## 4 Costs and Benefits

This section defines the economic costs and benefits that are contained in the analysis, and presents the cost and benefits profile of the Offline upgrade.

## 4.1 Economic Costs

## 4.1.1 Capital Costs

The capital cost of the Base Case is zero as it is a "do-nothing" case.

The capital cost of the project is estimated in 2014 dollars. The capital costs account for the following items:

- Cost comparison;
- Project Development;
- Investigation and Design;
- Property Acquisitions;
- Construction; and
- Finalisation.

The costs estimates are at a strategic stage (P90) and provided by the RMS. They include an average contingency allowance up to 62%.

The estimated cost for completion of the offline scheme is \$76M in 2014 dollars (\$86.7M outturn costs)<sup>5</sup> with the proposed timing and breakdown shown in Table 4-1.

Table 4-1 Capital Expenditure (\$000)

Offline Scheme	2014	2015	2016	2017	Total
Current cost	\$4,145	\$6,045	\$57,000	\$8,810	\$76,000
Out-turn cost	\$4,145	\$6,469	\$65,259	\$10,792	\$86,700

Source: RMS, F:\AA007308\Data as received\20141016\_Strategic Cost Estimates

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<sup>&</sup>lt;sup>5</sup> The out-turn value is equivalent to current costs inflated to future years when expenditure is expected to occur.

#### 4.1.2 Maintenance Costs

The maintenance costs are estimated using unit maintenance rates for works associated with existing and new pavements. Table 4-2 shows the assumed maintenance unit rates applied. The unit rates were provided by the RMS.

Table 4-2 Maintenance Unit Rates

Table 4-2 Maintenance Offici	vales	
Maintenance Work Item	Routine Frequency	Unit Rate
Existing Pavement		
Flush reseal	Every 5 years	\$7.31 per m <sup>2</sup>
Rehabilitation	Every 10 years	\$73 per m <sup>2</sup>
New Pavement		
AC re-sheet	Every 10 years	\$27.50 per m <sup>2</sup>
Rehabilitation	Every 20 years	\$94.00 per m <sup>2</sup>

Source: RMS, F:\AA007308\Data as received\20141103\_Pavement Areas for BCR

RMS provided pavement areas associated with base case and the Offline upgrade. The Offline upgrade comprised of existing pavement areas retained from the current pavement and new pavement areas constructed as part of the upgrade for inclusion in calculating maintenance costs. Table 4-3 summarises the pavement areas included in the analysis.

Table 4-3 Pavement Areas for Maintenance (m<sup>2</sup>)

	Base case	Offline Upgrade
Existing Pavement	84,473	
Existing Pavement to be Retained with Upgrade		29,982
New Pavement		72394

Source: RMS, F:\AA007308\Data as received\2014-07-16\_Cost Estimates

Maintenance costs were calculated for the base case and for the Offline upgrade scheme. The net maintenance costs are the difference between the base case maintenance cost and the offline upgrade scheme maintenance cost. A positive net maintenance cost reflects savings in maintenance costs while a negative net maintenance cost indicates an increase in maintenance costs over base case.

## 4.1.3 Vehicle Operating Costs per kilometre travelled

The vehicle operating cost (VOC) parameters used in the analysis was sourced from the *TfNSW Guidelines*. *Appendix 4, Table 16* reported VOC by vehicle type, and proportion of vehicle fleet. Based on the vehicle compositions, the weighted VOC per kilometre travelled was found approximately \$0.68/VKT (vehicle km travelled).

#### 4.1.4 Travel Time Costs

This entails the estimation of travel time costs based on the hourly value of travel time (VOTT) multiplied by the vehicle hours travelled for base case and the Offline upgrade. The hourly value of travel time was sourced from the *TfNSW Guidelines*. *Appendix 4, Table 9* reported VOTT by vehicle type, proportion of vehicle fleet, occupancy. The value for travel time for heavy vehicles is also considered in the assessment.

The VOTT used in this analysis reflects value of travel time for a non-urban (rural) condition of the project. This takes into account the impact of higher speed limits and speeds of travel generally observed in non-urban conditions.

A weighted average value of travel time was calculated using of observed composition of vehicle fleet on the M1 Princes Highway section between Picton Road and Bulli Tops. The resulting average VOTT used for the analysis is presented in Table 4-4.

Table 4-4 Weighted Average VOTT (\$/VHT)

Vehicle Type	% Vehicle <sup>1</sup>	\$/VHT
Light vehicle (Car and LCV)	87.0%	\$33.17 <sup>2</sup>
Heavy vehicle (HCV)	13.0%	\$47.93 <sup>2</sup>
Overall average		\$35.18

#### Source:

- (1) Vehicle composition based Mount Ousley Road/Southern Freeway Traffic Modelling Final Report, Bitzios Consulting, January 2010, page 8.
- (2) TfNSW Guidelines, Appendix 4, Table 15

#### 4.1.5 Crash Costs

One of the key objectives of the Offline upgrade is to improve road safety on the motorway. Analysis of crashes that have recently occurred on the Princes Motorway between Bellambi Creek and Picton Road is provided in the previous Section 2.3.3.

The proposed upgrade is expected to substantially improve road safety along and adjacent to the study area. Crash analysis has been undertaken by comparing existing and proposed conditions to determine estimated crash reduction statistics based on historical data between 1 August 2008 and 31 October 2013, using the RMS's Crash Reduction Guide, August 2005. Average crash costs by accident type are based on 'willingness to pay' approach sourced from TfNSW's Principles and Guideline for Economic Appraisal of Transport Investment and Investigation, March 2013.

The analysis assumed the following road safety improvements are implemented on the Princes Motorway between Bellambi Creek and Picton Road:

- Improved road alignment; and
- Additional lanes.

An improvement in road safety is estimated using RMS's *Crash Reduction Guide*, which includes typical percentage reductions in crashes by definitions for coding accidents (DCA) codes based on proposed midblock treatments. The existing crash data in the study area was analysed to determine if any crashes could have been prevented, or consequences minimised as a result of the construction of the proposed Offline upgrade.

The results presented in Table 4-5 indicate that total crashes on the Princes Motorway between Bellambi Creek and Picton Road would be reduced by 74% under the upgraded condition.

Table 4-6 shows that annual crash rate would reduce from 22.5 existing to 5.8 under upgrade condition with potential to eliminate all fatal crashes. The crashes per 100 million vehicle kilometres also experience a large reduction, falling from 31 to 8.

The annual cost of crashes under the new road alignment is estimated as \$0.26 million, which is saving of \$4.19 million per year or \$0.79 million per kilometre based on 2012/13 willingness to pay rates.

Detailed crash reduction analysis is documented in Appendix A.

Existing and Proposed Crash Statistics Based on Estimated Safety Improve

(J)	ting and Pro	posed Cra	sh Statistics	Existing and Proposed Crash Statistics Based on Estimated Safety Improve	mated Safety Ir	nprove						
Length					Cras	h by Collis	Crash by Collision Type / DCA Code <sup>(2)</sup>	\ Code (2)				
(km) Rear Lane end change	Chan		Hit parked vehicle	Pedestrian, crossing carriageway	Permanent obstruction on carriageway	Hit animal	Off carriageway , hit object	Out of control on straight	Off carriageway , on curve	Off carriageway , hit object	Out of control on curve	Total
301- 305-307	305-3	07	601	001-008; 901-902	605	609	703-704	705; 502	801; 802	803-804	805	
5.31 22	`	<del>-</del>	4	2	4	4	7	ത	r.	43	<del></del>	112
5.15		2	0	0	0	7	2	3	0	14	0	29
-0.16 -16 -9	6-	•	-4-	-2	-4	-2	·\$-	9-	-5	-29	-1-	-83
-3%▼ -73%▼ -82%▼			-100%	-100%	-100%	-20%	-71%	-%29-	-100%	-67%	-100%	-74%

Note: (1) RMS crash data recorded between 1 August 2009 and October 2013 (2) Potential crash reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.

Existing and Proposed Crash Statistics Based on Estimated Safety Improve, Annual Average Table 4-6

Scenario	Length (km)	Total Crashes	Number	Number of Crashes by Severity	y Severity	Total Crash Per 100	Crash Severity Index <sup>(4)</sup>	Crash Cost per Year (\$M)	t per Year A)
			Fatal Crashes	Injury Crashes	Non-injury Crashes	MVKM (3)		Total Cost <sup>(5)</sup>	Cost per Km
(1) Existing conditions (without Offline Upgrade)	5.31	22.4	0.4	5.4	16.6	31	1.16	4.45	0.84
(2) Proposed conditions (with Offline upgrade)	5.15	5.8	0	1.0	4.8	ω	1.09	0.26	0.05
Change in Conditions	-0.16▼	-16.6	-0.4	-4.4	-11.8	-23	▶20.0-	-4.19	-0.79
Change in Conditions (%)	-3%⊾	-74%	-100%	-81%	-71%	-74%	<b>\%</b> 9-	-94%	-94%

Note:

(1) RMS crash data recorded between 1 August 2009 and October 2013
(2) Potential crash reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.
(3) Crash rate per 100 MVKM = (total crashes x 100,000,000) / (no. of years x 365 x length (km) x AADT).
(4) Crash severity index = [(fatal crashes x 3.0)+(injury crashes x 1.5)+(non-injury crashes)]/total crashes.
(5) Costs per crash sourced from Table 45 (Page 257) of TfNSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013.

#### 4.1.6 External Costs

Road use produces external costs on society in terms of the economic costs of environmental impacts. Environmental costs are determined by applying externality values per VKT based on vehicle composition form the traffic analysis.

The TfNSW Guidelines, Appendix 4, Tables 52 and 53 provides parameter values for environmental externality costs in urban and rural areas. These parameter values include:

- Noise pollution;
- Air pollution;
- Water pollution;
- Greenhouse gas emissions;
- Nature and landscape;
- Urban separation; and
- Upstream and downstream.

#### **Light Vehicles**

Environmental unit costs for passenger vehicles are expressed in cents per VKT. The unit costs are directly applied to the change in VKT to estimate the change in environmental costs. The average external costs per VKT used primarily for light vehicles in the analysis are summarised in Table 4-7.

Table 4-7 Environmental Externality Costs

Environmental	Passenger Car	Light goods	s vehicle	Total light vehicles	Heavy v	vehicles
Externality	(\$/km) <sup>1</sup>	\$/1000 tonne-km <sup>1</sup>	\$/km²	<b>(\$/km</b> <sup>3</sup>	\$/1,000 tonne-km <sup>1</sup>	\$/km <sup>4</sup>
Noise pollution	\$0.00	\$0.00	\$0.00	\$0.00	\$0.42	\$0.01
Air pollution	\$0.00	\$0.00	\$0.00	\$0.00	\$0.25	\$0.01
Water pollution	\$0.00	\$0.28	\$0.00	\$0.00	\$1.49	\$0.04
Greenhouse gas emissions	\$0.02	\$57.88	\$0.02	\$0.02	\$5.51	\$0.15
Nature and landscape	\$0.01	\$0.21	\$0.00	\$0.01	\$4.14	\$0.11
Urban separation	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Upstream and downstream	\$0.04	\$192.91	\$0.08	\$0.05	\$22.05	\$0.61
Total	\$0.07	\$251.28	\$0.10	\$0.08	\$33.86	\$0.94

Source: TfNSW Guidelines Table 52 and Table 53.

 $F: AA007521 \\ D-Calculations \\ BCR\ Analysis \\ BCRAssessment\_Offline\ Option\_RevG.xls$ 

<sup>(1)</sup> TfNSW Guidelines, Table 52

<sup>(2)</sup> Based on average load carried of 389 kg for light commercial vehicles (ABS Survey of Motor Vehicle Usage 2012, Table 16)

<sup>(3)</sup> Weighted average of cars and light commercial vehicles using the percentage composition in Table 5-4

<sup>(4) 4</sup> Based on an average load carried of 27.7 tonnes for heavy vehicles (ABS Survey of Motor Vehicle Usage 2012, Table 16)

In order to convert the environmental cost parameters into annual environmental costs, the passenger vehicle costs per VKT are applied to the annual VKT.

#### **Heavy Vehicles**

For heavy vehicles the environmental unit costs are expressed in dollars per 1000 tonne kilometre (tkm) travelled. The tkm unit costs are converted to dollars per VKT using NSW average tonne kilometres and average VKT for the two truck types taken from the latest Australian Bureau of Statistics "Survey of Motor Vehicle Use".

## 4.2 Economic Benefits

The benefits of the Offline upgrade related to savings in road user costs due to the reduction in vehicle hours and vehicle kilometres compared with the base case, as well as the residual value of assets remaining at the end of the analysis period. The benefits include:

- Road User cost savings:
  - Savings in vehicle operating costs;
  - Savings in travel time costs; and
  - Savings in crash costs
- Residual Value of Assets

In order to quantify the savings, a comparison is made for each parameter relative to base case and unit cost values are applied.

## 4.2.1 Vehicle Operating Costs Savings

The unit VOC is applied to the VKTs in base case and the Offline upgrade to calculate the incremental VOC for VKT for the analysis period. The savings in vehicle operating costs for the Offline upgrade are estimated by combining the incremental (relative to the base case) vehicle kilometres (VKTs) with the unit vehicle operating costs.

## 4.2.2 Travel Time Costs Savings

The difference in the travel time from the traffic forecasts are used to estimate savings in travel time cost for the Offline upgrade relative to base case.

## 4.2.3 Crash Cost Savings

Appendix C of the RMS Accident Reduction Guide, August 2005, provides a standard list of treatments for a particular crash type and suggests a percentage reduction in accidents for intersection and mid-block treatments for low speed and high speed environments. The Guide notes that the accident reduction parameters have been derived by consideration of before and after studies conducted both in Australia and overseas. Where information was not available for a particular treatment, the assessment of benefits has been derived by an assessment of the likely impact of the treatment on risk at the site. It is also noted that the assumed reduction parameters do not specifically account for combinations of treatments at a site.

The crash types were derived from the crash data and a target reduction factor was assigned for each crash type using the accident reduction factors provided in *Appendix C of the RMS Guide*. Crash costs were calculated for base case and the Offline upgrade using the *TfNSW Guidelines, Appendix 4, Table 9*. The difference in the annual crash costs of base case minus the Offline upgrade reflects the estimated crash cost savings (safety benefits).

## 4.2.4 Externality Cost Savings

The savings in externality costs will accrue as a result of a decrease in VKT from base case and the Offline upgrade. Externality costs are calculated by applying the externality unit costs on the VKT and the differential with the improved case is used to estimate savings in externality costs.

#### 4.2.5 Residual Values

The economic appraisal includes the residual values of the road assets. The residual value reflects that fact that some infrastructure assets may have economic lives which extend beyond the evaluation period. Residual values are entered in the last year of the evaluation period to represent the unused portion of the asset that has lives greater than the evaluation period. The assumed economic life of the asset was sourced from *TfNSW Guidelines, Appendix 4, Table 66.* For this analysis, the road pavement asset was assumed to have an economic life of 60 years.

# 4.3 Summary of Benefits and Costs

Table 4-7 below provides a summary of the costs and benefits for the Offline upgrade in a similar format required by the Strategic Business Case.

Table 4-7 Discounted Costs and Benefits by Offline Upgrade (\$M)

		e (\$IVI)
		Comparison dollars, \$million unless
	•	rise indicated)
	Base Case	Offline Upgrade
Project Development		\$0.93
Investigation and Design		\$2.23
Property Acquisitions		\$0.86
Utility Adjustments		\$7.46
Construction		\$63.02
Finalisation		\$1.50
Total Project Development Costs <sup>1</sup>		\$76.00
Ongoing <b>Operating</b> Costs (Borne by users, over 30 years, discounted @ 7%)		n/a
Ongoing <b>Maintenance</b> Costs (Borne by RMS, over 30 years, discounted @ 7%) [Net Maintenance Costs]	\$4.82	\$4.02
<b>Total Ongoing</b> Costs (Discounted at 7% over 30 years) [PV of Costs]	\$4.82	\$4.02
Total <b>Cost</b> <sup>2</sup> (Discounted at 7% over 30 years) [PV of Costs]		\$71.82
Total Financial Benefits		n/a
Total User and Non-User Benefits [PV of Benefits]		\$121.34
Total Benefits <sup>3</sup>		\$121.34

<sup>&</sup>lt;sup>1</sup> Total asset related costs (purchase and/or building of asset/solution) plus other project costs to be included in the Capital Budget

Source: Roads and Maritime Data / Hyder Economic Analysis (F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment\_Offline%20Option\_RevG.xls)

<sup>&</sup>lt;sup>2</sup> Total of above amounts

 $<sup>^{\</sup>rm 3}$  Difference between all economic costs in the improved case and in the base case

Table 4-8 below provides a summary of the discounted benefits by road users for the offline upgrade assessed.

Table 4-8 Benefits Breakdown for Offline Upgrade (\$million)

Discounted Benefits	Offline Scheme	Percent to Total Savings
Savings in Travel Time	\$69.76	57%
Savings in Vehicle Operating Costs	\$5.33	4%
Savings in Crash Costs	\$39.63	33%
Externality Costs Savings	\$2.27	2%
Residual Value	\$4.34	4%
Total PV of Benefits	\$121.34	100%

Source: Hyder Economic Analysis

(F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment\_Offline%20Option\_RevG.xls)

The results from Table 4-8 indicates that offline upgrade will provide significant road user benefit. The analysis has identified travel time savings up to 57% of total benefit. The safety benefit comprised about 33% of total benefit.

Detailed discounted benefits and costs of Offline upgrade (incremental to base case) are included in **Appendix B.** 

## 5 Evaluation Results

The economic appraisal results are presented in terms of three decision criteria as follows:

- Net present value (NPV);
- Benefit Cost Ratio (BCR); and
- Net Present Value per Dollar of Investment (NPVI).

The first year rate of return (FYRR), internal rate of return (IRR) are also presented for the Offline upgrade. The results of the economic appraisal for the Offline upgrade is summarised in Table 5-1.

Table 5-1 Summary of Economic Appraisal for the Offline Upgrade (7% discount rate)

	Offline Upgrade
PV Cost (\$M)	\$71.82
PV Benefit (\$M)	\$121.34
NPV (\$M)	\$49.52
BCR	1.7
NPVI	0.7
FYRR	10.4%
IRR	11.8%

Source: Hyder Economic Analysis

 $(F: AA007521 \ D- Calculations \ BCR\%20 Analysis \ BCRAssessment\_Offline\%20 Option\_RevG.xls)$ 

The results from Table 5-1 show that:

- The road user benefit for proposed upgrade would exceed the capital cost, therefore the proposed offline upgrade is economically viable.
- The BCR for the offline upgrade was found 1.7.
- The total road user benefit would be \$121.3 million with a capital cost of \$71.8 million. The NPV of the proposed upgrade was found to be \$49.5 million.

Detailed economic appraisal results are included in Appendix B.

# 5.1 Sensitivity Analyses

Sensitivity analyse was undertaken as part of the economic appraisal. The economic analysis tests sensitivity of the results on discount rates and on estimation of costs and benefits.

## 5.1.1 Sensitivity on Discount Rates

The sensitivity analysis was undertaken for 4% and 10% discount rates. The results of the sensitivity analysis on discount rates are shown in Table 5-2.

Table 5-2 Sensitivity Analyses Results (On Discount Rates)

Discount Rate		Offline Upgrade
	NPV (\$M)	\$121.89
40/	BCR	2.6
4%	NPVI	1.6
	FYRR	11.0%
	NPV (\$M)	\$12.97
100/	BCR	1.2
10%	NPVI	0.2
	FYRR	9.8%

Source: Hyder Economic Analysis

(F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment\_Offline%20Option\_RevG.xls)

## 5.1.2 Sensitivity on Costs and Benefits

The results of the sensitivity analyses on the estimation of costs and benefits are provided in Table 5-3. The tables provide the resulting economic parameters for a +/- 20% deviation on the cost estimates and the benefits streams, as well as the effect of a delayed delivery by one year.

Table 5-3 Sensitivity Analyses (On Estimation of Costs and Benefits)

Offline Upgrade	BCR	NPV (\$M)	IRR	NPVI
Cost Estimate +20%	1.4	\$37	10.1%	0.4
Cost Estimate -20%	2.2	\$65	14.5%	1.2
Benefits +20%	2.1	\$76	14.1%	1.1
Benefits – 20%	1.4	\$27	9.8%	0.4
Delay in delivery by one year	1.7	\$48	12.0%	0.7

Source: Hyder Economic Analysis

 $(F: VAA007521 \ \ D-Calculations \ \ \ \ BCR\%20 \ \ Analysis \ \ \ \ BCRAssessment\_Offline\%20 \ \ \ \ Option\_RevG.xls)$ 

# 6 Summary of Findings

#### Overview

The M1 Princes Motorway is a key strategic corridor and the only B-Double-capable route, linking Sydney with the Illawarra region and NSW South Coast. The section from south of Picton Road to Bulli Tops is currently constrained to two lanes in each direction. Adjoining sections of the M1 Princes Motorway are mostly configured with three lanes in each direction. The constrained road space in the section of the road, together with the undulating topography generates the need for vehicle weaving between slow, heavily-laden freight vehicles and unladen heavy vehicles and lighter passenger vehicles on that section of the M1 Princes Motorway.

Roads and Maritime (Roads and Maritime Services, RMS) has developed a strategic concept design for an 'offline' road upgrade and realignment of the M1 Princes Motorway southern section between Bellambi Creek and Picton Road ('Offline upgrade') to provide greater traffic efficiency and safety.

The purpose of this Study is two-folds:

- Undertake traffic modelling of the M1 Princes Motorway Offline upgrade option between Bellambi Creek and Picton Road. The modelling has been undertaken using microsimulation Paramics software.
- Undertake economic merit of the Offline upgrade option. This involves estimating the net economic benefit, benefit cost ratio (BCR) and net present value (NPV) of the Offline upgrade option.

#### **Traffic Growth**

In agreement with RMS, the assessment assumed traffic growth of 2% per annum for light vehicles and 4% per annum for heavy vehicles on this M1 section until 2038. Between 2038 and 2048, the growth is predicted to reduce to 1% per annum for light vehicles and 2% per annum for heavy vehicles. The reduced growth in the longer term (between 2038 and 2048) was adopted due to significant congestion predicted on this section (2/2) of the M1 Princes Motorway.

#### Traffic Volumes on the M1 Princes Motorway

In 2014 M1 Princes Motorway, between Bulli Tops and Picton Road carried about 37,000 vehicles per day. The heavy vehicles proportion was about 13% of the total traffic. At opening year 2018, traffic on the M1 Princes Motorway is forecast in the order of 40,000 vehicles per day. In 2038 (20 years after opening), traffic on the M1 Princes Motorway is forecast in the order of 55,000 vehicles per day. In the future heavy vehicles proportions are retained in line with the current trend (i.e. 13% heavy vehicles and remaining 87% light vehicles).

## Offline Upgrade

The Offline upgrade involves road widening (3 lanes in each direction) and realignment of a 3.5 kilometres of the M1 Princes Motorway between Bellambi Creek and Picton Road. Figure 1-1 in this report shows an indicative Offline upgrade on the M1 Princes Motorway.

#### Performance of Offline Upgrade

For the purpose of traffic assessment, 2018 was assumed to be the opening year of the Offline upgrade. Traffic performance of the Offline upgrade was assessed for 2018 (at opening), 2028 (10 years after opening) and 2038 (20 years after opening).

Hyder's analysis found that:

- The Offline upgrade would improve travel time on the M1 Princes Motorway between Bulli Tops and Picton Road (measured for the entire 8.3 km section). In opening year 2018, travel time saving on the M1 is forecast up to 1 minute per vehicle (or 14%) in the northbound direction (towards Sydney). The travel time saving is forecast up to 1.3 minutes per vehicle (or 21%) in the southbound direction (towards Wollongong). In 2038 (20 years after opening), the travel time saving on the M1 is predicted up to 1.2 minutes (or 17%) in the northbound direction and about 2 minutes (or 27%) in the southbound direction.
- Model predicted substantial improvements on the M1 Princes Motorway section between Bellambi Creek and Picton Road (3.5 km) due to the proposed widening (three lanes in each direction).
- At opening year 2018, the average travel speed for light vehicles on the M1 would improve by 40% from about 74-78 km/h (do nothing) to about 96-100 km/h (with offline). In 2038, model predicted travel speed improvement from about 63-72 km/h (do nothing) to 89-92 km/h (off line).
- The offline upgrade would substantially improve heavy vehicles travel speed. In 2018 model predicted speed improvement up to 30% from about 44-49 km/h (do nothing) to about 56-57 km/h (off line). In 2038 model predicted speed improvement up to 33% from about 43-48 km/h (do nothing) to about 55-57 km/h (off line).
- Total crashes on the Princes Motorway between Bellambi Creek and Picton Road would be reduced by 74% under the upgraded condition. Annual crash rate would reduce from 22.5 (existing) to 5.8 (upgrade condition) with potential to eliminate all fatal crashes.

### **Economic Appraisal**

This economic appraisal has been carried out in accordance with the NSW Government guidelines. These guidelines are provided by the *Transport for NSW Principles and Guidelines for Economic Appraisal of Transport Investment and Initiatives, March 2013.* 

The economic assessment for the Offline upgrade returns a BCR of 1.7 and NPV of \$49.52 million (using discount rate of 7% in 2014 dollars) with capital expenditure of approximately \$76 million. The assessment identified significant road user benefit over the 30 year period from 2018 to 2048 with travel time benefit of \$697.7 million and safety benefit of \$39.6 million (2014 dollars).

As sensitivity analysis undertaken on the assumed discount rate as well as on the benefits and costs items resulted in a BCR range of 1.2 (discount rate of 10%) to 2.6 (discount rate of 4%).

In line with Strategic Business Case requirements, the economic appraisal for Offline upgrade is summarised as follows:

M1 Pr	inces Motorway – Offline Upgra	ade between Bellambi Creek and Picton Road
Α	Offline Upgrade between	30 year economic evaluation
	Bellambi Creek and Picton Road	Road user benefits
	11000	Bellambi Creek to Picton Road (3.5 kilometres)
		Offline upgrade considered as standalone project
B1	Summary of Evaluation Results	Base Case - existing two lane formation with general traffic lanes
	Cost Benefit Analysis (CBA)	Project Type: An 'offline' road upgrade (additional traffic lane) and realignment
		Local evaluation
B2	<b>Evaluation Assumptions</b>	Cost of Offline upgrade (at P90), \$76 million.
		Travel time, VOC and accident cost as per Economic Appraisal Guidelines
С	Summary of Evaluation	7% discount rate
	Results	At P90
		Benefit/Cost Ratio - 1.7
	Sensitivity Results	At 4% discount rate, P90
		Benefit/Cost Ratio - 2.6

# **APPENDIX A**

# **CRASH REDUCTION ANALYSIS**

# Offline Upgrade between Bellambi Creek and Picton Road (Option D4) M1 Princes Motorway Upgrade -

**Accident Reduction Summary** Analysis period:

Road Section

Section 4

years

Mode 4   Mode 5   Mode 5   Mode 5   Mode 6   M		Vehicle Accidents	DCA Code*	RUM Code*	Crash Description	Num	Number of of Crashes	Crashes	od	<b>Potential Accident</b>	ident	\$	\$ Cost Savings
Note 4   Note 5   N						record	ed in ana ( <mark>Note</mark> 1	ysis period I)	Reduc Ur	tions by th pgrade (No	e Offline te 4)		per year (Note 5)
Two Vehicle         101-109         10,11-19         Intersection, from adjacent approaches         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7		(Note 4)	(Note 4)	(Note 5)	(Note 4)	Total Fa	tal Injury	Non- casualty	Fatal Inj			Total	
Accidents         201-501         20,50         Head-on         Head-on         Pead-on         Pead-on <t< td=""><td>П</td><td>Two Vehicle</td><td>101-109</td><td>10,11 - 19</td><td>Intersection, from adjacent approaches</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	П	Two Vehicle	101-109	10,11 - 19	Intersection, from adjacent approaches								
202_206         22 - 29         Opposing vehicles; turning         7         7         4         7         4         7         4         7         4         7         4         7         4         7         4         7         4         7         4         7         4         7         4         4         7         7         4         4         7         7         4         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         8         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9         9		Accidents	201-501	20, 50	Head-on								
207-304         40         U-tum         Lame change         22         3         19         3           301-303         30 - 32         Rear end         22         3         19         3           305-307         30 - 37         Parallel lanes; tuming         11         5         6         4           401-409         42, 47, 48         Vehicle leaving driveway         7         2         2         8           503-506         51, 52, 54         Overlice leaving driveway         4         2         2         2           601         41, 60 - 63, 94         Hit parked vehicle         4         2         2         2         2           903         601         60         Hit railway train         4         2         2         2         2           Accidents         605         64 - 66, 91         Hit animal         4         4         4         4         4         4         4         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7 <td< td=""><td></td><td></td><td>202-206</td><td>22 - 29</td><td>Opposing vehicles; turning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>			202-206	22 - 29	Opposing vehicles; turning								
301-303         30 - 32         Rear end         22         3         19         3           305-307         33 - 35         Lane change         11         5         6         4           305-309         36 - 37         Parallel lanes; turning         11         5         6         4           401-409         42, 47, 48         Vehicle leaving diveway         1         5         6         4           503-506         51, 52, 54         Overtaking, same direction         4         2         2         2           601         41, 60 - 63, 94         Hit aniwal trainway train         4         2         2         2           Accidents         605         67 - 66, 91         Pedestrian, crossing carriageway         4         4         4         4           Accidents         605         67         Hit animal         4         4         4         4           701-702; 502; 706- 70, 72         7         Off carriageway, on straight         7         7         4         7           703-704         71, 73         Off carriageway, on curve         5         1         4         1           801; 802         80, 82, 84, 86         Off carriageway, on curve         1			207-304	40	U-turn								
305-307         33 - 35         Lane change         11         5         6         4           308-309         36 - 37         Parallel lanes; turning         1         5         6         4           401-409         42, 47, 48         Vehicle leaving driveway         1         2         2         2           503-506         51, 52, 54         Overtaking, same direction         4         2         2         2           601         41, 60 - 63, 94         Hit parked vehicle         4         2         2         2           903         Hit railway train         Hit railway train         Pedestrian, crossing carriageway         4         4         4           Accidents         605         64 - 66, 91         Hit animal         4         4         4           Accidents         605         67         Hit animal         4         4         4         1           Accidents         606         67         Hit animal         Air animal         4         4         4         4           703-704         71, 73         Off carriageway, hit object         7         1         4         1           805         805         80, 82, 84, 86         Off carriageway, hit obj			301-303	30 - 32	Rear end	22	က	19				16 \$	153,651
308-309         36 - 37         Parallel lanes; turning         1         401-409         42, 47, 48         Vehicle leaving dirkeway         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2			305-307	33 - 35	Lane change	7	2	9	Ì			8	181,955
401-409         42, 47, 48         Vehicle leaving driveway         401-409         42, 47, 48         Vehicle leaving driveway           503-506         51, 52, 54         Overtaking, same direction         4         2         2         2           601         41, 60 – 63, 94         Hit parked vehicle         4         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4			308-309	36 - 37									
503-506         51, 52, 54         Overtaking, same direction         4         2         2         2           601         41, 60 – 63, 94         Hit parked vehicle         4         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4			401-409	42, 47, 48	Vehicle leaving driveway								
Accidents         601         41, 60 – 63, 94         Hit parked vehicle         4         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2			503-506	51, 52, 54	Overtaking, same direction								
Single Vehicle         001-008; 901-902         Hit railway train         Hit railway train         Hit railway train         Crossing carriageway         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         2         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         3         4         3         4         3         4			601	41, 60 – 63, 94	Hit parked vehicle	4	2	2				4	90,048
Single Vehicle Accidents         001-008; 901-902         00 - 09         Pedestrian, crossing carriageway         2         2         2         2         2         2         2         2         2         2         3         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4			903		Hit railway train								
Accidents         605         64 – 66, 91         Permanent obstruction on carriageway         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4		Single Vehicle	001-008; 901-902	60 - 00	Pedestrian, crossing carriageway		2		2			2 \$	3,127,019
609         67         Hit animal         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         7         7         1         6         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         7         8         7         8         7         8         7         8         8         7         8         8         7         8         7         7         7         7         <	ÞI	Accidents	909	64 – 66, 91	Permanent obstruction on carriageway	4		4		4	`	4	7,431
701-702; 502; 706-       70, 72       Off carriageway, on straight       7       1       6       1         709-       703-704       71, 73       Off carriageway, hit object       7       1       6       1         705; 502       74       Out of control on straight       9       1       8       1         801; 802       80, 82, 84, 86       Off carriageway, on curve       5       1       4       1         803-804       81, 83, 85, 87       Off carriageway, hit object       43       14       29       10         805       88       Out of control on curve       1       1       1       1       1         Total       10       20       27       83       2       22       22	02/20		609	29	Hit animal	4		4		2	.,	2 \$	3,716
703-704         71, 73         Off carriageway, hit object         7         1         6         1           705; 502         74         Out of control on straight         9         1         8         1           801; 802         80, 82, 84, 86         Off carriageway, on curve         5         1         4         1           803-804         81, 83, 85, 87         Off carriageway, hit object         43         14         29         10           7 out of control on curve         1         1         1         1         1         1	1 D¢ - 10\		701-702; 502; 706- 709	70, 72	Off carriageway, on straight								
705; 502         74         Out of control on straight         9         1         8         1           801; 802         80, 82, 84, 86         Off carriageway, on curve         5         1         4         1           803-804         81, 83, 85, 87         Off carriageway, hit object         43         14         29         10           Rotal         88         Out of control on curve         1         1         1         1         1           Total         10         12         2         27         83         2         22	NOIT		703-704	71, 73	Off carriageway, hit object	7	_	9		1	47	5 \$	50,598
801; 802         80, 82, 84, 86         Off carriageway, on curve         5         1         4         1           803-804         81, 83, 85, 87         Off carriageway, hit object         43         14         29         10           805         88         Out of control on curve         1         1         1         1         1           Total         10         112         2         27         83         2         22         22	10 - 0		705; 502	74	Out of control on straight	6	_	8		1 5	•	\$ 9	52,455
803-804         81, 83, 85, 87         Off carriageway, hit object         43         14         29         10           805         88         Out of control on curve         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	JAOR		801; 802	80, 82, 84, 86	Off carriageway, on curve	2	_	4		4	47	5 \$	50,598
805         88         Out of control on curve         1         1         1         1         2         27         83         2         22           Total         Total         4112         2         27         83         2         22         22	SLEY		803-804	81, 83, 85, 87	Off carriageway, hit object	43	41	53	_			29 \$	466,962
Total   112   2   27   83   2   22	SUO T		802	88	Out of control on curve	_		_				-	1,858
	NNC	Total						83				83 \$	4,186,290

\* DCA - Definitions for Coding Accidents, RUM - Road User Movement

Note: PLAN - MR513 N

Section

ection 2

1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a five year period from 1 August 2008 and 31 October 2013.

2. Crash data for the subject M1 Princes Motorway Section between Picton Road and Bellambi Creek were used in the analysis.

3. Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.

4. Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied.

5. Costs per crash sourced from Table 45 (Page 257) of TfNSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013.

6. The analysis assumed the proposed M1 Princes Motorway Upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility

7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) have a new pavement overlay for entire upgrade section between Picton Road and Bellambi Creek. This in conjunction with realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.

Source: Hyder analysis, F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\Accident Reduction\_Offline Scheme\_RevE\_Willingness to Pay.xlsx

1   1   1   1   1   1   1   1   1   1	Market   M	Marie   Mari	March   Marc
1	1   1   1   1   1   1   1   1   1   1	1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,000   1,00	20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%   20%
1   1   1   1   1   1   1   1   1   1	1   1   2   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200   200	1970,   23%   30%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25%   25	20
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2 10% 30% 45% 45% 60% Off-straight crashes were previously due to the straight section of road, Majority of these crashes are observed to be located immediately after the curve. As 10% 30% 45% 60% The majority of the crashes were located within the sharp 10% 30% 60% 60% 60% 60% 60% 60% 60% 60% 60% 6	20% A 20% reduction is suggested 6 of 6 of 7 of 7 of 7 of 8 of 8 of 8 of 8 of 8	20% A 20% reduction is suggested.  10% 30% 45% 66% Offstriaght crashes were previously due to the sharp transition from the first control of Pictor Rd to the straight section of road. Major the care crashes are observed to be located mimediately after the curve. As the form of the sharp transition from the first control crash sharp transition from the first control crashes are observed to be located mimediately after the curve. As the form of the sharp transition from the first control crashes are charged will reduce by 60%.  10% 20% 60% 60% 60% 60% 60% 60% 60% 60% 60% 6	45%   45%   A 20% reduction is suggested.   0   0   1   1   1   5   5
10% 30% 45% 60% Off-straight crashes were previously due to the sharp transition from the foreign each of ordinal Majority of these crashes are observed to be located immediately after the curve, As 10 10% 10% 20% 10% 10% 10% 10% 10% 10% 10% 10% 10% 1	10%   30%   45%   66%   Off-straight crashes were previously due to the sharp transition from the straight section of read, and yellow   10%   30%   45%   66%   Off-straight crashes are observed to be located immediately after the curve. As   10%   30%   45%   66%   Off-straight crashes are located within the sharp previously due to the straight section of read, majority of the located immediately after the curve. As   10%   20%   66%   Off-straight crashes are likely to be reduced by 60%   11%   10%   20%   30%   66%   66%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%   00%	10%   30%   45%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%	45% 60% Orf-straght crashes were previously due to the sharp transition from the horizontal curve, north of Picton Rd to the straight section of road. Majority of these crashes are observed to be located immediately after the curve. As the fortine upgade will smoother this transition, of straight crashes can potentially be reduced by 60%.  45% 66% 10
10% 30% 45% 60% Off-straight crashes were previously due to the shalp transition from the horizontal curve, north of pictors Act under straight crashes can be actived by a control crashes are observed to be located immediately after the curve. As 10% 60% 10% 10% 10% 20% 60% 10% 10% 10% 60% 10% 10% 10% 10% 10% 10% 10% 10% 10% 1	10% 30% 45% 60% Off-straight crashes were previously due to the sharp transition from the horizontal crue, morth of Plotton Rd to the straight section of racid. Majority and provided racid immediately after the cure As 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10%   30%   45%   60%   Officiality creshes were previously due to the shap transition from the program of the shap transition of Pictor Rd to the straight scrion or Total Majorny of these creatives are deserved to be located mineralistly affection or Total Majorny of these creatives are deserved to be located mineralistly affectives or Associated mineralistly affectives or Associated by 80%.  10%   10%   20%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%   60%	45% 60% Charging tractises were previously due to the straight section from the horizontal curve, north of Petron Rd to the straight section of road Majorty of these crashes are observed to be located immediately after the curve. A 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1 8 10% 30% 45% 60% The majority of the loss of control crashes were located within the sharp of the loss of control crashes were located within the sharp of the	1 8 10% 30% 45% 60% The majority of the loss of control crashes were located within the sharp of 1 5 6 6 7 1 1 10% 20% 30% 60% 60% 60% 60% 60% 60% 60% 60% 60% 6	8 10% 30% 45% 60% The majority of the loss of control crashes were located within the sharp of a 20% 30% 60% 60% 60% 60% 60% 60% 60% 60% 60% 6	30%   60%   The majority of the loss of control crashes were located within the sharp   0   1   5   6   5   5   5   5   5   5   5   5
1 10% 20% 30% 60% curvature of this curve, loss of control crashes are likely to be reduced by 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 10% 20% 60% 60% cunature of this curve, loss of control crashes are likely to be reduced by 60% 60% 60% 60% 60% 60% 60% 60% 60% 60%	10% 20% 60% 60% 60% 60% curvature of this curve, loss of control crashes are likely to be reduced by 0 0 1 1 1 1 1 1	30% 60% cuntature of this curve, loss of control crashes are likely to be reduced by 0 1 1 1 5 5 144 50% 60% 60% 60% 60% 60% 0 0 0 0 0 0 0 0 0
10 10% 20% 30% 60% 60% 60% 60% 70 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10 10% 20% 30% 60% 60% 60% 0 0 0 0 0 0 0 0 0 0 0 0 0	10 10% 20% 30% 60% 60% 60% 60% 60% 60% 73 6 9 8 8 21 30 8 8 1.  31 August 2008 and 31 October 2013.	30% 60% 60% 0 3 6 9 8 5 1.  30% 60% 60% 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
20% 30% 60% 0 0 0 0	20%     30%     60%       1     8       2     5	31	30% 60% 60% 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	21 30 8	31	- visibility.  Creek. This in conjunction with realignment of the

Road Section V. A.	Vehicle DC Accidents	DCA Code * RU	M Code *	Crash Description	Number of of Crashes recorded in period (Note 1)	s recorded in perio		rcentage reduction	n in accidents for midbloc environment (Note 4)	Percentage reduction in accidents for midblock treatments: Hgh speed environment (Note 4)		Proposed percentage	Justification	Potential Accid	Potential Accident Reductions by the Offline Upgrade	the \$ Cost Savings per year (Note 5)	\$ Cost Savings per year
								- 1				reduction					
				•	Total   Northbound Southbound Fatal Injury	Ithbound Fatal Inju	Non- casualty (towaway)	89. Duplicated 9 Road Re (Clin	91. Accident 92 Reduction Rate Rec (Climbing Lanes) (	92. Accident 94. Reduction Rate (Horizontal Horiz	94. Alignment - ap Change Off Horizontal & Vert.	applied for the Offline Upgrade (%)		Fatal Injury	Non-casualty Total (towaway)	al Fatal Injury Non- casualty (towaway)	
Section 2 - Straight section	(Note 4) (No Two Vehicle 10 Accidents	(Note 4) (Note 10) (Note 10)	(Note 5) (Note 10 (Note 5) (No	(Notes 4 and 5) Intersection, from adjacent				30%				30%		0	0.0		ω
Bellambi Creek	20		20	approaches Head-on				100%	25%	30%	%09	∀ %06	A 90% reduction is suggested.	0 0	0.0		€9
	20	202-206 22		Opposing Opposing										d			€9
				verilcies, turning													
	20 20	207-304 40	5			c	,	30%		30%	%09 %09	Ī	the eterometer of the alone in this exection of the recol leads to beauti	0	0.0	0	<i>y</i> 6
Sellambi	<del>,</del>		<u> </u>	Kear end	<b>-</b>	<b>n</b>	4	%0°		% 0.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9.5 9	%,00	% %	The steephores of the slope in this section of the foad leads to heavy webticles hawing to slow down on approach to the steep grade. This further reflects the speed of light vehicles in the main traffic lane, leading to rear-end crashes. The addition of a third climbing lane in the brillier upgrade will mean heavy vehicles using the left-most lane and light vehicles using the adjacent traffic lanes. As such, there is less likelihood to be conflict between these vehicle types, hence reducing the occurrence of rear-end crashes. It is expected that rear-end crashes in this section will reduce by 60%.	0	0 %	0	9) / () / ()
	e	305-307 33	- 35	Lane change	-	-	~					60% 11	The third climbing lane in the 'offline upgrade' provided for heavy vehicles will reduce the tendency of lane changing manoeuves by light vehicles in order to overtake slow moving heavy vehicles. This crash type will reduce by 60%.	0	1 2.0		\$ 45,024
Option 194	93	308-309 36	- 37	Parallel lanes; turning										0 0	0.0 0.0		₽
	40	401-409 42,	47, 48	Vehicle leaving				20%				%09		0 0	0.0		ω
	50	503-506 51,	52, 54	Overtaking, same direction				20%	40%	30%	%09	%09		0 0	0.0		ω
C C	99	601 41,	60 – 63, 94		2 2	-	-	15%				15%		0 1	1 2.0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	\$ 45,024
V	06	903 90	н 206	Hit railway train						30%	%09	%09		0 0	0.0		€
OAORY.	Single 00 Vehicle 903 Accidents	001-008; 901- 00 - 09 902		Pedestrian, crossing carriageway				20%		30%	%09	20% P	A 20% reduction is suggested.	0	0.0	0	٠ ب
AT OUSLE		605 64	- 66, 91	Permanent obstruction on carriageway							%09	%09		0 0	0.0		ا ب
KINOW	09			Hit animal									A 20% reduction is suggested.	0 0	0.0		es es
	02 02	701-702; 502; 70, 706-709	72	Off camageway, on straight				40%	30%		45%	45%		0 0	0.0	0	· •
N∀ld	97	703-704 71,	73	way, hit	4	_	S	10%	30%		45%	0 %09 N	Off-straight crashes are concentrated in the SB direction. This implies that whices had ost control upon exting the curve south off Berlambi CK. This is the for a sharp transition from the curve to the straint's section of the	0 0	3 3.0		\$ 5,573
	02	705; 502 74		Out of control				10%	30%		45%	%09	road. As the 'offline upgrade' will smoothen this curve-to-straight transition, off-straight crashes can potentially be reduced by 60%.	0 0	0 0.0		σ
	98	801; 802 80,	82, 84, 86	y, on	2 2		2	10%	20%	30%	%09	M %09	The majority of the loss of control crashes were on approach to the reverse curve, north of Catarack Ck. These curves will be realigned and will reduce loss of control crashes by 60%.	0	2 2.0	0	3,716
Oatarack Creek	08	803-804 81	81, 83, 85, 87	geway, hit	1	3	m	10%	20%	30%	%09	%09		0 2	2 4.0		\$ 90,048
*v'	802	05 88		ouject Out of control on curve				10%	20%	30%	%09	%09		0 0	0 0.0		' ∽
	Total				21 11	10 0 5	16							0 4	12 16		\$ 194,959
2 6 4 6	* DCA - Definitions for Coding Accidents, Ruln - Road User Movement Note:  1. The crash analysis has been undertaken using crash data provided by Rc 2. Crash data for the subject M1 Princes Motoway Section between Picton 3. Potential accident reduction rates were estimated using the RMS Accide 4. Table C4 - Percentage reduction in accidents for midblock treatments; HS. Costs per crash sourced from Table 45 (Papae 257) of TNSW's Principles.	sis has been urne subject M1P and reduction rate subsection rate subsection rate subsection sourced from Tales.	Accidents, RUM ndertaken using Princes Motorwa es were estimat n in accidents fo able 45 (Page 2)	crash data provide y Section between ed using the RMS r midblock treatme 57 of TRNSW's Pri	* DCA - Definitions for Coding Accidents, RUM - Road User Movement  Note:  1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a five year period from 1 August 2008 and 31 October 2013.  2. Crash data for the subject M1 Princes Motorway Section between Piction Road and Bellambi Creek were used in the analysis.  3. Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.  4. Table CA - Percentage reduction in accidents for midblock treatments: High speed environment was applied.  5. Costs per crash sourced from Table 45 (Pages 257) or TINSW's Principles and Guideline of Economic Apprisacion (Transport Inwestment and Investment and Investment).	time (RMS) for a fiv llambi Creek were i Guide, August 200; ronment was applie	e year period from seed in the analysi 5. d. aisal of Transcort I aisal of Transcort I	1 August 2008 and is.	nd 31 October 2013	3. 2013.							
	5. The analysis as: 7. The analysis ass of the horizontal cur	sumed the prop sumed the properives will further	oosed M1 Prince oosed upgrade O reduce the amo	is Motorway Upgra iption D4 (Offline S unt of loss of conti	6. The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility.  7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) have a new pavement overlay for entire upgrade section between Picton Road and Bellambi Creek. This in conjunction with realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.	Scheme) involves ravement overlay for	ealignment of the entire upgrade se	horizontal curves a	and will also improvion Road and Bella	we driver visibility. ambi Creek. This in	n conjunction with	n realignment					
ŭ	:\AA007521\D-Ca	lculations\Cra	ssh Analysis\Of	fline Scheme Cras	F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction 2	duction Offline S	cheme_RevE_Wi	llingness to Pay.x	klsx]Accident Red	luction Section 2							

Road Section   Vehicle	DCA Code *	RUM Code *	Crash	Number of	of Crashes record	Number of of Crashes recorded in period (Note 1)	Percenta	ge reduction in ad	Percentage reduction in accidents for midblock treatments: Hgh speed	ock treatments: H		- A	Justification	Potential Acc	Potential Accident Reductions by the		\$ Cost Savings per year (Note 5)		\$ Cost Savings
Accidents			Description					w	environment (Note	4)		percentage reduction			Offline Upgrade				per year
:				Total Northbound	Southbound	Fatal Injury Non- casu: (towa	Non- 89. Duplicated casualty Road (towaway)		91. Accident 92. Ac Reduction Rate Reduct (Climbing Lanes) (Hori	92. Accident 94. Ali Reduction Rate Ct (Horizontal Horizor Alignment)	94. Alignment - applied for t Change Offline Upgra Horizontal & Vert. (%)	ed for the 9 Upgrade (%)		Fatal Injury	y Non-casualty (towaway)	Total Fatal	Injury Non- casualty (towaway)	lty way)	
Section 3 - Curve section south Accidents Accidents	(Note 4)	(Note 5) 10,11 - 19	(Notes 4 and 5) Intersection, from adjacent				30%	, o			(1)	30%		0	0	0.0		φ.	1
	201-501	20, 50	approaches Head-on				100%		30	30%	%09	90% A 9I	A 90% reduction is suggested.	0 0	0	0.0		မှာ	•
	202-206	22 - 29	Opposing vehicles;											0	0	0.0		₩	1
	207-304	40	tuming L-fiim				30%		36	30%	60% 60%	%U9		0	c			G	,
Beland Section 3	301-303	30 - 32	Rear end	9	2		9 30%	9	n				Rear-end crashes are caused by the sharp curvature and steepness of the stope, south of Bellambi Ck leading to differentials in speed between light and heavy wehicles and out the man traffic late. The proposed o'filme regred on M1 will potentially reduce this rear-end crash type as light vehicles and heavy vehicles will use separate lanes. Rear-end crash types		4	4.0		φ	7,431
	305-307	33 - 35	Lane change	2	5	~	m					are 60% The reduction to o to be lane	are predicted to be reduced by 60%. The third climbing lane in the "offline upgrade" provided for heavy vehicles will reduce the tendency of lane changing manoeuvres by light vehicles in order to overtake slow moving vehicles. This will further reduce the likelihood of allen side-winpe crashes between heavy and light vehicles. This crash type will reduce by 60%.	0	7	3.0		₩	46,882
	308-309	36 - 37	Parallel lanes;										reduce by or m.	0 0	0	0.0		₩	í
	401-409	42, 47, 48	Vehicle leaving				20%	,o			S	20%		0	0	0.0		₩.	1
	503-506	51, 52, 54	Overtaking,				20%		40% 30	30%	9 %09	%09		0	0	0.0		69	•
	601	41, 60 – 63, 94					15%	9				15%		0 0	0	0.0 \$7.817,548 \$215,832	\$215,832 \$9,289	\$ 682	•
	903	903	Hit railway train						ń	30%	9 %09	%09		0 0	0	0.0		69	ī
	001-008; 901- 00 - 902	60 - 00 -1	Pedestrian, crossing	-		-	%09	<b>,</b> 0	m	30%	60%	20% A 2I	A 20% reduction is suggested.	0	0	1.0		ω	1,563,510
ACCIDENT ACCIDENTS	605	64 – 66, 91	Carriageway Permanent obstruction on	2	2		2				9 %09	%09		0	7	2.0		₩	3,716
	609	29	Calliageway Hit animal										A 20% reduction is suggested.	0 0	0	0.0		ь	
NOON EI	701-702; 502; 706-709	2; 70, 72	Off carriageway, on straight				10%		30%		45% 4	45%		0 0	0	0.0		ω	
- AM - NA.	703-704	71, 73	Carriageway, hit	2	~	~	1 10%		30%		45% 6	60% Off≅ hori	Off-straight crashes were previously due to the sharp transition from the horizontal curve, south of Bellambi Ck to the straight section of road. As the origine increase will smoothen this transition offsetaint crashes can	0 1	~	2.0		ω	45,024
	705; 502	74	Out of control				10%		30%		45% 6	60% pote	potentially be reduced by 60%.	0 0	0	0.0		ь	
	801; 802	80, 82, 84, 86		2	-	~	1 10%		30% 30	30%	9 %09	60% The curv	The majority of the loss of control crashes were on approach to the reverse curve, south of Bellambi Ck. These curves are realigned and will reduce	0	~	2.0		69	45,024
	803-804	81, 83, 85, 87		11	7	ω	12 10%		30%	30%	9 %09	%09	oss of control crashes by 60%.	0 4	ω	12.0		↔	187,528
Creek	805	88	object Out of control on curve	20	Ų	(	10%		30%	30%	9 %09	%09		0 0	0	0.0		<i>ω</i>	- 17
* DCA - Defi	initions for Codir	ng Accidents, RL	DCA - Definitions for Coding Accidents, RUM - Road User Movement		2		67							-	<u>o</u>	07		9	1,039,113
Note: 1. The crash 2. Crash dat 3. Potential 4. Table 6-4 5. Costs de 6-4	h analysis has bee ta for the subject I accident reduction - Percentage reduicted to crash sourced fro	en undertaken usi. M1 Princes Motor n rates were estim ction in accidents	Note:  1. The crash analysis has been undertaken using crash data provided by Roads and Martime (RMS) for a five.  2. Crash data for the subject MI Princes Motoway Section between Picton Road and Bellambi Creek were us.  3. Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.  4. Table C4. Percentage reduction in accidents for midblock treatments: High speed environment was applied.  5. Costs beer crash sourced from Table 45 (Pages 257) of TNSVVs Principles and Guideline of Economic Appara	ted by Roads and an Picton Road an S' Accident Reduc nents: High speed rinciples and Guid	Maritime (RMS) food Bellambi Creek tion Guide, Augus environment was abline of Economic	Note:  1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a five year period from 1 August 2008 and 31 October 2013.  2. Crash data for the subject M1 Princes Motoway Section between Picton Road and Bellambi Creek were used in the analysis.  3. Potential accident reduction rates were estimated using the RMS Accident Reduction Guide, August 2006.  4. Table C4. Percentage reduction in accidents for midblock treatments: High speed environment was applied.  5. Costs ber crash sourced from Table 45 (Paea 257) of TMSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013.	om 1 August 2008 ysis. ort Investment and	and 31 October	2013. arch 2013.										
Proon Road 7. The analysh horizontal cu	vsis assumed the rais assumed the unves will further re	proposed M1 Prir. proposed upgrade aduce the amount	6. The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offine Scheme) 7. The analysis assumed the proposed upgrade Option D4 (Offine Scheme) have a new pavement of norizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.	rade Option D4 (O Scheme) have a n ashes occurring ii	offline Scheme) inw lew pavement over in wet weather.	6. The analysis assumed the proposed M1 Princes Motorway Upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility.  7. The analysis assumed the proposed upgrade Option D4 (Offline Scheme) have a new pavement overlay for entire upgrade section between Picton Road and Bellambi Creek. This in conjunction with realignment of the horizontal curves will further reduce the amount of loss of control crashes occurring in wet weather.	ne horizontal curve section between F	es and will also in Picton Road and	mprove driver visibi Bellambi Creek. T	ility. This in conjunction	in with realignment	of the							
F:\AA00752:	1\D-Calculations	\Crash Analysis\	Offline Scheme Cr	ash data\[Accider	nt Reduction_Off	F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction 3ection 3	Willingness to Pa	y.xlsx]Accident	t Reduction Section	on 3									

Road Section	Vehicle	DCA Code *	RUM Code *		Number of of Crashes recorded in period (Note 1)	ded in period (Note 1		Percentage reduction in accidents for midblock treatments: High speed	for midblock treatn	nents: High speed	Proposed	Justification	Potential Accide	Potential Accident Reductions by the	S Cost Savings per year (Note 5)	\$ Cost Savings
	Accidents			Description				environm	environment (Note 4)		per centage reduction		Offlin	Offline Upgrade		
	:				Total Northbound Southboun Fatal Injury Non-casualty (casualty (towawa)	Fatal Injury Non- casualty (towaway)	89. Duplicated y Road ay)	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment - Change Horizontal & Vert.	applied for the Offline Upgrade (%)		Fatal Injury	Non-casuaity Total (towaway)	Fatal Injury Non- casually (towaway)	6
Section 4 - north of Bellambi	Two Vehicle Accidents	101-109	10,11 - 19 II	(Notes 4 and 5) Intersection, from adjacent			30%				30%		0	0.0		₩
				approaches Head-on			100%	25%	30%	%09	90% A	A 90% reduction is suggested.	0	0.0		€
Section 4			- 29	Opposing vehicles;									0 0	0.0		₩
		207-304 4	40	U-tum			30%		30%	%09	%09		0 0	0.0		69
			- 32	Rear end	ى د	2	30%		30%	%09	M tr	The proposed offline upgrade is likely to improve travel speed the subject M1 section between Picton Rd and Bulli Tops. With this improvement in travel speed, there will be a better flow of vehicles in the main traffic lane, this reducing the likelihood of react-and creates by 60%.	0 2	2 4.0		\$ 90,048
Bellambil		305-307			-	-					20% A	A 20% reduction is suggested.	0 0	1 1.0		\$ 1,858
Creek			- 37	Parallel lanes; turning									0 0	0.0 0.0		φ
		401-409	42, 47, 48 V	Vehicle leaving			%09				20%		0 0	0.0		ω
		503-506	51, 52, 54 C	Overtaking,			20%	40%	30%	%09	%09		0 0	0.0 0.0		€
		601	41, 60 – 63, 94 F	Hit parked			15%				15%		0 0	0.0		₩
		903	903	Hit railway train					30%	%09	%09		0	0.0	67 047 540 6245 020 60 200	₩
\$1.02/12/01G	Single Vehicle	001-008; 901- 00 - 09 902		Pedestrian, crossing			20%		30%	%09	20% A	A 20% reduction is suggested.	0 0	0.0		€
ON De - 10		605	64 - 66, 91 F	Permanent obstruction on						<b>%</b> 09	%09		0	0.0		€
IITAO		9 609	67 H	animal	2 1 1	2					20% A	A 20% reduction is suggested.	0 0	1 1.0		\$ 1,858
		701-702; 502; 7 706-709	72	Off carriageway, on straight			10%	30%		45%	45%		0 0	0.0		€
ONSTEA		703-704	71,73	off Off carriageway, hit			10%	30%		45%	45%		0	0.0		€
		705; 502	74	object Out of control			10%	30%		45%	45%		c	0		₩
Option D4			87 84 86	on straight			10%	%00	30%	%U9	%09					e.
			82, 84, 86	iageway, on ve			<u> </u>	0. 0.	8	e 000	800		0 0	0.0 0.0		
Td .		803-804 8	81, 83, 85, 87	Off carriageway, hit object	4 4	4	10%	20%	30%	%09	%09		0 1	3 4.0		\$ 48,740
		805 8	88	control	-	_	10%	20%	30%	%09	%09		0 0	1.0		\$ 1,858
	Total * Dofinition	otal DCA - Definitions for Coding As	Accidente DIIM	llear Mo	14 11 3	0 3 11							0	8 11		\$ 144,362
Creek	Note: 1. The crash ana	lons for coung	Accidents, Kuiv	crash data provide	PDA - Definitions for Couling Accidents, Kolin - Road User Movement.  Note: 1. The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a five year period from 1 August 2008 and 31 October 2013.	'MS) for a five year p	eriod from 1 August	2008 and 31 Octob	ver 2013.							
	Crash data fo     S. Potential acci	or the subject M1	Princes Motorwates were estimat	sy Section between	<ol> <li>Crash data for the subject M1 Princes Motorway Section between Picton Road and Bellambi Creek were used in the analysis.</li> <li>Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.</li> </ol>	Creek were used in August 2005.	the analysis.									
	4. Table C4 - Per 5. Costs per cras 6. The analysis a 7. The analysis a realisment of the	ish sourced from assumed the propagations of the propagation of the pr	on in accidents for Table 45 (Page 2 posed M1 Prince posed upgrade O	or midblock treatm 257) of TfNSW's PI ss Motorway Upgra option D4 (Offline S	<ol> <li>Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied.</li> <li>Costs per crash sourced from Table 45 (Page 257) of TMSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013.</li> <li>The analysis assumed the proposed M1 Princes Motoway Upgrade Option D4 (Offline Scheme) involves realignment of the horizontal curves and will also improve driver visibility.</li> <li>The analysis assumed the proposed upgrade Option D4 (Offline Scheme) towards for entire upgrade section between Picton Road and Bellambi Creek. This in conjunction with a property of the proposed upgrade Option D4 (Offline Scheme) towards or an expensive and the proposed upgrade section between Picton Road and Bellambi Creek. This in conjunction with a property of the proposed upgrade option of the property of the proposed upgrade Option D4 (Offline Scheme) have a new pawner of the property of the proposed upgrade Option D4 (Offline Scheme) have a new pawner of the property of the prop</li></ol>	nt was applied. onomic Appraisal or ne) involves realignm nt overlay for entire t	Transport Investmenent of the horizontal	nt and Investigation, curves and will also veen Picton Road al	, March 2013. o improve driver visi nd Bellambi Creek.	bility. This in conjunction	n with					
Picton Road																
	F:\AA007521\D-	F:\AA007521\D-Calculations\Crash	sh Analysis∖Offlir	ne Scheme Crash	Analysis\Offline Scheme Crash datal{Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction Section 4	fline Scheme_RevE	Willingness to Pay	.xlsx]Accident Red	uction Section 4							

# **APPENDIX B**

# **ANNUAL COSTS AND BENEFITS**

		2										
Base Year	2014											
Opening Year	2018											
Analysis Period	30	years										
Economic Life		09										
			Costs				Benefits	s				
Analysis Period	Year	Construction Costs	Net Mainte nance Costs	Total Costs	Annual Veh-Hr Savings	Annual Veh-Km Savings	Crash Reduction	Externality	Residual Value	Total Benefits	Net Benefit (Cost)	First Year Benefit
Base Year	2014	\$ 4,145,455	ı	\$4,145,455	\$	0\$	\$0	\$	\$0	\$0	-\$4,145,455	0\$
1			0\$	\$6,468,637	\$0	0\$	\$0	\$0	\$0	\$0	-\$6,468,637	
2 6	2016	\$ 65,259,300	9 9	\$65,259,300	9	09	9	S &	09	0\$	-\$65,259,300	
4		· · ·		\$0	\$5,527,128	\$513,313	\$4,186,290	\$218,834	\$0\$	\$10,445,565	\$10,445,565	\$10,445,565
5	2019	€		\$0	\$5,700,428	\$507,760	\$4,186,290	\$216,467	\$0	\$10,610,945	\$10,610,945	
9				\$0	\$5,873,727	\$502,208	\$4,186,290	\$214,100	\$0	\$10,776,325	\$10,776,325	
`	2021		0000	0,000	\$6,047,027	\$496,656	\$4,186,290	\$211,733	0,9	\$10,941,706	\$10,941,706	
0 0				9399,329	\$6,393,626	\$485,552	\$4,186,230	\$206,900	9 4	\$11,272,466	\$11,772,466	
10				90	\$6,566,925	\$479,999	\$4,186,290	\$204,632	\$0	\$11,437,847	\$11,437,847	
11			\$0	\$0	\$6,740,225	\$474,447	\$4,186,290	\$202,265	\$0	\$11,603,227	\$11,603,227	
12					\$6,913,524	\$468,895	\$4,186,290	\$199,898	\$0	\$11,768,607	\$11,768,607	
13			\$1,987,0	\$1,987,008	\$7,086,824	\$463,343	\$4,186,290	\$197,531	\$	\$11,933,988	\$9,946,980	
4 4	2020			00	\$7,200,123 \$7,404,150	\$457,791 \$455,404	44, 166,290	\$195,164	000	412,039,300	412,099,300	
16			9	9 6	\$7,702,176	\$526.412	\$4,186,290	\$224 418	9 4	\$12,639,332	\$12,639,332	
171				0\$	\$7,923,203	\$560,723	\$4.186.290	\$239,046	\$0	\$12,909,261	\$12,909,261	
18			\$398,3	\$398,329	\$8,144,229	\$595,033	\$4,186,290	\$253,673	\$0	\$13,179,225	\$12,780,896	
19				\$0	\$8,365,255	\$629,344	\$4,186,290	\$268,300	\$0	\$13,449,189	\$13,449,189	
20			0\$	80	\$8,586,282	\$663,655	\$4,186,290	\$282,927	\$0	\$13,719,154	\$13,719,154	
12	2035			9 6	\$8,807,308	\$697,965	\$4,186,290	\$297,554	O# 6	\$13,989,118 644.260.002	\$13,989,118	
23			-\$2,827,1	-\$2,827,193	\$9.249.361	\$766.587	\$4.186.290	\$326.809	9 6	\$14,529,047	\$17,356,240	
24					\$9,470,387	\$800,897	\$4,186,290	\$341,436	\$0	\$14,799,011	\$14,799,011	
25				\$0	\$9,692,054	\$795,984	\$4,186,290	\$339,341	\$0	\$15,013,669	\$15,013,669	
26			\$0	\$0	\$9,913,721	\$791,070	\$4,186,290	\$337,247	\$0	\$15,228,328	\$15,228,328	
27					\$10,135,388	\$786,156	\$4,186,290	\$335,152	\$0	\$15,442,986	\$15,442,986	
28			\$398,3	\$398,329	\$10,357,055	\$781,243	\$4,186,290	\$333,057	\$0	\$15,657,645	\$15,259,315	
29			0\$	09	\$10,578,721	\$776,329	\$4,186,290	\$330,962	\$0	\$15,872,303	\$15,872,303	
30				9 6	\$10,800,388	\$771,415		\$328,868	O 6	\$16,086,961	\$16,086,961	
32	2043			000	\$11,022,033	\$764 F00	\$4, 106,230 \$4, 106,200	\$324 £70	000	\$16,301,620 646,646,379	416,301,620	
33		· • •	\$1,987,0	\$1,987,008	\$11,465,389	\$756,674	\$4,186,290	\$322,583	\$43,332,453	\$60,063,389	\$58,076,381	
	Discount	Canifal Coefe	Net Mainte nance	DV of Costs	DV of Bonofite	>QN	a	First Year Benefit	88		<u>α</u>	71
		_	5	-	#000 040 000 40	001 010 1010		aron of	744 000		1111	
	7%	\$ 77,206,544 \$ 71,028,037	\$1,164,829 \$795,157	\$78,371,373 \$71,823,195	\$200,249,962.48 \$121,333,091.29	\$121,878,590 \$49,509,897	2.6	\$8,585,492.72 \$7,447,543.22	11.0%			
	, o/, d) L	6										

M1 Princes Motorway – Offline Upgrade—Traffic Modelling and Economic Appraisal Hyder Consulting Pty Ltd-ABN 76 104 485 289 f:\aa007521\f.report\report\ref|ine upgrade\final report\_f=015\m1\_offline upgrade\_traffic modelling and economic appraisal\_revd.docx