Post Opening Project Evaluation

M6 Junction 5 – 8 Smart Motorway

One Year After

August 2017

Notice

Foreword

Highways England's motorways are some of the safest in the world. Our road network carries a third of road traffic and we have seen demand grow by a quarter since 2000 with continued growth forecast.

One reason for the introduction is smart motorways is because there are more vehicles on the road. By making use of the full width of the road, smart motorways add that extra capacity to carry more vehicles and ease congestion.

They have evolved from **Controlled Motorways** (with variable speed limits) to **Dynamic Hard Shoulder Running** (opening the hard shoulder as a running lane to traffic at busy periods) to **All Lane Running** (permanently removing the hard shoulder and converting it into a running lane).

Compared to a traditional motorway widening they deliver:

- Increased capacity at significantly less cost than traditional motorway widening.
- New technology and variable speed limits to improve traffic flow.
- Less congestion and more reliable journeys for customers.
- Environmental benefits of not taking an extra corridor of land to use as new road.
- A safety record that's at least as safe, if not safer than conventional motorways.

The M6 J5 to 8 was one of the earlier generations of smart motorways with a conversion to dynamic hard shoulder running. This section was a heavily congested part of the M6 which facilitates strategic transport flows through the major conurbation of Birmingham in the West Midlands linking the M1 and the North of England.

The scheme was designed to make customer journeys **more reliable**; applying speed restrictions to **better manage the flow of traffic** and **improving the capacity**.

This report indicates how the scheme was performing within its first year of operation. Whilst this study is not intended to provide conclusive evidence about scheme benefits, it provides an early indication about whether a scheme is heading in the right direction. This initial assessment forms part of a longer-term evaluation which reviews performance over five years.

The evaluation findings highlighted that at times where the road was busiest, such as in the morning, customer journeys became more reliable through the use of the hard shoulder running. However, improvements were needed our processes for opening the hard shoulder at other times of the day. We now assess whether the road is reaching its peak capacity and open the hard shoulder as required. As traffic levels increase the more effective the smart motorway will be in delivering benefits to road users, building on the improvements seen in the morning peak at the one year after point.

Personal injury collisions on the strategic road network are very rare and can be caused by many factors. Due to their unpredictable nature, we monitor trends over many years before we can be confident that a real change has occurred as result of the scheme. Within the first year, it has not been possible to confidently conclude the safety impacts of the scheme, but the findings indicate that the scheme is as safe the traditional motorway it replaced. We will continue to review this as part of the longer-term evaluation for the scheme.

We're working to continually improve our smart motorways so that they work better for customers. Our Traffic Officers work around the clock to operate our smart motorways, keeping customers safe from the control room and attending incidents the road. We've committed to additional signs and more visible markings for emergency areas and our latest set of standards will ensure that there's a safe place to stop in an emergency every mile on our upcoming schemes. All of this helps to provide one of the most modern and safe road environments in the world.

January 2020

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Executive summary

Scheme description

The M6 Junctions 5 – 8 Smart Motorway scheme is located in Birmingham and forms part of the strategic motorway network, connecting major conurbations in the north of the country, the Midlands, London and the channel ports in the south. The scheme opened to traffic in April 2014 and consists of three main elements to provide additional capacity as follows:

- ***Controlled Motorway*** – between Junctions 7 and 8
- ***All Lane Running*** – through the M6 – M5 link
- ***Dynamic Hard Shoulder Running*** **(DHSR)** – between Junctions 5 and 7

The Post Opening Project Evaluation programme considers early scheme performance, providing the opportunity for Highways England to make improvements, if required, in a timely manner to support the delivery of the future performance of the scheme.

Objectives

Objective (stated in Client Scheme Requirements, 2011)	Has the objective been achieved?
The Scheme shall deliver a managed motorway including hard shoulder running solution.	✓
The Scheme shall, as a priority, improve journey time reliability and shall also improve journey times, on the M6 between J5 and J8.	**Too early to conclude journey time impacts** **Improvements in reliability achieved in the AM peak**
Once open to traffic, the Scheme should aim not to detrimentally affect traffic on the surrounding road network.	✓
The Scheme shall reduce the number and severity of accidents per vehicle-kilometre.	**Too early to conclude**
The Scheme should ensure that queuing of traffic onto the mainline of the motorway due to congestion at junctions is minimised and deliver the minimum required junction improvements to ensure this.	✓
The Scheme should aim to improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway.	✓
The Scheme should aim to improve journey ambience.	**Too early to conclude**
The detrimental environmental effects of the Scheme shall be offset by mitigation measures where technically feasible and economic to do so.	✓

Key findings

- Early findings indicate increased journey times on the M6 post opening in most time periods. Further analysis (detail provided later in this summary) suggests that the operation of the smart motorway may not have been optimal, particularly relating to the length of time that the hard shoulder is open and the use of variable mandatory speed limits.
- The results in the opening year show there has been a journey time benefit across the scheme during the AM peak. However, the OYA results also show that there has been considerable journey time dis-benefit during the interpeak (IP) and PM peak. Forecast journey times show that large journey time improvements in the opening year were forecast, on the back of large forecast increases in traffic flow.
- Forecasts expected a substantial improvement in journey times in the opening year and stable improvements in journey times were expected in later years with the anticipated traffic growth.
- Traffic flows have increased although not to the level forecast. Consequently, congestion levels are lower than expected and therefore the use of Variable Mandatory Speed Limits (a Smart Motorway feature) has led to reduced average speeds and a slight worsening of journey times in the opening year.

Summary of Scheme Impacts

Traffic

Flows

- Changes in traffic flows on the mainline scheme sections are slightly higher than background growth in the region and for motorways nationally during the same period.
- Flows on the adjacent sections of the M6 have (in general) seen lower growth than the scheme sections.
- There has been a negligible change in the proportion of HGVs on the mainline scheme sections following scheme opening.
- Local changes in traffic across an urban area are subject to many sources of interference. However, it is clear that local traffic has not seen the consistent increases in traffic that the mainline scheme section has, suggesting a moderate level of rerouting onto the motorway has occurred since the scheme has opened.
- The forecasts assumed consistent growth in background traffic between pre-and post-scheme, whereas the observed trend shows only a modest growth in traffic in both national and regional traffic data. The forecasts overestimated the traffic that would use the corridor in the opening year.
- As forecast, across all time periods considered, traffic flows have increased by approximately 6%, which is below the forecast increase of approximately 16%. This increase in traffic is likely a result of traffic being attracted to the M6 corridor due to the increased capacity provided by the scheme.
- Forecast levels of traffic growth between the without scheme and with scheme scenarios has not occurred on the majority of scheme sections and junctions. Forecast levels of growth ranged from 0% to 33% and the highest level of growth observed is 19%, again suggesting little reassignment has actually occurred.

Journey Times

- Across the full scheme route, journey times have increased during the peak periods by up to 4 minutes and 43 seconds. This is not due to increased congestion, but due to reduced speed limits which are used to smooth the flow of traffic and improve journey time reliability.

- Where congestion (in terms of high flow) was evident before scheme opening, the DHSR has had a positive impact on average journey times (such as during the AM peak period in both directions), however at times of low congestion, particularly in the IP period, the DHSR has had a negative impact on average journey times when in operation (as the software limits all traffic to a maximum speed of 60mph unnecessarily).
- Large decreases in journey time were expected across all three forecast time periods when heading through the scheme northbound, however it was also shown that these forecast decreases were not split evenly across the scheme links.
- Southbound through the scheme, journey times were forecast to increase slightly in all three time periods. In comparison with the forecast decreases in journey times northbound, the slight increase heading southbound was negligible.
- Journey time forecasts do not match observed journey time data, which show a smaller decrease in AM peak journey time than forecasts and increases in journey times throughout the IP and PM peak periods.
- The forecast journey time saving was derived from modelling which was based on predictions of much higher volumes of traffic than those observed. However, less traffic is observed in both the before and after periods, so limited conclusions can be confidently inferred in relation to observed journey times compared to forecast savings.

Smart Motorway Operation

- The DHSR is in operation for a high proportion of the AM and PM peak on all sections. During the AM peak VMSL are set at 60mph for more than 90% of the time and VMSL below 60mph are negligible. Generally, when VMSL are in use the hard shoulder is open to traffic.
- Northbound through the scheme there is reasonable use of VMSL throughout the day, with VMSL in use between 40% and 80% of the time during the IP period. Between 11:00 and 14:00, VMSL are set at 50mph or less for around 10% of the time. The hard shoulder is not open as frequently as the VMSL are operational suggesting that VMSL are being set without providing additional capacity in the form of the hard shoulder. From 14:00 onwards, VMSL are in operation 100% of the time, with the hard shoulder open slightly less.
- Southbound, VMSL are in operation for 20 – 40 % of the time between 11:00 and 15:00, during this time they are almost always set at 60mph. From 16:00 – 19:00, VMSL are in operation for around 80% of the time, which is slightly less than the AM peak. During these hours, VMSL are set at 40mph for approximately 10% of the time, which is similar to the AM peak.
- The hard shoulder is well utilised across the scheme in both directions during the AM and PM peak periods.
- Speeds across the route northbound and southbound are relatively consistent, with the highest speeds northbound observed between M6 J6-7 and southbound between M6 J5-6.
- Speeds during the PM peak are notably lower heading southbound than northbound and are at their lowest when exiting the scheme at the southern end.
- It can also be noted that the shortest journey times have lengthened slightly in all time periods and in both directions. This may be indicative of drivers adhering more closely to the speed limits due to the visibility and frequency of the cameras.

Reliability

- Reliability has improved for vehicles travelling through the scheme during the week in the AM peak.
- Reliability for those travelling through the scheme during the IP has remained the same.
- During the PM peak, reliability has worsened for those travelling through the scheme and extreme journey times have increased in both directions.

Safety

- Post opening, no fatal collisions have been recorded, and the number of serious collisions have also reduced. This results in the proportion of fatal and serious collisions reducing from 9% observed in the pre-scheme period to 5% observed in the post-scheme period. However, the average number of collisions (of all severities) has increased by 9.8 per annum with the counterfactual applied.
- Significance testing found the increase in collisions is not significant at the 95% confidence level and could have occurred by chance alone hence the increase is not a direct result of the scheme implementation.
- The M6 J5-8 scheme section had a forecast collision rate saving of 15%. With the background changes in collisions accounted for, there has been around a 15% increase in collisions on the M6 J5-8 since the scheme opened. These results indicate that the scheme has saved less collisions than expected.

Environment

- In summary, the impact of the scheme upon most of the environmental sub-objectives are as expected at OYA.
- Based on traffic flows which are lower than expected there is potential for noise and local air quality to be better than expected although further information would be required to confirm this.
- Greenhouse gas emissions have reduced by 1% with the scheme, compared to the forecast 20% increase expected.
- Due to some open views to properties at OYA a score of slight adverse is considered to be more appropriate for the impact of the scheme upon landscape and townscape than the AST neutral.
- The scheme was not expected to result in any significant adverse impacts on any designated sites of nature conservation importance or on protected species. Whilst the wildlife corridor running the length of the route appears on visual inspection at OYA to have recovered from the construction works, further information would be required to fully evaluate the impact of the scheme on biodiversity effects.
- It was predicted that there would be no impacts on archaeology as all works would be within the highway boundary, therefore it is considered that as expected, any localised impacts on the setting of built heritage and historic landscape have not been significant.
- Based on the information available to POPE it would appear that scheme drainage has been implemented in line with proposals and it is likely that effects on the water environment are neutral as expected
- As expected, there has been no direct impact on pedestrians and cyclists as a result of the scheme and impacts are considered to be neutral.
- The forecast large beneficial effects of the scheme on journey quality for users may not have been fully realised at this OYA stage; congestion remains an issue at certain times and despite the introduction of increased capacity (in general) journey times have increased across the scheme.

Social Impacts Evaluation

- The impact of the scheme upon all social impacts (including; physical activity, journey quality, affordability, access to services, severance and option values) at OYA is as expected.

Summary of Economic Performance

All monetary values in £m 2002 market prices, discounted		Forecast	Outturn
Present Value Benefits	Journey Times	360.1	-310.9
	Vehicle Operating Costs (VOC)	0.9	0.1
	User Charges	61.6	61.6
	Construction Delay*	-62.9	-62.9
	Maintenance Delay*	29.9	29.9

	Safety	38.4	n/a
	Indirect Tax	-25.6	-2.9
	Noise*	-11.2	-11.2
	Carbon	2.5	0.1
	Operating Costs (private toll revenue)*	-36.7	-36.7
	Total PVB	357.0	-332.9
Present Value Costs including operating costs (PVC)		104.7	103.5
Benefit Cost Ratio (BCR)		6.4	n/a

** Assumed to be as forecast*

Summary of Scheme Economic Performance

- The scheme was forecast to generate safety benefits totalling £38.4 million over 60 years, the safety evaluation determined that the OYA results show no statistical significance and therefore the outturn economic result is not monetised.
- Forecast journey time benefits formed a considerable proportion of the overall benefits at £360.1 million. The outturn monetised impact of the scheme on journey times is -£310.9 million, a large proportion of the overall dis-benefits.
- VOC impacts of the scheme were forecast to benefit users by £0.9 million over the scheme life. The reforecast impact on VOC is a negligible benefit to users of £0.1 million.
- The forecast impact of the scheme on indirect tax (as a cost) was -£25.6 million, however, based on the impact of the scheme on vehicle operating costs, the outturn impact of the scheme upon indirect tax is -£2.9 million.
- The investment cost of building the scheme was £85.2 million in 2002 prices, which was 17% less than forecast.
- At the OYA evaluation stage there has been a net disbenefit and a BCR calculation is no longer meaningful. Therefore a BCR is not reported at this early stage.

1. Introduction

Background

1.1. This report represents the One Year After (OYA) Post Opening Project Evaluation (POPE) study of the M6 Junction 5 – 8 Smart Motorway (SM) scheme, also referred to as the Birmingham Box Motorway Phase 3 Managed Motorway (BBMM3), which opened in April 2014. Highways England now refer to Managed Motorways as "Smart Motorways" and this report therefore refers to the scheme as M6 Junction 5 – 8 Smart Motorway. The evaluation has been prepared as part of the Highways England Post Opening Project Evaluation (POPE) programme.

Scheme Context

1.2. The M6 is a national artery providing a direct motorway link between the major conurbations in the north of the country, the Midlands, London and the channel ports in the south. The route is also a major inter urban strategic route connecting Coventry, Birmingham and Manchester. The M6 also provides access to an international hub – Birmingham International Airport – and the National Exhibition Centre (located adjacent to the airport).

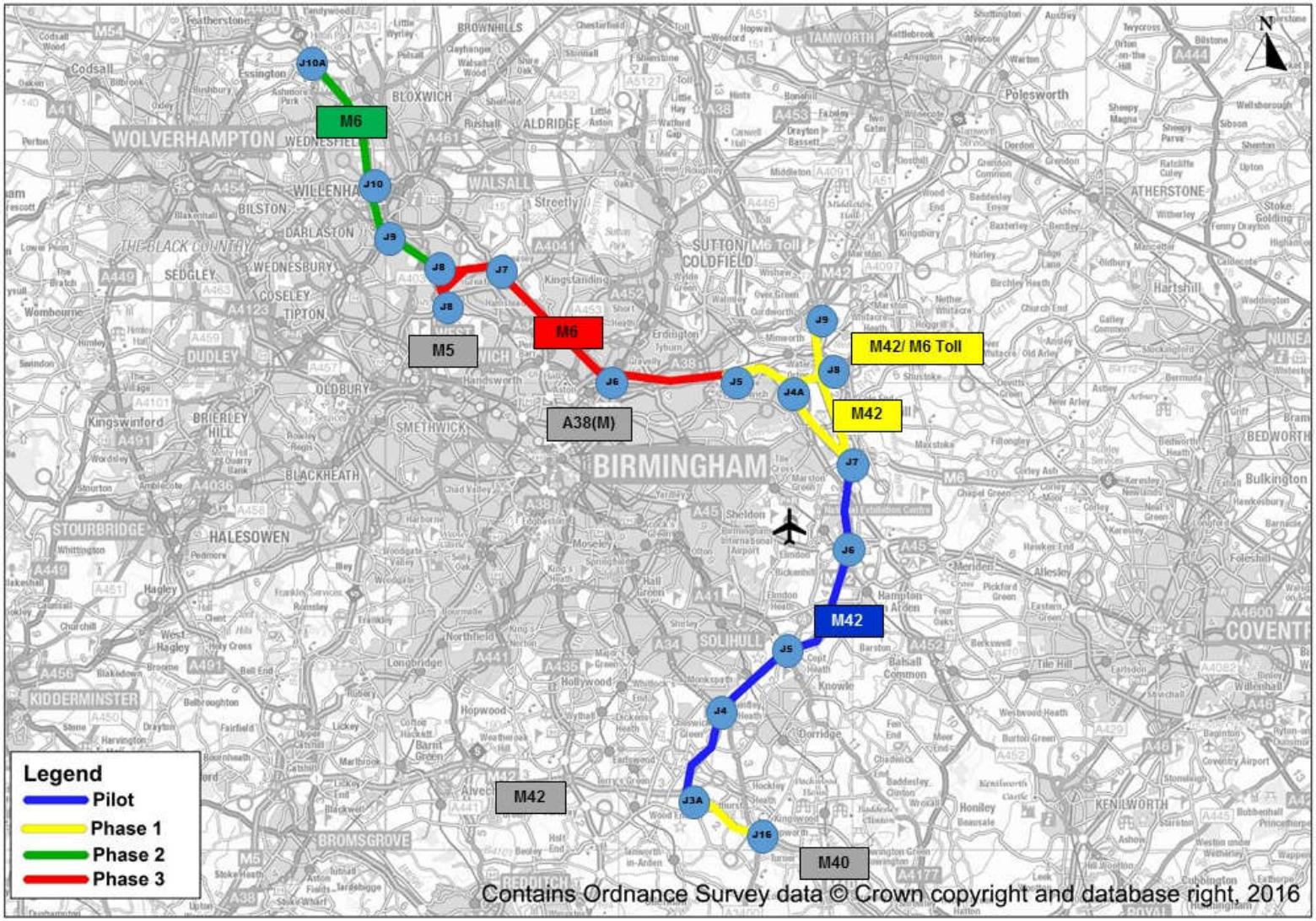
1.3. The West Midlands Multi-Modal Study (2001) recommended that additional capacity should be provided on the M6 Junction 4 to 10a and M5 / M6 links to Junction 4a. The Advanced Motorway Signalling and Traffic Management Feasibility Study (March, 2008) concluded that Dynamic Hard Shoulder with Active Traffic Management (ATM) could provide a large proportion of the benefits of widening at a significantly lower cost. The specific sections identified as a potential priority for the dynamic use of the hard shoulder were in three phases from the M6 Junction 4 to Junction 10a.

1.4. Table 1-1 provides details of each phase of the Birmingham Box Scheme. SM Phases 1 and 2 were already in operation at the time of Phase 3 scheme development and the M6 Junction 5 to 8 (Phase 3) is therefore seen as the 'missing link' between M6 Junction 4 – 10a. Figure 1-1 presents the location of each of the phases.

Table 1-1 Description of Smart Motorway phases

Phase	Opening Date	Description	Evaluation Complete
1 (BB1)	November 2009	M40 Junction 16 to M42 Junction 3a, M42 Junction 7 to 9 and M6 Junction 4 to 5.	Yes
2 (BB2)	March 2011	M6 Junction 8 to 10a	Yes
3 (BB3)	April 2014	M6 Junction 5 to 8	Yes

Figure 1-1 Phasing of Smart Motorway (Birmingham Box)



Reasons for Scheme

1.5. The Client Scheme Requirements (October, 2011) note that "*from Junction 5 to 8, the M6 is a heavily congested link in the motorway network that facilitates strategic transport flows through the major conurbation of Birmingham in the West Midlands linking the M1 and the North of England*". The following more detailed transport-related issues were also identified in the Client Scheme Requirements:

- AM and PM peak journey times between M6 Junction 5 and 8 are 65% higher in the northbound direction and 55% higher in the southbound direction than journey times during free flow conditions.
- A large proportion of traffic using the M6 Junction 5 to 8 is local traffic and the capacity of the A38 (M) contributes to congestion on the M6. As a strategic route into Birmingham, approximately 50% of traffic leaves the M6 at Junction 6 and joins the A38 (M) into Birmingham. The capacity restrictions on the A38 (M) mean that once flow breakdown occurs, traffic quickly queues back on to M6 Junction 6 approaches.
- Congestion occurs on the M6 northbound due to flow breakdown caused by peak queuing on the M6 junction 6 approach (as a result of the A38 and Salford Circus performance) and flow breakdown on the M6 Junction 8 (M5 / M6 merge). The Client Scheme Requirements report that BBMM Phase 2 (M6 Junction 8 – 10a) has reduced congestion and improved traffic flows at Junction 8. The completion of the "Smart Motorway" gap between Phase 1 and 2 is expected to reduce congestion on the M6 from Junction 4 to 10a.
- Journey time reliability measures show that all links consistently record delay in excess of the national baseline.
- The average collision rate for 2007 – 2009 is over 30% higher than the national motorway average.

1.6. Further challenges relating to the construction of the motorway was also identified as an issue. A number of sections on the M6 Junction 5 to 8 are elevated and subsequently alternative improvement solutions are required.

Scheme Description

1.7. The scheme includes the M6 motorway between Junctions 5 and Junction 8 (including on-slips and off-slips). The Client Scheme Requirements report that the route section is approximately 9.7 miles (15.6km), with 5.3 miles (8.5km) of the route elevated including:

- M6 Junction 5 to 6 Bromford and Gravelly Hill Viaduct (including Junction 6-Spaghetti junction)
- M6 Junction 6 to 7 Witton Viaduct
- M6 Junction 7 Thornbridge Viaduct
- M6 Junction 7 Questlett Viaduct
- M6 Junction 8 Ray Hall Viaduct

1.8. **M6 Junction 5 to 8:** Dynamic Hard Shoulder Running (DHSR) with through junction running (TJR) at Junction 5 only in both directions. Only one Emergency Refuge Area (ERA) is provided in both directions over Bromford Crossing (an elevated section) between Junction 5 and 6.

1.9. The Appraisal Summary Table (AST) (November, 2011) states that the scheme will include 20 super-span gantries, 6 ERAs, two of which make use of the existing hardstanding on the M6 Bromford Viaduct

1.10. **M6 Junction 7 – 8 Eastbound:** Four lane Controlled All Lane Running (CALR) with no hard shoulder present.

1.11. **M6 Junction 7 – 8 Westbound:** Three lanes with Variable Mandatory Speed Limits (controlled motorway) and diverge lane for Junction 7.

1.12. The scheme consists of Dynamic Hard Shoulder Running (DHSR) and Controlled Motorway sections and the location of these sections is shown in Figure 1-2. The sections below provide a brief description of these smart motorway features as taken from the Smart Motorways Driver Information guide produced by Highways England[1].

1.13. The scheme also includes Close Circuit Television (CCTV) and Motorway Incident Detection and Automatic Signalling outstation (MIDAS). The scheme is entirely within the motorway boundary.

Smart motorway elements

Dynamic Hard Shoulder Running (DHSR)

A DHSR section uses the hard shoulder as a temporary extra lane to provide more capacity when needed. On these sections the hard shoulder is only open to traffic at busy times to relieve congestion.

Controlled Motorway (CM)

CMs have three or more lanes with variable speed limits indicated through the use of overhead gantry signing. The hard shoulder is not used as a running lane, and is only used in a genuine emergency.

All Lane Running (ALR)

ALR refers to a section of motorway where the hard shoulder is permanently converted into a running lane.

Variable Mandatory Speed Limit (VMSL)

SM sections of mainline carriageway utilise VMSL as Active Traffic Management in order to control speed in times of congestion. When the use of DHSR is required, VMSLs are obligatory – with the maximum speed limit of 60mph imposed.

[1] *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/373070/S140389_Smart_motorways_ezine.pdf, [accessed 04 August 2016]*

Figure 1-2 Scheme layout

Nearby Schemes

1.14. There are several Highways England network improvements which are noted to have been implemented near to the scheme, a full list of which are provided in Appendix A. A focused list of Highways England network improvements immediately relevant to this POPE study are summarised in Table 1-2**.** It is important to understand the impact that these schemes may have had on the data collection for this evaluation. The locations of these schemes are shown in Figure 1-3**.**

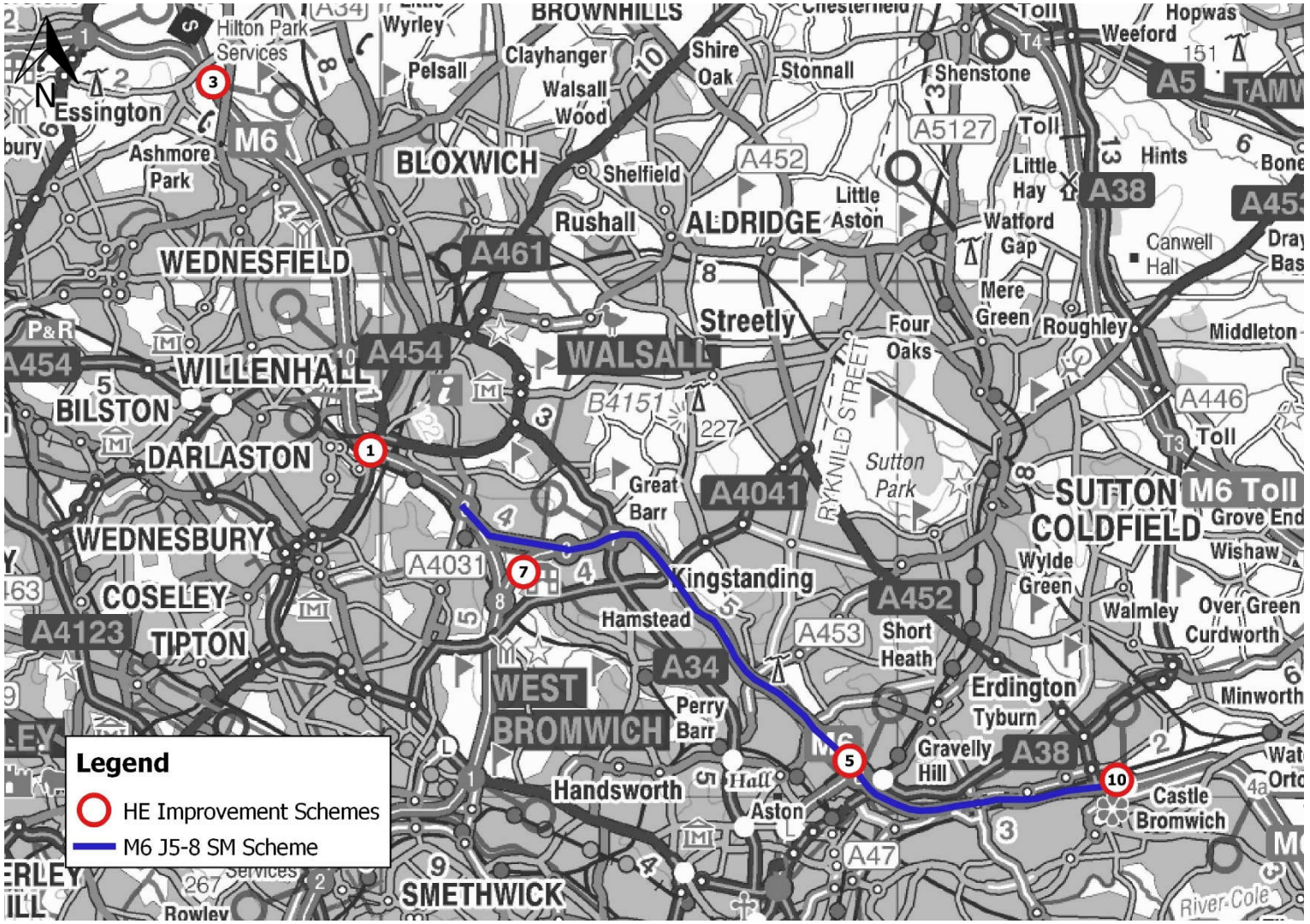
1.15. The construction and opening of these schemes will have an impact on the operation of M6 J5-J8. The traffic management in place during the construction of the neighbouring schemes will reduce the impact of M6 J5-J8, whereas increased capacity up and downstream of the scheme may increase traffic flows and scheme utilisation. The impact of these schemes will be considered in additional detail in **Chapter 2** of this report.

1.16. This evaluation was initially postponed due to concerns over the number of traffic count sites not operational in May 2016. In early 2017 some sites were fixed, however a review of data available for March 2017 showed that a higher proportion of sites appeared to be faulty, with a particular issue for the hard shoulder in the northbound direction. March 2017 also had some temporary overnight roadworks on the scheme section itself. For these reasons, on balance, May 2016 has been used throughout this evaluation although the below should be borne in mind for possible impact. A check on journey times in May 2017 compared to May 2016 indicates that speeds post opening are still lower than pre scheme.

Table 1-2 Nearby schemes

	Scheme	Description/Impact on Traffic	Start of Construction	Scheme Opening
1	BBMM2 (M6 Junction 8 to 10a)	Managed Motorway implemented between junction 8 to 10a.	April 2009	March 2011
3	M6 Junction 10a to 13 Smart Motorway Scheme	Smart Motorway implemented between junction 10a to 13.	October 2013	February 2016
5	Improvement scheme at M6 Junction 6 (Salford Circus Roundabout)	Widening of roundabout at Junction 6 and new traffic signals installed.	June 2014	July 2016
7	M6 J8 to M5 Link Southbound re-surfacing (waterproofing)	The bridges on the link road between the southbound M6 to the M5 require re-surfacing. Traffic management was in place throughout the construction period, with single lane running. There were some overnight closures in January 2016 to complete the works.	January 2015	December 2015
10	M6 Bromford and Witton Viaduct Concrete Repairs (near Junction 5)	Structural maintenance work was carried out at these two locations, as well as concrete repairs to the structure over the Junction 5 southbound on-slip. This is to improve the safety of the structures. Junction 5 southbound on-slip had a full closure from January 2016. Diversion routes were in place and signposted.	October 2014	June 2016

Figure 1-3 Nearby scheme locations



Scheme objectives

1.17. The scheme objectives to be evaluated in this report are provided below and are summarised from the Client Scheme Requirements:

1) The scheme shall deliver a managed motorway including hard shoulder running solution;

2) The scheme shall, as a priority, improve journey time reliability and shall also improve journey times, on the M6 between J5 and J8;

3) Once open to traffic, the scheme should aim not to detrimentally affect traffic on the surrounding road network;

4) The scheme shall reduce the number and severity of accidents per vehicle-kilometre;

5) The scheme should ensure that queuing of traffic onto the mainline of the motorway due to congestion at junctions is minimised and deliver the minimum required junction improvements to ensure this;

6) The scheme should aim to improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway;

7) The scheme should aim to improve journey ambiance; and

8) The detrimental environmental effects of the scheme shall be offset by mitigation measures where technically feasible and economic to do so.

A full list of all objectives in the Client Scheme Requirements are provided in Appendix B. Only those objectives from the Client Scheme Requirements considered relevant to POPE are provided above.

History of the scheme

1.18. A brief history of events involved in the development of the scheme are shown in Table 1-3.

Table 1-3 History of scheme

Date	Event
June 2008	Highways England undertook a study to determine whether the implementation of Managed Motorways was an alternative to widening for increasing capacity. The M6 Junction 5 to 8 scheme was included in this study of 25 schemes.
January 2009	The Secretary of State announced that hard shoulder running was to be extended to some of the busiest parts of the major road network under Highways England control and initiated the Managed Motorways Programme.
2011	The Secretary of State confirmed the M6 J5-8 scheme would commence construction in financial year 2012/13.
2012	9-week consultation period which closed on 4th June.
January 2012	Start of construction.
April 2014	Scheme opened to traffic.

Post Opening Project Evaluation (POPE)

1.19. Highways England is responsible for improving the strategic highway network (motorways and trunk roads) by delivering the Major Schemes Programme. At each key decision stage through the planning process, schemes are subject to a rigorous appraisal process to provide a justification for the project's continued development. When submitting a proposal for a major transport scheme, the Department for Transport (DfT) specifies that an Appraisal Summary Table (AST) is produced

which records the degree to which the DfT's objectives[2] for transport have been achieved. The contents of the AST allow judgements to be made about the overall value for money of the scheme. The AST for this scheme is presented in Table 8-1.

1.20. POPE studies are carried out for all major schemes to evaluate the strengths and weaknesses in the techniques used for appraising schemes. This is so that improvements can be made in the future. For POPE, this is achieved by comparing information collected before and after the opening of the scheme to traffic, against forecasts made during the planning process. The outturn impacts of a scheme are presented in an Evaluation Summary Table (EST) which summarises the extent to which the objectives of a scheme have been achieved. The EST for this scheme can be found in Table 8-2. POPE of Major Schemes goes beyond monitoring progress against targets set beforehand. Instead, it provides the opportunity to study which aspects of the intervention and appraisal tools used to evaluate it are performing better or worse than expected, and how they can be made more effective. More specifically the objectives of POPE evaluation reports are as follows:

- Provide a quantitative and qualitative analysis of scheme impacts consistent with national transport appraisal guidance (WebTAG) and scheme specific objectives.
- Identification and description of discrepancies between forecast and outturn impacts.
- Explanations of reasons for differences between forecast and outturn impacts.
- Identification of key issues relating to appraisal methods that will assist the Highways England in ongoing improvement of appraisal approaches and tools used for major schemes.

Report Structure

1.21. The remainder of this report is structured as follows:

- Section 2 – Traffic Impact Evaluation. This section looks what impacts the scheme had on traffic volumes on the scheme area and surrounding roads. It also covers journey times on the scheme section.
- Section 3 – Safety Evaluation. This section compares the pre-and post-opening collision numbers and looks at collision rates.
- Section 4 – Economy Evaluation. This section compares the monetary value of any changes in journey times and collisions and compares these benefits with the cost.
- Section 5 – Environment Evaluation. This section looks at the environmental impacts of the scheme and the success of any mitigation.
- Section 6 – Social Impacts Evaluation. This section contains a review of the scheme impacts on; physical activity, journey quality, affordability, access to services, severance and option values.
- Section 7 – Conclusions. This section summarises the main findings of this study against the key objectives.
- Section 8 – Appraisal Summary Table (AST) and Evaluation Summary Table (EST). This section contains an overview of the actual scheme impacts compared to those predicted in the original AST.

1.22. There are also several appendices listed below as follows:

- Appendix A – Highways England network improvement schemes local to M6 J5-8
- Appendix B – Client Scheme Requirements (CSR) Objectives (Full)

[2] *As of August 2011, this approach has been revised. However, POPE is concerned with evaluation against the appraisal and as such use objectives valid at the time of appraisal.*

- Appendix C – DM and DS Highway Network Scenarios
- Appendix D – Full PRISM 2016 Do-Minimum and Do-Something Modelled Link Speeds
- Appendix E – Interpeak MIDAS Analysis
- Appendix F – Environment Information Requested
- Appendix G – Landscape Character Areas
- Appendix H – Glossary
- Appendix I – List of Tables and Figures

2. Traffic Evaluation

Introduction

2.1. This section examines traffic data from a number of sources to provide a before and OYA opening comparison of traffic flows and journey times on the scheme and other roads in the vicinity. The purpose of this evaluation is to understand whether changes in traffic flows and journey times may be attributable to the scheme.

2.2. The traffic evaluation section is in the following structure:

- A summary of the traffic data sources used.
- A description of national, regional and local background changes in traffic to provide a context against which observed changes in actual traffic can be considered.
- A detailed comparison of before and OYA traffic flows on key routes in the study area likely to be affected by the scheme.
- An evaluation of key differences between the forecasts and outturn impacts of the scheme in terms of traffic flows and journey times to identify whether traffic flow changes are as expected. Any significant differences between observed and forecast impacts are considered to identify whether alternative approach in scheme appraisal would have led to more accurate forecasts.

Traffic Data Sources

Traffic Count Data

2.3. For the purpose of this evaluation study, the main sources of traffic count data include the following:

- Permanent count data obtained from the TRADS/Webtris[3] database for count locations on the Highways England network.
- Permanent and temporary count data provided on the West Midlands database[4] for pre- and post-scheme periods.

2.4. The details of the traffic count data sites used in this evaluation and their source are shown in Table 2-1:

[3] *TRADS/Webtris is Highways England website containing traffic flow data from automatic traffic counts on Highways England's strategic network.*

[4] *SPECTRUM is a database of traffic count data collected within the West Midlands and maintained by Mott MacDonald at the time of this report.*

Table 2-1 Traffic count sites

Source	Site Reference	Description
Highways England Count Data	1	M6 J4A – 5
	2	M6 J5 – 6
	3	M6 J6 – 7
	4	M6 J7 – 8
	5	M6 J8 – 9
SPECTRUM	6	A34 Birmingham Road (south of Skip Lane)
	7	A34 Birmingham Road (north of Sundial Lane)
	8	A34 Walsall Road
	9	A38 Aston Expressway
	10	A452 Chester Road
	11	A5127 Sutton New Road
	12	A38 Tyburn Road
	13	B4114 Chester Road

Journey Time Data

2.5. Satellite navigation[5] data for the M6 J5 – M6 J8 has been used to determine if there has been a change in average journey times and speeds and whether the distribution of journey times has changed since the scheme opened. Journey times for May 2011 (before opening) have been compared to May 2016 (two years after opening).

HALOGEN Data

2.6. HALOGEN data is available from Highways England and can be downloaded from the message screens displayed on overhead gantries forming part of a SM scheme. The data can be used to determine when, and for how long, the hard shoulder was open for traffic and the different speed limits in place as part of the variable speed limit (queue protection) used in SM.

Motorway Incident Detection Automated Signalling (MIDAS) Data

2.7. MIDAS technology forms part of the operation of SM. Data is available from Highways England and provides lane by lane traffic flows and speeds. This data along with the settings from the overhead gantries, obtained from HALOGEN data (e.g. whether the hard shoulder is open and the Variable Mandatory Speed Limit in operation) can provide additional insight into the operation of the Smart Motorway. As MIDAS and HALOGEN data form part of the technology of SMs, it is not possible to undertake pre-and post-scheme analysis using this data, but it does help inform the evaluation of the performance of the scheme.

Background Changes in Traffic

2.8. Historically in POPE scheme evaluations, the 'before' counts have often been factored to take account of background traffic growth so they are directly comparable with the 'after' counts. However, considering the recent economic climate, which has seen widespread reductions in motor vehicle travel in the United Kingdom (UK) since 2008, it is no longer deemed appropriate to use this method of factoring the 'before' counts to reflect background changes in traffic. Instead, recent POPE studies have taken a more considered approach in order to assess changes near the scheme, within the context of national, regional and locally observed background changes in traffic.

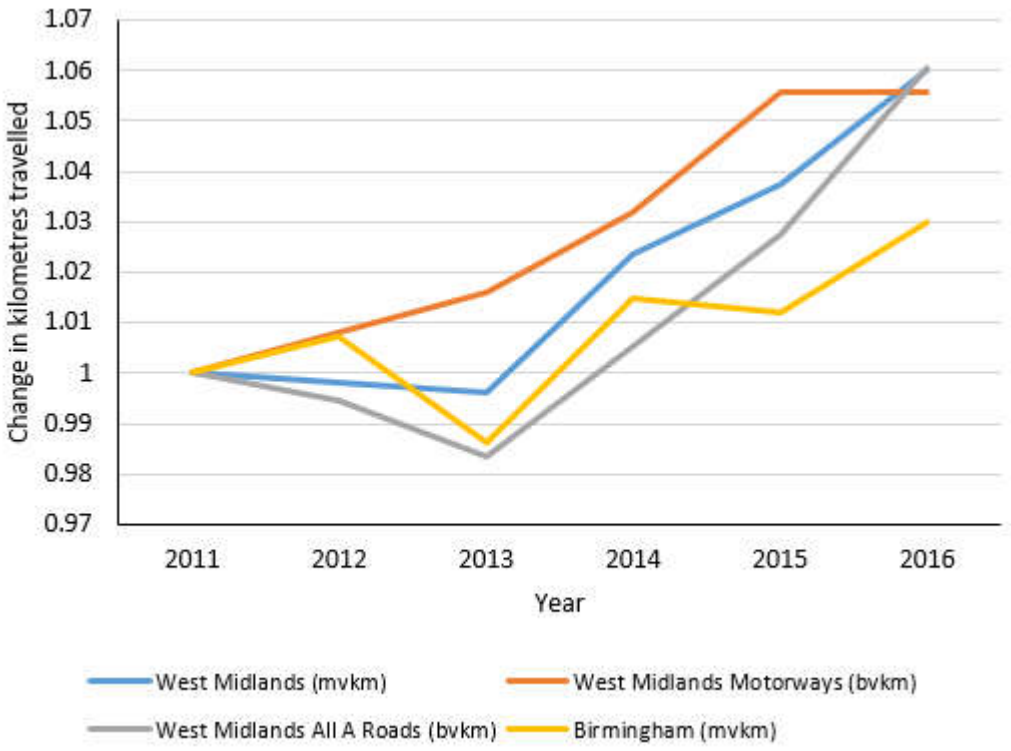
[5] Motorists who use satellite navigation devices have the option to voluntarily allow anonymous data about their journeys to be collected and use to provide a range of services, including the analysis of historic journey times along specific routes.

National, Regional and Local Trends

2.9. The DfT produces observed annual statistics for all motor vehicles by local authority and road type. The change in vehicle kilometres travelled between 2011 (before the start of construction) and 2016 (the latest available) is shown in Figure 2-1 for:

- Motorways in the West Midlands (regional trends);
- All roads and 'A' roads in the West Midlands (regional trends); and
- All roads in West Midlands and all roads in Birmingham (local trends).

Figure 2-1 Regional and local trends (kilometres travelled)



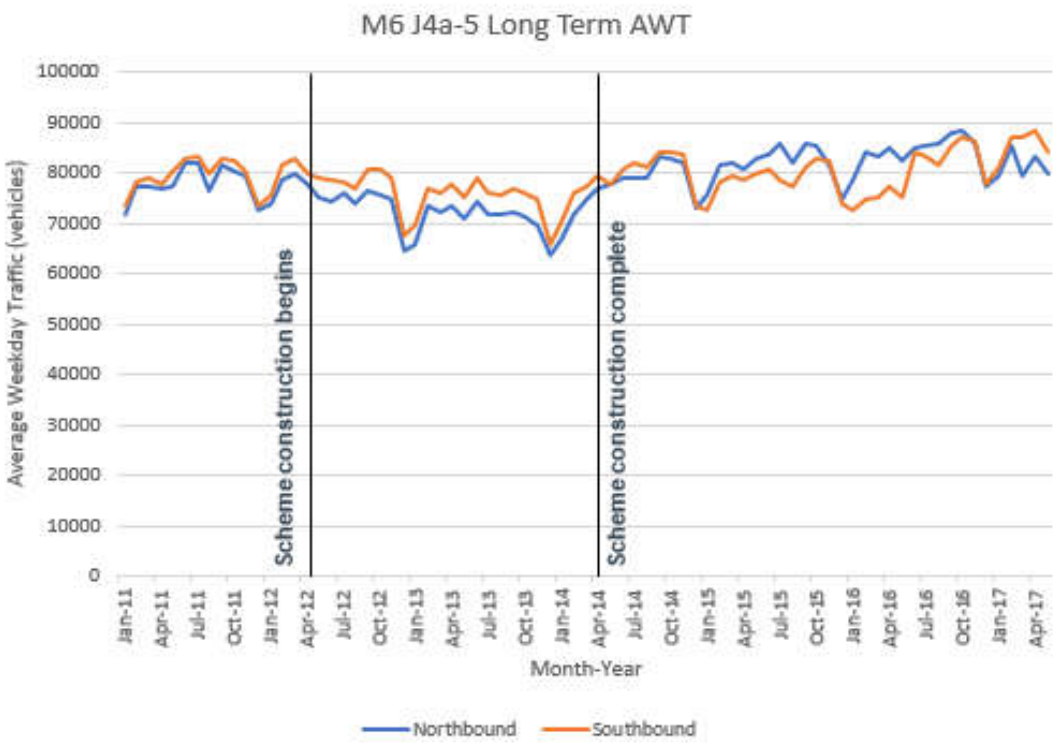
2.10. The results in Figure 2-1 show:

- Between 2011 and 2016, vehicle kilometres travelled on motorways in the West Midlands increased by approximately 6%. During the same period, the number of vehicle kilometres travelled on all roads in the West Midlands also increased by approximately 6%.
- On A roads in the West Midlands and all roads in Birmingham, vehicle kilometres travelled reduced between 2011 and 2013 by just over 1% before increasing by approximately 2% between 2013 and 2014. Following 2014, vehicle kilometres travelled in Birmingham increased by a further 2% to show growth of 3% between 2011 and 2016, whilst vehicle kilometres travelled on A roads in the West Midlands increased by around 5% to show 6% growth between 2011 and 2016.

Long Term Traffic Trends

2.11. To establish the degree of change that can be attributed to the scheme, changes in yearly traffic flows on the mainline sections since the scheme opened are considered against the wider context of background changes shown in Figure 2-1. Due to limited data availability across the scheme between mid-2012 and 2014 (through the construction period), it has only been possible to present monthly average weekday traffic (AWT) for the M6 J4a-5 from January 2011 to May 2017. The monthly AWT for the M6 J4a-5 is presented in Figure 2-2:

Figure 2-2 Monthly AWT M6 J4a-5



2.12. The results show that changes in traffic levels between before and after periods are largely in line with the trends shown in Figure 2-1 with an increase post scheme opening. The changes in flows across the mainline scheme sections are compared against the 5% increase in flows observed across motorways in the West Midlands. Figure 2-2 shows a slight dip in AWT flows throughout 2013 during the construction period, however this is followed by an increase between 2014 and 2017 which is consistent with background traffic trends. Figure 2-2 also shows that AWT flows on the M6 northbound and southbound are largely similar.

Conclusions on Background Growth

2.13. The analysis of background traffic changes show local and regional trends on all roads between 2011 and 2016 have increased by between around 3% to 6%. Growth in traffic flows across the POPE study area are relatively in line with the regional and local background changes on all roads and motorways. Given the observed background growth, no traffic flows presented in this report have been adjusted to reflect background traffic levels and it is therefore important to keep in mind any increase in flows of up to 6% may be due to the background increases rather than changes brought about by the scheme itself.

Traffic Volume Analysis

Data Sources

2.14. This section of the report uses a number of the data sources mentioned earlier in this section to inform the before and after analysis of changes in traffic volumes and journey times on key routes to understand whether changes may be attributable to the scheme. To complete this evaluation, data from before construction (May 2011) has been compared to one year after scheme opening (May 2016). The scheme construction period ranged from April 2012 to April 2014. May was chosen as a convenient month to compare pre-scheme (2011) and OYA (2016) traffic flows as it allows for a direct comparison between a full year prior to scheme construction and the most recent full year of data since construction ended.

2.15. Due to the large number of surrounding schemes and issues with data availability, both the pre- and post-dates chosen for traffic analysis in this study interact with surrounding schemes that may also have an impact on traffic. It is therefore important to take the potential impact upon traffic on

the M6 Junction 5-8 into account during analysis, the surrounding schemes are summarised in Table 1-2.

2.16. May 2011 does not coincide with any adjacent schemes undergoing construction. However, it is just one month post scheme opening of BBMM2 M6 Junction 8-10a, this could influence observed traffic volumes by making them appear artificially lower than expected as traffic is slow to return to this part of the network.

2.17. May 2015 lies within the construction period for four separate surrounding schemes; the M6 J8 to M5 Link Southbound resurfacing, the M6/A38 (M) Gravely Hill Interchange Waterproofing Scheme and Replacement of Lighting Columns and the M6 Bromford and Witton Viaduct Concrete Repairs.

2.18. The cumulative impact of the schemes is; a potential for traffic volumes to be lower than expected as traffic prioritises other routes. Overnight closures between the M6 J8 to M5 Link Southbound may lead to low overnight volumes across the scheme and a generalised scheme wide worsened performance during peak periods or in times of stress on the network.

Observed Flows

2.19. A comparison of pre-and post-scheme AWT flows along the scheme section are shown in Figure 2-3 and the change in AWT flows across the wider area later in this chapter in Figure 2-5.

Motorway Network

2.20. The results in Figure 2-3 show:

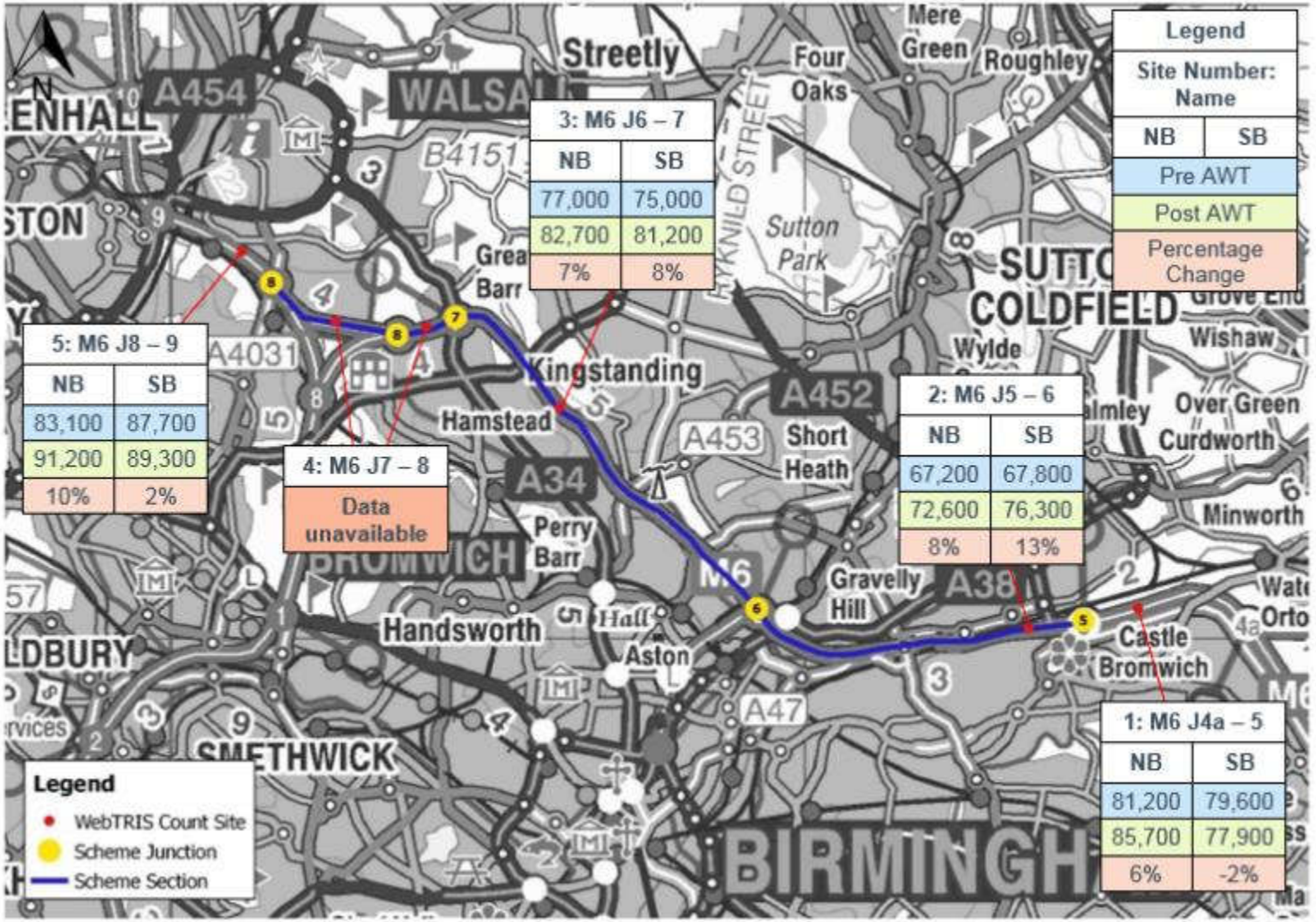
- Traffic flows across the scheme have increased by between 7% and 13% (approximately 5,700 – 8,500 vehicles). Levels of growth are similar across the scheme in both directions and are slightly higher than background traffic growth for motorways in the West Midlands, shown earlier to be approximately 5%.

- In general, the M6 mainline sections adjacent to Junctions 5 to 8 (J4a-5 and J8-9) have experienced lesser growth in traffic than the scheme sections. The M6 J8-9 has seen growth in traffic above regional background levels in the northbound direction at 10%, however it has witnessed just 2% growth in the southbound direction. The M6 J4a-5 has seen growth of 6% in the northbound direction and has decreased in traffic by 2% in the southbound direction. The decrease in southbound traffic on the M6 J4a-5 may be due to the M6 Bromford and Witton Viaduct Concrete Repairs (near Junction 5); the works included concrete repairs to the structure over the Junction 5 southbound on-slip, which required a full slip-road closure (which may have overlapped with our traffic count period).

- In summary, the scheme sections have observed increases in traffic volumes above background regional traffic growth. The increase in traffic is likely the result of traffic being attracted to the M6 corridor because of the increased capacity from the scheme. The same cannot be said for the M6 mainline sections adjacent to the scheme, which have (in general) seen lesser growth.

- Due to poor pre-scheme data availability, it has not been possible to present traffic flows between M6 J7-8.

Figure 2-3 Comparison of before and after scheme opening AWT flows on the scheme section and immediate surrounding motorway network

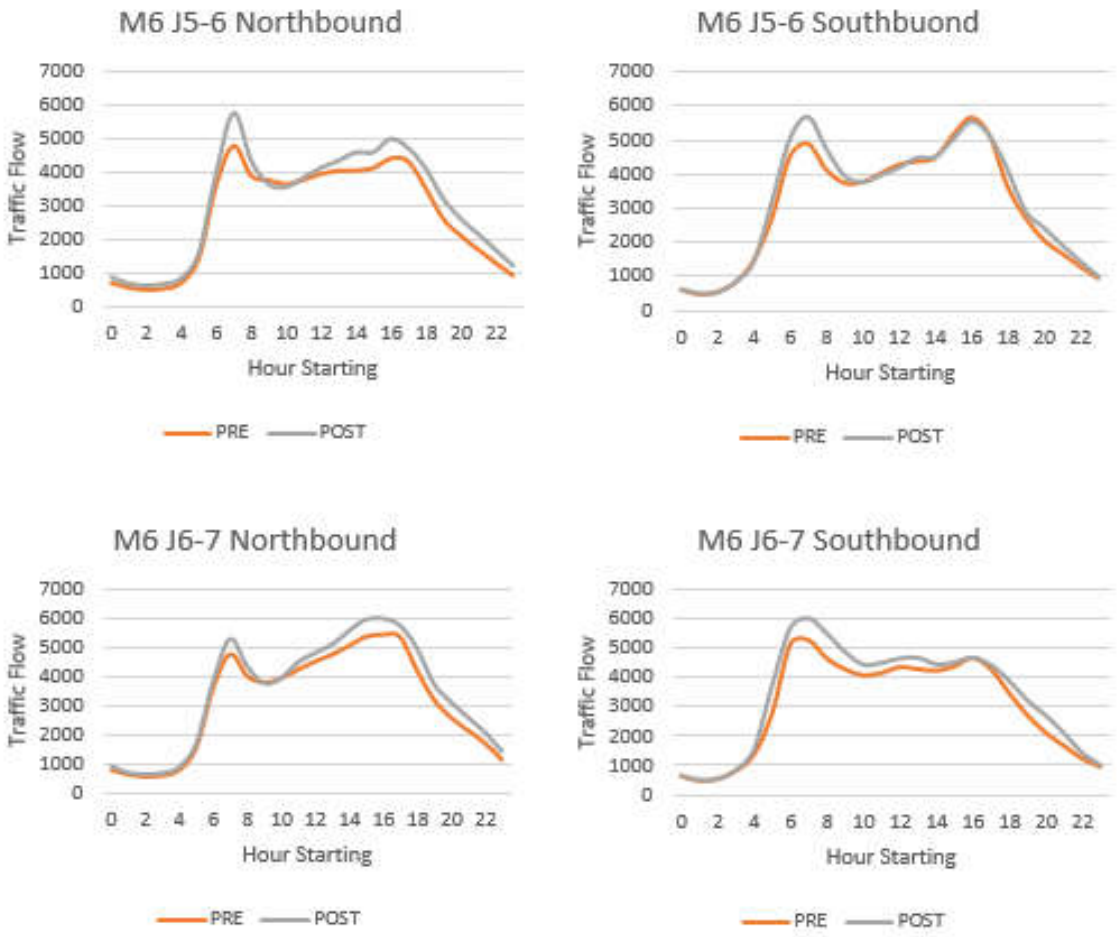


Hourly Distribution of Flows on Scheme Sections

2.21. The hourly distribution of flows across the day can be used to determine the nature of peak flows on particular links and whether peak periods have altered following scheme opening.

2.22. Figure 2-4 presents the hourly profile of traffic on an average weekday during May in 2011 (before scheme opening) and May 2016 (one year after scheme opening) on the two mainline sections of the scheme.

Figure 2-4 Hourly flow profile on scheme sections



2.23. The results show in Figure 2-4, show:

- Post-opening traffic flows have generally increased, particularly in the AM and PM peak periods.
- Interpeak flows have remained similar in traffic flow between pre-and post-opening, with only slight increases observed on three of the four sections presented above; M6 J5-6 northbound, M6 J6-7 northbound and M6 J6-7 southbound.
- There is evidence to suggest flows between Junction 6 and 7 are tidal, with higher flows in the AM peak than the PM peak in the southbound direction and vice versa for the northbound direction.
- There have been significant increases in traffic flow in the AM peak across all sections apart from the M6 J6-7 northbound.

- There is little evidence of any peak contraction or spreading across the scheme i.e. the daily traffic profiles of each scheme section have remained similar.

- Traffic flows across each of the scheme sections rise sharply from 05:00 to an AM Peak period which lasts from around 07:00-09:00, at which point traffic levels dip but remain relatively high throughout an IP period which lasts until approximately 15:00. From 15:00 until about 18:00 there seems to be a PM peak, at which point traffic dips to low off-peak and overnight levels.

Traffic flow changes on local roads

2.24. The local AWT flows in Figure 2-5 show:

- Across local roads adjacent to the scheme, traffic flow has seen (in general) a lesser percentage increase in traffic than that of background levels and the mainline scheme sections.

- The largest growth in traffic flows has been on the A34 Birmingham Road northbound (site 6), which has seen a 29% rise and on the A38 Tyburn Road northbound (site 12), which has shown a 19% increase.

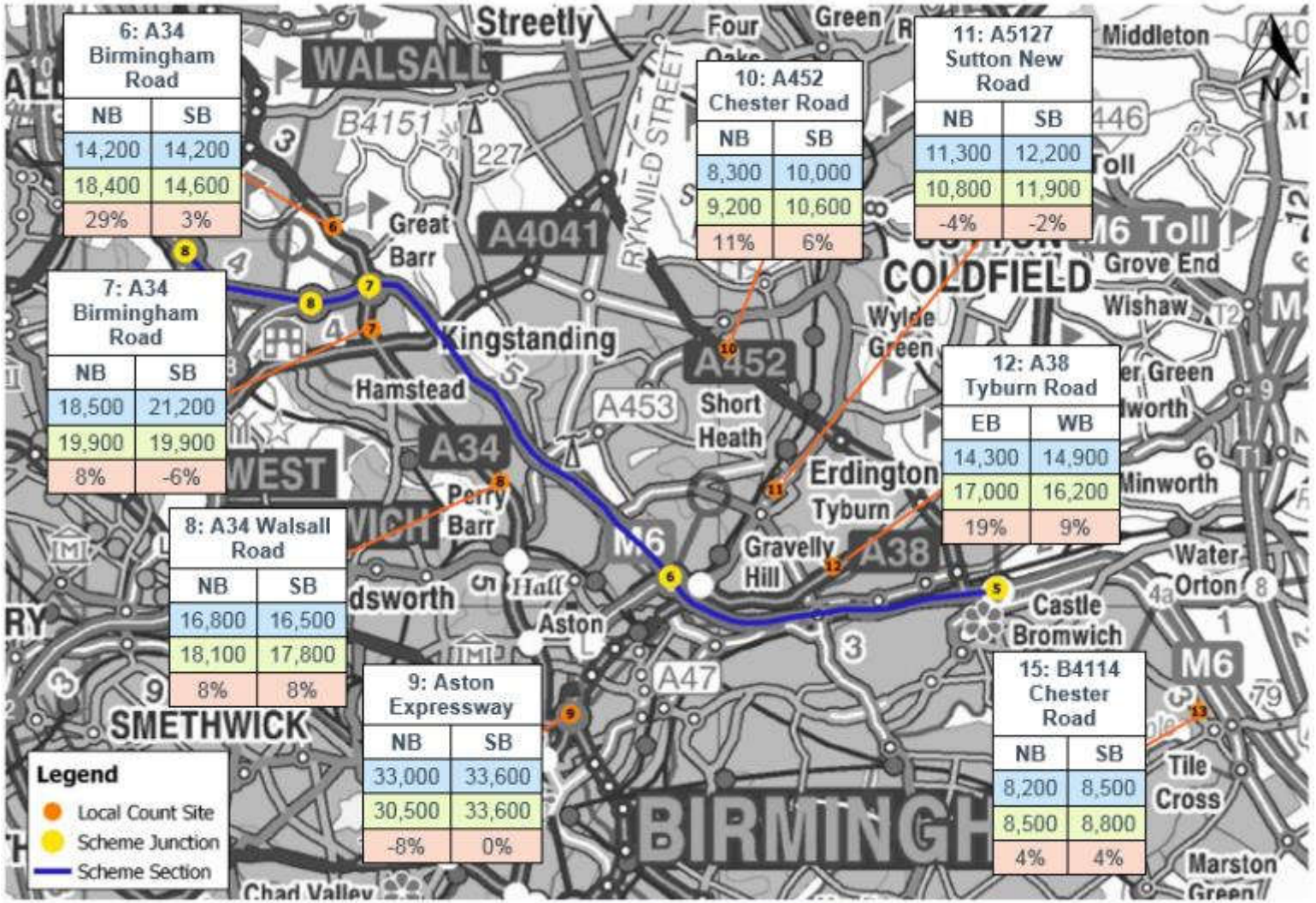
- The largest decrease in traffic flows is on the Aston Expressway northbound (site 9) and southbound on the A34 (site 7), at -8% and -6% respectively.

- The decrease shown for the Aston Expressway northbound is unlikely to be representative of actual traffic growth at this site, data availability was limited and this is a heavily utilised local road, therefore any decrease could simply have been subject to influence from a particular incident or roadworks.

- The decrease shown for the A34 southbound (site 7) suggests that it has become a more attractive option to stay on the M6 rather than exit at Junction 7 when travelling to the south or centre of Birmingham. This is in line with the increases in mainline scheme section traffic shown previously.

2.25. In summary, local changes in traffic across an urban area are subject to many sources of interference. However, it is clear that local traffic has not seen the consistent increases in traffic that the mainline scheme section has, suggesting a moderate level of rerouting onto the motorway has occurred since the scheme has opened.

Figure 2-5 Change in AWT flows on local roads since scheme opening



Heavy Goods Vehicle Traffic

2.26. The CSR notes that the volume of HGVs using the M6 J5-8 is high, with AWT flows in 2011 accounting for between 13 and 21% of traffic.

2.27. Analysis of HGV traffic is completed through vehicle classification by length, in which a HGV is classed as a vehicle over 6.6m in length. Due to inconsistent HGV data through the scheme, the scheme section HGV classification is not sufficiently accurate and cannot be analysed on this occasion. However, HGV data is available between M6 J4a-5, Table 2-2 shows the change in 2-way HGV AADT adjacent to the scheme at M6 J4a-5 between 2011 (pre-scheme) and 2016 (post-scheme):

Table 2-2 M6 J4a-5 – 2-Way HGV AADT change

Year	2-Way HGV AADT	% Change
2011	26,500	-
2016	27,300	3%

2.28. Table 2-2 shows that 2-way HGV AADT has increased by around 3% between pre-and post-scheme opening. HGV AAWT on the M6 J4a-5 has followed a similar trend to general traffic across the study area on, in that between 2011 and 2016 traffic has increased in line with the background changes shown in Figure 2-1 (around 3-6% increase).

Traffic Flow Forecasting Accuracy

2.29. This section compares the observed traffic impacts of the scheme to the traffic changes forecast in the scheme appraisal. Before comparing the forecast traffic impacts to the observed impacts, it is necessary to understand the appraisal approach and key assumptions underpinning the appraisal – as this may assist in explaining any potential differences between the forecast and observed impacts.

Traffic Modelling Approach and Forecast Assumptions

2.30. The details of the traffic modelling and forecast assumptions are taken from the Birmingham Box 3 – Managed Motorways Forecasting Report (November, 2011). The PRISM (Policy Responsive Integrated Strategic Model – West Midlands) transport model was used to forecast traffic as a result of the implementation of BB3 Managed Motorways. PRISM forecasts future travel demand for 2016 and 2026 by estimating growth factors based on the change in trips between a synthetic base (2006) and future forecasts. The growth is applied to validated 2006 base year matrices.

2.31. The 2016 and 2026 Do-Minimum (DM) scenarios contain highway and Public Transport schemes which are more than likely to exist in the forecast years regardless of whether the BB3 MM scheme is implemented. Changes to planning data are also covered i.e. local planning forecasts for new dwellings and employment as incorporated in the Regional Spatial Strategy 2 (RSS2) Preferred Option.

2.32. The model covers average hourly flows from the following time periods, as defined in the Birmingham Box Phase 3 Managed Motorways M6 5 – 8 Economic Assessment Report (SGAR5):

- Weekday AM peak period (07:00 – 09:30)
- Weekday interpeak period (09:30 – 15:30)
- Weekday PM peak period (15:30 – 19:00)

2.33. Note: the economic assessment was undertaken for an appraisal period of 60 years from the scheme opening year of 2016 and the forecasts were for average hourly flows in the Weekday AM

and Weekday PM periods, as defined above. As stated in the BBMM 3 Economic Assessment Report (November, 2011) – no benefits were claimed for the weekend and off-peak periods.

2.34. As discussed, both DM and Do-Something (DS) highway network scenarios incorporate committed and likely schemes and developments in the West Midlands area and in other surrounding regions including BBMM Phases 1 and 2 and other Highways England Schemes identified in the DfT announcement (January, 2009). The assumed schemes in both scenarios (considered relevant to analysis in this report and not including the previously covered earlier phases of BBMM) are shown in Table 2-3. The DS scenario includes all of the schemes listed below but crucially, includes the M6 J5-8 SM scheme. A list of all schemes considered in the Economic Assessment Report (EAR) is provided in Appendix C. Desktop research, including observations made during the site visit have been undertaken to confirm the status of the schemes at the time of writing this report.

Table 2-3 Progress of assumed highway network schemes

Scheme included in modelling as assumed complete by OY	Status (June 2017)
A38 Northfield Regeneration	Complete
Outer Circle/Radial Routes Showcase	Complete
Red Routes Package 1	Complete
Wolverhampton Centre Access Interchange	Complete
Coleshill Multi Modal Interchange	Complete
Birmingham New Street Station (Birmingham Gateway)	Complete
M40 Junction 15 (Longbridge Roundabout)	Complete
Hard Shoulder Running M42 Junctions 3a-7	Complete
Hard Shoulder Running M6 Junctions 4-5	Complete
Controlled Motorway M40 Junction 16 to J3a M42	Complete
Hard Shoulder Running M6 Junction 8-10a	Complete
Hard Shoulder Running M6 Junction 10a-13	Complete
Hard Shoulder Running M5 Junction 4a-6	Complete as of May 2017
Hard Shoulder Running M6 Junction 2-4	Went out for consultation in November 2016. Due to start construction Winter 2017/Spring 2018.
BIA/NEC Public Transport	Complete

Forecast vs. Observed Traffic Flows

2.35. Forecast traffic flows are provided in the TFR. Forecasts are compared with observed AWT flows on the same section for the Weekday AM, IP and weekday PM periods described earlier. The TFR provides flows forecast for a 2016 opening year and 2026 for the DM and DS scenarios. Flows were only presented for the motorway network.

2.36. Table 2-4 presents the modelled DM and DS flows on the scheme sections with forecasts for the adjusted opening year of 2016 and compares them with the observed DM and DS flows for the AM peak period. Note: in order to provide directly comparable figures the observed DM flows (observed pre) have been factored in line with background traffic growth between 2011 and 2016 (6%). Table 2-5 and Table 2-6 provide the same information for the IP and PM peak periods respectively.

2.37. The Traffic Forecast Report (TFR) notes that flows on the M6 were expected to increase in both directions during the AM, IP and PM peaks for 2016 and 2026. As there is no growth in the total number of car trips in the DM and DS scenarios, the growth in traffic on the M6 is expected to be due to vehicles re-routing from non-motorway roads (this is consistent with local traffic changes presented in Figure 2-5).

2.38. The tables show that the observed pre-scheme (factored to represent 2016) is consistently lower than the DM forecast (2016) across each three of the time periods, indicating that the forecasts have overestimated the background level of traffic growth. This is also shown for the observed post-scheme (2016) data, which presents consistently lower traffic than the DS forecast (2016) across each of the three time periods.

2.39. Ultimately the forecasts for this scheme overestimated the traffic that would use the M6 corridor in the opening year and forecast levels of growth between the without scheme and with scheme scenarios has not occurred on the majority of scheme sections and junctions.

Table 2-4 AM peak (vehicle) forecast and outturn traffic impacts

AM									
Link	**Direction**	**DM (2016)**	**Observed Pre (2016)[6]**	**% Difference**	**DS (2016)**	**Observed Post (2016)**	**% Difference**	**DM v DS**	**Pre v Post**
M6 J4a-5	NB	6,400	5,600	-13%	7,000	5,400	-23%	9%	-4%
M6 J4a-5	SB	6,500	5,400	-17%	6,600	4,800	-27%	2%	-11%
M6 J5-6	NB	5,200	4,500	-13%	6,000	4,800	-20%	15%	7%
M6 J5-6	SB	5,100	4,200	-18%	5,300	5,000	-6%	4%	19%
M6 J6-7	NB	5,200	4,500	-13%	6,300	4,700	-25%	21%	4%
M6 J6-7	SB	5,300	5,100	-4%	6,300	5,700	-10%	19%	12%

Table 2-5 IP (vehicle) forecast and outturn traffic impacts

IP									
Link	**Direction**	**DM (2016)**	**Observed Pre (2016)[6]**	**% Difference**	**DS (2016)**	**Observed Post (2016)**	**% Difference**	**DM v DS**	**Pre v Post**
M6 J4a-5	NB	6,400	5,000	-22%	6,900	4,900	-29%	8%	-2%
M6 J4a-5	SB	6,200	4,900	-21%	6,200	4,400	-29%	0%	-10%
M6 J5-6	NB	5,100	4,100	-20%	6,000	4,100	-32%	18%	0%
M6 J5-6	SB	5,100	4,000	-22%	5,200	4,200	-19%	2%	5%
M6 J6-7	NB	5,100	4,800	-6%	6,500	4,800	-26%	27%	0%
M6 J6-7	SB	5,200	4,500	-13%	5,900	4,600	-22%	13%	2%

[6] As explained in section 2.36 – in order to provide directly comparable figures the observed DM flows (observed pre) have been factored in line with background traffic growth between 2011 and 2016 (6%).

Table 2-6 PM peak (vehicle) forecast and outturn traffic impacts

PM									
Link	**Direction**	**DM (2016)**	**Observed Pre (2016)[6]**	**% Difference**	**DS (2016)**	**Observed Post (2016)**	**% Difference**	**DM v DS**	**Pre v Post**
M6 J4a-5	NB	6,600	5,200	-21%	7,200	5,400	-25%	9%	4%
M6 J4a-5	SB	6,700	5,200	-22%	6,800	5,000	-26%	1%	-4%
M6 J5-6	NB	5,200	4,300	-17%	5,900	4,600	-22%	13%	7%
M6 J5-6	SB	5,300	4,600	-13%	6,300	4,900	-22%	19%	7%
M6 J6-7	NB	5,400	5,400	0%	7,200	5,700	-21%	33%	6%
M6 J6-7	SB	5,100	4,400	-14%	5,700	4,400	-23%	12%	0%

2.40. The following more detailed observations can also be made from the Table 2-4, Table 2-5 and Table 2-6:

- Across all time periods considered the average increase in traffic flow along the scheme section was forecast to be approximately 16%. In comparison, the observed increase was 6%.
- The average increase along the scheme section was forecast to be approximately 15% in the AM peak, 15% in the IP and 19% in the PM peak. In comparison, the observed increases were 10%, 2% and 5% respectively.
- The forecasts assumed a consistent growth in background traffic between the base year of 2011 and opening year of 2016, whereas the observed trends show only modest growth between the pre-and post-scheme periods in both national and regional traffic data.
- Outside the scheme, M6 J4a-5 has seen consistent decline in traffic between the pre-and post-opening observed data in all three time periods. Generally, each of the scheme sections throughout all three time periods have seen increases between pre-and post-opening traffic.

Journey Time Evaluation

2.41. This section considers the impact on journey times following the implementation of the scheme. Pre-and post-scheme journey times are considered along the route shown in Figure 2-6. This route was selected as it is covers the length of the scheme.

2.42. Journey time analysis is considered in the following stages:

- Analysis of pre-and post-scheme average journey times and speeds along the scheme.
- A comparison of journey time reliability before and after the scheme opened.

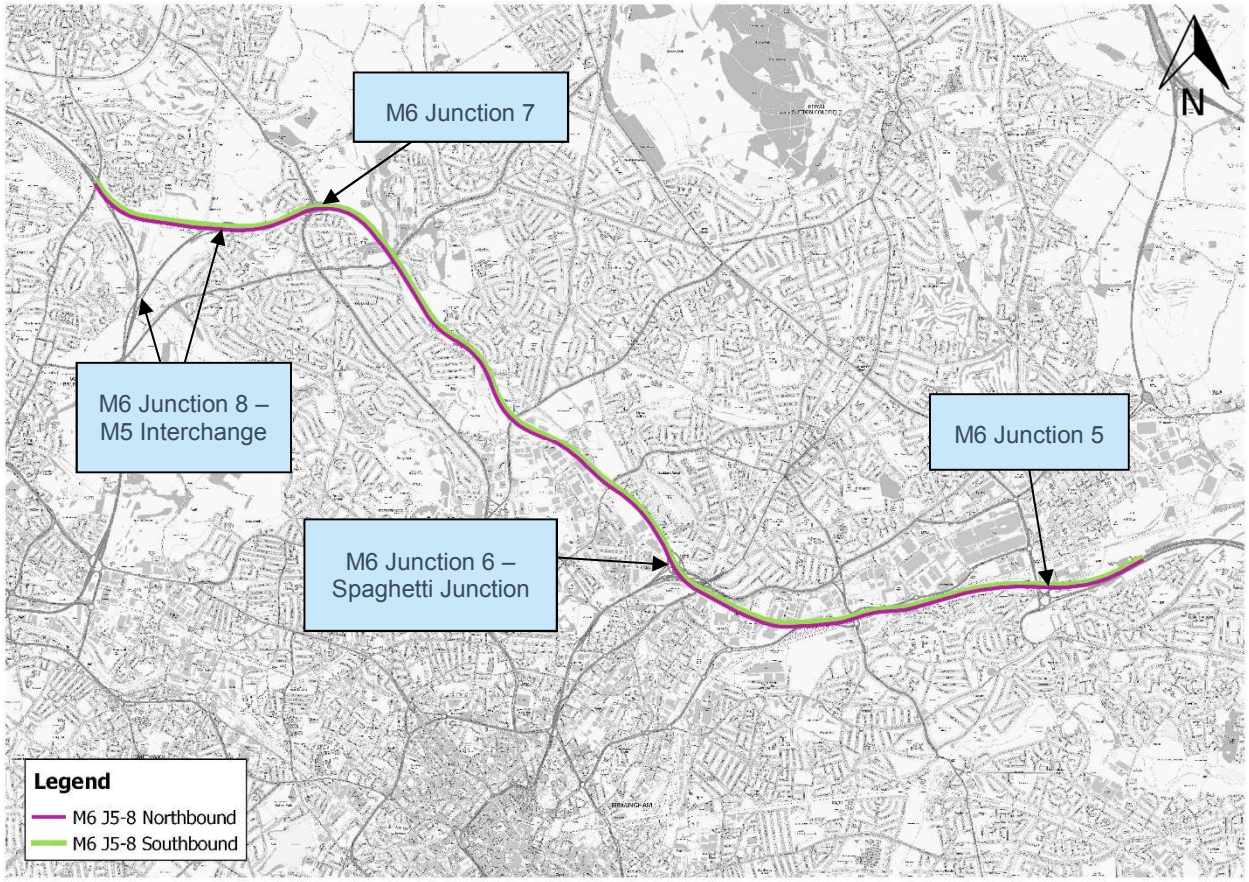
2.43. The journey time periods evaluated are in line with the PRISM model (as below) and cover the calendar periods May 2011 (pre-scheme) and May 2016 (post-scheme). Note: data obtained for May 2016 includes periods when the DHSR and VMSL are in operation and when they are not, hence the results represent average journey times over the period to be directly comparable with average journey times before opening (May 2011).

- Weekday AM peak period (07:00 – 09:30)
- Weekday interpeak period (09:30 – 15:30)
- Weekday PM peak period (15:30 – 19:00)
- Off-peak (19:00 – 07:00)

2.44. Weekend peak time periods have also been considered, based upon analysis of daily traffic profiles which highlight the high flows apparent during these periods:

- Weekend IP (10:00 – 14:00, Saturday and Sunday)
- Weekend PM peak (16:00 – 19:00, Sunday)

Figure 2-6 Journey time routes



Observed Journey Times

2.45. Pre-and post-construction average opening journey time information has been obtained from satellite navigation data. This section analyses the change in journey times and speeds along the routes shown in Figure 2-6.

2.46. Table 2-7 shows the pre-scheme and post-scheme average journey times along the total scheme section and the observed journey time savings. The differences in journey times are colour coded based on an increase in journey times of more than 10 seconds (red), reduction in journey times of more than 10 seconds (green) and a 10 second or less change in journey times (yellow).

Table 2-7 Change in journey times following scheme opening

	Pre-scheme (mm:ss)			Post-scheme (mm:ss)			Difference (mm:ss) (% change)		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
M6 J5 – J8 Northbound	13:42	11:29	14:04	12:55	12:41	18:22	-00:47 (-6%)	+01:12 (10%)	+04:18 (31%)
M6 J5 – J8 Southbound	16:27	10:47	10:57	13:50	12:36	13:58	-02:37 (-16%)	+01:49 (17%)	+03:01 (28%)

2.47. The results indicate an increase in average journey times across the scheme in both directions, with a rise of 4 minutes and 43 seconds northbound and 2 minutes and 13 seconds southbound. However, the table also shows that changes in journey time are not distributed evenly across each time – the AM Peak period has experienced a decrease in average journey time in both directions, with a total average journey time saving of 3 minutes and 24 seconds. Overall, Table 2-7 shows a clear increase in post-scheme opening average journey times, to investigate this further average journey times have been assessed by junction.

2.48. Figure 2-7 and Figure 2-8 present a journey time comparison in seconds by section between pre- and post-opening periods across the scheme sections, in each direction and for all the time periods.

Figure 2-7 M6 J5-8 northbound journey time comparison

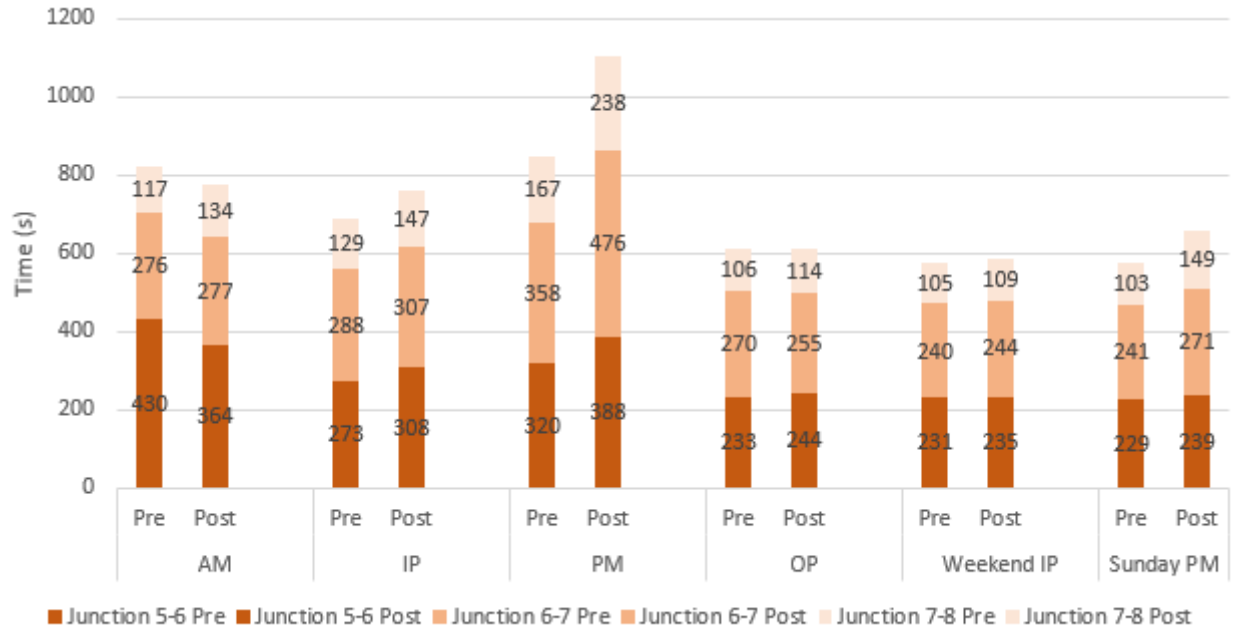
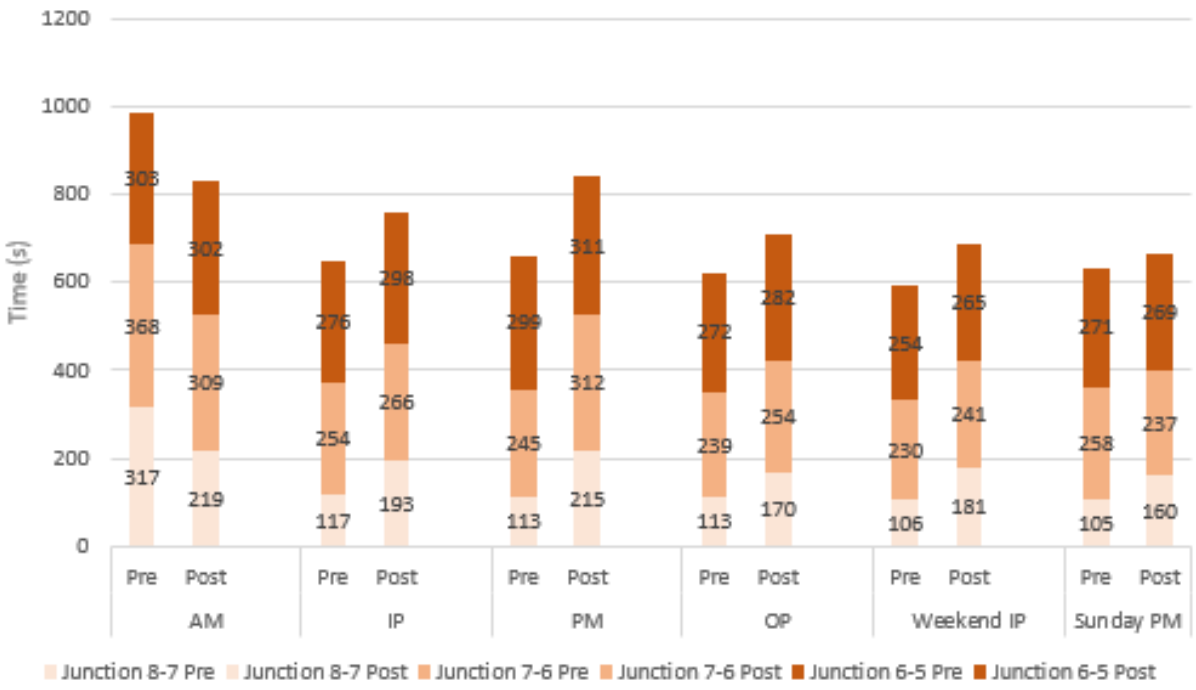


Figure 2-8 M6 J5-8 southbound journey time comparison



2.49. The following more detailed observations can be made from Table 2-7, Figure 2-7 and Figure 2-8:

- Across the route from the M6 J5-8, average journey times have increased during the IP and PM peak periods by 1 minute and 12 seconds and 4 minutes and 18 seconds respectively.

- The largest single average journey time change over the whole scheme is in the PM peak northbound, with an average journey time increase of 4 minutes and 18 seconds. Figure 2-7 shows that the total increase in average journey time for the PM peak northbound is split evenly across the three scheme sections M6 J5-6, J6-7 and J7-8 with a 1 minute and 8 seconds, 1 minute and 59 seconds and 1 minute and 11 seconds increase on each of the sections respectively. Figure 2-8 shows that during the PM peak in the southbound direction, journey time changes are not split as evenly across the sections as with the northbound PM peak. In fact, the M6 J5-6 has experienced a journey time increase of just 12 seconds, compared with increases of 1 minute and 2 seconds and 1 minute and 42 seconds for J6-7 and J7-8 respectively.

- Across the route from the M6 J5-8, average journey times have decreased during the AM peak by a total of 3 minutes and 24 seconds. The largest single average journey time saving is during the AM peak in the southbound direction, with a journey time saving of 2 minutes and 37 seconds. Figure 2-8 shows that the total decrease in average journey time for the AM peak southbound is not split evenly across the three scheme sections. The M6 J5-6 shows negligible change in average journey time, compared to a 59 seconds and 1 minute and 38 seconds decrease on each of the sections J6-7 and J7-8 respectively.

- In summary the journey time changes between pre-and post-scheme opening suggests that during the busy AM peak period, the increase in capacity and management as a result of the scheme has been successful in decreasing congestion. However, journey time changes also suggest that during the IP period the DHSR could be in operation for too long (reducing average speeds and increasing journey times), and during the PM peak VMSL are not having the desired effect. It must be noted that traffic congestion on this section of the M6 was already high and traffic growth would have continued without

implementatation of the the scheme (Figure 2-1), therefore it is likely that journey times would have naturally decreased between a before and DM scenario.

2.50. Table 2-8 shows average speeds (kph) before and after the scheme opened for the same calendar and time periods used to assess journey times.

Table 2-8 Change in average speeds (kph) following scheme opening

		Pre-scheme (kph)			Post-scheme (kph)			Difference (kph)		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
M6 J5 – J8 (NB)	M6 J5 – J6	57	85	73	67	76	60	+10	-10	-12
	M6 J6 – J7	89	85	71	90	81	51	+1	-4	-20
	M6 J7 – 8	92	87	75	83	77	54	-9	-10	-21
M6 J8 – J5 (SB)	M6 J8 – J7	36	91	94	61	67	56	+25	-24	-38
	M6 J7 – J6	71	96	99	80	92	78	+8	-4	-22
	M6 J6 – J5	87	97	88	88	89	84	+1	-8	-3

A negative difference indicates a reduction in average speeds and difference figures may not total due to rounding.
**The route average has been calculated from the original data and is not an average of the section by section results.*

2.51. Table 2-8 shows that in the majority of cases, where average speeds were in excess of 85kph (53mph) in the pre-scheme period (e.g. M6 J7 – 8 northbound in the AM peak period), average speeds in the post-scheme period have reduced. Alternatively, where speeds were less than 85kph before the scheme opened, average speeds have remained the same or increased (e.g. M6 J8 – 7 southbound). This suggests that on sections where congestion was evident before scheme opening the DHSR has had a positive impact on the operational performance. The following key points are also shown in Table 2-8:

- Average speeds in the AM peak have increased across all links in both directions apart from the M6 J7-8 northbound.
- Average speeds in the PM peak have decreased across all links in both directions.
- Average speeds in the IP have decreased across all links in both directions.
- The largest observed increase in average speed (M6 J8-7, AM, +25kph) occurred on the section and time period which reported the slowest average speed pre-scheme (M6 J8-7, AM, 36kph). This indicates that the scheme has been successful in increasing average speed where there are increases to be made.

2.52. As noted in the *Report to the Secretary of State for Transport and the Secretary of State for Communities and Local Government*, the technology used as part of the scheme enabled VMSL to be applied to the motorway. When the hard shoulder is operational, a maximum speed limit of 60mph would apply to all traffic although a lower speed limit may be applied if necessary during periods of congestion or in the event of an accident. In reality, variable speed limits may not be operating at the most efficient level.

2.53. Table 2-8 presented pre-and post-scheme average speeds across the specified sections from one point to another. The journey time results have been interrogated in more detail to identify average journey speed changes along the whole route. These changes in average speeds along the scheme section are shown in Figure 2-9 to Figure 2-14 and the results by time period are reported below:

- Average speeds in the AM peak have generally improved in both directions. Average speeds in the AM peak northbound have increased from around 50kph (extremely low) to 70kph between the M6 J5-6. Average speeds across the rest of the scheme at OYA

remain similar in the northbound direction. Average speeds in the AM peak southbound have from around 40kph to 80kph between the M6 J8-6, the rest of the scheme OYA has remained similar.

- Average speeds are lower across the route in both directions during both the IP and PM peak periods following scheme opening.

- Across the scheme the PM peak has shown a consistent reduction in speed of around 10-15kph in the northbound direction. In the southbound direction, the PM peak has seen minor improvements to speeds remaining around 90kph.

- Average speeds across the majority of the scheme length during the IP have seen a consistent reduction in speed, in both directions, of around 10kph. The profile of average speeds along the route in both directions are the same before and after scheme opening as shown in Figure 2-10 and Figure 2-13.

2.54. Excluding the AM peak, there is a consistent pattern which shows average speeds to be lower after opening than before opening, despite the additional capacity offered by DHSR. This requires further investigation to identify whether the operation of the DHSR is working efficiently, or whether the management of traffic speeds may not have increased traffic speeds, but made them more reliable. The following section summarises the findings on these two issues.

Figure 2-9 Average speed (kph) M6 J5-8 NB AM peak (07:00 - 09:30)

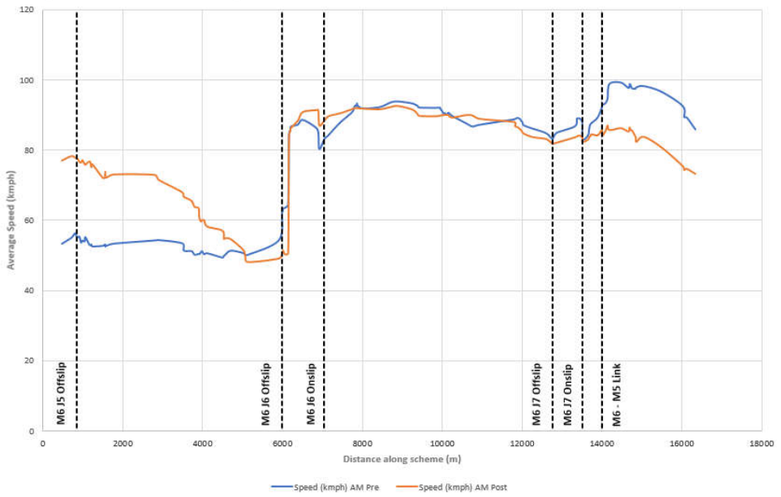


Figure 2-10 Average speed (kph) M6 J5-8 NB IP (09:30 - 15:30)

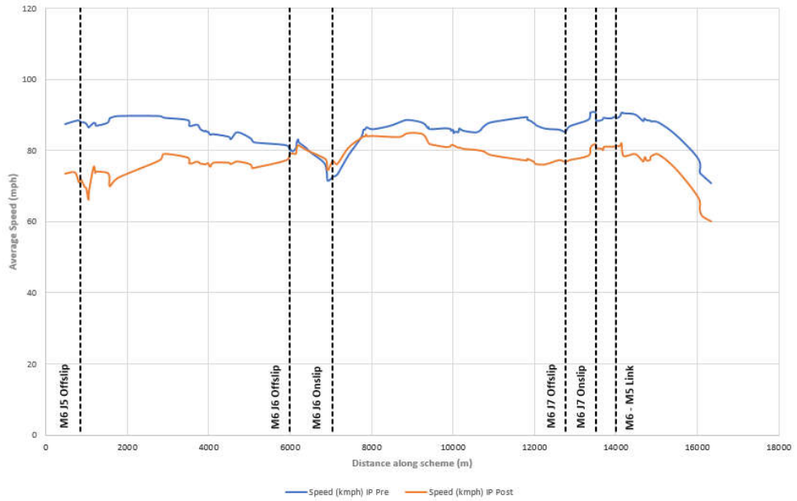


Figure 2-11 Average speed (kph) from M6 J5-8 NB PM peak (15:30 - 19:00)

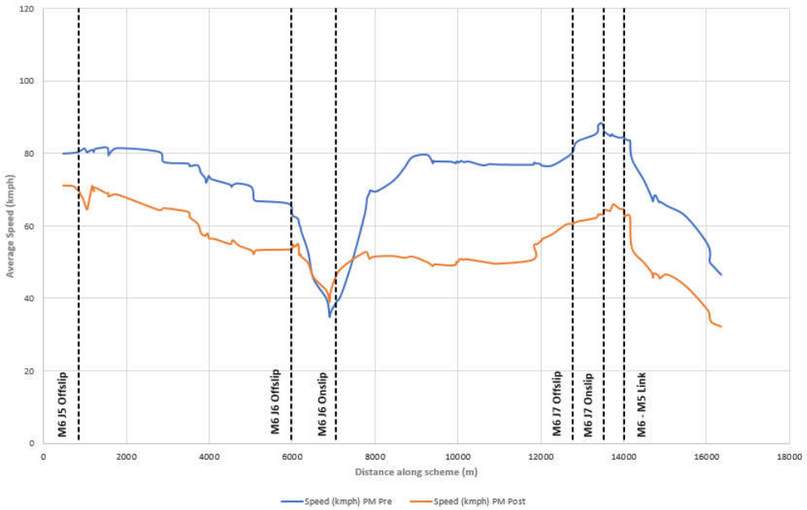


Figure 2-12 Average speed (kph) from M6 J5-8 SB AM peak (07:00 - 09:30)

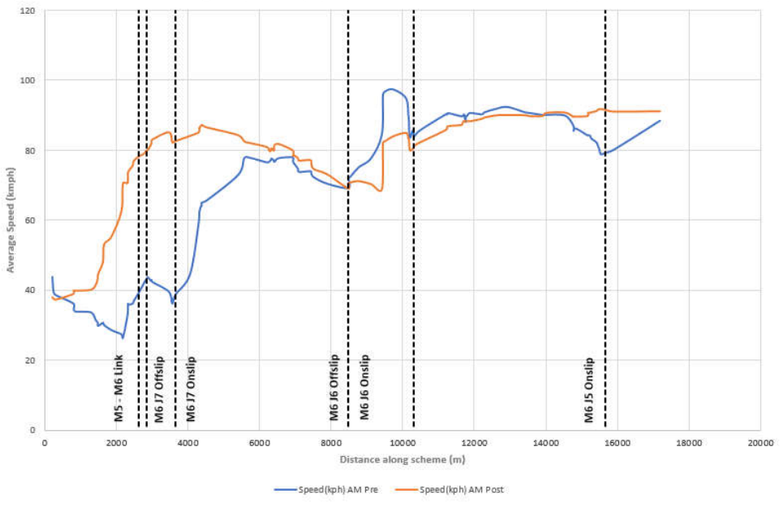


Figure 2-13 Average speed (kph) from M6 J5-8 SB IP (09:30 - 15:30)

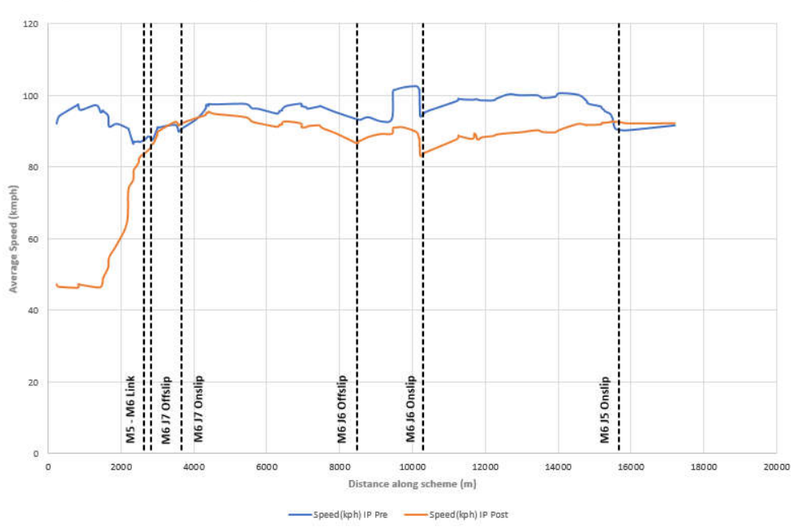
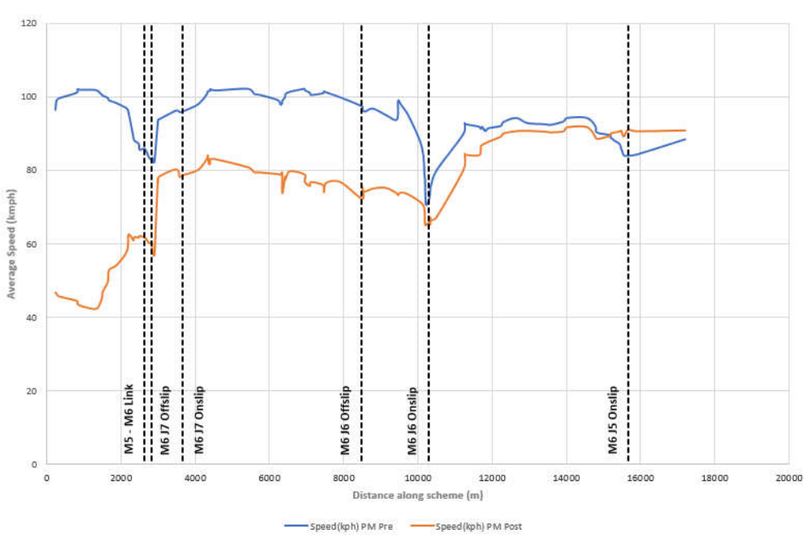


Figure 2-14 Average speed (kph) from M6 J5-8 SB PM peak (15:30 - 19:00)



Forecast vs. Observed Journey Times

2.55. The BBMM3 Forecasting Report (November, 2011) and Economic Assessment Report Stage 2 (December, 2009) do not contain specific details on the forecast impact of the scheme on journey times following scheme opening. The Traffic Forecasting Report does however provide 2016 and 2026 DM and DS forecast link speeds for each of the modelled time periods. The link speed forecasts contained within the Traffic Forecasting Report are in some cases split into multiple modelled links between junctions, the origin and destinations of the splits are not specified.

2.56. Based on the information made available in these reports, it has been possible to make a like for like comparison against observed changes in speeds and therefore journey times following scheme opening with forecast changes based upon assumptions made about the origin and destination of the splits.

2.57. The forecast speeds and the assumptions made in order to convert these link speeds into forecast journey times, are provided in Appendix D.

2.58. Based upon the assumptions made in Table 9-1 (Appendix D) and the forecast link speeds shown in Table 9-2, it has been possible to show the forecast scheme impact on average network travel times (s) for the modelled opening year (2016). The results are shown in comparison with observed pre-and post-opening changes, for northbound and southbound below in Table 2-9 and Table 2-10 respectively:

Table 2-9 Forecast and observed scheme impact on average travel time (northbound)

Link	Direction	2016 DM JT (s)			2016 DS JT (s)			Change in 2016 JT (DS – DM) (s)		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
M6 J5-6	NB	444	335	214	217	217	205	-227 (-51%)	-118 (-35%)	-9 (-3%)
M6 J6-7	NB	420	434	773	294	303	528	-126 (-30%)	-131 (-30%)	-245 (-32%)
M6 J7-8	NB	136	136	138	135	132	136	-1 (-1%)	-4 (-3%)	-1 (-1%)
Total by Time Period / **Total** (s)								-354	-253	-255
		Observed Pre			**Observed Post**			**Change in Observed JT (Post – Pre) (s)**		
M6 J5-6	NB	430	273	320	364	308	388	-66 (-15%)	35 (13%)	68 (21%)
M6 J6-7	NB	276	288	358	277	307	476	1 (0%)	19 (7%)	119 (33%)
M6 J7-8	NB	117	129	167	134	147	238	17 (15%)	18 (14%)	72 (43%)
Total by Time Period / **Total** (s)								-48	72	258

Table 2-10 Forecast and observed scheme impact on average travel time (southbound)

Link	Direction	2016 DM JT (s)			2016 DS JT (s)			Change in 2016 JT (DS – DM) (s)		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
M6 J5-6	SB	135	135	132	132	131	130	-3 (-2%)	-3 (-2%)	-1 (-1%)
M6 J6-7	SB	356	312	279	358	334	306	2 (0%)	22 (7%)	27 (10%)
M6 J7-8	SB	214	214	246	220	220	231	6 (3%)	5 (3%)	-15 (6%)
Total by Time Period / **Total** (s)								5	24	11
		Observed Pre			**Observed Post**			**Change in Observed JT (Post – Pre) (s)**		
M6 J5-6	SB	303	276	299	302	298	311	-1 (0%)	22 (8%)	12 (4%)
M6 J6-7	SB	368	254	245	309	266	312	-59 (-16%)	11 (5%)	67 (27%)
M6 J7-8	SB	317	117	113	219	193	215	-97 (-31%)	76 (65%)	102 (90%)
Total by Time Period / **Total** (s)								-157	110	181

2.59. Table 2-9 and Table 2-10 show that journey times across the scheme were forecast to decrease heading northbound but increase slightly in the southbound direction, they also show that observed journey times are not in line with forecasts. The key points on journey time forecasting accuracy are:

- Large decreases in journey time were expected across all three forecast time periods when heading through the scheme northbound – 354, 253 and 255 second decreases for the AM, IP and PM peaks respectively. However, it is also shown that these forecast decreases were not split evenly across the scheme links, for example the M6 J7-8 was expected to decrease journey times by just 6 seconds across each three time periods.

- Southbound through the scheme journey times were forecast to increase slightly in all three time periods. In comparison with the forecast decreases in journey times northbound, the slight increase heading southbound is negligible. However, it is also shown that in comparison with the negligible 5 second forecast increase in journey time during the AM peak southbound, there has actually been a large saving of 157 seconds average journey time.

- Journey time forecasts do not match observed journey time data, which shows a lower decrease in AM peak journey time than forecasts and increases in journey times throughout the IP and PM peak periods.

- The forecast was derived from modelling which was based on predictions of much higher volumes of traffic than those observed. However, these lower volumes apply to the before and after scenarios, so limited conclusions can be confidently inferred in relation to observed journey times compared to forecast savings.

2.60. In summary, the forecast impacts on average journey times and delays indicate the majority of travel time benefits were expected in the latter years following scheme implementation rather than the opening year. Analysis of changes in average journey times at the OYA stage, as shown earlier in this chapter, found average journey times have worsened on the scheme section in both directions by between 13% and 34%.

2.61. In addition, it is understood that traffic flow growth has not occurred at the level expected with observed DM and DS flows lower than forecast, indicating congestion levels at OYA are not as expected which are most likely due to the economic downturn, hence the smart motorway scheme is unlikely to be operating as efficiently as envisaged. Despite this, forecast impacts indicate

improvements to congestion were expected to be negligible in the opening year, which is in line with the analysis of average journey time impacts shown earlier in this chapter.

Operation of the Smart Motorway

2.62. Analysis of the operation of how the smart motorway is operating is based on data as recorded in HALOGEN data (formerly Highways Agency LOGging ENvironment)

2.63. HALOGEN Data has been downloaded for May 2016 to maintain consistency with the traffic and journey time data used in this report. The HALOGEN data has been used:

- To determine how much on average the hard shoulder was open for traffic during the different peak periods on the DHSR scheme sections.
- To determine how much on average different speed limits were in place during the peak periods on all sections of the scheme, noting that if DHSR is in operation, it is mandatory for speeds to reduce to at least 60mph.

2.64. HALOGEN data points have been taken from roughly the centre of each junction. The speed limits set by VMSL can vary along a scheme section of carriageway and therefore the speed analysis is relevant to the chosen gantry location, however the following analysis is appropriate for the full length of each section.

2.65. The peak periods used in this analysis are the same as those used in the journey time analysis section:

- Weekdays AM peak (07:00 – 09:30);
- Weekdays IP (09:30 – 15:30); and
- Weekdays PM peak (15:30 – 19:00)

2.66. As we have shown previously, there seems to be a general worsening in some time periods and therefore it is necessary to investigate the impact that VMSL are having across the scheme.

Northbound

2.67. Figure 2-15 to Figure 2-20 shows the HALOGEN data for the northbound DHSR sections of the scheme, recording the proportion of the time which the hard shoulder was open for traffic during the different peak periods and the different speed limits settings were in place during the peak periods.

Figure 2-15 M6 J5 – 6 northbound – weekday DHSR operation

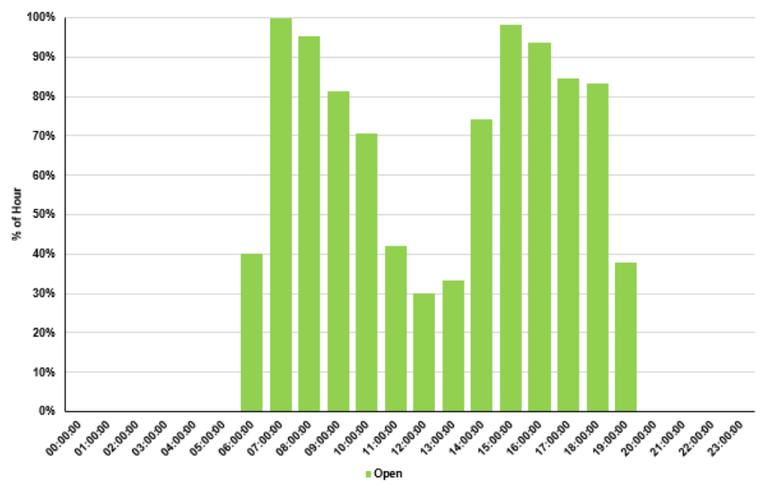


Figure 2-16 M6 J6 – 7 northbound – weekday DHSR operation

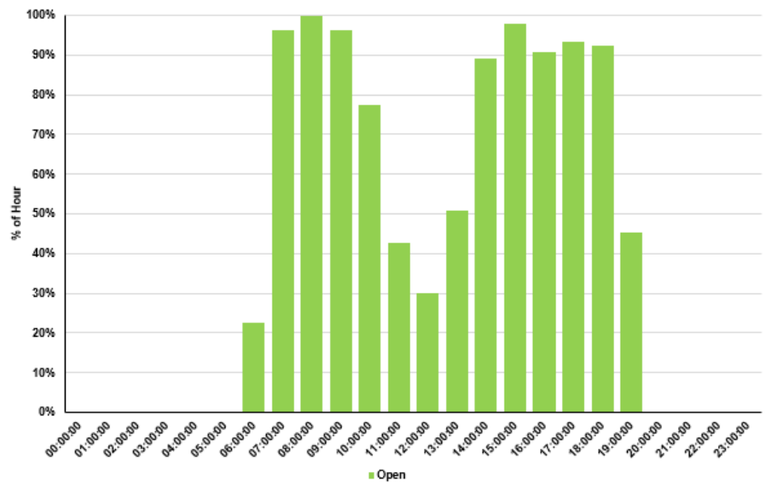


Figure 2-17 M6 J7 – 8 northbound – weekday DHSR operation

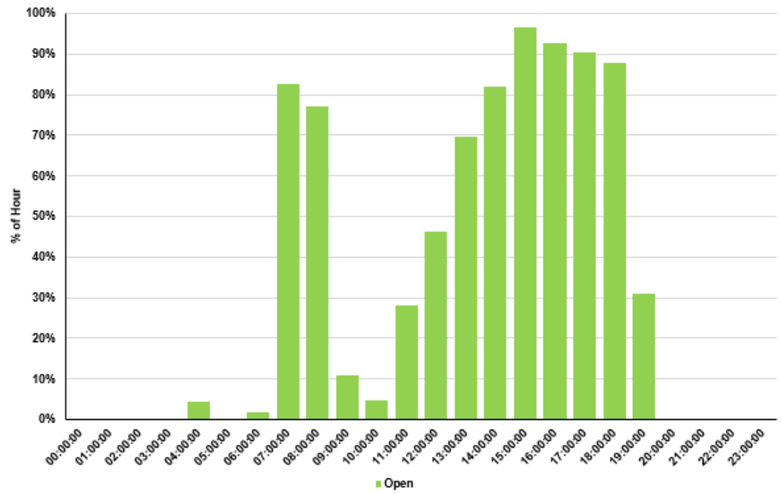


Figure 2-18 M6 J5 – 6 northbound – weekday VMSL operation

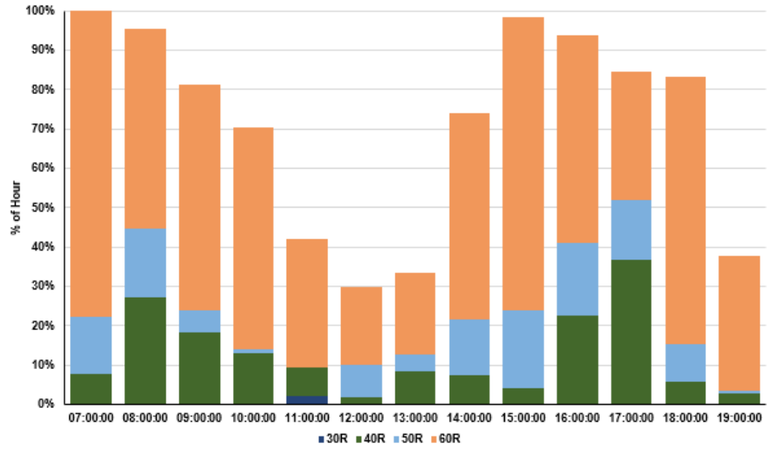


Figure 2-19 M6 J6 – 7 northbound – weekday VMSL operation

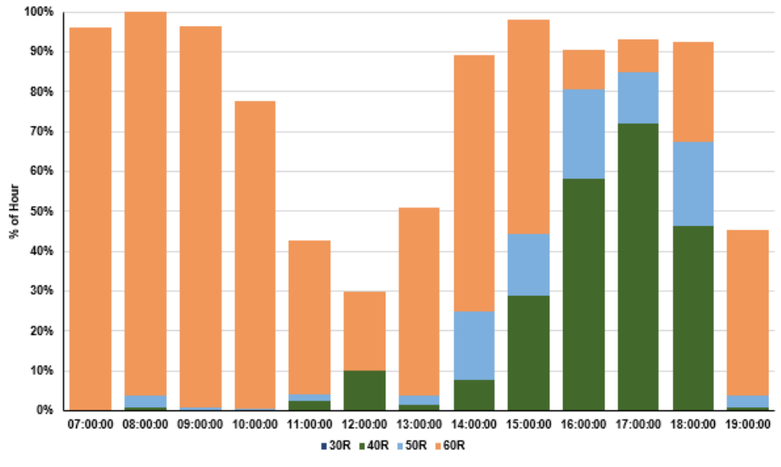
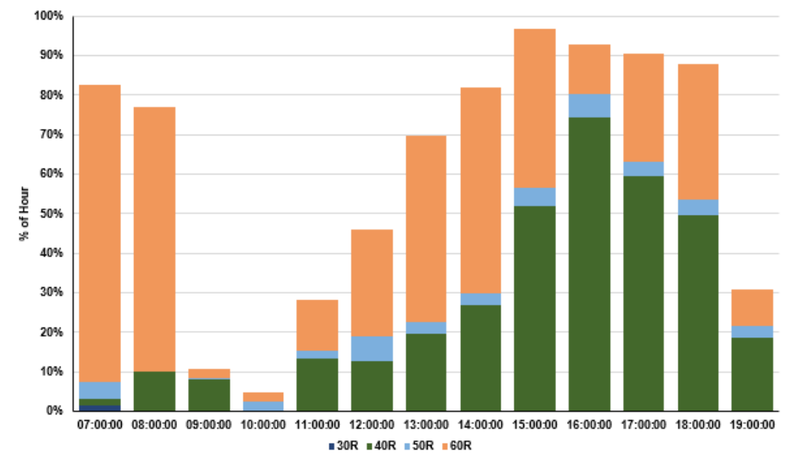


Figure 2-20 M6 J7 - 8 northbound - weekday VMSL operation



2.68. Figure 2-15, Figure 2-16 and Figure 2-17 show the DHSR usage through the scheme in the northbound direction. The DHSR is in operation for a high proportion of the AM and PM peak on all sections. Figure 2-18, Figure 2-19 and Figure 2-20 show the VMSL operation through the scheme in the northbound direction. During the AM peak VMSL are set at 60mph for more than 90% of the time and VMSL below 60mph are negligible. Generally, when VMSL are in use the hard shoulder is open, indicating that VMSL are mostly utilised in conjunction with the DHSR to offer extra capacity (and not in extreme circumstances).

2.69. Northbound through the scheme there is reasonable use of VMSL throughout the day, with VMSL in use between 40% and 80% of the time during the IP period. Between 11:00 and 14:00, VMSL are set at 50mph or less for around 10% of the time. The hard shoulder is not open as frequently as the VMSL are operational suggesting that VMSL are being set without providing additional capacity in the form of the hard shoulder. From 14:00 onwards, VMSL are in operation 100% of the time, with the hard shoulder open slightly less. The proportion of time that VMSL are set at 50mph or below increases from 30% at 14:00 – 15:00 to 90% at 17:00 – 18:00 during the PM peak.

Southbound

2.70. Figure 2-21 to Figure 2-24 show the HALOGEN data for the southbound DHSR sections of the scheme, displaying the proportion of the time which the hard shoulder was open for traffic during the different peak periods and how much on average different speed limits were in place during the peak periods.

Figure 2-21 M6 J5 – 6 southbound – weekday hard shoulder operation

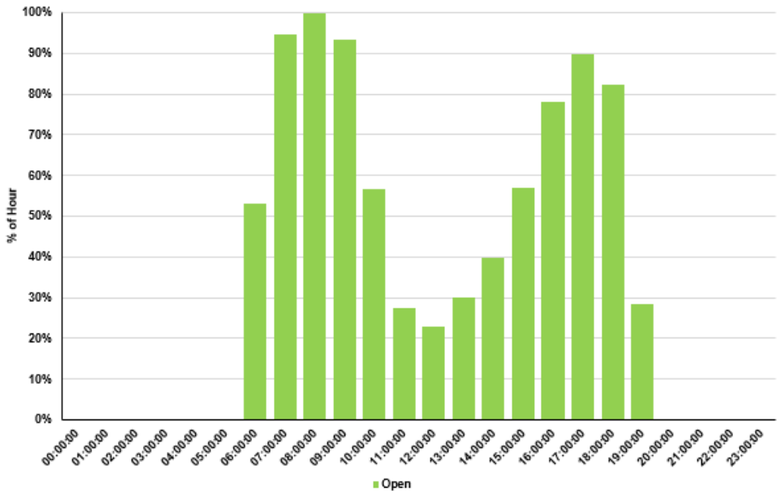


Figure 2-22 M6 J6 – 7 southbound – weekday hard shoulder operation

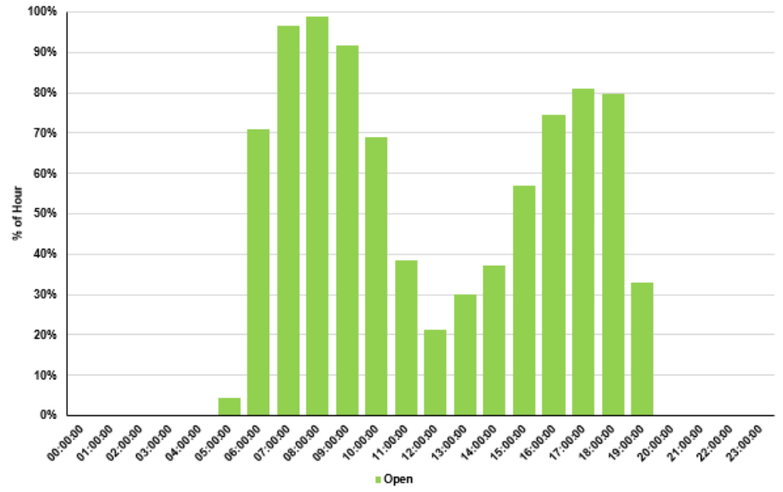


Figure 2-23 M6 J5 – 6 southbound – weekday variable speed limits

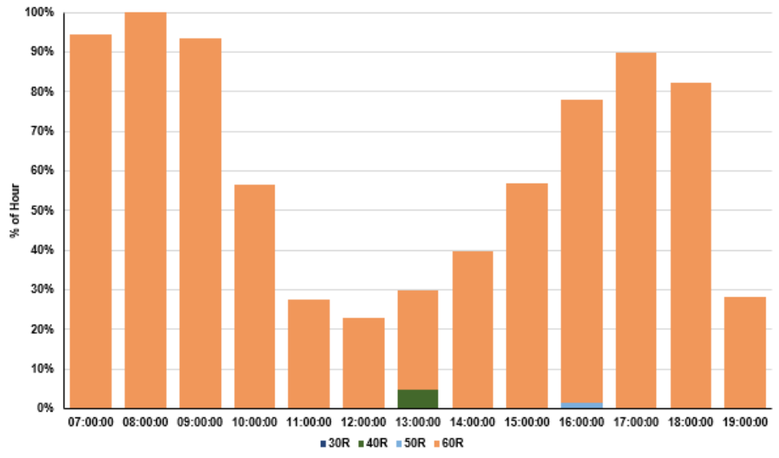
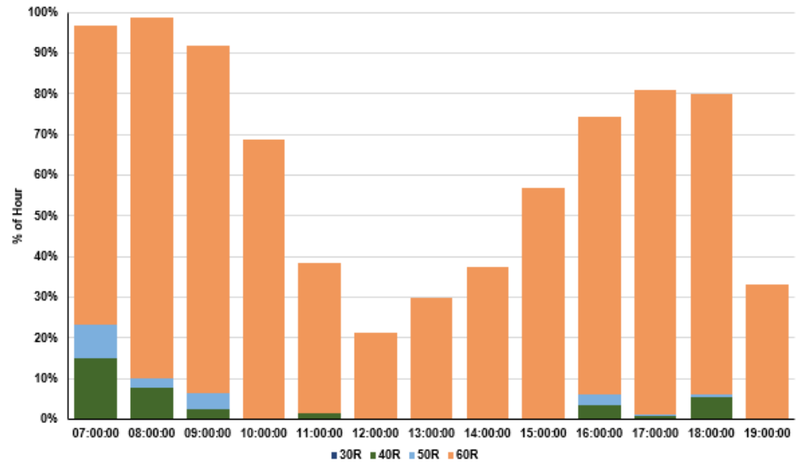


Figure 2-24 M6 J6 – 7 southbound – weekday variable speed limits



2.71. Figure 2-21 to Figure 2-24 show that as with the northbound direction, VMSL between 07:00 and 09:00 are on almost all of the time – predominately at 60mph (70 – 90%).

2.72. Southbound through the scheme, VMSL are in operation for 20 – 40 % of the time between 11:00 and 15:00, during this time they are almost always set at 60mph. From 16:00 – 19:00, VMSL are in operation for around 80% of the time, which is slightly less than the AM peak. During these hours, VMSL are set at 40mph for approximately 10% of the time, which is similar to the AM peak.

Flows and Speeds by Lane: MIDAS Data Analysis

2.73. In addition to traffic flow, journey time and HALOGEN analysis presented in this chapter, additional analysis has been undertaken to understand the journey time and speed changes following scheme opening.

AM Peak

2.74. During the AM peak travelling northbound there has been a slight decrease in journey times and both increases and decreases in the average speed across the scheme. The VMSL are set at 60mph for most of the AM peak, which is higher than the pre-scheme average speeds. The data suggests that additional capacity in the form of the hard shoulder could be helping to mitigate the impact of the additional traffic, however as the VMSL must be set at 60mph limit when the hard shoulder is open, there are minimal improvements in average speeds as a result of capacity enhancements.

2.75. During the AM peak heading southbound there has been a decrease in journey times and as with northbound, both increase and decreases in average speeds across the scheme. The disparity in changes to average speeds during the AM peak indicates that where average speeds were quite low (25mph) in locations such as after M6 Junction 7 on slip, the setting of VMSL at 60mph has improved travel conditions. Alternatively, where average speeds were higher at (40 – 50mph), the setting of VMSL at 60mph has had a limited impact on average speeds as the VMSL settings are at a higher speed than the pre-scheme average. Any increase in traffic flows should have been accommodated by the additional capacity in the form of the hard shoulder.

2.76. MIDAS data provides flows (Figure 2-25 and Figure 2-26) and speeds (Figure 2-27 and Figure 2-28) by lane. It should be noted that Lanes 1 and 2 are mainline lanes where ALR is in operation i.e. M6 J8 – M5 Link and Lane 2 is a mainline lane through DHSR sections of the scheme i.e. M6 J5-7 (except through Junction 6). Analysis of the data on the M6 J5 – 8 during the AM peak shows:

- The hard shoulder is well utilised across the scheme in both directions during the AM peak.
- Use of the hard shoulder increases on the approach to the M6 J6 northbound, linked to the hard shoulder being used for Junction 6 (A38) only. Use of the hard shoulder is particularly high on approach to the M6 J6 southbound, this is linked to the hard shoulder being used as a long off-slip for Junction 6 (A38).
- Speeds across the route northbound and southbound are relatively consistent, with the highest speeds northbound coming between M6 J6-7 and southbound between M6 J5-6.

Figure 2-25 AM flow northbound (07:30 – 09:30) M6 J5 - 8

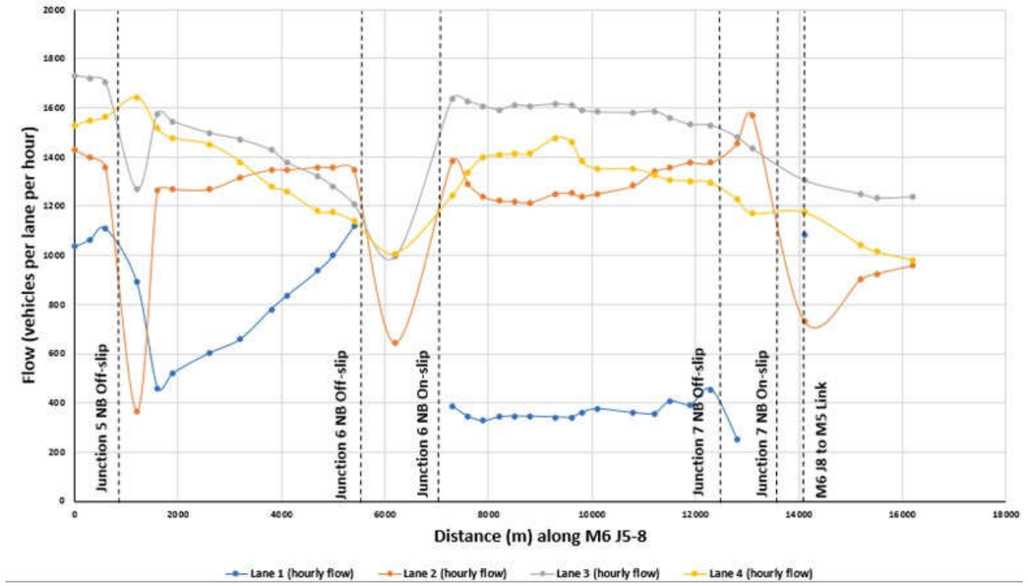


Figure 2-26 AM flow southbound (07:30 – 09:30) M6 J5 - 8

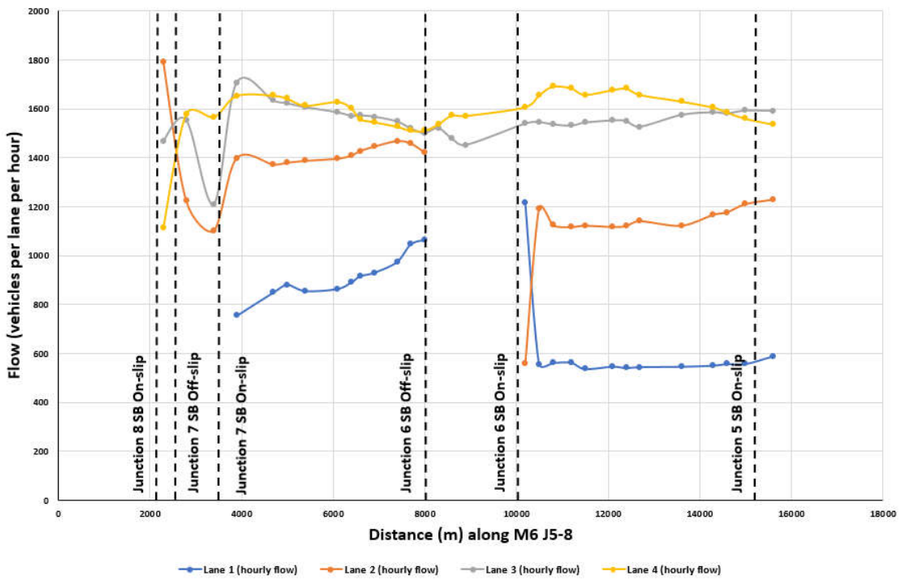


Figure 2-27 AM speed northbound (07:30 – 09:30) M6 J5 - 8

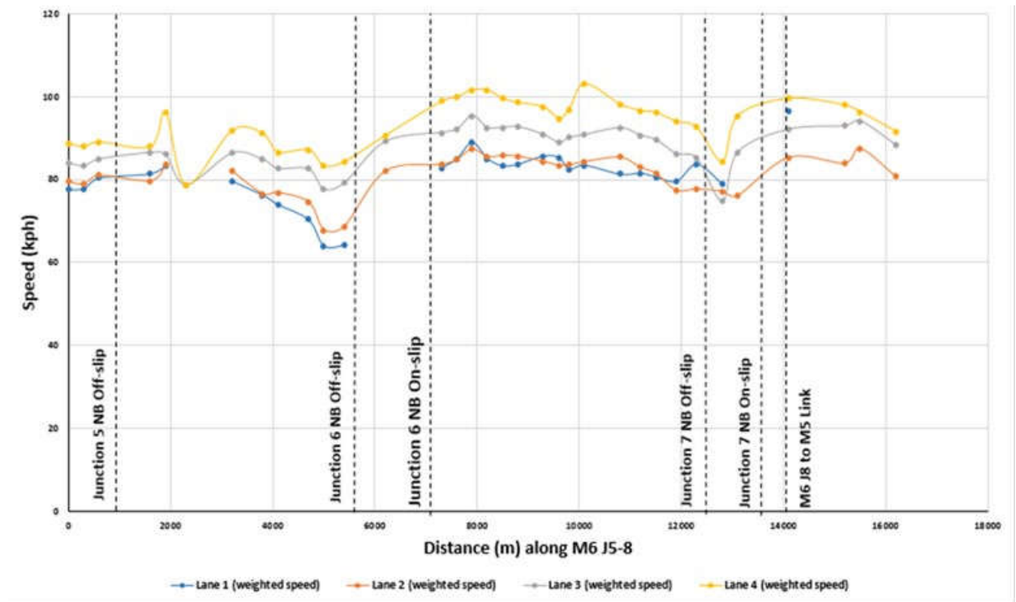
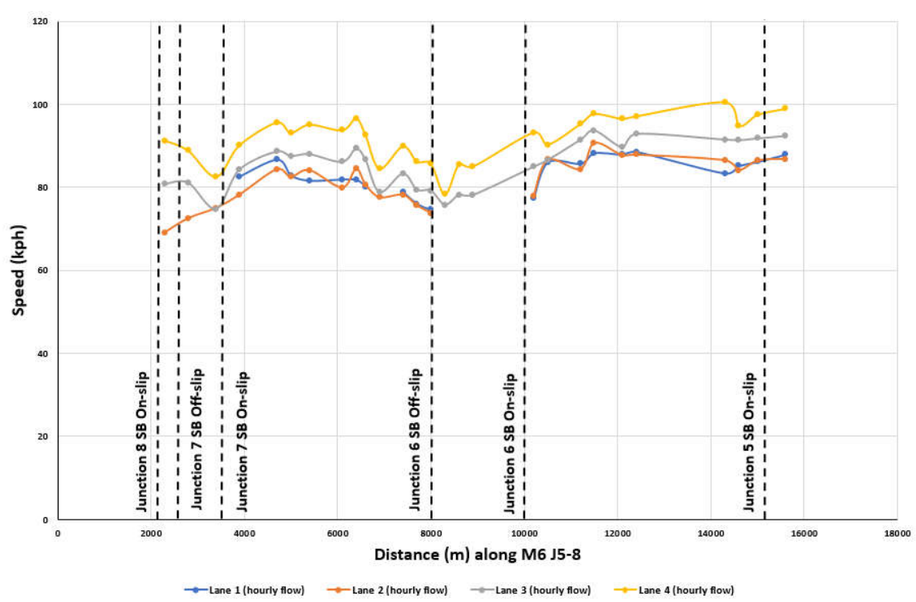


Figure 2-28 AM speed southbound (07:30 – 09:30) M6 J5 - 8



Interpeak

2.77. Southbound through the scheme, average speeds were around 50mph during the IP period and when VMSL are in operation (20 – 40% of the time), they are set at 60mph thus having limited impact on average speeds. This indicates that for 60 – 80% of the day, the motorway continues to operate as a three-lane motorway, as per the conditions prior to the scheme implementation. Midas data has been analysed for the IP (as shown in Appendix E), the results show that speeds are consistent in both directions and utilisation of the hard shoulder is lower than during the AM and PM peak periods.

PM Peak

2.78. Northbound during the PM peak, VSML are set at 40mph or less for 70% of the time between 16:00 and 18:00 hours. This speed setting is lower than the pre-scheme average speeds which were around 50mph. The PM peak on this section is experiencing the most frequent use of VMSL at 50mph or less than any other scheme section with DHSR.

2.79. The reasons for PM peak changes southbound through the scheme are similar to those experienced for the northbound direction. Prior to the scheme opening, average speeds were around 60mph and following the scheme opening they are around 50mph. When the hard shoulder is open, VMSL must be set at a maximum of 60mph which is a similar speed to the pre-scheme average speeds. Opening the hard shoulder is therefore unlikely to have an impact on average speeds even with the additional capacity in the form of the hard shoulder. The setting of VMSL at 50mph or less is likely to be the reasoning for the worsening of average speeds.

2.80. The MIDAS flows and speeds by lane for the PM peak are shown in Figure 2-29 to Figure 2-32. Analysis of the data on the M6 J5 – 8 during the PM peak shows:

- The hard shoulder is well utilised across the scheme in both directions during the PM peak.
- As with the AM peak, use of the hard shoulder increases on the approach to the M6 J6 northbound and is particularly high on approach to the M6 J6 southbound.
- Speeds during the PM peak are notably slower heading southbound than northbound and are at their slowest when exiting the scheme at the southern end.

Figure 2-29 PM flow northbound (15:30 – 19:00) M6 J5 - 8

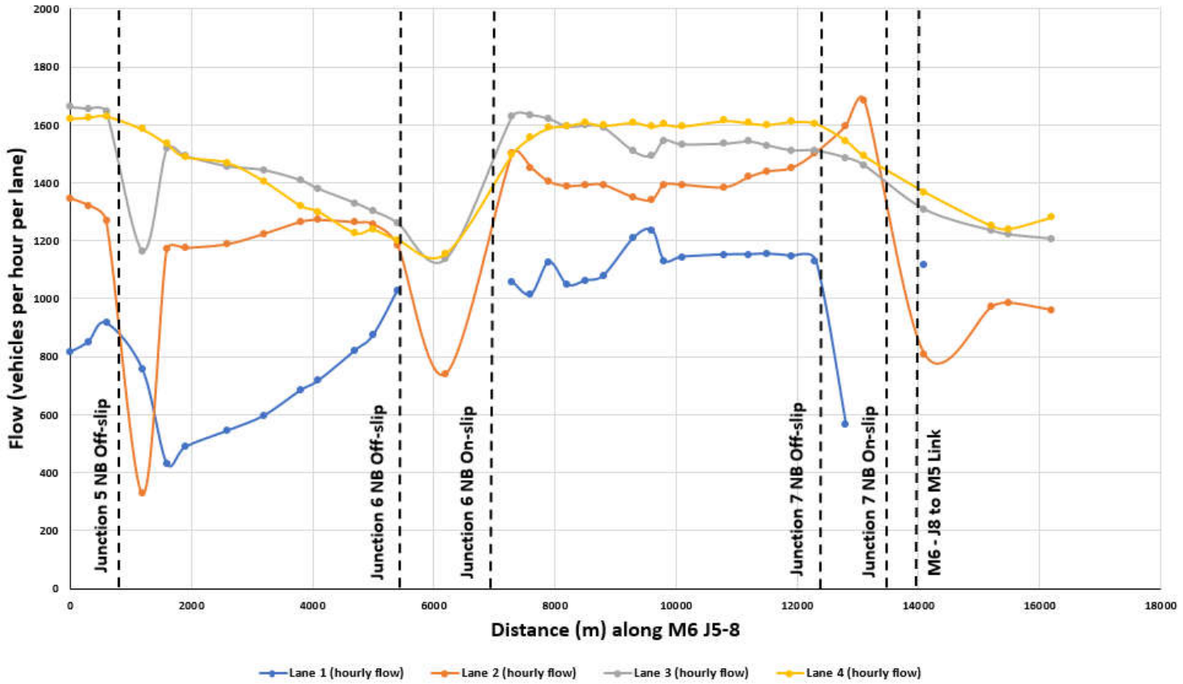


Figure 2-30 PM flow southbound (15:30 – 19:00) M6 J5 - 8

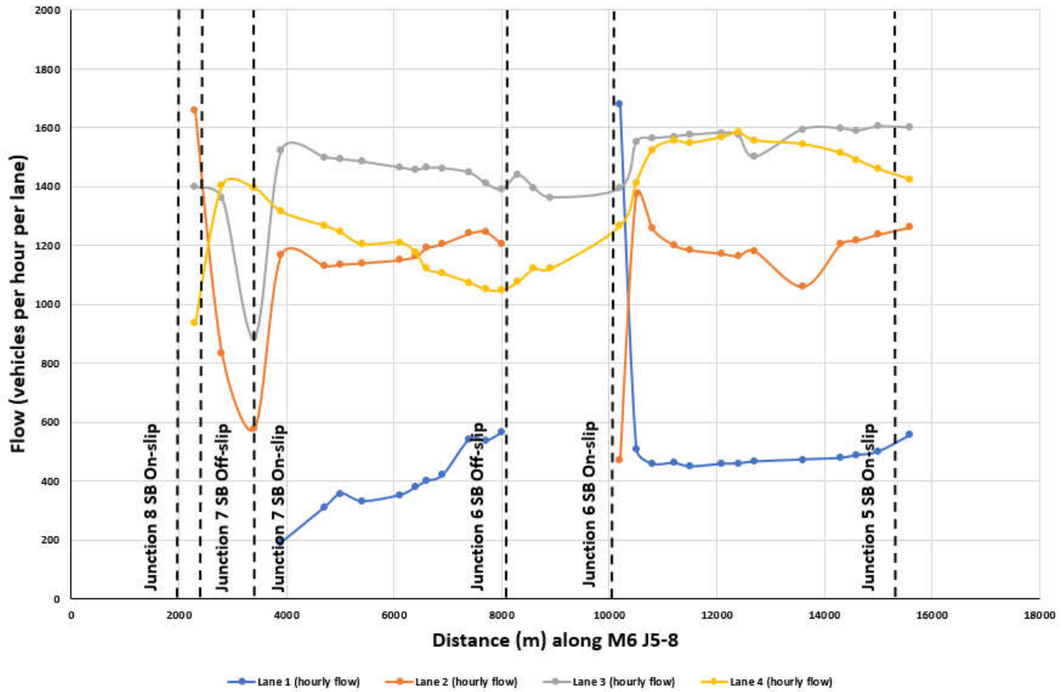


Figure 2-31 PM speed northbound (15:30 – 19:00) M6 J5 - 8

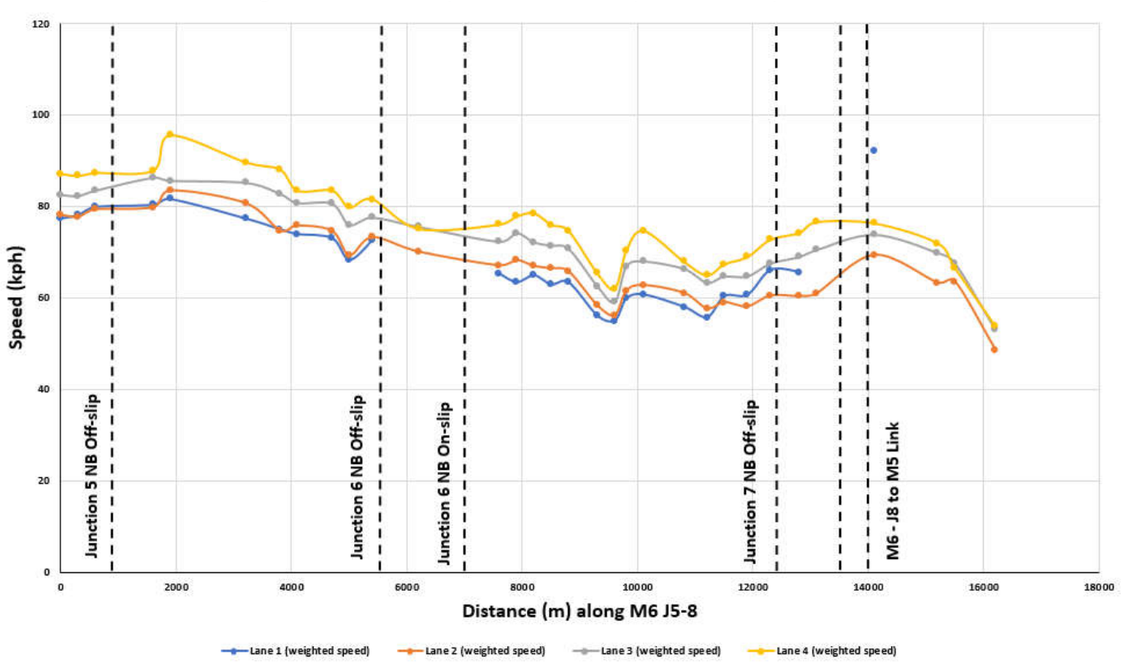
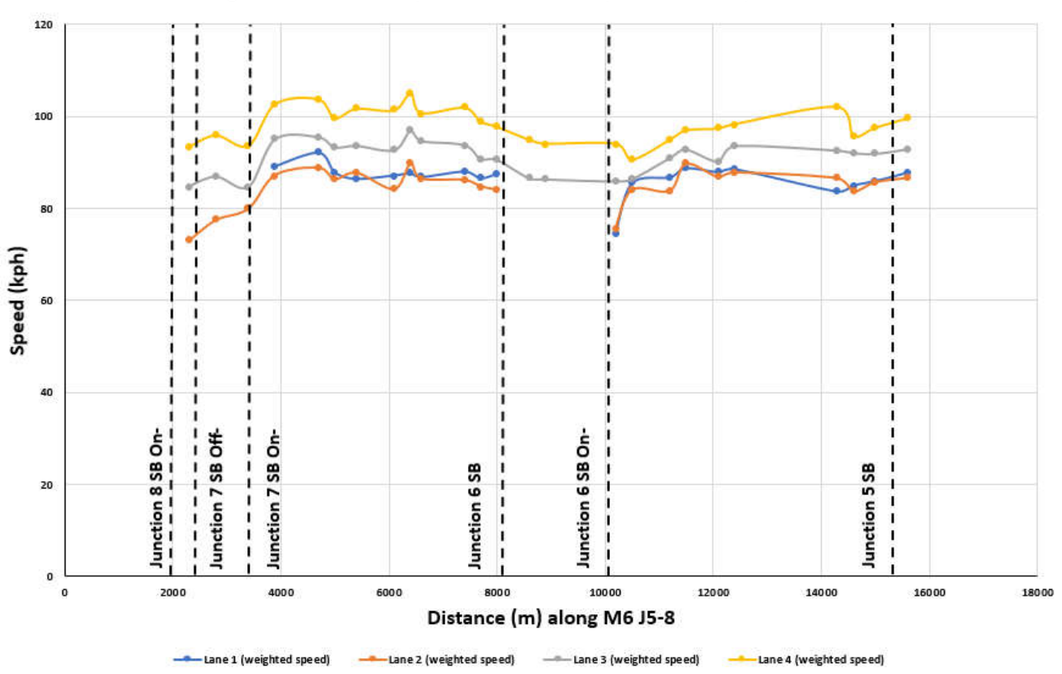


Figure 2-32 PM speed southbound (15:30 – 19:00) M6 J5 - 8



Journey Time Reliability

2.81. The reliability sub-objective includes the impact of the scheme on incidents and day to day journey time variability. Although average journey times have mostly increased on the M6 J5-8 after opening, a key objective for these sections is to improve driver experience by improving journey time reliability. This section assesses this objective.

2.82. Appraisal and monetisation of reliability are covered in the Economy section of this report.

2.83. The Client Scheme Requirements (CSR) setting out the need for the scheme indicated that journey time reliability between the M6 J5-8 was an issue, stating that:

- The journey time reliability measures showed that all links are consistently recording delays in excess of the national baseline;
- The capacity on the A38 (M) was such that flow breakdown happened on the A38 and queues quickly backed up onto the M6 J6 approaches; and
- Congestion on the M6 Northbound occurred due to two reasons, flow breakdown due to the peak queuing on M6 J6 approach and flow breakdown at the M6 J8.

2.84. Variability is the extent to which journey times vary from the expected average journey time on any day or time period. This distribution of journey times is considered to be a good indication of how much journey times vary. Evaluation of this was undertaken using the satellite navigation data to show the distribution of journey times before and after the scheme opened.

2.85. The distributions of the journey times are shown in Figure 2-29 and Figure 2-30 and the key points are:

- In both directions, the inter-quartile journey time range (difference between the 75th and 25th percentile) during the AM peak has reduced, indicating reliability has improved in this time period. Extreme journey times (95th percentile) have also reduced in both directions during the AM peak.
- It can also be noted that the shortest journey times (5th percentile) have lengthened slightly in all time periods and in both directions. This may be indicative drivers adhering more closely to the speed limits due to the visibility and frequency of the cameras.
- In the IP period, the inter-quartile journey time range during the IP has remained similar, suggesting that reliability has been unaltered as a result of the scheme during this period. There has been slight worsening of the extreme journey times southbound.
- During the PM peak, the inter-quartile range through the scheme has remained similar in both directions, suggesting that reliability is unchanged as a result of the scheme. The extreme journey time northbound has increased substantially during the PM peak, by 11 minutes and 45 seconds. Southbound the worst journeys (95th percentile journey times) have increased by 5 minutes and 43 seconds.

Figure 2-33 Journey time reliability M6 J5-8 northbound

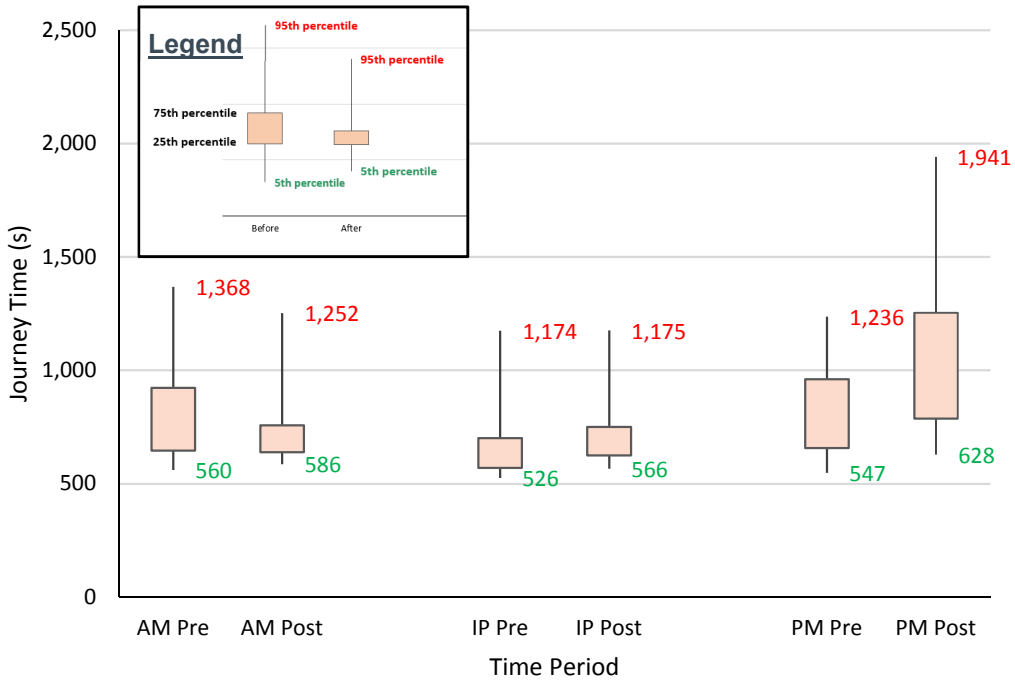
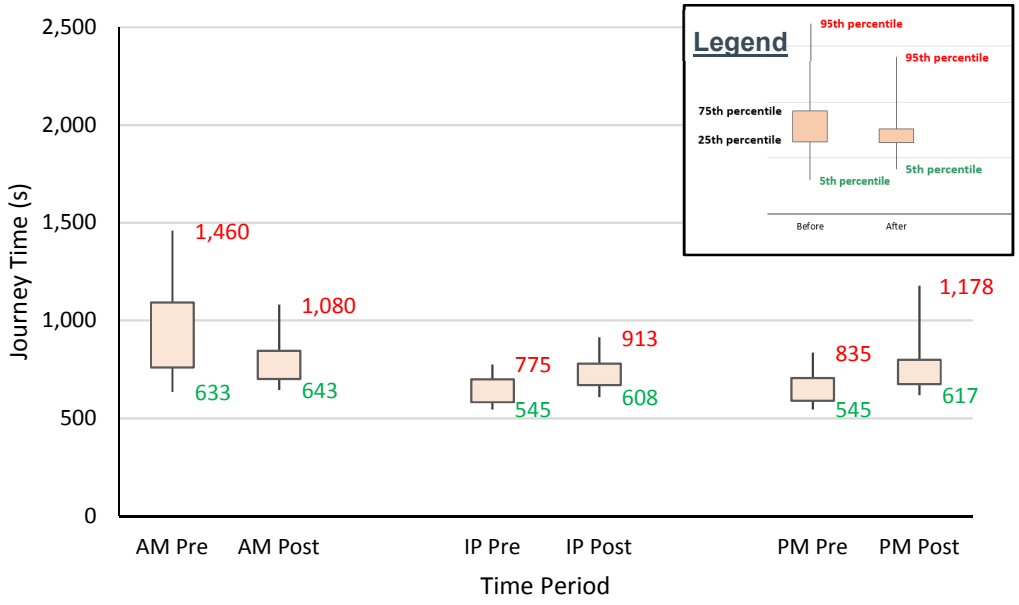


Figure 2-34 Journey time reliability from the M6 J5-8 southbound



Traffic Impacts - Key points

Traffic Flow impacts

- Changes in traffic flows on the mainline scheme sections are slightly higher than background growth in the region and for local roads during the same period.
- Flows on the adjacent sections of the M6 have (in general) seen lower growth than the scheme sections.
- HGV flows have grown in line with the general traffic on the mainline scheme sections following scheme opening.
- Local changes in traffic across an urban area are subject to many sources of interference. However, it is clear that local traffic has not seen the consistent increases in traffic that the mainline scheme section has, suggesting a moderate level of rerouting onto the motorway has occurred since the scheme has opened.

Traffic Flow Forecasting

- Traffic flow forecasting included growth in background traffic above the observed trend of regional traffic data. The forecasts for this scheme overestimated the traffic that would use the M6 corridor in the opening year.
- Across modelled AM, inter-peak and PM periods, the average increase on the M6 along the scheme section was forecast to be approximately 16%. In comparison, the observed average increase was 6%. This increase in traffic is likely a result of traffic being attracted to the M6 corridor as a result of the increased capacity provided by the scheme.
- Forecast levels of growth between the without scheme and with scheme scenarios has not occurred on the majority of scheme sections and junctions. Forecast levels of growth ranged from 0% to 33% and the highest level of growth observed is 19%, again suggesting little reassignment has actually occurred.

Journey Times

- There is reasonable evidence to suggest the impact of the scheme on journey times is determined by the pre-scheme speeds. On sections where average speeds were below 85kph in the pre-scheme period, speeds have remained the same or increased following scheme opening. On sections and in time periods where pre-scheme the average speed was in excess of 85kph, the average speeds have reduced in the post-scheme period.
- Improvements in journey times are observed in both directions in the AM peak periods. In these cases, there were particularly low speeds pre scheme.
- Where congestion was clearly evident before opening, the DHSR has had a positive impact on journey times, but at locations and times of less congestion, particularly in the IP, the use of the DHSR has had a negative impact on average journey times. The poor impact of the scheme upon the PM peak period suggests that the VMSL may not be being utilised to its best potential.
- When the hard shoulder is open to traffic, it is reasonable well-used with around 20% of the additional 25% capacity being used.

Operation of Smart Motorway

- The hard shoulder is in operation for over 80% of the AM and PM peak periods on the DHSR sections.

- Variable Mandatory Speed Limits (VMSL) are in operation for a similar proportion of time (as the VMSL are automatically set at a minimum of 60mph if the hard shoulder is open) primarily at a speed limit of 60mph.

- Analysis of flow and speeds by lane on the M6 J5 – 8 northbound indicate that use of the hard shoulder increases on the approach to the M6 J6 northbound, linked to the hard shoulder being used for Junction 6 (A38) only. Use of the hard shoulder is particularly high on approach to the M6 J6 southbound, this is linked to the hard shoulder being used as a long off-slip for Junction 6 (A38).

- Speeds across the route northbound and southbound are relatively consistent, with the highest speeds observed northbound between M6 J6-7 and southbound between M6 J5-6.

Journey Time Forecasting

- The forecast impact of the scheme upon journey times shows a large improvement expected in the opening year. Large traffic growth was forecast even without the scheme and therefore the forecast DM scenario expected large increases in average journey times. However, forecast traffic growth did not materialise and consequently, opening year changes in average journey times are not considered to reflect the benefits expected at OYA.

Reliability

- Reliability has improved in the AM peak in both directions as measured by reduction in the inter-quartile range of journey times. The length of the worst-case journey times have also reduced in both directions.

- It can also be noted that the shortest journey times (5th percentile) have lengthened slightly in all time periods and in both directions. This may be indicative of drivers adhering more closely to the speed limits due to the visibility and frequency of the cameras

- Inter-peak reliability is unchanged post opening.

- Post opening, reliability in the PM peak period has worsened in both directions.

3. Safety Evaluation

Introduction

3.1. This section examines the impact of the scheme on safety and how successful the scheme has been in addressing the objective of improving safety. The focus of this objective is to reduce loss of life, injuries and damage to property resulting from transport accidents and crime.

3.2. The Client Scheme Requirements (CSR) noted that the *"average collision rate for 2007 – 2009 is over 30% higher than the national motorway average"* and one of the Transport and Safety Objectives of the scheme is to *"reduce the number and severity of accidents per vehicle kilometre"*.

3.3. To assess the impact of the scheme on safety, this section of the report analyses changes in Personal Injury Collisions (PICs)[7] occurring in the five-year period before the start of construction compared to the available post-opening period. Evaluation of the scheme's impact on personal security has been undertaken through the use of observations made during a site visit.

Data Sources

Forecast Data

3.4. The forecast impacts of the scheme on safety have been obtained from the Birmingham Box Phase 3 Managed Motorways M6 Junctions 5 – 8 Economic Assessment Report (November 2011). The impact of the scheme on safety has been forecast using the Cost Benefit Analysis (COBA) program[8]. The COBA program considers the amount of traffic assigned to the network links and junctions and the accident rates on the links. The number of collisions are evaluated for the Do Minimum (without scheme) scenario and Do Something (with scheme) scenarios and a comparison is made to identify the change in the number of collisions and the economic impact of the change. The COBA assessment area was defined by including only network links identified as potentially experiencing a substantial change (5% change in flow or 100 vehicles per hour) in traffic flows between the DS and DM peak period assignments in the design year. Figure 3-1 shows the network covered in the COBA assessment[9] and identifies the following schemes that were assumed to be open in the opening year of the BBMM3 scheme:

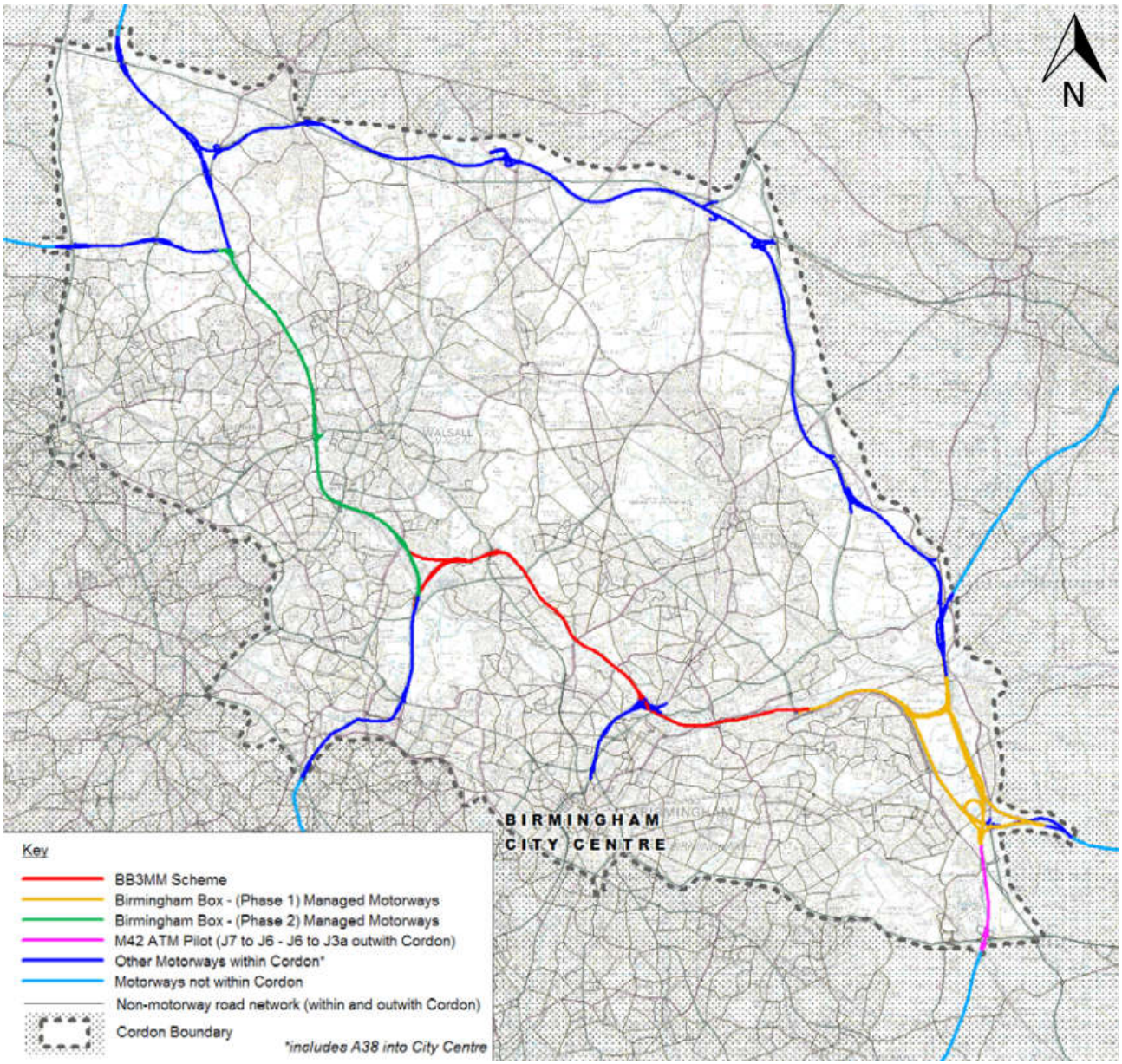
- M42 ATM Pilot scheme
- Birmingham Box Management Motorways Phase 1
- Birmingham Box Managed Motorways Phase 2

[7] Collisions previously referred to as accidents, naming convention has been changed in line with Highways England's current terminology.

[8] The version of COBA used to assess the impact is COBA11 R12, which includes changes required by TAG Units 3.5.6 and 3/3/5 (April 2011) incorporating NATA Refresh recommendations. These include changes to the economic parameters to include new values for forecast growth in the value of accidents.

[9] The COBA assessment used junctions and links combined rates and observed STATS19 data for 2005 – 2009.

Figure 3-1 Network extent covered in the COBA assessment



Observed Data

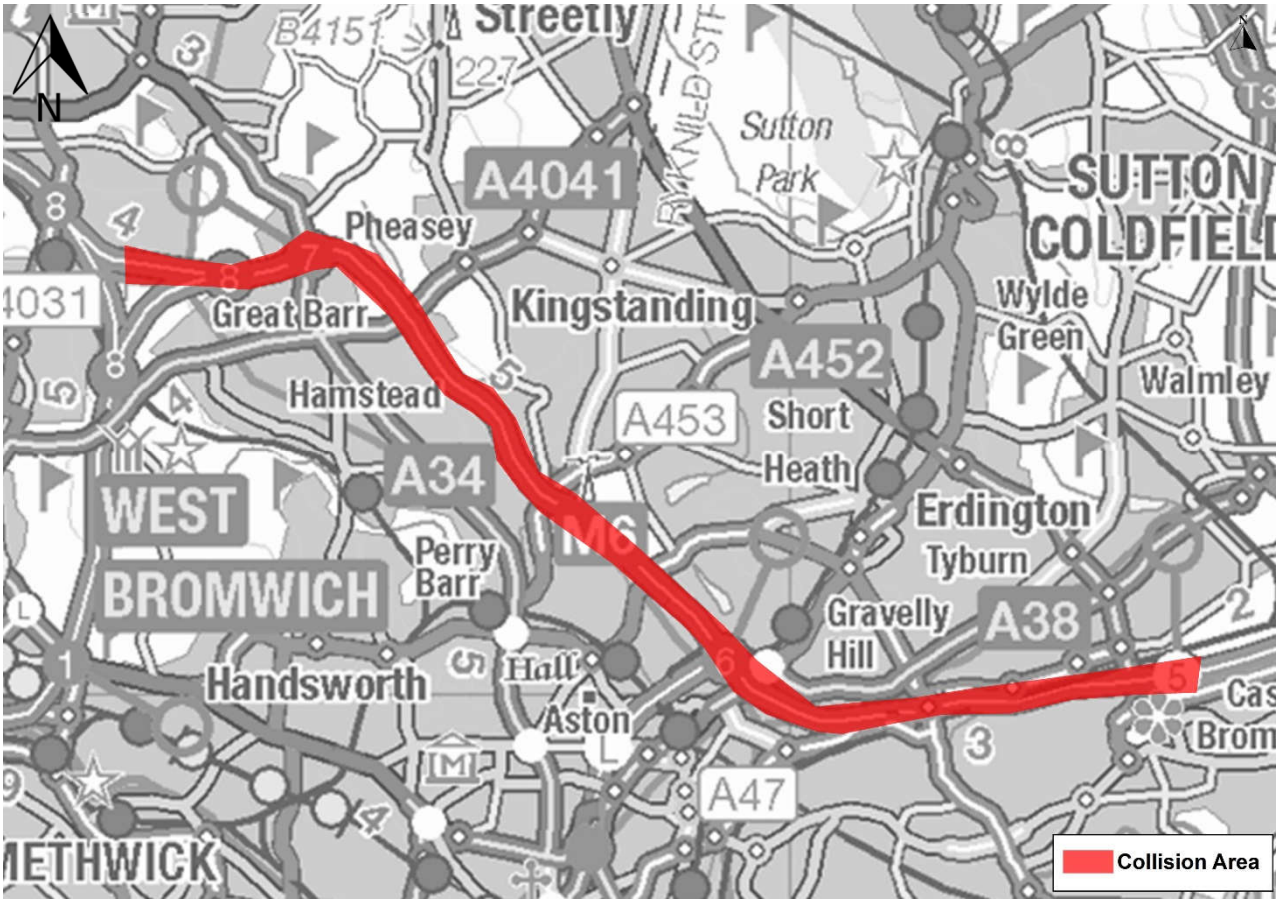
3.5. Collisions by their nature include random elements and are somewhat unpredictable events and therefore to ensure the scheme is the only known change, pre-scheme collision data has been obtained for the most recent five years before construction. Collision data has been obtained from the Department for Transport database for the area shown in Figure 3-2 for the period detailed below:

- **Before opening:** 1st January 2007 to 31st December 2011 *(60 months)*
- **Construction:** 1st January 2012 to 30th April 2014 *(28 months)*
- **After opening:** 1st May 2014 to 30th April 2015 *(12 months)*

3.6. The collision data is based on the records of PICs (i.e. collisions that involved injuries to one of more persons) recorded in STATS19 data as collected by the police when attending collisions. Collisions that do not result in injury are not included in this dataset hence are not considered in this evaluation. Only 12 months of post-opening data are used in this report and this should be considered when drawing conclusions.

3.7. Due to the size of the COBA area, at this early stage, a smaller area has been assessed as any changes over the COBA area post opening are very unlikely to only be linked to the scheme (due to random fluctuations and other roadworks in the area). Therefore, the analysis in this report focuses on the scheme section only, as shown in Figure 3-2. Note: analysis of the scheme section in this report does not include the scheme junctions i.e. slips and circulatory carriageway.

Figure 3-2 Geographic areas used in collision analysis



Background Changes in Collision Reduction

3.8. It is widely recognised that for much of the last decade, there has been a year-on-year reduction in the number of PICs on roads, even against the trend of increasing traffic volumes during much of the same period. The reasons for the reduction are considered to be wide ranging and include improved safety measures in vehicles and reduced number of younger drivers. This background trend needs to be considered when examining the changes in collision numbers. If the scheme had not been built, collision numbers in the area are still likely to have been influenced by wider trends and therefore reduced.

3.9. When the number of collisions in this area in the years before (pre-scheme) and after (post-scheme) the scheme was built are compared, the change in the number of collisions, once the change in the area is considered, can be primarily linked to the scheme. The best way to do this is to assume that, if the scheme had not been built, the number of collisions on the roads in the study area would have dropped at the same rate as they did nationally during the same time period. This gives what is known as a “counterfactual” scenario. The counterfactual scenario (without scheme) can be compared on a like for like basis with post-opening (with scheme) scenario.

3.10. The difference between the numbers of collisions in these two scenarios can then be attributed to the scheme rather than the wider national trends. This result will inform the calculation of monetised safety benefits achieved by the scheme as discussed in the economy chapter of this report.

3.11. The counterfactual scenario compares the national collision data[10] in the pre-scheme period (annual average) to the post-scheme period (annual average) for collision numbers and collision rates. The statistics analysed extend to 2014, this is in order not to capture any collissions that occurred during the construction period. Table 3-1 illustrates there has been an 18% reduction in collision numbers on motorways between the pre-scheme and post-scheme period. This reduction has been applied to the pre-scheme opening collision numbers to create the counterfactual scenario.

Table 3-1 Number of collisions on motorways in GB

Year	Collision Evaluation Period	Number of collisions on motorways 2007 to 2014	Annual Average
2007	Pre-Scheme	7,976	6,837
2008		7,249	
2009		6,643	
2010		6,500	
2011		5,819	
2012	Construction Period	5,615	NA
2013		5,397	
2014	Post Scheme	5,630	5,630
Counterfactual (difference between pre-and post-scheme annual average)			**-18%**

Observed Collision Numbers

3.12. This section analyses observed changes in the number of PICs following the implementation of the scheme and includes investigation of changes in the relative severity index.

3.13. In addition, to determine whether the changes in collision numbers observed before and after the scheme opened are statistically significant, a Chi-square test has been undertaken for the scheme section. This test uses the without scheme counterfactual collision numbers (pre-scheme) and post-scheme collision numbers to establish whether the changes are significant and related to the scheme, or are likely to have occurred by chance.

3.14. Table 3-2 presents the change in collisions on the scheme section since the scheme opened in April 2014.

Table 3-2 Number of collisions by severity on M6 Junction 5 – 8

Period	Date Period		Collision Severity			Total	Annual Average				Severity Index
	From	To	Fatal	Serious	Slight		Fatal	Serious	Slight	All	
Pre-scheme	Jan 2007	Dec 2007	0	9	76	85	0.4	5.2	54.4	60.0	9%
	Jan 2008	Dec 2008	1	8	59	68					
	Jan 2009	Dec 2009	0	1	45	46					
	Jan 2010	Dec 2010	1	4	48	53					
	Jan 2011	Dec 2011	0	4	44	48					
	Application of without scheme counterfactual (-18%)									49.4	
Post-scheme	May 2014	April 2015	0	3	56	59	0.0	3.0	56.2	59.2	5%
Total Annual Collision Saving										**9.8**	**-**

[10] National trend data is sourced from DfT Table RAS10002.

3.15. The results in Table 3-2 show:

- The raw data shows the number of collisions in the post-opening period is 0.8 lower than the annual average before, a 1% saving.
- With the counterfactual reduction of 18% applied, there has been a net increase of 9.8 (20%) in the number of collisions per annum, increasing from 49.4 per annum in the pre-scheme period to 59.2 in the post-scheme period.
- The severity index is the proportion of the total collisions classed as serious or fatal. This shows that whilst the total collisions has increased, the proportion which were fatal or serious has reduced from 9% in the pre-scheme period to 5% in the post-scheme period.

Statistical Significance

3.16. In order to determine whether the reduction in the annual collision numbers and collision rates observed on the scheme section before and after the scheme opened are statistically significant, a Chi-squared test has been undertaken.

3.17. Significance testing found the increase in collisions in one year post opening is not significant at the 95% confidence level, and is likely to have occurred by chance alone hence the increase is not a direct result of the scheme implementation.

3.18. The statistical significance test for collision rates uses the without scheme counterfactual and post-opening number of collisions alongside AADT flows to establish whether the changes in collision rates are significant and likely to be related to the scheme or to have occurred by chance alone. The results of the significance testing for collision rates is shown later in this chapter.

Collision Rates

3.19. The number of collisions along a length of road used together with AADT for the same section can be used to calculate a collision rate, known as PIC per million vehicle kilometres (mvkm). By looking at the rate it is possible to identify the impact of the scheme, eliminating any potential impact of traffic volume changes. As per the approach used to calculate a counterfactual for collision numbers, a counterfactual collision rate has also been calculated using DfT data. The results indicate that between the pre-scheme and post-scheme period, there has been a 20% reduction in collision rates nationally on motorways. The counterfactual rate is therefore 0.80. Table 3-3 shows the change in collisions rates following the scheme opening of the M6 Junction 5 – 8 Smart Motorway scheme.

Table 3-3 Collisions rates on M6 J5-8 (scheme sections)

Scenario	PICs/mvkm)
Pre Scheme	0.072
Without scheme counterfactual (includes application of background reduction of 0.80) (0.80)	0.061
Post Opening	0.070
Saving	**0.010 (14.75%)**

3.20. Table 3-3 also shows that between without scheme counterfactual scenario and post-opening, there has been an increase in collision rate of 0.010 PICs/mvkm. Statistical significance testing shows the increase in collision rates is not significant at this stage.

Fatalities and Weighted Injuries

3.21. The collision rate discussed previously and shown in Table 3-3 does not take into account the severity of collisions. To analyse this, the Fatalities and Weighted Injuries (FWI) metric, which is a combined measure based on the number of fatal, serious and slight casualties, is presented. The FWI for the three years before and one years after opening periods are shown in Table 3-4 for the M6 J5-8. To take into account the increased traffic on the M5 J5-8 and for comparison with other schemes, the metrics for per billion vehicle kilometres (bvkm) and billion vehicle miles (bvm) are also presented. It should however be noted that these figures do not take account any background reductions in numbers of casualties or collisions.

Table 3-4 FWI on M5 J5-8 (scheme section)

Period	FWI/collision	FWI/year	FWI/bvkm	FWI/bvm
Before (three years)	0.032	1.904	3.815	6.140
After (one year)	0.025	1.490	1.768	2.845

3.22. The results show that the FWI metrics have reduced following scheme opening.

Forecast vs Outturn Collision Numbers

3.23. The EAR provides details of the expected savings in the number of collisions over 60 years and across the area shown in Figure 3-1 as follows:

- Do Minimum total collisions: 256,149
- Do Something total collisions: 255,083
- Saving over 60 years with scheme: -1,066 (-0.4%)

3.24. The associated monetary benefit for this saving was forecast to be £40.377m over 60 years.

3.25. In terms of opening year forecast savings, no information is available in terms of the change in the number of collisions. Therefore, in this evaluation, no comparison has been made against the COBA area forecasts for the opening year. The EAR does state that '*it is assumed, in line with current recommendations, that the local accident rate on the scheme route will be reduced by 15% as a result of the application of Managed Motorways with its surveillance and control facilities'*.

3.26. In the absence of forecast collision numbers for the DM and DS scenarios in the opening year, the forecast reduction in collision rate of 15% on the M6 Junctions 5-8 have been compared to the observed percentage reduction in collision rate. Table 3-5 below shows there has been virtually no change in collision rate at 0% (an increase of 0.005 collisions per annum), which is statistically insignificant and lower than the impact forecast of 15%.

Table 3-5 Comparison of forecast and observed collision rates (PIC/mvkm)

Scenario		M6 J5-8
Forecast	Do Minimum (without scheme)	-
	Do Something (with scheme)	-
	Saving	**-**
	% Change	**15%**
Observed	Pre Scheme	0.072
	Pre Scheme (Counterfactual without scheme)	0.061
	Post Opening	0.070
	Saving	-0.010
	% Change	**-15%**

Other Monitoring

3.27. A Three Month Operational Safety Monitoring report of M6 J5 to 8 smart motorways Birmingham box phase 3 (October 2014) produced by Mouchel on behalf of Highways England was made available to POPE. This assessment uses various sources of information including HALOGEN data, traffic count data, Regional Control Centres (RCC) observations and Emergency Roadside Telephone (ERT) logs. The operational review covered several monitoring items including:

- Compliance (speed and hard shoulder);
- Use of Emergency Refuge Areas (ERAs);
- Number of vehicles stopping on the hard shoulder and in live lanes;
- Maintenance and repair;
- Frequency of incidents; and
- Assessment of specific scheme sections (e.g. Junction 5 northbound through diverge running).

3.28. Table 3-6 presents the key findings in relation to the items monitored in the Three Month operational safety monitoring report of M6 J5 to 8 smart motorways Birmingham box phase 3 (October, 2014).

Table 3-6 Items monitored and key findings (taken from Operational Safety Monitoring Report, October 2014)

Item Monitored	Summary of Findings
Compliance	Speed Compliance Speed limit compliance levels are generally below those recorded for the M42 ATM (Active Traffic Management) and BBMM1 (Birmingham Box Managed Motorways Phase 1) schemes. Compliance levels are similar to those on the M25 controlled motorway. Hard shoulder Compliance (dynamic sections) The levels of HS non-compliance are comparable to M42 and BBMM1. Levels of misuse are significantly higher towards the end of links on the approach to J6. Compliance has declined in month 3 on the northbound approach to J6. Hard shoulder Compliance (within junctions) There were Initial reports of hard shoulder misuse within J6, though subsequent feedback and analysis has not identified particular issues.
Emergency Refuge Areas (ERAs)	The frequency of ERA use and risk associated with exit from ERAs was found to be consistent with the assumptions and risk scores in the hazard logs. ERA usage was found to be significantly lower between J5 and J6 on the elevated section, despite greater ERA spacing compared with other ERAs within the scheme.
ERT usage outside ERAs on Bromford Viaduct	The highest levels of ERT usage on Bromford was found to be from those ERTs within ERA. ERT usage on Bromford has not caused any particular operational issues.
Perry Barr - access and egress	No high-risk access or egress manoeuvres were observed (59 diverges / merges), the vast majority were deemed low risk. No incidents have been reported relating to Perry Barr depot.
J6 southbound – 2 x 2 lane layout southbound	Weaving was observed on the approach to this junction but was within expected tolerances. A slight downward trend in the level of weaving and “high risk” manoeuvres was observed. No incidents have been reported in the area approaching the diverge. Traffic conditions typically remain free flowing which helps to mitigate against weaving hazards.
J5 southbound - through merge running	Weaving and hard shoulder non-compliance are within the expected tolerances at this item. There has generally been free flowing traffic seen at J5 TMR (even at peak times) which assists the mitigation against the hazards of weaving (vehicles collisions, near misses etc.).
J5 northbound – through diverge running	Both weaving and hard shoulder non-compliance are within the expected tolerances. A small minority of motorists continue to undertake late weaving.
J7 to J8e northbound weaving	The layout has remained unchanged from the pre-scheme layout. Weaving is observed to occur over this short link but is within expected boundaries.
Hard shoulder availability	With the exception of the specific issues on the J6 to J5 link which have now been resolved the non-availability of the hard shoulder resulting from technology faults appears to be broadly in line with those experienced on the M42 J3a to J7 scheme.
Number of vehicles stopping on the hard shoulder and in live lanes	The frequency of vehicles stopping on the hard shoulder and in live lanes is below those assumed within scheme hazard logs.

Incident frequency	The data analysed covered just three months of operation and is therefore insufficient to provide long term confidence in the findings. The results are promising and though incident rates remain above the national average they tentatively suggest a downward trend from pre-scheme levels.
Emergency services access	The mean traffic officer arrival time since the opening of BB3 is 11 minutes and 8 seconds. Overall, there has been an overall decrease in incident response times from month 1 to month 3.
Bromford Viaduct CCTV (vibration)	The quality of CCTV footage on the elevated Bromford viaduct section is not significantly affected by vibration and is sufficient for its intended usage.
Maintenance and Repair	Remote Monitoring - The maintaining agent has highlighted some issues with road side controllers affecting the functionality of remote monitoring with further engagement recommended as next steps. Carriageway Surface - Bridge and viaduct joints have been replaced. The carriageway has also been re-surfaced throughout. There does not appear to have been any operational or safety issues associated with carriageway surface.
RCC workload	The RCC are managing the additional workload introduced by the scheme and there does not appear to have been any operational or safety issues associated with the RCC resourcing levels.

Security

3.29. The aim of this sub-objective is to consider both the changes in security and the likely number of users affected by the changes. For highways schemes, security includes the perception of risk from damage to or theft from vehicles, personal injury or theft of property from individuals or from vehicles. Security issues may arise from the following:

- On the road, itself (e.g. being attacked whilst broken down).
- In service areas/ car parks/ lay-bys (e.g. vehicle damaged while parked at service stations or attacked whilst walking to a parked car).
- At junctions (e.g. smash and grab incidents whilst queueing at traffic lights).

3.30. The primary indicators for personal security on roads include:

- Surveillance
- Landscaping
- Lighting and Visibility
- Emergency call facilities
- Cyclists and pedestrian facilities

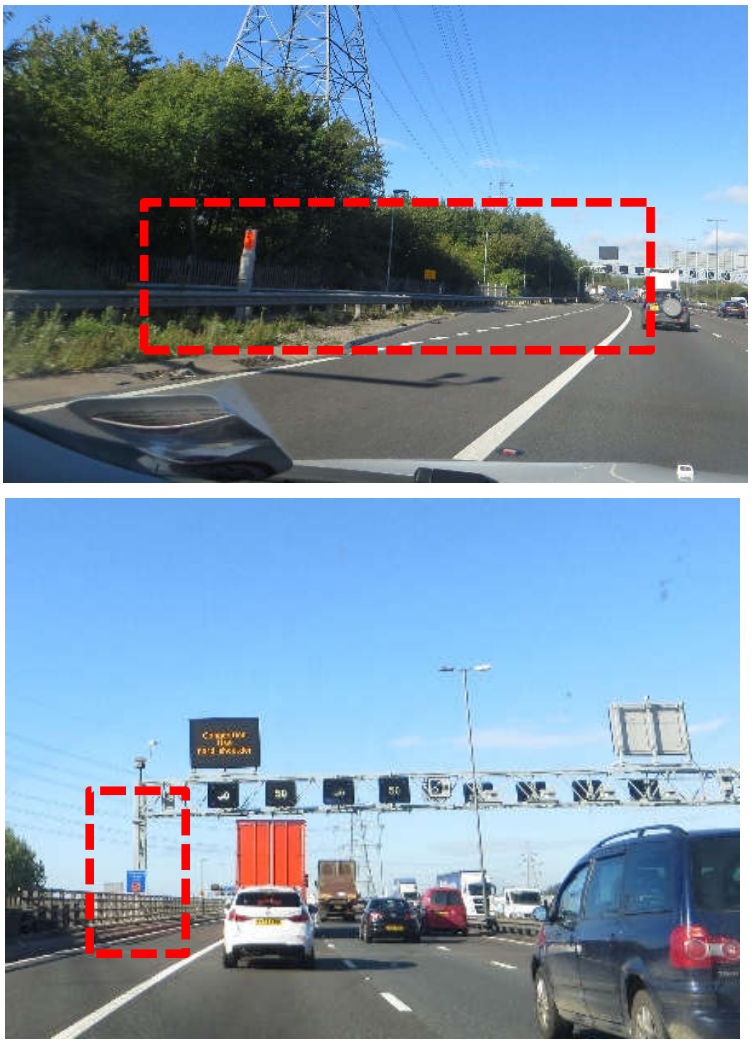
Forecast

3.31. The scheme AST scored the sub-objective slight beneficial and states *"although MM provides less hard shoulder provision for emergencies, the improved monitoring and control of traffic should improve security for road users".*

Evaluation

3.32. As shown in Figure 3-3, CCTV cameras and Emergency Refuge Areas have been provided in line with the AST. Overall, the impact of the scheme is considered to be "Slight Positive", as expected.

Figure 3-3 Additional CCTV cameras and emergency refuge area



Safety Impacts - Key points

Collisions

- Post opening, no fatal collisions have been recorded, and the number of serious collisions have also reduced. This results in the proportion of fatal and serious collisions reducing from 9% observed in the pre-scheme period to 5% observed in the post-scheme period. However, the average number of collisions (of all severities) has increased by 9.8 per annum with the counterfactual applied.
- Significance testing found the increase in collisions is not significant at the 95% confidence level and hence should not at this stage be linked to the scheme implementation.

Forecast vs. Outturn Collision Rate Savings

- The M6 J5-8 scheme section had a forecast collision rate saving of 15%.
- With the background changes in collisions accounted for, there has been around a 15% increase in collisions on the M6 J5-8 since the scheme opened. These results show the scheme has not had the saving forecast.

Personal Security

- The impact of the scheme on personal security is scored as slight beneficial (as forecast in the AST). The outturn score is balanced between the loss of hard shoulder provision, but additional installation of CCTV cameras, Emergency Refuge Areas and Controlled Motorway.

4. Economy

Introduction

4.1. The purpose of this chapter is to evaluate how the scheme is performing against the economy objective which is defined in WebTAG as:

"To support sustainable economic activity and achieve good value for money".

4.2. The economy sub-objectives are:

- To achieve good value for money in relation to impacts on public accounts.
- Improve transport economic efficiency for business users and transport providers.
- Improve transport economic efficiency for consumer users.
- Improve reliability.
- Provide benefits wider economic impacts.

4.3. Scheme appraisal consists of an economic assessment to determine the scheme's value for money. This assessment is based on an estimation of costs and benefits from different sources:

- Transport Economic Efficiency (TEE) benefits (savings related to travel times and vehicle operating costs).
- Collisions costs (saving related to number and severity of collisions).
- Costs to users due to delays during construction and future maintenance periods.
- Cost of building the scheme and;
- Cost of operating the scheme over its lifetime.

4.4. This section provides a comparison between the outturn costs and benefits and the forecast economic impact, as well as considering the wider economic impacts of the scheme. Outturn journey time and safety economic impacts are based on analysis presented in Chapters 2 and 3.

Sources

4.5. The following information has been used to inform the economic assessment in this chapter:

- BBMM3 M6 Junctions 5 – 8 Economic Appraisal Report (EAR) (November, 2011);
  - EAR (as above) Appendix A – Cost Estimate;
  - EAR (as above) Appendix E – TUBA; and
- Observed impacts on traffic and safety as noted in previous chapters.

4.6. Forecast benefits are presented for a 60-year appraisal period based on a 2016 opening year for the M6 between J5-8 scheme. Note: forecasts based upon traffic flows are presented for the whole scheme but are calculated based upon changes between the M6 J5-7, as such outturn evaluation is based upon this section only (but are attributed to the whole scheme). All monetary values are presented in this chapter are in 2002 prices discounted to 2002 unless otherwise stated. As stated in Chapter 2, the forecasts included a 2016 OYA scenario, however the scheme opened in January 2014 and the outturn 60 year benefits are presented based on a 2014 opening year.

Forecast Present Value Benefits

4.7. The appraisal of this scheme considered the economic impact in terms of present value. A summary of the predicted scheme impacts from the EAR is shown in Table 4-1.

Table 4-1 Economic impact of scheme

Benefits – in £m 2002 market prices, discounted	Forecast £m (EAR)	Evaluate?	Evaluation Approach
Journey Times	360.052	Yes	Represents a considerable proportion of the overall scheme benefits. Outturn journey time impacts in opening year can be calculated using observed changes in vehicles hours and forecasts.
Vehicle Operating Costs	0.939	Yes	Outturn impact of VOC can be calculated based on changes in fuel consumption monetised to calculate a proxy outturn reforecast value of VOC.
Safety	38.377	Yes	Safety impact not monetised as shown in safety chapter it is not to be statistically significant.
Construction Delay	-62.906	No	Evaluation is outside of the remit of POPE; therefore, outturn is assumed as forecast.
Maintenance Delay	29.942	No	Evaluation is outside of the remit of POPE; therefore, outturn is assumed as forecast.
Carbon Benefits	2.480	Yes	Ratio between forecast and outturn opening year carbon impact used to calculate 60 year reforecast
Noise Impact	-11.220	No	Very small proportion of the overall scheme impacts.
Operating Costs (private toll revenue)	-36.725	No	Evaluation is outside of the remit of POPE; therefore, outturn is assumed as forecast.
User Charges	61.600	No	Evaluation is outside of the remit of POPE; therefore, outturn is assumed as forecast.
PVB Subtotal	**382.539**		
Indirect tax impact as a benefit	-25.575	Yes	Calculate outturn change in fuel consumption and use ratio against forecast change to reforecast 60-year benefit.
Total PVB	**356.964**		
Reliability	26.500	No	INCA model was not provided to POPE and hence no recalculation can be made

Journey Time Benefits

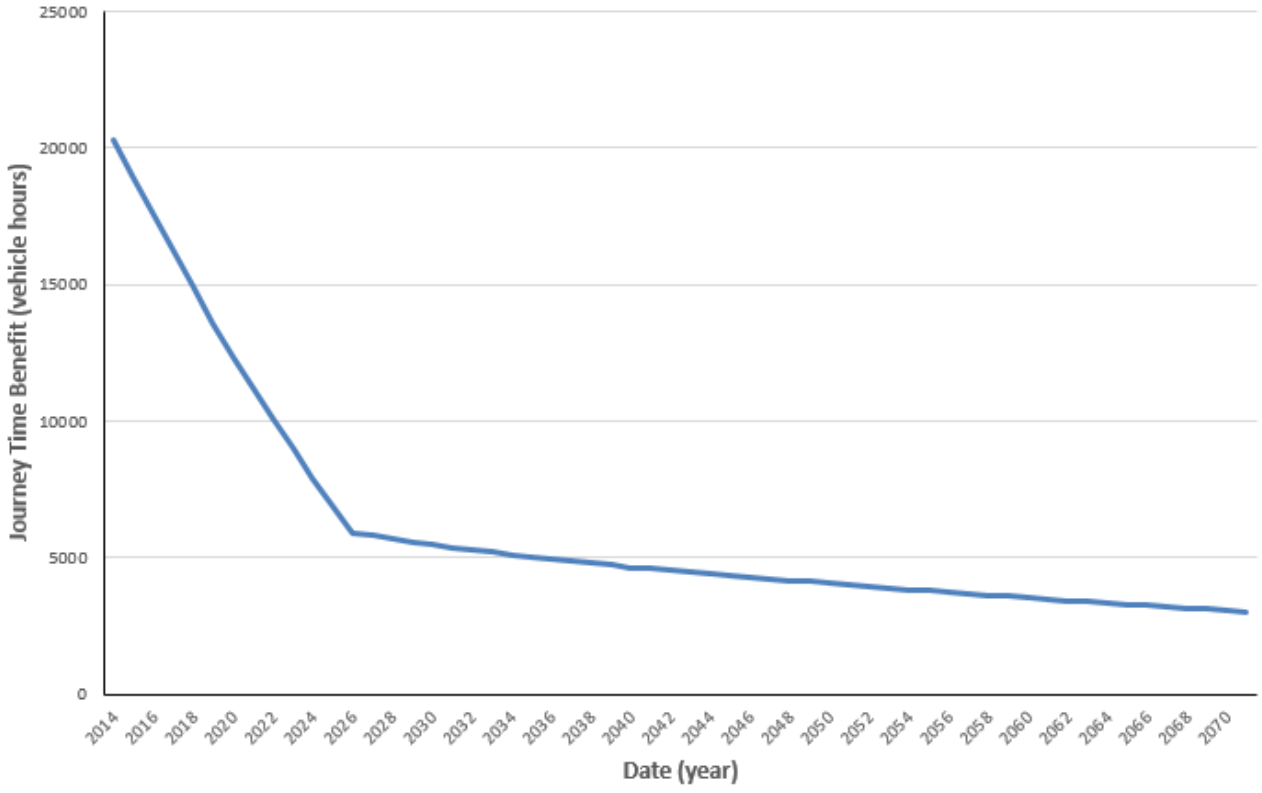
Forecast

4.8. Forecast journey time benefits for this scheme were derived from the PRISM transport model using the Department for Transport (DfT) TUBA (Transport User Benefit Analysis) program. Table 4-1 shows the forecast journey time benefit was approximately £360 million. This forecast was based on the assumption that the components on the mainline would operate in the weekday morning, inter-peak and evening peak periods but not in the off-peak period or at weekends. The EAR included analysis of the total hours when hourly flows would be in excess 4,500 vehicles per hour (kph) in 2016 and 2031 to establish when the HSR would be active. The results showed in 2016 the HSR would:

- Be active for most of the peak period hours on all links.
- Be active for long periods of the interpeak.
- Rarely be active in the evenings, overnight or on weekends.

4.9. The forecast journey time benefits have been taken from TUBA and presented over time in Figure 4-1. It is interesting to note that the majority of forecast journey time benefit from the scheme was expected to occur during the first 14 years post-opening.

Figure 4-1 Forecast journey time benefits over time



Evaluation

4.10. The POPE method of evaluating the economic value of the benefits derived from vehicle hour savings is built upon comparing the observed vehicle hour savings based on average journey speeds before and after opening.

4.11. This evaluation focusses on key links on the M6 between J5-8. The methodology detailed below (profile approach) was applied to obtain a POPE re-forecast for the 60-year journey time benefits:

- The total forecast vehicle hours saved in the first year post opening on the key links was calculated using forecast flows, speeds and journey times from the traffic forecasting report.
- The observed vehicle hours saved over the scheme section, was calculated using observed traffic flows and observed journey times from the opening year and one year after opening (2016).
- The predicted monetary vehicle hour benefit was taken from the EAR for the whole appraisal area.
- The actual vehicle hour saving was calculated using observed pre- and post-scheme flows and observed journey time data.
- The ratio between the forecast opening year vehicle saving and observed opening year vehicle saving along the M6 scheme section was applied to the forecast opening year monetised benefit from the TUBA appraisal. This assumes that the accuracy of journey time savings over the scheme section are representative of the wider modelled area.
- The profile method has been used to factor the observed opening year benefits to the full 60-year appraisal period. This method applies the absolute difference between the forecast and observed benefits in the first year post opening to the TUBA benefits profile for the remaining years of the appraisal period. It considers the difference between the observed and modelled benefits as an absolute difference rather than proportionally.

4.12. The modelled periods consisted of the annualised periods shown in Table 4-2:

Table 4-2 Annualisation factors

Year	Annualisation Factor (hours applied)
	2016
AM	608
IP	1,469
PM	858
OP	255

4.13. Table 4-2 shows that in comparison with the amount of hours in each of the time periods e.g. the AM peak period accounts for two and a half hours, the off-peak period (which accounts for 12 hours of the day) has an extremely low annualisation factor. This indicates that the off-peak period accounted for a very small proportion of the forecast benefits and thus the off-peak period has not been accounted for in our evaluation of the journey time benefits.

4.14. Therefore, to allow a like-for-like comparison with the economic appraisal, vehicle hour savings were considered for the modelled periods as below:

- Weekday AM peak (07:30 – 09:30)
- Weekday IP (09:30 – 15:30)
- Weekday PM peak (15:30 – 19:00)

4.15. The opening year reforecast and observed vehicle hour savings for the mainline M6 traffic are shown in Table 4-3:

Table 4-3 Opening year vehicle hour savings

Scheme Section	Forecast	Observed
M6 between J5 and J8	1,370,629	-355,302

4.16. Table 4-3 shows that despite the forecast vehicle hour saving, vehicle hours for the scheme post opening have increased.

4.17. The difference between the forecast and outturn vehicle hour savings in the opening year has been applied to the forecast monetary journey time benefits (using the profile in the appraisal) to calculate the outturn as shown in Table 4-4.

Table 4-4 Forecast and outturn estimate 60-year journey time benefits

Scheme Section (2002 prices, discounted to 2002)	Forecast	Outturn
M6 between J5 and J8	£360.052m	-£310.940m

4.18. As shown in Chapter 2, post-scheme opening journey times have increased and average speeds reduced across the entire scheme section in both directions. A more detailed breakdown of speed and journey time changes shows the scheme has been successful at reducing journey times and increasing average speeds in AM Peak. Table 4-4 shows forecast journey time benefits were estimated to be £360m but that outturn result was a £311m dis-benefit. As stated previously the forecast journey time benefits were based upon the assumption that the components on the mainline would operate in the weekday morning, interpeak and evening peak periods but not in the off-peak period or at weekends. The above scenario has (in general) materialised however, the negative outturn benefit is largely due to an increase in average journey times post-scheme opening in the PM Peak, which in turn is a reflection of congestion levels in the opening year being lower than expected.

4.19. Evidence in Chapter 2 shows the scheme has increased average journey times across the day in both directions (with the exception of the AM peak periods) and hence congestion needs to increase or the operation of SM needs to be more efficient for benefits to accrue. The benefits displayed in Table 4-4 have been calculated by capitalising the first-year benefits to generate the 60-year benefit stream, however, these results are conservative and assume the scheme performance in the first year is representative of the future 60 years. Large benefits were expected from the opening year (as shown in Figure 4-1), therefore based on the forecast profile (assuming the observed opening year is valid), this indicates that the forecast benefits will not be accrued.

Vehicle Operating Costs

4.20. WebTAG guidance states that the use of the road system by private cars and trucks gives rise to operating costs for the user. These are fuel and non-fuel costs, where fuel is the majority cost. In the case of this scheme, the forecast changes in Vehicle Operating Cost (VOC) are a small positive benefit for users and make up a minimal part of the overall forecast TEE benefits.

4.21. VOC impact has been evaluated by looking at the changes in fuel consumption across the opening year. As with indirect tax, the VOC evaluation has utilised the ratio between EAR forecast and POPE reforecast changes in fuel use and applied this to the monetary forecast in order to provide an outturn result. The result of the ratio applied to monetary VOC forecasts is shown in Table 4-5:

Table 4-5 Summary Vehicle Operating Costs 60 year benefits

Scheme Section (2002 prices, discounted to 2002)	Forecast	Outturn
M6 between J5 and J8	£0.939m	£0.103m

4.22. The TUBA model forecast that the scheme would deliver a small benefit to VOC for users, which is likely to be due to decreased fuel consumption, however the outturn impact is a negligible benefit of £0.103 million. This is due to the balancing of variations in average speeds impacts and limited changes in traffic flows, compared to the forecast traffic flow increases.

Safety Benefits

Forecast

4.23. Forecast collision benefits for the scheme are taken from the EAR, which showed a safety benefit of £38.377 million (2002 prices and discounted values). This forecast impact was based on a COBA assessment of the cordoned area as specified in Chapter 3 and construction dis-benefits and benefits during future maintenance. Construction dis-benefits and benefits during future maintenance were calculated using the DfT's Queues and Delays at Roadworks (QUADRO) program. QUADRO is the DfT program used to evaluate the likely cost to road users during construction of the scheme, it also used to evaluate the relative delay cost to road users during future major maintenance.

Evaluation

4.24. The evaluation of outturn safety benefits is based on the forecast 60-year appraisal period safety benefits and the comparison between the forecast and observed number of collisions saved in the opening year. The economic impact of changes in safety is calculated by assigning monetary benefits to the predicted reduction in the number and severity of personal injury collisions over the appraisal period.

4.25. Chapter 3 reported that although an increase in collision numbers and rates has been observed on the M6 mainline between Junction 5 and 8, there is no statistical significance and therefore no confidence that this change can be attributed to the scheme. As such there is no outturn monetised reforecast made. It should be noted that this analysis is based on a limited sample size and will be revisited during the FYA for this scheme, when there will be a larger post opening sample size.

Carbon Impact

Forecast

4.26. The impact of the scheme on greenhouse gases (change in carbon outputs) is considered in detail in the next chapter of the report. At the time this scheme was appraised, an output from the TUBA model was a monetary value for the change in carbon emissions. Estimates for the value of the additional global damage arising from an additional tonne of carbon being emitted into the atmosphere are referred to as estimates of the Shadow Price of Carbon (SPC). WebTAG also states that guidance suggests a shadow price per tonne of carbon is £25.50/t CO2 in 2007 prices and values, rising by 2% in per year in real terms. The forecast TUBA monetised impact over the 60-year appraisal period was calculated to a benefit of £2.480m, meaning a decrease in carbon consumption was forecast.

Evaluation

4.27. A reforecast of carbon emissions for the DM and DS scenarios at OYA has been calculated using current DMRB methodology (which covers all periods of weekday and weekends). Outturn carbon emissions were calculated using the same methodology for the DM and DS scenarios, using observed traffic flows, HGV proportions and speed data collected for this study. The results from the carbon emission assessment are as follows:

Table 4-6 Carbon evaluation (tonnes/year)

Scenario	Reforecast	Observed
DM/Without Scheme	41,677	38,161
DS/Post-Opening	50,143	38,516
Net Difference	8,466 (20%)	355 (1%)
Ratio	0.05	

4.28. Table 4-6 shows that observed carbon emissions have seen little change between the DM and DS scenarios, equivalent to 355 tonnes of carbon, where as in the reforecast the carbon emissions showed an increase between DM and DS scenarios of 20%, equivalent to 8,466 carbon tonnes. Table 4-6 also shows that the ratio between the net difference (DS minus DM) for the observed and reforecast is 0.05. This ratio can be applied to the forecast monetised carbon benefits of £2.480m to provide an outturn estimate of the benefits from implementing the scheme.

4.29. The outturn benefit is shown below in Table 4-7:

Table 4-7 Carbon impact

£m 2002 prices discounted to 2002	Forecast	Outturn
Carbon	£2.480m	£0.114m

4.30. Table 4-7 shows that the forecast benefits from carbon have not materialised, however that this is due to the forecast carbon emissions being much higher than the observed as a result of higher forecast flows and higher travel speeds. Observed traffic flows, whilst increasing, have not seen the increase forecast and as shown in the traffic chapter, speeds have decreased. Therefore, traffic is travelling at a more fuel-efficient speed compared with reforecast scenarios.

Reliability

Forecast

4.31. The scheme appraisal estimated the reliability benefits for the scheme. In line with guidance, the monetised reliability benefits were not included in the economic appraisal of the scheme. The reliability sub-objective includes the impact of the scheme on incidents and day to day journey time variability. In relation to reliability AST states:

"User benefits during incidents split in proportion to Consumer and Business User Benefits. Benefits on motorway and surrounding urban roads".

4.32. Incident Cost Benefit Analysis (INCA) Version 4.1 formed the basis of appraisal. INCA has been specifically developed for application to motorways and dual carriageways to estimate the benefits of reduced delay and travel time variability (TTV) caused by unforeseen incidents that reduce as a result of the scheme (such as collisions, breakdowns, debris on the carriageway and load shedding). Results from the INCA indicate reliability benefits of £26.5 million (in 2002 prices, discounted over the 60-year appraisal period). The combined impact on variability and delays is known as reliability. Table 4-8 shows the total reliability benefits, broken down by the two elements.

Table 4-8 Monetised journey time reliability benefits forecast (£'000s)

Journey Time Reliability Benefits	HSR on	HSR Off	Total
Travel Time Variability Benefit	12,200	5,000	17,200
Delay Benefit	8,200	1,100	9,300
Total Benefits	**20,400**	**6,100**	**26,500**

Evaluation

4.33. INCA assessment is based on the observed data on incidents on the motorway. Although this data does exist for the scheme before and after opening, the data cannot be compared on a like-for-like basis as once a smart motorway is fully operational, the additional technology means that far more incidents are automatically being detected and hence recorded, than was the case with manual recording before. It is possible to recalculate the reliability impacts based on the input of observed traffic flows for the first years of operation. However, in this case, no INCA model was provided to

POPE, and hence no recalculation can be made. At OYA the monetised reliability benefits (if achieved in line with forecasts) would be £26.5m over 60 years.

Summary of Present Value Benefits (PVB)

4.34. A cost benefit analysis of a major scheme requires all benefits to be considered for the whole of the appraisal period and they need to be expressed on a like-for-like basis, which is termed Present Value. This is the value today (or at a consistent date) of an amount of money in the future. In cost-benefit analysis, values in different years are converted to a standard base year by the process of discounting to allow comparison of benefits. A comparison of the forecast and outturn benefits is presented in Table 4-9.

Table 4-9 Summary of present value benefits

Benefit Stream	Benefits £m 2002 market prices, discounted to 2002	
	Forecast	Outturn Estimate
Journey Times	360.052	-310.940
Vehicle Operating Costs	0.939	0.103
Safety	38.377	n/a*
Construction Delay	62.906	62.906
Maintenance	29.942	29.942
Carbon Benefits	2.480	0.114
Noise Impact	-11.220	-11.220
Operating Costs (private toll revenue)	-36.725	-36.725
User Charges	61.600	61.600
Total PVB	**382.539**	**-330.032**

** For the purpose of the above table, the outturn safety impact is not included. The safety impact has not been monetised as the safety chapter has shown the changes not to be statistically significant.*

4.35. Table 4-9 demonstrates that the total outturn PVB is significantly different to the forecast PVB. This is largely owing to journey time benefits being far less than anticipated (approximately -£311m outturn compared to £360m forecast).

4.36. The outturn benefits presented in Table 4-9 have been calculated by capitalising the first-year benefits to a 60-year benefit stream. Our evaluation has shown that congestion levels in this first year are not as substantial as forecast, and therefore a disbenefit has been accrued. It should be noted however that the scheme was forecast to have significant journey time benefits in the first few years of operation, and as such this opening year finding (if taken as indicative of future years) suggests that the scheme may not deliver net journey time benefits.

Indirect Tax Revenue Impact

Forecast

4.37. Indirect tax revenue impact is the expected change in tax revenue to the Government over the appraisal period due to changes in the transport sector as a result of the scheme over the appraisal period. For the M6 J5-8 scheme, the forecast indirect tax impact is derived mainly from change in fuel consumption over the 60-year period resulting in changes to the revenue from tax on fuel. A scheme may result in changed fuel consumption for the following reasons:

- Changes in speeds resulting in greater or less fuel efficiency for same trips.

- Changes in distance travelled
- Increase road use through induced traffic or the reduction of trip suppression.

4.38. Forecast changes to indirect tax revenues were taken from the EAR. The scheme was expected reduce tax revenue over the 60-year appraisal period in comparison with the DM (no-scheme) scenario.

Evaluation

4.39. To assess the outturn impact, the change in fuel use along the mainline M6 between J5 and J7 at OYA has been calculated from observed changes in traffic flows and speeds. A corresponding calculation of the predicted change in fuel use has been performed using the forecast changes to traffic flows and speeds for the same section. The ratio between the forecast and observed changes in fuel use is then applied to the monetised impact on indirect tax revenues in the appraisal process to determine an outturn impact. This is shown in Table 4-10. This calculation has not considered the impact of the junctions due to the lack of detailed forecast changes in flows and speeds. However, the majority of the revenue changes are likely to be a result of changes to mainline traffic flows and speeds, which would account for a much larger proportion of any benefits than the anticipated impacts of the junctions.

Table 4-10 Indirect tax revenue impact as a benefit (60 years)

£m 2002 market prices, discounted	Forecast	Outturn
Change to indirect tax revenues	-£25.575m	-£2.875m

4.40. This evaluation shows that the outturn reforecast of the impact from the scheme on indirect tax revenue is a lower cost than forecast. This means that there are expected to be more payments in tax over the 60-year appraisal period i.e. a lesser disbenefit to the Treasury than forecast. The difference between forecast and outturn is a result of forecasts expecting higher traffic growth and increased speeds on the M6 J5-7 (i.e. increasing fuel use), whereas growth between the pre-and post-scheme period is negligible and speeds have shown decreases across the IP and PM peak (i.e. a much lower increase in fuel use than forecast).

Scheme Costs

4.41. Costs of the scheme are also considered for the full appraisal period of 60 years so that they can be compared with benefits over the same period. Investment costs are considered in terms of a common price base of 2002 for comparison with forecast. For comparison with the benefits, overall costs are expressed in terms of present value, termed Present Value Cost (PVC).

4.42. This section compares the forecast costs of the scheme as of the start of the construction period with the actual spend as of July 2017, (the date the cost was provided by the Regional Finance Manager). Costs are also considered for the full appraisal period of 60 years to allow comparison with the benefits over the same period. The full costs evaluated are made up of:

- Investment Costs (which includes maintenance over the 60-year appraisal period).
- Indirect Tax Revenues during the 60 years after opening.

Investment Costs

4.43. This section compares the forecast cost of the scheme with the outturn cost. Scheme costs include the cost to Highways England of constructing the scheme and purchasing land.

4.44. Forecast costs are taken from Appendix A of the Economic Assessment Report (November, 2011). The outturn cost (obtained from the Highways England Regional Finance Manager) presented in

Table 4-11 includes the cost of the scheme as of July 2017, and shows the forecast investment cost of £102.926 million (discounted to 2002) compared to the outturn cost (discounted to 2002).

Table 4-11 Investment cost (in 2002 prices, not discounted)

	Forecast Cost £m	Outturn Cost £m	Difference
As spent	126.547	110.577	n/a
As spent prices discounted to 2002	102.926	85.226	-17%

4.45. Table 4-11 shows the outturn cost is £85.226 million, which is 17% lower than the forecast cost (with maintenance removed).

Operation and Maintenance Costs

4.46. After completion of the scheme, forecast additional costs over the appraisal period were expected to be incurred in the form of infrastructure and equipment maintenance, the operational aspects of equipment spares, staff, enforcement, telecommunications etc. and infrastructure and equipment renewals. These costs were calculated based on Highway England's' Operational Cost Model for managed motorway schemes. The forecast costs presented in Table 4-12 are taken from the EAR and cover the 60-year appraisal period.

Table 4-12 Forecast operation and maintenance costs

£m 2002 prices and values	Forecast
Operation and Maintenance	30.000

4.47. For the purpose of this evaluation it is assumed that these costs are almost entirely in the future and no evaluation of operation and maintenance costs to date has been done. It is therefore assumed that the outturn operation, operation and maintenance costs are the same as forecast.

Summary of Present Value Costs (PVC)

4.48. Cost benefit analysis of a major scheme requires all the costs to be considered for the whole of the appraisal period and they need to be expressed on a like-for-like basis with the benefits. This basis is termed Present Value. Present Value is the value today of an amount of money in the future. In cost-benefit analysis, values in differing years are converted to a standard base year by the process of discounting giving a present value.

4.49. The full PVC for this scheme at the time of appraisal comprised the following costs converted to present value:

- Investment costs as noted above;
- Operating costs (including an allowance for maintenance);

4.50. A summary of the forecast and outturn PVC for this scheme are shown in Table 4-13. The result shows the outturn PVC . Note that as forecast, indirect tax is not included.

Table 4-13 Summary of PVC (£m)

£m 2002 prices and values	Forecast	Outturn
Investment Costs	85.716	73.545
Operation and Maintenance Costs	30.000	30.000
Total PVC according to recent guidance	115.716	103.545

Benefit Cost Ratio (BCR)

4.51. The benefit cost ratio is used as an indicator of the overall value for money of the scheme. It compares the benefits (PVB) and costs (PVC) to calculate the present value. A BCR in excess of 1 means the value of benefits is greater than the costs, thus they provide a positive Net Present Value (NPV). The higher the BCR, the greater the benefits relative to the costs. For the purpose of calculating the BCR, the forecast and outturn costs have been discounted to 2002 using the standard discount rate of 3.5% and converted to market prices.

4.52. It is noted that this is a One Year After evaluation and as referenced throughout this report, the forecast journey time benefits have not materialised in most time periods at this early stage. The forecast for this scheme expected journey time savings from the opening year, however, OYA benefits are negative due to VMSL being applied extensively during less congested conditions than expected. As a result, there has been a net disbenefit and a BCR calculation is no longer meaningful. Therefore a BCR is not reported at this early stage.

4.53. At the time of scheme appraisal, indirect tax was treated as a benefit and is such here. Table 4-14 below presents the BCR calculated according to current methodology.

4.54. Reliability benefits (totalling £26.5 million) were not included in the forecast BCR assessment.

Table 4-14 Forecast vs. reforecast outturn BCR

		Forecast	Observed
Costs	**PVC**	115.716	103.545
Benefits	Journey Time Benefits	360.052	-310.940
	Safety Benefits	38.377	n/a
	VOC	0.939	0.103
	User Charges	61.600	61.600
	Construction Delay	-62.906	-62.906
	Maintenance Delay	29.942	29.942
	Noise Benefits	-11.220	-11.220
	Carbon Benefits	2.480	0.114
	Operating Costs (private toll revenue)	-36.725	-36.725
	Indirect Tax Revenue	-25.575	-2.875
	Total PVB	**356.964**	**-332.907**
	BCR (with indirect tax in benefits)	**3.41**	**n/a**

4.55. The BCR ignores non-monetised impacts. In scheme appraisals, the impact of the scheme on wider objectives must be considered but not monetised. The evaluation of the environmental, accessibility and integration objectives are covered in the following sections.

Wider Economic Impacts

Forecast

4.56. The EAR notes that a Regeneration Report was prepared for the scheme, stating that:

"The report concludes the BBMM3 scheme would have a positive impact on the identified regeneration areas within the West Midlands, insofar as it would make it easier for people living in those areas to access the areas where there are likely to be employment opportunities, but would be unlikely to materially affect the number of available jobs within the Regeneration Areas."

Evaluation

4.57. The AST did not assess the Wider Economic Impacts, reasoning that the impacts are captured via regeneration and environmental assessments. The regeneration report noted above was not available to POPE, however the AST notes that for regeneration, the benefits were likely to occur due to increasing the number of accessible jobs (within a 45 minute journey time) due to reduced journey times.

4.58. POPE agrees that it is too soon to measure any impact from the scheme upon employment however, the other worsening of journey times at this early stage may mean that the positive impact expected do not materialise.

Economic Impacts - Key points

Benefits

- The scheme was forecast to generate safety benefits totalling £38.377 million over 60 years, the safety section evaluation determined that the OYA results show no statistical significance and therefore the outturn economic result is not monetised.
- Forecast journey time benefits formed a considerable proportion of the overall benefits at £360.052 million. Journey time forecasts expected decreases across all time periods and particularly in the northbound direction. Outturn journey time impacts showed substantial increases across the IP and PM peak (which outweighed decreases in journey time during the AM peak). The outturn monetised impact of the scheme on journey times is -£310.940 million, a large proportion of the overall dis-benefits.
- VOC impacts of the scheme were forecast to benefit users by £0.939 million over the scheme life. The reforecast impact on VOC is a negligible benefit to users of £0.103 million.
- The forecast impact of the scheme on indirect tax revenue as a benefit was -£25.575 million, however, based on the impact of the scheme on vehicle operating costs, the outturn impact of the scheme upon indirect tax is -£2.875 million.

Costs

- The investment cost of building the scheme was £85.2 million in 2002 prices, which is 17% less than forecast.
- The forecast operation and maintenance cost of the scheme is assumed to be as forecast at £30 million.

BCR

- An outturn BCR has not been calculated at the OYA stage as the scheme has been shown to have a net disbenefit at this early stage, compared to large net benefit forecast in the early years.

5. Environment Evaluation

Introduction

5.1. This section documents the evaluation of the impacts of the scheme on the environmental sub-objectives.

5.2. The overall scheme objectives were to provide an operational solution on the scheme extent through dynamic use of the carriageway to improve safety of road users and alleviate congestion thus improving journey time reliability. The aim was to tackle congestion through the introduction of new technology and innovative solutions to make best use of the existing road space whilst maintaining and, where possible, improving the existing safety standards. To achieve this, the project would make use of the hard shoulder as a running lane known as Hard Shoulder Running (HSR) during periods of congestion or accidents as part of a dynamic traffic management system termed Managed Motorways (MM).

5.3. The scheme included the installation of the following elements to create and operate the controlled MM environment:

- Portal signal and sign gantries
- Emergency Refuge Areas (ERAs)
- Maintenance Hard Standings (MHSs)
- Closed Circuit Television (CCTV) hard shoulder monitoring and Pan Tilt Zoom (PTZ) cameras
- Motorway Incident Detection and Automatic Signalling (MIDAS) to enable automatic signalling
- Ducted cable and cabinet infrastructure.
- A short length of carriageway realignment of northbound side to the west of J6 (184/1+70 to 184/8+80) with maximum offset of 7.4m with equivalent areas of redundant southbound carriageway broken out

5.4. It should be noted that much of this length of motorway is constructed on elevated deck with no associated soft estate areas.

Evaluation methodology

5.5. An environmental assessment for the Scheme was undertaken and reported in an Environmental Assessment Report (EnAR), which noted that one of the essential objectives of the Scheme was to make best use of existing infrastructure by providing additional capacity within the existing highway boundary and, where possible, within the existing paved area.

5.6. For each of the environmental sub-objectives considered by the EnAR, the evaluation in this chapter assesses the environmental impacts predicted in the Scheme's Appraisal Summary Table (AST) and the EnAR against those observed one year after opening (OYA).

5.7. In the context of the AST and EnAR forecasts and using evidence collected one year after opening, this chapter presents:

- A record of any significant changes to the Scheme that have taken place since publication of the EnAR;
- An evaluation of the effectiveness of the mitigation measures implemented as part of the Scheme; and

- A summary of key impacts against all relevant environmental WebTAG sub-objectives.

Changes

5.8. The project Handover Environmental Management Plan (HEMP) reported that during the construction phase a number of minor modifications to the design were made that were not anticipated to give rise to environmental effects; the following changes were considered to be of more significance:

- Relocation of an ERA on the NB carriageway further north - change agreed as impact had been assessed to be no worse than previous assessment conclusion of slight adverse residual effects.
- Relocation of gantry from Marker Post (MP)181/3+19 to 181/1(between J5-6) this was assessed at the time and no additional adverse environmental effects were identified.
- Localised widening was required at the northbound on slip at junction 6 – this was assessed at the time and no additional adverse environmental effects were identified.

Data Collection

5.9. The following documents have been used in the environmental evaluation:

- Appraisal Summary Table (AST), December 2011
- Birmingham Box Phase 3 Managed Motorways M6 Junctions 5 - 8 Environmental Assessment Report (EnAR) November 2011
- Final Construction (As Built) Drawings
- M6 Birmingham Box Phase 3 Managed Motorways - Pre-Construction Exhibition Material January 2012
- Birmingham Box Phase 3 Smart Motorway - Handover Environmental Management Plan, (HEMP) April 2014
- Birmingham Box Phase 3 Managed Motorways - Contract Management Plan February 2014.

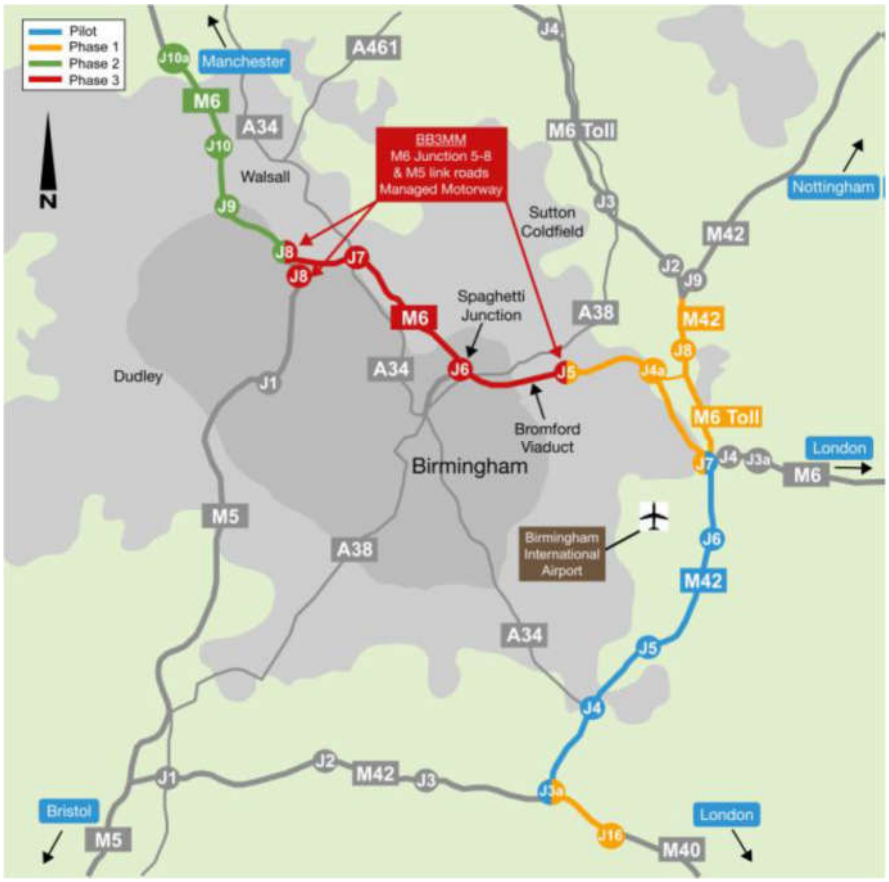
5.10. A full list of the background information requested and received to help with the compilation of this report is included in Appendix F.

5.11. In terms of requested animal mortality records, the only roadkill record received from the Maintaining Agent, dates from 2005 so can be discounted from this evaluation.

Site Inspections

5.12. A site visit was undertaken in July 2016. Photomontages taken from two locations were available in the EnAR and comparable panoramic photographs have been taken of the existing views.

Figure 5-1 Scheme location plan



Consultations

5.13. Table 5-1 lists the organisations contacted regarding their views on the impacts they perceive the scheme has had on the environment, and whether they feel that the mitigation measures implemented have been effective.

Table 5-1 Summary of environmental consultation responses

Organisation	Field of Interest	Comments
Environment Agency	Water	Unable to give an opinion on the impact on water quality with no negative feedback received on impact on water courses, drainage, pollution and attenuation
Natural England	Landscape & Visual; Nature Conservation	No comment to make regarding the 'before and after' studies on the environmental impacts of this scheme. We don't have enough information available to us relating to the situation beforehand to be able to provide any specific advice.
Historic England	Cultural Heritage	No comments to offer on the scheme
Birmingham City Council	Air Quality; Noise; Landscape & Visual; Nature Conservation; Cultural Heritage	Lacking some of the underpinning AQ data. Further information on nitrogen dioxide monitoring in the form of the previously requested concentration contour mapping would be required in order to provide detailed comments.
Walsall Metropolitan Borough Council	Air Quality; Noise; Landscape & Visual; Nature Conservation; Cultural Heritage	No response to the invitation to provide feedback
Sandwell Metropolitan Borough Council	Air Quality; Noise; Landscape & Visual; Nature Conservation; Cultural Heritage	No response to the invitation to provide feedback
Birmingham and Black Country Wildlife Trust (BBCWT)	Nature Conservation	Unable to express a view about whether the mitigation measures have been effective in avoiding / reducing impacts on biodiversity
Canal and River Trust	Landscape & Visual; Cultural Heritage	No response to the invitation to provide feedback

Traffic Forecasts and Evaluation

5.14. Three of the environmental sub-objectives (noise, local air quality and greenhouse gases) are directly related to traffic flows. No new environmental surveys are undertaken for POPE and an assumption is made that if the observed level of traffic is in line with forecasts, then it is likely that local noise and air quality impacts are as expected..

5.15. The EnAR noted that from J5 to J8, the M6 was a heavily congested section of the motorway network that facilitates strategic transport flows through the major conurbation of Birmingham in the West Midlands linking the M1 and the north west of England. It was subject to heavy traffic during peak times. Existing traffic volumes were stated to be greatest between J6 and J8, with 63,742 Annual Average Daily Traffic (AADT) on the northbound carriageway and 68,582 AADT on the southbound carriageway, with peak periods flows of about 4,871 and 4,784 vehicles per hour respectively. Traffic volumes were predicted to increase over the coming years.

5.16. The EnAR also noted that during peak periods, average speed between the junctions could drop as low as 10 miles per hour (mph); a problem exacerbated by weather events, road works and incidents. It was noted that delays frequently arose particularly between J6 and J7 and were also experienced between J7 and J8. The Scheme would introduce a variety of operating regimes - with HSR in operation a maximum speed of 60mph would be applied, and depending on specific traffic

conditions and or incidents a speed limit of less than 60mph might be applied on occasions. It has not been possible to make any direct comparisons with EnAR speed data at OYA.

5.17. The EnAR noted that M6 J5-8 also included high levels of Heavy Goods Vehicles (HGVs) which at the time, averaged between 20 - 35% of the total traffic flow depending on the section of the motorway and the time of day. Post opening there is limited HGV data available along the scheme sections and therefore it has not been possible to complete any HGV analysis at the outturn. Data is available between J4a-5 (see section 2.26, Table 2-2 for further detail).

5.18. With regard to the noise and air quality assessments, the EnAR used traffic data derived from the Policy Responsive Integrated Strategy Model (PRISM) model with a construction year of 2011, opening year of 2013 and design year 2028. Due to the Government's spending review at the time, the construction, opening and design years were revised to 2012, 2014 and 2029 respectively. As a result, a review of the implication of the difference in the traffic data assessment years and the actual assessment years of the proposed scheme on the conclusion of the traffic based environmental assessments (air quality and noise) was undertaken, which concluded that for noise there would be no significant additional effects and the conclusion of the noise assessment would not be limited / compromised as a result of the changes.

5.19. For air quality further assessment was required as the results based on the traffic figures in the PRISM model produced an unacceptable result for air quality. The traffic data used for the updated noise and air quality assessments were included in EnAR Volume 1: Appendix B 2.1: Noise Traffic Data, B2.2: Traffic Data Rationale and B2.3: Air Quality Traffic Data.

5.20. Table 5-2 and Table 5-3 below compare the traffic forecast based on EnAR Appendix B and observed traffic flows. Separate forecasts were made for the assessment of noise and air quality in the EnAR, neither of which made forecasts for the Do Minimum scenario or IP period. Forecasts were made for the Do Something (DS) scenario, in both the AM and PM peaks as defined in the traffic chapter. Observed data for the M6 J7-8 was not available and it has therefore not been possible to compare against.

Table 5-2 DS forecast and observed noise assessment traffic flows

Link	AM			PM		
	DS Forecast	DS Observed	% Difference	DS Forecast	DS Observed	% Difference
M6 J5-6 NB	6500	4800	-26%	6300	4600	-27%
M6 J5-6 SB	5700	5000	-12%	6500	4900	-25%
M6 J6-7 NB	6800	4700	-31%	7300	5700	-22%
M6 J6-7 SB	6800	5700	-16%	6000	4400	-27%

Table 5-3 DS forecast and observed air quality assessment traffic flows

Link	AM			PM		
	DS Forecast	DS Observed	% Difference	DS Forecast	DS Observed	% Difference
M6 J5-6 NB	6500	4800	-26%	6000	4600	-23%
M6 J5-6 SB	5700	5000	-12%	6400	4900	-23%
M6 J6-7 NB	6800	4700	-31%	7400	5700	-23%
M6 J6-7 SB	6800	5700	-16%	5900	4400	-25%

5.21. Table 5-2 and Table 5-3 above show that the observed traffic flows during both the AM and PM peak across the scheme are well below forecast, indicating that the forecasts overestimated the

background level of traffic growth between the baseline and OYA periods. Observed trends show only modest growth between the pre-and post-scheme periods in both national and regional traffic data.

Noise

Forecast

Appraisal Summary Table

5.22. The scheme was anticipated to have negligible short-term impact on traffic noise in the surrounding area. Some properties, in the vicinity of Junctions 5, 6 and 8 were predicted to experience noise reduction benefits in the short term. In the long term changes in noise and noise level perception were expected to be negligible. The AST also noted that local increases in noise would be attributed to increased traffic flow and speed due to the scheme.

Environment Assessment Report

5.23. The EnAR stated that in addition to noise modelling based on traffic data, noise surveys were also carried out. The EnAR noted that:

- On opening the proposed scheme, more properties were predicted to experience a minor increase in noise levels than a decrease in the short term. This was due to increases in traffic volume and the closer proximity of some traffic. The vast majority of changes in noise were attributed to increased traffic flow and speed on the motorway
- In the long-term, a minor increase in noise levels was expected at most properties as a result of traffic growth over the 15 year period. There was no large change in the predicted noise climate in the long term either with or without the proposed scheme. With the proposed scheme, 95% of dwellings were predicted to experience a minor increase in noise levels whilst without the proposed scheme this would be 93% of dwellings
- There was predicted to be no change in noise level greater than 2dB at any sensitive receptors in both the short and long term. Required changes to the barrier network were not predicted to result in increases in noise of more than 0.5dB at dwellings or other sensitive receptors

5.24. It was noted that as there were no significant changes in noise level predicted as a result of the scheme no mitigation was required. Existing environmental fencing was to remain in place (sometimes following temporary removal and reinstatement to facilitate construction) with the minor exception of a break in the noise barrier to accommodate a new works entrance at Perry Barr Depot (location marker 187/2, between J6-7). No receptors would experience anything worse than minor adverse effects, with the majority experiencing only negligible effects.

5.25. The EnAR confirmed that as a result of the first round of strategic mapping under the Environmental Noise Directive, a set of first priority action locations had been identified. There were numerous first priority locations that were said to overlap sections of the M6 covered by the scheme, however, no specific action plans, outlining how the noise environment in these areas would be addressed, had been published at the time and as such no further work had been undertaken with regards to this action plan.

Consultation

5.26. The local authorities Birmingham City Council, Walsall Council, and Sandwell Council were invited to submit comments. No comments were received in relation to noise.

Evaluation

5.27. An assumption is made by POPE methodology that noise levels will be as expected if observed traffic flows are within 25% more or 20% less than predicted; as can be seen by the comparison of the predicted and observed OYA average peak hour flows in Table 5-2, above, the data indicates that the observed flows are between 22% and 36% less than predicted at six links and as such, indicates that noise could be better than expected in these locations. For two links, although traffic is less than forecast (-12% and -16%) flows are within the 'as expected' tolerances prescribed by POPE.

5.28. Reduced traffic flows appear to be as a result of less traffic growth than forecast at the time of the EnAR rather than as a direct result of the scheme.

5.29. POPE methodology would normally also take HGV and speed data into account when evaluating noise, for this scheme no comparison data is available.

5.30. Based on traffic flows in Table 5-2 which are lower than expected there is potential for noise generated by traffic to be better than expected. It is suggested that noise is reconsidered at FYA when traffic data over a longer time period should be available.

Table 5-4 Evaluation summary: noise

Sub-Objective	AST	OYA
Noise	Number of people annoyed in 2028: With scheme – 7371, Without scheme – 7000 Difference; -371	Potential for noise to be better than expected for some locations and as expected at others..

Local Air Quality

Forecast

Appraisal Summary Table

5.31. No properties were anticipated to experience an exceedance of the annual mean PM_{10} (particulate matter between 2.5 and 10 microns diameter) to EU Limit Value and no exceedances were anticipated to be removed as a result of the proposed scheme.

5.32. With regard to nitrogen dioxide (NO_2), the Scheme intersected three Air Quality Management Areas (AQMAs). Nine AQMAs were noted to be affected by changes to road traffic characteristics. While the output of the appraisal indicated the scheme could lead to a deterioration in air quality overall, detailed assessment using dispersion modelling concluded that the scheme would not lead to an overall worsening of the annual mean NO_2 EU Limit Value.

Environment Assessment Report

5.33. The EnAR undertook several assessments against different criteria:

- The local air quality assessment noted that following implementation of the proposed scheme, 716 properties would experience an improvement in air quality associated with a reduction in local NO_2 concentrations, with 907 properties experiencing deterioration in air quality. The proposed scheme would give rise to 13 new NO_2 exceedances with 5 predicted exceedances without the scheme being removed with construction of the proposed scheme. The maximum deterioration was predicted as an increase in annual mean NO_2 of 1.8µg/m3, due to increased traffic flows associated with the scheme. The maximum

benefit was predicted as a reduction in annual mean NO_2 of 2.6µg/m3. This was as a result of the realignment of the carriageway north of M6 J6.

- The local air quality assessment also noted that there were no predicted exceedances of the annual mean or 24-hour mean PM_{10} Air Quality Standards (AQS) objectives in the opening year of the scheme.
- In assessing nitrogen deposition rates on three Sites of Special Scientific Interest (SSSI) near the scheme – Coleshill and Bannerley Pools, Chasewater Heaths, and Windmill Naps Wood – the predicted annual mean NOx concentrations were noted to exceed the annual mean oxides of nitrogen (NOx) objective of 30µg/m3 for the protection of vegetation in 2008 and 2013 Do Minimum and Do Something scenarios. Reductions in road traffic flows would provide a marginal reduction in annual mean NOx concentration being predicted at all three SSSIs. It was concluded that there would be a negligible reduction in nitrogen deposition rates as a result of the scheme.
- The Highways Agency Business Plan Commitments Assessment concluded that the scheme was neutral in terms of the effects of the scheme on PM_{10} and NO_2.
- The Regional Emissions Assessment considered the effects of the scheme on road links in the wider region. It A comparison of the Do Minimum and Do something scenarios indicated that there would be an increase of less than 1% in all emissions with the scheme in the opening year.

Consultation

5.34. The local authorities Birmingham City Council, Walsall Council, and Sandwell Council were invited to submit comments. No comments were received from Walsall or Sandwell councils.

5.35. Birmingham City Council (Environmental Protection) noted that they were unable to provide any detailed comments as they '*were lacking in some of the underpinning data to make these comments'*.

Evaluation

5.36. An assumption is made by POPE methodology that local air quality will be as expected if observed traffic flows are within 10% more or 10% less than predicted; as can be seen by the comparison of the predicted and observed OYA average hourly flows in Table 5-3, the data indicates that the observed flows are lower than forecast by more than 10% at all locations and as such there is potential for local air quality to be better than expected.

5.37. POPE methodology would normally also take HGV and speed data into account when evaluating local air quality, for this scheme no comparison data is available.

5.38. Reduced traffic flows appear to be as a result of less traffic growth than forecast at the time of the EnAR rather than as a direct result of the scheme.

5.39. Based on the traffic figures in Table 5-3 which are lower than expected there is potential for pollutant concentrations to be better than expected. It is suggested that local air quality is reconsidered at FYA when traffic data over a longer time period should be available.

Table 5-5 Evaluation summary: air quality

Sub-Objective	AST	OYA
Air Quality	PM_{10} – Net Benefit Number of properties with an improvement: 119,700 Number of properties with no change: 4,220 Number of properties with a deterioration: 102,190 NO_2 – Net adverse Number of properties with an improvement: 62,433 Number of properties with no change:114,667 Number of properties with a deterioration : 49,010	Potential to be better than expected

Greenhouse Gases

5.40. The assessment of the impacts of transport schemes on emissions of greenhouse gases is one of the environment sub-objectives. WebTAG notes that carbon dioxide (CO2) is considered the most important greenhouse gas and consequently this is used as the key indicator for assessing the impact of transport options on climate change. Changes in CO2 levels are considered in terms of equivalent tonnes of carbon released as part of carbon released as a result of the scheme. Carbon emissions are therefore estimated for the DS and DM scenarios using forecast and observed OYA data.

AST

5.41. The AST predicted there would be an decrease in carbon emissions of -119,592 tonnes over the 60 year appraisal period and a decrease in the opening year between the with scheme and without scheme scenarios.

Evaluation

5.42. As demonstrated in Chapter 4, a reforecast of carbon emissions for the DM and DS scenarios at OYA has been calculated using current DMRB guidance. Observed carbon emissions were calculated using the same methodology for the DM and DS scenarios, using flow and speed data collected for this study. Table 5-6 shows the results of the carbon evaluation, which is the same as that reported in Chapter 4. Table 5-6 shows that observed carbon emissions have seen little change between the DM and DS scenarios, equivalent to 355 tonnes of carbon, where as in the reforecast the carbon emissions showed an increase between DM and DS scenarios of 20%, equivalent to 8,466 carbon tonnes. The forecast carbon emissions are much higher than the observed due to higher forecast flows and higher travel speeds. Observed traffic flows, whilst increasing, have not seen the increase forecast and as shown in the traffic chapter, speeds have decreased and therefore traffic is travelling at a more fuel efficient speed.

5.43. It should be noted that this calculation only considers the impact on the mainline M6 and does not take into account any reassignment of traffic from other routes, which could mean increased distances for rerouting traffic and possibly higher speeds on alternate routes.

Table 5-6 Outturn carbon emissions (opening year, carbon tonnes/year)

	Reforecast	Observed
DM/Counterfactual (before)	41,677	38,161
DS/Post-opening	50,143	38,516
Net Difference	8,466 (20%)	355 (1%)

Landscape and Townscape

Forecast

Appraisal Summary Table

Landscape

5.44. The AST predicted there would be a slightly increased awareness of the motorway corridor as a result of an increased number of gantries and localised vegetation loss at major infrastructure locations but this would not result in significant adverse effects on the landscape character. Localised adverse impacts on a small number of residential properties were predicted. The overall effect was deemed to be neutral.

Townscape

5.45. The AST predicted that within the context of the predominantly urban fringe motorway corridor, the scheme would not give rise to significant impacts on the perception of the existing townscape. Incorporation of gantries on elevated sections of the motorway was predicted to give rise to minor impacts as a result of localised changes within the motorway corridor. The overall effect was deemed to be neutral.

Environment Assessment Report

5.46. The EnAR considered townscape within the landscape and visual effects chapter. Four distinct local Landscape Character Areas (LCAs A to D) were identified along the route. (See Appendix F).

5.47. In summary the EnAR noted that the existing M6 corridor to the east of J8, where the motorway is elevated above the Tame Valley Canal, was broadly within the Great Barr Parkland (LCA D) and surrounding residential areas of Queslett and Great Barr. Approaching Perry Park (LCA C) the motorway began to follow the natural broader valley landform of the River Tame and Tame Valley Canal, resulting in long stretches being elevated above the adjacent linear water bodies through to and beyond J5. Visually, the corridor was said to be well contained between J8 and Perry Park whilst the elevated sections towards J5 offered broader views to and from the surrounding landscape.

5.48. With the exception of LCA D Great Barr Parkland, a significant area of open space, the EnAR stated that the study area comprised a predominantly urban townscape that lacked a sense of tranquillity, although planting associated with the motorway corridor provided relief to the wider built environment.

5.49. The effect of existing lighting on the character of the study corridor was said to be noticeable during the hours of darkness; the majority of the area with the exception of LCA D was influenced by artificial light – the motorway corridor formed a noticeable linear pattern, due to its frequently elevated nature. Lighting would generally remain unaltered although luminaries would be changed to white light LED. The only new lighting within the scheme would be at the extended on-slip road lighting south of J5; and at the ERAs.

5.50. Potential overall significance of effect of the scheme on local landscape/townscape character areas were identified as neutral to slight adverse (See Appendix F for more detail). A **slight adverse** significance of effect rating was given to LCAs C ‘Unplanned Mixed Land Use’ and D ‘Contained Historic Parkland’ while the other two character areas were given a neutral rating. In general the EnAR concluded that the majority of structures could be incorporated into the surrounding landscape/townscape pattern with **negligible** residual effects.

Visual effects

5.51. The EnAR noted that the scheme was designed to utilise the existing infrastructure and some sections of the below ground cables etc. as far as practical, however the scheme corridor between J6 and J8 would be generally effected throughout as a result of verge works. The visual effects of

cabling, ducting, maintenance footpaths and transverse crossings as a result of loss of existing vegetation in close proximity to the hard shoulder were reported in EnAR Appendix B1: Checklist 2 and were all deemed to be slight adverse at worst (summarised in EnAR Volume 1, Table 9-1).

5.52. Detailed assessments of the potential effects of the installation of each proposed gantry location and major equipment site along with outline mitigation strategies were set out in Appendix B1: Checklist 3. The majority of impacts were considered to be no more than neutral to slight adverse, Those with residual impacts identified as slight adverse and above were summarised in EnAR Table 9-2.

5.53. Overall the EnAR identified 33 infrastructure sites with no perceptible change and a **neutral** effect; 19 sites anticipated **slight adverse** effects and 3 sites **moderate adverse** effects. The EnAR noted the key visually sensitive locations with residual adverse effects as a result of views to new or existing modified gantries and / or signs and MS4s and these are summarised in Appendix F.

5.54. In line with the EnAR the approximate numbers of properties are shown in brackets;

5.55. Overall the EnAR identified 33 infrastructure sites with no perceptible change and a **neutral** effect; 19 sites anticipated **slight adverse** effects and 3 sites **moderate adverse** effects. The EnAR noted the key visually sensitive locations with residual adverse effects as a result of views to new or existing modified gantries and / or signs and MS4s and these are summarised in Appendix F).

Changes to carriageways

5.56. Detailed assessment was undertaken of potential effects associated with widening of the existing carriageway as follows;

- M6 Junction 5 widening – the EnAR expected that there would be no significant impacts in relation to pavement widening in this section, with the A452 corridor immediately to the south beyond scattered belts of shrubs on the highway verge and open fields to the north. Mitigation would involve replacing the planting to reinstate the original highway objectives.
- M6 Junction 6 Re-alignment between 184/1+70 to 184/8+80 (between J6-7) would require the removal of short sections of existing roadside vegetation, reforming the embankment slope and a new retaining wall (110m) resulting visual impacts would occur to users of the adjacent allotment site, and properties on Amberley Grove, Brookvale Road, the Barn Social Club, large warehouses to the south of the motorway corridor of Deykin Avenue and on Gadwall Croft, Grebe Close and Shelley Drive. Existing central reserve lighting columns would be relocated to both carriageways. Overall it was expected that there would be a negligible change to the existing view of the slightly elevated motorway corridor, gantries and existing pylons beyond the adjacent allotment site. The resulting effect was considered to be slight adverse in the opening year reducing to neutral in the medium to long term.

Mitigation

5.57. In addition to design choices regarding location of gantries, minimising the need for vegetation removal, replacement of any environmental barriers temporarily removed during construction and sympathetic surface finishes for gantries and other equipment, the following was noted with regard to the use of new planting where necessary to mitigate effects:

'Where existing vegetation is removed to facilitate construction of new infrastructure consideration will be given to the replacement with native species appropriate to the location but likely to include species such as hawthorn, hazel, blackthorn, field maple, guelder rose, cherry, birch, spindle and oak. At specific locations where significant impacts have been identified the use of evergreen species such as Scots pine and holly may be used in a targeted manner to screen specific views.

'New planting would comprise a mixture of size and form in order to create a structured approach; this would include transplants, feathered and standard trees. At specific locations the use of larger stock such as extra heavy standards may be deemed appropriate in order to screen particular views from properties considered to be subject to significant visual impacts. A planting schedule for identified locations will be produced following site clearance'.

Consultation

5.58. The following were invited to submit comments: Birmingham City Council, Walsall Council, Sandwell Council, Natural England, and the Canal & River Trust. No comments were received in relation to landscape and visual effects.

Evaluation

5.59. The existing motorway already exerted a strong influence on the adjacent local landscape / townscape character areas; the scheme has made use of some existing structures whilst also introducing new infrastructure elements within the route corridor slightly increasing the awareness of the motorway and sense of urbanisation. It would appear that the existing highway planting has been retained where possible which has helped maintain the landscape framework and overall impacts are considered to be as expected at OYA.

5.60. New ERAs with associated lighting have been provided (Figure 5-2) which also illustrates retention of existing highway planting within the highway soft estate.

Figure 5-2 Example of new ERA M6 northbound between J6 and J7

5.61. Based on the OYA site visit, the sections of environmental barrier required to be removed to aid construction have been replaced, however it was noted that some sections of retained existing barriers appear to be in a poor state of repair Figure 5-3 and Figure 5-4 below.

Figure 5-3 Example of environmental barrier in poor state of repair (SB approaching J7)

Figure 5-4 Section of replacement environmental barrier at gantry location(SB approach to J7)

5.62. Replacement planting was included in the EnAR as mitigation, although the nature of the mainly elevated motorway meant that there were relatively few opportunities for any new planting. The HEMP confirms that during the construction phase detailed landscape proposals were prepared taking into account the extent of required vegetation clearance and the final location of infrastructure. A Draft Planting Schedule (HEMP Appendix F) identifies tree and shrub species, stock sizes and numbers on a plot by plot basis to cover reinstatement planting mainly associated with gantries, ERAs, CCTV, and drainage works.

5.63. It is understood from the HEMP that following construction of the main engineering works it would be the responsibility of the Network Maintaining Agents to deliver the planting and subsequently maintain it to ensure successful establishment and delivery of the environmental commitments. At the time of writing it has not been confirmed to POPE the full extent and locations of any planting undertaken, it is suggested that this aspect should be reconsidered at FYA when it is hoped further information would be available and the establishment growth of any planting, more apparent.

5.64. The EnAR included two photomontages illustrating locations where the installation of a gantry would result in adverse impacts;

Papyrus Way (V01) – the proposed gantry on Bromford viaduct was expected to result in clear unobstructed views from properties to the eastern end of Papyrus Way across the local open green space to the elevated motorway with moderate adverse impacts (Plate 9.1 below).

Turnberry Road Open Space (V07)- the proposed gantry would result in varying views towards the top of the gantry and sign through intervening park vegetation for properties on Turnberry Road and users of the local park with slight adverse impacts (Plate 9.2 below).

5.65. EnAR photomontages are reproduced in Figure 5-5 below. OYA comparison viewpoints (Figure 5-6 and Figure 5-7) illustrate that views are as expected.

Figure 5-5 EnAR photomontages Plate 9.1: View of a new gantry from Papyrus Way on the bromford viaduct. (178/8+80 (J5-6)) and Plate 9.2: new gantry from Turnberry Road open space (188/5+30 (J6-7))

Plate 9.1: Photomontage of the View of a New Gantry from Papyrus Way on the Bromford Viaduct. (178/8+80)

Plate 9.2: *Photomontage of View of New Gantry from Turnberry Road Open Space (188/5+30)*

Figure 5-6 Panoramic view from Papyrus Way at OYA (July 2016)

Figure 5-7 Panoramic view from Turnberry Road Open Space at OYA (July 2016)

5.66. The HEMP notes that during construction there were concerns raised by residents of Grebe Close (V04) on the views to and screening of gantry 17 (at 184/6B (J7-6)) and that possible screening alternatives were discussed for implementation by the Delivery Partner[11]. A cross section illustrating the planting proposals and schedules for targeted planting of a mix of transplants and larger size trees to the top of the cutting for properties on Gadwell Croft and Grebe Close are provided in the HEMP. Based on 'before' and 'after' images[12] the view at OYA is still very much open between the motorway/associated gantry and the housing. Existing vegetation has been removed to facilitate the scheme and it would appear that replacement planting may yet to have been implemented. It should also be noted that the road was realigned along this section and existing lighting has been relocated from the former central reserve to the SB and NB verges.

Figure 5-8 View looking towards Grebe Close at gantry 17 – post-construction (April, 2016) Image © Google

[11] Understood from HEMP to be the Network Maintaining Agents.

[12] Based on Google Streetview imagery comparing the current view (November 2015 – May 2016) with pre-construction view (July 2008)

Figure 5-9 View looking towards Grebe Close at pre-construction (July 2008) Image © Google

5.67. The HEMP also notes that concerns from residents at Ragley Drive (V10) were highlighted through the ongoing consultation process; photomontages were developed to explain the likely effect of the gantry (191/2+100 (J8)) and planting schedules to include larger nursery stock were prepared for subsequent planting. It has not been possible to confirm at OYA whether planting has been undertaken, some views are possible to the top of the gantry through intervening trees (Figure 5-10). It would appear that fencing along the back of pavement has been upgraded.

Figure 5-10 V10 view from Ragley Drive to top of gantry visible through intervening vegetation

5.68. In addition to Papyrus Way (V01) mentioned above, the EnAR expected moderate adverse effects for two other viewpoints - V03 and V05 and as illustrated below (Figure 5-10 and Figure 5-12) this would appear to be the case. Properties on Stonechat Drive (V03) are 3 storey blocks of flats with upper floor views towards the top of the gantry and signs above highway planting. For Moor Lane and Witton cemetery (V05) the new elevated gantry is clearly visible and has introduced a new built element into the skyline.

Figure 5-11 V03 view from Stonechat Drive towards SB gantry on elevated approach to J6

Figure 5-12 V05 view from Moor Lane towards gantry/signs on elevated section of M6

5.69. For V06, Willowbrook Nursing Home off Aldridge Road, the EnAR stated that semi mature trees at the top of embankments would be retained where possible and reinstated, if necessary, with a mix of transplants and feathered stock. It would appear that (based on google images) it was not possible to retain all the semi mature trees, which despite the environmental barrier is likely to have opened up views to the gantry. It has not been possible to confirm whether replacement planting has been implemented.

Summary

5.70. The introduction of new and additional infrastructure elements along the route corridor has slightly increased awareness of the motorway as expected.

5.71. Significant views are generally considered to be as expected at OYA, however, it is too soon to evaluate the effectiveness of any replacement planting undertaken which should be reconsidered at FYA. Concerns have been raised by local residents at Grebe Close V04 and Ragley Drive V10 and views have been opened up at Willowbrook Nursing Home off Aldridge Road V06 through the removal of semi-mature trees.

Table 5-7 Evaluation summary: landscape and townscape

Sub-Objective	AST	OYA
Landscape and Townscape	Neutral	Generally neutral as expected at OYA for landscape /townscape character. For visual impacts the EnAR score of slight adverse is likely to be more appropriate as some views are open at OYA. Reconsider at FYA when vegetation may be more well established.

Biodiversity

Forecast

Appraisal Summary Table

5.72. The AST forecast slight adverse impacts on three sites of local importance for nature conservation and the local designation - M6/M5 Wildlife Corridor. Implementation of precautionary mitigation measures for Great Crested newts would serve to ensure no adverse impacts on these species. Impacts on all other sites and species were predicted to be neutral except for Biodiversity Action Plan species which would be slight adverse.

Environment Assessment Report

5.73. The EnAR ecological assessment reported the likely effects of the proposals on a number of different categories of receptor. Designated Sites where a neutral effect was expected included:

- European Designated Sites: Cannock Extension Canal Special Area of Conservation (SAC), 9km away but hydrologically connected to the scheme as it is connected to the Tame Valley Canal which is crossed by the M6 at various locations, was subject to a Habitat Regulations Assessment which concluded that the scheme was unlikely to result in significant effects upon it.
- Local Nature Reserves (LNR): Hollywood LNR is immediately adjacent to the soft estate' however no works would take place near the site.
- Semi-natural Ancient Woodland (SNAW): Gilberts Wood and an area of SNAW in Yew Tree Site of Local Importance for Nature Conservation (SLINC) are both over 50 m away and deemed unlikely to be affected.
- Sites of Importance for Nature Conservation (SINC): Park Hall Wood, Perry Beeches, Hollywood, St Margaret Hospital grounds, Hill Farm Bridge Fields are all within 50 m of the scheme but given that works would be restricted to within the highway soft estate, of a limited scale and extent, and of a temporary nature, impacts as a result of construction activities were considered unlikely.
- Sites of Local Importance for Nature Conservation (SLINC): of the seventeen SLINCs within 250 m of the scheme, eleven were within 50m with potential for indirect impact during construction although this was considered unlikely assuming standard working practices were adhered to.
- Two Ecosites were identified within 250 m of the scheme – Castle Hills and Witton Cemetery, both were expected to be unaffected.

5.74. Designated sites where an adverse effect was predicted were identified as:

- Three SLINCs extending to or located within the highway soft estate identified as; 'lands bordering the M6 motorway', Wilderness Lane, and Rushall Junction to Biddlestone Bridge.

All three would incur direct impacts through land take, albeit of a minor nature not thought likely to affect their ecological integrity with **slight adverse** effects.

- Wildlife Corridor: The M5/M6 motorway corridor is designated as a wildlife corridor and would be affected by the scheme due to multiple areas of land take within the soft estate. This would entail the loss of areas of low quality habitat such as poor semi-improved grassland, scrub, and plantation woodland; it was not expected to result in a significant reduction in continuity of habitats which was overall deemed to have a **slight adverse** effect.
- Controlled Waters: None of the rivers, canals and streams located within 50m of the proposed development site would be subject to direct impacts as a result of the proposed works. It was noted that waterways that passed beneath the carriageways and the protected species they might support, could be subject to **slight adverse** effects.

Species and Other Habitats

5.75. Other habitats were not thought to be of sufficient nature conservation value to give rise to significant effects. Nevertheless the proposed scheme would involve the permanent loss of rough grassland, scrub and immature woodland habitats.

5.76. Species with the potential to be present within 250m of the scheme included: Great crested newt, common reptiles, nesting birds, water vole, bats, badger, otter, white clawed crayfish, fresh water fish and common toad (a UK priority BAP species). Potential impacts and likely effects are included within Table 5.8.

M6 Realignment

5.77. With specific regard to the M6 realignment (184/1+70 to 184/8+80 (J6-7)), along this short length of the scheme there would be more extensive land take of the Wildlife Corridor than along the rest of the scheme due to the proposed realignment. There was potential for reptiles to be present on the soft estate and also for the fragmentation and minor permanent loss of potential reptile habitat including potential breeding and over wintering sites for common reptiles. However this was expected to have no more than slight adverse effects on habitats and species (see Table 5.6).

Mitigation Measures

5.78. The EnAR confirmed that adverse impacts, where possible, had been avoided or minimised in the proposed design by adjustments to infrastructure locations. Where unavoidable, the magnitude of these impacts would be minimised by general good practice guidelines and execution of detailed, receptor specific, mitigation.

5.79. The EnAR also stated that post construction planting should aim to enhance the ecological value of the soft estate in the vicinity of the proposed scheme, and that this could include re-instating and re-linking severed linear wildlife corridors such as hedges or scrub lines by using new highway verge landscape planting using locally sourced native plants. Table 5.8 summarises the potential nature conservation residual impacts of the scheme for significant ecological receptors within 250m of the proposed scheme with mitigation in place.[13]

[13] Based on information in EnAR Table 7.6: Summary of Potential Nature Conservation Residual Impacts attributed to Significant Ecological Receptors and Impact Characterisation from EnAR Table 7.5

Table 5-8 Summary of potential nature conservation impacts

Ecological Receptor	Potential Impact	Mitigation and Residual Impact
SLINCs Lands bordering the M6 motorway, Wilderness Lane, Rushall Junction to Biddlestone Bridge	Areas extending to or located within the highway soft estate. Direct effects related to permanent loss of land. Slight adverse	Minor nature of land take not thought likely to affect their ecological integrity. Re-instate onsite habitats and ensure overall integrity / conservation objectives maintained. Mitigation to include planting with appropriate species. Slight adverse
Wildlife corridors including all highway land adjacent to the M5 and M6.	Direct effects related to permanent loss of land. Slight adverse	Re-instate onsite habitat and ensure overall integrity / conservation objectives maintained. Mitigation to include planting with appropriate species. Slight adverse
Water Courses	Potential direct/indirect degradation and disturbance due to close proximity of waterways many of which pass beneath the carriageways. Slight adverse	None of the rivers, canals and streams located within 50m of the proposed development site would be subject to direct impacts. Implementation of best practice working procedures to protect waterways that pass beneath the carriageways from indirect impacts. Neutral
Great crested newt (GCN)	Likely to be absent from sections of the soft estate affected, but known to be present within the wider area with limited potential, in the absence of mitigation, that small numbers of animals may be killed, injured or harmed during the works and/or disturbed by human presence. Slight adverse	Update GCN surveys to be carried out for Waterbody 1 - 4 prior to construction to provide contextual information to inform mitigation, if required. No works to take place and no material to be stored on the motorway soft estate from 177/4B (J4a-5) to the end of the proposed scheme until targeted GCN surveys undertaken in the 2012 GCN survey season (March to May) and until mitigation if required, had taken effect. The measures would ensure the scheme was legally compliant and GCN safeguarded. Neutral
Common Reptiles	In the absence of mitigation some limited potential that small numbers of animals may be killed, injured or harmed during the works and/or disturbed by human presence. Also the potential for the fragmentation and minor permanent loss of potential reptile habitat including potential breeding and over wintering sites for common reptiles. Slight adverse	As part of the pre-construction surveys, targeted update presence/likely absence reptile surveys to be carried out for reptiles as survey data would be out of date at the time of construction (2012). Mitigation would include; habitat manipulation carried out and completed during the active reptile season mid-March to end October (strimming prior to commencement of works to reduce the vegetation to a height of approx. 150mm, completed in phases, that encourages reptiles to move offsite and into adjacent areas. Neutral
Water vole	Unlikely to be any direct effects related to loss or disturbance to animals or habitat. During construction there was potential for temporary degradation to water vole habitat within	Mitigation to include implementation of best practice working procedures to protect waterways that pass beneath the carriageways from indirect impacts. Neutral

	the offsite wetland and water courses. Slight adverse	
Nesting birds	Potential that during construction small numbers may be disturbed while nesting and mating. Also some potential for destruction of nests and eggs and for permanent loss of suitable nesting and foraging habitat. Slight adverse.	Vegetation clearance to be undertaken outside bird nesting season or under ecological supervision. Ongoing watching brief and nest searches during construction. Neutral
Badger	In the absence of mitigation relatively high potential that badgers may be disturbed during the works. Neutral	Targeted pre-construction badger surveys to be carried out 6 weeks prior to works starting on site. No works proposed within 250m of Sett 2 and within approximately 35m of Sett 1 – works considered unlikely to require a disturbance licence for badgers. All works would be carried out in accordance with best practice site working guidelines and under ecological supervision. Night work to be avoided. Ecological monitoring of the setts to be undertaken periodically to check the setts' integrity was maintained. A final walkover of the setts would be undertaken to ensure that no damage or harm had occurred to any setts or badger and provide updated information on the status of the setts post works completion. Neutral
Bats	Some potential, for direct effects related to loss or disturbance to animals or habitat / severance of commuting routes. During construction potential for temporary degradation and/or disturbance to bats within the adjacent habitat. Possible construction impacts within the vicinity of the underpass at 191/1, Slight adverse.	The majority of the on-site habitat within the scheme extent was assessed as offering negligible potential for supporting bats. It was unlikely that works would indirectly impact upon the higher quality off-site habitat given the relatively limited extent and duration of works. A reduction in light levels generally and in the vicinity of the underpass was predicted due to the use of lower output LED lighting. To avoid disturbance to commuting / foraging bats during construction works would be undertaken during daylight, outside of the bat activity season (active season: late March to late September), retain existing tall vegetation and screen planting where possible along the entire scheme extent and particularly in the vicinity of underpasses and riparian corridors potentially used by bats to reduce light spill. Implementation of best practice working procedures and watching brief. Likely to be a reduction in light levels generally and within the vicinity of the underpass due to the implementation of lower output LED lighting. Neutral
Otter	Likely to be absent from the study area. However, otter are known to be present within the River	Mitigation to follow that for watercourses and include implementation of best practice working procedures to protect waterways that pass

	Tame (although not within those sections of the river within the study area), and consequently limited potential to impact the species. During construction limited potential for temporary indirect degradation to otter within the offsite wetlands and running water habitat. Slight adverse	beneath the carriageways from indirect impacts. Neutral
White Clawed Crayfish and Fresh Water Fish	During construction there was potential for temporary degradation to water courses. Slight adverse	Mitigation to follow that for watercourses and include implementation of best practice working procedures to protect waterways that pass beneath the carriageways from indirect impacts. Neutral
Other UK priority BAP species (common toad)	Potential to be killed, injured or harmed during the works. Also potential for the fragmentation and permanent loss of habitat. Slight adverse	Mitigation to be as for Reptiles above. Slight Adverse

Consultation

5.80. The following were invited to submit comments: Birmingham City Council, Walsall Council, Sandwell Council, Natural England, and the Wildlife Trust for Birmingham and the Black Country. Although responses were received from the Wildlife Trust and Natural England they were unable to make any comments on the scheme.

Evaluation

5.81. The scheme was not expected to result in any significant adverse impacts on any designated sites of nature conservation importance or on protected species and adherence to best practice was expected to prevent or minimise any temporary impacts on protected species during construction, with local impacts on the existing soft estate successfully mitigated by the application of the measures set out in the EnAR.

5.82. With regard to environmental commitments included in the EnAR the Handover Environmental Management Plan (HEMP) states that '*at the assessment phase numerous commitments were made as to the design and construction of the environmental aspects of the scheme, the majority of these have been delivered during the construction phase however a number extend into the post construction phase and subsequent establishment maintenance period'*, however, the HEMP does not provide any further clarification. It does report three environmental incidents; nesting birds were discovered in a traffic cone within the verge and as a result the location was fenced off and monitored until the birds had fledged; kestrels were identified on the viaduct supports close to junction 8 and as a result the nest was monitored and no works undertaken in close proximity to the nest until the birds had fledged; and Japanese knotweed was identified at a site to be excavated for environmental barrier work (189/3+50B (J6-7)) – the site was excavated and arisings removed to an approved site and subsequent re-growth treated with suitable herbicide.

5.83. The February 2014 Contract Management Plan for the scheme includes some information with regard to wildlife surveys:

- Badger- July 2011 feedback on the 2 identified setts (J7-8 N/B) noted that impacts would be minimal if at all and there was unlikely to be a need for a Natural England disturbance license. In January 2012 there was no evidence of Badgers with the exception of a possible outlier sett with a 30m area around the sett to be monitored for badger activity;
- GCN - August 2012 mitigation measures were undertaken on the M6 South bound Junction 5-4A specifically for the presence of Great Crested Newts. Although none were found, it was expected they were present outside the site boundary and workers in that area were to be mindful of the potential for migration into the works;
- Reptiles – January 2012 areas of rough grassland around the edges of the site compound were considered to be suitable habitat for reptiles. Any vegetation clearance was to be undertaken using hand tools to avoid injury to any reptiles that might have been hibernating within the root systems during winter;
- Water vole – July 2011 noted that targeted water vole surveys should be undertaken at work locations assessed as being within 10m of suitable water vole habitat to ensure that no voles were present at the time of construction. Habitat manipulation should be undertaken if no burrows were found.

5.84. POPE has received no further information e.g. which would confirm whether any water vole surveys were necessary or whether the proposed final walkover of the badger setts was undertaken to ensure that no damage or harm occurred to any setts or badger and provide updated information on the status of the setts post works completion. No comments were received from consultees relating to biodiversity. Whilst the wildlife corridor running the length of the route appears at OYA to have recovered from the construction works, further information (i.e. with regard to water vole and badger) would be required to fully evaluate the impact of the scheme on biodiversity, which should be reconsidered at FYA including whether theEnAR aims that planting should enhance the ecological value of the soft estate in the vicinity of the proposed scheme (see 5.78 above), have been achieved.

Table 5-9 Evaluation summary: biodiversity

Sub-Objective	AST	OYA
Biodiversity	Slight adverse	Likely to be as expected but further information would be required to confirm

Heritage and Historic Resources

Forecast

Appraisal Summary Table

5.85. The AST predicted that there would be no impact on the below ground archaeological resource as all works would be within the highway boundary. Impacts on the built heritage and historic landscape would be through local visual intrusion on their setting, but were not expected to be significant. Neutral effect overall.

Environment Assessment Report

5.86. The EnAR identified the following cultural heritage assets within 300m either side of the motorway;

- Castle Bromwich Scheduled Ancient Monument (SAM) a 12th century motte and bailey castle south of the existing highway at J5;
- Seventeen Listed Buildings - Nine Grade II bridge/canal structures associated with the Tame Valley canal, Birmingham & Fazeley canal and Grand Union canal, Six Grade II historic dwellings; the Grade II listed lodges and gate piers at Witton Cemetery and the

Grade I Church of St Mary and St Margaret located south of Castle Bromwich SAM 300m from the existing HA boundary; and

- Three Registered Parks and Gardens (RPGs): Grade II Witton Cemetery and Great Barr Hall both abut the existing motorway; the Grade II* Castle Bromwich Hall is located approximately 300m away. Great Barr Hall and Castle Bromwich Hall were also noted to be designated as Conservation Areas.

5.87. Due to the localised nature of the proposed scheme and restriction of works to the highway boundary, the EnAR concluded that there would be no change to their character and setting and that the proposed development would have a neutral effect on the cultural heritage assets identified.

5.88. The EnAR noted that there was a low potential for buried archaeological remains of unknown value to exist within the study area. In the unlikely event of the identification of archaeological features within the existing highway boundary during the construction process, the EnAR stated that works should be stopped to allow for recording or salvage excavation. A watching brief would be implemented with reporting of any finds.

Consultation

5.89. The following were invited to submit comments: Historic England and the Canal and River Trust. Historic England responded to say that they had no comments to offer on the scheme. No comments were received from the Canal and River Trust.

Evaluation

5.90. Castle Bromwich SAM – in line with the scheme proposals an existing gantry approximately 200m away was removed and a new gantry erected approximately 400m away (178/8 + 90 (J5-6)). It is considered by POPE at OYA that there has been no change to the setting of the SAM due to the distance of the new gantry and as expected the effect has been neutral.

5.91. Listed Buildings - no changes were expected to the character and setting of the 17 Listed Buildings identified within 300m of the motorway as they would not be in close proximity to any of the proposed gantry locations. Subject to structural assessment a signal gantry was proposed to be added to an existing gantry (183/2+95 J6)) some 95m away from the nearest listed structures; the Grand Union Canal aqueduct over the River Tame (183/0A J6) and the Birmingham & Fazeley Canal aqueduct just south of Salford Junction (183/2A J6) which go underneath the M6 just east of J6. It would appear that a new gantry had to be provided; this is similar in size and content to the existing gantry and it is considered at OYA that impacts are neutral as expected.

5.92. RPGs and conservation area impacts are considered at OYA to be neutral as expected;

- The setting of Castle Bromwich Hall, within the wider urban context of surrounding settlements and adjacent roads, has not been changed by the scheme;

- Witton Cemetery is situated on a west and south facing slope in an urban setting. To the south west the cemetery is alongside a raised section of the M6 and its setting was already influenced by the motorway. As expected the introduction of a new gantry nearby is not considered to have significantly increased the influence of the motorway its setting;

- Existing offsite vegetation associated with Great Barr Hall is likely to screen views to new signs / gantries so that the setting has not been affected.

5.93. Overall it is considered that based on the information presented above, and the localised nature of the proposals, the effects of the scheme on the heritage resource are likely to be generally **as expected**.

Table 5-10 Evaluation summary: heritage and historic resources

Sub-Objective	AST	OYA
Heritage and Historic Resources	Neutral	As expected

Water Environment

Forecast

Appraisal Summary Table

5.94. The AST reported that the drainage design would include measures to contain any accidental spillage from Emergency Refuge Areas (ERA) and that attenuation measures to handle additional surface run-off were designed to ensure scheme implementation would have no adverse impact with a neutral effect overall.

Environment Assessment Report

5.95. The EnAR identified a number of major water features in the immediate vicinity of the proposed scheme corridor including the River Tame, Grand Union Canal, Tame Valley Canal, Birmingham & Fazeley Canal, Rushall Canal and River Rea. Within the study area there were also 9 large standing water bodies, and a number of aquifers, but no groundwater Source Protection Zones (SPZs).

5.96. The EnAR confirmed that the drainage design had been undertaken in line with the principles agreed with the EA for MM schemes i.e. no increase in drainage rates or significant new incursions into the water table, impact on flood plains or direct impact on rivers or other waterbodies. As the proposed works were to take place within the existing motorway corridor, no modifications were proposed to the existing drainage infrastructure beyond the outfall locations which connected into the local watercourses. There would be no change in the rate of discharge at any of the existing outfalls which would all be maintained in their existing position and condition. There would also be no significant impacts on floodplain storage volume, groundwater or aquifers, and it was not expected that identified water features would be significantly affected.

5.97. The proposed scheme included the use of cut off valves, which could be operated in response to accidental pollution incidents which, it was expected, would be an operational benefit over the existing water quality control and management for this section of the Birmingham Box network.

5.98. It was noted that there was some potential for impacts on water quality and drainage during the construction phase and that adoption of best practice guidance for working near water bodies would control the risk to surface water bodies and that these would be set out in detailed method statements to be prepared within a Construction Environment Management Plan (CEMP).

ERAs

5.99. The EnAR stated that increased runoff was expected only at the proposed mainline ERA locations where additional hardstanding was being created. To prevent potential pollution incidents each mainline ERA would be equipped with underground storage traps with a gate valve that could contain spillages if required in order to be safely pumped out and disposed of. The proposed drainage was designed to ensure no net increase in the rate of discharge. Hard standing and drainage facilities at the existing ERAs on the Bromford viaduct would be retained, with apertures blocked with sand bags during any pollution spillage events (sand bags to be kept adjacent to the outfalls).

Realigned section of the M6

5.100. Along the realigned M6 (184/1+70 to 184/8+80 (J6-7)) it would be necessary to install new drainage along the NB carriageway and in the central reserve, however, there would be no net increase in hardstanding due to redundant areas being broken up and returned to soft verge. The new pipes would have the same catchment area and outfall to the same locations as the existing network therefore no change in discharge rates was expected.

Consultation

5.101. The Environment Agency (EA) was invited to submit comments on the scheme. The EA Integrated Environment Planning water quality specialist felt that as the Scheme retained the previous drainage arrangements and also included drain cut-offs it would be no worse than the previous situation should a road incident occur with the potential for seeing an improvement rather than deterioration. The EA Environment Management team commented that there were no records of any impact upon local watercourses as a result of this Scheme. In addition the EA commented that there appeared to have been no negative feedback regarding the Scheme's changes to drainage, pollution control and attenuation.

Evaluation

5.102. As built drawings indicate that scheme drainage has been implemented in line with proposals and drawings note that the surface water drainage connects into the existing drainage network and that the combined kerb drainage on viaduct sections uses existing gulley outfalls.

5.103. Based on the information available and the feedback provided by the EA, POPE has no reason to suppose that the highway drainage is performing other than as designed and it is likely that effects on the water environment are as expected.

Table 5-11 Evaluation summary: water environment

Sub-Objective	AST	OYA
Water Environment	Neutral	As expected

Physical Activity

Forecast

Appraisal Summary Table

5.104. The AST stated that the scheme would not change the number of pedestrian or cyclist journeys or change journey length and as a consequence no material impacts were expected. The impact of the scheme was assessed as neutral.

Environment Assessment Report

5.105. With regard to Pedestrians, Cyclists, Equestrians and Community Effects, the EnAR stated that 'scoping identified that implementation of the proposed scheme would not directly or indirectly affect non-motorised user (NMU) groups, as all proposed modifications would be contained within the existing highway boundary. Accordingly, effects associated with severance and changes to existing journeys made by such groups would be unlikely to arise.' Therefore this topic was scoped-out of the environmental assessment.

Consultation

5.106. No responses to consultation requests were received for this sub-objective.

Evaluation

5.107. The combination of desk studies and the site visit undertaken as part of POPE methodology has found no reason to suppose that there have been any significant changes to NMU facilities. No NMU survey has been undertaken specifically for this study, and POPE is not aware of any NMU audits or Vulnerable User Studies undertaken for this scheme.

5.108. It is concluded that the effects of the scheme on physical activity are likely to be as expected, as there has been no reduction or increase in the degree of severance of the NMU network; the overall effect of the scheme on NMUs is therefore considered to be **as expected**.

Table 5-12 Evaluation summary: physical activity

Sub-Objective	AST	OYA
Physical Activity	Neutral	As expected

Journey Quality

5.109. The journey quality sub-objective considers traveller care (facilities and information), traveller views and traveller stress (frustration, fear of potential accidents and route uncertainty).

5.110. Traveller views are defined as the extent to which travellers, including drivers, are exposed to different types of scenery, which the route passes through. The assessment considers landscape character and potential views, good or bad, along the route.

5.111. Driver stress is defined in DMRB as “the adverse mental and physiological effects experienced by drivers traversing a road network”. Driver stress is affected by a number of factors including; road layout and geometry, surface riding characteristics, junction frequency, traffic speed and flow per lane characteristics. Collectively these factors can induce feelings of discomfort, annoyance, frustration and fear in drivers resulting in physical and emotional tension, which detracts from the value and safety of the journey. The extent of stress induced in individual drivers differs greatly due to their level of skill, experience, temperament, knowledge of the route and state of health. Driver stress has the following components:

- Frustration;
- Fear of potential accidents; and
- Route uncertainty.

5.112. Traveller care is concerned with the quality of the journey as affected by the provision of facilities and information along the route. This includes the number and type of facilities and en-route information, together with their spacing and quality.

Forecast

Appraisal Summary Table

5.113. The AST stated that variable message signs would provide clear and unambiguous information to drivers which would serve to reduce driver stress. For traveller views, there would be increased awareness of the motorway due to the frequency of additional infrastructure. Neither passenger

nor freight interchange would be affected by the scheme. Overall, the impact of the scheme on journey quality was assessed as **large beneficial**.

Environment Assessment Report

5.114. The EnAR considered the effects of the scheme on vehicle travellers, including travellers' views, and driver stress in the chapter "Effects on All Travellers". Traveller care was not considered in the EnAR and has not been evaluated at OYA as facilities have not been affected by the scheme.

Traveller Views

5.115. The EnAR noted that the proposed scheme extent had relatively few particularly distinctive features or attributes upon which the road user could focus or recognise as having special or valued landscape characteristics. Changes to the existing visual context of the motorway corridor arising from the scheme would include:

- Marginally increased 'tunnel vision' created by a combination of increased number of gantries, the majority of which being superspan;
- The introduction of localised new equipment running along the hard shoulder verge such as lighting columns around ERAs, frequent CCTV cameras and additional signage;
- An increased sense of unity, arising from the application of a 'family' of high quality structures, finishes and information signs, removing many of the older, visually heavy and diverse structures along the existing corridor;
- An awareness of a change in local highway vegetation in areas where significant clearance of mature trees would be required, opening brief views towards adjacent urban fringe development. This perception of change would be alleviated within 10 to 15 years once new planting had been established and reintegrated.

5.116. There was expected to be a marginal increase in the urbanisation of the motorway due to the number and density of new structures. The greatest degree of change would be between J5 and J6 and the M6 NB section of J8 on elevated sections where bends in the road would not necessarily screen views of distant gantries to the same degree as sections typically enclosed by highway planting and environmental barriers, or where the road was in cutting. A degree of change would also be apparent in very localised areas wherever significant mature highway vegetation clearance was required to accommodate ERAs and gantries, exposing further brief transitional views towards adjacent urban development. Given its context within a predominantly urban landscape the overall impact for vehicle travellers was considered to be neutral.

Driver Stress

5.117. The proposed scheme aimed to address existing problems within the scheme extents such as congestion, increased journey times, uneven traffic flow and queues. The provision of the various scheme elements were expected to bring about a number of benefits such as smoother flowing traffic and better informed road users which were expected to reduce driver stress and increase safety. There was a slight potential for a temporary increase in driver stress once the scheme was first put into operation due to short term 'unfamiliarity' of the local changes to this section of MM. However, it was anticipated that travellers would quickly become familiar with the route and benefit from the proposed scheme.

5.118. The EnRA also noted that the provision of only one ERA on each carriageway on Bromford viaduct and Perry Barr depot would reduce potential safety benefits. Although it was expected that there would be an improvement in journey times, reduction in fuel consumption and better information for drivers leading to reduced driver stress the EnAR stated that it was difficult to draw any firm conclusions on the overall change in driver stress.

5.119. EnAR Table 11.3 summarised the factors that cause driver stress and provided details of the proposed scheme elements which it was expected would contribute to driver stress alleviation. This table is reproduced in the OYA evaluation Figure 5-13 below.

Consultation

5.120. No comments were received from consultees related to journey quality.

Evaluation

Traveller Views

5.121. As expected the introduction of additional infrastructure has slightly increased the urbanisation of the motorway corridor. Views from the motorway to the surrounding environment have not changed significantly as a result of the Scheme although inevitably there has been some minor vegetation reduction associated with some of the gantry locations.

5.122. It is noted however that with all lane running there is an increased visual dominance of the reinstated environmental barriers on the stretch of motorway to the northwest of J6 where these are present on both sides of the road. With the introduction of hard shoulder running this brings moving traffic closer to the carriageway edge and the relatively unattractive and hard visual appearance of these barriers.

Figure 5-13 View looking northwest at approximate location 188A (J6-7) with noise fence barriers post-construction (May 2016) Image © Google

Driver Stress

5.123. As expected additional capacity has been provided by the use of the hard shoulder as a running lane, however congestion at peak times remains a factor and journey times have increased across the scheme. Although accidents have also increased this is statistically not considered to be significant at OYA and should be reconsidered further at FYA when data over a longer time period should be available. Further detail can be found in the Traffic and Safety sections of this report. Table 5-13 below summarises driver stress factors at OYA.

Table 5-13 Summary of stress factors, scheme elements and evaluation

Cause of Stress	Proposed Scheme Elements	OYA Evaluation
Congestion	Additional capacity provided by the use of the hard shoulder as a running lane.	Additional capacity has been provided by the use of the hard shoulder as a running lane.
Increased Journey Times	Increased capacity of the pavement during times of congestion, through road works and around an incident, by the opening of the hard shoulder for trafficking. Rapid incident detection and clearance by the use of CCTV coverage of the motorway and CCTV Automatic Incident Detection through video imaging processing.	Despite the introduction of increased capacity (in general) journey times have increased across the scheme. Rapid incident detection has been implemented, no change has been observed in the reliability of the scheme during extreme circumstances.
Unpredictability of Journey Times	Controlled traffic speed regulates and smoothes the flow of traffic, reducing congestion.	In general, no change has been observed in the reliability as a result of the scheme.
Lack of Prior Notice	Variable Message Signs along the duration of the motorway to provide advanced warning to the driver prior to queues / incident increasing attention and awareness.	VMS have been implemented across the scheme and the quality of information provided to users has improved.
Uneven Traffic Flows	Automatic flow detection and variable speed limits through the use of MIDAS loops and the MM control system to regulate the traffic flow.	Automatic flow detection and variable speed limits are in place, however observations suggest better use of these factors could be made.
Joining Traffic	No new ramp metering sites to be installed; existing locations at J5 and J7 SB will need recalibrating following the opening of BB3MM. Use of hard shoulder to extend the entry slip, allowing merging drivers additional time to merge with the carriageway.	Proposed scheme elements have been implemented as forecast.
Exit Queues	Use of hard shoulder as an exit lane at congested junctions and improved signage in accordance with the latest IANs.	Proposed scheme elements have been implemented as forecast.
Queue Duration	Rapid incident detection and clearance by the use of, CCTV coverage of the motorway and CCTV Automatic Incident Detection through video imaging processing.	Journey reliability during periods of heavy traffic has remained unchanged as a result of the scheme.
Route Uncertainty	Improved fixed signage and improved road markings, clearly indicating positions of main lanes, exit and entry lanes.	Proposed scheme elements have been implemented as forecast.

Summary

5.124. With regard to driver views there has been an increased sense of urbanisation along the route corridor; however this is within the context of the existing motorway network and a predominantly urban landscape. Vegetation has been retained where possible which provides a framework to the route. Mitigation proposed as part of the landscape measures was expected to reduce any negative impacts of the works, increasing in effectiveness over time as planting matured - as noted in the landscape section above, it has not been possible at OYA to confirm the extent of any replacement planting undertaken and this aspect of the scheme in should be reconsidered at FYA. Overall, the impact for vehicle travellers is considered to be **neutral** as expected at OYA**.**

5.125. The scheme aimed to address problems such as congestion, increased journey times, uneven traffic flow and queues. The provision of the various scheme elements were expected to bring about a number of benefits such as smoother flowing traffic and better informed road users which would reduce driver stress and increase safety. The scheme elements have been implemented but at OYA the benefits to driver stress may not have been fully realised; congestion remains an issue at certain times, journey reliability and accidents have increased although it is too soon to come to any firm conclusions.

5.126. Journey quality should be reconsidered at FYA when data over a longer time frame should be available.

Table 5-14 Evaluation summary: journey quality

Sub-Objective	AST	OYA
Journey Quality	Large Beneficial	Based on data available at OYA the large beneficial effects may not have been fully realised. Slight beneficial.

Key Points - Environment

Noise and Local Air Quality

Based on traffic flows which are lower than expected there is potential for noise and local air quality to be better than expected although further information would be required to confirm. It is suggested that these aspects are reconsidered at FYA when traffic data over a longer time period should be available.

It should be noted that traffic growth has been lower than forecast at the time of the environmental assessments and is not a direct result of the scheme.

Greenhouse Gases

Carbon emissions have seen little change between the DM and DS scenarios, where as the reforecast carbon emissions showed an increase between DM and DS scenarios of 20%. The forecast carbon emissions are higher than the observed due to higher forecast flows and higher higher travel speeds. Observed traffic flows, whilst increasing, have not seen the increase forecast and as shown in the traffic chapter, speeds have decreased and therefore traffic is travelling at a more fuel efficient speed.

Landscape and Townscape

The introduction of new infrastructure and additional vertical elements will have slightly increased awareness of the motorway corridor within the local landscape / townscape character areas as expected.

Views are generally considered to be as expected at OYA, however, during construction concerns were raised by local residents at Grebe Close and Ragley Drive. Due to some open views to properties at OYA a score of slight adverse is considered to be more appropriate than the AST neutral. It is too soon to evaluate the effectiveness of any replacement planting undertaken, which should be reconsidered at FYA.

Biodiversity

The scheme was not expected to result in any significant adverse impacts on any designated sites of nature conservation importance or on protected species. Whilst the wildlife corridor running the length of the route appears on visual inspection at OYA to have recovered from the construction works, further information would be required to fully evaluate the impact of the scheme on biodiversity effects.

Heritage of Historic Resources

It was predicted that there would be no impacts on archaeology as all works would be within the highway boundary, this is likely to be the case although further information would be required to confirm. It is considered that as expected, any localised impacts on the setting of built heritage and historic landscape have not been significant. Neutral effect overall.

Water Environment

Based on the information available to POPE it would appear that scheme drainage has been implemented in line with proposals and it is likely that effects on the water environment are neutral as expected

Physical Activity

As expected, there has been no direct impact on the NMU network as a result of the scheme and impacts are considered to be neutral.

Journey Quality

There has been an increased sense of urbanisation within the context of the existing motorway corridor as expected and effects on traveller views are considered to be generally as expected.

The forecast large beneficial effects of the scheme may not have been fully realised at this OYA stage; congestion remains an issue at certain times and despite the introduction of increased capacity (in general) journey times have increased across the scheme. Accidents have also increased although this is not considered to be statistically significant at OYA.

6. Social Impacts Evaluation

Introduction

6.1. The WebTAG guidance at the time of scheme appraisal describes social impacts as covering the human experience of the transport system and its impact on social factors, not considered as part of economic or environmental impacts. This covers the following impacts:

- Accidents
- Physical Activity
- Security
- Severance
- Journey Quality
- Option and Non-Use Values
- Accessibility
- Personal Affordability

6.2. Accidents (collisions) and security were considered in section 3 of this report, and Physical Fitness and Journey Quality in the environment chapter. This section covers the remaining social impacts.

Physical Activity

6.3. Physical activity relates to pedestrian and cyclist journeys, and the impact of the scheme upon them.

6.4. A full evaluation is provided in the environment section, which concludes that the effects of the scheme on physical activity are likely to be neutral, as expected.

Journey Quality

6.5. Journey quality relates to traveller care (facilities and information), traveller views and traveller stress (frustration, fear of potential accidents and route uncertainty).

6.6. A full evaluation is provided in the environment section, which concludes that based on data available at OYA the large beneficial effects may not have been fully realised.

Affordability

6.7. Affordability relates to changes in transport costs. WebTAG states that the most significant impacts of the costs of travel are on young and old people, and low income household, particularly when travelling to employment or education.

6.8. The AST scores affordability as neutral to slight adverse, stating that:

"The scheme produces overall net benefits. These are spread across the income bands in equal proportions. Those in lower income groups receive relatively less per head of population."

6.9. It is considered that the AST forecast is valid and that further evaluation would reveal no changes in affordability connected to the scheme. Therefore, the score of neutral to slight adverse is upheld at the outturn.

Access to Services

6.10. WebTAG states that access to services is strongly influenced by access to a private vehicle and proximity to public transport services.

6.11. The AST states that this scheme does not affect the provision or location of transport facilities and hence access to transport is unaffected. The forecast score is recorded as neutral.

6.12. It is considered that the AST forecast is valid and that further evaluation would reveal no changes in access to services connected to the scheme. Therefore, the score of neutral is upheld at the outturn.

Severance

6.13. Severance refers to the degree to which movement and activities within the community are affected by the presence of a major road or other transport link, and particularly the degree of separation of residents from the facilities and services they use within their community.

6.14. The AST forecast scores severance as slight negative, stating:

"Between junctions people can only cross the M6 by grade-separated facilities that are unaffected by MM operation. At junctions, the potential increase in traffic on feeder roads may affect pedestrians crossing these roads."

6.15. At OYA observed traffic flows on local feeder roads have shown a slight increase in traffic (lower than that of background traffic growth). Although undetermined, it is possible that traffic on feeder roads has increased and affected pedestrian movements. As such, the forecast score of slight negative is upheld at the time of assessment.

Option Values

6.16. Option values as defined in WebTAG relate to the availability of different transport modes within the study area, even if they are not used. For example, a car user may value a bus service along their route even if they never use it because they have the option of another mode should their car become unavailable.

6.17. Access to the transport system is influenced by access to a private car and proximity to a public transport service.

6.18. The AST scores option values as neutral, noting that transport availability is unaffected by the scheme.

6.19. It is considered that the AST forecast is valid and that further evaluation would reveal no changes in option values connected to the scheme. Therefore, the score of neutral is upheld at the outturn.

Social Impacts - Key points

Physical Activity

- The impact of the scheme upon physical activity was forecast as neutral. The forecast of neutral is upheld at the outturn.

Journey Quality

- The impact of the scheme upon journey quality was forecast as large beneficial. The forecast of large beneficial is upheld at the reforecast as slight beneficial at the outturn.

Affordability

- The impact of the scheme upon affordability was forecast as neutral to slight adverse. The forecast of neutral to slight adverse is upheld at the outturn.

Access to Services

- The impact of the scheme upon access to services was forecast as neutral. The forecast of neutral is upheld at the outturn.

Severance

- The impact of the scheme upon access to services was forecast as slight negative. The forecast of slight negative is upheld at the outturn.

Option Values

- The impact of the scheme upon option values was forecast as neutral. The forecast of neutral is upheld at the outturn.

7. Conclusion

7.1. To conclude this report, this section summarises how the scheme is meeting its specified objectives.

Scheme Specific Objectives

7.2. Table 7-1 presents the success of the scheme against the specified scheme objectives.

Table 7-1 Success against scheme objectives

Objective (stated in Client Scheme Requirements, 2011)	Has the objective been achieved?
The Scheme shall deliver a managed motorway including hard shoulder running solution.	✓
The Scheme shall, as a priority, improve journey time reliability and shall also improve journey times, on the M6 between J5 and J8.	**Too early to conclude journey time impacts** **Improvements in reliability achieved in the AM peak**
Once open to traffic, the Scheme should aim not to detrimentally affect traffic on the surrounding road network.	✓
The Scheme shall reduce the number and severity of accidents per vehicle-kilometre.	**Too early to conclude** **Severity has decreased post opening**
The Scheme should ensure that queuing of traffic onto the mainline of the motorway due to congestion at junctions is minimised and deliver the minimum required junction improvements to ensure this.	✓
The Scheme should aim to improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway.	✓
The Scheme should aim to improve journey ambiance.	**Too early to conclude**
The detrimental environmental effects of the Scheme shall be offset by mitigation measures where technically feasible and economic to do so.	✓

8. Appraisal Summary Table (AST) and Evaluation Summary Table (EST)

Table 8-1 Appraisal Summary Table

					Contact:	
Name of scheme:	**Birmingham Box Managed Motorways**				**Name**	Rob Edwards
Description of scheme:	The BB3MM scheme will be implemented across the M6 Junctions 5 to 8, including M5 link roads to improve this 10.4 miles of motorway. It will provide an operational solution to current congestion problems through the dynamic use of the hard shoulder also improving journey time reliability. It requires the installation of 20 super-span gantries and 6 Emergency Refuge Areas; two of which will make use of the existing hard standing on the M6 Bromford viaduct. Fifteen gantries will be reused either being refurbished and strengthened or replaced with a like-for-like gantry, whilst 14 existing gantries and 1 cantilever are to be removed. Maintenance hard standing areas, associated Close Circuit Television (CCTV) and Motorway Incident Detection and Automatic Signalling outstations (MIDAS) are also to be provided. The project also includes proposals to realign the M6 west of junction 6 from MP184/1A+70 toMP184/8A+80 (approximately 710m). The proposed scheme when operational will be entirely within the motorway boundary.				**Organisation**	Highways England
					Role	Promoter/Official
		Assessment				
Impacts		**Summary of Key Impacts**	**Quantitative**	**Qualitative**	**Monetary £(NPV)**	**Distributional 7-pt scale/vulnerable grp**
Economy	**Business users & transport providers**	User benefits during construction and during future major maintenance included.	Value of journey time changes (£) Net journey time changes (£) 0 to 2 min: 128,284 / 2 to 5 min: 139,567 / >5 min: -10,990	-	PVB £241M	0-20%: Moderate Beneficial 20-40%: Moderate Beneficial 40-60%: Moderate Beneficial 60-80%: Moderate Beneficial 80-100%: Moderate Beneficial
	Reliability impact on Business users	User benefits during incidents split in proportion to Consumer and Business User Benefits.	Benefits on motorway & on surrounding urban roads	-	Potential Benefit £18.2M	-
	Regeneration	The scheme would have a positive impact on the identified Regeneration Areas within the West Midlands as it would make easier for people living in those areas to access the areas where there are likely to be employment opportunities.	The number of jobs accessible: within 45min, Future Foundations zone increases by 0.2% - within 30min, Arc of Opportunity zone increases by 4.9%.	The number of jobs accessible: within 45min, Future Foundations zone increases by 0.2% - within 30min, Arc of Opportunity zone increases by 4.9%.	-	-
	Wider Impacts	Agglomeration impacts not assessed; other impacts captured via regeneration & environmental assessments.	N/A	N/A	-	-
Environmental	**Noise**	The scheme is anticipated to have negligible short-term impact on traffic noise in the surrounding area. Some properties, in the vicinity of Junctions 5, 6 and 8 are predicted to experience noise reduction benefits in the short term. Local increases in noise can be attributed to increased traffic flow and speed due to the scheme. In the long-term changes in noise and noise level perception are negligible.	Number of people annoyed in the 2028: with scheme – 7371, without scheme – 7000	-	Difference in population annoyed: 371. NPV: -£11.2M	0-20%: Slight Adverse 20-40%: Moderate Adverse 40-60%: Slight Adverse 60-80%: Moderate Adverse 80-100%: Moderate Adverse Children and Young People (schools): Slight Adverse
	Air Quality	**PM10**	**PM10**	**PM10**	-	0-20%: Large

<table>
<tr><td></td><td></td><td>No properties experience exceedance of the annual mean PM10 EU Limit Value and no exceedances are removed as a result of the proposed scheme. The scheme is predicted to lead to an improvement in air quality overall.

NO2
The Scheme intersects three Air Quality Management Areas (AQMAs). Nine AQMAs are affected by changes to road traffic characteristics.
While the output of the appraisal indicates the scheme, it could lead to a deterioration in air quality overall, detailed assessment using dispersion modelling has concluded that the scheme does not lead to an overall worsening of the annual mean NO2 EU Limit Value.</td><td>Number of properties with an improvement (PM10): 119,700 Number of properties with no change (PM10): 4,220Number of properties with a deterioration (PM10): 102,190

NO2
Number of properties with an improvement (NO2): 62,433 Number of properties with no change (NO2): 114,667 Number of properties with a deterioration (NO2): 49,010</td><td>Net Benefit

NO2
Net Adverse</td><td></td><td>Beneficial
20-40%: Moderate Beneficial
40-60%: Slight Beneficial
60-80%: Large Adverse
80-100%: Neutral
Children and Young People (schools): Slight Adverse</td></tr>
<tr><td></td><td>Greenhouse gases</td><td>There is a reduction in carbon emissions between the 'without scheme' and 'with scheme' over the 60-year appraisal period and a reduction in carbon emissions between the 'without scheme' and
'with scheme' in the opening year.</td><td><table><tr><td>Change in non-traded carbon over 60y (CO2e)</td><td>-119,592</td></tr><tr><td>Change in traded carbon over 60y (CO2e)</td><td>0</td></tr></table></td><td>Net Benefit</td><td>PVB £2,090.254</td><td>-</td></tr>
<tr><td></td><td>Landscape</td><td>Slightly increased awareness of the motorway corridor as a result of increased number of gantries and localised vegetation loss at major infrastructure locations would not result in significant adverse effects on the landscape character. Localised adverse impacts on a small number of residential properties.</td><td>N/A</td><td>Neutral</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Townscape</td><td>Within the context of the predominantly urban fringe motorway corridor, the scheme would not give rise to significant impacts on the perception of the existing townscape. Incorporation of gantries on elevated sections of the motorway would give rise to minor impacts as a result of localised changes within the motorway corridor.</td><td>N/A</td><td>Neutral</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Heritage of Historic resources</td><td>There would be no impacts on the below ground archaeological resource as all works within highway boundary. Impacts on the built heritage and historic landscape would be through local visual intrusion on their setting, but are not significant.</td><td>N/A</td><td>Neutral</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Biodiversity</td><td>Slight adverse impacts on three sites of local importance for nature conservation and the local designation - M6/M5 Wildlife Corridor. Implementation of precautionary mitigation measures for Great Crested newts will serve to ensure no adverse impacts on these species, no impact therefore expected to this species. Impacts on all other sites and species are neutral except Biodiversity Action Plan species which is slight adverse.</td><td>N/A</td><td>Slight Adverse</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Water Environment</td><td>Drainage design includes measures to contain any accidental spillage from Emergency Refuge Areas and attenuation measures to handle additional surface run-off have been designed to ensure scheme implementation has no adverse impact.</td><td>N/A</td><td>Neutral</td><td></td><td></td></tr>
<tr><td>Social</td><td>Commuting and Other users</td><td>User benefits during construction and during future major maintenance included.</td><td><table><tr><td colspan="3">Value of journey time changes (£)</td></tr><tr><td colspan="3">Net journey time changes (£)</td></tr><tr><td>0 to 2 min</td><td>2 to 5 min</td><td>>5 min</td></tr><tr><td>83,426</td><td>50,469</td><td>-30,769</td></tr></table></td><td>-</td><td>PVB £112M</td><td>0-20%: Moderate Beneficial
20-40%: Moderate Beneficial
40-60%: Moderate Beneficial
60-80%: Moderate Beneficial
80-100%: Moderate Beneficial</td></tr>
<tr><td></td><td>Reliability impact on Commuting and Other users</td><td>User benefits during incidents split in proportion to Consumer and Business User Benefits.</td><td>Benefits on motorway & on surrounding urban roads</td><td>-</td><td>Potential Benefit £8.8M</td><td>-</td></tr>
<tr><td></td><td>Physical activity</td><td>Scheme will not change the number of pedestrian or cyclist journeys or change journey length as a consequence no material impacts expected.</td><td>N/A</td><td>Neutral</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Journey quality</td><td>Variable message signs to provide clear and unambiguous information to the driver, this would serve to reduce driver stress. Traveller Views: Increased awareness of the motorway due to frequency of additional</td><td>N/A</td><td>Large Beneficial</td><td>-</td><td>-</td></tr>
</table>

		infrastructure. Neither passenger nor freight interchange would be affected by the scheme.				
	Accidents	PIAs saved = 15% as agreed with HA/TAME for Managed Motorways schemes (following experience based on M42 Pilot). Assumes existing motorway has MIDAS installed. West Mids. has higher proportions of pedestrians and people under 16yrs than national averages. Changes in accidents reflect flow changes across the network and are balanced between benefits and disbenefits. Initial assessment of impact on SDI groups is neutral.	15 % saving. COBA £40M, QUADRO construction -£1M, QUADRO maintenance -£1M	-	PVB £38M	Neutral - no significant impacts on vulnerable groups have been identified.
	Security	Although MM provides less hard shoulder provision for emergencies, the improved monitoring and control of traffic should improve security for road users.	150,000 vpd on M6	Slight Beneficial	-	N/A
	Access to services	The Scheme does not affect the provision or location of transport facilities and hence access to transport is unaffected.	N/A	Neutral	-	N/A
	Affordability	The scheme produces overall net benefits. These are spread across the income bands in equal proportions. Those in the lower income groups receive relatively less per head of population. Final scoring is to be completed.		Neutral to slight adverse	-	Those in the lower income bands receive less benefit per capita.
	Severance	Between junction's people can only cross the M6 by grade-separated facilities that are unaffected by MM operation. At junctions, the potential increase in traffic on feeder roads may affect pedestrians crossing these roads.	The motorways junctions and feeder roads are in populated areas	Slight Negative	-	N/A
	Option values	Transport availability is unaffected by the Scheme	N/A	Neutral	-	-
Public Accounts	**Cost to Broad Transport Budget**	Investment cost of scheme including agreed target price cost (October 2011) and operational and maintenance costs	Central Government - Scheme Target Price £105M. PV Construction £75M, O&M £30M	-	PVC £105M	-
	Indirect Tax Revenues	Changes in vehicle kilometres travelled and vehicle speeds, and therefore fuel used following implementation of the scheme, would result in changes in indirect tax revenues to central government.	Central Government - Indirect Tax Revenues -£25.5M	-	PVB -£25.5M	-

Table 8-2 Evaluation Summary Table

Scheme Name: M6 J5 – 8 Smart Motorway		Qualitative Impacts	Quantitative Impact	Assessment
Impacts				
Economy	Business Users & Transport Providers	Average journey times have generally increased in the opening year where they were forecast to decrease. As a result, at OYA the impact of the scheme on TEE has shown a negative PVB.	-	PVB (inc. consumers) = -£310.9 million
	Reliability Impact on Business	The scheme has improved journey time reliability for vehicles travelling in the AM peak, had no impact upon those travelling during the IP and had a negative impact upon those travelling during the PM peak. Therefore the outturn impact of reliability is taken as forecast.	-	PVB = £26.5 million (as expected at OYA)
	Regeneration	The AST considered that the scheme would have a positive impact upon the identified Regeneration Areas within the West Midlands. It is too soon to provide a complete evaluation however, at this early stage, information showing that journey times have not improved may mean that the positive impact expected do not materialise	-	As expected at OYA
	Wider Impacts	The AST did not asses the Wider Economic Impacts, reasoning that the impacts are captured via regeneration and environmental assessments.	-	As expected at OYA
Environmental	Noise	The traffic data indicates that the observed flows are between 22% and 36% less than predicted at six links and as such, indicates that noise could be better than expected in these locations.	-	Potential for noise to be better than expected for some locations and as expected at others. Further information required to confirm.
	Air Quality	The traffic data indicates that the observed flows are lower than forecast by more than 10% at all locations and as such there is potential for local air quality to be better than expected.	-	Potential to be better than expected although further information required to confirm
	Greenhouse Gases	Observed carbon emissions have seen little change between the without scheme and with scenarios, equivalent to 355 tonnes of carbon, where as in the reforecast the carbon emissions showed an increase between without scheme and with scheme scenarios of 20%, equivalent to 8,466 carbon tonnes.	Forecast increase in emissions: 20% Observed increase in carbon emissions: 1%	Slight benefit
	Landscape	The introduction of new and additional infrastructure elements along the route corridor has slightly increased awareness of the motorway as expected. Significant views are generally considered to be as expected at OYA, however, it is too soon to evaluate the effectiveness of any replacement planting undertaken which should be reconsidered at FYA.	-	As expected at OYA
	Townscape	The introduction of new and additional infrastructure elements along the route corridor has slightly increased awareness of the motorway as expected. Significant views are generally considered to be as expected at OYA, however, it is too soon to evaluate the effectiveness of any replacement planting undertaken which should be reconsidered at FYA.	-	As expected at OYA
	Heritage and Historic Resources	Impacts to archaeology and built heritage are considered to be as expected. Overall, it is considered that based on the information presented above, and the localised nature of the proposals, the effects of the scheme on the heritage resource are likely to be generally as expected.	-	As expected at OYA
	Biodiversity	POPE has received no further information. No comments were received from consultees relating to biodiversity. Whilst the wildlife corridor running the length of the route appears at OYA to have recovered from the construction works, further information would be required to fully evaluate the impact of the scheme on biodiversity	-	As expected at OYA
	Water and Environment	As built drawings indicate that scheme drainage has been implemented in line with proposals and drawings note that the surface water drainage connects into the existing drainage network and that the combined kerb drainage on viaduct sections uses existing gulley outfalls. Based on the information available and the feedback provided by the EA, POPE has no reason to believe that the highway drainage is performing other than as designed and it is likely that effects on the water environment are as expected.	-	As expected at OYA
Social	Commuting and Other Users	As for Business Users & Transport Providers.	-	As with PVB for Business Users & Transport Providers
	Reliability Impact on Commuting and Other Users	As for Reliability Impact on Business.	-	PVB = £26.5 million (as expected at OYA)
	Physical Activity	No impacts on NMUs, as expected.	-	As expected at OYA
	Journey Quality	There has been an increased sense of urbanisation along the route corridor; however this is within the context of the existing motorway network and a predominantly urban landscape. Vegetation has been retained where possible which provides a framework to the route. Mitigation proposed as part of the landscape measures was expected to reduce any negative impacts of the works, increasing in effectiveness over time as planting matured - as noted in the landscape section above, it has not been possible at OYA to confirm the extent of any replacement planting undertaken and this aspect of the scheme in should be reconsidered at FYA	-	Slight Beneficial
	Accidents	There has been a 0.010 PIC/mvkm increase in the collision rate on the M6 J5-8 after background reductions are considered.	Not statistically significant	PVB = not monetised

	Security	There has been a loss of shoulder provision, but installation of CCTV cameras, Emergency Refuge Areas and Controlled Motorway has offset this loss and provided a benefit.	-	As expected at OYA
	Access to Services	It is considered that the AST forecast is valid and that further evaluation would reveal no changes in access to services connected to the scheme.	-	As expected at OYA
	Affordability	It is considered that the AST forecast is valid and that further evaluation would reveal no changes in affordability connected to the scheme.	-	As expected at OYA
	Severance	At OYA observed traffic flows on local feeder roads have shown a slight increase in traffic (lower than that of background traffic growth). Although undetermined, it is possible that traffic on feeder roads has increased and affected pedestrian movements.	-	As expected at OYA
	Option Values	It is considered that the AST forecast is valid and that further evaluation would reveal no changes in option values connected to the scheme.	-	As expected at OYA
Public Accounts	Cost to Broad Transport	The cost of the scheme is slightly lower than forecast, in cost and operating costs.	17% lower than forecast	PVC = £103.545 million
	Indirect Tax Revenues	The outturn reforecast of the impact from the scheme on indirect tax revenue is a lower reduction in benefit than forecast. This means that there are expected to be more payments in tax over the 60-year appraisal period i.e. a lesser cost to the Treasury than forecast.	-	PVB = -£2.875

9. Appendices

Appendix A. Highways England Network Improvement Schemes (Local to M6 J5-8)

	Scheme	Description/Impact on Traffic	Start of Construction	Scheme Opening
1	BBMM2 (M6 Junction 8 to 10a)	Managed Motorway implemented between junction 8 to 10a.	April 2009	March 2011
2	M6 Junction 9 Traffic Signal Upgrade (Pinch Point Programme)	Implementation of MOVA traffic signals at the roundabout of M6 junction 9.	April 2013	June 2013
3	M6 Junction 10a to 13 Smart Motorway Scheme	Smart Motorway implemented between junction 10a to 13.	October 2013	February 2016
4	M6 Walsall Canal Bridge Southbound re-surfacing (Junction 9-10)	Phase 1 of this work replaced joined and re-waterproofed the deck of Walsall canal bridge between junctions 9 and 10.	April 2014	July 2014
5	Improvement scheme at M6 Junction 6 (Salford Circus Roundabout)	Widening of roundabout at Junction 6 and new traffic signals installed.	June 2014	July 2016
6	M6 Northbound Junction 7 to 10 Carriageway re-surfacing and bridge expansion	The carriageway was re-surfaced between junction 7 and 10 (northbound) to improve safety and road conditions. There were overnight closures of the M6 northbound between junction 7 and 10.	February 2015	April 2015
7	M6 8 to M5 Link Southbound re-surfacing (waterproofing)	The bridges on the link road between the southbound M6 to the M5 require re-surfacing. Traffic management was in place throughout the construction period, with single lane running. There were some overnight closures in January 2017 to complete the works.	January 2015	January 2017
8	M6 Junction 4 northbound and southbound entry slip roadworks	Roadworks planned.	June 2016	
9	M6 / A38(M) Gravely Hill Interchange Waterproofing Scheme and Replacement of Lighting Columns	Roadworks planned.	May 2016	December 2016
10	M6 Bromford and Witton Viaduct Concrete Repairs (near Junction 5)	Structural maintenance work was carried out at these two locations, as well as concrete repairs to the structure over the Junction 5 southbound on-slip. This is to improve the safety of the structures. Junction 5 southbound on-slip had a full closure from January 2016. Diversion routes were in place and signposted.	October 2014	June 2016
11	M5 Junction 4a to 6 Smart Motorway	Upgrading to a smart motorway with all lanes running with four lanes for use by traffic. Overnight closures of M5 between Junctions 4a and 6 in both directions throughout construction period. 50mph speed limit enforced.	January 2016	Opened Spring 2017
12	M40 Junction 16 to M42 Junction 3a Safety Improvement	Maintenance work to improve safety and reduce queuing on the M40 northbound between Junction 16 and	February 2017	March 2017

	Scheme	Description/Impact on Traffic	Start of Construction	Scheme Opening
		M42 Junction 3a. Overnight closure of this stretch of road for 5 weeks		
13	A449 Improvements	Resurfacing of the carriageway on the A449 from A449/A5 Gailey Roundabout to M54 Junction. The safety barriers will also be upgraded. A fully signposted diversion route will be in place using M6 Junction 11/12	January 2017	Scheduled June 2017
14	M6 northbound (Junction 7 and 8)	Structural repairs to damaged concrete and waterproofing on northbound carriageway. Work taking place in hard shoulder and lane one to minimise disruption. Overnight and weekend closures of slip roads and main carriageway. Enforced stepped speed limit from 70mph, to 50mph and 40mph through the work area, with fully signposted diversions between Junction 7 and 8.	February 2017	April 2017
15	M5 Junction 1 to 2 Oldbury Viaduct	Preparation work for major concrete work and waterproofing in advance of main scheme which started in April/May 2017. This was carried out using overnight lane closures and weekend overnight full closures of slip roads and the main carriageway.	January 2017	Scheduled Autumn 2018
16	M42 re-surfacing	Re-surfacing M42 junction 6 to 7 northbound, M42 junction 6 to 7 southbound, M6 4A to M42 southbound junction 7 and northbound junction 8 link road. Full road closures will be in place overnight with full signposted diversions with no traffic management in place during the day.	March 2017	May 2017
16	M42 Junction 3a to 7 Radar Renewal	Renewal of traffic technology between Junction 3a and 7 on the M42 northbound. Some overnight closures were used with full diversions in place.	January 2017	March 2017
17	M6 Whitgreave Lane overbridge maintenance	Essential maintenance was carried out on the bridge, resulting in full closure of the bridge overnight. Diverted through Junction 14.	February 2017	March 2017
18	M6 Lymes Road Parapets	Replacement of parts of the concrete structure underbridge which carried the M6. Traffic diverted from Junction 15 and 16.	October 2016	April 2017

Appendix B. CSR Objective List (Full)

Number	Objectives (as per DfT CSR - October, 2011)	Considered	Notes
	Overall		
1	The Scheme shall be designed to support the delivery of the Department for Transport vision as described above [CSR Strategic Case].	N	
2	The Scheme shall deliver a managed motorway including hard shoulder running solution.	Y	
3	The Scheme should make best use of existing infrastructure by providing additional capacity within the existing highway boundary and, where possible, within the existing paved area.	N	
4	The Scheme shall deliver the minimum scope required to achieve safe and economic operation and maintainance of the network.	N	
5	The Scheme should be designed to suit the requirements of ongoing maintainance, the needs of Highways Agency Network Delivery and Development and Traffic Management directorates and to minimise whole life costs.	N	
6	The project shall provide high value for money against its whole of life costs in accordance with the Department's WebTAG guidance.	N	
7	Throughout the project, the scheme should aim to improve on AST sub-criteria assessment results that are produced during the Options Phase.	N	
	Transport and Safety		
8	The Scheme should improve the transport and safety problems identified in the Challenges and Issues section of this document.	N	These problems were described in detail as part of the Options Phase.
9	The Scheme shall, as a priority, improve journey time reliability.	Y	
10	Once open to traffic, the Scheme should aim not to detrimentally affect traffic on the surrounding road network.	Y	
11	The Scheme shall reduce the number and severity of accidents per vehicle-kilometre.	Y	
12	The Scheme should ensure that queuing of traffic onto the mainline of the motorway due to congestion at junctions is minimised and deliver the minimum required junction improvements to ensure this.	Y	
13	The Scheme should aim to improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway.	Y	
14	The Scheme should aim to improve journey ambiance.	Y	
15	The detrimental environmental effects of the Scheme shall be offset by mitigation measures where technicaly feasible and economic to do so.	Y	
16	The Scheme should aim not to worsen the severance of local thoroughfares for non-motorised users.	N	
17	The Scheme shall take into account the capacity improvements implemented on the M6 South of J5, North of J8 and the improvements on the M42 and M40.	N	
18	The Scheme shall ensure the HA Network Delivery and Developent Directorate, Traffic Management Directorate and other internal departments not consulted on the scheme design.	N	
19	The Scheme shall ensure HA Network Delivery & Developent Directorate (as Senior user for the Scheme) agree the Scheme design (operational principles have generally been agreed within the Options Phase).	N	
20	The Scheme shall ensure that value opportunities and buildability are maximised and the construction approach minimises impact on the travelling public.	N	
21	The Scheme shall ensure that lessons are brought across from BBMM1&2.	N	

Appendix C. DM and DS Highway Network Scenarios

Scheme Name	Source	DfT Status	Uncertainty	PRISM Model Year
A38 Northfield Regeneration	RFA2 Review	Complete	Built	2016, 2026
Coventry Bus Network (Primelines)	RFA2 Review	Complete	Built	2016, 2026
Hagley Road Bus Showcase	RFA2 Review	Under Construction	Near Certain	2016, 2026
Outer Circle/Radial Routes Showcase	RFA2 Review	Complete	Built	2016, 2026
Cradley Heath Town Centre Strategy	March 08 Mott MacDonald List	•••••	Built	2016, 2026
Red Routes Package 1	RFA2 Review	Under Construction	Near Certain	2016, 2026
Wolverhampton Centre Access Interchange	RFA2 Review	Full Approval	Near Certain	2016, 2026
Selly Oak New Road	RFA2 Review	Under Construction	Near Certain	2016, 2026
Walsall Town Centre Package	RFA2 Review	Complete	Near Certain	2016, 2026
Coleshill Multi Modal Interchange	March 08 Mott MacDonald List	•••••	Built	2016, 2026
Owen Street Level Crossing Relief Road	RFA2 Review	Under Construction	Near Certain	2016, 2026
Brierley Hill Sustainable Access Network	RFA2 Review	Complete	Near Certain	2016, 2026
Birmingham New Street Station (Birmingham Gateway)	RFA2 Review	Programme Entry	Near Certain	2016, 2026
M40 Junction 15 (Longbridge Roundabout)	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
Hard Shoulder Running M42 Junctions 3a-7	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
Hard Shoulder Running M6 Junction 4-5	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
Controlled Motorway M40 Junction 16 to J3A M42	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
Hard Shoulder Running M6 Junction 8-10a	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
Hard Shoulder Running M6 Junction 10a-13	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
Hard Shoulder Running M5 Junction 4a-6	TAME & DfT Announcements	•••••	Near Certain	2026
Hard Shoulder Running M6 Junction 2-4	TAME & DfT Announcements	•••••	Near Certain	2026
Hard Shoulder Running M6 between Birmingham and Manchester	TAME & DfT Announcements	•••••	Near Certain	2016, 2026
BIA/NEC Public Transport	RFA2 Review	Full Approval	Near Certain	2016, 2026
A4123 Junction (Burnt Tree)	RFA2 Review	Programme Entry	More Than Likely	2016, 2026
A41 Expressway / A4031 Junction	RFA2 Review	Programme Entry	More Than Likely	2016, 2026

Appendix D. Full PRISM 2016 Do-Minimum and Do-Something Modelled Link Speeds

Figure D-1 shows the complete 2016 DM and DS modelled link speeds from the TFR:

Figure D-1 PRISM 2016 Do-Minimum and Do-Something Modelled Link Speeds (Full)

	2016 Do Minimum Speeds by Time Period (km/hr)				2016 Do Something Speeds by Time Period (km/hr)			
Description	AM	IP	OP	PM	AM	IP	OP	PM
M6 NB between J4 and J5	84	84	103	85	52	56	103	78
M6 NB between J5 and J6	43	57	105	89	88	88	105	93
M6 NB within J6	98	98	107	98	94	93	107	95
M6 NB between J6 and J7	88	88	104	88	82	81	104	79
M6 NB between J6 and J7 2	56	54	104	29	85	82	104	44
M6 NB within J7	91	91	106	90	93	93	106	92
M6 NB between J7 and J8	91	90	105	89	85	85	105	84
M6 NB between J7 and J8 2	90	90	105	89	93	92	105	92
M6 NB from J7 to M5	108	110	110	110	106	110	110	109
M6 NB within J8	96	95	106	97	94	93	106	94
M6 NB after J8	79	79	103	79	79	79	103	79
M6 SB before J8	24	14	101	15	16	14	102	16
M6 SB within J8	96	94	105	97	95	93	106	96
M6 SB between J8 and J7 2	91	91	104	93	95	95	104	96
M6 SB between J8 and J7	91	91	104	93	86	87	104	87
M6 SB to J7 from M5	110	109	110	104	109	108	110	103
M6 SB within J7	92	92	105	93	95	96	105	97
M6 SB between J7 and J6 3	28	47	104	89	23	31	104	52
M6 SB between J7 and J6 2	43	62	104	89	86	89	104	92
M6 SB between J7 and J6	88	88	104	89	82	83	104	84
M6 SB within J6	99	98	107	100	99	99	107	99
M6 SB between J6 and J5 2	89	89	105	36	94	95	105	87
M6 SB between J6 and J5	89	89	105	88	86	86	105	82
M6 SB between J5 and J4	81	82	103	81	81	82	103	81

Figure D-1 shows that the link speed forecasts contained within the TFR are in some cases split into multiple modelled links between junctions, the origin and destinations of the splits are not specified. The length across each of the scheme links and the assumed length between splits within those links are provided in Table 9-1.

Table 9-1 Link and Link Split Distances

Link (Direction)	Length (km)	Link Split	Length (km)
M6 J5 – J6 (NB)	5.3	M6 J5 – J6	5.3
M6 J6 – J7 (NB)	6.9	M6 J6 – J7	1.0
		M6 J6 – J7 (2)	5.9
M6 J7 – J8 (NB)	3.4	M6 J7 – J8	0.9
		M6 J7 – J8 (2)	2.5
Total	**15.6**	**Total**	**15.6**
M6 J8 – J7 (SB)	3.4	M6 J8 – J7 (2)	2.7
		M6 J8 – J7	0.7
M6 J7 – J6 (SB)	6.9	M6 J7 – J6 (3)	0.5
		M6 J7 – J6 (2)	0.7
		M6 J7 – J6	5.7
M6 J6 – J5 (SB)	5.3	M6 J6 – J5 (2)	0.5
		M6 J6 – J5	4.8
Total	**15.6**	**Total**	**15.6**

Table 9-1 allows for the forecast speeds shown in Figure D-1 to be weighted proportionally in relation to the entirety of each scheme link, this allows for an estimation of the forecast speed across each scheme link.

Once speeds were estimated for the whole length of each scheme link, it was then possible to create proxy journey time forecasts based upon the estimated speeds and distances of each link.

The PRISM 2016 DM and DS modelled link speeds contained within the TFR are summarised below in Table 9-2.

Table 9-2 PRISM 2016 do-minimum and do-something modelled link speeds

Description	2016 DM Speeds by Time Period (kph)				2016 DS Speeds by Time Period (kph)			
	AM	IP	OP	PM	AM	IP	OP	PM
M6 J5 – J6	43	57	105	85	88	88	105	93
M6 J6 – J7	88	88	104	88	82	81	104	79
M6 J6 – J7 (2)	56	54	104	29	85	82	104	44
M6 J7 – J8	91	90	105	89	85	85	105	84
M6 J7 – J8 (2)	90	90	105	89	93	92	105	92
M6 J8 – J7 (2)	91	91	104	93	95	95	104	96
M6 J8 – J7	91	91	104	93	86	87	104	87
M6 J7 – J6 (3)	28	47	104	89	23	31	104	52
M6 J7 – J6 (2)	43	62	104	89	86	89	104	92
M6 J7 – J6	88	88	104	89	82	83	104	84
M6 J6 – J5 (2)	89	89	105	36	94	95	105	87
M6 J6 – J5	89	89	105	88	86	86	105	82

Table 9-2 shows that the scheme was forecast to have almost universal benefits upon speeds, particularly in the AM and PM peaks. The key points on modelled link speed forecasting accuracy are:

- Modelled link speeds were forecast to increase across most sections of the scheme for the AM and PM peaks e.g. AM DM M6 J5-J6 43kph to 88kph DS, M6 J7-J6 43kph to 86kph and PM DM M6 J6-J5 (2) 36kph to 87kph DS.

- Modelled link speeds were forecast no change between DM and DS scenarios for the Off-Peak period.

- The IP period modelled link speeds were forecast to both increase and decrease across the scheme. In general, where speeds were above 85kph in the DM scenario they have decreased slightly in the DS scenario e.g. M6 J6-J7 88kph to 81kph. Where speeds were not above 85kph in the DM scenario, they have increased in the DS scenario e.g. M6 J6-J7 (2) 54kph to 82kph.

- The M6 J7-J6 (3) was forecast extremely slow DM scenario speeds (in relation to the rest of the scheme), which are then forecast to decrease in the DS scenario e.g. DM M6 J7-J6 (3) AM 28kph, IP 47kph, 89kph to DS AM 23kph, IP 31kph and PM 52kph.

- Across the scheme forecasts for the AM peak are shown to be relatively accurate in that speeds have generally increased in both directions. Furthermore, the forecast AM peak increases in speed match the location of observed increases in speed e.g. M6 J5-J6 shows a forecast increase in speed of 45kph and Figure 2-9 indicated there has been an increase in speed across this link between pre-and post-scheme periods.

- The forecast was derived from modelling which was based on predictions of much higher volumes of traffic than those observed. However, these lower volumes apply to the before and after scenarios, so limited conclusions can be confidently inferred in relation to observed speeds compared to forecast speeds.

Appendix E. Interpeak MIDAS Analysis

Figure 9-2 IP flow northbound (09:30 – 15:30) M6 J5 - 8

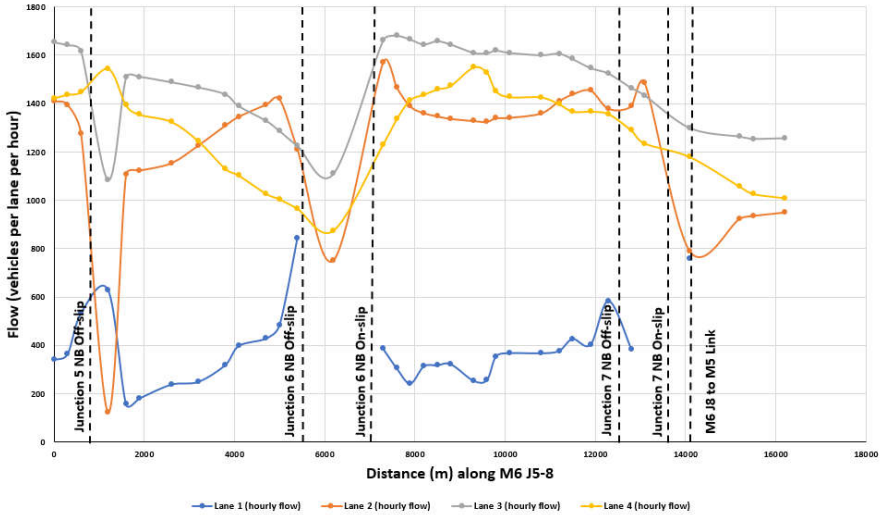


Figure 9-3 IP flow southbound (09:30 – 15:30) M6 J5 - 8

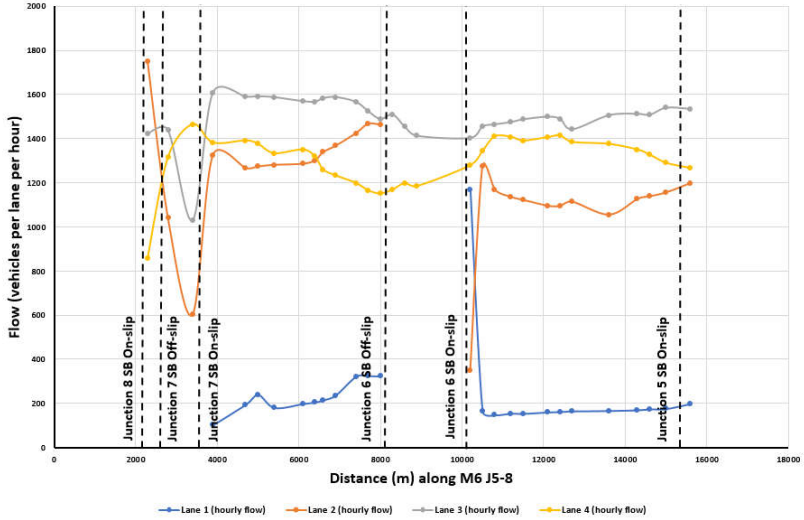


Figure 9-4 IP speed northbound (09:30 – 15:30) M6 J5 - 8

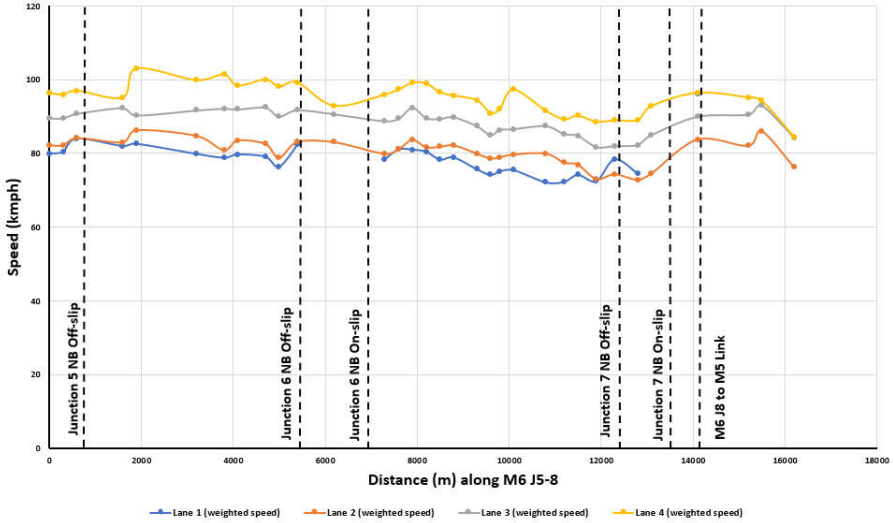
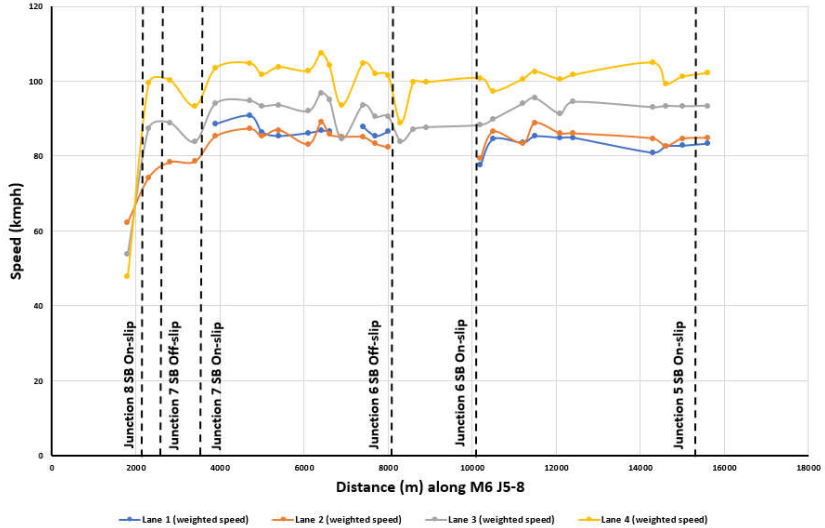


Figure 9-5 IP speed southbound (09:30 – 15:30) M6 J5 - 8



Appendix F. Environmental Information Requested

Requested Information	Response
Environmental Statement	N/A
Environmental Assessment Report	Environmental Assessment Report Volumes 1 and 2 and Appendices November 2011
AST	December 2011 version
Any amendments/updates/addendums etc to the EnAR or any further studies or reports relevant to environmental issues. Have there been any significant changes to the scheme since the EnAR.	N/A
'As Built' drawings for landscape, ecological mitigation measures, drainage, fencing, earthworks etc. Preferably electronically or on CD.	Provided as Appendix J H&S File
Contact names for consultation	Provided
Archaeology - were there any finds etc. Have any Archaeological reports been written either popular or academic and if so are these available?	No information made available
Have any properties been eligible for noise insulation?	No information made available
Have any post opening surveys been undertaken?	No information made available
Has any post opening survey or monitoring been carried out e.g. for ecology/biodiversity or water quality and if so would copies of the reports be available?	No information made available
Animal Mortality Data	Provided
Any publicity material	M6 Birmingham Box Phase 3 Managed Motorways - Pre-Construction Exhibition Material January 2012
Pre scheme Non-Motorised User (NMU) Audit or Vulnerable User Survey	N/A
Copy of NMU post opening survey	N/A
Employers Requirements Works Information - Environment sections	Not provided
Health and Safety File – Environment sections	Draft version provided
Construction Environment Management Plan (CEMP)	Contract Management Plan provided
Landscape and Ecology Aftercare Plan (LEAP) and / or Landscape Management Plan (LMP)	Five year Establishment Maintenance requirements included within HEMP
Handover Environmental Management Plan (HEMP)	Birmingham Box Phase 3 Smart Motorway - Handover Environmental Management Plan, April 2014
Has the scheme received any environmental awards	No information made available

Appendix G. Landscape Character Areas

9.1. Four distinct local Landscape Character Areas (LCAs A to D) were identified along the route.

- **LCA A – Industrial Corridor,** between J5 and J6, typified by a visually contained corridor of industrial townscape characterised by large warehouses, storage areas and a dense road network, intermixed with large scale business units and the Fort shopping complex. Vegetation cover sparse with manmade elements dominating. The M6 viaduct over the railway line was considered a prominent visual feature elevated above the surrounding landscape, particularly to the south.
- **LCA B – Dense Residential,** characterised by extensive areas of semi-detached housing with a good proportion of tree and shrub cover and open green spaces on the northern urban fringes of the Birmingham conurbation. The M6 corridor was said to be largely enclosed by existing highway planting belts and environmental barriers, with sporadic views of some elevated sections.
- **LCA C – Unplanned Mixed Land Use,** following the M6 corridor west of J6, a landscape characterised by a mosaic of land use; formal parkland, manmade lakes, industrial, residential, and recreational in an urban fringe context. Despite belts of trees, garden planting and parkland trees the M6 corridor was considered a dominant feature in the landscape.
- **LCA D – Great Barr Parkland**, immediately to the north and east of J7, a large recreational space of former parkland designated as a Registered Park and Garden (RPG); predominantly open grassland with a wide belt of mature woodland forming a physical and visual barrier to adjacent residential areas on its eastern fringe. The area includes lakes and golf courses with the motorway corridor largely contained by existing highway vegetation in combination with areas of cutting.

9.2. Potential overall significance of effect of the scheme on local landscape/townscape character areas were identified as neutral to slight adverse

- **LCA A – Industrial Corridor -** 2 existing gantries being used, 5 new gantries and 1 gantry to be removed. The scheme would be set within the existing extents of the highway including elevated sections and there was not expected to be a significant change in the setting of the wider industrial townscape character area. No additional mitigation deemed necessary to embankments / cuttings or possible on elevated sections – **overall significance of effect neutral**.
- **LCA B – Dense Residential -** 8 existing gantries being used, 5 new gantries and 5 gantries to be removed with potential for increased awareness of the motorway corridor within the wider townscape from new and taller infrastructure. Mitigation not possible within the highway boundary on elevated sections and in the context of the existing highway corridor was considered unnecessary. Retention of the existing roadside vegetation where feasible, would reduce the effect of new infrastructure locally. Mitigation to replace removed vegetation would in the medium to long term restore existing screening to the setting of the motorway corridor and reduce the effect– **overall significance of effect neutral**.
- **LCA C – Unplanned Mixed Land Use** - 5 existing gantries being used, 5 new gantries and 4 gantries to be removed. Widening of the carriageway west of J6 would result in the loss of short sections of existing highway verge and a new retaining structure (approx. 250m), which together with the additional gantries and loss of vegetation to accommodate the ERA's would increase awareness of the motorway corridor in the short term. Mitigation to replace vegetation removed would in the medium to long term restore the existing links with the wider vegetation framework – **overall significance of effects slight adverse.**
- **LCA D – Great Barr Parkland** - 1 existing gantry being used, 3 new gantries and 1 gantry to be removed. The scheme would be set within a strong landscape framework. Potential for some increased perception of the corridor as a result of localised vegetation loss and additional lighting columns between 189/3 and 189/8 (between J6-7) however in the context of the existing lighting strategy impacts were not considered to be significant. Targeted mitigation planting would be aimed at reducing the awareness of the scheme in the medium to long term – **overall significance of effects slight adverse.**

9.3. The EnAR noted the key visually sensitive locations with residual adverse effects as a result of views to new or existing modified gantries and / or signs and MS4s.

9.4. . In line with the EnAR the approximate numbers of properties are shown in brackets;

- V01: Papyrus Way to the west of J5 - super span gantry would become a large new element in the skyline, considered a **moderate adverse impact for the properties with direct views on Papyrus Way** (4) and slight adverse impacts for other receptors on Papyrus Way (8) and Berrandale Road (10) with both summer and winter views. Elevated section no mitigation possible;
- V02: Bromford Drive near the Fort Shopping Park (30) - new gantry would be elevated above surrounding area and highly visible from properties on Bromford Drive and the housing estate beyond. Elevated section, no mitigation possible. Slight adverse;
- V03: Row of flats on Stonechat Drive to north of J6 (approx. 12) - views from upper floors of flats to the north on Stonechat Drive towards top of gantry and signs above highway planting. **Moderate adverse impacts in winter months** and a limited opportunity to mitigate the effects on an elevated section of motorway;
- V04: Grebe Close and Gadwell Croft (approx. 18) - near, distant elevated and oblique views to the new MS4s from the upper floors and rear of properties on Gadwall Croft (approximately 30m) and in particular Grebe Close, backing onto the HA boundary. Slight adverse effects in winter months for those with a direct view;
- V05: Moor Lane, A4040 Brookvale Road and Witton Cemetery - gantry and signs would be elevated above surrounding landscape creating a new built element in the skyline for users of the adjacent Tame Valley canal, Moor Lane, Witton Cemetery users and nearby business units. **Moderate adverse**. Approximately 11 residential properties on Brookvale Road considered to be highly sensitive, with upper floor rear elevation views of the motorway corridor beyond the adjacent car park and allotments, the formation of a new embankment slope and short term loss of vegetation associated with the existing embankment slope;
- V06: Willowbrook Nursing Home off Aldridge Road -potential clearance of semi mature trees to top of embankments on both carriageways for gantry and CCD[14]. Retain where possible and reinstate with a mix of transplants and feathered stock. Slight adverse;
- V07: Turnberry Road (approx. 20) and Trehurst Avenue (approx.20) - potential distant filtered views to top of gantry from properties to the south west on Turnberry Road, through intervening row of poplar trees and predominantly in winter months. Near distant views likely from local footpaths and park through gaps in parkland trees. Oblique and direct views to the top of the MS4 above HA planting and environmental barrier from nearby properties on Trehurst Avenue. slight adverse;
- V08: Abbotsford Avenue to the east of J7 within Great Barr (12) - potentially distant views in winter from properties along Abbotsford Avenue and Whitecrest to the top of the ADS[15] signs above and through intervening mature planting along HA boundary. No clearance required. Slight adverse;
- V09: Hillside Road (16), Hillcrest Road (8) and Anderson Crescent to the west of J7 (12) - retain existing vegetation where possible and reinstate with a mix of transplants and feathers to match existing planting. Height of gantry signs in proximity to properties would not be possible to fully screen. Slight adverse;
- V10: Ragley Drive to north of Red House Park (6) - varying degrees of views from 6 adjacent properties on Ragley Drive to the south through intervening vegetation towards the top of the gantry and signs. Slight adverse impacts in winter, neutral in summer.

[14] Cross Carriageway Duct

[15] Advanced Directional Sign

Appendix H. Glossary

AADT	Average of 24 hour flows, seven days a week, for all days within the year.
ALR	All Lane Running is a type of smart motorway in which all lanes are open to traffic at all times. There is no lane which dynamically varies as a hard shoulder or normal lane.
AQMA	**A**ir **Q**uality **M**anagement **A**rea
AST	**A**ppraisal **S**ummary **T**able 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
BCR	**Benefit Cost Ratio** This is the ratio of benefits to costs when both are expressed in terms of present value i.e. PVB divided by PVC
CEMP	**C**onstruction **E**nvironmental **M**anagement **P**lan
CM	**C**ontrolled **M**otorway Controlled motorways have three or more lanes with variable speed limits indicated through the use of overhead gantry signing. The hard shoulder is not used as a running lane, and is only used in a genuine emergency.
DHSR/HSR	**Dynamic Hard Shoulder** is the inside line on a smart motorway when can operate in one of two modes: As the default, as a normal motorway hard shoulder i.e. only for emergency use; and Under operator control, open to all traffic. Dynamic Hard Shoulder Running is the system in a smart motorway which includes DHSR.
Discount Rate	The percentage rate applied to cash flows to enable comparisons to be made between payments made at different times. The rate quantifies the extent to which a sum of money is worth more to the Government today than the same amount in a year's time.
Discounting	Discounting is 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.
Do Minimum	In scheme modelling, this is the scenario which comprises only the existing road network and other committed schemes.
Do Something	In scheme modelling, this is the scenario detailing the planned scheme plus improvement schemes that have already been committed
EAR	**E**conomic **A**ssessment **R**eport
EnAR	**En**vironment **A**ssessment **R**eport
EIR	**E**conomic **I**mpact **R**eport
ERA	**E**mergency **R**efuge **A**rea
EST	**E**valuation **S**ummary **T**able In POPE studies, this is a summary of the evaluations of the TAG objectives using a similar format to the forecasts in the AST.
FWI	**F**atalities & **W**eighted **I**njuries
FWI/bvkm **FWI/mvkm**	This figure is a combined measure of casualties based on the numbers of fatal, serious and slight casualties. It is weighted by severity of injuries, with fatalities having the highest weighting.
FYA	**F**ive **Y**ears **A**fter
GCN	**G**reat **C**rested **N**ewt
HALOGEN Data	HALOGEN Data is the record of the overhead gantry settings and message screens forming part of a smart motorway scheme over time.
HEMP	**H**andover **E**nvironmental **M**anagement **P**lan

HSI	Habitat Suitable Index
INCA	**I**ncident **C**ost **B**enefit **A**ssessment can be used to estimate the benefits of reduce delay and travel time variability caused by unforeseen incidents that reduce capacity such as breakdowns, accidents and debris on the carriageway and major disruptions such as spillages.
KSI	**K**illed or **S**eriously **I**njured
LNA	**L**ocal **N**ature **A**rea
MAC	**M**anaging **A**gent **C**ontractor
MIDAS Data	**M**otorway **I**ncident **D**etection **A**utomated **S**ignalling (MIDAS) data is held by Highways England which contains lane by lane traffic flows and speeds.
MM-DHSR	See DHSR
NMU	**N**on-**m**otorised **U**ser
NPV	**Net Present Value** The difference between the Present Value Costs and Present Value Benefits.
OYA	**O**ne **Y**ear **A**fter
PIC	**P**ersonal **I**njury **C**ollision Data on these is obtained from records of road collisions collected from by police officers attending accidents.
PIC/mvkm	Ratio of PIC to the level of travel measured in million vehicle kilometres (mvkm)
Present Value	Present Value is the value today of an amount of money in the future. In cost-benefit analysis, values in differing years are converted to a standard base year by the process of discounting giving a present value.
PVB	**P**resent **V**alue **B**enefits Value of a stream of Benefits accruing over the appraisal period of a scheme expressed in the value of a Present Value
PVC	**P**resent **V**alue **C**ost
RSA	**R**oad **S**afety **A**udit
Smart Motorway	Referred to previously as “managed motorways”: a motorway which uses technology to vary speed limits in response to driving conditions. These smart motorways make the hard shoulder available to traffic. This could be permanently or at particularly busy times of the day.
SEGI	Site of Ecological / Geological Importance
TUBA	**T**ransport **U**ser **B**enefit **A**ssessment
VMSL	**V**ariable **M**andatory **S**peed **L**imit
WEBTAG	Department for Transport’s website for guidance on the conduct of transport studies at http://www.webtag.org.uk/

Appendix I. List of Tables and Figures