Bolivia Hill Upgrade - Assessment of Route Options

APPENDIX L

ECONOMIC ANALYSIS REPORT

Economic Analysis

Bolivia Hill Upgrade - Assessment of Route Options

NA89913018

Prepared for
Roads and Maritime Services

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Shaping the Future

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1 Introduction

1.1 Background and study area

The New England Highway passes through the Bolivia Range about 55 kilometres north of Glen Innes in NSW. The Bolivia Range runs east west and connects with the Great Dividing Range to the east and Deepwater River passes around the range to the west. Bolivia Hill (1225 metres) and Little Bolivia (1100 metres) are hills within the Range. Both the New England Highway (1025 metres) and the Great Northern Railway line (disused) pass through gaps in the range just to the west of Bolivia Hill.

The section of the New England Highway that passes through the Bolivia Range is approximately 9km long but the length of road locally known as "Bolivia Hill" is the section of the highway that descends 100m (980m to 880m AHD) over 2kms on the northern granite escarpment of the range. This alignment has steep cross falls and narrow road corridors with hard rock cutting to the east of the alignment and steep rockfill embankments to the west.

Bolivia Hill has poor horizontal alignment (curves with 75km/h advisory speeds) and steep grades (up to 9.0%) and a poor crash history with respect to fatalities and injuries. It has narrow or no road shoulders with a rock face to the east and steep drop to the west. Traffic at Bolivia Hill is relatively low (2007 average daily traffic of 2660 axle pairs at permanent count station 91.169 – Bolivia north of Pyes Creek Road) with little or no growth over recent years.

The study area identified for the proposed upgrade covers an area that starts at the top of Bolivia Hill (known as Chainage 56.4 kilometres) and descends to the valley floor to the north, ending at Pyes Creek bridge (known as Chainage 59.4 kilometres). The area is approximately three kilometres long and approximately 0.75 kilometres wide on either side of the existing highway. **Figure 1-1** shows the study area.

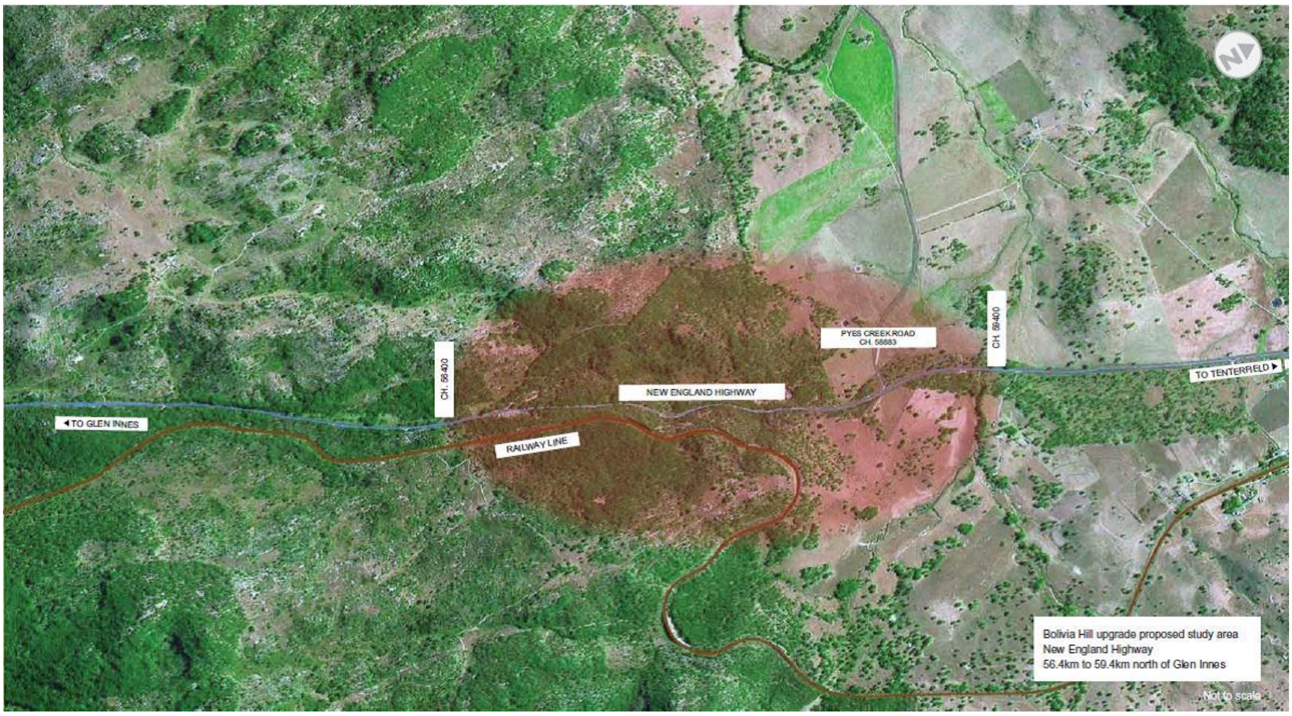

Figure 1-1 The study area (shaded red)

Within the study area, the Bolivia Hill Upgrade aims to improve New England Highway by reducing serious crashes and increasing road network efficiency through improving the horizontal and vertical design elements.

1.2 Key objectives of upgrade

The key objectives for the upgrade are:

> Improvements to road safety -
  - Reducing crash rates and injuries.
  - Improvements to road safety standards.
  - Minimising conflict points on the highway.
> Improve road transport productivity, efficiency and reliability of travel -
  - Reduced road freight user costs
  - Reduced travel time
  - Target a route level of service of A
> Minimise the impact on the natural, cultural and built environment
> Provide value for money
  - Cost benefit ratios
  - NPV over 30 years
  - Road user costs and benefits
  - Infrastructure operating costs (including maintenance)
  - Comparative project costs.

1.3 Overview of economic assessment process

The economic assessment has been undertaken in two stages:

> **Stage 1** – Preliminary Route Options. An economic assessment was undertaken on five potential route options for the highway, based on concept level cost estimates and benefits as described in this report. The outcomes of this part of the economic analysis was a key input to the selection of the preferred route option.

> **Stage 2** – Preferred Route Option. The economic assessment was re-visited with the refined cost estimates for the preferred route option.

1.4 Preliminary route options

As a part of the study, a number of preliminary route options were shortlisted as a part of the overall project. A brief description of these routes is provided in **Table 1-1**. Further details can be found in the Preferred Route Option Report.

Options 2, 6, 7 and 10 were the options originally shortlisted for further development. Options 7a and 7b were options subsequently developed to be “do minimum” road safety options.

Table 1-1 Preliminary Route Options

Option	Description
2	Option 2 is 3200 metres long and contains two bridges up to 200 metres long and large cuts up to 25 metres deep
6	Option 6 is 2610 metres long and contains a major bridge up to 350 metres long and retaining walls up to 12 metres high
7	Option 7 is 2350 metres long and contains a major bridge up to 330 metres and retaining walls up to 12 metres high

Option	Description
7a	Option 7a is a “do-minimum” road safety option and is a sub-option of Option 7. The option has a cross section consisting of one northbound lane, one southbound lane with 2.5 metre wide shoulders on either side. Option 7a is 1400 metres long and contains a major bridge up to 230 metres long and extensive retaining walls up to 8 metres high.
7b	Option 7b is a refinement of Option 7a and although longer, it minimises the requirement for the long lengths of retaining walls. As with Option 7a, the option has a cross section consisting of one northbound lane and one southbound lane, however, the shoulders are narrowed to 2.0 metres wide on either side. Option 7b is 1635 metres long and contains a major bridge up to 360 metres long and retaining walls of up to 3 metres high.
10	Option 10 is 3015 metres long and contains a major bridge up to 190 metres long and retaining walls up to 18 metres high.

2 Available data

The available data for the economic analysis was derived from the assessments being undertaken as a part of the overall project.

2.1 Traffic modelling results

Traffic modelling results, from the TRARR model, was provided on 8 May 2013 for the preliminary route options. The TRARR modelling was undertaken for the peak one hour period for each road alignment scenario and no expansion factors were used (*Detailed Traffic Assessment, Cardno June 2013*). This was provided in an Excel based format, suitable for input into the economic model. A summary of some of the key information is provided in the following tables.

Table 2-1 Summary of Travel Times per Journey (in seconds)

Scenario	Northbound			Southbound		All
	Cars	Trucks	All	Cars	Trucks	
Existing	182	203	187	184	235	193
Option 2	203	172	178	227	128	146
Option 6	176	195	178	162	209	169
Option 7	182	203	187	185	231	194
Option 7a	167	193	174	173	232	183
Option 7b	167	193	174	173	232	183
Option 10	179	200	184	188	224	191

Table 2-2 Summary of Vehicle Volumes

	Peak 1 hour volumes		Daily Volumes (2012)		Total
Vehicle Type	Northbound	Southbound	Northbound	Southbound	
Car	62	57	756	695	1451
Rigid	9	8	110	98	207
Articulated	12	11	146	134	280
Total	**83**	**76**	**1012**	**927**	**1939**

2.2 Cost estimates

Cost estimates were provided by the project team for the preliminary route options on 8 May 2013. Details of these are provided in **Section 3.2.1**.

3 Preliminary route options

The first part of the economic analysis was an assessment of the preliminary route options. By undertaking a cost benefit analysis, it is possible to compare the various route options and determine the most economically viable alternative. A high level economic analysis has been undertaken for the purpose of providing input for the preliminary route option comparison.

The key inputs to the economic analysis are estimates of costs and benefits over the life of the project. The following sections outline the key inputs and assumptions for the assessment.

3.1 Key assumptions

3.1.1 Base case

The base case for the assessment is the existing road. This is used to compare the various preliminary route options that are identified.

3.1.2 Discount rate

A discount rate of 4.4 per cent was adopted for the study, based on the requirement for federally funded projects. A sensitivity analysis was undertaken on the preferred option, and is discussed in **Section 4.1**.

All dollar values presented in this report are in 2013 Australian dollar values, unless otherwise stated.

3.1.3 Assessment period

For the purposes of the analysis, it was assumed that the works would commence in 2016. Without further detailed information on construction phasing, it was assumed that the works would be undertaken over a 2 year period, with the road becoming operational in 2018.

The assessment was undertaken over a 30 year period, finishing in 2047. It is expected that the life of the road would exceed this period. However, after 30 years, it would be expected that more significant maintenance would be undertaken. As this maintenance cost would effectively result in the continuation of benefits moving into the future, the economic assessment period has been assumed to be only for the first 30 years of the roads life.

No salvage values or periodic maintenance costs have been included in the preliminary route option assessment.

3.1.4 AADT & traffic growth

The Annual Average Daily Traffic (AADT) is estimated at 1939 vehicles, based on the traffic modelling. The expected growth rate in traffic is 3.26%,

This expected growth rate was calculated using the growth in traffic within the years of 1984 and 2001. Since the Yelgun to Chinderah upgrade took place in 2002 and an upgrade of the Cudgera Creek Road in 2006, the growth calculation only utilised values until 2001. It is assumed that the traffic growth rate was constant between 1984 and 2001. Further details are provided in the *Detailed Traffic Assessment, Cardno June 2013*.

3.2 Cost estimates

3.2.1 Capital costs

Capital cost estimates for the preliminary route options and the “value for money” road safety options were provided by the project team and are summarised in **Table 3-1** and **Table 3-2**. These capital costs include a 60% contingency.

Table 3-1 Capital Cost Estimates (Shortlisted Options)

Option	Capital Cost
2	$150M
6	$123M
7	$115M
10	$157M

Table 3-2 Capital Cost Estimates (Road Safety Options)

Option	Capital Cost
7a	$80M
7b	$60M

3.2.2 Annual maintenance costs

RMS reports that in 2012/2013, for the 386 kilometres of the New England HW (HW9) looked after by Tamworth RFS, $2,900,000 was spent for routine pavement maintenance, $400,000 for water blasting and $2,100,000 for heavy patching, totalling $5,400,000 for pavement maintenance in that year. This equates to approximately $13,900 per kilometre. A figure of $15,000 per kilometre has been adopted for this analysis for both the existing road and the upgraded road.

It is noted that there are a number of bridge structures in the design options, which would result in higher maintenance costs than a typical road. An annual maintenance cost for bridges of 0.1% of the capital cost of the bridge has been adopted for this analysis.

3.3 Benefits

A road user benefit cost analysis (RUBCA) has been undertaken for the proposed upgrade. This analysis incorporates only the direct benefits to road users, rather than any wider scale benefits or costs to the community or environment. These unquantified benefits and costs are discussed in more detail in **Section 3.5**.

The RUBCA analysis undertaken considers three key benefits:

> Reductions in Travel Time

> Reductions in Vehicle Operating Costs

> Reductions in Accidents

3.3.1 Travel time reductions

The proposed modifications to the road under each of the design alternatives generally result in a reduction in travel times. This reduction represents a reduction in costs, referred to as travel time benefits.

Values of travel time were estimated based on the *Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives* (2013) (Guidelines (2013)).**Table 3-3** provides a breakdown of the different vehicle types and the associated value of time for each vehicle type.. The traffic data provided is based on three categories of car, rigid and articulated vehicles. Values of travel time were estimated for these vehicle types based on the compositions provided in **Table 3-3**. The assumed travel time values to align with the traffic modelling categories are provided in **Table 3-4**.

Table 3-3 Travel Time Costs and Typical Compositions (after Guidelines (2013))

Vehicle Type	Typical Composition	Value of Travel Time ($/veh.hr) (in 2013 dollars)
Private Car	48.13%	$23.39
Business Car	14.12%	$57.24
Light Commercial	24.11%	$32.41
Heavy Commercial	8.28%	$35.15
B-Double/ Road Train	5.37%	$61.49

Table 3-4 Travel Time Values (2013 dollars)

Vehicle Type	Value of Travel Time ($/veh.hr) (in 2013 dollars)
Car	31.07
Rigid	32.4
Articulated	45.5

The traffic modelling provided estimates of the travel times for each vehicle type, and these were converted into a daily travel time based on the AADT estimates. This is summarised in **Table 3-5**.

Table 3-5 Travel Time Estimates – Daily (hours, 2013)

Option	Vehicle Type		
	Car	**Rigid**	**Articulated**
Existing	74.9	12.8	17.3
2	88.2	8.8	11.8
6	69.3	11.8	16.0
7	75.1	12.6	17.1
7a	69.6	12.4	16.8
7b	69.6	12.4	16.8
10	75.1	12.4	16.7

3.3.2 Vehicle operating costs

Vehicle operating costs were not included in the analysis. There is the potential for the fuel consumption to change as a result of the road upgrade, however, this change is assumed to be negligible.

There is no change in the expected distances for each of the options. Therefore, the key change in vehicle operating costs would be primarily through different grades and curvatures of the road, and the impact on vehicles. This is expected to result in an improvement over the base case in each of the options. However, the impact of this is expected to be low in comparison with the travel time savings and accident reduction rates. As a result the possible benefits have been ignored thus making the BCR estimate more conservative.

3.3.3 Crash reductions

Crashes occur when one vehicle collides violently with another vehicle or object resulting in costs to human life and damage to property. The Road Authorities have a legal obligation to ensure road safety for all users and to investigate incidents whilst continuously improving the roads safety and performance. Improvements to the safety and efficiency of the road can result in a reduction in crashes and a corresponding reduction in cost to the community. .

Information on the crash rates for the existing road are provided in the traffic report (Cardno, June 2013). These were recorded from 2007 to 2011, and are summarised in **Table 3-6**.

There are two ways that the costs of crashes can be assessed under the Guidelines 2013); the human capital approach (which is the more traditional approach) and the newer willingness to pay (WTP) approach.

The WTP method is the preferred method of crash valuation. However, the WTP method requires a detailed review of the number and type of expected crashes under the proposed route option. . This type of data is currently unavailable, thus the human capital approach was adopted.. The results of this analysis for the existing road are provided in **Table 3-6**.

A detailed review of the likely crashes based on the improvements under each of the options has not been undertaken at this preliminary level. Therefore, for each of the options, an average crash cost for a typical road has been assumed of $52,800 per MVKT, based on the Guidelines (2013).

Table 3-6 Accidents on the Existing Road

Accident Type	Number of Accidents between 2007 & 2011	Average rate of accidents per year	Average Cost Per Year (2014 in 2013 Dollars)
Fatality	2	0.4	$1,128,692
Injury	2	0.4	$95,386
Tow-Away	5	1	$8,366
Total			$1,232,444

3.4 Benefit cost analysis

The economic analysis was undertaken by comparing the benefits and costs of the preliminary route options. These are summarised in the **Table 3-7**, **Table 3-8** and **Table 3-9**. The benefit cost analysis was based on a time period of 30 years from completion of construction.

The outcomes of the analysis suggest that all options have a BCR of less than 1, where the overall costs exceed the benefits of the works. However, it is important to note that there are some conservative assumptions that have been made in the analysis:

> Maintenance cost estimates represent a dominant component of the overall costs. The results would improve with a refinement of this estimate.

> Vehicle Operating Costs have been conservatively ignored, although it is noted that these are likely to be minor.

In conclusion Option 7b has the highest benefit cost ratio and therefore represents the best possible outcome economically of the five route alternatives.

Table 3-7 Present Value Estimates ($millions, in 2013 dollars)

	Existing	2	6	7	7a	7b	10
Capital Costs	$0.0	$123.6	$101.4	$94.8	$65.9	$49.4	$129.4
Maintenance	$0.8	$1.1	$1.4	$1.4	$1.1	$1.2	$1.2
Travel time costs	$40.8	$41.1	$38.3	$40.9	$38.9	$38.9	$40.6
Accident Costs	$33.4	$9.6	$9.6	$9.6	$9.6	$9.6	$9.6

Table 3-8 Summary of Present Value Costs and Benefits ($millions, in 2013 dollars)

	Existing	2	6	7	7a	7b	10
Total Costs	$0.8	$124.7	$102.7	$96.1	$67.0	$50.6	$130.6
Total Benefits	$74.2	$50.7	$47.8	$50.5	$48.5	$48.5	$50.2

Table 3-9 Summary of Economic Analysis of Preliminary Options

	2	6	7	7a	7b	10
Net Cost	$123.9	$101.9	$95.3	$66.2	$49.8	$129.8
Net Benefit	$23.5	$26.4	$23.7	$25.8	$25.8	$24.0
NPV	-$100.4	-$75.5	-$71.7	-$40.4	-$24.1	-$105.8
BCR	0.19	0.26	0.25	0.39	0.52	0.18

3.5 Unquantified benefits and costs

The RUBCA analysis includes only the direct costs and benefits to the community and the RMS. However, there are a number of potential benefits and costs which have not been included in this analysis. These additional benefits and costs are generally difficult to quantify. **Table 3-10** provides an overview of some of these benefits and costs, and the potential impact that this might have. An estimate is also provided on the likely level of this impact and whether this would have a positive or negative impact on the economic outcome.

Table 3-10 Unquantified Benefits and Costs

Benefit/ Cost	Description Of Impact
Freight	The upgrade of this section of road would provide some level of improvement for freight. However, the entire road would require an upgrade to realise an overall regional freight benefit. Therefore, in the short term, this is unlikely to be significant.
Environmental	In comparison with the existing road, there is unlikely to be significant environmental impacts. These are addressed in more detail in the *Preferred Route Option Report, Cardno June 2013.*
Social Impacts	In comparison with the existing road, there is unlikely to be significant socio-economic impacts. These are addressed in more detail in the *Preferred Route Option Report, Cardno June 2013*.
Construction	There will be a short term impact on traffic and nearby localities during the construction period.

4 Preferred route option

The preferred route option (Option 7b) was selected through a workshop and consideration of factors such as the economic analysis identified in Section 3. Further details of this process are provided in the *Recommended Preferred Route Option Report, Cardno August 2013*.

The detailed cost estimate of the preferred route option was undertaken, with the P90 cost estimate being derived at $60 million. As this estimate is equivalent to the estimate provided in Section 3.2, the cost benefit analysis undertaken for the preliminary Option 7b remains unchanged. This is summarised in Table 4-1.

Table 4-1 Summary of Economic Analysis of Option 7b

	7b
Net Cost	$49.8
Net Benefit	$25.8
NPV	-$24.1
BCR	0.52

4.1 Sensitivity analysis

A sensitivity analysis was undertaken on the outcomes for Option 7b. A sensitivity analysis allows an assessment of the likely alternative outcomes with different assumptions on key parameter inputs to the economic modelling. The following parameters were tested in the sensitivity analysis:

> Capital Costs – increase and decrease by 20% (refer **Table 4-2**);

> Reduction in Accident and Travel Costs (Road User Costs) for the Option – increase and decrease by 20% (refer **Table 4-3**); and,

> Discount Rate – an alternative of 7% was tested (refer **Table 4-4**).

The results of the sensitivity analysis suggest that the outcomes are relatively insensitive to the parameters that are adopted. The largest increase in BCR occurred with a decrease in road user costs of 20%. However, the BCR still remains at 0.68.

Table 4-2 Sensitivity Analysis – Capital Costs

	Capital less 20%	Option 7b	Capital plus 20%
Net Cost	$39.8	$49.8	$59.6
Net Benefit	$26.7	$25.8	$26.5
NPV	-$13.2	-$24.1	-$33.1
BCR	0.67	0.52	0.45

Table 4-3 Sensitivity Analysis – Road User Costs

	Road User Costs less 20%	Option 7b	Road User Costs plus 20%
Net Cost	$49.7	$49.8	$49.7
Net Benefit	$33.9	$25.8	$19.3
NPV	-$15.9	-$24.1	-$30.4
BCR	0.68	0.52	0.39

Table 4-4 Sensitivity Analysis – Discount Rate

	Option 7b	Discount Rate = 7%
Net Cost	$49.8	$44.5
Net Benefit	$25.8	$16.8
NPV	-$24.1	-$27.7
BCR	0.52	0.38

5 Conclusions

An economic analysis was undertaken on the proposed Bolivia Hill Upgrade. This economic analysis was undertaken in two stages:

> **Stage 1** – Preliminary Route Options. An economic assessment was undertaken on five potential route options for the highway, based on concept level cost estimates and benefits as described in this report. The outcomes of this part of the economic analysis was a key input to the selection of the preferred route option.

> **Stage 2** – Preferred Route Option. The economic assessment was re-visited with the refined cost estimates for the preferred route option.

The analysis of the preliminary route options identified that Option 7b had the highest BCR at 0.52. This economic analysis considered road user costs estimated based on the traffic modelling outputs and the capital and maintenance cost estimates for each of the options. It is noted that a number of additional benefits beyond the direct benefits to road users, as identified in Section 3.5, were not included in this analysis.

Following the selection of the preferred Option 7b, the analysis was revisited with detailed P90 cost estimates. These cost estimates were equivalent to the preliminary analysis, and identified that the BCR remained at 0.52.

A sensitivity analysis was undertaken on the outcomes, and it was identified that the outcome was relatively insensitive to the key assumptions of the economic modelling.