Appendix A
Opus report: RoNS business case economic update 2013

OPUS

Wellington Northern Corridor RoNS

RoNS Business Case Economic Update 2013

FINAL

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Contents

1 Introduction

The Wellington Northern Corridor is one of the seven Roads of National Significance (RoNS) that the Government has identified in the Government Policy Statement (GPS) 2012/13 to 2021/22 as essential state highways which require upgrading to reduce traffic congestion, improve safety and support economic growth in New Zealand. The GPS indicates that the RoNS represent a substantial change in planning for major national transport infrastructure in New Zealand. This involves proactive infrastructure improvements that encourage economic growth. In the past, improvements have tended to be reactive and focused on improving transport networks to keep pace with growth.

The Wellington Northern Corridor RoNS (WNCR) covers a 110km stretch of road from Wellington Airport to Levin and will largely be four-laned. It is made up of the following projects (south to north):

- Airport to Mt Victoria Tunnel, improvements from the Cobham Drive/Evans Bay Parade intersection near the airport through to the Basin Reserve, including a second Mt Victoria Tunnel and widening of Ruahine Street and Wellington Road;
- Tunnel to Tunnel (T2T), combines the Basin Bridge, Buckle Street Underpass and improvements to the existing Inner-city Bypass;
- Terrace Tunnel Duplication;
- Aotea Quay to Ngauranga;
- Linden to MacKays (Transmission Gully);
- MacKays to Peka Peka (Kāpiti Expressway);
- Peka Peka to Ōtaki; and
- Ōtaki to Levin.

It should be noted that the Ngauranga Gorge to Linden (Petone to Grenada), which was included in the 2009 economics assessment, is now only included as a sensitivity test due to the involvement of Wellington City Council (WCC) and Hutt City Council (HCC).

The parts of the WNCR are also illustrated in Figure 1-1 on the next page.

Figure 1-1: Wellington Northern Corridor RoNS Map

2 Purpose

In late 2009, Opus was commissioned by the New Zealand Transport Agency (NZTA) to prepare an economic assessment to feed into the WNCR Business Case which calculated and summarised the Benefit Cost Ratios (BCRs) for each of the WNCR projects individually. This was done according to the proposed programme at the time.

Since the assessment of the original Business Case most of the Wellington Northern Corridor RoNS projects have progressed significantly and some components are currently being constructed. Greater understanding of site specific issues, preferred options and their relative costs and benefits are now becoming more apparent. Both the Wellington Transport Strategic Model (WTSM) and Wellington Traffic Model (WTM) have also been updated recently such that the RoNS scheme assessments can be improved through analysis using these models. There is also the ability to model the weekend peak for the Wellington network and significant additional information relating to wider economic benefits and agglomeration benefits.

The assessment of transport in the Wellington Region is completed by utilising these models and others. The WTSM model is produced in the EMME software package and assesses land use at a macro level. It is known as the traffic demand model for the Wellington Region. SATURN models, such as WTM, assess strategic traffic assignment at a meso scopic level with more detailed traffic congestion estimation, and in certain areas S-Paramics models assess network operation at a micro level. The traffic demand and the origin to destination information are passed from EMME to SATURN for traffic and economic assessments; the route choice information is then passed to S-Paramics for detailed design where appropriate. More details on the modelling interaction are provided in Section 3.1.

In late 2011, as part of the process to develop an Addendum to the 2009 Business Case, Opus was commissioned by the NZTA to develop a tool known as RoNS Economics Modelling Assessment Tool (REMAT) to assess all projects that form part of WNCR using a database which takes specific project information and analyses it consistently to give a total Benefit to Cost Ratio (BCR) while also allowing for sensitivity testing.

For such reasons, Opus has been commissioned by the NZTA to update the 2009 business case economics. The purpose of this is report is to:

- Summarise economics for each of the individual RoNS projects for Wellington;
- Update the REMAT with the most updated programme;
- Assess the economic efficiency for the total WNCR using REMAT; and
- Undertake sensitivity analysis of the WNCR.

The report is separated into two halves. Section 3 collates the previous work that has been done while the remaining sections of the report describe how that information is being used for economic analysis in REMAT.

3 Individual Parts

The WNCR has been divided into nine parts. These parts, consisting of either individual projects or a combination of projects, encompass the entire corridor from the southern end of SH1 at Wellington International Airport to the town of Levin in the north. This section of the report presents the previously reported benefit cost ratios (BCRs) as well as general project descriptions. Parts 1, 2 and 3 have additional comparisons between BCRs previously reported and those developed using the new WTM model. While Petone to Grenada is not officially part of the WNCR, it has been included as Part 5 as it will be assessed as a sensitivity test and previously formed part of the 2009 Business Case. The numbering of the individual parts is based on the geographic location of the project from south to north. Table 3-1 identifies the status of the projects at this time.

Table 3-1: Status of WNCR Parts

No.	Part	Status
1	Airport to Mt Victoria Tunnel	Scheme Assessment Report (SAR)
2	Tunnel to Tunnel	Construction, Detailed Design
3	Terrace Tunnel Duplication	Project Feasibility Report (PFR)
4	Aotea Quay to Ngauranga Gorge	Construction, SAR
5	Ngauranga Gorge to Linden (P2G)	PFR
6	Linden to MacKays (Transmission Gully)	Detailed Design
7	MacKays to Peka Peka	SAR
8	Peka Peka to North Ōtaki	SAR
9	North Ōtaki to Levin	Various PFRs

The NZTA's Cost Estimation Manual identifies the four development phases that most projects follow: project feasibility, investigation and reporting (I&R), design and project documentation (D&PD), and construction. The documentation produced for the project feasibility phase is a Project Feasibility Report (PFR). The I&R phase may include the development of a scoping report, and then a Scheme Assessment Report (SAR) followed by an Assessment of Environmental Effects (AEE). The I&R phase concludes with the lodgement of the notice of requirement for designation (NOR) and resource consents where applicable. Once an option is approved, it progresses to detailed design in the D&PD phase and then on to construction. Estimates are completed throughout the project development process and vary in their expected accuracy due to what can reasonably be known at the time about each project.

Section 3.1 of this report is comprised of general economic assumptions for the previously completed and reported economic analyses. The succeeding sections (3.2 to 3.10) describe the individual project parts as follows:

- General project description including location and issues;
- Specific scheme description taken through to modelling and economic analysis including a description of the Do Minimum network used for comparison and the WTSM demand assumptions; and

- The current expected cost estimate, a description of the conventional transportation benefits included in the economic analysis and the reported Net Present Value costs and benefits and BCR.

The conventional transportation benefits may include some or all of the following types of benefits:

- Vehicle Operating Cost (VOC) savings;
- Travel time cost savings;
- Carbon dioxide (CO_2) reduction;
- Crash reduction;
- Route security;
- Increased trip reliability; and
- Pedestrian, cycling and public transport benefits.

3.1 General economic assumptions

Many of the assumptions used in the modelling and economic analysis of the WNCR are consistent across all parts. Several general assumptions are listed below. Where the project in question differs from the assumptions listed here it will be stated in that project's subsection. The modelling, cost estimates and economic analysis sections of the previously completed reports are presented as appendices to this document where available. The general modelling and economic assumptions are as follows:

- A discounting rate of 8% has been applied for Parts 4-6, 8 and 9 as the economics for these parts was completed prior to 2013. A discounting rate of 6% has been used for Parts 1-3 and 7[1];
- A 30 year benefit period was applied for Parts 4-6, 8 and 9 as the economics for these parts was completed prior to 2013. A 40 year benefit period has been used for Parts 1-3 and 7[2];
- Time zero of 1/07/2012 (i.e. all dollar values for benefits and costs are expressed in 2012 dollars as some of the projects were under construction in 2012);
- Previously reported net present values (NPV's) are displayed as they have been stated in their respective reports;
- Conventional economics calculation assumes fixed values of time over time, which has been applied throughout the analysis period. This approach is the general practice for economic assessment of transport projects in New Zealand;
- CO2 costs have been taken as 4% of the VOC as indicated in the full procedures section of the Economic Evaluation Manual (EEM) (page 5-132); and
- SATURN modelling uses demands from the updated 2011 Wellington Transport Strategic Model (WTSM) unless stated otherwise. The schemes included in the WTSM demand matrices vary for WNCR parts and are discussed in more detail in the subsections 3.2 to 3.10.

Most of the economics were completed using SATURN software outputs and a fixed trip matrix methodology. That is, both the Option and the Do Minimum have been run using the same demand matrix. Using this method, no induced trips due to the project are included. This is generally expected to yield fewer benefits in most projects and thus to be a more conservative approach.

[1] Discounting rate of 6% applied to Parts 1, 2, 3 and 7 as per the EEM policies effective July 2013.
[2] Benefit period of 40 years applied to Parts 1, 2, 3 and 7 as per the EEM policies effective July 2013.

Work recently completed for the WNCR on this subject suggests 7.2% fewer benefits[3]. A variable trip matrix approach uses different matrices to run the Option and Do Minimum. This method is expected to capture the additional traffic that will potentially result on the network due to the introduction of the project. Table 3-2 identifies the projects that use fixed and variable trip matrix approaches, as well as what software the project was modelled in and the company that completed the modelling.

The EEM states that variable trip matrix methods are to be used for all complex improvements unless:

a. It can be demonstrated that the congestion level expected throughout the analysis period in the do-minimum or option will not be substantial, and the peak period passenger transport mode share is less than 15 per cent; or
b. Preliminary evaluation shows that the fixed trip matrix benefits are unlikely to differ by more than 10 percent from those from a variable trip matrix approach; or
c. The NZTA approves the use of a fixed matrix approach for other reasons.

Contrary to this, most of the WNCR projects have project models based on fixed vehicle trip matrices. The effect of this is to assume that there will be no induced trips following completion of the programme resulting in fewer transport benefits being generated by the programme

Table 3-2: Economics Type and Software Used for WNCR Parts

No.	Part	Economic Method	Software	Modeller
1	Airport to Mt Victoria Tunnel	Fixed Trip Matrix (FTM)	SATURN	Opus
2	Tunnel to Tunnel	FTM	SATURN	Opus
3	Terrace Tunnel Duplication	FTM	SATURN	Opus
4	Aotea Quay to Ngauranga Gorge	Variable Trips Matrix (VTM)	Paramics	Traffic Design Group
5	Ngauranga Gorge to Linden (P2G)	VTM	SATURN	SKM
6	Linden to MacKays (Transmission Gully)	FTM	SATURN	SKM
7	MacKays to Peka Peka	VTM	SATURN	BECA
8	Peka Peka to North Ōtaki	FTM	SATURN	Opus
9	North Ōtaki to Levin	n/a	n/a	Various

WTSM is a four-stage regional strategic model built using EMME software and regional census data. This model identifies the traffic effects of future land use changes, population increases and future projects, such as the WNCR, in the Wellington Region. This information is then passed down to the SATURN models. SATURN analyses the traffic effects on the network at a more detailed level than EMME and identifies routing and congestion issues. Paramics then uses the

[3] Sourced from WNCR WEB - Working Paper 10, Fixed or Variable Matrix Assessment by Richard Paling Consulting (April 2013).

information produced by SATURN to analyse the detailed network operation. The relationship between the three modelling software packages is shown in Figure 3-1.

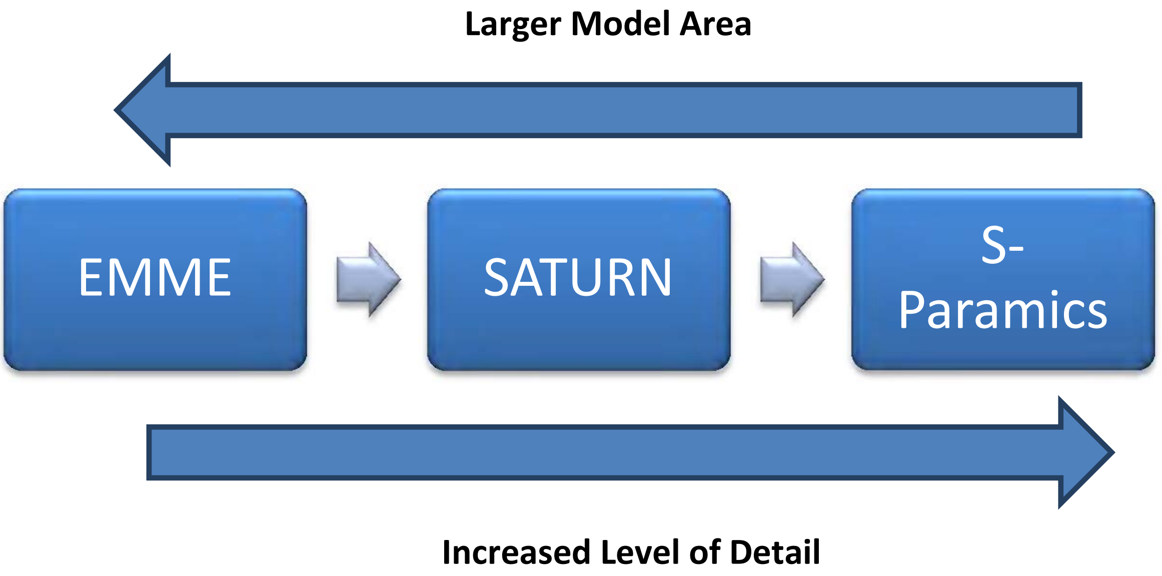

Figure 3-1: Model Inter-relationships

3.1.1 REMAT Assumptions

Additional assumptions for the inputs to REMAT are as follows, and are also discussed in Section 4 of this report:

- The expected costs and benefits inputted to REMAT are discounted to 2012 dollars;
- Time zero has been taken as 01/07/2012 for all parts to account for the projects that had already started in 2012. Time zero is meant to reflect when the funding application has been launched as it is assumed that funding is allocated at that time. In order to compare projects uniformly in REMAT they must all have the same time zero; and
- In accordance with the NZTA's policy contained in the EEM and the Cost Estimation Manual, cost inputs are exclusive of "sunk costs", that is, money that the NZTA has already spent on the project (not including property costs). These costs are removed from the analysis and they consist of investigation, research, design and some construction costs that are irrevocably committed to the project and have no salvageable value. Property purchased does have a realisable value and thus is not included as a sunk cost. Table 3-3 lists the sunk costs as reported by the NZTA as at 31 March 2013 that were removed from the analysis. Sunk benefits, principally those already realised by the Aotea Quay to Ngauranga 'Early Works' have also been excluded from the analysis and the Do Minimum model includes the Early Works to account for this, as discussed in Section 3.5.1. Removal of the sunk costs for the economic analysis indicates that the economic efficiencies provided by REMAT are on-going construction stage BCR's. This is also true of the current BCR's provided for Parts 1, 2 and 3.

Table 3-3: Sunk Costs Reported by the NZTA and Removed from REMAT Assessment as at 31 March 2013

No.	Part	Sunk Costs
1	Airport to Mt Victoria Tunnel	$6,331,000
2	Tunnel to Tunnel	$24,166,100
3	Terrace Tunnel Duplication	$56,800
4	Aotea Quay to Ngauranga Gorge	$5,280,500
5	Ngauranga Gorge to Linden (P2G)	$181,700
6	Linden to MacKays (Transmission Gully)	$34,602,300
7	MacKays to Peka Peka	$45,862,200
8	Peka Peka to North Ōtaki	$6,668,300
9	North Ōtaki to Levin	$1,676,800
	Total	$124,825,700

In addition to the assumptions previously stated, Table 3-4 identifies the construction programme assumptions applied in REMAT. These timings may not be the same as those used in the economics reported in this section as the construction programme has evolved since many of the reports have been completed.

Table 3-4: Construction Programme Assumptions

No.	Part	Programme	
		Start	Finish
1	Airport to Mt Victoria Tunnel	1/7/2018	1/5/2022
2	Tunnel to Tunnel	1/1/2013	1/7/2017
3	Terrace Tunnel Duplication	1/7/2020	1/7/2024
4	Aotea Quay to Ngauranga Gorge[4]	1/7/2013	1/7/2014
5	Ngauranga Gorge to Linden (P2G)	1/7/2019	1/7/2023
6	Linden to MacKays (Transmission Gully)	1/7/2014	1/7/2020
7	MacKays to Peka Peka	1/7/2013	1/7/2018
8	Peka Peka to North Ōtaki	1/7/2016	1/7/2020
9	North Ōtaki to Levin	1/07/2019	1/07/2024

[4] Due to the staged programme of the Aotea Quay to Ngauranga project, the construction timing has been taken as 1 year in REMAT in order to obtain benefits from the early works stage of the project and simplify the analysis. This is consistent with the economic assessment completed in the project's SAR.

3.2 Part 1: Airport to Mt Victoria Tunnel

The Airport to Mt Victoria Tunnel scheme consists of the Mt Victoria Tunnel duplication and widening of Wellington Road and Ruahine Street. As reported in the Mt Victoria to Cobham Drive Scheme Assessment Report (SAR), this section of SH1 experiences capacity issues which contribute to issues with trip reliability, particularly when an event or incident occurs. This is of particular concern to those travelling to and from the airport and to the projected growth in airport freight and passenger volumes. The projected growth in the eastern suburbs of Wellington City will only exacerbate the current issues on this section of the network.

The scheme also aims to address issues for other road users (pedestrians and cyclists), local access to properties along the highway and delays to public transport experienced along the corridor.

3.2.1 Scheme Description

The current scheme is dubbed the “Hybrid Option” in the SAR. It includes:

- Widening of Paterson Street, Wellington Road and Ruahine Street;
- Restricting access to Wellington Road and Ruahine Street at several locations;
- Providing a shared access lane along the eastern side of Ruahine Street and northern side of Wellington Road to allow access to residential properties and for pedestrian and cyclist traffic;
- New traffic lights at the following locations:
  - » Taurima Street and Moxham Avenue
  - » Ruahine Street and Goa Street
  - » Goa Street and Moxham Avenue
  - » Wellington Road and Ruahine Street
- Duplicating the Mt Victoria Tunnel (to the north of the existing tunnel).

The Do Minimum network used for comparison against this scheme includes the Tunnel to Tunnel project and the Aotea Quay to Ngauranga project. These parts of the WNCR have been included as the construction programming indicates that they will be completed prior to the Airport to Mt Victoria Tunnel project.

The WTSM demand matrices used for this project include all WNC RoNS projects and Petone to Grenada for both modelled years (2021 and 2031) and ‘medium’ growth as indicated in Appendix A.

3.2.2 Economic Efficiency (BCR)

The current expected estimate for the construction of the Hybrid Option is $370.1M (2012 $value). The cost estimate used for the WTM analysis and in REMAT taking into account sunk costs is $363.8M.

The benefits calculated using the WTM model only include travel time, VOC and CO_2 benefits. As well as these benefits, the SAR included benefits from reduced crashes, trip reliability, pedestrian and cycling and public transport. These other conventional transportation benefits calculated in the SAR have been included in REMAT and applied with the benefits estimated using the WTM. The trip reliability and public transport benefits have been included as net present values (NPVs) as no annual values were provided. As these two benefits were calculated using a 30 year analysis period and 8% discount rate, they are deemed to be conservative estimates.

Table 3-5: Airport to Mt Victoria Tunnel BCR summary

	NPV Benefit	NPV Cost	BCR
Previously Reported - SAR	$82.1M	$222.5M	0.4
Current -WTM	$131.4M	$235.5M	0.6

The difference in the benefits for the Airport to Mt Victoria Tunnel project is a result of using the updated 2011 WTM model and including the Saturday peak modelling outputs.

3.3 Part 2: Tunnel to Tunnel

The Tunnel to Tunnel (T2T) project encompasses the length of SH1 between Mt Victoria Tunnel and Terrace Tunnel. Previously this area had been separated into several projects to address the congestion issues experienced between the two tunnels. The NZTA has now taken the opportunity to combine the projects under one umbrella project called T2T. The individual projects that now make up T2T are the Basin Bridge, Buckle Street Underpass and Inner-city Bypass (ICB) improvements. A scheme assessment report has been completed for the Basin Bridge in 2012, while a PFR was produced for the ICB in 2012. For the underpass a cost estimate was completed however no economic evaluation has been published.

3.3.1 Scheme Description

The Basin Bridge scheme involves the grade separation of SH1 traffic along the northern side of the Basin Reserve. In addition, a pedestrian and cyclist facility will also be incorporated into the structure. Northbound SH1 traffic travelling on the Basin Bridge then feeds into the Buckle Street Underpass that runs adjacent to the War Memorial Park providing an opportunity to expand the park on the land above the underpass. Further included in the T2T project are improvements along northbound and southbound SH1 through the CBD, particularly at intersections where considerable congestion and travel time delay is currently occurring and predicted to get worse in the future.

The Do Minimum network used for comparison against this scheme does not include any of the RoNS projects. The Tunnel to Tunnel project is the first programmed of the WNCR and it is currently under construction and due to be to be completed in 2017. While the Aotea Quay to Ngauranga project has been recommended to be implemented in stages, and some of those stages may be completed prior to 2021, it has been modelled as one unit in SATURN due to the level of detail possible by the SATURN modelling program. SATURN is unable to model detailed schemes such as traffic management systems and thus, the Aotea Quay to Ngauranga project has not been included in the Do Minimum or the Option.

The WTSM demand matrices used for this project include all WNC RoNS projects and Petone to Grenada for both modelled years (2021 and 2031) and 'medium' growth as indicated in Appendix A.

3.3.2 Economic Efficiency (BCR)

The Basin Bridge SAR reported an expected estimate of $90M, the ICB PFR reported $7.5M for the moderate option and the Buckle Street Underpass has been estimated to cost $71.5M. Once the sunk costs ($24.2M) and Government contributions for the Buckle Street Underpass ($50M) have been taken into account the current estimate for the remaining costs of the T2T project is $94.8M (2012 $value).

The benefits calculated using the WTM model only include travel time, VOC and CO_2 benefits, as with the Airport to Mt Victoria Tunnel assessment above. The benefits reported in the ICB PFR also just include these benefits. The Basin Reserve SAR includes other benefits from crashes, trip reliability, public transport and pedestrian and cycling, which are included in the current WTM benefits and are also included in REMAT. The public transport and pedestrian and cycling benefits have been included as NPVs as no annual values were provided. As these two benefits were calculated using a 30 year analysis period and 8% discount rate, they are deemed to be conservative estimates.

Table 3-6: Tunnel to Tunnel BCR summary

	NPV Benefit	NPV Cost	BCR
Previously Reported – Basin Reserve SAR	$84.5M	$71.6M	1.2
Previously Reported – ICB PFR	$27.8M	$5.7M	4.9
Previously Reported – Buckle Street Underpass[5]	-	$71.5M[6]	-
Current (WTM) – Tunnel to Tunnel	$257.0M	$82.9M[7]	3.1

Using the updated 2011 WTM model and including the Saturday peak modelling outputs results in a higher value of benefits to those previously reported. Also, the benefits are now higher due to combining the three projects into one. As no recent economics are available for the Buckle Street Underpass project, they have not been included in the table above.

5 Benefits not calculated for the Buckle Street Underpass
6 This value represents the expected estimate. It has not been presented as a net present value as no economic calculations have been published. .
7 Sunk costs and Government contributions have been removed.

3.4 Part 3: Terrace Tunnel Duplication

The current layout of the Terrace Tunnel has two lanes northbound and only one lane southbound. Prior to the tunnel in the southbound direction there are two lanes that merge into one which causes significant delays, particularly in the morning peak, evening peak and weekend peak periods. Duplication of the Terrace Tunnel was investigated in 2008 resulting in the completion of the Terrace Tunnel Duplication and Waterfront Depowering Project Feasibility Report (PFR). The NZTA has recently awarded a tender for the investigation and reporting phase of this project.

3.4.1 Scheme Description

The details of the scheme for the Terrace Tunnel Duplication are relatively unknown at this time due to the early stages of the investigation. However, the option assumed in the WTM modelling was to utilise the existing tunnel for three lanes in the northbound direction and have two lanes southbound in a new tunnel. This differs from Option 2 in the Terrace Tunnel PFR which suggested two lanes northbound in the existing tunnel but is a likely scenario.

The Do Minimum network used for comparison against this scheme includes the Tunnel to Tunnel, Airport to Mount Victoria and Aotea Quay to Ngauranga projects. These parts of the WNCR have been included as the construction programming which indicates that they will be completed prior to the Terrace Tunnel project.

The WTSM demand matrices used for this project include all WNC RoNS projects and Petone to Grenada for both modelled years (2021 and 2031) and 'medium' growth as indicated in Appendix A.

3.4.2 Economic Efficiency (BCR)

The last cost estimate completed for the Terrace Tunnel project was completed in 2006. It has been factored up to 2012 values as discussed in the WTM economics note provided in Appendix A. The expected construction cost, less sunk costs, used for the current WTM and in REMAT is $181.5M.

As with Parts 1 and 2, the benefits calculated using the WTM model only include travel time, VOC and CO_2 benefits. The previous Terrace Tunnel PFR from 2008 also reported these same benefits.

Table 3-7: Terrace Tunnel BCR summary

	NPV Benefit	NPV Cost	BCR
Previously Reported - PFR	$2.5M	$89.0M	0.03
Current (WTM)	$154.1M	$104.5M	1.5

There are several reasons for the large discrepancy between the benefits previously reported and the current benefits.

- The benefits previously reported in the Terrace Tunnel PFR also included the depowering of the waterfront route which causes significant negative benefits to the network;
- The new modelled option has three northbound lanes through the tunnel instead of two which allows for some benefits to be achieved for northbound users;
- At the time the PFR was reported, the EEM policy included a 25 year benefit period and an 8% discount rate;

- The previous economics were based on WTSM outputs. The delay level modelled in this regional demand model is more coarse than the current WTM simulation model;
- The WTM now includes for the Saturday peak period that provides a more robust economics assessment of the weekend impacts; and
- In the PFR reported economics, the Aotea Quay to Ngauranga Gorge and the Inner City Bypass Improvement projects were not included in the WTSM modelling, which was the only model used for assessing the economics, as assessment of these projects had not been completed in 2008. The Aotea to Ngauranga Gorge project frees the inbound corridor of the network and increases the number of vehicles that are able to travel through the network to the Terrace Tunnel. Likewise, the Inner City Bypass Improvements allow improved tunnel access and discharge from the southern end of the tunnel. In the updated economics, the Aotea Quay to Ngauranga Gorge and Inner City Bypass Improvement projects are included in both the Do Minimum and the Option. This increases the number of vehicles travelling through the tunnel and thus increases the number of vehicles that the benefits of the tunnel apply to.

Conversely, the previous time zero used for the Terrace Tunnel project was July 2016 which would increase the benefits in the previous report (as the current economics uses a time zero of July 2012). This only has a slight effect compared to the magnitude of the benefit increases due to the reasons listed above.

3.5 Part 4: Aotea Quay to Ngauranga

The Aotea Quay to Ngauranga part of the Wellington RoNS consists of approximately 3km of SH1 from the Aotea Quay on and off ramps in the south to the Ngauranga interchange in the north. Currently there are 3 lanes in both the northbound and southbound directions along this section of SH1/Wellington Urban Motorway. Aotea Quay to Ngauranga is the most congested part of the Wellington network in the morning and evening peaks, providing access to the many people who travel into Wellington City for work from Kāpiti, Porirua and the Hutt Valley.

3.5.1 Scheme Description

The Ngauranga to Aotea Quay Wellington ATM Scheme Assessment Report (2012) suggests dividing the scheme into four stages for implementation. Those are:

- Stage 1: Improvements to the SH2 northbound on-ramp at Ngauranga;
- Stage 2: Improvements to the ATMS (Advanced Traffic Management System);
- Stage 3: Widening SH1 to four lanes northbound; and
- Stage 4: Widening SH1 to four lanes southbound.

In previous assessments it was suggested that an additional lane be operational only during peak periods and in alternating directions (i.e. a fourth lane southbound during the morning peak and a fourth lane northbound during the evening peak). In the SAR it was determined through economic and behavioural analysis that the additional lanes should be full time as it is safer, easier to manage and realises more benefits.

The Do Minimum network used for comparison against this scheme is the base Paramics model with the 'Early Works', therefore the benefits of the Early Works are not counted. The geographic extent of the model area excludes any other WNCR parts from being included in the model.

The WTSM demand matrices used 'high' growth for this project and included Peka Peka to North Ōtaki, MacKays to Peka Peka and the Basin Reserve[8] schemes in model year 2021. All WNC RoNS projects, except Aotea Quay to Ngauranga Gorge, and Petone to Grenada have been included in 2031 as indicated in Appendix B. Due to the use of the variable trip matrix (VTM) approach for this project, matrices including and excluding the Aotea Quay to Ngauranga project were used for the Option and Do Minimum, respectively.

3.5.2 Economic Efficiency (BCR)

The current expected estimate for the full scheme of the Aotea Quay to Ngauranga project is $87.6M. Less sunk costs and adjusting to 2012 dollars, the value for input to REMAT is $84.1M.

The benefits calculated in the SAR include travel time, VOC and CO_2 benefits as well as trip reliability and crash reduction benefits.

[8] The Basin Reserve project was coded using the scheme at the time the model was developed, prior to the Tunnel to Tunnel grouping of the three projects.

Table 3-8: Aotea Quay to Ngauranga BCR summary

	NPV Benefit	NPV Cost	BCR
Current	$79.1M	$75.1M	1.1

The economics and modelling sections of the Aotea Quay to Ngauranga SAR have been provided in Appendix B.

3.6 Part 5: Ngauranga Gorge to Linden (P2G)

Ngauranga Gorge to Linden, or Petone to Grenada as it is also known, will only be included in REMAT as a sensitivity test. This project does not form a core element of the RoNS, however it is nevertheless an important component of the future road network and the provision of relief on SH1 between Ngauranga and Linden.

The Petone to Grenada Link Road was identified as a potential solution in the Ngauranga Triangle Strategy Study. This link would ease congestion on both SH1 and SH2 while increasing regional connectivity and reducing travel times between Tawa/Porirua and the Hutt Valley/Petone. This project is currently in the Investigation and Reporting phase. Funding for the investigation, design and property is however sourced from the approved funding for the WNCR.

3.6.1 Scheme Description

The preferred alignment recommended by the Petone to Grenada Link Road Project Feasibility Report suggests a connection between SH1 at the Tawa interchange to SH2 at Petone with two lanes in both the northbound and southbound direction. The road would be approximately 6.4km in length and have a design speed of 70 kilometres per hour (kph). The link road has three proposed intersections/interchanges:

- Tawa Interchange SH1: grade separated with only southbound on ramp and northbound off ramp connections to SH1;
- Lincolnshire Farm Junction: grade separated full movement junction to connect with the proposed mixed development; and
- Petone Intersection SH2: grade separated full movement junction, with connections to The Esplanade and Hutt Road.

These are the assumptions used to determine the economics provided in Section 3.6.2 and may differ significantly from the results of the project's next phase of reporting.

Modelling for Petone to Grenada was completed in 2009 and thus many of the schemes are likely to have changed since. The Do Minimum network used for comparison against this scheme includes versions of the Terrace Tunnel, ICB improvements, MacKays to Peka Peka, Transmission Gully and Aotea Quay to Ngauranga projects. The WTSM demand matrices used for this project used medium growth and include these same projects for both modelled years (2016 and 2026) as indicated in Appendix C. The Petone to Grenada project modelling also used the VTM approach.

3.6.2 Economic Efficiency (BCR)

The last cost estimate prepared for the Petone to Grenada project was completed in 2009. It has been factored up to 2012 values using the construction cost update factor of 1.08 provided in Table A12.1 of the EEM. The expected construction cost used for the current REMAT (with sunk costs deducted) is $282.2M. Maintenance costs were included in the economic analysis and were calculated to have a NPV of $0.9M.

The benefits calculated for Petone to Grenada include travel time and VOC benefits. Crash benefits were assumed to be negligible with the exception of those at the Tawa interchange. These benefits were taken by SKM from the Tawa Interchange PFR completed by MWH in 2007 and factored. The crash benefits have also been included in REMAT as a NPV.

Table 3-9: Ngauranga to Linden BCR summary

	NPV Benefit	NPV Cost	BCR
Current	$280M	$252.7M	1.1

The economics and modelling sections of the Petone to Grenada Link Road PFR have been provided in Appendix C.

3.6.3 Modelling Exceptions

The Petone to Grenada economics uses some assumptions that are different from those in Section 3.1. Time zero was taken as 2014 which will not be carried over into REMAT. The modelling was completed using demand matrices from the 2006 WTSM. Also, CO_2 benefits have not been included in the NPV benefits above; however, they will be included as 4% of VOC in REMAT for comparison purposes.

3.7 Part 6: Linden to MacKays Crossing (TG)

Between Linden and MacKays Crossing the Transmission Gully (TG) project has been proposed as an alternate route to the SH1 corridor. This would provide route security as the SH1 coastal route is considered vulnerable to liquefaction, rockfall, slips and closure due to crashes. Transmission Gully would act as an additional corridor for emergency response. It will also improve the congestion that currently exists on the network through Porirua and the southern part of the Kāpiti District. The route aims to shift traffic and heavy goods vehicles away from the coastal communities of Mana, Plimmerton, Pukerua Bay and Paekakariki.

3.7.1 Scheme Description

The approved project option in the TG Business Case completed in September 2012 is for a four lane motorway. The link will be approximately 27km long with continuous median barrier between two lanes in each direction. Crawler lanes will also be included at some locations to account for the speed differential between trucks and other traffic, although grades are limited to an 8% maximum. Transmission Gully will connect with SH1 near Linden at the southern end of the route and near MacKays Crossing in the north. There are three grade separated intersections proposed at the following locations:

- Kenepuru Drive
- Whitby, James Cook Drive and Waitangirua
- SH58

The design and construction phases are likely to be progressed as a Public Private Partnership (PPP). As agreements on this PPP have yet to be reached, the current scheme information is used. The Do Minimum network used for comparison against this scheme includes a variation of the MacKays to Peka Peka project and the Petone to Grenada project. These parts of the WNCR have been included as the previous construction programming for the 2009 Business Case indicated that these two projects would be completed prior to the Transmission Gully project and are within the modelled area.

The WTSM demand matrices used for this project included all WNC RoNS projects and Petone to Grenada for model year 2026, with the exception of the Tunnel to Tunnel project as only the Basin Reserve project was being considered at that time. For model year 2016, WTSM matrices included versions of the Basin Reserve, Aotea Quay to Ngauranga and Peka Peka to North Ōtaki projects and used 'medium' growth.

3.7.2 Economic Efficiency (BCR)

The current expected estimate for the full scheme of the Transmission Gully project is $881.7M in 2011 dollars. Less sunk costs and updating to 2012 dollars, the value for input to REMAT is $847.1M. Maintenance costs were included in the economic analysis and were calculated to have a NPV of $4.8M.

The benefits calculated by the Transmission Gully economic update include travel time, VOC, CO2, trip reliability, crash, noise and route security benefits. The full details of the economic assessment can be found in Appendix D. The noise benefits were included in REMAT as a NPV.

Table 3-10: Linden to MacKays Crossing BCR summary

	NPV Benefit	NPV Cost	BCR
Current	$492.7M	$536.6M	0.9

3.7.3 Modelling Exceptions

The Transmission Gully economics calculated CO2 benefits using full economic procedures, not as stated in Section 3.1 as using 4% of VOC benefits. The modelling was completed using demand matrices from the 2006 WTSM.

3.8 Part 7: MacKays Crossing to Peka Peka

SH1 between MacKays Crossing and Peka Peka (M2PP) currently provides for both local and inter-regional movements resulting in a poor crash history, congestion and unreliable travel times. The geometry of SH1 through this alignment is currently sub-standard and has an inconsistent speed environment. The high number of side access and local road connections creates side friction which slows traffic on the highway and increases the crash risk. The expressway aims to reduce congestion and improve safety by separating these movements.

3.8.1 Scheme Description

The expressway will form the new SH1 connection between north of MacKays Crossing in the south to north of Peka Peka Road in the north. It will have two lanes in both the northbound and southbound directions and be approximately 18km long. The expressway has four proposed interchanges:

- South facing ramps only at Queen Elizabeth Park connecting to Poplar Avenue;
- Full interchange at Kāpiti Road;
- Full interchange at Te Moana Road; and
- North facing ramps only at Peka Peka Road.

The Do Minimum network used for comparison against this scheme includes the Peka Peka to Ōtaki project, discussed in Section 3.9. The WTSM demand matrices used for this project used medium growth and included Peka Peka to Ōtaki, Aotea Quay to Ngauranga and the Basin Reserve project for the forecast year 2021. The 2031 forecast matrices include all of the WNC RoNS and Petone to Grenada. The M2PP project modelling also used the VTM approach.

3.8.2 Economic Efficiency (BCR)

The current construction phase estimate (P50) for the full scheme of the M2PP project is $579.8M in 2013 dollars. This value already excludes sunk costs. Less escalation costs, the value for input to REMAT is $554.2M.

The benefits included in the economic evaluation are travel time, VOC, CO2, trip reliability, crash reduction and route security. The modelling and economic assumptions have been provided in Appendix E. The route security benefits were included in REMAT as a NPV

Table 3-11: MacKays Crossing to Peka Peka BCR summary

	NPV Benefit	NPV Cost	BCR
Current	$513.9M	$473.0M	1.1

3.8.3 Modelling Exceptions

The M2PP economics were calculated using a time zero of 2013.

3.9 Part 8: Peka Peka to North Ōtaki

As with MacKays Crossing to Peka Peka, SH1 caters for local and inter-regional traffic from Peka Peka to north of Ōtaki. SH1 runs through the centre of the Ōtaki Railway Retail Area causing significant congestion, particularly during weekends and holiday periods. The expressway would reduce this congestion and will also provide significant benefits for freight travel. This section of SH1 has a high crash record and provides the only north/south link on the west coast of the North Island.

3.9.1 Scheme Description

The scheme assessment report for this project was completed in 2011. The Peka Peka to Ōtaki Expressway will have two lanes in both the northbound and southbound directions and will run for approximately 15km from Peka Peka Road in the south to Taylors Road in the north. Two half interchanges are proposed along this section of the expressway; in the south at Ōtaki Gorge Road and in the north at Mill Road. Other crossing points are provided at Rahui Road and Te Horo. Another feature of this project is the realignment of the railway in the Ōtaki Retail Area. The project will significantly reduce the crash rate with most traffic travelling on the proposed median separated expressway.

The Do Minimum network used for comparison against this scheme included all WNC RoNS and Petone to Grenada as per the 2009 Business Case. The WTSM demand matrices also included these same assumptions for both modelled years (2016 and 2026) and 'medium' growth as indicated in Appendix E.

3.9.2 Economic Efficiency (BCR)

The current expected estimate for the Peka Peka to North Ōtaki project is $251.4M in 2011 dollars. Less sunk costs and adjusting to 2012 dollars, the value for input to REMAT is $249.8M. Maintenance costs were included in the economic analysis and were calculate to have a NPV of $2.8M over and above the Do Minimum scenario.

The benefits included in the economic evaluation are travel time, VOC, CO2 and crash reduction. The full details of the economic assessment can be found in Appendix F.

Table 3-12: Peka Peka to North Ōtaki BCR summary

	NPV Benefit	NPV Cost	BCR
Current	$90.7M	$175.1M	0.5

3.9.3 Modelling Exceptions

The Peka Peka to North Ōtaki economics were calculated using a time zero of July 2011. . The modelling was completed using demand matrices from the 2006 WTSM.

3.10 Part 9: North Ōtaki to Levin

3.10.1 Scheme Description

The North Ōtaki to Levin section of WNCR has been separated into various projects to improve the safety of the corridor and provide better levels of service. PFRs have been completed to address issues and concerns at particular locations and provide recommended improvements. A summary of the recommendations as well as costs, benefits and BCRs are provided in the Table 3-13 below:

Table 3-13: Summary of Ōtaki to Levin PFRs

PFR	Title	Recommendation	NPV Benefit	Capital Cost	BCR
1	Forest Lakes	Realignment and wire rope median barrier.	$17.4M	$14.0M	1.2
2	Manakau Settlement	Reduced speed limit through township and associated improvements.	$5.2M	$1.95M	2.7
3	Manakau to Ohau	Realignment of road to west of rail line.	$39.1M	$36.4M	1.1
4	Ohau Settlement	Reduced speed limit through township and associated improvements.	$4.7M	$3.8M	1.6
5	SH1 & SH57 Connection	Three possibilities - grade separation, roundabout or bifurcation.	$87.2M	$49.9M	1.7
6	Waiterere Beach Road Curves	Two different realignment options depending on the desired standard.	$23.0M	$9.6M	2.4
7	Whirokino Trestle	Replace Whirokino Trestle and Manawatu River bridge on new alignment, in context of less than 10 years' life of Whirokino Trestle.	$14.0	$46.2M	0.3

The original Scoping Options Report found that there was no immediate need for four laning of the Ōtaki to Levin route.

3.10.2 Economic Efficiency (BCR)

No current construction cost estimates have been provided. Due to the early stages of the assessment of this part of the WNCR, the economics have been assessed by summing the total costs and total benefits reported in Table 3-13 to calculate the current BCR. The Ōtaki to Levin project has been input in REMAT using Net Present Values only.

Table 3-14: North Ōtaki to Levin BCR summary

	NPV Benefit	NPV Cost	BCR
Current	$190.6M	$161.9M	1.2

3.11 Summary

The most up to date economic efficiencies reported to date have been collated and presented in the preceding sections. A summary of the most recent individually reported BCRs for each project are summarised in Table 3-15.

Table 3-15: Individually Reported BCRs for All WNCR Parts

No.	Part	NPV Benefit	NPV Cost	BCR
1	Airport to Mt Victoria Tunnel	$131.4M	$235.5M	0.6
2	Tunnel to Tunnel	$257M	$82.9M	3.1
3	Terrace Tunnel Duplication	$154.1M	$104.5M	1.5
4	Aotea Quay to Ngauranga Gorge	$79.1M	$75.1M	1.1
5	Ngauranga Gorge to Linden (P2G)	$280M	$252.7M	1.1
6	Linden to MacKays (Transmission Gully)	$492.7M	$536.6M	0.9
7	MacKays to Peka Peka	$513.9M	$473M	1.1
8	Peka Peka to North Ōtaki	$90.7M	$175.1M	0.5
9	North Ōtaki to Levin	$190.6M	$161.9M	1.2

4 REMAT

This section, and the remaining sections of this report, describes how the information collated and presented in Section 3 is used in the economic analysis of the WNCR.

4.1 What is REMAT

The RoNS Economics Modelling Assessment Tool (REMAT) is a platform where individual RoNS project economics can be loaded so that the NZTA can report on the holistic position for a package of projects (the All RoNS case). It has been specifically developed to inform the development of an Addendum to the 2009 Business Case. Additionally, in REMAT key assumptions within individual RoNS projects are able to be changed, such as programme timings, costs, benefits and discount rates. This allows the NZTA to better understand the impact of different decisions in relation to individual project benefit cost ratio's (BCRs) and the holistic All RoNS case. REMAT's strength is that it provides a consistent and well defined method, giving the NZTA confidence in their decision making process. Currently REMAT is only utilised for the Wellington Northern Corridor RoNS.

The outputs from REMAT are:

- Overall holistic RoNS Tangible Benefits, Costs and BCRs;
- Each individual project's Tangible Benefits, Costs and BCRs;
- Each individual project's FYRR; and
- A time versus cumulative present value benefits plot for the overall package.

The REMAT has been built using an Excel 2007 template file with VB macro (.xlsm) which aligns with the NZTA's current standard PC software toolset.

Please refer to the REMAT development plan (April 2012, Opus) for the detailed methodology.

4.2 REMAT Assumptions

The following key assumptions have been made in REMAT:

- Discounting rate of 6% used. It is noted that REMAT can report economics using other discount rates to be used for sensitivity analysis.
- The analysis period (which includes construction and benefit periods) for the holistic RoNS case, a minimum of 40 years is assumed for each part. Using this assumption, earlier stage projects will have longer analysis periods, as their analysis period will only end when the last staged project completes its 40 year analysis period.
- Time zero is 1/07/2012.
- The projects' annual benefits and total costs are obtained from each projects individual economic analysis. The detailed information for each individual project is discussed in the earlier Section 3.
- Construction periods are allowed to vary for the individual projects.
- Only the model years 2021 and 2031 are input into the analysis – all un-modelled years in the analysis will be extrapolated from the models. No model capping will be used in the analysis. The model inputs for the analysis provided for each project will be fixed (as reported by the relevant consultant).

- No construction disruption costs are considered between or during different stages. It is assumed that good construction management plans will be carried out to minimise the construction disruptions.
- Wider Economic Benefits (WEBs) such as agglomeration benefits have been assessed separately and entered as a NPV.
- Reporting of individual BCRs in REMAT will vary from the project specific BCR as there are a number of assumptions that differ to those in the individual project economics that have been assumed common for the REMAT evaluation. There are a large number of assumptions specific to each of the projects that have been discussed in earlier sections of this report. General assumptions for any particular project may change, be updated and/or evolve as the project progresses.

4.3 REMAT Summary

The risk with REMAT is it uses a generic approach to all projects, therefore project specific BCRs will vary from economics completed previously. The NZTA and other users of REMAT need to understand there will be output differences. Each individual BCR from REMAT is compared with the specific project BCR during the input process and assessed as to whether the differences seem acceptable and explainable with the generic assumptions.

Another risk with REMAT is communication, as it is possible to have a number of different versions exist at the same time. To control this, within REMAT there are three access levels to limit the number of versions that may exist. Level 1 only allows users to observe outputs from REMAT; level 2 allows this plus the ability to change input assumptions; Level 3, the highest level of access, allows new data input and changing of formulas within REMAT.

5 Wellington RoNS

5.1 Traffic Effects

The Wellington Transport Strategic Model (WTSM) is a regional traffic demand model built in the EMME software suite. It has been calibrated and validated to the base year of 2011 with forecast years 2021 and 2031 (2041 is also available but not used for this assessment).

The traffic demand flows on the WNCR are extracted from WTSM. A medium growth scenario is assumed in WTSM, and the traffic flow is used to understand the overall traffic impacts as a result of the WNCR schemes. Appendix G shows the two way Annual Average Daily Traffic (AADT) vehicle flow on WNCR in forecast year 2031 under Do Minimum and full RoNS scheme scenarios. Details regarding the included schemes have been provided in Appendix H.

With the RoNS schemes in place, changes in traffic volumes are predicted by WTSM across the total corridor on the WNCR (State Highway 1) and the arterials which form the existing SH1 from Linden to north of Ōtaki. These changes are due to the redistribution of strategic trips from the existing SH1 to the WNCR following the completion of the project and associated increased capacity. As a result trips previously made on local roads shift to the WNCR and arterial roads that are subsequently created. The additional capacity of the network may also change travel demand patterns, times of travel and mode of travel as people choose to travel further from their homes for work or school, using State Highways to make these longer journeys.

On SH1 to the north of the network (Ōtaki to Levin) this traffic volume increase is in the order of 2000 additional vehicles per day (vpd). With Transmission Gully in place, an additional 6,000 vpd have been predicted south of MacKays Crossing. Within the CBD, an additional 5,000 and 7,000 vpd is seen at Terrace Tunnel and ICB, respectively. There are 14,000 more vpd using the Mt Victoria Tunnel. The traffic effect shows the eight WNCR schemes and P2G will provide more network capacity to reduce traffic congestion.

5.2 Economics Efficiency

The overall BCR for the WNCR is calculated based on REMAT (as discussed in Section 4 above). The results are summarised in Table 5-1 below and the detailed REMAT outputs can be found in Appendix I.

Table 5-1: Total WNCR BCR summary

Scheme	NPV Benefits ($B)	NPV Cost ($B)	BCR
Total	3.02	1.94	1.56

The economic efficiency results indicate that the eight WNCR schemes will have a BCR of 1.54 without considering the P2G project. The agglomeration benefits have been included in the conventional BCR as per the EEM and to be consistent with the 2009 Business Case. These schemes are therefore considered important in supporting economic growth in New Zealand.

6 Wider Economic Benefits

6.1 What are Wider Economic Benefits

The role of Wider Economic Benefits (WEBs) has become increasingly recognised in the overall evaluation of transport schemes, especially in relation to large schemes impacting on major urban areas in New Zealand. The Wellington Northern Corridor RoNS forms such a scheme with a substantial package of investment in the SH1 corridor between Wellington City and the Kāpiti Coast to the north of the region.

With improved accessibility, the productivity of economic activities improves as firms and their workers have more opportunities to interact and suppliers can benefit from the larger markets which they are able to serve from a particular location. These effects can include both improvements to the productivity of existing operations and changes to these patterns as levels of employment and output change in response to the new opportunities. While the processes for estimating the magnitude of these WEBs is currently evolving with some being at a more advanced stage of development, it is recognised that they can be treated as additional to the benefits derived from a conventional economic evaluation.

Please refer to the Assessment of Wider Economic Impacts for the Wellington Northern Corridor RoNS (Version 2.4, July 2013, Richard Paling Consulting) for detailed information.

6.2 WEB Assumptions

All the WEBs have been evaluated over the period from 2021 to 2060 and discounted to 2012 with a 6% discount rate. The WEBs from the WNCR have been determined, with the benefits summarised in Table 6-1. These benefits are assessed as sensitivity tests in REMAT using current estimates from the report completed by Richard Paling Consulting. They will be included cumulatively in two stages (i.e. sensitivity test 1 includes category 2 only and sensitivity test 2 includes categories 2 and 3) based on their suggested categories.

Table 6-1: WNCR Estimates of WEBs (excluding P2G)

Type of Impact	NPV Benefits ($M)	Categories
Agglomeration Benefits - measure the potential increases in productivity that arise with improved accessibility as workers and firms are able to interact more effectively.	$410M	1. EEM standard procedures.
Imperfect Competition Benefits - the benefits for competitive markets that do not match the criteria of perfect competition.	$130M	2. EEM standard procedures; practice overseas.
Increased Labour Force Participation Benefits - the arisen labour supply benefits caused by the decline of commuting cost.	$35M	
Increases in Employment - benefits on the demand for labour that are impacted by the new transport scheme(s).	$230M	3. Less established procedures.

The agglomeration benefits reported in Table 6-1 do not include those reported for the Petone to Grenada project. The Petone to Grenada project is an important project within the corridor and is estimated to have high value in agglomeration benefits. The NZTA decided to include this project as one of the supporting elements; however the relevant RCAs have yet to determine how the construction of the link is to be funded. As a consequence an agglomeration benefit for the link has been treated as a sensitivity test.

6.3 WEBs Summary

In total, the WEBs including agglomeration are estimated to make an additional contribution of $0.8B to the economic benefits of the WNCR. This substantial total reflects the extent to which the upgrading of WNCR would potentially support increased employment and economic development in the area it serves.

These WEBs can be compared with the total conventional economic benefits of about $2.4B (not including the Ōtaki to Levin section) of which they represent about 35%. It is considered to be appropriate to only include those WEBs excluding agglomeration as sensitivity tests and this has been agreed with both the NZTA and the peer reviewer.

It should also be noted that typically economic evaluation overseas incorporates increasing values of time over time; this will give higher conventional economic benefits than the equivalent New Zealand procedures where the value of time stays constant. Evaluations overseas also typically would use variable matrix evaluation allowing trip patterns to change in response to the opportunities provided by the new schemes. Applying this approach in the case of the WNCR would again produce higher conventional benefits. The apparently high share of WEB benefits when compared against overseas examples may therefore reflect low estimates of conventional economic benefits which are considered to be conservative.

7 Sensitivity Tests

7.1 Test 1 – Ngauranga Gorge to Linden (P2G)

The key project between Ngauranga Gorge to Linden is the construction of a four lane, 70 kph link between SH1 (in the vicinity of the existing Tawa Interchange) and SH2 (in the vicinity of the Petone Overbridge). The description and assumptions of the P2G project can be found in Section 3.6.

This sensitivity test is to understand what the economic impact will be of including the Ngauranga Gorge to Linden (P2G) project in the WNCR. A large part of the agglomeration benefits generated by the WNCR are generated by P2G, and the sensitivity test allows for this.

7.2 Test 2 – Variable Trips Benefits

The effect of fixed or variable trips matrices on the economic benefits has been raised earlier in this report. Only two parts of the WNCR (Aotea Quay to Ngauranga and MacKays to Peka Peka) have assessed the economic benefits using a variable trips matrices (VTM) approach; the rest are assuming a fixed matrix approach (FTM). This sensitivity test is to understand what the economic impact will be if all the WNCR economics are assessed using VTM.

According to a working paper on the possible effects of Fixed or Variable Matrices on the Economic Evaluation produced by Richard Paling (WP10, Assessment of Wider Economics Benefits for the WNCR), it is suggested that the potential increase in benefits with variable matrices is estimated to be 7.2% (excluding P2G). Therefore, the additional benefit (7.2% of the NPV benefits) is included on the WNCR parts which were using FTM approach, including:

- Airport to Mt Victoria Tunnel;
- Tunnel to Tunnel;
- Terrace Tunnel Duplication;
- Linden to MacKays Crossing (TG);
- Peka Peka to North Ōtaki; and
- North Ōtaki to Levin.

7.3 Test 3 - Wider Economics Benefits

Different components of WEBs have been estimated by Richard Paling Consulting. Three sensitivity tests (as below) were carried out to understand how the total WNCR's BCR will be impacted by including different components of WEBs.

- 3a, Imperfect Competition Benefit (ICB) + Increased Labour; and
- 3b, ICB + Increased Labour + New Employment benefits.

7.4 Test 4 – Cost Estimates

The sensitivity of cost scenarios are tested assuming the following two scenarios. Table 7-1 summarises the detailed assumptions.

- 4a Low, reduce the expected cost by 20%; and
- 4b High, 95%tile cost where it is applicable and 20% increase in cost where 95%tile cost is not available.

Table 7-1: Cost Estimate Sensitivity Test Assumptions

Part	4a - Low	4b - High
1- Airport to Mt Vic Tunnel	-20%	95%tile
2- Tunnel to Tunnel	-20%	95%tile
3- Terrace Tunnel	-20%	95%tile
4- Aotea Quay to Ngauranga	-20%	95%tile
6- Linden to MacKays Crossing (TG)	-20%	+20%
7- MacKays Crossing to Peka Peka	-20%	+20%
8- Peka Peka to North Ōtaki	-20%	95%tile
9- North Ōtaki to Levin	-20%	+20%

Both of these scenarios could occur given the current procurement models being used to expedite and/or deliver projects (e.g. Alliance and PPP) while there also exists an extremely competitive market for construction projects under more traditional construction models.

7.5 Test 5 – Analysis Period vs. Discounting Rate

To understand the impact of the analysis period and discounting rate assumptions based on the EEM, various scenarios have been tested. The calculated BCRs for these sensitivity tests are summarised in Table 7-2 below. The EEM was recently updated to a recommended discount rate of 6% and a 40 year analysis period. Previously the discount rate used was 8%. Given current global market conditions the use of an 8% discount rate was considered to be very conservative and inconsistent with most countries internationally. The analysis period formerly used was 30 years and, as with the discount rate, was also considered conservative as the assets being constructed are likely to have a much greater life than 30 years (e.g. bridges and structures would be expected to have a life in excess of 60 years).

Table 7-2: Analysis Period vs. Discounting Rate Sensitivity Test Results

Analysis Period \ Discounting Rate	8%	6%	4%
30 Years	$1.89B / $1.79B (1.06)	$2.65B / $1.94B (1.36)	$3.88B / $2.12B (1.83)
40 Years	$2.07B / $1.79B (1.16)	$3.02B / $1.94B (1.56)	4.74B / $2.12B (2.23)
60 Years	$2.21B / $1.79B (1.24)	$3.44B / $1.94B (1.77)	$5.95B / $2.12B (2.80)

7.6 Test 6– Benefits Capping

The annual benefits are based on two model years (generally 2021 and 2031) and extrapolated for years outside that range. As it is not realistic to forecast that the annual benefits grow each year ad infinitum, two sensitivity tests have been completed to address this issue. These tests also address the possible mode shift that may occur under a congested situation, and also scenarios of increased travel cost.

- 6a, capping benefits at 2031 year level; and
- 6b, capping benefits at 2041 year level.

7.7 Test 7 – Growth Rate

The previously reported economic assessments on the WNCR have been assessed assuming a medium growth scenario which is based on WTSM base projection, with the exception of Aotea Quay to Ngauranga which used a high growth scenario. This growth includes assumptions regarding population and employment, migration age composition of population, births, deaths and number of households. The following sensitivity tests on growth rate are the standard growth tests undertaken when developing and using WTSM:

- 7a Low, Wellington low growth, apply growth factor on a territorial authority (TA) district basis (i.e. growth factor of WCC, factor of HCC, etc.);
- 7b, Wellington expansion high growth, apply growth factor on a territorial authority (TA) district basis; and
- 7c, Western drift high growth, apply growth factor on a territorial authority (TA) district basis.

Population growth factors have been calculated based on WTSM for each TA district and they are applied to each part of the NPV benefits of the WNCR. For more information on the WTSM growth scenarios, see WTSM technical note *TN29:Demographic Inputs to WTSM*. Table 7-3 summarises the factors applied.

Table 7-3: Factors applied to Growth Rate sensitivity tests

Territorial Authority	7a - Low	7b – Wellington Expansion	7c - Western Drift
Wellington City (including Airport to Mt Vic Tunnel, Tunnel to Tunnel, Terrace Tunnel and Aotea Quay to Ngauranga)	-7%	+7%	0%
Porirua City (including Linden to MacKays Crossing)	-11%	0%	+10%
Kāpiti Coast (including MacKays Crossing to Peka Peka, Peka Peka to North Ōtaki and Ōtaki to Levin)	-8%	0%	+7%

Growth rates of this magnitude are consistent with the aims and expectations of major infrastructure projects which seek to encourage and stimulate economic growth and development. The chance of low growth occurring is unlikely; however market conditions could result in more growth occurring in centres outside of Wellington (e.g. Auckland).

7.8 Sensitivity Test Summary

Table 7-4 below summarises the sensitivity test results for the WNCR economic assessment. The sensitivity tests show the WNCR has a range of benefits between $2.7B and $5.95B and a range of cost of $1.54B and $2.37B in 2012 dollars. Therefore, the WNCR benefit to cost ratio has been assessed to range between 1.06 and 2.80.

Table 7-4: Economic summary for sensitivity tests

Scheme		NPV Benefits ($B)	NPV Cost ($B)	BCR
Base		3.02	1.94	1.56
Test 1 – Include P2G		3.77	2.11	1.78
Test 2 – VTM		3.16	1.94	1.63
Test 3 -WEB	a- ICB and Increased labour	3.19	1.94	1.64
	b- All WEB benefits	3.42	1.94	1.76
Test 4 - Cost	a- Low	3.02	1.54	1.97
	b- High	3.02	2.37	1.27
Test 5 – EEM assumptions	Varies (refer to Table 7-2)	1.89 – 5.95	1.79 – 2.12	1.06 – 2.80
Test 6 – Benefits Capping	a- Capping at 2031	2.70	1.94	1.39
	b- Capping at 2041	2.92	1.94	1.51
Test 7 – Growth Scenarios	a- Low	2.80	1.94	1.44
	b- High (Wellington Expansion)	3.08	1.94	1.59
	c- Western Drift	3.18	1.94	1.64

8 Peer Review

As was completed in 2009, the BCR calculation, supporting materials and the REMAT were peer reviewed (by BECA).

The business case economic assessment is considered to be appropriate in that the analysis meets the requirements of the EEM and that it can be relied to provide an indication of the Benefit to Cost Ratio for the Wellington Northern Corridor RoNS project.

A copy of the peer review report, and the response addressing the recommendations in the report, has been attached in Appendix J.

9 Conclusion

The WNCR covers a 110km stretch of road from Wellington Airport to Levin and will largely be four-laned. Most of the projects forming the WNCR have progressed significantly since the previous economic assessment for the programme which was done in 2009.

According to the REMAT (version 2.03) the eight WNCR schemes have a total estimated benefit of $3.02B with an estimated cost of $1.94B (BCR 1.56).

Under the assumption that the Petone to Grenada project is considered and that all WEB benefits are included, the estimated benefits will be raised to $3.77B with an estimated cost of $2.11B (BCR 1.78). This is considered to be consistent with the previous 2009 estimate, which had a BCR of 1.4 using similar assumptions.

The wide range of sensitivity tests that have been carried out show that the on-going construction benefit to cost ratio will range between 1.06 and 2.80, which indicates the WNCR is most likely to have positive return (BCR over 1.0) under different reasonable circumstances.

Table 9-1 summarises the comparison between the current Business Case economics against those previously reported in 2009. It should be noted that the 2009 analysis assumed 30 years analysis period with 8% discounting rate, where the current assumption has 40 year analysis period with 6% discounting rate.

Table 9-1: WNCR business case economics summary comparison between 2013 and 2009

No.	Part	2009 BCR 8%/30y	2013 BCR 8%/30y	2013 BCR 6%/40y
1	Airport to Mt Victoria Tunnel	0.4	0.4	0.6
2	Tunnel to Tunnel	2.3	2.0	3.2
3	Terrace Tunnel Duplication	0.5	1.0	1.6
4	Aotea Quay to Ngauranga Gorge	2.8	1.0	1.9
5	Ngauranga Gorge to Linden (P2G)	1.3	1.2	2.4
6	Linden to MacKays (Transmission Gully)	0.6	0.9	1.3
7	MacKays to Peka Peka	1.0	0.7	1.0
8	Peka Peka to North Ōtaki	0.7	0.5	0.8
9	North Ōtaki to Levin	2.0	1.2	1.2
Total[9]		1.0	1.27	1.56

[9] For comparison purposes the total WNCR economics exclude all costs and benefits of the P2G project but include the agglomeration benefits for both 2009 and 2013 business case.

Appendix A

WTM Economics Memo for Parts 1-3 (Wellington City RoNS)

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To	
Copy	David Dunlop
From	Katie Levin, Hailin Hu
Date	March 2013
File	2013 Wellington RoNS Business Case, WTM 2011
Subject	Economics and Modelling Methodology Info

To Whom It May Concern:

This memo provides information and assumptions made in developing the economics and modelling methodology for the Wellington RoNS Business Case WTM 2011.

Background

In late 2009, Opus was commissioned by NZTA to prepare a Business Case which calculated and summarised the Benefit Cost Ratios (BCR's) for each of the Wellington Northern Corridor RoNS projects individually. This was done according to the proposed programme at the time.

Since the assessment of the original Business Case most of the Wellington Northern Corridor RoNS projects have progressed significantly. Greater understanding of site specific issues, preferred options, their relative costs and benefits are now becoming apparent.

Both the Wellington Transport Strategic Model (WTSM) and Wellington Traffic Model (WTM) have been updated recently such that the RoNS schemes' assessment can be improved by these models. There is also the ability to model the weekend peak for the Wellington network and significant additional information relating to wider economic benefits and agglomeration benefits.

For such reasons, Opus has been commissioned by NZTA to update the 2009 business case economics. The current project has been planned in two stages as below.

Stage 1 is to carry out a series of tests for the RoNS components within Wellington City which includes:

- Wellington Rd / Ruahine St / dupl. Mt Vic Tunnel (combined);
- Tunnel to Tunnel project (Including around the Basin Reserve, Buckle Street Underpass and Inner City Bypass improvement combined); and
- Terrace Tunnel.

Modelling assumptions

All modelling and economic assessment outside of the Wellington City area will utilise prior information.

For overall Regional information and matrices, the recently revalidated WTSM built in EMME software package will be used for the traffic demand forecasting. Matrices for two modelling years (i.e. 2021 and 2031) and three peak periods (i.e. am, interpeak and pm) will be modelled by WTSM. Using a fixed matrix approach, WTSM medium growth with all the RoNS schemes will be assumed for all models. Table 1 identifies the road and public transport (PT) schemes that have been included in the WTSM models.

Table 1: WTSM Matrix Assumptions

	WTSM Model Run Number	
Road Scheme	**31021 (2021)**	**31011 (2031)**
Basin Reserve Improvement	√	√
Mt Vic Tunnel Duplication	√	√
Ruahine St improvement	√	√
Widen Ngauranga to Aotea from 3L to 4L	√	√
Grenada to Petone Link (including Lincolnshire Farm)	√	√
Grade Separation of SH58	√	√
MacKays Crossing to Peka Peka	√	√
Peka Peka to Otaki	√	√
Transmission Gully	√	√
Adelaide Road Improvement	√	√
Johnsonville Triangle	√	√
Aotea Quay Improvements	√	√
Terrace Tunnel Duplication	√	√
SH1/Otaihanga Rd Roundabout	√	√
ICB Improvements	√	√
PT Scheme		
Base PT Services	√	√
Wellington City Bus Review PT Services	√	√
Rail Plan Option 1		
Rail Plan Option 2	√	√
Bus Lane from Bus Station to Hospital	√	√

For Wellington City projects, the Wellington Traffic Model (WTM) has been recently revalidated in the SATURN software suite to a base year 2011 with a Saturday peak[1]. Both the weekday WTM and weekend WTM have been validated and have been through external peer review processes.

[1] The validation and forecasting reports for the Wellington Traffic Model SATURN Updates are: SATURN Model 2011 Re-Validation Report (October 2012) and SATURN Model Forecasting Report (November 2012). One report was prepared for the Saturday peak model, WTM 2011 Saturday Peak Model – Validation and Forecasting Report (December 2012).

The WTM models have been used for economic analysis of the Wellington City RoNS schemes' modelling and economics calculation purposes. The same modelling years will be assumed as with WTSM (2021 and 2031) with four peak periods (i.e. am, interpeak, pm and Saturday peak). Table 2 identifies the scenario tests that have been modelled in WTM.

Table 2: WTM Model Runs

RoNS Element	WTM Tests – All peaks: T0	T1[2]	T2	T3	T4	T5
Wellington Rd, Ruahine St & Mt Vic Tunnel					✓	✓
Around the Basin Reserve			✓	✓	✓	✓
Buckle Street Underpass		✓	✓	✓	✓	✓
Inner City Bypass		✓	✓	✓	✓	✓
Terrace Tunnel						✓
Aotea Quay to Ngauranga[3]				✓	✓	✓

The Do Minimum network (or T0) has several changes from the 2011 base network due to Wellington City Council's recommendations of schemes that are likely to go ahead in the future. Those are:

- Signalisation of the Hanson/John Street intersection
- Kent/Cambridge Terrace bus only lanes (both directions during AM and PM peak periods)
- Adelaide Road bus only lanes (both directions during AM and PM peak periods)
- Future bus route changes (reduce overall route length and increase frequency)

The Buckle Street Underpass, or Memorial Park Tunnel as it is referred to in the WTM reports, has been removed from the Do Minimum network as it forms part of the analysis. For more information on these schemes please refer to the WTM forecasting reports.

Economics assumption

The economics analysis is limited to travel time costs, vehicle operating costs and Carbon dioxide only for the Wellington City RoNS schemes. The Ngauranga to Aotea Quay scheme has been modelled in Paramics and recently had a full economic evaluation completed thus it will not be investigated separately again. The economics information for this project and the rest of Wellington RoNS schemes will be obtained from each project team and documented in the 2013 Business Case report.

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[2] Has been modelled, however, not currently in use as it was agreed that economics would be completed for the Tunnel to Tunnel project combined.
[3] Included in order to properly understand the performance of other projects.

Table 3: Models Used for Economics

RoNS elements	Model Used
Tunnel to Tunnel Improvements (ICB, Basin Reserve, Buckle Street Underpass)	T2 – T0
Airport to Mt Victoria Tunnel (Wellington Rd / Ruahine St / dupl. Mt Vic Tunnel, combined)	T4 – T3
Terrace Tunnel	T5 – T4
Total	REMAT

The models have been assessed as in Table 3 to allow the construction programme of projects to be taken into account. The Tunnel to Tunnel and Aotea Quay to Ngauranga projects will likely be completed prior to the Airport to Mt Victoria Tunnel duplication and the Terrace Tunnel duplication would be completed last. Thus, the assessment of the Airport to Mt Victoria Tunnel will include these previously programmed projects in its Do Minimum. This method was adopted so that the full and realistic benefits of each project could be realised. For example, should the Terrace Tunnel project be completed prior to the Aotea Quay to Ngauranga project, the number of vehicles capable of reaching the tunnel, and thus receiving benefits from it, are constrained by the congestion on SH1 and SH2.

Other economic assumptions are provided here:

- Saturday peak matrix adapted from WTM IP matrix using the procedure described in the 2011 WTM Sat Model Validation and Forecasting Report. Other assumptions detailed in that report are the peak hours and Saturday peak factors used.
- The 13 hours of off peak values are determined by applying a factor of 0.34 to the inter peak values. The factor was determined from the WTM factor spreadsheet. This spreadsheet uses TMS data for locations throughout Wellington (from Newlands interchange to Calabar Road) as well as various manual counts collected around the Wellington CBD.
- All inputs from SATURN are converted to vehicles from pcu's.
- Economics are based on Travel Time Savings, Vehicle Operating Costs and CO2 Costs.
- Travel time savings are made up of:

  » Base travel time benefits; and,
  » Travel time benefits for reduced traffic congestion.

  Travel time benefits for improved trip reliability were not included in the assessment as they were deemed to be too complex to calculate for the additional value that they would provide. Base values of time and increments for congestion were taken from Table A4.3 of the EEM.
- Vehicle Operating Costs (VOC) are made up of:

  » Base running costs by speed and gradient for an urban arterial network (assuming a gradient of 0%); and,
  » Additional VOC due to congestion for urban roads.

  Additional VOC from road surface conditions, bottleneck delay and speed change cycles have not been included in the assessment as the information is not present in the model and/or the complexity of the calculations do not equate to the added value to the project. The VOC calculated have been applied on a link by link basis. Base running costs were taken from Table A5.7 of the EEM while additional VOC due to congestion were taken from Table A5.19.

- CO_2 costs have been taken as 4% of the VOC as indicated in the full procedures section of the EEM (page 5-132).
- Update factors applied to take prices to July 2012 from Table A12.2 in the EEM.
- Time zero as 01/07/2012;
- Benefit period of 40 years; and
- Discounting rate of 6%.

Economics spreadsheets for the three projects discussed above are attached.

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TIMINGS				TRAVEL TIME					CRV TRAVEL TIME			VEHICLE OPERATING COSTS		
OPTION and YEAR	**PERIOD**	**EQUIV TIME PERIODS PER DAY (hrs/day)**	**DAYS PER YEAR (days/year)**	**TOTAL SATURN TT on links (hours)**	**TOTAL SATURN TT on turns (hours)**	**TOTAL TT (hours)**	**VALUE OF TIME ($/veh.hr)**	**ANNUAL TRAVEL TIME COST ($/year)**	**TOTAL CONGESTION on links and turns SATURN (veh.hrs/hr)**	**CONGESTION VALUE ($/hour)**	**ANNUAL CONGESTION COST ($/year)**	**BASE VOC BY SPEED ($.veh/hr)**	**VOC DUE TO CONGESTION ($.veh/hr)**	**ANNUAL VEHICLE OPERATING COST ($/year)**
enario 1 - Basin/Mem Park/ICB/AC														
Base 2011	Morning Peak	2	245	0	0	0	$20.73	$0	0	$5.32	$0	0	0	$0
Base 2011	Inter Peak	7	245	0	0	0	$24.59	$0	0	$4.93	$0	0	0	$0
Base 2011	Evening Peak	2	245	0	0	0	$20.50	$0	0	$5.19	$0	0	0	$0
Base 2011	Off Peak	13	245	0	0	0	$20.45	$0	0	$5.04	$0	0	0	$0
Base 2011	Weekend Peak	6	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
Base 2011	Weekend off-peak	18	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
2011 Total								**$0**			**$0**			**$0**
Do min 2021	Morning Peak	2	245	3923	3450	7374	$20.73	$74,891,576	4216	$5.32	$10,981,209	63563	5054	$33,622,121
Do min 2021	Inter Peak	7	245	2087	1029	3116	$24.59	$131,423,166	1110	$4.93	$9,392,230	39546	665	$68,961,022
Do min 2021	Evening Peak	2	245	3587	2804	6391	$20.50	$64,182,839	3204	$5.19	$8,152,849	63977	3943	$33,280,655
Do min 2021	Off Peak	13	245	710	350	1060	$20.45	$69,022,631	378	$5.04	$6,062,312	13445	226	$43,543,960
Do min 2021	Weekend Peak	6	120	2678	1709	4387	$19.30	$60,977,079	1882	$5.84	$7,909,729	49646	1395	$36,749,415
Do min 2021	Weekend off-peak	18	120	994	634	1628	$19.30	$67,892,006	699	$5.84	$8,806,708	18425	518	$40,916,875
2021 Total								**$468,389,296**			**$51,305,037**			**$257,074,047**
Do Min 2031	Morning Peak	2	245	4338	4714	9051	$20.73	$91,932,696	5802	$5.32	$15,112,020	68565	6284	$36,675,866
Do Min 2031	Inter Peak	7	245	2329	1295	3624	$24.59	$152,826,173	1425	$4.93	$12,048,975	43810	939	$76,743,600
Do Min 2031	Evening Peak	2	245	4100	3778	7878	$20.50	$79,120,711	4473	$5.19	$11,381,291	70389	5481	$37,176,412
Do Min 2031	Off Peak	13	245	792	440	1232	$20.45	$80,263,357	484	$5.04	$7,777,135	14895	319	$48,458,102
Do Min 2031	Weekend Peak	6	120	3014	2205	5220	$19.30	$72,544,343	2445	$5.84	$10,272,622	55083	1943	$41,059,255
Do Min 2031	Weekend off-peak	18	120	1119	819	1937	$19.30	$80,771,021	907	$5.84	$11,437,558	20443	721	$45,715,460
2031 Total								**$557,458,302**			**$68,029,600**			**$285,828,694**
Scenario 2 - Mt Vic / Ruahine / Well														
Option 1 2011	Morning Peak	2	245	0	0	0	$20.73	$0	0	$5.32	$0	0	0	$0
Option 1 2011	Inter Peak	7	245	0	0	0	$24.59	$0	0	$4.93	$0	0	0	$0
Option 1 2011	Evening Peak	2	245	0	0	0	$20.50	$0	0	$5.19	$0	0	0	$0
Option 1 2011	Off Peak	13	245	0	0	0	$20.45	$0	0	$5.04	$0	0	0	$0
Option 1 2011	Weekend Peak	6	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
Option 1 2011	Weekend off-peak	18	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
2011 Total								**$0**			**$0**			**$0**
Option 1 2021	Morning Peak	2	245	3863	3412	7275	$20.73	$73,889,109	4152	$5.32	$10,814,174	62954	4954	$33,274,804
Option 1 2021	Inter Peak	7	245	2084	1050	3135	$24.59	$132,208,889	1087	$4.93	$9,198,183	39595	338	$68,485,037
Option 1 2021	Evening Peak	2	245	3536	2786	6322	$20.50	$63,494,174	3121	$5.19	$7,941,372	63548	3637	$32,920,626
Option 1 2021	Off Peak	13	245	709	357	1066	$20.45	$69,435,288	370	$5.04	$5,937,062	13462	115	$43,243,409
Option 1 2021	Weekend Peak	6	120	2655	1683	4338	$19.30	$60,293,859	1790	$5.84	$7,521,081	49489	1045	$36,384,403
Option 1 2021	Weekend off-peak	18	120	985	625	1610	$19.30	$67,131,307	664	$5.84	$8,373,987	18367	388	$40,510,470
2021 Total								**$466,452,626**			**$49,785,861**			**$254,818,749**
Option 1 2031	Morning Peak	2	245	4259	4664	8923	$20.73	$90,628,160	5729	$5.32	$14,920,872	67669	6175	$36,183,731
Option 1 2031	Inter Peak	7	245	2320	1289	3609	$24.59	$152,198,406	1348	$4.93	$11,401,672	43835	527	$76,082,256
Option 1 2031	Evening Peak	2	245	4030	3744	7775	$20.50	$78,076,845	4373	$5.19	$11,126,167	69616	5157	$36,638,789
Option 1 2031	Off Peak	13	245	789	438	1227	$20.45	$79,933,658	458	$5.04	$7,359,327	14904	179	$48,040,510
Option 1 2031	Weekend Peak	6	120	2983	2198	5181	$19.30	$72,007,848	2378	$5.84	$9,992,913	54761	1622	$40,595,359
Option 1 2031	Weekend off-peak	18	120	1107	816	1923	$19.30	$80,173,686	883	$5.84	$11,126,129	20324	602	$45,198,956
2031 Total								**$553,018,604**			**$65,927,080**			**$282,739,600**

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Option	Scenario 1 - Basin/Mem Park/ICB/AQtN
Time Zero	01/07/12
Year of Estimate	2012
Construction Period	3 years, 10 months
Benefit period	36 years, 2 months
Construction Start	1/7/2018
Construction payment	

Scenario 1 - Basin/Mem Park/ICB/AQtN

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396				
2014	2	0.889996		$406,040,992.49	$361,375,037.82	
2015	3	0.839619		$414,947,893.03	$348,398,252.44	
2016	4	0.792094		$423,854,793.56	$335,732,696.11	
2017	5	0.747258		$432,761,694.10	$323,384,712.82	
2018	6	0.704961		$441,668,594.63	$311,358,931.17	
2019	7	0.665057		$450,575,495.16	$299,658,438.28	
2020	8	0.627412		$459,482,395.70	$288,284,939.48	
2021	9	0.591898	$468,389,296.23	$468,389,296.23	$277,238,904.77	
2022	10	0.558395		$477,296,196.77	$266,519,703.32	$155,469,826.93
2023	11	0.526788		$486,203,097.30	$256,125,726.46	$256,125,726.46
2024	12	0.496969		$495,109,997.84	$246,054,500.52	$246,054,500.52
2025	13	0.468839		$504,016,898.37	$236,302,789.83	$236,302,789.83
2026	14	0.442301		$512,923,798.90	$226,866,690.91	$226,866,690.91
2027	15	0.417265		$521,830,699.44	$217,741,718.49	$217,741,718.49
2028	16	0.393646		$530,737,599.97	$208,922,883.86	$208,922,883.86
2029	17	0.371364		$539,644,500.51	$200,404,766.18	$200,404,766.18
2030	18	0.350344		$548,551,401.04	$192,181,577.47	$192,181,577.47
2031	19	0.330513	$557,458,301.57	$557,458,301.57	$184,247,221.48	$184,247,221.48
2032	20	0.311805		$566,365,202.11	$176,595,347.16	$176,595,347.16
2033	21	0.294155		$575,272,102.64	$169,219,397.03	$169,219,397.03
2034	22	0.277505		$584,179,003.18	$162,112,650.89	$162,112,650.89
2035	23	0.261797		$593,085,903.71	$155,268,265.27	$155,268,265.27
2036	24	0.246979		$601,992,804.24	$148,679,308.90	$148,679,308.90
2037	25	0.232999		$610,899,704.78	$142,338,794.59	$142,338,794.59
2038	26	0.21981		$619,806,605.31	$136,239,707.75	$136,239,707.75
2039	27	0.207368		$628,713,505.85	$130,375,031.90	$130,375,031.90
2040	28	0.19563		$637,620,406.38	$124,737,771.34	$124,737,771.34
2041	29	0.184557		$646,527,306.92	$119,320,971.29	$119,320,971.29
2042	30	0.17411		$655,434,207.45	$114,117,735.66	$114,117,735.66
2043	31	0.164255		$664,341,107.98	$109,121,242.72	$109,121,242.72
2044	32	0.154957		$673,248,008.52	$104,324,758.72	$104,324,758.72
2045	33	0.146186		$682,154,909.05	$99,721,649.85	$99,721,649.85
2046	34	0.137912		$691,061,809.59	$95,305,392.45	$95,305,392.45
2047	35	0.130105		$699,968,710.12	$91,069,581.83	$91,069,581.83
2048	36	0.122741		$708,875,610.65	$87,007,939.69	$87,007,939.69
2049	37	0.115793		$717,782,511.19	$83,114,320.32	$83,114,320.32
2050	38	0.109239		$726,689,411.72	$79,382,715.72	$79,382,715.72
2051	39	0.103056		$735,596,312.26	$75,807,259.71	$75,807,259.71
2052	40	0.097222		$744,503,212.79	$72,382,231.10	$72,382,231.10
2053	41	0.091719		$753,410,113.33	$69,102,056.09	$69,102,056.09
2054	42	0.086527		$762,317,013.86	$65,961,309.91	$65,961,309.91
2055	43	0.08163		$771,223,914.39	$62,954,717.80	$62,954,717.80
2056	44	0.077009		$780,130,814.93	$60,077,155.41	$60,077,155.41
2057	45	0.07265		$789,037,715.46	$57,323,648.69	$57,323,648.69
2058	46	0.068538		$797,944,616.00	$54,689,373.28	$27,344,686.64
2059	47	0.064658		$806,851,516.53	$52,169,653.49	
2060	48	0.060998		$815,758,417.06	$49,759,960.95	
2061	49	0.057546		$824,665,317.60	$47,455,912.89	
2062	50	0.054288		$833,572,218.13	$45,253,270.18	
2063	51	0.051215				
						$4,943,323,351

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$39,597,842.54	$35,241,938.89	
2015	3	0.83961928		$41,270,298.87	$34,651,338.74	
2016	4	0.79209366		$42,942,755.20	$34,014,684.27	
2017	5	0.74725817		$44,615,211.53	$33,339,081.45	
2018	6	0.70496054		$46,287,667.86	$32,630,979.35	
2019	7	0.66505711		$47,960,124.19	$31,896,221.76	
2020	8	0.62741237		$49,632,580.52	$31,140,095.04	
2021	9	0.59189846	$51,305,036.85	$51,305,036.85	$30,367,372.48	
2022	10	0.55839478		$52,977,493.18	$29,582,355.48	$17,256,374.03
2023	11	0.52678753		$54,649,949.51	$28,788,911.66	$28,788,911.66
2024	12	0.49696936		$56,322,405.84	$27,990,510.18	$27,990,510.18
2025	13	0.46883902		$57,994,862.17	$27,190,254.47	$27,190,254.47
2026	14	0.44230096		$59,667,318.50	$26,390,912.51	$26,390,912.51
2027	15	0.41726506		$61,339,774.83	$25,594,944.87	$25,594,944.87
2028	16	0.39364628		$63,012,231.16	$24,804,530.62	$24,804,530.62
2029	17	0.37136442		$64,684,687.49	$24,021,591.36	$24,021,591.36
2030	18	0.35034379		$66,357,143.82	$23,247,813.33	$23,247,813.33
2031	19	0.33051301	$68,029,600.15	$68,029,600.15	$22,484,667.95	$22,484,667.95
2032	20	0.31180473		$69,702,056.47	$21,733,430.68	$21,733,430.68
2033	21	0.2941554		$71,374,512.80	$20,995,198.56	$20,995,198.56
2034	22	0.2775051		$73,046,969.13	$20,270,906.25	$20,270,906.25
2035	23	0.26179726		$74,719,425.46	$19,561,340.95	$19,561,340.95
2036	24	0.24697855		$76,391,881.79	$18,867,156.07	$18,867,156.07
2037	25	0.23299863		$78,064,338.12	$18,188,883.87	$18,188,883.87
2038	26	0.21981003		$79,736,794.45	$17,526,947.08	$17,526,947.08
2039	27	0.20736795		$81,409,250.78	$16,881,669.58	$16,881,669.58
2040	28	0.19563014		$83,081,707.11	$16,253,286.25	$16,253,286.25
2041	29	0.18455674		$84,754,163.44	$15,641,952.00	$15,641,952.00
2042	30	0.17411013		$86,426,619.77	$15,047,750.08	$15,047,750.08
2043	31	0.16425484		$88,099,076.10	$14,470,699.69	$14,470,699.69
2044	32	0.1549574		$89,771,532.43	$13,910,762.96	$13,910,762.96
2045	33	0.14618622		$91,443,988.76	$13,367,851.36	$13,367,851.36
2046	34	0.13791153		$93,116,445.09	$12,841,831.54	$12,841,831.54
2047	35	0.13010522		$94,788,901.42	$12,332,530.71	$12,332,530.71
2048	36	0.12274077		$96,461,357.75	$11,839,741.52	$11,839,741.52
2049	37	0.11579318		$98,133,814.08	$11,363,226.51	$11,363,226.51
2050	38	0.10923885		$99,806,270.41	$10,902,722.21	$10,902,722.21
2051	39	0.10305552		$101,478,726.74	$10,457,942.85	$10,457,942.85
2052	40	0.09722219		$103,151,183.07	$10,028,583.68	$10,028,583.68
2053	41	0.09171905		$104,823,639.40	$9,614,324.10	$9,614,324.10
2054	42	0.0865274		$106,496,095.73	$9,214,830.38	$9,214,830.38
2055	43	0.08162962		$108,168,552.06	$8,829,758.18	$8,829,758.18
2056	44	0.07700908		$109,841,008.39	$8,458,754.87	$8,458,754.87
2057	45	0.07265007		$111,513,464.72	$8,101,461.50	$8,101,461.50
2058	46	0.06853781		$113,185,921.05	$7,757,514.70	$3,878,757.35
2059	47	0.06465831		$114,858,377.38	$7,426,548.29	
2060	48	0.0609984		$116,530,833.71	$7,108,194.80	
2061	49	0.05754566		$118,203,290.04	$6,802,086.76	
2062	50	0.05428836		$119,875,746.37	$6,507,857.89	
2063	51	0.05121544				
						$618,352,812

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$236,945,793.75	$210,880,912.92	
2015	3	0.83961928		$239,821,258.48	$201,358,553.10	
2016	4	0.79209366		$242,696,723.21	$192,238,536.55	
2017	5	0.74725817		$245,572,187.95	$183,505,824.47	
2018	6	0.70496054		$248,447,652.68	$175,145,791.50	
2019	7	0.66505711		$251,323,117.41	$167,144,227.05	
2020	8	0.62741237		$254,198,582.14	$159,487,335.21	
2021	9	0.59189846	$257,074,047	$257,074,046.87	$152,161,733.36	
2022	10	0.55839478		$259,949,511.60	$145,154,449.54	$84,673,428.90
2023	11	0.52678753		$262,824,976.33	$138,452,918.89	$138,452,918.89
2024	12	0.49696936		$265,700,441.06	$132,044,979.10	$132,044,979.10
2025	13	0.46883902		$268,575,905.80	$125,918,865.07	$125,918,865.07
2026	14	0.44230096		$271,451,370.53	$120,063,202.97	$120,063,202.97
2027	15	0.41726506		$274,326,835.26	$114,467,003.58	$114,467,003.58
2028	16	0.39364628		$277,202,299.99	$109,119,655.23	$109,119,655.23
2029	17	0.37136442		$280,077,764.72	$104,010,916.26	$104,010,916.26
2030	18	0.35034379		$282,953,229.45	$99,130,907.12	$99,130,907.12
2031	19	0.33051301	$285,828,694	$285,828,694.18	$94,470,102.20	$94,470,102.20
2032	20	0.31180473		$288,704,158.91	$90,019,321.42	$90,019,321.42
2033	21	0.2941554		$291,579,623.65	$85,769,721.62	$85,769,721.62
2034	22	0.2775051		$294,455,088.38	$81,712,787.84	$81,712,787.84
2035	23	0.26179726		$297,330,553.11	$77,840,324.49	$77,840,324.49
2036	24	0.24697855		$300,206,017.84	$74,144,446.49	$74,144,446.49
2037	25	0.23299863		$303,081,482.57	$70,617,570.37	$70,617,570.37
2038	26	0.21981003		$305,956,947.30	$67,252,405.39	$67,252,405.39
2039	27	0.20736795		$308,832,412.03	$64,041,944.69	$64,041,944.69
2040	28	0.19563014		$311,707,876.76	$60,979,456.53	$60,979,456.53
2041	29	0.18455674		$314,583,341.50	$58,058,475.58	$58,058,475.58
2042	30	0.17411013		$317,458,806.23	$55,272,794.31	$55,272,794.31
2043	31	0.16425484		$320,334,270.96	$52,616,454.58	$52,616,454.58
2044	32	0.1549574		$323,209,735.69	$50,083,739.22	$50,083,739.22
2045	33	0.14618622		$326,085,200.42	$47,669,163.92	$47,669,163.92
2046	34	0.13791153		$328,960,665.15	$45,367,469.10	$45,367,469.10
2047	35	0.13010522		$331,836,129.88	$43,173,612.12	$43,173,612.12
2048	36	0.12274077		$334,711,594.61	$41,082,759.51	$41,082,759.51
2049	37	0.11579318		$337,587,059.35	$39,090,279.51	$39,090,279.51
2050	38	0.10923885		$340,462,524.08	$37,191,734.64	$37,191,734.64
2051	39	0.10305552		$343,337,988.81	$35,382,874.62	$35,382,874.62
2052	40	0.09722219		$346,213,453.54	$33,659,629.37	$33,659,629.37
2053	41	0.09171905		$349,088,918.27	$32,018,102.21	$32,018,102.21
2054	42	0.0865274		$351,964,383.00	$30,454,563.29	$30,454,563.29
2055	43	0.08162962		$354,839,847.73	$28,965,443.19	$28,965,443.19
2056	44	0.07700908		$357,715,312.46	$27,547,326.69	$27,547,326.69
2057	45	0.07265007		$360,590,777.20	$26,196,946.77	$26,196,946.77
2058	46	0.06853781		$363,466,241.93	$24,911,178.77	$12,455,589.39
2059	47	0.06465831		$366,341,706.66	$23,687,034.73	
2060	48	0.0609984		$369,217,171.39	$22,521,657.94	
2061	49	0.05754566		$372,092,636.12	$21,412,317.64	
2062	50	0.05428836		$374,968,100.85	$20,356,403.93	
2063	51	0.05121544				
						$2,491,016,916

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396226				
2014	2	0.88999644		$9,477,831.75	$8,435,236.52	
2015	3	0.839619283		$9,592,850.34	$8,054,342.12	
2016	4	0.792093663		$9,707,868.93	$7,689,541.46	
2017	5	0.747258173		$9,822,887.52	$7,340,232.98	
2018	6	0.70496054		$9,937,906.11	$7,005,831.66	
2019	7	0.665057114		$10,052,924.70	$6,685,769.08	
2020	8	0.627412371		$10,167,943.29	$6,379,493.41	
2021	9	0.591898464	$10,282,962	$10,282,961.87	$6,086,469.33	
2022	10	0.558394777		$10,397,980.46	$5,806,177.98	$3,386,937.16
2023	11	0.526787525		$10,512,999.05	$5,538,116.76	$5,538,116.76
2024	12	0.496969364		$10,628,017.64	$5,281,799.16	$5,281,799.16
2025	13	0.468839022		$10,743,036.23	$5,036,754.60	$5,036,754.60
2026	14	0.442300964		$10,858,054.82	$4,802,528.12	$4,802,528.12
2027	15	0.417265061		$10,973,073.41	$4,578,680.14	$4,578,680.14
2028	16	0.393646284		$11,088,092.00	$4,364,786.21	$4,364,786.21
2029	17	0.371364419		$11,203,110.59	$4,160,436.65	$4,160,436.65
2030	18	0.350343791		$11,318,129.18	$3,965,236.28	$3,965,236.28
2031	19	0.33051301	$11,433,148	$11,433,147.77	$3,778,804.09	$3,778,804.09
2032	20	0.311804727		$11,548,166.36	$3,600,772.86	$3,600,772.86
2033	21	0.294155403		$11,663,184.95	$3,430,788.86	$3,430,788.86
2034	22	0.277505097		$11,778,203.54	$3,268,511.51	$3,268,511.51
2035	23	0.261797261		$11,893,222.12	$3,113,612.98	$3,113,612.98
2036	24	0.246978548		$12,008,240.71	$2,965,777.86	$2,965,777.86
2037	25	0.232998631		$12,123,259.30	$2,824,702.81	$2,824,702.81
2038	26	0.219810029		$12,238,277.89	$2,690,096.22	$2,690,096.22
2039	27	0.207367952		$12,353,296.48	$2,561,677.79	$2,561,677.79
2040	28	0.195630143		$12,468,315.07	$2,439,178.26	$2,439,178.26
2041	29	0.184556739		$12,583,333.66	$2,322,339.02	$2,322,339.02
2042	30	0.174110131		$12,698,352.25	$2,210,911.77	$2,210,911.77
2043	31	0.16425484		$12,813,370.84	$2,104,658.18	$2,104,658.18
2044	32	0.154957397		$12,928,389.43	$2,003,349.57	$2,003,349.57
2045	33	0.146186223		$13,043,408.02	$1,906,766.56	$1,906,766.56
2046	34	0.137911531		$13,158,426.61	$1,814,698.76	$1,814,698.76
2047	35	0.130105218		$13,273,445.20	$1,726,944.48	$1,726,944.48
2048	36	0.122740772		$13,388,463.78	$1,643,310.38	$1,643,310.38
2049	37	0.115793181		$13,503,482.37	$1,563,611.18	$1,563,611.18
2050	38	0.10923885		$13,618,500.96	$1,487,669.39	$1,487,669.39
2051	39	0.103055519		$13,733,519.55	$1,415,314.98	$1,415,314.98
2052	40	0.097222188		$13,848,538.14	$1,346,385.17	$1,346,385.17
2053	41	0.091719045		$13,963,556.73	$1,280,724.09	$1,280,724.09
2054	42	0.086527401		$14,078,575.32	$1,218,182.53	$1,218,182.53
2055	43	0.081629624		$14,193,593.91	$1,158,617.73	$1,158,617.73
2056	44	0.077009079		$14,308,612.50	$1,101,893.07	$1,101,893.07
2057	45	0.072650074		$14,423,631.09	$1,047,877.87	$1,047,877.87
2058	46	0.068537806		$14,538,649.68	$996,447.15	$498,223.58
2059	47	0.064658308		$14,653,668.27	$947,481.39	
2060	48	0.060998403		$14,768,686.86	$900,866.32	
2061	49	0.057545664		$14,883,705.44	$856,492.71	
2062	50	0.054288362		$14,998,724.03	$814,256.16	
2063	51	0.051215436				
						$99,640,677

ACCIDENT COSTS

A6.1 (b) 1.0%

Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1					
2013	1	0.943396226					
2014	2	0.88999644					
2015	3	0.839619283					
2016	4	0.792093663					
2017	5	0.747258173					
2018	6	0.70496054					
2019	7	0.665057114		$0.00	$0.00	$0.00	
2020	8	0.627412371		$0.00	$0.00	$0.00	
2021	9	0.591898464		$0.00	$0.00	$0.00	
2022	10	0.558394777		$0.00	$0.00	$0.00	$0.00
2023	11	0.526787525		$0.00	$0.00	$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00	$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00	$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00	$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00	$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00	$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00	$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00	$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00	$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00	$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00	$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00	$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00	$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00	$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00	$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00	$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00	$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00	$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00	$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00	$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00	$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00	$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00	$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00	$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00	$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00	$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00	$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00	$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00	$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00	$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00	$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00	$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00	$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00	$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00	$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00	$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00	$0.00	
2060	48	0.060998403		$0.00	$0.00	$0.00	
2061	49	0.057545664		$0.00	$0.00	$0.00	
2062	50	0.054288362		$0.00	$0.00	$0.00	
2063	51	0.051215436					
							$0

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1			
2013	1	0.943396226			
2014	2	0.88999644			
2015	3	0.839619283			
2016	4	0.792093663			
2017	5	0.747258173			
2018	6	0.70496054			
2019	7	0.665057114		$0.00	
2020	8	0.627412371		$0.00	
2021	9	0.591898464		$0.00	
2022	10	0.558394777		$0.00	$0.00
2023	11	0.526787525		$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00
2059	47	0.064658308		$0.00	
2060	48	0.060998403		$0.00	
2061	49	0.057545664		$0.00	
2062	50	0.054288362		$0.00	
2063	51	0.051215436			
					$0.00

OPUS

Option	Scenario 2 - Mt Vic / Ruahine / Well Rd
Time Zero	01/07/12
Year of Estimate	2012
Construction Period	3 years, 10 months
Benefit period	36 years, 2 months
Construction Start	1/7/2018
Construction payment	

Scenario 2 - Mt Vic / Ruahine / Well Rd

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396				
2014	2	0.889996		$405,856,442.51	$361,210,788.99	
2015	3	0.839619		$414,513,040.22	$348,033,141.63	
2016	4	0.792094		$423,169,637.92	$335,189,988.67	
2017	5	0.747258		$431,826,235.63	$322,685,683.83	
2018	6	0.704961		$440,482,833.34	$310,523,016.24	
2019	7	0.665057		$449,139,431.04	$298,703,373.62	
2020	8	0.627412		$457,796,028.75	$287,226,891.99	
2021	9	0.591898	$466,452,626.46	$466,452,626.46	$276,092,592.91	
2022	10	0.558395		$475,109,224.16	$265,298,509.24	$154,757,463.72
2023	11	0.526788		$483,765,821.87	$254,841,800.17	$254,841,800.17
2024	12	0.496969		$492,422,419.58	$244,718,856.47	$244,718,856.47
2025	13	0.468839		$501,079,017.29	$234,925,396.53	$234,925,396.53
2026	14	0.442301		$509,735,614.99	$225,456,554.09	$225,456,554.09
2027	15	0.417265		$518,392,212.70	$216,306,958.12	$216,306,958.12
2028	16	0.393646		$527,048,810.41	$207,470,805.55	$207,470,805.55
2029	17	0.371364		$535,705,408.11	$198,941,927.42	$198,941,927.42
2030	18	0.350344		$544,362,005.82	$190,713,848.87	$190,713,848.87
2031	19	0.330513	$553,018,603.53	$553,018,603.53	$182,779,843.51	$182,779,843.51
2032	20	0.311805		$561,675,201.23	$175,132,982.72	$175,132,982.72
2033	21	0.294155		$570,331,798.94	$167,766,180.00	$167,766,180.00
2034	22	0.277505		$578,988,396.65	$160,672,231.12	$160,672,231.12
2035	23	0.261797		$587,644,994.36	$153,843,850.10	$153,843,850.10
2036	24	0.246979		$596,301,592.06	$147,273,701.58	$147,273,701.58
2037	25	0.232999		$604,958,189.77	$140,954,429.73	$140,954,429.73
2038	26	0.21981		$613,614,787.48	$134,878,684.09	$134,878,684.09
2039	27	0.207368		$622,271,385.18	$129,039,142.53	$129,039,142.53
2040	28	0.19563		$630,927,982.89	$123,428,531.57	$123,428,531.57
2041	29	0.184557		$639,584,580.60	$118,039,644.36	$118,039,644.36
2042	30	0.17411		$648,241,178.30	$112,865,356.42	$112,865,356.42
2043	31	0.164255		$656,897,776.01	$107,898,639.41	$107,898,639.41
2044	32	0.154957		$665,554,373.72	$103,132,573.10	$103,132,573.10
2045	33	0.146186		$674,210,971.43	$98,560,355.61	$98,560,355.61
2046	34	0.137912		$682,867,569.13	$94,175,312.20	$94,175,312.20
2047	35	0.130105		$691,524,166.84	$89,970,902.69	$89,970,902.69
2048	36	0.122741		$700,180,764.55	$85,940,727.57	$85,940,727.57
2049	37	0.115793		$708,837,362.25	$82,078,533.07	$82,078,533.07
2050	38	0.109239		$717,493,959.96	$78,378,215.15	$78,378,215.15
2051	39	0.103056		$726,150,557.67	$74,833,822.57	$74,833,822.57
2052	40	0.097222		$734,807,155.37	$71,439,559.19	$71,439,559.19
2053	41	0.091719		$743,463,753.08	$68,189,785.43	$68,189,785.43
2054	42	0.086527		$752,120,350.79	$65,079,019.16	$65,079,019.16
2055	43	0.08163		$760,776,948.50	$62,101,935.90	$62,101,935.90
2056	44	0.077009		$769,433,546.20	$59,253,368.60	$59,253,368.60
2057	45	0.07265		$778,090,143.91	$56,528,306.81	$56,528,306.81
2058	46	0.068538		$786,746,741.62	$53,921,895.54	$26,960,947.77
2059	47	0.064658		$795,403,339.32	$51,429,433.73	
2060	48	0.060998		$804,059,937.03	$49,046,372.35	
2061	49	0.057546		$812,716,534.74	$46,768,312.25	
2062	50	0.054288		$821,373,132.44	$44,591,001.80	
2063	51	0.051215				
						$4,899,330,193

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$38,487,007.41	$34,253,299.58	
2015	3	0.83961928		$40,101,129.36	$33,669,681.48	
2016	4	0.79209366		$41,715,251.30	$33,042,386.21	
2017	5	0.74725817		$43,329,373.24	$32,378,228.28	
2018	6	0.70496054		$44,943,495.18	$31,683,390.65	
2019	7	0.66505711		$46,557,617.13	$30,963,474.46	
2020	8	0.62741237		$48,171,739.07	$30,223,545.04	
2021	9	0.59189846	$49,785,861.01	$49,785,861.01	$29,468,174.64	
2022	10	0.55839478		$51,399,982.96	$28,701,482.02	$16,742,531.18
2023	11	0.52678753		$53,014,104.90	$27,927,169.13	$27,927,169.13
2024	12	0.49696936		$54,628,226.84	$27,148,555.13	$27,148,555.13
2025	13	0.46883902		$56,242,348.78	$26,368,607.81	$26,368,607.81
2026	14	0.44230096		$57,856,470.73	$25,589,972.80	$25,589,972.80
2027	15	0.41726506		$59,470,592.67	$24,815,000.46	$24,815,000.46
2028	16	0.39364628		$61,084,714.61	$24,045,770.90	$24,045,770.90
2029	17	0.37136442		$62,698,836.55	$23,284,116.98	$23,284,116.98
2030	18	0.35034379		$64,312,958.50	$22,531,645.70	$22,531,645.70
2031	19	0.33051301	$65,927,080.44	$65,927,080.44	$21,789,757.83	$21,789,757.83
2032	20	0.31180473		$67,541,202.38	$21,059,666.16	$21,059,666.16
2033	21	0.2941554		$69,155,324.33	$20,342,412.28	$20,342,412.28
2034	22	0.2775051		$70,769,446.27	$19,638,882.04	$19,638,882.04
2035	23	0.26179726		$72,383,568.21	$18,949,819.92	$18,949,819.92
2036	24	0.24697855		$73,997,690.15	$18,275,842.09	$18,275,842.09
2037	25	0.23299863		$75,611,812.10	$17,617,448.67	$17,617,448.67
2038	26	0.21981003		$77,225,934.04	$16,975,034.78	$16,975,034.78
2039	27	0.20736795		$78,840,055.98	$16,348,900.92	$16,348,900.92
2040	28	0.19563014		$80,454,177.93	$15,739,262.34	$15,739,262.34
2041	29	0.18455674		$82,068,299.87	$15,146,257.78	$15,146,257.78
2042	30	0.17411013		$83,682,421.81	$14,569,957.42	$14,569,957.42
2043	31	0.16425484		$85,296,543.75	$14,010,370.19	$14,010,370.19
2044	32	0.1549574		$86,910,665.70	$13,467,450.50	$13,467,450.50
2045	33	0.14618622		$88,524,787.64	$12,941,104.37	$12,941,104.37
2046	34	0.13791153		$90,138,909.58	$12,431,195.06	$12,431,195.06
2047	35	0.13010522		$91,753,031.52	$11,937,548.20	$11,937,548.20
2048	36	0.12274077		$93,367,153.47	$11,459,956.49	$11,459,956.49
2049	37	0.11579318		$94,981,275.41	$10,998,184.03	$10,998,184.03
2050	38	0.10923885		$96,595,397.35	$10,551,970.13	$10,551,970.13
2051	39	0.10305552		$98,209,519.30	$10,121,032.98	$10,121,032.98
2052	40	0.09722219		$99,823,641.24	$9,705,072.79	$9,705,072.79
2053	41	0.09171905		$101,437,763.18	$9,303,774.77	$9,303,774.77
2054	42	0.0865274		$103,051,885.12	$8,916,811.78	$8,916,811.78
2055	43	0.08162962		$104,666,007.07	$8,543,846.75	$8,543,846.75
2056	44	0.07700908		$106,280,129.01	$8,184,534.83	$8,184,534.83
2057	45	0.07265007		$107,894,250.95	$7,838,525.35	$7,838,525.35
2058	46	0.06853781		$109,508,372.89	$7,505,463.62	$3,752,731.81
2059	47	0.06465831		$111,122,494.84	$7,184,992.45	
2060	48	0.0609984		$112,736,616.78	$6,876,753.62	
2061	49	0.05754566		$114,350,738.72	$6,580,389.13	
2062	50	0.05428836		$115,964,860.67	$6,295,542.31	
2063	51	0.05121544				
						$599,070,722

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$235,274,153.72	$209,393,159.24	
2015	3	0.83961928		$238,066,238.82	$199,885,004.75	
2016	4	0.79209366		$240,858,323.92	$190,782,352.12	
2017	5	0.74725817		$243,650,409.02	$182,069,759.47	
2018	6	0.70496054		$246,442,494.13	$173,732,233.85	
2019	7	0.66505711		$249,234,579.23	$165,755,229.87	
2020	8	0.62741237		$252,026,664.33	$158,124,647.11	
2021	9	0.59189846	$254,818,749.43	$254,818,749.43	$150,826,826.26	
2022	10	0.55839478		$257,610,834.53	$143,848,544.48	$83,911,650.95
2023	11	0.52678753		$260,402,919.63	$137,177,009.64	$137,177,009.64
2024	12	0.49696936		$263,195,004.73	$130,799,854.00	$130,799,854.00
2025	13	0.46883902		$265,987,089.83	$124,705,127.13	$124,705,127.13
2026	14	0.44230096		$268,779,174.93	$118,881,288.28	$118,881,288.28
2027	15	0.41726506		$271,571,260.03	$113,317,198.31	$113,317,198.31
2028	16	0.39364628		$274,363,345.13	$108,002,111.20	$108,002,111.20
2029	17	0.37136442		$277,155,430.23	$102,925,665.21	$102,925,665.21
2030	18	0.35034379		$279,947,515.33	$98,077,873.84	$98,077,873.84
2031	19	0.33051301	$282,739,600.44	$282,739,600.44	$93,449,116.53	$93,449,116.53
2032	20	0.31180473		$285,531,685.54	$89,030,129.23	$89,030,129.23
2033	21	0.2941554		$288,323,770.64	$84,811,994.87	$84,811,994.87
2034	22	0.2775051		$291,115,855.74	$80,786,133.76	$80,786,133.76
2035	23	0.26179726		$293,907,940.84	$76,944,293.97	$76,944,293.97
2036	24	0.24697855		$296,700,025.94	$73,278,541.70	$73,278,541.70
2037	25	0.23299863		$299,492,111.04	$69,781,251.72	$69,781,251.72
2038	26	0.21981003		$302,284,196.14	$66,445,097.85	$66,445,097.85
2039	27	0.20736795		$305,076,281.24	$63,263,043.55	$63,263,043.55
2040	28	0.19563014		$307,868,366.34	$60,228,332.56	$60,228,332.56
2041	29	0.18455674		$310,660,451.44	$57,334,479.78	$57,334,479.78
2042	30	0.17411013		$313,452,536.54	$54,575,262.17	$54,575,262.17
2043	31	0.16425484		$316,244,621.65	$51,944,709.88	$51,944,709.88
2044	32	0.1549574		$319,036,706.75	$49,437,097.52	$49,437,097.52
2045	33	0.14618622		$321,828,791.85	$47,046,935.62	$47,046,935.62
2046	34	0.13791153		$324,620,876.95	$44,768,962.26	$44,768,962.26
2047	35	0.13010522		$327,412,962.05	$42,598,134.90	$42,598,134.90
2048	36	0.12274077		$330,205,047.15	$40,529,622.40	$40,529,622.40
2049	37	0.11579318		$332,997,132.25	$38,558,797.25	$38,558,797.25
2050	38	0.10923885		$335,789,217.35	$36,681,227.98	$36,681,227.98
2051	39	0.10305552		$338,581,302.45	$34,892,671.84	$34,892,671.84
2052	40	0.09722219		$341,373,387.55	$33,189,067.56	$33,189,067.56
2053	41	0.09171905		$344,165,472.65	$31,566,528.48	$31,566,528.48
2054	42	0.0865274		$346,957,557.75	$30,021,335.71	$30,021,335.71
2055	43	0.08162962		$349,749,642.86	$28,549,931.68	$28,549,931.68
2056	44	0.07700908		$352,541,727.96	$27,148,913.71	$27,148,913.71
2057	45	0.07265007		$355,333,813.06	$25,815,027.94	$25,815,027.94
2058	46	0.06853781		$358,125,898.16	$24,545,163.33	$12,272,581.66
2059	47	0.06465831		$360,917,983.26	$23,336,345.96	
2060	48	0.0609984		$363,710,068.36	$22,185,733.45	
2061	49	0.05754566		$366,502,153.46	$21,090,609.60	
2062	50	0.05428836		$369,294,238.56	$20,048,379.24	
2063	51	0.05121544				
						$2,462,747,003

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$9,410,966.15	$8,375,726.37	
2015	3	0.83961928		$9,522,649.55	$7,995,400.19	
2016	4	0.79209366		$9,634,332.96	$7,631,294.08	
2017	5	0.74725817		$9,746,016.36	$7,282,790.38	
2018	6	0.70496054		$9,857,699.77	$6,949,289.35	
2019	7	0.66505711		$9,969,383.17	$6,630,209.19	
2020	8	0.62741237		$10,081,066.57	$6,324,985.88	
2021	9	0.59189846	$10,192,749.98	$10,192,749.98	$6,033,073.05	
2022	10	0.55839478		$10,304,433.38	$5,753,941.78	$3,356,466.04
2023	11	0.52678753		$10,416,116.79	$5,487,080.39	$5,487,080.39
2024	12	0.49696936		$10,527,800.19	$5,231,994.16	$5,231,994.16
2025	13	0.46883902		$10,639,483.59	$4,988,205.09	$4,988,205.09
2026	14	0.44230096		$10,751,167.00	$4,755,251.53	$4,755,251.53
2027	15	0.41726506		$10,862,850.40	$4,532,687.93	$4,532,687.93
2028	16	0.39364628		$10,974,533.81	$4,320,084.45	$4,320,084.45
2029	17	0.37136442		$11,086,217.21	$4,117,026.61	$4,117,026.61
2030	18	0.35034379		$11,197,900.61	$3,923,114.95	$3,923,114.95
2031	19	0.33051301	$11,309,584.02	$11,309,584.02	$3,737,964.66	$3,737,964.66
2032	20	0.31180473		$11,421,267.42	$3,561,205.17	$3,561,205.17
2033	21	0.2941554		$11,532,950.83	$3,392,479.79	$3,392,479.79
2034	22	0.2775051		$11,644,634.23	$3,231,445.35	$3,231,445.35
2035	23	0.26179726		$11,756,317.63	$3,077,771.76	$3,077,771.76
2036	24	0.24697855		$11,868,001.04	$2,931,141.67	$2,931,141.67
2037	25	0.23299863		$11,979,684.44	$2,791,250.07	$2,791,250.07
2038	26	0.21981003		$12,091,367.85	$2,657,803.91	$2,657,803.91
2039	27	0.20736795		$12,203,051.25	$2,530,521.74	$2,530,521.74
2040	28	0.19563014		$12,314,734.65	$2,409,133.30	$2,409,133.30
2041	29	0.18455674		$12,426,418.06	$2,293,379.19	$2,293,379.19
2042	30	0.17411013		$12,538,101.46	$2,183,010.49	$2,183,010.49
2043	31	0.16425484		$12,649,784.87	$2,077,788.40	$2,077,788.40
2044	32	0.1549574		$12,761,468.27	$1,977,483.90	$1,977,483.90
2045	33	0.14618622		$12,873,151.67	$1,881,877.42	$1,881,877.42
2046	34	0.13791153		$12,984,835.08	$1,790,758.49	$1,790,758.49
2047	35	0.13010522		$13,096,518.48	$1,703,925.40	$1,703,925.40
2048	36	0.12274077		$13,208,201.89	$1,621,184.90	$1,621,184.90
2049	37	0.11579318		$13,319,885.29	$1,542,351.89	$1,542,351.89
2050	38	0.10923885		$13,431,568.69	$1,467,249.12	$1,467,249.12
2051	39	0.10305552		$13,543,252.10	$1,395,706.87	$1,395,706.87
2052	40	0.09722219		$13,654,935.50	$1,327,562.70	$1,327,562.70
2053	41	0.09171905		$13,766,618.91	$1,262,661.14	$1,262,661.14
2054	42	0.0865274		$13,878,302.31	$1,200,853.43	$1,200,853.43
2055	43	0.08162962		$13,989,985.71	$1,141,997.27	$1,141,997.27
2056	44	0.07700908		$14,101,669.12	$1,085,956.55	$1,085,956.55
2057	45	0.07265007		$14,213,352.52	$1,032,601.12	$1,032,601.12
2058	46	0.06853781		$14,325,035.93	$981,806.53	$490,903.27
2059	47	0.06465831		$14,436,719.33	$933,453.84	
2060	48	0.0609984		$14,548,402.73	$887,429.34	
2061	49	0.05754566		$14,660,086.14	$843,624.38	
2062	50	0.05428836		$14,771,769.54	$801,935.17	
2063	51	0.05121544				
						$98,509,880

ACCIDENT COSTS

A6.1 (b) 1.0%

Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1					
2013	1	0.943396226					
2014	2	0.88999644					
2015	3	0.839619283					
2016	4	0.792093663					
2017	5	0.747258173					
2018	6	0.70496054					
2019	7	0.665057114		$0.00	$0.00	$0.00	
2020	8	0.627412371		$0.00	$0.00	$0.00	
2021	9	0.591898464		$0.00	$0.00	$0.00	
2022	10	0.558394777		$0.00	$0.00	$0.00	
2023	11	0.526787525		$0.00	$0.00	$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00	$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00	$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00	$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00	$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00	$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00	$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00	$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00	$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00	$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00	$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00	$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00	$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00	$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00	$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00	$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00	$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00	$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00	$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00	$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00	$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00	$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00	$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00	$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00	$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00	$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00	$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00	$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00	$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00	$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00	$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00	$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00	$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00	$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00	$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00	$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00	$0.00	$0.00
2060	48	0.060998403		$0.00	$0.00	$0.00	
2061	49	0.057545664		$0.00	$0.00	$0.00	
2062	50	0.054288362		$0.00	$0.00	$0.00	
2063	51	0.051215436					
							$0

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1			
2013	1	0.943396226			
2014	2	0.88999644			
2015	3	0.839619283			
2016	4	0.792093663			
2017	5	0.747258173			
2018	6	0.70496054			
2019	7	0.665057114		$0.00	
2020	8	0.627412371		$0.00	
2021	9	0.591898464		$0.00	
2022	10	0.558394777		$0.00	
2023	11	0.526787525		$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00
2060	48	0.060998403		$0.00	
2061	49	0.057545664		$0.00	
2062	50	0.054288362		$0.00	
2063	51	0.051215436			
					$0.00

CONSTRUCTION COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount
			$ 363,814,000	
1/07/2018	6	0.704961	$90,953,500	$64,118,629
1/07/2019	7	0.665057	$90,953,500	$60,489,272
1/07/2020	8	0.627412	$90,953,500	$57,065,351
1/07/2021	9	0.591898	$90,953,500	$53,835,237
1/04/2016	4.75	0.758223		$0
1/10/2016	5.25	0.736452		$0
1/04/2017	5.75	0.715305		$0
1/10/2017	6.25	0.694766		$0
1/04/2018	6.75	0.674816		$0
				$235,508,488.72

Transport Economics Analysis Summary

		Scenario 1 - Basin/Mem Park/ICB/AQtN	Scenario 2 - Mt Vic / Ruahine / Well Rd
	Capital Costs	N/A	235,508,489
	Maintenance Costs	0	0
1	**Total Costs**	**0**	**235,508,489**
	Transport Costs		
	Travel Time Costs	5,561,676,162	5,498,400,915
	Vehicle Operating Costs	2,491,016,916	2,462,747,003
	Accidents		
	Seal Extn / Passing Lane		
	Carbon Dioxide (4% of VOC)	99,640,677	98,509,880
2	**Total Transport Costs**	**8,152,333,755**	**8,059,657,798**
	Tangible Benefits		
	Travel Time Benefits	N/A	63,275,247
	Vehicle Operating Benefits	N/A	28,269,914
	Accidents*	N/A	11,986,000
	Trip Reliability*	N/A	17,094,000
	Pedestrian and Cycling*	N/A	8,409,000
	Public Transport*	N/A	1,222,000
	Seal Extn / Passing Lane Benefits	N/A	
	Carbon Dioxide Benefits	N/A	1,130,797
3	**Tangible Benefits**	**N/A**	**131,386,957**
4	Tangible B/C Ratio	N/A	0.56

* Present value taken from Mt Victoria to Cobham Drive SAR

TIMINGS				TRAVEL TIME					CRV TRAVEL TIME			VEHICLE OPERATING COSTS		
OPTION and YEAR	PERIOD	EQUIV TIME PERIODS PER DAY (hrs/day)	DAYS PER YEAR (days/year)	TOTAL SATURN TT on links (hours)	TOTAL SATURN TT on turns (hours)	TOTAL TT (hours)	VALUE OF TIME ($/veh.hr)	ANNUAL TRAVEL TIME COST ($/year)	TOTAL CONGESTION on links and turns SATURN (veh.hrs/hr)	CONGESTION VALUE ($/hour)	ANNUAL CONGESTION COST ($/year)	BASE VOC BY SPEED ($.veh/hr)	VOC DUE TO CONGESTION ($.veh/hr)	ANNUAL VEHICLE OPERATING COST ($/year)
Scenario 1 - Do Nothing														
Base 2011	Morning Peak	2	245	0	0	0	$20.73	$0	0	$5.32	$0	0	0	$0
Base 2011	Inter Peak	7	245	0	0	0	$24.59	$0	0	$4.93	$0	0	0	$0
Base 2011	Evening Peak	2	245	0	0	0	$20.50	$0	0	$5.19	$0	0	0	$0
Base 2011	Off Peak	13	245	0	0	0	$20.45	$0	0	$5.04	$0	0	0	$0
Base 2011	Weekend Peak	6	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
Base 2011	Weekend off-peak	18	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
2011 Total								**$0**			**$0**			**$0**
Do min 2021	Morning Peak	2	245	4117	3690	7807	$20.73	$79,296,882	4801	$5.32	$12,505,104	62267	5200	$33,059,022
Do min 2021	Inter Peak	7	245	2095	1080	3175	$24.59	$133,903,653	1172	$4.93	$9,914,170	39537	769	$69,124,463
Do min 2021	Evening Peak	2	245	3714	2985	6699	$20.50	$67,279,699	3603	$5.19	$9,166,950	63837	5064	$33,761,336
Do min 2021	Off Peak	13	245	712	367	1079	$20.45	$70,325,367	399	$5.04	$6,399,203	13442	262	$43,647,161
Do min 2021	Weekend Peak	6	120	2697	1844	4542	$19.30	$63,120,641	2031	$5.84	$8,534,972	49547	1637	$36,852,519
Do min 2021	Weekend off-peak	18	120	1001	684	1686	$19.30	$70,278,652	754	$5.84	$9,502,855	18389	607	$41,031,671
2021 Total								**$484,204,893**			**$56,023,254**			**$257,476,173**
Do Min 2031	Morning Peak	2	245	4598	5109	9707	$20.73	$98,591,668	6617	$5.32	$17,234,624	66039	6080	$35,338,540
Do Min 2031	Inter Peak	7	245	2339	1379	3718	$24.59	$156,790,832	1518	$4.93	$12,837,072	43763	1090	$76,922,587
Do Min 2031	Evening Peak	2	245	4195	4130	8325	$20.50	$83,603,281	5063	$5.19	$12,882,161	69749	6722	$37,470,946
Do Min 2031	Off Peak	13	245	795	469	1264	$20.45	$82,345,572	516	$5.04	$8,285,820	14879	371	$48,571,119
Do Min 2031	Weekend Peak	6	120	3048	2421	5469	$19.30	$76,004,276	2688	$5.84	$11,294,047	54925	2404	$41,276,555
Do Min 2031	Weekend off-peak	18	120	1131	899	2030	$19.30	$84,623,317	998	$5.84	$12,574,816	20384	892	$45,957,402
2031 Total								**$581,958,946**			**$75,108,540**			**$285,537,149**
Scenario 2 - Mem Park / ICB / Basin														
Option 1 2011	Morning Peak	2	245	0	0	0	$20.73	$0	0	$5.32	$0	0	0	$0
Option 1 2011	Inter Peak	7	245	0	0	0	$24.59	$0	0	$4.93	$0	0	0	$0
Option 1 2011	Evening Peak	2	245	0	0	0	$20.50	$0	0	$5.19	$0	0	0	$0
Option 1 2011	Off Peak	13	245	0	0	0	$20.45	$0	0	$5.04	$0	0	0	$0
Option 1 2011	Weekend Peak	6	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
Option 1 2011	Weekend off-peak	18	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
2011 Total								**$0**			**$0**			**$0**
Option 1 2021	Morning Peak	2	245	4116	3577	7694	$20.73	$78,144,831	4672	$5.32	$12,168,780	62074	4988	$32,860,269
Option 1 2021	Inter Peak	7	245	2090	1035	3125	$24.59	$131,805,631	1116	$4.93	$9,439,825	39474	670	$68,847,742
Option 1 2021	Evening Peak	2	245	3678	2866	6544	$20.50	$65,715,943	3462	$5.19	$8,808,563	63469	4921	$33,511,016
Option 1 2021	Off Peak	13	245	711	352	1063	$20.45	$69,223,499	379	$5.04	$6,093,032	13421	228	$43,472,431
Option 1 2021	Weekend Peak	6	120	2692	1710	4402	$19.30	$61,180,819	1886	$5.84	$7,924,369	49454	1497	$36,684,776
Option 1 2021	Weekend off-peak	18	120	999	635	1634	$19.30	$68,118,850	700	$5.84	$8,823,009	18354	556	$40,844,905
2021 Total								**$474,189,573**			**$53,257,577**			**$256,221,139**
Option 1 2031	Morning Peak	2	245	4637	4736	9373	$20.73	$95,199,028	6212	$5.32	$16,180,885	66479	5905	$35,468,013
Option 1 2031	Inter Peak	7	245	2336	1295	3631	$24.59	$153,150,747	1425	$4.93	$12,057,376	43711	964	$76,618,436
Option 1 2031	Evening Peak	2	245	4184	3912	8096	$20.50	$81,305,197	4793	$5.19	$12,193,384	69609	6441	$37,264,159
Option 1 2031	Off Peak	13	245	794	440	1235	$20.45	$80,433,822	485	$5.04	$7,782,558	14862	328	$48,379,069
Option 1 2031	Weekend Peak	6	120	3040	2212	5252	$19.30	$72,997,040	2460	$5.84	$10,335,864	54760	2231	$41,033,281
Option 1 2031	Weekend off-peak	18	120	1128	821	1949	$19.30	$81,275,055	913	$5.84	$11,507,973	20323	828	$45,686,539
2031 Total								**$564,360,888**			**$70,058,040**			**$284,449,497**

Option	Scenario 1 - Do Nothing	
Time Zero	01/07/12	
Year of Estimate	2012	
Construction Period	4.5	Years
Benefit period	35.5	
Construction Start	1/1/2013	
Construction payment		

Scenario 1 - Do Nothing

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396				
2014	2	0.889996		$415,777,056.78	$370,040,100.38	
2015	3	0.839619		$425,552,462.02	$357,302,053.06	
2016	4	0.792094		$435,327,867.26	$344,820,445.09	
2017	5	0.747258		$445,103,272.51	$332,607,058.15	$166,303,529.07
2018	6	0.704961		$454,878,677.75	$320,671,518.50	$320,671,518.50
2019	7	0.665057		$464,654,082.99	$309,021,503.27	$309,021,503.27
2020	8	0.627412		$474,429,488.23	$297,662,930.24	$297,662,930.24
2021	9	0.591898	$484,204,893.47	$484,204,893.47	$286,600,132.48	$286,600,132.48
2022	10	0.558395		$493,980,298.71	$275,836,018.70	$275,836,018.70
2023	11	0.526788		$503,755,703.95	$265,372,220.69	$265,372,220.69
2024	12	0.496969		$513,531,109.19	$255,209,228.51	$255,209,228.51
2025	13	0.468839		$523,306,514.44	$245,346,514.56	$245,346,514.56
2026	14	0.442301		$533,081,919.68	$235,782,647.17	$235,782,647.17
2027	15	0.417265		$542,857,324.92	$226,515,394.65	$226,515,394.65
2028	16	0.393646		$552,632,730.16	$217,541,820.49	$217,541,820.49
2029	17	0.371364		$562,408,135.40	$208,858,370.22	$208,858,370.22
2030	18	0.350344		$572,183,540.64	$200,460,950.85	$200,460,950.85
2031	19	0.330513	$581,958,945.88	$581,958,945.88	$192,345,003.19	$192,345,003.19
2032	20	0.311805		$591,734,351.13	$184,505,567.74	$184,505,567.74
2033	21	0.294155		$601,509,756.37	$176,937,344.63	$176,937,344.63
2034	22	0.277505		$611,285,161.61	$169,634,748.01	$169,634,748.01
2035	23	0.261797		$621,060,566.85	$162,591,955.46	$162,591,955.46
2036	24	0.246979		$630,835,972.09	$155,802,952.62	$155,802,952.62
2037	25	0.232999		$640,611,377.33	$149,261,573.60	$149,261,573.60
2038	26	0.21981		$650,386,782.57	$142,961,537.39	$142,961,537.39
2039	27	0.207368		$660,162,187.81	$136,896,480.66	$136,896,480.66
2040	28	0.19563		$669,937,593.06	$131,059,987.19	$131,059,987.19
2041	29	0.184557		$679,712,998.30	$125,445,614.26	$125,445,614.26
2042	30	0.17411		$689,488,403.54	$120,046,916.20	$120,046,916.20
2043	31	0.164255		$699,263,808.78	$114,857,465.37	$114,857,465.37
2044	32	0.154957		$709,039,214.02	$109,870,870.75	$109,870,870.75
2045	33	0.146186		$718,814,619.26	$105,080,794.43	$105,080,794.43
2046	34	0.137912		$728,590,024.50	$100,480,966.04	$100,480,966.04
2047	35	0.130105		$738,365,429.74	$96,065,195.42	$96,065,195.42
2048	36	0.122741		$748,140,834.99	$91,827,383.64	$91,827,383.64
2049	37	0.115793		$757,916,240.23	$87,761,532.48	$87,761,532.48
2050	38	0.109239		$767,691,645.47	$83,861,752.59	$83,861,752.59
2051	39	0.103056		$777,467,050.71	$80,122,270.39	$80,122,270.39
2052	40	0.097222		$787,242,455.95	$76,537,433.82	$76,537,433.82
2053	41	0.091719		$797,017,861.19	$73,101,717.08	
2054	42	0.086527		$806,793,266.43	$69,809,724.45	
2055	43	0.08163		$816,568,671.67	$66,656,193.26	
2056	44	0.077009		$826,344,076.92	$63,635,996.14	
2057	45	0.07265		$836,119,482.16	$60,744,142.54	
2058	46	0.068538		$845,894,887.40	$57,975,779.68	
2059	47	0.064658		$855,670,292.64	$55,326,192.93	
2060	48	0.060998		$865,445,697.88	$52,790,805.75	
2061	49	0.057546		$875,221,103.12	$50,365,179.11	
2062	50	0.054288		$884,996,508.36	$48,045,010.65	
2063	51	0.051215				
						$6,305,138,125

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$42,663,554.87	$37,970,411.95	
2015	3	0.83961928		$44,572,083.38	$37,423,580.69	
2016	4	0.79209366		$46,480,611.89	$36,816,998.15	
2017	5	0.74725817		$48,389,140.41	$36,159,180.65	$18,079,590.32
2018	6	0.70496054		$50,297,668.92	$35,457,871.86	$35,457,871.86
2019	7	0.66505711		$52,206,197.43	$34,720,102.98	$34,720,102.98
2020	8	0.62741237		$54,114,725.94	$33,952,248.53	$33,952,248.53
2021	9	0.59189846	$56,023,254.45	$56,023,254.45	$33,160,078.23	$33,160,078.23
2022	10	0.55839478		$57,931,782.97	$32,348,805.03	$32,348,805.03
2023	11	0.52678753		$59,840,311.48	$31,523,129.60	$31,523,129.60
2024	12	0.49696936		$61,748,839.99	$30,687,281.71	$30,687,281.71
2025	13	0.46883902		$63,657,368.50	$29,845,058.41	$29,845,058.41
2026	14	0.44230096		$65,565,897.01	$28,999,859.48	$28,999,859.48
2027	15	0.41726506		$67,474,425.52	$28,154,720.26	$28,154,720.26
2028	16	0.39364628		$69,382,954.04	$27,312,342.01	$27,312,342.01
2029	17	0.37136442		$71,291,482.55	$26,475,119.97	$26,475,119.97
2030	18	0.35034379		$73,200,011.06	$25,645,169.39	$25,645,169.39
2031	19	0.33051301	$75,108,539.57	$75,108,539.57	$24,824,349.53	$24,824,349.53
2032	20	0.31180473		$77,017,068.08	$24,014,285.88	$24,014,285.88
2033	21	0.2941554		$78,925,596.60	$23,216,390.65	$23,216,390.65
2034	22	0.2775051		$80,834,125.11	$22,431,881.72	$22,431,881.72
2035	23	0.26179726		$82,742,653.62	$21,661,800.10	$21,661,800.10
2036	24	0.24697855		$84,651,182.13	$20,907,026.08	$20,907,026.08
2037	25	0.23299863		$86,559,710.64	$20,168,294.04	$20,168,294.04
2038	26	0.21981003		$88,468,239.15	$19,446,206.19	$19,446,206.19
2039	27	0.20736795		$90,376,767.67	$18,741,245.19	$18,741,245.19
2040	28	0.19563014		$92,285,296.18	$18,053,785.70	$18,053,785.70
2041	29	0.18455674		$94,193,824.69	$17,384,105.10	$17,384,105.10
2042	30	0.17411013		$96,102,353.20	$16,732,393.30	$16,732,393.30
2043	31	0.16425484		$98,010,881.71	$16,098,761.74	$16,098,761.74
2044	32	0.1549574		$99,919,410.23	$15,483,251.69	$15,483,251.69
2045	33	0.14618622		$101,827,938.74	$14,885,841.79	$14,885,841.79
2046	34	0.13791153		$103,736,467.25	$14,306,455.06	$14,306,455.06
2047	35	0.13010522		$105,644,995.76	$13,744,965.24	$13,744,965.24
2048	36	0.12274077		$107,553,524.27	$13,201,202.60	$13,201,202.60
2049	37	0.11579318		$109,462,052.79	$12,674,959.30	$12,674,959.30
2050	38	0.10923885		$111,370,581.30	$12,165,994.24	$12,165,994.24
2051	39	0.10305552		$113,279,109.81	$11,674,037.45	$11,674,037.45
2052	40	0.09722219		$115,187,638.32	$11,198,794.19	$11,198,794.19
2053	41	0.09171905		$117,096,166.83	$10,739,948.60	
2054	42	0.0865274		$119,004,695.34	$10,297,166.99	
2055	43	0.08162962		$120,913,223.86	$9,870,100.94	
2056	44	0.07700908		$122,821,752.37	$9,458,390.01	
2057	45	0.07265007		$124,730,280.88	$9,061,664.18	
2058	46	0.06853781		$126,638,809.39	$8,679,546.15	
2059	47	0.06465831		$128,547,337.90	$8,311,653.31	
2060	48	0.0609984		$130,455,866.42	$7,957,599.56	
2061	49	0.05754566		$132,364,394.93	$7,616,996.93	
2062	50	0.05428836		$134,272,923.44	$7,289,457.05	
2063	51	0.05121544				
						$799,377,405

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$237,833,489.02	$211,670,958.54	
2015	3	0.83961928		$240,639,586.68	$202,045,637.24	
2016	4	0.79209366		$243,445,684.34	$192,831,783.90	
2017	5	0.74725817		$246,251,781.99	$184,013,656.68	$92,006,828.34
2018	6	0.70496054		$249,057,879.65	$175,575,977.44	$175,575,977.44
2019	7	0.66505711		$251,863,977.31	$167,503,929.77	$167,503,929.77
2020	8	0.62741237		$254,670,074.97	$159,783,155.64	$159,783,155.64
2021	9	0.59189846	$257,476,173	$257,476,172.62	$152,399,750.97	$152,399,750.97
2022	10	0.55839478		$260,282,270.28	$145,340,260.25	$145,340,260.25
2023	11	0.52678753		$263,088,367.94	$138,591,670.31	$138,591,670.31
2024	12	0.49696936		$265,894,465.60	$132,141,403.35	$132,141,403.35
2025	13	0.46883902		$268,700,563.25	$125,977,309.35	$125,977,309.35
2026	14	0.44230096		$271,506,660.91	$120,087,657.96	$120,087,657.96
2027	15	0.41726506		$274,312,758.57	$114,461,129.87	$114,461,129.87
2028	16	0.39364628		$277,118,856.23	$109,086,807.90	$109,086,807.90
2029	17	0.37136442		$279,924,953.88	$103,954,167.75	$103,954,167.75
2030	18	0.35034379		$282,731,051.54	$99,053,068.47	$99,053,068.47
2031	19	0.33051301	$285,537,149	$285,537,149.20	$94,373,742.79	$94,373,742.79
2032	20	0.31180473		$288,343,246.86	$89,906,787.34	$89,906,787.34
2033	21	0.2941554		$291,149,344.52	$85,643,152.69	$85,643,152.69
2034	22	0.2775051		$293,955,442.17	$81,574,133.47	$81,574,133.47
2035	23	0.26179726		$296,761,539.83	$77,691,358.37	$77,691,358.37
2036	24	0.24697855		$299,567,637.49	$73,986,780.23	$73,986,780.23
2037	25	0.23299863		$302,373,735.15	$70,452,666.19	$70,452,666.19
2038	26	0.21981003		$305,179,832.80	$67,081,587.83	$67,081,587.83
2039	27	0.20736795		$307,985,930.46	$63,866,411.55	$63,866,411.55
2040	28	0.19563014		$310,792,028.12	$60,800,288.93	$60,800,288.93
2041	29	0.18455674		$313,598,125.78	$57,876,647.38	$57,876,647.38
2042	30	0.17411013		$316,404,223.43	$55,089,180.76	$55,089,180.76
2043	31	0.16425484		$319,210,321.09	$52,431,840.37	$52,431,840.37
2044	32	0.1549574		$322,016,418.75	$49,898,825.94	$49,898,825.94
2045	33	0.14618622		$324,822,516.41	$47,484,576.91	$47,484,576.91
2046	34	0.13791153		$327,628,614.06	$45,183,763.90	$45,183,763.90
2047	35	0.13010522		$330,434,711.72	$42,991,280.30	$42,991,280.30
2048	36	0.12274077		$333,240,809.38	$40,902,234.20	$40,902,234.20
2049	37	0.11579318		$336,046,907.04	$38,911,940.37	$38,911,940.37
2050	38	0.10923885		$338,853,004.70	$37,015,912.59	$37,015,912.59
2051	39	0.10305552		$341,659,102.35	$35,209,856.10	$35,209,856.10
2052	40	0.09722219		$344,465,200.01	$33,489,660.33	$33,489,660.33
2053	41	0.09171905		$347,271,297.67	$31,851,391.78	
2054	42	0.0865274		$350,077,395.33	$30,291,287.15	
2055	43	0.08162962		$352,883,492.98	$28,805,746.69	
2056	44	0.07700908		$355,689,590.64	$27,391,327.72	
2057	45	0.07265007		$358,495,688.30	$26,044,738.41	
2058	46	0.06853781		$361,301,785.96	$24,762,831.71	
2059	47	0.06465831		$364,107,883.61	$23,542,599.52	
2060	48	0.0609984		$366,913,981.27	$22,381,167.02	
2061	49	0.05754566		$369,720,078.93	$21,275,787.26	
2062	50	0.05428836		$372,526,176.59	$20,223,835.86	
2063	51	0.05121544				
						$3,137,825,746

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396226				
2014	2	0.88999644		$9,513,339.56	$8,466,838.34	
2015	3	0.839619283		$9,625,583.47	$8,081,825.49	
2016	4	0.792093663		$9,737,827.37	$7,713,271.36	
2017	5	0.747258173		$9,850,071.28	$7,360,546.27	$3,680,273.13
2018	6	0.70496054		$9,962,315.19	$7,023,039.10	$7,023,039.10
2019	7	0.665057114		$10,074,559.09	$6,700,157.19	$6,700,157.19
2020	8	0.627412371		$10,186,803.00	$6,391,326.23	$6,391,326.23
2021	9	0.591898464	$10,299,047	$10,299,046.90	$6,095,990.04	$6,095,990.04
2022	10	0.558394777		$10,411,290.81	$5,813,610.41	$5,813,610.41
2023	11	0.526787525		$10,523,534.72	$5,543,666.81	$5,543,666.81
2024	12	0.496969364		$10,635,778.62	$5,285,656.13	$5,285,656.13
2025	13	0.468839022		$10,748,022.53	$5,039,092.37	$5,039,092.37
2026	14	0.442300964		$10,860,266.44	$4,803,506.32	$4,803,506.32
2027	15	0.417265061		$10,972,510.34	$4,578,445.19	$4,578,445.19
2028	16	0.393646284		$11,084,754.25	$4,363,472.32	$4,363,472.32
2029	17	0.371364419		$11,196,998.16	$4,158,166.71	$4,158,166.71
2030	18	0.350343791		$11,309,242.06	$3,962,122.74	$3,962,122.74
2031	19	0.33051301	$11,421,486	$11,421,485.97	$3,774,949.71	$3,774,949.71
2032	20	0.311804727		$11,533,729.87	$3,596,271.49	$3,596,271.49
2033	21	0.294155403		$11,645,973.78	$3,425,726.11	$3,425,726.11
2034	22	0.277505097		$11,758,217.69	$3,262,965.34	$3,262,965.34
2035	23	0.261797261		$11,870,461.59	$3,107,654.33	$3,107,654.33
2036	24	0.246978548		$11,982,705.50	$2,959,471.21	$2,959,471.21
2037	25	0.232998631		$12,094,949.41	$2,818,106.65	$2,818,106.65
2038	26	0.219810029		$12,207,193.31	$2,683,263.51	$2,683,263.51
2039	27	0.207367952		$12,319,437.22	$2,554,656.46	$2,554,656.46
2040	28	0.195630143		$12,431,681.12	$2,432,011.56	$2,432,011.56
2041	29	0.184556739		$12,543,925.03	$2,315,065.90	$2,315,065.90
2042	30	0.174110131		$12,656,168.94	$2,203,567.23	$2,203,567.23
2043	31	0.16425484		$12,768,412.84	$2,097,273.61	$2,097,273.61
2044	32	0.154957397		$12,880,656.75	$1,995,953.04	$1,995,953.04
2045	33	0.146186223		$12,992,900.66	$1,899,383.08	$1,899,383.08
2046	34	0.137911531		$13,105,144.56	$1,807,350.56	$1,807,350.56
2047	35	0.130105218		$13,217,388.47	$1,719,651.21	$1,719,651.21
2048	36	0.122740772		$13,329,632.38	$1,636,089.37	$1,636,089.37
2049	37	0.115793181		$13,441,876.28	$1,556,477.61	$1,556,477.61
2050	38	0.10923885		$13,554,120.19	$1,480,636.50	$1,480,636.50
2051	39	0.103055519		$13,666,364.09	$1,408,394.24	$1,408,394.24
2052	40	0.097222188		$13,778,608.00	$1,339,586.41	$1,339,586.41
2053	41	0.091719045		$13,890,851.91	$1,274,055.67	
2054	42	0.086527401		$14,003,095.81	$1,211,651.49	
2055	43	0.081629624		$14,115,339.72	$1,152,229.87	
2056	44	0.077009079		$14,227,583.63	$1,095,653.11	
2057	45	0.072650074		$14,339,827.53	$1,041,789.54	
2058	46	0.068537806		$14,452,071.44	$990,513.27	
2059	47	0.064658308		$14,564,315.34	$941,703.98	
2060	48	0.060998403		$14,676,559.25	$895,246.68	
2061	49	0.057545664		$14,788,803.16	$851,031.49	
2062	50	0.054288362		$14,901,047.06	$808,953.43	
2063	51	0.051215436				
						$125,513,030

ACCIDENT COSTS

A6.1 (b) 1.0% — Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1					
2013	1	0.943396226					
2014	2	0.88999644					
2015	3	0.839619283					
2016	4	0.792093663					
2017	5	0.747258173					$0.00
2018	6	0.70496054					$0.00
2019	7	0.665057114		$0.00	$0.00	$0.00	$0.00
2020	8	0.627412371		$0.00	$0.00	$0.00	$0.00
2021	9	0.591898464		$0.00	$0.00	$0.00	$0.00
2022	10	0.558394777		$0.00	$0.00	$0.00	$0.00
2023	11	0.526787525		$0.00	$0.00	$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00	$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00	$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00	$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00	$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00	$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00	$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00	$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00	$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00	$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00	$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00	$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00	$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00	$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00	$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00	$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00	$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00	$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00	$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00	$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00	$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00	$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00	$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00	$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00	$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00	$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00	$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00	$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00	$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00	$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00	$0.00	
2054	42	0.086527401		$0.00	$0.00	$0.00	
2055	43	0.081629624		$0.00	$0.00	$0.00	
2056	44	0.077009079		$0.00	$0.00	$0.00	
2057	45	0.072650074		$0.00	$0.00	$0.00	
2058	46	0.068537806		$0.00	$0.00	$0.00	
2059	47	0.064658308		$0.00	$0.00	$0.00	
2060	48	0.060998403		$0.00	$0.00	$0.00	
2061	49	0.057545664		$0.00	$0.00	$0.00	
2062	50	0.054288362		$0.00	$0.00	$0.00	
2063	51	0.051215436					
							$0

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1			
2013	1	0.943396226			
2014	2	0.88999644			
2015	3	0.839619283			
2016	4	0.792093663			
2017	5	0.747258173			$0.00
2018	6	0.70496054			$0.00
2019	7	0.665057114		$0.00	$0.00
2020	8	0.627412371		$0.00	$0.00
2021	9	0.591898464		$0.00	$0.00
2022	10	0.558394777		$0.00	$0.00
2023	11	0.526787525		$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00
2053	41	0.091719045		$0.00	
2054	42	0.086527401		$0.00	
2055	43	0.081629624		$0.00	
2056	44	0.077009079		$0.00	
2057	45	0.072650074		$0.00	
2058	46	0.068537806		$0.00	
2059	47	0.064658308		$0.00	
2060	48	0.060998403		$0.00	
2061	49	0.057545664		$0.00	
2062	50	0.054288362		$0.00	
2063	51	0.051215436			
					$0.00

Option	Scenario 2 - Mem Park / ICB / Basin	
Time Zero	01/07/12	
Year of Estimate	2012	
Construction Period	4.5	Years
Benefit period	35.5	
Construction Start	1/1/2013	
Construction payment		

Scenario 2 - Mem Park / ICB / Basin

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396		$402,052,521.39	$379,294,831.50	
2014	2	0.889996		$411,069,652.86	$365,850,527.65	
2015	3	0.839619		$420,086,784.34	$352,712,964.68	
2016	4	0.792094		$429,103,915.81	$339,890,492.59	
2017	5	0.747258		$438,121,047.29	$327,389,533.29	$163,694,766.64
2018	6	0.704961		$447,138,178.76	$315,214,772.15	$315,214,772.15
2019	7	0.665057		$456,155,310.23	$303,369,333.99	$303,369,333.99
2020	8	0.627412		$465,172,441.71	$291,854,944.73	$291,854,944.73
2021	9	0.591898	$474,189,573.18	$474,189,573.18	$280,672,079.79	$280,672,079.79
2022	10	0.558395		$483,206,704.66	$269,820,100.05	$269,820,100.05
2023	11	0.526788		$492,223,836.13	$259,297,376.57	$259,297,376.57
2024	12	0.496969		$501,240,967.60	$249,101,404.67	$249,101,404.67
2025	13	0.468839		$510,258,099.08	$239,228,908.26	$239,228,908.26
2026	14	0.442301		$519,275,230.55	$229,675,935.25	$229,675,935.25
2027	15	0.417265		$528,292,362.03	$220,437,944.53	$220,437,944.53
2028	16	0.393646		$537,309,493.50	$211,509,885.32	$211,509,885.32
2029	17	0.371364		$546,326,624.97	$202,886,269.45	$202,886,269.45
2030	18	0.350344		$555,343,756.45	$194,561,237.01	$194,561,237.01
2031	19	0.330513	$564,360,887.92	$564,360,887.92	$186,528,616.08	$186,528,616.08
2032	20	0.311805		$573,378,019.40	$178,781,976.74	$178,781,976.74
2033	21	0.294155		$582,395,150.87	$171,314,680.15	$171,314,680.15
2034	22	0.277505		$591,412,282.34	$164,119,922.72	$164,119,922.72
2035	23	0.261797		$600,429,413.82	$157,190,776.10	$157,190,776.10
2036	24	0.246979		$609,446,545.29	$150,520,223.04	$150,520,223.04
2037	25	0.232999		$618,463,676.77	$144,101,189.70	$144,101,189.70
2038	26	0.21981		$627,480,808.24	$137,926,574.52	$137,926,574.52
2039	27	0.207368		$636,497,939.71	$131,989,274.00	$131,989,274.00
2040	28	0.19563		$645,515,071.19	$126,282,205.74	$126,282,205.74
2041	29	0.184557		$654,532,202.66	$120,798,328.74	$120,798,328.74
2042	30	0.17411		$663,549,334.14	$115,530,661.43	$115,530,661.43
2043	31	0.164255		$672,566,465.61	$110,472,297.52	$110,472,297.52
2044	32	0.154957		$681,583,597.08	$105,616,419.82	$105,616,419.82
2045	33	0.146186		$690,600,728.56	$100,956,312.31	$100,956,312.31
2046	34	0.137912		$699,617,860.03	$96,485,370.47	$96,485,370.47
2047	35	0.130105		$708,634,991.51	$92,197,110.27	$92,197,110.27
2048	36	0.122741		$717,652,122.98	$88,085,175.59	$88,085,175.59
2049	37	0.115793		$726,669,254.45	$84,143,344.59	$84,143,344.59
2050	38	0.109239		$735,686,385.93	$80,365,534.84	$80,365,534.84
2051	39	0.103056		$744,703,517.40	$76,745,807.47	$76,745,807.47
2052	40	0.097222		$753,720,648.88	$73,278,370.40	$73,278,370.40
2053	41	0.091719		$762,737,780.35	$69,957,580.81	
2054	42	0.086527		$771,754,911.82	$66,777,946.69	
2055	43	0.08163		$780,772,043.30	$63,734,127.96	
2056	44	0.077009		$789,789,174.77	$60,820,936.80	
2057	45	0.07265		$798,806,306.25	$58,033,337.54	
2058	46	0.068538		$807,823,437.72	$55,366,446.05	
2059	47	0.064658		$816,840,569.19	$52,815,528.73	
2060	48	0.060998		$825,857,700.67	$50,376,001.12	
2061	49	0.057546		$834,874,832.14	$48,043,426.18	
2062	50	0.054288		$843,891,963.62	$45,813,512.26	
2063	51	0.051215				
						$6,124,755,131

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623		$39,817,206.46	$37,563,402.32	
2014	2	0.88999644		$41,497,252.80	$36,932,407.26	
2015	3	0.83961928		$43,177,299.13	$36,252,492.94	
2016	4	0.79209366		$44,857,345.46	$35,531,219.09	
2017	5	0.74725817		$46,537,391.80	$34,775,446.37	$17,387,723.18
2018	6	0.70496054		$48,217,438.13	$33,991,391.24	$33,991,391.24
2019	7	0.66505711		$49,897,484.47	$33,184,677.00	$33,184,677.00
2020	8	0.62741237		$51,577,530.80	$32,360,380.91	$32,360,380.91
2021	9	0.59189846	$53,257,577.13	$53,257,577.13	$31,523,078.08	$31,523,078.08
2022	10	0.55839478		$54,937,623.47	$30,676,882.00	$30,676,882.00
2023	11	0.52678753		$56,617,669.80	$29,825,482.17	$29,825,482.17
2024	12	0.49696936		$58,297,716.13	$28,972,178.89	$28,972,178.89
2025	13	0.46883902		$59,977,762.47	$28,119,915.51	$28,119,915.51
2026	14	0.44230096		$61,657,808.80	$27,271,308.29	$27,271,308.29
2027	15	0.41726506		$63,337,855.13	$26,428,673.97	$26,428,673.97
2028	16	0.39364628		$65,017,901.47	$25,594,055.29	$25,594,055.29
2029	17	0.37136442		$66,697,947.80	$24,769,244.61	$24,769,244.61
2030	18	0.35034379		$68,377,994.14	$23,955,805.70	$23,955,805.70
2031	19	0.33051301	$70,058,040.47	$70,058,040.47	$23,155,093.87	$23,155,093.87
2032	20	0.31180473		$71,738,086.80	$22,368,274.56	$22,368,274.56
2033	21	0.2941554		$73,418,133.14	$21,596,340.52	$21,596,340.52
2034	22	0.2775051		$75,098,179.47	$20,840,127.57	$20,840,127.57
2035	23	0.26179726		$76,778,225.80	$20,100,329.24	$20,100,329.24
2036	24	0.24697855		$78,458,272.14	$19,377,510.16	$19,377,510.16
2037	25	0.23299863		$80,138,318.47	$18,672,118.45	$18,672,118.45
2038	26	0.21981003		$81,818,364.80	$17,984,497.12	$17,984,497.12
2039	27	0.20736795		$83,498,411.14	$17,314,894.49	$17,314,894.49
2040	28	0.19563014		$85,178,457.47	$16,663,473.82	$16,663,473.82
2041	29	0.18455674		$86,858,503.81	$16,030,322.20	$16,030,322.20
2042	30	0.17411013		$88,538,550.14	$15,415,458.56	$15,415,458.56
2043	31	0.16425484		$90,218,596.47	$14,818,841.17	$14,818,841.17
2044	32	0.1549574		$91,898,642.81	$14,240,374.45	$14,240,374.45
2045	33	0.14618622		$93,578,689.14	$13,679,915.15	$13,679,915.15
2046	34	0.13791153		$95,258,735.47	$13,137,278.09	$13,137,278.09
2047	35	0.13010522		$96,938,781.81	$12,612,241.37	$12,612,241.37
2048	36	0.12274077		$98,618,828.14	$12,104,551.10	$12,104,551.10
2049	37	0.11579318		$100,298,874.47	$11,613,925.74	$11,613,925.74
2050	38	0.10923885		$101,978,920.81	$11,140,060.04	$11,140,060.04
2051	39	0.10305552		$103,658,967.14	$10,682,628.65	$10,682,628.65
2052	40	0.09722219		$105,339,013.48	$10,241,289.34	$10,241,289.34
2053	41	0.09171905		$107,019,059.81	$9,815,685.96	
2054	42	0.0865274		$108,699,106.14	$9,405,451.14	
2055	43	0.08162962		$110,379,152.48	$9,010,208.66	
2056	44	0.07700908		$112,059,198.81	$8,629,575.67	
2057	45	0.07265007		$113,739,245.14	$8,263,164.62	
2058	46	0.06853781		$115,419,291.48	$7,910,585.01	
2059	47	0.06465831		$117,099,337.81	$7,571,445.00	
2060	48	0.0609984		$118,779,384.14	$7,245,352.78	
2061	49	0.05754566		$120,459,430.48	$6,931,917.85	
2062	50	0.05428836		$122,139,476.81	$6,630,752.11	
2063	51	0.05121544				
						$747,850,342

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$236,461,288.07	$210,449,704.58	
2015	3	0.83961928		$239,284,123.89	$200,907,564.54	
2016	4	0.79209366		$242,106,959.70	$191,771,388.61	
2017	5	0.74725817		$244,929,795.52	$183,025,791.48	$91,512,895.74
2018	6	0.70496054		$247,752,631.34	$174,655,828.88	$174,655,828.88
2019	7	0.66505711		$250,575,467.15	$166,646,996.93	$166,646,996.93
2020	8	0.62741237		$253,398,302.97	$158,985,230.16	$158,985,230.16
2021	9	0.59189846	$256,221,138.79	$256,221,138.79	$151,656,898.37	$151,656,898.37
2022	10	0.55839478		$259,043,974.60	$144,648,802.41	$144,648,802.41
2023	11	0.52678753		$261,866,810.42	$137,948,169.04	$137,948,169.04
2024	12	0.49696936		$264,689,646.24	$131,542,645.04	$131,542,645.04
2025	13	0.46883902		$267,512,482.05	$125,420,290.52	$125,420,290.52
2026	14	0.44230096		$270,335,317.87	$119,569,571.80	$119,569,571.80
2027	15	0.41726506		$273,158,153.69	$113,979,353.59	$113,979,353.59
2028	16	0.39364628		$275,980,989.50	$108,638,890.89	$108,638,890.89
2029	17	0.37136442		$278,803,825.32	$103,537,820.49	$103,537,820.49
2030	18	0.35034379		$281,626,661.14	$98,666,152.15	$98,666,152.15
2031	19	0.33051301	$284,449,496.95	$284,449,496.95	$94,014,259.57	$94,014,259.57
2032	20	0.31180473		$287,272,332.77	$89,572,871.26	$89,572,871.26
2033	21	0.2941554		$290,095,168.59	$85,333,061.14	$85,333,061.14
2034	22	0.2775051		$292,918,004.40	$81,286,239.20	$81,286,239.20
2035	23	0.26179726		$295,740,840.22	$77,424,142.00	$77,424,142.00
2036	24	0.24697855		$298,563,676.04	$73,738,823.29	$73,738,823.29
2037	25	0.23299863		$301,386,511.85	$70,222,644.51	$70,222,644.51
2038	26	0.21981003		$304,209,347.67	$66,868,265.47	$66,868,265.47
2039	27	0.20736795		$307,032,183.48	$63,668,634.99	$63,668,634.99
2040	28	0.19563014		$309,855,019.30	$60,616,981.76	$60,616,981.76
2041	29	0.18455674		$312,677,855.12	$57,706,805.22	$57,706,805.22
2042	30	0.17411013		$315,500,690.93	$54,931,866.60	$54,931,866.60
2043	31	0.16425484		$318,323,526.75	$52,286,180.11	$52,286,180.11
2044	32	0.1549574		$321,146,362.57	$49,764,004.30	$49,764,004.30
2045	33	0.14618622		$323,969,198.38	$47,359,833.57	$47,359,833.57
2046	34	0.13791153		$326,792,034.20	$45,068,389.89	$45,068,389.89
2047	35	0.13010522		$329,614,870.02	$42,884,614.62	$42,884,614.62
2048	36	0.12274077		$332,437,705.83	$40,803,660.65	$40,803,660.65
2049	37	0.11579318		$335,260,541.65	$38,820,884.62	$38,820,884.62
2050	38	0.10923885		$338,083,377.47	$36,931,839.40	$36,931,839.40
2051	39	0.10305552		$340,906,213.28	$35,132,266.73	$35,132,266.73
2052	40	0.09722219		$343,729,049.10	$33,418,090.13	$33,418,090.13
2053	41	0.09171905		$346,551,884.92	$31,785,407.93	
2054	42	0.0865274		$349,374,720.73	$30,230,486.54	
2055	43	0.08162962		$352,197,556.55	$28,749,753.95	
2056	44	0.07700908		$355,020,392.37	$27,339,793.37	
2057	45	0.07265007		$357,843,228.18	$25,997,337.13	
2058	46	0.06853781		$360,666,064.00	$24,719,260.72	
2059	47	0.06465831		$363,488,899.82	$23,502,577.07	
2060	48	0.0609984		$366,311,735.63	$22,344,431.00	
2061	49	0.05754566		$369,134,571.45	$21,242,093.84	
2062	50	0.05428836		$371,957,407.27	$20,192,958.31	
2063	51	0.05121544				
						$3,125,263,905

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623		$9,345,538.09	$8,816,545.37	
2014	2	0.88999644		$9,458,451.52	$8,417,988.18	
2015	3	0.83961928		$9,571,364.96	$8,036,302.58	
2016	4	0.79209366		$9,684,278.39	$7,670,855.54	
2017	5	0.74725817		$9,797,191.82	$7,321,031.66	$3,660,515.83
2018	6	0.70496054		$9,910,105.25	$6,986,233.16	$6,986,233.16
2019	7	0.66505711		$10,023,018.69	$6,665,879.88	$6,665,879.88
2020	8	0.62741237		$10,135,932.12	$6,359,409.21	$6,359,409.21
2021	9	0.59189846	$10,248,845.55	$10,248,845.55	$6,066,275.93	$6,066,275.93
2022	10	0.55839478		$10,361,758.98	$5,785,952.10	$5,785,952.10
2023	11	0.52678753		$10,474,672.42	$5,517,926.76	$5,517,926.76
2024	12	0.49696936		$10,587,585.85	$5,261,705.80	$5,261,705.80
2025	13	0.46883902		$10,700,499.28	$5,016,811.62	$5,016,811.62
2026	14	0.44230096		$10,813,412.71	$4,782,782.87	$4,782,782.87
2027	15	0.41726506		$10,926,326.15	$4,559,174.14	$4,559,174.14
2028	16	0.39364628		$11,039,239.58	$4,345,555.64	$4,345,555.64
2029	17	0.37136442		$11,152,153.01	$4,141,512.82	$4,141,512.82
2030	18	0.35034379		$11,265,066.45	$3,946,646.09	$3,946,646.09
2031	19	0.33051301	$11,377,979.88	$11,377,979.88	$3,760,570.38	$3,760,570.38
2032	20	0.31180473		$11,490,893.31	$3,582,914.85	$3,582,914.85
2033	21	0.2941554		$11,603,806.74	$3,413,322.45	$3,413,322.45
2034	22	0.2775051		$11,716,720.18	$3,251,449.57	$3,251,449.57
2035	23	0.26179726		$11,829,633.61	$3,096,965.68	$3,096,965.68
2036	24	0.24697855		$11,942,547.04	$2,949,552.93	$2,949,552.93
2037	25	0.23299863		$12,055,460.47	$2,808,905.78	$2,808,905.78
2038	26	0.21981003		$12,168,373.91	$2,674,730.62	$2,674,730.62
2039	27	0.20736795		$12,281,287.34	$2,546,745.40	$2,546,745.40
2040	28	0.19563014		$12,394,200.77	$2,424,679.27	$2,424,679.27
2041	29	0.18455674		$12,507,114.20	$2,308,272.21	$2,308,272.21
2042	30	0.17411013		$12,620,027.64	$2,197,274.66	$2,197,274.66
2043	31	0.16425484		$12,732,941.07	$2,091,447.20	$2,091,447.20
2044	32	0.1549574		$12,845,854.50	$1,990,560.17	$1,990,560.17
2045	33	0.14618622		$12,958,767.94	$1,894,393.34	$1,894,393.34
2046	34	0.13791153		$13,071,681.37	$1,802,735.60	$1,802,735.60
2047	35	0.13010522		$13,184,594.80	$1,715,384.58	$1,715,384.58
2048	36	0.12274077		$13,297,508.23	$1,632,146.43	$1,632,146.43
2049	37	0.11579318		$13,410,421.67	$1,552,835.38	$1,552,835.38
2050	38	0.10923885		$13,523,335.10	$1,477,273.58	$1,477,273.58
2051	39	0.10305552		$13,636,248.53	$1,405,290.67	$1,405,290.67
2052	40	0.09722219		$13,749,161.96	$1,336,723.61	$1,336,723.61
2053	41	0.09171905		$13,862,075.40	$1,271,416.32	
2054	42	0.0865274		$13,974,988.83	$1,209,219.46	
2055	43	0.08162962		$14,087,902.26	$1,149,990.16	
2056	44	0.07700908		$14,200,815.69	$1,093,591.73	
2057	45	0.07265007		$14,313,729.13	$1,039,893.49	
2058	46	0.06853781		$14,426,642.56	$988,770.43	
2059	47	0.06465831		$14,539,555.99	$940,103.08	
2060	48	0.0609984		$14,652,469.43	$893,777.24	
2061	49	0.05754566		$14,765,382.86	$849,683.75	
2062	50	0.05428836		$14,878,296.29	$807,718.33	
2063	51	0.05121544				
						$125,010,556

ACCIDENT COSTS

A6.1 (b) 1.0% — Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1					
2013	1	0.943396226		$0.00	$0.00	$0.00	
2014	2	0.88999644		$0.00	$0.00	$0.00	
2015	3	0.839619283		$0.00	$0.00	$0.00	
2016	4	0.792093663		$0.00	$0.00	$0.00	
2017	5	0.747258173		$0.00	$0.00	$0.00	$0.00
2018	6	0.70496054		$0.00	$0.00	$0.00	$0.00
2019	7	0.665057114		$0.00	$0.00	$0.00	$0.00
2020	8	0.627412371		$0.00	$0.00	$0.00	$0.00
2021	9	0.591898464		$0.00	$0.00	$0.00	$0.00
2022	10	0.558394777		$0.00	$0.00	$0.00	$0.00
2023	11	0.526787525		$0.00	$0.00	$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00	$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00	$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00	$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00	$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00	$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00	$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00	$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00	$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00	$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00	$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00	$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00	$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00	$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00	$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00	$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00	$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00	$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00	$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00	$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00	$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00	$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00	$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00	$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00	$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00	$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00	$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00	$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00	$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00	$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00	$0.00	
2054	42	0.086527401		$0.00	$0.00	$0.00	
2055	43	0.081629624		$0.00	$0.00	$0.00	
2056	44	0.077009079		$0.00	$0.00	$0.00	
2057	45	0.072650074		$0.00	$0.00	$0.00	
2058	46	0.068537806		$0.00	$0.00	$0.00	
2059	47	0.064658308		$0.00	$0.00	$0.00	
2060	48	0.060998403		$0.00	$0.00	$0.00	
2061	49	0.057545664		$0.00	$0.00	$0.00	
2062	50	0.054288362		$0.00	$0.00	$0.00	
2063	51	0.051215436					
							$0

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1			
2013	1	0.943396226		$0.00	
2014	2	0.88999644		$0.00	
2015	3	0.839619283		$0.00	
2016	4	0.792093663		$0.00	
2017	5	0.747258173		$0.00	$0.00
2018	6	0.70496054		$0.00	$0.00
2019	7	0.665057114		$0.00	$0.00
2020	8	0.627412371		$0.00	$0.00
2021	9	0.591898464		$0.00	$0.00
2022	10	0.558394777		$0.00	$0.00
2023	11	0.526787525		$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00
2053	41	0.091719045		$0.00	
2054	42	0.086527401		$0.00	
2055	43	0.081629624		$0.00	
2056	44	0.077009079		$0.00	
2057	45	0.072650074		$0.00	
2058	46	0.068537806		$0.00	
2059	47	0.064658308		$0.00	
2060	48	0.060998403		$0.00	
2061	49	0.057545664		$0.00	
2062	50	0.054288362		$0.00	
2063	51	0.051215436			
					$0.00

CONSTRUCTION COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount
			$ 94,800,000	
1/07/2013	1	0.943396	$17,000,000	$16,037,736
1/07/2014	2.00	0.889996	$38,000,000	$33,819,865
1/07/2015	3.00	0.839619	$32,000,000	$26,867,817
1/07/2016	4.00	0.792094	$7,800,000	$6,178,331
1/04/2016	4.75	0.758223		$0
1/10/2016	5.25	0.736452		$0
1/04/2017	5.75	0.715305		$0
1/10/2017	6.25	0.694766		$0
1/04/2018	6.75	0.674816		$0
				$82,903,748.20

Transport Economics Analysis Summary

		Scenario 1 - Do Nothing	Scenario 2 - Mem Park / ICB / Basin
	Capital Costs	N/A	82,903,748
	Maintenance Costs	0	0
1	**Total Costs**	**0**	**82,903,748**
	Transport Costs		
	Travel Time Costs	7,104,515,530	6,872,605,473
	Vehicle Operating Costs	3,137,825,746	3,125,263,905
	Accidents	0	0
	Seal Extn / Passing Lane		
	Carbon Dioxide (4% of VOC)	125,513,030	125,010,556
2	**Total Transport Costs**	**10,367,854,306**	**10,122,879,934**
	Tangible Benefits		
	Travel Time Benefits	N/A	231,910,057
	Vehicle Operating Benefits	N/A	12,561,841
	Accidents*	N/A	8,279,220
	Trip Reliability*	N/A	1,868,047
	Pedestrian and Cycling*	N/A	881,602
	Public Transport*	N/A	1,043,639
	Seal Extn / Passing Lane Benefits	N/A	
	Carbon Dioxide Benefits	N/A	502,474
3	**Tangible Benefits**	**N/A**	**257,046,879**
4	Tangible B/C Ratio	N/A	3.10

* Present value taken from the Basin Reserve SAR Economics Technical Note

TIMINGS				TRAVEL TIME					CRV TRAVEL TIME			VEHICLE OPERATING COSTS		
OPTION and YEAR	**PERIOD**	**EQUIV TIME PERIODS PER DAY (hrs/day)**	**DAYS PER YEAR (days/year)**	**TOTAL SATURN TT on links (hours)**	**TOTAL SATURN TT on turns (hours)**	**TOTAL TT (hours)**	**VALUE OF TIME ($/veh.hr)**	**ANNUAL TRAVEL TIME COST ($/year)**	**TOTAL CONGESTION on links and turns SATURN (veh.hrs/hr)**	**CONGESTION VALUE ($/hour)**	**ANNUAL CONGESTION COST ($/year)**	**BASE VOC BY SPEED ($.veh/hr)**	**VOC DUE TO CONGESTION ($.veh/hr)**	**ANNUAL VEHICLE OPERATING COST ($/year)**
cenario 1 - Airport to Mt Vic Tunn														
Base 2011	Morning Peak	2	245	0	0	0	$20.73	$0	0	$5.32	$0	0	0	$0
Base 2011	Inter Peak	7	245	0	0	0	$24.59	$0	0	$4.93	$0	0	0	$0
Base 2011	Evening Peak	2	245	0	0	0	$20.50	$0	0	$5.19	$0	0	0	$0
Base 2011	Off Peak	13	245	0	0	0	$20.45	$0	0	$5.04	$0	0	0	$0
Base 2011	Weekend Peak	6	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
Base 2011	Weekend off-peak	18	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
2011 Total								**$0**			**$0**			**$0**
Do min 2021	Morning Peak	2	245	3863	3412	7275	$20.73	$73,889,109	4152	$5.32	$10,814,174	62954	4954	$33,274,804
Do min 2021	Inter Peak	7	245	2084	1050	3135	$24.59	$132,208,889	1087	$4.93	$9,198,183	39595	338	$68,485,037
Do min 2021	Evening Peak	2	245	3536	2786	6322	$20.50	$63,494,174	3121	$5.19	$7,941,372	63548	3637	$32,920,626
Do min 2021	Off Peak	13	245	709	357	1066	$20.45	$69,435,288	370	$5.04	$5,937,062	13462	115	$43,243,409
Do min 2021	Weekend Peak	6	120	2655	1683	4338	$19.30	$60,293,859	1790	$5.84	$7,521,081	49489	1045	$36,384,403
Do min 2021	Weekend off-peak	18	120	985	625	1610	$19.30	$67,131,307	664	$5.84	$8,373,987	18367	388	$40,510,470
2021 Total								**$466,452,626**			**$49,785,861**			**$254,818,749**
Do Min 2031	Morning Peak	2	245	4259	4664	8923	$20.73	$90,628,160	5729	$5.32	$14,920,872	67669	6175	$36,183,731
Do Min 2031	Inter Peak	7	245	2320	1289	3609	$24.59	$152,198,406	1348	$4.93	$11,401,672	43835	527	$76,082,256
Do Min 2031	Evening Peak	2	245	4030	3744	7775	$20.50	$78,076,845	4373	$5.19	$11,126,167	69616	5157	$36,638,789
Do Min 2031	Off Peak	13	245	789	438	1227	$20.45	$79,933,658	458	$5.04	$7,359,327	14904	179	$48,040,510
Do Min 2031	Weekend Peak	6	120	2983	2198	5181	$19.30	$72,007,848	2378	$5.84	$9,992,913	54761	1622	$40,595,359
Do Min 2031	Weekend off-peak	18	120	1107	816	1923	$19.30	$80,173,686	883	$5.84	$11,126,129	20324	602	$45,198,956
2031 Total								**$553,018,604**			**$65,927,080**			**$282,739,600**
Scenario 2 - Terrace Tunnel														
Option 1 2011	Morning Peak	2	245	0	0	0	$20.73	$0	0	$5.32	$0	0	0	$0
Option 1 2011	Inter Peak	7	245	0	0	0	$24.59	$0	0	$4.93	$0	0	0	$0
Option 1 2011	Evening Peak	2	245	0	0	0	$20.50	$0	0	$5.19	$0	0	0	$0
Option 1 2011	Off Peak	13	245	0	0	0	$20.45	$0	0	$5.04	$0	0	0	$0
Option 1 2011	Weekend Peak	6	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
Option 1 2011	Weekend off-peak	18	120	0	0	0	$19.30	$0	0	$5.84	$0	0	0	$0
2011 Total								**$0**			**$0**			**$0**
Option 1 2021	Morning Peak	2	245	3769	3069	6838	$20.73	$69,451,994	3696	$5.32	$9,627,657	63709	5156	$33,744,051
Option 1 2021	Inter Peak	7	245	2070	1030	3100	$24.59	$130,751,667	1046	$4.93	$8,849,198	39786	200	$68,575,814
Option 1 2021	Evening Peak	2	245	3508	2762	6270	$20.50	$62,963,806	3062	$5.19	$7,789,223	63782	3431	$32,934,602
Option 1 2021	Off Peak	13	245	704	350	1054	$20.45	$68,669,964	356	$5.04	$5,711,806	13527	68	$43,300,728
Option 1 2021	Weekend Peak	6	120	2633	1653	4286	$19.30	$59,568,998	1726	$5.84	$7,254,683	49702	904	$36,436,189
Option 1 2021	Weekend off-peak	18	120	977	613	1591	$19.30	$66,324,245	641	$5.84	$8,077,379	18446	335	$40,568,128
2021 Total								**$457,730,673**			**$47,309,946**			**$255,559,513**
Option 1 2031	Morning Peak	2	245	4141	4167	8308	$20.73	$84,381,799	5077	$5.32	$13,222,651	69001	6471	$36,980,918
Option 1 2031	Inter Peak	7	245	2299	1254	3553	$24.59	$149,832,291	1279	$4.93	$10,820,727	44057	376	$76,203,227
Option 1 2031	Evening Peak	2	245	3978	3736	7714	$20.50	$77,466,642	4293	$5.19	$10,922,345	69930	4978	$36,704,790
Option 1 2031	Off Peak	13	245	782	426	1208	$20.45	$78,690,989	435	$5.04	$6,984,350	14979	128	$48,116,895
Option 1 2031	Weekend Peak	6	120	2941	2111	5052	$19.30	$70,216,616	2237	$5.84	$9,399,602	54980	1473	$40,646,200
Option 1 2031	Weekend off-peak	18	120	1092	783	1875	$19.30	$78,179,325	830	$5.84	$10,465,536	20405	547	$45,255,563
2031 Total								**$538,767,662**			**$61,815,211**			**$283,907,594**

Option	Scenario 1 - Airport to Mt Vic Tunnel	
Time Zero	01/07/13	
Year of Estimate	2008	
Construction Period	4	Years
Benefit period	36	
Construction Start	1/7/2020	
Construction payment		

Scenario 1 - Airport to Mt Vic Tunnel

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1		$388,543,247.09	$388,543,247.09	
2013	1	0.943396		$397,199,844.80	$374,716,834.72	
2014	2	0.889996		$405,856,442.51	$361,210,788.99	
2015	3	0.839619		$414,513,040.22	$348,033,141.63	
2016	4	0.792094		$423,169,637.92	$335,189,988.67	
2017	5	0.747258		$431,826,235.63	$322,685,683.83	
2018	6	0.704961		$440,482,833.34	$310,523,016.24	
2019	7	0.665057		$449,139,431.04	$298,703,373.62	
2020	8	0.627412		$457,796,028.75	$287,226,891.99	
2021	9	0.591898	$466,452,626.46	$466,452,626.46	$276,092,592.91	
2022	10	0.558395		$475,109,224.16	$265,298,509.24	
2023	11	0.526788		$483,765,821.87	$254,841,800.17	
2024	12	0.496969		$492,422,419.58	$244,718,856.47	$122,359,428.23
2025	13	0.468839		$501,079,017.29	$234,925,396.53	$234,925,396.53
2026	14	0.442301		$509,735,614.99	$225,456,554.09	$225,456,554.09
2027	15	0.417265		$518,392,212.70	$216,306,958.12	$216,306,958.12
2028	16	0.393646		$527,048,810.41	$207,470,805.55	$207,470,805.55
2029	17	0.371364		$535,705,408.11	$198,941,927.42	$198,941,927.42
2030	18	0.350344		$544,362,005.82	$190,713,848.87	$190,713,848.87
2031	19	0.330513	$553,018,603.53	$553,018,603.53	$182,779,843.51	$182,779,843.51
2032	20	0.311805		$561,675,201.23	$175,132,982.72	$175,132,982.72
2033	21	0.294155		$570,331,798.94	$167,766,180.00	$167,766,180.00
2034	22	0.277505		$578,988,396.65	$160,672,231.12	$160,672,231.12
2035	23	0.261797		$587,644,994.36	$153,843,850.10	$153,843,850.10
2036	24	0.246979		$596,301,592.06	$147,273,701.58	$147,273,701.58
2037	25	0.232999		$604,958,189.77	$140,954,429.73	$140,954,429.73
2038	26	0.21981		$613,614,787.48	$134,878,684.09	$134,878,684.09
2039	27	0.207368		$622,271,385.18	$129,039,142.53	$129,039,142.53
2040	28	0.19563		$630,927,982.89	$123,428,531.57	$123,428,531.57
2041	29	0.184557		$639,584,580.60	$118,039,644.36	$118,039,644.36
2042	30	0.17411		$648,241,178.30	$112,865,356.42	$112,865,356.42
2043	31	0.164255		$656,897,776.01	$107,898,639.41	$107,898,639.41
2044	32	0.154957		$665,554,373.72	$103,132,573.10	$103,132,573.10
2045	33	0.146186		$674,210,971.43	$98,560,355.61	$98,560,355.61
2046	34	0.137912		$682,867,569.13	$94,175,312.20	$94,175,312.20
2047	35	0.130105		$691,524,166.84	$89,970,902.69	$89,970,902.69
2048	36	0.122741		$700,180,764.55	$85,940,727.57	$85,940,727.57
2049	37	0.115793		$708,837,362.25	$82,078,533.07	$82,078,533.07
2050	38	0.109239		$717,493,959.96	$78,378,215.15	$78,378,215.15
2051	39	0.103056		$726,150,557.67	$74,833,822.57	$74,833,822.57
2052	40	0.097222		$734,807,155.37	$71,439,559.19	$71,439,559.19
2053	41	0.091719		$743,463,753.08	$68,189,785.43	$68,189,785.43
2054	42	0.086527		$752,120,350.79	$65,079,019.16	$65,079,019.16
2055	43	0.08163		$760,776,948.50	$62,101,935.90	$62,101,935.90
2056	44	0.077009		$769,433,546.20	$59,253,368.60	$59,253,368.60
2057	45	0.07265		$778,090,143.91	$56,528,306.81	$56,528,306.81
2058	46	0.068538		$786,746,741.62	$53,921,895.54	$53,921,895.54
2059	47	0.064658		$795,403,339.32	$51,429,433.73	$51,429,433.73
2060	48	0.060998		$804,059,937.03	$49,046,372.35	$24,523,186.17
2061	49	0.057546		$812,716,534.74	$46,768,312.25	
2062	50	0.054288		$821,373,132.44	$44,591,001.80	
2063	51	0.051215				
						$4,470,285,068

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$38,487,007.41	$34,253,299.58	
2015	3	0.83961928		$40,101,129.36	$33,669,681.48	
2016	4	0.79209366		$41,715,251.30	$33,042,386.21	
2017	5	0.74725817		$43,329,373.24	$32,378,228.28	
2018	6	0.70496054		$44,943,495.18	$31,683,390.65	
2019	7	0.66505711		$46,557,617.13	$30,963,474.46	
2020	8	0.62741237		$48,171,739.07	$30,223,545.04	
2021	9	0.59189846	$49,785,861.01	$49,785,861.01	$29,468,174.64	
2022	10	0.55839478		$51,399,982.96	$28,701,482.02	
2023	11	0.52678753		$53,014,104.90	$27,927,169.13	
2024	12	0.49696936		$54,628,226.84	$27,148,555.13	$13,574,277.56
2025	13	0.46883902		$56,242,348.78	$26,368,607.81	$26,368,607.81
2026	14	0.44230096		$57,856,470.73	$25,589,972.80	$25,589,972.80
2027	15	0.41726506		$59,470,592.67	$24,815,000.46	$24,815,000.46
2028	16	0.39364628		$61,084,714.61	$24,045,770.90	$24,045,770.90
2029	17	0.37136442		$62,698,836.55	$23,284,116.98	$23,284,116.98
2030	18	0.35034379		$64,312,958.50	$22,531,645.70	$22,531,645.70
2031	19	0.33051301	$65,927,080.44	$65,927,080.44	$21,789,757.83	$21,789,757.83
2032	20	0.31180473		$67,541,202.38	$21,059,666.16	$21,059,666.16
2033	21	0.2941554		$69,155,324.33	$20,342,412.28	$20,342,412.28
2034	22	0.2775051		$70,769,446.27	$19,638,882.04	$19,638,882.04
2035	23	0.26179726		$72,383,568.21	$18,949,819.92	$18,949,819.92
2036	24	0.24697855		$73,997,690.15	$18,275,842.09	$18,275,842.09
2037	25	0.23299863		$75,611,812.10	$17,617,448.67	$17,617,448.67
2038	26	0.21981003		$77,225,934.04	$16,975,034.78	$16,975,034.78
2039	27	0.20736795		$78,840,055.98	$16,348,900.92	$16,348,900.92
2040	28	0.19563014		$80,454,177.93	$15,739,262.34	$15,739,262.34
2041	29	0.18455674		$82,068,299.87	$15,146,257.78	$15,146,257.78
2042	30	0.17411013		$83,682,421.81	$14,569,957.42	$14,569,957.42
2043	31	0.16425484		$85,296,543.75	$14,010,370.19	$14,010,370.19
2044	32	0.1549574		$86,910,665.70	$13,467,450.50	$13,467,450.50
2045	33	0.14618622		$88,524,787.64	$12,941,104.37	$12,941,104.37
2046	34	0.13791153		$90,138,909.58	$12,431,195.06	$12,431,195.06
2047	35	0.13010522		$91,753,031.52	$11,937,548.20	$11,937,548.20
2048	36	0.12274077		$93,367,153.47	$11,459,956.49	$11,459,956.49
2049	37	0.11579318		$94,981,275.41	$10,998,184.03	$10,998,184.03
2050	38	0.10923885		$96,595,397.35	$10,551,970.13	$10,551,970.13
2051	39	0.10305552		$98,209,519.30	$10,121,032.98	$10,121,032.98
2052	40	0.09722219		$99,823,641.24	$9,705,072.79	$9,705,072.79
2053	41	0.09171905		$101,437,763.18	$9,303,774.77	$9,303,774.77
2054	42	0.0865274		$103,051,885.12	$8,916,811.78	$8,916,811.78
2055	43	0.08162962		$104,666,007.07	$8,543,846.75	$8,543,846.75
2056	44	0.07700908		$106,280,129.01	$8,184,534.83	$8,184,534.83
2057	45	0.07265007		$107,894,250.95	$7,838,525.35	$7,838,525.35
2058	46	0.06853781		$109,508,372.89	$7,505,463.62	$7,505,463.62
2059	47	0.06465831		$111,122,494.84	$7,184,992.45	$7,184,992.45
2060	48	0.0609984		$112,736,616.78	$6,876,753.62	$3,438,376.81
2061	49	0.05754566		$114,350,738.72	$6,580,389.13	
2062	50	0.05428836		$115,964,860.67	$6,295,542.31	
2063	51	0.05121544				
						$555,202,846

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$235,274,153.72	$209,393,159.24	
2015	3	0.83961928		$238,066,238.82	$199,885,004.75	
2016	4	0.79209366		$240,858,323.92	$190,782,352.12	
2017	5	0.74725817		$243,650,409.02	$182,069,759.47	
2018	6	0.70496054		$246,442,494.13	$173,732,233.85	
2019	7	0.66505711		$249,234,579.23	$165,755,229.87	
2020	8	0.62741237		$252,026,664.33	$158,124,647.11	
2021	9	0.59189846	$254,818,749	$254,818,749.43	$150,826,826.26	
2022	10	0.55839478		$257,610,834.53	$143,848,544.48	
2023	11	0.52678753		$260,402,919.63	$137,177,009.64	
2024	12	0.49696936		$263,195,004.73	$130,799,854.00	$65,399,927.00
2025	13	0.46883902		$265,987,089.83	$124,705,127.13	$124,705,127.13
2026	14	0.44230096		$268,779,174.93	$118,881,288.28	$118,881,288.28
2027	15	0.41726506		$271,571,260.03	$113,317,198.31	$113,317,198.31
2028	16	0.39364628		$274,363,345.13	$108,002,111.20	$108,002,111.20
2029	17	0.37136442		$277,155,430.23	$102,925,665.21	$102,925,665.21
2030	18	0.35034379		$279,947,515.33	$98,077,873.84	$98,077,873.84
2031	19	0.33051301	$282,739,600	$282,739,600.44	$93,449,116.53	$93,449,116.53
2032	20	0.31180473		$285,531,685.54	$89,030,129.23	$89,030,129.23
2033	21	0.2941554		$288,323,770.64	$84,811,994.87	$84,811,994.87
2034	22	0.2775051		$291,115,855.74	$80,786,133.76	$80,786,133.76
2035	23	0.26179726		$293,907,940.84	$76,944,293.97	$76,944,293.97
2036	24	0.24697855		$296,700,025.94	$73,278,541.70	$73,278,541.70
2037	25	0.23299863		$299,492,111.04	$69,781,251.72	$69,781,251.72
2038	26	0.21981003		$302,284,196.14	$66,445,097.85	$66,445,097.85
2039	27	0.20736795		$305,076,281.24	$63,263,043.55	$63,263,043.55
2040	28	0.19563014		$307,868,366.34	$60,228,332.56	$60,228,332.56
2041	29	0.18455674		$310,660,451.44	$57,334,479.78	$57,334,479.78
2042	30	0.17411013		$313,452,536.54	$54,575,262.17	$54,575,262.17
2043	31	0.16425484		$316,244,621.65	$51,944,709.88	$51,944,709.88
2044	32	0.1549574		$319,036,706.75	$49,437,097.52	$49,437,097.52
2045	33	0.14618622		$321,828,791.85	$47,046,935.62	$47,046,935.62
2046	34	0.13791153		$324,620,876.95	$44,768,962.26	$44,768,962.26
2047	35	0.13010522		$327,412,962.05	$42,598,134.90	$42,598,134.90
2048	36	0.12274077		$330,205,047.15	$40,529,622.40	$40,529,622.40
2049	37	0.11579318		$332,997,132.25	$38,558,797.25	$38,558,797.25
2050	38	0.10923885		$335,789,217.35	$36,681,227.98	$36,681,227.98
2051	39	0.10305552		$338,581,302.45	$34,892,671.84	$34,892,671.84
2052	40	0.09722219		$341,373,387.55	$33,189,067.56	$33,189,067.56
2053	41	0.09171905		$344,165,472.65	$31,566,528.48	$31,566,528.48
2054	42	0.0865274		$346,957,557.75	$30,021,335.71	$30,021,335.71
2055	43	0.08162962		$349,749,642.86	$28,549,931.68	$28,549,931.68
2056	44	0.07700908		$352,541,727.96	$27,148,913.71	$27,148,913.71
2057	45	0.07265007		$355,333,813.06	$25,815,027.94	$25,815,027.94
2058	46	0.06853781		$358,125,898.16	$24,545,163.33	$24,545,163.33
2059	47	0.06465831		$360,917,983.26	$23,336,345.96	$23,336,345.96
2060	48	0.0609984		$363,710,068.36	$22,185,733.45	$11,092,866.72
2061	49	0.05754566		$366,502,153.46		
2062	50	0.05428836		$369,294,238.56		
2063	51	0.05121544				
						$2,222,960,209

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396226				
2014	2	0.88999644		$9,410,966.15	$8,375,726.37	
2015	3	0.839619283		$9,522,649.55	$7,995,400.19	
2016	4	0.792093663		$9,634,332.96	$7,631,294.08	
2017	5	0.747258173		$9,746,016.36	$7,282,790.38	
2018	6	0.70496054		$9,857,699.77	$6,949,289.35	
2019	7	0.665057114		$9,969,383.17	$6,630,209.19	
2020	8	0.627412371		$10,081,066.57	$6,324,985.88	
2021	9	0.591898464	$10,192,750	$10,192,749.98	$6,033,073.05	
2022	10	0.558394777		$10,304,433.38	$5,753,941.78	
2023	11	0.526787525		$10,416,116.79	$5,487,080.39	
2024	12	0.496969364		$10,527,800.19	$5,231,994.16	$2,615,997.08
2025	13	0.468839022		$10,639,483.59	$4,988,205.09	$4,988,205.09
2026	14	0.442300964		$10,751,167.00	$4,755,251.53	$4,755,251.53
2027	15	0.417265061		$10,862,850.40	$4,532,687.93	$4,532,687.93
2028	16	0.393646284		$10,974,533.81	$4,320,084.45	$4,320,084.45
2029	17	0.371364419		$11,086,217.21	$4,117,026.61	$4,117,026.61
2030	18	0.350343791		$11,197,900.61	$3,923,114.95	$3,923,114.95
2031	19	0.33051301	$11,309,584	$11,309,584.02	$3,737,964.66	$3,737,964.66
2032	20	0.311804727		$11,421,267.42	$3,561,205.17	$3,561,205.17
2033	21	0.294155403		$11,532,950.83	$3,392,479.79	$3,392,479.79
2034	22	0.277505097		$11,644,634.23	$3,231,445.35	$3,231,445.35
2035	23	0.261797261		$11,756,317.63	$3,077,771.76	$3,077,771.76
2036	24	0.246978548		$11,868,001.04	$2,931,141.67	$2,931,141.67
2037	25	0.232998631		$11,979,684.44	$2,791,250.07	$2,791,250.07
2038	26	0.219810029		$12,091,367.85	$2,657,803.91	$2,657,803.91
2039	27	0.207367952		$12,203,051.25	$2,530,521.74	$2,530,521.74
2040	28	0.195630143		$12,314,734.65	$2,409,133.30	$2,409,133.30
2041	29	0.184556739		$12,426,418.06	$2,293,379.19	$2,293,379.19
2042	30	0.174110131		$12,538,101.46	$2,183,010.49	$2,183,010.49
2043	31	0.16425484		$12,649,784.87	$2,077,788.40	$2,077,788.40
2044	32	0.154957397		$12,761,468.27	$1,977,483.90	$1,977,483.90
2045	33	0.146186223		$12,873,151.67	$1,881,877.42	$1,881,877.42
2046	34	0.137911531		$12,984,835.08	$1,790,758.49	$1,790,758.49
2047	35	0.130105218		$13,096,518.48	$1,703,925.40	$1,703,925.40
2048	36	0.122740772		$13,208,201.89	$1,621,184.90	$1,621,184.90
2049	37	0.115793181		$13,319,885.29	$1,542,351.89	$1,542,351.89
2050	38	0.10923885		$13,431,568.69	$1,467,249.12	$1,467,249.12
2051	39	0.103055519		$13,543,252.10	$1,395,706.87	$1,395,706.87
2052	40	0.097222188		$13,654,935.50	$1,327,562.70	$1,327,562.70
2053	41	0.091719045		$13,766,618.91	$1,262,661.14	$1,262,661.14
2054	42	0.086527401		$13,878,302.31	$1,200,853.43	$1,200,853.43
2055	43	0.081629624		$13,989,985.71	$1,141,997.27	$1,141,997.27
2056	44	0.077009079		$14,101,669.12	$1,085,956.55	$1,085,956.55
2057	45	0.072650074		$14,213,352.52	$1,032,601.12	$1,032,601.12
2058	46	0.068537806		$14,325,035.93	$981,806.53	$981,806.53
2059	47	0.064658308		$14,436,719.33	$933,453.84	$933,453.84
2060	48	0.060998403		$14,548,402.73	$887,429.34	$443,714.67
2061	49	0.057545664		$14,660,086.14	$843,624.38	
2062	50	0.054288362		$14,771,769.54	$801,935.17	
2063	51	0.051215436				
						$88,918,408

ACCIDENT COSTS

A6.1 (b) 1.0% Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1					
2013	1	0.943396226					
2014	2	0.88999644					
2015	3	0.839619283					
2016	4	0.792093663					
2017	5	0.747258173					
2018	6	0.70496054					
2019	7	0.665057114		$0.00	$0.00	$0.00	
2020	8	0.627412371		$0.00	$0.00	$0.00	
2021	9	0.591898464		$0.00	$0.00	$0.00	
2022	10	0.558394777		$0.00	$0.00	$0.00	
2023	11	0.526787525		$0.00	$0.00	$0.00	
2024	12	0.496969364		$0.00	$0.00	$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00	$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00	$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00	$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00	$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00	$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00	$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00	$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00	$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00	$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00	$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00	$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00	$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00	$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00	$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00	$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00	$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00	$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00	$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00	$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00	$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00	$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00	$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00	$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00	$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00	$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00	$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00	$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00	$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00	$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00	$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00	$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00	$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00	$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00	$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00	$0.00	$0.00
2060	48	0.060998403		$0.00	$0.00	$0.00	$0.00
2061	49	0.057545664		$0.00	$0.00	$0.00	
2062	50	0.054288362		$0.00	$0.00	$0.00	
2063	51	0.051215436					
							$0

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1			
2013	1	0.943396226			
2014	2	0.88999644			
2015	3	0.839619283			
2016	4	0.792093663			
2017	5	0.747258173			
2018	6	0.70496054			
2019	7	0.665057114		$0.00	
2020	8	0.627412371		$0.00	
2021	9	0.591898464		$0.00	
2022	10	0.558394777		$0.00	
2023	11	0.526787525		$0.00	
2024	12	0.496969364		$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00
2060	48	0.060998403		$0.00	$0.00
2061	49	0.057545664		$0.00	
2062	50	0.054288362		$0.00	
2063	51	0.051215436			
					$0.00

OPUS

Option	Scenario 2 - Terrace Tunnel	
Time Zero	01/07/13	
Year of Estimate	2008	
Construction Period	4	Years
Benefit period	36	
Construction Start	1/7/2020	
Construction payment		

Scenario 2 - Terrace Tunnel

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.943396				
2014	2	0.889996		$401,004,781.54	$356,892,828.00	
2015	3	0.839619		$409,108,480.39	$343,495,368.99	
2016	4	0.792094		$417,212,179.24	$330,471,123.40	
2017	5	0.747258		$425,315,878.09	$317,820,765.95	
2018	6	0.704961		$433,419,576.94	$305,543,699.20	
2019	7	0.665057		$441,523,275.79	$293,638,195.39	
2020	8	0.627412		$449,626,974.64	$282,101,526.38	
2021	9	0.591898	$457,730,673.49	$457,730,673.49	$270,930,082.35	
2022	10	0.558395		$465,834,372.33	$260,119,480.42	
2023	11	0.526788		$473,938,071.18	$249,664,663.71	
2024	12	0.496969		$482,041,770.03	$239,559,991.67	$119,779,995.84
2025	13	0.468839		$490,145,468.88	$229,799,322.39	$229,799,322.39
2026	14	0.442301		$498,249,167.73	$220,376,087.39	$220,376,087.39
2027	15	0.417265		$506,352,866.58	$211,283,359.63	$211,283,359.63
2028	16	0.393646		$514,456,565.43	$202,513,915.11	$202,513,915.11
2029	17	0.371364		$522,560,264.28	$194,060,288.73	$194,060,288.73
2030	18	0.350344		$530,663,963.13	$185,914,824.66	$185,914,824.66
2031	19	0.330513	$538,767,661.98	$538,767,661.98	$178,069,721.92	$178,069,721.92
2032	20	0.311805		$546,871,360.83	$170,517,075.30	$170,517,075.30
2033	21	0.294155		$554,975,059.68	$163,248,912.18	$163,248,912.18
2034	22	0.277505		$563,078,758.53	$156,257,225.45	$156,257,225.45
2035	23	0.261797		$571,182,457.38	$149,534,003.01	$149,534,003.01
2036	24	0.246979		$579,286,156.22	$143,071,253.93	$143,071,253.93
2037	25	0.232999		$587,389,855.07	$136,861,031.80	$136,861,031.80
2038	26	0.21981		$595,493,553.92	$130,895,455.22	$130,895,455.22
2039	27	0.207368		$603,597,252.77	$125,166,725.95	$125,166,725.95
2040	28	0.19563		$611,700,951.62	$119,667,144.69	$119,667,144.69
2041	29	0.184557		$619,804,650.47	$114,389,124.96	$114,389,124.96
2042	30	0.17411		$627,908,349.32	$109,325,204.90	$109,325,204.90
2043	31	0.164255		$636,012,048.17	$104,468,057.52	$104,468,057.52
2044	32	0.154957		$644,115,747.02	$99,810,499.32	$99,810,499.32
2045	33	0.146186		$652,219,445.87	$95,345,497.54	$95,345,497.54
2046	34	0.137912		$660,323,144.72	$91,066,176.11	$91,066,176.11
2047	35	0.130105		$668,426,843.57	$86,965,820.40	$86,965,820.40
2048	36	0.122741		$676,530,542.42	$83,037,881.05	$83,037,881.05
2049	37	0.115793		$684,634,241.27	$79,275,976.70	$79,275,976.70
2050	38	0.109239		$692,737,940.11	$75,673,896.01	$75,673,896.01
2051	39	0.103056		$700,841,638.96	$72,225,598.82	$72,225,598.82
2052	40	0.097222		$708,945,337.81	$68,925,216.71	$68,925,216.71
2053	41	0.091719		$717,049,036.66	$65,767,052.87	$65,767,052.87
2054	42	0.086527		$725,152,735.51	$62,745,581.50	$62,745,581.50
2055	43	0.08163		$733,256,434.36	$59,855,446.69	$59,855,446.69
2056	44	0.077009		$741,360,133.21	$57,091,460.93	$57,091,460.93
2057	45	0.07265		$749,463,832.06	$54,448,603.12	$54,448,603.12
2058	46	0.068538		$757,567,530.91	$51,922,016.46	$51,922,016.46
2059	47	0.064658		$765,671,229.76	$49,507,005.85	$49,507,005.85
2060	48	0.060998		$773,774,928.61	$47,199,035.19	$23,599,517.59
2061	49	0.057546		$781,878,627.46	$44,993,724.41	
2062	50	0.054288		$789,982,326.31	$42,886,846.36	
2063	51	0.051215				
						$4,342,461,978

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$37,156,261.33	$33,068,940.31	
2015	3	0.83961928		$38,606,787.78	$32,415,003.47	
2016	4	0.79209366		$40,057,314.22	$31,729,144.76	
2017	5	0.74725817		$41,507,840.66	$31,017,073.17	
2018	6	0.70496054		$42,958,367.10	$30,283,953.69	
2019	7	0.66505711		$44,408,893.54	$29,534,450.56	
2020	8	0.62741237		$45,859,419.99	$28,772,767.44	
2021	9	0.59189846	$47,309,946.43	$47,309,946.43	$28,002,684.60	
2022	10	0.55839478		$48,760,472.87	$27,227,593.37	
2023	11	0.52678753		$50,210,999.31	$26,450,528.07	
2024	12	0.49696936		$51,661,525.75	$25,674,195.57	$12,837,097.79
2025	13	0.46883902		$53,112,052.19	$24,901,002.62	$24,901,002.62
2026	14	0.44230096		$54,562,578.64	$24,133,081.15	$24,133,081.15
2027	15	0.41726506		$56,013,105.08	$23,372,311.69	$23,372,311.69
2028	16	0.39364628		$57,463,631.52	$22,620,345.00	$22,620,345.00
2029	17	0.37136442		$58,914,157.96	$21,878,622.02	$21,878,622.02
2030	18	0.35034379		$60,364,684.40	$21,148,392.38	$21,148,392.38
2031	19	0.33051301	$61,815,210.85	$61,815,210.85	$20,430,731.43	$20,430,731.43
2032	20	0.31180473		$63,265,737.29	$19,726,555.94	$19,726,555.94
2033	21	0.2941554		$64,716,263.73	$19,036,638.62	$19,036,638.62
2034	22	0.2775051		$66,166,790.17	$18,361,621.52	$18,361,621.52
2035	23	0.26179726		$67,617,316.61	$17,702,028.30	$17,702,028.30
2036	24	0.24697855		$69,067,843.06	$17,058,275.61	$17,058,275.61
2037	25	0.23299863		$70,518,369.50	$16,430,683.52	$16,430,683.52
2038	26	0.21981003		$71,968,895.94	$15,819,485.09	$15,819,485.09
2039	27	0.20736795		$73,419,422.38	$15,224,835.23	$15,224,835.23
2040	28	0.19563014		$74,869,948.82	$14,646,818.80	$14,646,818.80
2041	29	0.18455674		$76,320,475.26	$14,085,458.02	$14,085,458.02
2042	30	0.17411013		$77,771,001.71	$13,540,719.29	$13,540,719.29
2043	31	0.16425484		$79,221,528.15	$13,012,519.47	$13,012,519.47
2044	32	0.1549574		$80,672,054.59	$12,500,731.56	$12,500,731.56
2045	33	0.14618622		$82,122,581.03	$12,005,189.97	$12,005,189.97
2046	34	0.13791153		$83,573,107.47	$11,525,695.24	$11,525,695.24
2047	35	0.13010522		$85,023,633.92	$11,062,018.45	$11,062,018.45
2048	36	0.12274077		$86,474,160.36	$10,613,905.20	$10,613,905.20
2049	37	0.11579318		$87,924,686.80	$10,181,079.18	$10,181,079.18
2050	38	0.10923885		$89,375,213.24	$9,763,245.52	$9,763,245.52
2051	39	0.10305552		$90,825,739.68	$9,360,093.74	$9,360,093.74
2052	40	0.09722219		$92,276,266.12	$8,971,300.47	$8,971,300.47
2053	41	0.09171905		$93,726,792.57	$8,596,531.91	$8,596,531.91
2054	42	0.0865274		$95,177,319.01	$8,235,446.04	$8,235,446.04
2055	43	0.08162962		$96,627,845.45	$7,887,694.65	$7,887,694.65
2056	44	0.07700908		$98,078,371.89	$7,552,925.07	$7,552,925.07
2057	45	0.07265007		$99,528,898.33	$7,230,781.86	$7,230,781.86
2058	46	0.06853781		$100,979,424.78	$6,920,908.22	$6,920,908.22
2059	47	0.06465831		$102,429,951.22	$6,622,947.29	$6,622,947.29
2060	48	0.0609984		$103,880,477.66	$6,336,543.28	$3,168,271.64
2061	49	0.05754566		$105,331,004.10	$6,061,342.52	
2062	50	0.05428836		$106,781,530.54	$5,796,994.37	
2063	51	0.05121544				
						$518,165,989

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$235,715,855.95	$209,786,272.65	
2015	3	0.83961928		$238,550,664.05	$200,291,737.52	
2016	4	0.79209366		$241,385,472.15	$191,199,902.89	
2017	5	0.74725817		$244,220,280.26	$182,495,600.40	
2018	6	0.70496054		$247,055,088.36	$174,164,088.61	
2019	7	0.66505711		$249,889,896.46	$166,191,053.27	
2020	8	0.62741237		$252,724,704.57	$158,562,606.19	
2021	9	0.59189846	$255,559,512.67	$255,559,512.67	$151,265,282.89	
2022	10	0.55839478		$258,394,320.78	$144,286,039.11	
2023	11	0.52678753		$261,229,128.88	$137,612,246.36	
2024	12	0.49696936		$264,063,936.98	$131,231,686.71	$65,615,843.35
2025	13	0.46883902		$266,898,745.09	$125,132,546.68	$125,132,546.68
2026	14	0.44230096		$269,733,553.19	$119,303,410.70	$119,303,410.70
2027	15	0.41726506		$272,568,361.29	$113,733,253.83	$113,733,253.83
2028	16	0.39364628		$275,403,169.40	$108,411,434.16	$108,411,434.16
2029	17	0.37136442		$278,237,977.50	$103,327,684.75	$103,327,684.75
2030	18	0.35034379		$281,072,785.60	$98,472,105.29	$98,472,105.29
2031	19	0.33051301	$283,907,593.71	$283,907,593.71	$93,835,153.50	$93,835,153.50
2032	20	0.31180473		$286,742,401.81	$89,407,636.28	$89,407,636.28
2033	21	0.2941554		$289,577,209.91	$85,180,700.80	$85,180,700.80
2034	22	0.2775051		$292,412,018.02	$81,145,825.40	$81,145,825.40
2035	23	0.26179726		$295,246,826.12	$77,294,810.47	$77,294,810.47
2036	24	0.24697855		$298,081,634.22	$73,619,769.31	$73,619,769.31
2037	25	0.23299863		$300,916,442.33	$70,113,118.96	$70,113,118.96
2038	26	0.21981003		$303,751,250.43	$66,767,571.10	$66,767,571.10
2039	27	0.20736795		$306,586,058.53	$63,576,122.97	$63,576,122.97
2040	28	0.19563014		$309,420,866.64	$60,532,048.42	$60,532,048.42
2041	29	0.18455674		$312,255,674.74	$57,628,888.99	$57,628,888.99
2042	30	0.17411013		$315,090,482.84	$54,860,445.22	$54,860,445.22
2043	31	0.16425484		$317,925,290.95	$52,220,767.95	$52,220,767.95
2044	32	0.1549574		$320,760,099.05	$49,704,149.91	$49,704,149.91
2045	33	0.14618622		$323,594,907.16	$47,305,117.35	$47,305,117.35
2046	34	0.13791153		$326,429,715.26	$45,018,421.93	$45,018,421.93
2047	35	0.13010522		$329,264,523.36	$42,839,032.69	$42,839,032.69
2048	36	0.12274077		$332,099,331.47	$40,762,128.32	$40,762,128.32
2049	37	0.11579318		$334,934,139.57	$38,783,089.48	$38,783,089.48
2050	38	0.10923885		$337,768,947.67	$36,897,491.45	$36,897,491.45
2051	39	0.10305552		$340,603,755.78	$35,101,096.81	$35,101,096.81
2052	40	0.09722219		$343,438,563.88	$33,389,848.52	$33,389,848.52
2053	41	0.09171905		$346,273,371.98	$31,759,862.99	$31,759,862.99
2054	42	0.0865274		$349,108,180.09	$30,207,423.47	$30,207,423.47
2055	43	0.08162962		$351,942,988.19	$28,728,973.63	$28,728,973.63
2056	44	0.07700908		$354,777,796.29	$27,321,111.27	$27,321,111.27
2057	45	0.07265007		$357,612,604.40	$25,980,582.30	$25,980,582.30
2058	46	0.06853781		$360,447,412.50	$24,704,274.83	$24,704,274.83
2059	47	0.06465831		$363,282,220.60	$23,489,213.54	$23,489,213.54
2060	48	0.0609984		$366,117,028.71	$22,332,554.19	$11,166,277.09
2061	49	0.05754566		$368,951,836.81	$21,231,578.26	
2062	50	0.05428836		$371,786,644.91	$20,183,687.90	
2063	51	0.05121544				
						$2,233,337,234

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1				
2013	1	0.94339623				
2014	2	0.88999644		$9,428,634.24	$8,391,450.91	
2015	3	0.83961928		$9,542,026.56	$8,011,669.50	
2016	4	0.79209366		$9,655,418.89	$7,647,996.12	
2017	5	0.74725817		$9,768,811.21	$7,299,824.02	
2018	6	0.70496054		$9,882,203.53	$6,966,563.54	
2019	7	0.66505711		$9,995,595.86	$6,647,642.13	
2020	8	0.62741237		$10,108,988.18	$6,342,504.25	
2021	9	0.59189846	$10,222,380.51	$10,222,380.51	$6,050,611.32	
2022	10	0.55839478		$10,335,772.83	$5,771,441.56	
2023	11	0.52678753		$10,449,165.16	$5,504,489.85	
2024	12	0.49696936		$10,562,557.48	$5,249,267.47	$2,624,633.73
2025	13	0.46883902		$10,675,949.80	$5,005,301.87	$5,005,301.87
2026	14	0.44230096		$10,789,342.13	$4,772,136.43	$4,772,136.43
2027	15	0.41726506		$10,902,734.45	$4,549,330.15	$4,549,330.15
2028	16	0.39364628		$11,016,126.78	$4,336,457.37	$4,336,457.37
2029	17	0.37136442		$11,129,519.10	$4,133,107.39	$4,133,107.39
2030	18	0.35034379		$11,242,911.42	$3,938,884.21	$3,938,884.21
2031	19	0.33051301	$11,356,303.75	$11,356,303.75	$3,753,406.14	$3,753,406.14
2032	20	0.31180473		$11,469,696.07	$3,576,305.45	$3,576,305.45
2033	21	0.2941554		$11,583,088.40	$3,407,228.03	$3,407,228.03
2034	22	0.2775051		$11,696,480.72	$3,245,833.02	$3,245,833.02
2035	23	0.26179726		$11,809,873.04	$3,091,792.42	$3,091,792.42
2036	24	0.24697855		$11,923,265.37	$2,944,790.77	$2,944,790.77
2037	25	0.23299863		$12,036,657.69	$2,804,524.76	$2,804,524.76
2038	26	0.21981003		$12,150,050.02	$2,670,702.84	$2,670,702.84
2039	27	0.20736795		$12,263,442.34	$2,543,044.92	$2,543,044.92
2040	28	0.19563014		$12,376,834.67	$2,421,281.94	$2,421,281.94
2041	29	0.18455674		$12,490,226.99	$2,305,155.56	$2,305,155.56
2042	30	0.17411013		$12,603,619.31	$2,194,417.81	$2,194,417.81
2043	31	0.16425484		$12,717,011.64	$2,088,830.72	$2,088,830.72
2044	32	0.1549574		$12,830,403.96	$1,988,166.00	$1,988,166.00
2045	33	0.14618622		$12,943,796.29	$1,892,204.69	$1,892,204.69
2046	34	0.13791153		$13,057,188.61	$1,800,736.88	$1,800,736.88
2047	35	0.13010522		$13,170,580.93	$1,713,561.31	$1,713,561.31
2048	36	0.12274077		$13,283,973.26	$1,630,485.13	$1,630,485.13
2049	37	0.11579318		$13,397,365.58	$1,551,323.58	$1,551,323.58
2050	38	0.10923885		$13,510,757.91	$1,475,899.66	$1,475,899.66
2051	39	0.10305552		$13,624,150.23	$1,404,043.87	$1,404,043.87
2052	40	0.09722219		$13,737,542.56	$1,335,593.94	$1,335,593.94
2053	41	0.09171905		$13,850,934.88	$1,270,394.52	$1,270,394.52
2054	42	0.0865274		$13,964,327.20	$1,208,296.94	$1,208,296.94
2055	43	0.08162962		$14,077,719.53	$1,149,158.95	$1,149,158.95
2056	44	0.07700908		$14,191,111.85	$1,092,844.45	$1,092,844.45
2057	45	0.07265007		$14,304,504.18	$1,039,223.29	$1,039,223.29
2058	46	0.06853781		$14,417,896.50	$988,170.99	$988,170.99
2059	47	0.06465831		$14,531,288.82	$939,568.54	$939,568.54
2060	48	0.0609984		$14,644,681.15	$893,302.17	$446,651.08
2061	49	0.05754566		$14,758,073.47	$849,263.13	
2062	50	0.05428836		$14,871,465.80	$807,347.52	
2063	51	0.05121544				
						$89,333,489

ACCIDENT COSTS

A6.1 (b) 1.0% Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1					
2013	1	0.943396226					
2014	2	0.88999644					
2015	3	0.839619283					
2016	4	0.792093663					
2017	5	0.747258173					
2018	6	0.70496054					
2019	7	0.665057114		$0.00	$0.00	$0.00	
2020	8	0.627412371		$0.00	$0.00	$0.00	
2021	9	0.591898464		$0.00	$0.00	$0.00	
2022	10	0.558394777		$0.00	$0.00	$0.00	
2023	11	0.526787525		$0.00	$0.00	$0.00	$0.00
2024	12	0.496969364		$0.00	$0.00	$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00	$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00	$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00	$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00	$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00	$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00	$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00	$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00	$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00	$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00	$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00	$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00	$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00	$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00	$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00	$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00	$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00	$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00	$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00	$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00	$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00	$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00	$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00	$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00	$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00	$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00	$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00	$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00	$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00	$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00	$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00	$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00	$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00	$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00	$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00	$0.00	$0.00
2060	48	0.060998403		$0.00	$0.00	$0.00	$0.00
2061	49	0.057545664		$0.00	$0.00	$0.00	
2062	50	0.054288362		$0.00	$0.00	$0.00	
2063	51	0.051215436					
							$0

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2012	0	1			
2013	1	0.943396226			
2014	2	0.88999644			
2015	3	0.839619283			
2016	4	0.792093663			
2017	5	0.747258173			
2018	6	0.70496054			
2019	7	0.665057114		$0.00	
2020	8	0.627412371		$0.00	
2021	9	0.591898464		$0.00	
2022	10	0.558394777		$0.00	
2023	11	0.526787525		$0.00	
2024	12	0.496969364		$0.00	$0.00
2025	13	0.468839022		$0.00	$0.00
2026	14	0.442300964		$0.00	$0.00
2027	15	0.417265061		$0.00	$0.00
2028	16	0.393646284		$0.00	$0.00
2029	17	0.371364419		$0.00	$0.00
2030	18	0.350343791		$0.00	$0.00
2031	19	0.33051301		$0.00	$0.00
2032	20	0.311804727		$0.00	$0.00
2033	21	0.294155403		$0.00	$0.00
2034	22	0.277505097		$0.00	$0.00
2035	23	0.261797261		$0.00	$0.00
2036	24	0.246978548		$0.00	$0.00
2037	25	0.232998631		$0.00	$0.00
2038	26	0.219810029		$0.00	$0.00
2039	27	0.207367952		$0.00	$0.00
2040	28	0.195630143		$0.00	$0.00
2041	29	0.184556739		$0.00	$0.00
2042	30	0.174110131		$0.00	$0.00
2043	31	0.16425484		$0.00	$0.00
2044	32	0.154957397		$0.00	$0.00
2045	33	0.146186223		$0.00	$0.00
2046	34	0.137911531		$0.00	$0.00
2047	35	0.130105218		$0.00	$0.00
2048	36	0.122740772		$0.00	$0.00
2049	37	0.115793181		$0.00	$0.00
2050	38	0.10923885		$0.00	$0.00
2051	39	0.103055519		$0.00	$0.00
2052	40	0.097222188		$0.00	$0.00
2053	41	0.091719045		$0.00	$0.00
2054	42	0.086527401		$0.00	$0.00
2055	43	0.081629624		$0.00	$0.00
2056	44	0.077009079		$0.00	$0.00
2057	45	0.072650074		$0.00	$0.00
2058	46	0.068537806		$0.00	$0.00
2059	47	0.064658308		$0.00	$0.00
2060	48	0.060998403		$0.00	$0.00
2061	49	0.057545664		$0.00	
2062	50	0.054288362		$0.00	
2063	51	0.051215436			
					$0.00

CONSTRUCTION COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount
			$ 181,470,080	
1/07/2020	8	0.627412	$45,367,520	$28,464,143
1/07/2021	9	0.591898	$45,367,520	$26,852,965
1/07/2022	10	0.558395	$45,367,520	$25,332,986
1/07/2023	11	0.526788	$45,367,520	$23,899,044
1/04/2016	4.75	0.758223		$0
1/10/2016	5.25	0.736452		$0
1/04/2017	5.75	0.715305		$0
1/10/2017	6.25	0.694766		$0
1/04/2018	6.75	0.674816		$0
				$104,549,138.49

Transcript Economics Analysis Summary

		Scenario 1 - Airport to Mt Vic Tunnel	Scenario 2 - Terrace Tunnel
	Capital Costs	N/A	104,549,138
	Maintenance Costs	0	0
1	**Total Costs**	**0**	**104,549,138**
	Transport Costs		
	Travel Time Costs	5,025,487,914	4,860,627,968
	Vehicle Operating Costs	2,222,960,209	2,233,337,234
	Accidents	0	0
	Seal Extn / Passing Lane		
	Carbon Dioxide (4% of VOC)	88,918,408	89,333,489
2	**Total Transport Costs**	**7,337,366,532**	**7,183,298,691**
	Tangible Benefits		
	Travel Time Benefits	N/A	164,859,946
	Vehicle Operating Benefits	N/A	-10,377,024
	Accidents	N/A	0
	Seal Extn / Passing Lane Benefits	N/A	
	Carbon Dioxide Benefits	N/A	-415,081
3	**Tangible Benefits**	**N/A**	**154,067,841**
4	Tangible B/C Ratio	N/A	1.47

Appendix B

Modelling and Economics Reported for Part 4 (Aotea Quay to Ngauranga Gorge)

4. Preferred Scheme Evaluation

This section documents the various assessments of the preferred scheme that were undertaken including:

- Traffic modelling;
- Statutory planning; and
- Transport policy.

Costing of the preferred scheme, risk assessment, and economic evaluation are documented in subsequent chapters.

4.1. Traffic Modelling

4.1.1. Traffic Modelling Overview

Operational models are used to assess localised issues in more detail than is possible in the wider area strategic models. They are used primarily to investigate specific design issues such as likely length of queues and performance of motorway merge and weave areas. The operational model used to assess the Ngauranga to Aotea Quay project is a simulation model developed by Traffic Design Group in the S-Paramics mirco-simulation software. The model covers SH1 between Ngauranga Gorge and the Terrace Tunnel, SH2 from Petone interchange to the city and also includes Hutt Road and Aotea Quay. Further details are included in the separate validation report prepared by Traffic Design Group.

This model obtains travel demands, in the form of origin-destination trip tables, from the Wellington Transport Strategy Model (WTSM). These trip tables are then loaded as flow rates into the simulation models, along with assumed flow profiles to represent the build-up and dissipation of peak traffic flows.

Whilst the operational model can provide a more detailed assessment, it is noted that they are still only a 'simulation' of the potential operation of the road network during these peak periods. The aim of 'simulation' modelling is therefore to identify any potentially significant issues associated with the road network operation in a generic set of network operating conditions for the different assessment scenarios in order that design modification or any further mitigation can be identified. Whilst the models give consideration to the influence of factors such as driver behaviour and other operational and design factors, there will inevitably be fluctuations in the day-to-day operation of the road network, as well as across different times of year, depending on the specific road operating conditions at that time.

It is noted that the geographic extent of the operational model makes it more difficult to assess the effects of the scheme in the vicinity of the central city. Route choice through this area is taken from the WTSM which means that the choice of on/off-ramp at the city is restricted. This has the potential to exaggerate any adverse effects at the Aotea Quay off-ramp, where traffic may otherwise divert to a different inner-city off-ramp.

Consequently, whilst some optimisation of signalised intersections has generally been incorporated in the future year operational models, further improvements in network performance may be able to be achieved at certain locations with further refinement to the network.

This assessment identifies the operational performance of the scheme, with the full economic assessment based on these results discussed in **Section 8**.

4.1.2. Scenarios Modeled

The Project team provided a scope of modeling requirements for Traffic Design Group. Included in the scope was a requirement to model the full scheme as well as the component parts so as to enable the Project team to understand how parts of the full scheme performed as well as to assess the incremental benefits of the component parts. The modeling scenarios which were taken forward for analysis in this report include:

- The base model (includes "Early Works");
- Base minus "Early Works" (this is the Do-Minimum for the Project);

- Base + four lanes northbound and southbound + ATMS + SH2 northbound on ramp (the full scheme);
- Base + ATMS;
- Base + Four lanes northbound + ATMS;
- Base + Four lanes southbound + ATMS; and
- Base + SH2 northbound on ramp geometric improvements.

4.1.3. Model Inputs and Assumptions

A base year of 2011 has been modelled, along with two forecast years of 2021 and 2031.

The operational model covers morning, inter peak and evening periods, as follows:

- AM Peak (06:00 – 09:30)
- Inter-peak (11:00 – 13:00)
- PM Peak (15:00 – 19:30)

The Do Minimum scenario represents the minimum investment needed in the study corridor to maintain operations and for this analysis includes the Early Works. It is however assumed to include new projects and upgrades outside the study corridor, and these assumptions are common to the 'no project' and 'project' scenarios.

The Wellington Transport Strategy Model (WTSM) is the regional transport planning and forecasting tool. Inputs from the WTSM were used in the development of the operational model demand matrices. These were developed for 2021 and 2031 forecast years for both the Do Minimum and Option scenarios using the "High" land use growth.

Table 4.1 details the projects that have been assumed to be in place in each or the future modelled years for the Do-Minimum scenario and the Option. The Option networks also include widening from Ngauranga to Aotea Quay.

Table 4.1 WTSM Model Assumptions

	Do Minimum and Option	
RoNS Traffic Scheme	**2021**	**2031**
Otaki to north of Levin	×	✓
Peka Peka to Otaki	✓	✓
MacKays to Peka Peka	✓	✓
Linden to MacKays (Transmission Gully)	×	✓
Terrace Tunnel Duplication	×	✓
Basin Reserve	✓	✓
Airport to Mt Victoria Tunnel	×	✓
Other	**2021**	**2031**
Petone to Grenada link road	×	✓

The expected effects of the key network changes in the 2031 Do Minimum as outlined in **Table 4.1** are briefly outlined below:

- Petone to Grenada: the direct connection between SH1 and Hutt Valley provided by the Petone to Grenada link will remove the need for vehicles travelling between these destinations from using SH1 at Ngauranga Gorge and the Hutt Road / Centennial Highway intersection. The removal of this traffic will allow southbound vehicles to arrive at the SH1/SH2 merge faster. The queuing from this merge will hold these vehicles back from the merge itself so the actual arrival rate at the merge is likely to be unchanged. However the length of any queue back up the gorge is likely to be reduced

- Terrace Tunnel: the removal of the capacity constraint imposed by the single lane through the terrace tunnel will decrease the travel time from SH1 through to Willis St. This will make travelling by car to these destinations more attractive leading to an increase in the number of vehicles travelling through this part of the network. As most of these vehicles also have to travel along the length of SH1 from Ngauranga Gorge the volume of traffic southbound through the scheme area is likely to increase. The removal/reduction of queues associated with the merge may also make accessing some of the southbound off ramps easier, making these destinations slightly more attractive as well. In the northbound direction there is no change to the capacity or the likely costs of travel so traffic volumes are unlikely to change significantly.
- Transmission Gully and Other RoNS – The schemes implemented at Transmission Gully and the other RoNS projects north of this are unlikely to change the arrival pattern or rate at the top of Ngauranga Gorge.

Separate Do Minimum and Option forecasts have been produced to account for the induced traffic that may be produced by the scheme. Additional trips can be made on the network due to the extra capacity and reduced delay provided by the widening scheme.

The induced traffic levels are reliant on predictions from WTSM, which includes relationships between land-use and trip-making patterns. The WTSM forecasts show that there is little difference in the total demand matrix volume passing through the network between the Do Minimum and Option scenarios, with around 1% additional traffic in each period (this is roughly around 500 trips in the AM and PM periods). There are more noticeable changes on specific movements through the network between the Do Minimum and Option demands which appear to be associated with localised route choice in WTSM.

The percentage growth in demand, compared to 2011, is included in the **Table 4.2** below.

Table 4.2 Forecast Growth

Year	Forecast Growth				Option vs Do Minimum
	Do Minimum		Option		
Morning Period (6:00-9:30)					
2011	44,800				
2021	47,300	5.6%	47,800	6.6%	0.9%
2031	49,300	10.0%	50,000	11.5%	1.4%
Inter-Peak Period (11:00-13:00)					
2011	20,100				
2021	22,200	10.6%	22,300	11.0%	0.4%
2031	22,700	12.9%	22,900	14.0%	1.0%
Evening Period (15:00-18:30)					
2011	50,300				
2021	52,700	4.7%	53,000	5.3%	0.6%
2031	54,400	8.0%	54,900	9.0%	0.9%

A simple version of the proposed ATMS system has been simulated in the option model, which consists of introducing reduced speed limits (with full compliance) as traffic volumes approach specified speed / flow thresholds over the specified loop positions. The speed is reduced/increased in increments of 20kph, down to a minimum of 60kph, as per the operational strategy. The speed and flow thresholds used within the models vary according to the nature of the traffic congestion. The thresholds used are as follows:

- Reduction from 100kph to 80kph speed limit: speeds of 82-93 kph / flow of 4200-5340 vph
- Reduction from 80kph to 60kph speed limit: speeds of 70-72 kph / flow of 6120-6600 vph
- Increase from 60kph to 80kph speed limit: speeds of 50-52 kph / flow of 4620-5100 vph
- Increase from 80kph to 100kph speed limit: speeds of 65-70 kph / flow of 3900 - 4800

4.1.4. Traffic Demands

The traffic demands in the models are based on the matrices from the strategic model as discussed above. The demands for the southbound routes in the AM and the northbound routes in the PM are presented below in **Table 4.3** and **Table 4.4** respectively.

Table 4.3 Model Traffic Demands on Southbound Routes in AM

		2011	2021		2031	
From	To	Do Minimum and Option	Do Minimum	Option	Do Minimum	Option
SH1	CBD	7,000	7,190	7,440	7,430	8,120
SH2	CBD	5,560	5,640	6,090	6,250	6,980
SH1	Quays	1,460	1,490	1,990	2,090	2,100
SH2	Quays	2,800	2,770	2,490	2,880	2,850
SH1	CBD via Hutt Road	1,410	1,440	1,130	1,990	1,940
SH2	CBD via Hutt Road	670	730	720	1140	820

The main points regarding the southbound traffic demands in the morning period from **Table 4.3** are:

- The routes from SH1 and SH2 into the CBD are the busiest routes.
- In 2011, SH1 into the CBD has higher traffic volumes than from SH2 into the CBD, with a difference of around 1,500 vehicles. This difference reduces to around 1,100 vehicles in 2031. The smaller difference between the two routes shows that the flows from SH2 into the CBD are expected to experience greater growth, and this flow is likely to increase in dominance.
- A notable increase in traffic volumes occurs between SH1 and the Quays in the 2031 forecast year.
- With the exception of SH2 to the Quays, demand is higher on routes using the state highway in the option than in the do minimum, and it can be assumed that trips have rerouted onto the state highway as a result of the option being implemented.
- Hutt Road is shown to experience a growth in traffic volumes between 2011 and 2031.

Table 4.4 Model Traffic Demands on Northbound Routes in PM

		2011	2021		2031	
From	To	Do Minimum and Option	Do Minimum	Option	Do Minimum	Option
CBD	SH1	6,310	6,550	7,040	6,720	7,420
CBD	SH2	6,550	6,480	6,810	7,150	7,660
Quays	SH1	2,190	2,430	2,670	2,740	2,620
Quays	SH2	1,830	1,990	1,990	2,310	2,150
CBD	SH1 via Hutt Road	1,620	1,680	1,370	1,920	1,810
CBD	SH2 via Hutt Road	820	830	630	1030	920
SH1	SH2	1,510	1,520	1,420	540	460

SH2	SH1	2,680	2,890	2,880	700	690

The main points regarding the northbound traffic demands in the PM from **Table 4.4** are identified as:

- The routes from the CBD to SH1 and SH2 are the busiest and experience equal levels of demand.
- In 2021 the demand on the routes from the CBD to SH1 and SH2 and the route from the Quays to SH1 via the state highway are all predicted to increase. The alternative routes via Hutt Road for these destinations experience a reduction in flows, this demonstrates some rerouting onto the highway as a result of the scheme. The reduction in flows on Hutt Road is not equivalent to the increase on the State Highway which is potentially due to the removal of constraints in the study area which are allowing a higher total of traffic through.
- There is a significant decrease in demand for the movements between SH1 and SH2 northbound in 2031 do minimum and option, as a result of the Petone-Granada scheme which is included in the 2031 model.

As discussed in the problem description there are currently areas of congestion on the network which constrain the capacity of the scheme area. The modelling predicts that higher traffic flows will be accommodated at many points in the network with the implementation of the scheme. **Table 4.5** and **Table 4.6** show the three hour traffic flows in the peak direction at selected locations in the network for the do minimum and option in the current and future years.

Table 4.5 shows that the southbound traffic throughput at most locations are higher in the option than in the do minimum. The differences in throughput are small in 2011, however 2021 and 2031 forecast models show significantly higher southbound throughput. In 2031 a comparison of the option and do minimum models shows that around 2800 more vehicles pass the SH1/SH2 Merge, with approximately 2400 additional vehicles passing the Aotea Quay off ramp in the morning period. There are also increases in throughput of around 1000 vehicles on SH2 and Ngauranga Gorge before the merge in 2031.

Table 4.5 AM 3 Hour Traffic Flow Throughputs at Points on Southbound Route

	2011		2021		2031	
	Do Minimum	Option	Do Minimum	Option	Do Minimum	Option
SH2 East of Ngauranga Gorge	10,320	10,270	9,560	10,320	10,430	10,810
Ngauranga Gorge	11,430	11,870	11,210	11,420	12,410	12,210
SH1 after SH1/2 Merge	14,950	15,130	15,390	15,290	16,260	17,870
Hutt Road	3,850	4,070	4,380	3,510	3,620	4,570
SH1 before Aotea Quay Off Ramp	14,960	15,140	15,310	15,300	16,280	17,870
SH1 after Aotea Quay Off Ramp	11,440	11,600	11,350	11,440	12,280	13,720
Aotea Quay Off-Ramp	3,540	3,540	3,960	3,880	4,010	4,150

Figure 4-1 shows that in the do minimum (shown in red) traffic flows are at capacity, constrained at approximately 5,200 vehicles per hour from around 6:30am through until 9:00am. In the option scenario, this capacity is reached at around 6,000 vph from approximately 6:45-8:00am. This indicates that whilst the capacity and throughput is higher, the flows still reach the capacity but for a shorter period of time.

After 8:00 the throughput decreases in the option for 2011 and 2021, indicating that the peak demand is getting through and the section of motorway is below capacity. In 2031 the option remains at capacity through to 9:00am. This can be attributed to a higher demand and an increase in lane change movements prior to the Aotea Quay off-ramp.

Figure 4-1 Vehicle Throughput on SH1 before Aotea Quay Off-Ramp Southbound AM

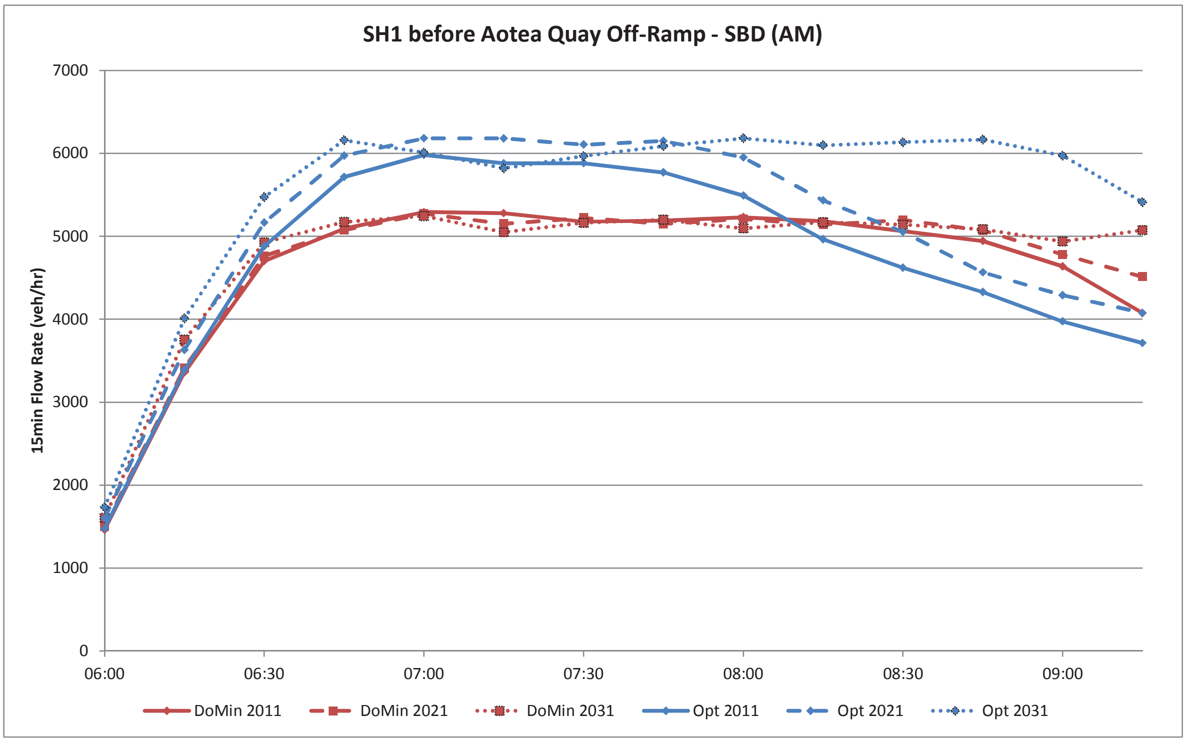


Figure 4-1 shows that not only is the total throughput higher over the whole period, but the throughput in the peak period is significantly higher in the option and there is less impact of flow constraints on those arriving towards the end of the morning period.

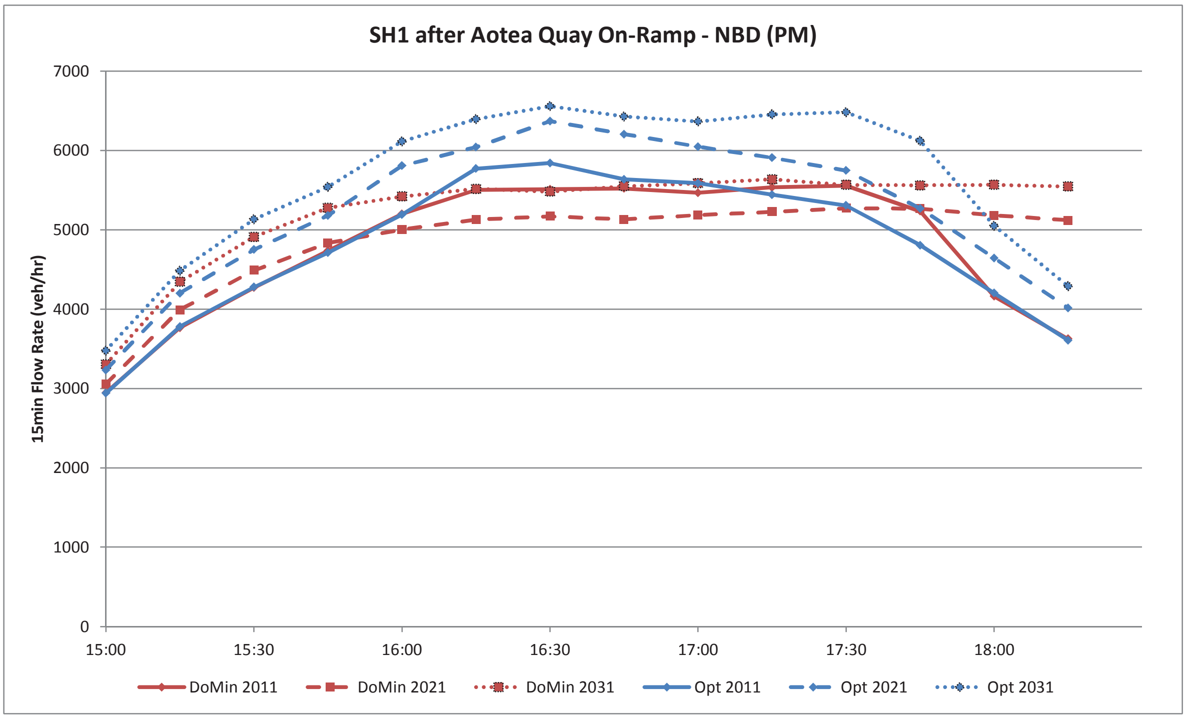
Table 4.6 PM 3 Hour Traffic Flow Throughputs at Points on Northbound Route

	2011		2021		2031	
	Do Minimum	Option	Do Minimum	Option	Do Minimum	Option
Aotea Quay On Ramp	3,580	3,600	3,910	4,130	4,440	4,270
SH1 Before Aotea Quay On Ramp	11,500	11,490	11,480	12,360	12,040	13,450
SH1 After Aotea Quay On Ramp	15,080	15,100	15,250	16,500	16,410	17,740
Hutt Road	3,920	3,900	4,070	3,560	4,420	4,200
SH1 Before SH1/SH2 Diverge	15,090	15,100	15,230	16,500	16,340	17,740
Ngauranga Gorge	12,240	12,240	12,760	13,260	11,460	12,130
SH2 East of Gorge	10,190	10,190	10,120	10,310	10,320	10,710
SH2 On Ramp	2,710	2,710	2,760	2,450	2,150	1,970

As presented in **Table 4.6** higher flows are accommodated at a number of key points on the northbound route in the three hour PM period in the option than in the do minimum. The main differences in throughput are on SH1 in the vicinity of Aotea Quay on-ramp and prior to the SH1/2 diverge. The 2011 throughputs are generally similar, but in 2021 and 2031 the option performs better, with a higher throughput (up to 1,000vph greater) achieved at these key locations.

Figure 4.2 shows that in the do minimum scenario the traffic flow is constrained by the consistency of flow from around 16:15pm until the end of the period. As well as the option lines showing that a greater number of vehicles get through in the peak period, the curve of the flows also shows that the flow is not artificially constrained.

Figure 4.2 Vehicle Throughput on SH1 after Aotea Quay On-Ramp Northbound PM



In **Table 4.6** it was shown that the total flows at this point are higher across the three hour period, **Figure 4.2** shows that not only is the total throughput higher over the whole period, but the throughput in the peak period is significantly higher and there is less impact of flow constraints on those arriving towards the end of the morning period.

4.1.5. Travel Times

The operational modelling has focused on the effect of the project on travel times, as there is minimal induced traffic in the corridor. The assessment considers both the 2021 and 2031 future year operating conditions with and without the scheme in place, as well as the baseline 2011 year.

In relation to the average travel times, the routes extracted from the operational model, shown in **Figure 4.3** and **Figure 4.4** include routes along SH1 and SH2 to and from the city and Aotea Quay, as well as routes along Hutt Road.

Figure 4.3 Journey Time Routes for SH1

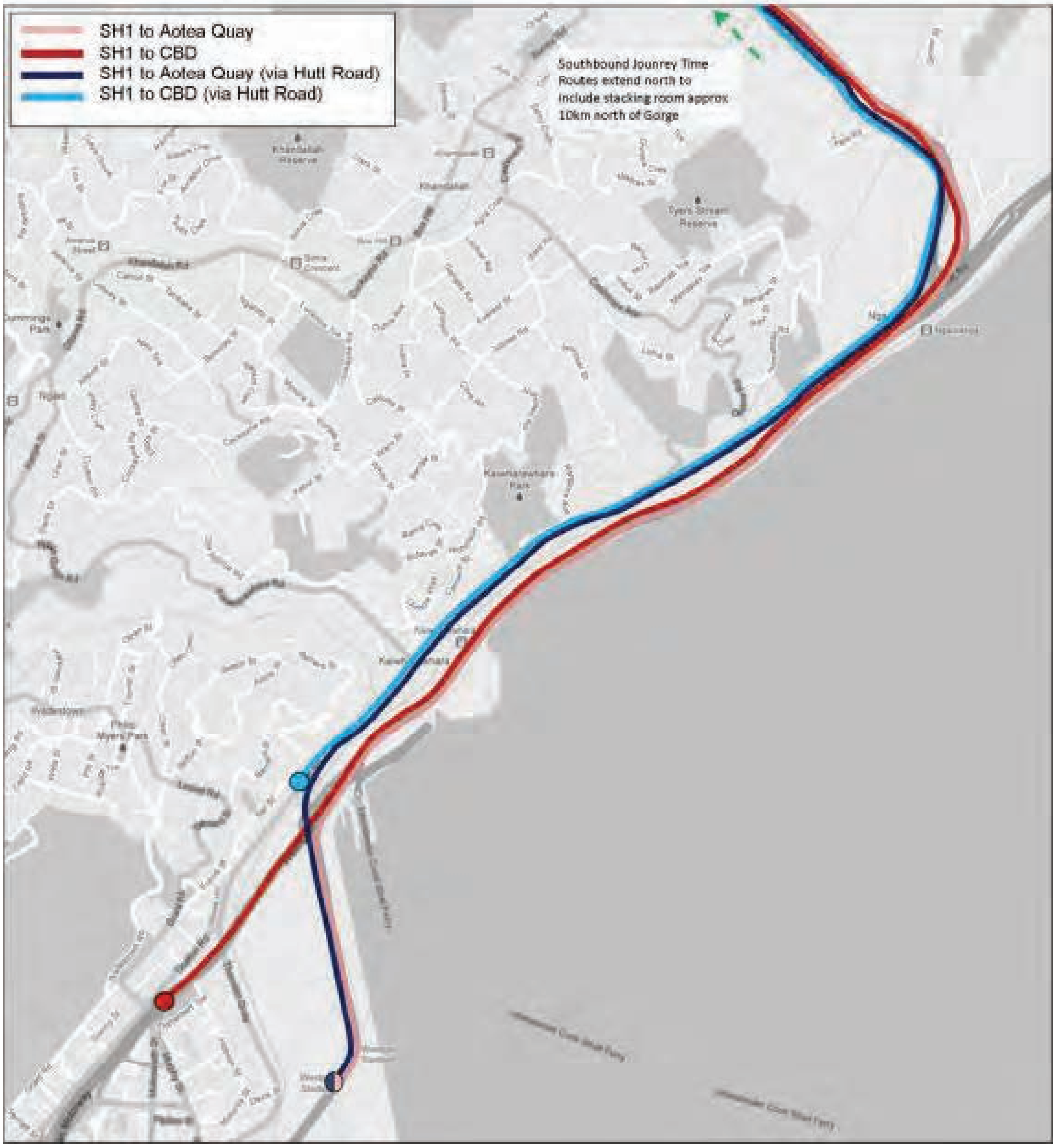
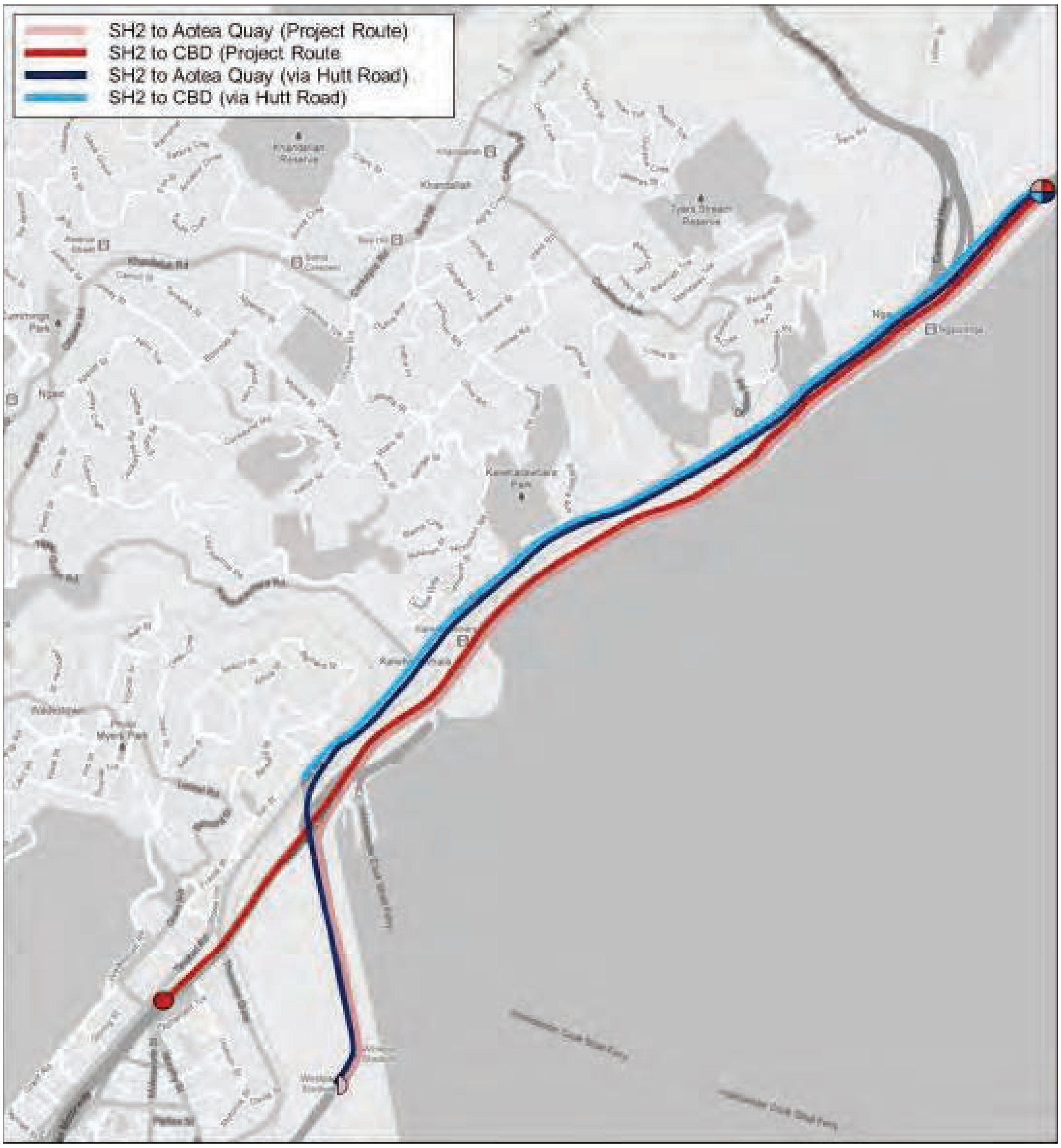


Figure 4.4 Journey Time Routes for SH2



Detailed modelling of the Project area has been undertaken to gain an operational understanding of the Project route. Two 2011 models were produced using the same demands, the first is a 2011 model which does not include the Early Works or the right turn rule change implemented in March 2012, the second includes both the Early Works and the rule change.

Table 4.7 summarises the average journey times on the Southbound routes in the AM peak period in these two 2011 models.

Table 4.7 Comparison of Pre Early Works / Do Min journey Times Southbound AM (Mins)

Journey Path	Pre-Early Works 2011	Do Minimum 2011 (Post Early Works and Rule Change)
SH1 – CBD	17.8	17.1
SH1 – Quays	20.7	20.0

Journey Path	Pre-Early Works 2011	Do Minimum 2011 (Post Early Works and Rule Change)
SH2 – CBD	5.7	5.8
SH2 – Quays	9.1	8.9
SH1 – CBD via Hutt Rd	16.2	16.0
SH1 – Quays via Hutt Rd	20.8	20.4
SH2 – CBD via Hutt Rd	5.5	5.5
SH2 – Quays via Hutt Rd	10.5	10.1

4.1.6. Comparison of Pre Early Works and Do Minimum Models

The average journey times shown in **Table 4.7** show that the micro-simulation modelling predicts that the early works and rule change result in a decrease in journey times of up to half a minute on routes from SH1 into the CBD and the Quays, along the SH1 route. The journey times on routes from SH2 are predicted to stay fairly consistent between the two models. Both routes along the Hutt Road to the Quays are also predicted to experience small decreases in journey time.

4.1.7. Comparison of Do Minimum model to Bluetooth Data:

The journey time routes in the model represent a different path from those extracted from the Bluetooth data and therefore the journey times are not comparable though the patterns and relationships between different routes can be broadly compared. From the Bluetooth data it is indicated that the journey time from SH2 into the CBD is approx.50% shorter than from SH1, the pre early works modelling supports the finding that the route from SH2 is quicker, however the difference is slightly more pronounced than shown in the Bluetooth data, due to the different route lengths covered.

Table 4.8 summarises the average journey times on the Northbound routes in the PM peak period in the two 2011 models. It should be noted that the routes recorded northbound cover a shorter length north of Ngauranga Gorge, than the southbound routes.

Table 4.8 Comparison of Pre Early Works / Base / Do Min journey Times Northbound PM (min)

Journey Path	Pre-Early Works 2011	Do Minimum 2011 (Post Early Works and Rule Change)
CBD – SH1	4.7	4.5
Quays – SH1	4.9	5.0
CBD – SH2	5.1	4.9
Quays – SH2	5.7	5.7
CBD – SH1 via Hutt Rd	7.9	7.8
Quays – SH1 via Hutt Rd	7.1	7.5
CBD – SH2 via Hutt Rd	7.3	7.3
Quays – SH2 via Hutt Rd	8.6	-
SH1 – SH2	13.8	13.6

4.1.8. Comparison of the Pre Early Works and Do Minimum Models

The average journey times presented in **Table 4.8** show that the modelling predicts a very small impact on travel times of the Early Works and rule change on the northbound routes. The journey times from the CBD along the State Highway routes are predicted to experience small decreases in journey times. All other journey times are expected to remain broadly consistent.

4.1.9. Comparison of Do Minimum and Bluetooth Data

Again as the journey time routes in the model are not the same length as the Bluetooth data the journey times are not comparable though the patterns and relationships between different routes can be broadly compared. The Bluetooth data indicates that the journey time from the CBD to SH1 is slightly quicker than the journey to SH2, which is a similar pattern to the modelling for both the pre early works and the do minimum models.

4.1.10. Summary of Do Minimum

The results presented throughout the rest of the report are based on the Do Minimum modelling as this is what currently existed at the time of preparing the report; from the above comparisons it is apparent that the Do Minimum scenario includes some improvements as a result of the Early Works and rule change, however the changes are fairly equal across the different routes and do not affect the integrity of the model. The patterns and relationships of journey times in the Do Minimum broadly match the Bluetooth data.

Table 4.9 summarises the changes in average journey time in the Do Minimum scenario from 2011 to 2031 on the main routes in the AM and PM peak periods.

Table 4.9 Comparison of Do Min Journey Times in Future Years Peak Periods

	Direction of travel	AM Peak Period Do Min			PM Peak Period Do Min		
		2011	2021	2031	2011	2021	2031
SH1 – CBD	South	17.1	18.6	28.2	13.8	13.9	13.9
SH1 – Quays	South	20.0	19.8	29.9	15.1	15.0	15.1
SH2 – CBD	South	5.8	6.2	7.3	3.7	3.7	3.7
SH2 – Quays	South	8.9	7.8	9.0	5.0	4.9	5.0
SH1 – CBD via Hutt Rd	South	16.0	16.6	31.3	14.8	14.8	14.8
SH1 – Quays via Hutt Rd	South	20.4	18.9	21.4	-	-	-
SH2 – CBD via Hutt Rd	South	5.5	5.5	11.7	4.4	4.5	4.4
SH2 – Quays via Hutt Rd	South	10.1	7.7	8.4	-	-	-
CBD – SH1	North	3.0	3.0	3.0	4.5	5.7	5.8
Quays – SH1	North	4.2	4.1	4.1	5.0	5.8	8.1
CBD – SH2	North	3.5	3.6	3.6	4.9	6.3	5.9
Quays – SH2	North	4.8	4.7	4.7	5.7	6.7	8.6
CBD – SH1 via Hutt Rd	North	5.1	5.1	5.1	7.8	10.4	10.2
Quays – SH1 via Hutt Rd	North	-	-	-	-	8.3	-
CBD – SH2 via Hutt Rd	North	7.2	9.3	9.6	7.3	7.4	10.0
Quays – SH2 via Hutt Rd	North	-	-	-	-	-	-
SH1 – SH2	North	13.0	13.7	21.5	13.6	12.8	12.5

AM Peak:

Generally the journey times along southbound routes are shown to get progressively longer from 2011 to 2031 in the do minimum scenario. In the AM peak the southbound routes to the Quays both by SH1 and the Hutt Road, are predicted to see a decrease in journey times from 2011 to 2021 which is due to improvements to the signal timings at the intersections on Aotea Quay. These journey times are then expected to increase from 2021 to 2031. The exception to this is SH1 – Quays via Hutt Road which gets slightly shorter in 2021 and then longer again by 2031, this is likely to be due to minor signal changes, however very few vehicles use this route.

For the northbound routes the journey times using both SH1 and Hutt Road are predicted to stay consistent from 2011 to 2031.Two northbound routes show an increase in journey time. From the CBD to SH2 via the Hutt Road an increase in 2021is predicted, this is due to increased congestion on the Hutt Road On Ramp where vehicles on the on ramp struggle to assert themselves against flows on the mainline. The movement from SH1 – SH2 is predicted to stay reasonably constant to 2021 but then increases in 2031, this is due to vehicles making this movement being caught in the queuing from the merge which extends beyond the off ramp and so delays those wishing to exit at the off ramp. By 2031 far less vehicles make this movement due to the Petone to Granada link being opened.

PM Peak:

On all of the northbound routes the journey times are predicted to increase between 2011 and 2021. For all but one route this trend continues from 2021 to 2031. For the route from the CBD to SH2 the journey times are predicted to decrease from 2021 to 2031, this is due to there being less disruption on SH2 around the Hutt Road on ramp, due to less traffic making the SH1 – SH2 movement as a result of the Petone – Granada scheme.

The journey times on the southbound routes are predicted to remain consistent between 2011 and 2031.

Inter-peak:

In the inter-peak period the travel times remain consistent from 2011 to 2031 with no notable changes.

Comparison of Do Minimum and Option Scenarios

Table 4.10 provides a summary of the predicted average travel times (minutes) southbound in the network, comparing the 2011 operational model outputs with the predicted operation in each forecast scenario for the morning peak period.

Table 4.10 Comparison of Morning Peak Southbound Travel Times (Mins)

	2011		2021		2031	
Journey Path	Do Minimum	Option	Do Minimum	Option	Do Minimum	Option
SH1 – CBD	17.1	15.4	18.6	16.5	28.2	22.9
SH2 – CBD	5.8	4.2	6.2	4.5	7.3	5.5
SH1 – Quays	20.0	17.6	19.8	18.6	29.9	24.0
SH2 – Quays	8.9	6.5	7.8	6.8	9.0	7.3
SH1 – CBD via Hutt Rd	16.0	15.8	16.6	16.1	31.3	21.8
SH2 – CBD via Hutt Rd	5.5	5.2	5.5	5.4	11.7	8.0
SH1 – Quays via Hutt Rd	20.4	-	18.9	19.3	21.4	21.6
SH2 – Quays via Hutt Rd	10.1	10.1	7.7	9.3	8.4	8.2

The main points relating to the southbound travel times in the morning peak from **Table 4.10** are identified as:

2011 Scenarios

- Southbound travel times on both the state highway and Hutt Road are predicted to decrease or be unchanged with the implementation of the option.
- Improvements of between 1.5 and 2.5 minutes are predicted for routes from SH1 using the State Highway network. The improved journey time on SH1 diverts traffic heading to Aotea Quay off Hutt Road and onto the motorway.
- The routes from SH2 are predicted to see decreases in journey time of around 1.5 minutes.

2021 Scenarios

- With the exception of the routes to the Quays via Hutt Road, all of the travel times in 2021 are expected to be lower or unchanged with the implementation of the option than in the do minimum.
- The routes from SH1 and SH2 to the city are predicted to see the greatest decreases in journey time, with the journey from SH1 expected to be two minutes quicker, and the journey from SH2 expected to be over a minute and a half quicker.
- A small increase in travel time from SH1 to the Quays via Hutt Road is predicted in the option, above the do minimum travel time. This is due to the fact that this route is only used by a small number of vehicles, who re–route during a short period when the State Highway network experiences a peak, therefore the only results are during the peak period rather than reflecting the operation of the Hutt Road over the modelled time period.
- The other travel times via the Hutt Road are anticipated to remain consistent or slightly decrease between the do minimum and the option.

2031 Scenarios

- Travel times from SH2 to both the CBD and the Quays are predicted to be lower with the option than in the do minimum by approximately two minutes.
- The routes from SH1 to both the CBD and the Quays are predicted to be lower with the option than in the do minimum by over five minutes.
- Travel times along Hutt Road in this morning peak are predicted to stay consistent or decrease between the do minimum and the option.

Table 4.11 provides a summary of the predicted average travel times (minutes) on the Northbound routes for the Do Minimum and Option in each of the modelled years for the PM period.

Table 4.11 Comparison of Evening Peak Northbound Travel Times (Mins)

	2011		2021		2031	
Journey Path	Do Minimum	Option	Do Minimum	Option	Do Minimum	Option
CBD – SH1	4.5	3.3	5.7	4.5	5.8	4.5
CBD – SH2	4.9	4.1	6.3	4.9	5.9	5.3
Quays – SH1	5.0	4.4	5.8	5.0	8.1	4.7
Quays – SH2	5.7	5.2	6.7	5.7	8.6	5.5
CBD – SH1 via Hutt Rd	7.8	7.4	10.4	7.8	10.2	8.7
CBD – SH2 via Hutt Rd	7.3	8.4	7.4	7.3	10.0	8.1
Quays – SH1 via Hutt Rd	7.5	-	8.3	7.5	5.8	-
Quays – SH2 via Hutt Rd	-	-	10.9	-	6.8	-
SH1 – SH2	13.6	14.9	12.8	13.6	12.5	12.9

The main points regarding the northbound journey times in the PM from **Table 4.11** are identified as:

2011 Scenarios

- Travel times on SH1 and SH2 are predicted to improve with the implementation of the scheme.
- Significant reductions in travel times are predicted on the routes from the CBD to SH1 and SH2.
- Traffic from Aotea Quay to SH1 and SH2 travel via the motorway to take advantage of the improved motorway times and avoid the SH2 Hutt Road on-ramp
- An increase in travel time (in the option) is predicted for routes using the SH2 Hutt Road on-ramp. Additional queuing on the on-ramp is noted due to the higher volumes of traffic on the mainline making merging more difficult.

2021 Scenarios

- All of the routes on the state highway are predicted to experience lower journey times with the implementation of the option than in the do minimum. The journey times are predicted to be between one and two minutes quicker.
- As with the 2011 scenario, the improvements on the state highway are expected to result in rerouting of vehicles from Hutt Road in the do minimum, to use the state highway in the option.
- Vehicles making the movement from SH1 – SH2 are predicated to experience a small increase in journey time, due to queuing on the Hutt Road on-ramp. With the four-laning in place, the modelling predicts that vehicles will transfer onto SH1/SH2 from the Hutt Road. The increase in traffic on SH1/SH2 makes it more difficult for vehicles from the on-ramp to merge with SH2, thereby increasing delay for these vehicles.

2031 Scenarios

- With the exception of the movement from SH1 to SH2 northbound, all routes are predicted to experience lower journey times in 2031 with the scheme implemented than in the do minimum.
- The largest decreases in journey time are predicted on the routes from the Quays to SH1 and SH2 using the state highway. Travel times are predicted to be over three minutes quicker with the option than in the do minimum due to a combination of the Aotea Quay on-ramp improvements and widening.
- Improvements on the state highway are expected to result in rerouting of the vehicles from Hutt Road onto the state highway.
- Travel times from SH1 to SH2 are predicted to be slightly higher with the option than in the do minimum, however the difference is much less pronounced in 2031 when the Petone-Grenada link is assumed to be open. This reduces the traffic volumes on this movement, and the travel time is less than the travel time in the 2011 do minimum scenario.

Journey Time Variability

To replicate aspects of the day to day variability in driver behaviors and to reduce potential bias each micro-simulation model was run ten times. The multiple model runs also allow for the variability of journey times to be ascertained by comparing the journey times between each model run, which approximate different driver behaviors on different days. In reality the traffic flows will also vary day to day and seasonally. As the model runs all use the same traffic demands, this element of the variability will not be fully captured in the micro simulation modelling.

Figure 4.5 and **Figure 4.6** present the mean travel time and the 10th percentile and 90th percentile travel times for the routes along the state highway between the Terrace Tunnel and Petone for the do minimum and full option. The percentile lines show the range of journey times within which 80% of journey times fall.

Figure 4.5 Do Minimum 2011 Model Journey Time Variability Terrace Tunnel to SH2 Petone

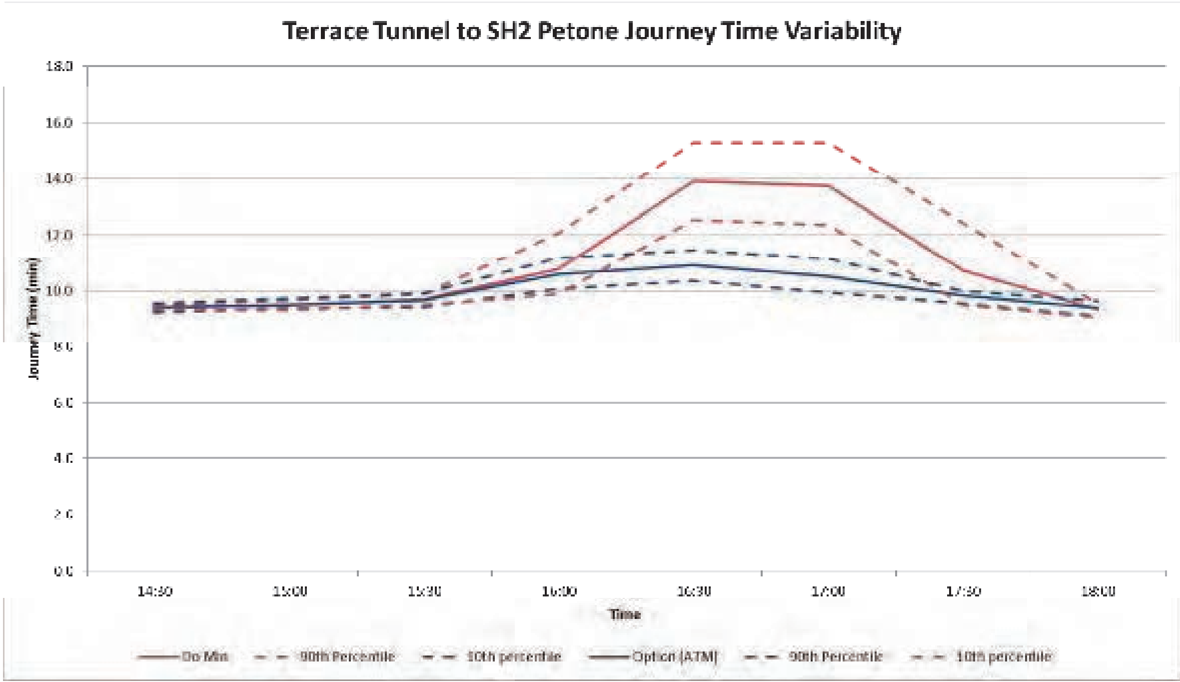


Figure 4.6 Do Minimum 2011 Model Journey Time Variability SH2 Petone to Terrace Tunnel

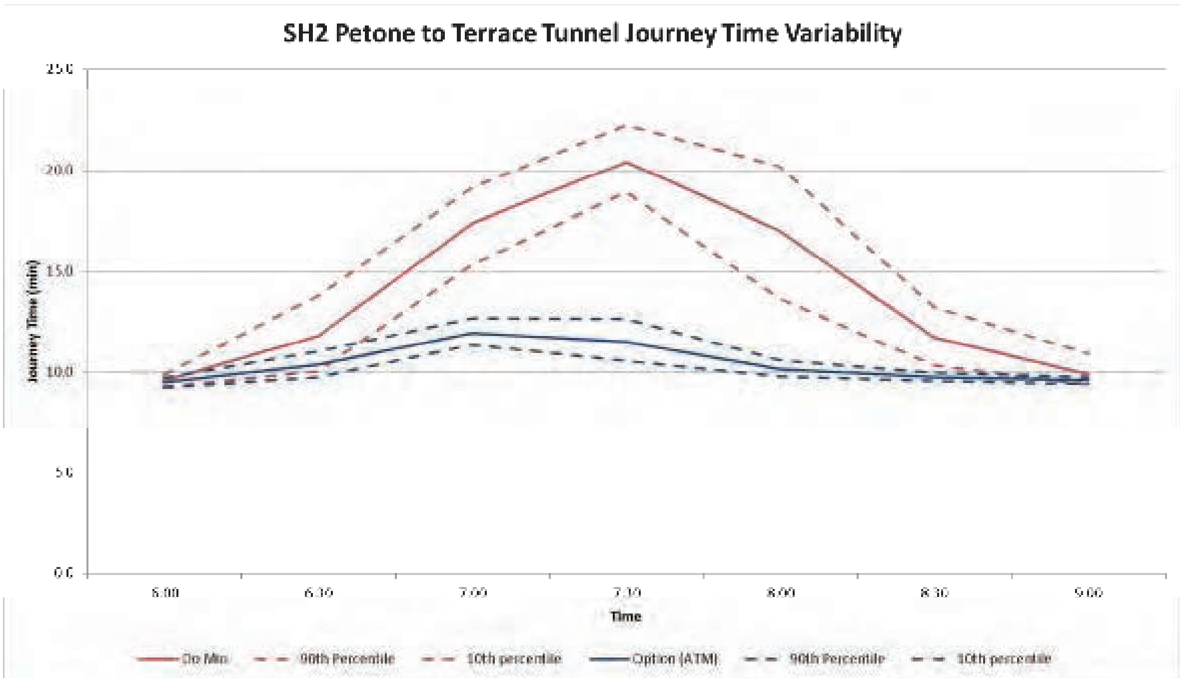


Figure 4.5 and **Figure 4.6** show that in the do minimum, in the peak period for each direction the mean journey time increases due to the increased congestion. The difference between the 10th, 50th and 90th percentile vehicles also increases, indicating that some of the journey time variability expected in the peak periods is captured by the model. When comparing **Figures 4.5** and **4.6** against Figures **2.4 and 2.5** above (observed travel time variability), however, it becomes apparent that the model is only capturing a small component of the total variability.

In the case of the option tests, the amount of variability is lower than in the do minimum with much less difference observed between the 10th and 90th percentile journey times. This is likely to be a combination of the lower congestion and journey times achieved with the option and the implementation of ATMS which will have smoothed out traffic speeds. Research indicates that there is a strong positive correlation between level of congestion and level of travel time variability. Therefore, with reductions in mean journey time attributed to the scheme, corresponding reductions in variability should be expected. This analysis indicates a 15% reduction in variability.

As mentioned above, the variability from the micro-simulation modelling captures the different driver behaviours well, but not daily fluctuations in traffic flow. Therefore, this modelled reduction is likely to represent an under-estimate. Data from the M42 motorway in the United Kingdom demonstrates that a 22% reduction in variability can be directly attributed to the introduction of ATMS alone.

Operational Model Observations

Observations from the micro-simulation modeling of the key aspects of the scheme area are discussed below. To replicate the day to day variability in driver behaviors and to reduce potential bias each micro-simulation model was run ten times. The observations below are based on reviewing a small number of runs and therefore the extent of queuing in certain areas will be subject to some variability, however the causality will be the same across the runs.

Morning Period Observations

In the weekday morning period there are three distinct areas which influence the southbound movement across the models. The explanations of these areas and the extent to which they are relieved or aggravated by the implementation of the option are discussed below:

a) SH1/SH2 Merge (Current Issue)

The do minimum modelling for 2011 shows that there is a significant issue at the SH1/SH2 merge where the outside lane from SH1 and the inside lane from SH2 merge into a single lane. This queuing from the merge is observed to affect SH1 to a greater extent than SH2, with queuing extending up the Ngauranga Gorge. Platoons of queuing vehicles are observed on both SH1 and SH2, primarily from the inner lanes at the merge.

The do minimum models for 2021 and 2031 show this merge continuing to cause problems, with the queuing on SH1 propagating increasingly further back up the gorge. In both forecast years queuing is observed to extend back from the merge as far as the model extent on SH1, with some queuing occurring outside of the model network.

This congestion resulting from the SH1/SH2 merge in the do minimum models is not apparent in the option models, where the merge occurs in a four lane section.

b) Aotea Quay Off-Ramp Weave (Current Issue)

In the 2011 do minimum model a notable weave occurs prior to the Aotea Quay off-ramp, where vehicles weave across to exit at Aotea Quay. All vehicles travelling from SH2 to the Aotea Quay off ramp undertake this weave, as do vehicles from SH1 that travel in the middle lane. The 2011 do minimum model shows the queuing from this weave propagates back to the SH1/SH2 merge and interacts with the congestion caused by the merge.

The do minimum forecasts for 2021 and 2031 show the weave causing slightly less congestion than in 2011; however this is likely as a result of the worsening merge regulating the flow which gets through to the weave point.

The converse is observed in the option forecasts, whereby the congestion at the merge is alleviated and the bottleneck moves downstream to the off-ramp weave. The additional lane between Ngauranga and Aotea Quay also creates additional weaving movements, as Aotea Quay becomes a lane drop. This adds an additional lane change to vehicles travelling from SH2, and requires any vehicles travelling from SH1 towards the city to move out of the outside lane.

The 2011 and 2021 option model shows localised congestion between Ngauranga and Aotea Quay as a result of weaving vehicles and queuing is not observed further upstream on either SH1 or SH2. The 2031 forecast of the option scenario shows a breakdown of traffic flow over the distance where the weave for the Aotea Quay off-ramp occurs. This queue extends back up Ngauranga Gorge and results in some traffic heading to Aotea Quay diverting onto Hutt Road.

This is an issue which will legitimately be occurring on site, however it is likely that the operational model may be overstating the extent of the weave issue as the area over which vehicles can weave is artificially constrained. Lane selection is also likely to occur at an earlier point as those on SH1 and SH2 may choose the most appropriate lane further north to minimise the amount of lanes which need to be crossed in a single movement closer to the off-ramp

c) Hutt Road Congestion (Future Issue)

An increase in congestion is observed southbound on Hutt Road in both 2031 scenarios. Additional queuing is noted at the Kaiwharawhara signalised intersection, above model observations from 2011 and 2021. This queuing is predicted with both the do minimum and option scenarios, with little difference between the two.

Queuing is also observed for the right turn movement from Hutt Road to the SH2 on-ramp in 2031. Further optimisation of the signal timings at this intersection would alleviate this congestion.

The additional congestion on Hutt Road is likely to be due to a combination of the additional traffic growth in 2031 and the increase in congestion noted on SH1.

Evening Period Observations

In the weekday evening period there are five distinct areas of focus which affect the northbound movement across the study area. The explanations of these issues and the extent to which they are relieved or aggravated by the implementation of the option are discussed below:

a) Aotea Quay On Ramp Merge

In the 2011 do minimum the Aotea Quay on ramp merge area is observed to cause queuing back on the on-ramp, with queues observed to extend back under the motorway. At the start of the evening peak, traffic on the on ramp has problems finding gaps in the traffic on SH1 and queuing builds up on the on ramp. This queuing begins to dissipate as congestion builds on SH1 northbound and slows traffic upstream of the on-ramp merge.

The 2021 and 2031 do minimum models show a similar pattern of queuing from the Aotea Quay on ramp merge, with the queuing on the on ramp shown to get progressively worse over time.

In the option models for 2011 and 2021 the queuing on the on ramp is significantly reduced from the do minimum as a result of the Aotea Quay on-ramp joining as a lane gain.

b) Weaving Prior to SH1/SH2 Diverge

In all three of the do minimum models queuing is shown to originate from the weave area prior to the SH1/SH2 diverge. Lane changes are required for a proportion of vehicles heading to both SH1 and SH2, depending on the lane that they originate in.

The 2011 model shows queuing from this weave area propagating back downstream and this is observed to get progressively worse in each of the forecast years. In 2021 and 2031 the queuing shockwaves from the weave area are shown to interact with the Aotea Quay on-ramp merge, with traffic on the on-ramp finding opportunities to merge into queuing traffic due to this effect.

The option models show that in each modelled year some weaving issues remain with the option implemented, however the weave is shown to cause less queuing in each forecast year than in the corresponding do minimum scenario.

c) Hutt Road Queuing

Hutt Road is shown to operate at similar levels in the 2011 and 2021. There is some queuing noted at the signalised intersections but it is generally transitory, with both the do minimum and option models performing similarly.

By 2031 substantial queuing is predicted on Hutt Road in both the do minimum and option models. The modelling shows that nearly all of the traffic using the Hutt Road in 2031 is heading to SH1, with much of this traffic having originated from the Tinakori Road/Thorndon Quay 'CBD' area in the model. It is noted that this movement through the model does not have the option of rerouting onto the state highway; rather the route choice is taken directly from WTSM. It is likely that alternative options for accessing SH1 from this area would be utilised, with a proportion of vehicles rerouting onto the state highway.

d) SH1 Northbound On-Ramp at Ngauranga Gorge

The do minimum models show queuing on the Hutt Road SH1 on-ramp due to the two to one lane drop. The queuing is shown to extend back to just prior to the signalised intersection, but is not observed to block back through the signals in the models. The signal timings work effectively and hold back traffic that is heading for the on-ramp, but for which there is no storage space. This issue is predicted to be relatively stable from 2011 to 2021. In the 2031 model the queuing on the on-ramp is lower due to lower traffic volumes from SH2 to SH1 (Petone to Grenada is opened) and further optimisation of signal timings would balance queuing on the on-ramp and Hutt Road.

The option models for each modelled year show a very similar pattern and level of queuing to the corresponding do minimum year as the scheme does not specifically target this area.

e) Hutt Road On-Ramp to SH2

The 2011 do minimum model predicts queuing on the Hutt Road on-ramp, but very little impact on the SH2 mainline at the merge area which is shown to be busy but with free flowing traffic. The level of traffic flows and traffic speeds on the SH2 mainline makes it difficult for traffic on the on-ramp to find suitable gaps in traffic resulting in queuing on the on-ramp.

In the 2021 do minimum model the queuing on the Hutt Road on-ramp is predicted to have decreased significantly from the 2011 model as the queuing on Hutt Road holds back traffic from the on-ramp, regulating the flow and resulting in less queuing. By 2031 virtually no queuing is predicted on the on-ramp due to the extent of the queuing on Hutt Road and rerouting of traffic to the mainline.

The 2011 option model predicts the queuing on the on-ramp to be slightly worse than in the do minimum model, as the increased throughput on SH2 make it increasingly difficult for traffic on the on-ramp to merge into the SH2 traffic. The geometric changes to the on-ramp mean there is more stacking room for the increased queuing and the queue is not observed in the models to extend as far as the signals.

In the 2021 option model the queuing at the on-ramp is predicted to be significantly worse than in the do minimum model, which is largely due to the increased throughput on SH2 making it difficult for on-ramp traffic to find appropriate gaps. It is also notable that in this model there is less queuing on the Hutt Road, therefore some of the increased queuing seen at the on-ramp may simply be displaced queuing from the adjacent signals.

Similar to the do minimum model, by 2031 the option model shows very little queuing at the on-ramp due rerouting of traffic destined for SH2 onto the state highway.

4.2. Statutory Planning

4.2.1. Introduction

As an overall summary, this project is more 'operational' in nature with the physical works being relatively minor and able to be undertaken within the existing highway footprint and designation boundary. There will be some physical works staged over time, as described in **Section 9**; however the social and environmental effects generated by these works will be no more than minor and in fact should result in an overall long-term positive effect for the road user and the environment (for example air quality) as those works help to ease congestion, smooth traffic flows and provide greater journey time reliability.

4.2.2. Planning Approvals

Planning approvals are expected to be relatively straightforward in nature and are summarised as follows:

Table 4.12: Statutory Planning Summary

Consenting Authority	Summary
Wellington City Council	All proposed physical works can be accommodated within the existing highway designation. Given the nature of the works, an outline plan of works will likely be required to be submitted to WCC for approval as and when the project is staged over time. NZTA continues to work with WCC to confirm the exact designation boundary in the area of the Thorndon Overbridge/Aotea Quay area and rail overbridge area (air rights). An alteration to designation boundary may be required.
Greater Wellington Regional Council	No resource consents will be required for the proposed works. The scheme and associate works are expected to be able to comply with the relevant Regional Plan permitted activity standards. There will be no works or structures within the Coastal Marine Area.

Consenting requirements for works in proximity to the Coastal Marine Area (CMA), for the construction of the retaining wall, will be confirmed during detailed design. At this stage it is envisaged that the actual structure will not be located in the CMA, and falls within the designation boundary, however a consent for disturbance of the CMA may be required for the construction of the retaining wall.

The preliminary assessment indicates that the storm water design will meet the permitted activity standards of the relevant regional plan; this will be confirmed at the detailed design stage.

4.2.3. Social and Environmental Management

A full social and environmental management form (PSF13) is provided at **Appendix K**. That form shows that there are no significant social and environmental issues for this project and all effects identified can be sufficiently avoided, remedied and/or mitigated. The key social and environmental matters are summarised in **Table 4.13** below.

Table 4.13: Key Social and Environmental Management Matters

Issue	Effect/ Degree of effect	Assessment and Action
Construction effects – Noise, Air Quality, Spill	Medium – minor and temporary short-term effect	Construction Management Plan – setting out appropriate noise standards, environmental management procedures, stormwater management, emergency response procedures for spills, communication and consultation activities for affected stakeholders, traffic management plans.
Water Resources	Low	The proposed works will be compliant with the relevant Regional Plans (including stormwater management) and no resource consents are expected to be required. Similarly, no works or structures are proposed within the CMA (Note: one new emergency breakdown area may require some temporary works within the CMA, to be confirmed at detailed design). Special attention and care will be required during construction works around the Kaiwharawhara Stream and surrounding area (including the Coastal Marine Area) to ensure no significant adverse effects are generated on

Issue	Effect/ Degree of effect	Assessment and Action
		the environment.
Cultural	Low	Accidental discovery protocol for Construction Management Plan
Public Health, including driver stress and security	Low – likely to be a positive effect as traffic management is implemented	This is the most congested part of Wellington's motorway network and the project objective is to ease congestion and smooth traffic flows as well as improve safety, route security and provide greater journey time reliability. This should result in less stress and higher personal security for road users.

4.2.4. Designation Boundary

As discussed above the NZTA continues to work with WCC to confirm the designation boundary in the area of the Thorndon Overbridge. The designation boundary as currently understood by NZTA is shown on the scheme plans. Depending on the outcome of the designation boundary confirmation, an alteration to designation may be required for the widening of the Thorndon Overbridge. Excluding the area of the Thorndon Overbridge, the physical extent of the highway and proposed improvements are within the existing designation boundary.

4.2.5. Property Acquisition

Additional property will not be required to accommodate the preferred scheme as proposed. If the emergency on-ramp is to be constructed at Ngauranga, property will be required from Kiwirail. To date no property discussions have taken place with Kiwirail.

4.3. Transport Policy Assessment

During the scoping stage, the Project was assessed against the Government Policy Statement objectives, the New Zealand Transport Strategy, and the Land Transport Management Act and was found to be consistent with each of these government policies.

A funding profile assessment is required in order for the Project to be funded by NZTA. It is understood that NZTA have moved away from the PPFM to the *Planning and Investment Knowledge Base* (Knowledge Base). The Project was assessed against the criteria for new and improved state highway infrastructure. This assessment is summarised below.

4.3.1. Strategic Fit

The Project has a **High** Strategic Fit because it is a Road of National Significance.

4.3.2. Effectiveness

The effectiveness assessment factor considers the contribution that the proposed solution makes to achieving the potential identified in the strategic fit assessment, and to the purpose and objectives of the Land Transport Management Act. Higher ratings are provided for those proposals that provide long-term, integrated and enduring solutions. There is no default rating for effectiveness and therefore an assessment must be undertaken to determine if the Project meets a Low, Medium, or High Effectiveness Rating. The assessment of the Project against the Effectiveness criteria is documented below.

To achieve a Low Effectiveness rating, the Project must meet each of the following criteria:

Table 4.14: Low Effectiveness Criteria Assessment

Criteria	Comment
■ the potential impact or outcome identified in the 'strategic fit' assessment	■ The Project has a High Strategic Fit
■ an agreed level of service	■ As a RoNS the Project seeks to achieve a high level of service.
■ the purpose and objectives of the LTMA	■ The Project was assessed against the purpose and objectives of the LTMA and found to be highly consistent with the LTMA.
■ has considered or will consider: –all relevant problems, issues and opportunities –all appropriate alternatives and options –opportunities for collaboration –any adverse effects or impacts	■ The Project through the scoping and scheme assessment stage has considered the existing and forecast problems on SH1 and connecting roads within the study area, developed options for addressing those problems, and assessed the effects of those options. ■ The Project has sought opportunities for collaboration and has worked collaboratively with Wellington City Council, Greater Wellington Regional Council, Centreport, InterIslander, and Kiwirail on addressing Port access. Further collaboration with Centreport and the InterIslander will occur in the design phase to minimise adverse effects on the operation of their facilities due to the widening of the Thorndon Overbridge.
■ is an affordable solution with a funding plan	■ The Project is included in the Wellington Regional Land Transport Plan and so is considered to have a funding plan. NZTA ultimately will determine if the Project is affordable when a construction funding application is made.
■ avoids duplication of activities	■ The Project is not duplicated with other transport activities
■ the scale of the proposed solution is appropriate to the potential impact or outcome in the strategic fit assessment	■ The scale of the activity is considered appropriate: it meets the objectives of the RoNS while making best use of the existing corridor.
■ includes a monitoring and review framework in plans and strategies, and other activities where appropriate.	■ The Project will include ongoing review of the ATMS operation and safety management system.

Based on the assessment above the Project meets the criteria for a Low Effectiveness rating.

The Project may be given a Medium rating for Effectiveness if evidence is provided to demonstrate that it meets each of the following criteria:

Table 4.15: Medium Effectiveness Criteria Assessment

Criteria	Comment
■ all the low effectiveness criteria	■ The Project meets all of the low effectiveness criteria
■ is part of or will contribute to an NZTA supported strategy, endorsed package, programme or plan (for inclusion to the NLTP a completed strategy that will be presented to the NZTA for support in the near future may be considered sufficient)	■ The Project is part of the NZTA endorsed Ngauranga to Airport Corridor Plan and is a RoNS project as part of the Wellington Northern Corridor.
■ is significantly effective (will deliver a measurable impact or outcome) in achieving the potential impact or outcome identified in the 'strategic fit' assessment.	■ The Project is significantly effective in that it delivers significant travel time savings and improves reliability while remaining within the existing corridor.
■ provides a long term solution with enduring benefits appropriate to the scale of the solution	■ The Project provides long term benefits as demonstrated by the traffic modelling and economic analysis.
■ provides a solution that responds to land use strategies and implementation plans, where appropriate to the activity	■ As part of the Ngauranga to Airport Corridor Plan (which was responsive to the Wellington Transport and Urban Growth Strategies) the Project is an integral part of an integrated land use and transport plan. Further, the Project has sought to be consistent with plans for the redevelopment of the InterIslander Ferry Terminal and Centreport.
■ provides a solution that makes a contribution to multiple GPS impacts, where appropriate to the activity.	■ As discussed above, the Project makes a strong contribution to the GPS impacts.

The Project meets the criteria for a Medium Effectiveness rating based on the assessment above.

Knowledge Base states that a High rating for Effectiveness must only be given if evidence is provided to demonstrate that the activity or combination of activities delivers on each of the following:

Table 4.16: High Effectiveness Criteria Assessment

Criteria	Comment
■ covers all of the low and medium effectiveness criteria	■ The Project meetings all of the low and medium effectiveness criteria.
■ is a key component of an NZTA-supported strategy, endorsed package, programme or plan (for inclusion to the NLTP a completed strategy that will be presented to the NZTA for support in the near future may be considered sufficient)	■ The Project is part of the NZTA endorsed Ngauranga to Airport Corridor Plan and the Wellington Northern Corridor RoNS.
■ is part of a whole-of-network approach	■ The Ngauranga to Airport Corridor Plan was a whole-of-network strategy and as a key component of that Corridor Plan, it is considered that the Project is part of a whole-of-network approach.
■ improves integration within and between transport modes, where appropriate to the activity	■ The Project is a key component of the Ngauranga to Airport multi-modal transport strategy. The Project delivers the state highway component of the package will also included bus lanes on the Hutt Road. It is considered that the Project improves integration within and between

Criteria	Comment
	transport modes as it is part of this multi-modal strategy.
▪ provides a strategic approach that successfully integrates land transport, land use, other infrastructure and activities, where appropriate to the activity	▪ As discussed above the Project is part of a multimodal transport strategy which was consistent with the Wellington Transport and Urban Growth Strategies.
▪ supports networks from a national perspective, where appropriate to the activity	▪ As a RoNS, and by providing significant travel time savings, it is considered that the Project supports the network from a national perspective.
▪ provides a strategic approach that makes a significant contribution to multiple GPS impacts, where appropriate to the activity	▪ As discussed above, the Project makes a strong contribution to the GPS impacts.
▪ is optimised against multiple transport outcomes and objectives	▪ The Project meets the objectives of the GPS, LTMA, and NZTS. By taking a staged approach to delivery, it is considered that the Project is optimised.
▪ adopts a collaborative approach to the development of studies, strategies and plans.	▪ As discussed above, the Project is part of a multi-modal transport strategy for Wellington and has worked collaboratively with Port stakeholders to resolve Port access issues.

Based on the assessment above the Project has an Effectiveness rating of **High**.

4.3.3. Efficiency

The Efficiency rating of the Project is based on the benefit-cost ratio (BCR). As described later in the report the Project has a BCR of 1.1. Therefore the Efficiency rating of the Project is **Low**.

4.3.4. Summary

During the scoping stage the Project was found to be highly consistent with the policies and objectives of the GPS, LTMA, and NZTS. During the scheme assessment stage the Project was assessed again the funding profile criteria contained in Knowledge Base. Based on the assessment of the funding profile criteria contained in Knowledge Base, the Project has a funding profile of:

- **High** Strategic Fit;
- **High** Effectiveness; and
- **Low** Efficiency

The evaluation of the preferred scheme has found that:

- **The Project will deliver significant travel time savings and improved journey time reliability;**
- **There are no significant adverse environmental effects generated by the Project;**
- **An alteration to designation may be required for the Thorndon Overbridge Widening depending on the outcome of discussions between NZTA and WCC; and**
- **The Project has an NZTA funding profile of High, High, Low (HHL).**

6. Cost Estimates

Cost Estimates have been developed for the preferred scheme described in Chapter 4. The estimates were prepared to the NZTA's Scheme Estimate specification described in the *Cost Estimation Manual* (SM014). Scheme estimates were also prepared for several of the components of the preferred scheme for use in developing the staging plan. These components include:

- SH2 Ngauranga Northbound On Ramp Improvements;
- Emergency On-ramp at Ngauranga;
- Upgrade of existing ATMS system;
- Widen northbound to four lanes; and
- Widen southbound to four lanes.

The Base, Expected, and the 95th percentile estimates for the preferred scheme and components is shown in **Table 6.1** below:

Table 6.1 – Scheme Estimate Values

Item and Description	Base Estimate ($M)	Expected Estimate ($M)	95th Percentile Estimate ($M)
Full Scheme (Includes all of the components below)	$78.2M	$87.3M	$100.5M
SH2 Ngauranga Northbound On Ramp Improvements (Geometric improvements to On-Ramp)	$2.4M	$3.7M	$3.1M
Emergency On-ramp at Ngauranga	$2.3M	$2.5M	$2.9M
Upgrade of existing ATMS system (New ATMS equipment and enforcement)	$13.3M	$14.7M	$17.0M
Widen northbound to four lanes (Includes Aotea Quay On-Ramp improvements and replacement of central median barrier)	$19.8M	$22.1M	$25.4M
Widen southbound to four lanes (Includes widening of Thorndon Overbridge)	$39.6M	$44.2M	$50.9M

The above scheme estimates include risks identified in the risk register which are discussed in Section 7. The scheme estimates do not include the cost of ground improvements for the Thorndon Overbridge or Aotea Quay off-ramp. It is noted that the sum of the stages does not equal the total cost of the Project. This is due to each stage being priced as a stand along Project Scheme estimates are contained in **Appendix L**.

The preferred scheme has an Expected Scheme Estimate of $87.3M.

8. Economic Assessment

The economic assessment of this Project has been undertaken in accordance with the requirements of the Economic Evaluation Manual, First Edition (EEM). The full economic worksheets are provided in **Appendix N**, with the main points presented below. The economics were peer reviewed by Opus and the results of the peer review are contained in **Appendix O**.

The base date for the analysis is 1 July 2011 and time zero is 1 July 2012.

The construction time for the full option has been assumed to be one year, with construction commencing at the start of the 2013/14 year.

8.1. Traffic Model Background

As reported earlier, traffic modelling has been undertaken to assess the operation of the various Options. These models also form the basis for the economic assessment, with outputs such as travel times and vehicle speeds being used to determine the cost to road users of each Option.

8.1.1. Economic Base and Do Minimum Models

The models used as the starting point for the economic assessment will be the Base or Do Minimum models pre-early works. This is to allow the benefits of the early works to be recognised as part of this project, as these improvements were identified and implemented during the early stages of this investigation.

8.1.2. Forecast Year Modelling Assumptions

The number of vehicle trips modelled, and their origins and destinations in the micro-simulation model, have been derived from the strategic WTSM model. The assumptions relating to improvements to the greater Wellington road and passenger transport network have been reported earlier. Of most significance to this Project are the following two improvements:

- Duplication of the Terrace Tunnel is expected between 2021 and 2031, significantly increasing the southbound capacity of the motorway; and
- The Petone to Grenada link is also expected between 2021 and 2031, routing traffic between SH1 and SH2 out of the area covered by the micro-simulation model.

The first network improvement increases the volume of traffic using the motorway to travel southbound to the end of the motorway, as the Terrace Tunnel bottleneck has been removed. As the second network improvement removes traffic travelling between SH1 and SH2 from the model, capacity is freed up on SH1 in the Ngauranga Gorge, through the interchange with Hutt Road and on SH2 between Ngauranga and Petone.

8.2. Time Periods

The traffic models represent three weekday periods separately, the morning and afternoon commuter peaks, and the inter-peak period between them. **Table 8.1** shows the length of the modelled time periods and the time within each of these time periods that the economic inputs are collected for.

Table 8.1 - Assessment Periods

Time Period	Modelled Period	Economic Period
AM Peak	6:00 – 9:30	6:30 – 9:30
Inter-peak	11:00 – 13:00	11:30 – 12:30
PM Peak	15:00 – 18:30	15:30 – 18:30

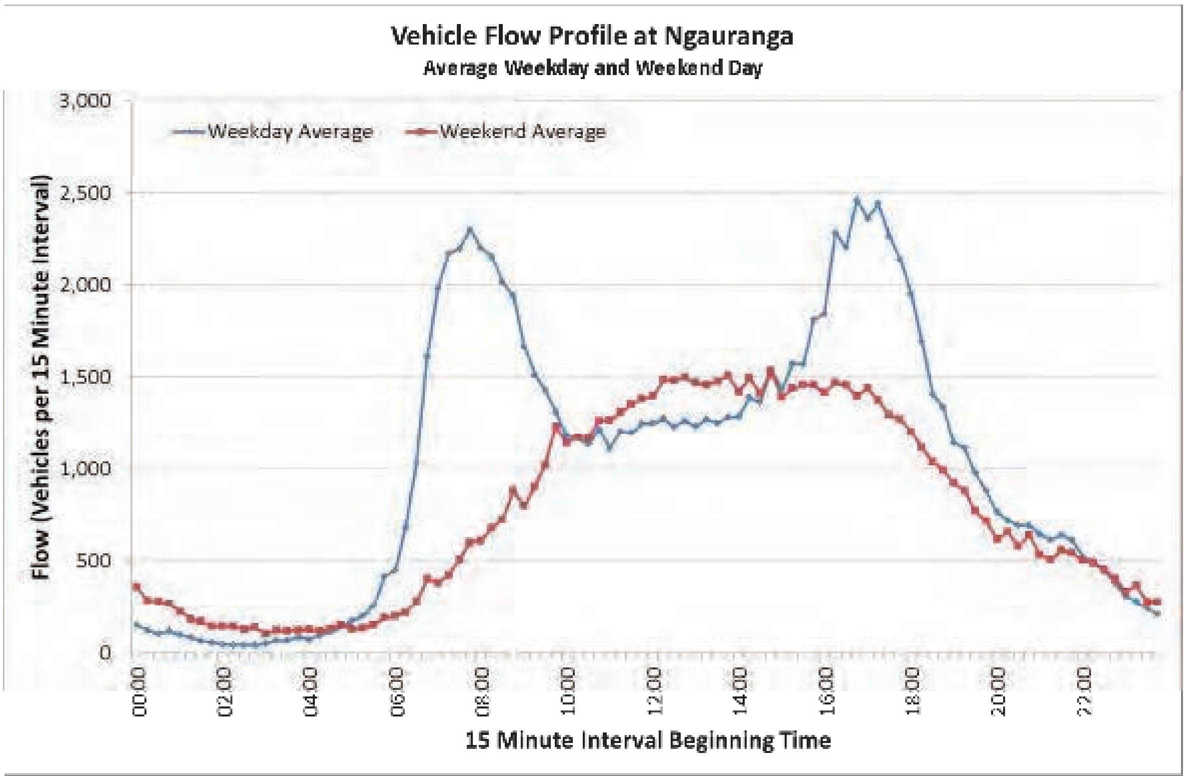
For the AM and PM peak periods, the full modelled period is 3½ hours, but only the last 3 hours are used to determine the economic benefits. This allows 30 minutes for the modelled network to fill up with traffic (a warm-up period), so the results used for this economic analysis are all collected whilst conditions in the network are representative of the vehicle interactions that occur in reality.

For the inter-peak period, this has a relatively flat profile, so vehicles are released onto the network without any distinctive peak being present. The two hour inter-peak period also represents the average conditions across the middle of the day, from the end of the AM peak period at 9:30 through to the start of the PM peak period at 15:00. Using the middle hour to gather the network outputs for this assessment allows for the network to warm-up during the first 30 minutes of the modelled period.

The Options which have been tested have all been designed to aid the movement of traffic in the busiest part of the day, so produce little or no benefit when traffic volumes are significantly lower. The inter-peak period has traffic volumes which are up to 48% lower than the traffic volumes recorded during the peak PM hour, and 44% lower than for the peak AM hour.

Weekend traffic volumes are similar to those during the weekday inter-peak period, although up to 15% higher. The comparison between these relative traffic volumes can be seen in **Figure 8.1**, which shows traffic volumes passing through the SH1/SH2 Ngauranga Interchange in 15 minute intervals for an average weekday and an average weekend day.

Figure 8.1 – Annualisation Graph



As none of the Options tested have a noticeable effect on vehicle speeds or routing during the inter-peak period, assessment of the benefits of the Options over the weekend has not been undertaken.

8.3. Annualisation Factors

The annualisation factors used to expand the results from the model periods to a full year for the economic assessment are shown in **Table 8.2**.

Table 8.2 - Expansion Factors used for Economic Assessment

Time Period	Model Period Used	Modelled Period Length (hours)	Periods Per Day	Days Per Year
Weekday Morning Commuter Peak	AM Peak	3	1	245
Weekday Inter-Peak	IP	1	6	245
Weekday Afternoon Commuter Peak	PM Peak	3	1	245
Weekday Evening/Night-time	None	-	-	-
Weekend/Holiday	None	-	-	-

8.4. Variable Trip Matrix Assessment

WTSM has been used to produce cordon matrices both with and without the full scheme in place. The number of trips in these cordon matrices differs between the with and without cases, due to two effects:

- Traffic rerouting on the wider transport network within WTSM to travel in the SH1/SH2 corridor, taking advantage of the improvements in travel conditions brought about by the full scheme; and
- Induced traffic, whereby tripmakers change their mode or time of travel, or their destination, as a result of the decrease in travel costs along the SH1/SH2 corridor.

Both of these effects are likely to increase the number of vehicles using the SH1/SH2 corridor with the full scheme in place, necessitating the use of variable trip matrix (VTM) assessment methods. Without specifically accounting for the change in the number (and origin or destination) of trips, a standard economic assessment will underestimate the benefits of a scheme, as the total road user costs with the induced (increased) demand are likely to be higher than for the Do Minimum, even though average travel times or distances have fallen.

To account for the variable trip matrix effects, two separate approaches have been used:

1. The individual road user costs for each vehicle on each path (travel time, delay, VOC, variability) were calculated for each scenario based on the trips in that scenario. The total road user costs for the scenario were then based on the number of vehicles on each path in the Do Minimum scenario, so for the purposes of the economic evaluation there is the same number of trips, and any difference in the total road user costs is due to changes in the operation of the network.

   This method will tend to underestimate the benefits of a scenario, as the benefits to the extra (induced) traffic in the option which takes advantage of the improved travel conditions, is not considered in the evaluation.

   This approach was used for the first draft version of this report.

2. Appendix A11.as of the EEM also specifies a methodology for conducting cost benefit analyses using VTM methods. A variant on the matrix-based approach has been used to account for the differences in the trip matrices, and is detailed below.

   This second approach has been used for this version of the report.

8.4.1. Economic Assessment Traffic Demands

For the second approach, the matrix based approach specified in Appendix A11.12 of the EEM has been adapted for use with the path data output from the Paramics model runs.

Rather than using matrix information (trips, travel times, VOC, etc) for individual origin-destination pairs, each path is used. Each path is similar to a single origin-destination pair, located within the model rather than at the model extremities.

The form of the benefit calculation is shown below:

$$B_{pi} = [R_{pi}^{DM}T_{pi}^{DM} - R_{pi}^{OPT}T_{pi}^{OPT}] + \frac{1}{2}[U_{pi}^{DM} + U_{pi}^{OPT}] \times [T_{pi}^{OPT} - T_{pi}^{DM}]$$

where:

B_{pi}	=	Total road user Benefit of Option.
$T_{pi}^{DM}, T_{pi}^{OPT}$	=	Number of trips on path *p* in time interval *i* in Do Minimum and Option.
$R_{pi}^{DM}, R_{pi}^{OPT}$	=	Resource costs on path *p* in time interval *i* in Do Minimum and Option (calculated separately for Travel Time, Travel Delay, VOC and Reliability).
$U_{pi}^{DM}, U_{pi}^{OPT}$	=	User costs on path *p* in time interval *i* in Do Minimum and Option (calculated separately for Travel Time, Travel Delay, VOC and Reliability).

8.5. Ramp Metering Benefits

The SH2 Ngauranga On-Ramp Ramp Metering option has not been well modelled in the Paramics model, with a simplistic algorithm used to control the signals on the on-ramp. The model results from this option do not show the improvements that would be expected. As a consequence, an alternative methodology has been employed to assess the benefits of this option.

The methodology is based on the approach used for the economic evaluation of ramp signalling on the Western Ring Route[12]. In this report a relationship was determined between the travel time benefits to traffic on the mainline and disbenefits to those on the on-ramp, based on experience in the UK and US. This relationship was further calibrated against modelling from the Auckland Southern Motorway.

Vehicles on the mainline are expected to have a 7% travel time saving immediately downstream of the merge, whilst those on the on-ramp are expected to experience a delay totalling an additional 25% of their travel time on the on-ramp.

This approach has only been applied to estimate the benefits of the SH2 Ngauranga On-Ramp option relative to the pre-early works model – it has not been applied to give any additional benefits for the full option.

8.6. Determination of Benefits

The benefits calculated for the benefit cost ratio (BCR) as set out in the EEM include benefits arising from travel time savings, vehicle operating cost (VOC) savings, crash reductions, CO_2 emission reductions and improvements in trip reliability. These are discussed in detail below.

8.6.1. Travel Time Benefits

Travel time benefits are likely to be the largest benefit component of the model output. Composite values of base travel time for light and heavy vehicles have been determined for the Urban Arterial road category and used in the economic evaluation for each of these vehicle classes separately. All delay associated with the network being over-capacity has been included as 'bottleneck' delay.

8.6.2. Vehicle Operating Cost Benefits

Vehicle operating cost (VOC) benefits have been calculated in accordance with the EEM (Appendix A5.2) for Base Running costs, which are a function of speed, distance and gradient. For the purposes of this assessment, the effects of gradient have been ignored, as the majority of the travel routes used to calculate the road user costs are generally flat, with the exception of Ngauranga Gorge, which comprises only a small segment of the travel routes starting or ending on SH1.

[12] Western Ring Route Ramp Signalling – Economic Evaluation and Efficiency Assessment, Richard Paling, December 2006.

Additional VOC benefits related to travelling in congested conditions have not been assessed as it is not possible to easily calculate the volume capacity ratios required by the EEM methodology from micro-simulation models.

Additional VOC benefits due to bottleneck delay have also not been calculated, as it is not possible to determine stopped time from the Paramics outputs.

8.6.3. Trip Reliability Benefits

Trip reliability benefits capture the economic benefits of reducing the variability of travel times for trips undertaken at broadly the same time each day. The variability in travel times assessed for trip reliability is not intended to account for the effects of major incidents on the road network. Rather it is the day to day differences in travel times that occur as a result of the random interaction of all the other vehicles on the road network. These changes in daily travel times are particularly prevalent on highly congested parts of the road network, such as the Ngauranga to Aotea Quay corridor at peak times.

Two approaches have been used to assess trip reliability benefits. The first has been used only for assessing the benefits of Stage 2, the ATMS implementation by itself. The second has been used to determine the trip reliability benefits for the remaining Stages.

Trip Reliability – Method 1

The implementation of ATMS in the Paramics model has not been able to replicate the behaviour of vehicles under a managed motorway regime. Model results from the first round of modelling showed travel time disbenefits from the ATMS, as the speed of modelled vehicles was capped without an improvement in vehicle throughput (as would be expected with the operation of ATMS).

A post-implementation study of the M42 ATMS and hard-shoulder running operating regime reported a 22% reduction in the variability of travel times[13]. Based on this, and approaches taken for similar motorway projects involving providing additional capacity, travel time reliability benefits have been assessed as 5% of the travel time benefits. This is likely to underestimate the trip reliability benefits given the highly congested nature of this section of the motorway, so the economic assessment will be conservative in respect to the trip reliability benefits.

This method has only been applied to determining the trip reliability benefits for the Stage 2 ATMS implementation.

Trip Reliability – Method 2

This second approach uses outputs from the Paramics model to determine the trip reliability benefits for the Do Minimum and Options (excluding the Stage 2 implementation of ATMS).

The methodology used is different to that contained in the EEM, due to the differences in the information reported from micro-simulation models compared to equilibrium-type assignment models. In particular, the EEM methodology requires link volume capacity ratios, which it is not practical to determine from the Paramics model. The methodology used determines the trip variability for each individual journey against the average journey time from the 10 Paramics runs.

As per the EEM[14], the value of reliability claimed uses a factor of 0.8 for light vehicles and 1.2 for heavy vehicles. As most trips assessed in the Paramics model start and end outside the extents of that model, an adjustment has been made to account for the change in trip variability over the entire journey. It has been assumed that 75% of the variance in travel times is outside the study area, so a factor of 50% has been used for the benefit calculation.

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[13] M42 ATM Monitoring and Evaluation – Project Summary Report, Highways Agency, November 2009.

[14] EEM, Page A4-13

8.6.4. Crash Reduction Benefits

A safety hazard analysis was undertaken which informed the crash benefit analysis. The hazard analysis involved using the Safety Baseline to calculate a percentage change to safety hazards for each option. The Safety Baseline was developed by Mouchel and subsequently validated by the ECI team. The hazard analysis was then verified by Mouchel.

For the five options the Baseline hazard logs were reviewed and the change in risk profile that would be expected for each hazard was estimated based on experience from other assessments. The risk profile for each hazard was mostly reduced but there were a few hazards where the risk increased.

The same crash costs calculated for 2011 have been used for each modelled future year, with the change in the risk profile for each particular option then applied. The resulting option (and Do Minimum with no change in the risk profile) crash costs are then discounted.

The use of the 2011 crash costs has been adopted due to significant difficulties in calculating the future year crash costs. It is noted that this approach will introduce some inaccuracies into the calculations due to:

- Crash costs will not account for changes in traffic volumes (likely to be increases on the motorway and decreases on Hutt Road); and
- Decreases in crash costs due to safety improvements in vehicle design over time will not be reflected in the future year crash costs.

However, it is considered that this approach will produce results which are consistent between the Do Minimum and the Options being assessed over the length of the assessment period.

8.6.5. CO_2 Emissions

As per the EEM A9.7, CO2 emission costs have been calculated as 4% of the vehicle operating costs.

8.6.6. Project Costs and Construction Period

Expected construction costs have been used for this assessment, as detailed in Section 6. For all Options, a construction period of one year has been used, with construction commencing at the start of the 2013/14 year.

It is noted that different staging strategies will reduce the present value of the costs of the Options, as the start of construction is deferred to later years. However, the effects of different staging options have not been undertaken as part of this assessment.

8.6.7. Project Benefit Cost Ratio

The economic evaluation for this project was undertaken in September 2012. As detailed earlier, the base date for the project is July 2011 and the time zero is 2012. The assessment has been undertaken over a 30 year assessment period, with an 8% discount rate.

Table 8.3 reports the present value of the benefits for the full scheme.

Table 8.3 Present Value of Full Scheme Benefits [$M]

Option	Travel Time	Congestion Benefits	Trip Reliability Benefits	Vehicle Operating Cost Benefits	CO_2 Benefits	Crash Costs	Total Benefits
Full Scheme (Northbound and Southbound Widening with ATMS)	54.8	15.0	10.2	-7.5	-0.3	7.0	**79.1**

The benefit cost ratio for the full scheme is shown in **Table 8.4**.

Table 8.4 Option Benefit Cost Ratios

Option	PV Benefits	PV Costs	BCR
Full Scheme (Northbound and Southbound Widening with ATMS)	79.1	75.1	**1.1**

Table 8.4 shows that the full scheme has a BCR above 1, indicating that from the modelling results alone the full scheme is justified from travel time, trip reliability, vehicle operating cost and crash cost savings. However, as noted above the method used will not capture benefits associated with changes in the performance of the network outside the 17 defined paths. It is likely that this will underestimate the benefits of the full scheme – for instance, improvements in travel conditions on Hutt Road for vehicles not coming from or going to SH1 or SH2 will not be included in these benefits.

An alternative assessment methodology, using model outputs from the entire network (as opposed to just on the 17 paths), was trialled initially. However, changes in how the model network operated well outside the area of the effect of the Project (particularly within the Hutt Valley) skewed the results. As a consequence, the decision was made to exclude the effects of this model "noise" by only using the outputs gathered from the 17 defined paths, even though this would also exclude benefits occurring on the network outside these paths.

In addition, the decrease in travel time benefits (resulting from the capped speed for vehicles) with the ATMS implemented within the model, combined with the cost of the ATMS, results in the full scheme having a lower BCR than would be expected.

The results of the economic analysis indicate that the full scheme is expected to realise benefits greater than its cost. Additional benefits not captured in this assessment (as noted earlier in this section) are likely to increase the benefits further, resulting in a BCR above the 1.1 reported here.

8.6.8. Sensitivity Tests

As a sensitivity test, the cost benefit analysis has also been undertaken with alternative discount rates of 6% and 4%, instead of the current 8%.

With a discount rate of either 4% or 6%, the BCR of the full scheme improves (as would be expected). These results are reported in **Table 8.5**.

Table 8.5 BCR of Option Benefits with Different Discount Rates

Option	4%	6%	8%
Full Scheme (Northbound and Southbound Widening with ATMS)	1.9	1.4	**1.1**

8.6.9. Staging of Scheme Elements

An assessment of each stage of the full scheme has been undertaken. For the ATMS stage, only trip reliability benefits (based on Method 1 described earlier) and crash benefits have been included, with no attempt made to quantify the travel time and congested travel benefits that could be expected from a managed motorway regime.

For the two widening stages, the approach used differs from the standard economic methodology, in that the costs of the ATMS have been excluded from the assessment. This has been done on the basis that as the Paramics model does not produce positive benefits associated with the implementation of the ATMS, so the cost of that stage should not be included either. In addition, the cost of the ATMS could be considered a sunk cost by the time widening is undertaken.

Table 8.6 reports the present value of the benefits for the stages comprising the full scheme.

Table 8.6 Present Value of Benefits for Staged Elements of Full Scheme [$M]

Option	Travel Time	Congestion Benefits	Trip Reliability Benefits	Vehicle Operating Cost Benefits	CO_2 Benefits	Crash Costs	Total Benefits
SH2 Ngauranga On-Ramp	4.2	0.0	0.0	0.0	0.0	0.0	**4.2**
Do Minimum with ATMS	0.0	0.0	18.5	0.0	0.0	6.2	**24.7**
Northbound Widening with ATMS	28.2	7.5	4.8	3.1	0.1	3.8	**47.6**
Southbound Widening with ATMS	26.6	7.6	5.4	-10.6	-0.4	3.1	**31.6**

The benefit cost ratios for the separate stages of the full scheme are shown in **Table 8.7**.

Table 8.7 Benefit Cost Ratios for Staged Elements of Full Scheme

Option	PV Benefits	PV Costs	BCR
SH2 Ngauranga On-Ramp	4.2	3.5	**1.2**
Do Minimum with ATMS	24.7	13.0	**1.9**
Northbound Widening with ATMS	47.6	19.3	**2.5**
Southbound Widening with ATMS	31.6	37.9	**0.8**

The analysis of the staged elements of the full scheme shows that implementation of geometric improvements and ramp metering on the SH2 Ngauranga on-ramp has a BCR of 1.2, although this is likely to underestimate the benefits due to the fairly simplistic assessment method used.

Implementing ATMS on the current three lane motorway is expected to have a BCR of 1.9, although this is likely to underestimate the BCR as no benefits have been claimed for travel time and congested travel savings.

Given implementation of the ATMS in stage 2, the northbound widening has a BCR of 2.5.

Although the southbound widening has a BCR of 0.8, it is noted that this element completes the full scheme, which overall has a BCR of 1.1. It is also likely that this additional capacity will be required to enable the full benefits of the northbound widening to be realised, as drivers benefiting from the northbound widening have to travel southbound at some time to complete their round trips.

It is again noted that congestion relief benefits have not been evaluated for any of the stages assessed, nor for the full scheme. The resulting BCR's are therefore all likely to be conservative.

The economic assessment has found that the complete Project has a BCR of 1.1.

The staged elements comprising the full scheme have the following BCR's:

- **SH2 Ngauranga On-Ramp: 1.2**
- **ATMS: 1.9**
- **Northbound Widening: 2.5**
- **Southbound Widening: 0.8**

Worksheet 3: Benefit Cost Analysis

Benefit Cost Analysis

Project:	**Ngauranga to Aotea Quay ATM**
Component:	**Full Scheme**
Discount Rate	*8%*
Analysis Period	*30 Years*

		PV of Benefits as Calculated		PV of Net Benefits (PV Option - PV Do Minimum Benefits)
	BENEFITS (NPV):	**Economic Do Minimum**	**Full Option**	**Full Option**
1a	Travel Time Benefits	771.602	716.843	54.8
1b	Congestion Benefits	34.971	19.939	15.0
1c	Trip Reliability	37.476	27.324	10.2
2	Vehicle Operating Costs Benefits	725.208	732.689	-7.5
3	Accident Costs	34.123	27.139	7.0
4	Carbon Dioxide	29.008	29.308	-0.3
5	Reduced Driver Frustration			
6	Monetised External impacts			
7	**PV Total Net Benefits**	1,632.388	1,553.241	**79.1**

	COSTS (NPV):	PV of Costs as Calculated		
8	I&R	0.000	0.000	0.0
9	D&PD	0.000	0.000	0.0
10	Property Cost	0.000	0.000	0.0
11	Construction	0.000	75.099	75.1
12	Annual Maintenance	0.000	0.000	0.0
13	Periodic Maintenance	0.000	0.000	0.0
14				
15				
16				
17				
18	**PV of Total Net Costs**	0.000	75.099	**75.1**
19	**National BCR = (7)/(18)**			**1.05**

Appendix C

Modelling and Economics Reported for Part 5 (P2G)

10. Economic Analysis and Risk Assessment

10.1. Cost Estimation

The expected and 95th percentile estimates for this project are summarised in the Table 10-1.

- **Table 10-1 Cost Estimate – Petone to Grenada Link**

Option Description	Expected Estimate	95th Percentile Estimate
Petone to Grenada Link	$246,278,608	$275,928,220

The detailed cost estimate for the project is included in Appendix G.

Further to the costs above MWH has assessed the costs for the three curve improvements as part of a separate Project Feasibility Study (refer Appendix H and MWH's 'Tawa Interchange Area' Project Feasibility Report for more details). The expected and 95th percentile estimates for these improvements are summarised in Table 10-2 .

- **Table 10-2 Cost Estimate - Tawa Safety Improvements[8]**

Option Description	Expected Estimate	95th Percentile Estimate
Realignment SH1 North of Tawa Interchange	$4,611,426	$6,202,336
Realignment Tawa Interchange	$6,266,564	$8,953,691
Realignment SH1 South of Tawa Interchange	$4,334,275	$6,252,826

The costs of both the Tawa interchange safety improvements (as calculated by MWH) and the Petone to Grenada Link Road, completed as one project are summarised in Table 10-3.

- **Table 10-3: Cost Estimate - Total**

Option Description	Expected Estimate	95th Percentile Estimate
Total	$261,490,873	$297,337,073

This cost estimate is in September 2009 dollars. The Net Present Value Cost Estimate including maintenance costs at year zero is **$252.7M.**

[8] Adjusted from the 2007 cent costs assessed by MWH to 2009 costs

10.2. Risk Assessment

The project risks have been assessed using the General Approach as determined in the Risk Management Process Manual (AC/Man/1).

The risk register is contained in Appendix I and the main risks to the project are summarised below:

- Land acquisition
- Environmental constraints
- Lincolnshire farm; Horokiwi Community; Quarry impacts on design
- Geometric Constraints
- Change in scope of works
- Excessive claims by the contractor
- Issues raised that cause redesign
- Increase in cost rates over and above current escalation
- Geotechnical risks / contaminated material
- Visual Impacts

10.3. Transport Modelling

10.3.1. Input Assumptions

The SATURN model developed for the Ngauranga Triangle Strategy Study has been used for producing economic outputs for this PFR. This model has been developed from the Transmission Gully SATURN model and incorporates all major roads in the Wellington Region and detailed intersection coding in the area bounded by SH1 at McKay's Crossing in the north, SH2 at Fergusson Drive in the east and SH1 south of Ngauranga interchange in the south.

The model was peer reviewed by Flow Transportation Specialists for use in the Ngauranga Triangle strategy study and found to be suitable for this purpose.

SATURN models have been constructed for the years 2016 and 2026 with the following schemes included in the Do Minimum (DM) scenario:

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- **Table 10-4 Do Minimum projects**

Ngauranga triangle DM	2006	2016	2026
Terrace Tunnel, Inner City Bypass, Kapiti WLR and a number of other schemes which are in the buffer area (coded simplistically and have limited effect on the simulation area)	✗	✓	✓
Dowse Interchange	✗	✓	✓
SH2/58 Upgrade	✗	✓	✓
Melling Interchange Upgrade	✗	✗	✓
Kennedy Good Bridge Upgrade	✗	✗	✓
Additional network representation around Mark Avenue / Westchester Drive	✗	✓	✓
Takapu Valley Road	✗	✓	✓
MacKay's Crossing	✗	✓	✓
Bing Lucas Drive	✗	✓	✓
Petone Interchange	✗	✓	✓
SH1 Widening (south of Ngauranga)	✗	✓	✓

These schemes have been included along with a number of other public transport and TDM schemes in the Wellington Transport Strategy Model (WTSM) modelling from which future year matrices were produced for input into the SATURN models.

Different WTSM output matrices have been used for the DM and option tests to reflect the changes in distribution resulting from the inclusion of the link road.

The Petone to Grenada Link Road (LR) connections are coded as:

- South facing ramps to SH1 at Tawa. The connection from the link road is assumed to be a lane gain into the existing auxiliary lane for the Takapu Road off ramp. This provides a merge/weave length of approximately 300m. (Note that any delays or loss in capacity due to this weaving length have not been incorporated into the transport model);
- A full access interchange at Lincolnshire Farms, assumed to be approximately 3.0km from the SH1 diverge; and
- A full grade separated roundabout at Petone.

10.3.2. Model Outputs

Model outputs have been used in the economic assessment such that the following benefits (and dis-benefits) are quantified:

1) Benefits to existing road users travelling between Petone and Grenada due to the provision of a quicker shorter route;
2) Benefits to existing users of SH58 and SH1 and SH2 south of the link through reductions in traffic volumes and therefore improved travel times;
3) Benefits to additional road users through the improved linkage between Petone and Grenada (see section A11.12 of the EEM volume 1); and

4) Dis-benefits due to increased congestion in areas upstream or downstream of the proposed link road resulting from the change in traffic distribution.

Model outputs used are:

- Full origin destination trip matrices;
- Travel time skimmed matrices; and
- Travel distance skimmed matrices.

These have been produced for:

- The AM, inter and PM peaks;
- Years 2016 and 2026; and
- Do Minimum and Option scenarios.

Travel time benefits have been rationalised to ensure that reductions in travel times are observed in the model for origins and destinations likely to benefit from the link road, i.e. to ensure that the benefits in points (1) to (4) above are appropriately captured.

Travel time changes have been capped at 5 minutes to exclude areas where there were unreasonably high delays in the Do Minimum scenario, typically on minor priority links. This cap is only used for trips from Horokiwi Road where all traffic joins at the existing priority intersection on SH2. Although Horokiwi Road connects to an at capacity SH2 link so that there are likely to be extremely high delays, it is not considered that these delays would exceed 5 minutes. These large changes in delay would only be applied to a small number of vehicles (a maximum of 114 in 2026 PM peak) but including this significant delay in the Do Minimum may artificially skew the benefits.

10.4. Economic Evaluation

10.4.1. Methodology

The benefits associated with the proposed scheme were calculated based on the guidance of the Economic Evaluation Manual (EEM) Volume 1, for undertaking cost benefit analyses using variable matrix methods.

The trip matrices, time and distance skims produced for the Do Minimum and Option scenarios were used as input for the calculation. Note that there has been no user cost correction in the economic modelling (15% increase for non-work trips) as the modelling has not separated out trips by purpose. This means that monetary travel time benefits may potentially be 15% higher for some of the vehicles affected by the inclusion of the link road.

The matrix based computation for calculating the benefits was used, where the components of cost are calculated for each Origin-Destination pair individually and then summed over the whole matrix.

Travel time savings and vehicle operating cost savings were included in the analysis.

Any accident benefits/ dis-benefits are likely to be minor due to the fact that the new road link will be of a similar standard as the existing road links, and not designed to address a specific accident black spot. With the inclusion of the new link road, there is an overall change in VKT of approximately 0.5% in 2016 and 0.4% in 2026.

The exception to this is accident benefits at the Tawa interchange. These have been taken from the MWH produced PFR and are documented in the Tawa interchange PFR report. Note that the accident benefit update factors (2002 to 2008) have been revised in line with EEM guidance. The travel time and vehicle operating cost benefit calculations from this report have been superseded by the modelling undertaken here.

10.5. Results

As discussed in the above, the calculation of benefits has focused on travel time savings and changes in vehicle operating costs, based on a variable trip matrix assessment to incorporate changes in trip distributions between the do minimum and options scenarios. This was done for 2016 and 2026, for the AM, inter peak and PM peak hours.

The analysis of travel time savings by origin-destination pair indicated that there were some dis-benefits arising from trips outside of the immediate area of influence of the proposed link road. For example, in the 2016 AM peak model, the WTSM model output matrices indicate a redistribution of trips such that more vehicles are travelling into Wellington CBD from both SH1 and SH2. This increase in trips results in additional congestion in the CBD which is appears as a dis-benefit due to overall increases in travel time for these trips.

In order to isolate these effects, the model output matrices have been split into the following sectors:

- **Simulation:** The core model area covering from Ngauranga Gorge in the south to MacKay's Crossing in the north and the SH2/SH58 interchange in the east;
- **South:** South of Ngauranga Gorge;
- **North:** North of MacKay's Crossing; and
- **East:** East of the SH2/SH58 interchange.

Peak hour benefits arising from travel between these sectors are shown in Table 10-5, Table 10-6 and Table 10-7 below:

- **Table 10-5: 2016 AM peak**

	Simulation	South	North	East
Simulation	$ 1,120.85	-$ 962.96	$ 19.50	$ 14.79
South	$ 55.30	-$ 106.72	$ 2.61	$ 14.77
North	-$ 64.81	-$ 154.54	-$ 0.37	$ 1.49
East	-$ 101.59	-$ 447.32	$ 0.08	-$ 10.08

- **Table 10-6: 2016 Inter peak**

	Simulation	South	North	East
Simulation	$ 1,015.26	$ 31.36	$ 26.17	$ 24.12
South	$ 51.09	-$ 13.10	$ 5.93	$ 8.18
North	$ 16.80	$ 1.19	-$ 0.20	-$ 0.04
East	$ 27.09	$ 3.23	$ 0.07	$ 0.32

- **Table 10-7: 2016 PM peak**

	Simulation	South	North	East
Simulation	$ 727.45	$ 484.78	-$ 77.18	-$ 178.14
South	-$ 1,176.90	$ 17.33	-$ 60.25	-$ 414.36
North	$ 5.96	$ 3.88	-$ 0.52	-$ 0.58
East	-$ 41.95	$ 31.99	-$ 4.58	-$ 6.86

Points of note from the tables above are:

- There are significant dis-benefits arising from trips to Wellington CBD from both the simulation area and the east in the AM peak. This is due to the increase in southbound trips in the option scenario (and therefore congestion) on SH2 and SH1 south of Ngauranga. This results in a total hourly dis-benefits of approximately $600 in the AM peak;
- With far less trip re-distribution in the IP period, the option trip matrix is relatively unchanged from the do minimum matrix and there are only minor dis-benefits likely to be arising from model noise within Wellington CBD. This results in a total hourly benefits of approximately $1,100 in the inter peak; and
- There are significant dis-benefits in the PM peak arising from the increase in trips from Wellington CBD. This results in a total hourly dis-benefit of approximately $700 in the PM peak.

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Table 10-8: Comparison of total trips

2016	Do Minimum	Option	Difference
AM Peak 2016	100,538	101,109	570
Inter Peak 2016	94,493	94,442	- 51
PM Peak 2016	120,552	120,948	396
SUB TOTAL	**315,583**	**316,499**	**915**
2026	**Do Minimum**	**Option**	**Difference**
AM Peak 2026	111,262	111,946	684
Inter Peak 2026	105,521	105,445	- 75
PM Peak 2026	132,378	132,888	510
SUB TOTAL	**349,161**	**350,280**	**1,119**

Table 10-8 shows the amount of induced traffic inherent in the WTSM matrices, indicating approximately 900 additional trips per day in the option scenario in 2016, and approximately 1,100 additional trips in 2026.

The dis-benefits resulting from the redistribution and induction of trips may be put into context by looking at a fixed trip matrix sensitivity analysis. If the Do Minimum WTSM matrices are assigned to the option network (referred to later as Test 37), the resulting travel time benefits for each sector are shown in Table 10-9, Table 10-10 and Table 10-11 below:

Table 10-9: 2016 AM peak fixed matrix

	Simulation	South	North	East
Simulation	$ 1,794.33	$1,392.76	$ 23.17	$ 71.45
South	$ 209.18	$ 13.26	$ 4.39	$ 25.92
North	-$ 59.19	$ 13.48	-$ 0.00	$ 2.21
East	$ 219.75	$ 409.16	$ 2.06	$ 0.98

Table 10-10: 2016 Inter peak fixed matrix

	Simulation	South	North	East
Simulation	$ 869.48	$ 44.42	$ 24.23	$ 26.92
South	$ 73.38	-$ 16.86	$ 6.73	$ 11.98
North	$ 15.95	$ 2.12	-$ 0.00	$ 0.03
East	$ 26.03	$ 4.24	$ 0.12	$ 0.01

- **Table 10-11: 2016 PM peak fixed matrix**

	Simulation	South	North	East
Simulation	$ 1,919.94	$1,003.24	-$ 70.77	$ 35.20
South	$ 679.24	-$ 24.43	$ 45.57	$ 77.99
North	$ 7.32	$ 2.25	-$ 0.00	$ 0.25
East	$ 58.99	$ 37.24	-$ 4.37	-$ 0.99

There are still minor dis-benefits resulting from model noise, but there are now benefits in the order of $4,100, $1,100 and $3,800 in the AM, inter and PM peak hours respectively for all sectors with the majority of these arising from travel in the simulation area and between the simulation area and Wellington CBD.

Incorporating the dis-benefits (i.e. variable trip matrix assessment), the results of the travel time calculations for the 2016 and 2026 scenarios are presented below.

- **Table 10-12: Annual savings ($July 2008)**

2016	Travel Time	VOC	TOTAL
AM Peak 2016	-$ 383,026.09	$ 1,653,511.93	$ 1,270,485.84
Inter Peak 2016	$ 4,594,187.56	$ 7,886,384.46	$ 12,480,572.03
PM Peak 2016	-$ 426,929.73	$ 1,724,485.12	$ 1,297,555.39
SUB TOTAL	**$ 3,784,231.75**	**$ 11,264,381.51**	**$ 15,048,613.26**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	$ 335,663.27	$ 1,828,304.17	$ 2,163,967.44
Inter Peak 2026	$ 18,109,880.26	$ 9,799,735.47	$ 27,909,615.73
PM Peak 2026	$ 480,036.58	$ 1,933,736.71	$ 2,413,773.29
SUB TOTAL	**$ 18,925,580.11**	**$ 13,561,776.35**	**$ 32,487,356.46**

Table 10-12 above shows that there is an annual travel time benefit of approximately $3.8M in 2016, rising to an annual benefit of $18.9M in 2026. The VOC benefits are greater with an annual benefit of approximately $11.3M in 2016, rising to an annual benefit of $13.6M in 2026

This gives a total annual benefit of $15.0M in 2016, rising to an annual benefit of $32.5M in 2026 due to travel time and vehicle operating cost savings.

The net present value of the sum of the travel time savings and vehicle operating cost savings was subsequently calculated, for a 30 year analysis period beginning in 2014 using a discount factor of 8%. The resulting Net Present Value benefit is **$280.0M**.

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10.6. Sensitivity tests

Three sensitivity tests were undertaken, namely

- Test 37: a fixed trip analysis based on the assignment of the DM matrix to both networks, showing the likely impact of the link if there were no redistribution effects, i.e. a trip elasticity of 0;
- Test 38: Applying an appropriate “toll” to the link road to make it less attractive to establish the impact of a reduction in link road users; and
- Test 39: a variable trip matrix analysis assigning an average of the DM and DS matrix to the DS network. This reflects elasticity somewhere between 0 and that implied in the WTSM analysis.

The results of these sensitivity tests are provided below:

10.6.1. Test 37: Elasticity = 0

As shown in Section 10.5, by using a fixed trip matrix, essentially assuming that there is no redistribution / mode shift effects arising from the construction of the new link, there are no substantial dis-benefits arising from increased traffic to and from Wellington CBD.

However, there due to there being no change in distribution of traffic, the VOC benefits are lower which results in a total benefit of **$271.6M** broken down as shown in Table 10-13 below:

- **Table 10-13: Test 37 Annual savings ($July 2008)**

2016	Travel Time	VOC	TOTAL
AM Peak 2016	$ 2,551,247.62	$ 1,639,281.42	$ 4,190,529.04
Inter Peak 2016	$ 4,177,157.89	$ 6,552,745.72	$ 10,729,903.61
PM Peak 2016	$ 2,330,811.05	$ 1,452,889.04	$ 3,783,700.09
SUB TOTAL	**$ 9,059,216.56**	**$ 9,644,916.17**	**$ 18,704,132.73**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	$ 3,688,446.04	$ 1,645,780.74	$ 5,334,226.78
Inter Peak 2026	$ 9,542,988.70	$ 8,246,416.37	$ 17,789,405.07
PM Peak 2026	$ 4,031,723.80	$ 1,903,209.55	$ 5,934,933.34
SUB TOTAL	**$ 17,263,158.54**	**$ 11,795,406.66**	**$ 29,058,565.20**

10.6.2. Test 38: Less attractive link road

The Test 38 network is assigned with the Do Something matrices. This is to establish the level benefits if more traffic was induced than the link road usage would support. This is done by making the link road a less attractive route in the network by application of a cost penalty.

The resulting benefit streams are shown in Table 10-14. Note that there are travel time dis-benefits in all periods in 2016 since the link road no longer provides such a low cost alterative so induced traffic is no longer able to benefit from the travel time savings. There are still VOC savings which outweigh the travel time dis-benefits leaving a total benefit of **$187.1M.**

- **Table 10-14: Test 38 Annual savings ($July 2008)**

2016	Travel Time	VOC	TOTAL
AM Peak 2016	-$ 445,957.58	$ 1,391,339.85	$ 945,382.27
Inter Peak 2016	-$ 1,281,632.39	$ 5,571,168.04	$ 4,289,535.65
PM Peak 2016	-$ 109,774.24	$ 1,589,896.38	$ 1,480,122.14
SUB TOTAL	**-$ 1,837,364.21**	**$ 8,552,404.27**	**$ 6,715,040.06**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	-$ 473,494.35	$ 1,489,756.00	$ 1,016,261.65
Inter Peak 2026	$ 11,833,546.51	$ 8,234,122.31	$ 20,067,668.82
PM Peak 2026	$ 198,245.33	$ 1,822,660.33	$ 2,020,905.65
SUB TOTAL	**$ 11,558,297.49**	**$ 11,546,538.64**	**$ 23,104,836.12**

10.6.3. Test 39: Partially induced traffic

The option test put forward documented in Section 10.5 shows the impact of the link road if traffic is redistributed / induced implicit in the WTSM output matrices with associated implied elasticity's (not calculated here). Test 37 showed the impact of the link road with no change in traffic pattern, equivalent to an elasticity of zero. Test 39 uses an average of the DM and DS WTSM matrices to establish the benefit levels if the level of traffic induction / redistribution implied by the WTSM model were not to fully eventuate.

The resulting benefit streams are shown in Table 10-15. Note that there are travel time benefits in all periods in 2016 since the negative impact of induced traffic is no longer sufficient to outweigh the positive impacts of the link road. In 2026 the travel time benefits are not as large as in the base case resulting in a total benefit of **$259.4M.**

- **Table 10-15: Test 39 Annual savings ($July 2008)**

2016	Travel Time	VOC	TOTAL
AM Peak 2016	$ 1,573,041.62	$ 1,830,937.87	$ 3,403,979.49
Inter Peak 2016	$ 4,555,860.50	$ 7,849,023.52	$ 12,404,884.01
PM Peak 2016	$ 1,335,489.77	$ 1,842,523.32	$ 3,178,013.09
SUB TOTAL	**$ 7,464,391.88**	**$ 11,522,484.70**	**$ 18,986,876.59**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	$ 2,172,805.16	$ 1,928,748.40	$ 4,101,553.57
Inter Peak 2026	$ 9,619,644.74	$ 9,753,653.49	$ 19,373,298.24
PM Peak 2026	$ 1,471,466.58	$ 2,079,598.17	$ 3,551,064.75
SUB TOTAL	**$ 13,263,916.48**	**$ 13,762,000.07**	**$ 27,025,916.56**

10.7. Link Road flows

As can be seen in Table 10-16, the hourly flows on the link road are highest in the base option tested as this incorporates both the induced traffic with no penalty placed on the link road.

Without the induced traffic effect, there are approximately 500vph less using the link road in the AM and PM peaks and 400vph less in the inter peak. This is a good proxy for the volumes of traffic that the link road is inducing.

Test 38 which make the link road less favourable through the application of an additional cost (not included in the travel time differences quoted) results in a reduction in flow on the link road slightly less than the reduction from using the DM trip matrix. The difference in flow on the link road between the base case and Test 38 represents the volume of traffic which is “forced” onto the local road network through the application of the additional cost.

Test 39 shows that by assuming that the induced traffic effect is half that implicit in the WTSM output matrices indicate a reduction in flow approximately half way between the base case and Test 37.

SINCLAIR KNIGHT MERZ
SKM

- **Table 10-16: Link Road flows**

Peak	Test	EB flow (PCU/hr)	WB flow (PCU/hr)
AM	Base	1117	619
	37	802	423
	38	947	393
	39	988	526
IP	Base	667	694
	37	478	483
	38	536	359
	39	572	588
PM	Base	740	1083
	37	457	784
	38	484	890
	39	607	935

10.8. Benefit Cost Ratio

The Benefit Cost Ratio for this project is **1.1.**

Table 10-17 provides a summary of the benefit cost ratios that are achieved with sensitivity testing. The BCR for the sensitivity tests has a range between 1.1 and 0.7

- **Table 10-17: Summary of the Sensitivity Analysis**

	Preferred Option	Test 37	Test 38	Test 39
PV Benefits	$280.0 million	$271.6 million	$187.1 million	$259.4 million
PV Cost	$252.7 million	$252.7 million	$252.7 million	$252.7 million
BCR	1.1	1.1	0.7	1.0

10.9. Conclusion

The modelling and economic analysis documented above has indicated a 30 year benefit, appropriately discounted of **$280.0M.** Sensitivity tests showing a range of induced traffic impacts indicate total benefits of between **$187.1M** and **$271.6M**.

The analysis has shown that significant travel time benefits and VOC are realised within the area bounded by south of Ngauranga Gorge on SH1, MacKay's Crossing on SH1 and north of SH58 on SH2. The analysis has also shown that there are dis-benefits arising in the peak direction in the AM and PM peaks due to additional traffic into and out of Wellington city induced by the inclusion of the link road. These dis-benefits are likely to occur and as such have been included in the analysis.

Appendix J Economic Evaluation

1	Evaluator(s)	Fainks Rossouw/ Darren Fidler	
	Reviewer(s)	Darren Fidler/ Dean Coutts	
	Approved organisation name	Sinclair Knight Merz	
	Project/ package name	Petone - Grenada PFR	
	Your reference	ZB00938.10	
	Project desription	Provide a new link road between Petone and Grenada, Wellington	
	Describe the problem to be addressed	A new link road between Petone and Grenada will provide a more direct link between the two areas reducing the number of vehicles turning between SH1 and SH2 at the Ngauranga interchange	
	Brief description of the location	Wellington - between Petone and Grenada	
	Describe the do minimum	No link road, other committed schemes outlined in the PFR report.	
	Summarise the options assessed	70kph link road between Petone and Grenada in line with outcomes of Ngauranga triangle strategy study. North facing connections at new Tawa interchange, full diamond connecting with Lincolnshire Farms and full grade separated roundabout at Petone. Demands consistent with WTSM output demand matrices incorporating the link road.	
2	Time zero (assumed construction date)	2014	
	Expected duration of construction (months)	24	
	Date economic evaluation completed	7/10/2009	
	Base date for costs and benefits	Jul-08	
	Road type	Urban Arterial	
	Travel time cost	As per EEM Table A4.3 updated to July 2008	
	Posted speed limit	70 kph	
	AADT at time zero	Do minimum flows taken from WTSM - N/A	
3	Calculations		
	VOC savings	$ 131,370,374	C
	Travel time savings	$ 137,881,530	D
	Comfort benefits from sealing	-	E
	PV accident cost savings	$ 10,762,925	F
	Maintenance cost savings	-	G
4	Benefits	$ 280,014,829	Y
	Costs	$ 252,714,935	Z
	Provisional BCR	**1.1**	

Option	Petone to Grenada Link Preferred Option	Base Date	Jul-08	Time Zero	Jul-14

BCR Calculation									
						Discount Factor	8%		
PV Benefit		0	1	2	3	4	5	6	7
[$ July2008]		2014	2015	2016	2017	2018	2019	2020	2021
		1.00	1.08	1.17	1.26	1.36	1.47	1.59	1.71
				$ 1,514,134.84					
	Travel Time Savings			**$ 3,784,231.75**	$ 5,298,366.58	$ 6,812,501.42	$ 8,326,636.26	$ 9,840,771.09	$ 11,354,905.93
$ 137,881,529.92				$ 3,244,368.78	$ 4,206,014.22	$ 5,007,391.92	$ 5,666,968.72	$ 6,201,355.05	$ 6,625,478.55
				$ 229,739.48					
	VOC savings			**$ 11,264,381.51**	$ 11,494,120.99	$ 11,723,860.48	$ 11,953,599.96	$ 12,183,339.44	$ 12,413,078.93
$ 131,370,374.26				$ 9,657,391.56	$ 9,124,403.83	$ 8,617,387.44	$ 8,135,419.28	$ 7,677,570.47	$ 7,242,912.33
				$ 1,743,874.32					
$ 269,251,904.18	Total VOC and Travel Time Savings			**$ 15,048,613.26**	$ 16,792,487.58	$ 18,536,361.90	$ 20,280,236.22	$ 22,024,110.54	$ 23,767,984.86
$ 269,251,904.18				$ 12,901,760.34	$ 13,330,418.05	$ 13,624,779.36	$ 13,802,388.00	$ 13,878,925.52	$ 13,868,390.88
PV Cost									
[$ July2008]	Capital Cost	$ 130,745,436.50	$ 130,745,436.50						
$ 251,806,025.85	$ 261,490,873.00	$ 130,745,436.50	$ 121,060,589.35	$ -	$ -	$ -	$ -	$ -	$ -
	(assume Sept 2009 costs = July 2008 costs)								
	Periodic Maintenance (Renewals)								
	Reseal								
	Rehab								
$ 842,785.47	$ 842,785.47			$ -	$ -	$ -	$ -	$ -	$ -
	Annual Maintenance			$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
$ 66,123.89	$ 66,123.89			$ 5,486.97	$ 5,080.53	$ 4,704.19	$ 4,355.73	$ 4,033.09	$ 3,734.34
$ 252,714,935.21									

		8	9	10	11	12	13	14	15	16	17	18	19
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
		1.85	2.00	2.16	2.33	2.52	2.72	2.94	3.17	3.43	3.70	4.00	4.32
	Travel Time Savings	$ 12,869,040.76	$ 14,383,175.60	$ 15,897,310.44	$ 17,411,445.27	**$ 18,925,580.11**	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11
$ 137,881,529.92		$ 6,952,742.30	$ 7,195,168.74	$ 7,363,530.67	$ 7,467,470.43	$ 7,515,608.25	$ 6,958,896.53	$ 6,443,422.71	$ 5,966,132.14	$ 5,524,196.43	$ 5,114,996.69	$ 4,736,108.05	$ 4,385,285.23
	VOC savings	$ 12,642,818.41	$ 12,872,557.90	$ 13,102,297.38	$ 13,332,036.86	**$ 13,561,776.35**	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35
$ 131,370,374.26		$ 6,830,521.40	$ 6,439,483.79	$ 6,068,898.83	$ 5,717,882.09	$ 5,385,567.98	$ 4,986,637.02	$ 4,617,256.50	$ 4,275,237.50	$ 3,958,553.24	$ 3,665,327.07	$ 3,393,821.36	$ 3,142,427.19
$ 269,251,904.18	Total VOC and Travel Time Savings	$ 25,511,859.18	$ 27,255,733.50	$ 28,999,607.82	$ 30,743,482.14	**$ 32,487,356.46**	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46
$ 269,251,904.18		$ 13,783,263.70	$ 13,634,652.53	$ 13,432,429.50	$ 13,185,352.52	$ 12,901,176.23	$ 11,945,533.55	$ 11,060,679.21	$ 10,241,369.64	$ 9,482,749.67	$ 8,780,323.76	$ 8,129,929.41	$ 7,527,712.42
$ 251,806,025.85	$ 261,490,873.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Periodic Maintenance (Renewals)					$ 761,600.00							
	Reseal					$ 761,600.00							
	Rehab												
$ 842,785.47	$ 842,785.47	$ -	$ -	$ -	$ -	$ 302,441.84	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
$ 66,123.89	$ 66,123.89	$ 3,457.72	$ 3,201.59	$ 2,964.44	$ 2,744.85	$ 2,541.53	$ 2,353.27	$ 2,178.95	$ 2,017.55	$ 1,868.10	$ 1,729.72	$ 1,601.59	$ 1,482.96

		20	21	22	23	24	25	26	27	28	29	30
		2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
		4.66	5.03	5.44	5.87	6.34	6.85	7.40	7.99	8.63	9.32	10.06
	Travel Time Savings	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11	$ 18,925,580.11
$ 137,881,529.92		$ 4,060,449.29	$ 3,759,675.27	$ 3,481,180.80	$ 3,223,315.56	$ 2,984,551.44	$ 2,763,473.56	$ 2,558,771.81	$ 2,369,233.16	$ 2,193,734.41	$ 2,031,235.56	$ 1,880,773.67
	VOC savings	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35	$ 13,561,776.35
$ 131,370,374.26		$ 2,909,654.80	$ 2,694,124.82	$ 2,494,560.02	$ 2,309,777.79	$ 2,138,683.14	$ 1,980,262.17	$ 1,833,576.08	$ 1,697,755.63	$ 1,571,995.96	$ 1,455,551.81	$ 1,347,733.16
$ 269,251,904.18	Total VOC and Travel Time Savings	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46	$ 32,487,356.46
$ 269,251,904.18		$ 6,970,104.09	$ 6,453,800.08	$ 5,975,740.82	$ 5,533,093.35	$ 5,123,234.58	$ 4,743,735.73	$ 4,392,347.89	$ 4,066,988.79	$ 3,765,730.36	$ 3,486,787.37	$ 3,228,506.83
$ 251,806,025.85	$ 261,490,873.00	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Periodic Maintenance (Renewals)			$ 2,937,600.00								
	Reseal			$ 761,600.00								
	Rehab			$ 2,176,000.00								
$ 842,785.47	$ 842,785.47	$ -	$ -	$ 540,343.63	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
$ 66,123.89	$ 66,123.89	$ 1,373.11	$ 1,271.40	$ 1,177.22	$ 1,090.02	$ 1,009.28	$ 934.51	$ 865.29	$ 801.20	$ 741.85	$ 686.90	$ 636.01

2016	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2016	-$ 383,026.09	$ 1,653,511.93	$ 1,270,485.84
Inter Peak 2016	$ 4,594,187.56	$ 7,886,384.46	$ 12,480,572.03
PM Peak 2016	-$ 426,929.73	$ 1,724,485.12	$ 1,297,555.39
SUB TOTAL	**$ 3,784,231.75**	**$ 11,264,381.51**	**$ 15,048,613.26**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	$ 335,663.27	$ 1,828,304.17	$ 2,163,967.44
Inter Peak 2026	$ 18,109,880.26	$ 9,799,735.47	$ 27,909,615.73
PM Peak 2026	$ 480,036.58	$ 1,933,736.71	$ 2,413,773.29
SUB TOTAL	**$ 18,925,580.11**	**$ 13,561,776.35**	**$ 32,487,356.46**

NPV Benefit	$ 269,251,904.18

2016	**Do Minimum**	**Option**	**Difference**
	Trips	**Trips**	**Trips**
AM Peak 2016	100,538.44	101,108.74	570.29
Inter Peak 2016	94,492.76	94,442.03	- 50.73
PM Peak 2016	120,552.20	120,947.77	395.57
SUB TOTAL	**315,583.41**	**316,498.54**	**915.14**
2026	**Do Minimum**	**Option**	**Difference**
	Trips	**Trips**	**Trips**
AM Peak 2026	111,261.99	111,945.65	683.66
Inter Peak 2026	105,520.76	105,445.47	- 75.30
PM Peak 2026	132,378.10	132,888.46	510.36
SUB TOTAL	**349,160.85**	**350,279.57**	**1,118.72**

2016	**Do Minimum**	**Option**	**Difference**
	VKT	**VKT**	**VKT**
AM Peak 2016	875,591.71	890,952.83	15,361.12
Inter Peak 2016	630,954.68	631,292.41	337.73
PM Peak 2016	914,637.43	926,985.88	12,348.45
SUB TOTAL	**2,421,183.83**	**2,449,231.12**	**28,047.30**
2026	**Do Minimum**	**Option**	**Difference**
	VKT	**VKT**	**VKT**
AM Peak 2026	962,422.91	980,044.50	17,621.59
Inter Peak 2026	713,113.54	712,208.91	- 904.63
PM Peak 2026	1,005,764.41	1,020,336.51	14,572.09
SUB TOTAL	**2,681,300.86**	**2,712,589.92**	**31,289.05**

2016	**Do Minimum**	**Option**	**Difference**
	VMT	**VMT**	**VMT**
AM Peak 2016	882,772.74	906,162.57	23,389.83
Inter Peak 2016	543,220.52	544,911.65	1,691.13
PM Peak 2016	893,446.69	911,027.72	17,581.03
SUB TOTAL	**2,319,439.95**	**2,362,101.94**	**42,661.99**
2026	**Do Minimum**	**Option**	**Difference**
	VMT	**VMT**	**VMT**
AM Peak 2026	1,018,801.04	1,038,409.39	19,608.35
Inter Peak 2026	629,216.85	620,375.03	- 8,841.82
PM Peak 2026	1,026,808.13	1,049,325.00	22,516.87
SUB TOTAL	**2,674,826.02**	**2,708,109.41**	**33,283.40**

Option	Sensitivity Test - Fixed Trip Matrix	Base Date	Jul-08	Time Zero	Jul-14

BCR Calculation						Discount Factor	8%					
PV Benefit		0	1	2	3	4	5	6	7	8	9	10
[$ July2008]		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
		1.00	1.08	1.17	1.26	1.36	1.47	1.59	1.71	1.85	2.00	2.16
				$ 820,394.20								
	Travel Time Savings			**$ 9,059,216.56**	$ 9,879,610.76	$ 10,700,004.95	$ 11,520,399.15	$ 12,340,793.35	$ 13,161,187.55	$ 13,981,581.75	$ 14,801,975.94	$ 15,622,370.14
$ 147,121,717.91				$ 7,766,818.04	$ 7,842,753.55	$ 7,864,823.07	$ 7,840,590.09	$ 7,776,793.14	$ 7,679,426.52	$ 7,553,813.57	$ 7,404,673.18	$ 7,236,180.12
				$ 215,049.05								
	VOC savings			**$ 9,644,916.17**	$ 9,859,965.22	$ 10,075,014.27	$ 10,290,063.32	$ 10,505,112.37	$ 10,720,161.42	$ 10,935,210.47	$ 11,150,259.51	$ 11,365,308.56
$ 113,679,873.39				$ 8,268,961.05	$ 7,827,158.29	$ 7,405,436.26	$ 7,003,244.19	$ 6,620,002.74	$ 6,255,111.22	$ 5,907,953.96	$ 5,577,905.81	$ 5,264,336.92
				$ 1,035,443.25								
$ 260,801,591.30	Total VOC and Travel Time Savings			**$ 18,704,132.73**	$ 19,739,575.98	$ 20,775,019.22	$ 21,810,462.47	$ 22,845,905.72	$ 23,881,348.96	$ 24,916,792.21	$ 25,952,235.46	$ 26,987,678.71
$ 260,801,591.30				$ 16,035,779.09	$ 15,669,911.83	$ 15,270,259.32	$ 14,843,834.28	$ 14,396,795.88	$ 13,934,537.75	$ 13,461,767.53	$ 12,982,578.98	$ 12,500,517.04
PV Cost												
[$ July2008]	Capital Cost	$ 130,745,436.50	$ 130,745,436.50									
$ 251,806,025.85	$ 261,490,873.00	$ 130,745,436.50	$ 121,060,589.35	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	(assume Sept 2009 costs = July 2008 costs)											
	Periodic Maintenance (Renewals)											
	Reseal											
	Rehab											
$ 842,785.47	$ 842,785.47			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual Maintenance			$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
$ 66,123.89	$ 66,123.89			$ 5,486.97	$ 5,080.53	$ 4,704.19	$ 4,355.73	$ 4,033.09	$ 3,734.34	$ 3,457.72	$ 3,201.59	$ 2,964.44
$ 252,714,935.21												

	11	12	13	14	15	16	17	18	19	20
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
	2.33	2.52	2.72	2.94	3.17	3.43	3.70	4.00	4.32	4.66
Travel Time Savings	$ 16,442,764.34	**$ 17,263,158.54**	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54
	$ 7,052,019.79	$ 6,855,437.77	$ 6,347,627.57	$ 5,877,432.93	$ 5,442,067.53	$ 5,038,951.42	$ 4,665,695.76	$ 4,320,088.66	$ 4,000,082.10	$ 3,703,779.72
VOC savings	$ 11,580,357.61	**$ 11,795,406.66**	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66
	$ 4,966,616.88	$ 4,684,118.27	$ 4,337,146.55	$ 4,015,876.44	$ 3,718,404.11	$ 3,442,966.77	$ 3,187,932.19	$ 2,951,789.06	$ 2,733,138.02	$ 2,530,683.35
Total VOC and Travel Time Savings	$ 28,023,121.95	**$ 29,058,565.20**	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20
	$ 12,018,636.67	$ 11,539,556.05	$ 10,684,774.12	$ 9,893,309.37	$ 9,160,471.64	$ 8,481,918.18	$ 7,853,627.95	$ 7,271,877.73	$ 6,733,220.12	$ 6,234,463.07
Capital Cost										
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Periodic Maintenance (Renewals)		$ 761,600.00								
Reseal		$ 761,600.00								
Rehab										
	$ -	$ 302,441.84	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
	$ 2,744.85	$ 2,541.53	$ 2,353.27	$ 2,178.95	$ 2,017.55	$ 1,868.10	$ 1,729.72	$ 1,601.59	$ 1,482.96	$ 1,373.11

	21	22	23	24	25	26	27	28	29	30
	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
	5.03	5.44	5.87	6.34	6.85	7.40	7.99	8.63	9.32	10.06
Travel Time Savings	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54	$ 17,263,158.54
	$ 3,429,425.67	$ 3,175,394.13	$ 2,940,179.75	$ 2,722,388.66	$ 2,520,730.24	$ 2,334,009.48	$ 2,161,119.89	$ 2,001,036.94	$ 1,852,811.98	$ 1,715,566.65
VOC savings	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66	$ 11,795,406.66
	$ 2,343,225.33	$ 2,169,653.08	$ 2,008,938.04	$ 1,860,127.81	$ 1,722,340.57	$ 1,594,759.79	$ 1,476,629.43	$ 1,367,249.47	$ 1,265,971.73	$ 1,172,196.05
Total VOC and Travel Time Savings	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20	$ 29,058,565.20
	$ 5,772,650.99	$ 5,345,047.22	$ 4,949,117.79	$ 4,582,516.48	$ 4,243,070.81	$ 3,928,769.27	$ 3,637,749.32	$ 3,368,286.41	$ 3,118,783.71	$ 2,887,762.70
Capital Cost										
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Periodic Maintenance (Renewals)		$ 2,937,600.00								
Reseal		$ 761,600.00								
Rehab		$ 2,176,000.00								
	$ -	$ 540,343.63	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
	$ 1,271.40	$ 1,177.22	$ 1,090.02	$ 1,009.28	$ 934.51	$ 865.29	$ 801.20	$ 741.85	$ 686.90	$ 636.01

2016	Travel Time	VOC	TOTAL
AM Peak 2016	$ 2,551,247.62	$ 1,639,281.42	$ 4,190,529.04
Inter Peak 2016	$ 4,177,157.89	$ 6,552,745.72	$ 10,729,903.61
PM Peak 2016	$ 2,330,811.05	$ 1,452,889.04	$ 3,783,700.09
SUB TOTAL	**$ 9,059,216.56**	**$ 9,644,916.17**	**$ 18,704,132.73**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	$ 3,688,446.04	$ 1,645,780.74	$ 5,334,226.78
Inter Peak 2026	$ 9,542,988.70	$ 8,246,416.37	$ 17,789,405.07
PM Peak 2026	$ 4,031,723.80	$ 1,903,209.55	$ 5,934,933.34
SUB TOTAL	**$ 17,263,158.54**	**$ 11,795,406.66**	**$ 29,058,565.20**

Calculations	
VOC savings	$ 113,679,873
Travel time savings	$ 147,121,718
Comfort benefits from sealing	-
PV accident cost savings	$ 10,762,925
Maintenance cost savings	-
Benefits	$ 271,564,516
Costs	$ 252,714,935
Provisional BCR	**1.1**

Option	Sensitivity Test - Less Attractive Link Road	Base Date	Jul-08	Time Zero	Jul-14

BCR Calculation						Discount Factor	8%					
PV Benefit		0	1	2	3	4	5	6	7	8	9	10
[$ July2008]		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
		1.00	1.08	1.17	1.26	1.36	1.47	1.59	1.71	1.85	2.00	2.16
				$ 1,339,566.17								
	Travel Time Savings			**-$ 1,837,364.21**	-$ 497,798.04	$ 841,768.13	$ 2,181,334.30	$ 3,520,900.47	$ 4,860,466.64	$ 6,200,032.81	$ 7,539,598.98	$ 8,879,165.15
$ 68,411,000.36				-$ 1,575,243.67	-$ 395,168.14	$ 618,724.70	$ 1,484,579.47	$ 2,218,764.53	$ 2,836,035.60	$ 3,349,684.81	$ 3,771,676.60	$ 4,112,771.48
				$ 299,413.44								
	VOC savings			**$ 8,552,404.27**	$ 8,851,817.71	$ 9,151,231.15	$ 9,450,644.58	$ 9,750,058.02	$ 10,049,471.46	$ 10,348,884.89	$ 10,648,298.33	$ 10,947,711.77
$ 107,896,197.43				$ 7,332,308.19	$ 7,026,858.29	$ 6,726,428.08	$ 6,431,949.90	$ 6,144,190.42	$ 5,863,770.07	$ 5,591,180.50	$ 5,326,800.24	$ 5,070,908.80
				$ 1,638,979.61								
$ 176,307,197.79	Total VOC and Travel Time Savings			**$ 6,715,040.06**	$ 8,354,019.67	$ 9,992,999.27	$ 11,631,978.88	$ 13,270,958.49	$ 14,909,938.09	$ 16,548,917.70	$ 18,187,897.31	$ 19,826,876.91
$ 176,307,197.79				$ 5,757,064.52	$ 6,631,690.15	$ 7,345,152.79	$ 7,916,529.37	$ 8,362,954.96	$ 8,699,805.67	$ 8,940,865.31	$ 9,098,476.84	$ 9,183,680.27
PV Cost												
[$ July2008]	Capital Cost	$ 130,745,436.50	$ 130,745,436.50									
$ 251,806,025.85	$ 261,490,873.00	$ 130,745,436.50	$ 121,060,589.35	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	(assume Sept 2009 costs = July 2008 costs)											
	Periodic Maintenance (Renewals)											
	Reseal											
	Rehab											
$ 842,785.47	$ 842,785.47			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual Maintenance			$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
$ 66,123.89	$ 66,123.89			$ 5,486.97	$ 5,080.53	$ 4,704.19	$ 4,355.73	$ 4,033.09	$ 3,734.34	$ 3,457.72	$ 3,201.59	$ 2,964.44
$ 252,714,935.21												

	11	12	13	14	15	16	17	18	19	20
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
	2.33	2.52	2.72	2.94	3.17	3.43	3.70	4.00	4.32	4.66
Travel Time Savings	$ 10,218,731.32	**$ 11,558,297.49**	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49
	$ 4,382,638.71	$ 4,589,958.96	$ 4,249,962.00	$ 3,935,150.00	$ 3,643,657.41	$ 3,373,756.86	$ 3,123,848.94	$ 2,892,452.72	$ 2,678,196.97	$ 2,479,812.01
VOC savings	$ 11,247,125.20	**$ 11,546,538.64**	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64
	$ 4,823,699.22	$ 4,585,289.36	$ 4,245,638.29	$ 3,931,146.57	$ 3,639,950.53	$ 3,370,324.56	$ 3,120,670.89	$ 2,889,510.08	$ 2,675,472.30	$ 2,477,289.17
Total VOC and Travel Time Savings	$ 21,465,856.52	**$ 23,104,836.12**	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12
	$ 9,206,337.92	$ 9,175,248.32	$ 8,495,600.29	$ 7,866,296.57	$ 7,283,607.93	$ 6,744,081.42	$ 6,244,519.83	$ 5,781,962.81	$ 5,353,669.27	$ 4,957,101.17
Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Periodic Maintenance (Renewals)		$ 761,600.00								
Reseal		$ 761,600.00								
Rehab										
	$ -	$ 302,441.84	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
	$ 2,744.85	$ 2,541.53	$ 2,353.27	$ 2,178.95	$ 2,017.55	$ 1,868.10	$ 1,729.72	$ 1,601.59	$ 1,482.96	$ 1,373.11

	21	22	23	24	25	26	27	28	29	30
	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
	5.03	5.44	5.87	6.34	6.85	7.40	7.99	8.63	9.32	10.06
Travel Time Savings	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49	$ 11,558,297.49
	$ 2,296,122.23	$ 2,126,039.10	$ 1,968,554.72	$ 1,822,735.85	$ 1,687,718.38	$ 1,562,702.21	$ 1,446,946.49	$ 1,339,765.27	$ 1,240,523.39	$ 1,148,632.77
VOC savings	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64	$ 11,546,538.64
	$ 2,293,786.27	$ 2,123,876.17	$ 1,966,552.01	$ 1,820,881.49	$ 1,686,001.38	$ 1,561,112.39	$ 1,445,474.44	$ 1,338,402.25	$ 1,239,261.35	$ 1,147,464.21
Total VOC and Travel Time Savings	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12	$ 23,104,836.12
	$ 4,589,908.49	$ 4,249,915.27	$ 3,935,106.73	$ 3,643,617.35	$ 3,373,719.76	$ 3,123,814.60	$ 2,892,420.92	$ 2,678,167.52	$ 2,479,784.74	$ 2,296,096.98
Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Periodic Maintenance (Renewals)		$ 2,937,600.00								
Reseal		$ 761,600.00								
Rehab		$ 2,176,000.00								
	$ -	$ 540,343.63	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
	$ 1,271.40	$ 1,177.22	$ 1,090.02	$ 1,009.28	$ 934.51	$ 865.29	$ 801.20	$ 741.85	$ 686.90	$ 636.01

2016	Travel Time	VOC	TOTAL
AM Peak 2016	-$ 445,957.58	$ 1,391,339.85	$ 945,382.27
Inter Peak 2016	-$ 1,281,632.39	$ 5,571,168.04	$ 4,289,535.65
PM Peak 2016	-$ 109,774.24	$ 1,589,896.38	$ 1,480,122.14
SUB TOTAL	**-$ 1,837,364.21**	**$ 8,552,404.27**	**$ 6,715,040.06**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	-$ 473,494.35	$ 1,489,756.00	$ 1,016,261.65
Inter Peak 2026	$ 11,833,546.51	$ 8,234,122.31	$ 20,067,668.82
PM Peak 2026	$ 198,245.33	$ 1,822,660.33	$ 2,020,905.65
SUB TOTAL	**$ 11,558,297.49**	**$ 11,546,538.64**	**$ 23,104,836.12**

Calculations	
VOC savings	$ 107,896,197
Travel time savings	$ 68,411,000
Comfort benefits from sealing	-
PV accident cost savings	$ 10,762,925
Maintenance cost savings	-
Benefits	$ 187,070,123
Costs	$ 252,714,935
Provisional BCR	**0.7**

Option	Sensitivity Test - 50% Elasticity	Base Date	Jul-08	Time Zero	Jul-14

BCR Calculation						Discount Factor	8%					
PV Benefit		0	1	2	3	4	5	6	7	8	9	10
[$ July2008]		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
		1.00	1.08	1.17	1.26	1.36	1.47	1.59	1.71	1.85	2.00	2.16
				$ 579,952.46								
	Travel Time Savings			**$ 7,464,391.88**	$ 8,044,344.34	$ 8,624,296.80	$ 9,204,249.26	$ 9,784,201.72	$ 10,364,154.18	$ 10,944,106.64	$ 11,524,059.10	$ 12,104,011.56
$ 114,957,602.40				$ 6,399,512.93	$ 6,385,859.90	$ 6,339,115.61	$ 6,264,257.39	$ 6,165,706.75	$ 6,047,384.42	$ 5,912,760.29	$ 5,764,898.66	$ 5,606,499.34
				$ 223,951.54								
	VOC savings			**$ 11,522,484.70**	$ 11,746,436.24	$ 11,970,387.78	$ 12,194,339.32	$ 12,418,290.85	$ 12,642,242.39	$ 12,866,193.93	$ 13,090,145.46	$ 13,314,097.00
$ 133,659,449.30				$ 9,878,673.44	$ 9,324,699.81	$ 8,798,592.37	$ 8,299,262.44	$ 7,825,629.71	$ 7,376,627.01	$ 6,951,204.24	$ 6,548,331.75	$ 6,167,003.03
				$ 803,904.00								
$ 248,617,051.70	Total VOC and Travel Time Savings			**$ 18,986,876.59**	$ 19,790,780.59	$ 20,594,684.58	$ 21,398,588.58	$ 22,202,492.58	$ 23,006,396.57	$ 23,810,300.57	$ 24,614,204.57	$ 25,418,108.56
$ 248,617,051.70				$ 16,278,186.38	$ 15,710,559.70	$ 15,137,707.98	$ 14,563,519.83	$ 13,991,336.46	$ 13,424,011.43	$ 12,863,964.53	$ 12,313,230.41	$ 11,773,502.37
PV Cost												
[$ July2008]	Capital Cost	$ 130,745,436.50	$ 130,745,436.50									
$ 251,806,025.85	$ 261,490,873.00	$ 130,745,436.50	$ 121,060,589.35	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	(assume Sept 2009 costs = July 2008 costs)											
	Periodic Maintenance (Renewals)											
	Reseal											
	Rehab											
$ 842,785.47	$ 842,785.47			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Annual Maintenance			$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
$ 66,123.89	$ 66,123.89			$ 5,486.97	$ 5,080.53	$ 4,704.19	$ 4,355.73	$ 4,033.09	$ 3,734.34	$ 3,457.72	$ 3,201.59	$ 2,964.44
$ 252,714,935.21												

Item	11	12	13	14	15	16	17	18	19	20
	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
	2.33	2.52	2.72	2.94	3.17	3.43	3.70	4.00	4.32	4.66
Travel Time Savings	$ 12,683,964.02	**$ 13,263,916.48**	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48
	$ 5,439,934.76	$ 5,267,283.73	$ 4,877,114.56	$ 4,515,846.82	$ 4,181,339.65	$ 3,871,610.78	$ 3,584,824.80	$ 3,319,282.22	$ 3,073,409.47	$ 2,845,749.50
VOC savings	$ 13,538,048.54	**$ 13,762,000.07**	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07
	$ 5,806,236.97	$ 5,465,079.58	$ 5,060,258.87	$ 4,685,424.88	$ 4,338,356.37	$ 4,016,996.64	$ 3,719,441.33	$ 3,443,927.16	$ 3,188,821.44	$ 2,952,612.45
Total VOC and Travel Time Savings	$ 26,222,012.56	**$ 27,025,916.56**	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56
	$ 11,246,171.72	$ 10,732,363.30	$ 9,937,373.43	$ 9,201,271.69	$ 8,519,696.01	$ 7,888,607.42	$ 7,304,266.13	$ 6,763,209.38	$ 6,262,230.91	$ 5,798,361.95
Capital Cost										
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Periodic Maintenance (Renewals)		$ 761,600.00								
Reseal		$ 761,600.00								
Rehab										
	$ -	$ 302,441.84	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
	$ 2,744.85	$ 2,541.53	$ 2,353.27	$ 2,178.95	$ 2,017.55	$ 1,868.10	$ 1,729.72	$ 1,601.59	$ 1,482.96	$ 1,373.11

Item	21	22	23	24	25	26	27	28	29	30
	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
	5.03	5.44	5.87	6.34	6.85	7.40	7.99	8.63	9.32	10.06
Travel Time Savings	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48	$ 13,263,916.48
	$ 2,634,953.25	$ 2,439,771.52	$ 2,259,047.71	$ 2,091,710.84	$ 1,936,769.30	$ 1,793,304.90	$ 1,660,467.50	$ 1,537,469.91	$ 1,423,583.25	$ 1,318,132.64
VOC savings	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07	$ 13,762,000.07
	$ 2,733,900.41	$ 2,531,389.27	$ 2,343,878.95	$ 2,170,258.29	$ 2,009,498.42	$ 1,860,646.68	$ 1,722,821.00	$ 1,595,204.63	$ 1,477,041.33	$ 1,367,630.86
Total VOC and Travel Time Savings	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56	$ 27,025,916.56
	$ 5,368,853.66	$ 4,971,160.79	$ 4,602,926.66	$ 4,261,969.13	$ 3,946,267.71	$ 3,653,951.59	$ 3,383,288.51	$ 3,132,674.54	$ 2,900,624.58	$ 2,685,763.50
Capital Cost										
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Periodic Maintenance (Renewals)		$ 2,937,600.00								
Reseal		$ 761,600.00								
Rehab		$ 2,176,000.00								
	$ -	$ 540,343.63	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual Maintenance	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00	$ 6,400.00
	$ 1,271.40	$ 1,177.22	$ 1,090.02	$ 1,009.28	$ 934.51	$ 865.29	$ 801.20	$ 741.85	$ 686.90	$ 636.01

2016	Travel Time	VOC	TOTAL
AM Peak 2016	$ 1,573,041.62	$ 1,830,937.87	$ 3,403,979.49
Inter Peak 2016	$ 4,555,860.50	$ 7,849,023.52	$ 12,404,884.01
PM Peak 2016	$ 1,335,489.77	$ 1,842,523.32	$ 3,178,013.09
SUB TOTAL	**$ 7,464,391.88**	**$ 11,522,484.70**	**$ 18,986,876.59**
2026	**Travel Time**	**VOC**	**TOTAL**
AM Peak 2026	$ 2,172,805.16	$ 1,928,748.40	$ 4,101,553.57
Inter Peak 2026	$ 9,619,644.74	$ 9,753,653.49	$ 19,373,298.24
PM Peak 2026	$ 1,471,466.58	$ 2,079,598.17	$ 3,551,064.75
SUB TOTAL	**$ 13,263,916.48**	**$ 13,762,000.07**	**$ 27,025,916.56**

Calculations	
VOC savings	$ 133,659,449
Travel time savings	$ 114,957,602
Comfort benefits from sealing	-
PV accident cost savings	$ 10,762,925
Maintenance cost savings	-
Benefits	$ 259,379,977
Costs	$ 252,714,935
Provisional BCR	**1.0**

		Option	
Length of road alignment	(km)	6.4	
Assumed cost per kilometer for mainenance	$	1000	
Maitenance costs / annum	$	$ 6,400.00	
Pavement Area	$	108800	
Cost of a reseal / m2	m2	7	
Cost of reseal	$	$ 761,600.00	every 10 years
Pavement Rehabilitation / m2	$	20	
Pavement Rehabilitation	$	$ 2,176,000.00	every 20 years

Appendix D

Modelling and Economics Reported for Part 6 (TG)

8 Recommended Option – Assessment

> The recommended option provides a high level of assurance of delivery when assessed against the four key performance criteria. The provision of an alternative strategic link, that will address safety, capacity, journey time reliability and enable and support regional and national economic development. Removal of freight and through traffic from the communities along the existing SH1 will allow better and easier access to transport (particularly pedestrian and, cycling modes, as well as rail and bus services.
>
> The early signalling of an inland route, the predominantly green fields rural site, and the strategic purchase of key properties means that the certainty of delivery of the transportation outcomes being sought is high.
>
> Gaining of the consents required for the project, plus widespread local and regional support from stakeholders and public means that efficient implementation of the project can occur. Ongoing reduction of risk through the project development has resulted in a high level of cost optimisation to-date along with a high level of project cost certainty.

This section assesses the performance of the recommended option against four key criteria:

- The Project Objectives
- Implementability Assessment
- Wider project impacts
- Cost Optimisation.

A summary of performance against the above criteria is given. The economic assessment of the recommended option is reported in Section 9.

8.1 Objectives

The TGP performs against the project objectives in the following manner:

Objective (ref. §4)	Performance
• **to provide an** alternative strategic link **for Wellington that improves regional network resilience and route security;**	An assessment of the seismic performance of the TGP against the existing SH1 has been completed; showing that full reinstatement of TG would be possible within 3 days to 2 weeks (limited access within 3 days) compared to 3-6 months for the coastal route.
• **to assist in remedying the** safety concerns **of, and projected** capacity and associated journey time and trip variability problems **on the existing SH1 by providing a safe and reliable route between Linden and MacKays Crossing in an environmentally sustainable manner;**	A minimum forty percent reduction in fatal and serious (combined) accidents per vehicle-kilometre travelled on TGP and the existing SH1 coastal route. TGP will operate with a mid-block LOS not less than LOS A at opening and LOS B for the forecast 2026 traffic volumes. TGP mid-block[5] LOS performance not less than LOS B at 150% of opening traffic volumes and LOS C at double the opening traffic volumes. A reduction of not-less-than 6 minutes for all journeys between Linden (SH1) and MacKays (SH1) for all periods, and a reduction of not-less-than 10 minutes for all journeys between SH58 (Pauatahanui roundabout) and MacKays for all periods.

[5] Where intersection performance is constrained by other factors ie. existing SH capacity this measure shall not apply.

Objective (ref. §4)	Performance
	Travel time variability at the 95% confidence interval of not-greater-than 30 seconds at opening, and 60 seconds at opening traffic volumes plus 60% traffic growth between MacKays and Linden, and 60% of those values between SH58 (Lanes Flat) and MacKays, for all periods.
• **to assist in enabling** wider national economic development **by providing a cost-optimised route that better provides for the through movement of freight and people; and**	A reduction of 6 minutes for all freight journeys between Linden (SH1) and MacKays (SH1) for all periods, and a reduction of 10 minutes for all freight journeys between SH58 (Pauatahanui roundabout) and MacKays for all periods. Freight travel time variability at the 95% confidence interval of not-more-than 30 seconds at opening and not-more-than 60 seconds (at opening plus 60% freight traffic numbers) between MacKays and Linden, and 60% of those values between SH58 (Pauatahanui roundabout) and MacKays, for all periods. Maximum freight travel time variability for twice the opening freight traffic volumes shall not exceed 120 seconds between MacKays and Linden, and 72 seconds between SH58 (Lanes Flat) and MacKays, for all periods.
• **to assist** integration of the land transport system **by enabling the SH1 to be developed into a safe multi-functional (including pedestrian and cycle friendly) alternative to the proposed strategic link.**	The daily traffic volumes on the existing SH1 between Linden and MacKays will reduce by between 14,000 and 20,000 vpd[6] in 2026. South of Paekakariki the residual traffic volume will be 3,100 vpd comprising only local traffic. Residual traffic volumes will be higher further south with 5,900 vpd to the south of Pukerua Bay, 20,500 vpd on Mana Esplanade and 44,200 vpd south of the Mungavin interchange. The significant reduction in traffic on the coastal route will improve accessibility, reduce severance and allow the corridor to function as an arterial delivering increased access to community facilities (schools, churches, shops, bus-stops, railway stations) and a resultant increase in users of non- motorised modes (pedestrian and cycling). Appropriate metrics to measure how successful the overall integration of the land transport system has been will be formulated as part of the project development process.

In addition to those objectives identified above, the Project will also result in a range of other direct and indirect benefits to the local area, region, and wider transport users as documented in Appendix A.

8.2 Implementability

8.2.1 Constructability

Constructability is potentially an issue for this project given the steep terrain, proximity to known earthquake fault zones, sensitive freshwater and marine receiving environments and potentially highly erodible material in places. This is similar to the coastal route, where oversteep batters, construction within a coastal marine area, along with live traffic management would be even more challenging.

Most of the associated risks have been reduced by way of consent conditions; however there are still consenting risks associated with the acceptance and certification by the consenting authorities, as well as engineering risks associated with the scale of earthworks required.

[6] vpd – vehicles per day

There are no novel or emerging technologies which represent project risk required to implement the recommended option; however provision of effective sediment and erosion control, and fish-passage in such steep terrain, and effective stream diversion and re-creation of stream habitat will be challenging.

Strong stakeholder support for the project, combined with the predominantly green-fields nature of the site with very limited traffic management requirements means very few constraints for a constructor, as opposed to the coastal route which had major opposition.

A number of consent conditions require early baseline ecological monitoring that have to be completed before construction can commence. These have the potential to delay the start of some construction activities if not completed before a construction contract is awarded. They include freshwater and marine water quality and ecology monitoring, bat monitoring plus fish-passage trials. In addition, consent conditions require the constructor to undertake stabilisation trials to confirm the effectiveness of their proposed erosion and sediment control measures.

Relocation and strengthening of a number of existing Transpower towers and relocation of the 110kV transmission lines is required and will to take up to 24 months to be completed. Close co-ordination with Transpower, their designers and contractor around co-ordinating some activities, such as the construction of access tracks and associated earthworks will be required in order to ensure that they are placed in locations that suit both parties.

A key driver for the programme will be the consideration of the movement of earthworks material around the Project (i.e. approximately 6.3 million cubic metres of cut and 5.8 million cubic metres of fill being required to construct the consented design). A key part of the earthworks construction are the consent conditions and how potential sedimentation effects on the harbour can be managed.

Although the construction methodology and approach adopted by the constructor may vary, those items identified above will be critical, and will influence value engineering and programming decisions.

The constructability and implementation of the project has been a major consideration in the refinement of the design and consenting of the project. Consideration has been given to the costs, environmental risks and effects, and route security trade-offs between earthworks and structures, including consideration of tunnelling options. Therefore, it is unlikely that there will be significant delays or disruptions to the programme due to consenting issues.

The Te Puka valley section of the Main Alignment is the most vulnerable to natural hazards, in particular earthquakes, and has the potential to reduce the security of the route. The geotechnical assessment identified risks associated with retaining walls on steep slopes in Te Puka and the vulnerability of bridges directly adjacent to steep slopes due to the risk of earthquake induced landslides.

8.2.2 Operability

Operational requirements for the existing State Highway network presently include:

- New Zealand Police Commercial Vehicles Investigation Unit (CVIU) weigh-station at Plimmerton (both directions)
- Variable Messages Signs (VMS) and other ITS infrastructure (including fibre-optic) plus traffic signals through Mana / Plimmerton
- VMS and other ITS infrastructure (including fibre-optic) plus traffic signals along the coastal section from Pukerua Bay north to Paekakariki
- Traffic signals – Whitford Brown Intersection
- Street lighting (urban sections and intersections)
- Weigh-in-motion and numerous traffic loop count sites.

The implications are that overall operating expenditure (OPEX) (not considering maintenance costs) will increase significantly (potentially double) due to the increased ITS requirements primarily. Highway lighting costs would be expected to reduce due to fewer and more efficient lighting fixtures.

It is expected that operational costs of tolling, if implemented, would be recovered under NZTA's existing toll recovery mechanisms and back-room operations.

Operational costs of traffic signals will be reduced to zero once revocation of the existing State Highway coastal route has occurred; however NZTA will still be assisting with funding local TA's operating costs for the street lighting and traffic signals. It is likely that there will be additional capital expenditure (CAPEX) requirements for NZTA for bridge replacements or seismic retro-fitting prior to revocation handover to the TA's.

Additional CAPEX could include minor safety improvement works required to address road safety audit issues relating to any change of traffic volumes and patterns resulting from the project.

8.2.3 Statutory Requirements

During the option selection phase of the WCP development, feedback from key stakeholders and the assessed cost, and scope of measures that would be required in order to satisfactorily mitigate the effects of a coastal route upgrade, meant that the previous cost of the coastal route had been significantly underestimated. Even with mitigation, NZTA's legal advisers were indicating that it still may not have been consentable, due to magnitude of the effects.

In contrast, the inland route already has a motorway designation in place, and although resource consents had not been secured, and the freshwater and marine receiving environments had high ecological values, obtaining of consents was not seen as anywhere near as difficult.

Apart from a few known exceptions, NZTA has been granted all necessary land NOR's and regional resource consents required to construct the project.

8.2.4 Property Impacts

Property constraints have had a very limited impact on the project design. An alternative inland route has been signalled for a many years and a TGP motorway designation included on District Plans since 2003 and hence property owners have been aware of the project.

Currently just over half of the designation by area has been acquired by the Crown for the purposes of road, with approximately a quarter of the remainder being in public ownership (PCC, GWRC or the Department of Conservation). In total, the number of property interests directly and indirectly affected by the inland TGP route is lower than the coastal route, due to the largely green-fields nature of the TGP route.

Utility owner assets and infrastructure impacts have and are likely to continue to influence the final design, and potentially programme of the construction of the inland route. Although the services are bulk gas, water and 110kv transmission lines, the green-fields nature of the route means that relocation and protection will be easier to manage than the much more numerous and complex services that would be encountered along the coastal route, particularly through Mana, Plimmerton and Paremata.

8.2.5 Asset Management

Throughout the development of options for the TGP, discussions have been held with the Regional Operations team within the NZTA to ensure consideration of future needs and associated cost implications are incorporated into the option assessment.

The recommended option is approximately 2% longer than the existing length of SH1 that it replaces. It is expected that the existing SH1 will be revoked and vested in the relevant TA. At this stage, no preliminary decision about revocation or otherwise of SH58 west of the TGP connection has been made. PCC have expressed a desire for this to become a local road to allow more multiple-modal use, including more cycle and pedestrian friendly uses.

The surface area of sealed pavement is considerably larger than the existing SH network, and the quantum of bridges and other structures (e.g. reinforced soil embankment retaining walls) will also increase.

Whilst pavement maintenance costs would typically be reduced as the result of it being a new piece of road this will need to be considered against the increase in the inspection and maintenance of bridges, structures, side protection, stormwater and other facilities, plus increased landscape and ecological mitigation planting maintenance.

Pavement maintenance costs (reseal/ rehabilitation) are not fixed and are variable over time so they can be linked with cost indexing as opposed to a fixed annual cost, and represent a value-for-money opportunity.

The cost of slip clearance (both maintenance and operational incident and traffic management costs) is directly related to design decisions.

8.3 Wider Project Impacts

8.3.1 Environmental Impact

Environmental impacts have had a large influence on selecting the recommended option, due to the sensitive freshwater and marine receiving environment (Porirua Harbour). While the project corridor has been identified for over 30 years and protected on District Plans, the more detailed design has been focussed on avoidance and mitigation in terms of the RMA. This has led to design refinements during the SAR and AEE phases of the project to avoid and reduce direct impacts on streams, reduce earthwork volumes, provide improved erosion and sediment control opportunities and avoid, where possible, direct effects on native flora and fauna.

Other environment impacts that have been considered are the landscape and visual effects of the project, and noise and vibration, which have the potential to be significant for such a large roading project. These have been successfully balanced, mitigated and managed and the consent conditions and associated mitigation measures identified.

While there exists flexibility for a constructor, there are also consenting risks around interpretation, and negotiation with consent authority, and the certification of the numerous management plans that are required.

8.3.2 Social Impact

Social impacts have heavily influenced the choice of the recommended option, particularly the decision to construct an inland alternative bypass to the existing SH1 coastal route. The ability to consent an equivalent upgrade to the existing SH1 to address and mitigate social impact effects, and the public response at the Regional Land Transport (RLT) sub-committee Hearing on the Wellington Western corridor, all led to the decision to proceed with the consented alignment.

Due to the essentially 'green-fields' nature of the project, social impacts of the consented alignment are generally low, with little community severance across the project alignment. The exceptions are the social impacts on recreational users particularly for the two Regional Parks that are bisected (Battle Hill Farm Forest Park and Belmont Regional Park) and farm operations for both these two parks and also private farmers.

The much lower volumes of traffic along the existing SH1 route will create opportunities for the implementation of measures to encourage walking and cycling, more consistent with the local function of the route.

8.3.3 Joint Working

Opportunities exist to work with the PCC around the development of the link roads although any potential benefits of collaborative working would need to be carefully considered as the resource consent conditions are inextricably linked and need to ensure that neither the PCC nor the NZTA are disadvantaged.

The main alignment (particularly vertical) design has been future proofed to facilitate the PCC link roads connecting at the James Cook Interchange. Any change to this interchange will require involvement of PCC to ensure that the PCC link roads are not compromised, or that NZTA does not incur future additional costs, either for the main alignment, or as part funder of the PCC link roads. The optimum approach to dealing with this would be dependent upon the procurement model adopted and would be re-examined in the next phase of work.

The NZTA is currently working with Transpower around a possible alternative to the Transmission Gully relocation project that could result in reduced costs to NZTA, and better operational and environmental outcomes for Transpower, in terms of reduced visual and landscape effects. Any cost savings will be passed onto NZTA, when measured against the TGP risk-adjusted Scheme Estimate. NZTA is managing this work closely to ensure that adoption of the Transpower alternative design does not negatively impact on the TGP programme.

8.4 Cost Optimisation

Cost optimisation and refinement has been a major part of the project development over the past four years, resulting in significant cost reductions which have contributed to the economic efficiency of the project.

As described earlier, the SAR Phase 1 of the project considered two alignments for the TGP route following exhaustive investigations and evaluations. Of these, an alignment which in some areas lay outside the previous designation was preferred. This alignment is estimated to cost up to 15% less than the best alignment that could be achieved within the previous designation. Following the SAR Phase 1, more investigation and specialist assessments were carried out as part of Phase 2 on the preferred alignment and additional cost savings were identified. These differences have been presented in Table 8-1 below.

Table 8-1: Change in TGP costs

Date	Phase	Project Expected Estimate[7] ($M)
2008	Phase 1: Scheme Assessment - In designation	$1,205
2008	Phase 1: Scheme Assessment- Preferred	$1,025
2011	Phase 2: Assessment of Effects	$928
2012	Phase 3: Consented Scheme Design	$882

8.4.1 Changes made during Phase I

In 2008 NZTA commenced a SAR including "Phase I Investigations - Investigations and Preliminary Design". The SAR was carried out between 2006 and 2008. The key objective was to identify the most advantageous route alignment which could then be further refined and used for assessment and consenting. The process involved multi-criteria analysis of 38 options and sub-options. Each one was assessed against the existing designation which was the baseline.

The Phase 1 process resulted in several important changes to the route alignment, the most significant being the decision to move the alignment from the east to the west slopes of the Te Puka and upper Horokiri valleys.

Road safety has been improved over previous designs. On sections of the route where steep grades will impact on truck speeds, crawler and auxiliary lanes have been provided. Improvements on earlier proposals include the removal of significant viaducts to increase the route's resilience to earthquake damage, revisions to road geometry to improve the alignment, particularly in terms of avoiding geological hazards such as active faults and historic landslides, and improved route security through changes to cut and fill slopes in line with the results of detailed geotechnical assessments.

Combining the James Cook and Warspite (Belmont Regional Park) interchanges into one was investigated early in the option development process. It was recognised that a combined interchange could provide similar transport functionality, and would benefit TGP's operability through reduced accident numbers. The Interchange connects to the industrial and commercially-zoned area of Waitangirua, as well as to James Cook Drive, and would provide the potential for renewal and intensification of the area.

Major cost saving areas included:

- Viaduct removed at Te Puka

[7] Risk-adjusted P50 Scheme Estimate Q2 2011 Dollars.

- Several structures removed along eastern valley through Battle Hill Farm and upper Horokiri stream valley
- Interchange removed from Belmont Regional Park
- Earthwork, structures, and alignment changes made during Phase 2.

Two Options were identified, developed and presented to NZTA and PCC. Option 2 was based around the SAR alignment utilising a 200 metre bridge crossing of Duck Creek, while Option 1 (an alignment to the west) eliminated the need for a significant bridge and reduced embankment heights. Consultation with affected parties and further assessment identified the eastern option (Option 1) as the preferred solution.

The benefits of Option 1 were the alignment was altered to achieve a best fit and minimise impacts on properties to provide better interface with existing topography. There was also a significant reduction in earthworks fill heights in vicinity of Duck Creek (reduced from 30 metres in height to approximately 10 metres) and the elimination of significant bridge structures which were replaced with a box culvert.

The road alignment was modified over approximately 5km through Horokiri and Battle Hill. The modified alignment introduced more winding elements that hug close to the existing land form, thereby creating opportunity for re-contouring the landform and integrating the road form into it. The new alignment also reduced the ecological impacts on the Horokiri Stream.

This change significantly reduces the effects on the lengths of stream diversion required and eliminates the physical impacts on the stream by removing bridge stream crossings and the number of cross culverts required. The earthworks cut volumes reduce by 725,000 cubic metres over this section of the project with no change to the proposed fill volumes.

Major cost saving areas:

- Significant reduction in earthwork volumes
- Removal of bridges for earth retaining structures.

Scheme Assessment

- Total earthworks cut is 7,900,000 cubic metres (cu.m)
- Total earthworks fill is 5,800,000cu.m
- Surplus cut material is 2,1000,000cu.m
- 2,300 metres of bridging
- 5.4km of stream diversions.

AEE Design

- Total earthworks cut is 6,100,000cu.m
- Total earthworks fill is 5,200,000cu.m
- Surplus cut material is 900,000cu.m
- 1,600 metres of bridging
- 5.9km of stream diversions.

NOR (Consented) Design

- Reduced global consenting risk related primarily to stream diversions, ecological mitigation, erosion and sediment control.

These modifications to the scheme design and associated project cost have resulted in the significant savings presented in Table 8-2 to the overall project costs.

Table 8-2: TGP Significant Areas of Savings

Item	Saving
Earthworks	$29M
Ground Improvements	$36M
Bridges/ Retaining Walls	$34M
Interchanges	$13M

8.5 Do-Minimum Option

The do-minimum for the network has been considered extensively as part of the SAR and most recently the Transport Assessment for the AEE and represents a realistic future scenario for 2026, but without the TGP in place. This has been developed to provide a do-minimum against which the effects of the TGP can then be assessed and might exist should the TGP not be implemented.

This recognises that a number of other transportation projects are likely to be progressed and development will continue to occur in the period to 2026, irrespective of the TGP. Therefore, expected external changes to both land use and transport networks have been included in the modelling undertaken to produce a realistic do-minimum scenario.

This is a standard approach used for assessing the effects of a project from a transport planning perspective. It is important to note that this is not an assessment of the economic benefits of the TGP, for which the definition of the do-minimum may differ slightly.

The do-minimum includes the land use changes forecast by the GWRC which are also applied in the assessment of other transportation projects across the region.

Transport projects which have not yet been constructed (and have not been consented), but are expected to be completed in 2026 regardless of whether the TGP goes ahead are included in the do-minimum.

The projects principally include:

- Other RoNS projects;
- Petone (SH2) - Grenada (SH1) Link Road;
- SH58 Safety Improvement Upgrades; and
- Public Transport improvements (i.e. new rolling stock, twin tracking and electrification to Waikanae, integrated ticketing etc.) which are largely completed.

9 Economic Analysis

Economic assessment of the entire Wellington Northern RoNS package was undertaken as part of a business case study in late 2009 involving the development of a methodology to capture the benefits of each individual RoNS project (including TG) and then combine them to provide an overall project BCR for the package.

As a result of this analysis it was determined that the Wellington Northern RoNS package (as assessed in 2009) had a BCR of between 1.1 and 1.4. The BCR of 1.4 included wider economic/agglomeration benefits associated with the full package.

As a result of design refinement and risk mitigation and management, the cost of the project has continued to reduce in real terms. As the costs have reduced and further work has been undertaken to capture the benefits of the TGP, the project economics have also changed. Over the past four years the economic efficiency for the project has more than doubled as a result of changes in the EEM, cost reductions, increased benefits and the inclusion of a wider range of benefits (e.g. agglomeration).

The calculations for the TGP economic efficiency shown above assume a construction cycle that is contingent on the availability of funding from the NLTF. The RoNS programme originally anticipated a construction start date for TGP of 2015 however under current provisions there is considerable doubt of achieving this and a worst case start date is possibly around 2020.

On balance meeting the original RoNS programmed construction start of TGP via alternative funding/revenue sources has an overall positive, albeit small, economic benefit for the country.

Economic analysis of the TGP has evolved over time as the investigation into the route has progressed. The assessment of the Project has been undertaken from a national perspective following the guidelines set out in NZTA's Economic Evaluation Manual (EEM). The EEM sets out a method for capturing and calculating the set of costs and benefits that are relevant to the assessment of transport projects.

9.1 Wellington Northern RoNS Economic Assessment

The economic analysis for the TGP has been considered as part of the wider Wellington Northern RoNS package for the purposes of NZTA's Scheme Assessment Report Addendum (SARA) requirements.

Economic assessment of the entire Wellington Northern RoNS package was undertaken as part of a business case study in late 2009. This evaluation involved the development of a methodology to capture the benefits of each individual RoNS project (including TG) and then combine them to provide an overall project BCR for the package.

As a result of this analysis it was determined that the Wellington Northern RoNS package (as assessed in 2009) had a BCR of between 1.1 and 1.4. The BCR of 1.4 included wider economic/agglomeration benefits associated with the full package. It is important to note that some projects within the total corridor have a BCR below one while others have a BCR much greater than one. But in order to provide an Expressway from Levin to Wellington it would be difficult to achieve the RoNS objectives and recognise the wider economic/agglomeration benefits associated with the project without implementing the full package of works.

Beca were employed by NZTA to undertake a review of the economics for the Wellington Northern RoNS package and agreement was reached as to the assessment approach and economic analysis undertaken.

9.2 Assessment Profile

The project was assessed using the latest NZTA Planning Programming and Funding Manual (PPFM). An assessment profile of HHL has been determined for the project using the NZTA's funding allocation process as detailed below:

Strategic fit of the problem, issue or opportunity that is being addressed: High

The TGP is listed in the GPS as a RoNS and therefore is given a High strategic fit rating.

The project also has potential to provide a major contribution to national economic growth and productivity by improving travel time and reliability on key freight routes.

Effectiveness of the proposed solution: High

The project contributes to the NZTA's IRS in that it enables and supports a strategic component of the national transport system and will help give effect to the GPS.

The project will improve travel time, reliability and safety between the North Island and Wellington CBD and CentrePort.

Economic efficiency of the proposed solution: **Low** (BCR<2.0)

The BCR for the Wellington Northern RoNS project is estimated to be 1.1. This excludes wider economic and possible agglomeration benefits.

9.3 Characterisation of the Do-Minimum

During the SAR phase of the project, significant work was undertaken to look at the do-minimum network and look at the impact the TGP had on demands. As described earlier in Section 8.5, the Do-Minimum consisted of the agreed RLTS at the time which included a wide range of projects and land use assumptions that largely remain the same today as they did in 2008. The key Do-Minimum characteristics included:

- Duplication of and improvement to the Kapiti Railway line (NIMT) between Pukerua Bay and the extension to Waikanae - this project has since been completed and these benefits are being recognised.
- Kapiti Western Link Road - this has now been modified with the Wellington Northern Corridor RoNS SH1 M2PP Expressway Project utilising this corridor instead; however, the overall arrangement functions in a similar manner (i.e. expressway + local arterial).
- Reduction in peak time work based trips to and from Wellington CBD by 5% due to TDM measures (including car pooling and integrated ticketing) - this has been retained in current forecasts.
- Petone to Grenada link road - this remains a future scheme.
- Grade separation of the SH2/SH58 Haywards Intersection - this has been dropped for the current programme and forecast modelling.
- Local access and safety improvements for SH58 - these remain current, however the solutions have yet to be finalised.

At the time that the SAR was prepared there was no additional growth assumed for Kapiti as a result of the RoNS or PT improvements to the District. Although the level of growth and development that might occur in the Kapiti area remains uncertain, development is occurring and expected to increase significantly with the development of the RoNS package, therefore the SAR is likely to under predict the benefits of the TGP scheme.

The WTSM model was also used to look at changes in PT trips on the NIMT, which is predicted to increase significantly without the improvement of projects such as TGP.

9.4 Progression of the Economic Efficiency

As the investigations into TGP have moved through subsequent phases, understanding of the economic impact of the project has developed.

At the time that the SAR for TGP was completed, the RoNS had not been initiated and TGP was being considered as part of the Western Corridor package, but the project was considered in isolation. TGP now forms a critical part of the Wellington Northern RoNS project.

As identified earlier, the total Wellington RoNS BCR at the time of the business case in 2009 was between 1.1 and 1.4. There have been a large number of refinements to the TGP (including a substantial cost estimate reduction) and the level of assessment undertaken over this time, however, the benefit range identified is considered to be conservative due to the following factors:

- The demand modelling from WTSM assumes that the PT corridor has no capacity constraint and as a result there are significant increases in demand through to 2026; however, there are already capacity restrictions on the service and there is limited room for significant short term improvement until the duplication of the rail network between Pukerua Bay and Paekakariki.
- The Statistics New Zealand medium population and employment growth forecasts have been used for Porirua and Kapiti which do not take into account the significant infrastructure investment that has and will continue to occur as a result of the RoNS projects. However, both Porirua and KCDC have current investment plans predicated on high future population and employment growth, and if this eventuates will see reduced economic efficiency without the project, due to traffic related problems in the corridor, and therefore greater project benefits accruing than have been modelled.
- There have been no adjustments to the do-minimum network to address current safety and accessibility issues in location such as Paekakariki, Pukerua Bay and Mana. Such improvements would not only impact on network performance, they would also have a significant construction cost that would be of no value following the construction of TGP.
- As the costs have reduced and further work has been undertaken to capture the benefits of the TGP, the project economics have also changed over the past 10-20 years. Over the past four years the economic efficiency for the project has more than doubled as a result of changes in the EEM, cost reductions, increased benefits and the inclusion of a wider range of benefits (e.g. agglomeration).

9.5 Sensitivity Analysis

Table 9-1: TGP Sensitivity Testing

Sensitivity Testing			
	Base Benefit	Lower Bound	Upper Bound
Agglomeration Benefits (4% ~ 23%)	$457.6m	$420.1m	$495.1m
WEB (22% of Total package)	$457.6m		$530.4m
Construction Cost (±20%)	$457.6m	$457.6m	$457.6m
Maintenance Cost (±20%)	$457.6m	$457.6m	$457.6m
TT benefits (±20%)	$457.6m	$415.2m	$500.0m
VOC benefits (±20%)	$457.6m	$454.2m	$461.0m
CO2 (±20%)	$457.6m	$457.4m	$457.8m
Crash (±20%)	$457.6m	$445.3m	$469.9m
Benefit period (40yr ~ 50yr)	$457.6m	$491.9m	$510.5m
Discounting Rate (6% ~ 4%)	$457.6m	$631.8m	$920.2m
Wellington value of time (12.5% greater than EEM)	$457.6m		$484.1m

9.6 Cost/Benefit Variability

Various sensitivity tests have been carried out on the overall base BCR for the RoNS project. The sensitivity tests included factors such as; high population growth in the region based upon Statistics New Zealand projections with consistent growth in fuel prices, capping of benefits, changes in cost estimates and different programmes.

It should be noted that each of the sensitivity tests undertaken have been based upon the base overall RoNS BCR value that includes agglomeration benefits but excludes wider economic benefits such as employment. These sensitivity tests highlight the range in BCR's if different assumptions were adopted for the project, with a range between 1.0 and 1.4. Full details of these sensitivity tests have been documented in the 2009 Business Case.

An extensive list of sensitivity test have been undertaken for the project in isolation and this has highlighted that the variability is all greater than that reported in the 2009 Business Case and is comparable to the total corridor package.

9.7 Programme Impacts

The calculations for the TGP economic efficiency shown above assume a construction cycle that is contingent on the availability of funding from the NLTF. The anticipated availability of funding is dependent on both the future revenue gathered and the demands on the fund.

The RoNS programme originally anticipated a construction start date for TGP of 2015[8] however, the availability of funding to achieve this under current provisions places considerable doubt on achieving this and a worst case start date is possibly around 2020.

[8] All years stated are financial years commencing 1 July 20XX.

Under an alternative funding/revenue arrangement, such as raised FED/RUC or structured borrowing (including a PPP), it is feasible to return the programme to its anticipated schedule.

In addition to returning the programme to schedule, increased revenue/funding would remove cashflow limitations which limit the overall project delivery timeframe. A further benefit of PPP's as a delivery mechanism is that, through Debt/Equity funders interests in the project further programme efficiencies can be realised over and above an unconstrained programme.

Work has been undertaken to examine the impact that an "on-time" construction start and unconstrained cashflow programme would have on the economic efficiency of TGP. A five year construction programme was assumed as an unconstrained option to the six year time to build used in the business case.

With the construction period held constant (at five years), the construction start was brought forward to the beginning of 2015 (from 2016), assuming design and enabling works were all completed by the end of 2014. Under this scheme, benefits start a year earlier in 2019 and run for a year longer at 32 years. However, the corresponding uplift in the economic efficiency was smaller at 2% despite benefits starting earlier and lasting longer.

The 2% differential in uplift between the economic efficiency's for the 2016 and 2015 construction starts represents the combined trade-off between higher discounted construction costs and benefit streams that start earlier and last longer. The analysis indicates that shortening the construction period and delivering the project to programme have combined positive economic impacts on the performance of the TGP and the Wellington RoNS corridor as a whole. The analysis indicates that the increase in the discounted costs associated with an timely start are more than covered by value of gaining access to TGP's benefits earlier. On this basis, meeting the original RoNS programmed construction start of TGP via alternative funding/revenue sources has an overall positive, albeit small, economic benefit for the country.

3 September 2012

Craig Nicholson
Principal Project Manager (TG)
New Zealand Transport Agency
PO Box 5084
Lambton Quay
Wellington 6145

OPUS

5-c1591.02

Dear Craig

Transmission Gully Economic Assessment September 2012 Update

At the request of the New Zealand Transport Agency, the September 2011 scheme assessment economics have been updated to reflect a number of recent changes. This letter sets out the revised inputs and presents the new benefit to cost ratio for Option 1B, the preferred route.

Background

The 2011 September economics were determined using the original 2008 project economics with a number of upgrades which were outlined in our letter to NZTA on 31 October 2011. As requested the September 2011 economics has been revised to incorporate a number of recent updates as listed below:

- New Time Zero of July 2012 (from previous 2011)
- Annualised Route Security benefits for year 2016 (previously a NPV)
- Inclusion of Residual Project Costs
- Inclusion of Agglomeration benefits
- Revised project costs and timestreams
- Reduction in project fees (as some now sunk costs)
- Project opening 3 months before final construction is completed. Remaining costs are associated with landscaping, site dis-establishment, etc.

A review of the past 5 year crash period indicates that there has been a slight change in the crash numbers and severity on SH1, SH2 and SH58. However as the determination of crash benefits is complex and time consuming, it was agreed (Opus/NZTA) that the 2011 assessment would be retained particularly as crashes do not contribute a significant benefit when compared to the overall project benefits.

The previous 2008 SATURN modelling results were also compared with the more recent SATURN outputs undertaken as part of the assessment of environmental effects. This indicated that the TT and VOC operating costs whilst higher, would yield an overall reduction in the total benefits due to assumed treatments along the SH1 Coastal Route which reduce traffic efficiency. Subsequent discussions with NZTA revealed that the assumed SH1 Coastal Route treatments are not required to mitigate any effect of the Transmission Gully project and will only be implemented if the perceived benefits to the coastal communities outweigh the traffic disadvantages. As no decisions have yet been made in relation to this, it was agreed to retain the September 2011 values, which were based on the 2008 SATURN modelling results.

Revised Inputs into the Economic Assessment Update

Since the September 2011 economic assessment NZTA has further refined the design which has resulted in a reduction in the overall estimate project costs and amended the project timeline.

Changes to the inputs include:

- Expected Project Cost Estimates of $881.7M (Q2/2011). This consists of:
  - $45.6M enabling works
  - $700.8M Construction Cost
  - $68M Land Cost
  - $67.3M Fees (although 31.5M is sunk investigation costs)

- A revised cash flow timeline as presented by NZTA with enabling works starting on 1st July 2015 and ending in Dec 2015. Main construction works start in January 2016 with an expected completion date of November 2021.

- Time zero has been changed from year 2011 to 2012. However the Base Year is still July 2011 as new update values for 2012 have not yet been released.

- Route Security benefits have been recalculated using an averaging methodology so that a yearly annual cost for both the Do Min and TG could be determined.

- Inclusion of a Residual Project Cost of $420.8M at year 2051. This has been determined using a general assumption that the expected useable life of TG is 70yrs. Hence 42% of the project has been consumed at the end of the economic assessment period. No value has been given to pavements, service relocations, traffic management or mitigation costs. The land value is deemed to be equal to 100% of its original purchase price. Although the residual amount appears significant, it only has a marginal impact on the BCR as its 2012 value is $20M.

- Inclusion of Agglomeration benefits. This has been assessed by Richard Paling Consulting as part of the Wellington Northern Corridor Appraisal. His assessment provided a NPV range of $15M to $90M for the TG project. The economic assessment has therefore taken the mid-point ($52.5M) as the NPV to adopt in the Standard EEM BCR calculation. The impact of the lower and higher values has been tested.

Table 1 below lists the annual 2016 costs used to determine the new September 2012 project BCR.

Benefit Type	Do Min		TG	
	Yr 2016 value	Growth rate	Yr 2016 value	Growth rate
TT	$450,747,484	1.04%	$434,984,386	0.75%
Trip Reliability	$121,701,821	1.04%	$117,445,784	0.75%
VOC	$173,998,374	0.81%	$174,019,566	0.70%
CO_2	$10,360,494	0.81%	$10,361,756	0.70%
Crashes	$58,661,079	-0.37%	$45,502,776	0.18%
Route Security	$47,742,222	0.50%	$40,156,725	0.36%

- Linear Growth Rate applies to year 2016 costs

Table 1: Standard Annual Operating Costs

Project BCR

Table 2 below indicates the range in BCR's for the project. This includes the standard EEM and 3 sensitivity tests as described below.

- Test 1- The annual Route Security costs have been determined using a range of possible events that would result in a road closure. These include (earthquakes, tsunami, weather, and other incidents). There is a possibility that the cost of an earthquake event could be significantly higher than determined in the original 2008 assessment (as described in scheme assessment report). To test the sensitivity of this a 10 fold increase in the earthquake costs has been adopted. This increased the Do Min annual earthquake cost by $34.2M (+72%), whereas TG increased by only $6.4M (+16%). The result is a substantial NPV increase from $54.1M to $230.8M.

- Test 2 – adopts the standard EEM values but includes the low NPV agglomeration benefits of $15M.

- Test 3, adopts the standard EEM values but includes the high NPV agglomeration benefits of $90M.

		NPV (using 8%)			
		Standard EEM	Sensitivity Test		
			Test 1 Route Security	Test 2 Agglom	Test 3 Agglom
Operating					
TT	Standard	$281.9M	$281.9M	$281.9M	$281.9M
VOC		$17.3M	$17.3M	$17.3M	$17.3M
Crashes		$58.7M	$58.7M	$58.7M	$58.7M
CO2		$1.0M	$1.0M	$1.0M	$1.0M
Reliability		$76.1M	$76.1M	$76.1M	$76.1M
Noise Benefit		$3,5M	$3,5M	$3,5M	$3,5M
Route Security	Standard	$54.1M	-	$54.1M	$54.1M
	10x cost for earthquake	-	$230.8M	-	-
Agglomeration	Standard	$52.5M	$52.5M	-	-
	Low	-	-	$15M	
	high	-	-	-	$90M
Total		**$545.2M**	**$721.9M**	**$507.7M**	**$582.7M**
Costs					
Fees	Standard	$31.5M	$31.5M	$31.5M	$31.5M
Property		$51.9M	$51.9M	$51.9M	$51.9M
Construction		$448.3M	$448.3M	$448.3M	$448.3M
Maintenance		$4.8M	$4.8M	$4.8M	$4.8M
Total		**$536.6M**	**$536.6M**	**$536.6M**	**$536.6**
BCR		**1.02**	**1.35**	**0.95**	**1.09**

Table 2: Project Economics for Option 1B (using the TG Option matrix)

The September 2012 updated economics for Option 1b using the option matrix indicates a **BCR of 1.02** using the revised expected project cost of **$881.7** million (Q2/2011).

The main sensitivity tests indicate that:

- The magnitude of change in the route security benefits is significant with the NPV increasing from $54.1M to $230.8M, thereby lifting the BCR by 32% to a value of BCR 1.35.

- Adoption of the low agglomeration benefit reduces the BCR by -7% (BCR 0.95), whilst adopting higher agglomeration benefit yields an increase of +7% (BCR 1.09).

Although considered unlikely, if the high agglomeration benefits (test 3) were adopted with the 10 fold increase in earthquake costs (test 1) then the economic efficiency ratio would increase to BCR 1.42

Further to the above tests, the impact of constructing TG within 5years or bringing the construction period forward was also assessed. The results of these two tests were:

- Test 4 – 5yr construction programme starting on 1 Jan 2016 with Design and Enabling works occurring in the same time period as above. The benefits start in Nov 2020 and end in Nov 2051 (as per Standard EEM assessment above) resulting in 31yrs of benefit.
  - NPV Benefits = $581.0M
  - NPV Costs = $550.4M
  - BCR = 1.06

- Test 5 – 5yr construction programme with a start date in January 2015. Design fees occur over the two & half year period 1 July 2012 to 31 Dec 2014 and enabling works between 1 July 2014 to 31 Dec 2014. Project benefits start in Nov 2019 with 32yrs of benefit.
  - NPV Benefits = $618.3M
  - NPV Costs = $594.0M
  - BCR = 1.04

A full copy of the economic worksheets for the Standard EEM (**BCR 1.02)** is attached to this letter. If you require further information please don't hesitate to contact me.

Yours sincerely

Mike Meister
Technical Principal Traffic & Transportation

Appendix E

Modelling and Economics Reported for Part 7 (M2PP)

Worksheet 1: Evaluation Summary

Evaluation Summary

1	Evaluator(s)	**Graham Bell (Wellington)**
	Reviewer(s)	**Andrew Murray (Auckland)**
2	**Project/Package**	
	Organisation Name	**NZTA**
	Project/Package name	**Mackays to Peka Peka**
	Your reference	**3320901**
	Project Description	The NZTA application sought approval to construct approximately 16 kilometres of expressway from just north of MacKays Crossing to Peka Peka Road following the designation set aside for the Western Link Road. The expressway will pass through Raumati, Paraparaumu and Waikanae between the existing state highway and the coast.
	Describe problem	The highway is the only continuous north-south arterial between MacKays Crossing and Peka Peka and it is the only road crossing of the Waikanae River. SH1 currently performs a local road function which erodes its ability to effectively perform its role of a National State Highway and Road of National Significance. The geometry of SH1 is currently sub-standard with "out of context" curves and an inconsistent speed environment. The high degree of side access and local road connections creates side friction which slows traffic on the highway and creates a crash risk.
3	**Location**	
	Brief description of location	The project area extends from north of MacKays Crossing to north of Peka Peka Road on State Highway 1 (SH1) on the Kāpiti Coast, including both the Paraparaumu and Waikanae townships.
4	**Alternatives and Options**	
	Describe the Do Minimum	The 'Do Minimum' scenario represents the current road network infrastructure along with committed, future year improvements. This scenario also includes maintenance work, planned future development and expected traffic growth in the region. No alteration to the existing SH1 alignment is assumed.
	Alternatives considered	In 2009, the NZTA considered four alignments for the Expressway, including upgrading the existing route, the "Eastern" alignment, the "Western" alignment, and the "Western Link" alignment. The NZTA Board chose the Western Link alignment which is the subject of this investigation.
	Options assessed	Expressway between MacKays Crossing and Peka Peka, with interchanges at Queen Elizabeth Park (south facing only) connecting into Poplar Avenue, Kāpiti Road, Te Moana Road and Peka Peka Road (north facing only).
5	**Timing**	
	Earliest construction start date (mm/yy)	01.01.2013
	Expected construction start date (mm/yy)	01.01.2013
	Expected duration of construction start date (months)	48
6	**Economic Efficiency**	
	Date economic evaluation completed (mm/yy)	07.05.2013
	Time Zero	2013
	Base date for costs and benefits	2012
	PV cost of do minimum, $m NPV	17.5
	PV net cost of preferred option, $m NPV	523.1
	PV net benefits of preferred option, $m NPV	513.9
7	**BCR**	**1.0**
8	**FYRR**	4%
9	**Non-monetised impacts**	
10	**National strategic factors**	

Worksheet 3: Benefit Cost Analysis - Variable Trip Matrix Method

Benefit Cost Anlaysis		**Worksheet 3 VTM**
Project:	**Mackays to Peka Peka (M2PP)**	
Component:	**April 2013 BCR refresh**	

Discount Rate= 6%

Analysis Period= 40

	Project Options	DM1	OPT1						OPT1	0	
	Code	**DM1**	**OPT1**						**OPT1**		
	Compared Against	**DM1**	**DM1**						**DM1**		
	VTM Code	DM1DM1	OPT1DM1								
	BENEFITS (NPV):										
1a	Travel Time Benefits								328.7		
1b	Congestion Benefits								96.7		
1c	Trip Reliability								16.4		
2	Vehicle Operating Costs Benefits								4.9		
3	Accident Costs								37.3		
4	Carbon Dioxide								0.2		
5	Route Security								**29.600**		
6	Monetised External impacts										
7	**PV Total Net Benefits**								**513.89**	**0.0**	
	COSTS (NPV):				PV of Costs				PV of Net Costs		
8	Investigation	0.000	0.000						-	-	
9	Design	0.000	10.247						10.2	-	
10	Property	0.000	61.991						62.0	-	
11	Construction	0.000	449.009						449.0	-	
12	Maintenance	17.503	19.400						1.9	-	
13	Renewal								-	-	
14	Operating (tolls)	0.000	0.000		0.000				-	-	
15	External Impact mitigation								-	-	
16	Project contingency costs								-	-	
17	Risk management								-	-	
18	**PV of Total Net Costs**	17.503	540.647		0.000				523.1		
19								**National BCR = (7)/(18)**	**1.0**		
20	Non-Government Costs	0	0.000		0.000				0.0	0.0	
21	Gross Toll Revenue	0	0.000		0.000				0.0	0.0	
	Third Party Revenues	0	0.000		0.000				**0.0**	**0.0**	
22	**PV of Benefits net of Toll Costs**							(7)-(21)	513.9	0.0	
23	**PV of Net Costs to Government**							(18)-(20)-(21)	523.1		
24								**Government BCR = (22)/(23)**	**1.0**		
								Start Delay, (years)		0.0	
	Aggolmeration Benefits:								**PV of Indirect Benefits**		
								Discount Factor for Delayed Benefit Start			
25	**Agglomeration Benefits, NPV $M**										
26	**PV Total Net Benefits with Agglomeration**								513.9		
27	**PV of Total Net Costs**								523.1		
								National BCR = (26)/(27)	**1.0**		
28	**PV of Benefits net of Toll Costs with Agglomeration**								513.9		
29	**PV of Net Costs to Government**								523.1		
								Government BCR = (28)/(29)	**1.0**		
	Wider Economic Benefits:								**PV of Indirect Benefits**		
30	**Wider Economic Benefits (WEBs), NPV $M**										
31	**PV Total Net Benefits with Agglomeration and WEBs**								513.9		
32	**PV of Total Net Costs**								523.1		
								National BCR = (31)/(32)	**1.0**		
33	**PV of Benefits net of Toll Costs with Agglomeration and WEBs**								513.9		
34	**PV of Net Costs to Government**								523.1		
								Government BCR = (33)/(34)	**1.0**		

Results of TOC Reconciliation Process

	IE	Alliance	
Direct costs inc P&G/design ($000's)	$000's	$000's	
Design	$ 29,060	$ 29,610	
Physical Works	$ 305,680	$ 310,430	
P&G	$ 91,280	$ 98,140	
P&G % of physical works	30%	32%	
Escalation	$ 24,690	$ 25,670	
Risk - threats	$ 18,200	$ 23,500	
Opportunities - Value Engineering	-$ 7,140	-$ 7,300	
Sub-total A	$ 461,770	$ 480,050	Limb 1 direct costs
Adjustment for risk/P&G	$ 2,800	-$ 6,050	
	$ 464,570	$ 474,000	**Variance to IE's estimate** **2.0%**
Less Beca design fee to June 13			
		$ 474,000	Limb 1 direct costs (subject to Limb 2)
Limb 2		$ 68,430	
Proposed Alliance TOC		**$ 542,430**	
add Limb 3 performance pool		$ 2,500	
NZTA Managed costs inc risk		$ 5,548	
Phase 2d costs to 30/6/13		$ 6,215	
Cultural mitigation package		$ 3,000	
Overspend on development phase		$ 150	
Sub-total C		$ 559,843	Construction Estimate (CE)
		$ 20,000	Funds needed to avoid Maori Freehold Land
		$ 579,843	Project Final Costs - Construction Phase
		$ 22,285	Previous funding
		$ 557,558	Additional funding required
		$550 - $570M	Range given to the Board

	Limb 1 costs	Limb 2 mar	Margin
Design fee subject to Limb	$ 29,610	36%	$ 10,660
Construction costs	$ 444,390	13%	$ 57,771
Proposed TOC	$ 474,000		$ 68,430

Property Acquisition costs (nett of disposals)	$ 57,062
Design Development	$ 42,400
Waterfall Rd early works	$ 4,430
Construction phase estimate (P50)	$ 579,843
Total Estimated Project Costs	$ 683,735
Previous Scheme Estimate (SE)	$ 637,462
Escalation	$ 44,567
	$ 682,029
Various to previous Scheme Estimate	$ 1,706
% Variance to Scheme Estimate	0.3%

Appendix F

Modelling and Economics Reported for Part 8 (Peka Peka to Ōtaki)

Appendix K

Economics Evaluation

PP20 Scheme Assessment Report

Economics Note

December 2011

PP20 Scheme Assessment Report Economics Note

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Contents

1 PP2O Economics Calculation

1.1 Overview

The economic analysis for the PP2O project has been considered both as part of the wider Wellington Northern RoNS package and in isolation for the purposes of NZTA's Scheme Assessment Report Addendum (SARA) requirements. As a result there has been an attempt to create a consistent approach to economic assessment over the entire RoNS corridor (Levin to Wellington). However, as the RoNS projects are at different stages of development and have adopted a range of individualised assumptions, there remains some variation in the approach used for economic evaluation. As with all of the projects to the south of PP2O, the Wellington Transport Strategy Model (WTSM) has been utilised as the basis in which the PP2O project has been assessed. In addition to the use of WTSM there have been a number of project specific traffic models built for analysis including the PP2O Traffic Model (PP2OTM).

In this economic analysis, outputs of the project specific models have been incorporated into the total benefit calculations. For the PP2O project the benefit calculations have subsequently included: travel time savings, vehicle operating cost savings, reductions in CO2 emissions, crash costs and maintenance costs. Methodologies for quantifying these components are outlined in later chapters of this report. Other benefits including route reliability and security have not been calculated as they are likely to be relatively small. Such benefit components would result in very little change to either the total Wellington Northern RoNS package or the PP2O specific BCR.

Agglomeration benefits result from productivity gains associated with the construction of the whole Wellington Northern RoNS Corridor. It is not possible to associate these benefits with a specific section of the corridor such as PP2O. This is because agglomeration benefits are only truly realised once the whole corridor is constructed. Therefore, agglomeration benefits are not included in the economics for this specific corridor segment and will only be included when analysing the benefits associated with the entire Wellington Northern RoNS.

1.2 Wellington Northern RoNS Economic Assessment

Economic assessment of the entire Wellington Northern RoNS package was undertaken as part of a business case study in late 2009. This evaluation involved the development of a methodology to capture the benefits of each individual RoNS project (including PP2O) and then combine them to calculate an overall package BCR of 1.1. Wider economic/agglomeration benefits were also considered for the entire package as part of a sensitivity test. The application of these benefits increased the Wellington Northern RoNS package BCR from 1.1 to 1.4.

While the approach used for calculating each individual project BCR in isolation has been consistent it is important to note that some projects within the total corridor have a BCR below one while others have a BCR much greater than one. But in order to provide an Expressway from Levin to Wellington without the full package of works associated with each corridor project it would be difficult to achieve the RoNS objectives and recognise the wider economic/agglomeration benefits associated with the package.

1.3 Traditional PP2O Project Economic Assessment

The benefits for the PP2O project in isolation were determined by using the outputs of the PP2OTM (built in SATURN packages) in conjunction with the latest version of NZTA's Economic Evaluation Manual (EEM). The PPOTM has been derived from the base land use, future year land use and travel demand scenarios from WTSM. This has enabled the testing of a Do-minimum and Option network for the PP2O project during the AM, IP and PM peak hours.

The following sections detail the key traffic modelling assumptions that are fundamental in understanding how the models contribute towards determining an individual BCR for the PP2O project.

1.3.1 WTSM

The current WTSM land use and travel demand modelling uses a base case which was updated to a 2006 demand in 2008. Associated with this update was the forecasting of a medium, low and high land use and travel demand range. In agreement with NZTA and GWRC, the Wellington Northern RoNS assessment has used the medium trip matrices for modelling in SATURN, with some project specific updates adopted for the PP2O project to account for growth in Otaki. This includes the Riverbank Road development which is growing rapidly both now and in the future. Such development is not incorporated into the WTSM medium matrices for the Otaki area.

GWRC and NZTA are currently working on growth scenarios which include land development and employment that might be stimulated as a result of significant infrastructure investment and/or the commitment to such investment in the future. The Wellington Northern RoNS project is one such project that is aimed at stimulating economic growth and productivity. Once the RoNS Land Use scenario has been developed, the following WTSM scenarios can then be considered in the PP2OTM:

1. Medium Land Use / Do-Minimum Network
2. Medium Land Use / Option Network
3. RoNS Land Use / Do-Minimum Network
4. RoNS Land Use / Option Network

These land-use and traffic demands would then need to be transferred into SATURN runs for economic purposes.

1.3.2 PP2OTM (SATURN)

The PP2OTM has been validated based on 2010 traffic counts in the study area (refer Peka Peka to Otaki SATURN model validation report, 2010 in Appendix A). Using the WTSM land use and travel demand scenarios, a fixed matrix approach was adopted in order to compare the following Do-minimum and Option networks:

Do-Minimum Network

- Travel demands based on 2016 & 2026 WTSM medium growth demands;

- Including all RoNS scheme developments as part of the Wellington Northern RoNS project (based on the 2009 business case);
- Additional Kapiti development (Paraparaumu town centre, Waikanae north and 50% Aerodrome);
- Additional Riverbank Rd development in Otaki; and
- Current zebra crossing north of Arthur St upgraded to a signalised crossing before 2016.

Option Scenario (same as Do-Minimum plus):

- 4 lane Expressway with 100 km/h speed limit through the study area;
- New Local Arterial (existing SH1) speed reduction from 100 km/hr to 80km/hr for rural sections;
- North facing ramps located north of Otaki;
- Rahui Rd (east/west) bridge connection;
- Otaki Gorge Rd south facing ramps with a roundabout located on the western side of the interchange to join the New Local Arterial;
- Local Road link between Otaki Gorge Road and Old Hautere Road;
- Local road bridge over at Te Horo from Beach Road to School Road;
- North facing ramps at Peka Peka Rd and Hadfield Rd (consistent with MacKay's to Peka Peka design);
- Isolating traffic demand at the southern end of the model (South of Te Horo traffic stays on local Arterial and north of Te Horo traffic stays on the Expressway to/from the south); and
- Taylors Road at grade with safety and operational improvements.

Note that the assumption to have all other parts of the RoNS package included in the Do-minimum may result in an overestimation of the benefits. This assumption was identified and agreed to by NZTA. There has subsequently been no WTSM test undertaken to remove the PP2O project from the package. It is possible that the traffic induced by the PP2O section may instead come from changes in land use with the completion of the entire RoNS package.

Induced Trip Assessment

By reducing travel time through the PP2O study area it may induce new trips or redistribute trips. In the cases where induced or redistributed trips are expected to significantly affect the evaluation, a variable matrix approach should be adopted.

Variable matrix methods differ from conventional fixed trip matrix techniques in that demand in the option matrix is generally higher than that in the do minimum matrix for a given forecast year. The EEM states that variable trip matrix methods are to be used for all complex improvements, unless:

(a) It can be demonstrated that
  (i) The congestion level expected throughout the analysis period in the do-minimum or option will not be substantial, and
  (ii) The peak period PT mode share is less than 15%; or
(b) Preliminary evaluation show that the fixed trip matrix benefits are unlikely to differ by more than 10% from those from a variable trip matrix approach; or
(c) The NZTA approves the use of a fixed trip matrix approach for other reasons.

In order to establish whether there was a need to undertake a variable trip matrix approach for the PP2O project, a test was undertaken using a variable trip matrix approach as part of the M2PP Kapiti network model. It was identified that the Option resulted in less trips than the Do-minimum. This appears counter-intuitive; however this is understood to be largely due to the relatively uncongested operating conditions in the AM, interpeak and PM peak periods. Additionally this could be because of the change in accessibility associated with the Option at Peka Peka, impacting on trips between Peka Peka and Te Horo.

On the recommendations of the external peer reviewer, additional sensitivity tests have also been carried out using the elastic assignment in the PP2O model. This would further justify the fixed matrix approach. Table 1 below shows the study area network demands in AADT and the percentage change between Do-minimum and Option. It suggested the Option will only introduce 2% extra AADT traffic in 2026 due to the uncongested network. The fix trip assignment benefits are unlikely to differ by more than 10 percent from that of the elastic assignment.

Table 1: PP2O network demand AADT summary (vehicles)

PP2O Demand Summary		Fix MX		Elastic MX	
		AADT	Diff%	AADT	Diff%
2010	Base	30,111		30,111	
	Option	30,111	0%	30,112	0%
2016	Do-Minimum	39,092		38,431	
	Option	39,092	0%	38,975	1%
2026	Do-Minimum	42,875		41,727	
	Option	42,875	0%	42,701	2%

Table 2 summaries the total network delay in modelled peak periods between the fixed and elastic assignment methods. The differences are again considered to be marginal.

Table 2: PP2O network delay between fix and elastic assignments (seconds)

Delays (hrs)		Fix MX	Elastic MX	Actual Diff
2016 Do-Minimum	am	12.0	11.2	-0.8
	ip	6.5	6.1	-0.4
	pm	18.8	17.0	-1.8
2016 Option	am	0.5	0.5	0.0
	ip	0.4	0.4	0.0
	pm	0.8	0.8	0.0
2026 Do-Minimum	am	21.1	18.4	-2.7
	ip	10.6	9.7	-0.9
	pm	29.5	25.9	-3.6
2026 Option	am	0.9	0.9	0.0
	ip	0.6	0.5	-0.1
	pm	1.2	1.1	-0.1

For the above reasons, the PP2O project modelling has used a fixed trip matrix approach. The project team believe that a variable matrix approach is unnecessary based on the fact that congestion levels are not significant and the change in trips are less than 10%.

1.3.3 PP2OTM vs. M2PP SATURN Model

As discussed in section 1.1 earlier, the PP2OTM has been used for assessment of this project due to concerns held by the team over the levels of validation in the PP2O project area using the M2PP SATURN Model. This decision was agreed with NZTA for the purposes of the SARA phase of the project, with future consideration to be given to improving the M2PP model north of Peka Peka Road prior to the planning process.

The peer reviewer raised concerns over the route choice at the southern part of the model, which was based upon manual calculation of trip lengths and travel time. A comparison was undertaken between the PP2OTM (manual allocation of traffic by corridor) and the M2PP models to better understand the accuracy of the results. It should be noted that given the issues associated with the M2PP model north of Peka Peka Road the results this may not provide any more certainty than the manual calculation.

Table 3 below summarises the AADT differences between the two models in year 2026 under expressway option near Peka Peka Rd. The results showed the split using the two approaches (modelled and calculated) are actually very similar which addresses the concerns raised by the peer reviewer.

Table 3: Modelled PP2O southern traffic demand split (North of Peka Peka)

2026 traffic demand		Existing SH1	Expressway	Screen line
PP2OTM	AADT	3553	20752	24305
	Proportion	15%	85%	100%
M2PP	AADT	4160	17942	22102
	Proportion	19%	81%	100%

2 Economic Assumptions

Based on the WTSM and SATURN outputs/issues, the following key assumptions were used for the purposes of the economic analysis in the PP2O project:

- All the costs and benefits have been discounted to 01/07/2011 (Time zero);
- An 8% discount rate has been used to discount the costs and benefits to time zero;
- A 30 years benefit period starting from time of significant expenditure (01/07/2014);
- Opening year has been assumed to be July 2018;
- A four year construction period starting 01/07/2014 and finishing 30/06/2018 has been assumed for economic purposes. For discounting it was assumed that property costs will be paid at the start of the construction period. The remaining phases of construction would be paid at the midpoint of every six month cycle, with the final payment occurring on 01/04/2018
- Only Rural Strategic trips have been assumed within the modelled area.
- SATURN model outputs for year 2016 and 2026 (AM, Inter, PM and Weekend Peaks) have been used to forecast the travel time, vehicle operating and CO2 emission benefits. Benefits for intermediate years have been interpolated, and benefits have been extrapolated beyond 2026 due to this being a largely uncongested network;
- Weekend peak model has been factored from the inter peak model which has been based on the study area traffic flow profile;
- The crash benefits have been calculated in general accordance with the EEM procedures, utilising the existing crash history between 01/07/2005 and 01/07/2010;
- CO_2 emission costs are assumed to be 4% of the vehicle operating costs;
- No travel time reliability or incident benefits have been calculated; and
- No agglomeration benefits have been included in the evaluation.

The economics worksheets are contained in Appendix B. Detailed discussions in regards to each of the economic components listed above is documented within the remaining chapters of this report.

3 Benefit Time Stream

Total annual costs are estimated for future years for both the Do-Minimum and Option scenarios from the 2016 and 2026 PP2OTM. For years before 2026, values are obtained from the linear trend between 2016 and 2026 values (including back-extrapolation for years before 2016); for years after 2026, values are extrapolated beyond the 2026 level. This is used to capture the 30 year benefit period from the start of construction.

4 Travel Time Assumptions

Total travel time for each scenario is the sum of all trips over the road network in vehicle-hours on each link and at each intersection. An additional value of time is also included for travel in congested conditions. Congested time on links is calculated for the AM, Inter and PM peaks. Intersection delay is also included in congested travel time for all time periods.

The EEM gives parameters for obtaining travel time costs from vehicle-hours for various road types and traffic composition. Travel time values recognise that there is a mixture of rural strategic and urban arterial traffic users within the modelled area. The EEM indicates the standard traffic composition for these two road classifications as:

- Urban Arterial: Cars/LCV = 95%, HCV's = 5%
- Rural Strategic: Cars/LCV = 88%, HCV's = 12%

NZTA's traffic count sites at North of Waitohu River Bridge, North of Waerenga Road and at Mary Crest indicate that an HCV composition of 12%, 10% and 11% can typically observed across each site respectively (refer to Chapter 8 for the detailed site and observation period information). These values are relatively close to the standard Rural Strategic mix. For such reasons, in the economic assessment of the PP2O project, the travel time and vehicle operating costs value for rural strategic road sections has been used. The EEM (pA4-3) gives composite value of travel time for the rural strategic road category.

Based on this assumption the results show that travel time accounts for around $57M benefits over 30 years. This equates to approximately 63% of the total project benefits. Note that of the travel time benefits, congestion relief values (CRV) account for around $1M benefits over the 30 year period, or around 1% of the total project benefits. CRV includes links where the VC ratio exceeds 70% and all turning movements.

The travel time benefits are directly related to the increased network capacity and the faster operating speed on the new expressway. The redistribution of the north/south through movement from the existing SH1 to the expressway creates better performance to and from local road intersections. To prove this, as a sensitivity the travel time benefits have been broken down on a geographical sector basis. The study area has been categorised into five sectors as shown in

Figure 1 below. The actual travel time savings for each modelled peak hour can be found in 4. Unsurprisingly the results indicate that approximately 90% of the travel time benefits are SH1 (sectors 1 and 5) related, regardless of the peak period being reviewed.

Figure 1: PP2O Sector Diagram

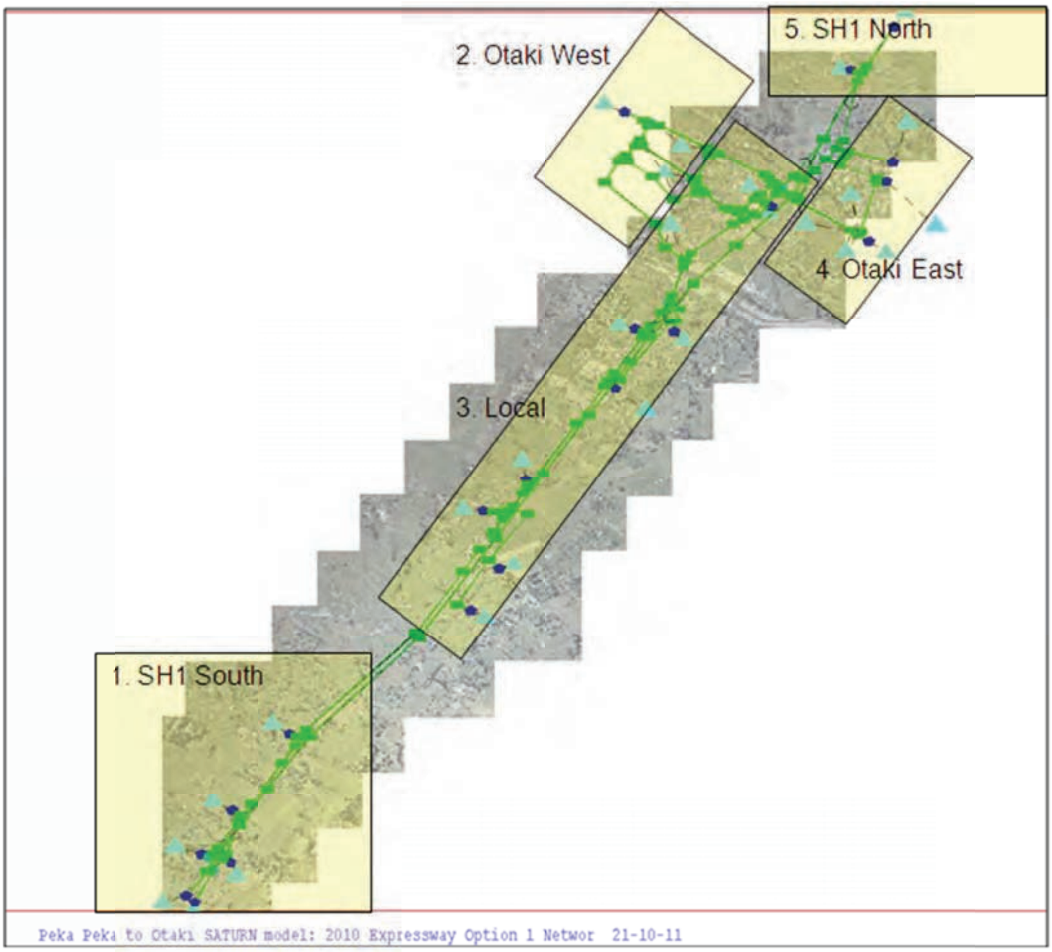


Table 4: Travel time saving in sectors

2026 Opt1 AM Savings (pcu*hrs/hr)						
Sectors	1	2	3	4	5	Total
1	0.0	1.9	0.3	0.7	17.9	**20.7**
2	3.7	0.0	0.4	0.1	1.1	**5.2**
3	1.0	0.1	0.1	0.1	1.1	**2.4**
4	1.2	0.1	0.4	0.0	0.1	**1.8**
5	24.2	0.2	0.7	0.0	0.0	**25.1**
Total	**30.0**	**2.3**	**1.8**	**0.9**	**20.2**	**55.1**
2026 Opt1 IP Savings (pcu*hrs/hr)						
Sectors	1	2	3	4	5	Total
1	-0.2	1.3	-0.9	0.5	14.8	**15.4**

2	1.9	0.0	0.0	0.1	1.0	**3.0**
3	-0.1	0.0	-0.4	0.1	1.5	**1.1**
4	0.5	0.1	0.0	0.0	0.1	**0.6**
5	16.2	0.1	0.1	0.0	0.0	**16.4**
Total	**18.3**	**1.4**	**-1.2**	**0.6**	**17.3**	**36.5**
2026 Opt1 PM Savings (pcu*hrs/hr)						
Sectors	1	2	3	4	5	Total
1	0.1	3.9	0.5	1.6	27.0	**33.1**
2	3.3	0.0	0.4	0.3	1.2	**5.1**
3	5.2	1.1	1.6	0.8	2.8	**11.7**
4	0.7	0.1	0.2	0.0	0.1	**1.1**
5	23.6	0.2	0.7	0.1	0.0	**24.6**
Total	**33.0**	**5.4**	**3.4**	**2.7**	**31.1**	**75.6**

5 Vehicle Operating & CO_2 Costs

Total travel distance for each scenario is the sum over the road network of the vehicle-kilometres on each link. And the total fuel consumption is the sum over the road network of the vehicle-litres on each link. Using the same rural strategic road category as the travel time calculations, the EEM gives parameters for obtaining vehicle operating costs from both vehicle kilometres and fuel costs in Table A5.9. CO_2 emission costs are estimated at 4% of vehicle operating costs (EEM A9.6).

The results showed there are annual disbenefits from vehicle operating cost. The reasons for the disbenefits include the following:

- Travel speeds on the network and the Expressway in particular result in additional fuel consumption, whereas improvements in VOC occur on the local arterial due to lower speeds and reduced congestion.
- Small increase in travel distance for southbound trips to and from Old Hautere Road, which was considered as part of the incremental analysis for this option.
- The Te Horo local road bridge will increase travel distance for movements to and from the existing SH1 (north and south), however it will reduce the distance between the communities on the east and west sides of the Te Horo. Travel times for both should be reduced due to the removal of SH1 through traffic.
- Based on travel time reductions on the Expressway, it has been calculated that the majority of road users in Te Horo north to Otaki Gorge Road will use the Expressway, resulting in additional travel distance and operating costs.

6 Crash Costs

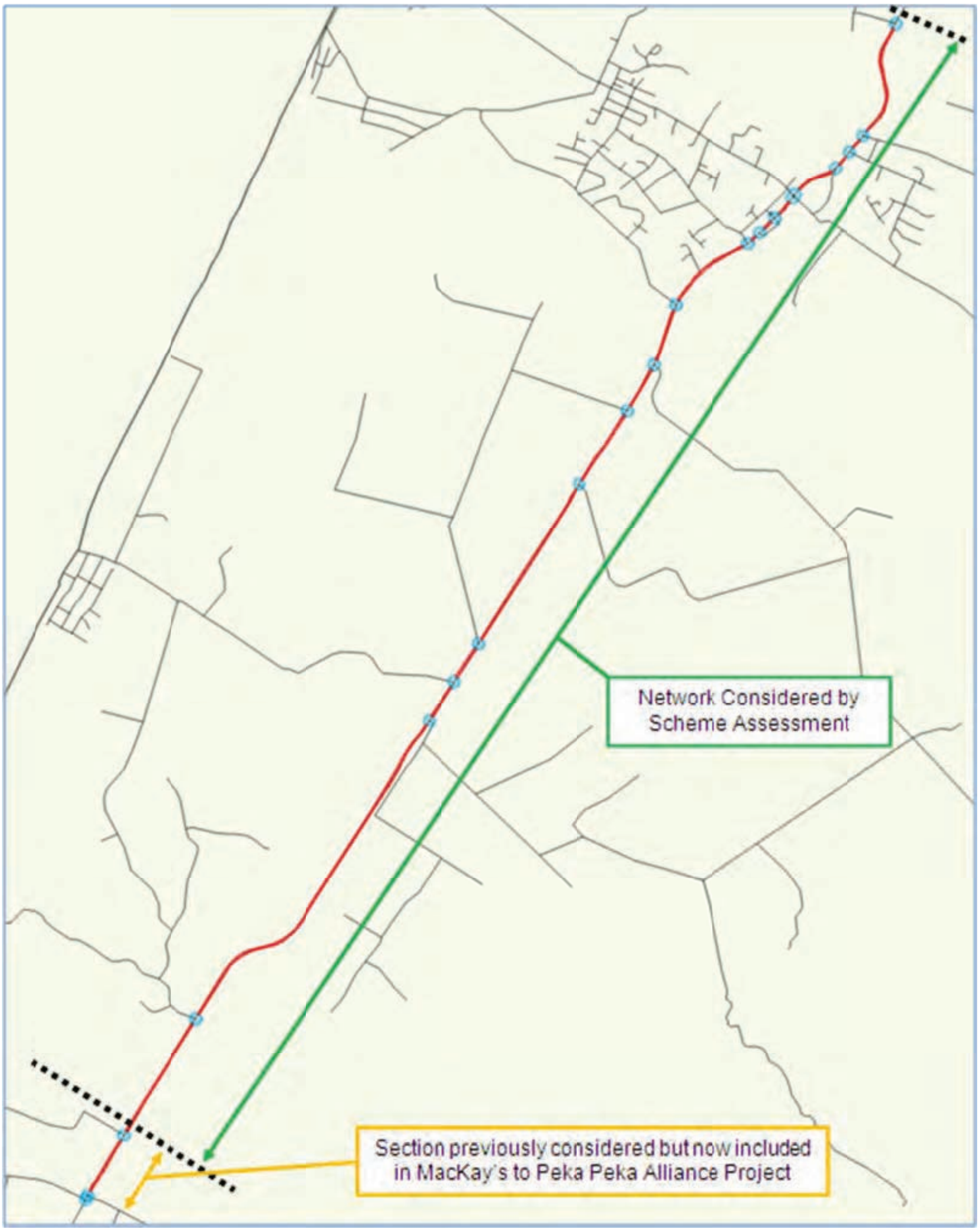
A crash model has been constructed to analyse the potential crash benefits/disbenefits associated with the construction of PP2O. The costs have been generated in accordance with Section A6 of the EEM.

The scope of the road network considered for the crash model is defined as the current SH1 alignment from the Taylors Road / SH1 priority-tee intersection (1N / 995 / 3.303) through to a location immediately to the north of the Te Kowhai / SH1 priority-tee intersection (1N / 995 / 15.373). Note that this differs from the route adopted during the PP2O scoping phase which went as far south as Peka Peka Road. The southern extension has now been included within the “MacKays to Peka Peka” RoNS project.

The analysis area is shown visually within Figure 2 of this document (overleaf). As can be seen all key intersection and midblock locations situated along the SH1 route are included within the crash model. These locations are those most likely to experience traffic volume changes as a result of the Otaki expressway option. For the purposes of this assessment, the option proposed is the same as that documented by the “Road Design Preferred Proposal Drawings” 5/2664/1/5504/1101-1108 issued on the 23rd of June 2011.

Note that elements of the local road network, particularly within Otaki were initially included in the early stages of the crash model’s development. However, it became apparent on review of the existing crash history and modelled traffic volume comparisons that these local links and intersections could be excluded. In the majority of these locations there is no crash history and the volumes do not fluctuate between the do-minimum and option scenarios. For such reasons the crash model is considered a conservative and realistic estimate of the crash costs for the project.

Figure 2: Extent of the Do-Minimum Crash Model Analysis Study Area



6.1 Crash History

At each of the existing intersection and midblock locations specified in Figure 2, the crash history has been reviewed using the NZTA "Crash Analysis System" (CAS) for the period 01/07/2005 to 30/06/2010. Within CAS a 50m radius for intersections and a 10m radius for midblock locations was specified. Crash costs for each location could then be determined individually.

As the crash model was finalised at the end of December 2010, the full 2010 calendar year crash data was not available. This is because CAS is typically three to six months behind the current date. However for comparative purposes and completeness, Table 55 below provides a summary of the crash history on SH1 between Taylors Road and Peka Peka Road for the different analysis periods that are now possible to be analysed. As can be seen there is very little difference between the data used for the crash model and the most current information that is available. The crash model is therefore still representative of the existing situation.

Note that the analysis period crash history is markedly different to the 2004-2008 five year period used originally as part of the high level RoNS economic assessments. The analysis period used for the PP2O crash model shows a significant decrease in the number of serious injury crashes and one less fatal crash. This will have an impact on the magnitude of existing crash costs and the potential benefits possible from the expressway option.

Table 5: Crash history adopted within this analysis and that previously used in past RoNS appraisal

Year	Fatal	Serious	Minor	Non-injury	Total
01/07/2005 to 30/06/2010 (Current Analysis)	3	13	27	96	139
2004 to 2008 (Past RoNS work)	4	43	26	77	150
2006 to 2010 (Latest Possible)	3	13	32	104	152

6.2 Crash Model Assumptions

The crash model has assessed the “Do-minimum” and “Option” networks using the methods described by Section A6 of the EEM Volume 1. Slight variations have been made to the standard methodologies due to the scope of the area considered and because the majority of the existing State Highway network will see no fundamental change in the “Option”. These links will instead experience only changes in traffic volumes. For such reasons a dollar / vehicle / kilometre approach has been used in order to calculate the forecast year crash costs.

In combination with the existing crash history, the PP20TM has significantly contributed to the development of the crash cost benefits. As the PP20TM assesses the network across the AM, IP and PM peak hours, flow factors have subsequently been used to determine a 24 hour AADT value for the appropriate network sections and their turning movements. The AADT conversion factors adopted for the PP2OTM for the purposes of the crash analysis included a:

- 2 hour AM peak;
- 11.4 hour IP peak; and

- 2 hour PM peak;

The PP20TM has been used to forecast the shift in vehicles from the existing SH1 network onto the new expressway proposed as part of the option. Based on the traffic volumes determined from the PP2OTM and the existing crash history, the following assumptions were made for the "Do-minimum" and "Option" scenarios:

6.2.1 Do Minimum Analysis

The do-minimum crash costs have been determined using "Method A: Accident by Accident Analysis" as per the procedure outlined within the EEM. This method allows a dollar per vehicle per kilometre approach to be used, simplifying the forecast year analysis significantly. "Method A" relies on the existing crash history in the area defined by Figure 2. In addition the following assumptions have been required for each "Do-minimum" intersection and midblock element:

- Calculated with the use of the EEM analysis software to account for different crash movements and vehicle types;
- Time zero of 01/07/2011;
- 2% annual traffic growth;
- All posted speed limits for each network element as is on site;
- All midblock lengths as measured on-site;
- Mean speeds of vehicles:
    - 85km/h assumed for a 100km/h posted speed limit;
    - 70km/h assumed for a 80km/h posted speed limit;
    - 60km/h assumed for a 70km/h posted speed limit;
    - 50km/h assumed for a 50km/h posted speed limit;
- Passing lane sections not assessed independently;

Note that the 2% annual traffic growth value has been adopted to be conservative. NZTA count station data in the Otaki (Site:01N01001 "Nth of Waerenga Road") indicated a 1.1% annual growth rate between 2001-2010. However in comparison, the SATURN flows forming the basis of the crash model, display an annual growth between 2010 and 2026 as approximately 3% once development is accounted for. Table A2.5 on Page A2-11 of the EEM was reviewed for the Wellington Region which states a 2% growth rate can be adopted for rural strategic roads. This value was hence adopted as it lies half way between the actual and predicted growth rate through Otaki.

6.2.2 Option

To calculate the option costs a mixture of “Method A: Accident by Accident Analysis” and “Method B: Accident Rate Analysis” has been adopted. For the majority of the existing SH1 network being considered there is no fundamental change between the “Do-Minimum” and “Option” as only traffic volumes will vary. For such elements the option crash cost has been calculated using the $/vehicle/km value determined in the “Do-minimum” analysis. The $/vehicle/km value was then multiplied by the new traffic volumes to generate an option cost.

The new road sections introduced as part of the expressway proposal were assessed using “Method B: Accident Rate Analysis”. This has included both the new expressway structure and the fundamental changes being made to existing locations. To generate the “Option” crash cost values, the following general EEM accident prediction models have been used in conjunction with SATURN volume values when “Method B” was applied:

- (1) Urban cross and T-intersections (50 – 70km/h);
- (2) Urban roundabouts (50- 70km/h);
- (5) General urban mid-blocks 50-70 km/h;
- (7) High speed cross and T-intersections (>80km/h) priority and traffic signals;
- (11) Rural two-lane roads (80km/h);
- (13) Motorways and four-lane divided rural roads.

6.2.3 Alternative Method

At the request of the external peer reviewer, a sensitivity test on the crash model was conducted using the generic accident prediction models. This would allow comparison between the adopted crash model methodology using accident by accident procedures and that calculated using the EEM’s prediction models. This would confirm the suitability of the crash model and the assumptions used. In assessing only the do-minimum intersections as the sensitivity check, it was found that when the prediction models are used, the crash cost value is 80% of that calculated using the accident by accident analysis. In general and as agreed with the peer reviewer, it can be concluded that there is a higher than average crash rate along this length of SH1. The adopted methodology is therefore appropriate.

6.3 Crash Savings

The crash model has indicated that once discounted over a 30 year period almost $42M in benefits is available. This accounts for approximately 46% of the total project benefits. It is acknowledged that the crash savings form a large component of the project benefits. However we believe this is intuitive. The option will see a substantial reduction in vehicles travelling along the existing SH1 route as traffic is shifted onto the new expressway. This will in-turn reduce the number of vehicle conflicts occurring on a daily basis along the existing SH1 route. The potential and probability of a crash occurring on the existing SH1 network will thus decrease due to a significant reduction in vehicle exposure. The adopted methodology does place a strong emphasis on the existing crash history data. It therefore will not be surprising if the crash benefits calculated at this point in time fluctuate in the future if the crash model is re-calculated at another time. As has already occurred between the completion of crash analysis for the RoNS business case and the PP2O project, the longer the project continues to be delayed the potential for further reductions to the BCR is likely given that in the long term it is evident that the number of crashes occurring on the road network annually is displaying a decreasing trend.

7 Maintenance Costs

Annual and periodic maintenance costs have been accounted for within the economic analysis. The maintenance assumptions adopted for the Do-minimum and Option scenarios are documented below:

7.1 Do Minimum Maintenance Costs

The Do-minimum infrastructure has been assumed to include three existing SH1 bridges and all of the SH1 pavement structure within the extents of the PP2O project corridor. Annual pavement, surfacing and structural maintenance has therefore been included. For the Do-minimum maintenance costs it has been assumed that the existing SH1 pavement is currently 10 years through a 25 year lifespan as at time zero. The pavement is assumed to be on a re-seal cycle of every 8 years and a reconstruction cycle of every 25 years. No periodic costs have been assumed for the structural component of the existing bridge infrastructure.

7.2 Option Maintenance Costs

The Option infrastructure has assumed to include two of the three existing SH1 bridges, nine new bridges, the existing SH1 pavement and the new expressway / local road pavements. For the Option maintenance costs it has been assumed existing bridges maintain the same maintenance costs with no renewals within the analysis period. For the existing SH1 pavement being converted to local roads it is assumed that with a drop in all traffic types including the majority of HCV traffic, the existing pavement structure cannot be assumed to deteriorate at the same rate it does currently. Therefore no reconstruction costs are assumed for the existing pavement. The expressway pavement is assumed to have a reseal cycle of 8 years and a reconstruction cycle 25 years. It has been assumed that the first pavement reconstruction will replace the basecourse layer with an asphalt layer and the annual maintenance costs for the pavement will reduce.

8 Construction Costs

The latest expected cost estimates adopted for the PP2O project and their expected payment dates have been assumed in the economic analysis as detailed in Table 6 below:

Table 6: Expected Construction Cost & Payment Dates Assumed in Economic Analysis

Start Date	End Date	Comment	Months	Cost
1/07/2014	1/07/2014	Initial Property Purchase	0	$40,145,000
1/07/2014	31/12/2014	Design +Construction	6	$17,591,318
1/01/2015	30/06/2015	Construction	6	$16,576,955
1/07/2015	31/12/2015	Construction	6	$16,576,955
1/01/2016	30/06/2016	Construction	6	$16,576,955
1/07/2016	31/12/2016	Construction	6	$37,934,705
1/01/2017	30/06/2017	Construction	6	$35,337,705
1/07/2017	31/12/2017	Construction	6	$35,337,705
1/01/2018	1/07/2018	Construction	6	$35,337,705
		Totals	48	$251,415,000

9 Annualisation Factors

The annualisation factors used in the economic analysis have been calculated using NZTA's State Highway Traffic Data. Table 77 shows the three count sites within the PP2O project extent used for this purpose. Table8 shows the hourly time periods and annualisation factors calculated and adopted for use in the economic analysis. Note that it has been assumed that 245 weekdays and 120 weekend days (including public holidays) are included within a year.

Table 7: NZTA count stations used for annualisation factor calculations

Site Location	Site Reference	Count period
North of Waitohu River Bridge	01N00998	21st June 2010 to 27th June 2010
North of Waerenga Rd	01N01001	21st June 2010 to 27th June 2010
Marycrest	01N01011	27th February 2010 to 5th March 2010

Table8: Hourly time periods and Annualisation Factors

Time Period	Representative hrs/day in a week	Annualisation factor
Weekday AM Peak	2 (7:00am to 9:00am)	245
Weekday IP	6.5 hrs (9:00am to3:30pm)	245
Weekday PM peak	2 hrs (3:30pm to 5:30pm)	245
Weekday Off Peak/Night (0.52*IP)	13.5hrs (5:30pm to 7:00am)	245
Weekend/ Holiday Day time (1.47*IP)	7.5hrs	120
Weekend/ Holiday Night (0.38*IP)	16.5hrs	120

Figure 3 and Figure 4 show the average daily flow profile of Weekday and Weekend day for every 15 minute period across the three NZTA count stations within the project extent to give an indication of how the representative hours have been selected.

Figure 3: Peka Peka to Otaki North weekday daily flow profile (vehicles/15 min)

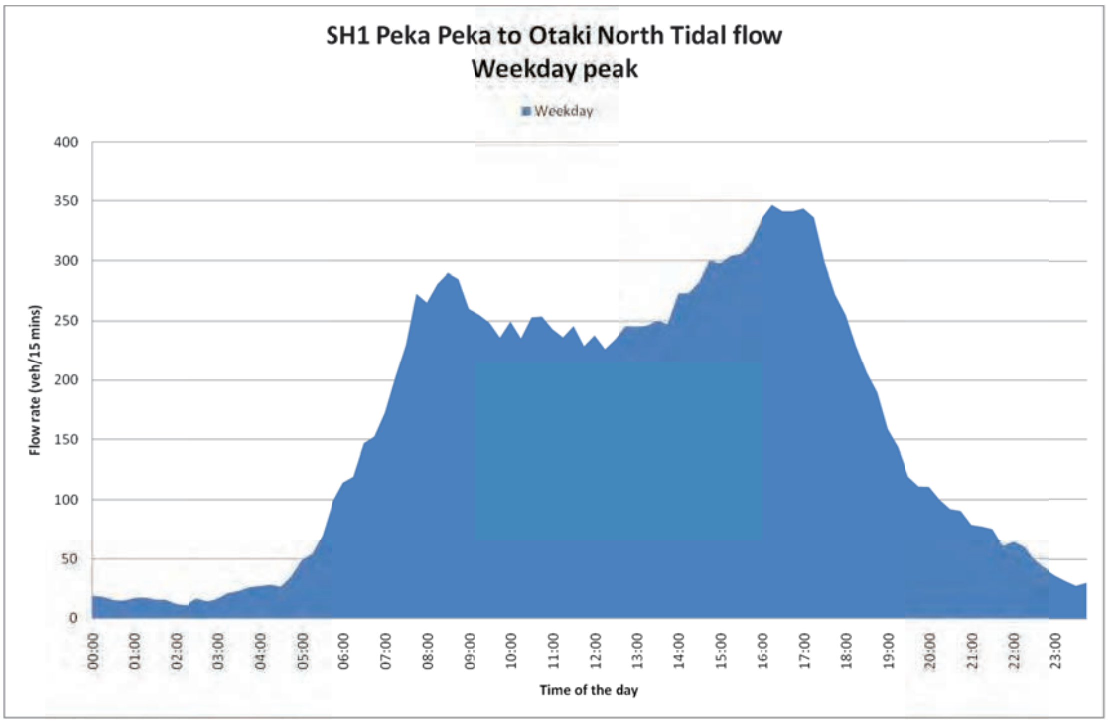
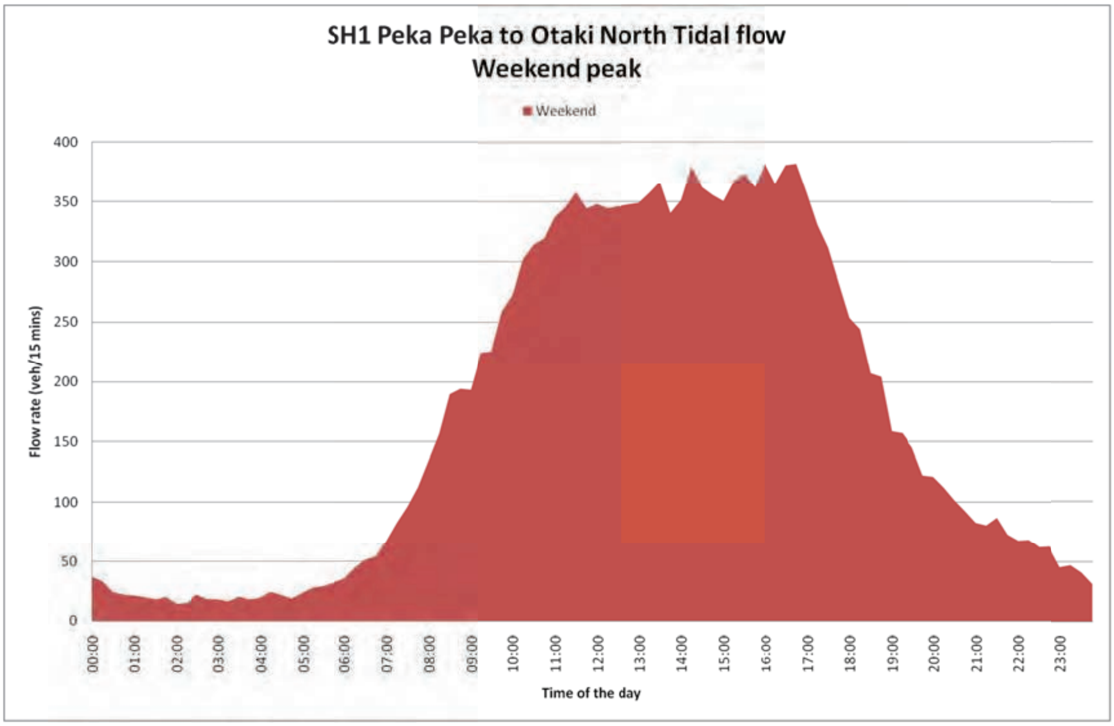


Figure 4: Peka Peka to Otaki North weekend daily flow profile (vehicles/15 min)



10 Update factors

The update factor for bringing travel time savings to 2011 values is 1.33 (EEM pA12-3). The equivalent factor for VOC (and therefore also CO2 emissions) is 1.04. Crash benefits have assumed an update factor of 1.17.

11 Benefit Summary

The expected discounted project benefits for the PP2O project are displayed in Table9 below. As discussed earlier, there are number of reasons why the project is resulting in a negative VOC benefit, however it should also be noted that the travel time benefits have included a factored interpeak to determine a weekend benefit due to this being the primary time of congestion on the network. Outside of these weekend peak periods the traffic demand on the network is relatively low and as a result there is very little congestion in the Do-minimum. A more refined assessment would require development of a weekend model.

Table9: NPV PP2O Project Benefits

Description	Benefits (NPV) ($m)
Travel Time	$57.30
VOC	-$8.16
CO_2	-$0.33
Crash Savings	$41.89
Total Benefits	**$90.71**

At the request of the external peer reviewer, the Travel Time, VOC and CO_2 transport benefits have also been reported by time period to confirm the emphasis on non-modelled period benefits. Table 10 below shows the emphasis of non-modelled period benefits is only 50%. Such results indicate that the analysis can be considered as being robust.

Table 10: 30 years NPV transportation benefits for each peak

Peak types	No. of hours per day	Benefits (NPV) ($m)	Proportion
Morning Peak	2	5.57	11%
Inter Peak	6.5	11.79	24%
Evening Peak	2	7.58	16%
Off Peak	13.5	12.73	26%
Weekend Peak	7.5	7.11	15%
Weekend off-peak	16.5	4.04	8%
Total Transportation benefits	**-**	**48.82**	**100%**

Subsequently given the above benefit streams, Table 1 has been provided to summarise the net present value (NPV) costs, benefits and an indicative BCR for the current PP2O Expressway Project as at the time of writing this report.

Table 11: NPV Costs, Benefits & Indicative BCR

Description	Costs (NPV) ($m)	Benefits (NPV) ($m)	BCR
PP2O Expressway Option 2 with Development (SC2)	$175.14	$90.71	0.5

12 Sensitivity Tests

For the purposes of this assessment, a number of sensitivity tests have been identified, some of which have been completed while others should be completed prior to finalising the SARA. The first sensitivity test completed looked at the effect of only using the WTSM medium growth matrices (excluding development). Further tests to look at changes to the construction costs have also been presented in Table 12 below.

Table 12: Sensitivity Tests

Description	Costs (NPV) ($m)	Benefits (NPV) ($m)	BCR
PP2O Expressway Option 1 WTSM medium growth (SC1)	$175.14	$63.77	0.4
10% increase in construction costs (SC2)	$192.38	$90.71	0.5
10% reduction in construction costs (SC2)	$155.10	$90.71	0.6
Neutral VOC outcome (SC2)	$175.14	$99.20	0.6
Un-calibrated Weekend Model Demands Included (SC2 + weekend)	$175.14	$109.94	0.6

The sensitivity tests that require inputs from the M2PP model or revised land use and growth forecasts from WTSM are dependent upon further work being undertaken by GWRC and NZTA. This additional work is known to be currently progressing.

13 Conclusions

The economic evaluation carried out for the PP2O project has utilised the PP2OTM SATURN model to capture transportation benefits, while a project specific crash model has also been built to determine crash cost savings. This has resulted in a BCR of 0.5 being calculated for the project. However the total BCR for the Wellington Northern RoNS package has been calculated at between 1.1 and 1.4 including wider economic benefits.

A number of sensitivity tests have been undertaken for the PP2O project, resulting in a BCR range of 0.4 to 0.6. However it should be noted that NZTA and GWRC are still working on a land use and economic growth scenario that takes account of the investment in infrastructure on the SH1 corridor. This new scenario will be used to determine what might happen to the overall package BCR and induced trips.

The transport benefits calculated have used similar assumptions to work undertaken previously to assess the PP2O project during preliminary feasibility studies. The 2009 Kapiti Strategy Study calculated a benefit stream of approximately $95m (NPV) using a manual calculation of the benefits, while the 2010 PP2O Scoping Report identified $96m used the PP2O transport model. The relative change and the refinement in the project costs from $215m, $296m and $251m respectively has resulted in a small change to the BCR, however it remains below 1 for the PP2O project in isolation.

The economics analysis documented within this memo has been externally peer reviewed by Darren Fidler (SKM). Darren was appointed by NZTA as the peer reviewer for this project and had been forwarded the transport modelling and associated economic information to undertake his review. A number of revisions and additional sensitivity tests have been completed for the study in order to make it a more robust economic assessment. A summary of the peer review correspondence is provided in the tracking sheets contained within Appendix C.

Darren is also involved in the review for the M2PP project and has been alerted to the issues associated with the use of the Do-minimum which includes the M2PP project and the land use assumptions adopted for the traffic modelling.

Appendix B

Economic Results Spreadsheets

Transport Economics Analysis Summary

		Scenario 2 - Do Minimum	Scenario 2 - Expressway Option 1
	Capital Costs	N/A	172,332,870
	Maintenance Costs	4,623,047	7,434,319
1	**Total Costs**	**4,623,047**	**179,767,190**
	Transport Costs		
	Travel Time Costs	446,959,824	389,656,577
	Vehicle Operating Costs	235,596,341	243,753,795
	Accidents	73,469,291	31,574,969
	Seal Extn / Passing Lane		
	Carbon Dioxide (4% of VOC)	9,423,854	9,750,152
2	**Total Transport Costs**	**691,980,019**	**674,735,493**
	Tangible Benefits		
	Travel Time Benefits	N/A	57,303,247
	Vehicle Operating Benefits	N/A	-8,157,454
	Accidents	N/A	41,894,321
	Seal Extn / Passing Lane Benefits	N/A	
	Carbon Dioxide Benefits	N/A	-326,298
3	**Tangible Benefits**	**N/A**	**90,713,816**
4	Tangible B/C Ratio	N/A	0.5

TIMINGS				TRAVEL TIME					CRV TRAVEL TIME			VEHICLE OPERATING COSTS							
OPTION and YEAR	PERIOD	TIME PERIODS PER DAY (hrs/day)	DAYS PER YEAR (days/year)	TOTAL SATURN TT on links (hours)	TOTAL SATURN TT on turns (hours)	TOTAL TT (hours)	VALUE OF TIME ($/veh.hr)	ANNUAL TRAVEL TIME COST ($/year)	TOTAL CONGESTION on links and turns SATURN (veh.hrs/hr)	CONGESTION VALUE ($/hour)	ANNUAL CONGESTION COST ($/year)	TOTAL SATURN (veh.km/h)	MEAN SPEED (km/h)	MEAN SPEED ROUNDED (km/h)	Fuel consumption (Ltr/hr)	OPERATING COST ($/Ltr)	OPERATING COST ($/veh.km)	FUEL COST WHILE STOPPED (cents/min)	ANNUAL VEHICLE OPERATING COST ($/year)
Scenario 2 - Do Minimum																			
Base 2010	Morning Peak	2	245	238	5	242	$33.70	$4,001,244	5	$5.63	$13,016	17518	72	72.0	1247	1.49	0.38		$2,056,223
Base 2010	Inter Peak	6.5	245	201	4	206	$33.70	$11,030,551	4	$5.63	$36,713	14864	72	72.0	1058	1.49	0.38	0.000	$5,670,328
Base 2010	Evening Peak	2	245	272	7	279	$33.70	$4,604,165	7	$5.63	$17,938	19919	71	71.0	1421	1.49	0.38	0.000	$2,334,778
Base 2010	Off Peak	13.5	245	105	2	107	$33.70	$11,912,996	2	$5.63	$39,650	7729	72	72.0	550	1.49	0.38	0.000	$6,123,954
Base 2010	Weekend Peak	7.5	120	296	6	302	$25.55	$6,947,017	6	$6.94	$37,638	21849	72	72.0	1555	1.49	0.38	0.000	$4,710,734
Base 2010	Weekend off-peak	16.5	120	77	2	78	$25.55	$3,950,821	2	$6.94	$21,405	5648	72	72.0	402	1.49	0.38	0.000	$2,679,030
2010 Total								**$42,446,794**			**$166,360**								**$23,575,046**
Do min 2016	Morning Peak	2	245	322	10	332	$33.70	$5,486,067	10	$5.63	$28,870	23202	70	70.0	1668	1.49	0.38	0.000	$2,714,743
Do min 2016	Inter Peak	6.5	245	277	9	285	$33.70	$15,320,634	9	$5.63	$77,316	20201	71	71.0	1451	1.49	0.38	0.000	$7,695,691
Do min 2016	Evening Peak	2	245	365	15	380	$33.70	$6,271,840	15	$5.63	$41,822	25870	68	68.0	1869	1.49	0.37	0.000	$3,020,168
Do min 2016	Off Peak	13.5	245	144	4	148	$33.70	$16,546,285	4	$5.63	$83,501	10504	71	71.0	755	1.49	0.38	0.000	$8,311,346
Do min 2016	Weekend Peak	7.5	120	407	13	420	$25.55	$9,648,902	13	$6.94	$79,264	29695	71	71.0	2133	1.49	0.38	0.000	$6,393,343
Do min 2016	Weekend off-peak	16.5	120	105	3	108	$25.55	$5,487,403	3	$6.94	$45,078	7676	71	71.0	551	1.49	0.38	0.000	$3,635,942
2016 Total								**$58,761,131**			**$355,850**								**$31,771,233**
Do Min 2026	Morning Peak	2	245	370	14	384	$33.70	$6,346,657	14	$5.63	$38,467	26281	68	68.0	1893	1.49	0.37	0.000	$3,067,842
Do Min 2026	Inter Peak	6.5	245	313	11	324	$33.70	$17,390,328	11	$5.63	$97,566	22654	70	70.0	1631	1.49	0.38	0.000	$8,618,988
Do Min 2026	Evening Peak	2	245	412	25	437	$33.70	$7,213,486	25	$5.63	$67,781	28686	66	66.0	2084	1.49	0.37	0.000	$3,339,465
Do Min 2026	Off Peak	13.5	245	163	6	168	$33.70	$18,781,554	6	$5.63	$105,371	11780	70	70.0	848	1.49	0.38	0.000	$9,308,507
Do Min 2026	Weekend Peak	7.5	120	460	16	476	$25.55	$10,952,391	16	$6.94	$100,025	33302	70	70.0	2397	1.49	0.38	0.000	$7,160,390
Do Min 2026	Weekend off-peak	16.5	120	119	4	123	$25.55	$6,228,706	4	$6.94	$56,885	8609	70	70.0	620	1.49	0.38	0.000	$4,072,167
2026 Total								**$66,913,122**			**$466,095**								**$35,567,360**
Scenario 2 - Expressway Option 1																			
Option 1 2010	Morning Peak	2	245	213	4	218	$33.70	$3,598,416	4	$5.63	$12,300	17680	81	81.0	1250	1.49	0.39	0.000	$2,122,704
Option 1 2010	Inter Peak	6.5	245	184	4	188	$33.70	$10,111,346	4	$5.63	$37,201	15034	80	80.0	1064	1.49	0.39	0.000	$5,843,313
Option 1 2010	Evening Peak	2	245	244	5	250	$33.70	$4,122,014	5	$5.63	$14,616	20137	81	81.0	1426	1.49	0.39	0.000	$2,414,767
Option 1 2010	Off Peak	13.5	245	96	2	98	$33.70	$10,920,254	2	$5.63	$40,177	7818	80	80.0	553	1.49	0.39	0.000	$6,310,778
Option 1 2010	Weekend Peak	7.5	120	271	6	277	$25.55	$6,368,104	6	$6.94	$38,138	22100	80	80.0	1564	1.49	0.39	0.000	$4,854,445
Option 1 2010	Weekend off-peak	16.5	120	70	2	72	$25.55	$3,621,588	2	$6.94	$21,689	5713	80	80.0	404	1.49	0.39	0.000	$2,760,759
2010 Total								**$38,741,721**			**$164,121**								**$24,306,765**
Option 1 2016	Morning Peak	2	245	283	7	290	$33.70	$4,791,266	7	$5.63	$19,528	23386	81	81.0	1661	1.49	0.39	0.000	$2,805,951
Option 1 2016	Inter Peak	6.5	245	249	7	255	$33.70	$13,698,762	7	$5.63	$58,744	20401	80	80.0	1450	1.49	0.39	0.000	$7,940,319
Option 1 2016	Evening Peak	2	245	317	8	325	$33.70	$5,362,678	8	$5.63	$22,582	26064	80	80.0	1854	1.49	0.39	0.000	$3,124,828
Option 1 2016	Off Peak	13.5	245	129	3	133	$33.70	$14,794,662	3	$5.63	$63,444	10609	80	80.0	754	1.49	0.39	0.000	$8,575,545
Option 1 2016	Weekend Peak	7.5	120	366	10	375	$25.55	$8,627,450	10	$6.94	$60,225	29990	80	80.0	2132	1.49	0.39	0.000	$6,596,573
Option 1 2016	Weekend off-peak	16.5	120	94	2	97	$25.55	$4,906,496	2	$6.94	$34,250	7752	80	80.0	551	1.49	0.39	0.000	$3,751,520
2016 Total								**$52,181,315**			**$258,774**								**$32,794,736**
Option 1 2026	Morning Peak	2	245	320	8	328	$33.70	$5,416,564	8	$5.63	$22,832	26483	81	81.0	1883	1.49	0.39	0.000	$3,179,459
Option 1 2026	Inter Peak	6.5	245	279	8	286	$33.70	$15,359,843	8	$5.63	$67,642	22876	80	80.0	1627	1.49	0.39	0.000	$8,905,416
Option 1 2026	Evening Peak	2	245	353	9	362	$33.70	$5,978,274	9	$5.63	$25,795	29055	80	80.0	2068	1.49	0.39	0.000	$3,483,880
Option 1 2026	Off Peak	13.5	245	145	4	149	$33.70	$16,588,631	4	$5.63	$73,053	11896	80	80.0	846	1.49	0.39	0.000	$9,617,849
Option 1 2026	Weekend Peak	7.5	120	410	11	421	$25.55	$9,673,596	11	$6.94	$69,347	33628	80	80.0	2392	1.49	0.39	0.000	$7,398,345
Option 1 2026	Weekend off-peak	16.5	120	106	3	109	$25.55	$5,501,446	3	$6.94	$39,438	8693	80	80.0	618	1.49	0.39	0.000	$4,207,494
2026 Total								**$58,518,354**			**$298,107**								**$36,792,444**

Option	Scenario 2 - Do Minimum	
Time Zero	01/07/11	
Year of Estimate	2011	
Construction Period	4	Years
Benefit period	26	
Construction Start	1/7/2014	
Construction payment		

Scenario 2 - Do Minimum

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	$0.00 $0.00 Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.925926				
2013	2	0.857339				
2014	3	0.793832		$57,130,732.76	$45,352,217.61	
2015	4	0.73503		$57,945,931.87	$42,591,989.77	
2016	5	0.680583	$58,761,130.98	$58,761,130.98	$39,991,838.39	
2017	6	0.63017		$59,576,330.10	$37,543,193.71	
2018	7	0.58349		$60,391,529.21	$35,237,877.25	$17,618,938.63
2019	8	0.540269		$61,206,728.33	$33,068,090.84	$33,068,090.84
2020	9	0.500249		$62,021,927.44	$31,026,405.14	$31,026,405.14
2021	10	0.463193		$62,837,126.56	$29,105,747.83	$29,105,747.83
2022	11	0.428883		$63,652,325.67	$27,299,391.44	$27,299,391.44
2023	12	0.397114		$64,467,524.78	$25,600,941.08	$25,600,941.08
2024	13	0.367698		$65,282,723.90	$24,004,322.09	$24,004,322.09
2025	14	0.340461		$66,097,923.01	$22,503,767.70	$22,503,767.70
2026	15	0.315242	$66,913,122.13	$66,913,122.13	$21,093,806.70	$21,093,806.70
2027	16	0.29189		$67,728,321.24	$19,769,251.35	$19,769,251.35
2028	17	0.270269		$68,543,520.36	$18,525,185.37	$18,525,185.37
2029	18	0.250249		$69,358,719.47	$17,356,952.21	$17,356,952.21
2030	19	0.231712		$70,173,918.58	$16,260,143.51	$16,260,143.51
2031	20	0.214548		$70,989,117.70	$15,230,587.95	$15,230,587.95
2032	21	0.198656		$71,804,316.81	$14,264,340.24	$14,264,340.24
2033	22	0.183941		$72,619,515.93	$13,357,670.58	$13,357,670.58
2034	23	0.170315		$73,434,715.04	$12,507,054.37	$12,507,054.37
2035	24	0.157699		$74,249,914.16	$11,709,162.26	$11,709,162.26
2036	25	0.146018		$75,065,113.27	$10,960,850.57	$10,960,850.57
2037	26	0.135202		$75,880,312.38	$10,259,152.07	$10,259,152.07
2038	27	0.125187		$76,695,511.50	$9,601,267.07	$9,601,267.07
2039	28	0.115914		$77,510,710.61	$8,984,554.86	$8,984,554.86
2040	29	0.107328		$78,325,909.73	$8,406,525.58	$8,406,525.58
2041	30	0.099377		$79,141,108.84	$7,864,832.29	$7,864,832.29
2042	31	0.092016		$79,956,307.95	$7,357,263.52	$7,357,263.52
2043	32	0.0852		$80,771,507.07	$6,881,736.04	$6,881,736.04
2044	33	0.078889		$81,586,706.18	$6,436,288.00	$3,218,144.00
2045	34	0.073045				
2046	35	0.067635				
						$443,836,085

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.92592593				
2013	2	0.85733882				
2014	3	0.79383224		$333,801.19	$264,982.14	
2015	4	0.73502985		$344,825.66	$253,457.15	
2016	5	0.6805832	$355,850.14	$355,850.14	$242,185.62	
2017	6	0.63016963		$366,874.61	$231,193.24	
2018	7	0.5834904		$377,899.09	$220,500.49	$110,250.24
2019	8	0.54026888		$388,923.56	$210,123.30	$210,123.30
2020	9	0.50024897		$399,948.04	$200,073.59	$200,073.59
2021	10	0.46319349		$410,972.51	$190,359.79	$190,359.79
2022	11	0.42888286		$421,996.99	$180,987.27	$180,987.27
2023	12	0.39711376		$433,021.46	$171,958.78	$171,958.78
2024	13	0.36769792		$444,045.94	$163,274.77	$163,274.77
2025	14	0.34046104		$455,070.41	$154,933.75	$154,933.75
2026	15	0.3152417	$466,094.89	$466,094.89	$146,932.55	$146,932.55
2027	16	0.29189047		$477,119.36	$139,266.59	$139,266.59
2028	17	0.27026895		$488,143.84	$131,930.12	$131,930.12
2029	18	0.25024903		$499,168.31	$124,916.39	$124,916.39
2030	19	0.23171206		$510,192.79	$118,217.82	$118,217.82
2031	20	0.21454821		$521,217.26	$111,826.23	$111,826.23
2032	21	0.19865575		$532,241.74	$105,732.88	$105,732.88
2033	22	0.18394051		$543,266.21	$99,928.66	$99,928.66
2034	23	0.17031528		$554,290.69	$94,404.18	$94,404.18
2035	24	0.15769934		$565,315.16	$89,149.83	$89,149.83
2036	25	0.1460179		$576,339.64	$84,155.91	$84,155.91
2037	26	0.13520176		$587,364.11	$79,412.66	$79,412.66
2038	27	0.12518682		$598,388.59	$74,910.36	$74,910.36
2039	28	0.11591372		$609,413.06	$70,639.34	$70,639.34
2040	29	0.10732752		$620,437.54	$66,590.02	$66,590.02
2041	30	0.09937733		$631,462.01	$62,753.01	$62,753.01
2042	31	0.09201605		$642,486.49	$59,119.07	$59,119.07
2043	32	0.08520005		$653,510.96	$55,679.16	$55,679.16
2044	33	0.07888893		$664,535.44	$52,424.49	$26,212.24
2045	34	0.07304531				
2046	35	0.06763454				
						$3,123,739

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.92592593				
2013	2	0.85733882				
2014	3	0.79383224		$31,012,007.10	$24,618,331.09	
2015	4	0.73502985		$31,391,619.81	$23,073,777.69	
2016	5	0.6805832	$31,771,233	$31,771,232.53	$21,622,967.01	
2017	6	0.63016963		$32,150,845.25	$20,260,486.16	
2018	7	0.5834904		$32,530,457.97	$18,981,209.78	$9,490,604.89
2019	8	0.54026888		$32,910,070.69	$17,780,287.18	$17,780,287.18
2020	9	0.50024897		$33,289,683.41	$16,653,129.74	$16,653,129.74
2021	10	0.46319349		$33,669,296.12	$15,595,398.71	$15,595,398.71
2022	11	0.42888286		$34,048,908.84	$14,602,993.38	$14,602,993.38
2023	12	0.39711376		$34,428,521.56	$13,672,039.60	$13,672,039.60
2024	13	0.36769792		$34,808,134.28	$12,798,878.74	$12,798,878.74
2025	14	0.34046104		$35,187,747.00	$11,980,056.99	$11,980,056.99
2026	15	0.3152417	$35,567,360	$35,567,359.72	$11,212,315.12	$11,212,315.12
2027	16	0.29189047		$35,946,972.43	$10,492,578.59	$10,492,578.59
2028	17	0.27026895		$36,326,585.15	$9,817,948.08	$9,817,948.08
2029	18	0.25024903		$36,706,197.87	$9,185,690.38	$9,185,690.38
2030	19	0.23171206		$37,085,810.59	$8,593,229.72	$8,593,229.72
2031	20	0.21454821		$37,465,423.31	$8,038,139.41	$8,038,139.41
2032	21	0.19865575		$37,845,036.03	$7,518,133.92	$7,518,133.92
2033	22	0.18394051		$38,224,648.74	$7,031,061.27	$7,031,061.27
2034	23	0.17031528		$38,604,261.46	$6,574,895.77	$6,574,895.77
2035	24	0.15769934		$38,983,874.18	$6,147,731.12	$6,147,731.12
2036	25	0.1460179		$39,363,486.90	$5,747,773.89	$5,747,773.89
2037	26	0.13520176		$39,743,099.62	$5,373,337.17	$5,373,337.17
2038	27	0.12518682		$40,122,712.34	$5,022,834.70	$5,022,834.70
2039	28	0.11591372		$40,502,325.05	$4,694,775.19	$4,694,775.19
2040	29	0.10732752		$40,881,937.77	$4,387,756.96	$4,387,756.96
2041	30	0.09937733		$41,261,550.49	$4,100,462.82	$4,100,462.82
2042	31	0.09201605		$41,641,163.21	$3,831,655.30	$3,831,655.30
2043	32	0.08520005		$42,020,775.93	$3,580,172.00	$3,580,172.00
2044	33	0.07888893		$42,400,388.65	$3,344,921.32	$1,672,460.66
2045	34	0.07304531				
2046	35	0.06763454				
						$235,596,341

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.925925926				
2013	2	0.85733882				
2014	3	0.793832241		$1,240,480.28	$984,733.24	
2015	4	0.735029853		$1,255,664.79	$922,951.11	
2016	5	0.680583197	$1,270,849	$1,270,849.30	$864,918.68	
2017	6	0.630169627		$1,286,033.81	$810,419.45	
2018	7	0.583490395		$1,301,218.32	$759,248.39	$379,624.20
2019	8	0.540268885		$1,316,402.83	$711,211.49	$711,211.49
2020	9	0.500248967		$1,331,587.34	$666,125.19	$666,125.19
2021	10	0.463193488		$1,346,771.84	$623,815.95	$623,815.95
2022	11	0.428882859		$1,361,956.35	$584,119.74	$584,119.74
2023	12	0.397113759		$1,377,140.86	$546,881.58	$546,881.58
2024	13	0.367697925		$1,392,325.37	$511,955.15	$511,955.15
2025	14	0.340461041		$1,407,509.88	$479,202.28	$479,202.28
2026	15	0.315241705	$1,422,694	$1,422,694.39	$448,492.60	$448,492.60
2027	16	0.291890468		$1,437,878.90	$419,703.14	$419,703.14
2028	17	0.270268951		$1,453,063.41	$392,717.92	$392,717.92
2029	18	0.250249029		$1,468,247.91	$367,427.62	$367,427.62
2030	19	0.231712064		$1,483,432.42	$343,729.19	$343,729.19
2031	20	0.214548207		$1,498,616.93	$321,525.58	$321,525.58
2032	21	0.198655748		$1,513,801.44	$300,725.36	$300,725.36
2033	22	0.183940507		$1,528,985.95	$281,242.45	$281,242.45
2034	23	0.170315284		$1,544,170.46	$262,995.83	$262,995.83
2035	24	0.157699337		$1,559,354.97	$245,909.24	$245,909.24
2036	25	0.146017905		$1,574,539.48	$229,910.96	$229,910.96
2037	26	0.135201764		$1,589,723.98	$214,933.49	$214,933.49
2038	27	0.125186818		$1,604,908.49	$200,913.39	$200,913.39
2039	28	0.115913721		$1,620,093.00	$187,791.01	$187,791.01
2040	29	0.107327519		$1,635,277.51	$175,510.28	$175,510.28
2041	30	0.099377333		$1,650,462.02	$164,018.51	$164,018.51
2042	31	0.092016049		$1,665,646.53	$153,266.21	$153,266.21
2043	32	0.085200045		$1,680,831.04	$143,206.88	$143,206.88
2044	33	0.078888931		$1,696,015.55	$133,796.85	$66,898.43
2045	34	0.073045306				
2046	35	0.067634543				
						$9,423,854

ACCIDENT COSTS

A6.1 (b) 1.0% — Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2006							
2007							
2008							
2009							
2010							
2011	0	1					
2012	1	0.925925926					
2013	2	0.85733882					
2014	3	0.793832241		$6,026,477.33	$7,262,507.83	$6,745,299.06	
2015	4	0.735029853		$6,143,837.67	$7,475,821.67	$6,429,093.96	
2016	5	0.680583197	$6,261,198	$6,261,198.00	$7,691,881.74	$6,124,909.60	
2017	6	0.630169627		$6,331,614.20	$7,852,467.93	$5,789,612.54	
2018	7	0.583490395		$6,402,030.40	$8,014,701.86	$5,471,506.82	$2,735,753.41
2019	8	0.540268885		$6,472,446.60	$8,178,583.52	$5,169,802.01	$5,169,802.01
2020	9	0.500248967		$6,542,862.80	$8,344,112.93	$4,883,736.63	$4,883,736.63
2021	10	0.463193488		$6,613,279.00	$8,511,290.07	$4,612,577.74	$4,612,577.74
2022	11	0.428882859		$6,683,695.20	$8,680,114.96	$4,355,620.45	$4,355,620.45
2023	12	0.397113759		$6,754,111.40	$8,850,587.58	$4,112,187.42	$4,112,187.42
2024	13	0.367697925		$6,824,527.60	$9,022,707.94	$3,881,628.25	$3,881,628.25
2025	14	0.340461041		$6,894,943.80	$9,196,476.04	$3,663,318.92	$3,663,318.92
2026	15	0.315241705	$6,965,360	$6,965,360.00	$9,371,891.88	$3,456,661.07	$3,456,661.07
2027	16	0.291890468		$7,035,776.20	$9,548,955.46	$3,261,081.42	$3,261,081.42
2028	17	0.270268951		$7,106,192.40	$9,727,666.78	$3,076,030.97	$3,076,030.97
2029	18	0.250249029		$7,176,608.60	$9,908,025.83	$2,900,984.40	$2,900,984.40
2030	19	0.231712064		$7,247,024.80	$10,090,032.63	$2,735,439.27	$2,735,439.27
2031	20	0.214548207		$7,317,441.00	$10,273,687.16	$2,578,915.36	$2,578,915.36
2032	21	0.198655748		$7,387,857.20	$10,458,989.44	$2,430,953.89	$2,430,953.89
2033	22	0.183940507		$7,458,273.40	$10,645,939.45	$2,291,116.82	$2,291,116.82
2034	23	0.170315284		$7,528,689.60	$10,834,537.20	$2,158,986.12	$2,158,986.12
2035	24	0.157699337		$7,599,105.80	$11,024,782.69	$2,034,163.08	$2,034,163.08
2036	25	0.146017905		$7,669,522.00	$11,216,675.93	$1,916,267.56	$1,916,267.56
2037	26	0.135201764		$7,739,938.20	$11,410,216.89	$1,804,937.30	$1,804,937.30
2038	27	0.125186818		$7,810,354.40	$11,605,405.60	$1,699,827.25	$1,699,827.25
2039	28	0.115913721		$7,880,770.60	$11,802,242.05	$1,600,608.89	$1,600,608.89
2040	29	0.107327519		$7,951,186.80	$12,000,726.24	$1,506,969.56	$1,506,969.56
2041	30	0.099377333		$8,021,603.00	$12,200,858.16	$1,418,611.82	$1,418,611.82
2042	31	0.092016049		$8,092,019.20	$12,402,637.83	$1,335,252.82	$1,335,252.82
2043	32	0.085200045		$8,162,435.40	$12,606,065.23	$1,256,623.67	$1,256,623.67
2044	33	0.078888931		$8,232,851.60	$12,811,140.37	$1,182,468.88	$591,234.44
2045	34	0.073045306					
2046	35	0.067634543					
							$73,469,291

MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
1/01/2012	0.5	0.962250449			
1/01/2013	1.5	0.890972638			
1/01/2014	2.5	0.824974664			
1/01/2015	3.5	0.76386543	$64,600.00	$49,345.71	
1/01/2016	4.5	0.707282806	$64,600.00	$45,690.47	
1/01/2017	5.5	0.654891487	$64,600.00	$42,305.99	
1/01/2018	6.5	0.606381006	$64,600.00	$39,172.21	
1/01/2019	7.5	0.561463895	$64,600.00	$36,270.57	$36,270.57
1/01/2020	8.5	0.519873977	$796,600.00	$414,131.61	$414,131.61
1/01/2021	9.5	0.481364793	$64,600.00	$31,096.17	$31,096.17
1/01/2022	10.5	0.445708142	$64,600.00	$28,792.75	$28,792.75
1/01/2023	11.5	0.412692724	$64,600.00	$26,659.95	$26,659.95
1/01/2024	12.5	0.382122892	$64,600.00	$24,685.14	$24,685.14
1/01/2025	13.5	0.353817493	$64,600.00	$22,856.61	$22,856.61
1/01/2026	14.5	0.32760879	$64,600.00	$21,163.53	$21,163.53
1/01/2027	15.5	0.303341472	$12,215,800.00	$3,705,558.75	$3,705,558.75
1/01/2028	16.5	0.280871733	$64,600.00	$18,144.31	$18,144.31
1/01/2029	17.5	0.26006642	$64,600.00	$16,800.29	$16,800.29
1/01/2030	18.5	0.240802241	$64,600.00	$15,555.82	$15,555.82
1/01/2031	19.5	0.222965038	$64,600.00	$14,403.54	$14,403.54
1/01/2032	20.5	0.206449109	$64,600.00	$13,336.61	$13,336.61
1/01/2033	21.5	0.191156582	$64,600.00	$12,348.72	$12,348.72
1/01/2034	22.5	0.176996835	$64,600.00	$11,434.00	$11,434.00
1/01/2035	23.5	0.163885959	$64,600.00	$10,587.03	$10,587.03
1/01/2036	24.5	0.151746258	$64,600.00	$9,802.81	$9,802.81
1/01/2037	25.5	0.140505795	$796,600.00	$111,926.92	$111,926.92
1/01/2038	26.5	0.130097958	$64,600.00	$8,404.33	$8,404.33
1/01/2039	27.5	0.120461072	$64,600.00	$7,781.79	$7,781.79
1/01/2040	28.5	0.11153803	$64,600.00	$7,205.36	$7,205.36
1/01/2041	29.5	0.103275953	$64,600.00	$6,671.63	$6,671.63
1/01/2042	30.5	0.095625883	$64,600.00	$6,177.43	$6,177.43
1/01/2043	31.5	0.088542484	$64,600.00	$5,719.84	$5,719.84
1/01/2044	32.5	0.081983782	$64,600.00	$5,296.15	$5,296.15
1/01/2045	33.5	0.075910909	$796,600.00	$60,470.63	$30,235.32
1/01/2046	34.5	0.070287879			
1/01/2047	35.5	0.065081369			
					$4,623,046.96

Peka Peka to Otaki North
Four lanes Expressway

Option	Scenario 2 - Expressway Option 1
Time Zero	01/07/11
Year of Estimate	2011
Construction Period	4 Years
Benefit period	26
Construction Start	1/7/2014
Construction payment	

Scenario 2 - Expressway Option 1

TRAVEL TIME COSTS

Calendar Year	Time Stream Year	Discount Factor	$0.00 $0.00 Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.925926				
2013	2	0.857339				
2014	3	0.793832		$50,913,906.68	$40,417,100.64	
2015	4	0.73503		$51,547,610.65	$37,889,032.66	
2016	5	0.680583	$52,181,314.61	$52,181,314.61	$35,513,725.92	
2017	6	0.63017		$52,815,018.57	$33,282,420.55	
2018	7	0.58349		$53,448,722.53	$31,186,816.24	$15,593,408.12
2019	8	0.540269		$54,082,426.49	$29,219,052.23	$29,219,052.23
2020	9	0.500249		$54,716,130.46	$27,371,687.75	$27,371,687.75
2021	10	0.463193		$55,349,834.42	$25,637,682.87	$25,637,682.87
2022	11	0.428883		$55,983,538.38	$24,010,380.02	$24,010,380.02
2023	12	0.397114		$56,617,242.34	$22,483,485.91	$22,483,485.91
2024	13	0.367698		$57,250,946.30	$21,051,054.14	$21,051,054.14
2025	14	0.340461		$57,884,650.27	$19,707,468.31	$19,707,468.31
2026	15	0.315242	$58,518,354.23	$58,518,354.23	$18,447,425.76	$18,447,425.76
2027	16	0.29189		$59,152,058.19	$17,265,921.92	$17,265,921.92
2028	17	0.270269		$59,785,762.15	$16,158,235.25	$16,158,235.25
2029	18	0.250249		$60,419,466.11	$15,119,912.73	$15,119,912.73
2030	19	0.231712		$61,053,170.08	$14,146,756.05	$14,146,756.05
2031	20	0.214548		$61,686,874.04	$13,234,808.25	$13,234,808.25
2032	21	0.198656		$62,320,578.00	$12,380,341.01	$12,380,341.01
2033	22	0.183941		$62,954,281.96	$11,579,842.54	$11,579,842.54
2034	23	0.170315		$63,587,985.92	$10,830,005.90	$10,830,005.90
2035	24	0.157699		$64,221,689.89	$10,127,717.94	$10,127,717.94
2036	25	0.146018		$64,855,393.85	$9,470,048.73	$9,470,048.73
2037	26	0.135202		$65,489,097.81	$8,854,241.53	$8,854,241.53
2038	27	0.125187		$66,122,801.77	$8,277,703.17	$8,277,703.17
2039	28	0.115914		$66,756,505.74	$7,737,994.96	$7,737,994.96
2040	29	0.107328		$67,390,209.70	$7,232,824.02	$7,232,824.02
2041	30	0.099377		$68,023,913.66	$6,760,035.09	$6,760,035.09
2042	31	0.092016		$68,657,617.62	$6,317,602.68	$6,317,602.68
2043	32	0.0852		$69,291,321.58	$5,903,623.72	$5,903,623.72
2044	33	0.078889		$69,925,025.55	$5,516,310.49	$2,758,155.24
2045	34	0.073045				
2046	35	0.067635				
						$387,677,416

CONGESTION RELIEF VALUES

Calendar Year	Time Stream Year	Discount Factor	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.92592593				
2013	2	0.85733882				
2014	3	0.79383224		$250,907.45	$199,178.42	
2015	4	0.73502985		$254,840.74	$187,315.55	
2016	5	0.6805832	$258,774.04	$258,774.04	$176,117.26	
2017	6	0.63016963		$262,707.33	$165,550.18	
2018	7	0.5834904		$266,640.62	$155,582.24	$77,791.12
2019	8	0.54026888		$270,573.91	$146,182.66	$146,182.66
2020	9	0.50024897		$274,507.20	$137,321.94	$137,321.94
2021	10	0.46319349		$278,440.49	$128,971.82	$128,971.82
2022	11	0.42888286		$282,373.79	$121,105.28	$121,105.28
2023	12	0.39711376		$286,307.08	$113,696.48	$113,696.48
2024	13	0.36769792		$290,240.37	$106,720.78	$106,720.78
2025	14	0.34046104		$294,173.66	$100,154.67	$100,154.67
2026	15	0.3152417	$298,106.95	$298,106.95	$93,975.74	$93,975.74
2027	16	0.29189047		$302,040.24	$88,162.67	$88,162.67
2028	17	0.27026895		$305,973.53	$82,695.15	$82,695.15
2029	18	0.25024903		$309,906.83	$77,553.88	$77,553.88
2030	19	0.23171206		$313,840.12	$72,720.54	$72,720.54
2031	20	0.21454821		$317,773.41	$68,177.72	$68,177.72
2032	21	0.19865575		$321,706.70	$63,908.89	$63,908.89
2033	22	0.18394051		$325,639.99	$59,898.39	$59,898.39
2034	23	0.17031528		$329,573.28	$56,131.37	$56,131.37
2035	24	0.15769934		$333,506.58	$52,593.77	$52,593.77
2036	25	0.1460179		$337,439.87	$49,272.26	$49,272.26
2037	26	0.13520176		$341,373.16	$46,154.25	$46,154.25
2038	27	0.12518682		$345,306.45	$43,227.82	$43,227.82
2039	28	0.11591372		$349,239.74	$40,481.68	$40,481.68
2040	29	0.10732752		$353,173.03	$37,905.19	$37,905.19
2041	30	0.09937733		$357,106.33	$35,488.27	$35,488.27
2042	31	0.09201605		$361,039.62	$33,221.44	$33,221.44
2043	32	0.08520005		$364,972.91	$31,095.71	$31,095.71
2044	33	0.07888893		$368,906.20	$29,102.62	$14,551.31
2045	34	0.07304531				
2046	35	0.06763454				
						$1,979,161

VEHICLE OPERATING COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.92592593				
2013	2	0.85733882				
2014	3	0.79383224		$31,995,194.06	$25,398,816.61	
2015	4	0.73502985		$32,394,964.93	$23,811,266.30	
2016	5	0.6805832	$32,794,735.80	$32,794,735.80	$22,319,546.13	
2017	6	0.63016963		$33,194,506.66	$20,918,169.88	
2018	7	0.5834904		$33,594,277.53	$19,601,938.27	$9,800,969.14
2019	8	0.54026888		$33,994,048.39	$18,365,926.61	$18,365,926.61
2020	9	0.50024897		$34,393,819.26	$17,205,472.56	$17,205,472.56
2021	10	0.46319349		$34,793,590.13	$16,116,164.37	$16,116,164.37
2022	11	0.42888286		$35,193,360.99	$15,093,829.29	$15,093,829.29
2023	12	0.39711376		$35,593,131.86	$14,134,522.37	$14,134,522.37
2024	13	0.36769792		$35,992,902.72	$13,234,515.63	$13,234,515.63
2025	14	0.34046104		$36,392,673.59	$12,390,287.55	$12,390,287.55
2026	15	0.3152417	$36,792,444.46	$36,792,444.46	$11,598,512.92	$11,598,512.92
2027	16	0.29189047		$37,192,215.32	$10,856,053.12	$10,856,053.12
2028	17	0.27026895		$37,591,986.19	$10,159,946.69	$10,159,946.69
2029	18	0.25024903		$37,991,757.05	$9,507,400.32	$9,507,400.32
2030	19	0.23171206		$38,391,527.92	$8,895,780.17	$8,895,780.17
2031	20	0.21454821		$38,791,298.79	$8,322,603.62	$8,322,603.62
2032	21	0.19865575		$39,191,069.65	$7,785,531.24	$7,785,531.24
2033	22	0.18394051		$39,590,840.52	$7,282,359.28	$7,282,359.28
2034	23	0.17031528		$39,990,611.38	$6,811,012.35	$6,811,012.35
2035	24	0.15769934		$40,390,382.25	$6,369,536.51	$6,369,536.51
2036	25	0.1460179		$40,790,153.11	$5,956,092.70	$5,956,092.70
2037	26	0.13520176		$41,189,923.98	$5,568,950.37	$5,568,950.37
2038	27	0.12518682		$41,589,694.85	$5,206,481.57	$5,206,481.57
2039	28	0.11591372		$41,989,465.71	$4,867,155.20	$4,867,155.20
2040	29	0.10732752		$42,389,236.58	$4,549,531.60	$4,549,531.60
2041	30	0.09937733		$42,789,007.44	$4,252,257.42	$4,252,257.42
2042	31	0.09201605		$43,188,778.31	$3,974,060.73	$3,974,060.73
2043	32	0.08520005		$43,588,549.18	$3,713,746.35	$3,713,746.35
2044	33	0.07888893		$43,988,320.04	$3,470,191.53	$1,735,095.76
2045	34	0.07304531				
2046	35	0.06763454				
						$243,753,795

CO2 COSTS

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
2006						
2007						
2008						
2009						
2010						
2011	0	1				
2012	1	0.925925926				
2013	2	0.85733882				
2014	3	0.793832241		$1,279,807.76	$1,015,952.66	
2015	4	0.735029853		$1,295,798.60	$952,450.65	
2016	5	0.680583197	$1,311,789.43	$1,311,789.43	$892,781.85	
2017	6	0.630169627		$1,327,780.27	$836,726.80	
2018	7	0.583490395		$1,343,771.10	$784,077.53	$392,038.77
2019	8	0.540268885		$1,359,761.94	$734,637.06	$734,637.06
2020	9	0.500248967		$1,375,752.77	$688,218.90	$688,218.90
2021	10	0.463193488		$1,391,743.61	$644,646.57	$644,646.57
2022	11	0.428882859		$1,407,734.44	$603,753.17	$603,753.17
2023	12	0.397113759		$1,423,725.27	$565,380.89	$565,380.89
2024	13	0.367697925		$1,439,716.11	$529,380.63	$529,380.63
2025	14	0.340461041		$1,455,706.94	$495,611.50	$495,611.50
2026	15	0.315241705	$1,471,697.78	$1,471,697.78	$463,940.52	$463,940.52
2027	16	0.291890468		$1,487,688.61	$434,242.12	$434,242.12
2028	17	0.270268951		$1,503,679.45	$406,397.87	$406,397.87
2029	18	0.250249029		$1,519,670.28	$380,296.01	$380,296.01
2030	19	0.231712064		$1,535,661.12	$355,831.21	$355,831.21
2031	20	0.214548207		$1,551,651.95	$332,904.14	$332,904.14
2032	21	0.198655748		$1,567,642.79	$311,421.25	$311,421.25
2033	22	0.183940507		$1,583,633.62	$291,294.37	$291,294.37
2034	23	0.170315284		$1,599,624.46	$272,440.49	$272,440.49
2035	24	0.157699337		$1,615,615.29	$254,781.46	$254,781.46
2036	25	0.146017905		$1,631,606.12	$238,243.71	$238,243.71
2037	26	0.135201764		$1,647,596.96	$222,758.01	$222,758.01
2038	27	0.125186818		$1,663,587.79	$208,259.26	$208,259.26
2039	28	0.115913721		$1,679,578.63	$194,686.21	$194,686.21
2040	29	0.107327519		$1,695,569.46	$181,981.26	$181,981.26
2041	30	0.099377333		$1,711,560.30	$170,090.30	$170,090.30
2042	31	0.092016049		$1,727,551.13	$158,962.43	$158,962.43
2043	32	0.085200045		$1,743,541.97	$148,549.85	$148,549.85
2044	33	0.078888931		$1,759,532.80	$138,807.66	$69,403.83
2045	34	0.073045306				
2046	35	0.067634543				
						$9,750,152

ACCIDENT COSTS

A6.1 (b) — 1.0% — Update Factor 1.17

Calendar Year	Time Stream Year	Discount Factor	Calculated Annual Amount	Interpolated Annual Amount	Growth Rate adjusted Annual Amount (incl. update factor)	Discounted Annual Amount	Amount Included in Benefit Period
2006							
2007							
2008							
2009							
2010							
2011	0	1					
2012	1	0.925925926					
2013	2	0.85733882					
2014	3	0.793832241		$2,541,485.33	$3,062,743.98	$2,844,626.75	
2015	4	0.735029853		$2,597,442.17	$3,160,567.63	$2,718,040.52	
2016	5	0.680583197	$2,653,399	$2,653,399.00	$3,259,700.67	$2,595,642.08	
2017	6	0.630169627		$2,686,973.10	$3,332,384.04	$2,456,961.63	
2018	7	0.583490395		$2,720,547.20	$3,405,853.04	$2,325,120.57	$1,162,560.28
2019	8	0.540268885		$2,754,121.30	$3,480,107.67	$2,199,826.85	$2,199,826.85
2020	9	0.500248967		$2,787,695.40	$3,555,147.94	$2,080,797.13	$2,080,797.13
2021	10	0.463193488		$2,821,269.50	$3,630,973.85	$1,967,756.83	$1,967,756.83
2022	11	0.428882859		$2,854,843.60	$3,707,585.38	$1,860,440.19	$1,860,440.19
2023	12	0.397113759		$2,888,417.70	$3,784,982.55	$1,758,590.32	$1,758,590.32
2024	13	0.367697925		$2,921,991.80	$3,863,165.36	$1,661,959.13	$1,661,959.13
2025	14	0.340461041		$2,955,565.90	$3,942,133.80	$1,570,307.28	$1,570,307.28
2026	15	0.315241705	$2,989,140	$2,989,140.00	$4,021,887.87	$1,483,404.14	$1,483,404.14
2027	16	0.291890468		$3,022,714.10	$4,102,427.58	$1,401,027.62	$1,401,027.62
2028	17	0.270268951		$3,056,288.20	$4,183,752.92	$1,322,964.06	$1,322,964.06
2029	18	0.250249029		$3,089,862.30	$4,265,863.89	$1,249,008.11	$1,249,008.11
2030	19	0.231712064		$3,123,436.40	$4,348,760.50	$1,178,962.52	$1,178,962.52
2031	20	0.214548207		$3,157,010.50	$4,432,442.74	$1,112,637.99	$1,112,637.99
2032	21	0.198655748		$3,190,584.60	$4,516,910.62	$1,049,853.00	$1,049,853.00
2033	22	0.183940507		$3,224,158.70	$4,602,164.13	$990,433.55	$990,433.55
2034	23	0.170315284		$3,257,732.80	$4,688,203.27	$934,213.03	$934,213.03
2035	24	0.157699337		$3,291,306.90	$4,775,028.05	$881,031.95	$881,031.95
2036	25	0.146017905		$3,324,881.00	$4,862,638.46	$830,737.77	$830,737.77
2037	26	0.135201764		$3,358,455.10	$4,951,034.51	$783,184.66	$783,184.66
2038	27	0.125186818		$3,392,029.20	$5,040,216.19	$738,233.30	$738,233.30
2039	28	0.115913721		$3,425,603.30	$5,130,183.50	$695,750.63	$695,750.63
2040	29	0.107327519		$3,459,177.40	$5,220,936.45	$655,609.68	$655,609.68
2041	30	0.099377333		$3,492,751.50	$5,312,475.03	$617,689.33	$617,689.33
2042	31	0.092016049		$3,526,325.60	$5,404,799.25	$581,874.08	$581,874.08
2043	32	0.085200045		$3,559,899.70	$5,497,909.10	$548,053.86	$548,053.86
2044	33	0.078888931		$3,593,473.80	$5,591,804.58	$516,123.84	$258,061.92
2045	34	0.073045306					
2046	35	0.067634543					
							$31,574,969

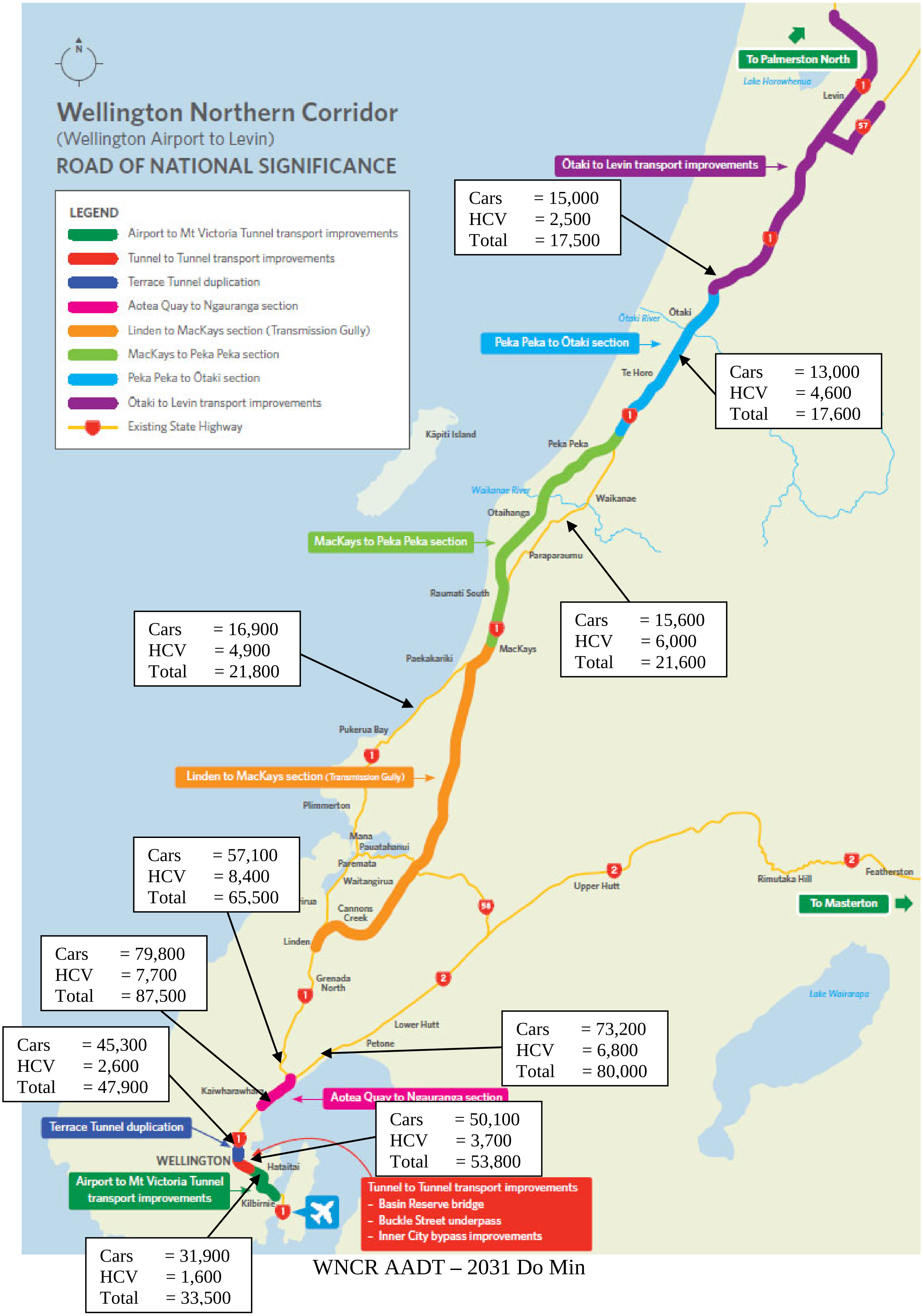
MAINTENANCE and PERIODIC COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount	Amount Included in Benefit Period
1/01/2012	0.5	0.962250449	$64,600		
1/01/2013	1.5	0.890972638	$64,600.00		
1/01/2014	2.5	0.824974664	$64,600		
1/01/2015	3.5	0.76386543	$64,600.00	$49,345.71	
1/01/2016	4.5	0.707282806	$64,600.00	$45,690.47	
1/01/2017	5.5	0.654891487	$64,600.00	$42,305.99	
1/01/2018	6.5	0.606381006	$64,600.00	$39,172.21	
1/01/2019	7.5	0.561463895	$364,359.27	$204,574.57	$102,287.29
1/01/2020	8.5	0.519873977	$948,509.27	$493,105.29	$493,105.29
1/01/2021	9.5	0.481364793	$364,359.27	$175,389.72	$175,389.72
1/01/2022	10.5	0.445708142	$364,359.27	$162,397.89	$162,397.89
1/01/2023	11.5	0.412692724	$364,359.27	$150,368.42	$150,368.42
1/01/2024	12.5	0.382122892	$364,359.27	$139,230.02	$139,230.02
1/01/2025	13.5	0.353817493	$364,359.27	$128,916.68	$128,916.68
1/01/2026	14.5	0.32760879	$364,359.27	$119,367.30	$119,367.30
1/01/2027	15.5	0.303341472	$3,876,419.27	$1,175,878.73	$1,175,878.73
1/01/2028	16.5	0.280871733	$364,359.27	$102,338.22	$102,338.22
1/01/2029	17.5	0.26006642	$948,509.27	$246,675.41	$246,675.41
1/01/2030	18.5	0.240802241	$364,359.27	$87,738.53	$87,738.53
1/01/2031	19.5	0.222965038	$364,359.27	$81,239.38	$81,239.38
1/01/2032	20.5	0.206449109	$364,359.27	$75,221.65	$75,221.65
1/01/2033	21.5	0.191156582	$364,359.27	$69,649.67	$69,649.67
1/01/2034	22.5	0.176996835	$364,359.27	$64,490.44	$64,490.44
1/01/2035	23.5	0.163885959	$3,876,419.27	$635,290.69	$635,290.69
1/01/2036	24.5	0.151746258	$364,359.27	$55,290.16	$55,290.16
1/01/2037	25.5	0.140505795	$948,509.27	$133,271.05	$133,271.05
1/01/2038	26.5	0.130097958	$364,359.27	$47,402.40	$47,402.40
1/01/2039	27.5	0.120461072	$364,359.27	$43,891.11	$43,891.11
1/01/2040	28.5	0.11153803	$364,359.27	$40,639.92	$40,639.92
1/01/2041	29.5	0.103275953	$364,359.27	$37,629.55	$37,629.55
1/01/2042	30.5	0.095625883	$364,359.27	$34,842.18	$34,842.18
1/01/2043	31.5	0.088542484	$364,359.27	$32,261.27	$32,261.27
1/01/2044	32.5	0.081983782	$36,154,997.04	$2,964,123.38	$2,964,123.38
1/01/2045	33.5	0.075910909	$932,221.04	$70,765.75	$35,382.87
1/01/2046	34.5	0.070287879			
1/01/2047	35.5	0.065081369			
					$7,434,319.20

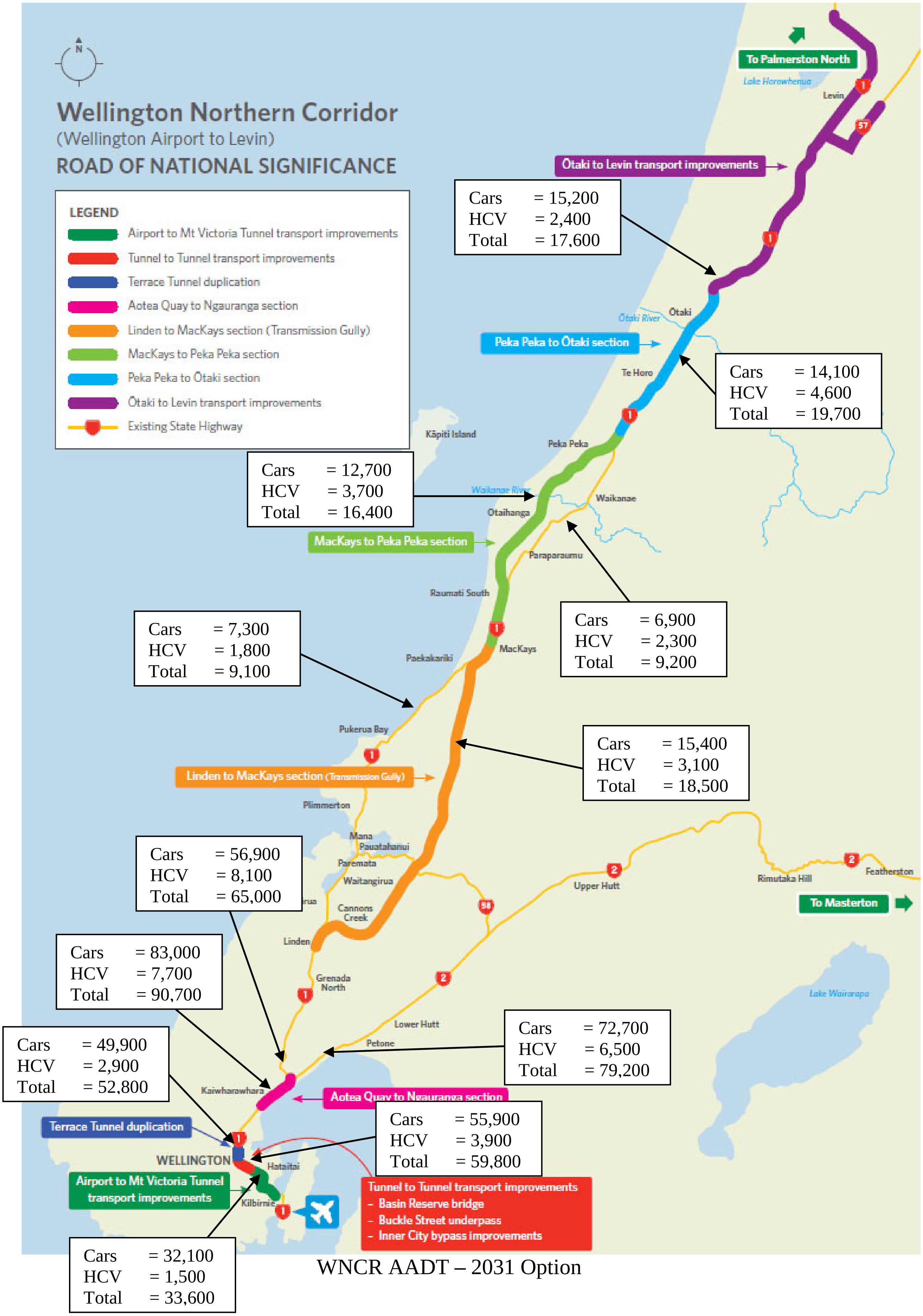
CONSTRUCTION COSTS

Calendar Year Payment	Time Stream Year	Discount Factor	Calculated Annual Amount	Discounted Annual Amount
			$ 251,415,000	
1/07/2014	3	0.793832	$40,145,000	$31,868,395
1/10/2014	3.25	0.778705	$17,591,318	$13,698,442
1/04/2015	3.75	0.749309	$16,576,955	$12,421,260
1/10/2015	4.25	0.721023	$16,576,955	$11,952,363
1/04/2016	4.75	0.693805	$16,576,955	$11,501,167
1/10/2016	5.25	0.667614	$37,934,705	$25,325,731
1/04/2017	5.75	0.642412	$35,337,705	$22,701,353
1/10/2017	6.25	0.618161	$35,337,705	$21,844,387
1/04/2018	6.75	0.594826	$35,337,705	$21,019,771
				$172,332,870.32

Appendix G
WTSM Traffic Demand Flows for WNCR 2031



WNCR AADT – 2031 Do Min



WNCR AADT – 2031 Option

Appendix H

WTSM Assumptions for Traffic Flow Analysis

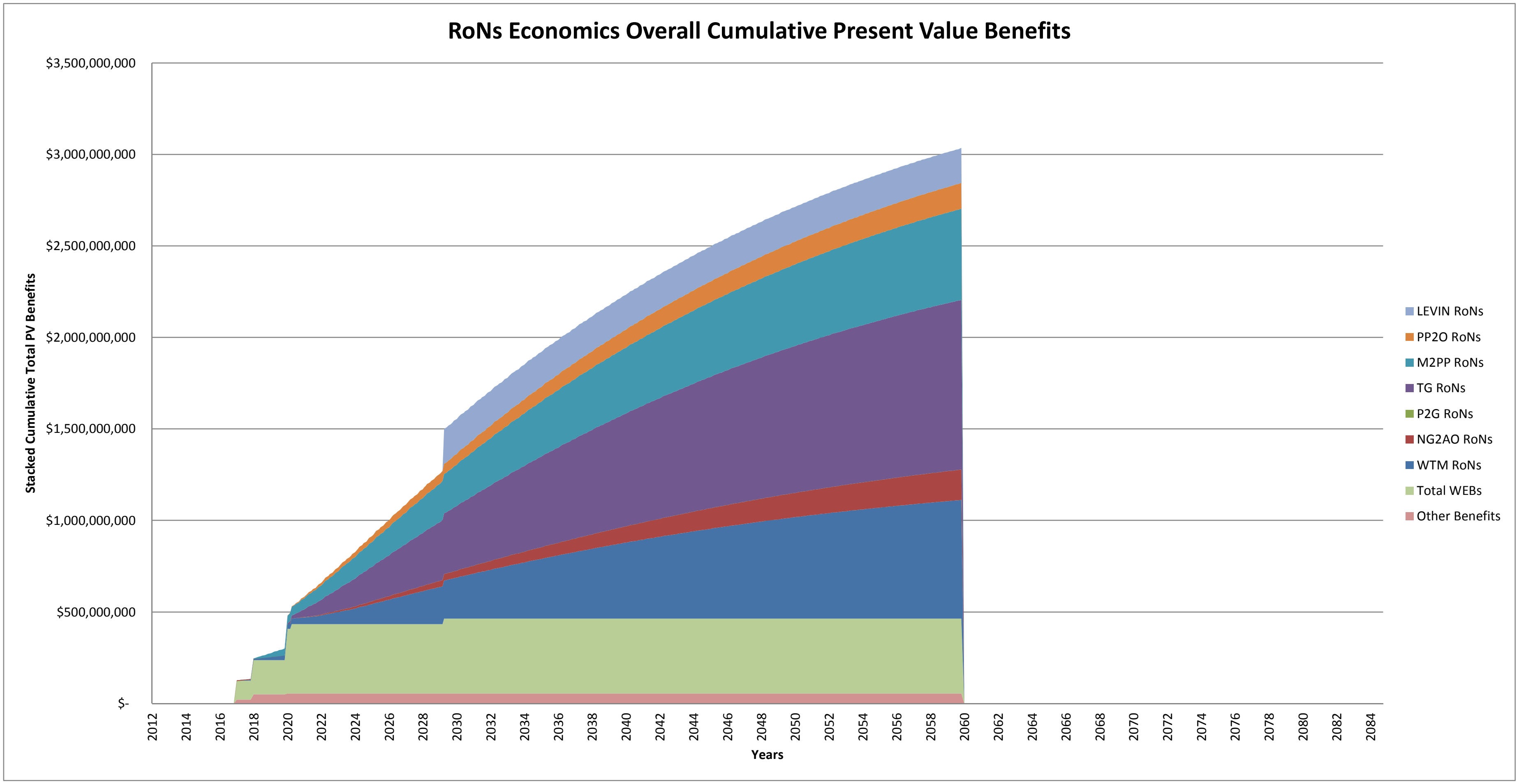
Road Scheme	WTSM Model Run Number Do Minimum 17011 (2021)	 17021 (2031)	 Full RoNS 31021 (2021)	 31011 (2031)
Basin Reserve Improvement			√	√
Mt Vic Tunnel Duplication			√	√
Ruahine St improvement			√	√
Widen Ngauranga to Aotea from 3L to 4L			√	√
Grenada to Petone Link (including Lincolnshire Farm)			√	√
Grade Separation of SH58			√	√
MacKays Crossing to Peka Peka			√	√
Peka Peka to Ōtaki			√	√
Transmission Gully			√	√
Adelaide Road Improvement			√	√
Johnsonville Triangle			√	√
Aotea Quay Improvements			√	√
Terrace Tunnel Duplication			√	√
SH1/Otaihanga Rd Roundabout			√	√
ICB Improvements			√	√
PT Scheme				
Base PT Services	√	√	√	√
Wellington City Bus Review PT Services	√	√	√	√
Rail Plan Option 1	√			
Rail Plan Option 2		√	√	√
Bus Lane from Bus Station to Hospital	√	√	√	√

For more information on general WTSM assumptions, refer to the WTSM suite of Technical Notes and Model Development Report.

Appendix I

REMAT Outputs

Ref	Sections	Year	Annual benefit							Extra NPV	Project Cost	Extra NPV	Construction Date		Source			
			TT	*CRV*	*VOC*	*CO2*	Crash	Cyc and Peds	Others	Benefit	(2012 $)	Cost	Start	End	Report	Date	Reported NPV B	Reported NPV C
A	**Airport to Mt Victoria Tunnel**	2021	$ 1,936,670	$ 1,519,176	$ 2,255,297	$ 90,212	$ 1,965,029	$ 1,678,213	$ 77,000						MtVicT SAR - Hybrid Opt	Nov-12		
A	**Airport to Mt Victoria Tunnel**	2031	$ 4,439,698	$ 2,102,520	$ 3,089,094	$ 123,564	$ 1,949,863	$ 1,678,213	$ 226,000	$ 18,316,000	$ 363,814,000		1/07/2018	1/05/2022	WTM 2011 (Opus)	Apr-13	$ 82,110,000	$ 222,538,000
B	**Tunnel to Tunnel**	2021	$ 10,015,320	$ 2,765,677	$ 1,255,034	$ 50,201	$1,175,310		$19,999						Basin SAR - ICB PFR	Mar-12		
B	**Tunnel to Tunnel**	2031	$ 17,598,058	$ 5,050,499	$ 1,087,652	$ 43,506	$1,437,682		$40,168	$ 1,925,241	$ 94,833,900		1/01/2013	1/07/2017	WTM 2011 (Opus)	Apr-13	$ 112,318,432	$ 77,315,018
C	**Terrace Tunnel**	2021	$ 8,721,953	$ 2,475,915	-$ 740,763	-$ 29,631	$ 521,374								TT PFR	Aug-08		
C	**Terrace Tunnel**	2031	$ 14,250,942	$ 4,111,870	-$ 1,167,993	-$ 46,720	$ 857,405				$ 181,470,080		1/07/2020	1/07/2024	WTM 2011 (Opus)	Apr-13	$ 2,500,000	$ 89,000,000
A+B	**MtVicT + T2T**	2021	$ 17,752,267	$ 6,237,393	$ 2,657,423	$ 106,297	$ 3,140,339	$ 1,678,213	$ 96,999									
A+B	**MtVicT + T2T**	2031	$ 28,940,342	$ 9,181,459	$ 2,797,549	$ 111,902	$ 3,387,545	$ 1,678,213	$ 266,168	$ 20,241,241	$ 458,647,900							
A+B+C	**MtVicT + T2T + TT**	2021	$ 26,474,220	$ 8,713,308	$ 1,916,660	$ 76,666	$ 3,661,712	$ 1,678,213	$ 96,999									
A+B+C	**MtVicT + T2T + TT**	2031	$ 43,191,284	$ 13,293,329	$ 1,629,555	$ 65,182	$ 4,244,949	$ 1,678,213	$ 266,168	$ 20,241,241	$ 640,117,980							
D	**Aotea Qy to Ngauranga**	2021	$ 3,040,000	$ 1,020,000	-$ 900,000	-$ 40,000	$ 730,000		$ 570,000									
D	**Aotea Qy to Ngauranga**	2031	$ 10,830,000	$ 2,780,000	-$ 1,260,000	-$ 50,000	$ 730,000	$ -	$ 2,180,000		$ 84,066,400		1/07/2013	1/07/2014	NtAQ SAR	Sep-12	$ 79,100,000	$ 75,100,000
E	**Ngauranga to Linden (P2G)**	2021	$ 11,354,906		$ 12,413,079	$ 496,523												
E	**Ngauranga to Linden (P2G)**	2031	$ 26,496,254		$ 14,710,473	$ 588,419				$ 10,800,000	$ 282,238,300		1/07/2019	1/07/2023	P2G PFR	Oct-09	$ 280,000,000	$ 252,700,000
F	**Linden to MacKay (TG)**	2021	$ 31,359,372	$ 8,467,031	$ 991,161	$ 59,017	$ 14,979,118		$ 8,056,232									
F	**Linden to MacKay (TG)**	2031	$ 50,887,228	$ 13,739,552	$ 3,018,409	$ 179,727	$ 13,357,426		$ 8,997,701	$ 3,500,000	$ 847,097,700	$ 4,707,146	1/07/2014	1/07/2020	TG Tech Letter	Aug-12	$ 492,700,000	$ 536,600,000
G	**MacKays to Peka Peka**	2021	$ 22,040,000	$6,260,000	-$80,000	$0	$3,170,000		$ 1,100,000									
G	**MacKays to Peka Peka**	2031	$ 32,370,000	$ 9,730,000	$ 1,020,000	$ 40,000	$ 3,280,000		$ 1,620,000									
G	**MacKays to Peka Peka**	2041	$ 37,550,000	$ 11,340,000	$ 1,010,000	$ 40,000	$ 3,280,000		$ 1,880,000	$ 29,600,000	$ 554,173,000	$ 19,400,000	1/07/2013	1/07/2018	M2PP SAR	May-13	$ 513,900,000	$ 523,000,000
H	**Peka Peka to North Otaki**	2021	$ 7,487,292	$ 132,532	-$ 1,124,294	-$ 44,972	$ 4,891,093											
H	**Peka Peka to North Otaki**	2031	$ 9,302,244	$ 203,444	-$ 1,325,875	-$ 53,035	$ 5,808,916				$ 249,775,000		1/07/2016	1/07/2020	PP2O SAR	Dec-11	$ 90,710,000	$ 175,140,000
I	**North Otaki to Levin**																	
I	**North Otaki to Levin**														Varies PFR	Feb-13	$ 190,600,000	$ 161,900,000
	Agglomeration Benefits																$ 410,000,000	
	Wider Economics Benefits														WNCR WEBs Report	Apr-13	$ 400,000,000	


RoNs Economics Overall Cumulative Present Value Benefits
$3,500,000,000
$3,000,000,000
$2,500,000,000
$2,000,000,000
$1,500,000,000
$1,000,000,000
$500,000,000
$-
Stacked Cumulative Total PV Benefits
2012
2014
2016
2018
2020
2022
2024
2026
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2070
2072
2074
2076
2078
2080
2082
2084
Years
LEVIN RoNs
PP2O RoNs
M2PP RoNs
TG RoNs
P2G RoNs
NG2AO RoNs
WTM RoNs
Total WEBs
Other Benefits

REMAT (version 2.03)		Option Include?	Terminate Interim?	Construction Start	Construction End	Cost	Benefits End	Tangible Benefits: Transport Benefits	Tangible Benefits: Others	Tangible Benefits: Total	Tangible Costs: Capital	Tangible Costs: Maintenance	Tangible Costs: Total	BCR	FYRR Benefit	FYRR Ratio
Section A	Airport to Mt Victoria	Yes		1/07/2018	1/05/2022	$ 371,216,900	1/07/2058	$ 126,081,030	$ 18,316,000	$ 144,397,030	$ 234,553,416		$ 234,553,416	0.62	$ 5,512,911	2.35%
A interim		No	Stage	1/07/2012	1/01/2013		1/07/2052	$ -		$ -	$ -		$ -	0.00	$ -	0.00%
Section B	Tunnel to Tunnel	Yes		1/01/2013	1/07/2017	$ 94,833,900	1/01/2053	$ 260,948,606	$ 1,925,241	$ 262,873,847	$ 81,017,375		$ 81,017,375	3.24	$ 8,554,627	10.56%
B interim		No	Stage	1/07/2012	1/04/2013		1/07/2052	$ -		$ -	$ -		$ -	0.00	$ -	0.00%
Section C	Terrace tunnel	Yes		1/07/2020	1/07/2024	$ 181,470,080	1/07/2060	$ 161,779,970		$ 161,779,970	$ 101,564,682		$ 101,564,682	1.59	$ 6,476,473	6.38%
C interim																
WTM RoNs				**30/06/2012**	**1/07/2025**	**$ 647,520,880**	**1/07/2060**	**$ 647,357,870**	**$ 20,241,241**	**$ 667,599,111**	**$ 417,135,472**	**$ -**	**$ 417,135,472**	**1.60**		
										26%			21%			
Section D	Aotea Quay to Ngauranga Gorge	Yes		1/07/2013	1/07/2014	$ 84,066,400	1/07/2053	$ 144,522,196		$ 144,522,196	$ 77,046,525		$ 77,046,525	1.88	$ 6,600,000	8.57%
D interim																
NG2AO RoNs				**30/06/2012**	**1/07/2025**	**$ 84,066,400**	**1/07/2060**	**$ 166,913,906**	**$ -**	**$ 166,913,906**	**$ 77,046,525**	**$ -**	**$ 77,046,525**	**2.17**		
										6%			4%			
Section E	Ngauranga to Linden (Petone to Grenada)	No		1/07/2019	1/07/2023		1/07/2059	$ -		$ -	$ -		$ -	0.00	$ -	0.00%
E interim																
P2G RoNs				**30/06/2012**	**1/07/2025**	**$ -**	**1/07/2060**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**0.00**		
										0%			0%			
Section F	Linden to MacKays (TG)	Yes		1/07/2014	1/07/2020	$ 847,097,700	1/07/2054	$ 854,721,829	$ 3,500,000	$ 858,221,829	$ 636,266,062	$ 4,707,146	$ 640,973,208	1.34	$ 38,145,234	5.95%
F interim																
TG RoNs				**30/06/2012**	**1/07/2025**	**$ 847,097,700**	**1/07/2060**	**$ 923,968,488**	**$ 3,500,000**	**$ 927,468,488**	**$ 636,266,062**	**$ 4,707,146**	**$ 640,973,208**	**1.45**		
										35%			33%			
Section G	MacKays to Peka Peka	Yes		1/07/2013	1/07/2018	$ 554,173,000	1/07/2053	$ 457,793,070	$ 29,600,000	$ 487,393,070	$ 453,565,461	$ 19,400,000	$ 472,965,461	1.03	$ 19,578,948	4.14%
G interim																
M2PP RoNs				**30/06/2012**	**1/07/2025**	**$ 554,173,000**	**1/07/2060**	**$ 492,510,450**	**$ 29,600,000**	**$ 522,110,450**	**$ 453,565,461**	**$ 19,400,000**	**$ 472,965,461**	**1.10**		
										20%			24%			
Section H	Peka Peka to North of Otaki	Yes		1/07/2016	1/07/2020	$ 249,775,000	1/07/2056	$ 134,394,483		$ 134,394,483	$ 176,483,687		$ 176,483,687	0.76	$ 6,832,830	3.87%
H interim																
PP2O RoNs				**30/06/2012**	**1/07/2025**	**$ 249,775,000**	**1/07/2060**	**$ 140,142,342**	**$ -**	**$ 140,142,342**	**$ 176,483,687**	**$ -**	**$ 176,483,687**	**0.79**		
										5%			9%			
Section I	North of Otaki to Levin	Yes		1/07/2020	1/07/2025		1/07/2060	$ -	$ 190,600,000	$ 190,600,000	$ -	$ 160,173,200	$ 160,173,200	1.19	$ -	0.00%
I interim		No	Stage	30/06/2012	1/07/2013		30/06/2052	$ -		$ -	$ -		$ -	0.00	$ -	0.00%
LEVIN RoNs				**30/06/2012**	**1/07/2025**	**$ -**	**1/07/2060**	**$ -**	**$ 190,600,000**	**$ 190,600,000**	**$ -**	**$ 160,173,200**	**$ 160,173,200**	**1.19**		
										7%			8%			
Agglomeration Benefits										**$ 410,000,000**						
Other Wider Economics Benefits																
Wellington Region RoNs ($ Billions)								**$**		**3.02**	**$**		**1.94**	**1.56**		

Appendix J

Peer Review Report and Response

Report

Wellington Region RoNS Economic Assessment Peer Review

Prepared for NZ Transport Agency (Client)

By Beca Ltd (Beca)

20 May 2013

Revision History

Revision Nº	Prepared By	Description	Date
A	Jerry Khoo	Draft for Issue to Evaluator	30/04/2013
B	Alan Kerr	Final following response to review	20/5/2013

Document Acceptance

Action	Name	Signed	Date
Prepared by	Jerry Khoo		20/5/13
Reviewed by	Alan Kerr		20/5/13
Approved by	Alan Kerr		20/5/13
on behalf of	Beca Ltd		

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A: Project Summary

1. Project Name: **Wellington Northern Corridor RoNS**
2. Project Attributes (package of works as submitted):

Road Controlling Authority	NZTA	*Undiscounted Capital Cost (Excluding Maintenance)*	$2.77 billion
AADT (% growth) Varies depending on section	Vehicles: Varies Vehicle Growth: Varies Cyclists (current): Not Provided Cyclist Growth Not Assessed Pedestrians (current) *Not provided* Pedestrian growth Not Assessed	*Length (km)*	Varies depending on section
Estimated Existing Peak Hour Traffic Speed	Varies depending on section	*Peak Hour Traffic Speed*	Varies depending on section
BCR	0.97	*FYRR*	*Not provided.*
Preferred Option	Combined project of many segments, with various options assessed within each individual project.		
Accident History	Refer individual packages		
Problem Identified	The Wellington Northern Corridor has been identified in the Government Policy Statement (GPS) 2012/13 to 2021/22 as essential state highways which require upgrading to reduce traffic congestion, improve safety and support economic growth.		
Proposed Solution	The Wellington Northern Corridor RoNS is being developed as a 110km four-lane expressway from Wellington Airport to Levin.		

3. Project Evaluator: **Opus International Consultants Ltd.**
4. Project Evaluation Date (BCR): **April 2013**

B: Project Description

This Peer Review has been based on information contained in the *Draft Wellington Northern Corridor RoNS Business Case Economic Update (April 2013)* prepared by Opus International Consultants on behalf of the NZTA, received on 26th April 2013. The Wellington Northern Corridor

RoNS is being developed as a 110km four-lane expressway from Wellington Airport to Levin, and includes the following projects (from south to north):

i. Airport to Mt Victoria Tunnel

Consists of Mt Victoria Tunnel duplication and widening of Wellington Road and Ruahine Street. Access along Wellington Road and Ruahine Street will be restricted and a shared access lane will be provided for residential properties and pedestrian/cycling traffic .

ii. Tunnel to Tunnel

This project encompasses the length of SH1 between Mt Victoria Tunnel and Terrace Tunnel. Previously this had been separated into several projects to address the congestion in the inner city. Enhancements include the grade separation of SH1 traffic along the northern side of the Basin Reserve, the underpass underneath war memorial park and improvements along SH1 through the city centre (the Inner City Bypass, or ICB), particularly at intersections.

iii. Terrace Tunnel

The investigation of this scheme is at a relatively early stage. However, for the purposes of this analysis it has been assumed that the three lanes of the existing tunnel will be used for northbound traffic and a new two lane tunnel will be constructed for southbound traffic.

iv. Aotea Quay to Ngauranga Gorge

The Aotea Quay to Ngauranga Gorge scheme incorporates a range of improvements resulting in four lanes of “Managed Motorway” in both directions. This will be implemented in stages. Firstly, the SH2 northbound on ramp will be improved. Secondly the existing ATMS (Advanced Traffic Management System) will be enhanced. Thirdly the northbound fourth lane will be added before, finally, the southbound fourth lane will be added.

v. Ngauranga Gorge to Linden

The construction of a new four lane divided road linking SH1 (at Tawa Interchange near Grenada) to SH2 (at Petone). This project includes the construction of a new interchanges at Petone, Tawa and Lincolnshire Farm Junction.

vi. Linden to Mackays Crossing

The construction of a new expressway standard (four lane) road along the “Transmission Gully” route. This project includes the construction of interchanges and connections to adjacent communities at Kenepuru Drive, Whitby, James Cook Drive and Waitangirua, and SH58. The project is to be progressed as a Public Private Partnership (PPP).

vii. Mackays Crossing to Peka Peka

This project consists of the construction of an expressway standard section of SH1 adjacent to the rail corridor between Mackays Crossing and Peka Peka Road. This wil including the construction of full interchanges at Kapiti Road and Te Moana.and partial interchanges at Peka Peka Road and Poplar Avenue. The economics for this project is currently being updated and will be incorporated into the overall corridor economics at a later date.

viii. Peka Peka to Otaki

The Peka Peka to Otaki Expressway will have two lanes in both northbound and southbound directions. This includes the construction of a bypass of Otaki and the construction of associated half interchanges at Otaki Gorge Road and Mill Road and links to the local communities.

ix. Otaki to Levin

The Otaki to Levin section of the corridor has been separated into various projects to improve the safety of the corridor and provide better levels of service. These include realignments, wire rope median barriers, passing lanes, intersection improvements and future proofing for four lane alignments.

C: Conclusions

Based on the peer review of the Wellington Northern Corridor RoNS Economic Analysis Reporting carried out by Opus, it can be concluded that the analysis has generally been undertaken in accordance with the requirements of the Economic Evaluation Manual and can be relied upon to provide an indication of the Benefits Cost Ratio for the Wellington Northern Corridor RoNS.

We have considered the adequacy of the processes used for the evaluation and have carried out a review of a sample selection of the calculation methods and results. No concerns or issues arose during our review of the Opus calculation spreadsheets. The Opus bespoke REMAT tool is a useful Excel application and sense checks have indicated that the methods and calculations used are consistent with the procedures contained in the EEM.

Following issue of the initial peer review report, the Opus team undertook some modifications and revisions to the analysis. All comments have been adequately addressed.

D: Recommendations

It is recommended that:

1. The evaluator confirms what demand matrices have been used for each individual projects assessed using the Fixed Trip Matrices.
2. The evaluator confirms whether Ngauranga Gorge to Linden (Petone to Grenada) is part of the WNCR as the report appears inconsistent on this matter. If this project is part of the WNCR, then regardless of council funding, this project should be included in the evaluation rather than assessed as sensitivity test (unless this is BCR only from the funder's perspective and not the government or national).
3. The evaluator should note this in the report that this BCR is the on-going construction stage BCR to avoid confusion. It is also unclear what the sunk costs are and it is also recommended that the evaluator clarifies this, such that these costs that are irrevocably committed have no salvage or realisable value, such as investigation, research and design costs already incurred. The evaluator should confirm whether the 'sunk' benefits (principally associated with Aotea Quay to Ngauranga Gorge) have also been excluded. Depending on reporting needs, should a BCR for the project from the outset be required, then all costs such as design and investigation would need to be included.
4. The evaluator clarifies the scope of Do Minimum for each individual project in the report.

E: Strategic Consistency

This has not been evaluated in the report, although this project has been identified as one of the seven Roads of National Significance (RoNS) identified in the Government Policy Statement (GPS) and as such this is consistent with the Government's strategic objectives.

F: Project Evaluation (as submitted)

Table 1 - Benefit Cost Ratio Results

		Sensitivity Analysis						
Item	**Base Option ($B)**	**1* ($B)**	**2* ($B)**	**3* ($B)**	**4* ($B)**	**5* ($B)**	**6* ($B)**	**7* ($B)**
Total Cost (NPV)	1.87	2.01	1.87	1.87	1.51-2.26	1.87-2.21	1.87	1.87
Total Benefits (NPV)	1.81	2.03	1.89	2.26-2.62	1.81	1.81-5.82	1.66-1.78	1.65-1.92
BCR	**0.97**	**1.01**	**1.01**	**1.21-1.40**	**0.80-1.19**	**0.97-2.63**	**0.89-0.95**	**0.88-1.02**

* Sensitivity Analysis

1. Include Ngauranga Gorge to Linden (P2G)

2. Variable Trips Benefits

3. Wider Economic Benefits.

4. Cost Estimates. Low scenarios by reducing expected costs by 20% and High scenarios using 95%tile costs where applicable and 20% increase in costs where 95%tile cost is not available.

5. Analysis period vs discounting rate. Various analysis period and discounting rates were tested.

6. Benefits capping. Capping of benefits by 2031 and 2041 year levels.

7. Growth rate, using Wellington low growth, expansion high growth and Western drift high growth.

The assessment of the wider economic benefits (agglomeration and employment benefits) has not been considered as part of this peer review, however, the monetary value appears to have been correctly incorporated into the overall BCR calculation.

G: Key Benefits of the Project

From the report, it is unclear where benefits have been derived from each individual project. Given that this review focuses on the process of putting the business case for the combined project as a whole, the key benefits derived from each individual project are as per summarised below.

Table 1 - Key Benefits of Project

Project	Total Benefits
Airport to Mt Victoria	$89,773,826
Tunnel to Tunnel	$154,681,281
Terrace tunnel	$86,422,123
WTM (including Agglomeration and WEBs)	**$395,697,055**
Aotea Quay to Ngauranga Gorge (including Agglomeration and WEBs)	**$86,582,260**
Linden to MacKays (including Agglomeration and WEBs)	**$551,797,988**
MacKays to Peka Peka (including Agglomeration and WEBs)	**$496,215,226**
Peka Peka to North of Otaki (including Agglomeration and WEBs)	**$85,949,725**
North of Otaki to Levin (including Agglomeration and WEBs)	**$190,600,000**
Total	**$1,806,842,254**

H: Major Factors Influencing the Evaluation

The major factors affecting the evaluation are as follows:

1. Economic Procedure: The economic evaluation of the project was done using the procedures outlined in Volume 1 of the EEM with update factors up to September 2008. The usual process for considering the costs and benefits of a series of projects would be to carry out an incremental analysis of each project and determine the effect each project has on the others. The method used for the analysis of the Wellington RoNS was to examine each project independently and then combine the benefits and costs of all packages to provide an overall Benefit Cost Ratio. Therefore the effect of each project on the others has not been assessed as part of this evaluation. We also understand that there are some projects of which their numbers have not been finalised at the time of reporting, hence this review is focused on the economic evaluation process adopted by the evaluator.
2. Sunk costs: Sunk costs have been excluded from the analysis. While this is consistent with the Economic Evaluation Manual procedure, the BCR for this evaluation represents the current BCR at the time of reporting for this project where the costs are continually being accrued. The evaluator should note this in the report that this BCR is the construction stage BCR to avoid confusion. It is also unclear what the sunk costs are and it is also recommended that the evaluator clarifies this, such that these costs that are irrevocably committed costs which have no salvage or realisable value, such as investigation, research and design costs already incurred. Furthermore, 'sunk' benefits, if applicable, have not been referred to. The evaluator should confirm whether the 'sunk' benefits (principally associated with Aotea Quay to Ngauranga Gorge) have also been excluded. Depending on reporting needs, should a BCR for the project from the outset be required, then all costs such as design and investigation would need to be included.
3. Individual project benefits: As noted above, this peer review focuses on the procedures and assumptions for the combined project and has excluded a detailed review of the benefits derived from each individual project. Some individual project benefits were found to increase significantly from the previous report (i.e. Terrace Tunnel Duplication with benefits increasing from $2.5 million to $82.7 million), although the reasons behind the significant increase have been explained by the evaluator.
4. Evaluation Period: A project evaluation period of 30 years was used in the economic analysis of the project. The evaluation period commenced at the construction start date of the last project, as opposed to typically the first year of significant costs incurring as per the Economic Evaluation Manual, unless otherwise agreed with the NZTA. Some benefits were considered for projects both prior to and during the construction period of the last project. This has resulted in benefits being included for some projects for periods longer than 30 years.
5. Scope of Do Minimum: It is unclear from the report what the scope of Do Minimum is for each individual project. This should be clarified by the evaluator.
6. Fixed and Variable Trip Matrices: If the Option flows have been used for the Fixed Trip Matrices (FTM), then it would be inappropriate to apply a factor to assess potential increase in benefits with Variable Trip Matrices (VTM) approach in the sensitivity tests. Theoretically, the VTM's benefits would be similar (or sometimes slightly lower) or higher than from the FTM (using Do Minimum demand) and lower than those derived from FTM (using Option demand). For projects that reduce the cost of travel by reducing travel time or removing

constraints can induce new trips or redistribute trips. In the cases where induced trips are expected to significantly affect the evaluation, then a VTM approach should be adopted. It is acknowledged that VTM is highly complex, and the use of a factor to convert the FTM benefits as a sensitivity test is supported. However, the evaluator needs to first confirm that the Do Minimum demand matrices have been used in the analysis.

7. Sensitivity Test 2: The second sensitivity test attempts to adjust the benefits derived from a Fixed Trip Matrix approach to those anticipated from a Variable Trip Matrix approach. This applies a global 7.2% adjustment to benefits to those projects using FTM. While it is acknowledged that this is a simplified approach for the purposes of a sensitivity test, it should be noted that the impact of using Variable Trip Matrices is likely to change depending on the context.
8. Scope of WNCR: This economic assessment has excluded the Ngauranga Gorge to Linden (Petone to Grenada) project. The report states that this is only included as a sensitivity test due to the involvement of Wellington City Council and Hutt City Council. It is noted that from a national (and Government) viewpoint, the costs of this project should be included. The evaluator should clarify in the report whether this project is part of the WNCR. If this project is part of the WNCR, then the exclusion of this project indicates a BCR from the funder's perspective rather than from the national or government viewpoints.
9. Wider Economic Benefits: This economic assessment has taken wider economic benefits (including agglomeration benefits) from a third party source (Richard Paling). The methodology used to develop these has not been reviewed as part of this exercise. The benefits from this represent approximately 45% of the total benefits. While it is acknowledged that this is not directly comparable, the benefits derived from this is slightly higher than some of our project experiences, which range between 25% and 40% (such as for AMETI, Tauranga Northern Link, and Western Ring Route).
10. Construction disbenefits: This has not been included in the analysis. The EEM states that if the impact of disruption is material, then the disbenefits shall be included in the evaluation. This should be determined through sensitivity analysis, e.g. preliminary estimate of the disbenefits to adjust the BCR to determine if its BCR remains within its funding profile, and if so there is no need to undertake detailed evaluation of the disbenefits.

I: Re-Evaluation

A re-evaluation has not been undertaken at this stage. However, all peer review comments were addressed acceptably following issue of the draft peer review report.

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17 May 2013

Sam Wilkie
Project Manager - RoNS Development
NZ Transport Agency
Level 9, PSIS House
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PO Box 5084, Lambton Quay
Wellington 6145

5-C2518.01

Dear Sam,

Response to 2013 WNCR Business Case Peer Review

In response to the peer review report prepared by Beca and dated 30th April 2013, see Attachment 1, Opus has prepared the following response to the Recommendations provided (in italics).

1. Demand Matrices

The evaluator confirms what demand matrices have been used for each individual projects assessed using the Fixed Trip Matrices.

Response: Completed. Assumptions regarding the schemes and growth level included in the demand matrices have been provided in the appropriate sub-sections of Section 3.

2. Petone to Grenada

The evaluator confirms whether Ngauranga Gorge o Linden (Petone to Grenada) is part of the WNCR as the report appears inconsistent on this matter. If this projec is part of the WNCR, then regardless of council funding, this project should be included in the evaluation rather than assessed as sensitivity test (unless this is BCR only from the funder's perspective and not the government or national).

Response: Clarification provided. More explanation has been provided as to the reason why Petone to Grenada is considered as a sensitivity test. It is agreed by NZTA that Petone to Grenada is currently not considered as part of the WNCR project and thus it has only been included in the analysis as a sensitivity test due to the size, location and thus effect that it may have on the network.

3. BCR Clarification

The evaluator should note this in the report that this BCR is the on-going construction stage BCR to avoid confusion. It is also unclear what the sunk costs are and it is also recommended that the evaluator clarifies this, such that these costs that are irrevocably committed have no salvage or realisable value, such as the investigation, research and design costs already incurred. The evaluator should confirm whether the 'sunk' benefits (principally associated with Aotea Quay to Ngauranga Gorge) have also been excluded. Depending on reporting needs, should a BCR for the project from the outset be required, then all costs such as design and investigation would need to be included.

Response: Clarification provided. More detail on sunk costs and benefits have been provided in Section 3.1 as well as the explanation that the BCR's presented are on-going construction BCR's. A BCR for the WNCR project from the outset has not been requested by the NZTA at this time.

4. Do Minimum Scope

The evaluator clarifies the scope of Do Minimum for each individual project in the report.

Response: Completed. Assumptions regarding the Do Minimum networks used have been provided in the appropriate sub-sections of Section 3.

Regards,

Katie Levin
Graduate Engineer

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