Smart motorways

Incident and infrastructure investigation

M1 Junction 30 to 35

Highways England response

highways england

Contents

Executive summary

Last year's *Smart motorway evidence stocktake and action plan* sought to gather the facts on smart motorway safety and set out an action plan to ensure smart motorways are as safe as possible.

The Action Plan included an action to investigate clusters of incidents at locations on the M6 and M1. An evidence-led independent incident and infrastructure investigation was commissioned by us at the four locations and a report produced for each. These investigations produced a series of potential interventions or control measures for the specific issues that have been linked to collisions and incidents. The schemes that were reviewed are:

- M6 J5 to 6 dynamic hard shoulder (part of M6 J5 to 8 scheme)
- M1 J10 to 13 dynamic hard shoulder scheme
- M1 J30 to 35 all lane running (part of M1 J28 to 35a scheme)
- M1 J39 to 42 all lane running scheme

We have now reviewed the potential interventions, proposed by the independent review, to assess their viability and likely impact.

This report is our response to the independent infrastructure and incident investigation[1] report produced as part of the DfT Smart Motorway Safety: Evidence Stocktake and Action Plan, and addresses the M1 between junctions 30 and 35 in both directions. Equivalent reports have been produced for the other three locations.

1 *Published separately*

M1 J30 to 35 investigation - response

This section of the M1 has a number of operational regimes. Junction 30 to 31 is all lane running (ALR), including through the junctions. Junction 31 to 32 has four lanes and a permanent hard shoulder and junctions 32 to 35 have ALR. Junction 32, 33 and 34 have three lanes and a hard shoulder through the junctions. Junction 32 comprises the M1 / M18 interchange and extends for approximately one mile. The main carrigeway does not have lighting and this was not changed as part of the smart motorway schemes.

We have already completed some of the recommendations and agreed some of the other recommendations, but not all. Where we have not implemented recommendations, the reasons are set out in this report. All of the recommended measures will require further design work.

These measures are in addition to the installation of a stopped vehicle detection system and additional emergency area approach signs which will be completed on the ALR sections in 2021.

Actions

A summary of the recommendations from the independent review report are set out on the next page. Alongside these actions are the actions we have already completed, are taking forward and those not being taken forward.

Independent review		
Key findings	**Recommended actions**	**Response actions**
J33 northbound exit slip road cluster of collisions including shunts and on wet road surface	Traffic signal timings to reduce queues at roundabout	**Keep under review:** a major scheme to improve traffic flows on the A630 Sheffield Parkway, will incorporate a number of improvements aimed at reducing congestion at Junction 33 on the M1. The scheme, funded by Rotherham Metropolitan Council, is due to be complete in June 2022. It will address existing and forecast issues of traffic congestion, improve safety, reduce the overall maintenance liability and deliver improvements in air quality. This is predicted to reduce congestion on J33 northbound exit slip road. The completed scheme will be monitored to see if any further action is required.
	Queue detection system re-calibration	**Keep under review:** as above, the Rotherham Metropolitan Council scheme is predicted to reduce congestion on the J33 northbound exit slip road. The completed scheme will be monitored to see if any further action is required.
	Pavement skid resistance and / or increase Investigatory Level	**Complete:** skid resistance of the road surface in lane 1 and exit slip road checked and is well above the 'Investigatory Level' as defined in the technical standard.
	Review the drainage capacity and maintenance cycle	**Complete:** a maintenance plan implemented to resolve a previous flooding hotspot has resolved the issue.
	Alternative exit slip road arrangement	**Keep under review:** the Rotherham Metropolitan Council scheme is predicted to reduce congestion on the northbound exit slip road. The completed scheme will be monitored to see if any further action is required.

Independent review		
Key findings	**Recommended actions**	**Response actions**
J32 to 31 lane change collisions	Lane destination markings on road	**Not taken forward:** it is not appropriate to install lane destination markings as they are only used when a lane leaves the carriageway. To do so here is likely to discourage non-exiting drivers from using lane 1.
	Supplementary advance direction sign approach to J31 southbound	**Being taken forward:** The installation of additional Advance Direction Sign and the installation of additional advanced hazard road markings to be progressed.
	Provision of hazard road markings	
J31 to 32 cluster of collisions in wet conditions	Drainage capacity and maintenance cycle	**Completed:** work has been undertaken to resolve a flooding problem on the northbound entry slip road.
North of Woodall MSA to J31 - cluster of live lane breakdown collisions	Add an emergency area to reduce places of relative safety spacing	**Being taken forward:** an additional emergency area will be installed. Due to be completed by end of July 2022.
	Aid forward visibility of the carriageway ahead improved by further removing vegetation in nearside verge	**Being taken forward:** the maintenance regime will be amended, subject to environmental considerations.
Pedestrian incidents and local risk factors	Use Walking Cycling and Horse Riding (GG 142) assessment process to review pedestrian facilities / access to motorway	**Being taken forward:** the installation of anti-access fencing at the locations identified will prevent access to the motorway for pedestrians.
	Consider suicide prevention measures	**Being taken forward:** carry out feasibility and preliminary design of suicide prevention measures at five structures. Carry out further investigation and scoping work at a further five structures on this stretch.
Technology availability	Investigate wider data set and reasons behind message sign and signal availability issues in J31 to 32 and J32 to 35 sections	**Keep under review:** availability of variable message signs has been improved through replacement of power supply units.

Introduction

Scheme background

The section of the M1 between junction 30 Barlborough Interchange (J30) and junction 35 Thorpe Hesley Interchange (J35) comprises of elements of M1 junction 28 to 31 and M1 junction 32 to 35a smart motorway ALR schemes, and the M1 junction 31 to 32 smart motorway infill scheme. The infill scheme provided mandatory signalling on an existing four lane section with a permanent hard shoulder.

The smart motorway schemes between junction 28 and 35a became operational at different times with junction 28 to 31 becoming operational in April 2016, prior to which the junction 31 to 32 scheme was completed. The junction 32 to 35a scheme was completed in April 2017 bringing the full 33 miles of smart motorway into operation.

For the purpose of this study, collision data has been analysed from the three years prior to each scheme start of construction date, and the latest available validated data from each scheme's opening date to December 2019.

Methodology

Identification of issues

The incident and infrastructure investigation report for M1 J30 to J35 ALR scheme was reviewed to understand the issues. A root cause analysis was undertaken to understand the root cause of each of the collision hotspots. Other data and evidence reviewed to assist with this understanding included:

- Source data, where necessary, including historic scheme operational safety analysis (Road Safety Audit (RSA) stage 4, specific scheme safety reviews, Post Opening Project Evaluation (POPE) reports
- Targeted CCTV analysis to understand traffic conditions that may be influencing the clusters
- Discussions with the Regional Operations Centre about each location

Potential interventions review

The positives and negatives of each proposed mitigations were reviewed, including:

- Likely impact on safety
- Estimated cost range
- Duration of applicability and timescales to implement the mitigation
- Other dependencies, for example need for authorisations, change to policy etc

Where the potential interventions are not feasible, we have proposed and assessed alternative interventions.

Alternative interventions

Where necessary, we have proposed alternative mitigations to target the root cause of the collision cluster. We have reviewed these against the same factors as the initial potential interventions.

M1 J30 to 35 investigation - response

Review of potential interventions

The independent review analysed collision data from the three years prior to the scheme construction date, and the latest available validated data from the scheme opening date to December 2019. Given the different operational regimes the collisions have been considered in three sections:

- Junction 30 to junction 31 including through junction 31, ALR section
- Junction 31 to junction 32 including through junction 32, four lanes / three lanes with permanent hard shoulder (controlled motorway)
- Junction 32 to junction 35, ALR section

The number of serious injury collisions per year has increased across both ALR sections. Fatal injury collisions have increased from one in three years, to three in three years, for the junction 32 to junction 35 section. Accordingly, the ratio of fatal and serious injury collisions has increased in the after period for both schemes.

Collision cluster locations were identified on the northbound approach to junction 33 between junction 31 and junction 32 and between Woodall motorway service area and junction 31.

J33 northbound exit slip road cluster of collisions including shunts and on wet road surface

Issue identified

Of the sixty-three collisions between junction 32 to 35, eighteen occurred between junction 32 and 33 northbound.

The majority of collisions occurred on the approach to junction 33, with a total of fifteen shunt collisions being recorded.

Figure 1 M1 J33 northbound exit slip road (shown on lower portion of image) © Google

In addition, eight of the eighteen collisions on this link occurred on a wet road surface. These were concentrated on the approach to junction 33.

Some potential causes include:

- The high proportion of shunt collisions between junction 32 and 33 northbound (83%), and the associated collision descriptions, highlight a potential issue with congestion and queuing on the exit to junction 33, with queues backing up onto the mainline, particularly during the morning peak.
- The significant proportion of incidents occurring on a wet road surface (44%), suggests there could be an issue with the wet skid resistance of the road surface or poor drainage.

Potential interventions from the independent review

Potential intervention 1

The following interventions may alleviate any congestion issues and reduce the likelihood of congestion occurring, leading to reduced number of shunt type collisions:

- the junction 33 traffic signal timings should be reviewed to examine whether any slip road queues could be reduced
- the motorway signalling should be reviewed to ensure it is providing suitable queue protection, including for queues on the exit slip road
- reconfiguration of the junction should be considered to increase queuing capacity and potentially reduce queuing on the mainline

Potential intervention 2

The following interventions may alleviate any road surface or drainage issues and reduce the likelihood of wet road collisions:

- The skid resistance of the carriageway should be investigated
- The presence of any flooding hotspots should be reviewed

Alternative interventions

Alternative intervention 1

A major scheme to improve traffic flows on the A630 Sheffield Parkway will incorporate a number of improvements aimed at reducing congestion at Junction 33 on the M1. The project, funded by Rotherham Metropolitan Council, received approval in Autumn 2015.

The proposed scheme will provide an additional lane in each direction of the 1.3 mile section of the A630 Parkway between the M1 junction 33 and the Catcliffe Interchange. Delivery of this scheme has begun, and is scheduled to be complete in June 2022. The scheme will address existing and forecast issues of traffic congestion, improve safety, reduce the overall maintenance liability and deliver improvements in air quality.

The M1 suffers from delays, and the stretch between junctions 33 and junction 35 is recognised in the top 20% of vehicle hours delay over our network. Although the junction 32 to junction 35a smart motorway scheme has delivered additional capacity on the motorway mainline, the slip roads and motorway junctions have not been improved.

As part of Rotherham's scheme, the following highway alterations will be carried out:

- Widening Parkway to 4 lanes on immediate approach to J33
- Allowing 2 lane exit to Rotherway
- Associated lane designation changes
- Widening to 5 lanes on northern circulatory plus 2 dedicated lanes to Rotherway
- Widening the M1 Southbound exit slip road to 4 lanes
- Widening the M1 Northbound exit slip road to 4 lanes
- Lane designation changes on the south bridge
- Lane designation changes on Parkway internal

After the proposals being made to improve the Sheffield Parkway and junction 33 of the M1, a further proposal has been made to construct a motorway service area (MSA). The proposed development will be located on land to the west of the M1 junction 33, both to the north and south of the motorway and linked via the existing underpass. Access to the MSA is proposed via junction 33, with a direct entry to the site from the circulatory carriageway, with traffic returning via the Sheffield Parkway or Rotherway.

As part of Rotherham Metropolitan Council's scheme, it is proposed to widen both the northbound and southbound exit slip road, at the M1 junction 33, to four lanes.

M1 J30 to 35 investigation - response

The proposed scheme is forecast to reduce the delay on every approach at the M1 junction 33, with the biggest impacts in the morning peak from the M1 off-slips and the biggest impacts in the afternoon peak from the A630 Parkway.

The alternative intervention detailed above will provide significant improvements to all aspects of junction 33, and will result in reductions in congestion when completed.

Actions

Alternative intervention 1, Rotherham Metropolitan Council's scheme to improve M1 Junction 33 provides suitable solutions to the issues identified. The scheme will provide improvements to signal timings, road layout and queuing capacity. It is recommended no action is taken until the scheme has been completed and a period of monitoring has taken place.

A skid resistance survey, carried out on the 20 and 21 August 2020, included the following links: 1.25 miles in advance of the M1 northbound Junction 33 and the full length of the northbound exit slip road. This confirmed the skid resistance of the road surface in lane 1 as being well above the required level. This covers the appropriate sections of carriageway and therefore no further action is required.

We also carried out a review of flooding hot spots (FHS) to look at any issues relating to drainage capacity and the maintenance cycle of drains being cleared. This review included the northbound exit slip road. Flooding reported was identified as being generally caused by blinded gullies, where the gully cover has been blocked by material, preventing water from entering so it runs further down the carriageway. The FHS has been maintained in accordance with the maintenance plan and, as a consequence, no flooding has been recorded for several years. As a result, no further action is required.

Junction 31 to Junction 32 lane change collisions

Issue identified

Collision data has been analysed from the three years prior to the scheme opening date and the latest available validated data from the scheme opening date to December 2019.

Twenty-four injury collisions were reported in the three years prior to the scheme starting construction between junction 31 and junction 32, and twenty-eight from the scheme opening date to December 2019, with those collisions classified as serious injury increasing.

Increases in the number of collisions occurring on the northbound carriageway were mostly shunt type accidents. These seem to be linked to the construction period, when a number of lane closures and extensive traffic management reduced the capacity of the carriageway, leading to periods of slow moving or standing traffic.

Since the northbound carriageway reopened fully, the number of collisions has fallen significantly.

In contrast, the increase in collisions on the southbound carriageway has significantly included a large proportion of lane change collisions.

Potential causes

The junction 28 to junction 31 smart motorway scheme removed the southbound lane drop at junction 31, to provide four lanes through the junction, and revised the signing on the approach to the junction to reflect the exit slip road layout.

There has been an increase in collisions involving lane changing in the after period.

The exit sign on the southbound carriageway, located on an overhead gantry, ½ mile in advance of the junction, is positioned above lane 1 and partially above lane 2 rather than being offset to the left.

M1 J30 to 35 investigation - response

Hazard road markings are provided between the ½ mile and ¼ mile (secondary advance direction sign) only.

Figure 2 M1 J31 southbound ½ mile advance direction sign and hazard road markings between lane 1 and 2 © Google

All these factors have the potential to cause confusion for road users and may lead to unnecessary lane changes. The link has a relatively short weaving length of just 0.86 miles.

Potential interventions from the independent review

Potential intervention 1
The installation of lane destination markings on the road surface may assist road users to judge the road layout at junction 31, and reduce the likelihood of road users making unnecessary lane changes.

Potential intervention 2
The installation of an additional Advance Direction Sign in the nearside verge on the approach to junction 31 southbound, may assist road users to judge the road layout at junction 31. It will also reduce the likelihood of all road users making unnecessary lane changes and is considered the best option to address this issue.

Potential intervention 3
A hazard lane marking is in place on the southbound carriageway between the 1/2 and 1/4 mile gantries only. The extension of this marking may give better guidance for road users at junction 31. It would make them aware that there is a hazard ahead, discouraging them from making a lane change until they are sure, therefore reducing unnecessary lane changes and collisions.

Actions
We do not recommend intervention 1 as the introduction of destination road markings in lane 1 would discourage use by other traffic not required to take the exit, and potentially lead to more lane changes on the approach to the junction.

We are progressing interventions 2 and 3, subject to signing approval.

M1 J30 to 35 investigation - response

Junction 31 to Junction 32 cluster of wet collisions

Issue identified
Several collisions have been recorded over this section of the M1 when the road surface was wet.

Potential causes
A lack of drainage capacity and the maintenance cycle applied to the upkeep may be potential causes.

Potential interventions from the independent review

Potential intervention 1
Undertake a review of existing drainage provision including any identified flooding hot spots and site surveys during varying weather conditions to identify potential problems. If problems are identified, develop appropriate drainage and/or surfacing schemes to address.

Action
We completed work in October 2019 to resolve a flooding problem on the northbound entry slip road. Several gullies, catchpits and sections of both pipework and channel were cleared. The problem has not re-occurred because of the work.

In relation to these issues it is recommended no further action is required for 12 months; we will continue to monitor the situation.

North of Woodall MSA to J31 - cluster of live lane breakdown collisions

Issues identified

A cluster of six collisions on the northbound ALR section to the north of Woodall motorway service area (MSA) has been identified. These collisions involved five serious collisions and one fatal collision, including four live lane stops.

Figure 3 M1 Woodall MSA (at the bottom of the image) and emergency areas to the north (orange trapezoids at the top of image) © Google

Signing is in place for the Woodhall MSA and it operates 24 hours. It could reasonably be expected that the local MSA would reduce the number of live lane stoppages by providing an obvious set of facilities for road users in difficulty.

The vehicle breakdowns that have led to the vehicles stopping north of Woodhall MSA in a live lane have occurred seemingly at random, with no connection to the road layout or infrastructure.

The section is on a sweeping left-hand bend so nearside vegetation has the potential to restrict the ability of approaching drivers to see a stopped vehicle.

Potential causes

There is a no clear reason for the localised number of serious live lane collisions, all of which appear to be breakdowns, in this location. Adequate facilities exist at Woodhall MSA for road users to stop.

There is a long left- hand curve, just north of Woodhall MSA which may affect forward visibility.

Potential interventions from the independent review

Potential intervention 1

The provision of an additional emergency area serving the northbound carriageway, between Woodhall MSA and junction 31 should be considered.

Potential intervention 2

Enhanced maintenance, to reduce vegetation during the growing season, at this location, may aid forward visibility for all road users, reducing the likelihood of live-lane stop collisions.

Actions

Apart from the location and live lane stop involvement, no other clear link between the collision factors can be identified, which makes it difficult to suggest or recommend further focussed or specific measures. We will take forward interventions 1 and 2.

Pedestrian Incidents and local risk factors

Issues identified

The independent review identified that there have been a number of incidents involving pedestrians on the motorway, with a particular cluster between junctions 31 and 32. In addition, some bridges have also been identified as a cause for concern, with suicide incidents recorded at them.

There are public rights of way that run immediately adjacent to the motorway between junction 31 and 32 and converge at a bridge in order to cross the motorway.

Figure 4 Hardwick Lane bridge and adjacent public rights of way between M1 J31 and J32 © Google

Potential interventions from the independent review

Potential intervention 1
Review the pedestrian provision, fencing, signing and other deterrents. The large scheme process set out in GG 142 Walking cycling and horse-riding assessment and review would be a suitable structure for this exercise.

Potential intervention 2
Consider the suicide prevention toolkit. We have carried out site assessments for 12 structures on the M1 J30 to J35, and have identified 5 structures where feasibility and preliminary design of suicide prevention measures should be progressed. A further 5 sites require further investigation and scoping work to fully understand the issues before we can commit to further feasibility work on these sites.

M1 J30 to 35 investigation - response

Action
We have reviewed the study area to identify potential pedestrian ‘desire’ lines and areas where the M1 could be accessed in line with potential intervention 1. A desire on the part of pedestrians to access or cross the motorway represents a clear hazard to all road users. Intervention 1, provision of an additional emergency area, removes this hazard. We have carried out an identification process of where pedestrians may access the network and this has highlighted the area around Hardwick Lane bridge.

The installation of anti-access fencing at the location identified will mitigate access to the motorway for pedestrians. This work fits with the recommendations in the suicide prevention toolkit.

We have identified the points of access to the network in line with proposed intervention 1 and we will progress the proposal to provide anti access fencing at the most appropriate locations to remove access to pedestrians. We will progress feasibility work to identify suitable interventions on 5 of the structures on this stretch. We have carried out initial site assessments and have identified some potential improvements at the structures where incidents have been recorded.

Further investigation and scoping work will also be progressed at a further five structures and we will consider whether further measures are required.

Message sign and signal availability

Issues Identified
The independent review identified a need to investigate issues around signs and signal availability, and the reliability of technology on this stretch of the M1.

Figure 5 Signs and signals used on a section of smart motorway

Potential intervention

Investigate wider data set and reasons behind message sign and signal availability in J31 to 32 and J32 to J35 sections.

Action

A national issue existed around the availability of power supply units (PSUs) for variable message signs. There has been a period where faults, particularly on the M1 J32 to 35a section, were unable to be resolved due to spares availability. We have prioritised signs in ALR sections, and 21 power supply replacements on the ALR sections on the M1 J28 to 35a have been carried out since August 2020.

We will continue to prioritise resolution of these faults commencing with the highest priority locations.

M1 J30 to 35 investigation - response

Actions

We have identified a number of recommendations to take forward into delivery. We anticipate starting preliminary design of these proposals by summer 2021, with delivery of some minor works able to start in 21/22. More technically complex schemes, such as the provision of the new emergency area, will be delivered in 22/23.

We have already completed actions around skid resistance checks and solving a flooding hotspot. We have replaced the power supply units for 21 large variable message signs on the ALR sections on the M1 J28 to 35a to improve availability.

A summary of the recommendations from the independent review report are set out on the following page. Alongside these opportunities for improvement are the actions we have already completed, are taking forward and those not being forward in response to these recommendations:

Independent review		
Key findings	**Recommended actions**	**Response actions**
J33 northbound exit slip road cluster of collisions including shunts and on wet road surface	Traffic signal timings to reduce queues at roundabout	**Keep under review:** a major scheme to improve traffic flows on the A630 Sheffield Parkway, will incorporate a number of improvements aimed at reducing congestion at Junction 33 on the M1. The scheme, funded by Rotherham Metropolitan Council, is due to be complete in June 2022. It will address existing and forecast issues of traffic congestion, improve safety, reduce the overall maintenance liability and deliver improvements in air quality. This is predicted to reduce congestion on J33 northbound exit slip road. The completed scheme will be monitored to see if any further action is required.
	Queue detection system re-calibration	**Keep under review:** as above, the Rotherham Metropolitan Council scheme is predicted to reduce congestion on the J33 northbound exit slip road. The completed scheme will be monitored to see if any further action is required.
	Pavement skid resistance and / or increase Investigatory Level	**Complete:** skid resistance of the road surface in lane 1 and exit slip road checked and is well above the 'Investigatory Level' as defined in the technical standard.
	Review the drainage capacity and maintenance cycle	**Complete:** a maintenance plan implemented to resolve a previous flooding hotspot has resolved the issue.
	Alternative exit slip road arrangement	**Keep under review:** the Rotherham Metropolitan Council scheme is predicted to reduce congestion on the northbound exit slip road. The completed scheme will be monitored to see if any further action is required.

Independent review		
Key findings	**Recommended actions**	**Response actions**
J32 to 31 lane change collisions	Lane destination markings on road	**Not taken forward:** it is not appropriate to install lane destination markings as they are only used when a lane leaves the carriageway. To do so here is likely to discourage non-exiting drivers from using lane 1.
	Supplementary advance direction sign approach to J31 southbound	**Being taken forward:** The installation of additional Advance Direction Sign and the installation of additional advanced hazard road markings to be progressed.
	Provision of hazard road markings	
J31 to 32 cluster of collisions in wet conditions	Drainage capacity and maintenance cycle	**Completed:** work has been undertaken to resolve a flooding problem on the northbound entry slip road.
North of Woodall MSA to J31 - cluster of live lane breakdown collisions	Add an emergency area to reduce places of relative safety spacing	**Being taken forward:** an additional emergency area will be installed. Due to be completed by end of July 2022.
	Aid forward visibility of the carriageway ahead improved by further removing vegetation in nearside verge	**Being taken forward:** the maintenance regime will be amended, subject to environmental considerations.
Pedestrian incidents and local risk factors	Use Walking Cycling and Horse Riding (GG 142) assessment process to review pedestrian facilities / access to motorway	**Being taken forward:** the installation of anti-access fencing at the locations identified will prevent access to the motorway for pedestrians.
	Consider suicide prevention measures	**Being taken forward:** carry out feasibility and preliminary design of suicide prevention measures at five structures. Carry out further investigation and scoping work at a further five structures on this stretch.
Technology availability	Investigate wider data set and reasons behind message sign and signal availability issues in J31 to 32 and J32 to 35 sections	**Keep under review:** availability of variable message signs has been improved through replacement of power supply units.

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

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

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

If you have any enquiries about this publication email **info@highwaysengland.co.uk**
or call **0300 123 5000***. Please quote the Highways England publications code **PR83/21**.

*Calls to 03 numbers cost no more than a national rate call to an 01 or 02 number and must count towards any inclusive minutes in the same way as 01 and 02 calls.

These rules apply to calls from any type of line including mobile, BT, other fixed line or payphone. Calls may be recorded or monitored.

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

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

Highways England Company Limited registered in England and Wales number 09346363