

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 (m²)

	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 TNSW'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 from 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

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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

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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

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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 analysis 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

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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

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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

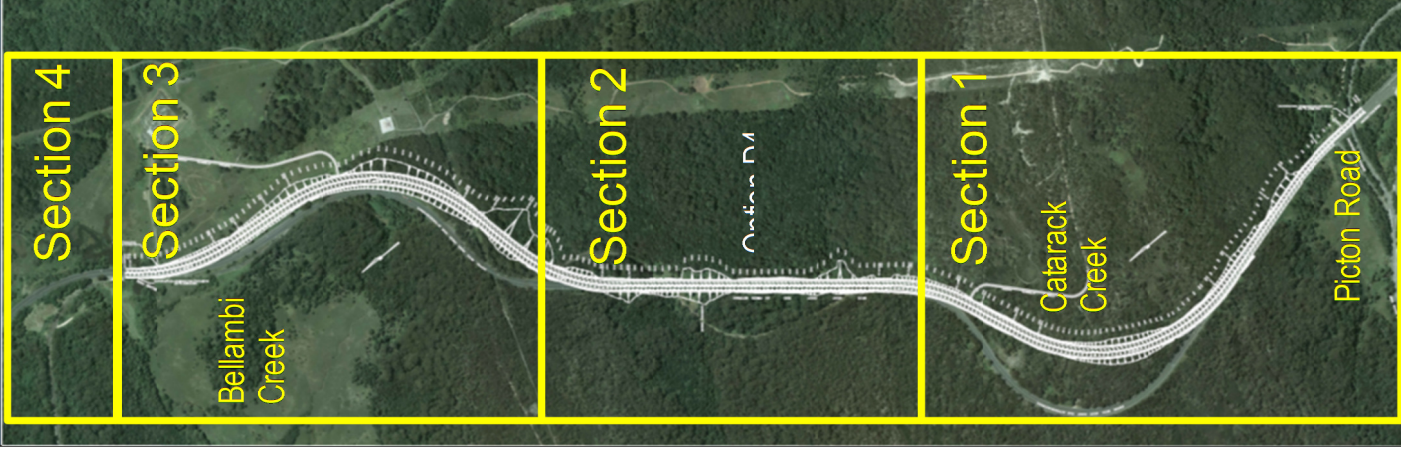
years

Road Section	Vehicle Accidents (Note 4)	DCA Code* (Note 4)	RUM Code* (Note 5)	Crash Description (Note 4)	Number of 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	Fatal	Injury	Non-casualty (tow away)	
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	
Single Vehicle Accidents	903		Hit railway train								
	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	2	22	59	\$ 4,186,290	

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

Note:

- 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.
- Crash data for the subject M1 Princes Motorway Section between Picton Road and Bellambi Creek were used in the analysis.
- Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.
- Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied.
- Costs per crash sourced from Table 45 (Page 257) of TNSW's Principles and Guideline of Economic Appraisal of Transport Investment and Investigation, March 2013.
- 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.
- 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.



Road Section	Vehicle Accidents	DCA Code * (Note 4)	RUMI Code * (Note 5)	Crash Description (Notes 4 and 5)	Number 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)			
					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)	Fatal	Injury
Section 1 - between Picton Road and Cataract Creek 	Two Vehicle Accidents	101-109	10, 11 - 19	Intersection, from adjacent approaches	7	4	4	0	0	0	30%	30%		0	0	0	\$ -	\$ -	\$ -		
		201-501	20, 50	Head-on	7	4	4	0	0	0	100%	25%	60%	A 90% reduction is suggested.	0	0	0	\$ -	\$ -	\$ -	
		202-206	22 - 29	Opposing vehicles;	7	4	4	0	0	0	30%	30%	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	0	0	\$ -	\$ -	\$ -	
		207-304	40	U-turn	7	4	4	0	0	0	30%	30%	60%		0	0	0	\$ -	\$ -	\$ -	
		301-303	30 - 32	Rear end	7	4	4	0	0	0	30%	30%	60%		0	0	0	\$ -	\$ -	\$ -	
		305-307	33 - 35	Lane change	4	4	4	0	0	0	60%		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	\$ 88,191	\$ -	\$ -	
		308-309	36 - 37	Parallel lanes, turning	4	4	4	0	0	0					0	0	0	\$ -	\$ -	\$ -	
		401-409	42, 47, 48	Vehicle leaving driveway	4	4	4	0	0	0	50%		50%		0	0	0	\$ -	\$ -	\$ -	
		503-506	51, 52, 54	Overtaking, same direction	4	4	4	0	0	0	50%	40%	60%		0	0	0	\$ -	\$ -	\$ -	
		601	41, 60 - 63, 84	Hit parked vehicle	2	2	2	0	0	0	15%		15%		0	1	1	\$ 45,024	\$ -	\$ -	
		903	903	Hit railway train	2	2	2	0	0	0		30%	60%		0	0	0	\$ -	\$ -	\$ -	
	Single Vehicle Accidents	001-008; 901-009	001-009	00 - 09	Pedestrian, crossing	1	1	1	0	0	0	50%	30%	60%	A 20% reduction is suggested.	1	0	0	\$ -	\$ -	\$ -
		605	64 - 66, 91	64 - 91	Permanent obstruction on carriageway	2	2	2	0	0	0			60%		0	0	0	\$ -	\$ -	\$ -
		609	67	67	Hit animal	2	2	2	0	0	0			20%	A 20% reduction is suggested.	0	0	0	\$ -	\$ -	\$ -
		701-702; 802; 706-709	701-702; 802; 706-709	701-702; 802; 706-709	Off carriageway, on	2	2	2	0	0	0	10%	30%	45%		0	0	0	\$ -	\$ -	\$ -
		703-704	71, 73	71, 73	Off carriageway, hit object	2	2	2	0	0	0	10%	30%	45%		0	0	0	\$ -	\$ -	\$ -
		705; 502	74	74	Out of control on straight	9	9	9	0	0	0			60%		0	0	0	\$ -	\$ -	\$ -
		801; 802	80, 82, 84, 86	80, 82, 84, 86	Off carriageway, on	1	1	1	0	0	0			45%		0	1	5	\$ 52,455	\$ -	\$ -
		803-804	81, 83, 85, 87	81, 83, 85, 87	Off carriageway, hit	14	13	1	0	0	0	10%	20%	60%		0	0	1	\$ 1,868	\$ -	\$ -
		805	88	88	Out of control on curve	14	13	1	0	0	0	10%	20%	60%		0	3	6	\$ 140,646	\$ -	\$ -
			805	88	Out of control on curve	14	13	1	0	0	0	10%	20%	60%		0	0	0	\$ -	\$ -	\$ -
Total					42	37	5	1	10	31				1	8	21	\$ 1,947,855	\$	\$		

* DCA - Definitions for Coding Accidents, RUMI - Road User Movement

- Note:
- 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.
 - Crash data for the subject M1 Princes Motorway Section between Picton Road and Bellambi Creek were used in the analysis.
 - Potential accident reduction rates were estimated using the RMS Accident Reduction Guide, August 2005.
 - Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied.
 - Costs per crash sourced from Table 45 (Page 257) of TNSW's Principles and Guidelines of Economic Appraisal of Transport Investment and Investigation, March 2013.
 - 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.
 - 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.

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Road Section	Vehicle Accidents	DCA Code *	RUJM Code *	Crash Description	Number 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								
					Northbound		Southbound		Total	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)	Fatal													Injury	Non-casualty (towaway)				
Section 2 - Straight section between Catarack Creek and Bellambi Creek	(Note 4) Two Vehicle Accidents	(Note 4) 101-109	(Note 5) 10,11 - 19	(Notes 4 and 5) Intersection, from adjacent approaches																						
		201-501	20, 50	Head-on					25%	30%	60%															
		202-206	22 - 29	Opposing vehicles, turning																						
		207-304	40	U-turn						30%	60%															
		301-303	30 - 32	Rear end		4	1	3	4		30%	60%														
		305-307	33 - 35	Lane change		2	1	1	1	1		60%														
		308-309	36 - 37	Parallel lanes, turning																						
		401-409	42, 47, 48	Vehicle leaving driveway							50%															
		503-506	51, 52, 54	Overtaking, same direction							50%															
		601	41, 60 - 63, 94	Hit parked vehicle		2	2				15%															
		903	903	Hit railway train																						
		001-008; 901-902	00 - 09	Pedestrian, crossing																						
		605	64 - 66, 91	Permanent obstruction on carriageway																						
		609	67	Hit animal																						
		701-702; 502; 706-709	70, 72	Off carriageway, on straight																						
703-704	71, 73	Off carriageway, hit object		5	4	1																				
705; 502	74	Out of control on straight																								
801; 802	80, 82, 84, 86	Off carriageway, on curve		2	2																					
803-804	81, 83, 85, 87	Off carriageway, hit object		6	1	5																				
805	88	Out of control on curve																								
Total					21	11	10	0	5	16					0	4	12	16						\$ 194,959		



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

Note:

- The crash analysis has been undertaken using crash data provided by Roads and Maritime (RMS) for a the year period from 1 August 2008 and 31 October 2013.
- Crash data for the subject M1 Princes Motorway Section between Picton Road and Bellambi Creek were used in the analysis.
- Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.
- Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied.
- 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.
- 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.
- 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.

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Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number 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		
					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
Section 3 - Curve section south of Bellambi Creek	(Note 4) Two Vehicle Accidents	(Note 4) 101-109	(Note 5) 10,11 - 19	Intersection from adjacent approaches									30%		0	0	0	0.0	\$ -		
		201-501	20, 50	Head-on									100%	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%		0	0	0	0.0	\$ -		
		301-303	30 - 32	Rear end	6	4	2	2	6	30%	30%	60%	60%			0	0	0	0.0	\$ 7,431	
		305-307	33 - 35	Lane change	4	2	2	2	3	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%						0	0	0	0.0	\$ -	
		503-506	51, 52, 54	Overtaking same direction						50%	40%	60%	60%			0	0	0	0.0	\$ -	
		601	41, 60 - 63, 94	Hit parked vehicle						15%						0	0	0	0.0	\$ -	
		903	903	Hit railway train							30%					0	0	0	0.0	\$ -	
		001-008; 901-902	00 - 09	Pedestrian, crossing carriageway	1	1			1	50%	30%	60%	60%			1	0	0	1.0	\$ 1,563,510	
		605	64 - 66, 91	Permanent obstruction on carriageway	2		2		2							0	0	2	2.0	\$ 3,716	
		609	701-702; 502; 706-709	Hit animal												0	0	0	0.0	\$ -	
		703-704	71, 73	Off carriageway, on straight	2	1	1		1	10%	30%	45%	45%			0	0	0	0.0	\$ -	
		705; 802	74	Off carriageway, hit object						10%	30%	60%	60%			0	1	1	2.0	\$ 45,024	
		801; 802	80, 82, 84, 86	Off carriageway, on curve	2	1	1		1	10%	20%	30%	60%			0	1	1	2.0	\$ 45,024	
		803-804	81, 83, 85, 87	Off carriageway, hit object	18	11	7		12	10%	20%	30%	60%			0	4	8	12.0	\$ 187,528	
		805	88	Out of control on curve						10%	20%	30%	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:

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- Crash data for the subject M1 Princes Motorway Section between Picton Road and Bellambi Creek were used in the analysis.
- Potential accident reduction rates were estimated using the RMS' Accident Reduction Guide, August 2005.
- Table C4 - Percentage reduction in accidents for midblock treatments: High speed environment was applied.
- Costs per crash sourced from Table 45 (Page 257) of TMSW's Principles and Guidelines of Economic Appraisal of Transport Investment and Investigation, March 2013.
- 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.
- 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.

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Road Section	Vehicle Accidents	DCA Code *	RUM Code *	Crash Description	Number 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)		
					Total	Northbound	Southbound	91. Accident Reduction Rate (Climbing Lanes)	92. Accident Reduction Rate (Horizontal Alignment)	94. Alignment Change Horizontal & Vert.			Fatal	Injury	Non-casualty (towaway)	Fatal		Injury	Non-casualty (towaway)
Section 4 - north of Bellambi Creek	(Note 4) Two Vehicle Accidents	(Note 4) 101-109	(Note 5) 10, 11 - 19	(Notes 4 and 5) Intersection, from adjacent approaches	30%			30%											
		201-501	20, 50	Head-on	100%			25%	30%	60%		A 90% reduction is suggested.							
		202-206	22 - 29	Opposing vehicles turning	30%					60%									
		207-304	40	U-turn	30%		2	30%		60%									
		301-303	30 - 32	Rear end	5	5	3	30%		60%		The proposed 'offline upgrade' is likely to improve travel speed the subject M1 section between Picton Rd and Bull 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												\$ 1,858
		308-309	36 - 37	Parallel lanes turning															
		401-409	42, 47, 48	Vehicle leaving driveway	50%														
		503-506	51, 52, 54	Overtaking, same direction	50%			40%		60%									
		601	41, 60 - 63, 94	Hit parked vehicle	15%														
		903	903	Hit railway train															
		001-008; 901-902	00 - 09	Pedestrian, crossing carriageway															
		605	64 - 66, 91	Permanent obstruction on carriageway	50%														
		609	67	Hit animal	2	1	1												
		701-702; 502; 706-709	70, 72	Off carriageway, on straight	10%			30%		45%									
		703-704	71, 73	Off carriageway, hit object	10%			30%		45%									
		705; 502	74	Out of control on straight	10%			30%		45%									
	801; 802	80, 82, 84, 86	Off carriageway, on curve	10%			20%		60%										
	803-804	81, 83, 85, 87	Off carriageway, hit object	10%		4	20%		60%										
	805	88	Out of control on curve	10%		1	20%		60%										
	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 TMSW'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.

APPENDIX B

ANNUAL COSTS AND BENEFITS

M1 Princes Motorway - Offline Upgrade between Belambi 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	\$0	\$0	\$0
1	2015	\$ 6,468,637	\$0	\$6,468,637	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2	2016	\$ 65,259,300	\$0	\$65,259,300	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
3	2017	\$ 10,791,514	\$0	\$10,791,514	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
4	2018	\$ -	\$0	\$0	\$5,527,128	\$513,313	\$4,186,290	\$218,834	\$0	\$0	\$0	\$10,445,565	\$10,445,565
5	2019	\$ -	\$0	\$0	\$5,700,428	\$507,760	\$4,186,290	\$216,467	\$0	\$0	\$0	\$10,610,945	\$10,610,945
6	2020	\$ -	\$0	\$0	\$5,873,727	\$502,208	\$4,186,290	\$214,100	\$0	\$0	\$0	\$10,776,325	\$10,776,325
7	2021	\$ -	\$0	\$0	\$6,047,027	\$496,656	\$4,186,290	\$211,733	\$0	\$0	\$0	\$10,941,706	\$10,941,706
8	2022	\$ -	\$398,329	\$398,329	\$6,220,326	\$491,104	\$4,186,290	\$209,366	\$0	\$0	\$0	\$11,107,086	\$11,107,086
9	2023	\$ -	\$0	\$0	\$6,393,626	\$485,552	\$4,186,290	\$206,999	\$0	\$0	\$0	\$11,272,466	\$11,272,466
10	2024	\$ -	\$0	\$0	\$6,566,925	\$479,999	\$4,186,290	\$204,632	\$0	\$0	\$0	\$11,437,847	\$11,437,847
11	2025	\$ -	\$0	\$0	\$6,740,225	\$474,447	\$4,186,290	\$202,265	\$0	\$0	\$0	\$11,603,227	\$11,603,227
12	2026	\$ -	\$0	\$0	\$6,913,524	\$468,895	\$4,186,290	\$199,898	\$0	\$0	\$0	\$11,768,607	\$11,768,607
13	2027	\$ -	\$1,987,008	\$1,987,008	\$7,086,824	\$463,343	\$4,186,290	\$197,531	\$0	\$0	\$0	\$11,933,988	\$9,946,980
14	2028	\$ -	\$0	\$0	\$7,260,123	\$457,791	\$4,186,290	\$195,164	\$0	\$0	\$0	\$12,099,368	\$12,099,368
15	2029	\$ -	\$0	\$0	\$7,433,422	\$452,239	\$4,186,290	\$192,797	\$0	\$0	\$0	\$12,264,748	\$12,264,748
16	2030	\$ -	\$0	\$0	\$7,606,721	\$446,687	\$4,186,290	\$190,430	\$0	\$0	\$0	\$12,430,128	\$12,430,128
17	2031	\$ -	\$0	\$0	\$7,780,020	\$441,135	\$4,186,290	\$188,063	\$0	\$0	\$0	\$12,595,508	\$12,595,508
18	2032	\$ -	\$398,329	\$398,329	\$7,953,319	\$435,583	\$4,186,290	\$185,696	\$0	\$0	\$0	\$12,760,888	\$12,760,888
19	2033	\$ -	\$0	\$0	\$8,126,618	\$430,031	\$4,186,290	\$183,329	\$0	\$0	\$0	\$12,926,268	\$12,926,268
20	2034	\$ -	\$0	\$0	\$8,300,917	\$424,479	\$4,186,290	\$180,962	\$0	\$0	\$0	\$13,091,648	\$13,091,648
21	2035	\$ -	\$0	\$0	\$8,475,216	\$418,927	\$4,186,290	\$178,595	\$0	\$0	\$0	\$13,257,028	\$13,257,028
22	2036	\$ -	\$0	\$0	\$8,649,515	\$413,375	\$4,186,290	\$176,228	\$0	\$0	\$0	\$13,422,408	\$13,422,408
23	2037	\$ -	\$-2,827,193	\$-2,827,193	\$8,823,814	\$407,823	\$4,186,290	\$173,861	\$0	\$0	\$0	\$13,587,788	\$13,587,788
24	2038	\$ -	\$0	\$0	\$9,000,113	\$402,271	\$4,186,290	\$171,494	\$0	\$0	\$0	\$13,753,168	\$13,753,168
25	2039	\$ -	\$0	\$0	\$9,176,412	\$396,719	\$4,186,290	\$169,127	\$0	\$0	\$0	\$13,918,548	\$13,918,548
26	2040	\$ -	\$0	\$0	\$9,352,711	\$391,167	\$4,186,290	\$166,760	\$0	\$0	\$0	\$14,083,928	\$14,083,928
27	2041	\$ -	\$0	\$0	\$9,529,010	\$385,615	\$4,186,290	\$164,393	\$0	\$0	\$0	\$14,249,308	\$14,249,308
28	2042	\$ -	\$398,329	\$398,329	\$9,705,309	\$380,063	\$4,186,290	\$162,026	\$0	\$0	\$0	\$14,414,688	\$14,414,688
29	2043	\$ -	\$0	\$0	\$9,881,608	\$374,511	\$4,186,290	\$159,659	\$0	\$0	\$0	\$14,580,068	\$14,580,068
30	2044	\$ -	\$0	\$0	\$10,057,907	\$368,959	\$4,186,290	\$157,292	\$0	\$0	\$0	\$14,745,448	\$14,745,448
31	2045	\$ -	\$0	\$0	\$10,234,206	\$363,407	\$4,186,290	\$154,925	\$0	\$0	\$0	\$14,910,828	\$14,910,828
32	2046	\$ -	\$0	\$0	\$10,410,505	\$357,855	\$4,186,290	\$152,558	\$0	\$0	\$0	\$15,076,208	\$15,076,208
33	2047	\$ -	\$1,987,008	\$1,987,008	\$10,586,804	\$352,303	\$4,186,290	\$150,191	\$0	\$0	\$0	\$15,241,588	\$15,241,588

Discount Rate	Net Maintenance Costs			NPV	BCR	First Year Benefit	FYRR
	Capital Costs	Maintenance Costs	PV of Costs				
4%	\$ 77,206,544	\$1,164,829	\$78,371,373	\$121,878,590	2.6	\$8,585,492.72	11.0%
7%	\$ 71,028,037	\$795,157	\$71,823,195	\$49,509,897	1.7	\$7,447,543.22	10.4%
10%	\$ 65,515,604	\$573,156	\$66,088,760	\$12,967,060	1.2	\$6,485,873.81	9.8%
							IRR
							11.8%