

## **Guidance for undertaking skid resistance site investigations in London**

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### **ABSTRACT**

In 2009, W.D.M. Limited developed a Policy Document and a Guidance Document for Implementing a Skid Resistance Policy for London. This was reported at the 3<sup>rd</sup> International Road Surface Friction Conference in 2011. Skid resistance surveys in London are undertaken using the Sideway-force Coefficient Routine Investigation Machine (SCRIM<sup>®</sup>).

Based on the guidelines specified in the strategy, annual Prioritised Site Listings for each of the 33 boroughs have been provided from 2009 to 2012. In simple terms, the Prioritised Site Listing provides a long list of 'sites' of the SCRIM Survey Network, that can be prioritised based on various factors related to accident risk. The key factors include SCRIM Difference that is based on the Investigatory Level (IL) assigned to the Site Category and the CSC (Characteristic SCRIM Coefficient), number of wet and dry accidents, number of Killed and Seriously Injured (KSI) accidents, and traffic flow.

It had been observed that there is no single method to undertake investigations, and a need was identified to develop guidance that can be applied during both the preliminary desktop investigations and secondary site investigations. The paper will outline the development of a guidance and a training manual for engineers undertaking investigations including:

- Use of the prioritised listing to identify sites for further investigation
- Interpreting accident records
- Carrying out secondary site investigations
- Recommendations

It will consider how the training manual can be used to demonstrate competence in undertaking investigations, and how the records can be used to justify investment, and to defend claims.

## 1. INTRODUCTION

In 2009, W.D.M. Limited developed a Policy Document and a Guidance Document for Implementing a Skid Resistance Strategy for London. London is the capital city of the United Kingdom, and it comprises of 32 boroughs and City of London (33 separate local government districts) covering an area of approximately 1570km<sup>2</sup>. Figure 1 illustrates the locality of these authorities within the greater London area. Typically the boroughs have around 50-100 lane Km of principal roads. In addition, Transport for London (TfL) are responsible for a further network of 1100 lane.km of principal roads in greater London.



Figure 1 – Location of London Boroughs

The skid resistance strategy is developed for the skid resistance survey network. Skid resistance in London is surveyed using the Sideway-force Coefficient Routine Investigation Machine (SCRIM<sup>®</sup>). SCRIM is a registered trademark of W.D.M. Limited.

Based on the guidelines specified in the strategy, W.D.M. Limited developed and supplied annual Prioritised Site Listings (previously referred to as Deficiency Listings) from 2009 to all 33 London boroughs. The principle behind the prioritisation methodology was reported to the 2011 safer Roads conference<sup>1</sup>.

<sup>1</sup> Implementing a skidding policy in London. Safer Roads conference 2011. Sachs, Kennedy and Stephenson.

In simple terms, the Prioritised Site Listing provides a long list of 'sites' of the SCRIM Survey Network, that are prioritised based on various factors related to accident risk. The key factors include SCRIM Difference, number and severity of wet and dry accidents and traffic flow. The SCRIM Difference is the Characteristic SCRIM Coefficient (CSC) minus the SCRIM Investigatory Level (IL)).

In order for each borough to implement the London-wide skid policy, the prioritised site listing is used as a key input into determining the resources required to undertake investigations into 'high risk' sites. In 2008/09 London Technical Advisers Group (LoTAG) successfully bid for £1m of Department of Transport funding to implement Highway Asset Management. This was supplemented by some additional matched funding to around £3.5m over 4 years. A separate steering group; the LoTAG Asset Management Board (LoTAMB) was formed to consider bids for funding. A successful bid was submitted that secured the funding required to progress the implementation of the skid resistance strategy in London.

Through working on the LoTAMB project with a number of boroughs it became apparent that a number of Borough Engineers did not feel confident in undertaking investigations and were seeking guidance. The Highways Agency skid resistance standard HD28/04<sup>2</sup> includes the recommendation that 'Site investigations shall be carried out in a prioritised order, by personnel experienced in Pavement Engineering.' Due to the comparatively small size of each borough it was considered that most boroughs may not be able to demonstrate that any of their staff met this requirement. Rather than allow each borough to develop their own guidelines, the LoTAMB skid resistance project board commissioned W.D.M. Limited to assist in developing a simple manual for use by those charged with undertaking desktop and site investigations, thus providing a trail of decisions made for audit purposes.

The key objectives of the commission were to:

- Provide a better understanding of the prioritised site listing
- Establish criteria to be applied in determining which sites are to be investigated
- Provide guidance on undertaking preliminary and secondary investigations
- Provide guidance on prioritising sites for treatments
- Provide advice and guidance on record keeping

The 33 London Boroughs operate under different political, financial and technical environments, and therefore any guidance cannot be prescriptive, but must be sufficiently detailed to allow the Borough Engineers to apply the principles. Maintenance of the Principal Road Network within all boroughs is typically funded through a bid process administered by TfL; with each borough being allocated funding for named schemes. In addition a 'neighbourhood and corridor' funding package is available for safety improvements and other interventions.

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<sup>2</sup> HD28/04 Skid Resistance, Section 3, Volume 7, Design Manual for Roads and Bridges, Department for Transport, UK

## **2. THE PRIORITISED SITE LISTING**

The objective of the London-wide skid resistance policy is to contribute to the London Mayor's Transport Strategy Objective of reducing the number of road casualties. SCRIM IL's were established following a network level review of accident and SCRIM data in 2008/09. Using these IL's the reported deficiency in London has been between 40-50% since 2009. The London skid project board was therefore looking at a methodology to prioritise sites based on skid resistance and accident details. Two separate methodologies were developed using the number of accidents, their severity, and the level of skid resistance.

London Borough of Hammersmith and Fulham acts as the 'lead' borough for the management of road condition surveys including SCRIM surveys. The data is managed on a London Pavement Management System (PMS); however the individual boroughs have their own 'in-house' systems and therefore transferring data between systems can be problematic. The Prioritised Site Listings are therefore delivered in spreadsheet form, with maps, and GIS layers to enable the sites to be accurately located.

The Prioritised Site Listing contains the summary for each borough, and the following data for each SCRIM summary length.

### **2.1.1 SCRIM Details**

The SCRIM survey data for each reporting length (average values at nominally 100m or shorter lengths) including:

- Survey date
- Site category
- IL
- SCRIM coefficient
- SCRIM difference

### **2.1.2 Accident Details**

The 3-year accident history and their details are obtained from the STATS19 data. STATS19 is the official form used by the police to record road accidents. Accidents that have occurred within individual sites are summarised as follows.

- Number of accidents occurred in wet surface conditions
- Number of accidents occurred in dry surface conditions
- Number of fatal accidents
- Number of serious injury accidents
- Number of slight injury accidents

The accident fitting methodology is beyond the scope of this paper, but relies upon the OS grid reference and road name/number provided by the police in STATS19.

### **2.1.3 Site Prioritisation**

Two separate methodologies are run; the first providing a rank, and the second providing an overall score.

1. **Priority Rank (Priority 1 to 5)** – this considers two factors: level of SCRIM Difference and the number of wet accidents in the past three years.
2. **Pan-London Priority Score (maximum score 105)** – this considers weighted scores for five factors: level of SCRIM Difference, number of wet accidents and the number of dry accidents in the past three years, accident severity, and traffic flow.

Details of site prioritisation are defined in reports that accompany the listings.

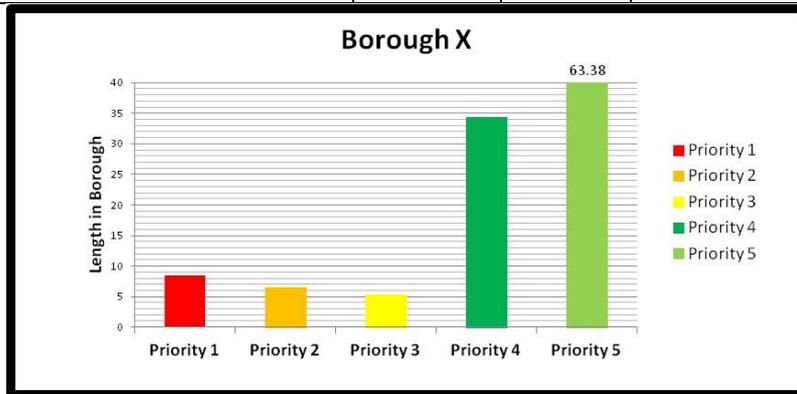
## **3. DETERMINING WHICH SITES REQUIRE INVESTIGATION**

Each Borough needs to make a decision on what prioritisation method to use and the criteria (both methods have their own merits; therefore, the choice would be based on the specific authority's local requirements (reflective of the Asset Management Plan and the long-term strategy).

Once the prioritisation method has been selected, a threshold level would need to be selected above which all sites would undergo the Preliminary Investigation. Therefore, consideration also needs to be given to the availability of resources to undertake an achievable amount of investigations. This will vary depending on the network length in each borough, the nature and types of sites, and the overall skid resistance of the network.

Figure 2 provides typical details for a Borough Council using both methodologies. Using the 'Priority Ranking', it can be seen that 37% of the network is below IL; however only 5% falls into Priority 1. Using the 'Pan-London Priority Score', 19% of the length falls into Band 1 (scores above 30).

Priority Rank	Description	Number of Sites in Borough		Length in Borough	
		#	%	Length (km)	%
Priority 1	At least 1 wet collision and MSSC<=IL	72	4.8%	8.466	7.2%
Priority 2	No wet collisions and MSSC<=IL-0.1	83	5.5%	6.549	5.5%
Priority 3	At least 1 wet collision and MSSC is >IL and <=IL+0.05	46	3.1%	5.252	4.4%
Priority 4	No wet collisions and MSSC is <=IL and >IL-0.1	412	27.3%	34.425	29.2%
Priority 5	Non-Priority	894	59.3%	63.38	53.7%
<b>Total</b>		<b>1507</b>	<b>100.0%</b>	<b>118.072</b>	<b>100.0%</b>



Pan-London Priority Score	Length in Borough	
	Length (km)	%
Band 1 (30+)	22.559	19.1%
Band 2 (20-30)	18.514	15.7%
Band 3 (10-20)	26.832	22.7%
Band 4 (0-10)	50.167	42.5%
<b>Total</b>	<b>118.072</b>	<b>100.0%</b>

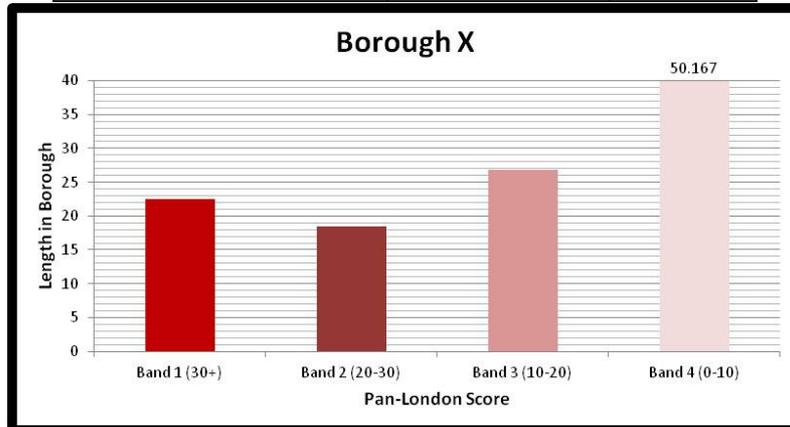


Figure 2 – Prioritisation outputs of a typical Borough

## **4. INVESTIGATIONS**

Road Conditions in England 2012<sup>3</sup> indicated that 5% of motorways and 13% of trunk roads required investigation; whereas 36% of London principal roads required investigation.

HD28/04 was developed for Motorways and Trunk Roads with a very different SCRIM profile to the London boroughs, and it requires all sites to be investigated, which is undertaken by the Highways Agency Managing Agents. It is not considered that this is a realistic standard for London given the limited resources available to the individual boroughs. As a consequence a 2-stage investigation process has been developed, following the identification of sites using the prioritisation tools.

### **4.1 PRELIMINARY INVESTIGATION**

The Preliminary Investigation is undertaken at desktop level on all sites that meet the Criteria to Undertake Site Investigations. It is carried out to validate individual sites before performing a Secondary Investigation. The Secondary Investigation includes a site inspection, which is a more time consuming task; therefore, it is important to ensure the selected sites do warrant a site visit.

The Preliminary Investigations should be carried out by persons that are competent to undertake this role. It is suggested that staff roles are reviewed on an annual basis, and training provided if required.

#### **4.1.1 Preliminary Investigation Methodology**

If the various data sources are available, the following items can be checked at the desktop level during the Preliminary Investigation.

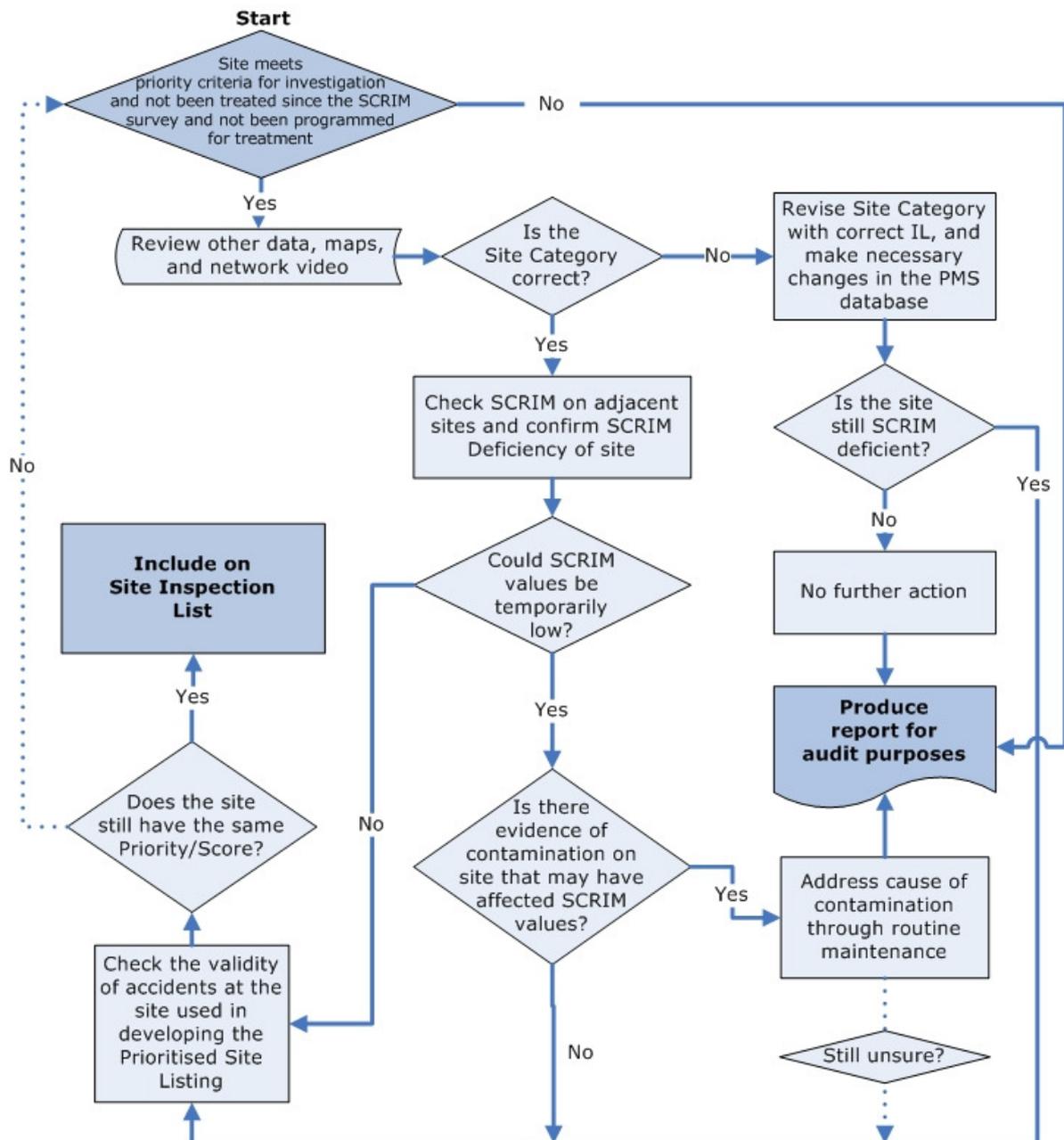
- Check whether the site has been already programmed for treatment or that a treatment has been applied since the SCRIM survey
- Review other proposed works at or adjacent to the site
- Ensure the site uses the correct Site Category
- Ensure the site uses the correct IL
- Determine whether the low SCRIM may be due to temporary road surface conditions

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<sup>3</sup> Road Conditions in England 2012, Statistical Release, Department for Transport, February 2013.

- Check the validity of accidents (to this investigation) by checking accident records
- Reassess site priority if any of the above needs adjustment

A generic process flow chart shown in Figure 3 can be used in this process.



**Figure 3 – Flow Chart for Preliminary Investigation**

Accident data is bulk uploaded into the PMS before it can be used in developing the site listings. The accuracy of the location of accidents depends on the information captured in the STATS19 form. In cases where there is insufficient information (for example, only an approximate distance from a junction or approximate grid reference is provided) the accident fitting software uses certain assumptions to fit them into the network. Therefore the accuracy of accident location depends on the accident fitting software used, and the settings used at the time of bulk loading and fitting process.

In some cases the accident description may assist in determining the exact location of accidents; however the quality of these descriptions can be variable, and undertaking this for the entire network would be a very time consuming task.

From the experience of reviewing a number of skid resistance policies around the UK, W.D.M. Limited has found that Maintenance Engineers can often misinterpret accident reports. Maintenance Engineers not experienced in dealing with accident data can often focus on the reporting of 'skidding' rather than looking at whether the surface condition may have contributed to the accidents (e.g. loss of control, failed to stop, etc.).

When preparing the Prioritised Site Listings for London Boroughs, all of the accidents that occurred in the SCRIM Survey Network in the past three years are considered. It is a very time consuming task to undertake detailed accident validation to identify accidents that are not related to road surface condition. Therefore, at the Preliminary Investigation stage, it is necessary to examine accidents in detail so that accidents that are invalid to this investigation could be ruled out. The checklist shown in Figure 4 has been developed to assist in this process in London.

In this process, accident validation starts with the assumption that all accidents that occurred at the site in the past three years in wet/damp conditions are relevant to the investigation. Then, by examining the accidents individually, accidents that 'clearly' are invalid for this investigation are omitted.

The 'clearly' invalid accidents may be identified by examining individual accident records in fields such as Accident Description and Contributory Factors.

Based on Figure 4, some examples of clearly 'invalid' accidents are listed below, but are not limited to these.

- Falls/Slips inside or when getting in and out of busses and other vehicles
- Reversing into objects (stationary vehicles, pedestrians, or other roadside objects)
- Accident involving only pedestrians without the involvement of a vehicle
- Accidents occurred outside the carriageway (i.e. on driveways, car parks, etc.)
- Accidents due to vehicles trying to evade the police

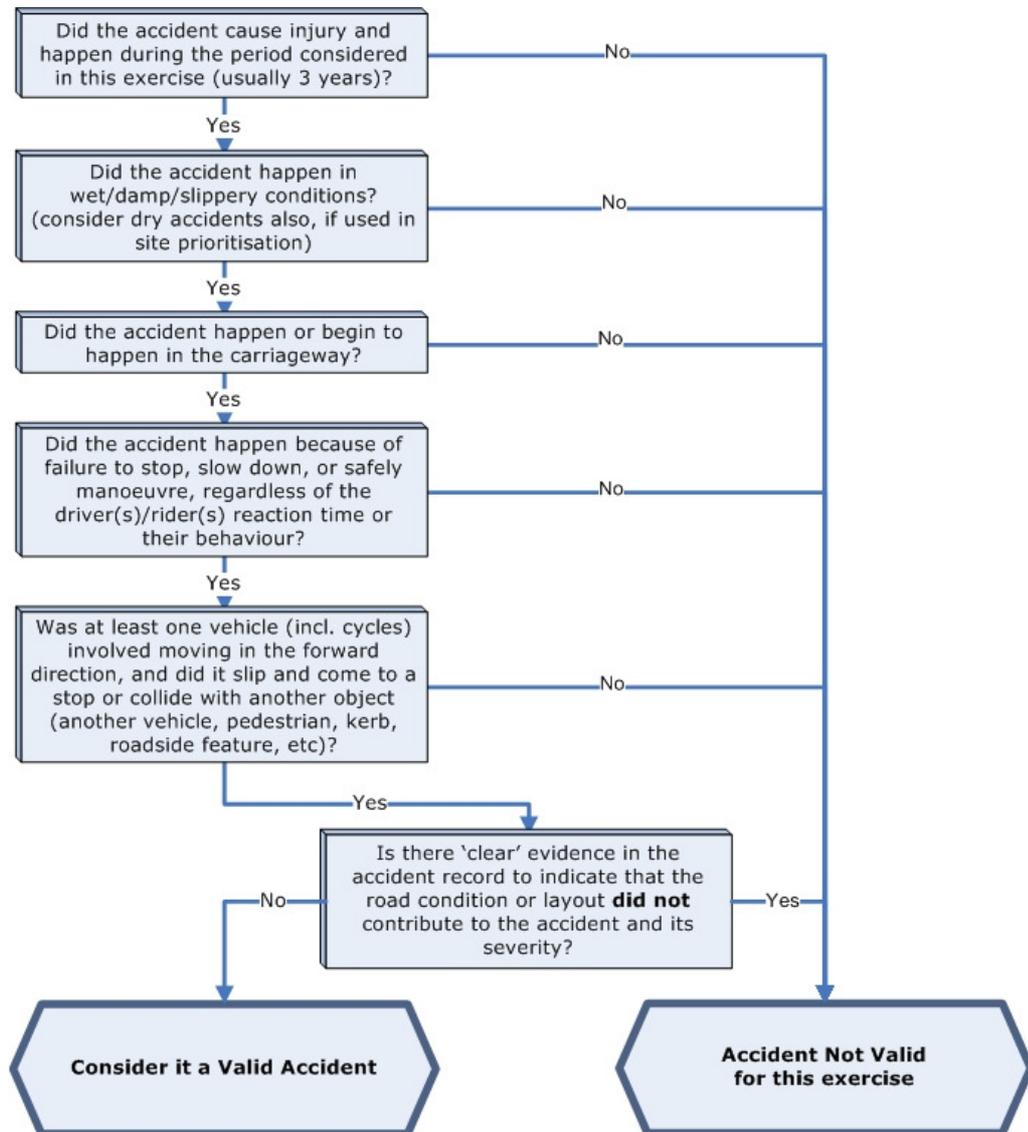


Figure 4 – Checking the Validity of Accidents

#### 4.1.2 Outcome of the Preliminary Investigation

In simple terms, the outcome of the Preliminary Investigation is to check all the information available at the desktop level, and validate sites to undertake the Secondary Investigation.

A permanent record of the various checks performed in the Preliminary Investigation (i.e. in flow chart) need to be made. In this process, all of the sites identified for investigation should be assigned an outcome. The sites that did not meet the Criteria to Undertake Site Investigations could simply display 'not investigated', or 'did not meet criteria' giving

reasons. Recording the outcome of the Preliminary Investigation should be done using a method that is suitable to the authority. In addition, further details regarding the outcome could be listed such as correcting the Site Category and/or IL if they were found incorrect, carrying out routine maintenance, etc.

The decision not to progress a site into a Secondary Investigation should be clearly specified, especially on the sites that met the priority criteria and underwent the Preliminary Investigation. At the end of this process, a list of sites to undertake the Secondary Investigation, referred to as the Site Inspection List, should be derived.

## **4.2 SECONDARY INVESTIGATION**

The secondary investigations should involve a site visit where possible. The objective is to make decision on whether a treatment is warranted to improve the skid resistance, or other measures to address concerns at the site.

### **4.2.1 Planning the Secondary Investigation**

The Site Inspection should be carried out by engineers recognised by the borough as competent to undertake the task, who have specific knowledge of local pavement design and maintenance standards, local surface treatment methods, performance of surfacing material, etc.

### **4.2.2 Information Required for the Secondary Investigation**

A variety of surface condition and inventory data could assist site inspectors in making an informed decision on site treatment. To ensure consistency in the Secondary Investigations, a Field Form similar to that shown in IAN 98/07<sup>4</sup> could be completed for each individual site included in the Site Inspection List or an equivalent alternative record kept.

If available, the following information could be extracted from the PMS databases, and entered into the field form. Some of this information is readily available from the Prioritised Site Listing.

- CSC
- SCRIM Difference
- Wet Accidents (3 year)
- Total Accidents (3 year)
- Surface Type
- Surface Age
- Polished Stone Value (PSV)
- One-way traffic (Average Annual Daily Flow (AADF))

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<sup>4</sup> IAN 98/07, Interim Advice Note, Guidance for HA Service Providers on Implementing the Skid Resistance Policy (HD28/04), Department for Transport, UK

If available from SCANNER (Surface Condition Assessment of the National Network of Roads in the UK) and other surveys, the following data may be useful to take to the field.

- Texture Depth Data
- Rut Depth Data
- 3m Profile Variance Data
- 10m Profile Variance data
- Detailed Visual Inspection (DVI) data

A locality plan showing the extent of the site would be very helpful in determining the correct location during the site visit, especially where a single site comprises of a number of summary subsection lengths.

#### **4.2.3 Information Collected During the Secondary Investigation**

The information collected on site should include the following general topics. An investigation form can be useful to capture the observations, and provide a 'narrative' of the considerations made at a particular site.

- General condition of the road at the site and surrounding roads
- Type of road users including vulnerable road users, and volume and type of traffic
- Road layout
- Visibility with respect to all road users including pedestrians and cyclists
- Road signs and marking
- Any other information/observations regarding the accident risk on site

Where necessary, the adjacent road sections may be included in the inspection. Aspects of the site such as characteristics of all approaches to the site, the opposite side of road, etc. may be considered.

Inspectors should make a recommendation based on the various information collected, whether a skid resistance treatment is required for the site. Generally, some form of skid resistance treatment is likely if:

1. The number of accidents observed is higher than average for the type of site, and the occurrence and severity of accidents are likely to be affected by skid resistance being too low for the type of site
2. The nature of the site and the demands of road users mean that there is a higher accident risk at the current level of skid resistance or if skid resistance were to fall further within the next year

If the Site Inspection identifies any characteristic of the site or road user behaviour that suggests other road safety measures could be appropriate in order to address the accident risk, then the accident investigation team should be contacted to decide the best course of action.

If it is found that there is a need for other types of routine maintenance such as reapplication of road markings, cleaning/repositioning of signs, drainage improvements road sweeping, etc then that should be addressed through the relevant maintenance team.

#### **4.2.4 Outcome of the Secondary Investigation**

The recommendations of the Site Inspection should be reviewed by the Highways Asset Manager to ensure that the inspectors are reviewing sites in a consistent manner. During reviews and audits it has been noted some inspectors are naturally inclined to recommend sites for treatment, whereas others can tend to recommend no treatment. The record on investigations can be helpful in documenting the thought process, and should provide a logical record of observations leading to the recommendation.

It is strongly recommended that the secondary investigations are subject to an independent review, to ensure:

- The policy is being appropriately applied
- To inform bids for funding
- To prioritise sites for treatments against available budgets
- To ensure 'other actions' are passed to the appropriate staff

## **5. TRAINING AND LESSONS LEARNT**

It was acknowledged that a training programme, run in conjunction with the roll out of the manual would assist those undertaking investigations. A training programme was developed involving both classroom exercises and site visits which included:

- Accident validation
- Preliminary Investigations
- Site visits

The site visits were based on sites from the host authority's deficiency listing, and was accompanied by the personnel who had undertaken the investigations. This provided context for the sites in terms of network usage, and enabled the outcomes to be tested against the actual final decision made by the host authority.

It was noted that at one site, the site layout had been changed, but the corresponding site category and IL's had not been updated. This would result in incorrect site information being used in preparing the Prioritised Site Listing in later years. This highlighted the importance of updating the network information following the maintenance work.

At another site there were some suggestions about making significant changes to the road markings and location of bus stops, which may not have been a realistic option. On a third site there was a detailed discussion about the selection and use of high PSV aggregate. These emphasized the importance of working with other teams in the local authority to assist in developing the optimum solution to each site.

The participants came from both a 'maintenance' and 'safety' background. This worked well for the exercise; however, it was evident that the two groups tended to look at different potential solutions. On this basis, it can be concluded that the best options for investigations is to engage with both disciplines, either during investigations, or as part of the review process.

## **6. CONCLUSION**

The London-wide skid policy has been developed to ensure consistency across the capital city, despite the 33 boroughs and TfL having an involvement in managing the principal road network. Typically the boroughs have around 50-100 lane.km of principal roads, and to manage the policy on such small networks can put pressure on maintenance engineers who often have a number of work demands.

A set of tools have been developed to assist in processing skid resistance data, and to allow the engineers to focus on areas needing detailed input and investigations. The logical extension of providing the data in a more usable fashion was to develop guidance on what to do with the data. The development of a training manual on undertaking preliminary desktop level investigations and secondary site investigations and providing hands-on training have assisted this objective.

## **7. ACKNOWLEDGEMENTS**

The assistance of the individual London Boroughs, and the LoTAG steering group in developing the ideas set out in this paper is acknowledged.

The co-author Anuradha Premathilaka undertook the work detailed in this paper whilst employed by W.D.M. Limited.

## **Author Biographies**

### **Dr Anuradha Premathilaka CEng MICE MIAM**

Anu is a Senior Asset Management Engineer at CH2M HILL's (formerly Halcrow) Transport planning and Advisory Business Group. He has worked both in the UK and in New Zealand, and has a range of experience in transportation asset management from a consultant, contractor, and researcher perspectives. His key experiences include lifecycle analysis, deterioration/financial modelling, economic evaluation, maintenance programme development and prioritisation, skid resistance, PAS55 assessments, and quantitative risk assessment. Anu undertakes consultancy work for a number of UK transport authorities. His recent projects include asset management and lifecycle modelling projects for the Highways Agency and the High Speed 1 railway, and risk assessment work on the Bristol Bus Rapid Transit Network project. Prior to joining CH2M HILL, Anu was a Senior Project Engineer in the Consultancy Services Division at W.D.M. Limited. In New Zealand, he worked at Downer EDI as a Project Engineer, then at Fulton Hogan as a Regional Technical Engineer. Anu has a Doctor of Philosophy (Civil) specialising in transport asset management, a Master of Engineering Studies specialising in transportation, and a Bachelor of Engineering in civil engineering. He is a Chartered Engineer and a Member of the Institute of Asset Management.

### **Mark Hodgson**

Mark Hodgson is Highways Group Manager at the Royal Borough of Greenwich (meaning he's responsible, amongst other things, for the maintenance and management of all the councils highway infrastructure). He has worked in London for 10 years and before that was a Route Manager for a section of State Highway in New Zealand. Prior to taking his current role for a number of years Mark was responsible for the delivery of the Road2000 project – a pan London initiative to collect consistent road condition data across all of the London A classified roads (except those managed by TfL) including DVI, SCANNER and SCRIM. Mark has been part of a number of working groups and is an active member within the London Technical Officer Group (LoTAG).

### **Mark Stephenson**

Mark Stephenson is a Chartered Civil Engineer and Head of Consultancy Services with W.D.M. Limited a post he has held since 2008. He is responsible for a range of projects undertaken for UK and overseas clients. These have involved the interpretation of highway condition surveys together with the development of tools and analysis to achieve cost-effective maintenance programmes. His current areas of interest include the measurement and management of skid resistance, Highway Asset Management, including lifecycle plans, scheme identification and prioritisation and policy implementation for clients.

He worked for twenty years at the Cornwall County Council where he was responsible for highway maintenance and construction. He represented the council on a number of national working groups and chaired the Highway Condition Assessment Group which reports to the UK Roads Board.