Economic Analysis of Majura Parkway (Updated for IA Submission)

For: TAMS

25 NOVEMBER, 2010

Project Name:	Majura Parkway PSP
Project Number:	3002212
Report for:	TAMS

PREPARATION, REVIEW AND AUTHORISATION

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
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1	25/11/2010	Josh Everett	Jerome Catbagan	Peter Cowper

ISSUE REGISTER

Distribution List	Date Issued	Number of Copies
TAMS:	25/11/2010	1 copy
SMEC staff:	25/11/2010	electronic
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Canberra Office Library (SMEC office location):	25/11/2010	electronic
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EXECUTIVE SUMMARY

SMEC was commissioned by the ACT Government to update the economic analysis of Majura Parkway, considering the ultimate configuration, to reflect the more accurate cost estimates prepared as part of the PSP process. This report is an update of a similar exercise performed by SMEC in January 2009 and again in September 2009.

The most recent land use assumptions and updated modelling parameters, provided by the ACT Government, were used in the transport modelling process to provide an accurate projection of future traffic demand.

Construction costs for Majura Parkway were estimated as *$287.96 million* with construction starting in 2013 and concluding in 2014. Appropriate maintenance costs (both annual and cyclic) were also estimated as a function of the construction costs.

Model runs were conducted for the years 2011, 2021 and 2031 for base ('do nothing') case and the upgrade case. Vehicle Operating Costs (VOC) and Vehicle Kilometres Travelled (VKT) were extracted from the model outputs and were used to determine the benefits associated with the upgrade case.

Benefits derived from the construction of Majura Parkway were estimated by calculating the cost savings for each option. These savings were mainly the differences between travel related costs associated with the 'do nothing' scenario and those associated with the upgrade cases (i.e. Majura Parkway). In addition to these travel cost savings, other benefits that were estimated include the generated traffic benefits, residual value of the project (after 30 years), environmental cost savings and carbon cost reductions.

The economic assessment results show that the Majura Parkway is economically feasible, given that the analysis produced a positive NPV and a BCR greater than 1. The estimated economic indicators are summarised in the following table:

Discount Rate	NPV ($,000)	BCR
4%	1,146,078	5.02
7%	622,744	3.32
10%	343,395	2.35

Further to this testing, sensitivity testing was carried out to determine the effect of:

- Variations in heavy vehicles due to freight facility development at Canberra Airport
- Higher than expected construction costs
- Lower than expected benefits
- Higher construction costs and lower benefits (worst case)
- Variations in the price of carbon

It was found that for all cases, the Majura Parkway project is economically viable.

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1 INTRODUCTION

1.1 Majura Parkway

The Majura Parkway is proposed to be constructed in the Majura Valley on the east side of Canberra. As well as its metropolitan functions, the Majura Parkway is important in enabling traffic from Sydney and other northern destinations to the Monaro region to bypass Canberra.

In selecting a route for the Parkway, several considerations were taken into account:

- To protect the important natural and cultural heritage features of the Majura Valley;
- To provide access to all the existing and future development in the Majura Valley from Majura Road;
- To make provision for a possible future very high speed train (VHST);
- To avoid major constraints on potentially important long-term land uses, such as the upgrading of facilities at Canberra International Airport;
- To limit the impacts on other existing land uses where practicable; and
- To construct the road at a realistic cost to the community

The Majura Parkway comprises a number of ramps, interchanges, and structures. The total length is about 11 km of dual carriageway linking the Monaro Highway and the Federal Highway. For each carriageway, cross sections of 2 x 3.5 m traffic lanes, 2.5 m roadside shoulder and 1.0 m offside shoulder are provided.

1.2 Objective

The main objective of this study is to update the economic assessment conducted for the Majura Parkway Ultimate Configuration (*SMEC, Jan 2009*). The layout of the Majura Parkway is shown in *Figure* **2** and is compared the traffic operational conditions if the existing condition is continued ('do nothing' scenario) as shown in *Figure* **1**.

Figure 1: Majura Rd Existing Conditions

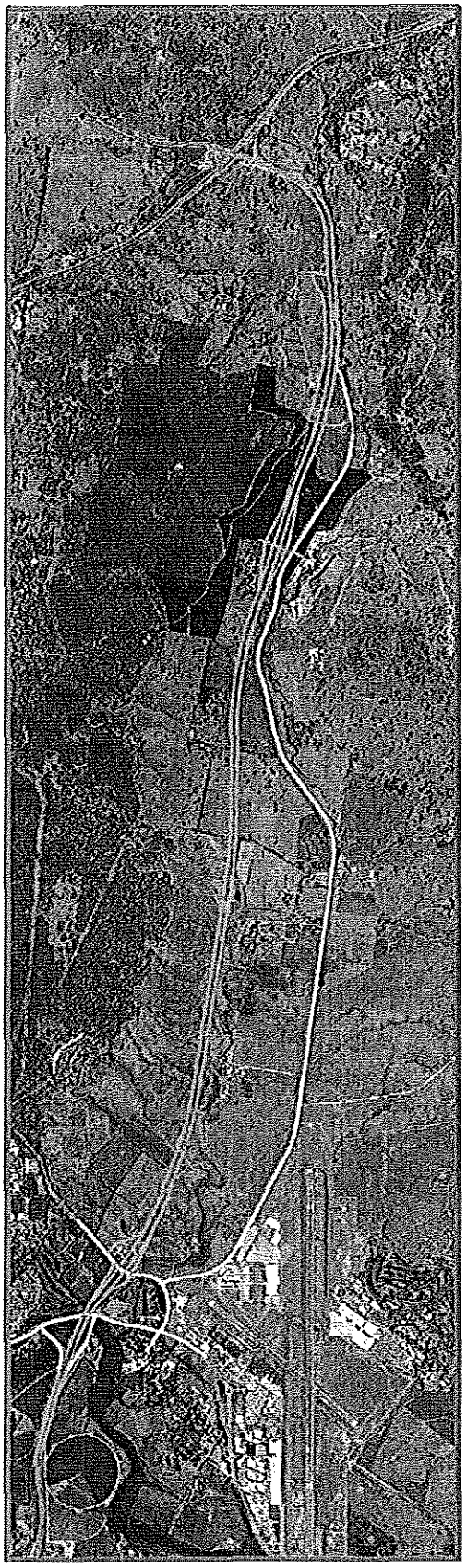

Figure 2: Majura Parkway (Green)

2 TRAFFIC MODELLING

Strategic transport modelling of the whole Canberra and Queanbeyan urban area, using TransCAD, was initially conducted to produce the demand matrix used for micro-simulation modelling of the study area in Paramics. The following sections describe the assumptions and processes followed for both modelling tasks.

2.1 Strategic Transport Modelling

An initial, metropolitan-wide transport modelling process was conducted to establish the impacts of Majura Parkway on a macro level. This involves the development and update of a strategic transport model of the whole ACT, incorporating all of the assumed developments associated with each forecast year.

SMEC currently maintains and regularly updates a strategic transport model representing the ACT road network as well as neighbouring Queanbeyan in NSW. This model can capture the impacts of nearby developments as well as those that are at considerable distances from the study area, which are otherwise very difficult or even impossible to determine in a localised network model. This model has been the cornerstone of most of SMEC's recent transport modelling efforts and has been very helpful in providing clients highly technical information in a very straightforward and understandable manner.

SMEC utilises TransCAD as its platform of choice for all of its strategic transport modelling works. This package is particularly useful due mainly to its integrated Geographical Information System (GIS) capability. It provides more efficient modelling procedures since data preparation is greatly facilitated and its database and visualization functionalities identify errors even before they cause any major issues. It can also interface with other travel demand modelling software easily, including EMME/2 – the current strategic transport modelling software being used by TaMS.

The basic assumptions used to estimate trip generation, determine trip distribution across zones and classify trips according to different modes, are discussed in the following sections.

2.1.1 Land Use Forecasts

The ACT Government, through ACTPLA and TaMS, has provided SMEC with the latest updates on land use projections for the forecast years 2006, 2011, 2021 and 2031. The following land use information was used for estimating trips generated in each of the 750 Traffic Analysis Zones (TAZs) included in the strategic transport model:

- Population
- Employment
- Retail Space
- School Enrolment
- Tertiary Enrolment

Table 1 shows land use information for Canberra and Queanbeyan for the forecast years 2006, 2011, 2021 and 2031. This table is shown to provide some general indication of the development trends in Canberra and its surrounding areas. This land use information was prepared by the ACT Government for use in future planning exercises. No project specific land use assumptions have been made for the economic analysis of the Majura Parkway project.

Table 1: Summary of Land Use Data for Canberra and Queanbeyan

Landuse	2006	2011	2021	2031
Population	372,798	399,150	460,451	521,947
Employment	209,295	223,361	250,050	275,860
Retail Space (m²)	1,502,810	1,703,760	1,790,750	2,056,560
School Enrolments	63,830	68,845	65,215	64,445
Tertiary Enrolments	53,985	53,590	54,150	55,770

The ACT government is currently investigating the effects of a proposed major employment corridor known as Eastern Broadacre. Majura Parkway runs the length of the Eastern Broadacre corridor and is expected to provide good access to any future landuse in the area and project benefits may increase with the higher land use scenario. However, the potential land use for Eastern Broadacre is still unknown and was not modelled for this economic analysis.

2.1.2 Trip Generation

The number of trips generated in each Traffic Analysis Zone (TAZ) is estimated on land use information provided by TaMS, as discussed in Section 2.1.1 .

The trip generation rates used for estimating generated trips, according to different trip purposes, in each TAZ are listed in *Table* **2**. These figures were taken from the Transport Modelling and Analysis 2006/2011, Study Report (Final) by MRC (2009).

Table 2: Assumed Trip Generation Rates for Different Trip Purposes

Trip Purpose		2006 Trip Rates (/2h)
Home Based	Work	0.239
	Education	0.104
	Shopping	0.040
	Other	0.085
Non Home Based	Business Appointments, etc.	0.107
	Other	0.039

Source: MRC, Transport Modelling and Analysis 2006/2011, Study Report – Final (p. 25)

The listed trip rates were further adjusted by applying the appropriate adjustment factors that are based on income levels and age. These income and age group-based adjustment factors were also used in the development of EMME/2 model of TaMS and are shown in ***Table 3*** and ***Table 4***, respectively. The adjustment factors for public transport (PT) usage are also shown in the tables.

Table 3: Trip Rate and Public Transport Usage Adjustment Factors based on Income

Income Level	2006 Trip Rate Adjustment Factors	2006 PT Usage Adjustment Factors
Low (< $25,999 p.a.)	0.593	1.332
Medium ($26,000 to $51,999 p.a.)	1.142	0.959
High (> $52,000 p.a.)	1.327	0.649

Source: MRC, Transport Modelling and Analysis 2006/2011, Study Report – Final (p. 25)

Table 4: Trip Rate and Public Transport Usage Adjustment Factors based on Age

Age Group	2006 Trip Rate Adjustment Factors	2006 PT Usage Adjustment Factors
< 14	0.756	0.781
15 to 24	0.704	1.537
25 to 44	1.316	1.091
45 to 64	1.198	0.795
> 65	0.336	0.705

Source: MRC, Transport Modelling and Analysis 2006/2011, Study Report – Final (p. 25)

2.1.3 Generalised Costs

Previous household travel surveys revealed trip-maker behaviour and perceptions, which served as the basis for estimating generalised cost function parameters, as shown in *Table 5*.

Table 5: ACTPLA – Primary Generalised Cost Elements

Elements	Key Influencing Factors	Base Year Value
Travel Time	Distance, Operating Speeds, Lane Capacity (Volume Delay Functions)	Defined for each link
	Traffic Volumes	Identified through network assignments
Operating Cost	Fixed Vehicle Operating Cost	$0.13/km
	Fuel Price ($/L) Fuel Cost per km ($/km)	$1.03/L $0.09/km
	Value of Time	$10/h

Elements	Key Influencing Factors	Base Year Value
Road User Charges	Parking Charges	Defined by area and factored with the Parking Charge Factor
	Public Transport Fares	Based on base year fares
	Tolls, etc.	Not implemented in current modelling framework

Source: MRC, ACT Strategic Public Transport Network Plan – Final Report (p. 57)

SMEC utilised the same highway generalised cost used by MRC in updating the EMME/2 model for the ACT Government, which is given by:

$$C_H = (TT \cdot VOT) + [(VOC + FCC) \cdot D] + C_{Park}$$

where

TT : zone to zone travel time (h)
VOT : Value of Time ($/h)
VOC : Vehicle Operating Cost ($/veh-km)
FCC : Fuel Consumption Cost ($/veh-km)
D : zone to zone travel distance (km)
C_{Park} : parking cost ($)

The FCC is the product of the average fuel consumption (FC; L/veh-km) and the estimated fuel cost ($FCost$; $/L). With the assumption that FC is constant throughout the forecast years at 0.09L/veh-km and $FCost$ increases such that it is $1.00/L in 2006, $1.50/L in 2011, $1.75/L in 2021 and $2.00/L in 2031, the corresponding FCC values for the modelled years will be *$0.09/veh-km*, *$0.135/veh-km*, *$0.1575/veh-km* and *$0.18/veh-km*, respectively.

The public transport generalised cost function mainly include travel time and fare costs. Travel time in public transport however also includes the variables and corresponding weights as outlined in ***Table 6***.

Table 6: Public Transport Travel Time Variables and the Corresponding Weights

Variable	Weight
Walk Time	1.15
Wait Time	1.2
Boarding Time	1.1
Travel Time (In-vehicle)	1

Source: MRC, ACT Strategic Public Transport Network Plan – Final Report (p. 57)

2.1.4 Trip Distribution

The trip distribution impedance function is assumed to be exponential in form given by:

$$f(d_{ij}) = e^{-c \cdot (d_{ij})}$$

where

$f(d_{ij})$: impedance function
d_{ij} : impedance from zone i to zone j
c : exponential function parameter; $c > 0$

The assumed values of c for different trip purposes were taken from the study report by MRC and are given in ***Table 7.***

Table 7: Assumed c Values for the Exponential Impedance Function

Trip Purpose	c
Work	0.256
Education	0.608
Other	0.494

Source: MRC, Transport Modelling and Analysis 2006/2011, Study Report – Final (p. 30)

2.1.5 Modal Split

The transport models developed only considered two modes – passenger cars (PC) and public transportation (PT). The proportion of trips opting to use public transportation was estimated using the following equation:

$$P_{PT} = \frac{1}{1 + e^{\lambda(C_H - C_{PT}) + \alpha}}$$

where

P_{PT} : proportion of public transport trips
λ : spread parameter
C_H : highway generalised cost
C_{PT} : public transport generalised cost
α : mode constant

The parameter values used for the mode choice equation given above are summarised in *Table 8.*

Table 8: Mode Choice Function Parameters

Trip Purpose	Spread Parameter	Constant
Work	-0.27	0.66
Education	-0.2	0.2
Other	-0.3	3

Source: MRC, Transport Modelling and Analysis 2006/2011, Study Report – Final (p. 32)

2.2 Micro-Simulation Modelling

Traffic micro-simulation was conducted to estimate operational parameters for both the 'base' and 'upgrade' cases. Micro-simulation of traffic is a preferred, and usually necessary, exercise to further investigate and assess traffic impacts of the potential network changes in any given study area. Outputs produced by strategic modelling packages can only provide results on a macroscopic level and can never analyse operational issues like vehicle queues and weaving sections. Detailed information on the impacts of minute changes in the network can also be obtained providing analysts and decision-makers a wealth of insight as to how capacity augmentation measures and network system improvements should proceed. It is thus a very useful tool, especially when comparing traffic operations between different, but somewhat similar design alternatives.

Quadstone Paramics is the traffic micro-simulation software of choice by SMEC. This is a suite of software tools that can be used to individually model vehicle behaviour and movement on any given road network. Paramics provides a visualisation of road network and traffic demands using a graphical user interface and has already been used in a number of previous SMEC projects, as well as ongoing ones.

2.2.1 Model Calibration

The existing Paramics model was calibrated by adjusting the default parameters in the standard behavioural models contained in the micro-simulation software to local conditions. This relied mainly on the RTA default Paramics input files.

2.2.2 Matrix Estimation

Origin-Destination (OD) matrices for forecast years 2006, 2011, 2021 and 2031 were obtained from SMEC's strategic transport model of the ACT. As mentioned earlier, these outputs were then used as the demand inputs for the subsequent micro-simulation modelling done in Paramics.

2.2.3 Micro-Simulation In Paramics

Assignment runs were conducted for the existing road network and the considered network option as listed in *Table 9*. Network layouts are shown in Figures 1 through 4. It should be noted that although Majura Parkway is still assumed to be under construction in 2011, a model run for this year was necessary to determine the benefits for the years 2012 to 2020 (through interpolation).

Table 9: Paramics Runs

	2006 AM	2011 AM	2021 AM	2031 AM
Do Nothing	✓	✓	✓	✓
Upgrade Case	-	✓	✓	✓

3 ECONOMIC ANALYSIS

In order to assess the economic feasibility of constructing the Majura Parkway, an analysis of the costs and benefits of the project against the 'do nothing' scenario was undertaken over a 30 year period. Through this process the Net Present Value (NPV) and Benefit Cost Ratio (BCR), associated with the full implementation of the Majura Parkway design and construction in the first 3 years of the analysis period, were estimated. The Australia Transport Council (ATC) *National Guidelines for Transport System Management in Australia* recommends a 30 year life for road projects and a 'much longer life' for bridges. The Majura Parkway has several major bridges and therefore the economic life of the project has been assumed to be 40 years, which still leaves it with a 10 year residual value after the 30 year evaluation period.

3.1 Construction And Maintenance Costs

Capital construction costs and maintenance life costs were estimated relating to the implementation of the Majura Parkway.

Table 10 below indicates the P90 cost estimate of the project design and construction costs. Although the estimate is still subject to further detailed design, it provides a broad overview of the magnitude of costs, which is considered appropriate for economic analysis purposes at this stage.

Table 10: Initial Project Costs

Option	Project Cost ($,000)
Do Nothing	0
Upgrade Case	287,962

It was assumed that there will be no capital costs associated with the Do Nothing case. This is due to the fact that the existing Majura Road will be retained in the Upgrade Case so the costs for this section of road will be the same in both cases.

A simplified maintenance cost was also calculated for the analysis. The cyclic maintenance was assumed to occur every 5 years from the year of work completion and opening to traffic. The cyclic maintenance cost was estimated as 0.5% of the construction cost for the first application and then for the remaining applications was estimated as 1% of the construction cost. Similarly for annual maintenance, its cost was estimated as 0.125% of the construction cost for the initial years of application prior to the first cyclic maintenance, and this is raised to 0.25% of the construction cost in the succeeding years of application. In years that cyclic maintenance is applied, the annual maintenance cost is assumed to be $0.

It was assumed that construction will commence in 2013 and be finished in 2014. 40% of the project cost would be incurred in 2013.

3.2 Travel Related Costs

Several indicators of travel were obtained as output from the Paramics runs in the AM peak, namely the number of Vehicle Kilometres Travelled (VKT), the number of Vehicle Hours Travelled (VHT) as well as the mean speed. These were obtained for the years 2006, 2011, 2021 and 2031. The annual stream of VKT and VHT was estimated over a

30 year period with annual values interpolated between modelled values in 2006, 2011, 2021 and 2031. The growth between 2021 and 2031 was used to extrapolate values for 2038. These were used to estimate the benefits for the existing condition continuing as well as for the upgraded network option. For each, the following travel related costs was estimated:

- Vehicle Operating Cost (VOC): this is dependent on the number of Vehicle-Kilometres Travelled (VKT) as well as on the Vehicle Operating Cost per km (VOC/km) obtained from the Austroads RUC Update to 2007 Manual. These costs include road user time costs.
- Accident Cost (AC): this is dependent on the VKT as well as on the accident rate per Million Vehicle-Kilometres Travelled (MVKT) obtained from the RTA Economic Analysis Manual
- Environmental Cost (EC): this is dependent on the VKT as well as on the environmental externalities cost per Vehicle-Kilometres Travelled (VKT) obtained from the RTA Economic Analysis Manual
- Generate Traffic Benefit: This is based on the difference in VKT between the Base and Option and reflects the diversion of existing traffic from outside the study area onto the new facilities.

The following sections detail the exact methodology used for estimating each of these costs:

3.2.1 Vehicle Operating Cost

Vehicle operating cost (VOC) is a function of kilometres travelled and VOC/km. From the most recent update of road user cost (RUC) values (to June 2007) by Austroads, the equation to estimate vehicle operating cost is given by:

$$c = A + \frac{B}{V} + C \cdot V + D \cdot V^2$$

where:

c	= vehicle operating cost (cents/km)
A, B, C, D	= model coefficients
V	= all day average link speed

This study considers four types of vehicles, namely private cars, business cars, light commercial vehicles and articulated trucks. Vehicle composition is calculated from the actual counts conducted by Datacol in 2007, and is shown in *Table **11**.* The proportions used for this study are figures for peak hours.

Table 11: Vehicle Fleet Composition

	Car	Light Commercial	Articulated Truck
Peak Hour	92	5	3

The annual VOC per vehicle type are calculated using the product of the total VKT each year and the estimated VOC per kilometre. The VKT for each vehicle type are calculated by multiplying the total VKT by the proportion of each vehicle type. The VOC per kilometre

of each vehicle type is estimated by applying the corresponding model coefficients, given in *Table 12* (At-Grade Roads), to the abovementioned equation.

Table 12: Estimated VOC Parameters for All At-Grade Roads (Austroads 2007)

VOC Model Coefficient (At-Grade Roads)				
Vehicle Type	**A**	**B**	**C**	**D**
Cars	2.185 (2.185)	3352.21 (976.21)	0.05711 (0.05711)	0.0005795 (0.0005795)
LCV	-3.096 (-3.096)	3863.48 (2092.48)	0.19609 (0.19609)	0.0005658 (0.0005658)
HCV + Buses	5.885 (5.885)	9182.53 (5471.53)	0.58625 (0.58625)	0.0002108 (0.0002108)

Note: Values in brackets are estimated parameters for VOC only specification, while estimated parameter values outside brackets are for VOC plus person time costs (commercial, freight and private time)

Travel time costs are already incorporated in the estimated VOCs, so the benefits derived from reduced travel times are included in the VOC savings.

3.2.2 Accident Costs

The expected number of accidents by type is a function of kilometres travelled. It is a known phenomenon that the more kilometres travelled, the higher the probability of being involved in an accident. *Table 13* shows the average cost of accidents per Million VKT by road type. For the Option case, the proportion of VKT travelled on each road type was calculated. The majority of the road network in the study area is assumed to be Arterial. Majura Parkway is assumed to be Freeway.

For the Base Case, accident records for Majura Rd for the period 01/01/2003 to 30/09/2008 were obtained. From these records, using the RTA average cost for each type of accident (Property Only, Injury and Fatal) the average crash cost per MVKT was found to be $50,587.87. This is higher than the average arterial cost per MVKT as defined by the RTA.

Table 13: Adopted Accident Rates and Costs

Road Type	Average Crash Cost ($/MVKM)
Arterial	45,800
Freeway	14,300
Majura Rd (Existing)	50,588

The Accident Costs (AC) is a summation of all the costs expected to be incurred as a result of occurrence of different types of accidents. The formulation for this computation is as follows:

$$AC_{option} = \left(\frac{Cost}{MVKT_{(Arterial)}} \times MVKT_{(Arterial)} \right)$$

3.2.3 Annualisation Factor

An annualisation factor was calculated based on Roads ACT counts. This was applied to the AM peak VOC and AC in order to estimate the annual incurred costs over the evaluation period. The expansion factor was estimated by applying the existing peak hour to daily flow ratio.

$$AnnualCosts_{option} = \left(VOC_{(option)} + AC_{(option)}\right) \times AnnualisationFactor$$

3.3 Generated Traffic

From the *National Guidelines for Transport System Management in Australia, Volume 3 (Appraisal of Initiatives)* published by the Australian Transport Council (ATC), 'existing traffic' is traffic that uses the infrastructure affected in both the base and upgrade scenarios. Traffic demand in excess of this that results from the implementation of the infrastructure improvement is considered 'diverted' or 'generated' traffic. This simply means that this demand came from somewhere outside the study area, and is *not* new demand induced by the upgrade.

After the Majura Parkway is implemented, it is expected that some traffic from the external network (i.e. outside the modelled study area) will go through the study area because of improved traffic operations. The benefits derived due to this generated traffic can be calculated by estimating the consumers' surplus gain, given by:

$$GTB = \frac{1}{2}(P_1 - P_2) \cdot (Q_2 - Q_1)$$

where:

GTB	= generated traffic benefit
P_1	= perceived price (assumed to be the sum of *VOC* and *AC*) for the base case
P_2	= perceived price (assumed to be the sum of *VOC* and *AC*) for the upgrade case
Q_1	= demand (converted to *VKT*) for the base case
Q_2	= demand (converted to *VKT*) for the upgrade case

3.4 Residual Value

A road construction project is expected to have no residual value (*RV*) left by the end of its economic life. For the Majura Parkway option, the economic life of the project is assumed to be 40 years. The residual value at the end of the appraisal period of 30 years is estimated as the present value of benefits for the remaining life of the asset for the remaining 10 years of the assumed 40-year economic life. This procedure for calculating

the residual value is suggested by the *National Guidelines for Transport System Management in Australia, Volume 3 (Appraisal of Initiatives)* published by the Australian Transport Council (ATC).

3.5 Environmental Externalities

The RTA Manual includes monetary values for environmental externalities (noise, air pollution, water pollution, etc) and these are mainly shown as functions of VKT. Environmental externalities (*EE*) are known to be functions not only of kilometres travelled but also of traffic operating speed (i.e. it increases with kilometres travelled and reduces with the increase in operating speeds). The Majura Parkway (upgraded network) option is expected to increase the operating speed for the expected traffic as well as to increase the number of vehicle kilometres travelled. In this context the RTA values are not sufficient to compare and assess the full impact of the environmental externalities.

However, some partial benefit may be estimated from the generated traffic outside the study area. This is mainly that portion of the future demand that will not have passed through the study area without the Majura Parkway. These are assumed to be traffic that are diverted from the external network (i.e. road networks outside the study area), which are then subsequently assumed to be more highly urbanised than the areas surrounding the Majura Parkway. With these assumptions, the environmental costs caused by these 'redirected' traffic should then be reduced once they opt to go through the Majura Parkway, which is in a more 'rural' setting than their original route choices. In other words, environmental impacts at or near the City Centre are reduced through the diversion of this demand to the Majura Parkway. The RTA costs for environmental externalities are classified according to urban and rural settings, as shown in *Table **14***. The *EE* benefits (albeit partial), or environmental cost savings (*ECS*), can then be estimated by getting the difference between the environmental costs of the diverted traffic from an urban to a rural setting.

Table 14: Environmental Externality Values per Veh-km for Passenger Cars and Buses (Economic Analysis Manual, RTA)

Environmental Externality	Passenger Vehicles (cents/veh-km)		Buses (cents/veh-km)	
	Urban	Rural	Urban	Rural
Noise	0.83	0.00	2.03	0.00
Air Pollution	2.58	0.03	29.08	0.00
Water Pollution	0.39	0.04	4.36	0.04
Greenhouse	2.03	2.03	11.98	11.98
Nature and Landscape	0.05	0.48	0.13	1.32
Urban Separation	0.60	0.00	1.92	0.00

3.6 Carbon Cost

The expected amount of Carbon Dioxide Equivalent (CO_2-e) emissions was calculated for both the base case and the project case. The methodology for calculating the carbon emissions did not use the micro-simulation model of the study area. Instead, the total fuel

consumption for the Canberra and Queanbeyan urban area was calculated from the strategic transport model using the following equation:

$$c = A + \frac{B}{V} + C \cdot V + D \cdot V^2$$

where:

c	= vehicle operating cost (cents/km)
A, B, C, D	= model coefficients
V	= all day average link speed

The coefficients used for fuel consumption were as shown in *Table* ***15***.

Table 15: Estimated Fuel Consumption Parameters for All At-Grade Roads (Austroads, 2007)

VOC Model Coefficient (At-Grade Roads)				
Vehicle Type	**A**	**B**	**C**	**D**
Cars	0.863	542.92	0.01333	0.0005847

The modelling was performed for 2011 and 2031 with other years interpolated and extrapolated from these values.

The total fuel consumption was then converted to CO_2-e emissions using a rate of 2.38 kt CO_2-e per ML of fuel (as per *National Greenhouse and Energy Reporting (Measurement) Determination 2008*, Department of Climate Change and Energy Efficiency).

For the analysis, it was assumed that the price of carbon would rise from $10/tonne CO_2-e in 2011 to $80/tonne CO_2-e in 2040 (2011 dollars).

3.7 Majura Parkway Benefits

The total expected benefits to be derived from constructing the Majura Parkway are estimated by calculating the savings of the upgrade option (Ultimate Majura Parkway) as compared to the base option ('do nothing') in terms of *VOC* savings, *TTC* savings, *AC* savings, the residual value (*RV*) after the 30-year appraisal period, and the environmental cost savings (*ECS*). Values of such savings for each option are depicted in *Table* ***16***. The formulation for this computation is as follows:

$$Benefits = \left(VOC_{Upgrade} - VOC_{Base}\right) + \left(AC_{Upgrade} - AC_{Base}\right) + GTB + RV + ECS$$

It is assumed that there will be no partial benefits obtained during the second year of construction. Full benefits will be obtained during the first year of opening, which is the third year of the project life.

3.8 Benefit Cost Ratio

In order to compare the costs and benefits of the proposed option relative to the existing road network over the evaluation period, the change in monetary values over time needs to be accounted for. This is achieved by discounting the annual costs and benefits of the project to the present year using a range of discount rates (4%, 7%, and 10%). The

normal indicators of the worth of a project, the NPV and BCR, for each option were estimated for each of these discount rates.

If the discounted present value of the benefits exceeds the discounted present value of the costs, then the project is worthwhile. This is equivalent to the condition that the net benefit must be positive. Another equivalent condition is that the ratio of the present value of the benefits to the present value of the costs must be greater than one

The results of the economic analysis of implementing the Majura Parkway, in varying discount rates, are shown in the succeeding tables. *Table 16* outlines the present values of costs and benefits for each of the considered options while *Table 17* summarises the resulting NPVs and BCRs.

Table 16 : Present Values of Costs and Benefits

Discount Rate	PV of Costs ($,000)	PV of Benefits ($,000)
4%	285,045	1,431,123
7%	268,052	890,797
10%	254,014	597,408

Table 17: Resulting Economic Indicators

Discount Rate	NPV ($,000)	BCR
4%	1,146,078	5.02
7%	622,744	3.32
10%	343,395	2.35

All options produced positive NPVs and BCRs greater than 1. Detailed spreadsheets of the cost benefit analysis outputs are included in Appendix A.

3.9 Sensitivity Testing

A number of sensitivity tests were conducted to examine the effect of different scenarios on the economic analysis. These included:

- Variations in heavy vehicles due to freight facility development
- Higher than expected construction costs
- Lower than expected benefits
- Higher construction costs and lower benefits (worst case)
- Variations in the price of carbon

All of these sensitivity testing scenarios have been analysed using 4%, 7% and 10% discount rates.

The results of these sensitivity tests are presented in the following sections. Please refer to Appendix A for detailed economic analysis spreadsheets for these options.

3.9.1 Sensitivity of Results to Airport Freight Hub

The Canberra Airport Master Plan has been approved recently and this involves the implementation of a 24-hour freight hub. Although this is expected to increase the total amount of total daily traffic, this does not necessarily mean that heavy vehicle traffic will increase during peak hours. In fact, extending the hours of freight operations in the airport could potentially spread freight demand throughout a single day, possibly even reducing heavy vehicle traffic during peak hours (if freight traffic going to and coming from the airport is managed accordingly).

Changing the proportion of heavy vehicle traffic can either have a positive or a negative effect on the economic indicators. Reducing truck traffic is expected to result in better overall network performance (i.e. higher average speeds, etc), thus also reducing travel costs. Intuitively, increasing the heavy vehicle percentage should then mean a decrease in NPV and BCR. However, if the increase in trucks does not significantly affect network performance and remains relatively similar to the reference scenario (currently 8% heavy vehicles), then an increase in benefits may be achieved. This is mainly due to the higher travel costs associated with commercial/heavy vehicles. The reduction in economic indicators will only occur if the amount of increase in heavy vehicle proportion is high enough to significantly contribute to the deterioration of overall network performance.

To test the sensitivity of the economic indicators to the variation in heavy vehicle proportions, additional cost-benefit analyses were performed assuming varying levels of heavy vehicles travelling to and from Canberra International Airport. The percentage of heavy vehicles currently in the study area is 8% (5% Light Commercial and 3% Articulated Trucks) in the current model, as indicated in *Table 11*. This was changed to 6%, 10% and 12% to test the sensitivity of the results and the results are presented in *Table 18*.

At 6%, the estimated NPVs and BCRs increased, which can be attributed to higher average speeds due to reduced truck volumes. At 10%, the resulting NPVs and BCRs still improved if compared to the 8% heavy vehicle scenario. In this case, the impact of the increased truck volumes are not yet high enough to offset the additional travel cost savings associated with the higher number of heavy vehicles. Having 12% heavy vehicles however resulted in reduced economic indicators, as shown in *Table 18*.

Table 18: Economic Indicators Assuming Varying Heavy Vehicles

Discount Rate	6% HV		10% HV		12% HV	
	NPV ($,000)	BCR	NPV ($,000)	BCR	NPV ($,000)	BCR
4%	1,238,004	5.34	1,165,259	5.09	1,033,970	4.63
7%	660,038	3.46	614,609	3.29	540,503	3.02
10%	357,308	2.41	326,452	2.29	281,485	2.11

3.9.2 Higher Construction Costs

While the construction costs have been estimated with some accuracy, there remains the possibility that they could be higher than anticipated. *Table **19*** shows the economic indicators assuming that construction costs are 20% higher than currently estimated.

Table 19: Economic Indicators Assuming 20% Higher Construction Costs

Discount Rate	NPV ($,000)	BCR
4%	1,089,069	4.18
7%	569,134	2.77
10%	292,592	1.96

3.9.3 Lower Benefits

Detailed modelling has been carried out to calculate the demand and resulting benefits for the Majura Parkway project. However, there are many unknowns when performing demand forecasting and demand could be lower than anticipated. *Table **20*** shows the economic indicators for the project assuming that benefits are 20% lower than the demand forecasting has calculated.

Table 20: Economic Indicators Assuming 20% Lower Benefits

Discount Rate	NPV ($,000)	BCR
4%	825,079	3.89
7%	429,768	2.60
10%	217,449	1.86

3.9.4 Worst Case (Higher Construction Costs and Lower Benefits)

In the unlikely case that both the construction costs and demand forecasting are incorrect, a worst case scenario was developed that assumed the construction costs would be 20% higher than currently estimated and the benefits would be 20% lower than anticipated. The results of this scenario are shown in *Table **21***.

Table 21: Economic Indicators Assuming 20% Higher Construction Costs and 20% Lower Benefits

Discount Rate	NPV ($,000)	BCR
4%	768,070	3.25
7%	376,158	2.17
10%	166,647	1.55

3.9.5 Variations in the Price of Carbon

For the economic analyses conducted in the preceding sections, it was assumed that the price of carbon would rise from \$10/tonne CO_2-e in 2011 to \$80/tonne CO_2-e in 2040 (2011 dollars). The economic analysis was also conducted for two other carbon price assumptions:

- The price of carbon would stay at \$10/tonne CO_2-e for the project life.
- The price of carbon would rise to \$130/tonne CO_2-e in 2040

The results of the economic analyses for these two scenarios are shown in *Table* **22.**

Table 22: Economic Indicators Assuming Variations in the Price of Carbon

Discount Rate	\$10/tonne		\$130/tonne	
	NPV (\$,000)	BCR	NPV (\$,000)	BCR
4%	1,050,283	4.68	1,241,509	5.36
7%	577,115	3.15	667,338	3.49
10%	320,794	2.26	364,946	2.44

4 CONCLUSIONS

Future demand and traffic operational conditions were modelled to determine the difference in network performance between the three considered options. The most recent land use assumptions for the years 2011, 2021 and 2031, provided by the ACT Government, were used as inputs during the modelling process. The modelling process was consistent with the strategic transport model owned by the ACT Government.

Benefits derived from the construction of Majura Parkway were estimated by calculating the cost savings for each option. These savings were mainly the differences between travel related costs associated with the 'do nothing' scenario and those associated with the upgrade cases (i.e. Majura Parkway). In addition to these travel cost savings, other benefits that were estimated include the generated traffic benefits, residual value of the project (after 30 years) environmental cost savings and carbon cost reductions.

The economic assessment results show that the project can be considered economically feasible, given that the analysis produced positive NPVs and BCRs greater than 1.

The sensitivity of the economic indicators was tested for the following cases:

- Variations in heavy vehicle proportions
- Variation in construction costs
- Variations in benefits
- Variations in discount rates
- Variations in carbon pricing

For all cases, the project was found to be economically feasible.

APPENDIX A: ECONOMIC ANALYSIS TABLES

Majura Parkway Economic Analysis										
	COSTS (shown as -ve)			BENEFITS (shown as +ve)						TOTALS
	Current Prices			*Current Prices*						
YEAR	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	*Current Prices* ($'000)
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$44,030	$712	$10,627	$1,070	$121	$0	$56,200
2016	$0	($360)	$0	$45,471	$711	$10,923	$1,120	$149	$0	$58,014
2017	$0	($360)	$0	$47,151	$709	$11,227	$1,173	$181	$0	$60,081
2018	$0	($360)	$0	$49,119	$706	$11,540	$1,228	$217	$0	$62,451
2019	$0	$0	($1,440)	$51,434	$703	$11,861	$1,286	$258	$0	$64,103
2020	$0	($720)	$0	$54,167	$698	$12,192	$1,347	$305	$0	$67,989
2021	$0	($720)	$0	$57,405	$693	$12,531	$1,410	$358	$0	$71,677
2022	$0	($720)	$0	$57,614	$681	$12,782	$1,477	$480	$0	$72,314
2023	$0	($720)	$0	$57,855	$669	$13,038	$1,546	$632	$0	$73,020
2024	$0	$0	($2,880)	$58,127	$656	$13,300	$1,619	$823	$0	$71,645
2025	$0	($720)	$0	$58,432	$644	$13,566	$1,695	$1,062	$0	$74,678
2026	$0	($720)	$0	$58,770	$631	$13,838	$1,775	$1,358	$0	$75,652
2027	$0	($720)	$0	$59,144	$617	$14,115	$1,859	$1,725	$0	$76,740
2028	$0	($720)	$0	$59,553	$604	$14,398	$1,946	$2,179	$0	$77,960
2029	$0	$0	($2,880)	$59,999	$590	$14,686	$2,038	$2,739	$0	$77,173
2030	$0	($720)	$0	$60,484	$575	$14,980	$2,134	$3,428	$0	$80,882
2031	$0	($720)	$0	$61,008	$561	$15,280	$2,054	$4,274	$0	$82,457
2032	$0	($720)	$0	$61,573	$546	$15,587	$2,132	$5,310	$0	$84,428
2033	$0	($720)	$0	$62,180	$530	$15,899	$2,214	$6,577	$0	$86,681
2034	$0	$0	($2,880)	$62,831	$515	$16,217	$2,299	$8,124	$0	$87,106
2035	$0	($720)	$0	$63,527	$499	$16,542	$2,387	$10,011	$0	$92,245
2036	$0	($720)	$0	$64,269	$482	$16,874	$2,478	$12,308	$0	$95,691
2037	$0	($720)	$0	$65,059	$465	$17,212	$2,573	$15,102	$0	$99,691
2038	$0	($720)	$0	$65,899	$448	$17,556	$2,672	$18,495	$0	$104,351
2039	$0	$0	($2,880)	$66,790	$431	$17,908	$2,774	$22,612	$0	$107,636
2040	$0	($720)	$0	$67,735	$413	$18,267	$2,881	$27,602	$0	$116,177
2041	$0	($720)	$0	$68,735	$394	$18,633	$2,991	$33,643	$0	$123,676
2042	$0	($720)	$0	$69,792	$375	$19,006	$3,105	$40,952	$704,931	$837,441
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,658,152**	**$16,255**	**$410,587**	**$55,286**	**$221,027**	**$704,931**	**$2,750,200**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$880,905	$9,439	$214,275	$27,617	$81,543	$217,343	$1,146,078
PV @ 7%	($258,560)	($5,293)	($4,200)	$591,033	$6,711	$142,179	$17,748	$40,521	$92,605	$622,744
PV @ 10%	($247,505)	($3,709)	($2,800)	$418,957	$4,998	$99,916	$12,111	$21,028	$40,399	$343,395

Discount Rate	**4%**	**7%**	**10%**
NPV ('000)	$1,146,078	$622,744	$343,395
BCR	5.02	3.32	2.35

Majura Parkway Economic Analysis (6% Heavy Vehicles)										
YEAR	COSTS (shown as -ve) *Current Prices*			BENEFITS (shown as +ve) *Current Prices*						TOTALS
	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	*Current Prices ($'000)*
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$44,962	$712	$10,852	$1,070	$121	$0	$57,356
2016	$0	($360)	$0	$45,646	$711	$10,966	$1,120	$149	$0	$58,232
2017	$0	($360)	$0	$46,529	$709	$11,081	$1,173	$181	$0	$59,313
2018	$0	($360)	$0	$47,647	$706	$11,198	$1,228	$217	$0	$60,636
2019	$0	$0	($1,440)	$49,042	$703	$11,315	$1,286	$258	$0	$61,164
2020	$0	($720)	$0	$50,765	$698	$11,434	$1,347	$305	$0	$63,829
2021	$0	($720)	$0	$52,876	$693	$11,555	$1,410	$358	$0	$66,172
2022	$0	($720)	$0	$53,854	$681	$11,958	$1,477	$480	$0	$67,730
2023	$0	($720)	$0	$54,880	$669	$12,376	$1,546	$632	$0	$69,383
2024	$0	$0	($2,880)	$55,955	$656	$12,809	$1,619	$823	$0	$68,983
2025	$0	($720)	$0	$57,083	$644	$13,256	$1,695	$1,062	$0	$73,020
2026	$0	($720)	$0	$58,266	$631	$13,720	$1,775	$1,358	$0	$75,030
2027	$0	($720)	$0	$59,508	$617	$14,199	$1,859	$1,725	$0	$77,189
2028	$0	($720)	$0	$60,812	$604	$14,695	$1,946	$2,179	$0	$79,517
2029	$0	$0	($2,880)	$62,180	$590	$15,209	$2,038	$2,739	$0	$79,877
2030	$0	($720)	$0	$63,617	$575	$15,741	$2,134	$3,428	$0	$84,775
2031	$0	($720)	$0	$65,126	$561	$16,291	$2,054	$4,274	$0	$87,585
2032	$0	($720)	$0	$66,711	$546	$16,860	$2,132	$5,310	$0	$90,839
2033	$0	($720)	$0	$68,377	$530	$17,449	$2,214	$6,577	$0	$94,428
2034	$0	$0	($2,880)	$70,127	$515	$18,059	$2,299	$8,124	$0	$96,244
2035	$0	($720)	$0	$71,967	$499	$18,690	$2,387	$10,011	$0	$102,833
2036	$0	($720)	$0	$73,900	$482	$19,343	$2,478	$12,308	$0	$107,793
2037	$0	($720)	$0	$75,933	$465	$20,019	$2,573	$15,102	$0	$113,373
2038	$0	($720)	$0	$78,070	$448	$20,719	$2,672	$18,495	$0	$119,685
2039	$0	$0	($2,880)	$80,318	$431	$21,443	$2,774	$22,612	$0	$124,699
2040	$0	($720)	$0	$82,682	$413	$22,193	$2,881	$27,602	$0	$135,050
2041	$0	($720)	$0	$85,169	$394	$22,968	$2,991	$33,643	$0	$144,446
2042	$0	($720)	$0	$87,785	$375	$23,771	$3,105	$40,952	$860,035	$1,015,303
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,769,788**	**$16,255**	**$440,171**	**$55,286**	**$221,027**	**$860,035**	**$3,046,524**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$915,576	$9,439	$223,709	$27,617	$81,543	$265,165	$1,238,004
PV @ 7%	($258,560)	($5,293)	($4,200)	$604,189	$6,711	$145,941	$17,748	$40,521	$112,980	$660,038
PV @ 10%	($247,505)	($3,709)	($2,800)	$422,725	$4,998	$101,173	$12,111	$21,028	$49,287	$357,308

Discount Rate	**4%**	**7%**	**10%**
NPV ('000)	**$1,238,004**	**$660,038**	**$357,308**
BCR	**5.34**	**3.46**	**2.41**

Majura Parkway Economic Analysis (10% Heavy Vehicles)										
	COSTS (shown as -ve) *Current Prices*			BENEFITS (shown as +ve) *Current Prices*						TOTALS
YEAR	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	*Current Prices* ($'000)
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$41,192	$712	$9,810	$1,070	$121	$0	$52,545
2016	$0	($360)	$0	$42,209	$711	$9,997	$1,120	$149	$0	$53,826
2017	$0	($360)	$0	$43,422	$709	$10,188	$1,173	$181	$0	$55,312
2018	$0	($360)	$0	$44,866	$706	$10,382	$1,228	$217	$0	$57,039
2019	$0	$0	($1,440)	$46,583	$703	$10,580	$1,286	$258	$0	$57,971
2020	$0	($720)	$0	$48,626	$698	$10,782	$1,347	$305	$0	$61,038
2021	$0	($720)	$0	$51,054	$693	$10,987	$1,410	$358	$0	$63,783
2022	$0	($720)	$0	$51,941	$681	$11,344	$1,477	$480	$0	$65,202
2023	$0	($720)	$0	$52,875	$669	$11,712	$1,546	$632	$0	$66,714
2024	$0	$0	($2,880)	$53,858	$656	$12,092	$1,619	$823	$0	$66,169
2025	$0	($720)	$0	$54,894	$644	$12,485	$1,695	$1,062	$0	$70,059
2026	$0	($720)	$0	$55,985	$631	$12,890	$1,775	$1,358	$0	$71,918
2027	$0	($720)	$0	$57,133	$617	$13,308	$1,859	$1,725	$0	$73,923
2028	$0	($720)	$0	$58,344	$604	$13,740	$1,946	$2,179	$0	$76,093
2029	$0	$0	($2,880)	$59,618	$590	$14,186	$2,038	$2,739	$0	$76,292
2030	$0	($720)	$0	$60,961	$575	$14,646	$2,134	$3,428	$0	$81,025
2031	$0	($720)	$0	$62,376	$561	$15,122	$2,054	$4,274	$0	$83,666
2032	$0	($720)	$0	$63,867	$546	$15,612	$2,132	$5,310	$0	$86,747
2033	$0	($720)	$0	$65,437	$530	$16,119	$2,214	$6,577	$0	$90,158
2034	$0	$0	($2,880)	$67,092	$515	$16,642	$2,299	$8,124	$0	$91,792
2035	$0	($720)	$0	$68,835	$499	$17,182	$2,387	$10,011	$0	$98,195
2036	$0	($720)	$0	$70,673	$482	$17,740	$2,478	$12,308	$0	$102,962
2037	$0	($720)	$0	$72,609	$465	$18,316	$2,573	$15,102	$0	$108,346
2038	$0	($720)	$0	$74,649	$448	$18,910	$2,672	$18,495	$0	$114,455
2039	$0	$0	($2,880)	$76,800	$431	$19,524	$2,774	$22,612	$0	$119,261
2040	$0	($720)	$0	$79,066	$413	$20,158	$2,881	$27,602	$0	$129,399
2041	$0	($720)	$0	$81,455	$394	$20,812	$2,991	$33,643	$0	$138,575
2042	$0	($720)	$0	$83,972	$375	$21,487	$3,105	$40,952	$815,382	$964,554
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,690,392**	**$16,255**	**$406,755**	**$55,286**	**$221,027**	**$815,382**	**$2,889,059**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$873,046	$9,439	$207,261	$27,617	$81,543	$251,398	$1,165,259
PV @ 7%	($258,560)	($5,293)	($4,200)	$575,188	$6,711	$135,378	$17,748	$40,521	$107,114	$614,609
PV @ 10%	($247,505)	($3,709)	($2,800)	$401,694	$4,998	$93,906	$12,111	$21,028	$46,728	$326,452

Discount Rate	4%	7%	10%
NPV ('000)	$1,165,259	$614,609	$326,452
BCR	5.09	3.29	2.29

Majura Parkway Economic Analysis (12% Heavy Vehicles)										
	COSTS (shown as -ve)			BENEFITS (shown as +ve)						TOTALS
	Current Prices			Current Prices						
YEAR	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	Current Prices ($'000)
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$40,173	$712	$9,529	$1,070	$121	$0	$51,244
2016	$0	($360)	$0	$40,771	$711	$9,592	$1,120	$149	$0	$51,983
2017	$0	($360)	$0	$41,571	$709	$9,656	$1,173	$181	$0	$52,930
2018	$0	($360)	$0	$42,608	$706	$9,720	$1,228	$217	$0	$54,120
2019	$0	$0	($1,440)	$43,925	$703	$9,785	$1,286	$258	$0	$54,517
2020	$0	($720)	$0	$45,573	$698	$9,850	$1,347	$305	$0	$57,053
2021	$0	($720)	$0	$47,611	$693	$9,916	$1,410	$358	$0	$59,268
2022	$0	($720)	$0	$48,237	$681	$10,155	$1,477	$480	$0	$60,309
2023	$0	($720)	$0	$48,912	$669	$10,399	$1,546	$632	$0	$61,439
2024	$0	$0	($2,880)	$49,638	$656	$10,650	$1,619	$823	$0	$60,507
2025	$0	($720)	$0	$50,418	$644	$10,907	$1,695	$1,062	$0	$64,006
2026	$0	($720)	$0	$51,255	$631	$11,170	$1,775	$1,358	$0	$65,469
2027	$0	($720)	$0	$52,152	$617	$11,439	$1,859	$1,725	$0	$67,072
2028	$0	($720)	$0	$53,111	$604	$11,714	$1,946	$2,179	$0	$68,836
2029	$0	$0	($2,880)	$54,137	$590	$11,997	$2,038	$2,739	$0	$68,622
2030	$0	($720)	$0	$55,233	$575	$12,286	$2,134	$3,428	$0	$72,936
2031	$0	($720)	$0	$56,402	$561	$12,582	$2,054	$4,274	$0	$75,152
2032	$0	($720)	$0	$57,648	$546	$12,885	$2,132	$5,310	$0	$77,801
2033	$0	($720)	$0	$58,976	$530	$13,196	$2,214	$6,577	$0	$80,773
2034	$0	$0	($2,880)	$60,389	$515	$13,514	$2,299	$8,124	$0	$81,961
2035	$0	($720)	$0	$61,893	$499	$13,840	$2,387	$10,011	$0	$87,910
2036	$0	($720)	$0	$63,493	$482	$14,173	$2,478	$12,308	$0	$92,215
2037	$0	($720)	$0	$65,193	$465	$14,515	$2,573	$15,102	$0	$97,128
2038	$0	($720)	$0	$66,998	$448	$14,864	$2,672	$18,495	$0	$102,758
2039	$0	$0	($2,880)	$68,915	$431	$15,223	$2,774	$22,612	$0	$107,075
2040	$0	($720)	$0	$70,949	$413	$15,590	$2,881	$27,602	$0	$116,714
2041	$0	($720)	$0	$73,107	$394	$15,965	$2,991	$33,643	$0	$125,381
2042	$0	($720)	$0	$75,396	$375	$16,350	$3,105	$40,952	$710,790	$846,249
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,544,686**	**$16,255**	**$341,461**	**$55,286**	**$221,027**	**$710,790**	**$2,573,467**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$803,345	$9,439	$177,921	$27,617	$81,543	$219,150	$1,033,970
PV @ 7%	($258,560)	($5,293)	($4,200)	$532,107	$6,711	$118,094	$17,748	$40,521	$93,374	$540,503
PV @ 10%	($247,505)	($3,709)	($2,800)	$373,515	$4,998	$83,112	$12,111	$21,028	$40,734	$281,485

Discount Rate	4%	7%	10%
NPV ('000)	$1,033,970	$540,503	$281,485
BCR	4.63	3.02	2.11

Majura Parkway Economic Analysis (Increased Costs)										
YEAR	COSTS (shown as -ve) Current Prices			BENEFITS (shown as +ve) Current Prices						TOTALS
	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	Current Prices ($'000)
2013	($138,222)	$0	$0	$0	$0	$0	$0	$0	$0	($138,222)
2014	($207,333)	$0	$0	$0	$0	$0	$0	$0	$0	($207,333)
2015	$0	($432)	$0	$44,030	$712	$10,627	$1,070	$121	$0	$56,128
2016	$0	($432)	$0	$45,471	$711	$10,923	$1,120	$149	$0	$57,942
2017	$0	($432)	$0	$47,151	$709	$11,227	$1,173	$181	$0	$60,009
2018	$0	($432)	$0	$49,119	$706	$11,540	$1,228	$217	$0	$62,379
2019	$0	$0	($1,728)	$51,434	$703	$11,861	$1,286	$258	$0	$63,815
2020	$0	($864)	$0	$54,167	$698	$12,192	$1,347	$305	$0	$67,845
2021	$0	($864)	$0	$57,405	$693	$12,531	$1,410	$358	$0	$71,533
2022	$0	($864)	$0	$57,614	$681	$12,782	$1,477	$480	$0	$72,170
2023	$0	($864)	$0	$57,855	$669	$13,038	$1,546	$632	$0	$72,876
2024	$0	$0	($3,456)	$58,127	$656	$13,300	$1,619	$823	$0	$71,069
2025	$0	($864)	$0	$58,432	$644	$13,566	$1,695	$1,062	$0	$74,534
2026	$0	($864)	$0	$58,770	$631	$13,838	$1,775	$1,358	$0	$75,508
2027	$0	($864)	$0	$59,144	$617	$14,115	$1,859	$1,725	$0	$76,596
2028	$0	($864)	$0	$59,553	$604	$14,398	$1,946	$2,179	$0	$77,816
2029	$0	$0	($3,456)	$59,999	$590	$14,686	$2,038	$2,739	$0	$76,597
2030	$0	($864)	$0	$60,484	$575	$14,980	$2,134	$3,428	$0	$80,738
2031	$0	($864)	$0	$61,008	$561	$15,280	$2,054	$4,274	$0	$82,313
2032	$0	($864)	$0	$61,573	$546	$15,587	$2,132	$5,310	$0	$84,284
2033	$0	($864)	$0	$62,180	$530	$15,899	$2,214	$6,577	$0	$86,537
2034	$0	$0	($3,456)	$62,831	$515	$16,217	$2,299	$8,124	$0	$86,531
2035	$0	($864)	$0	$63,527	$499	$16,542	$2,387	$10,011	$0	$92,101
2036	$0	($864)	$0	$64,269	$482	$16,874	$2,478	$12,308	$0	$95,547
2037	$0	($864)	$0	$65,059	$465	$17,212	$2,573	$15,102	$0	$99,547
2038	$0	($864)	$0	$65,899	$448	$17,556	$2,672	$18,495	$0	$104,207
2039	$0	$0	($3,456)	$66,790	$431	$17,908	$2,774	$22,612	$0	$107,060
2040	$0	($864)	$0	$67,735	$413	$18,267	$2,881	$27,602	$0	$116,033
2041	$0	($864)	$0	$68,735	$394	$18,633	$2,991	$33,643	$0	$123,532
2042	$0	($864)	$0	$69,792	$375	$19,006	$3,105	$40,952	$704,931	$837,297
Total	**($345,554)**	**($18,142)**	**($15,550)**	**$1,658,152**	**$16,255**	**$410,587**	**$55,286**	**$221,027**	**$704,931**	**$2,686,993**
PRESENT VALUES										
PV @ 4%	($324,596)	($9,556)	($7,902)	$880,905	$9,439	$214,275	$27,617	$81,543	$217,343	$1,089,069
PV @ 7%	($310,272)	($6,351)	($5,040)	$591,033	$6,711	$142,179	$17,748	$40,521	$92,605	$569,134
PV @ 10%	($297,005)	($4,451)	($3,359)	$418,957	$4,998	$99,916	$12,111	$21,028	$40,399	$292,592

Discount Rate	4%	7%	10%
NPV ('000)	$1,089,069	$569,134	$292,592
BCR	4.18	2.77	1.96

Majura Parkway Economic Analysis (Reduced Benefits)										
YEAR	COSTS (shown as -ve) Current Prices			BENEFITS (shown as +ve) Current Prices						TOTALS
	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	Current Prices ($'000)
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$35,224	$570	$8,502	$856	$97	$0	$44,888
2016	$0	($360)	$0	$36,377	$569	$8,739	$896	$119	$0	$46,339
2017	$0	($360)	$0	$37,721	$567	$8,982	$938	$144	$0	$47,993
2018	$0	($360)	$0	$39,295	$565	$9,232	$983	$174	$0	$49,888
2019	$0	$0	($1,440)	$41,147	$562	$9,489	$1,029	$207	$0	$50,994
2020	$0	($720)	$0	$43,334	$558	$9,753	$1,077	$244	$0	$54,247
2021	$0	($720)	$0	$45,924	$554	$10,025	$1,128	$287	$0	$57,198
2022	$0	($720)	$0	$46,091	$545	$10,226	$1,181	$384	$0	$57,707
2023	$0	($720)	$0	$46,284	$535	$10,431	$1,237	$506	$0	$58,272
2024	$0	$0	($2,880)	$46,501	$525	$10,640	$1,295	$659	$0	$56,740
2025	$0	($720)	$0	$46,745	$515	$10,853	$1,356	$849	$0	$59,599
2026	$0	($720)	$0	$47,016	$504	$11,070	$1,420	$1,086	$0	$60,378
2027	$0	($720)	$0	$47,315	$494	$11,292	$1,487	$1,380	$0	$61,248
2028	$0	($720)	$0	$47,642	$483	$11,518	$1,557	$1,744	$0	$62,224
2029	$0	$0	($2,880)	$48,000	$472	$11,749	$1,631	$2,192	$0	$61,163
2030	$0	($720)	$0	$48,387	$460	$11,984	$1,707	$2,743	$0	$64,562
2031	$0	($720)	$0	$48,807	$449	$12,224	$1,643	$3,419	$0	$65,822
2032	$0	($720)	$0	$49,259	$437	$12,469	$1,706	$4,248	$0	$67,398
2033	$0	($720)	$0	$49,744	$424	$12,719	$1,771	$5,262	$0	$69,200
2034	$0	$0	($2,880)	$50,265	$412	$12,974	$1,839	$6,499	$0	$69,109
2035	$0	($720)	$0	$50,821	$399	$13,234	$1,910	$8,009	$0	$73,652
2036	$0	($720)	$0	$51,415	$386	$13,499	$1,983	$9,847	$0	$76,409
2037	$0	($720)	$0	$52,047	$372	$13,769	$2,059	$12,082	$0	$79,609
2038	$0	($720)	$0	$52,719	$358	$14,045	$2,138	$14,796	$0	$83,337
2039	$0	$0	($2,880)	$53,432	$344	$14,327	$2,219	$18,090	$0	$85,533
2040	$0	($720)	$0	$54,188	$330	$14,614	$2,304	$22,082	$0	$92,798
2041	$0	($720)	$0	$54,988	$315	$14,906	$2,393	$26,915	$0	$98,797
2042	$0	($720)	$0	$55,833	$300	$15,205	$2,484	$32,761	$451,156	$557,020
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,326,522**	**$13,004**	**$328,470**	**$44,229**	**$176,821**	**$451,156**	**$2,024,164**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$704,724	$7,551	$171,420	$22,094	$65,234	$139,100	$825,079
PV @ 7%	($258,560)	($5,293)	($4,200)	$472,826	$5,369	$113,743	$14,198	$32,417	$59,267	$429,768
PV @ 10%	($247,505)	($3,709)	($2,800)	$335,166	$3,998	$79,933	$9,689	$16,823	$25,855	$217,449

Discount Rate	4%	7%	10%
NPV ('000)	$825,079	$429,768	$217,449
BCR	3.89	2.60	1.86

Majura Parkway Economic Analysis (Increased Costs and Reduced Benefits)										
YEAR	COSTS (shown as -ve) *Current Prices*			BENEFITS (shown as +ve) *Current Prices*						TOTALS
	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	*Current Prices* ($'000)
2013	($138,222)	$0	$0	$0	$0	$0	$0	$0	$0	($138,222)
2014	($207,333)	$0	$0	$0	$0	$0	$0	$0	$0	($207,333)
2015	$0	($432)	$0	$35,224	$570	$8,502	$856	$97	$0	$44,816
2016	$0	($432)	$0	$36,377	$569	$8,739	$896	$119	$0	$46,267
2017	$0	($432)	$0	$37,721	$567	$8,982	$938	$144	$0	$47,921
2018	$0	($432)	$0	$39,295	$565	$9,232	$983	$174	$0	$49,816
2019	$0	$0	($1,728)	$41,147	$562	$9,489	$1,029	$207	$0	$50,706
2020	$0	($864)	$0	$43,334	$558	$9,753	$1,077	$244	$0	$54,103
2021	$0	($864)	$0	$45,924	$554	$10,025	$1,128	$287	$0	$57,054
2022	$0	($864)	$0	$46,091	$545	$10,226	$1,181	$384	$0	$57,563
2023	$0	($864)	$0	$46,284	$535	$10,431	$1,237	$506	$0	$58,128
2024	$0	$0	($3,456)	$46,501	$525	$10,640	$1,295	$659	$0	$56,164
2025	$0	($864)	$0	$46,745	$515	$10,853	$1,356	$849	$0	$59,455
2026	$0	($864)	$0	$47,016	$504	$11,070	$1,420	$1,086	$0	$60,234
2027	$0	($864)	$0	$47,315	$494	$11,292	$1,487	$1,380	$0	$61,104
2028	$0	($864)	$0	$47,642	$483	$11,518	$1,557	$1,744	$0	$62,080
2029	$0	$0	($3,456)	$48,000	$472	$11,749	$1,631	$2,192	$0	$60,587
2030	$0	($864)	$0	$48,367	$460	$11,984	$1,707	$2,743	$0	$64,418
2031	$0	($864)	$0	$48,807	$449	$12,224	$1,643	$3,419	$0	$65,678
2032	$0	($864)	$0	$49,259	$437	$12,469	$1,706	$4,248	$0	$67,254
2033	$0	($864)	$0	$49,744	$424	$12,719	$1,771	$5,262	$0	$69,056
2034	$0	$0	($3,456)	$50,265	$412	$12,974	$1,839	$6,499	$0	$68,533
2035	$0	($864)	$0	$50,821	$399	$13,234	$1,910	$8,009	$0	$73,508
2036	$0	($864)	$0	$51,415	$386	$13,499	$1,983	$9,847	$0	$76,265
2037	$0	($864)	$0	$52,047	$372	$13,769	$2,059	$12,082	$0	$79,465
2038	$0	($864)	$0	$52,719	$358	$14,045	$2,138	$14,796	$0	$83,193
2039	$0	$0	($3,456)	$53,432	$344	$14,327	$2,219	$18,090	$0	$84,957
2040	$0	($864)	$0	$54,188	$330	$14,614	$2,304	$22,082	$0	$92,654
2041	$0	($864)	$0	$54,988	$315	$14,906	$2,393	$26,915	$0	$98,653
2042	$0	($864)	$0	$55,833	$300	$15,205	$2,484	$32,761	$451,156	$556,876
Total	**($345,554)**	**($18,142)**	**($15,550)**	**$1,326,522**	**$13,004**	**$328,470**	**$44,229**	**$176,821**	**$451,156**	**$1,960,956**
PRESENT VALUES										
PV @ 4%	($324,596)	($9,556)	($7,902)	$704,724	$7,551	$171,420	$22,094	$65,234	$139,100	$768,070
PV @ 7%	($310,272)	($6,351)	($5,040)	$472,826	$5,369	$113,743	$14,198	$32,417	$59,267	$376,158
PV @ 10%	($297,005)	($4,451)	($3,359)	$335,166	$3,998	$79,933	$9,689	$16,823	$25,855	$166,647

Discount Rate	**4%**	**7%**	**10%**
NPV ('000)	$768,070	$376,158	$166,647
BCR	3.25	2.17	1.55

Majura Parkway Economic Analysis ($10/tonne CO2-e)										
YEAR	COSTS (shown as -ve) Current Prices			BENEFITS (shown as +ve) Current Prices						TOTALS
	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	Current Prices ($'000)
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$44,030	$712	$10,627	$1,070	$91	$0	$56,170
2016	$0	($360)	$0	$45,471	$711	$10,923	$1,120	$104	$0	$57,969
2017	$0	($360)	$0	$47,151	$709	$11,227	$1,173	$117	$0	$60,018
2018	$0	($360)	$0	$49,119	$706	$11,540	$1,228	$131	$0	$62,365
2019	$0	$0	($1,440)	$51,434	$703	$11,861	$1,286	$146	$0	$63,990
2020	$0	($720)	$0	$54,167	$698	$12,192	$1,347	$160	$0	$67,844
2021	$0	($720)	$0	$57,405	$693	$12,531	$1,410	$175	$0	$71,494
2022	$0	($720)	$0	$57,614	$681	$12,782	$1,477	$204	$0	$72,038
2023	$0	($720)	$0	$57,855	$669	$13,038	$1,546	$235	$0	$72,623
2024	$0	$0	($2,880)	$58,127	$656	$13,300	$1,619	$267	$0	$71,089
2025	$0	($720)	$0	$58,432	$644	$13,566	$1,695	$301	$0	$73,917
2026	$0	($720)	$0	$58,770	$631	$13,838	$1,775	$335	$0	$74,629
2027	$0	($720)	$0	$59,144	$617	$14,115	$1,859	$372	$0	$75,387
2028	$0	($720)	$0	$59,553	$604	$14,398	$1,946	$410	$0	$76,191
2029	$0	$0	($2,880)	$59,999	$590	$14,686	$2,038	$450	$0	$74,883
2030	$0	($720)	$0	$60,484	$575	$14,980	$2,134	$491	$0	$77,945
2031	$0	($720)	$0	$61,008	$561	$15,280	$2,054	$534	$0	$78,717
2032	$0	($720)	$0	$61,573	$546	$15,587	$2,132	$579	$0	$79,697
2033	$0	($720)	$0	$62,180	$530	$15,899	$2,214	$626	$0	$80,730
2034	$0	$0	($2,880)	$62,831	$515	$16,217	$2,299	$675	$0	$79,657
2035	$0	($720)	$0	$63,527	$499	$16,542	$2,387	$726	$0	$82,960
2036	$0	($720)	$0	$64,269	$482	$16,874	$2,478	$779	$0	$84,161
2037	$0	($720)	$0	$65,059	$465	$17,212	$2,573	$834	$0	$85,423
2038	$0	($720)	$0	$65,899	$448	$17,556	$2,672	$891	$0	$86,746
2039	$0	$0	($2,880)	$66,790	$431	$17,908	$2,774	$950	$0	$85,974
2040	$0	($720)	$0	$67,735	$413	$18,267	$2,881	$1,012	$0	$89,588
2041	$0	($720)	$0	$68,735	$394	$18,633	$2,991	$1,077	$0	$91,110
2042	$0	($720)	$0	$69,792	$375	$19,006	$3,105	$1,144	$638,838	$731,541
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,658,152**	**$16,255**	**$410,587**	**$55,286**	**$13,815**	**$638,838**	**$2,476,896**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$880,905	$9,439	$214,275	$27,617	$6,125	$196,966	$1,050,283
PV @ 7%	($258,560)	($5,293)	($4,200)	$591,033	$6,711	$142,179	$17,748	$3,575	$83,922	$577,115
PV @ 10%	($247,505)	($3,709)	($2,800)	$418,957	$4,998	$99,916	$12,111	$2,216	$36,611	$320,794

Discount Rate	4%	7%	10%
NPV ('000)	$1,050,283	$577,115	$320,794
BCR	4.68	3.15	2.26

Majura Parkway Economic Analysis ($130/tonne CO2-e)										
	COSTS (shown as -ve) *Current Prices*			BENEFITS (shown as +ve) *Current Prices*						TOTALS
YEAR	CAPITAL COSTS ($'000)	ADDITIONAL Maintenance Annual ($'000)	ADDITIONAL Maintenance Cyclic ($'000)	Vehicle Operating Cost Savings ($,000)	Accident Cost Savings ($,000)	Generated Traffic Benefit ($,000)	Environmental Cost Savings ($,000)	Carbon Cost Savings ($,000)	Residual Value ($,000)	*Current Prices* ($'000)
2013	($115,185)	$0	$0	$0	$0	$0	$0	$0	$0	($115,185)
2014	($172,777)	$0	$0	$0	$0	$0	$0	$0	$0	($172,777)
2015	$0	($360)	$0	$44,030	$712	$10,627	$1,070	$129	$0	$56,209
2016	$0	($360)	$0	$45,471	$711	$10,923	$1,120	$162	$0	$58,027
2017	$0	($360)	$0	$47,151	$709	$11,227	$1,173	$200	$0	$60,100
2018	$0	($360)	$0	$49,119	$706	$11,540	$1,228	$244	$0	$62,478
2019	$0	$0	($1,440)	$51,434	$703	$11,861	$1,286	$295	$0	$64,140
2020	$0	($720)	$0	$54,167	$698	$12,192	$1,347	$355	$0	$68,039
2021	$0	($720)	$0	$57,405	$693	$12,531	$1,410	$424	$0	$71,743
2022	$0	($720)	$0	$57,614	$681	$12,782	$1,477	$585	$0	$72,419
2023	$0	($720)	$0	$57,855	$669	$13,038	$1,546	$796	$0	$73,184
2024	$0	$0	($2,880)	$58,127	$656	$13,300	$1,619	$1,071	$0	$71,893
2025	$0	($720)	$0	$58,432	$644	$13,566	$1,695	$1,425	$0	$75,042
2026	$0	($720)	$0	$58,770	$631	$13,838	$1,775	$1,882	$0	$76,176
2027	$0	($720)	$0	$59,144	$617	$14,115	$1,859	$2,469	$0	$77,484
2028	$0	($720)	$0	$59,553	$604	$14,398	$1,946	$3,219	$0	$79,000
2029	$0	$0	($2,880)	$59,999	$590	$14,686	$2,038	$4,177	$0	$78,611
2030	$0	($720)	$0	$60,484	$575	$14,980	$2,134	$5,396	$0	$82,850
2031	$0	($720)	$0	$61,008	$561	$15,280	$2,054	$6,945	$0	$85,128
2032	$0	($720)	$0	$61,573	$546	$15,587	$2,132	$8,907	$0	$88,025
2033	$0	($720)	$0	$62,180	$530	$15,899	$2,214	$11,390	$0	$91,493
2034	$0	$0	($2,880)	$62,831	$515	$16,217	$2,299	$14,524	$0	$93,506
2035	$0	($720)	$0	$63,527	$499	$16,542	$2,387	$18,475	$0	$100,710
2036	$0	($720)	$0	$64,269	$482	$16,874	$2,478	$23,449	$0	$106,832
2037	$0	($720)	$0	$65,059	$465	$17,212	$2,573	$29,702	$0	$114,291
2038	$0	($720)	$0	$65,899	$448	$17,556	$2,672	$37,551	$0	$123,406
2039	$0	$0	($2,880)	$66,790	$431	$17,908	$2,774	$47,393	$0	$132,417
2040	$0	($720)	$0	$67,735	$413	$18,267	$2,881	$59,721	$0	$148,296
2041	$0	($720)	$0	$68,735	$394	$18,633	$2,991	$75,145	$0	$165,178
2042	$0	($720)	$0	$69,792	$375	$19,006	$3,105	$94,424	$752,876	$938,859
Total	**($287,962)**	**($15,118)**	**($12,958)**	**$1,658,152**	**$16,255**	**$410,587**	**$55,286**	**$450,455**	**$752,876**	**$3,027,574**
PRESENT VALUES										
PV @ 4%	($270,497)	($7,963)	($6,585)	$880,905	$9,439	$214,275	$27,617	$162,191	$232,126	$1,241,509
PV @ 7%	($258,560)	($5,293)	($4,200)	$591,033	$6,711	$142,179	$17,748	$78,817	$98,903	$667,338
PV @ 10%	($247,505)	($3,709)	($2,800)	$418,957	$4,998	$99,916	$12,111	$39,832	$43,146	$364,946

Discount Rate	4%	7%	10%
NPV ('000)	$1,241,509	$667,338	$364,946
BCR	5.36	3.49	2.44

APPENDIX B: APPRAISAL SUMMARY TABLE 2

MONETISED COST BENEFIT ANALYSIS RESULTS			
Demand Model Outputs (Study area only, 2011)			
Parameter	Base Case	Option	% Change
Number of trips entering study area, AM Peak	7,975	8,521	6.8%
Average journey time	Not recorded	Not recorded	-
PT mode share	N/A	N/A	N/A
Freight mode share	N/A	N/A	N/A
Public transport fare revenue	N/A	N/A	N/A
Number of kilometres travelled	24,505	37,009	51.0%
Demand Model Outputs (Study area only, 2031)			
Parameter	Base Case	Option	% Change
Number of trips entering study area, AM Peak	6,931	10,961	58.1%
Average journey time	Not recorded	Not recorded	-
PT mode share	N/A	N/A	N/A
Freight mode share	N/A	N/A	N/A
Public transport fare revenue	N/A	N/A	N/A
Number of kilometres travelled	33,940	62,795	85.0%

Benefit Cost Analysis Result			
	Real Discount Rate (%)		
	4%	7%	10%
BCR	5.02	3.32	2.35
NPV ($M, 2010)	1,146	623	343
NPV ($M)[1]	2,750		
IRR[2]	21.05%		

1: This is the net value of the project, undiscounted
2: IRR is constant across all discount rates

Monetised Cost and Benefits		
Monetised Costs and Benefits	**Value ($M, discounted)**	**Percentage**
COSTS		
Construction Cost	258.560	96%
Annual Maintenance	5.293	2%
Cyclic (5 year) Maintenance	4.200	2%
Total	***268.052***	**100%**
BENEFITS		
VOC Savings	591.033	66%
Accident Cost Savings	6.711	1%
Generated Traffic Benefit	142.179	16%
Environmental Cost Savings	17.748	2%
Carbon Cost Savings	40.521	5%
Residual Value	92.605	10%
Total	***890.797***	**100%**

Detailed Monetised Benefits ($M, real, undiscounted)						
	Base Case			Option		
	2011[1]	*2021*	*2031*	*2011*	*2021*	*2031*
VOC	63.260	84.892	93.357	37.076	47.119	63.075
Accident Cost	2.262	2.939	3.133	1.553	2.246	2.572
Generated Traffic Benefit	-	-	-	9.522	12.531	15.280
Environmental Benefit	-	-	-	0.890	1.410	2.054
Carbon Cost[2]	8.080	18.927	95.385	8.039	15.569	91.111
Residual Value[3]	-	-	-	-	-	-

1: 2011 is modelled to allow calculation of opening year (2015) values
2: Carbon cost is calculated for the whole Canberra and Queanbeyan urban area.
3: The residual value of $M704.931 is applied in 2042

Vehicle Operating Cost		
	Base Case Forecast Year (*2031*)	Option Forecast Year (*2031*)
Demand model output(s)	*VOC*	*VOC*
Valuation parameter used and source	$c = A + \frac{B}{V} + C \cdot V + D \cdot V^2$ *Update of RUC to 2007 (Austroads)*	$c = A + \frac{B}{V} + C \cdot V + D \cdot V^2$ *Update of RUC to 2007 (Austroads)*
Algorithm used to calc. values in base case and option case	*Micro-simulation model of the study area calculates VOC for every vehicle based on speed every time-step for simulation period*	*Micro-simulation model of the study area calculates VOC for every vehicle based on speed every time-step for simulation period*
$M (undiscounted)	93.357	63.075
Accident Cost		
	Base Case Forecast Year (*2031*)	Option Forecast Year (*2031*)
Demand model output(s)	*Arterial Road VKT*	*Arterial Road VKT, Freeway VKT*
Valuation parameter used and source	*$50,588/MVKT (Based on historical accident records for study area)*	*$45,800/MVKT(Arterial), $14,300/MVKT (Freeway) RTA Economic Analysis Manual (2007)*

Algorithm	$\frac{VKT}{1{,}000{,}000} \times \$50{,}588$	$\left(\frac{VKT_{Arterial}}{1{,}000{,}000} \times \$45{,}800\right) + \left(\frac{VKT_{Freeway}}{1{,}000{,}000} \times \$14{,}300\right)$
$M (undiscounted)	3.133	2.572
Generated Traffic Benefit		
	Base Case Forecast Year (*20XX*)	Option Forecast Year (*20XX*)
Demand model output(s)	*VKT*	*VKT*
Valuation parameter used and source	*N/A*	*VOC/VKT, Accident Cost/VKT*
Algorithm	*N/A*	$\frac{Diff(Cost/VKT)}{2} \times Diff(VKT)$
$M (undiscounted)	N/A	15.280
Environmental benefit		
	Base Case Forecast Year (*2031*)	Option Forecast Year (*2031*)
Demand model output(s)	*VKT*	*VKT*
Valuation parameter used and source	*N/A*	*$0.039/VKT* *RTA Economic Analysis Manual (2007)* (It was assumed that new trips through the study area are transferring from urban to rural areas, thereby reducing environmental cost)
Algorithm used to calc. values in base case and option case	*N/A*	$(VKT(Option) - VKT(Base)) \times 0.039$
$M (undiscounted)	N/A	2.054
Carbon Cost		
	Base Case Forecast Year (*2031*)	Option Forecast Year (*2031*)

Demand model output(s)	*VKT, speeds, fuel consumption*	*VKT, speeds, fuel consumption*
Valuation parameter used and source	*2.38 tonne CO_2-e/ML Fuel (NGERS)* *$80/tonne CO_2-e*	*2.38 tonne CO_2-e/ML Fuel (NGERS)* *$80/tonne CO_2-e*
Algorithm used to calc. values in base case and option case	$\sum_{1}^{Links}\left(\left(0.863+\frac{542.92}{V}+0.01333\times V+0.0005847\times V^2\right)\times VKT\right)\times\frac{2.38}{1{,}000}\times 80$	
$M (undiscounted)	95.385	91.111
Residual Value		
	Base Case Forecast Year (*2042*)	Option Forecast Year (*2042*)
Demand model output(s)	*N/A*	*N/A*
Valuation parameter used and source	*N/A*	*Extrapolated benefits from economic analysis*
Algorithm used to calc. values in base case and option case	*N/A*	*NPV($, 2042)(Benefits from 2043 to 2052)*
$M (undiscounted)	N/A	704.931

APPENDIX C: APPRAISAL SUMMARY TABLE 3

Benefit Cost Ratio Sensitivity Testing		
Sensitivity test #	**Variation**	**Benefit-Cast Ratio (BCR)**
0	Starting result	3.32
1	Discount rate 4%	5.02
2	Discount rate 10%	2.35
3	6% Heavy Vehicles	3.46
4	10% Heavy Vehicles	3.29
5	12% Heavy Vehicles	3.02
6	Increased Construction Cost	2.77
7	Decreased Benefits	2.60
8	Worst Case	2.17
9	\$10/tonne CO_2-e	3.15
10	\$130/tonne CO_2-e	3.49

APPENDIX D: APPRAISAL SUMMARY TABLE 5

INFORMATION SOURCES

Compendium of 2006-2031 ACT Land-Use Data

This workbook contains the latest ACT land use data including population, employment, retail space, school enrolments and tertiary enrolments for 2006, 2011, 2021 and 2031. These data are provided by TAMS as input requirements to modelling exercises.

RTA Economic Analysis Manual, Version 2, 1999 (Economic Parameters for 2007)

Update of RUC to 2007, Austroads

National Guidelines for Transport System Management in Australia (ATC, 2006)