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NZ TRANSPORT AGENCY
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BETTER EVALUATION OF INTELLIGENT TRANSPORT SYSTEMS

Intelligent transport systems (ITS) are systems where 'information, data processing, communications and sensor technologies are applied to vehicles (including trains, aircraft and ships), infrastructure, operating and management systems, to provide benefits for transport users'.

ITS use information and communication technologies to address transport problems and improve transport networks. This is a relatively novel concept for transport projects, where conventionally the emphasis has been on making physical improvements to transport networks in order to bring about measurable benefits such as travel time savings, safety improvements and vehicle operating cost savings.

Because ITS projects use new and evolving technologies, it is likely that some of the benefits provided by these technologies, and the systems they comprise, are not yet captured by the procedures in the NZ Transport Agency's Economic evaluation manual (EEM). As a result, they may be overlooked, or quantified inaccurately, when the costs and benefits of transport projects that incorporate ITS are being evaluated.

To address this issue, a recent Transport Agency-funded research project aimed to develop a cost–benefit analysis framework that could take into account the distinctive costs and benefits associated with ITS projects.

The starting point for the project was to explore the range of common ITS project benefits, then assess whether or not they could be evaluated under the EEM's existing procedures. Where these procedures did not satisfactorily capture the benefits of particular ITS components, the project sought to develop a method that would capture the benefits. This method could then be used to compare the monetised and non-monetised outputs of ITS projects.

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A CLOSER LOOK AT BENEFITS

An initial review of the international literature showed that, although a lot of work had been done on identifying both the quantitative and qualitative benefits of ITS, there was very little information provided on how to monetise the value of benefits from specific ITS components (such as, for example, the value to commuters of real-time information being displayed at bus stops) so as to compare it with the monetised value of other non-ITS infrastructure improvements (for example, travel time savings).

The project outlined the main reported benefits of various types of ITS (namely traveller information systems, traffic control and management systems, public transport management systems, speed control and red light violation enforcement systems), noting for each of them whether or not it would be captured by the EEM procedures. However, the authors highlighted the need for caution around overstating the degree of these benefits, noting that a benefit in one respect, could be a draw-back or disadvantage in another. (An example would be lane signals at motorway on-ramps which, although they may improve traffic flows on the motorway, can cause congestion and queues on the ramps themselves and in surrounding streets.)

The authors also noted that, while the benefits of ITS were frequently stated in the literature, there was seldom related information about how they had been calculated. In addition, as stated above, there was a scarcity of literature that compared the potential benefits from ITS projects with those from other transport infrastructure improvements.

The project then went on to look at the EEM's ability to evaluate ITS applications and adequately capture the identified benefits. It concluded that there were many aspects or functions of ITS that could be evaluated using the manual. These tended to be the functions that physically enhanced the transport network, for example early detection and management of incidents, ramp signals, and parking management systems (among others).

ITS functions that did not physically alter the transport network tended to be harder to assess using the EEM. These were largely functions that provided information for travellers, such as real-time and pre-trip information. Characteristics of this information make its subsequent uptake and use difficult to assess using the manual's procedures.

CONCLUSIONS AND RECOMMENDATIONS

The report not only identified potential benefits unique to ITS, but also that benefits can be evaluated using a number of different procedures in the EEM and that it is not clear which specific procedures should be used. The report therefore recommended a separate section in the EEM on the evaluation of ITS benefits. This section should make it clearer how to assess ITS benefits and would also cover the ITS benefits not currently covered by the manual.

The report also identified a number of existing knowledge gaps and recommended further research to help fill these gaps. Perhaps most importantly there are some fundamental knowledge gaps in the economic theory underpinning ITS benefits - for example, whether willingness to pay or willingness to accept is the most appropriate methodology for assessing ITS benefits. Other specific topics identified include the collection and publication of local data from existing ITS projects (eg travel time savings provided by variable message signs, reduction in average delay as a result of signal pre-emption for buses, etc.) and further research into pre-trip information applications, as well as incident detection and management functions.

Considering a cost–benefit analysis framework for intelligent transport systems, NZ Transport Agency research report 584

Available online at **www.nzta.govt.nz/resources/research/reports/584**

TOOL PROVIDES IMPROVED ROAD RUNOFF SCREENING

The NZ Transport Agency's screening tool for road runoff has been revised to incorporate additional factors that allow its application to a wider range of receiving environments.

Photo credit: Porirua City Council

Road stormwater discharges can carry a complex mix of contaminants. Fuels, additives, oil, and brake and tyre residues are some of the more common and contain a variety of toxic and eco-toxic components, including heavy metals and organic compounds.

The receiving environments for this runoff are equally varied and include streams, rivers, lakes, wetlands, estuaries, harbours and the open coastline. Stormwater runoff can adversely affect these environments, with the characteristics of the particular water body having a significant influence on the fate of runoff contaminants, how they are assimilated and their sensitivity.

A 15-month study, completed earlier this year, built on earlier research to revise and enhance the Transport Agency's current VKT (vehicle kilometres travelled) screening tool for road runoff. The revised tool has a wider application for rivers, streams, coasts and estuaries, and is able to factor in the effects of pathway attenuation, traffic congestion and non-road contaminant sources.

The research team (MWH New Zealand and the National Institute of Water and Atmospheric Research) report that,'The road stormwater screening model developed in this study provides a robust, consistent method for establishing the relative risk of adverse effects from road runoff that can be applied anywhere in New Zealand using existing datasets'.

Other features of the model include the ability to:

- screen the road network for contaminant load 'hot spots'
- apportion contaminant loads between local roads and state highways
- analyse whole catchments for road contaminant contributions.

The model's risk-based approach to assess the impact of stormwater discharges on receiving environments aligns with current moves within regional councils towards a risk-based stormwater consenting regime, in support of the government's National Policy Statement for Freshwater Management 2014.

ROAD STORMWATER SCREENING MODEL

The new road stormwater screening model is described in the report, along with assumptions and limitations in its use.

The Transport Agency's current VKT screening tool was used as the starting point for the new model which includes the following enhancements:

- a road contaminant load module for estimating zinc and copper loads, at the sub-catchment level, from road traffic, vehicle emission factors that vary in relation to traffic congestion, pathway attenuation and conversion of vehicle kilometres travelled to contaminant load
- a non-road (urban) contaminant load module for estimating zinc and copper loads, at the sub-catchment level, from the extent of urban non-road impervious surfaces and contaminant yields for residential, industrial and commercial areas, respectively
- a method for assessing the risk to streams and rivers, based on estimates of in-stream copper and zinc concentrations relative to guideline concentrations, combined with a receiving environment sensitivity score, indicated by modelled values of the macroinvertebrate community index
- a method for assessing risk to coasts and estuaries, based on estimates of copper and zinc concentrations in sediments delivered to coastal discharge points, relative to guideline concentrations, combined with a receiving environment sensitivity score determined from the physical depositional characteristics of the water body.

Key concepts underlying the new model are:

- the adoption of a source-pathway-receptor conceptual model
- a focus on the potential effects of copper and zinc, using New Zealand road runoff sampling data collected under previous studies, recognising that these metals also function as proxies for a wider range of stormwater contaminants
- the ability to assess the risk associated with discharges to a range of receiving waterbodies including rivers, streams, coasts and estuaries.

The model is GIS-based to provide mapping of spatial output with the River Environments Classification used as the basis for analysis at the sub-catchment level. Excel provided the platform for estimating contaminant loads and risk.

TESTING THE MODEL'S PERFORMANCE

The model was evaluated during a case study of Te Awarua-o-Porirua Harbour and its catchment. This 178km2 area contains 365 sub-catchments and was chosen for its mix of local roads and state highways, receiving water bodies (streams and coast) and catchment conditions (urban and rural land uses).

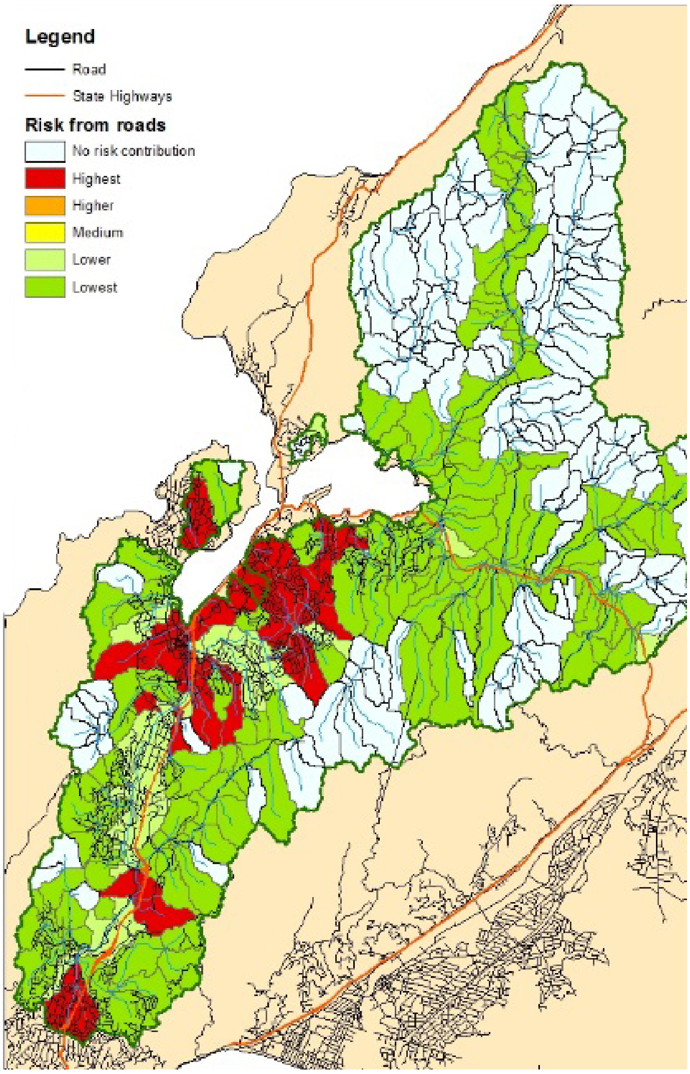
The model identified the relative risk to receiving environments from runoff (on a scale 'lowest' to 'highest'). As part of the case study, a sensitivity analysis checked the extent to which uncertainty in the model's inputs would influence the assessments of risk. Variations in road-derived loads of copper and zinc, and of residential roof-derived zinc loads, were found to create only a minor increase in the proportion of receiving stream reaches that were assessed as 'highest' risk. The authors concluded that any assumptions made in estimating contaminant loads were unlikely to have a major bearing on the screening model's outputs.

Example maps showing the modelled risk assessment of zinc and copper in streams in the case study area for road and urban contaminant sources is shown below.

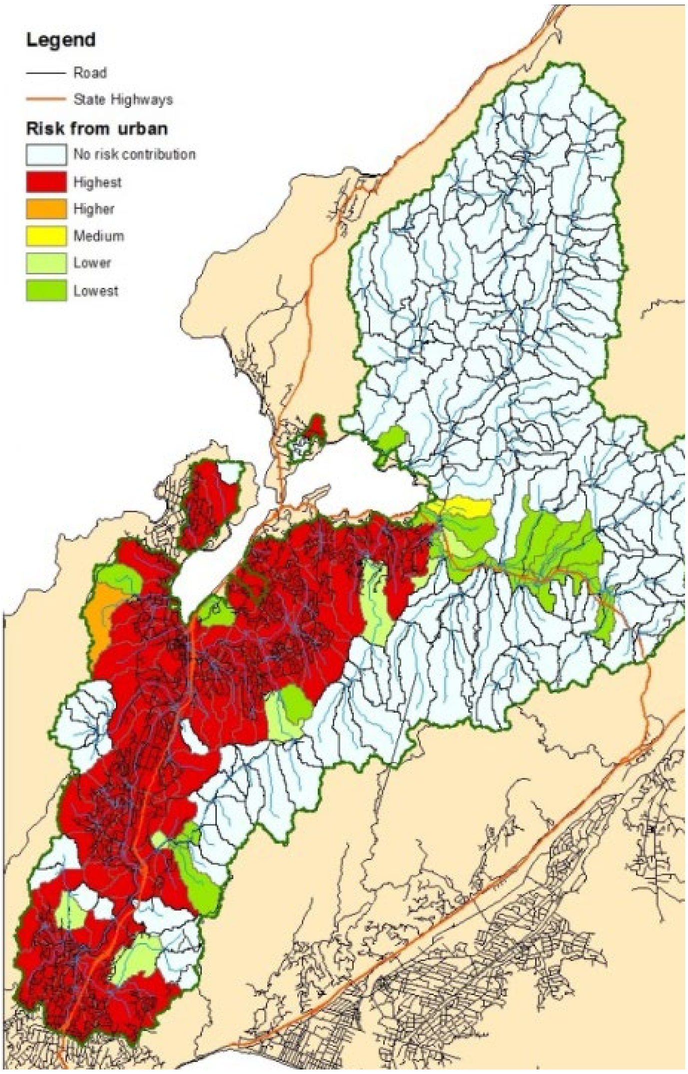
Of the 217 sub-catchments that contain roads, the model was able to screen the top 36 (17%) with the `highest' risk level (shown above in red). By comparison, 103 stream reaches (around 48%) were accorded a `higher' risk from urban contaminants in stormwater runoff.

'The model can be used for comparative screening of road networks and their likely risks to their receiving environments. It is intended for use by network operators and road controlling authorities to guide how they manage road runoff and develop their catchment management plans.' say the report authors.

ROAD RISK



URBAN RISK



Risk assessment of road stormwater runoff, NZ Transport Agency research report 585

Available online at **www.nzta.govt.nz/resources/research/reports/585**

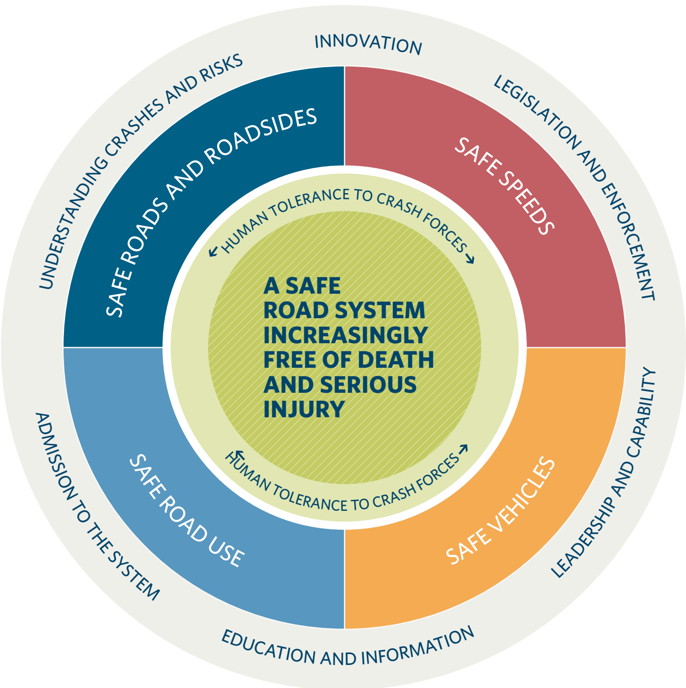
INCLUDING PUBLIC TRANSPORT IN *SAFER JOURNEYS*

Research has examined what steps would be required to increase the coverage of public transport within the government's *Safer Journeys* strategy and action plans.

Public transport is generally considered to be a safe form of transport. In New Zealand, passengers in cars and vans are seven times more likely to be killed or injured in a crash than passengers on buses. This figure is for time spent travelling and does not include injuries incurred by passengers while getting on to or off buses, en-route to and from buses, or falls once they are on the bus. Although the difference narrows when these types of injuries are taken into account, buses still remain a comparatively safer way to travel.

Recently published research by Opus Research has identified the contribution that public transport can make to a Safe System approach to road safety (sometimes also called Vision Zero or Sustainable Safety) and from this, developed an implementation plan to enable public transport to be inserted into the government's Safer Journeys strategy and its associated action plans.

SAFER JOURNEYS



Safer Journeys is the New Zealand Government's strategy to guide improvements in road safety from 2010 to 2020. The strategy's vision is 'A safe road system increasingly free of death and serious injury'. To achieve this, the strategy takes a Safe System approach, looking across the entire road system to improve safety by creating:

- safer roads and roadsides
- safer speeds
- safer vehicles
- safer road use.

Within these four categories, the strategy identifies a number of areas of concern (12 in all) where immediate improvement actions are needed. The strategy is accompanied by a number of action plans addressing each of these areas.

The *Safer Journeys* strategy officially introduced the Safe System approach to road safety into New Zealand government policy (although the approach had informed earlier road safety strategies). The aim of the Safe System approach is to create a road system in which serious and fatal crashes do not occur. The approach recognises that crashes will occur, but advocates that all necessary measures must be taken to avoid crashes, and that when they do occur, the people involved in them should not be subject to the sort of trauma that would result in fatal or serious injury.

The figure below demonstrates how the Safe System approach is encapsulated within the *Safer Journeys* strategy.

At present, public transport is only incorporated in *Safer Journeys* in relation to how it impacts on other road users, that is, through measures to reduce level crossing crashes and crashes where buses or trams hit other vehicles or pedestrians.

The strategy does not try to increase the mode share enjoyed by public transport (as a safer means of travel) in order to improve the safety of the road system overall. Instead, it leaves public transport's mode share to be influenced by other areas of government transport policy. Both *Safer Journeys* and these other transport policies are overarched by the *Government Policy Statement on Land Transport 2015/2016–2024/25* and are administered by the Ministry of Transport and its partner agencies.

One of the initial areas of enquiry for the current research was to survey what approaches governments overseas had taken to adopt public transport into Safe System approaches to road safety.

The survey indicated that, as in New Zealand, road safety strategists didn't attempt to shift the mode share enjoyed by public transport. Instead they tended to accept the mode split that resulted from other government policies (such as funding levels – a major determinant of public transport usage), and worked with these to maximise the overall safety of the networks, using Safe System principles.

The research team concluded that this approach remained appropriate for New Zealand.

INCLUDING PUBLIC TRANSPORT IN *SAFER JOURNEYS*

Bill Frith of Opus Research, Opus International Consultants, explains how the focus of the research team's enquiries then shifted to how public transport could best be accommodated within the Safe System approach represented by Safer Journeys.

Bill says,'For on-road public transport vehicles, such as buses and trams, it would be relatively straightforward to fit them into the *Safer Journeys* framework that we already have for motor vehicle crashes. All that would be required would be for new areas of interest and associated actions to be created, although of course there would also need to be a source of funding. All such actions have costs associated with them, both for gathering the crash information that you need to evolve countermeasures, and for the costs of the countermeasures themselves. It's also important to note that, if we retained the existing framework without modification, then only bus and tram-related injuries that involved collisions with other vehicles or pedestrians would be included. Other public-transport related injuries, such as tripping or falling injuries, would be excluded.'

Other forms of public transport that didn't use roads, such as commuter rail and ferries, would also be excluded. The research team considered that to bring all types of public transport within *Safer Journeys* (as well as other types of public transport-related injuries), the strategy's scope would need to be extended from urban road safety (the current focus) to urban transport safety. Again, no structural change to the framework itself would be required. Rather, what was needed was for the framework's reach to be restated, so it included some new areas of interest and action plans.

To achieve this, the team recommended that:

- the whole journey should be considered, rather than just the road phase
- data should be gathered and analysed about injuries relating to all aspects of the journey
- safety initiatives aimed at public transport operators should aim to influence how public transport is operated
- tools should be made available, and used, to better monitor public transport safety, including recording pedestrian-only crashes and injuries to public transport passengers (as has been done overseas).

RECOMMENDED MEASURES

In the report, the research team considers and sets out potential ways that *Safer Journeys* could be extend to better incorporate the safety of PT-related travel.

This includes ensuring the framework, and the systems behind it, recognise data about a broader range of injuries.

Bill says,'At present, *Safer Journeys* addresses injuries that occur on the road network and about which we have accessible data. Usually this involves crashes with a motor vehicle, although there is some information about cycling injuries where no motor vehicle is involved. This data comes from Police reported crashes and is held in the NZ Transport Agency's Crash Analysis System. Although data is also currently available about other sorts of public transport-related injuries, at the moment it is held in separate databases that do not feed into *Safer Journeys*, and as a result is excluded. This includes injuries that passengers incur while travelling on or within buses and trams, boarding or alighting from them, and walking to and from them.'

The research team considered that to make better use of this data, systems could be set up to better capture the incidence and characteristics of these types of injuries, so that effective countermeasures can be developed to address them.

Other practical measures suggested by the team include:

- examining the way pedestrian infrastructure is funded to ensure pedestrian routes to and from public transport are safe
- ensuring walking surfaces are well designed, implemented and maintained, so that they are not only visually appealing but can play a full part in a Safe System
- ensuring road work practices (including road and footpath closures) cater adequately for pedestrians, and users of public transport stops
- re-examining the interior design of public transport vehicles, driver training, the design of public transport interchanges, public transport vehicle design and operation, and driver management, to ensure they all maximise user safety
- providing safety input at the planning and design stages for public transport projects to ensure they reflect Safe System principles (for example, maximum separation between modes, and 'no surprises' routes).

In conclusion, the team made a series of recommendations for the National Road Safety Committee to consider. The National Road Safety Committee is responsible for producing, maintaining and overseeing the implementation of *Safer Journeys* and its associated action plans. The research team's recommendations to the committee are set out in the report.

The role public transport can play in Safer Journeys and, in particular, to advance the Safe System approach, NZ Transport Agency research report 581

Available online at **www.nzta.govt.nz/resources/research/reports/581**

DEVELOPING A FRAMEWORK FOR COMPARING RAIL SAFETY DATA

Research into international rail safety indicators has developed a draft implementation plan for potential use by the New Zealand rail industry.

In 2014, the NZ Transport Agency commissioned Interfleet Technology NZ Ltd to carry out research into international benchmarking of rail safety indicators. The aim was to develop recommendations for how safety data collection could be improved in New Zealand, and on suitable lead and lag time indicators that were applicable to the New Zealand rail environment.

To ensure that maximum value-for-money was obtained from the work for the rail sector, the research project was overseen by a Steering Committee comprised of representatives from the Rail Safety Unit and Research and Evaluations Team at the Transport Agency, the Ministry Of Transport, KiwiRail, Transdev and the Federation of Rail Operators of New Zealand. The industry participants also contributed valuable technical advice and material to the project to ensure the findings were appropriate for the New Zealand context.

The research will feed into the Transport Agency's longer term aim of being able to benchmark the safety performance of the New Zealand rail system against comparable systems overseas. However, it was recognised that to achieve this, the Transport Agency first needs to ensure that the data it is collecting is suitable for comparison.

CURRENT NEW ZEALAND RAIL SAFETY INFORMATION

All New Zealand rail vehicle operators and railway line providers must hold a licence under the Railways Act 2005. There are a wide range of activities occurring in the sector, including metro, freight, tourist and heritage operations. Licence holders are obliged to monitor, record and report on key safety performance factors and measures, including (but not limited to) accidents and incidents. They must also provide the Transport Agency with an annual safety performance report which contains summaries and trends of incidents and operational information (such as passengers carried). In addition, all operators who run trains on KiwiRail infrastructure must follow industry-agreed reporting processes for safety occurrences.

Overall, the system currently used in New Zealand for collecting, publishing and using rail safety data is acknowledged to be less mature than in Australia or Europe (including the UK). However, in some aspects (such as classification of incidents), New Zealand is performing well, and current work by the New Zealand rail industry with Australian rail safety organisations to develop rail safety initiatives will further improve the overall capability here.

IDENTIFYING THE INDICATORS

The first phase of the research involved identifying a shortlist of comparable rail systems overseas, from which the two systems most suitable for benchmarking could be identified. Given differences across the globe in traffic density, type of activity, technology, urbanisation and network sizes, there was no'perfect' match, but the UK and Australia emerged as the most suitable candidates, with safety data from these systems used for the initial benchmarking feasibility activity.

The research then reviewed the indicator definitions used in the two countries, and compared their local railway technologies, accident reporting systems, safety culture and geography to identify which indicators were sufficiently similar to be used for benchmarking. As the UK prepares information for the European Railway Agency (which collects and publishes safety data across Europe) the review also considered the safety indicators used by this agency.

From this process, the research identified a shortlist of proposed indicators where good comparisons could be made. It also listed the adjustments that would be needed (such as normalising for distance) to enable the indicators to be used for benchmarking across the different national systems. The final step was to develop a draft implementation plan, with recommendations for the New Zealand rail industry.

THE NEED FOR CAUTION

However, the research report urges caution with respect to the indicators, pointing out the many factors that can influence how a railway system performs.

The authors say, "Benchmarking can be a very valuable tool if used in the correct manner. However, it is important to recognise that no two railways are exactly alike. There are many differences between railways in relation to factors such as size, operating procedures, rules, technology, reporting cultures, infrastructure and traffic density, all of which may impact on risks in different ways. There are also differences between types of rail operation within a country. For example, a train operator who operates over great distances across infrastructure with few signals will be likely to have a lower risk of a 'signal passed at danger' than a train operator in a metropolitan area where signals are prevalent. Thus care should be taken when comparing one railway with another; the fact that a figure on a particular indicator is higher or lower than on another railway does not necessarily reflect the relative effectiveness of how risk is managed."

Positives of benchmarking were identified as the ability to monitor data on key risks, such as signals passed at danger, to understand whether trends are improving (or otherwise). Also, to compare what controls are being used by benchmarking partners to mitigate risks, and to review how effective these controls are in reducing risks, and hence whether they could be used in a local context. For instance, benchmarking allows partners to review specific technologies, such as automatic train protection systems, to gauge how effective they are in preventing the risk of signals passed at danger.

The report concludes that, 'The real reasons for benchmarking should be to measure whether you are continuing to improve and to explore what others are doing to better control your own risks.'

The indicators and implementation plan

The report includes five tables of indicators that could be used by the Transport Agency in benchmarking activities.

The broad range of indicators provided means the Transport Agency can select those that are most appropriate for its aspirations for improving safety on the rail system and that correlate well with the occurrence reporting categories that the Transport Agency currently collects data for. This will enable the Transport Agency to undertake meaningful benchmarking using the data it already has to hand.

It is envisaged that this work will be expanded over time to introduce more, and more varied, indicators. Over time, it should also be possible for the Transport Agency to benchmark against data from rail authorities in countries other than Australia and the UK, provided the definitions used for the various incident reporting categories are comparable.

The report also proposes a draft implementation plan for the roll out of the proposed safety indicators, including actions for both the rail industry and the Transport Agency. With time, the plan and actions would help the Transport Agency achieve its long-term aim of being able to benchmark the safety of the New Zealand rail system against equivalent system overseas.

International benchmarking of rail safety indicators, NZ Transport Agency research report 583

Available online at **www.nzta.govt.nz/resources/research/reports/583**

THREE STRIKES AND IT'S OUT: PREDICTING THE INCIDENCE AND COSTS OF VEHICLE STRIKES ON SAFETY BARRIERS

As the use of safety barriers at the sides and in the middle of roads becomes more prevalent, research has established what the associated costs of maintaining these barriers following a collision is likely to be.

Recent research in New Zealand and Australia has established the safety benefits of installing various types of barriers on the sides and in the median strips of roads. This is likely to lead to an increase in the installation of barriers, particularly on the state highway network, with an attendant increase in maintenance costs.

To manage this increase, the NZ Transport Agency contracted Abley Transportation Consultants to quantify the likelihood of barrier strike maintenance being needed on the New Zealand state highway and local road networks. The resulting research investigated the occurrence of vehicle strikes on W-beam and wire rope barrier installations, and the corresponding maintenance costs associated with these strikes. Other barriers, such as concrete and wooden barriers, were excluded from the research.

The research differentiated between nuisance strikes and all-strike events.

Nuisance strikes are events where a barrier is struck by a vehicle, which is then able to drive away. These events are significant as they are not recorded in the Transport Agency Crash Analysis System and the drivers are not identifiable or held liable for the costs of fixing any damage to the barrier. They are also significant because, as the use of flexible barriers (as opposed to more rigid barrier designs) increases, so does the proportion of nuisance strikes and un-claimable costs.

All-strikes, on the other hand, include both nuisance strikes and strikes recorded through the Crash Analysis System. The reason for considering nuisance strikes and all-strikes separately was in recognition of the significant maintenance costs that nuisance strikes create on the state highway network and the difficulty of recovering these costs through conventional channels.

Dave Smith of Abley Transportation Consultants explains that the purpose of the research project was to identify the significant variables that influence the frequency of barrier strikes, and the associated maintenance costs associated with these strike events.

'Once we had this information, our aim was to produce a predictive model that the Transport Agency could use to understand the relationship between the type of barrier installed, the collision maintenance costs of barriers once installed, and other environmental factors, such as the horizontal and vertical alignment of the terrain, width of the carriageway or median strip where the barrier was located,' he says.

The research initially focused on collecting information from New Zealand and international literature, and from practitioners here and overseas, on the variables that influence the crash risk for roadside safety barriers, barrier strike incident rates, and the associated maintenance costs.

The accumulated data was then interrogated using multiple regression analysis to determine which variables had a statistically significant impact on the rate of barrier strikes and on consequent collision maintenance costs. The key variables tested included traffic volumes, median width, carriageway width, offset from centreline, horizontal alignment, vertical alignment, number of lanes, length of barrier, posted speed, presence of audio-tactile-profiled road markings and the percentage of heavy vehicles.

Regression models were developed for wire rope and W-beam barriers, both for left-hand side and median installations. Two barrier strike categories were considered: nuisance strikes and all-strikes.

The models generated a set of significant variables that have an impact on barrier strike rates (and can explain variations in them) and in the consequential maintenance costs.

SIGNIFICANT VARIABLES	MEDIAN WIRE ROPE	LEFT-HAND SIDE WIRE ROPE	MEDIAN W-BEAM (>40M)	LEFT-HAND SIDE W-BEAM (>40M)	MEDIAN W-BEAM (≤40M)	LHS W-BEAM (≤40M)
Horizontal alignment	A/N	A/N		A/N	A	A/N
Median width	A/N					
ATP	A/N	A/N				
Posted speed	A/N					
Offset from centreline		A/N				
Terrain			A/N	A/N	N	A/N
Average annual daily traffic	A	A	A	A		A
Length of section	A	A	A	A		
Percentage heavy vehicles						A

These variables are summarised in the table above, for both the nuisance strike model (N) and the all-strike model (A). (Note that nuisance strike models predict the number of nuisance strikes per million vehicle kilometres travelled, and also take into consideration the length of each barrier and the volume of traffic at the corresponding barrier location. The all-strike models evaluated the number of strikes per annum.)

Dave says,'Planners and road controlling authorities can use the variables we've identified when deciding whether or not a barrier should be installed. The primary purpose of installing a safety barrier is to preserve lives and achieve excellent road safety outcomes. Practitioners can now also calculate and take into account the likely maintenance cost implications of barrier strikes when developing their business cases for installing further barriers.

To this end, the research team developed a barrier strike spreadsheet tool, which calculates the maintenance cost per annum associated with wire rope and W-Beam barriers. This cost prediction can be used in conjunction with other cost components to form part of the wider economic assessment of the relative benefits (or disadvantages) of installing a particular type of barrier in a given location.

'When deciding what type of barrier should be installed, the cost of crashes can now also be taken into consideration,' says Dave. 'In our report we recommend that the spreadsheet tool should be used to support decisions in relation to not only installing barriers, but also widening medians and carriageways, and installing audio-tactile road markings close to barriers.'

Quantifying the likelihood of barrier strike maintenance, NZ Transport Agency research report 580

Available online at **www.nzta.govt.nz/resources/research/reports/580**

NEW RESEARCH REPORTS

Regionalisation of the National Land Transport Demand model

NZ Transport Agency research report 586

Available online at www.nzta.govt.nz/resources/research/reports/586

Research was undertaken to convert a National Land Transport Demand Model to a Regional Land Transport Demand Model. The new model is intended to be used to construct quantitative long-term (30 year) regional transport planning scenarios. Model development undertaken included a series of regional and spatial econometric models covering: intra-regional density effects, land use and transport demand (congestion), regional mode of travel choices, inter-regional freight flows by origin and destination, and calibration of regional migration based on age- and location-specific propensities to migrate.

Bitumen performance tests

NZ Transport Agency research report 587

Available online at www.nzta.govt.nz/resources/research/reports/587

Aspects of bitumen performance in chipseals related to the development of a New Zealand performance-based specification for chipseal binders were investigated.

Compatibility with kerosene: Differences due to the base (unmodified) viscosity were far greater than those produced by small differences in kerosene compatibility showing that this requirement is probably unnecessary in the new specification.

Adhesion to aggregate: Acid number and a 'wetting test' based on the MSCR test (AASHTO T 350-14) at 25°C were suggested for inclusion in the new specification. Such tests provide protection against likely poorly performing bitumens and help ensure batch to batch consistency. The tests would be carried out in conjunction with Vialit plate tests.

Chip retention: Bitumen cohesive energy as a control property for chip retention was investigated. The measured cohesive energy was strongly affected by the viscoelastic properties of the binder. A tensile test at low temperatures is a better alternative with a minimum yield (rupture), stress and strain specified.

At high temperatures tensile tests are impractical and damage through large non-recoverable deformations of the binder below the yield strain must also be controlled for. Instead the MSCR test with a maximum creep compliance and a minimum percent recovery would be used.

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.

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Media contact

For media enquiries – contact Andrew Knackstedt, National Media Manager, on andrew.knackstedt@nzta.govt.nz, ph 04 894 5400.

Other Transport Agency contacts

Patricia McAloon – Manager National Programmes

Nigel Curran – Senior Analyst National Programmes

Karen Johnson – Coordinator National Programmes

For any enquiries, email research@nzta.govt.nz

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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.