PRIORITISING STATE HIGHWAY SKID RESISTANCE IN NEW ZEALAND - A POLICY FOR ALL BUDGETS

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ABSTRACT

The latest revision of the T10 specification for management of skid resistance on the state highway network was issued in 2012 following extensive industry consultation.

One of the main changes was to include a methodology for prioritisation of treatments to improve skid resistance where it is low with reference to the Investigatory Level (IL). This involves two levels of prioritisation to enable both reactive and pro-active management of skid resistance within any available funding level.

The first at Exception report stage uses non-seasonally corrected data to enable prompt action on the most urgent sections of the network. The second level uses the seasonally corrected data and Skid Assessment Lengths (SAL's) to assist in future programming of skid resistance treatments based on need.

Both levels take account of Microtexture, Macrotexture and Wet Crash history to target a "Best Value" safety outcome on the network. The amount of funding available will determine how far down the prioritisation list treatment will occur.

The paper details the process, criteria and steps used in the prioritisation and illustrates how this can be adjusted to suit available funding.

1.0 BACKGROUND

NZTA and its predecessor, Transit, have undertaken annual routine skid resistance measurements on the State highway network since 1998. This followed the introduction in 1997 of the T10 specification and notes which provided a policy for the management of skid resistance on the State highways.

The T10 specification was updated in 2002, 2010 and 2012 with the current version issued during 2013. These updates have incorporated the findings of new research and international "best practice".

The levels of skid resistance and macrotexture are managed around investigatory levels and threshold levels.
These are defined in T10 as:

"Investigatory level (IL): The level of skid resistance (SC or ESC) at or below which a site investigation may be undertaken, and the information used as a priority indicator for programming treatment."

"Threshold level (TL): A trigger level of skid resistance for determining priority for programming treatment."

For macrotexture they are referred to as investigatory level macrotexture (ILM) and threshold level macrotexture (TLM) and are defined as above with skid resistance replaced with macrotexture.

A central part of the State highway skid policy and T10 specification has been the issuing of an Exception Report by the survey contractor. This is to provide an "early warning system" of 10 m lengths of the network that are either below the threshold level (TL) for SCRIM Coefficient (SC), macrotexture or a combination of both. This has historically enabled our regions to address sections which may have priority for treatment to improve the skid resistance prior to the release of the seasonally corrected data at the end of the survey season.

Following the issue of T10:2010 the number of sites on the Exception Report increased significantly in each region throughout New Zealand. This was primarily due to the introduction of a "Curve risk analysis" policy (Cenek et al, 2011) to target a reduction in "loss of control" wet road crashes on curves. This resulted in a much higher proportion of the network length being managed as curves and some of these which were identified as "high risk" at a higher IL than previously.

Parallel to this, NZTA has experienced financial constraints on its annual maintenance budgets putting additional pressure on addressing this increase in the size of the Exception Report. Furthermore, T10:2010 did not provide any mechanism for prioritising skid resistance when the level of funding available was not able to deal with all sites on the Exception Report.

T10 also requires a further review of the data once the seasonal correction has been applied for the following reasons:

i. To identify sites with a seasonal correction <1 that might now be below the TL.

ii. To identify sites that may be trending towards the TL for future monitoring and programming.

With the issue of T10:2012 these problems have been addressed by providing a two level prioritisation process to enable both reactive and pro-active management of skid resistance within any available funding level. The first at Exception report stage looks at urgent 10m lengths around the threshold levels whilst the second targets the longer "skid assessment length" (SAL), typically 50-100m averages, around the investigatory level. Both use microtexture, macrotexture and "wet crash" history to target a "Best Value" safety outcome on the network.

The process for each level is outlined below.

2.0 EXCEPTION REPORT.

The first level of prioritisation is at Exception Report stage.

The Exception Report serves as an "early warning system" on the non-seasonally corrected data to identify the most urgent sites for investigation. It provides details of 10m sections that are ≤ TL or ≤ TLM, or both. Each 10m length will be assigned to priority A or B for investigation using the following criteria.

Priority A sites are defined in T10 as those that meet at least one of the following criteria:

- sites that are below the threshold and have had at least two wet skid crashes(Note 1) in the previous five years (any wet crash within ±250m of the site will be included in the analysis).

- sites that are flushed (defined as having a wheelpath SC value of ≤0.35 combined with a same wheelpath texture value of ≤ 0.7mm MPD)

- sites where the SC is very low (currently defined as having a lane SC value of <IL-0.15).

All other 10m lengths will be assigned to Priority B and need not be considered further at Exception Report stage unless they have been included within or immediately adjacent to a Priority A site.

2.1 INVESTIGATING PRIORITY A SITES

On receipt of the Exception Report all sites that are in priority A must be investigated to determine whether treatment is necessary. A list of features that should be recorded is included in the T10 Notes but the investigation should also include the following checks:

- Confirm that any "wet crashes" are correctly assigned to the exception for location and that the cause of each crash is likely to be related to the wet skidding resistance on site.
- Confirm that the current IL is correct.
- Whether the exception is caused by temporary contamination.

Note 1: Wet skidding crashes tend to be under reported therefore all wet crashes are considered at this stage. Confirmation that the crashes are due to wet skidding is carried out during investigation.

2.2 TREATMENT OPTIONS

Where treatment is found to be necessary it must be designed and programmed. A number of treatments may be appropriate and these include:

- Reseal in current year (providing timing allows for construction)
- Following year's reseal programme (if too late in season)
- Waterblasting or Re-texturing
- Signage (including use of temporary speed limits)
- No treatment (temporary contamination, false data, acceptable risk etc.)

Whilst the Exception Report process is largely reactive it can also be considered pro-active in that it also treats sites with low skid resistance without crash history.

A flow chart outlining the Exception Report process is given below in figure 1

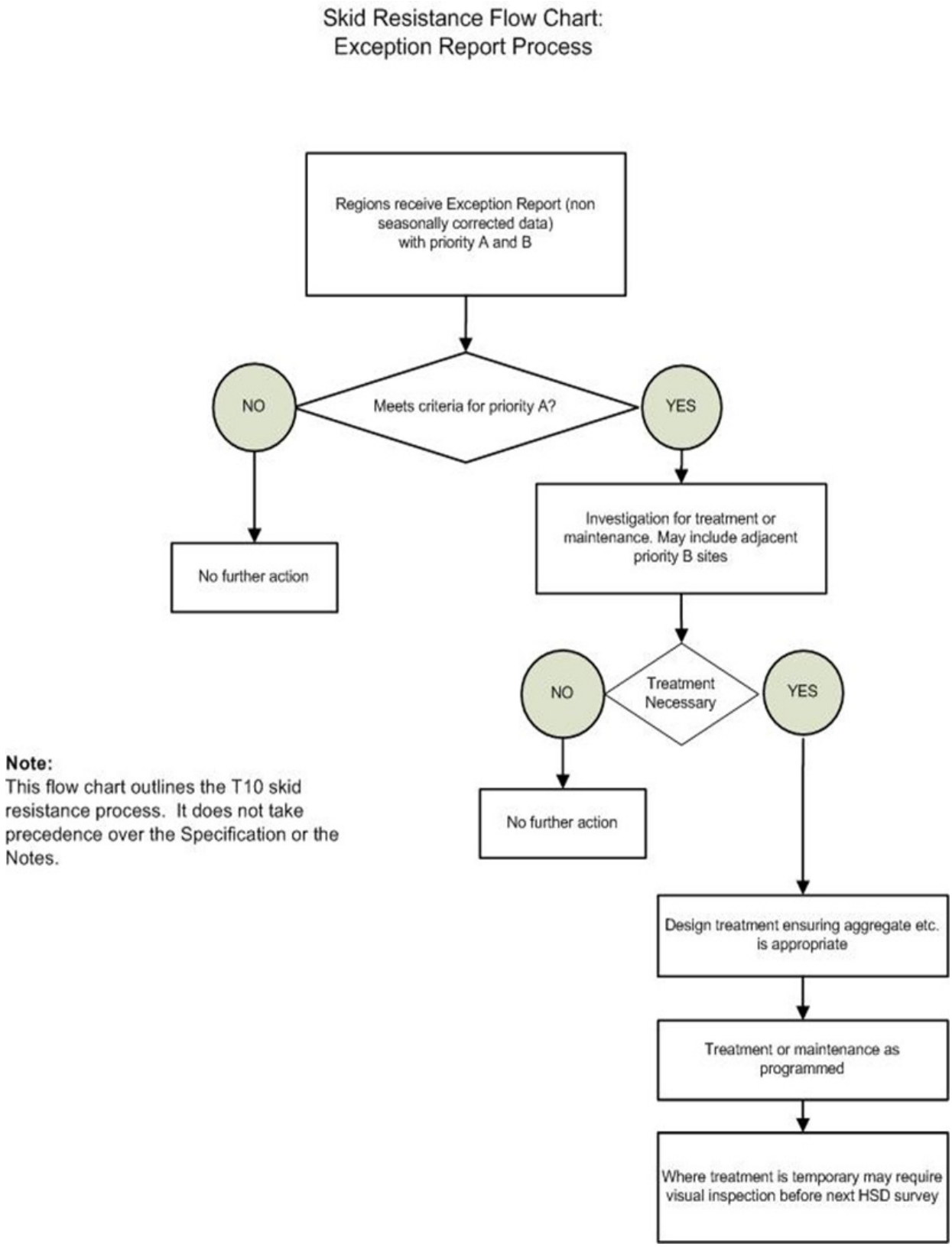
Skid Resistance Flow Chart:
Exception Report Process
Regions receive Exception Report (non seasonally corrected data) with priority A and B
Meets criteria for priority A?
NO
YES
No further action
Investigation for treatment or maintenance. May include adjacent priority B sites
Treatment Necessary
NO
YES
No further action
Design treatment ensuring aggregate etc. is appropriate
Treatment or maintenance as programmed
Where treatment is temporary may require visual inspection before next HSD survey
Note:
This flow chart outlines the T10 skid resistance process. It does not take precedence over the Specification or the Notes.

FIGURE 1

3.0 SKID ASSESSMENT LENGTHS.

The second level of prioritisation occurs after the skid resistance data has been seasonally corrected. In New Zealand we correct the SC for variations within season by obtaining a Mean Summer SCRIM Coefficient (MSSC) and for variations between years by calculating the Equilibrium SCRIM Coefficient (ESC).

The ESC is the measure of skid resistance used in the second level of prioritisation.

The network is then segmented into skid assessment lengths (SAL's) based on the fundamental site category lengths indicated in Table 1 below. This is undertaken for each direction as some site category features such as approaches and gradients are directional.

Table 1
Skid assessment length

Site category	Skid site description	Skid assessment length (SAL) metres
1	Approaches to: a) Railway level crossings b) Traffic signals c) Pedestrian crossings d) Stop and Give Way controlled intersections (where state highway traffic is required to stop or give way) e) Roundabouts One lane bridges: a) Approaches and bridge deck.	60
2	a) Urban curves <250m radius b) Rural curves <250m radius c) Rural curves 250-400m radius d) Down gradients >10%. e) On ramps with ramp metering	50
3a	State highway approach to a local road junction.	60
3b and 3c	Down gradients 5 - 10% Motorway junction area including on/off ramps	50
3d	Roundabouts, circular section only.	10
4	Undivided carriageways (event-free).	100
5	Divided carriageways (event-free).	100

3.1 PRIORITISING SITES FOR INVESTIGATION AFTER SEASONAL CORRECTION

Following the generation of the SAL lengths and after the skid data has been seasonally corrected, sites that are below the IL or ILM are prioritised for investigation using the scoring system in Table 2 below.
The ESC and the macrotexture values are averaged over each SAL and wet skid crash history is taken into account on the same basis applied to the Exception Report process.

Some allowance is also made for road classification by considering the annual average daily traffic (AADT) using the road.

Table 2
Scores for investigation priority, after seasonal correction

Parameter	Scores and criteria
Number of wet skid crashes	One crash zero points, two or more crashes 80 points for each crash.
SCRIM difference (averaged over the SAL)	4 points for each 0.01 between IL and IL-0.05. 10 points for each 0.01 between IL-0.06 and -0.1 15 points for each 0.01 below IL-0.1
Texture difference (averaged over the SAL)	5 points for each 0.1 between ILM-0.1 and ILM-0.3 10 points for each 0.1 when less than ILM-0.3
Annual average daily traffic (AADT)	1 point for each AADT/1,000

The score for each parameter is summed for each SAL under consideration using an automated process and the results are stored in a dedicated SAL table within the NZTA database. This enables analysis and interrogation of the output to determine which sites are to be investigated based on a priority from highest to lowest scoring SAL's.

The number of sites to be investigated can be determined by using a "cut off" SAL score targeted to suit available funding and resources. This methodology ensures that those with a larger proportion of SAL's above the "cut off" and therefore the greatest skid resistance need, investigate more sites.

3.2 INVESTIGATING SITES AFTER SEASONAL CORRECTION

Once the number of sites has been determined from the "cut off" score each site should be investigated to determine whether treatment is necessary. A column is provided in the database table to "flag" each SAL length which contains any 10m lengths from the Exception Report. This allows for an easy audit trail of those lengths which should have been investigated previously under the first stage of the prioritisation, avoiding duplication of site investigation.

A list of features that should be recorded is included in the T10 Notes but the investigation must also include the following check:

- Confirm that any "wet crashes" are likely to be wet skidding crashes and are correctly located and only assigned to one SAL.

The information from the site investigation and a decision made by the inspector must be recorded. The decision must include recommending one or more of the following:

- a change in the IL, with justification.
- treatment to improve the skid resistance, with details of what is required and when.
- treatment other than for the skid resistance, including reasons why and to whom this information will be communicated to ensure the necessary action is taken.
- no treatment, including the reason why.

3.3 TREATMENT OPTIONS

Where treatment is found to be necessary it should be prioritised and those above the "cut off" for available funding should be programmed and designed. Any surfacing type treatments will generally be programmed for the following year as the process takes place too late in the season for work to be carried out in the current year.

A flow chart outlining the seasonally corrected data process is given below in figure 2

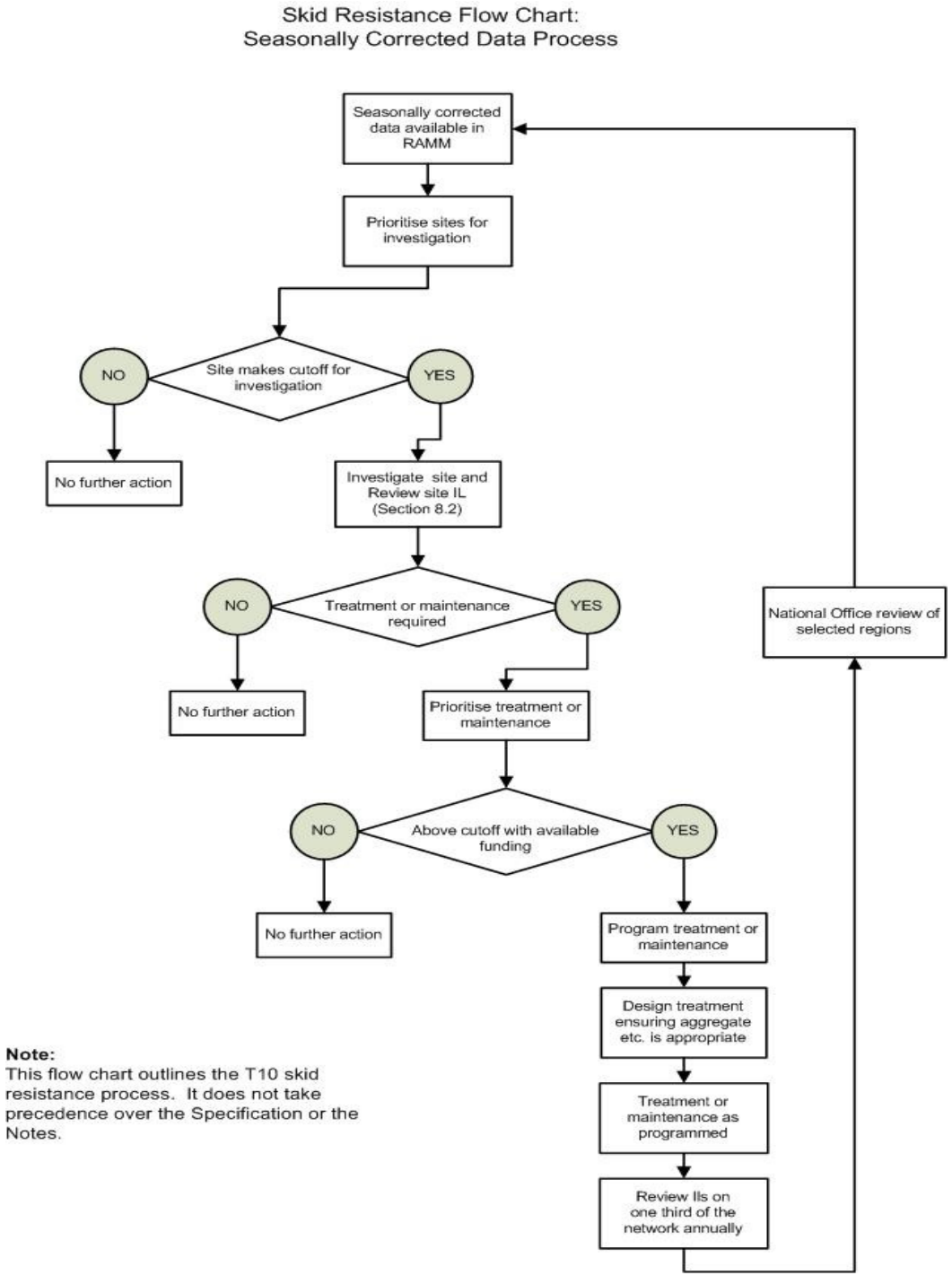

FIGURE 2

4.0 "RINGFENCED" FUNDING

NZTA have used the prioritisation process to determine the amount of "ringfenced" funding allocated to skid resistance treatment from the 2013/14 maintenance budget. Dedicated "ringfenced" funding for skid resistance was considered the correct way to proceed in order to remove the dilemma presented to the Engineer between prioritising asset preservation against safety when funding is constrained.

An appropriate value for the "cut off" SAL score was investigated by considering how many SAL lengths nationally and regionally met a range of different numbers. We took into consideration the influence of two wet crashes on the SAL score (160 points) in defining where to start the analysis.

We initially removed all the SAL lengths with a Priority A flag to establish what would be a desirable maximum number of new SAL sites for the "poorest" performing region to investigate (200-300 sites) during the second level of prioritisation. It was found that a SAL score of around 140 would be an appropriate value and would trigger some sites with very poor skid resistance and texture even if no wet crashes had occurred over the previous 5 years.

However, to truly reflect the skid resistance need and therefore the funding need, SAL's with Priority A sites were re-introduced for the remainder of the analysis. To account for the differences in network length and average length of SAL in each region, the number of 10m sites meeting the chosen criteria was calculated along with a percentage of the national total as shown in Table 3 below.

Table 3
2013/14 SAL Score Summary

Network Management Area (NMA)	No of 10m sites (140)	% of sites
Northland	73650	16.10%
West Wanganui	46010	10.05%
East Waikato	36200	7.91%
Wellington	26390	5.77%
PSMC006	26210	5.73%
Southland	25420	5.56%
Central Waikato	24120	5.27%
West Waikato	22220	4.86%
North Canterbury	20060	4.38%
Coastal Otago	18870	4.12%
East Wanganui	17620	3.85%
West Coast	14700	3.21%
Auckland North	14330	3.13%
Hawkes Bay	13730	3.00%
Nelson	13260	2.90%
Gisborne	11990	2.62%
AMA	10250	2.24%
Bay of Plenty West	9540	2.08%
South Canterbury	7860	1.72%
Marlborough	7100	1.55%
Rotorua	6260	1.37%
Bay of Plenty East	4170	0.91%
Otago Central	3890	0.85%
Tauranga	3740	0.82%
Total	**457590**	100.00%

For each SAL the chosen criteria used in the analysis included a total score of greater than 140 with an average ESC value of ≤ IL >-0.05. Initially "flushed" sites had been removed as these were to be treated as asset preservation but further discussions resulted in these being included in the final analysis.

These percentages were then tested against a range of dollar amounts to ascertain what length of treatment could be achieved in each area based on typical resurfacing and surface treatment costs. These lengths were then compared to historical lengths treated for skid resistance to confirm what would be an appropriate level of funding to "ringfence". Each region was then allocated funding to treat sites that had a SAL score > 140.

In 2013/14 this was confirmed as $4M but the amount of funding requirement is likely to differ from year to year based on the outcomes of the annual skid resistance survey.

It should be noted that the sites treated using the ringfenced funding, only include those where skid resistance or flushing is the sole reason for treatment. A large number of sites where the skid resistance needs to be improved are in the annual renewal programme, where the main need is based on asset preservation but as a natural side effect the skid resistance is improved after treatment.

5.0 THE BENEFITS OF PRIORITISING SKID RESISTANCE

One of the benefits of having a prioritised process is the flexibility to adjust the "cut off" criteria to suit different funding scenarios. Should more funding become available we can increase the number of Priority A sites on the Exception Report by reducing the criteria for low skid resistance or investigate more SAL lengths by reducing SAL "cut off" score. In times of even tighter budgets the reverse would apply.

Overall the goal is to reduce the size of the annual Exception Report and to improve the skid resistance of the network. The introduction of the prioritisation process allows us to work towards this goal in a cost effective "needs driven" manner within the available budgets. It also enables us to prioritise nationally to the areas and regions where the greatest need exists

It is also worth reinforcing that prioritisation needs to be coupled with targeting better treatments and better treatment life as well as using aggregates appropriate for each site category.

6.0 CONCLUSIONS

The aim of the T10 specification is to contribute to a reduction in the number of wet skidding crashes on the State highway network by improving the skid resistance. The introduction of a prioritisation process within the document will assist NZTA in achieving this aim within available budgets to deliver a "best value" safety outcome. This process also allows benchmarking between regions and identifies the areas in greatest need where we can direct expert assistance as appropriate.

AUTHOR BIOGRAPHIES

Dave Whitehead

Dave has over 30 years of experience in a variety of roles within the highways engineering sector of which the last 25 have been in highway maintenance and asset management. He has worked largely in the UK in both the private and public sectors but prior to moving to New Zealand in 2008 had previous overseas experience in Sri Lanka.

Dave currently holds the position of Senior Pavements Engineer within the Pavement Group at the NZ Transport Agency's National Office in Wellington. He has been part of the team responsible for developing the T10 specification relating to skid resistance as well as involvement in a range of technical projects related to asset management. Dave recently stepped down as the chair on the Skid Technical Advisory Group (STAG) within NZTA but still retains membership on the group.

John Donbavand

John arrived in NZ in 1983 and stayed for 18 years during this time he has held a number of positions including Bitumen Chemist, Surfacing Scientist and Engineering Policy Manager for Transit New Zealand.

John returned to the UK in 2001 to take up the position as Project Development Manager at W.D.M. Limited. In this position, John has been involved with a wide range of projects, including, developing procedures to estimate the national maintenance budgets for the Highway Agencies, asset valuation for local roads, providing scheme prioritisation techniques for Highway Authorities and providing skid policies for numerous Highway authorities, including London and Scotland.

John returned to New Zealand in March 2012 and started work with the New Zealand Transport Agency as the National Pavements Manager. In this role his principal responsibility is to maintain and develop the technical standards, specifications and guidelines for State Highway pavements.

David Cook

David holds the position of Senior Surfacing Engineer working in National Office of NZTA. He has over 40 years' experience in a wide range of roading issues from construction supervision, major project development and roading maintenance and construction.

He has been involved in a variety of roles relating to the development of the state highway skid resistance policy. He managed the initial High Speed Data Collection contract that included skid resistance. Recently he retired as chairman of STAG (Skid Technical Advisory Group), the group responsible for overview and management of the state highway skid resistance policy, following a period of 8 years as chairman. He currently works for New Zealand Transport agency on skid resistance, surfacing's and associated safety areas.