national highways

M6 junctions 10a to 13 controlled motorway and all lane running

Five-year post-opening project evaluation

The methodology used to generate the data in this document should only be considered in the context of this publication. This methodology, and its subsequent outputs may differ from methodologies used in different analyses at different points in time. This is due to continuous improvements of data mapping, capture, and quality. As these factors evolve over time any comparison with earlier data or data from other sources, should be interpreted with caution.

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 POPE[1] 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 10a to 13 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 10a to 13 project which opened in 2016, 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 sections would have been unable to cater for today's traffic (at the busiest times) if they had not been converted into smart motorways.

[1] Post Opening Project Evaluation (POPE)

According the 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 original 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 2024

Table of contents

1. Executive summary

The M6 junctions 10a to 13 smart motorway was a major project to improve ten miles of the M6 by providing additional capacity through the implementation of traffic management methods to increase capacity and reduce congestion.

Before construction, congestion and unreliable journey times were being experienced at busy periods and traffic was predicted to continue to grow over time. Additionally, this section of the M6 carries high volumes of heavy goods vehicles (HGVs), affecting the overall smooth operation of the network.

The project opened in February 2016 and forms part of a wider strategy to relieve congestion on the highway network in and around the West Midlands. The project consists of two main elements; controlled motorway[2] between junctions 10a and 11a and all lane running[3] between junctions 11a and 13.

The project aimed to deliver improved quality of information to road users, support local development plans, reduce congestion, improve journey time reliability, improve road safety and minimise environmental impacts.

During the first four years since opening, there has been a reduction in the number of personal injury collisions from an average of 41 per year over the five years prior to construction to an average of 20 per year in the four years after the project was operational. Statistical testing indicates that the reduction in collision rates compared to the counterfactual is significant and could be attributed to the all-lane running section.

Since the conversion, there has been less growth in traffic volumes than forecast. This impact is in line with national and regional trends.

Five years after opening, average journey times are reduced for the southbound morning and evening peaks. Average journey times are longer for all time periods for the northbound carriageway. There is a mixture of increases and decreases in journey time reliability. In the northbound direction, journey time reliability is either similar or worse than the situation before. In the southbound direction, the reliability of journey times has improved in the majority of time periods.

When comparing the observed and forecast traffic, the analysis shows that noise levels were as expected, and there would be no change in air quality. However, the project may have led to a smaller increase in carbon emissions than was predicted.

Value for money was forecasted over a range of possible traffic growth scenarios[4]. These scenarios forecast value for money[5] to range from 'medium' to 'very high'. The appraisal forecast significant traffic growth and improving journey times; the observed data suggested a more modest traffic growth accompanied by slower

[2] Controlled motorways apply technology to a conventional motorway to control the speed of traffic retaining a permanent hard shoulder. Overhead electronic signs display messages to drivers, such as warning of an incident ahead.

[3] All lane running (ALR) motorways apply technology to control speeds, and permanently convert the hard shoulder to a running lane. Emergency areas are available at regular intervals providing places to stop in an emergency.

[4] See section 7 – *Forecast value for money.*

[5] The high and low growth scenarios considered in the project appraisal did not contain monetised benefits for journey time reliability. For the purposes of calculating the high and low growth value for money range, we have applied the same proportion that the reliability benefits represent in relation to the journey time benefits in the core scenario to the other two cases.

journey times in most time periods. This has impacted the project’s value for money which we have re-forecast to be ’medium’. As traffic growth is expected to return to what was forecast when this project was appraised, it is likely that this investment is on track to deliver the value for money anticipated over the 60-year life of the project, however this is at the lower end of the expected range of benefits. If the journey time and traffic growth trends observed within the first five years continue, the project is expected to deliver lower than expected ‘medium’ value for money.

2. Introduction

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

The M6 junctions 10a to 13 smart motorway covers a ten-mile stretch of the M6, near Wolverhampton and Cannock. The project opened in February 2016.

Pre-construction, this section of the M6 experienced poor journey time reliability caused by flow breakdown and congestion. Additionally, this stretch of the M6 is heavily used by heavy goods vehicles (HGVs), which have a greater impact on the smooth operation of the network.

The project aimed to deliver improved quality of information to road users, support local development plans, reduce congestion, improve journey time reliability, improve road safety and minimise environmental impacts.

The key features of the project were:

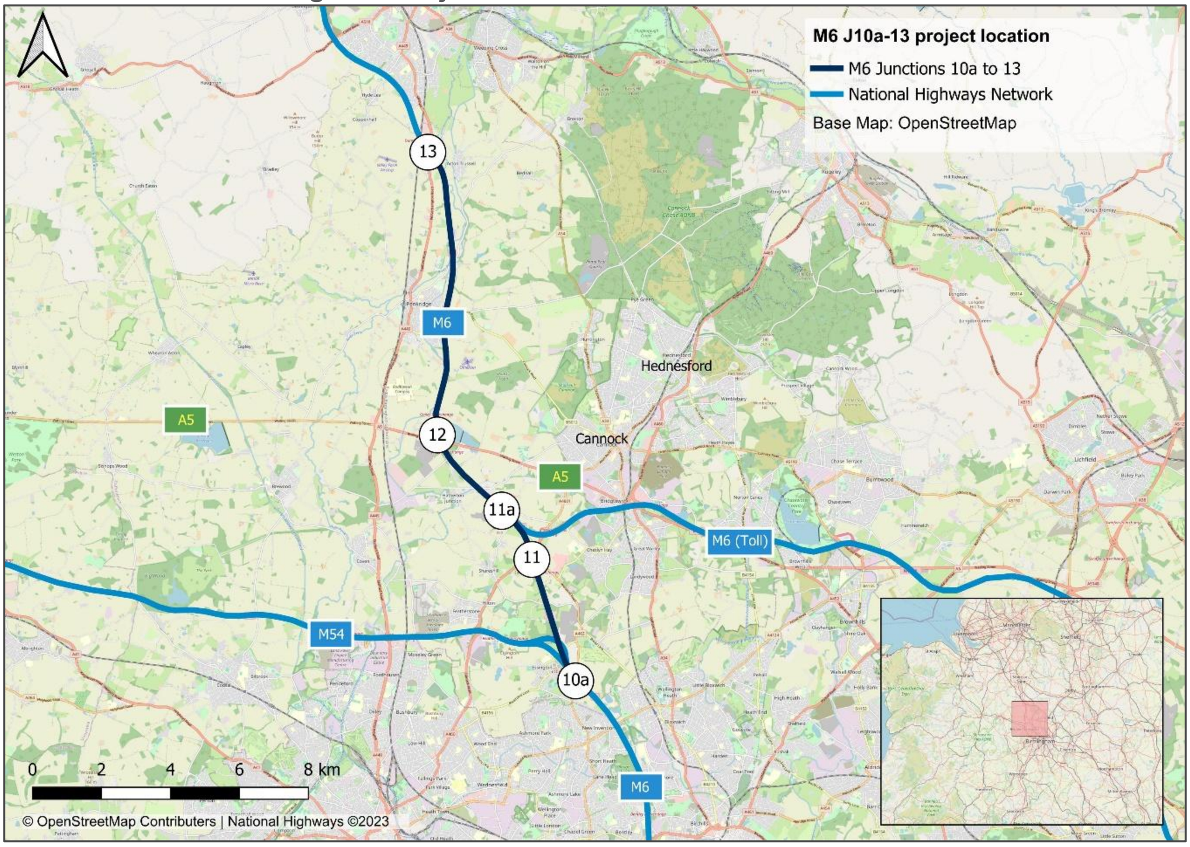
- M6 junctions 10a to 11a: introduction of controlled motorway technology; the hard shoulder was not converted into a running lane, leaving three lanes for traffic in each direction.
- M6 junctions 11a to 13: smart motorway all lane running, with the hard shoulder converted into a permanent running lane leaving four lanes for traffic in each direction and Variable Mandatory Speed Limits (VMSL) implemented to help manage traffic volumes.

Project location

The M6 junctions 10a to 13 is a smart motorway project located within the West Midlands, approximately 12.5 miles north of Birmingham. The M6 is a north-south orientated, strategically important motorway which spans from Coventry and Birmingham in the Midlands to the English-Scottish border, connecting many towns and cities in North West England, including Stoke-on-Trent, Manchester, Liverpool, Preston, Penrith and Carlisle.

There are five junctions across the project and the route section is approximately 16.5km (10.3 miles). The location of the project is shown in **Figure 1**.

Figure 1 M6 junctions 10a to 13 scheme 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 (POPE) compares changes in key impact areas[6] 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 POPE methodology manual (January 2022) on the National Highways website.[7]

[6] Key impact areas include safety, journey reliability and environmental impacts.
[7] https://nationalhighways.co.uk/media/exypgk11/pope-methodology-note-jan-2022.pdf

3. Delivering against objectives

How has the project performed against objectives?

All our major projects have specific objectives which are defined early in the business case when project options are being identified. The project had four key objectives, which were optimising the utilisation of existing road space, enhancing motorway capacity to alleviate congestion, ensuring smoother traffic flows for more reliable journey times, and increasing the quality of information available to road users.

These objectives are appraised to be realised over 60 years. The evaluation provides an early indication if the project is on track to deliver the benefits.

Table 1 summarises the project's performance against the objectives from the standard smart motorways programmatic Benefits Realisation & Evaluation Plan (BREP), mapped against the scheme specific objectives, using evidence gathered for this study.

Table 1 - Objectives and Evaluation summary

Smart motorway RIS2[8] Objectives	Objectives[9]	Five-year evaluation
Providing Fast and Reliable Journeys We want to help people and businesses have safe, reliable and efficient journeys with decreased journey times and increased journey time reliability on the M6 between Junctions 10a to 13.	Improve journey time reliability	There is a mixture of increases and decreases in journey time reliability. In the northbound direction, journey time reliability is either similar to or worse than the situation before. In the southbound direction, the reliability of journey times has improved in the majority of time periods. Traffic volumes on the routes have decreased since the project's opening. Nevertheless, we cannot be certain that this reduction is solely attributable to the project and not partially influenced by COVID-related factors.
	To reduce congestion	Five years after opening, the congestion has worsened during the morning and evening peaks in the northbound direction and inter-peak in the southbound direction. The congestion has reduced in the morning peak in the southbound direction. There is a mixture of increases and decreases in average speeds.

[8] During the first Road Investment Strategy (RIS) from 2015 to 2020, and subsequent RIS2 (2020-2025), universal objectives were created to ensure consistency across the smart motorway programme.
[9] The objectives as part of the original business case when the investment decision was made for the project.

Smart motorway RIS2[8] Objectives	Objectives[9]	Five-year evaluation
Improving Safety for All We need to keep our customers, people and suppliers safe, above all else. At a minimum, there will be no increase in the average number of Fatal and Weighted Injuries (FWI) per year or an increase in FWI per hundred million vehicle miles per year compared to baseline.	To improve road safety on the strategic road network	There has been a reduction in the number of personal injury collisions from an average of 41 per year over the five years prior to construction to an average of 20 per year in the four years after the project was operational. Statistical testing indicates that the reduction in collision rates compared to the counterfactual is significant and could be attributed to the all-lane running section.
Delivering Better Environmental Outcomes We want our roads to work more harmoniously with the communities that live alongside them, and the environment that surrounds them. This includes decreasing or maintaining noise and air quality levels.	To minimise the environmental impact, enhancing the environment where appropriate	When comparing the observed and forecast traffic, we found that noise levels were as expected, and there would be no change in air quality. However, the project may have led to a smaller increase in carbon emissions than was predicted.
	Improve currency and quality of information provided to road users	Variable Messaging Signs (VMS) on gantries above the M6 provide improved driver information.

4. Customer journeys

For this five-year after study, we have had to consider the effects of the COVID-19 pandemic and national lockdowns on traffic volumes. Our baseline for traffic analysis is 2012 (pre-construction). In our five-year post-opening study, we utilized data from 2022 to exclude the period affected by lockdown restrictions.

Our analysis has shown that the average weekly traffic volumes have been reduced five years after opening. However, we cannot assert with confidence that this outcome solely stems from the project and not partly from the associated impacts of COVID-19.

One of the project's objectives was to reduce congestion, five years after opening congestion has improved southbound in the morning peak, however worsened during the morning and evening peaks in the northbound direction and inter-peak in the southbound direction.

A further objective of the project was to improve journey time reliability. Five years after opening, in the southbound direction the reliability of journey times has improved in the majority of time periods. However, northbound direction, journey time reliability is either similar to or worse than the situation before

The analysis of morning peak average speeds revealed that, five years after opening, northbound speeds are consistently lower than the before situation. Meanwhile, in the southbound direction, speeds between junctions 13 and 11a remain comparable before and five years after opening. Notably, a sharp reduction in average speeds occurred between junctions 11a and 10a both before and five years after, though the reduction was less pronounced in the latter case.

How have traffic levels changed?

Prior to a pause on implementation in January 2022, smart motorways were built on stretches of the strategic road network that experience high levels of congestion and/or are expected to see traffic levels increase significantly in future years. The following sections examine how traffic levels changed between the before (March 2012), one year (March 2017) and five year after periods. Initially, 2021 data was used for the five year after analysis, however, analysis of the traffic flows on the M6 highlighted concerns about the accuracy of the data, so a data collection exercise was undertaken in Autumn 2022 for the project extent.

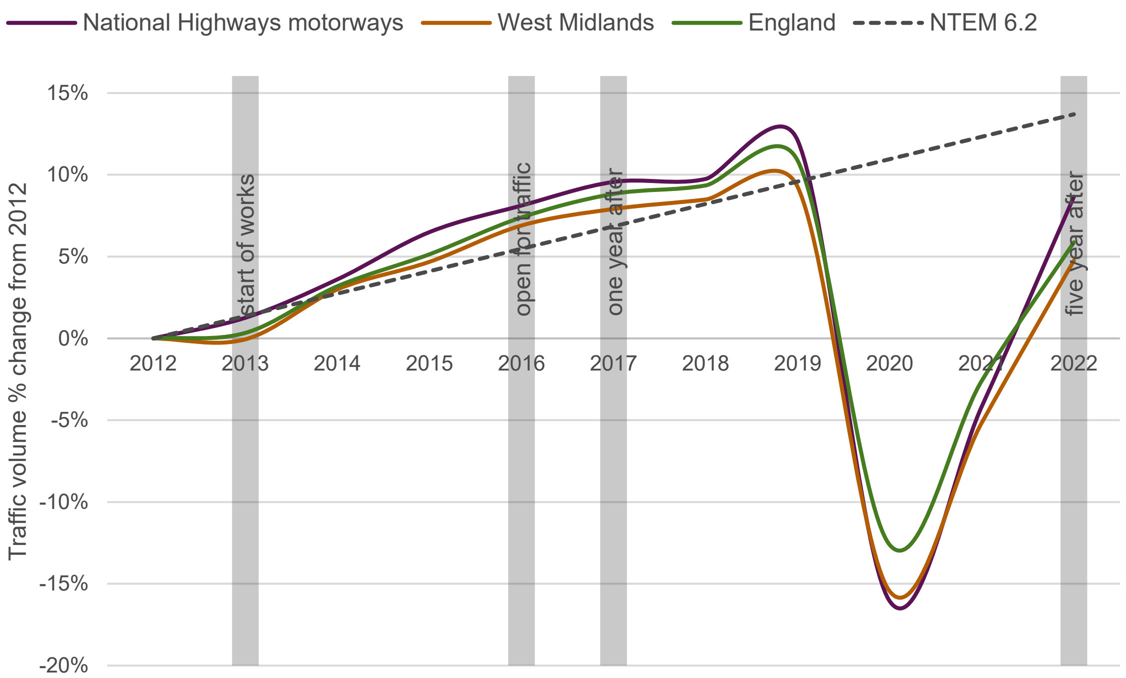
National and regional

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. To do this, we use the Department for Transport (DfT) annual statistics, the data is reported by local authority and road type, recording the total number of million vehicle kilometres travelled. This data is used as a baseline, and we attribute any growth observed on roads in the project area which is above national and regional trends to the project.

Figure 2 shows that traffic volumes increased at a regional and national level between 2012 and 2019 and that all background traffic growth was roughly in line with forecast expectations during this period, based on the National Trip End Model (NTEM) version 6.2. Key findings include:

- Observed traffic volumes were slightly lower than predicted between 2012 and 2013 and were approximately the same as those predicted in 2014. Following this, observed traffic volumes increased at a slightly faster pace than NTEM predicted between 2015 and 2019.
- Between 2012 and 2019, the West Midlands experienced the lowest growth in traffic volumes at 9.2%, which was similar to the NTEM expected growth. The West Midlands experienced lower growth than the average for England, which saw growth of 10.9% over the same period. Growth in motorway traffic was recorded at 12.1% between 2012 and 2019.
- All background traffic levels decreased dramatically in 2020, at the start of the COVID-19 pandemic reflecting associated travel restrictions that commenced in March 2020. The results clearly illustrate the immediate sharp impact that the COVID-19 pandemic had on background traffic volumes, which would not have been considered as part of the appraisal process. Traffic flows have since increased from 2020, but had still not returned to pre-pandemic levels in 2022.

Figure 2 Changes in National and Regional Background Levels of Traffic, between 2012 and 2022



Source: DfT Traffic Statistics Table TRA8901.

How did traffic volumes change?

Since the opening of the smart motorway, there have been some variability in traffic flow at different locations across the project extent and the surrounding road network.

To analyse how the traffic volumes have changed on the project extent, the following data has been used:

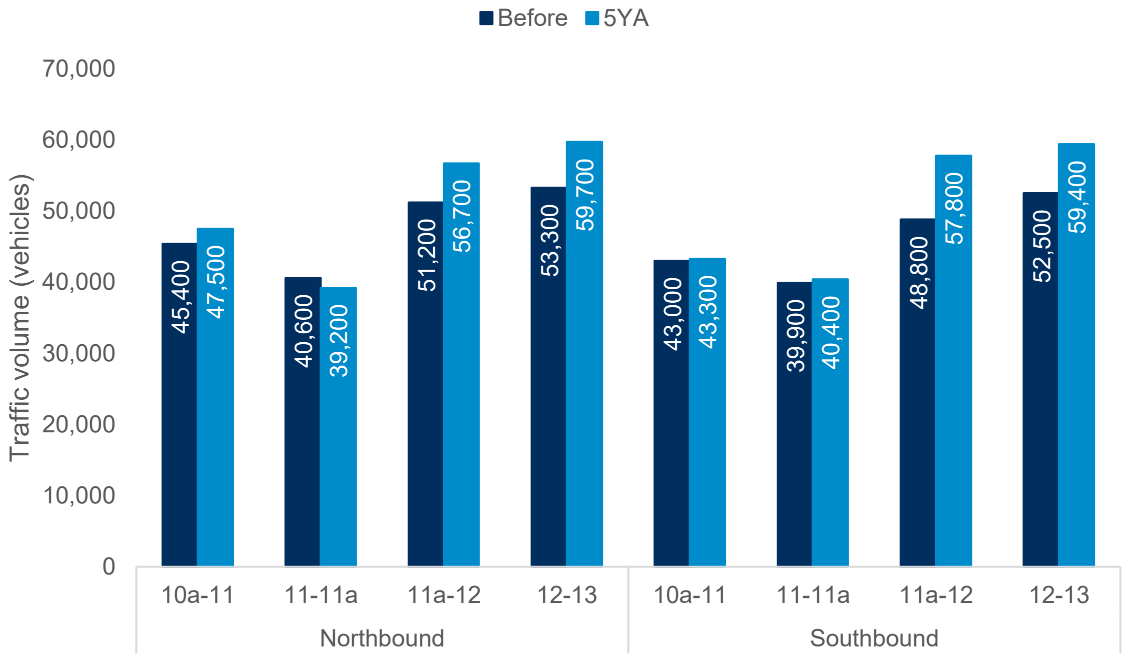
- Before (2012): 24-hour Annual Average Daily Traffic (AADT) data has been used from the Traffic Forecasting Report (March 2013); and

- Five Year After (2022): 24-hour Average Daily Traffic (ADT) data has been analysed using data from a two-week survey carried out in October 2022.

Before data was taken from the Traffic Forecasting Report and the one year after (2017) results have not been considered in the analysis.

The average traffic flows are shown in **Figure 3**. The five year after data shows that the increase in traffic flows ranged from 11% to 18% between junctions 11a and 13 in both directions. The flow changes on the junctions 10a and 11a section are much less marked than the junctions 10a and 12 section.

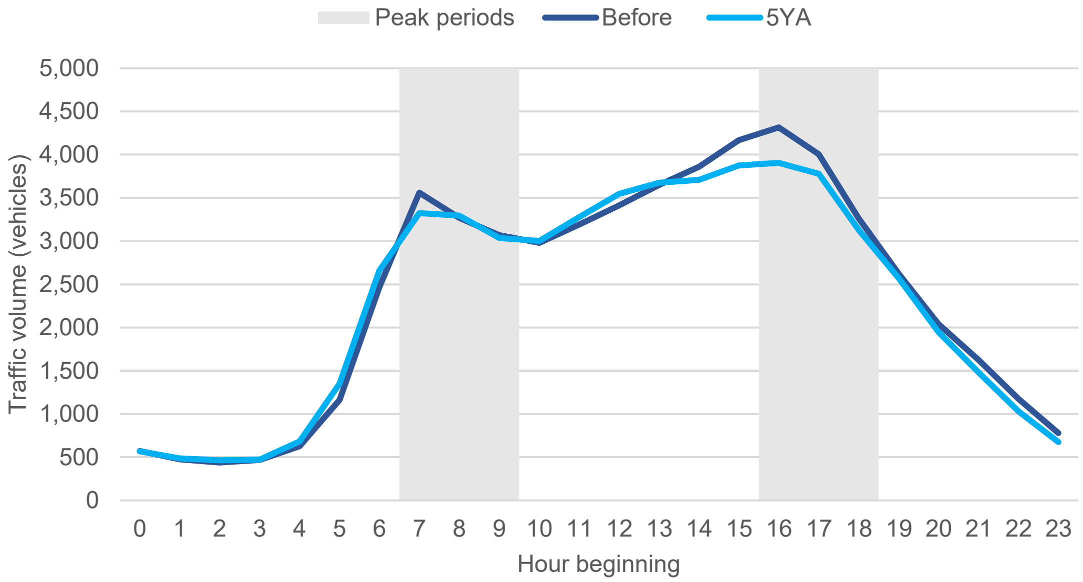
Figure 3 Average Traffic Volume – 24-hour AADT



Source: Traffic Forecasting Report (March 2013) and Survey Data, Before: 2012, 5YA: 2022.

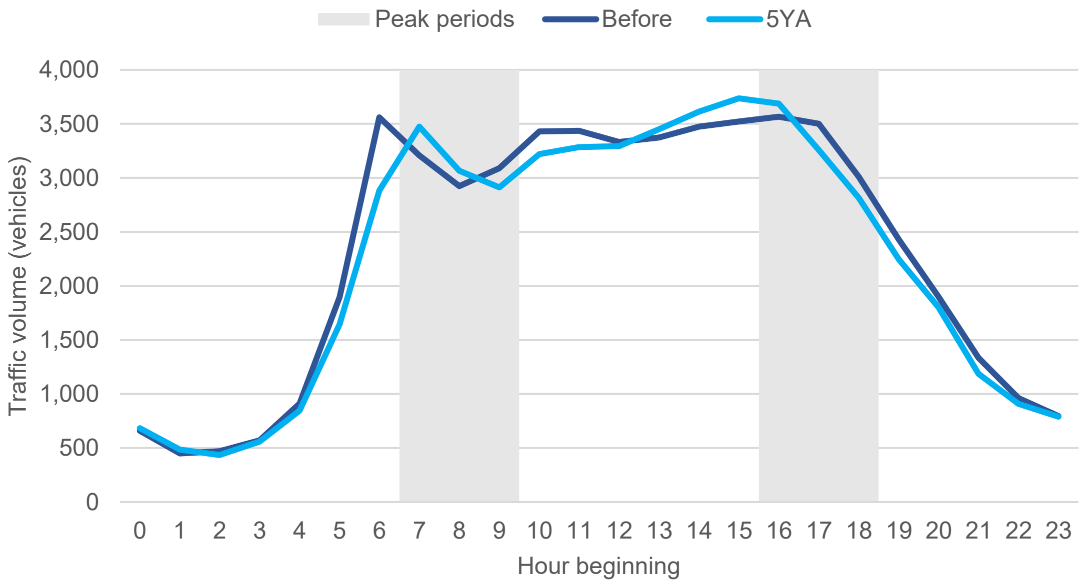
Figure 4 and **Figure 5** show the hourly weekday flow profiles for the project extent, overlayed against typical peak periods. It shows fairly high volumes throughout the core part of the day in both directions, with a fairly flat profile, particularly southbound.

Figure 4 Hourly weekday flow profile (northbound) - distance weighted AWT (J10a-13)



Source: National Highways (WebTRIS), Traffic Forecasting Report (March 2013) and Survey Data. Before: 2012, 5YA: 2022.

Figure 5 Hourly weekday flow profile (southbound) - distance weighted AWT (J10a-13)



Source: National Highways (WebTRIS), Traffic Forecasting Report (March 2013) and Survey Data. Before: 2012, 5YA: 2022.

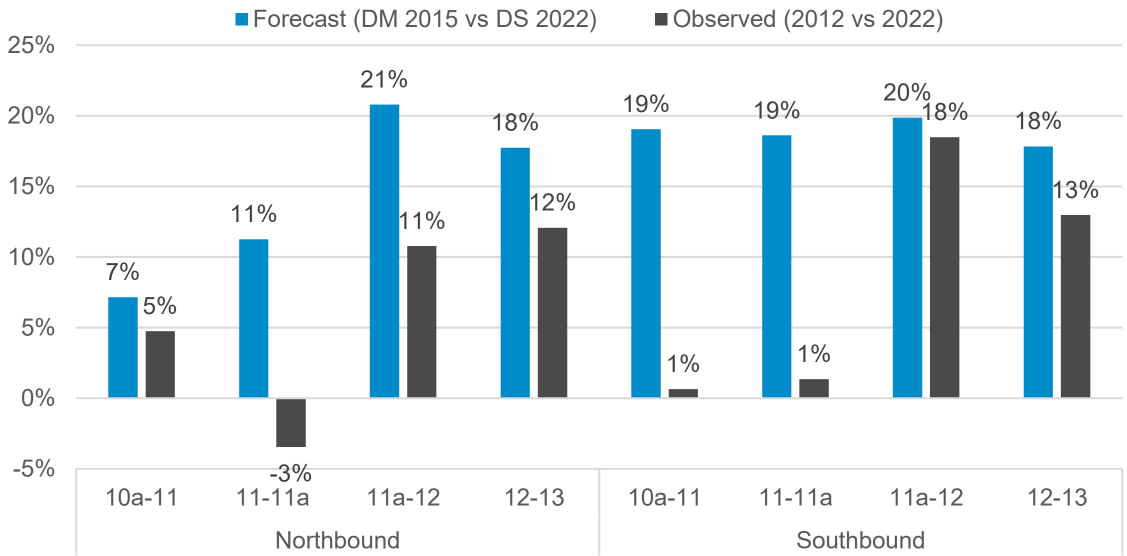
At five years after, the curves illustrate the PM peak being earlier in the southbound direction as the PM peak has shifted to between 14:00 to 16:00. In the northbound direction, the daily flow profile for both before and five year after periods are quite similar, except between 14:00 to 18:00, where the five year after flows have reduced.

In the southbound direction, the five year after opening peak periods were 07:00 to 08:00 and 15:00 to 17:00. The southbound curve shows that the five year after opening traffic volume is greater than the before between 13:00 and 17:00. Overall, there is a reduction in flows in the southbound direction five years after opening.

Was traffic growth as expected?

Figure 6 shows the comparison between the forecast AADT flows for the Do-Minimum (without project (DM)) 2015[10] and Do-Something (with project (DS)) 2022 and observed 2012 (before) and observed 2022 (five years after). Forecast 2022 flows have been interpolated using the AADT forecasts for 2021 and 2031.

Figure 6 Forecast (DM 2015 vs DS 2022) vs Observed (2012 vs 2022) Traffic Flows (% Difference)



Source: Traffic Forecasting Report (March 2013).

Traffic forecasts in the southbound assumed that there would be an 18 to 20% increase in traffic flows between 2015 and 2022. There was a similar level of growth anticipated northbound between junctions 11a and 12 and junctions 12 and 13. However, there was notably lower predicted increase between junctions 10a and 11 (7%) and junctions 11 and 11a (11%).

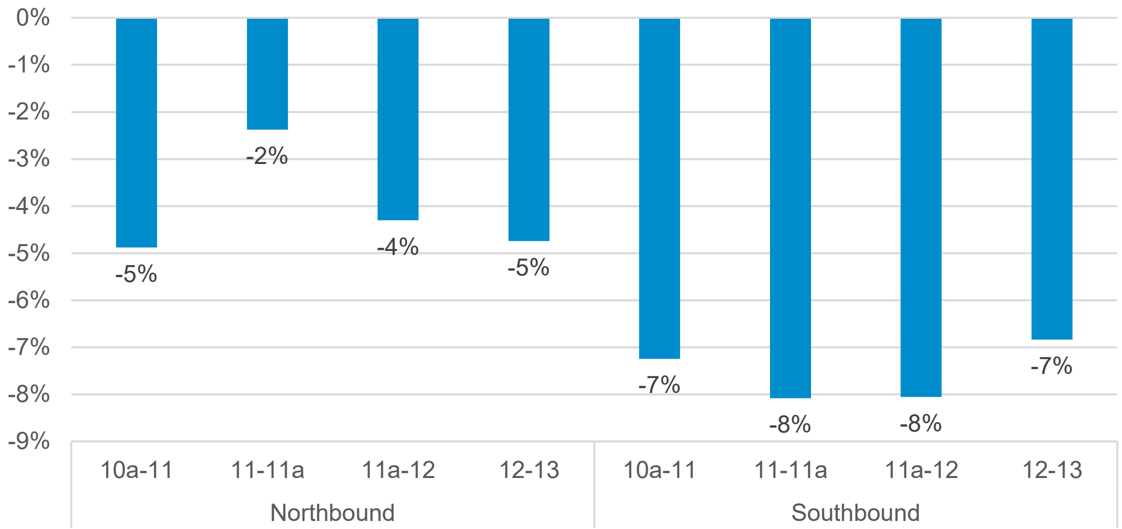
Five years after opening, traffic flows between junctions 11 and 11a northbound experienced a 3% reduction. During the same period, northbound traffic increased by between 5% and 12% between other junctions, while southbound traffic saw an increase of between 1% and 18%.

As illustrated in **Figure 6** the forecasted change in traffic flows was notably greater than the actual growth observed.

Figure 7 shows the comparison between the observed 2012 (before) and the forecast AADT flows for the Do-Minimum (without project) 2015 traffic flows.

[10] The Traffic Forecasting Report assumed that the scheme would have been completed in full before the first modelled year of 2015.

Figure 7 before 2012 (Observed Before Flows) vs Forecast DM 2015

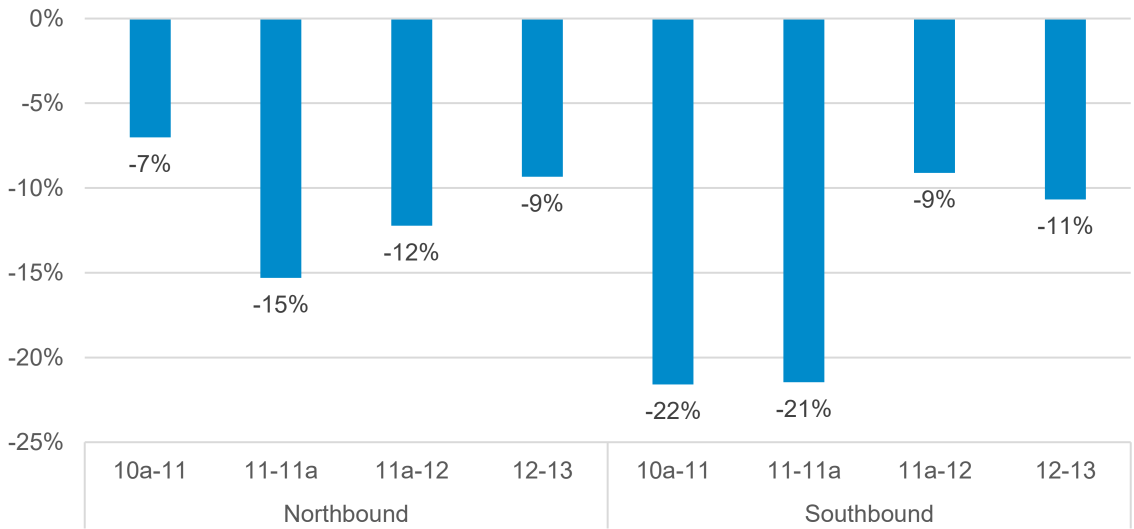


Source: Traffic Forecasting Report (March 2013)

The observed flows are less than the without project 2015 flows in both directions. The difference ranged from -2% to -5% in the northbound direction and -7% to -8% in the southbound direction.

Figure 8 shows the comparison between the interpolated Do-Something (with project) forecast 2022 and observed 2022 traffic flows, noting the observed 2022 flows are 24-hour ADT data, while the forecast is AADT.

Figure 8 Observed 2022 Traffic Flows vs Forecast DS 2022 (% Difference)



Source: Traffic Forecasting Report (March 2013) and Survey Data.

Overall, the observed flows are much lower than the forecast flows for 2022. This ranges from -7% to -15% in the northbound direction and -9% to -22% in the southbound direction.

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. Often these routes are where we anticipate congestion will increase in the future and our actions seek to limit this.

Analysis of journey times and speeds can 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.

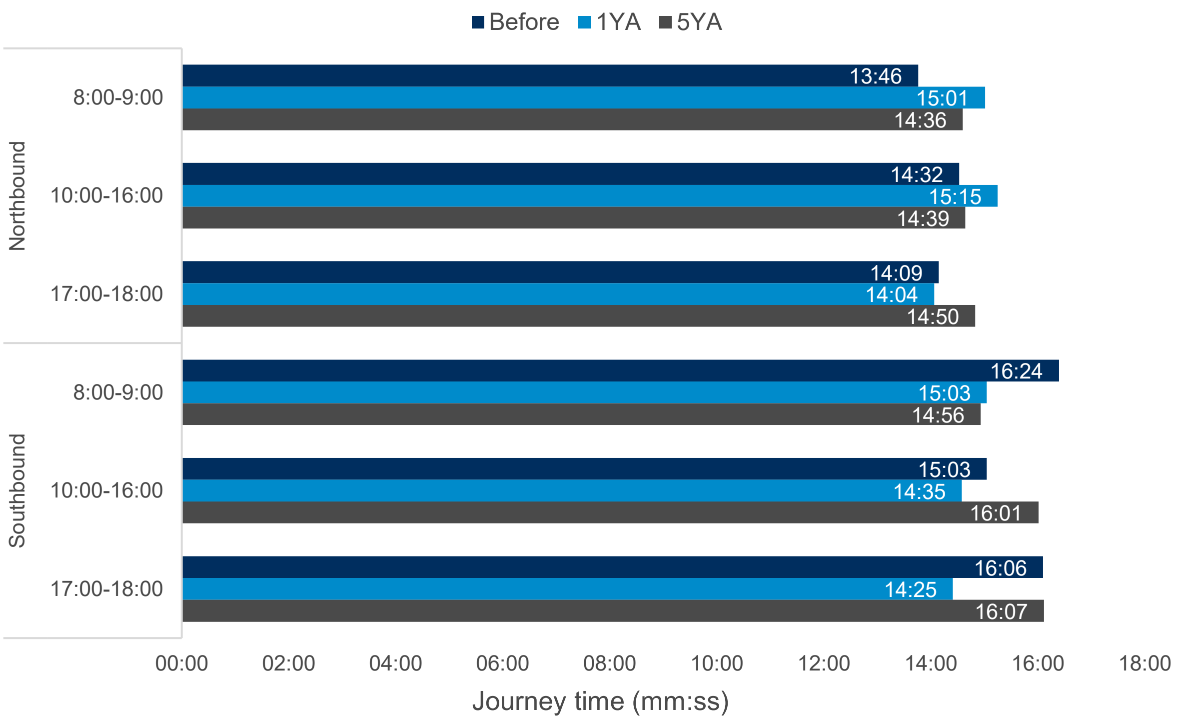
Did the project deliver journey time savings?

Reducing congestion was an objective of this project and at five years after opening, results show that journey times have increased in the morning and evening peaks in the northbound direction and inter-peak in the southbound direction. However, the journey times have improved in the morning peak in the southbound direction.

TomTom data has been used to present the average journey times for the morning peak, inter-peak, and evening peak periods in both directions. A comparison of the average journey times before (March 2012), one year after (March 2017), and five years after (October 2022) is shown in **Figure 9**.

Figure 9 shows the average journey times for each of the time periods, in both directions, between M6 junctions 10a and 14. While M6 junction 13 to 14 is not part of the project extent, it has been included to provide consistency with the one year after report, alongside demonstrating the impact of the traffic management between M6 junctions 13 to 15.

Figure 9 M6 junctions 10a – 14 average journey times in the northbound and southbound directions

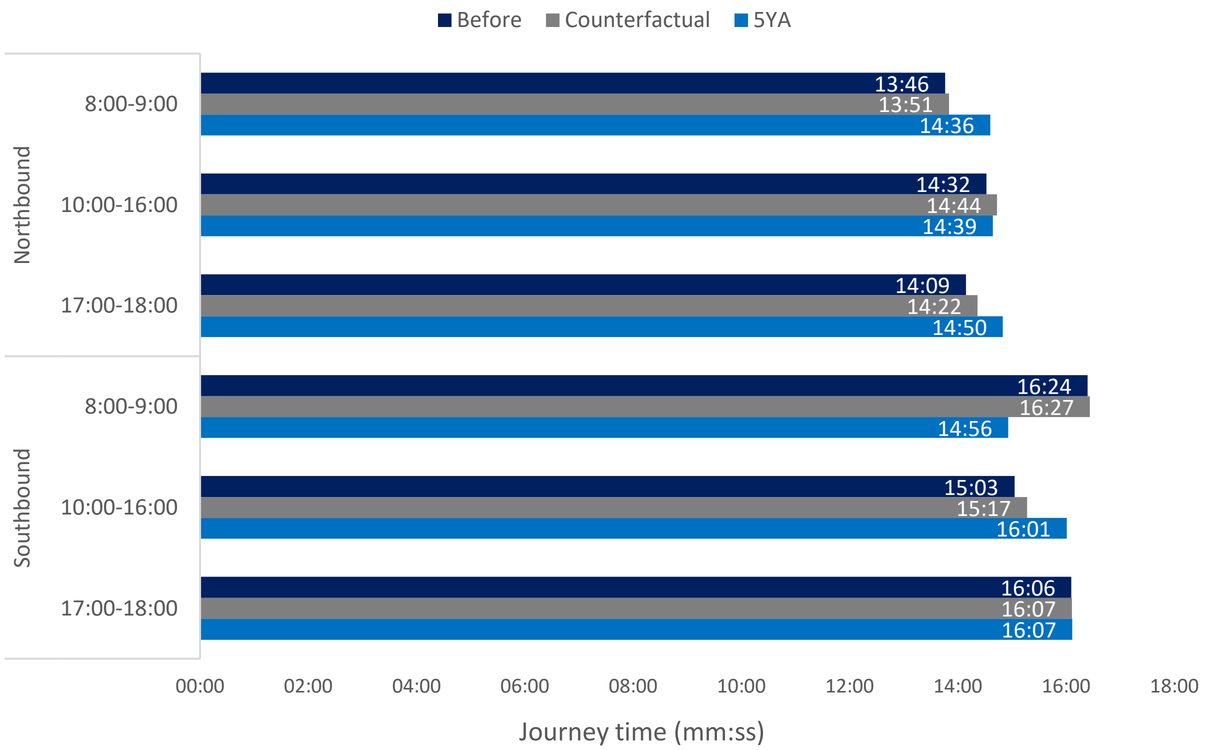


Source: Satellite Navigation (TomTom).

- Five years after opening, average journey times for all three time periods are slightly longer than the before construction journey times, in both directions, except for the southbound morning and evening peaks.
- In the morning peak, the northbound five year after average journey times were one minute longer than the before journey times. However, this was an improvement compared to the one year after journey times. In the inter-peak, the northbound average journey time five years after opening was very similar to before construction. Five years after opening, the northbound average journey time increased by 41 seconds in the evening peak.
- In the southbound direction, the five year after data shows the average journey time decreased by 1 minute and 28 seconds in the morning peak compared to the before data. However, the average journey time during the inter-peak was 58 seconds longer than the before period. While the one year after opening showed a decrease in journey times in the evening peak (1 minute and 41 seconds), the five years after average journey time was similar to the before average journey times.

Figure 10 shows the comparison between the average journey times for before, five years after, and counterfactual. The counterfactual journey times represent an estimation of the journey times assuming the project had not been implemented. Comparing the counterfactual data to the five years after data shows that the actual average journey times are longer five years after opening in all time periods, in both directions, except for the northbound inter-peak and southbound morning peak.

Figure 10 Average journey time comparison between before, counterfactual and five years after

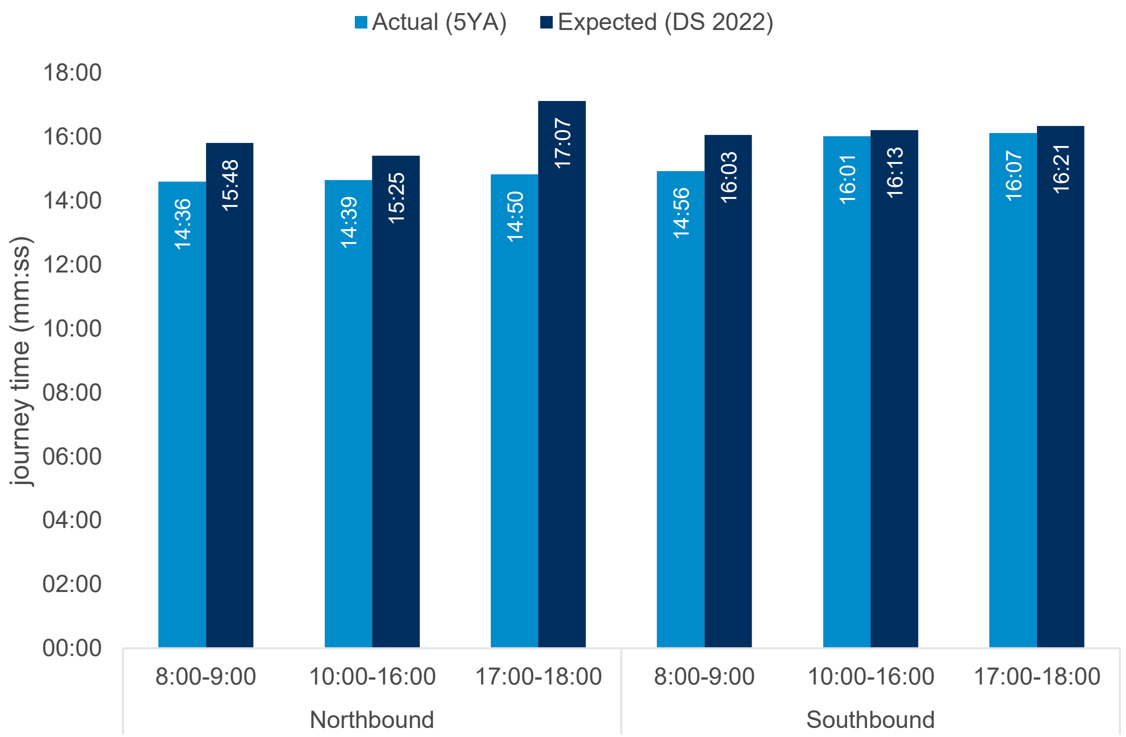


Source: Satellite Navigation (TomTom).

Were journey time savings in line with forecast?

The comparison between the actual (five year after) and expected (forecast with project, 2022) journey times is shown in **Figure 11**. The forecast 2022 DS was interpolated using the forecast 2021 DS and forecast 2031 DS data which was taken from the Traffic Forecasting Report (March 2013). Overall, the journey times in all time periods and both directions were lower in the five year after period compared to the expected (forecast 2022 with project) journey times.

Figure 11 Actual vs expected journey times

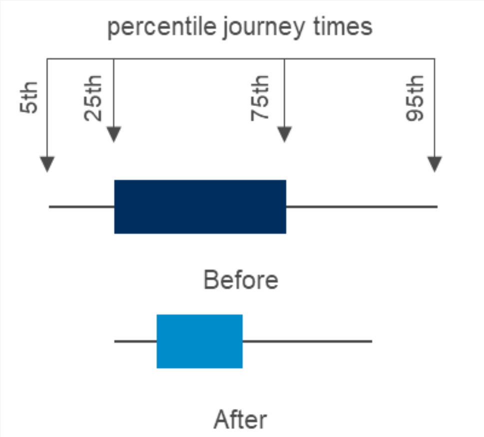


Source: Satellite Navigation (TomTom) and Traffic Forecasting Report (March 2013).

Did the project make journeys more reliable?

Congestion can make journey times unreliable. If the time taken to travel the same journey each day varies, journey times are unreliable, and the road user is less confident in planning how long their journey will take them. If journey times do not vary, the road user can be more confident in the time their journey will take and allow a smaller window of time to make that journey.

Figure 12 What does a box plot show?



The lowest point is the 5th percentile, this means 5% of journeys take less than this amount of time to complete. The highest point is the 95th percentile, this means 95% of journeys take less time than this to complete. This shows the difference between the longest and the shortest journey times observed.

The length of the box shows how the journey times vary between the 25th and 75th percentile (the journey time 25% and 75% of journeys are faster than). The narrower the box the less variable, and hence more reliable, the journey.

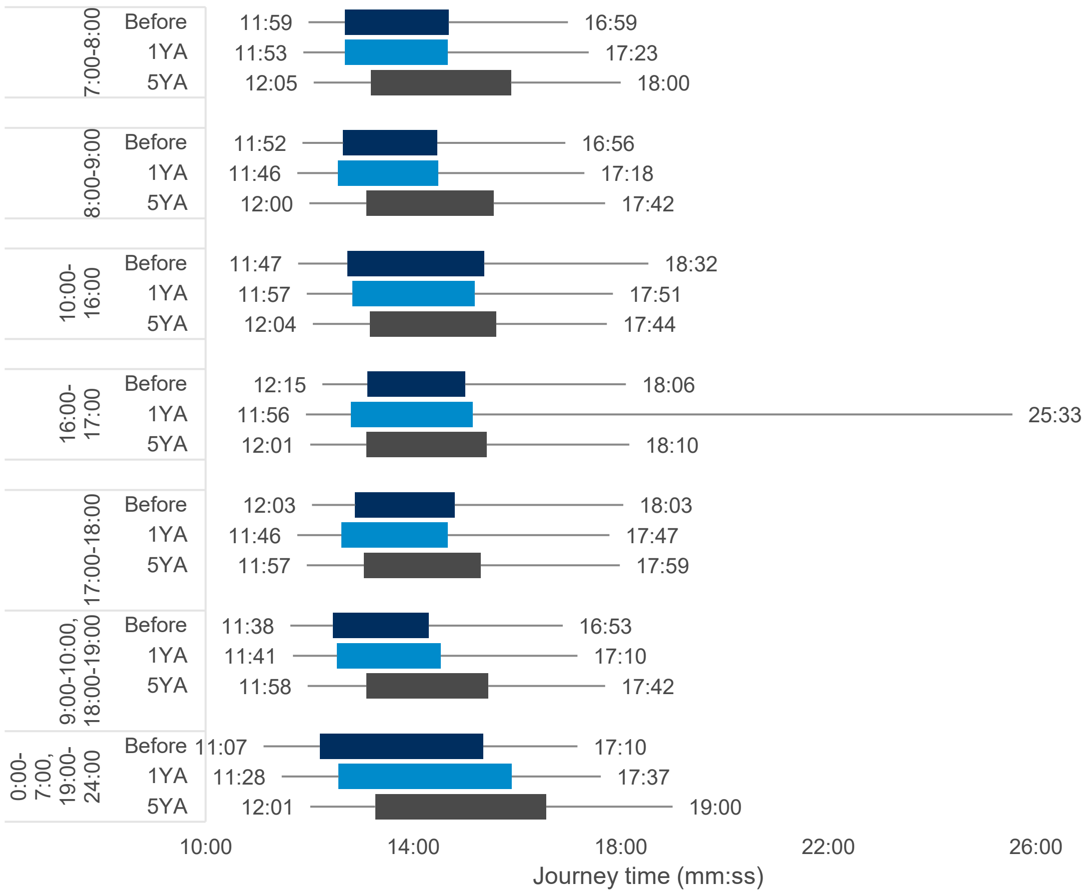
Average journey time variability was calculated for the journey time route (junctions 10a to 14) for before, one year after and five years after periods.

Five years after opening, in the northbound direction, journey time reliability is either similar to or worse than the situation before with the exception of the inter-peak which has improved. Similarly, the longest journey times have reduced in the inter-peak. The shortest journey times have increased for all time periods with the exception of the evening pre-peak and evening peak.

In the southbound direction, the reliability of journey times has improved in the majority of time periods. The longest journey times have significantly reduced in the morning pre-peak and morning peak and increased in the inter-peak, evening pre-peak and evening peak. The shortest journey times for all time periods, were similar to the before period.

The journeys' reliability for road users travelling shown in **Figures Figure** 13 and **Figure** 14**.**

Figure 13 Journey time reliability - Northbound



Source: Satellite Navigation (TomTom). Before: March 2012, 1YA: March 2017, 5YA: October 2022.

Journey reliability - Northbound

The five years after shows that the interquartile range (middle 50%) of journey times was greater in the morning peak and evening peak, compared to the before and one year after periods. The five years after journey time variability for the morning pre-peak and morning peak, increased by over 30 seconds compared to both before and one year after periods. There was minimal change in journey time variability in the evening peak, with no more than a 12-second increase in the five years after versus before.

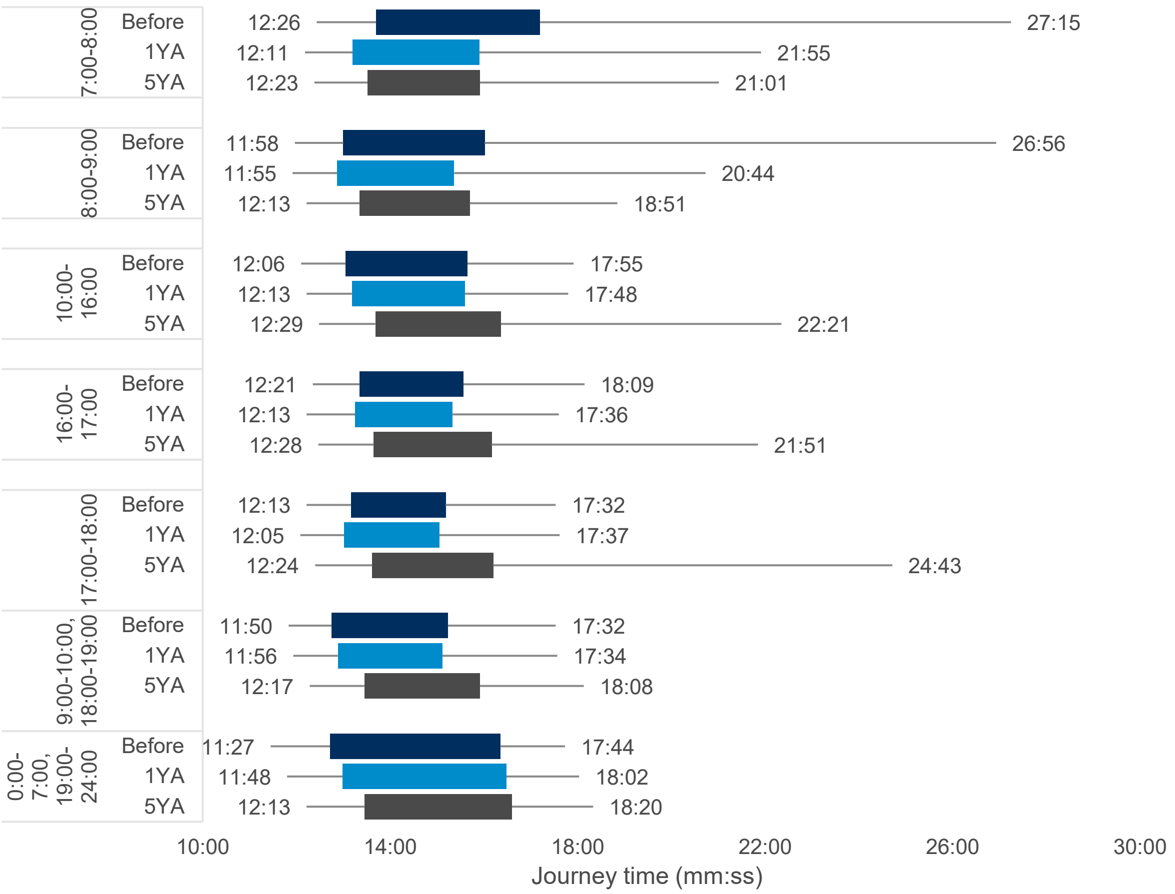
Longest journeys – Northbound

During the morning peak, the five years after opening data shows that the longest journey times, shown as the 95th percentile, increased by 46 seconds and 24 seconds compared to the before and one year after respectively. The five years after journey times were reduced by 48 seconds in the inter-peak and by 4 seconds in the evening peak, compared to the before period.

Shortest journey - Northbound

Five years after data shows that the shortest journey times, shown as the 5th percentile, increased for all time periods with the exception of the evening pre-peak (16:00-17:00) and evening peak (17:00-18:00), compared to the before period.

Figure 14 Journey time reliability - Southbound



Source: Satellite Navigation (TomTom). Before: March 2012, 1YA: March 2017, 5YA: October 2022.

Journey reliability - Southbound

The five year after opening journey time variability of the middle 50% improved by over 30 seconds in the morning pre-peak (7:00-8:00), morning peak (8:00-9:00), and off-peak (0:00-07:00 and 19:00-24:00).

In the inter-peak (10:00-16:00) and evening pre-peak (16:00-17:00), the journey time variability of the middle 50% improved one year after opening and worsened five years after opening, when compared to the before period.

Longest journeys – Southbound

In the southbound direction, the longest journey times were reduced by 6 minutes and 14 seconds in the morning pre-peak (7:00-8:00) and 8 minutes and 5 seconds in the morning peak (8:00-9:00) five years after opening compared to the before period. Five years after opening, the longest journey times increased by 4 minutes and 26 seconds in the inter-peak (10:00-16:00), 3 minutes 42 seconds in the PM pre-peak (16:00-17:00), and 7 minutes and 11 seconds in the evening peak (17:00-18:00). In majority of peak hours, longest journeys were longer five years after compared to one year after.

Shortest journeys – Southbound

Five years after opening, the shortest journey times for all time periods, were similar to the before period.

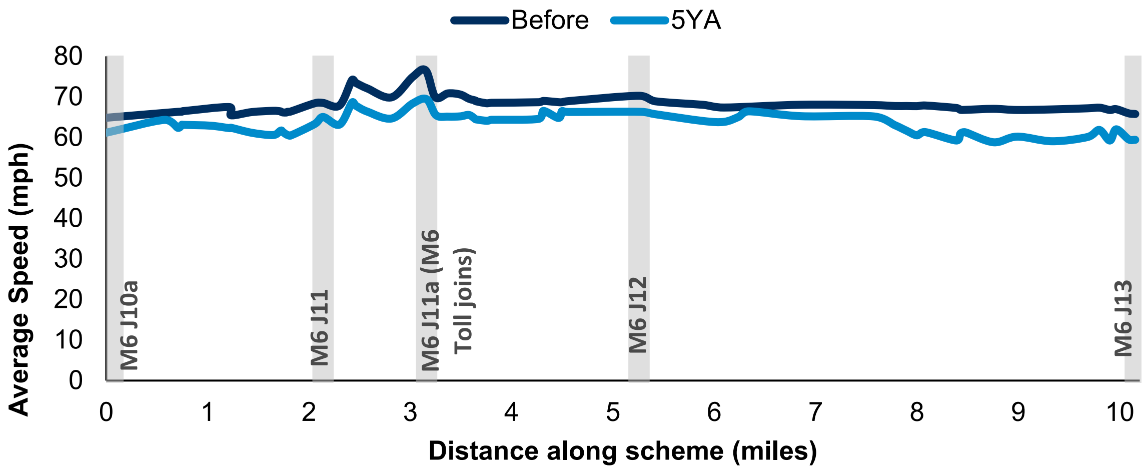
How did the project impact road user's speeds?

In combination with journey time analysis, speed can help to determine the impact the smart motorway had on congestion. Road users' average speeds are not necessarily quicker because of a smart motorway. Smart motorways are often implemented where there is congestion, and/or an increase in traffic is expected in the coming years. The aim is to make journeys smoother, and therefore speeds should be more consistent, with road users less likely to be accelerating and braking leading to unnecessary queuing.

Morning Peak (08:00 – 09:00)

Figure 15 shows the northbound average speed for the before and five years after periods by distance during the morning peak. Five years after opening, the average speeds were consistently lower than the before scenario.

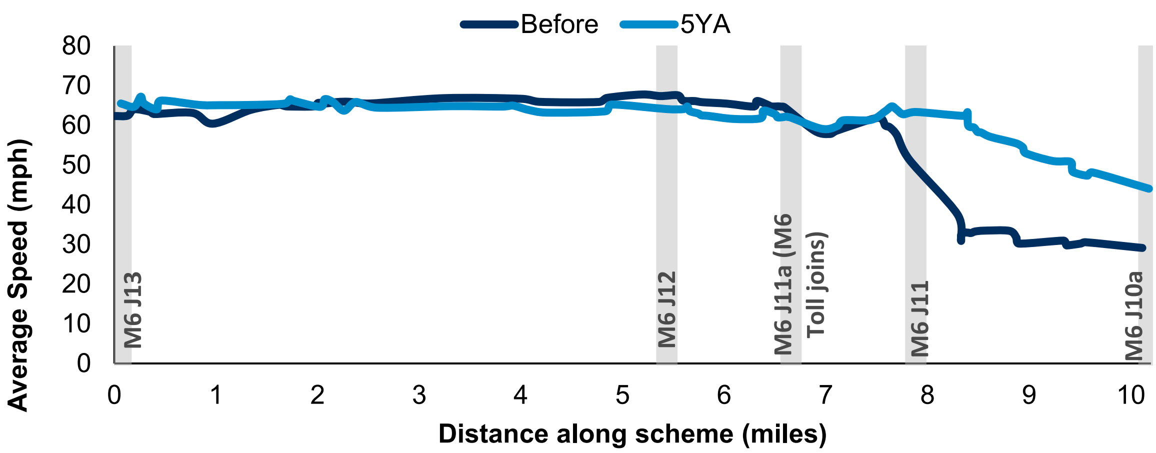
Figure 15 Average speed (mph) over distance in the AM peak - Northbound direction



Source: Satellite Navigation (TomTom). Before: March 2012, 5YA: October 2022.

Figure 16 shows the average speeds during the morning peak in the southbound direction. Average speeds between junctions 13 and 11a are comparable before and five years after opening. There was a sharp reduction in average speeds in the before period at junction 11, falling from 53mph to 25mph. While the average speeds also fell in the five after data, the reduction was not as severe.

Figure 16 Average speed (mph) over distance in the AM peak - Southbound direction



Source: Satellite Navigation (TomTom). Before: March 2012, 5YA: October 2022.

5. Safety evaluation

Summary

The scheme had an objective to improve safety performance. The number and rate per million vehicle kilometres of personal injury collisions[11] were analysed to identify a trend over time. The evaluation concluded that the scheme had met its safety objective.

In the first four years of the project being operational, there had been a reduction in the rate and number of personal injury collisions on the scheme extent. This is compared with the annual average for the five years before the scheme improvements.

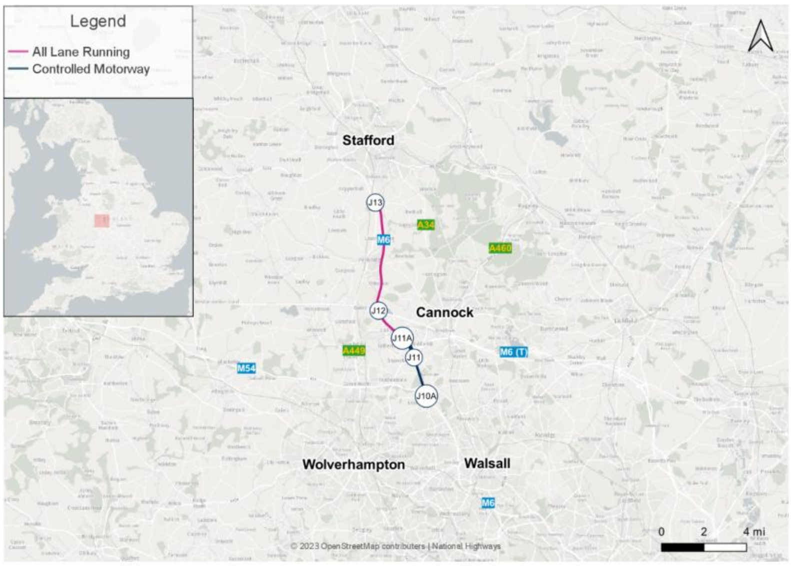
On the scheme, there had been an annual average reduction of 21 personal injury collisions, which is in line with the appraised business case for the scheme. This is based on an annual average of 20 personal injury collisions after the scheme was operational compared with 41 before the scheme. If the road had not been converted to a controlled motorway and smart motorway, the estimated number of personal injury collisions would have been between 27 and 54 **(Figure 20**).

The average collision rate had decreased to six personal injury collisions per hmvm. Before the scheme the collision rate was 12 per hmvm, which equates to traveling 8.6 million vehicle km before seeing an accident. We have observed a greater reduction in the rate of collisions compared to if the road had not been converted.

Safety study area

The safety study area, shown in **Figure 17** was defined as the scheme extent on the M6 junctions 10a-13 highlighting the all lane running and controlled motorway operation of the project.

Figure 17 Safety study area



Source: National Highways and OpenStreetMap contributors

[11] A collision that involves at least one vehicle and results in an injury to at least one person

Road user safety on the project extent

What impact did the project have on road user safety?

Safety data was obtained from DfT road safety data[12], which records incidents on public roads that are reported to the police. This evaluation considers only collisions that resulted in personal injury via this dataset.

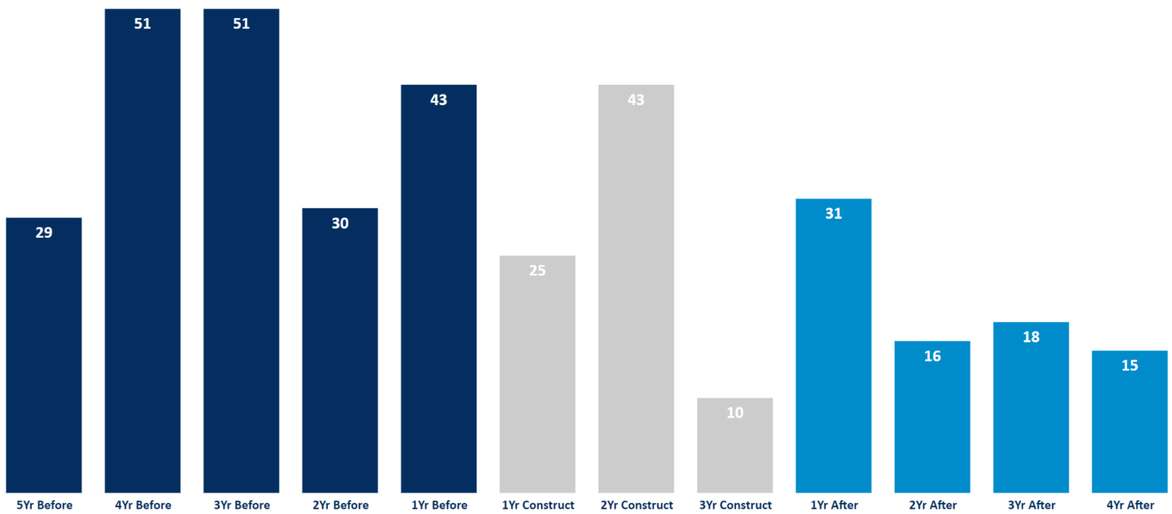
The safety analysis was undertaken to assess changes over time looking at the trends in the five years before the scheme was operational to provide an annual average. The four years after trends were then estimated, incorporating a period prior to the COVID-19 pandemic.

The analysis draws on the following data collection periods:

- Pre-construction: 31st October 2008 to 30th October 2013
- Construction: 31st October 2013 to 6th February 2016
- Post-opening: 7th February 2016 to 6th February 2020

The evaluation found the number of personal injury collisions had decreased. Over the four years after the scheme was operational, there were an average of 20 personal injury collisions per year, 21 fewer than the average 41 per year over the five years before the scheme was constructed.

Figure 18 Annual Personal Injury Collisions



Source: STATS19: 31st October 2008 to 6th February 2020

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 Figure 19 and POPE methodology manual[13]).

[12] https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data
[13] https://nationalhighways.co.uk/media/exypgk11/pope-methodology-note-2024-v2.pdf

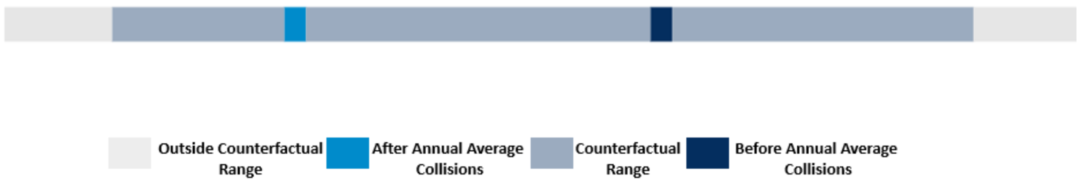
This is based on changes in regional safety trends for conventional motorways with a high volume of road users (**Figure 19**).

Based on this assessment, 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 20**.

Figure 19 What does the counterfactual show?

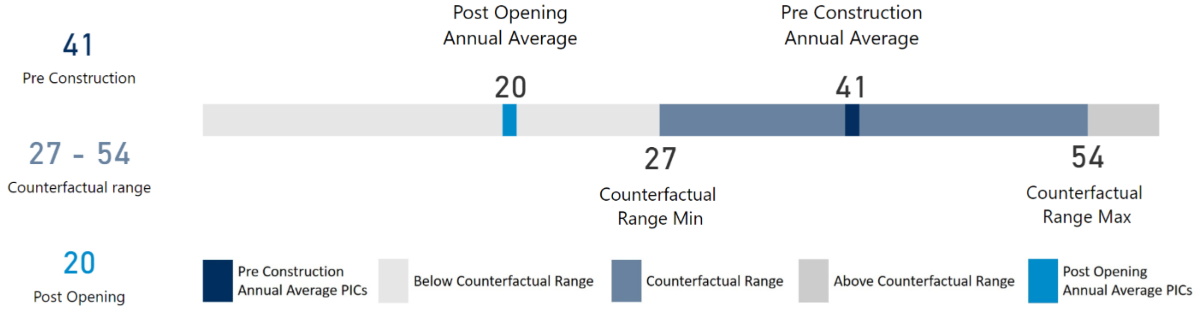
The counterfactual is an estimation of what we think would occur without the project taking place. We estimate a range of collisions that follow regional trends. The chart shows:

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 is developing new statistical methods to compare collision and casualty rates. We anticipate adopting these once the methods are finalised.



As shown in **Figure 20**, a range of between 27 and 45 personal injury collisions[14] during the four-year post-scheme period would be expected. Therefore, an annual average of 20 personal injury collisions observed over the four-year post-opening period, falls below the expected range.

Figure 20: Observed and expected range of personal injury collisions (annual average)



Source: STATS19: 31st October 2008 to 6th February 2020

[14] 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.

As the number of observed personal injury collisions falls below the expected range, the observed changes are significant. This means the decline in personal injury collisions could be attributed to the operation of the smart motorway.

How has traffic flow impacted collision rates?

It is important to contextualise any incidents in the volume of traffic seen on this stretch via a collision rate, the number of collisions per annual hundred million vehicle miles (hmvm).

Before the scheme, the collision rate was 12 personal injury collisions per hundred million vehicle miles. Post opening, the average collision rate had decreased to six personal injury collisions per hundred million vehicle miles.

The estimated rate if the smart motorway had not become operational was estimated at 10 personal injury collisions per hundred million vehicle miles. The counterfactual scenario indicates there would be an increase in the rate of collisions.

Statistical testing indicates that the reduction in collision rates compared to the counterfactual is significant and could be attributed to the smart motorway.

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 system (or 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 officer.[15] As a consequence, DfT has developed a severity adjustment methodology[16] 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 DfT's severity adjustment factors, to enable comparability with the post-conversion safety trends.[17]

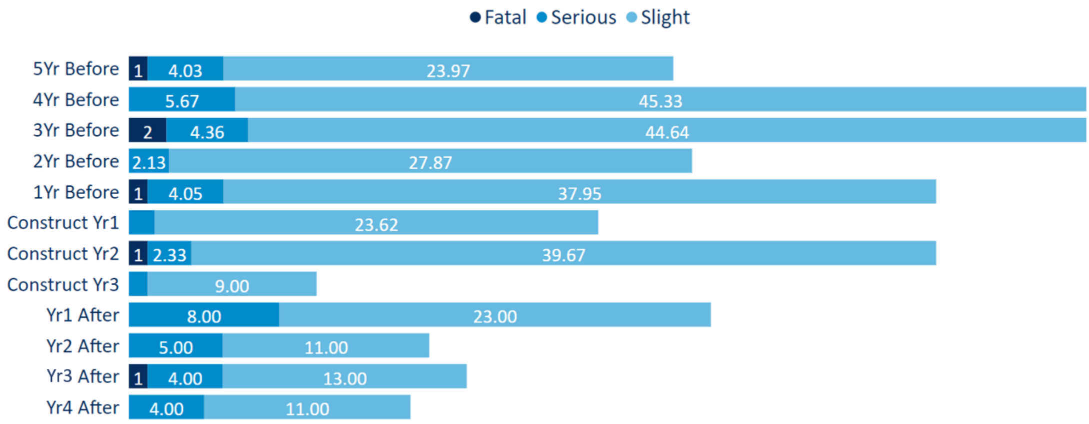
After the scheme, we have observed a total reduction of three collisions resulting in fatalities (the total before the scheme was four, compared to one after). There was an average increase of one more collision resulting in serious injuries per year (the annual average before the scheme was four, compared to five after). There was an average of 21 fewer collisions resulting in slight injuries per year (the annual average before the scheme was 36, compared to 15 after). **Figure 21** shows the severity of personal injury collisions.

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

[16] 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

[17] Collision severities within this report use the 2020 adjustment factor.

Figure 21: Collisions by Severity on Scheme Extent



Source: STATS19: 31st October 2008 to 6th February 2020

How has traffic flow impacted collision 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 casualty.[18] In effect, it takes all non-fatal injuries and adds them up using a weighting factor to give a total number of fatality equivalents.[19] This is represented by an annual average and a rate that standardises casualty severities against flow to show the likelihood of a fatality equivalent occurring per distance travelled.

A reduction of one fatality equivalents 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 two fatality equivalents were observed. After the scheme, this had reduced to an annual average of one fatality equivalents.

The combined measure showed an extra 144 million vehicle miles was travelled before a fatality. Before the scheme, 185 million vehicle miles needed to be travelled before a fatality equivalent (0.5 fatality equivalents per hmvm). After the scheme, this increased to 329 million vehicle miles (0.3 fatality equivalents per hmvm). The rate of fatality equivalents per hmvm 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.

Is the project on track to achieve its safety objective?

The safety objective for this scheme was to improve safety performance. The analysis shows personal injury collisions and rates have both decreased. Statistical testing of the results for collision reduction and collision rates are significant.

[18] 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.
[19] Casualty severities within this report use the 2020 adjustment factor.

Overall, we can be confident that the scheme has met its safety objective for the project extent.[20]

Initial appraisal undertaken in the business case for the project estimated that there would be a reduction of 34 personal injury collisions over the appraisal period (60 years).

Analysis shows that the appraisal underestimated the potential safety benefits for this scheme.

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

6. Environmental evaluation

Summary

The evaluation of environmental impacts considered information on the predicted impacts gathered from the Transport Appraisal Guidance (TAG) environmental appraisal (AST – Appraisal Summary Table) and compared them with findings observed at five-years after the project opened to determine if the predicted outcomes were likely to be achieved.

Five-years after observed impacts were determined during a site visit in July 2021 and supported by desktop research. The results of the evaluation are recorded against each of the transport appraisal guidance environmental sub-objectives. and presented in **Table 2.** Our environmental evaluation focused on the environmental sub-objectives of noise, air quality, greenhouse gas emissions, landscape, heritage and biodiversity. The additional features introduced by the M6 junctions 10a to 13 project were not expected to result in any significant changes to the townscape character and so were scoped out of the environmental assessment. Thus, townscape was scoped out of five-years after evaluation.

The project was not expected to alter the road drainage, and therefore, the overall impact of the project on watercourses, flood plains, and water features from the project was neutral. As there were no outstanding issues from the one-year after evaluation and no issues were observed during the five-years after evaluation visit, the impact of the project on the water environment was scoped out of five-years after evaluation.

Environmental evaluation often also considers social impacts[21] on severance, physical fitness, and journey quality. The project was not predicted to have any significant impacts on these areas as the project was developed within the existing boundary. The one-year after evaluation did not highlight any outstanding issues and so were scoped out of our five-years after evaluation.

The evaluation found that that most impacts were as predicted in the appraisal. With noise, air quality, landscape, heritage of historic resources and biodiversity as expected.

Based on the five years after site visit, there has been some progress from the time of the one-year after evaluation. Vegetation (shrubs and trees) was in place and establishing, i.e. beginning to screen gantries along the Staffordshire and Worcestershire Canal, where a Site of Biological Importance (SBI) exists.

Noise

The environmental assessment predicted that in the long term, a ‘negligible adverse’ effect at all of the non-residential sensitive buildings and 99% of the residential properties within the 600m study area will be experienced. The environmental assessment states that the works to the existing hard shoulder would be resurfaced with a low noise surface as part of the project. The M6 along the length of the project was currently surfaced with low noise surfacing. A noise barrier was installed at Penkridge as proposed.

[21] https://www.gov.uk/government/publications/tag-unit-a4-1-social-impact-appraisal

Overall, based on a comparison of the limited available forecast data to outturn data, it is anticipated that the differences between the outturn and forecast traffic result in an “as expected” change.

Air Quality

The appraisal predicted that regional emissions of particulate matter (PM_{10})[22] would increase by 0.6 tonnes per year in the opening year (2015). The regional emissions of NO_x were predicted to increase by 18.6 tonnes per year.

The project was not expected to lead to any significant effects. It was anticipated that the changes in Nitrogen Dioxide (NO_2)[23] and PM_{10} would be imperceptible or small and were not expected to lead to exceedances in the annual or daily mean averages. No mitigation measures were proposed for air quality.

Overall, it is likely that the observed NO_2 concentrations are lower than expected due to the decrease in overall traffic from the forecast values to the observed values. The variations in speed are unlikely to make a substantial difference to the expected NO_2 concentrations. The effect of changes in Heavy Duty Vehicle (HDV) flows has not been assessed as forecast %HDV is unavailable.

Based on a comparison of available observed data to forecast data, it is not anticipated that the differences between the observed and forecast traffic would lead to a change in the overall evaluation of significance for air quality for the project.

Greenhouse Gases

Government guidance[24] notes that CO_2 is considered the most important greenhouse gas and therefore it is used as the key indicator for the purposes of assessing the impacts of transport options on climate change. For this project, the environmental appraisal predicted that it would cause an overall increase in carbon emissions. This was due to increases in traffic across the project area. The change in non-traded carbon over the 60-year appraisal period (CO_2e[25]) was expected to be 507,933 tonnes. In the opening year (2016), carbon emissions were predicted to be 4,821 tonnes higher with the project in place than without. In the design year (2030), carbon emissions were predicted to be 10,690 tonnes higher with the project in place than without.

Overall, based on a comparison of available observed data to forecast data[26] the observed data resulted in lower calculated greenhouse gas emissions than the forecast data, with a difference of -11.7%.

The total change in emissions caused by the project cannot be evaluated with confidence from the limited data. However, the evaluation suggests that the Project may have led to a smaller increase in carbon emissions than was predicted in the opening year (2015) for the subset of road links evaluated.

---

[22] Particulate matter (PM) is everything in the air that is not a gas and therefore consists of a huge variety of chemical compounds and materials, some of which can be toxic. Exposure to PM can result in a serious impact to health. PM is classified according to size PM_{10} consists of particles that are less than 10 micrometres in diameter.

[23] Nitrogen dioxide (NO_2) is a gas that is mainly produced during the combustion of fossil fuels, along with nitric oxide (NO). Short term exposure to concentrations of NO_2 can cause inflammation of the airways and increase susceptibility to respiratory infections and to allergens. Nitrogen dioxide (NO2) - GOV.UK (www.gov.uk)

[24] DfT appraisal guidance: https://www.gov.uk/government/publications/tag-unit-a3-environmental-impact-appraisal.

[25] Carbon dioxide equivalent. A measure of global warming potential of carbon emissions.

[26] using both Emissions Factor Toolkit (EFT) v11 and v5.2.

Landscape and Townscape

The environmental appraisal stated that the area of M6 between junction 10a and junction 13 comprised a gently undulating, predominantly agricultural landscape, and included the market town of Penkridge and urban fringe development in the south of the project. The introduction of gantries and Emergency Refuge Areas along with some loss of vegetation was expected to cause localised increased intrusion to the landscape character and visual amenity. The assessment expected a slight beneficial effect in the vicinity of Rodbaston Lock from changes in gantry location and increased screening from mitigation. But the overall impact of the Project on the landscape was expected to be slight adverse.

The one-year after evaluation reported that the landscape and visual amenity effects of the Project were worse than expected. This was because the mitigation measures did not yet appear to have been fully implemented and the slight beneficial visual impacts resulting from the removal of gantry (G18E) near Great Saredon were not realised.

Our evaluation confirmed that the overall impacts of the project on the landscape were now as expected.

The intensification of motorway infrastructure (gantries, signs, CCTV, and lighting columns) and use of the hard shoulder have had the expected impact on the landscape and visual amenity. The M6 was already a prominent feature in the landscape and the project works, which were largely online, had not significantly affected the overall landscape character.

The proposal to remove the existing gantry around Great Saredon has not happened and so the predicted beneficial impacts expected for that location did not occur. Despite this, the overall visual impact of the project was largely as expected.

Some screening vegetation was lost to accommodate new infrastructure. However, vegetation was retained in woodland areas, e.g. along the Staffordshire and Worcestershire Canal (at Otherton Farm SBI) and Hilton Park. This has helped to mitigate the impacts of the project on the landscape as expected. Some progress on screening vegetation was observed from the time of the one-year after evaluation. Shrubs and trees were in place and beginning to screen gantries along the Staffordshire and Worcestershire Canal as expected. For the design year outcome to be achieved for the landscape delivery, a suitable maintenance regime is required.

Figure 22 Views of the M6 from Viewpoint 12, Sabrina Way (Public Right of Way / Bridleway No. 2) Teddesley Road

At 1YA (Source: 1YA Evaluation Report, June 2017)

At 5YA (Source: 5YA Evaluation visit, 13th July 2021)

Heritage of Historic Resources

The environmental appraisal reported that the majority of the project would not involve any new land-take and that any intrusive works proposed were within areas of previously disturbed ground. The existing M6 formed part of the context of the area. Therefore, key impacts were considered to be those which would increase the existing effects of the road. The appraisal reported that the project would have a slight adverse effect on one Scheduled Monument and one grade II* listed building. The overall impact of the project on heritage resources was assessed as slightly adverse. However, no mitigations were proposed because the impacts on heritage assets were generally expected to be limited.

The one-year after evaluation concluded that there was no reason to consider that the operational impacts of the project were anything other than as expected. Our five-years after evaluation confirmed that the impacts of the project on the historic environment were broadly in line with the proposals in the environmental assessments. The impacts of the project on the setting of the scheduled monument (The Acton Moat Farm moated site) and on historic buildings were broadly as expected. Based on the five-years after site visit, historic landscapes, and conservation areas were not significantly affected.

Biodiversity

The environmental appraisal stated that the project would not directly or indirectly impact any statutory designated sites and direct impacts would be limited to within the highway boundary. The ecological value of the highway verge impacted was considered to be low. It was considered likely that any effects on habitats and species (badger, great crested newts) that might arise during construction, could be mitigated to prevent any significant adverse impacts happening. The appraisal noted that project proposals for wetland habitat enhancements at the Otherton Farm SBI[27] would provide slight beneficial effects. These enhancements would include the installation of bat boxes. Overall, the project was considered to have a "neutral" effect on ecological resources.

The one-year after evaluation reported that the impact of the project on habitats was considered worse than expected as the mitigation proposals did not yet appear to have been fully implemented. The impact of the project on all species considered by the assessment was likely to be as expected, although further evidence was required to confirm.

The five-years after evaluation found that, as expected, the project's works were largely within the highway boundary, and impacts to species and habitats were therefore likely to be minimal. The draft Handover Environmental Management Plan (HEMP), and landscape and ecology drawings confirmed that mitigation such as species-rich grasslands had been provided around gantries. Some progress on habitats was observed from the time of the one-year after evaluation. Shrubs and trees were observed establishing at the Otherton Farm SBI at five-years after and retained vegetation in undisturbed woodland areas was as expected. Impacts of the project on species were expected to be insignificant or neutral for badgers and great crested newts, and were to be confirmed by post-construction surveys. At five years after, no monitoring reports and no further information was available to confirm this. Impacts of the project were expected to be beneficial for bats due to the proposal to install bat boxes on retained trees at the location where a roost was to be removed. However, at five years after, the HEMP reported that no bat roosts were removed by the project, and therefore the requirement for bat boxes was not actioned. Based on these findings, the impact of the Project on ecological resources was not likely to be other than as expected.

Overview

The results of the evaluation are summarised against each of the TAG environmental sub-objectives and presented in **Table 2**. 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 was insufficient evidence to draw firm conclusions.

[27] An area of woodland along the Staffordshire and Worcestershire Canal, considered important at the county level for nature conservation.

Table 2 Summary of environmental Impacts

Sub Objective	Appraisal Score	Five-years Evaluation	Summary
Noise	Net change: 50 more people annoyed. NPV: -2,474,47	As expected	Based on the five years after site visit and asset data, noise mitigation was installed and was likely to be working as expected. Overall, based on a comparison of the limited available forecast data to outturn data, it is anticipated that the differences between the outturn and forecast traffic result in an “as expected” change.
Air Quality	Slight Adverse NO_2 Overall Assessment Score: +4132.80μg/m^3. PM_{10} Overall Assessment Score: +353.6 μg/m^3.	As expected	Local air quality reporting along the project indicates that most locations within the project footprint showed air quality figures that were below the mean annual threshold. The only one location (Penkridge Village Centre) which exceeded the UK air quality threshold was already existing before the project and is not within an Air Quality Management Area.
Greenhouse Gases	Change in non-traded carbon over 60y: 507,933 (tCO2e) Change in traded carbon over 60y: 3004 (tCO_2e) NPV: -£24,302,891	Better than expected	The evaluation suggests that the project may have led to a smaller increase in carbon emissions than was predicted in the environmental assessment in the opening year (2016) for the subset of road links evaluated. However, due to limited data, the total change in emissions cannot be evaluated with confidence.
Landscape	Slight Adverse	As expected	New gantries, signs, CCTV and lighting columns had increased the dominance of the M6 and adversely impacted on the landscape and visual amenity as expected. Vegetation retention in woodland areas along the M6 had helped to minimise the impacts of the project on the landscape. However, as the existing gantry around Great Saredon had not been removed, the beneficial impacts expected for that location had not arisen.
Heritage of historic resources	Slight Adverse	As expected	The impacts of the project were limited to within the highway boundary and the effects on the setting of historic resources beyond the boundary were no worse than slight, as expected.
Biodiversity	Neutral	As expected	The works were largely within the highway boundary and impacts to species and low value habitats were likely to be minimal.

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 at a cost of £90.5 million[28], close to the forecast cost of £86m.

In the first five years, the project has improved safety, and if this trend continues, is reforecast to deliver £36 million of safety benefits over the 60-year period.

Journey time benefits made up most of the anticipated monetised impacts of this project. The evaluation has observed longer journey times, 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 -£27 million.[29] This figure only reflects journey time trends observed on the project area, not the surrounding road network, which would have been considered in the appraisal.

Value for money was forecasted over a range of possible traffic growth scenarios[30]. These scenarios forecast value for money[31] to range from ‘medium’ to ‘very high’. The appraisal forecast significant traffic growth and improving journey times; the observed data suggested a more modest traffic growth accompanied by slower journey times in most time periods. This has impacted the project’s value for money which we have re-forecast to be ’medium’. As traffic growth is expected to return to what was forecast when this project was appraised, it is likely that this project is on track to deliver the value for money anticipated over the 60-year life of the project, however this is at the lower end of the expected range of benefits.

Forecast value for money

An economic appraisal is undertaken prior to construction to determine a project’s value for money and inform the business case. The appraisal 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 can be monetised. This is undertaken using standard values which are consistent across government. The positive and negative impacts over the life of the project[32] are summed together and compared against the investment cost to produce a BCR, the monetised impacts are considered alongside additional impacts that are not able to be monetised, to allocate the project a ‘value for money’ category.

---

[28] Present value of costs in 2010 prices and values.
[29] 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.
[30] See section 7 – *Forecast value for money.*
[31] The high and low growth scenarios considered in the project appraisal did not contain monetised benefits for journey time reliability. For the purposes of calculating the high and low growth value for money range, we have applied the same proportion that the reliability benefits represent in relation to the journey time benefits in the core scenario to the other two cases.
[32] Typically scheme life is taken to be 60 years.

Since 2011, we have routinely forecasted benefits over a range of possible traffic growth scenarios[33].

Table 3 presents the monetised benefits forecast by the appraisal which supported the M6 junctions 10a to 13 business case. These benefits relate to the core traffic growth scenario which we use to re-forecast and provide an estimate for outturn value for money based on data from the first five years after opening. During this evaluation, we considered the high and low growth scenarios in response to the lower than forecast traffic levels we have observed. 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.

Table 3 Monetised benefits of the project (£ million)

	Forecast (£M)	% forecast monetised benefits[34]	Evaluation approach
Journey times	269	63%	Re-forecast using observed and counterfactual traffic flow and journey time data for the project area only and not those in the wider area
Vehicle operating costs	-88	-20%	Re-forecast using observed and forecast traffic flow and journey time data
Journey time & VOC during construction and maintenance	-33	-8%	Not evaluated (assumed as forecast)
Journey time reliability	189	44%	Monetised benefits assumed as forecast
Safety	1	0%	Re-forecast using observed and counterfactual safety data
Carbon	-24	-6%	Monetised benefits assumed as forecast
Air quality	-2	0%	Monetised benefits assumed as forecast
Noise	-2	0%	Monetised benefits assumed as forecast
Indirect tax revenues	71	17%	Re-forecast using observed and forecast traffic flow and journey time data
User charges	-61	-14%	Monetised benefits assumed as forecast
Operating costs (private toll revenue)	107	25%	Monetised benefits assumed as forecast
Total present value benefits	**427**	**100%**	

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

[33] For this project we undertook a core scenario, which is intended to provide a consistent basis for decision-making given current evidence, and a ‘common comparator’ to assess all projects and options against. There are significant uncertainties associated with forecasting travel demand. Therefore, we also undertook scenario testing to check whether the intervention is likely to still provide value for money under low demand assumptions and the likely effects of high demand on the scheme impacts. Not all the benefits considered would have contained high and low growth forecasts, so a proportionate method was designed to estimate these based on existing evidence.

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

Evaluation of costs

The project was delivered at a cost of £90.5 million[35], very close to the anticipated cost of £86 million (see **Table 4**).

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

Table 4 - Cost of the project (£ million)

	Forecast (£m)	% of forecast costs	Evaluation approach
Construction costs	86	74%	Current estimate of project cost
Maintenance costs	31	26%	Not evaluated (assumed as forecast)
Total Present Value Costs (PVC)	**117**	**100%**	

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 re-forecast 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 helps 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 3, monetised benefits were primarily driven by forecast reductions in journey times over the modelled period compared to a ‘do-minimum’ scenario, what would be expected to happen if the smart motorway were not built. Therefore, in this section of our study, we have compared the ‘after’ journey times to an estimate of the ‘counterfactual’, i.e. what journey times are likely to have been without the project. 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 forecasts generally overstated traffic increases[36]. The business case would have been based on growth assumptions before the 2008 global economic downturn, which slowed the rate of traffic growth, so this is a likely scenario.

[35] This is the PVC (present value cost) of the project. This means it is presented in 2010 prices, discounted to 2010 and converted from factor to market prices to be comparable with the other monetary values presented.
[36] Refer to section 4 for further details.

The overall impact on vehicle hours on the project section in the fifth year was estimated to be negative.[37] Without the detail of the original forecasts to compare to, it is difficult to draw conclusions but given the lifetime positive monetised impact presented in the pre-construction appraisal, this is unlikely to be in line with what was anticipated. Without further intervention, journey time benefits are unlikely to be on track to be realised.

This is likely to be due to a combination of reasons including:

- lower than forecast levels of traffic due to the 2008 economic downturn[38] resulting in the hard shoulder being required less frequently than may have been expected. 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.
- for all lane running sections, 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.

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. The evaluation has not monitored the journey time 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 -£27 million.[39] This figure only reflects journey time trends observed on the project area, not the surrounding road network, which would have been considered in the appraisal.[40]

Other reforecast impacts

We reforecast total safety benefits to be £36 million. This figure relates to the benefit on the strategic road network over 60-years as described in section 5. The reforecast is higher than the appraisal forecast. The observed personal injury collision savings are greater than those forecast in the appraisal.

There are two further impacts associated with the changes in numbers and speeds of vehicles – indirect tax revenues and vehicle operating costs (VOC). Indirect tax

[37] A disbenefit of 67,600 vehicle hours in the fifth year.

[38] 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.

[39] 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.

[40] The expected 60 year monetised benefit reported for the scheme was £269 million, which represented 70% of the total benefits. This compares with an estimated disbenefit of £27 million based on the current observations.

revenues are the benefit to the government (and therefore society) of the additional tax income from the additional fuel consumed due to increased speeds and distances travelled. This was forecast to be positive because more vehicles were forecast and they were forecast to be travelling at higher speeds, and therefore using more fuel and paying more tax. We have reforecast that the impact would be smaller than expected £71 million, a reduction in indirect tax revenues collected to £27 million[41], based on the observed differences in overall traffic demands and vehicle speeds.

The VOC element refers 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 disbenefit 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 disbenefit of -£33 million.

Impacts assumed as forecast

The evaluation has not been able to reforecast the monetary value of journey time reliability[42], noise and carbon benefits[43], 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 forecast.[44]

Journey times and VOC during construction and maintenance are not evaluated and therefore assumed as forecast. As the vast majority of this maintenance is still in the future, we did not have any information with which to update the estimate for this and therefore the forecast from the appraisal remains our 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 more modest traffic growth accompanied by slower journey times in most time periods. This has affected the project's value for money.

When considering an investment's value for money, we also consider benefits which we are not able to monetise. For this project, the following might be relevant considerations:

- Journey quality was appraised to be large beneficial, but our evaluation found that the benefits had not 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

[41] This is the contribution to the PVB of the project. This means it is presented in 2010 prices, discounted to 2010 to be comparable with the other monetary values presented.

[42] It has not been possible to re-forecast the monetised reliability impact for this project because our evaluation method reuses the INcident Cost-benefit Assessment (INCA) files used in the appraisal and these were not able to be located for this project.

[43] We do not have a proportionate methodology 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.

[44] Refer to section 6 for further detail on noise and greenhouse gas impacts.

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 ‘medium’ value for money. As traffic growth is expected to return to what was forecast when this project was appraised, it is likely that this investment is on track to deliver the value for money anticipated over the 60-year life of the project, however this is at the lower end of the expected range of benefits. If the journey time and traffic growth trends observed within the first five years continue, the project is expected to deliver lower than expected value for money.

Appendix A

A.1 Counterfactual safety 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 a 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 POPEs 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.

A.2 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.

A.3 Unadjusted Collision Severity

The project extent is covered by Staffordshire and West Midlands police constabularies which transferred from Stats19 to CRaSH in May and November 2015.

Table 5 shows the unadjusted collision severities on the project extent:

Table 5 Unadjusted collisions by severity for project extent

Observation Year ▲	Fatal	Serious	Slight
5Yr Before	1	2	26
4Yr Before		2	49
3Yr Before	2	1	48
2Yr Before			30
1Yr Before	1	1	41
1Yr Construct			25
2Yr Construct	1	1	41
3Yr Construct		1	9
1Yr After		8	23
2Yr After		5	11
3Yr After	1	4	13
4Yr After		4	11

Source: STATS19: 31st October 2008 to 6th February 2020

If you need help accessing this or any other National Highways information, please call **0300 123 5000** and we will help you.

This document is also available on our website at **www.nationalhighways.co.uk**

For an accessible version of this publication please call **0300 123 5000** and we will help you.

If you have any enquiries about this publication email **info@nationalhighways.co.uk** or call **0300 123 5000***.

Please quote the National Highways publications code **PR09/24**.

*Calls to 03 numbers cost no more than a national rate call to an 01 or 02 number and must count towards any inclusive minutes in the same way as 01 and 02 calls. These rules apply to calls from any type of line including mobile, BT, other fixed line or payphone. Calls may be recorded or monitored.

Printed on paper from well-managed forests and other controlled sources when issued directly by National Highways.

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

National Highways Limited registered in England and Wales number 09346363