ABSTRACT

Works Infrastructure maintains an unsealed road network of approximately 1125km in the Tasman and Marlborough districts. There is wide variation of both topography and climate within the districts, and between seasons.
Through an internal requirement to monitor maintenance performance, a condition rating survey has been developed. The survey combines a windshield survey in order to cover as much of the network as possible within a limited timeframe and a series of physical measurements.
The survey consists of rating "condition measures" associated with maintenance activities and rating of "permanent features" outside the scope of the maintenance contracts. The results provide a useful tool to identify problem areas and potential causes. These results are tabulated and presented in a report. Two surveys have now been undertaken for the Marlborough network repeated at six monthly intervals, post winter and post summer, and the results compared.
This paper describes how the survey was derived, presents results and explains how the results have been used to improve the condition of unsealed roads in the Marlborough district.

1. Introduction

1.1 BACKGROUND INFORMATION

Works Infrastructure Ltd's (Works) Nelson Marlborough operating unit maintains roading networks in Tasman District and Marlborough including 1125km of unsealed roads. For the purpose of clarity this paper will focus on Marlborough's unsealed roads.

Works currently operates 2 maintenance contracts in Marlborough, the Wairau North and Wairau South Maintenance contracts. Works has held the Wairau North contract for 3 years and the Southern contract for 2 years and out of a combined total of 1750km of roads maintained, 700km are unsealed.

The topography of the 2 regions vary considerably. The Wairau North contract includes the Marlborough Sounds, an area of tortuous bends and a weak, highly weathered Greywacke rock. The Wairau South includes the Wairau and Awatere Valleys, areas of alluvial floodplains overlain by windblown loess.

The contracts are based on a traditional Total Maintenance Management (TMM) philosophy. Although the contracts have Operational Performance Measures (OPM's), with which Works are contractually obliged to comply, it was deemed operationally advantageous to all parties to develop a monitoring procedure that would provide an overall benchmark of condition as opposed to a direct measure against the contract requirements. By doing so, it is possible to measure the overall condition of the network at a specific time.

2. Condition Rating Survey

2.1 SURVEY DEVELOPMENT

It was prudent to focus the survey on defects that cause the most significant complaints from the road user, and hence the most concern to the Client. It was clear from an early stage that the network condition depends on numerous factors, some of which can be controlled through the maintenance contracts and those that are affected by the topography of the region. As a result the survey was split in to two sections:

- "condition measures", those associated with maintenance and
- "permanent features", those outside the scope of the maintenance contracts. It was important to be able to measure both condition measures and permanent features during the same survey and not to hinder the speed and accuracy of the survey.

It was considered important that a representative length of the network be surveyed and, following consultation with the Client, sections of roads were selected. The danger in consciously selecting roads, instead of randomly selecting, is that it is natural to select those roads that present the most difficulty or receive the majority of complaints. The roads selected did contain known problematic areas and represented approximately 9% of the total unsealed network length (approximately 57km).

It was proposed to undertake surveys at 6 month intervals; post summer and post winter to identify condition due to effects of seasonal variation. Also by undertaking regular surveys, it was possible to identify trends and problematic areas resulting in pro-active maintenance.

The Client requested the information in a form that could be presented and understood by other stakeholders (Councillors, public etc).

2.2 SURVEY IMPLEMENTATION

The survey included a "windshield survey" in order to cover as much of the network as possible within a limited time and a series of "measured values" including a digital image. The measured values were taken at points indicative of the overall condition of the road (approximately 1 per road). The network surveyed was traversed at about 30 kph or a lesser safe driving speed, and both sides of the road were observed. The survey participants agreed on the rating of each defect. The length rated was generally 1 kilometre, except for the shorter final portion at road ends where these were integrated into the previous section.

2.3 METHOD OF SCORING

A simple scoring system of

- 1 = GOOD
- 2 = SATISFACTORY
- 3 = FAIR
- 4 = POOR

was used. The use of an even number of scores avoids the temptation of scoring at the middle number (for example, "3" if there was a range of 1 to 5 available).
As mentioned earlier, attributes on the unsealed roads were split in to "condition measures" –(associated with maintenance) and "permanent features" –(outside the scope of the maintenance contract). These are described below.

Condition Measures:

- Cross-fall
- Width
- Corrugations
- Potholes
- Drainage maintenance

Permanent Features:

- Longitudinal Slope
- Cross section (ability for pavement to drain)
- Sun/shade
- Winding
- Width (1=wide enough for two cars to pass, 4=single lane too narrow for safe passing)

Scoring of both condition measures and permanent features are as shown in Table 1 below.

Sample item & Score Range				
Permanent Features				
Longitudinal slope	1=flat	2=gradual	3=steep	4=very steep
Cross section	1=good drainage	2=generally drains	3=partial drainage	4=no drainage
Environment	1=sunny	2=mostly sunny	3=mostly shaded	4=shaded
Width	1=wide	2=generally wide	3=narrow	4=too narrow
Winding	1=straight	2=gentle curves	3=windy	4=tortuous
Condition measures				
Crossfall	1= 4-6%	2= 2-4, 6-8%	3= 1-2, 8-10%	4= 0-1, >10%
Drainage	1=fully operational	2=working	3=just working	4=not working
Potholes	1=none	2=some	3=some major	4=too many
Corrugations	1=none	2=ripples	3=noticeable	4=severe

Table 1. Scoresheet

"Measured values" record condition at specific points on the road. They are used as an indicator in the form of a "spot measure," and are not further discussed in this paper. Measured values include:

- Stone size
- Corrugations
- Loose metal
- Cross-fall
- Pothole
- Rutting
- Width

3. April 2002 Survey

3.1 SURVEY RESULTS

The first survey was conducted in mid-April 2002, nominally post summer, and was undertaken by a representative from the Contractor and the Consultant. The survey was implemented over 2 days; roads surveyed in the North contract followed by those in the South. The scores are presented in a spreadsheet format and conditionally formatted, showing red for poor through to white for good. Shading the scores in such a manner clearly identifies trends. For example, a section of road with a low score for potholes may also have been identified as an area with poor drainage and/or particularly shaded.

Table 2 below summarises the results for the unsealed subnetwork for the **Northern** region.

	Condition Measures					Permanent Features				
	Corrugations	Loose metal depth	Potholes	Crossfall	Drainage Maintenance	Longitudinal slope	Cross section	Sun/ shade	Winding	Width
Average	2.2	2.6	1.4	2.1	2.0	2.2	1.0	2.3	2.5	2.1
%=1	30	12	59	24	0	18	100	47	0	0
%=2	29	18	41	41	100	47	0	0	53	88
%=3	35	70	0	35	0	35	0	29	47	12
%=4	6	0	0	0	0	0	0	24	0	0

Table 2. Wairau North – Summary of Results (Apr '02)

The average score appeared quite satisfactory, with the highest average applying to "loose metal depth" and "corrugations" for the maintenance issues and "winding" & "sun/shade" for the permanent features. This highlighted the Marlborough Sounds challenging topography and subgrade materials. The high proportion of "3's" are associated with corrugations on a known problematic section of road which reinforces Works' experience that the road readily corrugates soon after grading due to logging truck usage. The road had been patch graded to remove the corrugations 5 weeks prior to the survey.

Table 3 below summarises the results for the unsealed subnetwork for the **Southern** region.

	Corrugations	Loose metal depth	Potholes	Crossfall	Drainage Maintenance	Longitudinal slope	Cross section	Sun/ shade	Winding	Width
Average	1.6	1.8	1.1	2.2	2.0	1.7	2.0	1.1	2.0	2.5
%=1	44	31	95	5	3	28	44	95	23	23
%=2	53	56	5	72	97	72	30	5	54	13
%=3	3	13	0	23	0	0	13	0	23	61
%=4	0	0	0	0	0	0	13	0	0	3

Table 3. Wairau South – Summary of Results (Apr '02)

The average score appeared quite satisfactory, with the highest average applying to "drainage maintenance" and "crossfall" for the maintenance issues and "width" for the permanent features.

3.2 DISCUSSION

Following the survey and tabulation of results, key items are discussed and the overall condition of the network summarised. The significant findings from the April 2002 survey are presented below.

3.2.1 Drainage

In most cases, water tables were in a reasonable working condition, with no major defects in performance.

3.2.2 Corrugations

Corrugations were not generally a problem throughout the network. The corrugations are most severe on Port Underwood Road, especially on climbing corners and mainly attributable to logging trucks. On completion of maintenance grading, the corrugations form almost immediately.

3.2.3 Width

The roads were surveyed with a view that a width that permitted 2 cars to pass was rated as “good” and a narrow road that only allowed single lane traffic with difficulty in finding suitable areas to pass was rated as “poor”.

This resulted in surveyed sections of the Awatere Valley Road, Atkinsons Road, Taylor Pass and Waterfalls Road as being rated “fair” due to the roads being narrow although cars being able to pass. Alternate views are held that a narrow road with sufficient number of passing areas is an optimum situation due to reduced maintenance costs.

3.2.4 Cross-fall

It is easier to maintain the desired 4% to 6% cross-fall when roads are narrow. This avoids the need to build up excessive heights of often unstable material.
Such cross-fall ensures that potholes do not form, especially on roads whose longitudinal section is flat. Where a road is climbing, then water is shed by flowing down the road rather than across it; hence a more liberal attitude towards cross-fall is tolerable. However, in such situations, adequate provision of cutouts is necessary to ensure that the scouring energy of run-off is limited.
Cross-falls are generally tolerable on the surveyed network, although rated as “fair” on much of Awatere Valley Road and French Pass Road.

3.2.5 Aggregate Size and Looseness

In general, there was satisfactory loose metal depth (10-15mm) throughout the network. However, on French Pass Road and Port Underwood Road the observed and measured depth was in the range of 0-5mm. While this is good from the point of view of skid resistance, there was evidence that the underlying formed base has been exposed. This is particularly evident on the French Pass Road where outcrops of rock appear at the road surface. Any placing of maintenance metal immediately migrates to the road edges.

3.2.6 Potholes

The network surveyed was relatively free of significant potholes. Many are in the nature of scabbing, and not so severe that drivers will take evasive action. Some potholes had formed on the French Pass Road however many of these had been filled prior to the survey under regular maintenance activities.

3.2.7 Summary

In general, the unsealed roads in Marlborough District were in good condition. The most dominant adverse feature was a natural phenomenon, not enough sun in some areas of the Northern network, with the result that the roads tend not to dry out, especially in winter periods. On the Southern network, a too narrow width along some sections is a feature that needs addressing progressively.

The presence of corrugations on climbing corners (Port Underwood Road) associated with heavy vehicles is one not easily resolved with unbound wearing course. The situation may be able to be improved with added clay binder (for example a slurry of bentonite applied during rip reshape and roll), but in other areas of the country (e.g. Rodney District), common practice is to provide a "traction seal" at such locations (funding permitting).

Where road base is lacking, and the road is worn to bedrock, then the most cost effective maintenance may include ripping of the bedrock to minimise the amount of imported base and wearing course. The ripping process also achieves a controlled, uniform plane of "subgrade" surface, facilitating future maintenance operations through ensuring that a more constant depth of metal tops it.

4. November 2002 Survey

4.1 SURVEY RESULTS

The second survey was conducted in November 2002, nominally post winter, and was undertaken by the same personnel who carried out the survey in April 2002. An identical procedure was undertaken to ensure consistency of results.

Table 4 below summarises the results for the unsealed subnetwork for the **Northern** region. The score results of the permanent features have not been included as these do not vary significantly from one survey to the next.

	Corrugations	Loose metal depth	Potholes	Crossfall	Drainage Maintenance
Average	2.0	2.8	1.2	1.8	2.0
%=1	18	6	82	18	0
%=2	64	12	18	82	100
%=3	18	82	0	0	0
%=4	0	0	0	0	0

Table 4. Wairau North – Summary of Results (Nov '02)

The average score appeared quite satisfactory, with the highest average applying to "loose metal depth". The views expressed in the April 2002 report are maintained that the underlying rock subgrade, in particular on the French Pass Road, cause any loose metal to readily migrate to the edges.

By comparing the 2 surveys (Table 4 above and Table 2, page 4) it can be seen that the average scores remained reasonably similar with a slight deterioration in loose metal depth but a slight improvement in the other measures. Table 5 below summarises the results for the unsealed subnetwork for the **Southern** region.

	Corrugations	Loose metal depth	Potholes	Crossfall	Drainage Maintenance
Average	1.7	1.4	1.2	1.4	1.9
%=1	36	62	87	64	13
%=2	56	38	10	36	87
%=3	8	0	3	0	0
%=4	0	0	0	0	0

Table 5. Wairau South – Summary of Results (Nov '02)

The average scores of between 1 and 2 indicates that the overall condition of the Southern network was generally good.

By comparing the two surveys (Table 5 above and Table 3, page 4) it can be seen that the average scores had generally improved with a very slight deterioration in the potholes score. The significant improvement of crossfall scores is, in the opinion of the authors, contributed to by a change in the Auditors' views coupled with a physical improvement.

4.2 DISCUSSION

The significant findings from the November 2002 survey are presented below.

4.2.1 Drainage

In most cases, water tables were in a reasonable working condition, with no major defects in performance.

4.2.2 Corrugations

Corrugations are not generally a problem throughout the network with the exception of Port Underwood Road and isolated areas of the Awatere Valley Road. The corrugations were most severe on climbing corners and mainly attributable to logging trucks and two wheel drive vehicles losing traction once the corrugations have formed. On completion of maintenance grading of Port Underwood Road, the corrugations form almost immediately.

4.2.3 Width

When a road is sufficiently wide for two vehicles to pass, then generally both directions of vehicles use a common wheelpath. The result is increased flattening of the crown which in turn causes water to pond and potholes to form. The maintenance issues involved with this can be significant.

4.2.4 Cross-fall

Atkinson Road and Tetley Brook Road have areas that are particularly flat, with limited ability to drain the water if the crossfall was increased. High shoulders and flat terrain cause difficulties not readily solvable in these areas.

4.2.5 Aggregate Size and Looseness

Comments made on the April 2002 remain unchanged.

4.2.6 Potholes

The network surveyed was relatively free of significant potholes. Many were in the nature of scabbing, and not so severe that drivers will take evasive action. Some potholes had formed on the French Pass Road.

5. Comparison of April '02 and November '02 Surveys

It would be expected that the unsealed roads would deteriorate to some degree over the winter months due to higher rainfall and associated build-up of moisture in the pavement. In fact, the results indicated a slight improvement in the overall condition of the network.

In the southern network, there was a slight increase in corrugations, but the depth of loose metal reduced during winter (possibly as a result of compaction taking place in the softer environment). Encouragingly, the increase in incidence of potholes in the wetter environment was very slight. There is a marked improvement in crossfall and in drainage condition, resulting from action being taken after the April survey. Table 6 below shows the difference in ratings between the two surveys. A"+" sign indicates an improvement in rating and a "-" shows a deterioration.

	Corrugations	Loose metal depth	Potholes	Crossfall	Drainage Maintenance
Wairau South Average	-0.1	+0.4	-0.1	+0.8	+0.1
Wairau North Average	+0.2	-0.2	+0.2	+0.3	0

Table 6. Net Difference of Results (April '02 - Nov '02)

Several explanations can be offered for the positive trends:

i. Increase in maintenance activities undertaken closer to survey date
ii. Maintenance frequency was increased over the winter period
iii. The winter was relatively dry coupled with less traffic
iv. The Auditors' standards were varied since first survey
v. Change in grader operator

Recent maintenance activities for the November 2002 survey were included in the report and should be documented in subsequent surveys in order to identify a trend.

Maintenance of the unsealed roads is generally undertaken in a cyclical manner. In addition, the roads are inspected regularly, especially over the winter months, and patch grading and/or metalling is undertaken as necessary. The benefit of this system contributes to the overall good condition of the network post winter.

It was not considered that the Auditors' standards varied significantly since the previous survey other than that discussed earlier in this paper. The same Auditors undertook the survey with the same equipment and expectations. Consistency of personnel involved is key to the ongoing success of the surveys.

It was not fully understood what effect the change of grader operator had on the network over the 6 month period. Anecdotal evidence suggested that the new operator was cutting slightly deeper which had positive benefits, especially when coupled with the relatively dry conditions.

The audit results confirmed that the unsealed road network was in good condition and that the overall condition of the network showed a slight improvement from April to November 2002. However, the improvement was small and due to the factors listed above, it was considered that the overall condition had remained approximately the same.

Where the network shows significant deficiencies, it is generally a geographic and/or topographic feature that forms the underlying cause. Although the problematic areas had been identified for some time, the survey quantified the extent and a mechanism to monitor and target these areas in order to reduce network deterioration and overall maintenance activities.

6. Conclusion

This paper has explained the advantages of having a condition rating survey, how the survey was derived and has discussed results from two surveys at 6 monthly intervals of Marlborough's North and South Wairau maintenance contracts.

As a result of action being taken after the initial survey, a notable improvement in condition was observed in the second survey, notwithstanding that this was at the end of winter. In particular, crossfall and drainage maintenance were targeted following the first survey and the resulting improvement was identified in the November '02 survey. Further surveys will provide a clearer picture of condition trends of the networks.