M25 junctions 16 to 23 widening and controlled motorway

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 M25 junctions 16 to 23 controlled motorway (CM) 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 M25 junctions 16 to 23 project which opened in 2012, 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.

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[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

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1. Executive Summary

The M25 junctions 16 to 23 widening and controlled motorway became operational in March 2014 and runs between M25 junction 16 near Uxbridge to junction 23 near South Mimms.

The route covers approximately twenty-two miles. It forms part of the strategic orbital road encircling London in south-east England. It has a pivotal role in our network. It is a vital route for freight, commuter, and tourist traffic. It connects the many radial motorways and trunk roads serving London and provides a bypass for through traffic. This section of the M25 operated as a three-lane motorway with a hard shoulder and suffered from increasing congestion levels and unpredictable journey times.

The project formed part of an overall, long-term strategy to address congestion and traffic growth on the M25 through a series of widening and smart motorway projects.[2] This programme resulted in the widening of virtually all the remaining dual-three lanes sections of the M25 to dual-four lanes. This project was included within a single 'design, built, finance and operate' (DBFO) contract with the aim of achieving best value for money.

Controlled motorways apply technology to control the speed of traffic and retain a permanent hard shoulder. 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 aimed to make travel safer by reducing the number and severity of accidents and to improve the overall driving experience, particularly the quality of information provided to drivers about the state of traffic on the motorway. Where feasible, the project sought to offset detrimental environmental effects by mitigation measures.

The completion of the project was expected to improve journey time reliability and improve journey times, on the M25 between junctions 16 and 23, without having a detrimental impact on the surrounding road network.

Since the conversion, there had been a reduction in the rate and number of personal injury collisions on both the project extent and the surrounding network. The evaluation concludes that the project has met its safety objective.

The smart motorway has been delivered, and the performance in the first five years indicates that the project had had positive impacts on congestion in some parts of the M25. We found road users' average speeds and journey times had mostly improved compared with before the project

Due to the observed trends in traffic growth, the 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.

[2] The strategy was produced in response to the London Orbital Multi-Modal Study (ORBIT MMS) which was published in November 2002. The study recommended, among other things, improvement works to the M25, including widening parts of the motorway between junctions 16 and 30 (Sections 1, 4 and 5), between junctions 1b and 3 (Section 3), and between junctions 5 and 7 (Section 2).

Overall, based on the evidence from the first five years, this project is on track to realise the anticipated value for money.

2. Introduction

What is the project?

The M25 is a strategic orbital road encircling London in south-east England. It has a pivotal role in our network. It is a vital route for freight, commuter and tourist traffic. It connects the many radial motorways and trunk roads serving London and provides a bypass for through traffic. It is of local, regional, national and international importance, and forms part of the E30 route on the European E-road network.

The M25 junctions 16 to 23 widening was completed in May 2012. It widened the M25 from three to four lanes in each direction between junction 16 at Iver Heath near Uxbridge and junction 23 near South Mimms.

In addition to widening the M25 between junctions 16 and 23 we erected gantries along the extent, enabling this section to operate as a controlled motorway. It began operation as a controlled motorway in March 2014.

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.

Before construction this section of the M25 suffered from growing congestion and unpredictable journey times, especially at peak times. The project formed part of an overall, long-term strategy to address congestion and traffic growth on the M25 through a series of widening and smart motorway projects. The strategy was produced in response to the London Orbital Multi-Modal Study (ORBIT MMS) which was published in November 2002. The study recommended, among other things, improvement works to the M25, including widening parts of the motorway between junctions 16 and 30 (Sections 1, 4 and 5), between junctions 1b and 3 (Section 3), and between junctions 5 and 7 (Section 2). This programme would result in the widening of virtually all the remaining dual-three lanes sections of the M25 to dual-four lanes.

The five widening projects (Sections 1, 2, 3, 4 and 5) entered the Highways Agency’s (HA) Targeted Programme of Improvements (TPI). Sections 1 and 4, were included within a single ‘design, built, finance and operate’ (DBFO) contract with the aim of achieving best value for money. Section 3 (Junctions 1b to 3) was taken forward separately under an ‘early contractor involvement’ (ECI) contract.[3]

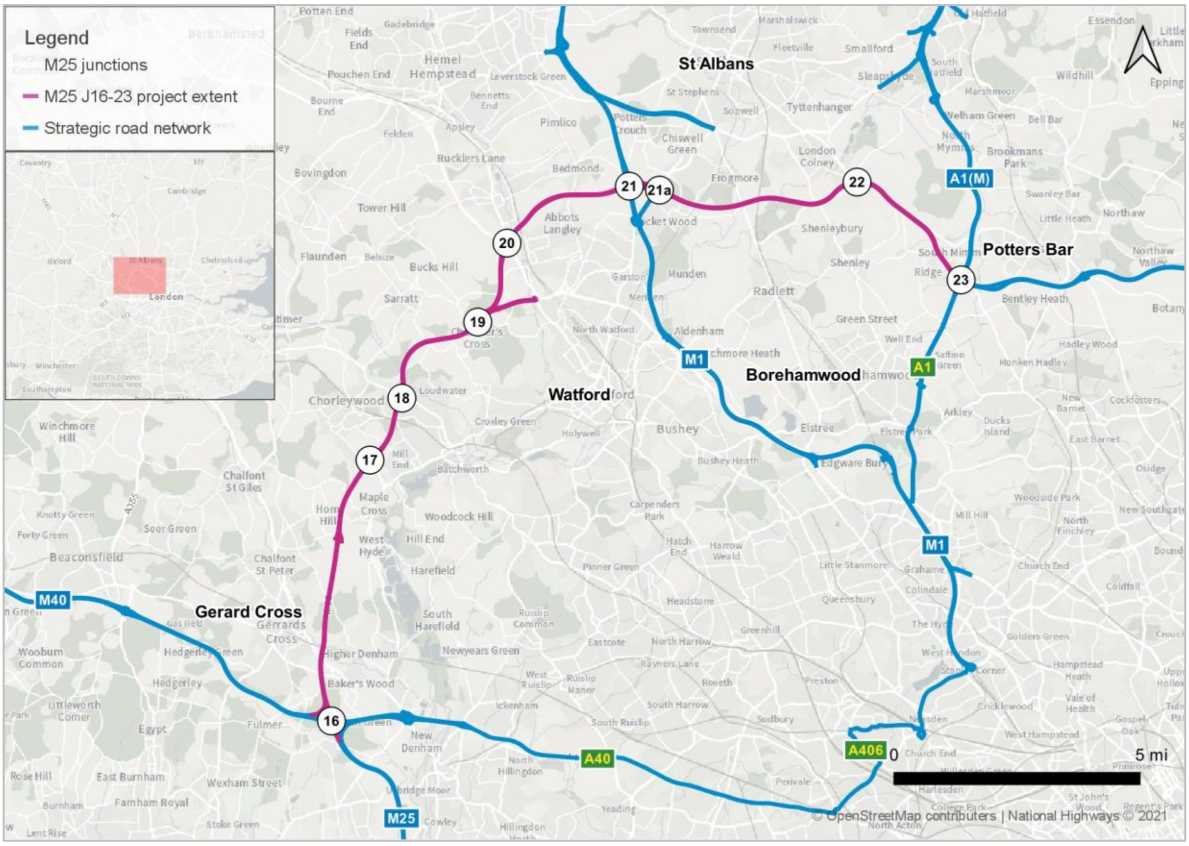
The project also entailed construction works on the Berry Lane Viaduct to enable the widening. It required the replacement of the existing Park Avenue Footbridge just south of junction 18 at Chorleywood.

[3] ECI is a type of construction contract where the main contractor is engaged at an early stage in a project to offer input into the design phase. In contrast, in the ‘design–bid–build’ model, the contractor is only brought onboard at the end of the design phase. The ECI model allows the contractor to provide input in the design of the project and suggest value engineering changes. (https://en.wikipedia.org/wiki/Early_contractor_involvement)

Scheme location

The M25 junctions 16 to 23 project extent lies on the northwest section of the M25 near to Watford. It crosses a number of roads and railway lines.

Figure 1 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 areas[4] 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.[5]

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

3. Delivering Against Objectives

How has the scheme performed against objectives?

All of our major projects have specific objectives which are defined early in the business case when scheme options are identified. These objectives are appraised to be realised over 60 years, our evaluation provides an early indication on whether the project is on track to be deliver the benefits.

Using evidence within this study, Table 1 shows the objectives that were defined for the M25 junctions 16 to 23 scheme and summarise the projects' performance against each of the objectives

Table 1 objectives and evaluation summary

Objective	Five-year evaluation
To improve reliability.	Journeys in both directions (apart from PM Peak travelling clockwise) have become more reliable. Journey times have also improved across all time periods for vehicles travelling anti-clockwise.
To reduce congestion.	Despite an increase in traffic volume on the M25 junction 16 to 23, journey times and reliability have improved. There is evidence that there has been continued and sustained reduction in traffic flows on the surrounding local road network.
To improve safety.	We have observed a statistically significant reduction in the number and rate of collisions on the project extent and model area. The project is on track to meet its safety objective.
To minimise adverse environmental impacts of upgraded section.	The five-years after evaluation found that the impacts of the project on noise, landscape, biodiversity and the water environment (drainage) were broadly as expected. The impacts on air quality and greenhouse gases along the project extent were better than expected. Based on the five-years after evaluation visit, some landscape mitigations were establishing. It is considered that the project will achieve its environmental objective
To improve driver information.	Upgraded twenty-two miles of the M25 between junction 16 to 23 to include gantry provision for variable speed limits.

4. Customer journeys

Summary of findings

We found the project had had positive impacts on congestion on some parts of the M25 within the scheme and wider area. Road users' average speeds and journey times had mostly improved compared with before the project. On the anti-clockwise carriageway road users' journey times were substantially improved, by on average 19 minutes in the morning, by around four minutes in the middle of the day and by nine minutes in the evening. These improvements seemed related to the project's enhancements between junctions 22 and 20 which incorporates the junction with the M1.

On the clockwise carriageway road users' journey times had improved by around three minutes in the morning. But they had got slightly longer at other times of the day, compared with before. However, closer analysis showed improvements were achieved, mostly between junctions 16 and 20.

The project's impacts on congestion within its extent were made against variable levels of traffic growth (between 5% and 32%) but which on average were above background growth (around 18%). Some of the higher growth observed may have been generated by traffic using several national routes which intersect with the M25.

On local roads, the project was found had to have helped reduce traffic volumes at one year after when there was an reduction was indicative of a reduction in rat-running on the local network. At five years after we found in most cases traffic volumes fallen below levels seen before the project's construction. Many of the largest falls occurred on roads inside the M25 linking to Watford and Rickmansworth. The evidence suggested most of the impacts seen at one year after were substantial and long-standing.

We found the project's traffic forecasting model used during its appraisal was generally accurate for most clockwise sections, but less so for the anti-clockwise sections.

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.

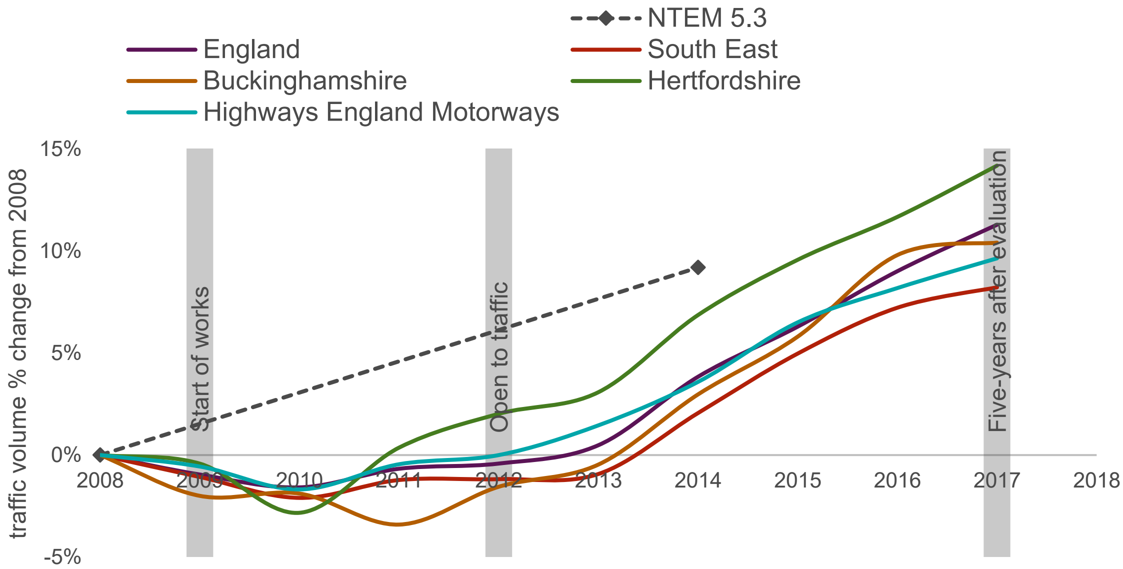
National and regional traffic

To assess the impact of the scheme 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 2008 and 2017 traffic, representing the pre-scheme baseline year used for comparison in this evaluation.

Considering local, regional and motorway traffic trends, around 8-15% 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



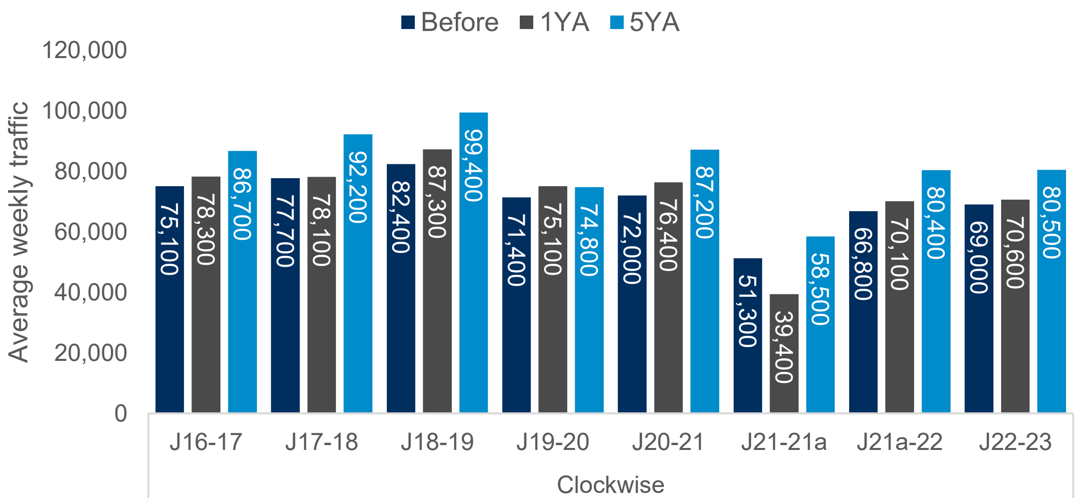
Source: DfT Transport Statistics (Data Table TRA8904), 2021

How did traffic volumes change?

Scheme section

Traffic data for November 2008, prior to construction, has been compared against data for 2012 (one year after opening) and November 2017 (five years after opening) along the M25. In the five years since the scheme opened, we found traffic growth ranged widely across the different sections of the M25, between 5% and 32% with the median around 18%, above background trends.

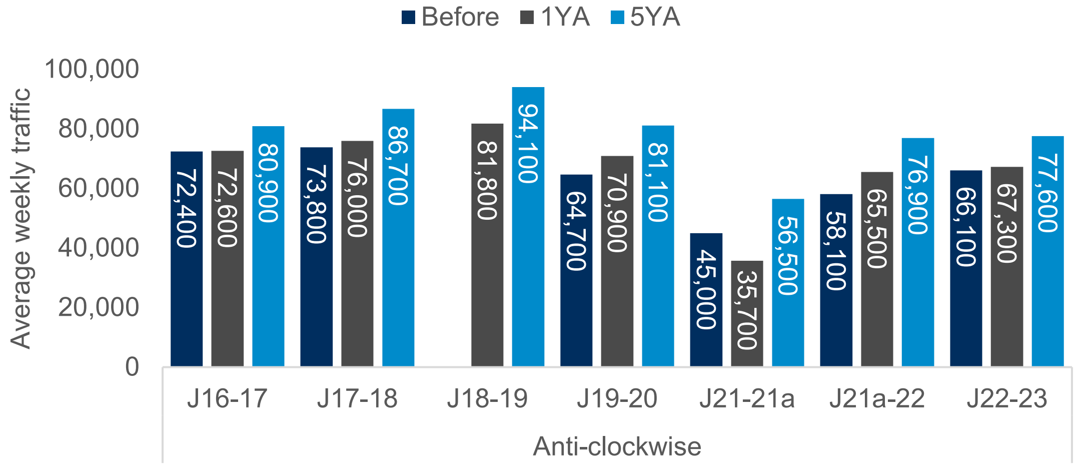
Figure 3 Comparison of before and five-year traffic flows on the M25 - clockwise



Source: Before (Nov 2008) and 1YA (2012): TRADS; 5YA (Nov 2017): National Highways WebTRIS

Note: figures presented are AWT (average weekday traffic)

Figure 4 Comparison of before and five-year traffic flows on the M25 - anticlockwise



Source: Before (Nov 2008) and 1YA (2012): TRADS; 5YA (Nov 2017): National Highways WebTRIS

Note: figures presented are AWT (average weekday traffic)

The highest growth occurred on the anti-clockwise carriageway near Hunton Bridge (between junctions 19-20), and near St Albans (between junctions 21-21a and junctions 21a-22). These parts of the M25 intersect with several important routes: the M1, the North Orbital Road, and the A1081. The traffic they carry was likely a contributory factor to the observed increases.

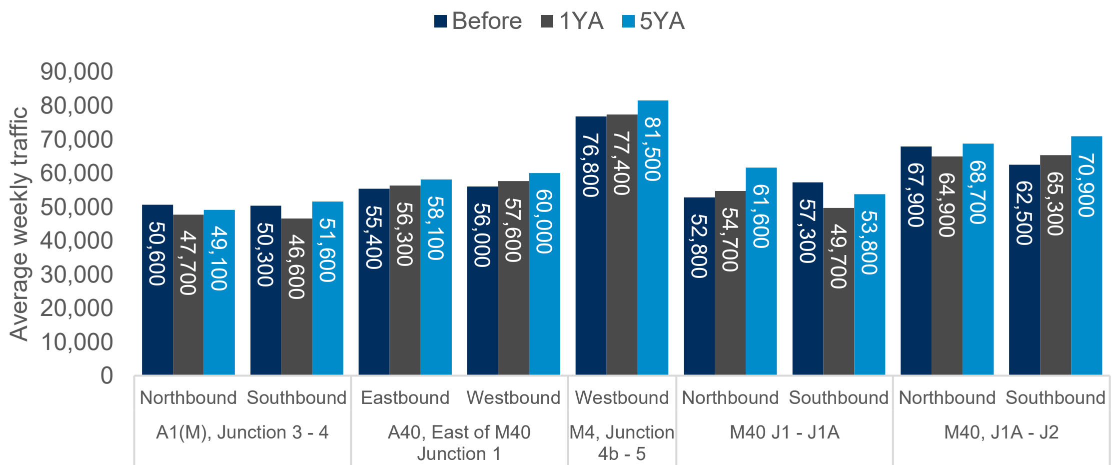
Wider area

We looked at the changes in traffic volumes on the relevant national routes which connect to the M25 to place the changes we observed on the project extent within a broader context. We assessed the A40, the M40 and the A1(M). Figure 5 shows the results for the years 2008, 2012 and 2017, where data was available.

The traffic growth on these routes was generally more modest compared to that seen on the project extent, and lower than the background trend for our motorways (9%).

. However, traffic on parts of the M40 grew between 13% and 17%. In contrast, volumes fell on another section of the M40 and on the A1(M).

Figure 5 Changes in strategic traffic in the model area



Note: No data was available at 5YA for the A1(M) between junctions 1 and 3, and for the M25 between junctions 24 and 25. These routes have been omitted from the analysis. Source: Before (Nov 2008) and 1YA (2012): TRADS; 5YA (Nov 2017): National Highways WebTRIS

The project's one-year after evaluation found that traffic volumes fell on most of the local roads that were assessed after opening. The project was deemed to have helped to reduce traffic flows with the reduction being indicative of a reduction in rat-running on the local network. For the five-years after evaluation we assessed several of the same roads to determine if anything had changed, and whether the project's impacts had continued. Figure 6 shows the two-way summarised results.

We found that traffic volumes on local roads had not kept pace with background trends. Indeed, in most cases they had fallen from the levels seen in 2008, before the project's construction. This suggested most of the impacts seen at one year after were substantial and long-standing.

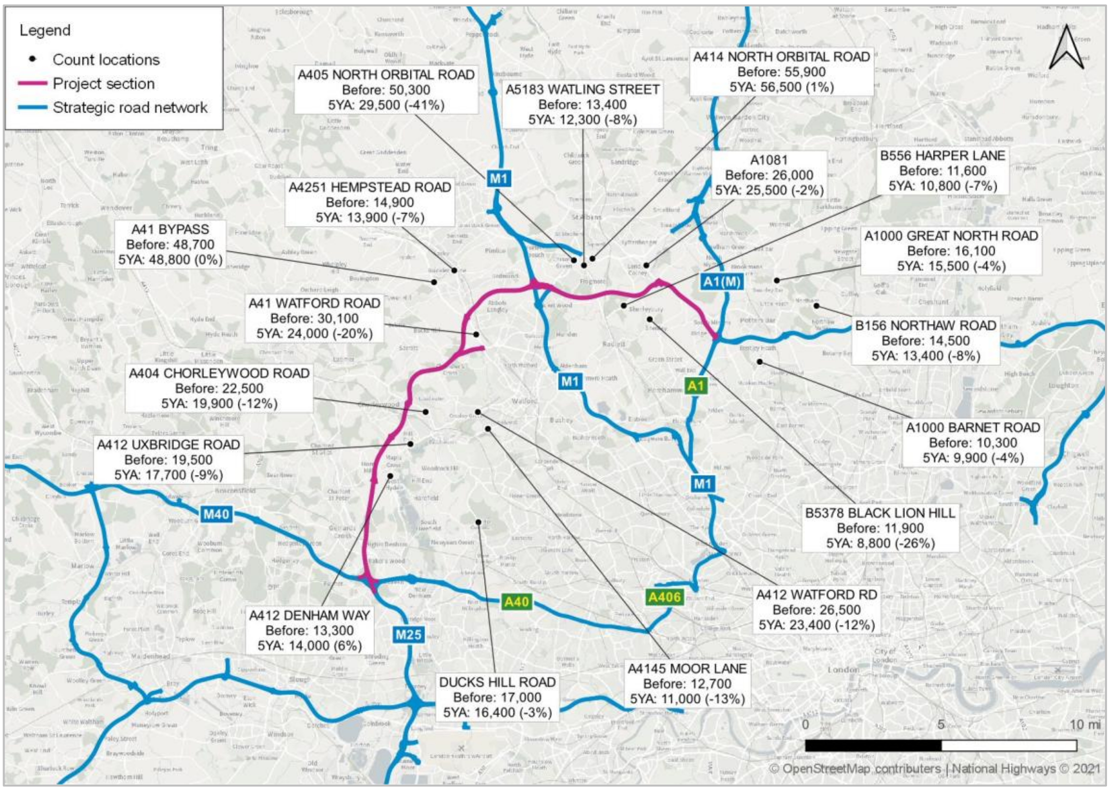
Many of the biggest declines occurred on roads inside the M25 on roads linking Watford and Rickmansworth to the nearby junctions of the M25. These ranged between a 10 and 24% decline on 2008 levels.

The largest fall however was seen on the A405 North Orbital Road, where there was a decline of 41% compared to 2008 levels. Such a fall was not observed at one year after, nor were the changes on nearby roads of similar size at five years after. Traffic on the A414 North Orbital Road fell by 1% and by 8% on the A1583 Watling Road. This evidence could indicate a change in the interim to the volume of road users routing between the M25 and the A414/M1/Hemel Hempstead and St Albans.

To the south of St Albans, inside the M25, traffic volumes on the B5378 Black Lion Hill in Shenley had fallen from 2008 levels by 26%. Closer inspection of the data found that traffic headed toward the M25 had fallen substantially (see Appendix A.1 Changes in traffic on the local road network).

On those roads where traffic levels didn't change much from 2008 levels we inferred that these were important local routes. These were the A41 bypass, A414 North Orbital Road, and the A1081.

Figure 6 Changes in traffic on local roads



Source: Data Insight, 2011, 2018, 2019 (formerly known as Spectrum)[6]

How are traffic flows distributed across the day?

The daily traffic profiles on most parts of the project section had not changed at five-years after from those observed before the project's construction. The morning and evening peaks occurred at the same times of the day. Volumes increased more in the later part of the day, mainly on sections clockwise from junction 18 onwards. The daily profiles can be found in Appendix A.

Was traffic growth as expected within the business case?

The investment decision for this project was supported by a project appraisal which included forecasts about the likely impact on traffic[7].

The modelled base year was 2004 and networks and demand matrices were developed for Section 1 using the following forecast years:

- 2012 – Proposed Opening Year.
- 2015 – Intermediate Year/Proposed Opening Year for Section 5.
- 2027 – Design Year (15 years after opening).

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[6] 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.

[7] The M25 North of Thames Assignment Model (NoTAM) was developed from the Highways Agency's NAOMI strategic traffic model v5.5 and used in the appraisal for Sections 1, 4 and 5 of the M25. SATURN (version 10.3) modelling suite was used to develop the M25 NoTAM model.

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(08:00 to 09:00)
- Inter peak period (10:00 to 16:00)
- PM peak (17:00 to 18:00)

The base network consisted of a simulation area, buffer area and a skeletal network covering a large part of Great Britain. The area covered by the SATURN simulation network included the entire area within the M25 and an area roughly bounded by Luton, Reading, Guildford, Crawley, Maidstone, Chelmsford and Stansted. Inside the simulation area, all motorways, A and B roads, as well as important unclassified roads, were included in the modelled network. Junctions were represented at several levels, with important junctions generally fully simulated.

Planning forecasts were taken from TEMPRO Version 5.3 to provide traffic growth for cars. Goods vehicle growth factors were derived from NRTF (NRTF 1997). The forecast flows for appraisal purposes were forecast assuming the most likely traffic growth (central) to future years. There were no low or high traffic growth forecasts.

The Do-Minimum network comprised of the M25 (in 2004) and any committed projects or projects on the verge of approval that were likely to have an impact of the M25 sections to be widened. This included the proposed widening projects for the rest of the M25 and excluding widening of Section 4 and Section 5 as discussed earlier.

The project's appraisal, traffic forecasts were produced in passenger car units (PCU) per average peak time period for the opening year.[8] For the five years after evaluation we interpolated the 'with project' forecast figures to 2017 and, where possible, compared them to factored observations[9] for the same time periods for 2017.

We compared the project's observed traffic volume impacts to those expected in its appraisal to understand how accurate the forecast model was. The full comparisons are presented in Appendix A1.3.

To get an overall sense of the accuracy of the forecasts we compared the proportional changes between the forecast change and the observed change (Figure 7). The results indicated the traffic forecasting model was generally accurate for most clockwise sections, with differences being within accepted ranges.[10]

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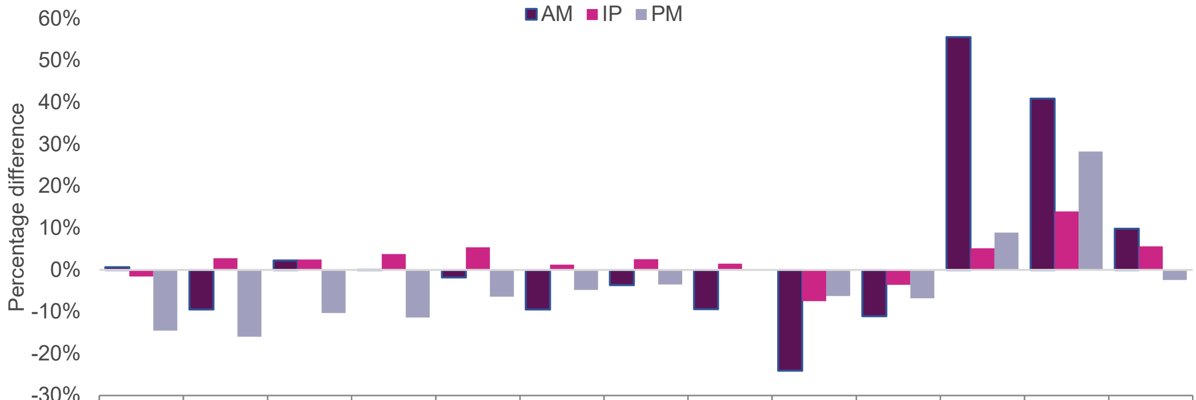
[8] PCU is a measure used in transport modelling to assess highway capacity. Different vehicles are assigned different values according to the space they take up. Smaller vehicles have lower values, larger vehicles have higher values. A car has a value of 1 while a HGV has a value of 2.3.

[9] The observed categorised average weekly traffic volumes for before and after the project were factored to produce respective PCU figures which could be more appropriately compared to the forecast values.

[10] Traffic models are usually deemed acceptably accurate if the forecast flows are within 85% of the observed flows used to valid the model.

Figure 7 Forecasting Accuracy



	Clockwise							Anti-clockwise					
	J15-J16	J16-J17	J17-J18	J18-J19	J20-J21	J21a-J22	J22-J23	J16-J15	J17-J16	J18-J17	J21-J20	J22-J21a	J23-J22
AM	1%	-9%	2%	0%	-2%	-9%	-4%	-9%	-24%	-11%	56%	41%	10%
IP	-2%	3%	2%	4%	5%	1%	3%	1%	-7%	-4%	5%	14%	6%
PM	-14%	-16%	-10%	-11%	-6%	-5%	-3%	0%	-6%	-7%	9%	28%	-2%

Note: Positive values indicate observed changes were greater than forecast changes. It is noted that a comparison of different years introduces a degree of uncertainty. Conclusions are deemed indicative rather than definitive. Source: Appraisal documents, TRADS and WebTRIS.

We found larger inaccuracies in forecasting for the anti-clockwise sections. Notably, there was an underestimation of the amount of traffic growth that occurred in the morning peak on the anti-clockwise carriageways between junctions 20 to 21a and between junctions 21a to 22. In contrast, the model overestimated the amount of growth that would occur in the morning on the anti-clockwise carriageway between junctions 16 to 17.

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.

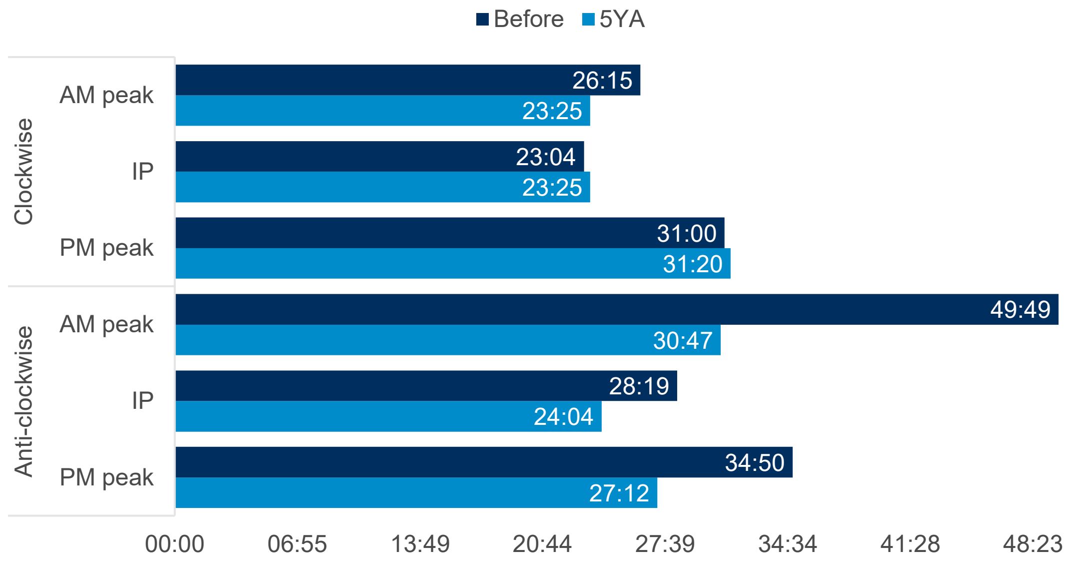
One of the objectives of the project was to improve journey time reliability on the M25 between junction 16 to 23. This section evaluates how the scheme impacted journey times and the reliability of journeys.

Did the project deliver journey time savings?

We have analysed average journey times from before (November 2008) and five years after (November 2017) the conversion to smart motorway as shown in Figure 8. One 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 extent[11].

[11] 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

Figure 8 Comparison of average journey times



Source: TomTom satnav data for November 2008 & 2017

In nearly all periods, we found that road users' average journey times had improved at five years after compared with before the project (Figure 8) This despite the increased traffic volumes that were observed.

Road users' journey times were most improved on the anti-clockwise carriageway, substantially so in the morning when road users saw improvements of 19 minutes on average. Their journeys in the middle of the day and in the evening peak were also improved, by an average of around 4 minutes and 8 minutes, respectively.

On the clockwise carriageway road users' journeys in the morning peak were improved too, by nearly 3 minutes on average. However, in the interpeak and evening peak their journeys got slightly longer, by around 20 seconds.

How did the scheme impact speed?

We analysed speeds along the length of the project to understand the impact on journey times in more detail. Figure 9 displays the average speeds.

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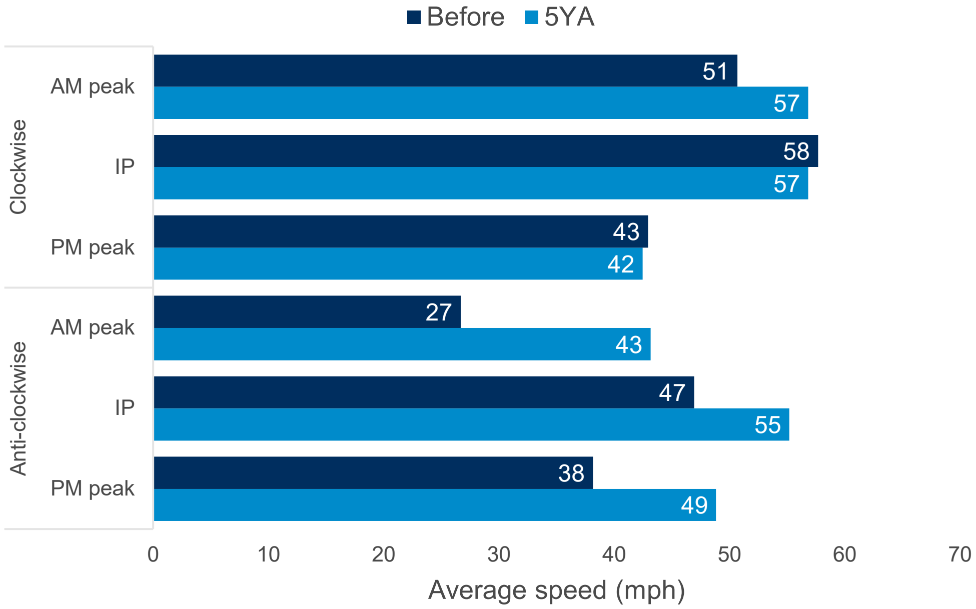
likely to have been without the scheme. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion. The counterfactual analysis concluded that overall there has been a benefit of 4,659,857 vehicle hours in the fifth year.

Figure 9 Changes in average speed per time period



Source: TomTom satnav data for November 2008 & 2017

As would be expected from the journey time analysis, road users' average speeds on the anti-clockwise carriageway at five years after were substantially improved compared to before. Road users were achieving average speeds of 43 mph in the morning compared to less than 30 mph before, and 49 mph in the evening compared to 38 mph before.

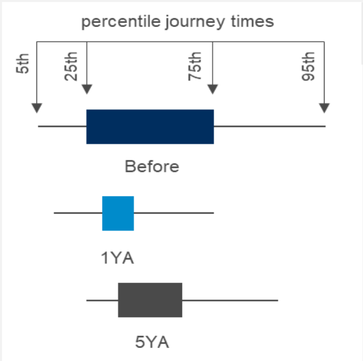
Analysis of speeds[12] over distance revealed more detail about the improvements seen at five years after (see Appendix A Changes in cumulative speeds). Before the project, road users' average speeds declined when travelling from junctions 23 to 20, especially in the morning and evening peaks. The evidence indicated the project's improvements had addressed this issue on the anti-clockwise carriageway.

Did the scheme 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.

[12] Harmonic averages provided by the TomTom satnav data.

Figure 10 What does a box plot show?



The lowest point is the 5th percentile, this means 5% of journeys take less than this 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.

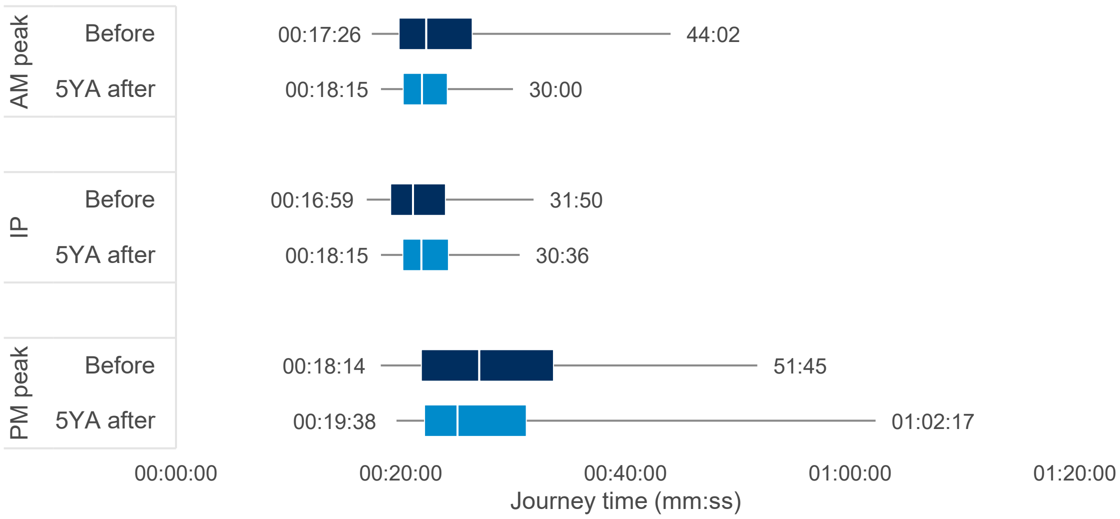
The length of the block shows how the journey times vary between the 25th and 75th percentile (25% and 75% of journeys). The shorter the block the less variable and hence more reliable a journey would be.

The impact on reliability is visualised in Figure 11 and Figure 12. 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. In almost all cases, road users' longest journeys at five years after were now shorter and more therefore more reliable. Some substantial improvements were seen, notably in the morning peak on the anti-clockwise carriageway, where the longest journeys had improved by over an hour. Before the project they were observed to be over two hours.

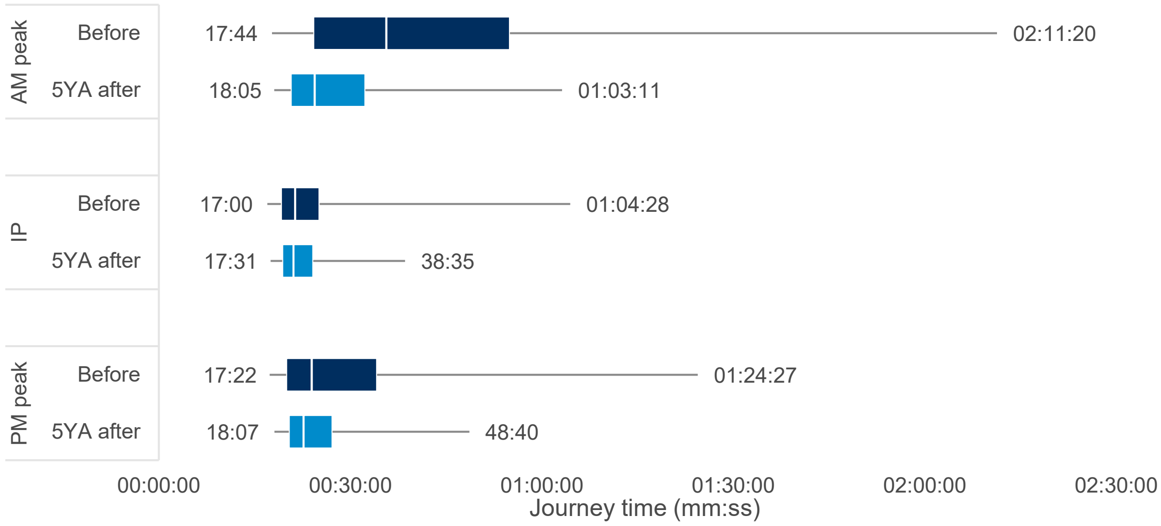
Only in the evening peak on the clockwise carriageway were the longest journeys longer. They had increased from around 50 minutes before the project to just over an hour at five years after.

Figure 11 Journey time reliability along the scheme length, clockwise



Source: TomTom satnav data for November 2008 & 2017

Figure 12 Journey time reliability along the scheme length, anticlockwise



Source: TomTom satnav data for November 2008 & 2017

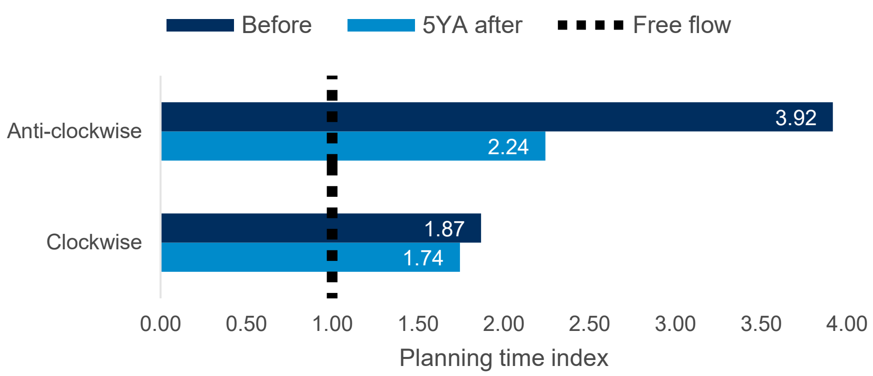
Road users' average journeys showed improvement at five years after, as denoted by the shift left of the 50th percentile.

Did the project impact the planning time index?

We analysed the journey time data to determine the impact of project on another aspect of reliability, the planning time index (PTI). This is a metric used by National Highways which provides an estimate of the amount of additional time that a road user would need to allow to ensure they arrive at their destination on time. It is a ratio of the 95th percentile to the free-flow journey time. The free-flow time is taken to be either the maximum of the journey time and 15 percentile journey time (i.e. that when taken at the 85th percentile speed) or the journey time taken at the 70mph motorway speed limit, whichever is the greater value.

The evidence suggested that at five years after, road users' journeys along the project section were more reliable. Notably journeys on the anti-clockwise carriageway had improved significantly since 2008. Figure 13 shows the results.

Figure 13 Change in planning time index



Source: TomTom satnav data for November 2008 & 2017

5. Safety Evaluation

Summary

The safety objective for this project was to improve safety performance [13].

The number of personal injury collisions[14] 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 improvements.

There had been an annual average reduction of 93 personal injury collisions, which is in line with the appraised business case for the project. This is based on an annual average of 111 personal injury collisions after the project was operational compared with 214 before the project. If the road had not converted to controlled motorway, we estimate that the number of personal injury collisions would have been between 181 and 243 (Figure 17).

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 10 personal injury collisions per hundred million vehicle miles, this equates to travelling 10 million vehicle miles before a collision occurs. Before the project the collision rate was 19 per hundred million vehicle miles, this equates to traveling five million vehicle miles before a collision occurs. If the road had not been converted to controlled motorway, we estimate the collision rate would remain at 17 collisions per hundred million vehicle miles.

The number of FWI[15] has decreased annually. Before the project there was an annual average of 9 FWI per year. After the project became operational, this has reduced to 4 FWI per year. When accounting for the increased number of road users over this period, there had been a reduction from 0.9 to 0.4 FWI per hundred million vehicle miles travelled.

On the surrounding network[16] there was an average decrease of 202 personal injury collisions per year (based on an annual average of 274 personal injury collisions observed after the project had opened compared with 476 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 435 to 529

Based on this analysis the project has exceeded what was expected and has met its safety objective.

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

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

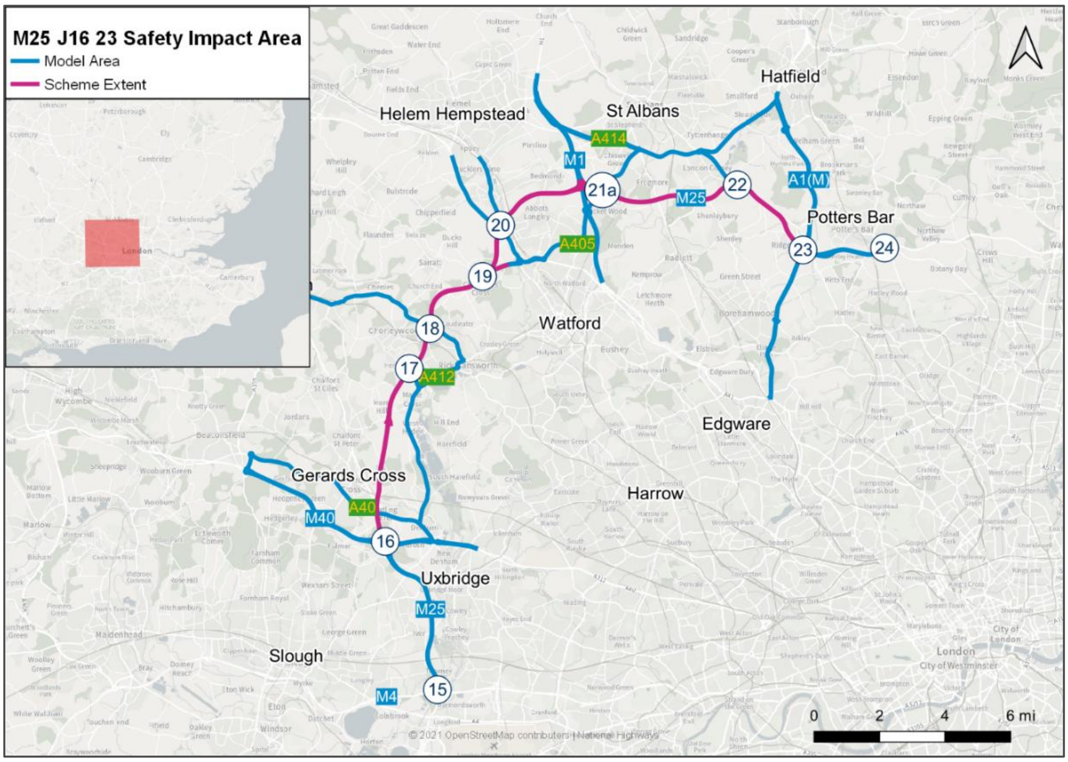
[15] The FWI weights Collisions based on their severity. A fatal collision is 1, a serious collision is 0.1 and a slight collision is 0.01. The combined measure is added up. A full number is the equivalent to a fatality.

[16] 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

Safety study area

The safety study area is shown in Figure 14This area was assessed in the appraisal supporting the business case for the project to check any potential wider implications of the intervention. 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 roads within the same area as the appraisal to understand the emerging safety trends.

Figure 14 Safety study area



Source: National Highways and OpenStreetMap contributors

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 data[17]. 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.

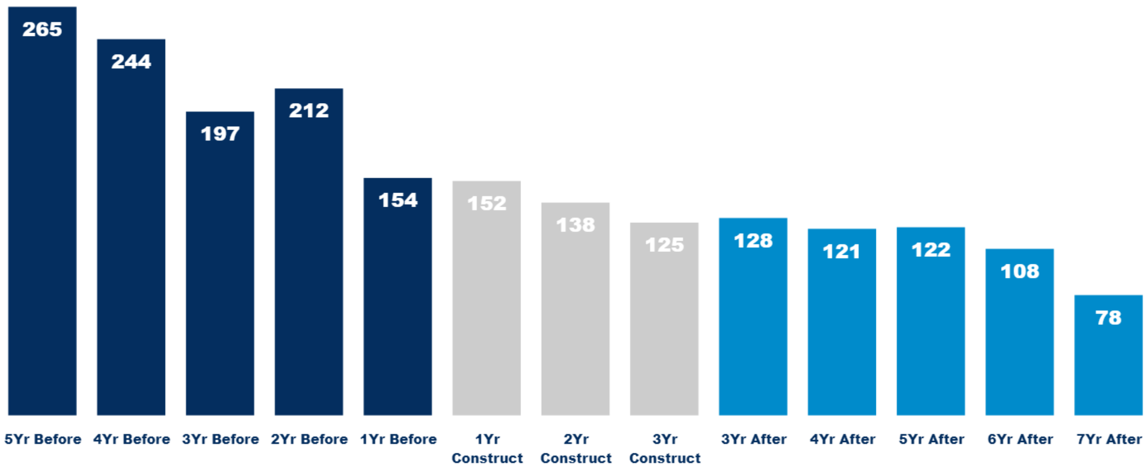
The analysis draws on the following data collection periods:

- Pre-construction: 1 May 2004 to 30 April 2009
- Construction: 1 May 2009 to 31 May 2012
- Post-opening: 1 June 2014 to 31 May 2019[18]

[17] https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data
[18] We have used Post Opening dates for when the controlled motorway gantries became operational

The evaluation found the number of personal injury collisions on the project extent, had decreased[19]. Over the five years after the project was operational, there were an average of 1221 personal injury collisions per year, 93 fewer than the average 214 per year over the five years before the project was constructed.

Figure 15 Annual Personal Injury Collisions



Source: STATS19: 1 May 2004 to 31 May 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 Figure 16 and POPE methodology manual[20]). This is based on changes in regional safety trends for conventional motorways with a high volume of roads users.

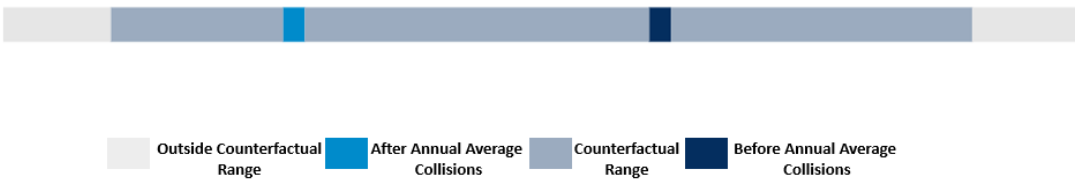
Based on this assessment we estimate that if the road had not been converted to a smart motorway, the trend in the number of personal injury collisions would likely have increased, and collision rates would remain stable as shown in Figure 17 below.

[19] impacts on the wider area are discussed in the next section
[20] https://nationalhighways.co.uk/media/exypgk11/pope-methodology-note-2024-v2.pdf

Figure 16 What does the counterfactual show?

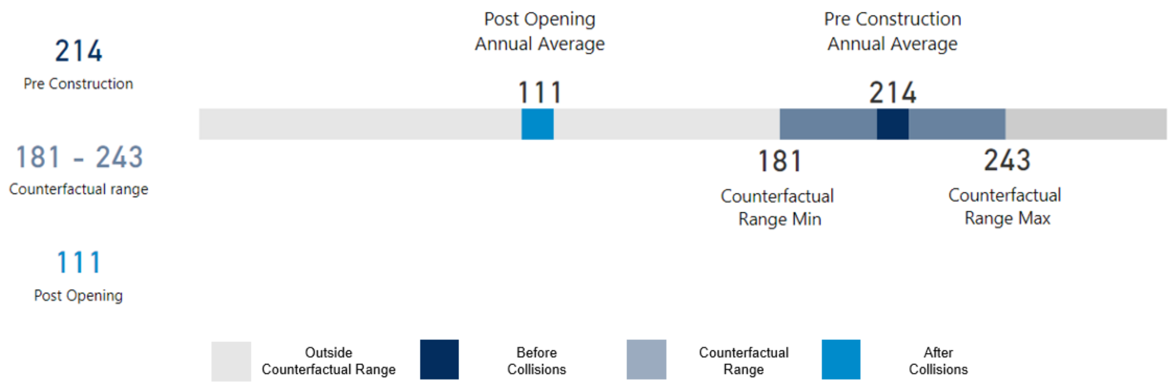
The counterfactual is an estimation of what we think would occur without the project taking place. We estimate a range of collisions that follow regional trends. The chart shows:

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 181 and 243 personal injury collisions[21] during the five-year post project period would be expected, as shown in Figure 17.

Figure 17 Observed and expected range of personal injury collisions



Source: STATS19: 1 May 2004 to 31 May 2019

The number of observed personal injury collisions falls below the expected range. Therefore, the observed changes are significant, which means the decline in personal injury collisions could be attributed to the project.

[21] 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.

How has traffic flow 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 19 personal injury collisions per annual hmvm. After the project improvements were made, there was a decrease to 10 personal injury collisions per annual hmvm.

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

A counterfactual test was undertaken. It found that the collision rate would likely have been 17 collisions per annual hmvm in the counterfactual scenario. Statistical testing of the results indicate that they are significant. We can be confident that the project has contributed to lowering the collision rate

What impact did the project have on the severity of collisions?

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 officer[22]. As a consequence, the Department for Transport have developed a severity adjustment methodology[23] 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.[24]

After the scheme we have observed a total reduction of 10 collisions resulting in fatalities (the total before the scheme was 14, compared to four after). There was an average of 97 fewer collisions resulting in slight injuries per year (the annual average before the scheme was 190, compared to 93 after), four fewer collisions resulting in serious injuries per year (the annual average before the scheme was 21, compared to 17 after. Figure 18 shows the severity of personal injury collisions.

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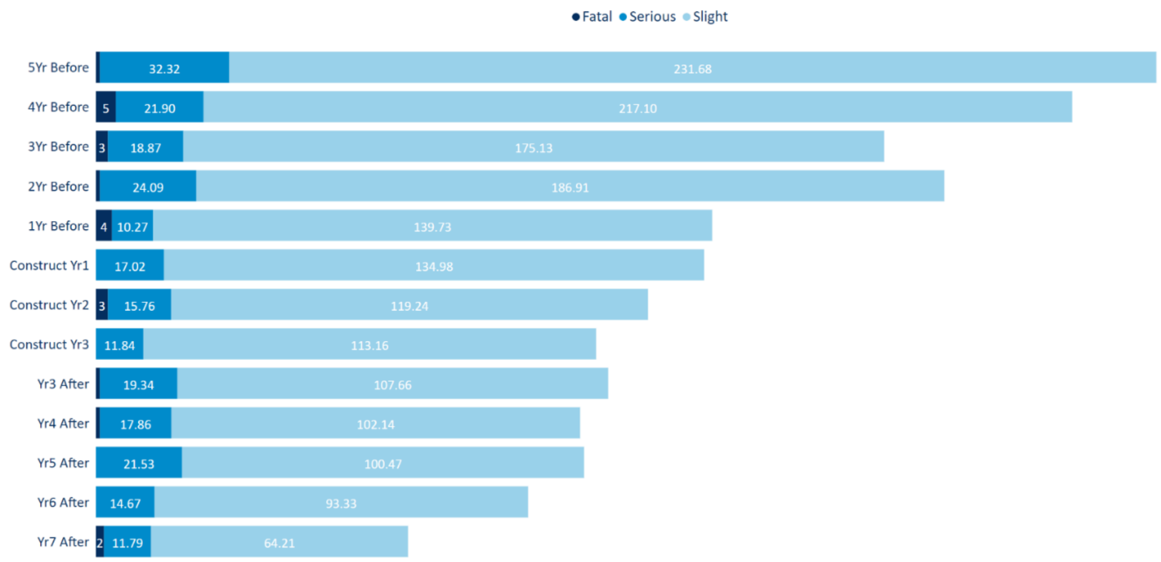
[22] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820588/severity-reporting-methodology-final-report.odt

[23] 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

[24] Collision Severities within this report use the 2020 adjustment factor

Figure 18 Severity of personal injury collisions within the project extent[25]



Source: STATS19: 1 May 2004 to 31 May 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 casualty[26]. In effect, it takes all non-fatal injuries and adds them up using a weighting factor to give a total number of fatality equivalents[27]. 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 five 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 nine FWI were observed. After the scheme this had reduced to an annual average of four fatality equivalents.

The combined measure showed an extra 122 million vehicle miles was travelled before a FWI[28]. The rate of FWI per hmvm[29] 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.

[25] As per DfT guidance, adjusted severities are presented with two decimal points
[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. So 10 serious collisions, or 100 slight collisions are taken as being statistically equivalent to one fatality.
[27] Casualty Severities within this report use the 2020 adjustment factor
[28] Before the scheme, 121 million vehicle miles needed to be travelled before a FWI (0.8 FWI per hmvm). After the scheme this increased to 242 million vehicle miles (0.4 FWI per hmvm).
[29] hmvm – hundred million vehicle miles

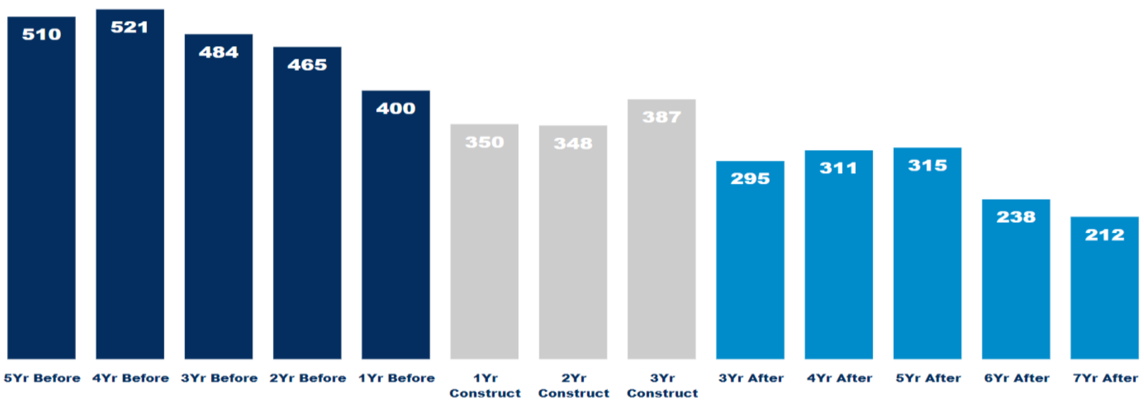
Road user safety on the junctions and wider area

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 as shown in Figure 14.

Before the project an annual average of 476 collisions were observed. After the project, this had fallen to 274, a decrease of 202.

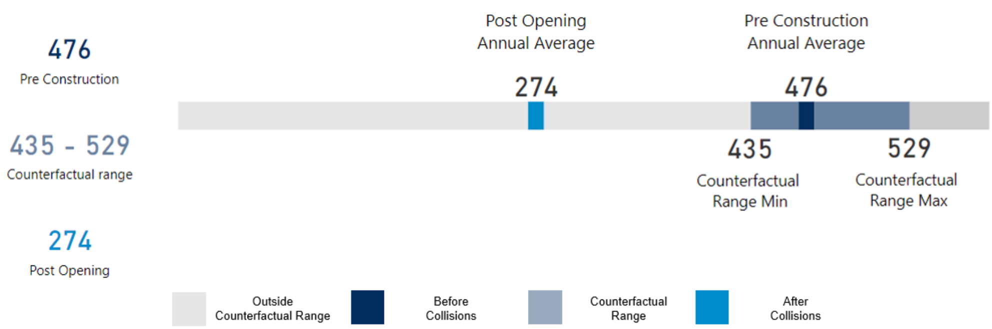
Figure 19 Annual personal injury collisions in wider area



Source: STATS19: 1 May 2004 to 31 May 2019

The counterfactual analysis indicated that it is likely that an annual average of between 131 and 214 personal injury collisions would have occurred. 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 20 Observed and expected range of personal injury collisions in wider area (annual average)



Source: STATS19: 1 May 2004 to 31 May 2019

How has traffic flow 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 scheme, there was an annual average of 26 personal injury collisions per hundred million vehicle miles. After the scheme improvements were made, there was a decrease to 15 personal injury collisions per hundred million vehicle miles. A decrease of 11 personal injury collisions per hundred million vehicle miles.

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

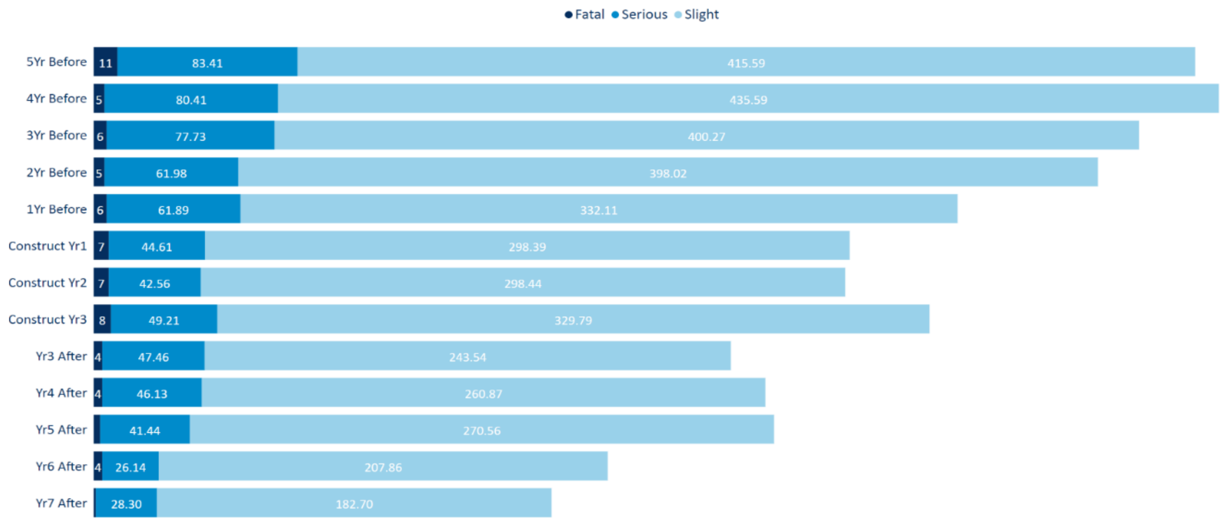
A counterfactual test was undertaken. It found that the collision rate would likely have been 28 collisions per hundred million vehicle miles in the counterfactual scenario. This indicates we have observed a larger reduction in the rate that personal injury collisions occur than predicted. Statistical 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 a reduction of 17 collisions resulting in fatalities (the total before the scheme was 33, compared to 16 after). There was an average of 35 fewer collisions resulting in serious injuries per year (the annual average before the scheme was 73, compared to 38 after). There was an average of 163 fewer collisions resulting in slight injuries per year (the annual average before the scheme was 396, compared to 233 after). Figure 20 shows the severity of personal injury collisions.

Figure 21 Personal Injury Collisions by Severity in wider area



Source: STATS19: 1 May 2004 to 31 May 2019

How has traffic flow 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 injuries[30] (FWI).

A decrease of 11 FWI has been observed. Before the project the average 22 FWI were observed. After the project this had decreased to 11.

The combined measure showed an increase of 62 million vehicle miles was travelled before a fatality[31].

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[30] FWI is explained above.

[31] Before the project, 67 million vehicle miles needed to be travelled before a FWI (1.5 FWI per hmvm). After the project this increased to 129 million vehicle miles (0.8 FWI per hmvm).

Has the project achieved its safety objectives?

The safety objective for this project 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 for project extent are significant. We can be confident that the project has met its safety objective for the project extent.

Statistical testing of the results for Collision Reduction and Collision Rates are significant for the model impact area. The project appears to have assisted in improving safety on the surrounding road network.

Initial appraisal for the project estimated that there would be a reduction of 12 personal injury collisions per year over the appraisal period (60 years) for the project extent. This equated to a decrease of 746 personal injury collisions over the appraisal period (60 years). The decrease in collisions would contribute to decrease in the number of casualties by 1280 during the same period (on average a reduction of 21 casualties per year).

Due to a predicted traffic increase on the model area the appraisal estimated that there would be an increase of 12 personal injury collisions per year over the appraisal period for the model area. This equated to an increase of 730 personal injury collisions over the appraisal period.

Overall, the appraisal predicted that the project would have a neutral net benefit of 16 fewer collisions for project extent and model area over the appraisal period. Analysis shows that the appraisal underestimated the potential safety benefits for this project.

6. Environmental Evaluation

Summary

The evaluation of environmental impacts used information on the predicted impacts gathered from the environmental appraisal and the environmental assessment report (ES). This information, along with our findings reported in our one-year after evaluation[32] were compared against the observed impacts determined during our five-years after site visit in September 2018. The results of the evaluation were recorded against each of the TAG[33] environmental sub-objectives. These are presented in the summary table 2. The evaluation of environmental impacts focused on the environmental sub-objectives (noise, air quality, greenhouse gas emissions, landscape, townscape, heritage, biodiversity and the Water Environment). The appraisal predicted that the project would not cause any changes to townscape. This was confirmed during our one-year after evaluation and so was scoped out of our five-years after evaluation. The society objectives of physical fitness, severance and journey quality were also scoped out of our five-years after evaluation because there were no outstanding issues following our one-year after evaluation. This is in line with the POPE Methodology Manual.

The five-years after evaluation found that the impacts of the project on noise, landscape, biodiversity and the water environment (drainage) were broadly as expected by the appraisal and the environmental assessment. The impacts on air quality and greenhouse gases along the project extent were better than expected because observed traffic flows were lower than those predicted. Based on the five-years after evaluation visit, some landscape mitigations (planting for screening and integration) and ecological mitigations (habitat reinstatement and species enhancement) were establishing, but there was little evidence of recent management of the planting plots. Despite the lack of obvious recent management, it was still considered that the design year outcomes would be met.

Noise

The appraisal reported that the number of properties exposed to more than 66 dB[34] of noise would reduce from 253 to 202 when the project opened for traffic. Mitigation of noise impacts from increased traffic flows was proposed and this included a central reserve concrete wall and new environmental barriers. The appraisal considered the predicted impacts on sensitive receptors such as schools and nursing homes. The appraisal predicted that Langlebury School would benefit from a slight reduction in noise and at both Allington Nursing Home and Sunrise Old People's Home, there would be no change in noise level. At a Pastoral Centre it was predicted that there would be a slight increase in noise level but this would be less than 3 dB. Further design work was undertaken prior to the start of works to help limit noise impacts. This works included improvement to the road surface material changes to landscape bunds and more noise barriers. Following this further work, twelve houses and four properties within a caravan park were shown to be eligible for discretionary noise insulation.

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32 M25 Junction 16-23 Widening One-year after study October 2014

33 TAG – Transport Appraisal Guidance: provides Government guidance on appraising the benefits of transport projects

34 decibels (dB)

The one-year after evaluation reported that the impacts of the project on noise were broadly as expected. This was because traffic flows were lower than expected. Traffic speeds were higher than expected during the interpeak and evening peak times but they were not significant enough to affect local noise. The five-years after evaluation found that the noise barriers, landscape bunds and low noise surfacing were in place. It was expected that they would be providing noise benefits for nearby residential properties. However, the scale of any benefit could not be quantified because the noise mitigation performance of these measures were not known. We compared the observed traffic flows against those forecast and found that the observed flows along most of the scheme are less than forecast but within 20% of the forecast flows. This suggested that the overall impact of the project on noise was likely to be as expected.

Air quality

The appraisal reported that there were seven AQMAs[35] along the project, declared by four of the seven local districts. It stated that there were no predicted increases of PM_{10}[36] of more than 1µg/m^3 and no predicted increases of NO_2 concentrations[37] of more than 2µg/m^3 or concentrations of more than the UK Air quality standard[38] of 40µg/m^3. Overall, a net improvement in air quality was predicted in the generalised assessment for NO_2, but deterioration for PM_{10}, although the percentage changes were predicted to be very small (e.g. 0.007% from do something 2012 for NO_2).

The one-year after evaluation reported that the observed traffic flows were lower than forecast along all sections of the motorway, which should indicate that pollutant concentrations were lower than those estimated in the environmental assessment. There was no change to the AQMAs in the surrounding area which suggested that air quality had remained the same, with continued breaches of the NO_2 annual average air quality standard at sites near the M25 J16 to 23. At five-years after, data from local AQ reports (from the districts of Hertsmere, [39] St Albans, [40] South Bucks District[41] and Three Rivers[42]) indicated that pollutant concentrations had not worsened within and around AQMAs. This was in line with the appraisal and the environmental assessment. Analysis of traffic data suggested that due to lower overall traffic flows and slower peak time speeds compared to those forecast, pollutant concentrations or emissions were likely to be lower than forecast.

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[35] AQMA – Air quality Management Area, declared due to exceedance of the EU annual limit value.
[36] PM_{10} describes inhalable particles with diameters generally 10 micrometers and smaller.
[37] NO_2 is the gaseous air pollutant nitrogen oxide.
[38] Information on UK Air quality limits can be found at: https://uk-air.defra.gov.uk/air-pollution/uk-eu-limits
[39] Hertsmere Air Quality Report: https://www.hertsmere.gov.uk/Documents/04-Environment-Refuse--Recycling/Environmental-Health/Pollution-Control/ASR-Hertsmere-2018-v2-PDF-4.45Mb.pdf
[40] St Albans Air Quality Report https://www.stalbans.gov.uk/sites/default/files/documents/publications/Environmental%20and%20Sustainability/air-pollution/Air%20Quality%20Annual%20Status%20Report%202019.pdf
[41] South Bucks Air Quality Reporting: https://www.southbucks.gov.uk/article/8321/Air-Quality-Review-and-Assessment
[42] Three Rivers Air Quality Report: https://www.airqualityengland.co.uk/assets/documents/Three_Rivers/FINAL_TRDC_ASR_2019_v2.pdf

Greenhouse gases

Government guidance notes that carbon dioxide (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.[43] The appraisal predicted that, compared to the Do-Minimum scenario, the project would slightly increase carbon emissions by about 0.175% over the 60-year appraisal period. The Change in total Carbon Emissions was predicted to be 18,576 tonnes in the opening year and 869,560 tonnes over 60 years, giving a NPV[44] of – £29.9m.

The POPE methodology manual sets out an approach for evaluating the carbon emissions along the project. 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.

The one-year after evaluation reported that the project had had a better than expected impact on greenhouse gases, as the outturn emission with the project were predicted to be less than forecast. This difference was considered to be primarily due to traffic flows being lower than expected.

At five-years after we intended to use the available traffic data to repeat our analysis and compare a recalculated forecast emission against an observed emission for the project extent. However, at five years after we did not have sufficient information on the percentage of heavy goods vehicle (HGVs) to allow us to quantify the emissions. At five-years after observed traffic flows 15% were lower (on average) than predicted. Whilst this suggested that emissions were likely to be lower than expected along the project extent, without the data to quantify the impact of changes in HGVs, we could not be certain.

Landscape and townscape

The environmental appraisal stated that continuous lighting (previously intermittent), gantries and signage would bring the greatest change in landscape character. It would also increase the perception of urbanisation in the countryside, including in Chilterns Area of Outstanding Natural Beauty. The appraisal predicted that it would be difficult to mitigate some of the effects of the project. This was because there was limited land available to help provide suitable planting to screen and integrate the new infrastructure into the landscape. The overall impact of the project on landscape was expected to be moderate adverse.

The one-year after evaluation report identified that changes to the project design were implemented during construction. These changes reduced the visual impacts by using less hard engineering structures to support embankments and maximising the opportunities for softer embankment reprofiling and vegetation retention. Although vegetation and screening planting was still lost, the permanent visual effect of vegetated slopes rather than the use of hard retaining features was considered to be positive. The evaluation did however highlight concerns with poor establishment of mitigation planting and attributed this to ground preparation measures and potential soil compaction issues on site. It was recommended that plant establishment be reconsidered at five-years after. This was considered

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[43] WebTAG Environmental Impact Appraisal: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/254128/webtag-tag-unit-a3-environmental-impact-appraisal.pdf

[44] NPV – Net present value.

especially relevant for planting plots that were designed to provide screening. Other landscape mitigations such as grassland plots and hedges were considered to be establishing as expected.

At five-years after we carried out a site visit to observe the impacts of the scheme and to consider how well the mitigation was progressing. Our site visit confirmed that the impacts of the project (widening and the introduction of gantries) on landscape character and visual amenity predicted by the environmental assessment were broadly as expected. New gantries and signage had added to the urbanisation of the landscape. Mitigation planting growth appeared to be on target to reach its screening, integration and habitat creation objectives. New gantries and lighting remained prominent within the landscape, but the mitigation planting was expected to help soften the effects by the Design year (year 15). Although there were some planting plots that were still showing limited growth, possibly due to continuing compaction issues, it was not expected to affect the overall landscape and visual effect of the project. Overall the impacts were considered to be as expected.

Figure 22 examples of mitigation along the project extent

Figure 23 View of M25 from Footpath F21 representative of residential receptors on Long Lane

Heritage of historic resources

The environmental appraisal stated that there were no surviving archaeological remains within the highway boundary, and so there was no impact on archaeological remains. The appraisal predicted there would be some impacts on archaeological remains at 12 sites outside the highway boundary due to widening and landscaping earth bunds at Chorleywood, Brickett Wood, J20 and South Mimms. But these would be mitigated through a programme of archaeological excavation and recording. The overall impact of the project on heritage resources was predicted to remain as Neutral.

The environmental assessment predicted a moderate to slight adverse effect on the Chiltern's Area of Outstanding Beauty (AONB, i.e., an historic landscape) due to new lighting and gantries causing new visual intrusion. However, these were noted as changes to an existing highway and so were not expected to be of scale likely to affect any key historic elements of the AONB.

The one-year after evaluation reported that design changes had reduced the visual impact of cuttings, embankments, and bunds. The changes had also optimised the mitigation effect of new vegetation and noise screening. Overall visual impacts on the setting of historic buildings were neutral as expected. However, it was considered that the new gantries had an adverse impact to the context of the Chalfont Viaduct (railway crossing over the Misbroune River valley). The environmental assessment considered that this impressive and distinctive landscape feature which is part of the built heritage but not listed could face an *uncertain* impact from the project. Archaeological investigations had been undertaken but at one-year after the analysis had not been completed and finds and archive not yet deposited. It was however expected that investigation would have added to our knowledge and understanding of the archaeology and would be helping to mitigate the impacts. It was recommended that the five years after evaluation confirm that the finds and archive had been deposited.

The five-years after evaluation including the site visit confirmed that the project has had a neutral residual impact on the setting of historic buildings. The design changed had been effective and the mitigation was in place. However, the new gantries were likely to have had a slight adverse impact to the context of the Chalfont Viaduct. The evaluation also confirmed that the archaeological finds and information had been deposited with St Albans City and District Council and should be adding to knowledge and understanding of the archaeology effected. Overall, it was considered that the impacts of the project were as expected.

Biodiversity

The appraisal anticipated that the project would result in slight beneficial impacts to biodiversity. This would be from the reinstatement of species-rich grasslands, the creation of new wetland and species-rich hedgerow habitat, and strategic planting to improve habitat connectivity. The improved habitats would provide large beneficial effects for otters and water voles. Bats, birds and aquatic species were expected to experience permanent slight adverse effects from increased lighting. This would reduce habitat quality particularly in areas unlit before the project. The overall impact of the project on biodiversity was assessed as slight adverse.

The one-year after evaluation report concluded that the effect of the project on biodiversity was broadly as expected. Habitat reinstatement was establishing as expected, although management of seeding and planting plots was not applied equally throughout. Species enhancements (hibernacula, bird and bat boxes, and otter holts) were provided as expected, although the success of these enhancements, including the refurbished badger tunnel at Junction 20, could not be determined at the one-year after stage. Residual effects on great crested newts, birds, bats, badgers and otters were as expected from the environmental assessment, . Habitat enhancements (e.g. the creation of a new pond for water voles within Junction 16) were likely to have a residual benefit for water voles. The reinstatement works proposed in the environmental assessment as compensation for the slight adverse impacts due to the loss of ancient woodland to widening did not appear to have commenced. It was recommended that this was reconsidered as part of five-years after evaluation.

At five years after, our evaluation site visit considered the condition of the habitat reinstatement and the progress made since one-year after. We found that habitat reinstatement was establishing broadly as expected. However, weed growth within many of the planting plots was widespread with little sign of recent management. We were unable to confirm the outcome of any bat monitoring and the extent and outcome of management works to help mitigate impacts to ancient woodlands. Species enhancements (bird and bat boxes) had been provided and Great Crested Newt surveys also confirmed that they appeared unaffected by the project. Overall, whilst there were issues, it was considered that the impacts of the project were broadly as expected.

Water environment

The appraisal reported that the project would increase the area of road surface which would increase the volume surface water runoff. It predicted however that there would be no increase in peak flow rates and there would be no further encroachment onto floodplains. The project was expected to improve overall water quality through new and improved water management and mitigation including the removal of some discharges to SPZ1[45]. The appraisal predicted that six watercourses would be improved but two watercourses would receive increased pollution loading from the increased surface water runoff. A further two watercourses would experience both improvements and deterioration for different water quality indicators. Three watercourses would be largely unchanged and so would maintain their existing potential to exceed an EQS[46] although with a reduced level of exceedance. Pollution risk from accidental spillage would be reduced by improved mitigation and containment provisions. Soakaways would be located further away from public water supply abstraction points to reduce the risk of impacts. The overall impact expected for water resources was assessed as slight beneficial.

The environmental assessment suggested operational mitigation, i.e., improved pollution control measures (the relocation of soakaways, improvements in routine run-off provision and significant improvements in spillage containment) to reduce the potential impacts of the project on water quality. These were expected to comprise a new surface water drainage system including new larger diameter pipes to provide additional attenuation and storage capacity to prevent increases in flow rates.

The one-year after evaluation concluded that the new mitigation measures had been implemented. Design changes had added new ponds to improve the storage and quality of surface water discharges to soakaways and also an overall reduction in the number of soakaways. These changes had been agreed with the Environment Agency and it was considered had resulted in an improvement on the pre-project situation. Whilst a flooding issue was raised by the Hertsmere Borough Council, and some decrease in water quality was noted, based on the information available at one-year after, it was considered that the project's overall impact had been as expected.

A visual inspection of surface drainage features was done during the five-years after evaluation site visit. The visit confirmed that the impacts of the project on water resources were likely to be broadly as expected, and the mitigation provided as planned. No evidence was found to suggest that mitigation ponds and the overall drainage systems were not performing other than as was intended. Based on the information available at five-years after, it was considered that the project's overall impact on the water environment was as expected.

Overview

The results of the evaluation are summarised against each of the Transport Appraisal Guidance (TAG)[47] 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 year 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

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[45] Source Protection Zone 1 – Inner protection zone: Defined as the 50-day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.

[46] EQS – Environment Quality Standard.

[47] TAG **provides guidance on appraising transport options against the Government's objective for transport.**

following the evaluation there remains insufficient evidence to draw firm conclusions.

Table 2 Five-year environment evaluation summary results

Sub - objective	Appraisal score	Five-years evaluation	Summary
Noise	Change in Population Annoyed (Yr. 15) = +27. Estimated Population Annoyed Do-Minimum 665. Do-Something 692	As expected overall.	Noise mitigations (noise barriers, landscape bunds and low noise surfacing) were likely to be a benefit to the local noise climate. A comparison of observed traffic flows against forecast suggests that the overall impact of the project on noise was likely to be as expected.
Air Quality	PM_{10}: Properties Improve 976; No Change 0; Made Worse 559. NO_2: Properties Improve 1129; No Change 0; Made Worse 406	Better than expected.	Local air quality monitoring data suggested that pollutant concentrations had not worsened within and around Air Quality Management Areas. Lower overall traffic flows and slower peak time speeds, suggested air quality impacts were likely to be lower than forecast.
Greenhouse Gases	0.175% over the 60-year; NPV= -£29.9m.	Better than expected.	Lower than forecast traffic flows suggested that GHG emissions were likely to be lower along the project extent than forecast. We did not have the necessary data to quantify the difference or consider the impact of changes in HGVs.
Landscape	Moderate adverse	As expected	New road infrastructure had added to urbanisation effects in the predominantly rural landscape as predicted. Overall, mitigation planting was establishing broadly as expected although poor

			ground conditions were affecting some plots.
Heritage of historic resources	Neutral	As expected.	The project had not had a significant impact on the setting of historic buildings, although new gantries were likely to have had a slight adverse impact to the setting of the Chalfont Viaduct. Archaeological finds and the knowledge they present had been deposited with the local Council.
Biodiversity	Slight Adverse.	As expected.	Habitat reinstatement was establishing broadly as expected species enhancements had been provided and Great Crested Newt surveys confirmed that they were unaffected. However, weed growth within plots was an issue and we could not confirm that bat monitoring or works to mitigate impacts on ancient woodlands had been completed.
Water resources	Slight Beneficial.	As expected.	Based on the site visit and information available, the impacts of the project on water resources were likely to be broadly as expected. Balancing ponds and the improved drainage system were likely to be performing as planned.

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 £634 million[48]. In the first five years, the road provided additional capacity to support more road users (an increase of between 5 to 32%), whilst improving the safety of those journeys. If this trend continues, the project is reforecast to deliver £217 million of safety benefits over the 60-year period[49], which is higher than originally anticipated within the business case.

The route has made journeys quicker for road users travelling across all periods. Journey time benefits made up the majority of the anticipated monetised impacts of this project.

This project has delivered benefits to road users, and the evaluation has found that if the trends observed in the first five years continue, it is on track to deliver 'high' value for money over the 60-year period[50].

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 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 scheme[51] 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 M25 junctions 16 to 23 smart motorway business case are set out in Table 3. 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.

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[48] Present value of costs in 2010 prices and values.
[49] Based on impacts on the Strategic and Local Road Network.
[50] The value for money categories referenced are defined by the Department for Transport https://www.gov.uk/government/publications/dft-value-for-money-framework
[51] Typically scheme life is taken to be 60 years.

Table 3 Monetised benefits of the project (£ million)

	Forecast (£M)	% forecast monetised benefits[52]	Evaluation approach
Journey times	2,264	115%	Re-forecast for the project area only (not the wider area) using observed and counterfactual[53] traffic flow and journey time data
Vehicle operating costs	-184	-9%	Re-forecast using observed and forecast traffic flow and journey time data
Journey time & VOC during construction and maintenance	-10	-1%	Not evaluated (assumed as forecast)
Journey time reliability	179	9%	Monetised benefits assumed as forecast
Safety	128	7%	Re-forecast using observed and counterfactual[54] safety data for the SRN only[55],
Carbon	-48	-2%	Monetised benefits assumed as forecast
Air quality	0	0%	Monetised benefits assumed as forecast
Noise	-1	0%	Monetised benefits assumed as forecast
Indirect tax revenues	-366	-19%	Re-forecast using observed and forecast traffic flow and journey time data
Total present value benefits	**1,962**	**100%**	

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 4. Based on this information, the scheme was anticipated to give 'high' value for money over the 60-year appraisal period.

Table 4 Cost of the project (£ million)

	Forecast (£M)	% of forecast costs	Evaluation approach
Construction costs	771	106%	Current estimate of project cost

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

[53] 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').

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

[55] SRN – Strategic Road Network

Maintenance costs	-41	-6%	Not evaluated (assumed as forecast)
Total present value costs	**730**	**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 costs

The project was delivered under the original construction budget, at a cost of £634 million[56] (see Table 4).

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.

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 scheme life. Appraisal of these major investments takes many years of complex and expensive analysis. Our evaluation methods are much simpler, so consequently there is a degree of uncertainty around these numbers.

Monetised journey time benefits

As can be seen in Table 3, journey time benefits made up the majority of the justification for investing in the M25 junctions 16 to 23 smart motorway.

As noted in section 4 (Customer journeys), within the first five years the expected level of journey time benefits are on track to be realised. This is likely to be due to a combination of reasons including:

- Road users' journey times were most improved on the anti-clockwise carriageway, substantially so in the morning when road users saw improvements of 19 minutes on average. Their journeys in the middle of the day and in the evening peak were also improved, by an average of around 4 minutes and 8 minutes, respectively.
- On the clockwise carriageway road users' journeys in the morning peak were improved too, by nearly 3 minutes on average. However, in the interpeak and evening peak their journeys got slightly longer, by around 20 seconds.

The M25 junctions 16 to 23 project has improved journey times. If the trends observed in the fifth year continue over the 60-year period, the monetised impact on journey times, for those using the road, would be £2,042 million – very close to the forecast of £2,264 million. 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. The monetised benefit would likely be even higher if these impacts were included.

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[56] 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.

Other reforecast impacts

We reforecast total safety benefits to be £217million[57]. This figure relates to the benefit on the strategic and local road network over 60-years (see Figure 14). 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 47% along the project extent, compared to the 11% 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 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 tax[58]. We have reforecast that the impact would be smaller than expected, and an increase in tax revenues (£157million). 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 disbenefit of -£105 million.

Impacts assumed as forecast

The evaluation has not been able to reforecast the monetary value of journey time reliability[59], noise and carbon benefits[60], and instead these were reported as forecast. For noise and carbon impacts, this assumption is conservative because lower than forecast traffic flows have been observed in the anticlockwise direction and is likely to mean that these impacts are better than forecast[61]. For journey time reliability this assumption is conservative because the impact on reliability has improved across all time periods[62].

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.

Overall value for money

The appraisal forecast a significant traffic growth and improving journey times; the observed data suggested these expectations for traffic growth accompanied by faster journey times has been achieved.

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57 This figure relates to the benefit on the strategic and local road network over 60-years.
58 Refer to Transport Analysis Guidance (TAG) unit A1.3
59 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.
60 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.
61 Refer to section 6 for further detail on noise and greenhouse gas impacts.
62 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.

Although not included in the appraisal, wider economic benefits might be relevant given the scheme's proximity to a functional urban area, which are usually dependent on delivering journey time savings.

Taking these into consideration, it is likely that this project has offered ‘high’ value for money. Overall, the evaluation indicated that in the first five years this investment is on track to deliver the value for money anticipated over the 60-year life of the project.

8. Appendices

Changes in traffic on the local road network

Table 5 Changes in traffic volumes on the local road network

Location	Direction	Before	5YA	Before-5YA Change	Before-5YA %Change
A5183 Watling Street, Park Street	Northbound	6,500	6,000	-500	-8%
	Southbound	6,900	6,400	-500	-8%
A1081	Northbound	14,300	13,200	-1,100	-8%
	Southbound	11,700	12,300	600	5%
A41 Watford Road, Hunton Bridge	Northbound	15,000	12,200	-2,800	-19%
	Southbound	15,100	12,500	-2,600	-17%
A405 North Orbital Road, Chiswell Green	Northbound	24,700	13,400	-11,300	-46%
	Southbound	25,500	16,100	-9,400	-37%
A414 North Orbital Road, Park Street	Eastbound	26,000	27,100	1,100	4%
	Westbound	29,900	29,400	-500	-2%
A412 Watford Rd, Croxley Green	Eastbound	12,900	11,600	-1,300	-10%
	Westbound	13,600	12,100	-1,500	-11%
A412 Denham Way, West Hyde	Northbound	7,200	8,100	900	12%
	Southbound	6,100	5,900	-200	-2%
A1000 Barnet Road, Kitts End	Northbound	5,200	5,100	-100	-3%
	Southbound	5,100	5,000	-100	-1%
A1000 Great North Road, Potters Bar	Northbound	8,100	7,900	-200	-2%
	Southbound	8,000	8,000	0	-1%
B156 Northaw Road, Cuffley	Eastbound	6,800	6,200	-600	-9%
	Westbound	7,600	7,200	-400	-6%
B556 Harper Lane, London Colney	Eastbound	6,100	5,000	-1,100	-18%
	Westbound	5,500	5,800	300	4%

Location	Direction	Before	5YA	Before-5YA Change	Before-5YA %Change
A4145 Moor Lane, Batchworth	Eastbound	6,100	5,400	-700	-12%
	Westbound	6,500	5,800	-700	-11%
A404 Chorleywood Road, Rickmansworth	Northbound	11,100	9,700	-1,400	-12%
	Southbound	11,400	10,600	-800	-7%
A412 Uxbridge Road, Rickmansworth	Eastbound	9,400	8,800	-600	-7%
	Westbound	10,100	9,200	-900	-9%
A41 Bypass, Kings Langley	Northbound	24,300	25,200	900	4%
	Southbound	24,400	23,600	-800	-3%
A4251 Hempstead Road, Kings Langley	Northbound	7,200	7,400	200	4%
	Southbound	7,800	6,600	-1,200	-15%
B5378 Black Lion Hill, Shenley	Northbound	5,600	3,300	-2,300	-41%
	Southbound	6,300	5,700	-600	-10%
Ducks Hill Road	Northbound	8,700	8,200	-500	-5%
	Southbound	8,300	8,200	-100	-2%

Note: Average weekly traffic by direction. Some 5YA counts factored due to observation month. Before: 2008; 5YA: 2017.
Sources: Hertfordshire County Council, Buckinghamshire County Council, Atkins, Tracsis.

Comparisons of forecast and observed traffic volumes

Table 6 Comparison of forecast and observed volumes - morning peak

Morning peak	Clockwise										Anti-clockwise									
	J15-J16	J16-J17	J17-J18	J18-J19	J19-J20	J20-J21	J21-J21a	J21a-J22	J22-J23	J23-J24	J16-J15	J17-J16	J18-J17	J19-J18	J20-J19	J21-J20	J21a-J21	J22-J21a	J23-J22	J24-J23
2012 DM	6,809	5,947	6,168	6,687	5,561	6,138	4,316	5,816	5,806	5,708	7,656	5,844	5,659	6,107	4,268	4,332	4,175	5,500	4,897	6,084
2017 DS interpolated	7,276	6,832	7,345	8,028	6,601	7,243	5,426	6,926	6,606	6,143	8,116	6,831	6,875	7,309	5,027	5,071	4,730	6,200	5,430	6,365
2008 Obs	6,129	5,467	5,138	5,514	-	5,155	-	5,007	4,891	-	7,014	4,988	4,634	-	-	2,928	-	3,257	3,881	-
2017 Obs	6,588	5,766	6,235	6,624	4,758	5,990	4,107	5,491	5,388	-	6,776	4,630	5,119	5,665	4,725	5,056	3,650	5,003	4,685	-
Forecast % change	7%	15%	19%	20%	19%	18%	26%	19%	14%	8%	6%	17%	21%	20%	18%	17%	13%	13%	11%	5%
Obs % change	7%	5%	21%	20%	-	16%	-	10%	10%	-	-3%	-7%	10%	-	-	73%	-	54%	21%	-

Table 7 Comparison of forecast and observed volumes - interpeak

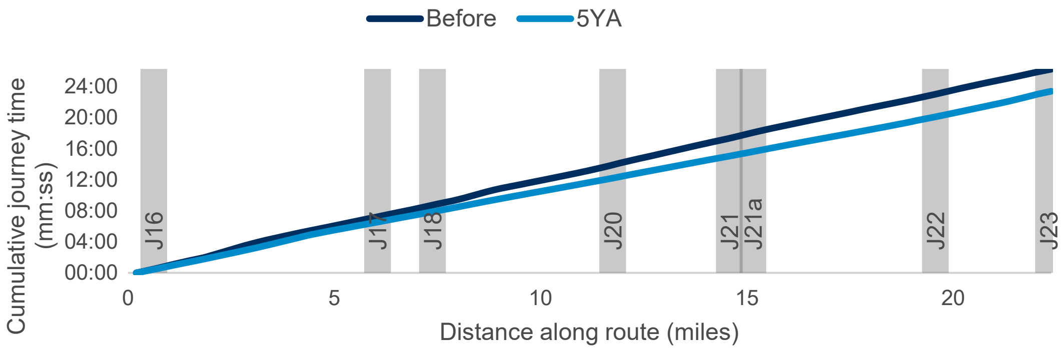
Interpeak	Clockwise										Anti-clockwise									
	J15-J16	J16-J17	J17-J18	J18-J19	J19-J20	J20-J21	J21-J21a	J21a-J22	J22-J23	J23-J24	J16-J15	J17-J16	J18-J17	J19-J18	J20-J19	J21-J20	J21a-J21	J22-J21a	J23-J22	J24-J23
2012 DM	7,736	6,142	6,068	6,333	5,446	5,481	4,251	4,999	5,486	5,673	6,894	5,578	5,522	6,049	5,189	5,255	4,490	5,252	5,178	5,363
2017 DS interpolated	8,228	7,262	7,114	7,440	6,334	6,396	5,074	5,922	6,261	6,049	7,507	6,728	6,743	7,272	6,181	6,335	5,342	6,187	5,798	5,805
2008 Obs	5,977	4,513	4,751	5,015	-	4,455	-	4,013	4,119	-	5,611	4,314	4,318	-	-	3,958	-	3,443	3,959	-
2017 Obs	6,263	5,461	5,689	6,082	4,795	5,439	3,611	4,805	4,807	-	6,192	4,880	5,120	5,474	4,841	4,976	3,368	4,536	4,657	-
Forecast % change	6%	18%	17%	17%	16%	17%	19%	18%	14%	7%	9%	21%	22%	20%	19%	21%	19%	18%	12%	8%
Obs % change	5%	21%	20%	21%	-	22%	-	20%	17%	-	10%	13%	19%	-	-	26%	-	32%	18%	-

Table 8 Comparison of forecast and observed volumes - evening peak

Evening peak	Clockwise										Anti-clockwise									
	J15-J16	J16-J17	J17-J18	J18-J19	J19-J20	J20-J21	J21-J21a	J21a-J22	J22-J23	J23-J24	J16-J15	J17-J16	J18-J17	J19-J18	J20-J19	J21-J20	J21a-J21	J22-J21a	J23-J22	J24-J23
2012 DM	8,015	6,219	6,464	6,687	5,534	5,273	4,640	5,489	5,567	5,535	6,145	5,320	5,514	6,210	4,907	5,521	4,835	5,576	4,877	5,642
2017 DS interpolated	8,280	7,382	7,843	8,280	6,865	6,357	5,607	6,535	6,340	5,939	6,487	6,366	6,819	7,534	5,872	6,523	5,735	6,529	6,048	6,024
2008 Obs	6,590	5,308	5,426	5,994	-	4,660	-	4,314	4,492	-	6,160	4,697	4,794	-	-	4,580	-	3,723	4,196	-
2017 Obs	5,854	5,453	6,027	6,742	4,571	5,321	3,816	4,931	4,959	-	6,502	5,327	5,605	6,222	5,124	5,820	4,083	5,412	5,103	-
Forecast % change	3%	19%	21%	24%	24%	21%	21%	19%	14%	7%	6%	20%	24%	21%	20%	18%	19%	17%	24%	7%
Obs % change	-11%	3%	11%	12%	-	14%	-	14%	10%	-	6%	13%	17%	-	-	27%	-	45%	22%	-

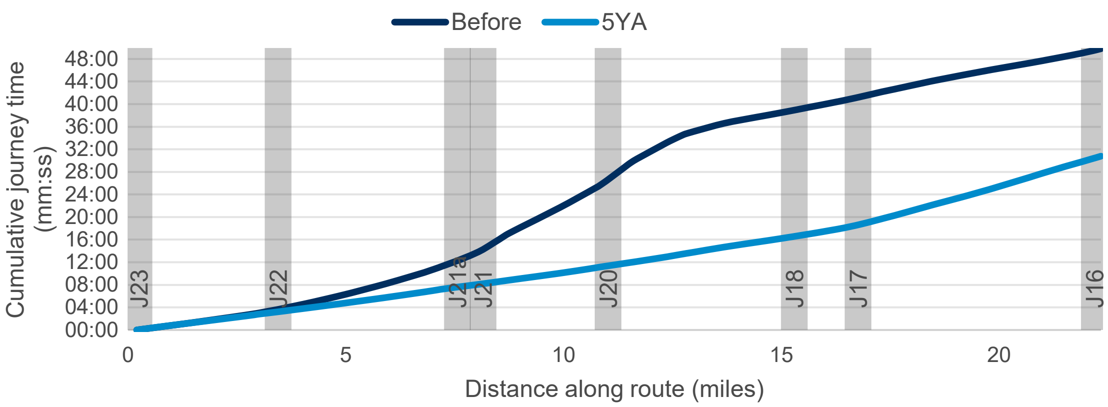
Changes in cumulative journey times

Figure 24 Cumulative journey times - clockwise morning peak



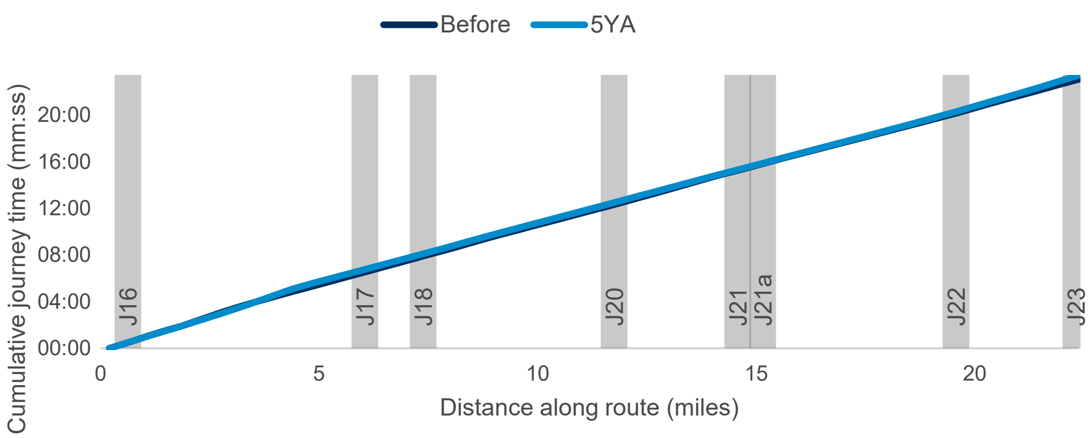
Source: TomTom satnav data

Figure 25 Cumulative journey times - anti-clockwise morning peak



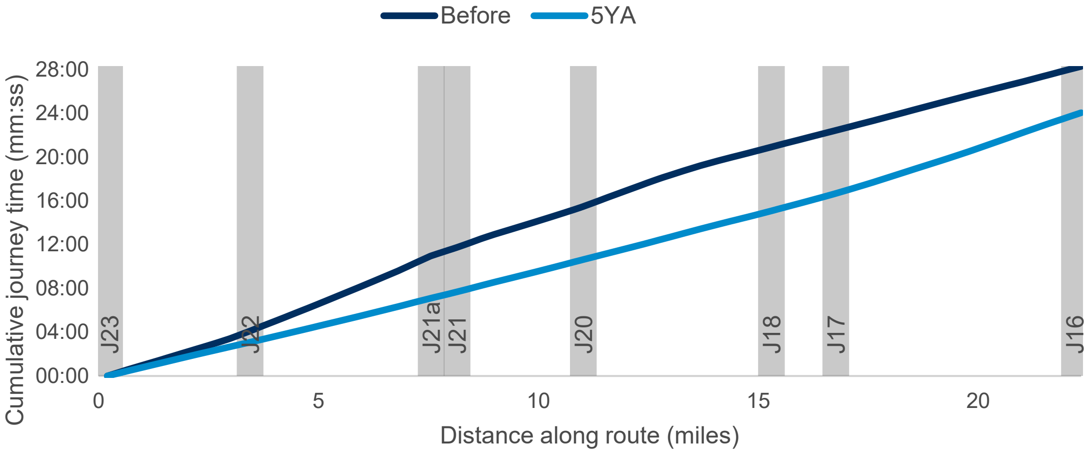
Source: TomTom satnav data

Figure 26 Cumulative journey times - clockwise interpeak



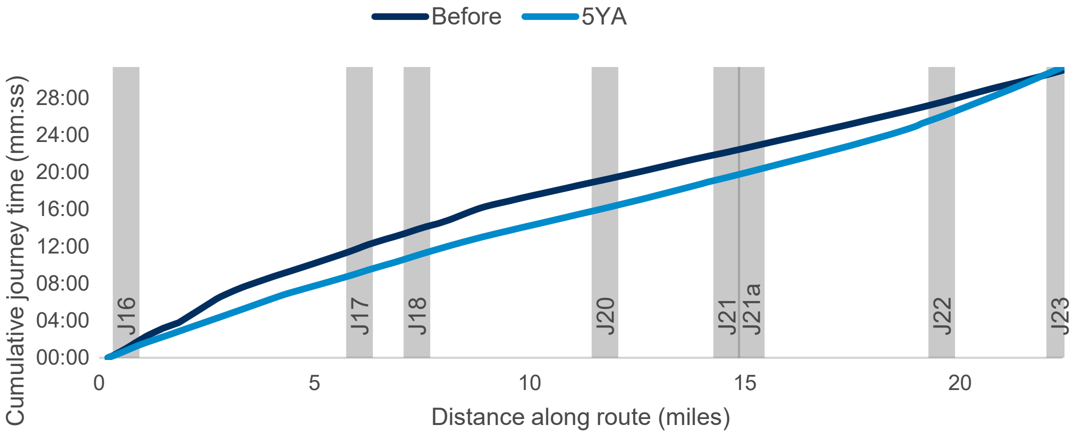
Source: TomTom satnav data

Figure 27 Cumulative journey times - anti-clockwise interpeak



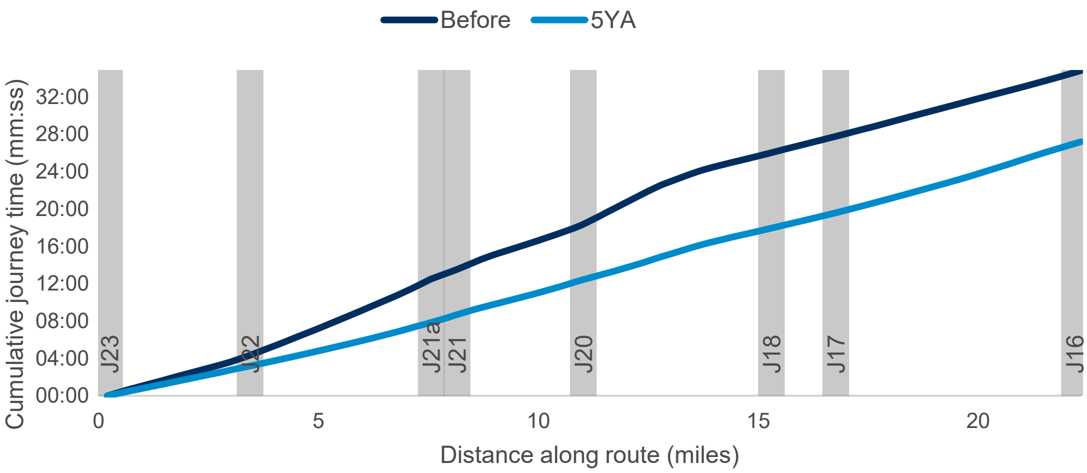
Source: TomTom satnav data

Figure 28 Cumulative journey times - clockwise evening peak



Source: TomTom satnav data

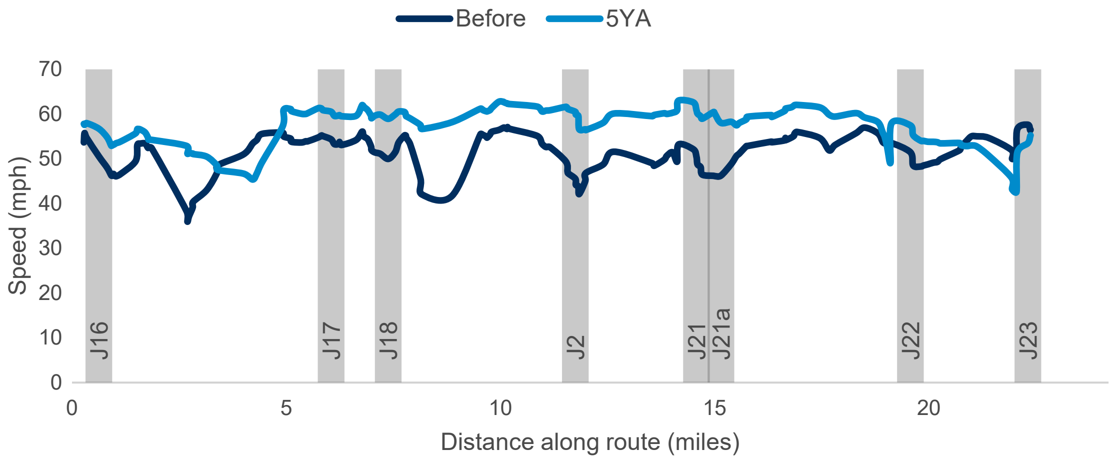
Figure 29 Cumulative journey times - anti-clockwise evening peak



Source: TomTom satnav data

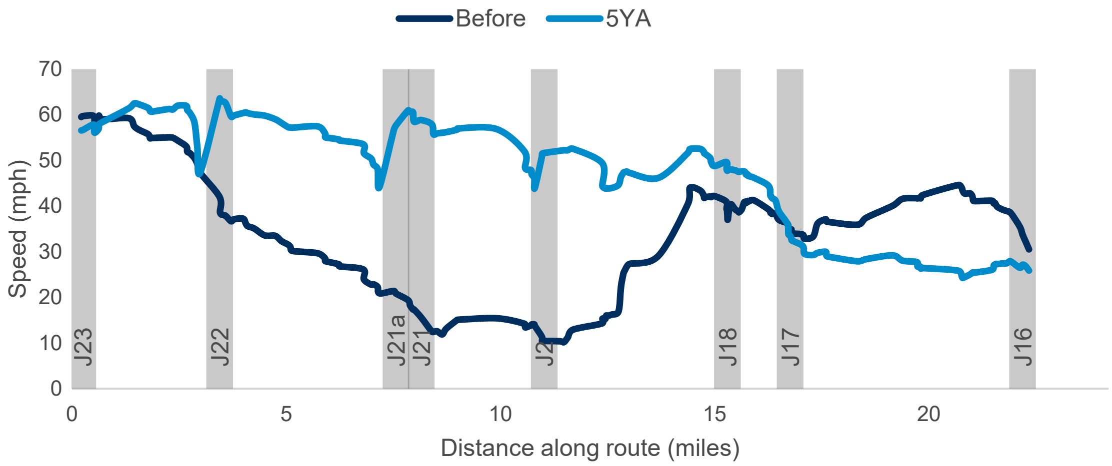
Changes in cumulative speeds

Figure 30 Changes in harmonic speeds - clockwise morning peak



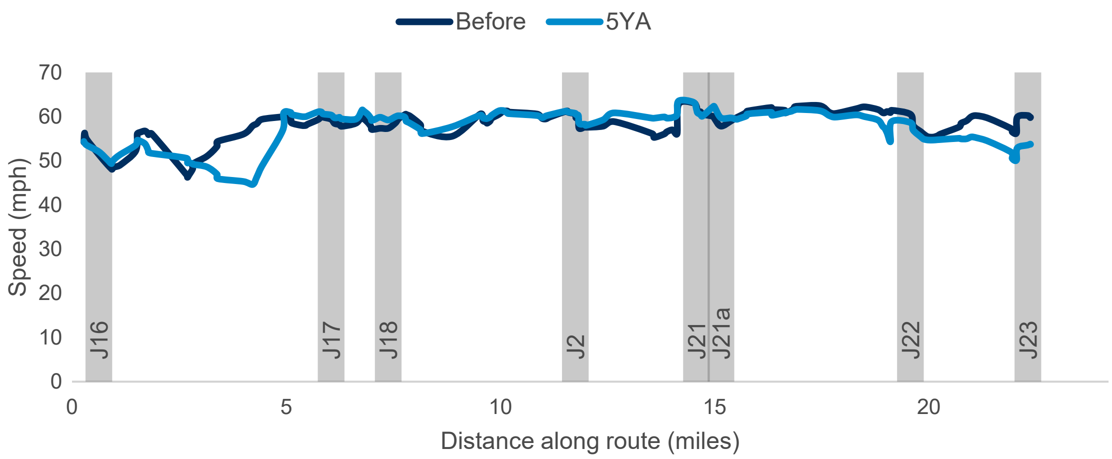
Source: TomTom satnav data

Figure 31 Changes in harmonic speeds - anti-clockwise morning peak



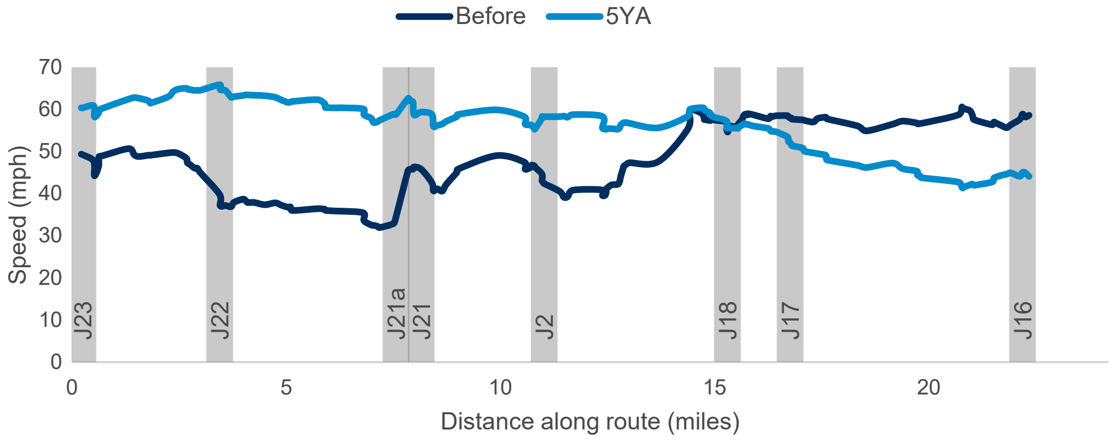
Source: TomTom satnav data

Figure 32 Changes in harmonic speeds - clockwise interpeak



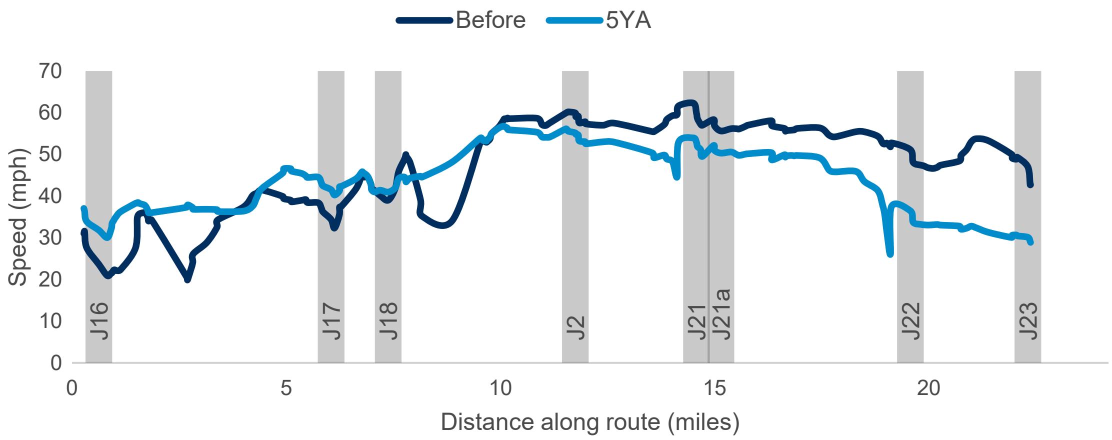
Source: TomTom satnav data

Figure 33 Changes in harmonic speeds - anti-clockwise interpeak



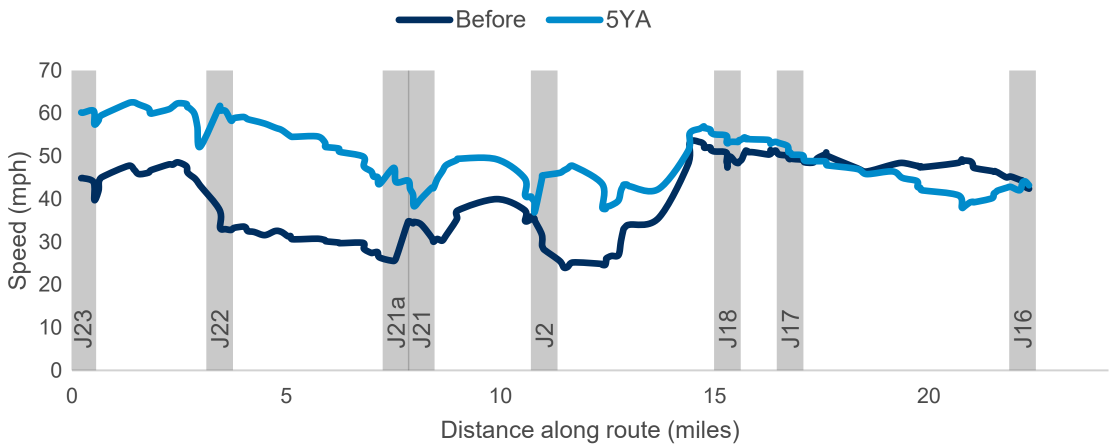
Source: TomTom satnav data

Figure 34 Changes in harmonic speeds - clockwise evening peak



Source: TomTom satnav data

Figure 35 Changes in harmonic speeds - anti-clockwise evening peak



Source: TomTom satnav data

Appendix B

B.1 Incident reporting methodology

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.

B.2 Unadjusted Collision Severity

Part of the project extent is covered by is covered by Hertfordshire police constabulary who transferred from Stats19 to CRASH system for reporting personal injury collisions in April 2016.

Part of the wider safety area of the M25 J16-23 project is covered by two police constabularies who transferred from Stats19 to injury-based reporting system for reporting personal injury collisions. Hertfordshire police constabulary transferred to CRASH in April 2016. Metropolitan Police constabulary transferred to COPA in January 2015.

Table 5 shows the unadjusted collision severities on the project extent and Table 6 shows the unadjusted collision severity on the wider safety area.

Table 5 Project extent

Observation Year	Fatal	Serious	Slight
5Yr Before	1	26	238
4Yr Before	5	15	224
3Yr Before	3	14	180
2Yr Before	1	18	193
1Yr Before	4	6	144
1Yr Construct		13	139
2Yr Construct	3	12	123
3Yr Construct		9	116
3Yr After	1	16	111
4Yr After	1	16	104
5Yr After		21	101
6Yr After		14	94
7Yr After	2	11	65

Table 6 Wider area

Observation Year	Fatal	Serious	Slight
5Yr Before	11	69	430
4Yr Before	5	66	450
3Yr Before	6	62	416
2Yr Before	5	46	414
1Yr Before	6	50	344
1Yr Construct	7	31	312
2Yr Construct	7	30	311
3Yr Construct	8	36	343
3Yr After	4	38	253
4Yr After	4	37	270
5Yr After	3	38	274
6Yr After	4	26	208
7Yr After	1	26	185

Source: STATS19: 1 May 2004 to 31 May 2019

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