

M25 junctions 27 to 30 widening and controlled motorway

Five-year post-opening project evaluation



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Foreword

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

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

This report evaluates the M25 junctions 27 to 30 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 27 to 30 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.

¹ Post Opening Project Evaluation (POPE)

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

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

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

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

Elliot Shaw

Chief Customer and Strategy Officer

September 2024

Table of contents

Chapter	Page
Foreword	3
Table of contents	5
1. Executive summary	7
2. Introduction	9
What was the project designed to achieve?	9
Project location	9
How has the project been evaluated?	10
3. Delivering against objectives	12
How has the project performed against objectives?	12
4. Traffic evaluation	14
Summary of findings	14
How have traffic levels changed?	14
National and regional	14
Project section	15
Wider area	16
How are traffic flows distributed across the day?	17
Was traffic growth as expected within the business case?	18
Relieving congestion and making journeys more reliable	19
Did the project deliver journey time savings?	19
Were journey time savings forecast?	21
Did the project make journeys more reliable?	22
5. Safety evaluation	25
Summary	25
Safety study area	25
Road user safety on the project extent	26
What impact did the project have on road user safety?	26
How has traffic flow impacted collision rates?	28
What impact did the project have on the severity of collisions?	28
How has traffic flow impacted collision severity?	29
Road user safety on the junctions and wider area	29
What impact did the project have on safety for the wider area?	30
How has traffic flow impacted collision rates for the wider area?	31
What impact did the project have on the severity of collisions in wider area?	31
How has traffic flow impacted collision severity in the wider area?	31
Has the project achieved its safety objectives?	32
How has the project performed compared to expectations?	32
6. Environmental evaluation	33

Summary	33
Noise	33
Air quality	34
Greenhouse gases	34
Landscape	35
Heritage of historic resources	35
Biodiversity	36
Water environment	36
Overview	37
7. Value for money	38
Summary	38
Forecast value for money	38
Evaluation of costs	40
Evaluation of monetised benefits	40
Impacts assumed as forecast	42
Overall value for money	42
Appendix A	43
A.1 Forecast and observed flows and journey times	43
Appendix B	44
B.1 Incident Reporting Mechanisms	44
B.2 Unadjusted Collision Severity	45

1. Executive summary

The M25 junctions 27 to 30 widening and controlled motorway became fully operational in March 2014. It runs between M25 junction 27 near Epping to junction 30 near Aveley.

Before the project, this section operated as a three-lane motorway with a hard shoulder and experienced increasing congestion levels and unpredictable journey times. The project involved the widening of the route to four lanes in both directions. In addition to widening, gantries were erected along the project extent to allow it to function as a controlled motorway in future.

The controlled motorway applied variable mandatory speed limits to control speeds but retained the permanent hard shoulder. After the widening project opened in March 2012, the controlled motorway capability became operational in March 2014 on the M25 between junctions 27 and 30.

The objectives were to reduce congestion, improve journey time reliability and improve safety. Additionally, the controlled motorway element aimed to make best use of the infrastructure, reduce flow breakdown, and reduce carbon dioxide emissions.

This five-year evaluation was carried out after the controlled motorway element became operational. This meant that in most cases it was difficult to isolate the impact of the project widening with that of the controlled motorway².

The number and rate of personal injury collisions have seen a marked improvement, beyond the level which could have been expected without the project. As a result, the objective of improving road user safety along this stretch of motorway has been achieved.

At five years after, traffic growth on the project has increased by between 16% and 25% in both directions; higher than the traffic growth trends seen locally and nationally, and higher than what was observed at the one-year evaluation.

The morning and evening peaks appear to be more pronounced following the project, indicating that the project has increased the capacity and possibly allowed more people to travel at the most popular time.

The overall impact of the projects on journey times and speeds was mixed. We found that journey times in the clockwise direction have increased by over three minutes in the morning peak and over six minutes in the interpeak but have decreased by over two minutes in the afternoon peak. In the anti-clockwise direction, average journey times have increased marginally in the morning peak and interpeak, while decreasing marginally in the afternoon peak. The model did not represent well the journey times on this section of road prior to the project, which had implications for the accuracy of the forecast impact of the project. There was not a conclusive change to journey time reliability, despite the increase in traffic over the ten years considered.

An evaluation of environmental impacts shows that the project has had effects broadly similar to those predicted at the appraisal stage. The forecast impact of the

² The one-year evaluation didn't have this issue as the evaluation was undertaken before the controlled motorway became operational, which meant the impact of the widening element could be evaluated in isolation.

controlled motorway on carbon emissions was marginal, and without detailed forecast information a full evaluation has not been possible.

The decision to invest in this project was driven by anticipated journey time benefits which have not materialised to the extent expected. This has impacted on the value for money of this project. Safety benefits are better than forecast, but although it isn't possible to present an outturn benefit to cost ratio³. This investment has delivered benefits to road users, but not the full value anticipated.

³ it has also not been possible to calculate an outturn re-forecast for journey time reliability due to there not being a combined appraisal of the two projects for us to base this on. This has meant it isn't possible to present an outturn BCR, however, it is evident from the numbers which are presented, this investment hasn't delivered the value anticipated.

2. Introduction

What was the project designed to achieve?

There were two elements to this improvement:

- A widening project, which opened in May 2012.
- Application of ‘controlled motorway’ technology, operational since March 2014

Before the improvements, this section of the M25 was a three-lane motorway with a hard shoulder in both directions. Road users travelling along this stretch frequently experienced congestion and poor journey times.

The *London Orbital Multi Modal Study (2002)* was tasked with addressing these issues along with wider problems of the M25 motorway and the orbital transport corridor around London. The study concluded that if current trends were to continue, users would suffer increasing congestion and unreliable journey times. It recommended that most of the three lane sections of the M25 should be widened, including junctions 27 to 30.

This section of the M25 was widened from three to four lanes in both directions, with the aim of improving journey time reliability, reducing congestion and improve safety. Gantries were also installed as part of this project to allow the road to run as a smart motorway with variable speed limits in the future.

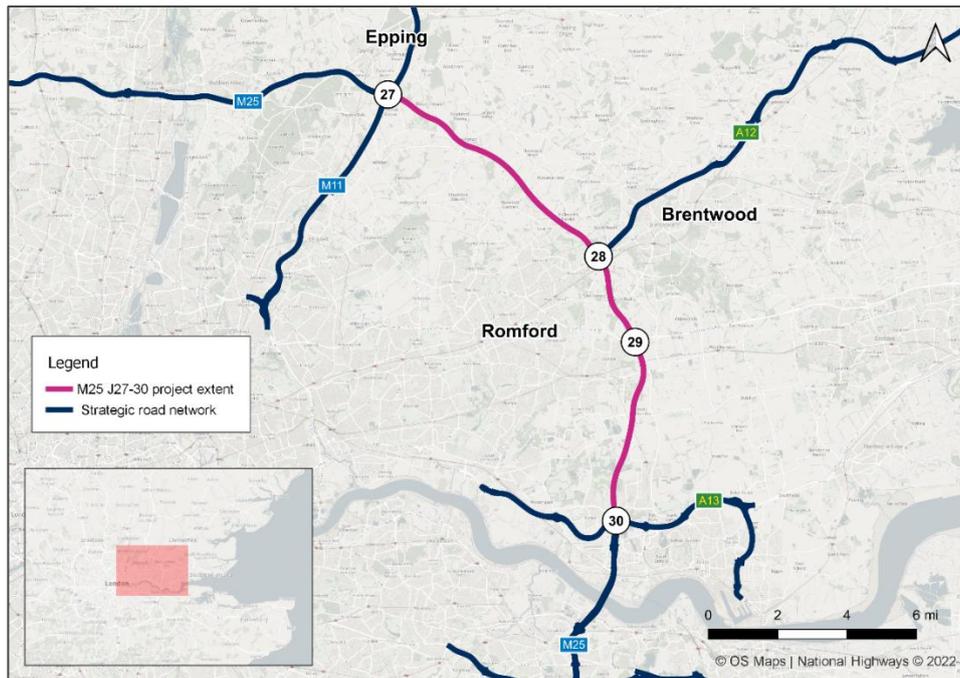
There are three types of smart motorway, all lane running (ALR), dynamic hard shoulder (DHS) and controlled motorway. ALR and DHS motorways create more space on some of the most congested sections of the SRN by using hard shoulder as a running lane either permanently (ALR) or only at busy times (DHS). A controlled motorway applies technology to control speeds but retains a permanent hard shoulder. This section is a controlled motorway. The controlled motorway element of the project became operational in March 2014 with the aim of reducing congestion, improving journey time reliability, improving safety, and reducing carbon emissions.

Project location

The M25 is a strategic orbital road in the south-east of England that surrounds London. It plays a pivotal role in the Strategic Road Network, providing a vital route for freight, commuter, and tourist traffic. The M25 is of local, regional, national, and international importance, forming part of the E30 route on the European E-road network. By linking with the M2 and M20, it also provides a gateway to and from the continent via the Eurotunnel and Dover. As one of Europe’s busiest motorways, demand for travel on the M25 is high, placing pressure on the network and leading to the reported congestion and unpredictable journey times especially during peak hours.

The project is a 16.8 mile stretch of the M25 in Essex which for part of its length forms a boundary with the Greater London Authority. The geographical context of the project is shown in Figure 1.

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, provide opportunities to learn and improve future project appraisals and business cases. They are also important for providing transparency and accountability for public expenditure, by assessing whether projects are on track to deliver value for money.

A post-opening project evaluation compares changes in key impact areas⁵, 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 methodology note⁴.

This report follows on from the one-year after post-opening project evaluation, which was undertaken at a point when the controlled motorways element was not yet fully functioning. This evaluation will capture both the impacts of the widening and controlled motorway projects as they are not possible to separate.

We compare evaluation findings against those forecast in the pre-construction appraisal. In the case of this project, the detailed appraisal documentation for the widening included the impacts of the infrastructure to facilitate the later switch to controlled motorway (for example, the impacts of the gantries on the landscape), but it did not include the impact of the operation of the controlled motorway on traffic flows or safety. At the time, the implementation of variable mandatory speed limits required the introduction of specific legislation relating to the section of road called a statutory instrument. Due to this, the improvement had to be delivered in two stages. A separate lighter-touch appraisal document was produced to appraise the impacts

⁴ <https://nationalhighways.co.uk/our-work/post-opening-project-evaluation-pope-of-major-projects/>

of the controlled motorway which uses variable mandatory speed limits to manage traffic. This section of road continues to have a permanent hard shoulder.

This study is largely based on 2018 observations. Although referenced as 'five years after' for simplicity, this is six years after the widening was completed and four years after the controlled motorway was operational.

3. Delivering against objectives

How has the project performed against objectives?

All of our major projects have specific objectives which were defined early in the business case when project options were being 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 and

Table 2 summarise the projects' performance against each of the original objectives. Note it is difficult to isolate the appraised widening project from the subsequent controlled motorway.

Table 1 - objectives of the widening

Objective	Five-year evaluation
Deliver trunk road improvements	Widened from three lanes to four lanes and gantries provided to facilitate controlled motorway.
Improve journey time reliability	The route was less congested, but the impact on reliability was inconclusive. ⁵
Improve safety	Personal injury collision numbers and rates have reduced and has outperformed the appraisal significantly. ⁵
Reduce congestion	Route stress calculations indicate improvements in congestion due to increased capacity, however there is no conclusive improvement to overall journey times. ⁵

Table 2 - objectives of the controlled motorway

Objective	Five-year evaluation
Making best use of the new and existing infrastructure	The controlled motorway makes use of the gantries installed as part of the widening project.

⁵ It is difficult to isolate the appraised widening project from the subsequent controlled motorway.

Objective	Five-year evaluation
Reducing congestion, increasing the throughput of traffic and improving the journey time reliability	The route was less congested and used by more traffic, but these benefits could largely be attributed to the widening. The impact on reliability was inconclusive. ⁵
Reduced traffic flow breakdown	Not within scope of this study.
Reduced accidents	Personal injury collision numbers and rates have reduced since the opening of the widening project. ⁶
Reduced carbon dioxide emissions	The forecast impact was marginal, and without detailed forecast information a full assessment is not possible.

⁶ It is difficult to isolate the appraised widening project from the subsequent controlled motorway.

4. Traffic evaluation

Summary of findings

Traffic flows have increased significantly on the improved section. This is above the trends we are seeing across England and also locally and regionally. The one-year evaluation found there had been very little traffic growth. This was attributed, at least in part, to the economic downturn in 2008 which affected traffic levels. The growth in traffic flows since then is typical of projects of this type.

The appraisal was relatively accurate in its forecast of percentage traffic growth in all time periods. However, the exact volumes of traffic forecast and observed are not a close match. This suggests that the appraisal over-estimated background traffic growth. The reason for the difference is likely to be the forecasts being made in 2004 when the economic downturn in 2008, which had a significant impact on traffic levels, could not be foreseen. The model did not represent well the journey times on this section of road prior to the project, which had implications for the accuracy of the forecast impact of the project.

Before the improvements, delays were particularly evident in the clockwise evening peak and anticlockwise morning peak. Outside of this, motorists were travelling through the section at an average speed 60mph or higher.

At one year after, journey times had improved slightly – particularly in the clockwise direction during the evening peak. Comparing journey times at five years after to those before the widening, shows sustained improvements in evening peak, but increases in other time periods. This pattern of the journey times improving initially, but increasing thereafter as traffic levels increase over time, is typical. In this section we are presenting before and after journey times unadjusted. For section 7 we have compared outturn journey times against a counterfactual estimate of what journey times are likely to have been without the project. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion. The counterfactual calculation estimated a disbenefit of 203,200 vehicle hours in the fifth year after opening.

There has not been any conclusive change to journey time reliability, despite the increase in traffic over the ten years considered.

How have traffic levels changed?

This section looks at traffic volumes in and around the project. We consider the national and regional changes over time, volumes on the project section, volumes throughout the day, and volumes in the surrounding areas. Finally, we compare these to forecast traffic flows.

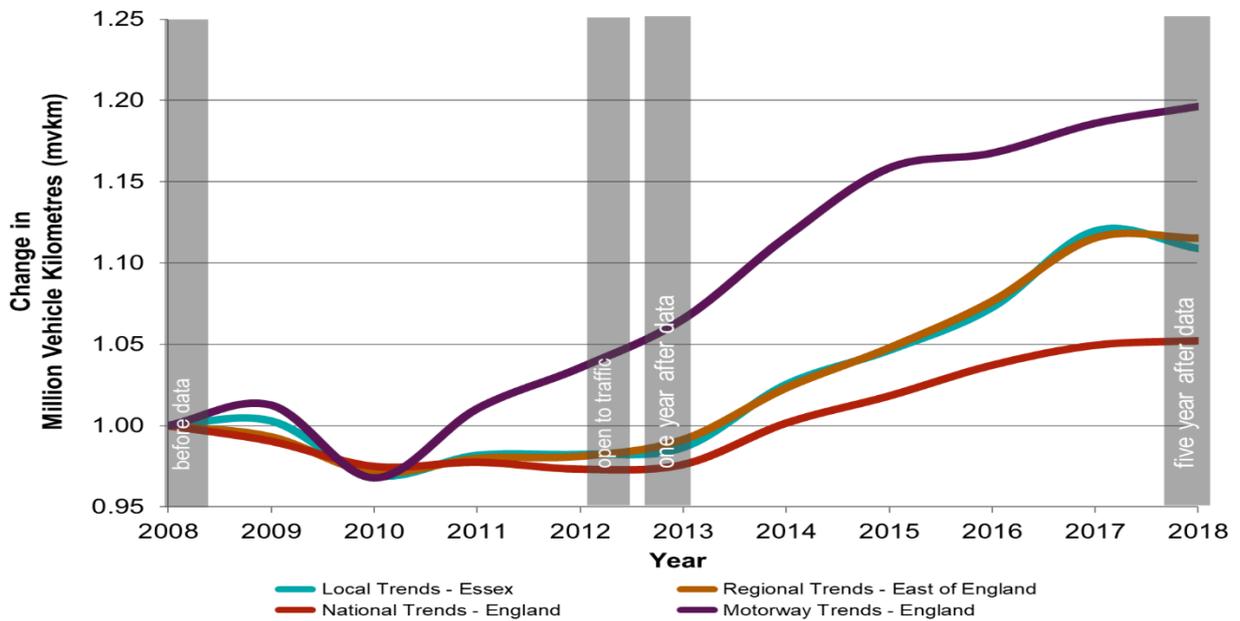
National and regional

To assess the impact of the project on traffic levels, it is useful to understand the changes within the context of national and regional traffic (Figure 2).

At a local and regional level, traffic flows followed a steady pattern until 2014, when traffic levels began to grow quite sharply (12% growth between 2008 and 2018 at a regional level). Motorway traffic in England has grown at a rate outpacing the

national and local trends: 18% between 2008 and 2018. 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: Department for Transport (TRA8904)

Project section

We now know that locally, regionally, and nationally, there has been a noticeable increase in traffic since 2014. We have also assessed whether this has been the case at the project level by comparing traffic flows on the project section before and five years after the project opened.

Figure 3 compares the Average Weekday Traffic (AWT) along the project extent and the percentage growth in this period. We can see that in the five years since the project opened, traffic has increased by 16% to 25% in both directions. This is slightly higher than the trends we are seeing across England and also locally and regionally.

The busiest section of the project is between junctions 27 and 28 (Figure 3, site 1), used by between 78,000 and 80,000 vehicles on an average weekday. The section between junction 28 and 29 (Figure 3, site 2) in the clockwise direction, has experienced the largest percentage increase in traffic, 25% growth between 2008 and 2018.

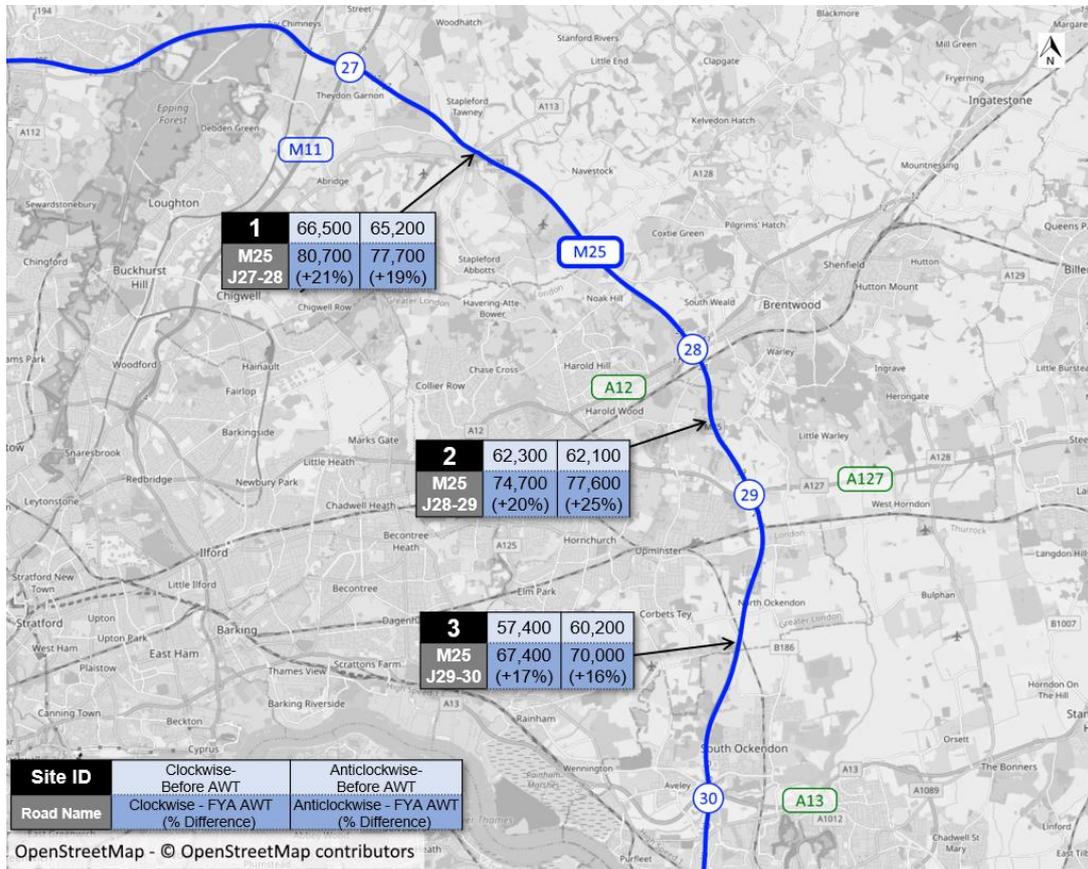
In the one-year evaluation we found that there had been very little traffic growth (approximately 1%). In line with national figures, this was partially due to the economic downturn that started in 2008 which affected traffic growth. The growth in traffic flows since then is typical of projects of this type. We would expect traffic flows to increase over time, in line with local, regional, and national levels, but also as road users are attracted by the project's additional capacity.

Growth has also likely been encouraged by the completion of other projects in the surrounding area, improving the desirability of the M25. The projects are:

- The adjacent section, M25 junction 23 to 27, was converted to smart motorway (2014)

- Dartford Crossing (south of M25 junction 30) introduced a free-flow system (2014)
- Improved connectivity between M25 junction 30 and the A13 (2017)

Figure 3: Comparison of before and five-year AWT



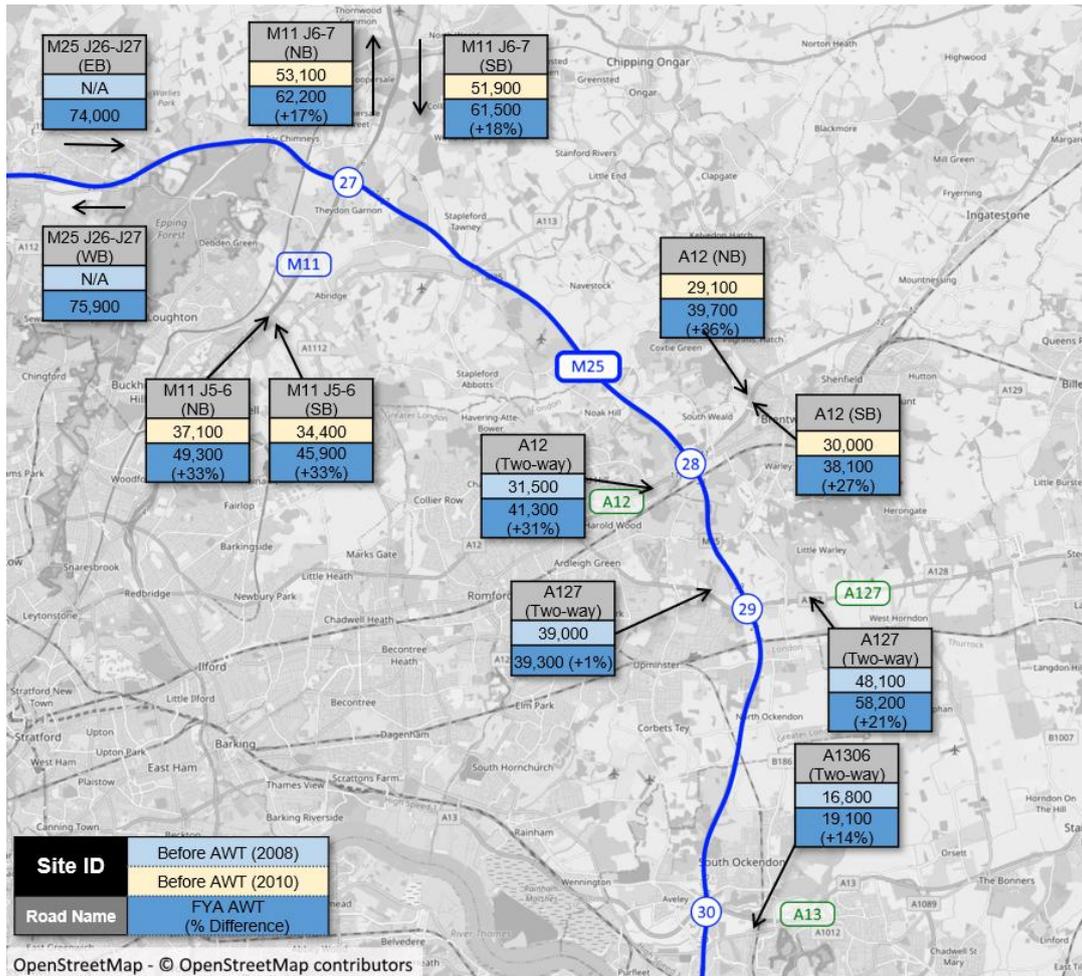
Source: WebTRIS traffic counts – 2008 (before) and 2018 (after)

Wider area

Figure 4 shows average weekday flows in the wider area around the project. The map illustrates the traffic flows before and after the project opened. The flow data used for before the project opened is largely from 2008, although due to data availability, some flows from 2010 were also used.

The data shows us that traffic on the roads which adjoin the M25, such as the A12 and M11, have increased between 27% and 36%. Flows on the M11 have increased by between 17% and 33%. These increases are considerably higher than those experienced across the rest of the East of England (as shown in Figure 2).

Figure 4: Comparison of before and five year after opening AWT (wider area)

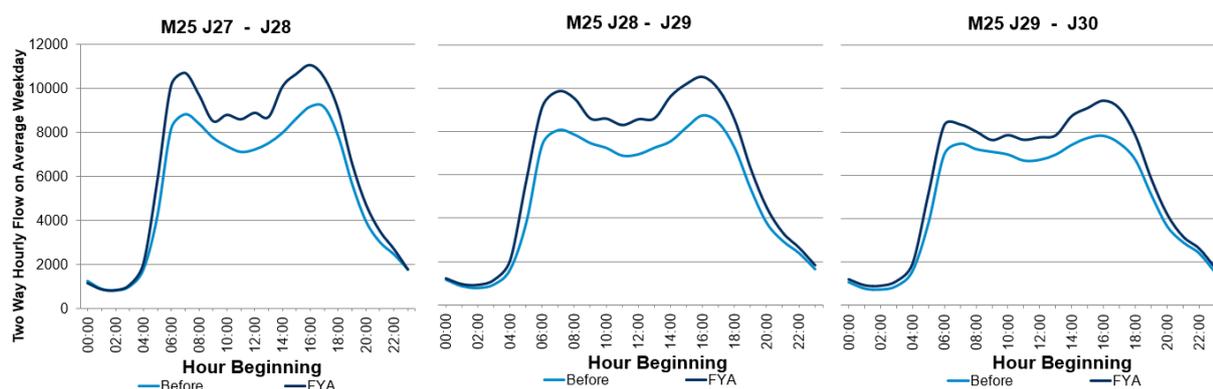


How are traffic flows distributed across the day?

We have analysed traffic flows across the day to determine whether traffic growth has occurred uniformly or at certain times of day (see Figure 5).

The morning and evening peaks appear to be more pronounced following the project, indicating that the project has increased the capacity and possibly allowed more people to travel at the most popular time.

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



Was traffic growth as expected within the business case?

We know that there was considerable increase in traffic growth on this section of the M25, and the surrounding area. This exceeds the levels of traffic growth we saw regionally and nationally. However, it is important to also understand whether this level of growth is as predicted when the project was originally developed.

Within this section, we compare the actual traffic flows against the traffic levels forecast in the project appraisal. The widening element was assessed using the North of Thames Assignment Model. The appraisal for the controlled motorway element forecast no additional traffic.

Usually in an appraisal, a Do Minimum⁷ projection is also calculated. This represents a future scenario in which the project is not delivered and is very important for projects like online widening where congestion is likely to increase without the intervention, with journey times getting increasingly slower over time. The appraisal considers the benefit to be how much the project slows the worsening of journey times relative to the worsening of journey times when the project is not introduced.

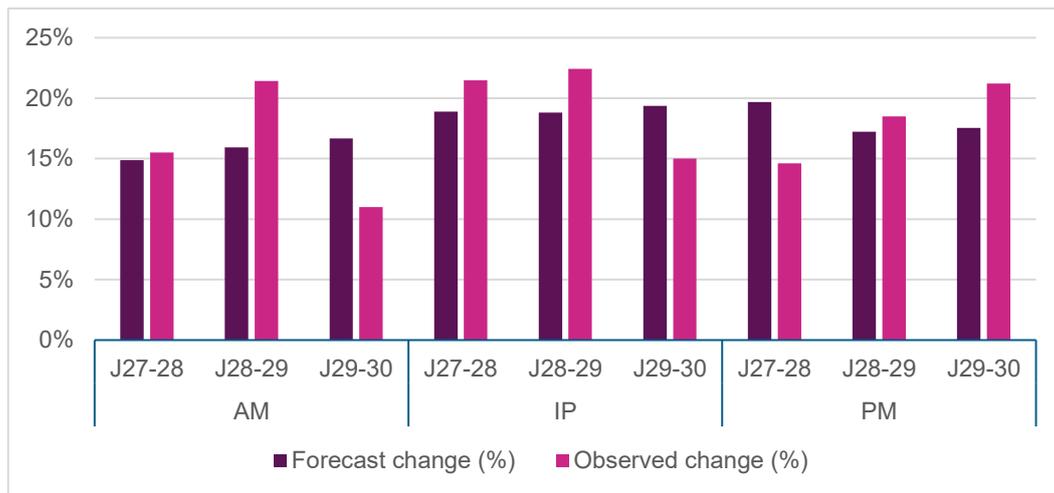
In this case, Do Minimum forecasts have only been provided in the appraisal for 2008 and 2012 (but no later). This limits the level of comparison of outturn to forecast possible at the five years after stage. This is because this comparison is usually the fairest way of comparing the observed traffic volumes and journey times against no project. The appraisal included modelled time periods that represented three time periods:

- AM peak hour (08:00 to 09:00)
- Average flow during an inter peak period (10:00 to 16:00)
- PM peak hour (17:00 and 18:00)

In each case, an average weekday hourly traffic flow was forecast for both directions together (two-way). Figure 6 shows the forecast flows in each of the three time periods, compared with the observed traffic flows, with further detail available in Appendix A.

⁷ DM – Do Minimum ie the forecast of how the road network would perform if the project wasn't constructed.

Figure 6: Change in traffic flow (2008 - 2018)



We can see that the appraisal was relatively accurate in its forecast of percentage traffic growth in all time periods and sections. There are some minor differences in some sections and time periods, but if we compare across the project extent then the forecast and actual percentage growth are relatively similar.

However, the exact volumes of traffic forecast and observed are not a close match. The best example of this is the 2008 observed against the 2008 do minimum. In some cases, 2008 do minimum forecasts are nearly 2,000 vehicles higher than those observed. This suggests that the appraisal over-estimated background traffic growth between its base year (2004) and 2008. This in turn appears to have then led to the 2018 do something⁸ flows being inaccurate also.

The reasons for the difference in 2008 observed and 2008 do minimum flows is likely due to these being forecast in 2004. When these flows were modelled, we did not foresee the economic downturn in 2008, which had a significant impact on traffic levels.

Relieving congestion and making journeys more reliable

We have analysed journey times and speeds as a way of identifying the impact of the project on congestion. The extent to which journey times vary from the expected average journey time indicates how reliable a journey is. Improving journey time reliability and reducing congestion were two of the key objectives for these projects.

Did the project deliver journey time savings?

To assess whether the project has met its objective of reducing congestion, we have analysed whether average journey times have reduced for road users. We use GPS data obtained from TomTom to do this.

We used data from October 2008 (before) and October 2018 (five years after)⁹. We used the same time periods that were used in the appraisal, namely:

- Weekday AM peak (08:00 – 09:00)

⁸ DS – Do Something ie the forecast of how the road network would perform with the project in place.

⁹ For both dates, the week representing the October half-term school holiday has been excluded from the results.

- Weekday inter peak (10:00 – 16:00)
- Weekday PM peak (17:00 – 18:00)

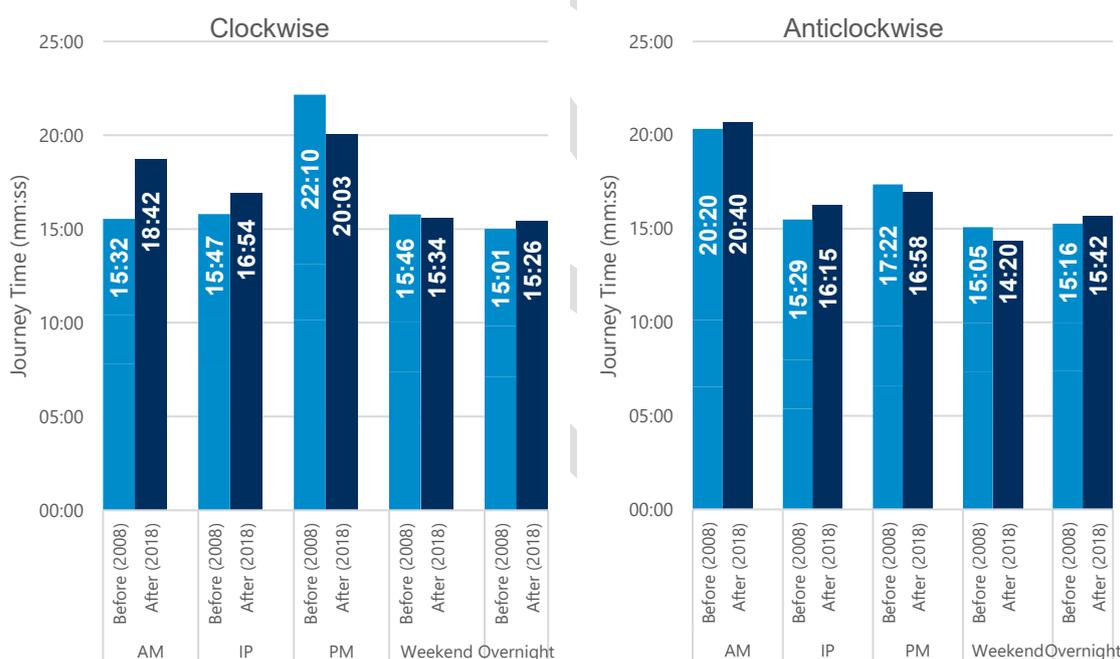
An assessment of other hourly time periods was carried out to check for relevant or unexpected observed changes, but the above time periods remain the key focus of analysis in this section.

Figure 7 provides the average observed journey times along the project extent before and after opening. It is important when interpreting these figures to note these show journey times ten years apart, during which time 19% to 25% traffic growth has been facilitated by the capacity improvements along the project extent.

For context, the project is 16.8 miles long, and a vehicle travelling at 60mph could travel the route in 16 minutes 48 seconds. The table shows that journeys were substantially slower than a 60mph journey time in the clockwise direction in the evening peak, and anticlockwise in the morning and evening peaks. Other time periods did not demonstrate a significant journey time issue before the project opened.

The maximum permitted speed both before and after the improvement was 70mph, although since the introduction of the controlled motorway this can be reduced as necessary to smooth traffic flow.

Figure 7: observed journey times ¹⁰



Note: *Weekend Day* represents averaged hourly data between 10:00 and 16:00 on Saturday and Sunday. *Overnight* represents averaged hourly data between 20:00 and 06:00 across all days of the week.

From these results, we can see that clockwise average journey times have increased by 20% in the AM peak and 7% in the interpeak. In the PM peak, the one period with a significant problem before the project opened, journey times have decreased by 10%.

¹⁰ Data for one year after has not been included in this graph because the journey time analysis in the one year after study was based on data from a different data source. The one year after study used JTDB (journey time database). This source is no longer available, so for this study we sourced data from TomTom.

In the AM peak, the average anticlockwise journey time along the whole route is two minutes slower than the clockwise equivalent. The reverse is true in the PM peak.

At one year after journey times had improved slightly, particularly in the clockwise direction during the PM peak, where savings of 13% were recorded.

At five years after the journey times have worsened, with most now slower than 60mph journeys. We typically see journey times improve after the introduction of projects of this type, but the journey times tend to increase thereafter as traffic levels increase over time. This is what we are seeing in our five-year evaluation analysis. Calculations undertaken to support the value for money analysis in section 7 have shown that even when considering how conditions were likely to deteriorate had the project not been built (the 'counterfactual'), the combined projects are not offering an overall improvement at five years after¹¹.

It is not possible to fully determine how much of this decline is due to traffic increases since the one-year evaluation and whether any of the impact is due to the interim addition of controlled motorway.

Were journey time savings forecast?

Forecast journey times were provided in the appraisal for the widening project. This data was provided in the form of expected average speeds in various future years following the project opening. We have converted these speeds into journey times. There is no 2018 forecast year meaning we have had to compare the actual journey times to the 2015 and 2021 forecasts.

The controlled motorway also forecast a small amount of vehicle hour savings. However, the savings are insignificant¹² and therefore comparisons will be made against the more detailed forecasts available in relation to the widening.

The model used to appraise this project¹³ did not perform well in two ways. Firstly, observations in 2008 showed long journey times in the morning peak anticlockwise and evening peak clockwise, yet the model expected journey times to be consistent throughout the day. Secondly, the modelled journey times were too slow – the modelled journey times for 2004 were slower than the observed journey times in 2008, when we would expect them to be the other way round¹⁴. The poor performance of the model in representing the road network without the project, casts doubt in the accuracy of the forecast savings in future years.

As illustrated in Figure 8 the observed 2018 journey times are generally longer than those expected in the appraisal in 2021 (clockwise in the inter peak is the only exception). As such it appears overall of the project section performance is worse than expected¹⁵.

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 likely to have been without the project. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion. The counterfactual calculation estimated a **dis**benefit of 203,000 vehicle hours in the fifth year after opening.

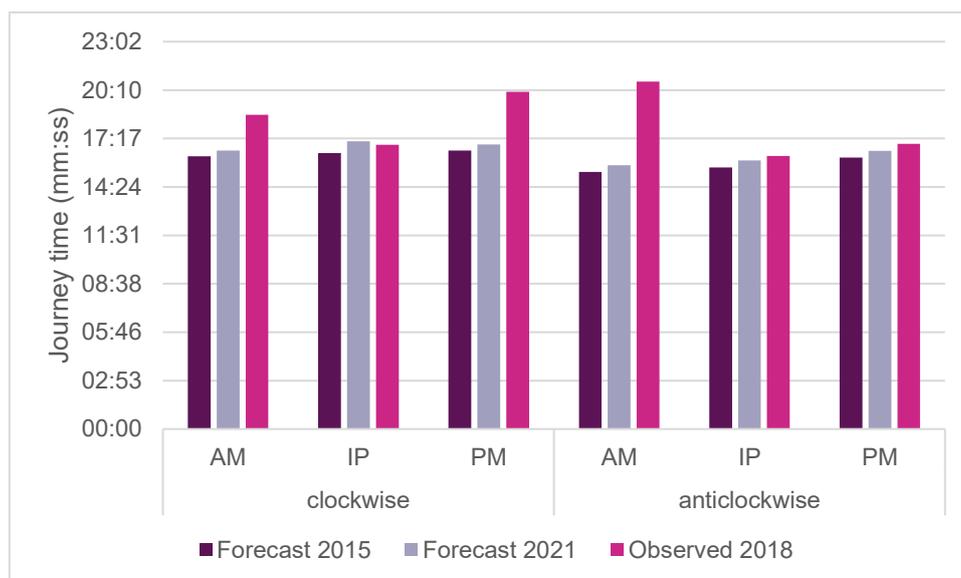
¹² Estimated to be equivalent to about 0.1 seconds per vehicle.

¹³ North of Thames Assignment Model

¹⁴ The detail of these numbers can be found in Appendix A

¹⁵ In this section we are comparing before and after journey times directly without adjustment. No counterfactual estimate of what journey times are likely to have been without the project has been included.

Figure 8 - forecast & observed journey times



Source: traffic forecasting report, TomTom data

Note: the forecasts are the Do-Something (with project forecasts).

The model that informed this investment decision was known at the time to have limitations, but within the time and budget constraints at the time, it was considered to have sufficient value to be used to inform the investment decision. This was within a context where the data and computing power available to improve the model was much more limited than that available today. Our models are now underpinned by substantially more real-life data.

Since this scheme was appraised, we have improved our processes so a decision maker in a similar situation today would be much clearer on the weaknesses and the risks this might pose when using the model to inform their decision¹⁶.

Did the project make journeys more reliable?

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

We use a box plot of the TomTom satnav data to illustrate the journey reliability, considering the variability of journey times in each of the same time periods as used previously. The impact on reliability is visualised in Figure 10 and Figure 11. Reliability is presented for each of the time periods that demonstrates a noteworthy change. If reliability has improved, then the bars in the graph will shorten in length. Further information on how to read the boxplot is provided in Figure 9.

¹⁶ They would now receive a short Red-Amber-Green rated Analytical Assurance Statement.

Figure 9: What does a box and whisker plot show?

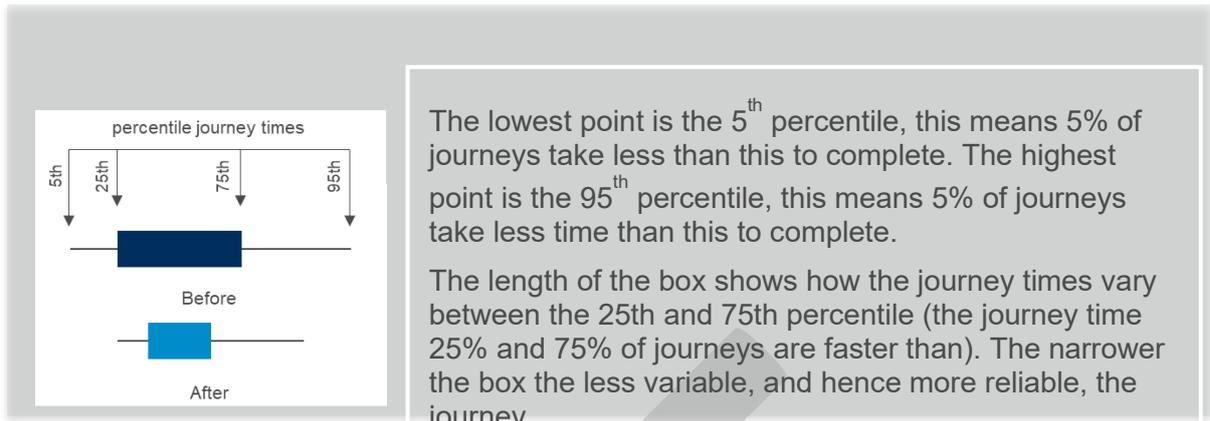
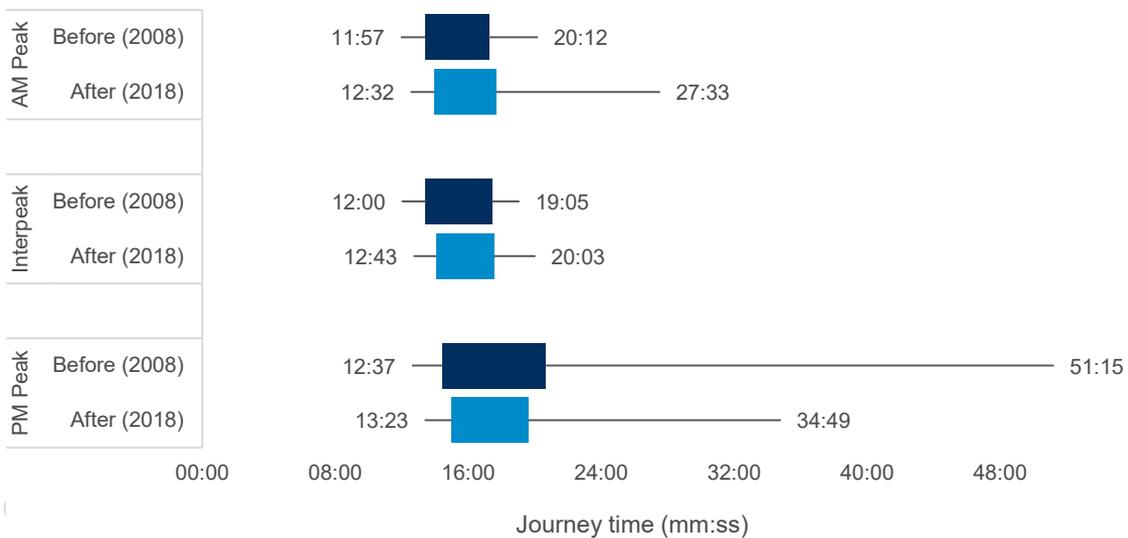
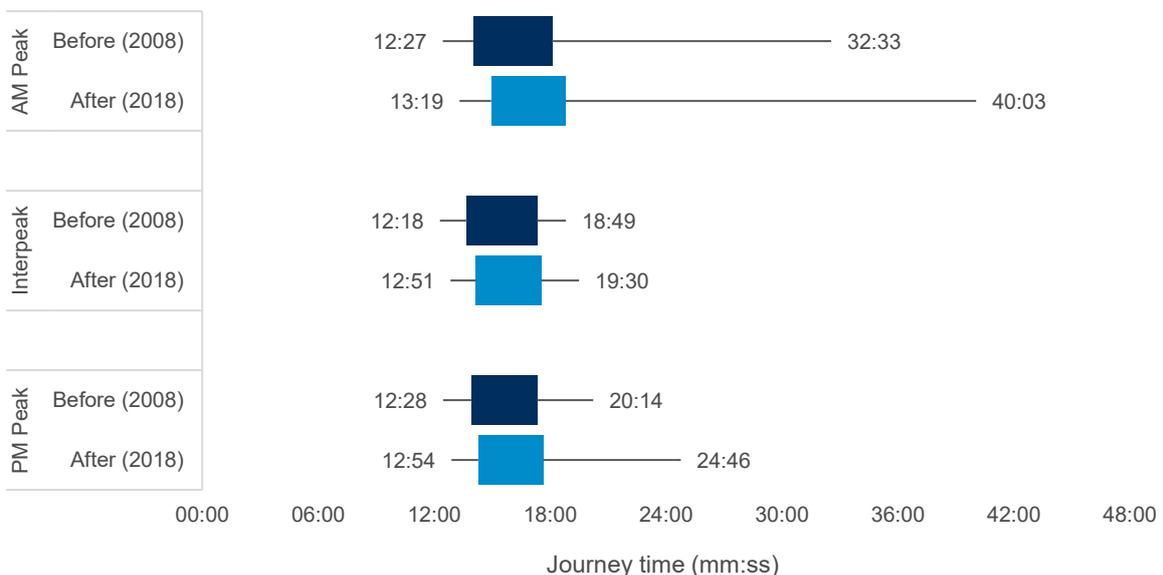


Figure 10: Journey time variability along the project (clockwise)



Source: Satellite navigation (TomTom) 2008, 2018

Figure 11: Journey time variability along the project (anticlockwise)



Source: Satellite navigation (TomTom) 2008, 2018

There has not been any conclusive change to journey time reliability. Given the increase in traffic over the ten years considered, this may be in itself an impact of the project. There was an improvement in the evening peak in the clockwise direction, but other time periods demonstrate mixed results. We are unable to determine the extent to which these changes are due to the widening or to the subsequent controlled motorway.

Another measure of reliability is route stress. The route stress measure allows us to look at the percentage of road capacity that is being used and is displayed in **Table 3**. A value of 100% means that the road is at full capacity. The results of the route stress calculations indicate that the increased capacity of the widening project has reduced congestion on the route, although we cannot isolate the impact of the controlled motorway.

Table 3: Route stress

Two-way section	Before	FYA	Less congested?
J27-28	102%	99%	Yes
J28-29	94%	89%	Yes
J29-30	90%	79%	Yes

Note: We have calculated this using November 2008 and 2018 traffic flow data

We have also considered reliability as represented by the Planning Time Index (PTI). This measure represents how much additional time a motorist should allow to ensure they will arrive on time¹⁷. A decrease in the index figure implies an improvement in journey time reliability. The results, shown in Table 8, highlight our previous findings that reliability has improved in the clockwise direction. The PTI tells us more about the relationship of the extreme journey times (the 95th percentile) to normal journey times than the above interquartile range analysis.

Table 4: Planning Time Index

Direction	Before PTI	FYA Post Project PTI	More Reliable?
Clockwise	1.8	1.7	Yes
Anti-clockwise	1.6	1.8	No

¹⁷ A PTI of 2 would mean the motorist should allow double the amount of time it would take to make the journey if the road was completely clear in order to be 95% confident of arriving on time. It is calculated as the 95th percentile journey time divided by the free flow journey time.

5. Safety evaluation

Summary

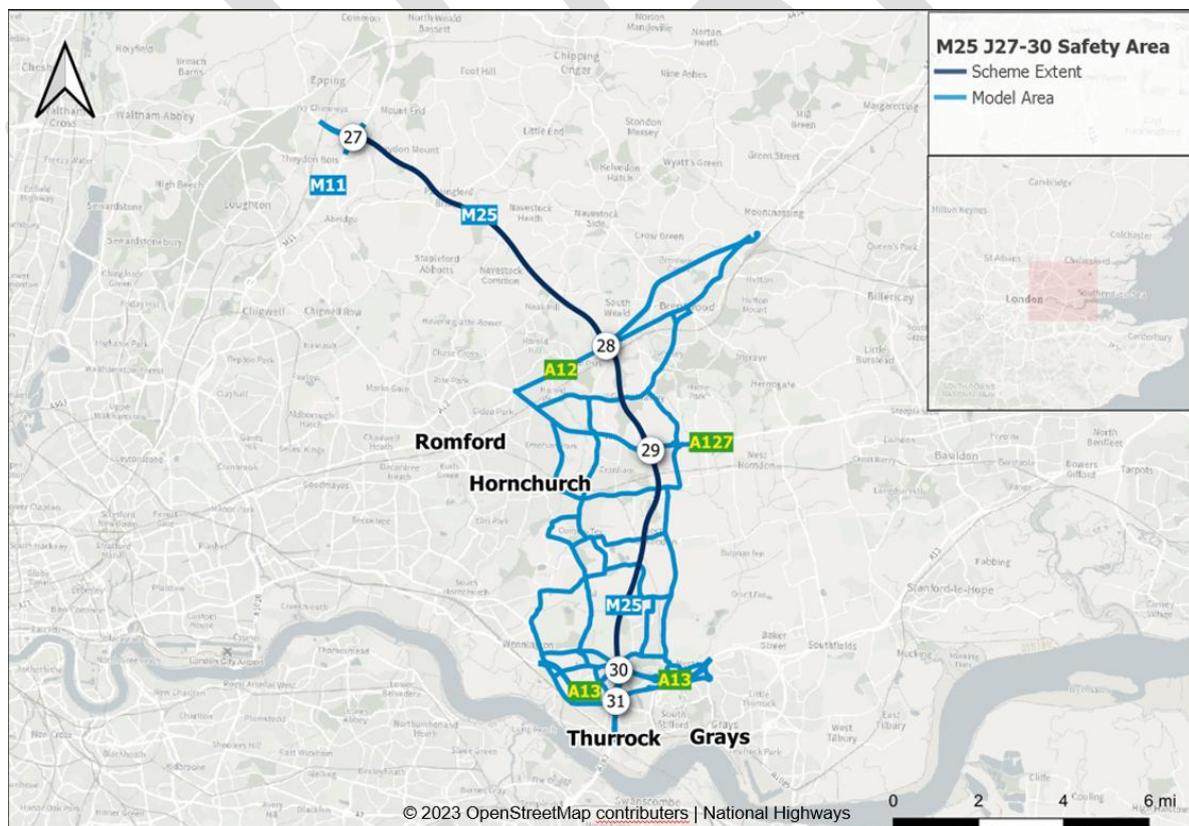
The project had an objective to improve safety performance. The number and rate per hundred million vehicle miles of personal injury collisions¹⁸ were analysed to identify a trend over time. The evaluation concluded that the project had met its safety objective.

In the first five years of the project being operational, there was a reduction in the rate and number of personal injury collisions on both the project extent and the surrounding network. This is compared with the annual average for the five years before the project improvements. We have also observed a reduction in fatalities over this time period.

Safety study area

The safety study area, shown in Figure 12 was defined as the project extent on the M25 between junctions 27 and 30, and a wider area including adjacent roads on the local road network. This area has been considered to allow us to determine the impacts on safety that the project has had on both the project extent and the wider area.

Figure 12: Safety study area



¹⁸ A collision that involves at least one vehicle and results in an injury to at least one person

Road user safety on the project extent

What impact did the project have on road user safety?

Safety data was obtained from the Department for Transport road safety data¹⁹. This records incidents on public roads that are reported to the police. Only collisions that resulted in personal injury are considered in our evaluations.

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.

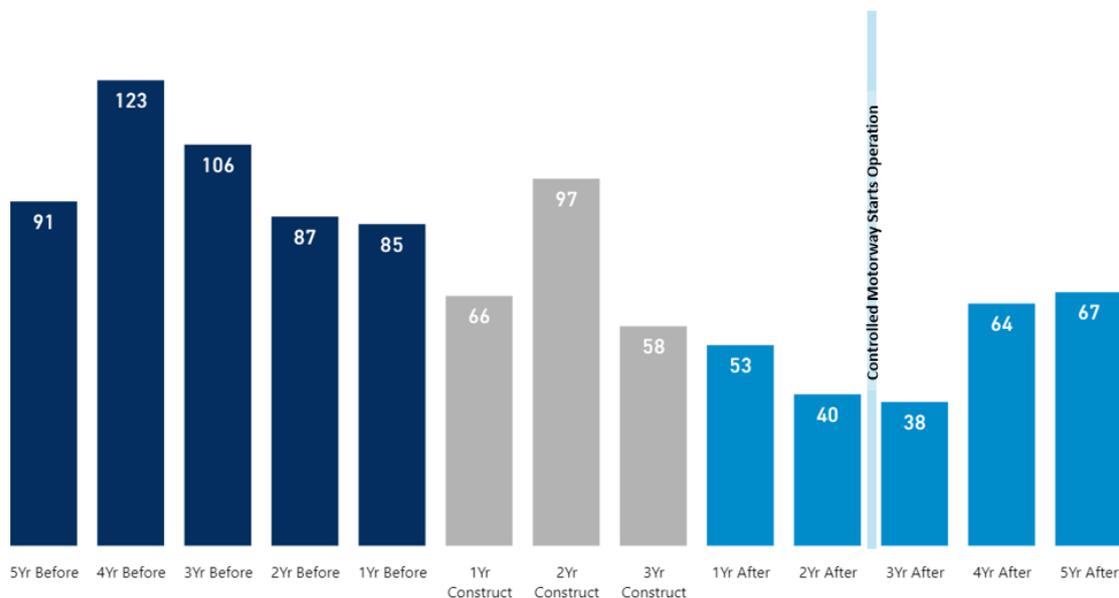
The analysis draws on the following data collection periods:

- Pre-construction: 1 July 2004 to 30 June 2009
- Construction: 1 July 2009 to 31 May 2012
- Post-opening: 1 June 2012 to 31 May 2017

The evaluation found the number of personal injury collisions on the project extent, junctions 27 to 30 had decreased (impacts on the wider area are discussed later).

Over the five years after the project was operational, there were an average of 56 personal injury collisions per year, 42 fewer than the average 98 per year over the five years before the project was constructed.

Figure 13: Annual Personal Injury Collisions



Source: STATS19: 1st July 2004 to 31st May 2017

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 time. To do this we estimate the trend in personal injury collisions which might have

¹⁹ <https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data>

occurred if the road had remained a conventional motorway (this is referred to as a counterfactual – see Figure 14 and the POPE methodology manual²⁰). This is based on changes in regional safety trends for conventional motorways with a high volume of roads users. An expected range of collisions that consider regional trends is calculated.

Figure 14 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 X² 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.

Outside Counterfactual Range
 After Annual Average Collisions
 Counterfactual Range
 Before Annual Average Collisions

If the observed annual number of collisions is within this range, the project is operating as expected compared to the regional trends and cannot said to have had a significant impact.

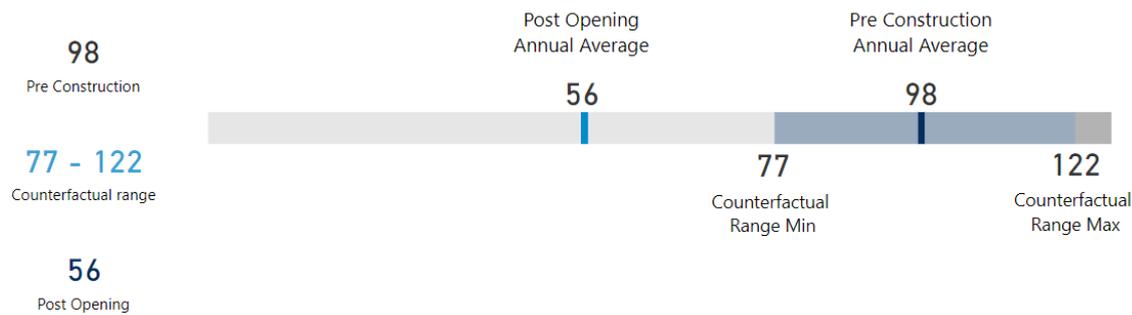
We estimated that if the road had not been widened, the trend in the number of personal injury collisions would likely have increased, and collision rates would have remained stable. A range of between 77 and 122 personal injury collisions²¹ during the five-year post project period would be expected.

An annual average of 56 personal injury collisions were observed over the five-year post-opening period, this falls below the expected range as shown in Figure 15 below. Therefore, the observed changes are significant, which means the decline in personal injury collisions can be attributed to the project.

Figure 15: Observed and expected range of personal injury collisions (annual average)

²⁰ <https://nationalhighways.co.uk/media/exyvgk11/pope-methodology-note-2024-v2.pdf>

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.



Source: STATS19: 1st July 2004 to 31st May 2017

How has traffic flow impacted collision rates?

It is important to contextualise collision numbers against changes in the volume of traffic seen on this stretch. We do this by calculating a collision rate, the number of personal injury collisions per hundred million vehicle miles (PIC/hmvm).

At five years after, the average collision rate had decreased to 8 (PIC/hmvm), this equates to travelling 13 million vehicle miles before a collision occurs. Before the project, the collision rate was 15 (PIC/hmvm), this equates to traveling 7 million vehicle miles before a collision occurs. The estimated rate if the smart motorway had not been built was 14 (PIC/hmvm). This counterfactual scenario indicates that without the project there would have been a slight decrease in the rate of collisions that occur.

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 this evaluation, following the introduction of a standardised reporting tool – CRASH (Collision Recording And Sharing). 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 officer²². Therefore, the Department for Transport have developed a severity adjustment methodology²³ to enable robust comparisons to be made.

For this evaluation, one reporting mechanism was largely used prior to the project implementation 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 project we have observed a total reduction of five collisions resulting in fatalities (the total before the project was seven, compared to two after). There was an average of 26 fewer collisions resulting in slight injuries per year (the annual average before the project was 75, compared to 49 after). There were also 16 fewer collisions resulting in serious injuries per year (the annual average before the

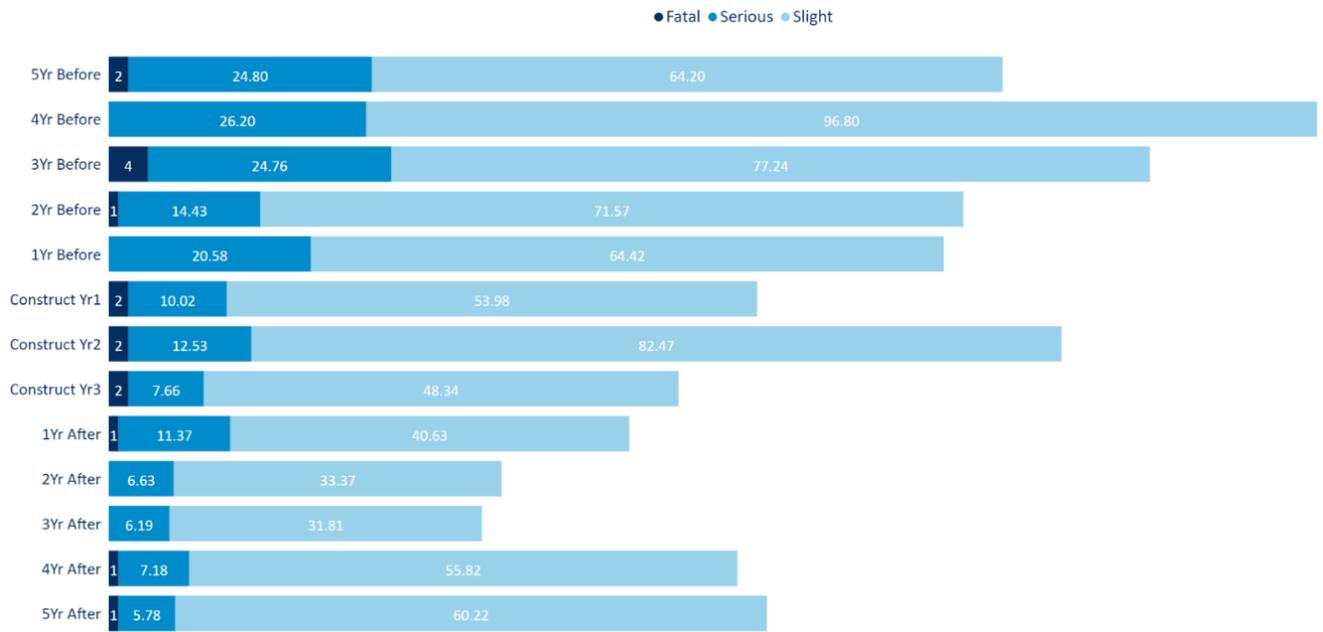
²² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820588/severity-reporting-methodology-final-report.odt

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

project was 22, compared to 6 after). Figure shows the severity of personal injury collisions by year.

Figure 16: Collisions by Severity within the project extent



STATS19: 1st July 2004 to 31st May 2017

How has traffic flow impacted collision severity?

Like other transport authorities across the UK the key measure we use to assess the safety of roads, is Fatal Weighted Injuries (FWI) metric. This gives a fatality 10 times the weight of a serious casualty, and a serious casualty 10 times the weight of a slight casualty to give a total number of FWI²⁵. This is presented as both an annual average and a rate (that standardises casualty severities against flow).

A reduction of four FWI has been observed annually²⁶, indicating that the severity of casualties occurring after the project became operational has reduced in the project extent. Before the project an annual average six FWI were observed. After the project this had reduced to an annual average of two FWI.

Considering this metric as a rate, showed an extra 260 million vehicle miles were travelled before a FWI. Before the project, 99 million vehicle miles needed to be travelled before a FWI (1 fatality equivalents per hmvm²⁷). After the project this increased to 359 million vehicle miles (0.3 FWI per hmvm). The rate of fatality equivalents per hmvm has reduced. This suggests that considering changes in traffic the project is having a positive safety impact on the severity of casualties within the project extent.

Road user safety on the junctions and wider area

There is an overlap geographically within the wider safety area for the M25 junction 27-30 and M25 junction 30/A13 projects. Construction for the M25 junction 30/A13

²⁵ 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.

²⁶ Casualty Severities within this report use the 2020 adjustment factor

²⁷ Hundred million vehicle miles

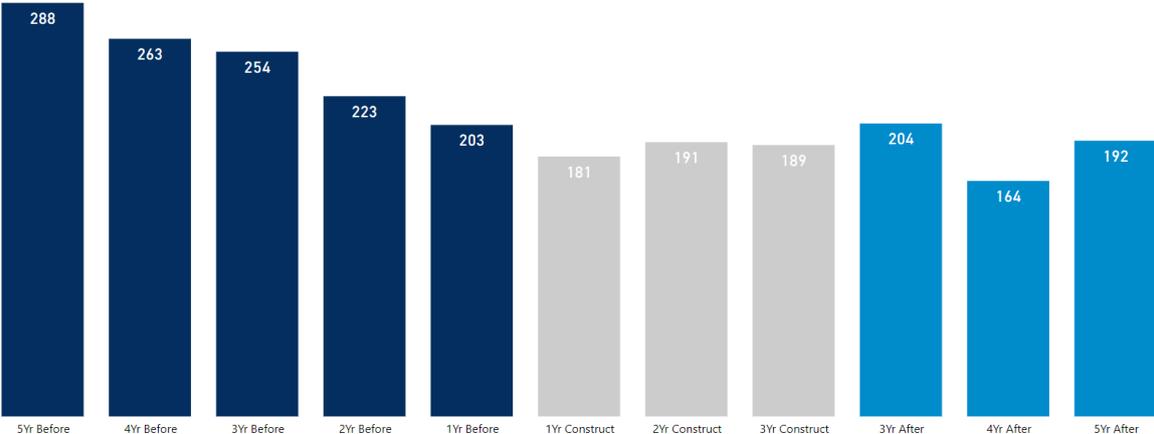
project started during the after-observation period. To isolate the impact of the projects we have used only three years of data for the wider area for the M25 junction 27-30 project.

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 to observe any potential wider impacts from the intervention.

Before the project an annual average of 246 collisions were observed within the local area. After the project the observed collisions had fallen to 187, a reduction of 59.

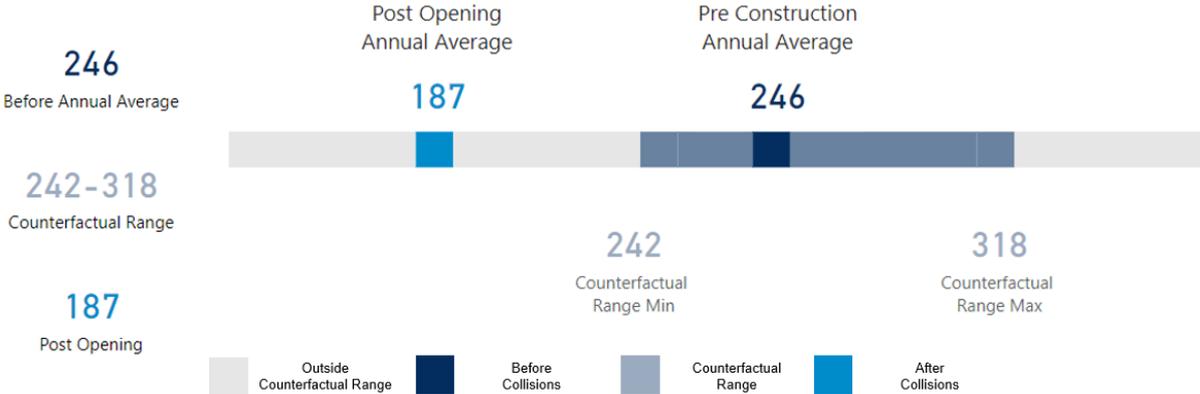
Figure 16: Personal Injury Collisions in Wider Area



Source: STATS19: 1st July 2004 to 31st May 2017

If the road had remained a conventional motorway, the counterfactual estimated the number of personal injury collisions would have been between 242 and 318. The observed annual average of 187 personal injury collisions falls outside the range. Therefore, the observed changes are significant, which means the decline in personal injury collisions within the local area can be attributed to the project.

Figure 17: Observed and expected range of personal injury collisions (wider area annual average)



Source: STATS19: 1st July 2004 to 31st May 2017

How has traffic flow impacted collision rates for the wider area?

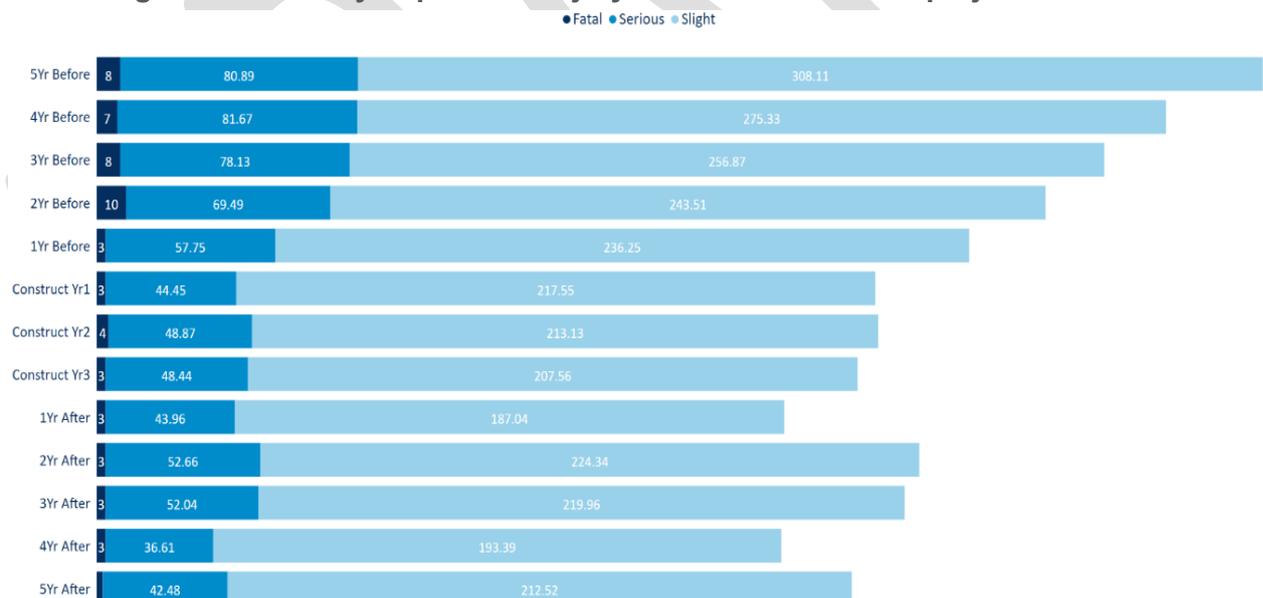
Since the project, the average collision rate had decreased to 26 personal injury collisions per hundred million vehicle miles (PIC/hmvm), this equates to travelling 4 million vehicle miles before a collision occurs. Before the project the collision rate was 31 PIC/hmvm, this equates to traveling 3 million vehicle miles before a collision occurs. The estimated rate if the motorway had remained as a conventional motorway was 30 personal injury collisions per hundred million vehicle miles. This counterfactual scenario indicates there has been a greater reduction in the rate of collisions than would have been expected without the project taking place.

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 project we have observed a reduction of 17 collisions resulting in fatalities (the total before the project was 36, compared to 19 after). There was an average of 30 fewer collisions resulting in serious injuries per year (the annual average before the project was 74, compared to 44 after). There was an average of 55 fewer collisions resulting in slight injuries per year (the annual average before the project was 264, compared to 209 after). Figure 17 shows the severity of personal injury collisions.

Figure 19: Severity of personal injury collisions within the project extent



Source: STATS19: 1st July 2004 to 31st May 2017

How has traffic flow impacted collision 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 injuries²⁸ (FWI).

A decrease of 10 FWI has been observed. Before the project the average 20 FWI were observed. After the project this had decreased to 10.

²⁸ See page 28 for explanation of the FWI

The combined measure showed an increase of 38 million vehicle miles was travelled before a FWI. Before the project, 40 million vehicle miles needed to be travelled before a FWI (this equates to 2.5 FWI per hmvm). After the project this increased to 78 million vehicle miles (this equates to 1.3 FWI per hmvm).

Has the project achieved its safety objectives?

A key objective for the project was to improve safety. 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.

How has the project performed compared to expectations?

Safety forecasts were undertaken for the widening²⁹ and controlled motorway³⁰ projects separately. The combined estimate for the two projects was that there would be an increase of 23 personal injury collisions per year over the appraisal period (60 years). This equated to an increase of 1393 PICs over the appraisal period³¹.

The appraisal was inaccurate, and the projects have outperformed expectations. This is largely due to the assumptions used for the forecast of the widening project.

²⁹ The appraisal for the widening project is based on the adoption of nationally derived collision rates for four-lane motorways that do not consider the local characteristics of the road and subsequently forecast an increase of 1999 personal injury collisions

³⁰ The appraisal for the controlled motorway project forecast a saving of 606 personal injury collisions

³¹ The outturn forecast has been calculated using the forecast of an increase of 1999 personal injury collisions for the widening and a saving of 606 personal injury collisions for the controlled motorway

6. Environmental evaluation

Summary

We undertook a site visit in June 2019 to observe the environmental impacts of the project. In addition, these observations allowed us to look at the effectiveness of any mitigation and compare this against those predicted in the project environmental assessment and one-year evaluation.

As there were no new severance³² issues generated by the widening project and no outstanding issues were experienced for physical fitness³³ and journey quality from the one-year evaluation, these three aspects have been scoped out of the five-year evaluation in line with POPE guidelines.

No townscape features were expected to be affected as settlements are well separated from the road and no townscape issues were identified from design changes. Thus, townscape has been incorporated under the landscape objective.

The Controlled Motorway project was anticipated to have a neutral impact on the environment, except a slight adverse impact on biodiversity (due to the construction of electrical control cabinets) and beneficial impacts on air quality and carbon from the smoothing of traffic flow. The gantries, and consequent impact on the landscape, were included as part of the widening project.

At five years after the impacts were evaluated to largely be 'as expected', with the traffic related impacts on noise, air quality and greenhouse gases likely to be better than expected as traffic levels are lower than forecast.

Noise

The appraisal³⁴ assessed 213 properties distributed between 85 locations. Of these properties, seven were predicted to experience an increase in local noise of 1-3 dB(A)³⁵, 160 were predicted to experience a decrease of 1-3 dB(A), six were predicted to experience a decrease of 3-5 dB(A), and 40 were expected to experience no change in noise levels by the assumed design year 2027 due to Low Noise Surfacing (LNS). Overall, the appraisal reported that eight more people would be annoyed by noise as a result of the project. The Appraisal Summary Table Report (ASTR) noted that the alternative design included two new environmental bunds which could affect the local noise at Passingford, clockwise, and at Upminster, anti-clockwise

The Environmental Statement stated that only one property was identified that would potentially qualify under the provisions of the Noise Insulation Regulations (1975), and only one property was predicted to be affected by vibration.

The overall impacts of the project on road traffic noise and vibration impacts were expected to be Slight Beneficial. However, seven properties in locations where the LNS was already in place were predicted to experience a Slight Adverse impact as a result of minor increases in traffic flows due to the project.

³² Severance means where the project causes additional separation of residents from facilities and services they use within their community

³³ Physical fitness in this context means health benefits of increased non-motorised travel (eg walking and cycling)

³⁴ The Traffic Noise and Vibration Technical Report and the Appraisal Summary Table (AST),

³⁵ dB(A) – A-weighted decibels, a unit for measuring traffic noise.

The evaluation has confirmed that low noise surfacing and noise barriers have been installed largely as expected. Based on asset data supplied on the Environmental Information System³⁶ and pavement data supplied by National Highways' Pavement Management System, noise mitigations (noise barriers and low noise surfacing) were installed/upgraded, and the mitigations are likely to be working as expected. The bunds along the project were designed to mitigate landscape impacts and are unlikely to have had any material impact on noise.

The appraisal overstated the traffic flows, and thus also overpredicted the magnitude of noise generated by traffic. As the observed flows were below forecast, it is considered that the noise impacts were better than predicted.

Air quality

The appraisal expected that the project would have a slight adverse impact overall, due to relatively small increases in traffic flows/ speeds and the small number of properties within 50m of the project. Most of properties affected by the project were stated to be on the Brentwood bypass, where the increase in pollutant concentration would be marginal at an average of 0.01ug/m³ for Nitrogen dioxide (NO₂). Air Quality objectives were also predicted to be met in all 9 Air Quality Management Areas (AQMAs) in the opening year and in subsequent years whether or not the widening took place.

Overall, the appraisal expected that 1,118 properties would experience a degree of deterioration in NO₂ concentrations. For Particulate Matter (PM₁₀) concentrations, 170 properties were predicted to experience improvement, 134 were expected to experience deterioration, and 841 were expected to experience no change as a result of the project.

Based on the available monitoring data³⁷ for the two local AQMAs close to M25 (Brookstreet near J28 and Nag Head Lane), levels of NO₂ are below the threshold for concern about air quality.

As with the noise assessment, the air quality appraisal was based on traffic flows that overstated the expected levels of forecast traffic. As the observed traffic levels are significantly below forecast, it is proposed that air quality impacts are better than expected.

Greenhouse gases

It was expected that the widening would result in a net increase in carbon emissions over the 60-year appraisal period, compared to the do minimum scenario due to more vehicles. However, the increase was forecast to be less than 0.03%. Net carbon emissions over the 60-year appraisal period were estimated to be 142,894 tonnes and in the opening year this was forecast to be 1,783 tonnes.

It is not possible to undertake a like-for-like evaluation of greenhouse gas emission, because the appraisal did not include forecasts of the percentage of traffic that would be heavy goods vehicles (HGVs). An accurate figure for the volume of carbon removed or added to the atmosphere as a result of the project

³⁶ EnvIS – Environmental Information System, a database used to store information about our environmental assets.

³⁷ Data published in air quality annual status report (2019) from Brentwood Borough Council

cannot be calculated. However, as traffic volumes were substantially lower than forecast, it was likely that emissions along this stretch were lower than forecast.

Landscape

The appraisal determined that no townscape features were expected to be affected as settlements are generally well separated from M25 by embankments and vegetation. The study area has a generally rural character. Therefore, evaluation of townscape impacts was scoped out and any impacts are considered under landscape.

The appraisal for the widening notes that loss of screening due to increased road surface, gantries and structures was expected to negatively impact on the landscape. The number of lighting columns was expected to increase but with better control of light spillage. Overall, the impact of widening on landscape and visual impact was expected to be slight adverse. The impact on townscape was expected to be neutral, due to the project's separation from settlements.

Figure 20: View of the cluttering and lighting around J28 taken from the overbridge along Nags Head Lane



(Source: FYA Evaluation visit, 20 June 2019)

Based on the evidence gathered as part of the five-year evaluation site visit of June 2019, general landscape character change was minimal, as expected. The M25 was already prominent in the landscape and the works were largely online. The visual amenity has been impacted largely as expected.

The mitigation provided was mostly hedgerows for screening along footpaths and some woodland plots, and these were doing well at the five-year evaluation stage. For example, the Thames Chase Initiative³⁸ appears to be working in Tyler's Wood. However, there is mixed success for other types of planting, for example on landscape bunds. Where the soft estate is limited, and the road is at an elevation, screening may need more than 15 years to establish. Ongoing aftercare will be required to ensure the mitigation planting delivers the intended design year benefits.

Heritage of historic resources

The appraisal expected that the project would have slight adverse impacts on 15 known archaeological sites and areas of general archaeological potential, along with slight adverse impacts to 98 listed buildings. It anticipated neutral impacts to two Scheduled Ancient Monuments, on four Registered Parks and Gardens

³⁸ Thames Chase Initiative – tree planting to create a community forest around Tyler's Wood to compensate for lost trees.

(RPGs), eight Conservation Areas and four Historic Woodlands. Overall, the impact of the project was appraised as slight adverse.

The evidence gathered during the five-year evaluation site visit suggests that as expected, most historic monuments are unaffected by the project. Desktop information provided in the Environmental Statement assessments and the published report for the archaeological investigation of the project suggests archaeological investigations were undertaken as expected. Impacts on historic buildings observed were also largely as expected. For historic landscapes and conservation areas, the impacts were as expected in Ockenden and better than expected in Belhus Park. As with the one-year evaluation, the impacts of the widening project on the historic environment are in line with the proposals in the environmental assessments.

Biodiversity

The widening project was expected to result in slight beneficial impacts for the River Roding, along with species such as amphibians, otters, water voles and common aquatic invertebrates due to improved motorway drainage. Slight adverse impacts were expected on bats and birds resulting from an increase in habitat edge effects and changes in noise/light pollution. Overall, the expected impact of the widening project on biodiversity was assessed as slight adverse. The Controlled Motorway technology was expected to lead to slight adverse impacts due to space lost to accommodate additional cabinets within low value verge habitats. Designated sites were not expected to be affected by the proposals.

This five-year evaluation confirms that the works were largely on time and impacts to species were likely to be very limited, as expected. There were no night-time observations to confirm lighting impacts on birds and bats and no up-to-date information on the monitoring of ecological aspects associated with the project was made available for the five-year evaluation. There was generally limited opportunity during the five-year evaluation site visit to observe biodiversity. Some species mitigations for example, works under licences (creation of balancing ponds, hibernacula's and log piles) were done as confirmed in the Environmental Statement Comparison Report (ESCR) and the draft Handover Environmental Management Plan. New hedgerows and the Thames Chase Community Forest were doing well at the five-year evaluation stage. However, some planting had failed, and evidence of any active management was lacking. Maintenance is required if the environmental benefits of planting to support species are to be fully realised by the design year.

Water environment

The appraisal stated that no additional floodplain land would be utilised by the project and that despite an increase in highway area, additional flow attenuation and treatment included as part of the project would result in slight beneficial impacts overall.

At the five-year evaluation stage, the reported impact/benefits of the widening project on drainage could not be confirmed due to limited access to the drainage infrastructure during the site visit and lack of drainage flow, pollution control device and monitoring/maintenance data. Environmental Information System (EnVIS) asset data for land water and land vegetation is not up to date. Based on the one-year evaluation, although embankment widening did encroach onto the River Roding

floodplain, this was compensated for via design. The Environment Agency considered the agreed designs to adequately mitigate any adverse impacts on the water environment and in some cases, provide an improvement over the previous controls. As there is insufficient information on the maintenance of the drainage system at the five-year evaluation stage to indicate that there has been any change in performance since the one-year evaluation, the five-year evaluation confirms that it is likely that the overall effect of the project on water quality and drainage is as expected.

Overview

Table 5: Environmental impacts – M25 junctions 27-30

Sub Objective	Appraisal Summary Table Score	Five-year Evaluation	Summary
Noise	Slight adverse	Better than expected	Resurfacing (low noise surfacing) and barriers were implemented as expected. Observed traffic flows were lower than predicted in appraisal, noise generation will be lower as a result.
Air quality	Slight adverse	Better than expected	Local air quality monitoring data suggested that levels of NO ₂ were below the air quality threshold. Observed traffic flows were lower than predicted in appraisal; impacts on air quality were likely to be less adverse than forecast.
Greenhouse gases	Slight adverse	Better than expected	Full assessment was not possible due to the lack of forecast HGV flows. However, as the observed traffic flows were significantly lower than the forecast flows, it is likely that greenhouse gas levels were better than expected.
Landscape	Slight adverse	As expected	General landscape character change was minimal, as expected as were impacts on visual amenity. Mitigation was provided as expected, but maintenance will be required to ensure design year outcomes are met.
Townscape	Neutral	As expected	Settlements are well separated from the road and were unlikely to be affected.
Heritage of historic resource	Slight adverse	As expected	Impacts on historic monuments, archaeology, historic building and historic landscapes were in line with expectations.
Biodiversity	Slight adverse	As expected	The works were largely online and impacts on ecology were likely to be very limited, as expected. Habitat improvements were working well at the five-year stage, although needing ongoing maintenance.
Water environment	Slight beneficial	Likely to be as expected	Encroachment into the River Roding Floodplain was compensated for via the project design, as agreed with the Environment Agency.

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 for the widening and 30 years for the controlled motorway element.

In this study we have been limited in what reassessments we can make because it is not possible to separate out the observed impacts of the widening from the controlled motorway. There was no appraisal of the widening combined with the impact of the controlled motorway, so instead we have combined the appraisal forecasts to estimate the anticipated impact of both projects in combination³⁹.

The combined projects were delivered well below the forecast cost. In the first five years, the road provided additional capacity to support more road users (an increase of 16% to 25%), whilst improving the safety of those journeys. If this trend continues, the project is reforecast to deliver £50 million safety benefits over the 60-year period⁴⁰.

While delivering some journey time improvements (evening peak) most other times experienced increased journey times. As the projects' monetised benefits were primarily driven by forecasted reductions in journey times, this has impacted the project's value for money assessment.

Overall, the evaluation indicated that in the first five years this investment is not on track to deliver the expected value for money over the 60-year life of the project. If the journey time trends observed within the first five years continue, the project is likely to deliver 'poor' value for money⁴¹.

It must be noted however that the reforecast does not represent the full impact of the project, as it does not reflect the journey time impact on the wider road network.

Forecast value for money

An economic appraisal is undertaken prior to construction to determine a project's value for money and inform the business case. The appraisal is based on an estimation of costs and benefits. The impacts of a project, such as journey time savings, changes to user costs, safety impacts and some environmental impacts can be monetised. This is undertaken using standard values which are consistent across government. The positive and negative impacts over the life of the project⁴² are summed together and compared against the investment cost to produce a benefit cost ratio (BCR). The monetised impacts are considered alongside

³⁹ Although this is a simplification, we think this is appropriate because the controlled motorway appraisal was based on the widening already being in place (ie in the 'do-minimum' scenario) and therefore the forecast impacts were over and above the impacts of the widening. The controlled motorway was only appraised over 30 years. This is because our standard assumption is that technology will be life-expired beyond this point. Benefits will stop accruing and new investment will be required.

⁴⁰ Based on impacts on the Strategic Road Network.

⁴¹ The value for money categories referenced are defined by the Department for Transport <https://www.gov.uk/government/publications/dft-value-for-money-framework>

⁴² Typically, project life is taken to be 60 years.

additional impacts which are not able to be monetised, to allocate the project a 'value for money' category⁴³.

The combined monetised benefits forecast by the appraisals of the M25 junctions 27 to 30 widening and controlled motorway are set out in Table 6. We have also included an indication of what proportion of the monetised benefits each impact accounted for and a summary of how we have treated the monetisation of each impact in this evaluation.

Table 6: Forecast economic impact of the project (£m)

	Forecast (£m)	% of forecast monetised benefits	Evaluation approach
Journey times	1,020	84%	Re-forecast using observed and counterfactual traffic flow and journey time data for the project area only and not those in the wider area
Vehicle operating costs (VOC)	-30	-2%	Re-forecast using observed and forecast traffic flow and journey time data
Journey time & VOC during construction and maintenance	100	8%	Not evaluated (assumed as forecast)
Journey time reliability	155	13%	Not evaluated (assumed as forecast)
Safety	-80	-7%	Re-forecast using observed and counterfactual safety data
Carbon	-8	-1%	Monetised benefits assumed as forecast
Noise	0	0%	Monetised benefits assumed as forecast
Indirect tax revenues	64	5%	Re-forecast using observed and forecast traffic flow and journey time data
Total present value benefits	1,221	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 7. Based on this information, the project was anticipated to give 'high' value for money over the 60-year appraisal period⁴⁴.

It should be noted that given the complexity of two overlapping projects, the re-forecast safety and journey time benefits have been based on monetising the observed impact on the project section and do not reflect the whole modelled area considered in the appraisal.

⁴³ The value for money categories referenced are defined by the Department for Transport <https://www.gov.uk/government/publications/dft-value-for-money-framework>

⁴⁴ The value for money categories referenced are defined by the Department for Transport <https://www.gov.uk/government/publications/dft-value-for-money-framework>

Evaluation of costs

The project was delivered at a cost of £453 million, well below the anticipated cost of £610 million (see Table 7), and resulting in an estimated whole-life cost of £420m⁴⁵ once expected maintenance savings are accounted for. This project was delivered as a lumpsum element of a larger contract. Our contractor was incentivised to reduce costs throughout their delivery, but these savings do not become apparent until final accounts have been agreed.

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

Table 7 – Cost of the project (£ million)

	Forecast (£m)	% of forecast costs	Evaluation approach
Construction costs	610	106%	Current estimate of project cost
Maintenance costs	-34	-6%	Not evaluated (assumed as forecast)
Total present value costs	577	100%	

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

Evaluation of monetised benefits

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

Monetised journey time benefits

As can be seen in Table 6, monetised benefits were primarily driven by forecasted reductions in journey times over the modelled period compared to a 'do-minimum' scenario, what would be expected to happen if the smart motorway were not built. Therefore, in this section of our study, we have compared the 'after' journey times to an estimate of the 'counterfactual', an estimate of what journey times are likely to have been without the project. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion.

The project has improved journey times in the evening peak, but journey times have increased in other time periods. If the trends observed at the fifth year

⁴⁵ All costs presented are PVCs (present value costs). This means it is presented in 2010 prices, discounted to 2010 to be comparable with the other monetary values presented.

continue over the 60-year period, without any further action to optimise benefits, the monetised impact on journey times, for those using the road, would be -£81 million⁴⁶. 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 model used to appraise this project did not accurately represent the variation in journey times across the day in the without project scenario. This will have contributed to inaccuracy in the forecasting of the impacts on journey time. The forecasts also generally overstated the traffic increase⁴⁷. The appraisal assumed the project would deliver journey time savings for both those using junctions 27 to 30 and those using the surrounding road network, where congestion would be eased by the additional capacity. The evaluation has not monitored the journey time impact on the surrounding roads and can only directly quantify a proportion of the journey times. We were unable to use the forecasts to estimate the benefit in the wider area as there was no appraisal of the two projects combined and the files for the widening project (which contributed the majority of benefits) were no longer available. We acknowledge that the monetised value presented above does not represent the full impact of the project, as it does not reflect any impact on the wider road network.

Monetised safety benefits

The combined estimate for the two projects was that there would be an increase of 23 personal injury collisions per year over the 60-year appraisal period, equating to a disbenefit of £80 million. This was largely due to the assumptions used about the forecast rates relating to the widening project. We have actually seen an improvement in safety, expected to equate to a monetised benefit of £50 million over the project life.

Other reforecast impacts

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 positive because more vehicles were forecast and they were forecast to be travelling at higher speeds, and therefore using more fuel and paying more tax. We have reforecast that the impact would be smaller than expected (an increase in tax revenues of £48 million). The impact is smaller because our evaluation has shown that there wasn't as much traffic growth as forecast and in some time periods the speeds have got slower. Vehicle operating costs refer to the fuel and other costs borne by the user (such as the wear and tear on vehicles). These generally increase with increased distance travelled and for these projects there was a disbenefit of £30 million forecast. Based off the changes we have seen in our estimate of fuel consumption and indirect tax revenue, we estimate the outturn impact to be a slightly smaller disbenefit of £23 million.

⁴⁶ This is against a counterfactual where we have estimated what the journey time is likely to have been if the road had remained a conventional motorway.

⁴⁷ Refer to section 4 for further details.

Impacts assumed as forecast

Journey time reliability was a main objective of this project. The route was less congested at five-years after, but the impact on reliability was inconclusive. It has not been possible to calculate an outturn re-forecast for journey time reliability due to there not being a combined appraisal of the two projects for us to base this on. We have assumed the monetised value of reliability to be as forecast for the purposes of this evaluation. This might be a generous assumption given the inconclusive findings.

The evaluation has also not been able to reforecast the monetary value of noise and carbon benefits⁴⁸, and instead these were reported as forecast. For noise and carbon impacts, this assumption is conservative because lower than forecast traffic flows are likely to mean that these impacts are better than forecast⁴⁹.

Journey times and vehicle operating costs during construction and maintenance are not evaluated and therefore are assumed as forecast. As the vast majority of this maintenance is still in the future, we did not have any information with which to update the estimate for this and therefore the forecast from the appraisal remains our best estimate.

Overall value for money

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

When considering an investment's value for money we also consider benefits which we are not able to monetise. For this project journey ambience⁵⁰ would be a relevant consideration, as the pre-construction appraisal expected a large beneficial impact in reducing driver stress by improving route certainty⁵¹. Journey ambience was considered in our one-year after evaluation⁵². The conclusion of this was that although the benefits were not as large as anticipated, there was still a positive benefit on journey ambience. Whilst this impact might increase the project's value for money slightly, it would not be a significant enough impact to change its value for money category, therefore it is likely that this project has offered 'poor' value for money. This investment has delivered benefits to road users, but not the full value anticipated.

⁴⁸ 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 projects and therefore the impact of assuming as forecast is unlikely to impact on the value for money rating of the project.

⁴⁹ Refer to section 6 for further detail on noise and greenhouse gas impacts.

⁵⁰ Journey ambience was a measure of the experience of travelling. This includes traveller care (eg information and facilities), travellers' views; and traveller stress factors (eg perceptions of safety, congestion and reliability). Refer to former [TAG unit 3.3.13](#). It has now been replaced by the term 'journey quality'

⁵¹ Route certainty relates to signage and lane layouts

⁵²

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/448746/PO PE_M25_J27-30_OYA_Final.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/448746/PO_PE_M25_J27-30_OYA_Final.pdf)

Appendix A

A.1 Forecast and observed flows and journey times

Table 8: Observed and forecast traffic flows, average weekday AM peak hour, 2-way

Section	Observed flows		%Growth (Observed)	Forecast flows		%Growth (Forecast)
	2008	2018		2008 DM	2018 DS	
J27-28	8,390	9,691	15.5%	9,264	10,643	14.9%
J28-29	7,866	9,552	21.4%	9,400	10,898	15.9%
J29-30	7,217	8,010	11.0%	8,944	10,434	16.7%

Table 9: Observed and forecast traffic flows, average weekday interpeak hour, 2-way

Section	Observed flows		%Growth (Observed)	Forecast flows		%Growth (Forecast)
	2008	2018		2008 DM	2018 DS	
J27-28	7,635	9,275	21.5%	9,294	11,050	18.9%
J28-29	7,352	9,001	22.4%	9,340	11,096	18.8%
J29-30	7,082	8,145	15.0%	9,674	11,547	19.4%

Table 10: Observed and forecast traffic flows, average weekday PM peak hour, 2-way

Section	Observed flows		%Growth (Observed)	Forecast flows		%Growth (Forecast)
	2008	2018		2008 DM	2018 DS	
J27-28	9,134	10,468	14.6%	10,138	12,133	19.7%
J28-29	8,404	9,959	18.5%	10,272	12,042	17.2%
J29-30	7,484	9,071	21.2%	9,994	11,747	17.5%

Table 11: Observed and forecast journey times in each time period (clockwise)

Time Period	Observed journey time (mm:ss)		% Diff. (Obs.)	Forecast journey time – Base/DM (mm:ss)		Forecast journey time – DS (mm:ss)	
	2008	2018		Base 2004	2012 DM	2015 DS	2021 DS
AM	15:32	18:42	+20%	16:47	17:42	16:13	16:34
IP	15:47	16:54	+7%	16:52	18:01	16:25	17:07
PM	22:10	20:03	-10%	17:26	18:19	16:34	16:55

Table 12: Observed and forecast journey times (anti-clockwise)

Time Period	Observed journey time (mm:ss)		% Diff. (Obs.)	Forecast journey time – Base/DM (mm:ss)		Forecast journey time – DS (mm:ss)	
	2008	2018		Base 2004	2012 DM	2015 DS	2021 DS
AM	20:20	20:40	+2%	15:44	16:09	15:17	15:41
IP	15:29	16:15	+5%	15:51	16:30	15:33	15:59
PM	17:22	16:58	-2%	16:46	17:16	16:09	16:33

Appendix B

B.1 Incident Reporting Mechanisms

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

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

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

B.2 Unadjusted Collision Severity

The project extent is covered by Essex police constabulary who transferred from Stats19 to CRASH in November 2012.

Figure 18 shows the unadjusted collision severities on the project extent:

Figure 21: Unadjusted Collision Severity on Project Extent

Observation Year	Fatal	Serious	Slight
5Yr Before	2	16	73
4Yr Before		16	107
3Yr Before	4	17	85
2Yr Before	1	6	80
1Yr Before		13	72
1Yr Construct	2	4	60
2Yr Construct	2	6	89
3Yr Construct	2	3	53
3Yr After		4	34
4Yr After	1	4	59
5Yr After	1	5	61

Source: STATS19: 1st June 2004 to 31st May 2017

Part of the wider safety area of the M25 J16-23 project is covered by Metropolitan Police constabulary who transferred from Stats19 to COPA in January 2015.

Figure 19 shows the unadjusted collision severities on the wider safety area:

Figure 22: Unadjusted Collision Severity on Project Extent

Observation Year	Fatal	Serious	Slight
5Yr Before	6	35	247
4Yr Before	5	34	224
3Yr Before	6	44	204
2Yr Before	7	30	186
1Yr Before	2	32	169
1Yr Construct	3	22	156
2Yr Construct	4	23	164
3Yr Construct	3	23	163
3Yr After	3	28	173
4Yr After	3	18	143
5Yr After	2	31	159

Source: STATS19: 1st June 2004 to 31st May 2017

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