SARAP

Mthatha Scholar Patrol Assessment

September 2015

Compiled by:

RTMC: Research and Development Unit

&

iRAP: UK

1 Executive Summary

The RTMC entered into a MOA with iRAP to establish SARAP in South Africa as part of the Decade of Action initiative to reduce road crash fatalities in South Africa. As the pilot project for the South African Road Assessment Programme (SARAP), the R573 Motolo road was assessed in 2014/15 as the first step in establishing the SARAP.

In early 2015, scholar patrols were proposed by the Eastern Cape provincial government at several schools in the Mthatha rural area. Officials from the RTMC's Education Unit assessed the proposed scholar patrol sites and requested engineering inputs from the RTMC Research & Development Unit (R&D) to ascertain if the proposed scholar patrol sites are conducive to scholar patrols. Four scholar patrol sites were visited in July 2015 by RTMC and it was found that the sites visited would be hazardous for scholar patrol. To confirm the latter, the R&D Unit assessed two of the roads on which scholar patrols were proposed with the SARAP.

This report is intended for the use by all authorities where scholar patrols are or are to be operated. The main aim of this report is to highlight the fact that scholar patrols can only be operated in a safe environment and the recommendations should be implemented by all authorities or even jointly with other partners, including private sector stakeholders who want to make an investment in road safety.

This report describes the Mancam & Mzomhle Junior Secondary Schools road assessment project, undertaken to access road safety at the proposed scholar patrol sites. The report includes details on data collection, the methodology used and a summary of the results.

The infrastructure-related risk assessment involved detailed surveys and coding of 50 road attributes at 100 metre intervals along the network and creation of Star Ratings, which provides a simple and objective measure showing the level of risk on the road network. The assessment found that 100% of the 18.6km of road surveyed is rated 3-stars (out of a possible 5-stars) for vehicle occupants, 84% is rated 3-stars and 16% is rated 2-Stars for pedestrians and 84% rated 3-stars for cyclists. None of the road sections achieved a 4- or 5-star rating.

Star Ratings by road user, Mancam JSS & Mzomhle JSS roads

	Vehicle Occupants		Motorcyclists		Pedestrians		Bicyclists	
Star Ratings	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent	Length (km)	Percent
5 Stars	0	0%	0	0%	0	0%	0	0%
4 Stars	0	0%	0	0%	0	0%	0	0%
3 Stars	18.6	100%	0	0%	15.6	84%	15.6	84%
2 Stars	0	0%	0	0%	3.0	16%	3.0	16%

Star Ratings	Vehicle Occupants Length (km)	Vehicle Occupants Percent	Motorcyclists Length (km)	Motorcyclists Percent	Pedestrians Length (km)	Pedestrians Percent	Bicyclists Length (km)	Bicyclists Percent
1 Star	0	0%	0	0%	0	0%	0	0%
Not applicable	0	0%	18.6	100%	0	0%	0	0%
Totals	**18.6**		**18.6**		**18.6**		**18.6**	

Note: the table shows 'smoothed' Star Ratings.

The road attribute data shows that the sections of road are two-lane, undivided carriageway, with no physical separation between opposing flows. Roadside hazards are numerous, with 72% of the survey length having hazardous objects within 5m of the running lane and limited road side protection (such as safety barriers). Provision for vulnerable road users is poor with insufficient footpath provision and crossing facilities where pedestrian numbers are higher. However, the low operating speeds and low flow help compensate for infrastructure deficiencies.

The project also involved the creation of a Safer Roads Investment Plan (SRIP), that consider the relative benefits of over 90 different countermeasure options, ranging from low cost road markings and pedestrian refuges to higher cost intersection upgrades and full highway duplication.

A summary of the investment plan is shown in the table below.

Safer Road Investment Plan summary (20 year analysis):

Present value of investment	ZAR 6,625,000
Deaths and serious injuries prevented	24
Present value of safety benefits	ZAR 13,300,000
Cost per death and serious injury prevented	ZAR 281,272
Benefit cost ratio (BCR)	2:1
Reduction in death and serious injuries	25%

In line with expectations for this sections of road speed and volume the SRIP is recommending school zone warning signs, rather than school patrols. These are in addition to sidewalks and a handful of low level crossings; of course these sections of road would also benefit from improvements like cleaning up the roadsides and improvement delineation.

The selection of an appropriate level of investment is open for decision by the road authority. Final proposed implementation of the plan will preferably include the following steps:

- local examination of proposed countermeasures (including a 'value engineering' type workshop including all relevant stakeholders)

- detailed analysis of traffic survey and crash data (if available)
- preliminary scheme investigation studies, including site surveys and preliminary design
- detailed design, star ratings of the designs, road safety audit, detailed costing and procurement, final evaluation and construction
- post-construction evaluation and road safety audit, including Star Ratings for the upgraded road and analysis of crash data (if it is available)

The detailed results of the project and online software that enabled the iRAP analyses to be undertaken are available to stakeholders for further exploration and use (http://vida.irap.org).

In order to achieve the best road safety gains on the network, efforts that go beyond the engineering improvements discussed in this report will be necessary. Significant benefits could be realised through the coordinated improvement of road user behaviour such as improving speed limit compliance, seat belt and helmet wearing rates and reducing alcohol use, improving the safety of the vehicle fleet, as well as road infrastructure. The Road Safety Toolkit (http://toolkit.irap.org) and United Nations Road Safety Collaboration Good Practice Manuals provide further information on these issues.

Further, research has demonstrated that it is crucial to ensure that local communities have the opportunity to both contribute to road designs but also understand the intended use of various road design features (see for example, BRAC, 2005). The RTMC and relevant road authorities should pursue these complementary approaches as part of the ongoing core road network development programme.

2 Acknowledgments

The Mancam JSS & Mzomhle JSS road assessment project would not have been possible without:

- Selebalo Phasha, Sidumo Khoza, Marcia Gxowa - Researchers RTMC
- James Bradford - Global Product Director, iRAP
- Deon Roux – RTMC Sub-Head: Research & Development
- Refilwe Mongale – RTMC Executive Head: Strategic Services

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iRAP's activities are also supported by the FIA Foundation and the Road Safety Fund.

3 Contents

4 Document version history

Version	Date	Description
iRAP502	September 2015	iRAP Draft Technical Document
1.1 SARAP Report – Mthatha Schools – Sep15	September 2015	RTMC Final Document
1.2 SARAP Report – Mthatha Schools – Sep15	September 2015	RTMC Final Document

5 Background and Introduction

Scholar patrol or school patrol goes back as far as 1920 when the Safety Patrol Program was started by the American Automobile Association (AAA). Boys, when they reached the sixth grade, would be screened for the proper character traits and then trained in safety and put to use. In South Africa this becomes even more important in light of the fact that approximately 36% of road fatalities are pedestrian fatalities.

The benefits of scholar patrols are endless with the following major benefits highlighted:

- The Scholar Patrol program benefits the school, the community and the student safety patrollers.
- The program provides quality training and recognition for student safety patroller's efforts.
- Apart from providing safer access to schools at nearby crossings, this program inspires patrollers to develop positive relationships with peers and authority figures and develop leadership skills, teamwork, maturity and a sense of responsibility.
- The Scholar Patrol helps foster closer ties with the community and increases the school's visibility in the community.
- Student patrollers are visible ambassadors for their school and assist both parents and their children at school crossings.

The awareness of road safety brought about by the exposure to scholar patrol at an early age can only benefit our older road users. This might teach adults not to cross the road without caution, and might teach motorists to be careful near schools, playgrounds and bus stops.

5.1 Aim of this Report

This report is intended for the use by all authorities where scholar patrols are or are to be operated. The main aim of this report is to highlight the fact that scholar patrols can only be operated in a safe environment and the recommendations should be implemented by all authorities or even jointly with other partners, including private sector stakeholders who want to make an investment in road safety.

5.2 Objective this Report

This report describes the Mancam JSS & Mzomhle JSS road assessment project, undertaken to access road safety at the proposed scholar patrol sites and as part of establishing the South Africa Road Assessment Programme (SARAP). The report includes details on data collection, the methodology used and a summary of the results.

5.3 Problem Statement

The implementation of scholar patrols along roads near schools should only be implemented when and where it is safe for kids to operate such patrols. In early 2015, scholar patrols were proposed by the Eastern Cape provincial government at several schools in the Mthatha rural area. Officials from the RTMC's Education Unit assessed the proposed scholar patrol sites and requested engineering inputs from the RTMC Research & Development Unit (R&D) to ascertain if the proposed scholar patrol sites are safe to implement scholar patrols. Four scholar patrol sites were visited in July 2015 by RTMC Education and R&D Units and it was found that the sites visited would be hazardous for scholar patrol. To confirm the latter, the R&D Unit assessed two of the roads on which scholar patrols were proposed with the South African Road Assessment Programme (SARAP).

5.4 Global Road Safety

Around the world 1.24 million people die as a result of road traffic crashes each year, that's 3,400 deaths per day, or one every 25 seconds.[1] Although several high income countries are reducing the number of deaths on their roads, many low and middle-income countries are experiencing an increase in the numbers of fatal and serious injuries.

With road traffic fatalities now the leading cause of death for young people aged 15 to 29 worldwide and 92% of road traffic deaths occurring in low and middle-income countries, key partners in global road safety have come together in an attempt to tackle this rapidly worsening public health crisis through accelerated investment in road safety and by fundamentally changing the way we design, build and maintain our road infrastructure networks around the world. As such, the United Nations has declared 2011-2020 the Decade of Action for Road Safety. It is expected that during the decade, significant efforts will be made to stabilise and then reduce the death toll through systematic improvements in road infrastructure, road user behaviour and vehicle safety.

We need to insert the **purpose of the report**: this report is intended for the use of the local and provincial authorities and the recommendations should be implemented by them or even jointly with other partners, we can even stretch the use to include the private sector stakeholders who want to make an investment in road safety.

[1] WHO Global status report on road safety (2013)

5.5 Road safety in South Africa

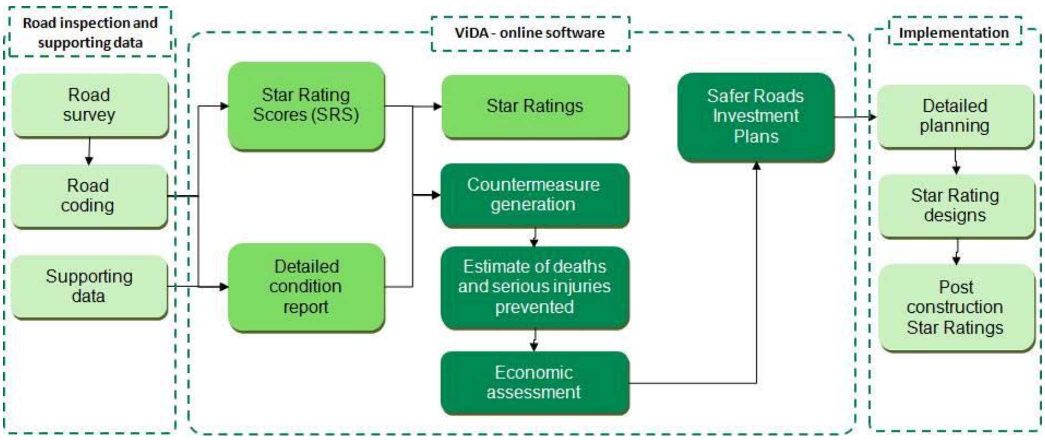
It is recognised that investment in the transport network plays an important role in a country's economic development and poverty reduction. To this end, investment in road building programmes is often focused on improving mobility and reducing journey times. However, it is of paramount importance that every opportunity be taken to ensure that these new roads and rehabilitation projects focus on the need for safe road infrastructure for all road users, particularly the young and vulnerable.

Road crashes in South Africa result in high levels of death and serious injury. The latest official figures show that 10,367 people were reported killed in South Africa in 2014 which is a slight decrease from 2013 fatalities reported as 10,170 due to road crashes. Urgent action is required to improve safe road design in order to significantly reduce these avoidable tragedies.

5.6 Methodology

The production of Star Ratings and Safer Road Investment Plans involve a number of data collection, survey and analysis processes, as illustrated in Figure 1. The iRAP assessments make use of road attribute data for more than 50 variables at 100 metre intervals along a road. This data was compiled through road surveys that collect digital images of the road using multi-view high-resolution cameras as it is driven. After the images were collected, they were viewed by coders using specialised software to record the road attributes.

Figure 1 The iRAP Road Survey, Coding, Star Rating and Safer Roads Investment Plan process



iRAP uses globally consistent models to produce vehicle occupant, motorcyclist, pedestrian and bicyclist Star Ratings and Safer Road Investment Plans. The methodology is described in the following fact sheets:

- iRAP Methodology Fact Sheet 3: Road Attributes
- iRAP Methodology Fact Sheet 4: Crash Types
- iRAP Methodology Fact Sheet 5: External Flow and Median Traversability

- iRAP Methodology Fact Sheet 6: Star Rating Score Equations
- iRAP Methodology Fact Sheet 7: Star Rating Bands
- iRAP Methodology Fact Sheet 8: Smoothed Star Ratings
- iRAP Methodology Fact Sheet 9: Star Rating Worked Example
- iRAP Methodology Fact Sheet 10: Casualty Estimation and Calibration
- iRAP Methodology Fact Sheet 11: Countermeasures
- iRAP Methodology Fact Sheet 12: Multiple Countermeasures
- iRAP Methodology Fact Sheet 13: Economic Analysis

6 iRAP and the Safe System Approach

Road deaths and injuries are the result of a complex interaction between the way people behave on the roads, the types of vehicles in use and the speed they are travelling, and the design of the roads themselves. Despite this complexity, the process of creating a road system that is genuinely safe is now well understood. Experience in implementing the well-established 'safe system' approach, which recognises the mutual importance of safe road users, safe vehicles and safe roads, shows how death and serious injury can be prevented on a large scale.[2] The following principles broadly underline the safe system approach and inform the iRAP process:

- mistakes, errors of judgment and poor driving decisions are intrinsic to humans. The road safety system needs to be designed and operated to account for this
- humans are fragile. Unprotected, we cannot survive impacts that occur at even moderate speeds
- people who behave with criminal disregard for the safety of themselves and others should expect tough policing and tough penalties
- safety can be built into the road system in a comprehensive and systematic fashion, not just having the apparent problem areas patched up
- the 'engineered' elements of the system - vehicles and roads - can be designed to be compatible with the human element, perhaps taking lessons from motor racing that while crashes will occur, the total system is designed to minimise harm.

The role of iRAP is to focus specifically on the 'safe roads' element of the safety equation, in the context of safer road users, safer vehicles and safe roads. iRAP builds on the experience of developed countries that have a proven track record in infrastructure safety and, with the support of local engineers and researchers, applies knowledge and technical processes that are applicable for low and middle-income countries.

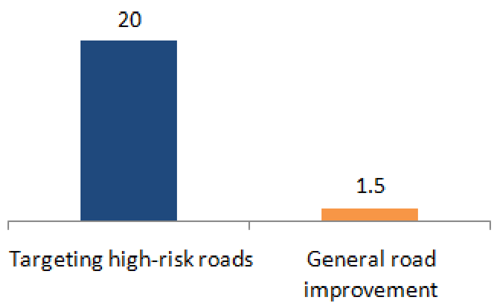
A safe road will recognise and make provision for the limitations of humans within the transport system. The network should be designed to limit the probability of crashes occurring and minimise the severity of those crashes that do occur.

Evidence shows that affordable, safe road infrastructure can cut vehicle occupant, motorcyclist, pedestrian and bicyclist deaths dramatically. Few infrastructure investments can match the economic benefits of those generated by targeted road safety measures (see Figure 3 below). Research from Australia, the United States, the United Kingdom, Norway, France, Canada, Netherlands, the Nordic Countries and New Zealand shows that targeted road safety projects

[2] See for example www.who.int/violence_injury_prevention/road_traffic/strategies/en/index.html and www.ors.wa.gov.au/.

generated crash cost savings of up to 60 times the cost of construction.[3] That is, for each $1 invested, there was a return of up to $60 in terms of crash costs avoided. Other research has shown that low-cost improvements at specific high-risk sites have shown first year rates of return of 300%.[4] With adequate maintenance, road infrastructure investment can last decades, so the safe roads built today will continue saving lives and preventing injuries long into the future.

Figure 3 Number of lives saved for each $100m invested [5]



Engineering solutions exist for all of the primary crash types that kill road users, Table 1 below shows a summary of each of the common crash types with details of the engineering solutions that are proven to reduce risk, further information on these treatments can be found in the iRAP Road Safety Toolkit (http://toolkit.irap.org).

Table 1 Primary causes of road death and engineering solutions that save lives

Crash Type / Mechanism	Engineering Solutions	Examples
Hit Pedestrian Crash Pedestrians are killed walking along the road and in trying to cross the road.	Solutions include: Footpaths, pedestrian fencing, speed management and traffic calming, safe crossing points.	
Hit Motorcyclist Crash Motorcyclists are killed when they are hit by heavier vehicles and trucks.	Solutions include: Fully separated motorcycle lanes, on-road motorcycle lanes.	

[3] OECD (2008) Towards Zero – Ambitious road safety targets and the safe systems approach -- page 96, section 4.2 "The road safety management system".
[4] Road Safety Foundation (2008).

[5] Vulcan, P. and Corben, B. (1998) Prediction of Australian Road Fatalities for the Year 2010, Monash University Accident Research Centre (MUARC), Melbourne.

Crash Type / Mechanism	Engineering Solutions	Examples
Head-on Crash Oncoming traffic collides at high speed (while overtaking or when momentarily crossing into the opposing lane).	Solutions include: Provision of overtaking lanes, median barriers or separation, flexible posts, central hatching.	
Run-off Road Crash Vehicle leaves the road and strikes a fixed object (tree, pole, structure) or steep embankment.	Solutions include: Protection of the hazard with barriers, remove hazard, provide safe run-off area.	
Intersection Crash High speed frontal or side impact, rear-end crash with non-compatible vehicles.	Solutions include: Grade separation, speed management, roundabouts, signalisation, turning lanes.	
Hit Bicyclist Crash Bicyclists are killed cycling along the road and in trying to cross the road.	Solutions include: On-road and off-road, cycle paths, speed management and traffic calming, safe crossing points.	

7 Road Surveys and Coding

Using a specially equipped vehicle the selected road sections was surveyed, recording continuous digital images and geo-reference data to enable the coding of more than 50 road attributes relating to the likelihood and severity of a crash.

7.1 Road surveys

The surveys were undertaken by the RTMC during August 2015 using a road inspection system. The features of the inspection system were:

- Dual roof mounted high-resolution digital cameras. Enabling wide field of view images to be taken every 20m
- Geo-reference data linked to the images.

Figure 4 The road survey vehicle

7.2 iRAP coding

Upon completion of the surveys, the RTMC coding team recorded road attributes in accordance with the *iRAP Star Ratings and Investment Plans: Coding Manual*. The coded data was subject to quality assurance checks in accordance with the *iRAP Star Ratings and Investment Plans: Quality Assurance Guide,* to ensure the highest standards of quality and consistency during the road coding process and subsequent quality reviews prior to data processing.

7.3 Road attributes

The following table summarises the road attributes recorded and helps to illustrate the relationship between road infrastructure attributes and road user risk. A full data set of the coded attributes is also available as a downloadable file from http://vida.irap.org.

Table 2 Recorded road attributes (survey length: 18.6km)

Road attribute	Category	Details / key findings	Road User Risk*			
			V	MC	P	B
Traffic flow (AADT in vehicles)	0 - 1,000	74%				
	1,000 - 2,000	26%				
Operating speed (see next section on the importance of operating speed in relation to the iRAP model)	65 km/h	100%				
Area type	Rural/open area	100%				
Lane width	wide	6%	✓	✓		✓
	medium	94%				
Paved shoulder width	medium	3%	✓	✓	✓	✓
	narrow	66%				
	none	31%				
Curvature	straight or gently curving	68%	✓	✓		✓
	moderate	32%				
Delineation	adequate	24%	✓	✓		✓
	poor	76%				
Shoulder rumble strips (raised profile edge lines)	present	0%	✓	✓		
	not present	100%				
Road surface condition	good	13%	✓	✓		✓
	medium	87%				
Roadside severity (left) - object	upwards slope 15° to 75°	17%	✓	✓		✓
	deep drainage ditch	21%				
	downwards slope > 15°	5%				
	tree >= 10cm	5%				
	sign, post or pole >=10cm	35%				
	rigid structure/bridge or building	8%				
	large boulders >- 20cm high	1%				
	None (>20m clear zone)	9%				
Roadside severity (left) - distance	object 0-1m	31%	✓	✓		✓
	object 1-5m	34%				
	object 5-10m	8%				

Road attribute	Category		Details / key findings			
	object >=10m	27%				
Roadside severity (right) - object	upwards slope 15° to 75°	23%	✓	✓		✓
	deep drainage ditch	8%				
	downwards slope > 15°	2%				
	sign, post or pole >=10cm	59%				
	rigid structure/bridge or building	5%				
	None (>20m clear zone)	4%				
Roadside severity (right) - distance	object 0-1m	29%	✓	✓		✓
	object 1-5m	43%				
	object 5-10m	6%				
	object >=10m	22%				
Median type	centre line	84%	✓	✓	✓	✓
	wide centre line (0.3m to 1m)	16%				
Intersections	3-leg (unsignalised)	1	✓			✓
	none	185				
Intersection quality	adequate	0	✓	✓		✓
	poor	1				
Sidewalk provision (left)	none	3%			✓	
	informal path	97%				
Sidewalk provision (right)	none	3%			✓	
	informal path	97%				
Pedestrian crossing facilities	none	100%			✓	✓
Pedestrian fencing	present	0%			✓	
Street lighting	not present	100%			✓	✓
Traffic calming	not present	100%	✓	✓	✓	✓
Bicycle lane	not present	100%				✓
Motorcycle lane	not present	100%		✓		

**VO - vehicle occupants, MC motorcyclists, P - pedestrians, BC - bicyclists*

The Detailed Road Condition tables within ViDA provide the length and percentage for each category of recorded road attribute. They can be used to compare the infrastructure attributes of different roads or road sections and can help to provide an understanding of the Star Ratings of a given road section and the proposed countermeasures that will potentially alter the road attributes and reduce risk.

For example the data shows that 100% of the road length is undivided with no physical median separating opposing traffic flows, 97% of curved sections have hazardous roadsides and intersections are at-grade, unsignalised and do not incorporate turning lanes. Facilities for vulnerable roads users are also poor. For example 66% of roads where pedestrians are present have no purpose built footpath and there are no bicycle lanes throughout the entire surveyed sections of road.

8 Supporting Data

Although the iRAP Star Ratings and Safer Roads Investment Plans use a standardised global methodology, the models are calibrated with local data to ensure that the results reflect local conditions. The following section outlines the supporting data and how it was used in the iRAP analysis.

8.1 The role of speed

The issue of speed management is of paramount importance in road safety and traffic speeds have a significant bearing on the iRAP Star Ratings.

The risk of death or serious injury is minimised in any crash, where:

- vulnerable road users (e.g. motorcyclists, bicyclists and pedestrians) are physically separated from cars and heavier vehicles, or where traffic speeds are 40km/h or less
- opposing traffic is physically separated and roadside hazards such as trees and other fixed objects (including concrete guard posts) are well managed
- traffic speeds are restricted to 60km/h or less on roads where opposing traffic flows are not physically separated, or where roadside hazards exist.

The safety of infrastructure is heavily influenced by the speed of traffic and without an understanding of the operating speeds it is difficult to assess the safety performance of infrastructure at a given location. All iRAP assessments are based on vehicle operating speeds to ensure that the Star Rating is based on how the road is actively functioning, which in some cases can be above the posted speed limit. For further details of the iRAP specifications in relation to vehicle speeds see *Vehicle Speeds and the iRAP Protocols*, which can be found on the iRAP website http://irap.org/about-irap-3/research-and-technical-papers.

In many countries there can be a marked difference between the posted speed limit and the actual speed of vehicles using the road. This is a function of local behaviour, local enforcement practice and whether the engineering features of the road are designed in accordance with the speed limit, for example the use of traffic calming measures to help manage speeds.

8.1.1 Speed data

For much of the road inspected where speed limit signs were observed, vehicle operating speeds often appeared to be slightly in excess of the posted limit. Data from previous speed surveys were used to derive a general relationship between vehicle operating speeds and the posted speed limit.

The method adopted to estimate 85th percentile and mean operating speeds and the assumptions made are detailed below:

Table 3 Operating speeds used

Posted Speed Limit	85th Percentile Operating Speed	Mean Operating Speed
60km/h	65km/h	60km/h

8.2 Traffic flows

8.2.1 Vehicle traffic volumes

Total traffic flow (or volume) for all motorised vehicles is required for the road and is used in the estimation of the distribution of the numbers of deaths and serious injuries that could be prevented on the network. The data is required to be in Annual Average Daily Traffic (AADT) format and should not be adjusted to passenger car equivalent (PCU) volumes.

The AADT for this assessment is shown in Table 4.

Table 4 Traffic survey and crash data as supplied by RTMC

Road	Section	AADT (vehicles per day)
DR08032	Mancam to Kulozulu	1,000
DR08032	Mzomhle to Kulozulu	900

Notes: AADT (including motorcycle percentage) supplied by RTMC.

8.2.2 Motorcycle volumes

Based on existing data plus other data sources such as observed flow during coding, percentage of powered two-wheelers from vehicle registry it was decided that the motorcycle flow was too low to be included within this project.

8.2.3 Pedestrian and bicycle flows

Pedestrian and bicycle flows were recorded during the coding process. It is possible to rely solely on this data for processing, though it is not recommended. This is because pedestrian and bicycle flows can be transitory and a one-off visual inspection is unlikely to provide a strong basis for determining overall flows. In this project, pedestrian and bicyclist flows were estimated based on observed flows and the surrounding land use and road attributes. The approach used for estimating pedestrian along and crossing flows and bicyclist flows was as follows:

- An estimate was made for each 100 metre segment of road based on adjacent land use and road attributes. See *iRAP 310: A Guide to Producing iRAP Star Ratings and Safer Roads Investment Plans* for further information on estimating flows based on adjacent land use.
- If the estimate was less than the observed flow, then the observed flow was selected. It is noted that from time to time, this step could cause create an artificially high number if an unusually large number of people or bicycles happened to be observed. However, in the case of South Africa, very high pedestrian and bicycle movements are not unusual and it is also common that pedestrians walk along rural sections of road.
- The pedestrian flows along the road were 'smoothed' across 500 metre lengths for pedestrians and 1km for bicyclists by taking the highest value in that length (pedestrian crossing volumes were not smoothed).

8.3 Number of deaths and serious injuries

As part of the iRAP model calibration, an estimate of the number of deaths that occur on the road was required. In order to allocate deaths and serious injuries to the network, the iRAP model also requires an estimate of the distribution of deaths by road user type and the ratio of deaths to serious injuries.

Due to the lack of crash data on the specific road sections inspected calibrations factor from similar roads within South Africa were utilised. These factors resulted in the fatality estimates shown in Table 5.

Table 5 Road deaths by user type (2011-13)

	Vehicle occupant	Motorcyclist	Pedestrian	Bicyclist
Fatalities	1 each 4 yrs	-	1 each 5 yrs	minimal

The number of serious injuries was estimated using the standard iRAP assumption that for each death, 10 serious injuries occur.[6]

8.4 The economic cost of a death and serious injury

Safer Roads Investment Plans: The iRAP Methodology describes the process used to estimate the economic cost of a road death and a serious injury for iRAP projects. This approach is applied globally by iRAP and is based on research undertaken by McMahon and Dahdah (2008).

[6] K. McMahon and S. Dahdah, *The True Cost of Road Crashes: Valuing life and the cost of a serious injury*, iRAP, 2008. http://irap.org/library.aspx.

The key equations used are:

- the economic cost of a death is estimated to be: 70 x Gross Domestic Product (GDP) per capita (current prices)
- the economic cost of a serious injury is estimated to be: 0.25 x economic cost of a death.

On this basis:

- the economic cost of a death is estimated to be 70 x ZAR 68,000 = ZAR 4,760,000
- the economic cost of a serious injury is estimated to be: 0.25 x ZAR 4,760,000 = ZAR 1,190,000.

To calculate present value costs and benefits, a discount rate of 12% was used.

8.5 Countermeasure costs

The iRAP model requires the input of local construction and maintenance costs for each of the 93 countermeasures that are considered in the development of the Safer Roads Investment Plans. The estimated costs are categorised by area type (urban and rural) and upper and lower costs (low, medium and high), based on the extent to which the surrounding land use and physical environment impacts upon the construction cost of major works. This means that up to six different costs can be assigned to the same countermeasure treatment, although for some countermeasures the costs may be the same regardless of area type and environment.

The countermeasure costs used in this study were based on estimates calculated by engineering staff from LEA Associates South Asia Pvt. Ltd. (LASA) who are currently working as consulting engineers with the Roads & Buildings Department, Government of Gujarat and converted into ZAR. Indian countermeasures costs were used in this pilot data due to similarities in the economies between India and South Africa. The full data set for the study is available in the iRAP online software http://vida.irap.org/.

9 Star Ratings

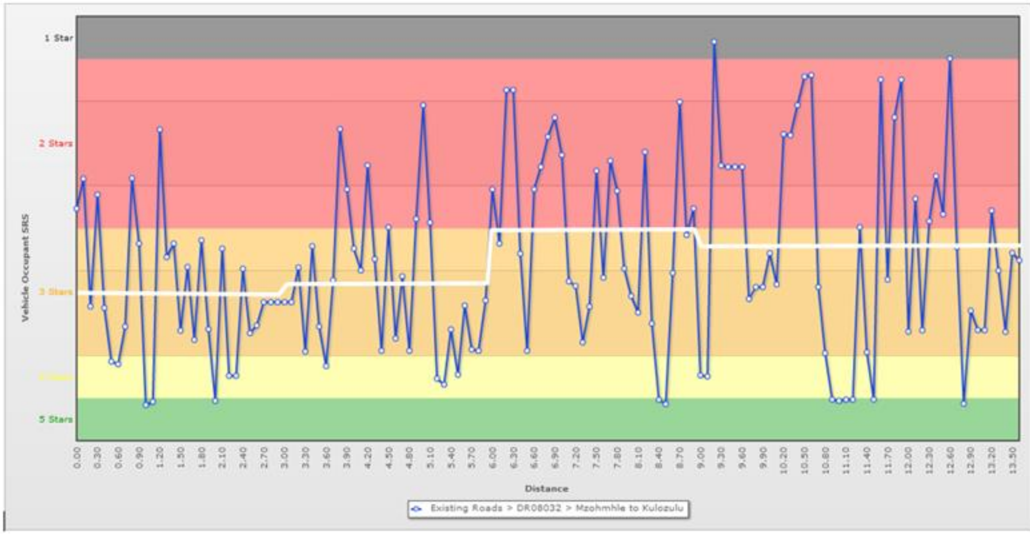
iRAP Star Ratings are based on road infrastructure features and the degree to which they impact the likelihood and severity of road crashes. The focus is on the features which influence the most common and severe types of crash on roads for motor vehicles, motorcyclists, pedestrians and bicyclists. They provide a simple and objective measure of the relative level of risk associated with road infrastructure for an individual road user. 5-star (green) roads are the safest, while 1-star (black) roads are the least safe. Star Ratings were not assigned to roads where there was very low use by that type of road user. For example, if no bicyclists use a section of road, then a bicyclist Star Rating is not assigned to it.

The Star Ratings are based on Star Rating Scores (SRS). The iRAP models are used to calculate an SRS at 100 metre intervals for each of the four road user types, based on relative risk factors for each of the road attributes. The scores are developed by combining relative risk factors using a multiplicative model. More information on the risk factors used within the model can be found within the Methodology Documents at www.irap.org.

9.1 Smoothed Star Ratings

A Star Rating Score (SRS) is calculated for each 100 metre segment of road for vehicles occupants, motorcyclists, pedestrians and bicyclists. These scores are then allocated to Star Rating bands to determine the Star Rating for each 100 metre of road. However, for the purposes of producing a network level map showing Star Ratings, 100 metres is too much detail. Hence, Star Ratings are smoothed (or averaged) over longer lengths in order to produce more meaningful results. The effect of smoothing is illustrated in the chart below, which shows unsmoothed (raw) Star Rating Scores (SRS) in blue and smoothed SRS in white.

Figure 6 Raw Star Rating Scores (blue) and smoothed SRS (white)



9.2 Star Rating results

The Star Rating results for the sections of road alongside the Mancam & Mzomhle schools demonstrate that there is potential to improve the safety of road infrastructure for all users. High risk road sections feature significantly in the results with the majority of the surveyed sections rated 3-stars or less (out of a possible of 5-stars) for all road user types.

The star ratings show that:

- For vehicle occupants, 100% of road length is rated as 3-star.
- For pedestrians 84% of the road length is rated as 3-star and 16% of road length is rated as 2-star.

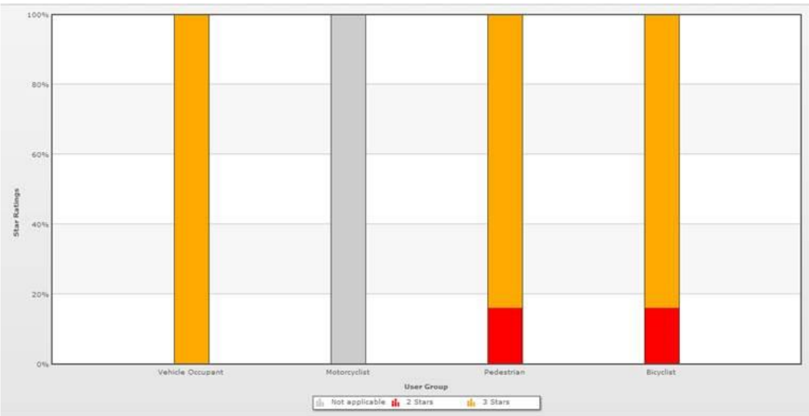
None of the road is rated 5-star or 4-star for vehicle occupants or pedestrians.

Table 6 Star Ratings

	Vehicle Occupants		Motorcyclists		Pedestrians		Bicyclists	
Star Ratings	Length (km)	**Percent**	**Length (km)**	**Percent**	**Length (km)**	**Percent**	**Length (km)**	**Percent**
5 Stars	0	0%	0	0%	0	0%	0	0%
4 Stars	0	0%	0	0%	0	0%	0	0%
3 Stars	18.6	100%	0	0%	15.6	84%	15.6	84%
2 Stars	0	0%	0	0%	3.0	16%	3.0	16%
1 Star	0	0%	0	0%	0	0%	0	0%
Not applicable	0	0%	18.6	100%	0	0%	0	0%
Totals	**18.6**		**18.6**		**18.6**		**18.6**	

Note: the table shows 'smoothed' Star Ratings.

Figure 7 Star Ratings



9.3 Star Rating maps

The following images show the Star Rating maps for vehicle occupants, motorcyclists, pedestrians and bicyclists. The maps show how road user risk can change along a route based on the safety aspects provided by the road infrastructure and can be used to identify the high-risk corridors for priority treatment.

Figure 8 Vehicle occupant Star Ratings

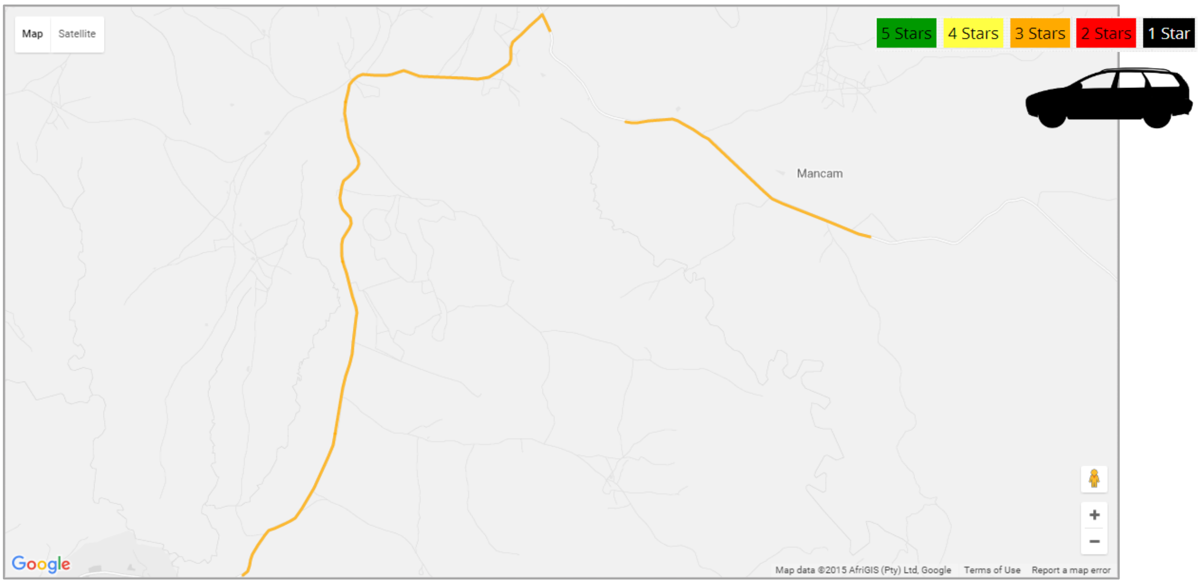
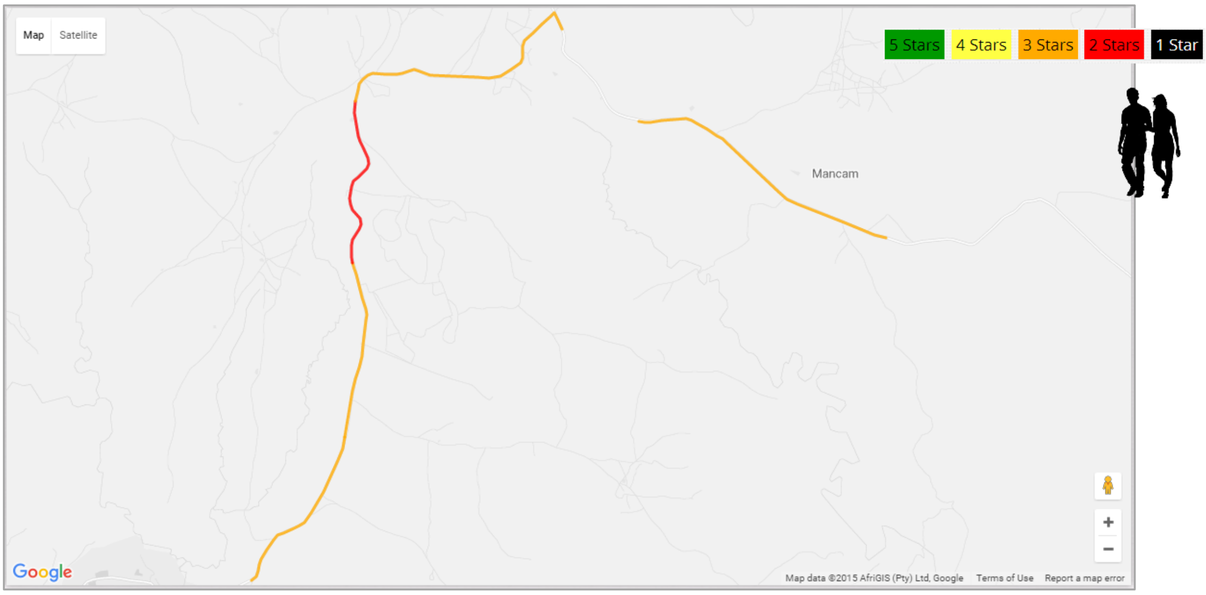


Figure 9 Pedestrian Star Ratings



9.4 Example Star Ratings

The following images illustrate sections of roads, their Star Ratings and the road attributes that influenced the Star Rating. The figures show Star Ratings for vehicle occupants and pedestrians, as these road users account for a significant number of deaths and illustrate typical road layouts. However, similar examples can be produced for motorcyclists and bicyclists.

In the figures:

- Green coloured attributes are associated with a reduced level of risk
- Yellow coloured attributes are associated with an intermediate level of risk
- Red coloured attributes are associated with an increased level of risk

The figures help to illustrate the fact that the level of risk associated with a road's infrastructure, and hence its Star Rating, is a function of numerous attributes, including travel speeds.

Figure 10 Example of 2-Star Rating for vehicle occupants

Figure 11 Example of 2-Star Rating for pedestrians

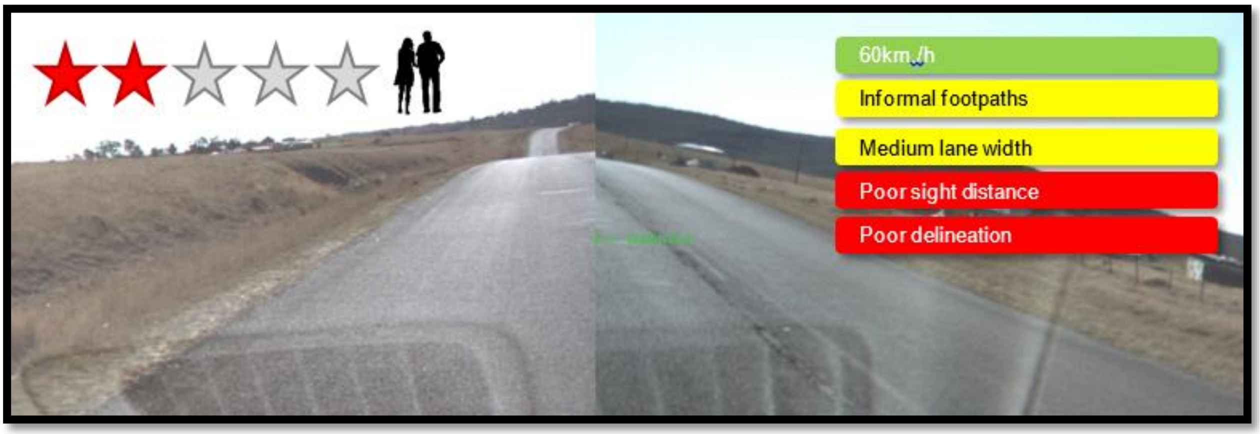


Figure 12 Example of 3-Star Rating for pedestrians

10 Safer Roads Investment Plans

iRAP considers more than 90 proven road improvement options to generate affordable and economically sound Safer Road Investment Plans (SRIP) that will save lives. Road improvement options range from low-cost road markings and pedestrian refuges to higher-cost intersection upgrades and full highway duplication.

Plans are developed in three key steps:

i. Drawing on the Star Ratings and traffic volume data, estimated numbers of deaths and serious injuries are distributed across the road network.

ii. For each 100 metre segment of road, countermeasure options are tested for their potential to reduce deaths and injuries. For example, a section of road that has a poor pedestrian Star Rating and high pedestrian activity might be a candidate for a footpath or pedestrian crossing facility.

iii. Each countermeasure option is assessed against affordability and economic effectiveness criteria. The economic benefit of a countermeasure (measured in terms of the economic benefit of the deaths and serious injuries prevented) must, at a minimum, exceed the cost of its construction and maintenance (that is, it must have a benefit cost ratio (BCR) greater than one). In many circumstances, the 'threshold' BCR for a plan is lifted above one, which has the effect of reducing the overall cost of the plan. This helps to ensure that the plan is affordable while representing a positive return on investment and the responsible use of public money.

A SRIP shows a list of affordable and economically sound road safety treatments, specifically tailored to reduce risk on the sections of road. Each countermeasure proposed in the SRIPs is supported by strong evidence that, if implemented, it will prevent deaths and serious injuries in a cost-effective way). Nevertheless, each countermeasure should be subject to additional prioritisation, concept planning and detailed design before implementation.

Three SRIP options were produced to prioritise countermeasure options that could maximise the prevention of deaths and serious injuries within the available budget. The plans largely focus on:

- reducing risk at intersections
- reducing the risk associated with run-off road crashes by improving shoulders and reducing the severity of roadsides
- providing facilities for pedestrians.

Table 7 Investment plan options (20 years)

Present value of investment	ZAR 6,625,000
Deaths and serious injuries prevented	24
Present value of safety benefits	ZAR 13,300,000
Cost per death and serious injury prevented	ZAR 281,272
Benefit cost ratio (BCR)	2:1
Reduction in death and serious injuries	25%

The SRIP shows that, by investing ZAR 6,625,000 over a 20 year period, the number of deaths and serious injuries on the sections of road could be reduced by 25%, preventing 24 deaths and serious injuries over 20 years. The overall benefit cost ratio of this approach would be 2:1.

The list of countermeasures shown in the plan suggest that safety improvements can be made to the sections of road through the implementation of several key route safety treatments. Roadside improvements such as hazard removal and the implementation of roadside safety barriers could reduce run-off the road fatal and injuries. Countermeasures focused on reducing risk for vulnerable users are also estimated to provide a good return on investment. These include pedestrian footpaths and crossings, pedestrian fencing, traffic calming in the urban areas plus bicycle and motorcycle lanes.

The countermeasures identified are shown in Table 8

Table 8 Safer Road Investment Plan

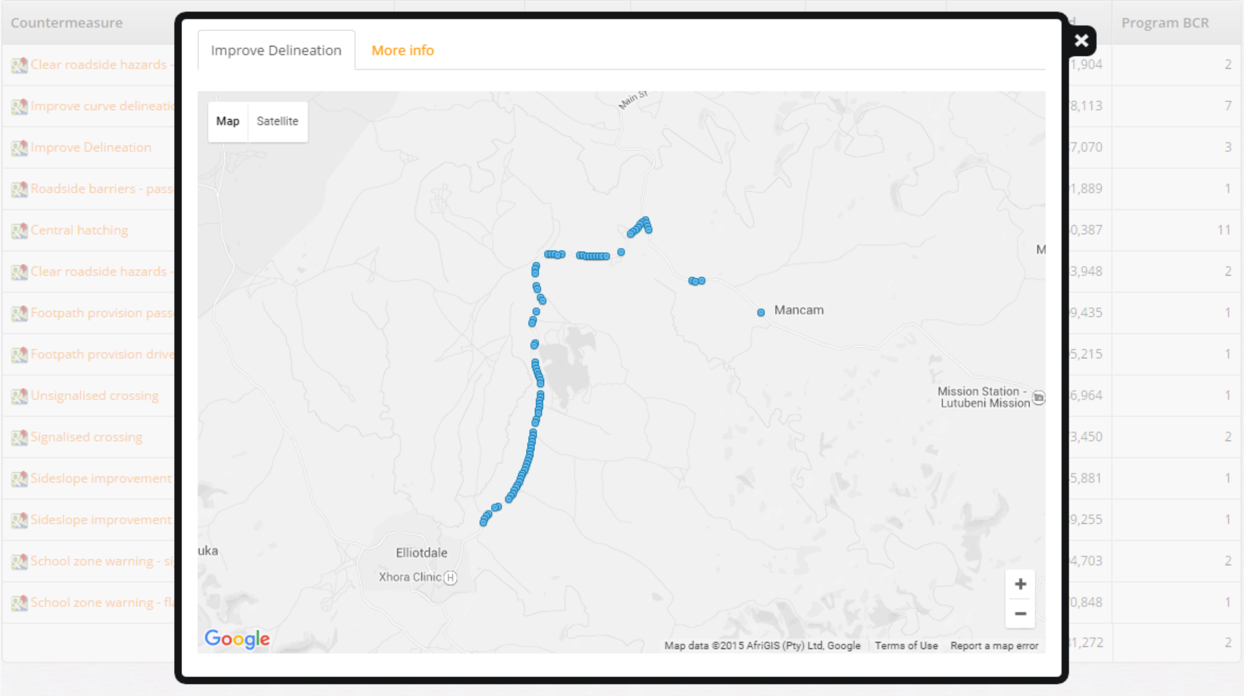
Countermeasure	Length / sites	FSI saved (20 years)	BCR
Clear roadside hazards - driver side	4.30 km	5	2
Improve curve delineation	5.80 km	4	7
Improve Delineation	8.70 km	3	3
Roadside barriers - passenger side	2.80 km	3	1
Central hatching	4.20 km	2	11
Clear roadside hazards - passenger side	2.00 km	2	2
Footpath provision passenger side (adjacent to road)	5.50 km	2	1

Countermeasure	Length / sites	FSI saved (20 years)	BCR
Footpath provision driver side (adjacent to road)	5.70 km	2	1
Unsignalised crossing	4 sites	1	1
Signalised crossing	2 sites	1	2
Sideslope improvement - passenger side	0.10 km	0	1
Sideslope improvement - driver side	0.10 km	0	1
School zone warning - signs and markings	0.10 km	0	2
School zone warning - flashing beacon	2 sites	0	1
Total		**24**	**2**

FSI = fatal and seriously injured

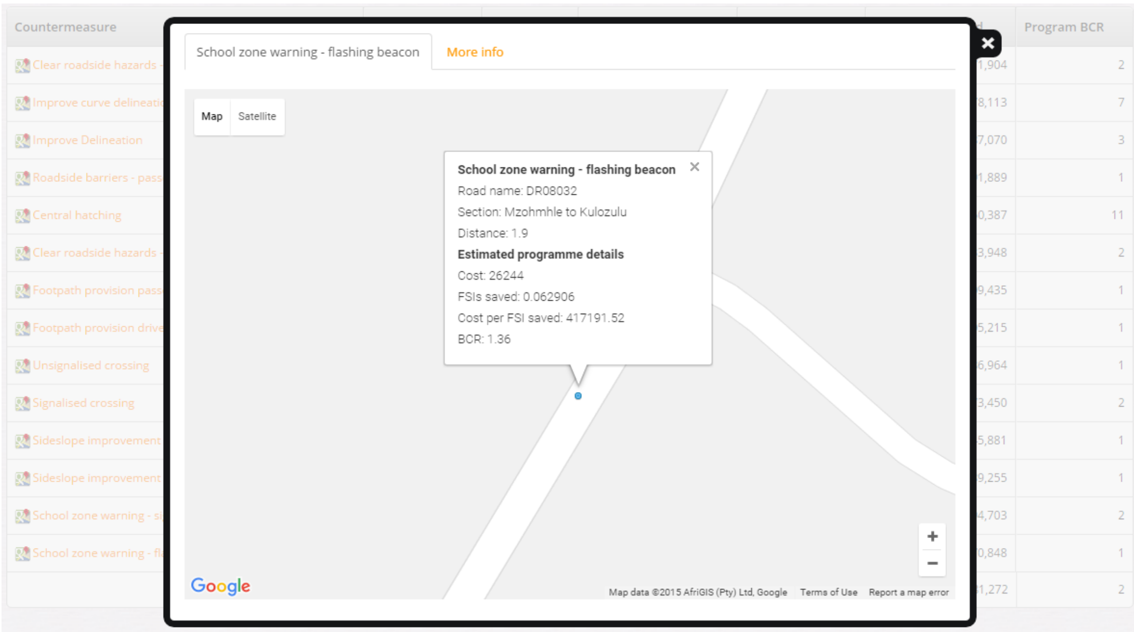
BCR = benefit cost ratio

Figure 13 Map showing location of a treatment (improve delineation)



Full details of each recommended countermeasure, including location description, geo-reference data and economics is provided by clicking on an individual icon as shown in Figure 22. Strip plans showing the location, by distance, of up to five recommended countermeasures for each road section, are also available within ViDA, the iRAP online software at http://vida.irap.org/.

Figure 14 Individual countermeasure details



Descriptions of these countermeasures, and many other road safety treatments, including advice on implementation issues and crash reduction effectiveness can be found at the Road Safety Toolkit http://toolkit.irap.org.

10.1 Star Ratings after countermeasure implementation

The Star Rating (After) table provides details of the projected Star Ratings based on the countermeasures within the investment plan. The Star Rating (After) table shown below provides the percentage change for each star rating category relative to the original Star Rating.

Table 9 Star Ratings After (smoothed)

Road User	Vehicle Occupants			Motorcyclists			Pedestrians			Bicyclists		
	Length (km)	Percent	Change	Length (km)	Percent	Change	Length (km)	Percent	Change	Length (km)	Percent	Change
5 Star	0	0%	±0%	0	0%	±0%	0	0%	±0%	0	0%	±0%
4 Star	4.9	26%	26%	0	0%	±0%	3	16%	16%	0	0%	±0%
3 Star	13.7	74%	-26%	0	0%	±0%	15.6	84%	±0%	18.6	100%	16%
2 Star	0	0%	±0%	0	0%	±0%	0	0%	-16%	0	0%	-16%
1 Star	0	0%	±0%	0	0%	±0%	0	0%	±0%	0	0%	±0%
Not applicable	0	0%	±0%	0	0%	±0%	0	0%	±0%	0	0%	±0%

Analysis of the projected Star Ratings after implementation shows that it is economically viable to increase Star Rating for both the vehicle occupants and pedestrians.

10.2 Economic assessment

Using actual crash data where available, an estimate of the number of deaths and serious injuries that occur on the surveyed network has been made. Crash modification factors are then used to provide an estimate of the number of road deaths and serious injuries that are likely to be prevented through the infrastructure improvements that are proposed in each investment plan. More information on the crash modification factors used in the model is available in the iRAP Road Attribute Risk Factor factsheets in the Documents section of the iRAP website at: http://irap.org/about-irap-3/methodology.

It is important to ensure that improvements such as lane widening, resurfacing, additional lanes and paved shoulders do not result in excessive vehicle speeds, particularly where vulnerable road users such as pedestrians and bicyclists are present. In such cases vehicle speeds must be effectively managed in order to minimise risk.

Assuming that the proposed countermeasures do not lead to an increase in vehicle operating speeds, it is estimated that fatal and serious injuries (FSIs) are likely to reduce by 25%, preventing 24 deaths and serious injuries over the next 20 years. It is estimated that the economic benefits of a reduction in the numbers of deaths and serious injuries, would total approximately ZAR 666,000 per year in crash costs saved.

11 Implementation and recommendations

11.1 Recommendations

This assessment highlights the necessity for all relevant authorities to ensure that road conditions are safe for scholar patrols to be operated in South Africa. The SARAP is a scientific tool which can assist authorities to assess road safety at scholar patrols.

The Mancam JSS & Mzomhle JSS road assessment survey successfully assessed 18.6 kilometres of road and generated Star Ratings for vehicle occupants and pedestrians. The Star Rating results show that road infrastructure poses a moderate risk for all users.

In line with expectations for this road speed and volume the SRIP is recommending school zone warning signs, rather than school patrols. These are in addition to sidewalks and a handful of low level crossings; of course these sections of road would also benefit from improvements like cleaning up the roadsides and improvement delineation.

The road attribute data shows that the sections of road are single carriageway road. Roadside hazards are numerous, with most of the survey length having hazardous objects within 5m of the running lane and limited roadside protection. Provision for vulnerable road users is poor. However, the low operating speeds and low flow help compensate for infrastructure deficiencies.

The available data from a road assessment such as this provides extensive planning and engineering information such as road attribute records, road user risk, countermeasure proposals and economic assessments for 100 metre sections of road network. The assessments are supported by the iRAP online software which makes this information highly accessible. Each countermeasure proposed in a SRIP is backed by strong evidence that, if implemented, it will prevent deaths and serious injuries in a cost-effective way. Nevertheless, in interpreting the results of this report, it is important to recognise that iRAP is designed to provide a network-level assessment of risk and cost-effective countermeasures. As such, a SRIP should be considered just the first step in building a safe road.

11.2 Implementation

Implementation of the proposals in this report will ideally include the following steps:

- local examination of proposed countermeasures (including a 'value engineering' type workshop including all relevant stakeholders)
- detailed analysis of traffic survey and crash data (if available)
- preliminary scheme investigation studies, including site surveys and preliminary design

- detailed design, star ratings of the designs, road safety audit, detailed costing and procurement, final evaluation and construction
- post-construction evaluation and road safety audit, including Star Ratings for the upgraded road and analysis of crash data (if it is available).

The detailed results of the project and access to the iRAP online software (http://vida.irap.org) have been provided to key stakeholders for further exploration and use. Detailed briefings are also able to be held with key funding bodies, elected members, government officials, design engineers and planners to ensure a common understanding of the investment priorities and potential to save lives and reduce serious injuries.

11.3 Commit to a Safe System approach

The investment plans contain infrastructure improvements that can be set in place immediately. To complement those improvements, a series of additional measures need to be implemented, and a longer-term safety strategy set in place.

The Safe System approach is based on the theory that all humans make mistakes, but that a mistake made on the highway should not result in death or serious injury. It recognises that the human body is vulnerable and is unlikely to survive an uncushioned impact at speeds of 30km/h or more.

When these occasional, but inevitable mistakes occur on our busy roads, it stands to reason that collisions or crashes will result. Currently some of these collisions have fatal consequences, and others are less severe. The Safe System provides a forgiving highway infrastructure, one which recognises that mistakes will be made and attempts to minimise their occurrence, and the forces involved in a resulting crash, to reduce its severity to survivable levels.

The Safe System approach includes engineering measures such as the removal or protection of roadside hazards, the re-design of roads, roadsides and intersections to reduce risk to a minimum and the setting of appropriate speed limits according to the existing levels of infrastructure safety. The adoption of this approach is recommended.

11.4 Engage with local communities

In order to maximise the benefits from road safety projects it is recommended that public participation is encouraged. Community engagement and cooperation between road authority and local interest groups is regarded as providing a useful two-way flow of information that will not only educate and inform local road users and communities on how they are expected to use the road network, but can also provide designers and decision makers with an understanding of the needs and requirements of affected groups. For example, research has demonstrated that it is crucial to ensure that local communities not only have the opportunity to contribute to new road designs but that they also understand the intended use of various road design features.[7]

Star Ratings can be used to effectively communicate the need for safe road design, not only within road authorises, but also to local residents and other stakeholders. Using Star Ratings will allow opportunities to celebrate success i.e. Ministers, local politicians, and/or road authorities can celebrate road safety upgrades "1-star road upgraded to 3-star standard" etc.

In addition to the road safety engineering upgrades, significant benefits could also be realised through the coordinated targeting of behavioural risk factors for road users (such as speeding, seat belt wearing, helmet use, the adherence to traffic regulations and alcohol use) and road vehicle safety (i.e. ABS brakes, side-impact bars and airbags). This would be consistent with taking a Safe System approach to the programme. The Road Safety Toolkit (toolkit.irap.org) and United Nations Road Safety Collaboration Good Practice Manuals provide further information on these issues.[8]

[7] BRAC Annual Report 2009 http://www.brac.net/

[8] UN Road Safety Collaboration manuals: http://www.who.int/roadsafety/projects/manuals/en/index.html

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