national highways

A23 Handcross to Warninglid

Five-year post-opening project evaluation

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Foreword

National Highways is the government-owned company that operates, maintains, and improves England's motorways and major A roads. Our roads help our customers get to their destination safely – and in the time they expect to. Safety is our top priority, and we are committed to reducing the number of road users killed or seriously injured on the strategic road network by 50% (from the 2005-2009 baseline) by the end of 2025, with a vision of zero harm by 2040.

As Chief Customer and Strategy Officer, I want to know that developments on our network are meeting their objectives and are putting the needs of drivers first. Post-Opening Project Evaluations (POPEs) are a vital part of that assessment. POPEs are undertaken for all our major projects to understand how traffic changes, due to a project being in place, the environmental and safety impacts and how a project supports the economy.

The Handcross to Warninglid project completed in October 2014 and marked the last remaining section of the A23 to have improvements made to its alignment and profile. Before 2014, those driving the stretch experienced regular delays and congestion, especially during the morning and afternoon peak hours. The long steep gradient of this section also caused Heavy Goods Vehicles to block the inside lane, creating a single lane bottleneck for other vehicles. Historically, this section of the A23 also had high collision rates, poor forward visibility (due to bends and inclines), and several direct accesses leading onto it.

We widened the road, changing it from a dual two-lane carriageway to a dual three lane carriageway. This would add capacity and fewer peak time delays. We improved safety by removing all the direct private and commercial accesses to the A23 and building a new path and subway for walkers and cyclists.

Road user safety has improved on the project section, and journey times have also been better since the project was delivered. However, in relation to impacts on various aspects of the environment, outcomes have been mixed. While air quality and noise impacts were better than expected, landscape and drainage were not. Managing the environmental impacts of our projects is an important element of our work which, for this project, was influenced by the collapse of the contractor Carillion. This report sets out our understanding of why those impacts have been higher than we expected – valuable findings which we are committed to using in future projects as we aim for environmental outcomes that are far less varied.

Since the project opened, we have also published our new Environmental Sustainability Strategy1. We expect that the environmental management framework it implements will strengthen environmental governance and ensure projects deliver their environmental commitments.

Elliot Shaw

Chief Customer and Strategy Officer

December 2023

[1] https://nationalhighways.co.uk/our-work/environment/environmental-sustainability-strategy/

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1. Executive summary

The A23 Handcross to Warninglid project opened to traffic in October 2014 to provide additional capacity, improve journey times and journey time reliability, and improve safety for road users.

The project extends for 2.4 miles on the A23 between the villages of Handcross and Warninglid, West Sussex. The A23 itself is the principal route linking the M25, M23 and Gatwick Airport to the north, with the A27 and coastal towns in the south. Before the project, this section had poor forward visibility (due to bends and inclines), and numerous accesses to residential and commercial properties. There had been a high number of collisions, with these often resulting in traffic congestion on the A23.

The project involved the widening of the existing dual two-lane carriageway to three lanes in both directions between Handcross and Warninglid junctions. All direct private accesses onto the A23 mainline carriageway between Handcross and Warninglid junctions were closed. A new two-way service road was constructed from Warninglid to provide access to commercial and residential properties on the west side of the A23, and the junction at Warninglid was amended to include a new roundabout to link the A23 and B2115 to the new service road. Other measures included a new footway and cycleway between Handcross and Warninglid and an equestrian, cyclist, and pedestrian subway.

The evaluation has found that journey times have improved, with the largest journey time savings being in the morning peak northbound direction.

Road user safety has improved on the project section, but the average collision rate has increased in the wider area. We know that the road safety improvements on the project section are statistically significant, which means they could be attributed to the project.

Landscape and water impacts were worse than expected. This was because there had been insufficient maintenance work undertaken since opening which had led to the poor condition of the landscape and drainage mitigation. This was influenced in part by the collapse of the contractor Carillion. The poor condition of the landscape mitigation meant that there was a risk that environmental commitments to ongoing management of landscape and drainage mitigation were not being fulfilled. Air quality and noise impacts were better than expected due to lower actual flows than that forecast.

Overall, based on the evidence from the first five years, this project is on track to provide high value money.

2. Introduction

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

The A23 Handcross to Warninglid project opened in October 2014. Before the project opened, this part of the road network was experiencing congestion and delay, especially during the morning and afternoon peak hours. The long steep gradient of this section was also reported to cause Heavy Goods Vehicles (travelling northbound) to block the inside lane, reportedly creating a single lane bottleneck for other vehicles. Historically, this section of the A23 also had high collision rates, poor forward visibility (due to bends and inclines), and numerous direct accesses leading onto it.

The project aimed to provide additional capacity, by removing the existing bottleneck on the strategic M23/A23 route between London and Brighton associated with peak hour delays. As a result, this was expected to improve overall journey times and journey time reliability for road users. This section of the A23 (between Handcross and Warninglid) was also the last remaining section of the A23 to have improvement works made to its alignment and profile.

The project aimed to improve safety for road users and residents by removing all direct private and commercial accesses to the A23. And make improvements for pedestrians, cyclists, and equestrians by providing a new footway and cycleway and new equestrian, cyclist and pedestrian subway.

The project involved the following elements (Table 1):

- Widening of the existing dual two-lane carriageway to three lane carriageways between Handcross and Warninglid junctions (image A)
- Closure of all direct private accesses onto the A23 mainline carriageway between Handcross and Warninglid junctions
- Construction of a two-way service road from Warninglid to provide access to commercial and residential properties on the west side of the A23.
- Amended junction at Warninglid, including a new roundabout to link the A23 and B2115 to the new two-way service road (image B)
- Amended junction at Handcross, including the rebuilding of the Driver and Vehicle Standards Agency weighbridge.
- The closure of the off-slip road for access to Slaugham
- A new footway and cycleway between Handcross and Warninglid, connecting to the local footpath network between Slaugham and Warninglid
- A new equestrian, cyclist, and pedestrian subway to link existing footpaths on either side of the A23 (image C)

Table 1 Images of the project

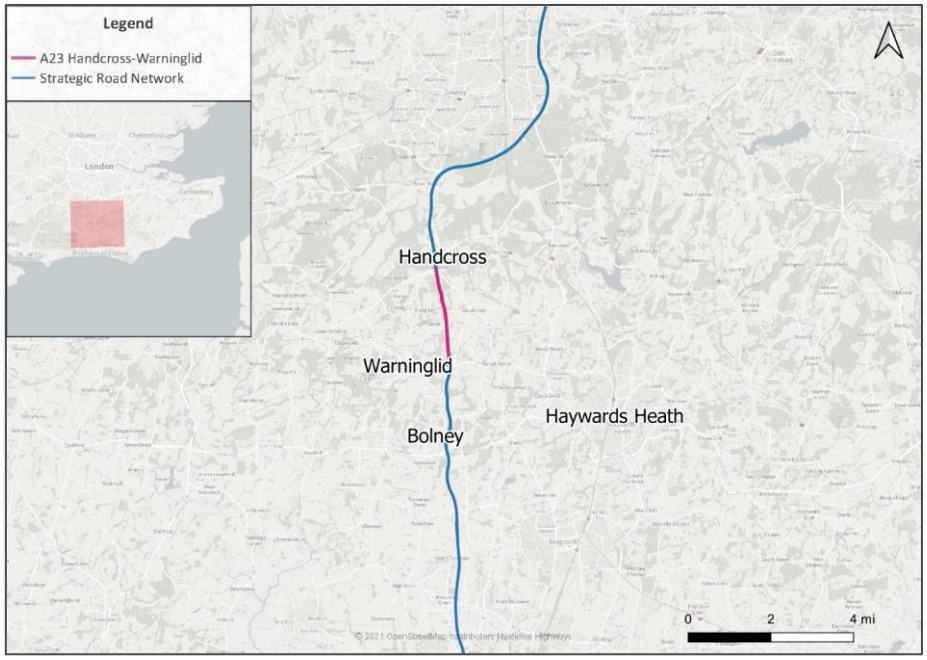
Source: Images taken from the one-year evaluation

Project location

The project extends for 2.4 miles on the A23 between the villages of Handcross and Warninglid, West Sussex. The A23 itself is the principal route linking the M25, M23 and Gatwick airport to the north, with the A27 and coastal towns in the south. Along its entire route, the A23 intersects with several other major roads, most notably the M25 junction 7, the A27 Brighton Bypass, and M23 at Pease Pottage.

The project extent lies within the High Weald Area of Outstanding Beauty. The geographical context of the project is shown in Figure 1.

Figure 1: A23 Handcross to Warninglid project location



Source: National Highways and OpenStreetMap contributors

How has the project been evaluated?

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

deliver value for money. They also provide opportunities to learn and improve future project appraisals and business cases.

A post-opening project evaluation compares changes in key impact areas[2] by observing trends on a route before a project is constructed (baseline) and tracking these after it has opened to traffic. The outturn impacts are evaluated against the expected impacts (presented in the forecasts made during the appraisal) to review the project's performance. For more details of the evaluation methods used in this study please refer to the post-opening project evaluation (POPE) methodology manual on our website.[3]

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

3. Delivering against objectives

How has the project performed against objectives?

All our major projects have specific objectives which are defined early in the business case when project options are being identified. Objectives are appraised to be realised over 60 years; the evaluation provides early indication if the project is on track to deliver the benefits.

Table 2 summarises the project's performance against each of the objectives4, using evidence gathered for this study.

Table 2: Project objectives and evaluation summary

Objective	Five-year evaluation
Provide increased capacity by removing the existing bottleneck on the strategic M23/A23 route between London and Brighton with associated peak hour delays.	Additional capacity provided. Peak hour delays, in the morning peak especially, have noticeably decreased along the project extent and beyond.
Provide improved journey times and increased safety.	Journey times and safety have improved.
Improve safety for residents and operators by removing all direct private and comemrcial accesses to the A23.	The new local access road and closure of private and commercial direct accesses to the A23 has reduced the risk of collisions. The collision rate has fallen on the project extent.
Reduce congeston and improve reliability along the A23 and improve existing junctions at Handcross and Warninglid.	Additional capacity has been provided through the upgrade of the A23, improving journey time reliability along this stretch of the A23.
Reduce congestion and improve reliability to/from Gatwick Airport, to/from the key infrastructure element of the Gatwick Diamond economic growth area, and the major new housing allocations.	Additional capacity has been provided through the upgrade of the A23, improving journey time reliability along this stretch of the A23. Access to the M23, and consequently Gatwick, has improved. The increased capacity provides a level of futureproofing for new developments.
Provide improved routes for pedestrians, equestrians and cyclists, and improved junctions at Handcross and Warninglid, thereby improving safety.	Improved routes have been provided for pedestrians, equestrians, and cyclists, including a new underpass to ease passage across the A23. Improved junctions have also assisted cyclists crossing slip roads.
Minimise environmental impact and seek opportunities for enhancement taking account of value for money.	The project was constructed within the existing highway boundary as far as possible and new landscape mitigation planting was provided. However, the collapse of the construction contractor meant that at five-years after, the landscaping was in poor condition. Unless improved, there was a risk that the environmental impacts would not be minimised as intended.
Minimise land acquisition, particularly of National Trust land. Minimise the effect on ancient woodland.	Works to limit encroachment on the National Trust site at Orange Gill (i.e., using a retaining wall) were carried out. The conversion of the original vegetated central reserve for traffic use minimised land take beyond the highway boundary and impacts on ancient woodlands.

[4] Client Scheme Requirements (2011).

4. Customer journeys

Summary

Following the road improvement, we found that average weekday traffic on the A23 has increased by 8% However, this is no greater than the increases in background traffic over this time period.

Our analysis has shown that traffic volumes prior to the project were considerably lower than forecast. This is likely due to the 2008 recession causing a reduction in traffic volumes after the appraisal was complete. This problem follows through to the forecasts after opening, but the percentage increase was forecast accurately.

Journey times on the A23 has improved in all time periods in both the northbound and southbound directions. The largest change is in the morning peak. Customers travelling Southbound experienced improved journey times from an average of just over 6 minutes to just over 5 minutes.

Journey time improvements were forecast to be greater, particularly in the morning peak. This appears to stem from an overestimation of the congestion that would occur without the project. We can see this by comparing the before observed journey times to projections from the model; the model expected journey times to get substantially worse prior to the project and this did not occur, this is likely a result of traffic growth not increasing due to the 2008 recession.

Reliability has improved in all time periods and in both directions. As with the average journey times, reliability improvements are most noticeable in the morning peaks, which is to be expected given this period suffered the most prominent delays before the project.

How have traffic levels changed?

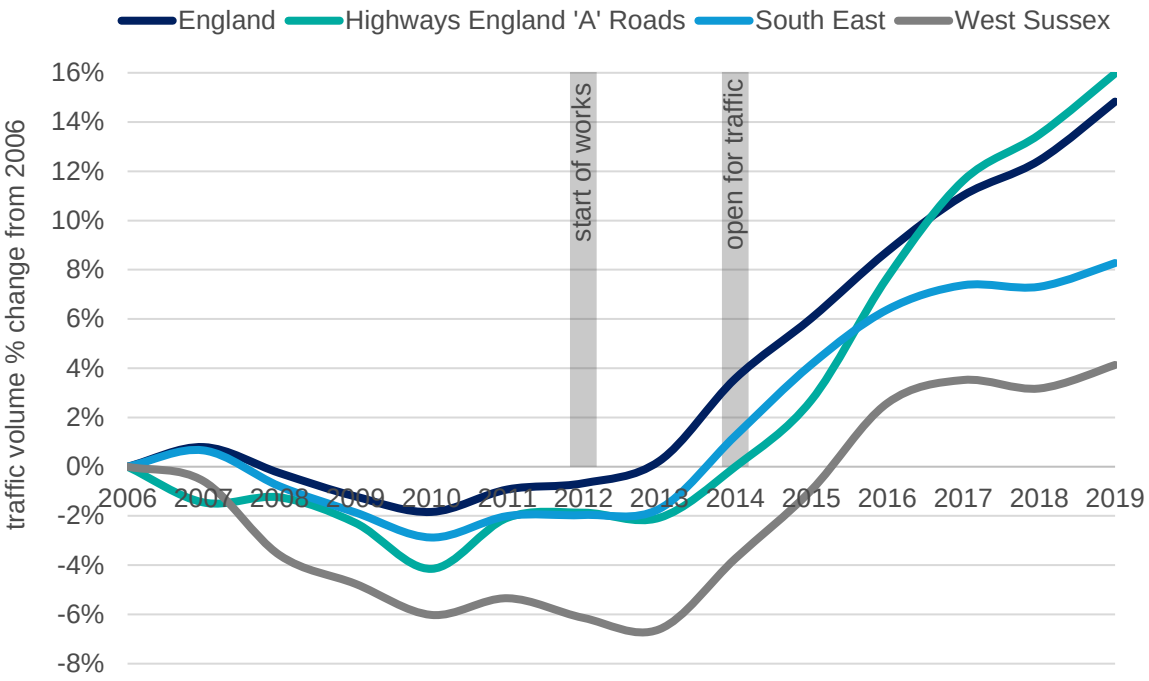
This section examines how traffic levels have changed in the years since the project opened, and how it was expected to perform over the same timeframe.

National and Regional

To assess the impact of the project on traffic levels, it is helpful to understand the changes within the context of national and regional traffic. The Department for Transport produces annual statistics for all observed traffic by local authority and road type. This data includes the total number of million vehicle kilometres (mvkm) travelled[5]. This data gives a picture of the background change in the level of traffic. We have presented the change between 2006, which represents the project model base year, and 2019 which is five years after the project opened. Figure 2 shows the results of this analysis.

[5] DfT Data Table TRA4112, TR0202, TRA8904 (Motor vehicle traffic (vehicle kilometres) by local authority in Great Britain, annual from 1993), https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

Figure 2 National and regional traffic volumes



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

Overall, traffic flows have increased nationally, regionally (South East), and locally (West Sussex) between 2006 and 2019. This rise is most noticeable from 2013 onwards, where there was a rapid increase in traffic flows.

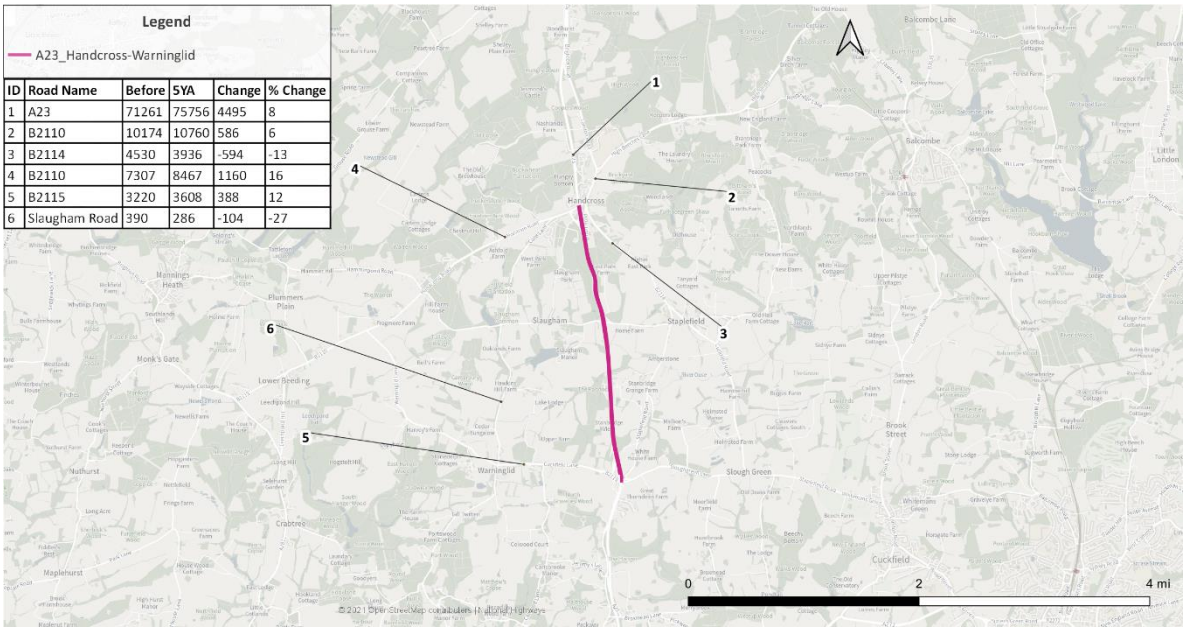
Traffic levels were lower between 2006 through to 2012, due to the recession. This would have been unanticipated at the time of the appraisal, and we can therefore expect that growth estimates made by the model relating to the pre-construction conditions will be too high.

If we focus on the level of growth between 2012 (before the project was constructed) and 2019 (five years after opening), we observe that traffic flows on England major A roads have increased by 18%. However, in the South East and West Sussex, the level of growth was lower at 10 to11%.

Now we know how background traffic flows changed over the five-year evaluation period, we can compare this to traffic flows locally, on the A23 and surrounding area.

Figure 3 presents a comparison of Average Weekday Traffic flows on the A23 and surrounding area, before (March 2012) and five years after (September 2019) the opening of the project. Traffic flows are taken from the A23 (north of the project, rather than on the project extent) due to data availability issues but they are expected to be consistent with flows on the project itself. Data was not available for the A23 northbound in 2019 (five years after the project opened), and instead 2018 data was factored up to provide a 2019 figure based on the level of growth observed in the southbound direction.

Figure 3 Average Weekday Traffic flows on the A23 and surrounding area



ID	Road Name	Before	5YA	Change	% Change
1	A23	71261	75756	4495	8
2	B2110	10174	10760	586	6
3	B2114	4530	3936	-594	-13
4	B2110	7307	8467	1160	16
5	B2115	3220	3608	388	12
6	Slaugham Road	390	286	-104	-27

Source: All counts are West Sussex County Council except for the A23 (WebTRIS)

On the A23 (north of the project) traffic flows have increased by 8%. We note that in Figure 3, traffic flows had increased locally by 10 to11% in the South East and West Sussex, and as such it appears traffic flows have increased by a lower amount than what we would expect in the area. As such, there is little evidence that the project itself has generated traffic growth beyond background levels.

In general, traffic flows on surrounding roads are in line with regional and national figures (12-16%). Some sites (Slaugham Lane and B2114) have experienced a decrease in traffic flows, but this is not thought to be due to the project.

Was traffic growth as expected?

The investment decision for this project was supported by a project appraisal which included forecasts about the likely impact on traffic. The appraisal forecast average daily traffic flows on the A23 project extent, for the Do Minimum (2012) and Do Something (2019) scenarios. The Do Minimum is a 'without project' scenario and models the effects over time of continuing with the former road layout without the project. The Do Something is a 'with project' scenario which models the impact of the A23 Handcross to Warninglid project.

We have compared these figures against the observed average daily traffic flows for the same years to understand how accurate the modelled flows were to what occurred. This is different to the data used previously, which was for one month only, whereas now this is data across the year. As noted earlier, the observed figures are from the A23 to the north of the project but are expected to closely reflect data on the project section itself given the absence of major junctions in between. As before, there was a lack of data available for the northbound, and so 2018 data was factored up using the same level of growth experienced in the southbound. Table 3 presents the modelled and observed flows.

Table 3: Forecasting accuracy of traffic flows

Direction	Before flows	After flows		

	DM 2012	Observed 2012	Difference	DS 2019	Observed 2019	Difference	Forecast change DM - DS	Outturn change Before – After
NB	40,466	33,813	-6,654	46,083	39,006	-6,511	12%	15%
SB	36,386	31,169	-5,217	41,259	35,644	-5,615	13%	14%

These findings demonstrate that observed flows were far lower (5000-6000 vehicles lower) than predicted in both the Do Minimum (2012) and Do Something (2019) periods. The recession that occurred in 2008 would not have been anticipated and is likely to be a key contributor to the inaccurate estimates in 2012, which appear to have carried through to 2019. Note that the 2019 traffic volume figures show similar differences to the 2012 figures, suggesting that almost all the inaccuracy in the forecasts comes from the period affected by the recession, rather than during the subsequent growth from 2012 to 2019. Because of this, the actual percentage growth between 2012 and 2019 is in line with forecast.

Relieving congestion and making journeys more reliable

In this section we consider the impact of the project on journey times, particularly as reducing congestion was a key aim of the project. The analysis compares the journey times before and after the project opened to understand whether journey times and journey time reliability has improved. We have also compared the observed change in journey times with the forecast journey time changes.

Did the project deliver journey time savings?

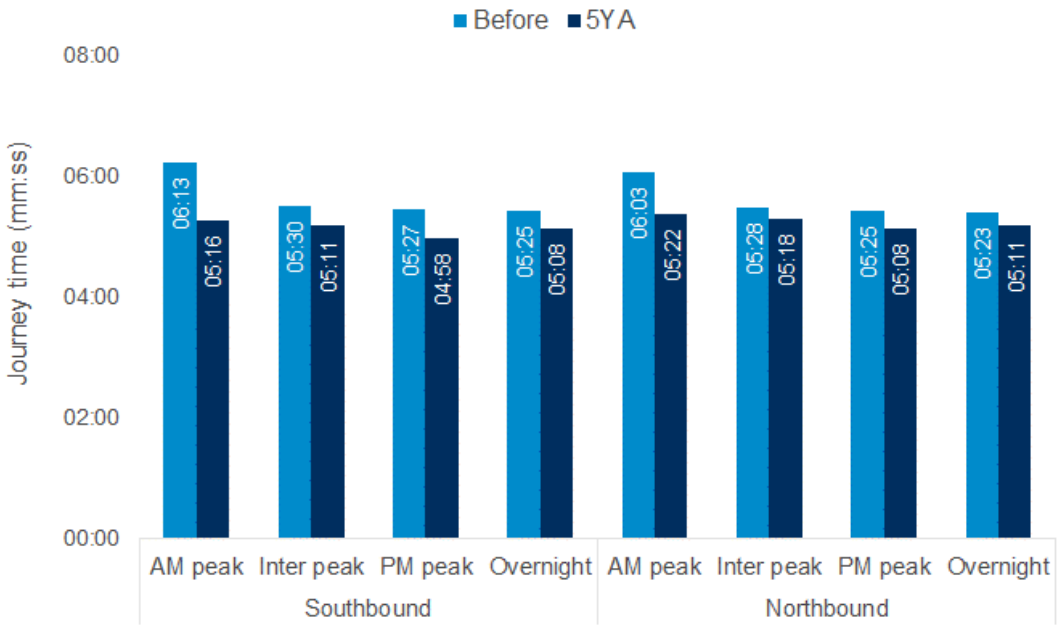
For this section satnav (TomTom) data is used to calculate the average journey times for each direction, and time-period, set out in the traffic forecast documentation. The dates used for this analysis was March 2012 (before construction) and September 2019 (five year after the project opened).

At five-years after, journey times have improved, with customers travelling in the morning peak experiencing an improvement of one minute. There is minimal change in journeys travelled outside the morning peak, however, this is consistent with these periods already being relatively free flowing to begin with.

The evaluation looked at three peak periods of flow during the day, to enable a direct comparison with the traffic forecast impacts. (Weekdays morning peak 07:00-10:00, Interpeak 10:00-16:00 and afternoon peak 16:00-19:00). As well as the overnight time periods which helps us to understand the ‘free flow’ conditions. We would expect overnight journey times to be uncongested and so this works as a good comparator for the best possible journey time performance.

Our analysis covered the route from Woodhurst (north of the project) and Bolney (south of the project). The purpose of extending the route past the project extent was to understand the project impacts on the wider area, specifically its success in addressing the previous bottleneck issues. Figure 4 displays the observed journey time findings.

Figure 4 Observed journey times



Before the project opened the 'free flowing' journey times were around 5 minutes and 25 seconds. In comparison to this, customers travelling in the morning peak experienced delays in both directions. (For instance, the A23 southbound, customers had an average journey time of 6 minutes 13 seconds) In the inter and afternoon peaks, customer journey times were only between 2 and 5 seconds higher than the overnight period, which suggests delay wasn't an issue in these time periods.

Were journey time savings in line with forecast?

Journey time savings were lower than expected in all time periods, with the exception in the morning peak travelling southbound, where actual savings were similar to forecast (forecast saving of 25 seconds compared to a saving of 31 seconds).

The journey time forecasts were provided for the morning and afternoon peak between Bolney and Handcross[6],The Traffic Forecasting Report[7] included journey time forecasts for Do Minimum (without project) and Do Something (with project) scenarios for 2013 (anticipated to be the first year of the project being complete).

The data is summarised in Table 4 and Table 5.

Table 4 Observed and forecast journey times – morning Peak.

Direction	Forecast journey time (mm:ss)				Observed journey time (mm:ss)			
	DM 2013	DS 2013	DS 2028	Saving (DM-DS 2013)	Before (2012)	1 yr after (2016)	5 yr after (2019)	Saving (Bef-5YA)
NB	07:54	04:57	05:32	**02:57**	04:40	03:51	04:02	**00:38**
SB	04:37	04:12	04:18	**00:25**	04:24	03:45	03:53	**00:31**

[6] as such the observed journey times here are different than those shown previously
[7] A23 Handcross to Warninglid Traffic Forecasting report Dec 2009

Table 5 Observed and forecast journey times – afternoon Peak.

Direction	Forecast journey time (mm:ss)				Observed journey time (mm:ss)			
	DM 2013	DS 2013	DS 2028	Saving (DM-DS 2013)	Before (2012)	1 yr after (2016)	5 yr after (2019)	Saving (Bef-5YA)
NB	04:34	04:12	04:18	**00:22**	04:02	03:49	03:57	**00:05**
SB	05:24	04:35	05:21	**00:49**	03:59	03:39	03:49	**00:10**

Note that the 5 year after journey times are for a route approximately 84m longer than the before and 1YA route due to the change in junctions, therefore availability of data

The northbound morning peak journey times has been overestimated in all scenarios. Without the project, journey times were anticipated to be just under 8 minutes, but journey times prior to the project were just under five minutes. This is likely to be a consequence of the model not anticipating the 2008 recession, which stopped traffic growth for several years and led to fewer vehicles on the A23. In turn, this is likely to have meant that journey times did not worsen as anticipated. The other time periods in both directions have also been overestimated, but to a lesser degree.

This overestimation of journey times leads to a big difference in the forecast and actual saving on the A23 northbound in the morning peak (2 minutes 57 seconds compared to 38 seconds). It would not have been possible for the project to achieve a journey time saving of this degree, due to the journey times not worsening as expected prior to the project delivery. In the afternoon peak in both directions, savings were also lower than expected.

Did the project make journeys more reliable?

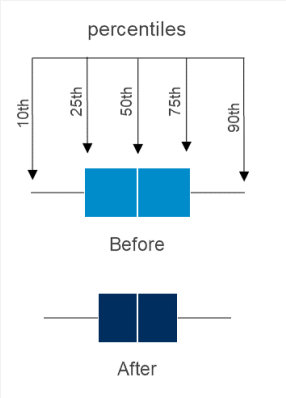
An objective of the project was to improve the reliability of journeys, making customer journeys more predictable. To measure this, we examine how much journey times vary from the average journey time, on any day or time-period. Where journeys were less variable, road users can allow a smaller window of time to travel through that stretch of smart motorway, when travelling at a similar time.

Overall, the reliability has improved in all time periods and in both directions. As with the average journey times, reliability improvements are most noticeable in the morning peaks.

As with the journey time findings, reliability was not a prominent issue prior to the project, with only the northbound morning peak showing poor reliability. As such, this is the only period and direction in which benefits are seen.

Figure 6 and Figure 7 show the 5th, 25th, 75th and 95th percentile journey times in each period. As a means for understanding these, the 95th percentile journey time is the time that 95/100 vehicles will be quicker than.

Figure 5 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 narrower the block the less variable, and hence more reliable, the journey.

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Figure 6 A23 Handcross to Warninglid northbound journey time reliability

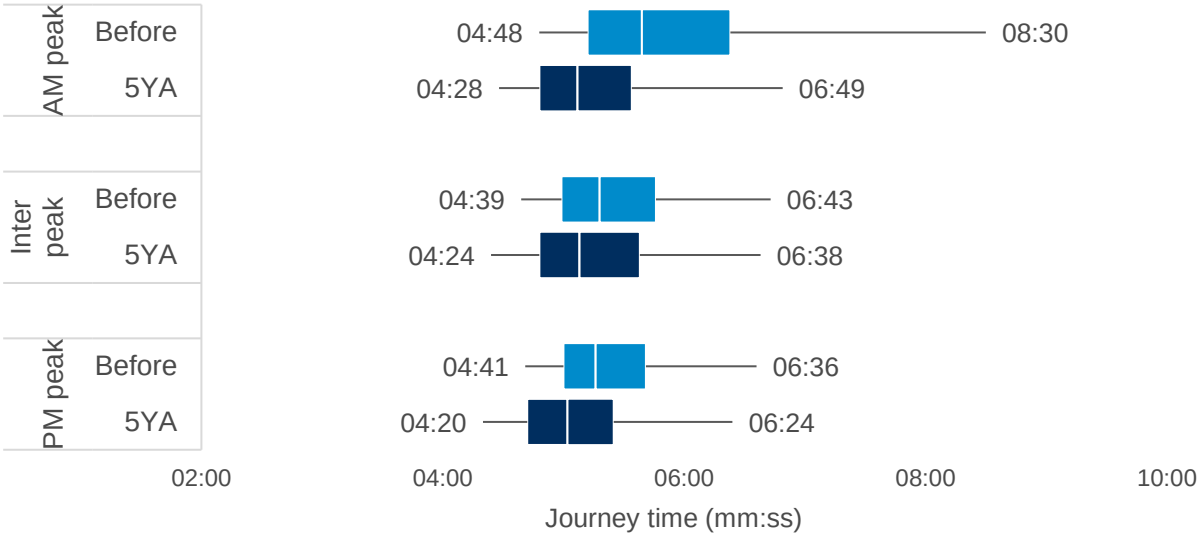
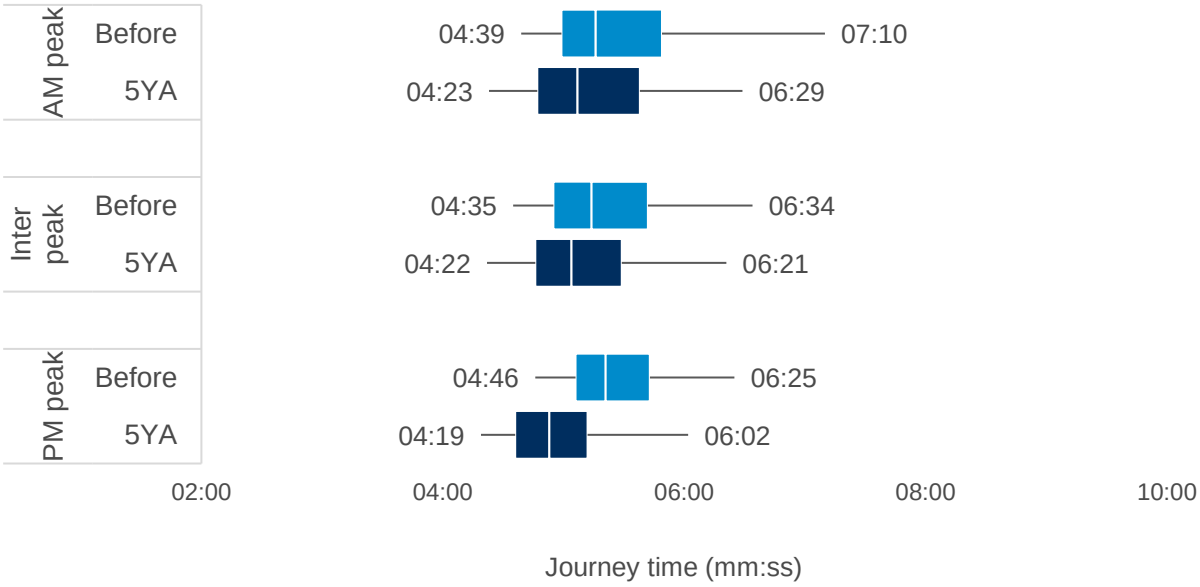


Figure 7 A23 Handcross to Warninglid southbound journey time reliability



5. Safety evaluation

Summary

The safety objective was to improve safety performance by reducing the number of collisions. The number and rate per hundred million vehicle miles of personal injury collisions[8] 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 had been 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.

On the project there had been an annual average reduction of 11 personal injury collisions, which is in line with the appraised business case for the project. This is based on an annual average of 9 personal injury collisions after the project was operational compared with 20 before the project. If the road had not been converted to a dual carriageway, we estimate that the number of personal injury collisions would have been between 15 and 26 (Figure 10).

When accounting for the increased volume of road users over this period, the annual average rate of personal injury collisions per million vehicle miles had also improved over time. The average collision rate had decreased to 15 personal injury collisions per hundred million vehicle miles, this equates to travelling seven million vehicle miles before a collision occurs. Before the project the collision rate was 41 personal injury collisions per hundred million vehicle miles, this equates to traveling 2 million vehicle miles before a collision occurs. If the road had not been widened, we estimate the collision rate would reduce to 26 personal injury collisions per hundred million vehicle miles. The observed reduction in collision rates is greater than expected without the project being constructed.

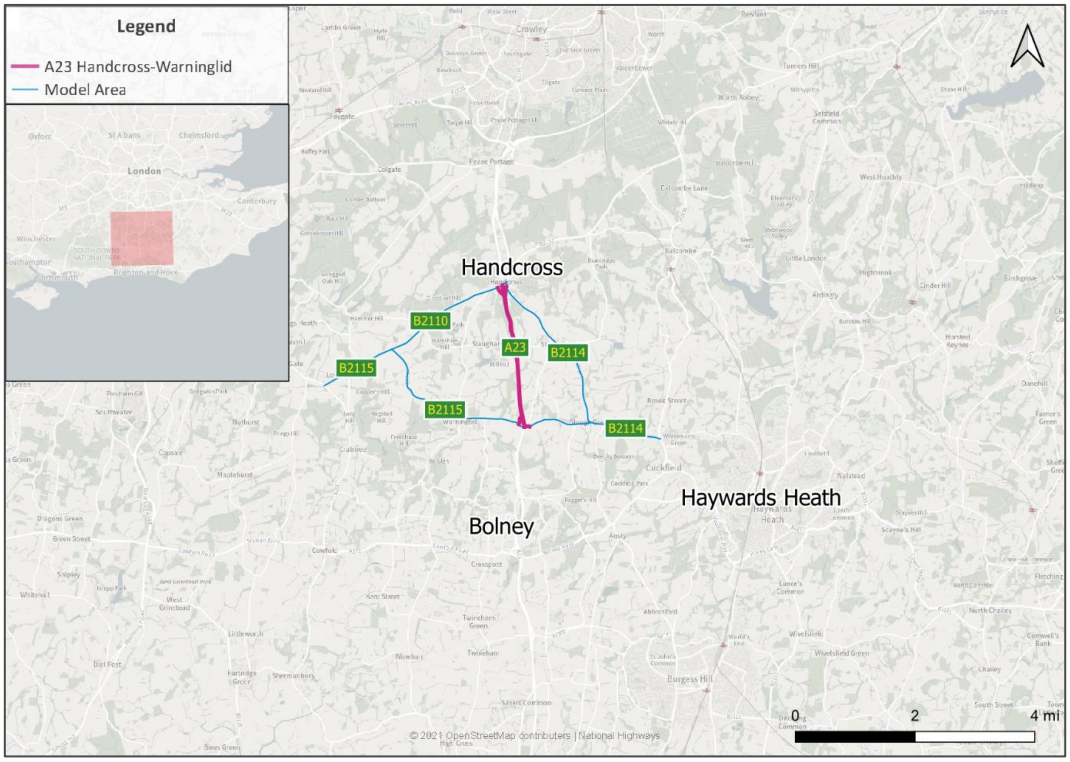
Over the evaluation period for the wider area, there was an average increase of 4 personal injury collisions per year (based on an annual average of 9 personal injury collisions observed after the project had opened compared with 13 before the project). If the road had not been widened, we estimate that the number of personal injury collisions would have increased to between 6 to 14.

Safety study area

The safety study area, shown in Figure 8 was defined as the project extent on the A23, 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.

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

Figure 8 Safety study area



Source: National Highways and OpenStreetMap contributors

Road user safety on the project extent

What impact did the project have on road user safety?

Safety data was obtained from the Department for Transport road safety data[9]. This records incidents on public roads that are reported to the police. This evaluation considers only collisions that resulted in personal injury via this dataset.

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

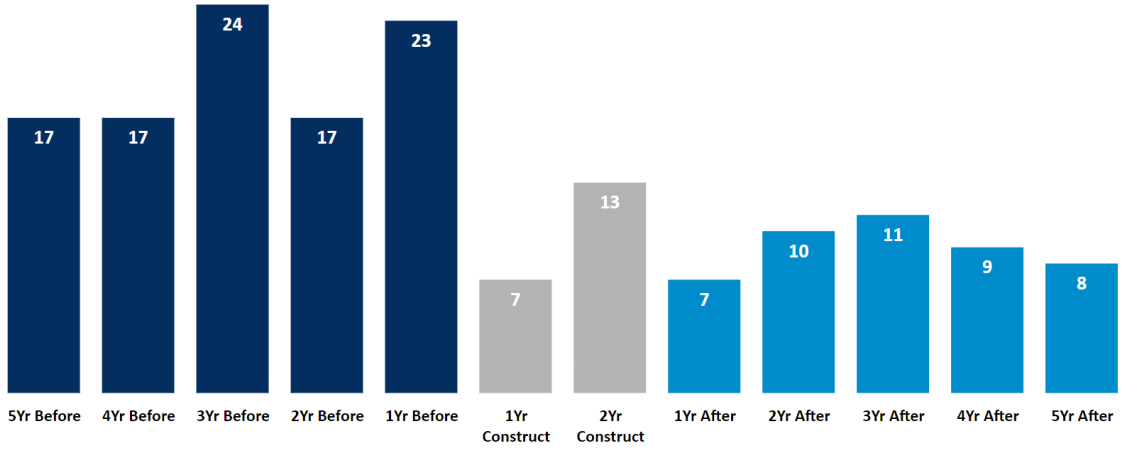
The analysis draws on the following data collection periods:

- Pre-construction: 1 June 2007 to 31 May 2012
- Construction: 1 June 2012 to 5 October 2014
- Post-opening: 6 October 2014 to 5 October 2019

The evaluation found the number of personal injury collisions on the project extent, A23 had decreased (impacts on the wider area are discussed later). Over the five years after the project was operational, there were an average of 9 personal injury collisions per year, 11 fewer than the average 20 per year over the five years before the project was constructed.

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

Figure 9 Annual Personal Injury Collisions



Source: STATS19: 1st June 2007 to 5th October 2019

As part of the safety evaluation, we look to assess what changes in personal injury collisions might have occurred due to factors external to the project over this timeframe. To do this we estimate the trend in personal injury collisions which might have occurred if the road had not been widened (this is referred to as a counterfactual - see Annex 2: Safety Counterfactual Methodology). This is based on changes in regional safety trends for A Roads with a high volume of roads users. A range of collisions that consider regional trends is calculated.

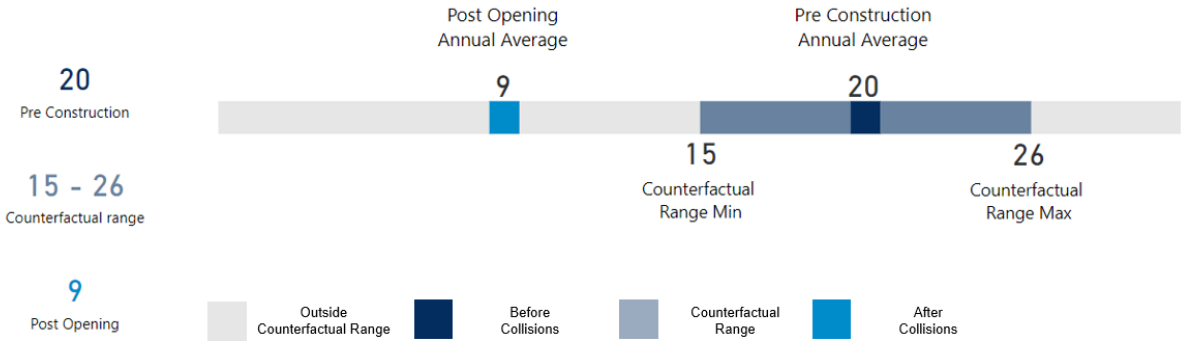
If the observed annual number of collisions is within this range, the project is operating as expected compared to the regional trends. If the number of observed collisions fall under the range the project is outperforming compared to the regional trends. If the observed number of collisions is higher than the range the project is underperforming compared to the regional trends. Based on this assessment we estimate 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 remain stable.

A range of between 15 and 26 personal injury collisions[10] during the five-year post project period would be expected. An annual average of 8 personal injury collisions were observed over the five-year post-opening period, this falls below the expected range as show in Figure 11 below.

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

[10] 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.

Figure 10 Observed and expected range of personal injury collisions



Source: STATS19: 1st June 2007 to 5th October 2019

Figure 11 What does the counterfactual show?

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

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

How has traffic flow impacted collision rates?

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

The average collision rate had decreased to 15 personal injury collisions per hundred million vehicle miles, this equates to travelling 6.5 million vehicle miles before seeing a collision. Before the project the collision rate was 41 personal injury collisions per hundred million vehicle miles, this equates to traveling 2.4 million vehicle miles before seeing a collision.

The estimated rate if the extra lane had not been built would reduce to 26 personal injury collisions per hundred million vehicle miles. This counterfactual scenario indicates we would observe a reduction in the rate of collisions. The observed reduction in collision rates is greater than what would be reasonably expected without the project.

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

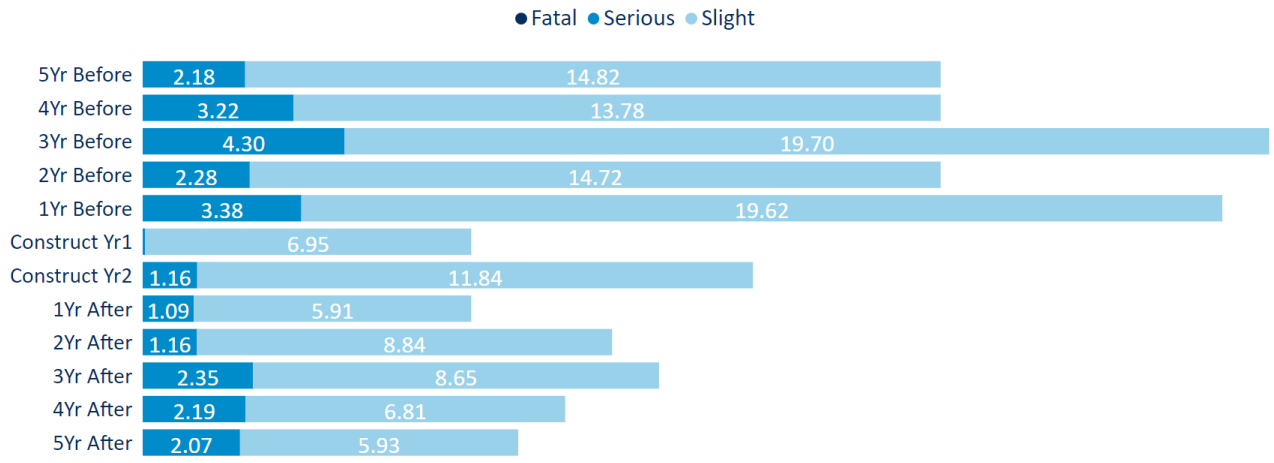
Collisions which result in injury are recorded by severity as either fatal, serious, or slight. The way the police record the severity of road safety collisions changed within the timeframes of the evaluation, following the introduction of a standardised reporting tool – Collision Recording and Sharing. This is an injury-based reporting

system, and as such severity is categorised automatically by the most severe injury. This has led to some disparity when comparing trends with the previous reporting method, where severity was categorised by the attending police officer[11]. Therefore, the Department for Transport have developed a severity adjustment methodology[12] to enable robust comparisons to be made.

For this evaluation, one reporting mechanism was largely used prior to the smart motorway conversion and another afterwards. The pre-conversion collision severity has been adjusted, using the Department for Transport's severity adjustment factors, to enable comparability with the post-conversion safety trends.[13]

After the project there were an average of 9.2 fewer collisions resulting in slight injuries per year (the annual average before the project was 16.4, compared to 7.2 after), 7.8 fewer collisions resulting in serious injuries per year (the annual average before the project was 9, compared to 1.2 after. There have been no fatal collisions observed before or after the project became operational Figure 12 shows the severity of personal injury collisions.

Figure 12 Personal Injury Collisions by Severity



Source: STATS19: 1st June 2007 to 5th October 2019

How has traffic flow impacted collision severity?

Like other transport authorities across the UK the key measure we use to assess the safety of roads, is Fatal and Weighted Injuries (FWI). This gives a fatality 10 times the weight of a serious casualty, and a serious casualty 10 times the weight of a slight casualty[14]. In effect, it takes all non-fatal injuries and adds them up using a weighting factor to give a total number of fatality equivalents[15]. This is represented by an annual average and a rate that standardise casualty severities against flow to show the likelihood of a fatality equivalent occurring per distance travelled.

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

12 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

13 Collision Severities within this report use the 2020 adjustment factor.

14 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.

15 Casualty Severities within this report use the 2020 adjustment factor.

A reduction of 0.3 fatality equivalents has been observed annually. The severity of casualties occurring after the project became operational has reduced in the project extent. Before the project an annual average 0.7 fatality equivalents were observed. After the project this had reduced to an annual average of 0.4 fatality equivalents.

The combined measure showed an extra 97 million vehicle miles was travelled before a fatality. Before the project, 67 million vehicle miles needed to be travelled before a fatality (1.5 fatality equivalents per hmvm[16]). After the project this increased to 164 million vehicle miles (0.6 fatality equivalents 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.

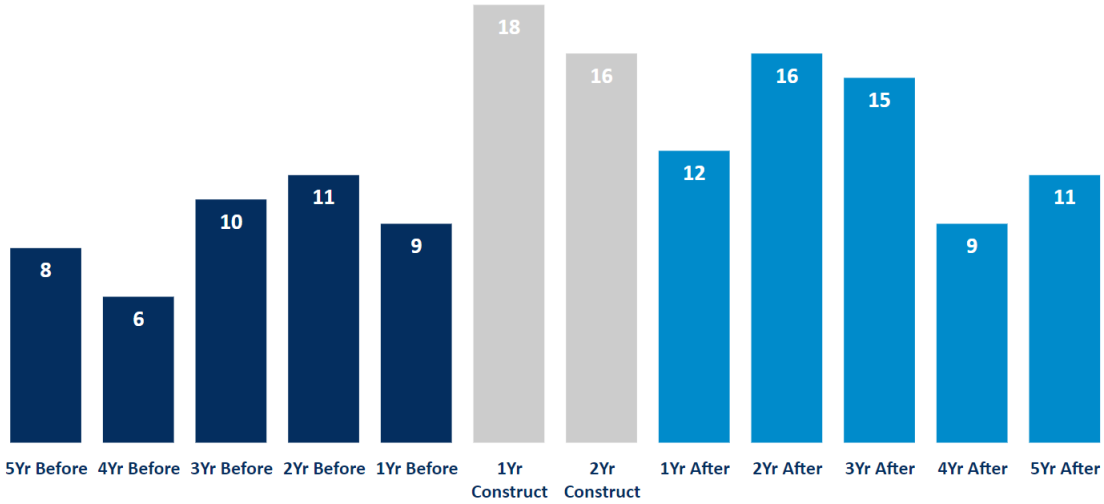
Road user safety on the junctions and wider area

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 9 collisions were observed within the local area. After the project the observed collisions had risen to 13, an increase of 4.

Figure 13 Annual Personal Injury Collisions in Wider Area



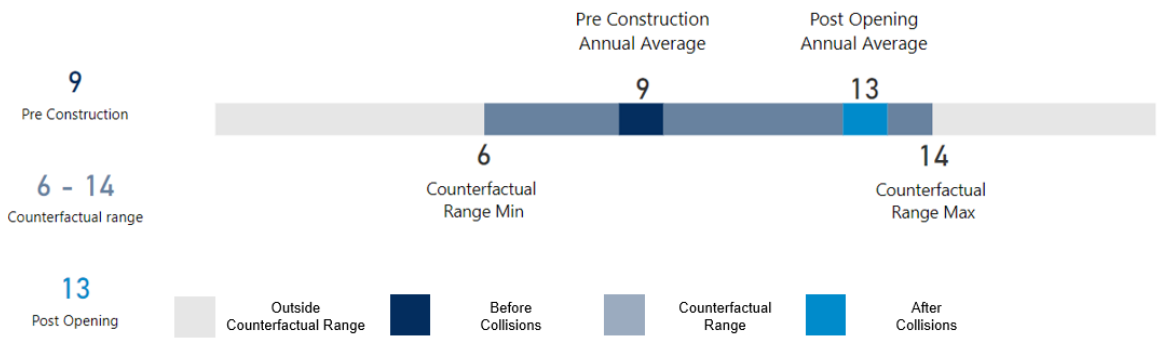
Source: STATS19: 1st June 2007 to 5th October 2019

A counterfactual test has been undertaken. A range of between six and 14 personal injury collisions[17] during the five-year post project period would be expected. An annual average of 13 personal injury collisions were observed over the five-year post-opening period, this falls below the expected range as show in Figure 14 below. This suggests that the project is assisting positive safety trends in the wider area.

[16] Hundred million vehicle miles

[17] 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.

Figure 14 Observed and expected range of personal injury collisions in wider area



Source: STATS19: 1st June 2007 to 5th October 2019

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

The average collision rate had increased to 52 personal injury collisions per hundred million vehicle miles, this equates to travelling 0.5 million vehicle miles before seeing a collision. Before the project the collision rate was 36 personal injury collisions per hundred million vehicle miles, this equates to traveling 0.7 million vehicle miles before seeing a collision.

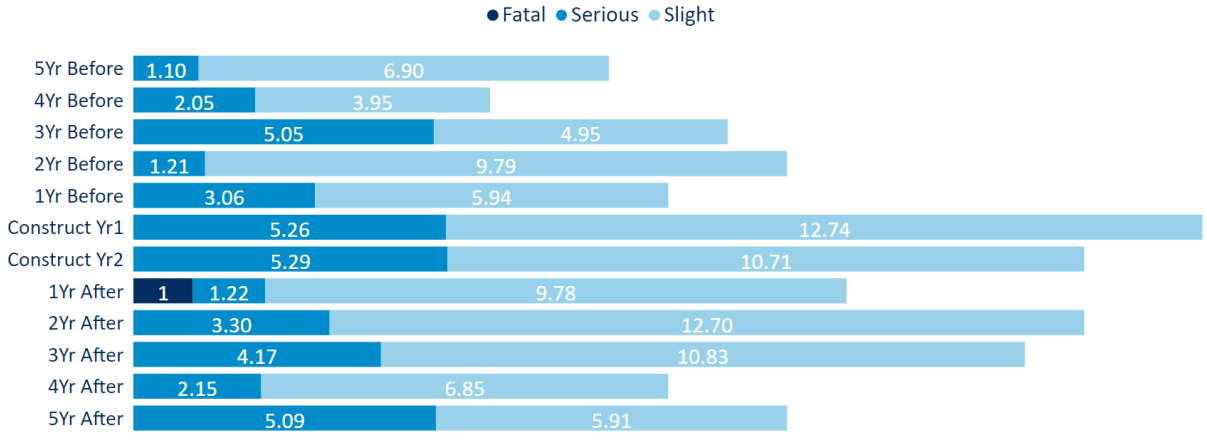
The estimated collision rate would increase to 43 personal injury collisions per hundred million vehicle miles if the widening had not occurred. This counterfactual scenario indicates that the number and frequency of collisions would have increased because of reduced traffic flows.

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

Collision severity analysis was undertaken for the local and wider area using the same method as for the mainline A23.

After the project there were an average of 3 more collisions resulting in slight injuries per year (the annual average before the project was 6.2, compared to 9.2 after), 0.8 more collisions resulting in serious injuries per year (the annual average before the project was 2.4, compared to 3.2 after. One fatal collision has been observed after the project became operational. Figure 15 shows the severity of personal injury collisions.

Figure 15 Personal Injury Collisions by Severity in wider area



Source: STATS19: 1st June 2007 to 5th October 2019

How has traffic flow impacted casualty severity in the wider area?

An increase of 0.4 fatality equivalents has been observed annually indicating that the severity of casualties occurring after the project became operational has increased the wider area. Before the project an annual average 0.4 fatality equivalents were observed. After the project this had reduced to an annual average of 0.8 fatality equivalents.

The combined measure showed a decrease of 34 million vehicle miles was travelled before a fatality. Before the project, 65 million vehicle miles needed to be travelled before a fatality (1.5 fatality equivalents per hmvm[18]). After the project this decreased to 31 million vehicle miles (3.3 fatality equivalents per hmvm). The rate of fatality equivalents per hundred million vehicle miles has increased.

Has the project achieved its safety objectives?

The appraisal for the project estimated that there would be a reduction of accident numbers over the appraisal period of 60 years. This would mean that over the 60-year period the number of collisions would fall by 170 (by 3 annually). This reduction in collisions would also reduce the number of all casualties by 263 during the same period (on average a reduction of 4 casualties per year). Analysis shows that the appraisal estimations are as anticipated for this project.

The safety objective for this project was to improve safety performance reducing the number of collisions. 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 is on track to meet its safety objective for the project extent.

[18] Hundred million vehicle miles

6. Environmental evaluation

Summary

The evaluation of environmental impacts used information on the predicted impacts gathered from the environmental appraisal and the Environmental Statement (October 2008). This information was then compared with findings observed at one and then again at five-years after opening to understand how well the mitigation had established and to determine whether the project environmental outcomes were likely to be met. Five-years after observed impacts were determined during a site visit in September 2019 and supported by further desktop research. The results of the evaluation are recorded against each of the transport analysis guidance environmental sub-objectives. These are presented in Table 6.

The environmental evaluation focuses on the environmental sub-objectives of noise, air quality, greenhouse gas emissions, landscape, townscape, heritage, biodiversity and the water environment. Overall, the impact of the project on townscape was expected to be neutral. No specific assessment was undertaken in the Environmental Statement for townscape and no impacts on townscape were found during the one-year evaluation site visit. As such, evaluation of townscape impacts was scoped out in this five-year evaluation.

The environmental evaluation often also considers the social impacts on severance, physical fitness and journey ambience (quality). However, as there were no outstanding issues from the one-year evaluation, these topics were also scoped out of the five-year evaluation.

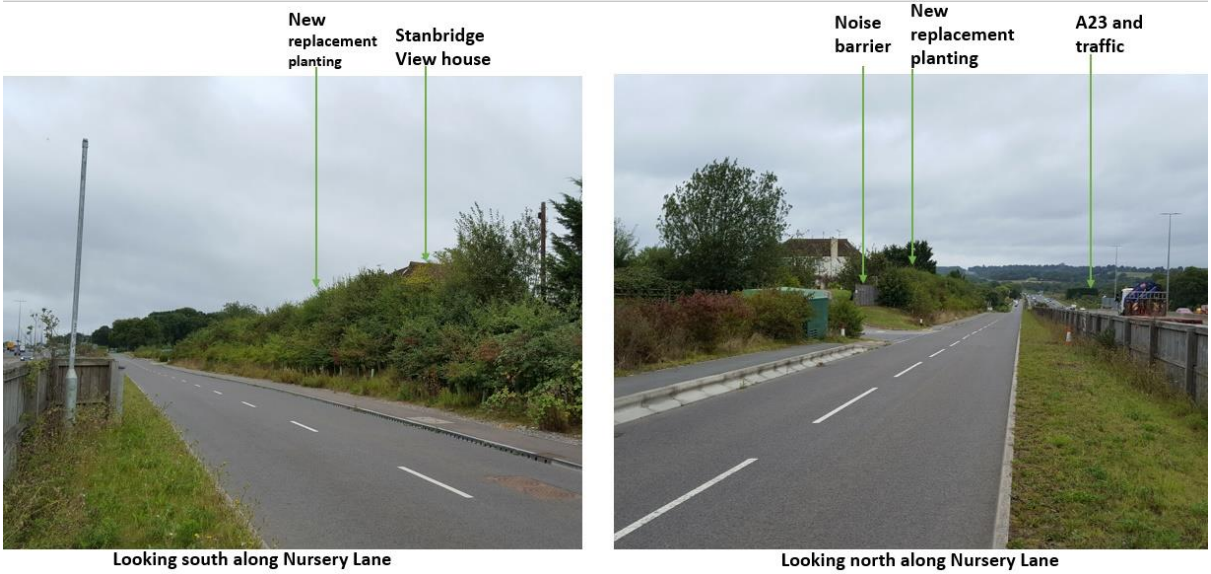
This five-year evaluation found that most of the impacts on noise, cultural heritage and biodiversity were broadly as expected. Landscape and water impacts were worse than expected because there had been insufficient maintenance work undertaken since opening. This was influenced by the collapse of the contractor - Carillion. The poor condition of the landscape mitigation meant that there was a risk that environmental commitments for ongoing management of habitats were not being fulfilled. Air quality impacts were better than expected because observed traffic flows at five-years after were lower than forecast.

Noise

The project appraisal predicted that properties and other noise sensitive receptors located adjacent to the A23, and associated slip roads would experience a slight increase in noise levels by the design year. This was predicted due to the removal of the junction at Slaugham and alignment changes on the A23. Overall, the project was expected to have a slight adverse impact on noise.

The environmental assessment undertook a scoping exercise to identify the potential for noise impacts from the project. It concluded that noise levels would, in general, improve near the proposed project due to the introduction of low noise surface in the opening year. However, in the design year, a greater number of properties were predicted to experience noise increases. Such noise increases were expected to be at worst minor adverse but not significant. The five-year evaluation confirmed that the low noise surfacing and noise barriers (key noise mitigations of the project) were implemented as expected.

Figure 16 Mitigation for noise impacts: new barrier and replacement vegetation adjacent to Stanbridge View at five years after



Source: Five Years After Evaluation visit, September 2019

Local traffic noise impacts were also evaluated by comparing forecast with observed post project traffic flows. An assumption was made that the local noise climate would be as expected if observed traffic flows were within 25% more or 20% less than predicted. Based on the available traffic flow data the observed flows are lower than forecast by up to 15%. This is within the 20% threshold and suggested that the effects of the project on the noise climate along the A23 were likely to be as expected.

Air quality

The appraisal reported that all assessed properties would experience a deterioration in air quality due to the widening of the A23 from Handcross to Warninglid. However, pollutant concentrations would remain well below air quality standard[19] levels. The appraisal reported that as a result of the project, minor changes in the traffic flows due to the removal of the junction at Slaugham and the resulting reassignment of the traffic, would cause marginal changes in the air quality. The environmental assessment reported that the impact of the project on noise would be neutral and insignificant in the long-term

Mid Sussex District Council local air quality monitoring data[20] from the closest air quality monitoring location to the project (Smugglers End), showed a NO_2 reading of 26.2ug/m3 in 2018. This meant that concentrations of NO_2 around the project appeared to be below the air quality threshold.

Based on the information available (differences between the predicted and observed traffic flows), the one-year evaluation concluded that the effects of the project on local air quality were likely to be better than expected

An evaluation of local air quality has also been conducted by comparing forecast with observed post-project traffic flows. An assumption was made that if observed after opening traffic flows vary by more than +/- 1,000 AADT from those predicted

[19] https://uk-air.defra.gov.uk/air-pollution/uk-eu-limits
[20] Air Quality report link: https://www.midsussex.gov.uk/media/4551/2019-air-quality-annual-statement-status-report.pdf

in the environmental assessment, it would be considered that air pollutant concentrations are likely to be either ‘higher’ or ‘lower than’ expected. Data available for AADT (flows) suggested that there were 12,692 flows less than predicted. Based on the available information, the effects of the project on local air quality were likely to be ‘better than expected’, although more detailed analysis would be required to confirm.

Greenhouse gases

The appraisal reported that over the 60-year appraisal period, the predicted amount of carbon emissions would be higher with the project due to changes in the volume of traffic. The change in carbon emissions in the opening year was estimated to be 743 tonnes, while the change in emissions over a 60-year appraisal period was estimated to be 54,409 tonnes.

It was not possible to effectively evaluate greenhouse gas emissions of the project because to replicate the extent of the original appraisal we would require forecast and observed traffic data for all the road links used in the appraisal study area. This data was not available and so we focussed just on the project extent[21].

Observed traffic volumes were lower than forecast along the project extent. This suggested that greenhouse gas emissions were likely to be lower than forecast along this section of the project. However, we did not have sufficient forecast speed and HGV data to be able to quantify or measure the effect of these changes or what impact this might have had on our conclusion.

Landscape and Townscape

The environmental appraisal reported that the proposed changes to the landscape due to the project, i.e., the removal of Slaugham Junction, widening of the carriageway, changes to the horizontal alignment and alterations to proposed position and height of earthworks, would lead to a 'slight adverse' impact. It reported that the project would result in the loss of the tree-covered central reserve and encroachment onto the National Trust land. There would also be localised adverse impacts on the High Weald Area of Outstanding Natural Beauty[22]. The proposed access to East Park properties and Stanbridge Place, culvert works, and pond access roads were expected to cause localised impacts to landscape outside the road corridor.

Our evaluation confirmed that as expected, the replacement of the previously vegetated central reserve with a vertical concrete barrier and use of the extra width to accommodate the widened carriageway had helped to minimise land take. It had also helped accommodate the slip roads at that northern end of the project (Handcross) and minimised impacts beyond the highway boundary. However, the new concrete central reserve and new timber noise and environmental barriers had[23] increased the sense of urbanisation[24] and opened views of the road. New mitigation planting had been provided to help reduce the impacts of the project.

[21] We don’t normally have observed data for the whole appraisal area, so we would usually recalculate a forecast and a new observed emission along a section of the project where we do have data, usually just the project extent. We would then comment on its accuracy. For this project we didn’t have the necessary speed and HGV data to enable us to do this.
[22] https://landscapesforlife.org.uk/about-aonbs/aonbs/high-weald
[23] View of A23 before construction in 2011 https://goo.gl/maps/gwAQw3G965bnq3v58
[24] View of A23 in 2021 https://goo.gl/maps/SkZn1JdtnUnvBHpn7

However, whilst some new landscape plots were establishing, there were many examples of failed planting and poor establishment. Weeds were widespread in many of the plots and following the collapse of the contractor Carillion there was little evidence of recent management. If maintenance is not improved, there was a risk that the mitigation planting would not establish as well as expected and design year objectives would not be met. Overall, at five-years after, it was considered that the impacts were worse than expected.

Figure 17 Slow growth in vegetation plot non replacement of failed trees near East Park at five years after.

Source: Five Years After Evaluation visit, September 2019

Heritage of historic resources

The appraisal stated that there would be direct construction impacts on three known cultural heritage sites of local importance. There would also be an impact at one site of national importance on either side of the road at Slaugham junction and in the River Ouse floodplain. A small area of Nymans Gardens (Registered Historic Garden) was deemed to already be compromised by the construction of an existing access track. The potential impact of the project on the gardens was neutral. Overall, the assessed impacts on the heritage resources were expected to be slightly adverse.

The one-year after evaluation confirmed that the impacts of the project on historic monuments and buildings including the listed buildings at Nymans and Slaugham Place and historic landscapes were as expected. Landform and retained vegetation had provided a buffer to minimise the visual impacts. However, at that time there was insufficient information available to evaluate impacts to archaeology and it was recommended that this was revisited at five-years after.

Our five-years after evaluation reviewed the available documentary evidence and confirmed that preliminary archaeological (paleoenvironmental) works had been undertaken before construction as expected. However, it was expected that a watching brief would be implemented during construction to ensure any unexpected archaeology encountered would be managed correctly. We were

unable to find any information on the outcome of the watching brief and so were unable to comment on anything that may have been found.

Overall, the impact on cultural heritage was as expected although the absence of information on the outcome of the watching brief means that some doubt remains.

Biodiversity

The appraisal anticipated that the project would result in the permanent loss of some woodland and scrub, including along the highway verge and a small area of Ancient Woodland in the Orange Gill Woods Site of Nature Conservation Interest. This was expected to lead to an adverse impact on protected species (e.g., dormice and bats - Barbastelle's, Bechstein's and Natterer's), and some bird species whose conservation was of concern[25] due to loss and severance of habitat. The project was expected to include extensive habitat compensation and mitigation measures. These included substantial replanting and habitat creation; improved management of retained ancient woodland and the construction of new wildlife crossings. Constructions works were also programmed to avoid undertaking activities at sensitive periods of the year, e.g., to avoid the bird nesting season. These proposals were likely to reduce the area of habitat affected and direct impacts on species. However, the project was still expected to result in the loss of habitats and predicted to result in an overall impact of moderate adverse.

The one-year evaluation reported that ecological mitigations provided by the project appeared to have been implemented as expected. However, no post construction monitoring information was available to confirm their effectiveness. Our five-year after evaluation reaffirmed these findings. The predicted impacts on biodiversity had arisen but the ecological mitigation had been implemented largely as expected. The loss of woodland in the High Weald Area of Outstanding Natural Beauty had been minimised by the use of the original central reserve as a running lane and encroachment into the Orange Gill Woods had been minimised with a retaining wall. Native hedgerows had been transplanted and wildlife crossings provided. However, at five-years after, the contractor Carillion had collapsed and as was the case at one-year after, information on the proposed aftercare monitoring was unavailable. It was still not possible to confirm how effective the mitigation had been. Our evaluation site visit confirmed that there had been little maintenance, and this had affected the condition of many of the new habitats and planting plots. At five-years after, a programme of remedial works was under development to rectifying the outstanding issues. Provided these works improve the condition of the biodiversity mitigation, it was considered that the design year objectives could still be met as expected.

[25] https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/uk-conservation-status-explained/

Figure 18 Animal crossings and monitoring in the River Ouse Valley

Source: Five-year evaluation visit, 11th September 2019

Water environment

The appraisal reported that the project crossed two named watercourses: River Ouse and Anne's Wood Stream. It was expected that the project would provide benefits through a new improved drainage system which would include new pollution control facilities such as balancing ponds and oil interceptors. The new drainage system would improve the management of spillages and provide an overall slight beneficial outcome for water resources.

The one-year evaluation concluded that the new drainage system and pollution control measures had been implemented as expected. Although there were some maintenance issues, the new mitigation appeared to be functioning as expected. However, it was recommended that these issues were reconsidered at five-years after.

At five-years after, a visual inspection of surface drainage features was carried out as part of our evaluation site visit. The visit confirmed that although the drainage network appeared to be functioning there had not been any recent maintenance. The balancing ponds that were intended to provide additional storage and attenuation capacity to manage the extra surface water run off resulting from the road widening were heavily overgrown with trees and other vegetation. The ponds were also intended to provide some additional biodiversity value but Typha Latifolia[26] - a vigorous and invasive plant - had swamped many of the ponds. This was affecting the diversity and appeared to be impacting on the flow of water through the ponds. It was considered that the absence of maintenance was beginning to adversely affect the efficient operation of the ponds. If an appropriate management regime is implemented the overall design year drainage outcomes should still be met. However, until that happens the outcome at five-year after was worse than expected.

[26] https://www.rhs.org.uk/plants/18566/typha-latifolia/details

Figure 19 Heavily vegetated pond with trees

Pond with clear water at one year after (Source: One Year After Evaluation Report, March 2017)

Heavily vegetated at five years after (Source: FYA Evaluation visit, 10 September 2019)

Overview

The results of the evaluation are summarised against each of the Transport Appraisal Guidance[27] environmental sub-objectives and presented in Table 6. In the table we report the evaluation 'as expected' if we believe that the observed impacts in the five-year evaluation were as predicted in the appraisal. We report them as 'better or worse than expected' if we feel the observed impacts were better or worse than expected.

Table 6: Environmental impacts

Sub Objective	AST Score	Five-year evaluation outcome	Five-year evaluation summary
Noise	Net benefit	As expected	Low Noise Surfacing and noise barriers had been installed. Traffic levels were found to be lower than forecast by up to 15%. This suggested that the impact on the noise climate from traffic was likely to be 'as expected'.
Air Quality	Slight benefit	Better than expected	Air quality monitoring data for 2019 suggested that there were no air quality issues in the vicinity of the project. Traffic levels were found to be lower than forecast. This suggested that the impact on the local air quality was better than expected.
Greenhouse Gases	Overall increase in GHGs (NPV+ -£2.24million)	N/A	Observed traffic flows were lower than forecast along the project extent suggesting that the impact of the project was better than expected. However, the absence of key data meant that the impact could not be quantified.

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

Sub Objective	AST Score	Five-year evaluation outcome	Five-year evaluation summary
Landscape	Adverse	Worse than expected	Mitigation had been provided but there was no evidence of recent maintenance and many of the planting plots were in poor condition. There was a risk that design year outcomes would not be met.
Heritage of historic resource	Slight Adverse	As expected	Preconstruction archaeological investigations had been done and the observed impacts on the settings of cultural heritage such as historic buildings were all likely to be as expected.
Biodiversity	Moderate Adverse	Likely to be as expected	Habitats and species mitigations were implemented as expected. However, poor maintenance and aftercare could delay or risk the delivery of the benefits of the mitigation.
Water Environment	Slight beneficial	Worse than expected	The new drainage network and pollution control systems were provided as planned. However, the balancing ponds were heavily overgrown with trees and other vegetation which could affect their performance. An appropriate management regime is required if the overall design year outcome is to be met.

7. Value for money

Summary

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

The project was delivered above the original construction budget, at a cost of £82 million compared to the forecast of £77 million[28]. In the first five years, the road provided additional capacity to support more road users, whilst improving the safety of those journeys. If this trend continues, the project is reforecast to deliver £1 million of safety benefits over the 60-year period[29]

The route has made journeys quicker for road users travelling across all time periods. Journey time benefits made up most of the anticipated monetised impacts of this project. The appraisal forecast significant traffic growth and improving journey times; the observed data suggested much more modest traffic growth accompanied by faster journey times.

Overall, the evaluation indicated that in the first five years this investment is on track to deliver the value for money anticipated over the 60-year life of the project. If the journey time trends observed within the first five years continue, and without further benefits optimisation the project is expected to deliver high value for money over the 60-year period[30].

Forecast value for money

An economic assessment is undertaken prior to construction to determine a project's value for money and inform the business case. The assessment is based on an estimation of costs and benefits. The impacts of a project such as journey time savings, changes to user costs, safety impacts and some environmental impacts can be monetised. This is undertaken using standard values which are consistent across government. The positive and negative impacts over the life of the scheme[31] are summed together and compared against the investment cost to produce a benefit cost ratio (BCR). The monetised impacts are considered alongside additional impacts which are not able to be monetised, to allocate the project a 'value for money' category.

The monetised benefits forecast by the appraisal which supported A23 Handcross to Warninglid business case are set out in Table . 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.

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

Table 6 - Monetised benefits of the project (£ million)

	Forecast (£M)	% forecast monetised benefits[32]	Evaluation approach
Journey times	£287	105%	Re-forecast for the project area only (not the wider area) using observed and counterfactual[33] traffic flow and journey time data.
Vehicle operating costs	-£32	-12%	Re-forecast using observed and forecast traffic flow and journey time data.
Journey time & VOC during construction and maintenance	£0	-0%	Not evaluated (assumed as forecast)
Safety	£2	1%	Re-forecast using observed and counterfactual[34] safety data for project extent and wider area,
Carbon	-£4	-1%	Monetised benefits assumed as forecast.
Indirect tax revenues	£21	8%	Re-forecast using observed and forecast traffic flow and journey time data.
Total present value benefits	**274**		

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

Evaluation of costs

The project was delivered slightly above the original construction budget, at a cost of £82 million[35] (see table 7).

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

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

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

[34] We compared observed trends with an estimation of the trends if the road had remained a conventional motorway (i.e., a 'counterfactual')

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

Table 7 - Cost of the project (£ million)

	Forecast (£M)	% of forecast costs	Evaluation approach
Construction costs	77	90%	Current estimate of project cost
Maintenance costs	9	10%	Not evaluated (assumed as forecast)
Total present value costs	**86**	**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 reforecast these for the 60-year project life. It is not proportionate to replicate modelling undertaken at the appraisal of a project or to monitor benefits over the entire lifecycle, so we take an assessment based on the trends observed over the first five years of operation and estimate the trend over the project life, based on these observations. This provides a useful indication and help to identify opportunities for optimising benefits. In instances where it was not feasible to robustly compare forecast and observed impacts, the findings have been presented with relevant caveats.

Monetised journey time benefits

As can be seen in Table , journey time benefits made up most of the justification for investing in the A23 Handcross to Warninglid.

As previously noted, within the first five years the forecast level of journey time benefits are on track to be realised.

If the trends observed at the fifth year continue over the 60-year period, without any further action to optimise benefits, the monetised impact on journey times, for those using the road, would be £286 million[36]. 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.

Other reforecast impacts

We reforecast total safety benefits to be £1 million. This figure relates to the benefit on the project extent and wider model area over 60-years. The reforecast is lower than the appraisal forecast which fits with the findings in section 5 where we saw an improvement in the collision rate along the project extent but an increase in the number of personal injury collisions in the wider model area.

There are two further impacts associated with the changes in numbers and speeds of vehicles – indirect tax revenues and vehicle operating costs. Indirect tax revenues are the benefit to the government (and therefore society) of the additional tax income from the additional fuel consumed due to increased speeds and distances travelled. This was forecast to be negative. Although more vehicles were

[36] This is against a counterfactual where we have estimated what the journey time is likely to have been if the road had remained a dual carriageway.

forecast and they were forecast to be travelling at higher speeds, this expected reduction in tax revenues is likely to be due to the vehicles being forecast to travel at a more fuel-efficient speed and therefore using less fuel and paying less tax[37]. We have reforecast that the impact would be smaller than expected, and an increase in tax revenues (£8 million). The impact is small because our evaluation has shown that there wasn't as much traffic growth as forecast and the change in speeds was mixed, with some vehicle types moving to less fuel-efficient speeds at in some time periods.

Vehicle operating costs refer to the fuel and other costs borne by the user (such as the wear and tear on vehicles). This generally increases with increased distance travelled. There was a small benefit forecast. Based on the changes we have seen in our estimate of fuel consumption and indirect tax revenue, we estimate the outturn impact to be a marginal disbenefit of -£12 million.

Impacts assumed as forecast

The evaluation has not been able to reforecast the monetary value of journey time reliability[38], noise and carbon benefits[39], and instead these were reported as forecast. For noise and carbon impacts, this assumption is conservative because lower than forecast traffic flows are likely to mean that these impacts are better than forecast[40].

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

Overall value for money

The economic impacts show that the journey time benefits were slightly lower than forecast, however they are still high. Similarly, the five-year evaluation reforecast of safety benefits was lower than the original forecast by roughly half. Despite this, we saw a positive impact on road safety on the project extent.

We calculated at the five-year evaluation that the A23 Handcross to Warninglid was considered high value for money.

[37] Refer to Transport Analysis Guidance (TAG) unit A1.3

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

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

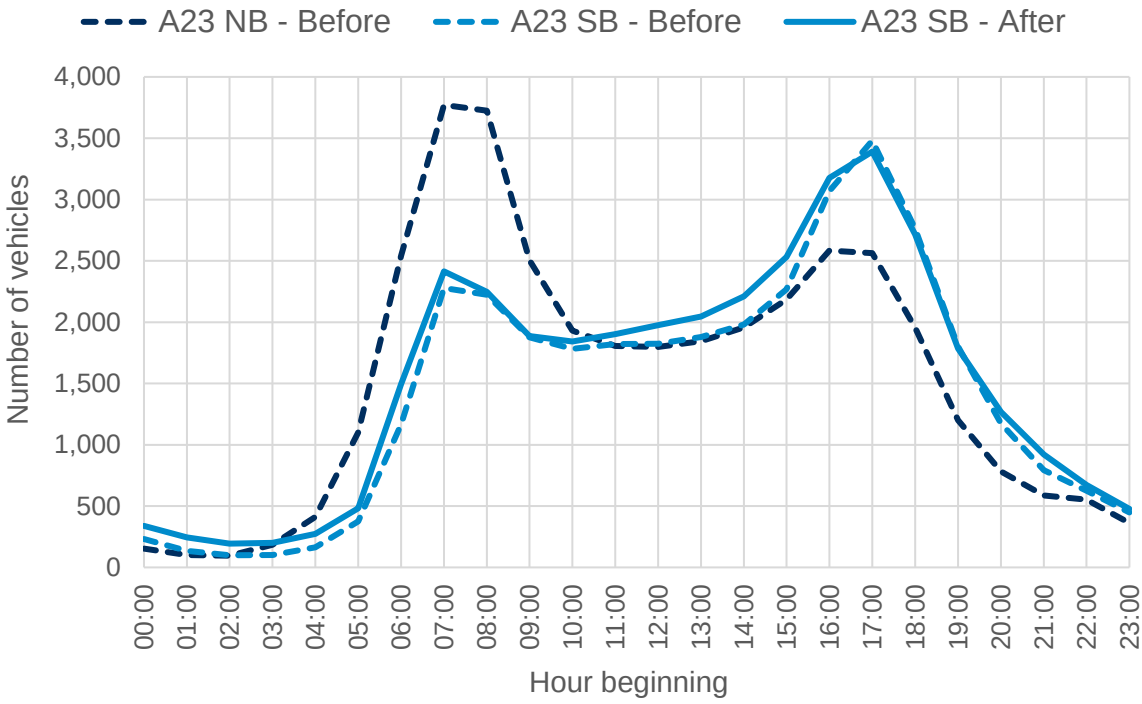
[40] Refer to section 6 for further detail on noise and greenhouse gas impacts.

Annex 1: How are traffic flows distributed across the day?

We have look at the pattern of traffic flows across the day and the project does not appear to have changed this.

We analysed WebTRIS traffic flows across a typical weekday to determine whether traffic growth has occurred uniformly or at certain times of day, as shown in Figure 20. As before, traffic flows are taken from the A23 (north of the project) due to data availability issues, but they are expected to be consistent with flows on the project itself. Data is shown before (March 2012) and after the project opened (September 2019). Data was not available for the A23 northbound after the project opened, and as such the before northbound data is shown without its counterpart. Given the southbound data shows little difference in profile between before and after it is reasonable to assume the northbound data would do likewise.

Figure 20 Change in Average Weekday Traffic flows



We can see that the route is tidal; the A23 northbound carries a higher amount of traffic in the AM peak compared to the PM peak, with the southbound data showing the reverse pattern. In both directions the AM peak is between 7am and 9am, whereas the PM peak is between 4pm and 6pm.

Annex 2: Counterfactual Methodology

Safety counterfactual methodology

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

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

Amended Data Collection Method

Revised method for identifying collisions that occurred on the network.

Only validated STATS19 information is used for reporting purposes.

Adjusting for Traffic Flows

Baseline traffic flows are an important factor when determining the counterfactual. We now assume that without the changes made to the network, the trends would follow regional background traffic growth patterns.

We can now calculate the collision rate for the busiest stretches of conventional motorways.

Better Differentiation between different types of Motorway

The existing methodology only had one definition of motorway.

The new method allows us to differentiate between conventional motorways, conventional motorways with high traffic flows and smart motorways.

Assessing Regional Trends

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

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

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

Appendix B

Incident reporting mechanisms

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

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

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

Appendix C

Unadjusted collision severity

The project extent is covered by Sussex police constabulary who transferred from Stats19 to CRASH in April 2019.

Table shows the unadjusted collision severities on the project extent:

Table 8 - Unadjusted collisions by severity for project extent

Year Order	Serious	Slight
5Yr Before	2	15
4Yr Before	3	14
3Yr Before	4	20
2Yr Before	2	15
1Yr Before	3	20
1Yr Construct		7
2Yr Construct	1	12
1Yr After	1	6
2Yr After	1	9
3Yr After	2	9
4Yr After	2	7
5Yr After	2	6

Source: STATS19: 1st June 2007 to 5th October 2019

The project extent is covered by Sussex police constabulary who transferred from Stats19 to CRASH in April 2019.

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

Table 9 - Unadjusted collisions by severity for wider area

Year Order	Fatal	Serious	Slight
5Yr Before		1	7
4Yr Before		2	4
3Yr Before		5	5
2Yr Before		1	10
1Yr Before		3	6
1Yr Construct		5	13
2Yr Construct		5	11
1Yr After	1	1	10
2Yr After		3	13
3Yr After		4	11
4Yr After		2	7
5Yr After		5	6

Source: STATS19: 1st June 2007 to 5th October 2019

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