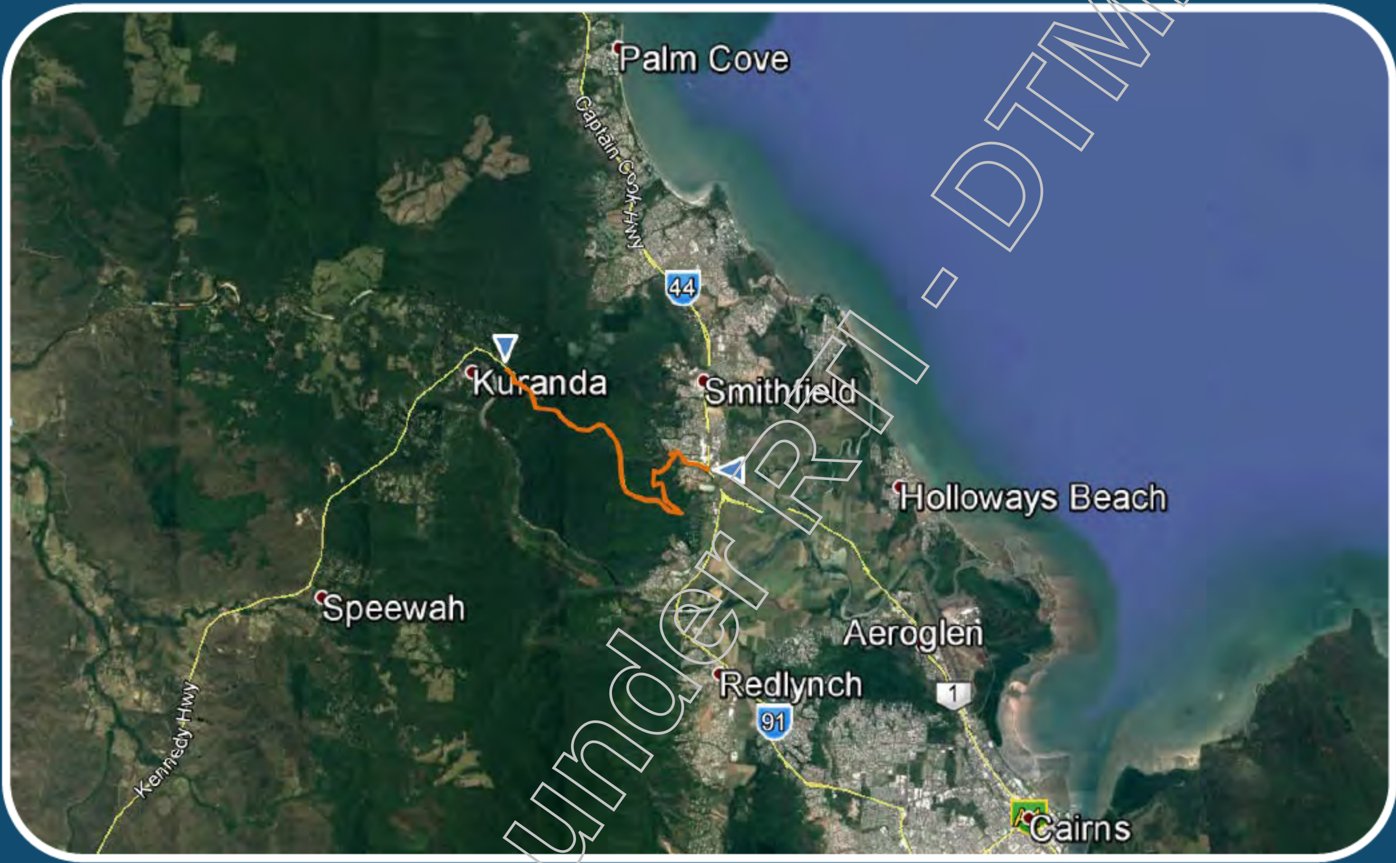
Department of Transport and Main Roads



Kuranda Range Road Link Study Report

Kennedy Highway (32A, Smithfield – Kuranda)

Great state. Great opportunity.

Queensland Government

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Project Summary

Region/Unit	Far North Queensland
Location	Cairns
Program	
Project Number	
Project Description	Kuranda Range Road Link Study Report

Document Control

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Endorsement and Approval

Customer (delete for Project Plan)

I agree to the project proceeding as proposed in this document.

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Signature	NR	Date	08/01/19.
Comments			

Sponsor

I agree to the project proceeding as proposed in this document.

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Signature	NR	Date	21/12/18
Comments			

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Executive summary

The Kuranda Range Road (Kennedy Highway) is currently a two lane two way range road with a large number of blind corners and steep climbs. The Kennedy Highway is classified as a Regional Road (State Controlled). The road climbs through rainforest and is frequently wet with a high friction demand. Kuranda Range Road (KRR) offers the shortest route between Cairns and Mareeba or Atherton, passing through the Wet Tropics World Heritage Area (WTWHA). KRR is a significant tourist route in addition to its functions for freight and commuter usage. **Figure 1** shows the location of KRR and the WTWHA.

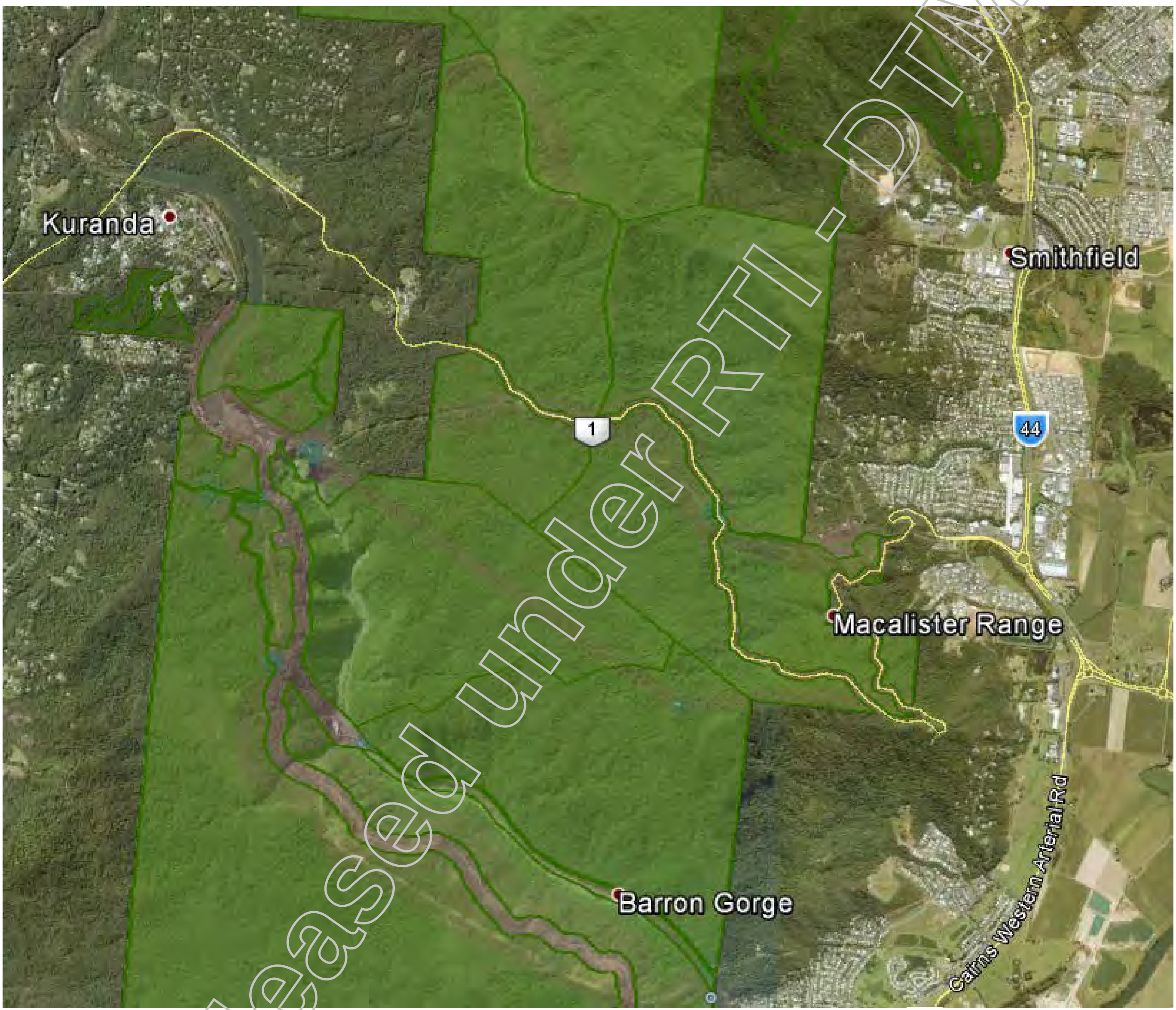

Figure 1 Study area showing WTWHA (shaded green).

The traffic volumes along the Kuranda Range Road are fairly consistent due to limited access points. **Figure 2** presents the annual average daily traffic (AADT) for the permanent counter at the bottom of the range, since 1985. The AADT is for bi-directional traffic flow. The AADT for 2017 was 8,871 vehicles per day.

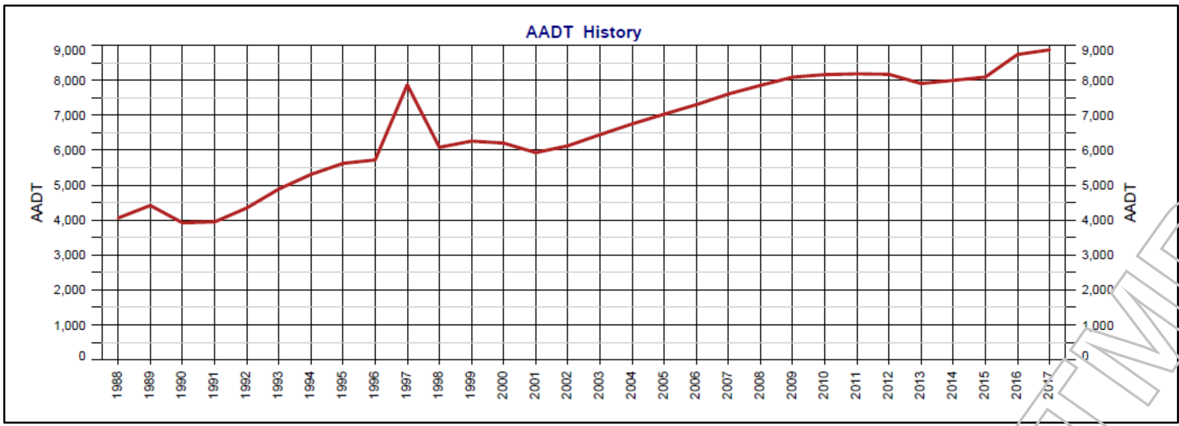

Figure 2 Historical AADT (permanent counter at the bottom of KRR)

While there are some limited overtaking opportunities, the short length of these overtaking lanes and poor road geometry only allows a small number of overtaking manoeuvres to be performed. The limited overtaking opportunities result in increased travel times when slower moving vehicles are present and they contribute to driver frustration which can lead to motorists attempting unsafe overtaking manoeuvres. The range section currently operates at an average Level of Service (LoS) D, has a high crash history and suffers regular closures/detours of up to 8 hours duration as a result of crashes. In 2014, the range was closed for more than 200 hours as a result of crashes. The State Controlled Priority Road Network Guidelines define the Interim and Final Vision Standards for State rural roads as LoS C, and State urban roads as LoS D. Given the high cost of upgrading the Kuranda Range to 4 lanes, alternate upgrade solutions to improve safety and operational efficiency have been investigated as part of this study.

Since 1 January 2000, a total of 311 crashes have been reported for the section of the range extending from west of the Smithfield roundabout (Ch.1000) to just west of Rainforestation (Chainage 11200). Of these crashes, 24% were Killed or Seriously Injured (KSI) severity-type crashes, including one fatality. The crash data shows that the number of KSI crashes since 2010 has remained fairly consistent, with the numbers varying from five to seven KSI crashes per year. Key crash trends are: over 60% of crashes occurred when the road surface was wet, 60% occurred on the eastern face section of the range (approximately 7km in length), and violation of road rules were reported for 49% of all crashes. The most common crash types were "Loss of Control Off Path on Curve (DCA code 800s)" - 54% of crashes, followed by "Head-on" (DCA code 201) - 26% of crashes. These crash types were not confined to certain sections of the range, but rather have generally occurred at most curves along the range.

In 2003, in response to the FNQ2010 Regional Plan which envisaged significant urban growth on the Tablelands at Myola, TMR prepared a concept design for the upgrade of the existing route to a 4 lane grade separated arrangement. The concept design followed on from a transport options study and impact assessment prepared in 2000 which identified a 4 lane surface solution as the preferred upgrade to the existing route to accommodate future transport demand including the use of freight efficient vehicles. Further investigation of the proposed 4 lane upgrade of the Kuranda Range found it to be unaffordable in the short to medium term, in both a regional and state wide context. A Cabinet briefing document in 2006 stated the 4 lane upgrade had an estimated cost of $770M.

Owing to the high cost of the 4 lane upgrade TMR prepared the Kuranda Range Road Upgrading Strategy (TMR, 2009-2012) with the aim of determining whether alternative options to the ultimate 4 lane upgrade could be identified that would allow an upgrade to be delivered in a more affordable and staged manner while still providing capacity, safety and environmental benefits. The Upgrade Strategy also included a study into interim solutions for improving capacity via a 'lesser upgrade'. Recommendations included:

- Further investigation be undertaken into the feasible overtaking lane locations identified
- Investigating duplicating the alignment at both the top and bottom and leaving the centre constrained section in its current form.

This project (Kuranda Range Road Link Study) sought to review and build upon previous work in order to identify an affordable solution for the Kuranda Range section of the Kennedy Highway to form a master plan for staged upgrades over 20 years. The study objective was to develop a prioritised list of projects, with an initial package of works ($50 to $100 million) to provide short-medium term improvements in safety, freight efficiency, reliability and, if possible, capacity, consistent with the masterplan. It will allow better and safer access for emergency vehicles following incidents and limit the impact of incidents.

The study methodology included dividing the link into 24 sections and a masterplan has been produced consisting of 34 infrastructure and non-infrastructure projects, by section, developed to address safety and reliability issues and meet the desired outcomes. These included environmental options developed as alternatives to provide additional fauna connectivity in response to consultation with Wet Tropics Management Authority (WTMA).

The Link Study has been developed with the objective of achieving the following desired outcomes:

- Improved safety for all road users
- Increased efficiency and reliability of heavy vehicle movements
- Reduced travel times and freight transport costs
- Maximised use of existing infrastructure
- Minimised potential environmental and/or cultural heritage impacts.

As part of the link study, a multi-criteria analysis (MCA) framework was developed based on high level, qualitative and quantitative criteria to prioritise sections for upgrade and to identify priorities for the potential infrastructure funding of $50 - $100 million. The highest priority projects for the potential infrastructure funding of $50 - $100 million are listed in order of priority in **Table 1**, while non-infrastructure priorities are listed (in order of priority) in **Table 2**.

Table 1 Infrastructure Priorities

Priority	Project No.	Project	Indicative Cost	Indicative Cumulative Cost
1	13	Water Point - Includes Scheme Curve 59 - 61	$10,838,228	$10,838,228
2	21a	Streets Creek Hole	$17,843,529	$28,681,757
3	17	Ch 7100 - 7350	$18,159,720	$46,841,477
3	18	Ch 7350 - 7600	$21,996,302	$68,837,779
5	3	Scheme Curve 15 - 18 (17 & 18)	$21,663,703	$90,501,482

Cumulative cost <$50M

$50M <Cumulative cost <$100M

Table 2 Non Infrastructure Priorities

Priority	Project No.	Project
1	25	Implement ITS Strategy
1	26	Implement RSA recommendations
3	1a	Bottom Hairpin - ITS/Signage
3	10a	Top Hairpin - ITS/Signage
3	16a	Henry Ross Lookout - ITS/Signage
6	13a	Water Point - Fencing and dam

While the proposed masterplan and priority projects will improve safety and reliability by providing safe passing width and some overtaking opportunities, they will not provide significant additional overall capacity. It should be noted that unless the whole length of the Kuranda Range Road is duplicated to four lanes (two-lanes in each direction of travel), capacity improvements cannot be fully realised. Upgrades which increase overtaking opportunities for short road sections will only improve the capacity of those sections, with bottlenecks still being sections of the road which remain a single lane in each direction. Furthermore, with the exception of Project Number 21A, the projects that scored highest in the MCA do not necessarily address locations with the highest crash rates.

As part of this study Dr John Morrall, President of the Canadian Highways Institute and international expert in mountain roads, carried out a review of previous reports relevant to the Kuranda Range Road Link Study and concluded that previous traffic modelling undertaken as part of the Kuranda Range Road Upgrading Strategy (TMR, 2009-2012) reported unrealistic vehicle travel times for the anticipated traffic growth along the link. Assuming traffic volumes would reach 17,000 vehicles per day (vpd) in 2030, continuous vehicle platooning would occur as a result of slow heavy vehicles (travelling at 30-40 km/h) limiting average speeds along the road. This would result in travel times increasing by 36-82% (an order of magnitude of 10 times the earlier VISSIM estimates), in addition to a number of adverse effects including shock waves from vehicle braking, increased risk of rear-end crashes and associated difficulties and delays for emergency vehicles attending crashes.

While not the primary focus of this study, Dr Morrall recommended utilising the Traffic on Rural Roads (TRARR) program as a more appropriate tool for measuring capacity. TRARR estimates capacity by calculating the percent time spent following and mean vehicle speed (among other characteristics) along various points of the road and takes into account road and traffic characteristics such as road geometry, presence of climbing and overtaking lanes, traffic volumes, heavy vehicles and the posted speed limit.

TRARR analysis previously completed as part of the IAS in 2000 indicated that the western section of the range has a higher capacity compared to the eastern section (approximately 16,000 and 10,500 vehicles per day for LoS E, respectively). Based on two future scenarios of 1% and 3.5% traffic growth rates, in the 2000 TRARR analysis LoS E could be reached within 5 - 10 years.

In October 2018 TMR engaged the Australian Road Research Board (ARRB) to conduct a new capacity analysis of the range using the latest version of their Traffic on Rural Roads (TRARR) software. A copy of the assessment is attached in Appendix F. The analysis examined the Kuranda Range Road in its current configuration and at various future traffic demand scenarios. The analysis confirmed that the range section is currently operating at LoS D under current traffic volumes and will potentially reach an unacceptable Level of Service (LoS E) by 2040 using median traffic growth rates, or possibly as early as 2032 if traffic growth is higher than the historical median trend.

As the masterplan has been designed to be stageable and maximise use of the existing asset, it is not compatible with the ultimate four lane solution which does not reuse the existing formation. The masterplan is a 20 year, medium term solution to manage safety and reliability, not capacity, and it will not remove the need for a four lane solution when capacity is exceeded. This can only be achieved with the ultimate four lane solution for the entire range section. As the level of growth is uncertain, it is not possible to define exactly when LoS E for the Kuranda Range Road will be reached, however this is currently estimated as anywhere from 5 to 33 years depending on future traffic growth.

Indicative cost estimates for the 34 projects were prepared based on proposed construction works within each individual planning area. Assuming each area is constructed individually, the overall cost of implementation of the whole masterplan is likely to be in the order of $750 – $850 million. By comparison, in 2006 the estimated cost of the four lane upgrade was $770M. The Australian Bureau of Statistics - Index Number; 3101 Road and bridge construction Queensland shows an approximate increase in construction costs of 41% from June 2006 to June 2018. Applying this percentage to the 2006 estimated cost results in a 2018 cost of approximately $1.1B. Given the masterplan does not address capacity and that this link is already operating at LoS D, the vision standard to upgrade a State urban road, and that LoS E will be reached within 5 – 33 years, the high cost of implementing this masterplan isn't considered justified when weighed up against the cost of implementing the ultimate four lane solution.

Key issues not addressed in this study but relevant to future decision making are:

- Any construction work on the existing KRR alignment generally requires the closure of one lane as side tracking is not normally feasible. This is highly disruptive to traffic flow. A progressive and staged upgrade to the existing alignment to implement the projects identified in this study would potentially see construction occurring continuously for a 10 to 20 year period. It is noted that construction of the proposed four lane solution will have significant but potentially lesser impacts during construction as the majority of the new roadway is offline.
- The timeframes associated with planning and environmental approvals of upgrades to the KRR are expected to be longer than other similar sized projects in Queensland owing to the environmental sensitivities of the World Heritage Listed Wet Tropics. Of relevance is the fact that in approving the four lane upgrade, the Commonwealth Government required that TMR undertake an assessment of the cumulative and consequential impacts of the works. TMR obtained the necessary environmental approvals to construct the four lane solution, however, there were stringent conditions including limiting sediment runoff during construction and rehabilitation of the existing road. Any changes to the approved design concept of the four lane upgrade would require new environmental approvals.

  New approvals would take into account the proposed total upgrades to KRR and would almost certainly require TMR to provide details of all proposed works that make up the overall scheme, in the environmental approval applications. Given the projects identified in this study do not provide any significant capacity improvements there would still be a need to address capacity at a future time. Therefore, the environmental assessments are likely to require consideration of the impacts from both schemes, and both schemes would need to be adequately documented to allow a detailed assessment. Based on the timeframes associated with previous KRR planning studies it is anticipated that planning and environmental approvals to achieve a capacity upgrade could take between five and ten years.
- Kuranda has approximately 150 rainy days per year and in order to manage the sediment runoff from a major construction project in steep terrain it would be necessary to restrict construction to the drier months of the year i.e. avoid construction in the wet season. This was generally the approach taken in determining the construction program for the four lane solution. When this requirement is added to other requirements, such as limiting the construction footprint to minimise rainforest destruction and maintaining acceptable travel times for motorists using the KRR, the resulting timeframe for constructing the four lane solution was in the order of 9 years.
- A tunnel was considered in earlier planning stages of the IAS (2000). It is likely to be an option TMR will need to explore in the future, if a capacity upgrade to KRR is required, in order to demonstrate that all prudent and feasible alternatives have been considered. The tunnel option previously considered sought to limit the length of the tunnel due to its high cost. This resulted in a considerable length of roadway being required from the western tunnel portal to Kuranda. All of the issues associated with the impacts of the four lane surface solution applied to this section of roadway. Timeframes for planning, environmental approvals and construction are unlikely to be any shorter for a tunnel option compared to a surface solution.
- For the aforementioned reasons, it is estimated that it would take between 15 and 20 years to undertake planning, detailed design and construction of a new four lane highway to replace the existing KRR. The timeframe to secure funding would be additional.
- While it is estimated the KRR capacity will reach LoS E within 5 to 33 years this excludes the impact of construction traffic, which will have a major impact on travel times and significantly reduce the road's capacity. It would also add significantly to the safety risks on the range. When the impacts of construction traffic are taken

into account it is likely the timeframe to upgrade the capacity of KRR (15 to 20 years plus time to secure funding) will see the upgrade completed well after the road has reached capacity.

The high cost of the infrastructure projects detailed in this study are not considered to be justified given the cost is similar in scale to the ultimate 4 lane solution. The key factor affecting cost is the adopted road cross section width which results in either steep cuttings or large fills supported by gabions. The following recommendations are made, taking the findings of this study into account in conjunction with the aforementioned key issues:

1. The non-infrastructure projects, which target safety and reliability, be progressed. These solutions can effectively address safety issues that are not directly associated with insufficient pavement width and defer the need to construct the associated upgrade projects, enabling funds to be spread over a greater length of the range.
2. The infrastructure projects are not recommended for progression in their current form due to their high cost and limited benefit. Instead, it is recommended the proposed cross sections be reviewed to determine if a cost-effective outcome can be achieved by reducing shoulder widths and separation widths. This would include consideration of removing cyclists from the road in order to allow reduced shoulder widths. This work should be performed to a level of detail sufficient to develop P90 cost estimates.
3. If the actions of Point 2 above, achieve a list of cost effective infrastructure projects that improve the safety and/or travel reliability of KRR it is recommended that TMR establish the environmental approval conditions. These conditions have the potential to add significant cost to infrastructure projects and potentially make them unviable.
4. A Management Strategy be developed for KRR considering short, medium and long term timeframes. The suggested focus of each timeframe is as follows:
   I. Short term (0 to 5 years) – safety and travel reliability with a focus on non-infrastructure solutions.
   II. Medium term (5 to 20 years) – safety and travel reliability with a focus on cost effective infrastructure solutions, environmental permit requirements, impacts of construction traffic and delivery timeframes.
   III. Long term (>20 years) – safety, travel reliability and capacity with a focus on the long term solution, the impacts this will have on KRR during construction and the timeframe to implement.

Definitions

TERM	MEANING
AADT	Average Annual Daily Traffic
ANPR	Automatic Number Plate Recognition
ARRB	Australian Road Research Board
ASS / PASS	Acid Sulfate Soil / Potential Acid Sulfate Soil
CRC	Cairns Regional Council
DAF	Department of Agriculture and Fisheries
DATSIP	Department of Aboriginal and Torres Strait Islander Partnerships
DoE	Department of the Environment (Commonwealth)
EHP	(Department of) Environment and Heritage Protection
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)
EPM	Environmental Processes Manual
ESR	Environmental Scoping Report
EVNT	Endangered, Vulnerable, or Near Threatened (plants or animals)
IAS	Impact Assessment Study
ITS	Intelligent Transport Systems
ITSKR	Integrated Transport Study for Kuranda Range
KRR	Kuranda Range Road
KSI	Killed or Serious Injury
LoS	Level of Service
MNES	Matters of National Environmental Significance
MSC	Mareeba Shire Council
MSES	Matters of State Environmental Significance
MSW	Minor Safety Works
NC Act	*Nature Conservation Act 1992* (Qld)
PDO	Property Damage Only
QPS	Queensland Police Service
SIMS	STREAMS Incident Management System
TMR	(Department of) Transport and Main Roads
TRARR	TRAffic on Rural Roads - a microscopic computer simulation model that tracks the progress of individual vehicles along a section of two-lane rural roads
VISSIM	"Verkehr In Städten - SIMulationsmodell" (German for "Traffic in cities - simulation model")
VM Act	Vegetation Management Act 1999 (Qld)
VMS	Variable Message Sign
WTMA	Wet Tropics Management Authority
WTMP	Wet Tropics Management Plan 1998 (Qld)

1. Introduction

AECOM was commissioned by the Department of Transport and Main Roads (TMR) in September 2015 to carry out the Kuranda Range Road Link Study. The objectives of this project are to:

- Identify an affordable masterplan to guide the staged development of the Kuranda Range section of the Kennedy Highway over the next 20 years.
- Develop feasible and affordable staged upgrade options (infrastructure and non-infrastructure), consistent with the masterplan that will improve:
  1. safety
  2. freight efficiency
  3. reliability, and where possible,
  4. capacity
- Develop concept designs of the upgrade options.
- Prioritise the staged upgrade options to identify the first stage(s) of delivery at a capital cost of between $50 - $100 million.

Desired outcomes:

- Improved safety for all road users
- Increased efficiency and reliability of heavy vehicle movements
- Reduced travel times and freight transport costs
- Maximised use of existing infrastructure
- Minimised potential environmental and/or cultural heritage impacts

A link strategy and link plans documenting a 20 year masterplan for the staged upgrade and a prioritised list of upgrades consistent with the link plans.

A project or projects identified as the highest priority for an initial capital investment of between $50 and $100 million.

It must be noted that, while capacity improvement (where possible) is an objective of the study, it is in the context of localised capacity improvement, in other words additional lanes in isolated sections. It should be noted that unless the whole length of Kuranda Range Road is duplicated (two-lanes in each direction of travel), capacity improvements cannot be fully realised. Upgrades which increase overtaking opportunities for short road sections will only improve the capacity of certain areas, with bottlenecks still being those sections of the road which remain as a single lane. As described in **Section 2**, an ultimate solution that provides an increase in capacity over the whole link has previously been identified and found to be unaffordable in the short to medium term. This study is not intended to replace the ultimate upgrade and will not address the future need to increase capacity.

The main driver therefore is to improve safety, operational efficiency particularly for freight and reliability while maximising use of existing infrastructure and minimising environmental impacts.

1.1 Purpose and Scope of the Report

The outcomes of the Link Study are contained in a Link Strategy for the Kuranda Range Road between Smithfield and the Barron River and associated Link Plans for each of the defined planning sections of the highway. The outcomes are provided in two volumes:

- Volume 1 comprises the Link Strategy Report (this document) which sets out the existing and future performance issues on the Kuranda Range Road, defines link objectives, and identifies strategic infrastructure and non-infrastructure priorities and investment requirements. Associated traffic, crash and multi-criteria analysis is provided in appendices.

- Volume 2 contains the Link Plan Design Report and associated drawings and typical cross sections for the proposed upgrade of the highway. It outlines the development of the design and land requirements identified in the road link plans, including identification of limitations on the design. It also contains a high level opinion of probable costs for each of the priority projects identified in the Link Strategy.

Together, the two volumes form the Link Study Report.

1.2 Project Zones and Planning Areas

The Kuranda Range Road is the local name for the Kennedy Highway between Smithfield and Kuranda.

Due to the length of the road link and for the purpose of developing link plans in association with the link strategy, the project location has been split into 2 project zones and 24 planning areas based on geographic features, major cuts and fills, waterway crossings, key accident clusters and manageable sections for design and reporting purposes. Sections have been determined from the base of the range running notionally west along the highway in line with the TMR Gazettal Chainages for the Kennedy Highway, with the intersection with the Captain Cook Highway noted as Chainage 0.00km.

The two zones are based on the distinct topographical change that occurs at the north/south ridge which is reflected in the zone extents which are separated as follows:

- Zone 1 – Eastern Face – Base of Range to North/South Ridge.(Ch. 0.98 to 7.9)
- Zone 2 – Western Fall – North/South Ridge to existing overtaking section west of Rainforestation (Ch. 7.9 to 11.18)

The study area for the Link study is presented in **Figure 4**.

The breakup of the corridor into the planning areas is provided in

Figure 5 and **Table 3** and illustrated on the sketches attached in **Appendix A.**

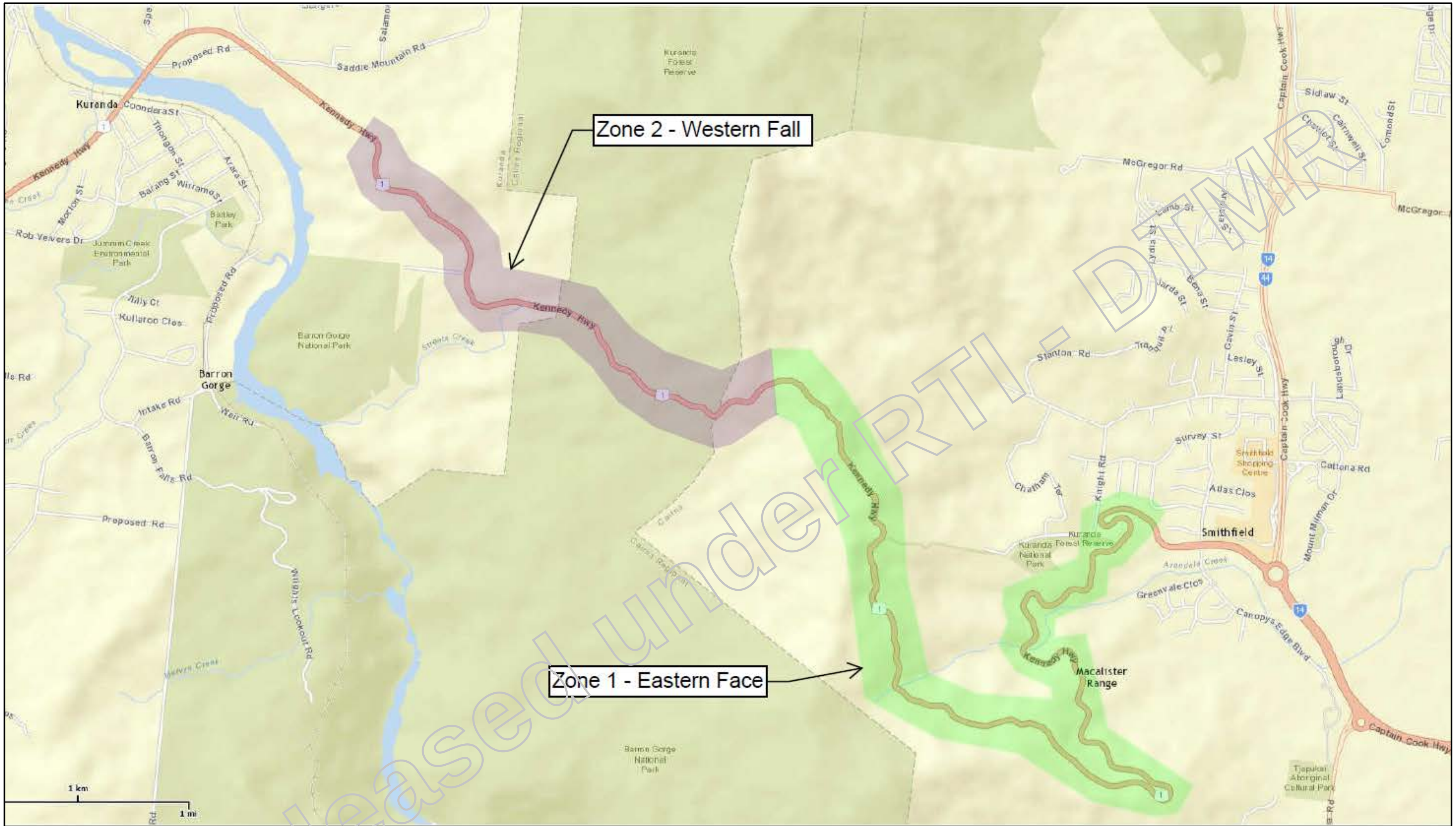

Figure 3 **Study area for the Link study**

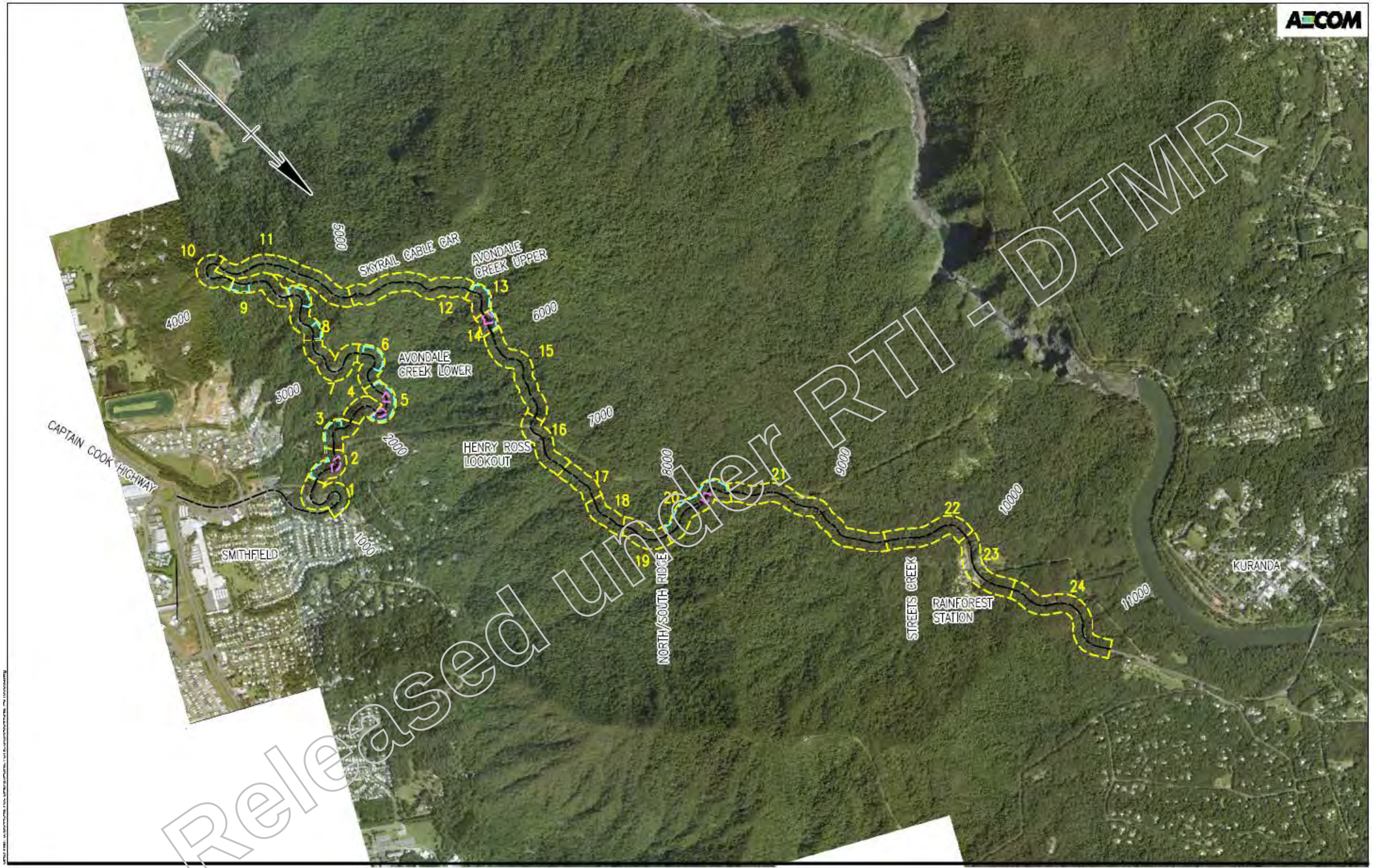

Figure 4 Planning Areas

Table 3 Planning Area reporting for Kuranda Range Road (Kennedy Highway) Smithfield to Ch 11.18

Area	Start	End	Current Description	Superseded Description
Zone 1	0.98 km	7.90 km	Eastern Face - Smithfield to Top of Range	
1	0.98	1.44	Curves C11 and C12. Bottom hairpin.	
2	1.44	1.69	Curves C13 to C15	Scheme Curve 15 to 18 (15-01 to 15-08 and 15-15 to 15-20)
3	1.69	1.93	Curves C16 and C17	
4	1.93	2.13	Curves C18 to C20	
5	2.13	2.39	Curves C21 to C23	Scheme Curve 22 (22-01 to 22-04)
6	2.39	2.67	Curves C24 and C25. Avondale Creek lower crossing.	Scheme Curve 26 (26-01 to 26-04)
7	2.67	3.11	Curves C26 to C29	
8	3.11	3.49	Curves C30 to C32. Skyrail Cable Car crosses corridor.	Scheme Curve 32 (32-01 to 32-04) Scheme Curve 34 (34-01 to 34-04)
9	3.49	3.86	Curves C33 to C35	Scheme Curve 34 (34-01 to 34-04) Scheme Curve 38 (38-01 to 38-04)
10	3.86	4.16	Curves C36 and C37	Scheme Curve 38 (38-01 to 38-04)
11	4.16	5.01	Curves C38 to C41. Overtaking Lane, Skyrail Cable Car crosses corridor.	
12	5.01	5.76	Curves C42 to C51	
13	5.76	5.95	Curves C52 to C54. Avondale Creek upper crossing.	Scheme Curve 59 to 61 (59-01 to 59-10)
14	5.95	6.07	Curves C55 and C56	
15	6.07	6.69	Curves C57 to C65	
16	6.69	7.10	Curves C66 to C69. Henry Ross Lookout.	
17	7.10	7.36	Curves C70 to C73	
18	7.36	7.61	Curves C74 to C77	
19	7.61	7.90	Curves C78 and C79	
Zone 2	7.90 km	11.18 km	Western Fall - Top of Range to Ch 11.18km	
20	7.90	8.41	Curves C80 to C85	Scheme Curve 79 to 83 (78-01 to 78-17)
21	8.41	9.43	Curves C86 to C95. Streets Creek Hole at C92.	
22	9.43	9.95	Curves C96 to C98. Streets Creek crossing.	
23	9.95	10.41	Curves C99 and C100. Rainforestation Nature Park intersection.	
24	10.41	11.18	Curves C101 to C104	

Previous planning and design work completed by TMR for the Kuranda Range Road used a chainage based curve number referencing system. These references have historically been used to identify various isolated packages of work. As the current Link Study has assessed every single horizontal element within the alignment the previous chainage based curve number system was found to be too coarse to remain a functional approach. For reference they have been correlated to the current Planning Sections and noted as the Superseded Descriptions in **Table 3** above. For clarity, the Scheme Curve references will generally not be used again within this document except when referencing historical projects named using these descriptors.

2. Planning Context

The Kuranda Range Road (Kennedy Highway) is currently a two lane two way range road with a large number of blind corners and steep climbs. The Kennedy Highway is classified as a Regional Road (State Controlled). The road climbs through rainforest and is frequently wet with a high friction demand. Kuranda Range Road offers the shortest route between Cairns and Mareeba or Atherton and crosses the Wet Tropics World Heritage Area. It features significant remnant vegetation and is a significant tourist route in addition to its freight and commuter usage.

While there are some limited overtaking opportunities, the short length of these overtaking lanes and poor geometry only allows a small number of overtaking manoeuvres to be performed. The limited overtaking opportunities result in increased travel times when slower moving vehicles are present and frustrated motorists attempt unsafe overtaking manoeuvres. The range section currently operates at Level of Service (LoS) D/E, has a high crash history and suffers regular closures/detours of up to 8 hours duration as a result of crashes. In 2014 the range was closed for more than 200 hours as a result of crashes.

In 2003, in response to the FNQ2010 Regional Plan which envisaged significant urban growth on the Tablelands at Myola, TMR prepared a concept design for the upgrade of the existing route to a 4 lane grade separated arrangement. The concept design followed on from a transport options study and impact assessment prepared in 2000 which identified a 4 lane surface solution as the preferred upgrade to the existing route to accommodate future transport demand including the use of freight efficient vehicles. Further investigation of the proposed 4 lane upgrade of the Kuranda Range found it to be unaffordable in the short to medium term, in both a regional and state wide context.

This project seeks to identify an affordable solution for the Kuranda Range section of the Kennedy Highway to form a master plan for staged upgrades over 20 years. This will then be used to identify a prioritised list of projects, with an initial package of works ($50 to $100 million) to provide short-medium term improvements in safety, freight efficiency, reliability and, if possible, capacity, consistent with the masterplan. Upgrade works will alleviate congestion and improve safety, freight efficiency and reliability through staged improvements to the geometry and formation of the existing road section. It will allow better and safer access for emergency vehicles following incidents and limit the impact of incidents.

The master plan is not intended to increase the capacity of the link and does not replace the need for an ultimate 4 lane solution. The capacity of the link is limited by the capacity of the eastern face. It should be noted that unless the whole length of Kuranda Range Road is duplicated (two-lanes in each direction of travel), capacity improvements cannot be fully realised. Upgrades which increase overtaking opportunities for short road sections will only improve the capacity of certain areas, with bottlenecks still being those sections of the road which remain as a single lane. Substantial capacity improvement can only be achieved through the implementation of a 4 lane ultimate solution. While there is uncertainty in the timing, as traffic continues to grow the capacity of the range, even with full implementation of the masterplan, will be exceeded in the future.

2.1 Higher level requirements

This Link Study has been informed by knowledge of the values of the areas adjacent to the road corridor and the legislative framework that will apply to any on-ground works that may be proposed to be undertaken in the implementation phase.

A number of previous planning studies are relevant to the Kuranda Range Road corridor from Smithfield to the Barron River. These include:

- Integrated Transport Study for Kuranda Range (TMR, 1998-2008)
- Minor Safety Works program (TMR, 2007-2009)
- Kuranda Range Road Upgrading Strategy (TMR, 2009 - 2012).

Table 4 provides a summary of relevant key points from previous planning study reports.

More detail is provided on World Heritage issues in **Section 3.3** and EPBC Act issues in **Section 3.4.**

Table 4 Previous studies relevant to the Kuranda Range Road corridor from Smithfield to the Barron River – Link Study

Planning Study	Key points relevant to the Link Study
Integrated Transport Study for Kuranda Range (ITSKR) **TMR 1998-2008**	A Directive of the FNQ2010 Regional Plan, the study was required to cater for significant population growth in Myola. The Impact Assessment Study (IAS) carried out as part of the ITSKR investigated 4 lane solution options (Road and Tunnel). The preferred solution was a 4 lane surface solution generally utilising the existing corridor to build a new road, on top of existing with often significant vertical grade differences. Further stages of the study (IAS Addendum) identified significant constructability issues with the IAS alignment and instead developed a largely off-line solution that improved constructability, at the expense of affordable staging, providing significant environmental benefits with improved fauna connectivity. The IAS Addendum scheme was issued a permit and rezoning under the Wet Tropics Management Plan (WTMP) and approval under the EPBC Act. The solution was deemed unaffordable by the Queensland Government in the short to medium term and did not proceed. The permit and EPBC approval applied only to the IAS Addendum alignment. A new permit will be required for works arising from this Link Study. A new EPBC permit may be required depending on the assessed significance of projects arising. The rezoning still stands and is expected to provide an adequate corridor for the Link Study masterplan.
Minor Safety Works program **TMR 2007-2009**	A Road Safety Audit was undertaken on the corridor and Minor Safety Works packages were developed to address issues identified in the RSA. A permit under the WTMP was received for specific schemes between Ch 1.5 and 8.3km. EPBC approval was not required as the projects were deemed “not a controlled action” A number of schemes have been constructed but some have not. Permit expired in 2014.
Kuranda Range Road Upgrading Strategy **TMR 2009 - 2012**	The aim of the commission was to determine whether alternative options to the ultimate 4 lane upgrade could be identified that would allow an upgrade to be delivered in a more affordable and staged manner while still providing capacity, safety and environmental benefits. This determination was to be guided by traffic modelling undertaken by TMR to identify capacity restriction points on the existing alignment and to allow the performance of any proposed upgrades to be tested. VISSIM modelling indicated that with traffic growth of 3.5% compounding travel times would only increase by up to 9% over a 20 year period, suggesting a much higher limiting capacity. This does not correlate with calculations using TRAAR and is considered unrealistic. (see **Section 2.1.1**) The Upgrade Strategy was designed to address specific safety problems, essentially at nominated curves. It recommended: - ITS measures

	- Linemarking and signage improvements - Upgrading of deficient curves The Upgrade Strategy also included a study into interim solutions for improving capacity via a 'lesser upgrade'. Recommendations included: - Further investigation be undertaken into the feasible overtaking lane locations identified - Investigating duplicating the alignment at both the top and bottom and leaving the centre constrained section in its current form.

2.1.1 Dr. John Morrall Review

Dr. John Morrall, President of the Canadian Highways Institute was invited to bring his considerable international experience in mountain roads. Dr Morrall conducted a site visit in February 2016 and reviewed previous reports. Dr Morrall presented his initial findings to TMR representatives and the project team at a workshop in Cairns on March 3 2016. A brief paper documenting his work is attached in **Appendix B.**

His review concluded that:

- The Kuranda Range Road can be classified as a high volume mountain highway in a highly sensitive environment, namely passing through a World Heritage Site. While this is not totally unique, for example the Trans-Canada Highway traverses four national parks, the combination of terrain, geometry, highway function and environment is rare. This makes the Kuranda Range Road upgrading challenging, but not impossible.
- The road is "self-explaining" in that the horizontal and vertical geometry conveys to drivers to proceed cautiously, resulting in a low speed environment.
- Grades up to 6% are high but not excessive for a mountain road. The impact of grades is to reduce heavy truck speed by 15 km/h in 300 m, then to crawl speed in approximately 500 m.
- Cross sections on horizontal curves result in off-tracking, inadequate separation of opposing traffic streams and limited shy distance.

Dr Morrall reviewed the results of previous VISSIM modelling and concluded that the outcomes of VISSIM modelling carried out by Bitzios for the Kuranda Range Road Upgrading Strategy TMR 2009 – 2012 are counter intuitive. If traffic growth continued at 3.5 % compounded, as assumed by the previous work, the expected traffic volumes would approach 17,000vpd in 2030. According to the VISSIM modelling this would result in an increase in travel times of between 2 and 9%. An independent check by Dr Morrall concluded that, assuming 17000vpd, there would be continuous platooning with heavy vehicles travelling at 30 – 40km/hr being the controlling speed. In this case the estimate of travel time increase would be between 36% and 82%, which is an order of magnitude 10 times that estimated by the previous modelling. In addition to an increase in travel time, there would be a number of adverse effects, including shock wave effects caused by vehicles braking, high driver workload leading to high potential for driver error, high potential for rear end crashes, with associated delays and difficulties for emergency services attending crashes. Dr Morrall recommended assessing the range utilising TRARR as a more appropriate tool for measuring capacity.

Recommendations include:

- In order to enhance safety and operations, a four-lane undivided section on the eastern and western approach to the summit is recommended. The main benefit of this recommendation would be to reduce percent time spent following, which is a surrogate measure of driver frustration. The longer four-lane sections would provide a major improvement to assured overtaking opportunities and mitigate risky unsafe overtaking in both upgrade and downgrade directions on both sides of the summit.

- Selected curve widening is recommended for those locations where low speed off-tracking over the centre-line has been observed.
- ITS Recommendations include:
    - Inform drivers at Smithfield roundabout and before the traffic lights at Kuranda of any road closures on the Kuranda Range Road.
    - Inform drivers of expected travel time (based on Bluetooth).
    - Inform drivers of wet road conditions.

2.2 Related Projects

A number of related projects are currently underway and these can be expected to inform further planning.

2.2.1 Incident Management

An independent review was undertaken on improving the performance of traffic incident management operations on the Kuranda Range Road, in relation to unplanned traffic incidents. The accompanying report is titled "Improving Kuranda Range Road Traffic Incident Management Operations, Professor Phil Charles, Draft Version 18-Jan-16".

The methodology consists of the six tasks shown in **Figure 6.**

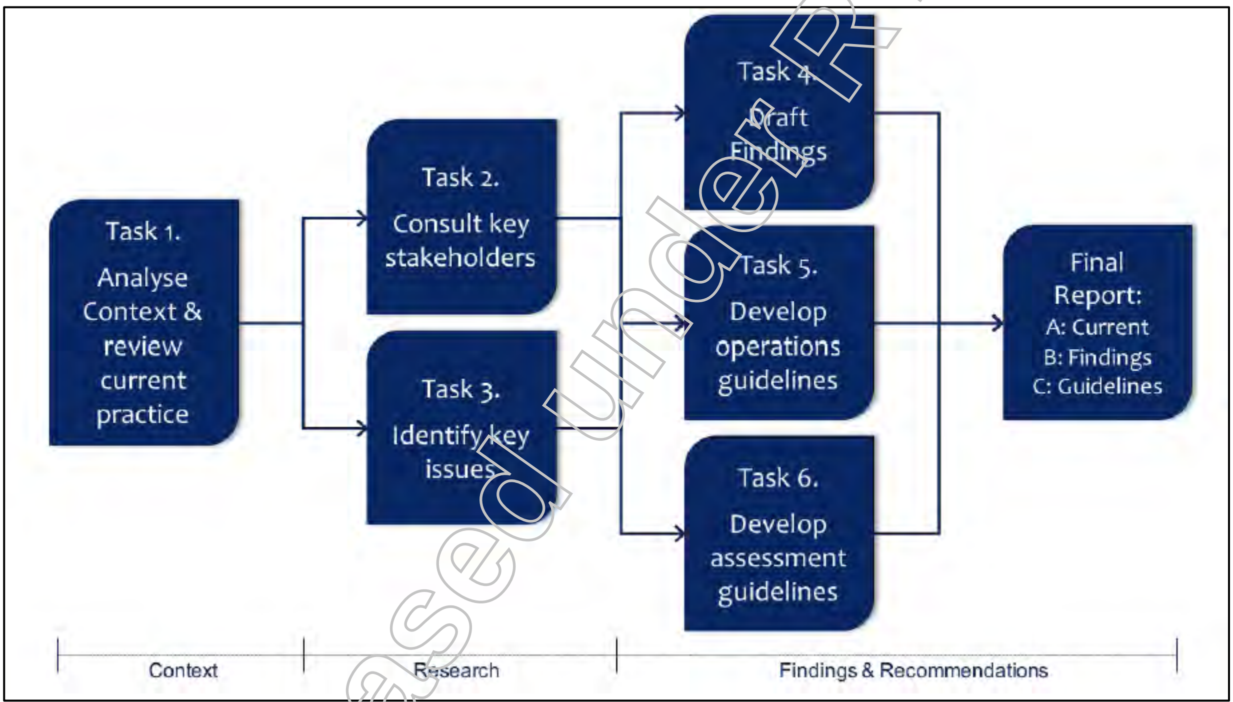

Figure 5 Incident Management Review Methodology

The deliverables for this project involve a report on improving Kuranda Range Road traffic incident management in three parts:

- Part A: Assessment of current incident management operations.
- Part B: Recommendations for the improvement of traffic incident management, safety and customer service.
- Part C: Guidelines for ongoing performance review and assessment of proposed investment in incident management operations.

2.2.1.1 Part A: Assessment of Current Operations

This task involved a review of information and stakeholder consultation to identify key issues and findings in relation to traffic incident management on the Kuranda Range Road, considering the various phases of current incident management operations and best practice success factors.

Traffic incidents have a number of cost impacts on road users, government, key stakeholders and the community, including:

- Safety
- Travel time delay
- Travel time reliability
- Cost to agencies.

An analysis of SIMS data between January 2007 and July 2015 provided 1,152 incidents of which 33% were crashes, for the Kuranda Range area. A breakdown of these incidents is provided in the **Figure 7.**

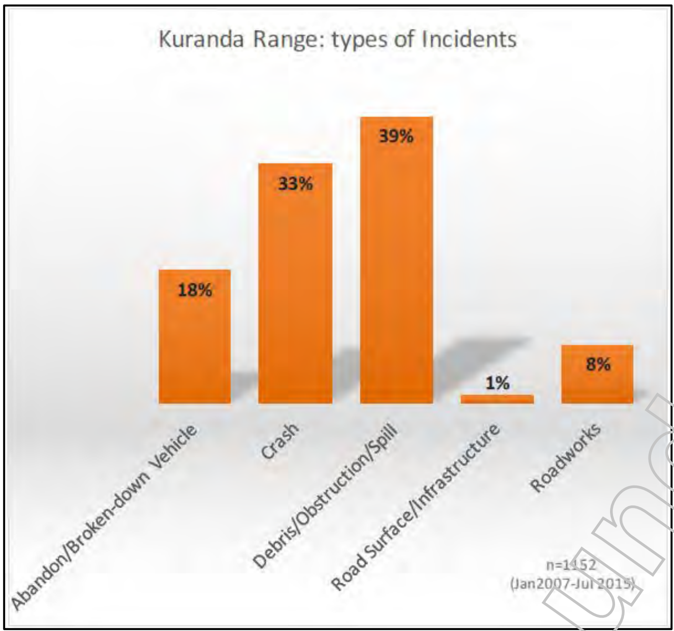

Figure 6 SIMS Incident Data Summary

Analysis of the duration of incidents was also conducted, noting there are concerns about the accuracy of the data, based on inadequate advice on when incidents are resolved. Also the duration is not necessarily related to closures, as this information is not readily available from the SIMS data. Of the 344 entries with start and end times for the incident:

- 75% less than 2 hours
- 25% more than 2 hours (approx. 10 per annum).

An analysis of crash data between July 2007 and June 2012 was undertaken by RoadPro Consulting with the following results:

- 115 casualty crashes, average of 23 crashes per year
- 80% of the incidents were between 7am and 6pm
- 3% fatal, 39% hospitalised, 38% medical and 20% minor
- 52% wet pavement
- 47% run off road, 30% head-on crash.

An extract of QPS traffic crash data on the Kuranda Range was obtained. QPS crash data reported in the media included:

- 95% of crashes were local residents (92 reported crashes in 2 years)
- 38% due to driver error; 58% on wet roads; 46% single vehicle

- 50% resulted in injury.

2.2.1.2 Part B: recommendations for Improvement

Part B provides practical recommendations for the improvement of traffic incident management operations for the Kuranda Range Road, improving mobility, accessibility, safety and customer service outcomes.

The recommended approach to road traffic incident management operations on the Kuranda Range Road is: Prevent. Detect. Respond. Inform. Clear.

- The review highlights a number of actions to improve traffic management including:
- Prepare a TMR traffic incident management action plan.
- Develop contingency plans to respond to major incidents.
- Develop an inter-agency agreement for traffic incident management.
- Establish governance arrangements.

2.2.1.3 Part C: Guidelines for Performance Review and Investment Assessment

Part C provides guidelines for:

- The ongoing review of the performance of traffic incident management operations.
- Assessment of proposed investment in incident management operations.

2.2.1.4 ITS Option Analysis

Options Analysis was carried out to investigate ITS that can improve incident detection, reduce the number of incidents and enhance the level of traveller information provided to users of the Kuranda Range Road. This investigation was undertaken by PB on behalf of TMR in early 2016. The accompanying report is titled "Options Analysis – Kuranda Range Road Improvement Project, April 2016".

The goals of the ITS strategy within this context can be summarised by:

- Incident Reduction and improving road safety.
- Rapid Incident Detection and communication.
- Rapid dissemination of Traveller information to road users and stakeholders.

Four ITS options were presented in the report for analysis and comparison. The scale of the options was reflective of the level of infrastructure investment required. Options were optimised to achieve the highest value for money whilst satisfying stakeholder needs appropriate to the level of investment. The options proposed were as follows:

- Option 1 - High level ITS intervention
- Option 2 - Mid level ITS intervention
- Option 3 - Low level ITS intervention
- Option 4 - Do Nothing Option which did not recommend any further infrastructure than that already committed to the Range for construction in 2016 as listed below:
    - 4 VMS signs to be installed at Smithfield, East of Kuranda and at Mareeba.
    - 4 Hybrid VMS signs to be installed on the Kuranda Range.
    - 2 ANPR Camera Systems to be installed at the top and the bottom of the Range.
    - Bluetooth receivers installed at multiple locations on the Range to monitor travel times on the Range.

The four options were compared according to performance in these areas:

- Established performance of incident reduction, incident detection and traveller information
- The estimated cost of each option
- The level of project risk associated with each option.

Option 3 had the highest weighted score of the four choices. It had the best mix of infrastructure solutions and provided the highest constructability with the lowest risk profile. The Options Analysis recommended that Option 3 be progressed as the preferred option to the Business Case stage. Option 3 involves:

- Road safety treatments:
  - Vehicle activated signs (VAS) – three in total
  - Road weather monitoring stations – three in total
- Incident detection and monitoring:
  - Incident detection loops – 12 in total
  - CCTV – 14 in total
  - Web cameras – three in total
  - High priority crash zones are not treated under this option
- Traveller information:
  - Variable message signs (VMS), hybrid signs and other digital solutions
- Supporting infrastructure for all detection and CCTV sites such as standalone solar power and 3G communications.

2.2.2 Infrastructure Upgrades

In recent years TMR developed a program of minor safety works for several locations along Kuranda Range Road. The majority of the proposed upgrades involve minor curve widening and associated earthworks. Some of these upgrades were identified to address safety concerns at known crash Black Spots.

While definitive information on the status of these projects was not able to be obtained, **Table 5** details the understanding of schemes identified in the minor safety works program and whether construction has occurred to date.

Table 5 Infrastructure Upgrades

Scheme	Curve	Constructed
Scheme Curve 15 - 18	15 and 16	✓
	17 and 18	✗
Scheme Curve 22	22	✓
Scheme Curve 26	26	✗
Scheme Curve 32	32	✗
Scheme Curve 34	34	✗
Scheme Curve 38	38	✗
Scheme Curve 59 - 61	59	✗
	60 and 61	✓
Scheme Curve 79 - 83	79 to 81	✗
	82	✓
	83	✗

3. Environmental Issues

3.1 TMR Environmental Processes

All road projects in Queensland under the Queensland Transport and Roads Investment Program (QTRIP) are undertaken in accordance with the Environmental Processes Manual (EPM) (TMR 2013). The environmental processes described in the EPM support:

- The department's general environmental duty to the environment as required by the Environmental Protection Act 1994.
- The department to manage the performance of its functions and operations in accordance with the Corporate Governance Framework (2010).
- The strategies of the Transport and Main Roads Corporate Plan 2011 – 2015, including the Corporate Strategies to:
    - 'Reduce the environmental impact of our [departmental] operations' and
    - 'Implement effective business systems, processes and practices'.

The following figure shows the processes graphically, related to the overall OnQ project management framework.

OnQ Project Management Phases							
OnQ Project Management Phase	Concept (including Link Study)			Development		Implementation	Finalisation
	Project Proposal	Options Analysis	Business Case	Preliminary Design	Detailed Design	Construction	Handover
Key documents in Environmental Process	ESR*	LOW	**	**	EDR* (Detailed Design)	EMP* (Construction) Checklist Review	
		MED	**	EAR*; EDR** (Preliminary Design)		EMP*(Construction) Review; Environmental Site Inspection Checklist; Environmental Compliance Audit Report	
		HIGH	REF*; EMP* Planning	EDR* (Preliminary Design)			Post Implementation Review / Handover Report (Environment)
Environmental tasks aligned to project phases	LINK STUDY Typically centred on route or corridor analysis Link study utilises desktop study tools (electronic environmental datasets (GIS)) (Link Studies include environmental input in to Route Constraints Analysis (RCA) & Corridor Development Plans (CDPs))		CONCEPT PHASE Environmental input to overall project proposal Includes environmental component options analysis and cost estimate which contribute to the overall project Business Case.	Input to Preliminary and Detailed Design Recommendations for Environmental Management Input to Contract Documentation		Project EMP*	Project Maintenance Plans Input to RMPC* Input to RCP*

*Document acronyms provided in Glossary and also in later manual content with accompanying document / process descriptions.

** Content of ESR is considered sufficient for this phase

Figure 7 Environmental Processes Manual - Alignment of Key Environmental Processes.

Source: TMR (2013) Table 1.6.1

As shown above, the first step in the EPM process is an environmental risk assessment undertaken under what is termed an Environmental Scoping Report (ESR). The ESR is usually undertaken as part of an Options Analysis under the OnQ project management system where the concept project is quite well defined. However, the EPM also states that risk assessment can start at any time and the above figure includes a Link Study in the Concept Phase. Referring to the EPM, the purpose of an ESR is to make 'an early assessment of potential environmental impacts and opportunities associated with a proposed project'. The intended outcomes of the ESR are:

- An overall environmental risk rating for a project.
- Assessment of whether or not further environmental assessments are warranted as part of the pre-construction process.

It is usual for an ESR to be undertaken as part of an Options Analysis. However, there is no intent to subject any project developed under this Link Study to the full rigour of an Options Analysis / Business Case until a basic concept is produced and appropriate options are considered at a high level because of current uncertainty regarding project budget. The final budget will depend on the high level estimation of costs and benefits of any concepts developed. Accordingly, a full ESR is not appropriate.

However, the EPM notes that the scoping process is commenced at the Concept / Link Study phase and for this reason, a modified scoping process was adopted for this study. The adopted methodology has been developed in partnership with TMR and consists of the following:

- Environmental risk assessment to determine implications for the development of options, risk, and recommended environmental aspects of the Link Study.
- Assessment of environmental values of the road corridor (based on comprehensive previous work supplemented by targeted fieldwork and desktop assessment) to inform consideration of design solutions.
- Inclusion of appropriate environmental criteria in the development and analysis of options.
- Recommendations for additional future work.

This is documented in **Appendix D** where an environmental risk assessment was undertaken as described below.

3.1.1 Environmental Risk Assessment

The EPM template states that elements to be described in an ESR are:

- Water
- Soil and Land Management
- Biodiversity
- Cultural Heritage
- Public Amenity and Health
- Resource Use and Management
- Special Areas and Land Tenures
- Other – Landscape
- Environmental project classification
- Options analysis.

Further, the overall environmental risk rating for the project is based on:

- Existing environmental values
- The scope of works and potential impacts from the works
- Legislative triggers likely associated with the works.

The following table records the results of an initial screening of values and issues, using the headings from the ESR template listed above, and based on findings of previous studies. The key resource is Chapter 5 of the IAS Addendum

(Environment North 2004) where a comprehensive assessment of environmental and other values was documented. This study and more recent work is described later in this Link Study report as appropriate.

This risk assessment was undertaken at the commencement of the Link Study and informed its progress on environmental matters**.**

Table 6 below is an extract from **Table 1-1** of **Appendix D**, modified slightly to reflect the current status of the study.

This assessment reveals that the project has a High environmental project classification. An REF and EMP (Planning) will be required as part of a future Business Case (if approved). However, targeted environmental assessment were undertaken to inform the Link Study during the development of engineering solutions.

3.1.2 Future Assessment

Should TMR wish to proceed with investigations beyond this Link Study (i.e. to an Options Analysis / Business Case), then the EPM requires that these be informed by:

- A Review of Environmental Factors (REF)
- An Environmental Management Plan (Planning) (EMP (Planning)).

Table 6 Environmental risk assessment

ESR ELEMENT	SUMMARY	RELEVANCE OF VALUE / ISSUE TO LINK STUDY / INITIAL OPTIONS ANALYSIS	LOCATION OF KEY VALUE / THREAT	RECOMMENDED LEVEL / TIMING OF ASSESSMENT
Water	In general, all parameters measured are acceptable for a slightly disturbed upland tropical stream. These levels are consistent with the key management objective of maintenance of biological diversity.	Nil. Water quality is not expected be a distinctive that separates options. Increased paving and traffic can be expected to increase the threat to water quality and mitigation by design will be required.	Avondale Creek (lower) Avondale Creek (upper) Streets Creek	Link Study – nil. Address in detailed design.
Soil and Land Management	The key land management issue is slope stability. Along the Kuranda Range Road, two modes of failure are dominant: slumping or rotational failure in soil type material (this type of failure may generate a debris flow if the slope is long enough) rock falls (wedge, planar and toppling failures) caused by the unfavourable orientation of rock defects and the broken nature of the rock. In some of the more weathered rock, a combination of the two types also occurs where relict joint planes have unfavourable orientation.	Slope stability is relevant at both the local level and globally (i.e. overall stability of the escarpment). Almost all failures have a common trigger of an intense rainfall event or episode which causes saturation of the material in the slope. Drainage is therefore a critical consideration. Contaminated land and ASS / PASS are not an issue. Erosion and sedimentation control will be required for construction (i.e. not a distinctive).	Eastern Fall, in particular above Avondale Creek. Other areas depending on relative orientation of cuttings and dip / strike of faults.	Link Study – broad assessment of likely stable embankments and cuttings based on existing studies, solutions will affect costing. Specialist detailed investigation of global stability may be warranted, based on the above.
Biodiversity	Flora and fauna values are extremely high in most areas, although previous work has stratified these into zones of relative value. Values include regional ecosystems of state significance, listed threatened plants and animals of up to national significance. Highest values accrue where the road crosses regionally significant biodiversity corridors (the first three listed opposite under 'Location').	Although values are high, it is unlikely that upgrade options affordable under this project will have significantly different impacts on biodiversity. However, these values will influence the design of works (especially crossings of watercourses) and require attention to fauna connectivity. Weeds management is issue for construction.	Avondale Creek (lower) Avondale Creek (upper) North / south ridge and Diplazium Gully Streets Creek Quartzite Outcrop	Link Study – avoidance of key areas where possible (these can be mapped based on existing information although further assessment is required). Solutions will affect costing.
Cultural Heritage	There are few known or recorded places of particular indigenous or non-indigenous cultural significance in the immediate vicinity of the road or the four lane upgrade.	Minor. However, since the completion of the IAS Addendum, the Wet Tropics World Heritage Area (WTWHA) is now listed for its cultural values. This will need to be addressed in any permit for works.	A section of dry stone-pitched wall exists on the 'switchback' of the current road. Quartzite Outcrop (Chainage 10630 - 10850).	Link Study – consider mappable values. Also undertake initial review of consequences for future WTMA permits of cultural heritage listing.
Public Amenity and Health	Air, noise, and vibration are currently not an issue and there are few sensitive receptors other than in the Smithfield area.	Because the existing air quality in the region and along the Kuranda Range Road is quite high,	Where the road is above houses at Smithfield local	Link Study – nil.

ESR ELEMENT	SUMMARY	RELEVANCE OF VALUE / ISSUE TO LINK STUDY / INITIAL OPTIONS ANALYSIS	LOCATION OF KEY VALUE / THREAT	RECOMMENDED LEVEL / TIMING OF ASSESSMENT
		there are no major constraints to the upgrade based on this criterion. Traffic noise is not currently a problem (as determined by current policies)	noise issues could be a design concern.	
Resource Use and Management	Some surface water is used (commercial, domestic). There are no significant groundwater water values (i.e. commercial or domestic consumption) likely to be affected by the upgrade.	Surface water (extraction) values are not a major constraint on the upgrade although it is desirable to maintain water quality to permit the continuing use of potable water from Streets Creek and Avondale Creek by holders of extraction permits.	Avondale Creek Streets Creek	Link Study – nil.
Special Areas and Land Tenures	Most of the existing road is in the WTWHA and is national park. While the current road and the route of the four lane upgrade is within road reserve, it is still subject to the *Wet Tropics Management Plan 1998* (Qld) (WTMP).	Most of the existing road is in the WTWHA and is subject to a zoning and permit system. National park revocation will be required if the upgrade involves alignments outside the road reserve. The key value is integrity, largely based on connectivity of habitat and associated ecological processes, and scenic amenity. Cultural World Heritage values are now relevant.	Most of the road is in the WHA and is therefore directly affected.	Link Study – while permits are not required under this commission, it should be assumed that all options developed need to be able to be approved. Solutions to make options approvable will affect costing.
Other – Landscape	The forested hills of the Macalister Range through which the Kuranda Range Road passes have important scenic values, especially for viewers located on the coastal plain. Important views are also provided from the road itself, with views in general being better for east-bound than west-bound traffic. The most important of these are the Henry Ross Lookout which provides panoramic views of the coastal plain and the coral sea and the general forested drive views that occur along much of the road.	Roadworks (especially those involving cuttings) can result in visible scars. However, these influences are generally transient as weathering and natural revegetation takes place. Revegetation will accelerate this process and will be required under any WTMA permits.	Eastern Fall (most highly visible). Detailed visual assessment work is available for review.	Link Study – a WTWHA issue (as above).
Environmental project classification	*High* (World Heritage values, Matters of National Environmental Significance under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act)).	Any options that are to be taken forward to implementation will require a permit (WTMP) and possibly EPBC Act approval. For options to be approvable they will need to demonstrate compliance with the WTMP.	Whole corridor.	Link Study – limited desktop and field assessment as dictated by details of options. Business Case – REF and EMP (Planning) required.

ESR ELEMENT	SUMMARY	RELEVANCE OF VALUE / ISSUE TO LINK STUDY / INITIAL OPTIONS ANALYSIS	LOCATION OF KEY VALUE / THREAT	RECOMMENDED LEVEL / TIMING OF ASSESSMENT
Options analysis	As above (i.e. multiple values).	As above (i.e. multiple values). Key issue is WTMP approvals and what these mean for environmental design and performance.	-	Link Study – consider environmental constraints in particular areas once alignment options are known, and take note of possible cost implications of works to make options approvable.

Source: **Appendix D – Environmental Issues** based on **Table 1-1**.

3.2 Previous Environmental Assessments

Much work has been undertaken on the environmental values of the Kuranda Range Road. Key work is outlined below in **Table 7** and covered in more detail in **Appendix D.**

Table 7 Previous Environmental Assessments relevant to the Kuranda Range Road Link Study

Planning Study	Key points relevant to the Link Study
Integrated Transport Study for Kuranda Range (ITSKR) **TMR 1998-2008**	As an outcome of the IAS Addendum approvals were sought and obtained from the Wet Tropics Management Authority (WTMA) under the *Wet Tropics Management Plan 1998* (Qld). The zoning stands and is likely to provide an adequate corridor for schemes developed under this study (i.e. in close proximity to the existing alignment). The permit applies only to the IAS Addendum scheme and a new permit will be required for any work arising from this Link Study. The IAS Addendum and several additional studies were used as 'preliminary documentation' for the EPBC Act assessment. An approval was issued on 25 May 2007. While this is valid until 31 December 2030, it applies only to the upgrade as then proposed. The permit requires a 'substantial start' within seven years (i.e. to May 2014) and this date has now passed. A new EPBC Act approval may be required (the current one is not relevant and in any case has lapsed due to failure to commence works). Whether or not an EPBC Act approval is actually required depends on the assessed significance of impacts on MNES and the preparedness of the Department of the Environment (Commonwealth) (DoE) to 'delegate' assessment to WTMA.
Minor Safety Works program **GHD 2007-2009**	The MSW package was referred to the then Department of the Environment, Water, Heritage and the Arts (now DoE) The Decision Notice dated 26 January 2009 was that the proposed works were 'not a controlled action' and hence no assessment was required. A new EPBC Act approval may be required for any new works arising from this Link Study. Whether or not an EPBC Act approval is actually required depends on the assessed significance of impacts on MNES and the preparedness of DoE to 'delegate' assessment to WTMA.
Kuranda Range Road Upgrading Strategy **AECOM 2009 – 2012**	Although no new environmental work was involved, the report considered key environmental factors derived from the IAS Addendum.

3.3 World Heritage Issues

3.3.1 Introduction

The Kuranda Range Road traverses the heavily vegetated foothills and ridge of the MacAllister Range at one of its narrowest sections described as the Black Mountain Corridor. Much of this crossing is within the Wet Tropics of Queensland World Heritage Area (WTWHA) as shown on **Figure 9**.

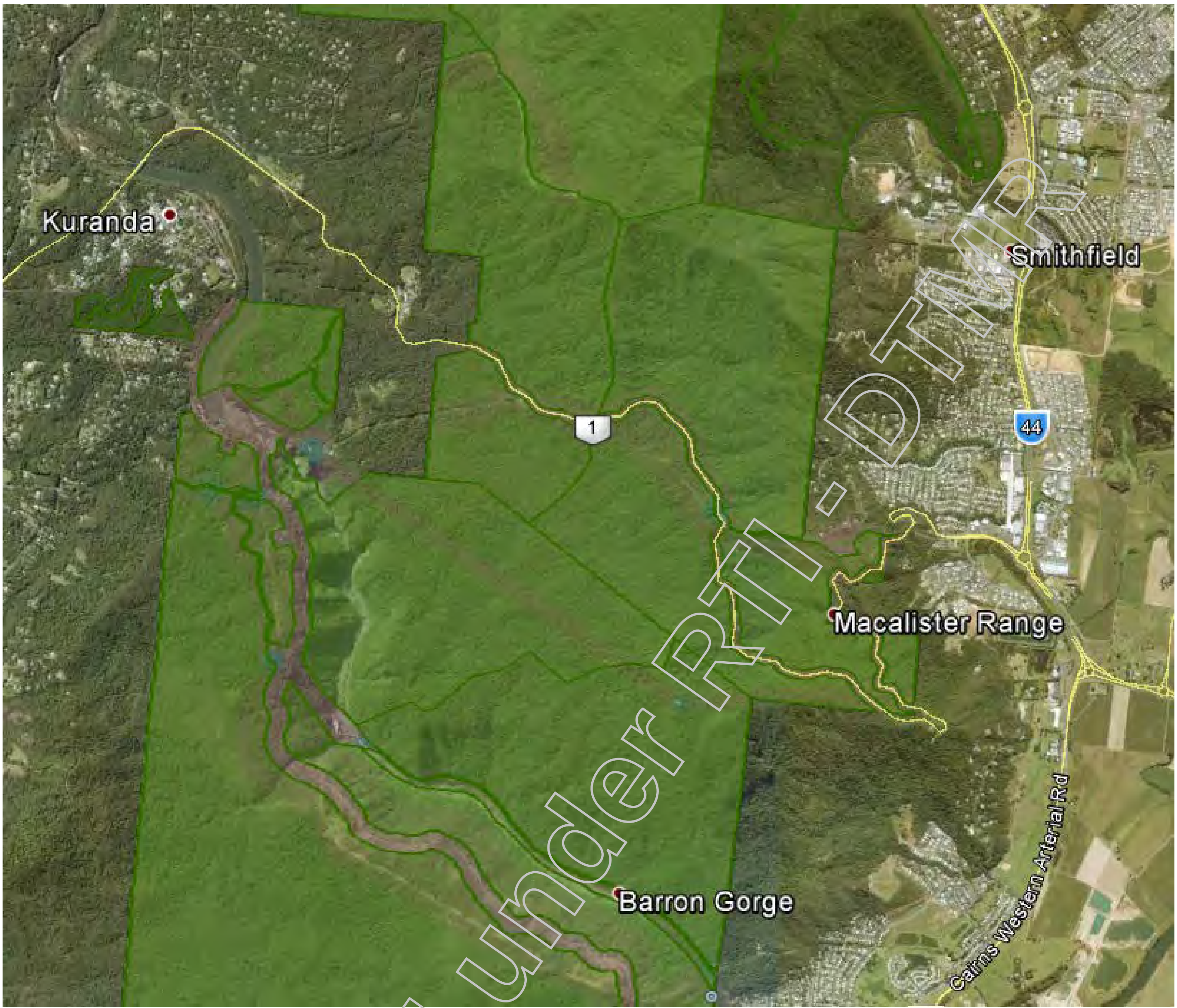

Figure 8 Study area showing WTWHA (shaded green).

Areas within the WTWHA are subject to the Wet Tropics Management Plan 1998 (Qld) (WTMP) and in particular the zoning and permit systems as described in more detail below. The WTWHA is also a Matter of National Environmental Significance (MNES) under the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) (EPBC Act) (sections 12 and 15A) as are various listed threatened species and communities (sections 18 and 18A of the EPBC Act). Refer **Section 3.4**. It is known that species listed under both the EPBC Act and the Nature Conservation Act 1992 (Qld) (NC Act) exist both within and outside the WHA.

With respect to the WTMP:

- The existing road is currently within Zone C (disturbed for community infrastructure) and Zone D (containing developed visitor facilities).
- Roads can only be built in Zones C and D, for which a permit is required.
- Roads cannot be built within Zone B (i.e. a rezoning is necessary to convert such areas to Zone C or D).

Environmental Issues, refer **Appendix D**, includes an appendix (Appendix A) that sets out a very detailed description of the application of the WTMP to the four lane upgrade proposal. This is an extract from the IAS Addendum and is included as part of this Link Study as it is highly relevant to further consideration in the implementation phase.

3.3.2 Zoning

The existing road lies entirely within Zone C as originally established when the WTMP commenced. As part of the Integrated Transport Study for Kuranda Range (ITSKR), the Zone C boundary was amended to allow for the construction of the four lane scheme. The actual extent of rezoning approved was slightly greater than needed for the four lane footprint for the following reasons:

- To allow for survey inaccuracy.
- To provide design flexibility.
- To allow for a construction working area.
- To rationalise the boundary to remove minor kinks etc.

The rezoning was approved on 9 July 2005 and this amendment remains in place. See **Figure 10**.

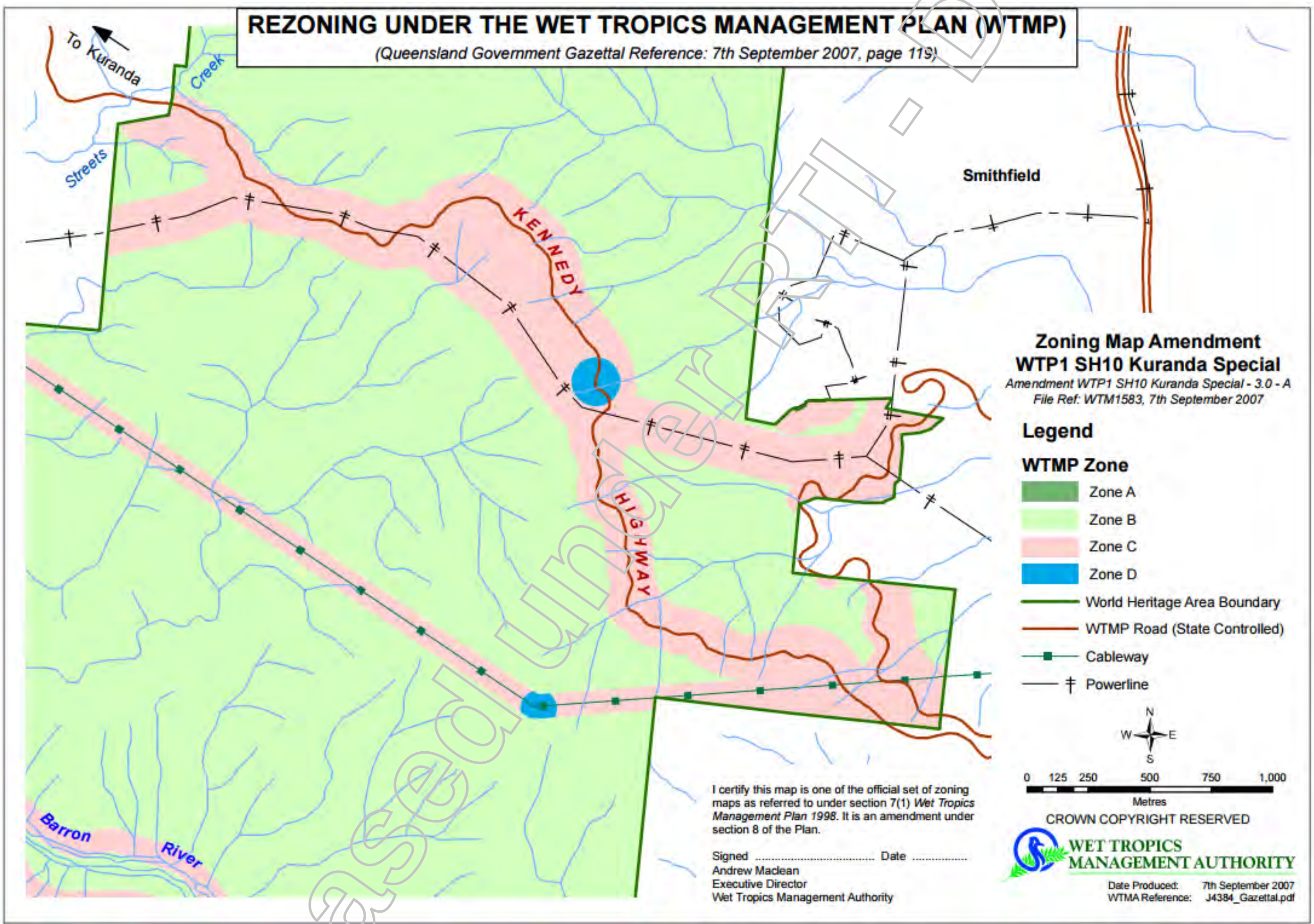

Figure 9 'Kuranda Special' Zoning Plan (as achieved by the rezoning for the four lane upgrade).

Note that not all of the Kuranda Range Road between Ch 0.98 and 11.18 km is within the WTWHA (see figure above). By way of explanation, for its whole length, the current road is within road reserve – but within the WHA there is a zoning overlay that defines what works can be permitted.

3.3.3 Permit to Undertake Roadworks

3.3.3.1 Overview

The current road and the IAS Addendum four lane upgrade both lie within Zones C and D of the Wet Tropics Management Plan 1998 (Qld) (WTMP). Roads can only be built in Zones C and D and then only with a permit.

The WTMP includes a number of policy statements and guidelines that set out the basis for issuing a permit for roadworks. These are highly relevant to this Link Study as they provide details of infrastructure and its underlying planning is likely to be able to be approved as part of the implementation phase.

3.3.3.2 General Principles

The WTMP includes the following section:

- s56(1): most important consideration (likely impact on area's integrity)
- s56(2): have regard to the intended physical and social setting and management purpose for the particular zone, particularly the impact on nearby zones
- s57: application of the precautionary principle
- s58: prudent and feasible alternatives to the proposed activity
- s59: minimising the likely impact on the area's World Heritage values
- s60: community considerations
- s61: carrying capacity.

3.3.3.3 Section 62 Guidelines

s62 includes provision for the creation of guidelines. To date nine guidelines have been produced, namely (those potentially relevant to this Link Study are shaded):

- Guideline 1: Minor and Inconsequential Impact
- Guideline 2: Definition of a Rainforest
- Guideline 3: Consulting Aboriginal People Particularly Concerned with Land in the Wet Tropics Area
- Guideline 4: The Queensland Electricity Supply Industry Maintenance Code Behana Creek
- Guideline 5: Seed Collecting in Wet Tropics World Heritage Area
- Guideline 6: Community Consultation re Assessment of Permit Applications
- Guideline 7: Water Code of Practice
- Guideline 7: Field Guide - Water Infrastructure Code of Practice
- Guideline 8: Use of Motor Vehicles on Presentation (Restricted) and Management Roads in Wet Tropics World Heritage Area
- Guideline 9: Roads in Rainforest:
    - Best Practice Guidelines for Planning, Design and Management
    - Science Behind the Guidelines
    - Road maintenance code of practice.

At the time of writing the IAS Addendum, only guidelines 3 and 6 had been produced (see **Appendix A** of Environmental Issues, attached in **Appendix D**).

3.3.3.4 Permit Applications for Particular Activities – Roadworks

The WTMP contains specific references of roadworks (s65) as outlined below:

- s65(1): no net adverse impact on the integrity of the area [is permitted] if there is no prudent and feasible alternative (s58).
- s65(2): works should, to the greatest possible extent, be confined to land already cleared or degraded.

- s65(3): canopy clearing should be avoided.
- These principles have been followed in the development of this Link Study as described later.

3.3.4 Required Permits

A permit will be required to undertake any works in the WHA and it is known from experience gained during the ITSKR and the MSW projects that WTMA takes a particular interest in the Kuranda Range Road.

Project implications:

The brief for this Link Study does not require that a rezoning be undertaken (if required) or a permit be secured as part of the link study.

However, the consideration of options and the cost estimate both need to be informed by likely rezoning issues (if applicable) and permit conditions.

'World Heritage requirements' are covered by the WTMP. This stipulates that WTMA must consider a number of matters, principal among which are (quotes are from the WTMP):

- **Integrity.** 'The most important consideration for deciding the application is the likely impact of the proposed activity on the area's integrity'. During the ITSKR, WTMA required TMR to demonstrate 'no net loss (of the integrity of the area)' and this involved considerable efforts in terms of assessment and cost in terms of 'environmental works'.
- **Precautionary principle**. 'The authority must decide the application under the principle that, if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.'
- **Prudent and feasible alternatives.** 'The authority must consider whether there is any prudent and feasible alternative to a proposed activity.'

3.3.5 Project Implications

To address these criteria requires comprehensive assessment and documentation supported by recent and relevant fieldwork and analysis.

This will involve considerable effort in terms of assessment and will require environmental works as part of any upgrade.

The overall implications of the WTMP can be summarised as follows:

1. Any upgrade projects located within the Wet Tropics World Heritage Area (WHA) (and this is likely to include most options to be examined) will require a permit under the Wet Tropics Management Plan 1998 (Qld) (WTMP).
2. The current permit for the four lane upgrade will not be relevant.
3. It is known from the WTMP itself and from previous experience that the Wet Tropics Management Authority (WTMA) will require that environmental criteria be integrated into the design.
4. Although securing a permit is out of scope, future permit conditions need to be considered and allowed for in the scope and cost of works required to inform the Options Analysis and Business Case.

3.4 EPBC Act Issues

3.4.1 Introduction

As noted above, 'World Heritage requirements' are not restricted to WTMA under the WTMP as they are also under the control of DoE under the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) (EPBC Act). Depending on the significance of impacts of proposed works on matters of national environmental significance (matters of NES), approval may be required under the EPBC Act.

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the EPBC Act as matters of national environmental significance (matters of NES) by requiring that actions that pose significant impacts be subject to assessment by the Commonwealth Minister for the Environment.

Under the EPBC Act, a person must not take an action that has, will have, or is likely to have a significant impact on a matter of NES without Commonwealth approval. An action includes a project, undertaking or an activity or series of activities. A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. Proponents should consider all of these factors when determining whether an action is likely to have a significant impact on matters of national environmental significance (DoTE 2013).

3.4.2 Matters of National Environmental Significance

Matters of NES are defined under Part 3 of the EPBC Act, namely:

- World Heritage properties (sections 12 and 15A).
- National Heritage places (sections 15B and 15C).
- Wetlands of international importance (sections 16 and 17B).
- Listed threatened species and communities (sections 18 and 18A).
- Listed migratory species (sections 20 and 20A).
- Protection of the environment from nuclear actions (sections 21 and 22A).
- Commonwealth marine environment (sections 23 and 24A) – includes listed marine species.
- Great Barrier Reef Marine Park (sections 24B and 24C).
- A water resource, in relation to coal seam gas development and large coal mining development (sections 24D and 24E).

The environment, if the action involves Commonwealth land (sections 26 and 27A), including:

- Actions that are likely to have a significant impact on the environment of Commonwealth land (even if taken outside Commonwealth land).
- Actions taken on Commonwealth land that may have a significant impact on the environment generally.
- The environment, if the action is taken by the Commonwealth (section 28).
- Commonwealth Heritage places outside the Australian jurisdiction (sections 27B and 27C).

3.4.3 IAS Addendum Findings

The IAS Addendum concluded that for the project area, the key matters of NES are:

- World Heritage properties (sections 12 and 15A) (within or proximal to the Wet Tropics World Heritage Area).
- Listed threatened species and communities (sections 18 and 18A). Key species identified in previous work are (other species may also be relevant):
    - the Southern cassowary (Casuarius casuarius)
    - the fern Diplazium pallidum
    - certain frogs (Torrent Tree Frog (Litoria nannotis), Creek Frog (Litoria rheocola, New Guinea Tree Frog (or Green-eyed Tree Frog - Litoria genimaculata), Sharp-snouted Torrent Frog (Taudactylus acutirostris).

If there is likely to be a significant impact on a matter of NES, then a referral is required as part of the approvals phase. Although not required until an ‘action’ is taken (i.e. construction), the cost of any work that may be required to secure approval (such as design aimed at mitigation or offsets) would form part of the project cost and should be allowed for.

3.4.4 Cumulative and Consequential Impacts

Of relevance is the fact that in approving the four lane upgrade, the Commonwealth Government required that TMR undertake an assessment of the cumulative and consequential impacts of the works. At the time, these were largely related to the development of the Myola area (the upgrade was required by the then current Regional Plan (FNQ 2010) to allow for the development of Myola as a regional growth centre).

Any ‘cumulative and consequential’ impacts of the proposed works must be considered (i.e. impacts that could occur if the current deficiencies in the road were removed).

Project implications:

- Like WTMA, DoE is interested in a no net loss solution or, if this cannot be achieved, offsets.
- A package of these was negotiated in 2007 and some of these may still be current.
- Cumulative and consequential impacts will need to be considered.

3.4.5 Other Approvals

Approvals will be required at the operational works stage of any projects arising from this Link Study. These include:

- Approval to clear regulated vegetation under the Vegetation Management Act 1999 (Qld).
- Approval to take listed threatened plants or disturb the habitats of listed threatened animals under the Nature Conservation Act 1992 (Qld) (NC Act).
- Approval to undertake works in the Kuranda National Park under the NC Act.

Offsets may be required when approvals are needed and when impacts cannot be successfully avoided, minimised, and/or mitigated. Various offsets framework exist under both Queensland and Commonwealth legislation.

Further details on approvals and offsets can be expected to be addressed during the preparation of a Review of Environmental Factors report undertaken as part of the Business Case.

4. Current Situation

4.1 Existing Road Function

The Kuranda Range Road (Kennedy Highway) is currently a two lane two way range road with a large number of blind corners and steep climbs. The road climbs through rainforest and is frequently wet with a high friction demand. Kuranda Range Road offers the shortest route between Cairns and Mareeba or Atherton and crosses the Wet Tropics World Heritage Area. It features significant remnant vegetation and is a significant tourist route in addition to its freight and commuter usage.

While there are some limited overtaking opportunities, the short length of these passing lanes and poor geometry only allows a small number of overtaking manoeuvres to be performed. The limited overtaking opportunities result in increased travel times when slower moving vehicles are present and frustrated motorists attempt unsafe overtaking manoeuvres. The range section currently operates at Level of Service (LoS) D/E, has a high crash history and suffers regular closures/detours of up to 8 hours duration as a result of crashes. In 2014 the range was closed for more than 200 hours as a result of crashes.

There are four road connections between the Atherton Tableland and the coast in the Cairns region:

- Palmerston Highway
- Gillies Highway
- Kennedy Highway
- Rex Range (Mossman – Mt Molloy Road).

All highways cross the World Heritage Area. While the Palmerston Highway is the designated freight route it requires a significant detour for traffic from the northern Tablelands. It also has poor direct access from the Northern Tablelands between the Burke Developmental Road and the Kennedy Highway. The Gillies Highway does not have suitable geometry for freight vehicles and the Rex Range is not preferred for general freight as it would be longer for most vehicles and increasing freight on this route would put further pressure on the Captain Cook Highway north of Cairns, which is a major tourist route with restricted geometry. The Kuranda Range Road is the most direct and is the preferred route for freight between the Northern Tablelands and Cairns. An example of the existing demands on the Kuranda Range Road is the trucks carrying waste between the Tablelands and the Cairns Regional Waste Transfer Station.

The Kuranda Range Road also functions as a tourist route and with its scenic views and rainforest drive is a tourist attraction in its own right. Kuranda is a destination for tourist buses from Cairns and beyond. The Henry Ross Lookout provides panoramic views to the Coral Sea and is an important tourism feature as well as the starting point for a downhill mountain bike track. The Rainforestation Nature Park is a major tourist attraction.

As the administrative centre for Far North Queensland, Cairns also attracts significant commuter traffic from the northern Tablelands beyond the Kuranda Range Road.

4.2 Existing Road Condition

4.2.1 Corridor Width and Typical Cross Sections

Kuranda Range Road within the study area is a two-way two-lane undivided carriageway. There are sections of road which potentially could allow for overtaking opportunities and these are described as either:

- Pullover / breakdown areas; or
- Overtaking lanes; or

- Slow vehicle turnouts.

It should be noted that although these are classified as potential overtaking opportunities, anecdotal evidence suggests that several are seldom used for overtaking as intended. This may be because the length is insufficient to allow vehicles to complete the overtaking manoeuvre safely, and in some instances heavy vehicles avoid using these areas as the gradient is such that they then have difficulty in maintaining sufficient speed to re-enter the traffic stream safely.

Therefore in reality the existing road has limited overtaking opportunities (limited to the overtaking lanes) which leads to increased driver frustration as traffic increases over time.

Figure 11 Existing Potential Overtaking Opportunities schematically shows the location and length of each of these potential overtaking opportunities. **Figure 12** Existing Overtaking Lanes - schematically shows the location and length of each of the effective overtaking opportunities and **Table 8** summarises the potential and effective overtaking opportunities along the range the majority of which are located along the eastern face.

Table 8 Existing Overtaking Opportunities along Kuranda Range Road

Road Section	Pullover / Breakdown Areas	Overtaking Lanes	Slow Vehicle Turnouts	All Potential Overtaking Opportunities	Effective Overtaking Opportunities (Overtaking Lanes)
East limit to Henry Ross Lookout (approx. length = 5893m)	8	1	5	14	1
West limit to Henry Ross Lookout (approx. length = 5909m)	2	5	2	9	5
Total	**10**	**6**	**7**	**23**	**6**

The posted speed limit is 60 km/h for both directions of travel along the length of the range from the start of the eastern face to Saddle Mountain Road where it increases to 80 km/h. The westbound overtaking lane (Chainage 4385 to 4800) has a posted speed limit of 70 km/h. There are numerous curve advisory speed signs located along the range of varying speed values.

4.2.2 Formation Width, Seal Width and Roughness

Up to date information on formation and seal width was not available. Due to the geometry of the road, the formation and seal width varies along the length of the alignment and a large proportion of the width is insufficient for two 19m semi - trailers to safely pass. A desktop swept path assessment was carried out to identify locations where seal width was insufficient (see **Table 9**).

No specific details on pavement roughness were available. The surfacing is generally well maintained.

4.2.3 Pavement / Seal Type

Limited information is readily available on the existing pavements. Improvement works have been undertaken in recent years and in general the pavement condition is good.

A common crash causal factor was found to be road conditions during wet weather with 61% of crashes occurring when the road surface was wet. A review of the crashes occurring in wet conditions did not suggest any link between wet weather crashes and the pavement type. As stated above the surfacing is generally well maintained including water blasting every two years. The majority of the wet weather crashes occurring in the wet conditions occurred due to driver error.

The crash data indicates that wet weather crashes are particular problematic at Curves C104 (19 crashes) and C37 Top Hairpin (17 crashes). The three areas with the highest ranking occurrence of wet weather crashes are; Area 24, Area 21 and Area 10.

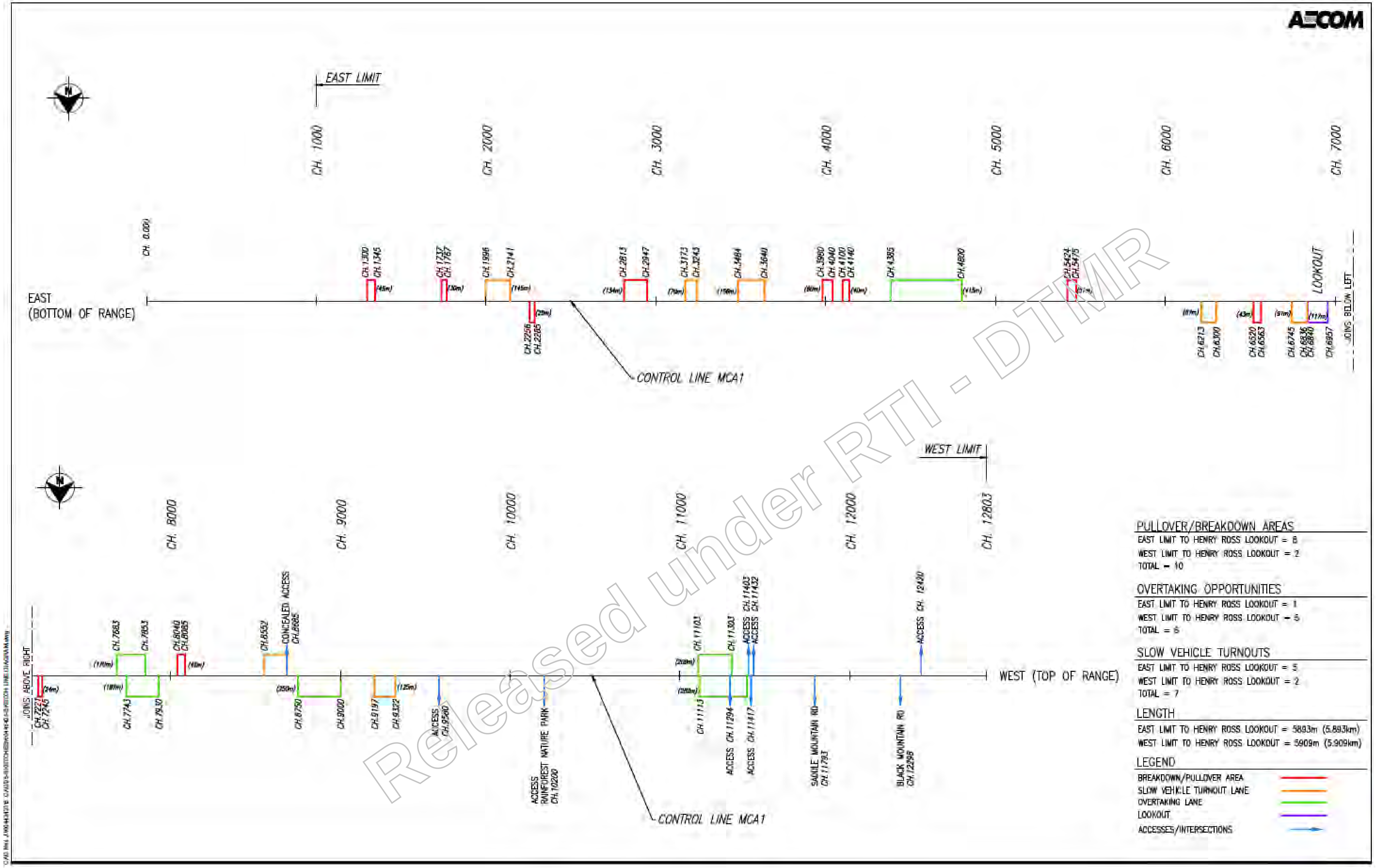

Figure 10 **Existing Potential Overtaking Opportunities**

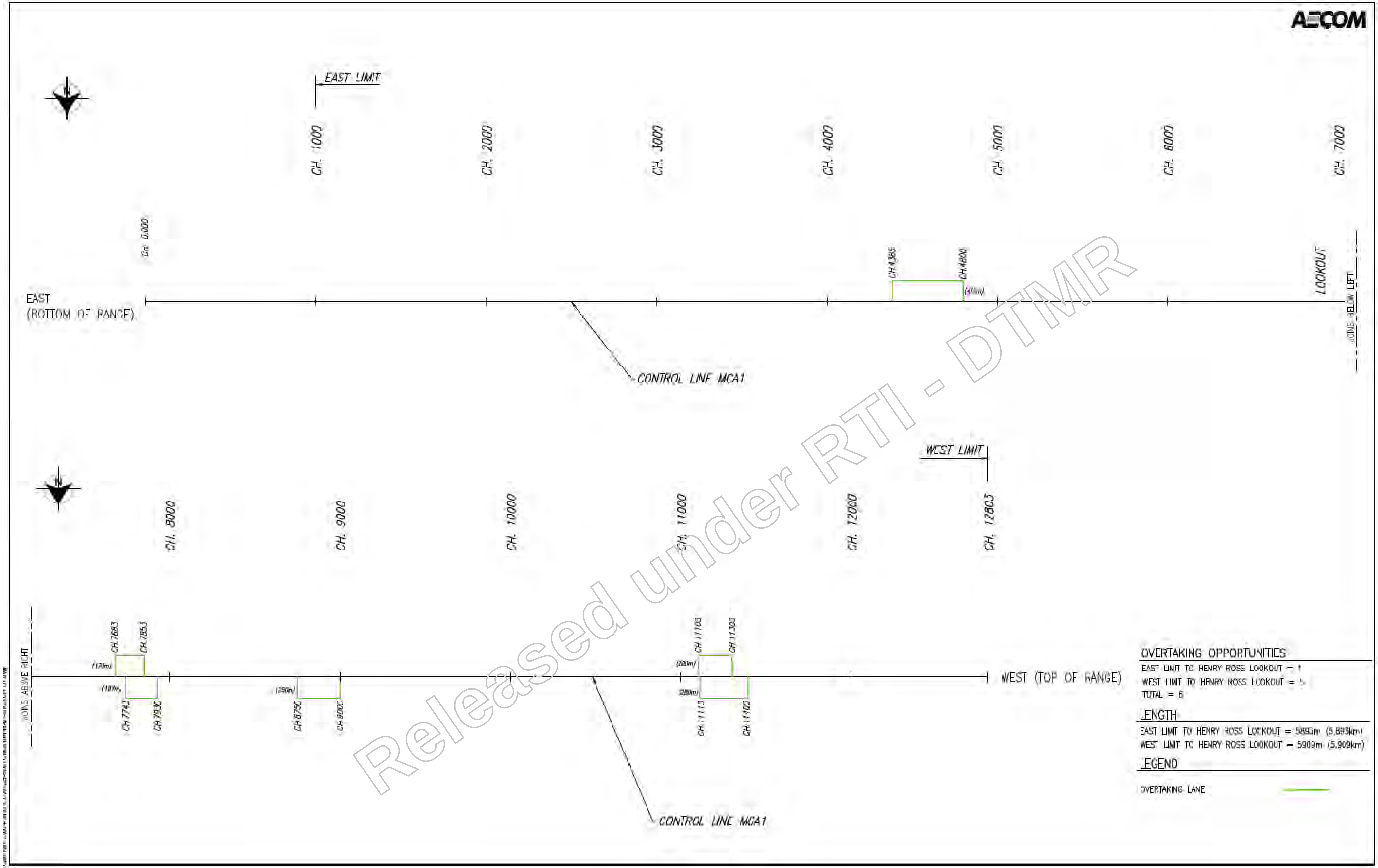

Figure 11 **Existing Overtaking Lanes**

Table 9 Swept Path Assessment of Seal Width

Area	Curve	Eastbound (towards Smithfield)	Westbound (towards Kuranda)
1	Curve 11 (Chainage 1100)	Existing Turn Path OK	Existing Turn Path OK
	Curve 12 (Chainage 1280)	Existing Turn Path OK	Existing Turn Path OK
2	Curve 13 (Chainage 1500)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 14 (Chainage 1600)	Existing Turn Path off Shoulder	Existing Turn Path over Centerline
	Curve 15 (Chainage 1650)	Existing Turn Path OK	Existing Turn Path OK
3	Curve 16 (Chainage 1725)	Existing Turn Path OK	Existing Turn Path OK
	Curve 17 (Chainage 1800)	Existing Turn Path over Centerline	Existing Turn Path over Centerline
	Curve 18 (Chainage 1880)	Existing Turn Path over Centerline	Existing Turn Path off Shoulder
4	Curve 19 (Chainage 1980)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 20 (Chainage 2050)	Existing Turn Path OK	Existing Turn Path OK
5	Curve 21 (Chainage 2150)	Existing Turn Path over Centerline	Existing Turn Path over Centerline
	Curve 22 (Chainage 2280)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 23 (Chainage 2350)	Existing Turn Path off Shoulder	Existing Turn Path OK
6	Curve 24 (Chainage 2450)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 25 (Chainage 2550)	Existing Turn Path off Shoulder	Existing Turn Path over Centerline
7	Curve 26 (Chainage 2725)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 27 (Chainage 2850)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 28 (Chainage 3000)	Existing Turn Path OK	Existing Turn Path OK
	Curve 29 (Chainage 3050)	Existing Turn Path off Shoulder	Existing Turn Path OK
8	Curve 30 (Chainage 3180)	Existing Turn Path over Centerline	Existing Turn Path off Shoulder
	Curve 31 (Chainage 3280)	Existing Turn Path over Centerline	Existing Turn Path OK
	Curve 32 (Chainage 3400)	Existing Turn Path over Centerline	Existing Turn Path over Centerline
9	Curve 33 (Chainage 3550)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 34 (Chainage 3680)	Existing Turn Path over Centerline	Existing Turn Path over Centerline
	Curve 35 (Chainage 3825)	Existing Turn Path off Shoulder	Existing Turn Path OK
10	Curve 36 (Chainage 3925)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 37 (Chainage 4050)	Existing Turn Path off Shoulder	Existing Turn Path OK
11	Curve 38 (Chainage 4250)	Existing Turn Path OK	Existing Turn Path OK

Area	Curve	Eastbound (towards Smithfield)	Westbound (towards Kuranda)
	Curve 39 (Chainage 4425)	Existing Turn Path OK	Existing Turn Path OK
	Curve 40 (Chainage 4925)	Existing Turn Path OK	Existing Turn Path OK
	Curve 41 (Chainage 5000)	Existing Turn Path OK	Existing Turn Path OK
12	Curve 42 (Chainage 5050)	Existing Turn Path OK	Existing Turn Path OK
	Curve 43 (Chainage 5100)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 44 (Chainage 5170)	Existing Turn Path OK	Existing Turn Path OK
	Curve 45 (Chainage 5250)	Existing Turn Path OK	Existing Turn Path OK
	Curve 46 (Chainage 5350)	Existing Turn Path OK	Existing Turn Path OK
	Curve 47 (Chainage 5450)	Existing Turn Path OK	Existing Turn Path OK
	Curve 48 (Chainage 5500)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 49 (Chainage 5580)	Existing Turn Path OK	Existing Turn Path OK
	Curve 50 (Chainage 5650)	Existing Turn Path OK	Existing Turn Path OK
	Curve 51 (Chainage 5720)	Existing Turn Path off Shoulder	Existing Turn Path OK
13	Curve 52 (Chainage 5780)	Existing Turn Path OK	Existing Turn Path OK
	Curve 53 (Chainage 5825)	Existing Turn Path over Centerline	Existing Turn Path off Shoulder
	Curve 54 (Chainage 5940)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
14	Curve 55 (Chainage 5980)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 56 (Chainage 6050)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
15	Curve 57 (Chainage 6100)	Existing Turn Path OK	Existing Turn Path OK
	Curve 58 (Chainage 6150)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 59 (Chainage 6250)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 60 (Chainage 6350)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 61 (Chainage 6450)	Existing Turn Path over Centerline	Existing Turn Path off Shoulder
	Curve 62 (Chainage 6500)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 63 (Chainage 6550)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 64 (Chainage 6600)	Existing Turn Path OK	Existing Turn Path OK
	Curve 65 (Chainage 6650)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
16	Curve 66 (Chainage 6750)	Existing Turn Path off Shoulder	Existing Turn Path OK

Area	Curve	Eastbound (towards Smithfield)	Westbound (towards Kuranda)
	Curve 67 (Chainage 6850)	Existing Turn Path OK	Existing Turn Path OK
	Curve 68 (Chainage 7000)	Existing Turn Path OK	Existing Turn Path over Centerline
	Curve 69 (Chainage 7050)	Existing Turn Path OK	Existing Turn Path off Shoulder
17	Curve 70 (Chainage 7180)	Existing Turn Path OK	Existing Turn Path OK
	Curve 71 (Chainage 7250)	Existing Turn Path OK	Existing Turn Path over Centerline
	Curve 72 (Chainage 7280)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 73 (Chainage 7340)	Existing Turn Path off Shoulder	Existing Turn Path over Centerline
18	Curve 74 (Chainage 7380)	Existing Turn Path OK	Existing Turn Path OK
	Curve 75 (Chainage 7450)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 76 (Chainage 7520)	Existing Turn Path OK	Existing Turn Path OK
	Curve 77 (Chainage 7570)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
19	Curve 78 (Chainage 7650)	Existing Turn Path OK	Existing Turn Path OK
	Curve 79 (Chainage 7760)	Existing Turn Path OK	Existing Turn Path OK
20	Curve 80 (Chainage 7970)	Existing Turn Path OK	Existing Turn Path OK
	Curve 81 (Chainage 8100)	Existing Turn Path off Shoulder	Existing Turn Path over Centerline
	Curve 82 (Chainage 8150)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 83 (Chainage 8250)	Existing Turn Path OK	Existing Turn Path OK
	Curve 84 (Chainage 8300)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 85 (Chainage 8380)	Existing Turn Path OK	Existing Turn Path OK
21	Curve 86 (Chainage 8450)	Existing Turn Path OK	Existing Turn Path OK
	Curve 87 (Chainage 8540)	Existing Turn Path OK	Existing Turn Path OK
	Curve 88 (Chainage 8700)	Existing Turn Path OK	Existing Turn Path OK
	Curve 89 (Chainage 8825)	Existing Turn Path OK	Existing Turn Path OK
	Curve 90 (Chainage 8950)	Existing Turn Path off Shoulder	Existing Turn Path off Shoulder
	Curve 91 (Chainage 9025)	Existing Turn Path OK	Existing Turn Path OK
	Curve 92 (Chainage 9100)	Existing Turn Path OK	Existing Turn Path off Shoulder
	Curve 93 (Chainage 9160)	Existing Turn Path OK	Existing Turn Path over Centerline
	Curve 94 (Chainage 9290)	Existing Turn Path OK	Existing Turn Path OK

Area	Curve	Eastbound (towards Smithfield)	Westbound (towards Kuranda)
	Curve 95 (Chainage 9400)	Existing Turn Path OK	Existing Turn Path OK
22	Curve 96 (Chainage 9480)	Existing Turn Path OK	Existing Turn Path OK
	Curve 97 (Chainage 9700)	Existing Turn Path OK	Existing Turn Path OK
	Curve 98 (Chainage 9850)	Existing Turn Path OK	Existing Turn Path OK
23	Curve 99 (Chainage 10000)	Existing Turn Path OK	Existing Turn Path OK
	Curve 100 (Chainage 10200)	Existing Turn Path OK	Existing Turn Path OK
24	Curve 101 (Chainage 10450)	Existing Turn Path off Shoulder	Existing Turn Path OK
	Curve 102 (Chainage 10600)	Existing Turn Path OK	Existing Turn Path OK
	Curve 103 (Chainage 10800)	Existing Turn Path OK	Existing Turn Path OK
	Curve 104 (Chainage 11020)	Existing Turn Path OK	Existing Turn Path OK

4.2.4 Existing Structures

There are no existing bridge structures along Kuranda Range Road. The existing culvert details are included in **Table 10**. There are 83 known culverts along the road.

Table 10 Existing Culvert Details

Culvert Type	Sizes	Number
Reinforced Concrete Pipe (RCP)	400, 450, 425, 530, 550, 600, 750, 1200 2x450, 2x600, 2x750, 2x900 3x750, 3x900 4x750	79
Reinforced Concrete Box Culvert (RCBC)	2650x3000	1
Reinforced Concrete Culvert (RCC)	3660x3660	1
PVC	350	1
Half Oval	3000x2640	1

4.2.5 Flood Immunity

There are no known flooding issues along the range due to undersized culverts. Localised surface flooding can occur during intense weather events, however this is generally only evident during and shortly after the event.

4.3 Existing Traffic Performance

4.3.1 Safety

A crash analysis has been undertaken to identify common crash causal factors, with this information being used to assist in the identification of mitigation measures to improve safety for users of the Kuranda Range Road and to rank and prioritise projects. Crash data for use in this analysis was obtained from TMRs WebCrash database.

A summary of the key results from crash analysis for the period since 1 January 2000 are:

- 311 reported crashes.
- 0.3% fatal, 24% hospitalised, 16% medical treatment and 12% minor injury (Killed or Seriously Injured (KSI) = 24%).
- The number of KSI crashes varies from three to seven per year and there is no typical trend in this data.
- 60% of crashes occurred on the eastern face section of the range (approximately 7km section).
- 81% of the crashes occurred between 7am and 6pm.
- Majority of crashes occurred in November, December and January.
- Wet road conditions were recorded for 61% of crashes.
- 54% "Loss of Control Off Path on Curve (DCA code 800s)" type crashes and 26% "Head-on (DCA code 201) crashes.
- Excessive speeding was reported as contributing to 28 crashes.
- Violation of road rules were reported for 152 (49%) of the crashes.
- Heavy vehicles were involved in 20 of the crashes.

In addition to TMRs source of data, Queensland Police Service (QPS) crash data reported in the media included:

- 95% of crashes were local residents (92 reported crashes in 2 years).
- 38% due to driver error; 58% on wet roads; 46% single vehicle.
- 50% resulted in injury.
- The following sections of the report present further details of the crash analysis.

4.3.1.1 Crash Data

Crash data was analysed for the section of the range extending from west of the Smithfield roundabout to just west of Rainforestation (approximate Chainage 1000 to 11200). TMR provided reported crash data for this section of the range for:

- Fatal crashes 1 January 2000 to 30 November 2015.
- Hospitalisation crashes 1 January 2000 to 31 December 2014.
- Medical treatment and minor injury crashes 1 January 2000 to 30 June 2012.
- Property damage only crashes (PDOs) 1 January 2000 to 31 December 2010.

The crash analysis was carried out using all data provided since 1 January 2000. This does however mean that the number of PDOs, medical treatment and minor injury crashes will be under represented in the results.

Taking in consideration the details above, there have been 311 recorded crashes along Kuranda Range Road since 1 January 2000. It should be noted that several crashes were found to be miscoded with incorrect location details. These have been excluded from the analysis as they occurred outside of the study area.

4.3.1.2 Crash Severity

The crashes were categorised into the following severities:

- 0.3% Fatal (1 crash)
- 24% Hospitalisation
- 16% Medical Treatment
- 12% Minor Injury
- 48% PDO.

Figure 13 graphically shows the number of reported KSI crashes for each year since 2000. The number of KSI crashes varies from three to seven per year. The graph suggests that there is no typical trend in KSI crashes, other than the numbers have remained fairly consistent since 2010.

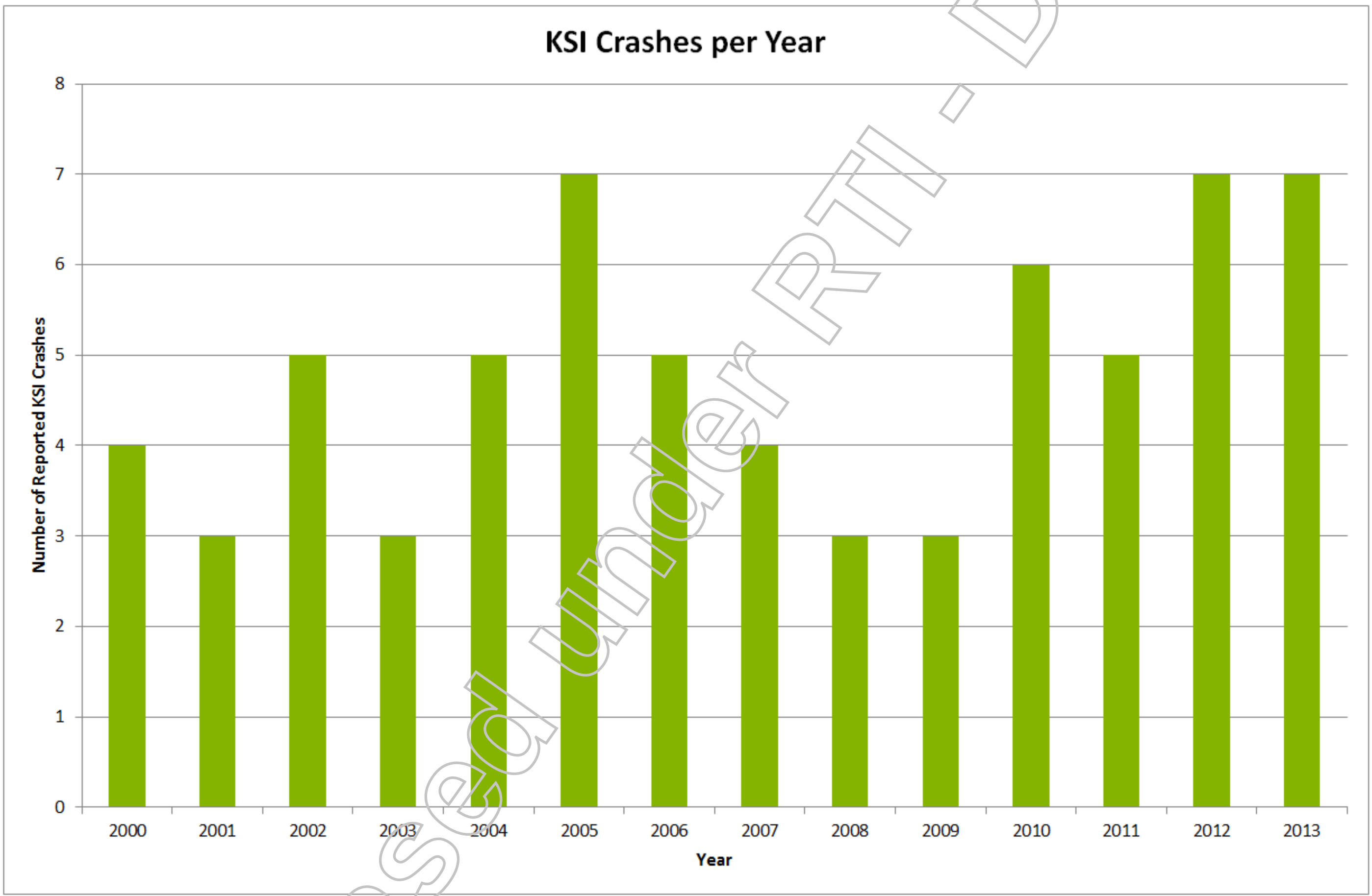

Figure 12 **KSI Crashes Reported per Year**

Figure 14 below shows that crashes have been recorded along the extent of the range, although the majority (60%) of crashes occur along the eastern face of the range.

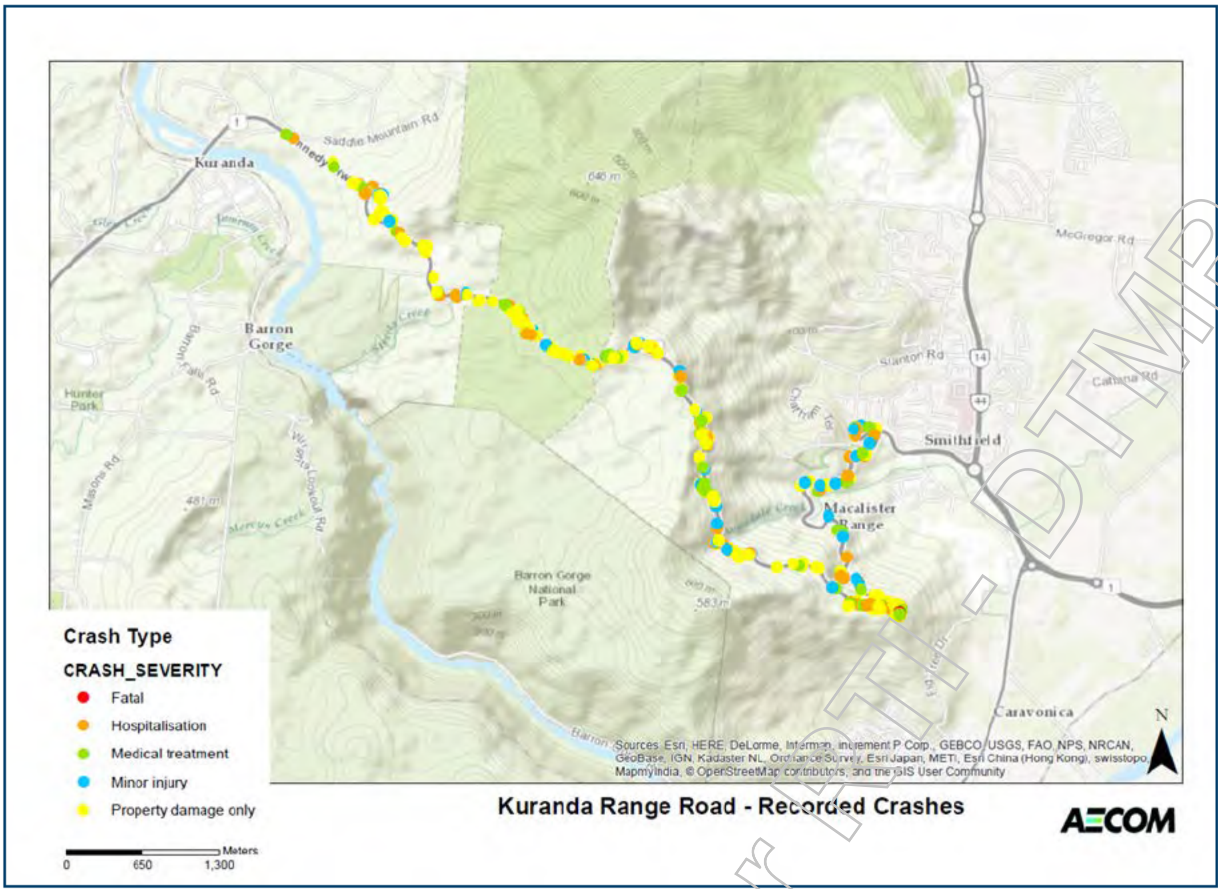

Figure 13 Reported Crashes along Kuranda Range Road since 1 January 2000 – By Severity

A summary of the number and severity of crashes reported in each of the 24 planning areas defined in **Section 1.2** is given in **Table 11**.

Table 11 Summary of Reported Crashes along Kuranda Range Road since 1 January 2000 – By Severity

Area	Fatal	Hospitalisation	Medical Treatment	Minor Injury	Property Damage Only	Total
1	0	4	2	0	7	13
2	0	1	1	0	6	8
3	0	0	1	0	4	5
4	1	2	1	0	4	8
5	0	0	1	0	2	3
6	0	0	0	0	0	0
7	0	1	0	2	2	5
8	0	2	1	1	3	7
9	0	0	1	1	5	7
10	0	8	5	6	11	30
11	0	8	2	4	8	22
12	0	6	3	2	5	16
13	0	0	2	1	4	6

Area	Fatal	Hospitalisation	Medical Treatment	Minor Injury	Property Damage Only	Total
14	0	1	0	0	1	2
15	0	4	2	4	5	15
16	0	7	3	0	12	22
17	0	1	1	0	3	5
18	0	2	2	0	2	6
19	0	2	1	1	5	9
Total Eastern Face	***1***	***49***	***29***	***22***	***88***	***189***
20	0	8	8	1	8	27
21	0	10	5	6	14	35
22	0	2	1	2	6	11
23	0	1	2	0	5	8
24	0	6	4	5	26	41
Total Western Fall	***0***	***27***	***20***	***15***	***60***	***122***
Total Eastern Face & Western Fall	**1**	**76**	**49**	**37**	**148**	**311**

4.3.1.3 Crash Type

Figure 15 below shows that the majority of crashes are "Loss of Control Off Path on Curve (DCA code 800s)" at 54% and "Head-on (DCA code 201) at 26%. These types of crashes are not confined to certain sections of the range, but rather they have occurred at most curves along the range

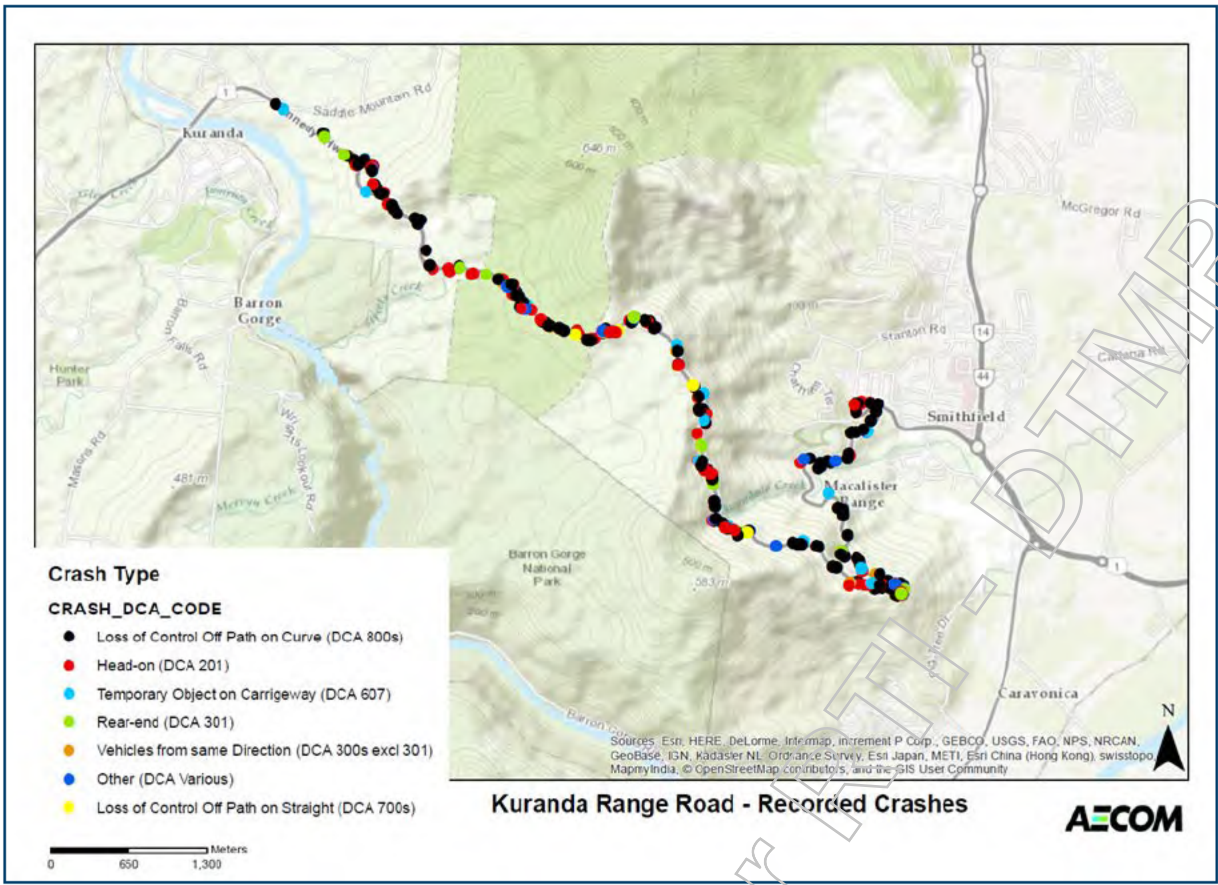

Figure 14 Reported Crashes along Kuranda Range Road since 1 January 2000 – By Crash Type

The crashes have been grouped into the following seven crash type categories:

- 54% Loss of Control Off Path on Curve (DCA code 800s)
- 26% Head-on (DCA code 201)
- 7% Temporary Object on Carriageway (DCA code 607)
- 5% Rear-end (DCA code 301)
- 3% Vehicles from Same Direction (DCA code 300s excl 301)
- 3% Other (DCA code various)
- 2% Loss of Control Off Path on Straight (DCA code 700s).

On closer inspection of the WebCrash crash details, several of the Head-on crashes resulted from vehicles initially losing control.

A summary of the number and type of crashes reported in each of the 24 planning areas is given in **Table 12**.

Table 12 Summary of Reported Crashes along Kuranda Range Road since 1 January 2000 – By Crash Type

Area	Loss of Control Off Path on Curve (DCA code 800s)	Head-on (DCA code 201)	Temporary Object on Carriageway (DCA code 607)	Rear-end (DCA code 301)	Vehicles from Same Direction (DCA code 300s excl 301)	Other (Various DCA codes)	Loss of Control Off Path on Straight (DCA code 700s)	Total
1	9	4	0	0	0	0	0	13
2	6	1	0	1	0	0	0	8
3	3	1	0	0	0	0	1	5

Area	Loss of Control Off Path on Curve (DCA code 800s)	Head-on (DCA code 201)	Temporary Object on Carriageway (DCA code 607)	Rear-end (DCA code 301)	Vehicles from Same Direction (DCA code 300s excl 301)	Other (Various DCA codes)	Loss of Control Off Path on Straight (DCA code 700s)	Total
4	3	4	0	1	0	0	0	8
5	2	1	0	0	0	0	0	3
6	0	0	0	0	0	0	0	0
7	3	1	0	0	0	1	0	5
8	3	3	0	0	1	0	0	7
9	4	1	1	0	1	0	0	7
10	13	13	2	1	1	0	0	30
11	10	8	1	1	0	1	1	22
12	8	5	0	2	0	1	0	16
13	3	0	1	0	1	1	0	6
14	0	2	0	0	0	0	0	2
15	8	4	0	2	0	1	0	15
16	10	4	2	2	3	1	0	22
17	2	1	0	0	1	0	1	5
18	3	2	0	0	1	0	0	6
19	5	1	2	1	0	0	0	9
Total Eastern Face	***95***	***56***	***9***	***11***	***9***	***6***	***3***	***189***
20	13	9	1	1	1	1	2	27
21	20	7	5	1	0	0	1	35
22	7	1	2	0	0	1	0	11
23	4	1	1	0	0	1	1	8
24	28	8	4	1	0	0	0	41
Total Western Fall	***72***	***26***	***13***	***3***	***1***	***3***	***4***	***122***
Total Eastern Face & Western Fall	**167**	**82**	**22**	**14**	**10**	**9**	**7**	**311**

The three areas with the highest number of crashes are given in **Table 13**.

Table 13 Area with Highest Number of Crashes

Area	Loss of Control Off Path on Curve (DCA code 800s)	Head-on (DCA code 201)	Total Reported Crashes
24 (West of Rainforestation)	28	8	41
21 (includes Streets Creek Hole)	20	7	35
10 (Top Hairpin)	13	13	30

4.3.1.4 Crash Casual Factor

Table 14 summarises the reported road conditions at the time of the crash. Wet road conditions were present for the majority of crashes (61%). 66% of Loss of Control Off Path on Curve crashes occurred when the road surface was wet. The road condition was unknown for one crash.

Table 14 Reported Road Conditions at Time of Crash – By Crash Type

Crash Type	Road Condition - Wet	Road Condition - Dry
Loss of Control Off Path on Curve (DCA code 800s)	110	57
Head-on (DCA code 201)	48	34
Temporary Object on Carriageway (DCA code 607)	11	11
Rear-end (DCA code 301)	6	7
Vehicles from Same Direction (DCA code 300s excl 301)	5	5
Other (DCA code various)	4	5
Loss of Control Off Path on Straight (DCA code 700s)	4	3
Total	**188 (61%)**	**122 (39%)**

In addition, the following crash causal factors were predominant in the data:

- Excessive speeding was reported as contributing to 28 crashes.
- Violation of road rules were reported for 152 (49%) of the crashes.

4.3.2 Reliability

The Incident Management review carried out by Professor Phil Charles highlighted an increasing awareness of the importance of travel time reliability. From a user perspective, the reliability of travel ranks as one of the most important attributes, even ahead of total trip travel time. Unexpected delays tend to be perceived as much costlier to travellers than expected delays.

Road closures or travel time delays due to crashes affects travel time reliability along the range, which has a cost impact on road users and other stakeholders.

An analysis of SIMS data between January 2007 and July 2015 provided 1,152 incidents of which 33% were crashes, for the Kuranda Range area. A breakdown of these incidents is provided in the **Figure 16**.

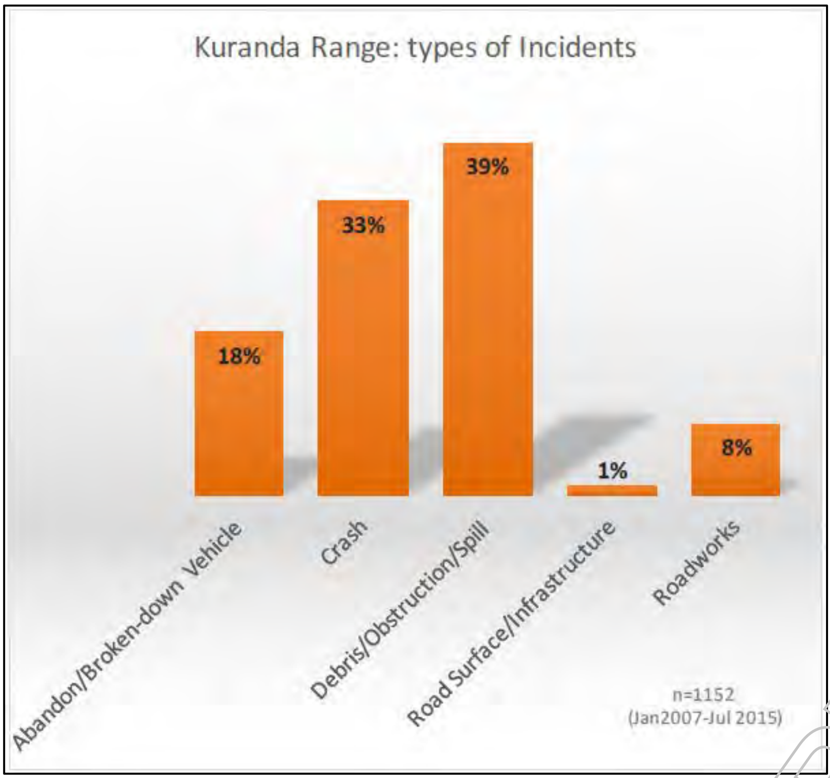

Figure 15 **SIMS Incident Data Summary**

Analysis of the duration of incidents was also conducted, noting there are concerns about the accuracy of the data, based on inadequate advice on when incidents are resolved. Also the duration is not necessarily related to closures, as this information is not readily available from the SIMS data. Of the 224 entries coded as 'Primary Crash' the duration of closure was recorded as:

- 38%: 0-1 hour
- 30%: 1-2 hours
- 9%: 2-3 hours
- 3%: 3-4 hours
- 20%: >4 hours.

The majority of crashes result in closure of the road for less than 2 hours.

4.3.3 Traffic Volumes

The traffic volumes along the Kuranda Range Road are fairly consistent due to limited access points. Traffic data for this road has been obtained from the TMR permanent count station located 500m west of the Captain Cook Highway (Site 110005).

Figure 17 presents the annual average daily traffic (AADT) for this permanent count station since 1985. The AADT is for bi-directional traffic flow. The AADT for 2017 is 8871 vehicles per day.

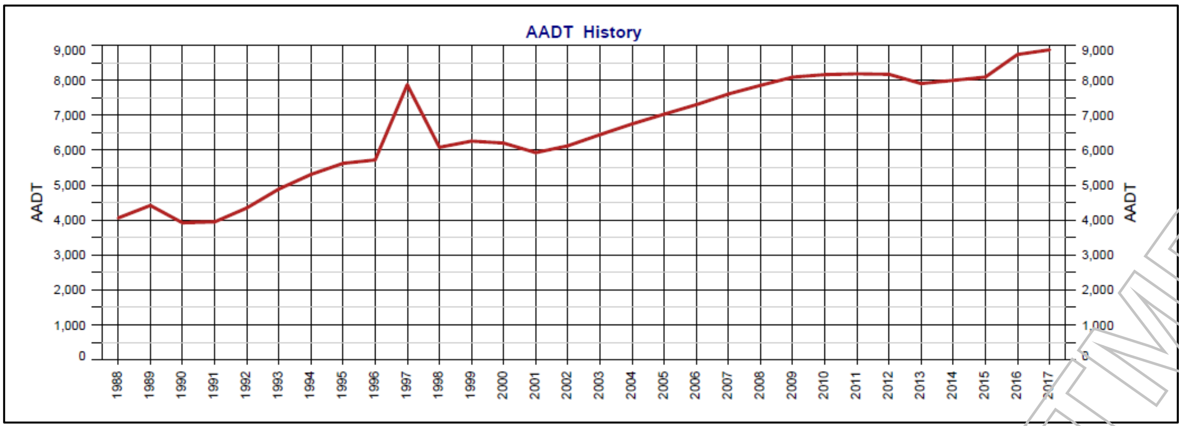

Figure 16 Historical AADT at Site 110005

The traffic growth along this road is closely related to economic growth in Cairns and the surrounding region. For example: the Australian pilots' dispute of 1989 resulted in a decline in traffic, while the strong economic growth during the early to mid-2000s was reflected in strong traffic growth. There was no growth in traffic volumes between 2009 and 2015 due to the economic downturn in Cairns attributed in part to the global financial crisis in 2007/08.

The AADT data indicates that traffic increases from Monday to Friday with Friday accounting for the highest volumes for the week. The peak periods are:

- Westbound: 10-11am and 4-5pm
- Eastbound: 7-8am and 3-4pm.

The eastbound morning peak consists of commuters travelling towards Cairns, with the return trip occurring in the evening. The data shows that the road is still well utilised throughout the remainder of the day, in part due to its role in the tourism industry.

The Kuranda Range Road experiences the highest traffic demands during the months of July and August which coincides with peak tourist season.

4.3.4 Traffic Congestion

Anecdotal evidence suggests that Kuranda Range Road experiences localised congestion which is not related to high traffic volumes but rather unexpected events such as slow vehicles or incidents (crashes, roadworks).

As traffic volumes increase over time, flow breakdown resulting from congestion will occur as the road reaches capacity.

5. Road Planning Pressures (Next 20 Years)

5.1 Factors Influencing Road Transport Demand

The main drivers of transport demand for Kuranda Range Road is economic growth in Cairns and the Far North Queensland Region. The economic growth in the region is heavily reliant on the tourism industry and to a lesser extent industry associated freight.

Kuranda has been identified as an important area for tourists visiting the region, with the Kuranda Range Road providing the most direct access. The Henry Ross Lookout located along the road also attracts visitors as it provides panoramic views of Cairns and the Northern Beaches, with a backdrop of Trinity Bay and the Coral Sea in the distance.

Each year a large number of people travel along the Kuranda Range Road for the purposes of tourism or recreation. This road is used regularly by tour coaches transporting tourists to attractions such as Rainforestation Nature Park, Kuranda and areas beyond Kuranda.

Although the Palmerston Highway is the priority freight route between the Tablelands and the coast, the Kennedy Highway including Kuranda Range Road is utilised to transport freight to and from Cairns. Despite its geometric constraints, anecdotally there is interest in the freight industry in accessing the Kuranda Range with Freight Efficient Vehicles (B-Doubles). Any increase in traffic along Kuranda Range Road will affect travel time reliability of freight vehicles using the range, acting as a major constraint on road freight development in the region.

Commuter traffic also uses Kuranda Range Road to access employment in Cairns.

5.2 Future Road Transport Demand

Due to traffic growth along this road being closely related to economic growth and not population growth it is difficult to predict the future road transport demand. Historical traffic data indicates some very rapid accelerations as well as some very low growth years, with virtually no growth over a six year period following the global financial crisis in 2008. The data also shows a significant increase between 2015 to 2016 and 2017, highlighting the inconsistent traffic growth rates and therefore making it more appropriate to provide a range of future traffic demand projections.

Utilising the available AADT data for KRR, the 10 year growth rate calculated for the period from 2008 to 2017 is approximately 1.52% per annum. Due to the uncertainty in future traffic volumes, two possible traffic growth scenarios are shown in Figure 18 below: a lower bound of 1% per annum growth, as shown by blue dashed line; and a upper bound of 3.5%, shown by the green dashed line. The difference in forecast traffic volumes becomes more significant beyond 2025.

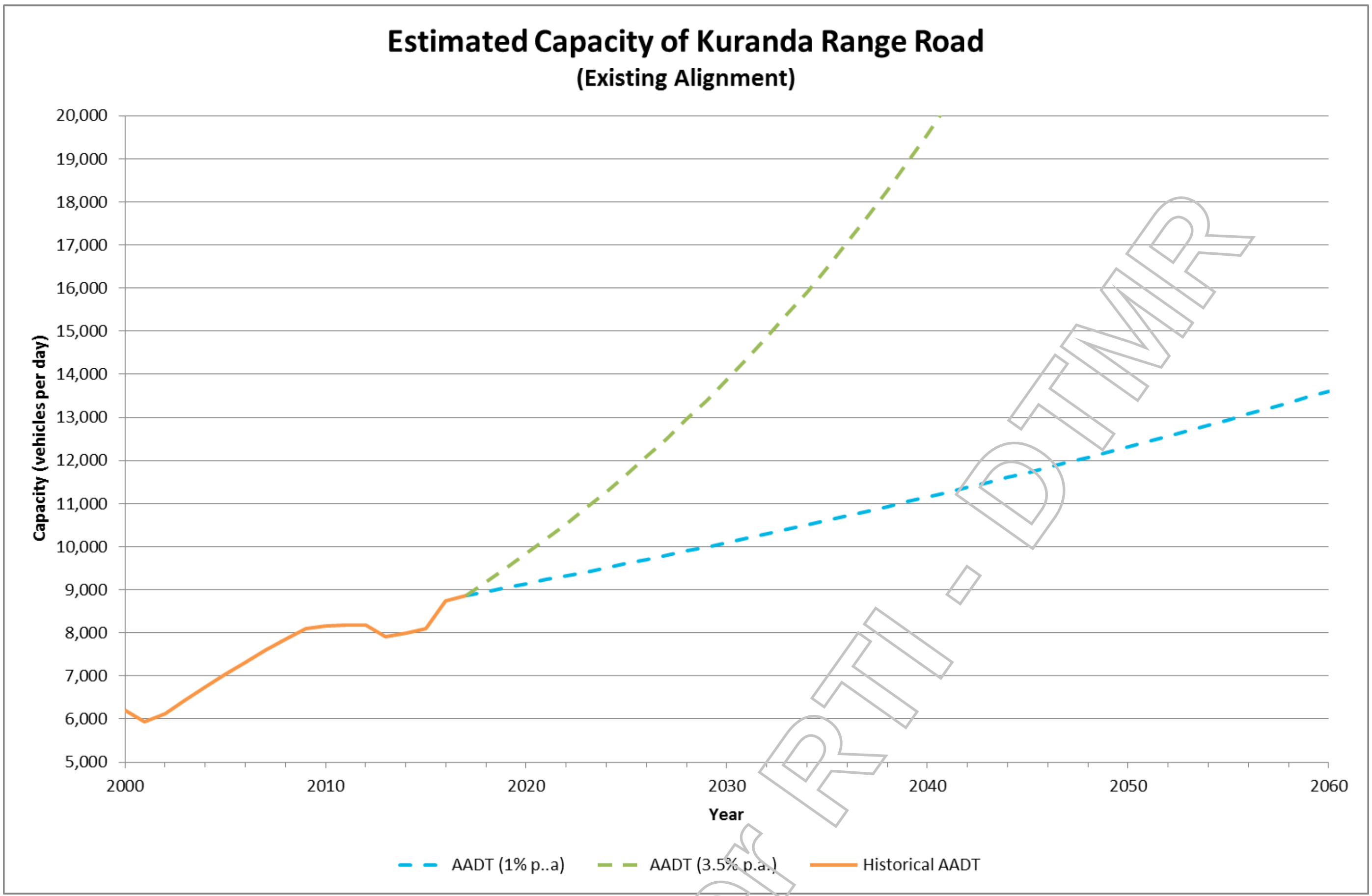

Figure 17 **Projected Future Traffic Demands**

5.3 Capacity of the Road

Capacity of the Kuranda Range Road is limited by grade, lack of overtaking opportunities, poor horizontal alignment and other constraints. These factors also make capacity difficult to estimate. As traffic volumes increase over time, flow breakdown resulting from congestion will occur as the road reaches capacity.

The Integrated Transport Study for Kuranda Range IAS (2000) calculated capacity of the range alignment using a program developed by the Australian Road Research Board titled TRARR (Traffic on Rural Roads). This program calculates the mean speed of vehicles, among other characteristics at specific points along the road and takes into account road and traffic characteristics such as:

- Vertical and horizontal geometry
- Presence of climbing and overtaking lanes
- Traffic volume
- Proportion of heavy vehicles
- Posted speed limit.

An estimate of capacity is then inferred from the data produced by TRARR. AUSTROADS defines a road to be close to capacity at level of service (LoS) E when there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.

The TRARR analysis calculated the capacity of the Kuranda Range Road at that time to be:

- Eastern section = 10,500 vehicles per day
- Western section = 16,000 vehicles per day.

The TRARR analysis was also undertaken to determine the capacity for local or particular sections along the road in order to examine or confirm the existence of specific problem areas. This identified that the eastern section of the range has a limiting capacity of 9,500 vehicles per day.

The projected future traffic demands along with the capacity calculated using TRARR are presented in **Figure 19**. The graph shows that the capacity of the western section of the range is higher than that of the eastern section, and the limiting capacity of the eastern section dictates when the link reaches capacity.

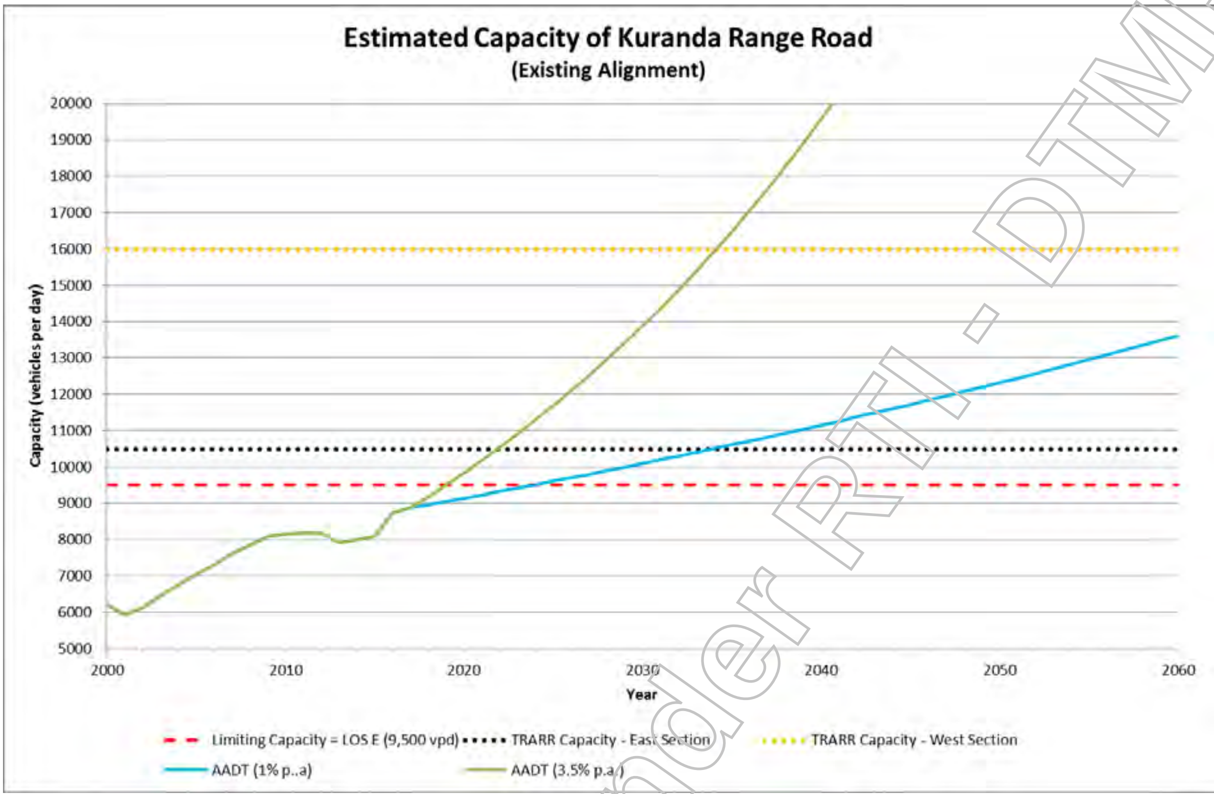

Figure 18 **Estimated Capacity of Existing Alignment**

Depending on the realised future traffic growth, the existing Kuranda Range Road may reach capacity within the next 15 to 20 years.

It should be noted that unless the whole length of Kuranda Range Road is duplicated (two-lanes in each direction of travel), capacity improvements cannot be fully realised. Upgrades which increase overtaking opportunities for short road sections will only improve the capacity of certain areas, with bottlenecks still being those sections of the road which remain as a single lane in each direction.

In October 2018 TMR engaged the Australian Road Research Board (ARRB) to conduct a new capacity analysis of the range using the latest version of their Traffic on Rural Roads (TRARR) software. A copy of the assessment is attached in Appendix F. The analysis examined the Kuranda Range Road in its current configuration and at various future traffic demand scenarios. The analysis confirmed that the range section is currently operating at LoS D under current traffic volumes and will potentially reach an unacceptable Level of Service (LoS E) by 2040 using median traffic growth rates, or possibly as early as 2032 if traffic growth is higher than the historical median trend. As the level of future traffic growth is uncertain it is not possible to define exactly when the capacity of the Kuranda Range Road will be exceeded, however it currently has limited spare capacity, with capacity likely to be exceeded in the next 15 – 20 years.

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5.4 Traffic Operations

5.4.1 Level of Service

The Integrated Transport Study for Kuranda Range IAS (2000) determined the Level of Service (LOS) of the range utilising TRARR which calculates the percent time spent following. From this assessment, with traffic volumes of 6000vpd, the existing LOS for the eastern section of the range was estimated as LoS D, while that of the western section is LoS C. At current traffic volumes of around 8900 vpd the TRARR analysis completed in 2018 indicated a LoS D.

The capacity on the western side is higher than for the eastern side due to the undulating nature of the terrain compared to a constant grade as on the eastern side.

5.4.2 Incident Management

The Incident Management review carried out by Professor Phil Charles highlighted an increasing awareness of the importance of travel time reliability. Road closures or travel time delays due to incidents affects travel time reliability along the range, which has a cost impact on road users and other stakeholders.

Without any intervention to the current situation (infrastructure upgrades, improved incident management) increased traffic demands in the future are likely to impact on travel time reliability due to the expected increase in incidents. This will also have a detrimental impact on the efficiency of freight movements along the range.

5.5 Land management

5.5.1 Access

The Kuranda Range Road passes predominantly through a Wet Tropics of Queensland World Heritage Area (WTWHA) and as such direct property access is generally not required along the majority of the length of this link. However, direct access is currently provided to:

- Private property on Curve C37 at about Ch 4.16 km.
- Unsealed management road on Curve C88 at about Ch 8.70 km.
- Private property on Curve C99 at about Ch 10.05 km.
- Rainforestation Nature Park on Curve C100 at about Ch 10.20 km.
- Private property between Curve C102 and C103 at about Ch 10.70 km

5.5.2 Noise

The IAS Addendum concluded that measured noise at noise monitoring locations at Kuranda and Smithfield were well below the TMR 68 dB(A) L_{10} (18 hour) criteria. This is a 2004 finding and no work has been undertaken since. The modelled noise emissions (based on 2004 traffic levels) were also under the TMR thresholds for all sites.

Modelling of the four lane solution (capacity 45 000 AADT) suggested that, without amelioration other than the use of SMA, future road traffic noise levels for the ultimate case would exceed the 68 dB(A) road traffic noise criterion at 8 residences and at one approved but as yet undeveloped residential development. Over the time period between the 10 year post construction and the ultimate case, the increase in road traffic noise levels would be of the order of 8 dB(A). The predicted increase in noise levels from the existing case to the ten year case varied along the route and was estimated to be approximately 2 dB(A). All residences exceeding the 68 dB(A) noise level goal would therefore qualify for Priority 2 consideration, requiring that measures for noise attenuation be considered within the road reserve with the aim of reducing levels to 68 dB(A) or less.

Noise impacts would be experienced differently by different communities and stakeholders. Those who use the road but do not live near it would not be as impacted as those who live near the road, but may not use it as frequently.

No assessment has been made of noise on the existing road with an increase in traffic. However, it is likely that growth in the number of heavy vehicles in particular will increase noise levels at Smithfield. Although signage requests that heavy vehicles refrain from using air brakes at this location, this is not a guaranteed mitigation solution.

5.5.3 Natural habitat/sensitive areas

Most of the study corridor contains highly significant environmental values as described in **Appendix D**. Over the next 20 years, these values are likely to be under threat as follows (in the absence of intervention):

- As traffic numbers increase, the risk to fauna attempting to cross the road will also increase. This could lead to a number of outcomes, including increased mortality for animals that attempt to cross but are hit by traffic, or increased barrier effect for animals that chose to not attempt the crossing. In either case biodiversity will suffer. This will apply in most areas and will be most critical at the north south ridge. Streets Creek crossings will be largely immune from the effect of traffic as they occur beneath the road.
- Landslips and storms can be expected to increase the disturbance of the road corridor, although natural rehabilitation will compensate for this in most cases.

Demands for road widening will put these natural areas at further risk.

Water quality impacts are closely correlated with traffic numbers and in particular incidents that result in fuel spills. The most sensitive area is at Streets Creek.

Research undertaken by TMR and the Rainforest CRC (Environment North 2007) investigated techniques to remove pollutants and this work will be of use in detailed design. The four lane solution envisaged that some type of stormwater quality improvement devices would be incorporated in certain road sections and at the proposed Streets Creek bridge. This may be worth considering further.

5.5.4 Cultural heritage/native title

The environmental risk assessment () concluded that cultural heritage issues are not relevant to this Link Study other than when considering alignments in the vicinity of mappable values.

5.5.4.1 Non-indigenous Cultural Heritage Values

Referring to the IAS Addendum, non-indigenous cultural heritage values include:

- Quartzite Outcrop (Chainage 10630 - 10850) - the area is of significance in terms of European cultural heritage also. The top of the hill has an overgrown lookout with steel ladders which were installed in the 1920s for tourism purposes (Doug Stratford pers. comm.). The lookout was opened by Governor Goodwin and was associated with a tourist enterprise his family ran at that time. Visitors were boated across the Barron River to present day Paradise (Recreation Reserve) and walked out to the lookout via an attraction called the Maze.
- The memorial to early pathfinders over the range situated adjacent to the base of the present road at Smithfield (reportedly this was moved from its original location on the opposite side of the road in May 1996). Unveiled 9 June 1956.
- The memorial to commemorate the Battle of the Coral Sea and the Australian-American ‘relationship’ unveiled 3 December 1952 (the memorial is situated at the Henry Ross Lookout).

- A memorial to the memory of Lionel Moody and Alexander Lucuz who died during construction work for the current bridge over the Barron River at Kuranda in 1962 (the memorial (unveiled 1995) is situated on south-western side of bridge).
- What remains of the original 'Government Dray Road' or 'Smithfield Track'.
- A section of dry stone-pitched wall on the 'switchback' of the current road (constructed by the road working team to prevent slippage of the road above).
- The original powerline from the Barron Gorge HEP Station to Cairns (the line follows, in large part, the old Smithfield Track).
- A damaged headstone in memory of John Keating, which may or may not be associated with a burial site. The remaining portions of the headstone are set in a concrete slab located within the proposed road alignment in the section between the Barron River Bridge and the Kuranda turnoff.

5.5.4.2 Indigenous Cultural Heritage Values

Indigenous cultural heritage values were assessed in the IAS Addendum. This found that these values are inextricably linked to the natural environment. Indigenous consultation undertaken at the time revealed that key indigenous concerns include:

- Environmental considerations: the option chosen should optimise the balance between impact on the environment and cost to the community (no specific concerns regarding environmental or cultural matters were raised)
- Management and employment issues: there was a strong desire for on-going employment for Rangers as part of the road development, construction, and management process.

These issues can be expected to be assessed in the future REF undertaken as part of a Business Case.

5.5.5 Stakeholder Concerns

Stakeholder consultation was undertaken with Wet Tropics Management Authority (WTMA) as part of the preparation of the link strategy and link planning. They confirmed that a permit would be required for the masterplan. While the level of planning was too preliminary for detailed comments, the main concern expressed was that options for fauna connectivity be considered early. Other issues included the potential for the Henry Ross Lookout to be upgraded to a high quality facility for presenting the World Heritage Area. The Department of Environment (DoE) was invited to participate in a briefing. They advised that the Link Study is too early in the planning process but that formal engagement would be required in the future (PE/Business Case phases). Verbal advice was that projects are likely to need to be referred under the EPBC Act (including the whole Master Plan, even of only small pieces are to be implemented initially). It is also likely that any project would be a controlled action, meaning that assessment is required. DoE decide the form of that assessment when reviewing the referral. This will influence the scope and process of any REF (or EIS etc.) as this would need to be suitable for EPBC Act assessment.

6. Link Objectives

6.1 Link Vision

The link strategy for the range section of the Kennedy Highway between Smithfield and Kuranda has been framed around the Government's objectives, as articulated in the Department of Transport and Main Roads Strategic Plan 2016 – 2020, of a transport network that:

- Is efficient and affordable
- Considers the environment
- Responds to emergencies
- Is resilient
- Provides jobs
- Encourages economic prosperity.

6.2 Desired Outcomes

The Link Plans have been developed with the objective of achieving the following desired outcomes:

- Improved safety for all road users
- Increased efficiency and reliability of heavy vehicle movements
- Reduced travel times and freight transport costs
- Maximised use of existing infrastructure
- Minimised potential environmental and/or cultural heritage impacts.

6.3 Service Requirements and Desired Outcomes

Service requirements and desired outcomes for the Kuranda Range Road have been developed from the analysis of existing and future performance issues of the link, study objectives, and the link vision as described above. These are presented in **Table 15.**

Table 15 Service Requirements and Desired Outcomes

Service requirements	Desired outcomes
Kuranda Range Road safety is maximised in accordance with what the corridor can accommodate in a sustainable manner	- Increased transport system efficiency - Improved travel time and reliability for general traffic and freight trips - Reduced number and severity of road crashes - Reduced incident management and accident costs - Supports intra- and inter-regional accessibility and economic growth in the region - Efficient and effective investment in transport infrastructure - Congestion management
Kuranda Range Road providing a road environment that meets minimum width requirements for the needs of all road users while minimising impacts on World Heritage values.	- Increased transport system efficiency - Improved travel time and reliability for general traffic and freight trips - Efficient and effective investment in transport infrastructure - Protection of World Heritage Values

Service requirements	Desired outcomes
Kuranda Range Road caters for maximum amount of traffic commensurate with its capacity	- Increased transport system efficiency - Potential for flow-breakdown is reduced - Support for economic growth with an emphasis on strengthening use as a freight route
Investment in the Kuranda Range Road maximises benefits generated from staged/sequencing of required upgrades	- Identification of highway needs for the next 20 years in priority order of highest need/safety outcomes - Ensuring funding through a value for money approach in planning - Efficient and effective investment in transport infrastructure

7. Strategic Priorities

7.1 Masterplan

A masterplan was developed based on the service requirements and desired outcomes above. The masterplan design was split into the two planning zones described in **Section 1.2**. The masterplan design is focussed on minimising environmental impact (by minimising footprint and scale of cut and fill) while providing sufficient width for two 19m semitrailers to pass while remaining within their respective lanes separated by a wide centre line treatment. A key consideration has been to retain the existing geometry as much as possible to not only minimise impacts but also to ensure a consistent speed environment suitable for the available sight distance.

The wide centre line treatment (WCLT) proposed involves replacing the existing dividing centre line/s on a road with two new dividing lines approximately one metre apart. This creates a greater distance between opposing traffic and improves road safety by:

- Reducing the risk of head-on crashes (through increased separation of opposing traffic)
- Providing additional space for motorists to pass stopped vehicles, cyclists or other roadside hazards
- Improving sight distance for overtaking vehicles
- Providing additional reaction time in the event that a driver unintentionally drifts over the centre line.

In recent years WCLT have become internationally recognised as an effective and relatively low-cost measure to reduce head-on collisions. WCLT is often applied to heavily trafficked, high-speed roads and highways and usually requires widening of the road shoulder to accommodate the wider centre line. Since introduction of WCLT in 2011, TMR have rolled out WCLTs across more than 700 kilometres of Queensland roads, including the Bruce Highway, Cunningham Highway and Warrego Highway.

For two-lane, two-way roads with a design AADT of greater than 4,000 vpd, TMR standards for WCLT require a total cross-section (seal width) of 11.0m (under normal design domain (NDD) conditions), or 10.5m (extended design domain (EDD) conditions), as shown in **Table 16.** However, TMR have recently adopted a revised WCLT with a reduced overall cross-section of 9.0m as a design exception for the Gillies Range Road High Risk Roads project.

Gillies Range Road forms part of the Gillies Highway with a posted speed limit of 80km/h and 100km/h, and has similar road conditions to Kuranda Range Road being a highway which traverses through national parks with challenging vertical and horizontal geometry and terrain. NDD and EDD widths for WCLT treatments were initially investigated for Gillies Range Road, however there were significant costs associated with road widening through steep and environmentally sensitive terrain d, therefore, an interim 9.0m WCLT treatment was adopted as a design exception. A reduction in safety benefits are anticipated by adoption of 0.75m shoulders for the WCLTs.

Table 16 TMR standards for WCLT cross-section for two-lane, two-way road

Design Domain	Design AADT	Vehicle routes	Sealed Shoulder (m)	Lane Width (m)	WCLT (m)	Total Seal Width (m)
NDD	> 4000	All vehicles up to B-double	1.75	3.25	1.0	11.0
EDD	> 4000	All vehicles up to B-double	1.50	3.25	1.0	10.5
Design exception*	-	-	0.75	3.25	1.0	9.0

** Design exception for the interim shoulder width recently adopted by TMR for the Gillies Range Road High Risk Roads project.*

Source: TN155 Wide Centre Line Treatment – Interim Advice Technical Note (TMR, 2017)

Currently, there are six overtaking lanes along Kuranda Range Road (one on the east section and five on the west), which provides a total of 1.5km of overtaking lanes. The masterplan includes provision of overtaking lanes in both directions to reduce driver frustration and improve reliability. This includes provision of additional overtaking lanes and extension of existing lanes, increasing the total length of overtaking lanes to 6.6km (roughly 5km increase compared to the existing situation). This has resulted in one overtaking lane in each direction on the eastern face, and three on the western fall (one eastbound and two westbound).

7.1.1 Eastern Face – Base of Range to North/South Ridge

Zone 1 extends from approximate Ch. 0.98 to Ch. 7.9 just below the North/South Ridge. The 6.92 km section of highway is split into 19 discreet planning areas.

The masterplan design provides a standardised 2 lane cross section with wide centre line treatment, curve widening, sealed shoulders and guardrail for the entire length of the zone. Just above the Top Hairpin there is a 3 and 4-lane cross-section which provides a 570 m over-taking lane up-range and a 350 m over-taking lane down-range.

7.1.2 Western Fall – North/South Ridge to overtaking section west of Rainforestation

Zone 2 extends from approximate Ch. 7.9 to Ch. 11.18, tying-in to the existing four lane section of the highway approximately 1.4 km before the Barron River Bridge at Kuranda. The 3.28 km section of highway is split into 5 discreet planning areas.

The masterplan design provides a standardised 2 lane cross section with wide centre line treatment, curve widening, sealed shoulders and guardrail for the entire length of the zone. Just north of the North-South Ridge is the start of the 3 and 4-lane cross-section which extends through to the tie-in point north of Rainforestation. This widening provides a 1,070m over-taking lane going up-range and a second overtaking segment as part of the Rainforestation intersection which extends for the last 1,240 m of the design. The 4-lane section from the tie-in, north of Rainforestation, provides a continual 4 lane section of 2,870 m going down-range.

Typical two and four lane cross sections are shown in **Figure 20** and **Figure 21** below and the extent of overtaking provided by the masterplan is shown in **Figure 22**:

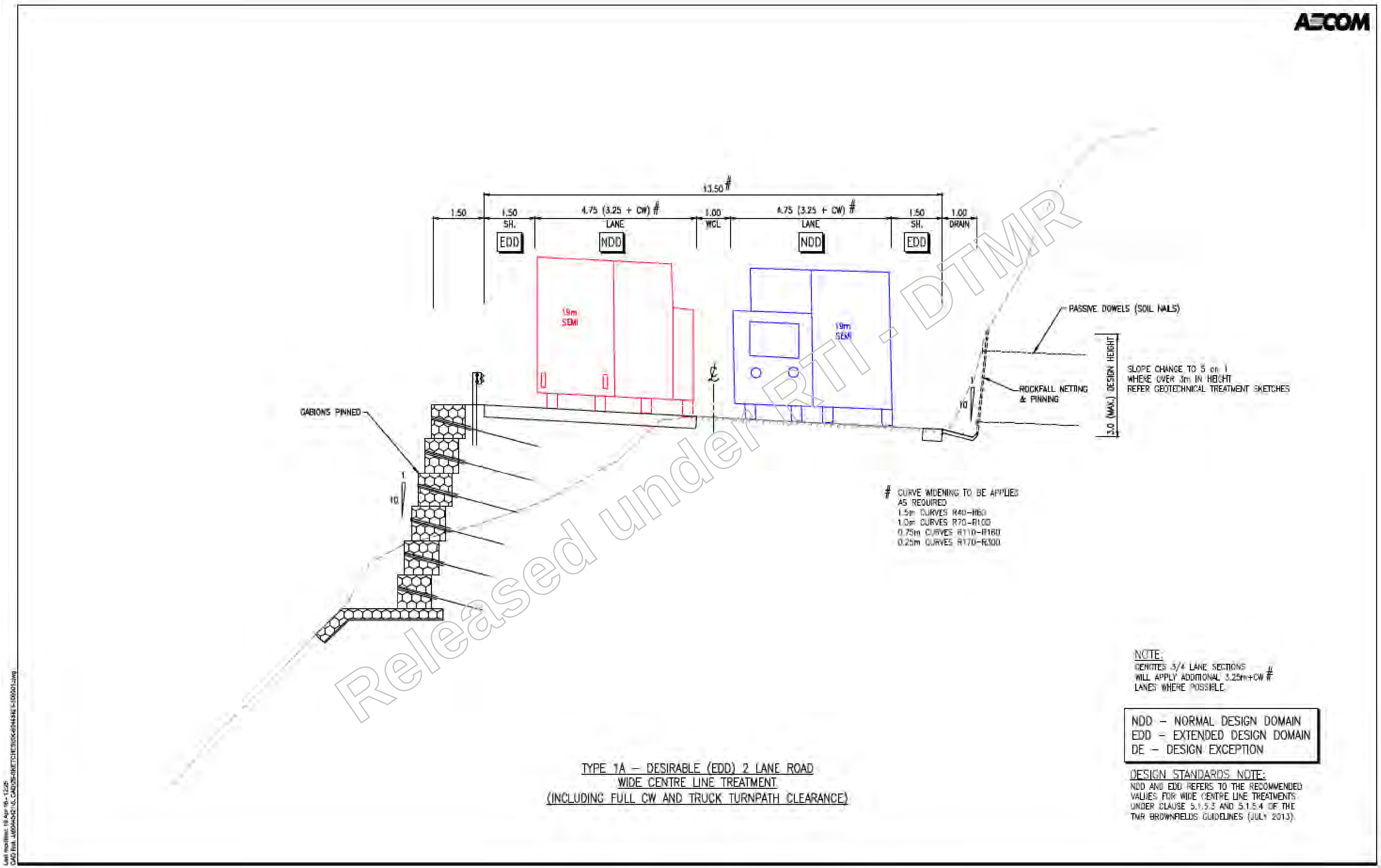

Figure 19 Typical two lane cross section

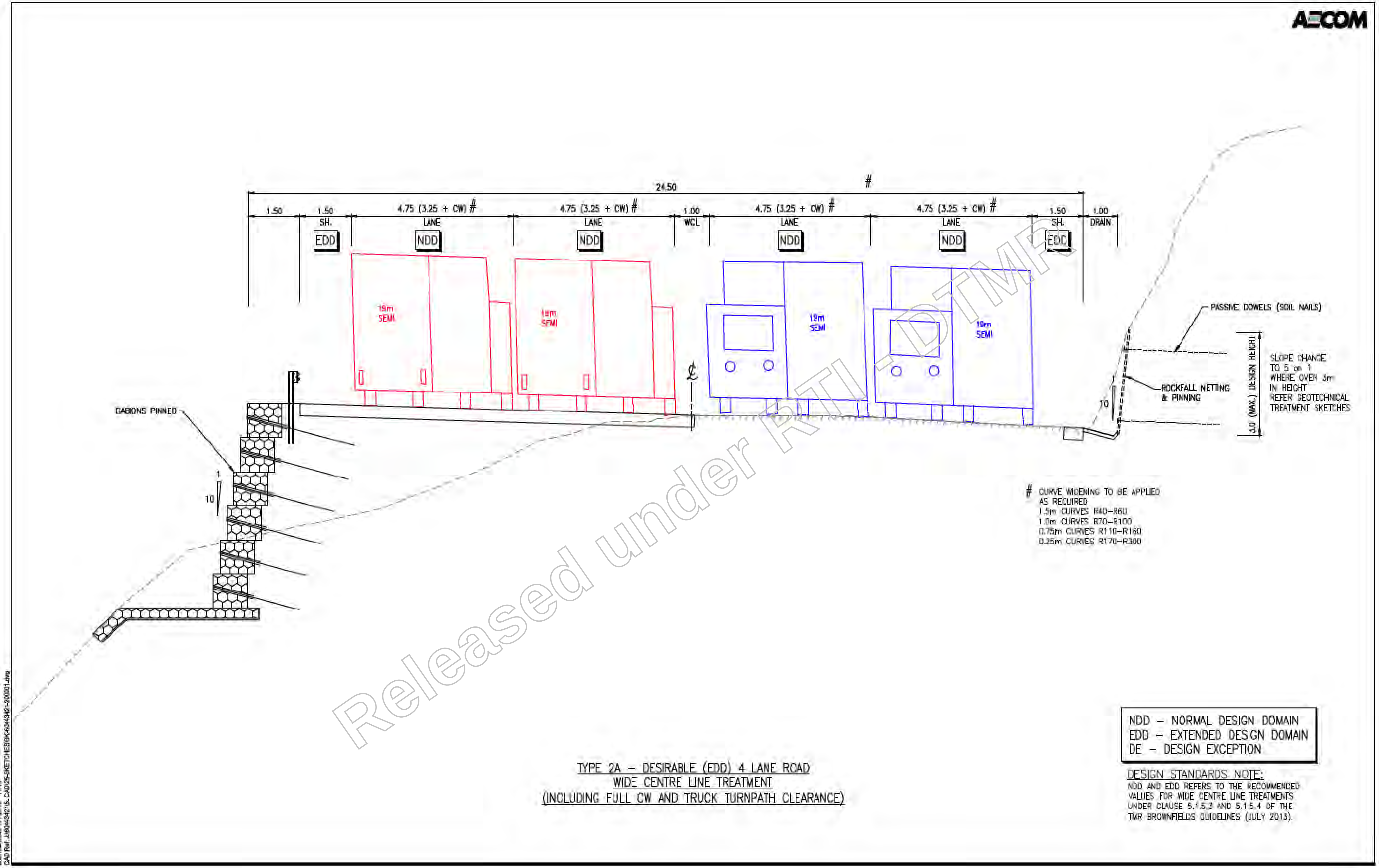

Figure 20 Typical four lane cross section

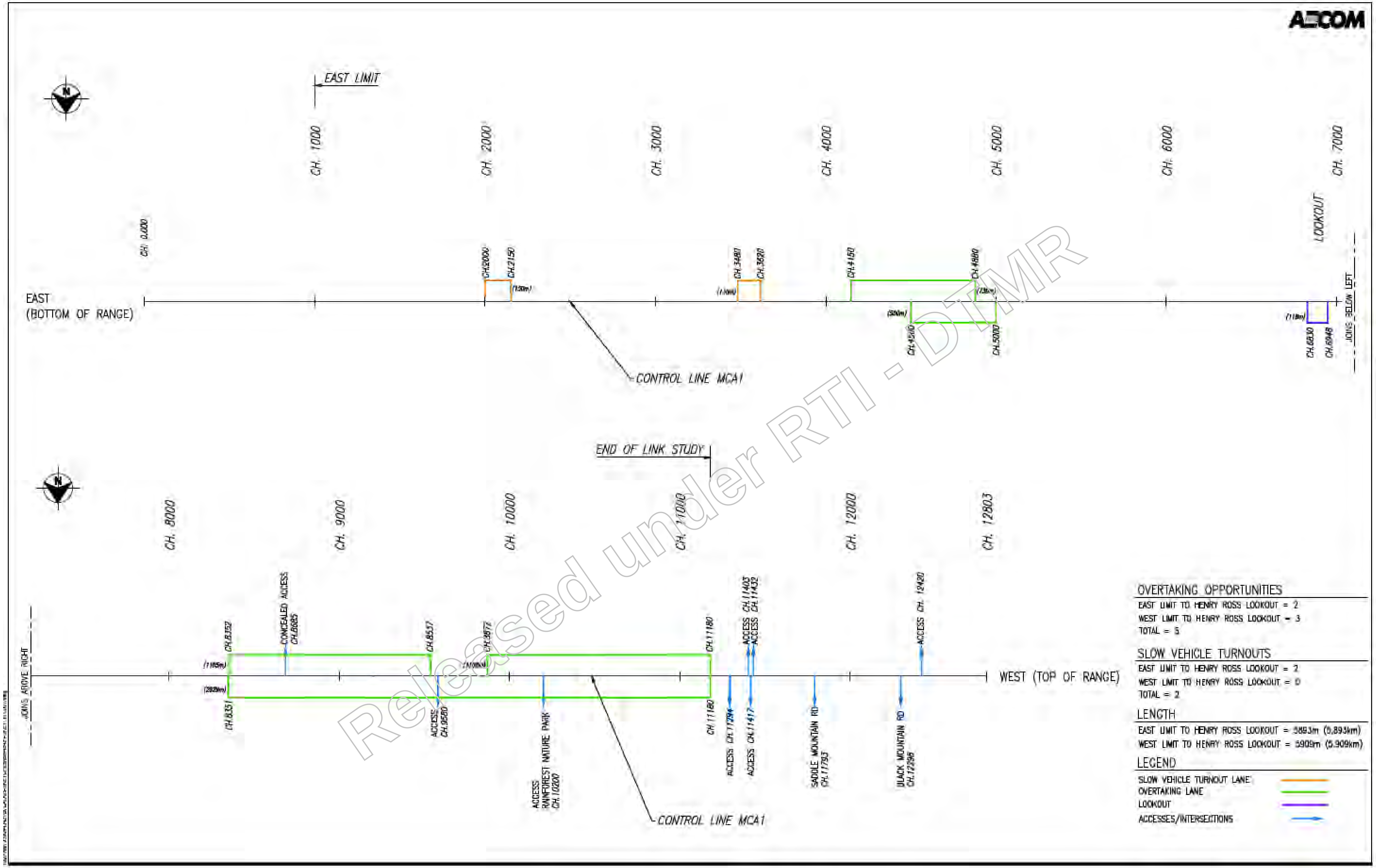

Figure 21 Masterplan Overtaking Opportunities

7.1.3 Compatibility with ultimate upgrade

As the masterplan has been designed to be stageable and maximise use of the existing asset, it is not compatible with the ultimate 4 lane solution which does not reuse the existing formation. The masterplan is a 20 year, medium term solution to manage safety and reliability, not capacity, and will not preclude the need for a 4 lane solution when capacity is exceeded.

7.1.4 Masterplan cost

At this stage only indicative costing has been carried out based on proposed construction works within each individual planning area. Assuming each area is constructed individually the overall cost of implementation of the whole masterplan is likely to be in the order of **$750 - $850 million**. The Australian Bureau of Statistics - Index Number; 3101 Road and bridge construction Queensland shows an approximate increase in construction costs of 41% from June 2006 to June 2018. Applying this percentage to the 2006 estimated cost of $770M for the full four lane upgrade results in a 2018 cost of approximately $1.1B. Given the masterplan does not address capacity and that capacity could be exceeded within the next 10 – 20 years, the high cost of implementing the masterplan needs to be weighed up against the cost of implementing the ultimate four lane solution.

7.2 Project Prioritisation

Individual projects for the Kuranda Range Road were developed to address safety and reliability issues and meet the desired outcomes. A total of 34 projects were identified consisting of infrastructure solutions for the 24 project areas, developed through the design process described in Volume 2. This includes 3 environmental options developed as alternatives to provide additional fauna connectivity in response to consultation with WTMA and 6 non-infrastructure solutions. All infrastructure projects have been designed to achieve the cross section described in **Section 7.1** with detailed descriptions of each project in Volume 2.

A list of all projects is provided in **Table 17** – the project numbers align with each of the 24 project areas, with the exception of project number 25 and 26 which involve treatments along the entire link section.

A multi-criteria framework was developed based on high level, qualitative and quantitative criteria to assess the projects and identify strategic priorities rather than comparing alternatives.

All upgrade projects were assessed under three themes:

- Effectiveness - focusses on the anticipated impacts of the scheme with the objectives of the study in terms of safety and reliability.
- Feasibility - focussed on the strategic cost, deliverability and constructability and construction impacts.
- Acceptability - focussed on the environmental impacts, or more specifically, the potential for environmental benefit.

A copy of the MCA framework and assessment is provided in **Appendix C** The themes and their objectives used in the MCA can be linked back to the objectives and desired outcomes. The MCA framework (augmented with more specific criteria and quantitative data) can also be used as the basis for more detailed assessment in future options analysis stages for the priority projects. This would ensure a consistent approach to project planning from link strategy to business case.

All projects were scored together, so that the relative priority of non-infrastructure, infrastructure and environmental options could be identified, but infrastructure and non-infrastructure projects were reported separately, with non-infrastructure projects prioritised for early delivery due to their low cost and potentially high benefit.

A number of sensitivity tests were carried out to identify the impact of feasibility and environmental criteria on the outcomes. This was to ensure that the final priorities were those best able to address the objectives of the study so that maximum benefit could be achieved with the limited funding available. For this reason the final sensitivity test, which involved effectiveness and cost criteria only was used as the basis for recommendations for the infrastructure priorities in this report.

Table 17 Project List

Project no.*	Start Chainage (km)	End Chainage (km)	Length (km)	Project Name
1	0.98	1.44	0.46	Bottom Hairpin 2 lane widening
1a	0.98	1.44	0.46	Bottom Hairpin - ITS/Signage
2	1.44	1.69	0.25	Ch 1400 - 1700 - Scheme Curve 15 - 18 (15 & 16) – CONSTRUCTED 2 lane widening
3	1.69	1.93	0.24	Scheme Curve 15 - 18 (17 & 18) 2 lane widening
4	1.93	2.13	0.2	Ch 1900 – 2100 2 lane widening
5	2.13	2.39	0.26	Lower Avondale Creek 1 - Includes Scheme Curve 22 - PARTIALLY CONSTRUCTED 2 lane widening
6	2.39	2.67	0.28	Lower Avondale Creek 2 - Includes Scheme Curve 26 - NOT CONSTRUCTED 2 lane widening
6a	2.39	2.67	0.28	Lower Avondale Creek 2 - Bridge alternative – off line new bridge alignment
7	2.67	3.11	0.44	Ch 2650 – 3100 2 lane widening
8	3.11	3.49	0.38	Includes Scheme Curve 32 and 34 - NOT CONSTRUCTED 2 lane widening
9	3.49	3.86	0.37	Includes Scheme Curve 38 - NOT CONSTRUCTED 2 lane widening
10	3.86	4.16	0.3	Top Hairpin 2 lane widening
10a	3.86	4.16	0.3	Top Hairpin - ITS/Signage
11	4.16	5.01	0.85	Overtaking Lane (East) 4 lane widening
12	5.01	5.76	0.75	Ch 5000 – 5800 2 lane widening
13	5.76	5.95	0.19	Water Point - Includes Scheme Curve 59 - 61 (59) - NOT CONSTRUCTED 2 lane widening
13a	5.76	5.95	0.19	Water Point - Fencing and dam
14	5.95	6.07	0.12	Scheme Curve 59 - 61 (60 - 61) - CONSTRUCTED 2 lane widening
15	6.07	6.69	0.62	Ch 6100 – 6700 2 lane widening
16	6.69	7.1	0.41	Henry Ross Lookout 2 lane widening (Lookout details to be determined)
16a	6.69	7.1	0.41	Henry Ross Lookout - ITS/Signage
17	7.1	7.36	0.26	Ch 7100 – 7350 2 lane widening
18	7.36	7.61	0.25	Ch 7350 – 7600 2 lane widening
19	7.61	7.9	0.29	Ch 7600 – 7900 2 lane widening
20	7.9	8.41	0.51	North South Ridge - On Line - Scheme Curve 79 - 83 - PARTIALLY CONSTRUCTED 2 lane widening
20a	7.9	8.41	0.51	North South Ridge - Bridge alternative - Scheme Curve 79 - 83 - PARTIALLY CONSTRUCTED – off line new bridge alignment
21	8.41	9.43	1.02	Overtaking Lanes (West) 4 lane widening
21a	8.41	9.43	1.02	Streets Creek Hole - interim 2 lane widening to address accident hot spot
22	9.43	9.95	0.52	Streets Creek 3 lane widening (2 eastbound, 1 westbound) across existing widened culvert
22a	9.43	9.95	0.52	Streets Creek - Bridge alternative off line bridge alternative
23	9.95	10.41	0.46	Rainforestation 4 lane widening including intersection to Rainforestation
24	10.41	11.18	0.77	Rainforestation – End 4 lane widening to tie into existing 4 lane section
25	0.98	11.18	10.2	Implement ITS Strategy
26	0.98	11.18	10.2	Implement RSA recommendations

"Non-Infrastructure" Solutions
Environmental Options
* project numbers align with each of the 24 project areas, with the exception of project number 25 and 26 which involve treatments along the entire link section.

7.3 Infrastructure Priorities

Priorities for the potential infrastructure funding of $50 - $100million are listed in order of priority in **Table 18**.

Table 18 Infrastructure Priorities

Priority	Project No.	Project	Indicative Cost	Indicative Cumulative Cost
1	13	Water Point - Includes Scheme Curve 59 – 61. Project involves application of typical 2-lane, WCLT, curve widening and associated earthworks treatments.	$10,838,228	$10,838,228
2	21a	Streets Creek Hole. Project involves interim 2-lane widening to address accident hot spot, with the ultimate 4-lane earthworks.	$17,843,529	$28,681,757
3	17	Ch 7100 – 7350. Project involves application of typical 2-lane, WCLT, curve widening and associated earthworks treatments.	$18,159,720	$46,841,477
3	18	Ch 7350 - 7600. Project involves application of typical 2-lane, WCLT, curve widening and associated earthworks treatments.	$21,996,302	$68,837,779
5	3	Scheme Curve 15 - 18 (17 & 18). Project involves application of typical 2-lane, WCLT, curve widening and associated earthworks treatments.	$21,663,703	$90,501,482

Cumulative cost <$50M
$50M <Cumulative cost <$100M
Cumulative cost >$100M

7.4 Non-Infrastructure Priorities

Non-infrastructure priorities are listed in order of priority in **Table 19**:

Table 19 Non Infrastructure Priorities

Priority	Project No.	Project
1	25	Implement ITS Strategy recommendation (Option 3). This includes a range of treatments to improve road safety, incident detection and monitoring, and traveller information (including VAS, VMS, CCTV, incident detection loops and supporting infrastructure) refer **Section 2.2.1.4** for further details.
1	26	Implement RSA recommendations (Minor Safety Works program GHD 2007-2009)
3	1a	Bottom Hairpin - ITS/Signage to moderate approach speeds for vehicles descending the range prior to entering the steep, small radius curves.
3	10a	Top Hairpin - ITS/Signage to moderate approach speeds for vehicles descending the range prior to entering the steep, small radius curve.
3	16a	Henry Ross Lookout - ITS/Signage to address poor sight distance and provide drivers with improved warning/guidance of the presence of the lookout and risk of vehicles entering/exiting the lookout.
6	13a	Water Point - Road fencing and dam to reduce the amount of wildlife crossing the road in this area (includes investigation of an alternative water source for wildlife).

7.5 Conclusions

The following conclusions can be drawn from the scoring and sensitivity tests:

- The North/South Ridge (bridge alternative) project (20a) scores highly from an effectiveness and an acceptability perspective. This is because it addresses an area of high crash cost and substandard passing width while providing a high priority fauna crossing opportunity. However as a high cost project it exceeds the $50M budget limit and utilises most of the $100M budget limit. In other words if this project is delivered it would utilise most if not all of the possible future funding.
- The other environmental projects, Lower Avondale Creek bridge (project 6a) and Streets Creek bridge alternative (project 22a) generally do not score highly due to their high cost and low effectiveness scores (low ranking on passing width and crash cost).
- Based on the high level estimating carried out for the study, the additional cost of the bridge solutions investigated is relatively low, with the Lower Avondale Creek and North South Ridge bridge options being only 5% more expensive than the on line solution.
- When Effectiveness is considered on its own, projects that provide overtaking opportunities score well (projects 21, 24 and 11) but are expensive.
- The Streets Creek Hole (project 21a) consistently scores in the top 5 priorities. This is consistent with its known record for crashes.
- The Henry Ross Lookout (project 16) scores consistently well, however the proposed solution considered here only allows for the implementation of the improved road cross section. It does not address the need for a reconfigured or improved lookout facility or a reconfigured access arrangement. If these are considered, the cost and impact of the solution is likely to be considerably greater. For this reason a non-infrastructure solution to address driver awareness, visibility and speed should be considered a higher short term priority.
- The Top Hairpin (project 10) generally scores well due to the high crash rate. However, as the existing width is generally adequate it is likely that the infrastructure solution on its own would not fully address the issue. For this reason a non-infrastructure solution addressing driver awareness and speed should be considered a higher short term priority.
- Non Infrastructure Solutions generally score highly when cost is considered. The exception is the Water Point Fencing and Dam (project 13a), which generally scores much lower than the others as it does not provide a significant transport benefit. The highest scoring non infrastructure solutions are the implementation of the ITS Strategy and the RSA recommendations (projects 25 and 26).
- The non-infrastructure alternatives score more highly than their associated infrastructure solution except when cost or constructability are not a consideration.

7.6 Key Issues Relevant to Future Decision Making

Key issues not addressed in this study but relevant to future decision making are:

- Any construction work on the existing KRR alignment generally requires the closure of one lane as side tracking is not normally feasible. This is highly disruptive to traffic flow. A progressive and staged upgrade to the existing alignment to implement the projects identified in this study would potentially see construction occurring continuously for a 10 to 20 year period. It is noted that construction of the proposed four lane solution will have significant but potentially lesser impacts during construction as the majority of the new roadway is offline.

- The timeframes associated with planning and environmental approvals of upgrades to the KRR are expected to be longer than other similar sized projects in Queensland owing to the environmental sensitivities of the World Heritage Listed Wet Tropics. Of relevance is the fact that in approving the four lane upgrade, the Commonwealth Government required that TMR undertake an assessment of the cumulative and consequential impacts of the works. TMR obtained the necessary environmental approvals to construct the four lane solution, however, there were stringent conditions including limiting sediment runoff during construction and rehabilitation of the existing road. Any changes to the approved design concept of the four lane upgrade would require new environmental approvals.

  New approvals would take into account the proposed total upgrades to KRR and would almost certainly require TMR to provide details of all proposed works that make up the overall scheme, in the environmental approval applications. Given the projects identified in this study do not provide any significant capacity improvements there would still be a need to address capacity at a future time. Therefore, the environmental assessments are likely to require consideration of the impacts from both schemes, and both schemes would need to be adequately documented to allow a detailed assessment. Based on the timeframes associated with previous KRR planning studies it is anticipated that planning and environmental approvals to achieve a capacity upgrade could take between five and ten years.

- Kuranda has approximately 150 rainy days per year and in order to manage the sediment runoff from a major construction project in steep terrain it would be necessary to restrict construction to the drier months of the year i.e. avoid construction in the wet season. This was generally the approach taken in determining the construction program for the four lane solution. When this requirement is added to other requirements, such as limiting the construction footprint to minimise rainforest destruction and maintaining acceptable travel times for motorists using the KRR, the resulting timeframe for constructing the four lane solution was in the order of 9 years.

- A tunnel was considered in earlier planning stages of the IAS (2000). It is likely to be an option TMR will need to explore in the future, if a capacity upgrade to KRR is required, in order to demonstrate that all prudent and feasible alternatives have been considered. The tunnel option previously considered sought to limit the length of the tunnel due to its high cost. This resulted in a considerable length of roadway being required from the western tunnel portal to Kuranda. All of the issues associated with the impacts of the four lane surface solution applied to this section of roadway. Timeframes for planning, environmental approvals and construction are unlikely to be any shorter for a tunnel option compared to a surface solution.

- For the aforementioned reasons, it is estimated that it would take between 15 and 20 years to undertake planning, detailed design and construction of a new four lane highway to replace the existing KRR. The timeframe to secure funding would be additional.

- While it is estimated KRR's capacity will be reached within 10 to 20 years this excludes the impact of construction traffic, which will have a major impact on travel times and significantly reduce the road's capacity. It would also add significantly to the safety risks on the range. When the impacts of construction traffic are taken into account it is likely the timeframe to upgrade the capacity of KRR (15 to 20 years plus time to secure funding) will see the upgrade completed well after the road has reached capacity (10 to 20 years less the impacts of construction traffic).

7.7 Recommendations

The high cost of the infrastructure projects as detailed in this study is unlikely to be justified by the potential benefits due to the lack of any significant capacity improvements. The key factor affecting cost is the adopted road cross section width which results in either steep cuttings or large fills supported by gabions. The following recommendations are made, taking the findings of this study into account in conjunction with the aforementioned key issues:

1. The non-infrastructure projects, which target safety and reliability, be progressed. These solutions can effectively address safety issues that are not directly associated with insufficient pavement width and defer the need to construct the associated upgrade projects, enabling funds to be spread over a greater length of the range.
2. The infrastructure projects are not recommended for progression in their current form due to their high cost and limited benefit. Instead, it is recommended the proposed cross sections be reviewed to determine if a cost effective outcome can be achieved by reducing shoulder widths and separation widths. This would include consideration of removing cyclists from the road in order to allow reduced shoulder widths. This work should be performed to a level of detail sufficient to develop P90 cost estimates.
3. If the actions of Point 2 above, achieve a list of cost effective infrastructure projects that improve the safety and/or travel reliability of KRR it is recommended that TMR establish the environmental approval conditions. These conditions have the potential to add significant cost to infrastructure projects and potentially make them unviable.
4. A Management Strategy be developed for KRR considering short, medium and long term timeframes. The suggested focus of each timeframe is as follows:
   I. Short term (0 to 5 years) – safety and travel reliability with a focus on non-infrastructure solutions.
   II. Medium term (5 to 20 years) – safety and travel reliability with a focus on cost effective infrastructure solutions, environmental permit requirements, impacts of construction traffic and delivery timeframes.
   III. Long term (>20 years) – safety, travel reliability and capacity with a focus on the long term solution, the impacts this will have on KRR during construction and the timeframe to implement.

8. Environmental Permitting Implications

1. Any project developed by the Link Study will be high risk, requiring comprehensive environmental assessment and attention to mitigation works and possibly offsets.
2. Any upgrade projects located within the Wet Tropics World Heritage Area (WHA) (and this is likely to include most options to be examined) will require a permit under the Wet Tropics Management Plan 1998 (Qld) (WTMP). The current permit for the four lane upgrade will not be relevant. It is known from the WTMP itself and from previous experience that the Wet Tropics Management Authority (WTMA) will require that environmental criteria be integrated into the design. Although securing a permit is out of scope, future permit conditions need to be considered and allowed for in the scope and cost of works required to inform the Options Analysis and Business Case. Consultation with WTMA can be expected to reveal their detailed requirements. See Item 4 below.
3. Any upgrade projects (whether or not they are located within the WHA) could require a future Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) (EPBC Act) approval. This cannot be ascertained until the scope of works and hence likely impacts is known. As for the WTMP permit, the cost of works required as part of any projects that can be approved needs to inform the Options Analysis and Business Case. Consultation with the Department of the Environment (Commonwealth) (DoE) can be expected to reveal their requirements. See Item 4 below.
4. It is known from direct experience with the Integrated Transport Study for Kuranda Range and the Minor Safety Works packages that WTMA's and DoE's interests require that TMR should:
   - demonstrate that all opportunities to avoid / reduce impacts by design are investigated and specifically documented
   - address the specific matters for considering a permit required by the WTMP and in particular faunal connectivity (canopy and riparian)
   - design works and nominate procedures to protect listed threatened plants and the habitats of listed threatened animals
   - design works and nominate procedures to protect scenic values (in particular, where possible widening by stabilising fills is preferred to extensive cuttings)
   - commit to appropriate rehabilitation (that is more extensive than hydromulching) and a future maintenance regime
   - design and budget for offsets as required to maintain the integrity of the WHA and listed threatened species.
5. These requirements are explicitly covered by the WTMP and the EPBC Act and will be features of any future permits.
6. TMR's Environmental Processes Manual is integrated with the OnQ project management framework and stipulates that an Environmental Scoping Report (ESR) should be undertaken during the Project Proposal / Options analysis. An initial screening based on the extensive work already done on Kuranda Range Road upgrades reveals that risk is High. For High risk projects, an REF (Planning) and EMP (Planning) are required in support of a Business Case.
7. The previous environmental assessments undertaken for the four lane upgrade and the Minor Safety Works are considered to be insufficient to inform the proposed work, although some material will be relevant.

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Appendices

Appendix A – Planning Area Sketches

Appendix B – Dr John Morrall Review of KRR

Appendix C - MCA Report

Appendix D – Environmental Issues

Appendix E – Habitat Connectivity Review

Appendix F – ARRB TRARR Analysis 2018