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

Task 1127
Smart Motorway Incident and Infrastructure Investigation – M1 Junction 10 to 13

July 2021

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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 user safety on the M1 Junctions 10 to 13 (Luton) section.

The M1 Junctions 10-13 scheme was a Highways England major project to improve 15 miles (24km) of the M1 by reducing congestion and improving journey time reliability through conversion of the hard shoulder for dynamic hard shoulder running (DHS). The scheme opened in December 2012 and included:

- managed (smart) motorway between junction 10 and junction 13,
- enhanced on-road technology to manage flow;
- four lanes of traffic at times of peak demand; and
- through junction running (maintaining four full-time running lanes at junctions) at junction 10, junction 11 and junction 12.

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?".

The Post Opening Project Evaluation (POPE) report[1] published in October 2015 highlighted that average journey times had increased by up to 18% post opening and collisions increased by 19%. As a result of the POPE report the smart motorway operating systems were recalibrated, control room operating protocol revised and signing upgrades implemented on approach to junctions. This work was completed in 2017 after which operations are reported to have improved. However the opening of the M1 Junction 11a as part of A5-M1 Link in May 2017 has made before and after comparisons difficult.

Since 2017 there has been an overall decrease in the average number of injury collisions per year (across all severities) but an increase in the average number of serious injury collisions per year.

Incident records for breakdowns in live lanes indicate these occur frequently, 0.38 live lane breakdowns per mile per day in 2018 on this section of the M1, indicating a typical rate of five to six live lane breakdown incidents per day across the entire 15 mile scheme. One of the fatal collisions included in the seven year post opening period, December 2012 to November 2019, involved a stop in LBS1[2] when it was open. There have been six serious injury collisions and sixteen slight injury collisions that are related to live lane stops. These events are not frequent but have the potential to result in high severity collisions. Since November 2019 a further three fatal collisions have occurred, two of which involved live lane stops.

Operations have highlighted misuse of LBS1 and the potential for lane change collisions (particularly regarding left hand drive heavy goods vehicles) as an issue. Pedestrian incidents were prevalent at the southern end of the scheme where it passes through the built-up area between Luton and Dunstable.

The findings of this investigation must be viewed in the context of the proposed improvements to smart motorways outlined in the smart motorway evidence stocktake and action plan[3]. Highways England has committed to:

- End the use of dynamic hard shoulders by converting to all lane running.
- Faster roll out of stopped vehicle detection.

These measures will be implemented on M1 junction 10 to 13 by the end of March 2025.

[1] Post Opening Project Evaluation M1 J10-13 Hard Shoulder Running and Junctions One Year After Study
[2] LBS refers to lane below sign, in this instance the 1 refers to the hard shoulder
[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873000/smart-motorway-safety-evidence-stocktake-and-action-plan.pdf

The stocktake commitment to enhance emergency areas[4] with orange surfacing and comprehensive approach signing has already been met on this section of the M1.

Potential interventions arising from the data review and focussed investigation are given in Table E-1.

Table E-1 M1 junction 10-13 potential interventions

Key Findings – Data Analysis	**M1 10 to 13 Potential interventions**
A) Operations report mis-use of LBS1, also observed upon site visit / drive-through	• Display **consistent and repeated messages** confirming status of hard shoulder on existing signals • Increase number of **verge-side signs** for DHS status after merges
B) J11 cluster of collisions with lane changes predominant	• **Extend auxiliary lane** at J11 southbound merge
C) Mainline at J12 & Toddington MSA SB – constrained layout, no local reduction in collisions	• **Improve visibility** at southbound merge • **Extend length** of southbound merge • **Signing and markings** depicting status of hard shoulder • Additional “traffic merging” **hazard signs**
D) 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
Key Findings – Operations Feedback	**M1 10 to 13 Potential interventions**
E) Efficiency of ‘fixed text message signs’	• Investigate **upgrading to digital / signal** items
F) Transition between J10 to 13 DHS and J13 to 16 ALR operating regimes	• J13 to 16 ALR scheme to **identify if risk mitigation measures required** at interface

[4] At the time of scheme design and construction these were referred to as emergency refuge areas (ERAs) as defined in the Motorways Traffic (England and Wales) Regulations 1982.

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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 10 to 13 (Luton) section.

So that interventions can be identified 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 potential interventions 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. Figure 1.1 summarises this process.

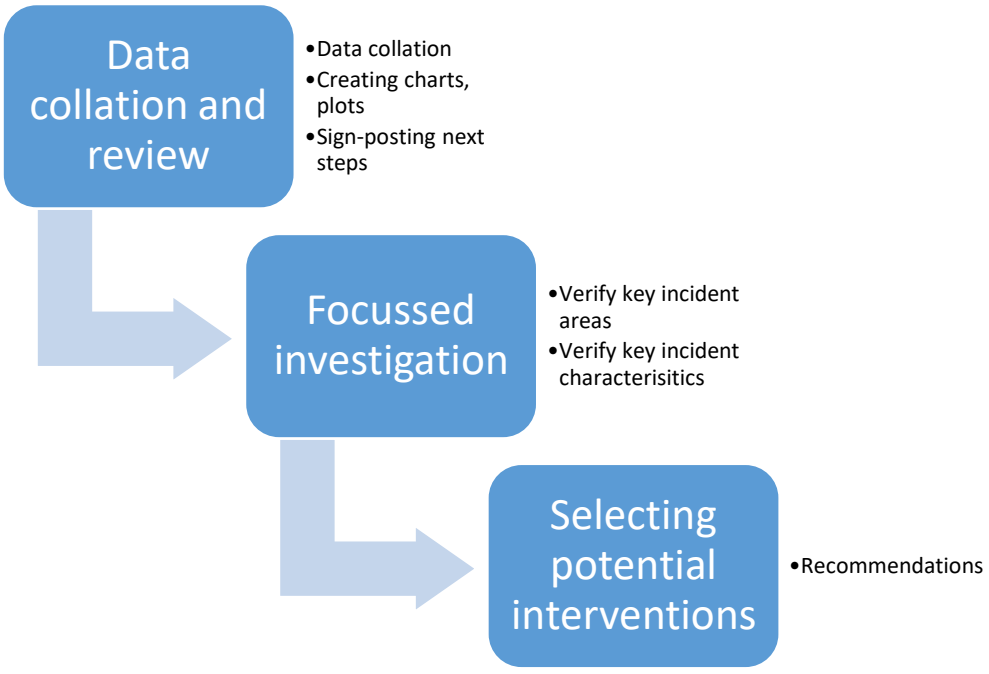


Figure 1.1 Structure of investigation

2. Methodology

2.1 Stage 1 - Data collation and review

A variety of data types and means of analysis formed the first stage of this 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 road safety audits were also reviewed (prior to scheme opening) to investigate trends or continuity in the types of observations raised in the stage 4 road safety audit.

Collision data from the three years prior to the scheme construction date and the latest available data since the scheme opening date were analysed; these sets have been compared as the average number of collisions per year. Only injury collisions are captured in this dataset (often referred to as 'STATS 19'), with data obtained via regional or area teams from police records. The data has been considered by location and by trend, illustrated using data plots. The trends reviewed include 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).

Approximately half of English police forces have adopted the CRASH (Collision Recording and Sharing) system of collision reporting, including Bedfordshire police (the police force local to this section of the M1) who adopted CRASH in April 2016. This report shows the data as reported to or by the police and does not make any adjustments.

CRASH is an injury-based severity reporting systems where the officer records the most severe injury for the casualty. The injuries are then automatically converted to a severity level from 'slight' to 'serious'. This system eliminates the uncertainty in determining severity that arises from the officer having to make their own judgement and means that the new severity level data observed from these systems using injury based methods are expected to be more accurate than the data from other systems. Further reading on the potential impacts of changes to the reporting system is available on the gov.uk website[5].

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 are 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 Safety Report 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 Highways England Operations and high quality dashcam video from a recent drive-through in July 2020 were 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 review in Stage 1, considering their relative significance in both isolation and potential combination. Key points for identifying issues for further consideration included whether:

[5] https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-main-results-2018

- 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 becomes more noticeable or frequent over the years of operation.

In addition to the specifically identified elements, the analysis has included a detailed review of:

- all serious injury and fatal collisions occurring post-opening;
- all injury collisions involving a live lane stop; and
- for 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 considers prospective interventions or control measures for the specific issues that are likely to be 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 the context of other Stocktake Action Plan measures, including the roll-out of stopped vehicle detection, and the conversion of existing dynamic hard shoulder running sections to all lane running.

3. M1 Junction 10 to Junction 13 Scheme Outline

The M1 Junction 10 to Junction 13 scheme was a Highways England major project to improve 15 miles (24km) of the M1 by reducing congestion and improving journey time reliability through the implementation of dynamic hard shoulder running. The scheme included smart motorway[6] between junction 10 and junction 13, allowing four lanes of traffic at times of peak demand and through junction running (maintaining four running lanes at junctions) at junction 10, junction 11 and junction 12. The scheme also included junction improvements at junction 11 and junction 12.

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. The key smart motorway features in the scheme were the following, introduced in both directions:

- Conversion of the hard shoulder for use as a 'dynamic hard shoulder' allowing four lanes of traffic at times of high demand.
- 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.

Further points of note:

- The scheme was designed using Highways England's Interim Advice Note 111/09 which set a maximum spacing between refuges and / or decision points of 1000m. Interim Advice Note 111/09 is an early iteration of the current design standard for smart motorways.
- Construction work for the scheme commenced in December 2009 and the scheme opened to traffic in December 2012.
- The section between Toddington motorway service area (MSA) and junction 12 to the north has extended through junction running with no dynamic hard shoulder, effectively making it an all lane running section.
- South of the scheme the M1 comprises a controlled four lane motorway with hard shoulder.
- North of the scheme the M1 comprised a conventional three lane motorway with hard shoulder. An all lane running Smart Motorway scheme from junction 13 to junction 16 is currently being constructed.
- In May 2017 a new junction 11a was opened as part of the A5-M1 Link scheme. The junction has all lane running through the junction with dynamic hard shoulder on either side.
- Installation of stopped vehicle detection and conversion to all lane running is programmed for completion by the end of March 2025 between junction 10 and 13 of the M1.

The Post Opening Project Evaluation (POPE) report[7] published in October 2015 highlighted that average journey times had increased by up to 18% post opening and collisions increased by 19%. As a result of the POPE report the smart motorway operating systems were recalibrated, control room operating protocol revised and signing upgrades implemented on approach to junctions. This work was completed in 2017 after which operations are reported to have improved.

The information in Table 3.1 sets out some key elements of the scheme layout and Figure 3.1 illustrates the extents of the scheme.

[6] At the time of construction this was referred to as managed motorway.
[7] Post Opening Project Evaluation M1 J10-13 Hard Shoulder Running and Junctions One Year After Study

Table 3.1 M1 J10-13 layout, features and amendments to street lighting

Link / Junction	Lanes / Emergency refuge area	Street lighting provision	
		Before	After
J10	NB: Dual 4 lane motorway and hard shoulder SB: Dual 4 lane motorway and hard shoulder	Lit	Lit
J10 to J11 – 5.5km between junction centres	NB: Dual 4 lane motorway including dynamic hard shoulder running, four mainline emergency areas (EA) SB: Dual 4 lane motorway including dynamic hard shoulder running, three mainline emergency areas	Lit	Unlit
J11	NB: Through junction running SB: Through junction running	Lit	Lit
J11 to J11a – 3.5km between junction centres	NB: Dual 4 lane motorway including dynamic hard shoulder running, one mainline emergency area, one within junction 11A SB: Dual 4 lane motorway including dynamic hard shoulder running, one mainline emergency area, one within junction 11A	Lit	Unlit
J11a	NB: Through junction running SB: Through junction running	Lit	Unlit
J11a to Toddington motorway service area – 1.9km between junction centres	NB: Dual 4 lane motorway including dynamic hard shoulder running, one mainline emergency area SB: Dual 4 lane motorway including dynamic hard shoulder running, one mainline emergency area	Lit	Unlit
Toddington motorway service area	NB: Through junction running SB: Through junction running	Lit	Unlit
Toddington motorway service area to J12 – 1.8km between junction centres	NB: Extended through junction running, one mainline emergency area SB: Extended through junction running, one mainline emergency area	Lit	Unlit
J12	NB: Through junction running SB: Through junction running	Lit	Unlit
J12 to J13 – 10.2km between junction centres	NB: Dual 4 lane motorway including dynamic hard shoulder running, eight mainline emergency areas SB: Dual 4 lane motorway including dynamic hard shoulder running, nine mainline emergency areas	Lit	Unlit
J13	NB: Lane drop SB: Lane gain	Lit	Unlit

Figure 3.1 M1 J10-13 scheme 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 further safety analysis.

4.1 Road safety audit stage 4 review

The 12 month post opening stage 4 road safety audit document has been reviewed with key points identified in Table 4.1.

Table 4.1 M1 J10-13 Hard shoulder running Improvements road safety audit stage 4A

	Summary of 12 month post opening stage 4 road safety audit (Highways England)	Relevance to this investigation
General points	The 12 month post opening stage 4 road safety audit was undertaken in May 2015. Site visits were carried out in December 2014 and February 2015. The road safety audit was undertaken in accordance with HD 19/03.	The audit listed the key features of the scheme including reduced lane widths throughout, removal of street lighting except for at junction 10 and at junction 11. Hard shoulder running during peak periods and through junction running at junctions 10, 11, 12 and Toddington motorway service area. **Next step: Layout considered as part of departures review.**
Collision analysis	The collision analysis included basic analysis of the 12 month before (103 collisions) and after (102 collisions) data. It demonstrated a similar total number of collisions and an increase in severity post opening, eight serious personal injury collisions (PICs) before opening compared to 14 after. Collision data at four locations has been looked at in response to road safety problems identified in the 12 month post opening stage 4 road safety audit. The four locations are M1 Toddington southbound, M1 Toddington northbound, M1 junction 13 northbound and MP 67/0 southbound. One collision identified as live lane stop.	Analysis of collision data is limited to severity, conditions, time of day and commonly reported contributory factors, e.g. failed to look. No collision rates have been calculated or detailed collision analysis undertaken. **Next step: Specific safety analysis for: Collisions occurring during darkness. Collisions occurring in the vicinity of Toddington motorway service area, junction 13 and MP 67/0.**
Traffic conditions	Automatic traffic count (ATC) data for 2013, assumed this represents post opening flows but no comparison with pre-opening flows.	Traffic data does not indicate if the scheme has resulted in any significant changes in traffic flow. Percentage of heavy goods vehicles noted as 13%.
Review of previous road safety audits	Stage 2 road safety audit – all issues have been resolved and one exception report prepared in relation to the location of a hard shoulder ends sign. Five Stage 3 road safety audits have been undertaken on the scheme; Section 1 (10 issues), Sections 2&3 (21 issues, 2 unresolved), Section 3 (13 issues), junction 11 (22 issues) and junction 12 (22 issues). All but two were resolved and these related to missing SOS symbols on marker posts.	None
Identified road safety problems	Seven road safety problems were identified in the 12 month post opening Stage 4 road safety audit. • Missing 'no stopping in layby' signs in emergency areas . • MP 53/6 northbound hard shoulder end sign obscured by vegetation.	Two of the issues raised in the 12 month post opening Stage 4 road safety audit relate to police concerns over lighting. **Next step: Specific safety analysis for: Collisions occurring during darkness.**

	Summary of 12 month post opening stage 4 road safety audit (Highways England)	Relevance to this investigation
	• Response to a serious 3 vehicle collision 26/8/14 (outside 12 month after period) which occurred at night on an unlit section of M1 northbound at Toddington. Police suggested that lighting may have reduced severity. • Response to a fatal 9 vehicle collision 15/9/14 (outside 12 month after period). Post fatal inspection with police recorded no highway issue but has since queried when lighting was switched off. • Record of concerns from MOTO services manager regarding confusing signing prior to the Toddington motorway service area potentially resulting in unnecessary weaving. Site visit with police raised no specific concerns. Nearside concrete barrier prior to the motorway service area southbound merge partially obscures the view of vehicles – 5 injury collisions recorded at this location. Motorway service area sign at northbound diverge is partially obscured by other signs but no alternative location identified – no injury collisions. • Response to report of near misses at M1 junction 13 due to limited signing of lane drop. Query over requirement for two verge mounted direction signs as only one provided but limited on where to locate the second. • Response to a customer concern in 2014 relating to the abrupt end of hard shoulder without advance warning between junction 12 - 13 northbound. This was raised at stage 2 road safety audit and an exception report issued in May 2012.	**Collisions occurring in the vicinity of Toddington motorway service area specifically relating to visibility on exit due to concrete barriers in the nearside and also signs resulting in unnecessary lane changing.**
Conclusions	**Key road safety audit recommendations are:** Convert the northbound section between junction 11a merge and Toddington motorway service area diverge to all lane running. Convert the southbound section in the same way to all lane running between Toddington motorway service area and junction 11a. Provision of an additional sign for the junction layout at junction 13.	**Next step: Specific conclusions to be considered in the collision analysis.**

Key findings

The 12 month post opening Stage 4 road safety audit identified a number of road safety problems focussing on:

- the potential impact of lighting removal throughout this section except at junction 10 and junction 11;
- signing in the vicinity of the motorway service area and potential for unnecessary weaving;
- impact of the nearside concrete barrier at the motorway service area southbound merge; and,
- signing between junctions 12 and 13 northbound.

4.2 Collision data review

4.2.1 Scheme data

The scheme before period includes the three years prior to the start of construction: 1 December 2006, to 30 November 2009. Average traffic (annual average daily traffic) for the whole section during this before period is 103,780 vehicles.

The focus of this study has been on the after period which comprises the seven years of collision data since opening to traffic: December 2012 to November 2019. This extended after period has been used to ensure that significant changes or shifts in patterns are captured. 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.

Average traffic in the after period is 133,333 vehicles per day, approximately a 28% increase over the before period.

Three fatal collisions have occurred since November 2019, two of which involved live lane stops, and although not included in this data analysis section these are considered in detail in section 5.1.1.

4.2.2 Severity

This section compares the recorded injury collisions before and after the scheme. Table 4.2 provides the collisions by year and severity for both the before and after periods. Year 1 in the after period refers to the period December 2012 to 30 November 2013 with subsequent years using the same date range but twelve months later.

Table 4.2 Collision severity for the before and after data periods

SEVERITY	Before				After								Mean number of collisions /yr	
	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total	Before	After
Fatal	3	0	1	**4**	0	1	2	0	1	0	1	**5**	1.3	0.7
Serious	6	2	11	**19**	14	11	9	11	13	5	8	**71**	6.3	10.1
Slight	100	98	129	**327**	78	96	84	96	106	91	51	**602**	109.0	86.0
All	**109**	**100**	**141**	**350**	**92**	**108**	**95**	**107**	**120**	**96**	**60**	**678**	**116.7**	**96.9**

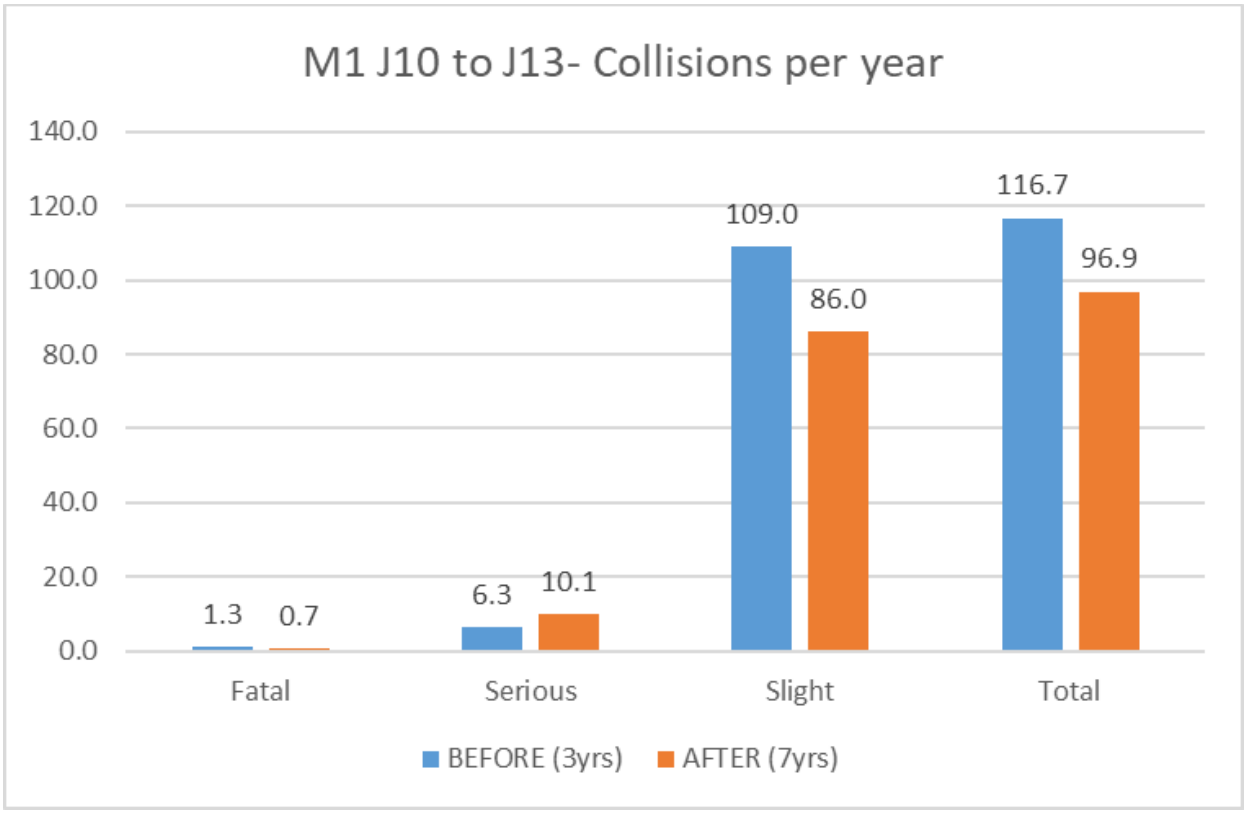


Figure 4.1 Collision severity for the before and after data periods

Table 4.2 and Figure 4.1 show that over the seven year after period from December 2012 slight, fatal and total average number of collisions per year have reduced while serious collisions have risen compared to the three year before period. The average number of collisions per year has decreased by approximately 16%, while traffic growth has increased by 27% on average. Table 4.2 indicates that in year 6 and year 7 post opening (i.e. from December 2017 to November 2019 inclusive) there has been a decrease in collisions compared to prior years.

The data indicates a higher ratio of fatal and serious collisions than in the before period (6.6% before and 11.1% after), with the most notable increase in numbers of collisions being those of serious injury severity. At 11.1% the fatal and seriously injured ratio is below average for all motorways (the 2018 Strategic Road Network Casualty Report indicates 17% of all motorway collisions were fatal or serious in 2018). A detailed review of the fatal and serious collisions is undertaken in section 5.1.

The introduction of CRASH in April 2016 coincides with part way through year 4 in the after period. The number of serious collisions since year 4 showed an increase in year 5 followed by two years when the number of serious injury collisions was below the average number for the seven year period. The impact of changing to the CRASH system has not resulted in a marked increase in reported serious collisions.

In 2017 the smart motorway operating systems were recalibrated to improve the operation of LBS1 specifically opening and closing in response to demand, control room operating protocol was revised and signing upgrades implemented on approach to junctions in response to the post opening project evaluation (POPE) report for the scheme. This coincides with year 5 in the after period. In May 2017 junction 11a was opened.

Table 4.3 provides a breakdown of average collisions per year by severity and link and indicates a decrease in total injury collisions except for serious collisions which increased on all links initially. Prior to junction 11a being opened the average number of serious collisions between junctions 11 and 12 increased from 1.7 to 3.6. Post opening of junction 11a the total average number of serious collisions on both new links showed a marginal decrease, 1.6 compared to 1.7 in the before period. This is not

necessarily as a result of the new junction but potentially the improvements to the smart motorway operating systems and control room protocols which took place in 2017.

Table 4.3 Average number of collisions per year by severity and link

Severity	Junction 10-11		Junction 11-12		Junction 11-11a	Junction 11a - 12	Junction 12 - 13	
	Before	After	Before	After (Dec 2012-April 2017)	After (May 2017 to November 2019)	After (May 2017 to November 2019)	Before	After
Fatal	0.7	0	0.3	0.5	0.4	0	0.3	0.3
Serious	2.0	4.0	1.7	3.6	0.4	1.2	2.7	3.3
Slight	34.0	25.4	32.5	31.7	15.9	9.3	39.3	29.7
All	36.7	29.4	34.7	35.8	17.0	10.1	42.3	33.3

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 Figure 4.2.

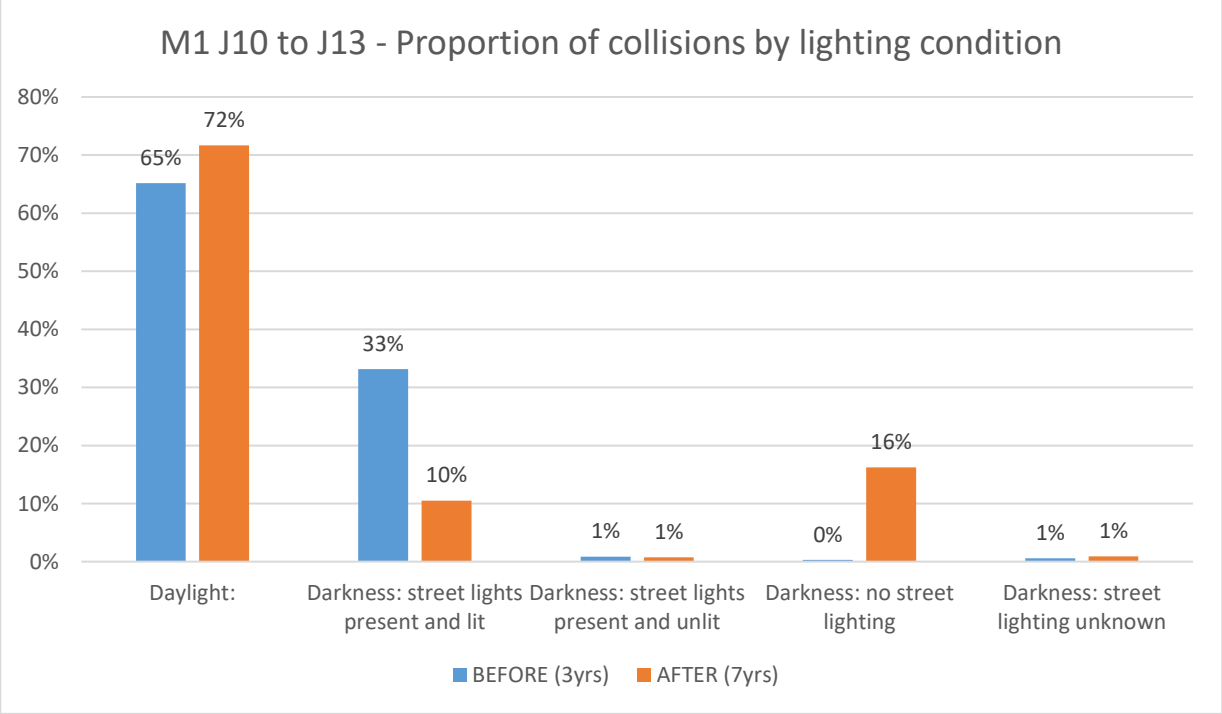


Figure 4.2 Proportion of collisions by lighting condition for the before and after periods

Figure 4.2 shows an increase in the proportion of collisions occurring during daylight from 65% to 72%. The decrease in 'darkness: street lights present and lit' collisions and increase in 'darkness: no street lighting' is likely to be as a result of the removal of much of the lighting along this section with only junction 10 and junction 11 retaining lighting. The removal of the lighting along the majority of this section does not appear to have had a detrimental effect on the overall proportion of injury collisions being reported in the dark. The impact of the removal of lighting specifically between Toddington motorway service area and junction 12 is assessed in section 5.3 of this report.

4.2.4 Collisions by weather

This section compares collisions before and after by the weather conditions. Figure 4.3 indicates a small decrease in the proportion of wet collisions of 3% identified from the before and after collision data.

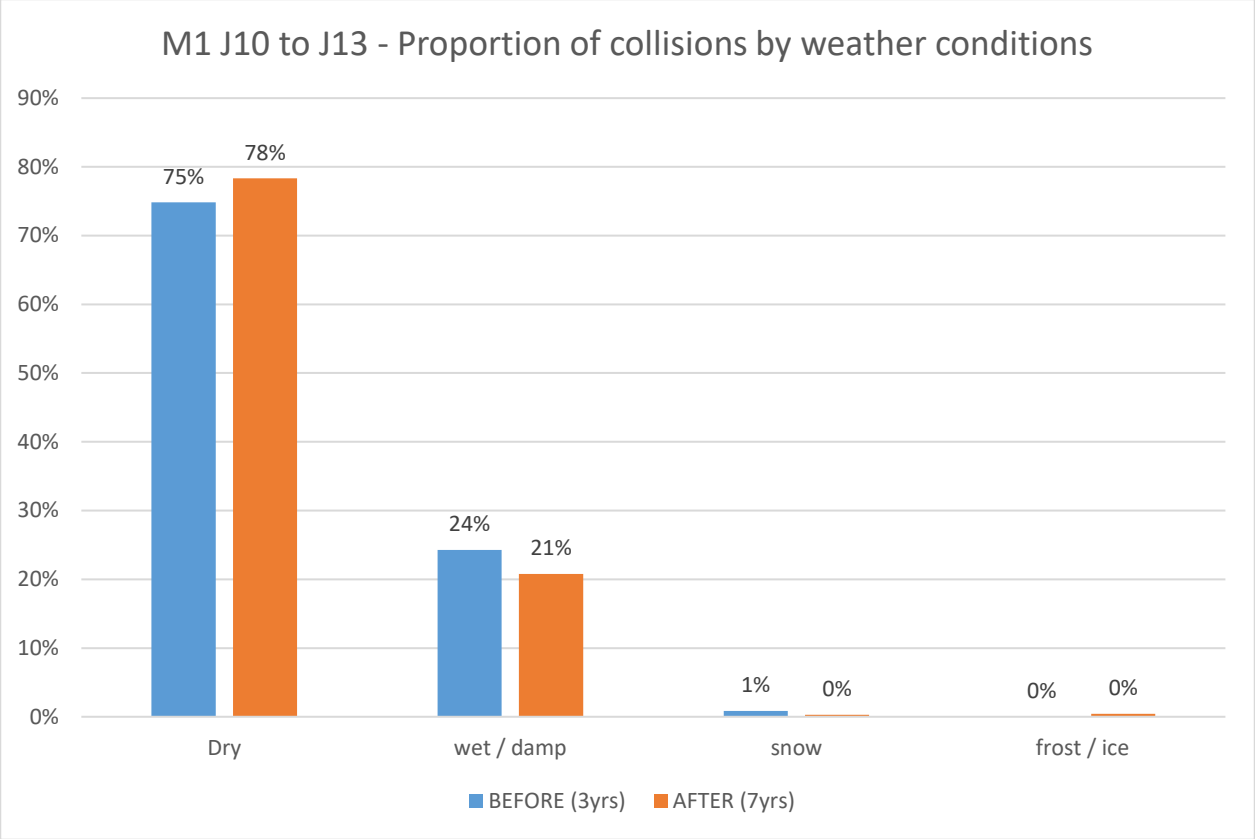


Figure 4.3 Proportion of collisions by weather conditions for the before and after periods

4.2.5 Collisions by vehicle type

This section compares collisions before and after by type of vehicles involved, see Figure 4.4. There has been a 1% decrease in the proportion of cars involved in collisions and a 1% increase in all goods vehicles involved. In the after period the goods vehicle (unknown) category has been recorded for 10% of the goods vehicle collisions.

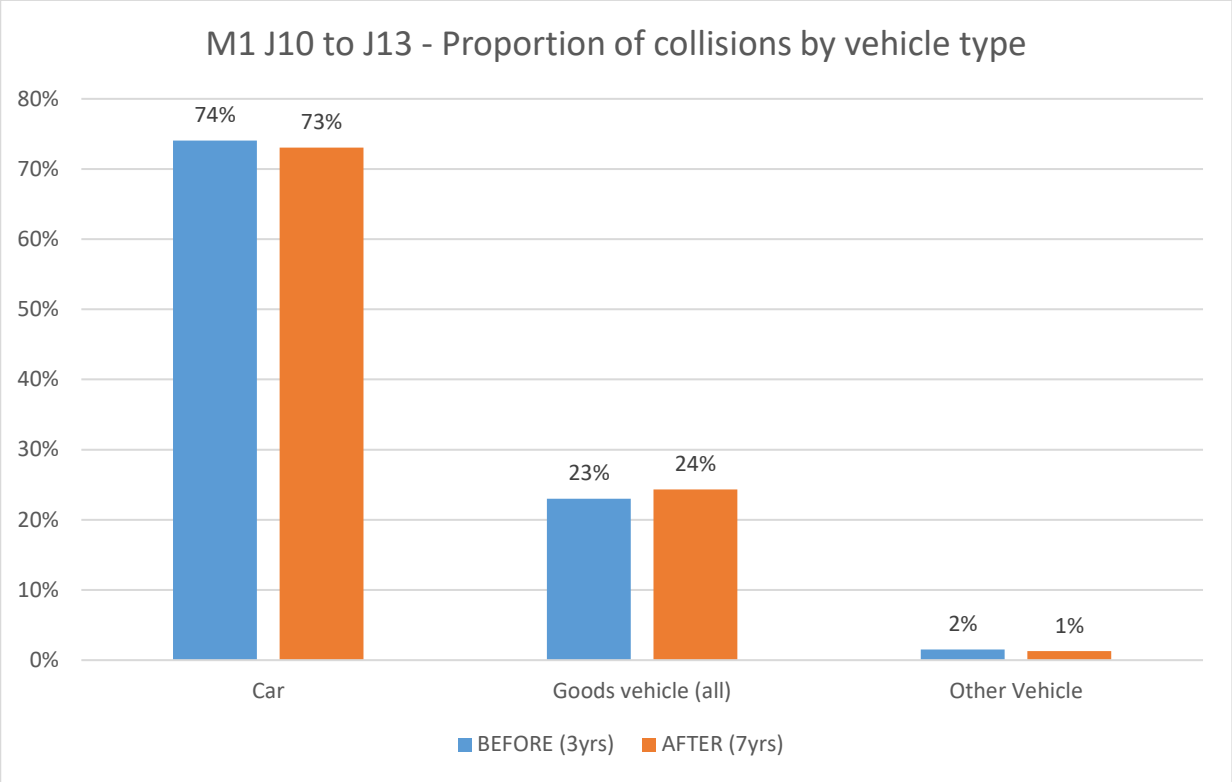


Figure 4.4 Proportion of collisions by vehicle type for the before and after periods

4.2.6 Collisions by vehicle manoeuvre and point of impact

This section compares collisions before and after by vehicle movement and manoeuvre. Figure 4.5 indicates that there has been very little change in collisions by vehicle manoeuvre, the biggest difference is a 4% decrease in the proportion of collisions involving 'vehicles waiting to go ahead but held up' but this is partially negated by a 2% increase in the proportion of 'slowing or stopping' collisions. There has been a 1% shift in collisions involving vehicles 'changing lane to the left' and 'changing lane to the right'.

In terms of points of impact (refer to Figure 4.6), this has shifted slightly in the after period with a greater proportion of nearside as first point of impact and a reduction in front, although front / back (implying a shunt collision) is still the most frequent.

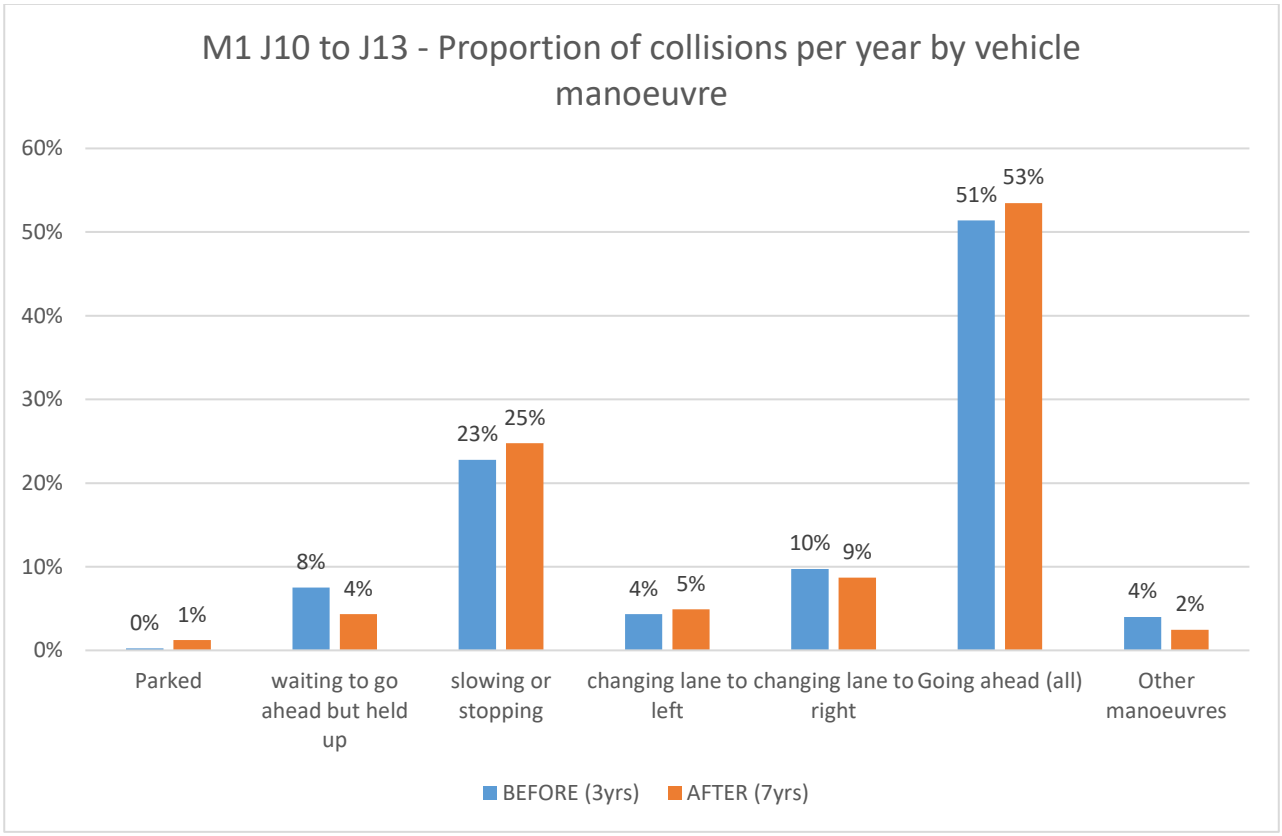


Figure 4.5 Proportion of collisions by vehicle manoeuvre

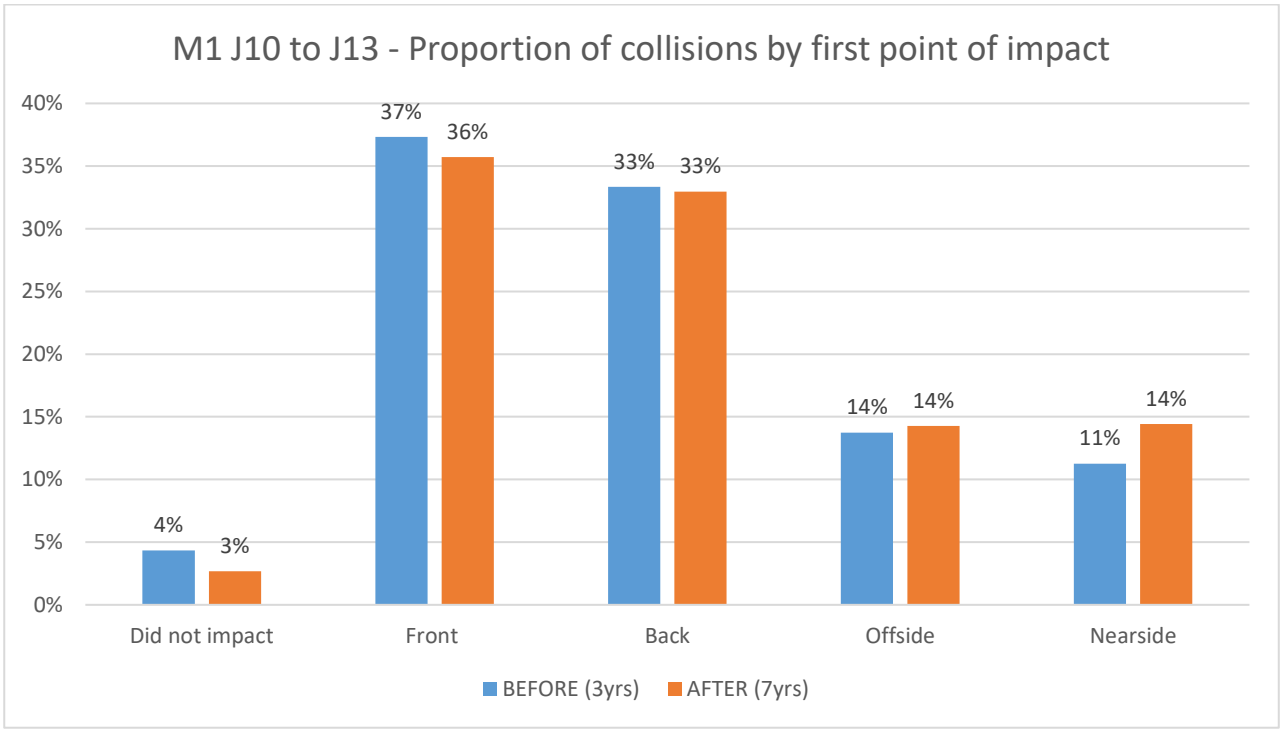


Figure 4.6 Proportion of collisions by first point of contact

Key findings

The collision review indicates that there has been an overall decrease in the overall average number of injury collisions per year post scheme opening but an increase in the average number of serious injury

collisions. A decrease in the number of collisions is noted after year 5 (December 2016 to November 2017) which coincides with when the smart motorway operating system was recalibrated and control room operating protocol revised. When broken down by link the average number of injury collisions has reduced although the average number of serious collisions has increased on all links.

4.3 Incident data review

In addition to collision data, Operations' incident data from the most recent three years post-opening 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 years of incident data has been used to provide a manageable and robust record of the types of incident recorded. Table 4.4 and Figure 4.7 summarises the reported incidents by event and year and for context includes the total number of incidents recorded.

Table 4.4 Incident records for selected categories

Year	Traffic collision	Pedestrian on network	Breakdown				Total
			Not in live lane	In live lane	Undisclosed location[8]	All	
2017	778	142	1116	1889	344	3349	10486
2018	822	125	1224	2061	424	3709	10659
2019	804	137	960	1239	1305	3548	10353
Avg	801.3	134.7	1100.0	1729.7	691.0	3535.3	10499.3

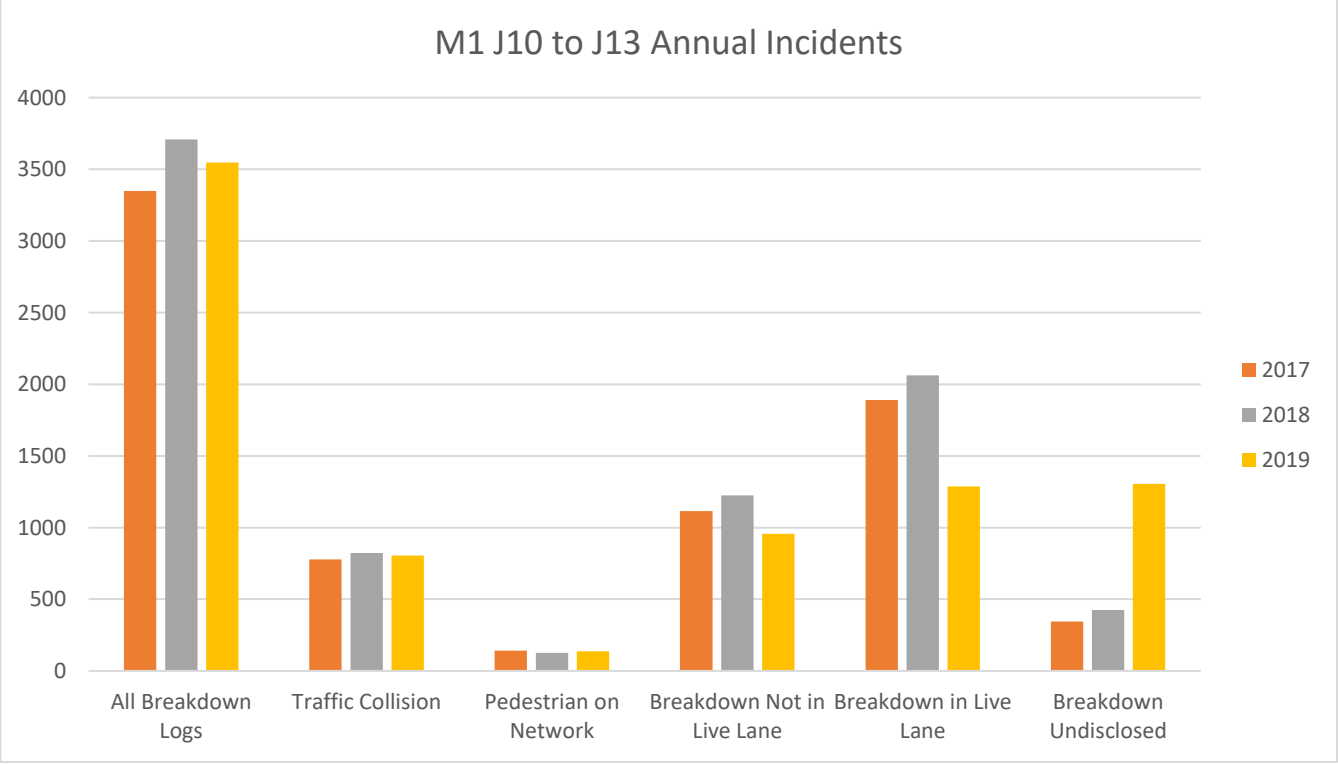


Figure 4.7 Annual incidents by type

[8] The way Incident data was reported changed part way through 2019, which included the way location information was categorised. For the purposes of this analysis and to ensure comparison of equivalent data, 2019 post-change data has been separated out into the Breakdown Undisclosed field and not compared to the location data from 2017 and 2018 and the early part of 2019.

Table 4.4 and Figure 4.7 indicates that the reported number of traffic collisions have changed little over the last three years (it is important to note that this will include *all* collisions of which the operations team are made aware, which will include damage-only collisions not captured elsewhere). The number of incidents recorded as a collision far exceeds those reported officially in injury collision records and suggests that there are a larger number of damage only collisions compared to injury collisions.

Reports of pedestrians on the network have been recorded in the range 125 to 142 per year (i.e. around 2.5 per week on average).

The total number of breakdowns by year increased in 2018 compared to 2017 but then decreased in 2019. Table 4.5 summarises the breakdown in a live lane rate by year for this 15 mile section of motorway.

Table 4.5 Live lane breakdown rates by year

Year	Breakdown in live lane	Breakdown in live lane rate (LLB/day/mile)
2017	1889	0.35
2018	2061	0.38
2019 [8]	1239	0.23

Key findings

The rate of live lane breakdowns has fluctuated. A change in reporting of incident location categories occurred part way through 2019 and is likely to have affected the apparent rate of live lane breakdowns reported. Using the 2018 rate (to exclude the effects of the reporting change) this indicates a typical rate of five to six live lane breakdown incidents per day across the entire 15 mile scheme.

Reports of pedestrians on the network indicate between two and three occurrences a week.

4.4 Design Safety Report and Departures from Standards review

The investigation has included a review of the Design Safety Report and the associated departure from standard entries. The scheme Design Safety Report produced for the M1 Junction 10 to 13 scheme contains different information to the Design Strategy Record that was introduced for later projects and captured design decisions taken in the development of a scheme. Key scheme specific design features that relate to user safety from the Design Safety Report are summarised in Table 4.6.

Table 4.6 Key elements from scheme Design Safety Report

Specific Design Features	Findings
Permanent through junction running at Junctions 10, 11 and 12 and Toddington motorway service area, and extended through junction running between the motorway service area and junction 12. The transitions between operational regimes creates potential issues including: drivers using LBS1 when it is closed following a through junction section; drivers anticipating the opening of LBS1 due to the operating regime elsewhere on the scheme; or drivers using the hardshoulder outside of the scheme limits.	Check operational and safety performance of link – refer to the focussed analysis section.
Emergency area spacing not in accordance with the applicable design standard IAN 111/09	Requirements at the time of this scheme's design and construction (IAN 111/09) set a maximum

which also required an assessment of the need for intra junction emergency areas at through junction running sections. Emergency area provision assessments were completed in March and April 2010 and mitigation measures recommended including discreet emergency roadside telephones, the optimisation of pivot turn and zoom camera resting positions and provision of a footpath behind the vehicle restraint barrier at Toddington motorway service area to assist stranded drivers to reach the service area.	spacing between refuges and / or decision points of 1000m (current all lane running standards require a maximum spacing of 1600m) Spacings above 1600m are considered as key relaxations. There are four locations where the spacings exceed this, two northbound and two southbound either side of junction 11a.
Junction 11 southbound merge - vehicles moving early to LBS2 in anticipation that LBS1 downstream was closed, then moving back to LBS1 once visibility to the fixed text message sign and entry datum point was achieved, causing excessive lane changing. This was due to the relatively winding alignment and reduced forward visibility	This issue was also raised in the 12 month post opening stage 4 road safety audit at other locations.
Non-provision of intra-junction emergency areas. For intra junction sections the diverge slip road hardstrips/hard shoulders were assumed to provide similar benefits to emergency areas.	Provision of Intra-junction emergency areas at junction 12 and the motorway service area was considered in the report, however these would not be required for compliance with current smart motorway standards (assuming spacing requirements are met). This design feature is therefore not considered a key relaxation. Note that the latter addition of junction 11a did provide an intra-junction emergency area for each carriageway.
Emergency roadside telephones are not provided on hard shoulder in some areas – only at emergency areas. Hazard for road users walking in live lane to emergency areas in event of a breakdown in open LBS1 scenario.	Emergency roadside telephone provision on this scheme is similar to that on a current all lane running scheme. This is therefore not considered to be a key relaxation.
The scheme is unlit (apart from small sections at junctions). A qualitative increase in risk from operating through junction running in darkness was identified through the motorway service area to junction 12 [9].	Street lighting is not a requirement for current smart motorway schemes however the impact of removing lighting specifically between Toddington motorway service area and junction 12 has been considered later in section 5.3 .
The automation of the opening, monitoring and closing of the hard shoulder running regimes through low light CCTV technology was still being investigated and the technology was not yet proven.	Low light CCTV technology has since been proven to be reliable but not for automatic opening and closing of the LBS1.

Table 4.7 summarises key departures from Highways England's Interim Advice Note 111/09 that have been identified with potential operational or safety issues related to the design. Departures are used to formalise the assessment, appraisal and approval for all instances where mandatory requirements are

[9] Reference D123845/11/12v2 Safety and Lighting Report 29 September 2010

not implemented during schemes on the motorway and all-purpose trunk road network. The departures for this scheme predominantly relate to the junctions within this section where there may be a cumulative effect.

Table 4.7 Key departures from standard

DAS ID	Location	Element	Potential relevance to this work
56230	J10 Northbound merge	Parallel merge should be a ghost island lane gain	Impact on performance of junction.
57517	J10 Southbound diverge	Taper diverge in place of a ghost island	
56006 59944	J11 Northbound diverge	3 step relaxation in in stopping sight distance Taper diverge instead of ghost island lane drop	Impact on performance of junction in terms of shunts and lane changing.
60697 60176	J11 Southbound merge	4 step relaxation in in stopping sight distance One lane taper merge should be a 2-lane ghost island with lane gain.	
56009 60192	J11 Southbound diverge	2 step relaxation in in stopping sight distance Taper diverge should be a lane drop	
61284 62587 61277 61293	MSA Northbound merge	No near straight Short auxiliary lane length (186m should be 230m) Substandard nose length (56m should be 115m) Reduced lane width of 3.5m (should be 3.7m) and variable hard shoulder width	Potential cumulative effect of departures on merging and diverging traffic in terms of shunts and lane changing.
61285 61291	MSA Northbound diverge	No near straight 4 step relaxation in horizontal curvature	
61273 62389 61292	MSA Southbound merge	No near straight Short auxiliary lane length (156m should be 230m) Reduced lane width 3.5m (should be 3.7m) and variable HS width	
61272 61283	MSA Southbound diverge	No near straight Substandard nose length (65m should be 115m)	
59928	J12 Southbound merge	Taper merge type A instead of type E lane gain	Impact on performance of junction in terms of shunts and lane changing.
59951 59894	J12 Southbound diverge	2 step relaxation in in stopping sight distance One-lane type A taper diverge instead of type C lane drop	
60955 60921 60922	J13 Northbound diverge	2 step relaxation in stopping sight distance Reduced nose length of 70m (should be 80m) and ratio of 1:8.6 (should be 1:15) Reduced lane widths (3.5m rather than 3.65m)	Compound effect of departures on diverging traffic in terms of loss of control, shunts and lane changing.
60906	J13 Southbound merge	Single lane gain rather than ghost island lane gain	Impact on performance of junction in terms of shunts and lane changing.
55513	Scheme wide	Provision of reduced lane widths 3.5, 3.5, 3.5, 3.3m (standard requires 3.4, 3.7, 3.5, 3.2m)	Potential impact on links, specifically lane changing.
59889	MSA Northbound merge to J12 diverge	Weaving length is 857m (standard requires 2km)	Prevalence of lane changing collisions

DAS ID	Location	Element	Potential relevance to this work
59891	J12 Southbound merge to motorway service area diverge	Weaving length is 1032m (standard requires 2km)	
64097	Emergency refuge areas - scheme wide northbound	Emergency refuge areas spacings greater than 1000m at 2 locations: Emergency refuge area at gantry 19 to emergency refuge area at gantry 24 = 1970m Emergency refuge area at gantry 24 to emergency refuge area at gantry 31 = 1990m Average spacing is 1980m (standard requires maximum 800m average)	Prevalence of live lane stops
64098	Emergency refuge areas - scheme wide southbound	EA spacings of greater than 1000m at 2 locations: Emergency refuge area at gantry 31 to emergency refuge area at gantry 24 = 1755m Emergency refuge area at gantry 24 to emergency refuge area at gantry 19 = 2205m Average spacing is 1980m (standard requires maximum 800m average)	

Key findings

Potential hazards noted in relation to the transitions between operational regimes, including unnecessary lane changing and the impact of removing the lighting between Toddington motorway service area and junction 12.

Some design compromises noted relating to:

- Toddington motorway service area junction and weaving lengths some of which may have been pre-existing;
- cumulative effect of the departures, particularly at junction 11 and the northbound diverge at junction 13.

These areas will be considered specifically as part of the detailed investigation.

4.5 Operations feedback

The Operations Team for the M1 Junction 10-13 corresponded with the project team via Microsoft Teams and email on the 19th and 24th August 2020 respectively. Key points are noted below:

- No traffic signs are obscured and CCTV coverage in the area is considered to be good by the Operations team, with pan-tilt-zoom cameras and hard shoulder monitoring cameras. One hard shoulder camera on the southbound section is currently misty and waiting repair (reference HSM 58.2B).
- The nearest outstation is at Toddington motorway service area northbound where Traffic Officers are able to deploy either north or southbound using either the service road or Junction 12.
- Daily occurrences of motorists using LBS1 when closed, particularly after through junction running sections.
- Left hand drive vehicle involvement in incidents associated with lane changing, particularly when there is a switch in the use of LBS1.

- Toddington motorway service area operation, merge and diverges were not identified as a key issue.
- Emergency area use is low with most drivers stopping in LBS1 during the off peak when it operates as a hard shoulder, even when in close proximity to an emergency area.
- Indication of the start of the hard shoulder is limited on the northbound approach to junction 12, junction 11a and junction 11 to 10.
- Pedestrians are reported on a weekly basis on the network, particularly in the vicinity of junctions 10 and 11.
- Reported unreliability of fixed text message signs and the rotation mechanism seizing, so operators are reliant on variable message signing (MS4s) which are automatically set legends.

Key findings

The scheme operation was amended significantly in 2017 by the opening of junction 11a and the operational changes described in section 3. These were viewed positively, nevertheless misuse of LBS1 and potential for lane change collisions (particularly regarding left hand drive vehicles) remains. Pedestrian incidents occur regularly at the southern end of the scheme particularly at junctions 10 and 11 where the M1 passes through the built-up areas of Luton and Dunstable.

4.6 Data review outputs

The following specific factors, identified through the data collection and review stage of this investigation, were considered further in the safety analysis section.

- Collisions occurring in the vicinity of Toddington motorway service area.
- Collisions at junction 13 immediately south of the junction and at junction 11.
- Darkness collisions, specifically the impact of removing lighting through Toddington motorway service area to junction 12.
- Collisions involving live lane stops.
- Collisions resulting from lane changing.
- Pedestrian involvement in collisions and incidents.
- Left hand drive vehicle involvement in collisions.

These factors are illustrated in Figure 4.8.

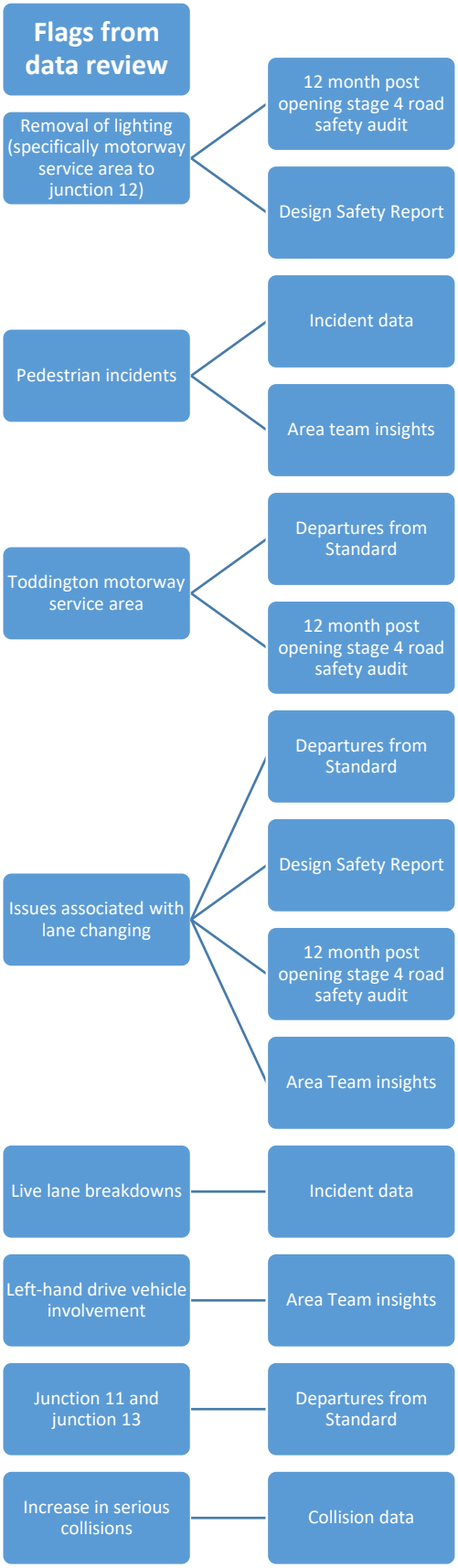


Figure 4.8 Factors to be considered in the focussed investigation

5. Focussed Investigation

This section investigates in detail the key factors or areas identified in the preceding chapter, plus any additional factors 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 Context

Section 4.2.2 in this report highlighted that:

- over the seven year after period from December 2012 slight, fatal and total collisions have reduced while serious collisions have risen compared to the three year before period.
- during the after period there has been a higher ratio of fatal and serious collisions than in the before period (6.6% before and 11.1% after),
- at 11.1% the fatal and seriously injured ratio is below average for all motorways (the 2018 Strategic Road Network Casualty Report indicates 17% of all motorway collisions were fatal or serious in 2018).

5.1.2 Fatal collisions

Five fatal collisions have been recorded on the M1 between junctions 10 and 13 since the smart motorway scheme became operational on 1 December 2012 and up to 30 November 2019. Table 5.1 summarises the five collisions. A plot illustrating the locations of the fatal and serious collisions is included in Appendix A.

Table 5.1 Details of fatal collisions

Ref.	Location	Date Time	Conditions	Gender | Age | Severity	Detail	Comment
14CA1034	Northbound nr junction 12	15/09/2014 0540	Dry/light(1)	M 23 Se M 26 Sl F 37 F M 53 Se F 90 F F 88 Se F 81 Se M 53 Se M 35 Sl	**Vehicle 1 changes lane, vehicle 3 (motorcyclist) brakes and loses control and is struck by vehicle 4**. Debris hit by Vehicles 5 to 9. Vehicles 1 and 2 left the scene.	Lane changing. No contributory factors given. **Unlikely to be related specifically to smart motorway.**
15DA0078	Northbound between junctions 12 and 13	14/02/2015 0646	Dry/dark	M 22 F M 20 F M 21 Se	Vehicle 2 **stops on hard shoulder** with hazards on, vehicle 1 (coach) used LBS1 when closed and supported by additional signage, and hits vehicle 2.	No contributory factors given although hard shoulder misuse (whilst closed) a key factor. Coach driver jailed for seven years. **Breakdown on hard shoulder (when not open to traffic).**

Ref.	Location	Date Time	Conditions	Gender | Age | Severity	Detail	Comment
15DA0636	Southbound nr Chalton (north of junction 11a)	22/08/2015 2355	Dry/dark	M 33 F F 19 Sl	Vehicle 1 **loss of control**, strikes nearside barrier.	No contributory factors given **Unlikely to be related specifically to smart motorway.**
193493	Southbound junction 11	21/06/2017 1135	Dry/light	M 30 F	**Pedestrian** on junction 11 exit slip road then crossing towards central reservation and struck in LBS4 by a car. Contributory Factors: exceeding speed limit/careless/reckless, pedestrian dangerous action /disability/illness.	**Unlikely to be related specifically to smart motorway.**
825231	Northbound 300m before junction 13	11/03/2019 1109	Dry/light	M 83 F F 78 Se	**Vehicle 1 (left hand drive goods vehicle) changed lane** and struck vehicle 2 in LBS2.	Lane changing. No contributory factors given. Goods vehicle was left hand drive but not foreign vehicle. **Unlikely to be specifically related to smart motorway.**

(1) Sunrise is approximately 0630 so may have been dark at 0540.

The five recorded fatal collisions included two lane changing collisions (one a left hand drive vehicle), one live lane stop in the dark where LBS1 was closed and the gantry signals at the time were contravened, one loss of control and one involving a pedestrian walking in the carriageway. Two of the collisions occurred in the dark with the possibility of a third also being in darkness but recorded as light.

It is not clear from the limited details available for the pedestrian fatality (collision reference 193493) if this was a suicide attempt or illness related.

Since 30 November 2019 three further fatal collisions have been recorded on this section of the M1, These three fatal collisions occurred after the period in which collision data was available for this report and therefore the details have been provided separately in Table 5.2. Two southbound collisions involved some form of mechanical breakdown resulting in a live lane stop and a northbound collision involved a vehicle striking the nearside barrier and ending up stationary in the running lane. Two of the collisions occurred in darkness.

Table 5.2 Details of fatal collisions reported since 30 November 2019

Date Time	Location	Conditions	Detail	Comment
1/12/2019 1530	Southbound junction 11a	Daylight	**Slow moving car emerged into LBS1** having stopped in the emergency area for less than one minute, before then being struck by a heavy goods vehicle. Heavy goods vehicle driver prosecuted for dangerous driving.	**Breakdown / limping vehicle where no hard shoulder.**

Date Time	Location	Conditions	Detail	Comment
24/12/2019 2316	Northbound near junction 11a -12	Darkness	**Single vehicle loss of control initially**, vehicle strikes vehicle restraint system and comes to rest across LBS3. Vehicle is then struck by oncoming traffic.	**Unlikely to be related specifically to smart motorway.**
4/1/2020 0640	Southbound between junctions 13 and 12	Darkness	**Heavy goods vehicle stopped in LBS1** hit by another heavy goods vehicle (left hand drive).	**Live lane stop leads to collision.**

Key Findings

Five of the eight fatal injury collisions are unlikely to have been as a result of 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.

Three of the remaining fatal collisions which could have been as a result of the design or operation of the smart motorway involved a vehicle stopped or limping in a live lane. In one case the driver was in contravention of gantry signing using LBS1 when closed, resulting in a collision with a vehicle stationary on the hard shoulder. Live lane stop related collisions of all severities are analysed in the Section 5.2.

5.1.3 Serious collisions

Seventy one serious injury collisions have been recorded on the M1 between junctions 10 and 13 since the smart motorway scheme became operational up to 30 November 2019. Thirty eight were recorded on the northbound carriageway and thirty three on the southbound carriageway.

Table 4.2 indicates that serious injury collisions have increased in comparison with the three year before period with an average of 6.3 serious injury collisions per year in the before period and 10.1 per year in the after period. However all collisions, including serious collisions, decreased in years 6 and 7 in the after period with an average of 6.5 serious injury collisions per year, comparable with the before period.

Table 5.3 summarises the number of serious injury collisions by link and gives an indication of where the serious collisions are occurring. The section between junction 10 and junction 11 is just over half the length of the junction 12 to junction 13 section but has recorded slightly more collisions, resulting in a higher serious injury collisions per km per year during the after period. The table also indicates that the opening of junction 11a has resulted in a marginal decrease in serious collisions per km per year when the two links – junction 11 to 11a and 11a to 12, are compared to the entire link.

Table 5.3 Fatal and serious injury collisions by link

Link	Serious	Serious injury collisions per year	Link length (km)	Serious collisions per km per year
J10-J11	28	4.0	5.5	0.73
J11-J12 (Dec 2012 to April 2017)	16	3.6	7.2	0.50
J11-J11A (May 2017 to November 2019)	1	0.4	3.5	0.11
J11A-J12 (May 2017 to November 2019)	3	1.2	3.7	0.32
J12-J13	24	3.4	10.2	0.33
Total	71			

Of the 71 serious collisions, 28 were darkness collisions (39%), of which ten were lit. Nineteen of the collisions were recorded on a wet road surface (26%) and one in snow. Table 5.4 summarises which sections the dark and wet road surface collisions took place. No serious injury collisions have been recorded between junctions 11 and 12 since junction 11a was opened.

Table 5.4 Dark and wet collisions by link

Link	Dark	Dark (lit)	Total dark	Wet
J10-J11	7	5	12	6
J11-J12 (Dec 2012 to April 2017)	3	3	6	4
J11-J11A (May 2017 to November 2019)	0	0	0	0
J11A-J12 (May 2017 to November 2019)	0	0	0	1
J12-J13	8	2	10	8
Total	18	10	28	19

Table 5.5 summarises the type of collisions by direction of travel and Table 5.6 illustrates the four most frequent type of collision by post-opening year.

Table 5.5 Type of serious injury collisions by direction of travel

Collision type	Northbound	Southbound	Total
Rear shunt	15	10	25
Lane change/merge	11	7	18
Loss of control	7	4	11
Live lane stop	2	4	6
Drugs/alcohol related	1	3	4
Late exiting	2	0	2
Other	0	5	5
Total	38	33	71

Table 5.6 Type of serious injury collision by post-opening year

Post-opening year	1	2	3	4	5	6	7	Total
Rear shunt	6	2	4	5	5	0	3	25
Lane change/merge	4	3	3	2	3	3	0	18
Loss of control	3	3	1	1	1	2	0	11
Live lane stop	1	1	0	1	1	0	2	6
Drugs/alcohol	0	0	1	1	2	0	0	4
Late exiting	0	0	0	1	1	0	0	2
Other	0	2	0	0	0	0	3	5
Total	**14**	**11**	**9**	**11**	**13**	**5**	**8**	**71**

Table 5.6 indicates a decrease in shunt type collisions after year 5 during which changes were introduced associated with the recalibration of the smart motorway operating regime. The three other collision types show a less marked change at this point.

Rear shunts

There have been 25 injury collisions involving a rear shunt, six in darkness and four in roadworks. Eight occurred during a weekday peak and six on a Sunday. Eight of the collisions involved four or more vehicles. The reason stated is predominantly due to slowing or queuing traffic. The average number of shunts occurring per year in the first five years since opening is 4.4 compared to the last two available years of 1.5. This corresponds with the changes introduced in 2017 associated with the recalibration of the motorway operating systems, control room operating protocol revised and signing upgrades implemented on approach to junctions.

Lane change collisions

Of the 18 injury collisions involving lane changing five occurred at night, three of which were within lit sections. Four of the collisions occurred on a wet road surface. Fourteen of the 18 collisions involved a goods vehicle of which eight were from LBS1 to LBS2. Four of these involved a left hand drive goods vehicle. The average number of lane change collisions occurring per year in the first five years since opening is three compared to 1.5 in the last two available years although this involves low numbers. This corresponds with the changes introduced in 2017 mentioned above.

Loss of control collisions

Of the eleven loss of control collisions, seven were recorded at night, four within lit sections, and three on a wet road surface. Four of the collisions occurred between midnight and 4am and four involved a single vehicle. At least one loss of control collision is recorded each year. The contributory factors stated include: fatigue, braking, swerved and inexperience.

Live lane stops

Of the six live lane stops four were dark collisions, one within a lit section and two in the latest two years of data. One of the live lane stops occurred on the exit slip at junction 10 northbound, three involved cars broken down in LBS1 on the mainline and one occurred in roadworks and involved a goods vehicle colliding with a crash cushion that was protecting other works vehicles. The sixth collision involved a car moving from LBS4 to LBS1 in order to assist a broken down motorcyclist and then colliding with another car; the broken down motorcyclist was not a casualty. Five of the live lane stop collisions were recorded between junctions 12 and 13.

Table 5.7 summarises other common factors noted in the analysis of the serious injury collisions

Table 5.7 Other serious injury collision common factors

Other factors	Northbound	Southbound	Total
Roadworks	5	2	7
Motorcyclists	3	5	8
Left hand drive	3	2	5

Collisions recorded in roadworks

Of the seven serious injury collisions recorded in roadworks five involved shunts and two lane changing. Four of the collisions occurred in darkness. One of the seven collisions involved a goods vehicle colliding with the crash cushion in place to protect other works vehicles (see live lane stops above.) Two of the collisions occurred in 2013 (February and October), one in December 2015 and one in April 2017. Three occurred in 2019, one in May and two eight days apart in October but on different carriageways.

Motorcycle collisions

Of the eight serious injury collisions involving motorcyclists four were recorded in the dark. Four occurred in 2013 and then one per year except for 2017 and 2019. Three of the collisions involved motorcyclists braking - two in traffic, two involved motorcyclists filtering through traffic and two involved a car changing lane and colliding with a motorcyclist. One involved a car colliding with a motorcyclist due to being dazzled by the sun.

Left hand drive involvement in collisions

Of the five recorded serious injury collisions four involved a left hand drive goods vehicle merging/changing lane and then colliding with a car and the fifth a shunt. None of the collisions occurred in the dark. One additional collision not recorded as a left hand drive vehicle involved a goods vehicle where the contributary factor related to inexperience driving on the left. All five occurred in the first three years of post-opening data.

Collision location

A number of serious collision clusters have been identified from the fatal and serious collision plot. Some of these locations have also been highlighted from the Design Safety Report and 12 months post opening stage 4 road safety audit. Table 5.8 summarises the locations which are reviewed in the next section along with the slight collision data.

Table 5.8 Serious injury collision clusters by location

Location	Frequency	Identified from
North of junction 10	6 serious	Collision plots for this investigation
Junction 11	6 (5 serious and 1 fatal)	Design safety report
Vicinity of Toddington motorway service area	4 serious	12 month post opening stage 4 road safety audit, design safety report
Junction 12	10 (9 serious and 1 fatal)	Collision plots for this investigation
South of Junction 13	5 (4 serious and 1 fatal)	12 month post opening stage 4 road safety audit, design safety report

Key Findings

Serious collisions have decreased in the latest two years of collision data. This could be as a result of the changes introduced in 2017 associated with the recalibration of the motorway operating systems, specifically the opening and closing of LBS1 between junctions 10 to 13, and revised control room operating protocols.

Six of the 71 serious injury collisions may have been as a result of the design or operation of the smart motorway; i.e. they could reasonably have occurred due to a feature or factor of the smart motorway environment. These involved stopping or stopped vehicles in live lanes which have continued to be recorded post opening.

Eighteen of the serious injury collisions involved lane changing, particularly at merges where the hard shoulder is intermittent under the current dynamic hard shoulder regime.

Five of the recorded collisions involved a left hand drive goods vehicle although this appears to be a decreasing issue.

Clusters of serious collisions have been noted in the vicinity of Toddington motorway service area and junctions 10, 11, 12 and 13.

5.2 Live lane stop related collisions

A review of all injury collisions has identified 23 collisions relating to live lane stops have been recorded on the M1 junction 10 to junction 13 between opening in December 2012 to 30th November 2019. A plot

illustrating the locations of live lane stop collisions is included in Appendix B.

Of these injury collisions:

- One was classified as fatal, six serious and 16 slight.
- Fourteen of the collisions were recorded on the northbound carriageway and nine on the southbound carriageway.
- In 18 of the 23 collisions vehicle breakdown or burst tyre is stated as the reason for stopping, 14 related to a car and four to a goods vehicle.
- Nine of the collisions were recorded in darkness (39%) and five on a wet road surface.

As noted in section 5.1.1, two further fatal collisions occurred which involved live lane breakdowns in December 2019 and January 2020.

As this section of the M1 is operating with a dynamic hard shoulder it is not always clear from the collision descriptions if the live lane stop comprised a vehicle in LBS1 when operating as a hard shoulder and not a running lane, or whether it was operating as a running lane at the time. The details of the one fatal collision specifically state that the overhead signing had been contravened by a vehicle resulting in the collision with the stopped vehicle. One of the serious collisions occurred during road works and a vehicle collided with a works crash cushion. Table 5.9 details the live lane stop collisions including the two fatal collisions recorded outside of the after study period but which resulted from a live lane stop.

Table 5.9 Details of live lane stop injury collisions by year and direction of travel

Year	Northbound		Southbound		Total
	Frequency	Summary	Frequency	Summary	
Year 1	1 slight	Van broken down LBS 2	1 serious 2 slight	Car broken down on hardshoulder. Car moves from LBS4 to 1 and breaks down. Car broken down on junction 11 southound entry slip.	4
Year 2	0		1 serious 1 slight	Car broken down in LBS1 (dark) Car broken down in LBS1 – signing ignored (dark)	2
Year 3	1 fatal 2 slight	Coach contravenes signing in hard shoulder (dark) Car broken down in hard shoulder Car broken down in hard shoulder and is struck by a goods vehicle (GV) contravening gantry signing	1 slight	Car broken down in LBS2	4
Year 4	1 serious 2 slight	Car broken down on exit slip (dark) Van broken down in hardshoulder Goods vehicle broken down in traffic	0		3
Year 5	2 slight	Car trying to reach emergency area from	1 serious 1 slight	Lane change collision as a result of driving attempting to assist broken down m/c.	4

Year	Northbound		Southbound		Total
	Frequency	Summary	Frequency	Summary	
		LBS2 collides with goods vehicle in LBS1. Car puncture in hardshoulder.		Car broken down in LBS3 (dark)	
Year 6	4 slight	Car puncture entry slip Car broken down hardshoulder (dark) Car stopped on hardshoulder due to illness (dark) GV broken down in hardshoulder	0		4
Year 7	1 serious	Car broken down in hardshoulder (dark)	1 serious	Goods vehicle into back of works crash cushion in hardshoulder, roadworks (dark)	2
December 2019 - January 2020			2 fatal	Heavy goods vehicle broken down in LBS1 Car limping/stalled in LBS1	[2]
Total	14		9		23 [25]

Table 5.9 indicates that the number of recorded live lane stop injury collisions recorded per year has fluctuated between two and four since the scheme opened and that over 75% of the collisions occurred as a result of a vehicle breaking down. The incident data for this section of the M1 includes live lane breakdowns with 2,061 recorded in 2018.

Table 5.10 summarises where the live lane stop collisions have occurred by junction link and indicates that the highest number of live lane collisions per kilometre over the seven year after period occurred between junctions 12 to 13 and junctions 10 to 11. All four of the collisions recorded between junctions 11 and 12 occurred before junction 11a was opened in May 2017.

Table 5.10 Frequency of live lane stop collisions by junction link

Link	Frequency	Link length (km)	Live lane stop collision/km
J10-J11	6	5.5	1.1
J11-J12 (Dec 2012 to April 2017)	4	7.2	0.6
J11-J11A (May 2017 to November 2019)	0	3.5	0
J11A-J12 (May 2017 to November 2019)	0	3.7	0
J12-J13	13	10.2	1.3
Total	23		

5.2.1 Discussion

Requirements at the time of this scheme's design and construction (IAN 111/09) set a maximum spacing between refuges and / or decision points of 1000m. Emergency area spacing was identified as not being in accordance with the contemporary standard in the scheme's design safety report. For this investigation, given that places of relative safety are currently required at up to 1600m intervals when designing all lane running schemes, spacings above 1600m have been considered as key relaxations.

There are four locations where the spacings exceed this, two northbound and two southbound either side of junction 11a.

The number of live lane stop collisions has fluctuated between two and four per year over the seven year after period. Over the seven year after period 1.1 collisions per kilometre have been recorded between junctions 10 to 11 and 1.3 per kilometre between junctions 12 to 13. The four live lane stops between junctions 11 and 12 were recorded prior to the opening of junction 11a and result in a lower live lane collision rate per km than the other two links.

Of the six live lane stop collisions recorded between junctions 10 and 11 four involved a broken down vehicle or a burst tyre – one on the northbound entry slip, one on the northbound exit slip and two mid link. The fifth occurred in roadworks and involved a goods vehicle colliding with the works crash cushion in the dark, and the sixth involved a northbound car attempting to access an emergency area from LBS 2 and colliding with a goods vehicle in LBS 1. Three of these collisions involved drivers stopping or attempting to stop in a place of relative safety, i.e. a slip road or emergency area. Two of the collisions involved in a vehicle contravening signing associated with the hard shoulder or roadworks.

Of the thirteen live lane stop collisions recorded between junctions 12 to 13, seven involved vehicle breakdowns on the northbound carriageway and three on the southbound carriageway. The remaining three incidents were a fatal collision involving a coach contravening the gantry signing and colliding with a vehicle stationary on the hard shoulder, a serious collision involving a driver changing lanes with the intention to help a broken down motorcyclist but colliding with a car in LBS 1 and a driver stopping in LBS 1 due to illness.

Two slight collisions were recorded between junction 11a and junction 12, both located in the vicinity of junction 12 involving vehicles breaking down, one in LBS 2 and one in LBS 3.

It is not possible from the recorded injury collision data to determine if the collisions have occurred when the hard shoulder is operating as a live lane or not. There is also limited detail on how long vehicles have been stationary prior to the collision or any indication if these are occurring in spite of signals being set to protect the stopped vehicle, potentially with insufficient time or no notification to Highways England of the live lane stop. The programme-wide introduction of Stopped Vehicle Detection (SVD) may reduce the risk for some of these collisions. Prior to the introduction of stopped vehicle detection, providing the maximum clarity and consistency over the status of LBS 1 through the signalling could help road user comprehension and compliance.

Incident data for the length being investigated recorded 3,709 breakdown events in 2018 of which 2,061 were recorded in a live lane. The analysis used 2018 data due to changes in the recording of incidents in 2019, specifically the use of ‘undisclosed’ in relation to a breakdowns reducing the understanding of whether the breakdown was in a lane or not. This means that, in the same period that three injury collisions relating to live lane stops due to a breakdown have occurred, Highways England have recorded 2,061 live lane breakdowns overall – giving an approximate ratio of one injury collision for every 687 live lane breakdown incident reports.

5.2.2 Potential intervention

Consider enhancing consistent and repeated messaging on LBS 1 status via signals. Use message signs (MS4s) to display ‘hard shoulder for emergency use only’ message at all available signals when hard shoulder is closed – dashcam footage showed only intermittent use currently of this message. Set a red-x on all LBS1 signals at all times when LBS1 is not open as a running lane. Similarly, when LBS1 is open to traffic, consistently display ‘congestion use hard shoulder’ at all available variable message signals.

5.3 Collisions during darkness between Toddington motorway service area and junction 12

Figure 4.2 indicated that the number of collisions occurring during darkness on this section of the M1 between junctions 10 to 13 has decreased from 35% in the three years before opening to 28% in the

seven years post opening. This is similar to the average for collisions recorded on the Highways England motorway network of 30% in 2018[10].

There is a decrease in 'darkness: street lights present and lit' collisions and increase in 'darkness: no street lighting' which is likely to be as a result of the removal of much of the lighting along this section with only junction 10 and junction 11 retaining lighting. The removal of the lighting along the majority of this section does not appear to have had a detrimental effect as the proportion of injury collisions being reported in the dark has reduced.

The design safety report identified a qualitative increase in risk from operating through junction running in darkness through the motorway service area to junction 12. Collision data for the section of M1 through Toddington motorway service area to junction 12 has been reviewed in terms of collisions occurring in darkness, to establish if there has been an increase in darkness collisions since the lighting was removed. Table 5.11 summarises the before and after collisions by lighting condition.

Table 5.11 Before and after collisions by lighting condition between Toddington motorway service area and junction 12

	Before (3 years)	After year							After	
	Per year	1	2	3	4	5	6	7	Total	Per year
Daylight	8								73	10.4
Darkness: Lit	3.3	0	1	1	3	1	1	0	7	1
Darkness: (unlit, none, unknown)		1	4	2	4	2	6	3	22	3.1
Total darkness	**3.3**	**1**	**5**	**3**	**7**	**3**	**7**	**3**	**29**	**4.1**

Table 5.11 indicates that the number of collisions recorded on this section in daylight has increased per year, and the number of collisions recorded in darkness but lit has decreased as expected due to the removal of the lighting. The total number of collisions recorded in darkness (lit, unlit, none and unknown) is 4.1 per year in the after period compared to 3.3 in the before period. This equates to a 0.8 collision per year increase in darkness collisions since removing the lighting.

The proportion of collisions occurring during darkness along this section of the M1 through Toddington motorway service area to junction 12 is 28% in the after period, below the average for darkness collisions on the motorway network of 30% (2018 values).

The removal of lighting from the section of M1 through Toddington motorway service area to junction 12 has not resulted in a significant increase in recorded darkness collisions and there is limited evidence of a treatable issue with darkness-related collisions on this section.

5.4 Collisions involving left hand drive vehicles

A review of all injury collisions within the scheme extents has identified that 69 out of 678 (10.2%) injury collisions recorded left hand drive vehicle involvement over the seven-year data period, including one fatal and six serious collisions. A plot illustrating the locations of left hand drive vehicle collisions are included in Appendix C.

Four of the serious injury collisions and the fatal collision involved a lane changing manoeuvre. Thirty of the collisions were northbound and 39 southbound. In the three-year period before the scheme was constructed, ten collisions were recorded with left hand drive vehicle involvement, eight slight and two serious; eight of the collisions involved changing lane manoeuvres. This equates to an average of 3.3 collisions per year in the before period compared to 9.8 collisions per year in the after period.

[10] Reported Road Casualties on the Strategic Network 2018

When the collisions are reviewed by year there has been a significant decrease in recorded collisions involving left hand drive vehicles since year 4. Table 5.12 summarises the occurrences and shows that in the latest three years of collision data there have only been two collisions per year, less than in the before period.

Table 5.12 Collisions involving left hand drive vehicles by year

	Before (3 years)	After year							After	
	Per year	1	2	3	4	5	6	7	Total	Per year
Left hand drive vehicles	3.3	9	21	19	14	2	1	3	69	9.8

Table 5.13 summarises the number of collisions with left hand drive vehicle involvement by link and indicates that there is higher involvement between junctions 10 to 11 and junctions 11a to 12 based on link length. Junction 11a to 12 includes Toddington motorway service area and is reviewed later in this document. It should be noted that Table 5.13 has included junction 11a although it was not open to traffic until May 2017. Since the opening of the junction only one collision involving a left hand drive vehicle has been recorded between junctions 11 and 12.

Table 5.13 Collisions involving left hand drive vehicles

Link	Frequency	Link length (km)	Collisions per km
J10-J11	22	5.5	4
J11- J11a	6	3.5	1.7
J11a- J12	21	3.7	5.7
J12-J13	18	10.2	2.1
Total	69		

5.4.1 Discussion

Although the frequency of collisions involving left hand drive vehicles has reduced considerably over the latest three year period it is worth highlighting that the transitions from through junction running and a dynamic hard shoulder are likely to increase the level of lane changing required whilst driving through the scheme. When LBS1 is closed drivers wishing to remain in the near side lane have to manoeuvre into and out of LBS1 seven times along this section. For all drivers, blind spots are larger on the passenger side of the vehicle, therefore for left hand drive vehicles an increase in lane changing from LBS1 to LBS2 will increase the risk of their involvement in collisions.

There are also reduced weaving lengths, north and southbound, between junctions 12 and the motorway service area which reduce the amount of time drivers have to be in the correct lane if intending to exit for the services or junction 12. This can result in drivers making late lane changing decisions.

Currently the signing for the transition from four lanes running through junction to LBS 1 closed as a running lane is limited to one sign, see Figure 5.1. Typically the one sign is provided between 130 and 200 yards upstream, and only on the northbound approach to junction 10 are two signs provided, a ½ mile (for mainline through traffic) and a 100 yard sign.

In comparison, elsewhere on the network lane drop diverges are relatively common. These require through traffic to make a similar manoeuvre from LBS1 to LBS2 to continue through the junction, however this lane drop arrangement is signed typically from one half or one third of a mile (or greater) in advance, and does not occur immediately following a merge. The lane change manoeuvre at lane drops

can therefore be considered as easier to undertake than those required at merges by this scheme's operational regime.

Figure 5.1 View of advance signing associated with the transition from through junction running to dynamic hardshoulder

5.4.2 Potential intervention

Consider increasing the number of signs for the transition from through junction running to dynamic hard shoulder downstream of the junction merges to provide additional warning and instruction for all drivers but particularly those in LBS1 and LBS2. Currently the signing is limited to one sign, see figure 5.1 providing between 130 and of 200 yards warning. Only on the northbound approach to junction 10 are two signs provided, a ½ mile and 100 yard sign. It is noted that the transitions between through junction running and dynamic hardshoulder will not exist when this section of the M1 is converted to an all lane running scheme, programmed for completion by the end of March 2025.

5.5 Pedestrian incidents and collisions

Analysis of the fatal collision on this section identified a pedestrian using the southbound exit slip road at junction 11 and then crossing towards the central reservation. A signal controlled pedestrian facility is provided at the end of the slip road to facilitate pedestrian movements at the junction with the A505. This, in combination with operational feedback and incident data relating to regular pedestrian incidents, has prompted analysis of data to establish other trends around pedestrians on this section of the network.

Three injury collisions with pedestrian involvement have been identified over seven years:

- The aforementioned fatality in 2017 involving a pedestrian who had gained access to the carriageway from the southbound exit slip road at junction 11.
- A serious injury collision in 2019 which began possibly as a result of a medical episode when several people have stopped to help the driver and have then been struck by the vehicle which lurched forward resulting in injuries. The collision occurred at the southbound exit slip road at junction 10. It is assumed those helping are other motorists as there are no pedestrian facilities

at junction 10.

- A slight injury collision also in 2017 involving an intoxicated pedestrian in the carriageway approximately one kilometre north of junction 11a, in the early hours of the morning. The collision occurred along a section where a public footpath runs parallel to the M1 on its east side for approximately a kilometre. Public rights of way linking Upper Sundon with Fancott and Chalton cross the motorway at this point via two accommodation bridges.

Incident data referenced as 'pedestrian on the network' has been reviewed and identified that on average 134 incidents per year were recorded. These included:

- clusters recorded at junctions 10 and 11 which are located adjacent to the built up areas of Luton and Dunstable.
- between junctions 10 and 11a the incidents appear adjacent to local routes which cross the M1, for example High Street, or potentially offer short cuts between residential areas.
- between junctions 11a and 13 the incidents are recorded in close proximity to emergency areas; possibly associated with ex-passengers or potentially associated with where public rights of way cross the motorway either via accommodation bridges or subways. Figure 5.2 provides an example of where a public right of way runs immediately adjacent to the M1 and then uses an accommodation bridge to cross the carriageway on an indirect route.

Figure 5.2 Aerial view of public right of way immediately adjacent to the M1 and corresponding incident plot showing 2019 'pedestrian on the network' data

5.5.1 Discussion

Based on feedback from Operations, pedestrian incidents are regularly reported on the motorway around junctions 10 and 11 and where the M1 passes between the conurbations of Luton and Dunstable.

Figure 5.3 shows an extract from the 'pedestrian on network' incident plot for 2019 between junctions 11 and 11a and highlights the potential severance effect of the M1 between Dunstable to the west and Luton to the east. At the southern end of this link there are a number of reported incidents shown, some could be associated with the emergency areas.

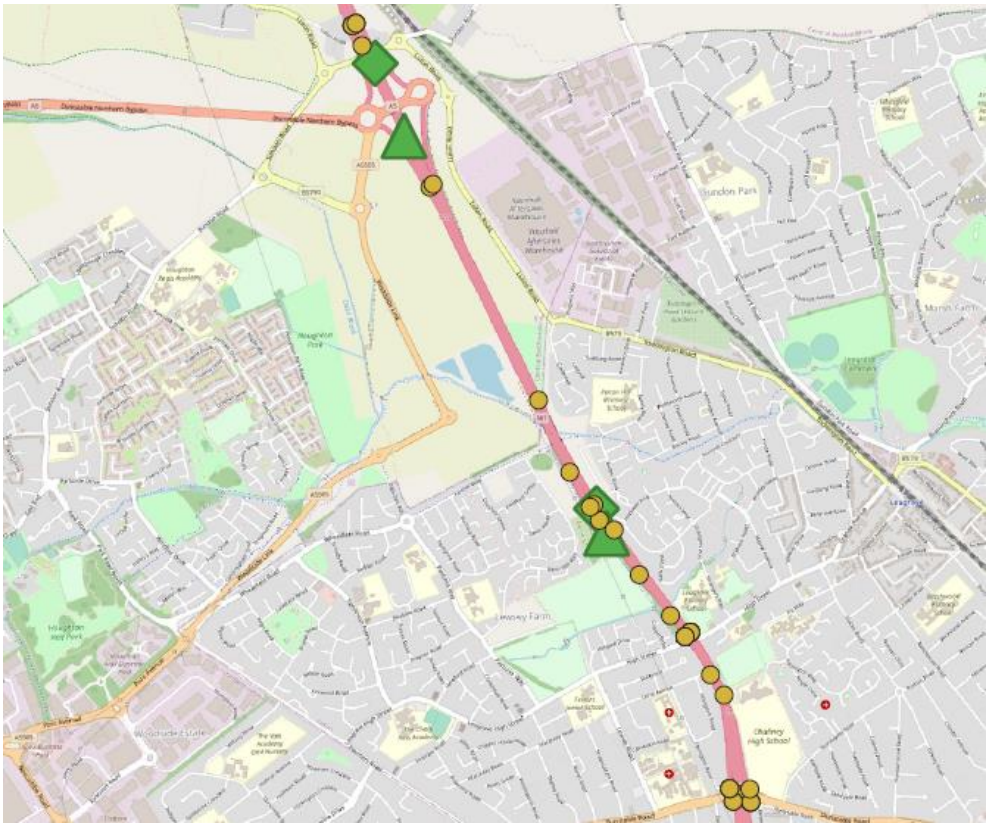


Figure 5.3 'Pedestrian on network' incidents in 2019 between junctions 11 and 11A

Over the three year period 2017 to 2019, 145 incidents involving pedestrians on the network were reported between junctions 11 and 11a, an average of 48 per year, almost one per week. This coincides with where the fatal collision was recorded involving a pedestrian on the southbound exit slip road. Figure 5.4 shows a StreetView image of the southbound exit slip road.

Figure 5.4 StreetView image of junction 11 southbound exit slip

Luton and Dunstable University Hospital is situated immediately west of junction 11 and the Highways England Operations team considered that this may be either an attractor or source of some pedestrians.

Figure 5.5 shows the proximity of the hospital to junction 11 and pedestrian facilities at the northbound merge slip road.

Figure 5.5 Google Mapping and StreetView showing hospital proximity to junction 11 and pedestrian facilities at the northbound merge slip

There are potential pedestrian crossing and access points along this section of the M1 and although actual injury collisions involving pedestrians are low, reports of 'pedestrian on the network' incidents are high. The urban setting, particularly between junctions 10 to 11a, could increase this risk.

5.5.2 Potential intervention

No clearly identifiable issues have been found, however it is recommended that pedestrian provision, fencing and other deterrents are reviewed, particularly at the southern end of the scheme where the M1 passes through the built up areas of Luton and Dunstable. The large scheme process set out in GG 142 *Walking cycling and horse-riding assessment and review* is suitable for this application - to identify demand opportunities for new and improved facilities and their integration with the local and national network(s). This was not a mandatory requirement when this scheme was designed although it now is for all Highways England promoted schemes. Additionally, consider applying Highways England's suicide prevention tool kit.

5.6 Collisions in the vicinity of Toddington motorway service area

Toddington motorway service area is located between junctions 11A and 12 and accessed from both sides of the motorway – Toddington Services North and Toddington Services South. Concerns have been identified in the 12 month post opening stage 4 road safety audit relating to the southbound merge from Toddington Services South and the northbound diverge to Toddington Services North and a cluster of four serious collisions recorded on the northbound carriageway in the vicinity of the services. A

review of all injury collisions have been analysed between the 300 yard signs in advance of the motorway service area exit slips in both directions (approximately 1.2km measured in one direction).

Fifty five collisions have been identified in this locality over the seven year after period; four serious and 51 slight ; averaging at 7.9 collisions per year and a severity ratio of 7%. No fatal collisions have been recorded. Eleven collisions (20%) occurred during darkness and twelve (22%) on a wet road surface. In comparison 23 collisions were recorded in the three year before period based on the same search area, one fatal, two serious injury and twenty slight injury collisions. This equates to an average of 7.7 collisions per year and a severity ratio of 13%. This indicates that the average number of collisions has not changed and the severity has reduced since opening.

In the after data twenty eight collisions have been recorded northbound and twenty seven southbound. All four of the serious collisions were recorded on the northbound carriageway. Table 5.14 summarises the collision type by direction of travel.

Table 5.14 Collision type by direction of travel

	Northbound	Southbound	Total
Shunt	12	8	20
Lane change	9	17	26
Loss of control	3	1	4
Live lane stop	0	1	1
Late exit	1	0	1
Other	3	0	3
Total	**28**	**27**	**55**

Further analysis established that 33 of the collisions involved a goods vehicle, of which seven were left hand drive vehicles. In terms of type of collision type it is helpful to consider the north and southbound collisions separately.

Northbound - Twelve of the northbound collisions resulted in shunt type collisions where five involved a goods vehicle. Five of the shunts were recorded on the northbound approach to the motorway service area exit slip, four in congested conditions. A further six were recorded on the mainline between the exit and entry slips. Three lane change collisions occurred prior to the exit slip and four after the entry slip.

Southbound - Seventeen (63%) of the southbound collisions involved a lane change collision of which 16 involved a goods vehicle. Thirteen of these were recorded in the vicinity of the motorway service area merge and four at the diverge. Four of the shunts occurred prior to the motorway service area exit slip.

The review of the approved departures from standard highlighted the motorway service area junction as having a non-standard merge layout including short auxiliary lanes and substandard nose lengths at both merges, which are likely to affect the ability of drivers to re-join the mainline carriageway and potentially increase the risk of lane changing collisions.

There is also a reduced weaving length between junction 12 and the motorway service area and reduced mainline lane widths which could be contributing to the lane change collisions prior to the southbound diverge for the services in particular. The reduced weaving length results in drivers having less opportunity to make decisions or complete manoeuvres safely.

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

- Northbound mainline collisions are most frequently shunt type collisions on the approach to and on the mainline between the merge and diverge for the services;

- Southbound mainline collisions are most frequently lane change collisions of which thirteen occurred in the vicinity of the motorway service area merge and all but one involved a goods vehicle.

5.6.1 Discussion

The comparison of before and after collision data in the vicinity of Toddington motorway service area indicates that the frequency of collisions has not changed after the smart motorway scheme was introduced and the severity of recorded collisions has reduced. However given that on average almost eight injury collisions are recorded within a 1.2km stretch each year further analysis has been undertaken.

The analysis indicates that a similar number of collisions are occurring north and southbound although there is a clear difference in collision type. The predominant collision type northbound are rear shunts and southbound are lane change collisions. The lane change collisions recorded in the vicinity of the motorway service area southbound merge predominantly involved goods vehicles.

In the 12 month post opening, stage 4 road safety audit concerns raised by the motorway service area manager were cited around confusing signing prior to the service area potentially resulting in unnecessary weaving. This relates to the northbound approach to the motorway service area where signs indicating the end of the hard shoulder are provided just before the 300 yard sign for the diverge, see Figure 5.6. Drivers using LBS 1 when permitted, may react to this sign and change lane only to change back again as the through junction running starts or if they wish to leave the motorway at the services. Three lane change collisions were recorded on the northbound approach to the motorway service area, one slight and one serious in year 3 and one slight in year 6.

Figure 5.6 View northbound prior to MSA diverge (Dashcam footage 22/07/2020)

The 12 month post opening stage 4 road safety audit also identified that the nearside concrete barrier prior to the motorway service area southbound merge partially obscured the view of vehicles. This may be resulting in drivers changing lanes rapidly on seeing a vehicle in the merge from the motorway service area.

The collision descriptions indicate that six of the thirteen lane change collisions at this location involved a vehicle moving from LBS 1 to LBS 2, which suggests that they are anticipating or accommodating a vehicle merge. The frequency of these collisions has fluctuated with four recorded in years 1 and 2, one in year 4, three in year 6 and one in year 7.

Figures 5.7 and 5.8 show the view to and from the motorway service area merge and illustrate why drivers might choose to change lane on the approach to the merge in anticipation of a vehicle joining the southbound carriageway.

Figure 5.7 View southbound prior to motorway service area merge (Dashcam footage 22/07/2020)

Figure 5.8 View looking from motorway service area merge (Google Streetview July 2018)

Both factors could be contributing to the frequency of lane change collisions at this location.

5.6.2 Potential intervention

This section of the M1 between junctions 10 to 13 is being converted from a dynamic hard shoulder operation to all lane running programmed for completion by the end of March 2025 as committed to in the smart motorway stocktake. This will help reduce the level of lane changing throughout the section

due to the intermittent use of LBS1 and potentially accentuated by the reduced weaving lengths. On this basis some of the potential interventions identified below are interim short term measures and focused on the southbound merge where a high proportion of lane change collisions have been recorded.

- Review the type of barrier being used at this location to improve visibility to and from the southbound merge.
- Assess the potential to extend the southbound motorway service area merge if practicable, given the constraint of a National Grid pylon close to the southbound carriageway.
- Improve signs and markings ahead of the transition from motorway service area merge to the start of the southbound hard shoulder. Users are given very little warning that they need to merge from LBS1 to LBS2.

5.7 Northbound junction 10

The collision data has identified a cluster of thirteen slight injury collisions prior to the northbound merge for junction 10. The collisions have all been recorded in year 4 onwards. Seven of the collisions involved vehicles changing lanes; four from LBS1 to LBS2 as might be expected in this location. This is the only location on this section where two signs warning of the transition from four lane motorway to dynamic hard shoulder are provided.

5.7.1 Discussion

On the mainline approach to the northbound merge, half mile and 100 yard rotating fixed message signs are provided to indicate if the hard shoulder is operating as a running lane, see Figure 5.9. Feedback from Highways England Traffic Officers on this section of the M1 highlighted that there have been issues with these signs becoming stuck and so it is possible that the signs do not necessarily depict the same message as the gantry signing resulting in unnecessary lane changing movements or misuse of the hard shoulder.

Figure 5.9 View northbound prior to junction 10 merge and rotating fixed message sign (Google Streetview image, Sep 2020)

From the collision data descriptions it is not always clear if the dynamic hard shoulder is in operation however of the 13 slight collisions prior to the merge, six occurred during the weekday peak; four on a Friday, when it would be expected that four lanes were available north of junction 10. Six of the thirteen collisions have occurred during darkness, which is a greater than average for Highways England motorways of 30% (2018) – and particularly notable as this is a lit link.

There is a second cluster of injury collisions at the merge from junction 10 where further lane changing occurs. Nine collisions have been recorded, two serious and seven slight. Six involved lane changing

and three were shunts. Two of these collisions were recorded in year seven after opening. Again an understanding of whether the operation of the dynamic hard shoulder at the time of these collisions can only be surmised from the time recorded for the collision.

5.7.2 Potential interventions

Given the anecdotal evidence that the rotating fixed message signs can become stuck and the commitment that this section of the M1 between junctions 10 to 13 is being converted from a dynamic hard shoulder operation to all lane running at which point these signs can be removed, it is recommended that:

- the maintenance regime associated with the rotating fixed message signs is reviewed and that they are included as safety critical signs. If necessary consider replacing with verge-mounted digital signals.
- establish if the existing upstream gantry signing could be utilised to provide additional information relating to the status of the downstream LBS1.

5.8 Junction 11

Junction 11 was highlighted in the Design Safety Report, specifically the southbound merge where vehicles were moving early to LBS2 in anticipation that LBS1 downstream was closed, then moving back to LBS1 once visibility to the fixed text rotating traffic sign was achieved, causing excessive lane changing.

A review of all injury collision data at junction 11 specifically in relation to the mainline at the merge and diverges indicates that there has been a general decrease in recorded injury collisions particularly after year 5 (December 2017 onwards). This corresponds with when the smart motorway operating systems were recalibrated, control room operating protocol revised and signing upgrades implemented on approach to junctions. It also coincided with the opening of junction 11a which potentially relieved some junction 11 Dunstable traffic. Table 5.15 summarises the collisions by merge or diverge and by after year.

Table 5.15 Frequency of collision by after year

After Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
NB diverge	2	2	0	2	3	1	0	10
NB merge	2	1	1	1	1	1	0	7
SB diverge	2	1	3	3	1	1	0	11
SB merge	3	3	2	2	2	1	1	14

5.8.1 Discussion

Of the collisions recorded at these locations, one was a fatal injury collision involving a pedestrian, four were serious all in the vicinity of the northbound diverge and thirty seven were slight. Twenty-one involved lane changing, thirteen were shunts and two involved a live lane stop. The live lane stop collisions were recorded in years 1 and 3 and both involved vehicle breakdowns, one on the southbound merge and one southbound in LBS2.

The departures at junction 11 relate to reduced stopping sight distance on the diverges and southbound merge. Both the north and southbound diverges are taper diverges but should incorporate a ghost island lane drop to accommodate peak time volumes of diverging traffic. Similarly, the southbound

merge is a one lane taper merge but should be a two lane ghost island merge.

On the southbound carriageway at junction 11 the overhead structures combine with the high nearside retaining wall to create a tunnel-like effect. The horizontal alignment may also increase the effect of the 'blind spot' particularly when moving from LBS1 to LBS2. Of the fourteen collisions recorded in the vicinity of the southbound merge there have been seven lane change collisions; four of which involved a left hand drive vehicle, and four shunts. Figure 5.10 shows the view southbound at the merge tip.

Figure 5.10 View southbound at junction 11 merge tip (Dashcam footage July 2020)

Advance signing of the transition from through junction running to hard shoulder running on the southbound carriageway is limited to one sign without a distance plate. Visibility to the sign is also reduced, particularly from LBS1 due to the preceding overbridge. Both the dashcam footage and Google StreetView images from June 2019 indicate that the overhead signals are set to try and reinforce the layout using the 'move across' arrow and red x on successive signals, see Figure 5.11.

Figure 5.11 View southbound of overhead signs prior to junction 11 merge (Dashcam footage July 2020)

5.8.2 Potential interventions

The general reduction in collisions and the commitment to converting this section of the M1 from dynamic hard shoulder to all lane running has limited the potential interventions listed here to:

- Review the viability of moving the start of the hard shoulder downstream to allow a more complete set of signing (constraints prevent additional upstream verge signing) and give more space to lane changes and merges.
- Install a distance plate to the existing southbound fixed message rotating sign.

5.9 Junction 12

Junction 12 was identified for further collision analysis from the serious collision review, section 5.1.2. Further analysis, including all injury collision data, identified a concentration of collisions in the vicinity of the southbound merge at junction 12. Seventeen collisions have been recorded, two serious and fifteen slight. Of the collisions:

- Eight involved lane changing
- Seven resulted in a rear shunt
- Six were recorded in darkness
- The two serious collisions involved a rear shunt in year 2 and an alcohol related collision in year 3.
- One of the collisions was a live lane stop in LBS3 due to a vehicle breakdown immediately south of junction 12. This was recorded in year 5.

In terms of when the injury collisions occurred the three latest years of post-opening data show an increase compared to the first four years. See Table 5.16.

Table 5.16 Frequency of injury collisions by post opening year at junction 12 southbound merge

Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
Frequency	0	3	1	2	5	3	3	17

5.9.1 Discussion

The southbound carriageway through junction 12 to Toddington motorway service area operates as extended through junction running with four lanes and therefore does not have the complication of intermittently changing status of LBS1 in the way that a dynamic hard shoulder section does. The junction 12 merge is subject to a departure from standard and provides a taper merge rather than a lane gain with a ghost island merge which may be impacting on the recorded collisions at this location.

The collisions recorded in years 5, 6 and 7 in the vicinity of the southbound merge are summarised in Table 5.17. The decrease from five in year 5 to three in years 6 and 7 may be a reflection of the recalibration of the smart motorway operating system and the opening of junction 11a in 2017.

Table 5.17 Southbound collisions by year at junction 12

	Frequency	Detail
Year 5	5	Five slight collisions Three lane change collisions all involving a goods vehicle moving between lanes 1 and 2. One shunt during the weekday evening peak. One live lane stop in darkness and involving a car breaking down in LBS 3.
Year 6	3	Three slight collisions, two involving lane changing and one shunt. All occurred on a weekday off peak.
Year 7	3	Three slight collisions, two involving shunts – one in the early hours of the morning, and one involving a lane change on a Friday in the evening peak.

Over half of the injury collisions involved lane changing and four were shunts, two of which were during a weekday peak. No advance signing of the merge is provided for mainline traffic.

5.9.2 Potential intervention

Introduce a 'traffic joining from the left' sign in advance of the southbound merge.

5.10 Junction 13

A review of all injury collision data has identified a concentration of collisions in the vicinity of the northbound diverge at junction 13. Twenty four collisions have been recorded, one fatal, two serious and twenty one slight, taken from the southern limit of the 210 yard road layout sign prior to the junction. Of the collisions:

- Nine involved lane changing
- Fourteen resulted in a rear shunt
- Three were recorded in darkness
- One was a live lane stop in LBS 3 due to a vehicle puncture.

Collisions by year have fluctuated since the opening year as shown in Table 5.18, but indications are of a general decline in collisions since year 5 with two recorded in both years 6 and year 7. This could be a reflection of the changes made in 2017 to the recalibration of the smart motorway operating system.

Table 5.18 Frequency of collision by after year

Year	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
Frequency	5	4	1	2	8	2	2	24

5.10.1 Discussion

The northbound diverge at junction 13 incorporates a lane drop with three lanes continuing through the junction. The prevalence of shunt type collisions may be a reflection of the volume of traffic using this exit to access Bedford and Milton Keynes and its distribution hubs. This may also be compounded by the combination of departures at this location; a 2 step relaxation in stopping sight distance, reduced nose length and reduced lane widths.

A review of the collisions recorded in years 5, 6 and 7 are summarised in Table 5.19.

Table 5.19 Northbound collisions by year at junction 13

	Frequency	Detail
Year 5	8	Seven slight and one serious collision Three lane change all recorded as slight and during off peak periods. Four shunts, three slight and one serious. Two reported in slow or queuing traffic and one in temporary speed restrictions. One live lane stop involving a car stationary on the hard shoulder with a puncture. The collision occurred on a Sunday at 0613 when it is unlikely that the dynamic hard shoulder was open to traffic.
Year 6	2	Two slight collisions involving lane changing, both in roadworks
Year 7	2	One serious collision involving a shunt in roadworks (dark:lit, wet) One fatal collision involving a left hand drive goods vehicle changing lane and struck a car in LBS 2.

The frequency of collisions being recorded on the northbound approach to junction 13 is decreasing after a peak of eight in year 5. Although the severity of the collisions recorded in subsequent years 6 and 7 has increased, three of these collisions were recorded in roadworks.

The conversion of junction 13 to 16 to all lane running smart motorway is currently under way and road works are in place at junction 13. Transitions between all lane running and dynamic hard shoulder operational regimes can create potential issues associated with drivers anticipating the opening of LBS1 or using the hard shoulder outside of the scheme limits. This will have more impact for southbound traffic at this location. This junction 10 to junction 13 scheme is understood to be converted to all lane running by the end of March 2025; the M1 Junction 13 to 16 smart motorway project is currently advising of completion in 2022/23, which indicates that M1 junction 10 to junction 13 all lane running conversion works may not be underway at the time the adjacent all lane running section opens.

5.10.2 Potential interventions

The general reduction in collisions, the committed conversion of this section of the M1 from dynamic hard shoulder to all lane running, and the current construction of the all lane running scheme from junction 13 to 16 has limited the potential interventions to:

- a review of the risks associated with the interim transition between the all lane running scheme between junction 13 and 16 and the dynamic hard shoulder southbound at junction 13, and
- those potential interventions already suggested in other sections of this report relevant to live lane stop collisions (section 5.2.2) and left hand drive vehicles (section 5.4.2).

6. Potential interventions

The preceding sections have identified the following key findings, which are considered for specific potential interventions. The potential interventions provide an answer to the question posed for the scheme of, “what more could be done to improve safety?”. They must be viewed in context of the national programme of improvements to smart motorways, which for this scheme is planned to result in the conversion to an all lane running scheme by the end of March 2025 including the introduction of stopped vehicle detection technology.

Table 6.1 Smart motorway incident and infrastructure potential interventions

Key finding – Data analysis	Existing, programmed or national campaign control measures	Potential intervention measure	Potential interventions
Concerns over the reported mis-use of LBS1 and the potential risk of collisions given the live lane breakdown rate.	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 drivers understanding and complying with the signing associated with a dynamic hard shoulder arrangement. Existing signing, particularly at the transitions between through junction running and dynamic hard shoulder are limited in number and can offer limited advance warning of LBS1 status. This could be addressed by additional warning signing. The existing overhead signalling is used intermittently and could be used on a permanent basis to support other operational regime signalling.	A) Consider enhancing consistent and repeated messaging on LBS1 / hard shoulder status via signals. For example; display ‘hard shoulder for emergency use only’ message and red X at *all* available variable message signals whenever LBS1 is closed to remove any ambiguity. Similarly, when LBS1 is open to traffic, consistently display ‘Congestion Use hard shoulder’ at *all* available variable message signals. These ‘default’ aspects would be replaced for tactical management messages where required, e.g. ‘Queue ahead’. Consider measures to increase the clarity of hard shoulder / LBS1 status at merges. This could be via enhanced use of VMS signs to display pictograms as per M42 Junction 5. It could also be via increasing the number of verge signs for the transition from through junction running to dynamic hard shoulder downstream of the junction merges, to provide additional warning and instruction for all drivers but particularly those in LBS1 and LBS2. Currently the signing is limited to one sign providing between 130 and of 200 yards’ warning (no distance plate is given at junction 11 southbound). Only on the northbound

Key finding – Data analysis	Existing, programmed or national campaign control measures	Potential intervention measure	Potential interventions
			approach to junction 10 are two signs provided, a ½ mile and 100 yard sign. Part of the consideration of measures should target a consistent approach repeatable for the length of the scheme.
The arrangement to the south of junction 11 is constrained and a cluster of collisions is present, including a high proportion of lane changing collisions. The combination of the horizontal alignment and the transition from through junction running to dynamic hard shoulder may be a factor.	None – locally specific issue	Extending the distance from merge to start of the hard shoulder would increase opportunities for lane changing prior to the start of dynamic hard shoulder. Provide additional signing to highlight the transition between through junction running and a dynamic hard shoulder. Permanent use of the overhead signing would provide continuous and consistent information for drivers around the downstream status of LBS1.	B) Review the viability of moving the start of the hard shoulder downstream of junction 11 to allow a more complete set of signing (constraints prevent additional upstream verge signing) and give more space to lane changes and merges. Provide a distance plate to the existing southbound fixed text message rotating sign downstream of junction 11.

Key finding – Data analysis	Existing, programmed or national campaign control measures	Potential intervention measure	Potential interventions
A comparison of before and after collision data in the vicinity of Toddington motorway service area indicates that introduction of the dynamic hard shoulder scheme has not increased collisions overall. However, whilst the overall number of collisions between junctions 10 and 13 have decreased, a reduction in collisions in the vicinity of Toddington motorway services has not been realised. Particular focus has been directed at the southbound merge where a high proportion of the lane change collisions have been recorded.	None – locally specific issue	Amended layout geometry could better accommodate exit manoeuvres and address potential visibility issues from the motorway service area southbound merge. In line with the earlier intervention, there is scope to improve the signing relating to the transition from through junction running to a dynamic hard shoulder.	C) Consider a package of measures to improve the southbound merge at Toddington motorway service area and the mainline southbound at junction 12 including; • a review of the type of barrier being used at the Toddington motorway service area southbound merge to determine whether an alternative type of barrier could improve visibility to and from the southbound merge. • assess the potential to extend the southbound motorway service area merge. This may not be possible due to the proximity of a National Grid pylon to the southbound carriageway. • improve signs and markings ahead of the transition from motorway service area merge to the start of the southbound hard shoulder. Users are currently given little warning that they need to merge from LBS1 to LBS2. • Introduce additional signs warning of merging traffic southbound at junction 12.
The arrangement to the south of junction 12 is a short length of all lane running through Toddington motorway service area, with dynamic hard shoulder sections upstream and downstream of it. This removes the issues around an intermittent hard shoulder, however a cluster of collisions is present, specifically shunts and lane changing.	None – locally specific issue	Consider ways of highlighting merging traffic at junction 12 southbound to reduce late manoeuvres or braking.	
Pedestrian collisions and existence of potential risk factors, particularly through the southern	Motorway Regulations prohibit pedestrians, although those who are vulnerable, in distress or with	Consider local desire lines, quality and provision of facilities and identify opportunities for improvement.	D) Review the pedestrian provision, fencing and other deterrents. The large scheme process set out in GG 142 *Walking cycling and horse-riding*

Key finding – Data analysis	Existing, programmed or national campaign control measures	Potential intervention measure	Potential interventions
section of the scheme and the built up areas of Luton and Dunstable.	judgement impaired by drugs or alcohol are unlikely to be deterred by this. The process for assessing if suitable facilities are provided for walking, cycling and horse riding are set out in standard GG 142 . Note however that this scheme was designed prior to GG 142. Highways England have a Suicide Prevention Strategy, which sets out how it will continue to contribute to the cross-government National Suicide Prevention Strategy through reducing the number of suicides and attempted suicides on the road network.		*assessment and review* would be a suitable structure for this exercise. Consider applying the suicide prevention tool kit.

Key finding – Operations feedback	Existing, programmed or national campaign control measures	Potential intervention measure	Potential interventions
Anecdotal evidence suggests that there are concerns over the reliability of the fixed text message (rotating prism) signs, which indicate the status of hard shoulder / LBS1 after each merge.	Technology maintenance is regionally managed with performance levels established.	Alternative options to the use of fixed text message signs may improve reliability. Existing overhead variable message signalling could be utilised to permanently relay information around the downstream status of all lanes, particularly LBS1.	E) Assess the maintenance regime associated with the rotating fixed text message signs and ensure repair response times align with the signs' operational importance. If necessary investigate replacing or supplementing with aspects on digital signals.
The current conversion of junction 13 to 16 from a conventional motorway to all lane running could introduce another	None – locally specific issue	The timescales for converting junction 10 to 13 from dynamic hard shoulder to all lane running should overlap with the junction 13 to 16 construction	F) Consider the risks of there being a period where there is interim transition between the all lane running scheme between junction 13 and 16, and

Key finding – Operations feedback	Existing, programmed or national campaign control measures	Potential intervention measure	Potential interventions
transition between operating regimes.		period. This should result in a continuous all lane running regimes.	the dynamic hard shoulder operations remaining southbound at junction 13. In case of a situation where there is an interim transition, identify control measures to reduce the risk of hard shoulder / LBS1 misuse south of junction 13.

7. Conclusion

The safety of the smart motorway section of the M1 between junctions 10 and 13 has been investigated in response to the Smart Motorway Safety Evidence Stocktake and Action Plan.

Fewer collisions are occurring per year after the smart motorway opened than before, despite an average growth in daily traffic of 27% over that period. The decrease is noted after 2017 when the smart motorway operating system was recalibrated, control room operating protocol was revised and junction 11a was opened.

Eight fatal collisions have been recorded within the extents of this study, three of which occurred after the time period analysed.

A rise in collisions of serious severity has been noted scheme-wide with rear shunts and lane changing being the predominant collision type indicative of the short links between junctions, particularly junction 11, 11a, Toddington motorway service area and junction 12. Further investigation has also identified a notable incidence of left hand drive vehicle involvement in the recorded injury collisions.

There is a high number of occurrences of recorded incidents of breakdowns in live lanes. Actual rates of collisions relating to vehicles stopping in live lanes are highest between junctions 12 and 13, indicating a rate of 1.3 collisions per km over a seven year period. Establishing confidently if the collisions and incidents have occurred when the hard shoulder is operating as a live lane or not has not been possible from most collision descriptions. An approximate ratio for injury collisions due to live lane breakdowns, to recorded incidents due to live lane breakdowns is 1 in 687.

The removal of lighting from the section of M1 through Toddington motorway service area to junction 12 has not resulted in an increase in recorded darkness collisions.

A comparison of before and after collision data in the vicinity of Toddington motorway service area indicates that the dynamic hard shoulder scheme has not increased collisions. However there has been an overall decrease in collisions along this section which has not been realised at this location.

Over half of the recorded injury collisions in the vicinity of the northbound merge at junction 10 have involved lane changing despite this being the only location on this section of the M1 where two fixed message rotating signs have been provided. There is some anecdotal evidence that these signs can be unreliable and the utilisation of the gantry signalling could provide additional warning of the downstream status of LBS1 at the transition to a dynamic hard shoulder.

At the southbound merge at junction 11 there is a combination of departures in addition to the tunnel-like effect of a nearside retaining wall and overhead structures. The horizontal alignment of the mainline through junction 11 may increase the effect of the ‘blind spot’ particularly when moving from LBS1 to LBS2 resulting in a higher proportion of lane change collisions.

The recorded collisions in the vicinity of the southbound merge at junction 12 have increased over the latest two years of data. The predominant collision types are rear shunts and lane changes where extended through junction running is provided to Toddington motorway service area and the issues around transitioning from all lane running to a dynamic hard shoulder are not present.

The upgrade of junction 13 to 16 to all lane running Smart Motorway is currently under construction and road works are in place at junction 13. The number of recorded injury collisions in the vicinity of the northbound diverge at junction 13 has been decreasing and in the latest two year period three of the four collisions have occurred in roadworks.

Six key potential interventions are identified:

A. Consider enhancing consistent and repeated messaging on LBS1 / hard shoulder status via signals. For example; display ‘hard shoulder for emergency use only’ message and red X at *all* available variable message signals whenever LBS1 is closed to remove any ambiguity. Similarly, when LBS1 is open to traffic, consistently display ‘Congestion Use hard shoulder’ at *all* available variable message signals. Consider measures to increase the clarity of hard shoulder / LBS1

status at merges. This could be via enhanced use of VMS signs to display pictograms as per M42 Junction 5. It could also be via increasing the number of verge signs for the transition from through junction running to dynamic hard shoulder downstream of the junction merges, to provide additional warning and instruction for all drivers but particularly those in LBS1 and LBS2. Currently the signing is limited to one sign providing between 130 and of 200 yards' warning (no distance plate is given at junction 11 southbound). Only on the northbound approach to junction 10 are two signs provided, a ½ mile and 100 yard sign. Part of the consideration of measures should target a consistent approach repeatable for the length of the scheme.

B. Review the viability of moving the start of the hard shoulder downstream of junction 11 to allow a more complete set of signing (constraints prevent additional upstream verge signing) and give more space to lane changes and merges. Provide a distance plate to the existing southbound fixed text message rotating sign downstream of junction 11.

C. Consider a package of measures to improve the southbound merge at Toddington motorway service area and the mainline at junction 12 including;

- a review of the type of barrier being used at the Toddington motorway service area southbound merge to determine whether an alternative type of barrier could improve visibility to and from the southbound merge.
- assess the potential to extend the southbound motorway service area merge. This may not be possible due to the proximity of a National Grid pylon to the southbound carriageway.
- improve signs and markings ahead of the transition from motorway service area merge to the start of the southbound hard shoulder. Users are currently given little warning that they need to merge from LBS1 to LBS2.
- introduce additional signs warning of merging traffic southbound at junction 12.

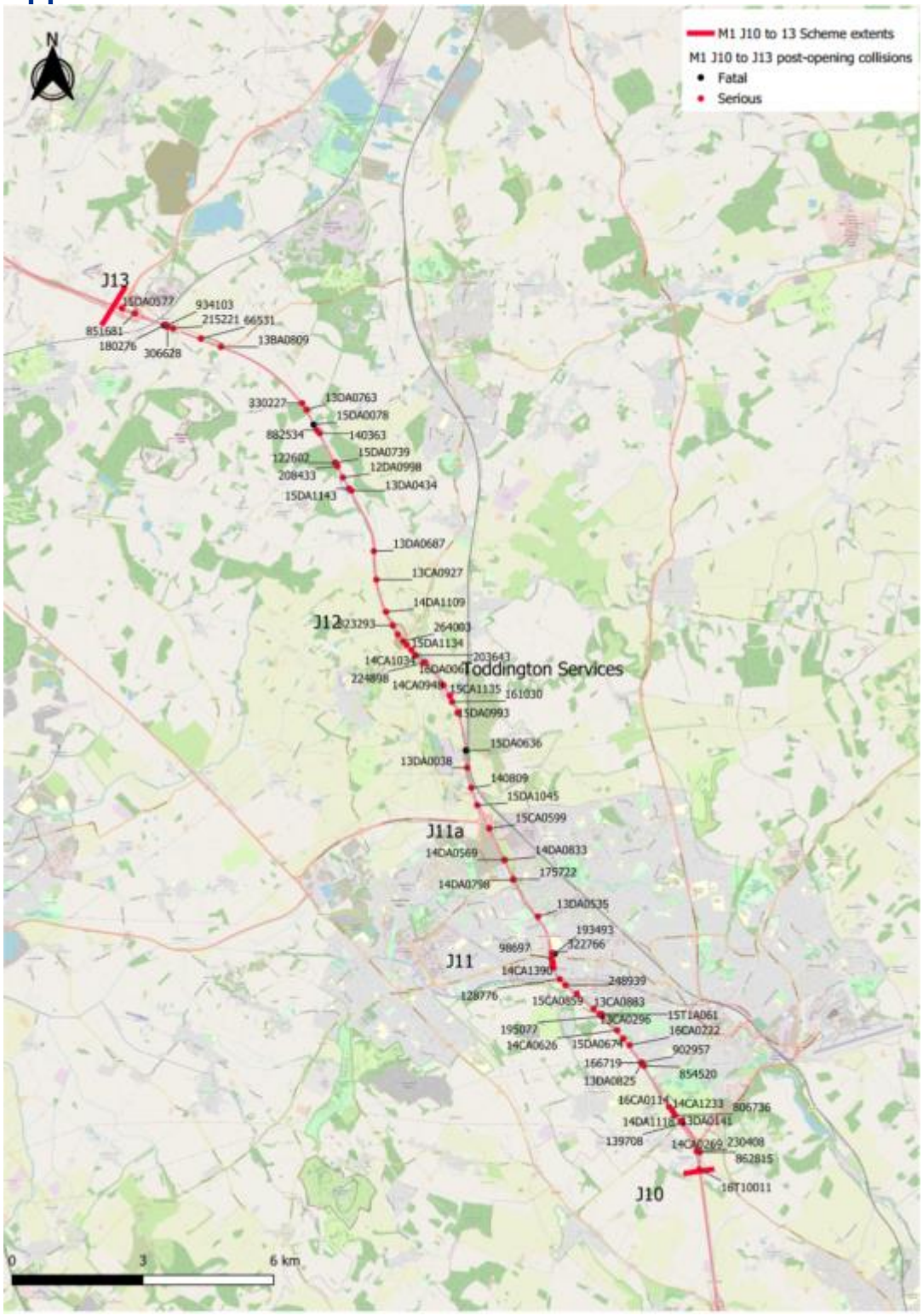
D. Review the pedestrian provision, fencing and other deterrents particularly through the southern end of the scheme and the built up areas of Luton and Dunstable . The large scheme process set out in GG 142 Walking cycling and horse-riding assessment and review would be a suitable structure for this exercise.

E. Assess the maintenance regime associated with the rotating fixed text message signs and ensure repair response times align with the signs' operational importance. If necessary investigate replacing or supplementing with aspects on digital signals.

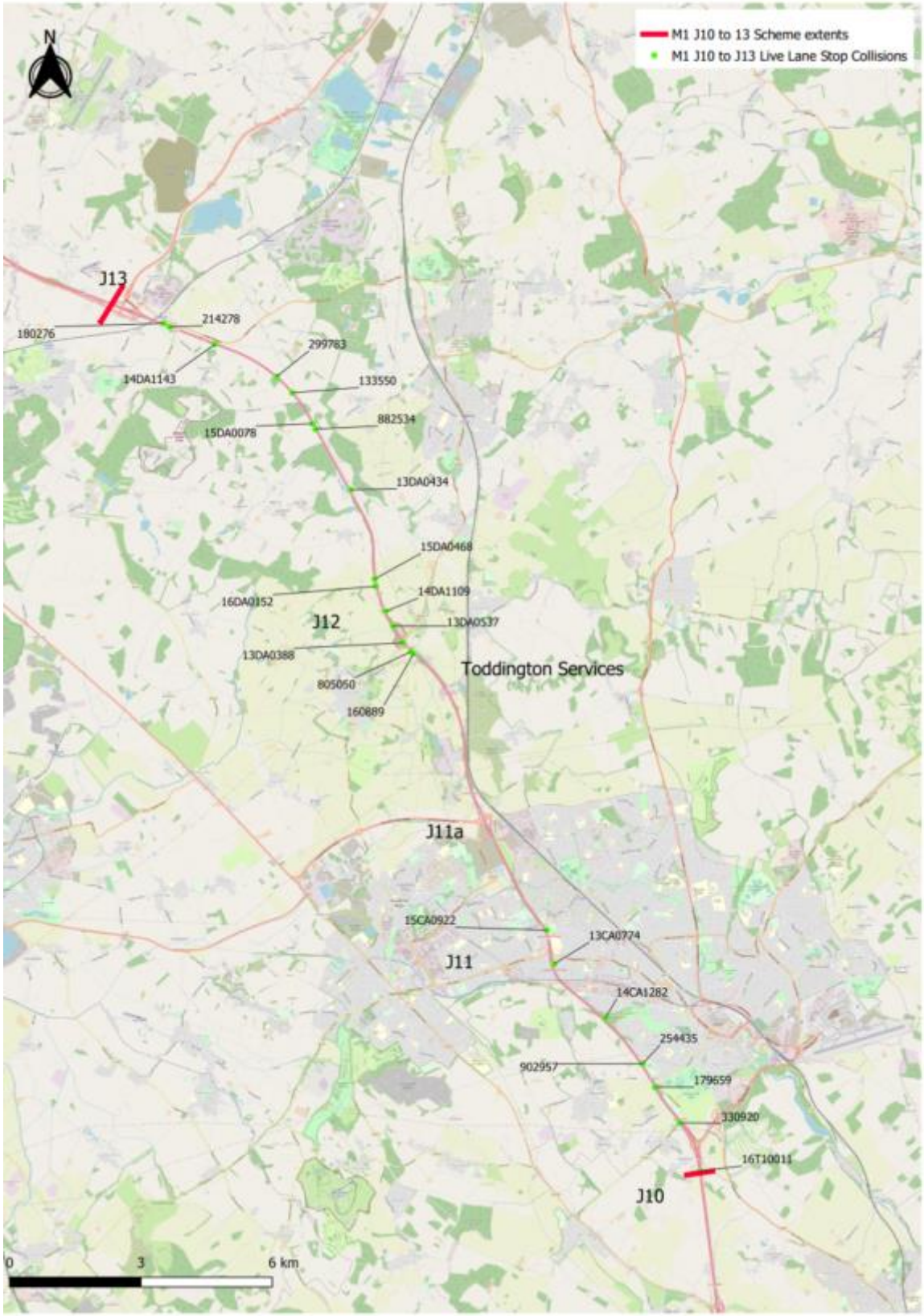
F. Consider the risks of there being a period where there is interim transition between the all lane running scheme between junction 13 and 16, and the dynamic hard shoulder operations remaining southbound at junction 13. In case of a situation where there is an interim transition, identify control measures to reduce the risk of hard shoulder / LBS1 misuse south of junction 13.

Appendices

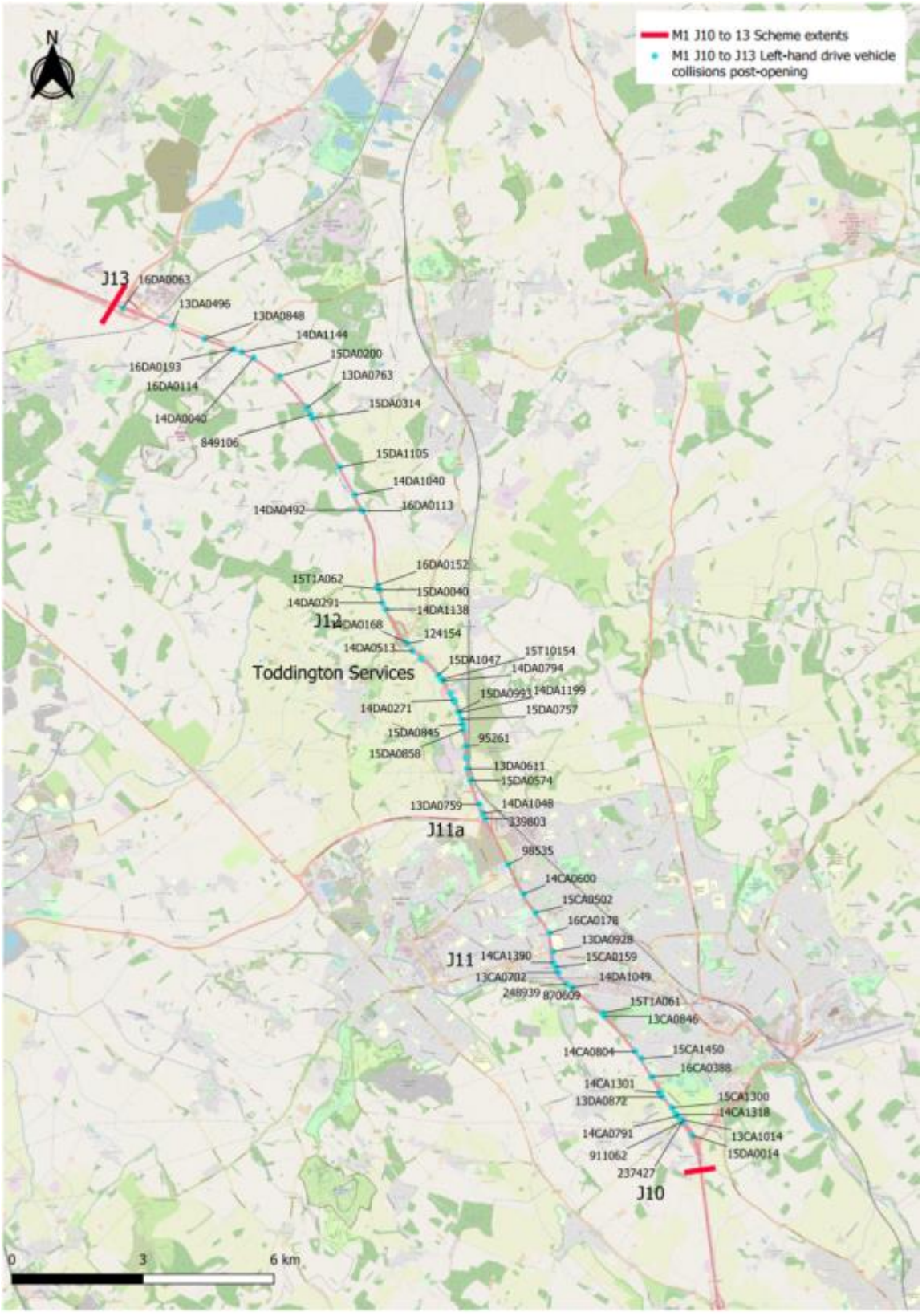
Appendix A. M1 Junction 10 to 13 Fatal and serious collisions



Appendix B. M1 Junction 10 to 13 Live lane stop collisions



Appendix C. M1 Junction 10 to 13 Left hand drive vehicle collisions



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