

M6 junctions 5 to 8 dynamic hard shoulder

Five-year post-opening project evaluation



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Foreword

As Chief Customer and Strategy Officer, I want to know whether developments on our network are meeting their objectives and making a difference for our customers – the four million people that use the Strategic Road Network every day.

Evaluation is a key function in the safe running of the Strategic Road Network (SRN) and we carry out POPE¹ evaluations at set points during a major enhancement scheme's lifetime to enable us to take stock and make any necessary interventions. POPEs provide an early indication if the scheme is on track to deliver the benefits over 60 years as set out in the business case appraisal.

This report evaluates the M6 junctions 5 to 8 all lane running (ALR) smart motorway scheme within five years of operation following its conversion from a conventional three lane motorway.

An initial study was conducted one year after the M6 junctions 5 to 8 project which opened in 2014, followed by this report after five years which provides more robust data and analysis. The report includes an understanding of the safety and environmental impacts of a scheme, as well as how traffic has changed due to a scheme being in place and how the scheme supports the economy.

There are three types of smart motorway, all lane running (ALR), dynamic hard shoulder (DHS) and controlled motorway. ALR and DHS motorways create more space on some of the most congested sections of the SRN by using hard shoulder as a running lane either permanently or only at busy times. They create extra capacity with less disruption to road users and fewer environmental impacts than physically widening the road, along with reduced carbon emissions associated with construction.

Although the performance of individual scheme is important at a local level, drawing together findings at a programme level helps us to understand patterns and trends across our network.

Safety remains our number one priority and the five-year POPEs published to date (representing approximately a quarter of those in operation) demonstrate that smart motorways are delivering safety benefits in line with or above those originally forecast, with most schemes evaluated having lower collision rates than would have been expected on the conventional motorways they replaced. Where it has been possible to assess changes to the severity of such collisions, the evidence shows those collisions have been less severe.

The published five-year POPEs show that smart motorways are broadly on track to realise their envisaged environmental objectives. With further planned mitigation these will be fully met.

The five-year ALR and DHS POPEs published to date for smart motorways also show that the schemes are delivering much needed capacity with schemes accommodating up to almost a quarter (22%) more traffic than before they were converted into smart motorways. The reports indicate that many of the motorway

¹ Post Opening Project Evaluation (POPE)

sections would have been unable to cater for today's traffic (at the busiest times) if they had not been converted into smart motorways.

According to the reports, the schemes are currently on course to deliver benefits, but will not deliver all the originally expected benefits within the 60-year appraisal period. There has been lower traffic growth than was expected when these schemes were appraised, due to the 2008 financial crisis and lower population growth than originally forecast (this will impact all transport schemes, built around this time). This means fewer drivers are benefiting today from smart motorway schemes than originally anticipated. Five-year POPEs also show that traffic on some smart motorway sections is not travelling as quickly as was forecast at the appraisal stage. Together these factors have resulted in the value for money for all schemes with five-year appraisals, over the 60-year appraisal period, currently being lower than anticipated at this stage when compared with the original appraisal. This is, however, a forecast and there is the opportunity to take further action to improve benefits.

We have therefore examined these results in detail and have identified specific actions to further improve the performance of schemes, including:

- Standardised operating procedures for DHS schemes
- Technology improvements
- Optimisation of the algorithms that set speed limits
- Investigating physical constraints off the network that impact performance

We will continue to monitor schemes in operation, enabling us to track their benefits and take further action if required to ensure these schemes deliver an improved experience for our customers.

Elliot Shaw

Chief Customer and Strategy Officer

September 2023

Table of contents

Chapter	Page
Table of contents	3
Foreword	3
1. Executive summary	7
2. Introduction	9
What is the project and what was it designed to achieve?	9
Project location	9
How has the project been evaluated?	10
3. Delivering against objectives	11
How has the project performed against objectives?	11
4. Customer journeys	13
Summary	13
How have traffic levels changed?	13
Relieving congestion and making journeys more reliable	20
How was the smart motorway operated?	27
5. Safety evaluation	34
Summary	34
Safety study area	35
Road user safety on the project extent	36
Road user safety on the wider area	39
Has the project achieved its safety objectives?	42
6. Environmental evaluation	43
Summary	43
Noise	44
Air quality	44
Greenhouse gases	45
Landscape and townscape	46
Biodiversity	47
Journey quality	48
Overview	49
7. Value for money	51
Summary	51
Forecast value for money	51
Evaluation of costs	53
Evaluation of monetised benefits	53
Overall value for money	55
Appendix A	57
Safety counterfactual methodology	57

Appendix B	58
Incident reporting mechanisms	58
Appendix C	59
Unadjusted collision severity	59

1. Executive summary

The M6 junctions 5 to 8 motorway is a 9-mile stretch of road through the West Midlands, of which five miles are elevated across several viaducts. It forms part of the strategic road network, connecting the Midlands with the North of England and M5 motorway to the Southwest.

Prior to the project, this section of the M6 operated as a three-lane motorway with a hard shoulder and suffered from increasing congestion levels and unpredictable journey times. As most of this section is on a viaduct, a smart motorway solution was the only cost-effective option to provide additional capacity. The motorway was converted to a dynamic hard shoulder² (DHS) smart motorway, which opened in April 2014.

This project aimed to deliver improvements to capacity, journey times, reliability, safety, information for drivers, journey ambience, while minimising the effects on the environment and surrounding road network.

Performance in the first five years indicates that the project has met its safety objective. The project has contributed to a reduction in the number, rate and severity of personal injury collisions. The safety benefits observed within the first five years, are greater than originally anticipated within the business case for the project.

Since the conversion, the route has supported more road users and led to faster and more reliable journeys for those travelling in the morning peak period. These benefits have not been observed during other times of the day. The application of the speed restrictions required to operate the smart motorway safely has led to an increase in journey times for some road users, particularly those travelling northbound in the evening peak period.

Within the first five years, the growth in road users has been slower than originally expected within the business case, this was likely to be due to a number of factors including the business case being based on growth assumptions made before the 2008 economic crisis, which slowed the rate of traffic growth, and potential impacts of construction on the surrounding roads during the evaluation period. This means that the additional capacity provided by the smart motorway is not yet being fully optimised to realise the benefits to customer journeys. However, the capacity is available to support an increase in road users in the future.

Due to the observed trends in traffic growth, the anticipated impacts on air quality, noise and greenhouse gases were better than expected along the project extent. Impacts to landscape character were broadly as expected. There is a need for further mitigation planting in order to realise the expected visual impacts. The evaluation of journey quality suggested that the predicted large beneficial effects are not on track to be realised without further improvements to journey time reliability and visual impacts.

Based on the evidence from the first five years, this project is not yet fully realising its anticipated value for money over the 60-year life of the project, and we are exploring what further action can be taken to improve benefits. The primary reason

² Dynamic hard shoulder (DHS) running motorways apply technology to control speeds and use electronic signs to temporarily increase capacity by utilising the hard shoulder at busy times. Emergency areas are available at regular intervals providing places to stop in an emergency.

for the overall reduced level of benefits is lower than expected traffic growth and slower journey times. It is nevertheless delivering benefits - construction of the project was delivered under budget, it is delivering safety benefits to road users and most of the environmental benefits are as expected, or better.

2. Introduction

What is the project and what was it designed to achieve?

The M6 junction 5 to 8 smart motorway opened to traffic in April 2014. Before the project opened, this section of the M6 was a three-lane motorway with a hard shoulder in both directions. Road users travelling along this stretch frequently experienced congestion, which caused average speeds to decline and journey times to increase.

The project forms part of the Birmingham Box Motorway Phase 3 Managed Motorway (BBMM3) programme. National Highways now uses the term 'smart motorways' to refer to motorways with a dynamic hard shoulder, controlled motorway, all lane running, or variable mandatory speed limit provisions.

The project consisted of three main elements to provide additional capacity:

- M6 J5-7: dynamic hard shoulder, allows the hard shoulder to be used as an additional running lane during busy periods, providing extra capacity and easing congestion. Electronic signs and signals guide drivers when it is safe to use for live running. A lower speed limit is in force to smooth the flow of traffic and emergency areas are available at regular intervals, providing places to stop in an emergency.
- M6 J7-8: the 0.4-mile stretch of motorway between junction 7 (for A34) and junction 8 has merge and diverge lanes for the M5, with only the approach to junction 8 retaining a permanent hard shoulder. Technology has been applied to add variable and mandatory speed limits to a conventional motorway to control the speed of traffic. Overhead electronic signs display messages to drivers, such as warning of an incident ahead.
- M6/M5 link (within junction 8): three-lane motorway controlled motorway with the application of technology to add variable and mandatory speed limits to a conventional motorway to control the speed of traffic, while retaining a permanent hard shoulder. Overhead electronic signs display messages to drivers, such as warning of an incident ahead.

Prior to the smart motorway, the M6 suffered from heavy traffic and increasing journey times. In particular, junction 6 (the Gravelly Hill Interchange) forms a key traffic route into Birmingham with approximately 50% of traffic leaving the M6 at junction 6 to join the A38(M) into Birmingham. Once congestion occurred on the A38(M), it was reported that traffic quickly queued back on to the M6 junction 6 approaches and mainline carriageway. Congestion occurred on the northbound M6 and on the approach to junction 8 (M5/M6 merge) as traffic backed up on the A38 Aston Expressway route and the Salford Circus junction.

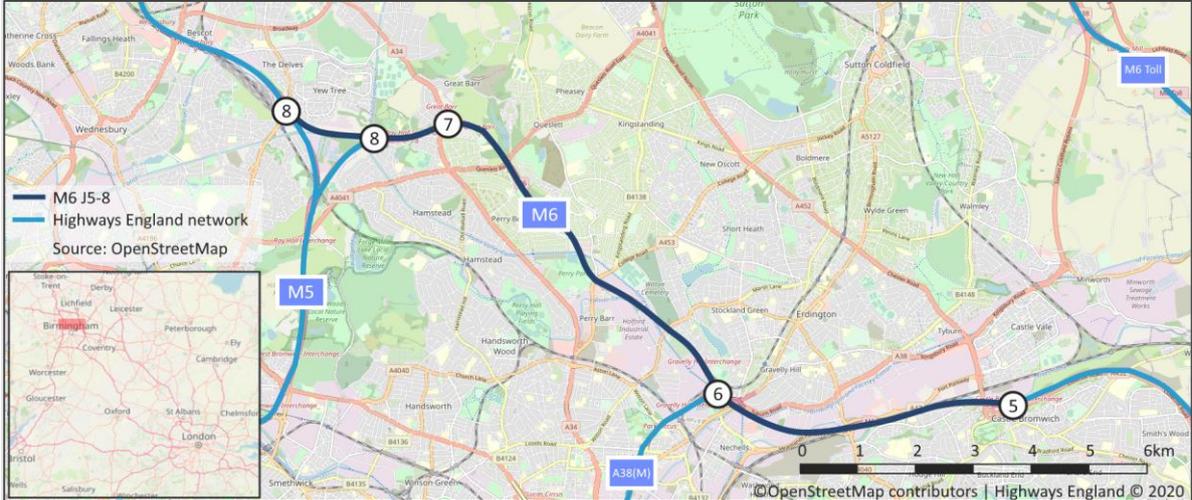
The completion of the project was expected to bridge the gap between pre-existing smart motorway sections along the route and aimed to contribute to an overall reduction in congestion along the M6 corridor between junctions 4 and 10a.

Project location

The project runs between M6 junction 5 near Castle Bromwich to junction 8 at the M5 interchange north of Birmingham. The route covers approximately 9 miles, of which 5 miles are elevated across several viaducts. The M6 plays a pivotal role in

the National Highways network, providing a vital route for freight, commuter and tourist traffic. It connects major conurbations in the north of the country with the Midlands and the south of England, and also provides access to Birmingham Airport and the nearby National Exhibition Centre. As one of the nation's busiest motorways, vehicle demand on the M6 is high.

Figure 1 M6 junction 5 to 8 project location



Source: National Highways and OpenStreetMap contributors

How has the project been evaluated?

Post-opening project evaluations are carried out for major projects to validate the accuracy of expected project impacts which were agreed as part of the business case for investment. They seek to determine whether the expected project benefits are likely to be realised and are important for providing transparency and accountability for public expenditure, by assessing whether projects are on track to deliver value for money. They also provide opportunities to learn and improve future project appraisals and business cases.

A post-opening project evaluation compares changes in key impact areas³ by observing trends on a route before a project is constructed (baseline) and tracking these after it has opened to traffic. The outturn impacts are evaluated against the expected impacts (presented in the forecasts made during the appraisal) to review the project's performance. For more details of the evaluation methods used in this study please refer to the post-opening project evaluation (POPE) methodology manual on our website.⁴

³ Key impact areas include safety, journey reliability and environmental impacts.
⁴ <https://nationalhighways.co.uk/media/exypgk11/pope-methodology-note-jan-2022.pdf>

3. Delivering against objectives

How has the project performed against objectives?

All National Highways major projects have specific objectives which are defined early in the business case when project options are identified. Table 1 shows the objectives that were defined for the M6 junctions 5 to 8 project.

Table 1 Main carriageway objectives and evaluation summary

Objective	Five-year evaluation
Deliver a managed motorway including hard shoulder running solution.	Upgraded nine miles of the M6 between junction 5 and junction 8 to include Dynamic Hard Shoulder Running and gantry provision for variable speed limits.
Improve journey time reliability and improve journey times on the M6 between J5 and J8.	Journey times and reliability in the morning peak had improved following the conversion, whilst supporting more road users ⁵ . In the evening peak journey times had become slower than before and less reliable than before.
Not to detrimentally affect traffic on the surrounding road network.	There has not been an overall detrimental impact on the surrounding road network ⁶ .
Reduce the number and severity of accidents per vehicle-kilometre.	The evaluation found there has been a reduction in the number, rate and severity of personal injury collisions. At this five-year evaluation point the project has met its objective to reduce the number and severity of accidents ⁷ .
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.	Speeds on the approach to junctions have declined since pre-scheme and one year after, implying that congestion is occurring at the junctions.
Improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway.	The scheme has provided speed limit and other information via gantries to drivers at regular intervals along the scheme section.

⁵ Analysis for section 7 included a comparison of outturn journey times against an estimate of what journey times might have been if the road had remained a conventional motorway.

⁶ Refer to section 4 for further information.

⁷ Projects are appraised over a 60-year period. This conclusion is based on the findings at five years after the project opened for traffic.

Improve journey ambience ⁸ .	The predicted large beneficial impacts on journey quality are not on track to be realised without further improvements to journey time reliability and visual impacts
Offset detrimental environmental effects by mitigation measures where technically feasible and economic to do so.	The environmental impact of the project was predicted to range from neutral to slight adverse. Impacts on noise and air quality may be better than expected, due to lower traffic flows than anticipated. Landscape mitigation planting had not been fully implemented and so was worse than expected.

⁸ Journey ambience was a measure of the experience of travelling. This includes traveller care (eg information and facilities), travellers' views; and traveller stress factors (eg perceptions of safety, congestion and reliability). Refer to former [TAG unit 3.3.13](#). It has now been replaced by the term 'journey quality' and is evaluated in section 6.

4. Customer journeys

Summary

Five years after opening, this smart motorway was supporting up to 167,000⁹ customers a day. This was an increase of between 4% and 12% over the pre-construction levels, but this is lower than the increase seen elsewhere in the region and lower than the increase anticipated in the business case. The level of growth is likely to have been constrained by nearby construction (on Oldbury Viaduct, M6 junction 2 to 4 and M6 junction 13 to 15) and a slower pace of growth due to the 2008 economic downturn.

Journey times and reliability improved in the morning peak in both directions since the project opened (by 11-12%, whilst supporting between 7 and 20% more customers).

In contrast, journey times in the evening peak were slower than before construction, particularly in the northbound direction. These journeys were also less reliable. Outside of the peak periods, increases in journey times were also observed, although to a lesser extent.

Five years after opening, the dynamic hard shoulder was used almost 100% of the time during northbound evening peak period, and there was heavy use of variable mandatory speed limits (VMSLs) throughout the day, with use of lower speeds limits at five years compared to one year after. 40mph became the most common speed limit in northbound evening peak period.

It is estimated that if the road had remained a conventional motorway, congestion would have continued to worsen due to increased numbers of road users, although the level of demand is likely to have remained within the capacity of the three-lane motorway. In this scenario, it is estimated that journey times would not have deteriorated to the levels observed for the project. However, if traffic growth increased in the future, a conventional three-lane motorway would not have resilience to support the additional road users without a further reduction in journey times. The assumption within the business case was that the increase in road users would generally need to be above the capacity of a conventional three-lane motorway for the smart motorway to realise benefits for customer journeys. The evaluation has found that this level has not been reached in the first five years of operation.

How have traffic levels changed?

Smart motorways are built on stretches of motorway which experience high levels of congestion and/or are expected to see traffic levels increase in future years. The following sections will examine how traffic levels changed over the evaluation period and to what extent the forecast traffic levels were realised.

National and regional

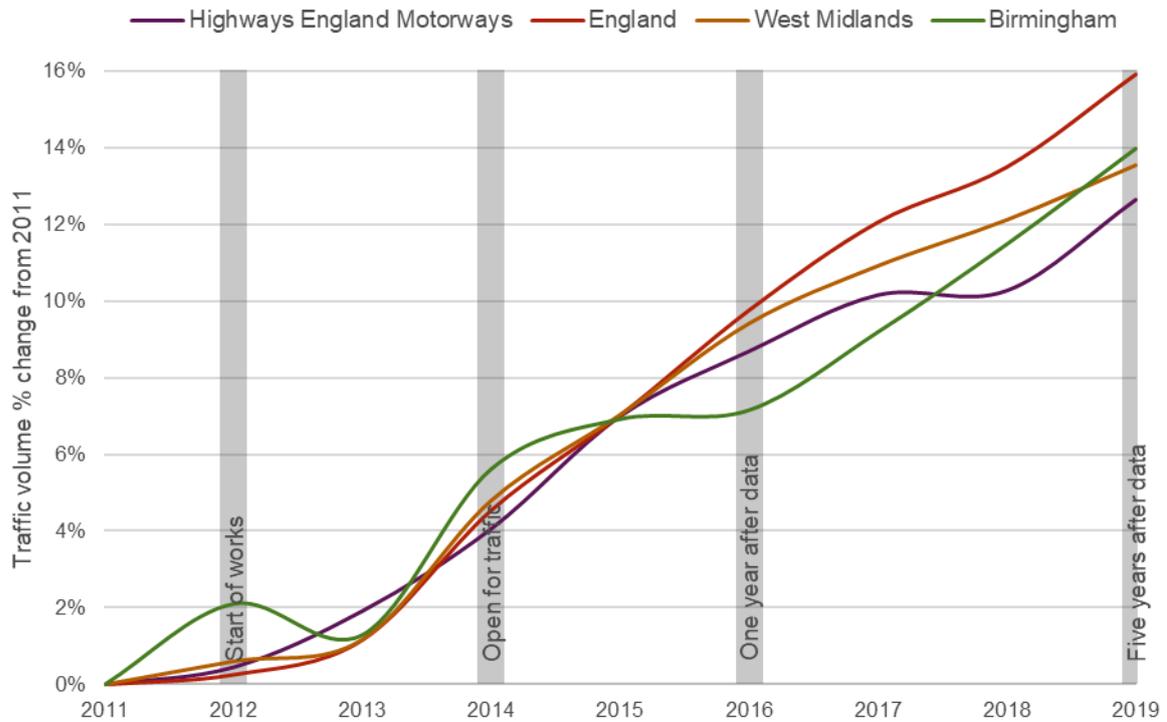
To assess the impact of the project on traffic levels, it is useful to understand the changes within the context of national and regional traffic (Figure 2). We analysed annual data from the Department for Transport for a period between 2011 and

⁹ Two-way flows junctions 7 to 8, refer to Figure 3.

2019 traffic, indexed to 2011, representing the pre-scheme baseline year used for comparison in this evaluation.

Considering local, regional and motorway traffic trends, around 13-14% growth might be expected to have occurred regardless of the project being implemented. The analysis in the following sections should be considered in this context as no adjustments have been made to take account of background traffic growth.

Figure 2 National, regional and local traffic trends

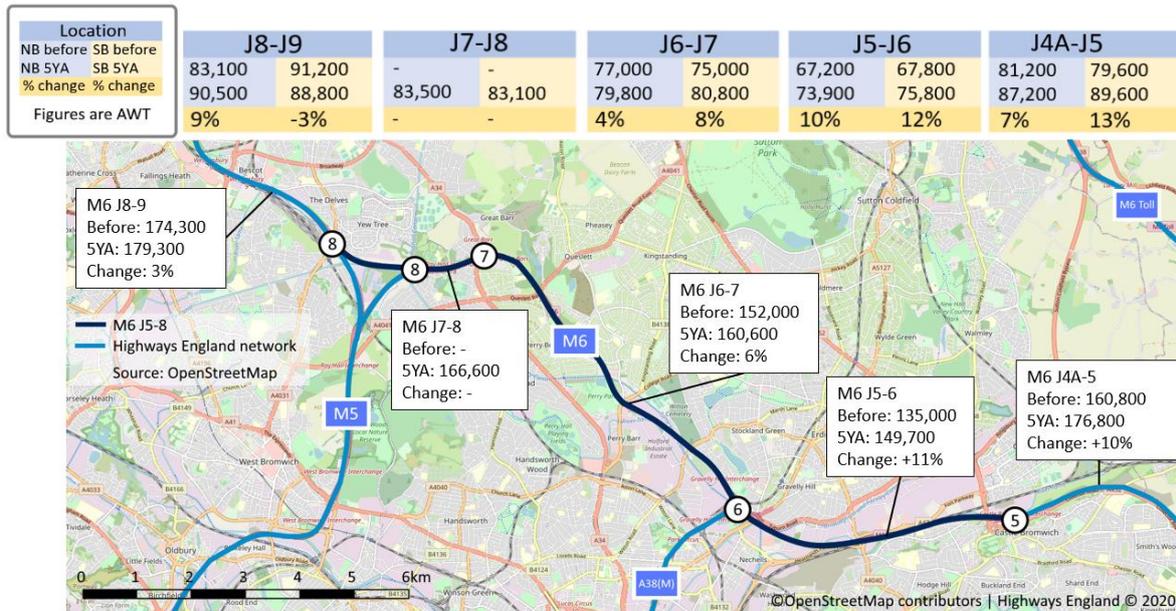


Source: DfT Transport Statistics (Data Table TRA8904), 2021

How did traffic volumes change on the project extent?

Traffic data for May 2011, prior to construction, has been compared against data for May 2019 along the M6. In the five years since the scheme opened, traffic has increased by 4-10% in the northbound direction. In the southbound direction, traffic flows have increased by around 8-12% between junction 5 and junction 7. These growth figures fall slightly short of national and regional trends.

Figure 3 Comparison of before and five-year traffic flows on the M6



Source: National Highways, WebTRIS 2011 and 2019

Note: figures presented are AWT (average weekday traffic)

The southbound section between junction 5 and 6 has experienced the largest percentage increase in traffic, 12% growth between 2011 and 2019, with the adjacent section just outside the scheme extent seeing similar growth.

Traffic growth along the M6 corridor may have been encouraged by the completion of other schemes in the surrounding area, improving the capacity of the M6. The surrounding schemes are:

- M6 junction 10a – junction 13 smart motorway (opened February 2016)
- M6 junction 6 improvements (finished July 2016)
- M6 junction 6 Salford Circus roundabout improvements (finished July 2014)

While there was growth since prior to the scheme, the traffic volumes show no further growth since the one-year after evaluation report. In some instances, there is a slight reduction in traffic volume since the one year after data from 2016.

For context it is worth noting that throughout 2019, a large-scale repair project was undertaken on Oldbury Viaduct, the three kilometre viaduct that carries the M5 carriageway near West Bromwich. The M5 joins the M6 at junction 8, and thus the repairs may have impacted traffic conditions on the M6. The Oldbury Viaduct repairs included construction works during May 2019, the month on which much of the data in this report is based. The effect, if any, this has had on traffic levels between M6 junction 5 and 8 is difficult to ascertain.

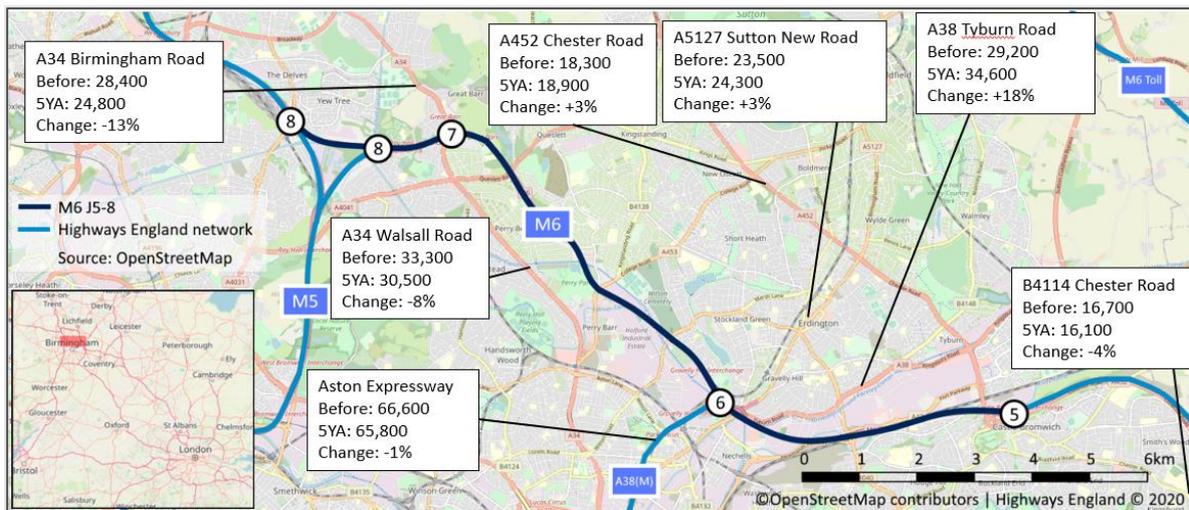
Further smart motorway schemes on the M6 were in construction at the time of this evaluation. The M6 junction 2 to 4 project was in construction between 2017 and March 2020. The M6 junction 13 to 15 project was in construction between March 2018 and August 2022. This, along with the Oldbury Viaduct works, may have had the effect of making trips on the M6 less desirable for the duration of this analysis.

How did traffic volumes change in the wider area?

Figure 4 shows the two-way average weekday traffic (AWT) for various sites near the M6, comparing data from before and five years after the project. From the counts available in the wider area there is no clear consistent pattern of traffic response, with some major roads seeing increases and others seeing decreases in traffic volumes.

There is some evidence of decongestion on the wider network. The A34 in particular appears to have experienced some traffic relief, with a reduction in traffic against a general trend of increasing traffic in the area. However, the A38 has seen traffic growth above the trend in the area, so the picture is mixed.

Figure 4 Comparison of before and five-year AWT in the wider area



Source: Data Insight, 2011, 2018, 2019 (formerly known as Spectrum)¹⁰

As noted above, traffic levels on the M6 have not increased above background levels, so we cannot be confident that traffic had rerouted onto the M6 from the local road network.

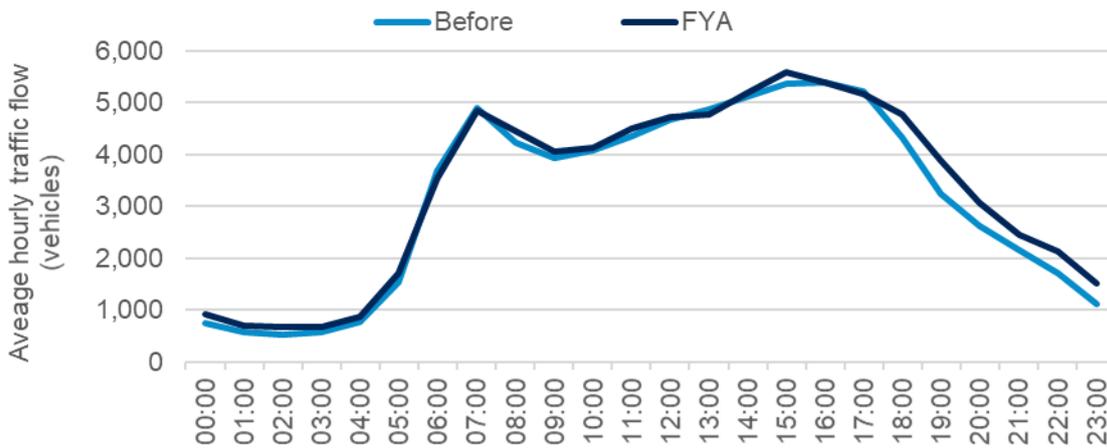
How were traffic flows distributed across the day?

By analysing traffic flows across the day, we are able to understand whether traffic growth has occurred uniformly or at certain times of day.

In the northbound direction (Figure 5), the profile of traffic had remained similar since before construction. While traffic is generally higher throughout the day, the most notable change is an increase in traffic volumes between 5pm and midnight. A similar analysis for just heavy goods vehicles looked very similar in the northbound direction with very little change and identical shape.

¹⁰ Due to data availability, 2018 data was used alongside 2019 data to maximise the number of sites that could be included in the analysis. There was no consistent month available for all sites, so a range of months have been used, but the before and after months in each location remain the same to allow a like for like comparison.

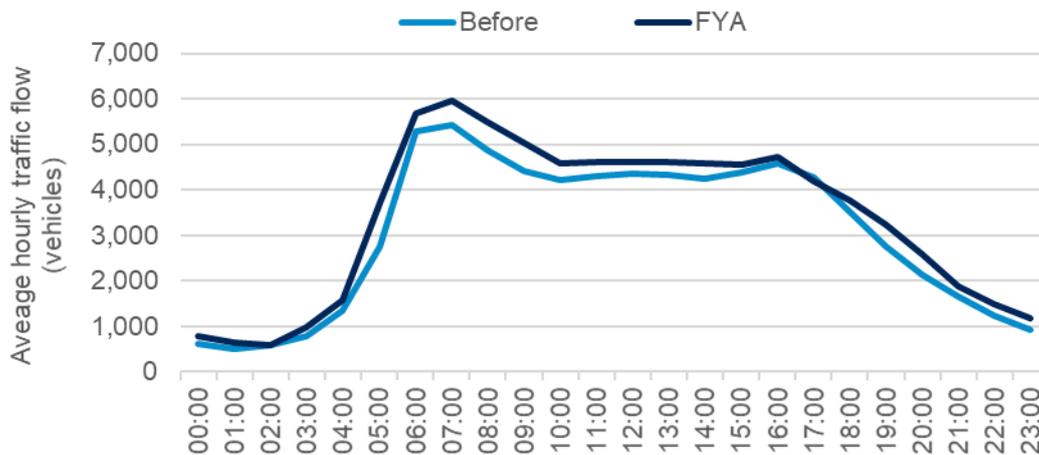
Figure 5 Comparison of average weekday hourly flows before and five years after opening, northbound



Source: National Highways, WebTRIS 2019. Data is for M6 J6-7 – the busiest section of the project.

In the southbound direction (Figure 6), traffic had increased by around 500 vehicles an hour in the AM peak. A small increase in traffic volumes has been seen during the interpeak and in the hours after the PM peak. The timing and magnitude of the PM peak itself has changed little. As with the northbound data, when the same analysis is conducted with just heavy goods vehicles the finding is very similar with small growth throughout the day with the most growth in the AM peak.

Figure 6 Comparison of average weekday hourly flows before and five years after opening, southbound



Source: National Highways, WebTRIS, 2019

Considering the directions together, there is a small amount of tidality to this section of the M6, with the southbound peak higher in the AM peak and the northbound higher in the PM peak. This is likely due to this section being north of the Junction 6 turn off to the A38(M) for central Birmingham which will be the main commuter attractor in the area. As such, we could expect the opposite tidality on M6 junction 5 to junction 6.

Was traffic growth as expected?

The investment decision for this project was supported by a project appraisal which included forecasts about the likely impact on traffic. The initial modelling was carried out as part of the *Birmingham Box 3 – Managed Motorways* scheme, using

the West Midlands PRISM model¹¹. A Do Something (DS) scenario, which forecast of how the road network would perform with the project in place, was compared to a Do Minimum (DM), which forecast how the road network would perform in the same future year without the project.

The appraisal included modelling to represent an average hour within each of three time periods:

- AM peak (07:00 to 09:30)
- Inter peak period (09:30 to 15:30)
- PM peak (15:30 to 19:00)

The improved section of the M6 experienced an increase in traffic volumes compared to before the project, but this was less than the level of growth seen regionally and nationally. A comparison of these actual traffic flows to the appraisal forecasts was made to help identify and understand any differences. Table 2, Table 3 and T

¹¹ using a modelling base year of 2006 and forecasting Do Something and Do Minimum scenarios based on the years 2016 and 2026. The modelling was undertaken in VISUM software.

Table 4 show the forecast average weekday flows in each of the three time periods, compared with the observed traffic flows¹².

Our observed data is from 2011 (before) and 2019 (five years after). In order to ensure the forecast data matches the observed dates of 2011 and 2019, we have interpolated the modelled data to give a comparable figure.

Table 2 Observed and forecast traffic flows, average weekday AM peak hour

Section	Observed flows		%Growth (Observed)	Forecast flows		%Growth (Forecast)
	2011	2019		2011 DM	2019 DS	
J5 – J6 NB	4,200	4,600	7%	4,900	6,100	25%
J5 – J6 SB	4,000	4,800	20%	4,700	5,300	14%
J6 – J7 NB	4,200	4,500	7%	4,900	6,400	30%
J6 – J7 SB	4,800	5,600	16%	5,300	6,400	20%

Table 3 Observed and forecast traffic flows, average weekday interpeak hour

Section	Observed flows		%Growth (Observed)	Forecast flows		%Growth (Forecast)
	2011	2019		2011 DM	2019 DS	
J5 – J6 NB	3,900	4,300	12%	4,800	6,000	24%
J5 – J6 SB	3,800	4,400	16%	4,600	5,200	13%
J6 – J7 NB	4,500	4,700	3%	4,900	6,600	34%
J6 – J7 SB	4,200	4,600	9%	4,900	5,900	21%

¹² Forecasts for J7 – J8 were not documented. There is only a short length of carriageway between the slip roads for J7 and J8.

Table 4 Observed and forecast traffic flows, average weekday PM peak hour

Section	Observed flows		%Growth (Observed)	Forecast flows		%Growth (Forecast)
	2011	2019		2011 DM	2019 DS	
J5 – J6 NB	4,100	4,500	12%	4,800	6,000	25%
J5 – J6 SB	4,300	4,700	8%	5,200	6,300	22%
J6 – J7 NB	5,100	5,200	3%	5,300	7,200	36%
J6 – J7 SB	4,200	4,300	4%	4,800	5,700	19%

The observed flows were generally lower than observed in both 2011 and 2019. This can be partly explained by the impact of the recession which stalled traffic growth in 2008-2011 as a consequence of impacts on fuel price and travel demand. We can be confident that this is the cause as the discrepancy also impacted the Do Minimum forecasts. The business case, completed before signs of an economic recession, forecast a higher demand in travel, due to using projected growth trends observed before 2008¹³.

Looking at the percentage growth, this is almost always higher in the forecast data than the observed data. This suggests that the model overestimates the traffic growth due to the scheme. The context of the Oldbury Viaduct repairs and the construction of other smart motorways on the M6 (noted in traffic volumes section) may also have had an impact.

Relieving congestion and making journeys more reliable

Smart motorways are applied to the busiest routes, to ease congestion and ensure journey times are more predictable. These routes are often where we anticipate congestion will increase and the smart motorway seeks to limit this. Analysis of journey times and speeds indicate the impact of the smart motorway on congestion. The extent to which journey times vary from the expected average journey time indicates how reliable a journey is.

One of the objectives of the project was to improve journey time reliability and improve journey times, on the M6 between junction 5 and junction 8. This section evaluates how the scheme impacted journey times and the reliability of journeys.

Did the project deliver journey time savings?

We have analysed average journey times from before (May 2011) and five years after (May 2019)¹⁴ the conversion to smart motorway as shown in Figure 7. One

¹³ The traffic model supporting the business case was created with a base year of 2006. In 2008 Department for Transport guidance was revised to reflect the uncertainties in forecasting future impacts (webTAG unit 3.15.5). It required a more detailed handling of the sources of uncertainty and required a minimum of two additional scenarios to be used to inform the business case. The current version of this guidance can be found in TAG unit M4.

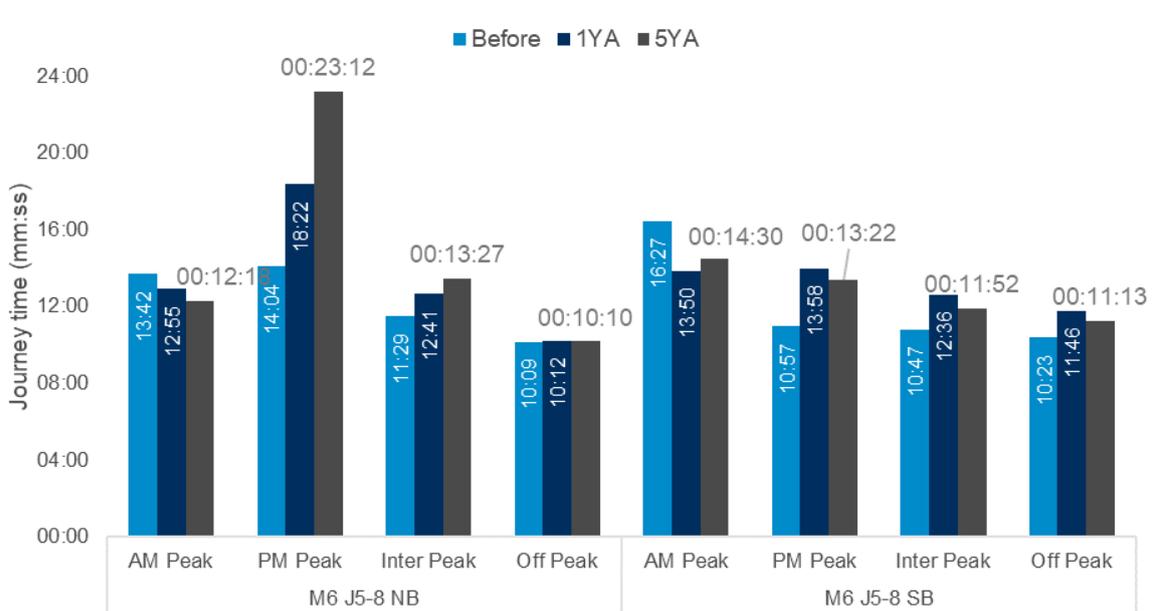
<https://www.gov.uk/government/publications/tag-unit-m4-forecasting-and-uncertainty>

¹⁴ Monday data has been excluded from the results, so that the results aren't affected by the two May bank holidays. Data obtained from TomTom satnav data. Time periods analysed were consistent with the appraisal:

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

year after results are also included for comparison. It is important when interpreting these figures to consider that these show journey times eight years apart, during which time up to 12% traffic growth has occurred along the scheme extent¹⁵.

Figure 7 Comparison of average journey times



Source: TomTom satnav data for May 2011, 2016 & 2019

AM peak journey times have improved in both directions compared to before the project. This is the clearest benefit of the scheme on congestion with an 11% improvement northbound and 12% improvement southbound. This benefit has occurred despite the southbound AM peak being both the busiest time and the time period which saw the most traffic growth (see Figure 5 and Figure 6).

Inter peak and PM peak journey times have increased in both directions since before the project. Northbound journey times in the PM peak have seen the most substantial deterioration, rising to over 23 minutes on average (an increase of 65% between 2019 and pre-scheme). This continues an increasing journey time trend already observed in the one year after evaluation.

PM peak southbound journey times have also increased by 22%. The significant PM peak journey time deteriorations have occurred despite only small traffic volume increases in this direction. This indicates that the observed journey time increase cannot be fully attributed to the traffic growth.

A vehicle travelling at 60mph could travel the route in 10 minutes 12 seconds. Figure 7 shows that journeys were slower than a 60mph journey time in all time periods in both directions, before and after the project. Northbound PM peak journey times are now over twice that which could be achieved at 60mph. Only the off-peak journey times get close to an average journey time of 60mph. This tells us

¹⁵ In this section we are presenting before and after journey times unadjusted. For section 7 we have compared outturn journey times against a counterfactual estimate of what journey times are likely to have been without the scheme. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion. The counterfactual analysis concluded that overall there has been a **disbenefit** of 378,000 vehicle hours in the fifth year.

that both prior to and following the scheme (one year and five year) there remains delay on this section of the network.

How did the project impact road user's speeds?

We analysed speeds along the length of the project to understand the impact on journey times in more detail. Figure 8 displays the average speeds at each point along the scheme on the northbound carriageway during the worst performing time period (PM peak) for each of the three observed years. It shows that the increased journey times are arising due to a consistent decline in speeds across the entire project extent.

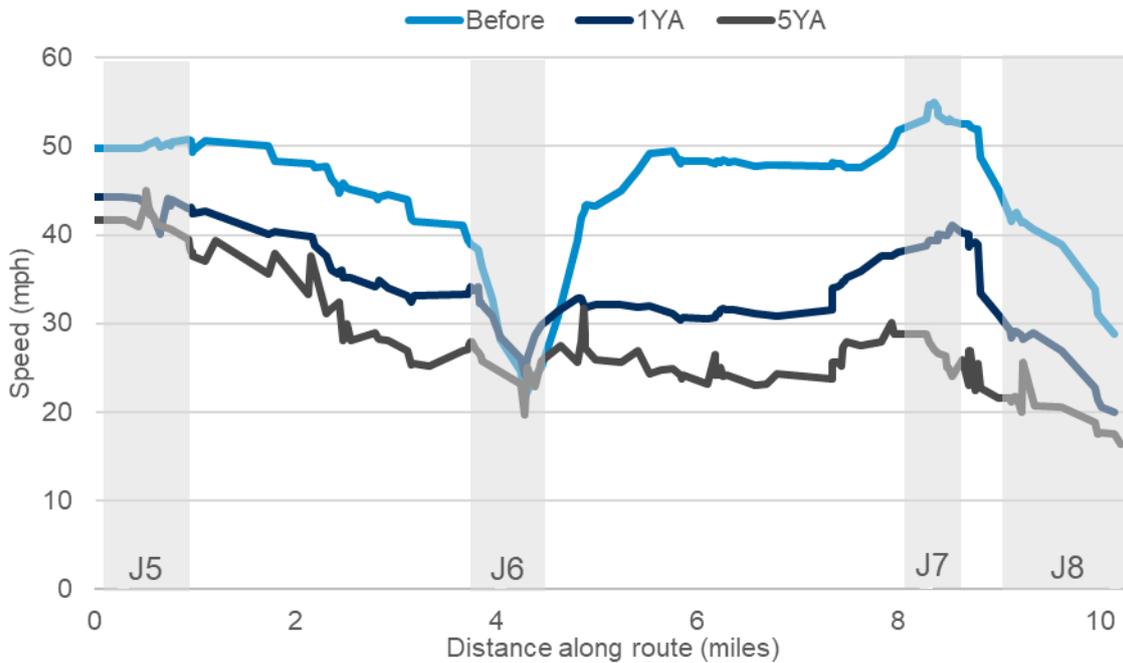
The key problem areas in the pre-scheme were the approach to junction 6 and junction 8, representing the complex intersections with the A38(M) and M5 respectively. These continue to be areas of slow speed after implementation of the smart motorway. The data shows no improvement on the approach to junction 6 and a worsening of performance on the approach to junction 8.

The trend in speed between junction 5 and junction 6 is generally the same as it was pre-scheme; speeds decline towards 20mph as traffic approaches junction 6. Before the implementation of the smart motorway, speeds showed a clear recovery in speed immediately following junction 6, but since implementation results show that this recovery is no longer occurring, and that average speeds now remain between 20mph and 30mph towards junction 7. This implies that the objective of reducing the impact of congestion at the junctions on the mainline has not been achieved.

When accounting for the observed traffic growth seen at five years after, if the section of road had remained as a 3-lane motorway they would have been unable to support the additional road users, without experiencing a reduction in speed¹⁶.

¹⁶ Analysis has shown that with observed increased in traffic at five years after, a 3-lane motorway would not be able to support these additional road users without experiencing a reduction in speed, in at least one peak time period.

Figure 8 Average speeds along the scheme, northbound evening peak



Source: TomTom satnav data for May 2011, 2016 & 2019

Were journey time savings in line with forecast?

The project is not currently on track to realise the journey time benefits expected in the business case¹⁷. This has occurred despite the traffic volumes largely being lower than anticipated. Calculations undertaken to support the value for money analysis in section 7 have shown that even when considering how conditions were likely to deteriorate had the scheme not been built (the 'counterfactual'), the projects was not offering an overall improvement at five years after¹⁸. The traffic model for developing the forecasts was not providing an accurate estimate of conditions without the smart motorway in place (DM), with southbound underestimated and northbound overestimated.

As shown in Table 5, the project was expected to deliver substantial journey time savings for the northbound direction (between 25-32%). This was due largely to the journey times on the route expected to get considerably worse without the additional capacity provided by the smart motorway.

Table 5 - Observed and forecast journey times, northbound

Time Period	Observed journey times (mm:ss)		% Diff. (Obs.)	Forecast journey times (mm:ss)		% Diff. (Forecast)
	2011	2019		2016 DM	2016 DS	

¹⁷ This was provided in the form of expected average speeds along the route for various future years. We converted these speeds into journey times for the purposes of this analysis.

¹⁸ In this section we are presenting before and after journey times unadjusted. For section 7 we have compared outturn journey times against a counterfactual estimate of what journey times are likely to have been without the scheme. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion. The counterfactual calculation estimated a **disbenefit** of 378,000 vehicle hours in the fifth year after opening.

AM	13:42	12:18	-11%	17:58	12:11	-32%
IP	11:29	13:27	+17%	16:23	12:20	-25%
PM	14:04	23:12	+65%	22:34	16:05	-29%

In the morning peak, the appraisal was relatively accurate with journeys becoming quicker for road users and journeys taking just over 12 minutes. However, the appraisal had expected that this would be achieved whilst accommodating a larger volume of road users.

In the inter peak and evening peak the journey time savings estimated during within the business case are not on track to be realised. Most notably, the evening peak northbound average journey times take over seven minutes slower than expected, despite traffic levels being lower than anticipated (see traffic growth section).

For customers travelling southbound, the appraisal predicted very slight increases in journey times with the smart motorway in place, as shown in Table 6.

Table 6 - Observed and forecast journey times, southbound

Time Period	Observed journey times (mm:ss)		% Diff. (Obs.)	Forecast journey times (mm:ss)		% Diff. (Forecast)
	2011	2019		2016 DM	2016 DS	
AM	16:27	14:30	-12%	10:26	10:24	0%
IP	10:47	11:52	+10%	09:43	09:57	+2%
PM	10:57	13:22	+22%	09:08	09:33	+5%

The appraisal underestimated the level of delay on the road before the conversion to smart motorway. For example, during the morning peak period the journeys made before the conversion to smart motorway were around six minutes slower than the times forecasted in the appraisal when accounting for additional congestion. Therefore, whilst the observed journey times are longer than expected in the appraisal, there has been a 12 percent reduction in journey times, which was a larger benefit than predicted.

Journey times in the inter peak and evening peak were slower than expected in the appraisal, although to a lesser extent than the northbound journeys. Again, the appraisal underestimated the level of delay before the conversion to smart motorway.

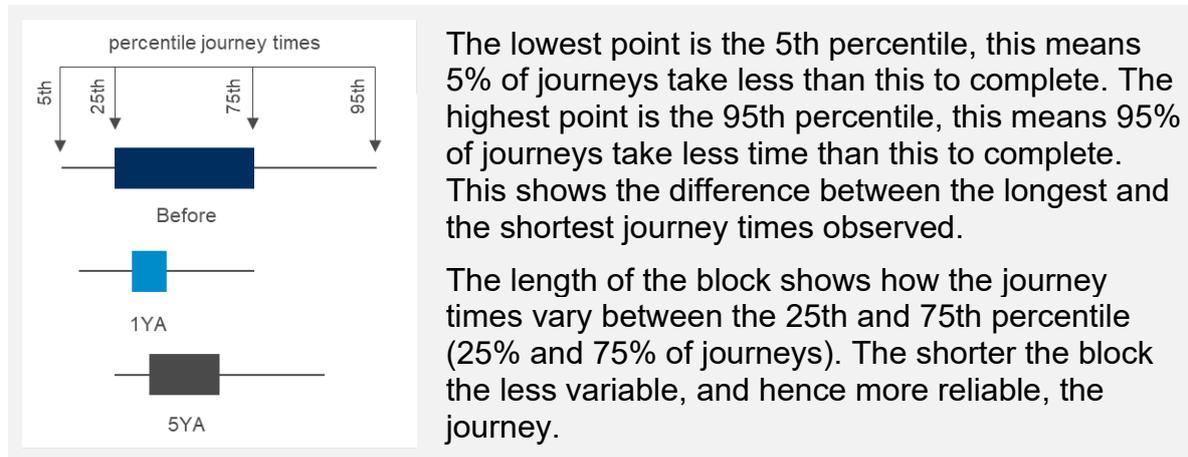
In line with appraisals of other smart motorway projects, we used a strategic model to forecast the impacts of this project¹⁹. These models are limited in their representation of merges. Where junctions are in close proximity, and therefore a substantial proportion of the route is impacted by merging, diverging and weaving behaviour, they are likely to be less accurate. Where appropriate, we now regularly test the representation of junctions in our modelling.

¹⁹ Refer to the section on forecasting of traffic growth for details of the model.

Did the project make journeys more reliable?

One of the scheme objectives was to improve journey time reliability. Our assessment of reliability looks at the variability of journey times along the scheme using the same time periods as used previously. We do this by using satnav data, which includes percentiles of journey time, and interpreting whether any changes in reliability have occurred.

Figure 9 What does a box plot show?

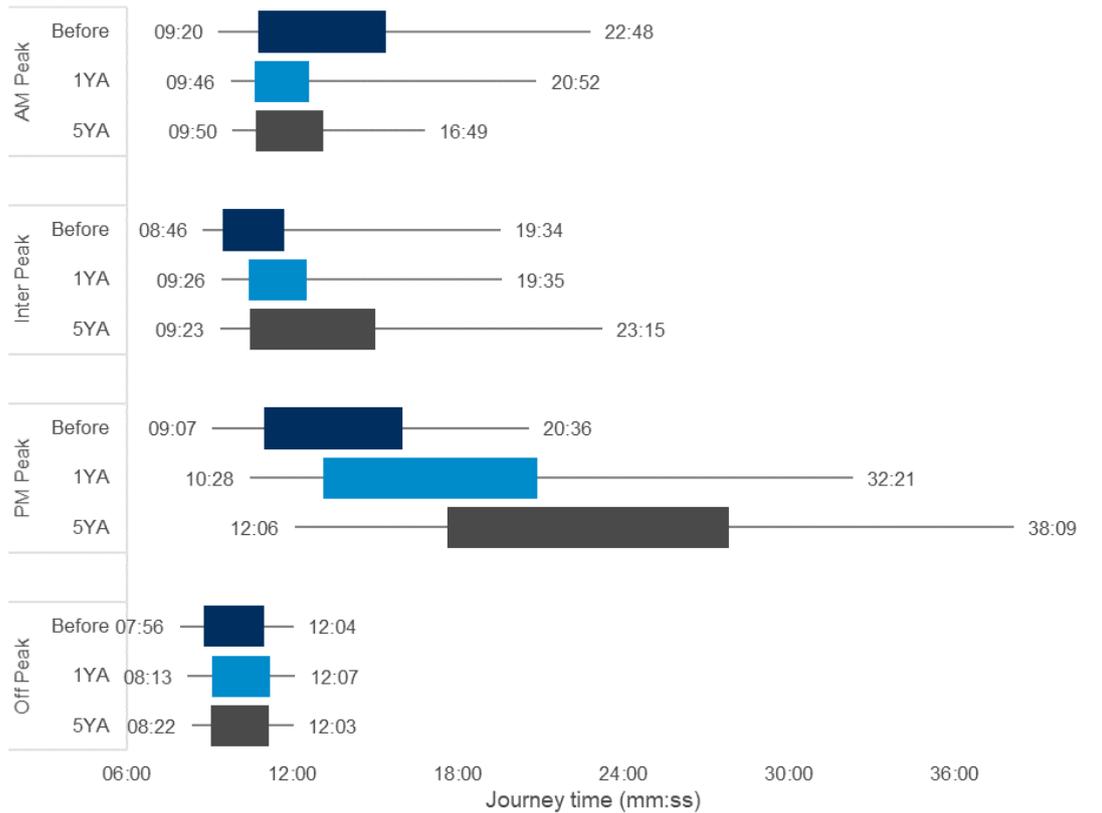


The impact on reliability is visualised in Figure 10 and Figure 11. If reliability has improved, the bars in the graph will shorten in length. This type of analysis cannot account for how reliable the road would have been had the scheme not been constructed, which would be the true comparison required to fully understand the benefits of the scheme. Nonetheless this analysis gives an understanding of outturn reliability in absolute terms.

The results of the reliability analysis are very similar to that of the journey time findings. Northbound, the reliability in the AM peak has improved when compared to the pre-scheme. This is true for the most extreme journey times and the interquartile range. The PM peak has become much less reliable in 2019 compared to 2011, with the interquartile range increasing substantially, informing us that journey times are more variable. On the southbound carriageway, reliability has also improved in the AM peak compared to conditions prior to the scheme. However, there has been a worsening of reliability since the one year after evaluation.

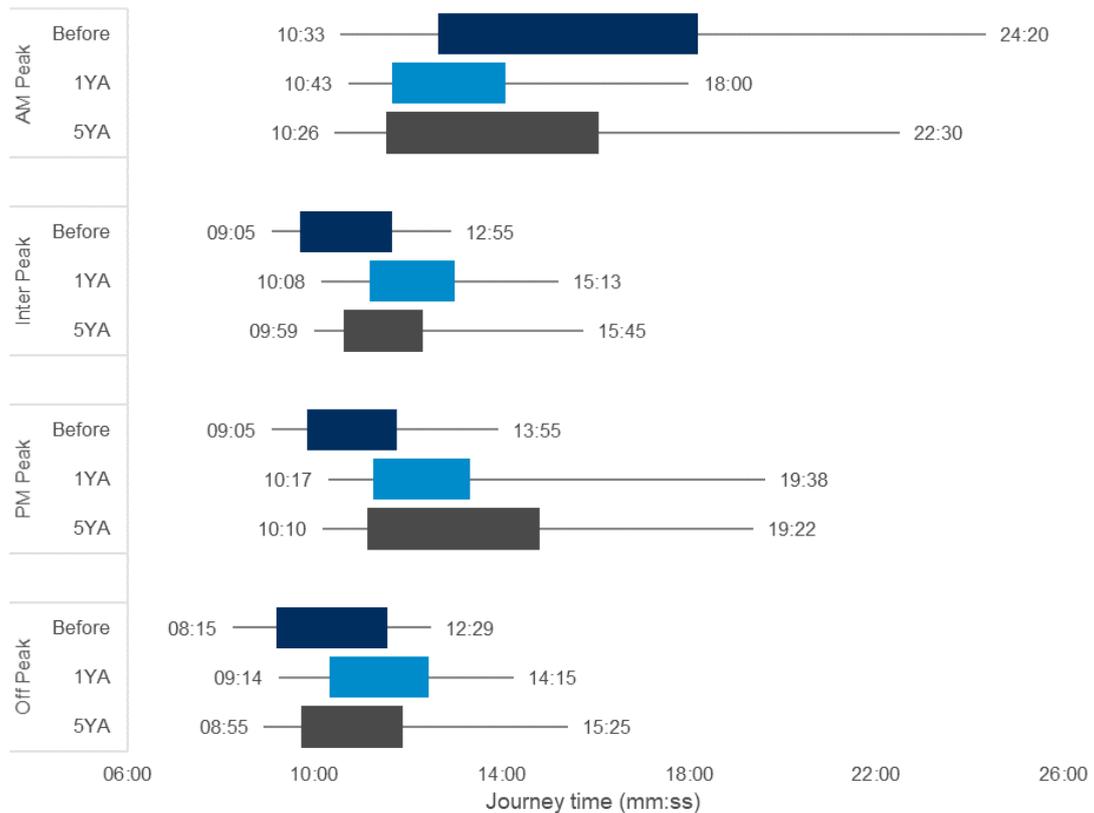
In all other time periods and in both directions, the reliability has continued to worsen, as it had at the one-year evaluation. Reliability is poor in absolute terms on the northbound carriageway in the PM peak. Deteriorating reliability between the one-year and five-year after analysis suggests that either increasing traffic flows year-on-year are having a detrimental impact on the performance of the scheme, or that the operation of the road (see the section to follow) is having an adverse impact.

Figure 10 Journey time reliability along the scheme length, northbound



Source: TomTom satnav data for May 2011, 2016 & 2019

Figure 11 Journey time reliability along the scheme length, southbound



Source: TomTom satnav data for May 2011, 2016 & 2019

The appraisal which informed the investment business case assumed that application of variable mandatory speed limits would improve reliability by 15%. This appears to have been an overestimate, potentially connected to utilisation of the hard shoulder (when it is available as a running lane), being less than anticipated in the appraisal. Evidence from this evaluation, along with other evidence being collated as an ongoing part of the 2020 Stocktake and Action Plan²⁰, allows us to examine whether that is an appropriate assumption.

How was the smart motorway operated?

We have shown evidence of journey times along the scheme slowing alongside moderate (and lower than expected) traffic growth. This section presents analysis of the operational aspects of the smart motorway to gain insight into how it may have affected overall scheme performance and journey times.

Our analysis of the operation of the smart motorway was based on HALOGEN²¹ data for May 2019. The data was used to determine on average how often the hard shoulder was open to traffic (on the relevant sections), and how often different speed limits were in place during the peak periods.

Dynamic hard shoulder operation – northbound

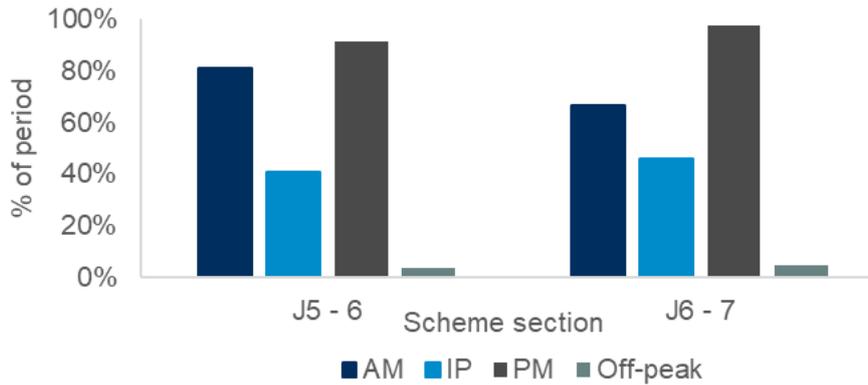
It has already been noted that the northbound carriageway suffered from heavy congestion and slow speeds in the PM peak, which had both worsened since the one year after analysis. In the AM peak, journey times had improved since before the scheme and the one year after stage. The dynamic hard shoulder operation should be considered in this context.

Figure 12 shows that on the northbound carriageway, the hard shoulder was generally open more often in the PM peak than the AM peak. Between junctions 6 and 7, the usage approached 100% in the PM peak. This gives context to the analysis in the journey times section, which showed speeds on this section were worse than before the scheme. When the additional lane is open to traffic, there is more capacity, yet despite this performance has declined due to the associated speed limits.

²⁰ In November 2021 the Transport Select Committee published its report into the rollout and safety of smart motorways. The Government agreed to all of the recommendations, including pausing the roll out of new ALR motorways in order to gather further safety and economic data for those sections of ALR introduced before 2020, together with evaluating the rollout of measures within the 2020 Stocktake and Action Plan.

²¹ Highways Agency LOGging ENvironment (HALOGEN) records signal settings for every gantry along the route.

Figure 12 Percentage of time hard shoulder is open, northbound carriageway, 2019 data



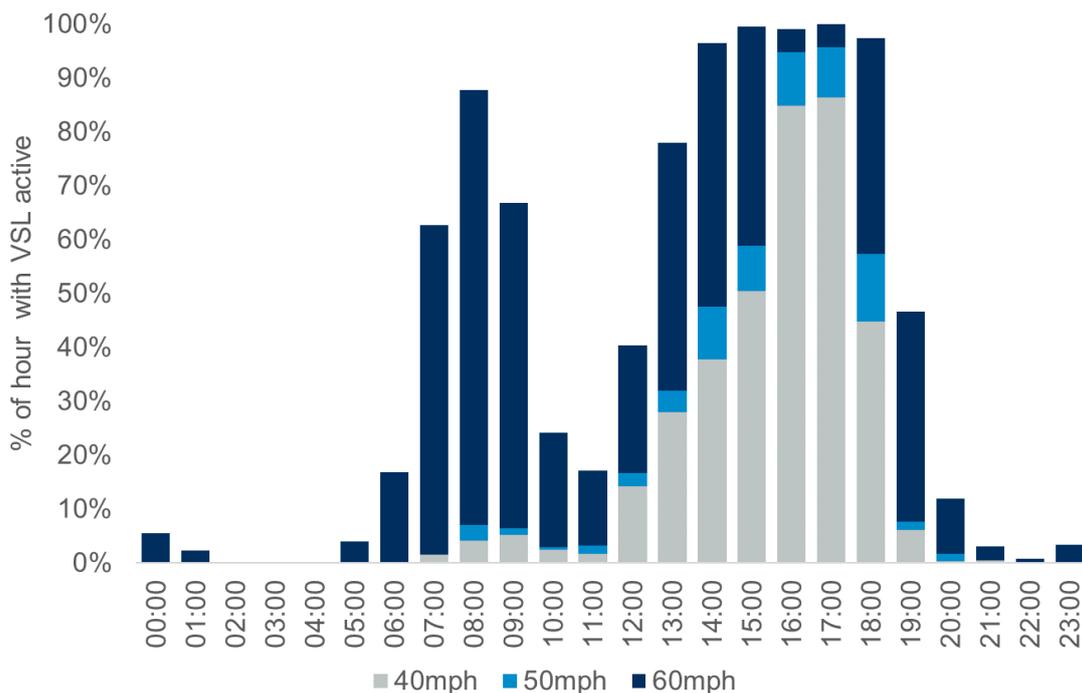
Source: HALOGEN, 2019

Figure 13 analyses the speed limits used throughout the average weekday across May 2019. It shows the percentage of each hour for which the various speed limits were displayed on the overhead gantries. The data was taken from the gantry on the northbound carriageway at the mid-point between junction 6 and junction 7, the section on which congestion was found to be at its worst.

During the AM peak, a 60mph limit was in place for the majority of the time; lower speed limits are used sparingly. Usage of lower speed limits decreased towards midday but increased in the afternoon in the leadup to the PM peak.

In the peak hours of 4–6pm, a 40mph speed limit was in place around 85% of the time. These findings are consistent with the journey time results, where we have observed much better journey times in the AM and interpeak periods than in the PM peak, which showed substantial delay. Analysis shown earlier in the journey times section found that traffic averaged below the 40mph shown on the gantries, often at around 25mph between junction 6 and junction 7. The data tells us that the operational and journey time data were consistent but does not give us clear understanding of cause and effect.

Figure 13 M6 J6-7 northbound, speed limit usage throughout the day, 2019 data

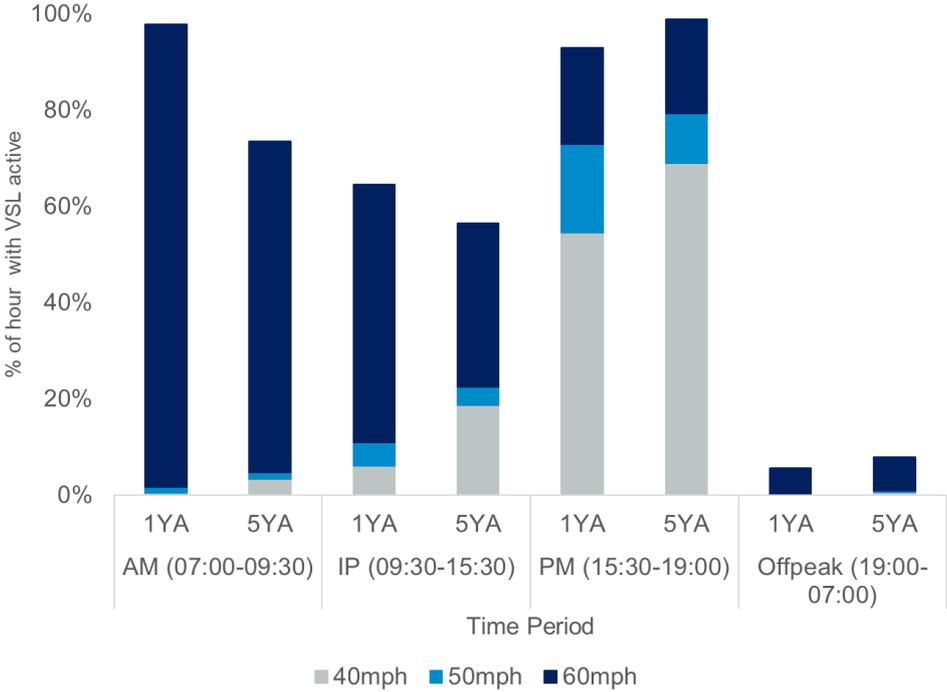


Source: HALOGEN, 2019

Figure 14 compares the speed limit usage in 2019 with the results from the one year after evaluation for the same scheme section. In the AM peak, speed limit usage has actually decreased from close to 100% at the one year after stage to current levels. This correlates with the small improvements in average journey time that were observed during the AM peak.

In contrast, in the PM peak, usage of a 40mph speed limit has increased. In the inter peak, a small shift from 60mph limits towards 40mph limits is observed. This links to the slow build-up of 40mph signs through to the PM peak as described above. The increased usage of 40mph speed limits matches the worsening of journey times between one year and five years after.

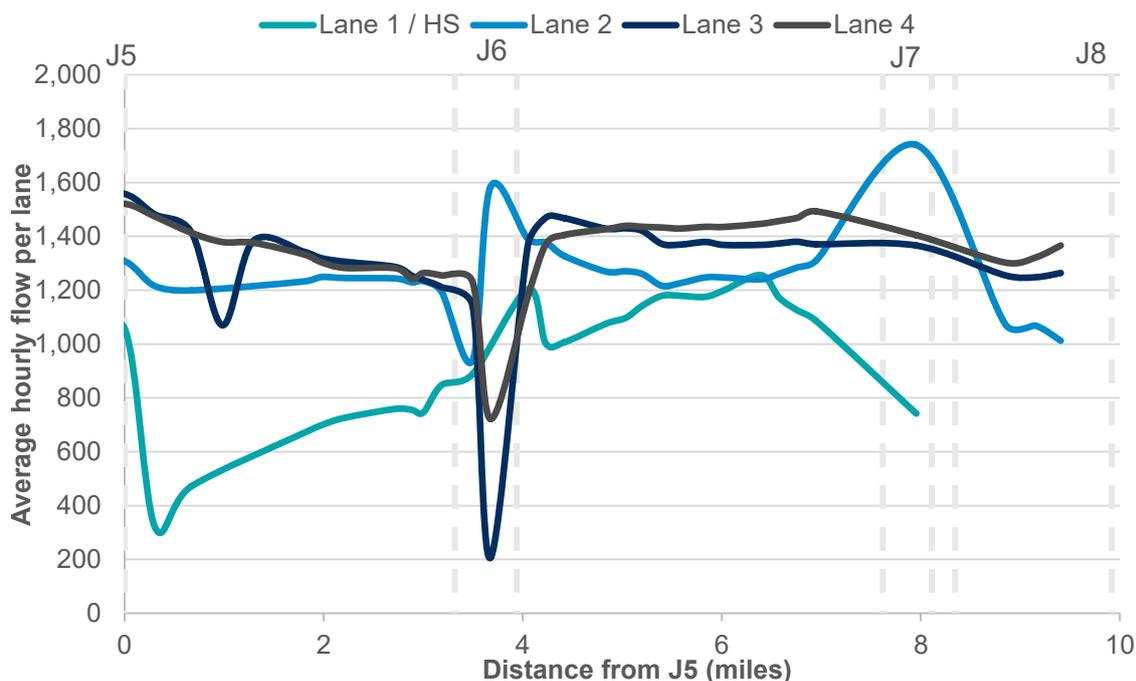
Figure 14 M6 J6-7 northbound, speed limit usage throughout the day, 2016 vs 2019 data



Source: HALOGEN, 2019

Figure 15 below shows that even during the busiest time period, which for the northbound direction is the PM peak, lane 1 has low levels of flow, particularly between junction 5 and junction 6.

Figure 15 - Lane utilisation northbound in PM peak



Source: MIDAS22, 2019. Note: J7-8 is controlled motorway, the hard shoulder is not a running lane at this point.

Dynamic hard shoulder operation – southbound

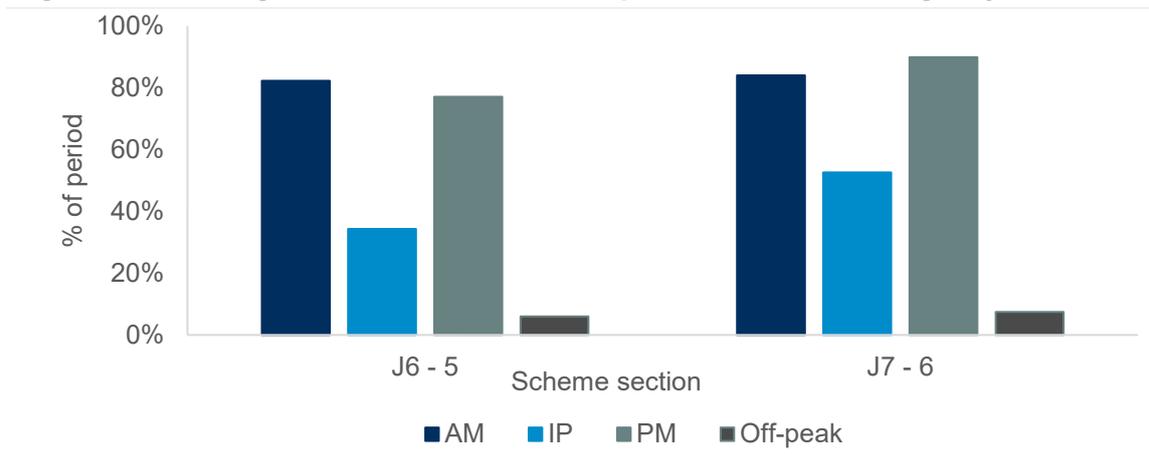
Performance on the southbound carriageway has generally been better than the northbound carriageway. AM peak average journey times improved between the before and after the scheme implementation. In the PM peak, journey times have increased since the scheme implementation, though the five years after journey times are marginally better than those at one year after.

Figure 16 shows that on the southbound carriageway, the hard shoulder is in operational as a live lane around 80% of the time during both peak periods. This is slightly less frequently than on the northbound carriageway, but nonetheless the additional capacity is normally provided in the peak periods.

Figure 17 shows the speed limits used throughout the average weekday during May 2019, showing the results for the southbound carriageway this time. 40mph speed limits are used much less in the PM peak when compared to the northbound carriageway. The use of 40mph is fairly similar in the AM and PM peaks on the southbound carriageway. The findings of the VMSL settings are consistent with the journey time findings reported earlier.

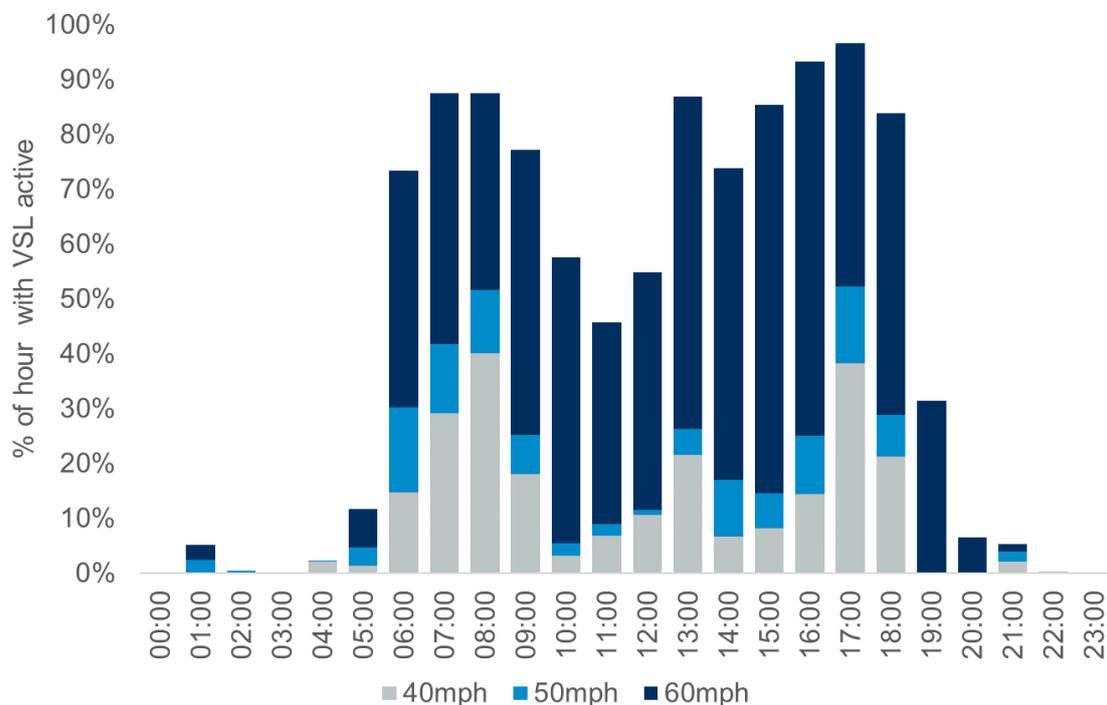
²² MIDAS (Motorway Incident Detection and Automatic Signalling) is a sensor based network covering the UK's motorways designed to collect traffic data and automatically display variable messaging, including variable speed limits

Figure 16 Percentage of time hard shoulder is open, southbound carriageway, 2019 data



Source: HALOGEN, 2019

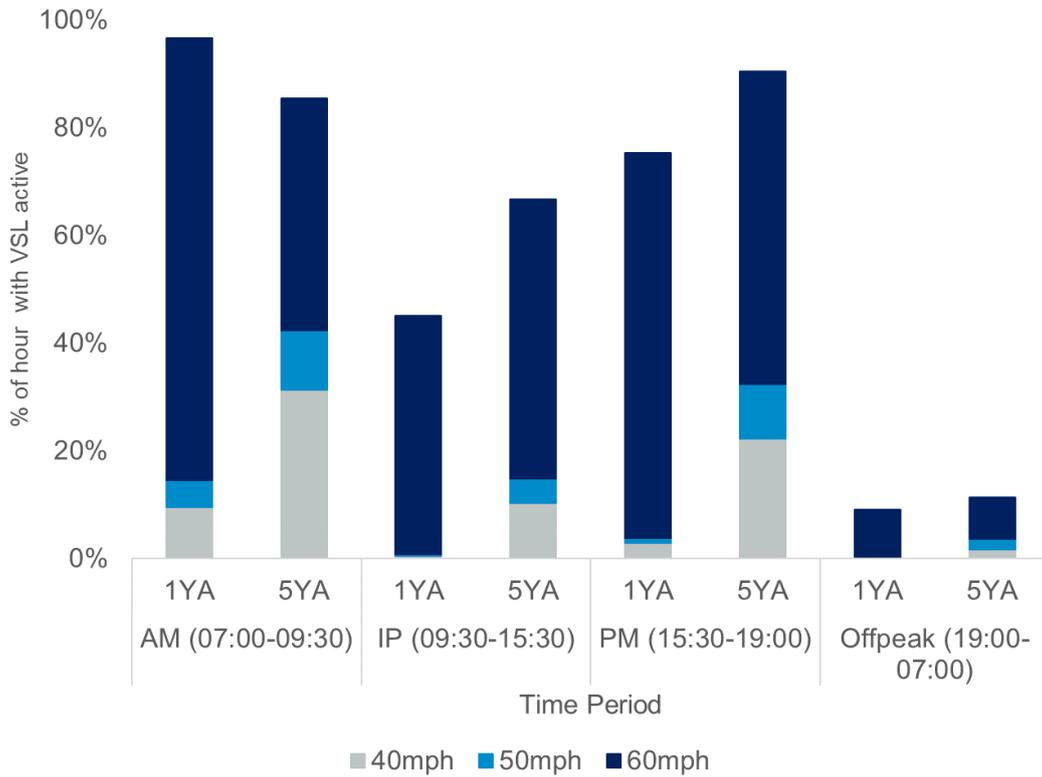
Figure 17 M6 J6-7 southbound, speed limit usage throughout the day, 2019 data



Source: HALOGEN, 2019

Figure 18 compares the southbound speed limit usage in 2019 with the usage from the one year after evaluation. It is seen that usage of 40mph and 50mph speed limits have increased in both peak periods, perhaps in response to growing traffic and higher congestion. The overall use of VMSLs has reduced in the AM peak (where benefits are observed) but increased in the inter and PM peaks (where journey times have got worse). What is not clear is the cause and effect from this analysis.

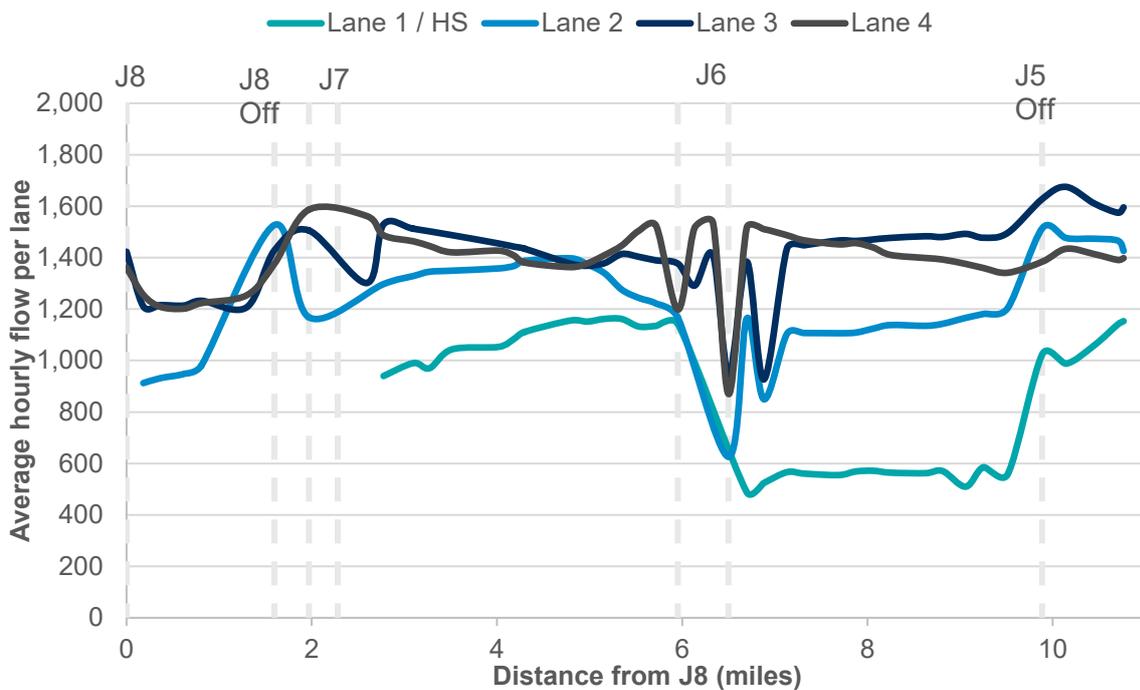
Figure 18 - M6 J6-7 southbound, speed limit usage throughout the day, 2016 vs 2019 data



Source: HALOGEN, 2019

Figure 19 below shows that even during the busiest time period, which for the southbound direction is the AM peak, lane 1 has low levels of flow, particularly between junction 6 and junction 5.

Figure 19 - lane utilisation southbound in AM Peak



Source: MIDAS, 2019. Note: J8-7 is controlled motorway, the hard shoulder is not a running lane at this point.

Summary

In both directions, the operational data indicated that the hard shoulder and VMSL settings are being utilised logically. Hard shoulder usage is higher in periods of high demand. However, there is some discrepancy between the observed usage and the assumptions in the forecasts which informed the investment business case.

The forecasting report indicates that in 2016 hard shoulder would be in operation for:

- 93% of the AM peak period
- 94% of the inter-peak period
- 94% of the PM peak period
- 6% of the off-peak period

Although we see high utilisation of the hard shoulder, it is not as high as this, particularly in the inter-peak period where we observed it to be open approximately 44% of the time.

The appraisal only assumed benefits of the DHS for the hours it was active. Given that the hours of operation are less than forecast, we expect this will accrue less benefit than forecast.

In addition, when the hard shoulder is used as a running lane Figure 15 and Figure 19 show that the hard shoulder is utilised less than the other lanes. This could be due to drivers being hesitant to use it, but more likely is due to the number of junctions in close proximity, with traffic tending to move into this lane when leaving/joining the motorway and other traffic avoiding merging/diverging traffic. The appraisal would have assumed that the additional lane had the same amount of capacity as the normal running lanes and that at busy times the traffic would have spread evenly across them. If in fact there was an underutilisation of the hard shoulder, then we haven't seen the full amount of additional capacity the appraisal assumed and therefore the observed benefits will be lower than anticipated.

Journey times and reliability generally worsened since both before the project and one year after opening, despite moderate traffic growth, and traffic levels far below that anticipated. The operational data from the motorway tallies with the performance findings with increasingly lower speed limits put in place for increasingly long periods of time. These matched the times of day that the performance had declined. However, although we have demonstrated that performance was worse than expected, we have been unable to evidence the underlying causes.

5. Safety evaluation

Summary

The safety objective for this scheme was to reduce the number and severity of accidents per vehicle-kilometre²³.

The number of personal injury collision²⁴ and the rate of these collisions per hundred million vehicle miles were analysed to track a change over time.

There has been a reduction in the rate and number of personal injury collisions on both the project extent and the surrounding network. This is based on comparing the first five years of the project being operational with the annual average for the five years before the project improvements²⁵.

There had been an annual average reduction of 12 personal injury collisions, which is in line with the appraised business case for the project. This is based on an annual average of 49 personal injury collisions after the project was operational compared with 61 before the project. If the road had not converted to dynamic hard shoulder running, we estimate that the number of personal injury collisions would have been between 45 and 83 (Figure 23).

When accounting for the increased volume of road users over this period, the annual average rate of personal injury collisions per hundred million vehicle miles had also improved over time. The average collision rate had decreased to 12 personal injury collisions per hundred million vehicle miles, this equates to travelling eight million vehicle miles before seeing an accident. Before the project the collision rate was 14 per hundred million vehicle miles, this equates to traveling seven million vehicle miles before seeing an accident. If the road had not been converted to dynamic hard shoulder running, we estimate the collision rate would remain at 13 collisions per hundred million vehicle miles. The reduction in collision rates suggest that safety has improved but we are less confident in this conclusion.

The number of fatal collisions has not changed with a total of three before and after the project became operational.

The number of FWI²⁶ has decreased annually. Before the project there was an annual average of 3 FWI per year. After the project became operational, this has reduced to 2 FWI per year. When accounting for the increased number of road users over this period, there had been a reduction from 0.6 to 0.5 FWI per hundred million vehicle miles travelled.

On the surrounding network²⁷ there was an average decrease of 41 personal injury collisions per year (based on an annual average of 141 personal injury collisions

²³ The objective is for the reduction of accidents per million vehicle kilometres. This has been assessed using hundred million vehicle miles

²⁴ A collision that involves at least one vehicle and results in an injury to at least one person

²⁵ We have tested the results at 90% confidence interval. The critical value at 90% confidence interval is 47, the observed collision savings for the project extent are close to this value of 47. We believe that the collisions savings observed for the project extent and wider safety area ensure that the project has met its safety objective

²⁶ The FWI weights Collisions based on their severity. A fatal collision is 1, a serious collision is 0.1 and a slight collision is 0.01. The combined measure is added up. A full number is the equivalent to a fatality.

²⁷ The road network is determined as part of the appraisal process to understand changes to road safety on the project extent and roads which the project may have an impact

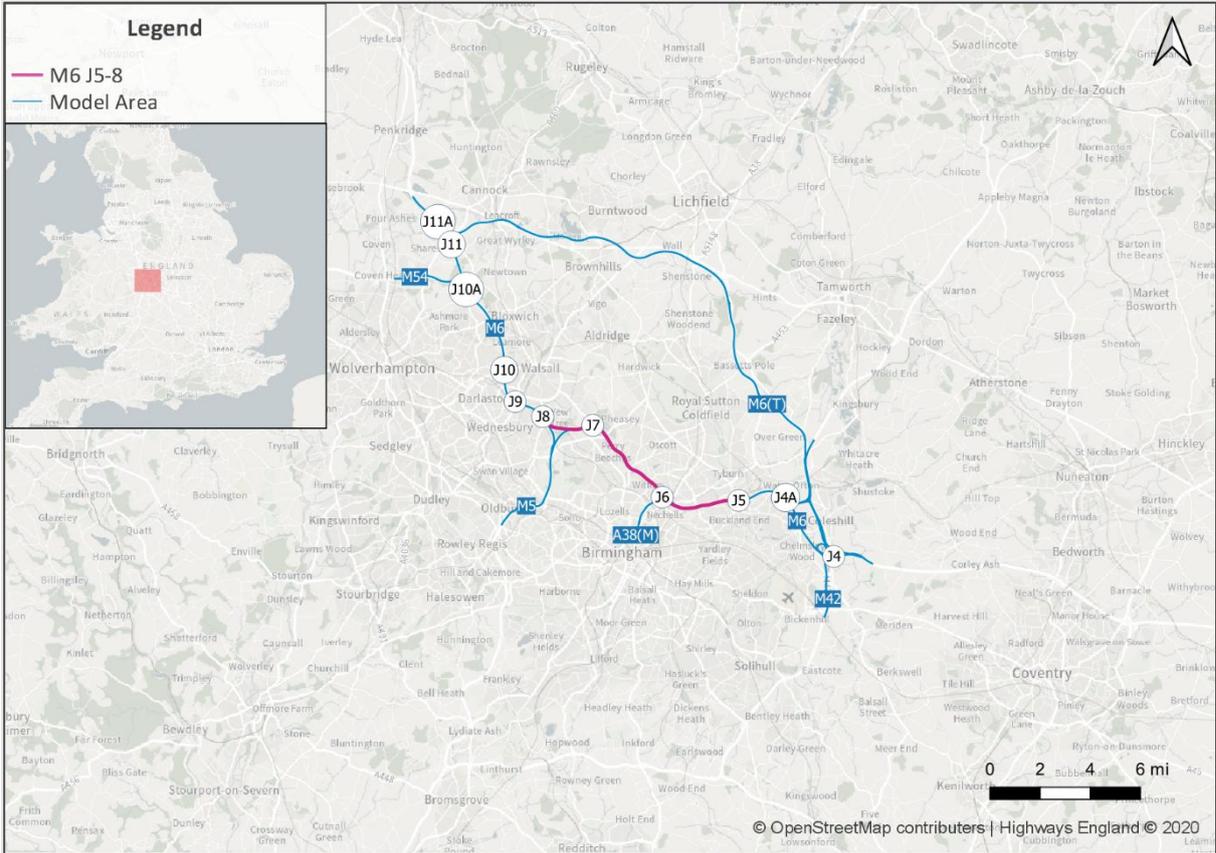
observed after the project had opened compared with 182 before the project). If the road had not been converted to a smart motorway, we estimate that the number of personal injury collisions would be between 131 to 214.

Based on this analysis the evaluation found there has been a reduction in the number, rate and severity of personal injury collisions. At this five-year evaluation point the project has met its objective to reduce the number and severity of accidents²⁸. However, we cannot be confident that this is because of the project itself and not part of observed wider trends for a reduction in collisions and rates.

Safety study area

The safety study area is shown in Figure 20. This area was assessed in the appraisal supporting the business case for the project to check any potential wider implications of the intervention²⁹. This information was then used with other predictions around the potential impact of the scheme such as by how much traffic may grow. The evaluation has used the strategic roads within the same area as the appraisal to understand the emerging safety trends.

Figure 20 Safety study area



Source: National Highways and OpenStreetMap contributors

²⁸ Projects are appraised over a 60-year period. This conclusion is based on the findings at five years after the project opened for traffic.

²⁹ The wider area evaluation has compared before and after analysis for the strategic road network, where the main impact is likely to occur. The appraisal also included some local roads, but we do not have the data to include this in our evaluation.

Road user safety on the project extent

What impact did the project have on road user safety?

Safety data was obtained from the Department for Transport road safety data³⁰. This records incidents on public roads that are reported to the police. This evaluation considers only collisions that resulted in personal injury via this dataset.

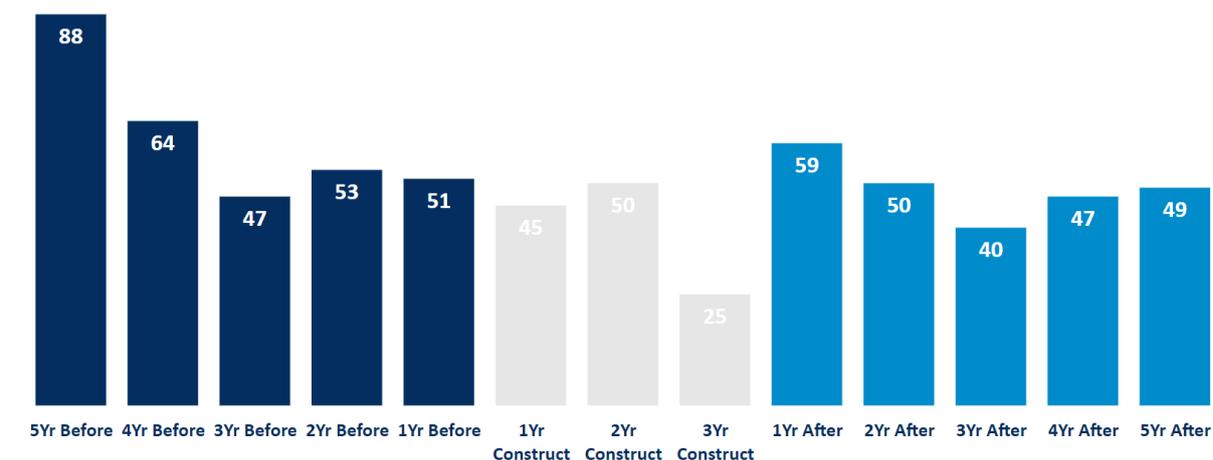
The safety analysis was undertaken to assess changes over time looking at the trends in the five years before the project was operational to provide an annual average. We have then assessed the trends five years after.

The analysis draws on the following data collection periods:

- Pre-construction: 1 January 2007 to 31 December 2011
- Construction: 1 January 2012 to 30 April 2014
- Post-opening: 1 May 2014 to 30 April 2019

The evaluation found the number of personal injury collisions on the project extent, had decreased³¹. Over the five years after the project was operational, there were an average of 49 personal injury collisions per year, 11 fewer than the average 61 per year over the five years before the project was constructed.

Figure 21 Annual Personal Injury Collisions



Source: STATS19: 1st January 2007 to 30th April 2019

As part of the safety evaluation, we look to assess what changes in personal injury collisions might have occurred due to factors external to the project over this timeframe. To do this we estimate the trend in personal injury collisions which might have occurred if the road had remained a conventional motorway (this is referred to as a counterfactual - see Annex 1: Safety Counterfactual Methodology). This is based on changes in regional safety trends for conventional motorways with a high volume of roads users.

Based on this assessment we estimate that if the road had not been converted to a smart motorway, the trend in the number of personal injury collisions would likely have increased, and collision rates would remain stable as shown in Figure 22 below.

³⁰ <https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data>

³¹ impacts on the wider area are discussed in the next section

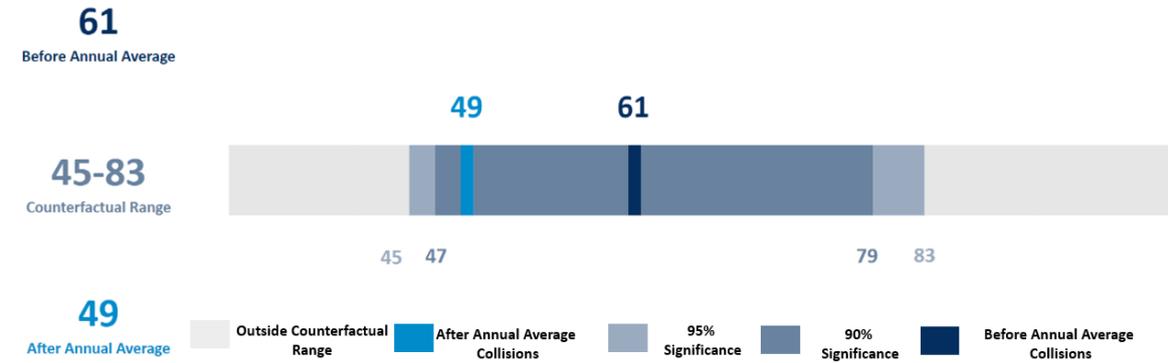
Figure 22 What does the counterfactual show?

The counterfactual is an estimation of what we think would occur without the project taking place. We estimate a range of collisions that follow regional trends. The chart shows:

1. Annual average number of collisions from before the project
2. Annual average number of collisions after the project
3. Estimated counterfactual range, which comes from a X^2 hypothesis test on one degree of freedom using a significance level of 0.05. More details can be found in the [POPE Methodology Manual](#).
4. National Highways are developing [new statistical methods to compare collision and casualty rates](#). We anticipate adopting these once the methods are finalised.

A range of between 45 and 83 personal injury collisions³² during the five-year post project period would be expected, as shown in Figure 23.

Figure 23 Observed and expected range of personal injury collisions (annual average)



Source: STATS19: 1st January 2007 to 30th April 2019

An annual average of 49 personal injury collisions were observed over the five-year post-opening period. This falls within the counterfactual range but is closer to the lower limit of 45 than the upper limit of 83. Therefore, this may be evidence to suggest that safety has improved³³, however we cannot be fully confident with these results.

³² The safety methodology is different from one-year to five-year evaluation. We still have confidence in the accuracy of the previous methodology but have made suitable changes that will ensure a methodology fit for purpose for the future.
³³ We have tested the results at 90% confidence interval. The critical value at 90% confidence interval is 47, the observed collision savings for the project extent are close to this value of 47. We believe that the collisions savings observed for the project extent and wider safety area ensure that the project has met its safety objective.

How had traffic flows impacted collision rates?

Smart motorways are implemented on some of England's busiest routes. It is therefore important to contextualise any incidents in the volume of traffic seen on this stretch via a collision rate, the number of personal injury collisions per annual hundred million vehicle miles (hmvm). Our evaluation has identified a decrease in the rate of personal injury collisions per annual hundred million miles.

Prior to the project, there was an annual average of 14 personal injury collisions per annual hmvm. After the project improvements were made, there was a decrease to 12 personal injury collisions per annual hmvm.

The average distance travelled before a personal injury collision occurred increased from seven to eight million vehicle miles per personal injury collision.

A counterfactual test was undertaken. It found that the collision rate would likely have been 13 collisions per annual hmvm in the counterfactual scenario. The reduction in collision rates suggest that safety has also improved³⁴.

What changes in the severity of collisions did we see?

Collisions which result in injury are recorded by severity as either fatal, serious, or slight. The way the police record the severity of road safety collisions changed within the timeframes of the evaluation, following the introduction of a standardised reporting tool – Collision Recording and SHaring (CRASH). This is an injury-based reporting system, and as such severity is categorised automatically by the most severe injury. This has led to some disparity when comparing trends with the previous reporting method, where severity was categorised by the attending police officer³⁵. As a consequence, the Department for Transport have developed a severity adjustment methodology³⁶ to enable robust comparisons to be made.

For this evaluation, one reporting mechanism was largely used prior to the smart motorway conversion and another afterwards. The pre-conversion collision severity has been adjusted, using the Department for Transport's severity adjustment factors, to enable comparability with the post-conversion safety trends.³⁷

After the scheme we have observed no change in collisions resulting in fatalities (the total before the scheme was three, compared to three after). There was an average of two fewer collisions resulting in serious injuries per year (the annual average before the scheme was six, compared to four after). There was an average of 10 fewer collisions resulting in slight injuries per year (the annual average before the scheme was 54, compared to 44 after). Figure 24 shows the severity of personal injury collisions.

³⁴ We have tested the results at 90% confidence interval and believe the project has met its safety objective

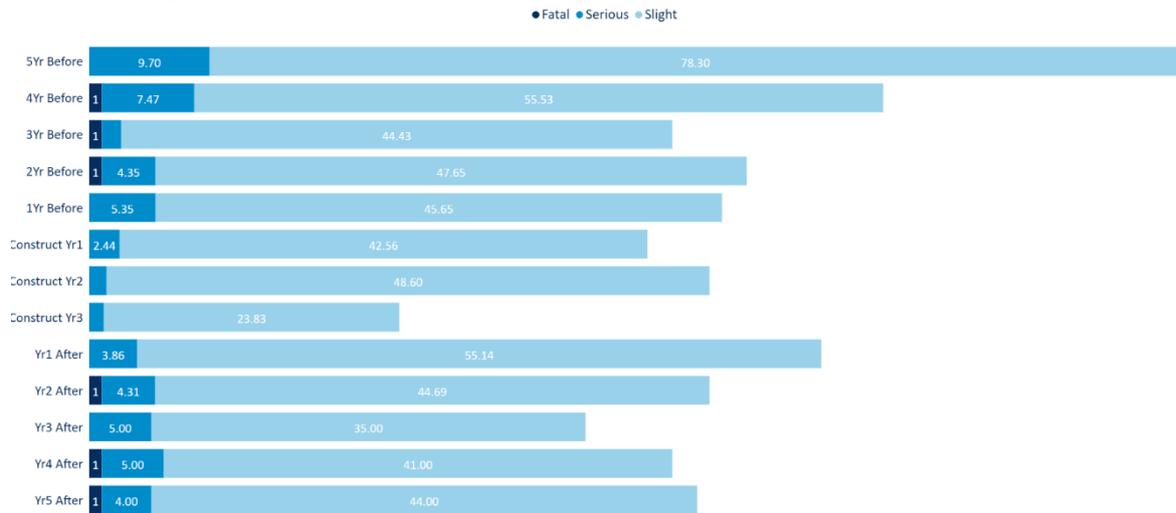
³⁵

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820588/severity-reporting-methodology-final-report.odt

³⁶ <https://www.gov.uk/government/publications/guide-to-severity-adjustments-for-reported-road-casualty-statistics/guide-to-severity-adjustments-for-reported-road-casualties-great-britain#guidance-on-severity-adjustment-use>

³⁷ Collision Severities within this report use the 2020 adjustment factor

Figure 24 Severity of personal injury collisions within the project extent³⁸



Source: STATS19: 1st January 2007 to 30th April 2019

How has traffic flow impacted casualty severity?

Like other transport authorities across the UK the key measure we use to assess the safety of roads, is Fatal and Weighted Injuries (FWI). This gives a fatality 10 times the weight of a serious casualty, and a serious casualty 10 times the weight of a slight casualty³⁹. In effect, it takes all non-fatal injuries and adds them up using a weighting factor to give a total number of fatality equivalents⁴⁰. This is represented by an annual average and a rate that standardise casualty severities against flow to show the likelihood of a fatality equivalent occurring per distance travelled.

A reduction of one FWI has been observed annually. The severity of casualties occurring after the project became operational has reduced in the scheme extent. Before the project an annual average three FWI were observed. After the scheme this had reduced to an annual average of two fatality equivalents.

The combined measure showed an extra 62 million vehicle miles was travelled before a fatality⁴¹. The rate of FWI per hmvm⁴² has reduced. This suggests that taking into account changes in traffic the project is having a positive safety impact on the severity of casualties within the scheme extent.

Road user safety on the wider area

What impact did the project have on safety for the wider area?

Personal injury collisions were observed for a wider impact area, which is derived from the safety appraisal for the project. The appraised wider area was split into two areas as shown in Figure 25. The local area, comprising of roads adjacent to

³⁸ As per DfT guidance, adjusted severities are presented with two decimal points

³⁹ The FWI weights Collisions based on their severity. A fatal collision is 1, a serious collision is 0.1 and a slight collision is 0.01. So 10 serious collisions, or 100 slight collisions are taken as being statistically equivalent to one fatality.

⁴⁰ Casualty Severities within this report use the 2020 adjustment factor

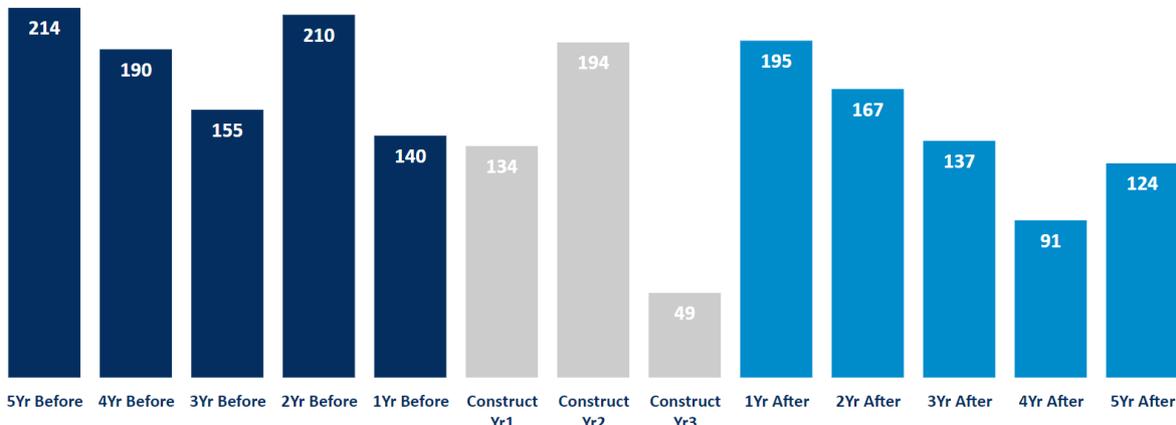
⁴¹ Before the scheme, 153 million vehicle miles needed to be travelled before a fatality equivalent (0.7 fatality equivalents per hmvm). After the scheme this increased to 213 million vehicle miles (0.5 fatality equivalents per hmvm).

⁴² hmvm – hundred million vehicle miles

the project extent and a wider area, to check any potential wider impacts from the intervention.

Before the project an annual average of 182 collisions were observed. After the project, this had risen to 141, a decrease of 41.

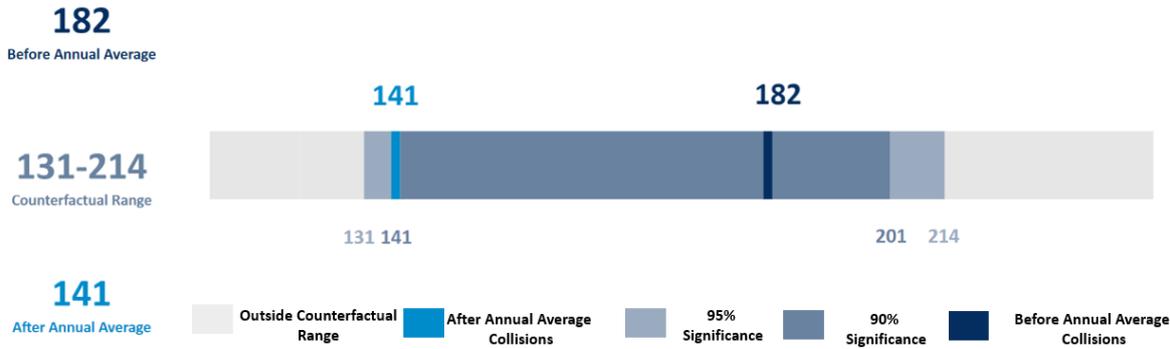
Figure 25 Annual personal injury collisions in wider area



Source: STATS19: 1st January 2007 to 30th April 2019

The counterfactual analysis indicated that it is likely that an annual average of between 131 and 214⁴³ personal injury collisions would have occurred (Figure 26). The observed annual average of 141 personal injury collisions falls just outside the range. Therefore, this may be evidence to suggest that safety has improved.

Figure 26 Observed and expected range of personal injury collisions in wider area (annual average)



Source: STATS19: 1st January 2007 to 30th April 2019

How had traffic flows impacted collision rates in the wider area?

The evaluation has identified a decrease in the rate of collisions per hundred million vehicle miles.

Prior to the project, there was an annual average of ten personal injury collisions per hundred million vehicle miles. After the scheme improvements were made, there was a decrease to nine personal injury collisions per hundred million vehicle

⁴³ We have tested the results at 90% confidence interval. The critical value at 90% confidence interval is 141, the observed collision savings for the project extent are the same as this value of 141. We believe that the collisions savings observed for the project extent and wider safety area ensure that the project has met its safety objective

miles. A decrease of one personal injury collisions per hundred million vehicle miles.

The distance travelled before a personal injury collision occurred increased from 10 to 11 million vehicle miles per personal injury collision.

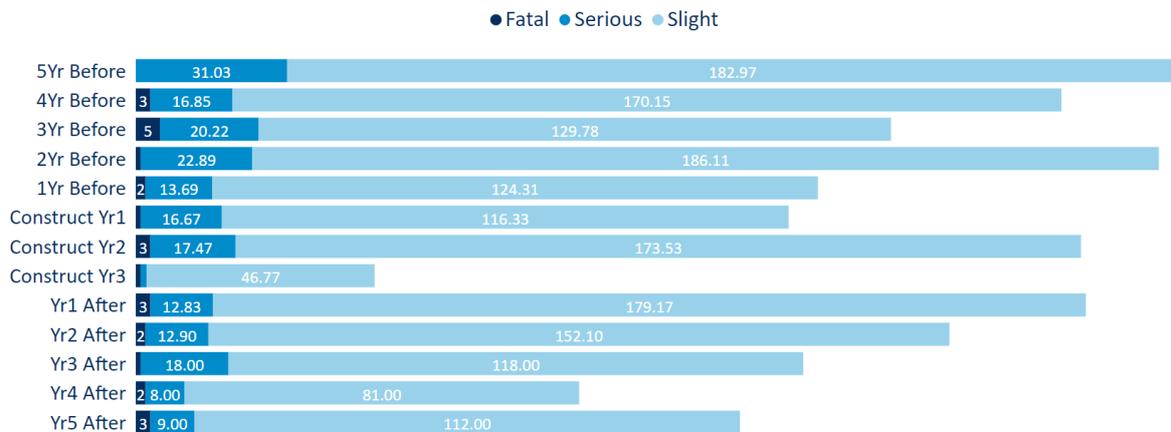
A counterfactual test was undertaken. It found that the collision rate would likely have been 13 collisions per hundred million vehicle miles in the counterfactual scenario. This indicates we have observed a larger reduction in the rate that personal injury collisions occur than predicted. Statistical testing indicates this reduction is significant suggesting that the project could be having a positive impact on the wider area.

What impact did the project have on the severity of collisions in wider area?

Collision severity analysis was undertaken for the wider area using the same method as for the project extent.

After the scheme we have observed no change in collisions resulting in fatalities (the total before the scheme was 11, compared to 11 after). There was an average of nine fewer collisions resulting in serious injuries per year (the annual average before the scheme was 21, compared to 12 after). There was an average of 31 fewer collisions resulting in slight injuries per year (the annual average before the scheme was 159, compared to 128 after). Figure 27 shows the severity of personal injury collisions.

Figure 27 Personal Injury Collisions by Severity in wider area



Source: STATS19: 1st January 2007 to 30th April 2019

How had traffic flows impacted casualty severity in the wider area?

To understand the impact of the increased traffic flow on collision severity, the measure we use is fatalities and weighted injuries⁴⁴ (FWI).

A decrease of one FWI has been observed. Before the project the average seven fatality equivalents were observed. After the project this had decreased to six.

The combined measure showed an increase of 37 million vehicle miles was travelled before a fatality. Before the project, 222 million vehicle miles needed to be

⁴⁴ FWI is explained above.

travelled before a FWI (0.5 FWI per hmvm). After the project this increased to 259 million vehicle miles (0.4 FWI per hmvm).

Has the project achieved its safety objectives?

The schemes safety objective was to reduce the number and severity of accidents per vehicle-kilometre. The evaluation found personal injury collisions and rates have both decreased. The counterfactual scenario suggests that safety has improved but we are less confident in this conclusion.

We have observed an improvement when comparing the severity of collisions before and after the project became operational.

Appraised expectation for the project forecast an improvement of 15% in the collision rate. This translates into an annual saving of 18 personal injury collisions for the scheme extent and wider area. The evaluation found that the appraisal underestimated collisions savings for this scheme with an average of 24 collisions saved annually.

The changes we have observed exceed with what was expected for the project.

6. Environmental evaluation

Summary

The evaluation of environmental impacts uses information on the predicted impacts gathered from the environmental appraisal and the environmental assessment report. Information from the one-year after evaluation was also used. This information was then compared with observations five-years after the project opened for traffic. Observed impacts were determined during a site visit in May 2019 and supported by desktop research. The results of the evaluation are recorded against each of the appraisal environmental sub-objectives.

The consideration of impacts to the water environment were removed from the scope of the evaluation at five-years after. This was because no new drainage assets were required by the project and there were no outstanding issues following the one-year after report. The society sub-objectives of physical activity and severance were also removed from the scope as there were no outstanding issues since the one-year after evaluation. At one-year after the evaluation indicated that there was uncertainty surrounding the outcome of the journey quality benefits. For this reason, journey quality was re-considered again at five years after.

Our five-years after evaluation confirmed many of the findings reported at one-year after. The impacts of the project on the environment were broadly restricted to within the highway boundary and were either neutral or slight adverse as expected by the assessment.

At five-years after, traffic flows were much lower than predicted and so it was anticipated that impacts on air quality, noise and greenhouse gases were better than expected along the project extent. Impacts to landscape character were broadly as expected. However, as the proposed mitigation planting had not been provided, visual impacts were likely to be worse than expected. The evaluation of journey quality suggested that the predicted large beneficial effects were not on track to be realised without further improvements to journey time reliability and visual impacts.

The traffic data used in this analysis is presented in Table 7 below.

Table 7 Forecast (interpolated) versus observed AADT⁴⁵ flows on the M6 junctions 5 to 8

Location	Direction	AADT for 2019		Difference in forecast and observed (2019)	
		Forecast ⁴⁶	Observed	Absolute difference	%
M6 J5-6	Northbound	93,500	67,300	-26,200	-28%
	Southbound	85,800	69,200	-16,700	-19%
M6 J6-7	Northbound	106,300	74,300	-32,000	-30%
	Southbound	95,000	76,500	-18,500	-19%

⁴⁵ AADT – annual average daily traffic

⁴⁶ A forecast AADT value was not available within the appraisal documents. A forecast AADT was calculated by interpolated 'Do-Something' forecast flows to estimate the forecast for 2019. The forecast flows were for specific time periods. These forecasts were multiplied up to estimate 12 hours of data and then a factor was used from observed traffic data to estimate AADT.

Noise

The environmental assessment work considered the impacts of the project on noise. It predicted that in the short term increases in traffic flows and the closer proximity of traffic would mean that more properties would experience an increase in noise than a decrease. These changes would only be minor. In the longer term, most properties affected by the project would experience minor increases in noise although much of this was due to traffic growth over the 15-year period. There were no large changes in noise predicted either with or without the project and no additional noise mitigation was proposed. Overall, the project was not predicted to cause any significant noise effects. At the one-year after stage, comparison of forecast against observed traffic data found that noise impacts could be worse than expected at some locations, but better than expected at others.

POPE methodology states that if observed traffic flows (number of vehicles >1,000 per day) are 25% more or 20% less than expected, the impact on noise will be assessed as either worse or better than expected respectively. The interpolated traffic flow data in Table 7 suggests that the effects of the project on the noise climate along the M6 between junctions 5 and 7 were better than expected along the northbound carriageway, and as expected along the southbound carriageway. Overall, it was likely that the impact of the project on the noise climate was better than expected between junctions 5 and 7. Between junctions 7 and 8 however, no conclusions about any changes in the noise climate as a result of the project could be drawn because there was insufficient observed traffic flow data.

Air quality

The environmental assessment work highlighted that the project passed through an area of existing poor air quality with three air quality management areas within the project footprint and a further nine in the wider area. It was predicted that increased traffic flows caused by the project would cause an overall worsening of air quality with 907 properties experiencing a deterioration in air quality, but only 716 experiencing an improvement. It was predicted that the project would cause 13 new exceedances of the annual average Nitrogen Dioxide (NO₂) air quality standard, but it would remove five existing ones. The maximum worsening in NO₂ was predicted to be 1.8µg/m³ and the maximum improvement, principally due to the realignment of the carriageway north on M6 junction 6, was predicted to be 2.6µg/m³. The potential impact of nitrogen deposition on nearby sites of special scientific interest was considered. However, it was concluded that a negligible reduction in nitrogen deposition would occur and therefore not significant.

Overall, it was predicted that the project would cause a worsening of air quality, but these changes would not be significant.

No new air quality monitoring is undertaken as part of our evaluation. Instead, we consider the impact on the outcome of the air quality assessment had the actual five-year after traffic data been used. The one-year after evaluation reported that there was potential for air quality improvements to be better than expected.

POPE methodology states that if observed traffic flows differ from forecasted traffic flows by more than 1,000 vehicles, the concentrations of air pollutants will be assumed to be either higher or lower than expected. The interpolated traffic flow data in Table 7 suggests that the concentrations of air pollutants along the M6 may

have been lower than expected between junctions 5 and 7. Between junctions 7 and 8 however, we could not draw firm conclusions about any changes in the concentrations of air pollutants as a result of the project because there was insufficient observed traffic flow data.

Greenhouse gases

The appraisal predicted that the project would cause a reduction in carbon emissions between the 'without project' and 'with project' over the 60-year appraisal period. It also predicted a reduction in carbon emissions between the 'without project' and 'with project' in the opening year. A net benefit over 60 years was predicted of £2,090,254 or a reduction of 119,592 tonnes CO_{2e}.⁴⁷

The POPE methodology manual sets out an approach for evaluating the carbon emissions along our projects. It recognises that it is not possible to make a direct comparison between predicted and observed carbon emission. This is because the appraisal is based on the entire modelled area over 60 years whereas, at evaluation, traffic information for the whole study area is not usually available. Instead we evaluate the impacts by comparing a forecast and observed emission just for the project extent. To estimate the emissions our evaluation method uses the emission factor toolkit⁴⁸ published by UK Government is used.

For this project it was not possible to quantify the emissions along the project extent because we did not have sufficient information on the Heavy Goods Vehicles (HGVs) and speeds to enable this to be done. However, based on the available traffic flow data (Table 7), the observed two-way flows between junction 5 to 7 were between 16,700 and 32,000 (between 19% and 30%) lower than forecast. This would suggest that carbon emissions may be lower than forecast along much of the project extent. However, as we were unable to quantify the emissions we do not know what effects speeds and HGVs may have had on this outcome.

⁴⁷ Carbon dioxide equivalent is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_{2e} signifies the amount of CO₂ which would have the equivalent global warming impact.

⁴⁸ <https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/>

Landscape and townscape

The environmental appraisal reported that the existing motorway was a prominent feature in the largely urban environment. This was especially the case along the elevated sections east of junction 7. The project would involve the construction of new infrastructure including new gantries, signage and emergency refuge areas although these would be within the existing highway boundary. Existing road lighting would be upgraded but, other than at the new emergency refuge areas and on the slip roads at junction 5, no new lighting was proposed. Existing mature vegetation would be cleared to accommodate the new infrastructure which would cause localised visual impacts to nearby properties. However, this was not predicted to have a significant effect on the overall landscape and townscape character. Design work was done to optimise the number and location of gantries to help reduce their visual impacts. New mitigation planting was also proposed to further reduce the visual impacts that were predicted. Overall, once the mitigation planting had matured, the impacts to landscape and local townscape character were predicted to be neutral.

Our five-year after evaluation examined the observed impacts of the project on landscape and townscape and compared them against those predicted in the environmental assessment work. It focused on a sample of key impacts including some of the viewpoint locations reported in the environmental assessment and built on the findings that were reported in the one-year evaluation. It was not possible to access all locations and so supporting background information including online imagery and information in the handover environmental management plan (HEMP)⁴⁹ were used.

Analysis of the evidence gathered confirmed that overall the additional infrastructure had not had a noticeable effect on the townscape. Although there was some localised vegetation loss and new gantries had been installed, the road corridor and local townscape remained broadly the same. The outcome at five-years after was determined to be as expected.

Figure 28 - View from Bromford Drive; new gantry visible on elevated section



Source: Site visit 2019

⁴⁹ Handover Environmental Management Plan. A project document that provides information on the environmental mitigation provided by a scheme and guidance on maintenance regimes.

Figure 29 - View from Stonechat Drive. Gantry and top of sign just visible above retained vegetation on elevated section



Source: Site visit 2019

The one-year after evaluation identified that, at that time, the proposed mitigation planting did not appear to have been provided at all locations expected. Access to these locations which, included private properties was limited and so at five-years after, internet imagery was used to support the limited visual observations that were made. The evaluation confirmed that the mitigation planting proposed by the environmental assessment and the HEMP had not been provided. This included planting adjacent to new gantries near Grebe Close and Aldridge Road. At Grebe Close pre-project⁵⁰ imagery from Google Street View shows existing planting behind the original gantry and post-opening⁵¹ no new mitigation planting provided as was planned.

The HEMP suggested that the mitigation planting would be provided by the area maintenance contractor following completion of the project and not the project contractor themselves. This is an unusual approach as normally the major project would be responsible for implementing its own mitigation. As the planting was not provided at the two locations examined it was considered likely that many of the visual impacts had not been mitigated as predicted by the environmental assessment. The outcome for landscape including visual impacts was considered to be worse than expected.

Biodiversity

The environmental appraisal and assessment reported that, as all works would be within the existing highway boundary, no statutorily designated wildlife sites would be affected. However, three wildlife sites of local interest to nature conservation would be affected by the project as they extended on to the motorway verge. The assessment identified that the motorway verge had the potential to provide some foraging habitat for wildlife but that surveys and preconstruction mitigation would avoid harm to any species present. Some verge habitats along the M6 would be lost to accommodate the new gantries and emergency refuge areas but the reinstatement of the verge and new planting would help mitigate some of the loss. The environmental assessment also indicated that replacement planting could provide an opportunity for some localised enhancement. Overall, the impacts on biodiversity were reported as slight adverse.

Our evaluation considered the impacts of the project on biodiversity but was affected by the limited access that was possible. Observations were made whilst

⁵⁰ [Google Street View 2008](#)

⁵¹ [Google Street View 2019](#)

driving along the route and some analysis was done using online imagery and documentary records.

Our evaluation confirmed that the impacts of the project were limited to within the highway boundary. The motorway verge had been reinstated including along sections that included wildlife sites of local interest and it was considered that the integrity of these sites had been maintained. However, there was no evidence that any localised enhancements had been done.

The one-year after evaluation reported that documentary evidence confirmed that pre-scheme species surveys were done. The HEMP also confirmed that all biodiversity commitments during the construction works had been met. The HEMP indicated that a final walkover to confirm that badger setts had not been disturbed would be undertaken. However, our evaluation has found no evidence that this walkover was done and so impacts on badger setts could not be ruled out.

The observed impacts were broadly as predicted and although impacts on badger setts could not be ruled out, it was considered that the overall outcome was as expected.

Journey quality

The environmental assessment work predicted that the project would help improve journey quality⁵² by reducing driver stress. The project would achieve this by smoothing traffic flows which would reduce congestion and queuing, assist in improving journey times and improve safety. Improved signage would also help reduce route uncertainty by providing clear and unambiguous information. Overall, it was predicted the project would provide a large beneficial impact on journey quality.

The one-year after evaluation confirmed that the project had been implemented as expected but that not all of the benefits to journey quality had been fully realised. It was considered that congestion remained an issue at certain times of the day, journey reliability was an issue and there was insufficient data on accidents to determine if changes were significant. For these reasons the one-year after evaluation recommended that journey quality was reconsidered at five-years after.

At five-years after, the focus of the evaluation was on gathering evidence to further our understanding of the projects impacts on traveller views and stress. Our analysis showed that new and replacement planting had not been undertaken to the extent expected. This meant that whilst changes to views had been marginal as expected these impacts had not been mitigated and so overall the outcome was worse than expected. Our analysis of traffic and safety information suggested that journey times had not improved nor had reliability. There had been a reduction in personal injury collisions, which is likely to be reducing the fear of accidents for road users. It was considered that driver stress was worse than expected. Overall, as both traveller views and stress were considered to be worse than expected, the outcome for journey quality was also worse than expected.

⁵² Journey quality is a measure of the experience of travelling. This includes traveller care (eg information and facilities), travellers' views; and traveller stress factors (eg perceptions of safety, congestion and reliability). Refer to [webTAG A4.1](#).

Overview

The results of the evaluation are summarised against each of the Transport Appraisal Guidance (TAG) environmental sub-objectives⁵³ and presented in Table 8. In the table we report the evaluation as expected if we believe that the observed impacts at five-years after were as predicted in the appraisal. We report them as better or worse than expected if we feel the observed impacts were better or worse than expected. Finally, we report impacts as too soon to say if we feel that at five-years after there remains insufficient evidence to draw firm conclusions.

Table 8 Environmental impacts – M6 main carriageway

Sub Objective	Appraisal Summary Table Score	Five-year Evaluation	Summary
Noise	Neutral	Better than expected	Traffic flows were lower than expected; noise impacts were therefore better than expected.
Air Quality	Neutral	Better than expected	Traffic flows were lower than expected; air quality impacts were also better than expected.
Greenhouse Gases	A reduction in carbon emissions of 119,592 over 60-year period	Unable to evaluate	Total traffic flows along the project extent were lower than forecast. This may suggest that emissions were lower than forecast but it was not possible to quantify
Landscape	Neutral	Worse than expected	Impacts to landscape character were broadly as expected. However, as the mitigation planting had not been provided, visual impacts were considered to be worse than expected.
Townscape	Neutral	As expected	Although there had been some localised vegetation loss and new gantries installed, the corridor and local townscape remained broadly unchanged. Overall it was considered that there had been no significant change to the perception of the townscape.
Biodiversity	Slight adverse	As expected	Motorway verge was lost but the integrity of the local wildlife sites affected by the project were maintained. Whilst overall it was likely that the outcome for biodiversity was as expected, the absence of evidence on badger surveys meant that impacts on badger setts could not be ruled out. There was no evidence that any enhancement was done.

⁵³ <https://www.gov.uk/government/publications/tag-unit-a3-environmental-impact-appraisal>

Journey Quality	Large beneficial	Worse than expected	Traffic and safety data suggested that driver stress had not improved, and as new and replacement planting had not been provided impacts to traveller views had not been mitigated.
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7. Value for money

Summary

As part of the business case, an economic appraisal was conducted to determine the project's value for money. This assessment was based on an estimation of costs and benefits over a 60-year period.

The project was delivered within the original construction budget, at a cost of £118 million⁵⁴. In the first five years, the road provided additional capacity to support more road users (an increase of between 4-12%), whilst improving the safety of those journeys. If this trend continues, the project is reforecast to deliver £96million of safety benefits over the 60-year period⁵⁵, which is higher than originally anticipated within the business case.

The route has made journeys quicker for road users travelling during the morning peak periods. However, journey times increased for road users travelling at other times during the evening peak periods. Journey time benefits made up the majority of the anticipated monetised impacts of this project. The appraisal forecast significant traffic growth and improving journey times; the observed data suggested much more modest traffic growth accompanied by slower journey times.

Overall, the evaluation indicated that in the first five years this investment is not on track to deliver the value for money anticipated over the 60-year life of the project. If the journey time trends observed within the first five years continue, the project is expected to deliver 'very poor' value for money⁵⁶.

Forecast value for money

An economic assessment is undertaken prior to construction to determine a project's value for money and inform the business case. The assessment is based on an estimation of costs and benefits. The impacts of a project such as journey time savings, changes to user costs, safety impacts and some environmental impacts are able to be monetised. This is undertaken using standard values which are consistent across government. The positive and negative impacts over the life of the scheme⁵⁷ are summed together and compared against the investment cost to produce a benefit cost ratio (BCR). The monetised impacts are considered alongside additional impacts which are not able to be monetised, to allocate the project a 'value for money' category.

The monetised benefits forecast by the appraisal which supported M6 junctions 5 to 8 smart motorway business case are set out in Table 9. We have also included an indication of what proportion of the monetised benefits each impact accounted for and a summary of how we have treated the monetisation of each impact in this evaluation.

⁵⁴ Present value of costs in 2010 prices and values.

⁵⁵ Based on impacts on the Strategic Road Network.

⁵⁶ The value for money categories referenced are defined by the Department for Transport <https://www.gov.uk/government/publications/dft-value-for-money-framework>

⁵⁷ Typically scheme life is taken to be 60 years.

Table 9 - Monetised benefits of the project (£ million)

	Forecast (£M)	% forecast monetised benefits⁵⁸	Evaluation approach
Journey times	574	94%	Re-forecast for the project area only (not the wider area) using observed and counterfactual ⁵⁹ traffic flow and journey time data
Vehicle operating costs	1	1%	Re-forecast using observed and forecast traffic flow and journey time data
Journey time & VOC during construction and maintenance	-53	-9%	Not evaluated (assumed as forecast)
Journey time reliability	42	7%	Monetised benefits assumed as forecast
Safety	61	10%	Re-forecast using observed and counterfactual ⁶⁰ safety data for the SRN only ⁶¹ ,
Carbon	4	1%	Monetised benefits assumed as forecast
Air quality	0	0%	Monetised benefits assumed as forecast
Noise	-18	-3%	Monetised benefits assumed as forecast
Indirect tax revenues	-41	-7%	Re-forecast using observed and forecast traffic flow and journey time data
User charges	98	16%	Not evaluated (assumed as forecast)
Operating costs	-59	-10%	Not evaluated (assumed as forecast)
Total present value benefits	611		

Note: 2010 prices discounted to 2010. Due to rounding the numbers and percentages may not always add up exactly to the presented totals.

The costs anticipated in the appraisal are set out in Table 10. Based on this information, the scheme was anticipated to give 'high' value for money over the 60-year appraisal period.

⁵⁸ Disbenefits are presented as negative numbers and percentages. The total of the positive and negative contributions total to 100%

⁵⁹ We calculated the vehicle hours saved by comparing outturn journey times with an estimate of how journey times would have continued to deteriorate had the project not been implemented (ie a 'counterfactual').

⁶⁰ We compared observed trends with an estimation of the trends if the road had remained a conventional motorway (ie a 'counterfactual')

⁶¹ SRN – Strategic Road Network

Evaluation of costs

The project was delivered within the original construction budget, at a cost of £118 million⁶² (Table 10).

The appraisal expected that the project would result in an increase in maintenance costs over the life of the project. As the vast majority of this maintenance is still in the future, the evaluation uses the maintenance costs forecast within the business case.

Table 10 - Cost of the project (£ million)

	Forecast (£M)	% of forecast costs	Evaluation approach
Construction costs	119	71%	Current estimate of project cost
Maintenance costs	48	29%	Not evaluated (assumed as forecast)
Total present value costs	167		

Note: 2010 prices discounted to 2010. Due to rounding the numbers and percentages may not always add up exactly to the presented totals.

Evaluation of monetised benefits

Once a project has been operating for five-years, the evaluation monitors the construction costs and the trajectory of benefits to reforecast these for the 60-year project life. It is not proportionate to replicate modelling undertaken at the appraisal of a project or to monitor benefits over the entire lifecycle, so we take an assessment based on the trends observed over the first five years of operation and estimate the trend over the project life, based on these observations. This provides a useful indication and help to identify opportunities for optimising benefits. In instances where it was not feasible to robustly compare forecast and observed impacts, the findings have been presented with relevant caveats.

Monetised journey time benefits

As can be seen in Table 9, journey time benefits made up the majority of the justification for investing in the M6 junctions 5 to 8 smart motorway.

As previously noted, within the first five years the forecast level of journey time benefits are not on track to be realised without further intervention. This is likely to be due to a combination of reasons including:

- lower than forecast levels of traffic due to the 2008 economic downturn⁶³ resulting in less additional traffic on the M6 than forecast, which in turn results in less need for the hard shoulder to be opened. It should be noted that some flow suppression could be due to construction works at the time of the evaluation.

⁶² This is the PVC (present value cost) of the project. This means it is presented in 2010 prices, discounted to 2010 to be comparable with the other monetary values presented.

⁶³ The 2008 economic downturn was not anticipated within the appraisal but led to recession which stalled traffic growth between 2008 and 2011 as a consequence of impacts on fuel price and travel demand.

- when the hard-shoulder is open, the levels of flow may not always warrant it and therefore in some periods people may be travelling slower than they otherwise would, although still experiencing the associated safety benefits
- when the hard shoulder was open, fewer people are making use of the additional capacity than we anticipated
- the benefits may have been over forecast due to the way the model represented junctions (refer to section 4).

This means that the additional capacity provided by the smart motorway is not yet being fully optimised to realise the benefits to customer journeys. However, the capacity is available to support an increase in road users in the future.

The appraisal assumed the project would deliver journey time savings for both those using the smart motorway and those using the surrounding road network, where congestion would be eased by the additional capacity on the M6. The evaluation has not monitored the impact on the surrounding roads and can only directly quantify a proportion of the journey times. Our findings relating to the project area are very different from those forecast for that area. We therefore did not feel we had sufficient confidence in the forecasts to use them as the basis of an estimate of the outturn impact in the wider area.

If the trends observed at the fifth year continue over the 60-year period, without any further action to optimise benefits, the monetised impact on journey times, for those using the road, would be -£174million⁶⁴. This figure only reflects journey time trends observed on the project area, not the surrounding road network which would have been considered in the appraisal⁶⁵.

Our observations of flows in the wider area showed mixed evidence for decongestion effects on the wider network. As noted in section 4, the A34 appears to have experienced some traffic relief, with a reduction in traffic against a general trend of increasing traffic in the area. However, the A38 saw traffic growth above the trend in the area, so the picture is mixed. We acknowledge that the monetised value presented above does not represent the full impact of the project and does not reflect any impact on the wider road network.

Other reforecast impacts

We reforecast total safety benefits to be £96million⁶⁶. This figure relates to the benefit on the strategic road network over 60-years (see Figure 20). This is not the full area used in the appraisal (we do not have data for all the local roads) but does represent the area where we expect the majority of impacts to occur⁶⁷. The reforecast is higher than the appraisal forecast which fits with the findings in section 5 where we saw an improvement in the collision rate of 18% along the project extent, compared to the 15% which was forecast. There are two further impacts associated with the changes in numbers and speeds of vehicles – indirect tax revenues and vehicle operating costs. Indirect tax revenues are the benefit to the government (and therefore society) of the additional tax income from the

⁶⁴ This is against a counterfactual where we have estimated what the journey time is likely to have been if the road had remained a conventional motorway.

⁶⁵ We estimate that the expected monetised benefit on the scheme section in the fifth year was £15M, which we estimate to represent 63% of the total benefits. This compares with an estimated disbenefit of £4M based on our observations.

⁶⁶ This figure relates to the benefit on the strategic road network over 60-years.

⁶⁷ We would expect this number to be a conservative re-estimate

additional fuel consumed due to increased speeds and distances travelled. This was forecast to be negative. Although more vehicles were forecast and they were forecast to be travelling at higher speeds, this expected reduction in tax revenues is likely to be due to the vehicles being forecast to travel at a more fuel-efficient speed and therefore using less fuel and paying less tax⁶⁸. We have reforecast that the impact would be smaller than expected, and an increase in tax revenues (£4million). The impact is small because our evaluation has shown that there wasn't as much traffic growth as forecast and the change in speeds was mixed, with some vehicle types moving to less fuel efficient speeds at in some time periods. Vehicle operating costs refer to the fuel and other costs borne by the user (such as the wear and tear on vehicles). This generally increases with increased distance travelled. There was a small benefit forecast. Based on the changes we have seen in our estimate of fuel consumption and indirect tax revenue, we estimate the outturn impact to be a marginal disbenefit of -£0.1million.

Impacts assumed as forecast

The evaluation has not been able to reforecast the monetary value of journey time reliability⁶⁹, noise and carbon benefits⁷⁰, and instead these were reported as forecast. For noise and carbon impacts, this assumption is conservative because lower than forecast traffic flows are likely to mean that these impacts are better than forecast⁷¹. However, for journey time reliability this assumption is generous because the impact on reliability is mixed, with clear benefits only being seen in the AM peaks⁷².

Journey times and vehicle operating costs during future construction and maintenance have been assumed as forecast. As the vast majority of this maintenance is still in the future, the evaluation uses the impacts forecast within the business case.

User charges (which are benefits to drivers who were forecast to switch from the M6 toll to the improved route) and operating costs (which is the loss in income attributable to the reduction in users on the M6 toll) have also been assumed as forecast. There are no new observations relating to these, so the forecasts used in the appraisal remains the best estimate.

Overall value for money

The main reason for the overall reduced level of benefits from this project is the lack of journey time savings. The appraisal forecast a significant traffic growth and improving journey times; the observed data suggested a much more modest traffic growth accompanied by slower journey times and this has affected the project's value for money.

⁶⁸ Refer to Transport Analysis Guidance (TAG) unit A1.3

⁶⁹ It has not been possible to re-forecast the monetised reliability impact for this project because our evaluation method reuses the INCA files used in the appraisal and these were not able to be located for this project.

⁷⁰ We do not have a method for reforecasting the monetised impact of noise or carbon impacts. These generally have a small contribution to the monetised benefits of schemes and therefore the impact of assuming as forecast is unlikely to impact on the value for money rating of the project.

⁷¹ Refer to section 6 for further detail on noise and greenhouse gas impacts.

⁷² Refer to section 4 for further detail on reliability

When considering an investment's value for money we also take into account benefits which we are not able to monetise. For this project landscape, journey quality and wider economic benefits might be relevant considerations:

- Landscape⁷³ was forecast to be neutral and our evaluation concludes it is likely to be 'worse than expected' as not all the anticipated planting is present.
- Journey quality⁷⁴ was appraised to be large beneficial, but our evaluation found that the benefits hadn't fully materialised.
- Although not included in the appraisal, wider economic benefits might be relevant given the scheme's proximity to a functional urban area, but these are usually dependent on delivering journey time savings. As the journey time savings have not been realised, there are unlikely to be additional benefits in this area.

With few non-monetised benefits to take into consideration, it is likely that this project has offered 'very poor' value for money.

Based on the evidence from the first five years, this project is not on track to realise the anticipated value for money. However, there have been benefits delivered - construction of the project was delivered slightly under budget, it is delivering safety benefits to road users and many of the environmental benefits are as expected, or better.

⁷³ Refer to section 6 for further detail on landscape.

⁷⁴ Refer to section 6 for further detail on journey quality.

Appendix A

Safety counterfactual methodology

Personal injury collisions (hereafter referred to as collisions) on the strategic road network are 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.

To establish whether any change in collision numbers is due to the scheme or part of wider regional trends we have established a test we call the 'counterfactual'. The Counterfactual answers the question: What would have likely occurred without the scheme being implemented? To answer this question, we estimate the range of collisions that could have occurred without the scheme in place. Previous Post Opening Project Evaluations answered this question by looking at national trends in collisions. Adjustments have been made to the methodology for estimating the Counterfactual. These have been made to address the following areas:

Amended Data Collection Method

- Revised method for identifying collisions that occurred on the network.
- Only validated STATS19 information is used for reporting purposes.

Adjusting for Traffic Flows

- Baseline traffic flows are an important factor when determining the counterfactual. We now assume that without the changes made to the network, the trends would follow regional background traffic growth patterns.
- We can now calculate the collision rate for the busiest stretches of conventional motorways.

Better Differentiation between different types of motorway

- The existing methodology only had one definition of motorway.
- The new method allows us to differentiate between conventional motorways, conventional motorways with high traffic flows and smart motorways.

Assessing Regional Trends

- The new method uses regional rather than national trends for collision rates and background traffic growth, which provides greater granularity and makes the hypotheses more realistic.

We have found that the adjustments have resulted in a slight change from the previous methodology. We still have confidence in the accuracy of the previous methodology but believe we have made suitable changes that will ensure a methodology fit for purpose for the future.

Since this scheme, smart motorways have evolved. More recent all lane running schemes have demonstrated that they are making journeys more reliable for those travelling during congested periods, enabling us to operate the road at a higher speed limit for longer periods, whilst maintaining safety.

Appendix B

Incident reporting mechanisms

Since 2012, many police forces have changed the way they collect STATS19 data (for more information see [here](#)). These changes mean casualty severity is now categorised automatically based on the most severe injury, rather than the judgement of an attending police officer.

Police forces using the new systems, called injury-based severity reporting systems, (also known as CRaSH and COPA) report more seriously injured casualties than those which don't. These changes make it particularly difficult to monitor trends in the number of killed and seriously injured casualties over time, or between different police forces. In response to these challenges, DfT and the Office for National Statistics (ONS) have developed an approach to adjust the data collected from those police forces not currently using injury-based reporting systems.

These adjustments are estimates for how casualty severity may have been recorded had the new injury-based reporting system been used. These adjusted estimates apply retrospectively from 2004 and adjust historical data to show casualty severity 'as if' this was recorded under the new injury-based system. Until all police forces have started using the new systems, these historical adjustments will continue to be updated every year. Using these adjusted totals allows for more consistent and comparable reporting when tracking casualty severity over time, across a region, or nationally. While there is no impact on total casualties or collisions, and no impact on total fatalities, these adjustments do impact serious and slight casualties and collisions.

Appendix C

Unadjusted collision severity

The project extent is covered by West Midlands police constabulary who transferred from Stats19 to CRASH in November 2015.

Table 11 shows the unadjusted collision severities on the project extent:

Table 11 - Unadjusted collisions by severity for project extent

Observation Year	Fatal	Serious	Slight
5Yr Before		9	79
4Yr Before	1	7	56
3Yr Before	1	1	45
2Yr Before	1	4	48
1Yr Before		5	46
1Yr Construct		2	43
2Yr Construct		1	49
3Yr Construct		1	24
1Yr After		3	56
2Yr After	1	4	45
3Yr After		5	35
4Yr After	1	5	41
5Yr After	1	4	44

Source: STATS19: 1st January 2007 to 30th April 2019

The wider safety area of the M6 J5-8 project is covered by three police constabularies who transferred from Stats19 to CRASH. West Midlands and Warwickshire constabularies transferred in November 2015. Staffordshire transferred in May 2015

Table 12 shows the unadjusted collision severities on the wider safety area:

Table 12 - Unadjusted collisions by severity for wider area

Year_Type	Fatal	Serious	Slight
5Yr Before	0	24	190
4Yr Before	3	11	176
3Yr Before	5	17	133
2Yr Before	1	17	192
1Yr Before	2	9	129
Construct Yr1	1	13	120
Construct Yr2	3	12	179
Construct Yr3	1	0	48
1Yr After	3	7	185
2Yr After	2	12	153
3Yr After	1	18	118
4Yr After	2	8	81
5Yr After	3	9	112

Source: STATS19: 1st January 2007 to 30th April 2019

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Registered office Bridge House, 1 Walnut Tree Close, Guildford GU1 4LZ

National Highways Limited registered in England and Wales number 09346363