RAA Highway Assessment

Dukes Highway

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0	17/06/13	IB, RB, MJ	CM	Draft.
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Contents

Executive Summary

The Dukes Highway is 190 km in length and runs from Tailem Bend in a south easterly direction, passing through the major towns of Keith and Bordertown, and continues into the Victorian border. The Dukes highway is the most direct route between Adelaide and Melbourne, and as such is one of South Australia's busiest highways. This highway has been previously analysed by RAA in Towards 2020 (2009) and Backwater to Benchmark (2005).

RAA conducted a review of the Dukes Highway in May 2013 to assess the conditions of the road, the improvements have been made, and determine the treatments that are still required. The review was carried out in both directions, to assess all aspects of safety and efficiency.

RAA's highway review recognised a number of improvements to the Dukes Highway as a result of the government's commitment of $100m towards upgrades of the highway. Lane widths were found to be 3.5m to 4m wide for the majority of the highway and sealed shoulders were found to vary between 1m and 2.4m with only a small number of sections falling below the 1.5m desirable width.

A recent safety addition to the highway included a wide centreline treatment to reduce the instances of head on collisions. The RAA also welcome the use of Audio Tactile Line Markings at a number of locations along the highway. These cause a noise and vibration when the wheel traverses the line and alerts the driver that they are drifting from the lane of traffic. These assist in reducing both head on and runoff road collisions and the RAA wish to see this treatment consistently applied throughout the highway.

An assessment was made of the pavement and this showed that the motorists can expect a relatively smooth ride for most of the highway. A lot of pavement rehabilitation has been carried out and this is reflected in the survey results. Rutting depths were generally acceptable for most of the route however evidence of significant rutting was found east of Coomandook. Further pavement rehabilitation will be required to correct this. The pavement survey showed that the pavement was well textured for most of the highway with a couple of exceptions at Keith and Bordertown, where the texture was visibly worn.

Hazard protection has been a priority with the recent funding works and this is demonstrated by the long sections of highway that have been treated with safety barriers. The Dukes Highway has a number of hazards which include significant trees, embankments and Stobie or other infrastructure poles. The RAA encourage barrier installation to continue to protect motorists from these hazards.

The highway review identified that a number of rest stops have been upgraded and while not all the recommendations outlined in Towards 2020 have been adopted, the rest areas have significantly improved. A number of rest stops however had bins that were overflowing suggesting that the rest areas are not being maintained at the required frequency.

The results of the RAA survey were combined with AusRAP data collected in early 2012 and used to form the basis of the RAA's recommendations for investment in the highway. These recommendations include:

- **Installation of roadside barriers (162 km)**
- **Provision of audio tactile edge of carriageway line marking (57 km)**
- **Pavement rehabilitation (3 km)**
- **Vegetation removal (roadside hazards & sight distance) (20 km)**
- **Upgrade junction treatments (protected turn lanes) (19 Sites)**
- **Shoulder sealing greater than 1m (6 km)**

Table 1 shows the results of the 2012 AusRAP star rating for the Dukes Highway and compares this to the star rating that could be achieved if all of the above recommendations are followed.

	Length (%)		
Star Rating	**2012**	**Post Investment Plan**	**Change**
★★★★★	-	-	-
★★★★	5%	27%	+ 22%
★★★	59%	72%	+ 13%
★★	28%	2%	- 26%
★	7%	-	- 7%

Table 1 - AusRAP Star Rating Pre & Post Investment Plan

1 Traffic Volumes

The Dukes Highway is 190 km in length and runs from Tailem Bend in a south easterly direction, passing through the major towns of Keith and Bordertown, and continues into the Victorian border. The Dukes Highway is the most direct route between Adelaide and Melbourne, and as such is one of South Australia's busiest highways. This highway has been previously analysed by RAA in Towards 2020 (2009) and Backwater to Benchmark (2005).

The Dukes Highway is the most direct route between Adelaide and Melbourne, and carries a high level of both commercial and private vehicles, including a large volume of tourist traffic. Analysis of traffic volumes for the past four years suggests that traffic volumes have not increased on the Dukes Highway. Traffic volumes in 2009 at the time of *Towards 2020* were between 3,600 and 4,600 vehicles per day, 40% of which were commercial vehicles. The 2013 traffic volumes are between 2,400 and 4,600 vehicles per day, with between 25% and 38% of this being commercial vehicles.

This composition of traffic can create potential risks as there is a greater frequency of overtaking manoeuvres along the route due to heavy vehicles or farm traffic. For this reason, 30 overtaking lanes have been provided at evenly spaced locations along the Dukes Highway. If a semi-rigid truck was to travel on the highway at 100km/h and a small vehicle was travelling at 110km/h, on the assumption that the vehicle maintains the minimum safe gap of two seconds before and after the truck and does not exceed the speed limit, it would take the vehicle 1.44km to overtake the truck. This emphasises the need to provide a high number of overtaking lanes along the highway.

It should be noted that long term projects are dependent on significant increases in freight vehicles along the route. Nevertheless, once the vehicle volumes increase beyond 9,000 vehicles per day then duplication should be considered.

2 Crash Statistics

The crash statistics over the last 10 years have remained consistent, with an average of 41 crashes per year. In 2008, the lowest numbers of crashes were recorded on the Dukes Highway with only 33 crashes, however in 2012, 54 crashes were recorded. Run off road incidents that resulted in hitting fixed objects or roll overs are the most frequent types of collision but rear end and head on collisions are also quite common. Hitting fixed objects and head on collisions result in the most fatalities and have accounted for 11 out of 15 fatal crashes in the past five years.

The following image illustrates the number of crashes by location along the Dukes Highway by section for the five year period, 2008 to 2012.

Figure 1 – Crashes Along Dukes Highway, 2008-2012

Crash totals tend to vary along different sections of the Dukes Highway, with crashes most numerous on the section between Tintinara and Keith.

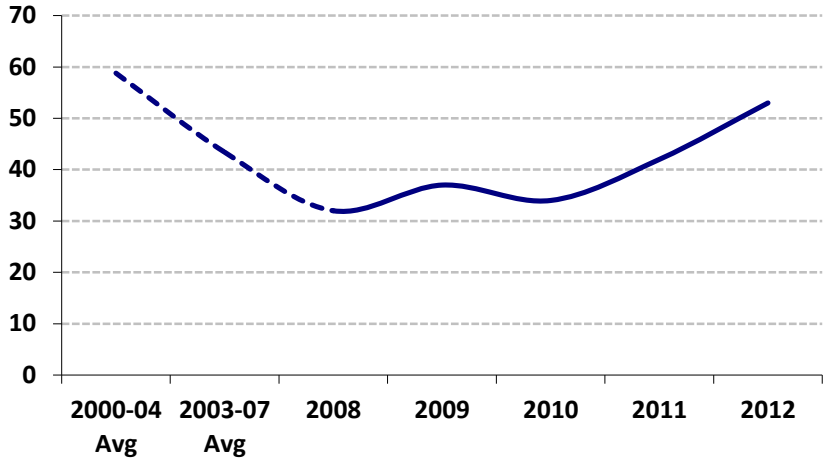

Figure 2 – Crashes On Dukes Highway, 2008-2012

The majority of crashes along the Dukes Highway tend to involve property damage only. During the five year monitoring period there have been 100 property damage only crashes, 52 minor injury crashes, 31 serious injury crashes and 15 fatal crashes.

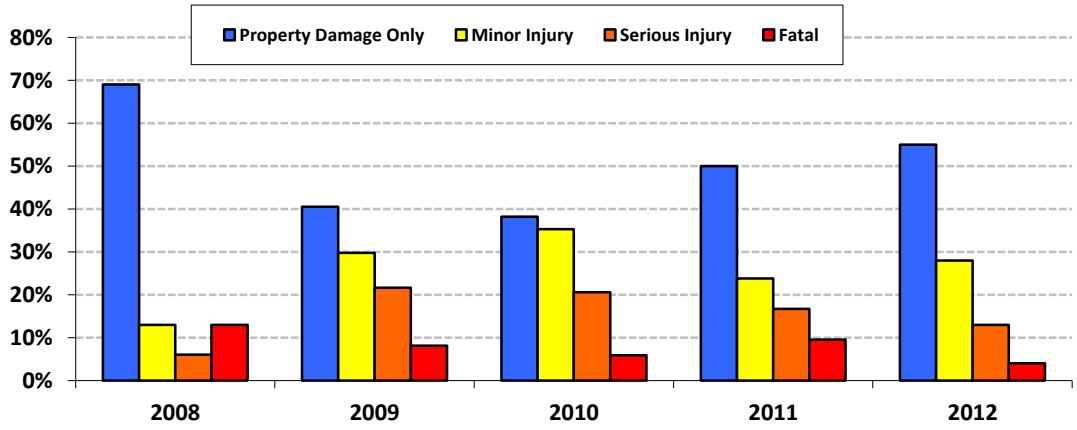

Figure 3 – Crashes By Severity, 2008-2012

Crash Severity	Cost per Crash[1]	Number of crashes	Total Cost (2012 Values)
Property Damage Only	$11,743	100	$1,174,300
Minor Injury	$17,309	52	$900,068
Serious Injury	$340,000	31	$10,540,000
Fatal	$7,200,000	15	$108,000,000

Table 2 - Cost of Crashes on Dukes Highway (2012 Values), 2008-2012

Crashes along the Dukes Highway between 2008 and 2012 cost $120,614,368. This figure includes losses to workplace and households as well as a number of medical, insurance, accident investigation, legal and repair costs. The above table breaks down the cost of crashes by severity for the past five years and highlights that each fatality costs over $7M (in 2012), which in turn is almost 21 times higher than the cost of a serious injury. Therefore any change in the number of fatalities would have a significant impact on the overall cost for a particular road or area.

3 Highway Geometry

3.1 Lane Widths

Although traffic volumes and freight movements have not significantly increased in line with the predictions of Towards 2020, it is still important to provide the minimum AusRAP star rating for a critical freight corridor. To achieve an AusRAP three star rating, a minimum lane width of 3.25m is required although other factors may prevent a three star rating being awarded even when the lane widths meet this requirement. Driving lane widths on the Dukes Highway are currently acceptable, with the majority of the highway having driving lanes between 3.5m to 4.0m wide.

3.2 Sealed Shoulders

Sealed shoulders on the Dukes Highway are mostly between one metre and 2.4m, with up to 30 km of the highway having sealed shoulders of above 2.4m. As a minimum for a critical freight route, the highway should have sealed shoulders of 1.5m or above, and as such the Dukes Highway is currently meeting this minimum for the most of its length. Sealed shoulders are an important feature of the highway as they provide additional room and time for drivers to correct their course if they drift from the main driving lane due to fatigue or inattention.

[1] Property damage only and minor injury costs derived from 'Cost of Crashes in Australia 2006', BITRE Research Report 118; Figures amended to reflect 2012 values. Serious jury 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 Wide Centreline Treatment

A wide centreline treatment has been a recent addition to the Dukes Highway in an attempt to reduce head on collision crashes in high fatigue areas. Wide centrelines provide motorists more time to correct an error should they drift from their traffic lane towards the lane of oncoming traffic. They are especially effective if used with Audio-Tactile Line Marking (ATLM). If a driver was to momentarily lose concentration and begin to drift, the noise and vibration caused by the ATLM should alert them and afford time to react before they enter the path of oncoming traffic or run off the road.

Figure 4 – Wide Centreline Treatment on the Dukes Highway

A wide centreline treatment is a good safety improvement to the Dukes Highway, and extending the length of the wide centrelines is encouraged and supported by RAA.

3.4 Audio Tactile Line Markings

Audio-Tactile Line Marking (ATLM) is another good addition to the Dukes Highway. ATLM is a series of raised bars positioned on the edge lines of the highway, 50mm wide, 150mm long and at 200mm spacing along the edge line. Currently, the Department of Planning, Transport, and Infrastructure use *Thermoplastic Rib Profile ATLM* on South Australian highways, and it is their policy to install ATLM on key arterial roads which have a high frequency of crashes due to driver fatigue (DPTI 2009).

ATLM reduce crashes due to driver fatigue by alerting the driver when they begin to move out of the driving lane. When a wheel passes over the ATLM, noise and vibration

is noticed by the driver, alerting them to move back into the driving lane. ATLM also helps to highlight delineation in wet or low visibility situations, such as heavy rain or fog.

During the 2013 review of the Dukes Highway it was evident that much of the highway had ATLM on edge lines and even on centre lines at some locations. However it was also evident that in some locations the ATLM were beginning to wear away, and as such were losing effectiveness.

Figure 5 – Worn Out Audio Tactile Line Markings on the Dukes Highway

It was noted that these worn out ATLM do not produce the same noise and vibration as newer ATLM, therefore maintenance and upgrades should be considered to restore old and worn ATLM to improve the effectiveness of this safety strategy.

The RAA also recommend that further work is conducted to assess the useable life of this type of treatment.

4 Pavement Performance

4.1 Ride Quality

Towards 2020 that the Dukes Highway provided a relatively smooth ride, with a low level of roughness when compared to other major South Australian Highways. This is supported by RAA's 2013 review, only minor roughness and undulations were noted just east of Ki Ki, and a section 5 – 10 km east of Bordertown. As the Dukes Highway is almost 200 km in length, only two instances of noticeable roughness is considered good. Furthermore, much of the highway was noted as having relatively smooth surface conditions, at least once every 10 – 15 km the highway was noted as having only minor undulations or a very smooth surface where the undulations were barely detectable.

Figure 6 – Good Pavement Conditions on the Dukes Highway

The pavement survey results showing ride quality for the Dukes Highway is shown in Figure 7 below. The measurements are represented in terms of the International Roughness Index (IRI). A greater the IRI reflects a rougher road surface and the less comfortable the ride experience for the motorist. The results show that the ride quality along Dukes Highway is either better than average (IRI between 1.94 to 2.68) or is very good (IRI less than 1.94), resonating the ride quality typically expected of a newly constructed road. The results are a tribute to the pavement rehabilitation work that DPTI have invested in over the past three years and has set the benchmark in ride quality for other highways in the state.

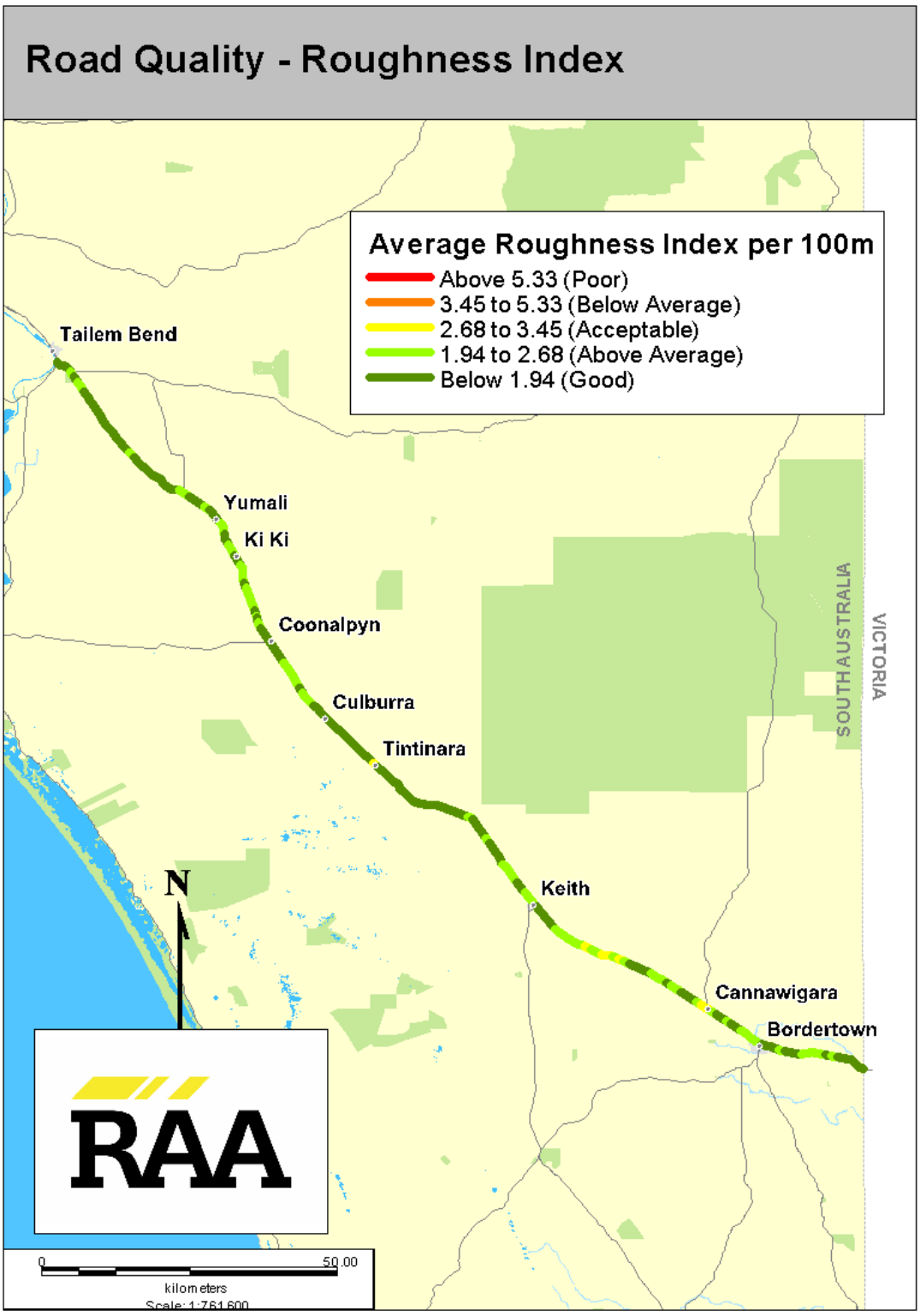

Figure 7 – Ride Quality Map for Dukes Highway

4.2 Rutting

The main surface issue identified on the Dukes Highway is rutting. Rutting is the channelling of the road under vehicle wheel paths which occurs over time due to heavy vehicles and high traffic volumes. Rutting is dangerous as it can prevent rainwater from flowing off the road, trapping it in the depressions. This can cause aquaplaning and result in loss of control of the vehicle. Severe cases of rutting can also act as guide rails to the vehicle tyres and affect the steering performance and tracking of trailers.

Towards 2020 suggested that rutting was worst around the towns of Coomandook, Ki Ki, and Tintinara with ruts in excess of 10mm. This was confirmed by the 2013 review, where significant rutting was evident just east of Coomandook, minor rutting around Ki Ki, and minor rutting west of Tintinara.

Figure 8 shows the 2012 pavement survey results for rutting. The results show that the depths of rutting are within average levels (between 5mm and 10mm) for almost the full route. There are a small number of isolated sections where, the rut depths are below average (greater than 10mm) and these sections should be addressed as part of the future pavement maintenance program. Increased and regular maintenance along this route will address the issue of rutting, with priority of repairs being directed at the most severe cases.

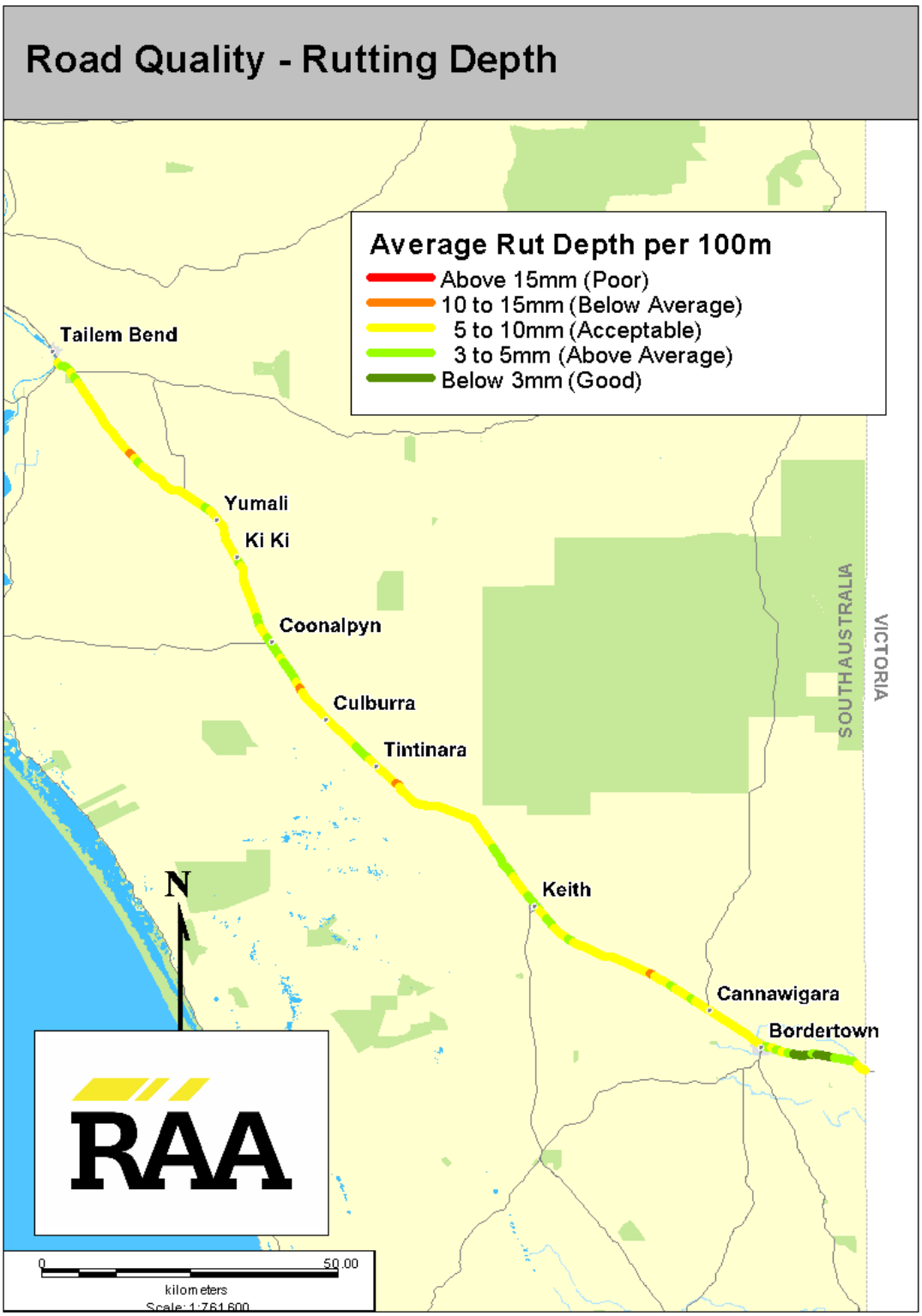

Figure 8 – Rutting Map for Dukes Highway

4.3 Texture

Along with rutting, surface aggregate loss was noted at many locations along the Dukes Highway, approximately once every 20km. Aggregate loss was only noted as severe at two locations; east of Coomandook and 5 km west of Coonalpyn.

Figure 9 – Severe Rutting and Signs of Aggregate Loss

The survey results for texture depth are shown in Figure 10. The deeper or more coarse the texture, the greater the skid resistance and better the tyres grip the pavement. The results show that the texture depth is well textured (between 1.1mm to 1.89mm) for most of the highway. There are some isolated sections, where the texture depth is smooth (between 0.7mm to 1.0mm), the two longest sections of which are through Keith and Bordertown. These sections should be addressed as part of the future pavement maintenance program to ensure that the pavement texture at these locations falls within safe limits (greater than 1.1mm)

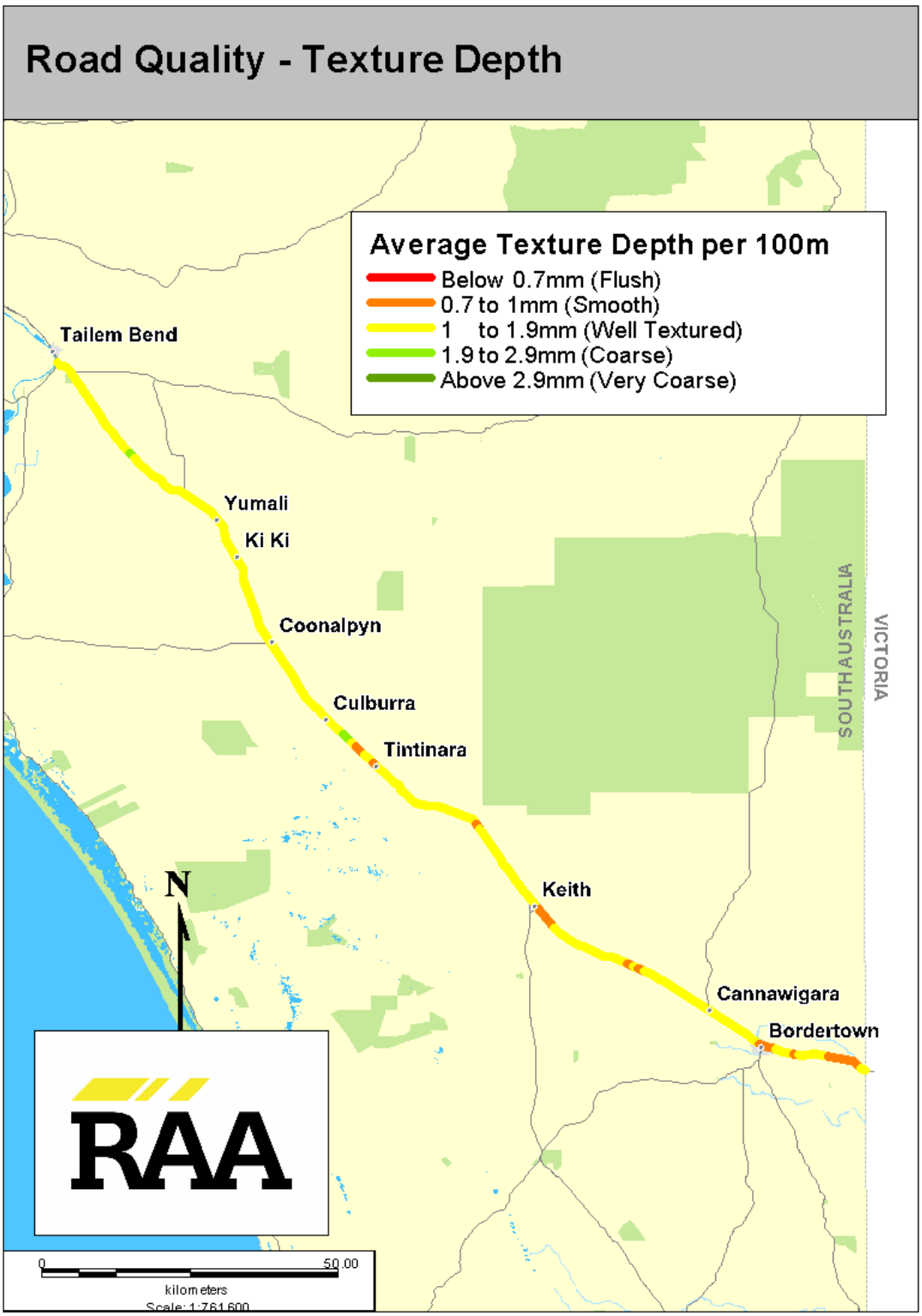

Figure 10 – Texture Map for Dukes Highway

5 Roadside Hazards

5.1 General Hazards

Significant work is currently underway or has recently been completed to provide hazard protection along the Dukes Highway. The work addresses run off road crashes and head on collisions which statistically result in the highest number of fatalities. *Towards 2020* recognised the importance of protecting motorists from roadside hazards, stating that the installation of safety barriers could reduce run-off road crashes by 40%, and up to 100% of head on collisions could be prevented by duplication of the highway.

Hazards on the Dukes Highway include significant trees, large drop offs, and a few instances of Stobie or other types of poles close to the side of the road.

5.2 Embankments

At approximately once every 20 km along the Dukes Highway significant drop offs on the side of the road were left unprotected. These drops ranged from two metres high up to 10 metres high, and pose a significant roadside risk to motorists. This is another issue which should be monitored into the future to assess if further roadside barrier upgrades are required to protect the embankments.

6 Safety Barriers

During the 2013 review of the Dukes Highway it was noted that the implementation of wire rope safety barriers is currently underway for many locations along the highway. There are long sections of road with wire rope barrier protection, particularly at the eastern end of the highway around Keith and Bordertown. Some sections of road have full edge protection for lengths of several kilometres.

The installation of wire rope barrier fencing is a positive step towards reducing fatalities on the Dukes Highway however the placement of fencing appeared to be inconsistent. Some locations had hazard protection, while other locations with a similar hazard did not. This should continue to be monitored to enable planning of future barrier placement.

Another issue identified with wire rope safety barriers is the close proximity of significant trees behind the barriers. Wire rope safety barriers are flexible, and therefore clear space is needed behind the barrier to allow for deflection. Wire rope safety barriers require a minimum of 3.14 metres for deflection (DPTI 2002), and it was noted on a few occasions during the 2013 highway review that significant trees were well within this distance and in some instances, were against the barrier. This poses a significant danger to motorists if a crash was to occur at these locations, as the barrier fence would provide minimal protection against the roadside hazard.

Figure 11 – New Wire Rope Barrier Fencing on the Dukes Highway

7 Rest Areas

Good quality rest areas are important in preventing driver fatigue, as they encourage drivers to stop and take a break, which is recommended at least once every two hours. At the time of *Towards 2020* it was identified that while there were rest areas available to motorists, most of them were of a poor standard. It was also recommended that upgrades of rest areas be undertaken to provide toilet facilities, solar lighting, tables and chairs, and shelter at all rest areas.

The 2013 highway review showed that the rest areas did not meet the expected standard. All rest areas had bins, however some did not even have tables and chairs. The best of the rest areas had covered tables and chairs, solar lighting, and were protected from the highway by safety barriers.

It appears that although many rest stops are provided, they are not being frequently maintained. The first rest area encountered after Tailem Bend in the eastbound direction appeared to be fairly new, however the provided bin was overflowing, indicating that it had not been emptied in some time.

Figure 12 – Overflowing Bin on the Dukes Highway

Improvements to rest areas on the Dukes Highway would involve upgrading facilities and regular maintenance to ensure that they are clean and useable. Upgrades and maintenance will make these rest areas more attractive for drivers, who will therefore be more inclined to stop, helping to reduce driver fatigue.

8 AusRAP

The AusRAP star rating for Dukes Highway is shown in Table 3 below. The star rating appears to have declined over the years and is a result of significantly stringent assessment conditions being applied year after year rather than deteriorating conditions of the highway. It is encouraging to note that the length of highway rated at four stars has increased since 2007. The highway data was collected in early 2012 and it is expected that there will be a significant improvement in future star ratings as a result of the highway work that the government has undertaken since then.

	Length (%)		
Star Rating	2006	2007	2012
★★★★★	-	-	-
★★★★	7%	3%	5%
★★★	93%	97%	59%
★★	-	-	28%
★	-	-	7%

Table 3 - AusRAP Star Rating 2006 - 2012

The AusRAP program develops a series of highway improvements, based on the star ratings. A schedule of highway upgrades is included in Appendix B. Table 4 below shows a comparison of the current star rating and the potential star rating awarded to Dukes Highway if all the proposed improvements are implemented. Some of these improvements may have been addressed by the upgrades undertaken throughout 2012.

	Length (%)		
Star Rating	2012	Post Investment Plan	Change
★★★★★	-	-	-
★★★★	5%	27%	+ 22%
★★★	59%	72%	+ 13%
★★	28%	2%	- 26%
★	7%	-	- 7%

Table 4 - AusRAP Star Rating Pre & Post Investment Plan

9 Recommendations

The RAA has analysed the AusRAP assessment and recommend the following treatments to improve the safety performance of the Dukes Highway:

- **Installation of roadside barriers (162 km)**
- **Provision of audio tactile edge of carriageway line marking (57 km)**
- **Pavement rehabilitation (3 km)**
- **Vegetation removal (roadside hazards & sight distance) (20 km)**
- **Upgrade junction treatments (protected turn lanes) (19 Sites)**
- **Shoulder sealing greater than 1m (6 km)**

These recommendations would result in an improvement to the extent of the sections awarded a three star rating.

10 References

Clark, S 2009, *Audio-Tactile Line Marking*, Department of Planning, Transport and Infrastructure (DPTI), Government of South Australia, Adelaide.

Principal Road Designer 2002, *Guide to the Selection of Safety Barriers – GD100*, Department of Planning, Transport and Infrastructure (DPTI), Government of South Australia, Adelaide.

Appendix A
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 0.5m 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 indicated 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.

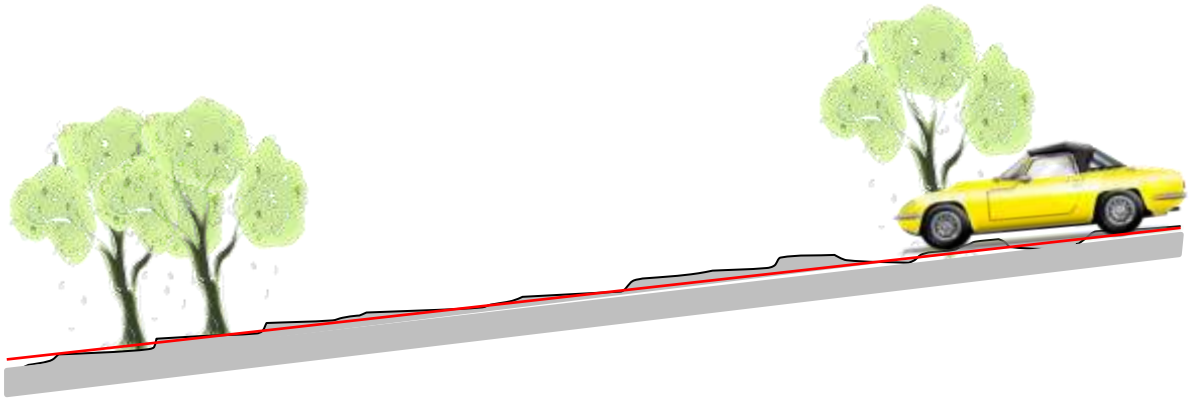

Figure 1 – Longitudinal Road Section

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.

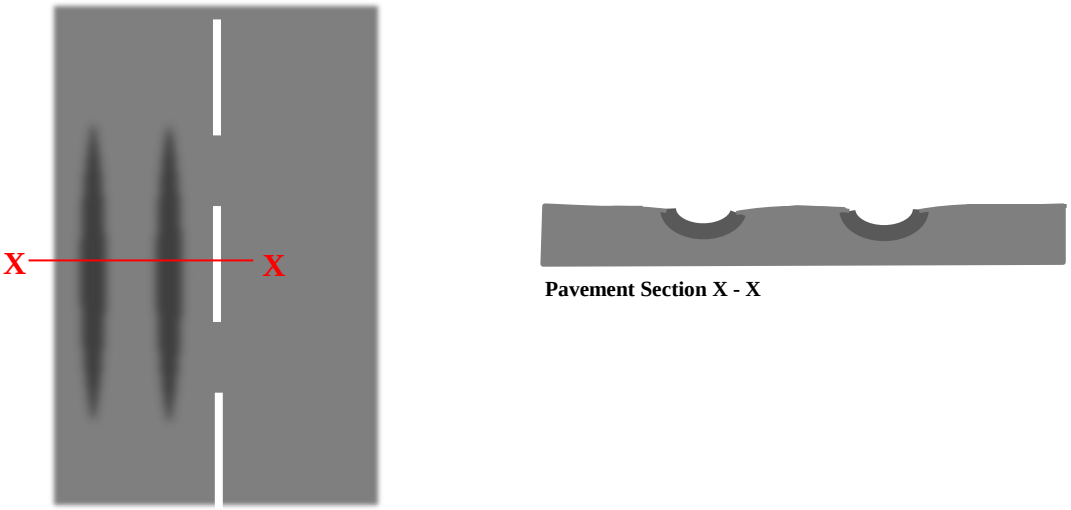

Figure 2 – Pavement Rutting

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 having 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.

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 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.

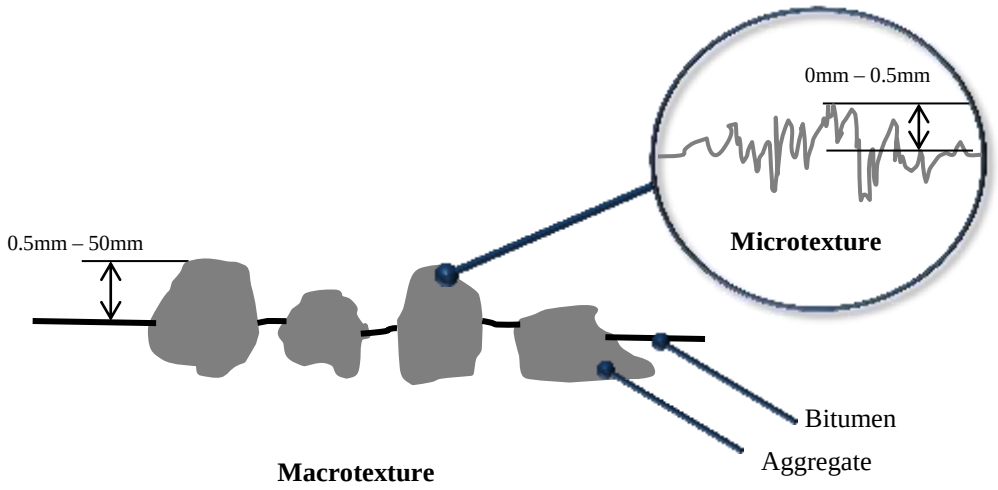

Figure 3 – Pavement Texture

Appendix B
AusRAP Safer Roads Investment Plan

Dukes Highway

Safer Roads Investment Plan

Total FSIs Saved	Program BCR
231.52	3.01

Countermeasure	Length / Sites	FSIs saved	Program BCR
Sight distance (obstruction removal)	0.30 km	1.69	102.17
Protected turn lane (unsignalised 4 leg)	4 sites	3.05	19.18
Clear roadside hazards - driver side	4.20 km	1.16	4.66
Clear roadside hazards - passenger	15.40 km	3.52	4.46
Shoulder sealing driver side (>1m)	3.00 km	0.80	4.13
Roadside barriers - driver side	90.70 km	118.64	3.64
Skid Resistance (paved road)	2.40 km	4.49	3.41
Protected turn lane (unsignalised 3 leg)	15 sites	1.05	3.18
Roadside barriers - passenger side	70.70 km	65.46	2.58
Shoulder rumble strips	56.80 km	30.77	2.01
Shoulder sealing passenger side (>1m)	2.50 km	0.88	1.32
Total		**231.52**	**3.01**