



Motorcycle Safety Advisory Council

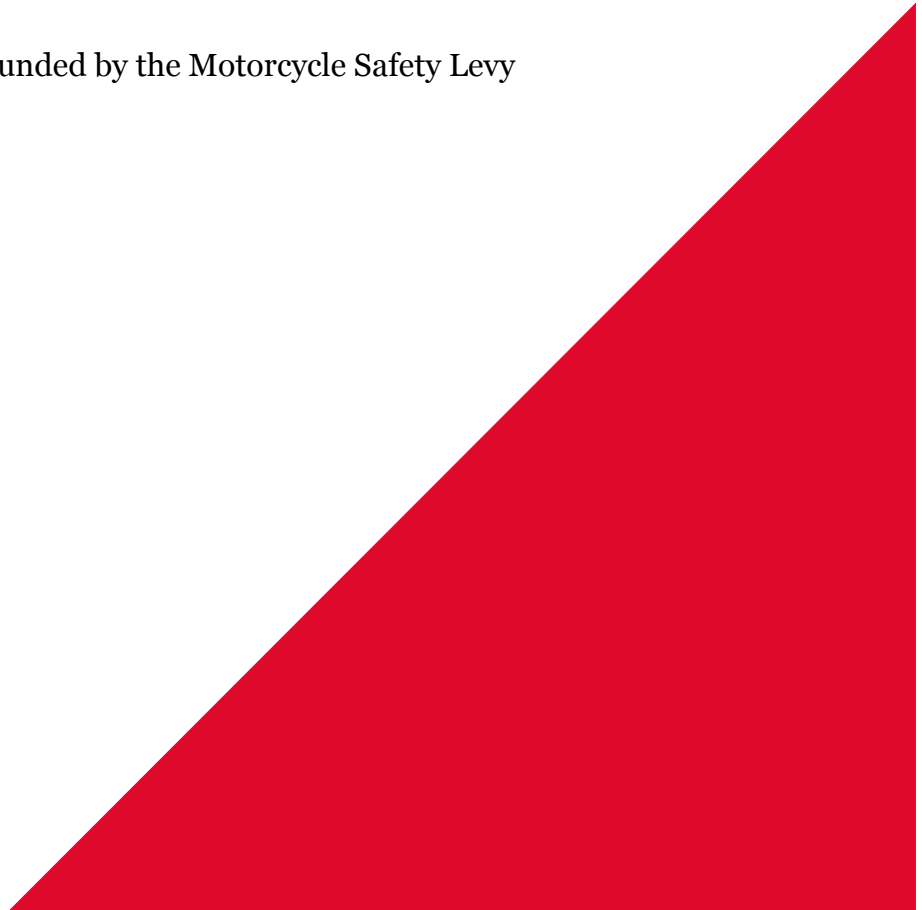
Making Motorcycling Safer



ACC - Motorcycle Sign Trial

Evaluation of 'High Risk Route' signage

This project was funded by the Motorcycle Safety Levy





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1 Acknowledgements

We gratefully acknowledge those who responded to the survey for their time and effort in participating.

2 Executive Summary

Motorcyclists in New Zealand are at a much greater risk of road accidents leading to injury than are other road users (Ministry of Transport, 2014). To this end, the Accident Compensation Corporation (ACC) has tasked the Motorcycle Safety Advisory Council (MSAC) to investigate interventions that aim to reduce the number of accidents motorcyclists are having on New Zealand roads.

One particular intervention identified is the use of 'High Risk Route' signs to indicate that the sign-posted route is of particular risk to motorcyclists.

The objective of this study was to evaluate road users' perceptions and understanding of high risk signs in a real roading environment, and if such signs led to any change in road user behaviour. To this end, signs were installed on the Rimutaka Hill Road of State Highway 2, a popular motorcyclist route in the Greater Wellington Region, and road user behaviour was monitored using traffic counters (recording vehicle class, speed and headway) before and after of any changes. A survey was also conducted of those that used the Rimutaka Hill Road asking various questions about the signage, such as what they thought the sign meant and who they thought was the target audience.

The results of the survey showed that such signs had a high retention value with the majority of road users remembering they had seen it. Also, the majority of road users, both motorcyclists and light vehicle users, thought that the sign indicated that the following route was of particular risk to motorcyclists and those riding motorcycles needed to exercise extra care. It was also the majority opinion that the sign was targeted solely at motorcyclists, though light vehicle users were inclined to think the sign meant they should also watch out for motorcyclists as well.

While the majority of respondents did not feel that anything needed changing in the design of the sign, those who did stated that such signs could be changed to make them more applicable to all road users, not just motorcyclists. These participants also suggested that it would be useful to state why this particular route was of high risk.

When respondents were asked what behaviour changes road users (both themselves and other road users) would make when seeing the sign, the light vehicle users indicated the greatest change for both themselves and others would be paying closer attention and being more cautious when taking corners. For motorcyclists, the majority response was that they would not change their behaviour in response to the sign, however a third of this cohort did say that they would make some changes to their own behaviour such as being more cautious in corners.

While road users stated that the signs would instigate some changes in behaviour to a greater or lesser extent, the results of the traffic count data (vehicle speeds and headways), before and after the signs had been installed, indicated that, while there were significant differences between the two time periods, these differences were not of 'practical' significance (Kirk, 1996) due to their effect size explaining less than 1% of the variance ($r < 0.10$). The differences in speed equated to at most a 3 km/h difference (4 km/h when looking at the 85th percentile), and less than a quarter of a second change in headway distances. This is not to say the signs categorically do not lead to actual behavioural change, but rather that, on these two particular measures, there was no change observed.

Taking the above into account, the recommendations that arose from this work were:

-
- If the sign is to be implemented it should be supported by a strong and wide reaching education campaign about what the sign actually means for road users.
 - Establish a clearly defined set of criteria about what makes a route 'High Risk'.
 - Consider adding extra information to signs to inform users about the specific risks involved and the reasons why the route has been labelled high risk e.g. high winds on the Rimutaka Hill Road.
 - The sign should come under the remit of the NZTA MOTSAM (and its upcoming successor). This means that it can only be applied in a prescribed manner on clearly defined routes.

3 Background

Riding a motorcycle carries substantially more risk than driving a car on New Zealand roads. This is evidenced by the fact that a motorcyclist is 19 times more likely to suffer a serious or fatal injury travelling the same distance as a car driver (MoT, 2014).

Due to this increased likelihood injury, reducing the risk to motorcyclists is a key priority of the Accident Compensation Corporation (ACC). To this end, the Motorcycle Safety Advisory Council (MSAC) has been tasked by the Minister of the ACC to identify initiatives for the investment of Motorcycle Safety Levy funds and make recommendations to the ACC for programme initiatives that have the potential to prevent or minimise the severity of injuries where incidents involve a motorcyclist.

Of the several initiatives that have been identified, one is the proposed use of specific signs that indicate high-risk motorcycle routes in New Zealand. However, before such signage can be implemented across these 'High Risk Routes,' the signs need to be evaluated for road users understanding and perceptions as well as any behavioural changes that come about from placing the sign on specified routes. According to Fisher (1992), while retention of road signs is generally poor, they can nevertheless still have a significant effect on behaviour. It is therefore important to test not only retention of a new sign but also the resulting behaviour change.

Taking the above into account, it was decided that this potential 'High Risk Route' signage would be tested on an established motorcycle route and road users would be surveyed on their retention and comprehension of said sign. This would be done while also monitoring actual road user behaviour (speed and vehicle headway) before and after the signs had been installed on said route.

The results of the survey and vehicle monitoring would then be used to devise a set of recommendations around the implementation of the sign across the New Zealand roading network.

4 Method

4.1 Signage design

The sign that was to be tested was designed by the New Zealand Transport Agency, hence forth referred to as The Agency (using The Agency's colours) and can be seen in Figure 1 below.

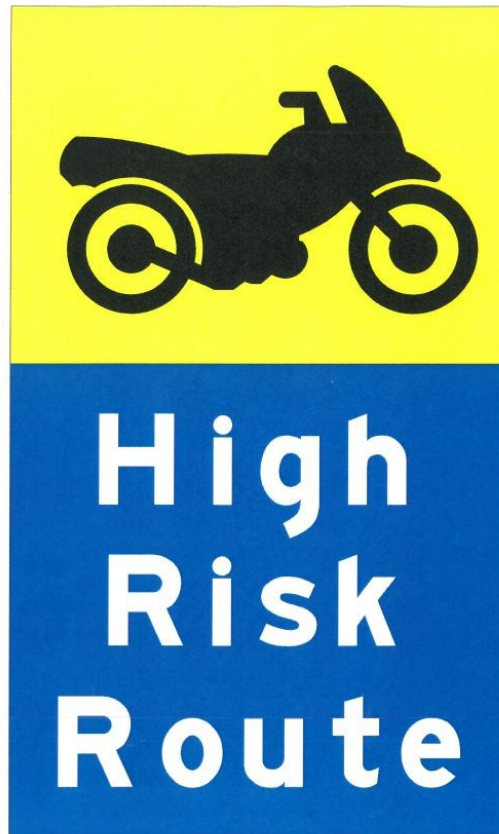


Figure 1: NZTA Designed 'High Risk Route' sign

4.2 Sign placement

Site selection for the placement of the signs on the Rimutaka Hill Road was decided by The Agency. There were four sites in total: one at the start of the route on the Wellington side of the Rimutaka Hill Road, one approximately 800 m northward bound from the Wellington side site, one at the start of the route on the Featherston side of the Rimutaka Hill road, and one approximately 3 km southward bound from the Featherston side site. See Table 1 for detailed site locations and Figure 2 to Figure 5 for photos of each.

Table 1: Site locations

Site	Description	Number of signs	Latitude, Longitude
One	Wellington entrance to Rimutaka Hill Road	2	-41.083322, 175.206103
Two	Approx. 800 m northward bound of Site one	1	-41.090784, 175.207593
Three	Featherston entrance to Rimutaka Hill Road	2	-41.113249, 175.312028
Four	Approx. 3km southward bound of Site Three	1	-41.107916, 175.281338

**Figure 2: Site One at the start of the Rimutaka Hill Road on the Wellington side**



Figure 3: Site Two approximately 800 meters northward bound from Site One



Figure 4: Site Three at the start of the Rimutaka Hill Road on the Featherston side



Figure 5: Site Four approximately 3 kilometres southward bound from Site Three

These signs were installed at approximately 11:00 am on Tuesday the 25th of November 2015.

4.3 Survey Design

An online survey was designed to investigate several facets of the new signage from the perspective of different road users.

The survey was structured as follows:

1. Experience with road and types of vehicles used:
 - a. Road users' reasons for using the Rimutaka Hill Road and frequency of use. Example reasons for using include commuting, while working, and for pleasure.
 - b. Types of vehicles they have used on the road and what type they use most frequently.
2. Sign Retention (unprompted, so the respondent is not shown the sign):
 - a. Did the road user remember seeing a new sign and if so what did they think it meant?
3. Sign retention, meaning and target audience (prompted, so the respondent is shown the sign):

- a. Did the road user remember seeing the sign?
 - b. What did they think the sign meant and at whom did they think it was targeted?
4. Expected change in on-road behaviour due to observing the sign:
 - a. What changes did the road user think they would make to their on-road behaviour after viewing the sign?
 - b. What changes did they think other road users would make to their on-road behaviour after viewing the sign?
5. Respondents perceived potential for sign improvement:
 - a. What, if any, improvements did the road user think could be made to the sign, (e.g., wording, symbol).
6. Demographics:
 - a. Road users age and gender.

A copy of the survey format and questions can be seen in Appendix A.

4.4 Participant recruitment

Participants were recruited to take part in the survey via two methods; the first was based around recording the vehicle registration plate of vehicles traveling on the Rimutaka Hill Road, while the second was through contacting various motorcycle communities in the Greater Wellington Region.

The first method was accomplished by parking in the stopping bay at the top of the Rimutaka Hill Road and photographing the vehicle registration plate of every vehicle that passed the site travelling in either direction. A total of 823 observations were made between 10.00 and 13.00 on Wednesday the 3rd of December 2014.

Once the vehicle registration plates had been collected, a request was sent to The Agency's Access and Use Group for the address details of the registered owners of the vehicles. A letter was then sent to each registered owner inviting them to take part in an online survey investigating road users understanding of a new roadside sign for use on motorcycle routes across New Zealand.

Due to the low number of motorcyclists using the road during the observation period, an invite to participate in the survey was also sent out to the motorcyclist community in the Greater Wellington Region. This was accomplished by asking various motorcycle clubs, shops and motorcycle representative groups to post the invite to their members, on their social media pages, and to email their subscription lists.

4.5 Traffic Counters

To capture actual road user behaviour, four traffic counters (recording vehicle class, speed and headway) were placed on the Rimutaka Hill Road on Friday the 21st of November at 11.51 am until the 2nd of December at 11.24 am. This meant that vehicle behaviour was recorded for approximately four days before the signs were installed and seven days afterwards. Each time period captured a mixture of weekday and weekend traffic.

A counter was placed the start of the Rimutaka Hill road on both the Wellington and Featherston side. Additionally, two counters were placed on the entry and exit of The Agency identified high risk curve, approximately half way along the route. The site locations for each counter can be seen in Figure 6 to Figure 9 that follow (the red line marking the location of the counter on the road).



Figure 6: Traffic counter site one (Wellington side).



Figure 7: Traffic counter site two (Featherston side).



Figure 8: Traffic counter site three (high risk curve).

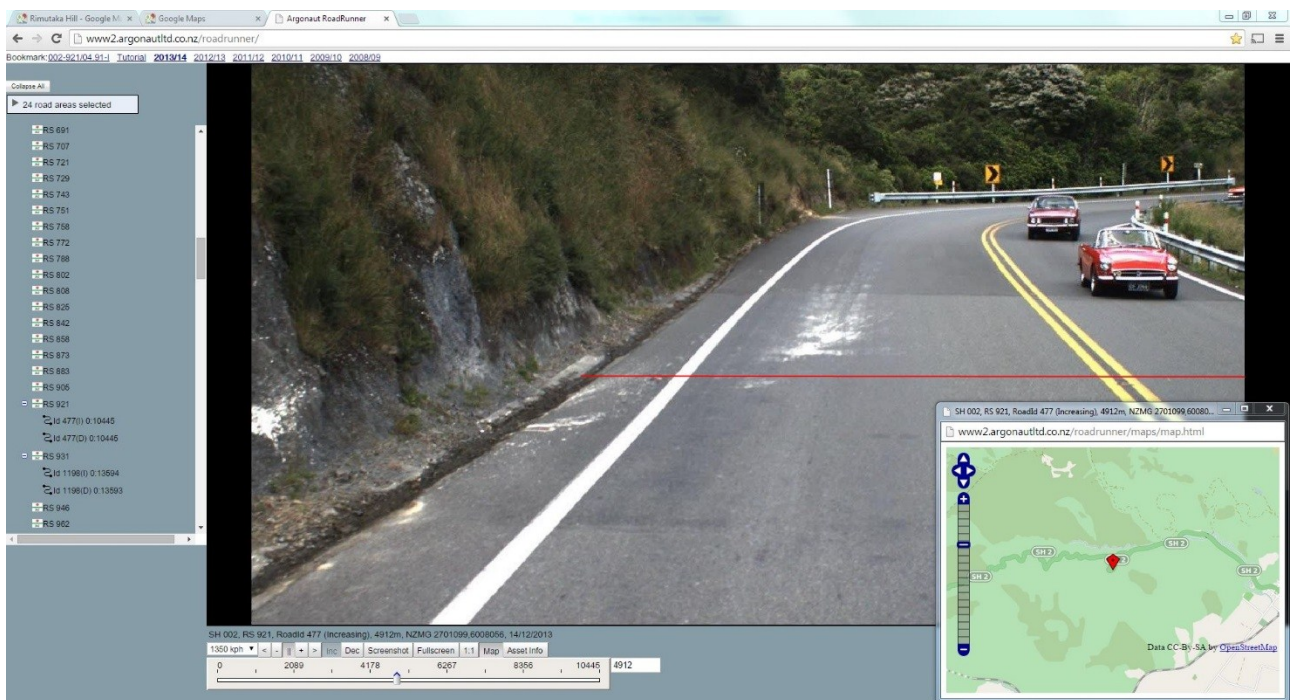


Figure 9: Traffic counter site four (high risk curve).

4.6 Results

4.6.1 Survey

4.6.1.1 Experience with road and types of vehicles used

A total of 159 participants completed the survey. Of these respondents, 51 were female and the mean age was 54.2 (SD = 13.3). Of the 159 respondents, 39 (24.5%) stated that their main mode of transport on the Rimutaka Hill Road was a motorcycle, while the remaining respondents stated their main mode of transport was a light vehicle. See Table 2 for a breakdown by main transport type.

Table 2: Main mode of Transport on Rimutaka Hill Road.

Vehicle Type	N.	%
Motorcycles	39	24.5
Light vehicles, e.g. cars, vans, utes, light trucks	120	75.5
Heavy vehicles, e.g. HGVs etc	0	0.0
Other	0	0.0

The majority of respondents (71%) stated that they used the Rimutaka Hill Road at least a few times a month or more, and that their predominant reason for this trip was for pleasure (61.6%). Table 3 shows respondents' stated reasons for using the Rimutaka Hill Road, while Table 4 shows the frequency of use.

Table 3: Why respondents use the Rimutaka Hill Road

Main purpose for using Rimutaka Hill Road	N.	%
Commuting to work	15	9.4
While working (e.g. trades person, commercial rider/driver)	16	10.1
Pleasure	98	61.6
Other	30	18.9

In the 'Other' category in Table 3 the two main reasons given were 1) visiting family/friends and 2) for an appointment.

Table 4: Frequency of use of the Rimutaka Hill Road

Frequency of use of the Rimutaka Hill Road	N.	%
Most Days	11	6.9
Few times a week	22	13.8
Few times a month	80	50.3
Few times a year	46	28.9

4.6.1.2 Sign retention unprompted

When the respondents were asked if they remembered seeing a new sign on their last trip on the Rimutaka Hill Road, the majority (63.5%) stated they had, as shown in Table 5.

Table 5: Number of respondents that remember seeing a new sign on the Rimutaka Hill Road

Remember seeing new sign on Rimutaka Hill Road	N.	%
Yes	101	63.5
No	58	36.5

The respondents were then asked to describe the sign and what they thought it meant. Their responses were separated into two main categories: 1) those that stated a motorcycle was their main mode of transport on the Rimutaka Hill Road and 2) those that stated a light vehicle as their main mode.

Responses from those that stated a motorcycle was their main vehicle type:

The main theme that emerged from the data was that the new sign was meant as a warning to motorcyclists that the following road was a 'high risk route', with example statements such as:

"I have seen the new motorcycle high risk route or hazardous route signs (not sure of the actual wording). I understand the signs are warning motorcyclists that the route over the Rimutaka Hill is hazardous and extra care needs to be taken."

"Motorcyclists take special care."

"Dangerous road for motorcycles, care needed."

"I believe that it was telling motorcycle this is a high risk Road be careful."

The other themes had far fewer responses than the main theme but each were general variations of 'drivers be aware of motorcyclists', and 'risk to all on the following route', examples being:

"High Risk Route Motorcyclists - Take care; Other Motorists - Be aware of motorcyclist"

"HIGH RISK ROUTE. A serious consideration would be there is a higher risk of an accident or 'normal driving' interruptions (could mean accident or weather)."

Responses from those that stated a light vehicle as their main vehicle type:

A similar pattern emerged for those that stated their main vehicle type was a light vehicle. The vast majority of the responses followed the theme that the sign was meant to warn motorcyclists that the route ahead was of high risk. Examples of these were:

"Motorcycle high risk route with a picture of a motorcycle on it. Means motorcyclists need to take extra care on the hill road as they are more at risk of an accident."

"I think I recall seeing at the beginning of the Rimutaka Hill, there was a sign indicating the road was dangerous to motorcyclists? Or motorcyclists drive with caution?"

"High risk route for motorcyclists, which I assume means motorcyclists should take extra care."

“High risk motorcycle route. I take it to mean that the route is dangerous for motorcycles and they should take extra care.”

Other, smaller themes that emerged included ‘Be aware of motorcycles and dangerous road’, for example:

“Be aware of motorcycles.”

“Danger, look out for motorcycles, motorcyclist danger route.”

“The high risk route sign signalling a higher risk of accidents due to the windy nature of the road”

Following on from the respondents unprompted recall of the sign and what they thought it meant, the respondents were then shown an actual image of the sign (Figure 1) and asked if they recalled seeing this specific sign while travelling on the Rimutaka Hill Road, what they thought it meant and at whom the sign was targeted.

4.6.1.3 Sign retention (prompted), meaning and target audience

When the respondents were presented with a picture of the sign and asked if they remember seeing it on the Rimutaka Hill Road, 131 (82.4%) stated that they remembered seeing it. When asked to state at whom the sign was targeted, the majority (93.1%) responded that it targeted at motorcyclists, while only a third responded the sign was targeted at light (37.7%) and heavy vehicles (35.2%) respectively. Table 6 shows a breakdown by respondents’ main vehicle type as to at whom they thought the sign was targeted.

Table 6: Respondents perception to the signs target audience

Sign targets...	Motorcyclists		Light vehicles		Combined	
	N	%	N	%	N	%
Motorcycles	37	94.9	111	92.5	148	93.1
Light vehicles, e.g. cars, vans, utes, light trucks	14	35.9	46	38.3	60	37.7
Heavy vehicles, e.g. HGVs etc	11	28.2	45	37.5	56	35.2

Again, as with the unprompted recall, the responses made to the question regarding the signs meaning were separated into those that stated a motorcycle was their main type of vehicle used on the Rimutaka Hill Road and those that stated a light vehicle was their main vehicle type.

Responses from those that stated a motorcycle as their main vehicle type:

Once again, the main theme to emerge from this group was that the sign was meant to warn motorcyclists that the following route was dangerous, as can be seen in the following responses:

“For motorcyclists to be extra vigilant due to the road being more hazardous than those normally travelled on.”

“It is a prompt to motorcycle riders to take extra care - not to ride at the limit!”

“It means that riders should be careful, this is a high risk route.”

“High risk route for motorcycle users.”

Responses from those that stated a light vehicle as their main vehicle type:

While the largest number of responses from the light vehicle users was that the sign was meant for motorcyclists, two other substantial themes also emerged: 1) that the signs meaning was intended as a warning to motorcyclists of the risk of the road and for drivers to be aware of motorcyclists; and 2) other road users to be aware of motorcyclists.

Examples of warnings that were perceived as targeting motorcyclists only were characterised as such:

“If you're a motorbike rider, then riding the Rimutaka hill road is a route which is more dangerous than other routes.”

“Motorcyclists should take extra care as they are at particular risk on that route.”

“It's a dangerous place for motorcycles, they should take care.”

Warnings that were perceived as targeting both motorcyclists and other vehicle drivers:

“That drivers of motorcycles should drive with extra care as the route has a high risk of accidents. I'm sure it's also targeted at other users of the road to indicate that the route is frequented by motorcyclists.”

“To me it says that care and caution needs to be taken by motorcycles, leaning into the corners through speed could be dangerous because of the narrow road especially on corners. Also warning other drivers to be aware.”

“Warning for all cars and heavy vehicles that many motorcycles may use this road. That is a warning for motorcyclists that, due to the conditions that they may encounter on this road, extra care and attention should be taken.”

Warnings to other road users to be aware for motorcyclists:

“Keep an eye out for motorcycles.”

“Be aware of motorcycles.”

“Be careful of motorbikes.”

Following on from the prompted recall and understanding of the sign, the respondents were then asked what changes they expected to happen to both their own and others' on-road behaviour in response to seeing the sign.

4.6.1.4 Expected changes in on-road behaviour due to sign

Respondents were asked to select all potential on-road behavioural changes, if any, that they believed would be brought about by the sign. This applied to both the respondents' own behaviours as well as the behaviours of other road users. Table 7 shows the overall potential behavioural changes and number of respondents that stated these changes would occur, broken down by main vehicle type.

Table 7: Potential behaviour change in relation to sign

Potential behavioural change	Motorcycle				Light vehicles			
	Other		Self		Other		Self	
	N.	%	N.	%	N.	%	N.	%
No change to behaviour	13	33.3	20	51.3	35	29.2	39	32.5
Would reduce speed	4	10.3	4	10.3	17	14.2	17	14.2
Pay closer attention	15	38.5	11	28.2	68	56.7	61	50.8
Increase distance	4	10.3	3	7.7	15	12.5	21	17.5
Move away from centre line	9	23.1	13	33.3	35	29.2	41	34.2
More cautious at corners	14	35.9	15	38.5	60	50.0	58	48.3
Other behavioural change	14	35.9	8	20.5	20	16.7	14	11.7

For those who stated a motorcycle was their main vehicle type on the Rimutaka Hill Road, the behavioural change the greatest number of participants thought others would make was to pay closer attention to other road users (38.5%). When it came to changes in their own behaviour however, the category selected by the greatest number of participants (also being the majority), was that they would not change their behaviour at all (51.3%).

Of those who stated a light vehicle was their main vehicle type, the majority responded that both themselves (50.8%) and others (56.7%) would pay closer attention, and approximately half stated they (50%) and others (48.3%) would be more cautious at corners.

For respondents who selected 'Other behavioural change,' one theme that repeatedly appeared across both the main vehicle types was the belief that, since the signs were perceived as being directed at motorcyclists, other road users would do nothing:

"Drivers of other vehicles will ignore it as it is not targeted at them."

"Car drivers would think that the sign is purely directed at motorcyclists so would not take any action to improve their driving."

"As this sign appears to be directed at motorcyclists, I do not think that a car driver would take particular attention of it."

"As I drive a car and the sign is aimed at motorcycles, I wouldn't take much notice or change my driving style."

Considering that the vast majority of both motorcyclists and light vehicle users stated that the sign was targeted at motorcyclists (see Table 6), it is a valid concern that light vehicle road users may indeed feel that the sign does not require them to make any changes to their own behaviour. This

is, however, offset by the fact half of these respondents did say that they would make some changes to their own behaviour.

The final part of the survey asked what improvements, if any, the respondents felt could be made to the sign.

4.6.1.5 Respondents' perceived potential for sign improvement

When the respondents were asked what could be changed, if anything, to improve the sign, approximately half (47.8%) stated nothing needed to change. The next greatest response was a quarter (25.8%) of the respondents saying that the wording could be improved. Table 8 gives a breakdown of the responses by main vehicle type and in total.

Table 8: Potential sign improvements by vehicle type and combined

Factor to change	Motorcyclists		Light vehicles		Combined	
	N.	%	N.	%	N.	%
Nothing	13	33.3	63	52.5	76	47.8
Wording	16	41.0	25	20.8	41	25.8
Symbol	6	15.4	17	14.2	23	14.5
Colour	3	7.7	17	14.2	20	12.6
Other	6	15.4	10	8.3	16	10.1

The 'other' responses were broadly arranged around word change, size of sign and frequency of placement.

When those respondents who had indicated that the sign could be improved were asked specifically how this could be done, two main suggested changes became apparent: 1) altering the target audience, and 2) additional wording.

Most of the recommendations around altering the target of the sign were to make it more applicable to all road users:

"Perhaps add "All Users" to the wording, but leave the symbol which targets motorcyclists especially. This makes it more inclusive (since the risk is higher for all motorists)."

"Changing the symbol of the motorcycle as it's not just the motorcyclists that the Rimutakas are a high risk route for it's dangerous for many drivers as, being in a small car myself, I've had many close calls with other drivers almost hitting me."

"I would focus on all motorists not just motorcycles. The issues are speed and weather related issues and motorists unfamiliar with how unforgiving hill driving is."

"Change the wording to make it a bit less motorcyclist centric."

"Make it apply to all road users and eliminate the impression that it only applies to bike riders."

Suggestions around wording generally ran towards adding more to the sign:

“Include the phrase ‘motor cyclists slow down’ ”

“But change the wording to just ‘take care’.”

“Add ‘Take great care’.”

Other themes included changing the colour of the sign (predominant suggestions were red) and increasing the frequency of the sign along the route:

“I may try the high risk surround in red instead of blue.”

“High risk route panel in red.”

“I would put the signs on the hill in many places not just at the beginning; its easy to forget as you are going up and down.”

“Put more on the road.”

A final note to make on the issue of improvements to the sign was that, while it never emerged as strong theme in any one question, there was an overarching theme concentrated around what made the route ‘High Risk’. This came through as either the respondent stating what the risk was in an unprompted fashion or stating the sign should state what the risk was.

*“High risk motorcycle route. There is a high risk for motorcycle involved incidents. **High wind danger.**”*

*“High Risk Route with picture of motorbike - Dangerous for Motorbikes, **need to take care due to wind and twisty corners.**”*

*“High risk section of road due to weather related issues such as **high winds, slippery surfaces when wet and multiple corners.**”*

*“Beware of other riders, **high winds and vehicles utilising the same lane** as you in opposite directions.”*

*“Given that the road is in generally good condition and well sign posted, a generic high risk sign is worthless as you do not know why. The main things on that route that you need to be aware of is **strong wind gusts and ice in winter.**”*

*“What is the risk ? **wind , twisty, motorbikes, bad surface, bad drivers/rides, foreign drives/riders, Black spot** ????”*

4.6.2 Traffic counters

While the above results show that the retention of the sign is high, with 82.4% of respondents stating they remember seeing the sign when prompted, as suggested by Fisher (1992), an important aspect of signage is that it leads to desired behaviour change. Two measureable behavioural changes that could have arisen from this sign were a reduction in speed as well as an increase in the headway between vehicles.

A total of 66,053 vehicles were captured entering the Rimutaka Hill Road during the period the traffic counters were monitoring road user behaviour. Of these, 1107 (1.6%) were motorcycles while 57,501 (87.1%) were light vehicles. The remaining 7,445 vehicles (11.3%) were made up of all other vehicle types, such as buses and heavy goods vehicles.

4.6.2.1 Vehicle speed

Vehicle speed was analysed by main vehicle type (motorcycle vs. light vehicle), day of the week (weekday vs. weekend) and section of road (whole road, bottom of the hill and corner). Only the speeds of vehicles with a four second or greater headway were analysed as these vehicles were considered to be travelling at 'free speed', meaning that the vehicles are travelling at a speed unimpeded by the presence of other vehicles.¹

The analysis revealed that there were several significant differences (see Table 9) in vehicle speeds between the time period before the signs were installed and afterwards. However, while these differences were statistically significant, these were not of 'practical' significance (Kirk, 1996), as they explained less than 1% of the variance ($r < 0.1$). The actual differences were only approximately 1 to 3 km/h between the two time periods, with no consistent change as some speeds increased and some decreased. The largest difference observed was for motorcycles at the bottom of the hill during the weekend. The results of the analysis can be seen in Table 9.

Table 9: Average vehicle speeds before and after signage installation broken down by vehicle type, day of the week and section of road

Section of road		Motorcycle		Light vehicle	
		Before	After	Before	After
Whole road	Weekday	82.3	82.1	73.5*	73.2*
	Weekend	84.9	84.5	71.4*	72.3*
Bottom of hill	Weekday	98.8	97.4	90.1	90
	Weekend	99.2*	102*	87.9*	89.2*
Corner	Weekday	64.2	63.7	56*	55.6*
	Weekend	69.4	68.6	54.4*	55.3*

* indicates there is a significant difference, $p < 0.05$

This lack of practical change in vehicle speed is also seen in the 85th percentile speeds. Again, the largest difference only equated to a 4 km/h change between the time period before and after the sign installation for motorcyclists at the bottom of the hill on the weekend. The majority of the 85th percentile speeds either had 1 km/h change (with inconstant decreases and increases) or no change at all. Table 10 gives a breakdown of 85th speeds by vehicle type, day of week and section of road.

¹ This measure is used by the New Zealand Ministry of Transport for its annual Speed Survey <http://www.transport.govt.nz/research/roadsafety-surveys/speed-surveys/>

Table 10: 85th speed percentile before and after signage installation broken down by vehicle type, day of the week and section of road

Section of road		Motorcycle		Light vehicle	
		85 th before	85 th after	85 th before	85 th after
Whole road	Weekday	107	108	97	96
	Weekend	108	108	94	95
Bottom of hill	Weekday	111	114	101	101
	Weekend	113	117	99	100
Corner	Weekday	78	80	65	65
	Weekend	88	87	62	64

The results from the traffic counters indicate that the signs had no ‘practically’ significant effect on motorcycle or light vehicle speed on the Rimutaka Hill Road.

4.6.2.2 Vehicle headway

As with vehicle speed, vehicle headway was analysed by main vehicle type (motorcycle vs. light vehicle), day of the week (weekday vs. weekend) and section of road (whole road, bottom of the hill and corner). Only the headways of vehicles of less than four seconds were analysed due to the fact that if the sign lead to better vehicle operator behaviour, then there should have been an increase in distance between vehicles when not in a free speed situation. This is supported by the fact that 7.7% of motorcyclists and 17.5% of light vehicle drivers stated they would increase their distance from other road users (see Table 7). If this stated behaviour actually occurred then of the approximately 619 motorcycles and 33,681 light vehicles that used the Rimutaka Hill Road after the signs where installed 48 of the motorcyclists and 5,894 of the light vehicle users should have increased the distance between them and the next vehicle.

While the results did show there was a significant difference (see Table 11) in relation to vehicle headway, as with the speed analysis these results showed no ‘practically’ significant difference ($r < 0.1$), failing to equate to even a full seconds shift in following times. This would suggest that, as with the speed results, the signs did not have any practical effect on-road user behaviour on the Rimutaka Hill Road, at least in relation to vehicle headway. Table 11 shows a complete breakdown of headway by vehicle type, section of road and day of week.

Table 11: Average vehicle headway (of vehicles with equal to or less than 4 second headway) before and after signage installation broken down by vehicle type, day of the week and section of road

Section of road		Motorcycle		Light vehicle	
		Before	After	Before	After
Whole road	Weekday	1.6	1.6	1.7*	1.7*
	Weekend	1.6	1.6	1.8*	1.8*
Bottom of hill	Weekday	1.5	1.5	1.7	1.7
	Weekend	1.5	1.5	1.8*	1.8*
Corner	Weekday	1.7	1.7	1.7*	1.6*
	Weekend	1.8	1.7	1.8	1.8

* indicates there is a significant difference, $p < 0.05$

5 Discussion

From the point of view of sign retention, this trial should be considered successful as a majority of the respondents (63.5%) remembered seeing the sign unprompted and when asked to describe the sign detail were able to do so effectively. Recall was even greater when the respondents were prompted (82.4%). This level of retention indicates that road users are certainly detecting the sign. While new users on the road are arguably the most important to inform around driving risk, this retention could be due, in part, to novelty value because this sign has not been used on New Zealand roads before.

The unprompted, understood meaning of the sign also appeared to be universal across both motorcyclists and light vehicle users, with the main response being that the route ahead was of high risk to motorcyclists and motorcycle riders should take extra care travelling this road.

This theme carried across into the prompted responses as well, with both motorcyclists and light vehicle users generally saying the sign was meant as warning for motorcyclists to be cautious on the following route. This was supported by the fact that the vast majority of respondents stated that the sign was targeted at motorcyclists. There was some variance within the light vehicle respondents regarding the meaning of the sign, with two smaller themes capturing the perceptions that the sign was either a warning to both motorcyclists as well as other road users, or that it was intended as just a warning to other road users to be aware of motorcyclists.

The results do indicate strongly that the perception road users have of the sign is that it's purely targeted at motorcyclists and it is intended to warn them that extra care is required on the following route. This could raise potential concern that other road users may not make any changes to their own on-road behaviour, which is an issue given that other road users are at fault in over half (54.5%) of multi-vehicle accidents involving a motorcycle (MoT, 2014).

While the sign does appear to be perceived as a warning, its effectiveness is undermined if there are not corresponding improvements in on-road user behaviour. Again, the results from the perceptual part of this research would indicate that those seeing the sign would change their own behaviour as well as expect others to change behaviour. Counterintuitively, it was the light vehicle users that stated there would be the greatest change in behaviour, even though the majority stated the sign was targeted at motorcyclists, while the majority of motorcyclists stated they wouldn't change their own behaviour. However, approximately one third of the motorcyclist respondents did state they would change some of their behaviours, for example, being more cautious in corners.

The stated change in behaviour however did not appear to be reflected in actual vehicle speeds or headways. The results of the analysis showed that, while there were some significant difference in speeds between the two periods, these results were not what would be described as being a 'practically' significant difference. It should be noted that these were only two measures of on-road user behaviour and changes may have happened to other, unobserved behaviours. For instance, changes to lane position (moving away from the centre line), road users paying more attention, or road users being more cautious at corners. The latter two behaviours were actually behaviours the majority of light vehicle users stated they would expect others and themselves to change due to seeing the sign.

While nearly half of the respondents stated the sign, in its current design, needed nothing to improve it, others did make possible suggestions. The responses that were made when asked how the sign could be improved followed several themes. The most common theme was that the sign should be changed to apply to all road users. If the sign was applicable to all road users then changes would be needed as, in its current design, it is perceived as entirely motorcycle-centric.

The final point that emerged from looking at the survey responses as a whole was that respondents thought it was important to identify what specifically made the route 'high risk' compared to other routes and that this information should be included in the signage. This was apparent from the answers where respondents stated what the risk was or asked that the risk be stated.

In conclusion, the sign, in its current design, is memorable, is perceived as a warning to motorcyclists, and therefore has the potential to lead to behavioural change (though maybe not for vehicle speed or headway). Finally, there are ways in which the sign could possibly be improved from the road users' perspective. Taking all the above into the account, the next section of this report outlines some recommendations for next steps.

6 Recommendations

The first recommendation is that, if the sign is to be implemented, it should be supported by a strong and wide reaching education campaign confirming at who the sign is targeted (e.g., purely motorcyclists or all road users), and what is expected of said target audience. Having a better understanding of the intention of the sign should make behavioural changes more likely.

The second recommendation supports the first by recommending that there needs to be a clearly defined set of criteria about what makes a route 'High Risk'. Having a firm set of guidelines about what constitutes a 'High Risk Route', in other words, which factors make a particular route higher risk than another, will help in designing the education campaign in regards to what information the target audience requires.

The third recommendation is to evaluate adding the specific risk to the sign based on why the route has been labelled high risk, for example, high winds on Rimutaka Hill Road (see Figure 10). This ties into the second recommendation as the target audience will know specifically why the following route is 'high risk', even if they are unaware of the underlining criteria used to decide if a route is of higher risk than other routes.



Figure 10: Potential evaluation sign change

The final recommendation is that, if the decision is made to use these signs, they should come under the remit of the NZTA MOTSAM (and its upcoming successor). This means that it can only be applied in a prescribed manner on clearly defined routes. The risk of not making it a regulated sign is that there would be no control over where the sign is installed or what design it follows.

Another advantage of including it under The Agency remit is then the sign can leverage off The Agency's brand and also helps with signage continuity. It will also further enhance the guidance related to 'High Risk Routes' contained in The Agency's document 'Safer journeys for motorcycling on New Zealand roads' (NZTA, 2012).

7 References

Fisher J (1992) Testing the effect of road traffic signs' informational value on driver behaviour. *Human Factors*, 34: 231-237.

Kirk, R. E. (1996). Practical significance: A concept whose time has come. *Educational and psychological measurement*, 56(5), 746-759.

Ministry of Transport (2014). *Motorcycles 2014*. Retrieved from <http://www.transport.govt.nz/assets/Uploads/Research/Documents/Motorcycles-2014.pdf>

New Transport Agency (2012). *Making journeys for motorcycling on New Zealand roads*. Retrieved from <http://www.nzta.govt.nz/resources/safer-journeys-motorcyclists/>

Appendix A

Copy of online survey

'High Risk Route' Motorcycle Sign Survey

The following survey has been commissioned by the Accident Compensation Corporation (ACC) and the Motorcycle Safety Advisory Council (MSAC) to test road users understanding of a potential new road sign for use on motorcycle routes in New Zealand.

IMPORTANT: Please only complete this survey if you have been the driver or rider of a vehicle on the Rimutaka Hill Road on Wednesday the 3rd or Sunday the 7th of December.

This is funded by the ACC Motorcycle Safety levy, which is administered by the MSAC.

This is public good research aimed at improving rider safety, your answers to this survey are completely confidential, you are free to withdraw from this survey at any point, at the end of the survey you have the opportunity to enter a prize draw for \$500 in MTA, supermarket or other vouchers.

For further information, please contact:

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Phone: 0800 444 350

Preliminary questions

Please answer the following question...

The license plate number quoted on your invitation letter is for what vehicle type? (select one)		
	<input type="radio"/>	Motorcycle
	<input type="radio"/>	Light vehicle, e.g. car, van, ute, light truck
	<input type="radio"/>	Heavy vehicle, e.g. HGVs etc
	<input type="radio"/>	Other _____

Have you been the driver or rider a vehicle on the Rimutaka Hill Road on Wednesday the 3rd or Sunday the 7th of December 2014?		
	<input type="radio"/>	No
	<input type="radio"/>	Yes

Experience with road and types of vehicles used:

Please answer the following questions regarding why you use the Rimutaka Hill Road, how frequently you use this road and the types of vehicles you use when travelling it...

For what purpose do you MAINLY use the Rimutaka Hill Road? (select one)	
<input type="radio"/>	Commuting to work
<input type="radio"/>	While working (e.g. trades person, commercial driver/rider)
<input type="radio"/>	Pleasure
<input type="radio"/>	Other _____

How frequently do you drive or ride the Rimutaka Hill Road?	
<input type="radio"/>	Most days
<input type="radio"/>	Few times a week
<input type="radio"/>	Few times a month
<input type="radio"/>	Few times a year

What types of vehicle have you used on the Rimutaka Hill Road? (select all that apply)	
<input type="checkbox"/>	Motorcycles
<input type="checkbox"/>	Light vehicles, e.g. cars, vans, utes, light trucks
<input type="checkbox"/>	Heavy vehicles, e.g. HGVs etc
<input type="checkbox"/>	Other _____

What type of vehicle do you MAINLY drive or ride on the Rimutaka Hill Road? (select one)	
<input type="radio"/>	Motorcycle
<input type="radio"/>	Light vehicles, e.g. cars, vans, utes, light trucks
<input type="radio"/>	Heavy vehicles, e.g. HGVs etc
<input type="radio"/>	Other _____

Sign retention:

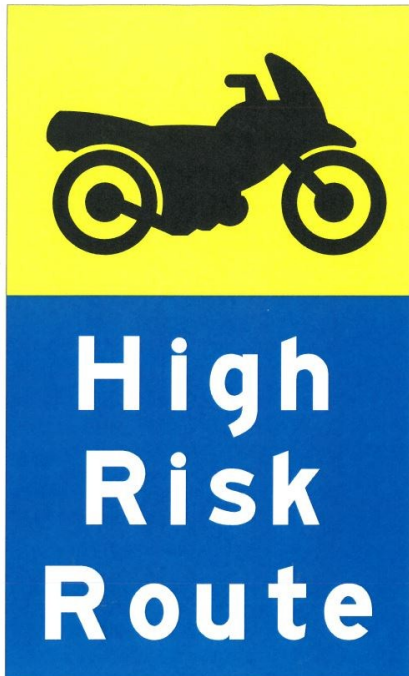
Please answer the following questions relating to your last trip on the Rimutaka Hill Road...

Do you remember seeing a new sign on your last drive or ride on the Rimutaka Hill Road?		
<input type="radio"/>	No	
<input type="radio"/>	Yes	

If you do remember seeing a sign, please describe what the sign was and what you thought it meant.	

Sign retention, meaning and target audience:

Please look at the sign to the left and answer the following questions...



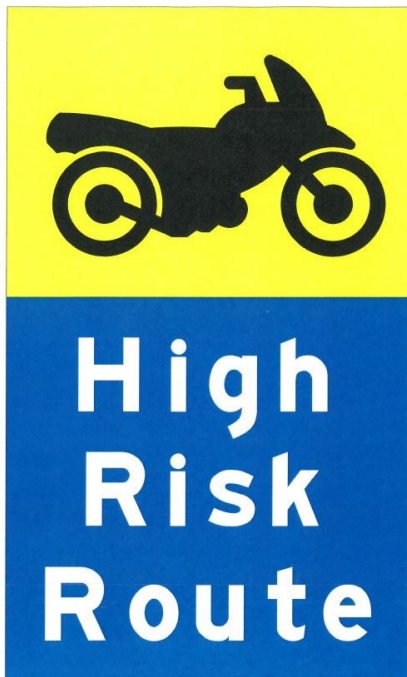
Do you remember seeing this sign on the Rimutaka Hill Road?	
<input type="radio"/>	No
<input type="radio"/>	Yes

What do you think this sign means?	

Whom do you think this sign is targeted at? (Select all that apply)	
<input type="checkbox"/>	Motorcycle riders
<input type="checkbox"/>	Light vehicle drivers, e.g. cars, vans, utes, light trucks
<input type="checkbox"/>	Heavy vehicle drivers, e.g. HGVs etc

Expected change in the way of driving or riding:

Please look at the sign to the left and answer the following questions...



Which, if any, of the following changes do you think **OTHER ROAD USERS** would make to the way they drive or ride on the Rimutaka Hill Road after viewing this sign? (select all that apply)

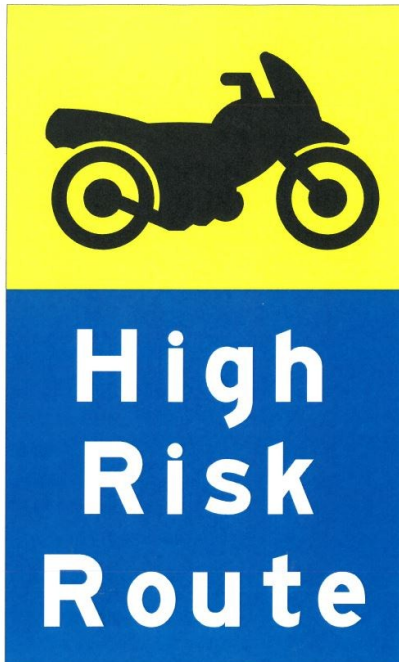
<input type="checkbox"/>	It would not change how other road users drive or ride at all
<input type="checkbox"/>	They would reduce their speed
<input type="checkbox"/>	They would pay closer attention to other road users
<input type="checkbox"/>	They would increase their distance between other road users
<input type="checkbox"/>	They would make greater efforts to stay away from the centre line
<input type="checkbox"/>	They would be more cautious approaching corners
<input type="checkbox"/>	Other

Which, if any, of the following changes would **YOU** make to the way you drive or ride on the Rimutaka Hill Road after viewing this sign? (select all that apply)

<input type="checkbox"/>	It would not change how I drive or ride at all
<input type="checkbox"/>	I would reduce my speed
<input type="checkbox"/>	I would pay closer attention to other road users
<input type="checkbox"/>	I would increase my distance from other road users
<input type="checkbox"/>	I would make greater efforts to stay away from the centre line
<input type="checkbox"/>	I would be more cautious approaching corners
<input type="checkbox"/>	Other

Potential improvement:

Please look at the sign to the left and answer the following question...



Which, if any, of the following sign features do you think could be improved?	
<input type="checkbox"/>	I would change nothing
<input type="checkbox"/>	Symbol
<input type="checkbox"/>	Wording
<input type="checkbox"/>	Colour
<input type="checkbox"/>	Other

If you said there could be improvements made, how would you make said improvements?	

Your demographics:

In this final section we will ask you questions about yourself...

Please indicate your age	<input type="text"/>	years old
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Please indicate your gender		
<input type="radio"/>	Female	
	<input type="radio"/> Male	
	<input type="radio"/> I prefer not to say	
	<input type="radio"/> Other	<input type="text"/>

This is the end of the survey

Thank you

If you wish to enter the prize draw for \$500 in MTA, supermarket or other vouchers please supply either a contact number or email address below:

Contact number or email address	
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If you have any further questions please feel free to contact:

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