Specialist Professional and Technical Services (SPATS) Framework
Lot 1 & Lot 2

Task 1127
Smart Motorway Incident and Infrastructure Investigation – M1 Junction 39 to 42

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Executive Summary

This report has been prepared as part of Highways England's response to the Government's Smart Motorway Safety Evidence Stocktake and Action Plan. It delivers on the commitment of the Smart Motorway Stocktake Action, to investigate road user safety on the M1 Junctions 39 to 42 (Wakefield) section.

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. This is 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.

In order to identify potential interventions in a robust way, this investigation was evidence-led. Analysis of a wide data set sign-posted possible areas of interest. Road safety analysis was applied to determine potential interventions, which answer the question posed for the scheme of, "what more could be done to improve road safety?".

Collision data from the three years prior to the scheme construction date (2011-2013) and the latest available data since the scheme opening date (2016-2019, referred to as the 'after period') were analysed. 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. The CRASH collision reporting system has not been introduced in West Yorkshire, so collision reporting methodology has remained consistent.

Incident data since opening in 2016 has been analysed. The overall number of reported incidents has increased, particularly non-live lane breakdowns which could reflect changes in behaviour with drivers increasingly managing to stop clear of live lanes, or could be reflective of changes to reporting. The number of live lane breakdowns per motorway mile per day in 2019 was high compared to smart motorway averages but within expected tolerances from the programme safety analysis.

Feedback from Operations found that congestion and high weaving flow are still apparent on the J41-42 link, although the smart motorway scheme has significantly reduced routine peak time congestion.

A cluster of collisions is evident in the area at and immediately north of Junction 39. Twenty-three 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 (seven) than shunts (six), with lane change collisions also similar in number (five). It is possible that constraining factors such as the curvature and Calder Navigation bridge lead to a layout where some users do not perceive and react to hazards, which in turn is seeing local collision occurrences with some higher severity incidents.

Across the whole scheme contributory factors for collisions occurring during darkness hours were relatively typical of those reported for motorway collisions nationally (as per the 2018 Strategic Road Network Casualty Report). However an exception is the appearance of impairment by alcohol as the fifth most common contributory factor; it is not typically a top ten contributory factor in motorway collisions nationally. Six collisions were identified with impairment by alcohol as a contributory factor in the after period (2016-2019), compared to one in the before period (2011-2013). Two associated casualties in these after collisions were intoxicated pedestrians.

One fatal collision has occurred in the after period, which involved a pedestrian on the carriageway at night, potentially a vulnerable and / or intoxicated individual. There is no apparent link to the smart motorway layout or concept, however, it did occur adjacent to a pedestrian subway.

Ten of the 14 serious injury collisions in the after period are judged unlikely to have a causal link with the design or operation of the smart motorway; they could reasonably be expected to have occurred elsewhere on the network with similar frequency or outcomes. Four of the 14 serious injury collisions involved stopping / stopped vehicles in live lanes and could have a causal link with the design or operation of the smart motorway. The frequency or outcomes of these collisions may have been affected by not having a hard shoulder available.

Overall, five injury-collisions occurred over four years from vehicles stopped in live lanes. Two could be linked to driver behaviour and their occurrence could potentially have been avoided by different driver action. The outcome or severity of the remaining three collisions are likely to have been affected by not having a hard shoulder available. On average there were 562 live lane breakdown incident reports per year on this section of the M1, and five live lane stop related injury collisions over the four year period.

Four pedestrian injury collisions have been recorded in the four year after period; one fatal, two serious injury and one slight injury. Two pedestrians were ex-vehicle, two 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 points of (unlawful) access and the suburban setting of this link are risk factors; Existing bridges and subways do appear to serve most desire lines between origins and destinations, although the provision and fencing details vary.

No particular or concerning trends in collisions or operation are apparent on the highly trafficked and high weaving M1 J41 to J42 link. Of all incident records raised for this section, breakdowns were the most frequent (averaging 0.6 per day) followed by obstruction. Twenty one injury collisions have been recorded in four years on this link, two of which are serious injury severity.

Potential interventions arising from the data review and focussed investigation are given in Table E.1.1.

Table E.1.1 M1 J39-42 potential interventions

Key Findings – Data Analysis	M1 39 to 42 Potential interventions
A) 0.25 live lane breakdowns per mile per day	• Add **specific signing for diverge slip hard shoulders** as places of relative safety
B) Pedestrian incidents and local risk factors	• Use Walking Cycling and Horse Riding (GG 142) assessment process to **review pedestrian facilities** / access to motorway • Apply Suicide Prevention Toolkit
C) Cluster of collisions north of J39	Road user **perception of road layout**: • Bend ahead warning signs • Overhead primary direction sign to reflect southbound lane drop • Explore provision of street lighting • Lane destination markings and hazard lines for southbound lane drop • Alternative diverge layout • Display variable speed limits earlier, prior to peak periods • Display national speed limit off-peak

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1. Scope and Purpose

This report has been prepared as part of Highways England's response to the Government's Smart Motorway Safety Evidence Stocktake and Action Plan.

1.15 We have heard the concerns about clusters of incidents on specific sections of the M6 and M1 smart motorway. This includes the M6 Bromford viaduct between Junctions 5 and 6, where places to stop in an emergency are furthest apart. Though Highways England traffic officers are stationed at each end of the viaduct so they are close by, we know that some people remain worried. Concerns have also been raised about sections of the M1 where multiple collisions have occurred. These include M1 Junctions 10 to 13 (Luton) and Junctions 30 to 35 (Sheffield). We have also seen evidence of multiple incidents on the M1 Junctions 39 to 42 (Wakefield).

1.16 We are committing to investigate urgently what more could be done on the M6 Bromford viaduct and on these sections of the M1. Where an intervention is considered likely to make a difference, we will look to make changes to the motorway at these locations.

This report delivers this investigation into what more could be done to improve road user safety on the M1 Junction 39 to 42 (Wakefield) section.

In order to identify interventions in a robust way this investigation is evidence-led. Analysis of a wide data set sign-posted possible areas of interest. Road safety analysis was applied to determine potential interventions. The recommendations provide a robust answer to the question posed for the scheme of, "what more could be done to improve road safety?".

This report sets out the data sources and methodology used, the specific areas of investigation, interpretation and conclusions regarding collision occurrences, incident occurrences, and identifies potential interventions. This process is illustrated in Figure 1.1.

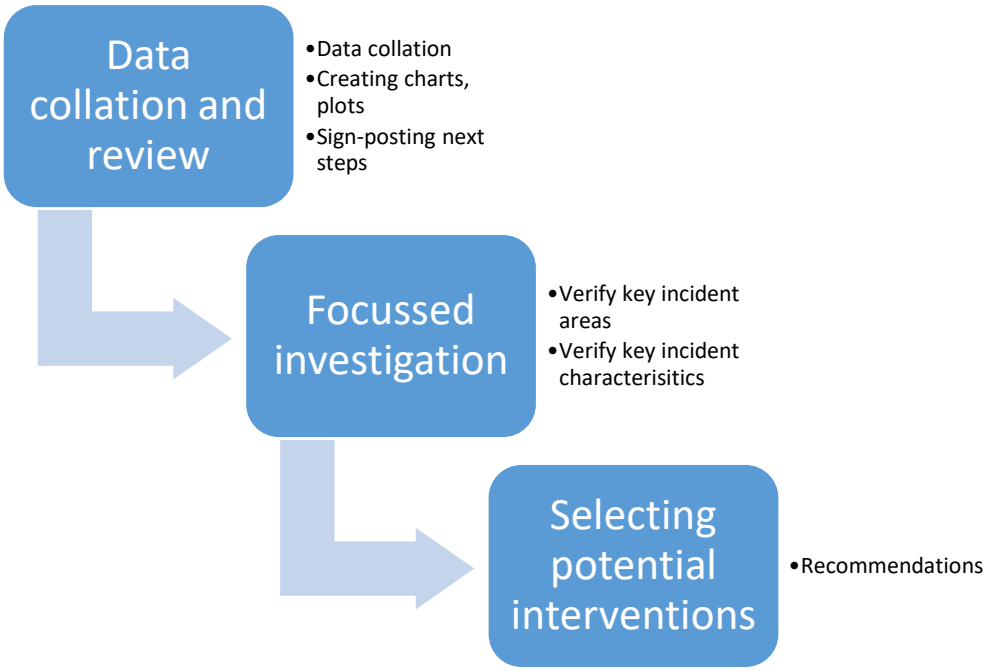


Figure 1.1 Structure of investigation

2. Methodology

2.1 Stage 1 - Data collation and review

A variety of data types and means of analysis formed the first stage of assessment. Data and information inputs were reviewed with the initial objective of sign-posting trends, findings or areas of interest that warrant further analysis.

The Stage 4 (post-opening) Road Safety Audits (RSAs) were reviewed to understand road safety observations made after the scheme was opened to traffic and how these were resolved. If appropriate, earlier RSAs were also reviewed (prior to scheme opening) to investigate trends or continuity in the types of observations raised in Stage 4.

Collision data from the three years prior to the scheme start of construction date and the latest available data since the scheme opening date were analysed; these sets were compared as the average number of collisions per year. Only injury collisions are captured in this dataset (often referred to as 'STATS19 data'), with data obtained via regional or area teams from police records. The data was considered by location and by trend, illustrated using data plots. The trends reviewed included collision and casualty severity, proportion of collisions that have occurred in darkness or daylight, weather conditions, vehicle type and collision type (e.g. nose to tail, side swipe etc).

Collision data reporting via CRASH has not been introduced by West Yorkshire police so is not a factor in the collision records for this scheme.

In addition to collision data, Operations' incident data was reviewed for this section of the road network, with the aim of giving insight into the occurrence of breakdowns and the proportion of stops in live and non-live lanes. Incidents were characterised as having impact on the operational performance of a scheme (e.g. congestion / formation of queues), these do not necessarily result in injury but have the potential to do so.

Design information for this scheme, including the Design Strategy Record documents and Departures from Standards Checklist, were reviewed to understand the rationale behind the road layout. The potential operational impact of the Departures from Standards was assessed and summarised.

To gain an understanding of the operation of the scheme in practice, feedback from consultation with local Operations stakeholders and high quality dashcam video from a recent drive-through was reviewed.

The outcome of the review identifies emerging areas and aspects that warrant further investigation and focussed road safety analysis (Stage 2 of the methodology).

2.2 Stage 2 - Focussed investigation

Road safety analysis drew upon the sign-posted elements from the initial data analysis in Stage 1, considering their relative significance in both isolation and potential combination. Key points for identifying issues for further consideration included whether:

- the number of a particular collision type has increased since the smart motorway opened.
- there is a location where a number of collisions and/or incidents have occurred.
- there may be a trend of common factor in collision occurrence.
- an issue has become more noticeable or frequent over the years of operation.

In addition to the specifically identified elements, the focussed investigation included a detailed review of:

- all serious injury and fatal collisions occurring post-opening;
- all collisions involving a live lane stop; and,

- for any further areas of interest identified in the Data Review stage, injury collisions of all severities.

Where the analysis identified prospective links between collisions and/or incidents, either spatially (i.e. a cluster) or by common factor (e.g. collisions in wet conditions), these were taken forward for identification of potential interventions.

The outputs from this stage of the investigation were:

- data on all prospective issues.
- sifting of issues with no clear pattern, trend or appropriate treatment.
- issues potentially linked to collisions and/or incidents taken forward for intervention recommendations.

2.3 Stage 3 - Potential interventions

This element of the methodology considered prospective interventions or control measures for the specific issues that have been linked to collisions and/or incidents. These were specific to the scheme and the issues identified.

The output from this stage of the investigation will address what more could be done to mitigate future collisions and/or incidents. Potential interventions will be recommended in context of other Stocktake Action Plan measures, including the roll-out of a stopped vehicle detection technology by September 2021.

3. M1 Junction 39 to Junction 42 Scheme Outline

The M1 Junction 39 to Junction 42 Smart Motorway scheme was a Highways England major project to improve approximately 6 miles (10km) of the M1, providing additional capacity to the west of Wakefield through the implementation of a smart motorway. The scheme location is depicted in Figure 3.1.

The key smart motorway features introduced by the scheme were:

- Conversion of the hard shoulder for use as a permanent traffic lane, known as All Lane Running.
- Introduction of enhanced on-road technology, including CCTV, signalling and variable mandatory speed limits (VMSL) to manage traffic flow; national speed limits apply unless signals display lower limits.

Smart motorways convert the hard shoulder to add capacity without the need for land take, introducing speed limits to manage congestion at peak and non-peak times, as well as support incident management. Further points of note:

- The scheme was designed using Highways England's Interim Advice Note 161/12.
- Construction work for the scheme commenced in July 2013.
- The scheme was completed in two stages, Junction 39 to Junction 41 opening in December 2015 and Junction 41 to Junction 42 opening in January 2016.
- South of the scheme the M1 comprises a conventional dual three lane (D3M) motorway with hard shoulder.
- Junction 42 at the northern limits of the scheme is Lofthouse Interchange, the interchange between the M1 and M62. North of J42, the M1 and M621 divide. To the west, the M62 comprises a smart motorway with links providing differing regimes of All Lane Running (ALR) and Dynamic Hard Shoulder Running.
- The information in Table 3.1 sets out some key elements of the scheme layout.

Table 3.1 M1 J39-42 layout and features

Link / Junction	Lanes / Places of relative safety	Lighting provision before smart motorway scheme	Lighting provision after smart motorway scheme
Junction 39	NB: Lane gain, hard shoulder ends SB: Lane drop, no hard shoulder on diverge slip	Unlit	Unlit
J39 to J40 link – 4.4km between junction centres	NB: Four lanes ALR, one mainline EA SB: Four lanes ALR, one mainline EA	Unlit	Unlit
Junction 40	NB: Four lanes through junction running (TJR) SB: Four lanes TJR Hard shoulders on diverge slips	Lit (north side only)	Unlit
J40 to J41 link – 4.1km between junction centres	NB: Four lanes ALR, one mainline EA SB: Four lanes ALR, one mainline EA	Lit	Unlit
Junction 41	NB: Four lanes TJR, plus lane gain SB: Four lanes TJR Hard shoulders on diverge slips	Lit	Lit (north side only)
J41 to J42 link – 2.5km between junction centres	NB: Five lanes ALR, no mainline EA SB: Four lanes ALR, no mainline EA	Lit	Lit
Junction 42	NB: 2 lane drop, hard shoulder on diverge slip and hard shoulder recommences on mainline SB: lane gain	Lit	Lit

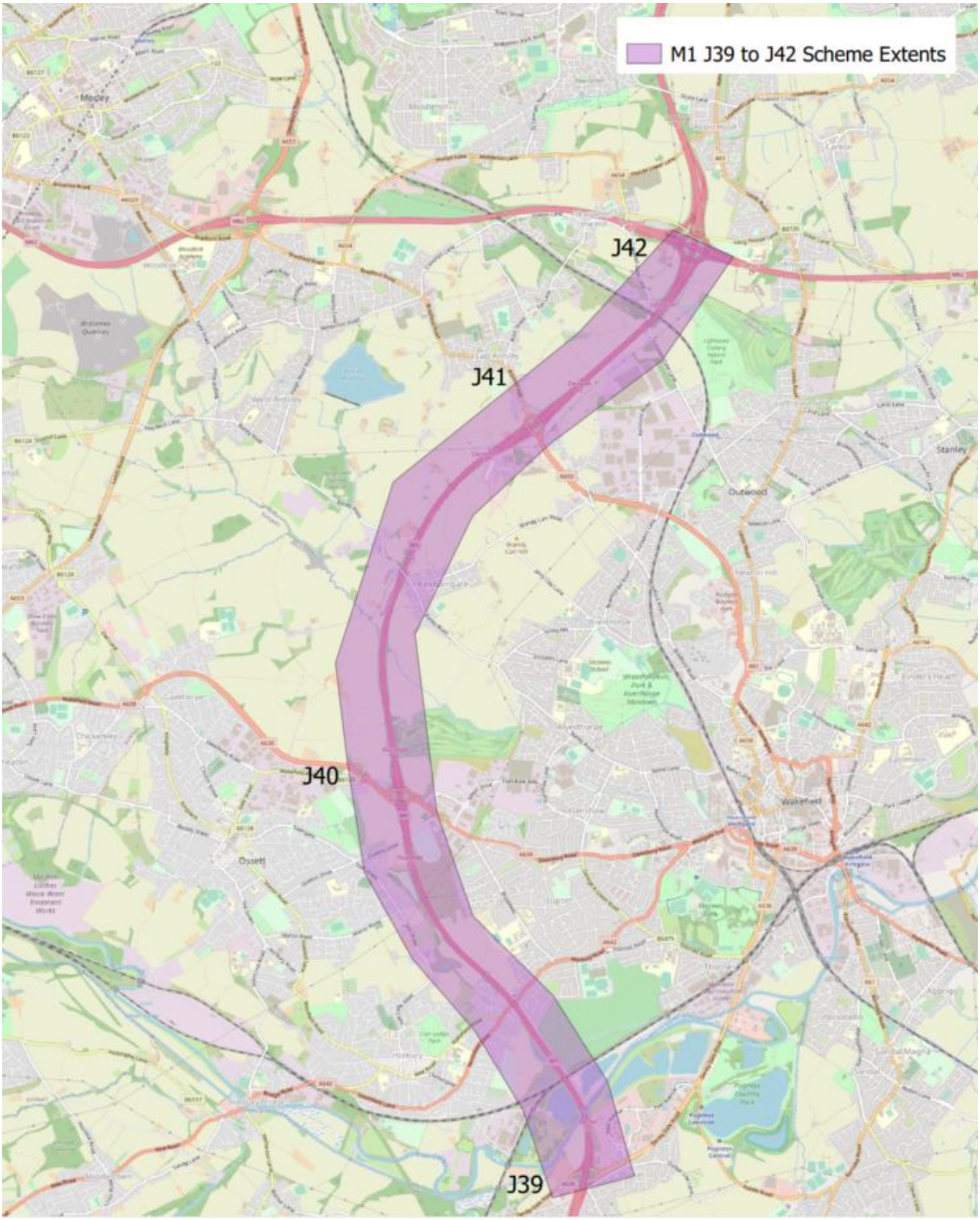


Figure 3.1 Overview of scheme location and extents

4. Data collation and review

This section contains the results of the initial review and analysis of the key data sources. Outputs from this section are taken forward to the following section for focussed investigation.

4.1 Road Safety Audit Stage 4 review

The Stage 4 Road Safety Audit (RSA) document has been reviewed with key points identified in Table 4.1.

Table 4.1 M1 J39-42 Smart Motorway (SM) All Lane Running Improvement – 12 month post-opening Stage 4 Road Safety Audit

	Summary of RSA 4A (Highways England)	Relevance to this investigation
General points	RSA 4 undertaken in Oct/Nov 2017. Undertaken in accordance with HD 19/15. The audit team did not undertake a site visit. 66 Departures submitted to the RSA team (not attached to the RSA 4).	Unclear from the RSA 4 what the departures relate to, i.e. technology, geometry. Cross check with other smart motorway sections regarding number/type of departures to determine if there is any correlation between departures and collisions. **Considered as part of departures review (section 4.4).**
Collision analysis	The collision analysis compared an average value of the 3 years pre scheme with 12 months post scheme. The scheme saw an increase in personal injury collisions (PICs) (17 to 20) and an increased collision rate (68 to 76 PIC per billion vehicle km) although this remained below the national average for motorways (80 to 85 PICs per billion vehicle km). The ratio of killed or seriously injured collisions increased to 25% from 8% before, although the before figure was noted as "unusually low". Highlighted an increase in darkness collisions, 50% in the after period compared to 33% before. Collision type reflects the general trend on smart motorways of a reduction in loss of control type collisions. There was no change in shunts. The data did identify an increase in 'random collisions' including tyre blow outs, mechanical failure, medical episodes etc. which were then removed from the data set as 'untreatable'. (However these could have resulted in live lane stops). The RSA 4 identified four collision cluster sites, describing 2 PICs in each cluster: The four locations were: J39 northbound mainline; J39 northbound entry slip; J39 southbound exit slip and J41 northbound exit slip. None of the clusters demonstrated a pattern and were not targeted for remedial measures. Only one of the collisions involved a 'live lane stop'.	The collision data does not distinguish between junctions or carriageway direction but looks at the length as a whole. The 'untreatable' collisions could have resulted in live lane stops. Analysis of the latest collision data to include a review of: • PICs occurring during hours of darkness to establish if the proportion remains above the national average and how significant this is; • review the four cluster sites to determine if this initial data was an early indicator of a problem. **Specific safety analysis for: Collisions occurring during darkness (section 5.3). Collisions occurring in the vicinity of J39 (section 5.6).**
Traffic conditions	Before and after automatic traffic count data indicated an average increase in traffic flow of approximately 5.6% between 2013 and 2016.	None

	Summary of RSA 4A (Highways England)	Relevance to this investigation
Review of previous RSAs	Reference is made to the RSA 2 which included three issues that were not accepted by the designer and exception reports prepared. The RSA 3 identified 12 problems, 10 of which were accepted and 2 had relevant exceptions reports. Confirmation was received in November that all the RSA 3 problems were addressed.	No further relevance
Identified road safety problems	None	To note - no site visit was undertaken by the RSA 4 team.
Conclusions	The RSA 4 concluded that the scheme has not had a detrimental effect on road safety.	To note – this is a different conclusion from that in the Smart Motorways Stocktake, owing to differing time periods and datasets.

4.2 Collision data review

4.2.1 Scheme data

The scheme before period is the three years prior to the scheme being constructed: 2011, 2012 and 2013. Average traffic (annual average daily traffic) in this period was 109,000 vehicles per day.

The scheme after period comprises the four years of collision data since opening to traffic: 2016, 2017, 2018 and 2019. The operational data used is considered unvalidated. Using this data rather than validated data meant that the most recent collisions could be included, and the investigation could include the full description of the collision circumstances. Note that the final link opened in January 2016, but this is not expected to have a significant impact on collision numbers.

Average traffic in the after period is 131,000 vehicles per day, approximately a 20% increase over the before period. For context, the *2018 SRN Casualty Report* states a network-wide 11.1% increase in motorway traffic between 2010 and 2018.

4.2.2 Severity

This section compares the collisions before and after the scheme. Refer to the Appendix for collision plots.

Table 4.2 Collision severity for the before and after data periods

	Before				After					Mean number of collisions per year	
	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Year 4	Total	Before	After
Fatal	0	0	0	**0**	0	0	1	0	**1**	0.0	0.3
Serious	3	1	2	**6**	5	4	1	3	**13**	2.0	3.3
Slight	18	16	14	**48**	17	15	17	20	**69**	16.0	17.3
Total	**21**	**17**	**16**	**54**	**22**	**19**	**19**	**23**	**83**	**18.0**	**20.8**

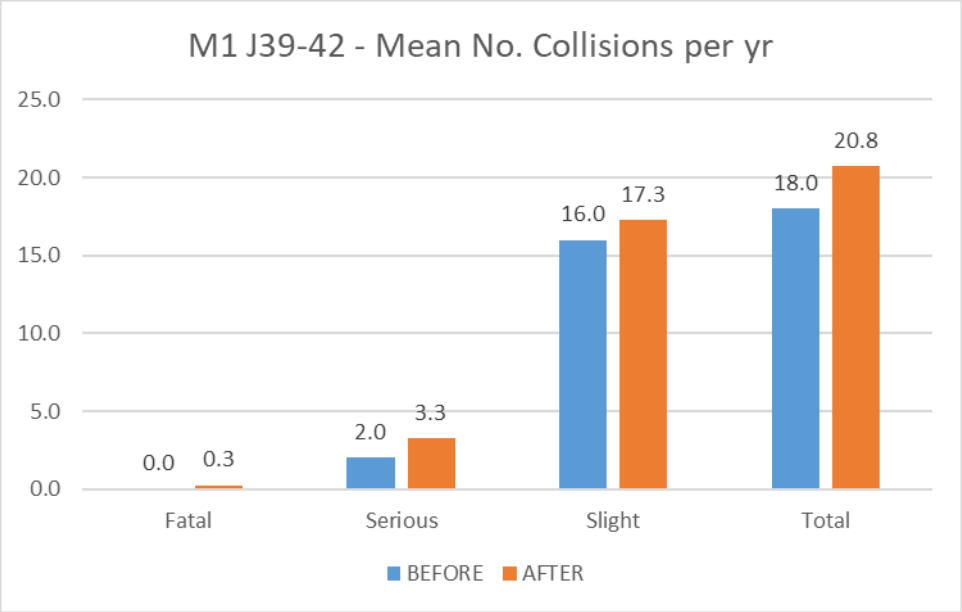


Figure 4.1 Collision severity for the before and after data periods

Table 4.2 and Figure 4.1 show that average number of collisions per year for every severity have risen compared to the before period. The total mean number of collisions per year has increased by approximately 15% in the after period; however this should be viewed in context of the approximate 20% increase in daily traffic for the after scheme. A detailed review of the one fatal collision in the after period, which involved a pedestrian in the carriageway at night, has been undertaken in section 5.1 of this report.

The after collisions indicate a higher ratio of fatal and serious injury collisions (17%) than in the before period (11%). In 2018 the Highways England SRN Casualty Report indicated that 17% of all motorway collisions in 2018 were fatal or serious severity, so the scheme aligns with the national average for collision severity ratio.

The most notable change in numbers of collisions in the after period is those of serious injury severity – numbers increasing from a mean of 2.0 per year before to 3.3 per year after. A detailed review of collisions resulting in serious injury has been undertaken in section 5.1.

Collision data has also been considered link by link. Table 4.3 shows that collisions occurred in similar proportions across the three links of this scheme in the before period. In the after period, the distribution of collisions has changed with most collisions occurring in the J39 – J40 link, the least occurring in the J40 – J41 link.

Table 4.3 Collision proportions by link

Link	Before proportion of collisions	After proportion of collisions
J39-J40	34%	41%
J40-J41	31%	23%
J41-J42	35%	36%

4.2.3 Lighting condition

This section compares the collisions before and after the scheme by lighting condition. Lighting provision is as set out in Table 3.1.

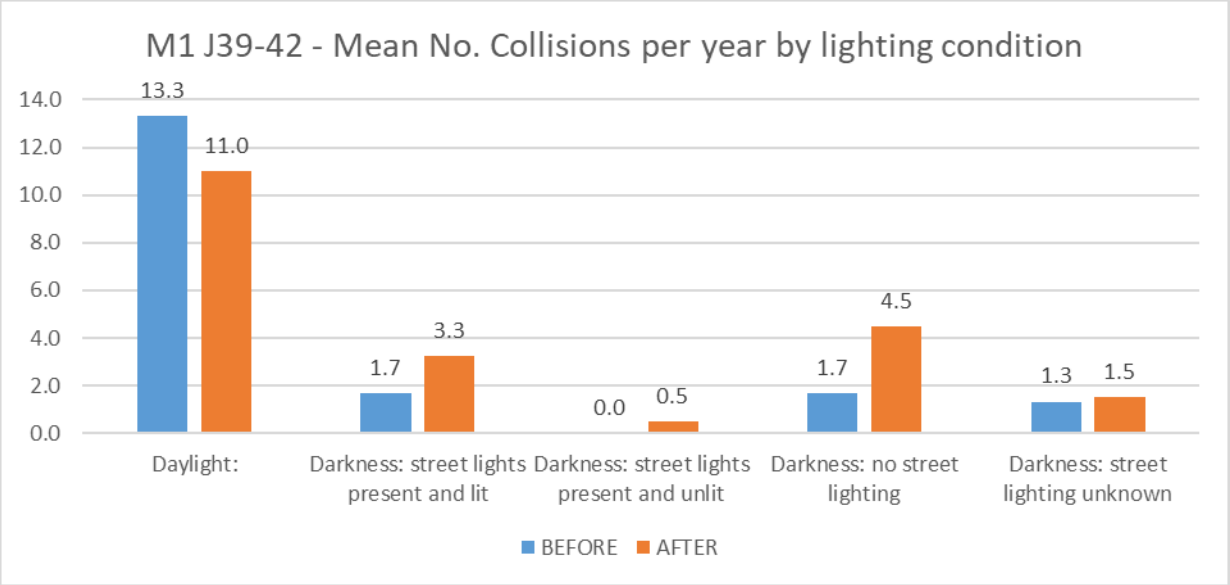


Figure 4.2 Collisions by lighting condition for the before and after data periods

Figure 4.2 shows a reduction in the number of collisions occurring during daylight in the after period, indicating that increases in total average numbers of collisions per year are driven by those occurring during hours of darkness. Overall, approximately 47% of collisions in the after period are reported in hours of darkness, which exceeds the 2018 national motorway average of 30%.

The growth in collisions during hours of darkness with 'street lights present and lit' can only be associated with the Junction 41 to 42 link, as this is the only link to retain street lighting - the scheme removed lighting from Junction 40 to 41 link (the Junction 39 to 40 link has never been lit). The number of collisions in the after period and the 'street lighting unknown' category represents 15% of all darkness collisions. Collisions occurring during hours of darkness are investigated in detail in section 5.3.

4.2.4 Collisions by weather and road conditions

This section compares collisions by conditions of the road surface. Comparison of before and after data in Figure 4.3 finds no change in collisions on wet compared to dry road surfaces, indicating no change in performance related to drainage or surface water.

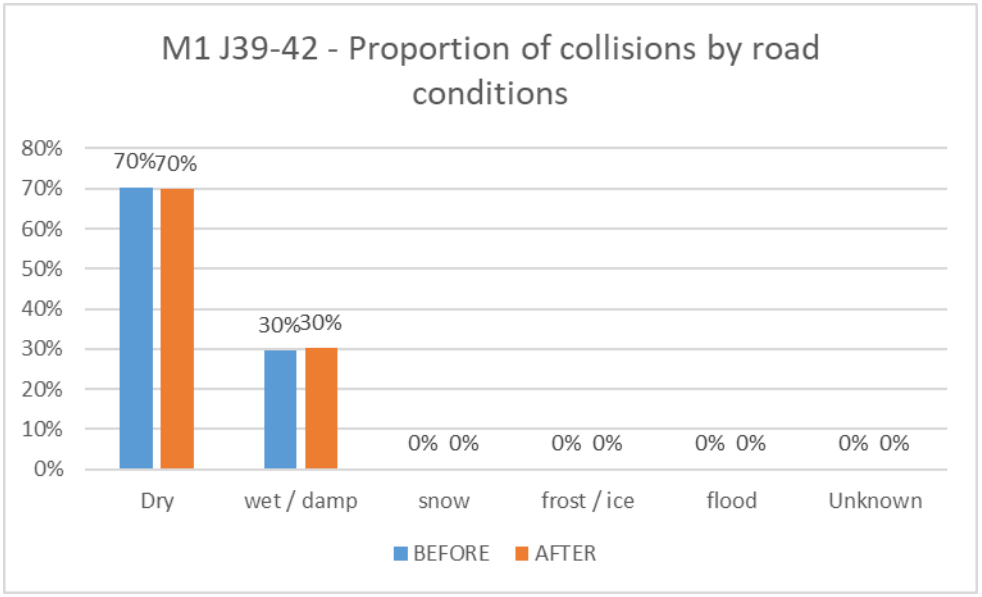


Figure 4.3 Collisions by road surface condition (weather related) for the before and after data periods

4.2.5 Collisions by vehicle type

This section compares collisions before and after by type of vehicles involved. Negligible changes are evident in the vehicle proportions in the before and after periods as shown in Figure 4.4.

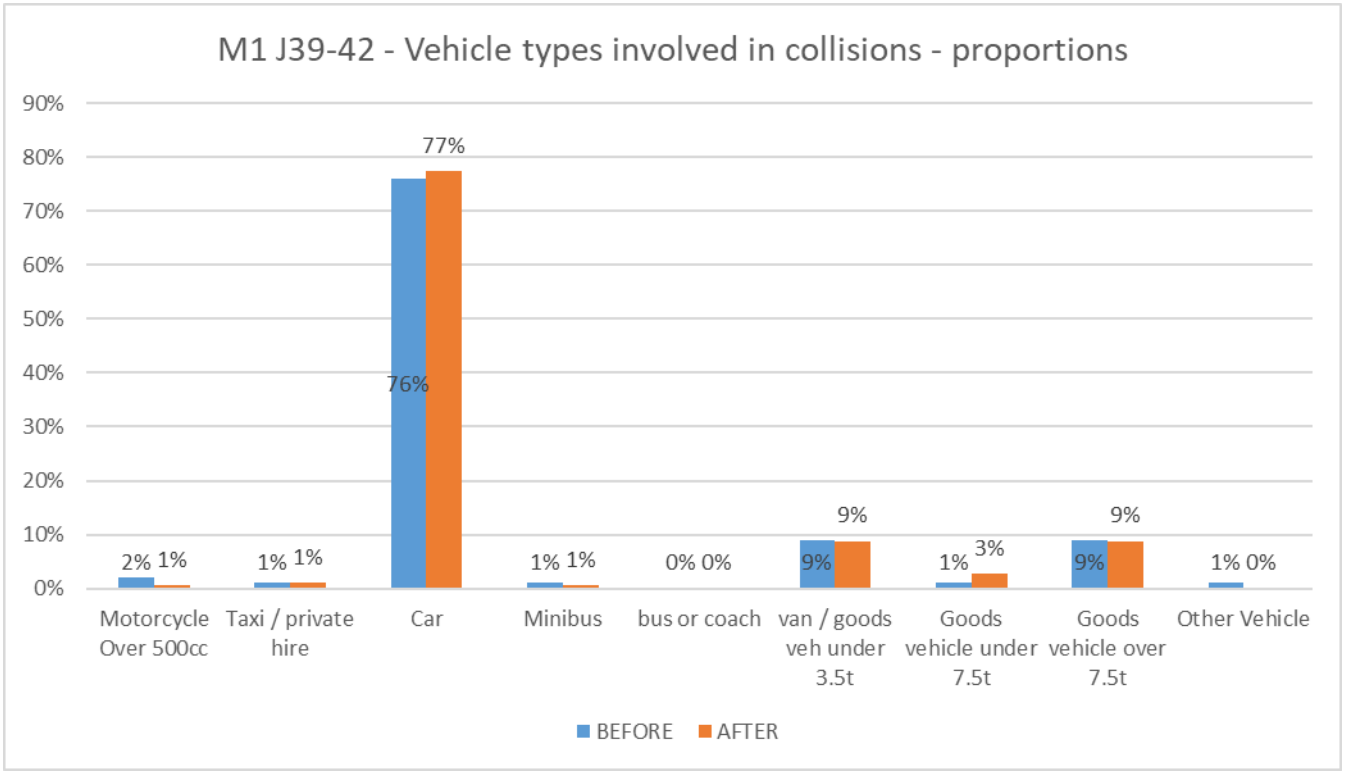


Figure 4.4 Vehicle types involved in collisions for the before and after data periods

4.2.6 Collisions by vehicle manoeuvre and point of impact

This section compares collisions before and after by vehicle movement and manoeuvre and point of impact. Very minor changes in vehicle movements are evident from Figure 4.5, indicating a slight reduction across the two manoeuvres typically assigned to vehicles in shunt collisions ('slowing or stopping' and 'going ahead other') and a very slight increase across the 'changing lane' manoeuvres. Similarly, first points of impact (Figure 4.6) have shifted slightly with a greater proportion of side as first point of impact in the after period, although front / back (implying a shunt collision) is still the most frequent.

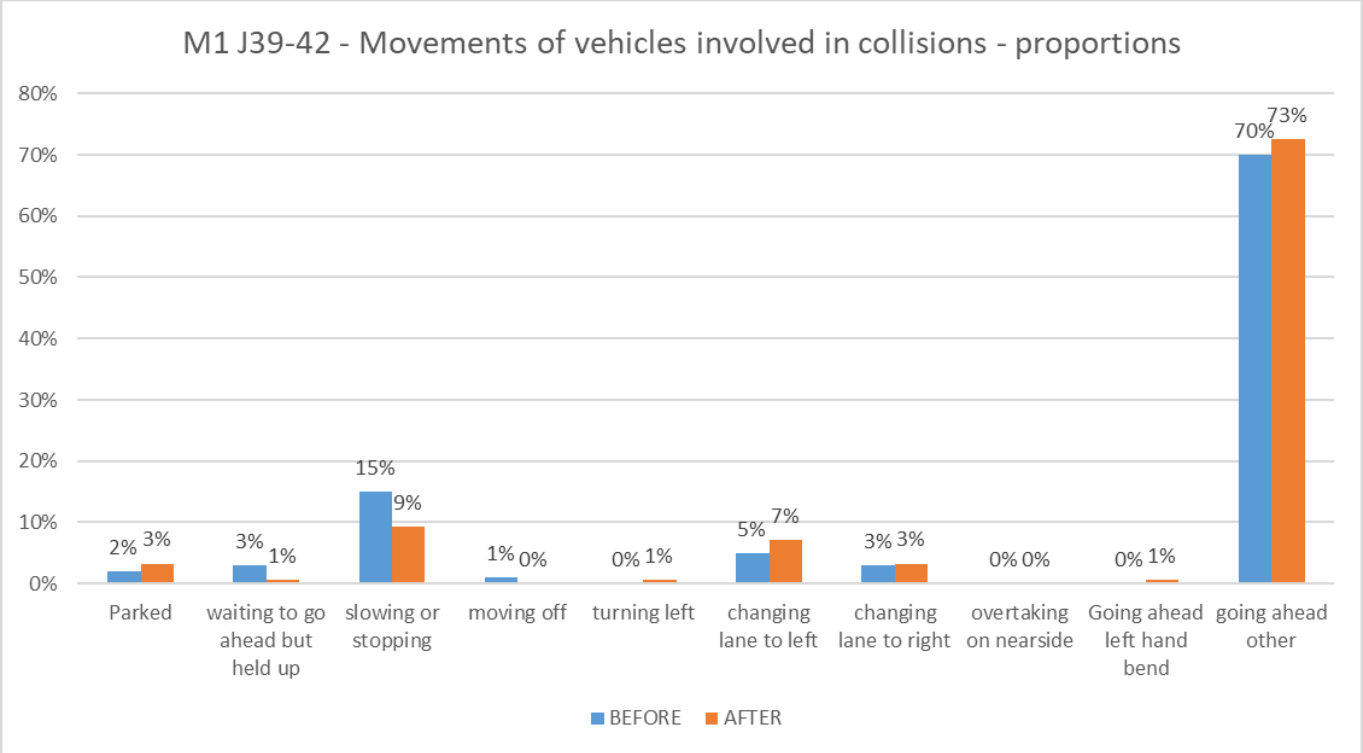


Figure 4.5 Movements of vehicles involved in collisions for the before and after data periods

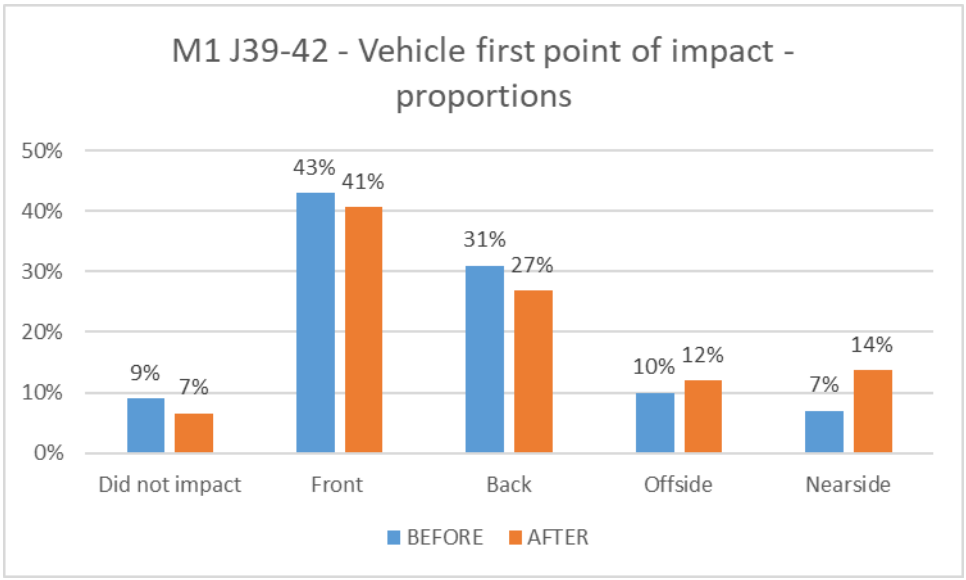


Figure 4.6 Vehicle first point of impact for the before and after data periods

4.3 Incident data review

Incident data from the post-opening period has been reviewed, with a focus on incidents most likely to affect live lanes (and which may otherwise or previously have involved use of the hard shoulder). Three most recent years' data has been used in order to provide a manageable but robust data set. Incident data has an initial location filter applied on grid references to identify locations between the main smart motorway extents of the Junction 39 north facing noses and the Junction 42 south facing noses.

Table 4.4 Incident records – Total and selected categories

Year	All incident logs	Traffic collision	Pedestrian on network	Breakdown not in live lane	Breakdown in live lane	Breakdowns (Total)
2016	2615	90	92	517	540	1057
2017	2505	81	129	605	546	1151
2018	2670	81	112	689	578	1267
2019	2832	107	107	698	584	1282

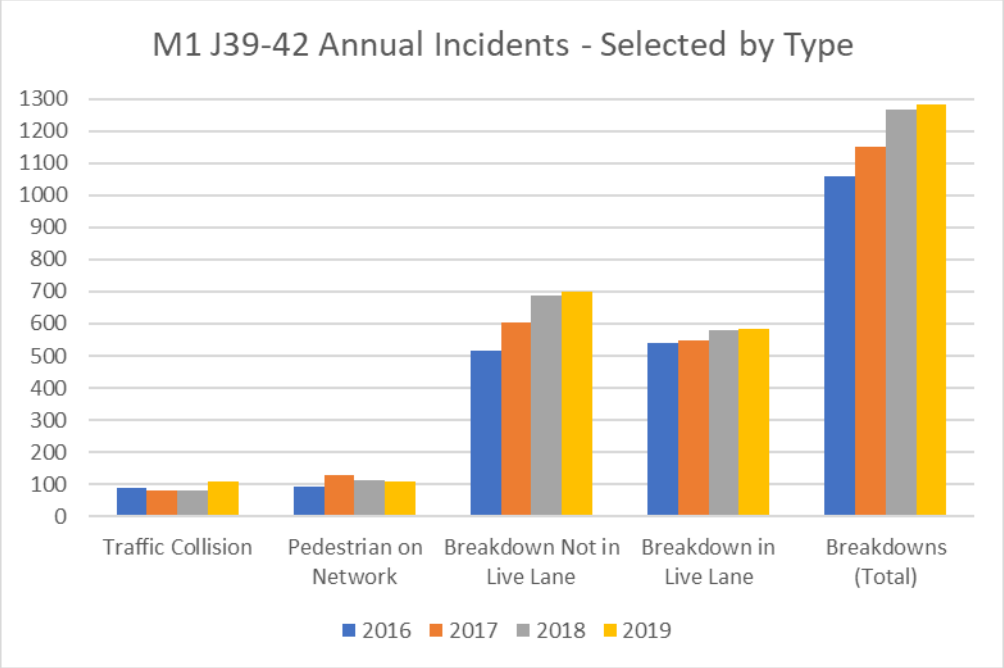


Figure 4.7 Annual incidents by type

Table 4.4 and Figure 4.7 indicate that reported number of traffic collisions have fluctuated since opening, with a limited increase in 2019 (it is important to note that this will include *all* collisions of which Operations are made aware, which will include damage-only collisions not captured elsewhere).

Reports of pedestrians on the network are in the range 92 to 129 per year (i.e. around twice per week on average); the 2017 value of 129 incidents is notably higher than other years'.

The total number of breakdowns is indicated as increasing, although the number reported in live lanes have remained relatively steady in the approximate range of 540 to 584 per year (i.e. approximately 1.5 per day on average). This means that increases in total numbers of breakdowns are driven by breakdowns not in a live lane, which could reflect changes in behaviour with drivers increasingly managing to stop clear of live lanes, or could also be reflective of changes to reporting approaches or behaviours.

For context, it should be noted that the overall number of incidents reported per year also shows a general upward trend. Again, this could be reflective of changes to reporting approaches or behaviours.

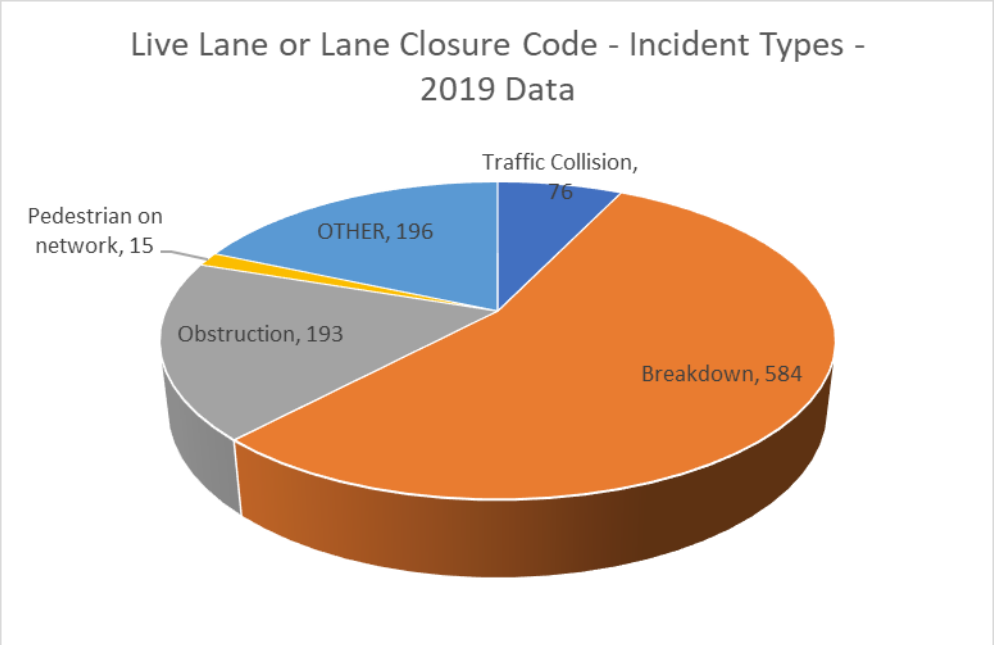


Figure 4.8 - 2019 incident types with live lane or lane closure final closure codes

Potential causes of lane closures have also been reviewed by considering the incident record classification codes for the full year of 2019. A single year dataset has been selected to be of a manageable size and to capture the most recent occurrences. Figure 4.8 indicates that by far the largest number of lane closures or live lane stops are associated with breakdown incidents, making up over half of the total. Of note, traffic collisions make up a relatively small number of reasons for lane closure, and lane closures due to pedestrians occurred only 15 times.

The rate of occurrence of breakdowns has been considered. For this 6.3 motorway mile scheme, 584 live lane breakdowns corresponds to an overall live lane breakdown rate of 93 per mile per year or 0.25 per mile per day. The Smart Motorway – All Lane Running Overarching Safety Report 2019 reported that the predicted live lane breakdown rate on a standard all lane running scheme was 0.35 live lane breakdowns per day per mile as an upper threshold for occurrence. However, evidence collected from nine operational schemes (including this one, but across an earlier time period) showed the overall actual average rate of live lane breakdowns is 0.18 per day. Therefore, in 2019, this scheme reported more live lane breakdowns per mile per day than average, but is still within the expected tolerance.

Key finding

Indication of a relatively high rate of live lane breakdown incident occurrences in comparison with other all lane running schemes, but remaining within tolerances.

4.4 Design Strategy Record and Departures from Standards review

The scheme Design Strategy Record has been reviewed to identify potential operational or safety related relaxations or departures relating to design. Departures are used to formalise the assessment, appraisal and approval for all instances where mandatory requirements are not implemented during schemes on the Motorway and All-Purpose Trunk Road Network. Many identified are likely to have a negligible impact but are included in Appendix E for completeness; those elements of note are shown in Table 4.5 below. Scheme design utilised Interim Advice Note 161/12.

Table 4.5 Key elements from scheme Design Strategy Record

Ref	Chapter	Element	Potential relevance to this work	Follow-on
4.1.4	Cross-section	Narrow lanes (J41-42)	J41-42 NB is five lanes No cross-section in standards for 5 lanes, but here Lanes 1 and 2 'narrowed' to 3.5m due to underbridge constraints. (L3 3.5m; L4 3.4m; L5 3.2m). Limited setback NB over rail bridge.	Check operational and safety performance of link – refer to Safety Analysis section 5.7
5.3.5.9	Junction Design	J41-42 weaving length	1130m weaving length, improvement to pre-scheme and counting against using ghost island at J42 diverge as this longer diverge layout reduces weaving length on the link. Requirements were auxiliary merge with ghost island lane drop, so auxiliary lane has been extended for whole link with alternative diverge layout.	Check operational and safety performance of link – refer to Safety Analysis section 5.7
5.5.14	Junction Design	J39 SB diverge	Permitted relaxation of single lane drop to two lane slip, instead of ghost island lane drop - to avoid Calder Navigation bridge. Taper length reduced to APTR dimensions.	Check operational and safety performance of this terminal junction – refer to Safety Analysis section 5.6
5.6	Junction Design	J42-41 weaving length	Less than 2km, appears to be slight improvement on 1100m weaving length before	Check operational and safety performance of link – refer to Safety Analysis section 5.7
5.12.2.1	Visibility	J39 NB stopping sight distance	Lane 1 stopping sight distance (SSD) reduced by max. of 3 steps (to 160m) to low and high objects due to Calder Navigation bridge	Check for problems at Calder Navigation bridge – refer to Safety Analysis section 5.6
9.1.1	ERAs	Strategy	Places of relative safety prior to the J41-42 5 lane high weaving link: • J40-41 emergency area at 296+155 (signed) • [approx. 1600m gap] • J41 exit slip 297+750 approx. (unsigned) • [Approx. 2335m gap to start of J42 hard shoulders] • J41 merge nearside wide hatching 298+750 approx. (unofficial, unsigned, would require weave across merge) • [5 lane high weave section] • J42 diverge hard shoulder and start of through J42 hard shoulder 300+085 approx. This is compliant with IAN 161/12 design requirements:	Check link for live lane stops, incidents – refer to Safety Analysis section 5.7
9.1.5.4	ERAs	J40 SB diverge	Pinchpoint widening converting hard shoulder to traffic lane in advance of the stop line, so "equivalent hard standing" area identified to be provided [this appears to have been completed]	Check link for live lane stops, incidents – refer to Safety Analysis section 5.2

Key findings

The following design compromises have been noted in order to accommodate constraints:

- Relating to the Junction 41 to 42 link, in particular northbound -

  - five lanes,
  - reduced nearside lane width,
  - limited setback over rail bridge.
- Relating to the Calder Navigation Bridge horizontal curve.
- At the Junction 39 diverge layout.

These areas were specifically considered as part of the safety analysis.

4.5 Operations feedback

Operations for the M1 Junction 39 to Junction 42 spoke to this project team via Microsoft Teams on 17th August 2020. Key points are noted below:

The tidal flows into (AM peak), and out of, Leeds (PM peak) were noted as presenting an operational challenge linked to volumes of traffic. Operations' view was that implementation of the M1 Junction 39 to 42 smart motorway scheme had considerably reduced congestion. Nevertheless, traffic volumes and movements on the Junction 41 to 42 link remained challenging, especially northbound with five lanes and high weaving flow.

No concerns were raised around breakdowns or emergency areas. Short term unlawful use of emergency areas undoubtedly occurs, but was rarely reported (due to short durations) and Operations considered that this very rarely led to incidents. Some potential for user confusion was noted given the adjoining section of M62 which has elements of both all lane running and dynamic hard shoulder operation.

Asset condition was discussed; no concerns raised around drainage, however potholes and bridge joints have required prompt responses. In particular the joints at the Calder Navigation bridge just north of Junction 39 have required attention.

Key findings

The operational challenges and remaining level of congestion on the Junction 41 to 42 link aligns with findings from the Stage 4 road safety audit and the design challenges acknowledged in the Design Strategy Record. This link will be considered specifically in the Safety Analysis section.

4.6 Data review outputs

Given the findings from the data review, the following specific factors will be considered further in the safety analysis section, drawing on all collision data in the after period:

- Junction 39 and immediately north of the junction
- Junction 41 to 42 link
- Collisions occurring during darkness hours

These are illustrated in Figure 4.9.

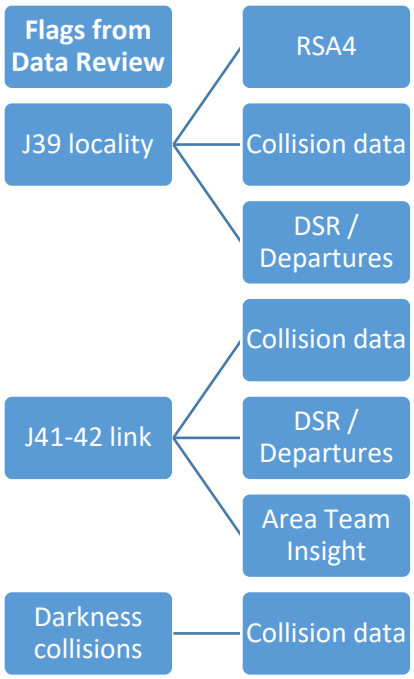


Figure 4.9 Specific factors identified from data review, to be considered for further safety analysis

5. Focussed Investigation

This section investigates in detail the key factors or areas identified in the preceding chapter, plus any additional factors or areas which come to light. It commences with a review of all collisions of fatal and serious severity, and all collisions associated with live lane stops. The objective of this section is to identify and verify treatable safety issues, or to clarify where certain factors or areas cannot be linked to a safety issue.

5.1 Fatal and serious collisions

5.1.1 Fatal collisions

One fatal collision has been recorded on the M1 between Junctions 39 and 42 between January 2016 and December 2019. Table 5.1 details the collision.

Table 5.1 Details of fatal collisions

Ref.	Location	Date Time	Conditions	Detail	Casualties Sex | Age - Severity	Comment
52I0085	Northbound, prior to J40	18/2/2018 0058	Dry/dark	Pedestrian on motorway struck by two vehicles. Contributory Factors: Pedestrian in dark clothing and pedestrian dangerous action in carriageway.	Male, 35 - Fatal	This section is unlit (was also unlit prior to smart motorway). The collision occurred on carriageway coincident with location of the Baptist Lane pedestrian/ cycle underpass under the M1 designated as Bridleway public right of way (underpass structure not amended by the smart motorway scheme).

Factors for further consideration

It is not clear from the limited details available for the pedestrian fatality if illness was a factor in the collision or if it was a suicide attempt. The incident location coincides with that of a dedicated pedestrian subway, hence all pedestrian-related incidents and collisions will be considered further (refer to section 5.5).

However, it can reasonably be concluded that this fatal collision is highly unlikely to have a causal link with the design or operation of the smart motorway itself.

5.1.2 Serious collisions

Fourteen serious collisions have been recorded on the M1 between Junctions 39 and 42 between January 2016 and December 2019. Of these:

- eight were recorded on the northbound carriageway and six on the southbound carriageway.
- four were recorded on a wet road surface (29%).
- seven were darkness collisions (50%), of which three were in a lit section.

Table 5.2 summarises these collisions.

Table 5.2 Details of serious injury collisions

Ref.	Location	Date Time	Conditions	Detail	Casualties Sex | Age - Severity	Comment
33V0635	Northbound, north of J39	31/03/2016 1238	Dry/Light	Lane 1 **live lane stop** for mechanical reasons. Vehicle 1 (car) stops in lane 1, Vehicle 2 (goods vehicle - GV) stops behind, Vehicle 3 (GV) strikes the rear of stationary vehicles. Contributory factors: failed to judge, failed to look.	Female, 35 – Slight Male, 67 – Serious Male, 37 – Slight	Live lane stop due to mechanical reasons. This appears in Incident data only as a collision, so it appears the breakdown itself was not reported to Operations (it may be that the collision happened too quickly after initial breakdown to reasonably expect a breakdown to be reported). **Likely to be related to smart motorway – breakdown in live lane, no hard shoulder.**
3481626	Northbound, near J39	08/04/2016 2105	Dry/Dark	**Loss of control** in lane 2 resulting in 2 vehicle collision. Contributory factors: loss of control	Female, 49 - Serious Male, 33 - Slight Male, 56 - Serious	Loss of control. Shown as light in data but sunset around 7.45pm, so assumed to have occurred in the dark. **Unlikely to be directly related to smart motorway.**
3670789	Southbound, approach to J39 exit slip	07/06/2016 1350	Dry/Light	Vehicle 1(car) **changing lane to exit** at J39 struck by Vehicle 2 (GV) changing lane from lane 2 to 1 on offside. At the same time there was a broken down GV in J39 exit slip road. Contributory factors: vision affected by vehicle blind spot	Female, 37 - Serious	Related to exiting from mainline and lane change **Unlikely to be directly related to smart motorway.**
38K1694	Northbound at J39	20/08/2016 2200	Wet/Dark	Vehicle 1 avoided **pedestrian in lane** 3 and struck barrier and vehicle 2. Vehicle 3 struck pedestrian and failed to stop. Contributory factors: **Pedestrian impaired by alcohol/** dangerous action in carriageway.	Male, 41 - Serious	Pedestrian in carriageway impaired by alcohol (no indication that this was an ex-vehicle pedestrian). **Unlikely to be related to smart motorway.**
38O1281	Northbound, J41 exit slip	24/08/2016 1633	Dry/Light	**Late exit manoeuvre**, Vehicle 1 struck barrier on nosing. Contributory factors: swerved, poor turn manoeuvre	Female, 26 - Serious Female, 17 Serious	Relating to exiting from mainline. **Unlikely to be related to smart motorway.**

Ref.	Location	Date Time	Conditions	Detail	Casualties Sex | Age - Severity	Comment
42P0232	Northbound near J41	25/02/2017 0320	Dry/Dark	Vehicle 1 **loss of control** due to sneezing fit, vehicle ends up sideways in lane 2. Vehicle 2 struck vehicle 1. Contributory factors: loss of control, travelling too fast for conditions.	Male, 33 - Slight Male, 36 - Slight Female, 42 - Serious	Loss of control, medical. **Unlikely to be related to smart motorway.**
4391696	Southbound between J42 and 41	09/03/2017 2030	Dry/Dark(lit)	Lane 4 **live lane stop** due to vehicle 1 **running out of fuel**. Vehicle 2 struck vehicle. Contributory factors: failed to judge.	Female, 24 - Serious Male, 42 - Slight	Live lane stop due to running out of fuel. This appears in Incident data only as a collision, so it appears the breakdown itself was not reported to TOS (it may be that the collision happened too quickly after initial breakdown to reasonably expect a breakdown to be reported). **Likely to be related to smart motorway, breakdown in live lane, no hard shoulder.** However root cause of breakdown was avoidable.
48J0366	Southbound, J39 exit slip	19/08/2017 0639	Dry/Light	Vehicle 1 struck island/barrier while exiting for J39, left carriageway down embankment. Contributory factors: **junction overshoot, impaired by alcohol**.	Male, 25 - Serious	Unclear direction of travel, description contradicts compass point. Relating to exiting from mainline. Impaired by alcohol. **Unlikely to be related to smart motorway.**
4930343	Northbound between J39 and J40 (MP 293/1)	03/09/2017 0540	Wet/Dark	Vehicle 1 struck nearside barrier resulting in **loss of control**. Contributory factors: loss of control.	Male, 24 - Serious Male, 24 Slight	Loss of control, wet conditions. **Unlikely to be directly related to smart motorway.**
53A0329	Northbound J41- 42 (link interpreted from Incident Data)	10/03/2018 0522	Wet/Dark(lit)	Vehicle 2 (minibus) mechanical failure so **travelling slowly in lane 1** intending to move into hard shoulder. Struck by Vehicle 1 (car) also in lane 1. Driver of Vehicle 1 positive breath test. Contributory factors: **Impaired by alcohol**, failed to judge.	Male, 36 Serious Female, 36 Slight	Mechanical failure led to slow vehicle. Reference made to hard shoulder but there isn't one, possible that this vehicle would have limped in hard shoulder had one been available. Impaired by alcohol. **Likely to be related to smart motorway, slow vehicle in live lane, no hard shoulder.**

Ref.	Location	Date Time	Conditions	Detail	Casualties Sex | Age - Severity	Comment
						However, alcohol impaired driver also a key factor.
5831431	Southbound, J39 exit slip	03/08/2018 1629	Dry/Light	Vehicle 1 (M/C) **changes lane** from 2 to 1 as traffic in lane 1 braking. Vehicle 1 **collides with rear of Vehicle 2** (car). Contributory factors: failed to look, failed to judge.	Male, 53 - Serious	Lane changing becomes shunt. **Unlikely to be related to smart motorway.**
68P1652	Southbound, J40 exit slip	25/08/2018 1830	Dry/Light	Vehicle 1 in lane 2 intending to exit at J40 **starts to change lane** but Vehicle 2 undertaking. Vehicle 1 loses control and strikes barrier. Contributory factors: none provided.	Male, 79 - Serious Female, 80 - Serious	Relating to exiting from mainline and lane change. **Unlikely to be related to smart motorway.**
6CI1918	Northbound, approach to J42	18/12/2019 2310	Wet/Dark(lit)	Vehicle 2 in lane 4 slows and moves across to lane 1 where it becomes a **live lane stop**. Vehicle 1 in lane 1 collides with rear of Vehicle 2. Contributory factors: failed to judge, failed to look, careless/reckless, sudden braking.	Male, 34 - Serious	Live lane stop. This appears in Incident data only as a collision, so it appears the breakdown itself was not reported to TOS (it may be that the collision happened too quickly after initial breakdown to reasonably expect a breakdown to be reported). **Likely to be related to smart motorway, breakdown in live lane, no hard shoulder.**
6CP1074	Southbound, approach to J39	25/12/2019 1854	Dry/Dark	Vehicle 1 has **struck central barrier** and stopped. Vehicle 1 **occupant has walked across** the carriageway and been struck by Vehicle 2. Contributory factors: none provided.	Male, 50 - Serious Male, 48 Slight	Root cause is a loss of control. Unclear direction of travel, description contradicts compass point. Pedestrian in carriageway. Occurred on Christmas Day. **Unlikely to be directly related to smart motorway.**

Key Findings

Ten of the 14 serious injury collisions are unlikely to be related to the design or operation of the smart motorway; i.e. they could reasonably be expected to have occurred elsewhere on the network with similar frequency or outcomes.

The four remaining collisions which could be related to the design or operation of the smart motorway all involve stopping / stopped vehicles in live lanes. The frequency or outcomes of these collisions may have been affected by not having a hard shoulder available. Live lane stop- related collisions of all severities are analysed in section 5.2. Common factors in serious injury collisions are highlighted in Table 5.3.

Table 5.3 Common factors in serious injury collisions

Factor	Frequency	Comment
Pedestrians in carriageway	2	One involved a pedestrian impaired by alcohol walking in the northbound carriageway near J39 and the second a passenger having been involved in a collision crossing the carriageway also at J39. **Two occurrences resulting in serious injury (plus one fatality) on a six mile long motorway scheme indicate that pedestrian-related collisions should be further analysed – refer to section 5.5.**
Alcohol related	3	One involved a pedestrian impaired by alcohol walking in the northbound carriageway near J39. Remaining two collisions occurred before 7am on a Sunday morning - one at the exit slip for J39 and the other involved the driver colliding into the rear of a stopped vehicle in a live lane. **Three alcohol-related occurrences resulting in serious injury for a six mile long motorway scheme indicate that alcohol-related collisions should be further analysed – refer to section 5.4.**
Live lane stops	4	Two of the live lane stops involved mechanical failure of some form. One involved a vehicle in lane 4 moving across to lane 1 to stop, and one was a lane 4 stop as a result of running out of fuel. Three of the live lane stops occurred at night on lit sections. Three were northbound and one southbound. **Live lane stop collisions of all severities to be further analysed – refer to section 5.2.**
Southbound approach to J39	4	Two of the collisions involved lane changing, one collision involved a vehicle exiting the mainline with the driver under the influence of alcohol, and the fourth collision involved a vehicle striking the central barrier, stopping and the occupant then crossing the carriageway. (Note: This includes the two southbound collisions which could have occurred on the northbound carriageway references 48J0366 and 6CP1074.) **Collisions in the vicinity and north of Junction 39 to be further analysed – refer to section 5.6.**
Vicinity of J39 northbound	3	One of the collisions involved loss of control in the dark, one a live lane stop and one a collision with a pedestrian walking in the carriageway under the influence of alcohol. **Collisions in the vicinity and north of Junction 39 to be further analysed – refer to section 5.6.**

5.2 Live lane stop related collisions and places of relative safety

Injury collisions (of all severities) have been investigated where they relate to live lane stops on the M1 Junction 39 to 42. The investigation is based on collisions recorded as occurring between opening (January 2016) to 31st December 2019. No further unverified incidents of live lane stop collisions have been identified as occurring in 2020 up to the date of this report's production.

The existing scheme provision of places of relative safety (including emergency areas) is first considered for context.

5.2.1 Places of relative safety

Places of relative safety provision comprises of emergency areas[1] (EAs) on the J39-40 and J40-41 links, and hard shoulders on diverge slip roads – refer to Figure 5.1. Measurement is approximate and from decision points. Requirements at the time of this scheme's design and construction (IAN 161/12) set a maximum spacing between emergency areas and / or decision points of 2.5km. The strategy and spacing for this scheme complies with those requirements.

Northbound		Southbound	
J42 Hard shoulder start		J42 hard shoulder end -100m	
2.25km		1.5km	
J41 diverge decision point		J41 diverge decision point	
1.75km		2.0km	
J40-41 EA		J41-40 EA	
2.3km		2.1km	
J40 diverge decision point		J40 diverge decision point	
2.1km		2.2km	
J39-40 EA		J40-39 EA	
1.6km		2.1km	
J39 Hard shoulder end -100m		J39 hard shoulder start	

Figure 5.1 Place of relative safety provision

Emergency areas have been retrofitted with orange surfacing and the latest sequence of approach signing; see for example Figure 5.2 showing the emergency area between Junction 40 and 39.

[1] An emergency refuge area (ERAs) as defined in the Motorways Traffic (England and Wales) Regulations 1982.

Figure 5.2 - Example of scheme emergency area - Southbound J40 to J39 (image from dashcam drive through footage July 2020)

5.2.2 Live lane stop collisions

Three collisions were serious severity and two were slight severity, as detailed below (repeating the serious injury collision details from section 5.1 above):

Table 5.4 Live lane stop related collisions

Ref.	Location	Date Time	Conditions	Detail	Casualties Sex | Age - Severity	Comment
47B1184	At J39 NB merge, indicated downstream of nosing	11/07/2017 1620 (Peak)	Rain – poor visibility / Light	Vehicle 1 (Car) stopped and broken down in merge L1, vehicle 2 (car) unable to avoid. Contributory factor: Poor turn or manoeuvre.	F17 – Sl F18 - Sl	Live lane stop in ghost island lane gain, struck by approaching vehicle in poor conditions. Casualties are in vehicle 2 only, assumed those in broken down car had exited vehicle. The apparent match in Incident records has the final closure code of breakdown at 16:04hrs, Operations deployed at 16:07 and arrived at 16:34, although a collision is also mentioned in the same incident entry. Possible, though not certain, that breakdown occurred and reported but car was then struck before Operations could reach scene. No hard shoulder on this slip / merge in current smart motorway layout, although a nearside hatched section potentially of a car's width is present at start of slip. **Likely to be related to smart motorway - no hard shoulder.**
33V0635	Northbound, north of J39, just north of Calder Navigation bridge	31/03/2016 1238 (Inter-peak)	Dry/Light	Lane 1 live lane stop for mechanical reasons. Vehicle 1 (car) stops in lane 1, Vehicle 2 (GV) stops behind, Vehicle 3 (GV) gone into the rear of stationary vehicles. Contributory factor: failed to judge, failed to look.	F35 – Sl M67 – Se M37 – Sl	Live lane stop due to mechanical reasons. This appears in Incident data only as a collision, so it appears the breakdown itself was not reported to Operations (it may be that the collision happened too quickly after initial breakdown to reasonably expect a breakdown to be reported). This is an area potentially affected by limited sight stopping distance (SSD) in lane 1 (identified in the scheme DSR) due to the left-hand curve and bridge parapet constraints. Next place of relative safety is emergency area, approx. 875m downstream; previous place of relative safety was at J39 intra-junction hard shoulder approx. 625m upstream. **Likely to be related to smart motorway – no hard shoulder, collision appears to have occurred at or downstream of area with reduced SSD.**
5340568	J41 to J40 SB, mid-link	04/03/2018 1034	Rain / Light	Vehicle 1 (car) stops in lane 1, reported no vehicle hazard lights illuminated, no attempts	M31 – Sl F24 - Sl	Live lane stop without precautionary measures applied by driver.

		(Inter-peak)		to contact HE or emergency services. Struck after approx. 5 minutes by vehicle 2 (car), in process of trying to avoid by swerving into L2. Contributory factor: failed to look, failed to judge, swerved, loss of control		Next place of relative safety is J40 exit approx. 1.1km downstream, previous place of relative safety was emergency areas approx. 1.1km upstream. Contributory factors appear to assign more responsibility to approaching driver. **Likely smart motorway related, no hard shoulder, although inaction of stopping driver as noted in collision report (i.e. no use of hazard lights, no reporting of breakdown / stoppage) did not follow advice or Highway Code.**
4391696	Southbound between J42 and 41	09/03/2017 2030 (Off Peak)	Dry/Dark(lit)	Lane 4 live lane stop due to vehicle 1 running out of fuel. Vehicle 2 struck vehicle. Contributory factor: failed to judge.	F24 Se M42 Sl	Live lane stop in offside lane due to running out of fuel. This appears in Incident data only as a collision, so it appears the breakdown itself was not reported to TOS (it may be that the collision happened too quickly after initial breakdown to reasonably expect a breakdown to be reported). Collision is mid-link on J42 to J41 section (no emergency areas on this link), next place of relative safety is J41 exit approx. 800m downstream, previous place of relative safety was hard shoulder at J42 approx. 800m upstream. **Likely to be related to smart motorway, no hard shoulder, breakdown in live lane; although out of fuel is a foreseeable and preventable breakdown.**
6CI1918	Northbound, approach to J42	18/12/2019 2310 (Off Peak)	Wet/Dark(lit)	Vehicle 2 in lane 4 slows and moves across to lane 1 where it becomes a live lane stop. Vehicle 1 in lane 1 collides with rear of Vehicle 2. Contributory factor: failed to judge.	M34 Se	Live lane stop. This appears in Incident data only as a collision, so it appears the breakdown itself was not reported to TOS (it may be that the collision happened too quickly after initial breakdown to reasonably expect a breakdown to be reported). Collision occurs at diverge taper, so approximately 100m short of the start of hard shoulders at J42. Previous place of relative safety would have been J41 exit, approx. 2km upstream. Collision occurring approx. 100m short of hard shoulders demonstrates that some vehicles / circumstances make ability to limp on very difficult. **Likely to be related to smart motorway, no hard shoulder, breakdown in live lane.**

5.2.3 Live lane stop- related collisions - discussion

One live-lane stop-related collision occurred during peak hours, the remainder occurred off peak.

Two of the five live-lane stop-related collisions were caused or exacerbated by driver action – allowing a vehicle to run out of fuel in lane 4, and stopping without setting hazard lights or alerting / seeking help. The manner of stopping (i.e. in lane 4 in one case, or without any warning lights set in the other) and the driver behaviours indicate that the smart motorway had a limited material effect on the occurrence or outcomes of these two collisions.

One of the collisions occurred at the junction 42 northbound only approximately 100m short of the start of hard shoulder. This demonstrates that some vehicles will rapidly come to a stop and not be able to continue, in which case even much closer emergency areas spacing would still present a low probability of capturing a suitable stopping place. Closer places of relative safety spacing may not have changed the outcome of this event as the stopping vehicle appears to have had very limited ability to limp.

The two incidents recorded north of junction 39 can be more closely linked to the smart motorway. The first occurred on a merge which no longer has a hard shoulder, although the stricken vehicle would only just have passed a length of hatching on the slip road itself. Here, the hard shoulder has been converted to create a merge which can adequately cater for peak time traffic, which itself reduces risks of congestion and congestion-related collisions. However, in creating the suitable merge there was no place of relative safety and a broken down vehicle has been struck.

The second incident occurs north of junction 39 just after the left-hand curve over the Calder Navigation bridge, a set of constraints which reduce stopping sight distance, in the worst case from 295m to 160m for a length of 80m in lane 1. The collision occurred at 12:38 pm, not a time where the road tends to be congested.

Whilst the curve and bridge pre-date the smart motorway scheme, creating a new lane 1 closer to the parapet would create visibility challenges in circumstances such as these. The visibility constraint could have been a factor in this collision, reducing the opportunities for the approaching vehicles to identify the stopped vehicle. However, it is important to judge this in context; only one other northbound collision (of any type) is recorded within 300m of this one – which relates to a lane change. There is no other history of shunts or striking stopped vehicles in this locality within four years' collision data.

All live lane stop- related collisions appear to have happened within a short time of the vehicle stopping; there is no indication of these occurring in spite of signals being set to protect the stopped vehicle, as there was insufficient time or no notification to Highways England. The programme wide introduction of Stopped Vehicle Detection may reduce the risk for some of these collisions, in particular for those where the vehicle stopped in live lane with no lights nor attempts to alert emergency services or Highways England.

Incident data for the scheme records an average of 562 breakdown events per year which attract a live lane code. This means that, in the same four year period that these five injury collisions relating to live lane stops have occurred, Highways England have recorded 2,248 live lane breakdowns – giving an approximate ratio of one live lane stop injury collision for every 450 live lane breakdown incident reports.

Key findings

Whilst reported occurrences of live lane breakdowns are high on the scheme, the number of resulting injury collisions is relatively low. Given that two of the five live lane stop-related collisions could feasibly have been avoided by different driver behaviour or journey preparation, there is limited evidence of a treatable issue with live-lane stop-related collisions on this scheme[2].

[2] It should be noted for context that two fatal collisions from the before period involved vehicles stopped on the hard shoulder. However these occurred just outside the scheme extents (one J39 SB in 2011 and one J42 NB in 2013) so have been excluded from the analysis. This is incidental to the scope of this report, but serves to illustrate the risks from hard shoulders and how the before collision figures could have been quite different under a slightly amended scope.

5.3 Collisions during darkness

The collision data review identified 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).

Thirty-seven collisions during darkness have been identified after scheme opening; one fatal (intoxicated pedestrian - reviewed above), nine serious and 29 slight.

Seventeen collisions have been recorded in the link between J39 and J40 (including the pedestrian fatality and a further pedestrian serious injury collision), and ten between J40 and J41; both links are approximately 4km long and unlit. Ten collisions occurred in the approximately 2km long lit link between J41 and J42.

As part of this analysis, the darkness collisions have been grouped by type.

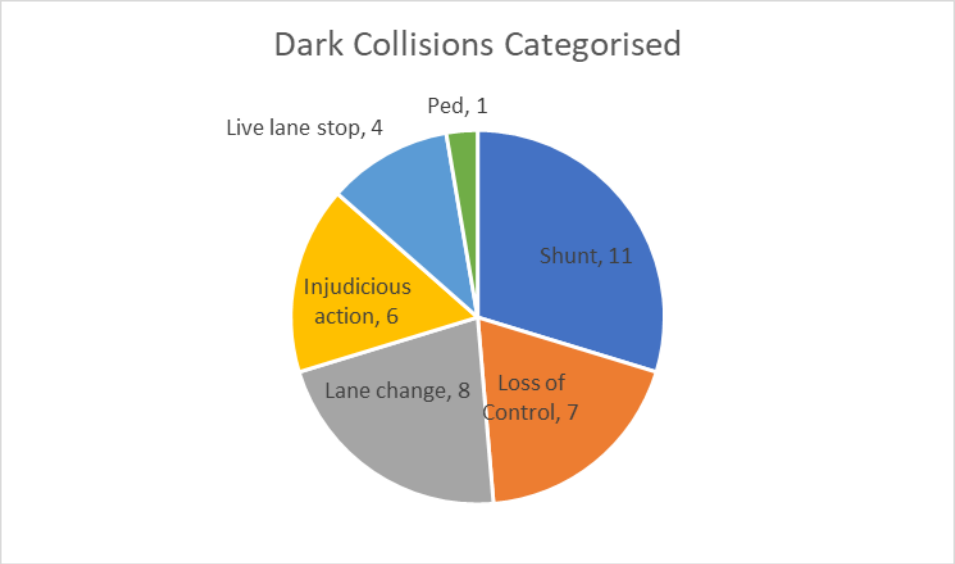


Figure 5.3 Collisions occurring in darkness grouped by type

Figure 5.3 shows that shunt collisions remain the most common type during hours of darkness, followed by lane changes. During darkness hours, loss of control collisions tend to occur more frequently as these are times of low flow and potentially high speeds overnight.

Contributory factors allocated to vehicles involved in darkness collisions have been considered, with those making up the most frequently reported 80% shown in Figure 5.4.

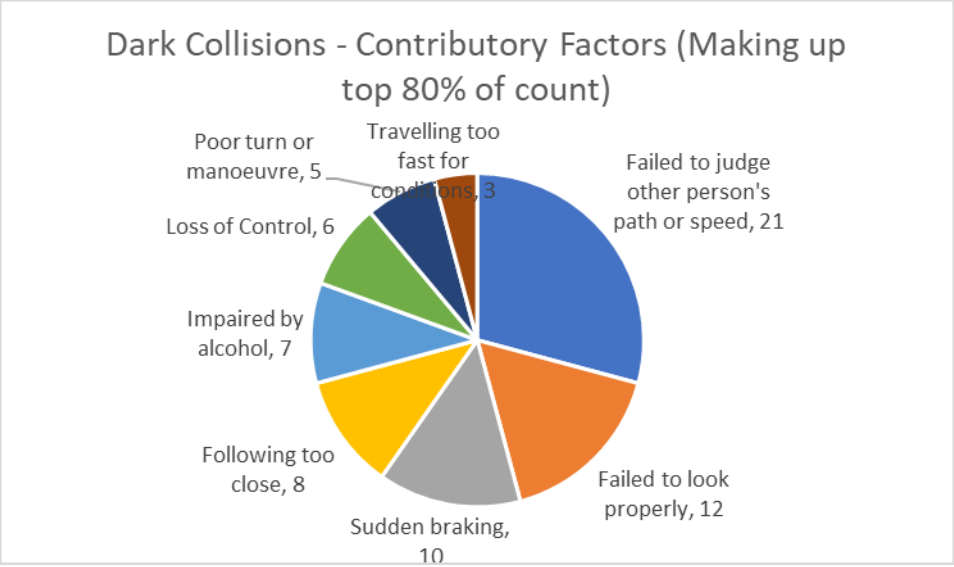


Figure 5.4 Top contributory factors for collisions occurring in darkness

Key findings

Two key points are evident from Figure 5.4:

- the appearance of impaired by alcohol as the fifth most frequently cited factor – this is more typically outside of the top ten contributory factors (13th overall in the 2018 SRN Casualty report).
- Sudden braking is third most frequent – more typically this is less frequently reported, being 7th overall in the 2018 SRN Casualty Report.

Collisions occurring during darkness are higher in proportion and consideration of contributory factors has highlighted two points – sudden braking (and associated factor following too close) point towards a level of congestion and flow breakdown on the scheme having a bearing on collision occurrences; and impairment by alcohol appears more frequently than would be expected and warrants further analysis.

5.4 Collisions with impaired by alcohol contributory factor

Six out of eighty (7.5%) injury collisions within the scheme extents recorded an impaired by alcohol contributory factor (four-year data period). As noted in section 5.3 the occurrence of this contributory factor is higher than would typically be expected on motorways. In the three-year period before the scheme, only one collision attracted an impaired by alcohol contributory factor.

In two of the collisions the casualties impaired by alcohol were pedestrians – one a fatality who was reported walking in live lanes, and one an ex-vehicle pedestrian struck having exited a stricken vehicle following an initial loss of control collision at Junction 39.

Of the other collisions, two involved loss of control, one was a live lane stop (out of fuel, as included in above analysis) and one collision did not attract a description.

Driver postcodes where available constitute a very small data set but South Yorkshire / Sheffield codes appear most frequently. A Wakefield postcode (implying a very local driver) appears only once.

Against a national trend of low and generally declining drink drive collisions, it is unlikely that a significant additional number of people are choosing to drink and drive. Whilst the number of collisions with impaired by alcohol cited as a contributory factor has increased in the after period, there is no clear explanation as to why; the smart motorway has amended elements of the layout but also introduced elements of control.

Key findings

As with all roads, smart motorways are designed for the majority of drivers who are alert and not impaired. Preventing drink driving remains a national, social issue addressed by social intervention and enforcement. There is limited prospect of engineering or operational changes having a material effect; the social issues continue to be addressed by social intervention, educational campaigns and enforcement.

5.5 Pedestrian incidents and collisions

Analysis of the fatal collision on this section identified an intoxicated pedestrian in the carriageway at a location where an underpass is present. This has prompted analysis of data to establish other trends around pedestrians on the network, with the southern extents of the analysis incorporating all of Junction 39 - as south-facing slips may provide an access route.

Four injury collisions with pedestrian involvement have been identified over four years, all during darkness hours, two originating off-network and two ex-vehicle:

- The aforementioned fatality from a potentially socially vulnerable pedestrian, who had gained access to the carriageway at a location where an underpass (Baptist Lane pedestrian subway) is provided.
- A serious injury collision from an intoxicated pedestrian in the carriageway intra-junction at Junction 39.
- A serious injury collision which began as loss of control and striking central reservation, then an intoxicated passenger left the stricken vehicle and was struck by on-coming traffic.
- A slight injury collision where a driver had stopped to refuel in lane 1 and was struck by a passing vehicle, breaking their elbow.

Incident data has been assessed with a final closure code of Pedestrian or Pedestrian on network, with incidents grouped by location, see Figure 5.5. This data represents 270 incident reports over four years. Of note, when further filtered to identify whether a pedestrian code was accompanied by a broken down vehicle code, this occurred only 11 times (4%). This indicates that only a small proportion of Pedestrian incident reports are associated with a break down or stopped vehicle.

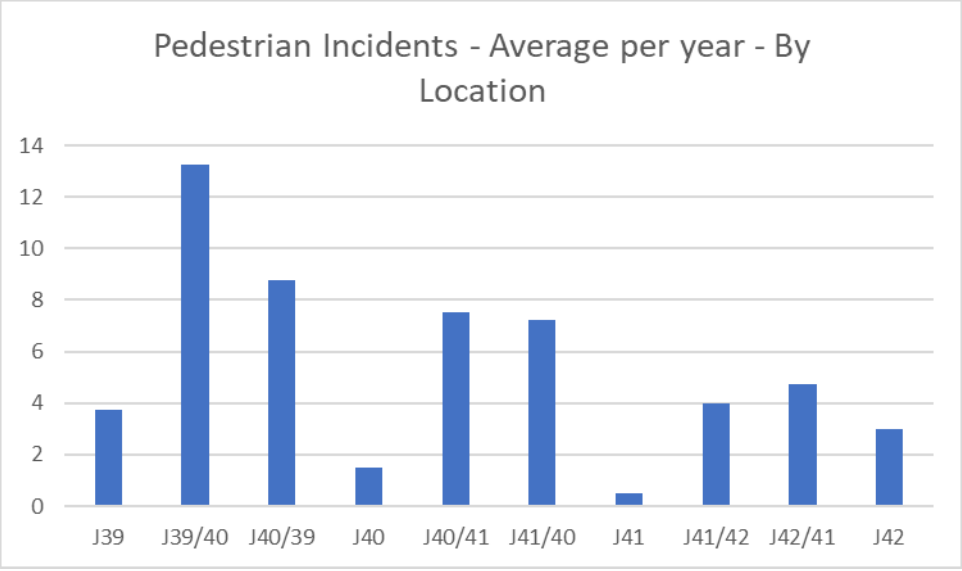


Figure 5.5 Average pedestrian incidents per year by location

Pedestrian incident reports have been grouped by location. This identified that:

- Most incidents are recorded for the Junction 39 to 40 link.

- The junction with highest number of incidents was Junction 39.

As the Junction 39 to 40 link is the link closest to urban / sub-urban areas of Lupset to the east and South Osset to the west, the available crossing points for pedestrian, cycle or equestrians have been considered within that link. These are shown below using most recently available mapping images.

Horbury Underpass / Green Lane (431048,418200) – a public right of way

Figure 5.6 shows metal palisade fencing of the railway estate to the right of the image, and timber post and rail fencing provided at the motorway boundary.

Figure 5.6 Horbury Underpass / Green Lane viewed from the west (source: Google Streetview, August 2020)

Figure 5.7 Horbury Underpass / Green Lane viewed from the east (source: Google Streetview, August 2020)

Horbury Road Bridge (430566,418885) – the A642

Wide footways are provided and some lighting is evident.

Figure 5.8 Horbury Road Bridge viewed from the west (source: Google Streetview, August 2020)

Figure 5.9 Horbury Road Bridge viewed from the east (source: Google Streetview, August 2020)

Snapethorpe Accommodation Bridge (430302,419160)

Figure 5.10 Snapethorpe Accommodation Bridge viewed from the south (source: Google Streetview, August 2020)

Baptist Lane Pedestrian Subway (429715,419895) – a public right of way

It has not been possible to source publicly available ground-level images.

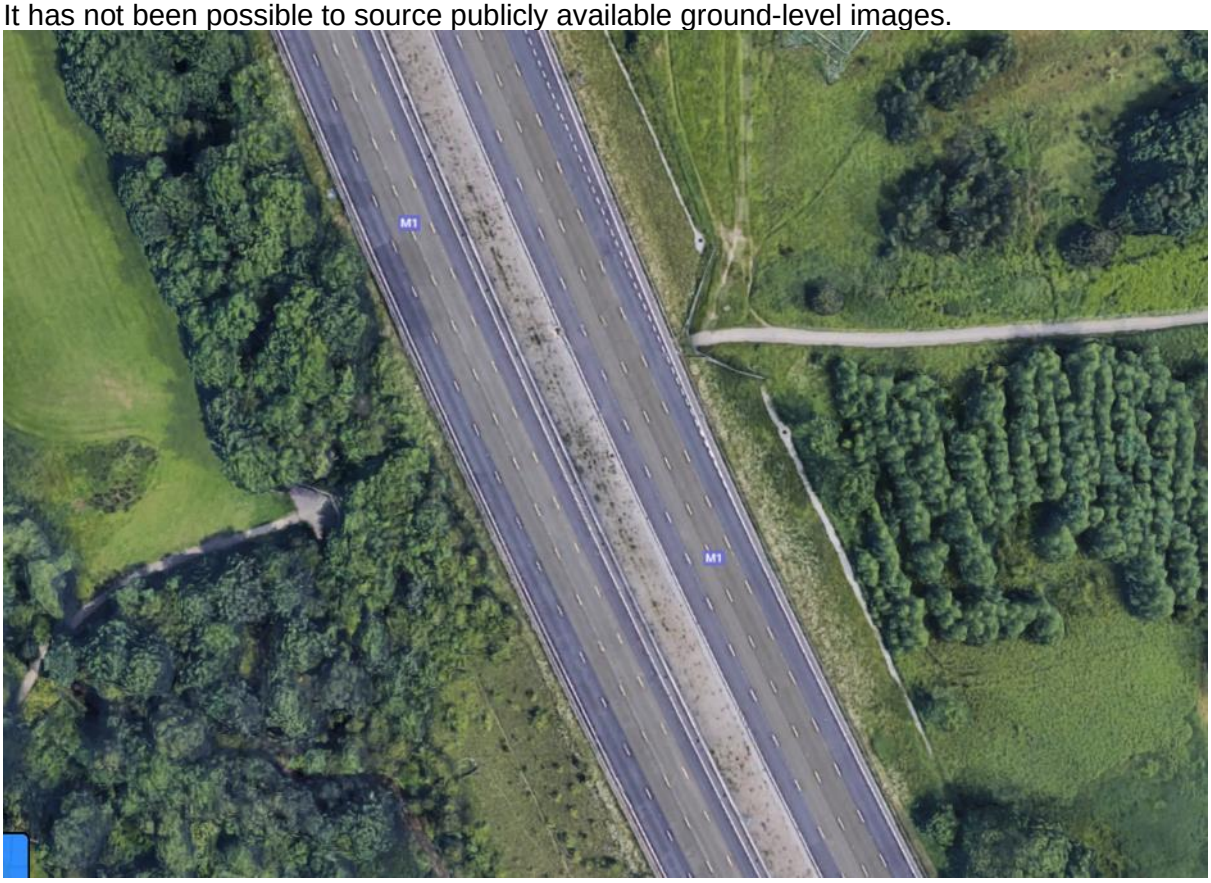


Figure 5.11 Baptist Lane Pedestrian Subway (source: Google Maps, August 2020)

Queens Drive Bridge (429546,420477) – Sub-urban road incorporating public rights of way

In Figure 5.12, note coincidence of pedestrian visible on carriageway in this image, apparently next to a stopped vehicle (most likely ex-vehicle pedestrian).

Footways are provided and some lighting evident.

Figure 5.12 Queens Drive Bridge viewed from the west (source: Google Streetview, August 2020)

Figure 5.13 Queens Drive Bridge viewed from the east (source: Google Streetview, August 2020)

5.5.1 Discussion

The southern end of the scheme, in particular the J39 to J40 link, appear to have notably high instances of pedestrian-related incidents; the one fatal and one of the serious injury pedestrian collisions relate to pedestrians from off the network being harmed on this link.

Key findings

The range of potential crossing and access points and the sub-urban setting of this link are risk factors. Pedestrian crossing facilities are provided at the obvious desire lines, although provision of fencing does appear to vary and it has not been possible to verify lighting levels in subways. Further consideration should be given to a review of the measures that restrict access to the motorway, and to the safety and quality of facilities to ensure that pedestrians are not being prevented or deterred from using them.

5.6 Collisions in the vicinity of Junction 39

A cluster of collisions has been identified for analysis around the north side of Junction 39, in an area from the Junction 39 north-facing noses (i.e. the start / end of the smart motorway environment) to the half mile southbound advance direction sign (approximately marker post 291/3).

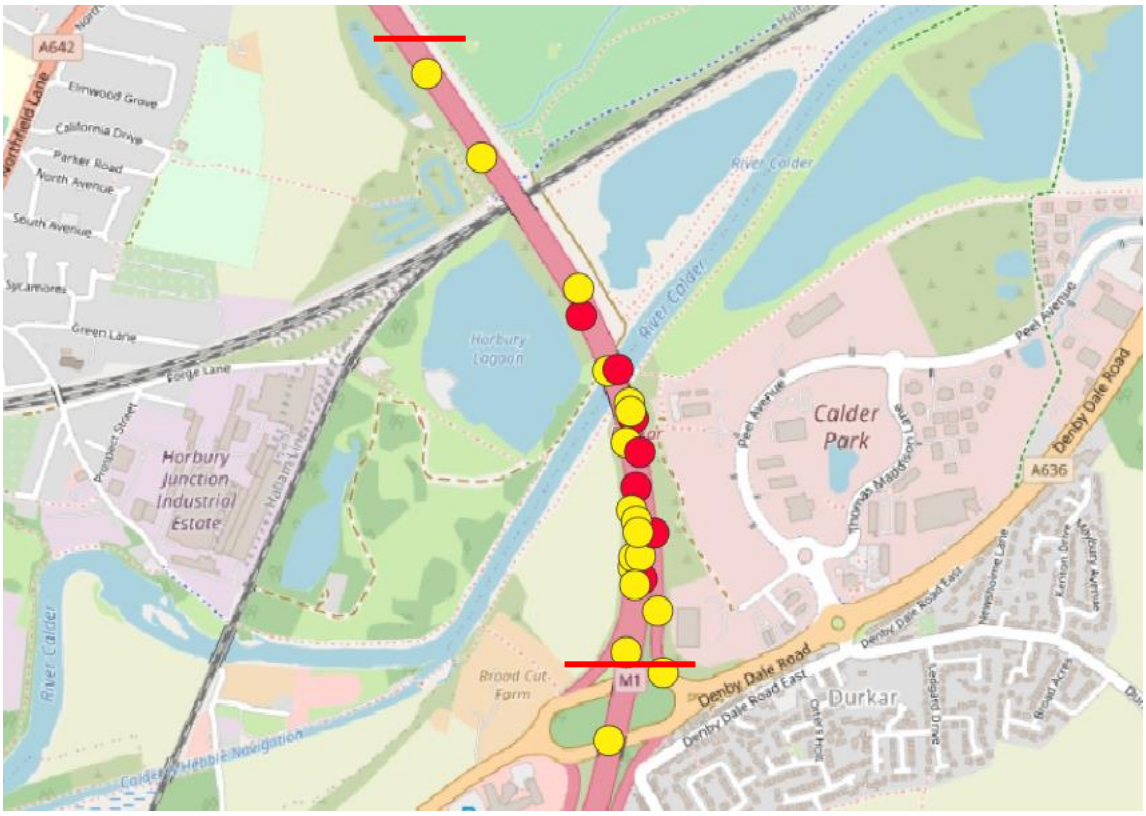


Figure 5.14 M1 junction 39 area of focus, showing post-opening collisions (yellow = slight, red = serious severity; no fatals recorded in this section)

Twenty three injury collisions have been identified in this locality over four years (averaging 5.75 per year); seven serious severity (1.75 per year) and sixteen slight (four per year). No fatal collisions have been recorded. Twelve collisions occurred during darkness hours, 11 during daylight. It is unusual to see more darkness than daylight collisions in general on a motorway, although it should be noted that this is a specific location with small overall numbers of collisions under consideration.

Within the area of interest, collision locations have been categorised from records between the mainline (northbound or southbound), the merge / diverge slips, or intra-junction. One collision with no supporting data is also recorded within the section. Collisions are distributed relatively evenly, apart from the northbound mainline, which contains notably the greatest number. Collisions have also been analysed to be grouped by type. Refer to Table 5.5.

Table 5.5 Collisions at Junction 39

Date	Severity	Daylight / Dark	Collision location	Collision category
11/04/2017	Slight injury	Dark	? [direction not recorded]	? [not recorded]
22/10/2016	Slight injury	Dark	SB mainline	Injudicious action
02/03/2016	Slight injury	Dark	NB mainline	Lane change
14/05/2019	Slight injury	Daylight	NB mainline	Lane change
25/01/2018	Slight injury	Dark	NB mainline	Lane change

Date	Severity	Daylight / Dark	Collision location	Collision category
16/06/2017	Slight injury	Daylight	SB mainline	Lane change
07/06/2016	Serious injury	Daylight	SB diverge	Lane change
31/03/2016	Serious injury	Daylight	NB mainline	Live lane stop
11/07/2017	Slight injury	Daylight	NB merge	Live lane stop
12/10/2018	Slight injury	Daylight	NB mainline	Loss of control
08/04/2016	Serious injury	Daylight	NB mainline	Loss of control
17/07/2019	Slight injury	Daylight	NB mainline	Loss of control
28/10/2017	Slight injury	Dark	NB mainline	Loss of control
25/12/2019	Serious injury	Dark	SB mainline	Loss of control
10/04/2018	Slight injury	Daylight	SB mainline	Loss of control
19/08/2017	Serious injury	Dark	SB diverge	Loss of control
20/08/2016	Serious injury	Dark	Intra-junction	Pedestrian
02/02/2019	Slight injury	Dark	NB mainline	Shunt
31/03/2016	Slight injury	Daylight	NB merge	Shunt
03/11/2016	Slight injury	Daylight	NB merge	Shunt
08/11/2018	Slight injury	Dark	SB mainline	Shunt
21/09/2018	Slight injury	Dark	SB diverge	Shunt
03/08/2018	Serious injury	Daylight	SB diverge	Shunt

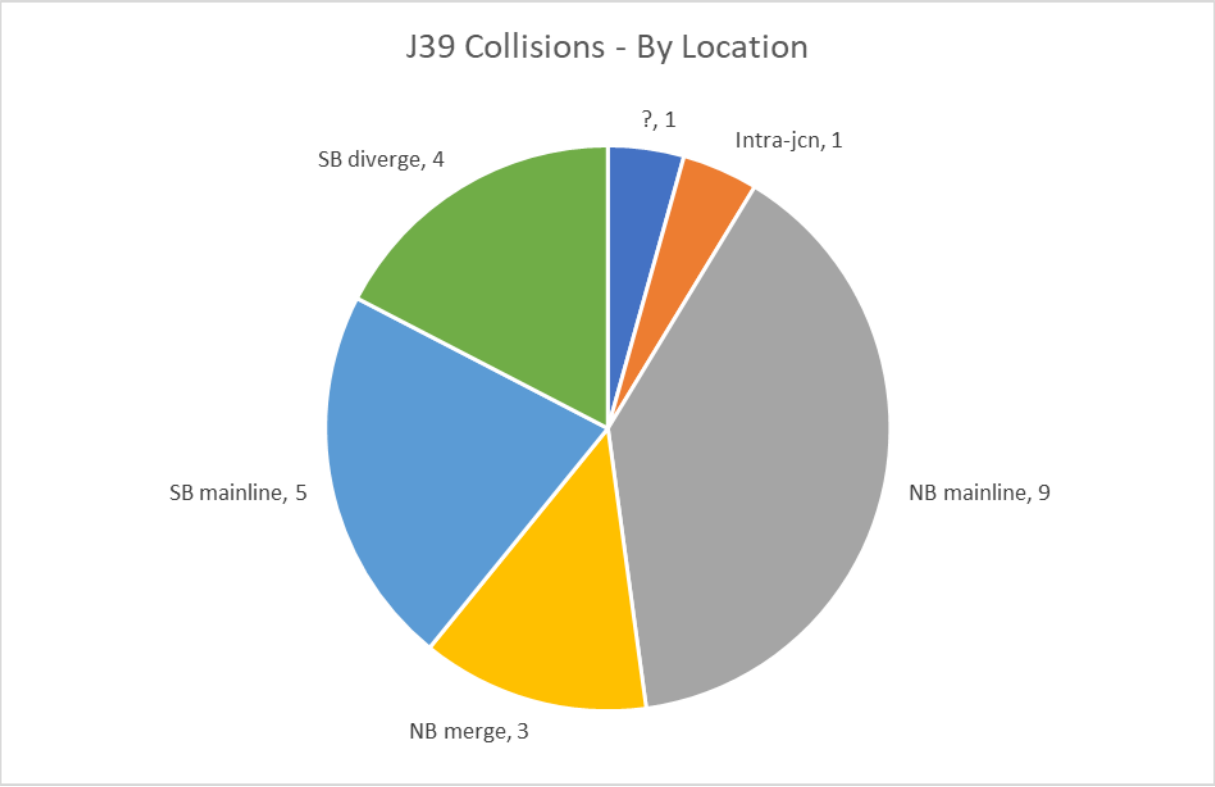


Figure 5.15 M1 Junction 39 collisions by location

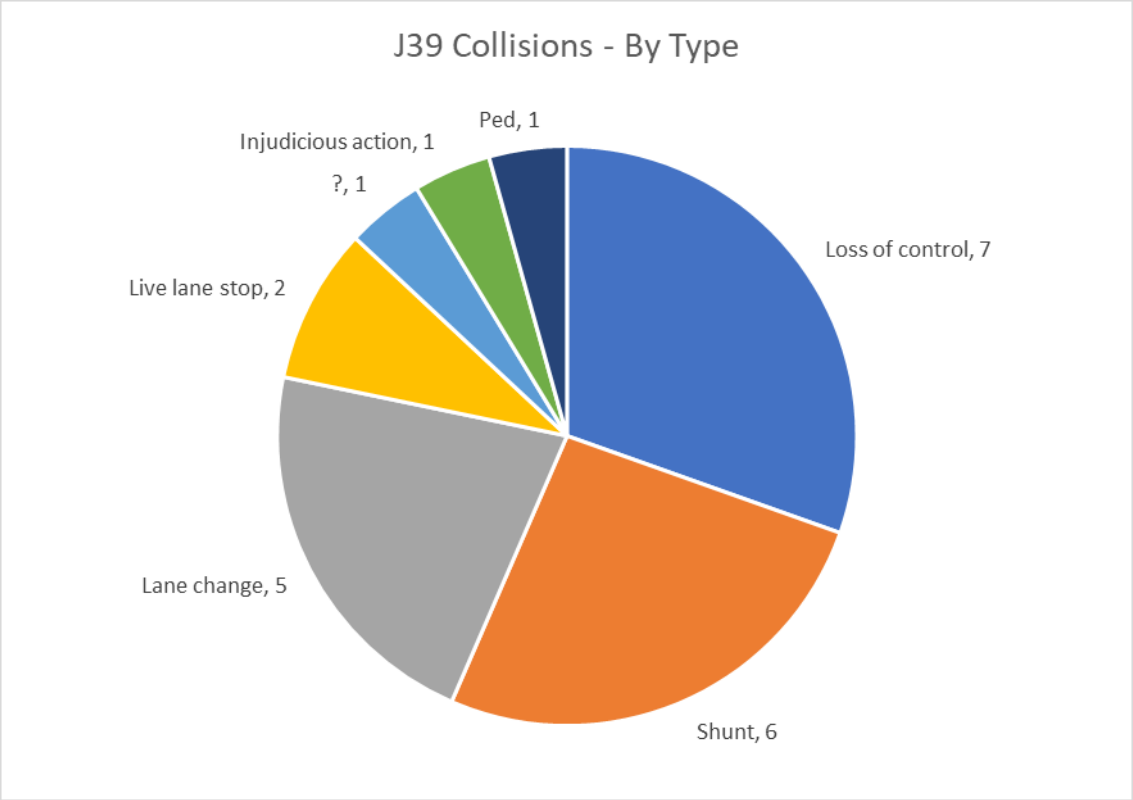


Figure 5.16 M1 Junction 39 collisions by type

Considering the location factors and collision type information together, the following points emerge:

- Northbound mainline collisions are most frequently loss of control or lane change collisions;
- Southbound mainline collision types vary; loss of control is most frequent, occurring twice;
- Unusually for a motorway, loss of control collisions occur more frequently than shunts[3];
- Shunts are associated with the merge or diverge slips more than the mainlines, the northbound mainline shunt is unconventional in occurring at night in low flow conditions where a taxi struck the rear of another car;
- Only two loss of control collisions have occurred in rain conditions, although two of four occur during high winds which may be associated with the 'open' river bridge setting in the locality. One, involving an SUV, directly cites a gust of wind as leading to loss of control.
- In addition to two shunts, the southbound diverge also has both a lane change and a loss of control collision; the northbound merge has shunts and one live lane stop (i.e. a specific type of shunt) only.

Contributory factors cited at least twice have also been counted for these collisions (note that each vehicle can have up to six contributory factors assigned by the reporting police officer, so there will typically be more contributory factors than collisions):

[3] Shunts are the most frequently occurring collision type in the SM-ALR Overarching Safety Report 2019

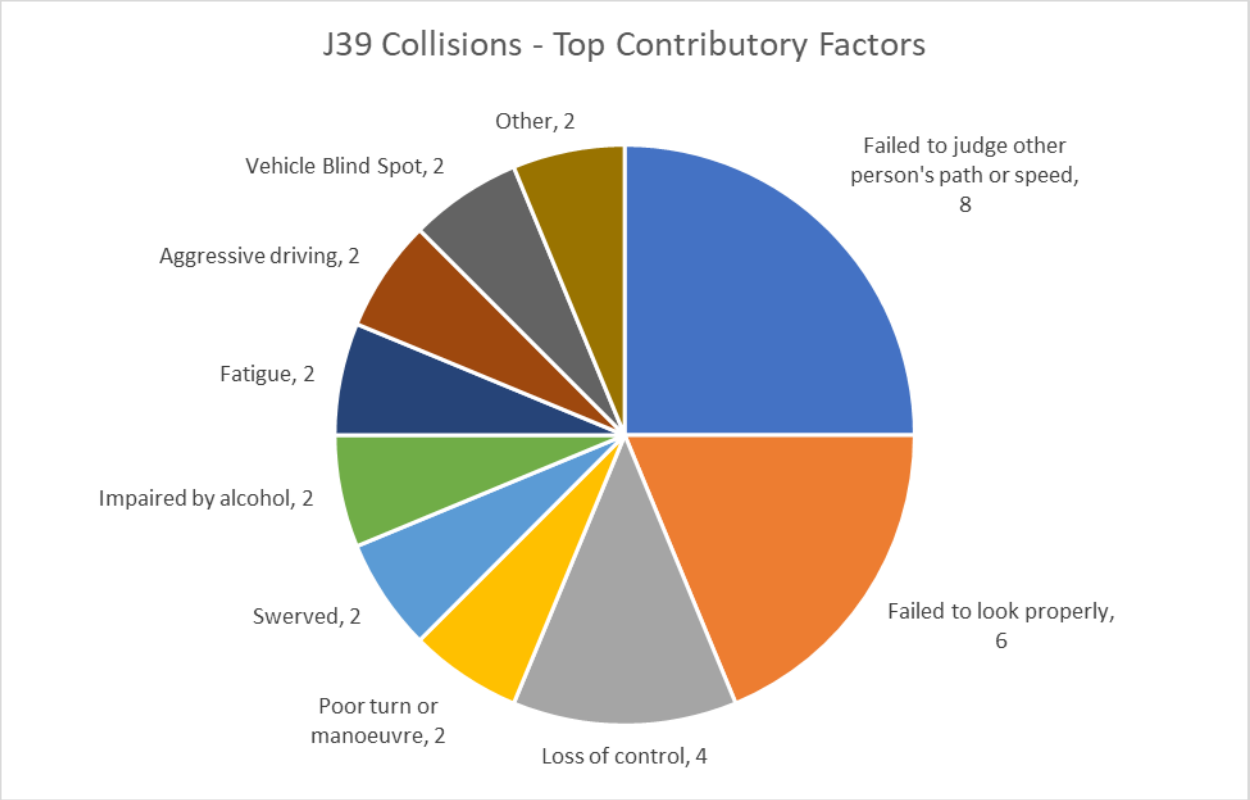


Figure 5.17 M1 J39 collisions - top contributory factors

This distribution of contributory factors is relatively similar to that reported for motorways nationally in the SRN Casualty Report 2018, with the exception of impairment by alcohol, which would not ordinarily be a top ten factor. It should be noted however that these are represented by a small data set when considering collisions within such a specific locality.

5.6.1 Discussion

Analysis of the cluster of collisions in the vicinity of Junction 39 has shown few common factors, although more collisions occur northbound than southbound. Loss of control collisions occurring northbound are the largest discernible sub-group here, accounting for four collisions.

It is not unusual to find a number of lane change collisions in the vicinity of a junction as vehicles change lanes to avoid slower leaving or joining traffic. This factor may be exacerbated by the lane gain / drop arrangement here, however this is a necessary feature as the terminal junction of the smart motorway scheme.

The setting at this location is worthy of consideration. This is a low point in terms of elevation (i.e. notable downhill approaches from both directions); there is a horizontal curve and the bridge over the Calder Navigation watercourse reduces setback to a vehicle restraint system and forward visibility in lane 1 northbound. Refer to Figures 5.18 and 5.19.

As a lane drop terminal junction this location is also prompting lane change movements southbound, however the primary 1 mile direction sign is verge mounted map-style (not indicating a lane drop) and it is situated immediately after other signing and an emergency area, which may draw attention away. Refer to Figure 5.20.

Figure 5.18 - M1 Northbound north of Junction 39 merge - image from July 2020 dashcam footage. Lefthand curve and bridge visible.

Figure 5.19 - M1 Southbound north of Junction 39 diverge - image from July 2020 dashcam footage. Righthand curve and bridge parapet visible.

Figure 5.20 - M1 Junction 39 Southbound: primary 1 mile direction sign, located immediately downstream of emergency area and other signing. Image from July 2020 dashcam footage.

Key findings

The rate of occurrence of injury collisions in this relatively concentrated area at Junction 39 does indicate that further measures should be considered. It is possible that the confluence of the downhill approaches, horizontal curvature, the Calder Navigation bridge with limited setback to vehicle restraint system and an open aspect, and the lane gain /drop arrangement, is creating a particularly unforgiving environment. This could be contributing to loss of control collisions and some higher speed, higher severity incidents. This section is unlit (and was unlit prior to the smart motorway), which may further restrict road user ability to perceive and react appropriately to the layout during darkness hours.

The occurrence of injury collisions at this location indicates that specific local improvement measures should be considered (refer to section 6 Potential Interventions).

5.7 Operation of the Junction 41 to 42 link

Operation of this link is analysed in detail due to the intrinsic features – a short weaving length with high flows and five northbound lanes is noted within the scheme Design Strategy Report and was commented upon by Operations. Initial collision analysis also identified a potentially high number of collisions occurring during darkness hours on this link. Refer to Figure 5.21 for an image of the northbound link, showing the five-lane arrangement. Analysis considers occurrences between the centre of Junction 41 and the approximate back of south facing noses (i.e. the limit of the smart motorway) at Junction 42.

Figure 5.21 – Junction 42 northbound diverge - five lanes and bridge parapet constrains setback, dashcam footage July 2020

Incident data has been analysed in addition to collision data to provide a broader picture on the overall operation of this link. Incident data identifies 1,748 incidents reported in four years on this section (averaging 1.2 per day, or 6 incidents reported every 5 days).

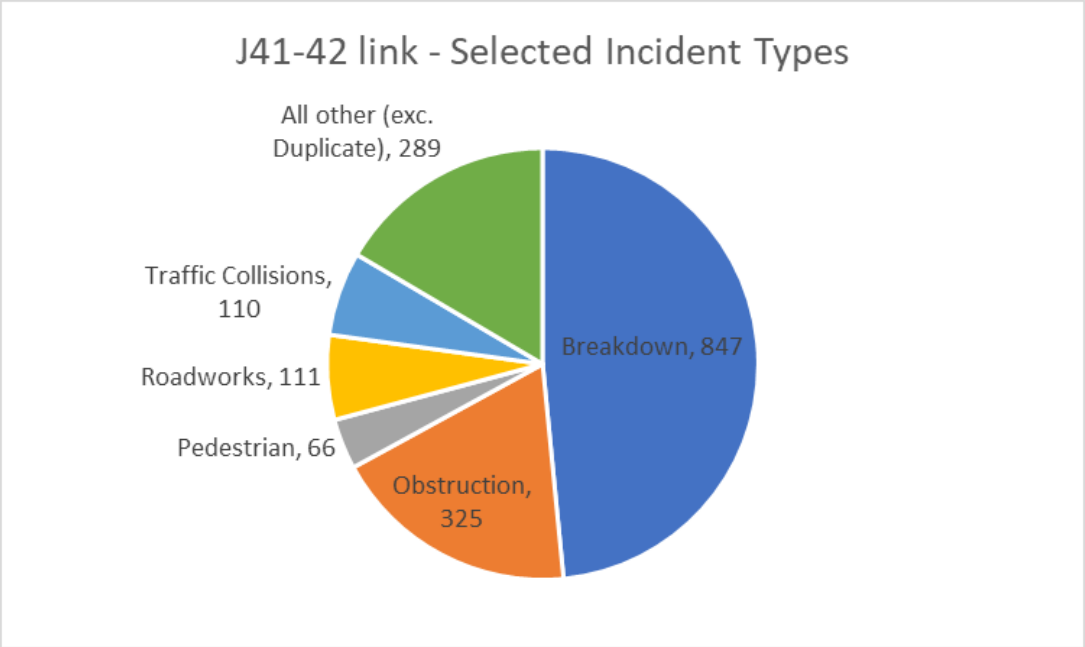


Figure 5.22 M1 J41-42 selected incident types

The make up of these is similar to the distribution of incidents across the overall scheme, with breakdowns the most common occurrence (average approximately 0.6 per day, or three every five days), followed by obstruction and traffic collision. Planned roadworks also occur relatively frequently within the reported data; although included in 'Incident data' these occurrences are business as usual, planned and controlled, they are not reactive incidents in the conventional sense.

From collision data, twenty one injury collisions have been identified on this link over four years (averaging approximately five per year); two serious severity and nineteen slight. No fatal collisions have been recorded.

Within the link, collision locations have been categorised from records between the mainline (northbound or southbound), the merge / diverge slips, or intra-junction.

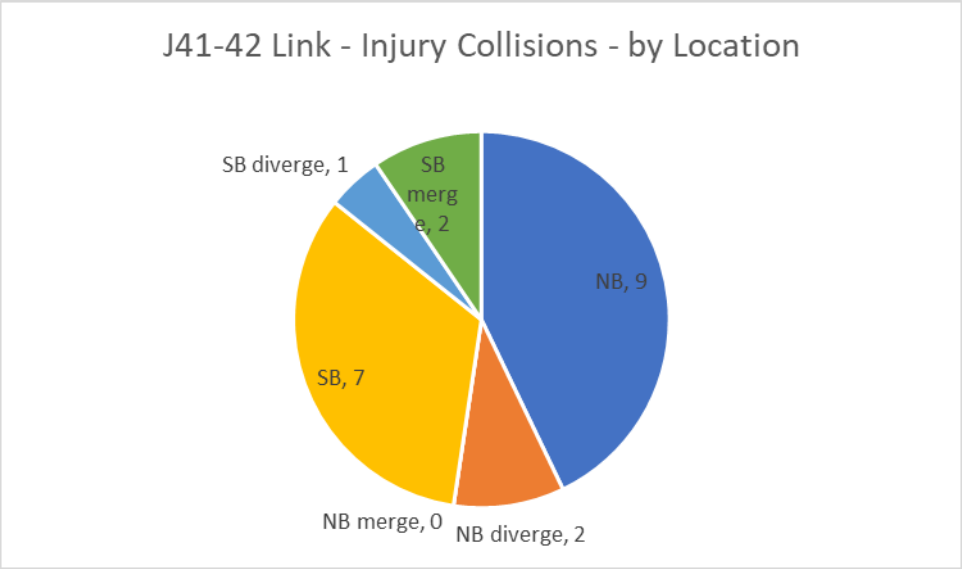


Figure 5.23 M1 J41-42 injury collisions by location

Collisions are distributed relatively evenly between northbound (five lane section) and southbound (four lane section); only one collision is recorded at Junction 41 (southbound diverge), with four at Junction 42 (two on northbound diverge, two on southbound merge).

Collisions have also been analysed to be grouped by type:

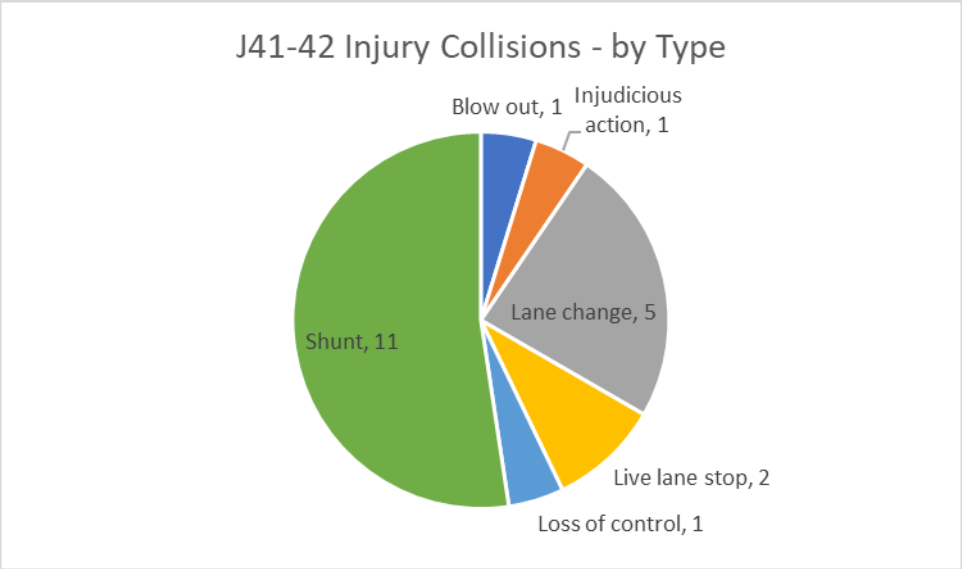


Figure 5.24 M1 J41-42 injury collisions by type

Considering the location factors and collision type information together it can be seen that:

- All collision types are relatively evenly distributed across locations, for example four shunts occur on the southbound mainline and five on the northbound mainline.
- The exception to the above is lane change type collisions, none of which are recorded on the northbound mainline five lane section.
- There is no emergency area provision on this link, however only two live lane stop- related injury collisions are recorded (one northbound, one southbound).

Ten (almost 50%) of the collisions on this link have occurred during darkness, which is a greater than typical proportion based on the 2018 SRN Casualty Report – and particularly notable as this is a lit link. Only three shunts occurred during darkness, whilst all lane change collisions and both live lane stop collisions occurred during darkness. Reduced ambient lighting compared to daylight reduces drivers' ability to perceive and react to a stopped vehicle in the carriageway. Note however, that this same logic – of difficulties in perceiving and reacting to slow or stopped vehicles in artificial light - has not seen a high proportion of shunt collisions during darkness on this link, so lighting levels or quality appear unlikely to be a key factor. Lighting provided is recent, being replaced by the smart motorway scheme in 2013-16.

Contributory factors cited at least twice have also been counted for these collisions:

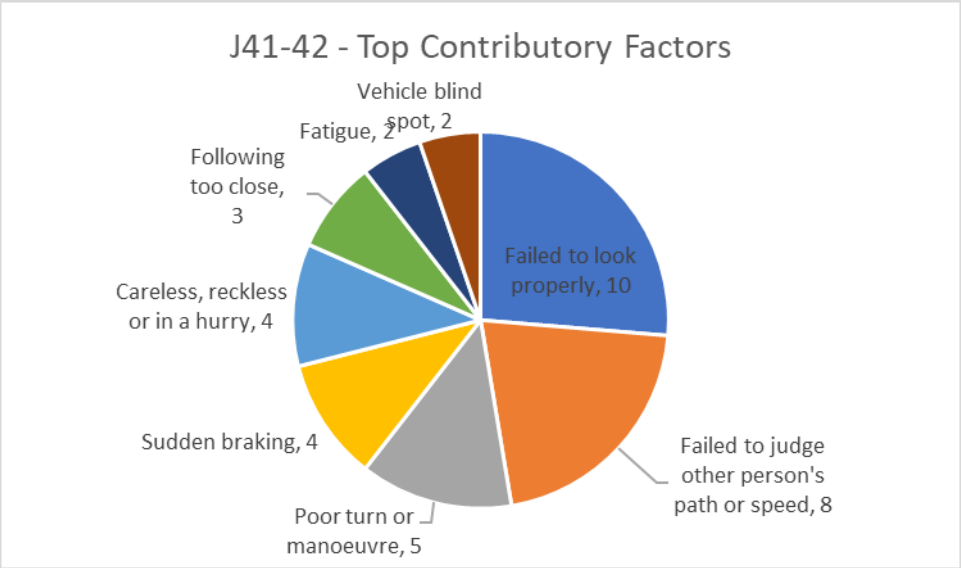


Figure 5.25 M1 J41-42 collisions - top contributory factors

The distribution of these contributory factors is relatively typical for a motorway, although loss of control, a typical top ten contributory factor in motorway collisions (as per the SRN 2018 Casualty Report), has not been cited against any collisions on this link.

5.7.1 Discussion

This link had been highlighted following insights from Operations who identified the high traffic and high weaving environment, a relatively high number of reported incidents given the link's short length, and potentially high proportion of darkness collisions.

A large number of incidents are reported, averaging approximately three breakdowns every five days. However, despite no emergency area provision on this short link, only two live lane stop- related injury collisions have been recorded in four years which does not indicate that the rate of breakdowns (847 recorded over four years) is leading to a collision issue.

Similarly, collision types and distributions between carriageway lengths and merge /diverge areas are not unusual nor indicative of any particular operational issues.

The northbound mainline section has five lanes with reduced widths in lanes 1 and 2 and a reduced setback at the rail bridge (refer to Figure 5.21); given this relatively unusual set of cross-section constraints it is relevant to note that no lane-change type collisions have been recorded. Congestion from weaving movements, from Lofthouse Interchange itself or from the M62 (in particular westbound) are likely to be the main causes of the shunt collisions that do occur.

Aside from the fundamental challenges of weaving and traffic volume, there is little of note regarding the operation and safety of this link. Given that shunt collisions occur most frequently it is likely that a step change in reducing congestion has the greatest potential to further improve safety of this section –

which could only be achieved by major works elsewhere (for example improvements to Lofthouse Interchange capacity).

6. Potential interventions

The preceding sections have identified the following key findings, which are considered for specific intervention recommendations. The recommendations provide a robust answer to the question posed for the scheme of, “what more could be done to improve safety?”. They must also be viewed in the context of the national programme of improvements to smart motorways, which for this scheme is planned to result in the introduction of Stopped Vehicle Detection technology by September 2021.

Table 6.1 Smart Motorway Incident and Infrastructure Investigation potential interventions

Key finding	Existing, programmed or national campaign control measures	Rationale for potential intervention measures	Potential interventions
High rate of live lane breakdown incidents reported. Note however, that this has not manifested itself as a particularly high number of live-lane stop- related collisions.	Stocktake action – *More signs giving the distance to the next place to stop in an emergency*, will continue to increase signing provision. Highways England continue campaigns relating to suitable DIY checks of vehicles to reduce instances of breakdowns – fuel level, oil / water level, tyre pressure and tread. Guidance exists and is readily searchable on Smart Motorways and what to do if you breakdown. Updates to the Highway Code, to explicitly cover smart motorways, are planned. Emergency areas have been enhanced with orange surfacing and comprehensive approach signing to make them more obvious.	The scheme relies on hard shoulders on exit slips to maintain place of relative safety spacing to requirements, in addition to mainline emergency areas. However no signing or extra conspicuity measures are evident for these places of relative safety, so the same ‘encouragement’ given to users not to stop in a live lane and to continue on to a mainline emergency area where possible, is not present for exit slip hard shoulders. The relatively low occurrence of live lane stop-related injury collisions indicates that the emergency area spacing itself is not presenting particular difficulties.	A) As part of the general Stocktake action to increase emergency area advance sign provision, consider a specific signing and / or information scheme to improve the understanding and conspicuity of exit slip hard shoulders as places of relative safety for this scheme. This is intended to encourage road users to limp to a diverge place of relative safety wherever suitable. There is a signing approach for slip road emergency areas set out in requirements in MPI 66; by expanding its scope slightly this could provide a framework to sign the diverge slip hard shoulder places of relative safety.
Pedestrian collisions and potential risk factors, particularly in the Junction 39 to 40 link.	Motorway Regulations prohibit pedestrians, although those who are vulnerable, in distress or with judgement impaired by drugs or alcohol are unlikely to be deterred by this.	Consider local desire lines, quality and provision of facilities and identify opportunities for improvement.	B) Review the pedestrian provision, fencing and other deterrents for the Junction 39 to 40 link. The large scheme process set out in GG 142 *Walking cycling and horse-riding assessment and review* would be a suitable

Key finding	Existing, programmed or national campaign control measures	Rationale for potential intervention measures	Potential interventions
	The process for assessing if suitable facilities are provided for walking, cycling and horse-riding for contemporary schemes is set out in GG 142. Note however that this scheme was designed prior to the release of GG 142.		structure for this exercise. Apply the suicide prevention toolkit.
The arrangement to the north of Junction 39 contains some design compromises and a cluster of collisions is present. It is possible that the confluence of the horizontal curve, the Calder Navigation bridge with limited setback to VRS and an open aspect, and the lane gain /drop arrangement, is creating a particularly unforgiving environment. This could be contributing to loss of control collisions and some higher speed, higher severity incidents.	Locally specific issue. Operations are able to set warning messages for weather conditions, including high winds. Hazard warning signs for high winds are present on both carriageways.	Hazard signing – sharp deviation signs would warn of horizontal curvature which may have been a factor in the recorded loss of control collisions. Amending the southbound 1 mile direction sign would more clearly reflect the lane drop layout ahead. Lane destination markings and longitudinal hazard lines would also ensure SB lane drop layout is as clear as possible on approach. Street lighting would help users better comprehend the layout and hazards at this location during darkness hours and may help reduce loss of control collisions during hours of darkness. Alternative diverge layout options such as ghost island diverges can reduce last minute 'swooping' and resulting collisions at diverges. However, careful consideration is required for junction interaction and queuing capacity on diverge given latest traffic flows. Speed limits can reduce risks and raise perception of the controlled environment, which may reduce the potential for loss of control collisions. There is potential to lower the threshold for the high occupancy algorithm in recognition of the local difficulties at this location.	C) Investigate a package of measures to improve clarity of layout and driver perception of hazards to the north side of Junction 39, with the following suggestions for consideration: • Introduce hazard warning signs for sharp deviation ('bend ahead'). • Revise the southbound 1 mile direction sign to reflect the lane drop layout. • Add lane destination markings and longitudinal hazard lines for the southbound lane drop. • Review potential for new lighting to the mainline through Junction 39 and northwards to the southbound half mile direction sign. • Examine options for an alternative southbound diverge layout such as ghost island type, and the potential disbenefits on exit traffic this could have. • Make specific local adjustments to the high occupancy algorithm, so that variable speed limits trigger earlier and control flows at peak times. • Keep a national speed limit set at all times until a lower limit is required, to provide greater control, perception of a controlled environment and improved driver behaviour overnight and during low flow

Key finding	Existing, programmed or national campaign control measures	Rationale for potential intervention measures	Potential interventions
			periods. This may require consultation with Department for Transport to agree suitable application and messaging.

7. Conclusion

The safety of the smart motorway section of the M1 between Junctions 39 and 42 has been investigated.

More collisions are occurring per year after the smart motorway opened compared to before, however the scheme has seen a growth in daily traffic of almost 20% over that time period. Operations observe that the scheme has significantly reduced congestion.

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 determined. Further investigation has also identified an unusually high proportion of collisions scheme-wide where a contributory factor of impairment by alcohol is cited.

Occurrences of incident records for breakdowns in live lanes are at a high level, although actual collisions relating to vehicles stopping in live lanes are infrequent in comparison. The Junction 41 to 42 link has high weaving flows, five lanes northbound and cross-section constraints, but no notable collision clusters or trends are apparent.

The single fatal collision in the after period involved a pedestrian on network at night. Although not linked to the smart motorway, the collision location coincides with that of a pedestrian underpass.

Three potential interventions are identified:

A. Capitalise on stocktake action to further increase emergency area signing, to enhance comprehension of hard shoulder emergency areas on diverge slip roads in a similar way to that already implemented for mainline emergency areas.

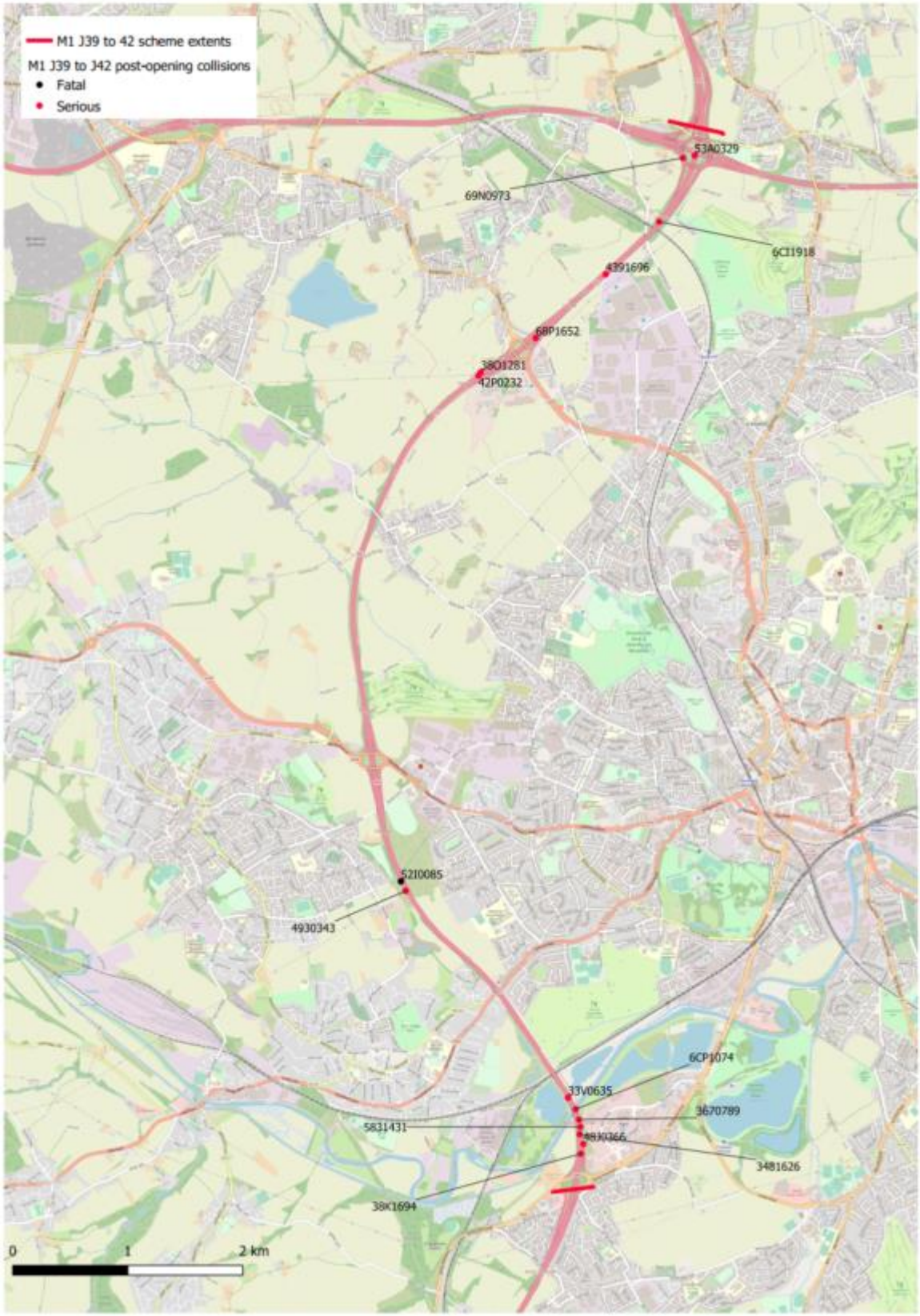
B. Review pedestrian routes and provision and network fencing integrity on the Junction 39 to 40 link to provide better facilities and prevent or deter future pedestrian incidents.

C. Consider a package of measures to improve comprehension of road layout and junction requirements to the north side of Junction 39, potentially covering signing, marking and lighting measures. Review smart motorway algorithms to prompt speed limit activation at lower traffic levels to provide a great degree of speed reduction and control.

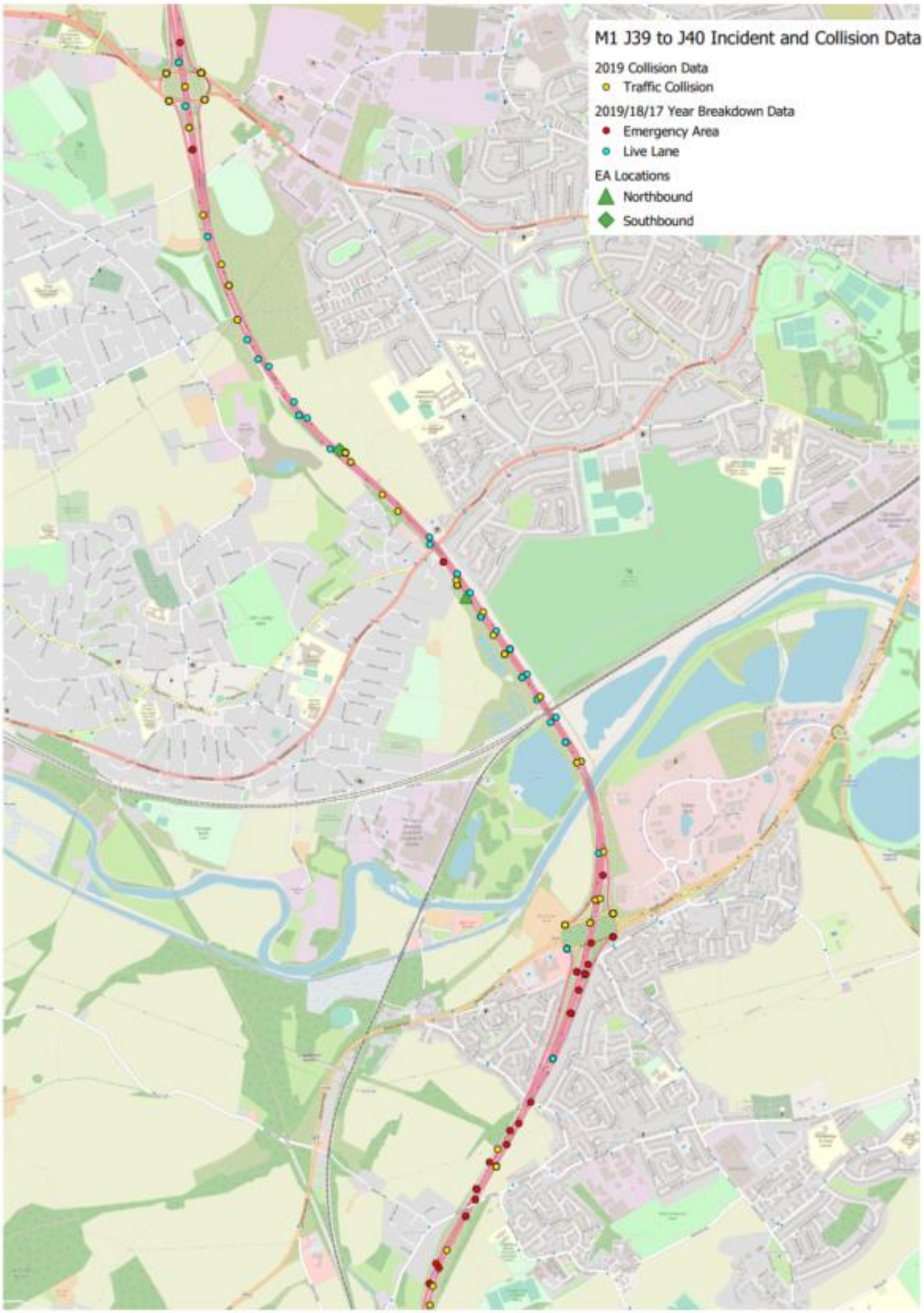
Appendices

Appendix A. All Collisions

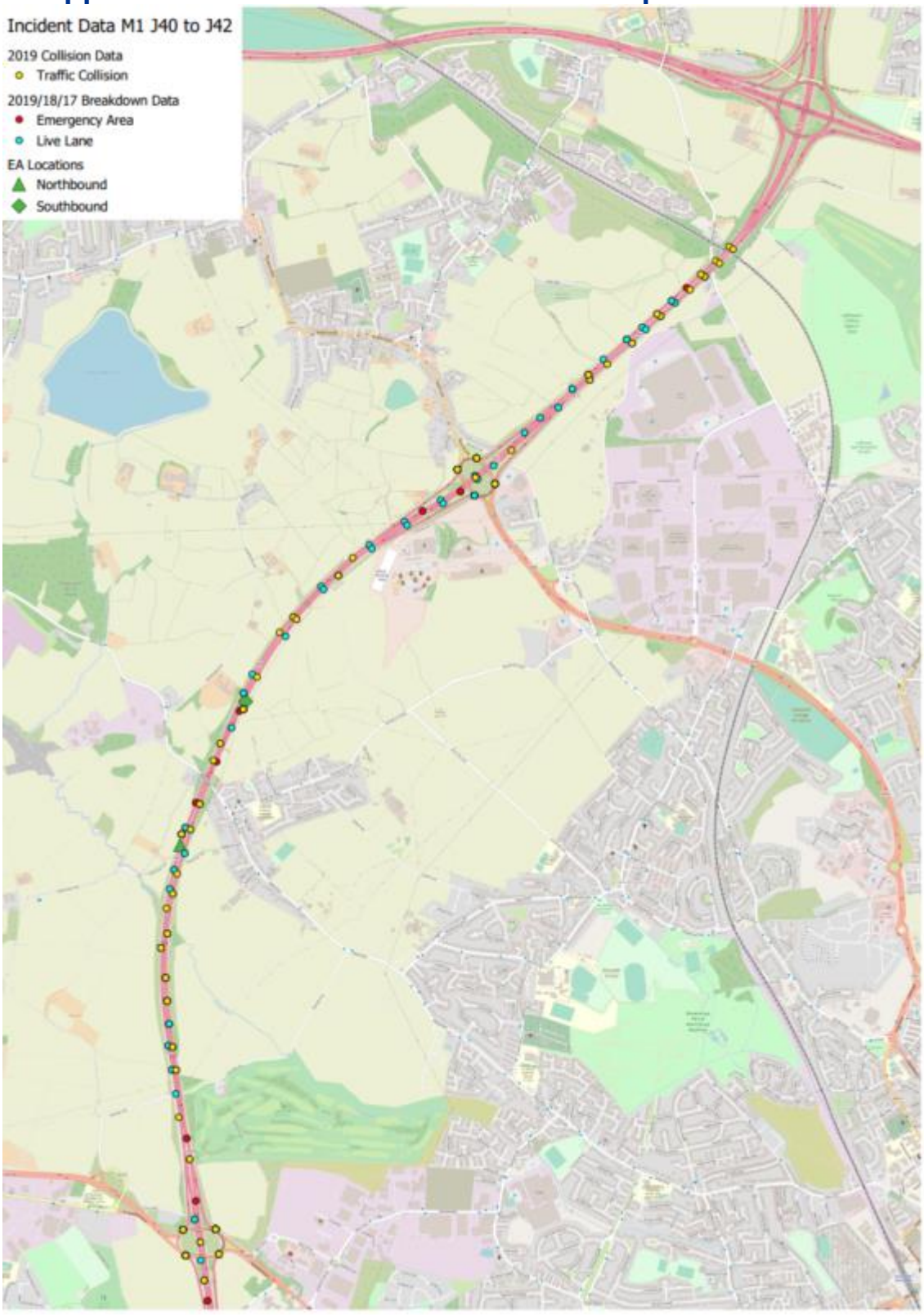
Appendix B. Fatal and Serious Collisions



Appendix C. Collisions and breakdowns plotted M1 Junction 39 to 40



Appendix D. Collisions and breakdowns plotted M1 Junction 40 to 42



Appendix E. Design Strategy Record and Departures

Ref	Chapter	Element	Potential relevance to this work	Follow-on
4.1.4	Cross-section	Narrow Lanes	J41-42 NB is five lanes No cross-section in standards for 5 lanes, but here Lanes 1 and 2 'narrowed' to 3.5m due to underbridge constraints. (L3 3.5m; L4 3.4m; L5 3.2m). Limited setback NB over rail bridge.	Check operational and safety performance of link – refer to Safety Analysis section
5.2.1	Junction Design	J39 NB merge	Layout ok as Type F ghost island lane gain, but relaxation to all-purpose dimensions	Awareness
5.2.5	Junction Design	J40 NB merge	Ghost island merge at all purpose dimensions with reduced ghost island, instead of Type F ghost island lane gain to allow TJR (ramp metered)	Awareness
5.2.7	Junction Design	J41 NB diverge	Taper diverge with two lane slip provided instead of single lane drop to allow TJR	Awareness
5.2.9	Junction Design	J41 NB merge	Lane gain merge instead of ghost island lane gain, due to J41-42 weaving length (see below)	Awareness
5.2.10	Junction Design	J42 diverge	Two lane drop provided as terminal junction and as part of J41 to 42 link weaving considerations.	Awareness
5.3.5.9	Junction Design	J41-42 weaving length	1130m weaving length, improvement to pre-scheme and counting against using ghost island at J42 diverge as this reduces weaving length. (Requirements were auxiliary merge with ghost island lane drop, so auxiliary lane has been extended for whole link with alternative diverge layout)	Check operational and safety performance of link – refer to Safety Analysis section
5.5.5	Junction Design	J41 SB diverge	Taper diverge with two lane slip provided instead of single lane drop to allow through junction running (TJR)	Awareness
5.5.7	Junction Design	J41 SB merge	Ghost island merge at all purpose dimensions with reduced ghost island, instead of Type F ghost island lane gain to allow TJR	Awareness
5.5.9	Junction Design	J40 SB diverge	Parallel diverge to two lane slip instead of ghost island lane drop to allow TJR and avoid bridge constraint	Awareness
5.5.11	Junction Design	J40 SB merge	Ghost island merge instead of ghost island lane gain to accommodate TJR	Awareness
5.5.14	Junction Design	J39 SB diverge	Single lane drop to two lane slip instead of ghost island lane drop to avoid Calder Navigation bridge. Taper length reduced to APTR dimensions	Check operational and safety performance of this terminal junction – refer to Safety Analysis section
5.6	Junction Design	J42-41 weaving length	Less than 2km, appears to be slight improvement on 1100m weaving length before	Check operational and safety performance of link – refer to Safety Analysis section
5.12.2.1	Visibility	J39 NB SSD	Lane 1 stopping sight distance (SSD) reduced by max. of 3 steps (160m) to low	Check for problems at Calder Navigation bridge

Ref	Chapter	Element	Potential relevance to this work	Follow-on
			and high objects due to Calder Navigation bridge	– refer to Safety Analysis section
7.1.2	Lighting	40-41 link	Lighting removed (TA 49 assessment)	Awareness
7.1.3	Lighting	41-42 link	TA 49 Assessment recommended removal but retained on safety grounds due to weaving	Awareness
8.2.7	Signing	J42 NB Exit Datum	IAN 149 exit datum not defined. Taken as 200m from nosing. See DAS 67176	Awareness
8.3.4	Signing	J42 NB Secondary ADS	120m from preferred position [unclear if upstream or downstream]	Awareness
8.3.5	Signing	J41 SB Secondary ADS	1/3 mile used with 1 mile primary to avoid ghost island lane gain at J42 merge	Awareness
8.4.5	Signalling	J41 NB Gateway	162m from datum	Awareness
8.4.6	Signalling	J42 SB gateway	165m from datum with 1/3 mile ADS	Awareness
9.1.1	ERAs	Strategy	J40 and J41 diverge slip hard shoulders are considered place of relative safety	Awareness
9.1.1	ERAs	Strategy	Place of relative safety strategy prior to the J41-42 5 lane high weaving link. Compliant with IAN 161/12 design requirements: • J40-41 ERA at 296+155 (signed) • [approx. 1600m gap] • J41 exit slip 297+750 approx. (unsigned) • [Approx. 2335m gap to start of J42 hard shoulders] • J41 merge nearside wide hatching 298+750 approx. (unofficial, unsigned, would require weave across merge) • [5 lane high weave section] • J42 diverge hard shoulder and start of through J42 hard shoulder 300+085 approx.	Check link for live lane stops, incidents – refer to Safety Analysis section
9.1.5.4	ERAs	J40 SB diverge	Pinchpoint widening converting hard shoulder during scheme development, so “equivalent hard standing” area identified to be provided [may not be to modern MPI 66 standards]	Check link for live lane stops, incidents – refer to Safety Analysis section

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