M3 junctions 2 to 4a all lane running

One-year post opening project evaluation

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Foreword

Highways England's motorways are among the safest in the world[1]. Our road network carries a third of road traffic, and we have seen demand grow by a quarter since 2000, with continued growth forecast.

Smart motorways were introduced in 2006, to help meet growing demand for space on our motorways. By making use of the full width of the road, smart motorways add extra capacity to carry more vehicles and keep traffic flowing.

Compared to conventional motorway widening they deliver:

- Increased capacity at significantly less cost than traditional motorway widening.
- New technology and variable speed limits to improve traffic flow.
- Environmental benefits of not taking an extra corridor of land to use as new road.
- A safety record that is at least as safe, if not safer than conventional motorways[2].

Since 2006 smart motorways have evolved from controlled motorways (with variable speed limits) to dynamic hard shoulder running (opening the hard shoulder as a running lane to traffic at busy periods) to all lane running (permanently removing the hard shoulder and converting it into a running lane). The M3 junctions 2 to 4a scheme is the last type - all lane running - where the hard shoulder becomes a normal running lane. Emergency areas are provided for drivers experiencing a breakdown or other emergency.

This report indicates how the scheme performed in its first year of operation, between August 2017 and July 2018. This initial assessment forms part of a longer-term evaluation, which will review performance over a number of years. This one year after study is not intended to provide conclusive evidence about scheme benefits, but gives an early indication about whether a scheme is meeting its objectives.

Initial journey time analysis suggests this scheme is helping to ease congestion. Before the installation of all lane running, commuters were experiencing unreliable and congested journeys in the morning heading towards London, and to some extent returning away from London in the evening. At these times journeys have become smoother and quicker.

Personal injury collisions on the strategic road network are very rare, and can be caused by many factors. Due to their unpredictable nature, we monitor trends over several years before we can be confident that a real change has occurred as result of a scheme. Within the first year, it has not been possible to reach conclusions about the safety impacts of this scheme, but there are positive early signs, with the number of collisions reducing in the context of some small traffic growth.

In March 2020, the Department for Transport published its smart motorway safety evidence stocktake and action plan[2]. This concluded that in most ways, smart motorways are as safe as, or safer than, the conventional ones; but not in every way. To ensure we are doing all we can do to improve safety, Highways England is implementing all 18 measures recommended. This will allow us to retain the benefits of smart motorways, while addressing the concerns that have been identified.

One such measure was to roll out stopped vehicle detection technology more quickly. The technology detects a stationary vehicle within approximately 20 seconds. This sends an alert to our control centre, where we check CCTV and close the blocked lane. Work had already started to install stopped vehicle detection on this stretch of the M3 when the stocktake was being carried out. Stopped vehicle detection has now been live on this stretch of the M3 since the end of December 2020; after the period covered by this evaluation report (August 2017 to July 2018).

Elliot Shaw

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March 2021

[1] https://www.gov.uk/government/statistical-data-sets/ras52-international-comparisons
[2] https://www.gov.uk/government/publications/smart-motorway-evidence-stocktake-and-action-plan

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1. Executive summary

1.1 Background

The M3, junctions 2 to 4a, was identified as one of six highway improvement schemes in the government's growth agenda review in 2011. These schemes aimed to tackle areas of congestion and improve the national road network. Congestion was high on this stretch of the M3. For example, heading east in the morning, the level of congestion meant that road users were often driving under 40mph. Further congestion was forecast in later years; especially with new developments planned in the area. A smart motorway was therefore installed between junctions 2 and 4a, with construction starting in 2014 and opening 2017. Capacity was increased by converting the hard shoulder into an additional motorway lane, permanently open to traffic. Emergency areas were installed for use in the event of a breakdown or other emergency. Technology was also deployed, such as the ability to display variable mandatory speed limits. Adjusting speed limits alerts drivers to adapt their speed, helping them to respond to changes in traffic conditions. This can smooth out traffic flow and ease congestion.

1.2 Evaluation findings

This report indicates how the scheme was performing within its first year of operation. This initial assessment forms part of a longer-term evaluation which reviews performance over time as the benefits mature. The one-year after study is not intended to provide conclusive evidence about scheme benefits but gives an early indication about whether a scheme is heading in the right direction. This helps to identify areas to focus effort and optimise the benefits of the scheme.

1.2.1. Customer journeys

The additional lane available to road users has unlocked extra capacity and led to improvements in customers' journeys. The greatest benefits are seen where the motorway was most congested ahead of its installation: heading east towards London in the morning; and to some extent returning away from London in the evening. Average journeys are approximately 12 minutes quicker in the morning (7-8am), heading towards London. Speeds also increased at this time, from 20-40mph to 50-60mph. In the evening, coming away from London, journeys are almost 3 minutes quicker. Journey times at other times of the day also decreased, between approximately 30 seconds and 2 minutes.

Journey times have also become more consistent and reliable; both for average journeys and those undertaken at the most congested periods (based on the 10% slowest journeys). Road users can therefore be more confident of the time it will take to travel through this stretch of motorway. Similar to journey duration, those heading towards London in the morning, and away from London in the evening, have seen the greatest improvements. These were the times when journeys were most unpredictable before the smart motorway. Speed analysis also indicates less variation in speeds, leading to a smoother journey overall. Although, there are still some areas of congestion leaving the smart motorway – such as at junction 3 heading east and joining the M25 heading west.

Quicker and more reliable journeys should be taken in the context of traffic volumes. The number of vehicles passing through this stretch has not increased greatly in the first year, nor was it expected to. The exception to this rule were increases in the morning, heading towards London, which were in line with forecasts. Traffic flows increased by 23% 7-8am and 11% 8-9am here, but even accounting for this growth in road users, journeys have still become quicker than before the conversion to the smart motorway.

It should be noted that, in later years, traffic volumes are expected to rise. The smart motorway aims to limit the impact of these increased volumes on journey times. We will continue to monitor this benefit over a longer timeframe.

1.2.2. Safety

Personal injury collisions on the strategic road network are rare and can have many contributing factors. Due to their unpredictable nature, trends are monitored over many years before we can be confident that a real change has occurred. Within the first year, it is not possible to conclude the safety impacts of the scheme, but it is an important indicator to check if we are on track.

The annual average number of collisions on this stretch of motorway decreased and was lower than our estimation of what we would expect without the scheme being built. During the first 12 months of the smart motorway being open there were 36 personal injury collisions compared to an estimated 57-107 collisions without it. When considered in light of changes in the number of road users, the annual average rate of personal injury collisions has also reduced.

In the context of other findings in this report these are positive early signs. Traffic levels are set to increase in later years, however, and so results at the follow up evaluation will be essential to check if this trend continues.

1.2.3. Environment

In relation to environmental performance, only some aspects are assessed at this stage. A full environmental evaluation will take place in a follow up evaluation. The initial one-year evaluation examines noise, air quality and greenhouse gases. Noise mitigation measures have been put in place as expected, with noise monitoring[3] suggesting that, in the opening year, daytime noise levels were lower than pre-construction levels. Air quality monitoring data indicates that, as expected, the scheme has not caused any significant air quality effects. We have only been able to consider greenhouse gas emissions along the smart motorway. The data suggests that due to higher than predicted flows of heavy goods vehicles, higher than predicted greenhouse gas emissions have occurred in the opening year. We do not know how traffic patterns may have changed due to the scheme in the wider area, so cannot know the full impact on greenhouse gas emissions.

[3] Direct noise monitoring is not undertaken as part of the post opening evaluation methodology. It is used, however, when this is commissioned by the project team. M3 J2-4a Smart Motorway: Post Opening Noise Monitoring (February 2018).

2. Introduction

2.1 What is the scheme and what was it designed to achieve?

The M3, junctions 2 to 4a, was identified as one of six highway improvement schemes in the government's growth agenda review in 2011. This aimed to tackle areas of congestion and improve the national road network. Existing congestion was high on this stretch. For example, heading east in the morning, speeds could struggle to exceed 40mph. Traffic was set to increase in later years; especially given potential developments around Rushmoor, Basingstoke, Dean and Winchester. Traffic forecasts estimated that effective operation of this section would only be maintained if an additional lane of capacity was provided.

Highways England, therefore, constructed a smart motorway on the M3 between junctions 2 and 4a starting in 2014, opening for traffic in June 2017. Although all lanes were open at the end of June, this was at a reduced speed limit. The road was operating at national speed limit at the start of August 2017, which is when we started the one-year evaluation point from.

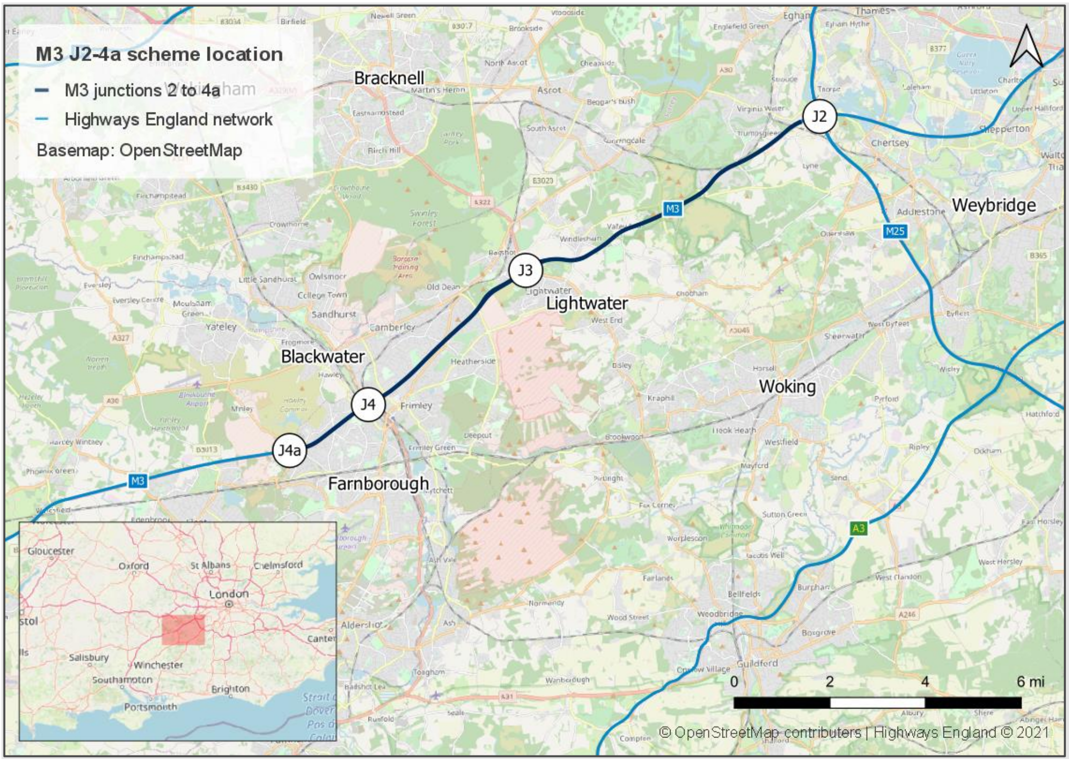
The type of smart motorway built was all lane running. This meant converting the hard shoulder into a lane that is permanently open to road users. Technology was also put in place to support variable mandatory speed limits. This allows speed adjustments when there is congestion or for safety reasons, for example during an incident; or to slow down vehicles to smooth the flow of traffic. Other aspects of a smart motorway were also employed such as: speed enforcement cameras, a queue protection system, CCTV and emergency areas for emergencies such as breakdowns.

As well as the smart motorway, the works involved shifting capacity on the link roads between the M3 junction 2 and the M25. Capacity was increased between M3 eastbound to M25 northbound and M25 north and southbound to M3 westbound. The 50mph average speed limit section through junction 2 of the M25, to the M3 westbound, was also extended by just over 1km further into the M3. Other works included installing a concrete reserve and low noise surfacing.

2.2 Scheme Location

The smart motorway starts at junction 2, where the M3 joins with the M25 circular motorway around greater London. The smart motorway continues along the M3 westbound to junction 4a, near Farnborough. The east of stretch is predominantly rural. Between junctions 2 and 3 there is also a site of special scientific interest: Chobham Common.

Figure 1 Map of M3 J2-4a scheme location and surrounding highway network



Source: Highways England and OpenStreetMap contributors

2.3 How has the scheme been evaluated?

Post-opening evaluations take place after the opening of major schemes. This paper examines the one-year after results for the M3 junctions 2 to 4a smart motorway. Post-opening evaluations are carried out to validate the accuracy of estimated scheme impacts, which were agreed as part of the business case for investment. The evaluations measure whether the expected benefits are likely to be realised. This provides lessons learned to improve future scheme appraisals and business cases.

The evaluation is also important for transparency and accountability of public expenditure, assessing whether schemes are on track to deliver the anticipated value for money.

A post-opening project evaluation compares changes in key impact areas[4] by observing trends on the route before the scheme was constructed (baseline) and tracking these after the opening of the scheme to traffic. The outturn impacts of the scheme are evaluated against the expected impacts - presented in the forecasts made during the project planning process - to review the scheme's performance.

[4] Key impact areas including, safety, journey reliability and environmental impacts

3. Delivering against objectives

3.1 How has the scheme performed against objectives?

All Highways England major schemes have specific objectives which are defined early in the business case when scheme options are being identified. These benefits are appraised to be realised over 60 years, so the first-year evaluation provides early indication of progress. The objectives for the M3 junctions 2 to 4a included the following:

Table 1 Objectives and Evaluation Summary

Objective	One-year evaluation
Increase motorway capacity and reduce congestion	An extra lane of capacity has been added to this stretch. This has helped ease congestion, particularly where journeys were the slowest - heading towards London in the morning rush hours. Traffic growth is expected in later years, so we will need to review at a later time.
Improve journey times on the M3 between junctions 2 to 4a	Journey times have improved across all time periods, particularly in the morning heading towards London, when journeys were most congested pre-smart motorway. Traffic growth is expected in later years, so we will need to check if this trend continues.
Smooth traffic flows	Journeys are smoother at the most congested times but there is queuing to leave some junctions, particularly heading east.
Provide more reliable journey times as measured by the average delay experienced by the worst 10% of journeys	Journeys are more reliable meaning those travelling the stretch repeatedly can be more confident in the consistency of their journey time.
Maintain and, where possible, improve current safety standards	The number of personal injury collisions has decreased. The rate of personal injury collisions, when considered in the proportion of traffic, has also decreased. These are early findings, however, and a later evaluation will determine if we can have confidence in these results.
Increase and improve the quality of information for the driver and improve journey ambience	Not assessed in this study, this will be measured in a follow up evaluation.
Offset the detrimental environmental impacts through mitigation measures	Noise mitigation measures implemented broadly as expected. The remaining measures will be considered as part of a follow up evaluation site visit.

4. Traffic Evaluation

4.1 Summary

Multiple sources of traffic data have been analysed to understand the impact of the smart motorway on road users. Speed and journey time analysis indicated that journeys were most congested heading towards London in the morning. Those returning from London in the evening also experienced some congestion, although not to the same extent. These were the times that benefitted most from the smart motorway, although smaller benefits were seen across all time periods.

Journey time savings exceeded the first-year benefits forecast within the business case. This was due to an underestimation how much traffic levels would increase prior to installation of the smart motorway. There are still some locations, however, where traffic is an issue. For example, queueing to leave the smart motorway still occurs in some places, such as leaving junction 3 heading east.

Quicker journeys should be considered in the context of traffic levels. These have largely remained stable, as predicted, for the first year. As such, an additional lane of capacity has eased traffic and made journeys quicker. It is important to note, however, that traffic levels are forecast to increase in later years. Some of the larger journey time benefits therefore may not endure, but are expected to minimise greater deterioration compared with not installing the smart motorway.

4.2 How have traffic levels changed?

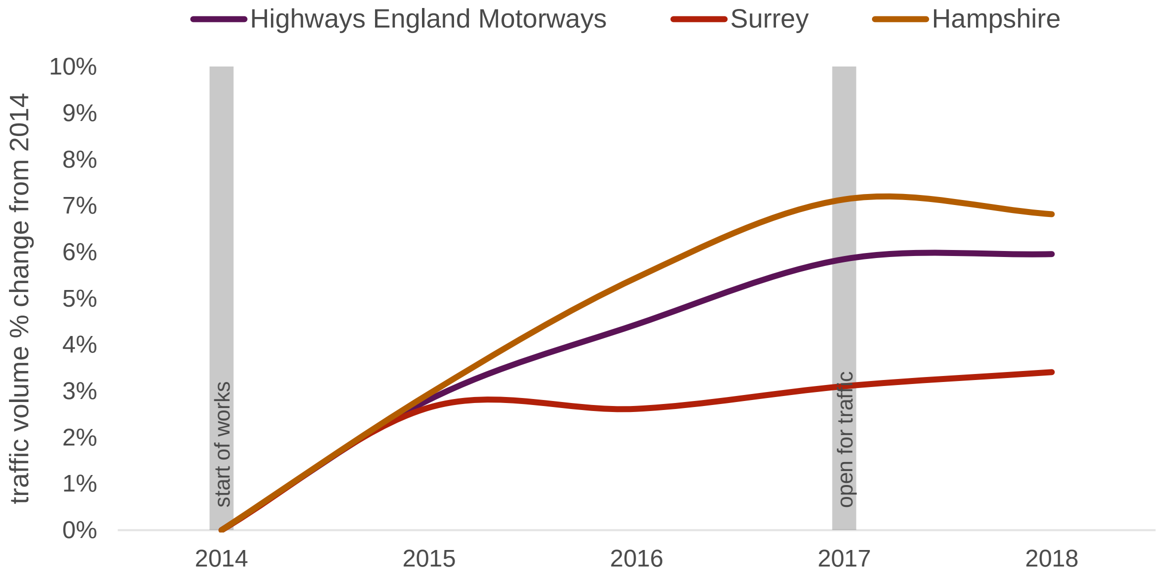
Smart motorways are built on stretches of motorway which experience high levels of congestion and/or are expected to see traffic levels increase in future years. The following sections will examine if traffic levels changed over the evaluation period and to what extent the forecast traffic levels were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

4.2.1. National and Regional

To assess the impact of the scheme on traffic levels, it is helpful to understand the changes within the context of national and regional traffic (Figure 2). During the construction period, traffic volumes were increasing after a dip due to the UK economic downturn in 2008. Surrounding the scheme, and on motorways in England more generally, traffic volumes plateaued from around the time the smart motorway opened - 2017.

Our forecasts anticipated that traffic volumes on the M3 junctions 2 to 4a would show a similar trend to those nationally and regionally; a relative stabilisation in the first few years after construction. The scheme was to tackle pre-existing congestion in these early years, in addition to further traffic growth in later years, estimated up to 60 years post opening.

Figure 2 National and regional percentage traffic volume changes since 2014



Source: Department for Transport road traffic statistics https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

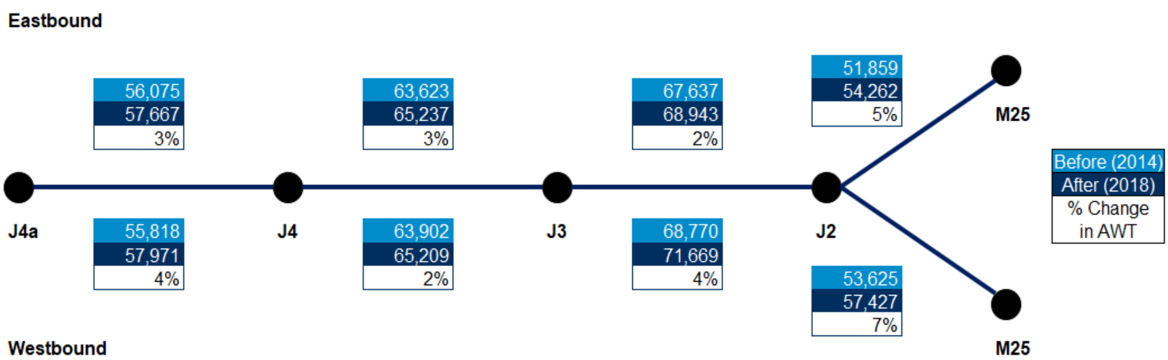
4.2.2. How did traffic volumes change?

The smart motorway focused on increasing capacity on the M3 junctions 2 to 4a, while also improving link roads where the stretch meets the M25. This section of the report looks at the differences between traffic volumes, before and after the smart motorway was opened, to determine if traffic volumes changed with increased capacity.

Traffic volumes were assessed in September 2014 and again in 2018, pre and post-scheme. In selecting a representative month for analysis, aspects such as peaks and troughs caused by seasonality and availability of accurate counter data can be mitigated against.

The number of vehicles travelling along the stretch has seen a small increase, which is in line with background traffic trends. Link roads between the M3 and M25 saw slightly greater increases in traffic volume. These link roads were widened as part of the smart motorway works and could have contributed to the greater number of vehicles now able to flow through this part of the road network.

Figure 3 Changes in average weekday traffic (AWT)



Source: Highways England traffic count data

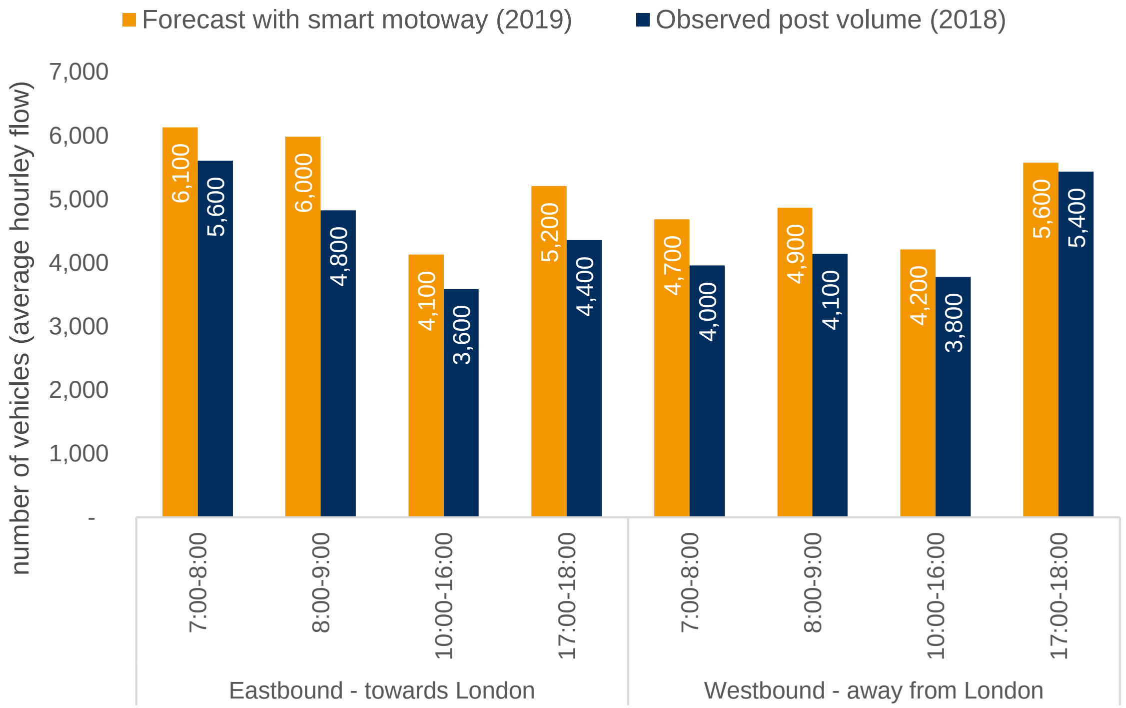
4.2.3. Was traffic growth as expected within the business case?

Overall traffic forecasts have been accurate in the proportion of traffic growth (Figure 6), but may have slightly overestimated traffic flows in absolute terms. Forecasts with the smart motorway were more likely to follow this trend (Figure 4). The only time-period with volumes much greater than ~15% accuracy thresholds was 8-9am heading towards London. Here forecasts were greater than actual traffic volumes by 24%. Predictions of traffic volumes without the smart motorway were more likely to be within reasonable tolerance levels (Figure 5).

The 2019 forecast year was the closest to the 2018 observed data at the time of analysis. Usually there are not large differences between individual years and so these time-periods should be comparable.

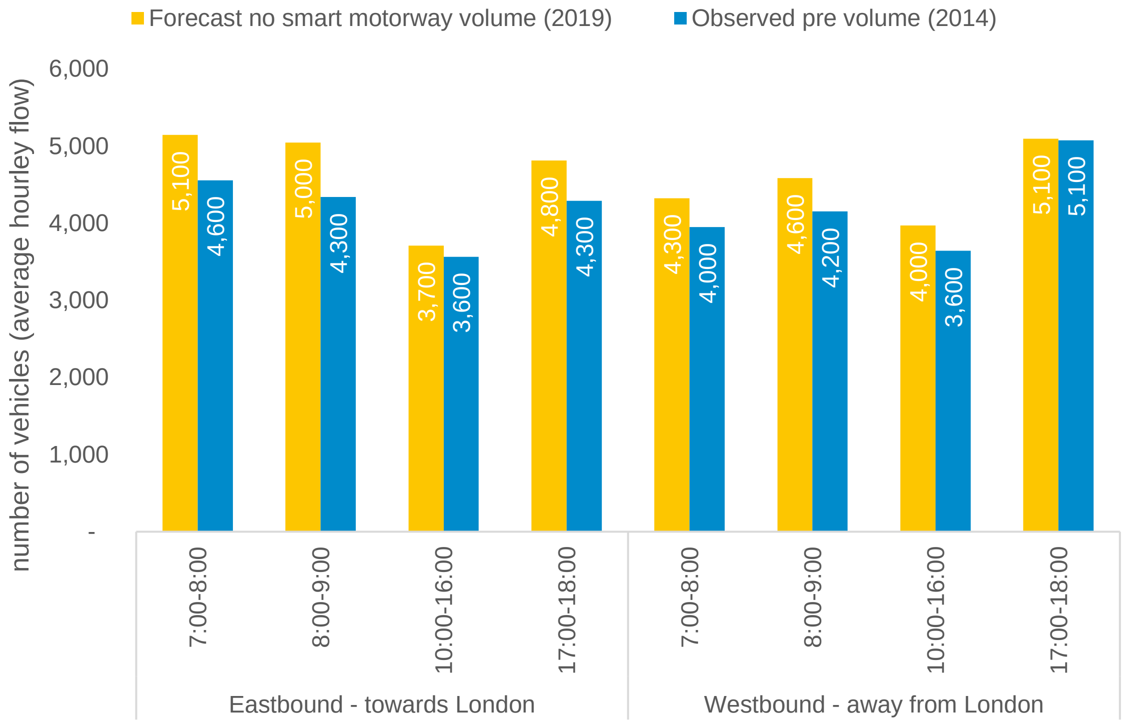
It should be noted that these results are early after the smart motorway opening. Greater increases in traffic volume are anticipated over time. The additional lane should enable greater traffic volumes able to pass through the stretch as a smart motorway than without it.

Figure 4 Forecast traffic volume with smart motorway (2019) and observed post volume (2018)



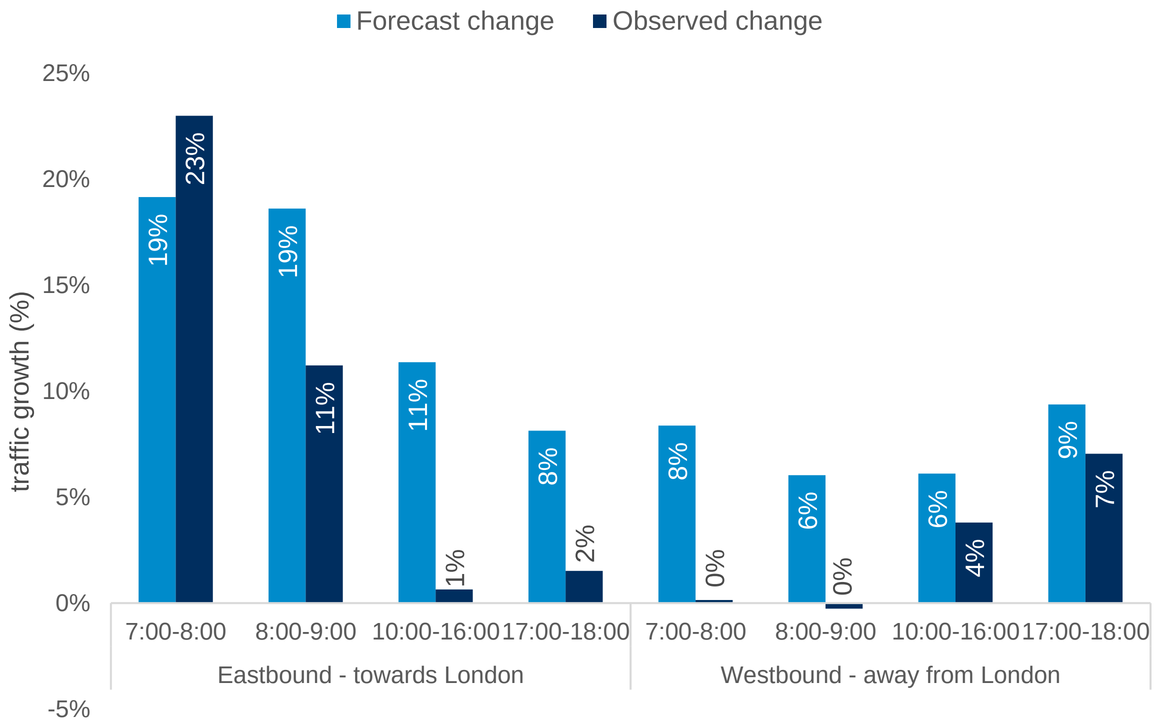
Source: Forecasts from traffic forecast report. Observed data from Highways England traffic count data. Note: Forecasts of do something (2019) – with smart motorway and observed post smart motorway volumes (2018). 2019 forecasts used as closest to post analysis year of 2018. Volumes are average volumes between junctions, labels rounded to the nearest 100.

Figure 5 Forecast traffic volume without smart motorway (2019) and observed before smart motorway volume (2014)



Source: Forecasts from traffic forecast report. Observed data from Highways England traffic count data. Note: Forecasts of do minimum (2019) – with smart motorway and observed before smart motorway volumes (2014). 2019 forecasts used as closest to post analysis year of 2018. Volumes are average volumes between junctions, labels rounded to the nearest 100.

Figure 6 Forecast vs observed change in traffic volumes comparing with and without smart motorway scenarios



Source: Forecasts from traffic forecast report. Observed data from Highways England traffic count data. Note: Forecast change: Do minimum (2019) to do something (2019). Observed change: before smart motorway (2014) to post smart motorway (2018). 2019 forecasts were used as closest to the post analysis year of 2018.

4.3 Relieving congestion and making journeys more reliable

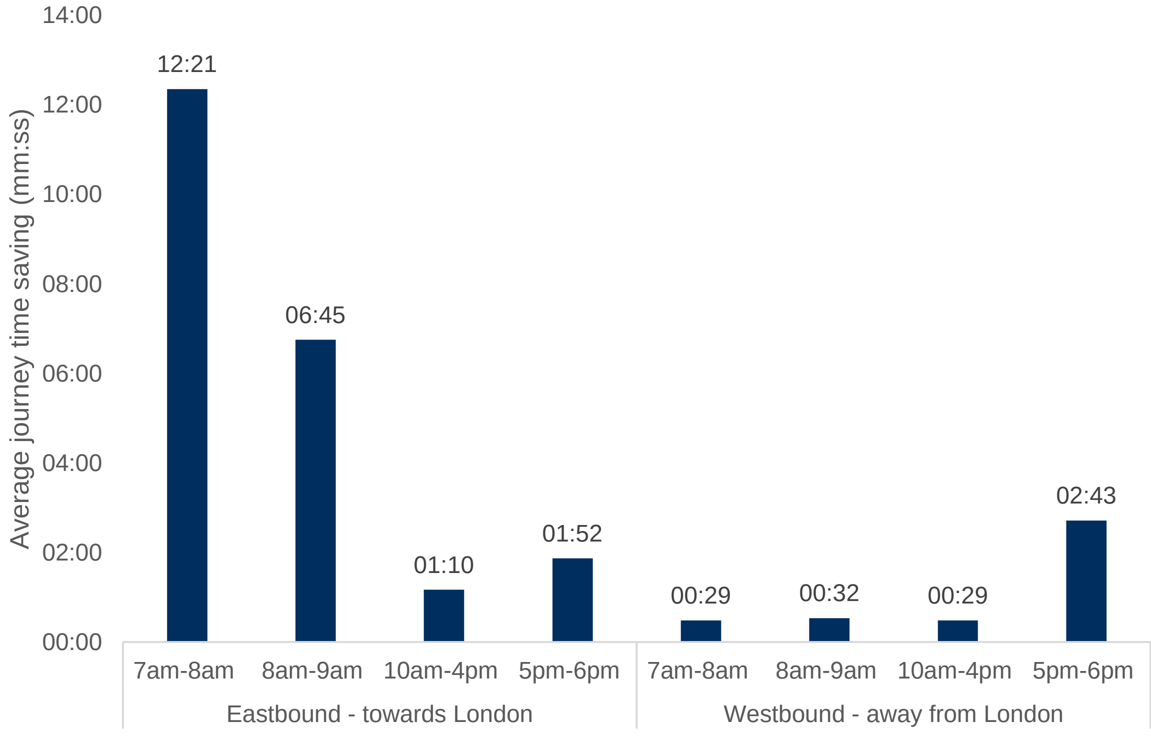
Smart motorways are applied to the busiest routes, to ease congestion and ensure journey times are more predictable. These routes are often where we anticipate congestion will increase and the smart motorway seeks to limit this. Analysis of journey times and speeds indicate the impact of the smart motorway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

4.3.1. Did the scheme deliver journey time savings?

For this section TomTom satellite navigation data is used to calculate the average journey times for each direction, and time-period, set out in our traffic forecast documentation. To compare like for like against our original forecasts, journey time savings, speed and reliability are calculated from junctions 1 to 5, a junction either side of the smart motorway that was built. Data was used from November 2013 – October 2014 before the smart motorway and November 2017 – October 2018 after it was built.

There have been journey time savings in all weekday time periods compared to before the scheme was opened. The morning rush hours, going eastbound towards London, have seen the most improvement. 7-8am and 8-9am have savings of over 12 and 6 minutes, a 31% and 20% journey time decrease respectively. The same time periods also saw traffic volumes increase: 23% 7-8am and 11% 8-9am (Figure 7). Quicker journeys with more vehicles travelling through the smart motorway suggests the extra lane has provided extra capacity and eased congestion.

Figure 7 Average weekday journey time savings in minutes: first year of opening (2018) vs pre-smart motorway (2014)



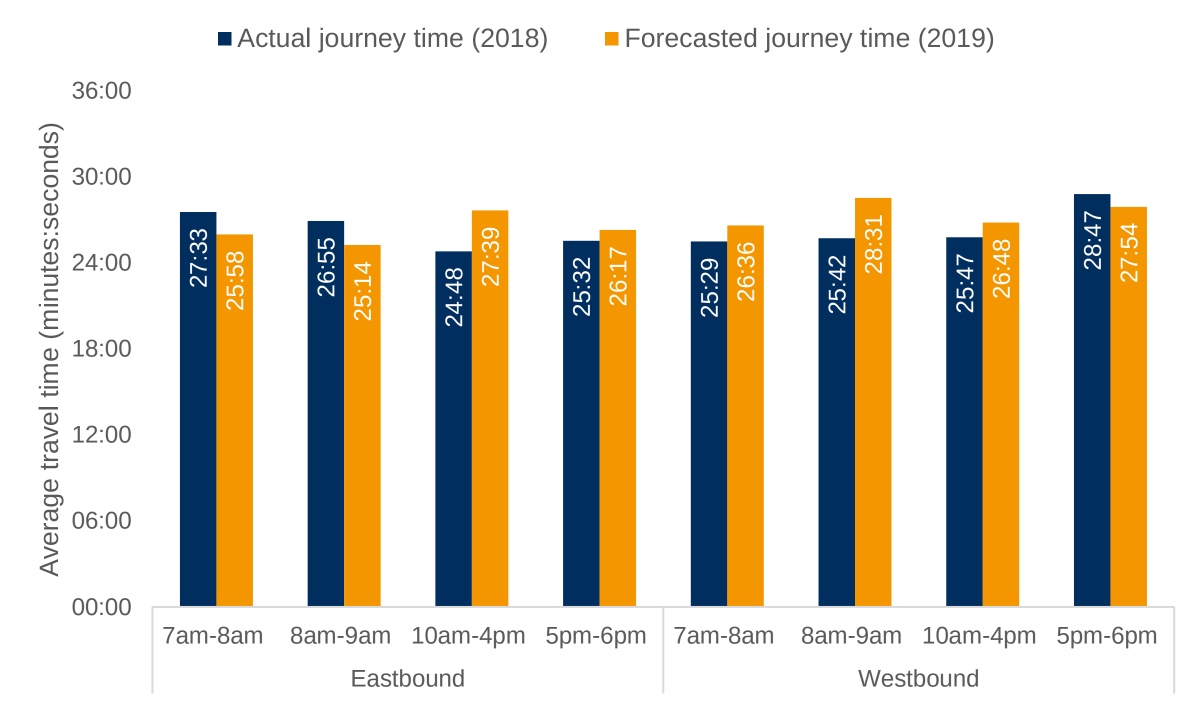
Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018. Junctions 1-5.

Journey time savings of 6-12 minutes are high compared to previously evaluated smart motorways. This is because smart motorways do not always improve journey times compared to before the smart motorway existed. Smart motorways are applied to routes where further increases in traffic are likely, so add extra capacity to accommodate this, and seek to limit further slowing of journeys. Additionally, smart motorways aim to make journey's more consistent by smoothing out traffic flow in in the most congested times. On this stretch, however, there have not been large increases in traffic in the first year. Increases in traffic volumes are, instead, expected in later years.

4.3.2. Were journey time savings in line with forecast?

The time it takes to drive through the smart motorway is relatively similar to forecasts. All time periods are within reasonable margins of error (Figure 8).

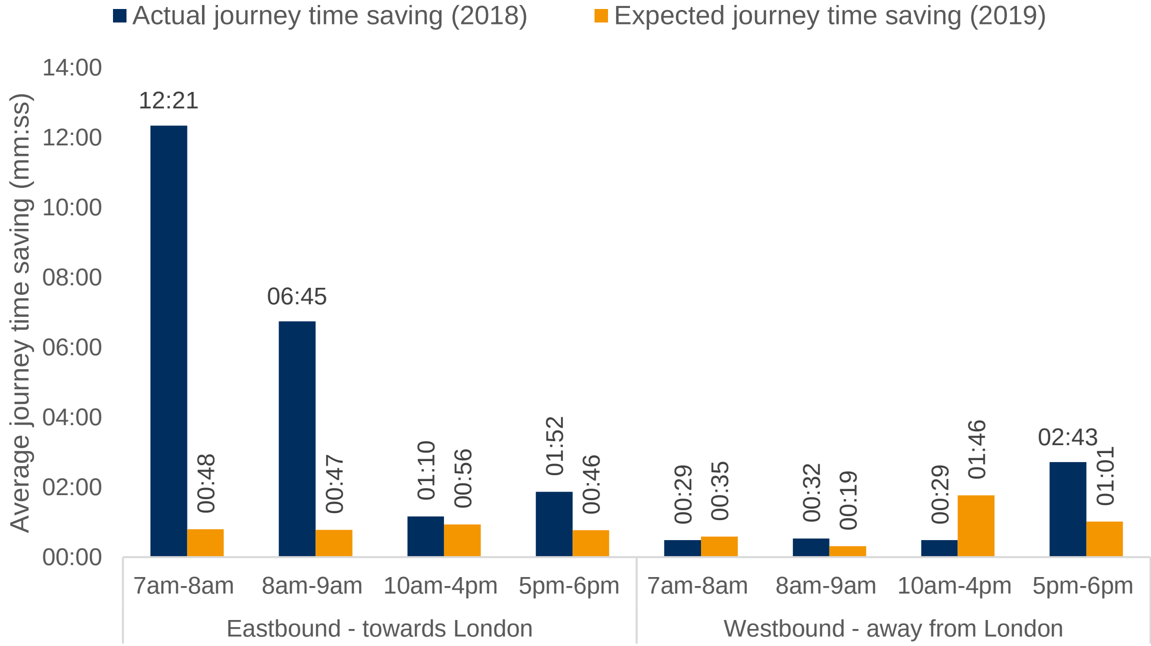
Figure 8 Actual vs expected average weekday journey time duration



Source: Actual journey time from TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018. Forecast journey time from traffic forecast report, forecast for year 2019. Junctions 1-5.

This presents a slightly different picture to journey time saving forecasts (Figure 9). Journey time savings were greater than forecast for the morning rush hours, heading east towards London. This was because journeys were taking longer than we estimated just before the smart motorway construction started. As such there was greater potential to improve these journey times than expected.

Figure 9 Actual vs expected journey time savings for an average weekday



Source: Actual journey time savings from TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018. Forecast journey time savings from traffic forecast report, do minimum vs do somethings forecasts for year 2019. Junctions 1-5.

4.3.3. Did the scheme make journeys more reliable?

A key aim of smart motorways is to improve the reliability of journeys, making them more predictable for road users. To measure this, we examine how much journey times vary from the average journey time, on any day or time-period. Where journeys are less variable, road users can allow a smaller window of time to travel through that stretch of smart motorway, when travelling at a similar time.

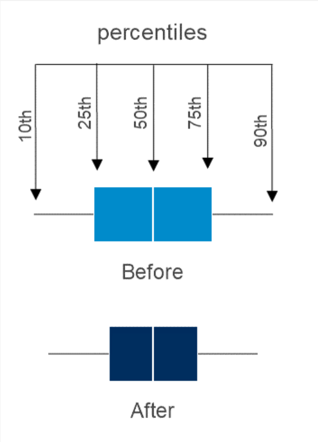
Overall, the time taken to complete these journeys have become more consistent when compared with the average journey time since the implementation of the smart motorway (Figure 11, Figure 12). In particular, during the morning rush hours, heading east towards London the difference between the shortest and longest 10% of times taken to travel through the route has reduced. For road users travelling 7-8am this has reduced to 11 minutes from 40 minutes before the scheme was constructed. Between 8-9am the variability reduced from just over 25 minutes to just under 11 minutes.

4.3.3.1. Are the longest journeys more reliable?

The reliability objective for M3 junctions 2 to 4a was to provide more reliable journey times, as measured by the 10% of journeys which took the longest time to complete. This is depicted as the 90th percentile in Figure 11 and Figure 12; the line extending to the right of the boxes.

Heading east, the longest 10% of journeys (90th percentile) decreased by almost 30 minutes 7-8am, and almost 15 minutes 8-9am (Figure 11). Heading west, the greatest impacts on the longest journeys were 5-6pm, which reduced by just over 4½ minutes (Figure 12). All other measured time periods saw reductions, resulting in this measure of the objective being achieved at the one-year after point. We will continue to measure reliability to understand if benefits can be maintained whilst traffic grows in later years.

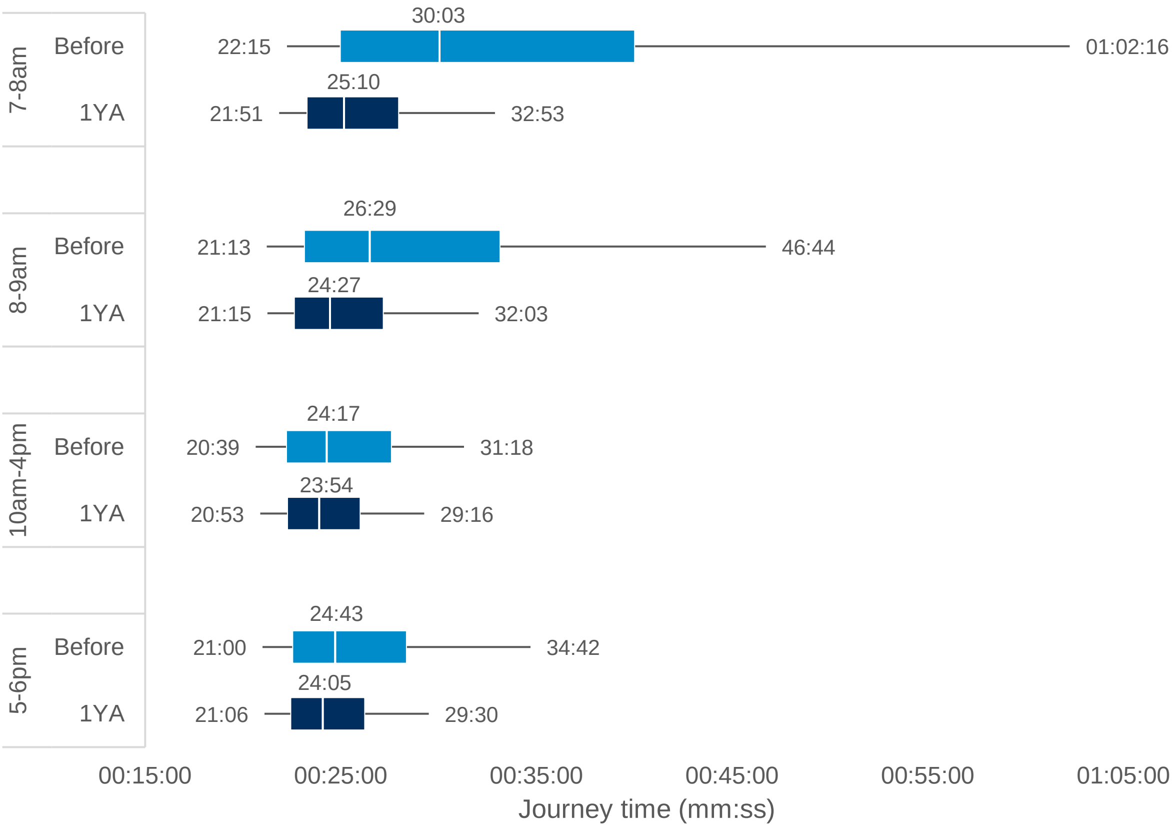
Figure 10 What does a box plot show?



The lowest point is the 10th percentile, this means 10% of journeys take less than this to complete. The highest point is the 90th percentile, this means 90% of journeys take less time than this to complete. This shows the difference between the longest and the shortest journey times observed.

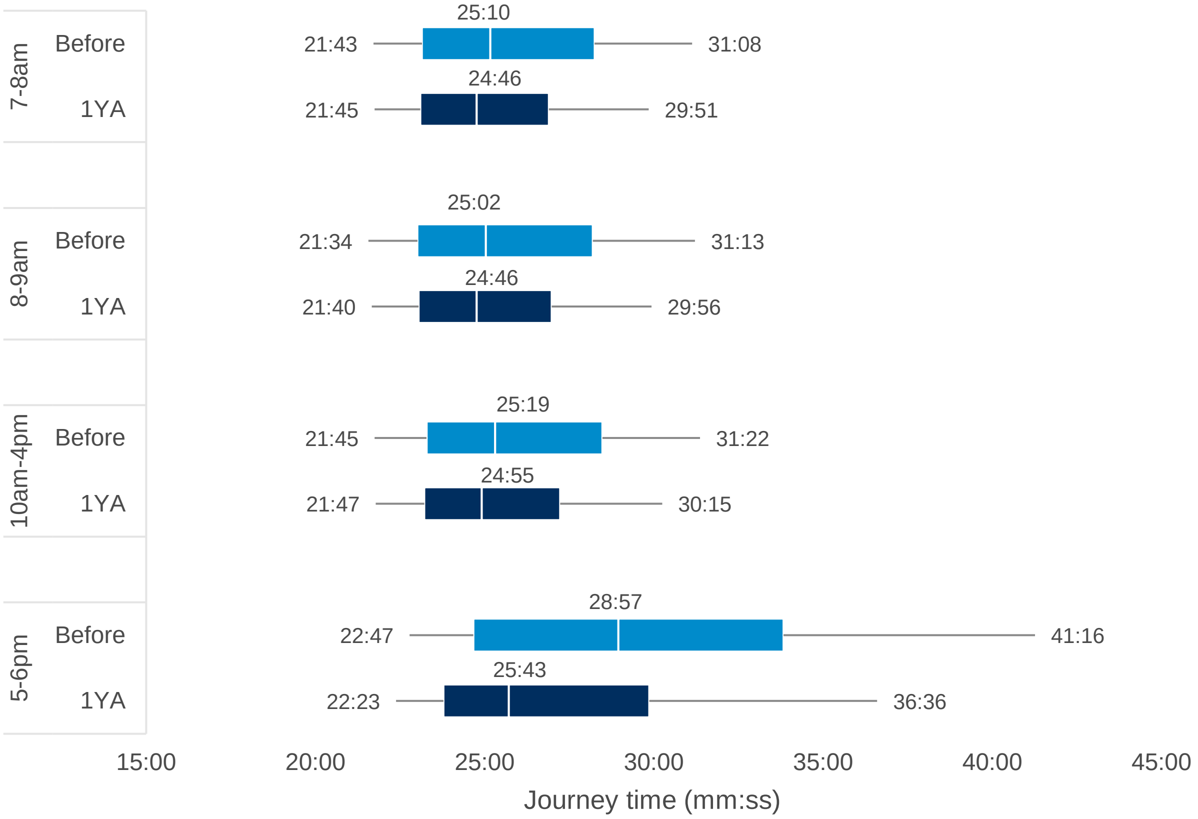
The length of the block shows how the journey times vary between the 25th and 75th percentile (25% and 75% of journeys). The shorter the block the less variable and hence more reliable a journey would be.

Figure 11 Journey time reliability (eastbound)



Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

Figure 12 Journey time reliability (westbound)



Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

4.3.3.2. Are average journeys more reliable?

Half of all journeys made within these time periods are contained within the blue boxes presented in Figure 11 and Figure 12. If these boxes get shorter then journeys become less variable, meaning road users can be more confident of the time it takes to travel through the route.

Heading eastbound, towards London, all weekday time periods have seen reduced journey time variability along this smart motorway. On average, for those travelling during the busiest period (7-9am) the scheme has increased reliability to the extent that journey times are more consistent with those experienced at other times of the day.

Heading west, journeys were more consistent than those going east before the smart motorway was built. As such, the scheme has not changed the reliability as much as for those heading east; although there have still been improvements. The most variable time of day heading west was the evening rush hour, 5-6pm. During this timeframe, the variability of average journeys reduced by just over three minutes.

The smart motorway has, therefore, resulted in more reliable average journeys. With less variability comes increased confidence that road users can get through the stretch in smaller time window.

4.3.3.3. Have the quickest journeys been impacted?

The shortest journey times have remained very similar before and after the smart motorway. These are the 10th percentile tails to the left in Figure 11 and Figure 12. The shortest journeys can become longer, especially over a number of years, if traffic volumes increase. As we have seen in other sections, however, traffic volumes have not increased greatly on this stretch. This helped to keep consistency of the fastest journey times.

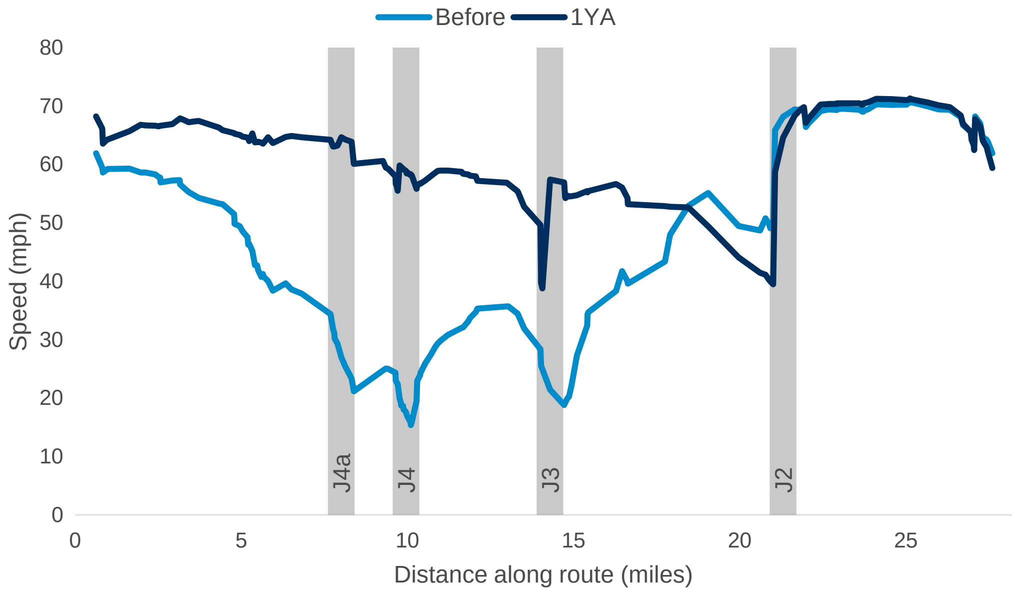
4.3.4. How did the scheme impact speed?

In combination with journey time analysis, speed can help to determine the impact the smart motorway has had on congestion. Speeds are not necessarily quicker as a result of a smart motorway. Smart motorways are often implemented where there is pre-existing congestion, and/or an increase in traffic is expected in the coming years. Instead, smart motorways aim to make journeys smoother, so ideally speeds should be more consistent.

Typically, speeds have increased where there was congestion prior to the smart motorway installation. Combined with only small increases in the number of vehicles using the stretch, the addition of an extra lane has enabled speeds to increase where they were low pre-smart motorway.

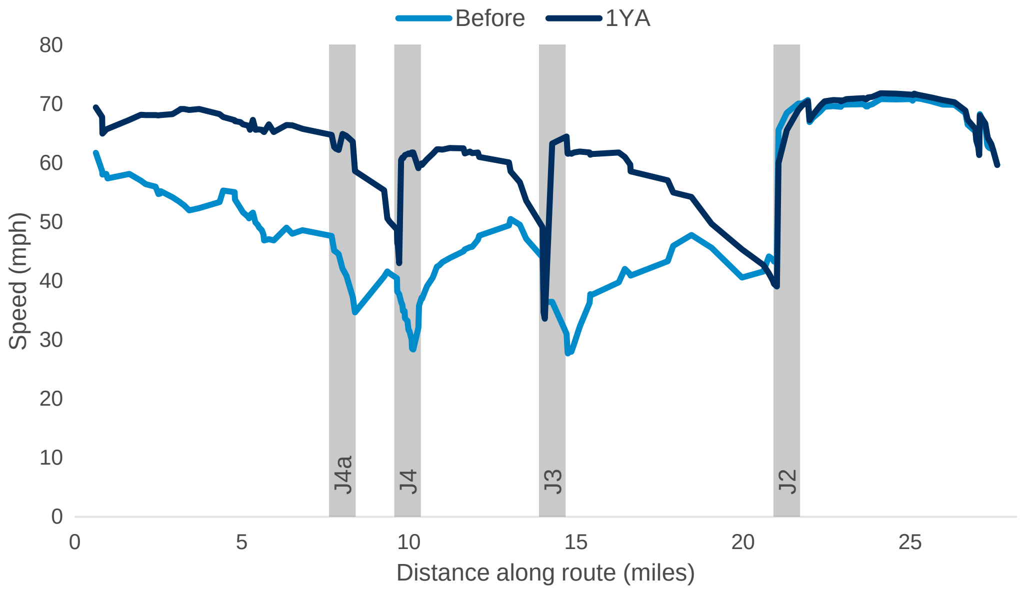
Heading east towards London, for example, journeys were more stop-start before the smart motorway in the morning. Speeds for journeys undertaken between 7-8am, before the smart motorway was constructed, averaged between 20-40mph for most of the stretch (Figure 13). After the smart motorway speeds are more likely to be between 50 and 60mph (Figure 13). From a road user perspective, this has alleviated some of the persistent slow speeds in this time, allowing traffic to flow better. Where speeds were higher before the smart motorway, such as heading west away from London, then these have remained at a similar level (Figure 16, Figure 17, Annex 1: Speed).

Figure 13 Average speed comparison 7-8am eastbound



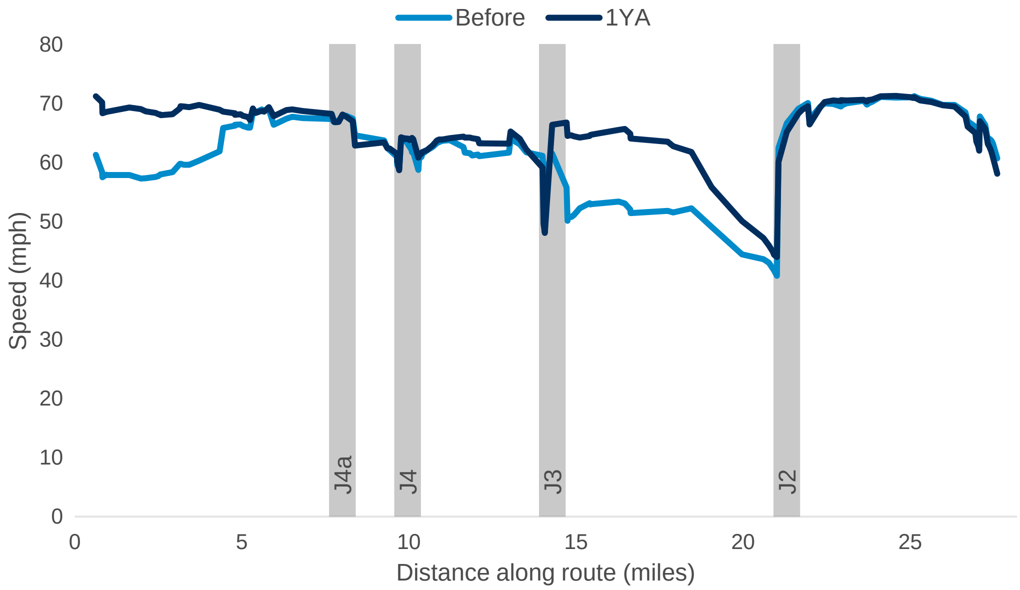
Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

Figure 14 Average speed comparison 8-9am eastbound



Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

Figure 15 Average speed comparison 5-6pm eastbound



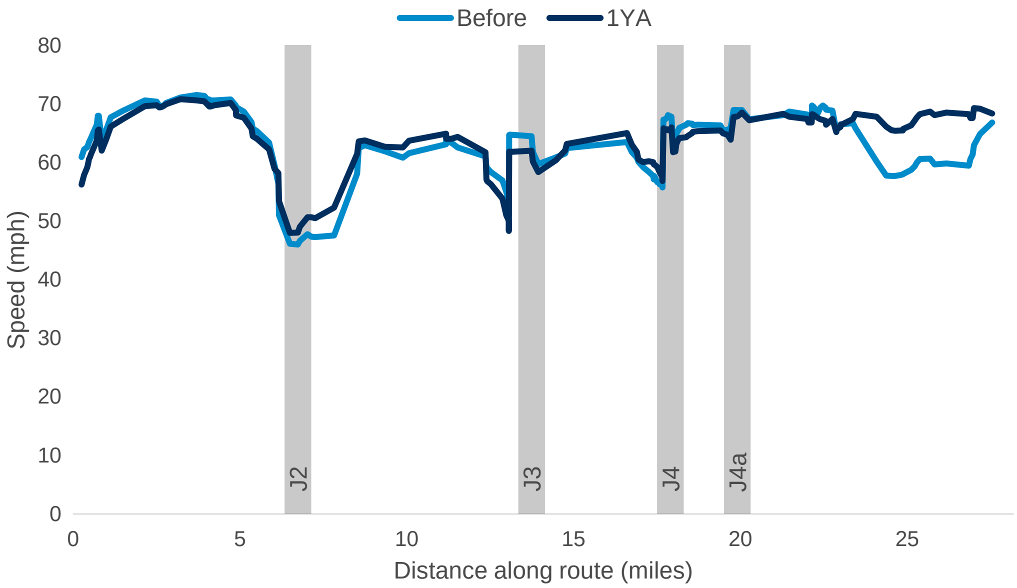
Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

Speeds just before junction 3 in rush hours, for both directions, decrease as vehicles leave at this junction. Speeds have deteriorated lower than before the smart motorway at this point in some time periods – most notably in morning rush hours heading east and in the evening heading west.

Several factors may be having a cumulative impact on tailbacks and slower speeds around the junction 3 exit. Heading east, where the largest decreases in speed have been, a study is currently underway to identify the cause of the congestion and explore possible solutions. The timings of the traffic signals on the A322 at New Road have been reviewed and it may be possible to improve the traffic flows by adjusting these signals. The traffic signals are a few hundred meters after the junction 3 exit onto the A322. Additionally, there have been residential developments around junction 3 which may have had an impact. Heading west, for example, there has been an increase from approximately 9,500[5] vehicles leaving the junction 3 exit, pre- smart motorway, to approximately 20,700[5] afterwards. There are just over 15,700[5] vehicles exiting eastbound exit one year after opening. Unfortunately, comparative data for this junction is unavailable for the time before the smart motorway was implemented.

Speeds around junction 2 dip throughout the day in both directions and indicates the impact of the congested M25 on the M3. Heading west, away from London, vehicles are joining the M3 at junction 2. The greatest speed reductions are in the evening just before entering the scheme, as vehicles commute out of London and congestion is higher. There is also a 50mph average speed restriction in place through junction 2 heading west. This is likely impacting speeds in the morning and through the day when congestion is lower. Heading east, towards London, speeds decrease just prior to junction 2, where a large proportion of vehicles leave for the M25.

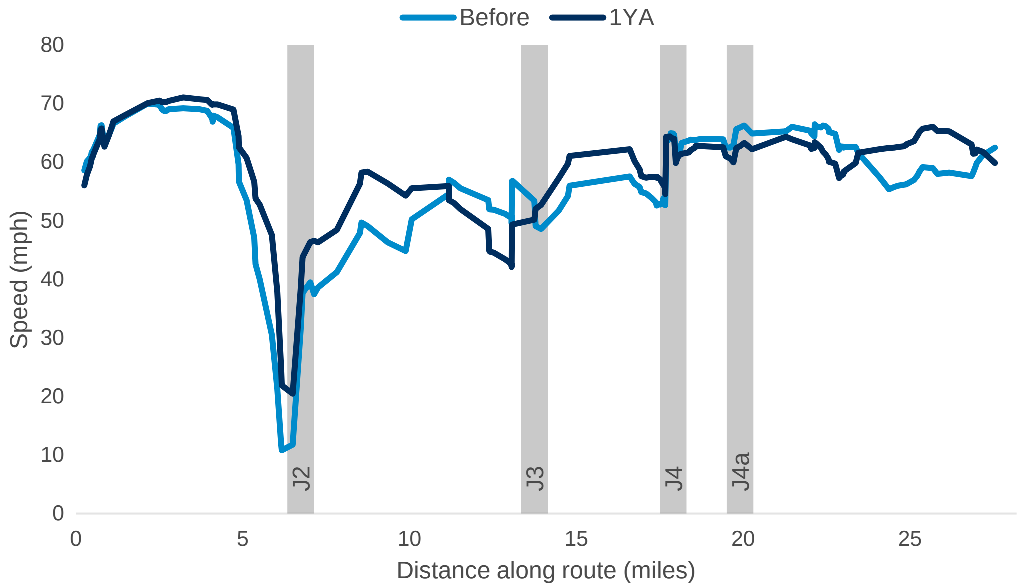
Figure 16 Average speed comparison 8-9am westbound



Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018. Note: 7-8am has a very similar speed profile to 8-9am above. 7-8am detail can be found in Annex 1: Speed

5 On an average weekday, over a 24-hour period. Rounded to the nearest 100.

Figure 17 Average speed comparison 5-6pm westbound



Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

5. Safety evaluation

5.1 Summary

The safety objective for this smart motorway was to maintain and, where possible, improve current safety performance. This first year's analysis will check key safety metrics, but we will need data over a number of years to establish if the objective is being met.

The number and rate per million vehicle kilometres of personal injury collisions were analysed to track a change over time. In the first year of the smart motorway being operational, there has been a reduction in the rate and number of personal injury collisions compared with the annual average for the five years before the scheme was built.

During the first 12 months of the smart motorway being open there were 36 personal injury collisions compared with an average of 74 per year before the scheme was constructed. If the road had not been converted to a smart motorway, we estimate that the number of personal injury collisions would have reduced to between 57 and 107 (Figure 19). The number of personal injury collisions was also lower than forecast within the business case.

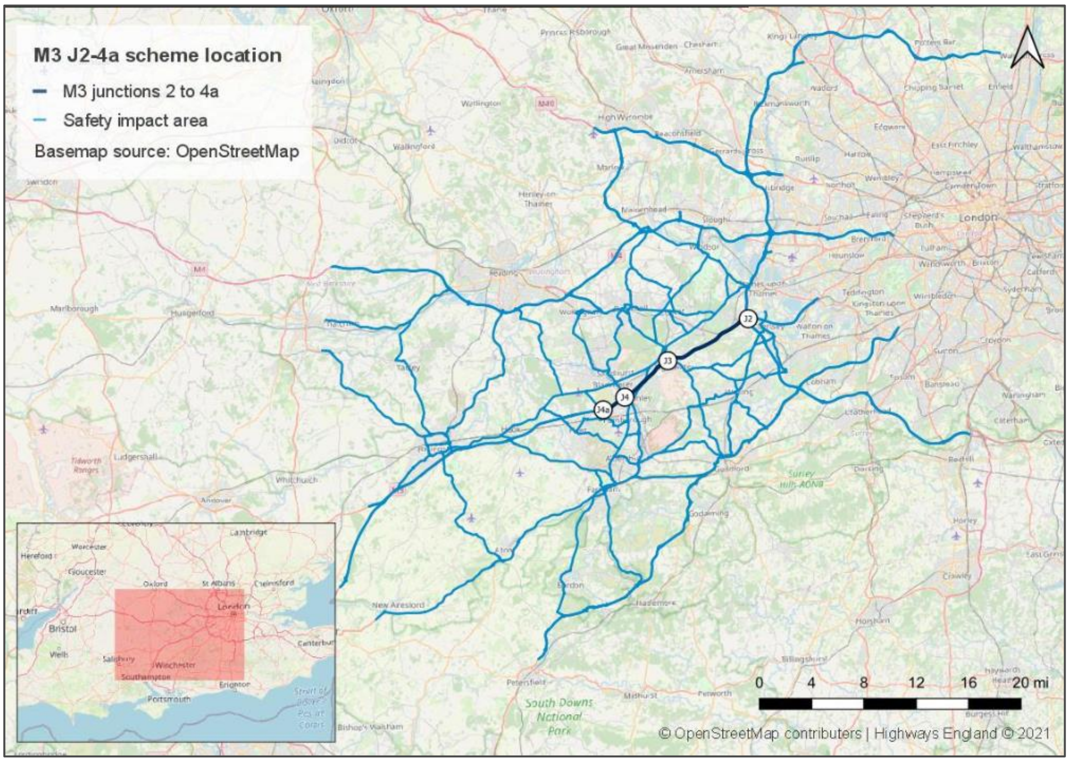
In the context of other findings in this report these are positive early signs. Collisions are reducing at a time where congestion is being released and traffic is moving quicker in some time periods. Traffic levels are set to increase in later years, however, and so results at the follow up evaluation will be essential to check if this trend continues.

The early indications are that the safety objective, is on track to be achieved. The analysis will need to be revisited in later years before we are sure that the change is significant. It will require a longer timeframe to determine if these initial positive findings are a real trend or natural fluctuation.

5.2 Safety study area

The safety study area is shown in Figure 18. This is a wider area, encapsulating roads surrounding the smart motorway. This area is assessed in the appraisal supporting the business case for the project. It checks any potential wider implications for the intervention. This information is then used with other predictions around the potential impact of the scheme such as by how much traffic may grow. We have therefore replicated the appraisal study area to understand the emerging safety trends.

Figure 18 Safety study area



Source: Highways England and OpenStreetMap contributors

5.3 What are the emerging safety trends within the first 12 months of the smart motorway?

Safety data for this evaluation was obtained from the Department for Transport road safety data[6]. This records incidents on public roads that are reported to the police. This evaluation considers only collisions that resulted in personal injury via this dataset.

The safety analysis has been undertaken to assess changes over time looking at the trends in the five years before the scheme was constructed to provide an annual average. We have then assessed the trends from the first 12 months after the smart motorway was operational and open for road users. This provides an early indication of safety trends, but this will be monitored over a longer timeframe before conclusions can be drawn about the safety impact of the scheme.

The analysis draws on the following data collection periods:

- Pre-construction: 1st May 2009-30th April 2014;
- Construction: 1st May 2014-31st July 2017;
- Post-opening: 1st August 2017-31st July 2018

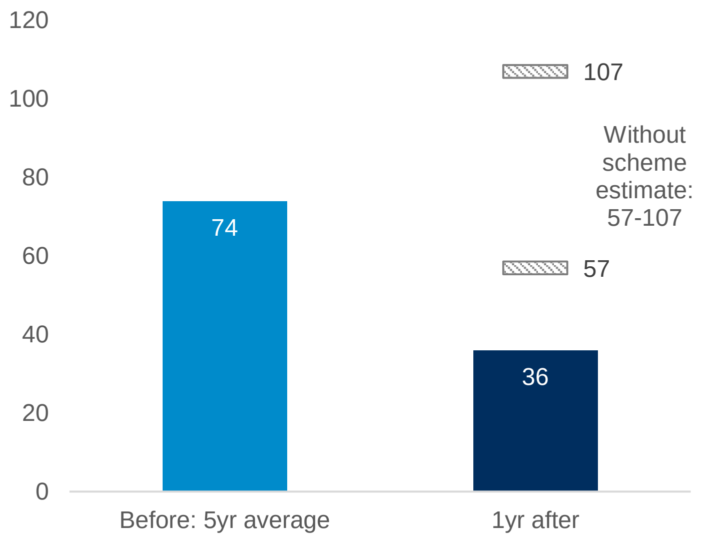
The early indications are that the number of personal injury collisions for the first year of the smart motorway are lower than the period before construction began. The number of personal injury collisions has reduced from an annual average of 74 to 36 personal injury collisions during the first 12 months of the smart motorway being open for road users. Safety trends can vary each year and we will monitor

[6] https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data

this trend over a longer timeframe before drawing conclusions about the safety impact of the smart motorway.

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 scheme over this timeframe. To do this we estimate the trend in personal injury collisions which might have occurred if the road had remained a conventional motorway (this is referred to as a counterfactual - see Annex 2: Safety Counterfactual Methodology). This is based on changes in regional safety trends for conventional motorways with a high volume of roads users. This helps us to estimate how the pre-construction safety levels would have changed over the evaluation period if the road had remained a conventional motorway. Based on this assessment we estimate that if the road had not been converted to a smart motorway the trend in the number of personal injury collisions would likely have reduced over time period, to between 57 – 107, but not by as much as we have observed for the smart motorway.

Figure 19 Annual number of personal injury collisions on the smart motorway



Source: STATS19 1st May 2009 – 31st July 2018. Range at 95% confidence interval.

The business case for the scheme predicted that the conversion to the smart motorway would reduce the number of personal injury collisions by an average of 11 per year[7] . The result indicates that the smart motorway is on its way to achieving the objective to maintain, and where possible, improve safety standards. Another study will be conducted after the smart motorway has been open for a longer timeframe, allowing a more representative time-period, to determine if the safety objective has been achieved.

[7] Based on a reduction of 634 personal injury collisions over a 60-year appraisal period

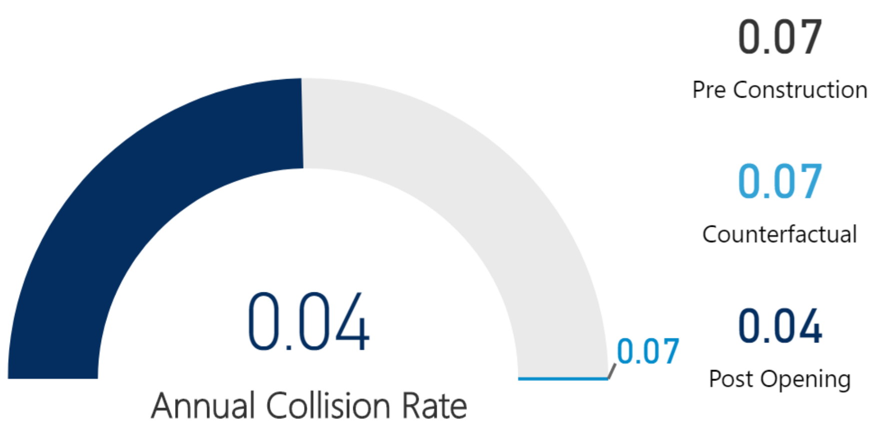
5.4 How has traffic flow impacted collision rates?

Smart motorways are implemented on some of England's busiest routes. It is, therefore, important to contextualise any incidents in the volume of traffic seen on this stretch via a collision rate.

The average collision rate has decreased to 0.04 per million vehicle km – this equates to travelling almost 25 million vehicle km before seeing an incident. Before the scheme the collision rate stood at 0.07 per million vehicle km; equating to 13 million vehicle km before seeing an incident. The estimated rate if the smart motorway had not been built was similar to before the scheme at 0.07; this is known as the counterfactual (Figure 20).

Collision rates, therefore, are also lower than what we would have expected without the scheme. This is a positive initial indication: even though traffic levels have increased slightly, collisions have reduced. As these are the first year's results, however, we are not yet confident yet that these initial indications are enough to form a trend. An evaluation will be conducted at five years after opening to establish if early positive findings have continued.

Figure 20 Collision rates - personal injury collisions per million vehicle km on the smart motorway



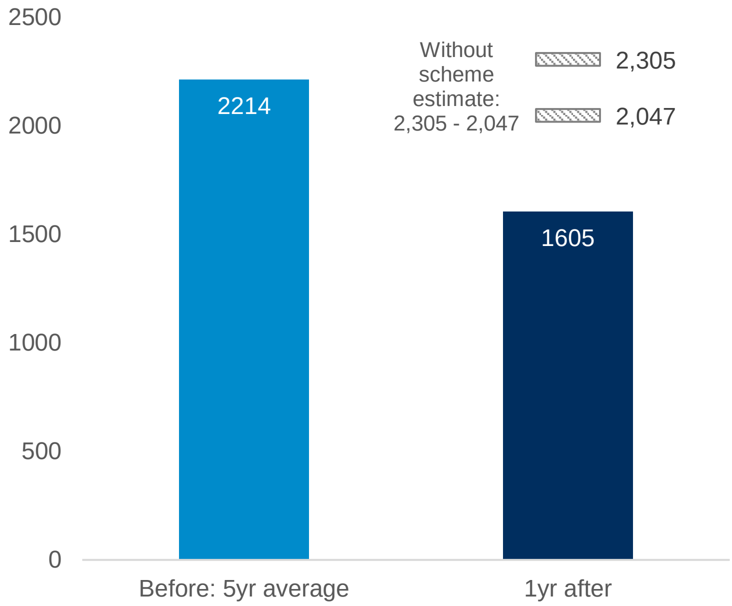
Source: STATS19 1st May 2009 – 31st July 2018

5.5 Changes in safety trends on other parts of the strategic and local road network

Changes in personal injury collisions in the wider impact area were analysed. The area was defined in the scheme's appraisal – where the evidence for the value of a scheme is assessed ahead of a decision to deliver an intervention. More detail on the study area can be found in section 5.2 Safety study area.

There has been a reduction in the average number of personal injury collisions per year in the wider safety area, from 2,214 per year in the 5 years before the scheme to 1605 in the first year after. Motorway the safety trends across the wider area were estimated to reduce to between 2,047 and 2,305 personal injury collisions per year (Figure 21). This indicates a positive impact on the safety of the surrounding road network, as anticipated within the scheme's business case. However, more evidence is required before it is possible to conclude whether the anticipated safety benefits across the wider safety area are likely to be realised.

Figure 21 Annual average number of personal injury collisions on the smart motorway and wider study area



Source: STATS19: 1st May 2009 to 31st July 2018. Range at 95% confidence interval.

5.6 What were the emerging trends on the severity of collisions?

The way the police record the severity of road safety collisions changed within the timeframes of the evaluation. There has been a shift to a standardised reporting tool known as CRASH – Collision Recording and Sharing. CRASH is an injury based reporting system, and as such severity is categorised automatically by the most severe injury. This has led to some disparity with the previous reporting methods, where severity was categorised by the attending police officer[8].

In this instance, one reporting mechanism was largely used prior to the smart motorway installation and another afterwards. As this will have an impact on severity categorisation that is not attributable to the smart motorway; it would produce unmeaningful results at this stage. For more detail see Annex 3: Incident Reporting Mechanisms.

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

6. Environmental Evaluation

6.1 Summary

The evaluation after the first 12 months has focused on assessing the traffic-related environmental impacts (air quality, noise and greenhouse gases). This is considered a proportionate risk-based approach which reflects that the construction associated with the conversion to smart motorway was contained within the highway boundary. A site visit will be undertaken at five years after which will seek to evaluate all the remaining environmental impacts[9]

Assessments at one year after opening suggest there have been no significant impacts on noise or air quality. The original appraisal for the scheme indicated a speed restriction would need to be in place for the first year to minimise air quality impacts. The scheme was reassessed, however, due to the scheme opening in a later year than originally planned. Due to a later opening year, and improvements in vehicle emissions, speed restrictions in the first year were no longer required. There has been a larger than anticipated increase in the number of heavy goods vehicles using the stretch, but monitoring data shows the annual average nitrogen dioxide limit has not been exceeded.

The higher level of heavy goods vehicle use may have an impact on greenhouse gas emissions along the scheme. The original forecast made estimates based on the whole study area, however, we do not have observed traffic data for the whole study area to allow a reassessment to be made. Direct comparisons, therefore, cannot be made.

6.2 Noise

The evaluation of noise impacts has considered the predicted impacts described in the environmental appraisal and assessment and compared them against predicted and observed traffic flows. This is alongside a review of available asset data to understand whether the proposed physical mitigation measures have been put in place; such as noise barriers or low noise road surfacing. Where post-opening noise monitoring data is available, this has been considered too.

Low noise surfacing and noise barriers have been installed to mitigate any noise dis-benefits to the communities living near the route. These were installed as expected in the scheme design.

There are some data quality issues that need to be addressed to ensure efficient long-term asset management. For example, some noise barrier records didn't match what was on site in terms of the type of fencing, and in some instances the type of material the noise barrier used. This could impact on the appropriate maintenance of noise barriers and potentially their long-term benefits realisation. This will be revisited during the five-year after evaluation.

Noise monitoring undertaken[10] suggests that, in the first 12 months daytime noise levels were lower than pre-construction levels. A comparison has been made

[9] The evaluation of environmental impacts uses information on the predicted impacts gathered from the TAG environmental appraisal (appraisal summary table) and the environmental assessment report and compares them with findings obtained one year after the schemes opened for traffic. The results of the evaluation are recorded against each of the TAG environmental sub-objectives. These are discussed in the sections that follow.

[10] Direct noise monitoring is not undertaken as part of the post opening evaluation methodology. It is used, however, when this is commissioned by the project team. M3 J2-4a Smart Motorway: Post Opening Noise Monitoring (February 2018).

between forecast and observed traffic data (section 4.2.3) which indicates that noise impacts are likely to be broadly as expected. Given the slight increases in traffic volumes, and increases in HGVs, noise barriers and low noise surfacing may be contributing to lower day-time noise levels recorded via direct monitoring[10].

Table 2 summary of noise assessment

Origin of assessment	Summary of Effects on Noise	Assessment
Environmental Assessment Addendum: Predicted impact on noise	In the short term 99% of residential properties would experience a decrease in noise and 1% an increase. The impact overall was assessed to be negligible/minor beneficial. In the long term 92% would experience a reduction in noise, 7% an increase and 1% no change. Overall, the impact was assessed to be negligible beneficial.	No significant effects
Evaluation Summary Table: the first year's impact on noise	Low noise surfacing has been provided broadly as expected. Asset data for noise barriers has been provided, although there are errors which could affect long term asset management. A comparison of forecast and observed traffic flows suggests that overall impacts are as expected.	As expected

6.3 Air Quality

An evaluation of the air quality outcomes of the scheme has been undertaken one year after the smart motorway opened. This has considered the predicted impacts described in the environmental appraisal and the environmental assessment report (including 2015 update with addendum) and compared them against available monitoring data and observed traffic flows along the scheme extent.

The scheme was originally designed with a temporary 60mph speed limit between junction 4 and 4a. This was to manage predicted adverse air quality effects caused by changes in traffic flows in the opening year. During the detailed design of the scheme further assessment work was done. This concluded that with a delay in opening year to 2017, and improvements in emissions from vehicles, the speed restriction was no longer required. The outcome of this further assessment work was reported in the Environmental Assessment Addendum June 2015.

The total traffic flow and speed data indicates that, for most of the scheme, flows and speeds are broadly as expected; although between J4 and 4a flows are over 1000 vehicles lower. However, observed heavy duty vehicle flows are higher than expected along the scheme extent, so there remains a risk that overall emissions may still be higher than expected. To understand this risk further, air quality monitoring data along the scheme, from both Surrey Heath Borough Council and Highways England, has been considered. For 2018, none of the monitoring locations, including those within the Surrey Heath air quality management areas, exceed the annual average nitrogen dioxide (NO2) objective. Overall, this suggests that, despite the increase heavy duty vehicle flows, no significant effects have arisen, one year after opening, due to the implementation of the scheme. This was as expected by the environmental assessment report addendum.

Table 3 Summary of air quality assessment

Origin of assessment	Summary of Effects on Air Quality	Assessment
Environmental Assessment Addendum: predicted impact on air quality.	There are 7 air quality management areas within the scheme study area and receptors sensitive to air quality changes. This includes residential properties and designated ecosystems. With the scheme the assessment predicted that the majority of receptors would be below the NO_2 air quality objective. For those above, the majority of increases would be small or imperceptible. The scheme was assessed to be at low risk of non-compliance with the EU Air Quality Directive.	No significant effects
Evaluation Summary Table: the first year's impact on air quality	Evaluation of available forecast and observed traffic data indicates that flows and speeds are broadly consistent with those predicted, although heavy duty vehicle flows are higher than expected. Available monitoring data from Surrey Heath Borough Council and Highways England indicates that the annual average NO_2 objective was not exceeded in 2018, including within the air quality management area. Overall, this suggests that, despite the higher than predicted heavy duty vehicle flows, no significant effects have arisen. This was expected by the Environmental Addendum.	Not significant as expected

6.4 Greenhouse Gases

The scheme appraisal predicted that the scheme would have an adverse impact on carbon emissions dues to changes in traffic flows following the implementation of the scheme.

To evaluate the greenhouse gas emissions of the appraised scheme, forecast and observed traffic data is required for the appraised study area. Traffic data is not usually available for the whole study area and typically we only have data for the scheme extent. This means that the evaluation considers just the opening year emissions for the scheme extent itself (M3 J2-4a). This approach has limitations as it means direct comparisons with the forecast emissions reported in the appraisal which are for the whole study area cannot be made. However, it does allow some understanding into the accuracy of the opening year forecast and observed emissions along this section of the scheme. This has shown that in the first year the estimated level of carbon emissions was within eight percent of the observed level, along the scheme extent only. In the context of traffic analysis, volumes are not as high as forecasted at this point along the stretch. Heavy duty vehicle use is greater than forecasted, however, and so may be driving the increase.

A new forecast emission and an observed emission for the scheme extent has been calculated using the emission factor toolkit version 9 published by the

Department for Environment, Food and Rural Affairs[11]. The total forecast and observed emissions along the scheme extent are reported in Table 4.

Table 4 Tonnes of greenhouse gases for M3 J2-4a: forecast and observed for scheme extent only

Forecast (CO_2 tonnes per annum in opening year)	Observed (CO_2 tonnes per annum in opening year)	Difference (CO_2 tonnes per annum in opening year)
196,660	211,881	15,221

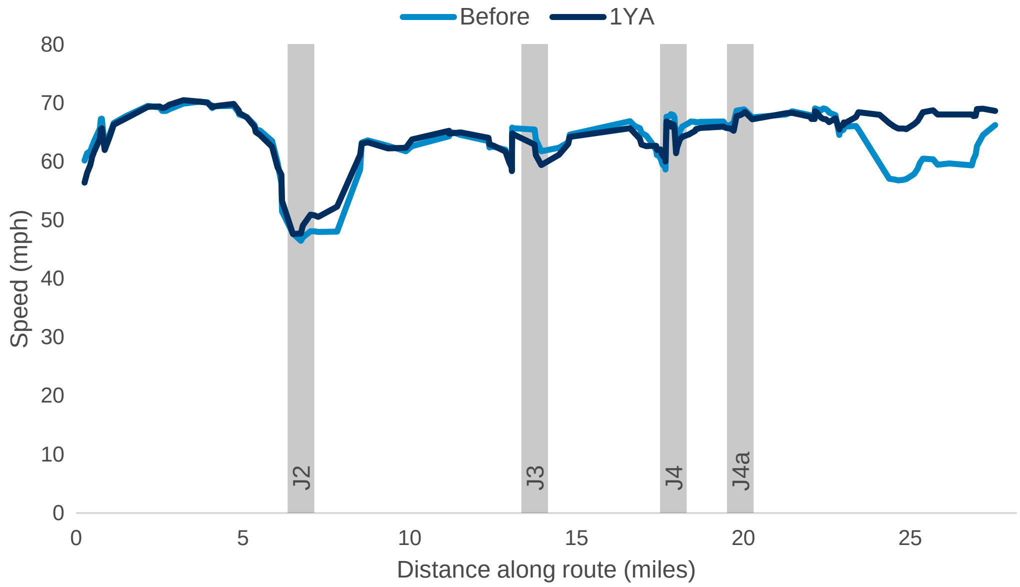
Note: traffic data is unavailable for the whole study area, so we cannot know the full impact of the scheme on how traffic may have changed due to the smart motorway installation.

[11] https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

Annex 1: Speed

The following figure was not included in the main report above due to very similar trends to the 8-9am period. The graph is represented here for completeness.

Figure 22 Average speed comparison 7-8am westbound



Source: TomTom satellite navigation data Nov 2013 – Oct 2014 vs Nov 2017 – Oct 2018

Annex 2: Safety Counterfactual Methodology

Personal injury collisions on the strategic road network are rare and can be caused by many factors. Due to their unpredictable nature, we monitor trends over many years before we can be confident that a real change has occurred as result of the scheme.

To establish whether any change in collision numbers is due to the scheme or part of wider regional trends we estimate what would have likely occurred to the safety trends if the scheme was not constructed. Prior to 2020, post opening project evaluations answered this question by applying the national average trends in personal injury collisions to the baseline observed before the scheme was constructed

During 2020 the methodology was reviewed and updated to generate a more accurate estimation. The revised method enables us to align the counterfactual with regional rather than national trends in traffic volumes and personal injury collisions.

It also allows for a more granular differentiation of road type. Previously the counterfactual for smart motorways was based on the national trends averaged across all types of motorways, the new method provides information for average conventional motorways and those with higher-than-average traffic levels (which are more comparative to the motorways which were converted to smart motorways). It also allows for differentiation between different types of smart motorways.

We now also report a counterfactual range, rather than an individual figure. This is the likely number of collisions that would occur, at the same post evaluation point, if the smart motorway was not built. The range is based on a 95% confidence interval.

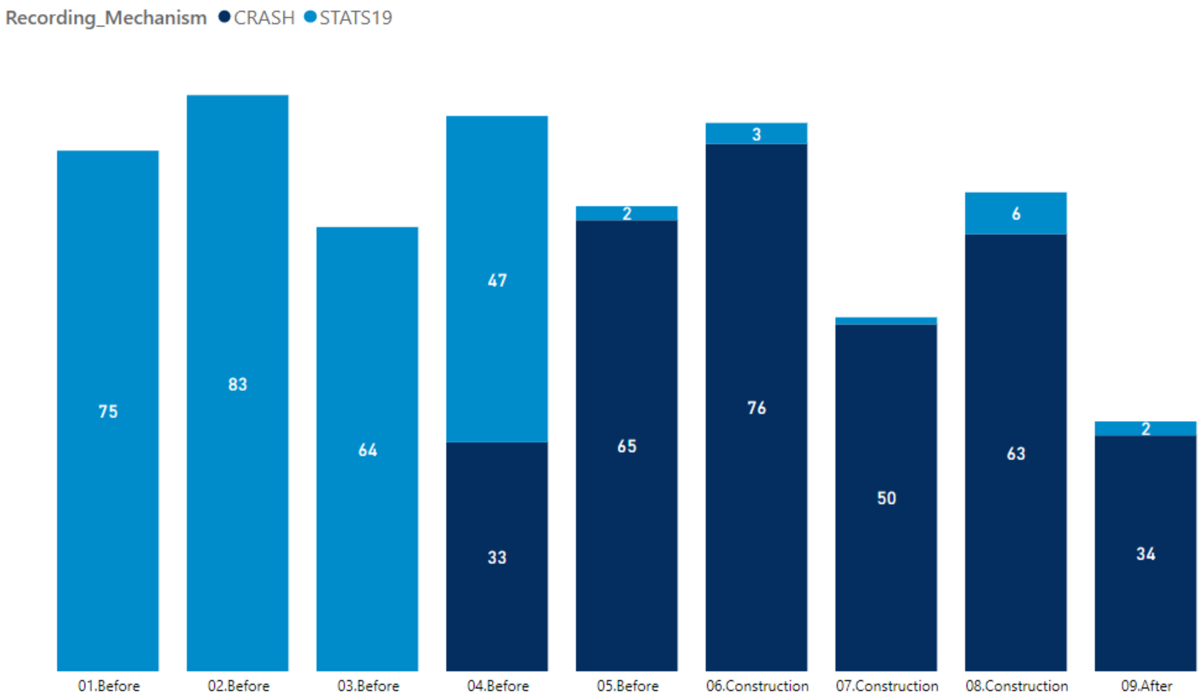
Annex 3: Incident Reporting Mechanisms

The scheme extent of the M3 J2-4a is covered by two police forces, Surrey and Hampshire.

In November 2012 Surrey police constabulary transferred from Stats19 to Collision Recording And SHaring (CRASH) system for reporting personal injury collisions. In CRASH reporting, police officers record the types of injuries suffered by the casualty rather than the severity. In previous systems the determination of severity was at the discretion of the reporting police officer. CRASH automatically converts the injury type to a severity classification. This led to implications for reporting on collision severity as there had been an increase in the number of serious collisions recorded[12]. Hampshire still records using STATS19.

The chart shows when the transfer from STATS19 to CRASH occurred in Surrey within this scheme, in the 2nd year before construction started. A small proportion of collisions are still recorded using STATS19, from two years pre-construction onwards, due to Hampshire still using this format.

Figure 23 Collision reporting mechanisms on M3 J2-4a



Source: STATS19: 1st May 2009 to 31st July 2018

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

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