THE BENEFITS OF A LONG TERM PARTNERSHIP APPROACH TO THE PROVISION OF NETWORK CONDITION DATA.

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ABSTRACT

New Zealand Transport Authority (previously Transit NZ) has undertaken skid resistance and high-speed data collection surveys since 1996/7. The initial contracts were tendered for 3 years but since 2002 contracts were tendered for three years with 2 one year extensions based on performance over years 1, 2 and 3 respectively. The current contract is in its 4th Year. These long term contracts have enabled the client and survey contractor to work closely together to provide continuous improvement in service delivery while continuing to satisfy the contractual obligations.

This paper describes and quantifies the benefits, both in quality and cost that have accrued over the 13 year period. The enhancements have included the provision of all survey measurements from a single survey vehicle, the improvement of seasonal corrections procedures, the introduction of geo-referenced digital video images at marginal cost, the addition of vertical load correction to improve the stability of measurements on sharp bends, the reduction of risk though vehicle duplication, the implementation of water control to protect the environment, enhancements to the annual validation process and data fitting using GPS referencing.

INTRODUCTION

In 1995 Transit NZ, now the New Zealand Transport Authority, NZTA, issued two tenders, one for the collection of high speed data and one for the collection of skid resistance data on the whole of the State Highway network. Each survey included 22,000 lane km of survey. The tender was for three years covering survey years 1996/7 to 1998/9. This was followed by a single tender including both surveys covering the survey years 1999/2000 to 2001/2. In 2002, a further tender was issued for both surveys covering the survey years 2002/3 to 2004/5 but with 2 one year extensions based on performance over years 1, 2 and 3 respectively. The extensions were granted and the current contract was let in 2007 to cover years 2007/8 to 2009/10 but again with 2 one year extensions. The two extensions have been granted on the basis of performance and the current contract is now in its fourth year and due to end after the 2011/12 survey in March 2012.

The award of long term contracts, initially for 3 years and latterly for 5 years, if the contractor achieves a high score in an annual performance assessment, provides the contractor with sufficient stability to consider long term resourcing. It also provides the ability to work with the client to innovate both in term of the clients changing business needs and the contractors knowledge of technical developments. The latter is particularly significant in driving forward with a programme of continuous improvement and has been steered through an informal Partnership Arrangement. The Partnership Agreement stands alongside the formal Contractual Agreement but does not take precedence over the contractual agreement and contains no financial conditions on either party. What it sets out is an open approach to annual discussions that allows both partners to understand the business needs of each organisation while striving to provide added value throughout the period of a contract.

This paper sets out the achievements that have resulted from the long term relationship of each contract. WDM® have been successful in tendering for each of the contracts since 1995 tender and so the achievement described have accrued as a result of working in Partnership for 14 years. The Partnership has been particularly successful because WDM® not only provide a

survey service to the client but also develop and build all the equipment that has been used for the network surveys an aspect that has allowed a much faster response to design changes than would normally be possible.

THE CONTRACT REQUIREMENTS

Although the tenders have changed over the 10 year period each tender has had the same fundamental objectives and they are summarised in this section. Some requirements have not been in all the contracts but this section outlines the broad basis of the work.

Each tender has been issued and awarded one year in advance of the start date for survey work to ensure all potential contractors, especially those based overseas have sufficient lead time to establish equipment and people to commence the contract on the start date.

Each tender has stated that Transit New Zealand/NZTA wishes to engage a Consultant and Survey Contractor to undertake high-speed data collection surveys on the whole of the sealed State Highway Network, which is about 22,000 lane km in extent.

In each of the three years of survey, the whole contract for the early years and the first three years of the latter contracts,, the minimum survey requirement is for the measurement in both wheel paths of roughness, rutting, shoving and deformation and mean texture profile depth and skid resistance, using a SCRIM or providing a correlation to SCRIM coefficients, together with gradient and horizontal radius, GPS coordinates elapse distance and air and road surface temperature. Additionally, it is necessary to record and report roadside events and reference station locations. The results are to be reported as 10 or 20m averages as well as 100m averages and for texture the distribution of texture from 1m averages is also required. Since 2002/3 forward facing right of way digital video images have been provided.

The works include for an annual validation in New Zealand to demonstrate the equipment and the processes are working correctly as well as ongoing monthly re-validation. It is also a requirement to establish annually, correction factors, to allow for seasonal variation in skid resistance. In the early years of the contracts it was also necessary to develop corrections for test speed and test temperature. These factors are then be applied to the skid resistance to produce equivalent measurements standardised to the New Zealand Equivalent Mean Summer SCRIM Coefficient (NZ MSSC) and more recently the NZ Equilibrium SCRIM Coefficient (NZESC) allowing for both within and between year variations.

The survey work must comply throughout with strict operational accuracy limits and data supply time limits. A quality plan to demonstrate how this can be achieved forms part of the survey programme.

The overall aims of the contract are to provide accurate and precisely-located measurements of road condition data in a meaningful and easily-accessed form so that maintenance work can be targeted onto these sections of the network which are deficient and where treatments will produce value for money. The data collection procedures are required to minimise delays and minimise any increased risks to other road users resulting from the survey work.

THE BENEFITS

The benefits that have accrued have occurred throughout the 14 years of survey work under the informal partnership approach. However, in this paper rather than a presentation in chronological order it has seemed more appropriate to group the improvements under generic headings related to the contract objectives and emphasis on quality, accuracy and safety while delivering continuous improvement.

Operational Improvements.

All four tenders have specified the requirement to measure roughness, rutting, texture, alignment and skid resistance with air and surface temperature using two survey vehicles, one for the high speed functions and one for skid resistance.

In the first year of the survey work in 1996/7 WDM® used one of its standard (at that time) vehicles to collect the high-speed functions, the MRM, Figure 1, because in that survey year the measurement of skid resistance was not specified. However, WDM® always considered that they should try and remove the need for two separate survey vehicles in order to:

- Provide a cost efficient survey for the client;
- Minimise the risks to other road users ;
- Improve the quality of data by ensuring all the data was aligned to each other.

This was achieved for survey work in 1997/8 with the development of what the Company has called SCRIM+ on which the high-speed functions have been added to the SCRIM system. With two years of survey work remaining, the development cost was borne by the contractor to enhance the service being provided. SCRIM+ satisfies all three bullet points by providing:

- both surveys at considerable less cost to the client than when two separate survey vehicles are operated;
- reduced risk to other road users by only have one vehicle to pass;
- all the measurements of condition recorded at exactly the same elapse distance, which is particularly important when:
  - alignment data is being used to define SCRIM site categories;
  - texture and skid resistance are being compared to determine if low skid resistance is due to polishing , flushing or a combination of both.

The first version of SCRIM+ had a beam added to the front of the vehicle, Figure 2. This worked well in the UK as it was being developed but incurred some operational challenges when operated on the road network in New Zealand where the substantial crossfall on many parts of the network made entry and exit from garages and hotel car parks difficult. When WDM®'s tender for the contract starting in 1999 was successful the Company immediately, again at its own cost, redesigned SCRIM+ to overcome the operational issues. The problem was overcome by moving the beam from the front of the vehicle to a point behind the front axle but ahead of the SCRIM test wheels, Figure 3. This has now become the standard layout for SCRIM+ and for the contract starting in 2007/8 the Company produced a completely new vehicle, Figure 4, based on the previous layout but with a larger water tank, emission control and other features described below. The Company has continued to send both survey vehicles shown in Figures 3 and 4 to New Zealand each year and to validate both vehicles so that there is immediate cover for the lead survey vehicle; before the second vehicle was available it would have been necessary to source separate vehicles from the UK to complete annual contractual obligations, if the SCRIM+ vehicle had been badly damaged.

During the 14 years of survey work significant changes have been introduced in the requirements for traffic management and these have been warmly welcomed by both NZTA and WDM® who both consider safety and minimising hazards as critical achievements in satisfying their corporate objectives. However, one aspect of the traffic management code concerned both parties and that was a requirement to provide a pilot vehicle both behind and in-front of survey vehicles because they did not travel at normal traffic speed. WDM® were able to bring their international experience and work with engineers in NZTA to demonstrate, successfully, that requiring other drivers to overtake 3 vehicle travelling at 50 km/hr was more hazardous that one vehicle, particularly if high intensity flashing lights were added to the test vehicle. However, both the Company and NZTA accepted this was not an ideal solution and that it would be better if the survey vehicle could travel faster, particularly on the less tortuous sections of the network, while

Figure 1: 1997/8 high speed survey vehicle.

Figure 2: The first SCRIM+ 1998/9: scrim + high speed survey vehicle.

Figure 3: The second SCRIM+ 1999/2000: scrim + high speed survey vehicle.

Figure 4: The third SCRIM+ 2007/2008: SCRIM + high speed survey vehicle.

still obtaining valid measurements of skid resistance. The main reason for constraining the speed of SCRIM was to minimise short duration over or under recording of skid resistance due to centrifugal forces causing load shift as a survey vehicle negotiates sharp, or low radius, curves. The Company undertook to develop a vertical load measuring system, implement it on a SCRIM, validate it at the UK annual SCRIM trial and then demonstrate to NZTA through the annual NZ based validation that the system corrected measurements so that test speeds up to 80 km/hr could be used. This work was carried out under the company's own development programme because it saw benefits in productivity over a long term contract. The client and the company both benefit from a much safer survey procedure.

These operational improvements have resulted from the long term contracts on offer:

- single test vehicle recording all the required measurements in a single pass;
- changes to vehicle warning lights to provide an initial solution to new traffic management requirements;
- development of load correction to allow higher speed testing providing a long term solution to new traffic management requirements;
- duplication of survey vehicles to reduce risk that the surveys are not completed each year, with associated financial risk to the contractor but also risk to the business plan for the client.

Data Quality

The provision of accurate and precisely located measurements is the primary objective of all data collection contracts and survey contractors strive to achieve the best results regardless of the duration of a contract. However, long term contracts provide opportunities to enhance the normal delivery by providing the contractor access to a time series of datasets and also, in the case of skid resistance, to add value to a clients correction process.

By far the greatest enhancement of accurate location referencing has been achieved through the introduction of geo-referencing the data rather than relying on linear referencing. Although the use of GPS for referencing the data was a client requirement of the 2007 contract as is often the case the devil was in the detail of the implementation. Irregularities in the network referencing were highlighted as the system was introduced:

- some networks contained roundabouts within a section causing quality assurance limits on the separation between carriageways to be exceeded,

- a number of section end points were in the centre of large junctions while the state highway turned left at the junction causing the quality assurance limits on the separation between reference point coordinates and the closest approach of the survey vehicle to be exceeded;
- the coordinates at the end of one section were not the same as those for the start of the adjacent section making route selection impossible;
- small gaps in GPS satellite coverage occurred regularly during a survey and required fill-in to maintain accuracy;
- processes were required to cope with small realignments within the network where the change in section length was insignificant when using linear references but the change in coordinates exceeded quality assurance limits on the separation between reference point coordinates and the closest approach of the survey vehicle between each years survey.

These issues would normally have resulted in difficult contractual discussions to apportion costs and responsibilities and resolve. However, with both NZTA and WDM® identifying considerable long term benefits, the processes were worked through on a shared basis and without recourse to the contract. The system adopted is reported in detail elsewhere1.

A further major benefit of the long term contracts has been the ability of WDM® to introduce a high level of quality assurance by carrying out a 100% data audit as a survey progresses. The company has access to year on year survey data and has developed software to produce what have been termed ‘sanity plots’ of all the collected measurements over the entire survey network. These sanity plots show the measurements obtained on a section by second basis for the current survey and two previous years. Any questions regarding data accuracy can be identified immediately and corrective action undertaken. This process has been introduced in addition to the contractual requirement for monthly Austroads type revalidation. The process has been introduced at no cost to the client because WDM®’s commitment to the supply of the most accurate data and its concern that errors in the measurements would undermine its credibility in this respect.

NZTA and WDM® have worked together closely over the years in refining and developing a pragmatic yet accurate system to allow for the seasonal or weather related influence on the measurements of skid resistance. The client has identified the correction process as a high risk and within the partnership approach WDM® has freely shared their international experience in developing the current procedures. A significant aspect of the process is a dual audit of the correction factors undertaken initially by WDM® and then duplicated by Opus engineers who act for NZTA as the Management Service and Quality Assurance, MSQA, Consultants for these survey contracts. The system currently involves testing 113 control sections located throughout the North and South Island with the backup survey vehicle at the start, the middle and the end of the summer test season. These surveys establish the mean summer SCRIM coefficient for each site. The mean values are then used to determine a long term mean for the site to allow the between year correction to be defined. The main survey vehicle tests the 113 sites at the start of the summer at the same time as the backup survey vehicle, to confirm there are no significant differences in their measurements, and again when it tests the highway network in the vicinity of each site. The latter test site results allows the within year correction to be established and this is then combined with the between year correction before reporting the SCRIM results. The locations of the sites in the North Island are shown in Figure 5.

Engineers from NZTA, the MSQA consultants and WDM® have openly discussed and continuously reviewed the annual validation procedure in relation to its objectives of demonstrating the survey vehicle is measuring accurately and that it will do so when operating over the full range of conditions that will be encountered on the State Highway network. Enhancements to the system have been introduced with each new contract to challenge the survey contractor to provide continuous improvements through improved performance of accuracy.

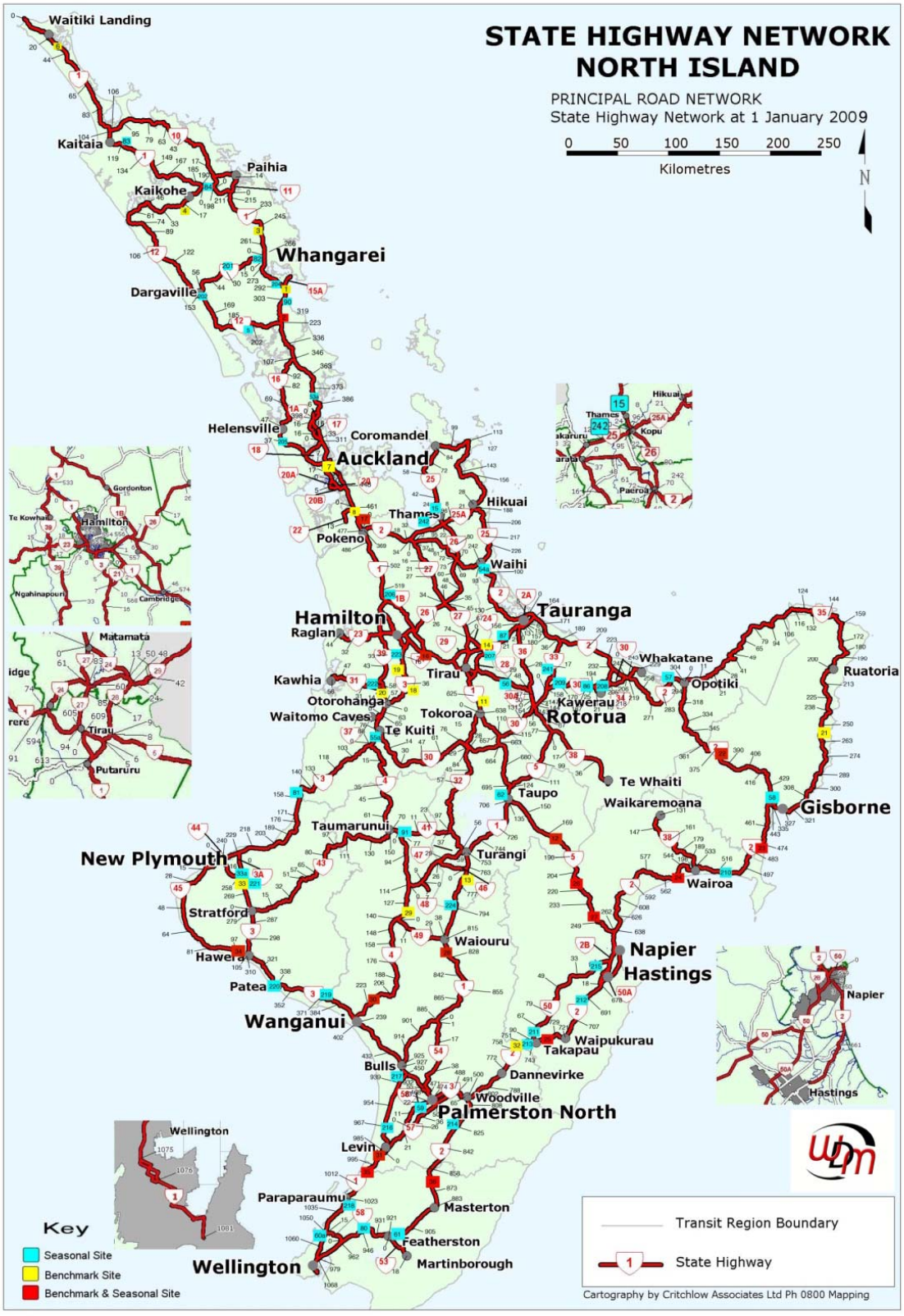

Figure 5: The location of the seasonal control sites used on the North Island.

Other data quality improvements that result from the long term contracts, which allow assured return for the contractor, are the introduction of vertical load correction, discussed in the

previous section in relation to improving safety, and continuation of the annual comparison with the UK fleet at TRL for both survey vehicles.

Innovation

Throughout the contract periods WDM® have regularly advised NZTA of international developments and discussed how these could be introduced within the contract periods. The most significant development in this respect has been the provision of forward facing video images. These images can be provided at only a marginal cost to the main survey and at a considerably lower cost than from a separate survey. They also have the advantage of recording conditions at exactly the same time as the survey data is collected which has often been useful in reconciling condition measurements with road conditions and minor networking issues that existed at the time of the survey. Although reluctant to receive the images initially NZTA quickly recognised their value and they now form a critical part of the data supply. The images are geo-referenced and software is provided to allow images to be easily exported, although NZTA use their own system for internal use. Because of the importance now placed on the video, NZTA recently asked if changes could be made to further improve the image quality and if a wider angle image could be provided. WDM® investigated the options, carried out the design of new fittings and software to capture store and deliver the much larger images at its own cost while NZTA contributed only towards the cost of the cameras; again an effective example of a partnership approach to add value to the delivered product. Examples of the current image quality is shown in Figures 6, which shows the detail of inventory that could be extracted, and Figure 7, which shows the detail of road condition that can be observed. NZTA is now investigating how inventory items could be extracted from the images and WDM® have produced inventory extraction software.

In the UK, WDM® provide a wide range of high speed surveys with different condition measurements from those traditionally recorded in Australia and New Zealand. These measures include a root mean square measure of texture, rather than the peak detection associated with the MPD texture, and measurements of roughness, which limit the wavelengths included.

These measures, and others, are collected at marginal cost across the network for NZTA and provided referenced to the network to allow the evaluation of their use and effectiveness, as better indicators of condition, than the current measures used in NZTA's Road Asset Maintenance Management, RAMM, system.

The alternative measure of texture has been particularly successful because a separate study has found this to be a very promising indicator of areas that have or are about to flush2. This measure, when combined with skid resistance will allow local maintenance engineers to better determine if low skid resistance is due to polishing, flushing or a combination of both and thereby better able to define appropriate remedial treatments. The use of roughness measurements restricted to short wavelengths, less than 3m, and medium wavelengths, less than 10m has been shown to provide a link with truck ride and the measures may in the future provide a better measure of deterioration in roughness than the IRI with its amalgam of wavelengths from 0.5 to 50m and its relative lack of sensitivity on networks with relative smooth conditions over the majority of their length.

Environment

Long term contracts with options for extensions based on performance put the risk of a secure income stream against up-front investment directly with the survey Contractor. This allows a number of improvements to be introduced, which benefit the environment, that might not otherwise have been achieved. Two significant examples are the use of one test vehicle rather than two separate vehicles, the introduction of a new vehicle, with the highest levels of emission control, and the introduction of a water control device for skid testing.

The partnership approach achieved the change to higher speed skid testing, but this resulted in a higher use of water because the system had to set the flow to provide sufficient water film depth at the highest test speed (water film depth is critical at low thicknesses but beyond a critical thickness skid resistance is largely insensitive). WDM® have developed and implemented

Figure 6: Typical digital image quality showing potential for inventory extraction

Figure 7: Typical digital image quality showing road condition

a water control system that adjusts the water flow in response to vehicle speed. The system has been fully tested and validation work both at the UK annual trials and the New Zealand annual validation have demonstrated that measurements of skid resistance have not been affected by the change. Water is a scarce resource and by introducing this technology significant saving will be made each year over the network survey, with or without the use of the higher test speed. This development supports the strategic corporate environmental objects of both NZTA and WDM®. The introduction of the system also means the SCRIM vehicle has to obtain water less often so there are some benefits in productivity but more importantly in safety because a stationary truck at a water fill station is always more vulnerable to being hit by other vehicles than a moving truck.

Network survey contracts involve operating a civil engineering contract spread over the whole network and in the case of New Zealand State Highway Network this makes the site over 11,000km in length. Efficient project management over a site of that size is difficult because it is

impossible to have a detailed knowledge of its full extent. A further advantage of long term contracts, in environmental terms, is the knowledge that is built up of the network being tested. Over time this minimises unproductive, or 'dead running', as project managers and field operators identify locally efficient test routes results in the use of less fuel and produces even fewer emissions and causes less interference to other road users.

CONCLUDING REMARKS

The examples of improvements described in this paper are not an exhaustive list but have been selected to demonstrate the range of improvements that can be achieved when an informal partnership approach is applied to survey contracts, particularly when the contracts cover a number of repeat survey years. The benefits and improvements described have all been implemented at marginal cost or no cost to the client, and the development costs, have all been borne by the contractor. This form of approach brings benefits to the client, to the survey contractor and to the industry in general.

From the Client's perspective, long term contracts with extensions based on performance will produce lower survey rates because the contractor's risks are always higher during the first survey of a network and by having work certainty based on performance, the contractor is in full control of the contract duration. This form of contract also provides the client with continuity of survey measurement method and therefore consistent standards. Combining long term contracts with a partnership approach provides the client with additional benefits of:

- knowledge transfer through the experience of the contractor working for other clients both nationally and internationally;
- early access to the latest technological advances in the specialised survey market;
- low or no-cost options to evaluate and implement new techniques more quickly than within conventional contractual arrangements.

From the Survey Contractor's perspective, long term planning of resources and investment is the greatest benefit of contracts let for many years with extensions based on performance. However, the greater benefits accrue from the partnership approach and these include:

- better understanding of the clients changing business requirements and therefore early understanding of the way in which the market is changing;
- knowledge transfer from the client side to appreciate more effectively what the client does with the condition data and, therefore, how the deliverables can be enhanced to make this process easier for the client's staff during a contract and provide added value, when tendering for subsequent contracts with a quality element in the evaluation and selection process;
- early understanding of conditions and defects the client would like to be able to measure objectively so the contractor can consider how these might be added to current surveys or how new measurement techniques could be applied to provide those measures i.e. understand more effectively where the market opportunities may go;
- a proven track record of success in providing innovation, quality data and continuous improvement within a contract for subsequent tenders.

The industry in general benefits from the developments achieved, because these ensure the survey market will continue, by providing measures directly relevant to the client's changing needs. If the measurements provided, no longer fulfil the requirements of the client then the survey market will disappear and that would not be good for Survey Contractors who would lose business but would be equally bad for clients who would lose their ability to effectively manage their assets. A detailed knowledge of the condition of highway networks, in a form that reflects need, is an essential pre-requisite to ensure cost effective treatments are applied at the optimum time, to save lives and protect the long term investment in the infrastructure; in short condition data will remain an essential part of producing asset plans and life cycle programmes.

REFERENCES

Blagdon, P, Mitchell, J and Kennedy, C. Improved locational accuracy of SCRIM data using GPS. Proceedings 3rd International Surface Friction Conference, Safer Road Surfaces – Saving Lives, Gold Coast, Australia, 2011. www.friction.org.au

Whithead, D, Donbavand, J and Mitchell, J. Developing an objective measure of flushing. Proceedings 3rd International Surface Friction Conference, Safer Road Surfaces – Saving Lives, Gold Coast, Australia, 2011. www.friction.org.au

AUTHOR BIOGRAPHIES

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Dave Robertson is a Registered Engineers Associate with a long career in the State Highway asset management field in New Zealand's National Roading authority - NZ Transport Agency. During the 1980's he was the project manager for the development and implementation of the RAMM (Road Asset Maintenance and Management) system throughout New Zealand both in the State Highway and Local Authority sectors. During this period the NZTA (formerly Transit NZ) embarked on multi functional data collection surveys including skid resistance, commencing in 1997. He was responsible for integrating this data into the asset management procedures in NZTA and the national reporting against the Key Performance Measures. In addition he was the New Zealand representative on the Austroads Asset Management Reference Group for a period of 6 years. A move to the Wellington Regional Office in 2002 provided him with network management experience followed by a recent change to a strategic role to make a further contribution to asset management of the State Highway network.

Chris Kennedy

Chris Kennedy is a Chartered Civil Engineer and a Director of W.D.M. Limited a post he has held since 1985. He is responsible for Survey and Consultancy surveys. This has involved the introduction and development of highway condition surveys which are now operated on a world-wide basis, together with the development of computerised management systems to achieve cost-effective maintenance programmes. His current areas of interest include surface characteristics of roads, particularly skid resistance, and the development of Safety Policies and tools to enhance Asset Management of highway networks as well as developing budget prediction models to define service levels outcomes.

After gaining his Doctorate at Birmingham University he worked for four years at the Transport Research Laboratory where he took a leading role in development the UK Structural Maintenance Evaluation and Overlay Design Method. He then moved to the University of Plymouth, England as Head of Department of Civil Engineering before joining W.D.M. Limited.