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 out-turn costs)[5] 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

[5] 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

Maintenance Work Item	Routine Frequency	Unit Rate
Existing Pavement		
Flush reseal	Every 5 years	$7.31 per m^2
Rehabilitation	Every 10 years	$73 per m^2
New Pavement		
AC re-sheet	Every 10 years	$27.50 per m^2
Rehabilitation	Every 20 years	$94.00 per m^2

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^2)

	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[1]	$/VHT
Light vehicle (Car and LCV)	87.0%	$33.17[2]
Heavy vehicle (HCV)	13.0%	$47.93[2]
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**.

Table 4-5 Existing and Proposed Crash Statistics Based on Estimated Safety Improve

Scenario	Length (km)	Crash by Collision Type / DCA Code [2]											
		Rear end	Lane change	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
		301-303	305-307	601	001-008; 901-902	605	609	703-704	705; 502	801; 802	803-804	805	
(1) Existing conditions (without Offline Upgrade)	5.31	22	11	4	2	4	4	7	9	5	43	1	112
(2) Proposed conditions (with Offline upgrade)	5.15	6	2	0	0	0	2	2	3	0	14	0	29
Change in Conditions	-0.16▼	-16▼	-9▼	-4▼	-2▼	-4▼	-2▼	-5▼	-6▼	-5▼	-29▼	-1▼	-83▼
Change in Conditions %	-3%▼	-73%▼	-82%▼	-100%▼	-100%▼	-100%▼	-50%▼	-71%▼	-67%▼	-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.

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

Scenario	Length (km)	Total Crashes	Number of Crashes by Severity			Total Crash Per 100 MVKM [3]	Crash Severity Index [4]	Crash Cost per Year ($M)	
			Fatal Crashes	Injury Crashes	Non-injury Crashes			Total Cost [5]	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	8	1.09	0.26	0.05
Change in Conditions	-0.16▼	-16.6▼	-0.4▼	-4.4▼	-11.8▼	-23▼	-0.07▼	-4.19▼	-0.79▼
Change in Conditions (%)	-3%▼	-74%▼	-100%▼	-81%▼	-71%▼	-74%▼	-6%▼	-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 Externality	Passenger Car	Light goods vehicle		Total light vehicles	Heavy vehicles	
	($/km)[1]	$/1000 tonne-km[1]	$/km[2]	($/km[3]	$/1,000 tonne-km[1]	$/km[4]
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.

(1) TfNSW Guidelines, Table 52

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

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

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

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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)

	Cost Comparison (in 2014 constant dollars, $million unless otherwise 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 [1]		$76.00
Ongoing **Operating** Costs (Borne by users, over 30 years, discounted @ 7%)		n/a
Ongoing **Maintenance** Costs (Borne by RMS, over 30 years, discounted @ 7%) ***[Net Maintenance Costs]***	$4.82	$4.02
Total Ongoing Costs (Discounted at 7% over 30 years) [PV of Costs]	$4.82	$4.02
Total **Cost** [2] (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 [3]		$121.34

[1] Total asset related costs (purchase and/or building of asset/solution) plus other project costs to be included in the Capital Budget

[2] Total of above amounts

[3] Difference between all economic costs in the improved case and in the base case

Source: Roads and Maritime Data / Hyder Economic Analysis *(F:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment_Offline%20Option_RevG.xls)*

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%20Analysis\BCRAssessment_Offline%20Option_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
4%	NPV ($M)	$121.89
	BCR	2.6
	NPVI	1.6
	FYRR	11.0%
10%	NPV ($M)	$12.97
	BCR	1.2
	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:\AA007521\D-Calculations\BCR%20Analysis\BCRAssessment_Offline%20Option_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 micro-simulation 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 Princes Motorway – Offline Upgrade between Bellambi Creek and Picton Road		
A	Offline Upgrade between Bellambi Creek and Picton Road	30 year economic evaluation Road user benefits Bellambi Creek to Picton Road (3.5 kilometres) Offline upgrade considered as standalone project
B1	Summary of Evaluation Results Cost Benefit Analysis (CBA)	Base Case - existing two lane formation with general traffic lanes Project Type: An 'offline' road upgrade (additional traffic lane) and realignment Local evaluation
B2	Evaluation Assumptions	Cost of Offline upgrade (at P90), $76 million. Travel time, VOC and accident cost as per Economic Appraisal Guidelines
C	Summary of Evaluation Results Sensitivity Results	7% discount rate At P90 Benefit/Cost Ratio - 1.7 At 4% discount rate, P90 Benefit/Cost Ratio - 2.6

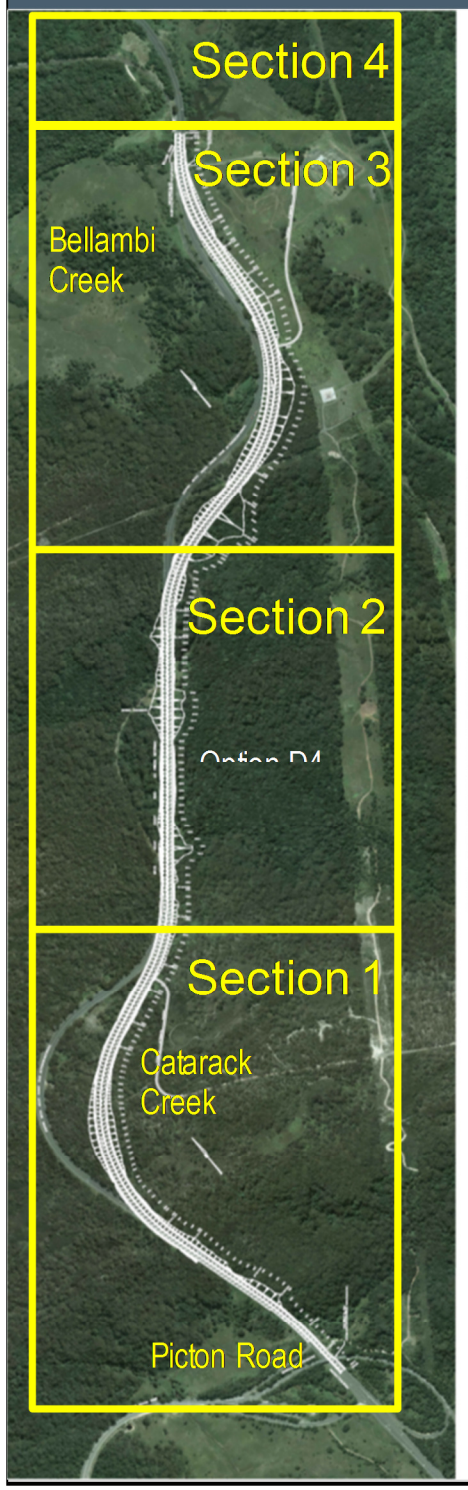
APPENDIX A

CRASH REDUCTION ANALYSIS

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

Accident Reduction Summary

Analysis period: 5 years

Road Section	Vehicle Accidents (Note 4)	DCA Code* (Note 4)	RUM Code* (Note 5)	Crash Description (Note 4)	Number of of Crashes recorded in analysis period (Note 1)				Potential Accident Reductions by the Offline Upgrade (Note 4)				$ Cost Savings per year (Note 5)
					Total	Fatal	Injury	Non-casualty (towaway)	Fatal	Injury	Non-casualty (towaway)	Total	
	**Two Vehicle Accidents**	**101-109**	**10,11 - 19**	Intersection, from adjacent approaches									
		201-501	**20, 50**	Head-on									
		202-206	**22 - 29**	Opposing vehicles; turning									
		207-304	**40**	U-turn									
		301-303	**30 - 32**	Rear end	22		3	19		3	13	16	$ 153,651
		305-307	**33 - 35**	Lane change	11		5	6		4	5	9	$ 181,955
		308-309	**36 - 37**	Parallel lanes; turning									
		401-409	**42, 47, 48**	Vehicle leaving driveway									
		503-506	**51, 52, 54**	Overtaking, same direction									
		601	**41, 60 – 63, 94**	Hit parked vehicle	4		2	2		2	2	4	$ 90,048
		903		Hit railway train									
	Single Vehicle Accidents	**001-008; 901-902**	**00 - 09**	Pedestrian, crossing carriageway	2	2			2			2	$ 3,127,019
		605	**64 – 66, 91**	Permanent obstruction on carriageway	4			4			4	4	$ 7,431
		609	**67**	Hit animal	4			4			2	2	$ 3,716
		701-702; 502; 706-709	**70, 72**	Off carriageway, on straight									
		703-704	**71, 73**	Off carriageway, hit object	7		1	6		1	4	5	$ 50,598
		705; 502	**74**	Out of control on straight	9		1	8		1	5	6	$ 52,455
		801; 802	**80, 82, 84, 86**	Off carriageway, on curve	5		1	4		1	4	5	$ 50,598
		803-804	**81, 83, 85, 87**	Off carriageway, hit object	43		14	29		10	19	29	$ 466,962
		805	**88**	Out of control on curve	1			1			1	1	$ 1,858
Total					**112**	**2**	**27**	**83**	**2**	**22**	**59**	**83**	**$ 4,186,290**

*** 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 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

Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number of of Crashes recorded in period (Note 1)						Percentage reduction in accidents for midblock treatments: High speed environment (Note 4)				Proposed percentage reduction applied for the Offline Upgrade (%)	Justification	Potential Accident Reductions by the Offline Upgrade				$ Cost Savings per year (Note 5)			$ Cost Savings per year
					Total	Northbound	Southbound	Fatal	Injury	Non-casualty (towaway)	89. Duplicated Road	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment - Change Horizontal & Vert.			Fatal	Injury	Non-casualty (towaway)	Total	Fatal	Injury	Non-casualty (towaway)	
	(Note 4)	(Note 4)	(Note 5)	(Notes 4 and 5)																				
Section 1 - between Picton Road and Cataract Creek	**Two Vehicle Accidents**	**101-109**	**10,11 - 19**	Intersection, from adjacent approaches							30%				30%		0	0	0	0				$ -
		201-501	**20, 50**	Head-on							100%	25%	30%	60%	90%	A 90% reduction is suggested.	0	0	0	0				$ -
		202-206	**22 - 29**	Opposing vehicles;													0	0	0	0				$ -
		207-304	**40**	U-turn							30%		30%	60%	60%		0	0	0	0				$ -
		301-303	**30 - 32**	Rear end	7	7			1	6	30%		30%	60%	60%	Rear-end crashes are mostly in NB direction for this section. The sharp curvature in conjunction with the steepness of the slope leads to speed differentials between light and heavy vehicles along the main traffic lane; thus inducing rear-end crashes. The proposed 'offline upgrade' which will realign the curve and remove the aforementioned merge on M1 will potentially reduce this rear-end crash type on the subject road section up to 60%.	0	1	4	5				$ 50,598
		305-307	**33 - 35**	Lane change	4	4			3	1					60%	The 'offline upgrade' of M1 will reduce lane changing manoeuvres of vehicles, north of Picton Rd. The likelihood of side-swipe crashes will also reduce between heavy vehicles and light vehicles as there is a designated third lane provided for heavy vehicles. The proposed 'offline upgrade' on M1 will potentially reduce the tendency of vehicles undertaking lane changing manoeuvres by 60%.	0	2	1	3				$ 88,191
		308-309	**36 - 37**	Parallel lanes; turning													0	0	0	0				$ -
		401-409	**42, 47, 48**	Vehicle leaving driveway							50%				50%		0	0	0	0				$ -
		503-506	**51, 52, 54**	Overtaking, same direction							50%	40%	30%	60%	60%		0	0	0	0	$ 7,817,548	$215,832	$9,289	$ -
		601	**41, 60 – 63, 94**	Hit parked vehicle	2	2			1	1	15%				15%		0	1	1	2				$ 45,024
		903	**903**	Hit railway train									30%	60%	60%		0	0	0	0				$ -
	Single Vehicle Accidents	**001-008; 901-902**	**00 - 09**	Pedestrian, crossing carriageway	1	1		1			50%		30%	60%	20%	A 20% reduction is suggested.	1	0	0	1				$ 1,563,510
		605	**64 – 66, 91**	Permanent obstruction on carriageway	2		2			2				60%	60%		0	0	2	2				$ 3,716
		609	**67**	Hit animal	2	1	1			2					20%	A 20% reduction is suggested.	0	0	1	1				$ 1,858
		701-702; 706-709	**70, 72**	Off carriageway, on							10%	30%		45%	45%		0	0	0	0				$ -
		703-704	**71, 73**	Off carriageway, hit object							10%	30%		45%	60%	Off-straight 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 'offline upgrade' will smoothen this transition, off-straight crashes can potentially be reduced by 60%.	0	0	0	0				$ -
		705; 502	**74**	Out of control on straight	9	9			1	8	10%	30%		45%	60%	The majority of the loss of control crashes were located within the sharp horizontal curve, north of Picton Rd. As the 'offline upgrade' will reduce the curvature of this curve, loss of control crashes are likely to be reduced by 60%.	0	1	5	6				$ 52,455
		801; 802	**80, 82, 84, 86**	Off carriageway, on	1		1			1	10%	20%	30%	60%	60%		0	0	1	1				$ 1,858
		803-804	**81, 83, 85, 87**	Off carriageway, hit	14	13	1		4	10	10%	20%	30%	60%	60%		0	3	6	9				$ 140,646
		805	**88**	Out of control on curve							10%	20%	30%	60%	60%		0	0	0	0				$ -
	Total				**42**	**37**	**5**	**1**	**10**	**31**							**1**	**8**	**21**	**30**				**$ 1,947,855**

*** 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 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.

F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction_Section 1

Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number of of Crashes recorded in period (Note 1)						Percentage reduction in accidents for midblock treatments: High speed environment (Note 4)				Proposed percentage reduction applied for the Offline Upgrade (%)	Justification	Potential Accident Reductions by the Offline Upgrade				$ Cost Savings per year (Note 5)			$ Cost Savings per year
					Total	Northbound	Southbound	Fatal	Injury	Non-casualty (towaway)	89. Duplicated Road	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment - Change Horizontal & Vert.			Fatal	Injury	Non-casualty (towaway)	Total	Fatal	Injury	Non-casualty (towaway)	
	(Note 4)	(Note 4)	(Note 5)	(Notes 4 and 5)																				
Section 2 - Straight section between Catarack Creek and Bellambi Creek	**Two Vehicle Accidents**	**101-109**	**10,11 - 19**	Intersection, from adjacent approaches							30%				30%		0	0	0	0.0				$ -
		201-501	**20, 50**	Head-on							100%	25%	30%	60%	90%	A 90% reduction is suggested.	0	0	0	0.0				$ -
		202-206	**22 - 29**	Opposing vehicles; turning													0	0	0	0.0				$ -
		207-304	**40**	U-turn							30%		30%	60%	60%		0	0	0	0.0				$ -
		301-303	**30 - 32**	Rear end	4	1	3			4	30%		30%	60%	60%	The steepness of the slope in this section of the road leads to heavy vehicles having to slow down on approach to the steep grade. This further affects the speed of light vehicles in the main traffic lane, leading to rear-end crashes. The addition of a third climbing lane in the 'offline 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	3	3.0				$ 5,573
		305-307	**33 - 35**	Lane change	2	1	1		1	1					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 heavy vehicles. This crash type will reduce by 60%.	0	1	1	2.0				$ 45,024
		308-309	**36 - 37**	Parallel lanes; turning													0	0	0	0.0				$ -
		401-409	**42, 47, 48**	Vehicle leaving driveway							50%				50%		0	0	0	0.0				$ -
		503-506	**51, 52, 54**	Overtaking, same direction							50%	40%	30%	60%	60%		0	0	0	0.0				$ -
		601	**41, 60 – 63, 94**	Hit parked vehicle	2	2			1	1	15%				15%		0	1	1	2.0	$ 7,817,548	$215,832	$9,289	$ 45,024
		903	**903**	Hit railway train									30%	60%	60%		0	0	0	0.0				$ -
	Single Vehicle Accidents	**001-008; 901-902**	**00 - 09**	Pedestrian, crossing carriageway							50%		30%	60%	20%	A 20% reduction is suggested.	0	0	0	0.0				$ -
		605	**64 – 66, 91**	Permanent obstruction on carriageway										60%	60%		0	0	0	0.0				$ -
		609	**67**	Hit animal											20%	A 20% reduction is suggested.	0	0	0	0.0				$ -
		701-702; 502; 706-709	**70, 72**	Off carriageway, on straight							10%	30%		45%	45%		0	0	0	0.0				$ -
		703-704	**71, 73**	Off carriageway, hit object	5	4	1			5	10%	30%		45%	60%	Off-straight crashes are concentrated in the SB direction. This implies that vehicles had lost control upon exiting the curve south of Bellambi Ck. This is due to a sharp transition from the curve to the straight section of the road. As the 'offline upgrade' will smoothen this curve-to-straight transition, off-straight crashes can potentially be reduced by 60%.	0	0	3	3.0				$ 5,573
		705; 502	**74**	Out of control on straight							10%	30%		45%	60%		0	0	0	0.0				$ -
		801; 802	**80, 82, 84, 86**	Off carriageway, on curve	2	2				2	10%	20%	30%	60%	60%	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	0	2	2.0				$ 3,716
		803-804	**81, 83, 85, 87**	Off carriageway, hit object	6	1	5		3	3	10%	20%	30%	60%	60%		0	2	2	4.0				$ 90,048
		805	**88**	Out of control on curve							10%	20%	30%	60%	60%		0	0	0	0.0				$ -
	Total				**21**	**11**	**10**	**0**	**5**	**16**							**0**	**4**	**12**	**16**				**$ 194,959**

*** 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 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.

F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction Section 2

Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number of of Crashes recorded in period (Note 1)						Percentage reduction in accidents for midblock treatments: High speed environment (Note 4)				Proposed percentage reduction applied for the Offline Upgrade (%)	Justification	Potential Accident Reductions by the Offline Upgrade				$ Cost Savings per year (Note 5)			$ Cost Savings per year
					Total	Northbound	Southbound	Fatal	Injury	Non-casualty (towaway)	89. Duplicated Road	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment - Change Horizontal & Vert.			Fatal	Injury	Non-casualty (towaway)	Total	Fatal	Injury	Non-casualty (towaway)	
	(Note 4)	(Note 4)	(Note 5)	(Notes 4 and 5)																				
Section 3 - Curve section south of Bellambi Creek	**Two Vehicle Accidents**	**101-109**	**10,11 - 19**	Intersection, from adjacent approaches							30%				30%		0	0	0	0.0				$ -
		201-501	**20, 50**	Head-on							100%	25%	30%	60%	90%	A 90% reduction is suggested.	0	0	0	0.0				$ -
		202-206	**22 - 29**	Opposing vehicles; turning													0	0	0	0.0				$ -
		207-304	**40**	U-turn							30%		30%	60%	60%		0	0	0	0.0				$ -
		301-303	**30 - 32**	Rear end	6	4	2			6	30%		30%	60%	60%	Rear-end crashes are caused by the sharp curvature and steepness of the slope, south of Bellambi Ck leading to differentials in speed between light and heavy vehicles along the main traffic lane. The proposed 'offline upgrade' on M1 will potentially reduce this rear-end crash type as light vehicles and heavy vehicles will use separate lanes. Rear-end crash types are predicted to be reduced by 60%.	0	0	4	4.0				$ 7,431
		305-307	**33 - 35**	Lane change	4	2	2		1	3					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 lane side-swipe crashes between heavy and light vehicles. This crash type will reduce by 60%.	0	1	2	3.0				$ 46,882
		308-309	**36 - 37**	Parallel lanes; turning													0	0	0	0.0				$ -
		401-409	**42, 47, 48**	Vehicle leaving driveway							50%				50%		0	0	0	0.0				$ -
		503-506	**51, 52, 54**	Overtaking, same direction							50%	40%	30%	60%	60%		0	0	0	0.0				$ -
		601	**41, 60 – 63, 94**	Hit parked vehicle							15%				15%		0	0	0	0.0	$ 7,817,548	$215,832	$9,289	$ -
		903	**903**	Hit railway train									30%	60%	60%		0	0	0	0.0				$ -
	Single Vehicle Accidents	**001-008; 901-902**	**00 - 09**	Pedestrian, crossing carriageway	1	1		1			50%		30%	60%	20%	A 20% reduction is suggested.	1	0	0	1.0				$ 1,563,510
		605	**64 – 66, 91**	Permanent obstruction on carriageway	2		2			2				60%	60%		0	0	2	2.0				$ 3,716
		609	**67**	Hit animal											20%	A 20% reduction is suggested.	0	0	0	0.0				$ -
		701-702; 502; 706-709	**70, 72**	Off carriageway, on straight							10%	30%		45%	45%		0	0	0	0.0				$ -
		703-704	**71, 73**	Off carriageway, hit object	2	1	1		1	1	10%	30%		45%	60%	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 'offline upgrade' will smoothen this transition, off-straight crashes can potentially be reduced by 60%.	0	1	1	2.0				$ 45,024
		705; 502	**74**	Out of control on straight							10%	30%		45%	60%		0	0	0	0.0				$ -
		801; 802	**80, 82, 84, 86**	Off carriageway, on curve	2	1	1		1	1	10%	20%	30%	60%	60%	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 loss of control crashes by 60%.	0	1	1	2.0				$ 45,024
		803-804	**81, 83, 85, 87**	Off carriageway, hit object	18	11	7		6	12	10%	20%	30%	60%	60%		0	4	8	12.0				$ 187,528
		805	**88**	Out of control on curve							10%	20%	30%	60%	60%		0	0	0	0.0				$ -
	Total				**35**	**20**	**15**	**1**	**9**	**25**							**1**	**7**	**18**	**26**				**$ 1,899,115**

*** 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 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.

F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction Section 3

Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number of of Crashes recorded in period (Note 1)						Percentage reduction in accidents for midblock treatments: High speed environment (Note 4)				Proposed percentage reduction applied for the Offline Upgrade (%)	Justification	Potential Accident Reductions by the Offline Upgrade				$ Cost Savings per year (Note 5)			$ Cost Savings per year
					Total	Northbound	Southbound	Fatal	Injury	Non-casualty (towaway)	89. Duplicated Road	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment - Change Horizontal & Vert.			Fatal	Injury	Non-casualty (towaway)	Total	Fatal	Injury	Non-casualty (towaway)	
	(Note 4)	(Note 4)	(Note 5)	(Notes 4 and 5)																				
Section 4 - north of Bellambi Creek	**Two Vehicle Accidents**	**101-109**	**10,11 - 19**	Intersection, from adjacent approaches							30%				30%		0	0	0	0.0				$ -
		201-501	**20, 50**	Head-on							100%	25%	30%	60%	90%	A 90% reduction is suggested.	0	0	0	0.0				$ -
		202-206	**22 - 29**	Opposing vehicles; turning													0	0	0	0.0				$ -
		207-304	**40**	U-turn							30%		30%	60%	60%		0	0	0	0.0				$ -
		301-303	**30 - 32**	Rear end	5	5			2	3	30%		30%	60%	60%	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, thus reducing the likelihood of rear-end crashes by 60%.	0	2	2	4.0				$ 90,048
		305-307	**33 - 35**	Lane change	1	1				1					20%	A 20% reduction is suggested.	0	0	1	1.0				$ 1,858
		308-309	**36 - 37**	Parallel lanes; turning													0	0	0	0.0				$ -
		401-409	**42, 47, 48**	Vehicle leaving driveway							50%				50%		0	0	0	0.0				$ -
		503-506	**51, 52, 54**	Overtaking, same direction							50%	40%	30%	60%	60%		0	0	0	0.0				$ -
		601	**41, 60 – 63, 94**	Hit parked vehicle							15%				15%		0	0	0	0.0				$ -
		903	**903**	Hit railway train									30%	60%	60%		0	0	0	0.0				$ -
	Single Vehicle Accidents	**001-008; 901-902**	**00 - 09**	Pedestrian, crossing carriageway							50%		30%	60%	20%	A 20% reduction is suggested.	0	0	0	0.0	$ 7,817,548	$215,832	$9,289	$ -
		605	**64 – 66, 91**	Permanent obstruction on carriageway										60%	60%		0	0	0	0.0				$ -
		609	**67**	Hit animal	2	1	1			2					20%	A 20% reduction is suggested.	0	0	1	1.0				$ 1,858
		701-702; 502; 706-709	**70, 72**	Off carriageway, on straight							10%	30%		45%	45%		0	0	0	0.0				$ -
		703-704	**71, 73**	Off carriageway, hit object							10%	30%		45%	45%		0	0	0	0.0				$ -
		705; 502	**74**	Out of control on straight							10%	30%		45%	45%		0	0	0	0.0				$ -
		801; 802	**80, 82, 84, 86**	Off carriageway, on curve							10%	20%	30%	60%	60%		0	0	0	0.0				$ -
		803-804	**81, 83, 85, 87**	Off carriageway, hit object	5	4	1		1	4	10%	20%	30%	60%	60%		0	1	3	4.0				$ 48,740
		805	**88**	Out of control on curve	1		1			1	10%	20%	30%	60%	60%		0	0	1	1.0				$ 1,858
	Total				**14**	**11**	**3**	**0**	**3**	**11**							**0**	**3**	**8**	**11**				**$ 144,362**

*** 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 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.

F:\AA007521\D-Calculations\Crash Analysis\Offline Scheme Crash data\[Accident Reduction_Offline Scheme_RevE_Willingness to Pay.xlsx]Accident Reduction Section 4

APPENDIX B

ANNUAL COSTS AND BENEFITS

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

Base Year	2014	
Opening Year	2018	
Analysis Period	30	years
Economic Life	60	

Analysis Period	Year	Costs			Benefits						Net Benefit (Cost)	First Year Benefit
		Construction Costs	Net Maintenance Costs	Total Costs	Annual Veh-Hr Savings	Annual Veh-Km Savings	Crash Reduction	Externality	Residual Value	Total Benefits		
Base Year	2014	$ 4,145,455	0	$4,145,455	$0	$0	$0	$0	$0	$0	-$4,145,455	$0
1	2015	$ 6,468,637	$0	$6,468,637	$0	$0	$0	$0	$0	$0	-$6,468,637	$0
2	2016	$ 65,259,300	$0	$65,259,300	$0	$0	$0	$0	$0	$0	-$65,259,300	$0
3	2017	$ 10,791,514	$0	$10,791,514	$0	$0	$0	$0	$0	$0	-$10,791,514	$0
4	2018	$ -	$0	$0	$5,527,128	$513,313	$4,186,290	$218,834	$0	$10,445,565	$10,445,565	$10,445,565
5	2019	$ -	$0	$0	$5,700,428	$507,760	$4,186,290	$216,467	$0	$10,610,945	$10,610,945	$0
6	2020	$ -	$0	$0	$5,873,727	$502,208	$4,186,290	$214,100	$0	$10,776,325	$10,776,325	$0
7	2021	$ -	$0	$0	$6,047,027	$496,656	$4,186,290	$211,733	$0	$10,941,706	$10,941,706	$0
8	2022	$ -	$398,329	$398,329	$6,220,326	$491,104	$4,186,290	$209,366	$0	$11,107,086	$10,708,757	$0
9	2023	$ -	$0	$0	$6,393,626	$485,552	$4,186,290	$206,999	$0	$11,272,466	$11,272,466	$0
10	2024	$ -	$0	$0	$6,566,925	$479,999	$4,186,290	$204,632	$0	$11,437,847	$11,437,847	$0
11	2025	$ -	$0	$0	$6,740,225	$474,447	$4,186,290	$202,265	$0	$11,603,227	$11,603,227	$0
12	2026	$ -	$0	$0	$6,913,524	$468,895	$4,186,290	$199,898	$0	$11,768,607	$11,768,607	$0
13	2027	$ -	$1,987,008	$1,987,008	$7,086,824	$463,343	$4,186,290	$197,531	$0	$11,933,988	$9,946,980	$0
14	2028	$ -	$0	$0	$7,260,123	$457,791	$4,186,290	$195,164	$0	$12,099,368	$12,099,368	$0
15	2029	$ -	$0	$0	$7,481,150	$492,101	$4,186,290	$209,791	$0	$12,369,332	$12,369,332	$0
16	2030	$ -	$0	$0	$7,702,176	$526,412	$4,186,290	$224,418	$0	$12,639,297	$12,639,297	$0
17	2031	$ -	$0	$0	$7,923,203	$560,723	$4,186,290	$239,046	$0	$12,909,261	$12,909,261	$0
18	2032	$ -	$398,329	$398,329	$8,144,229	$595,033	$4,186,290	$253,673	$0	$13,179,225	$12,780,896	$0
19	2033	$ -	$0	$0	$8,365,255	$629,344	$4,186,290	$268,300	$0	$13,449,189	$13,449,189	$0
20	2034	$ -	$0	$0	$8,586,282	$663,655	$4,186,290	$282,927	$0	$13,719,154	$13,719,154	$0
21	2035	$ -	$0	$0	$8,807,308	$697,965	$4,186,290	$297,554	$0	$13,989,118	$13,989,118	$0
22	2036	$ -	$0	$0	$9,028,335	$732,276	$4,186,290	$312,182	$0	$14,259,082	$14,259,082	$0
23	2037	$ -	-$2,827,193	-$2,827,193	$9,249,361	$766,587	$4,186,290	$326,809	$0	$14,529,047	$17,356,240	$0
24	2038	$ -	$0	$0	$9,470,387	$800,897	$4,186,290	$341,436	$0	$14,799,011	$14,799,011	$0
25	2039	$ -	$0	$0	$9,692,054	$795,984	$4,186,290	$339,341	$0	$15,013,669	$15,013,669	$0
26	2040	$ -	$0	$0	$9,913,721	$791,070	$4,186,290	$337,247	$0	$15,228,328	$15,228,328	$0
27	2041	$ -	$0	$0	$10,135,388	$786,156	$4,186,290	$335,152	$0	$15,442,986	$15,442,986	$0
28	2042	$ -	$398,329	$398,329	$10,357,055	$781,243	$4,186,290	$333,057	$0	$15,657,645	$15,259,315	$0
29	2043	$ -	$0	$0	$10,578,721	$776,329	$4,186,290	$330,962	$0	$15,872,303	$15,872,303	$0
30	2044	$ -	$0	$0	$10,800,388	$771,415	$4,186,290	$328,868	$0	$16,086,961	$16,086,961	$0
31	2045	$ -	$0	$0	$11,022,055	$766,502	$4,186,290	$326,773	$0	$16,301,620	$16,301,620	$0
32	2046	$ -	$0	$0	$11,243,722	$761,588	$4,186,290	$324,678	$0	$16,516,278	$16,516,278	$0
33	2047	$ -	$1,987,008	$1,987,008	$11,465,389	$756,674	$4,186,290	$322,583	$43,332,453	$60,063,389	$58,076,381	$0

Discount Rate	Capital Costs	Net Maintenance Costs	PV of Costs	PV of Benefits	NPV	BCR	First Year Benefit	FYRR
4%	$ 77,206,544	$1,164,829	$78,371,373	$200,249,962.48	$121,878,590	2.6	$8,585,492.72	11.0%
7%	$ 71,028,037	$795,157	$71,823,195	$121,333,091.29	$49,509,897	1.7	$7,447,543.22	10.4%
10%	$ 65,515,604	$573,156	$66,088,760	$79,055,819.97	$12,967,060	1.2	$6,485,873.81	9.8%

IRR	11.8%