Smart motorways Incident and infrastructure investigation M1 Junction 39 to 42 Highways England response



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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 / or 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 investigation¹ report produced as part of the DfT Smart Motorway Safety: Evidence Stocktake and Action Plan, and addresses the M1 between junctions 39 and 42 in both directions. Equivalent reports have been produced for the other three locations.

The M1 Junction 39 to 42 smart motorway scheme was a Highways England major project to improve six miles (10km) of the M1 to the west of Wakefield in both directions, aiming to provide additional capacity.

We will implement the majority of recommendations resulting from the independent review, as well as some additional measures identified though production of this report. We are now working on more detailed design work, to derive accurate cost estimates and delivery timescales. The small number of recommendations not being progressed were, upon further analysis, determined not to adequately address the identified causes of collisions.

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 this section in 2022.

Actions

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

¹ Published separately

Inde	ependent review	
Key findings	Recommended actions	Response actions
0.25 live lane breakdowns per mile per day	Add specific signing for exit slip road hard shoulders as places of relative safety	Being taken forward: we will add specific signing for exit slip road hard shoulders which could provide a place of relative safety as part of the stocktake action to increase the amount of approach signage to places to stop in an emergency. Due for completion September 2022.
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 unauthorised access to the motorway for pedestrians.
	Consider suicide prevention measures.	Being taken forward: we plan to install crisis signs at M1 J40 and carry out a detailed assessment of installing higher parapets and emergency telephone as well as examining CCTV coverage of bridges. A detailed feasibility study will be taken forward.
Cluster of collisions north of J39	Bend ahead warning signs	Being taken forward: a review of signing will be carried out as part of a broader feasibility study on the junction (see 'alternative exit slip road layout' on the next page).
	Overhead primary direction sign to reflect southbound lane drop	Being taken forward: change 1 mile Advance Direction Sign to a different approved sign.
	Explore provision of street lighting	Being taken forward: initial analysis suggests street lighting and high reflectivity markings/studs could result in accident savings. We will carry out a detailed feasibility study and review environmental effects.
	Lane destination markings and hazard lines for southbound lane drop	Being taken forward: hazard lines will be extended, subject to necessary approval. Surface lane destination markings will not be progressed as this would be unique to this stretch of the M1, and as such potentially lead to confusion for motorists.

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Introduction

Scheme background

The M1 Junction 39 Durkar Interchange (J39) to 42 Lofthouse Interchange (J42) smart motorway scheme was a major project to improve six miles (10 km) of the M1 to the west of Wakefield in both directions, providing additional capacity.



This was through the conversion of the hard shoulder for use as a permanent traffic lane (known as all lane running) and the introduction of enhanced on-road technology to manage traffic flow. Lighting changes were made as part of the scheme and are described in an annex to this document.

The scheme was completed in two stages, J39 to J41 opening in December 2015 and J41 to J42 opening in January 2016.

Methodology

Identification of issues

We reviewed the 'Incident and infrastructure investigation' report for M1 J39 to J42 all lane running scheme to understand the issues. We undertook an analysis to understand the root cause of each of the collision hotspots. Other evidence reviewed to assist with this understanding included:

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

Review of potential interventions

We reviewed each proposed mitigation, looking at the:

- 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 prospective interventions are not feasible we have proposed and assessed alternative interventions.

Alternative interventions

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

Review of potential interventions

The independent review analysed collision data from the three years prior to the scheme construction date (2011-2013) and the latest available validated data since the scheme opening date (2016-2019, referred to as the 'after period'). In summary, the average numbers of collisions per year have increased in the after period for all severities, most notably for serious injuries, and the proportion of collisions occurring during hours of darkness has also increased.

More collisions are occurring per year after the smart motorway opened compared to before. A rise in collisions of serious-injury severity has been noted scheme-wide and a cluster site at and to the north of junction 39 has been identified. 23 injury collisions occurred in this locality in the four-year after period (2016-2019), of which 30% were serious injury collisions. Unusually for a section close to a motorway junction, there were more loss of control collisions (7) than shunts (6), with lane change collisions also similar in number (5).

Pedestrian collisions and incidents

Issues identified

Four pedestrian injury collisions have been recorded in the four-year period since opening; one fatal, two serious injury and one slight injury.

Two pedestrians were on the carriageway having exited their vehicle and two pedestrians originated from off the network.

Pedestrian incident reports are most common on the J39 to J40 link, which runs between two suburban areas. The range of potential crossing and access points, and the suburban setting of this link are risk factors and although they appear to serve most pedestrian routes, the provision and fencing details vary.





Figure 1 Public rights of way parallel to and across the motorway between J39 and J40 © Google

M1 J40 has been identified as a high frequency site for suicide incidents with more than two incidents recorded in a 12-month period. While extremely important, this is not related to smart motorways. However concerns over the incidents have prompted a site assessment to be carried out in accordance with our site escalation process.

Potential causes

- The J39 to J40 link is the link closest to built up areas of Lupset to the east and South Ossett to the west.
- An extensive network of recreational footways running parallel to the M1 just north of junction 39 provides potential access to the motorway.
- Potential access for pedestrians from public footways at Queens Drive and Northfield Lane (A642).
- Junction 40 links residential areas with employment areas in Ossett and towards Wakefield and so could be used by pedestrians.

Potential interventions from the independent review

Potential intervention 1

Review the access points along the route and install anti-access fencing at specific locations on the J39 to 40 link, to prevent access to the motorway for pedestrians and remove the risk of further incidents.

Potential intervention 2

Consider higher parapets on the overbridges at J40, with Samaritans crisis signs and an emergency telephone for customers in crisis in line with the suicide prevention toolkit. A site assessment has identified these as potential measures to be developed through further feasibility work.

We have reviewed the study area to identify potential pedestrian routes and areas where the M1 can be accessed by those on foot. A desire on the part of pedestrians to access or cross the motorway represents a clear hazard to all road users. The measures identified remove this hazard.

Intervention 1 and 2 will both be progressed. Intervention 2 will require detailed feasibility work in the first instance to identify the most suitable options to develop through detailed design and delivery.

Junction 39 – Perception of road layout

Issues identified

A cluster of collisions has occurred in the area at and immediately north of M1 Junction 39. 23 injury collisions occurred in this locality in the four year after period (2016-2019), of which 30% were serious injury collisions. Unusually for a section close to a motorway junction, there were more loss of control collisions (7 than shunts (6), with lane change collisions also similar in number (5).

Potential causes

It is highly likely that factors such as the curvature of the carriageway, the short northbound entry slip and the Calder Navigation bridge at this point on the M1 all contribute to the increase in collision occurrences and higher severity incidents.

Potential interventions from the independent review

Potential intervention 1

The installation of 'bend ahead' warning signs on both approaches to junction 39 to assist road users to judge the road layout.



Figure 2 Bend ahead warning sign © Google

We have reviewed the road layout at this point and conclude that it meets all the standards in terms of geometric alignment. The installation of bend warning signs would normally be complemented with the introduction of chevron warning signs, but it is not considered that this is appropriate at this location.

Potential Intervention 1 will not be progressed as the introduction of signs would have little impact at this location. Bend ahead warning signs would be largely masked to higher speed traffic by slower/larger vehicles in lane 1.

At this location there are a number of signs that are competing for the driver's attention between the slips. We will review the signing to ensure it is as effective as it can be, as part of a broader junction study. We will expand the proposed study into an alternate exit slip road arrangement at junction 39 to to cover this.

Junction 39 – southbound lane drop signing

Issues identified

As a lane-drop junction, this location results in a significant number of lane change movements southbound. The primary 1 mile direction sign is verge mounted map-style and does not indicate a lane-drop road layout. The sign is situated immediately after other signing and an emergency area, which may draw road user's attention away.



southbound approach to J39 © Google

There have been four injury collisions recorded in the vicinity of the lane-drop in the four year period (2016-2019), three recorded as serious and one slight collision.

Potential causes

The lack of signing accurately reflecting the road layout.

Potential interventions from the independent review

Potential intervention 1

It is proposed the existing verge mounted Advanced Direction Sign is replaced with

Figure 3 Verge mounted primary 1 mile direction sign on the

a different authorised sign which better reflects the lane drop layout at this junction.

We have reviewed the location and believe that signing which accurately reflects the road layout should reduce confusion for all road users and reduce the likelihood of collisions.

It is recommended potential intervention 1 is progressed and new signing installed.

Darkness collisions

Issues identified

An analysis of collision data indicates an increase in the number of collisions occurring in darkness for the scheme compared to the period before the smart motorway was implemented (from 6.7 per year to 9 per year). 37 injury collisions during darkness have been identified after scheme opening; one fatal, nine serious and 29 slight casualties.

Seventeen injury collisions have been recorded in the link between J39 and J40, and ten between J40 and J41. Both links are approximately 2.5 miles (4 km) long and unlit. Ten collisions occurred in the 1.2 mile (2 km) long lit link between J41 and J42.

Potential causes

Consideration of contributory factors of collisions during darkness has highlighted that sudden braking, and associated factor following too close, point towards congestion having a bearing on collision occurrence.

Potential interventions from the independent review

Potential intervention 1

The installation of a street lighting system over the length of the M1, between Junction 39 and junction 41.

Alternative potential intervention 2

The installation of high reflectivity markings and studs to highlight the carriageway alignment has also been considered in addition to the above intervention.

We have reviewed the location and consider that the cost of installing a street lighting system over a distance of 2.5 miles (4 km) could be disproportionate and its value needs to be considered carefully. Our standards for deciding whether to install lighting consider multiple factors, including expected safety benefits, environmental considerations (such as the additional emissions that are required) and the costs.

A further, more detailed study will be carried out to establish the benefits of installing a street lighting system and improved markings and road studs.



Figure 4 Example of motorway lighting

Junction 39 southbound road markings

Issues identified

A cluster of collisions is evident on the southbound carriageway and exit slip road, at and immediately north of M1 J39. Nine injury collisions were recorded in this locality in the four year after period (2016-2019), of which four (45%) were serious injury collisions.

Two were recorded as lane changes and three as shunts and all are associated with the exit slip road layout.

Potential causes

It is possible that the combination of the horizontal curve and unclear signing related to the lane-gain / drop arrangement, is causing some confusion for motorists on the approach to the junction.

Potential interventions from the independent review

Potential intervention 1

A hazard lane marking is in place on the southbound carriageway from the 1/2 mile marker to the junction. The extension of this marking northwards to the 1 mile necessary approval.

marker would give better guidance for road users. Implementation is subject to the



Figure 5 Change in lane markings between lane 1 and 2 at the 1/2 mile marker to the junction © Google

Potential intervention 2

The installation of lane destination markings on the road surface.

We have reviewed the location and believe that extending the existing hazard lane markings would seem to offer benefits to safety.

However the installation of lane destination markings on the road surface at this location would be unique to this stretch of the M1, and as such potentially lead to confusion for motorists. As a consequence, it is likely to result in more lane changes (from lane 1 to lane 2) on the approach to the junction.

We will progress potential intervention 1, subject to discussions with signing specialists and any necessary approvals.

Junction 39 southbound – alternative exit slip road layout

Issues identified

The combination of the horizontal curve and the signing related to the lane gain / drop arrangement, appears to be creating confusion for motorists on the approach to the junction which is resulting in late lane changes.

A cluster of collisions is evident on the southbound carriageway and exit slip road, at and immediately north of M1 J39. Nine injury collisions were recorded in this locality in the four-year after period (2016-2019), of which four (45%) were serious injury collisions.



Two were recorded as lane changes and three as shunts and all are associated with the exit slip road layout.

Figure 6 M1 J39 southbound exit slip road (shown on right portion of image) © Google

Potential causes

The arrangement on the southbound approach to Junction 39 in terms of its layout, road markings and signing, while within standards, combines a number of issues which appear to cause road users confusion leading to late lane changes

Potential interventions from the independent review

Potential intervention 1

Carry out a study to investigate the possibility of installing an alternative exit slip road layout

We have reviewed the location and believe any improvement in the signing and road markings on the southbound approach to Junction 39, which would further emphasise and separate traffic leaving and remaining on the main carriageway, would be advantageous.

Intervention 1, a study into a potential new exit slip road layout for J39, will be progressed to identify suitable options.

Display variable speed limits earlier, prior to peak periods

Issues identified

The incident and infrastructure investigation report for the M1 J39 to 42 scheme found that there was a cluster of collisions immediately north of M1 J39.

Potential causes

The accident data shows that generally the collision types are spread out across the northbound and southbound collision clusters and there is not much of a pattern. In the northbound direction there are two shunt type collisions just before the merge with lane 2, which suggests that some drivers may be nervous about entering the carriageway. Just after the merge there are three loss of control type collisions, which could be related to speeding. In the southbound direction there are three shunt type collisions near the merge and on the slip road, but still quite far apart from each other and the loss of control type collisions are spread out.

Potential interventions from the independent review

Display variable speed limits prior to the peak periods.

We have reviewed the location and believe that this method of reducing any congestion is not appropriate on the M1 junction 39 to junction 42 smart motorway scheme. This is because the extra capacity generated by installing additional lanes has mostly eliminated peak time congestion.

The link generally experiences high traffic flows and speeds which would be adversely impacted by unnecessarily reduced speed limits.

For the purpose of encouraging compliance, it is important motorists are able to see a reason for speed limit reduction.

The approach to junction 41 north already has congestion management active, which does reduce speeds during high flow conditions and has been shown to reduce the flow breakdown and queuing experiencing junction 42 to junction 41 during morning peaks.

The display of variable speed limits earlier, prior to peak periods will not be progressed.



Figure 7 Variable speed limits in operation

Display national speed limit off peak

Issues identified

The incident and infrastructure investigation report for the M1 J39 to 42 scheme found that there was a cluster of collisions immediately north of M1 J39.

Potential causes

Some possible causes have been proposed in the independent review report for this cluster of collisions:

- Constraints imposed by Calder Navigation Bridge, particularly the parapets. A departure has been identified in the Design Strategy Record for the scheme identifying constraints relating to the J39 northbound stopping sight distance (SSD) - Lane 1 SSD reduced by a maximum of 3 steps (to 160 metres) to low and high objects due to the bridge. Although this does impact the stopping sight distance just north of J39, this is likely not the primary cause of the collision cluster due to the location of the collisions. Most of the collisions are further south than the Calder Navigation bridge. However, the location of the bridge does have an impact on some of the other factors including the junction layouts.
- The horizontal left-hand curve just north of J39. This also impacts the stopping sight distance in this area. This could be a contributory factor to the collision cluster, but is unlikely the primary cause as the collisions are south of the bend.
- The junction layout at J39. On the northbound carriageway there is a lane gain with a second lane that merges with lane 2, which is short. Evidence suggests that at peak times the traffic is heavy, and vehicles often drive too guickly and have to brake suddenly when they merge with lane 2. Traffic count data reflects this, with 1800 vehicles per hour entering the carriageway here at the morning peak. On the southbound carriageway there is a pattern of weaving and vehicles swooping in to leave the carriageway at the last minute.
- This section is a low point in terms of elevation. There are notable downhill approaches from both direction.

It is important to note that some of these constraints were there before the smart motorway was introduced, however turning the hard shoulder into a running lane may have added to the situation.

The independent review report suggested that the combination of these factors has resulted in a particularly unforgiving environment just north of J39.

Potential interventions from the independent review

Display national speed limit during the off-peak period.



Figure 8 National speed limit displayed on signals

Alternative intervention 1 Improved speed enforcement between J39 to 40.

Alternative intervention 2

Junction layout changes.

We have investigated the location and believe there is no evidence to suggest that displaying the national speed limit outside of peak hours would provide greater control or improve driver behaviour at the junction. It would also be unusual for drivers to see these signal settings and it could affect driver speed compliance on other parts of the road network.

Improved speed enforcement would require either new speed enforcement cameras to be installed or the enforcement camera mid-link between J39 and J40 to be moved closer to J39. The safety implications of doing this needs further consideration.

Some small changes to the junction layouts could bring benefits to both the northbound entry slip road and southbound exit slip road. The feasibility study already identified to consider the southbound entry slip road will be extended to consider the entire junction.

The display of national speed limit outside of peak periods will not be progressed

We will progress a detailed feasibility study to consider improvements to enforcement and potential alterations to the junction layout including merges and diverges. This will be considered as part of the alternative diverge study above.

Live-lane stop incidents

Issues identified

The suggested intervention to add specific signing for exit slip road slip hard shoulders as places of relative safety is already being taken forward.

This is as part of the stocktake action to increase the amount of approach signage to places to stop in an emergency, which includes hard shoulders on slip roads, where present.

This measure is in addition to the installation of a stopped vehicle detection system which is currently being retrofitted across the all lane running network by the end of September 2022.



Figure 9 Approach signs indicating the presence of an emergency roadside telephone adjacent to hard shoulder on an exit slip road

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 works able to start by March 2022. All proposals will go through a detailed design phase to further develop the solutions, allow a detailed cost estimate and an accurate delivery timescale to be produced.

In addition, we have also identified a number of locations that require additional feasibility study to inform the next steps. These include an M1 J39 junction study to consider the southbound exit slip road, northbound entry slip road, sign provision and speed enforcement, along with a study to consider the provision of lighting between M1 J39 to 41.

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

Inde	ependent review	
Key findings	Recommended actions	Response actions
0.25 live lane breakdowns per mile per day	Add specific signing for exit slip road hard shoulders as places of relative safety	Being taken forward: we will add specific signing for exit slip road hard shoulders which could provide a place of relative safety as part of the stocktake action to increase the amount of approach signage to places to stop in an emergency. Due for completion September 2022.
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 unauthorised access to the motorway for pedestrians.
	Consider suicide prevention measures.	Being taken forward: we plan to install crisis signs at M1 J40 and carry out a detailed assessment of installing higher parapets and emergency telephone as well as examining CCTV coverage of bridges. A detailed feasibility study will be taken forward.
Cluster of collisions north of J39	Bend ahead warning signs	Being taken forward: a review of signing will be carried out as part of a broader feasibility study on the junction (see 'alternative exit slip road layout' on the next page).
	Overhead primary direction sign to reflect southbound lane drop Explore provision of street lighting	 Being taken forward: change 1 mile Advance Direction Sign to a different approved sign. Being taken forward: initial analysis suggests street lighting and high reflectivity markings/studs could result in accident savings. We will carry out a detailed feasibility study and review environmental effects.
	Lane destination markings and hazard lines for southbound lane drop	Being taken forward: hazard lines will be extended, subject to necessary approval. Surface lane destination markings will not be progressed as this would be unique to this stretch of the M1, and as such potentially lead to confusion for motorists.

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Lighting changes made by the J39 to 42 scheme

We have reviewed lighting records before and after the scheme, and the following reflects the lighting changes made as part the J39 to 42 all lane running scheme:

- J42 to J41: mainline lighting and sections of the northbound exit and southbound entry at J42 renewed, with lighting removed from the centre to the verge to add concrete vehicle restraint system
- J41: northbound entry and southbound exit fully lit to tie in with mainline lighting up to J42
- J41: northbound exit and southbound entry slips now part lit when previously fully lit
- J41 to J40: mainline lighting removed from the centre and not replaced to allow upgrade with concrete VRS
- J40: northbound entry and southbound exit slips now part lit when previously fully lit

The lighting situation on other sections is included for context:

- J41 roundabout: roundabout is fully lit and is the responsibility of the local authority (Wakefield Metropolitan District Council (MDC))
- J40 northbound exit and southbound entry slips: the lighting was retained on the slip roads and are part lit, no lighting intervention was undertaken
- J40 roundabout: roundabout is fully lit and is the responsibility of the local authority (Wakefield MDC)
- J40 to J39: mainline has never been lit
- J39: lighting retained on all of the slip roads and are part lit, no lighting intervention was undertaken
- J39 roundabout: roundabout is fully lit and is the responsibility of the local authority (Wakefield MDC)

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