542/1352

Main Road 3 Laning

COSTS

Total	Renewal	Backlog	Unallocated	Growth
$1,652,000	$330,400	$568,288	0	$753,312

COST ALLOCATION

Primary Driver:	The purpose of this 3-laning option is to remove the capacity restraint of the westbound Main Road section between McCormacks Bay Road and the Ferrymead Bridge. Currently this constraint creates a long queue tailing back to Redcliffs. From 2008, with the growth in traffic and the signalisation of the Main Road / Bridle Path Road intersection (as part of the Ferrymead Bridge Widening), this congestion will become worse.
Secondary Driver:	
Capacity discussion:	
References:	

ATTRIBUTES

Project Manager:	Alix Newman, Paul Roberts
Work Planned:	Three lanes with a flush median, cycle lanes in each direction. The new (kerbside) lane starts as an exclusive left turn exit lane from McCormacks Bay Road. Traffic crossing the causeway travels directly into the outside lane. McCormacks Bay Road intersection to be moved to the east.
Location:	Main Road between McCormack Bay Road and Ferrymead Bridge.
Special features being addressed:	The traffic queues result from “reverse priority” at the McCormacks Bay intersection and at other locations along Main Road between the causeway and Ferrymead Bridge. Reverse priority is where drivers on the main road stop and let drivers from the side road enter the

	main flow of traffic.
A statement of the outcomes being addressed (LoS, Community Outcomes):	Base travel time savings; Congested travel time savings (CRV); Vehicle operating costs; Traffic crash costs; Carbon Dioxide costs (CO2).
Options considered:	Two options were considered within the evaluation report.
Implications of not doing the project:	The purpose of this 3-laning option is to remove the capacity restraint of the westbound Main Road section between McCormacks Bay Road and the Ferrymead Bridge. Currently this constraint creates a long queue tailing back to Redcliffs. From 2008, with the growth in traffic and the signalisation of the Main Road / Bridle Path Road intersection (as part of the Ferrymead Bridge Widening), this congestion will become worse.
Linkages with other projects:	542/790 Ferrymead Bridge replacement and St Andrews Hill Road/ Main Road/ Bridle Path Road intersection 542/201 Ferry Road/Humphreys Drive intersection upgrade It is expected that these will be completed before Main Road 3 Laning.
Location of other relevant supporting information:	CCC project file

report

Main Road 3-Laning Economic Evaluation

report

Main Road 3-Laning Economic Evaluation

Prepared for

Christchurch City Council

By

Beca Infrastructure Ltd

August 2004

Christchurch City Council
City Streets Unit
PO Box 237
CHRISTCHURCH

2 August 2004
Our Ref: 3851320/010
R1:46409-SAT48R01.DOC

Attention: John Falconer

Dear Sir

Main Road 3-Laning Economic Evaluation

Please find attached two copies of the draft report for your review.

The BCRs for both options evaluated are high and it is suggested that the Council progress this project through to preliminary design. It is reassuring that even if the construction costs were to double, the BCR would remain relatively high. While we have built a number of contingencies into the construction cost, there are a number of cost risks associated with work on the seawall. It is suggested that the next stage of the design should involve geotechnical and structural investigations of the seawall that will enable these risk elements to be better quantified and a more accurate cost estimate produced.

We expect there will be a number of resource consent issues associated with changes to the seawall and in particular ECan consents. There is a potential for the resource consent process to slow down progress of the project, and this is identified as a major programme risk. Given this risk and the cost risks mentioned above we would recommend a risk workshop at the beginning of the preliminary design phase.

It is suggested that discussions be held within the Council regarding any future plans for a continuous walkway on the Estuary side of Main Road and also any future changes that may be required to the Estuary to address the growth of sea lettuce within McCormacks Bay. If either of these issues needs to be addressed, this is likely to impact on the estuary and also required Ecan resource consent. It makes sense to address all these consents together. Beca can provide advice on these two issues if required.

Finally, thank you for inviting us to do this project for the Council. We are happy to prepare a scope and fee estimate for the preliminary design, if you are interested in using Beca Infrastructure for the next stage of the project.

Yours faithfully
Shane Turner
Associate (Transport)

on behalf of
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Revision History

Revision Nº	Prepared By	Description	Date
A	Sheldon Teo Alex Gu	Draft Report	4/8/04

Document Acceptance

Action	Name	Signed	Date
Prepared by	Sheldon Teo Alex Gu		
Reviewed by	Shane Turner		
Approved by	Stephen Hewett		
on behalf of	**Beca Infrastructure Ltd**		

Table of Contents

Appendices

1 Introduction

Beca Infrastructure Limited has been commissioned by Christchurch City Council (CCC) to undertake a concept level economic evaluation for the three-laning of Main Road between McCormack Bay Road and the Ferrymead Bridge.

1.1 The Problem

During the morning peak period on the majority of weekdays a long westbound traffic queue forms on Main Road from the McCormack Bay intersection. Depending on traffic demand this queue can extend back to the Redcliffs shops. Vehicles in the queue, while stop-start, are usual moving, but at a lower than desirable speed.

A queue generally forms for a ½ peak period. Outside this period the route is normally free flowing. A similar ½ peak period is observed on a number of other arterial around Christchurch, and generally coincides with the preferred time commuters wish to travel to work. On wet days the queue lengths are often longer and the peak period can be longer. The unstable traffic flow conditions in this corridor can lead to variable queue lengths and travel times in the peak period from one day to the next. There is hence a problem with travel time reliability in this peak period.

The traffic queues result from "reverse priority" at the McCormacks Bay intersection and at other locations along Main Road between the causeway and Ferrymead Bridge. Reverse priority is where drivers on the main road stop and let drivers from the side road enter the main flow of traffic. When traffic volumes are high this can create traffic queues on a normally unimpeded road, such as Main Road.

With the high traffic volumes along Main Road "reverse priority" is often the only way drivers from side-roads and accesses along Main Road can safely enter Main Road. Another cause of the queuing is drivers letting buses re-enter the main traffic stream. The combined effect of these two causes, is often call "side friction". The section of road between McCormacks Bay and the Ferrymead bridge has considerable "side friction" compared to the causeway, which has no direct access to properties and therefore virtually has no side friction. Kerbside parking and vehicles turning right and left from the Main Road are other sources of "side friction".

The Council are aware of the current level of congestion occurring on the route in the peak period, and of the potential for further development to occur east of the Ferrymead Bridge. Indeed the expected growth in the number of households in the catchment area of Main Road is predicted to exceed the city wide average over the next 20 years. If capacity improvements are not made to the route the effect of this population growth and corresponding traffic growth will be to exacerbate the current levels of peak period congestion on the western section of Main Road.

1.2 Background

There are a number of roading projects planned along Main Road and Ferry Road. Other projects include:

1. Installation of traffic signals at Humphreys Drive intersection,

2. Replacement and widening of the Ferrymead Bridge, and
3. Upgrading and signalisation of St Andrews Hill Road/ Main Road/ Bridle Path Road intersection.

It has been assumed that all these projects will have been constructed prior to the 3-laning option being constructed.

2 Current Situation

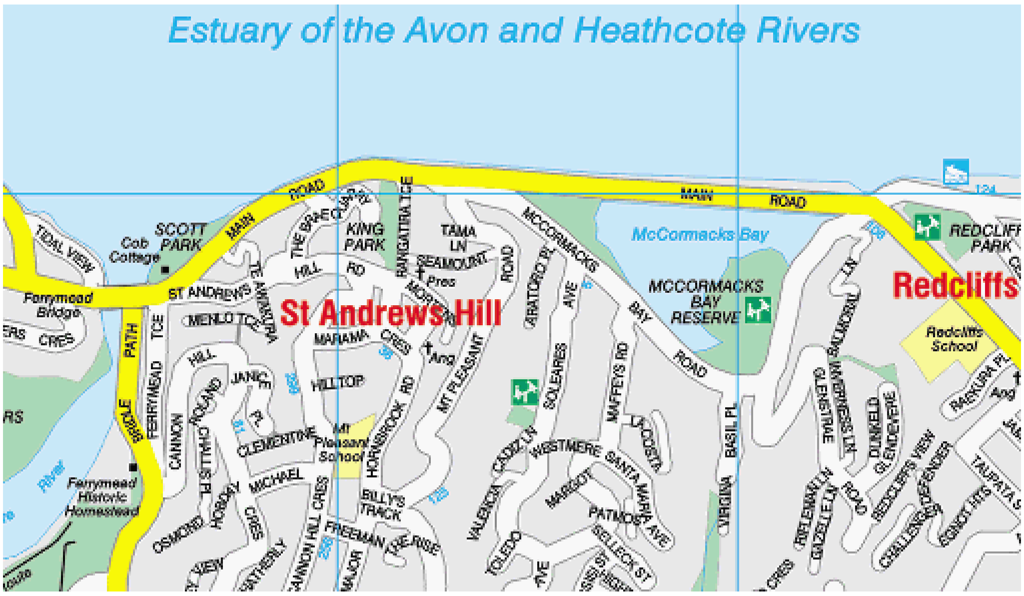
2.1 Route Description

Main Road is located to the south-east of the city centre, and provides access to the suburbs of Sumner, Moncks Bay, Redcliffs and St Andrews Hill. The route generally follows the Avon-Heathcote Estuary. The route includes the causeway, which crosses McCormacks Bay (see Figure 1).

Main road is the only principal route into and out of the suburbs of Sumner, Moncks Bay, Clifton, Redcliffs and Scarborough. The only alternative route to Main Road is the Summit Road, which is a significant detour. With hazardous goods not permitted through the Lyttelton Tunnel, vehicles carrying hazardous goods use Main Road and Evans Pass to access the Lyttelton Port.

Main Road has a single traffic lane and a marked cycle lane in each direction over its entire length. It is classified as a minor arterial in the City Plan. The current average carriageway width along Main Road is 12 m. The posted speed limit is 50 km/hr.

Figure 1: Site Location



2.2 Traffic Characteristics

2.2.1 Traffic Volumes (and Growth)

Traffic volumes were obtained from 7-day tube counts collected during September 2002, both on the causeway and near the Sumner surf club. The peak and daily traffic volumes are shown in Table 1.

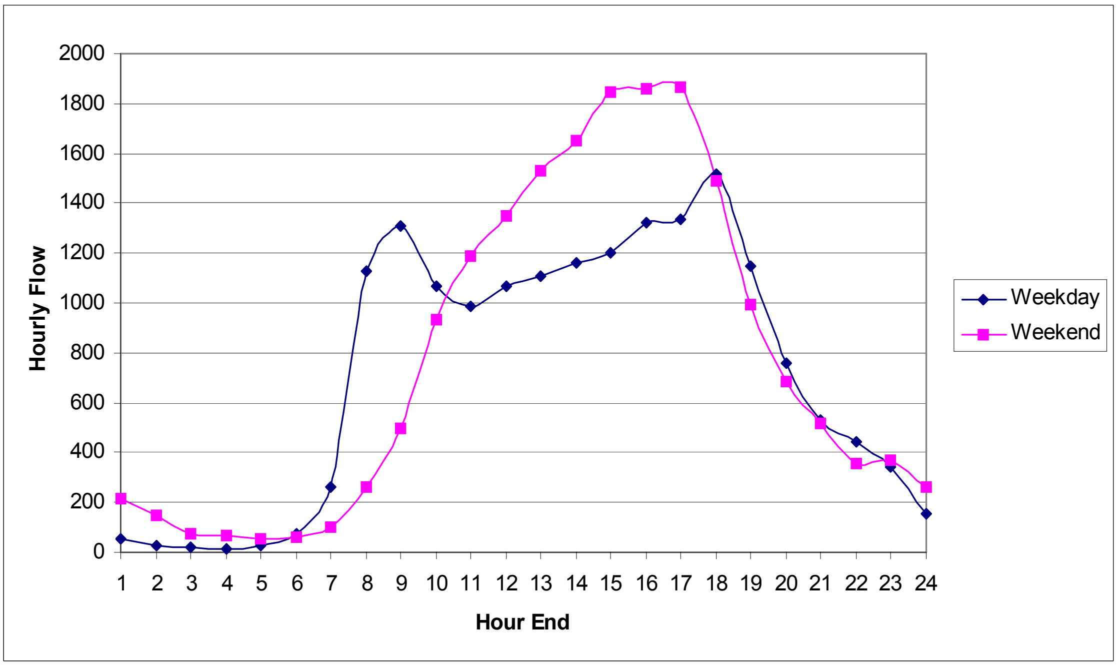
Table 1

Traffic Volumes

Traffic Flows (2 way)	Causeway	Sumner Surf Club
Weekend peak (vph)	1,900	1,600
Weekend ADT (vpd)	18,400	15,100
Weekday AM peak (vph)	1,300	850
Weekday PM peak (vph)	1,500	1,075
Weekday ADT (vpd)	17,000	12,400

Even though the weekend and weekday ADTs are similar, the distribution of traffic over the day is quite different with two distinct morning and evening peaks during weekdays and one large afternoon peak during the weekend. This is shown in Figure 2. During the weekdays, the morning peak is predominately westbound, with the reverse in the evening peak. The single large peak during weekends is due to Sumner being a popular recreational destination.

Figure 2: Traffic Flow Profile on the Causeway.



There is seasonal variation in the traffic counts along Main Road. The summer traffic peak is in the order of 24% higher than that observed during September The count data above is for September). Sumner is a more popular destination in the summer months and is particularly popular during school holidays and in the weekends.

The annual traffic growth rate on Main Road is 2.7%. This was calculated from historic traffic counts.

2.2.2 Bus Services

The Sumner/Mt Pleasant 30, 31 and 32 bus services run along Main Road and have an average frequency each of 3 inbound and 3 outbound buses per hour during the weekday peak period. This reduces to on average one bus per hour (in each direction) on weekends.

2.2.3 Cycle Counts

The cycle lanes on Main Road are part of the Christchurch strategic cycle network. The Main Road cycle lane is used by both commuting and recreational cyclists. Cycle counts from September 2001 are presented in Table 2.

Table 2

Main Road Cycle Flow

Period	Cycle Volume	Percentage of Main Road Traffic
Peak hours	47	2.1%
Off peak hours	19	1.2%

3 Three-Laning Options

The purpose of the three-laning option is to create more capacity for westbound traffic on Main Road between the McCormack Bay intersection and the proposed intersection upgrade at the Main Road/St Andrews Hill/Bridle Path/Ferry Road intersection. The intersection upgrade includes two westbound approach lanes on the Main Road approach.

The 3-laning options extend the two westbound lanes at the intersection through to the McCormack Bay Road intersection. The kerbside lane will be used by traffic turning into Main Road from side-roads and property accesses. The causeway traffic can use the outside lane and hence can keep clear of merging/turning traffic and buses. In effect the extra lane removes the effect of the "side friction" on Main Road as drivers no longer need to let vehicles in from side-roads and accesses.

3.1 Two 3-laning Options

There are two options for three-laning Main Road. The first option is to have three lanes with a flush median, no parking and cycle lanes in each direction. The second option is the same as option one, but has no flush median. However right turn bays are provided in several places in Option 2 for vehicles turning into sideroads and the surf and bowling clubs. The two options are shown in the drawings in Appendix A.

In both options the new (kerbside) lane starts as an exclusive left turn exit lane from McCormacks Bay Road. Traffic crossing the causeway travels directly into the outside lane.

In both options the McCormacks Bay Road intersection has been moved to the east. This is required to create enough separation between the two intersections so that vehicles travelling from the causeway can change lanes to turn left into Mt Pleasant Road.

3.2 Cycle Provision

Westbound cyclists have two options under the new road layout. They can exit the causeway on-road lane and use the cycle path show to access the western end of McCormacks Bay Road. They can then slip onto Main Road using the exclusive left turn slip lane, which will have an on-road cycle lane, from McCormack Bay Road. Alternatively they can stay on Main Road and cross the exclusive left turn slip lane at the new splitter island at the McCormacks Bay Intersection.

Cyclists travelling eastbound will continue to have a continuous on-road facility. However, given that the cycle lane will now be closer to the edge of the seawall, a low level fence is to be constructed so cyclists that fall are prevented from falling into the Estuary.

3.3 Bus Provision

There is currently a bus stop between the McCormack Bay Road and Mt Pleasant Road Intersections. Ideally this bus stop should be moved to the western end of McCormack Bay Road, with the bus route using McCormacks Bay Road. The bus can then slip onto the Main Road at the exclusive left turn slip lane, and does not have to cross from the outside lane to the kerbside lane and then into the current bus stop. This needs to be considered further in the preliminary design phase of the project.

Other bus stops along the route should be indented into the berm, so that buses can stop clear of the through traffic. Further work on location and design to be considered during the preliminary design phase.

3.4 Assumptions and Cross-section Standards

The following design standards have been used, where applicable, for each of the options:

- 3.2 m wide lanes;
- 1.7 m wide cycle path;
- No footpath on estuary side;
- Curve widening to 3.5 m;
- 2.0 m wide flush median;
- 2.5m wide right turn bays;

Design assumptions that have been made in the calculation of the cost estimate:

- No maintenance included;
- Consent estimate for lodging consent only;
- No stormwater treatment required;
- No relocation of power poles required;
- No structural assessment or remaining life of existing seawall undertaken.

4 Economic Evaluation

4.1 Traffic Model Development

4.1.1 Modelling Technique

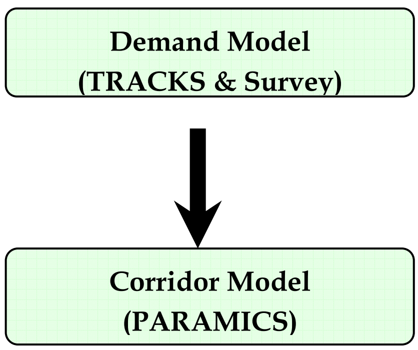
For this study we determined that the accurate representation of the dynamic operation of traffic on Main Road was important to the assessment of this project. The detailed traffic micro-simulation suite – PARAMICS, has therefore been used to assess the vehicle interaction and queuing effects.

4.1.2 Model Structure

The model developed for this study comprises two main components as below:

- The trip demand model, where existing and future demand patterns are estimated; and
- The corridor model (project model), where the trip demand is loaded onto the road network.

Figure 3: Model Structure



The trip demand model is based on traffic surveys and the Christchurch City Council (CCC)'s regional TRACKS model (CTS model). The demand matrices for the current year (2004) were developed from traffic counts and the Origin – Destination (O-D) information from the TRACKS model.

The corridor model was built in PARAMICS.

4.1.3 Network Representation

The project model covers Main Road from the western end of the Ferrymead Bridge to the eastern end of the Causeway. This is highlighted in Figure 4.

Figure 4: Extent of PARAMICS Model

4.1.4 Future Network

The Ferrymead Bridge Widening project is assumed to be completed by 2007, and this was included in the future model network.

4.1.5 Modelling Periods

The traffic flow patterns during the following modelling periods were represented in the model:

- Weekday AM (7:00 – 9:00)
- Weekday Midday (11:00 – 13:00)
- Weekday PM (16:00 – 18:00)

Other periods were not explicitly modelled; however, they were represented in the annualisation process of the economic evaluation

4.1.6 Demand Forecast

Two future year scenarios have been set up for the traffic modelling – 2008 (the assumed opening date of Main Road 3-Laning), and 2011. An annual growth rate of 2.7% (as specified in CCC's Main Road Study) was adopted for the demand forecast.

4.1.7 Traffic Assignment

The traffic demand was loaded onto the PARAMICS network dynamically. Each model was continuous for the whole period; however, the demand matrices were proportionally allocated to each 15-minute phase in a way consistent with the traffic flow profile of the Causeway, as established in the CCC's Main Road Study. No route choice is available during the assignment. Three vehicle types were modelled; car, bus and truck.

4.1.8 Model Validation

A micro-simulation model does not provide a unique solution to a given problem; it just tries to emulate the behaviour of a complex system in which randomness in involved. The final result is obtained through the statistical processing of simulation results from a number of replications. For this study nine replications have been adopted for each scenario.

The validation of the project model was based on visual and analytical assessments. For the visual assessment, the model successfully replicated the traffic behaviours as below:

1. During the Midday and PM periods a free-flow traffic condition was observed along Main Road; and
2. During the peak of the AM period a long westbound queue was built up along Main Road and "reversed priority" was observed on the Main Road intersections (i.e. the drivers on Main Road gave way to the vehicles from the minor approaches).

For the analytical assessment the modelled flows and travel times were compared with the observed data. The comparison results detailed in Appendix A demonstrates that the project model has been adequately validated in accordance with the Transfund's Project Evaluation Manual (PEM).

4.2 Option Evaluation

Both the do minimum and the proposed 3-laning options were tested within the project model for 2008 and 2011. Both options do not differ from each other in terms of traffic modelling. Note that it is not possible with the simulation model to assess the impact of right turners turning into sideroads and accesses along Main Road partially blocking through traffic when a flush median is not provided. The following analysis is therefore applicable to both options.

4.2.1 Operational Assessment

The purpose of this 3-laning option is to remove the capacity restraint of the westbound Main Road section between McCormacks Bay Road and the Ferrymead Bridge. Currently this constraint creates a long queue tailing back to Redcliffs. From 2008, with the growth in traffic and the signalisation of the Main Road / Bridle Path Road intersection (as part of the Ferrymead Bridge Widening), this congestion will become worse.

The proposed 3-laning option provides Main Road with an extra westbound lane from McCormacks Bay Road to Bridle Path Road, and hence remove the capacity restraint for the westbound traffic in the AM peak. For example, the network average speed over the modelled AM period in 2008 is increased from 27 km/hour to 50 km/hour. This is illustrated by the following screen shots from the PARAMICS model (Figures 5 and 6).

Figure 5: Screen Shot from the 2008 Do Minimum model at 8AM

Figure 6: Screen Shot from the 2008 3-Laning Option model at 8AM

The proposed option has little impact on the traffic during the Midday and PM periods; however it seems that from 2011 the single eastbound lane on Main Road will significantly constrain the traffic during the PM peak. We recommend that the timing of the need for the additional eastbound capacity be investigated in more detail as part of the scheme assessment.

4.2.2 Economic Evaluation Framework

An economic evaluation was undertaken in accordance with Transfund New Zealand's Project Evaluation Manual (PEM, December 2003 Update).

The key assumptions used for the evaluation are as follows:

- A base date for user and capital costs of 1 July 2004;
- A Time Zero date for discounting of 1 July 2006;
- A one-year construction programme commencing in the 2007/2008 financial year, with an opening date of 1 July 2008 (after one-year design period after 2006);
- Typical PEM Urban Arterial traffic and occupant composition and hence Urban Arterial composite costs used for travel time and vehicle operating costs;
- Road user costs were assessed across the entire modelled area;
- Road user costs were assessed for the modelled AM, Midday and PM periods, with off peak and weekend periods represented by factored proportions of the Midday model results;
- Costs assessed for the modelled 2008 and 2011 years, with other years assessed by interpolation/extrapolation between these two points. The growth in costs and hence benefits was capped at 2011.

4.2.3 Benefits Assessed

The following benefits have been assessed using the median results from 9 repetitions of the model:

- Base travel time savings;
- Congested travel time savings (CRV);
- Vehicle operating costs;
- Traffic crash costs;
- Carbon Dioxide costs (CO_2).

These components are discussed in more detail below.

4.2.4 Travel Time Costs

The Urban Arterial composite travel time cost values are shown in Table 3. These costs were applied to the total network vehicle-hours extracted from the models.

Table 3: Travel Time Unit Rates ($/hour)

Period	Unit Rates
Morning Commuter	15.13
Interpeak	17.95
Evening Commuter	14.96
Off peak	14.93
Weekend/Holiday	14.09

4.2.5 Congestion Travel Time (CRV)

Congestion time costs were assessed as the additional costs for the delays caused by congestion. The delays were estimated as the difference between the modelled vehicle travel times and the vehicle travel times at the speed limit (50 km/hour). This was adopted because the capacity-based method from the PEM was not applicable for micro-simulation model. We believe this simplified approach is sufficient for feasibility studies.

The unit rates used in the evaluation are shown in Table 4.

Table 4: Congested Travel Time Unit Rates (CRV $/hour)

Period	Unit Rates
Morning Commuter	3.88
Interpeak	3.60
Evening Commuter	3.79
Off peak	3.68
Weekend/Holiday	4.26

4.2.6 Vehicle Operating Costs

The basic running costs were included. The basic running rates were extracted from the following lookup table for Urban Arterial recommended by the PEM:

Table 5: Vehicle Running Costs (Cent/KM)

Speed (Km/Hour)	Running Costs
10	24.6
15	22.5
20	20.8
25	19.7
30	18.8
35	18.2
40	17.7
45	17.4
50	17.2
55	17.1
60	17.1
65	17.2
70	17.2

Other vehicle operation costs such as stops and speed change cycles were omitted from this feasibility study, as they were not expected to add significant benefits.

4.2.7 Carbon Dioxide Costs

The carbon dioxide costs were estimated as 5% of the vehicle operating costs, as recommended by the PEM.

4.2.8 Accident Costs

The recent 5-year accident history (1999 – 2003) in the study area lists a total of 15 accidents. This includes 2 serious injury accidents, 5 minor injury accidents and 8 non-injury accidents. The accident history and a collision diagram are shown in Appendix B.

Three westbound rear-end accidents occurred in the weekday morning peak period between McCormacks Bay Road (western end) and Redcliffs. The three accidents are likely to have resulting from the morning peak traffic queues. Two of the accidents were non-injury and one was a minor injury. The benefit from a reduction in these accidents has not been included in the economic evaluation, as it would be low, due to the low accident severity and compared with travel time and vehicles operation cost savings. The accident benefits should be considered further in the preliminary design stage.

4.2.9 Annualisation

Annual user costs were derived from the three modelled periods (AM, Midday and PM). The weekend periods were represented by the weekday Midday model in proportion to the traffic volumes from the following traffic flow profile (See Figure 2). The proposed 3-laning option is expected to have little effect during the off peak period.

The final annualisation factors used are shown in Table 6.

Table 6: Annualisation Factors

	AM (7-9)	IP (9-16)	PM (16-18)	Off Peak	Weekend (9-19)
Modelled hours	2	2	2	-	-
2-hr Periods per day	1	3.64	1	-	6.77
Days per year	245	245	245	245	120

It is noted that almost all the benefits are from the Weekday AM periods.

4.2.10 Capital and Maintenance Costs

The capital cost was estimated to be $1.15M for Option 1 and $1.52M for Option 2. The detailed calculations and worksheets are provided in Appendix E. The additional annual maintenance cost was estimated to be $10K for both of them.

4.2.11 Evaluation Summary

The results of this evaluation are summarised in Table 7. The detailed calculations and worksheets are provided in Appendix D.

Table 7: Evaluation Summary

Item	Option 1	Option 2
Capital Cost, $M NPV	0.9	1.2
Maintenance Cost, $M NPV	0.1	0.1
Total Costs, $M NPV	**1.0**	**1.3**
Travel Time Benefits (incl. Congestion), $M NPV	10.0	10.0
Vehicle Operating Benefits, $M NPV	0.6	0.6
Crash Benefits, $M NPV	0.0	0.0
CO_2 Benefits, $M NPV	0.0	0.0
Total Tangible Benefits, $M NPV	**10.6**	**10.6**
Tangible BCR	**10**	**8.0**
FYRR	**88%**	**67%**

4.2.12 Sensitivity Tests

Sensitivity tests were undertaken for Option 1 (with higher BCR) on the key influencing factors, namely traffic growth and capital costs:

1. If no capping of the traffic growth is applied, the BCR of Option 1 will increase to 16;
2. If the traffic growth is capped at 2008, the BCR of Option 1 will be reduced to 7.8;
3. If the capital cost is doubled, the BCR of Option 1 will be reduced to 5.4;
4. If the capital cost is halved, the BCR of Option 1 will increase to 19.

5 Recommendations

The proposed three-laning option for Main Road has a high benefit-cost ratio of 10, which will provide substantial benefits and should be implemented accordingly. Furthermore, it is expected that the problems on Main Road will worsen if no actions is taken in the next few years, as more development and hence traffic growth, occurs in the Main Road corridor. The project should proceed to the preliminary design phase.

Appendix A – Three-Laning Options Drawings

Appendix B – Accident History & Collision Diagram

Appendix C – Model Validation Results

Traffic Flow Validation

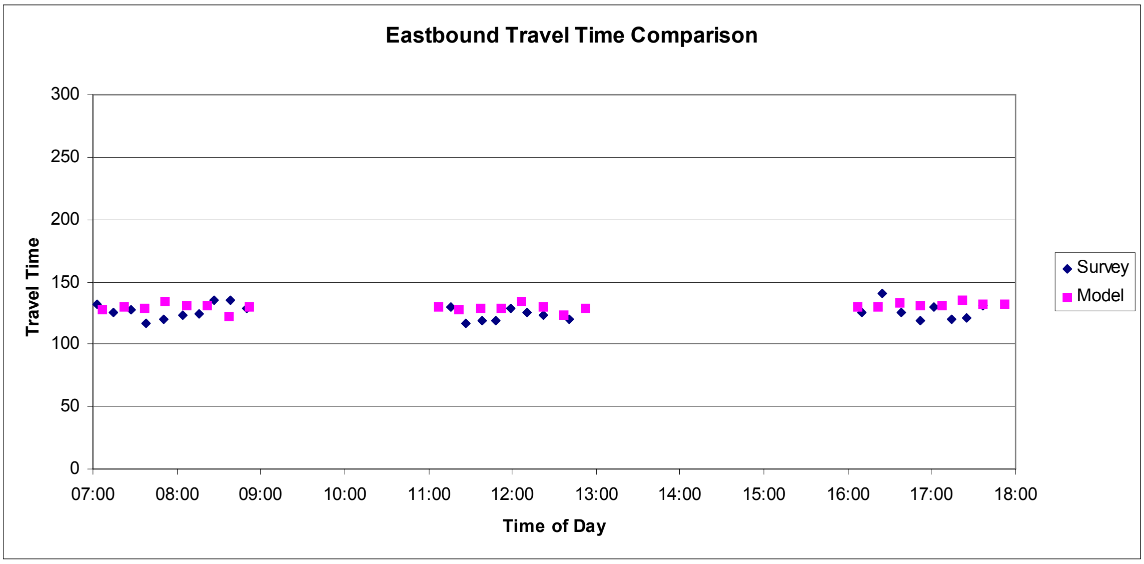
Location	Period	Direction	Survey	Model	%Diff	GEH
The Causeway	AM	EB	719	601	-16%	3.2
		WB	2037	1975	-3%	1.0
	IP	EB	931	825	-11%	2.5
		WB	1049	1041	-1%	0.2
	PM	EB	1762	1802	2%	0.7
		WB	1011	1029	2%	0.4
Ferrymead Bridge	AM	EB	763	891	17%	3.1
		WB	2667	2957	11%	3.9
	IP	EB	1034	1180	14%	3.1
		WB	1366	1501	10%	2.5
	PM	EB	2948	2916	-1%	0.4
		WB	1575	1580	0%	0.1

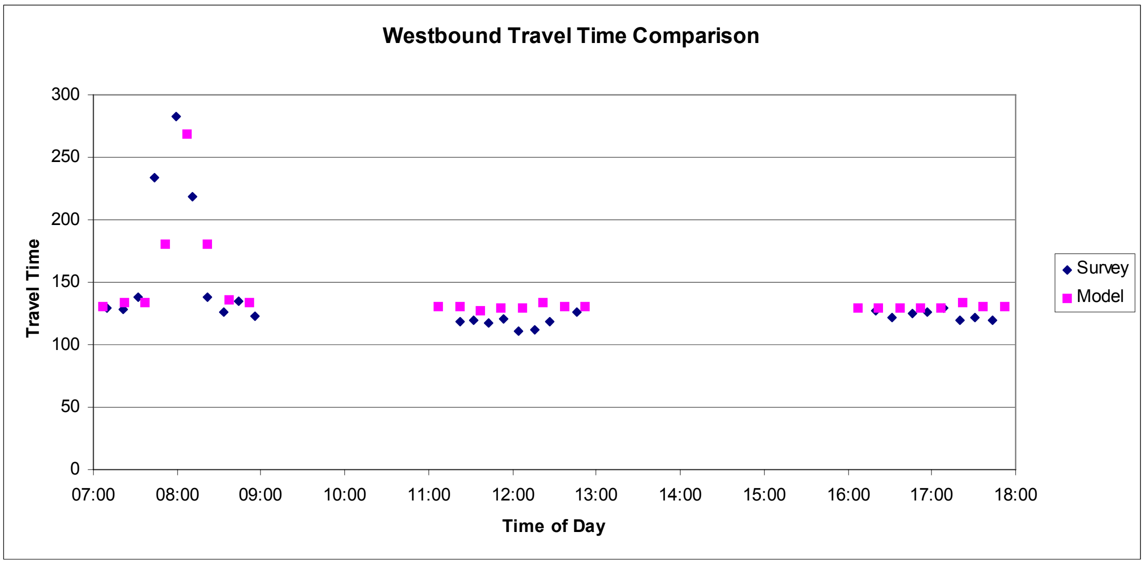
Travel Time Validation

The average results for the modelling periods are listed in the table below. The detailed comparisons throughout each modelling period are shown in the following two figures.

Between East of Ferrymead Bridge and Beachville Road (North)

Direction	Period	Survey Time (seconds)			Model	%Diff
		Average	Min	Max		
	AM	127	117	135	130	2.5%
Eastbound	IP	123	117	130	129	5.1%
	PM	127	119	141	132	4.2%
	AM	165	123	283	171	3.4%
Westbound	IP	118	111	126	130	9.7%
	PM	124	120	129	130	4.9%


Eastbound Travel Time Comparison
Travel Time
300
250
200
150
100
50
0
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
Time of Day
Survey
Model


Westbound Travel Time Comparison
Travel Time
300
250
200
150
100
50
0
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
Time of Day
Survey
Model

Appendix D – Economic Evaluation Sheets

Project: **Main Road 3-Laning**
Component: **BCR**

Time Period

Time Zero:	**2006**
Base Date:	**2004**

Options

Code	Name	Description
DM	**Do Minimum**	Do Minimum including Ferrymead Bridge Widening
Opt1	**Option 1**	Main Road 3-Laning

Unit Cost Values

Table: RUCRATES

Modelled Period		**AM**	**IP**	**PM**	**Off peak**	**Weekend**	Notes
Unit Rates,							
Travel Time Costs, $/hr		15.13	17.95	14.96	14.93	14.09	PEM Urban Arterial
Congestion Time Costs, $/hr		3.88	3.6	3.79	3.68	4.26	PEM Urban Arterial
Vehicle Operating Costs							
Running costs:	**Urban Arterial**		Table Offset **2**				see table VOCRUN below
Update Factors, to base date:		2004					
Travel Time Costs		**1.00**					
Vehicle Operating Costs		**1.00**					
Accident Costs		**1.00**					

Annualisation

Table: ANNUAL

Modelled Period		**AM**	**IP**	**PM**	**Off peak**	**Weekend**	Notes
Daily/annual periods:	length (hr):	**2**	**2**	**2**	IP	IP	
Periods per weekday peak		**1**	**3.64**	**1**	**0**	**6.77**	
Weekdays/Weekends per year		**245**	**245**	**245**	**245**	**120**	
Periods per weekend							
weekends per year							
Adjustments							
VOC					1	1	Factors so weekday interpeak results
TT Cost:					0.832	0.785	can be used for off peak and weekends
CRV Costs					1.022	1.183	
Annual Factors:							
VOC		245.0	1704.2	245.0			
TTC		245.0	1529.5	245.0			
CRV		245.0	1853.1	245.0			

VEHICLE RUNNING COSTS, c/km
Source: PEM, no gradient

SPEED	Running Costs
10	24.6
15	22.5
20	20.8
25	19.7
30	18.8
35	18.2
40	17.7
45	17.4
50	17.2
55	17.1
60	17.1
65	17.2
70	17.2

CAPITAL COST STREAMS, $millions

SUMMARY OF PERIOD MODEL RESULTS

RUN DATA				Total Travel Time	Total Travel Distance	Average Speed	Uncongested Speed	Total Delay	UNIT RATES			PERIOD TRAVEL COSTS, $			ANNUAL FACTORS			ANNUAL TRAVEL COSTS, $M			
Option Name	Code	Period	Year	(second)	(m)	km/hr	km/hr	(second)	TTC, $/hr	CRV, $/hr	VRC, $/km	TTC	CRV	VOC	TTC	CRV	VOC	TTC	CRV	VOC	Total
Do Minimum	DM	AM	2008	1343975	10172455	27	50	611558	15.13	3.88	0.197	5648	659	2004	245	245	245	1.38	0.16	0.49	2.04
Do Minimum	DM	IP	2008	486045	6892426	51	50	0	17.95	3.6	0.172	2423	0	1185	1529.5	1853.1	1704.2	3.71	0.00	2.02	5.73
Do Minimum	DM	PM	2008	769377	10227608	48	50	32989	14.96	3.79	0.174	3197	35	1780	245	245	245	0.78	0.01	0.44	1.23
Do Minimum	DM	AM	2011	1881712	10321623	20	50	1138555	15.13	3.88	0.225	7908	1227	2322	245	245	245	1.94	0.30	0.57	2.81
Do Minimum	DM	IP	2011	514074	7274990	51	50	0	17.95	3.6	0.172	2563	0	1251	1529.5	1853.1	1704.2	3.92	0.00	2.13	6.05
Do Minimum	DM	PM	2011	881546	10762418	44	50	106652	14.96	3.79	0.177	3663	112	1905	245	245	245	0.90	0.03	0.47	1.39
Option 1	Opt1	AM	2008	700961	9775768	50	50	0	15.13	3.88	0.172	2946	0	1681	245	245	245	0.72	0.00	0.41	1.13
Option 1	Opt1	IP	2008	474205	6781430	51	50	0	17.95	3.6	0.172	2364	0	1166	1529.5	1853.1	1704.2	3.62	0.00	1.99	5.60
Option 1	Opt1	PM	2008	749020	10145668	49	50	18532	14.96	3.79	0.174	3113	20	1765	245	245	245	0.76	0.00	0.43	1.20
Option 1	Opt1	AM	2011	759629	10477466	50	50	5251	15.13	3.88	0.174	3193	6	1823	245	245	245	0.78	0.00	0.45	1.23
Option 1	Opt1	IP	2011	521762	7443585	51	50	0	17.95	3.6	0.172	2602	0	1280	1529.5	1853.1	1704.2	3.98	0.00	2.18	6.16
Option 1	Opt1	PM	2011	847897	11010759	47	50	55122	14.96	3.79	0.174	3523	58	1916	245	245	245	0.86	0.01	0.47	1.35

Annual Maintenance	0.074	0.240								0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Periodic Maintenance	0.000	0.000																															
TOTAL COST	1.022	1.387	0.000	0.000	0.000	0.000	0.000	0.000	1.147	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010

Summary of Costs ($Million PV)	Table:	COSTPV					TOTAL		
Option	Pre Cons	Land	Fees	Cons	Annual	Periodic	TOTAL	CAPITAL	MAINT
Do Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Option 1	0.000	0.000	0.000	0.948	0.074	0.000	1.022	0.948	0.074

SUMMARY OF PERIOD MODEL RESULTS

RUN DATA				Total Travel Time	Total Travel Distance	Average Speed	Uncongested Speed	Total Delay	UNIT RATES			PERIOD TRAVEL COSTS, $			ANNUAL FACTORS			ANNUAL TRAVEL COSTS, $M			
Option Name	Code	Period	Year	(second)	(m)	km/hr	km/hr	(second)	TTC, $/hr	CRV, $/hr	VRC, $/km	TTC	CRV	VOC	TTC	CRV	VOC	TTC	CRV	VOC	Total
Do Minimum	DM	AM	2008	1343975	10172455	27	50	611558	15.13	3.88	0.197	5648	659	2004	245	245	245	1.38	0.16	0.49	2.04
Do Minimum	DM	IP	2008	486045	6892426	51	50	0	17.95	3.6	0.172	2423	0	1185	1529.5	1853.1	1704.2	3.71	0.00	2.02	5.73
Do Minimum	DM	PM	2008	769377	10227608	48	50	32989	14.96	3.79	0.174	3197	35	1780	245	245	245	0.78	0.01	0.44	1.23
Do Minimum	DM	AM	2011	1881712	10321623	20	50	1138555	15.13	3.88	0.225	7908	1227	2322	245	245	245	1.94	0.30	0.57	2.81
Do Minimum	DM	IP	2011	514074	7274990	51	50	0	17.95	3.6	0.172	2563	0	1251	1529.5	1853.1	1704.2	3.92	0.00	2.13	6.05
Do Minimum	DM	PM	2011	881546	10762418	44	50	106652	14.96	3.79	0.177	3663	112	1905	245	245	245	0.90	0.03	0.47	1.39
Option 1	Opt1	AM	2008	700961	9775768	50	50	0	15.13	3.88	0.172	2946	0	1681	245	245	245	0.72	0.00	0.41	1.13
Option 1	Opt1	IP	2008	474205	6781430	51	50	0	17.95	3.6	0.172	2364	0	1166	1529.5	1853.1	1704.2	3.62	0.00	1.99	5.60
Option 1	Opt1	PM	2008	749020	10145668	49	50	18532	14.96	3.79	0.174	3113	20	1765	245	245	245	0.76	0.00	0.43	1.20
Option 1	Opt1	AM	2011	759629	10477466	50	50	5251	15.13	3.88	0.174	3193	6	1823	245	245	245	0.78	0.00	0.45	1.23
Option 1	Opt1	IP	2011	521762	7443585	51	50	0	17.95	3.6	0.172	2602	0	1280	1529.5	1853.1	1704.2	3.98	0.00	2.18	6.16
Option 1	Opt1	PM	2011	847897	11010759	47	50	55122	14.96	3.79	0.174	3523	58	1916	245	245	245	0.86	0.01	0.47	1.35

ANNUAL MODEL RESULTS **$2004**

Update factor **1.00** **1.00** **1.00** **1.00**

1 2 3 4 5 6 7 8 9 10 11

2008

Option	Year	TTC	CRV	VOC	Ax	CO2	Other 1	Other 2	TOTAL
Do Minimum	2008	5.87	0.17	2.95		0.15			9.14
Option 1	2008	5.10	0.00	2.83		0.14			8.08

2011

Option		Year	TTC-Links	TTC-Int	CRV-Link	Ax	CO2	Other 1	Other 2	TOTAL
Do Minimum		2011	6.76	0.33	3.17		0.16			10.41
Option 1		2011	5.62	0.02	3.10		0.15			8.89

MODELLED ROAD USER COST STREAMS, $Millions												avg					2016													
Time Zero:	**2006**																													
Base Date:	**2004**										Include																			
Start Construction:	**2**									Cap @ 2011	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Model Years						**2008**			**2011**																				
	SPPWF	1.0000	1.0000	1.0000	0.9091	0.8264	0.7513	0.6830	0.6209	0.5645	0.5132	0.4665	0.4241	0.3855	0.3505	0.3186	0.2897	0.2633	0.2394	0.2176	0.1978	0.1799	0.1635	0.1486	0.1351	0.1228	0.1117	0.1015	0.0923	0.0839
	Year (July-June)	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026	2026/2027	2027/2028	2028/2029	2029/2030	2030/2031	2031/2032
	Analysis Year	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Do Minimum	**NPV**																													
Travel Time costs	63.326			4.992	5.286	5.580	**5.874**	6.168	6.462	**6.756**	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756
Congestion Costs	2.381			0.012	0.065	0.117	**0.170**	0.223	0.275	**0.328**	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328
Vehicle Operating Costs	30.860			2.726	2.800	2.874	**2.947**	3.021	3.095	**3.168**	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168
Accident Costs	0.000			0.000	0.000	0.000	**0.000**	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	1.543			0.136	0.140	0.144	**0.147**	0.151	0.155	**0.158**	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
Other 1	0.000			0.000	0.000	0.000	**0.000**	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000			0.000	0.000	0.000	**0.000**	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	98.109			7.867	8.291	8.715	9.139	9.562	9.986	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410
Option 1	**NPV**																													
Travel Time costs	53.992			4.577	4.752	4.926	**5.101**	5.275	5.450	**5.625**	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625
Congestion Costs	0.102			0.000	0.000	0.001	**0.005**	0.008	0.012	**0.016**	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Vehicle Operating Costs	29.876			2.567	2.655	2.744	**2.832**	2.921	3.009	**3.098**	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098
Accident Costs	0.000			0.000	0.000	0.000	**0.000**	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	1.494			0.128	0.133	0.137	**0.142**	0.146	0.150	**0.155**	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155
Other 1	0.000			0.000	0.000	0.000	**0.000**	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000			0.000	0.000	0.000	**0.000**	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	85.463			7.272	7.539	7.808	8.079	8.351	8.622	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893

Main Road 3-Laning Economic Evaluation

	Offset:	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Year (July-June)	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017
	Analysis Year	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11
Option 1															
Opening (years from time 0)	3														
Compared against :															
Do Minimum		Do Minimu	Do Minimum	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimum	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu
Base Cost Stream	NPV														
Travel Time costs	63.326	0.000	0.000	4.992	5.286	5.580	5.874	6.168	6.462	6.756	6.756	6.756	6.756	6.756	6.756
Congestion Costs	2.381	0.000	0.000	0.012	0.065	0.117	0.170	0.223	0.275	0.328	0.328	0.328	0.328	0.328	0.328
Vehicle Operating Costs	30.860	0.000	0.000	2.726	2.800	2.874	2.947	3.021	3.095	3.168	3.168	3.168	3.168	3.168	3.168
Accident Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	1.543	0.000	0.000	0.136	0.140	0.144	0.147	0.151	0.155	0.158	0.158	0.158	0.158	0.158	0.158
Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	98.109	0.000	0.000	7.867	8.291	8.715	9.139	9.562	9.986	10.410	10.410	10.410	10.410	10.410	10.410
Option 1		Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1
Option Cost Stream	NPV														
Travel Time costs	55.433	0.000	0.000	4.992	5.286	5.580	5.101	5.275	5.450	5.625	5.625	5.625	5.625	5.625	5.625
Congestion Costs	0.268	0.000	0.000	0.012	0.065	0.117	0.005	0.008	0.012	0.016	0.016	0.016	0.016	0.016	0.016
Vehicle Operating Costs	30.275	0.000	0.000	2.726	2.800	2.874	2.832	2.921	3.009	3.098	3.098	3.098	3.098	3.098	3.098
Accident Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	1.514	0.000	0.000	0.136	0.140	0.144	0.142	0.146	0.150	0.155	0.155	0.155	0.155	0.155	0.155
Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	87.490	0.000	0.000	7.867	8.291	8.715	8.079	8.351	8.622	8.893	8.893	8.893	8.893	8.893	8.893
BENEFITS	NPV														
Travel Time costs	7.892	0.000	0.000	0.000	0.000	0.000	0.773	0.892	1.012	1.131	1.131	1.131	1.131	1.131	1.131
Congestion Costs	2.113	0.000	0.000	0.000	0.000	0.000	0.165	0.214	0.263	0.313	0.313	0.313	0.313	0.313	0.313
Vehicle Operating Costs	0.585	0.000	0.000	0.000	0.000	0.000	0.115	0.100	0.085	0.070	0.070	0.070	0.070	0.070	0.070
Accident Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	0.029	0.000	0.000	0.000	0.000	0.000	0.006	0.005	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	10.619	0.000	0.000	0.000	0.000	0.000	1.059	1.212	1.365	1.517	1.517	1.517	1.517	1.517	1.517
FYRR															
NPV Capital Cost:	0.948														
Discounted First Year Benefits		-	-	-	-	-	0.835	0.868	0.889	0.898	0.817	0.742	0.675	0.614	0.558
Discounted Costs		-	-	-	-	-	0.948	0.862	0.783	0.712	0.647	0.589	0.535	0.486	0.442
	FYRR	-	-	-	-	-	88.0%	100.7%	113.4%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%

Offset:	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Year (July-June)	2017/2018	2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026	2026/2027	2027/2028	2028/2029	2029/2030	2030/2031	2031/2032
Analysis Year	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Option 1															
Opening (years from time 0)															
Compared against :															
Do Minimum	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimu	Do Minimum	Do Minimum
Base Cost Stream															
Travel Time costs	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756	6.756
Congestion Costs	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328
Vehicle Operating Costs	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168	3.168
Accident Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410	10.410
Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1	Option 1
Option Cost Stream															
Travel Time costs	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625	5.625
Congestion Costs	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016
Vehicle Operating Costs	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098	3.098
Accident Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155
Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893	8.893
BENEFITS															
Travel Time costs	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131
Congestion Costs	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313
Vehicle Operating Costs	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070
Accident Costs	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CO_2	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Other 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Other 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517	1.517
FYRR															
NPV Capital Cost:															
Discounted First Year Benefits	0.507	0.461	0.419	0.381	0.346	0.315	0.286	0.260	0.237	0.215	0.195	0.178	0.162	0.147	0.134
Discounted Costs	0.402	0.365	0.332	0.302	0.275	0.250	0.227	0.206	0.188	0.170	0.155	0.141	0.128	0.116	0.106
FYRR	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%	126.1%

COST- BENEFIT ANALYSIS OF THE OPTIONS WORKSHEET 4

Project: **Main Road 3-Laning**
Component: **BCR**

1	Project Options	Base **Do Minimum**	Option **Option 1**	**Option 1**
COSTS ($M):				
2	Capital Costs	0.000	0.948	0.948
3	Maintenance Costs	0.000	0.074	0.074
4	Total Costs (2) + (3)	0.000	1.022	1.022
BENEFITS ($M):				
5a	Travel Time Costs	63.326	55.433	7.892
5b	Congestion Costs	2.381	0.268	2.113
6	Vehicle Operating Costs	30.860	30.275	0.585
7	Accident Costs	0.000	0.000	0.000
8	Carbon Dioxide	1.543	1.514	0.029
9	Tangible Benefits (5) to (9)			10.619
10	Tangible B/C Ratio (10)/(4)	98.109	87.490	**10**
11	Net Present Value			9.60

Appendix E – Cost Breakdown

Appendix A

Three-Laning Options Drawings

Appendix B

Accident History and Collision Diagram

Appendix C

Model Validation Results

Appendix D

Economic Evaluation Sheets

Appendix E

Cost Breakdown