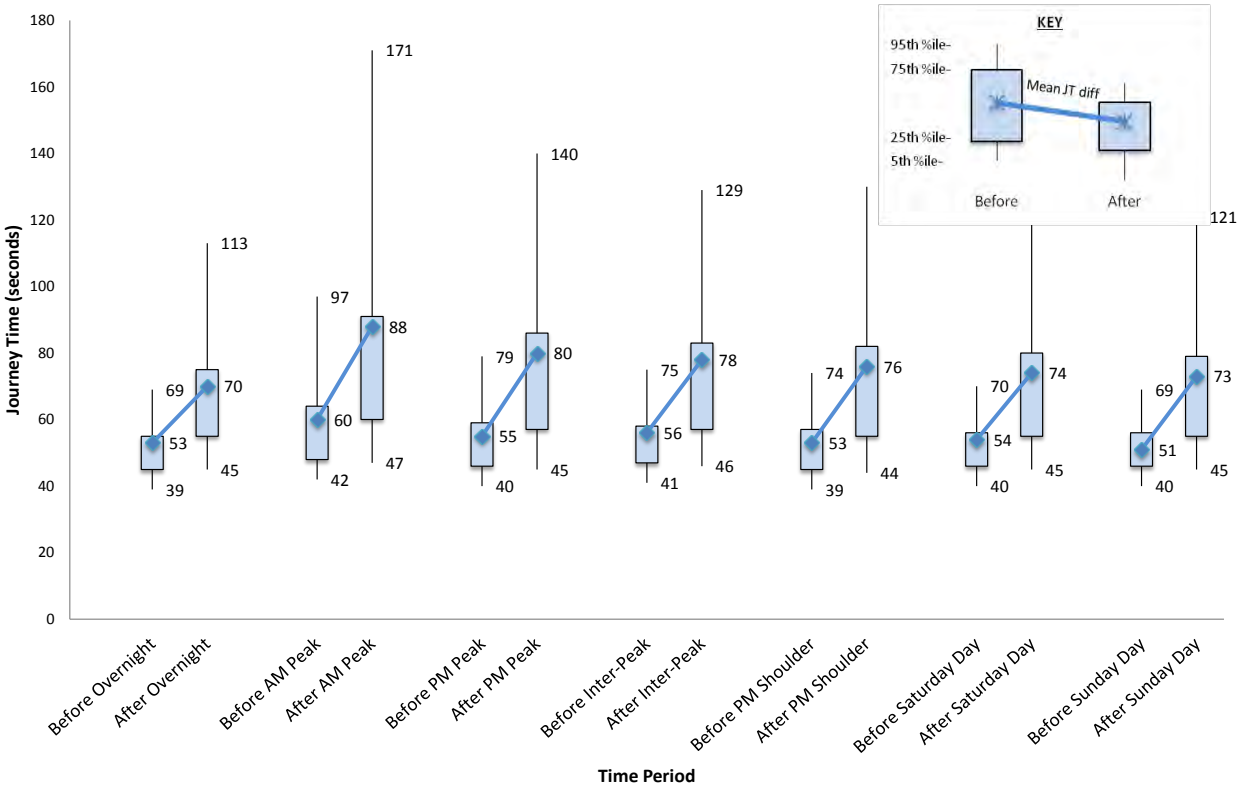
Arm From	Arm To	AM Peak	PM Peak	Inter Peak	PM Shoulder	Saturday Day	Sunday Day	Overnight	Average
A – A449 North	**B**	48	41	43	40	40	40	40	42
	C	72	60	61	58	58	57	56	60
	D	89	81	79	77	75	73	71	78
B – M54 West	**A**	71	76	69	70	65	63	59	68
	C	84	90	81	82	77	75	69	80
C – A449 South	**A**	105	108	99	99	94	91	83	97
	B	55	42	42	40	40	39	37	42
	D	85	77	71	71	69	66	61	71
D – M54 East	**A**	77	79	76	75	73	73	71	75
	C	121	116	111	110	107	106	101	111
Total		**807**	**769**	**733**	**723**	**697**	**683**	**648**	

Journey times are given in seconds

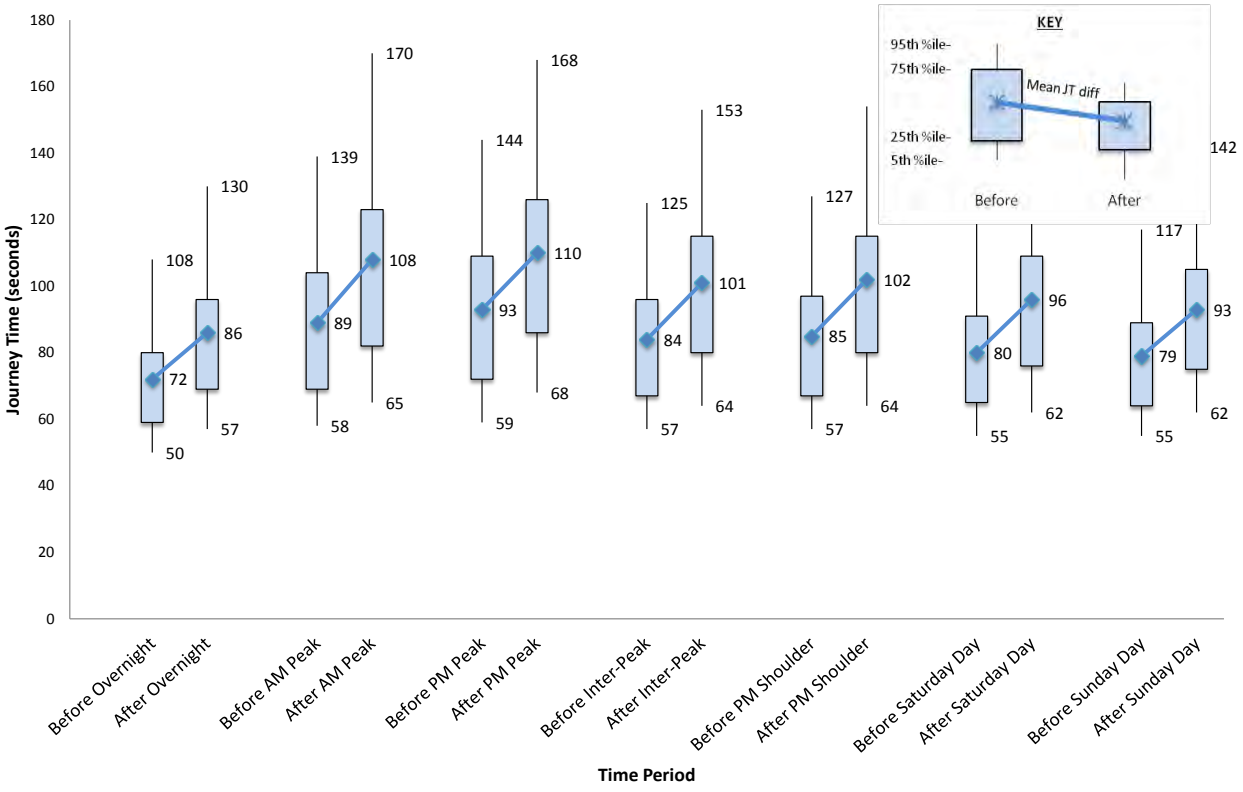
Note: The average value is a simple average, and is not weighted by volume of traffic

Appendix C. Journey Time Reliability Comparison Graphs

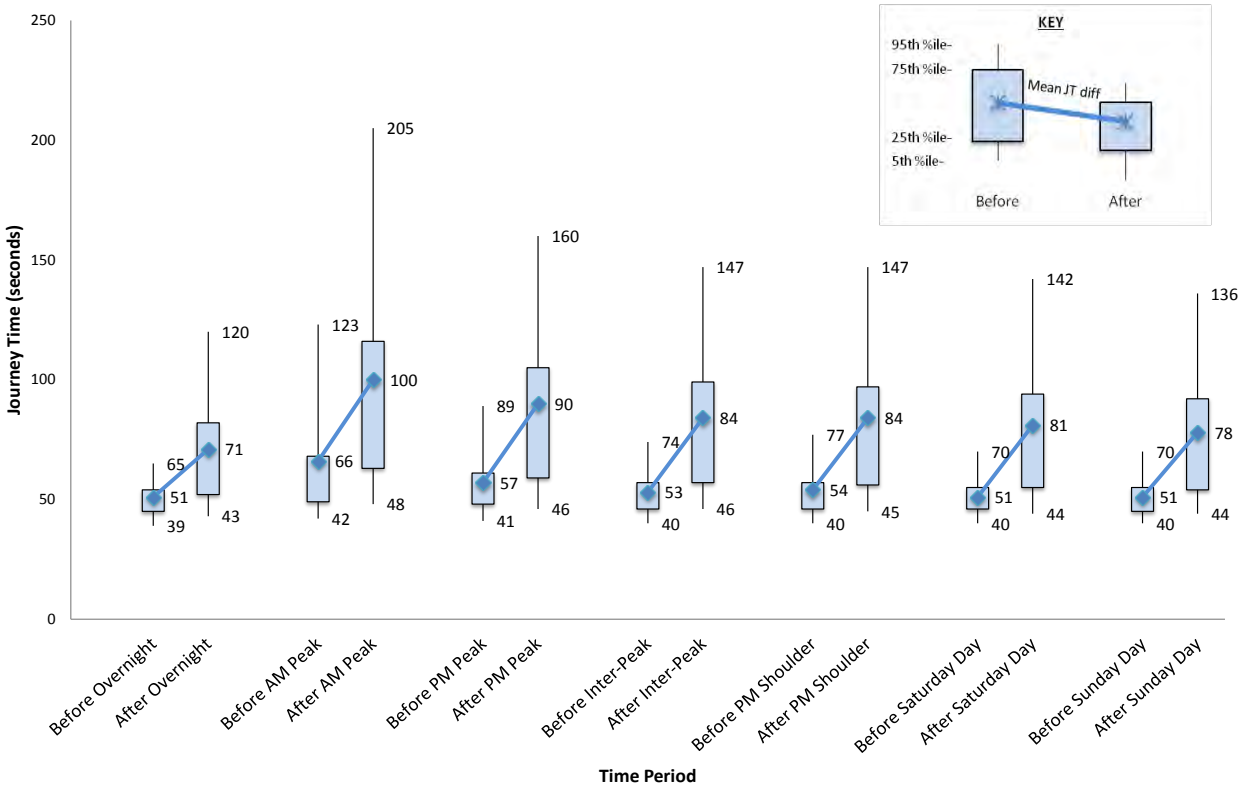
A449 North – M54 West



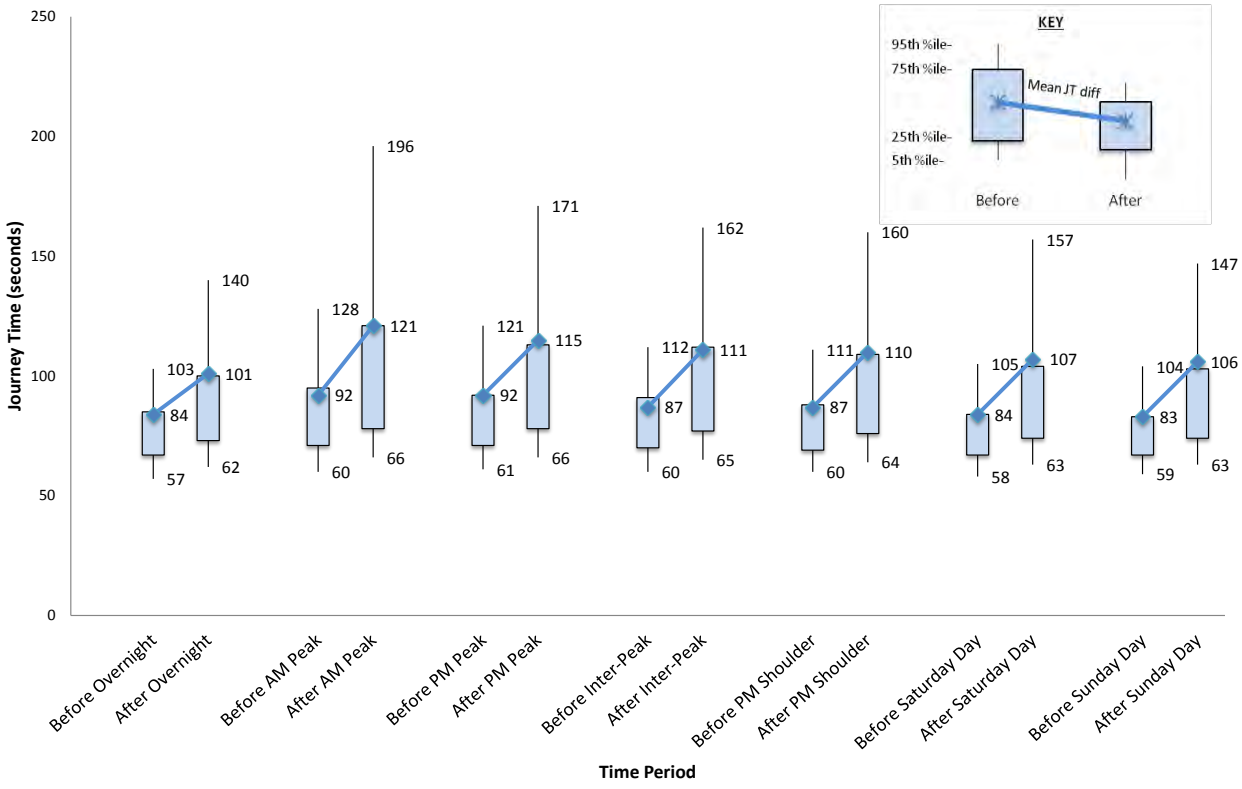
A449 South – M54 East



M54 East – A449 North



M54 West – A449 South



Appendix D. Appraisal Summary Table (AST)

	Sub-Objective	Beneficial	Neutral	Adverse
ENVIRONMENT	Noise		✔	
	Local Air Quality		✔	
	Greenhouse Gases		✔	
	Landscape		✔	
	Townscape		✔	
	Heritage and Historical Resources		✔	
	Biodiversity		✔	
	Water Environment		✔	
	Physical Fitness	✔		
	Journey Ambience	✔		
SAFETY	Accidents	✔		
	Security		✔	
ECONOMY	Public Accounts		✔	
	Transport Economic Efficiency		✔	
	Reliability	✔		
	Wider Economic Impacts		✔	
ACCESSIBILITY	Option values		✔	
	Severance	✔		
	Access to Transport System		✔	
INTEGRATION	Transport Interchange		✔	
	Land Use Policy		✔	
	Other Government Policies	✔		

Appendix E. Evaluation Summary Table (EST)

	Sub-Objective	Beneficial	Neutral	Adverse
ENVIRONMENT	Noise		✔	
	Local Air Quality		✔	
	Greenhouse Gases		✔	
	Landscape			✔
	Townscape		✔	
	Heritage and Historical Resources		✔	
	Biodiversity		✔	
	Water Environment		✔	
	Physical Fitness		✔	
	Journey Ambience		✔	
SAFETY	Accidents	✔		
	Security		✔	
ECONOMY	Public Accounts		✔	
	Transport Economic Efficiency			✔
	Reliability			✔
	Wider Economic Impacts		✔	
ACCESSIBILITY	Option values		✔	
	Severance	✔		
	Access to Transport System		✔	
INTEGRATION	Transport Interchange		✔	
	Land Use Policy		✔	
	Other Government Policies		✔	

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