

# An Analysis of Skid Resistance Investigatory Levels in Wiltshire

Project Report

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Submitted in accordance with the requirements for the degree of BEng Civil &  
Environmental Engineering University of the West of England

April 2025

## Abstract

This study evaluates the effectiveness of Wiltshire Council's Skid Resistance Policy by analysing the relationship between skidding resistance and collision risk on the local road network. The policy, derived from standards designed for the UK Strategic Road Network (SRN), may not accurately reflect the risks on Wiltshire's predominantly rural roads. With 43.76% of the network at or below the investigatory level (IL), a data-driven approach is required to refine IL thresholds and optimize resource allocation for maintenance interventions.

The analysis integrates multiple datasets, including SCRIM survey data to assess surface friction, SCANNER alignment data for curvature and gradient classification, speed limit extents, STATS19 collision records, and Department for Transport (DfT) traffic counts. Using GIS-based spatial analysis, collision data is linked to 10m subsections of the network to examine trends in skidding-related accidents. Traffic volume is factored in to normalise crash rates, ensuring a statistically robust assessment. The study adopts classification techniques for the Continuous Sideway-Force Coefficient (CSC) values and refines site categories based on curvature banding, in alignment with methodologies used by previous studies for Transport Scotland.

Findings indicate that Wiltshire's existing IL thresholds may overemphasize the role of skidding resistance in some site categories, necessitating adjustments to better reflect collision risk. Recommendations include modifications to ILs and site category criteria, such as reducing bend radius thresholds for certain speed categories and refining criteria for roundabouts, gradients, and junctions. However, limitations exist, including gaps in traffic count data and inconsistencies in roundabout collision reporting due to SCRIM survey constraints.

By implementing these refined investigatory levels, Wiltshire Council can more effectively prioritize interventions, improving road safety while ensuring maintenance efforts are targeted where skid resistance improvements will yield the greatest safety benefits. This targeted approach also helps reduce unnecessary resurfacing, lowering carbon emissions associated with road maintenance.

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# 1. Introduction

## 1.1. Context

This project reviews Wiltshire Council's Skid Resistance policy to assess the appropriateness of current Investigatory Levels (ILs). Friction from carriageway surfaces is a key factor in road safety, so pavement design and maintenance should ensure adequate skidding resistance to keep the road network safe.

Wiltshire Council, responsible for maintaining approximately 4,600 km of mostly rural carriageway, has had a Skid Resistance policy since 2010. However, this policy is based on guidance for the UK strategic road network (SRN), setting investigatory levels (ILs) to SRN standards. While the policy monitors skidding resistance on Wiltshire's key roads, the characteristics of Wiltshire's network differ significantly from the SRN, meaning the risks associated with poor skidding resistance may vary.

The Department for Transport (DfT) requests annual key performance indicators from local highway authorities. Wiltshire's current skidding resistance metric, measured by the length of carriageway at or below the IL, stands at 43.76% (Wiltshire Council, 2025). This high figure is unsustainable with current resources, prompting a review of the investigatory levels to assess their accuracy in reflecting the impact of skidding resistance on collision risk across the Wiltshire Network.

Skid resistance policies also carry environmental implications. Road surfacing and resurfacing works are resource-intensive activities that contribute significantly to carbon emissions due to material extraction, transport, and the use of bituminous products. By refining Investigatory Levels (ILs) based on actual collision risk, interventions can be better prioritised, reducing the frequency of unnecessary treatments. This approach aligns with broader goals of carbon reduction and supports Wiltshire Council's commitment to sustainable asset management.

## 1.2. Literature Review

### 1.2.1. History

The development of skid resistance standards spans nearly a century. Early measurements used SFC devices, including a motorcycle sidecar rig with angled wheels (Bird and Scott, 1936). Giles (1957) first established a link between skidding resistance and wet accident rates, recommending site-specific standards.

Due to logistical challenges, SFC surveys were initially limited in scale. The introduction of SCRIM in the 1960s enabled network-wide testing through onboard water systems and electronic data logging (Hosking and Woodford, 1976). Studies such as Salt and Szatkowski (1973) and Rogers and Gargett (1991) helped formalise the link between

SCRIM data and collision risk. This led to the creation of Investigatory Levels (ILs) under the HD28/88 standard.

By the late 1980s, local authorities began using SCRIM, with advice to consider lower ILs than those applied to trunk roads (Local Authority Association, 1989), acknowledging differences in road geometry and usage.

### 1.2.2. Current Standards and Policy

Since the introduction of HD28/88 in 1988, skid resistance standards have been updated with ongoing research. Wiltshire Council's current policy (2018) is based on HD28/15, which was later replaced by CS 228, though the core principles remain consistent. Figure 1 shows the process flow from CS 228. Wiltshire's approach aligns closely with this national structure but modifies elements from Section 6 onward to account for resource constraints and local needs.

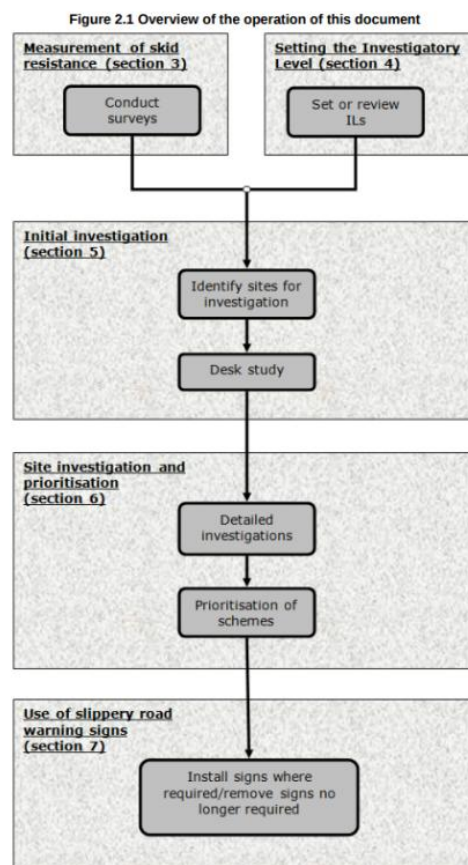


Figure 1: Process flow for managing Skid Resistance using CS-228 (National Highways, 2020)

Figure 2 shows the current site categories and ILs defined in Wiltshire Council's Skid resistance policy. The ILs are adapted from HD28/15, which, while superseded by CS228 remain unchanged between standards. The Wiltshire version further divides several categories by posted speed limits. For example, approaches to junctions and crossings are split at 40 mph, and bends and non-event sections are split at 50 mph. This aims to reflect the varying risk profiles associated with site geometry and speed.



| Site Category and definition                                                                     | Investigatory Levels at 50km/h |      |      |      |      |      |      |      |
|--------------------------------------------------------------------------------------------------|--------------------------------|------|------|------|------|------|------|------|
|                                                                                                  | 0.30                           | 0.35 | 0.40 | 0.45 | 0.50 | 0.55 | 0.60 | 0.65 |
| <b>A</b> Motorway >50mph                                                                         |                                | X    |      |      |      |      |      |      |
| <b>B</b> Dual Carriageway non event >50mph                                                       |                                | X    |      |      |      |      |      |      |
| <b>C</b> Single Carriageway non event >50mph                                                     |                                |      | X    |      |      |      |      |      |
| <b>B-1</b> Dual Carriageway non event <50mph                                                     | X                              |      |      |      |      |      |      |      |
| <b>C-1</b> Single Carriageway non event <50mph                                                   |                                | X    |      |      |      |      |      |      |
| <b>Q</b> Approaches to and across minor and major junctions, approaches to roundabouts >40mph    |                                |      |      |      | X    |      |      |      |
| <b>Q-1</b> Approaches to and across minor and major junctions, approaches to roundabouts ≤ 40mph |                                |      |      | X    |      |      |      |      |
| <b>K</b> Approaches to pedestrian crossings and other high risk situations >40mph                |                                |      |      |      |      | X    |      |      |
| <b>K-1</b> Approaches to pedestrian crossings and other high risk situations ≤ 40mph             |                                |      |      |      | X    |      |      |      |
| <b>R</b> Roundabout                                                                              |                                |      |      |      | X    |      |      |      |
| <b>G1</b> Gradient 5-10% longer than 50m                                                         |                                |      |      |      | X    |      |      |      |
| <b>G2</b> Gradient 10% longer than 50m                                                           |                                |      |      |      |      | X    |      |      |
| <b>S1</b> Bend radius <500m – dual                                                               |                                |      |      |      | X    |      |      |      |
| <b>S2</b> Bend radius <500m – single carriageway >50mph                                          |                                |      |      |      |      | X    |      |      |
| <b>S1-1</b> Bend radius <500m – dual carriageway <50mph                                          |                                |      |      | X    |      |      |      |      |
| <b>S2-1</b> Bend radius <500m – single carriageway <50mph                                        |                                |      |      |      | X    |      |      |      |

**Table A.1 Wiltshire Site Categories and Investigatory Levels – Adapted from HD28/15**  
**Notes:** X denotes the Investigation Level (IL) which is to be used in Wiltshire

Figure 2: Table of ILs Wiltshire Council Skid Resistance Policy (Wiltshire Council 2018)

The policy is also consistent with the Well-Managed Highway Infrastructure (WMHI) code (UKRLG, 2015), which encourages risk-based asset management. Wiltshire’s documented, systematic application of ILs meets these best practice recommendations; however, further risk analysis could lead to improvements.

### 1.2.3. Recent Research

Transport Scotland’s network shares many rural characteristics with Wiltshire’s. A review by Atkins (2020) evaluated whether national ILs were suitable. While most thresholds were retained, the study suggested merging gradient bands into a single >5% category and lowering the maximum bend radius for classification from 500 metres to 250 metres. WSP (2020) investigated collision risk further, recommending that low-risk bend categories could be reclassified and that bends with a radius above 250 metres be treated as non-event sections. Their analysis showed a weak correlation between CSC and the wet collision frequency in these cases.

Viner et al. (2021; 2023) proposed the LASR approach, a data-driven method for setting ILs based on wet collision rates. Applied across several local authorities, the LASR approach examined excess wet collision rates across different site categories. Their findings proposed ILs for four site categories (Table 1).

Table 1: The LASR approach - proposed ILs adapted from Viner et al. (2021)

| Site Category       | IL (CSC) |
|---------------------|----------|
| Non-event           | 0.35     |
| Bends and gradients | 0.40     |
| Junctions           | 0.30     |
| Roundabouts         | 0.50     |

The proposed IL thresholds for each category are generally lower than their counterpart in CS-228. Additionally, Junctions were found to support an IL lower than that of Non-event sections. Due to these large departures from current standards, the study is continuing into phase two, with further collision rate monitoring to validate the findings. While the findings do provide further support that the ILs set through national guidance overstate the actual risk on local authority networks, Viner et al. (2021) would recommend cautious implementation until further validation of the methodology is completed through further study.

#### 1.2.4. Research Gap

National standards like CS 228 are based primarily on the Strategic Road Network (SRN), which differs from local networks in geometry, traffic volume, and design. While CS 228 allows local authorities to set bespoke ILs, there remains a lack of evidence-based adjustments tailored to local risk profiles.

This study aims to address that gap by analysing Wiltshire's SCRIM and collision data to evaluate whether current ILs accurately reflect actual collision risk. The results will inform potential refinements to IL thresholds and site category definitions, ensuring maintenance decisions are both safety-led and resource-efficient.

### 1.3. Research questions

This project seeks to answer the following research questions:

- How has the skidding resistance of Wiltshire's carriageway network performed over time and how does this relate to rates wet-skidding collisions?
- Do the ILs currently set in Wiltshire's Skid resistance policy accurately reflect the collision risk posed on their managed network?
- Can site category definitions (e.g., bends, gradients) be improved to better reflect collision risk and optimise maintenance prioritisation?

## 2. Methodology

### 2.1. Study Domain

The study focuses on Wiltshire Council's Skid Resistance Network, which includes all A and B roads, along with selected C and unclassified roads. The total length of surveyed carriageway is approximately 2,100 km (Figure 3).



Figure 3: Wiltshire Council Skid Resistance Survey Network (Wiltshire Council 2018).

### 2.2. Datasets

To assess the effectiveness of Wiltshire's current skid resistance policy, the study draws on multiple datasets to evaluate the relationship between carriageway friction and collision risk.

#### 2.2.1. SCRIM Survey Data

Processed SCRIM data from Wiltshire's Pavement Management System (PMS) was used. This dataset includes 10 m lane-specific summaries, recording Continuous Sideway-Force Coefficient (CSC), Investigatory Levels (ILs), and site categories. Each record also includes calculated deficiency values, allowing for detailed condition analysis. The dataset is spatially referenced to Wiltshire's PMS centreline network.

### 2.2.2. SCANNER Survey Data.

SCANNER alignment data, also processed into 10 m segments, provides curvature and gradient information. These values were used to reclassify bend sites into radius bands (0–100 m, 100–250 m, and 250–500 m), aligning with the methodology applied in Transport Scotland’s IL review by Atkins (2020).

### 2.2.3. Speed Limit Extents

Posted speed limits influence IL thresholds for several categories. Although speed ranges can be inferred from SCRIM site categories present within the SCRIM summary dataset, this study uses a dedicated speed limit shapefile to increase accuracy, especially in validating the effects of speed on CSC and collision risk.

### 2.2.4. Collision Data

Wiltshire Council collision records were obtained, sourced from police-reported STATS19 data. As skid-related crashes are known to be underreported, all wet-condition collisions were included in the analysis, in line with the approach recommended by Atkins (2020). The time period analysed spans from 2015 to 2023 to ensure statistical reliability across all site types.

### 2.2.5. Traffic Counts

Crash rates were normalised using Annual Average Daily Flow (AADF) data from the Department for Transport (DfT). Where possible, count points were matched spatially to PMS road sections. In cases where data was missing, representative average AADFs were used based on road class. This approach allowed crash rate calculations per 100 million vehicle-kilometres (100MVehkm), consistent with Atkins (2020).

## 2.3. Data Processing

### 2.3.1. SCRIM/SCANNER Data Collation

The initial skeleton of the dataset was formed from the SCRIM 2024 CL1 Dataset indexed by section code and subsection start chainage (Table 2).

*Table 2: SCRIM Data Skeleton*

| Section Location | Section Code | Start Metres | Category Code | Category    | IL   | CSC  |
|------------------|--------------|--------------|---------------|-------------|------|------|
| A27/106 20       | A27/106      | 10           | S2HN          | Single Bend | 0.55 | 0.45 |

CSC values for each year were classified into bands (Table 3). These bands support group-based analysis of collision trends by friction level.

Table 3: CSC Classification Table

| Classified Value | Lower Bound | Upper Bound | Banding  |
|------------------|-------------|-------------|----------|
| 0.225            | 0           | 0.25        | <=0.24   |
| 0.275            | 0.25        | 0.3         | 0.25-0.3 |
| 0.325            | 0.30        | 0.35        | 0.3-0.35 |
| 0.375            | 0.35        | 0.4         | 0.35-0.4 |
| 0.425            | 0.40        | 0.45        | 0.4-0.45 |
| 0.475            | 0.45        | 0.5         | 0.45-0.5 |
| 0.525            | 0.50        | 0.55        | 0.5-0.55 |
| 0.575            | 0.55        | 0.6         | 0.55-0.6 |
| 0.625            | 0.60        | 0.65        | 0.6-0.65 |
| 0.675            | 0.65        | 0.7         | 0.65-0.7 |
| 0.725            | 0.70        | 0.75        | 0.7-0.75 |
| 0.775            | 0.75        | 0.8         | 0.75-0.8 |
| 0.825            | 0.8         | 1           | >=0.8    |

The classified CSC values were combined into the main dataset using the section location index field (Table 4).

Table 4: Sample Processed CSC data

| Section Location | 2015 CSC Class | 2016 CSC Class | 2017 CSC Class | 2018 CSC Class | 2019 CSC Class | 2020 CSC Class | 2021 CSC Class | 2022 CSC Class | 2023 CSC Class |
|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| A27/106 20       | 0.475          | 0.525          | 0.575          | 0.425          | 0.425          | 0.575          | 0.725          | 0.475          | 0.475          |
| A27/106 30       | 0.475          | 0.475          | 0.525          | 0.425          | 0.375          | 0.475          | 0.625          | 0.525          | 0.375          |

### 2.3.2. Alignment Data Processing

A spatial join was undertaken in turn for the scanner Alignment data. Once the Alignment data was joined to the SCRIM survey data the dissolve tool was used to aggregate the minimum radius value for each site category before being spatially joined back to the main dataset.

The absolute value was then banded within the categories of 0-100 m, 100-250 m, 250-500 m and values greater than 500 m (Table 5).

Table 5: Sample Processed Alignment Data

| Section Location | Gradient | Bend Radius | Radius Category | Minimum Bend Radius | Minimum Radius Category | Site Category |
|------------------|----------|-------------|-----------------|---------------------|-------------------------|---------------|
| A27/106 30       | -2.71    | 50.25       | <100m           | 34.84               | <100m                   | S2HN          |

### 2.3.3. Assigning Traffic Counts.

The DfT traffic count points were plotted using spatial coordinates. Count data for each PMS section was selected based on proximity and coverage, prioritising the highest available count. An initial spatial join was carried out to filter for the relevant count points. A manual process was then carried out systematically to work through each section and assign the best available matched count point.

Once the count point was assigned to each section the full AADF history for each section was combined by a look up from the full DfT traffic count dataset. Missing values were backfilled using the earliest available data. Default class averages were used for where data was completely unavailable for a road link.

The count point for each PMS section was then joined to each SCRIM subsection to provide columns with AADF figures for each year within the study period (Table 6).

Table 6: Sample Processed AADF Data

| Section Code | Count point ID | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--------------|----------------|------|------|------|------|------|------|------|------|------|
| A27/106      | 73593          | 7578 | 7764 | 7840 | 8644 | 8660 | 6521 | 7188 | 7763 | 7935 |

### 2.3.4. Collision Data

The STATS 19 collision data was divided by calendar year and plotted via the easting and northing an initial spatial join was undertaken with the collision points as the target to find the nearest SCRIM sub-section with a maximum search distance of 10 m. A further spatial join was then completed using the SCRIM sub-section as the target and the Section Location field as a field matcher to ensure that no collisions were double counted. This joining process was repeated for each year's data in turn to produce the columns in Table 7.

Table 7: Sample Processed Collision data

| Section Location | 2015 Coll | 2016 Coll | 2017 Coll | 2018 Coll | 2019 Coll | 2020 Coll | 2021 Coll | 2022 Coll | 2023 Coll |
|------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| A30/110 880      | 0         | 0         | 0         | 0         | 0         | 1         | 0         | 0         | 0         |

### 2.3.5. Final Compilation

A unified dataset was assembled with each row representing a single year for a specific road segment, incorporating site category, CSC class, AADF, gradient, bend radius, and collision count (Table 8).

Table 8: Compiled Data structure

| Section Location | SCRIM Site Category Columns | Alignment Data Columns | AADF by Year Columns | Collision Count by Year Columns | Classified CSC by Year Columns |
|------------------|-----------------------------|------------------------|----------------------|---------------------------------|--------------------------------|
|                  |                             |                        |                      |                                 |                                |

The dataset was restructured using Excel Power Query to enable pivot analysis and trend visualisation. Traffic exposure was standardised using 100MVehkm units (Table 9).

Table 9: Final Analysis Data Set Sample

| Section Location and Year | Site Category    | Speed Limit | Gradient | Minimum Radius Category | CSC Band | Collision Count | Traffic 100MVe hKm |
|---------------------------|------------------|-------------|----------|-------------------------|----------|-----------------|--------------------|
| B3089/155<br>110 2015     | Single Non-Event | 60          | 2.1      | >500                    | 0.475    | 0               | 0.00015            |

Collision rates for each CSC band were calculated by dividing collisions by traffic exposure, allowing comparison across site types and CSC classes (Table 10). The data was then filtered and grouped by site category and geometry for further analysis.

Table 10: Collision Rate Analysis Table Sample

| CSC Band           | Traffic Volume (100MVehkm) | Collision Count | Collision Rate RTC/100MVehkm | % of Site Category within CSC Band |
|--------------------|----------------------------|-----------------|------------------------------|------------------------------------|
| 0.225              | 0.001151356                | 0               | 0.00                         | 0.01%                              |
| 0.275              | 0.02626832                 | 0               | 0.00                         | 0.44%                              |
| 0.325              | 0.256964928                | 0               | 0.00                         | 5.43%                              |
| 0.375              | 1.003018905                | 0               | 0.00                         | 18.38%                             |
| 0.425              | 1.263819471                | 1               | 0.79                         | 21.08%                             |
| 0.475              | 1.040706615                | 0               | 0.00                         | 24.94%                             |
| 0.525              | 0.700407223                | 0               | 0.00                         | 18.03%                             |
| 0.575              | 0.306170139                | 0               | 0.00                         | 7.60%                              |
| 0.625              | 0.100947247                | 1               | 9.91                         | 2.29%                              |
| 0.675              | 0.046238821                | 0               | 0.00                         | 1.20%                              |
| 0.725              | 0.021723669                | 0               | 0.00                         | 0.48%                              |
| 0.775              | 0.001934646                | 0               | 0.00                         | 0.10%                              |
| <b>Grand Total</b> | <b>4.76935134</b>          | <b>2</b>        | <b>0.42</b>                  | <b>100.00%</b>                     |

## 3. Results

### 3.1. Network Summary

Initial network level analysis was carried out to evaluate the levels of skidding resistance over the study period.

#### 3.1.1. SCRIM Deficiency

Analysis of the overall network condition trend was carried out by examining the percentage of the network at or below the IL over the study date period (Figure 4).

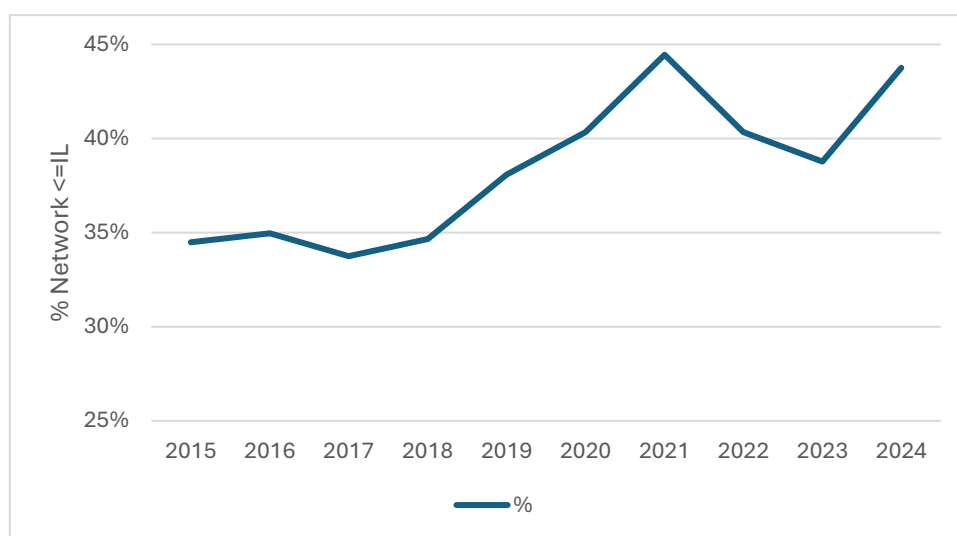


Figure 4: Percentage of Network at or Below IL 2015-2023

The trend across the period is that the percentage of network at or below IL has increased which indicates a decline in the skidding resistance provided by the carriageway surface. The values peaked in 2021 and were followed by a dip before climbing again. The dip coincides with a network-wide review of site categories and ILs. During the review site categories were updated to better reflect the current nature of the carriageway network such as changes in speed limits and additional crossings and junctions. The review also adjusted bend and gradient site categories to align them with SCANNER curvature and gradient data. The trends during this review found that ILs were generally lowered as more appropriate categories were selected.

#### 3.1.2. Collisions and Collision Rates

Collision data extracted from Wiltshire Council's database showed 11,582 collisions between 01/01/2015 and 31/12/2023 of which 3202 were recorded as having occurred in Wet/Damp conditions. (723 recorded with a vehicle skidding in wet). After spatial analysis with the study network 1193 were matched within 10 m to the closest SCRIM summary length. Traffic volume data was combined with the collision data to examine the network-level trend across the study period (Figure 5).



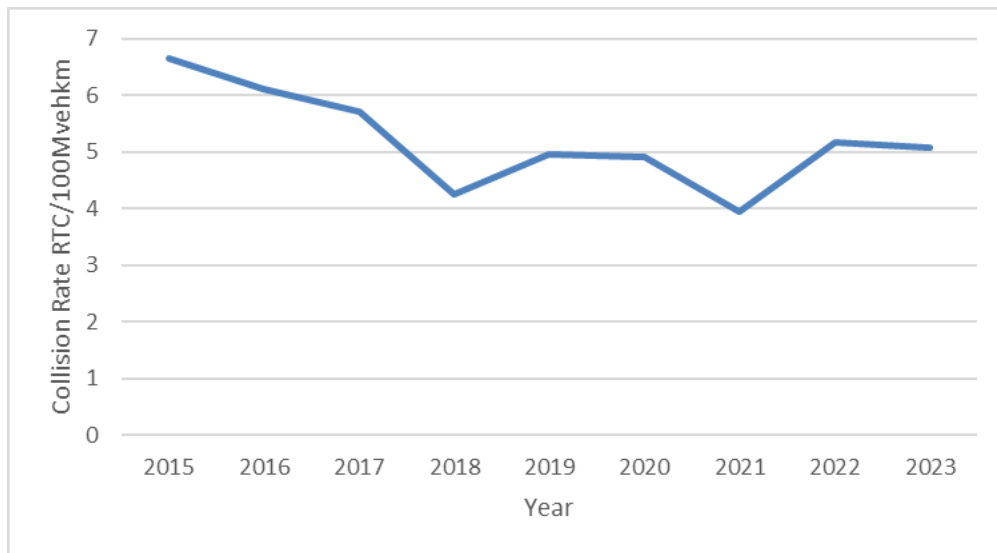


Figure 5: Network Wide Wet Collision Risk over Study Period

The trend seen across the network is that the wet collision rate has remained reasonably constant with a slight decrease over the 9 years of data. This is despite the increase of lengths of carriageway at or below the IL over the same period. Despite a growing proportion of network sections falling below the IL threshold, the absence of a corresponding increase in collision rates suggests that some ILs may be overly cautious. Revising ILs in these areas could prevent premature surface treatments, reducing CO<sub>2</sub> emissions from surfacing operations without compromising road safety.

Using the traffic volume figures calculated for each SCRIM summary length, the collision rate could be calculated. The overall rates for each category are summarised below in Table 11.

Table 11: Network Summary of Collision Rates by Site Category

| Site Category                                  | Traffic<br>100MVehKm | Wet<br>Collision<br>Count | Wet<br>Collision<br>Rate | Site<br>Length<br>KM | Proportion of<br>Network |
|------------------------------------------------|----------------------|---------------------------|--------------------------|----------------------|--------------------------|
| <b>B - Dual Non-Event</b>                      | 4.70                 | 2                         | 0.43                     | 10.94                | 1.12%                    |
| <b>C - Single Non-Event</b>                    | 119.32               | 324                       | 2.72                     | 523.17               | 53.55%                   |
| <b>Q - Approach to<br/>Junction/Roundabout</b> | 28.21                | 375                       | 13.29                    | 132.18               | 13.53%                   |
| <b>K - Approach to<br/>Pedestrian Crossing</b> | 3.42                 | 73                        | 21.32                    | 14.49                | 1.48%                    |
| <b>R - Roundabout</b>                          | 0.98                 | 18                        | 18.45                    | 4.27                 | 0.44%                    |
| <b>G1 - Gradient 5-10%</b>                     | 15.38                | 48                        | 3.12                     | 68.34                | 7.00%                    |
| <b>G2 - Gradient &gt;10%</b>                   | 1.52                 | 8                         | 5.25                     | 7.11                 | 0.73%                    |
| <b>S1 - Dual Bend</b>                          | 0.75                 | 5                         | 6.68                     | 1.78                 | 0.18%                    |
| <b>S2 - Single Bend</b>                        | 43.04                | 266                       | 6.18                     | 214.7                | 21.98%                   |
| <b>Network Total</b>                           | 217.32               | 1119                      | 5.15                     | 976.98               | 100.00%                  |

## 3.2. Collision Rate vs CSC Results by Site Category

The collision rate and csc values have been analysed for each site category in turn to evaluate the IL bandings set for each category.

### 3.2.1. Dual Non-Event

Figure 6 shows the results for dual carriageway non-event categories.

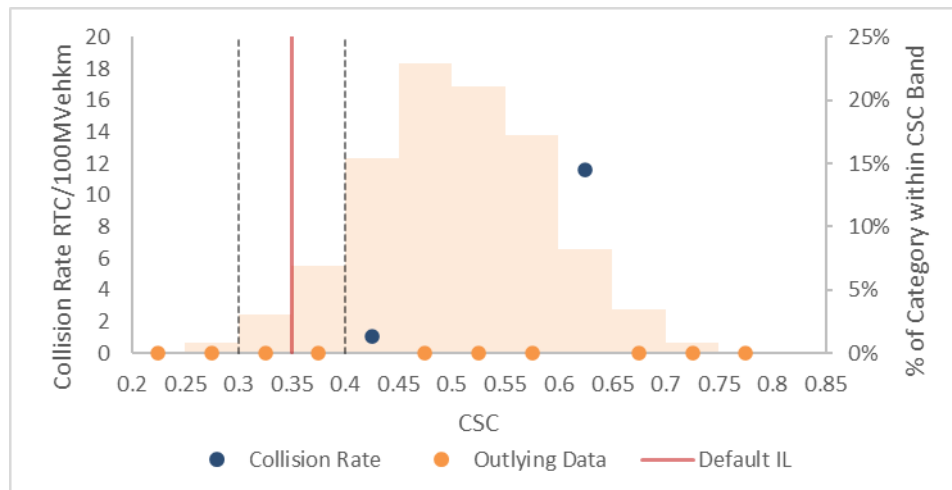


Figure 6: CSC vs Collision Rate Dual Carriageway Non-Event

Only 2 wet collisions were recorded on dual non-event categories during the study period. This does not provide enough data points for any meaningful analysis of IL; however, when considered alongside the network-level summary, the collision risk on dual non-event sections is very low, which suggests that the lowest IL within the band suggested in CS-228 could be used as the default.

### 3.2.2. Single Non-Event

Single carriageway non-event categories are currently split into two categories based on the signed speed limit. Category C is assigned to non-event sections with a speed limit greater than 50 mph. Category C-1 is assigned to those less than or equal to 50 mph. The categories have the same IL range (0.35-0.45) with differing default ILs assigned.

Results for category C are shown in Figure 7 below.

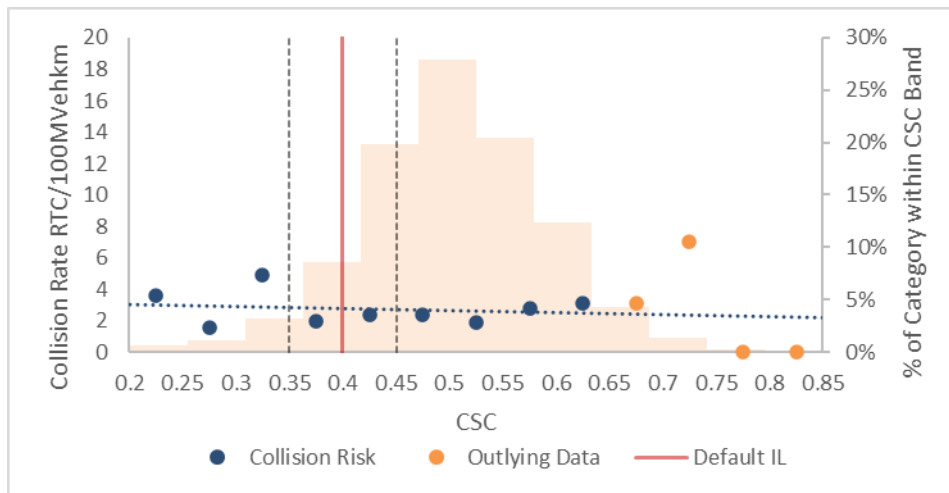


Figure 7: CSC vs Collision Rate Single Carriageway Non-Event >50 mph

Outlying data was removed for sections with a very low proportion of the site category within that CSC band. Some high collision rates were observed at high CSC values of over 0.65. These were removed as outliers. The very weak relationship between CSC and Collision risk at high-speed non-event sites could provide evidence to support reducing the default IL to the lower value of 0.35 within the banding in CS-228.

The results for category C-1 are shown in Figure 8.

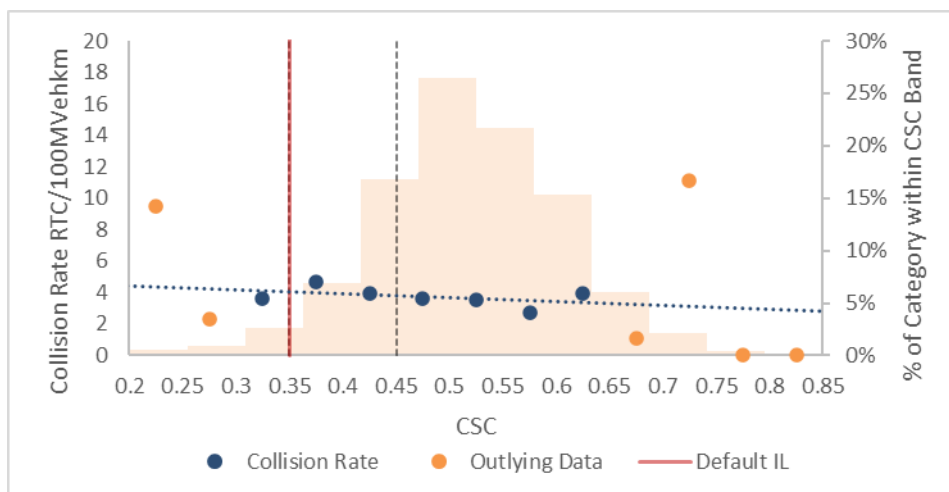


Figure 8: CSC vs Collision Rate Single Carriageway Non-event <=50 mph

After removing outlying data from CSC bands representing very low proportions of the site category Figure 8 shows that for this site category the collision risk increases as the CSC value drops however no point at which the risk begins to spike was identified. This could provide evidence that the current default IL of 0.35 is suitable.

The recommendations were taken to reduce the IL for non-event sections above 50 mph; this would effectively merge the two subcategories into a single non-event category with a default value of 0.35. This value is consistent with the value proposed by Viner et al. (2023) in the LASR approach.

### 3.2.3. Approaches to Junctions & Roundabouts

Approaches to Roundabouts and junctions (Category Q) are assigned ILs within the 0.45-0.55 range. The default IL selected is determined by the speed limit, with 0.45 assigned to those equal to or below 40 mph (Q-1) and 0.5 to those where the speed limit is greater than 40 mph (Q). It should be noted that where the approach to junction also coincides with another site category such as a bend or gradient then the IL will be set to whichever is highest. In practice, this currently leads to Q-1 and Q site categories being assigned an IL 0.05 higher than the default, where additional risk is present from the carriageway geometry.

Figure 10 below shows the results for approaches to junctions where the speed limit is less than 40 mph. 199 Collisions were recorded in the study period for this category.

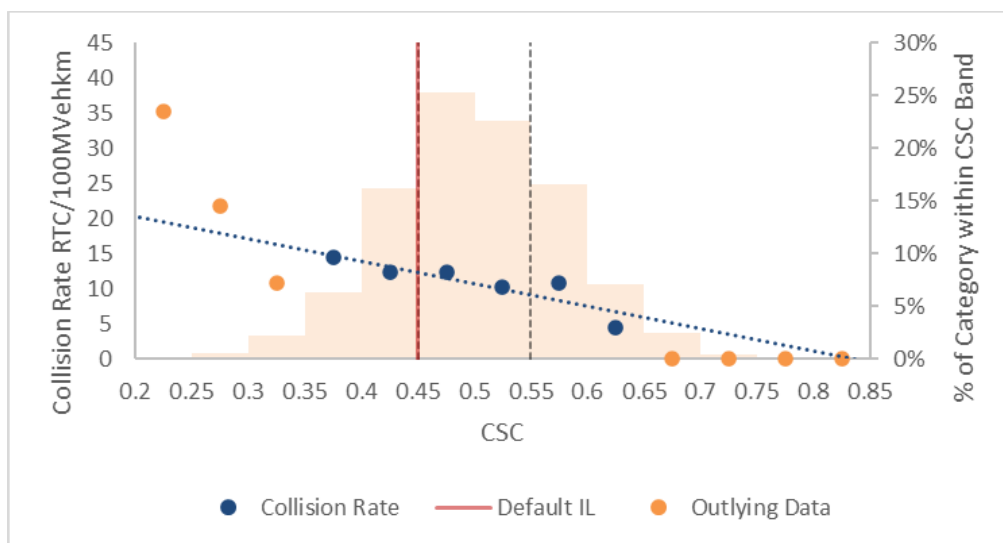


Figure 9: CSC vs Collision Rate - Approach to Junction <=40 mph

Outlying data has been identified below 0.35 as these represented a very small proportion of the site category. Additionally, no collisions were recorded for CSC values above 0.65 so these have been removed from the trendline analysis.

The collision rate appears to increase as CSC reduces from 0.60 to 0.35. The relationship appears quite weak and provides evidence that the default IL at the lower end of the banding is suitable for approaches to junctions at these speeds.

Figure 11 displays results for Approaches to junctions above 40 mph.

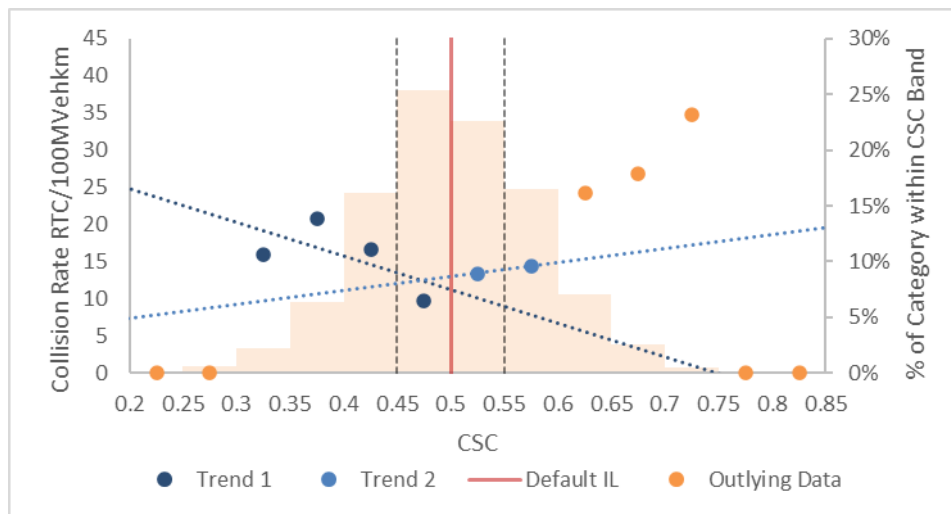


Figure 10: CSC vs Collision Risk - Approach to Junction >40 mph

193 collisions were recorded on this site category during the study window. Data above 0.60 CSC appears to exhibit much higher collision risk than those where the skid resistance is lower. Atkins (2020) suggests that to provide this level of skidding the resistance the surfacing material will very likely be high friction surfacing. They go on to justify removing these outlying values from the trend analysis by theorising that the collision risk at those sites are driven factors other than the skidding resistance such as speed and visibility. As such these values have been removed from the trend line analysis for this study.

Two trends have been assigned to the dataset. The collision risk begins to rise again below 0.50 CSC and as such the recommendation that the current default IL is suitable.

### 3.2.4. Approaches to Pedestrian Crossings

Approaches to pedestrian crossings are also assigned a category and default IL based upon the speed limit of the site. Category K and an IL of 0.55 is assigned to sites with a speed limit greater than 40 mph while Category K-1 and an IL of 0.50 is assigned to those 40 mph or less. Similarly, to approaches to junctions if the site contains other risk factors such as bends or gradients the higher IL is selected. In practice for these categories the IL is only upgraded on category K-1 where there are gradients of greater than 10%.

Figure 11 below shows the results for category K-1.

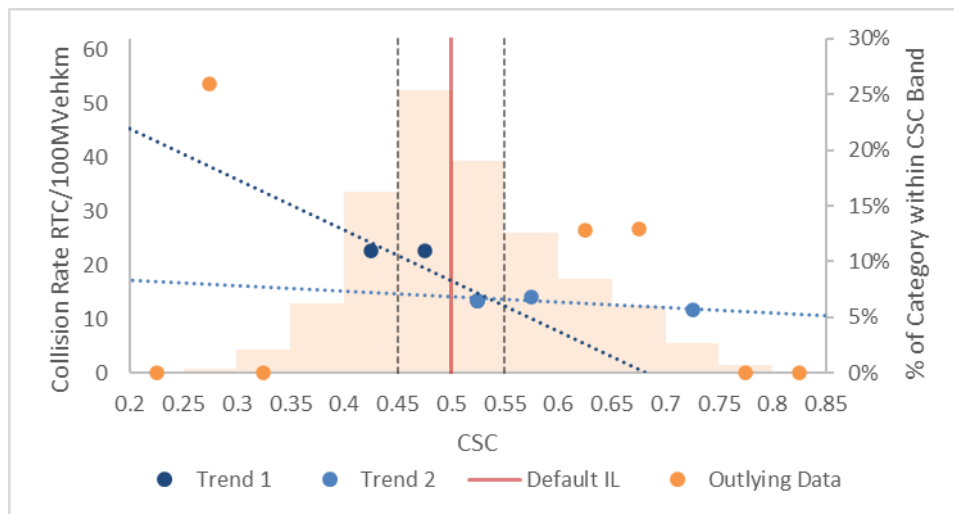


Figure 11: CSC vs Collision Rate - Approach to Pedestrian Crossing <=40 mph

68 collisions were recorded during the study period; however, there is a large degree of variability of the collision risk with CSC. As for category Q there is a higher collision risk exhibited at CSCs above 0.6 and these excessively high values have been discounted from the trend line analysis for the same reasons. The trend line analysis indicates that there is a potential increase in the collision risk as the CSC drops from 0.55 to 0.50. This could be evidence that the default IL could be increase here to better reflect the collision risks.

Only 2 wet collisions were recorded during the study period for approaches to pedestrian crossings above 40 mph. The limited number of data points mean that no meaningful relationship can be shown for this site category.

### 3.2.5. Roundabouts

The roundabout site category is assigned to the circulatory carriageway of roundabouts. The IL range for this category is 0.45-0.50 and a default value of 0.50 is assigned in Wiltshire.

Figure 12 shows the results for this site category.

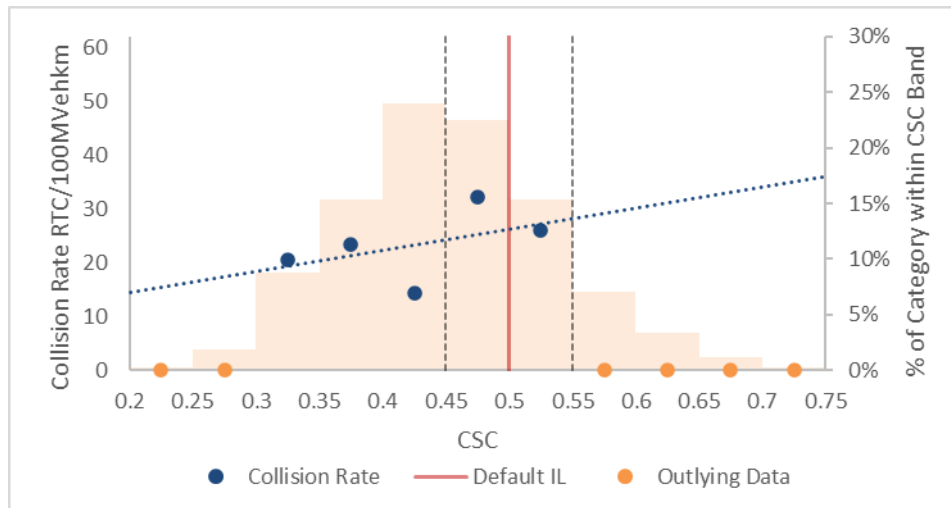


Figure 12: CSC vs Collision Rate – Roundabouts

A relatively low number of 22 wet collisions were assigned to this site category during the study period. The limited number of data points mean that no meaningful relationship can be shown for this site category. The default IL and range should remain at the current values.

### 3.2.6. Gradients

The Gradient site categories are assigned to sites where the gradient falls into the bandings of between 5 and 10% or greater than 10%. Categories G1 and G2 are assigned respectively with a default ILs of 0.50 and 0.55 in Wiltshire. The IL range for these categories is 0.45 to 0.55. Following the national standard (National Highways, 2021), the category is only assigned when the gradient exceeds 5% for 50 m or more

The results for gradients between 5 and 10% are displayed below in Figure 13.

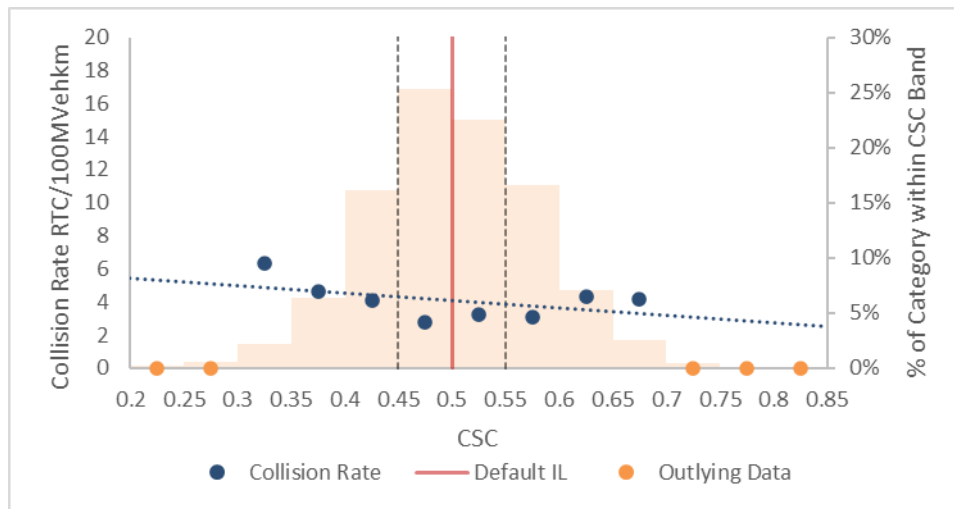


Figure 13: CSC vs Collision Rate - Gradient 5-10%

53 Collisions were attributed to category G1 during the study period. There is a weak relationship between CSC and Collision risk at this site category. However, it should be noted that the changes in collision risk occur over a very narrow banding.

Data for Gradients greater than 10% is shown in figure 14 below.

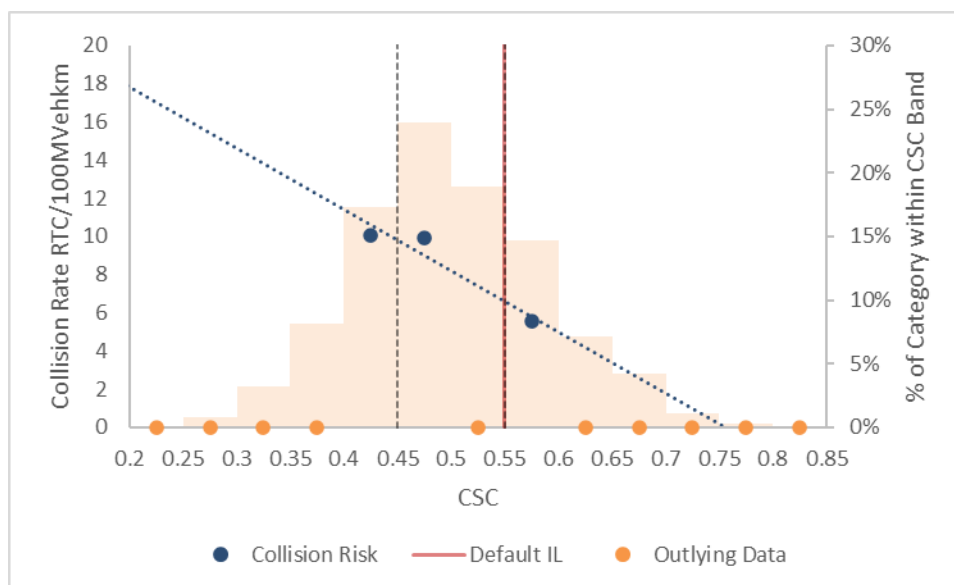


Figure 14: CSC vs Collision Rate - Gradients >10%

A very limited number of data points were available over the study period as only 8 wet collisions were recorded and matched to the G2 category. Further analysis was carried out using the SCANNER gradient data. When extended to include all sub-sections with a gradient of ten percent or more the number of matched collisions only increased to 11.

No meaningful statistical relationship can be determined, and so no direct recommendation can be made regarding the default IL. In the absence of data showing a higher or lower risk the middle band value from CS-228 could be selected for this category.



### 3.2.7. Bends with one-way traffic.

Category S1 Dual carriageway bends with a radius of less than 500 m radius have ILs set within the range of 0.45 to 0.50. Category S1 is split into two sub-categories dependent on the posted speed limit. Category S1-1 is assigned to all sites where the speed limit is less than or equal to 50 mph and are assigned a default IL of 0.45. Sites with higher speed limits are assigned a default IL of 0.50.

Figure 15 below presents the results for category S1-1. Only three collisions were recorded for this category; therefore, no meaningful relationship can be determined, nor can a recommendation for changes to the IL be made.

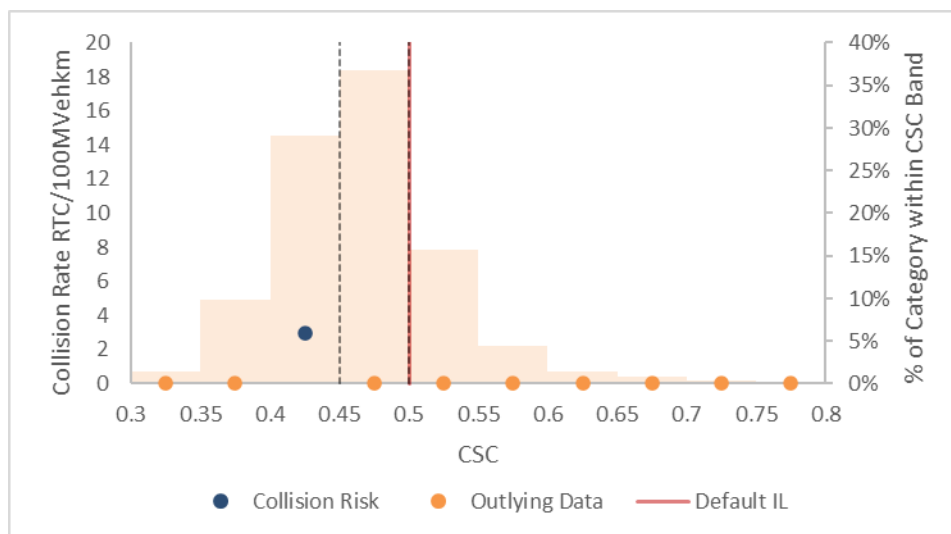


Figure 15: CSC vs Collision Rate - Dual Bends <=50 mph

Figure 16 shows the results for category S1 where the speed limit is greater than 50 mph. Two collisions were recorded over the study period for this category. Not enough data is present to make any recommendations as to the appropriate IL for this category.

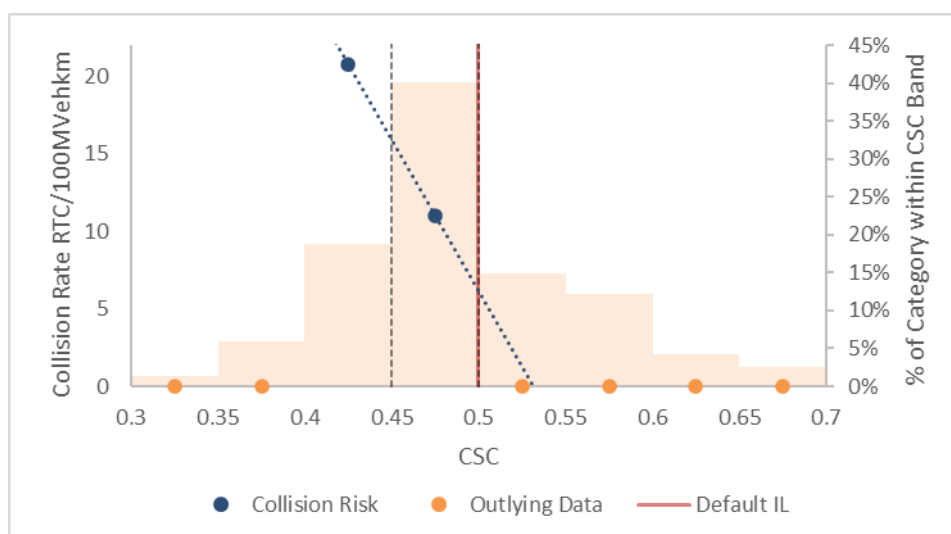


Figure 16: CSC vs Collision Rate - Dual Bends >50 mph

### 3.2.8. Bends with two-way traffic (Existing Categories)

Category S2 covers bends on two-way (single carriageway) roads with a radius under 500 m with ILs set between 0.45 and 0.55. Bends with speed limits up to 50 mph are classified as S2-1 with a default IL of 0.50, while those above 50 mph are assigned a default IL of 0.55. The existing speed limit bandings for this category were analysed to evaluate the current policy ILs.

201 collisions were recorded on the lower-speed S2-1 bends during the survey period, and the collision rates have been split into two trends (Figure 17).

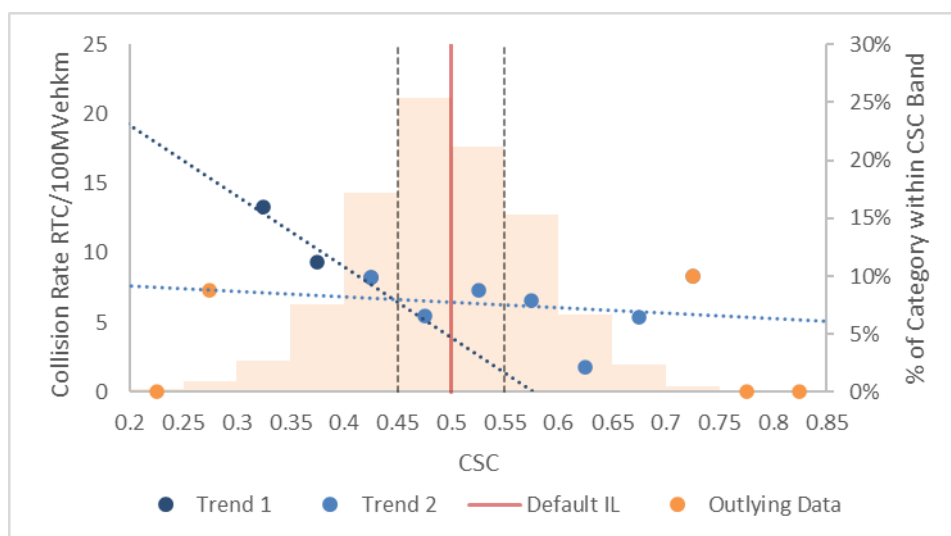


Figure 17: CSC vs Collision Rate - Single Carriageway Bends <=50 mph (All Radii)

The data suggests that the default IL could be lowered to 0.45 as below this the collision risk begins to rise more sharply.

Category S2 bends saw 92 collisions recorded at this site category during the study period. The data has been split into two trends (Figure 18), which shows a similar pattern to the lower speed S2-1 bends.

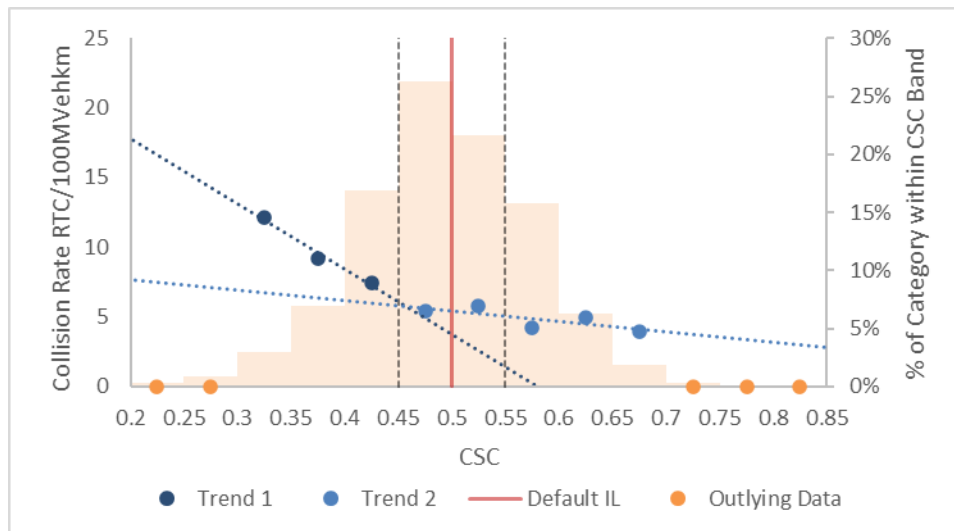


Figure 18: CSC vs Collision Rate - Single Carriageway Bends >50 mph

Collision risk appears to rise slowly as CSC drops from 0.65 to 0.5 before rising quicker at values below 0.5. The evidence supports reducing the default IL of these high-speed bends to 0.5.

### 3.2.9. Bends with two-way traffic (By Radius)

Further analysis has been carried out to examine the relationship between bend radius, CSC and collision risk. Current bends are classified as any sites with a radius of curvature below 500 m. The bend radius has been classified into three groups: 0-100 m, 100-250 m, and 250-500 m, based on the minimum radius recorded for each site.

Figure 19 shows results for bends where the radius is less than 100 m and has been split into two distinct trends.

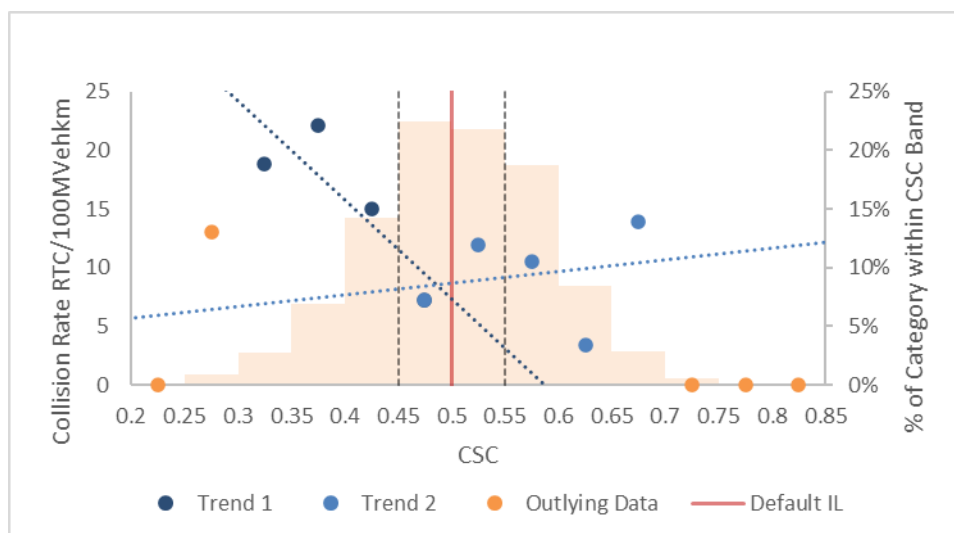


Figure 19: CSC vs Collision Rate - Single Carriageway Bends (0-100 m Radius)

108 collisions were recorded at bends with this radius. The collision risk trends are similar to the trends shown for the existing bend categories, with collision rates relatively constant until falling below 0.5 CSC.

Figure 20 shows results for the banding of bends between 100 and 250 m radius. The data has been split into two trends.

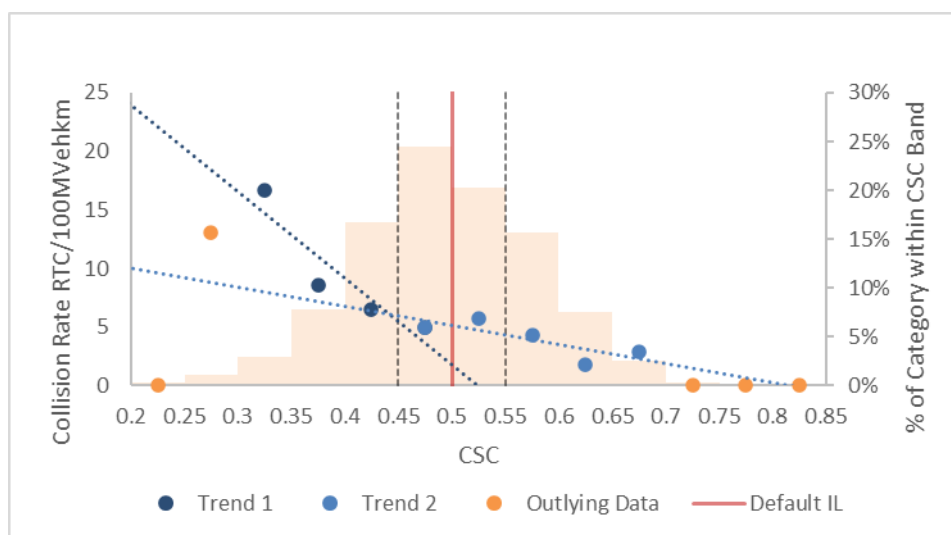


Figure 20: CSC vs Collision Rate - Single Carriageway Bends (100-250 m Radius)

106 collisions were recorded at this category during the study period. The collision rates increase slowly as CSC drops to 0.45 before they begin to increase more quickly.

Results for bends between 250 and 500 m are displayed in Figure 21.

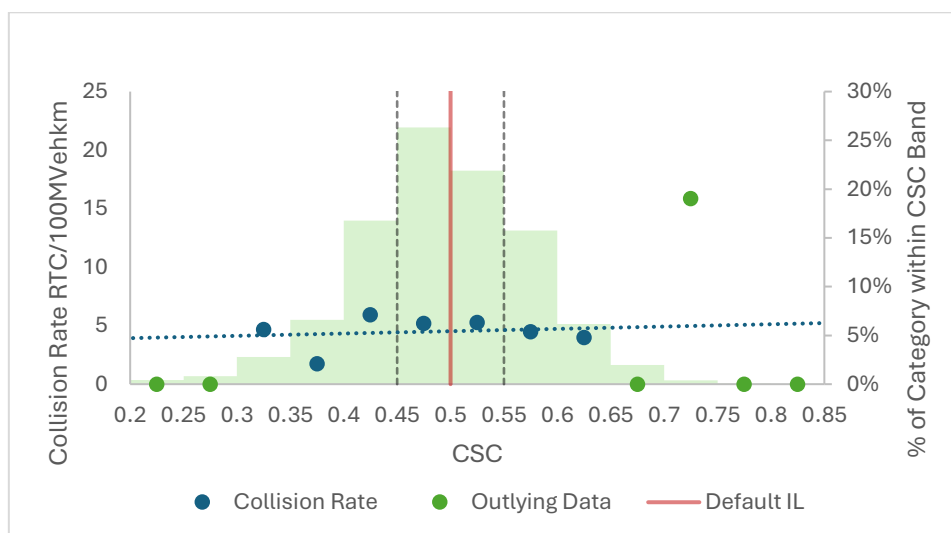


Figure 21: CSC vs Collision Rate - Single Carriageway Bends (>250 m Radius)

79 collisions were recorded on bends within this range. The analysis shows a weak relationship between CSC and collision rates. There is strong evidence here to reclassify all bends above 250 m radius as non-event sections.

The analysis was repeated but with bends greater than 250 m in radius further broken down by the existing speed limit thresholds to understand if the relationship holds for both sub-categories.

The results (Figures 22 and 23) show a weak relationship between CSC and collision risk, which further supports a reduction in the classifying radius to 250 m for all bends.

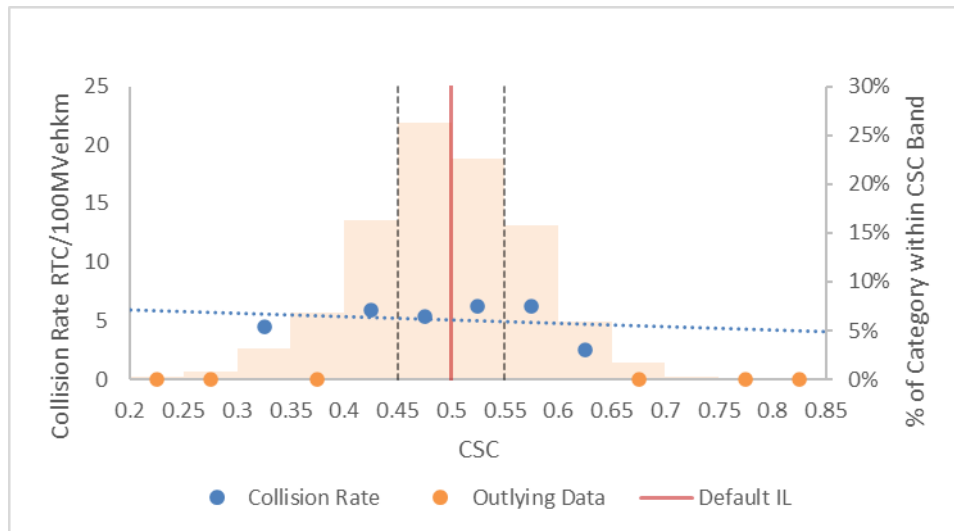


Figure 22: CSC vs Collision Risk - Single Carriageway Bends <=50 mph (250-500 m Radius)

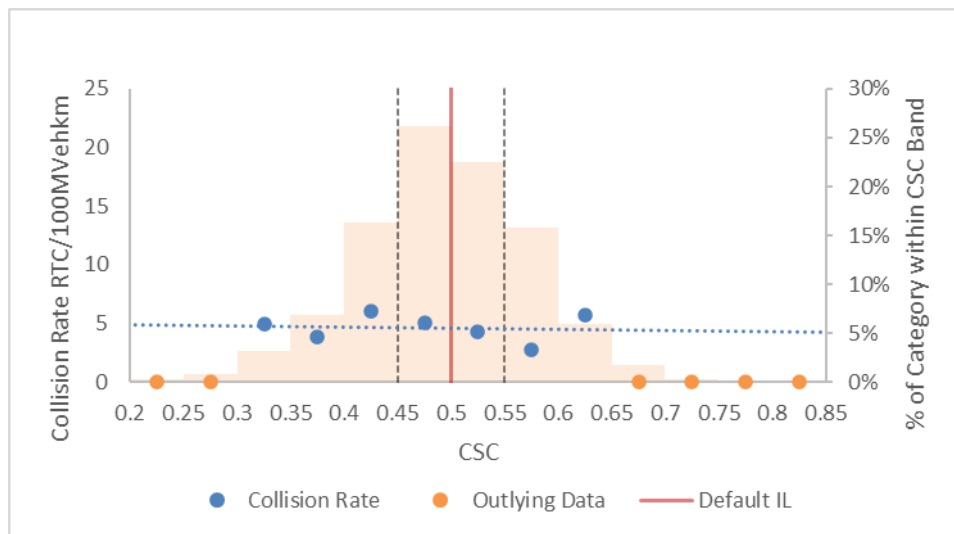


Figure 23: CSC vs collision Risk - Single Carriageway Bends >50 mph (250-500 m Radius)

### 3.2.10. Bends with two-way traffic (Low speed)

Further consideration was given to the relationship between speed limit, bend radius, CSC and collision risk with the view of possible relaxations of the qualifying bend radius at low speeds. Current practice in Wiltshire does not differentiate the radius which qualifies a section as a bend by speed limit. This is in conflict with guidance in CS228 (National Highways, 2021) which states that bend categories shall be applied to all

bends where the radius of curvature is <100 m and to all bends where the radius is between 100 m and 500 m where the speed limits is  $\geq 50$  mph.

Figure 24 shows results for single carriageway bends at sites where the speed limit is less than or equal 30 mph in addition to having a minimum radius of greater than 100 m.

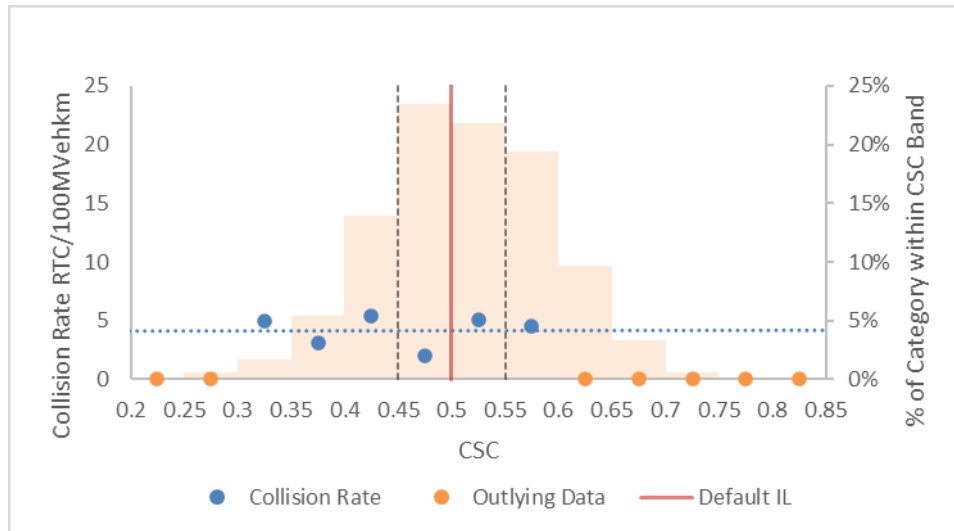


Figure 24: CSC vs Collision Risk - Single Carriageway Bends  $\leq 30$  mph ( $>100$  m Radius)

While only 24 collisions were recorded over the time period at these sites the collision risk appears to have a weak relationship with CSC indicating that these sites could be reclassified as non-event. This approach has been adopted in other local authority skid resistance strategies (Warwickshire County Council, 2018).

Taking this approach further, Figure 25 shows results for bends with a radius greater than 100 m where the speed limit is 40 mph or less.

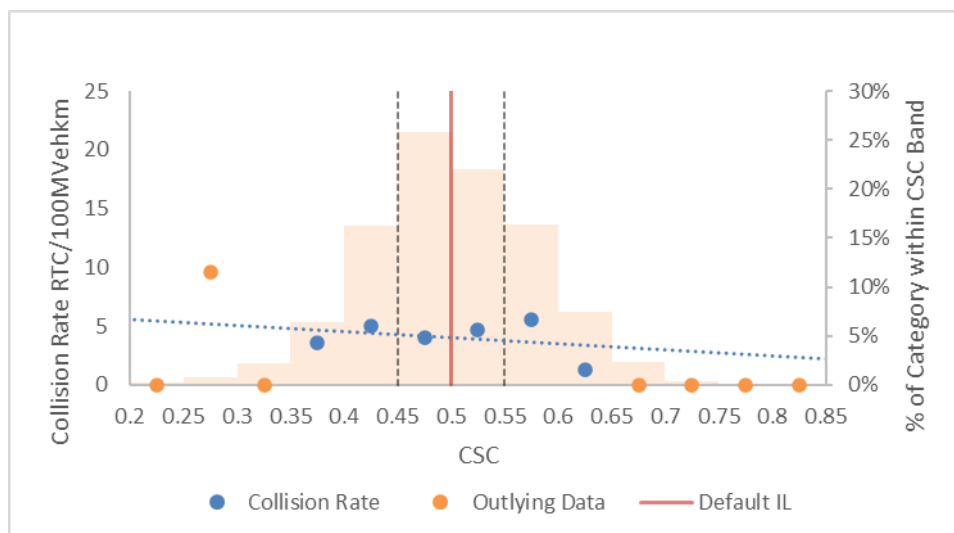


Figure 25: CSC vs Collision Risk - Single Carriageway Bends  $\leq 40$  mph ( $>100$  m Radius)

These sites recorded 51 collisions and also presented a weak relationship between CSC and collision risk. This provides further evidence that bends with a minimum radius greater than 100 m could be classified as non-event sections.

Figure 26 below shows the data for bends between 100 and 250 m radius at 40 mph or less. The weak trend of collision risk with reducing CSC holds for this range of radii too.

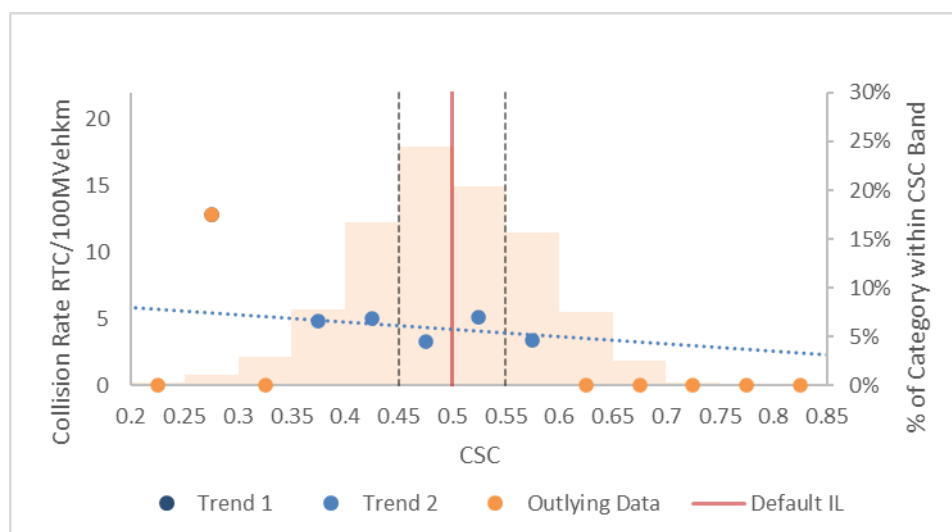


Figure 26: CSC vs Collision Risk - Single Carriageway Bends <=40 mph (100-250 m Radius)

Figure 27 shows the results for those bends below 100 m radius where the speed limit is 40 mph or less. The results have been split into two trends.

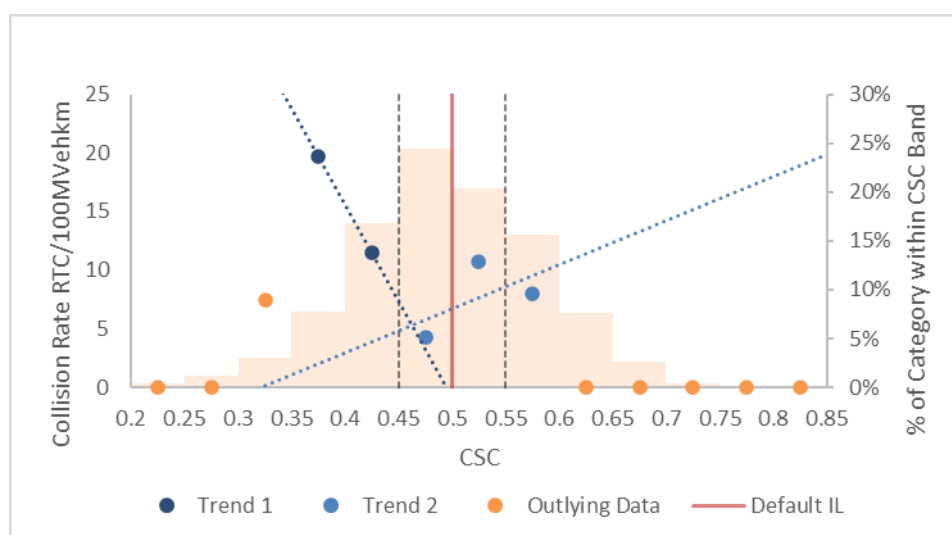


Figure 27: CSC vs Collision Risk - Single Carriageway Bends <=40 mph (<100 m Radius)

45 collisions were recorded at these sites. The collision rate appears to decrease as CSC drops from 0.6 to 0.45 before increasing sharply. The crossover point of the two trends appears to be between 0.45 and 0.5. As such, the proposed default IL for these sites would remain at 0.5. These results are consistent with the recommendations given in current guidance for assigning bend categories (National Highways, 2021).

## 4. Recommendations and Conclusions

### 4.1. Site Category and IL recommendations

The analysis has provided evidence for the change of IL for some site categories in addition to amendments to the qualifying criteria for assigning site categories to the network. The recommendations are compiled below in Table 12 which shows proposed amendments of the current Wiltshire site category and IL table.

Table 12: Recommended Site Categories and ILs

| Site Category and definition                                                                         | Investigatory level at 50 km/h |              |              |      |              |      |
|------------------------------------------------------------------------------------------------------|--------------------------------|--------------|--------------|------|--------------|------|
|                                                                                                      | 0.30                           | 0.35         | 0.40         | 0.45 | 0.50         | 0.55 |
| B Non-Event Carriageway with one-way traffic                                                         | X                              | X<br>>50 mph |              |      |              |      |
| C Non-Event Carriageway with two- way traffic                                                        |                                | X            | X<br>>50 mph |      |              |      |
| Q1 Approaches to and across minor and major junctions, Approaches to roundabouts >40 mph             |                                |              |              |      | X            |      |
| Q2 Approaches to and across minor and major junctions, Approaches to roundabouts <=40 mph            |                                |              |              | X    |              |      |
| K1 Approaches to pedestrian crossings pedestrian crossings and other high-risk situations. >40 mph   |                                |              |              |      |              | X    |
| K2 Approaches to pedestrian crossings pedestrian crossings and other high-risk situations. <=40 mph  |                                |              |              |      | X            |      |
| R Roundabout                                                                                         |                                |              |              |      | X            |      |
| G1 Gradient 5-10% longer than 50 m                                                                   |                                |              |              | X    | X            |      |
| G2 Gradient >=10% longer than 50 m                                                                   |                                |              |              |      | X            | X    |
| S1 Bend with one way traffic <=250 m radius 1                                                        |                                |              |              | X    | X<br>>50 mph |      |
| S2 Bend with two-way traffic <=250 m radius >40 mph 2                                                |                                |              |              |      | X            |      |
| S3 Bend with two-way traffic <=100 m Radius <=40 mph 3                                               |                                |              |              |      | X            |      |
| X - Default IL recommended for Wiltshire                                                             | Range of ILs in CS-228         |              |              |      |              |      |
| X – Current Wiltshire Policy Default IL                                                              |                                |              |              |      |              |      |
| 1 – Reduction of bend radius from 500 m to 250 m                                                     |                                |              |              |      |              |      |
| 2 – Reduction of bend radius from 500 m to 250 m for sites where speed limit is greater than 40 mph. |                                |              |              |      |              |      |
| 3 – Reduction of bend radius from 500 m to 100 m where speeds are less than or equal to 40 mph.      |                                |              |              |      |              |      |



Alongside the changes to bend site categories detailed in Table 11, the proposed changes would see a 0.05 reduction in IL for high-speed non-event sections by the removal of the higher speed limit category and setting of the default IL at the existing lower banding value. Additionally, approaches to Junctions, Pedestrian crossings and Roundabouts as well as the circulatory carriageway of roundabouts will keep the current ILs. Finally, gradient categories would see a 0.05 reduction in IL for each of the two bandings.

## 4.2. Sustainability Implications

Refining ILs to target only high-risk sites reduces unnecessary resurfacing, cutting emissions from bitumen use, vehicle fuel, and material transport. This approach supports Wiltshire Council's contribution to Net Zero goals by aligning safety interventions with environmental sustainability.

## 4.3. Limitations

Some key limitations were identified. Traffic count data was vital to the analysis of collision risk to accurately model the risk for each site. The data used from the DfT had large gaps particularly for the minor road network. Where data was present, it is acknowledged that the data set is often based upon estimated values as well instead of actual count figures. Improving the robustness of this dataset for future analysis would require investment from local authorities in commissioning traffic counts.

Some site categories made up such a small proportion of the network or had very low numbers of wet collisions recorded, which made the statistical analysis of the collision risk difficult.

Roundabout collisions appeared to be under-represented based on the numbers matched for analysis. This prompted a review of the data set to examine possible causes. Viewing the data in ArcGIS (Figure 28) revealed that for some roundabouts, some subsections were missing from the 2024 SCRIM dataset that formed the skeleton of the analysis database.



Figure 28: Example gaps in Roundabout survey data - ArcGIS

From this image, some collisions have been missed from analysis. Due to the nature of how SCRIM measures skidding resistance readings are not valid if recorded below 25 kph, and as the surveys are undertaken on a live carriageway, maintaining this speed is not always practicable or safe, especially at junctions, or in this case, roundabouts.

Further analysis could be carried out by using longer CSC averaging lengths to cover the gaps in the data. Alternatively, a roundabout-focused study could be undertaken using a full network dataset as the initial data skeleton to minimise gaps, in addition to a manual collision review to ensure the collision risk is appropriately estimated.

#### 4.4. Conclusion

Over the ten-year study period, the proportion of Wiltshire's network at or below the IL has increased, indicating a decline in carriageway skidding resistance. However, the collision rate has remained relatively stable, if not slightly decreasing.

This analysis of the long-term relationship between collision rates and skidding resistance provides evidence that current ILs may overemphasize the role of surface friction in collision risk for certain site categories on the Wiltshire Road network.

Based on these findings and by comparing with national guidance and contemporary research, data-driven recommendations have been made to adjust the default ILs and refine the classification criteria for bend site categories, ensuring they better reflect the actual contribution of skid resistance to collision risk. With these improvements, investigations and interventions can be more effectively targeted at high-risk locations, where enhancements to skid resistance will offer the greatest safety benefits.

In addition to improving road safety outcomes, this data-driven approach can contribute to Wiltshire Council's environmental goals. By aligning maintenance interventions more closely with actual risk, carbon emissions associated with road treatments can be meaningfully reduced, advancing both road safety and sustainability agendas.

## 5. References

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