SELF EXPLAINING RURAL ROADS: FROM CONCEPT TO THE CHALLENGE OF IMPLEMENTATION

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ABSTRACT

Supporting Safer Journeys and the National Speed Management Programme, there is a need to demonstrate how rural road design features can be planned and designed to support safer driver behaviour. Ensuring that rural roads reflect their desired function and are intuitive to drivers so that they are more likely to drive safely and consistently is an important ingredient for road safety.

Auckland Transport has undertaken a pilot Self Explaining Rural Roads (SERR) project in the rural southeast Auckland area to explore and demonstrate methods for implementing safer road environments in rural areas. Building on SER principles and a previous related urban project, a process of community engagement, data gathering and area-wide planning set a platform for the project. Key road types, based on their functional characteristics were identified in response to the variety of road users and routes in the area. Design goals for each road type were then established and a number of design responses and trials were then conducted to explore how each road type might be established in reality to create a coherent road network across the area.

The project has been designed so that infrastructure improvements in accordance with design goals can be implemented as maintenance and minor safety funding becomes available. For example, shoulder widening on arterial routes as part of the design response have already been progressively delivered.

For the most part, the project is at the detailed design stage with varying levels of progress for the roads in the area. Some specific areas still require detailed planning and delivery. For example, the area is one of Auckland's most popular recreational and training rural cycling areas and further design work is needed to deliver safe and user-friendly rural cycling routes.

To date the project has demonstrated a process for planning, designing and delivering user-friendly rural roads on an area-wide basis. There have been a number of challenges in doing this, which should provide learning for future projects, including a need to obtain whole of organisation buy in. Although the project was conceptualised in parallel with the development of the One Network Road Classification system and Speed management guide, there is a need to integrate the approach taken in this study with these other initiatives.

Introduction

The purpose of this project was to conduct an area wide demonstration Self Explaining Rural Roads (SERR) project in the South East Auckland (Clevedon, Maraetai, Whitford) area to explore and develop the principles of Self Explaining Rural Roads in a rural setting. The Whitford / Clevedon / Maraetai area of south Auckland, covering over 100km of rural road, was selected for the SERR project based on the crash risk. Over the period 2012-2016 across the area there have been six fatalities, 44 serious injuries and 198 minor injury crashes and the area is among the highest risk for rural roads in the Auckland region.

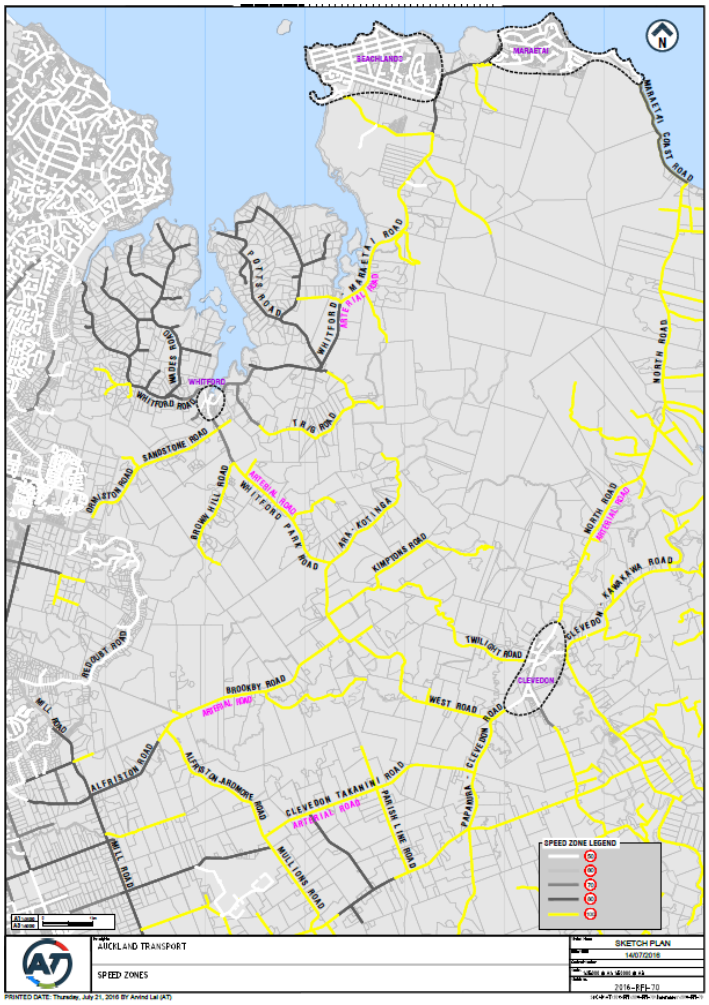

Figure 1. Project area

This paper outlines the two key parts of the SERR project. Firstly, the community engagement, data analysis and concept development work is described; and secondly the process of delivering the infrastructure improvements required to realise the project objectives is outlined.

Background

The Safer Journeys Road Safety Strategy 2011-2020 (National Road Safety Committee 2011) sets out a long-term vision for New Zealand of *"A safe road system increasingly free of*

death and serious injury."[1] To support the vision, Safer Journeys introduces, for the first time in New Zealand, a Safe System approach to road safety.

Under the Safer Journeys Action Plan 2011-2012 (National Road Safety Committee 2011a), the Transport Agency and local government were responsible for delivering the following action: "Ensure the uptake of effective safe speed limits in high-risk … rural areas, including implementation of demonstration areas as part of Safe System demonstration projects." Further, in the 2013-2015 Action Plan (National Road Safety Committee 2013) the development and implementation of the Safer Speeds Programme featured strongly and now the 2016-2020 Action Plan (National Road Safety Committee 2016) continues to ensure that speeds and speed limits are appropriate to the function of the road, and risks are obvious to drivers.

Safer speed area demonstration projects such as the SERR project are encouraged under the 2016-2020 action plan. These projects are intended to demonstrate the best methods for implementing speed management in rural areas, including how best to communicate project goals to road users.

As part of a focus on speed management, there is a need to demonstrate how road design features can be planned and designed to support safer driver behaviour. This would ensure that various road contexts reflect their desired function and are intuitive to drivers so that they are more likely to drive safely and consistently.

This is particularly important where the road infrastructure doesn't provide for safe travel at high speed and yet significant investment is not available to transform roads. In such cases, a range of approaches including the introduction of perceptual countermeasures, enhanced signage and other road improvements, along with a review of speed limits, can be used to prevent death and serious injuries.

It is hypothesised that, following previous successful applications of Self Explaining Roads principles in urban settings (Charlton et al. 2010), a more legible and user-friendly rural road network following SER principles may yield road safety benefits. In Point England, Auckland, five years following the implementation of an urban self-explaining roads scheme, crash costs have reduced by 48% (Scott 2016). International literature supports the SER approach. In particular Arts & van Schengen (2006) noted that roads with a larger speed variance (lower homogeneity) had a higher crash rate than roads with a smaller speed variance. Similarly, van Nes, Brandenburg, & Twisk (2010) reported that reduction of speeding and increased homogeneity are known to lower the risk and severity of traffic accidents.

Combining SERR principles with speed changes as part of the National Speed Management Programme, there is the potential to significantly improve rural road safety and amenity. However, it is potentially more challenging to apply SER principles consistently in rural settings, given the large length of network that requires treating, and this has never been formally demonstrated. Further, it may seem that there is broader scope to manipulate urban road features to create 'self explaining roads', with comparatively fewer treatment options available for rural roads. However, a range of treatment variations have been shown to substantially influence driver behaviour. For example, examining the relationship between drivers' perceptions of risk and the speeds they choose to drive in a driving simulator and on the road, double yellow and wide centreline markings have been associated with lower speed choices and higher perceptions of risk, with the effect magnified under high traffic conditions (Charlton and Starkey 2016, Figure 1).

[1] Safer Journeys 2020 Strategy, NZ Transport Agency, 2010

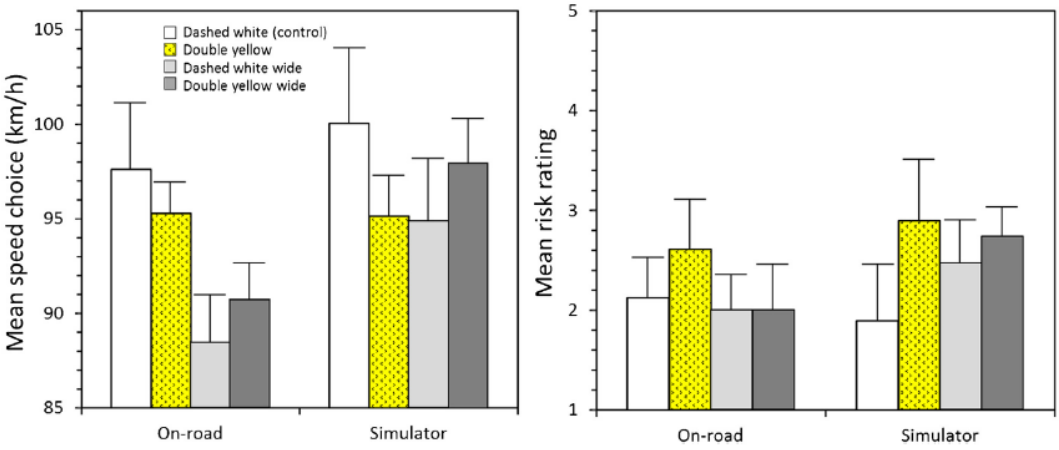

Figure 1. Mean speed and risk ratings for four different types of centreline for an on-road group and simulator group. Error bars indicate 95% confidence intervals. On-road group n=23, simulator group n=19. (Source Charlton and Starkey 2016).

Another road design feature shown to be closely related to speed homogeneity is the credibility of the speed limits established for a given road. As Goldenbeld and Van Schagen (2007) pointed out, "Credible speed limits contribute to road safety as increased credibility leads to better speed limit compliance and is likely to improve homogeneity of traffic flows. The credibility of a speed limit is influenced by identifiable features of the road and its surroundings… This makes it possible to make a limit more credible… this can be done by either fitting the limit better to the features, or fitting the features better to the limit." However, attempting to force speeds downwards through speed limits alone, when the road environment seems relatively faster, can have the effect of reducing homogeneity. This concept is key to the SERR project where a credible road environment is expected to come from both the 'look and feel' of the road and eventually also safe and appropriate speed limits.

For this SERR project, the following design goals were established:

1) Acknowledge and reinforce arterial road function with a common "look and feel"
2) Improve safety and efficiency by reducing speed variability
3) Promote improved reliability of travel time rather than simply reducing speed limits across the area
4) Improve drivers' lane keeping performance
5) Improve night time driving safety measures
6) Improve the error tolerance for the roads by addressing hazardous locations

Development of the South East Auckland SERR project

The vision for the project is to provide a safe road system that is credible and predictable for road users through self-explaining rural roads principles. Following on from this vision, a set of project desired outcomes were developed to steer implementation of the project. These were:

1) Involve road users, stakeholders and the community to better understand local issues related to road function and design.
2) Demonstrate and document a process for implementing SERR on an area-wide scale.

3) Develop and implement changes to the road environment based on SERR principles.
4) Monitor and evaluate the implemented SERR scheme, by collecting baseline data prior to the work and comparing with follow-up data when the works have been implemented.
5) Refine measures as required.
6) Document outcomes and learnings from the SERR project.

Stakeholder engagement

An important early step for the SERR project was the Public Perception Workshops that were held in Clevedon and Maraetai (Charlton and Mackie, 2013). This allowed, along with other data, members of the local public the opportunity to outline their views for the various roads in the area, confirm 'safe speeds' and identify issues on various parts of the network. This work also laid the way for a functional road hierarchy for the area which has been the basis for the treatment options.

What became clear from this early engagement work, is that there are a wide range of road users in the area, all with different requirements. Commuters, local traffic, truck traffic, cyclists, tourists, day-trippers towing boats and even horses were commonly cited road users. The workshops did emphasise the arterial requirement of some of the roads (Whitford Maraetai in particular), given the commuter traffic that comes from Maraetai and Beachlands, which are growing rapidly, without associated arterial road investment.

Other Data Collection

A range of other data were collected to gain an understanding of road user behaviour and crash problems. Road user counts and speeds were obtained and crash patterns across the areas were determined. More recently risk and speed management maps have also been consulted to guide the design process (Figure 2 and Figure 3). A network safety inspection process has complemented the data collected for SERR and informed intervention decision making. Driver and other road user perspectives have been considered as part of this and specific infrastructure deficiencies, within the context of the hierarchy that has been developed, have been identified.

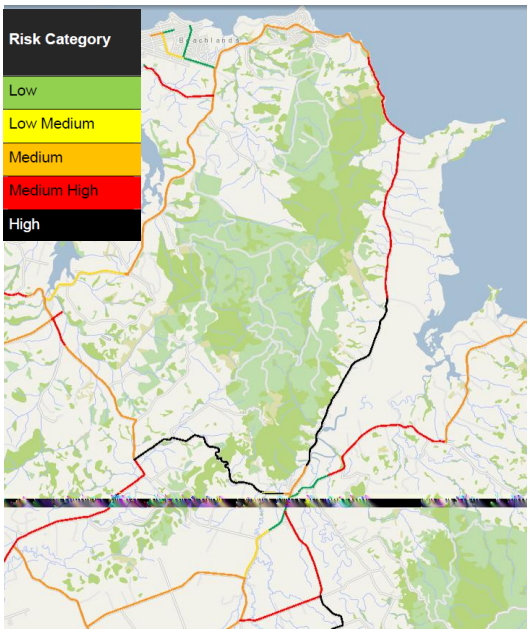

Figure 2: Personal Risk

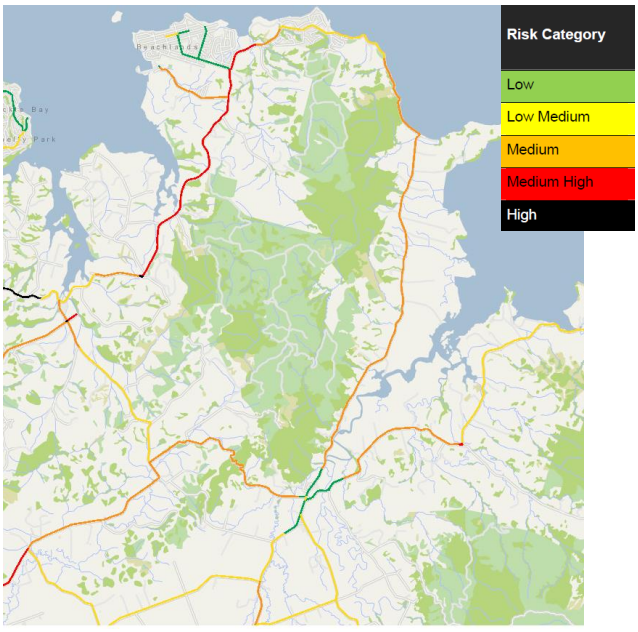

Figure 3: Collective Risk

Treatment options

Through the participatory and data collection process, the functional road types in the area were further defined (Charlton 2014), via the hierarchy shown in Table 1 below:

Table 1. Functional road types determined from the SERR process

Road Type	Design goals, reflecting desired function
Village roads	Reinforce the change in road environment and sense of place Improve safety for vulnerable road users Improve drivers' compliance with speed reductions
Rural arterials	Acknowledge and reinforce the arterial function with a common "look and feel" Improve safety and efficiency by reducing speed variability Promote improved travel time rather than simply reducing speed limits. (Measure travel times before and after treatments) Improve drivers' lane keeping performance Improve night-time driving safety measures Improve the error tolerance of the roads by addressing hazardous locations
Local rural roads	No specific improvements except as required
Amenity road	Reinforce the scenic and recreational functions and sense of place Improve safety for vulnerable road users Increase the feeling of shared use among different types road users

Treatment approach

A number of guiding principles underpin this project to make it unique and moving beyond the business as usual approach. Together, the guiding principles suggest an approach that is holistic, designed around the needs of people, reflects the latest thinking in road safety and also seeks to achieve a cost-effective model for delivery. The key principles are outlined below.

An area-wide approach

Taking an area-wide approach to the project was considered essential as this better reflects the journeys that people make and considers the inter-relationship between the various road types. This represents a departure from conventional approaches which typically concentrate on corridors or black spots. Although it does add complexity and scale to the project, the benefits of coherency and a natural community scale are across the area are more likely.

Self Explaining Road approach

Taking a view that road user error can be minimised (and not only mitigated), a second set of guiding principles for this project come from the Self Explaining Roads design philosophy. The SER approach focuses on the three key principles of functionality, homogeneity, and predictability.

- **Functionality:** requires the creation of a few well-defined road categories and ensuring that the road design matches its intended function, and thus promotes appropriate road user behaviour and reduces error
- **Homogeneity:** refers to road designs that promote equilibrium and equality in vehicle speed, direction, and mass. While this can be a challenge in the rural road environment, it is recognised that speed variability is significantly predictive of fatality

rates for rural roads and that credible speed limits (match between speed limit and design speed) are one means of achieving better speed homogeneity
- **Predictability:** means keeping the road design and layout within each category as uniform as possible and clearly differentiated from other categories so that the function of a road is easily recognised and will elicit the correct behaviour from road users

Overall, these principles suggest a well-planned, intuitive and user-friendly road network that provides for the various road users who are expected, reduces uncertainty, minimises cognitive load and encourages more consistent road user behaviour, which in turn is likely to lead to safer roads.

A Safe System approach

The Safe System principles have been followed in the development of treatment options:

- **People make mistakes:** therefore a forgiving road environment is needed. But we can also help to prevent mistakes by creating an intuitive and user-friendly road network
- **People are vulnerable:** people have a limited ability to withstand crash forces and this needs to be considered when considering speed and passing distances
- **Shared responsibility:** Both system designers and users have a role to play in road safety, hence the community participatory approach.
- **All of system response:** All parts of the system need to be working to create a safe system.

Implementation of the treatment options described in this report also need to be considered within the four pillars of the safe system; Roads and Roadsides, Speed, Users, and Vehicles. While many of the options and recommendations described necessarily focus on the first of these pillars (Roads and roadsides), the action plan and implementation of the programme will need to consider the other three pillars as well. Implications for all pillars are outlined in detail in the Treatment Options Report (Charlton, 2014), however, some discussion of road users and speed is also warranted here:

A wide range of road users characterise the treatment area.

- **Cyclists**: They are seen as a nuisance to some motorists and cyclists feel unsafe on many of the roads. There are clear preferences for some routes by fitness/recreational cyclists in particular, although many of the roads are used for recreational and fitness cycling. This is one of the key training cycle areas for Auckland.
- **Heavy vehicle operators**: Significant heavy vehicle operations are underway between the city and the Whitford landfill, and a dumping facility is planned for Twilight road. The safety implications of these vehicle movements need to be considered for the routes these vehicles are likely to frequent
- **School travel:** Brookby and Alfriston Schools in particular require specific focus, taking an approach that is consistent with other rural school safety approaches, in particular consider the Safer Journeys for Schools Guide.
- **Commuters:** A significant number of residents who live in the Beachlands/Maraetai area expect their commuting needs to be met by Whitford-Maraetai Rd, especially as the area grows.

- **Other road users:** Horses, boats on trailers and tourists are other road users that frequently use some of the roads in the area

The National Speed Management programme is likely to feature as part of the project, especially as speed limits are considered for the area. This should be regarded as a complementary process rather than the key focus of this project.

A Safety Maintenance / Safer Corridor approach

Another key principle for the project is the introduction of safety improvements as maintenance on the network is required. The scheme under development for the area, will guide the nature of any re-marks, re-surfacing, seal extensions, sign replacements and other routine maintenance and minor safety work. This means that a process of 'continual improvement' will be set in motion by the project. Currently, many of these activities take place without any thought given to whether improvements could be made or not, which means that the road network does not naturally improve without dedicated safety works.

Approach Summary

In order to achieve meaningful, coherent and sustainable changes over time, it is considered that all elements of this treatment approach are needed for successful delivery. It is recommended that these elements are included in future projects.

Treatment Options and Concepts to date

Road treatment concepts for the trial study area, based on development work, are detailed in the SERR project report, including some on-road experiments that followed an earlier treatment options report (Charlton; 2014). Treatment concepts are presented for each of five road categories: village roads, rural arterials, local rural roads, amenity roads and the 'special' North road. These concepts portray the overall treatment approach and how each road type is intended to change to meet the project's goals. It is important to reinforce that the development of options was based on a careful engagement and data gathering process.

In developing the treatment options, the project utilised the following process to ensure that there was a high level of robustness to any solutions and outcomes.

The treatment options for each road type concept were earlier classified as being either short (within 12 months), medium (within 3 years), or long term (within 10 years). Medium and long term options are dependent on available budgets and may be implemented earlier if budget is available, or if the emerging crash trends indicate that an earlier intervention is required. For more detail about the short, medium and long-term treatment options, see the Treatment Options Report (Charlton; 2014).

The following treatment concepts give examples of some treatments developed. Some elements are unique and others aren't. The key point is that a coherent and consistent design approach to the area is adopted to meet the design principles outlined earlier.

Village Roads

The roads in this category have two important functions: safely and effectively transitioning drivers from one speed environment to another, and clearly communicating a sense of place and the presence of other road users.

The treatment elements used to achieve these design goals are detailed in the Treatment Options Report.

An example of the street changes is shown in **Error! Reference source not found.**. Threshold treatments, coloured/textured pavement, line marking differentiation, safe crossing points, slow speed areas and street landscaping and furniture are examples of elements that may contribute to this road type.

Figure 4: Maraetai Village gateway treatment design

Rural Arterial Roads

Speed and road user heterogeneity is a key issue on arterial roads in this area. Cues to provide a consistent arterial look and feel, including enhanced delineation and signage are key. Space for cyclists and recovery space for vehicles through shoulder widening is also important. Speed limits are also inconsistent and speed management maps will be used for speed management purposes. Examples of treatment concepts for arterial roads are shown in **Figure 5** and Figure 6 below.


Figure 5: Proposed treatments: (Experimental) Centre line marking on straights – Rural Arterial

Figure 6: Proposed flared yellow centreline on tight curves

Local Rural Roads

The current standard of delineation and signage for the roads in this category is low and thus will be discriminable different from the roads in the rural arterial category. Because of the low volumes, relatively low speeds and low crash history generally associated with these roads, the design goal is predominantly one of low level intervention, ensuring that the reduced level of road markings and signage is continued through future maintenance cycles. Certainly site specific hazards should (and will) be addressed on an as-needed basis with appropriate signage, markings and delineation, within the treatment approach to his road type, with particular attention given to the High personal risk roads.

Eventually, speed management may also play a key role on these roads, with many of them potentially qualifying for lower speed limits that match the safe and appropriate speeds as per the Speed Management Guide.

Treatments for this level of road could include isolated centreline and edge line markings, no markings, or as recently trialled 2-1 markings, acknowledging the issues that need to be considered for these markings following earlier research (Trotter et al. 2016).

Field Trials

To better understand some treatment styles a series of field trials using temporary delineation were undertaken to explore alternative treatment configurations Figure 7Figure 8. After each installation, the review team undertook an expert assessment of the layout, using a cohort of road safety personnel. This was a relatively informal process to test the feasibility of this design approach. The approach proved to be very useful and although more robust evaluation methods would eventually need to be employed, the testing found for example, that a 4.5m central lane was the optimal spacing for edge lines to achieve both cyclist and motorist satisfaction on one particular minor road **Figure 9**).

Figure 7: Example of effect of two different wide centreline trials

Figure 8: Centreline widening for a curve, visible at night time

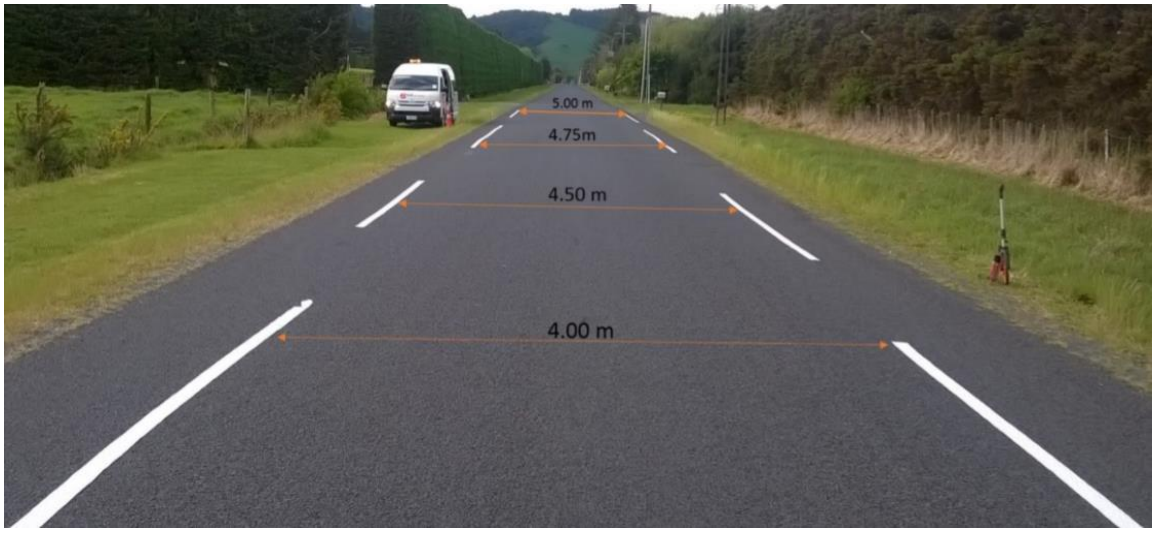

Figure 9. Various edge marking widths trialled on local road

Discussion

Progress to date and challenges

The road changes are gradually being implemented as maintenance funds allow with some works completed, but with many roads yet to be treated. A full evaluation of success will take

time, and will require a constant review (and reassessment) of performance. It is important to outline that this is a living process, and will continually develop as and when new approaches, and review of applied treatments are incorporated.

In the meantime, comment on the delivery of SERR to date is possible. There have been difficulties in maintaining momentum in the SERR project, partly due to organisational change, and partly due to the non-business as usual nature of the project. There have been issues in developing a unified approach to treating roads on an area-wide basis, especially where contractors differ. At the time of writing, the Road Safety team were in discussions with the maintenance and operation teams to further develop the integrated approach via current contracts. This may take some effort to coordinate but highlights the importance of institutional processes in addition to technical solutions. Despite these challenges, a commitment to SERR in southeast Auckland remains and the project contains valuable lessons for future rural road improvement projects.

ONRC and Speed Management

Although the project was conceptualised in parallel with the development of the One Network Road Classification system, there may be a need to integrate the approach taken in this study with the ONRC framework. However, in comparing the SERR and ONRC road types for the area, there are some areas that will need resolution.

Special Treatment Areas

The SERR project team identified the need for various levels of special treatment for other users such as cyclists and equestrian. Cyclists were identified as a key user group on some of the roads assessed, with many cyclists identifying their safety concern in response to high severity cyclist crashes that that happened in the area. This area is an iconic cycling route for the greater Auckland area, and corresponding well designed rural cycling routes, where rural cycling amenity is obvious is being considered.

Similarly, special consideration needs to be given to the protection of equestrian and other user groups. An understanding of their desired routes, along with their safety needs (i.e. low vehicle noise / speed past horses) will dictate appropriate treatment options.

Conclusions

To date the SERR project in South Auckland has demonstrated a promising approach to planning rural road safety improvements, with the goal of achieving a more coherent, user-friendly and ultimately safer rural road network. The process is complementary with existing initiatives such as the Speed Management Programme and the ONRC, although more work is needed to integrate these initiatives and also to demonstrate the delivery of the road improvements across the area.

The project has demonstrated how public engagement, and other local data gathering can be combined with national tools such as risk and speed management maps to create an area-wide plan for rural roads. This approach is important as future speed management initiatives are also likely to be employed on an area-wide basis.

While the process of developing and delivering the SERR project has not been smooth for a variety of reasons, the process does show promise for more legible, coherent and ultimately safer rural road networks. Therefore, further effort should seek to iron out the issues associated with the delivery of SERR, rather than starting again with other approaches.

Acknowledgements

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