Prioritising local authority skid resistance: Pilot trial of the LASR approach

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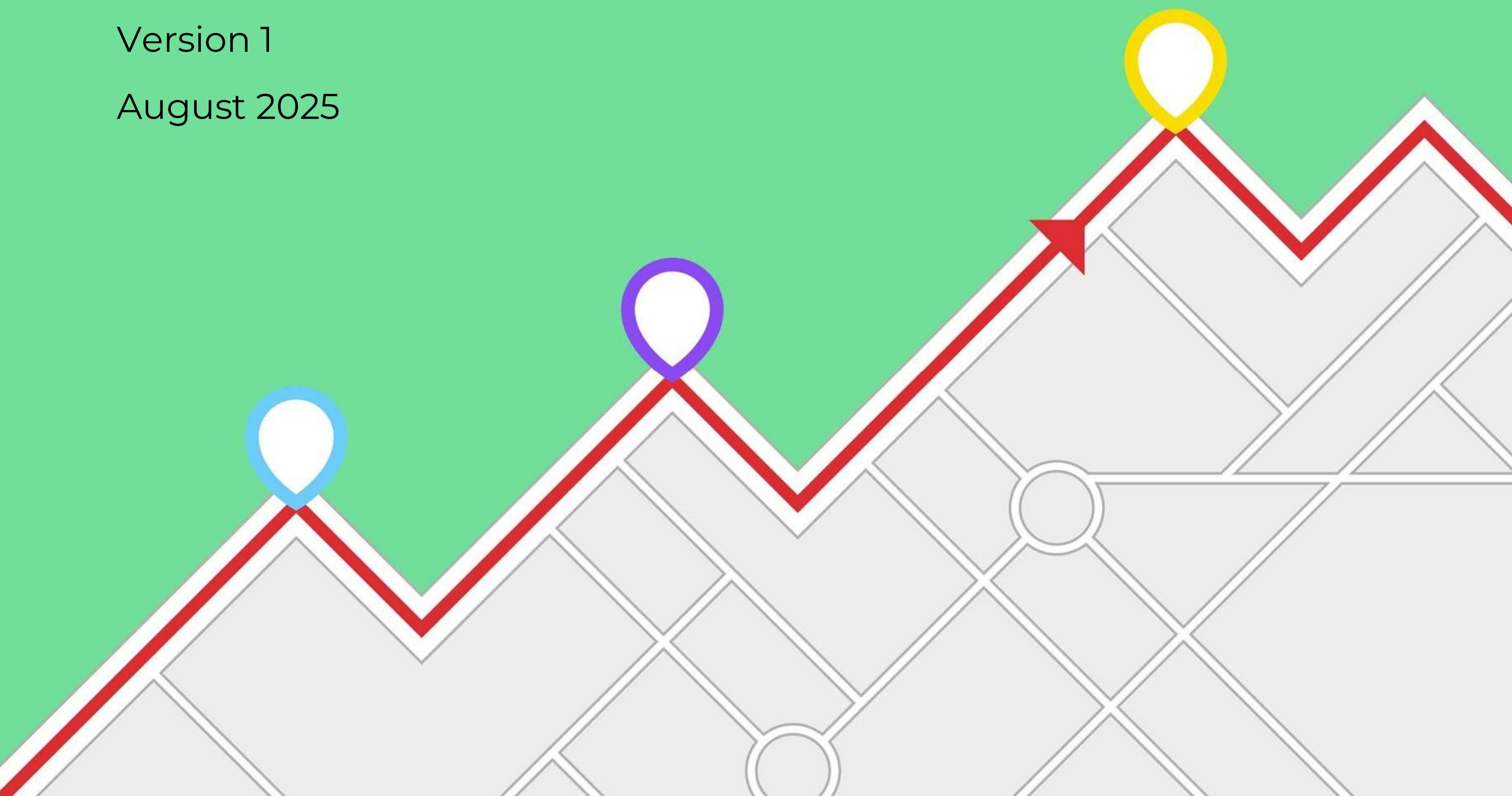

Project Collaborators:

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Phase 2:

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Prioritising Local Authority Skid Resistance – Pilot trial of the LASR approach

Final project report (Version 1: 5 August 2025)

Contents

Glossary

BCR	Estimated benefit-to-cost ratio for treatment to improve the skid resistance
Comparison lengths	Untreated lengths of road with similar characteristics to the treatment lengths
Dry collision	Personal injury collision recorded in STATS19, where the road surface condition was recorded as "dry"
IL	Investigatory Level, a skid resistance threshold triggering further investigation
P1-6, Px	Priority bands 1 to 6, the output of the LASR method
RL	Relative likelihood of wet collisions, derived from the collision history for a length of road
SC	SCRIM Coefficient, a measure of skid resistance
Site category	A classification of the road layout (bend / gradient, junction/crossing, roundabout or non-event) used to determine the requirement for skid resistance
SCRIM difference	The extent to which the skid resistance is below the Investigatory Level
Treatment effectiveness	A measure, theta, which is approximately the ratio of collisions observed after treatment divided by the collisions expected had no treatment occurred. Values below 1.0 indicate a reduction.
Treatment lengths	Road lengths where surface treatment was applied
Wet collision	Personal injury collision recorded in STATS19, where the road surface condition was recorded as "wet / damp"

Project summary

Many highway authorities measure the skid resistance on key routes and carry out targeted improvements to reduce the risk of collisions in wet conditions. Typically, decisions about when and where to invest are guided by the approaches taken for national roads, which have different characteristics. The lack of evidence to support a risk-based approach on local roads poses a challenge for the effective management of these networks.

Phase 1 of this research, funded by the Road Safety Trust in 2020 – 2021, addressed this gap by examining the link between skid resistance and collision risk on local roads. It proposed new skid resistance thresholds and a decision-framework, "the LASR approach", to support prioritisation of maintenance funding. Details are provided on the project website: https://www.lasr-approach.org/

In Phase 2, reported here, a practical trial of the LASR approach has been carried out to determine if it is appropriate for implementation. The main objective was to assess whether the benefits of treatments predicted by the Phase 1 work, i.e. a reduction in collisions on wet roads, are achieved in practice.

Thirteen local authorities participated in the study. Each provided data and identified sites that were treated to improve the skid resistance. Comparable sites were left untreated. Most treatments were carried out between January and August 2022 and the collision history was monitored for approximately 5 years before and 2 years after treatment.

Where treatments resulted in a significant improvement in skid resistance, a 38% reduction in wet collisions was achieved on the treatment sites compared with the comparison sites. As a result of this work, some changes to the thresholds for skid resistance are recommended. The LASR approach appears to be effective in targeting lengths that can deliver safety benefits, and it has the advantage over traditional strategies in that it balances the collision history of a site with the loss of skid resistance in assessing the priority for treatment. This allows areas for treatment to be identified on a preventative basis, before injury occurs.

Feedback from the local authority Steering Group was positive, members being broadly confident in the results and the proposed revision to skid resistance thresholds, and feeling it a realistic strategy to adopt.

The next steps will be to work with the Steering Group towards implementation. The study results will be disseminated more widely amongst local authority practitioners and a short 'case for change' will be produced to support local authorities in changing their current policies. The description of the LASR method and the LASR analysis template on the project website will be updated and further Steering Group meetings will be held for authorities that wish to collaborate on implementing the LASR approach.

Introduction

Background

Many highway authorities measure the skid resistance on key routes and carry out targeted improvements to reduce the risk of collisions in wet conditions[1]. Typically, decisions about when and where to invest are guided by the research and approaches taken for national road networks (for example, see National Highways, 2021). However, local authority roads have different geometries, junction types, traffic speeds and traffic flow. A lack of evidence to support a risk-based approach poses a challenge for the effective management of these networks.

Phase 1 of this research, funded by the Road Safety Trust in 2020 – 2021, addressed this gap by examining the link between skid resistance and collision risk on local roads (Viner et al., 2021). The analysis showed that current approaches may not be targeting maintenance at the locations most likely to deliver safety benefit. The project proposed new skid resistance thresholds and a decision-framework, "the LASR approach", to support prioritisation of maintenance funding.

In Phase 2, a practical trial of the LASR approach has been carried out to determine if it is appropriate for implementation. This work is reported here.

The LASR approach

The current version of the LASR (Local Authority Skid Resistance) method is described in Viner et al., 2023. It produces a ranking representing the priority for treatment to improve skid resistance, based on:

- The benefit-to-cost ratio of treatment, BCR. This is an estimate of the reduction in collisions achieved by improving the skid resistance at this type of location, over the lifetime of treatment, compared with the cost of treatment.
- The relative likelihood of wet collisions, RL, from the collision history for the length of road under consideration. An RL value of 50 corresponds to zero collisions; higher RL values correspond to a higher proportion of wet collisions and lower RL values correspond to more dry collisions[2].

BCR and RL values are combined to give an overall prioritisation as indicated in Table 1. From the Phase 1 work, this approach is expected to target maintenance funds better, towards sites that are likely to deliver safety benefits, compared with the approach used currently by many authorities. However, the new method has some significant differences, including a greater priority given to treatments at roundabouts and reduced priority given to treatments at junctions and

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[1] The focus on wet conditions is because skid resistance on dry roads is generally high.

[2] A high proportion of wet collisions can be indicative of a skid resistance problem. Reporting the percentage of wet collisions is not satisfactory for individual sites where the number of collisions is small, and RL was devised as a more robust approach.

pedestrian crossings. In view of this, a cautious approach to implementation was recommended, to allow the benefits and justification to be assessed more closely.

Table 1 LASR prioritisation bands, Px, based on BCR and RL values

Benefit-to-cost ratio of treatment (BCR)	Relative Likelihood, RL	
	≤50	>50
≥2	P3 – preventive treatment	P1 – high predicted benefit
0<x<2	P5 – lower justification	P2 – lower predicted benefit
0	P6 – little justification	P4 – monitor

Aims and objectives

The aim of the project was to coordinate participating local authorities in a pilot of the LASR approach. The LASR priority bands would be used as a basis for selecting locations for treatment to improve the skid resistance and the outcomes for these treated sites would be compared with untreated sites with similar characteristics. This project would provide for coordination and central collection, validation and analysis of data.

The overall objective was to assess whether the benefits of treatments that are predicted by the models, i.e. a reduction in collisions on wet roads, are achieved in practice and, if so, to provide confidence to enable local authorities to proceed with the new method.

In parallel, feedback would be sought from participating local authorities to refine the method and make it suitable for implementation.

Project design and activities

Selection of study sites

Thirteen local authorities participated in Phase 2 of the study, led by Derby City Council (Table 2).

Table 2 Local authorities participating in the research

Derby City Council		
Coventry City Council	Doncaster Council	Hampshire County Council
Kirklees Council	Leeds City Council	Manchester City Council
Norfolk County Council	Nottingham City Council	Oldham Council
Surrey County Council	Telford & Wrekin Council	Wiltshire Council

Data were obtained from each authority to perform the LASR ranking and the results were displayed on GIS maps (e.g. Figure 1). Discussion with each authority led to the selection of sites for maintenance treatment.

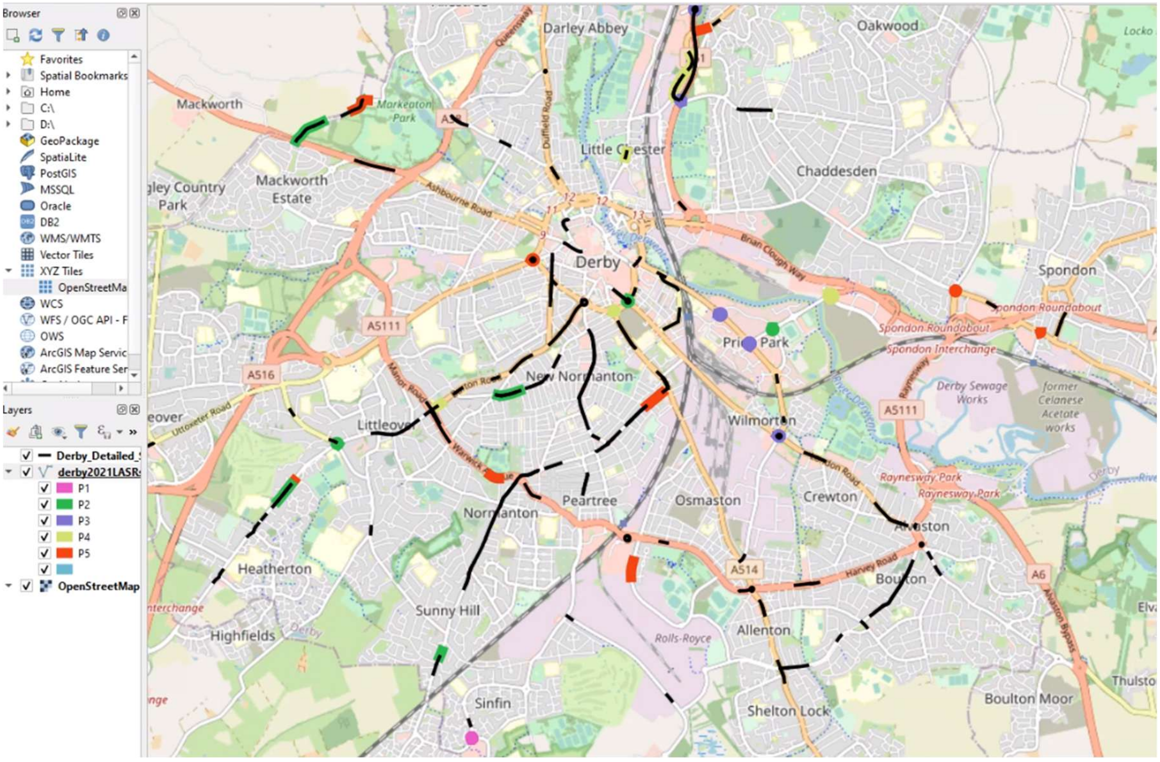


Figure 1 GIS view of Derby City provisional maintenance programme (black lines) and LASR priority sites (coloured lines) to identify sites for inclusion in this study

73 locations were identified where surface treatment was undertaken. In practice, the choice of locations for treatment was significantly constrained by pre-existing maintenance programmes and available budget. However, the locations selected included all site categories, rural and urban environments and a range of traffic and skid resistance levels. Of the 57 km total length identified, 72% was surface dressed, 18% resurfaced, and other treatments were carried out on 10%. For each location, one or more comparison sites were identified with similar characteristics, to be left untreated.

Most treatments were carried out between January and August 2022.

Data collected

The following data were obtained from the participating local authorities and from sources made available by the Department for Transport:

Road attributes – road type (dual or single carriageway, or roundabout), road class (A, B, C, U) and environment (rural: speed limit ≥50 mph; urban: ≤40 mph).

Skid resistance site category – assigned as one of four types: non-event (no other feature present), bend or gradient, junction or crossing, roundabout. As local authorities do not necessarily apply the same criteria, the project team assessed the features present using a consistent method.

Skid resistance (SC) – the average over each road length from the most recent survey, corrected for seasonal variation following each authority's survey strategy.

Traffic flow – the average annual daily flow (AADF) for all motor vehicles in the direction of travel. In most cases this was obtained from local DfT count points[3]. In some cases, data supplied by the local authority was used in preference. Since 2024 data were not available at the time of writing, an assumption was made of a 2% growth from 2023 values, based on the previous national trends.

Rainfall – the number of days in each month when >1.0 mm rainfall was recorded, taking the appropriate regional data from a Met Office dataset[4].

Collision data – the number of personal injury collisions recorded in STATS 19, obtained from DfT Road Safety Tables on Accidents and Vehicles[5]. Collisions were initially included where their coordinates fell inside a buffer around each analysis length. Each collision identified this way was reviewed to confirm it had been associated with the correct length.

Collisions of all severities (fatal, serious and slight injury) and with road surface condition 'wet' or 'dry' were included in the analysis. The collision history was obtained for approximately 5 years before and 2 years after treatment. However, collisions within a quarantine period of 30 days before and 90 days after treatment were excluded to avoid potential influence of 'early-life' friction characteristics (Coyle & Greene, 2010). The resulting number of collisions in the analysis is summarised in Table 3.

Table 3. Number of collisions available for analysis (approx. 5 years before and 2 years after each treatment)

	Treatment lengths		**Comparison lengths**	
	Before treatment	After treatment	Before treatment	After treatment
Wet collisions	54	16	95	30
Dry collisions	114	36	165	47
Total collisions*	168	52	260	77
% Wet	32	30	36	39

*Total = wet + dry collisions (excludes other surface condition e.g. frost / ice)

On roads with two-way traffic, each collision was assigned with a 0.5 value to the analysis lengths in each direction, to avoid double counting. Furthermore, collisions located close to the boundary of analysis lengths could be also associated with multiple analysis lengths, due to the finite buffer size. In this case, a 1.0 weighting for each collision was split equally between these analysis lengths.

[3] https://roadtraffic.dft.gov.uk/local-authorities
[4] https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-and-regional-series
[5] https://data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data

Definition of analysis lengths

The data described above were combined in a single database and then exported for analysis. On carriageways with two-way traffic, the two directions were treated separately as independent analysis lengths.

Due to the way the data are held in asset management systems, each site was made up of relatively short lengths. The short lengths are problematic for analysis because of the high proportion where no collisions are observed (Chowdhury et al., 2024). Also, the lengths used are not consistent for all local authorities. To address this, individual lengths with similar characteristics were grouped as follows into longer analysis lengths:

- Lengths within the same part of the site (i.e. within the same roundabout or length of road) could be grouped.
- All lengths in a group must have the same number of lanes, the same road environment (i.e. rural or urban) and the same site category.
- Within each group, the range of skid resistance prior to treatment was minimised as far as possible.

Although the analysis lengths produced are not necessarily contiguous, they represent a collection of short lengths with similar characteristics within the same overall site. For the resulting analysis lengths (Table 4):

- 90% are between 50 m and 1,050 m in length.
- A large majority, nearly 90%, have one lane in the direction of travel.
- There is an even split between rural and urban environments and between A-roads and other classes of road.
- The average skid resistance ranges from 0.1 to 0.6 SC. Within each analysis length there is a limited range of skid resistance in most cases.
- The most common site categories are non-event and bend / gradient.
- When assessed using the LASR prioritisation method, around 30 to 40 groups fell in each of the bands P1 – P4, and there were over 100 groups in bands P5 and P6. The relatively low numbers in the higher priority bands was constrained by the treatments that could be carried out for this study and because of the variation that occurs naturally along the length of each site.

Table 4 Properties of grouped analysis lengths

Length	Minimum	5 %ile	Average	95 %ile	Maximum
Length in m	24	50	327	1,051	1,591

Type of site	Treatment site	Comparison site
Number of groups	163	187
Length in km	56.691	57.885

Lanes in direction of travel	1	2	3
Number of groups	311	36	3

Environment	Rural road	Urban road
Number of groups	180	170

Road Class	A	B, C or U
Number of groups	169	181

Mean skid resistance for group	Min	Average	Max
Average SC	0.13	0.37	0.61

Range of skid resistance in group	0	0<x≤0.05	0.05<x≤0.1	0.1<x≤0.3	0.3<x≤0.9
Number of groups	149	118	56	23	4

Site category	Non-event	Junction / crossing	Bend / gradient	Roundabout
Number of groups	167	36	100	47

LASR prioritisation	P1	P2	P3	P4	P5	P6
Number of groups	30	34	44	31	107	104

Skid resistance before and after treatment

Skid resistance data were also obtained from each local authority following treatment. Appendix A provides further details. For the comparison sites, which had not been treated, the data confirmed there was little change in the skid resistance.

For the treatment sites, a significant improvement in the skid resistance was achieved in many cases. However, this was not always the case, and not all the treated length achieved a skid resistance above the LASR threshold. Roundabouts, with a high threshold of 0.5 in the LASR method, were particularly challenging, suggesting this threshold to be impractically high[6].

[6] Particularly as specialist treatments to achieve high friction are not well-suited to roundabouts

The variable improvement in skid resistance is relevant to the analysis of the study results, as the safety benefit of treatment may not be so high if the skid resistance prior to treatment was already high, or if a significant increase in skid resistance was not achieved by treatment.

Model for traffic flow

Changes in traffic flow during the study were expected to influence the results, particularly as the period before treatment included significant changes due to the Covid pandemic. The influence of traffic flow on collision risk was modelled by plotting the mean collision risk for the grouped analysis lengths in different traffic bands and fitting the resulting trend, Figure 2.

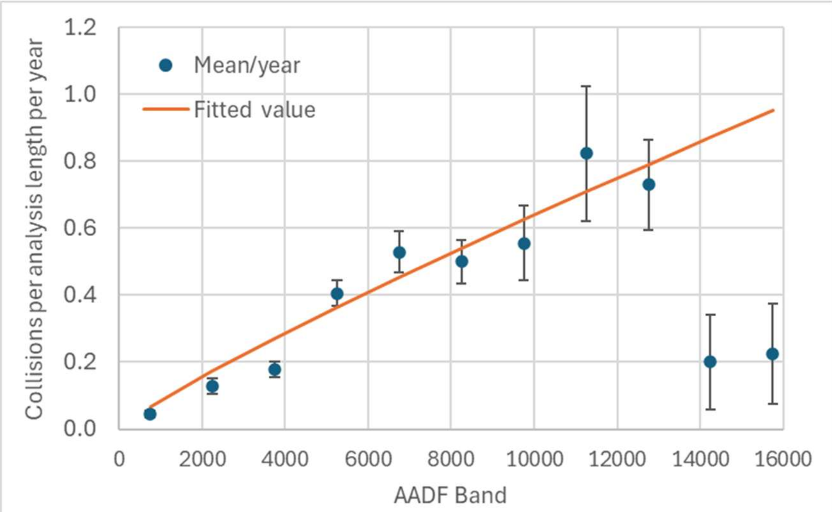


Figure 2 Model for the influence of traffic flow on collision risk

The form of the model obtained was:

$$Collisions\ per\ analysis\ length\ per\ year = 2.00 * 10^{-4} * AADF^{0.876} \qquad (1)$$

Where: AADF = annual average daily flow in the direction of travel

Estimating treatment effectiveness

To assess the effectiveness of treatment, it is necessary to estimate the number of collisions that would have occurred on each site had treatment not taken place. This estimate is then compared with the number of collisions that did occur following treatment. This was assessed separately for wet and dry collisions.

The Empirical Bayes approach was used, following the method outlined by Hauer (Hauer, 1997). This addresses the problem of regression-to-mean, which is observed when collision data are used as part of the site selection process[7]. The

[7] Regression-to-mean is expected whenever an extreme collision history, e.g. a high proportion of wet collisions, is a factor in selecting treatment locations. This is because high values can result from random variations, which does not provide a robust view of the safety of the site. In this case the most likely future situation is that a lower result will be observed, closer to the mean behaviour, even if no intervention is made.

method combines two types of information to estimate the safety of each site before treatment:

- The collisions observed for each site, K, and
- The mean collisions observed for a "reference population" of sites, E(k)

For this work, the reference population has been taken to be all the study sites prior to treatment (treatment and comparison sites), taken together as a group.

Using the values of K and E(k), predictions were made of the number of collisions in the period after treatment, by adjusting as follows to cater for known differences between the before and after periods. For wet collisions on individual analysis lengths, the prediction SP_{Wet} for the after period was:

$$SP_{Wet} = K_{Wet} * RD * RT * RRain \qquad (2)$$

Where:

SP_{Wet} = expected number of wet collisions for this analysis length *after* treatment

K_{Wet} = number of wet collisions for this analysis length *before* treatment

RD = ratio of duration of after period / duration of before period

RT = (average traffic in after period / average traffic in before period) ^ 0.876
(The value of 0.876 was derived from modelling traffic flow, above)

RRain = ratio of rainfall days per year after / rainfall days per year before
(For dry collisions, the ratio RNotRain (ratio of days with no rainfall) was used).

The ratios RD, RT and RRain were calculated for each analysis length.

Similarly, the prediction of wet collisions for each analysis length from the reference population, RP_{Wet}, was:

$$RP_{Wet} = E(k) * D * RT * RRain \qquad (3)$$

Where:

E(k) = mean collisions per year for the reference group in the before period
(The mean per year was used here because not all sites had the same duration of the before period.)

D = duration of the after period in years

These predictions take account of known factors that will influence the number of collisions observed after treatment in a predictable way. However, other sources of change will remain, that are not accounted for by this analysis.

The variance of SP_{Wet} was derived from[8]:

$$VAR(SP_{Wet}) = K_{Wet} * RD^2 * RT^2 * RRain^2 \quad (4)$$

Similarly, for RP_{Wet}:

$$VAR(RP_{Wet}) = E(k) * D * RT^2 * RRain^2 \quad (5)$$

For each analysis length, the process above produces two predictions of the collisions in the after period: the first based on the collision history of that length, SP, and the second based on the collision history of the reference population, RP. In the Empirical Bayes approach, the best estimate for each site, P, lies between these two values, at a position determined by the value of a parameter, a:

$$P = a.RP + (1 - a).SP \quad (6)$$

Where:

$$a = 1/\left(1 + \frac{VAR(RP)}{RP}\right) \quad (7)$$

Equation 7 means that when the variance of the reference population is high in relation to the mean, the denominator is high and the value of a decreases. This places less weight on the estimate from the reference population and more weight on the estimate from the individual site in equation 6.

From here, **a measure of the effectiveness of treatment, theta**, is defined as:

$$Theta = (L/P)\ /(1 + VAR(P)/P^2) \quad (8)$$

Where: L = collisions observed after treatment

P = collisions expected had no treatment occurred

VAR(P) = variance associated with the estimate of P

The first term in equation 8 gives the sense of the indicator – the ratio of collisions observed after treatment divided by the collisions predicted had no treatment taken place. An effective treatment will generate theta values below 1.0. The second term in the equation is less obvious but provides a small correction of bias in the first term[9].

[8] Hauer 1997, pages 101-102
[9] Hauer 1997, pages 64 and 69

Findings

Effectiveness of treatment in reducing wet collisions

Summing over all analysis lengths for treatment and comparison sites, the number of collisions predicted (P) and observed (L) after treatment are shown in Table 5. The three predictions are included: SP from the history of each analysis length, RP from the reference population and P, the preferred Empirical Bayes estimate. Intrinsically, P falls between SP and RP. Each of the three estimates can be used to generate a value of theta and these are plotted in Figure 3.

Table 5 Predicted (P) and observed (L) collisions, on wet and dry roads, in the period after treatment. Standard deviations are shown in brackets.

	Estimate of collisions expected after treatment			**Collisions observed after treatment, L**
	From site history, SP	From reference population, RP	**Empirical Bayes estimate, P**	
Collisions on wet road surface				
Treatment sites	23.8 (3.3)	31.6 (6.1)	28.5 (3.4)	15.9 (4.0)
Comparison sites	43.0 (4.5)	37.1 (6.6)	39.5 (4.0)	30.1 (5.5)
Collisions on dry road surface				
Treatment sites	41.7 (4.1)	49.5 (6.9)	44.0 (5.5)	36.2 (6.0)
Comparison sites	63.4 (5.1)	59.3 (7.6)	62.2 (6.6)	46.9 (6.8)

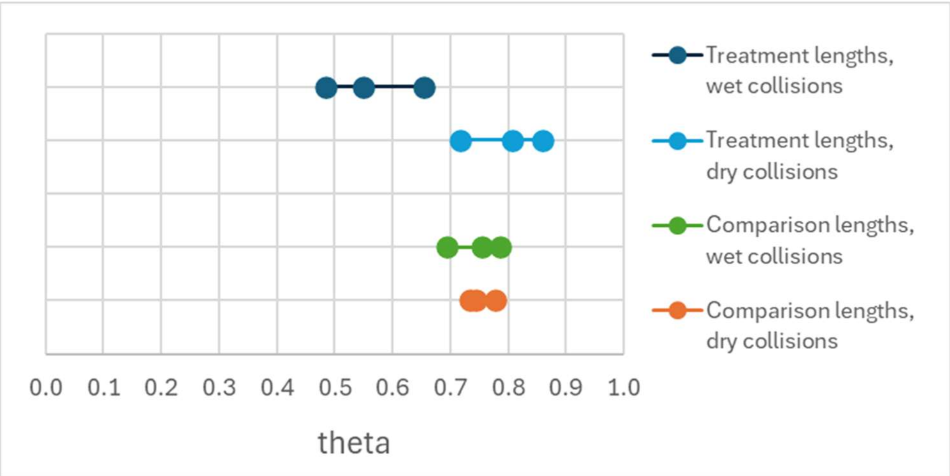


Figure 3 Estimate of "treatment" effectiveness, theta (approximately the ratio of collisions observed / collisions expected in the after period). The three points plotted for each series are from i) the site history, ii) the reference population, and iii) the Empirical Bayes combination of i and ii.

All the theta estimates are below 1.0. This indicates a reduction in collisions occurred for all groups, i.e. even for the untreated comparison sites. This must reflect changes in safety between the before and after periods that are not accounted for by the predictions above. A reduction in collisions over this period is also seen in Great Britain data and the trends seen for the project sites broadly mirror the national trends (Figure 4).

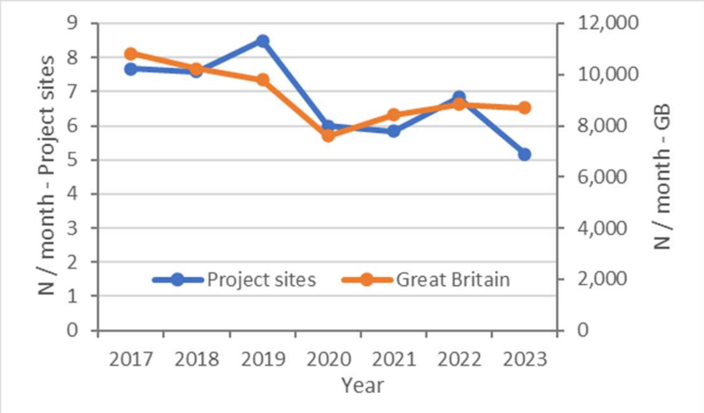


Figure 4 Average collisions per month for project sites compared with GB data[10]. (2024 is excluded as the project sites do not have complete data in this year.)

The theta value for dry collisions on the treatment lengths (0.81 for the Empirical Bayes estimate) is similar to the values for the untreated comparison lengths (0.75 for wet collisions and 0.74 for dry collisions). This is expected: the friction on dry roads is normally high, even when worn, so improving skid resistance is not expected to have much effect on collisions on dry roads.

There is a bigger reduction for wet collisions on the treatment lengths than for the other groups (theta 0.55). This result corresponds to a 27% additional reduction for wet collisions on treated sites compared to the reduction seen for the comparison sites, implying that the treatments carried out have been effective in reducing collisions on wet roads.

Figure 3 represents the results from all lengths, although not all treatments achieved a significant improvement in skid resistance throughout their length (see Appendix A). Limiting the analysis to the treated analysis lengths with an improvement of at least 0.05 SC and comparing this with untreated lengths with no significant change, the additional reduction for wet collisions rises from 27% to 38%.

The confidence in this result should be regarded as 'balance of probability' rather than 'beyond reasonable doubt': the 95% confidence intervals for the estimates of theta are in the region of ±0.3.

[10] Reported road casualties in Great Britain, provisional estimates: year ending June 2024. www.gov.uk/government/statistics/reported-road-casualties-in-great-britain-provisional-estimates-year-ending-june-2024

Influence of site category and SC on treatment effectiveness

In the LASR method, the BCR depends on the site category (e.g. junction, bend) and the extent to which the skid resistance is below the threshold for that site category. This section explores whether the treatment effectiveness varies for the different site categories and for differing initial skid resistance.

As with Figure 3, the treatment effectiveness was determined for different subsets of the analysis lengths. The results (Table 6) are expressed as values of theta*, which is the additional reduction in wet collisions on treated sites, compared to the reduction seen for comparison sites.

Table 6 Treatment effectiveness – sensitivity to site category and skid resistance
(Results are from treated lengths with at least 0.05 improvement in skid resistance)

Site category	SC before treatment	Number of lengths	Wet collisions after treatment		
			Expected, P	Observed, L	Theta*
Non-event	0.1 – 0.3	9	1.8	1.3	0.60
	0.3 – 0.35	19	2.0	2.0	0.88
	0.35 – 0.4	9	0.4	0	0
	0.4 – 0.65	15	0.6	0.8	1.2
	All (0.1 – 0.65)	52	5.3	4.1	0.75
Junctions / crossings	0.1 – 0.35	4	1.7	2.0	0.93
	0.35 – 0.65	9	0.1	0.7	4.8
	All (0.1 – 0.65)	13	1.6	2.7	1.4
Bends / gradients	0.1 – 0.35	15	1.9	0	0
	0.35 – 0.4	13	1.1	0	0
	0.4 – 0.65	6	1.2	0	0
	All (0.1 – 0.65)	34	4.4	0	0
Roundabouts	0.1 – 0.4	6	1.0	1.0	0.88
	0.4 – 0.65	2	0.4	1.0	1.1
	All (0.1 – 0.65)	8	2.4	2.0	0.73
All categories	All (0.1 – 0.65)	107	14.0	8.8	0.62

Theta* = treatment effectiveness in reducing wet collisions compared to the untreated comparison sites

Owing to the small groups and low collision numbers, individual results in this table are not reliable. However, the trend for lower theta* values **(more effective treatments) on lengths with lower initial skid resistance** is consistent for all site categories apart from bends and gradients.

For bends and gradients, there were **no collisions on any of the 34 lengths following treatment**. This result is outside the 95% confidence interval for the expected number of collisions, i.e. it is unlikely to have occurred by chance.

For junctions and crossings, treating the 4 sites with SC below 0.35 was no more effective in reducing wet collisions than for non-event sites with comparable SC. This observation is from a very small number of analysis lengths and not reliable. However, for the whole site category, theta* is 1.4 for the 13 analysis lengths, i.e. **there is no apparent reduction in wet collisions following treatment**. This is the only site category with theta* above 1.0 overall.

For roundabouts, **the results are similar to non-event sections** but, again, the number of analysis lengths is small.

As above, the confidence in these results should be regarded as 'balance of probability' rather than 'beyond reasonable doubt'. On this basis, it appears that:

- Treating bends and gradients was very successful, eliminating wet collisions during the period studied, irrespective of the prior skid resistance.
- For all other categories, treatments were more effective for lengths with lower skid resistance.
- There is no evidence to contradict the Phase 1 recommendation for a lower threshold for junctions and crossings: the treatment effectiveness was not as high as for non-event sites.
- The treatment effectiveness for roundabouts was only comparable to non-event sites. This is surprising given the high threshold recommended from Phase 1, but the number of analysis lengths is very low.

Suggested future LASR thresholds

From these results and other feedback, the following changes are suggested to the LASR thresholds recommended from Phase 1:

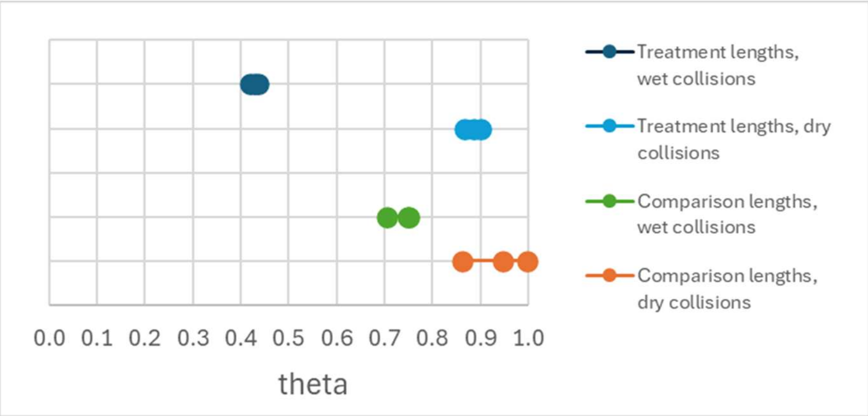
Non-event lengths – 0.35 (no change)

Junctions and crossings – 0.35 (increased from 0.3 for parity with non-event lengths). Although justified by the data, the Phase 1 recommendation of a lower threshold than for non-event lengths, seems perverse. A higher threshold of 0.35 still represents a significant drop from the requirements currently implemented by many local authorities. However, the possibility of 'high risk' junctions could remain, for example, for major/minor junctions with short tapers onto fast roads. These may still warrant a higher threshold.

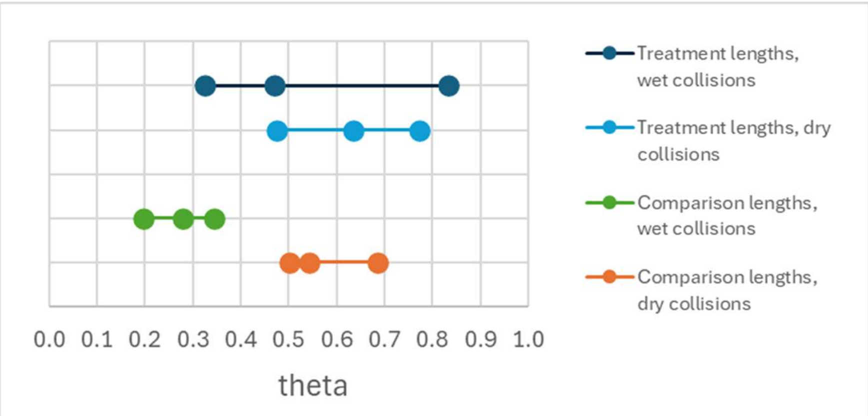
Bends and gradients – 0.45 (increased from 0.4). This would be in line with many current strategies and in keeping with the very high effectiveness of treatments in this study.

Roundabouts – 0.45 (reduced from 0.50). Phase 1 suggested a threshold of 0.5 but the skid resistance after treatment seen in this study suggests it is not practical to achieve this level in practice (see Appendix A). The treatment effectiveness was lower than for other site categories, but the number of lengths and collisions is very small. Continued monitoring and adding additional roundabout sites would be beneficial.

Figure 5 compares the treatment effectiveness for analysis lengths above and below these thresholds.



a) Lengths below thresholds



b) Lengths above thresholds

Figure 5 Treatment effectiveness for lengths below (a) and above (b) the proposed skid resistance thresholds. (Results are for lengths where at least 0.05 improvement in SC was achieved on treatment sites and no change for comparison sites.)

In the upper plot, for lengths below these thresholds, the low theta value (high treatment effectiveness) for wet collisions on the treatment lengths is clear.

Conversely, the lower plot, for lengths above the thresholds, shows a mixed picture with varied and overlapping results. All lengths have theta below 1.0, reflecting the downward trend in Great Britain safety data noted above. There is no notable difference between treated and untreated lengths.

Whereas the untreated lengths **above** the thresholds, in the lower plot, have theta values below 1.0, the untreated lengths **below** the thresholds (upper plot) have theta values closer to 1.0, i.e. despite the GB downwards trend, their safety does not seem to have improved as much.

The results indicate that these thresholds identify sites that deliver a benefit in reducing wet collisions when the skid resistance is improved.

Assessment of the LASR prioritisation method

The LASR method combines the estimated benefit from treatment (BCR) with the estimated risk of wet collisions (RL) in a ranking system (see Table 1). This section explores two aspects of the LASR prioritisation model:

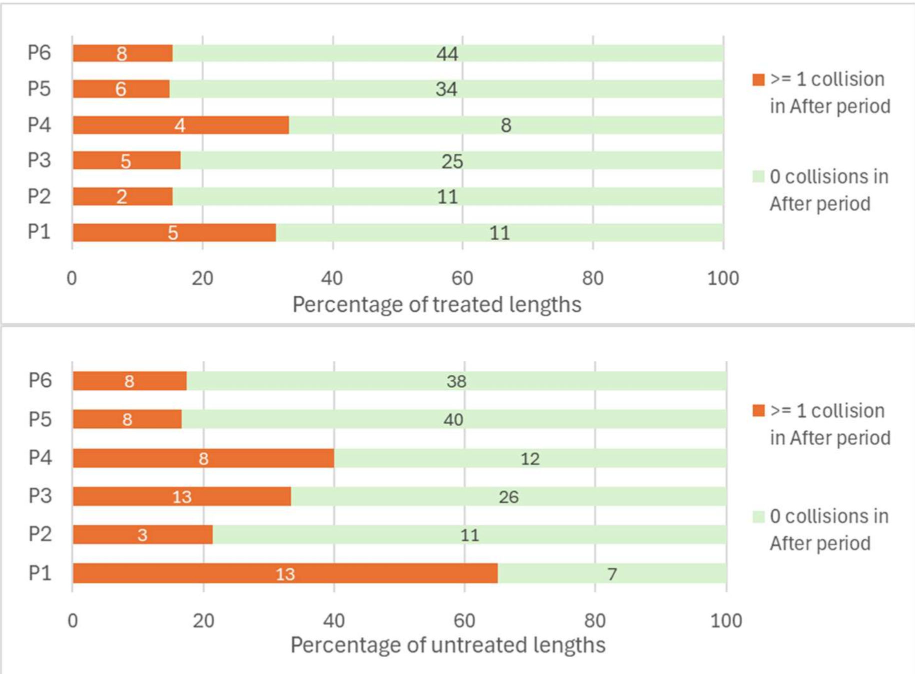
- Whether the high priority lengths (P1 > P2 >P3) are being correctly prioritised and produce a measurable benefit in reducing collisions, particularly wet collisions, on the treatment lengths.
- Whether the low priority lengths (P6 < P5 < P4) are being correctly deprioritised and continue to experience a low rate of wet collisions on the comparison lengths which are untreated.

Table 7 assesses wet collisions on treated lengths that achieved a significant improvement in skid resistance. The overall benefit from treatment, theta* is 0.62, corresponding to a 38% reduction in wet collisions. However, the effectiveness is greater for high priority sites, P1 – P3 (theta* of 0.41 i.e. a 59% reduction) than for the lower priority sites P4 – P6 (theta* of 1.04, i.e. no reduction).

Table 7 Treatment effectiveness by LASR priority band
(Results are from treated lengths with at least 0.05 improvement in skid resistance)

LASR Priority before treatment	Number of lengths	Wet collisions after treatment		
		Expected, P	**Observed, L**	**Theta***
P1 – P3	43	10.2	4.3	0.41
P4 – P6	64	4.1	4.5	1.04
All	107	14.0	8.8	0.62

Breaking this analysis down further to individual Px bands was inconclusive. This is probably because each band includes varying proportions of the different site categories, and the effectiveness of treatments varied for these site categories. In a more straightforward approach, Figure 6 compares for the different Px bands the percentage of the analysis lengths where at last one collision was observed in the after period. The number of analysis lengths represented by each bar is shown and caution is needed where these numbers are small.



a) Outcomes for treated lengths

b) Outcomes for untreated lengths

Figure 6 Percentage and number of analysis lengths with one or more collision in the After period, by LASR priority band (Px)

In the after period, collisions were recorded on a higher proportion of analysis lengths for the untreated comparison sites than for the treatment sites (longer orange bars in the lower plot). For bands P5 and P6, collisions were recorded on 15-17% of the analysis lengths. There is little difference between the results for the treated and untreated lengths for these bands, confirming they should not be a priority. The largest differences between treated and untreated lengths are for P1, where collisions were recorded on 65% of untreated lengths compared with 31% of treated lengths, and P3 (33% compared with 17%).

Is RL helpful in the ranking? Comparing the outcomes for **untreated** lengths with the same BCR but different RL (see Table 1), suggests the RL value is useful: P1 outcomes are worse than P3, i.e. collisions are observed on a higher proportion of P1 analysis lengths than P3 in the after period. P2 outcomes are worse than P5 and P4 worse than P6.

Is BCR helpful in the ranking? Comparing P1, P2 and P4 for the **untreated** lengths (which have RL>50 but with different BCR, see Table 2), we see that the outcomes for P1 sites are worse than for P2 and P4. Unexpectedly, P2 outcomes are better than for P4, but the numbers in both bands are rather low and this result may not be reliable. Similarly, for P3, P5 and P6 there is a difference between P3 and P5 but P5 although P6 are similar. This implies the BCR estimate is useful.

The conclusion is that RL and BCR are both helpful and that the LASR method produces a prioritisation that is relevant to identifying lengths that can deliver treatment benefits. Although the results are somewhat dependent on the thresholds used, changing the thresholds does not alter this general pattern. The thresholds used here were, as suggested above, 0.35 for non-event, junctions and crossings, and 0.45 for bends, gradients and roundabouts.

Comparison with SCRIM difference strategies

This section explores whether the LASR approach is more effective than current strategies that identify lengths using skid resistance and current investigatory levels ('SCRIM difference'), or by using the SCRIM difference combined with the number of wet collisions. Figure 7 compares the outcomes for untreated lengths that would have been selected for treatment by the four strategies listed below.

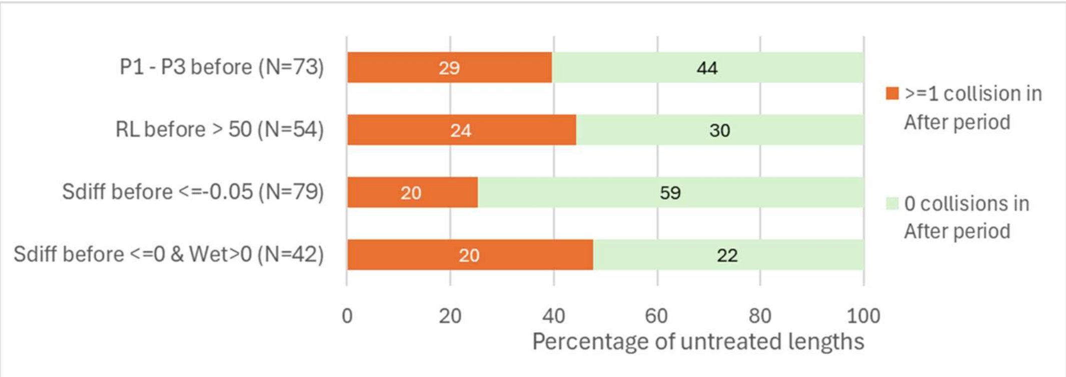


Figure 7 Comparison of strategies to identify treatment lengths

Outcomes for two strategies based on the LASR approach:

1) Prioritise the 73 lengths in bands P1-P3, or
2) Prioritise the 54 lengths with RL>50 (corresponding to P1 + P2 + P4, Table 1).

There were similar outcomes for the lengths identified by these strategies. However, the P1-P3 strategy is preferred because considering only lengths with RL>50 means that no action will be considered before someone is injured.

Outcomes for two strategies based on SCRIM difference:

1) Prioritise the 79 lengths at least 0.05 SC below the Investigatory Level[11] (IL), or
2) Prioritise the 42 lengths at or below the IL with at least one wet collision.

These strategies both seek to reduce an impractically large number of lengths below the skid resistance ILs – the first effectively reduces the IL by 0.05 and the second removes lengths with no history of wet collisions. These are common approaches because many local authorities have significant road lengths below IL.

The first strategy would be the least effective as, with no treatment applied, collisions were observed on relatively few lengths. The second strategy would be more effective as, with no treatment, collisions were recorded on a higher percentage of analysis lengths.

From these results, the LASR strategies were slightly less effective than the combination of SCRIM difference with at least one wet collision. However, the LASR approach allows the collision history to be balanced with the loss of skid resistance via the RL and BCR. In contrast, the strategies based on SCRIM difference either rely on using a low threshold, 0.05 below IL, to reduce the number of lengths to a manageable level, which is less effective, or on adding a requirement for at least one wet collision, which is more effective but results in action only after an injury has occurred.

Updating the LASR methodology – v3.0

Version 3.0 of the LASR method has been drafted to implement the results of this research and is included as Appendix B. The changes from the previous version 2.0 are:

- Restricting the definition of total collisions to those with surface condition dry or wet/damp, mirroring this research by excluding collisions with unknown surface condition or with frost, ice or flood recorded.
- Adjustment to the skid resistance thresholds for all site categories apart from non-event.
- A change to the slope that defines the predicted increase in wet collisions below the skid resistance threshold for junctions and crossings. These slopes were defined for each site category from the Phase 1 results and

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[11] The ILs for this analysis were in line with those from the UK national skid resistance standard CS 228 (National Highways, 2021), which are adopted by many local authorities.

were reviewed in the light of the changes to skid resistance thresholds. The junctions and crossings category was unusual in that a steep slope below 0.3 SC was driven by a single data point. Fitting the data below 0.35 SC (the new threshold) was judged to produce a more balanced result. Similar changes were not required for the other site categories.
- Updating the average cost per collision to reflect current values.
- Updating the examples of average traffic flow to reflect current values.

Learning and next steps

Reflection on the study approach

A. What went well?

The engagement from the 13 participating authorities has been excellent. Staff from each authority have spent considerable time with our project team to identify sites, obtain data, attend meetings, and provide technical feedback.

The study design has demonstrated the effectiveness of treatment and given insights that will refine the approach developed in Phase 1. A majority of Steering Group members reported being confident to implement the approach as a result of this work.

B. What could be improved?

Although the intention was to target treatments at areas with low skid resistance, this was not always possible. The result was that more, low priority lengths were included than expected. Furthermore, there were limited numbers of some types of sites, particularly roundabouts. Consequently, there remains scope to extend the study to provide greater confidence and new insights.

Next steps

The next steps will be to continue to work with the Steering Group towards implementation. It is recommended that local authorities initially carry out their standard assessment of skid resistance data in parallel with the LASR approach to assess the differences at a network level. Developing the prioritisation matrix (Table 1) to provide more granularity will also be investigated.

The description of the LASR method and the LASR analysis template on the project website will be updated, also considering suggestions from the Steering Group.

The study results will be disseminated more widely amongst local authority practitioners. A short ‘project briefing’ and ‘case for change’ have been drafted to assist in gaining approval to change existing policies.

Further Steering Group meetings will be held for authorities that wish to collaborate on implementing the LASR approach. Their appetite to extending this work to address limitations in the data, particularly for roundabouts, will be gauged.

Conclusions and recommendations

Overall conclusions from Phase 2

The headline findings are:

- The treatments carried out were effective in reducing collisions in wet conditions. For locations with a significant improvement in skid resistance, a 38% reduction in wet collisions was observed on the treatment sites compared with the untreated comparison sites.
- The reduction in wet collisions appears to be greatest on sites with lower initial skid resistance.
- Treatments on bends and gradients were particularly successful, and it is recommended that the LASR threshold for these is increased to 0.45.
- Treatments on roundabouts appeared to be comparable to those on non-event sites with similar skid resistance. This is a surprising result but is based on a small number of analysis lengths so may not be reliable. However, the LASR threshold of 0.5 has been seen to be difficult to achieve in practice and for this reason it is recommended to reduce it to 0.45.
- There was no evidence to counter the Phase 1 recommendation for a lower threshold for junctions and crossings. It is recommended that a threshold of 0.35, the same as non-event lengths, is used. However, if implementing this lower threshold, practitioners should note there may be some higher risk junctions and crossings that would benefit from a higher threshold, and that this will place an onus on them to identify such sites.
- The LASR approach is effective in targeting lengths that can deliver safety benefits, and both BCR and RL are useful in the approach. An advantage over traditional strategies based on SCRIM difference is that it allows the collision history of a site to be balanced with the loss of skid resistance. This allows areas for treatment to be identified on a preventative basis, before injury occurs.

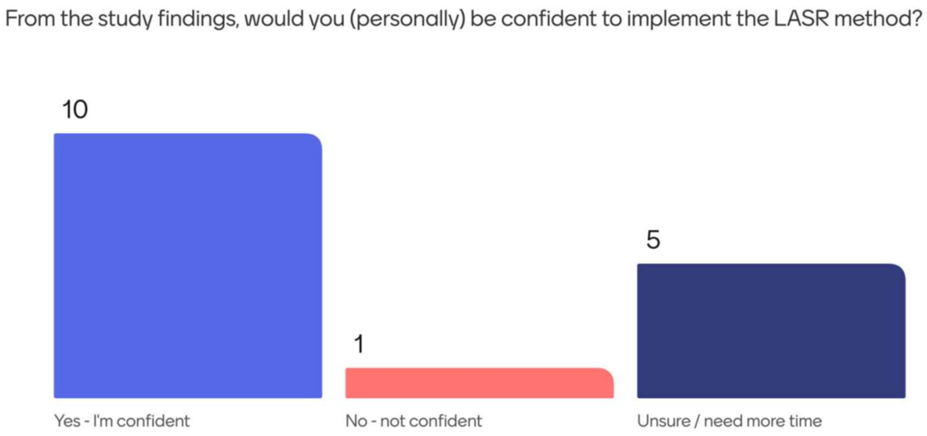
Feedback from the Steering Group

The Phase 2 results were presented to the local authority Steering Group on 2 April 2025 to ascertain their feedback and views on the practicality of the approach. The LASR approach requires additional data sources such as traffic, that may not be routinely available, and new systems would need to be set up to manipulate the data and produce the ranking.

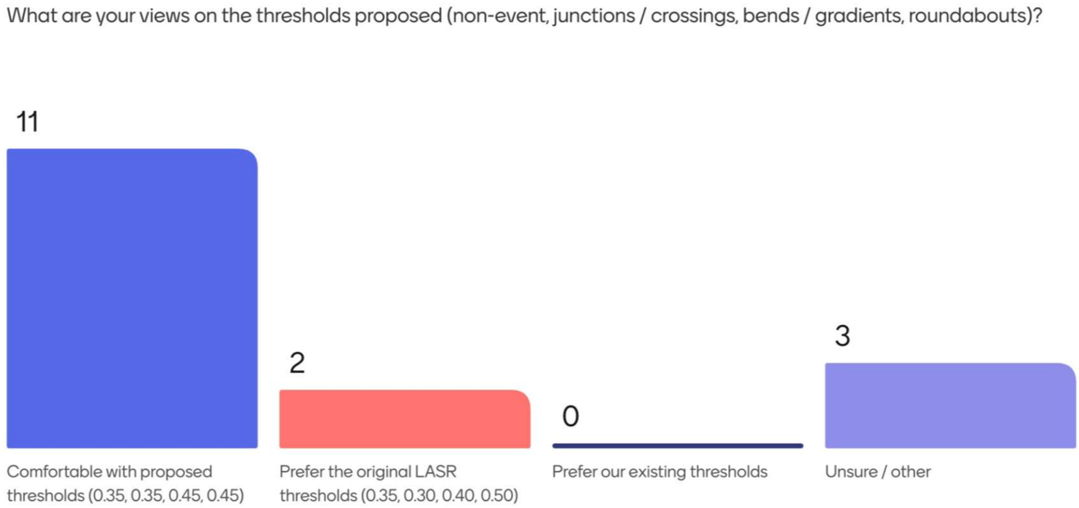
18 people, representing 13 local authorities attended the meeting in addition to the project team. The following feedback was captured during the meeting using Mentimeter[12]:

[12]https://www.mentimeter.com/

Question 1:

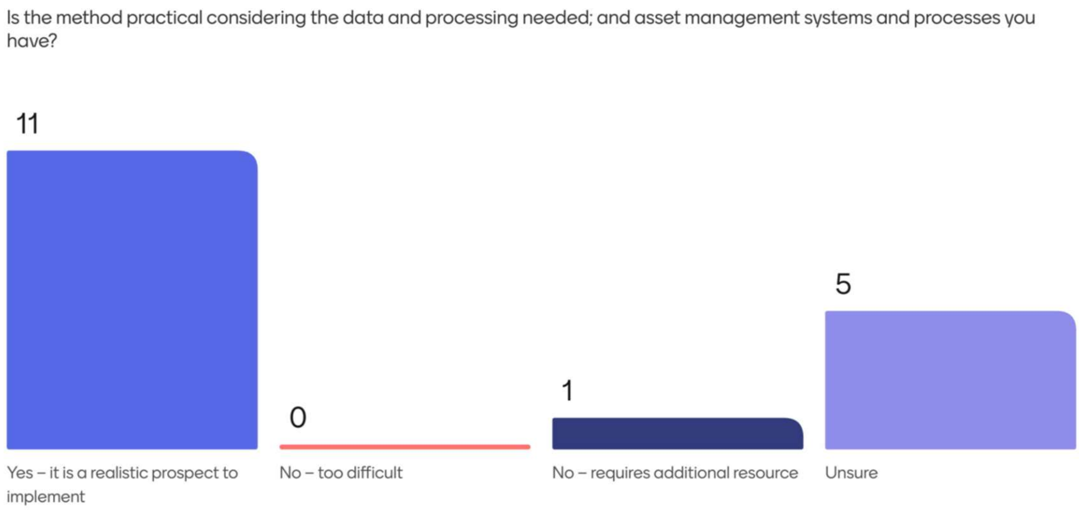


Question 2:



NB. One participant stated they mistakenly responded "Prefer the original thresholds" but had intended to vote for the proposed threshold. This alters the result shown.

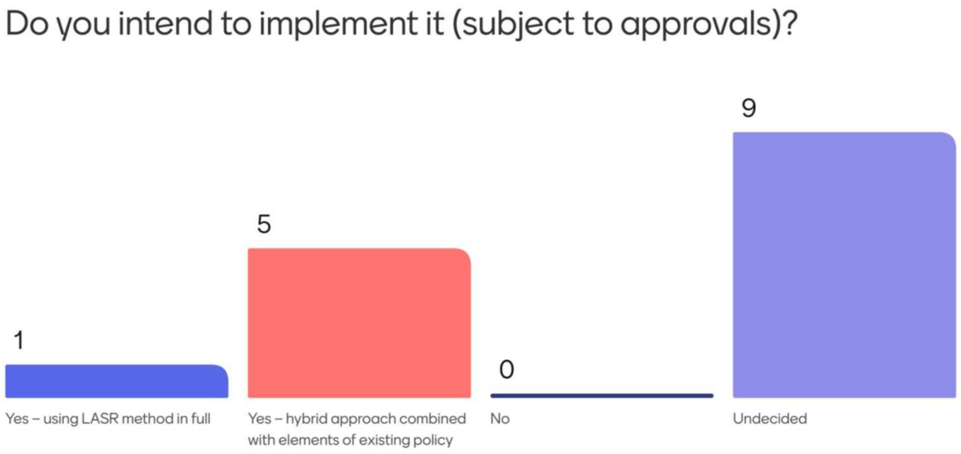
Question 3:



Question 4: Do you have any suggestions to improve the method or its implementation? Summary of responses received:

- Provide a table of thresholds with an emphasis that higher risk sites can be catered for. Include guidance on how to set the site category and threshold (e.g. bend radius and speed limit). E.g. a zebra crossing might require a higher threshold than typical junctions. What are the requirements for 20 mph zones?
- Request to split the analysis into rural and urban lengths.
- Include the method in the Code of Practice for Well Maintained Highways to provide confidence to other local authorities
- Produce a simple guide for non-technical audience

Question 5:



Summary of feedback

Overall, the Steering Group was broadly confident in the results and the proposed LASR thresholds and thought it a realistic strategy to adopt. Points raised in discussion were:

- With a lower overall threshold for junctions and crossings, some locations will still need a higher threshold, e.g. zebra crossings and school locations. Guidance on the situations where this is appropriate would be useful.
- The assignment of wet / dry collisions is important in the prioritisation but is not recorded wholly accurately in STATS19.
- Some concerns were noted over the practicality and resource needed to obtain the additional data needed. Feedback from some authorities that had already set up systems to implement the approach was that they had found it to be manageable.

40% of the Group intended to implement the method, mainly in a hybrid approach combined with elements of existing policies, whereas 60% were undecided. No participants were decided against.

Points raised on implementation were the need for a wider discussion within each organisation, obtaining agreement from colleagues. The change is significant and will need approval and confidence that the revised approach would stand up to legal challenge.

Hints and tips for future projects

Based on the experience from this project, our recommendations are:

Allow more time to assemble data. Significant effort was made to establish a robust source of data for analysis. This was essential but the amount of manual effort was significantly underestimated. The main sources of effort were:

- Obtaining and checking the various sources of data
- Liaising individually with each local authority
- Converting data to a consistent format where needed
- Collating the data sources in a single geographic database.
- Grouping lengths with similar characteristics for the analysis

Allow for more contingency when planning the size of the study. Although a promising number of sites were identified, some were abandoned at different stages, the overall profile of their characteristics was not ideal and not all treated lengths achieved a significant improvement in skid resistance. Therefore, although we were pleased with the number of sites identified, more would have been better.

Engage with the eventual practitioners. This study would not have been possible without the support of the Steering Group and engaging with them throughout the project provides a good base and consensus to continue to implementation.

References

Chowdhury, S., Makosa, H., Harpham, N., Collis, C., Wallbank, C., & Fletcher, J. (2024) PPR2030 Collision prediction model for the Irish National Road Network Phase 1. Wokingham: TRL Limited.

Coyle, F., & Greene, M. J. (2010). PPR493 Early life skid resistance – an assessment of accident risk (2003-2006). Wokingham: TRL Limited.

Hauer (1997). Observational before-after studies in road safety. Emerald Group Publishing, Bingley UK.

National Highways (2021). CS 228 'Skidding Resistance'. Revision 2 www.standardsforhighways.co.uk

Viner, H., Smith, S., Phillips, S., & Boden, K. (2021). A new methodology for prioritising Local Authority Skid Resistance. www.lasr-approach.org

Viner, H., Smith, S., Phillips, S., & Boden, K. (2023). Updated methodology for prioritising Local Authority Skid Resistance – LASR v2. Retrieved from www.lasr-approach.org

Appendix A. Change in skid resistance due to treatment

Skid resistance data before and after treatment were available for 864 individual lengths on 143 local authority sites, total length 104.4 km. For the treatment lengths, there was a considerable range of skid resistance before treatment – in Figure A1 (left) the values on the x-axis range from <0.1 to >0.5, i.e. not all locations had poor skid resistance prior to treatment.

Most data for the treatment sites lie above the y=x line, i.e. the skid resistance for each length generally improves after treatment. However, a small proportion of lengths remain with skid resistance below 0.4 after treatment, which is surprising. For the comparison lengths there are fewer length with very low initial skid resistance. The data generally lie on the y=x line, i.e. there is little overall change in skid resistance, as expected.

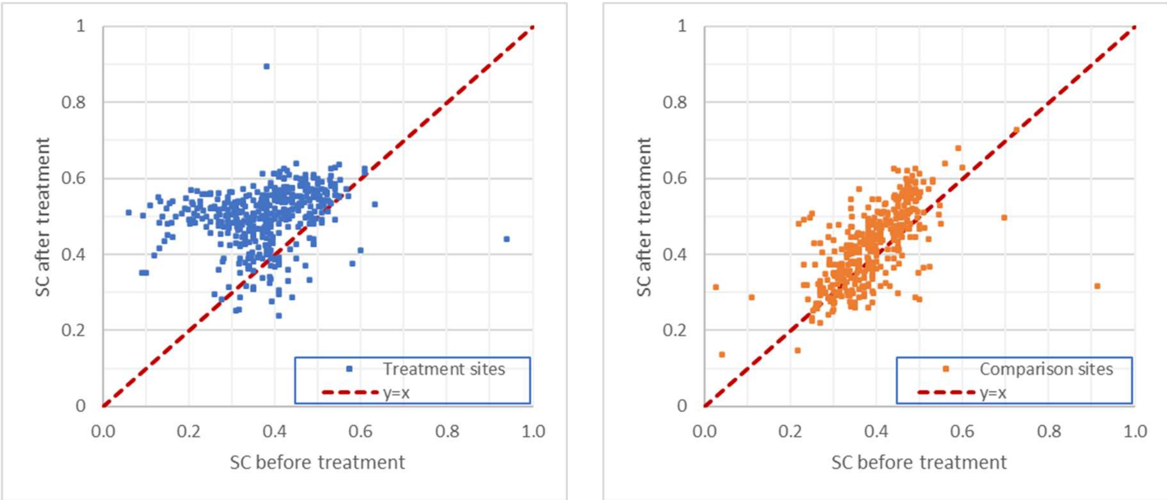


Figure A1 Skid resistance (SC) before and after treatment

On average, a small increase in skid resistance occurred for the comparison lengths and a larger increase for the treatment lengths (Table A1). The average for the treatment lengths reflects a mixture of small and large changes: lengths with a high starting point, say >0.5 prior to treatment, are not much affected by treatment (they are close to the y=x line) whereas lengths with a low initial skid resistance less, say <0.2, show a large increase and appear well above y=x in the plot.

Table A1 Average skid resistance before and after treatment

Average SC	Treatment lengths	Comparison lengths
Before treatment	0.38	0.38
After treatment	0.50	0.42
Change	+0.12	+0.04

This is confirmed in Figure A2, which shows how much the skid resistance changed for individual lengths. There is a wide distribution for the treatment lengths – substantial increases are observed for some lengths and little change or a small reduction is observed for other lengths.

By contrast, the distribution for the comparison lengths is centred close to zero, although there is a tail to both sides. As skid resistance varies due to a wide range of factors, these tails are not surprising.

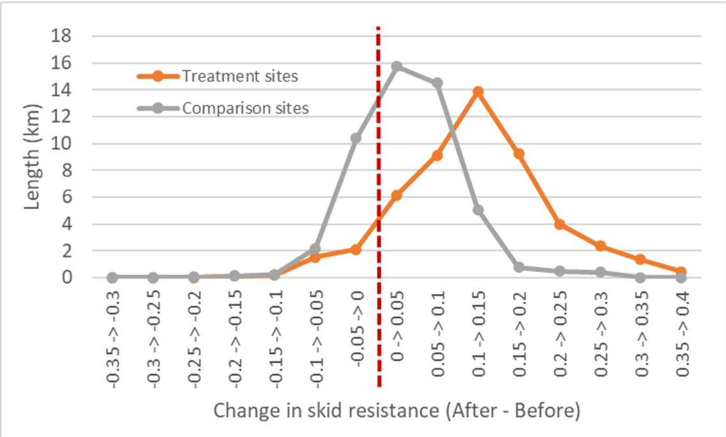


Figure A2 Change in skid resistance following treatment – distributions for individual lengths

Figure A3(a) explores whether the change in skid resistance before and after treatment was the same for different site categories.

3a.

3b.

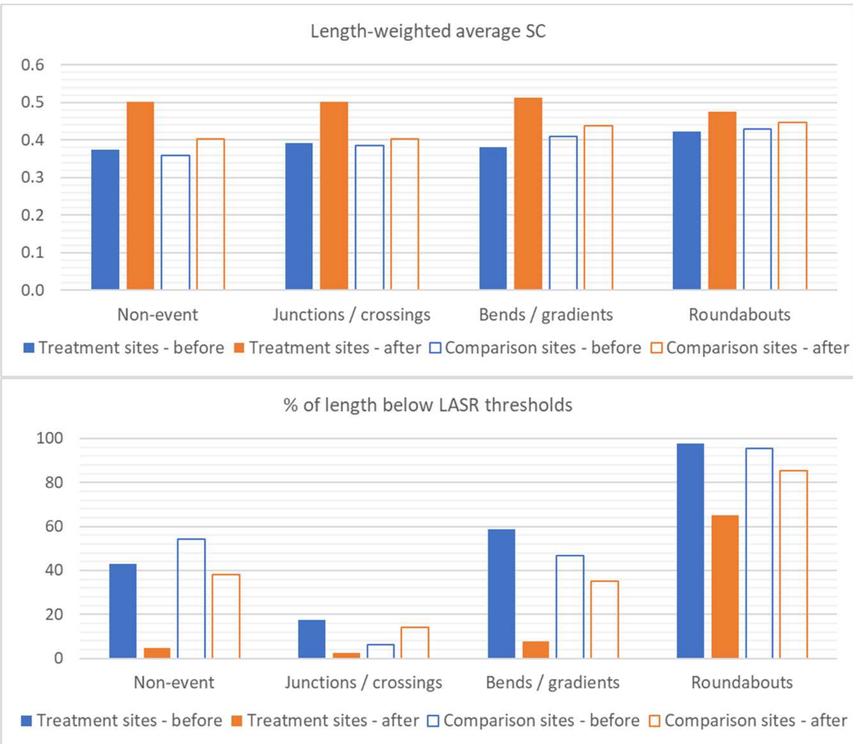


Figure A3 Skid resistance (a) and percentage of length below thresholds (b), by site category, before and after treatment

The analysis focusses on the treatment lengths, but the comparison lengths are included for comparison. Apart from roundabouts, there is a consistent increase in skid resistance for the treatment lengths, achieving close to 0.5 after treatment. There is a smaller increase for roundabouts and, although from a higher starting point, the average remains below 0.5.

For the comparison lengths, a small increase is seen for all site categories.

The different site categories have different thresholds for skid resistance. In the LASR methodology (v2, i.e. prior to the update recommended by this research) the thresholds were:

- 0.35 Non-event lengths (BC)
- 0.3 Junctions and crossings (KQ)
- 0.4 Bends and gradients (SG)
- 0.5 Roundabouts (R)

Figure A3(b) shows how the changes in skid resistance affect the length below these thresholds. Apart from roundabouts, the percentage of length below the LASR threshold is close to zero after treatment. Before treatment the percentage was not always high – only 40% for non-event lengths and less than 20% for junctions and crossings.

For roundabouts there is a different picture – following treatment, 60% of the length remains below the LASR threshold, which suggests the high LASR threshold is difficult to achieve in practice.

Appendix B Procedure for prioritising skid resistance improvement to individual road lengths

Version 3.0

August 2025

B1 Overview

The method described below is a method for prioritising skid resistance improvements to individual road lengths in the context of a Road Authority's policy for managing the skid resistance of its network ("the LASR approach"). It makes use of models for skid resistance and collision risk developed in a project which was grant-funded by the Road Safety Trust (Viner, Smith, Phillips, & Boden, A new methodology for prioritising Local Authority Skid Resistance, 2021).

Version 2.0 of the LASR approach implemented simplified treatment rules for estimating the cost of treatment and a revision to the priority banding. Details are published in (Viner, Smith, Phillips, & Boden, Updated methodology for prioritising Local Authority Skid Resistance - LASR v2, 2023).

This is version 3.0 of the LASR method, implemented following the results of the further research reported here (Viner, Smith, & Boden, Prioritising local authority skid resistance: Pilot trial of the LASR approach, 2025). The changes from version 2.0 are:

- Restricting the definition of total collisions to those with surface condition dry or wet/damp (see section B2, below). This mirrors the approach taken in the recent research by excluding collisions with unknown surface condition or with frost, ice or flood recorded.
- Adjustment to the skid resistance thresholds for all site categories apart from non-event (see section B3, subsection 2)
- A change to the benefit rate for the junctions and crossings site category (see Section B3, subsection 3). This was carried out after a review the Phase 1 results in the light of the changes to skid resistance thresholds. Similar changes were not required for the other site categories.

Two other updates have been made:

- The example traffic data have been uplifted to estimate 2024 values and examples included from different authorities (see section B3, subsection 1)
- The average cost per collision has been updated to reflect the current value in July 2025 (section B3, subsection 7)

The cost of surface dressing was reviewed, and it was judged that the value remained representative and did not need to be updated (section B3, subsection 6).

There are two components to the LASR prioritisation method:

1. Estimate the BCR for improvement

This component assesses the likely benefit of treatment, which is combined with an estimate of treatment cost to determine the Benefit to Cost Ratio (BCR). The estimate of BCR enables the economic justification for treatment to be assessed, using models for the average collision risk for different types of site. The method uses the concept of 'Excess Wet Collisions' to model collision risk.

2. Assess the recent collision history

This component uses the history of collisions for each specific road length to assess the likelihood that that road length has an elevated risk of wet collisions suggestive of a skid resistance problem.

B2. Data required

The method requires the road network to have been segmented into homogeneous lengths, for each of which the following information is needed. Note the calculations are applied separately for each direction of travel, therefore the number of lanes and AADF values for each analysis length should reflect a single direction of travel:

- Lanes – number of permanent lanes in the direction of travel – used to estimate treatment cost; it is assumed that all permanent lanes will be treated
- Road class (A, B, C or U) – used to estimate treatment life
- Length (m)
- CSC (units SC) – Characteristic Skid Resistance: a measurement of road surface skid resistance made in accordance with CS228, i.e. using SCRIM, corrected for seasonal variation and index of SFC. In this context refers to the average value calculated over the road length described.
- Event type – one of the following 4 types: non-event (none of the other events present), bend or gradient, junction or crossing, roundabout
- Traffic flow (AADF) – average daily traffic flow for all motor vehicles, in the direction of travel, i.e. dividing by 2 if necessary for two-way roads.
- Total collisions – the number of personal injury collisions recorded in STATS 19 during a specified period (3 year period suggested) with surface condition dry or wet/damp
- Wet collisions – of the total collisions recorded, the number where road surface condition was recorded as wet/damp

B3 Method for calculating BCR via Excess Wet Collisions

The Benefit / Cost ratio for treating each road length is estimated using the following method:

1. Calculate the annual vehicle kilometres driven on the site, *VKM*:

$$VKM = \frac{Length}{1000} * AADF * 365$$

Where no suitable data are available from traffic count points, it will be necessary to identify a default value to use. The examples in Table B1 approximate the median traffic flow for each road class for the local authorities participating in the Phase 1 research. The original 2018 values have been uplifted to estimate 2024 counts using data Great Britain traffic growth data.

Table B1 *Median AADF values updated to 2024 for example local authorities*

Authority type	By road class			By road class and environment					
	A	B	C	A - Urban	A - Rural	B - Urban	B - Rural	C- Urban	C - Rural
Large city council (1)	11100	5800	3100	11057		5762		3005	
Large city council (2)	10300	5000	1800	10533	8223	4987	3193	1782	2303
Large city council (3)	10400								
Large county council (1)	7900	3900							
Large county council (2)	6200	3200	2100	6374	5798	4065	2487	2061	2061
Large county council (3)	5000	2400		5382	3971	3339	1782		
Medium mixed environment council (1)	8900	4100	4400	8850	6752	5425	3161	4940	786
Medium mixed environment council (2)	7900	2200	2700	8742	6512	3585	2114	4442	1772
Medium rural council (1)	6500	2300	3200	6920	3211	4675	1440	3251	778
Medium rural council (2)	3700	900		3684	3684	791	887		
Small urban city council	8200	3800	4100	7210	9456	3952	3784	4208	4045
All	7600	3100	3000	7558	5295	3784	2032	3251	1772

2. Calculate the skid resistance deficiency, *SRD*:

If CSC < threshold: $SRD = Threshold - CSC$

Otherwise: $SRD = 0$

Where the Threshold value is determined from the event type, using Table B2.

Table B2 *Skid resistance threshold for Benefit / Cost analysis*

Event type	Non-event	Bend or Gradient	Junction or Crossing	Roundabout
Threshold (units SC)	0.35	0.45	0.35	0.45

3. Calculate the annual benefit from treatment, *ABen*:

ABen is the average reduction in Excess Wet Collisions expected to result from increasing the skid resistance up to the Threshold. It uses the traffic flow at the site in this calculation, and so greater benefits are predicted for road lengths with higher traffic flow. Where SRD is equal to zero because the skid resistance is greater than the Threshold listed in Table B2, zero benefit is predicted.

$$ABen = SRD * Benefit\ Rate * VKM$$

Benefit Rate is the slope of the plot of collision rate (number of Excess Wet collisions per 10^8 VKM) against skid resistance (in units CSC). It represents the change in excess wet collisions, per unit traffic flow, per unit change of CSC. The values of *Benefit Rate* determined during RST research for each type of event are given in Table B3.

Table B3 *Benefit Rate for Benefit / Cost analysis*

Event type	Non-event	Bend or Gradient	Junction or Crossing	Roundabout
Benefit Rate* (N/unit CSC/VKM)	$3.76 * 10^{-7}$	$6.64 * 10^{-7}$	$1.11 * 10^{-6}$	$1.21 * 10^{-6}$

** Change in Excess Wet collisions per unit SRD, per VKM*

4. Calculate the overall benefit from treatment, *OBen*:

OBen is the total reduction in Excess Wet Collisions expected to result over the treatment lifetime

$$OBen = ABen * Treatment\ life$$

Where *Treatment life* is determined from the road class as shown in Table B5. This is based on the life of surface dressing treatments, estimated by an experienced asset manager.

Table B5 *Treatment life (years)*

Road class			
A	B	C	U
9	11	11	11

6. Calculate the treatment cost, *TCost*:

Treatment cost is the total cost of works including traffic management and is estimated assuming a standard lane width of 3.6m

$$TCost = Length * \ Lanes * 3.6 * Cost\ per\ m^2$$

Where *Cost per* m^2 for surface dressing treatments was estimated by an experienced asset manager as shown in Table B6.

Table B6 *Treatment cost*

Treatment cost (£/m^2)	6

7. Calculate the Benefit / Cost ratio, BCR

BCR is the overall cost saving during the lifetime of the treatment as a result of improving the skid resistance, divided by the cost of the treatment. Values above 1.0 indicate that the benefit exceeds the cost.

$$BCR = \frac{OBen * Average\ cost\ per\ collision}{TCost}$$

Where the *Average cost per collision* is £133,307 from Table RAS4001 'Average value of prevention of reported road accidents by road type' (all injury collisions, all roads), DfT, downloaded July 2025. NB it would be possible to use different values of collision cost for built-up and non built-up roads. However, this would introduce a complexity that was outside the scope of the original research. Consequently, the average value has been used.

B4 Method for assessing recent collision history

The assessment of collision risk for individual road lengths is problematic due to the small number of collisions that are observed for most sites. Consequently, the results of any assessment are uncertain. While uncertain, the following method allows a comparison between different road lengths by assessing relative likelihood that each length has an elevated risk of wet collisions that could be suggestive of a skid resistance problem. The relative likelihood is determined from the number of Total and Wet collisions using Table B7.

Table B7 *Relative likelihood of there being an elevated risk of wet collisions*

Wet collisions (N)	Total collisions (N)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	50	43	36	29	23	19	14	11	9	6	5	4	3	2	2	1
1		66	59	51	44	37	30	24	19	15	12	9	7	5	4	3
2			78	73	67	60	53	45	38	31	25	20	16	12	9	7
3				87	84	79	74	68	61	54	47	39	33	26	21	17
4					93	91	88	85	80	75	69	63	55	48	41	34
5						96	95	93	91	89	85	81	76	70	64	57
6							98	97	96	95	94	92	89	86	82	77
7								99	99	98	97	97	95	94	92	90
8									99	99	99	99	98	98	97	96
9										100	100	99	99	99	99	98
10											100	100	100	100	99	99
11												100	100	100	100	100
12													100	100	100	100
13														100	100	100
14															100	100
15																100

Low values indicate low relative likelihood

Each column in the table considers the different outcomes that are possible for a road length where a total of *T* collisions has been observed: the number of wet collisions, *W*, can range from 0 to *T*. The relative likelihood of each of these outcomes is estimated as follows.

1. General approach:

Calculate the probability that *W* wet collisions occur within *T* total collisions, p(*W*,*T*), by assuming that wet collisions occur randomly, with a probability p(*Wet*). Values of p(*Wet*) are given below.

$$p(W,T) = \frac{T!}{W!\,(T-W)!} * p(Wet)^{W}(1-p(Wet))^{(T-W)}$$

This approach follows the binomial probability distribution. The first part of the equation calculates the number of ways of achieving the stated outcome. For example, 1 wet collision in 3 total collisions can be achieved in three ways: WDD, DWD or DDW. [W=wet; D='not wet']. This is calculated as: 3!/(1!2!) = (3 * 2 * 1) / (1 * 2 * 1) = 3.

The second part of the equation calculates the probability of any one of these three results occurring, by combining the probability that *W* wet collisions will occur, p(Wet)^W, with the probability that (*T*-*W*) 'not wet' collisions will occur, (1-p(Wet))^(*T*-*W*).

The overall result describes the probability of achieving the outcome (*W*,*T*) from *T* 'dice rolls' where the random probability that a dice roll will return W is p(*Wet*).

2. Application to determine the relative likelihood of elevated wet collisions for each road length:

For roads with high skid resistance, which are assumed to be Low Risk in terms of friction-related collisions, the proportion of wet collisions was 22% from the RST study. Similarly, for roads with low skid resistance, assumed to be High Risk in terms of friction-related collisions, the proportion of wet collisions was 42%.

i. Calculate the probability of the outcome (W,T) if a road length is behaving as a Low Risk site, using p(Wet) = 0.22. For the case of 1 wet collision in 3 total collisions, we obtain:

$$p_{LowRisk(1,3)} = \frac{3!}{1!\,2!} * 0.22^1 * (1 - 0.22)^2 = 0.401$$

ii. Calculate the probability of the outcome (W,T) if a road length is behaving as a High Risk site, using p(Wet) = 0.42. For the case of 1 wet collision in 3 total collisions, we obtain:

$$p_{HighRisk(1,3)} = \frac{3!}{1!\,2!} * 0.42^1 * (1 - 0.42)^2 = 0.424$$

The relative likelihood that the road length is behaving as a High Risk site, i.e. with elevated risk of wet collisions, is assessed by comparing the relative sizes of p_LowRisk and p_HighRisk.

iii. Calculate the relative likelihood, RL, that this road length is behaving as High Risk:

$$RL = \frac{p_{HighRisk(W,T)}}{p_{LowRisk(W,T)} + p_{HighRisk(W,T)}} * 100$$

The addition of p_LowRisk and p_HighRisk in the denominator with no weighting assumes that in the overall 'probability space' representing T total collisions, these possibilities are equally likely. (If information is available to suggest otherwise, this approach could be refined to incorporate it.)

For the case of 1 wet collision in 3 total collisions we obtain:

$$RL = \frac{0.424}{0.401 + 0.424} * 100 = 51$$

The value is close to 50%, reflecting the result that the probability of the road length behaving as low risk is rather similar to the probability of the road length behaving as high risk, i.e. for 1 wet collision in 3 total, the data are not strongly suggestive of either High Risk or Low Risk behaviour. For the other possible outcomes for 3 collisions (0, 2 or 3 wet) the relative likelihood values are more suggestive (29, 73 and 87, respectively, from Table B7).

B5 Prioritisation

The BCR and likelihood values determined in sections B3 and B4 should be used to determine the priority for investigation and treatment as follows:

- Priority 1. Lengths with BCR ≥ 2.0 and likelihood > 50, ranked in order of descending likelihood followed by descending BCR in the event of a tie.
- Priority 2. Lengths with 0 < BCR < 2.0 and likelihood > 50, ranked in order of descending likelihood followed by descending BCR in the event of a tie.
- Priority 3. Lengths with BCR ≥ 2.0 and likelihood ≤ 50, ranked in order of descending BCR followed by descending likelihood in the event of a tie.

- Priority 4. Lengths with BCR = 0 and likelihood > 50, ranked in order of descending likelihood.
- Priority 5. Lengths with 0 < BCR < 2.0 and likelihood ≤ 50, ranked in order of descending likelihood followed by descending BCR in the event of a tie.
- Priority 6. Lengths with BCR = 0 and likelihood ≤ 50, ranked in order of descending likelihood.