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MODEL DISPLAYS CLEAR PICTURE OF NETWORK PERFORMANCE

Research has provided guidance on how the performance of New Zealand's state highway network can be effectively monitored using emerging digital data sources.

While directed at the NZ Transport Agency, as the agency primarily responsible for managing and operating the state highway network, the research will also be of interest to other road controlling authorities for monitoring their own road networks.

The report summarises the background to the research, including how the data sources and monitoring indicators were selected, and details how the proof-of-concept monitoring model was developed and delivered. It also explores future opportunities to understand the performance of the state highway road network, both spatially and over time, using emerging digital data technologies.

LOOKING AT THE OPTIONS

The research project, conducted by Abley Transportation Consultants with support by URS New Zealand, built on other recently published Transport Agency research (Denne, T, R Irvine, A Schiff and C Sweetman (2013) *Blueprint for a best practice measurement indicator set and benchmarking*, NZ Transport Agency research report 522), which established a comprehensive set of indicators to measure road performance.

This project extended that concept by exploring how emerging digital data sources can be used to inform these monitoring indicators. Such indicators are used to support transport planning, transport optimisation, road safety and asset management functions for the New Zealand state highway network.

A first step was to review the emerging digital technologies and data sources to determine which might be suitable. Only six technologies were available in New Zealand and, of these, four could feasibly provide data that network indicators could be generated from: GPS, Bluetooth, mobile phones and weigh-in-motion stations. Data was sourced from a number of GPS, Bluetooth and mobile data suppliers; however, the number of weigh-in-motion stations currently in operation in New Zealand was too low to be useful at a network level.

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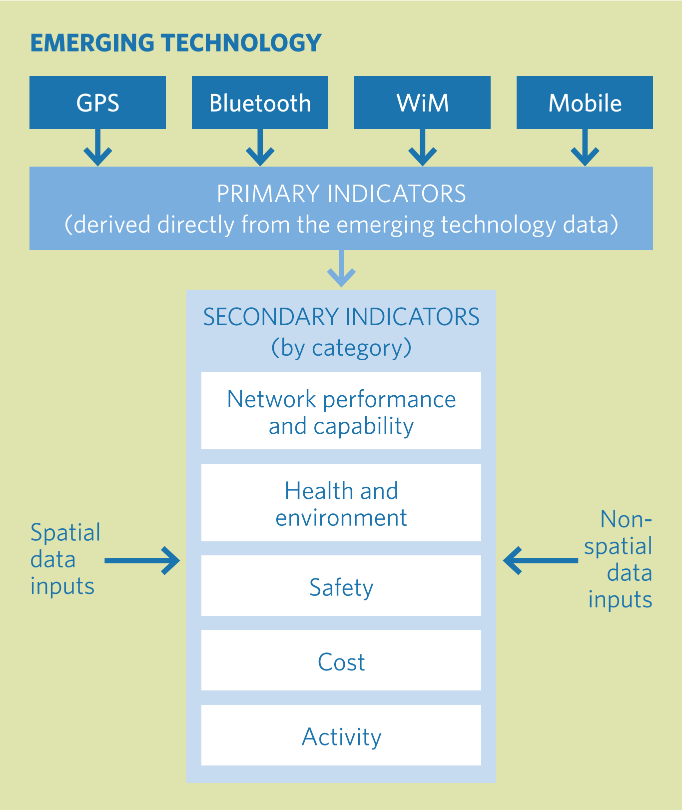
The next step was to review the literature on transport monitoring frameworks to identify a best-practice set of indicators. In line with the earlier research project, the team found a number of gaps in the monitoring frameworks currently used in New Zealand. This led the team to adopt the new indicator framework proposed by the earlier research, which is based around the concept of wellbeing.

The wellbeing approach is based on the idea that, although wellbeing is not a direct outcome of transport, transport can either promote or negatively affect people's wellbeing. Indicators are categorised according to the characteristics of the transport system that tend to impact on people's aggregate wellbeing, namely: network performance and capability; health and environment; safety; activity; and cost.

MODEL CONCEPTUAL FRAMEWORK



Once the technologies and indicators had been identified, the team tested the indicators against data generated by the technologies to determine whether it was sufficient to support the indicators' use.

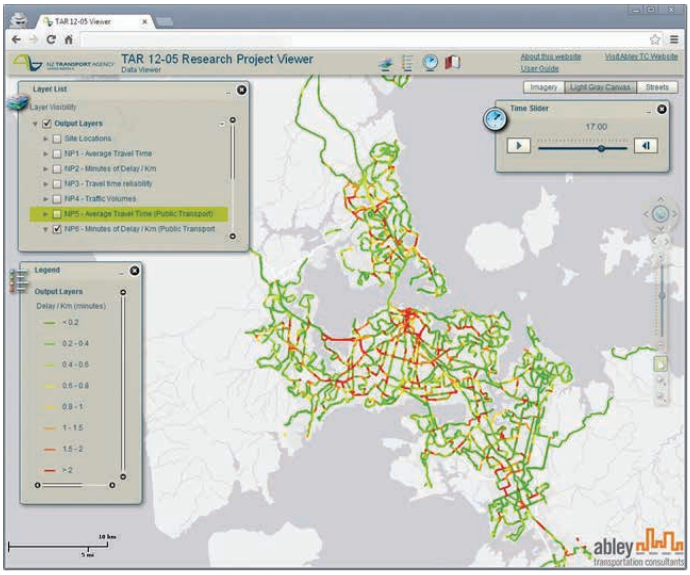
From this process, the team extracted a concise list of transport monitoring indicators that could be generated from the data provided by the emerging technologies. These were then split into primary indicators, where the data itself could be used, and secondary indicators, where the data needed to be paired with other information in order to provide a meaningful output.

This initial testing also revealed that GPS and Bluetooth digital data technologies were particularly effective in providing a meaningful output for the indicators tested. Commercially available mobile phone data was coarse and the research team encountered privacy issues around receiving detailed data sets to inform the state highway monitoring indicator set. The future of mobile data was identified as most likely being 'opt-in' applications, which is a rapidly evolving area.

The team then developed a GIS-based proof-of-concept model to demonstrate how the currently available data sources could inform the selected indicators.

The model incorporated four datasets from different suppliers, two from GPS technology and two being Bluetooth data. These included state highway and non-state highway road networks, rural and urban environments, and public transport modes. The proof-of-concept model was developed in a geospatial environment and performed successfully, reporting well on all the indicators to give a comprehensive picture of the performance of the state highway network, with the results displayed in a GIS web viewer.

TRAVEL-TIME VARIABILITY: AUCKLAND PT SUB-PROJECT



In their report, the research team recommends that the indicator framework and GIS viewer could be used as starting point for a national-level state highway performance monitoring portal.

'The proof-of-concept model provides a common source from which a range of Transport Agency business units can be informed, and has been developed to share common elements with other Transport Agency geospatial tools and applications. Thus, there is the opportunity to standardise data sources, achieve synergies between the model and other Transport Agency initiatives such as the Transport Data Warehouse, and support the Transport Agency's desire to centralise geospatial resources. This has the potential to deliver benefits for subsequent analysis and reporting across a range of business units of the Transport Agency while maintaining flexibility so the model can continue to develop to meet future needs,' the report says.

The report also includes a business case for the roll-out of the proof-of-concept model to a nationwide level, including an assessment of opportunities and risks, and recommendations for engaging with third party data suppliers.

Identifying the uses of emerging sources of digital data to assess the efficiency of the state highway network,
NZ Transport Agency research report 559

Available online at **www.nzta.govt.nz/resources/research/reports/559**

POTENTIAL USE OF EPOXY BITUMEN IN CHIP SEAL

Exploratory research has assessed the potential benefits of using epoxy modified bitumen chip seals.

The research, led by Phil Herrington, Opus Research, showed that epoxy bitumen may have significant practical benefits, through reducing flushing, if used as a binder in chip seal road surfaces, and that this, along with how the bitumen behaves at low temperatures, needed to be explored further.

EPOXY BITUMEN

Epoxy bitumen is a form of polymer modified bitumen and is increasingly being used as a binder in asphalt mixes. The material has several demonstrated advantages, including very high strength, good resistance to fatigue and oxidative degradation, and the ability, as a result, to provide very long-life road surfacings (when used in asphalt).

To date, epoxy modified bitumen has not been used for constructing chip seal pavement surfaces, which are the main road surfaces used in New Zealand. (Its only application with chip seals to date has been as a temporary surface material for bridge decks that are being resurfaced with epoxy asphalt.)

The research investigated its potential use as a sealing binder in chip seal surfaces, with a view to establishing whether it might reduce or eliminate some of the problems associated with conventional seals.

In particular, the research investigated whether epoxy modified bitumen seals might:

- provide a treatment for flushed chip seal surfaces at reasonable life cycle cost
- act as a lower cost binder for high skid-resistant surfacing systems employing calcined bauxite aggregates
- have a lower rate of binder oxidation and offer the potential for very long-life seals (on low-volume roads where polishing is not an issue), and if so what are the estimated lifecycle costs
- provide enhanced binder to chip adhesion and resistance to water-induced stripping.

The possibility of using epoxy modified binders for general chip sealing operations is a new concept, and suitable plant and binder materials are not as yet commercially available in New Zealand. The research was, therefore, only a preliminary investigation into the likely performance of such surfaces, rather than a comprehensive study.

FINDINGS

The research used a prototype epoxy modified bitumen (produced in the United States), with added accelerator to increase its curing rate.

The epoxy bitumen's shear modulus, needle penetration and cohesive energy were measured to monitor any changes, as it cured at 35°C and 45°C, and after accelerated ageing at 85°C for 177 days. Wheel-tracking tests were used to determine the epoxy bitumen's ability to resist chip embedment and flushing. Its adhesion to aggregate and resistance to water-induced stripping were also measured.

The research produced the following findings.

- Flushing – a major finding was that (after at least five days curing at 35°C) the epoxy bitumen binders could prevent chip embedment in a simulated soft, flushed seal. The low 'tack' of the cured binders also meant they did not retain aggregate fines. Accordingly, an epoxy bitumen seal might also be less likely to lose texture as a result of voids in the surface filling with fines, compared with conventional seals. Both of these observations indicate that epoxy bitumen may have significant practical benefits in reducing or eliminating flushing in chip seals.
- Curing rates – epoxy bitumen has very high initial penetration, compared with conventional New Zealand sealing grade bitumens. It was anticipated that the epoxy bitumen would require rapid curing (over a few hours) to achieve a level comparable with normal binders and attain adequate strength for chip retention and prevent bitumen tracking.

  A test patch of a chip seal surface with an epoxy modified bitumen binder was created as part of the research, and confirmed that the epoxy bitumen's curing rate was sufficiently rapid to be suitable for normal chip sealing operations. However, the curing rate would be too slow for epoxy bitumen to be useful as a lower-cost substitute for high-friction surface binders.

  The research also found that the epoxy bitumen's curing rate would be adequate at realistic summer road temperatures. However, the test patch was constructed in cold winter conditions and there was a problem with chip loss due to brittle failure of the bitumen. It was unclear whether this brittleness at cold temperatures was an inherent property of the epoxy bitumen or simply due to the cold conditions at the test site, as even standard 80–100 or even 180–200 bitumen might have failed in similar conditions.
- Adhesion and resistance to water-induced stripping – the epoxy binders showed excellent adhesion and resistance to water stripping without the need to add adhesion agents. This is an important finding, as the amine-based adhesion agents commonly used in binders would probably react with the epoxy resin and become ineffective.
- Durability – no problems were found with the epoxy bitumen's durability and resistance to oxidation. Its strength increased significantly after accelerated ageing, until it reached a comparable (or better) level to that of the commercial, high-friction surfacing binders tested.

The research report recommends that the potential for epoxy bitumen to resist flushing warrants further research, including laboratory and field trials to explore the effect parameters such as temperature and higher tyre loadings might have on its flushing resistance. This would enable the practical benefits and costs of using epoxy modified bitumen binders in chip seal surfaces to be assessed more accurately.

The behaviour of epoxy bitumen at low temperatures also needs to be studied in more detail to investigate the causes of the brittle behaviour observed in the field test and to fully understand its behaviour at low temperatures.

Epoxy modified bitumen chip seals, NZ Transport Agency research report 558

Available online at **www.nzta.govt.nz/resources/research/reports/558**

USING EMULSIONS TO REDUCE BITUMEN APPLICATION RATES

Research has looked into reducing the amount of bitumen used in chip seal road surfaces, by applying the bitumen binder as an emulsion, rather than as hot cutback bitumen.

The project found statistically significant differences in how cohesive the different bitumen binders tested were, although the report authors caution that, in practice, the overall strength of a chip seal surface depends on many more factors than the cohesiveness of the bitumen film.

THE TESTS

At present in New Zealand, chip seal road surfaces are generally created using hot cutback bitumen binders of various grades. The bitumens are cut back with kerosene.

This project hoped to establish whether, by using emulsions, the bitumen binder application rates could be reduced, while at the same time maintaining the pavement's performance. If so, then it might be possible to reduce the overall construction costs of chip seal pavements.

A preliminary literature review did not provide any clear indication that applying bitumen emulsions at lower residual rates than cutback bitumens would be acceptable. The use of cutback bitumens for chip sealing is uncommon internationally, and while the use of bitumen emulsions for this purpose is increasing in New Zealand, there is little research or literature that compares the two approaches.

To help address this knowledge gap, the project investigated the differences in the cohesive energies of model chip seal samples. Two different non-polymer modified bitumen binders of different viscosities were used. Sample chip seals were prepared using the two base binders, a kerosene cutback version of each base binder, and emulsions manufactured from those binders.

The experiment then tested the apparent cohesive energy (ACE) of the bitumen layer in the samples. Cohesion is the ability of a material to resist, by means of internal forces, the separation of its constituent particles. It is near impossible to measure cohesion alone in a complex system, such as a chip seal surface. The ACE of bitumen layers in chip seal is therefore measured, which is not a direct function of the binder, but is influenced by several variables: the bitumen-chip adhesion, the chip application rate, the binder film's thickness and the inherent cohesion.

The experiment used the swinging pendulum 'knock-off' test to infer the ACE of each of the samples. This test measures the momentum lost from a pendulum as a result of knocking off an aluminium tower that is firmly attached to the top of a sample chip seal surface using epoxy resin. When the tower is knocked off it takes the chips it is attached to with it. The momentum lost by the pendulum in knocking off the tower and attached chips is considered to be equal to the cohesive energy of the bitumen layer.

The differences in ACE between the emulsions, the base binders and the cutback base binders were compared. The results showed clear, statistically significant differences in the ACE of the different seal samples. The samples prepared using the cutback base binder demonstrated the lowest ACE, followed by the samples made with the emulsions. The samples made with the base binders demonstrated the highest ACE.

Opus Research pendulum tester with chipseal sample in place

The implication from these findings is that, if all other aspects are equal and the binders are applied at the same rates, the cohesion of a bitumen chip seal may be improved by using an emulsion compared with a cutback bitumen, but both will be inferior to the unmodified base binder.

Steve Bagshaw of Opus International Consultants, who conducted the research says, 'Our preliminary conclusion was that if the ACE values we measured were the same as those you might expect in the field, then it might be possible to apply bitumen emulsions at lower residual rates than a cutback prepared from the same bitumen, without undermining the seal's performance.'

The relative strengths of the different bitumen samples tested were not unexpected in the case of the cutback seals. Previous research has shown that some of the kerosene added to the bitumen in the cutback process does not evaporate, remaining instead in the binder and making it softer. The results were more surprising for the emulsified seal, however, as it had previously been assumed that after the water used in the emulsification process had evaporated, the properties of the emulsified bitumen would be essentially the same as those of the base binder. The project's results show that this might not be the case.

Steve stresses, however, that laboratory tests can only go so far towards replicating an actual chip seal surface.

'The overall strength of an actual chip seal surface is built by more than just the bitumen cohesive energy,' he says. 'Other aspects also contribute, for example the mosaic interlock of the chips. Our results focus purely on the cohesion within the bitumen film.

'Verifying the preliminary conclusions we've drawn would require road field trials, where different emulsion, cutback and base-binder application rates can be tested over an appropriate time scale. The trials must include at least one winter and of course will need to include sections where there is seal failure, so that we can establish the bounds of the specification.'

WHAT'S HAPPENING IN PRACTICE

As part of the project, the research team analysed the Transport Agency's Road assessment and maintenance management (RAMM) database to see how existing pavement surfaces created using the different types of binders were faring in the field.

The results indicated (tentatively) that bitumen emulsions were in fact being applied at residual rates lower than those for cutback bitumens. This backs up the preliminary conclusions suggested by the research project's tests.

The database could not indicate, however, how this was affecting the pavement's performance. New Zealand road surfaces prepared using bitumen emulsions are not yet sufficiently old enough for us to know, with confidence, if they are failing prematurely or performing adequately. The research team suggests that the analysis should be revisited after another few years of road use.

Reduced bitumen application rates using bitumen emulsions, NZ Transport Agency research report 560

Available online at **www.nzta.govt.nz/resources/research/reports/560**

Before

After

KEEPING ROADSIDE DRAINS IN TOP CONDITION

There's an old adage that water, water and water are the three factors that most affect how well a pavement performs. A recent research report aimed to provide a more reasoned approach for preventing pavement failure due to water ingress – by investigating and recommending an optimal drainage maintenance strategy.

It is well established that poor drainage can significantly affect a pavement's performance. Excess water content in pavement layers can decrease pavement strength, degrade materials and lessen bonding between the layers.

It is also clear that renewing failed pavements is a costly business: in the 2010/11 financial year, the Transport Agency spent 23.2% of its total state highway maintenance budget on pavement renewals, and just 3.7% on drainage maintenance.

It follows that when funding for pavement renewals is tight, making sure that roadside drainage is well maintained and working as it should be is a cost-effective way to not only optimise a pavement's life, but also reduce the number and costs of the renewals needed.

This research project had dual aims: to investigate how important drainage maintenance was to pavement performance; and to recommend a strategy that could guide when and where drainage maintenance should occur.

With regard to the former aim, the project used a combination of repeated-load triaxial testing and water movement modelling to show that once water has infiltrated a pavement's basecourse (usually as a result of prolonged rainfall and inadequate drainage) it can take weeks for the water content to return to its equilibrium condition. During this time the pavement can suffer significant damage. There is also a high probability that further rainfall will occur and thus re-saturate the pavement.

These findings were backed up by extensive past research into the relationship between pavement performance and water, and observations from the field, where water build-up in a pavement has been noted to lead to rapid pavement failure.

With regards to the second aim – to recommend a drainage strategy – the first step was to develop a scorecard. The scorecard would produce a drainage risk profile for an area of network, which would enable it to be ranked in terms of how important drainage maintenance was for its ongoing performance.

Drainage maintenance works (which also bear a cost) could then be targeted at those areas of the network that would benefit most. Lower-risk areas, such as low traffic areas, where drainage is not a huge factor in how well the pavement performs, could receive less frequent maintenance works.

The resulting scorecard ranks how important drainage maintenance is for a particular pavement network in terms of the following features.

- Climate – how much rain falls on the network? Is the area subject to freeze-thaw?
- Topography – does the water run away quickly and easily? Is the terrain mountainous, rolling or flat?
- Drainage position – are the drains close to the traffic wheel path? This is a factor of the shoulder width. Are they sealed?
- Pavement type – will water significantly affect the pavement's performance? Bound materials such as asphalt will be less susceptible to poor drainage than granular materials.
- Traffic level – how much traffic is using the pavement?
- Surface water flow – will water flow across the surface if the drainage is inadequate? This is both a vehicle safety issue and a pavement issue, as tyre pressure can force water through a thin surfacing.

Road asset managers can use the results from the scorecard to make decisions about the best drainage maintenance regime for a particular area, including whether new drains or shoulders are required.

The project's proposed maintenance strategy, based on the scorecard's results, involves the following steps.

1. Identifying areas on the network where inadequate drainage may have a significant effect on the pavement's performance or create a traffic risk. Based on the responses given to the scorecard's questions, sites can be ranked as being at high, medium or low risk of suffering from water-induced damage.
2. Identifying 'black spots' on the network where specific drainage features may result in water flowing across the road, eg blocked sumps. Black spots may occur in all areas: high, medium and low risk.
3. Performing an annual visual rating survey of the drainage in the high-risk areas identified in step 1. There is already a drainage rating system described in the RAMM manual and this would be suitable.
4. Ensuring regular inspections and maintenance are performed, especially before forecast heavy rain, in areas identified in steps 1 and 2.

Any events or features that could block drains should be minimised, and dealt with as in steps 2 and 4 of the strategy. This would include such things as eroded drainage side slopes or scour around the structure, sediment deposit and silting, vegetation and debris blocking the drainage path, erosion on the road shoulder (which can cause ponding), and vegetation or fine deposit blocking the slope of the shoulder.

The project team, led by John Patrick, Opus International Consultants, recommended the scorecard should be included in the RAMM manual, for use by road controlling authorities. Most of the information needed to complete the scorecard can already be found in the RAMM database.

Once the system is in place, the costs of maintaining drainage to an appropriate level could be monitored to establish if it was cost effective. Developing a renewals strategy (for those areas where maintenance is not cost effective or drainage capacity is inadequate for the water flow) was beyond the scope of the project.

Optimising drainage maintenance for pavement performance, NZ Transport Agency research report 555

Available online at **www.nzta.govt.nz/resources/research/reports/555**

KEEPING TABS ON MOBILE PHONE USE

Research to identify the best means of detecting mobile phone use by drivers revealed both implementation issues and future potential.

Mobile phone ownership and use in New Zealand is likely to increase in the future. It is also likely to change, as phone technologies continue to advance. Driver distraction, as a result of using a mobile phone while driving, is already a concern, and is targeted in the government's Safer Journeys programme. Safer Journeys aims to reduce driver distraction (including phone use) in order to improve the safety of New Zealand roads.In a project funded by the Transport Agency, Opus Research examined the options for monitoring mobile phone use by drivers while they are driving.

'Enhancing accurate detection is critical to monitoring and implementing policy and enforcement interventions to reduce driver distraction and improve safety,' the project team, led by Jared Thomas, states in their report.

The detection option selected and tested in the study – of roadside observation supported by mobile phone detection technology – returned patchy results, including insufficiently robust detection by the technology employed, and huge discrepancies between the mobile phone use that was observed and that which was electronically detected.

Yet, despite these discrepancies, the project team also thought the combined approach held promise.

'If the issues identified in the technology study could be overcome, there is evidence that observational methods of mobile phone detection could be greatly enhanced through technological solutions,' the team states.

TESTING THE OPTIONS

At present, driver mobile phone use in New Zealand is monitored (by the Ministry of Transport and others) by direct visual observation. There are problems with this approach though, including indications that it substantially under-reports actual use.

As an example, direct roadside observation studies (here and overseas) generally record fewer than 10% of drivers using mobile phones while driving. (In New Zealand, the figure tends to be lower at 2% in studies conducted in recent years.) Surveys, however, have indicated that up to 69% of drivers self-report using mobile phones while driving. This discrepancy is sufficiently large to warrant exploring more accurate ways to detect and monitor actual phone use.

During the project, the research team investigated five key methods for detecting mobile phone use, before settling on roadside observation supplemented by an external mobile phone detector as 'the preferred method to monitor mobile phone usage over a longer period'. Although some of the other options promised to be more accurate and offered richer data, the difficulties and costs of implementing them meant they were discounted.

Having selected a method, the team evaluated the available mobile phone detectors to see which was best suited for New Zealand use. Numerous devices were rejected due to their cost, excessive simplicity, privacy ramifications and uncertain legality. Of the remaining devices, a received signal strength intensity meter was selected as the most suitable for field testing.

Criteria taken into account during the selection process included whether the device could cover all of the telecommunications frequency bands used in New Zealand, had an area of detection that was directional (to increase confidence that the phone being detected was actually in the vehicle) and had adjustable detection threshold and sensitivity levels (again to ensure that the device was not detecting phones in the surrounding environment, rather than the vehicle being observed).

The team chose three sites to carry out a pilot survey using the preferred detection method. Sites were selected to represent typical New Zealand roads with varying speed limits, and to provide different levels of background noise so that the team could investigate what effect this had on the detector's ability to accurately pick up in-vehicle phone use.

INCONSISTENCIES WITH THE RESULTS

In total, 4,837 vehicles were observed across all three sites. Of these, 5.5% of the drivers (265) were visually observed to be using a mobile phone while driving. Observations included hand-held phones, headsets, and drivers who were texting and talking when no passengers were present. This was a greater level of mobile phone usage than has previously been observed in New Zealand.

In comparison, the electronic detector picked up mobile phone use in 9.6% of vehicles (462) passing the observation reference point. This shows that only 57% of the mobile phone use identified by the detector was being identified by visual observation.

However, there was a catch, in that when the detector's results were compared with those from the visual observations at all three sites, it became apparent that the detector had only picked up 35.8% of the times when drivers were observed to be using a mobile phone. The result was slightly better when the team looked at only those incidences where the driver could be seen to be holding their phone as if they were making a call (96); in this case the detector recorded mobile phone activity 41.7% (40) of the time. This meant that over half the time (58.3%, 56) the device did not detect mobile phone use when a phone call was observed.



The three locations where the tests took place.

Potential reasons for the visual observations being so much lower than the rates found by the detector could be covert texting (which is hard to observe directly in fast-moving traffic), drivers not speaking on a call at the point they were observed (eg using hands-free while the phone is out of sight or listening rather than talking), and environmental factors (such as difficulty seeing what drivers were doing due to tinted windscreen or weather conditions).

Another possible explanation was that the detector was picking up phones that were passively sending or receiving data with no interaction from the driver (for example, recalculating a route in a mapping program, downloading emails or receiving calls or texts in the background). In these cases, although the detector might register activity, it was not necessarily of a sort to distract the driver or affect road safety.

With regards to the opposite scenario, where drivers were visually observed to be using their phones but this was not picked up by the detector, this could be because the detector's threshold level had been set too conservatively to detect the mobile phone activity, or the high level of noise at the site was masking it.

In their report, the project team point out that this latter possibility is a very real issue for future detection and monitoring efforts.

'The greater the noise at a site, the higher the detector's threshold has to be set in an effort to detect phone usage from a specific vehicle. These low signal-to-noise ratios may be caused by mobile phone masts, pedestrians with phones near the site or residential sites with high mobile phone usage within homes (eg anywhere with a large non-vehicle-based mobile phone user group). As this threshold is increased, there is a growing chance of dismissing drivers' mobile phone usage as noise rather than actual usage,' they say.

To get around this, the team suggests that techniques such as triangulation could be used, with multiple mobile detection devices set up to corroborate that a signal comes from the target vehicle.

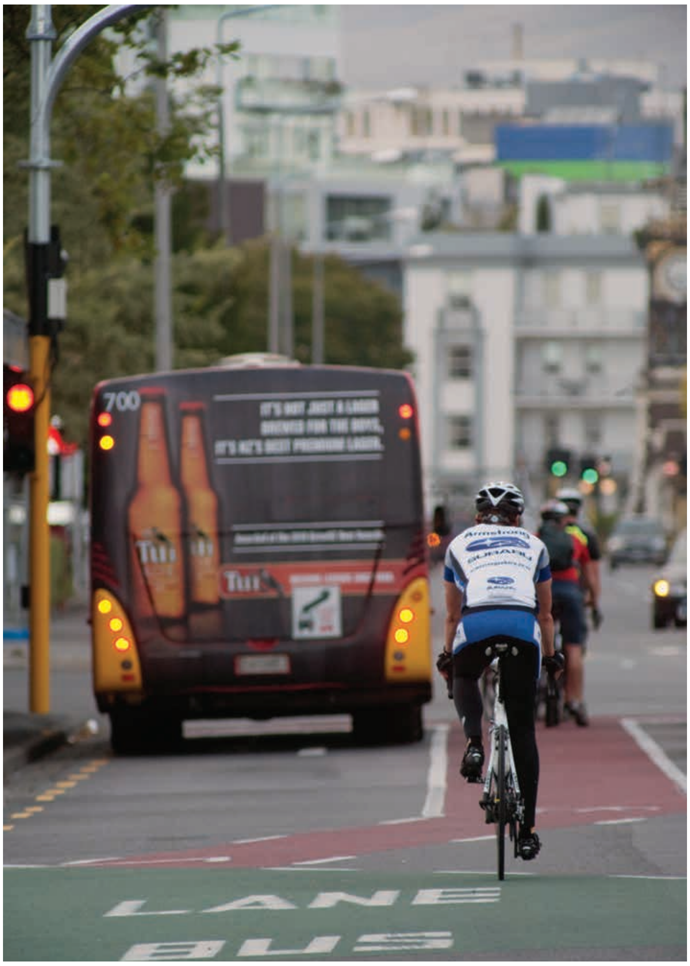
FUTURE USEFULNESS

Overall, the project's results indicate there is potential for using mobile phone detector technology to monitor drivers' mobile phone usage from outside the vehicle. However, further robust testing is required before this can occur.

In their report, the project team recommends measures to address the limitations found in the pilot trial and makes suggestions for future research into using technological methods to monitor drivers' mobile phone usage.

Survey methods for driver mobile phone use, NZ Transport Agency research report 556

Available online at **www.nzta.govt.nz/resources/research/reports/556**



SPECIAL VEHICLE LANES: GETTING MORE FROM OUR ROADS

Special vehicle lanes are a tool available to road controlling authorities where demand for travel is increasing but the opportunities for expanding road infrastructure are limited.

Special vehicle lanes involve the allocation or reallocation of road space for the use of particular classes of traffic, such as buses, trucks or private vehicles carrying one or more passengers (high-occupancy vehicles). The remaining traffic shares the other general traffic lane or lanes.

Only vehicles of the prescribed types may use the special vehicle lanes, with the restriction applying either at certain times (such as peak hours) or all the time. Sometimes when a special vehicle lane is introduced, road users will change their travel behaviour in order to take advantage of it (for example, by carrying more passengers or switching to public transport), although not all users are willing or able to do this.

Special vehicle lanes are already used in New Zealand. However, the decision to install a lane and the selection of the treatment has, more often than not, been based purely on a policy decision without the evidence to support one form of treatment over another.

Without the evidence, proposals to install special vehicle lanes are vulnerable and easily undermined. In addition, performance measures developed for special vehicle lanes to date have tended to focus on the performance of the lane itself, rather than its broader impact on the road corridor and its users.

GHD Ltd, in a research project funded by the Transport Agency, looked at this issue, drawing on New Zealand and international research to develop a systematic approach and analytical modelling techniques for assessing the performance of special vehicle lanes on urban arterial roads.

Report author Tim Brown says, 'Special vehicle lanes provide lower and more reliable travel times for those eligible to use the lane. However, their effectiveness at moving people and freight along a corridor more efficiently is largely dependent on the impacts to other users.

'The vehicles that are eligible to use special vehicle lanes are usually only a limited part of the total traffic using a particular arterial route. The value or scale of the people and freight being moved in those vehicles may be greater than that of the vehicles not eligible to use the special vehicle lanes.

'By considering the value of the people and goods being moved along a corridor, and not just in the special vehicle lane, we have been able to demonstrate that in the right circumstances, corridors with special vehicle lanes are more effective at moving people and freight more efficiently than corridors without them.'

MEASURING EFFECTIVENESS

The research developed a corridor assessment model, which can be used to evaluate the viability of implementing various types of special vehicle lanes.

The model (created in Microsoft Excel) provides a simple and useful tool to assess the predicted performance of corridors with a special vehicle lane. It provides a quantifiable estimate of performance, which practitioners can use to decide whether a special vehicle lane should be installed and in what form, rather than having to rely purely on policy decisions.

The model takes into account all of the major factors that influence traffic flows in urban corridors, namely:

- intersection performance, spacing and level of coordination
- mid-block lane performance
- on-line or off-line bus stops and bus stopping times
- level of take-up and level of violation
- parking, merging and access
- behavioural response to the implementation of special vehicle lanes.

The model's results are presented as a series of tables and figures showing the relative performance of the different types of special vehicle lanes that could potentially be installed, based on the above inputs.

The performance measures used to assess the effectiveness of the various lanes were selected because they:

- were closely linked to the policy objectives
- considered the performance of the whole corridor (eg economic efficiency and corridor productivity) and of the individual special vehicle lane
- were relatively simple to measure, and could be easily reported on
- reflected the need to consider the operational performance of the corridor or lane (ie compliance, reliability and level of service by mode) and user safety.

The model provides an unweighted analysis of the corridor's performance, with an additional output to measure the level of service gap, relative to the target performance criteria. It allows the user to specify either observed data or model data, and provide standalone outputs or to feed back into a network assignment model or other assessment processes, such as the SMARTROADS network fit assessment tool.

The model can be accessed in the research report at www.nzta.govt.nz/resources/research/reports/557.

TESTING AND DEVELOPING THE MODEL

The research project tested the model by using it to assess the performance of six Auckland arterial corridors with special vehicle lanes during morning and evening peak periods. A key finding of the tests was that when a corridor becomes congested, a special vehicle lane offers a more efficient means of moving more people in a quicker time than a general vehicle lane. Another finding indicated there is an opportunity to determine the level of public transport patronage that would justify on economic grounds, the use of a bus lane over a transit lane.

Areas where further research is needed include the impacts that special vehicle lanes have on corridor capacity and transport mode choice, and the relative safety of special vehicle lanes.

The research team also suggests refining the model to enable it to assess multiple potential layouts and intersection capacities, and determine the thresholds for patronage and vehicle use that would justify a particular type of special vehicle lane, rather than relying on demand analysis, as at present.

Getting more from our roads – an evaluation of special vehicle lanes on urban arterials, NZ Transport Agency research report 557

Available online at **www.nzta.govt.nz/resources/research/reports/557**

NEW RESEARCH REPORTS

Benefits and delivery risks for bus infrastructure schemes

NZ Transport Agency research report 561

Available online at www.nzta.govt.nz/resources/research/reports/561

This research evaluates existing policy and planning practices, both in New Zealand and overseas, and identifies a framework for appraising and evaluating the benefits and costs of bus-based infrastructure (bus stops and shelters, bus interchanges and bus priority) and the risks to successful project delivery. It suggests a combination of multi-criteria analysis and cost-benefit analysis can provide local authorities with useful tools for assessing proposed projects. At the heart of this appraisal method is the appraisal summary table (AST), which gives a summarised overview of the expected benefits, costs and risks relating to a project. The AST provides procedures suitable for both ex-ante and ex-post evaluation, and integrates risk management considerations into project appraisal from the outset. The proposed framework would usefully inform future revisions of the Economic evaluation manual and Guidelines for public transport infrastructure and facilities. Sustained application and refinement of the framework should ensure more systematic recording of the quantitative and qualitative benefits and risks of public transport infrastructure projects.

Economic benefits of park and ride

NZ Transport Agency research report 562

Available online at www.nzta.govt.nz/resources/research/reports/562

This research report investigated the economic and financial benefits from providing expanded park and ride (P&R) facilities. The project objectives were to assist decision makers by providing guidance on:

- the rationale for investment in P&R, as a cost-effective and efficient means of improving state highway and local arterial road performance and/or reducing public transport subsidies
- methods for the economic and financial appraisal of P&R investments
- the process and necessary conditions for optimal P&R investment decisions to be made.

The research included a review of international literature and New Zealand practice on quantification, assessment and evaluation methodologies for P&R facilities. The outcome of the research was an economic and financial evaluation framework adopting a cost-benefit analysis methodology. This framework was tested by applying it to five case studies covering both Auckland and Wellington for potential expansion of existing rail and bus-based P&R sites. The case studies demonstrated that increasing P&R provision produced high returns relative to most other types of investment schemes that encourage modal shift to PT in major urban areas, with estimated benefit-cost ratios in the range of 2 to 4.

Safer speeds: public acceptance and compliance

NZ Transport Agency research report 563

Available online at www.nzta.govt.nz/resources/research/reports/563

A key element of the Safer Journeys national road safety strategy is safer speeds that suit road function, design, safety and use. In some cases, particularly where investment to make roads safer at current speeds cannot be justified, this is likely to mean reduced speed limits for both urban and rural roads. This research considered the level of acceptance of and compliance with reduced speed limits. It examined information from a number of speed limit changes around New Zealand, including town centres, along strip shopping, suburban streets, mountainous roads, flat state highways and local roads. Before and after speeds were compared for any speed reductions and driver compliance.

The acceptance of reduced speed limits was researched using the limited literature available on this topic, a web questionnaire survey and the experience of three local councils. These showed a greater acceptance of reduced speed limits on hilly and mountainous rural roads and in shopping streets. There was less acceptance for reduced speed limits in suburban streets (except immediately around schools) and on straight flat rural roads with a lot of roadside hazards and frequently occurring priority intersections. Drivers do not appear to understand the crash risks of these scenarios, even when relatively extensive media and consultation programmes are undertaken.

OBTAINING TRANSPORT AGENCY RESEARCH REPORTS

All research reports published since 2005 are available free of cost for downloading from the Transport Agency's website www.nzta.govt.nz/planning/programming/research

PDF scans of research reports published prior to 2005 are available by emailing research@nzta.govt.nz

A NOTE FOR READERS

NZTA research newsletter

The *NZTA research* newsletter is published quarterly by the NZ Transport Agency. Its purpose is to profile research funded through the Transport Agency's Research Programme, to act as a forum for passing on national and international information, and to aid collaboration between all those involved. For information about the Transport Agency's Research Programme, see www.nzta.govt.nz/planning/programming/research.html.

Advertisements of forthcoming conferences and workshops, that are within the newsletter's field of interest, may be published free of charge when space permits.

All general correspondence, queries related to conference notices, and requests for additions or amendments to the mailing list, should be made to research@nzta.govt.nz.

Disclaimer

The views expressed in the *NZTA research* newsletter are the outcome of research and should not be regarded as being the opinion, responsibility or policy of the Transport Agency or of any agency of the New Zealand Government.

Availability of *NZTA research*

The current edition of the *NZTA research* newsletter is available in hard copy or on the Transport Agency website, along with all previous editions of the newsletter, at www.nzta.govt.nz/resources/nzta-research/.

Email alerts of newly published research reports

Email notifications are provided when new issues of the *NZTA research* newsletter are published. Notification is also provided when new Transport Agency research reports are published on the Transport Agency's website at www.nzta.govt.nz/planning/programming/research.html. Please email research@nzta.govt.nz if you would like to receive these email alerts.

Do we have your correct details?

We would like to hear from you at research@nzta.govt.nz if you wish to:

- add or update names, email or address details
- receive the *NZTA research* newsletter in hard copy format
- receive email notification of the publication of the *NZTA research* newsletter and research reports
- alter the number of *NZTA research* newsletter hard copies you receive.

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DID YOU KNOW...

That there is a spreadsheet on the Transport Agency website listing all published Transport Agency research reports?

The spreadsheet is searchable by several criteria and can be found at **www.nzta.govt.nz/planning/programming/research.html.**

The spreadsheet has two worksheets; the first worksheet lists research reports with associated key words and the second lists research reports with the report abstracts.