Infrastructure Risk Rating Manual

Road to Zero Edition 2022

WAKA KOTAHI
NZ TRANSPORT AGENCY

New Zealand Government

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1 Introduction

Section 1 explains the purpose of and background to Infrastructure Risk Rating (IRR) (1.1) and the changes in this updated version of the *Infrastructure Risk Rating Manual* (1.2).

1.1 Purpose and Background

IRR is a proactive method for assessing road safety risk developed by Waka Kotahi NZ Transport Agency. IRR is based on the Star Rating approach of coding road and roadside features to model the underlying risk of a road section but requires fewer inputs.

As with Star Rating, IRR predicts the underlying level of risk a road presents to an individual road user based on key physical and operational attributes. IRR was first trialled on a 600km sample of the Aotearoa New Zealand state highway network that included a wide variety of different road environments, including 215km of urban roads. IRR-coded data was compared with crash rates and Star Ratings to calibrate the model. The IRR Technical Committee, which oversaw the development of IRR, agreed the results from the trial were sufficiently encouraging to endorse the use of IRR as a means of proactively predicting road safety risk and as a risk metric in the first version of the Speed Management Guide (2016).[1]

Since 2016, IRR has been used in a growing number of road safety applications in Aotearoa New Zealand and Australia to help road controlling authorities move away from reactive means of establishing road safety risk.

1.2 Changes to the *Infrastructure Risk Rating Manual*

This updated *Infrastructure Risk Rating Manual* was informed by a rigorous technical review of the IRR scores assigned to each IRR attribute category and the IRR risk bands. Some IRR scores and risk bands have changed, but the form of the IRR model and its attributes have not.

The manual has also been updated to align with *Aotearoa Speed Management Guide: Road to Zero edition* (2022)[2] and *MegaMaps: Road to Zero edition* (2022).[3]

1.3 Content of the Manual

- **Section 2** introduces the IRR attributes, identifies suitable data sources and provides guidance for coders to segment roads into sections for coding.
- **Section 3** sets out how to code each corridor segment against the IRR attributes
- **Section 4** specifies the risk scores assigned to each IRR attribute, details the equation used to calculate the IRR score, outlines the relationship between IRR score and Personal Risk, and presents the IRR risk bands.
- **Section 5** details the automated IRR coding process that is used in MegaMaps.
- The Appendix presents examples of roadside environments in each of the roadside hazard categories.

[1] NZ Transport Agency. 2016. *Speed Management Guide*. Wellington

[2] Waka Kotahi NZ Transport Agency. 2022. *Aotearoa Speed Management Guide: Road to Zero edition*. Wellington

[3] Waka Kotahi NZ Transport Agency. 2022. *MegaMaps: Road to Zero edition*. Wellington

2 Infrastructure Risk Rating Data Inputs and Preparation

2.1 Attributes

In IRR, the eight key road and roadside attributes that affect safety risk are:

- land use
- road stereotype
- carriageway width
- horizontal alignment
- roadside hazards
- intersection density
- access density
- traffic volume.

To assess risk and determine a corridor's IRR score, the eight IRR attributes must be assessed and coded by assigning each attribute a value based on the available categories. Before manual coding can begin, supporting data sources need to be collated (2.2) and roads need to be segmented into homogeneous corridors (2.3). A homogeneous corridor has little variation in the road and roadside attributes along its length.

The automated segmentation and coding process used in applications such as MegaMaps is described in section 5.

2.2 Supporting data sources

An IRR assessment is usually undertaken as a desktop exercise using existing datasets and local knowledge. The assessment requires the identification and coding of road and roadside features that impact on road safety risk. A variety of data sources can be used to identify these features, including the following.

- **Aerial imagery** is useful for gaining an overview of the road section to be coded and to determine attributes such as horizontal alignment, access density and intersection density.
- **Road asset management datasets** are useful for coding road stereotype, traffic volume, lane width and shoulder width.
- **Street view imagery** is helpful for coding features such as roadside hazards, land use and road stereotype. Google Street View is a good source of street-level imagery. However, it is important to check the date the image was taken, particularly on remote or low-volume roads. Site visits or drive-overs can also be undertaken to gather the necessary information for coding.
- **Other datasets** that are useful are map (GIS) layers of land use activity or land use zoning, traffic count datasets, road centreline datasets and speed limit datasets.

2.3 Segmentation of roads into homogeneous corridors

Once data sources have been collated, the next step in the IRR assessment process is to segment roads into homogeneous corridors, that is road segments with little variation across the road and roadside attributes.

The first step in identifying homogeneous corridors is to segment by the One Network Framework street category and then to use road name, speed environment, road stereotype, land use, horizontal alignment (rural roads only) and traffic volume for additional segmentation (2.2.1 to 2.2.7, respectively). A full description of each IRR category is presented in Section 3.

2.3.1 Segment by One Network Framework street category

The first step in segmenting the road network is to use the One Network Framework street categories.[4] This framework represents an evolution from a mobility-focused classification system to a two-dimensional classification focused on movement and place. This classification acknowledges that roads and streets are destinations for people as well as transport corridors. The framework also includes classifications for different modes of transport, recognising that Aotearoa roads and streets have different functions for different modes.

One Network Framework street categories are moderated by each road controlling authority and are sourced from a Waka Kotahi centreline dataset.

2.3.2 Segment by road name

Segmenting by road name means corridors are only made up of a single road name. Segmenting by road name help divide the network into understandable segments for subsequent analysis.

2.3.3 Segment by speed environment

Segmenting by speed environment means introducing a new segment where the existing speed limit changes from an urban speed environment (≤ 70km/h) to a rural speed environment (≥ 80km/h) and vice versa.

2.3.4 Segment by road stereotype

The Road stereotype (refer Section 3.2) should be consistent over the length of the corridor, except for short changes in length at intersections and for turning bays, slow vehicle bays and short (< 1km) overtaking lanes.

The difference between divided and undivided roads are as follows.

- A **divided road** has a physical feature that separates traffic travelling in opposite directions (for example, a median barrier or raised island). There may be gaps in the median at intersections. Each direction of travel on a divided road is coded separately based on the direction of travel (increasing or decreasing direction).
- An **undivided road** has no barrier or restriction to vehicles crossing the centreline (for example, roads with flush medians, wide centreline markings or no overtaking markings). Ignore short lengths of divided road (< 500m), such as on the approach to an intersection, and treat them as part of the undivided road section.

2.3.5 Segment by land use

Further segmentation by the adjacent land use category may be necessary in instances where the One Network Framework street category accommodates more than one type of land use. For example, a road with an ‘Urban Connector’ street category may have different land uses along its length, such as sections with commercial land use and sections with residential land use. In these instances, it would be appropriate to segment the road further.

2.3.6 Segment by horizontal alignment (rural roads only)

On rural roads, significant changes in horizontal alignment should be used to create segments. For example, a rural road may have a consistent One Network Framework category, adjacent land use and road stereotype over long lengths; however, within these lengths, there may be long straights and more curvilinear sections. In these instances, further segmentation should occur so straight and curvilinear

[4] Waka Kotahi NZ Transport Agency. 2022. One Network Framework (webpage).

sections are assessed separately. Isolated curves in otherwise straight sections should not constitute a new segment.

2.3.7 Segment by traffic volume

Further segmentation can occur where traffic volumes along a road segment change significantly (that is, by at least one traffic volume band category as defined in Section 3.7). This can occur when the road has a major intersection where a lot of traffic is added to or removed from the road. Smaller changes in traffic volume, such as when traffic volumes reduce or increase near the boundary of two categories, are acceptable within a corridor.

3 Infrastructure Risk Rating coding

This section sets out how to code each homogeneous corridor against the IRR road and roadside attributes:

- land use (3.1)
- road stereotype (3.2)
- carriageway width (3.3)
- horizontal alignment (3.4)
- roadside hazards (3.5
- intersection and access density (3.6)
- traffic volume (3.7).

Each category for each IRR attribute has an individual score. These scores and the equation for calculating the IRR score are in section 4.

3.1 Land use

The land use attribute is indicative of the likely level of road user activity on and near the road. This includes pedestrian and cyclist activity as well as vehicle movements, such as parking manoeuvres and turning movements at intersections and accessways. The features of this attribute are described in Table 1.

Table 1: Land use categories

Category	Environment	Description
Commercial strip shopping	Urban	Numerous shops facing the street front with high levels of pedestrian and cyclist activity. High occupancy on-street parking may be present, resulting in many vehicle movements to and from the road. Regular intersections and accesses may be present.
Commercial big box or industrial	Urban	Large (big box) shops, industry or factories or a combination with intermittent accessways leading to large off-street parking areas. Regular intersections and some pedestrians and cyclists may be observed.
Urban residential	Urban	Urban residential area dominated by housing with frequent driveways and on-street parking. Regular intersections are likely to be present. Pedestrians and cyclists may be observed, particularly at certain times of the day.
Rural town or urbanfringe	Urban	Rural town with a mixture of residential activity and some shops **or** a low-density urban road on the outskirts of an urban centre. Some intersections and accesses may be observed. Some pedestrians and cyclists may be present.

Category	Environment	Description
Controlled access	Urban	Road with roadside development and controlled access, such as an urban highway or arterial route with few accesses to the road. Some pedestrians and cyclists may be present but with few crossing movements.
Rural residential	Rural	Rural area with accesses to private dwellings and farms. Occasional industrial activity may be present. Some pedestrian and cyclist activity may also be observed, particularly at certain times of the day, but with few crossing movements.
Remote rural	Rural	Surrounding land is rural with few houses and almost no industry. Occasional accesses and intersections.
No access (e.g., motorway)	Rural	No accessways or at-grade intersections. Pedestrians and cyclists are not allowed.

When coding land use, consider how the adjacent land use is accessed from the road. For example, an isolated retail shopping centre accessed from a road through an intersection, rather than directly from the road itself, is more likely to be ‘controlled access’ rather than ‘commercial big box’.

If more than one category could be applied to the road, for example when the land use is different on each side of the road, select the category that appears higher in the table.

3.2 Road stereotype

The five categories of the road stereotype attribute are described in Table 2.

In the case of any ambiguity or overlap between categories, select the category that appears higher in the table. For example, classify an unsealed one-way road as ‘unsealed’.

Table 2: Road stereotype categories

Category	Description
Unsealed	Any road that is unsealed.
Two-lane undivided	An undivided road with one lane in each direction.
Multi-lane undivided	An undivided road with more than one lane in each direction. Includes roads with two lanes in one direction and one lane in the other direction.
Wide centreline or flush median	Roads that increase separation between opposing lanes of traffic but do not prevent a vehicle crossing into the opposing traffic lane. In rural areas, this includes roads with any of: • wide centreline treatments • physical medians that are traversable • frangible median dividers, such as flexi-hit posts. In urban areas, this includes roads with continuous flush medians. Isolated sections of flush median, such as in advanced of a right-turn lane, should not be coded in this category. Roads with a physical raised island in an urban area are classified as ‘divided or one way’ (see the definition below).

Divided or one way	Roads with a non-traversable median, roads with a physical raised island (in urban areas only) and one-way roads. Non-traversable medians would stop an out-of-control vehicle and include: • safety barriers (concrete, wire rope, and so on) • separation between opposing traffic flows of 10m or more.

3.3 Carriageway width

The carriageway width attribute requires individual coding of both the general traffic lane width and the sealed shoulder width (see Table 3).

Lane width is the distance between the centreline and edgeline.

Where no edgeline is marked, the lane width is the distance between the centreline and the edge of the seal, up to a maximum of 3.5m.

Where no centreline and edgeline are marked, the lane width is half the sealed carriageway width, up to a maximum of 3.5m with any remainder assigned as shoulder width.

Where lane widths are uneven, the narrowest lane width is coded.

Shoulder width is the distance between the edgeline and the edge of seal.

Where no edgeline is marked, the shoulder width is the distance between the centreline and the edge of the seal minus 3.5m.

Where no centreline and edgeline are marked, the shoulder width is the carriageway width minus 7m and divided by 2.

Where no edgeline is marked and the calculated lane width is < 3.5m, the shoulder width should be coded as 'very narrow' (< 0.5m).

Where shoulder widths are uneven, the narrowest shoulder width is coded.

Special purpose lanes, such as bus or cycle lanes, to the left of a general-purpose traffic lane are not included in the definition of the shoulder. However, they are included in the offset calculation for the coding of roadside hazards (see Section 3.5).

Parking lanes are not coded as part of the shoulder, because they contain roadside hazards (that is, parked cars), which are evaluated as part of the roadside hazard attribute (see Section 3.5).

For unsealed roads, the lane width must be coded as half the formed width up to a maximum of 3.0m. Where the formed width is > 6m, the residual width should be assigned as shoulder width.

Where the lane or shoulder width varies along a homogeneous corridor, coding should be based on the most common combination of lane and shoulder width that is present.

Table 3: Carriageway width categories

Category	Lane width	Shoulder width
Very narrow	n/a	< 0.50m
Narrow	≤ 3.00m	0.50 – 0.99m
Medium	3.01 – 3.49m	1.00 – 1.99m
Wide	≥ 3.50m	≥ 2.0m

3.4 Horizontal alignment

The categories of the horizontal alignment attribute are based on the degrees of turn per kilometre, calculated by summing the deviation angles of the horizontal curves along the corridor and dividing by the road length. For simplicity, horizontal alignment can also be estimated using the descriptions in Table 4.

Horizontal alignment can vary over a homogeneous segment and not trigger the formation of separate segments. In these instances, select the most common alignment category.

Table 4: Horizontal alignment categories

Category	Technical definition	Description
Tortuous	≥ 300 degrees of turn per km	Numerous consecutive curves (350–500m radius) and numerous sharp curves (radii < 350m).
Winding	≥ 150 and < 300 degrees of turn per km	Many consecutive curves and sharp curves (350–500m radius).
Curved	≥ 50 and < 150 degrees of turn per km	Moderate curves (typical radii of 500–1500m) with some straight sections or isolated sharp curves.
Straight	< 50 degrees of turn per km	Straight or gently curved with curves typically > 1500m radius. Occasional isolated curves may be present.

3.5 Roadside hazards

The coding of the roadside hazards attribute requires assessment of both the nature and the offset of the hazard (explained in 3.5.1 and 3.5.2, respectively) to determine the severity rating of the hazard (see Table 5).

Roadside hazards are rated separately for each side of the road with offset measured to the left in the direction of travel from the left-most general traffic lane.

For divided and one-way roads (as per the road stereotype attribute), hazards are measured on both sides with hazards on the right-hand side (including the median where a median is present) being measured from the outer point of the right-hand lane.

Table 5: Roadside hazards categories

Roadside Hazard	Offset		
	< 5m	**5–10m**	**> 10m**
Cliffs *	Severe	High	Low
Deep water *	Severe	High	
Aggressive vertical faces *	Severe	Moderate	
Deep drainage ditches *	Severe	Moderate	
Buildings, rigid structures or bridges *	Severe	Moderate	
≥ 20 non-frangible point hazards per km (≥ 1 per 50m), including: * • trees, signs, posts, poles ≥ 10cm diameter • large boulders ≥ 20cm diameter • unprotected barrier ends	Severe	Moderate	
Upslopes and downslopes that would cause rollover (> 15 degrees and > 1m height difference) *	High	Moderate	
Car parking, semi-rigid structures or buildings *	Moderate	Minor	

Roadside Hazard	Offset		
	< 5m	5–10m	> 10m
< 20 non-frangible point hazards per km (< 1 per 50m) including: * • trees, signs, posts, poles ≥ 10cm diameter • large boulders ≥ 20cm diameter • unprotected barrier ends	Moderate	Low	
Metal or concrete safety barriers *	Minor	Low	
Low severity hazards, including: • kerb and channel • level and safe slopes (≤ 15 degrees and ≤ 1m high) • frangible trees, posts or poles < 10cm diameter • wire-rope barriers	Low	Low	

* Over 50% of the homogeneous corridor where they occur intermittently.

Examples of roadside environments in each of the roadside hazard categories are provided in the Appendix.

3.5.1 Nature of hazard

Roadside hazards can vary considerably along a homogeneous corridor. Therefore, judgement is required to determine the roadside hazards risk category that best reflects the overall level of hazard posed by roadside features.

'Point' features, such as trees or non-frangible poles, have different roadside hazard risk categories depending on their frequency. Where the frequency is 20 or more per km (approximately 1 every 50m), a higher risk category applies, than where the frequency is less than 20 per km.

Intermittent hazards, such as structures, buildings or occasional cliffs and slopes, are coded to a hazard category if they occur at relatively regular intervals and cover at least 50% of the homogeneous corridor. For example, a road exposed to cliffs within 5m of the edgeline for over half the corridor, is coded as 'severe'.

If roadside hazards do not meet these density requirements, judgement is required to determine the average hazard score. For example, if less than half the section is exposed to cliffs within 5m of the edgeline ('severe'), but the remainder of the section has metal barriers within 5m of the edgeline ('minor'), then the road should be coded as 'high' if cliffs are present for about half the section, but 'moderate' if the cliffs affect less than half the section.

If the roadside hazard changes over short sections, the average hazard category should be selected. For example, for a flat, straight road with occasional trees and poles (fewer than 20 per km) that are 5–10m from the edgeline, then the roadside hazard category alternates between 'moderate' (where there are trees and poles) and 'low' (where there are no hazards). The average category that should be selected is 'minor'.

3.5.2 Offset of the hazard

The roadside hazard offset is recorded from the edgeline if one is present. If no edgeline is present, then the offset is recorded from the edge of the seal.

Figure 1 shows an example of a roadside hazard risk of severe–moderate based on:

- severe (deep drainage ditch within 5m) – left-hand side of the figure
- moderate (≥ 20 non-frangible point hazards per km offset 5–10m) – right-hand side of the figure.

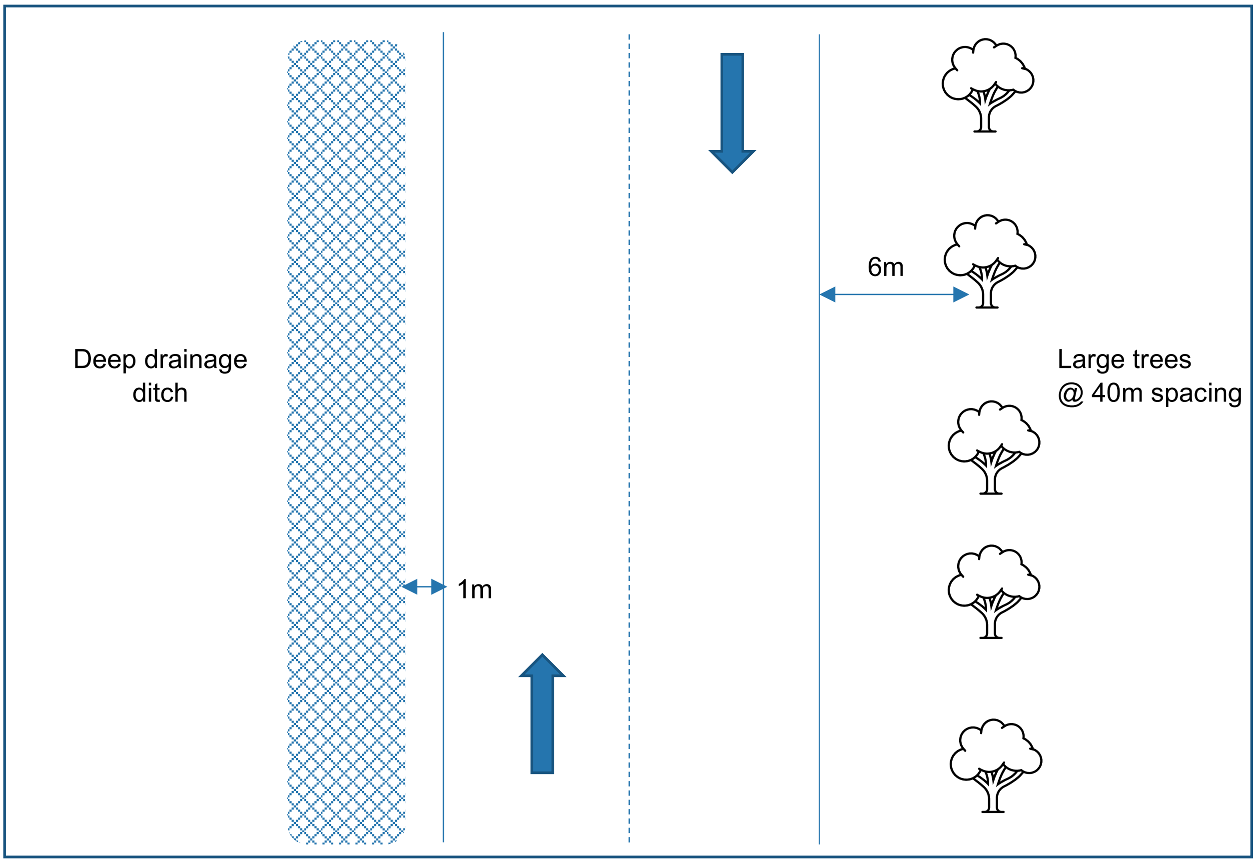


Figure 1: Example of a roadside hazard risk of severe–moderate

3.6 Intersection and access density

The density of intersections and accesses is calculated by counting the number of at-grade intersections and vehicle accesses respectively and dividing by the corridor length (see Table 6).

Where intersection or access density changes significantly along a homogeneous corridor, then consider further segmentation.

Where a significant change occurs over a short length (< 1km), then use judgement to determine whether further segmentation is required, depending on how large the change in density is.

Table 6: Intersection and access density categories

Intersection density		Access density	
Category	**Description**	**Category**	**Description**
≥ 10 intersections per km	>1 intersection every 100m	≥ 20+ accesses per km	> 1 access every 50m
5 to < 10 intersections per km	1 intersection every 100–200m	10 to < 20 accesses per km	1 access every 50–100m
3 to < 5 intersections per km	1 intersection every 200–330m	5 to < 10 accesses per km	1 access every 100–200m
2 to < 3 intersections per km	1 intersection every 330–500m	2 to < 5 accesses per km	1 access every 200–500m
1 to < 2 intersections per km	1 intersection every 500–1000m	1 to < 2 accesses per km	1 access every 500–1000m
< 1 intersection per km	< 1 intersection every 1000m	< 1 access per km	< 1 access every 1000m

3.7 Traffic volume

Traffic volume is coded using four broad categories based on annual average daily traffic volumes (see Table 7).

Table 7: Traffic volume categories

Category
> 12,000 vehicles per day
6000–12,000 vehicles per day
1000–5999 vehicles per day
< 1000 vehicles per day

4 Infrastructure Risk Rating calculation

This section explains how the IRR calculation is made. It discusses the IRR attribute scores (4.1), IRR score equation (4.2), the relationship between IRR score and Personal Risk (4.3) and risk bands (4.4).

4.1 IRR attribute scores

The risk scores assigned to each IRR attribute category are in Table 8. Carriageway width scores are in Table 9 for the various lane and shoulder width combinations.

Table 8: Risk scores assigned to each attribute category

Road attribute	Category	IRR score
Land use	Commercial strip shopping	8.00
	Commercial big box or industrial	5.00
	Urban residential	3.00
	Rural town or urban fringe	2.50
	Controlled access	2.50
	Rural residential	1.50
	Remote rural	1.50
	No access (eg, motorway)	0.80
Road stereotype	Unsealed	7.00
	Two-lane undivided	4.00
	Multi-lane undivided	2.50
	Wide centreline or flush median	2.50
	Divided or one way	1.00
Horizontal alignment	Tortuous (≥ 300 degrees of turn per km)	6.50
	Winding (≥ 150 and <300 degrees of turn per km)	5.00
	Curved (≥ 50 and < 150 degrees of turn per km)	1.80
	Straight (< 50 degrees of turn per km)	0.90
Roadside hazard	Severe	2.80
	High	2.00
	Moderate	1.70
	Minor	0.90
	Low	0.40
At-grade intersection density	≥ 10 intersections per km	8.00
	5 to < 10 intersections per km	2.60
	3 to < 5 intersections per km	1.50
	2 to < 3 intersections per km	1.25
	1 to < 2 intersections per km	1.15
	< 1 intersection per km	1.00

Road attribute	Category	IRR score
Access density	≥ 20 accesses per km	1.30
	10 to < 20 accesses per km	1.10
	5 to <10 accesses per km	1.06
	2 to < 5 accesses per km	1.03
	1 to < 2 accesses per km	1.01
	< 1 access per km	1.00
Traffic volume	> 12,000 vehicles per day	2.50
	6000–12,000 vehicles per day	1.90
	1000–5999 vehicles per day	1.40
	< 1000 vehicles per day	1.00

Table 9: Risk scores assigned to lane and shoulder width attribute categories

		Lane width		
		Narrow (<3.0m)	Medium (3.0m to 3.5m)	Wide (>3.5m)
Shoulder width	Very narrow (0 to 0.5m)	**2.50**	**2.01**	**1.22**
	Narrow (0.5m to 1.0m)	**2.01**	**1.79**	**0.78**
	Wide (1.0m to 2.0m)	1.22	1.00	**0.60**
	Very wide (>2m)	1.00	0.78	**0.60**

4.2 IRR score equation

The IRR score is calculated using a multiplicative log equation using the category score for each category.

$$\boldsymbol{IRR\ Score} = log10(Land\ Use\ score\ x\ Road\ Stereotype\ score\ x\ Horizonal\ Alignment\ score\ x\ Carriageway\ Width\ score\ x\ average(Roadside\ Hazard\ score\ each\ direction)\ x\ Intersection\ Density\ score\ x\ Access\ Density\ score\ x\ Traffic\ Volume\ score)$$

Where the IRR score ≤ 0, set the IRR score equal to 0.

4.3 Relationship with Personal Risk

The relationship between the IRR score and Personal Risk has been developed for generic urban and rural land uses and for the commercial strip shopping land use. Best fit equations provide confidence in the strength of the relationship. This means the relationship can be used to forecast predicted levels of safety performance of a road corridor based on the IRR score.

The urban and rural classification is based on the coded land use category. Corridors with the following land use categories are assessed as urban corridors:

- commercial big box or industrial
- urban residential
- controlled access
- rural town.

Corridors with the following land use categories are assessed as rural corridors:

- no access
- rural residential
- remote rural.

The relationships shown in Figure 2 can be used to predict the safety performance of a homogeneous corridor. For example, a rural road with an IRR score of 1.50 has a predicted Personal Risk of 7.64 deaths and serious injuries (DSI) per 100 million vehicle kilometres travelled (vkt).

The predicted Personal Risk can be translated into a Collective Risk by multiplying by the exposure on the corridor (measured as 100 million vkt). For example, if the corridor is 10km long and carries 5,000 vehicles per day (vpd), then the exposure would be 0.9125 (100 million vkt over 5 years). This means the predicted Collective Risk would be:

- 6.97 DSI per 5 years, which is equivalent to:
  - 1.39 DSI per year
  - 0.14 DSI per km per year (based on the corridor being 10km long).

This approach is useful for gaining an appreciation of the long-term expected safety performance of a corridor and understanding whether the reported safety performance (based on actual crashes and converted to DSI equivalents using severity indices and speed scaling factors) is above, below or in line with predicted performance.

The relationships between IRR and Personal Risk are also highly beneficial for understanding the expected change in safety performance associated with changes to IRR attributes, such as road stereotype or roadside hazards. Changes in IRR attributes typically result from infrastructure projects or where the adjacent land use changes. For example, if an infrastructure project was expected to change the IRR score from 1.50 to 1.10, then a 29% improvement in safety performance could be expected based on a future predicted personal risk of 5.45 DSI per 100 million vkt.

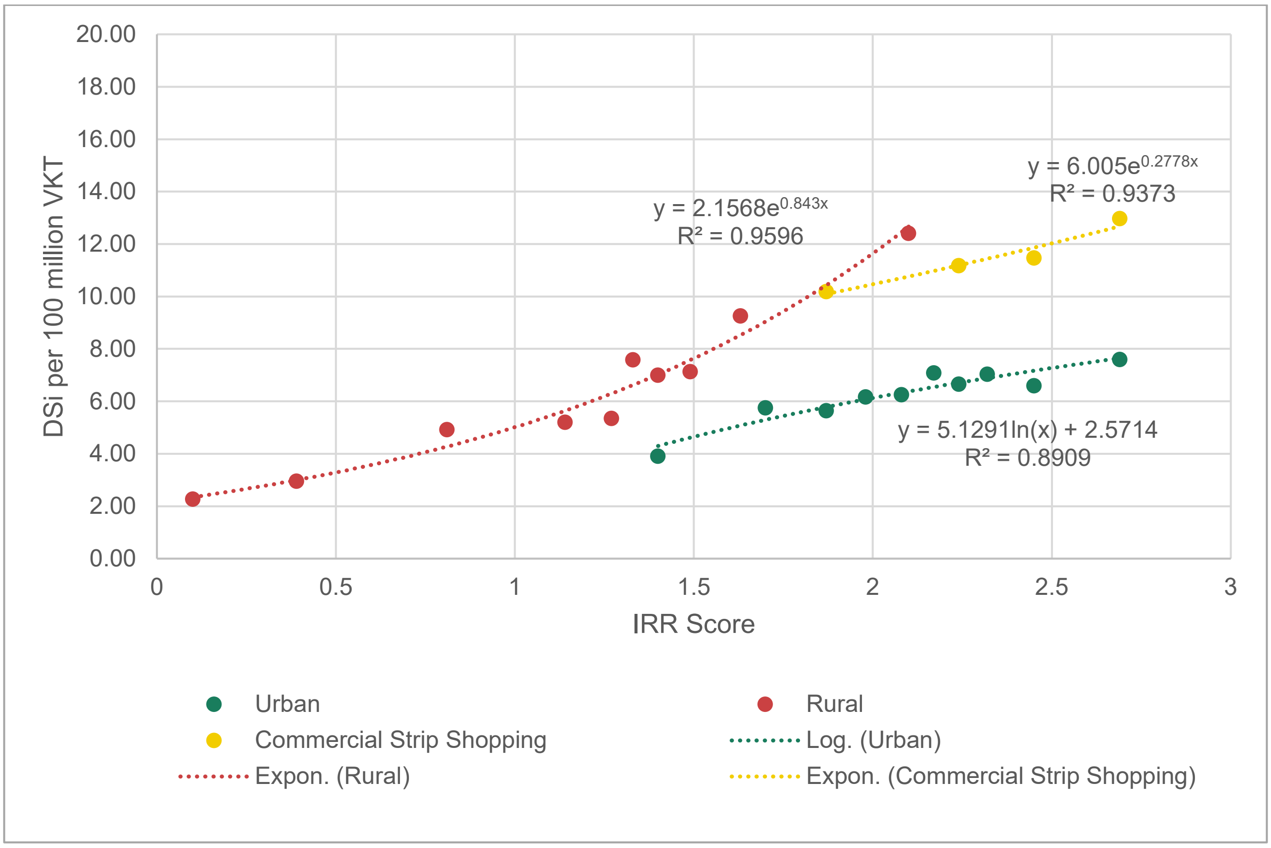


Figure 2: Relationship between IRR score and Personal Risk for urban and rural generic land uses and commercial strip shopping land use

4.4 IRR risk bands

The IRR risk bands in Table 10 are based on the relationships between the IRR score and Personal Risk in Figure 2 and target Personal Risk outcomes of:

- Low risk < 4.0 DSI per 100 million vkt
- Low–Medium risk 4.0 to < 6.0 DSI per 100 million vkt
- Medium risk 6.0 to < 8.0 DSI per 100 million vkt
- Medium-High Risk 8.0 To < 12.0 DSI Per 100 Million Vkt
- High risk ≥ 12.0 DSI per 100 million vkt

Table 10: IRR risk bands

IRR score	Rural	Urban	Commercial Strip Shopping
0 to < 0.1	Low	Low	Medium
0.1 to < 0.2	Low	Low	Medium
0.2 to < 0.3	Low	Low	Medium
0.3 to < 0.4	Low	Low	Medium
0.4 to < 0.5	Low	Low	Medium
0.5 to < 0.6	Low	Low	Medium
0.6 to < 0.7	Low	Low	Medium
0.7 to < 0.8	Low-Medium	Low	Medium
0.8 to < 0.9	Low-Medium	Low	Medium
0.9 to < 1.0	Low-Medium	Low	Medium
1.0 to < 1.1	Low-Medium	Low	Medium-High
1.1 to < 1.2	Low-Medium	Low	Medium-High
1.2 to < 1.3	Medium	Low	Medium-High
1.3 to < 1.4	Medium	Low-Medium	Medium-High
1.4 to < 1.5	Medium	Low-Medium	Medium-High
1.5 to < 1.6	Medium	Low-Medium	Medium-High
1.6 to < 1.7	Medium-High	Low-Medium	Medium-High
1.7 to < 1.8	Medium-High	Low-Medium	Medium-High
1.8 to < 1.9	Medium-High	Low-Medium	Medium-High
1.9 to < 2.0	Medium-High	Medium	Medium-High
2.0 to < 2.1	Medium-High	Medium	Medium-High
2.1 to < 2.2	High	Medium	Medium-High
2.2 to < 2.3	High	Medium	Medium-High

IRR score	Rural	Urban	Commercial Strip Shopping
2.3 to < 2.4	High	Medium	Medium-High
2.4 to < 2.5	High	Medium	Medium-High
2.5 to < 2.6	High	Medium	High
2.6 to < 2.7	High	Medium	High
2.7 to < 2.8	High	Medium-High	High
2.8 to < 2.9	High	Medium-High	High
2.9 to < 3.0	High	Medium-High	High
3.0 to < 3.1	High	Medium-High	High
3.1 to <3.2	High	Medium-High	High
≥ 3.2	High	High	High

5 Automated Infrastructure Risk Rating coding process

An automated geospatial process is a fast and cost-effective method of IRR coding. While this process has some limitations and is likely to be less accurate than manual coding for some attributes, it has the benefit of facilitating an objective network-wide assessment that eliminates inconsistencies between coders undertaking a manual assessment. This is the process used to calculate IRR scores and risk bands in MegaMaps.

5.1 Segmentation into homogeneous corridors

The geospatial process generally follows the segmentation process described in Section 2.

Segmentation based on land use occurs only if the adjacent land use is more than 250m in length in urban areas or 500m in length in rural areas. Additional segmentation does not take place where the change in land use is below these thresholds.

Segmentation based on road stereotype, horizontal alignment and traffic volume occurs when these attributes change over a length of more than 1km in both urban and rural areas. This avoids short segments being created based on isolated changes in the corridor, such as a short length of divided carriageway or series of bends in an otherwise straight road.

5.2 Land use coding

Land use coding has been automated using urban and rural boundaries and the density of residential and commercial developments sourced from planning zones, Open Street Map and Land Information New Zealand (LINZ) datasets.

5.3 Road stereotype coding

The coding of the road stereotype attribute has been automated by drawing data from the Road Asset Maintenance Management database. This database includes the number of lanes, whether the road is divided or undivided, and whether the road is sealed or unsealed.

The following logic is applied in the automated coding process:

- All divided roads with a median barrier are assumed to be non-traversable and coded as ‘divided’.
- All divided roads in urban areas are coded as ‘divided’.
- All one-way roads are coded as ‘divided’.
- Divided roads in rural areas without a barrier recorded are assumed to be traversable and are coded as ‘wide centreline or flush median’.
- Roads with more than two lanes that are not divided are coded as ‘multi-lane undivided’.
- Roads that are unsealed are coded as ‘unsealed’.

5.4 Horizontal alignment coding

The horizontal alignment category is determined using outputs of a geospatial model that assigns curvature based on degrees of turn per kilometre.

5.5 Roadside hazards

is no national database in Aotearoa New Zealand that captures both the nature and proximity of roadside hazards to traffic lanes. Therefore, the roadside hazard category is estimated based on a combination of land use and horizontal alignment categories. The assignment of the roadside hazard category is based on typical road environments (see Table 10).

Table 11: Automated assignment of roadside hazard categories

Land use category	Horizontal alignment category	Approximated roadside hazard risk
Commercial strip shopping Commercial big box or industrial Urban residential Rural towns	Any alignment	Severe-Moderate*
Controlled access	Any alignment	High-Moderate*
Rural residential	Any alignment	High-Moderate*
Remote rural	Tortuous alignment	High
Remote rural	Any alignment other than tortuous	Moderate
No access	Any alignment	Minor

* Where more than one category is shown, the average risk score associated with the categories listed is used.

5.6 Intersection density coding

Intersection density is calculated by generating geospatial points at each intersection and calculating the number of points per kilometre for each corridor.

5.7 Access density coding

Access density is estimated based on a combination of land use and posted speed limit codes (see Table 11. The following model has been produced to estimated access density:

$$ADB = -1.35\ln(SL) + 7.56(CAU) + 8.26(RemR) + 8.94\,(CBBI) + 9.32\,(RRes) + 10.26(RT) + 11.13(UR) + 11.17(CSS)$$

Where:

ADB = access density value

SL = speed limit (km/h)

CAU = controlled access (binary variable that equals 1 if land use is Controlled Access)

RemR = remote rural (binary variable that equals 1 if land use is Remote Rural)

CBBI = commercial big box or industrial (binary variable that equals 1 if land use is Commercial Big Box or Industrial)

RRes = rural residential (binary variable that equals 1 if land use is Rural Residential)

RT = rural town (binary variable that equals 1 if land use is Rural Town)

UR = urban residential (binary variable that equals 1 if land use is Urban Residential)

CSS = commercial strip shopping (binary variable that equals 1 if land use is Commercial Strip Shopping)

If the adjacent land use is no access, then access density is equal to zero.

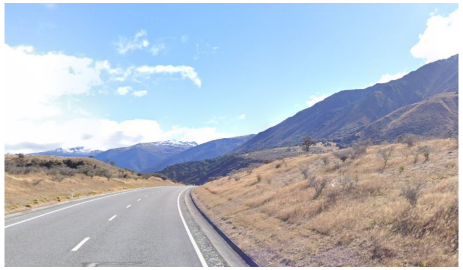
Table 12: Access density value by density category

Access density value (ADV)	Access density category
< 1.5	< 1 access per km
< 2.5	1 to < 2 accesses per km
< 3.5	2 to < 5 accesses per km
< 4.5	5 to < 10 accesses per km
< 5.5	10 to < 20 accesses per km
> 5.5	≥ 20 accesses per km

5.8 Traffic volume coding

Traffic volume data in the Road Asset Maintenance Management database is used to automate the coding of traffic volume.

Appendix: Examples of roadside hazards by severity

Severity of hazard			
Severe ***(within 5m from edgeline)***	 Deep water	 Aggressive vertical face	 Large trees at 20m spacing
High	 Upslopes (> 15 degrees and > 1m height difference) *within 5m of edgeline*	 Cliff or deep water *5–10m from edgeline*	
Moderate	 Buildings *5–10m from edgeline*	 Large trees < 50m spacing *5–10m from edgeline*	 Car parking *within 5m of edgeline*

Severity of hazard			
Minor	 Metal barrier *within 5m of edgeline*	 Semi-rigid structure (timber fence) *5–10m from edgeline*	 Concrete barrier *within 5m of edgeline*
Low	 Frangible posts or level and safe slopes (≤ 15 degrees and ≤ 1m high) *within 5m of edge of seal (no edgeline)*	 Wire rope barrier *within 5m of edgeline*	