

Mid North

RAA Regional Road Assessment



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Executive Summary

RAA undertook a regional roads assessment in the Mid North in July 2015. The assessment primarily aimed to examine the B-class network but also included a number of minor roads in the region. The assessment aimed to determine the level of safety built into a road while also examining the driveability from a road user perspective.

Narrow lane widths and sealed shoulders was identified as a common issue across most of the roads in the network. The B-class network typically accommodates higher traffic volumes and greater proportions of heavy vehicles than the minor routes, RAA therefore wish to see lane widths of at least 3.5m with a 300 to 500mm sealed shoulder. For the minor routes, lane widths of 3.2m would be considered acceptable however sealed shoulders of a minimum of 300mm should be provided. Until such time as funds are available to upgrade the network to this benchmark, RAA would welcome the application of seal extensions on bends, recognising that there is a greater risk of run-off road crashes on bends and safely passing heavy vehicles on bends can be a challenge on the narrower roads.

The assessment found that roads subject to 110km/h speed restrictions did offer the minimum desirable lane widths RAA wish to see on the B-class network. The one exception was the Flinders Ranges Way between Quorn and Hawker which had narrower than desired lane widths of 3.2m. While these roads also had edge lines, on some occasions, the lines were worn or faded and required refreshing.

Asphalt edge break and edge drop has been flagged as an issue across the network but particularly on roads such as RM Williams Way where drops between the sealed and unsealed surfaces in excess of 100mm were recorded. Edge drop can be dangerous as it can make recovery of the vehicle onto the seal at speed difficult and has been known to cause blowouts where the depth of the edge drop is severe.

Barrier installation has been widely recommended across the network. Many roads have had a significant amount of money invested in their barrier systems and RAA welcome the extensive program of barrier installation that has run in the last few years. There however remain numerous roadside hazards that desperately require protection and there are frequent sombre reminders across the network of fatal crashes which have involved hitting fixed roadside objects, particularly on bends.

Many of the other recommendations broadly relate to good housekeeping in terms of issues such as signs and line marking. These generally tend to be relatively low cost projects and can be undertaken in the short term. RAA would welcome the timely resolution of these issues being addressed.

Table 1 – Summary of Recommendations

Highway / Road	Section	Road Geometry & Pavement							Signs							Speed Zones	Linemarking			Delineation			Intersections		Hazard Protection										
		Increase lane widths to 3.2m minimum	Increase lane widths to 3.5m minimum	Construct sealed shoulder to 300mm minimum	Construct sealed shoulder to 500mm minimum	Construct sealed shoulder to 1m minimum	Pavement rehabilitation	Undertake rut filling program	Repair pavement edge break / edge drop	Unsealed shoulder rehabilitation	Unsealed shoulder grading	Drainage improvements	Review / install intersection warning signage	Review / install bend warning signage	Review /install warning signs for slippery surface conditions	Review / install animal warning signage	Review, upgrade or install railway crossing signage	Install depth markers at floodways	Replace fading signage	Repair / replace damaged signage	Speed limit reduction to 100km/h	Refresh linemarking	Apply edge of carriageway lines	Blackout abandoned linemarking		Audio Tactile Line Marking (ATLM)	Additional hazard marker posts	Repair damaged hazard marker posts	Install Raised Reflective Pavement Markers (RRPMS)	Replace missing or damaged Raised Reflective Pavement Markers (RRPMS)	Intersection upgrade	Rail crossing upgrade			
B84 (Multiple Roads)	Eudunda to Port Wakefield				✓					✓			✓																				✓		
B82 Horrocks Highway	Clare to Birkworth		✓																														✓		
	Georgetown to Murray Town			✓																													✓		
	Murray Town to Wilmington	✓																															✓		
	Wilmington to Quorn																																✓		
	Birkworth to Georgetown		✓				✓																										✓		
B83 Finlins Ranges Way	Port Augusta to Quorn											✓																					✓		
	Quorn to Hawker							✓																									✓		
B84 Goyder Highway	Spalding to Morgan								✓																								✓		
	Spalding to Gullare									✓																							✓		
	Gullare to Crystal Brook									✓																							✓		
B89 Spender Highway	Port Pirie to Port Broughton	✓																																✓	
B79 Wilkins Way	Gladstone to Jamestown																																	✓	
B80 RM Williams Way	Hawker to Orroroo																																	✓	
	Spalding to Clare																																	✓	
	Jamestown to Spalding																																	✓	
B81 Thiele Highway	Eudunda to Kapunda																																	✓	
Worlds End Highway																																		✓	
Clements Road & Gadd Avenue																																		✓	
Eudunda to Robertstown Road																																		✓	
Marabel Road	Kapunda to Marabel						✓																											✓	
Lochiel to Clare																																		✓	
Orroroo to Laura																																		✓	
Over Road	Balldarra to Roseworthy																																	✓	
Redhill to Birkworth																																		✓	
Birkworth to Snowtown																																		✓	

① Application of treatment should be prioritised on bends.

② At a specific location as identified in the report.

Table 30 summarises the crash costs for each of the sections of highway surveyed during the assessment. The table examines the traffic volumes, length of section and the estimated cost due to crashes in the 5 year period between 2010 and 2014. A crash cost ranking has been calculated based on the length of the road and the average annual daily traffic volume on the road, to provide an indication of the order in which the roads should be prioritised for funding; number 1 being one of the worst performing roads in need of attention and number 27 being one of the best performing. This value is determined by dividing the estimated crash cost by the product of the length of the road and the traffic volume. Obviously it would be expected that a length of road which is longer and carries a higher traffic volume than another would have a higher crash rate, but not necessarily a higher cost ranking when looking at the data in this way. Note this ranking is just an indication, and is subject to interpretation. It is estimated that these roads alone have an estimated crash cost total of \$62,647,054. The full table has been included in Appendix A.

Table 2 – Summary of Recommendations

Road	Traffic Volume (vpd)	Length of Road (km)	Total Crashes	Estimated Crash Cost	Crash Cost Ranking
Eudunda to Robertstown	420	22	7	\$7,601,650	1
B82 Georgetown to Murray Town	650	52.4	15	\$8,057,180	2
B81 Eudunda to Kapunda	1200	27.3	12	\$7,359,006	3
B89 Port Pirie to Port Broughton	900	56.4	26	\$9,158,288	4
B64 Spalding to Gulnare	330	15	3	\$692,330	5
B84 (Multiple Roads)	1200	102.7	44	\$16,281,136	6
Redhill to Brinkworth	160	29.1	8	\$437,998	7
Lochiel to Clare	135	45	13	\$517,180	8
B82 Brinkworth to Georgetown	600	38.4	12	\$1,809,686	9
B83 Port Augusta to Quorn	1200	31.7	41	\$2,541,678	10
B64 Gulnare to Crystal Brook	490	25.3	11	\$808,502	11
B79 Gladstone to Jamestown	700	28	21	\$970,710	12
B82 Clare to Brinkworth	900	31.8	24	\$1,313,994	13
B80 Hawker to Orroroo	240	108	12	\$1,142,658	14
B80 Spalding to Clare	700	39	4	\$704,660	15
B64 Spalding to Burra	400	43	5	\$401,008	16
Kapunda to Marrabel	700	24	4	\$388,678	17
B64 Burra to Morgan	390	84.8	17	\$572,344	18
Port Broughton to Crystal Brook	370	20	7	\$92,154	19
B80 Jamestown to Spalding	550	34.2	13	\$189,510	20
Balaklava to Roseworthy	2100	59	18	\$1,245,858	21
Worlds End Highway	145	29.9	3	\$42,834	22
B83 Quorn to Hawker	340	66	12	\$159,648	23
Orroroo to Laura	200	62	3	\$48,678	24
B82 Murray Town to Wilmington	600	38.1	4	\$61,008	25
B82 Wilmington to Quorn	500	39.6	2	\$36,348	26
Brinkworth to Snowtown	335	26	1	\$12,330	27
			Total	\$62,647,054	

It is also worth noting that RM Williams Way was considered to be the worst road in the region according to RAA's 2013 Risky Roads campaign, while also demonstrating some of the worst edge break and poorest quality shoulders during our assessment. It is therefore recommended that RM Williams Way should also be considered a regional priority for further road funding.

1 Introduction

1.1 Introduction

RAA undertook a regional roads assessment in the Mid North in July 2015. The assessment primarily aimed to examine the B-class network but also included a number of minor roads in the region. The assessment aimed to determine the level of safety built into a road while also examining the driveability from a road user perspective.

This report analyses the crash data for each of the routes travelled, outlines RAA's findings for each of the sections and provides recommendations for infrastructure improvements in the region.



1.2 Glossary of Terms

ATLM **Audio Tactile Line Marking (ATLM)** is a ribbed profile thermoplastic line marking typically used for edge of carriageway lines, but it can also be used for centre lines. The ribbed profile causes a vibration and a rumbling sound when the vehicle passes over the line which alerts the driver to the fact that they are drifting from the lane and allows them to correct their course.

RRPMs **Raised Reflective Pavement Markers (RRPMs)** are plastic markers with a retroreflective lens face that are attached to the road, typically used to compliment edge of carriageway line and centre line markings. The markings are used to improve delineation at night and in bad weather and are particularly useful in wet weather since they are typically higher than any water lying on the road which might otherwise reflect light and obscure the line marking.

2 B84 (Multiple Roads)

The B84 runs in an east-west direction for a distance of 100km and includes:

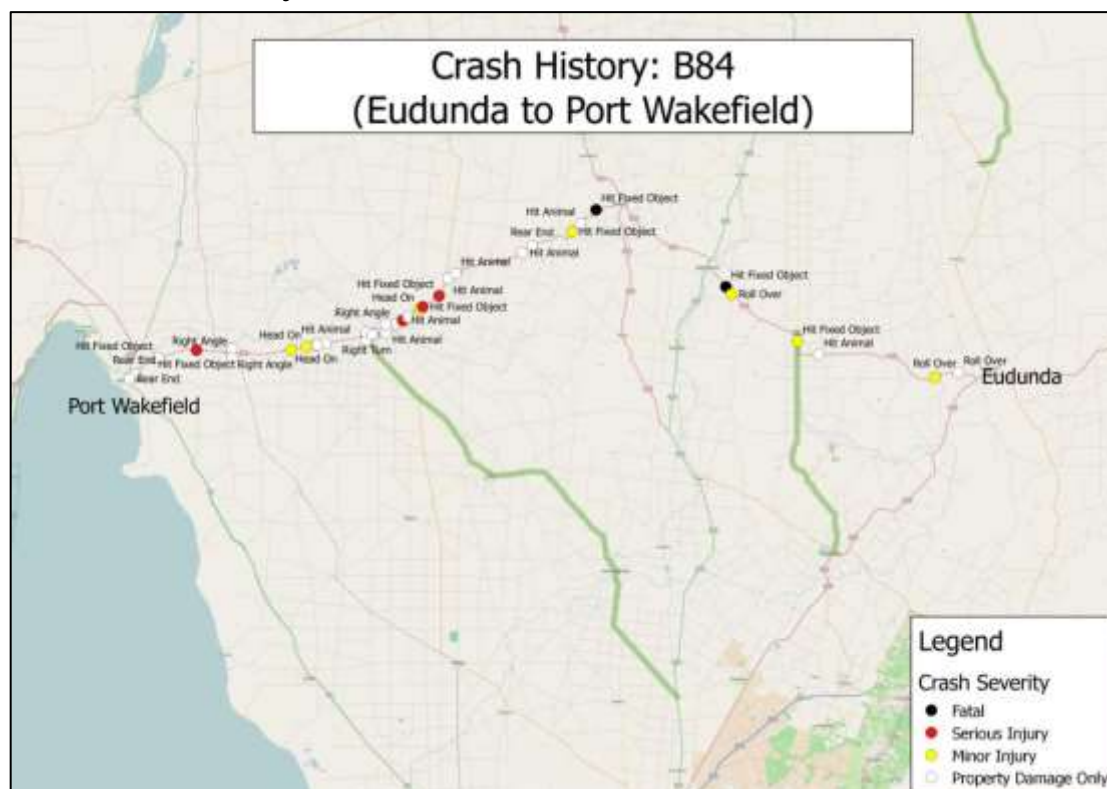
- Marrabel – Eudunda Road
- Riverton – Marrabel Road
- Saddleworth Road
- Port Wakefield – Auburn Road

The daily traffic flow averages between 240 and 1,500 vehicles per day with the busiest section being between Halbury and Port Wakefield where volumes average 1,200 vehicles. Heavy vehicles account for between 9 and 21 percent of the total traffic volume.

The speed limit along the road is 100km/h. The assessment along the B84 was conducted in the westbound direction and the trip meter commenced at the intersection of the B84 and the Thiele Highway.

2.1 Eudunda to Port Wakefield

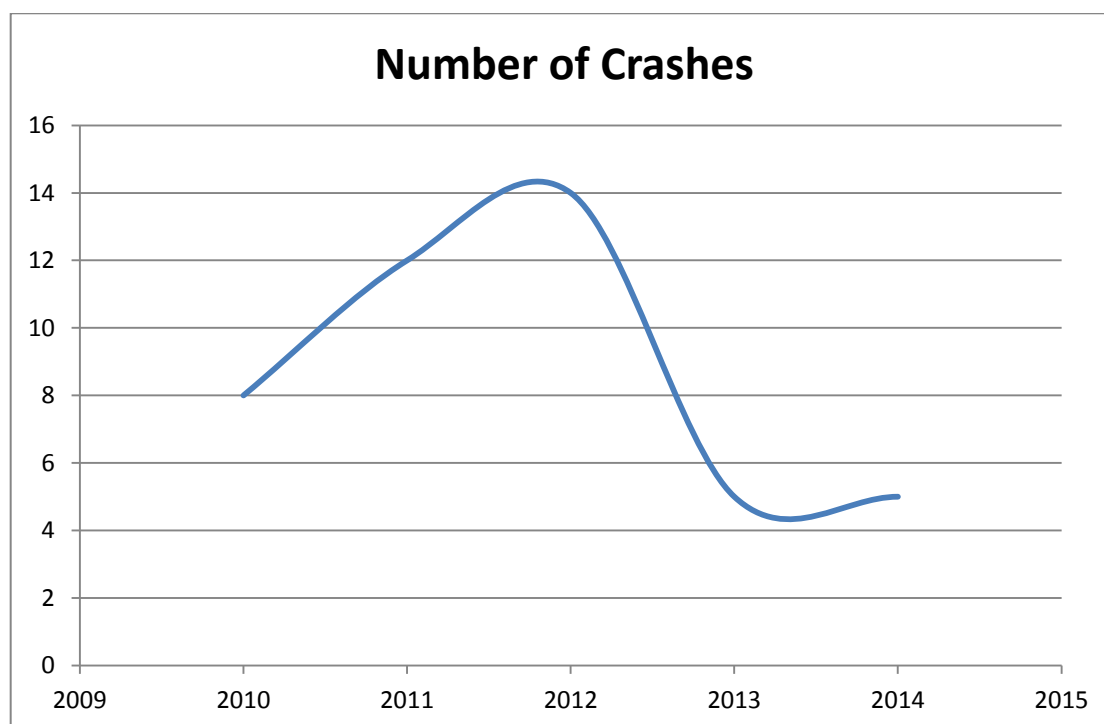
2.1.1 Crash History



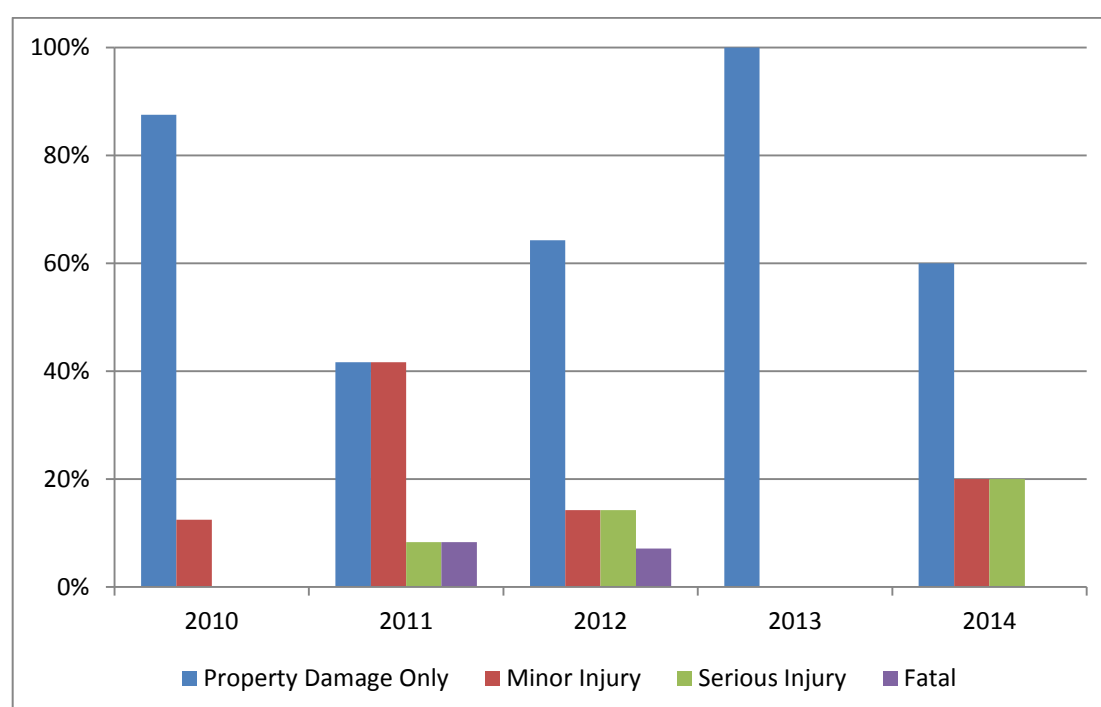
The number of crashes along this stretch of road peaked in 2012 with a total of 14 crashes. In 2013 and 2014 this dropped to 5 crashes per year.

The most common crash type is hit fixed object. Over the 5 year period a total of 15 hit fixed object crashes have occurred. Alarming, 100% of the serious injury or fatal crashes that occurred within this period were hit fixed object crashes, 2 of which were fatal crashes and 4 were serious injury. All other crash types were mostly property damage only and a few minor injury crashes.

- Hit fixed object (15 crashes)
- Hit animal crashes (8 crashes)
- Right angle (8 crashes)
- Head on (4 crashes)
- Roll over (4 crashes)
- Rear end (3 crashes)
- Side swipe (1 crash)
- Right turn (1 crash)



As can be seen in the figure below which displays the percentage of crash type per year; property damage only crashes make up a high proportion of all crashes which occurred in the 5 year period. There were two fatal crashes, one each occurring in 2011 and 2012.



The estimated economic cost of crashes on the road between Eudunda and Port Wakefield from 2010 to 2014 is \$16,281,136. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 3 - Cost of Crashes on the B84 Between Eudunda and Port Wakefield (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	29	\$357,570
Minor Injury	\$18,174	9	\$163,566
Serious Injury	\$340,000	4	\$1,360,000
Fatal	\$7,200,000	2	\$14,400,000

2.1.2 Geometry

The lane widths remained consistent at 3.3 to 3.4m along the B84 however the sealed shoulder widths varied. For a distance of up to 3km west of Eudunda, sealed shoulder widths were 1.5m but thereafter no sealed shoulder was provided. Unsealed shoulders throughout the highway measured between 2 and 2.1m.

Lane widths between Marrabel and Auburn were consistently found to be around 3.2m with a 1m sealed shoulder. After Auburn however lanes on sections of the road were

¹ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

visibly narrower with widths of between 3m and 3.3m recorded. Sealed shoulders were barely present for up to 3km after Auburn with an average shoulder width of 100mm. The sealed shoulder then varied between 300mm and 1m to Halbury. Between Halbury and Port Wakefield lanes were measured between 3.2m and 3.3m with no sealed shoulder present, which is disappointing as some road sections were measured to be between 3.5m and 4m which could comfortably accommodate an edge of carriageway line providing some level of shoulder seal. On approach to Port Wakefield the sealed shoulder recommenced with a width of about 500mm which then increased to between 1m and 1.2m immediately south of Port Wakefield.



It is highly recommended that a sealed shoulder of at least 500mm is provided throughout the B84 to reduce the risk of run off road crashes and allow additional room to pass heavy vehicles, particularly where lane widths are restricted to just 3m. This is particularly important since the narrow lane widths also cause difficulty in keeping trailers or caravans wholly on the bitumen.

2.1.3 Pavement

The ride quality of the B84 was generally found to be smooth however there is a small section demonstrating some minor corrugations and undulations. The texture was considered to be coarse which should offer excellent skid resistance and surface drainage. Some areas of bitumen bleeding were however recorded, particularly along a stretch 12km west of Eudunda and it is recommended that this is monitored.

RAA are concerned about the edge drop along the B84. Bad edge drop was noted in a number of areas and some sections were estimated to be as much as 60 – 70mm between the sealed and unsealed surfaces. It is therefore highly recommended that the edge drop be addressed through a combination of shoulder grading and seal extension.

Between Marrabel and Saddleworth the road offers good ride quality providing a smooth ride with few instances of rutting or texture polishing recorded.

From Saddleworth to Auburn however, the ride quality deteriorates with some areas of noticeably poor ride quality characterised by bad bumps and undulations in the road surface. Edge drop along this section was also found to be poor, with differences of up to 40mm estimated to occur between the sealed and unsealed surfaces.

Along the highway between Auburn and Halbury, there was a significant improvement in the ride quality, offering a smooth drive. Rutting however was a problem along this section with ruts noted in many areas but were particularly bad and included sections of bitumen bleeding about 3km east of Halbury. Bad edge break and edge drop was also noted in some areas.

From Halbury to Balaklava, the road surface was found to offer a good texture which should maintain acceptable levels of skid resistance and also drain well in periods of wet weather. There were some sections which demonstrated bitumen bleeding which can reduce skid resistance but a number of areas of patching were noted which showed that defects were being addressed. The primary issue along this section was bad edge break and edge drop with a difference of up to 50mm estimated between surfaces. This can make recovery onto the seal difficult, particularly if towing, if a vehicle drifts onto the unsealed shoulder.

West of Balaklava and continuing on to Port Wakefield, minor rutting and bitumen bleeding was observed along the highway. Some sections have undergone repair but the sections of patching were beginning to demonstrate rutting and bleeding. The texture was reasonably good and likely to offer good skid resistance but edge drop was again a problem. In some areas, where edge repair work had been undertaken, there were drops of up to 90 or 100mm observed. The unsealed shoulders also required grading in some areas and appeared to be soft and muddy with a lot of loose gravel along some sections. It would be recommended that the shoulders are regraded with a graded road base material at these sections.

2.1.4 Signs & Line Marking

The line marking between Eudunda and Marrabel was considered to be good quality offering a clear and contrasting line to the road surface and providing good lane delineation. It was noted that the line marking appeared to have been recently refreshed.

On a few occasions, the assessment recorded intersections on bends and while warning signs were provided, the schematic wasn't correct for the location of the intersection. It is recommended that the intersection warning signs are reviewed and updated as part of ongoing maintenance.

The quality of the line marking was very good throughout the highway between Marrabel and Port Wakefield, offering a solid line with good contrast to the road. There were no edge of carriageway lines between Saddleworth and Auburn and it would be recommended that these are introduced to reduce the risk of run off road crashes. In the long term, if traffic volumes increase, ATLM may be considered as a premium edge of carriageway treatment. In the interim, it would be beneficial to introduce RRPMs to improve night time delineation.

Between Balaklava and Port Wakefield, a number of hazard marker posts were found to be damaged. It is highly recommended that these are replaced as soon as possible,

particularly those on bends to maintain an adequate level of delineation in low light and wet weather.

2.1.5 Roadside Hazards

There was an inconsistent use of W beam barrier along the B84. Barrier has been used to protect some of the major drops along the straight while other drops of up to 3m have been protected on the outside of bends. There were however bends with either embankments or significant vegetation on the outside that require barrier protection. It's encouraging to note that W beam barrier has been used along the B84 to protect culvert headwalls and over creeks.

Between Marrabel and Saddleworth, some Stobie Poles were noted along the road within 3m from the seal which were unprotected together with some significant trees on the outside of a bend. Where hazards occur on the outside curve, protection is crucial due to the increased risk of run-off road crashes.

From Saddleworth to Auburn, there were further instances of Stobie Poles close to the road which could pose a run-off crash risk however it was noted that at a number of farm accesses mud had been drawn onto the road and could give rise to slippery conditions when wet. It is recommended that warning signs should be erected in areas where there is heavy farm traffic movement that could cause mud to lie on the road.

From Auburn to Halbury, there were a number of drops to the side of the road, including a deep creek, which remained unprotected. It is recommended that barrier protection is provided along this stretch since steep drops can cause roll over hazards and in some cases vehicles may be hidden from view of the road if involved in a crash. This continued onto Balaklava however most culverts benefitted from W-beam barrier at the headwalls.

Between Balaklava and Port Wakefield, most hazards in the form of steep embankments were generally protected. There were however further areas of mud on the road when passing some farms and additional warning signs through these sections would be a worthy treatment.

2.1.6 Key Recommendations

The assessment outlined the following recommendations for the B84:

- Increase sealed shoulder widths to a minimum of 500mm throughout the highway
- Regrade shoulders to correct adverse cross fall
- Repair asphalt edge break / edge drop between Auburn and Port Wakefield
- Update warning signs for intersections on bends
- Repair damaged hazard markers between Balaklava and Port Wakefield
- Mark edge of carriageway line between Saddleworth and Auburn
- Install barrier system to protect drops and vegetation on bends
- Extend headwall protection at culverts

3 B82 Horrocks Highway

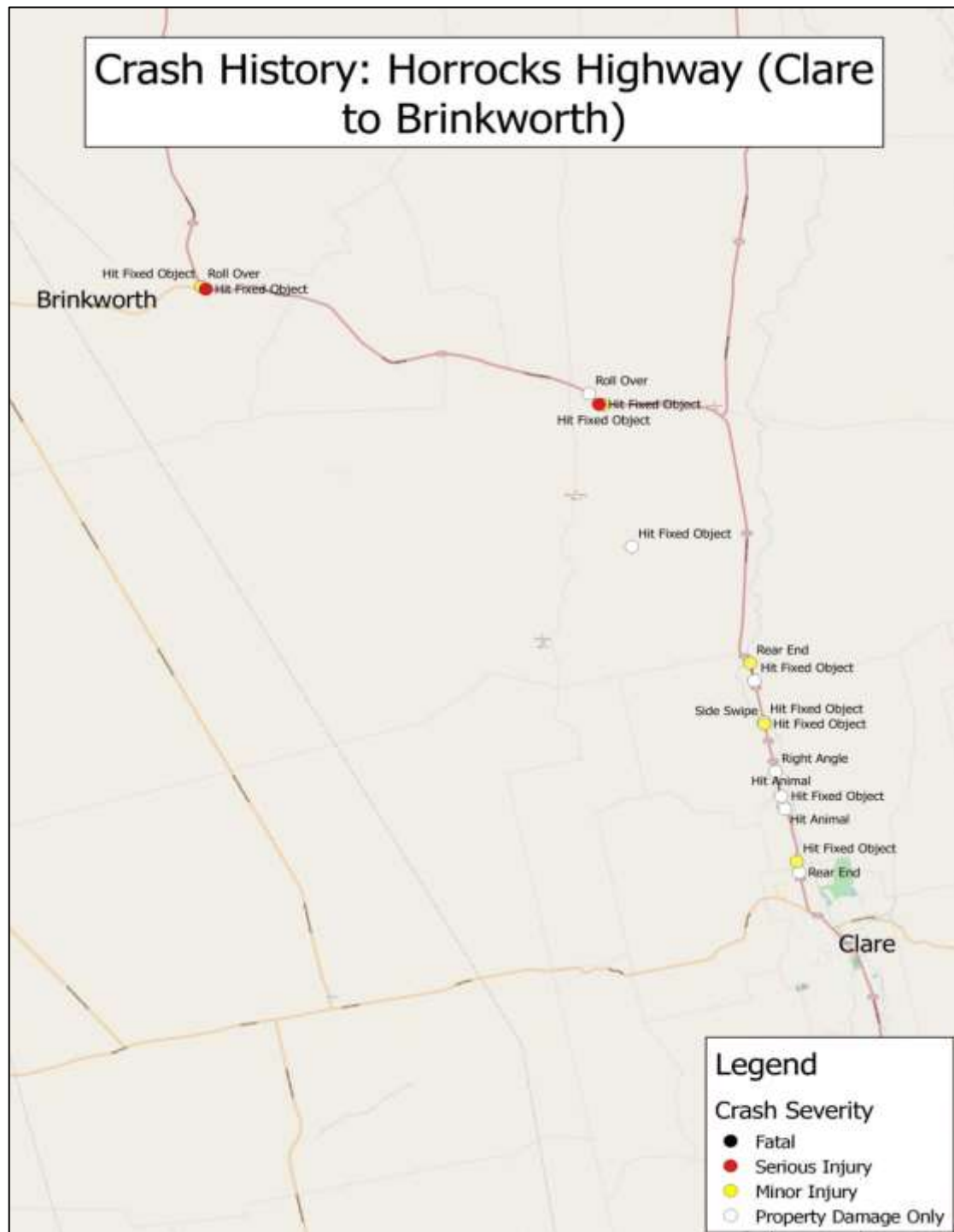
The Horrocks Highway runs in a north-south direction for a distance of approximately 200km between Brinkworth and Quorn. There are between 500 and 900 vehicles per day that travel along the highway, with heavy vehicles representing on average 13.6% of the total traffic volume. The route plan for the Mid North separated the assessment of the Horrocks Highway into the following sections:

- Clare to Brinkworth
- Georgetown to Murray Town
- Murray Town to Wilmington
- Wilmington to Quorn
- Brinkworth to Georgetown

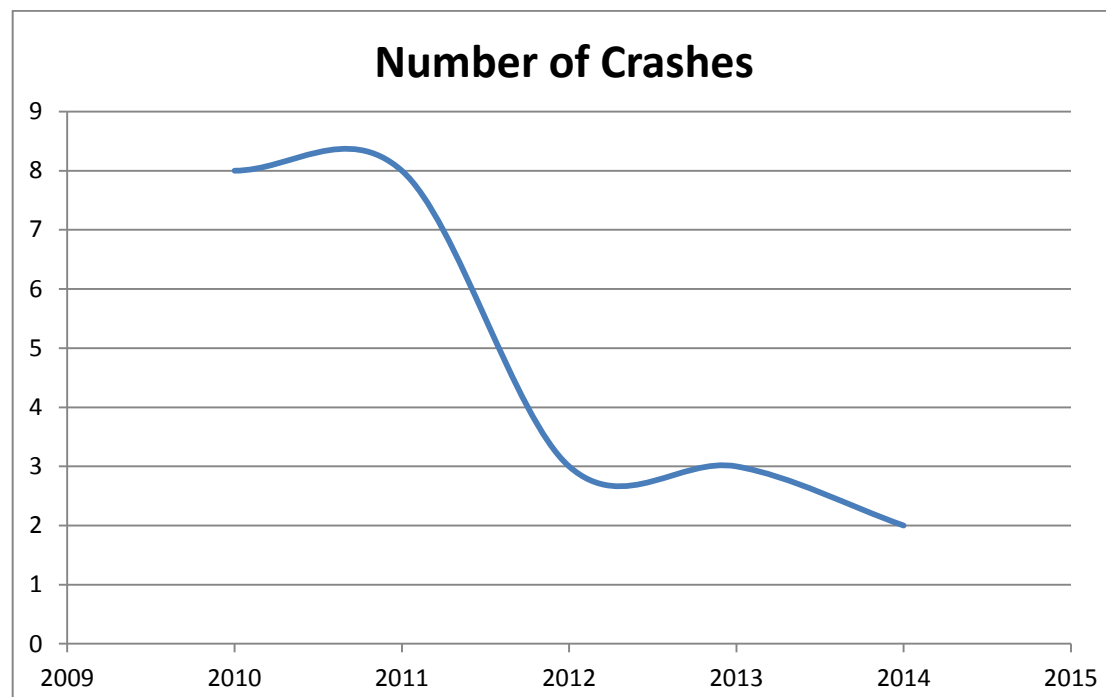
3.1 Clare to Brinkworth

The section of the Horrocks Highway between Clare and Brinkworth runs in a north-south direction is about 32km long, taking around 24 minutes to drive. The section carries around 900 vehicles per day with 10.5% of the traffic consisting of heavy vehicles. The speed limit along this section is 100km/h and the assessment was carried out in the northbound direction.

3.1.1 Crash History



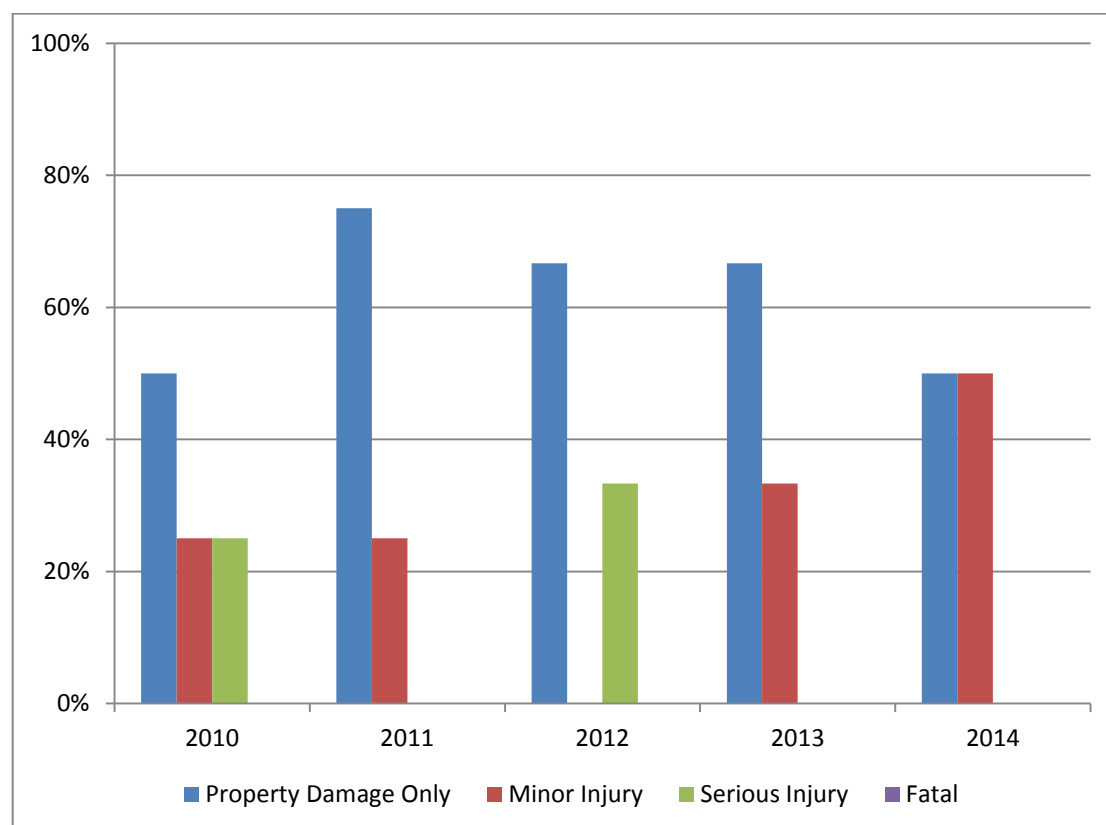
A declining trend in the number of crashes is observed in the 5 year period between 2010 and 2014. Starting at 8 crashes in both 2010 and 2011, the annual number of crashes falls to around 2 or 3 crashes per year.



Hit fixed object crashes are by far the most represented in the dataset. These are followed by roll overs, hit animal, and rear end crashes. A breakdown is seen below:

- Hit fixed object (12 crashes)
- Roll over (4 crashes)
- Rear end (3 crashes)
- Hit animal (3 crashes)
- Right angle (1 crash)
- Side swipe (1 crash)

Again the majority of the crashes are property damage only. A small number of crashes were minor injury or serious injury crashes. The three serious injury crashes were all run off road crashes of hit fixed object or roll over type nature. The table below shows the distribution of crash severity per year.



The estimated economic cost of crashes on the Horrocks Highway between Clare and Brinkworth from 2010 to 2014 is \$1,313,994. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 4 - Cost of Crashes On the Horrocks Highway between Clare and Brinkworth (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	15	\$184,950
Minor Injury	\$18,174	6	\$109,044
Serious Injury	\$340,000	3	\$1,020,000
Fatal	\$7,200,000	0	\$0

3.1.2 Geometry

The B82 between Clare and Brinkworth tended to have 3.5m lanes with a 300mm sealed shoulder which is appropriate for the class of road and volume of vehicles. About 5km

² Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

north of Clare, a seal of about 2m has been provided however wire rope barrier has been installed in the middle of the sealed shoulder resulting on motorists having only 1m of available width to pull over in the event of an emergency or breakdown. RAA welcomes the installation of wire rope barrier to protect roadside hazards however is concerned that reducing the available shoulder width may introduce other safety risks. The cross section of the road remains reasonably constant until the section east of Brinkworth where the lane widths are reduced to about 3.3m with no sealed shoulder provided. The assessment did note however that along some sections of road where significant drops to the side occurred, sealed shoulders of about a metre were provided to reduce the risk of run-off road crashes. It is recommended that a minimum seal width is provided to allow 3.5m lane widths with 300mm sealed shoulders throughout and that the width of the sealed shoulder is increased on the outside of bends to reduce the risk of vehicles running off the road.

3.1.3 Pavement

The assessment noted that unsealed shoulders on the B82 from Clare to Brinkworth were well graded and of good quality.

North of Clare, the highway had excellent ride quality, offering a smooth drive and few undulations in the surface. This continued until the B82 branched west heading towards Brinkworth. Approximately 16km northwest of Clare, the ride quality was found to be poor with a number of undulations and bumps in the road that resulted in a rough ride and this continued until Brinkworth where the ride quality was found to improve.

The texture was found to be very good along the road, with a coarse appearance which is likely to provide good skid resistance.

The assessment noted however that at about 12km north of Clare, there was very bad rutting in the road which were observed trapping water. The rutting was so bad in some areas, with estimated depths of around 100mm that the pavement could be seen visibly lifting at the edge of the seal and there was significant distortion of the edge of carriageway lines at some locations. It would be recommended that pavement rehabilitation is undertaken in areas that show extreme rutting and that rut filling is undertaken where ruts are shallower.



3.1.4 Signs & Line Marking

While the quality of the line marking was generally good between Clare and Brinkworth, providing clear solid lines, the assessment again found that the line marking was difficult to see in the wet weather. This was particularly worth noting since line marking had been used to create a marked island at one intersection which was difficult to see. RRPMs or a raised island should perhaps be considered to reinforce the painted treatment.

RRPMs were used about 10km north of Clare, which is beneficial delineation on the road and RAA would welcome the expansion of this treatment throughout the B82.

3.1.5 Roadside Hazards

RAA welcome the use of W beam barrier along the B82 which was often used to protect significant vegetation, steep embankments or culvert headwalls at creek crossings. Approximately 16km northwest of Clare, a drop of about 5m was found to be unprotected and RAA recommend continuing the barrier installation program to protect such hazards.

A steep ditch was recorded at the side of the road 8km north of Clare which coincided with an adverse cross fall on the unsealed shoulder. It is recommended that the shoulder be reggraded to reduce the cross fall and the risk of a vehicle being pulled into the ditch if it drifts off the sealed pavement at speed.

3.1.6 Key Recommendations

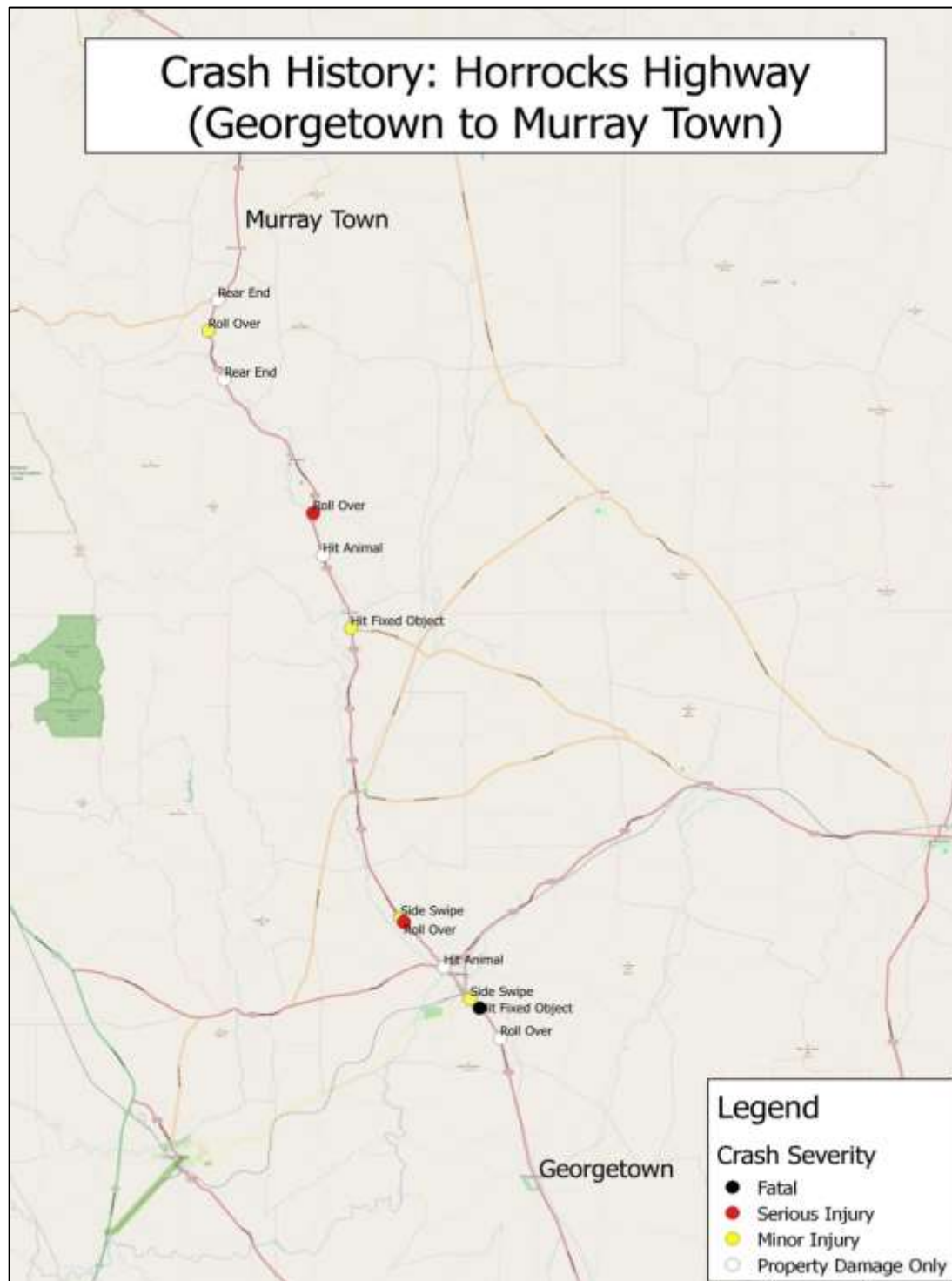
The assessment outlined the following recommendations for the B82:

- Increase seal to accommodate 3.5m minimum lane widths
- Increase sealed shoulders to minimum 500mm
- Pavement rehabilitation to address rutting
- Install RRPMs along high traffic sections
- Regrade shoulders to reduce cross fall
- Install barriers to protect steep drops

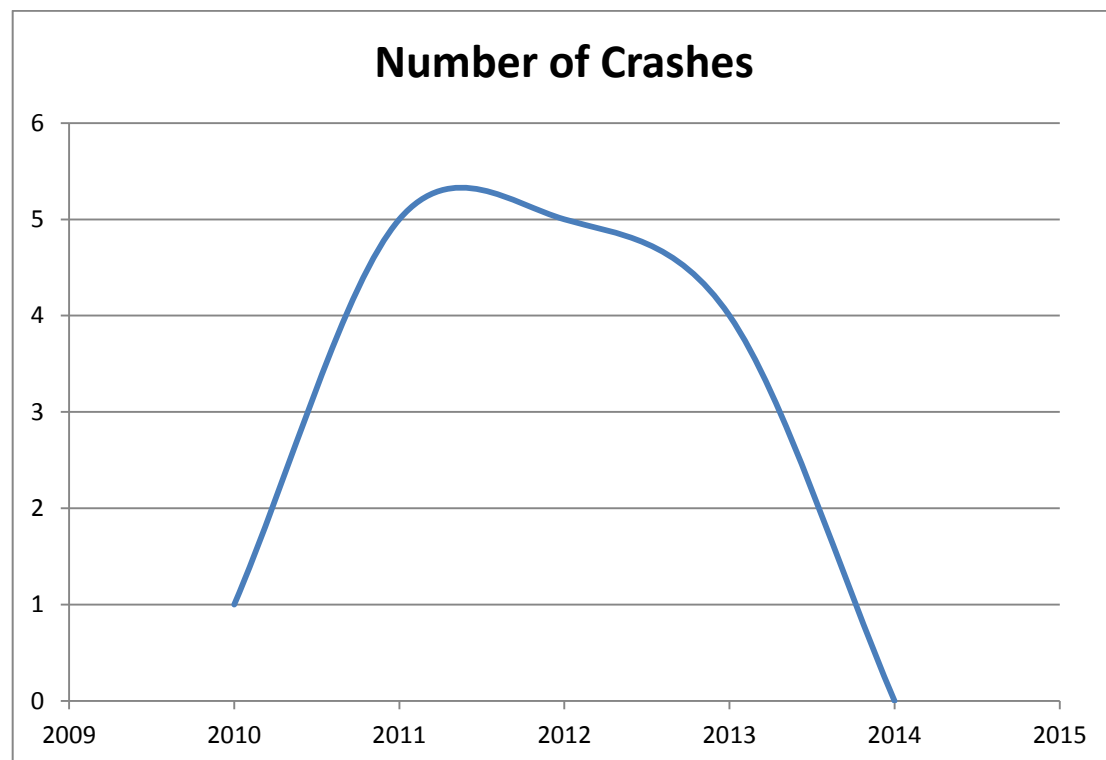
3.2 Georgetown to Murray Town

The section of Highway between Georgetown and Murray Town is about a 36 minute drive at 52km long and carries approximately 650 vehicles per day. Heavy vehicles account for an average of 15% of the total traffic volumes along this section. The speed limit continues at 100km/h and the assessment was conducted in the northbound direction.

3.2.1 Crash History

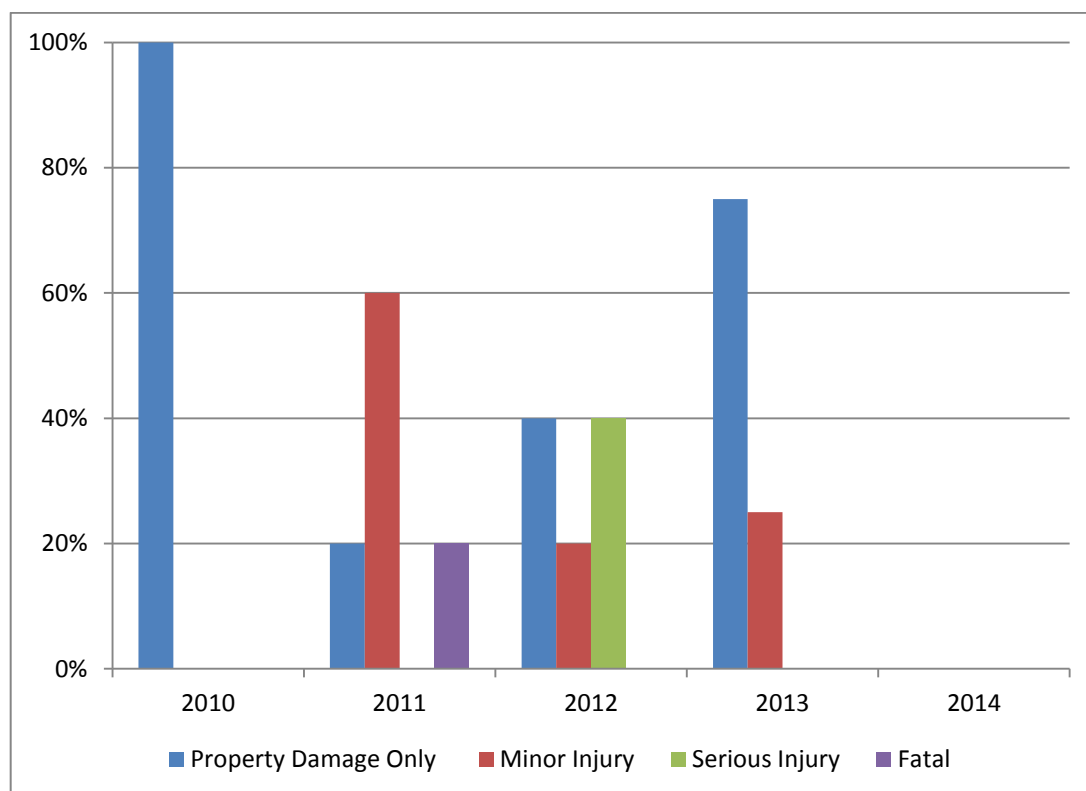


Interestingly the crash rate was highly variable during the 5 year period. The graph below displays the annual number of crashes on this section of the Horrocks Highway.



- Roll over (5 crashes)
- Hit fixed object (3 crashes)
- Rear end (2 crashes)
- Hit animal (2 crashes)
- Side swipe (2 crashes)
- Right angle (1 crash)

Again a high proportion of the crashes are run off road crashes, many of which resulted in roll overs. In 2011 there was a fatal hit fixed object crash and in 2012, a couple of roll over crashes resulted in serious injuries. It can be seen that property damage only crashes are also common. The breakdown of crash severity for each year is shown below.



The estimated economic cost of crashes on the Horrocks Highway between Georgetown and Murray Town from 2010 to 2014 is \$8,057,180. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 5 - Cost of Crashes On the Horrocks Highway between Clare and Brinkworth (2014 Values), 2010-2014

Crash Severity	Cost per Crash ³	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	7	\$86,310
Minor Injury	\$18,174	5	\$90,870
Serious Injury	\$340,000	2	\$680,000
Fatal	\$7,200,000	1	\$7,200,000

3.2.2 Geometry

For the most part, between Georgetown and Murray Town, the B82 has lane widths of between 3.2 to 3.3m with a minimal sealed shoulder, usually 100 or 200mm at the most.

³ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.



There was no sealed shoulder between Georgetown and Gladstone but from a point approximately 1km north of Gladstone, there were sealed shoulders of between 1 and 1.1m provided through to Laura. RAA welcomes the seal extension that has been undertaken on bends between Laura and Stone Hut. Along this section of the B82, RAA wish to see an increase in the lane widths to 3.5m with a minimum sealed shoulder of 300mm.



3.2.3 Pavement

The ride quality from Georgetown to Gladstone felt average, offering some sections of smooth driving while other sections caused a slightly rougher ride. On approach to

Gladstone, the ride quality improved and continued offering a relatively smooth ride to Murray Town.

The texture was generally good along this section of the B82 offering a medium to coarse texture which should offer good skid resistance and assist with drainage. Some minor texture loss and bitumen bleeding was noted between Georgetown and Gladstone but can be addressed as part of ongoing maintenance. Between Stone Hut and Murray Town, the texture was coarse.

Edge break was observed along some sections of the highway, particularly between Georgetown and Gladstone but the road authority has attempted to repair the damage. Some rutting was noted 5km south of Laura but generally rutting wasn't identified as a significant problem along the route.

3.2.4 Signs & Line Marking

The quality of the line marking between Georgetown and Gladstone was considered to be average. The line marking was visible in the dry weather however was found to be fading in some areas. The quality of the marking improved between Gladstone and Stone Hut but further fading was noted between Stone Hut and Murray Town.

RRPMS have been installed for a distance of about 14km north of Gladstone. RAA welcome the treatment and would recommend that it is continued throughout the B82. Line marking along the route should be refreshed to improve delineation.

3.2.5 Roadside Hazards

Stobie poles are located for a distance along the road of about 2km between Georgetown and Gladstone, about 1km between Gladstone and Laura and then some isolated poles between Stone Hut and Murray Town. In each instance, the poles were located at about 4m from the seal and pose a run-off road hazard. Protection should be considered for these as part of a longer term safety strategy.

The assessment noted the location of a number of culverts along the route. The road authority has installed hazard boards at some of the culverts which draws attention to their presence if a motorist wishes to pull over at the side of the road but offers no form of protection for those that unintentionally drift from the highway. Barrier protection is therefore recommended adjacent to culverts.

From Gladstone to Stone Hut, the assessment identified some bends with drops of up to 2m on the outside of the bend which would benefit from protection. It is recommended that in the absence of a barrier, at a minimum, the seal is increased and ATLM introduced.

From Stone Hut to Murray Town, the roadside hazards appeared better protected. W beam barrier was used on a number of occasions to protect drops of between 2 and 5m on both straight sections and bends, as well as to protect significant vegetation. W Beam barrier was also used to protect motorists passing over a culvert at a creek. It is recommended that the same level of protection is provided from Georgetown.

3.2.6 Key Recommendations

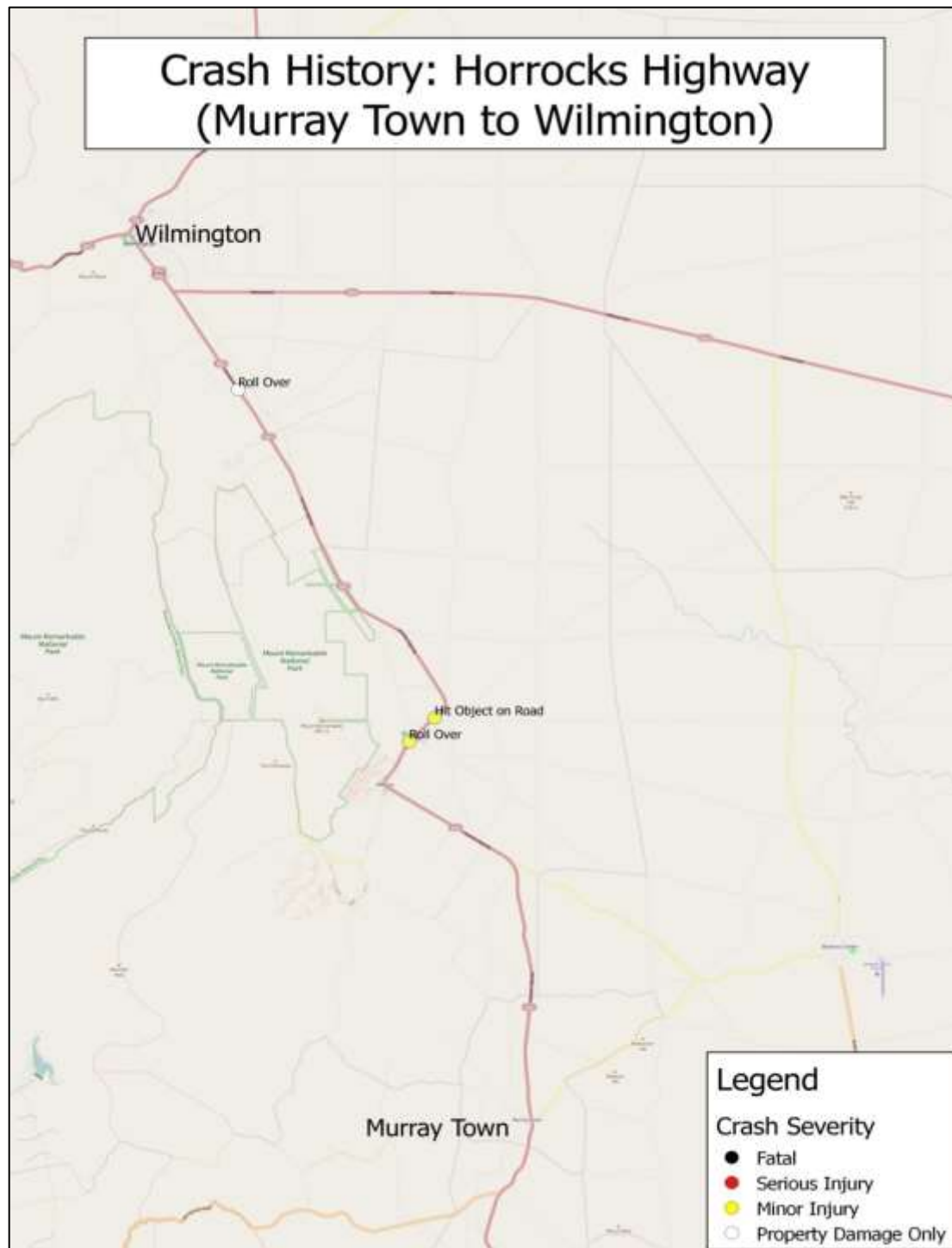
The assessment outlined the following recommendations for the Georgetown to Murraytown Road:

- Increase seal to accommodate 3.5m minimum lane widths
- Increase sealed shoulders to minimum 300mm
- Refresh line marking
- Install ATLM on bends
- Install barrier system to protect culverts

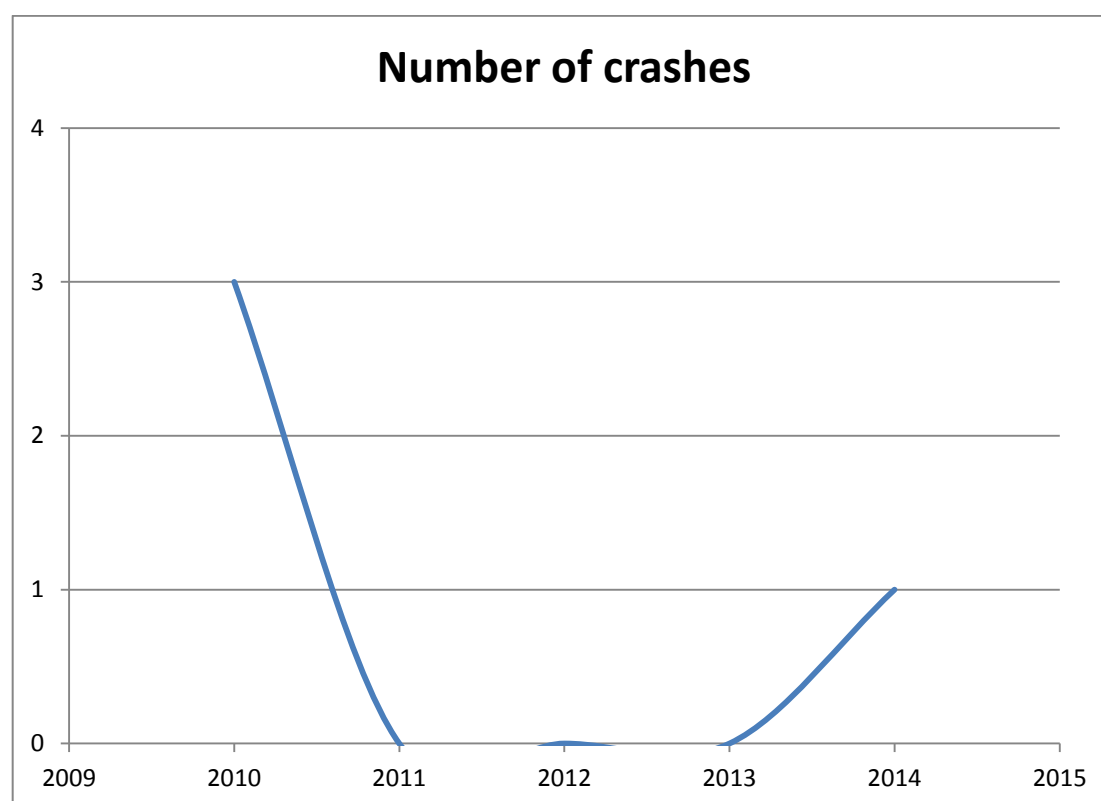
3.3 Murray Town to Wilmington

The section of the Horrocks Highway between Murray Town and Wilmington is 38km long and takes about 26 minutes to drive. 600 vehicles travel along this section of the highway per day, about 10% of which is heavy traffic. The speed limit along this section is 100km/h and the assessment was carried out in the northbound direction.

3.3.1 Crash History



There were a total of 4 recorded crashes on this section of road between Murray Town and Wilmington. Three of these occurred in 2010 and one occurred in 2014. Two of the crashes were roll overs of only property damage only or minor injury severity, while the other two were hit object on road, and hit parked vehicle crashes.



The estimated economic cost of crashes on the Horrocks Highway between Murray Town and Wilmington from 2010 to 2014 is \$61,008. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 6 - Cost of Crashes On the Horrocks Highway between Clare and Brinkworth (2014 Values), 2010-2014

Crash Severity	Cost per Crash ⁴	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	2	\$24,660
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

⁴ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

3.3.2 Geometry

Along the 10km stretch of the B82 between Murraytown and Wilmington, there's a significant variation in the cross section of the highway. North of Murraytown, the lane widths were found to be 3.3m with a 1.0 to 1.2m sealed shoulder. About 9km north of Murraytown the lane widths continue between 3.3 and 3.4m but no sealed shoulder is provided until Bishop's Road where the lane width reduces to 3.2m but a sealed shoulder is provided of between 200 and 600mm. RAA would recommend that the geometry is rationalised to provide lanes of between 3.3 and 3.4m with a minimum 500mm sealed shoulder.



Between Melrose and Wilmington, lanes widths were between 3.2 and 3.3m with a 200 to 300mm sealed shoulder and a 1.4 to 1.5m unsealed shoulder. 11km north of Wilmington, there is a 5km section that has no sealed shoulder. A sealed shoulder of between 100 and 300mm is then provided to Wilmington. RAA would recommend an increase in the total seal to provide lane widths of 3.3 to 3.4m with a 500mm sealed shoulder.

3.3.3 Pavement

From Murraytown to Melrose, the B82 appears to offer a medium to coarse texture which should offer reasonably good skid resistance and drainage. On one occasion some bitumen bleeding was noted but the extent of this was considered acceptable. The ride quality was however found to be poor, offering motorists a rougher ride with a number of bumps and undulations experienced between the towns. The areas noted to be poor also demonstrated rutting and patching of the pavement and could be addressed as part of a longer term maintenance program.

Between Melrose and Wilmington, the ride quality remains largely the same as before with the exception of a 10km section that provides a smoother ride for motorists.



The quality of the texture along this section is very good, offering a coarse texture to provide good skid resistance and drainage. Bitumen bleeding and slight texture polishing was noted at two locations but was not considered to be significant.

The main areas of concern along this section was the extent of the asphalt edge break in some areas which was estimated to be between 40 and 50mm. Approximately 4km north of Melrose, pavement cracks were detected and it is recommended that crack sealing is undertaken as a priority. Further on from this at about 7km north of Melrose, rutting was recorded with some potholes starting to appear in the surface.

3.3.4 Signs & Line Marking

There were no concerns identified relating to signs and line marking along this section. The quality of the line marking was considered good, providing a reasonably bright, clear line. RAA noted the use of CAMS on bends which provide good night delineation.

The quality of line marking from Melrose to Wilmington was considered to be very good offering a clear line with good contrast to the pavement. Where no sealed shoulder was provided, RAA were pleased to find that edge of carriageway lines had been used to improve delineation on bends.

3.3.5 Roadside Hazards

Stobie Poles and some significant gum trees were noted on a few occasions being located within 3 to 4m of the seal on both the straight sections and on bends.

Good use of W beam barrier was noted protecting hazards such as culvert and significant vegetation on the outside of bends however about 7km north of Murrays town, a barrier on a bend was considered to start too late on the bend and provide limited protection to motorists. It is recommended that the barrier is extended to start on the

straight prior to the bend. Despite the barrier protection offered, there were notable hazards that remained unprotected and RAA would recommend that further sites are assessed for barrier protection.

The assessment noted large deposits of dirt on the road around farm accesses and would recommend that warning signs are considered to advise of poor surface conditions in these areas.

At about 8km north of Melrose, a significant gum tree was growing within about 1.5m of the seal and had a black and white hazard board installed in front of it. Further on, a Stobie pole located within 2m of the seal on the inside of the bend also had a hazard board installed. Hazard boards can be useful for drawing attention to the presence of an object, particularly for the case of high side vehicles, which on bends may strike the object due to the camber of the road. Since rural crashes are often attributed to inattention or swerve to avoid wildlife, the effectiveness of hazard boards is questionable and other forms of hazard protection should be considered.

Between Melrose and Wilmington, the assessment noted further areas of mud and loose material on the road around farm accesses and warning signs are again recommended to draw attention to potential for reduced grip.

3.3.6 Key Recommendations

The assessment outlined the following recommendations for the Murraytown to Wilmington Road:

- Extend seal to provide consistent lane widths of 3.3m minimum
- Construct shoulders to a minimum width of 500mm
- Review barrier installations, consider increasing barrier length
- Install warning signs for slippery road conditions near farm accesses

3.4 Wilmington to Quorn

Just shy of 40km, this trip between Wilmington and Quorn takes less than half an hour. It is quite a low usage road of less than 500 vehicles per day. The traffic is made up of mainly small private vehicles, and only a small percentage of heavy vehicles. The road was surveyed starting at Wilmington and travelling north until Quorn. The trip meter was started at the intersection with Sherman Street. The signed speed limit is 100km/h.

3.4.1 Crash History



There were only two crashes along this section of the Horrocks Highway between 2010 and 2014. One of which happened in 2012 at an intersection in Quorn and was a minor injury - hit pedestrian crash. The other crash was in 2014 and was a minor injury – run off road crash.

The estimated economic cost of crashes along the Horrocks Highway between Wilmington and Quorn from 2010 to 2014 is \$36,348. This figure includes losses to workplace and households as well as a number of medical, insurance, accident

investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 7 - Cost of Crashes Horrocks Highway (Wilmington to Quorn) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ⁵	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	0	\$0
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

3.4.2 Geometry

Centre lines, and edge lines provided a road lane width of 3.3-3.4m and also a sealed shoulder of approximately 0.3m. This gave the road a nice comfortable width and plenty of room to pass by larger vehicles travelling in the opposing direction. Unsealed shoulders were approximately 2.1m.



3.4.3 Pavement

All in all the pavement conditions were fairly good at the time of the assessment. There were a few minor defects such as rutting under the wheel paths and surface bleeding. These were located mainly in the first 13km with the worst section found just 2.05km in

⁵ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

from Wilmington. This coincided with a change in the road surface to what appeared to be an older looking seal. The ride quality was quite good despite a few patches of bumps and undulations which were noted to be the worst at 23km. A number of locations showed signs of edge break and edge drop that should be remediated. The worst areas noted were at 3.31km on the inside of a right hand bend and also at and 37.5km.

3.4.4 Line Marking, Signs and Delineation

Good quality line marking was noted for the entire stretch between Wilmington and Quorn. Areas for improvement would be to implement audio tactile line marking and retro reflective pavement markers to both reduce the instance of run off road crashes, and better delineate the road in times of reduced visibility.

3.4.5 Roadside Hazards

Roadside drops were the biggest safety concern noted for this stretch of road. Some of these drops ranged from 1-3m in depth. These drops located at 10.3km, 25.4km, 29.3km, and 33.6km should be considered for protection with W Beam barriers or at the very minimum an increase to the sealed shoulder and audio tactile line marking to allow drivers to take corrective action.

Small to medium trees and shrubs line the sides of the road which are also a hazard when in close proximity to the seal. A number of creek crossings with culverts were traversed, all of which were protected with W Beam barriers.

3.4.6 Key Recommendations

RAA recommend the following treatments for the Horrocks Highway between Wilmington and Quorn:

- Protection of unprotected roadside drops.
- Implement ATLM & RRPM's.
- Repair of edge break and edge drop.

3.5 Brinkworth to Georgetown

This road was driven from Brinkworth north to Georgetown. The trip meter was started on the intersection of Clare Road and the Horrocks Highway. Traffic volume is medium to high at approximately 600 per day and is primarily comprised of small private vehicles along with a number of heavy vehicles (16%). The distance to Brinkworth from where the trip meter was started is 38km. The speed limit for this section of road is 100km/h.

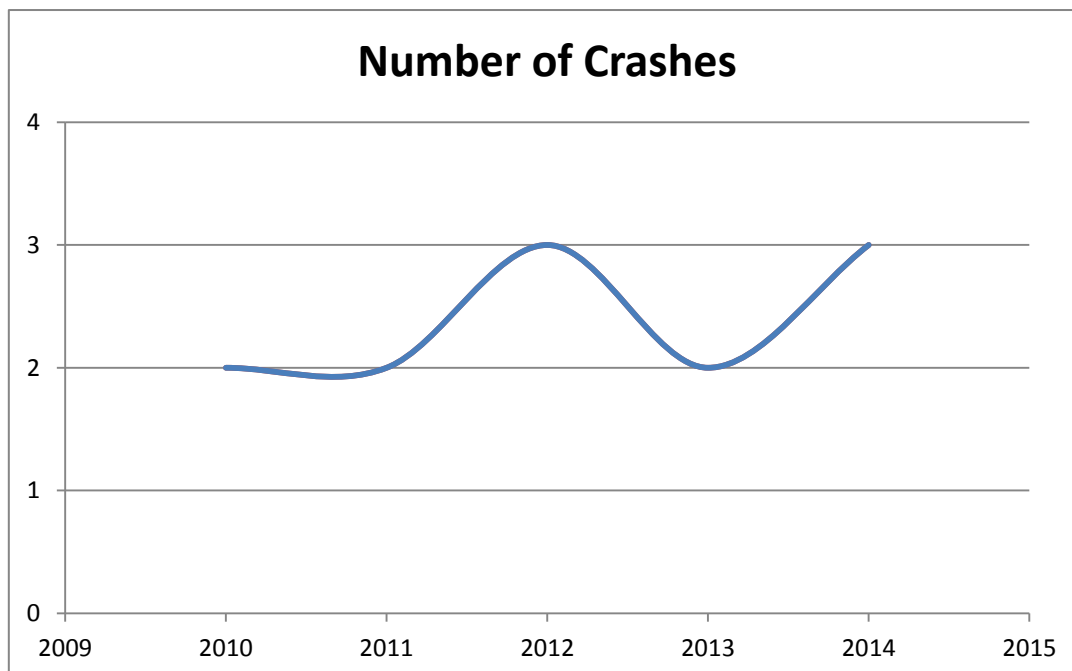
3.5.1 Crash History



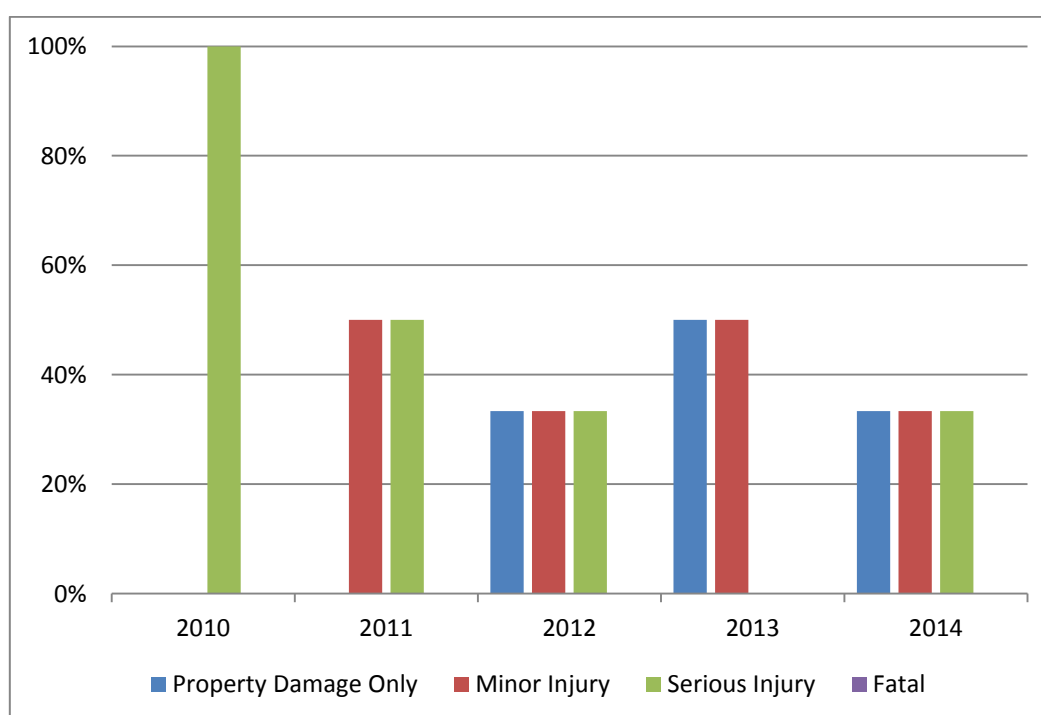
A steady rate of 2 or 3 crashes occur on this section of the Horrocks Highway annually. These crashes tend to be mostly run off road crashes or animal crashes:

- Hit Fixed Object (6 crashes)

- Roll Over (2 crashes)
- Hit Animal (2 crashes)
- Side Swipe (1 crash)



Although there have been no fatalities between 2010 and 2014, a higher proportion of crashes are casualty crashes, 5 of which resulted in serious injuries (hit fixed object crashes). 4 other crashes caused minor injuries, again all run off road crashes aside from one side swipe.



The estimated economic cost of crashes along the Horrocks Highway between Brinkworth and Georgetown from 2010 to 2014 is \$1,809,686. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 8 - Cost of Crashes Redhill to Brinkworth (2014 Values), 2010-2014

Crash Severity	Cost per Crash⁶	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	3	\$36,990
Minor Injury	\$18,174	4	\$72,696
Serious Injury	\$340,000	5	\$1,700,000
Fatal	\$7,200,000	0	\$0

3.5.2 Geometry

The lane widths for this section of road were highly inconsistent. In one location the lane widths were a comfortable 3.6m wide, complimented by a 0.2m sealed shoulder on one side and a 0.5m sealed shoulder on the other. The unsealed shoulder was between 2.1 and 2.3m. However, most of the road was far narrower, and the narrowest sections were as little as 3.0m wide with no edge line or sealed shoulder for each lane. These areas were located at 3.5km, and 11.35km. The northern section after Yacka was far better with most of the road being above 3.2m wide and some sections were even provided with an edge line and 1.0m sealed shoulder.

3.5.3 Pavement

Generally the pavement varied from average to poor on the B82 between Brinkworth and Georgetown. The major concern was significant edge break especially on the 20km stretch on the southern side of Yacka. For this section most of the road displayed a width of 3.2m or less. As a result significant edge break was constantly an issue, because of the high recurrence of vehicle tyres hitting the edge of asphalt. Drops from the sealed surface onto the unsealed surface were also common on these locations, and varied between 50 and 100mm. The worst drops were located at 4.8km, 7.1km, and 9.1km.

On the northern side of Yacka, the road surface was bumpier and additional cracking and rutting was observed, especially near to Georgetown.

The photo below was taken on one of the better sections of this part of the road, near to the intersection with the Goyder Highway.

⁶ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.



3.5.4 Line Marking, Signs and Delineation

The quality of the line marking was quite good for the most part, with only a few sections around 30km that are beginning to look faded and should be refreshed at some point in the near future.

It was noted that the bends were quite well delineated by increased frequency of hazard marker posts. This however could further be improved by upgrading the remaining areas that are currently without edge lines or sealed shoulders.

As this road is currently set at a speed limit of 110km/h, audio tactile line marking would be a good feature to implement in order to reduce the likelihood of run off road crashes.

3.5.5 Roadside Hazards

On a positive note, this section of road displayed very little evidence of roadside hazards. The hazards identified included power lines that run along the roadside, a culvert which was already protected with W beam barriers, and some other hazards that were already identified by increased frequency of hazard marker posts.

There was one significant unprotected roadside drop that was noted during the assessment. This was located on the outside of a bend at 12.3km, and should be protected by W beam barriers and an increase in seal width.

3.5.6 Key Recommendations

RAA recommend the following treatments for the Horrocks Highway between Brinkworth and Georgetown:

- Lane widening to consistent 3.5m lanes and 0.5m shoulders.
- Repairs to edge break.
- Rehabilitation of surface in noted locations.
- Protection of unprotected roadside drops.
- ATLM

4 B83 Flinders Ranges Way

The Flinders Ranges Way is around 107km between Port Augusta and Hawker, taking a little over an hour to drive. Traffic volumes significantly vary with between 340 and 1,200 vehicles per day travelling along the highway. Heavy vehicles represent on average 15% of the total traffic. The assessment was conducted in two stages along the highway:

- Port Augusta to Quorn; and
- Quorn to Hawker

4.1 Port Augusta to Quorn

This road carries between 900 and 1400 vehicles per day. Approximately 15% of these are heavy vehicles. Flinders Ranges Way, otherwise known as the B83 is a very winding road that runs through the hillside adjacent the Mount Brown Conservation Park. This road is set at a speed limit of 110km/h and has received quite a lot of funding in the past to improve safety along the roadside.

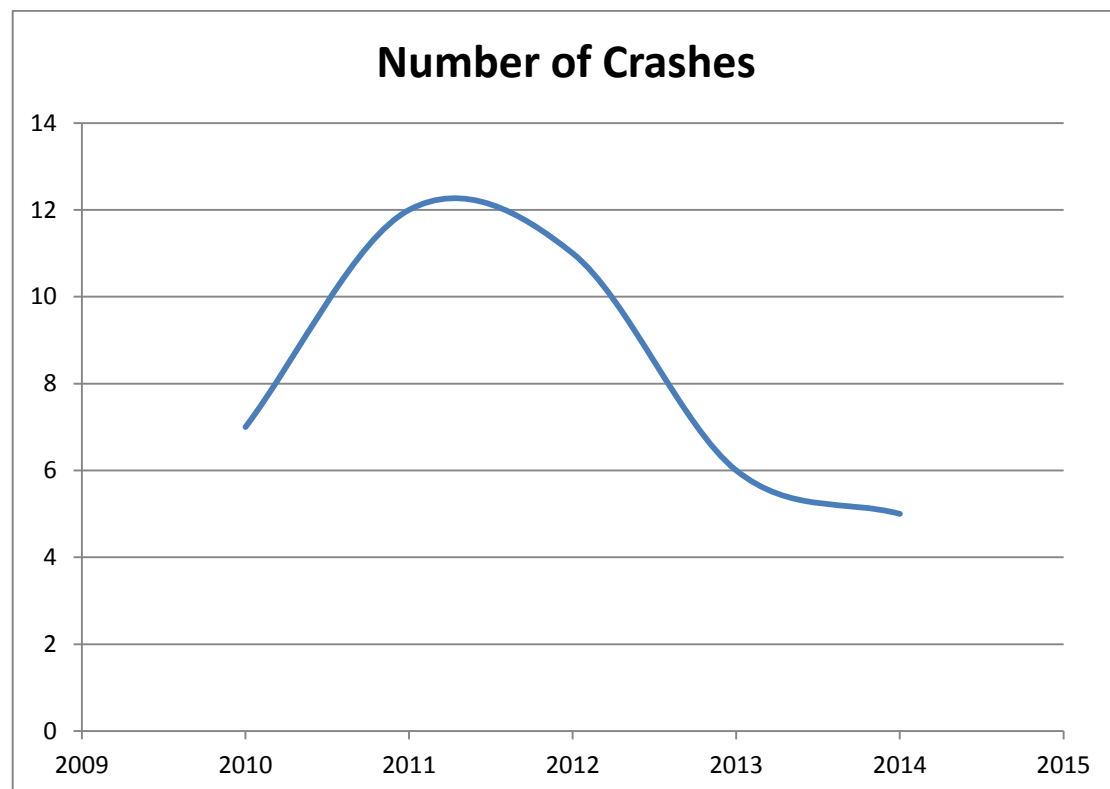
**Crash History: Flinders Ranges Way
(Port Augusta to Quorn)**

Legend

Crash Severity

- Fatal
- Serious Injury
- Minor Injury
- Property Damage Only

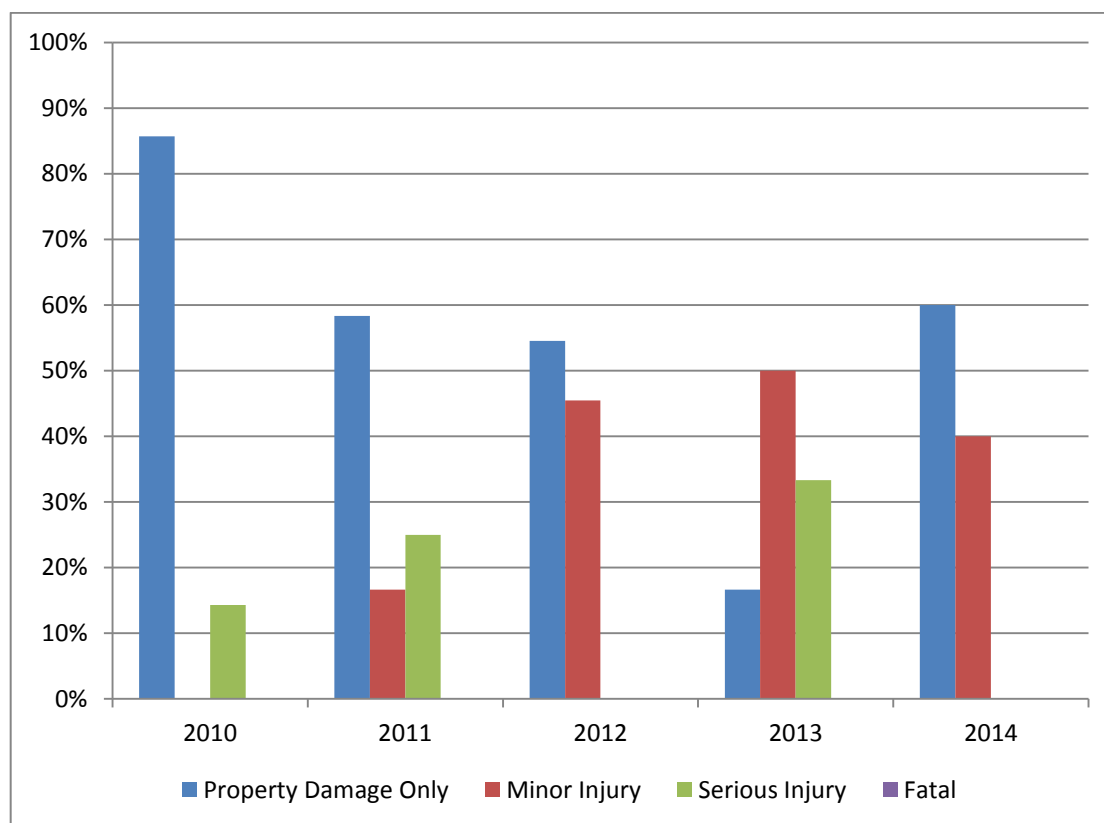
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Property damage only crashes again make up over 50% of all crashes recorded in the five years. There were no fatalities, however there were 12 minor injury crashes and 6 serious injury crashes. A number of different crash types were included, and looking specifically at serious injury crashes these were:

- Hit fixed object (2 crashes)
- Hit pedestrian (1 crash)
- Left road – out of control (1 crash)
- Roll over (1 crash)
- Head on (1 crash)

It is good to see that run off road and roll over crashes are not over represented on this section of road. This is an indicator that many of the roadside hazards which are common along this route are well delineated and protected. The following table breaks down the percentage of property damage only, minor injury, serious injury and fatality crashes for each year.



The estimated economic cost of crashes on this section of Flinders Ranges Way from 2010 to 2014 is \$2,541,678. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 9 - Cost of Crashes Flinders Ranges Way (Port Augusta – Quorn) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ⁷	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	23	\$283,590
Minor Injury	\$18,174	12	\$218,088
Serious Injury	\$340,000	6	\$2,040,000
Fatal	\$7,200,000	0	\$0

4.1.2 Geometry

It was good to see that the entire stretch of this road has quite wide lane widths, and has been delineated well with edge lines giving a varying sealed shoulder. A measurement at 10.02km indicated 3.4m lane widths with sealed shoulders of 0.8m and 1.0m. The

⁷ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

unsealed shoulder was between 2.2m and 2.5m. The photo below shows a typical road width and surface along this section of road.



4.1.3 Pavement

Although the major concern for this road was not the pavement condition, there were some defects noted at the time of the assessment. There were also some signs of both rutting in the road surface under the wheel paths and bitumen bleeding. Quite often these two issues were seen hand in hand, and the worst areas tended to be on the western end nearer to the intersection with Augusta Highway. Edge break and pot holing again featured on this road, although not as significant or common as seen on other roads in this area. The most significant pot holes and edge break were noted on a driveway access approximately 9.6km from Quorn.

4.1.4 Line Marking, Signs and Delineation

The line marking was generally in a respectable state, if slightly faded on the approach to Quorn. Retro Reflective Pavement Markers supplemented the line marking by assisting in road delineation, especially during times of low light. It was noted that many of these are now missing, and it is recommended that these be replaced. Notably there was some yellow edge line marking used on the outside of some of the severe bends in the road which had steep drops on the outside of the bend which is assumedly to further delineate the edge by the dangerous drop. Audio Tactile Line Marking (ATLM) was not present on this road.

There was no lack of speed advisory signage for this very winding road, and all sharp bends were accompanied with a speed advisory sign of appropriate speed. Quite often the advisory speeds dropped to as low as 60 or 70km/h around the sharper of the bends.

Along this road, a number of rail crossings were encountered, and generally they were well signed with both roadside signage and pavement markings. However, when traveling in the other direction (from Quorn to Port Augusta), approximately 20km from Quorn there was a rail crossing which follows a sharp bend to the left. It was noted that this area could do with some additional signage, as the first sign is easily missed when negotiating the sharp bend to the left which is just prior to and blocks visibility of the rail crossing.

4.1.5 Roadside Hazards

Roadside Hazards are the major cause for concern on this road. As the road is highly winding and travels through the hillside this causes there to be many steep roadside drops. It was good to see that almost all of these steep drops were protected by a barrier. Most common were w-beam barriers which offer very good protection through the deflection of vehicles. Wire rope barrier was also present and similarly provides very good protection. There was one bend in the road with a large drop on the outside of the bend. This was noted at 21.45km from Quorn and should be protected with wire rope or W-beam barrier.

Sealed shoulder length was and larger vehicles around some of the sharper bends which provides some additional room for cars and larger vehicles should they find themselves out of the travel lane. One addition to these areas would be Audio Tactile Line Marking which will alert drivers that they are in the wrong spot and allow them additional time to correct.

When travelling on this road, a number of bridges and culverts were crossed. It was noted that they were all well protected with w- beam barriers.

Approximately 3.3km from Quorn there was some significant ponding on the roadside, in the unsealed shoulders. This is because the shoulder slopes back towards the road, trapping the water runoff. This area displayed a large area of water which should be addressed as at the time of assessment there wasn't an abundance of rainfall.

Because of the winding nature of this road along with the high number of roadside hazards it raises the question of why the speed limit is still set at 110km/h when for a majority of time it isn't possible to travel at that speed. Dropping this section of road to 100km/h would have negligible effect on the travel time between Port Augusta and Quorn as well as improving the safety around the dangerous roadside hazards.

4.1.6 Key Recommendations

RAA recommend the following treatments for the Flinders Ranges Way between Port Augusta and Quorn:

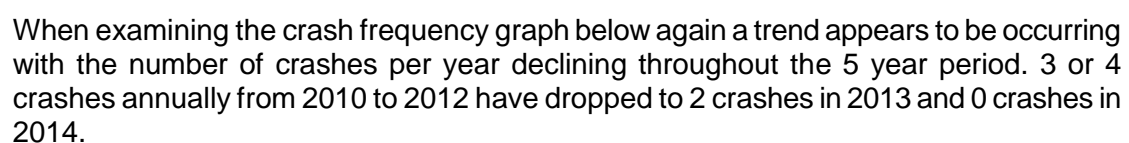
- Replace missing RRPM's.
- Increase warning signage for rail crossing (approx. 20km from Quorn).
- Protection from unprotected drops.
- Address roadside drainage issues near Quorn.

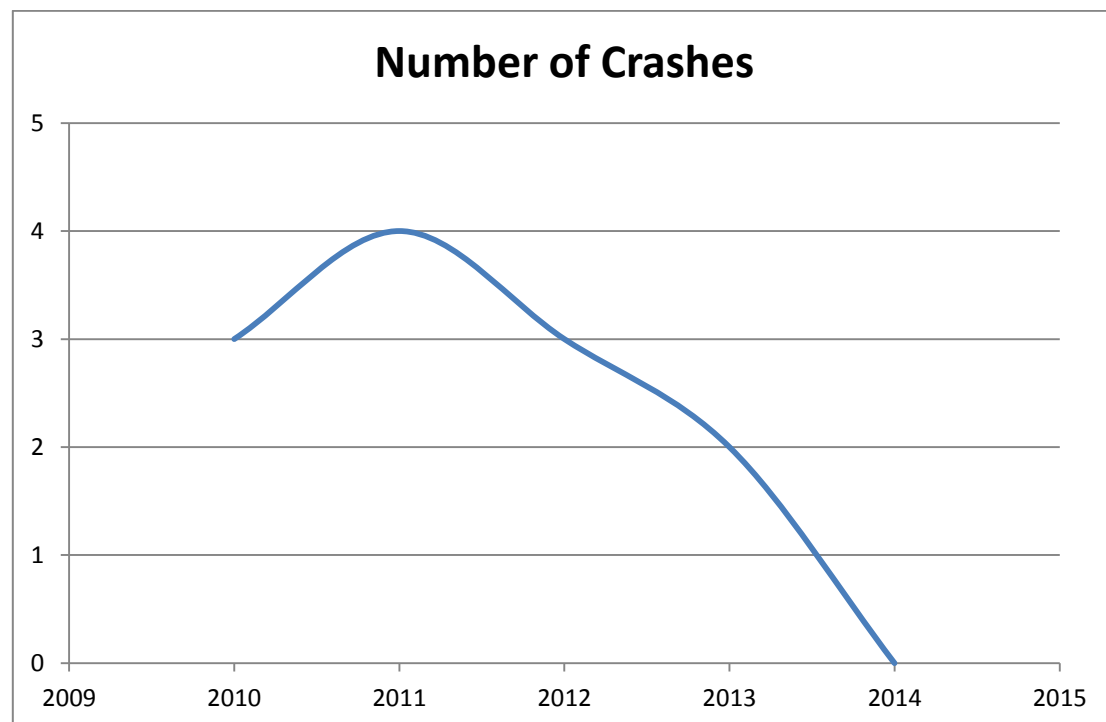
- Reduction of speed limit to 100km/h.

4.2 Quorn to Hawker

The section of the Flinders Highway between Quorn and Hawker is about 66km and carries 340 vehicles per day, 20% of the volume is heavy traffic. The assessment was undertaken in the eastbound direction and the reference point for the odometer was set at the intersection of the B83 and Ardenvale Vale Road in Quorn.

Crash History: Flinders Ranges Way (Quorn to Hawker)

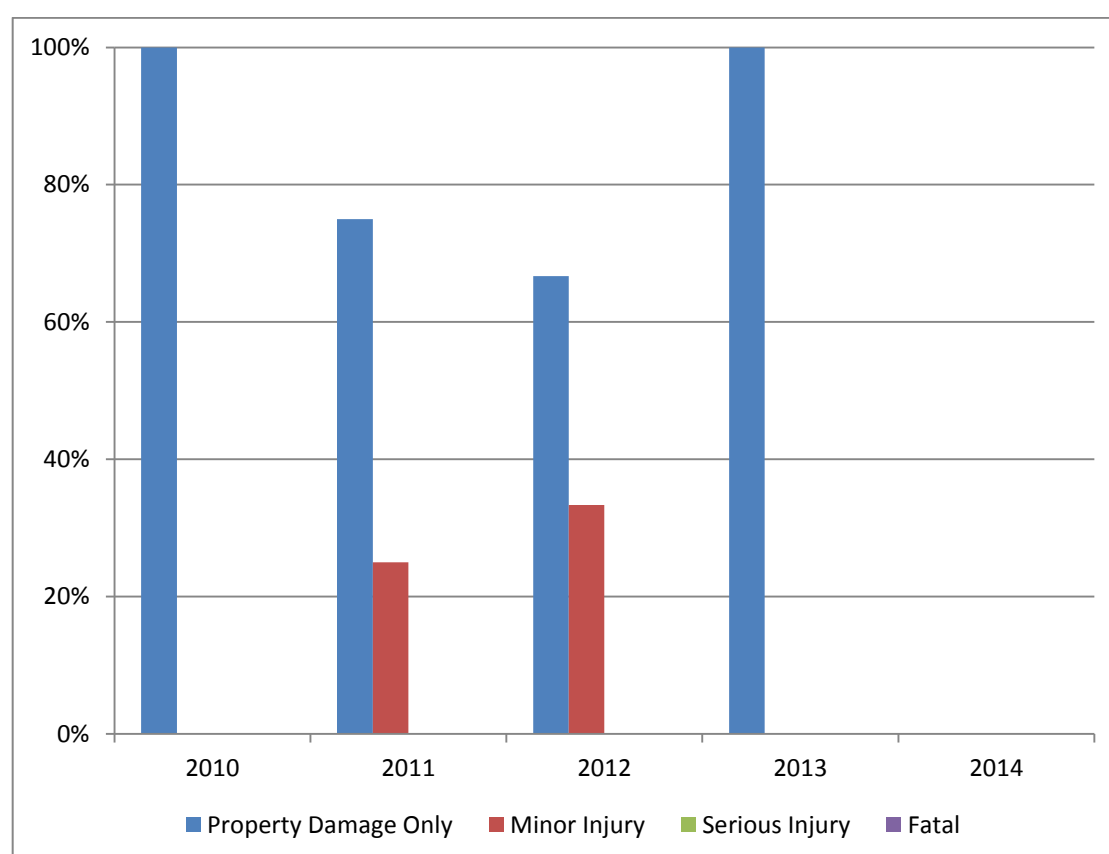




Hit animal crashes were the most recorded crash type with a total of 7 reported crashes. This is cause for concern as hit animal crashes tend to be less often reported to the police and may be more of a problem than the stats show. This indicates that hit animal crashes are very common along this route. A complete breakdown of the crash types is provided below:

- Hit animal (7 crashes)
- Hit fixed object (3 crashes)
- Left road - out of control (1 crash)
- Roll over (1 crash)

Crashes on this section of road tend to have been less severe than other roads in the mid north assessment. The crashes are mainly property damage only crashes, with a few minor injuries. The table below depicts the crash severity of each year in the 5 year period.



The estimated economic cost of crashes on this section of road in the five year period is \$159,648. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 10 - Cost of Crashes On Flinders Ranges Way between Quorn and Hawker (2014 Values), 2010-2014

Crash Severity	Cost per Crash ⁸	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	10	\$123,300
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

4.2.2 Geometry

The width of the lanes along the B83 varied between 3 and 3.2m with a 200 to 300mm sealed shoulder. About 52km northwest of Quorn, the sealed shoulder reduced to around 100mm. The assessment noted however that the sealed shoulder was increased

⁸ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

to between 1.0m and 1.2m across and for about a distance of about 10m on either side of flood ways. This upgrade is welcomed as it will reduce the risk of vehicles running off road and rutting when water flows across the road.

RAA recommend that the seal extensions are carried out along the B83 to provide 3.2m wide traffic lanes and a minimum of 500mm sealed shoulder between Quorn and Hawker.

4.2.3 Pavement

The ride quality provided along the B83 is fair with only minor undulations experienced. The pavement was found to have a coarse texture, likely to provide good drainage and skid resistance.

Notable rutting was recorded along a section 15km north west and about 21.5km northwest of Quorn. Rutting was particularly noticeable at the latter location since water was trapped in the ruts and was ponding. This is a concern since the risk of hydroplaning is increased. It is recommended that rut filling is undertaken at these two locations.

Bitumen bleeding was identified at a number of locations along the highway. It appeared to occur in many instances on the upslope from flood ways but was also noted to coincide with the rutting 15km north west of Quorn.

Unsealed shoulders along the B83 were considered to be well graded and in reasonably good quality with only minor loose material. There is a reduced risk of loss of control of a vehicle if drifting on to these shoulders at high speed.

4.2.4 Signs & Line Marking

The quality of the line marking was considered to be fair, providing a reasonably solid line however the line marking was difficult to see in the wet weather.

The assessment identified the need to update some of the bend warning signs since some of the intersections occurred on the bend so the incorrect schematic had been used.

One area of concern was the absence of depth markers on a number of floodways. Depth markers on floodways are critical for safety since they allow the driver to make an informed decision as to whether it is safe to proceed when water flows across the road. It is highly recommended that the depth markers are reinstated along the road.

4.2.5 Roadside Hazards

Unprotected drops of between 1 and 1.5m on the outside of bends were identified in numerous areas. There were fatality markers at such locations at both 35km and 40km northwest of Quorn, a sombre reminder of the run-off road risk. Further drops of between 2 and 3m were also recorded along the route. RAA highly recommends barrier protection for any batter potentially capable of causing a rollover but believe that barrier

protection should be prioritised where the drop occurs on the outside of the bend, due to the increased risk of vehicle run-offs.

RAA also noted during the assessment that protection was not offered from culvert headwalls which are major roadside hazards.

4.2.6 Key Recommendations

RAA recommend the following treatment for the B83 between Quorn and Hawker:

- Increase seal to provided minimum lane widths of 3.2m
- Increase seal to provide minimum 500mm sealed shoulders
- Undertake a program of rut filling
- Review and update intersection warning signs for bends
- Install depth markers at all floodways
- Install barrier protection for significant drops and at culvert headwalls
- Review and install wildlife warning signs

5 B64 Goyder Highway

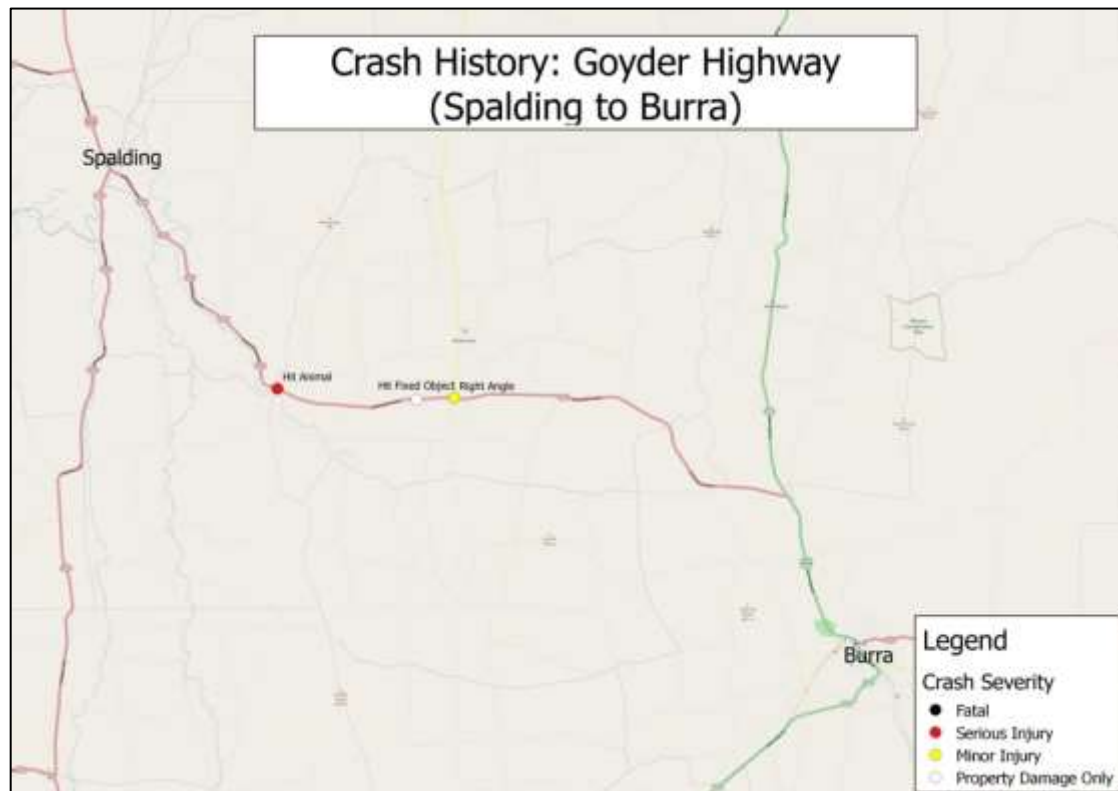
The Goyder Highway runs in an east-west direction and is 174km long between Crystal Brook and Morgan, before continuing on into the Riverland. The highway carries between 220 and 550 vehicles per day with heavy vehicles representing between 20 and 29% of the total traffic volume. The speed limit along the highway is 110km/h.

The assessment was conducted in the eastbound direction and the reference point for the odometer was set at the intersection of the B69 and John Street in Spalding. The trip meter was then reset at the parking layby on the east side of Burra.

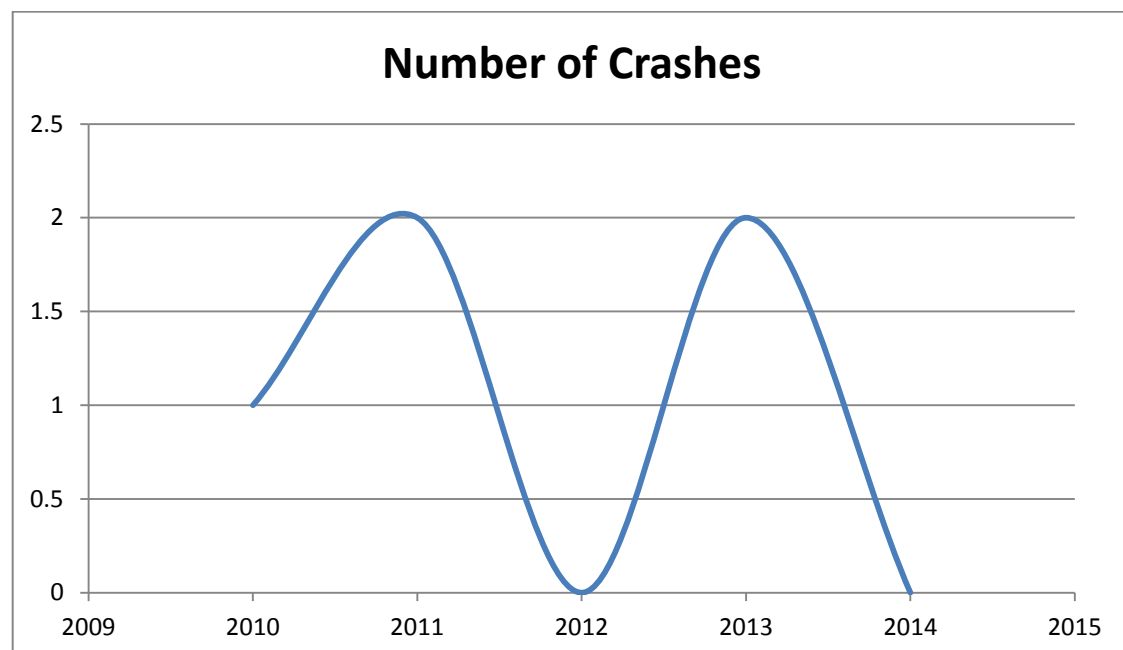
5.1 Spalding to Morgan

The section of the Goyder Highway between Spalding and Morgan is 128km long and about 1 hour 20 mins drive. Traffic volumes along this section are around 400 vehicles per day, with an average of 21% of these being heavy vehicles.

5.1.1 Crash History



In the 5 year period between 2010 and 2014 there have been only 5 crashes between Spalding and Burra. 2012 and 2014 had no crashes, while 2011 and 2013 saw two crashes each.

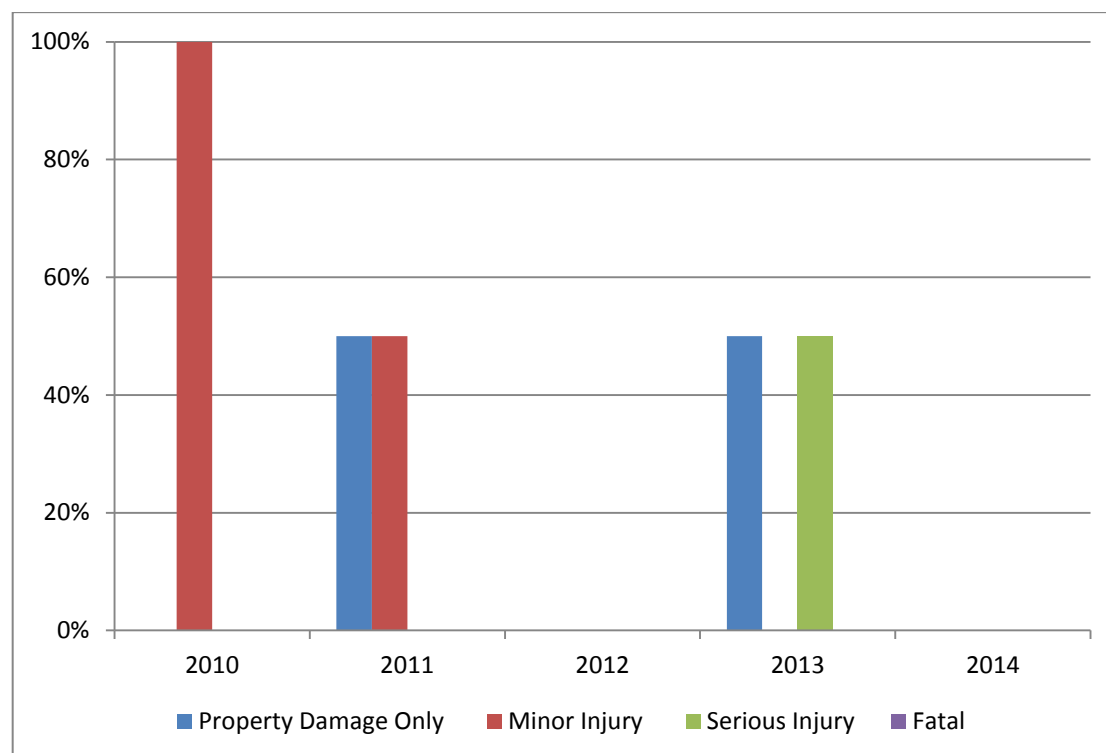


Between Spalding and Burra, there was a variety of different crash types.

- Roll over (1 crash)

- Head on (1 crash)
- Right angle (1 crash)
- Hit animal (1 crash)
- Hit fixed object (1 crash)

Two of the crashes that occurred were property damage only crashes. There were also two minor injury crashes and one serious injury crash. The following graph breaks down the crash severity for each year.

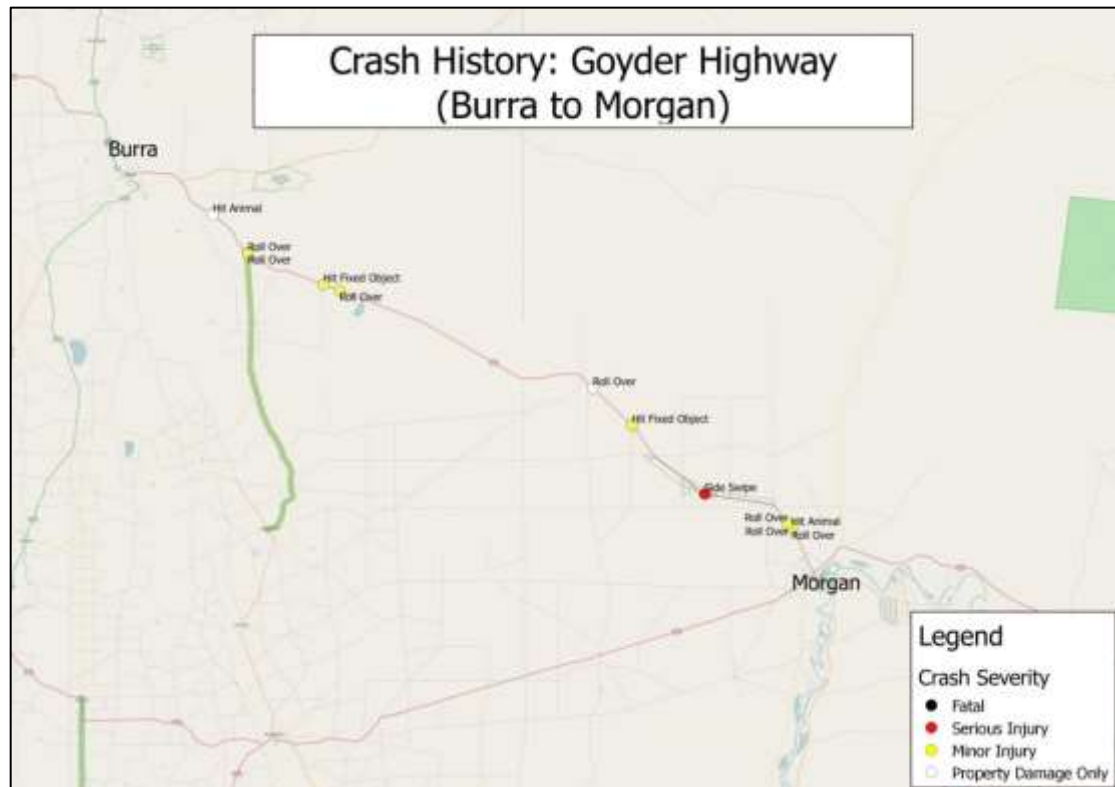


The estimated economic cost of crashes between Spalding and Burra in the five year period is \$401,008. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 11 - Cost of Crashes On The Goyder Highway between Spalding and Burra (2014 Values), 2010-2014

Crash Severity	Cost per Crash ⁹	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	2	\$24,660
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	1	\$340,000
Fatal	\$7,200,000	0	\$0

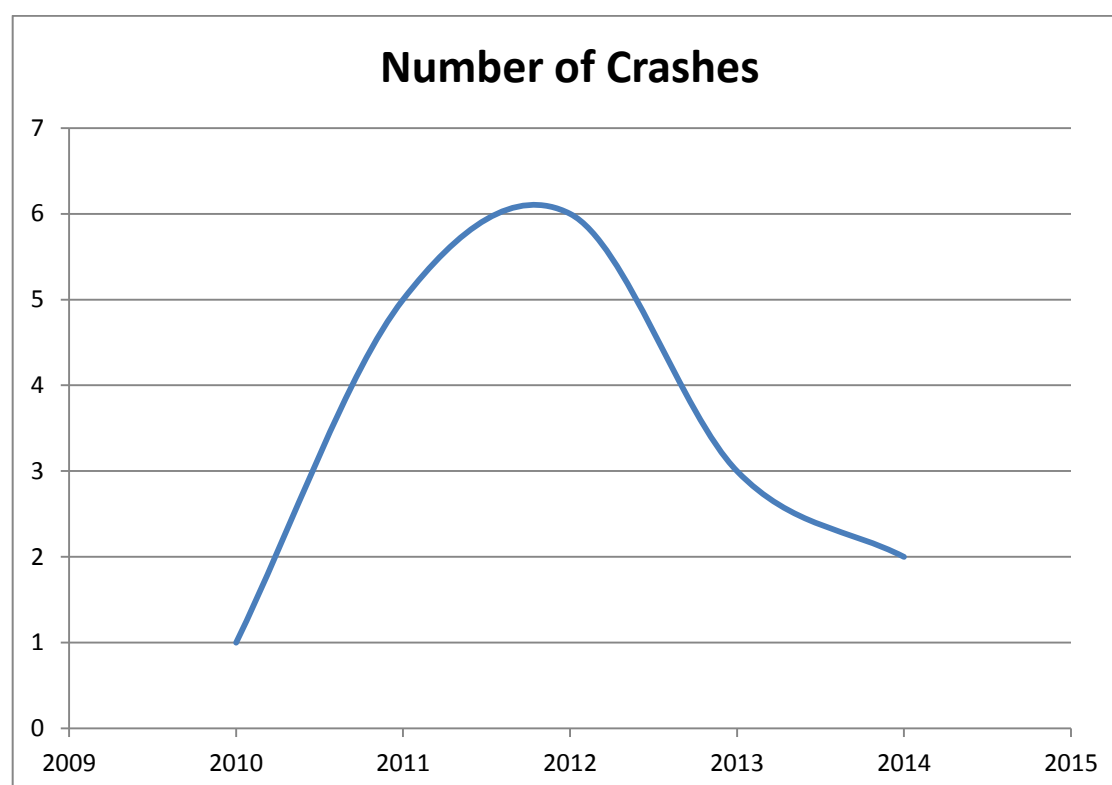
⁹ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.



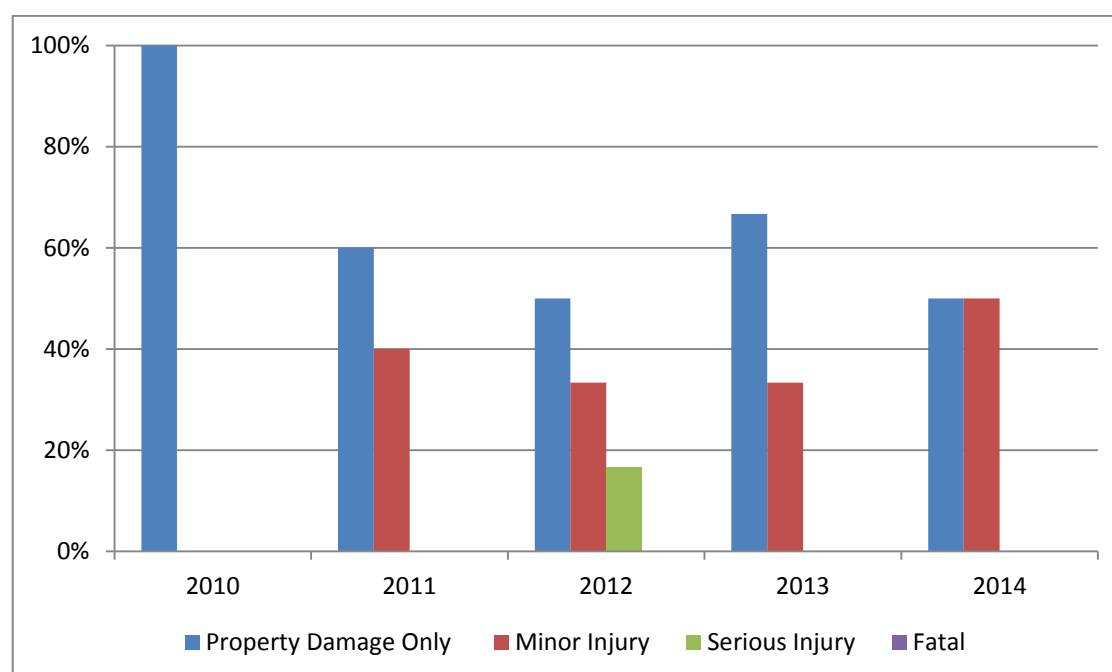
In the 5 year period a total of 17 crashes occurred between Burra and Morgan. A peak of 5 and 6 crashes occurred in 2011 and 2012 respectively, with all other years having between only 1 and 3 crashes annually.

There was a high number of roll over crashes along this section of road. A high priority should be given to preventing these crashes from occurring and protecting the areas that have the greatest embankments.

- Roll over (8 crashes)
- Hit animal (4 crashes)
- Hit fixed object (3 crashes)
- Side swipe (1 crash)
- Left road – out of control (1 crash)



Again a high proportion of crashes were either property damage only or minor injury crashes. There was one serious injury side swipe crash that occurred in 2012. The table below depicts the proportion of crash severity for each year.



The estimated economic cost of crashes between Burra and Morgan in the five year period is \$572,344. The table below breaks down the cost of crashes in the last five years by severity.

Table 12 - Cost of Crashes On The Road Between Burra and Morgan (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹⁰	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	10	\$123,300
Minor Injury	\$18,174	6	\$109,044
Serious Injury	\$340,000	1	\$340,000
Fatal	\$7,200,000	0	\$0

5.1.2 Geometry

From Spalding to Burra, the cross sectional geometry varied with lane widths ranging from 3 to 3.2m and sealed shoulders from 200mm to 1.2m. Where the lane widths are as low as 3m, the sealed shoulders are 1.2m which is acceptable. To increase the lateral gap however between opposing traffic, RAA would prefer wider lanes with narrow shoulders and would recommend that as part of future lining works, the road is remarked to provide 3.5m lanes with 600mm sealed shoulders. For the remaining sections with 3.2m wide lanes, RAA recommend that the seal is increased to allow a minimum of 500mm sealed shoulders.

Between Burra and Morgan, lanes widths generally tended to be 3.5m with some sections having widths of 3.1 to 3.2m. Sealed shoulders varied again between 200mm and 1.2m which is a significant variance. 77km east of Spalding, edge lines disappear and not sealed shoulder is provided. RAA would again recommend favouring a wider lane over shoulder where permitted and increasing the seal to provide a minimum of 3.2m lane widths and 500mm sealed shoulders.

5.1.3 Pavement

The ride quality along the B69 was found to be good, offering few bumps or undulation and providing a smooth ride for the motorist. West of Burra, the ride quality reduced and was considered to be average, offering some smooth sections but with some minor corrugations in the surface.

The pavement consistently offered a medium to coarse texture between Spalding and Burra and should provide really good surface drainage and skid resistance. Despite offering good texture, there were some areas that showed signs of bitumen bleeding, which should continue to be monitored.

Between Burra and Morgan, rutting was more evident and in some instances, the ruts were trapping water and causing water to pond on the road. Rut filling should be considered along this section to reduce the risk of aquaplaning in the worst areas. It was

¹⁰ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

noted that towards Morgan, rut filling and patching has been undertaken to remedy the issue along some of the sections.



Unsealed shoulders were considered to be in good condition having been graded and appear to be well compacted. A few isolated areas were identified between Burra and Morgan where edge break was occurring but the extent of the problem wasn't significant and could perhaps be addressed with further grading to reduce any drop between the sealed and unsealed surfaces.

5.1.4 Signs & Line Marking

Generally there were few issues with the line marking between Spalding and Morgan. The marking provided offered clear delineation of the lanes. Between Burra and Morgan the assessment identified a section of road that had been remarked over the existing line marking. Along one section, RAA noted that a dashed line was marked over a previously solid line. This practice is not encouraged and where a decision has been made to alter the traffic management, the older lines should be blacked out to avoid confusion. Lack of reinstatement of line markings following pavement repairs was found to be a problem between Burra and Morgan.



The assessment considered delineation on bends to be adequate however could be improved with the addition of ATLM or RRPMS or a combination of both. Further sections between Burra and Morgan could benefit from RRPMS to enhance night delineation along the edge of carriageway line. It was noted that ATLM had been provided along sections 5km and 42km east of Burra, which is a welcome improvement.

Hazard posts were provided on bends but between Burra and Morgan they appeared to be spaced further apart. It is recommended that the spacing is reduced on bends to improve night delineation and outline the horizontal curve.

5.1.5 Roadside Hazards

Typical roadside hazards were noted along the B86. Between Spalding and Burra, a number of Stobie Poles were observed between 3 to 5m of the seal. Some of these occurred on the outside of bends and RAA would recommend prioritising the protection treatment on bends in the first instance.

Immediately east of Spalding, the assessment noted the presence of a 1m diameter high pressure water line running within 4m of the seal. It is strongly recommended that barrier protection is provided for this infrastructure. If a vehicle were to crash into the pipeline, a light vehicle will tend to pitch under the pipe, likely to result in a fatality while heavier vehicles are likely to sustain serious injuries as well as breaching the pipeline.

It was encouraging to note that most of the drops along this section, varying between 2 and 5m, had been protected with W beam barrier. There however remained a few steep embankments between 2 to 3m which RAA felt would benefit from barrier protection to prevent potential roll-over crashes.

Culverts were delineated with hazard posts at the headwalls however no protection was offered. Where the culverts have a substantial headwall or drop at either side, barrier protection should be provided.

The assessment welcomed the provision of a rest area between Burra and Morgan. The rest area provided a safe area for motorists to stop off the road and included sheltered seating and bins. In addition to the current facilities, it may be beneficial to provide solar LED lighting to encourage motorists to stop and rest in the evening and at night.

5.1.6 Key Recommendations

RAA recommend the following treatments for the Goyder Highway between Spalding and Morgan:

- Increase seal to a minimum of 500mm
- Undertake rut filling
- Repair pavement edge break / edge drop
- Reinstate line marking where repairs have been carried out
- Increase number of hazard marker posts on bend
- Install barrier system on bends with hazards and protect pipeline

5.2 Spalding to Gulnare

This road is just over 15km in length and was driven from east to west. DPTI traffic volumes indicate that this is a low usage road with only 330 vehicles per day and a heavy vehicle percentage of 10%. A speed limit of 100km/h applies to this road for its entire length. The trip meter was started at the intersection with RM Williams Way.

5.2.1 Crash History



There were three crashes along this section of the Goyder Highway between 2010 and 2014. One of which happened in 2010 was a serious injury – roll over crash. The other two crashes were in 2014, one of which was also a serious injury - hit fixed object crash and the other was a minor injury – side swipe crash.

The estimated economic cost of crashes along the Goyder highway between RM Williams Way and the Horrocks Highway from 2010 to 2014 is \$692,330. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 13 - Cost of Crashes Horrocks Highway to RM Williams Way (2014 Values), 2010-2014

Crash Severity	Cost per Crash¹¹	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	1	\$12,330
Minor Injury	\$18,174	0	\$0
Serious Injury	\$340,000	2	\$680,000
Fatal	\$7,200,000	0	\$0

5.2.2 Geometry

On the eastern end, the road width was measured after travelling a distance of 2.70km. The widths were 3.3m lanes with no sealed shoulders. The unsealed shoulder was between 1.8m and 2.0m. These lane widths, the lack of sealed shoulder and a winding road environment made the road feel inadequate for the posted speed even although the posted speed was achievable. Further along the road at 13.91km there was an increase in width to provide for sealed shoulders. The lane widths remained at 3.3m but on top of that a 0.5m of sealed shoulder was added. This small increase to the sealed surface made a huge difference in driver comfort and confidence. The entire length of this road should be upgraded become consistent with these measurements. A seal extension on the eastern end of the road to match the 3.3m lanes and 0.5m sealed shoulders is recommended.

5.2.3 Pavement

Overall, the road surface was considered to be fairly poor for this short section of the Goyder Highway. The first issue encountered was the substantial rutting which was most significant in the first 5km of the drive. At the time of the assessment, water was pooling in the ruts. Not only can this affect the steering of vehicles but it also poses a risk to aquaplaning of vehicles in wet weather.

Bitumen bleeding and cracking were also common along this road, especially on the eastern end in the same locations as the major sections of rutting.

¹¹ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

Edge drop from the sealed surface down to the unsealed surface was noted consistently along this road especially at 11.8km with drops of over 100mm. Further sections of less significant edge drop were noted all along and only a few areas with complete respite.

There were many small sections of repairs and patching to the road surface where it appeared that sections of severe rutting, cracking and bleeding had been repaired. In many of these locations the road was beginning to break up again. This was especially the case on the crest of a hill at 3.22km.

The ride quality produced by this road was average at best. The ruts on the surface, coupled with the old repair work patches and generally undulating surface provided a bumpy and uncomfortable ride. The only saving grace is the western end which appeared to have received a complete reseal in the more recent past. The photo below shows evidence of rutting bleeding and patches on the road surface which results in poor ride quality.



5.2.4 Line Marking, Signs and Delineation

During the assessment the quality of the line marking was showing some signs of wear but still provided an adequate contrast with the sealed surface. It was noted that the hazard marker posts that are used could be increased in frequency on a number of bends to allow better delineation at night or in wet weather.

As discussed in the geometry section, most of this road was lacking in sealed shoulders or edge lines, as a result there are no additional safety features such as audio tactile line markings. This road is also quite winding in nature and as such it would be recommended to include edge of carriageway lines, audio tactile line marking and retro

reflective pavement markers. These improvements would better delineate the road and reduce the chance of run off road crashes.

5.2.5 Roadside Hazards

Significant roadside drops are a major issue along this short section of road. While many of them are already protected with W beam barriers, there are still a number that are not protected and pose roll over threats. Occurring on the bends in the road, these drops range from 2-5m in depth and should be protected with W beam barriers. These drops were recorded at 4km, 4.2km, 5.8km, and 7km. This last area at 7km aligns with the coordinates of the roll over crash that occurred in 2010.

A number of significant trees within 2 to 5m of the seal were observed during the assessment. These also pose threats to run off road crashes and provide a good reason to increase the lane widths and provide an edge of carriageway line as additional runoff road deterrents.

5.2.6 Key Recommendations

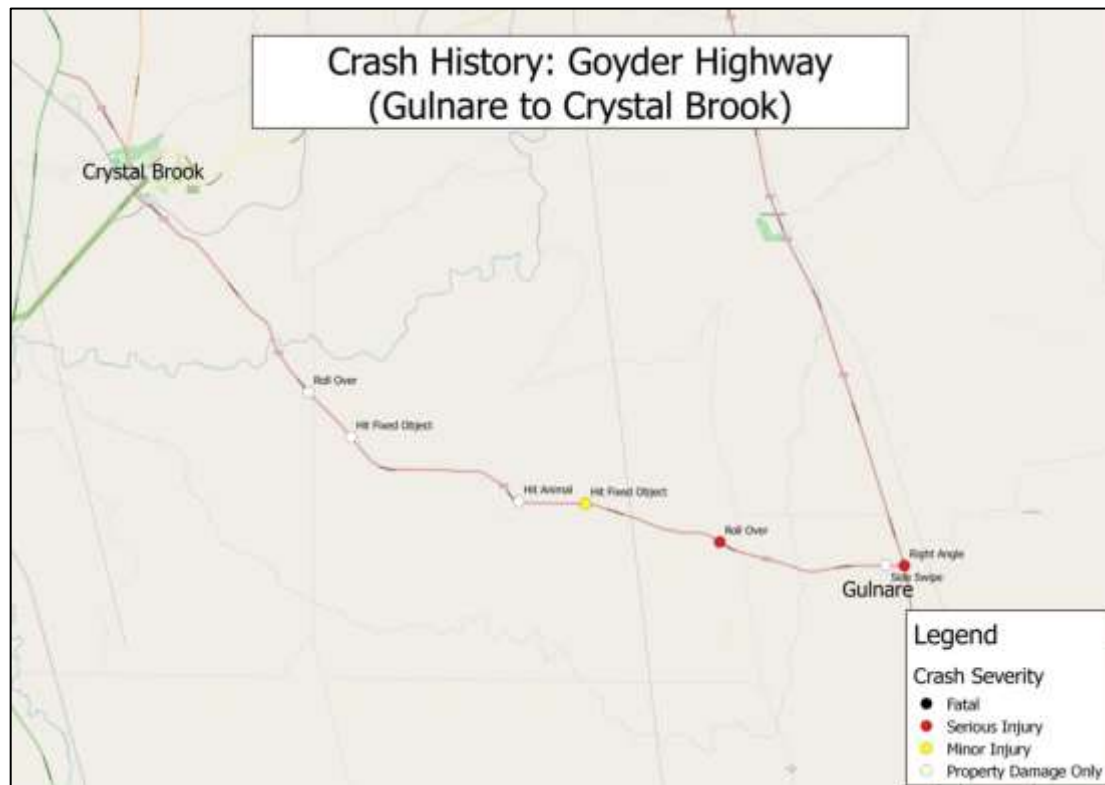
RAA recommend the following treatments for the Goyder Highway between Spalding and Gulnare:

- Increase the sealed shoulders to 0.5m for entire length.
- Repair of edge break and edge drop.
- Repairs to particularly poor sections of road surface.
- Increase the number of hazard marker posts on some bends.
- Protection of unprotected drops.

5.3 Gulnare to Crystal Brook

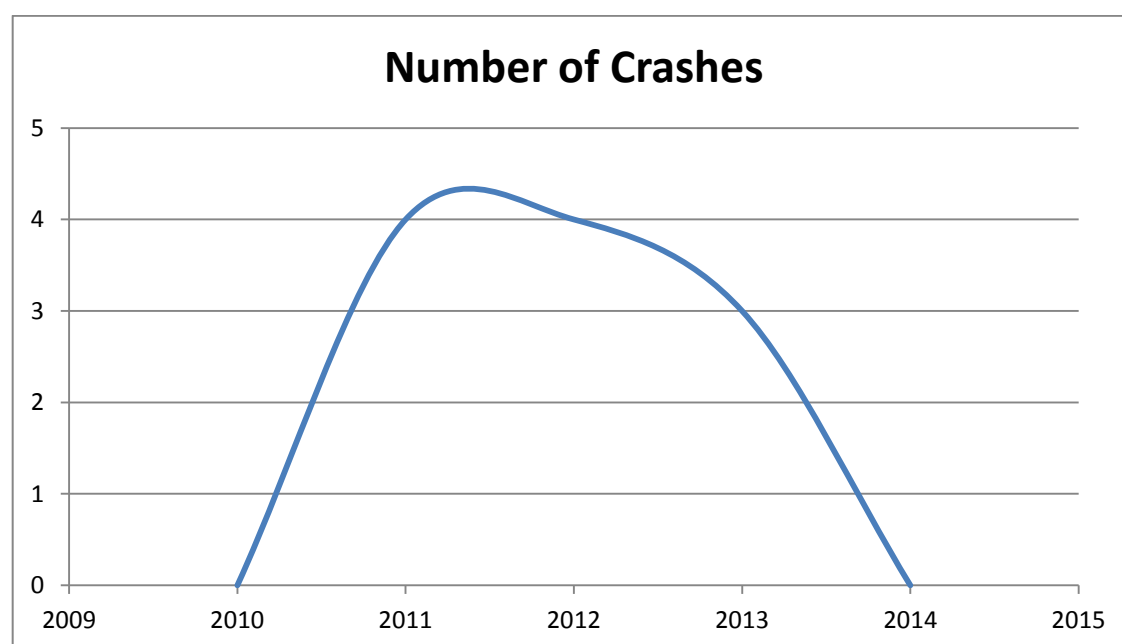
This is a quiet road with only 490 vehicles per day and a portion of this (17.5%) is made up of heavy vehicles. A speed limit of 110km/h applies to the entire length of the road. The trip meter was started on the intersection of the Goyder and Horrocks Highways. The total distance from the start of the trip meter to Crystal Brook is approximately 25.3km.

5.3.1 Crash History

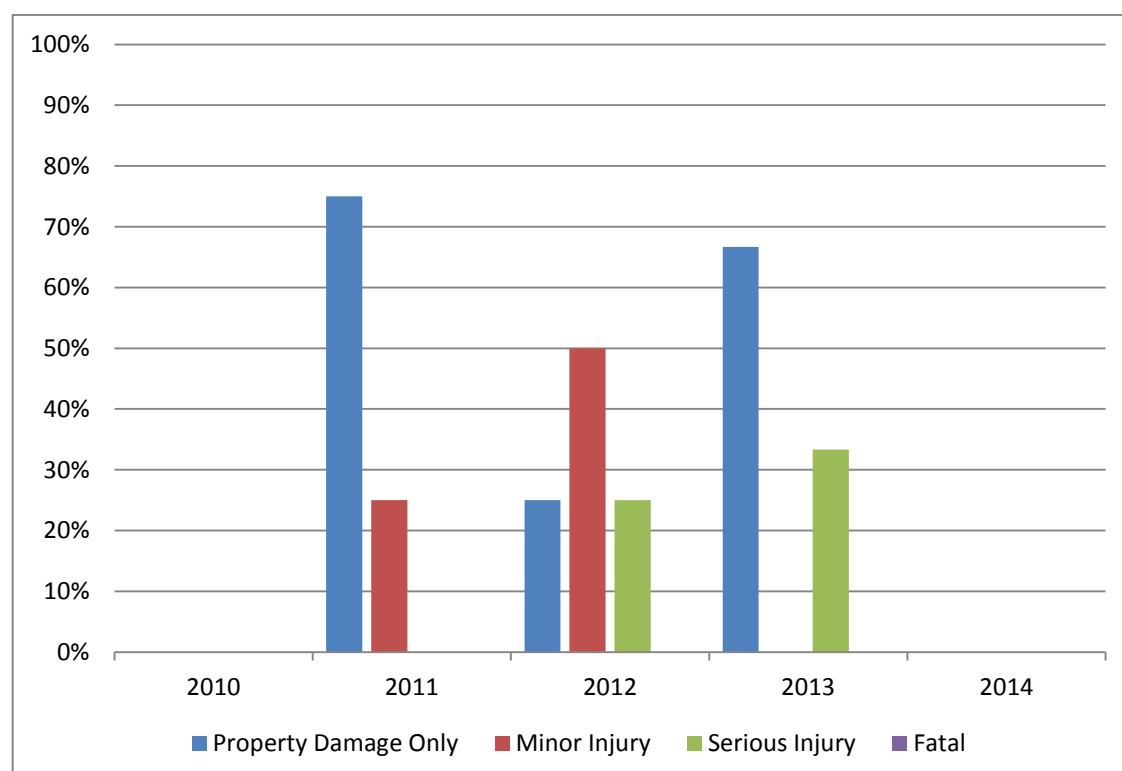


Interestingly there were no crashes on this section of road for both of 2010 and 2014. 2011 and 2012 had 4 crashes each and 2013 had 3. There was a variety of crash types which are listed below:

- Roll Over (3 crashes)
- Hit Fixed Object (2 crashes)
- Hit Object on Road (1 crash)
- Right Angle (1 crash)
- Side Swipe (1 crash)
- Hit Animal (1 crash)



The majority of crashes tend to be property damage only or minor injury crashes with a serious injury crash occurring each in 2012 and 2013. There were no fatalities in the 5 year period. The serious injury crashes were right angle and roll over type crashes.



The estimated economic cost of crashes along the Goyder highway between Gulnare and Crystal Brook from 2010 to 2014 is \$808,502. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 14 - Cost of Crashes Goyder Highway (Gulnare – Crystal Brook) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹²	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	6	\$73,980
Minor Injury	\$18,174	3	\$54,522
Serious Injury	\$340,000	2	\$680,000
Fatal	\$7,200,000	0	\$808,502

5.3.2 Geometry

Road widths varied somewhat on the Goyder Highway. 3.6m lanes were recorded 7km from Gulnare. Edge lines were also provided although they were accompanied by a sealed shoulder that varied in width, sometimes as little as only 50mm wide. Being a 110km/h speed limit on this road, the sealed shoulders should be extended to provide a minimum of 0.5m and desirable 1m of sealed shoulder each side. Unsealed shoulder was between 1.3 and 1.7m. These sealed shoulders narrowed mostly on sections closer to Port Pirie. The image below shows the typical road environment found while driving this road.



5.3.3 Pavement

Heading off from Gulnare, the first 6km of the road surface provided an acceptable ride quality. There were very few bumps ruts, cracks or defects noted, and the lane widths were felt quite wide, causing a comfortable ride. After 6km, the road deteriorated slightly with an increase in the number of bumps and also some patches of bitumen bleeding, specifically under the wheel paths. These persisted for a couple of kilometres before returning to the previous smooth state. At 9.5km, the bitumen bleeding returns but is more significant and causes the surface to become somewhat polished. Following on

¹² Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

from this there were some longitudinal cracks and ruts, although not hugely significant. There are a further two sections of severe bitumen bleeding at 17-22km that would benefit from repairs. The remainder of the road surface was somewhat bumpy.

5.3.4 Line Marking, Signs and Delineation

Line marking was very good for the road between Gulnare and Crystal Brook. The lines appeared to be fairly recently painted and provided a good contrast to the road surface. Other improvements could include retro reflective pavement markings and audio tactile line markings which will help to delineate the road during night time and reduce fatigue related crashes.

5.3.5 Roadside Hazards

Beginning at Gulnare, there are some small drainage ditches on the roadside that could be hazardous for run off road crashes, there are also a number of bridges and culverts along the journey, but they are already protected by W-beam crash barriers. At 3km there were some significant trees set back 3 to 5 m. Further at 9km there were additional patches of significant trees in close proximity to the road. The worst of these and also a deep drainage ditch were protected with a W-beam barrier. At 15km the foliage in the area grows increasingly dense and is a wildlife visibility hazard. Two unprotected drops at 13.1km and 14.5km should be considered for barrier protection as they are a roll over hazard and occur on the outside of bends in the road.

5.3.6 Key Recommendations

RAA recommend the following treatments for the Goyder Highway between Spalding and Gulnare:

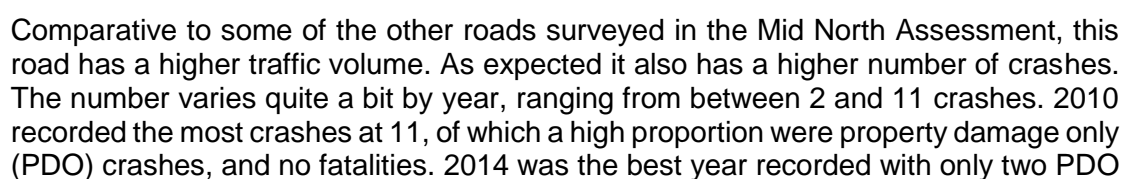
- Shoulder widening to minimum 0.5m (desired 1.0m).
- Repair bleeding surface at most severe locations.
- Install RRPM's and ATLM.
- Protection for unprotected roadside drops.

6 B89 Spencer Highway

6.1 Port Pirie to Port Broughton

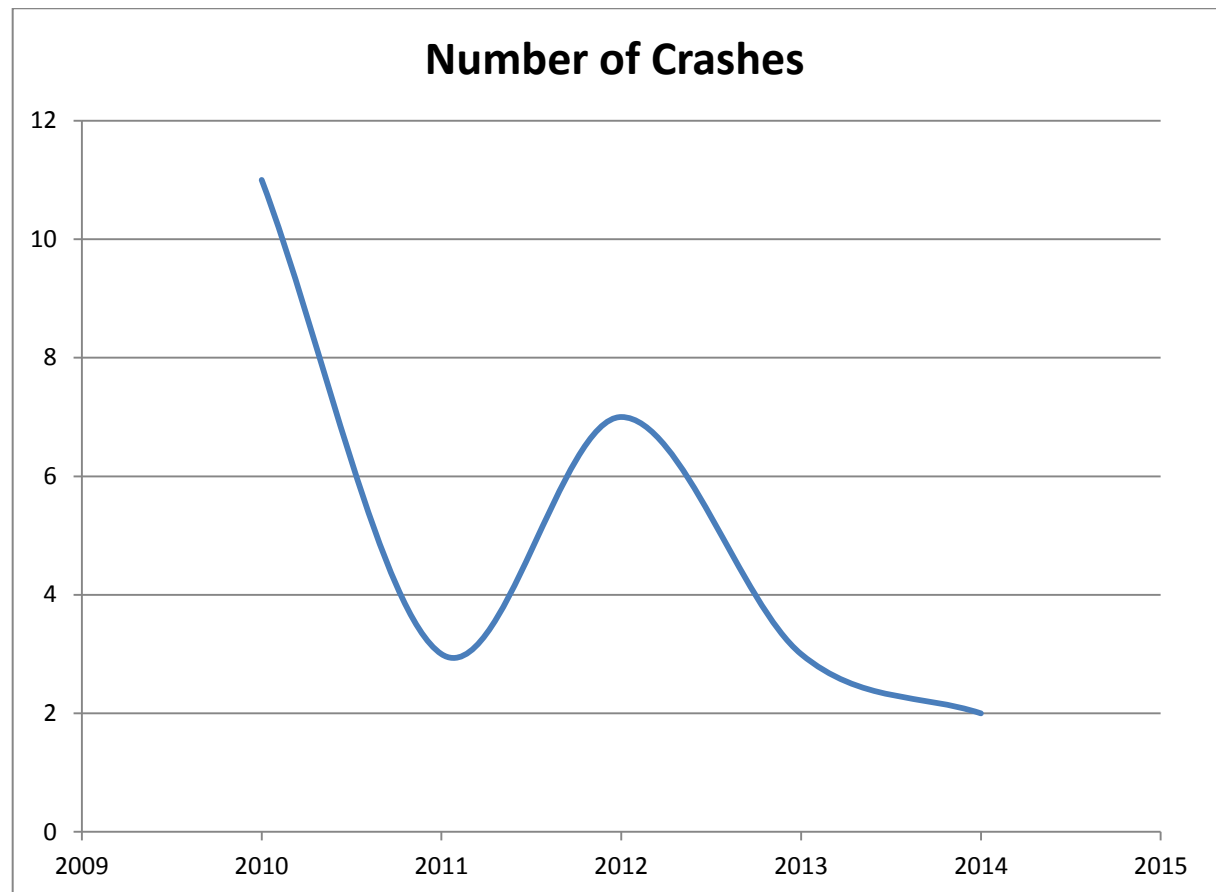
Between 800 and 1000 vehicles use this road daily. The traffic is made up mainly by small vehicles, and heavy vehicles only account for a small portion (8.5%). The speed limit for this section of road is 110km/h. The trip meter was started at the intersection of Wandearah Road.

Crash History: Spencer Highway (Port Pirie to Port Broughton)

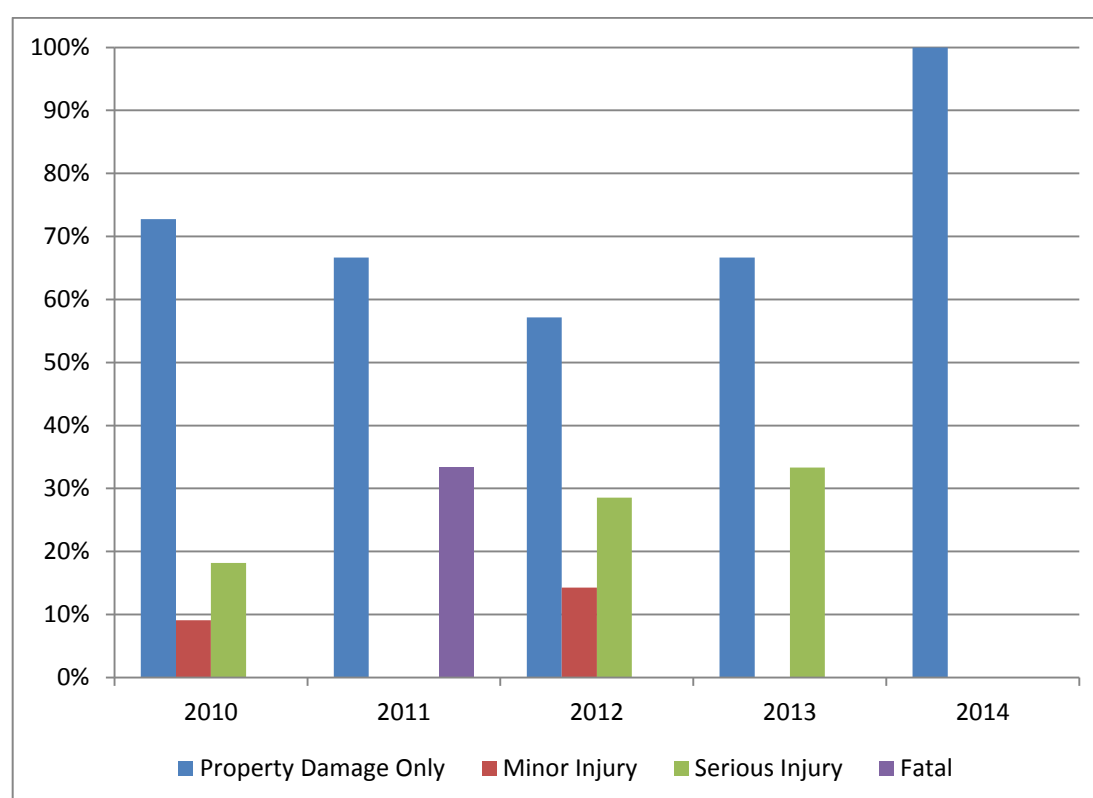


crashes. A fatal head on crash occurred in 2011. A number of serious injuries were recorded throughout the 5 year period. All of which are run off road incidents such as:

- Roll overs (3 crashes)
- Hit fixed objects (1 crash)
- Left road out of control (1 crash)



A high proportion of the crashes reported have been property damage only crashes. The following table breaks down the percentage of crash severity for each year in the 5 year period.



The estimated economic cost of crashes along the Spencer highway between Port Pirie to Port Broughton from 2010 to 2014 is \$9,158,288. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

**Table 15 - Cost of Crashes Spencer Highway (Port Pirie – Port Broughton)
(2014 Values), 2010-2014**

Crash Severity	Cost per Crash ¹³	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	18	\$221,940
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	5	\$1,700,000
Fatal	\$7,200,000	1	\$7,200,000

6.1.2 Geometry

There were no edge lines or sealed shoulders provided for the first 34.26km of the trip. Prior to this the lane widths were approximately 2.9-3.1m and highly varying due to the edge break. At 34.26km the road was widened and edge lines, along with a sealed shoulder of nearly 1m. From there on in, the edge break was significantly less

¹³ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

prominent, likely due to the fact that vehicles are not as often hitting the edge of the seal. It is highly recommended that the entire stretch of road is widened to be consistent with the southern area because of the huge safety benefits in preventing run off road crashes. Edge of seal repairs will be an ongoing expense until this is achieved.



6.1.3 Pavement

Between Port Pirie and Port Broughton the pavement varies significantly in terms of pavement width and surface conditions. The most significant issue again is edge break, which is common along the entire length of this road but especially the northern end. The edge break is commonly seen with drops to the unsealed surface of up to 100mm, which poses threats to run off road incidents and tyre side blowouts. On the northern end, sections of pavement rutting and bitumen bleeding were also encountered, but while not considered serious at this stage, should continue to be monitored. The road undergoes a number of changes in the pavement, each bringing slight changes to the ride quality and surface. Some sections are quite bumpy particularly between 40 and 47.5km before it improves following another change in surface at 47.5km.



6.1.4 Line Marking, Signs and Delineation

The line marking was good quality for the entire length of road and provided strong contrast against all of the different road surfaces. Other safety features which were not provided, like audio tactile line marking and RRPM's would be of benefit in reducing fatigue related crashes and enhancing night time visibility.

6.1.5 Roadside Hazards

Power lines set back approximately 3 to 5m from the road were the first of the roadside hazards identified during the assessment. These were only a hazard for 6.7km as they soon moved further away from the roadside. There were minimal roadside hazards until 21km, where there were significant amounts of foliage within 3m of the seal. Not only do these trees and shrubs pose a threat to run off road incidents, but also block visibility of wildlife that may jump out in front of vehicles. At 29.8km, and 30.0km there were significant roadside drops of up to 3m on both sides of the road. Further on at 30.6km, there was an increase in foliage and also an accompanying warning sign for kangaroos which implies that wildlife is a roadside hazard. On the final 20km of road it was noted that W-beam barrier protection was provided on all major roadside drops, a culvert and even some significant trees on the roadside.

6.1.6 Key Recommendations

RAA recommend the following treatments for the Spencer Highway:

- Widening of sealed shoulders and implementation of edge lines on northern section.

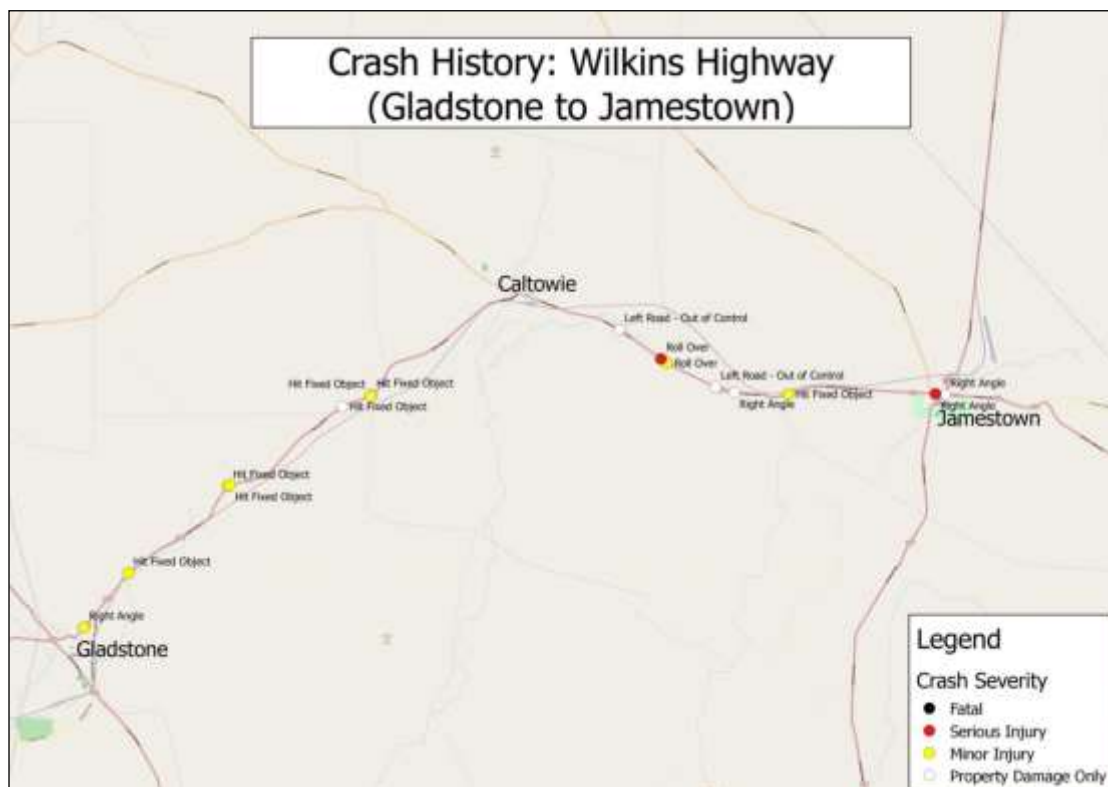
- Repair of severe edge break and edge drop.
- Audio tactile line marking.
- Protection for unprotected roadside drops.

7 B79 Wilkins Highway

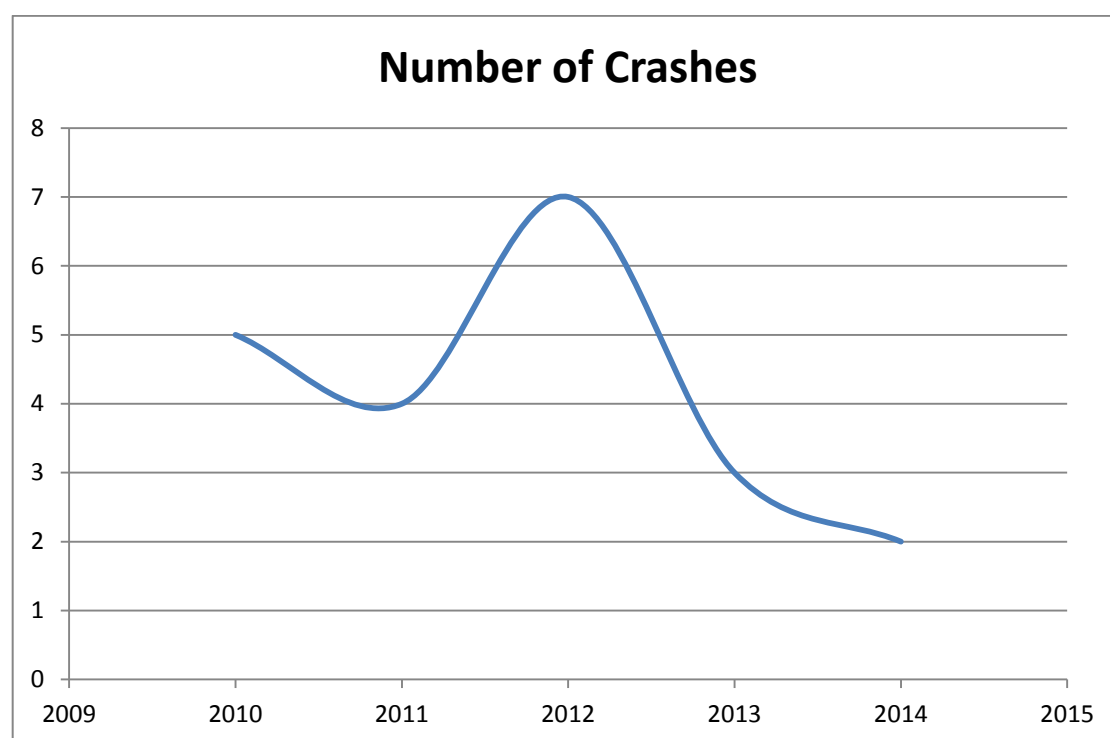
7.1 Gladstone to Jamestown

On the western end near Gladstone, traffic volume data shows 700 vehicles use this road daily with 20% heavy vehicles. Because of various minor roads this increases to a total of 1100 vehicles on the eastern end near Jamestown. The speed limit from Gladstone to Jamestown is 110km/h. The trip meter commenced at the intersection of the Horrocks and Wilkins Highways, and the total distance from there to Jamestown is 28km.

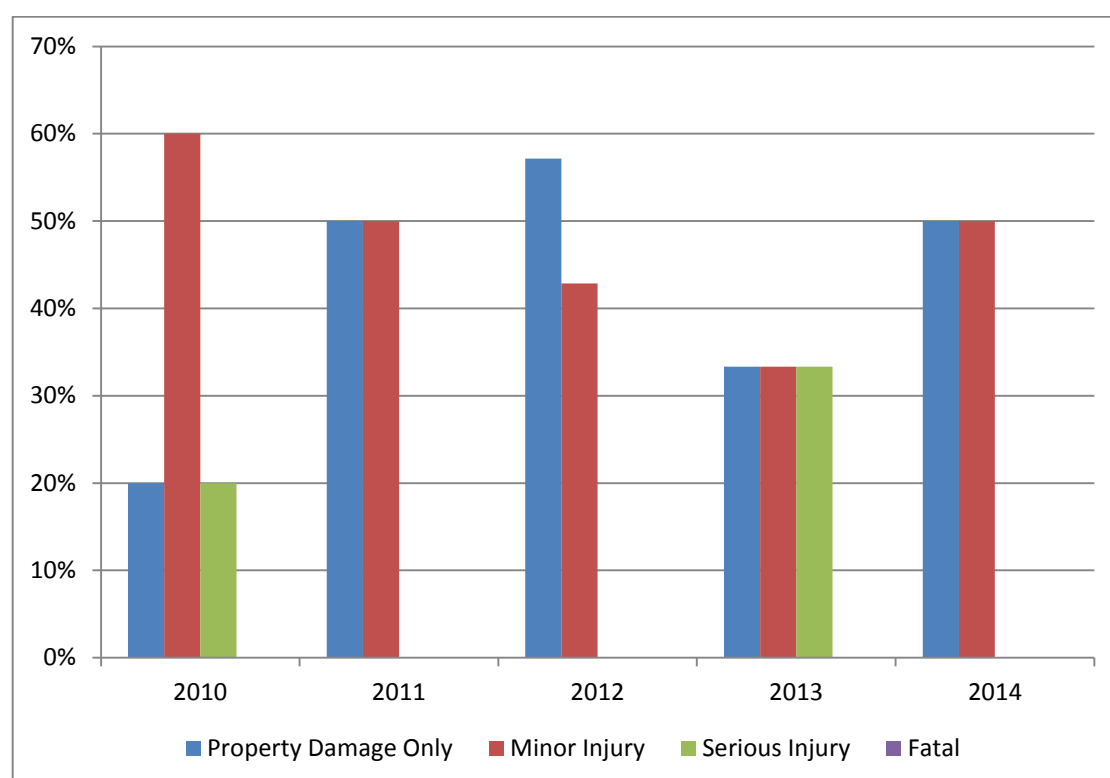
7.1.1 Crash History



Between 2 and 7 crashes occurred annually in the 5 year period between 2010 and 2014. 2012 had the highest number of recorded crashes at 7. Since then, 2013 and 2014 have significantly improved with only 3 and 2 crashes each.



When comparing with other roads in the mid north area, while there were no fatalities in the 5 year period there was a higher number of casualty crashes than many of the other roads. The graph below shows 80% of the crashes in 2010 were casualty crashes, along with 67% in 2013 and 50% in 2011 and 2014.



There were a high number of run off road crashes, specifically of the hit fixed object variety. Other run off road crashes such as left road – out of control were also common.

- Hit fixed object (4 crashes)
- Right angle (3 crashes)
- Hit animal (2 crashes)
- Roll over (2 crashes)
- Left road out of control (2 crashes)
- Rear end (1 crash)

The estimated economic cost of crashes on this section of Wilkins Highway from 2010 to 2014 is \$970,710. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 16 - Cost of Crashes Wilkins Highway (Gladstone – Jamestown) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹⁴	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	9	\$110,970
Minor Injury	\$18,174	10	\$181,740
Serious Injury	\$340,000	2	\$680,000
Fatal	\$7,200,000	0	\$0

7.1.2 Geometry

A road width recording took place at 19.35km and showed 3.2m lanes with sealed shoulders of 0.5m. The unsealed shoulder was between 2.6m and 2.9m. The entire road was not of this standard though, with many places having significantly less sealed shoulder width.

¹⁴ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.



7.1.3 Pavement

When driving from Gladstone to Jamestown, the pavement for the first 12 km starts in average condition with a medium to coarse texture and a few bumps resulting in average ride quality. Beyond 12 km there are sections of road with significant rutting which are a hazard and can cause aquaplaning in wet weather. Also present is substantial bitumen bleeding of the sealed surface, which is becoming polished and providing a very poor texture and friction for the car tyre. Further sections of patches and repairs are scattered all along. Some of these repairs appear to have taken place quite a while ago, and the road is again bleeding or rutting through the repaired surface. The road repairs cause the road to be very bumpy and uncomfortable to ride on. These extremely poor sections of road should be repaired. The worst areas marked were: 12 - 14km and 22.5 - 23.6km which were measured using a trip meter from the roundabout in Gladstone. Isolated sections of edge break along with a drop to the unsealed surface should be repaired at approximately 21.85km.

7.1.4 Line Marking, Signs and Delineation

The line marking along this section of road appeared to have been refreshed sometime recently. Signage was standard with no issues identified. Hazard marker posts were used along the roadside to assist in night time delineation, and were increased in frequency around bends or when hazards were present, such as a culvert. There were no additional features such as retro reflective pavement markers or audio tactile line marking.

7.1.5 Roadside Hazards

Foliage in the area generally consisted of small to medium sized shrubs and trees which were set back 3 or 4m from the road. These were noted to be smaller at the Gladstone end and some more significant trees were noted on the Jamestown end. There were a few unprotected drops to the roadside which pose a risk of roll over crashes. Located at 5.6km and 11.4km on the outside of the bends, these roadside drops would benefit from W beam barrier protection or a seal extension coupled with a short strip of audio tactile line marking. This will help to minimise the chance of leaving the sealed surface and assisting drivers to recover the car in instances of inattention or driver distraction.

7.1.6 Key Recommendations

RAA recommend the following treatments for the Wilkins Highway:

- Shoulder widening to minimum 0.5m.
- Repairs to sealed surface on worst affected areas.
- Protection for unprotected roadside drops.

8 B80 RM Williams Way

RM Williams Way is 188km long and runs in a north-south direction between the B82 south of Hawker and Spalding. Traffic volumes vary between 240 and 700 vehicles per day, around 12.5% of which is heavy traffic. The assessment along the highway was conducted over 3 stages which included:

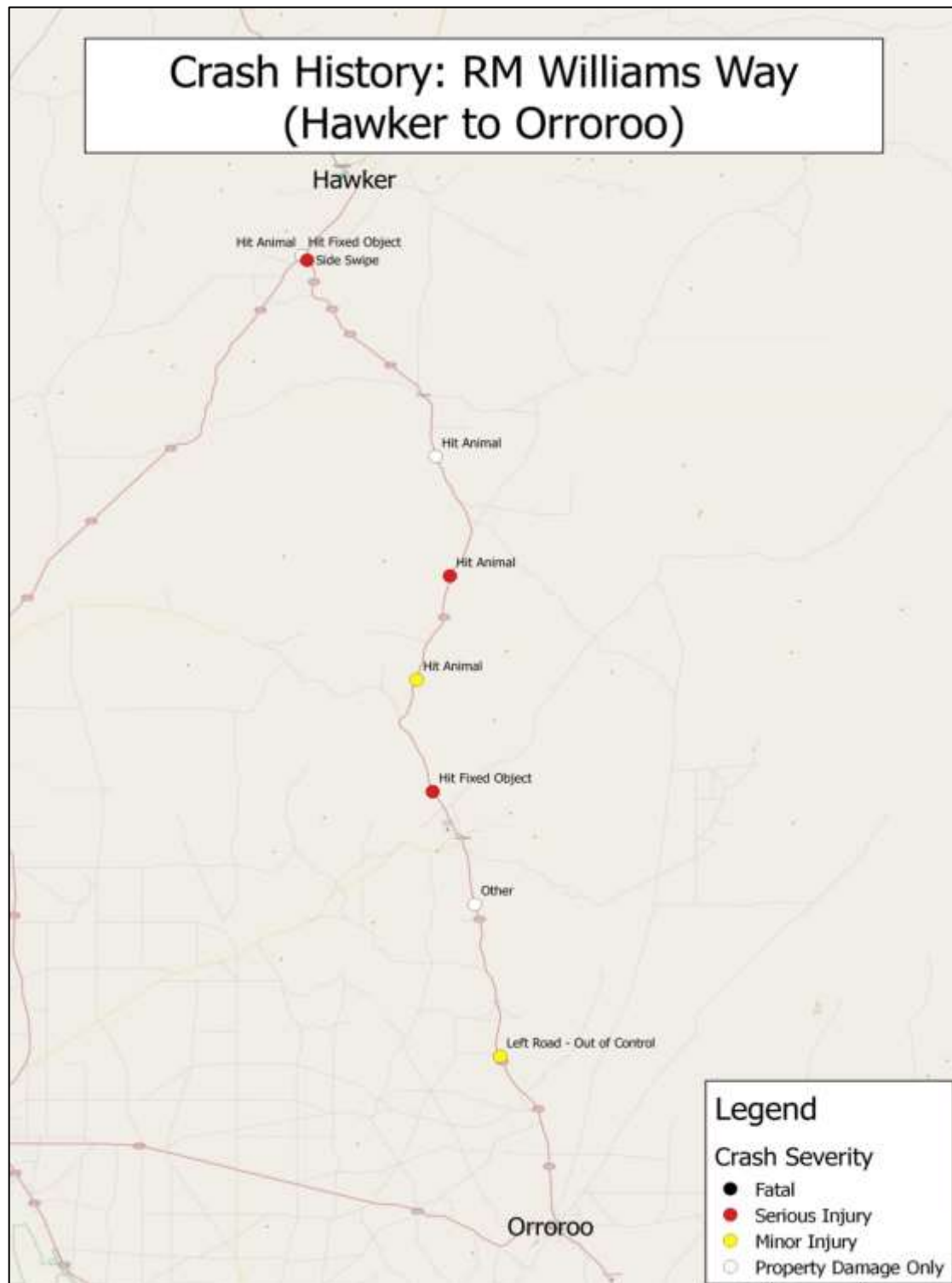
- Hawker to Orroroo;
- Spalding to Clare; and
- Jamestown to Spalding

8.1 Hawker to Orroroo

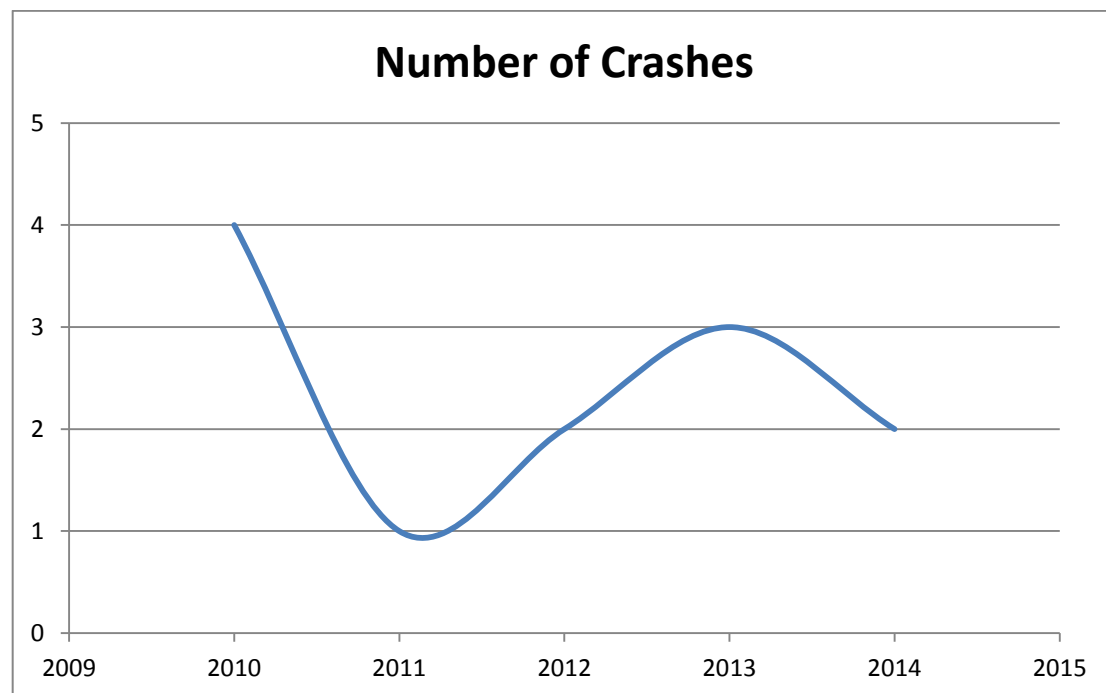
The section of RM Williams Way between Hawker and Orroroo is 108km long. There are between 210 and 270 vehicles per day along this section with heavy vehicles representing an average of 23% of the total traffic volume. The speed limit along this section is 100km/h.

The assessment was conducted in the southbound direction and the trip meter was set at the intersection of the B80 and B83.

8.1.1 Crash History



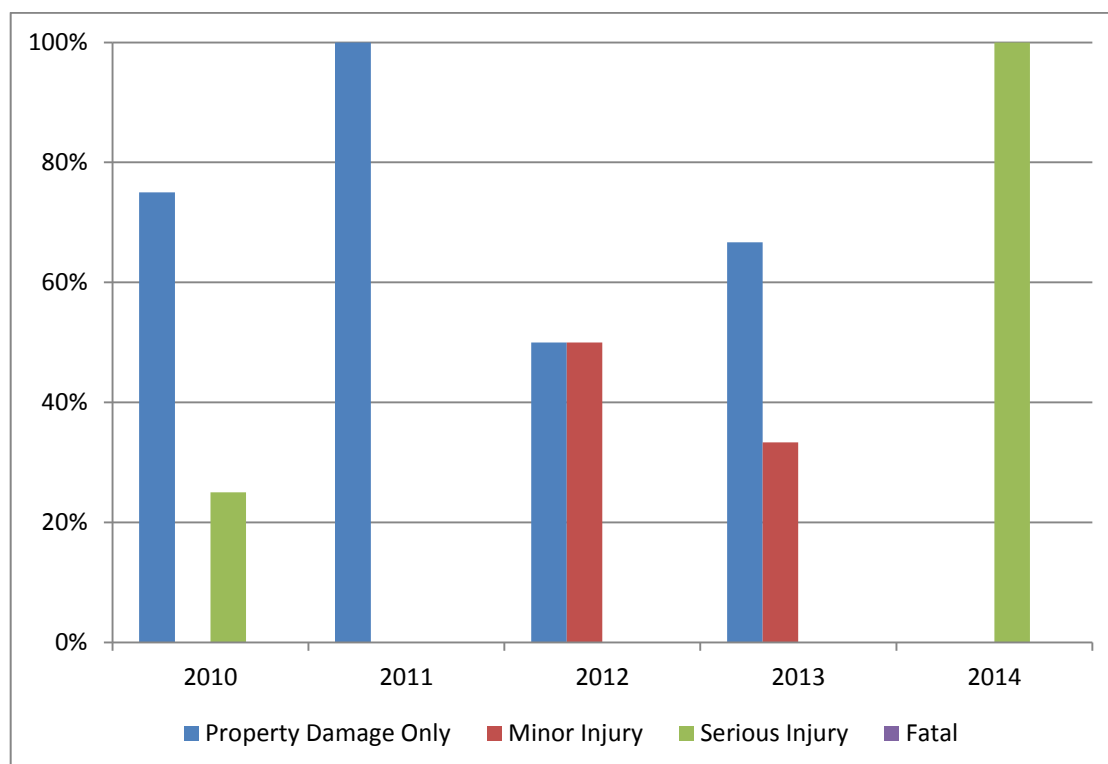
A total of 12 crashes occurred within the 5 year period. The graph below shows the number of crashes for each year.



Hit animal crashes are common along this section of road and attribute to 50% of all crashes reported. The high percentage of hit animal crashes indicates that action should be taken to better warn drivers of this hazard. The remaining crash types tend to be run off road type crashes.

- Hit animal (6 crashes)
- Hit fixed object (3 crashes)
- Left road – out of control (1 crash)
- Other (1 crash)
- Side swipe (1 crash)

Again, a high proportion of all crashes are property damage only crashes. There have been a small number of both minor injuries and serious injuries, but no fatalities within the 5 years. The graph below shows the percentage of crash severity for each year.



The estimated economic cost of crashes on this section of road in the five year period is \$1,142,658. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 17 - Cost of Crashes On RM Williams Way between Hawker and Orroroo (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹⁵	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	7	\$86,310
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	3	\$1,020,000
Fatal	\$7,200,000	0	\$0

8.1.2 Geometry

Between the intersection of the B80 and B82, south east of Hawker and Cradock, lanes widths were measured at between 3.5 and 3.6m with a 300 to 500mm sealed shoulder and a 1.4m to 1.6m unsealed shoulder.

¹⁵ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

Following Craddock, lane widths reduced to between 3 and 3.1m with a 300mm sealed shoulder however 2m sealed shoulders were provided on bends. While the extra seal provided on bends is a positive step to reduce run-off road crashes, the traffic lane widths are considered narrow for the class of road.

North of Carrieton, measurements showed the lane widths were between 3.5 and 3.6m with a 300mm sealed shoulder and 2m unsealed shoulder.

From Carrieton to Orroroo, the cross section remained consistent with lane widths of between 3.1 and 3.2m but the width of the sealed shoulder varied between 100 and 300mm.

RAA recommend that seal extensions are undertaken on RM Williams Way to provide a minimum lane width of 3.2m and a minimum sealed shoulder of 500mm between Hawker to Orroroo.

8.1.3 Pavement

The pavement along RM Williams way provides a coarse texture that should provide good surface drainage and enhance skid resistance.

The presence of edge break was noted throughout RM Williams Way with attempts made to repair the damage. Between Carrieton and Orroroo, drops from the asphalt of between 50 and 60mm were estimated. It is recommended that the edge drop is repaired along that section either through seal extension or shoulder grading since drops of over 50mm can make vehicle recovery onto the pavement difficult.



Rutting was noted in many areas along the B82. Between Craddock and Carrieton, minor rutting was observed but from Carrieton to Orroroo, the rutting was notably worse, with water ponding in some ruts. Bitumen bleeding was also observed but tended to coincide with the sections that had deeper rutting.

Despite the rutting, the ride quality overall was found to be good, offering a relatively smooth journey for motorists.

8.1.4 Signs & Line Marking

Between the B80 and Cradock, it was noted that a broken line had been relined but not directly over the previous markings. The first set should have been removed before the relining work was undertaken. It is recommended that the line marking is refreshed where worn and markings no longer required are completely removed.



The quality of the line marking was good between Cradock and Carrieton, having appeared to have recently been refreshed, and was highly visible in the conditions encountered.



By contrast, the line marking between Carrieton and Orroroo was badly faded and about 84km south of Carrieton, had almost completely faded away. Prior to Orroroo, the centreline marking appeared to have been recently refreshed but the edge lines had not been marked at the same time. It is therefore recommended that the line marking be refreshed along this section as a priority.

8.1.5 Roadside Hazards

The primary hazard identified along RM Williams Way was steep embankments at the side of the road which could have the potential to cause a roll over crash if a vehicle were to run off the road. In most cases, the drops were estimated to be about 2m, with occasional drops of between 3 to 4m. Some drops were noted on the outside of bends, including a drop of between 5 to 6m and these should be prioritised for barrier treatment.

Between Cradock and Carrieton, the assessment noted skid marks on a bend which indicated that a motorist had travelled straight and crossed the lane of opposing traffic. RAA recommend that ATLM is used on bends to reduce the risk of run-off road crashes and would suggest the delineation could be improved on some of the bends travelled.

8.1.6 Key Recommendations

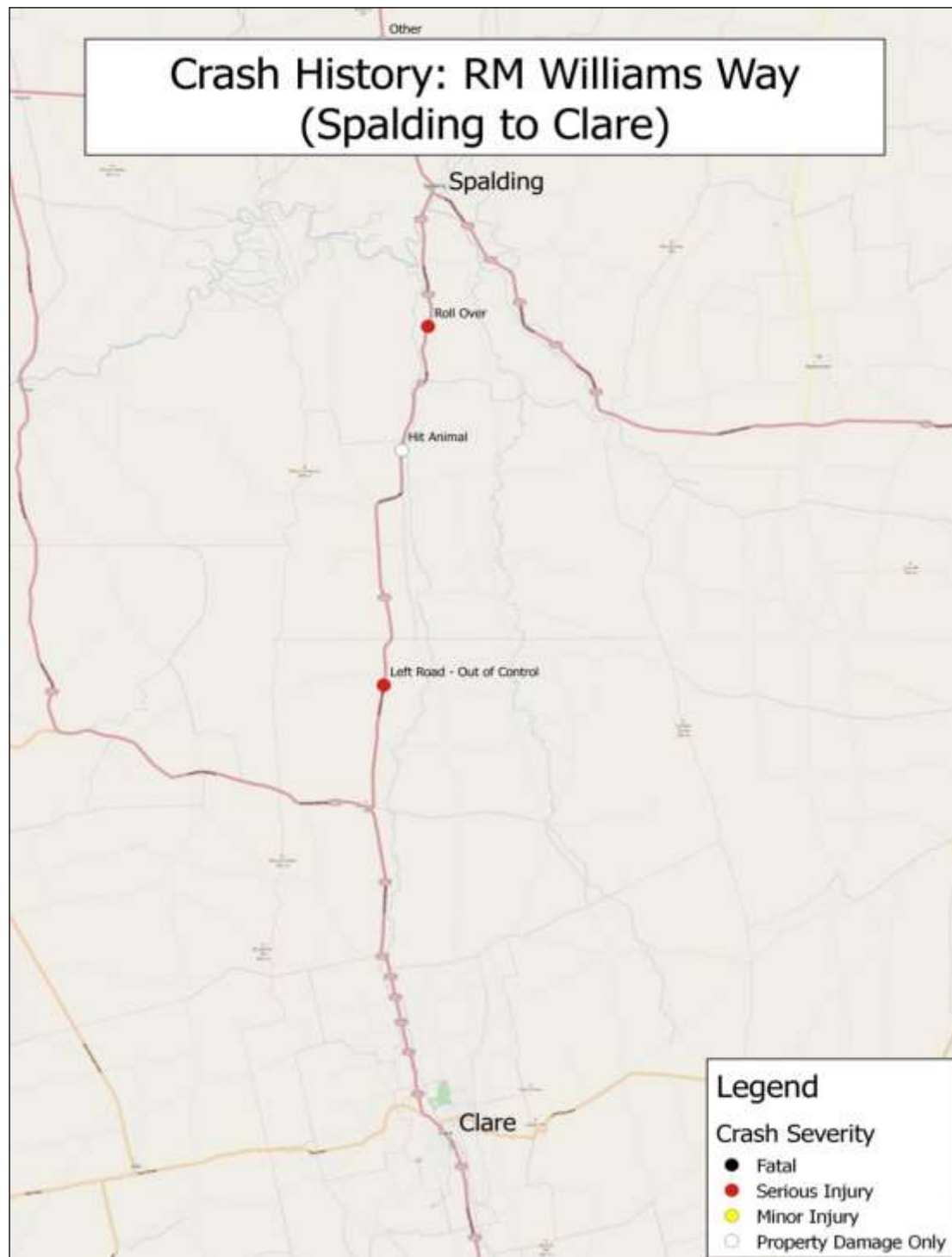
RAA recommend the following treatments for the section between Hawker and Orroroo:

- Extend seal to provide minimum 3.2m lanes
- Extend seal to provide minimum 500mm sealed shoulders.
- Repair edge break / edge drop
- Undertake rut filling program
- Remove abandoned line marking
- Refresh worn line marking
- Install ATLM on bends
- Install barrier protection for steep drops at the roadside

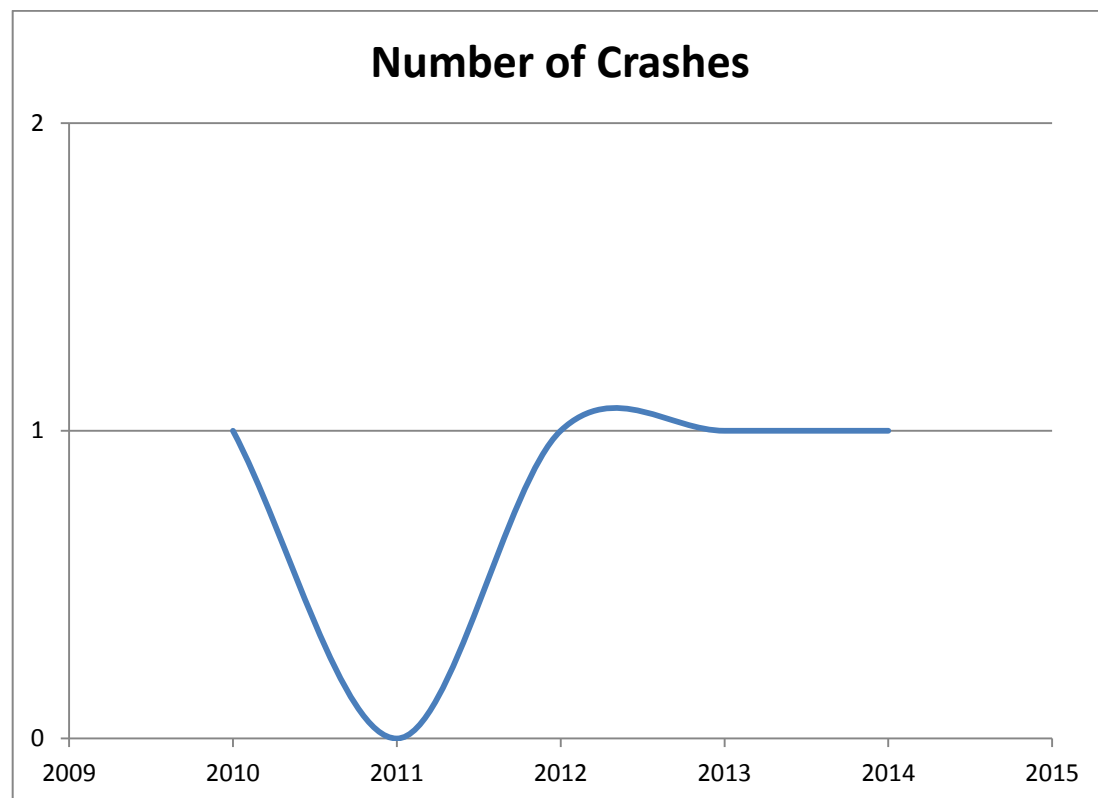
8.2 Spalding to Clare

The section of RM Williams Way between Spalding and Clare is 39km long and was driven from Spalding south to Clare. It carries up to 700 vehicles per day, approximately 15% of which are heavy vehicles. The speed limit is 100km/h. It is understood that state government has committed to funding 6km of road rehabilitation and widening which will address some of the surface and lane width issues on this road. The trip meter was started at the intersection of Government Road and RM Williams Way.

8.2.1 Crash History

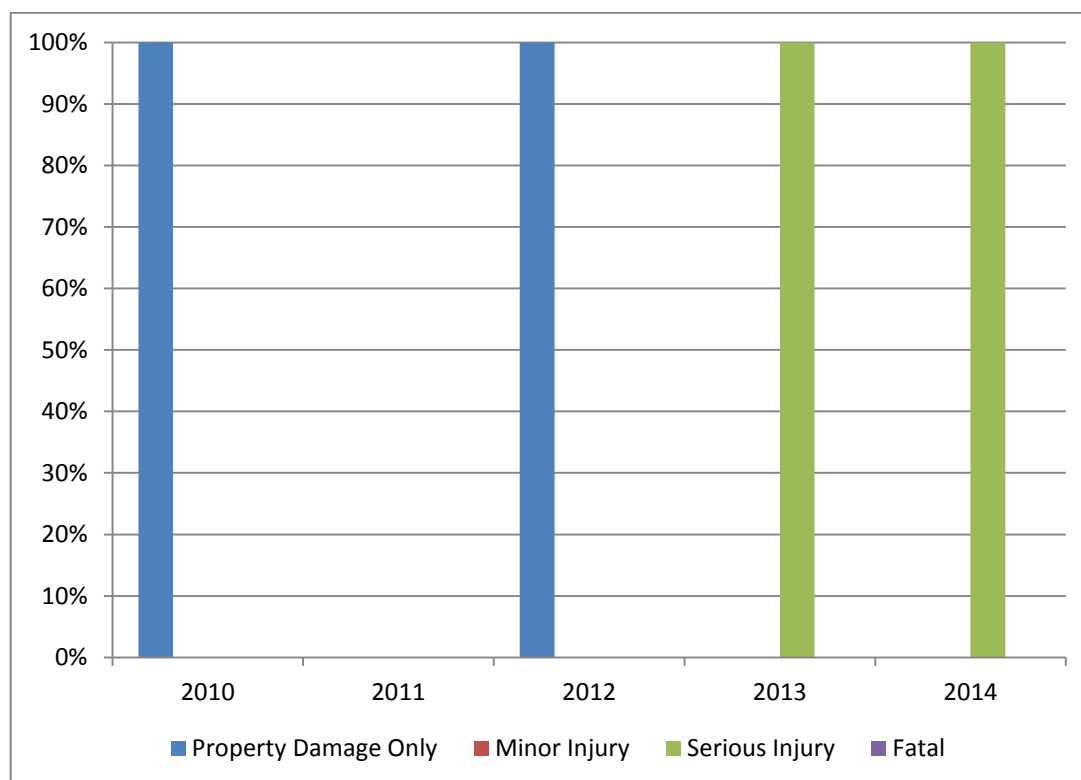


There were a low number of crashes in the 5 year period between 2010 and 2014. One crash was recorded per year with the exception of 2011, when no crashes were recorded



2010 and 2014 saw one roll over crash each, one of which resulted in a serious injury and one was property damage only. 2012 and 2013 saw a hit animal crash and a serious injury left road – out of control crash.

Of the low number of crashes on this road, 50% were property damage only and 50% were serious injury crashes. This high percentage of serious injury crashes implies that while crashes don't occur that often, if they do occur, the consequence is high. As such, road hazards should be addressed to ensure crashes are less likely and more forgiving in the event that a crash is inevitable. The following graph shows the breakdown of crash severity by year.



The estimated economic cost of crashes on this section of RM Williams Way from 2010 to 2014 is \$704,660. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 18 - Cost of Crashes RM Williams Way (Spalding – Clare) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹⁶	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	2	\$24,660
Minor Injury	\$18,174	0	\$0
Serious Injury	\$340,000	2	\$680,000
Fatal	\$7,200,000	0	\$0

8.2.2 Geometry

The northern section of this road exhibited extremely narrow lanes of between 2.7 to 2.9m and no edge line or sealed shoulder was provided. Traveling along this section was very uncomfortable and potentially dangerous, especially when passing larger vehicles in the opposite direction. There were multiple occasions when the passenger

¹⁶ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

tyres hit the edge of the unsealed shoulder when traversing the bend or passing. Further south another recording was taken which showed 3.3m lanes and sealed shoulders of between 1.0m and 1.3m. The unsealed shoulder was between 1.1m and 1.4m.

8.2.3 Pavement

This road was considered among the poorest in terms of its pavement quality, especially on the northern part several kilometres from Spalding (2.51km – 8.4km). The road surface consisted of a bumpy, undulating ride surface which was caused by many old pot-hole repairs and new pot holes that are forming.

There was also some very severe edge break and edge drop, with evidence that it has been repaired sometime in the past but with poor results as it is breaking out again. Worst areas of edge break are located at 5.5km and 12.16km. The high recurrence of edge break in this location is likely related to the poor quality of sealed shoulder along with the narrow lanes that cause cars to hit the edge of seal often.



At 8.4km the road surface improved somewhat with what appeared to be a reseal that happened sometime in the past. With this the ride quality improved with less pot holes and patches, however at the same time the road showed signs of rutting and bleeding on the surface. Both of these issues persist for a further 15km and quite often water was observed pooling in the ruts which were often located on the passenger wheel path.

8.2.4 Line Marking, Signs and Delineation

No issues were noted about the quality of the line marking along this section of road as the line provided an adequate contrast to the road surface. This road would benefit from lane widening and the implementation of an edge line along with sealed shoulders.

8.2.5 Roadside Hazards

The roadside hazards on this road are particularly dangerous when they occur in the same location as the areas with narrow lane widths, edge break and edge drop.

During the time of the assessment it was evident that the unsealed shoulders were of poor quality material. The weather was wet and as a result the shoulders were becoming soft and muddy in some areas. It is recommended that the shoulders be reconstructed with a better quality material, especially where the road is narrow.

A number of hazardous drops to the roadside were noted at 5.5km. Numerous culverts under the road were also unprotected with anything but hazard markers at approximately 20.55km and 23.5km. All of these drops could be hazardous to run off road crashes and would benefit from extra protection.

8.2.6 Key Recommendations

RAA recommend the following treatments for RM Williams Way between Clare and Spalding:

- Land and shoulder widening to match the southern end (3.3m lanes 1.0m sealed shoulder).
- Repairs to edge break and edge drop on northern end.
- Repairs to pavement surface in worst affected areas.
- Shoulder reconstruction for poor quality muddy areas.
- Protection of unprotected roadside drops.

8.3 Jamestown to Spalding

The trip meter was started at the intersection of RM Williams Way and Wilkins Highway in Jamestown. From there the road is 34.2km to Spalding and the speed limit is set at 100km/h. Approximately 550 vehicles travel this road per day. Between 9 and 12% of these are heavy vehicles.

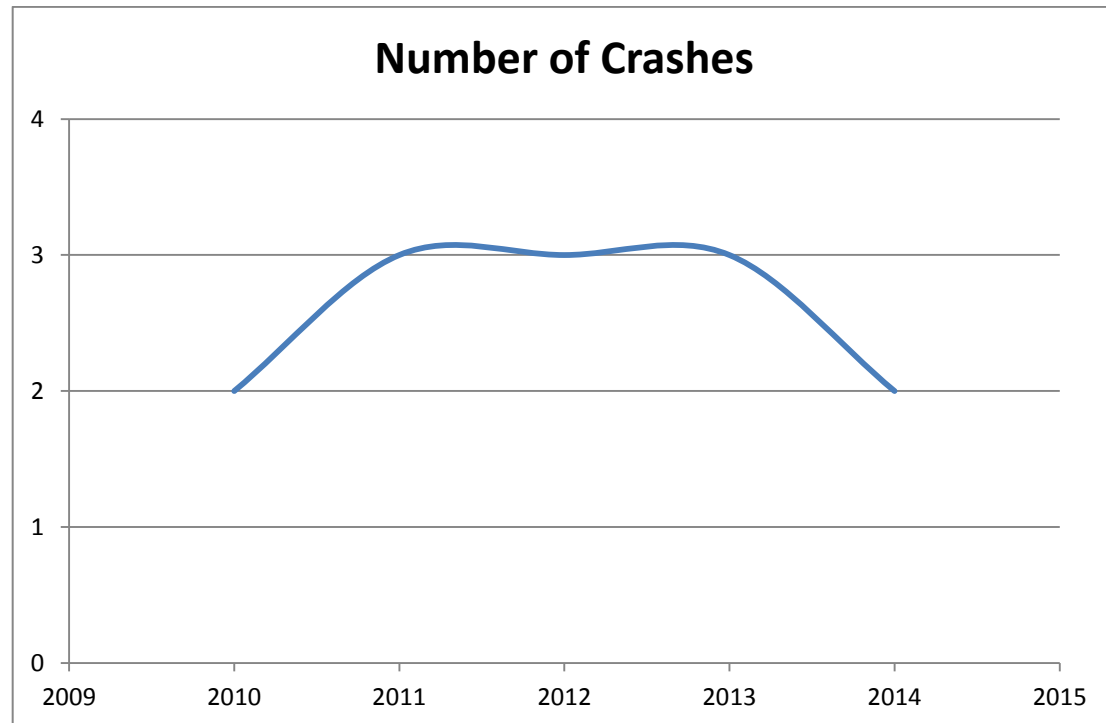
8.3.1 Crash History



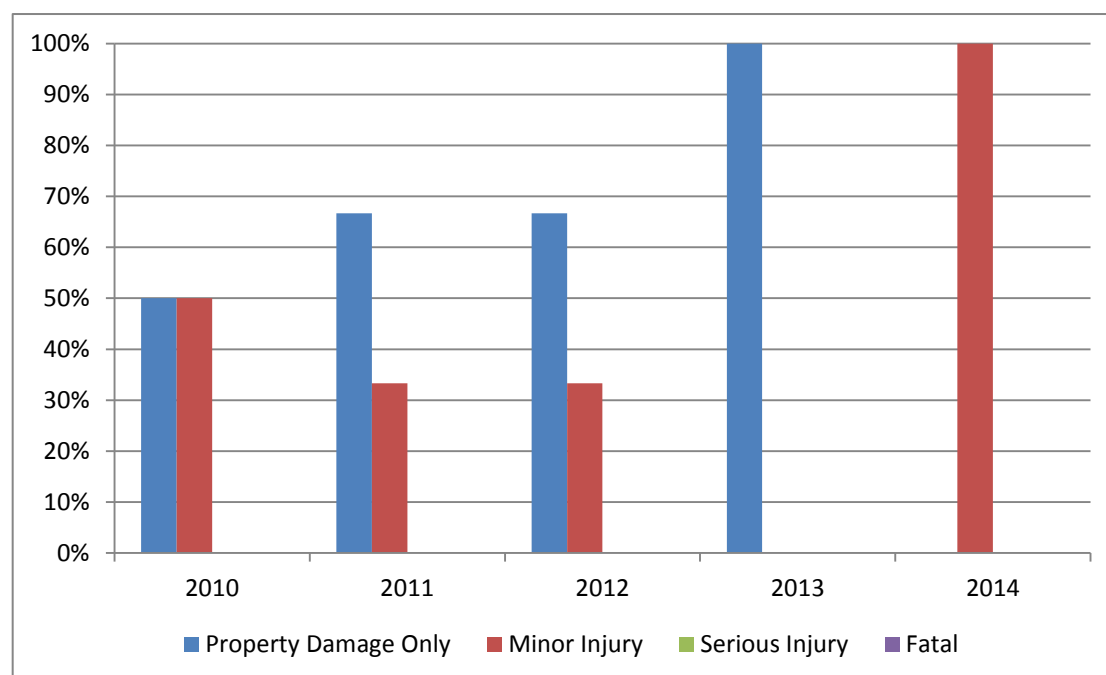
The crashes along this section of RM Williams Way have been quite consistent throughout the 5 year period. Between 2 and 3 crashes occurred annually, most of which were hit fixed object crashes of property damage only or minor injury consequence.

- Hit fixed object (8 crashes)
- Roll Over (2 crashes)

- Left road – out of control (2 crashes)
- Other (1 crash)



There was no recorded serious injury or fatal crashes in the 5 year period between 2010 and 2014. Depending on year, there was a mix of property damage only and minor injury crashes.



The estimated economic cost of crashes on this section of RM Williams Way from 2010 to 2014 is \$189,510. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 19 - Cost of Crashes RM Williams Way (Jamestown - Spalding) (2014 Values), 2010-2014

Crash Severity	Cost per Crash¹⁷	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	8	\$98,640
Minor Injury	\$18,174	5	\$90,870
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

8.3.2 Geometry

Along with the Spalding to Clare trip on R.M. Williams Way, this road displayed some of the narrowest lane widths out of all of the roads surveyed during the Mid North Assessment. The northern section of road measured approximately 3.1m lanes, with no edge line or sealed shoulders. Beyond this the unsealed shoulder was between 2.4m and 2.9m.

Further south the lanes narrowed to 2.9m, still without any edge line or sealed shoulder.

8.3.3 Pavement

The assessment identified a number of pavement defects along this section of road. The entire length of this road was particularly bad for ride quality as a result of many old patches and repairs to the road surface.

Significant rutting to the extent of water pooling in the ruts was commonly noted for nearly the entire length. The worst sections of rutting that should be addressed are located (measured from the intersection of RM Williams Way and the Wilkins Highway) 3km, 21km, and 28km.

The road was very bumpy on the whole, providing a poor ride quality, with only some sections of respite at 15.6km and 18.5km. The bumps were mainly caused by the significant rutting, bleeding, and cracking that appear to have been repaired in the past but are now failing again. Bitumen bleeding on the road surface was very significant along this stretch of road and was observed to be in locations where the rutting was more serious. The worst sections of bleeding in need of repairs were located at 3.5km, 12km, 15km, and 22-28km.

Edge break was again a significant problem between Jamestown and Spalding. Particularly in the middle area, further from both Jamestown and Spalding, the edge

¹⁷ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

break was accompanied by significant drops to the unsealed surface of up to 100mm. These are dangerous for run off road incidents and can cause tyre side blow outs or loss of control of the vehicle.

Unsealed shoulders were poor and appeared to be very muddy, indicating potential drainage issues or poor quality material. At the time of assessment, it was raining which caused the shoulders to be very slippery and muddy. There are many sections where the shoulder has quite an adverse cross fall, and then falls back in towards the road which causes water to pool on the roadside. This issue coupled with the material that the shoulder consists of results in a soft muddy surface. These areas and particularly at 8.72km, should be modified with drainage channels created to ensure that water is taken away from the roadside. The shoulders should also be graded with a proper crushed rock material added. This issue was less significant on the southern end near Spalding, where the material was of a higher quality and appeared to be better and more recently graded. The photo below shows a particularly muddy area.



8.3.4 Line Marking, Signs and Delineation

There were no complaints of line marking quality on this section of road. The centre line was quite fresh and provided a good contrast to the road surface. There was no edge lines provided, which was probably because the narrow lanes wouldn't allow enough space. Hazard marker posts were used regularly to help delineate the road during night driving. Signage was deemed adequate with no issues identified. This road being a heavy freight route would benefit greatly from increasing the lane widths and implementing an edge of carriageway line which will allow wide vehicles to more easily

pass. It is more than likely that the significant edge break and edge drop is because of the vehicles that have to partially leave the road surface to pass other wide vehicles. An increase to the width of the road would address this issue.

8.3.5 Roadside Hazards

Roadside hazards were considered to be less of an issue along this road due to the high number of issues identified on the road surface. The major issue on the roadside was the unsealed shoulder which was poorly maintained and of a poor quality material. Other roadside hazards included some significant trees located at 11.4km and were set back approximately 3m from the road.

8.3.6 Key Recommendations

RAA recommend the following treatments for RM Williams Way between Jamestown and Spalding:

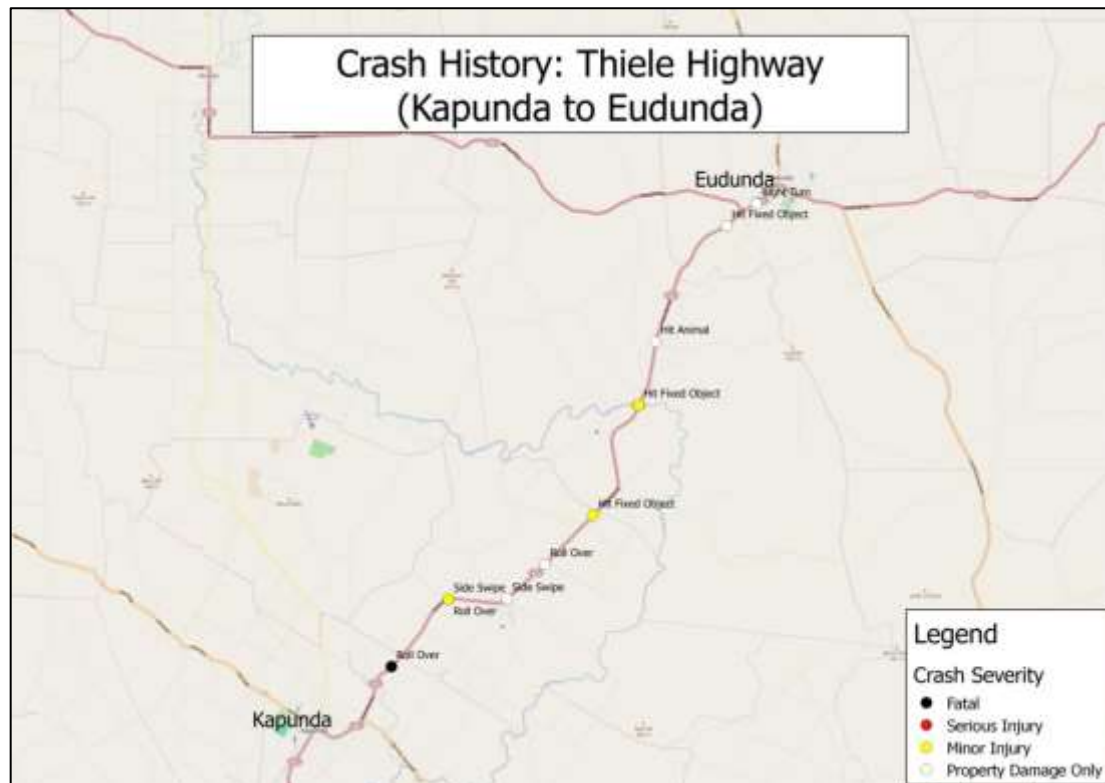
- Shoulder and lane widening
- Edge of carriageway lines
- Pavement rehabilitation for rutted areas.
- Repairs to the surface on severely bleeding areas.
- Repairs to edge break and edge drop.
- Shoulder reconstruction for poor quality muddy areas.

9 B81 Thiele Highway

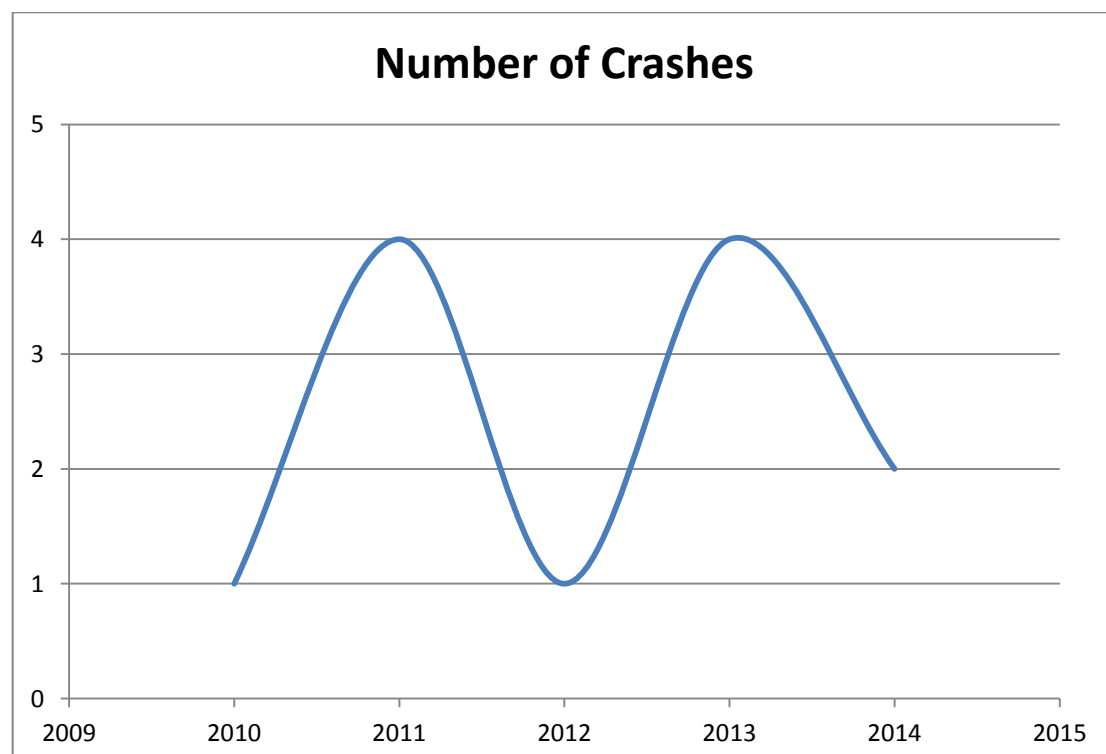
9.1 Eudunda to Kapunda

This road was driven from north to south, starting at Eudunda and travelling south to Kapunda. The total distance is 27.3km and has a speed limit of 110km/h. The trip meter was started at the intersection of Burra – Eudunda Road and Kapunda – Morgan Road. Traffic volumes are higher than the northern side of Eudunda, carrying 1200 vehicles per day, 12.5% of which are heavy vehicles.

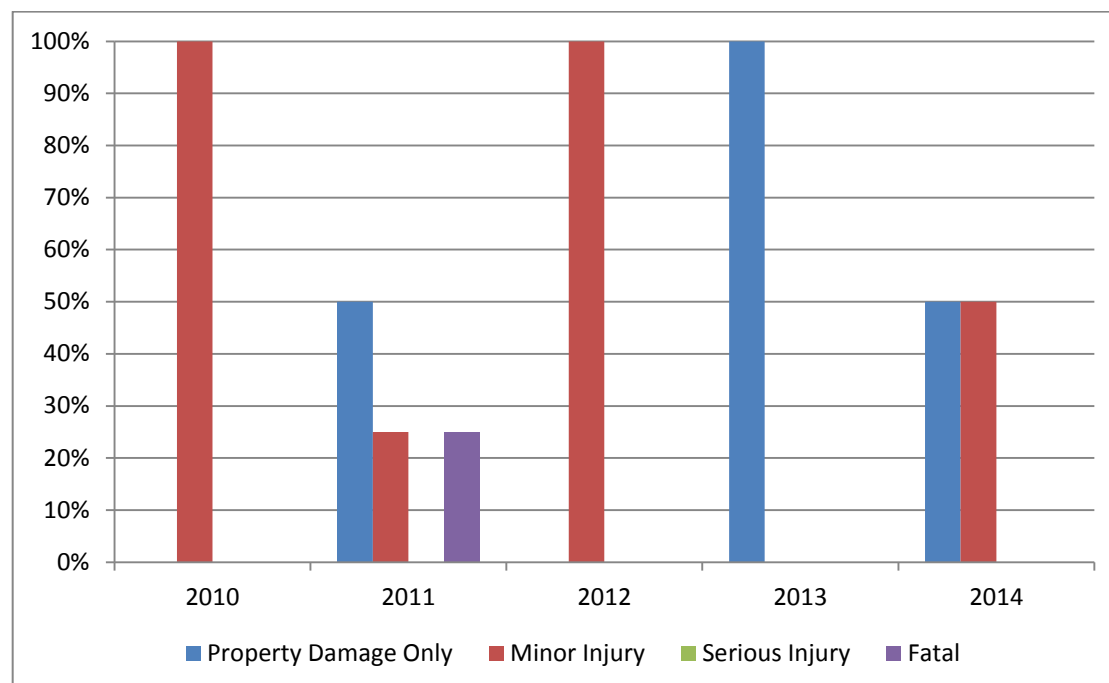
9.1.1 Crash History



There have been a number of crashes recorded for the 5 year period between 2010 and 2014. These vary between 1 and 4 crashes per year, with both 2011 and 2013 having 4 crashes each. 2011 was the most costly year because of a fatal roll over crash.



Again there was a high proportion of property damage only and minor injury crashes. There was no serious injury crashes recorded. The table below shows the distribution of crash severity by year.



The estimated economic cost of crashes on this section of the Thiele Highway from 2010 to 2014 was \$7,359,006. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 20 - Cost of Crashes Thiele Highway (Eudunda - Kapunda) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ¹⁸	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	7	\$86,310
Minor Injury	\$18,174	4	\$72,696
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	1	\$7,200,000

9.1.2 Geometry

Again the lane widths were fairly consistent for this section of the Thiele Highway with lanes of approximately 3.3m. Conversely the sealed shoulders were highly variable and

¹⁸ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

were measured at 0.7m for the northern section but in the southern section significant edge break caused them to vary between 0m and 1m. It was interesting to note that the sealed shoulder on the southern end, which was breaking away, was actually sealed over on top of another older sealed shoulder. Essentially the new sealed shoulder was breaking away and exposing the old sealed shoulder which was measured up to 1.8m in some locations. The unsealed shoulder beyond was between 1.0m and 2.0m on both sides of the road.

9.1.3 Pavement

The road surface on the northern section between Eudunda and Kapunda is average at the best locations and worse everywhere else. Starting at Eudunda there is evidence of bitumen bleeding and also texture loss on the surface. This continues along with sections of rutting and a very bumpy ride quality for 3.6km before there is a change in road surface. The changed surface brought a smoother ride quality but also a significant increase in the severity of the bleeding on the road surface, to the point where the road is becoming polished and unsafe because of the poor texture. Just a few kilometres further south the road becomes bumpy again with a poor ride quality. This is because of the high number of small patches of repairs that have taken place in the past to repair what looks like rutting in the road. More sections of very severe rutting occur at 6.15km, all of which should be repaired.



On the southern half of the highway between Hansborough and Kapunda, the rough ride quality, rutting, bleeding and general texture of the road improves somewhat with the exception of severe rutting and bleeding at 15.33km. The final 12km of road before Kapunda displays very severe edge break which appears to be crumbling away and causing the shoulders to be highly variable in width.

9.1.4 Line Marking, Signs and Delineation

Again, no issues were identified with the quality of the line marking as it was providing a good delineation of the road lanes. The only issue was at the southern end of the road there were a few areas where the edge break was so severe that the edge of carriageway line was lost. This issue should be addressed to ensure that the road continues to be well delineated. Further improvements could be made by implementing audio tactile line marking and retro reflective pavement markers to reduce the chance of run off road crashes. This would be particularly effective on the southern end of this road as there are a number of roadside hazards.

9.1.5 Roadside Hazards

Most of the Roadside hazards were located on the southern end of the road between Kapunda and Eudunda. Roadside drops were the most notable hazard with many drops of up to 4m that were unprotected by any kind of barrier. The worst drops that should be protected were measured from the start at Eudunda and were located at 8.1km, 19.55km, 20km and 21.7km. There were also drops on the outskirts of Kapunda just prior to the drop to 80km/h advisory sign.

9.1.6 Key Recommendations

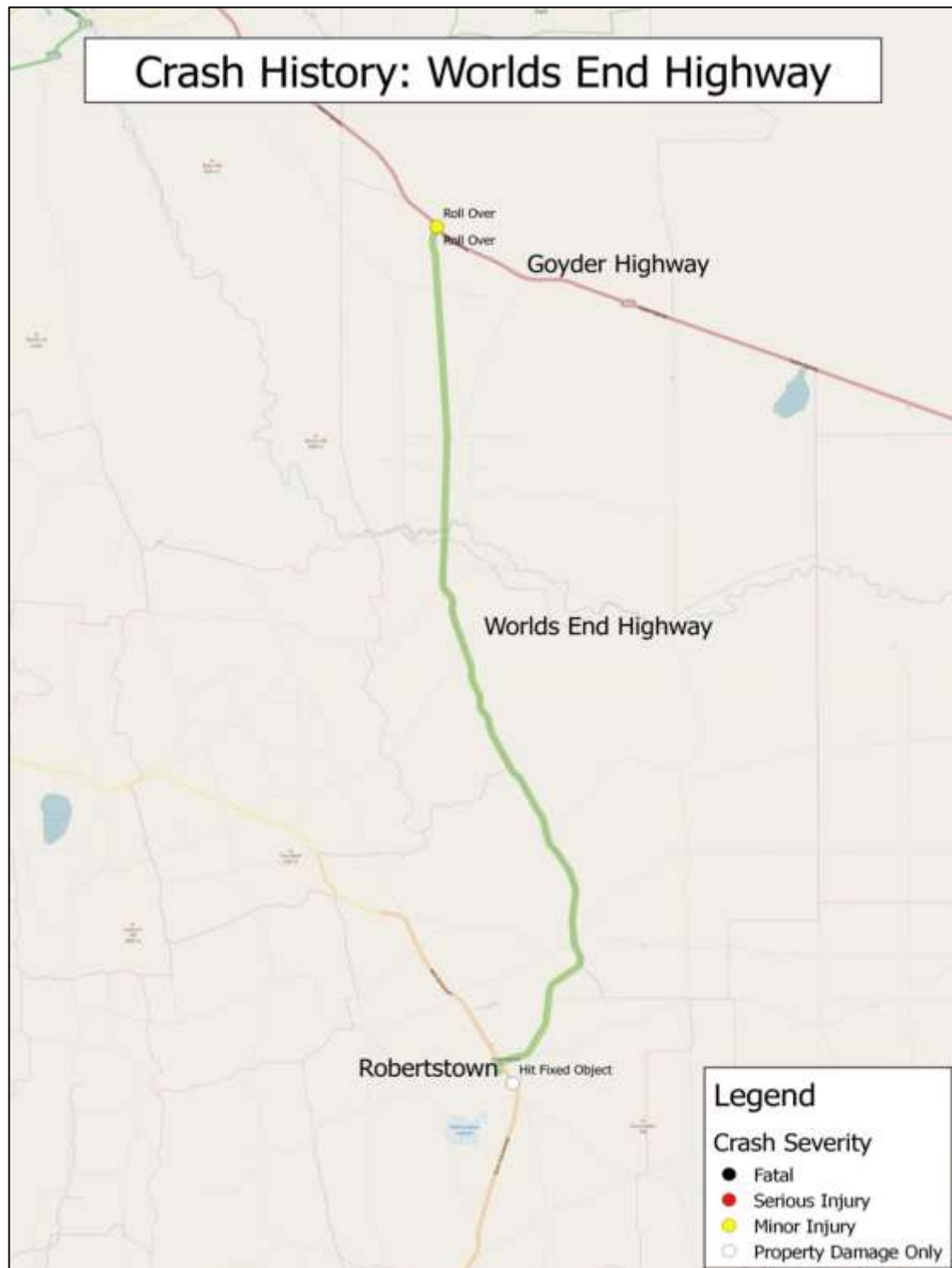
RAA recommend the following treatments for the Thiele Highway:

- Shoulder widening to minimum 0.5m.
- Repair of edge break and edge drop.
- Rehabilitation of pavement for severely rutted and bumpy surfaces.
- Resurfacing of particularly bleeding locations.
- ATLM and RRPM's
- Protection for unprotected roadside drops.

10 Worlds End Highway

This road was driven from north to south, starting at the intersection with the Goyder Highway and travelling to Robertstown. At 29.9km in length it carries between 120 and 170 vehicles per day, 20% of which are heavy vehicles. The trip meter was started at the intersection with the Goyder Highway. The posted speed limit is 100km/h.

10.1.1 Crash History



Unsurprisingly due to the low traffic volumes and exemplary road infrastructure (refer to 10.1.3 Pavement), there were only 2 property damage only, and 1 minor injury roll over crashes on this section of road in the 5 year period. Two of the crashes were in close proximity to the intersection and one was an unknown location in the Worlds End area. These crashes occurred in 2011, 2012, and 2014. These crash stats imply that current road infrastructure is acceptable and that the most important improvement would be to implement barrier protection for unprotected roadside drops.

The estimated economic cost of crashes on this section of The Worlds End Highway from 2010 to 2014 was \$42,834. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

**Table 21 - Cost of Crashes RM Williams Way (Goyder Highway - Robertstown)
(2014 Values), 2010-2014**

Crash Severity	Cost per Crash¹⁹	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	2	\$24,660
Minor Injury	\$18,174	1	\$18,174
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

10.1.2 Geometry

Multiple road width measurements were conducted on this road. It was found that the widths were very consistent at 3.6m lanes and 0.4m sealed shoulders. The unsealed shoulder was between 1.3m and 1.7m depending on the location. These wide lanes and sealed shoulder provided a very comfortable ride with plenty of breathing space when passing a large vehicle.

10.1.3 Pavement

This road was a delight to drive on because of its smooth road surface and very few defects. Noted was the macro-texture which was coarse and provided a good friction for tyres as well as decent drainage properties. The surface in general was smooth with very little bumps or lumps, which caused the ride quality to be exceptionally good. The only defects that were recorded during the assessment were rutting and pot holing which was found in one of the floodway dips but had been repaired in the past. This was recorded at approximately 20.48km.

¹⁹ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.



10.1.4 Line Marking, Signs and Delineation

Again the Worlds End Highway set a high standard with line marking that was of a very high quality and provided a good contrast with the road for the entire length between the Goyder Highway and Robertstown. There were no issues with hazard markers or signage, although it was noted that audio tactile line markings and retro reflective pavement markers could further improve the safety by reducing run off road fatigue related crashes, and also improving the delineation during night time hours.

10.1.5 Roadside Hazards

A number of roadside hazards were identified on the Worlds End Highway. The most significant hazards were the roadside drops that occurred at 0.9km, 12km, 12.5km, 19.9km, 22.4 and 22.9km. It is recommended that all of these be protected with w beam or wire rope barriers, especially as casualty markers were present at some of the drops indicating a crash history at these locations.

10.1.6 Key Recommendations

- ATLM and RRPM's
- Protection for unprotected roadside drops.

11 Clements Road & Gadd Ave

11.1 Port Broughton to Crystal Brook

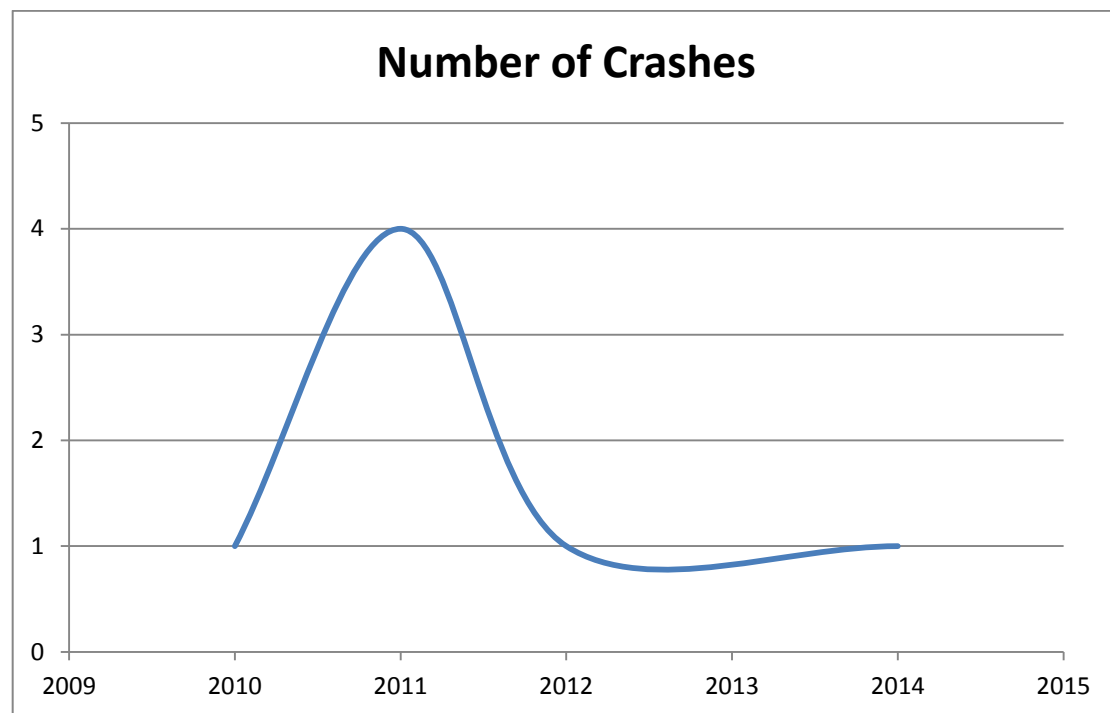
Interestingly, the traffic volumes vary greatly along this road. The traffic volumes are significantly less than the adjacent section between Port Broughton and Port Pirie. The variance in traffic volumes are likely attributed to the larger population density in Port Pirie than in Crystal Brook. The section of road to the east of the Spencer Highway which travels to Merriton and on to Crystal Brook only carries approximately 370

vehicles per day. Heavy vehicles account for between 13% and 15% of the total volume. The speed limit here is 110km/h.

11.1.1 Crash History



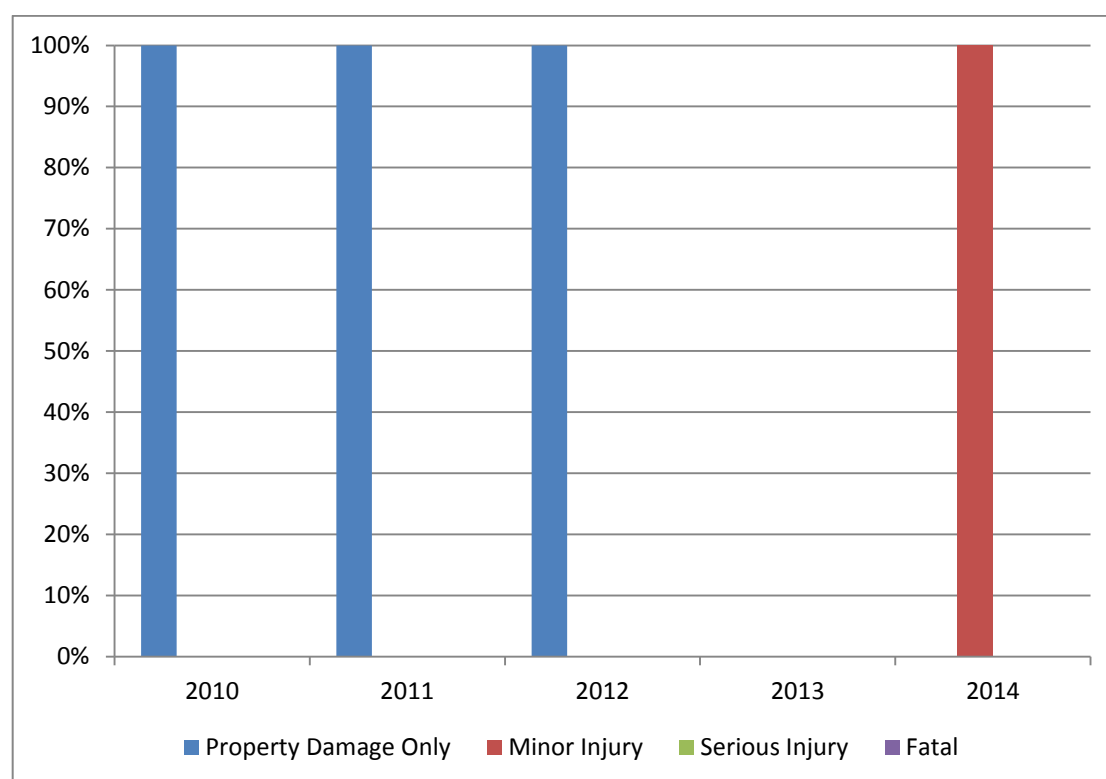
This route has a low traffic volume and as expected also displays a low number of crashes in the 5 year period. 2011 was the worst year with 4 reported crashes.



All of these crashes bar one minor injury have been property damage only crashes. One or two crashes occurred yearly, with the exception of 2013 having no crashes. Hit animal crashes tend to be the most common crash, which is interesting because animal crashes are often not reported. The crash types are broken down below:

- Hit animal (3 crashes)
- Hit fixed object (2 crashes)
- Roll over (1 crash)
- Right angle (1 crash)

The roll over crash was in an unknown location on Clements Road and is not shown on the map for this reason. The below graph displays the high proportion of property damage only crashes.



The estimated economic cost of crashes along the route between Port Broughton and Crystal Brook from 2010 to 2014 is \$92,154. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 22 - Cost of Crashes Clements Road and Gadd Avenue (Port Broughton – Crystal Brook) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²⁰	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	6	\$73,980
Minor Injury	\$18,174	1	\$18,174
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

11.1.2 Geometry

On Clements Road, 3.5m lane widths provided a fairly wide driving surface for the first 12.2km. After this the road widened slightly and an edge line with a 100mm sealed shoulder was provided. On the short section of road between the Augusta Highway and

²⁰ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

Crystal Brook (Gadd Ave) the lane widths were wider and there was more sealed shoulder, giving plenty of room to pass large vehicles. An edge line was also provided.

11.1.3 Pavement

Small bumps and lumps in the pavement surface resulted in a poor ride quality on the outskirts of Port Broughton. The addition of ruts and some bleeding in the passenger and driver wheel paths along with short sections of road repairs did not improve the ride either. Occasional edge break was seen, although not as significant as the edge break on Port Pirie to Port Broughton Road. The texture was average to good, and generally provided a coarse surface with good drainage properties. On the short section of road between the Augusta Highway and Crystal Brook (Gadd Ave) the road surface was significantly better with very little signs of bleeding rutting or cracking in the pavement surface. The photo below was taken near Clements Gap.



11.1.4 Line Marking, Signs and Delineation

The line quality was good. Hazard marker posts were used along the roadside, and provided good night time delineation. No other features such as RRPMS or ATLM were provided.

11.1.5 Roadside Hazards

Steep roadside drops were more common along this section of road. It was noted that most of these were already protected with w-beam barriers. Further back from the road,

medium to large trees lined the road, within 3 to 5m. Small roadside drops were noted on the short section of road between the Augusta Highway and Crystal Brook (Gadd Ave). The high instance of animal crashes suggests that animals are somewhat of a roadside hazard in this area, particularly on Clements Road. Care should be taken by vehicles travelling this road during times of dusk and dawn. A review of signage warning motorists of this hazard is recommended.

11.1.6 Key Recommendations

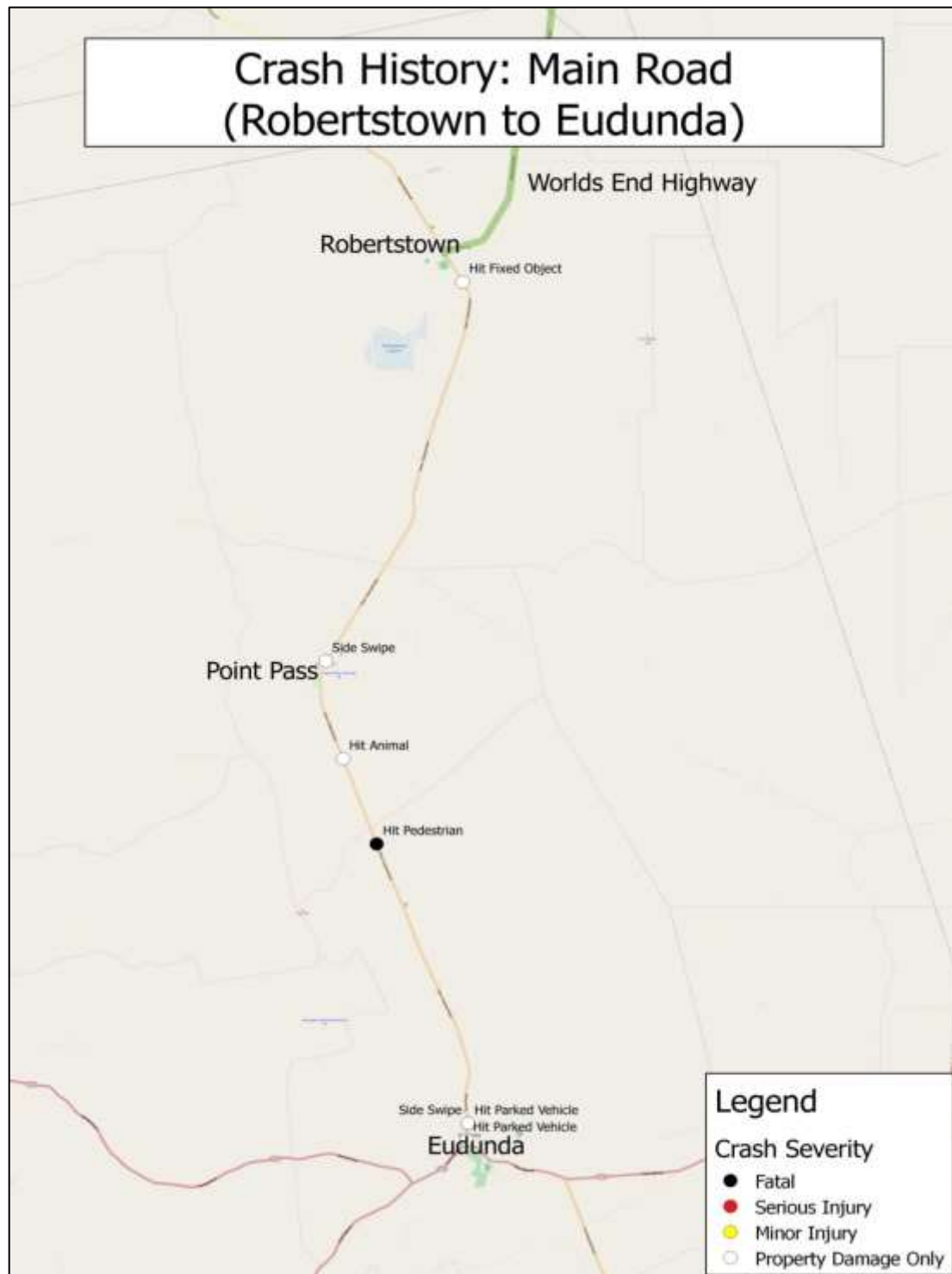
RAA recommend the following treatments for Clements Road and Gadd Avenue:

- Protection for unprotected drops on the roadside.
- Signage to warn of animals.
- Provide edge of carriageway lines on all sections.

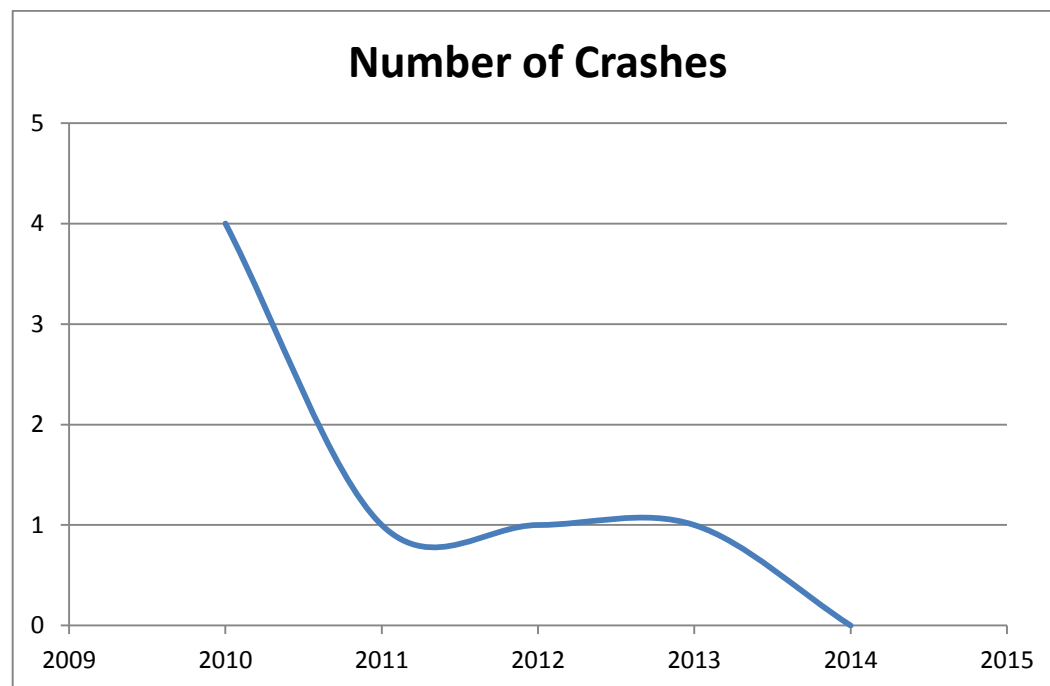
12 Eudunda to Robertstown

This road was driven from north to south, commencing the trip meter at the intersection with the Worlds End Highway and travelling south to Eudunda. The distance is approximately 22km from Robertstown to Eudunda with a speed limit of 110km/h. Traffic volumes are low at approximately 340 to 500 vehicles per day and an average of 11% heavy vehicles.

12.1.1 Crash History



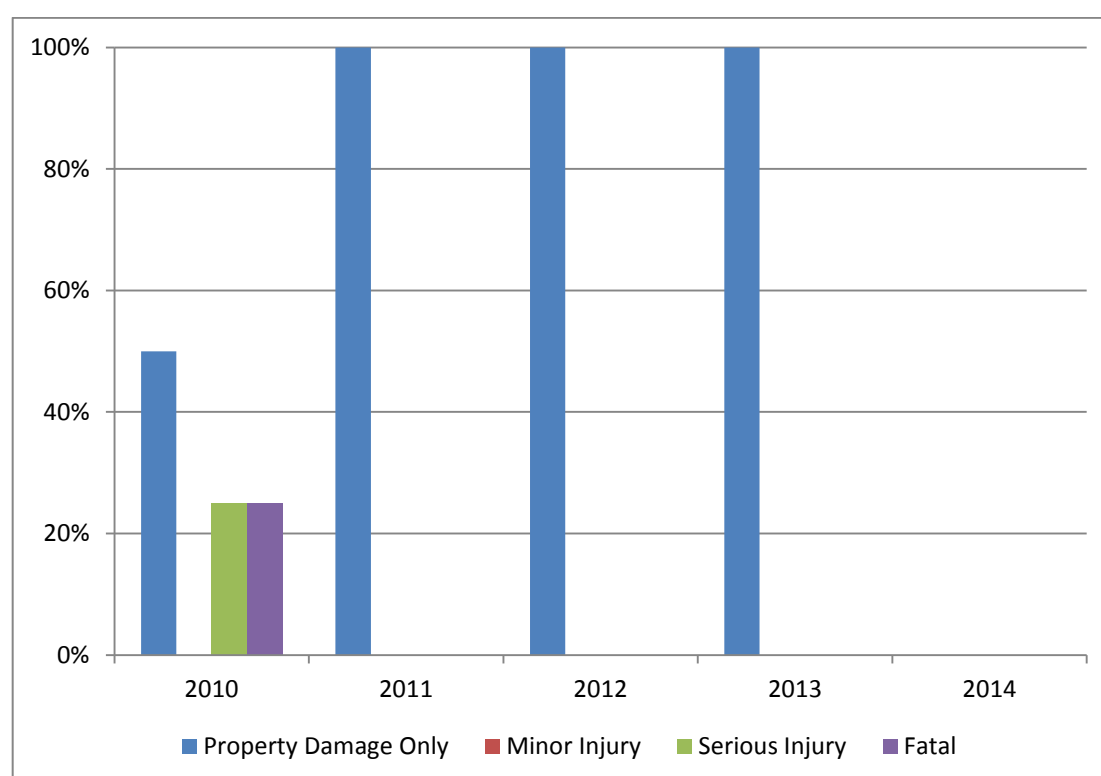
There appears to be a downwards trend in the number of crashes occurring along this section of road. 2010 by far had the most recorded crashes at 4. 2011 to 2013 each had only one crash and then 2014 had no recorded crashes.



The majority of crashes tend to be of hit fixed object type among other crash types.

- Hit animal (2 crashes)
- Hit fixed object (3 crashes)
- Hit pedestrian (1 crash)
- Side swipe (1 crash)

A majority of the crashes were property damage only crashes, with 3 out of the 4 years with crashes occurring being 100% property damage only. In 2010 there were 4 crashes, and 2 of these were again property damage only crashes. Of the others one was a serious injury and the other a fatal crash.



The estimated economic cost of crashes on this section of road between Eudunda and Robertstown from 2010 to 2014 was \$7,601,650. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 23 - Cost of Crashes Main Road (Eudunda - Robertstown) (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²¹	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	5	\$61,650
Minor Injury	\$18,174	0	\$0
Serious Injury	\$340,000	1	\$340,000
Fatal	\$7,200,000	1	\$7,200,000

12.1.2 Geometry

It was found that the lane widths were extremely narrow on the outskirts of Robertstown with a road width of only 3.0m lanes, no sealed shoulders and unsealed shoulders of approximately 2.3m. Further south, after travelling 3.1km the lane widths widened to 3.4m, still with no sealed shoulders. Notably the extra 0.4m on each side of the road felt

²¹ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

much more comfortable to drive on especially when passing other vehicles in the opposing direction. Unfortunately this seal extension persisted for approximately 2km before reducing back down to barely more than 3.0m per lane and then continued at a similar width for the remainder of the journey.



12.1.3 Pavement

Many defects in the pavement were noted during the assessment. Edge break was common along this road, as is expected when the lane widths are so narrow. Having such narrow lanes causes more vehicles to be hitting the edge of the carriageway with their tyres, which slowly breaks away more and more of the sealed surface. Along with the edge break, some of the most significant edge drop that the road safety team has seen was recorded on this section of road. At 11.3km the drop was approximately 150mm and poses a significant threat to run off road crashes and tyre side blow outs. It is extremely vital to rectify this issue as the road widths are very narrow and the chance of hitting the edge of carriageway is high.



The texture was also quite poor and it appeared that the surface was becoming worn down to a smoother macro and micro texture. Despite this the road surface was not smooth. The ride quality was poor because of many bumps and undulations. These bumps were often but not always caused by small sections of patching and repairs. Rutting and bleeding was again very common along this section of road, particularly when closer to Eudunda. The surface at 15.95km was particularly bad and should be remediated.

12.1.4 Line Marking, Signs and Delineation

No issues were noted about the quality of the line marking along this section of road as the line provided an adequate contrast to the road surface. This road would benefit from lane widening and the implementation of an edge line along with sealed shoulders. Dropping this road to 100km/h because of the high number of pavement defects including edge drop, poor texture, and narrow lanes is also recommended.

12.1.5 Roadside Hazards

The roadside was generally fairly open with the occasional tree or shrub within 5m of the road surface. The shoulders were quite poor and unkempt with some areas consisting of loose material while other areas consisted mainly of weeds and grasses. Power lines also ran within 4m of the sealed surface for long sections near point pass.

12.1.6 Key Recommendations

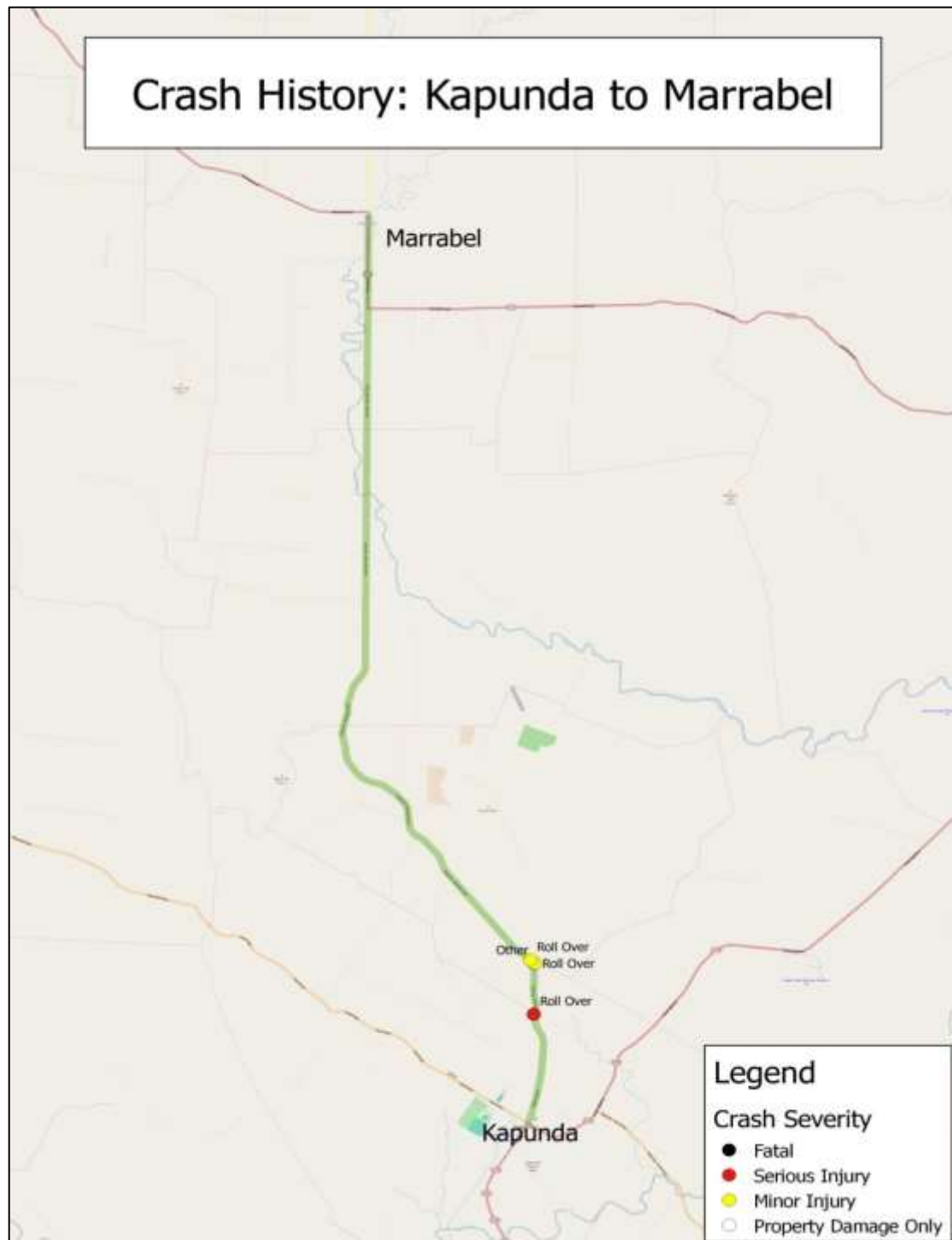
RAA recommend the following treatments for Main Road:

- Lane and shoulder widening.
- Edge of carriageway lines.
- Repair of edge break and edge drop.

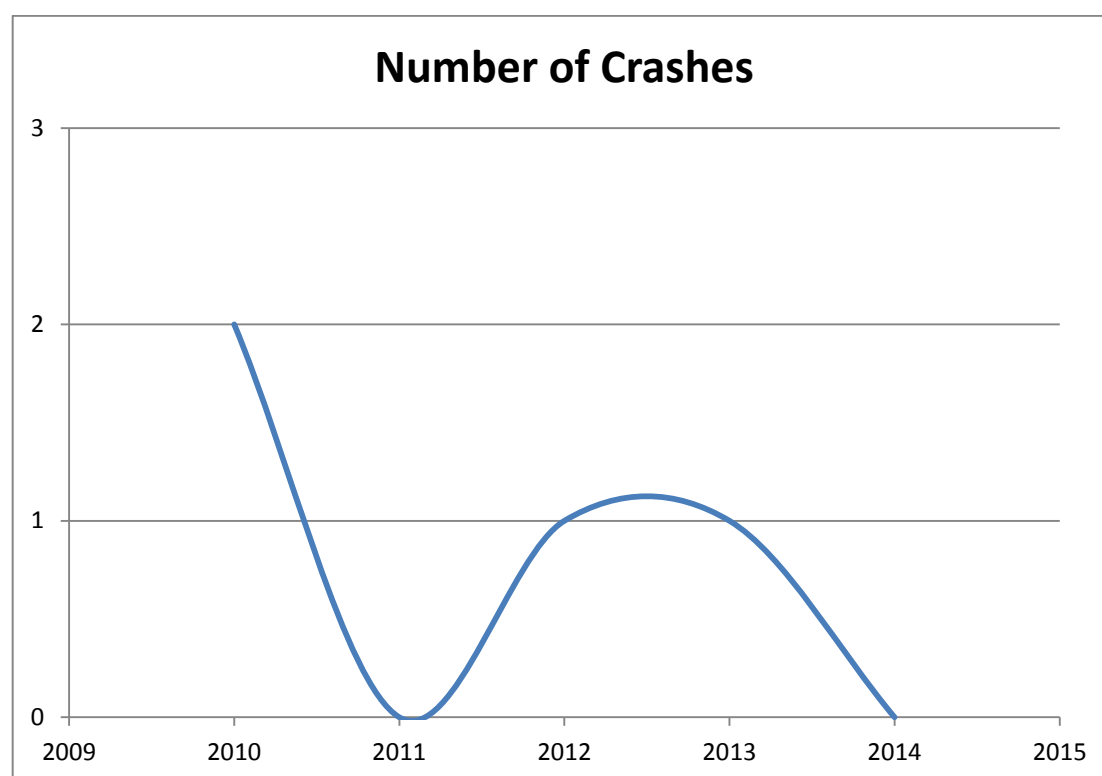
13 Marrabel Road (Kapunda to Marrabel)

Marrabel Road runs in a north-south direction for a distance of approximately 24km. The road carries around 700 vehicles per day, with heavy vehicles representing about 10 percent of the traffic. The speed limit along the road is 100km/h. The assessment on Marrabel Road was conducted in the northbound direction, commencing the trip meter at the intersection with North Terrace in Kapunda.

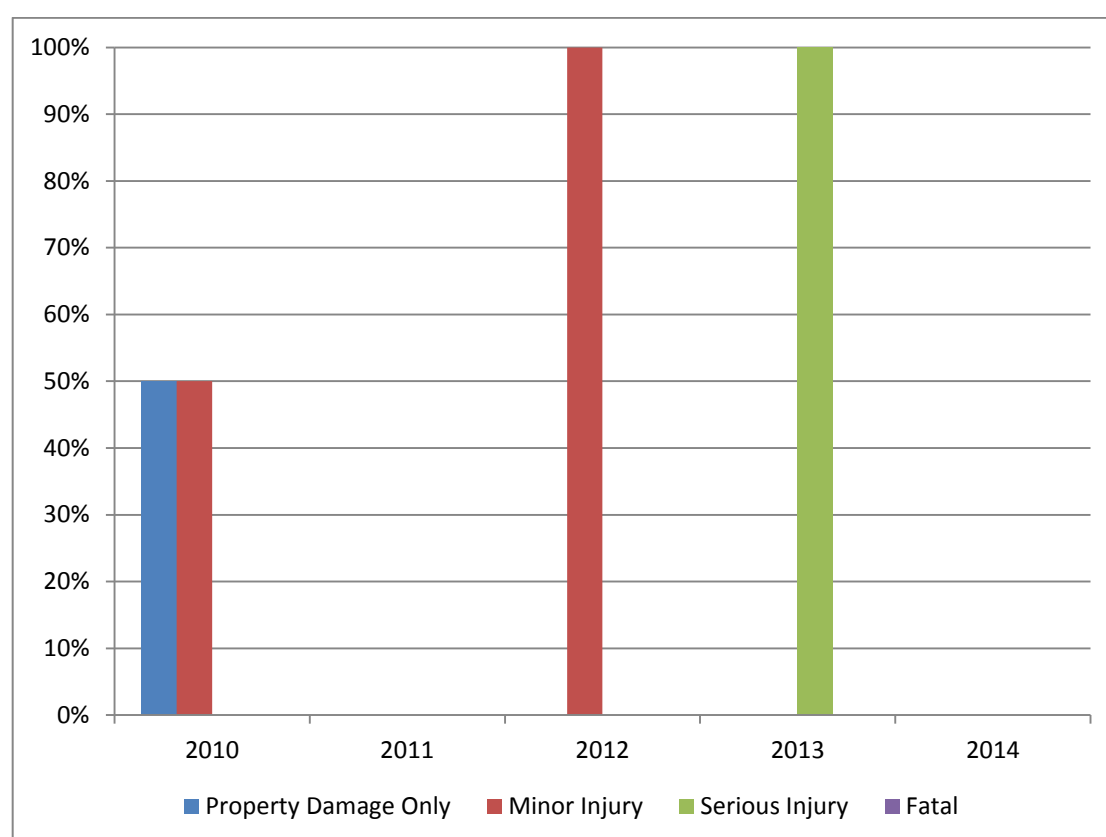
13.1.1 Crash History



This is a low traffic volume road and as expected the number of crashes within the 5 year period is also low. A total of 4 crashes were recorded, two of which occurred in 2010. 2011 and 2014 have no recorded crashes.



Three of the crashes were roll overs, and the fourth crash was classed as “other”. Of the three roll overs, there was one of each property damage only, serious injury and minor injury crashes. The graph below depicts the distribution of crash severity for each year.



The estimated economic cost of crashes on the road between Kapunda and Marrabel from 2010 to 2014 is \$388,678. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 24 - Cost of Crashes Between Kapunda and Marrabel (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²²	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	1	\$12,330
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	1	\$340,000
Fatal	\$7,200,000	0	\$0

²² Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

13.1.2 Geometry

Lane widths were found to vary between 3.3m and 3.4m between Kapunda and Maribel. A sealed shoulder of about 1m was provided throughout with the exception of a 3km section after leaving Kapunda which only had a shoulder seal of around 100mm. It would be recommended that this section is upgraded to achieve uniform sealed shoulder widths throughout. Given the classification of road and traffic volumes along the road, the lane and shoulder widths are considered suitable. Unsealed shoulders varied between 2.1m and 3.7m in width.

13.1.3 Pavement

Ride quality was found to be bad on sections of the Kapunda-Maribel road, with a number of bumps and undulations in the road which made the ride less comfortable. This was particularly noticeable north of Kapunda.

The unsealed shoulders were found to have a poor surface with a lot of loose material as well as having adverse cross falls in some locations that could cause a vehicle to suddenly veer off to the side if a driver becomes inattentive and the vehicle drifts onto the shoulder at high speed.

13.1.4 Signs & Line Marking

The audit noted that the use of hazard marker posts were inconsistent through some of the sections of road. There were some sections with trees which had frequently spaced posts then sections with fewer hazards but had irregularly spaced posts. It would be recommended that the locations of the posts are reviewed to provide regular and consistent use of these delineators.

Crossroad warning signs, while in reasonable condition were found to be the old sign face which did not indicate the primary direction of through traffic. It is recommended that these signs are replaced by the new sign type when required to be replaced through ongoing maintenance. It was also noted that approximately a kilometre south of Marrabel one of the warning signs had been knocked down and requires replacement.

13.1.5 Roadside Hazards

Stobie poles were commonly found within 2 to 3 metres of the seal as well as large gum trees. While traffic volumes may result in less priority for crash treatments along this road, it would certainly be recommended that barrier treatments are considered at least on the outside of bends where these hazards occur. A few steep embankments, over 2m in height were identified along the route and again should be protected as they may cause vehicle roll overs if a vehicle were to depart the highway, increasing the severity of a crash.

The road passes over a number of culverts and most are protected with W beam barrier and delineated with hazard marker posts. Between Hamilton and Marrabel however, there were a number of culverts which were delineated with black and white hazard

boards but had no form of protection. It's recommended that barrier protection is considered to protect the culvert headwalls.

13.1.6 Key Recommendations

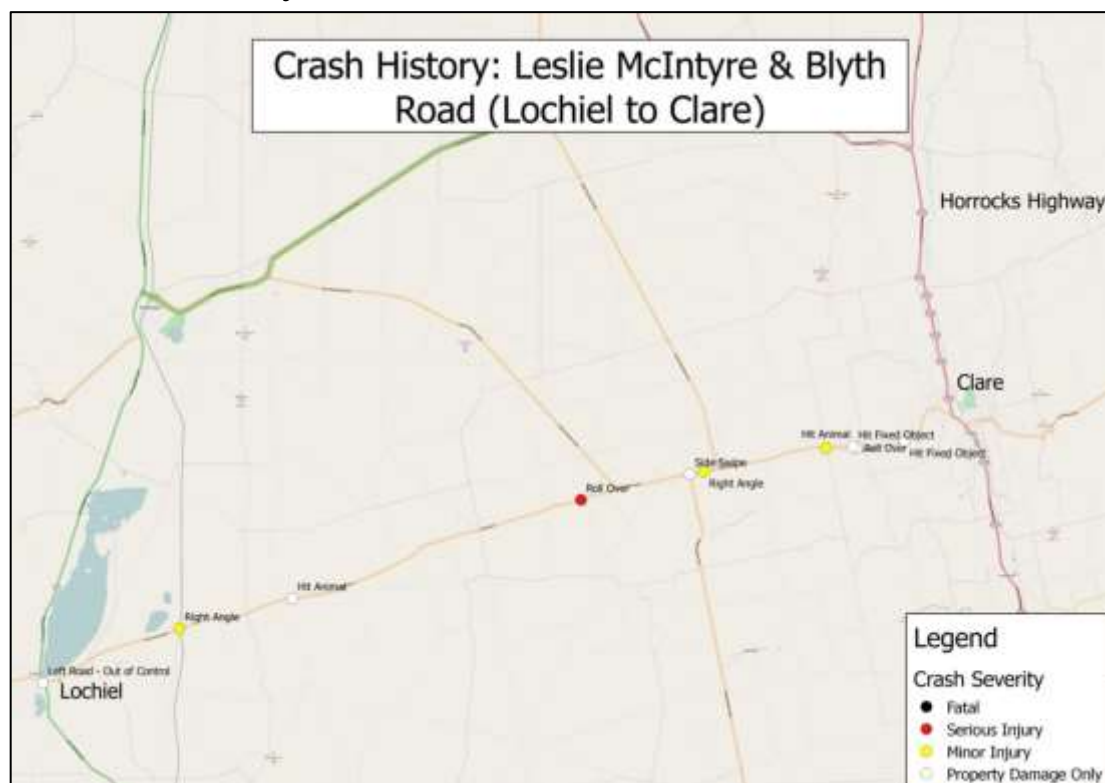
RAA recommends the following treatments for Marrabel Road:

- North of Kapunda, extend sealed shoulders to a minimum of 500mm
- Grade shoulders to reduce cross fall
- Review hazard mark posts and install additional posts
- Barrier protection for steep embankments and culverts

14 Lochiel to Clare

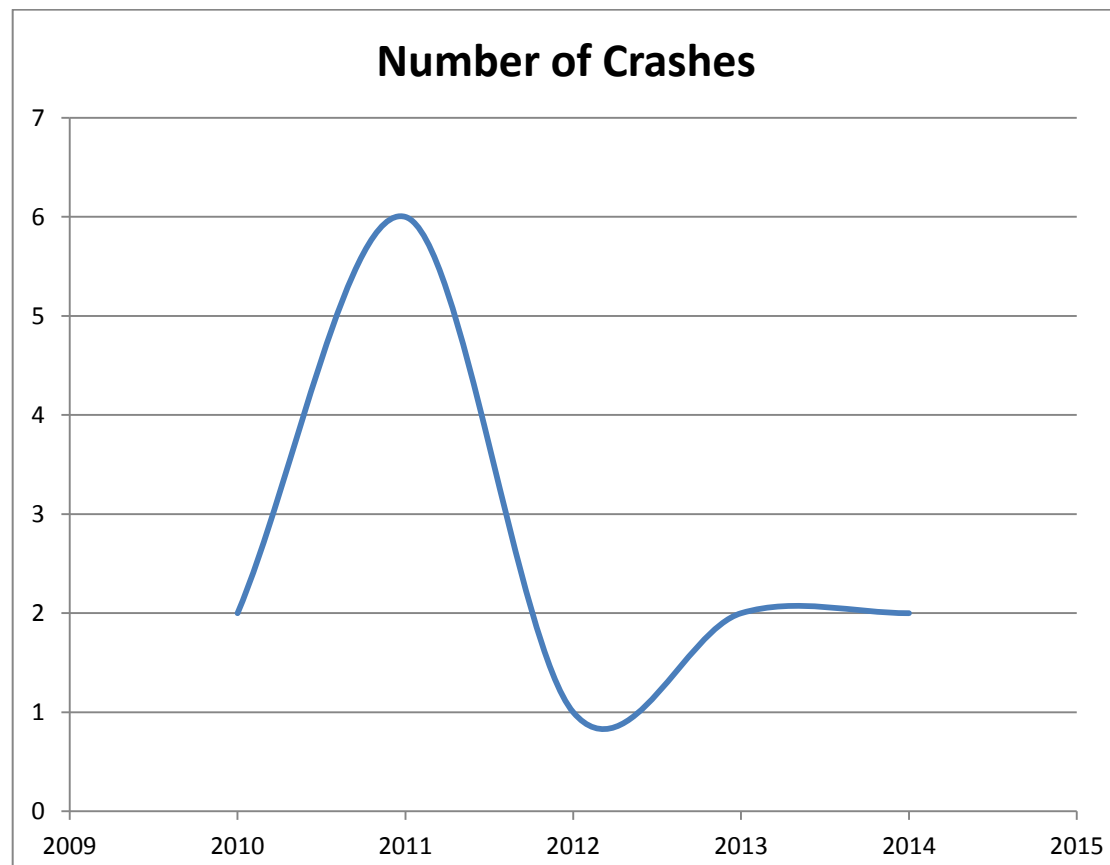
The road between Lochiel and Clare is unclassified and at 45km long, carries between 130 and 140 vehicles per day, approximately 11.5% of which are heavy vehicles. The speed limit on the road is 100km/h. The assessment commenced in the eastbound direction and the trip meter commenced that the intersection of the A1 Augusta Highway.

14.1.1 Crash History

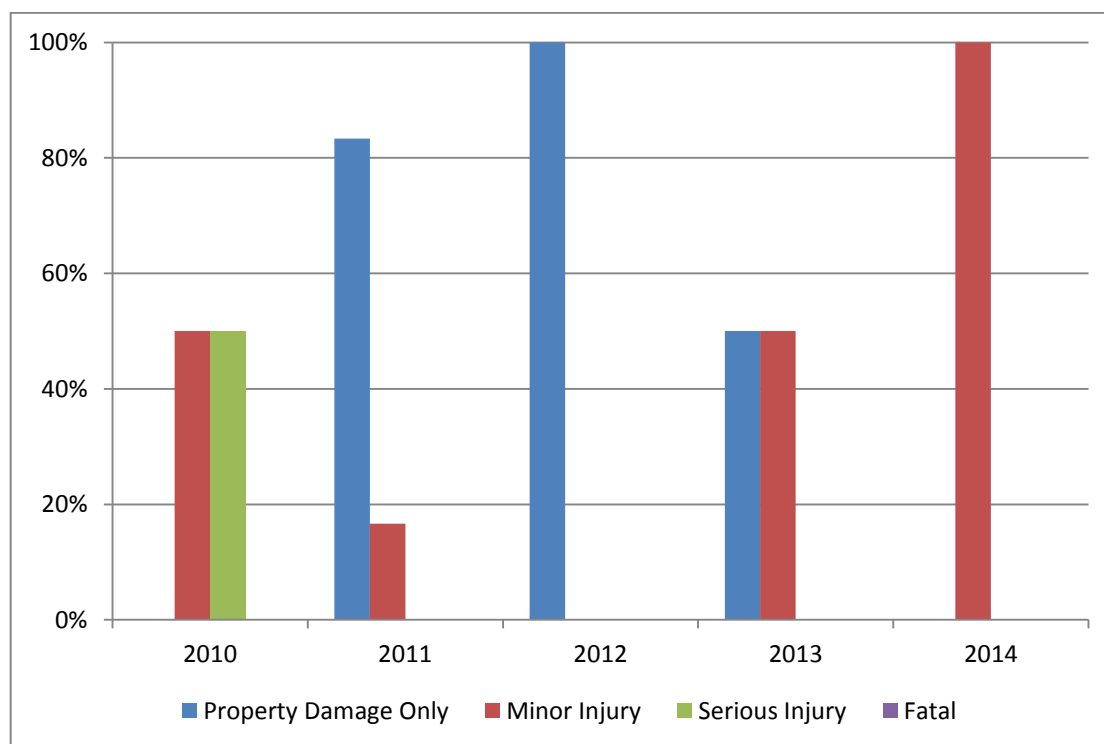


Three out of the 5 years have had 2 crashes each, with an outlying year in 2011, which had a massive 6 crashes, and was followed in 2012 to have only one crash. Hit fixed object and hit animal crashes are the most common crashes along this section of road. A breakdown of the crash types is displayed below.

- Hit animal (3 crashes)
- Hit fixed object (3 crashes)
- Left road – out of control (1 crash)
- Right angle (2 crashes)
- Roll over (2 crashes)
- Side swipe (1 crash)
- Head on (1 crash)



A high proportion of the crashes that occurred were either property damage only or a minor injury severity. One serious injury roll over occurred in 2011. No fatalities have occurred in the 5 year period.



The estimated economic cost of crashes on the road between Lochiel and Clare from 2010 to 2014 is \$517,180. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 25 - Cost of Crashes Between Lochiel and Clare (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²³	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	7	\$86,310
Minor Injury	\$18,174	5	\$90,870
Serious Injury	\$340,000	1	\$340,000
Fatal	\$7,200,000	0	\$0

14.1.2 Geometry

The assessment found that the lane widths between Lochiel and Blyth varied between 3.5m and 3.6m and did not include a sealed shoulder. With these dimensions, it would be possible to include an edge of carriageway line which would improve night delineation. Approximately 25km east of Lochiel, the lane widths increase to between 3.4m and 3.8m for a 4km stretch, before reducing down to just 3.0 to 3.2m along the

²³ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

remaining section towards Blyth. To the east of Blyth, the lanes remain the same width and the assessment noted that the lanes were particularly narrow and made driving uncomfortable when passing heavy vehicles on bends. Seal widening is therefore recommended to provide a minimum of between 3.2m and 3.3m lanes with at least a 300mm sealed shoulder.



14.1.3 Pavement

Ride quality was average along the highway with a number of areas offering a rougher ride, particularly where patching has been undertaken. Some sections were found to offer a reasonably good and smooth ride, about half way between Lochiel and Blyth but there was then a reduction in ride quality again between Blyth and Clare.

The pavement was found to offer a moderate to coarse texture from Lochiel to Blyth which should offer good skid resistance and drainage. Some small sections of bitumen bleeding were found to the west of Blyth but the problem was not extensive.

Between Blyth and Clare, rutting was noted along some sections of the highway, which were trapping water. It is recommended that rut filling is considered to reduce the risk of hydroplaning in wet weather.

Edge break was noted on several occasions along the route but particularly to the west of Blyth and to the west of Clare where edge break was notably occurring on the inside of bends where vehicles appeared to cut the corner. It would be worth considering extending the seal on the inside of bends to accommodate the vehicle path and prevent further deterioration to the edge of the asphalt.

To the east of Lochiel, the assessment noted a number of areas along the unsealed shoulder where there was an adverse cross fall and loose material. This can pose a run-off hazard for vehicles and can be improved with further grading work.

The assessment found that the approach to the rail crossing at Bumbunga-Nantawarra Road was an issue, with a bad dip on the opposite side of the tracks. It is recommended that the road is re-profiled as part of future maintenance to provide a smoother transition over the crossing.

14.1.4 Signs & Line Marking

Line marking was identified as an issue along the highway between Lochiel and Blyth with several sections noted as being worn or fading. One section in particular was noted 22km east of Lochiel where line marking was visibly fading. Between Blyth and Clare, the line marking was in a much better condition however the wet weather lead to sheen on the road and in some areas the line marking was difficult to see.

Signs were found to be more of an issue along this highway compared to others in the region. In a number of instances, signs were found to be fading including directional and warning signs. Particularly notable was a T-intersection warning sign and some other signs to the east of the railway crossing at Bumbunga-Nantawarra Road and a directional sign for Blyth, Balaklava and Snowtown. Vegetation obscuring signs was also found to be a problem and included a bend warning sign and a T-intersection warning sign about 27km east of Lochiel. The assessment noted that some cross road warning signs are an older design sign face and when replaced, they should be replaced with signs that meet the current standards rather than like for like.

There was a good use of hazard marker posts along the highway, particularly on bends where the frequency of posts was increased and provides improved night delineation. About 12km east of Lochiel, it was noted that several marker posts had been damaged and it is recommended that these are replaced, as soon as possible.

14.1.5 Roadside Hazards

Like many of the roads in the region, vegetation was scattered along some sections with large trees growing between 3 and 4m from the seal. While these are well within the clear zone, it is impossible to protect all vegetation hazards and it would be recommended that vegetation hazards on the outside of bends are prioritised due to the higher risk of run-off road crashes.

There were a number of culverts along the highway which were delineated with hazard marker posts at either side of the headwall however no other form of protection is offered. RAA wish to see the application of barrier systems on approach to and over significant headwalls due to the potential crash severity if a vehicle departs the highway at the culvert.

Along the section between Blyth and Clare, there is a stretch for about one or two kilometres that has Stobie poles running along the road within 3m of the seal. It would be recommended that some form of protection is offered for these since they are well within the clear zone. It was however encouraging to see that there has been good use of W-beam barrier to protect significant drops ranging between 3m and 10m.

14.1.6 Key Recommendations

RAA recommend the following treatments for the Lochiel to Clare Road:

- Extend seal to provide minimum lane widths of 3.2m
- Extend sealed shoulders to a minimum of 300mm
- Profile road on approach to Bumbunga-Nantawarra Road rail crossing
- Refresh line marking
- Replace fading signs
- Replace damaged hazard marker posts
- Install barrier system to protect culvert headwalls

15 Orroroo to Laura

The route between Orroroo and Laura is approximately 62km in length and consists of the following minor roads:

- Orroroo Road
- Tarcowie Road
- Appila – Laura Road

The speed limit along the route is 100km/h. At the time of this report, traffic volumes were unavailable for these roads. The assessment was conducted in the southbound direction.

15.1 Crash History



There were only three crashes on this road within the 5 year period which is likely the result of a fairly low traffic volume. Two of the crashes were minor injuries caused by run off road incidents (Hit fixed object & Left road – out of control) one occurred at an intersection (Right angle) and was a property damage only crash. The estimated cost of crashes on this stretch of road for the 5 year period is \$48,678.

Table 26 - Cost of Crashes On The Road Between Orroroo and Laura (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²⁴	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	1	\$12,330
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	0	\$0
Fatal	\$7,200,000	0	\$0

15.1.1 Geometry

From Orroroo to Pekina, the lane widths were measured at 3.5m with a 300 to 400mm sealed shoulder. Between Pekina and Appila, the road width reduced and lanes were generally restricted to 3.3m with no sealed shoulder. The assessment found that for some short sections, a shoulder seal of 400mm was provided. On approach to Appila, the lane widths were measured at 3.6 to 3.8m with no sealed shoulder although the available seal width could permit an edge of carriageway line that would provide a shoulder. The wider seal continued on south to Laura with unsealed shoulders of between 1.2 and 1.5m provided.



The lane widths are reasonably wide along the Orroroo to Laura Road considering that it is unclassified road. RAA would however recommend an increase in the seal width that would allow provision of a sealed shoulder of between 300 and 500mm.

²⁴ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

15.1.2 Pavement

The ride quality along the Orroroo to Pekina Road was found to be good, offering a smooth ride for motorists with few bumps and undulations. The pavement appeared to provide a medium to coarse texture that should provide adequate skid resistance and surface drainage.

From Pekina to Appila, there were a few defects noted which included edge break and potholes that have opened in the seal, exposing the underlying road base. Pavement remedial work is recommended for this section to prevent further deterioration in the pavement.

15.1.3 Signs & Line Marking

Between Pekina and Appila, the quality of the centreline was good, offering a clear solid line. By contrast, the quality of the edge line was poor and had faded in many areas. The edge line was barely visible at some sections and would offer little safety benefit. A refresh of the edge lines along this section should be a maintenance priority.

Hazard marker posts have been provided on bends however it was noted that the posts were sparsely spaced. To improve night delineation, it is recommended that the spacing of the posts on bends is reduced. South of Appila, some of the posts located has been damaged and requires replacing.

15.1.4 Roadside Hazards

The roll-over risk was identified on a couple of occasions between Orroroo and Appila where drops of between 2 and 6m were identified as requiring barrier protection.

Culverts between Pekina and Appila had hazard marker posts placed at their headwalls but no protection was offered from these hazards. It is recommended that barrier installation is considered around the headwalls.

Approximately 9km south of Appila, the assessment noted the provision of W-beam barrier on approach to a bridge. The assessment determined however the barrier was of insufficient length to fully protect the creek and that extension of the barrier is required on either side.

RAA observed mud from the side roads at a number of locations and would recommend that appropriate surface condition signs are erected if determined to be an issue for most of the year.

15.1.5 Key Recommendations

RAA recommend the following treatments for the Orroroo to Laura Road:

- Construct sealed shoulders to a minimum width of 300mm
- Repair pavement edge break / edge drop
- Refresh edge lines

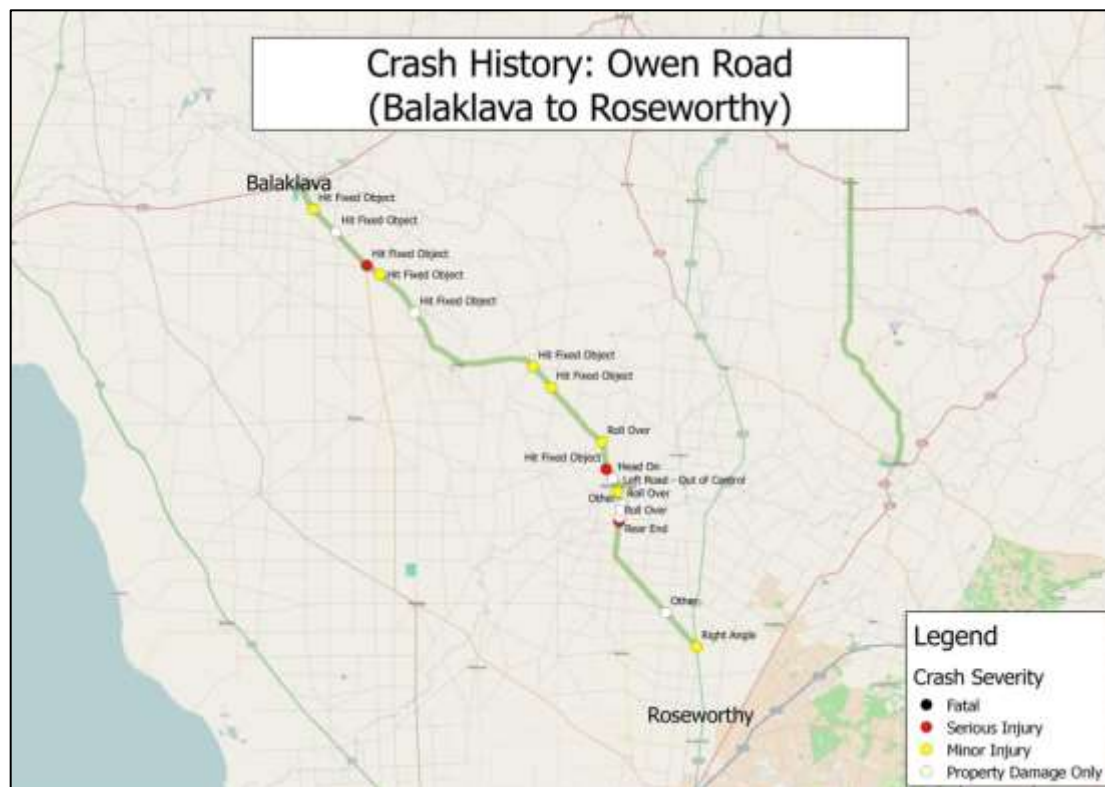
- Replace damaged hazard marker posts and install additional posts on bends
- Install barrier to protect significant drops at the roadside and culvert headwalls
- Extend barrier on approach to bridges
- Consider installing warning signs for slippery road conditions

16 Balaklava to Roseworthy (Owen Road)

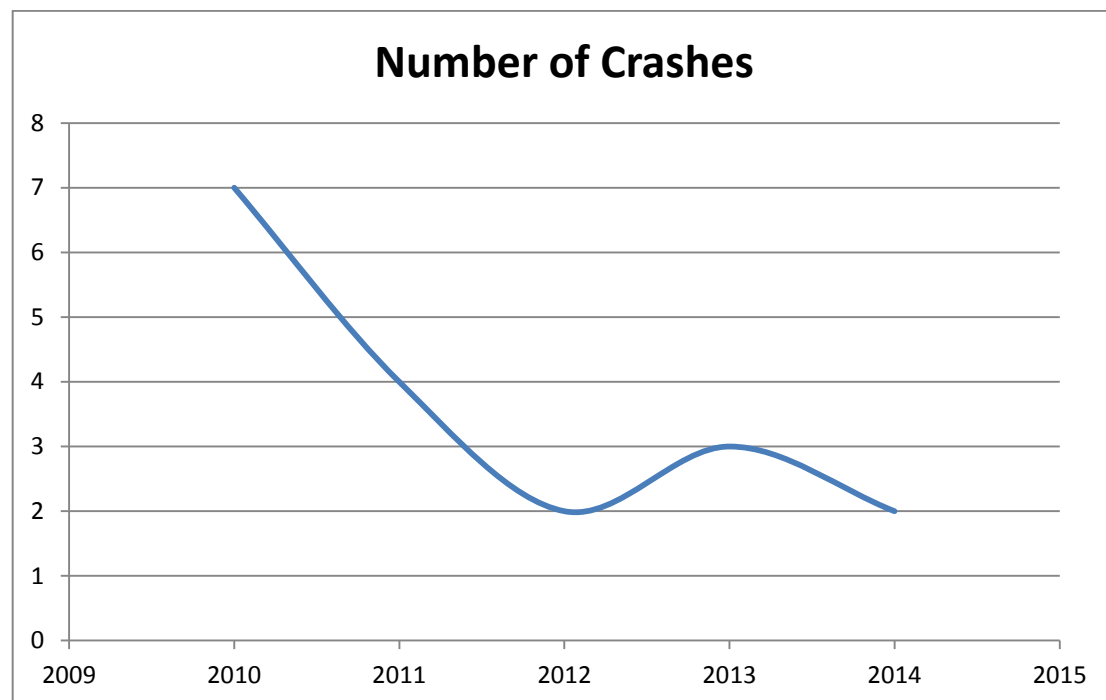
Owen Road runs in a north-south direction between Balaklava and Roseworthy and is about 59km long. The 2015 traffic volumes along Owen Road show traffic volumes vary between 500 and 2,100 vehicles per day with heavy vehicles representing on average 9.5% of the total traffic volume. The speed limit along Owen Road is 100km/h.

The assessment was carried out in the westbound direction and the reference point for the odometer was set at the intersection of Traeger Road and Owen Road in Balaklava.

16.1.1 Crash History



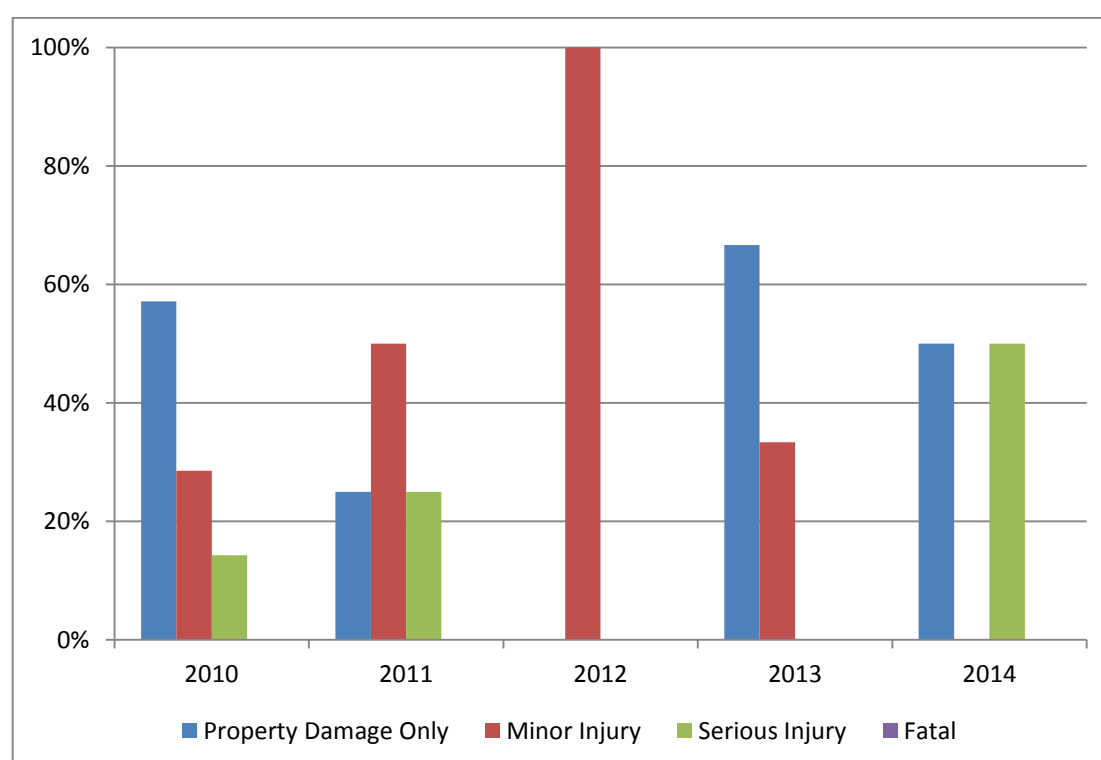
2010 was by far the worst of the years in the 5 year period with 7 crashes recorded. This has steadily declined to an average of between 2 and 3 crashes annually from 2012 onwards.



Crashes tend to be mostly run off road in nature with a high number of hit fixed object crashes and also some roll overs. A breakdown of the crash types within the 5 year period is shown below.

- Hit fixed object (8 crashes)
- Roll over (3 crashes)
- Left road – out of control (2 crashes)
- Other (2 crashes)
- Head on (1 crash)
- Rear end (1 crash)
- Right angle (1 crash)

There have been no fatalities along this stretch of road within the 5 years, and only a small number of crashes resulted in serious injury. Most of the crashes were property damage only or minor injury crashes. The graph below displays the percentage of crash severities for each year.



The estimated economic cost of crashes on this section of road in the five year period is \$1,245,858. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 27 - Cost of Crashes On The Road Between Balaklava and Roseworthy (2014 Values), 2010-2014

Crash Severity	Cost per Crash ²⁵	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	8	\$98,640
Minor Injury	\$18,174	7	\$127,218
Serious Injury	\$340,000	3	\$1,020,000
Fatal	\$7,200,000	0	\$0

16.1.2 Geometry

For the most part, between Balaklava and Roseworthy, the B81 has lane widths of 3.2 to 3.3m but does not offer a sealed shoulder. A sealed shoulder of between 700 and 800mm is provided southeast of Balaklava and a 600mm shoulder northwest of Roseworthy. Measurements between Balaklava and Owen also revealed a section with lane widths of 3m and no sealed shoulders, RAA considers to be unacceptable for a B class road.

²⁵ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.

RAA strongly recommends that the B81 is prioritised for seal extensions to provide lane widths throughout to a minimum of 3.2m and a sealed shoulder of 500mm.

16.1.3 Pavement

The B81 was found to offer a medium to poor ride quality between Balaklava and Roseworthy with a number of bumps, undulations and corrugations in the surface which provided a rough and less comfortable ride to motorists compared with similar class roads in the region. The ride quality was noted to be very bad 29km south of Balaklava where the undulation caused the vehicle to rock when travelling at the posted speed. There were a few exceptions noted where ride quality was smoother along some sections.

The pavement along the B81 was found to offer a medium to coarse texture which should provide adequate to good surface drainage and skid resistance. Bleeding was however found to be a problem, mainly between Owen and Roseworthy where it was noted on many occasions and frequently found in areas that suffered from rutting. Rutting was observed on a few occasions including 4km south east of Balaklava and again between Owen and Roseworthy but was not extensive. The rutting should however continue to be monitored as rut filling may be required in the future.

Edge break was a widespread issue along the B81 between Owen and Roseworthy. Bad edge break was noted on numerous occasions and the resulting edge drop was estimated to be between 30 and 60mm. About 32km south of Balaklava, a section of the highway demonstrated extreme edge break with an estimated drop of around 100mm. The edge break should be repaired as a priority to address safety issues and to prevent loss of the edge of carriageway lines.



16.1.4 Signs & Line Marking

The line marking along the B81 was generally considered to be in a good condition, offering a clear, sharp line. There were exceptions between Owen and Roseworthy where edge break was eating into the edge lines and these will need to be refreshed when the edge break is repaired. A lining conflict was also noted between Owen and Roseworthy where new lines have been marked over existing resulting in conflict about overtaking permissions. The older line marking should be blacked out to avoid confusion as soon as possible.

There was an absence of edge lines between Owen and Roseworthy and it is strongly recommended that seal extension is undertaken to allow the application of an edge line along this section.

The assessment noted a disused railway crossing 33km south east of Balaklava. The signs however indicated the presence of a working crossing and new signage should be installed to indicate that the crossing is disused.

On approach to the intersection with the Thiele Highway, there is no advanced warning of the intersection ahead, which given the length of the B81 would be worth installing to warn motorists to slow on approach, particularly at night when the intersection may be less visible.

16.1.5 Roadside Hazards

Stobie poles were found along the B81 within 3 to 4m of the seal and since these are well within the clear zone, protection should be considered. Culverts however along the B81 have been protected with W beam barrier which is a welcome road safety improvement.

Loose mud was found at a number of intersections along the route where there are farm traffic turning movements and signs warning of deteriorated pavement conditions should be considered since skid resistance is likely to be reduced in the wetter months.

Between Owen and Roseworthy, the assessment noted adverse crossfall in a few areas along the unsealed shoulder. This coincided with water ponding on the shoulder and creates a risk for vehicles running onto the shoulder at speed. It is recommended that the shoulder be regraded at these locations to improve drainage and prevent vehicle pull off to the side if they run onto the shoulder.

16.1.6 Key recommendations

RAA recommend the following treatments for Owen Road:

- Extend the seal to provide a minimum of 3.2m lanes
- Construct a sealed shoulder to a minimum width of 500mm
- Repair pavement edge break / edge drop
- Remove abandoned line marking
- Install “Disused Railway Crossing” signage
- Install warning signs on approach to the intersection with Thiele Highway

- Install warnings signs for slippery road surface
- Grade unsealed shoulders to reduce crossfall

17 Redhill to Brinkworth

This road was surveyed starting at Redhill, travelling through Koolunga and then on to Brinkworth. The trip meter was started at the intersection of Barr Street and Ellis Street in Redhill. This is a low traffic volume road with only 160 vehicles per day. The speed limit between Redhill and Koolunga was 80km/h. On the other side of Koolunga, to Brinkworth the speed limit was increased to 100km/h.

17.1.1 Crash History

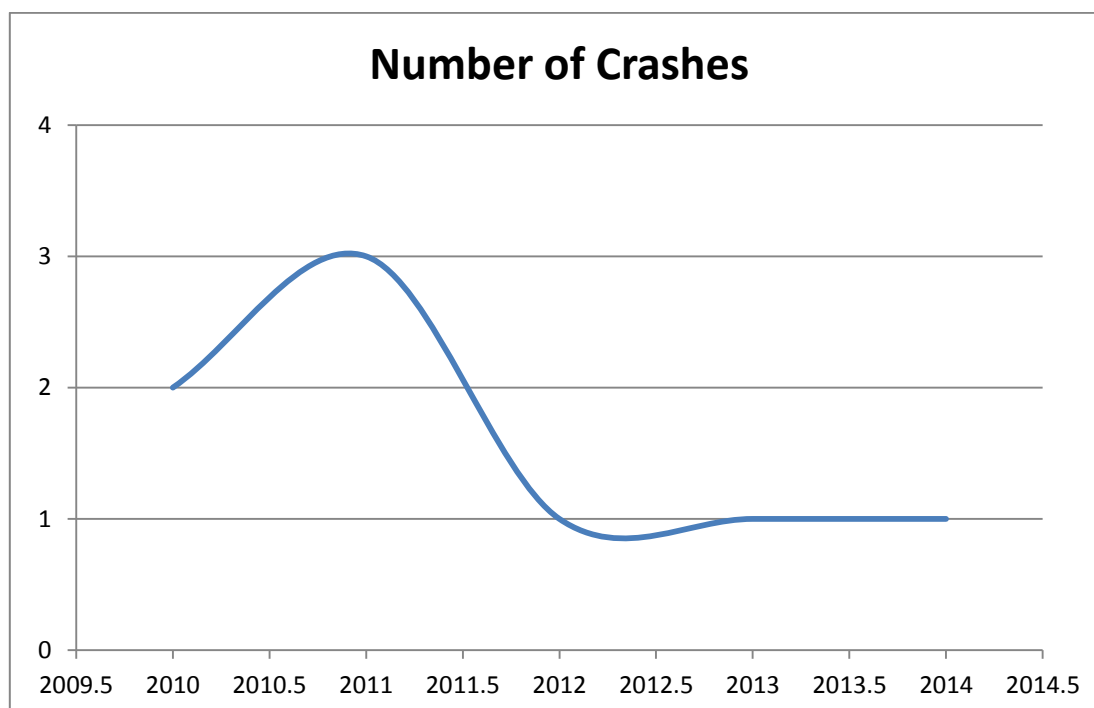


Figure 1: Crashes between Redhill and Brinkworth (2010 to 2014)

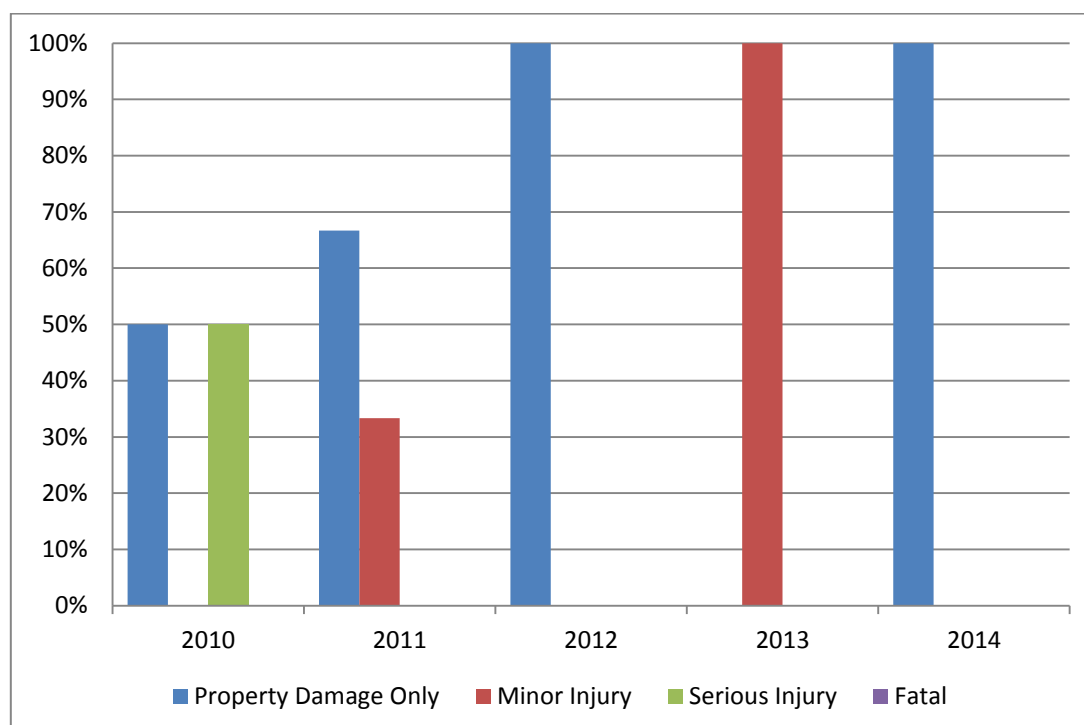
The number of reported crashes on this section of road peaked at 3 in 2011 but has fallen to an average of one per year since. The most common crashes are:

- Hit Fixed Object (3 crashes)
- Hit Animal (2 crashes)
- Rear End / Roll Over / Side Swipe (1 crash each)

The crash history suggests that for the current usage, the road is close to adequate and the priorities are preventing the hit fixed object crashes.



The majority of crashes along the road between Redhill and Brinkworth tend to be mostly property damage only crashes. However, in 2010 a side swipe crash resulted in a serious injury, while in 2011 and 2013 one roll over and one hit fixed object crash each resulted in a minor injury.



The estimated economic cost of crashes for this section of road between 2010 and 2014 is \$437,998. This figure includes losses to workplace and households as well as a

number of medical, insurance, accident investigation, legal and repair costs. The table below breaks down the cost of crashes in the last five years by severity.

Table 28 - Cost of Crashes Redhill to Brinkworth (2014 Values), 2010-2014

Crash Severity	Cost per Crash²⁶	Number of crashes	Total Cost (2014 Values)
Property Damage Only	\$12,330	5	\$61,650
Minor Injury	\$18,174	2	\$36,348
Serious Injury	\$340,000	1	\$340,000
Fatal	\$7,200,000	0	\$0

17.1.2 Geometry

Interestingly the road widths vary markedly on this road due to non-centred line marking. Multiple readings were taken with various widths of approximately 3.3m. A recording at 16.06km showed one lane to be 3.0m and the other to be 3.7m due to the off centre line marking. The unsealed shoulder was between 2.2 and 2.4m depending on location.

17.1.3 Pavement

Between Redhill and Brinkworth the road surface is quite inconsistent with many sections that appear to be in good condition and other sections that have been patched and repaired in places. There are also areas which have been completely resealed at some point in the past. Understandably this provides a varying ride quality but overall was noted to be acceptable when considering the traffic volume of the road. Generally the road is characterised by an average quality surface with medium to coarse texture and some bumps and undulations. In the areas where the road is patched and repaired, the ride is generally bumpier and less comfortable. At some locations there is evidence of rutting under the passenger and driver wheel paths although not to a huge extent. Bitumen bleeding was less common on this section of road and was only present in a couple of areas, approximately 19km and 21km from Redhill.

The most concerning factor on this road is the significant presence of edge break which occurs on almost the entire length of road between Redhill and Brinkworth. The narrow lanes and lack of edge lines have likely been a contributing factor in forming the edge break because of the common occurrence of vehicles hitting the edge of the sealed surface with their tyres. The worst edge break was found on bends. This is likely the result of more vehicles hitting the edge of the bitumen at these locations. The following image shows a typical section of road for this area.

²⁶ Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2015 values. Serious injury and fatal costs derived from AusRAP 2013 'Star Rating Australia's National Roads'. Note that the costs displayed are for each crash type and not for each casualty.



17.1.4 Line Marking, Signs and Delineation

At first appearance, the speed limit between Redhill and Koolunga was only 80km/h however subsequent investigation has found that the posted speed limit is 100km/h however the speed limit signs are missing at the outer boundary of Redhill. The speed limit signs should be reinstated. Hazard marker posts delineate the sides of the roads, and are increased in frequency on the sharpest of the bends. On the eastern side of Koolunga, on the road which travels towards Brinkworth, the speed limit continues at 100km/h. The line marking was very inconsistent, where in some sections it was bright and fairly recently painted, which provided a good contrast to the road surface. In other sections, especially around the Koolunga area it was quite faded. It was noted on the southern side of Koolunga that the line marking appeared to be not quite centred as one lane was measured to be significantly wider than the other.

17.1.5 Roadside Hazards

The roadside in general was quite open as a result of the farm land surroundings. This gave good visibility of the immediate area in most locations. There were a number of roadside hazards identified during the road assessment. First noted was the stobie poles that run along the left hand side of the road and are set back approximately 3 to 5m from the road. These Stobie poles are a significant crash hazard. On the southern side of the intersection with Collinsfield Road, the shoulders appeared to consist of quite large loose material which could be both slippery when hitting at speed and also a hazard for flicking up rocks onto oncoming vehicles. Warning signage of loose stones was noted at the time of assessment.

On the last few kilometres prior to Brinkworth foliage in the area became more significant which is both a hazard for run off road crashes and also animal crashes. Along with the increase in roadside foliage, there is also a drainage channel of up to 300mm, which is set back approximately 3m.

17.1.6 Key Recommendations

RAA recommend the following treatments for the Brinkworth to Redhill Road:

- Install 100km/h speed limit signs on departure from Redhill
- Refresh centre line.
- Lane and shoulder widening.
- Edge of carriageway lines.

- Repair to significant edge break and edge drop.

18 Brinkworth to Snowtown

The Brinkworth to Snowtown Road runs in a east-west direction for 26km connecting Snowtown to the B82 Horrocks Highway. The route consists of a join between Blyth Road and Burnsfield Road. Between 120 and 550 vehicles travel along the road per day with 12.5 to 18 percent of which is heavy traffic.

18.1.1 Crash History



There was only one hit animal crash in 2011 which was reported within the 5 year period. The crash was property damage only and did not cause any injury to the occupants. There were no recorded casualty crashes for this stretch of road. The estimated economic cost is \$12,330.

18.1.2 Geometry

Measurements along the road between Brinkworth and Snowtown showed that lane widths varied between 3.3 and 3.4m with a 300mm to 500mm sealed shoulder and 1.3m to 1.7m unsealed shoulder. These dimensions are considered adequate for the class of road and the volume of traffic however seal extension is recommended on bends. For a section of about 5km east of Snowtown, the sealed shoulders were noted to fall to

around 200mm wide and it is highly recommended that seal extensions are undertaken to provide a sealed shoulder of between 300 and 500mm.



18.1.3 Pavement

Bitumen bleed and texture polishing was found under the wheel paths along many sections of the road. This coincided with some bad rutting which has resulted in noticeable deformation of the pavement surface. It was noted that some sections had benefitted from patch repair work however the bleeding was beginning to show again in the repaired surface.

The assessment also identified edge crumbling and in a few instances, evidence of the pavement breaking towards the centre of the road. In some areas edge drop of between 40 and 50mm was observed. It is recommended that repairs are undertaken to improve the edge of the pavement and rut filling is also considered.

Despite the pavement defects, the ride quality was good on the run and the pavement provided a reasonably smooth surface with few significant undulations.

18.1.4 Signs & Line Marking

The quality of the line marking between Brinkworth and Snowtown was good, providing a clear and solid line both down the centre of the carriageway and along the edge lines.

The assessment noted that the speed limit signs at Churches Road has been damaged and require replacement.

18.1.5 Roadside Hazards

Stobie poles were found to run along the road and carried between 3 and 5m from the edge of the seal. Poles close to the edge of the road and particularly on bends should be protected to minimise the severity of a run-off road crash.

There was at least one culvert along the road which appeared to be marked with hazard marker posts but did not benefit from protection at the headwalls.

18.1.6 Key recommendations

RAA recommend the following treatments for the Brinkworth to Snowtown Road:

- Extend sealed shoulders to a minimum of 300mm
- Repair pavement edge break
- Replace speed limit signs at Churches Road
- Install barrier protection for culverts

19 Summary & Recommendations

RAA has undertaken an extensive review of the B-class road network for the Mid North region of SA. The review has sought to assess the level of safety built into each of the roads driven while also assessing their driveability from the road user's perspective.

A summary of the key recommendations are provided in Table 29 below.

Generally, the speed limits throughout the network were considered appropriate for the conditions and geometry of the highway. The exception was the Flinders Ranges Way which was posted at 110km/h however the assessment was largely carried out at 100km/h along this route as it was felt to be safer primarily due to the winding nature of the road and steep drops between Stirling North and Hawker but also because of the narrow lane widths between Hawker and Quorn.

Narrow lane widths and lack of sealed shoulders was identified as common issues across most of the roads in the network. The B-class network typically accommodates higher traffic volumes and greater proportions of heavy vehicles than the minor routes, RAA therefore considers lane widths of at least 3.5m with a 300 to 500mm sealed shoulder should be provided. For the minor routes, lane widths of 3.2m would be considered acceptable however sealed shoulders of a minimum of 300mm should be provided. Until such time as funds are available to upgrade the network to this benchmark, RAA would welcome the application of seal extensions on bends, recognising that there is a greater risk of run-off road crashes on bends and safely passing heavy vehicles on bends can be a challenge on the narrower roads.

The assessment found that roads subject to a 110km/h speed limit did offer the minimum desirable lane widths RAA wish to see on the B-class network. The one exception was the Flinders Ranges Way between Quorn and Hawker which had narrower than desired lane widths of 3.2m. While these roads also had edge lines, at some locations, the lines were worn or faded and required refreshing.

Asphalt edge break and edge drop has been flagged as an issue across the network but particularly on roads such as RM Williams Way where drops between the sealed and unsealed surfaces in excess of 100mm were recorded. Edge drop can be dangerous as it can make recovery of the vehicle onto the seal at speed difficult and has been known to cause blowouts where the depth of the edge drop is severe.

Barrier installation has been widely recommended across the network. Many roads have had a significant amount of money invested in barrier systems and RAA welcomes the extensive program of barrier installation that has run in the last few years. There however remain numerous roadside hazards that desperately require protection and there are frequent sombre reminders across the network of fatal crashes which have involved hitting fixed roadside objects, particularly on bends.

Many of the other recommendations broadly relate to good housekeeping in terms of issues such as signs and line marking. The generally tend to be relatively low cost projects and can be undertaken in the short term. RAA would welcome the timely resolution of these issues being addressed.

Table 29 – Summary of Recommendations

Highway / Road	Section	Road Geometry & Pavement							Signs							Speed Zones	Linemarking			Delineation			Intersections		Hazard Protection											
		Increase lane widths to 3.2m minimum	Increase lane widths to 3.5m minimum	Construct sealed shoulder to 300mm minimum	Construct sealed shoulder to 500mm minimum	Construct sealed shoulder to 1m minimum	Pavement rehabilitation	Undertake rut filling program	Repair pavement edge break / edge drop	Unsealed shoulder rehabilitation	Unsealed shoulder grading	Drainage improvements	Review / install intersection warning signage	Review / install bend warning signage	Review /install warning signs for slippery surface conditions	Review / install animal warning signage	Review, upgrade or install railway crossing signage	Install depth markers at floodways	Replace fading signage	Repair / replace damaged signage	Speed limit reduction to 100km/h	Refresh linemarking	Apply edge of carriageway lines	Blackout abandoned linemarking		Audio Tactile Line Marking (ATLM)	Additional hazard marker posts	Repair damaged hazard marker posts	Install Raised Reflective Pavement Markers (RRPMS)	Replace missing or damaged Raised Reflective Pavement Markers (RRPMS)	Intersection upgrade	Rail crossing upgrade				
B84 (Multiple Roads)	Eudunda to Port Wakefield				✓					✓			✓														✓							✓		
B82 Horrocks Highway	Clare to Birkworth																																	✓		
	Georgetown to Murray Town		✓																															✓		
	Murray Town to Wilmington	✓																																✓		
	Wilmington to Quom																																	✓		
	Birkworth to Georgetown		✓																															✓		
B83 Finlins Ranges Way	Port Augusta to Quom																																	✓		
	Quom to Hawker																																	✓		
B84 Goyder Highway	Spalding to Morgan																																	✓		
	Spalding to Gullare																																	✓		
	Gullare to Crystal Brook																																	✓		
B89 Spender Highway	Port Pirie to Port Broughton	✓																																	✓	
B79 Wilkins Way	Gladstone to Jamestown																																	✓		
B80 RM Williams Way	Hawker to Orroroo																																	✓		
	Spalding to Clare																																	✓		
	Jamestown to Spalding		✓																															✓		
B81 Thiele Highway	Eudunda to Kapunda																																	✓		
Worlds End Highway																																		✓		
Clements Road & Gadd Avenue																																		✓		
Eudunda to Robertstown Road		✓																																✓		
Marabel Road	Kapunda to Marabel																																	✓		
Lochiel to Clare																																		✓		
Orroroo to Laura																																		✓		
Over Road	Balldarra to Roseworthy																																	✓		
Redhill to Birkworth																																		✓		
Birkworth to Snowtown																																		✓		
Application of treatment should be prioritised on bends.																																		✓		
② A specific location as identified in the report.																																		✓		

① Application of treatment should be prioritised on bends.

② At a specific location as identified in the report.

Table 30 summarises the crash costs for each of the sections of highway surveyed during the assessment. The table examines the traffic volumes, length of section and the estimated cost due to crashes in the 5 year period between 2010 and 2014. A crash cost ranking has been calculated based on the length of the road and the average annual daily traffic volume on the road, to provide an indication of the order in which the roads should be prioritised for funding; number 1 being one of the worst performing roads in need of attention and number 27 being one of the best performing. This value is determined by dividing the estimated crash cost by the product of the length of the road and the traffic volume. Obviously it would be expected that a length of road which is longer and carries a higher traffic volume than another would have a higher crash rate, but not necessarily a higher cost ranking when looking at the data in this way. Note this ranking is just an indication, and is subject to interpretation. It is estimated that these roads alone have an estimated crash cost total of \$62,647,054. The full table has been included in Appendix A.

Table 30 – Summary of Recommendations

Road	Traffic Volume (vpd)	Length of Road (km)	Total Crashes	Estimated Crash Cost	Crash Cost Ranking
Eudunda to Robertstown	420	22	7	\$7,601,650	1
B82 Georgetown to Murray Town	650	52.4	15	\$8,057,180	2
B81 Eudunda to Kapunda	1200	27.3	12	\$7,359,006	3
B89 Port Pirie to Port Broughton	900	56.4	26	\$9,158,288	4
B64 Spalding to Gulnare	330	15	3	\$692,330	5
B84 (Multiple Roads)	1200	102.7	44	\$16,281,136	6
Redhill to Brinkworth	160	29.1	8	\$437,998	7
Lochiel to Clare	135	45	13	\$517,180	8
B82 Brinkworth to Georgetown	600	38.4	12	\$1,809,686	9
B83 Port Augusta to Quorn	1200	31.7	41	\$2,541,678	10
B64 Gulnare to Crystal Brook	490	25.3	11	\$808,502	11
B79 Gladstone to Jamestown	700	28	21	\$970,710	12
B82 Clare to Brinkworth	900	31.8	24	\$1,313,994	13
B80 Hawker to Orroroo	240	108	12	\$1,142,658	14
B80 Spalding to Clare	700	39	4	\$704,660	15
B64 Spalding to Burra	400	43	5	\$401,008	16
Kapunda to Marrabel	700	24	4	\$388,678	17
B64 Burra to Morgan	390	84.8	17	\$572,344	18
Port Broughton to Crystal Brook	370	20	7	\$92,154	19
B80 Jamestown to Spalding	550	34.2	13	\$189,510	20
Balaklava to Roseworthy	2100	59	18	\$1,245,858	21
Worlds End Highway	145	29.9	3	\$42,834	22
B83 Quorn to Hawker	340	66	12	\$159,648	23
Orroroo to Laura	200	62	3	\$48,678	24
B82 Murray Town to Wilmington	600	38.1	4	\$61,008	25
B82 Wilmington to Quorn	500	39.6	2	\$36,348	26
Brinkworth to Snowtown	335	26	1	\$12,330	27
			Total	\$62,647,054	

It is also worth noting that RM Williams Way was considered to be the worst road in the region according to RAA's 2013 Risky Roads campaign, while also demonstrating some of the worst edge break and poorest quality shoulders during our assessment. It is therefore recommended that RM Williams Way should also be considered a regional priority for upgrading.

Appendix A – Mid North Crash Cost Rankings



2013

Note: Top three of each category are highlighted with orange colouring. The bottom three are highlighted in blue.

Road	Traffic Volume (vpd)	Length of Road (km)	Total Crashes	Estimated Crash Cost	Cost per Length	Cost per Volume	Cost Ranking per (length x Volume)	Crashes per km	Crash Cost Ranking
Eudunda to Robertstown	420	22	7	\$7,601,650	\$345,529.55	\$18,099.17	822.7	0.3	1
B82 Georgetown to Murray Town	650	52.4	15	\$8,057,180	\$153,762.98	\$12,395.66	236.6	0.3	2
B81 Eudunda to Kapunda	1200	27.3	12	\$7,359,006	\$269,560.66	\$6,132.51	224.6	0.4	3
B89 Port Pirie to Port Broughton	900	56.4	26	\$9,158,288	\$162,380.99	\$10,175.88	180.4	0.5	4
B64 Spalding to Gulnare	330	15	3	\$692,330	\$46,155.33	\$2,097.97	139.9	0.2	5
B84 (Multiple Roads)	1200	102.7	44	\$16,281,136	\$158,531.02	\$13,567.61	132.1	0.4	6
Redhill to Brinkworth	160	29.1	8	\$437,998	\$15,051.48	\$2,737.49	94.1	0.3	7
Lochiel to Clare	135	45	13	\$517,180	\$11,492.89	\$3,830.96	85.1	0.3	8
B82 Brinkworth to Georgetown	600	38.4	12	\$1,809,686	\$47,127.24	\$3,016.14	78.5	0.3	9
B83 Port Augusta to Quorn	1200	31.7	41	\$2,541,678	\$80,179.12	\$2,118.07	66.8	1.3	10
B64 Gulnare to Crystal Brook	490	25.3	11	\$808,502	\$31,956.60	\$1,650.00	65.2	0.4	11
B79 Gladstone to Jamestown	700	28	21	\$970,710	\$34,668.21	\$1,386.73	49.5	0.8	12
B82 Clare to Brinkworth	900	31.8	24	\$1,313,994	\$41,320.57	\$1,459.99	45.9	0.8	13
B80 Hawker to Ororoo	240	108	12	\$1,142,658	\$10,580.17	\$4,761.08	44.1	0.1	14
B80 Spalding to Clare	700	39	4	\$704,660	\$18,068.21	\$1,006.66	25.8	0.1	15
B64 Spalding to Burra	400	43	5	\$401,008	\$9,325.77	\$1,002.52	23.3	0.1	16
Kapunda to Marrabel	700	24	4	\$388,678	\$16,194.92	\$555.25	23.1	0.2	17
B64 Burra to Morgan	390	84.8	17	\$572,344	\$6,749.34	\$1,467.55	17.3	0.2	18
Port Broughton to Crystal Brook	370	20	7	\$92,154	\$4,607.70	\$249.06	12.5	0.4	19
B80 Jamestown to Spalding	550	34.2	13	\$189,510	\$5,541.23	\$344.56	10.1	0.4	20
Balaklava to Roseworthy	2100	59	18	\$1,245,858	\$21,116.24	\$593.27	10.1	0.3	21
Worlds End Highway	145	29.9	3	\$42,834	\$1,432.58	\$295.41	9.9	0.1	22
B83 Quorn to Hawker	340	66	12	\$159,648	\$2,418.91	\$469.55	7.1	0.2	23
Ororoo to Laura	200	62	3	\$48,678	\$785.13	\$243.39	3.9	0.0	24
B82 Murray Town to Willemington	600	38.1	4	\$61,008	\$1,601.26	\$101.68	2.7	0.1	25
B82 Willemington to Quorn	500	39.6	2	\$36,348	\$917.88	\$72.70	1.8	0.1	26
Brinkworth to Snowtown	335	26	1	\$12,330	\$474.23	\$36.81	1.4	0.0	27
Total				\$62,647,054					

Appendix B – Mid North Freight Routes (2013)

Road Assessment



2013

In 2013, RAA undertook an assessment of the Mid North Freight Routes which encompassed four main sections of road: B79 from Barrier Highway to Mannanarie, B79 from Jamestown to Highway One, B80 from Jamestown to Orroroo, and B56 Orroroo to Winninowie.

1.0 B79 Barrier Highway to Mannanarie (2013)

This section of road is 38km long and was driven predominately in a westerly direction. It starts at the intersection of the Barrier Highway and the Wilmington-Ucolta Road, passes through Peterborough and Yongala, and finishes in the town of Mannanarie.

1.1 Lane Widths

The Mid North Freight Routes are considered to be major freight corridors, and as such should have lanes with a minimum width of 3.5 metres. The RAA has recognised the seasonal usage of these freight routes and the overall low traffic volumes of each road, and as such have suggested in *Towards 2020* that minimum lane widths of 3.4 metres, and sealed shoulder of no less than 1 metre would be adequate.

During the 2013 audit it was noted that lane widths around the beginning of this section of road, between the Barrier Highway and Peterborough are very narrow, at only 2.7 metres, with 0.3 metres of sealed shoulder. There is also a short section of road approximately 10km from the Barrier Highway that does not have edge lines, resulting in a 3.0m wide lane and no sealed shoulder. Lane widths increase to the west of Peterborough, where they are 3.4 metres with 1m of sealed shoulder, therefore meeting minimum requirements suggested in *Towards 2020*.

Overall the lane widths through this section of road did feel narrow, especially near the Barrier Highway intersection. Negotiating corners at speed and passing heavy vehicles travelling in the opposite direction was harder than it should have been, and would present a risk for other motorists. RAA recommends increasing the shoulder width east of Peterborough to provide minimum lane width of 3.4 metres.

1.2 Pavement

The surface conditions of this section of road between the Barrier Highway and Mannanarie were considered to be acceptable. There were no signs of significant aggregate loss, no rutting, and no noticeable undulations. There were a couple of instances of patching on the edge of the roadway; however this did not affect ride quality. This is interesting, as *Towards 2020* had noted that the section of road between the Barrier Highway and Yongala (13km prior to Mannanarie) is one of the worst in the Mid North Freight Routes, with levels of roughness and rutting well below the accepted technical standards. This therefore needs to be corroborated with the latest Hawkeye road quality data. The Hawkeye data is a series of still photos recorded every 100m on a survey vehicle and is used to code the AusRAP model which produces star ratings to indicate the level of safety built into the road along the national highway network.



Figure 2: A section of road between the Barrier Highway and Peterborough. Surface conditions and line markings are good; however the lanes and shoulder seals are narrow.

Line marking was also considered generally acceptable through this section of road. There were a couple of instances of missing edge lines, at the 94km maintenance marker and the 90km maintenance marker prior to Peterborough. It appeared that the local authorities were in the process of re-painting these edge lines as a line-painting truck was seen in the process of edge line painting during the audit.

1.3 Roadside Hazards

Towards 2020 states that roadside hazards have been addressed, and this was supported by the 2013 highway audit for this section of the road. There were minimal roadside hazards identified, besides some isolated circumstances of medium sized trees set back 3-4 metres from the edge of the road seal. These were located close to the intersection with the Barrier Highway and also 13km from Mannanarie, and 3km from Mannanarie. One large tree was seen, however this was protected by hazard boards.

There was no evidence of hazards such as stobie poles, or unprotected drop offs on the side of the road. There was some small to medium sized vegetation on the sides of the road in various sections which could cause an animal hazard, however there was no evidence of road kill on the road.

1.4 Crash History

The Crash statistics with known GPS locations, recorded in the 5 year period between 2009 and 2013 show an average of 2.25 crashes per year. The majority of the crashes occurred in 2010 or 2011 (7 of 9) whilst 2012 had no recorded crashes. Run off road incidents that resulted in hitting fixed objects or roll overs are the most serious crashes. 5 of 9 were vehicle damage only crashes. There are no recorded fatalities for this section of road between 2009 and 2013. One third of all crashes were side swipes and may have some correlation with the narrow lane widths.

Table 31: Crashes between Barrier Highway and Mannanarie (2009-2013)

Crash Severity	Crash Type				
	Hit Fixed Object	Right Angle	Roll Over	Side Swipe	Grand Total
Property Damage Only		2		3	5
Minor Injury	2				2
Serious Injury	1		1		2
Grand Total	3	2	1	3	9

1.5 Key Recommendations

- Increase to minimum 3.4m lane width between Barrier Highway and Peterborough.

2.0 B79 Jamestown to Highway One (2013)

This section of road is 48km long and was also driven in a westerly direction. It starts at Jamestown and passes through Caltowie and Gladstone, before finishing at the intersection of Highway A1 and Warnertown-Jamestown Road (B79).

2.1 Lane Widths

As with all sections of the Mid North Freight Routes, lane widths of 3.4 metres and sealed shoulders of 1 metre are considered acceptable by the RAA in *Towards 2020*. Through the 2013 highway audit it is apparent that this section of road is close to meeting these minimum requirements.

The beginning of this road had adequate lane widths of 3.5 to 3.6 metres, which drops to 3.3 to 3.4 metres after the 27km maintenance marker. Shoulder seals start at 0.2 to 0.5 metres which is significantly narrower than the recommended shoulder seal of 1 metre. However, this increases to varying seal widths between 0.7 and 1.1 metres, which is considered adequate when combined with acceptable lane widths. This section of road would benefit from increasing sealed shoulder widths to 1 metre or above for the entirety of its length.

2.2 Pavement

The pavement conditions through this section of the Mid North Freight Routes appeared to be significantly worse than the Barrier Highway to Mannanarie section of road analysed in the 2013 highway audit. The road is characterised by undulations, surface failures, and aggregate loss, together with faded and missing line markings. This is identified in *Towards 2020*, where the road between Jamestown and Gladstone is mentioned to be one of the worst for roughness and rutting.

The most prevalent issue encountered along this section of road was the loss of surface aggregate. This results in a road surface which is very dark and smooth, reducing the friction between the road and a car tyre, which can be dangerous in wet conditions or

when cornering at speed. Aggregate loss in this section of the road was so bad that it often created a situation where the road line markings could no longer be seen, which causes a danger of vehicles accidentally moving out of their lane into oncoming traffic or onto the unsealed shoulder. Figure 3 below shows a section of road with severe stripping of aggregate and poor line marking quality.



Figure 3: Aggregate loss in the road surface resulting in line markings which cannot be seen.

Road surface aggregate loss was evident every 5-10km between Jamestown and Highway A1. In some cases it lasted for a kilometre or more.

Road patching is another significant pavement surface issue for this section of road. The road is patched in many sections due to previous road failure which creates a bumpy and inconsistent ride for drivers. There are also many sections of the road where patching has occurred over the edge lines or centre lines of the road and the lines have not been repainted, mainly in the second half of this section of road after Gladstone. Missing centre lines are of particular concern and should be addressed as an issue of high priority. There are particularly long sections of missing centre lines after Gladstone close to the intersection with Highway A1, as can be seen below in figure 4.



Figure 4: A long section of road with no centre line, just prior to the intersection with Highway A1.

2.3 Roadside Hazards

Roadside hazards along the section of road between Jamestown and the intersection with Highway A1 include stobie poles, trees, areas of dense vegetation, and unprotected drop offs on the side of the road.

Of highest concern is the high number of unprotected stobie poles and trees which are situated close to the side of the road in this section of the Mid North Freight Routes. In places these approach as close as 3 metres from the edge of seal, and are common and evenly spaced along the entire 48km between Jamestown and Highway A1. This is hazardous as it increases the chance of a serious crash resulting from a vehicle running off the road. These significant roadside hazards should ideally be either relocated, or protected with W-Beam railing when within 5 metres of the seal. Figure 5 below shows the stobie poles in close proximity to the road.

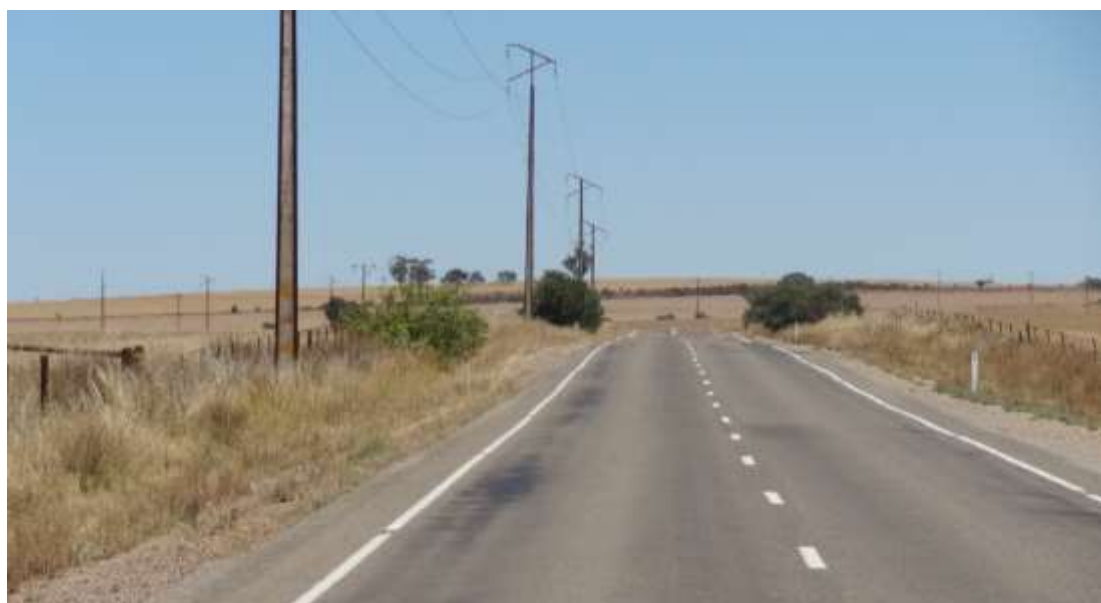


Figure 5: Roadside hazards of stobie poles and trees.

As with previous sections of road, dense vegetation close to the side of the road can cause an animal hazard; however there was no evidence of road kill on this section of road. Also of concern is one instance of a steep drop off on both sides of the road which was unprotected near the 11km maintenance marker. In *Towards 2020* the RAA estimated that the installation of safety barriers for roadside hazards could reduce run-off road crashes by 40%, and as such it should be an issue of high priority to provide protection for all of these hazards.

2.4 Crash History

The 5 year period between 2009 and 2013 shows a total of 40 crashes. This gives an average of 8 crashes per year on this section of road, however in 2011 there were 10 crashes recorded. Run off road incidents that resulted in hitting fixed objects were the most frequent types of collision (16 out of 40) which also happen to account for more of the serious crashes (along with roll over crashes). This further reinforces the need to reduce roadside hazards. Interestingly, there were no recorded fatalities between 2009 and 2013. There were a small number of “Hit animal” crashes recorded. Table 2 displays the number of crashes between Highway A1 and Jamestown.

Table 32: Crashes between Highway One and Jamestown (2009-2013)

Year	Vehicle Damage	Minor Injury	Serious Injury	Grand Total
2009	3	2	3	8
2010	1	5	1	7
2011	7	2	1	10
2012	5	3		8
2013	3	3	1	7
Grand Total	19	15	6	40

2.5 Key Recommendations

- Increase sealed shoulder width to 1.0m throughout.
- Additional protection for unprotected hazardous drops.
- Pavement rehabilitation of the particularly bumpy or stripped surfaces
- Refresh line marking.

3.0 B80 Jamestown to Orroroo (2013)

The section of road between Jamestown and Orroroo is part of the highway known as R.M. Williams Way. This section is 57km long and was driven in a northerly direction starting at Jamestown, traveling north through Mannanarie, Yatina, and Black Rock before finishing at Orroroo.

3.1 Lane Widths

Lane widths of this section of the Mid North Freight Routes were just below the desired minimum of 3.4 metres for the majority of the 57km. Lane widths were between 3.2 and 3.4 metres, with the 10km, prior to Orroroo, widening to 3.4 to 3.5 metres. It was noted that more than half of the 57km has no sealed shoulder, which can be hazardous when lane widths of only 3.2 metres are encountered. There is a noticeable camber on the unsealed shoulder at numerous locations, where the side of the road slanted down from the road seal away from the road. This creates a situation where a motorist would find it very difficult to recover their vehicle if they were to accidentally move onto the unsealed shoulder of the road. Also, at these locations, a significant ridge was noticed between the sealed surface and the unsealed shoulder, which once again would make it difficult to move back into the driving lane if a wheel was dropped onto the unsealed shoulder. This also significantly increases the risk of tyre sidewall damage and potential blowout.

These conditions are hazardous for drivers and a solution would be to flatten and seal the shoulders for the entire length of this section of road.

3.2 Pavement

The pavement conditions through the section of road between Jamestown and Orroroo are typical of the Mid North Freight Routes. The surface is continually changing between poor and acceptable, with random sections of aggregate loss, repairs and patchwork. While this section of road is in better condition than the opposite side of Jamestown, towards Highway A1, there is still room for improvement especially just north of Jamestown and around Yatina where the ride quality is considered very poor due to undulations and surface failure together with patching.

Significant signs of aggregate loss were evident just north of Jamestown, which was an area of road that was noted as having the worst pavement conditions for this section of road, giving a bumpy ride due to significant undulations. More significant aggregate loss was evident around the 34km maintenance marker. The area of road with the worst levels of surface failure and patchwork causing an inconsistent ride was around Yatina.

3.3 Roadside Hazards

Roadside hazards for the section of road between Jamestown and Orroroo are similar to previous sections of road but not as severe. There are isolated instances of large trees and significant bushes; however there are no unprotected stobie poles or unprotected

drops to the side of the road. This section of road is characterised by consistent small scale shrubbery lining the sides of the road which causes a medium hazard for vehicles running off the road, and a hazard for concealing animals that may run out in front of a vehicle. However, there were no animals or road kill witnessed during the audit along this section of road.

A few instances of significant unprotected trees were evident in the 10km north of Jamestown, and 5km prior to Black Rock. One such instance is displayed in figure 6 below.



Figure 6: *Small to medium sized shrubbery lining the sides of RM Williams Way.*

3.4 Crash History

For this road in the 5 year period between 2009 and 2013 there were more crashes occurring on the sections of road near to, or in the local towns when compared to the highway in between. There were a total of 15 reported crashes for this 5 year period, with 8 crashes reported in Jamestown and 4 in Orroroo. The remaining 4 crashes occurred on sections of the highway between. Table 3 below shows right angle crashes were the most common type of crash. This again shows the high number of crashes occurring in the town rather than the highway; as right angle crashes are more common on intersections. There was only one fatal crash which was a head on collision.

Table 33: Crashes between Jamestown and Orroroo (2009-2013)

Crash Severity	Crash Type					
	Head On	Hit Animal	Hit Fixed Object	Right Angle	Roll Over	Grand Total
Property Damage Only		2	3	6	1	12
Minor Injury		1		1		2
Fatal	1					1
Grand Total	1	3	3	7	1	15

3.5 Key Recommendations

- Increase sealed shoulder width to 1.0m throughout.
- Additional protection for unprotected hazardous drops.
- Pavement rehabilitation of the particularly bumpy or stripped surfaces north of Jamestown and near to Yatina.

4.0 B56 Orroroo to Winninowie (2013)

This section of road is the final section driven in the 2013 highway audit. It is 70km in length and was driven in a westerly direction, from Orroroo through Morchard, Willowie, and Wilmington, before passing through Horrocks Pass and finishing at the intersection with Highway A1.

4.1 Lane Widths

This section of the Mid North Freight Routes once again mainly has lane widths which are just below the minimum width of 3.4 metres as suggested by the RAA in *Towards 2020*. Of highest concern is the section of road passing through the mountains just north of Mt. Remarkable, known as Horrocks Pass. This section of road has an AusRAP rating of just two stars, due to narrow lanes, tight bends and roadside hazards.

On a positive note, the section of road between Orroroo and Winninowie has edge lines and some degree of sealed shoulder for the entire length of the road, which is good when compared to other sections of the Mid North Freight Routes. Lane widths vary between 3.0 and 3.3 metres, and sealed shoulders are between 0.3 and 0.4 metres prior to and through Horrocks Pass. For the section of road just after Horrocks Pass the road lane width widens to around 3.7 metres, and sealed shoulders increase to between 1 and 2 metres, which is above the recommended minimum. After this lanes continue at 3.7 metres and sealed shoulder of 0.3 metres for the remaining 9km of road.

Improvements for this section of road would include increasing lane and sealed shoulder widths, especially for the section of road through Horrocks Pass, which is hazardous for drivers in its current state because of narrow winding lanes with numerous unprotected drops and roadside hazards.

4.2 Pavement

Surface pavement conditions through the section of road between Orroroo and Winninowie are generally good. *Towards 2020* indicated that pavement conditions were poor around Orroroo and between Wilmington and Winninowie, however this was not noticed during the 2013 audit, especially compared to other sections of road which were significantly worse. There was minimal aggregate loss or surface failure. Evidence of pavement repair and patching were noted on a few sections of the road; however they were not significant enough to greatly affect ride quality.

4.3 Roadside Hazards

Roadside hazards are a problem of concern for this section of the Mid North Freight Routes. There are significant unprotected trees evident just after Orroroo, just after Wilmington, and through the section of Horrocks Pass. Close vegetation to side of the road is also an issue for road run-offs and concealing animals which may move onto the road, although once again there was no evidence of road kill.

Roadside drop offs were the most significant and frequent hazard noted on this section of road, especially through Horrocks Pass. There are parts of the road which have large drops of up to 2-3 metres very close to the sides of the road. These were often protected by W-Beam barriers, however some were not. This hazard is compounded by the nature of the road, having narrow lanes, minimal shoulder seal widths, and tight bends for vehicles which are travelling at speeds of up to 100km/h, as is the speed restriction through this area. Due to the tight bends and hazards, recommended speeds around bends are as low as 45km/h, however the speed limit is still 100km/h, and as such some aggressive motorists may attempt to drive at this speed.

It is clear that much work has been done in an attempt to improve the safety of the Horrocks Pass. There are long sections of W-Beam railing protecting from drops and significant trees, and there is a lot of signage warning of narrow roads, tight bends, directional boards, and suggested speeds. To improve the safety of this dangerous section of road W-Beam barriers should be considered for the entire length of Horrocks Pass, protecting from all roadside drop offs and vegetation hazards. Another improvement to consider would be to reduce the speed limit in this area to 80km/h, rather than simply suggesting slower speeds. It is a short section of road, as such a slower speed limit will have minimal effects on motorists and would benefit tourists or anyone who isn't familiar with the layout of the road. Figure 7 below displays a section of Horrocks Pass with a large unprotected drop in close proximity to the road.



Figure 7: A section of Horrocks Pass with a large unprotected drop on the side of the road. Provided W-Beam railing does not fully protect this hazard. Suggested speed sign reads 45km/h (Google Street view 2009).

4.4 Crash History

The Crash statistics with known GPS locations recorded in the 5 year period between 2009 and 2013 show more crashes occurring on the Horrocks Pass section of road, when compared to the Orroroo to Wilmington section, despite it being a shorter section of road.

For Horrocks Pass in the 5 year period there was an average of 3 crashes per year. In 2013, 5 crashes were recorded; however in 2010 only 1 crash was recorded. Run off road incidents that resulted in roll over or hitting fixed objects were the most frequent types of crash and reinforce the need for more W-Beam railing. Hit fixed object crashes result in the most fatalities and have accounted for all 3 of the fatal crashes in the 5 year period.

For Orroroo to Wilmington, the 5 year period shows an average of only 1.6 crashes per year. The number of crashes on this section of road fluctuated between 1 and 3 crashes with the maximum of 3 occurring in 2010. Run off road incidents that resulted in roll over or hitting fixed objects were again the most frequent types of collision. There were no fatalities recorded for this section of road within the 5 year period.

4.5 Key Recommendations

- Increase sealed shoulder width to 1.0m throughout.
- Additional protection for unprotected hazardous drops.
- Consider speed limit reduction throughout Horrocks Pass.

Appendix C – Pavement Performance Factors



Overview of Pavement Properties

Roughness

The pavement roughness refers to the irregularities in the road's surface in the direction of travel. These irregularities vary from 0.5 to 50m long and are measured in relation to the intended road surface and recorded in terms of the International Roughness Index (IRI). As the IRI increases, it indicates a rougher pavement surface which will produce an uncomfortable ride for the vehicle's occupants through bumps and undulations. Figure 1 shows the longitudinal profile of a road with an exaggerated surface. The red line indicates the intended surface level and the difference between the lines is the measured roughness.

The roughness is not only important for the ride quality experienced by the motorist but prolonged vehicle exposure to a rough road may also increase wear, maintenance and fuel consumption.

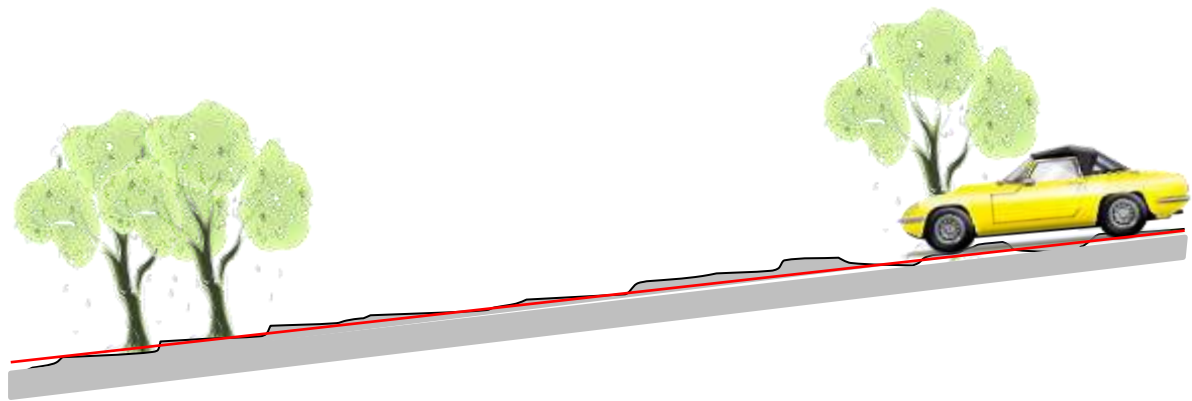


Figure 1 – Longitudinal Road Section

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Rutting

A rut is a defect in the form of a longitudinal depression in the pavement surface. It usually occurs in the wheel path of vehicles (Figure 2) and is caused by high volumes of heavy vehicles over time. Ruts can also form as a result of environmental influences such as extensive rainfall combined with a poorly sealed surface. This can permit moisture to enter the pavement foundations which can weaken the structure or cause movement in the soil beneath, both of which can lead to rutting.

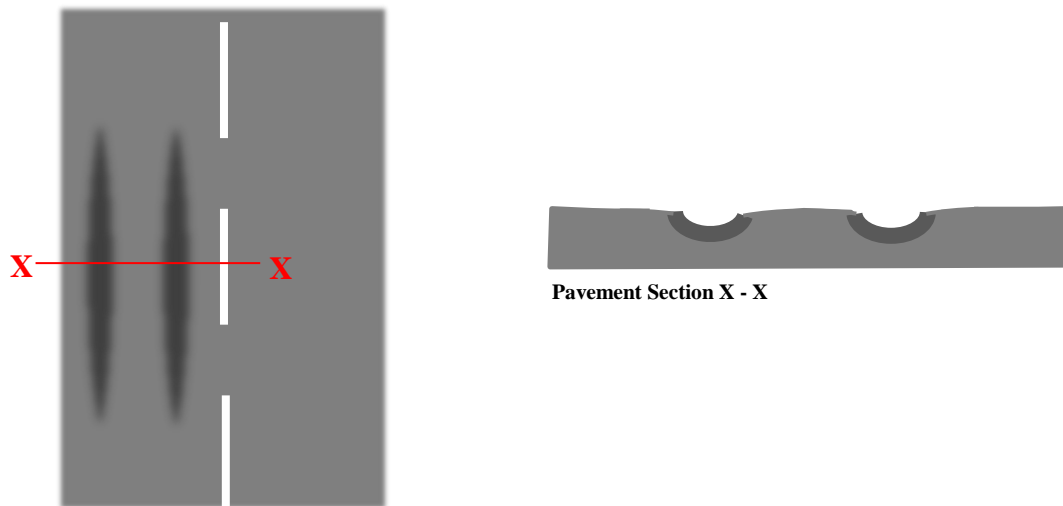


Figure 2 – Pavement Rutting

While rutting can lead to further pavement deterioration, several other problems may also arise as a result. Deep ruts can cause a “guide channel” for wheels and drivers may experience reduced steering performance or have difficulty with trailers tracking the vehicle. Ruts are also prone to filling with water which can increase the potential for aquaplaning, depending on the vehicle speed and depth of the rut. Drivers should always exercise caution when driving in wet weather but particularly on roads that are prone to bad rutting.

Report Title

Road Safety Audit

Texture

The pavement texture is important to ensure safety for motorists as it provides friction between the contact area of the tyre and the pavement surface. If there is insufficient friction between the tyre and surface, the braking distance will be significantly reduced and if the vehicle speed is too high, there may be a loss of control on curves and bends resulting in collisions with roadside objects.

There are two forms of texture within the road surface, the microtexture and macrotexture. The microtexture is created by the rough surface of the aggregate in the surface of the road and contributes to the friction that ensures the vehicle maintains contact with the road and provides good braking performance. The macrotexture is formed from the grooves created in the road surface by the different heights and shape of the aggregate and is important to ensure that rainwater drains away from the tyre, reducing the potential for aquaplaning.

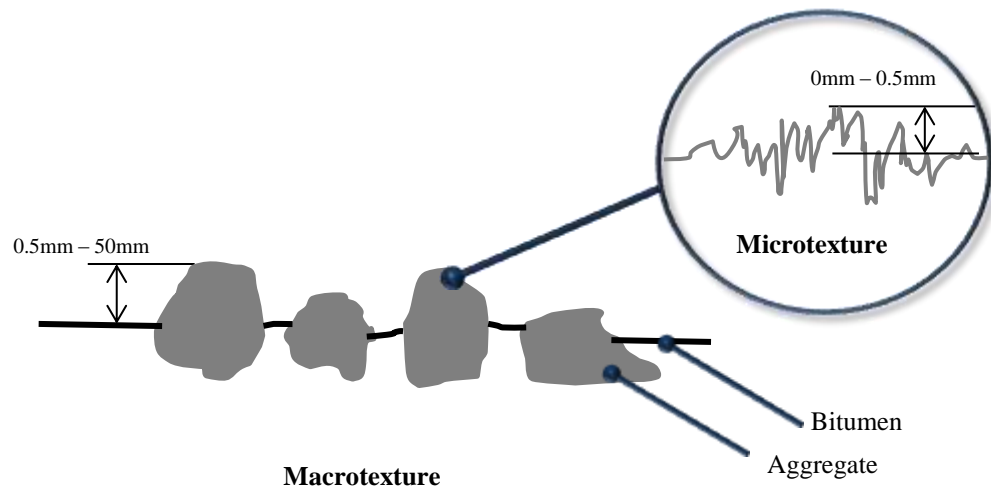


Figure 3 – Pavement Texture