

# Promoting cost effective road safety improvement strategies for rural roads in New Zealand

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## Abstract

In 2010 the New Zealand Government published Safer Journeys. This is the guiding document for road safety over the next decade, and introduced the Safe System Approach to New Zealand. One of the five high priority areas in Safer Journeys relates to Safer Road and Roadsides and includes a requirement to focus efforts on high risk rural roads and a first action being the development of an industry guide for the identification and treatment of high risk rural roads.

This paper explores the background to the guide, the contents of the guide, including the development of a categorisation system based on personal and collective crash risk. The use of the guide is then discussed, focussing on the categorisation of road sections/corridors, and how this categorisation assists practitioners and policy makers to broadly determine the appropriate road safety management strategy for road corridors.

**Key words:** High Risk Rural Roads, Collective Risk, Personal Risk, Safety Management, Applied Research.

## 1. Introduction

Since the early to mid 1980's, safety improvements on New Zealand roads have typically resulted from accident blackspot crash reduction studies, discretionary minor improvement spending and safety retro-fit programmes (in more recent years), or as a component of larger projects that address transport efficiency. While this approach has served New Zealand well for almost 30 years, it has some downsides:

- only specific locations along a corridor are improved, and only as a reactive response to crashes,
- the level of improvement at a location has varied according to the available benefits and qualifying benefit cost criteria,
- the sections of highway between improvement sites and without a significant crash history often remain unimproved, resulting in
- an increasingly inconsistent network.

In addition to the above, the simple focus on crash numbers has seen:

- many of the same sites being investigated every five years or so, even though the scope for further low to medium cost improvements was limited. While in,
- lower volume networks in particular, there was an increasing focus on sites with clusters of minor injury crashes.

Toward the end of the previous decade it became increasingly clear that a reliance on crash cluster identification and treatment was not going to generate the desired reductions in death and serious injury because:

- the proportion of fatal and serious crashes that occurred at traditional blackspots<sup>1</sup> was low, and
- the rate at which blackspots were being treated was also low.

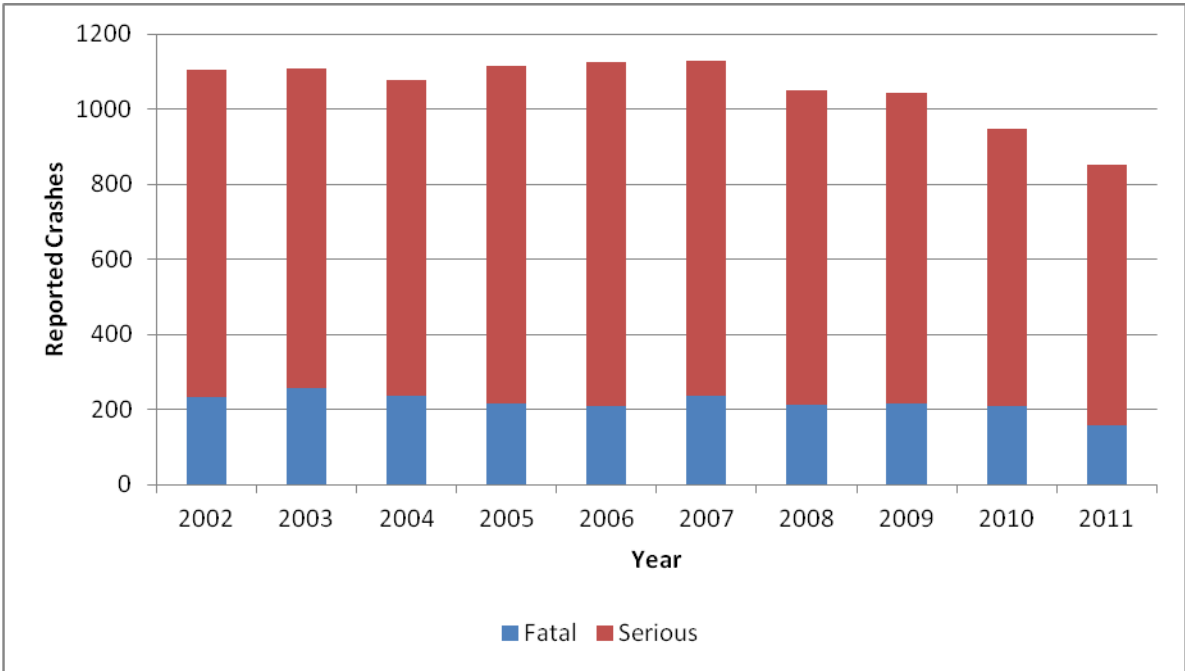
In 2010 the Government released Safer Journeys, the government's strategy to guide improvements in road safety over the period 2010–2020. Key features of Safer Journeys included:

- the vision of : “A safe road system increasingly free of death and serious injury”, supported by,
- the adoption of the Safe System approach to road safety.

Safer Journeys also included a series of “First Actions” one of which was the requirement to focus improvements on high risk rural roads. Associated with this First Action, was the need to develop a guide to the identification and treatment of high risk rural roads.

Despite decreases in recent years (Figure 1), rural mid-block crashes make up approximately 60% of New Zealand’s fatal crashes and 40% of the serious injury crashes. As such they represent one of New Zealand’s most pressing road safety issues. Importantly, around 70% of the rural mid-block fatalities and 60% of rural mid-block serious injury crashes occur on the state highway network.

**Figure 1 Reported fatal and serious crashes occurring on the mid-block sections of rural roads (speed limits >70 km/h)**



<sup>1</sup> Traditional working definition of blackspot was 2 or more fatal or serious crashes or 5 or more injury crashes in 5 years within a radius of 30m in urban situations or 250m in rural situations

## **2. The High Risk Rural Roads Guide**

The High Risk Rural Roads Guide (HRRRG or 'the Guide') has been prepared by the NZ Transport Agency (NZTA) and is available at <http://www.nzta.govt.nz/resources/high-risk-rural-roads-guide/docs/high-risk-rural-roads-guide.pdf>

The Guide is intended to provide practitioners and policy makers:

- with best practice guidance to identify, target and address key road safety issues on high risk rural roads, and
- provide national consistency regarding the identification of high risk rural roads and the application of proven countermeasures.

To do so the Guide provides links to a number of road safety resources and guidance for planning, funding and evaluating safety projects and programmes.

The Guide is divided into 8 sections. Sections 1 to 3 provide an introduction; discuss the strategic context including the Government's priorities for safety. The Safe System approach to road safety management is introduced before setting out the crash priorities for rural roads.

Section 4 provides a method for assessing the risk on rural road sections a method for establishing the most appropriate road safety management strategy.

Sections 5 to 8 look at some of the analysis techniques that may help practitioners gain a better understanding of the crash problem on a particular road section or corridor, countermeasures that may address these crashes, the approach to monitoring and evaluation and lists other resources.

The key to the Guide is Section 4 and the remainder of this paper outlines the process by which the risk classification system was developed and how the risk classification system is used to determine the most appropriate road section or corridor safety strategy.

## **3. What is a High Risk Rural Road?**

### **3.1. KiwiRAP Risk Maps**

Having followed developments in Australia, a joint working group was formed in late 2006, to develop the New Zealand Road Assessment Programme (KiwiRAP). The group comprising Ministry of Transport (MoT), the New Zealand Automobile Association (AA), New Zealand Transport Agency (NZTA), the Accident Compensation Commission (ACC) and New Zealand Police (Police), set out to map historic crash risk, the first protocol of the road assessment programme (RAP).

Under this protocol two sets of crash risk maps were published 2008, based on fatal and serious crashes reported as having occurred on State Highways during the period 2002 to 2006 inclusive.

The State Highway network was divided into approximately 172 routes, ranging in length from 7.3 km to 317.8km, average approximately 60 km. This is because the maps were initially aimed at informing the general public about travel risk and hence the links were selected primarily between major town centres or intersections of state highways. For statistical reliability purposes, each link was designed to have a minimum number of fatal and serious crashes, typically 30. As per the RAP protocol for each route maps of both Collective and Personal crash risk were produced:

**Collective Risk** is a measure of crash density expressed as crashes (in this case those resulting in death or serious injury), per kilometre, per year.

$$\text{Collective risk} = \frac{(\text{fatal crashes} + \text{serious crashes}) / \text{number of years of data}}{\text{Length of road section}}$$

**Personal Risk** is in effect the risk of a particular individual being involved in a crash (in this case those resulting in death or serious injury), as a result of travelling a distance on the route, measured as crashes per unit of travel (typically 100 million vehicle kilometres).

$$\text{Personal risk} = \frac{\text{Fatal crashes} + \text{serious crashes}}{(\text{length of road in km} \times \text{number of years of data} \times 365 \text{ days} \times \text{AADT}) / 10^8}$$

In each case the risk maps use a 5 category rating system ranging from High, through Medium to Low, with approximately 20% of the links (by number) being allocated to each band (Figure 2).

While the KiwiRAP risk maps provided a means of identifying high risk routes the way in which these state highway links have been selected has two effects:

1. Many of the high collective risk links are shorter higher-volume sections typically located in the North Island.
2. The higher personal risk lengths tend to be longer lengths with lower traffic volumes and are typically in the South Island.

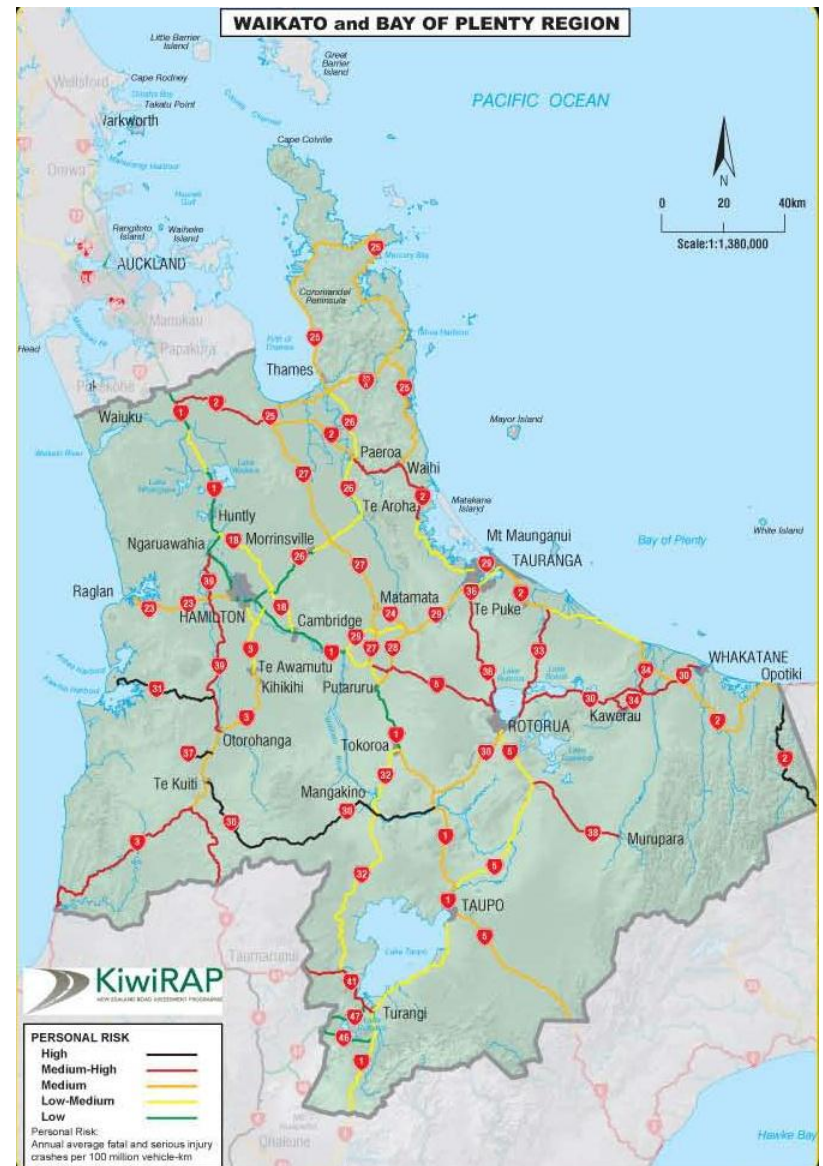
The result of these biases is that only 22% (2372km) of the rural state highway network has been mapped as 'high' or 'medium-high' in terms of collective risk, while 46% (4962km) has been mapped as 'high' or 'medium-high' in terms of personal risk.

There was a concern that should safety improvements on these long routes receive funding priority simply because they occurred on a black or high risk route, there could be a mis-allocation of funding.

Within any particular link, there will be sections, sub-routes or corridors that may have higher risk ratings than the link itself and these sub-sections may be high-risk rural roads (sections) in their own right. Similarly, there will be lengths with lower risk ratings.

Although the KiwiRAP risk maps do provide a starting point for investigating high-risk rural routes the risk mapping only applied to State Highways and the intention of Safer Journeys was to focus on all high risk rural roads be they State Highways or Local Authority roads. It was therefore necessary to develop a specific set of criteria that would be applicable to all rural roads.

Figure 2 Example of KiwiRAP risk maps (left -collective risk right- personal risk)



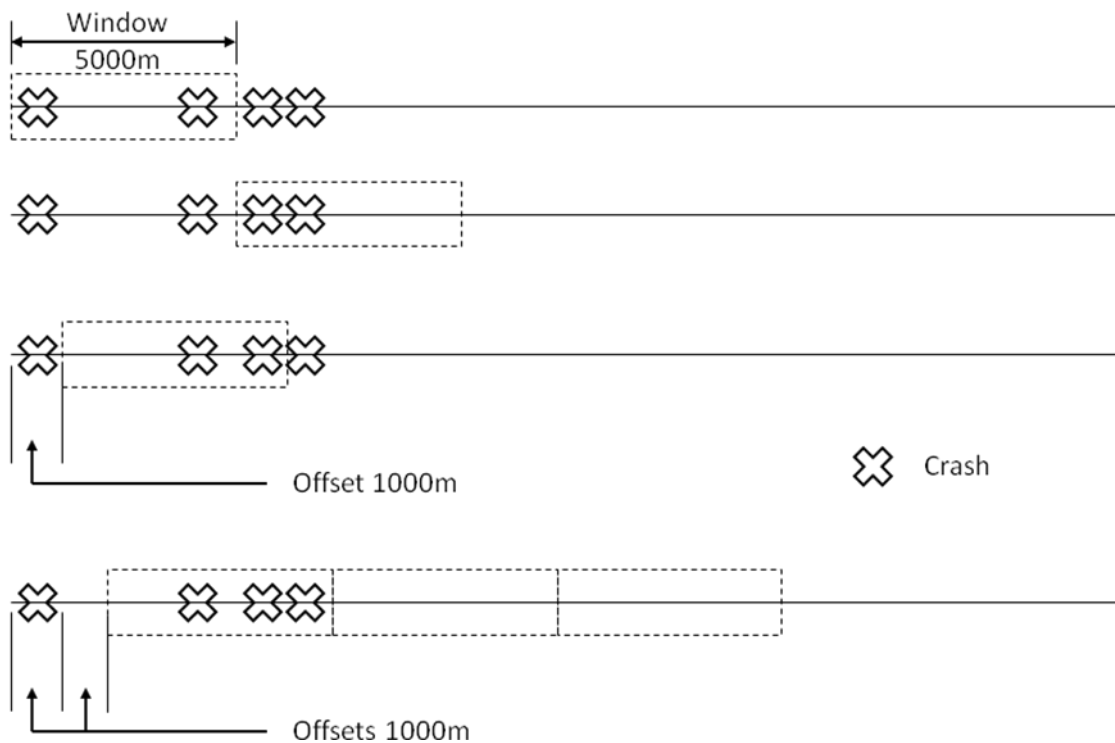
### 3.2. Developing Risk Assessment Categories

As the KiwiRAP risk maps had been established using a 5 category system, for no other reason than it seemed appropriate, the investigation of high risk rural roads also adopted a 5 category rating system High, Medium-High, Medium, Medium-Low and Low, for both collective and personal risk. These bands would be set so each contained approximately 20% of the risk spectrum associated with reported fatal and serious injury crashes. Since the traffic volume data is required in order to establish personal risk, State Highway data, for which there is a consistent and complete set of annual average daily traffic (AADT) estimates was selected to define risk category boundaries.

A sliding window routine, developed by consultants MWH New Zealand Limited, was used to interrogate the State Highway network. The routine looks at the crashes within a window of user defined length (5000m in Figure 3). The window is then moved along each highway according to the user defined offset (1000m in Figure 3), and the crashes within the window are reported for each increment.

If the window and offsets are equal in length each window abuts the previous as, can be seen in the top two lines of Figure 3. The result will always be an underestimate of the crash density. However, if the increment is small, there is a significant component of “double counting”.

Figure 3 Sliding window approach



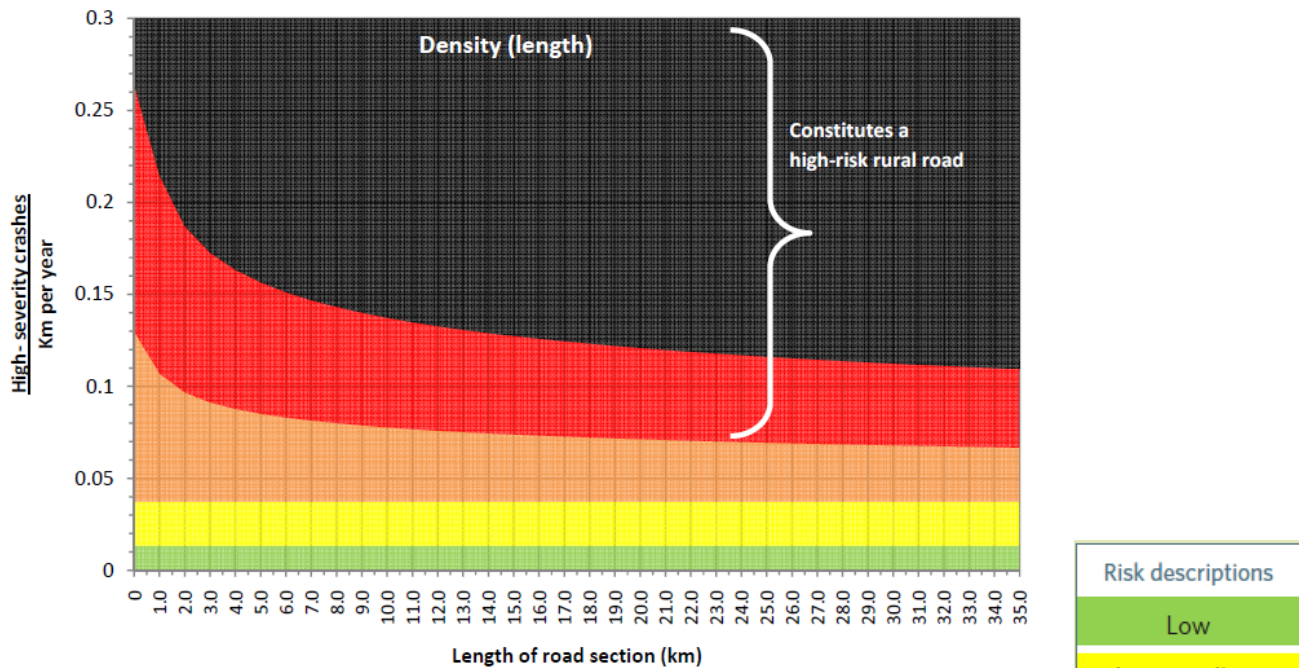
Following some experimentation, using a range of window and offset combinations it was found that an offset of 20% of the window length gave essentially stable results.

It is important to bear in mind that the estimates of collective and personal risk are subject to two key effects. Firstly the collective risk increases as traffic volumes increase, and secondly the longer the length of window the less the variation in risk.

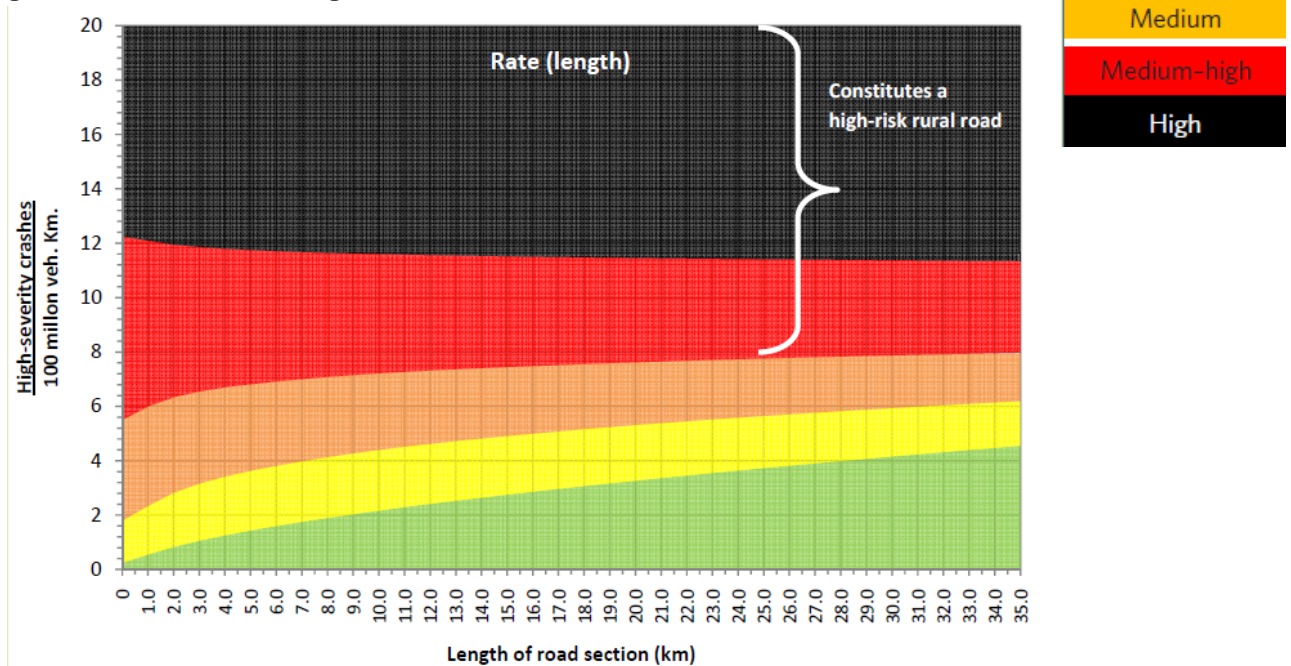
The sliding windows approach was run over a range of window lengths from 2 km through to 30 km: lengths below 2 km were considered to be better covered by crash cluster analysis, while those greater than 35 km would be covered by the KiwiRAP risk maps.

The final assessment was made using window lengths of 7.5 km, 15 km and 30km The Collective and Personal Risk calculated for each window were categorised according to the traffic volume, AADT. For each traffic volume band the risk distributions were divided into 5 bands each of 20%, representing the five risk bands as shown in Figure 4 and Figure 5.

**Figure 4 Collective risk rating**



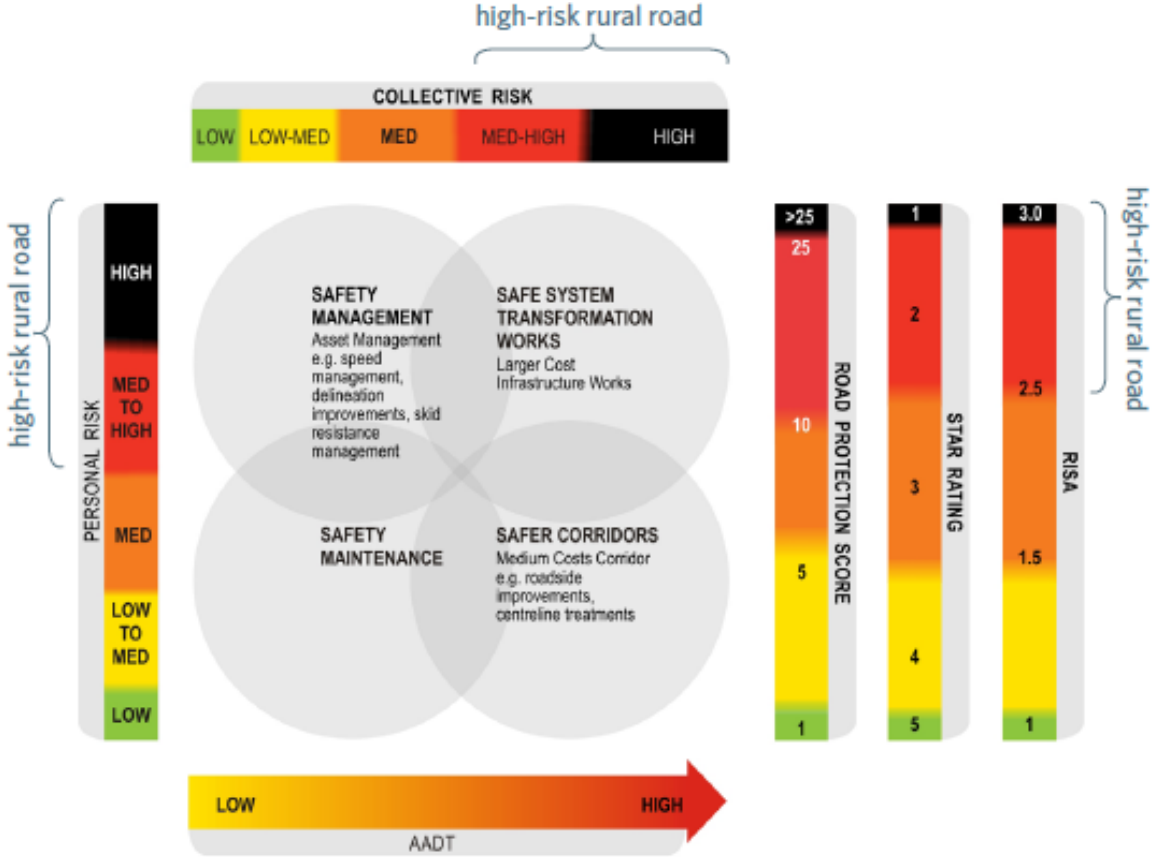
**Figure 5 Personal risk rating**



#### 4. Determining the appropriate road safety strategy

The result of this exercise is essentially a five by five matrix of Personal Risk (rows) and Collective Risk (columns), as shown in Figure 6. This five by five matrix, can then be simplified into effectively four quadrants. These four quadrants define the most appropriate safety management and improvement strategies, and section 6 of the guide suggests the types of works that are likely to be appropriate components of the safety management and improvement strategy for roads in a particular quadrant.

Figure 6 Assessing the appropriate improvement strategy



In the upper right there are those roads with both high personal and high collective risk, there is significant crash reduction potential on these roads and it is likely that major transformation projects will be viable. At the other extreme there are roads with both low Collective Risk and low Personal risk. These roads require only maintenance and little in the way of safety improvements will be required or justified.

The lower right quadrant contains those roads with high Collective Risk but low Personal Risk. Roads in this quadrant have higher traffic volumes and while not necessarily able to support major transformation projects such as grade separated interchanges, these roads will benefit from medium cost corridor treatments such as wider lane or shoulder works, roadside hazard management and median barriers.

The upper left quadrant contains those roads with relatively low traffic volumes and therefore lower Collective Risk but high Personal Risk. It is unlikely that even medium cost treatments will be economically viable on these roads. Although blackspot or crash cluster treatments will still deliver benefits at key locations, the most appropriate safety management strategy will revolve around improvements in delineation and markings, road surface maintenance and speed management.



While the treatment selection strategy, Figure 6, can be determined using Collective and Personal Risk, it is recognised that the detailed traffic volume data required to determine Personal Risk may not be available, users are provided with alternative measures of personal risk based on the KiwiRAP Road Protection Score and Star Rating ([http://kiwirap.co.nz/star\\_ratings.html](http://kiwirap.co.nz/star_ratings.html)) and a local inspection methodology known as RISA (road infrastructure safety assessment) an observational forerunner to KiwiRAP designed principally for local roads (<http://www.nzta.govt.nz/planning/monitoring/audits/risa.html>).

The Guide provides a list of recommended treatments depending on the road safety management strategy derived from Figure 6, and the crash types and user groups (Figure 7) with more detailed discussions of the counter measures and associated references given in the appendices.

**Figure 7 Recommended treatment options**

Key crash type	Safe System Transformation treatments	Safe Corridor treatments	Safety Management treatments
Head-on	<ul style="list-style-type: none"> <li>Median barriers (solid/semi-rigid and flexible)</li> <li>Safe System speeds</li> </ul>	<ul style="list-style-type: none"> <li>Marked median treatments</li> <li>ATP markings</li> <li>Improved delineation (signs and markings)</li> <li>Active signs</li> <li>Harm reduction speeds</li> </ul>	<ul style="list-style-type: none"> <li>Increased intervention levels</li> <li>Skid resistance</li> <li>Hazard removal</li> </ul>
Run-off-road	<ul style="list-style-type: none"> <li>Roadside barriers</li> <li>Clear zones</li> <li>Safe System speeds</li> </ul>	<ul style="list-style-type: none"> <li>Wider shoulders</li> <li>ATP markings</li> <li>Improved delineation</li> <li>Harm reduction speeds</li> </ul>	<ul style="list-style-type: none"> <li>Increased intervention levels</li> <li>Skid resistance</li> <li>Planting policies</li> <li>Hazard removal</li> </ul>
Intersections	<ul style="list-style-type: none"> <li>Grade-separated interchanges or overpasses</li> <li>Roundabouts</li> <li>Safe System speeds</li> </ul>	<ul style="list-style-type: none"> <li>Wider shoulders and separated turning facilities</li> <li>Improved delineation</li> <li>Active signs</li> <li>Harm reduction speeds</li> </ul>	<ul style="list-style-type: none"> <li>Intervention levels</li> <li>Skid resistance</li> <li>Improved sight visibility through various treatment</li> </ul>
Vulnerable road users	<ul style="list-style-type: none"> <li>Separated off-road facilities</li> <li>Safe System speeds</li> </ul>	<ul style="list-style-type: none"> <li>Wider shoulders</li> <li>Improved delineation</li> <li>Active signs</li> <li>Harm reduction speeds</li> </ul>	<ul style="list-style-type: none"> <li>Improved sight visibility</li> <li>reduce pinch points</li> <li>maintain consistent shoulder width and surface quality</li> </ul>

## **5. Summary**

The New Zealand Transport Agency's High Risk Rural Roads Guide provides practitioners with a means for assessing the appropriate safety management strategy for route sections or corridor lengths, based on a combination of Personal and Collective Risk. Once the most appropriate strategy has been determined the Guide provides a list of possible treatments, and an estimate of the likely benefits, that practitioners may use as part of corridor wide treatments.