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18/09/2020

[redacted]

Dear [redacted],

Request for Information – Local Government Official Information and Meetings Act 1987

We refer to your official information request dated 21 August 2020 for information regarding Cross Valley Connections Background Information.

We have decided to grant your request. Part of the information you have requested is enclosed. However, it will take us some time to prepare the rest of the information for release. We will send you the balance of information requested by as early as possible next week, the week beginning Monday, 21 September 2020.

- The National Economic Benefits Permitted by the Cross Valley Link, 2010
  - Attached
- Petone Esplanade Capacity Study, 2012
  - Will be supplied shortly
- Seaview Links Project Feasibility Report, 2015
  - Attached
- Petone, Esplanade Strategic Case Part B (I have previously been provided Part A of this document which references a Part B).
  - This is referenced once in the Strategic Case Part A and assumed we would move immediately to an Indicative Business Case, which didn't happen. Therefore Part B, which was anticipated, did not eventuate.

We are still gathering all the relevant correspondence relating to the decision to move to a Programme Business Case rather than an Indicative Business Case. This correspondence took place over a 2 year period. In order to provide context this was a decision made by NZTA rather than by Hutt City Council. With this knowledge do you still require a copy of this email correspondence?

You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

If you wish to discuss this decision with us, please feel free to contact John Gloag at John.Gloag@huttcity.govt.nz.

Yours sincerely

John Gloag

Encl:

Feasibility Report - Seaview Links Project.pdf

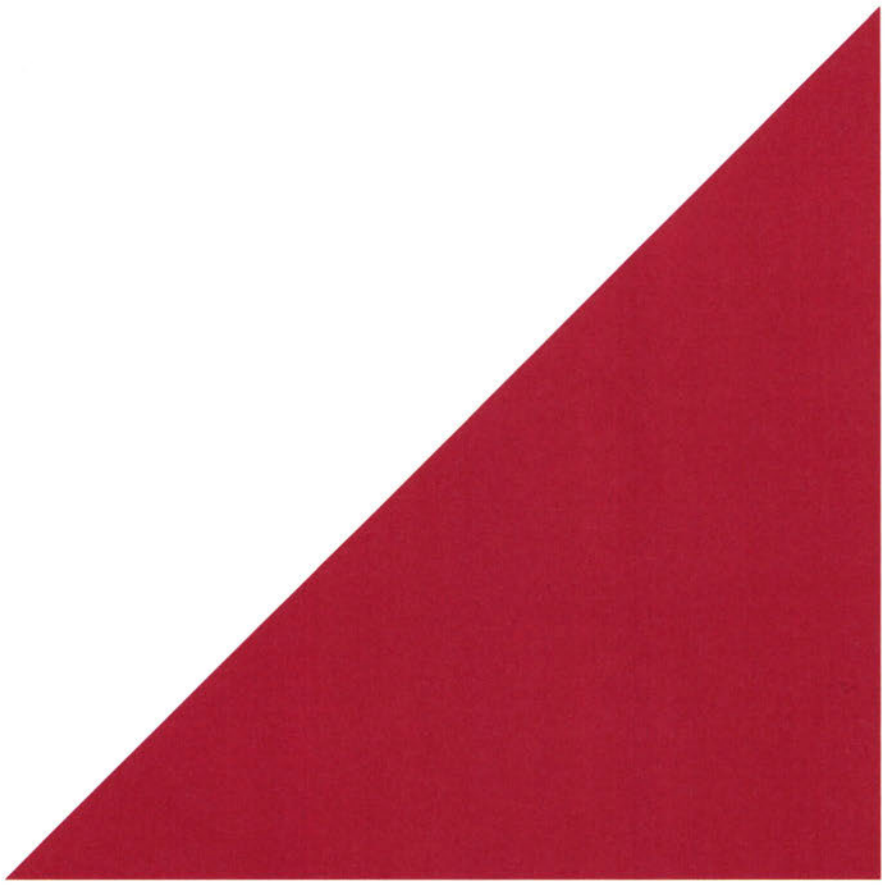
The national economic benefits permitted by the CVL.pdf

OPUS

Petone to Grenada

Seaview Links Project Feasibility Report

Petone to Grenada I&R



Petone to Grenada

Seaview Links

Project Feasibility Report

Petone to Grenada I&R

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Revision Schedule					
Rev. No.	**Date**	**Description**	**Prepared**	**Reviewed**	**Approved**
Draft	August 2013	Draft issue for comment	K Levin	D Dunlop	D Dunlop
Issue 1	August 2014	Final issue addressing Comments	B Gnanasampanthan	D Dunlop	D Dunlop
Issue 2	June 2015	2015 update addressing additional comments	J Pell	E Sutton	E Sutton
Issue 3	September 2015	Update reference to Petone Esplanade Capacity Study (May 2012)	J Pell	E Sutton	E Sutton

Contents

Executive Summary

Opus International Consultants (Opus) has been commissioned by the Hutt City Council (HCC) and the NZ Transport Agency (Transport Agency) to complete a Project Feasibility Report (PFR) for a transportation link between Seaview and Petone, assuming that the Petone to Grenada project is in place.

Seaview is one of the logistic, industrial and commercial hubs in Wellington distributing freight across the region and this is forecast to grow. Employment in the Lower Hutt area is forecast to grow by 11%[1] by 2031 placing additional pressure on the transport network.

The Petone Esplanade is the primary road link between Seaview and the region, which as a result carries high traffic volumes, buses and freight movements.

The Petone Esplanade is subject to peak time congestion and delay with high proportions of freight traffic throughout the day. These problems result in inefficient freight movements, poor travel time reliability, severance between the Petone suburbs and the foreshore, increasing safety risk for vulnerable road users.

The aim of this PFR is to investigate alternative options to upgrade routes and transport options to serve Seaview and suburbs to the south and east.

There have been several studies completed in the last 10 years to consider options to connect the east and west sides of the Hutt Valley. Options previously identified which provide the appropriate outcomes for HCC and the community have not been considered economically viable. The following objectives were agreed at a workshop with representatives from the Transport Agency, HCC, Greater Wellington Regional Council (GWRC) and Opus:

- To improve safety and efficiency of the transport network including efficiency and connectivity of HCVs travelling between Seaview and the State Highway network. Demonstrate value for money;
- Support the economic growth and development of the Hutt Valley by improving connectivity within the region;
- Enhance resilience to the local road network within the Region;
- Reduce adverse environmental impacts; and
- Enhance the linkage between the sea and Petone for all users.

Multi-modal option concepts were developed following the stakeholder consultations during the 6th and 28th June 2013 with a view to address both the project objectives and the stakeholder inputs. Desktop analysis and discussions amongst the project team were conducted to assess the multi-modal option concepts and from this the list was shortened to include those that best achieved the project objectives and desired stakeholder outcomes. Following this process the following multi-modal options were evaluated in greater detail:

[1] table 4-2 http://www.gw.govt.nz/assets/Transport/Transport-models/TN29-Demographic-Inputs-to-WTSM-FINAL-with-Appendicies.pdf

- **MM1** – Reinstate Gracefield Rail Link,
- **MM2** – Enhance Bus Services,
- **MM3** – Weekday Ferry Service, and
- **MM4** – Improve Walking and Cycling Facilities

The table below outlines the findings of the multi-modal options assessment against the project objectives:

Objective	MM1	MM2	MM3	MM4
Maximise Value for money*	Likely positive (but dependent on funding)	Likely Negative (As requires significant modal shift)	Likely Negative	Likely Positive
Facilitate Economic Growth	Positive Effects as improves freight efficiency	Positive as, if successful, would relieve network congestion	Positive	No Change
Enhance Resilience	Positive Effects as provides alternative freight route	No Change	Positive - alternative transport route established	No Change
Minimise Environment Impacts	Positive	Positive	Positive	Positive
Enhance Linkage between Petone and the Sea	Positive as removes freight from the network	Positive	Positive	Positive

* Note that no economic analysis has been carried out

All of the multi-modal options align well with the project objectives, with the exception of the value for money objective where MM2 and MM3 are noted as likely negative.

In addition to the multi-modal options, a number of roading options were identified both from previous studies and by the project team with the aim of satisfying the project objectives. The following roading options were identified:

- **SV1** – Intersection and active mode / bus improvements as per GHD's Petone Esplanade Capacity Study, May 2012
- **SV2a** – Cross Valley Link along Whites Line East alignment
- **SV2b** – Cross Valley Link along Whites Line East alignment and Esplanade depowering
- **SV3a** – Cross Valley Link along Railway Line alignment
- **SV3b** – Cross Valley Link along Railway Line alignment and Esplanade depowering
- **SV4** – Esplanade depowering
- **SV5** – Four laning Esplanade – from Hutt Road to Estuary Bridge
- **SV6** – Four laning Esplanade – from Hutt Road to Victoria Street
- **SV7** – Four laning Esplanade – from Hutt Road to Seaview(including Estuary Bridge)
- **SV8a** – Cross Valley Link along Railway Line alignment and HCV restrictions on the Esplanade
- **SV8b** – Cross Valley Link along Railway Line alignment, HCV restrictions on the Esplanade and Esplanade depowering

These roading options have been assessed both in terms of the project objectives and economic benefits. A summary of this assessment is provided in the following table.

Option	Description	Cost ($M)	BCR[2]	Project Objective Rating				
				Maximise Value for money	Facilitate Economic Growth	Enhance Resilience	Minimise Environment Impacts	Enhance Linkage between Petone and the Sea
SV-1	Esplanade Improvements	30.4	0.0	Minimal	Minimal	None	Minimal	Positive
SV-2a	Whites Line CVL	57.6	1.9	Positive	Positive	Positive	Negative	Positive
SV-2b	Whites Line CVL with Esplanade Depowering	88.0	Negative*	Negative*	Positive	Positive	Negative	Positive
SV-3a	Railway Alignment CVL	63.6	1.7	Positive	Positive	Positive	Negative	Positive
SV-3b	Railway Alignment CVL with Esplanade Depowering	94.0	Negative*	Negative*	Positive	Positive	Negative	Positive
SV-4	Esplanade Depowering	30.4	-8.4	Negative	Negative	None	Minimal	Positive
SV-5	Full four-laning	35.4	2.1	Positive	Positive	None	Negative	Negative
SV-6	Partial four-laning	31.3	-0.1	Negative	Positive	None	Minimal	Positive
SV-7	Full four-laning including Estuary Bridge	54.4	2.0	Positive	Positive	None	Negative	Negative
SV-8a	Railway Alignment CVL with HCV restrictions	63.6	1.5	Positive	Positive	Positive	Negative	Positive
SV-8b	Railway Alignment CVL with HCV restrictions and Esplanade Depowering	94.0	Negative*	Negative*	Positive	Positive	Negative	Positive

* As determined by the EEM, the negative transport benefits of depowering are higher than the benefits of the CVL options; therefore the BCR and the Maximise Value For Money objective ratings are negative. Costs for these are calculated as the addition of the relevant CVL option and the SV4 depowering option; however there may be economies of scale through carrying out these works together.

Since the initial assessment, the SATURN model has been updated and the Cross Valley Link (CVL) options rerun. To give an idea of how these options perform under the updated model the following table presents the 2031 travel time costs (Travel time benefits typically form about 80% of overall benefits) between the earlier and updated modelling for the Do Min and CVL options.

[2] The BCRs are based on earlier modelling and they include agglomeration benefits. As per EEM, 40 year benefits at a 6% discount rate have been assumed.

Options	Travel Time Costs ($M Earlier Model)	Travel Time Costs ($M Updated Model)	Difference
Do Min	1,438.70	1,438.60	-0.1
SV2a	1,434.50	1,433.10	-1.4
SV2b	-	1,446.60	-
SV3a	1,434.40	1,434.40	0.0
SV3b	-	1,449.20	-
SV4	1,451.00	-	-
SV8a	1,434.90	1,435.00	0.1
SV8b	-	1,480.80	-

Based on the above updated model results, particularly the relatively small differences between the travel time costs for the earlier and updated model, SV2a, SV3a and SV8a options are likely to produce similar transport benefits to those of the earlier modelling economics.

Options SV2b and SV3b will likely produce greater benefits than SV4, however these options result in increased travel time costs compared to the do minimum (e.g. the travel time costs for SV3b are $1,449.2M, some $10.6M more than the Do Min costs of $1,438.6M), and therefore there are no forecast transport benefits for these options, in fact the transport benefits are negative. SV8b will likely produce fewer benefits compared to SV4.

Following this assessment it was determined that there are several economically viable options. Of these SV-3a (called SV-3 hence forward) was selected as the option that would be assessed at a greater detail in this report as it had a positive BCR, promoted economic growth and improved resilience. Although SV-2a (called SV-2 hence forward) has the highest BCR and lowest cost it also requires greater land acquisition, which carries a risk to the project. SV-2 also necessitates the removal of more greenspace so has the greater adverse environmental effects. Because of these issues SV-3 was selected over SV-2. SV-3 also diverted traffic away from The Esplanade so in turn enhancing the linkage between Petone and the sea. Additionally from an urban design perspective SV-3 was identified as the best solution.

Although the multi-modal options align well with the project objectives, the project team considered that, given the magnitude of modal-shift required to have a noticeable effect on network congestion, and the unlikelihood that this shift would be achieved, these options would be complementary to a road option rather than an option in their own right.

Following the more detailed evaluation, a Transport Agency Assessment profile was given to SV-3 based on the requirements of NZTA's Planning and Investment Knowledge Base. The following ratings were given:

Strategic Fit: **Medium**

Effectiveness: **High**

Efficiency: **Low**

This rating (MHL) classifies this option as a priority 6 project which is in the middle of the Transport Agency's priority range (1 to 11).

In summary this report proves that an improved link to Seaview is a feasible option. Going forward an optimal solution should be identified once the preferred Petone to Grenada (P2G) option has been selected. At this stage sensitivity testing around growth assumptions as well as further consideration for urban design, stakeholder and community inputs, and planning issues should be undertaken, while the option to restrict freight on certain roads should also be consideration further.

A decision to improve the east-west connectivity through a combination of a cross valley link and changes to the Esplanade should be a strategic planning response not a decision driven by cost benefit ratios.

Limitations of this report

This PFR has been undertaken using the best available information to hand. The assessment relied on the North Wellington SATURN Model (NWSM) which has been developed by Jacobs as part of the NZTA Petone to Grenada Project. This model has been subject to an on-going peer review process which has not been resolved at the time of publishing this document. In particular, travel speeds and delays in the base model around the Petone Interchange area do not replicate the travel times and speeds observed from the established Bluetooth-Wi-Fi detectors. Any future application for works in the area should utilise a more up-to-date model if available. It should be noted that the option assessment within this report incorporates the Petone to Grenada link road project as its do minimum scenario, which address the existing Petone Interchange issues with the provision of a new and improved interchange. Based on this any issues in the base model likely won't affect the comparative assessment or resulting option ranking contained within this report.

Note:

The NZ Transport Agency recognises that The Esplanade depowering option considered herein achieves one of the key project objectives to address the current severance issue experienced along this route. It is noted, however, that the option introduces significant delays resulting in transport dis-benefits as measured by the Transport Agency's Economic Evaluation Manual. If this depowering option were to be pursued along with another option the overall benefits (transport and other benefits such as those arising from increased amenity) will need to be considered as part of any future funding application which may be made to the Transport Agency.

1 Introduction

1.1 Overview

Opus International Consultants (Opus) has been commissioned by the Hutt City Council (HCC) and the New Zealand Transport Agency (NZTA) to complete a Project Feasibility Report (PFR) for a link between Seaview and the State Highway with the Petone to Grenada project in place. The local linkage along the Petone Esplanade provides the main access for high traffic volumes and freight movements, which also creates a severance between Petone and the harbour. The Esplanade is subject to peak time congestion and delay with high proportions of HCV traffic throughout the day. The aim of the PFR is to investigate the alternative options to upgrade routes and transport options to serve Seaview and suburbs to the south and east (Wainuiomata and Eastbourne).

Currently the Hutt City Council's long term plan is to de-power The Esplanade and to reassign vehicles to the Cross Valley Link. This PFR will investigate whether the Petone to Grenada link corresponds to this outcome while also improving the network's performance. If this goal is unattainable, HCC and the NZTA will be informed of other options that may better achieve the objectives sought. The position and connections between the Petone to Grenada link and the route between Petone and Seaview will ensure there is a robust and effective strategy for future transport needs in this area.

1.2 Background

The Government has identified seven essential State Highways as Roads of National Significance (RoNS) that are closely aligned to New Zealand's economic prosperity. In the Wellington Region the SH1 route from Wellington Airport to Levin (Wellington Northern Corridor) has been identified as having a key role to play in supporting economic transformation.

Although the Petone to Grenada (P2G) project does not officially form part of this RoNS package, it is being progressed by the RoNS team because it contributes to the benefits of the RoNS programme. It has subsequently been commissioned to proceed through an investigation and reporting (I&R) phase. The Petone to Grenada link will significantly alleviate congestion on the busiest part of the Wellington Northern Corridor, which is between Grenada and Wellington on SH1 and between Petone and Ngauranga on SH2. The link also plays an important role in optimising the Wellington Northern Corridor by ensuring that the full benefits of the different RoNS packages are realised.

In conjunction with the P2G I&R phase, three project feasibility studies have also been commissioned. These studies have been commissioned to investigate alternative options to ensure that the Petone to Grenada link is realising the greatest benefits possible. The subject of this PFR is the transport link between Seaview and Petone. Seaview is a major industrial hub in the Wellington Region and a large part of the economy of Hutt City. There are two main goals for this PFR, and they are to:

a. Investigate transport options and alternatives to improve the linkage between Seaview, Petone and the wider transport network, including the Petone to Grenada Link. Various options will be discussed in relation to the project objectives, detailed in Section 1.6; and
b. Identify the most suitable location for the connection of the Seaview area to the Petone to Grenada link.

Plans to provide an east-west link across the Hutt Valley have been considered since the 1960's. A number of different alignments have been considered over this time, and have included:

- Wakefield Street/Whites Line[3];
- Wakefield Street/Railway corridor;
- Udy Street; and
- The Esplanade.

These different alignments have their own positive and negative outcomes. The purpose of this report is to identify an alignment that optimises the positive benefits gained by private vehicles, vehicle freight, public transport, rail freight, pedestrians and cyclists.

The purpose of this PFR is to recommend a preferred outcome that will enable the Petone to Grenada link I&R to be developed with confidence that it will be able to connect to a Seaview to Petone transport link at some time in the future.

1.3 Previous Work

There have been several studies completed in the last 10 years to determine the best routes and options to proceed with in order to connect the east and west sides of the Hutt Valley.

This PFR builds on this work previously completed, including the:

- Valley Floor Connector Needs Analysis, October 2003
- Ngauranga Triangle Strategy Study, January 2010
- Cross Valley Link Options Council Briefing Paper, March 2011
- Petone Esplanade Capacity Study, May 2012
- Hutt Corridor Plan, October 2011

These different studies are summarised below.

1.3.1 Valley Floor Connector Needs Analysis, October 2003

The Valley Floor Connector Needs Analysis was completed by MWH in 2003. The objectives of this study were to evaluate the need for improved access in the Lower Hutt valley, summarise findings of previous reports, and recommend an action plan for the Hutt City Council to manage traffic demands.

The study found that a Cross Valley Link is needed to address the increasing congestion. The Wakefield/Railway option was recommended despite having a lower BCR than the Wakefield/ Whites Line option since the Railway option had less social and environmental impacts.

[3] The HCC removed a designation from the Wakefield Street/ Whites Line route in 1989 due to the social and environmental issues and the view that there were more beneficial options available.

1.3.2 Ngauranga Triangle Strategy Study, January 2010

The Ngauranga Triangle Strategy Study completed by SKM considered the whole Ngauranga Triangle area. As part of this strategy study there was considerable work done on the SH2 to Seaview / Gracefield component. This study included issue identification, option development, fatal flaw screening (long list option assessment), more detailed analysis of the options (short list option assessment), identification and evaluation of preferred strategy components, and finally an implementation plan.

The short listed options in the report included:

- Traffic Calming on The Esplanade
- Esplanade Multi Lane Efficient Arterial
- Wakefield Street to Rail Alignment
- Wakefield Street to Whites Line Alignment
- Gracefield Multi Modal Hub
- Udy Street "Wiggle"
- Two Way Pairs –Petone Esplanade and Udy Street "Wiggle"

For SH2 to Seaview/Gracefield the Ngauranga Triangle Study recommends a Cross Valley Link following the Wakefield Street/ Railway alignment, as shown schematically in Figure 1-1. Traffic calming along The Esplanade was also included in this option. Overall the direct transportation related benefits gave the recommended route a BCR of 0.5. This includes the negative travel benefits produced by the traffic calming. The report suggests that further work to quantify potential amenity and economic regeneration benefits associated with the link should be considered.

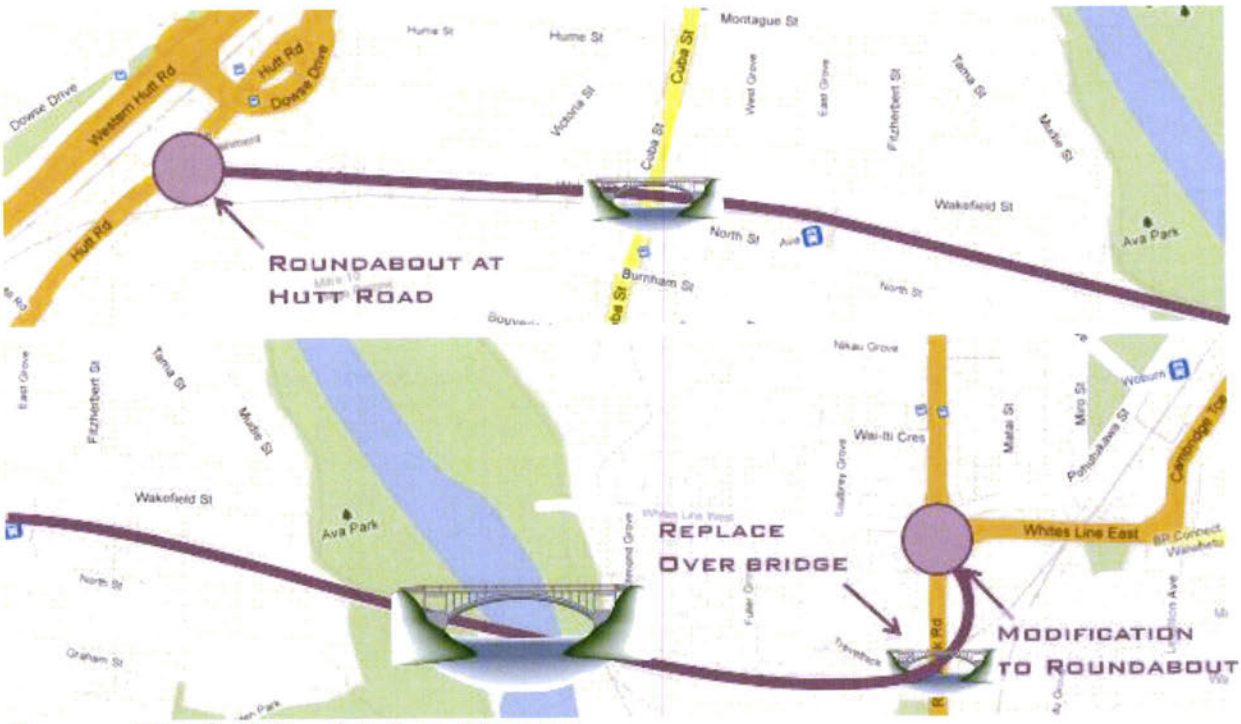

Figure 1-1: Wakefield Street/ Railway Alignment

The implementation plan contains short term (within 10 years) and long term (beyond 10 years) actions related to the Cross Valley Link. The short term actions are:

- HCC to undertake additional economic regeneration benefit analysis of the Cross Valley Link and supporting policy/planning frameworks, and
- HCC to undertake full investigation and reporting, design and gain consents for the Cross Valley Link.

The long term actions are:

- HCC to construct the Cross Valley Link.

The implementation plan also notes that if the additional work that HCC is undertaking further justifies the Cross Valley Link road then bringing the construction of the Cross Valley Link forward should be considered.

1.3.3 Cross Valley Link Options Council Briefing Paper, March 2011

Three options were discussed in the council briefing paper:

- Option A: Do nothing;
- Option B: Build the Cross Valley Link; and
- Option C: Develop options for a staged upgrade of The Esplanade to maximise traffic efficiency and foreshore amenity.

These options are schematically shown in Figure 1-2, below.

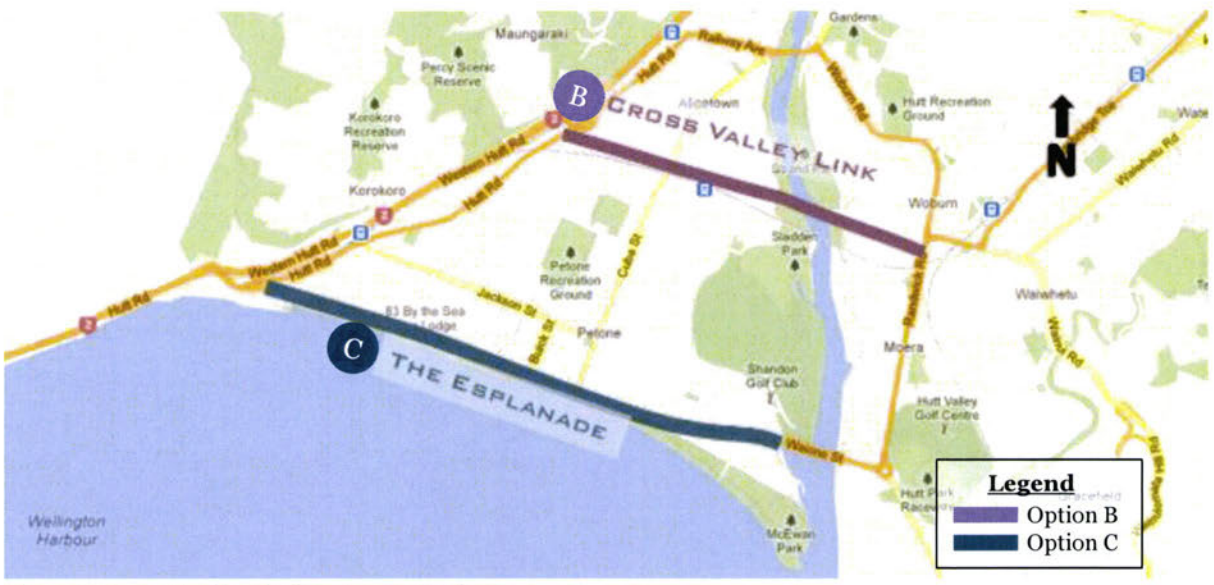

Figure 1-2: Council Briefing Paper Options

The council officers considered Option A (do nothing) not a feasible option since it does not address increasing congestion, community severance, Petone foreshore amenity, or economic development issues.

Option B, Cross Valley Link would provide significant benefits to the city, but it has a low BCR and the assessment profile based on NZTA's Planning Programming and Funding manual for the Cross Valley Link is low strategic fit, low effectiveness, and low efficiency (LLL). This is the lowest possible rating and means the project is unlikely to be eligible for a NZTA subsidy.

Officers feel that Option B is not a realistic option, despite the benefits to the city, since Council would need to meet the full cost of construction.

Option C involves developing a range of improvements that would optimise traffic efficiency of The Esplanade by minimising congestion and travel time variability, improve pedestrian access to the foreshore, enhance the recreational amenity of the foreshore and provide dedicated pedestrian and cycle facilities to form part of the "Great Harbour Way". The council officers consider this to be a pragmatic approach to addressing the objectives of the Cross Valley Link.

1.3.4 Petone Esplanade Capacity Study, May 2012

GHD completed a study of The Esplanade for HCC. This study found that:

- The proportion of heavy vehicles on The Esplanade is high for an urban road;
- The two-lane Estuary Bridge has a structural life span of at least another 25 years provided that continued maintenance is undertaken;
- With the Petone to Grenada link, the traffic flow on The Esplanade will increase by about 3,000 vehicles per day due to induced traffic;
- The capacity of The Esplanade is limited by the intersections along it and the SH2 on-ramps;
- Currently vehicles use Jackson Street and Te Puni Street as a rat-run to avoid the queuing in the morning peak to get onto SH2;
- The proposed Cross Valley Link will reduce the traffic volumes on The Esplanade by around 10,000 vpd. Based on the economic evaluation, construction of the Cross Valley Link is not warranted.
- Upgrading The Esplanade to maintain and improve the level of service required for access to the region's industrial hub in Seaview can generate many of the same benefits as the Cross Valley Link. The cost of upgrading The Esplanade was not included in the economic analysis for the do-minimum scenario.

Short term capacity improvements are possible by changing some signals and the lane allocation, as shown in Figure 1-3. However, these changes may make it more difficult for traffic on the side road to access The Esplanade.

Figure 1-3: Esplanade Short Term Capacity Improvements

1.4 Land Use Policy

1.4.1 Hutt Corridor Plan, October 2011

The Hutt Corridor Plan identifies a number of significant issues on the transport network for Seaview/Gracefield to SH2. These issues include:

- Seaview/Gracefield has around 6000 employees in about 700 businesses;
- Large companies have growth plans for the Seaview/Gracefield area;
- Severe congestion on The Esplanade during peak times makes access between Seaview and key freight destinations/markets difficult. Part of the issue is the need to merge with SH2 traffic at the western end and the way the current Petone Interchange functions;
- Capacity/delay issues with intersections along The Esplanade; and
- High volumes and large trucks are not consistent with the community vision for the area, including desires to enhance the amenity values and increase walking, cycling and other recreational uses.

The Hutt Corridor Plan then identifies the priority projects for the strategic road network. The Gracefield package includes:

- Short term plans by HCC to investigate options for optimising traffic efficiency as well as pedestrian and cycling access along and across The Esplanade;
- Further work to investigate the wider economic benefits and finding a way to fund the preferred long term solution (Cross Valley Link); and
- Advocating for the retention of the Gracefield rail corridor. CentrePort and KiwiRail both have key roles in investigating the feasibility of reinstating the Gracefield rail line.

1.4.2 Petone Vision Statement

The Petone Vision Statement Element 2 is, "Growth in Petone will be managed in an economically and environmentally sustainable manner". One of the identified means of achieving this is through changed roading networks that improve the movement of residential and business traffic and add amenity value to areas such as the foreshore.

Element 4 is, "An attractive and vibrant village culture at the heart of Petone". Part of this element acknowledges that more should be done to face and better connect with the harbour. A key consideration in this is whether the Cross Valley Link is established.

1.4.3 Vision Seaview Gracefield 2030

Seaview Gracefield has approximately 700 businesses employing around 6000 people. Since the adoption of the Council's Economic Development Strategy in 2002 the number of businesses in the area has increased by 25 percent compared to 20 percent for Hutt City.

One of the key outcomes identified in the vision is improving traffic efficiency for commercial vehicles including over-weight and over-dimension trucks. Traffic congestion along The Esplanade results in loss of trade, costs for businesses, costs for employees, and a lack of competitiveness of Seaview Gracefield as a location.

Another outcome is to provide safer roads for pedestrians and cyclists to encourage people to walk or cycle to work. The Esplanade has heavy mixed traffic and there is a lack of space for cyclists on the Hutt Estuary Bridge.

1.4.4 Hutt City Urban Growth Strategy

Hutt City Council has drafted a growth strategy for the city to help achieve the desired economic and population growth outcomes. The Statistics NZ median forecast is for a population of 105,000 by the year 2031. The focus of the strategy is on providing more housing to address the needs of the ageing population, provide economically feasible options for residents of Hutt City and encourage migration to the city. This growth in housing is proposed to be achieved through intensification with some Greenfield development and subsequently, changes to the District Plan. The 'moderate intensification' strategy would be achieved through infill housing and growth in apartments to a total growth of 5,000 homes for a population of 107,000 by 2031. The 'proactive intensification' strategy enhances the moderate strategy with a wider range of smaller dwellings through infill homes and multi-unit developments with a total growth of 7,500 homes for a population of 113,000 by 2031. This forecasted growth will increase traffic demand in the region and will subsequently require an increase in the Hutt River crossing capacity as well as improved access to SH2.

1.4.5 Great Harbour Way

The Great Harbour Way (GHW) concept is to provide a shared use path around the coastline of Wellington Harbour from Pencarrow Head in the east to Red Rocks in the west. The link between Seaview and SH2 along The Esplanade is part of the GHW. This idea was first developed in 2002 and further progressed through Wellington City Council to the GHW coalition group that champions the concept today. This coalition consists of members from Living Streets Aotearoa, Cycle Aware Wellington, Wellington Waterfront, and Hutt Valley and Wellington Rotary clubs. While the GHW mainly focuses on recreational path use, it also aims to connect communities as

part of a wider network and promote the history and cultural aspects of the harbour. The objectives of the GHW are to:

- Provide a safe continuous walking and cycling route for both transport and recreation movement around the perimeter of the harbour between Pencarrow Head and Red Rocks;
- Be predominantly designed to accommodate a continuous 2-way path;
- Provide a safe cycling commuter route between the communities along the route;
- Be located immediately along the harbour edge as far as is practicable;
- Be planned and designed in such a way as to avoid adverse effects on environmentally sensitive areas;
- Highlight Māori cultural history and values and other historical values;
- Recognise the opportunities of this route to act as a catalyst for new ancillary or development opportunities within the corridor of land it traverses;
- Enhance knowledge and awareness of the Wellington Harbour environment and immediate environs through interpretation, storytelling and art;
- Become a nationally recognised cycleway / walkway, and a key part of the National Cycleway project promoted by the Government; and
- Be developed and upgraded over time and in stages as resources allow. The initial focus is providing at least a basic level of access along the entire length.

1.5 Stakeholders

Hutt City Council and NZTA have been identified as the key stakeholders. The proposed changes would occur on roads within HCC's jurisdiction. The recommended option is also likely to affect the State Highway network and may influence current and future projects that NZTA may be considering, such as the Petone to Grenada project. Both NZTA and HCC have been involved in a workshop discussing the problem, project objectives, opportunities and constraints. Greater Wellington Regional Council (GWRC) has also been included to provide transport policy advice and input from a land use, transport and public transport integration perspective.

Other stakeholders that have been consulted are KiwiRail and CentrePort. CentrePort runs the port off of Seaview and KiwiRail owns property in the Seaview / Gracefield area and has a currently disused rail corridor; therefore, their input regarding growth aspirations in the study area as well as current issues and restraints was sought. In addition to these stakeholders, consultation was undertaken with various freight groups that operate in the Seaview / Gracefield area, including the New Zealand Heavy Haulage Association, Road Transport Association of New Zealand, and individual freight companies to understand their concerns regarding the existing situation in Hutt City and proposed options and to identify opportunities for improvement. A summary of the dates and attendees at each meeting is provided in Appendix A.

Some consistent themes came out of these discussions:

- The Seaview area is the main freight service area in the Wellington Region;
    - 2.5Mt of CentrePort's cargo travel via The Esplanade
    - 3Mt are from the fuel industry
    - There are a large number of freight operators in the area and even if they don't have a depot in Seaview, they move large quantities of freight to and from this area.

- Congestion on The Esplanade during both AM and PM peaks is a significant concern for businesses with regard to development and investment in the Seaview / Gracefield area;
    - The port aims to have efficient cargo movement therefore congestion influences their business decisions.
    - Port has a large amount of developable land in Seaview but its growth will be influenced by congestion
- Consideration needs to be given for a heavy haulage and/or dangerous goods route through the Hutt Valley;
    - Need to maintain the driveable width of The Esplanade
    - Stopping and starting at traffic lights adds to repairs and maintenance. A more continuous route is preferable, even if it is slightly longer
    - Dimensions under the Petone Bridge are too small
- There is potential for fuel / oil related growth in the area
    - There is speculation that Seaview will house the centralised lower North Island operations for a major oil company.
    - The airport extension may well require further fuel to be transported form Seaview.
- Freight companies prefer routes that don't cater to cyclists or school children.
    - Freight companies try to avoid routes near schools
    - There is a road conflict between cyclists and trucks. There is a preference for them to not share a road.

Overall, the various freight operators in the Seaview area have identified congestion along The Esplanade as a major risk to the future development of their business. Their desire is that the outcome from this project will provide them with a safe and efficient route that will help their business grow.

1.6 Project Objectives

The project objectives were refined and agreed at a workshop, on 29 January 2013, with representatives from the NZTA HCC, GWRC and Opus. The agreed objectives and their performance measures are presented in Table 1-1.

Table 1-1: Agreed Project Objectives and Performance Measures

	Objective	Performance Measure
1	To improve safety and efficiency of the transport network including efficiency and connectivity of HCVs travelling between Seaview and the State Highway network. Demonstrate value for money.	Achieve an acceptable BCR to receive project funding.
2	Support the economic growth and development of the Hutt Valley by improving connectivity within the region.	Wider economic benefits. Strategic Fit.
3	Enhance resilience to the local road network within the Region.	Assessment of the reduction of risk against each potential hazard affecting the resilience of the study area.
4	Reduce adverse environmental impacts.	Specialist's subjective assessment of effects.
5	Enhance the linkage between the sea and Petone for all users.	Either through less traffic on The Esplanade or better connectivity, with less congestion.

Also of relevance to this assessment, the Petone to Grenada (P2G) Project Objectives were considered, to determine how the Seaview Links options may complement and/or support the outcomes of that project. The P2G Project Objectives (as of May 2015) are:

- *enhance local, regional and national economic growth and productivity for people and freight;*
- *improve connectivity between the lower Hutt Valley and Johnsonville and Porirua;*
- *reduce journey times and improve journey time reliability between the lower Hutt Valley, Ngauranga and Porirua, and on the Wellington State Highway network;*
- *enhance safety of travel on the Wellington State Highway network;*
- *enhance resilience of the Wellington State Highway network; and*
- *manage the immediate and long term social, cultural, land use and other environmental impacts of the Project on the Wellington region and its communities by, so far as practicable, avoiding, remedying or mitigating any such effects through route and alignment selection, expressway design and conditions;*

  by developing and constructing a cost efficient new road alignment to expressway standards between SH2 in the lower Hutt Valley and SH1 north of Ngauranga.

2 Problem Definition

The Esplanade is a major arterial which provides access from Seaview to SH2. It also provides access to Gracefield, Eastbourne and Wainuiomata. Seaview is an industrial hub for the region and a good transport connection to the wider network is required for the efficient movement of freight and economic growth of the area. Currently The Esplanade carries a high number of HCVs. Approximately 10 percent of the ADT on The Esplanade is HCVs.

Listed below are some of the key transportation issues between Seaview and SH2:

- The high traffic volumes result in severance and decreased amenity for users of the Petone foreshore.
    - » There is a desire from HCC and the community to enhance the amenity of the Petone foreshore, reduce severance and improve connections for pedestrians and cyclists which is a competing function with the high volume of traffic and HCVs currently using The Esplanade.
    - » Traffic volumes on The Esplanade are expected to increase as a result of the construction of a link from Petone to Grenada.
- Queues along The Esplanade in the westbound direction mainly occur due to insufficient capacity at the Petone on-ramp.
    - » In the morning queues often extend to around the Petone Wharf (GHD, 2011) as shown in Figure 2-1. This results in traffic rat-running along Jackson Street and then using the streets closest to the western end such as Te Puni Street to access The Esplanade.
- In the eastbound direction, queuing occurs at The Esplanade and Cuba Street intersection.
    - » This is due to the capacity constraints at the signal lights and typically occurs in the afternoon between 3pm and 6pm. This situation is worsening and also starting to occur outside of the peak periods.
- Seismic strengthening of both the Cuba Street Rail over-bridge is needed in the future. Its locations is shown in Figure 2-1.
    - » The Cuba Street rail over-bridge has a remaining life of approximately 40 - 45 years;

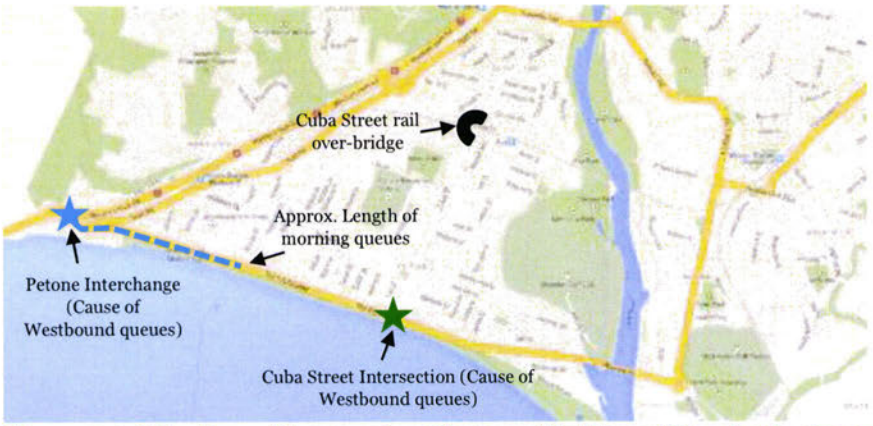

Figure 2-1: Site plan with queue locations and bridges with seismic strengthening requirements

3 Site Description

3.1 Study Area

The study area considered by the PFR is shown in Figure 3-1. It mainly consists of the Lower Hutt Valley bounded by SH2 in the west, Wainui Road in the east, The Esplanade in the south to north of Wakefield Street. Most of the focus and analysis of traffic volumes will centre on the key roads in the study area as these roads are most heavily impacted by options discussed in Section 7: The Esplanade, Waione Street, Randwick Road, Wakefield Street and Whites Line East. Any improvements to this network could also give benefits to zones outside the study area. However these are beyond the scope of this project and have therefore not been considered in this report.

Figure 3-1: Petone to Seaview PFR Area (green)

3.2 Traffic volumes

The traffic volumes, based on annual HCC count data, collected between 2007 and 2012, is shown in Figure 3-2, below. The Estuary Bridge and Randwick Road both carry 27,000 and 17,000 vehicles per day, respectively.

Figure 3-2: Current Traffic Volumes (HCC Count Data)

3.3 Road Network

The road network in the Lower Hutt Valley mainly consists of two way roads with one lane in each direction. Most of the intersections are priority controlled. Some traffic signals are present, generally on Cuba Street and Jackson Streets at various locations.

The roading hierarchy for the study area from the City of Lower Hutt District Plan is shown in Figure 3-3. All unmarked roads are classified as Access Roads.

Note currently congestion regularly forms on SH2, The Esplanade and Hutt Road in both the AM and PM peak periods.

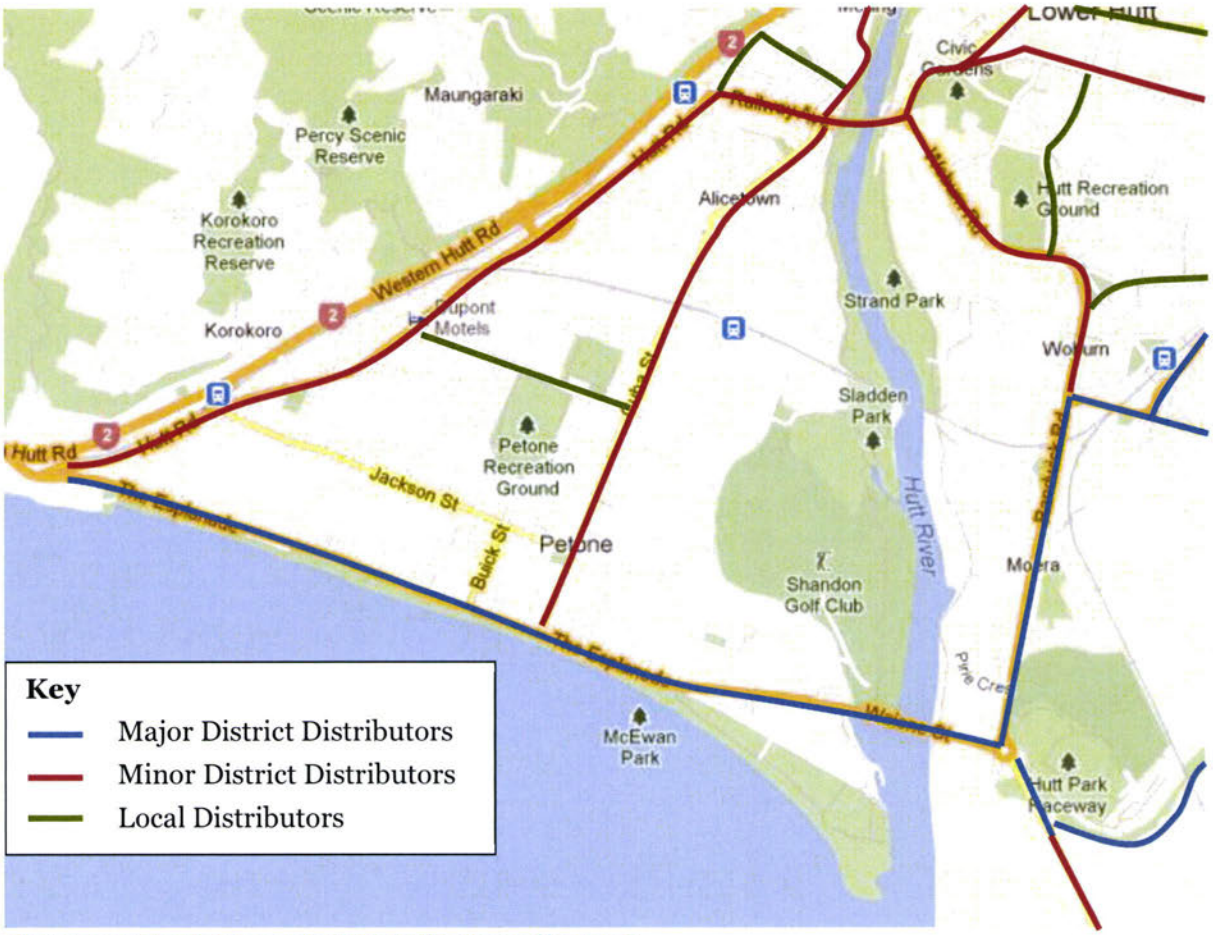

Figure 3-3: Road Hierarchy (Hutt City Council, 2004)

3.4 Resilience

Resilience is the ability to recover readily and return to its original form from adversity. In a transportation context, resilience comes from:

- Resilience to natural hazard events;
- Resilience to technological hazards; and
- Resilience to operation incidents or maintenance.

Resilience of access depends on:

- Route security – less vulnerable to failures in natural hazards;
- Redundancy – availability of alternate routes in hazards, accidents or maintenance; and
- Connectivity – trip diversity and ability to move from one link to other to avoid blockage.

3.4.1 Importance of Resilience

Resilience is important to avoid loss of access in the routine operation of the network (e.g. allow people to get to the hospital), as well as to respond and recover after major hazard events (e.g. allow for rescue after a significant earthquake or provide access for essential services).

The Petone/Seaview region is also identified by the National Infrastructure Unit as a 'hotspot'. A hotspot is defined as a "geographic area where the presence of multiple elements of infrastructure lead to interdependency vulnerabilities" meaning that this region deserves particular attention to ensure on-going operations. Damage to this area will impact key lifeline utilities including the fuel terminals at Seaview, 33kV fluid-filled buried power cables and buried water and wastewater pipes.

3.4.2 Current Regional Resilience in Wellington

The Wellington Region is very vulnerable to failures of the transport links in large hazard events. It also has very limited redundancy and connectivity and has poor operational resilience.

The situation after a major earthquake (M7.5 which is the commonly used for assessment in the Wellington Region) is illustrated in Figure 3-4. Wellington will be cut off from the North (SH1 and North Island Main Trunk railway) by failures along the Pukerua Bay to Paekakariki section in particular, and along the Porirua Harbour; and from the East by failures along the Rimutaka Hill Road (SH2). Transmission Gully expressway will substantially improve this scenario.

Also Wellington, Hutt Valley, Upper Hutt and Porirua will be cut off from each other, due to major failures along SH 58; between Ngauranga and Petone (SH2): and moderate failures in Silverstream (SH2), Eastern Hutt Road (Stokes Valley) and SH1 between Porirua and Wellington (SH1). This will NOT be improved by Transmission Gully.

In particular SH2 Ngauranga to Petone and SH 58 will be cut off for a number of months after a major earthquake. There is also vulnerability along SH1 between Porirua and Ngauranga which can close the link for days. The Petone to Grenada link will improve access into the Hutt Valley.

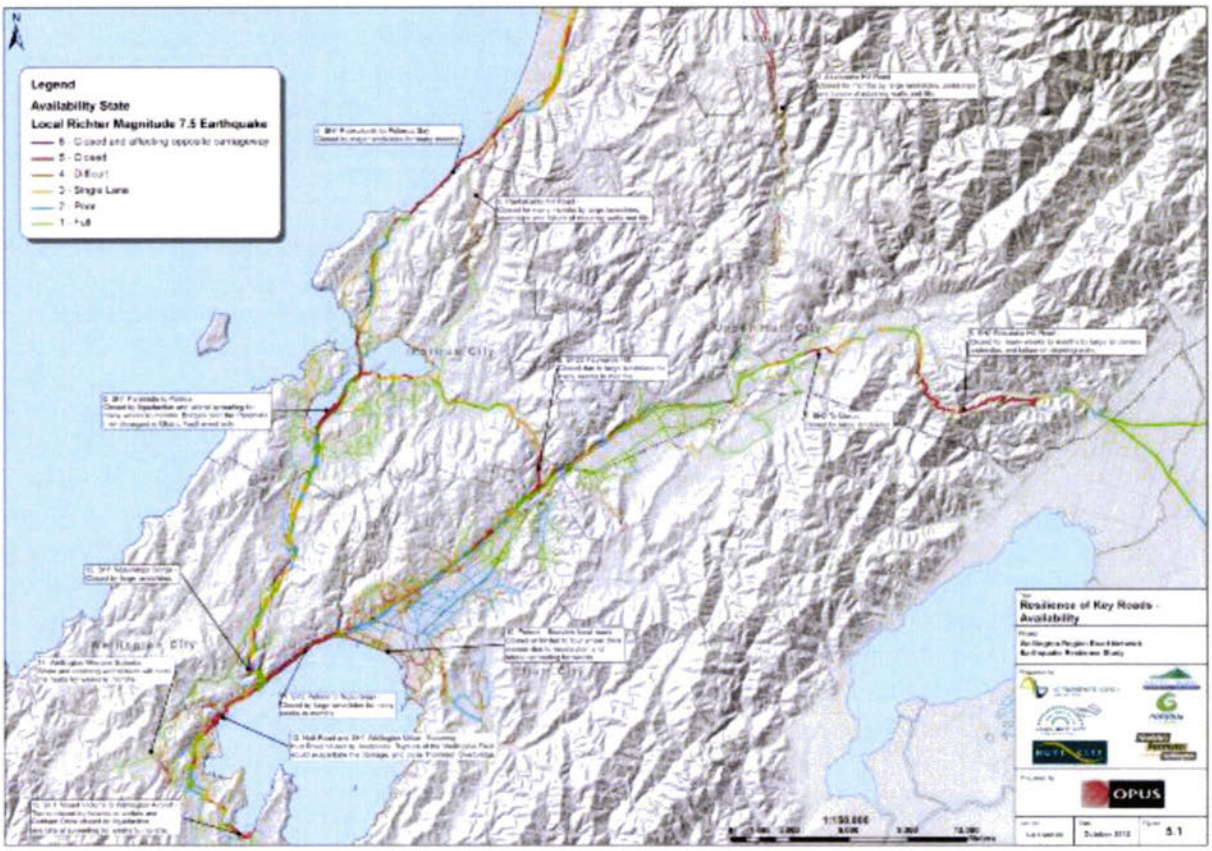

Figure 3-4: Road closures in the Wellington Region that will occur after a major earthquake

3.4.3 Resilience within the southern part of Hutt Valley

Resilience within the Hutt Valley is influenced by the limited number of crossings of the Hutt River and the railway corridor. Between Petone and the lower part of the Hutt Valley area, there are only two road river crossings at Ewen Bridge and Waione Street Bridge.

The Waione Street Bridge is one of the few places where a river crossing is provided. In the event of a crash during routine operation, or even routine maintenance, significant congestion issues can arise. Its approaches are vulnerable to liquefaction and lateral spreading towards the harbour as well as the Hutt River.

The bridges between Moera / Gracefield and Seaview are also vulnerable to failure due in earthquakes and associated liquefaction and lateral spreading. Such liquefaction and lateral spreading caused extensive damage to bridges in the Canterbury earthquakes of 2010-2011.

The Esplanade is susceptible to natural hazards such as winds, storm surge, earthquakes and tsunami. Being located adjacent to the sea, on the southern side, this section of road is exposed to high winds and leaves the roadway vulnerable to storm events such as the event experienced in late July 2013. The Esplanade is mainly one lane in both the eastbound and westbound directions, although the bus lane in the westbound direction may be utilised in the event of an emergency or to divert around a crash. These low duration hazards are likely to become frequent as a result of climate change.

The Esplanade road is also vulnerable to earthquake induced liquefaction. Although the western part of the route is only likely to be vulnerable in larger earthquakes, the consequences of liquefaction are more severe because of its location adjacent to the harbour making it vulnerable to lateral spreading. The route is particularly vulnerable because of the high potential for liquefaction and lateral spreading vulnerability of the eastern section adjacent to the Hutt River as identified by Brabhaharan et al (1994)[4].

3.5 Pedestrians and Cyclists

Footpaths for pedestrians are generally provided throughout Lower Hutt. Pedestrian phases are provided at all signalised intersections.

HCC has provided shared use paths along the Hutt River and the waterfront adjacent to The Esplanade, as well as other locations not located within the study area. Pedestrians and cyclists are able to cross the Estuary Bridge via a barrier separated lane on the south side of the bridge. Where the railway crosses the river and at Ewen Bridge the path travels underneath the structures.

There are also several on road cycle lanes provided in Hutt City. Many of the cycle lanes are short sections that provide access / egress to the shared use paths. Within the study area there are two main on road cycle lanes: Waione Street between East Street west and East Street east and Randwick Road from York Street south to Seaview Road at Gough Street. A map of the existing cycle lanes and shared use paths in Hutt City has been provided in Appendix B. A map showing the cycle lanes in the study area is provided as Figure 3-5. Designated routes such as the Hutt River Trail and NZ Cycle Trail are also identified.

[4] Brabhaharan, P, Hastie, WJ and Kingsbury, PA (1994). Liquefaction Hazard Mapping Techniques Developed for the Wellington Region, New Zealand. Annual NZNSEE Conference, Wairakei, 18-20 March 1994.

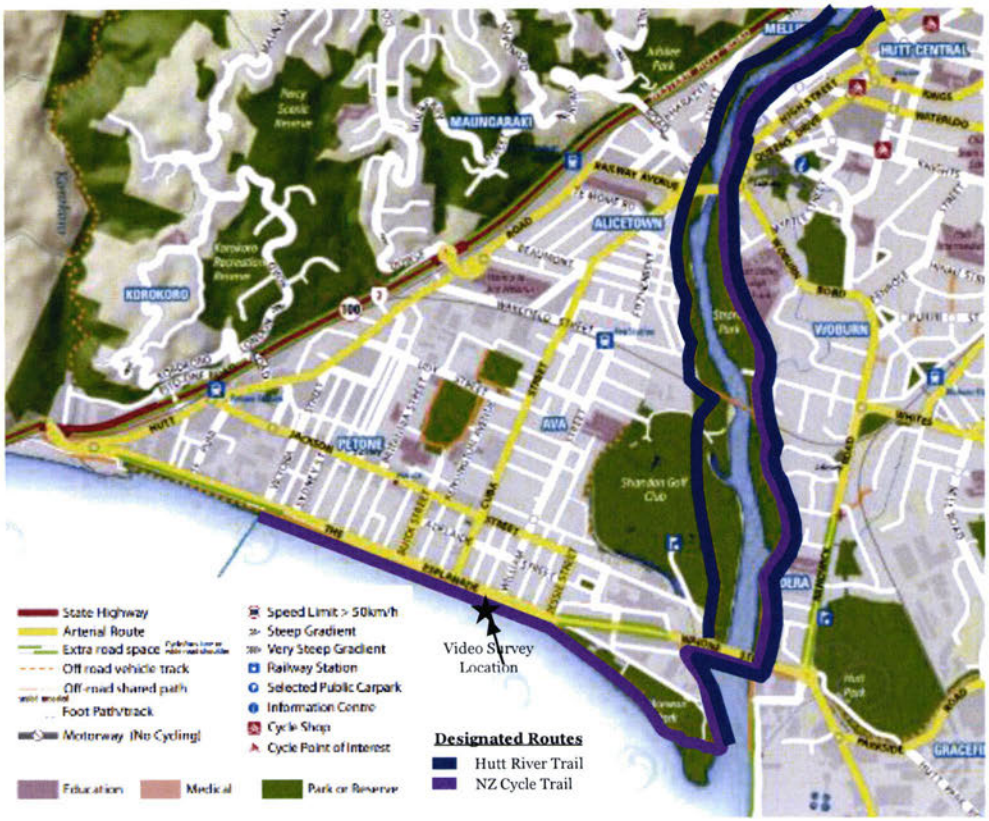

Figure 3-5: Excerpt from HCC Map of Existing Cycle Lanes and Shared Paths

Hutt City has collected video footage of the cyclist and pedestrian movements at the intersection of The Esplanade and Cuba Street (reference 6819), see Figure 3-5. Six hours of video was recorded: from 7.30am to 10.30am and 3.30pm to 6.30pm. This footage was reviewed for Wednesday, 27 March 2013 which was a sunny summer day prior to the Easter weekend (Good Friday was 29 March 2013).

At this location there are pedestrian crosswalks in both the north-south and east-west directions. A wide footpath is also provided on the shore side of The Esplanade that is often used by cyclists. The majority of cyclists and pedestrians that travelled through the intersection were travelling either eastbound or westbound on this footpath (approximately 60%). A summary of the total cyclists and pedestrians recorded, and the peak flow hours, is provided in Table 3-1. A summary of all the recorded movements has been provided in Appendix C.

Table 3-1: Pedestrian and Cyclist Counts on The Esplanade

Time Period	Cyclists	Time Period	Pedestrians
AM Total – 7.30-10.30	41	AM Total – 7.30-10.30	59
AM Peak – 7.45-8.45	20	AM Peak – 8.45-9.45	27
PM Total – 15.30-18.30	45	PM Total – 15.30-18.30	134
PM Peak – 17.30-18.30	29	PM Peak – 17.30-18.30	66

Figure 3-6 and Figure 3-7 provide an illustration of the cycling and pedestrian movements during both the total AM and PM periods, respectively.

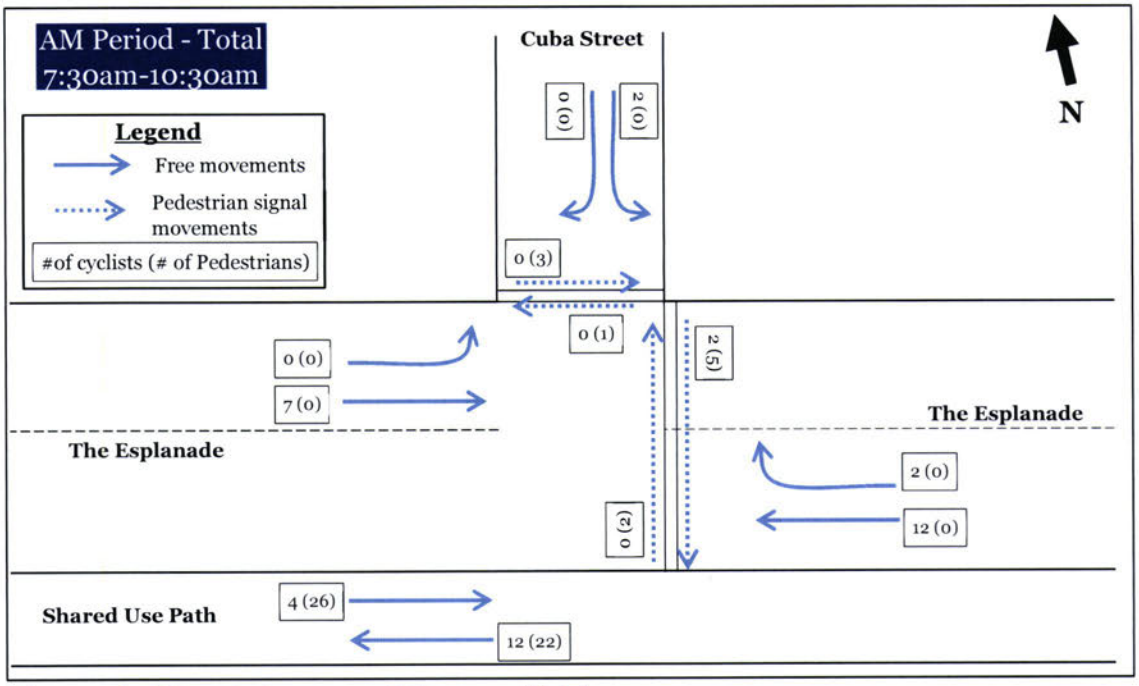

Figure 3-6: AM period movement diagram - Total

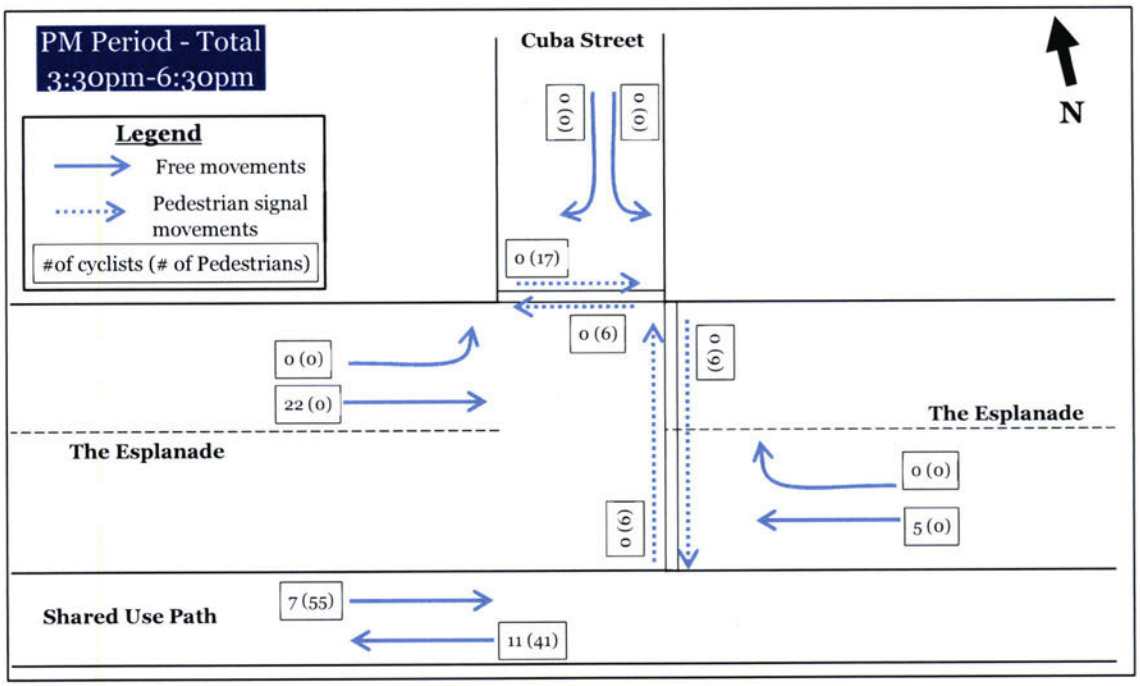

Figure 3-7: PM period movement diagram - Total

This information indicates that the number of active transportation mode users are fairly small especially relative to the number of vehicles. This supports the present notion that the high traffic volume along The Esplanade is negatively impacting on the amenity of the foreshore particularly

for pedestrians and cyclists. However there is a desire among the Hutt City population to use the foreshore as a means of travelling using active transportation modes and for recreational purposes, so the options identified in this report will have provisions for this. Additionally the inclusion of cycling facilities along The Esplanade will support the current Ngauranga to Petone cycleway project as well as help achieve the aspirations set out in the Great Harbour Way.

Between May and August 2012 NZTA conducted user surveys and focus groups as part of the consultation for the Ngauranga to Petone cycleway upgrade project. Results from the survey were published October 2012[5]. A key finding was that *"35% of respondents do not currently cycle between Wellington and the Hutt Valley. The most common reason was that the journey was too dangerous"*. This suggests that providing safer cycle facilities would increase the cyclist mode share. The economics for the project at the time assumed cyclist growth of 4.75% per annum by providing improved facilities. Findings from the focus groups suggested the actual cyclist growth achieved could be much higher, provided the option of using the SH2 shoulder remained. This indicates that there is latent cyclist demand for which the mode share could be improved by providing improved cyclist facilities.

Travel to work data for collected in the 2013 census data is shown in Table 3-2 at both a Lower Hutt regional and overall national level. Mode share for cycling was 2% which is consistent with the national figure. Walking to work was 4% in the Lower Hutt area, 1% below the national figure of 5%.

Table 3-2: 2013 Census Travel to Work Statistics

Main means of travel to work	Lower Hutt City Users	NZ Wide Users	Lower Hutt mode share	NZ Wide mode share
Worked at home	2,256	169,674	5%	8%
Did not go to work today	4,794	207,141	10%	10%
Drove a private car, truck or van	20,304	971,730	43%	49%
Drove a company car, truck or van	4,887	217,407	10%	11%
Passenger in a car, truck, van or company bus	2,283	76,437	5%	4%
Public bus	2,352	64,380	5%	3%
Train	4,602	24,639	10%	1%
Motor cycle or power cycle	414	26,205	1%	1%
Bicycle	849	44,184	2%	2%
Walked or jogged	1,785	106,119	4%	5%
Other	522	18,333	1%	1%
Not elsewhere included	1,779	74,757	4%	4%
Total people	**46,824**	**2,001,006**	**100%**	**100%**

Source: Statistics New Zealand

[5] http://nzta.govt.nz/network/projects/ngauranga-to-petone-cycleway/docs/n2p-executive-summary-cycle-groups.pdf

3.6 Freight Movements

3.6.1 HCV Movements

Several data sources were reviewed to try to get an accurate representation of the HCV flows in the Hutt Valley and the HCV movements to and from the Seaview / Gracefield area. These include the Wellington Transport Strategic Model (WTSM), the Northern Wellington SATURN Model (NWSM) and HCC traffic data. In addition to these data sources, a survey of businesses in the Seaview / Gracefield area undertaken for the Valley Floor Connector Needs Analysis (see Section 1.3.1) was reviewed.

The WTSM transport model suggests that 75 percent of HCVs travelling on Seaview Road have an origin or destination within Hutt City or Upper Hutt City. The remaining 25 percent are distributed between Wellington City, northern SH1 and northern SH2. Knowledge of the area and consultation of other data sources indicates that this does not accurately reflect the actual HCV movements in the region. The HCV trip generation in the current WTSM model is a known weakness and GWRC are currently working on a project to improve this part of the model. For this reason, the new NWSM used electronic Road User Charges (eRUC) data in addition to the HCV demands from WTSM in order to more accurately reflect the commercial vehicle movements. However, the origin / destination results produced by NWSM are similar to those provided by WTSM in that a large proportion of HCVs remain in the Hutt Valley.

In the Valley Floor Connector Needs Analysis contract in 2003, a survey of Seaview/ Gracefield businesses found that 50 percent of HCVs remained in the Hutt Valley while the remaining 50 percent travelled to destinations on the wider state highway network as shown in Figure 3-8. Almost all HCVs that travel south towards Ngauranga and north to Porirua will access SH2 via The Esplanade. Anecdotal information collected during meetings, on the 6th and 28th June 2013, with stakeholders from the freight industry during this project confirms that the survey results are a better reflection of the HCV activity in the area than WTSM, despite the age of the survey.

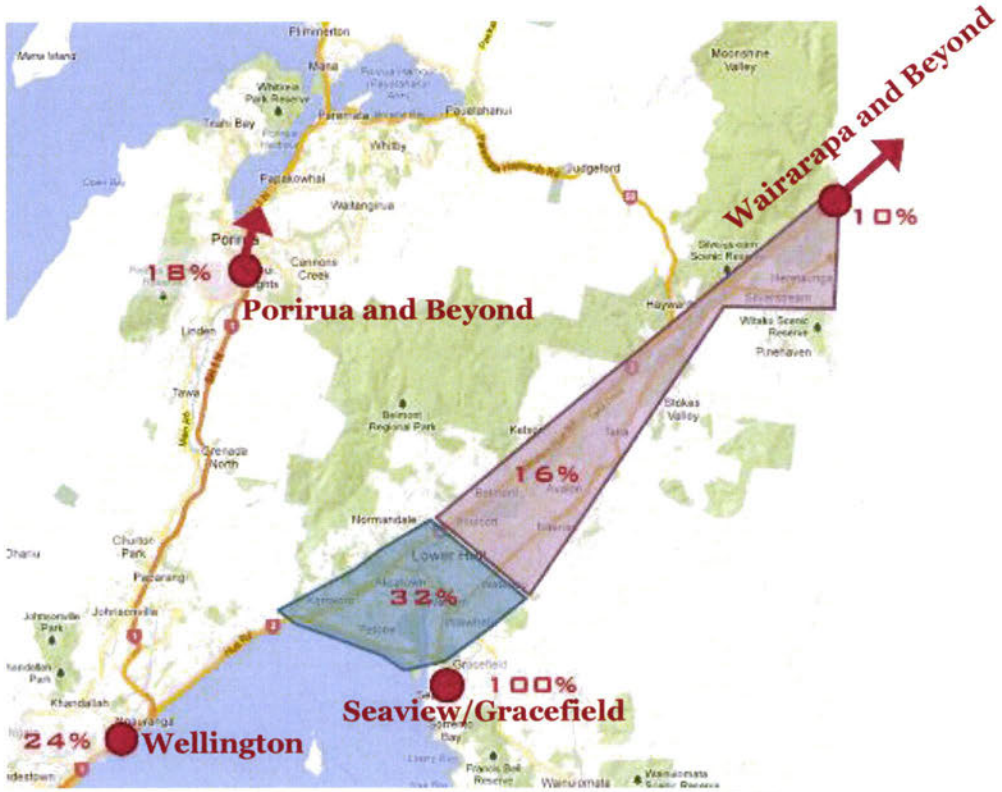

Figure 3-8: HCV Origins and Destinations for Seaview/Gracefield

HCC traffic count data collected between 2003 and 2012 was also reviewed. While this data does not provide origin / destination information, it does provide data for different user classes. This data indicates that approximately 10 percent of traffic on The Esplanade are HCVs. Randwick Road carries approximately 7 percent HCVs.

3.6.2 Rail Freight

KiwiRail operates freight trains to and from Wellington. The freight trains follow the same rail line as the Hutt Valley Line. Previously KiwiRail operated a rail line that travelled south from the Woburn Station through Gracefield and into Seaview. This line has been decommissioned and as a result portions of the rail have been removed and other sections are no longer present or are in very poor condition. Sections of land have also been leased to other businesses that operate in the area. As an input to this project KiwiRail produced a high level estimate to refurbish and reinstate the rail line. The costs are estimated at $3M, including the necessary replacement of the bridge over Waiwhetu Stream. This high level estimate along with notes following consultation with KiwiRail are provided in Appendix F. KiwiRail have identified the following operational issues associated the Gracefield rail line making it an unlikely reinstatement candidate:

- Shunting of cars to split off the main rail line;
- The short distance to Wellington Port means that freight companies are unlikely to utilise it to avoid additional handling of the cargo and associated costs of that handling; and
- Conflicts with the public transport rail that uses the same lines.

KiwiRail currently has no plans to refurbish the rail line and proposals have been made to convert the decommissioned line into a trail for walking and cycling. This would allow the land to become useable and provide an additional 3.75km of shared paths for Hutt City. During consultation with

other stakeholders, it was also suggested that this rail corridor could be converted to a road for HCV use, thus allowing easier access to any Cross Valley Link options while avoiding busier urban roads such as Randwick Road.

3.7 Public Transport

Hutt City has freight rail, passenger rail and bus services available. The freight rail is privately owned and operated by KiwiRail. Passenger rail and bus services are operated by Metlink. The public transport volumes have been modelled in the Wellington Public Transport Model (WPTM) which is a facet of WTSM that can model the public transport movements in more detail. WPTM provides peak two hour flows for the AM and inter peak periods only. PM public transport flows are assumed to be the reverse of AM flows.

Table 3-3 summarises the volume of people travelling by bus on key roads in Hutt City from the Base 2011 and future 2031 WPTM/WTSM models. The assumptions used in this model are reported in Section 4.3.1. Screenshots of the WPTM outputs are provided in Appendix D. Passenger rail volumes are discussed later in this section.

Table 3-3: Public Transport Passenger Volumes in the AM and Inter Peak Periods

Road	Direction	Number of Passengers			
		2011		2031[6]	
		AM	IP	AM	IP
The Esplanade* (West of Fitzherbert Street)	Westbound	400	10	700	140
Estuary Bridge	Westbound	310	40	380	20
	Eastbound	80	30	60	30
Jackson Street* (West of Richmond Street)	Westbound	420	290	370	70
	Eastbound	220	200	320	350
Randwick Road	Northbound	60	80	50	50
	Southbound	80	80	50	80
Cuba Street	Northbound	180	210	230	340
	Southbound	200	260	370	210
Hutt Road (South of Jackson Street)	Northbound	210	180	280	330
	Southbound	160	250	70	40

*Peak flows on this road

[6] 2031 volumes taken from the P2G-2 WTSM model which includes the RoNS projects and P2G.

Generally, the number of passengers on public transport has increased by 24% in the AM peak in 2031. Overall the inter peak volumes are relatively stagnant. Some decreases are shown on specific corridors; however, this may be due to the proposed bus route and frequency changes that have been incorporated into the future WTSM/WPTM models. It is evident that bus patronage on The Esplanade is predicted to increase significantly.

3.7.1 Bus Routes

There are several bus routes that pass through the study area. Most of the bus routes travel along Cuba and Jackson Streets, however, three routes use at least a portion of The Esplanade. One route travels via Randwick Road while five use the Estuary Bridge. A summary of the bus routes and the key roads they travel is provided in Table 3-4. Additionally, maps illustrating the route taken by each bus service through the study area is provided in Appendix E.

Table 3-4: Summary of Bus Routes in the Study Area

Route No.	Route Name	Key Roads
80	Wainuiomata Commuter (to Wellington)	Waione Street The Esplanade from Cuba St to Hutt Rd
81	Eastbourne – Wellington	Waione Street
83	Eastbourne – Lower Hutt – Wellington	Randwick Road
84	Gracefield – Wellington	Waione Street
85	Eastbourne Express	Waione Street The Esplanade
91	Airport Flyer (Lower Hutt – Airport)	The Esplanade from Fitzherbert Street to Hutt Road
130	Petone – Naenae	Randwick Road Waione Street

3.7.2 Passenger Rail

The Hutt Valley Line (Wellington – Upper Hutt) travels through the study area. From the north, the railway line follows Cambridge Terrace under Whites Line East and Randwick Road and crosses the river south of Wakefield Street. It then travels west meeting up with Wakefield Street before diverting south again under Hutt Road to follow Western Hutt Road.

There are three train stations in the study area:

- Woburn Station at Cambridge Terrace north of Whites Line East;
- Ava Station at North Street; and
- Petone Station at Western Hutt Road near Jackson Street.

The Melling Line travels adjacent to Western Hutt Road from the north and joins up with the Hutt Valley Line just north of the Petone Station. Rail passenger volumes from WTSM/WPTM are provided in Table 3-4. The table indicates that rail volumes will decrease in the future by approximately 300 people in the AM peak travelling westbound and southbound (the main AM peak direction of travel). However, passenger volumes in the opposite direction will increase. The number of people utilising the train system in both directions during the inter peak will also increase by 740 people in the year 2031.

Table 3-5: Rail Passenger Volumes in the AM and Inter Peak Periods

Road	Direction	Number of Passengers			
		2011		2031	
		AM	IP	AM	IP
East of Ava Station (Hutt Valley Line)	Westbound	4500	230	4200	310
	Eastbound	120	80	300	360
South of Petone Station (Hutt Valley Line and Melling Line)	Southbound	4900	230	4600	330
	Northbound	150	90	370	370

3.8 Existing Urban Situation

An assessment of the current urban situation in the study area was undertaken in conjunction with an assessment of the options, provided in Section 12 of this report. The full urban design assessment is provided in Appendix G. Figure 3-9 shows the key land use patterns and topographical features that influence this assessment.

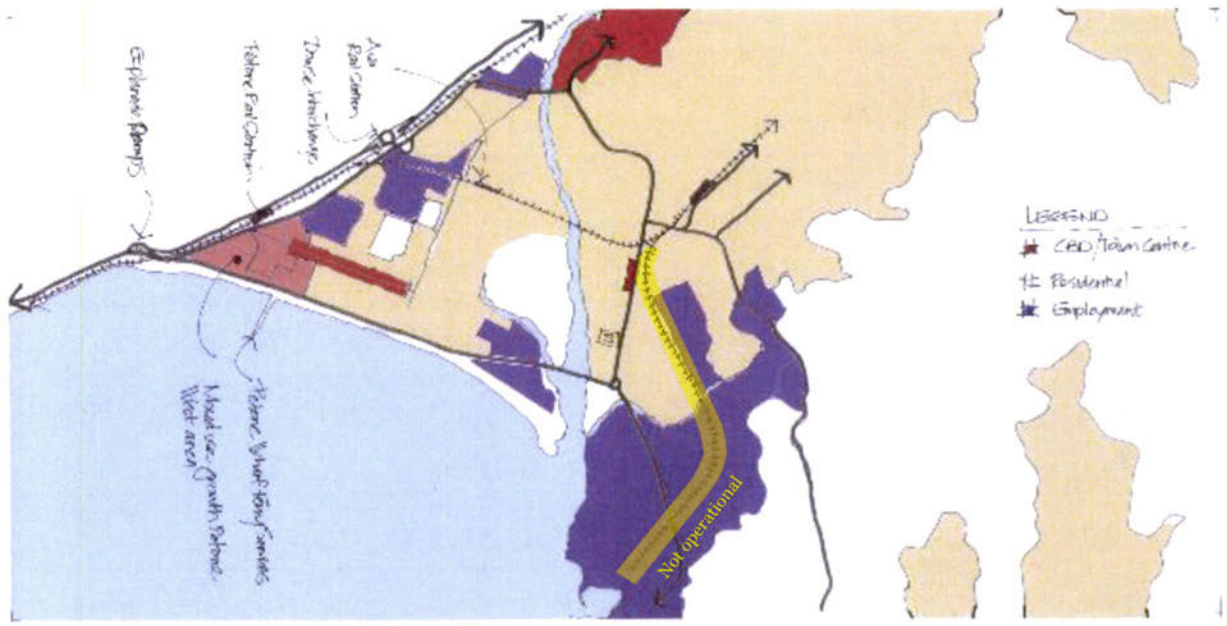

Figure 3-9: Land Use Patterns in Hutt City

3.8.1 Town Centres

Hutt CBD, Petone Town Centre (Jackson Street) and Moera Village are shown in red fill in Figure 3-9. Petone has become a desirable residential and small business address, and encouragement of this change is significant given the lower population growth rates in other areas of the Hutt Valley. Transport options are one important factor in this existing growth including direct access to SH2 and Petone Railway Station, and to a lesser extent ferry services from Petone Wharf. Access to open space is another key attractor so linkages to The Esplanade foreshore and Hutt River Trails will continue to grow in importance.

Moera Village shops, Randwick Primary School, churches and a marae are located along Randwick Road. While smaller in size, it remains an important neighbourhood centre. Mature trees make an attractive walking route along Randwick Road which is important for the primary school children.

Hutt City Council's (HCC) Plan Change 29 seeks to capitalize on this population and employment growth by encouraging mixed use intensification in Petone West. This area and the 'trade retail' area of Petone are shown in a lighter red fill in Figure 3-9. HCC's Plan Change 29 will achieve this by rezoning this area to allow a greater range of activities. Additionally under this change taller buildings as well as larger retail and commercial developments are now permitted in the area.

3.8.1.1 Future Town Centre Predictions

As property values increase many of the larger light industrial and trade retail sites will be subdivided for smaller commercial, retail and residential activities. This will lead to new streets, discouragement of front yard parking and a larger reliance on street parking to increase streetscape amenity. The Esplanade road frontage will transform from front yard car parking and industrial buildings to buildings with active frontages built on front boundaries. Kerbside parking and a high quality footpath on The Esplanade are important to encourage small commercial, retail and hospitality businesses in accordance with a desire to reduce severance issues.

3.8.2 Employment Areas

The industrial employment areas are shown in purple fill on Figure 3-9. Seaview is the dominant area, with 700 businesses employing around 6000 people, and is the largest heavy industrial precinct in the Wellington / Hutt Valley area. The other significant areas are Waione Street (west of the Hutt River), Petone North, Wakefield Street and Cornish Street.

In addition to predominantly industrial employment, the Seaview and Gracefield areas also has retail and food services employment types.

3.8.3 Transport Linkages

There are two rail stations in the project area, as shown in Figure 3-9. Petone is the most important station as it serves an existing town centre. Employment and residential intensification is occurring in Petone West and will be encouraged by Plan Change 29. Therefore, the walk to the station across Hutt Road is an important linkage to encourage rail patronage.

Ava Rail Station is located south of Wakefield Street alongside the Cross Valley Link route. The Ava Rail station is less utilised compare to other stations on the line and is located in a lower density employment and residential area. WTSM figures indicate that 400 passengers utilise the both Petone and Ava stations during the peak period.

The key roading elements are the SH2 interchange locations and the Hutt River bridges as they constrain options. Petone has south facing ramps only, with Hutt Road and The Esplanade providing the local arterial access roads. Dowse Interchange was upgraded in 2009 and has north and south facing ramps to SH2. The Estuary Bridge provides a direct access along The Esplanade to the Petone Interchange for Seaview, Moera and other eastern suburbs. Whereas for Dowse, access to central Lower Hutt and the eastern suburbs is available via Railway Avenue and Ewen Bridge.

3.8.4 Hutt River

The Hutt River is being developed, as detailed in the Hutt Corridor Plan, into an attractive green corridor with improved cycling/walking trails.

3.8.5 Esplanade Foreshore

For a country of two islands New Zealand has remarkably few cities that have foreshore roads close to major urban centres. New Plymouth's Molesworth Street, Auckland's Tamaki Drive, Mount Maunganui's Marine Parade, Napier's Marine Parade, Taupo's Lake Terrace, Queenstown's Marine Parade / Beach Street, Wanaka's Ardmore Street and perhaps most importantly Oriental Parade in Wellington are examples of such foreshore roads.

The Esplanade and Petone Beach important for the area as they are the only major seafront connection for the Hutt Valley. As evidenced by the scarcity of foreshores near urban centres it represents an important relationship between city and sea. The enhancement of the linkage between the sea and Petone is also listed as a project objective in section 1.6 so is important to consider when assessing options.

4 Network Characteristics

The following sections detail the traffic related characteristics of the study area under Do Minimum and future year forecast traffic flow conditions. The analysis undertaken provides a quantified measure of performance thus allowing comparisons to be made against potential improvement options and against the Project objectives. All traffic data utilised for this assessment has been obtained from HCC or the Northern Wellington SATURN Model (NWSM).

Results from two versions of the NWSM model have been presented, the earlier version which was completed in 2013 and used for the initial Seaview Links option investigation, and the updated version which was completed late 2014 and used for further option refinement of the Cross Valley Link (CVL) options (with and without The Esplanade depowering). As the underlying base model has been completely recalibrated and used different base assumptions the earlier NWSM and the updated NWSM results are not directly comparable. Both sets of results have been included as some option scenarios were not rerun with the new models.

4.1 Existing Traffic Volumes and Historic Growth

HCC collects data at different locations on their network every year. They also retain several permanent count sites that collect data throughout the year. Annual Daily Traffic (ADT) volumes on key roads in the study area have been estimated using this count data. As this data is generally only collected for one or two weeks out of the year, the counts do not necessarily represent an average for the year, nor have seasonal adjustment factors been applied. The permanent count sites have been used to calculate a traffic growth rate for Hutt City.

Since July 2009, Hutt City has had a traffic growth rate of -1%. This negative growth rate is consistent with the trends in the region and reflects the negative net migration and falling employment base in Hutt City as reported in the Draft Urban Growth Strategy (see Section 1.4.4).

The most recent traffic flows collected by HCC's data collection programme are presented in Table 4-1.

Table 4-1: ADT from HCC Count Sites

Road	Current ADT	% of HCV
The Esplanade	24,000	11
Wakefield Street West*	1,500	4
Wakefield Street East**	700	n/a
Randwick Road	17,000	7
Whites Line East	20,000	4

*Count taken between Rush Grove and Victoria Street
**Count taken between Cuba Street and Fitzherbert Street

4.2 Travel Time Surveys

On Tuesday 5th March 2013 SKM carried a journey time survey along The Esplanade. Runs were made in both the eastbound and westbound direction during all peak periods. A summary of the survey results are provided in Table 4-2.

Table 4-2: Summary of the SKM Journey Time Survey on The Esplanade

Peak Period	Direction	# Runs	Avg. Speed (km/h)	Travel Time (sec)	Coefficient of Variation
AM	EB	6	42	310	0.09
AM	WB	7	23	573	0.46
IP	EB	18	42	308	0.11
IP	WB	17	48	274	0.06
PM	EB	9	25	515	0.18
PM	WB	8	48	275	0.07

From Table 4-2 it is evident that travel times are higher in the westbound direction during the AM peak period and eastbound direction during the PM peak period. These directions and times are consistent with the principal commuter flow directions and are due to the congestion that occurs along The Esplanade. When there is no congestion the 3.62km route along Esplanade takes around 300 sec (5 min) at an average speed of over 40 km/h. Comparatively, when there is congestion the travel time increases to over 500 sec (8.5 min) at an average speed of around 25 km/h.

The coefficient of variation reported in Table 4-2 represents the travel time reliability of the trip. The highest level of variability is observed in the AM peak in the westbound direction. This is largely due to the high level of congestion on the road and the relatively large proportion of HCVs on the road. The next highest level of variation occurs in the eastbound direction during the PM peak. Again this is most likely caused by the level of congestion in that direction during the peak period. The coefficient of variation for other periods and directions are relatively stable and suggests that their travel time is more reliable.

4.3 Forecast Future Year Traffic Volumes

The NWSM has been utilised for the modelling of this project. The SATURN model has been used for the quantitative assessment, including economic assessment, of the 'Do Minimum' and proposed options. Due to the size of the study area and the impact that the Petone to Grenada project has on the Seaview Links project, the SATURN model has also been used for the operational assessment of the intersections and links instead of a micro-simulation modelling tool. This information is documented in later sections of this report.

4.3.1 Do-Minimum Modelling Assumptions

The models have a base year of 2011 with forecast years of 2021 and 2031. Medium growth trip matrices from WTSM 2011 have been used as the basis for the NWSM matrices. The medium growth assumption is used because it is consistent with the growth occurring in the region as a whole, which is included in the model.

The other Do-Minimum assumptions for the transportation modelling of the Seaview Links PFR include:

- Wellington Northern RoNS as per the RoNS construction programme, See Table 4.3;
- Passenger Transport Improvements as per the Wellington Regional Rail Plan 2010-2035;
- SH58 improvements (SH2/SH58 grade separation, uphill passing lane extension on SH58); and
- Petone to Grenada as per the PFR alignment but with an 80 km/h speed environment.

These assumptions are included in the Do-Minimum because they are either identified in the current Wellington Regional Land Transport Programme 2012-2015 or it is reasonable to expect them to be completed in the forecast years. Additionally no peak spreading has been predicted in the Do-Minimum model for the purposes of this assessment.

Since one of the aims of this investigation is to determine what effect the Petone to Grenada (P2G) link will have on Hutt City, P2G has been included in the Do-Minimum modelling with the assumption it will be constructed before 2021 and therefore is included in the 2021 model network. The P2G modelling arrangement is based on the PFR alignment as a preferred option for the P2G Scoping Report had not been chosen at the time of preparing the models. The P2G PFR alignment is modelled with a full interchange at the Petone end, north facing ramps only at the Tawa end and six lanes of SH1 between the Tawa Interchange and Transmission Gully. As the P2G project is currently at the scoping stage, the preferred arrangement is subject to change. It should be noted that an option to link P2G with the Dowse Interchange, with north facing ramps only at SH2, was considered (as part of the 2013 P2G Scoping phase works) but resulted in significantly less benefits, accessibility and network resilience. For these reasons it has been assumed that the main Hutt Valley Interchange with P2G will be at the western end of Petone (as per the P2G PFR).

Table 4-3 provides a detailed list of all the roading projects that have been included in the Do-Minimum model, including the years which they will be constructed.

Throughout the development of this PFR the NWSM has been refined. Results from the initial version of the model were delivered in July 2013 and are referred to as the "earlier model" throughout this report. NWSM was then recalibrated following the collection of additional data, results from which were delivered in April 2015. Results from this recalibrated NWSM version are referred to throughout this report as the "updated model".

Table 4-3: List of Roading Infrastructure Projects Included in the Do-Minimum Models

Wellington Northern Corridor RoNS	Construction Finish Date	2021	2031
Airport to Mt. Victoria Tunnel	2022	No	WTSM
Tunnel to Tunnel	2017	WTSM	WTSM
Terrace Tunnel Duplication	2024	No	WTSM
Ngauranga to Aotea Quay	2021	Included	Included
Transmission Gully	2020	Included	Included
MacKays to PekaPeka	2018	WTSM	WTSM
Peka Peka to Otaki	2020	WTSM	WTSM
Otaki to north of Levin	2024	No	WTSM
Other Schemes			
Petone to Grenada PFR Alignment	2021	WTSM	WTSM
PT Improvements as per the Rail Plan		WTSM	WTSM
SH2/SH58 Grade Separation		Included	Included
Uphill passing lane extension (SH58)		Included	Included

No =Not built, therefore not included in WTSM or SATURN modelling
WTSM = Project built but located beyond SATURN model extents, therefore only in the WTSM modelling
Included= Project operational and included in both WTSM and SATURN modelling

The ADT factors listed in Table 4-4 have been used to convert the peak hour models into ADT's. The ADT factors have been calculated using TMS counts from NZTA and the NWSM 2011 base model. These factors are derived from weekdays only as this is the most critical period with regards to traffic demand on the network.

Table 4-4: ADT Factors

Peak Hour	ADT Factor
AM	2
IP	11.3
PM	2

4.3.2 Do-Minimum Traffic Volumes

Table 4-5 summarises the 2011 Base traffic volumes in addition to the 2021 and 2031 forecast Do-Minimum volumes from NWSM for various locations in Hutt City using the earlier NWSM model and Table 4-6 shows this for the updated NWSM model. This forecast shows that demands in Hutt City are expected to grow in the future Do-Minimum scenario despite the negative growth rate given in Section 4.1. This is partially due to the demand matrices provided by WTSM as growth is expected in the Wellington Region as a whole. The extent of the growth predicted, however, is likely a product of the Petone to Grenada project that is included in the Do Minimum. This project is expected to create economic growth in Hutt City and change origin and destination patterns in the region.

Table 4-5: Forecast ADT from SATURN Actual Flows with P2G (Earlier Model)

Road	ADT (vpd)		
	Base 2011	2021	2031
The Esplanade West (West of Nevis Street)	20,100	25,100	26,800
The Esplanade East (West of Cuba Street)	18,600	22,200	23,400
Estuary Bridge	23,100	25,300	26,900
Randwick Road	15,600	15,500	16,300
Whites Line East	17,600	19,100	20,300
Wakefield Street West (East of Hutt Road)	1,100	1,300	1,600
Wakefield Street East (East of Cuba Street)	410	470	510

Table 4-6: Forecast ADT from SATURN Actual Flows with P2G (Updated Model)

Road	ADT (vpd)		
	Base 2011	2021	2031
The Esplanade West (West of Nevis Street)	21,000	23,500	24,700
The Esplanade East (West of Cuba Street)	20,700	22,400	23,800
Estuary Bridge	25,500	27,000	28,500
Randwick Road	17,000	16,900	17,700
Whites Line East	18,300	19,600	20,500
Wakefield Street West (East of Hutt Road)	1,100	1,300	1,500
Wakefield Street East (East of Cuba Street)	550	660	770

NWSM has also been run without P2G in place. Table 4-7 shows the predicted traffic volumes for this scenario as per the earlier model and Table 4-8 shows this for the updated model. Traffic volumes are generally lower under this scenario, with volumes on Wakefield Street West actually decreasing from the Base year model. Of note is that traffic flows on Randwick Road are greater without P2G than with it.

Table 4-7: Forecast ADT from SATURN Actual Flows without P2G (Earlier Model)

Road	ADT (vpd)		
	Base 2011	2021	2031
The Esplanade West (West of Nevis Street)	20,100	23,000	24,500
The Esplanade East (West of Cuba Street)	18,600	20,000	21,000
Estuary Bridge	23,100	23,500	24,600
Randwick Road	15,600	16,100	17,000
Whites Line East	17,600	18,200	19,600
Wakefield Street West (East of Hutt Road)	1,100	900	1,000
Wakefield Street East (East of Cuba Street)	410	450	480

Table 4-8: Forecast ADT from SATURN Actual Flows without P2G (Updated Model)

Road	ADT (vpd)		
	Base 2011	2021	2031
The Esplanade West (West of Nevis Street)	21,000	21,500	22,100
The Esplanade East (West of Cuba Street)	20,700	20,900	21,800
Estuary Bridge	25,500	25,600	26,600
Randwick Road	17,000	17,600	18,400
Whites Line East	18,300	18,900	19,900
Wakefield Street West (East of Hutt Road)	1,100	850	900
Wakefield Street East (East of Cuba Street)	550	600	690

Together these four tables show that the Hutt Valley road network will be put under additional strain if P2G is built, however these changes are relatively small. P2G more directly connects two business districts, Hutt City and Porirua, and subsequently promotes economic growth. This growth will result in increased employment and improved network connectivity and is the primary cause of the increased vehicle flow.

There are some discrepancies between the 2011 base results and those mentioned in Section 3.2. Notably, the current observed flow on The Esplanade (24,000 ADT is recorded at 20,100 ADT in the model). This model discrepancy is significant, but the slightly higher assumption of medium growth should convert this into more reliable future volumes. Nevertheless, the model is most useful as a tool for comparison and should be treated as such. Subsequently, in this report the difference between results are of more importance than the actual results. These lower than actual recorded demands and forecast demands are being investigated further by the Transport Agency. As such, options, designs and outputs have been mindful of the impact increased demands may have as a result of these issues being resolved in subsequent versions of the NWSM.

Generally the updated NWSM is showing higher flows than the previous NWSM version. The exception to this is the west end of The Esplanade which is showing a decrease of 1600 and 1500 vehicles with P2G included and excluded respectively in 2021 and a decrease of 2100 and 2400 respectively in 2031.

4.3.3 Forecast Land Use

Hutt City Council has aspirations to grow the Seaview / Gracefield area and has outlined this aspiration in many of the plans discussed in Section 1.4. However, it was deemed necessary to determine how the future models change with respect to land use. In order to do this, a brief sector based analysis was completed using the NWSM matrices. The model area was split into 10 different geographical areas and the origin and destination pairs within these areas were then determined and graphed. Maps and graphs of this work have been provided as Appendix H.

The results of this sector analysis indicate that the overall growth in trips from the 2011 Base model to the 2031 forecast model (without Petone to Grenada) is 20% overall. The Seaview and Gracefield sector experiences a growth of approximately 23% greater than the average of 20%. When these results are compared to the matrices that include the Petone to Grenada project, there are negligible differences (i.e. minimal additional growth in Seaview and Gracefield as a result of the Petone to Grenada project is modelled). The number of business in the Seaview/Gracefield area has however grown by 25% since 2002. This is higher than the 20% average growth experienced in other parts Hutt Valley. This supports the findings from the sector analysis which indicates that slightly more trips can be expected in the Seaview/Gracefield area than for the rest of the Hutt Valley.

This information indicates that the forecasted trip growth in the area is higher than the overall model. While this is consistent with HCC's growth aspirations for the Seaview / Gracefield area, the actual growth in the area may not achieve these aspirations. The Hutt City Urban Growth Strategy, discussed in Section 1.4.4, quotes Statistics New Zealand forecasts of 2% population growth over the next 20 years in Hutt City while Wellington is expected to grow by 10%.

The growth in the Seaview / Gracefield area is not wholly dependent on the population growth of Hutt City, however, should the population growth in the region be this low, the growth in Seaview is likely to be similarly low. Thus, the land use predicted in the model may not be considered a conservative estimation of the growth in the Seaview / Gracefield area.

4.4 Do Minimum Network Operations

The performance of the Do Minimum network has been assessed using outputs from the NWSM. The model outputs provide measurable comparisons for the network as a whole under a number of key criteria. The following data has formed the basis of the Do Minimum network analysis:

- General network statistics;
- Level of service that is currently provided on The Esplanade, Randwick Road and Whites Line East; and
- Journey times along The Esplanade and Waione Street from the Petone Interchange in the west to the Randwick Road roundabout in the east (and vice versa).

4.4.1 Network Statistics

The NWSM provides network statistics that indicate the overall network performance. Network statistics with and without P2G have been included in Table 4-9 show the effect that the Petone to Grenada project has on the network in the earlier model and Table 4-10 shows this effect in the updated model. It is of note that the 2011 base, 2031 with no P2G and 2031 with P2G models have not been run with the same matrix.

Table 4-9: Network Statistics for 2011 Base, 2031 (No P2G) and 2031 (P2G) (Earlier Model)

Peak	Network / Matrix	Average Speed (km/h)	Travel Time (pcu hrs/hr)	Total Delay (pcu hrs/hr)	Network Queue (pcu hrs/hr)	Travel Distance (pcu kms/hr)	Total Trips (pcus)
AM	2011	49	9,510	910	1,930	465,000	81,500
	2031 (No P2G)	48	11,170	1,420	2,190	541,000	97,200
	2031 (P2G)	53	10,620	1,140	1,590	556,000	97,700
IP	2011	59	5,070	70	595	298,000	72,900
	2031 (No P2G)	62	5,590	120	484	347,000	86,200
	2031 (P2G)	62	5,700	110	490	351,000	86,300
PM	2011	46	11,200	1,630	2,110	516,000	95,900
	2031 (No P2G)	47	12,690	2,080	2,230	594,000	112,300
	2031 (P2G)	50	12,540	1,690	2,060	620,000	112,900

Table 4-10: Network Statistics for 2011 Base, 2031 (No P2G) and 2031 (P2G) (Updated Model)

Peak	Option	Average Speed (km/h)	Travel Time (pcu hrs/hr)	Total Delay (pcu hrs/hr)	Network Queue (pcu hrs/hr)	Travel Distance (pcu kms/hr)	Total Trips (pcus)
AM	2011	50	9,160	900	1,550	455,000	82,200
	2031 (No P2G)	46	11,500	1,450	1,980	530,000	96,500
	2031 (P2G)	51	10,710	1,090	1,730	549,000	96,900
IP	2011	58	5,100	75	660	290,000	73,000
	2031 (No P2G)	59	6,040	135	890	354,000	85,900
	2031 (P2G)	58	6,080	110	805	355,000	85,900
PM	2011	45	11,300	1,530	1,960	510,000	96,400
	2031 (No P2G)	44	13,370	1,920	2,260	590,000	111,600
	2031 (P2G)	47	13,000	1,430	2,250	611,000	112,100

It is observed that in the AM and PM peaks, more trips are observed on the P2G network than on the network without P2G. This increase is largely due to the improved connectivity between Tawa/Porirua and the Hutt Valley. The P2G scoping report indicates that there will be a 40% increase in trips between the two areas, suggesting an increase in economic growth in both locations. To a lesser extent the removal of congestion will also increase the number of trips as more people may switch from public transport to private vehicles. Further discussion is available in the P2G Scoping Report.

Even though the number of trips have increased in both AM and PM peak instances the total travel time decreases by 7% and 3%, respectively but the total travel distance increases by 4% in both the AM and PM periods. Consequently the overall Average Speed increases by 1% in both the AM and PM periods. This is indicative of the reduction of congestion that will occur along the network as a result of P2G.

Conversely, the average speed during the Inter peak has decreased in the P2G option relative to the without P2G network. This is due to lower levels of congestion during the inter peak. As there is less congestion the relative increase in the travel distance in the P2G model is not offset by the relative reduction in total delays, therefore the average speed in the P2G model is lower.

4.4.2 Level of Service

The following tables will show the changing Level of Service (LOS) along three of main corridors in Hutt City. The LOS represents the quality of performance by a road. LOS A is given to the best operating roads and LOS F given to the worst. In this instance, the LOS is derived using the travel speed for through vehicles in addition to the volume to capacity ratio (V/C). However, the V/C only becomes a contributing factor if greater than one. This is the suggested method for analysing urban road segments by the Highway Capacity Manual (2010). The criteria are outlined in Table 4-11.

Table 4-11: Level of Service Criteria Based on Travel Speed and Volume to Capacity Ratio[7]

Travel Speed as a Percentage of Free Flow Speed (%)	LOS by V/C	
	≤1	>1
>85	A	F
>67-85	B	F
>50-67	C	F
>40-50	D	F
>30-40	E	F
≤30	F	F

To determine the LOS, the modelled speeds from the 2031 Do Minimum SATURN model are compared to the free flow speeds (FFS) identified by the model link. The AM and PM peak flow volumes are also compared to the SATURN modelled capacity to determine if the volume to capacity ratio is 1 or greater. The capacity used for comparison is obtained from the link capacities

[7] Adapted from Exhibit 17-2 from the Highway Capacity Manual (2010)

stated in the Do Minimum model and are is generally 1600 pcu/hr, with the exception of Wakefield Street, which is modelled with a capacity of 1200 pcu/hr.

Using these criteria with the existing average speeds from the travel time surveys conducted by SKM (March 2013), and average free flow speed of 50km/h[8] from the Do Minimum model, the current LOS on The Esplanade in 2013 is displayed in Table 4-12. As would be expected, the lowest Levels of Service are experienced westbound in the AM peak and eastbound in the PM peak.

Table 4-12: 2013 Travel Time Survey LOS on Petone Esplanade

Peak Period	Direction	Avg. Speed (km/h)	% of FFS	LOS
AM	EB	42.04	84%	B
AM	WB	23.43	47%	D
IP	EB	42.37	85%	B
IP	WB	48.11	96%	A
PM	EB	25.37	51%	C
PM	WB	47.61	95%	A

Table 4-13 shows the same criteria applied to the modelled free flow speeds in the 2011 Base model and 2031 Do Minimum model for the AM and PM peaks in the earlier NWSM model. This same table is included showing outputs from the updated NWSM as Table 4-14.

Table 4-13: 2011 Base and 2031 Do Minimum AM and PM Peak Link LOS (Earlier Model)

Link	Direction	AM LOS		PM LOS	
		2011	2031	2011	2031
The Esplanade (approaching Victoria Street)	EB	A	B	B	B
	WB	A	B	B	C
The Esplanade (approaching Cuba Street)	EB	B	B	B	B
	WB	A	A	B	B
Estuary Bridge	EB	A	B	B	C
	WB	B	C	B	C
Wakefield Street (approaching Cuba Street)	EB	A	A	A	A
	WB	A	A	A	A
Randwick Road (south end)	NB	A	A	A	A
	SB	A	A	A	A
Randwick Road (north end)	NB	A	A	A	A
	SB	B	B	A	A
Whites Line East (approaching Cambridge Terrace)	EB	A	B	A	A
	WB	A	A	B	C

[8] In the Do Minimum model the east and west sections of The Esplanade have 48km/h and 52km/h FFS. Subsequently an average of 50km/h is used.

Table 4-14: 2011 Base and 2031 Do Minimum AM and PM Peak Link LOS (Updated Model)

Link	Direction	AM LOS		PM LOS	
		2011	2031	2011	2031
The Esplanade (approaching Victoria Street)	EB	A	B	A	B
	WB	A	B	B	B
The Esplanade (approaching Cuba Street)	EB	B	B	A	B
	WB	A	A	A	B
Estuary Bridge	EB	A	B	B	C
	WB	B	C	B	B
Wakefield Street (approaching Cuba Street)	EB	A	A	A	A
	WB	A	A	A	A
Randwick Road (south end)	NB	A	A	A	A
	SB	A	A	A	A
Randwick Road (north end)	NB	A	A	B	B
	SB	B	B	B	B
Whites Line East (approaching Cambridge Terrace)	EB	A	A	A	A
	WB	A	A	A	A

While the levels of service shown in Table 4-13 may seem acceptable, these are not necessarily representative of the actual LOS experienced by road users. When comparing the results in Table 4-13 to those in Table 4-12, LOS based on actual travel time surveys, we can see that the model may be overestimating the cruise speeds along The Esplanade, and likely in the rest of the model as well. When reviewing these results we should consider the change in LOS between years (and in latter sections of this report, options) rather than the LOS itself as the main indicator of network operation.

Table 4-13 shows that The Esplanade and the Estuary Bridge generally have the poorest LOS than the other modelled roads assessed, particularly in the PM peak. The LOS on the Estuary Bridge also gets consistently worse in the future year.

Whites Line East also has a worsening LOS in the eastbound direction during the AM peak and in the westbound direction during the PM peak. This is consistent with increased traffic on the network and indicates that effects of congestion will be increasingly felt on Whites Line East in the future.

In the 2031 Do Minimum model the LOS has still deteriorated slightly even though improvements have been made to Petone Interchange. This is due to the increase in traffic volumes offsetting some of the congestion relief provided by the new interchange.

Table 4-14 shows a similar comparison between 2011 and 2031 as indicated by the earlier model. Generally the LOS is the same or better in the updated model. Of note is the Whites Line East LOS which is performing much better in the updated model, achieving LOS of A in all periods and assessment years, whereas previously the PM eastbound indicated a LOS of B and C in 2011 and 2031 respectively.

4.4.3 Journey Times

The route used to analyse the modelled journey times has been taken along The Esplanade and Waione Street from east of the Petone Interchange to west of Randwick Road, as depicted in Figure 4-1.

Figure 4-1: Journey Time Route along The Esplanade and Waione Street

The modelled time taken for the trip in the 2031 Do Minimum models has been plotted in Figure 4-2 and Figure 4-4 for the earlier model and Figure 4-3 and Figure 4-5 for the updated model. Journey times over the same route in the Base model have also been plotted for comparison. Various road names have also been plotted on the x axis of the diagrams as a reference.

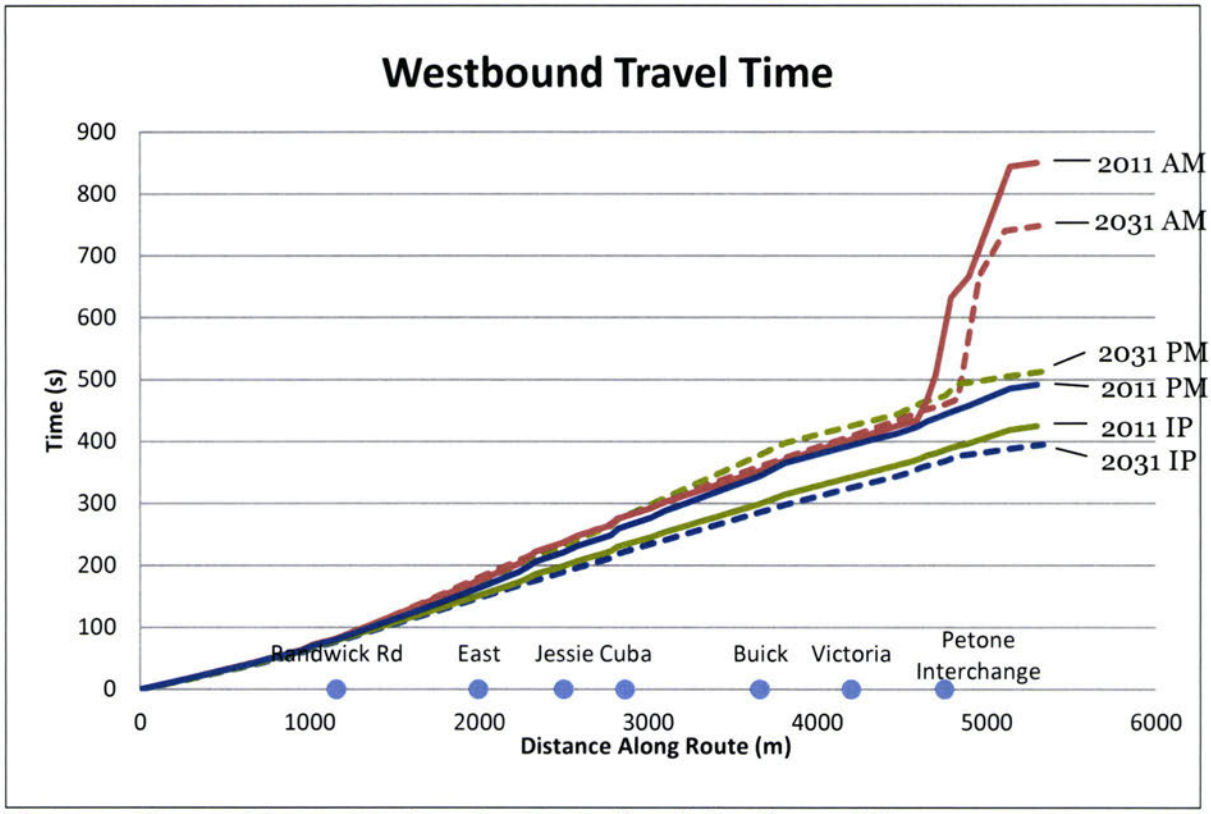

Figure 4-2: Journey Times – Westbound on The Esplanade (Earlier Model)

The westbound journey times in the AM peak are very consistent prior to reaching the Petone Interchange. After this point, both AM peak lines spike indicating the congestion faced at this location. The new interchange incorporated with the Petone to Grenada project, however, appears to improve the overall journey time in 2031 by approximately 100 seconds despite having more volume in the later model year.

The differences between the AM peak and inter peak journey times are less pronounced and follow a pretty steady progression. The 2031 inter peak journey time is approximately 30 seconds less than that of the Base model while the 2031 PM peak time is about 20 seconds greater than the Base model.

Figure 4-2 also suggests an improvement in travel time variability. This notion is supported by the size of the difference between the longest trip (AM) and the shortest trip (IP) decreasing from 2011 to 2031. This improvement will largely be due to the new Petone Interchange.

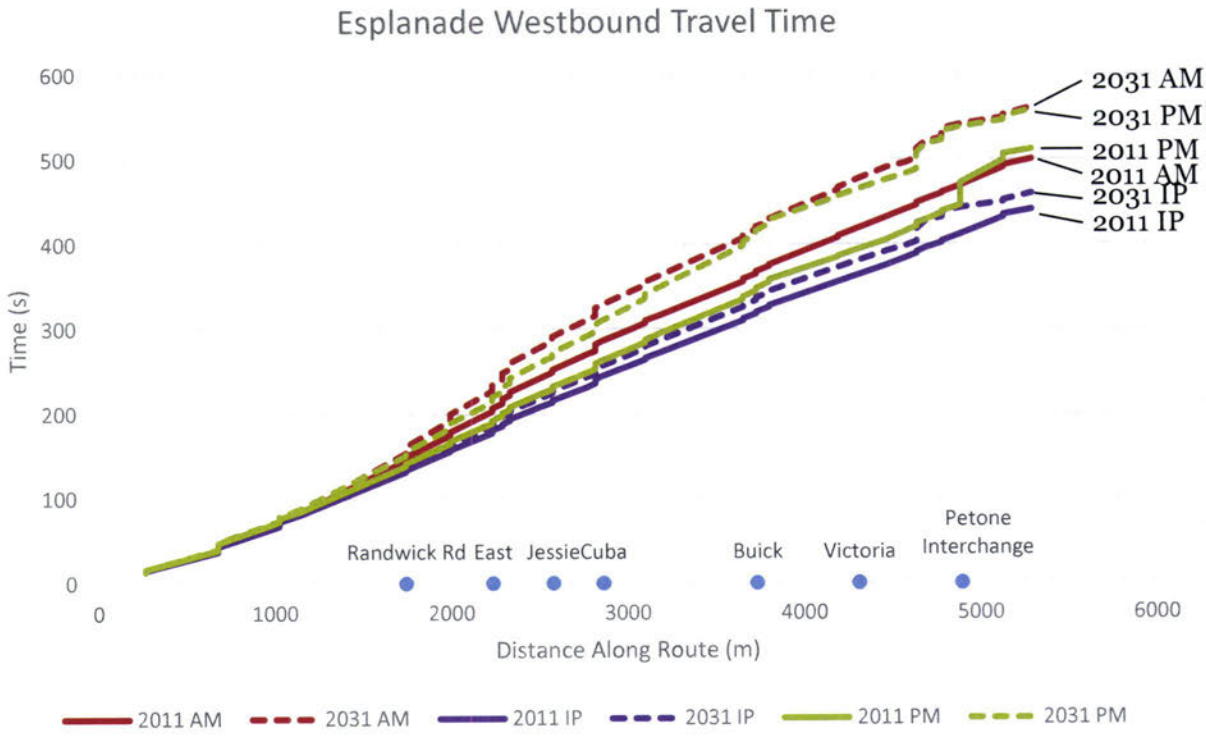

Figure 4-3: Journey Times – Westbound on The Esplanade (Updated Model)

The updated model is showing a significant reduction in journey times in the AM period along The Esplanade compared to the earlier model. This AM reduction is seen in both the 2011 and 2031 models and is in the order of five minutes and two minutes respectively and appears to occur in the approach to the Petone interchange.

Conversely, the IP and PM peaks are showing a higher journey time in both the IP and PM in the updated model. For the 2011 PM, 2031 IP and 2031 PM this is in the order of 60 sections.

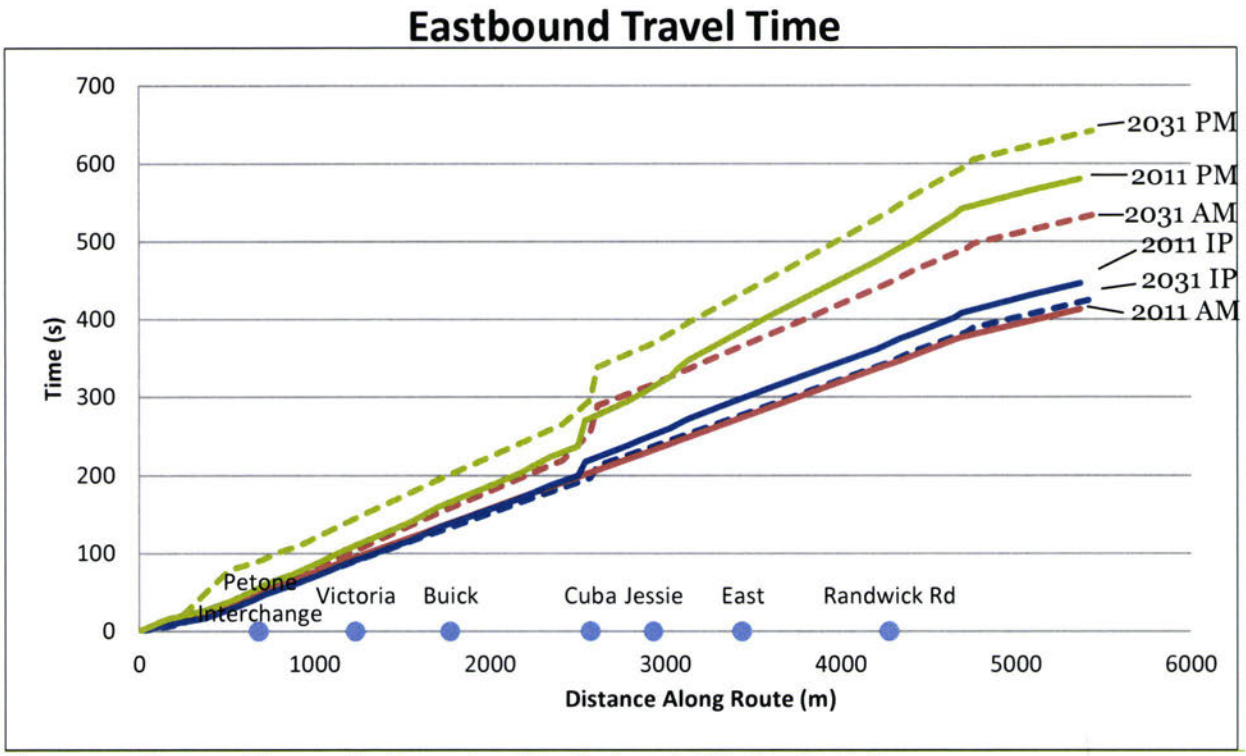

Figure 4-4: Journey Times – Eastbound on The Esplanade (Earlier Model)

As in the westbound direction, the AM journey times in the eastbound direction show the greatest difference between 2031 and 2011, however, in this instance travel in 2031 takes approximately 120 seconds longer than in the Base model. The overall travel time is greater but the journey also seems to be affected by a 10sec delay due to congestion near the Cuba Street intersection.

The eastbound PM peak has the highest travel time with the 2031 journey taking about 60 seconds longer than it did in 2011. Again the 2031 inter peak journey time is lower than that of 2011 by approximately 20 seconds despite having greater volumes on the road network. This is likely due to the overall travel time benefits provided by the new Petone Interchange linking to Petone to Grenada.

In contrast to the westbound direction the travel time variability appears to worsen in the eastbound direction. This is shown by the increase in the difference between the longest and shortest trips.

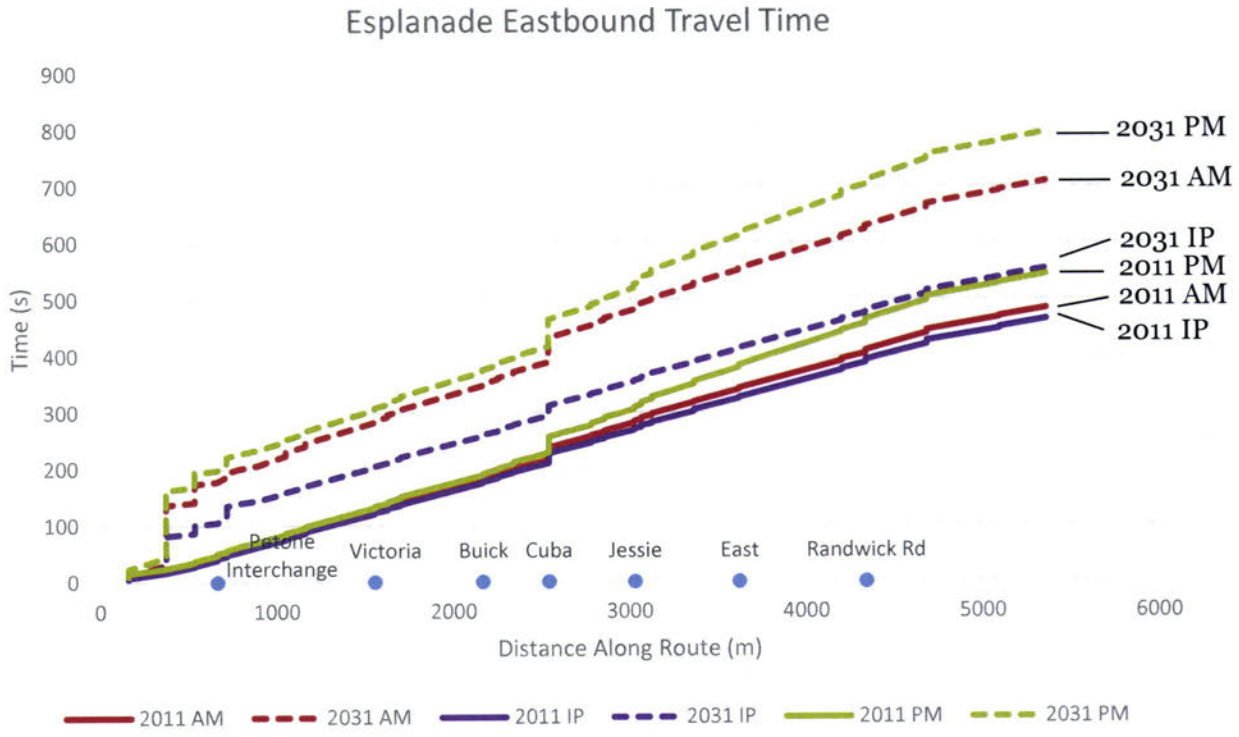

Figure 4-5: Journey Times – Eastbound on The Esplanade (Updated Model)

The updated model is showing higher overall travel times in all comparisons except for the 2011 PM. In 2011, journey times in the updated model have increased by 70 seconds in the AM, 18 seconds in the interpeak and reduced by 35 sections in the PM when compared to the earlier model. This same comparison in between the 2031 forecast models shows an increase of in the AM of 190 second (over 3 minutes), in the IP of 140 seconds (over 2 minutes) and in the PM 170 seconds (just under 3 minutes).

This shows a significant increase in travel times in the updated model over the earlier model. In 2031 this increase appears to occur at the Petone interchange. This can likely be attributed to the addition of signals on the upgraded Petone interchange however the magnitude of the increase suggests that the new signals could be further coordinated.

5 Crash History

The NZTA Crash Analysis System (CAS) was used to analyse the crash history of three road corridors in Lower Hutt from 1/01/2008 to 31/12/2012. This study period represented the most recent full-five year period at the time of the initial PFR development. An updated comparison accident for the 5-year period to 2014 is included later in this section. The corridors chosen were based on the options previously assessed as well as the options considered in this study, identified in Sections 6 and 7. Those corridors are listed below and presented in Figure 5-1.

a. The Esplanade / Waione Street;
b. Randwick Road; and
c. Wakefield Street / Whites Line West.

The study area has been selected using a 10m offset around midblock sections and 35m radii around intersections. Only police reported crashes have been included in this analysis. Throughout this section the crash history of the corridors will be compared to the national averages obtained from CAS for all non-state highway roads in New Zealand. The crash summary reports from CAS have been included in Appendix I.

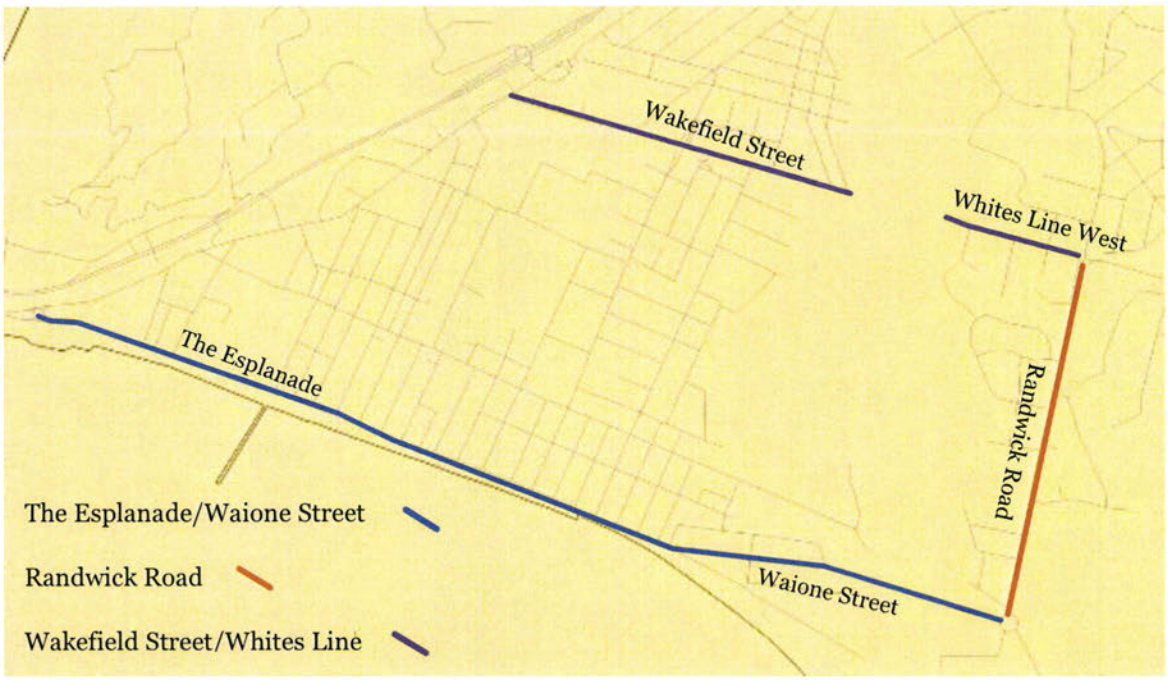

Figure 5-1: Crash Study Corridors

Updated crash history outputs covering the three corridors from 1/01/2010 to 31/12/2014 are included in Section 5.4. These are included to determine if the crash trends identified in the original analysis have changed significantly.

5.1 The Esplanade / Waione Street

Over the defined five year period analysed, a total of 150 crashes were recorded along The Esplanade / Waione Street corridor. Two of these crashes resulted in serious injury, 33 in minor injury and 115 were non-injury. The injury classification is based on the most severe injury sustained by any party involved in the crash. Table 5-1 summarises the crash severity by year. The average number of crashes per year over the study period is 30. The number of collisions in 2011 and 2012 is less than that average at 24 and 25 crashes, respectively.

Table 5-1: The Esplanade/ Waione Street Crash History 2008-2012

Year	Serious	Minor	Non-Injury	Total
2008	0	7	31	38
2009	2	6	21	29
2010	0	7	27	34
2011	0	6	18	24
2012	0	7	18	25
Total	2	33	115	150

Figure 5-2 shows the locations of the crashes on The Esplanade and Waione Street.

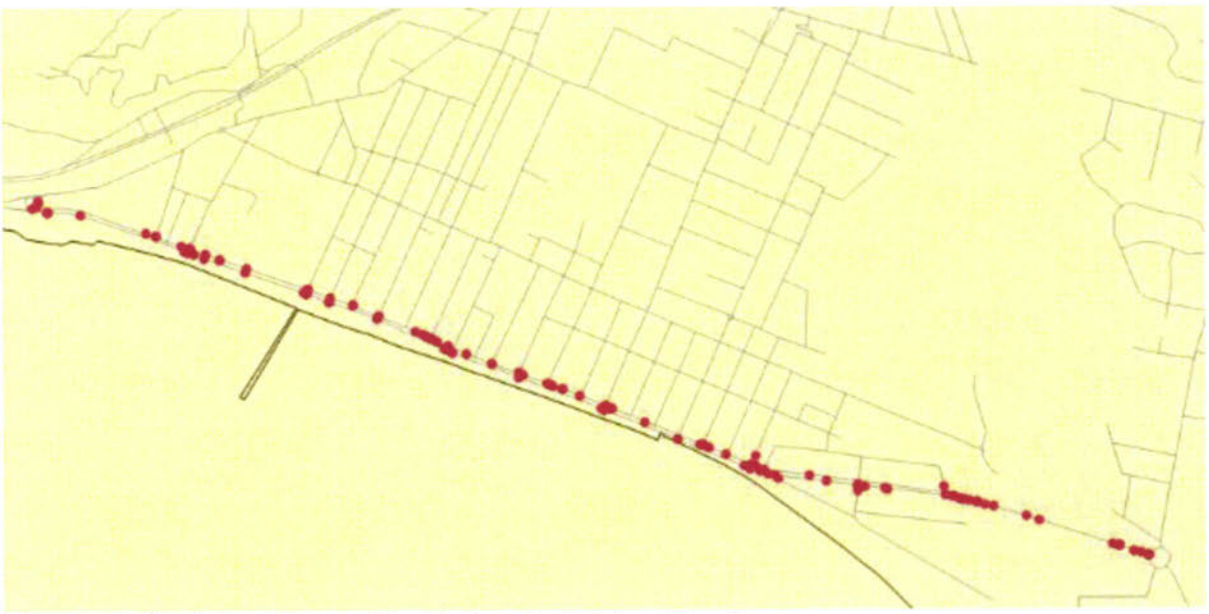

Figure 5-2: Crash Locations on The Esplanade / Waione Street

Based on the quantity of crashes the following intersections along The Esplanade/Waione Street Corridor were identified as having a notably poor crash history:

1. Waione Street at Kirkcaldy Street: There were nine crashes recorded at this intersection, all of which involved right turning vehicles out of Kirkcaldy Street.
2. Waione Street at the Randwick Road / Seaview Road roundabout: There were five crashes recorded at the Waione Street entrance/exit to the roundabout. Four of the crashes were rear ends due to the car ahead slowing or stopping for traffic in the roundabout. The remaining crash was caused by failure to give way to traffic in the roundabout.

5.1.1 Road User Groups

Table 5-2 summarises the road user type and crash severity. Since most crashes involve more than one road user type, the total number of road users (323) is greater than the total number of crashes (150). Approximately 55% of the road users involved in crashes were cars or station wagons.

Table 5-2: Road User/Vehicle Type by Crash Severity

Road User	Serious	Minor	Non-Injury	Total	% of Total	National Average (%)
Bus	0	0	8	8	2	1
Car/Station Wagon	0	47	131	178	55	74
Cyclist	0	7	1	8	2	2
Moped	0	0	2	2	1	1
Motorcycle	0	3	7	10	3	2
Pedestrian	1	3	0	4	1	2
School Bus	0	0	1	1	<1	<1
SUV	0	5	28	33	10	7
Taxi	0	0	1	1	<1	1
Truck	0	9	21	30	9	3
Van or Utility	3	10	35	48	15	7
Total	4	84	235	323	100	100

There were four pedestrians and eight cyclists involved in crashes. Unsurprisingly, due to their vulnerability, the injury rate for pedestrians and cyclists is significantly higher than the overall injury rate (92% vs. 27%). Failure to give way by motorists was noted as a factor in over half of the pedestrian and cyclist crashes (7 of 12).

Compared to the national averages by road user types, there are higher rates of crashes involving vans/ utility vehicles, SUVs and trucks on The Esplanade. While the proportion of truck crashes are higher than the national average for non-state highway roads it is still representative of the traffic profile along this corridor as The Esplanade is made up of 10% HCVs. All other road users with the

exception of cars have similar crash proportions to the national average. Car crashes along this corridor are well below the national average.

5.1.2 Intersection/Midblock Comparison

Table 5-3 summarises the crash severity by location type.

Table 5-3: Crash Severity by Location Type

Location	Serious	Minor	Non-Injury	Total	% of Total	National Average (%)
Intersection	0	24	55	79	53	47
Midblock	2	9	60	71	47	53
Total	2	33	115	150	100	100

The proportion of crashes occurring at midblock locations versus intersections is approximately the same with 79 crashes occurring at intersections (53%) and 71 crashes occurring at midblock locations (47%). Whilst the two serious injury crashes occurred at midblock locations, the proportion of injury crashes is less for the midblock than for intersections crashes (15% vs. 30%). When compared to the New Zealand average there is a higher proportion of intersection crashes. This will most likely be due to the relatively higher number of intersections that are on this corridor.

5.1.3 Time of Day/Day of Week

The number of crashes occurring during each hour of the day is presented in Figure 5-3. This graph includes crashes that occurred on both weekdays and weekends. The number of crashes peaks three times, during the am and pm peaks and around noon. This is consistent with traffic and congestion peaking. Between 6pm and 7am there are five or fewer crashes per hour. The largest number of crashes per hour (15) occurs from noon to 1pm and from 5pm to 6pm.

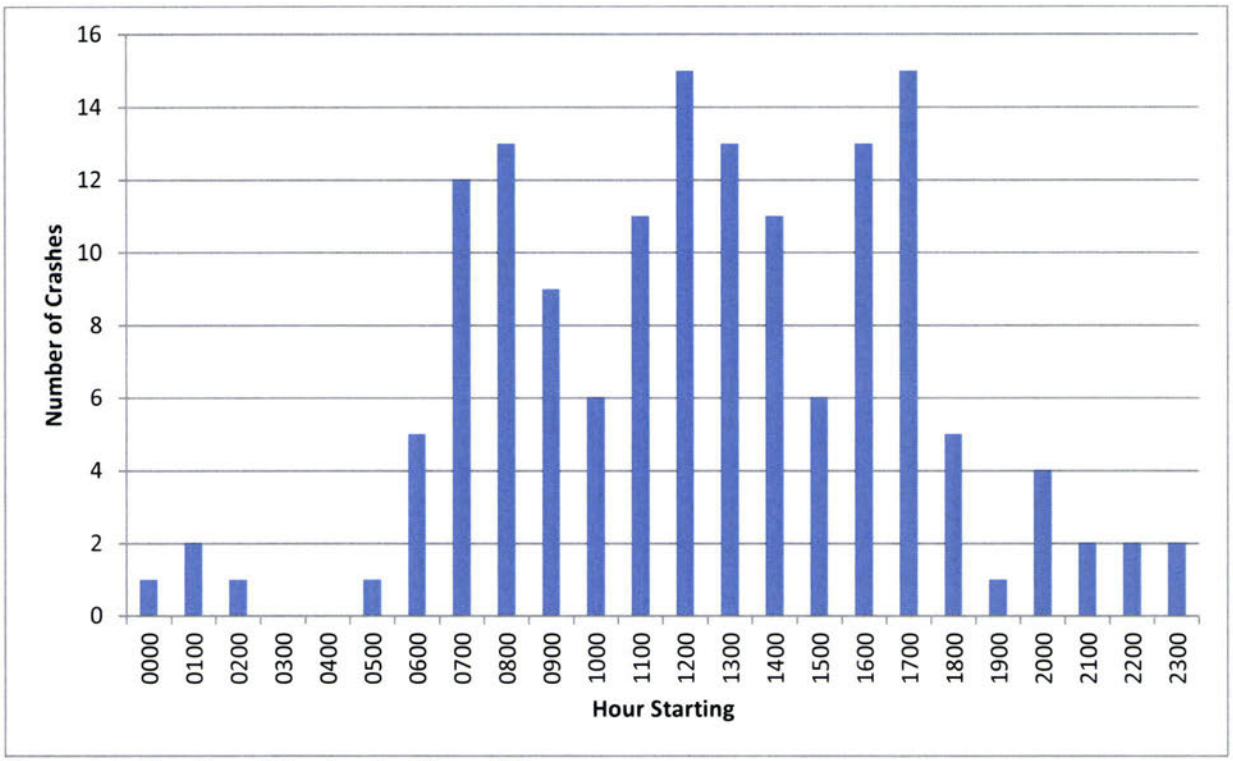

Figure 5-3: Number of Crashes by Time of Day

The number of crashes occurring during each day of the week, including severity of crash, has been presented in Figure 5-4.

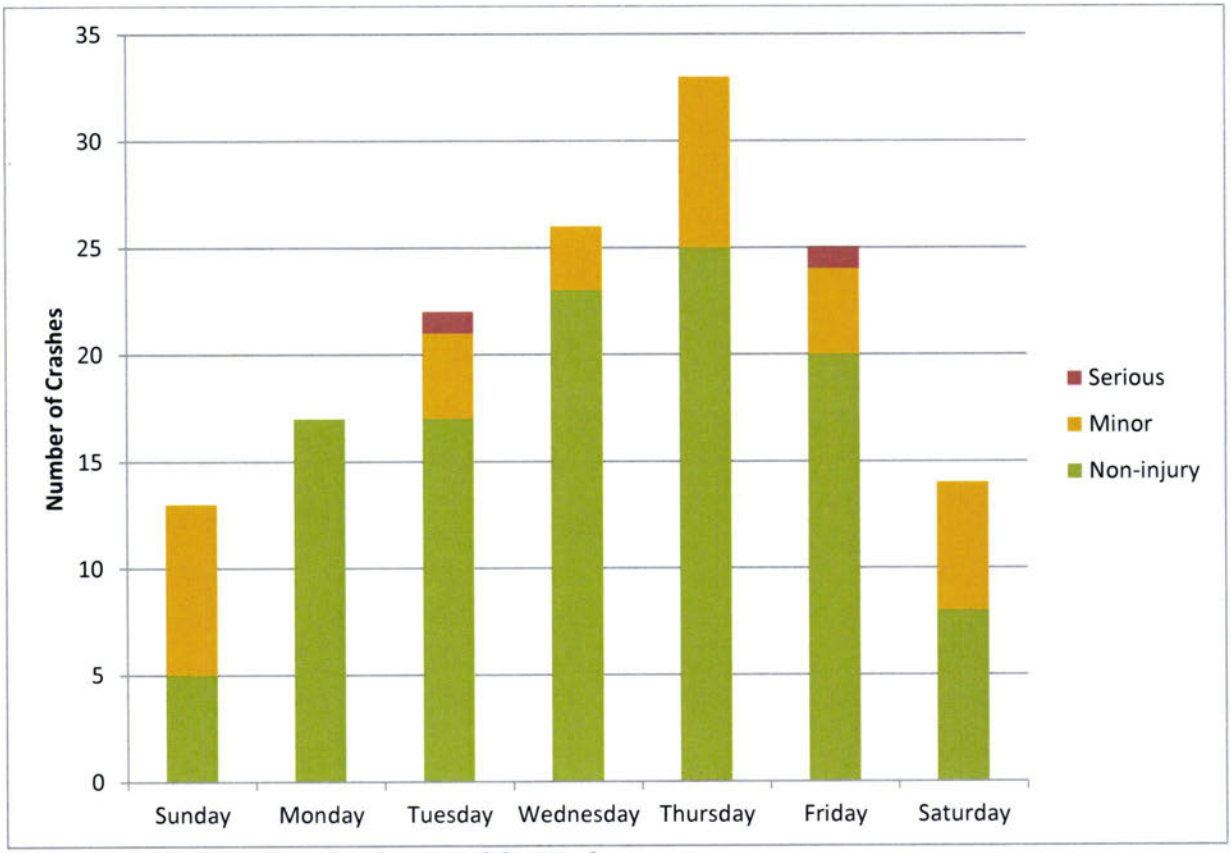

Figure 5-4: Number of Crashes by Day of the Week

The number of crashes occurring on Saturday and Sunday are 13 and 14, respectively. The number of crashes occurring on weekdays (Monday to Friday) range from 17 on Monday to 33 on Thursday. As expected more crashes occur during the weekdays as there is more traffic during the week than on weekends. Although there are fewer crashes on the weekend, the injury rate is higher with 52% of crashes resulting in injury on the weekend as opposed to an average injury rate of 16% on the weekdays.

5.1.4 Environmental Conditions

Analysis was undertaken to determine if environmental conditions were significant factors in crashes. Table 5-4 and Table 5-5 present the crash severity by road and light condition and environmental conditions, respectively.

Table 5-4: Crash Severity by Road and Light Conditions

	Dry	Wet	Light	Dark
Serious	2	0	2	0
Minor	24	9	28	5
Non-Injury	93	22	99	16
Total	119	31	129	21
Grand Total	150		150	

Table 5-5: Environmental Conditions

	Light	Dark	Total	% of total	National Average (%)
Dry	105	14	119	79	75
Wet	24	7	31	21	25
Total	129	21	150		
% of total	86	14			
National Average (%)	68	32			

The two serious injury crashes occurred during light and dry conditions. 79% of crashes occurred in dry conditions and 86% occurred during daylight with 70% during both light and dry conditions. Overall when compared against the national averages, wet and dark condition crashes are less common implying that environmental factors are not a major factor at this site.

5.1.5 Crash Movement Type

Table 5-6 presents the number of crashes by crash movement along The Esplanade/Waione Street corridor.

Table 5-6: Crash Movement Types

Crash Movement	Crashes	% of Total	National Average (%)
Overtaking	19	13	6
Straight Road - Lost Control/Head On	11	7	9
Bend – Lost Control/Head On	5	3	21
Rear End/Obstruction	85	57	35
Crossing/Turning	27	18	24
Pedestrian	3	2	4
Miscellaneous	0	0	1
Total	150	100	100

The most common crash movement type was rear end / obstruction accounting for 57% of crashes (85 of 150). This is significantly high proportion relative to the national average and is indicative of the large number of intersections in the area and does not necessarily indicate there is a crash problem along this road. Other notable crash movement types for The Esplanade / Waione Street are crossing / turning (18%) and overtaking (13%). These are common crash types in urban areas due to the congestion and close proximity of intersections to one another.

5.2 Randwick Road

Over the defined five year period analysed, a total of 49 crashes were recorded along the Randwick Road corridor. One of these crashes resulted in serious injury, 11 in minor injury and 37 were non-injury. Table 5-7 summarises the crash severity by year. The average number of crashes per year over the study period is 10. The number of collisions in 2011 and 2012 is less than that average at 5 and 7 crashes, respectively.

Table 5-7: Randwick Road Crash History 2008-2012

Year	Serious	Minor	Non-Injury	Total
2008	0	4	8	12
2009	0	2	12	14
2010	0	2	9	11
2011	0	2	3	5
2012	1	1	5	7
Total	1	11	37	49

Figure 5-5 shows the locations of the crashes on this corridor.

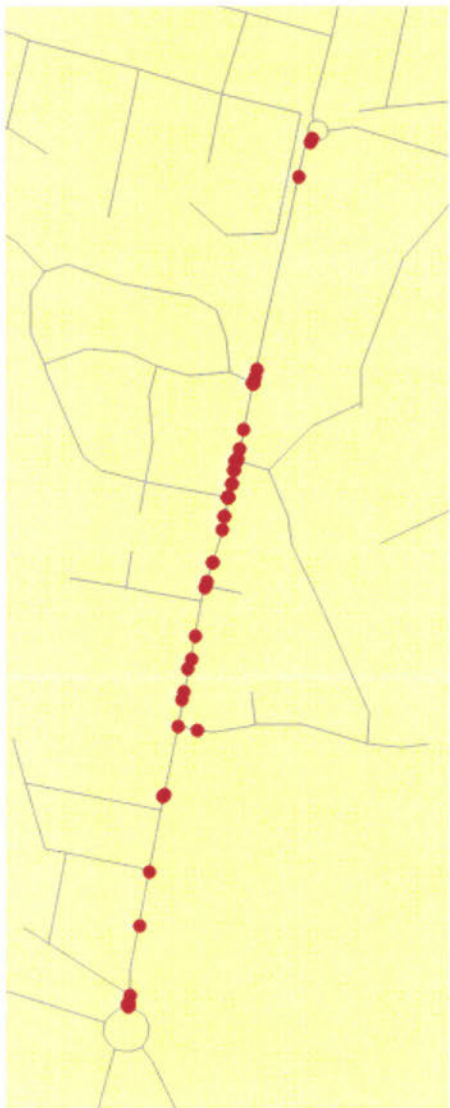

Figure 5-5: Crash Locations on Randwick Road

The three locations listed below have been identified on Randwick road as having markedly poor crash history:

1. Randwick Road at the Waione Street / Seaview Road roundabout: All five crashes recorded at the Randwick Road entrance / exit to the roundabout were rear end crashes.
2. Randwick Road at Randwick Crescent: There were six crashes recorded at this intersection. No overarching theme was determined.
3. Randwick Road at York Street: There were five crashes recorded at this intersection. Four of the crashes were rear ends due to the car ahead slowing or stopping for pedestrians, a queue or to turn. The remaining crash was due to a driver failing to give way to a pedestrian on the footpath.

5.2.1 Road User Groups

Table 5-8 summarises the road user type and crash severity. Since most crashes involve more than one road user type, the total number of road users (98) is greater than the total number of crashes (49). Approximately 78% of the road users involved in crashes were cars or station wagons.

Table 5-8: Road User/Vehicle Type by Crash Severity

Road User	Serious	Minor	Non-Injury	Total	% of Total	National Average (%)
Bus	0	0	1	1	1	1
Car/Station Wagon	1	14	61	76	78	74
Cyclist	0	2	0	2	2	2
Motorcycle	1	0	0	1	1	2
SUV	0	1	3	4	4	7
Taxi	0	0	1	1	1	1
Van or Utility	0	3	9	12	12	7
Wheeled Pedestrian	0	1	0	1	1	2
Other	0	0	0	0	0	4
Total	2	21	75	98	100	100

There were two cyclists and one wheeled pedestrian involved in crashes. All three collisions resulted in minor injury to one of the parties involved. There are no truck crashes along this corridor but the overall proportion of crashes by user type is approximately similar to the national average, implying there are no safety risk for any specific user group.

5.2.2 Intersection/Midblock Comparison

Table 5-9 summarises the crash severity by location type.

Table 5-9: Crash Severity by Location Type

Location	Serious	Minor	Non-Injury	Total	% of Total	National Average (%)
Intersection	0	5	19	24	49	47
Midblock	1	6	18	25	51	53
Total	1	11	37	49	100	100

The proportion of crashes occurring at midblock locations versus intersections is approximately the same with 24 crashes occurring at intersections (49%) and 25 crashes occurring at midblock locations (51%). This is very similar to the national averages. In this instance the proportion of midblock crashes with injuries is slightly greater than those at intersections. The results are representative of the fact that in this corridor there are larger midblock sections and fewer intersection.

5.2.3 Time of Day/Day of Week

The number of crashes occurring during each hour of the day is presented in Figure 5-6. This figure presents crashes that occurred during both weekdays and weekends. Between 7pm and 7am there are 2 or fewer crashes per hour. The largest number of crashes per hour (6) occurs from 6pm to 7pm.

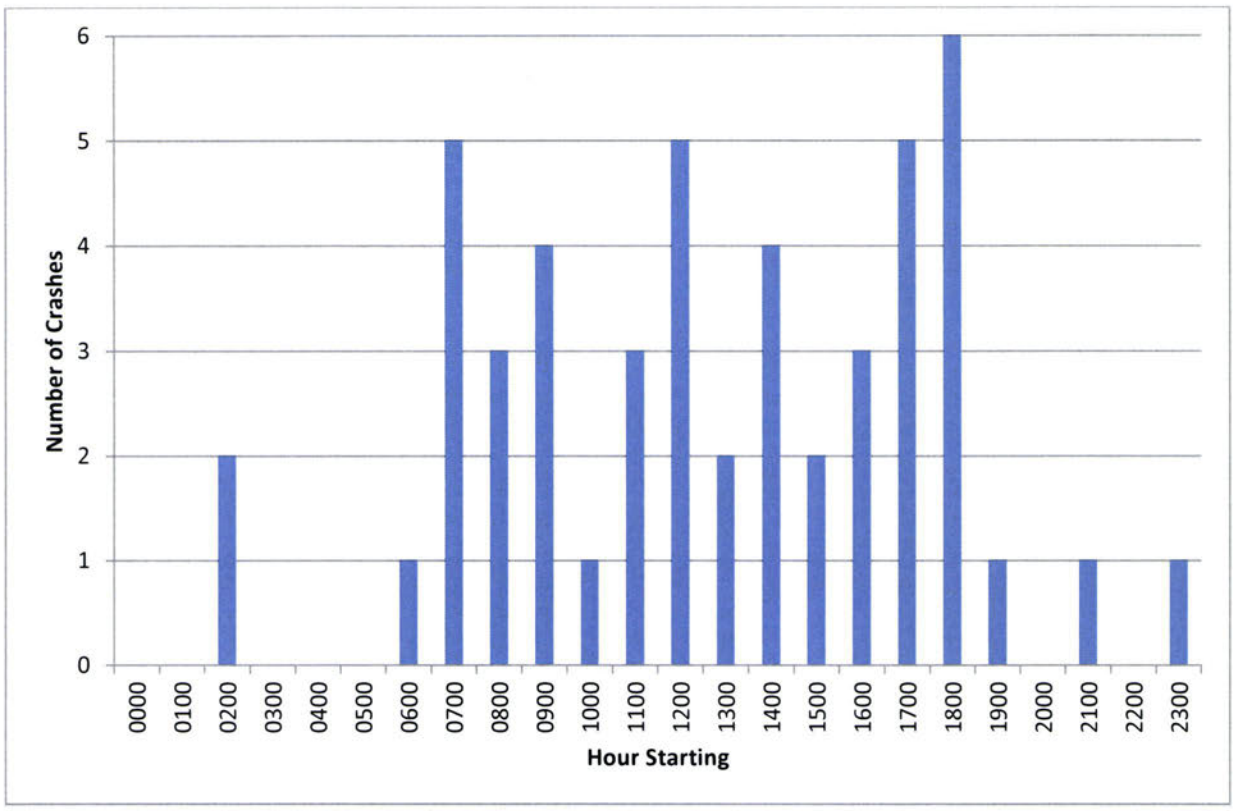

Figure 5-6: Number of Crashes by Time of Day

The number of crashes occurring during each day of the week, including severity of crash, has been presented in Figure 5-7.

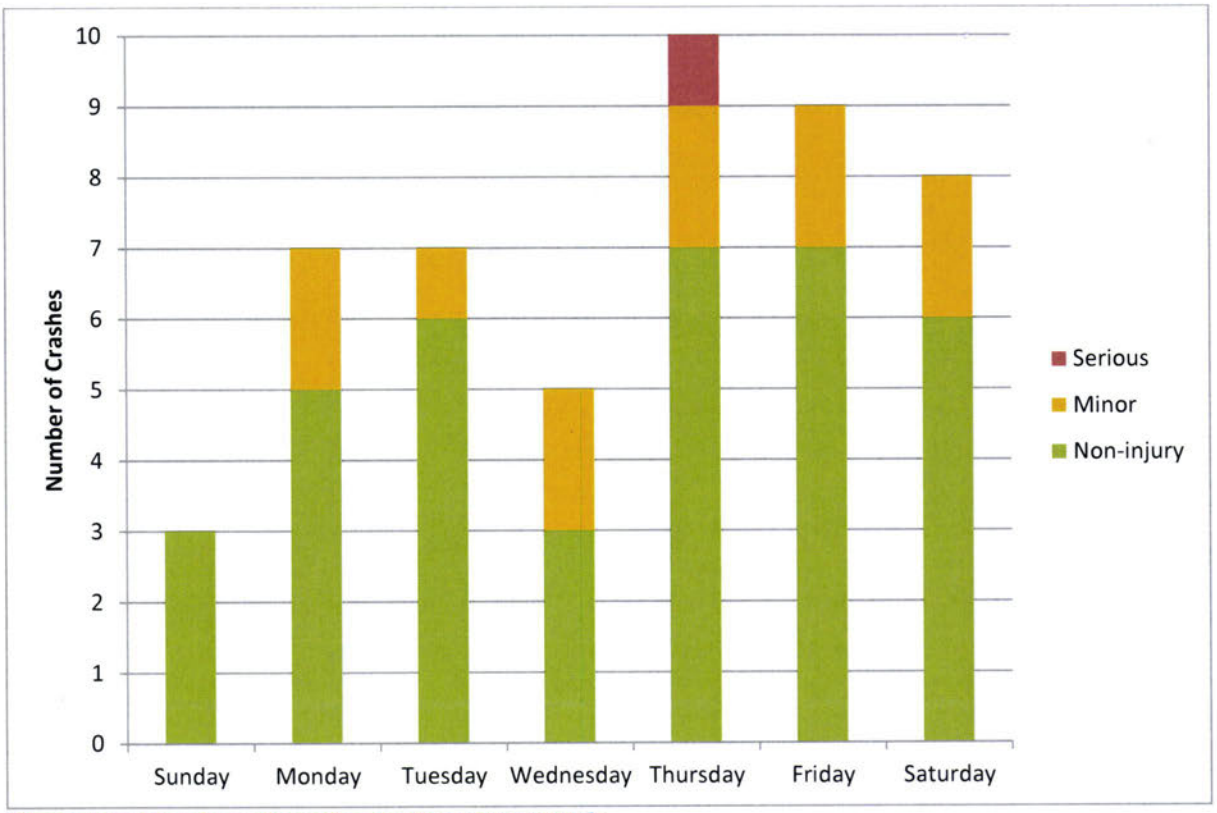

Figure 5-7: Number of Crashes by Day of the Week

The fewest number of crashes occur on Sundays (3) with no recorded injuries. The highest number of crashes occur between Thursday and Saturday of each week, with the highest number of crashes, 10, occurring on Thursday followed by 9 and 8 crashes on Friday and Saturday respectively. There is also 1 serious crash included in the 10 crashes which occur on Thursday. Most traffic occurs on weekdays and subsequently it is anticipated that most crashes will occur on these days too. However there are relatively crashes on Wednesday and comparatively more on Saturday. This indicates that Saturday crashes are overrepresented along this corridor.

5.2.4 Environmental Conditions

Table 5-10 and Table 5-11 present the crash severity by road and light condition and environmental conditions, respectively.

Table 5-10: Crash Severity by Road and Light Conditions

	Dry	Wet	Light	Dark
Serious	1	0	1	0
Minor	10	1	9	2
Non-Injury	34	3	30	7
Total	45	4	40	9
Grand Total	49		49	

Table 5-11: Environmental Conditions

	Light	Dark	Total	% of total	National Average (%)
Dry	38	7	45	92	75
Wet	2	2	4	8	25
Total	40	9	49		
% of total	82	18			
National Average (%)	68	32			

The serious injury crash occurred during light and dry conditions. 92% of crashes occurred in dry conditions and 82% occurred during daylight with 78% during both light and dry conditions. These proportions are relatively higher than the national averages. Overall, this indicates environmental factors are not a major concern along this corridor.

5.2.5 Crash Movement Type

Table 5-12 presents the number of crashes by crash movement along the Randwick Road corridor.

Table 5-12: Crash Movement Types

Crash Movement	Crashes	% of Total	National Average (%)
Overtaking	5	10	6
Straight Road - Lost Control/Head On	4	8	9
Bend – Lost Control/Head On	0	0	21
Rear End/Obstruction	32	65	35
Crossing/Turning	6	12	24
Pedestrian	2	4	4
Miscellaneous	0	0	1
Total	49	100	100

The most common crash movement type was rear end / obstruction accounting for 65% of crashes (32 of 49). Other notable crash movement types for Randwick Road are crossing / turning (12%) and overtaking (10%). In summary this corridor has similar crash type proportions to The Esplanade / Waione Street with the high proportion of rear end/obstruction crashes being indicative of a busy urban road with several intersections.

5.3 Wakefield Street / Whites Line West

Table 5-13 summarises the crash severity by year.

Table 5-13: Wakefield Street/ Whites Line West Crash History 2008-2012

Year	Serious	Minor	Non-Injury	Total
2008	0	0	0	0
2009	0	1	3	4
2010	2	1	2	5
2011	0	0	2	2
2012	0	0	2	2
Total	2	2	9	13

Over the defined five year period analysed, a total of 13 crashes were recorded along Wakefield Street. There were no reported crashes on Whites Line West during the analysis period. There were 2 serious injury and two minor injury crashes. The remaining nine were non-injury crashes. As with the previous two corridors assessed, Wakefield Street has seen a reduction in the number of crashes reported for 2011 and 2012 compared to the previous few years.

Figure 5-8 shows the locations of the crashes on this corridor.

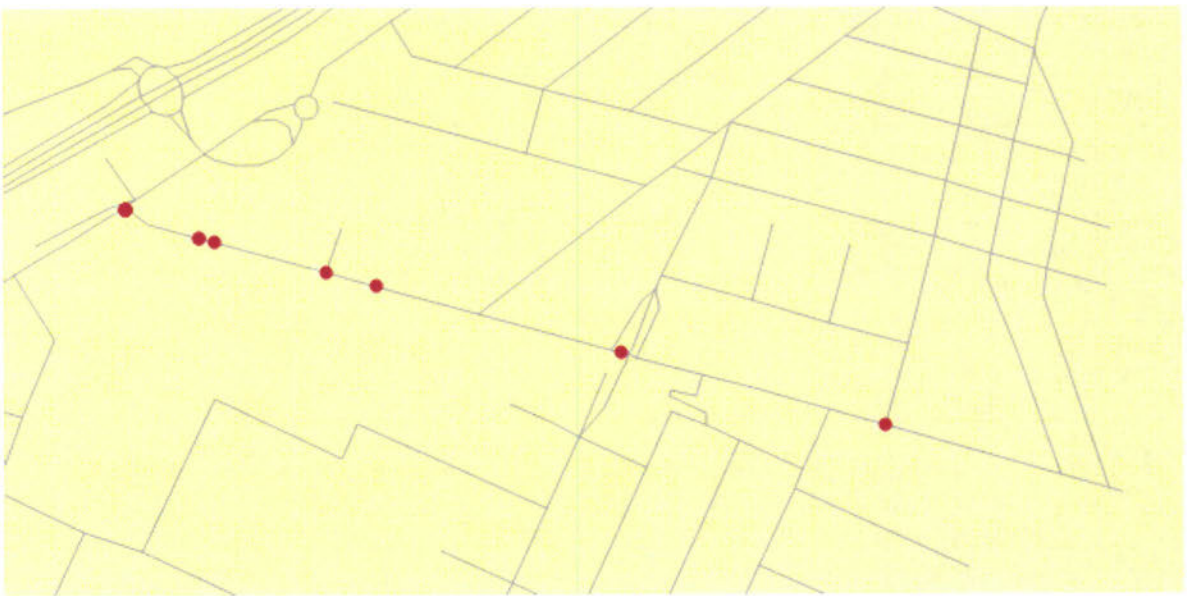

Figure 5-8: Crash Locations on Wakefield Street

Along this corridor the Wakefield Street/Hutt Road intersection was identified has having a poor crash history. This intersection had six crashes over the five year study period. Three of these crashes were lost control on bend crashes. This indicates that there may be issues with the geometry of the intersection. Three of the four injury crashes reported on the Wakefield Street corridor occurred at this intersection.

5.3.1 Road User Groups

Table 5-14 summarises the road user type and crash severity.

Table 5-14: Road User/Vehicle Type by Crash Severity

Road User	Serious	Minor	Non-Injury	Total	% of Total	National Average (%)
Car/Station Wagon	0	3	10	13	57	74
Motorcycle	2	0	0	2	9	2
SUV	0	0	3	3	13	7
Truck	0	0	3	3	13	3
Van or Utility	0	0	2	2	9	7
Other	0	0	0	0	0	7
Total	2	3	18	23	100	100

There were 23 road users involved in the 13 crashes. The two serious injury crashes were single vehicle crashes involving motorcycles that lost control on a bend. There were no pedestrians or cyclists involved in any of the reported crashes on Wakefield Street during the study period. The proportion of car crashes are well below the national average and are underrepresented along this corridor. Additionally, truck crashes are overrepresented and are significantly higher than the national average.

5.3.2 Intersection/Midblock Comparison

Table 5-15 summarises the crash severity by location type.

Table 5-15: Crash Severity by Location Type

Location	Serious	Minor	Non-Injury	Total	% of Total	National Average (%)
Intersection	2	2	4	8	62	47
Midblock	0	0	5	5	38	53
Total	2	2	9	13	100	100

Eight of the crashes, including all of the reported injury crashes, occurred at intersections on Wakefield Street. Five crashes occurred at the midblock. This ratio is relatively higher than the national average but is still representative of the urban nature of the corridor and is not indicative of a serious crash problem.

5.3.3 Time of Day/Day of Week

The number of crashes occurring during each hour of the day is presented in Figure 5-9. The crashes presented in this charted occurred during both weekdays and weekends. The majority of crashes occur between 11am and 6pm (the afternoon). There are two or fewer crashes per hour for all hours of the day.

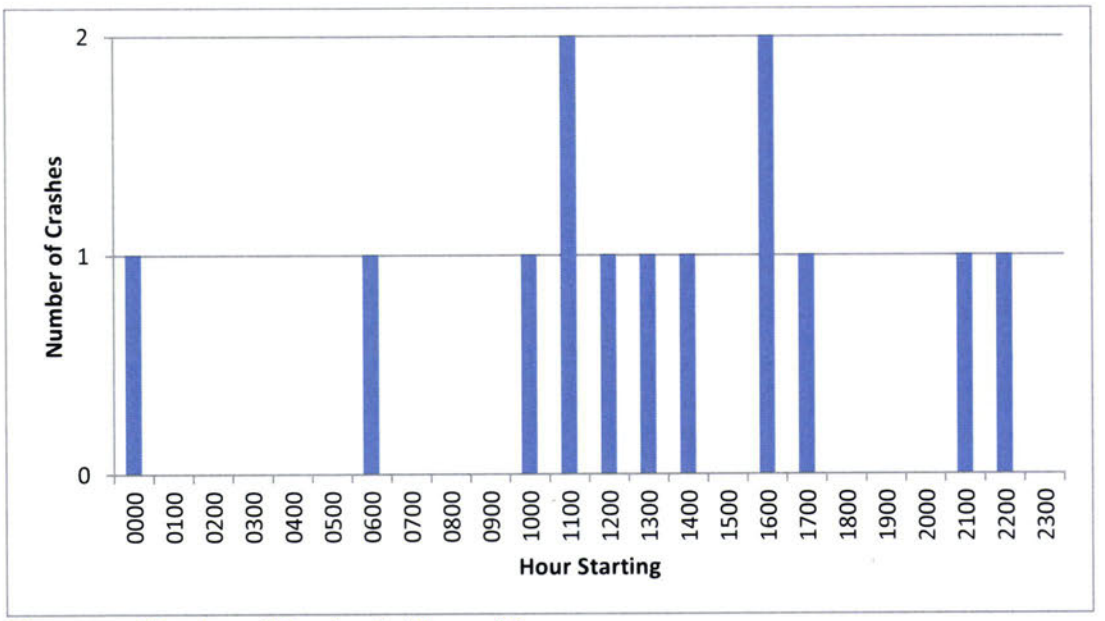

Figure 5-9: Number of Crashes by Time of Day

The number of crashes occurring during each day of the week, including severity of crash, has been presented in Figure 5-10. The highest number of crashes occurs on Mondays and Tuesdays with four recorded crashes.

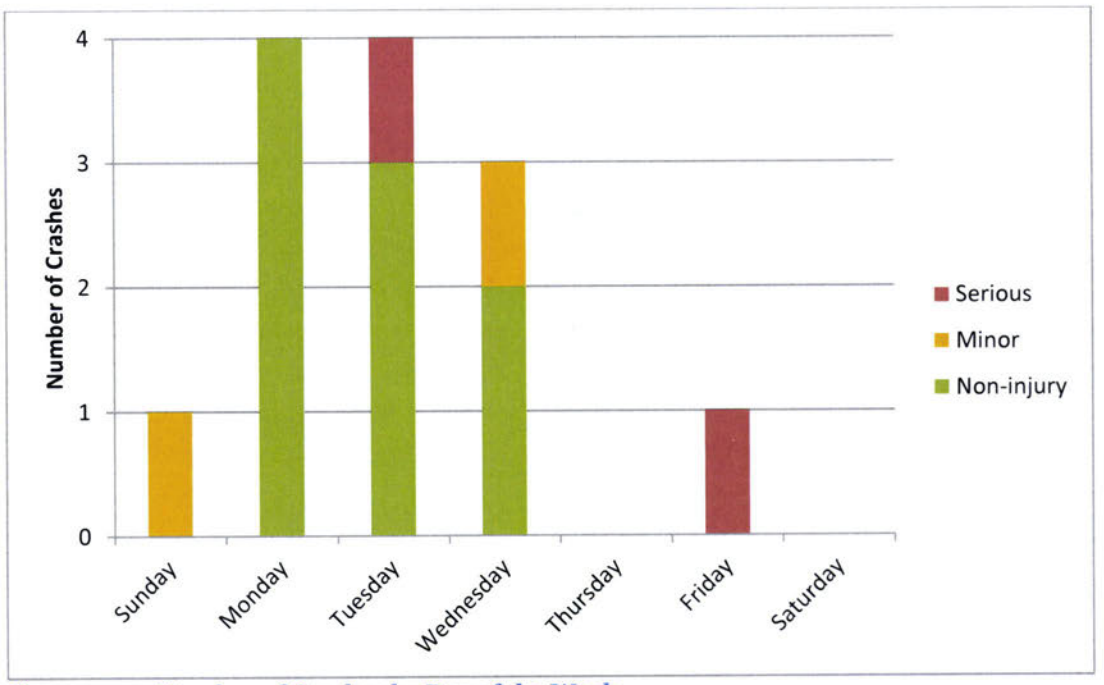

Figure 5-10: Number of Crashes by Day of the Week

5.3.4 Environmental Conditions

Table 5-16 and Table 5-17 present the crash severity by road and light condition and environmental conditions, respectively.

Table 5-16: Crash Severity by Road and Light Conditions

	Dry	Wet	Light	Dark
Serious	2	0	2	0
Minor	0	2	0	2
Non-Injury	8	1	7	2
Total	10	3	9	4
Grand Total	13		13	

Table 5-17: Environmental Conditions

	Light	Dark	Total	% of total	National Average (%)
Dry	8	2	10	77	75
Wet	1	2	3	23	25
Total	9	4	13		
% of total	69	31			
National Average (%)	68	32			

As with the previous two corridors assessed, the serious injury crashes occurred during light and dry conditions. The proportion of light and dry condition crashes are also similar to the national averages. Overall, Environmental conditions are not a significant factor in the cause of crashes along this corridor.

5.3.5 Crash Movement Type

Table 5-18 presents the number of crashes by crash movement along the Wakefield/White Line West corridor.

The most common crash movement type was rear end / obstruction accounting for seven of 13 crashes. The second most common crash movement type was lost control on a bend with four of 13. Alcohol and/or speed were factors in these four crashes.

Table 5-18: Crash Movement Types

Crash Movement	Crashes	% of Total	National Average (%)
Overtaking	1	8	6
Straight Road - Lost Control/Head On	0	0	9
Bend – Lost Control/Head On	4	31	21
Rear End/Obstruction	7	54	35
Crossing/Turning	1	8	24
Pedestrian	0	0	4
Miscellaneous	0	0	1
Total	13	100	100

The most common crash movement type was rear end / obstruction accounting for seven of 13 crashes. The second most common crash movement type was lost control on a bend with four of 13. Alcohol and/or speed were factors in these four crashes. With the exception of these the crash movements along this corridor is indicative of an urban environment.

5.4 Updated Crash History (2010 – 2014)

The initial data analysed from The Esplanade / Waione Street, Randwick Road and Whites Line / Wakefield Street corridors as shown above, has been updated in the following tables to reflect and the present crash history, and to identify any changes to the crash trends. As before the data has been obtained through the NZTA Crash Analysis System (CAS) with a 10m offset around midblock sections and 35m radii around intersections.

The three corridors analysed previously have been updated for the five year period between 1/01/2010 – 31/12/2014, inclusive. The following tables detail the updated analysis.

Table 5-19: The Esplanade/ Waione Street Crash History 2010-2014

Year	Serious	Minor	Non-Injury	Total
2010	0	7	26	33
2011	0	6	18	24
2012	0	7	18	25
2013	1	7	19	27
2014	1	6	13	20
Total	2	33	94	129

The Esplanade / Waione corridor shows an overall reduction in the number of crashes of 15% when compared to the previous study period. This overall reduction consisted entirely of a reduced number of non-injury crashes from 115 in the previous study period to 94 in the current study period, for a total of 18% reduction. As the number of serious and minor injuries have remained consistent, the crash trends long the Esplanade/Waione corridor have not significantly changed.

Table 5-20: Randwick Road Crash History 2010-2014

Year	Serious	Minor	Non-Injury	Total
2010	0	2	9	11
2011	0	2	3	5
2012	1	1	5	7
2013	0	2	7	9
2014	1	2	6	9
Total	2	9	30	44

Over the updated five year period analysed, the number of crashes along the Randwick Road corridor showed an overall reduction in total crashes by 11% when compared to the previous study period. Serious crashes decreased by 100% from 2 down to 1, while both minor and non-injury crashes showed a decrease of 20% and 19% respectively when compared to the previous study period. As serious injury crashes have only decreased by 1 and minor and non-injury crashes have both decreased, the crash trends along the Randwick road corridor are not considered to have significantly changed.

Table 5-21: Wakefield Street/ Whites Line West Crash History 2010-2014

Year	Serious	Minor	Non-Injury	Total
2010	2	1	2	5
2011	0	0	2	2
2012	0	0	2	2
2013	0	0	1	1
2014	0	0	2	2
Total	2	1	9	12

The Wakefield Street / White Line West corridor showed a reduction in minor crashes from 2 during the previous study period down to 1 during the current period, showing a 100% reduction in minor crashes and an overall reduction in total crashes of 8% when compared to the previous study period. Crash Trends on the Wakefield / White Line corridor have therefore not significantly changed.

The updated analysis has shown that injury crashes within the three corridors has not significantly changed since the initial crash analysis. While the total number of crashes appears to have reduced, this is largely due to a reduction in non-injury crashes. This reduction in non-injury incidents may indicated a safety improvement along the three corridors, it could also be that, as the analysis include police reported crashes only, less non-injury crashes involved the police and were therefore unreported.

5.5 Summary

The crash history along three corridors within the study area was reviewed for the five year period of 2008 to 2012, inclusive. A number of themes were evident in the crash assessment. Those are:

- Rear end crashes feature highly;
- Cars and station wagons are the main road users involved in crashes;
- Approximately half of crashes occur at the midblock and half at intersections;
- Between 2010 and 2012, total annual crashes have decreased by 32%; and
- This decrease is at a higher rate than the national average (19%);
- However there has been a slight increase in overall crashes along the corridors (3 crashes) between 2011 and 2012.

More similarities were observed between the Randwick Road and The Esplanade / Waione Street corridors:

- Crossing / turning and overtaking were the second and third most common crash movement types after rear end crashes;
- The proportion of crashes with pedestrians and cyclists is representative of the traffic composition along these corridors (3% are pedestrians and cyclists); and
- There is a correlation between the time of day that crashes are occurring and congestion peaks.

Many of these themes are consistent with an urban setting with many intersecting roads and thus crossing and turning movements. It is also important to note that no fatalities have occurred as a

result of the crashes over the five year study period and only five (of 222) resulted in serious injury. Environmental conditions have not been a major factor in the crash history.

Crashes by road users are also generally representative of the traffic profile along the corridors. The only exceptions to this are where car crashes are underrepresented along The Esplanade and Wakefield Street corridors and truck crashes are overrepresented along the Wakefield Street corridor only. Overall these corridors have crash histories that strongly support the fact that they are urban corridors, and no significant crash problems are present.

The updated analysis of all accidents within the 5-year period to 2014, as detailed in section 5.4 has shown that the number injury crashes within the three corridors has not significantly altered since the initial crash analysis. While the total number of crashes appears to have reduced, this is largely due to a reduction in non-injury crashes. This reduction in non-injury incidents may indicate safety improvements along the three corridors, it could also be that, as the analysis include police reported crashes only, less non-injury crashes were reported to the Police.

6 Multi-Modal Options

This section discusses active and sustainable mode options. Roading only options (which include those which enable multi modal options) are discussed in Section 7.

6.1 Options

Section 3 discussed many of the various modes of transportation that operate within the study area. Multi-modal option concepts were developed following the stakeholder consultations during the 6th and 28th June 2013 with a view to address both the project objectives and the stakeholder inputs. Attendance at the stakeholder consultation meetings are outlined in Appendix A.

Desktop analysis and discussions amongst the project team were conducted to assess the multi-modal option concepts and from this the list was shortened to include those options that conformed best to the project objective and desired stakeholder outcomes. Following this process the following multi-modal options were evaluated in greater detail:

- **MM1** – Reinstate Gracefield Rail Link,
- **MM2** – Enhance Bus Services,
- **MM3** – Weekday Ferry Service, and
- **MM4** – Improve Walking and Cycling Facilities

This section describes how multi-modal options compare to the project objective as well as the strengths and limitations of each option.

MM-1 Reinstate Gracefield Rail Link

This option involves repairing the existing Gracefield rail line and making it operational. This will provide an alternative method for freight companies based in Seaview to transport their goods to Wellington Port. Once the rail line is active the freight rail will be able to avoid the congestion along The Esplanade and travel directly to Wellington. Any freight service will have to share the existing rail corridor with the passenger rail services.

Implementing this option will help to address all the goals identified in the project objectives, through improved connectivity, enhanced resilience etc., however this would be dependent upon uptake of demand. In particular it will improve the efficiency of the transport network especially for freight movements. The resilience of the network would also improve as freight would have an alternative route that can be utilised in case another route is closed.

Limitations

Listed below are the issues surrounding this option:

- Existing business need to invest in capital that will allow them to use the rail, so the level of uptake and utilisation of the line isn't likely to be high;
- The existing rail link would require significant investment in order to make it operational;
- Wellington port is relatively close and freight companies have suggested they would prefer not to use rail as it involves additional handling of the cargo and many trips are over short distances (particularly Seaview to CentrePort Wellington); and

- Would need to work around the busy public transport schedule.

MM-2 Enhanced Bus Service

As identified in section 3.7.1 there are many services that travel through the study area. Of these all the Wellington bound buses use the Petone interchange to access SH2. The main element of this option is to increase the frequency of these buses. The aim is to provide a regular bus service that will promote a modal shift away from private vehicles to the bus. This will help achieve the project objectives of improving transport efficiency and minimising adverse environmental impacts.

Limitations

Listed below are the drawbacks of this option:

- Large sections of The Esplanade are still single lane therefore the buses will still be impacted by congestion;
- While patronage is expected to grow, a significant modal shift is required to achieve a noticeable difference in congestion. However this level of change is highly unlikely and well beyond the expected patronage increases as noted in section 3.7; and
- Without a significant modal shift the bus service will still be limited by the performance of the roading network.

Modal shift could be encouraged by various means. In WTSM, Wellington commuters are particularly sensitive to parking costs, which could be a measure to shift commuters onto bus services.

MM-3 Weekday Ferry Service

At present, during the peak weekday periods, the 'East by West' ferry service provides a direct link between Days Bay, Eastbourne and Queens Wharf, Wellington. The ferry runs at 25min intervals in both direction. Under this option the following changes are proposed:

- The ferry service will operate between Petone Wharf and Queens Wharf.
    - » This will implemented by either including Petone as a stop on the exiting Days Bay to Queens Wharf route or a direct trip to Queens Wharf will be provided.
    - » Additional ferries will need to be purchased to ensure that trip frequency is maintained.
- Additional parking facilities are provided near Petone Wharf
- The Esplanade/Victoria Street intersection will need be signalised to accommodate the increased flows that will be accessing parking near the wharf
- Amenities such as shelters and ticket booths will be erected on the wharf near the ferry dock.

The aim of this option is to promote a modal shift away from private vehicles to using the ferry. This would aid in achieving the project objectives of improving traffic efficiency and minimising adverse environmental impacts. A review of WTSM suggests that the ferry mode's sensitivity to factors such as price limit the uptake of ferry improvement options.

Limitations

Listed below are the shortcomings of this solution:

- The ferry is highly susceptible to poor weather as it is unsafe to operate during rough sea conditions;
- To access the ferry, the walk from residential area to the ferry is long and exposed and there is no shelter for waiting passengers, this would need to be improved;
- The catchment for users of the service is small and a number of other alternative options exist;
- A large modal shift is required to noticeably reduce congestion. However this is unlikely to be achieved, especially considering the ferry's route largely replicates that of the regular rail service which is less susceptible to the weather;
- The ferry trip takes approximately 30mins, between Petone Wharf and Queens Wharf. This is longer than the time taken to travel by train, bus or car; and
- A review of WTSM suggests that the ferry mode's sensitivity to factors such as price limit the uptake of ferry improvement options;

It is noted that the Greater Wellington Regional Council has previously trialled such a service in 2006 which ultimately failed due to lack of patronage. This previous trial should be investigated further should this option be progressed.

MM-4 Improve Walking/Cycling Facilities

This option will involve improving the existing walking and cycling facilities along The Esplanade. A designated cycling lane will be provided along the entire length of the road and will be connected to the Ngauranga to Petone cycleway. This will improve cycling safety and subsequently encourage road users to switch to cycling.

The wide seaside footpath at the eastern end of the road would also be extended to encompass the full length of the Petone foreshore. Additionally, traffic lights will replace the existing pedestrian crossings. This will help calm traffic speeds and improve the accessibility of the beach for pedestrians.

Overall this option will help achieve the project objectives of improving transport safety and efficiency, minimising adverse environmental impacts and enhancing the linkage between the sea and Petone.

Limitations

Listed below are the issues faced by this solution:

- The implementation of pedestrian friendly infrastructure will reduce the speed on the road and therefore worsen the transport efficiency of the network; and
- The size of the modal shift required to significantly reduce congestion is unlikely to occur.

6.2 Summary

The above mentioned multi-modal options could all provide solutions which may assist in the accomplishment of the project objectives. However, as identified there are some notable shortcomings that may affect the performance of these options. That does not mean that aspects of certain options should not be considered further in the future (e.g. increased bus provision and improvements to walking and cycling).

This conclusion was also supported by discussions held with stakeholders and interest groups, however it is acknowledged that wider public consultation and community engagement has not occurred. If this was to occur, this should be based upon an option which the HCC and the Transport Agency might be prepared to progress in order to meet the project objectives, at this time there is no evidence to suggest that such an option exists in isolation.

A summary of the preliminary assessment of the multi-modal options against the project objective is shown in Table 6-1 below.

Table 6-1: Preliminary Multi-Modal Option Assessment

Objective	MM1	MM2	MM3	MM4
Maximise Value for money*	Likely positive (but dependent on funding)	Likely Negative (As requires significant modal shift)	Likely Negative	Likely Positive
Facilitate Economic Growth	Positive Effects as improves freight efficiency	Positive as, if successful, would relieve network congestion	Positive	No Change
Enhance Resilience	Positive Effects as provides alternative freight route	No Change	Positive - alternative transport route established	No Change
Minimise Environment Impacts	Positive	Positive	Positive	Positive
Enhance Linkage between Petone and the Sea	Positive as removes freight from the network	Positive	Positive	Positive

In order to achieve a better outcome for all transport users, roading options will also be considered as they are more likely to significantly improve the network performance and subsequently more effectively accomplish the project objectives.

The roading options considered are discussed in Section 7. These options also contain multi-modal elements including on-road cycling facilities, improved pedestrian facilities and bus lanes.

7 Roading Options

7.1 Options

There have been many road options and alignments reviewed in the past. The results of those previous studies have indicated that a road link to Seaview with an alignment utilising Wakefield Street and/or changes to The Esplanade were the most desired options as they were most in line with the HCC's vision for the region and had the best economic value. For reporting purposes, The Esplanade depowering options have been included in this section with the roading options, despite these options providing amenity benefits rather than transportation benefits.

Initially options identified from previous work, stated in Section 1.3, were considered. Additional options were then created with the aim of satisfying the project objectives. The list was then shortened based on how likely they were to meet these goals. A long list of options that were not tested are included in Section 7.2. All options focus on vehicle traffic and freight movement, however public transport, walking and cycling modes have been considered in the design and assessment where appropriate. A schematic of all the options progressed is shown in Figure 7-1.

Figure 7-1: Schematic of all Roading Options

SV-1 Esplanade Improvements

This option has been modelled as per GHD's Petone Esplanade Capacity Study, May 2012. Drawings of the proposed layout have been provided in Appendix J. Features of The Esplanade Improvements include:

- Changes to intersections resulting in:
    - » New traffic signals at the Victoria Street intersection. The existing signalised pedestrian crossing east of Victoria Street would be removed, providing additional storage for the westbound right turn lane on The Esplanade. The existing roadway will be widened to accommodate an eastbound right turn lane. The existing westbound bus only lane will now begin approximately 40 metres west of the intersection.
    - » New traffic signals at the Buick Street intersection. The zebra crossing at Queen Street would be removed. Two through movements would be provided for westbound traffic and an additional eastbound through movement is provided by altering the left lane to a combined left and through. The two through lanes merge into one downstream of the intersection in both directions.
    - » Widening of traffic signals at the Cuba Street intersection. Additional changes include an additional eastbound through lane by altering the left lane to a combined left and through. Two through traffic lanes then merge into one lane downstream.
    - » New traffic signals at the Jessie Street intersection. The zebra crossing east of the intersection would be removed. Three approach lanes would be provided in the eastbound direction and two lanes would be in the westbound directions. Two lanes are also proposed immediately downstream in both direction but these will merge into a single lane after approximately 50m.
    - » New traffic signals at the Kirkcaldy Street intersection. The new intersection layout has two lanes in the northbound and southbound directions and three lanes in the east and westbound directions including two through movements that merge to one lane downstream.
- Removal of zebra crossings at Bay Street, Oriental Street and Patrick Street. The zebra crossing at Bay Street is proposed to be replaced with a signalised pedestrian crossing, however, this has not been modelled in NWSM as Bay Street has not been included in the model;
- A planted median barrier along the majority of The Esplanade, reducing the opportunities for right turning traffic;
- A westbound bus lane from west of the Victoria Street intersection to the Hutt Road roundabout; and
- On-road cycle lanes in both the eastbound and westbound directions.

SV-2 Whites Line Cross Valley Link

A Cross Valley Link route beginning at Wakefield Street in the west has been reviewed several times in the past, as summarised in Section 1.3. It is considered a good alternative route to The Esplanade as it is in close proximity to the existing interchange at Dowse Drive providing easy access to the State Highway network at this point. If this option was implemented vehicles wanting to travel on SH2 could avoid the congestion at the Petone interchange and access it via the Dowse interchange. Consequently, this would also reduce the demand the Petone interchange and improve its performance. It is also not too great of a distance to reroute for traffic travelling from Seaview and Gracefield, a major origin/destination for HCV traffic, as it is approximately 1.3 km north of The Esplanade. This route also provides good access to Wainuiomata. The route finishes at Whites Line East which is connected directly to Wainui Road, the main road to and from Wainuiomata.

The Whites Line Cross Valley Link would be a 50km/h, two lane road. It would follow Wakefield Street across a new bridge crossing the Hutt River and connecting with Whites Line West before tying into the Randwick Road/Whites Line East roundabout. The improvements associated with this route are based on those identified in the MWH Valley Floor Connector Needs Analysis Report (2003) with updates provided by GHD (2012). Drawings of the route are provided in Appendix K. The suggested improvements include:

- A two lane roundabout at Wakefield Street and Hutt Road incorporating an access to Percy Avenue, this in turn provides access from the proposed link into the Dowse interchange;
- Restriction of movements at the Rush Grove and Wakefield Street intersection (left-in/left-out only) and associated upgrades to the intersection;
- Upgrades to the Cuba Street rail overbridge;
- New traffic signals at the Fitzherbert Street and Wakefield Street intersection providing right turn lanes in both the eastbound and westbound directions.
- Closure of the Tama Street intersection due to the ramping up of the road prior to the new bridge;
- Restricted access from Mudie Street. Instead of a full closure as was suggested by the MWH report, local traffic and pedestrians from Mudie Street would be able to access westbound Wakefield Street via an underpass. Pedestrians will also have access provided to the north side of the bridge.
- New bridge structure of approximately 350 metres length connecting Wakefield Street to Whites Line West across the Hutt River;
- Modification to intersections at Richmond Grove and Fuller Grove to priority controlled intersections;
- New traffic signals at the Saulbrey Grove and Whites Line West intersection with two lanes at three out of four approaches; and
- Modification of the existing Ludlam Crescent/Whites Line East/Randwick Road roundabout to include Whites Line West as a fourth entry/exit point from the west.

Some land acquisition would be required to complete this option, particularly on either side of the new bridge structure and near the connection to the Randwick Road roundabout. Land requirements will be discussed in more detail in Section 11.

An alternative version of SV-2 has also been assessed where The Esplanade depowering and HCV restrictions, as detailed in SV-4, are included.

SV-3 Railway Alignment Cross Valley Link

The Railway Alignment Cross Valley Link starts at the Hutt Road/Wakefield Street roundabout and travels east along Wakefield Street to the Ava Railway Station. The route then follows the railway line to Randwick Road. It is a 60km/h, two lane road. The improvements associated with this route are broadly based on those identified in the MWH Valley Floor Connector Needs Analysis Report (2003). The eastern section of the route, up to the Cuba Street rail overbridge has been adopted from the GHD drawings completed in 2012. Drawings of the route are provided in Appendix L. The suggested improvements include:

- A two lane roundabout at Wakefield Street and Hutt Road incorporating an access to Percy Avenue, this in turn provides access from the proposed link into the Dowse interchange;
- Restriction of movements at the Rush Grove and Wakefield Street intersection (left-in/left-out only) and associated upgrades to the intersection;
- Upgrades to the Cuba Street rail overbridge;
- The link between Cuba Street and Fitzherbert Street will divide into two roads: a service lane following the Wakefield Street alignment to Fitzherbert Street and the other being the main link following the railway corridor. The service lane would provide access to the properties on the northern side of Wakefield Street and a suggested new Park and Ride facility for Ava Station. Westbound traffic on Wakefield Street east of the new link will not have access to it and would be directed up Fitzherbert Street;
- The Park and Ride facility has been suggested in response to the effect (i.e. reduced accessibility) the new alignment would have on the properties on the southern side of Wakefield Street. In this scenario these properties would be purchased and the land used for the parking facility;
- New bridge structure of approximately 270 metres length for vehicle traffic to cross the Hutt River. This new bridge would be adjacent to the current railway bridge (which would remain as a separate structure);
- As with the Whites Line Cross Valley Link option, the east end of the route would tie into the existing Ludlam Crescent/Whites Line East/Randwick Road roundabout. This option has extremely tight geometrics with the new link placed between Randwick Road and Whites Line East. It would also require realignment of Randwick Road and replacement of the Randwick Road rail overbridge.

The widening of the existing railway corridor requires a considerable amount of land acquisition, discussed in more detail in Section 11.

An alternative version of SV-3 has also been assessed where The Esplanade depowering and HCV restrictions, as detailed in SV-4, are included.

SV-4 Esplanade Depowering

This option uses traffic calming, likely through 30km/h speed restrictions, in addition to The Esplanade Improvements option discussed in Section 0. The Esplanade Depowering has been modelled by reducing the free flow speed on The Esplanade and on Jackson Street. The speed reduction on Jackson Street may or may not be included in the physical works of this option but is necessary for modelling to prevent 'rat-running' on the network. This option is being modelled individually for information purposes as it may be considered in conjunction with a Cross Valley Link option in the future.

This option is not intended to be built on its own. It will supplement another solution. However to understand the specific impact of this option this report will assess it as an independent project, as well as in conjunction with the three CVL options.

SV-5 – SV-7 Esplanade Four Laning

The four laning of The Esplanade would provide additional through capacity for eastbound and westbound traffic. These options have been modelled using The Esplanade Improvements option, as described in Section SV-1, as a base. The safety improvements at key intersections along The Esplanade provided in SV-1 complements the introduction of additional traffic lanes as turning traffic would otherwise be subjected to a larger conflict area, crossing two lanes instead of one as they do currently. There are three options considered, and are described below. Drawings are provided in Appendix M.

SV-5: Full Four Laning

Two through lanes in the westbound and eastbound directions from the Hutt Road roundabout in the west to Waione Street in the east.

SV-6: Partial Four Laning

Two through lanes in the westbound and eastbound directions from the Hutt Road roundabout in the west to Victoria Street in the east.

SV-7: Full Four Laning including Estuary Bridge

Two through lanes in the westbound and eastbound directions from the Hutt Road roundabout in the west to the Waione Street/Randwick Road roundabout in the east. This option has been modelled to determine the effects of four laning the Estuary Bridge (aka the Waione Street Bridge).

SV-8 Railway Alignment CVL with Restricted HCV Movements

This option uses the Railway Alignment Cross Valley Link in combination with restricting HCV movements on the Estuary Bridge. HCVs can still access The Esplanade as far as East Street but no further, forcing HCV traffic from Seaview and Gracefield to use the Cross Valley Link. Only authorised HCVs with destinations between Hutt Road and East Street will be allowed to access the restricted zone. This option could have been applied to the Whites Line Cross Valley Link (SV-2) also however the initial urban design assessment suggested that SV-3 would be preferred if it was to facilitate high HCV volumes.

An alternative version of SV-8 has also been assessed where The Esplanade depowering and HCV restrictions, as detailed in SV-4, are included.

7.2 Other Long List Options

There were several other options initially considered but then discounted for various reasons. Some of the options that were considered are described below. A schematic of these options are illustrated in Figure 7-2.

Figure 7-2: Schematic of long list options

A. Waione St, Jackson St to Cuba St then The Esplanade

This option reroutes the main traffic flow from Waione Street, onto Jessie Street, followed by Jackson Street, followed by Cuba Street and finally back along The Esplanade. It was considered to relieve the congestion on The Esplanade and make it a more desirable amenity. The specifics of enforcing the traffic redirection has not been developed but could be achieved in a number of ways including changing traffic priorities, directional signage and traffic calming measures.

Reason for omission:

The option mainly shifts the problem from The Esplanade to Jackson Street that has less capacity or room to handle it without removing parking. It also moves the severance problem from The Esplanade to Jackson Street which will likely only increase foreshore accessibility for the few residents that live between the two roads and only for those east of Cuba Street.

B. Cross Valley Link Udy Street to Golf Course.

This option creates a Cross Valley Link beginning at Udy Street and continuing over the golf course and over the Hutt River.

Reason for omission:

It is not possible to create a route through the golf course as this is a significant amenity for Hutt City. Udy Street would also require significant upgrading and a new bridge over the river. It is located further south of the Dowse Interchange and therefore the Wakefield Street options were deemed to be more effective at achieving the desired objectives of the project. In particular this option would have adverse environmental impacts through the removal of green space.

C. Waione St, East St, Adelaide St to Cuba St then The Esplanade

This option reroute the main traffic flow from Waione Street, into Kirkcaldy Street, then East Street, then onto Adelaide Street followed by Cuba Street and finally back along The Esplanade.

Reason for omission:

This option provided little benefit in terms of accessibility to the foreshore and resulted in a major diversion onto residential streets. Again, it would only be relocating the issues rather than solving them.

D. Jackson/Esplanade one way system

Between Buick Street and Hutt Road The Esplanade will only allow vehicles in the westbound direction and Jackson Street will only allow vehicles in the eastbound direction. The purpose of this change is to relieve congestion.

Reason for omission:

This option does not negate the severance issues and may even make it more difficult to reach the foreshore.

E. Cross Valley Link - Wakefield Street alignment to Railway Overbridge via Ava Park

This option is a Cross Valley Link that follow Wakefield Street and then connects onto the railway overbridge at Ava Park. It was originally considered as it used mostly existing infrastructure.

Reason for omission:

It would require the removal of a portion of green space in Ava Park which is not in line the project objective of minimising adverse environmental impacts. Considering that the railway bridge will require a clip on for vehicles or the construction of a second bridge, the cost savings are not substantial enough to make this a feasible option.

F. Travel Demand Management

This option increases bus and rail service frequencies in addition to implementing improved park and ride facilities and parking cost increases in the Wellington CBD. The idea of this option is to encourage a modal shift from cars and onto public transport services to relieve congestion and improve the performance of the network.

Reason for omission:

This option has implications well beyond the scope of this PFR and is thus instead being investigated as part of the Petone to Grenada project.

7.3 Updated Model Options

As noted in Section 4.4 throughout the development of this PFR the NWSM has been refined. Results from the initial version of the model were delivered in July 2013 and are referred to as the "earlier model" throughout this report. NWSM was then recalibrated following the collection of additional data, results from which were delivered in April 2015. Results from this recalibrated NWSM version are referred to throughout this report as the "updated model".

In conjunction with the updated model some additional options were tested. These options were effectively a combination of previous options (particularly combining options SV2, SV3 and SV8 with SV4 (Esplanade depowering). These additional tests have been denoted as SV2b, SV3b and SV8b respectively with the original tests annotated with an "a".

The results of these additional tests have not been assessed in detail in the following sections and only feature in the executive summary and the economic analysis in section 10 below.

8 Traffic Assessment and Modelling of Options

Traffic modelling was carried out using the Northern Wellington SATURN Model (NWSM) updated to a base year of 2011 by SKM. Modelling in NWSM is carried out using demands extracted from the Wellington Strategic Transportation Model (WTSM) which is a four stage EMME model covering the whole Wellington region.

To simplify the economic evaluation process, a fixed matrix approach has been taken, where the same WTSM demand matrices are used in both the option and Do Minimum models. This is consistent with the Economic Evaluation Manual (EEM). The P2G project is using a variable matrix approach to better reflect the wider regional impacts that project will have, whereas the effects of the options covered in this report are predominantly contained to the Lower Hutt region.

As noted in Section 4.4 throughout the development of this PFR the NWSM has been refined. Results from the initial version of the model were delivered in July 2013 and are referred to as the earlier model throughout this report. NWSM was then recalibrated following the collection of additional data, results from which were delivered in April 2015. Results from this recalibrated NWSM version are referred to throughout this report as the updated model. As the underlying base model has been completely recalibrated and used different base assumptions the earlier NWSM and the updated NWSM results are not directly comparable.

Using the earlier NWSM, eight different options were modelled, as detailed in Section 7, in addition to the Do Minimum. The Do Minimum assumptions, described in Section 4.3.1, have remained constant throughout the project. With the updated NWSM only the three Cross Valley Link (CVL) options were remodelled with and without depowering The Esplanade.

8.1 Option Performance

The performance of the options has been assessed using outputs from the NWSM. The assessment contained in this section is only for the 2031 horizon year as the trends are similar to the horizon year 2021, but escalated. As with the Do Minimum network, the following data has formed the basis of the option network analysis:

- General network statistics;
- Traffic volumes along key routes;
- Level of service that is currently provided on The Esplanade, Randwick Road and Whites Line East; and
- Journey times along The Esplanade and Waione Street from the Petone Interchange in the west to the Randwick Road roundabout in the east (and vice versa).

8.1.1 Network Statistics

The network statistics from Saturn, presented in Table 8-1 for the earlier model and in Table 8-2 for the updated model, are meant to provide an overall picture of the performance of the network. These results are also presented in a different format in Appendix N. All of the networks listed in this section have been run using the same matrix.

Note that in the updated model table, options denoted with 'a' represent the options as described and those with 'b' also include Esplanade depowering.

Table 8-1: Network Statistics for all options during all the peaks (Earlier Model)

Peak	Option	Average Speed (km/h	Travel Time (pcu hrs/hr)	Total Delay (pcu hrs/hr)	Network Queue (pcu hrs/hr)	Travel Distance (pcu kms/hr)	Total Trips (pcus)
AM	Do Min	53	10,620	1,140	1,590	560,000	97,700
	SV-1	53	10,640	1,130	1,610	560,000	97,700
	SV-2	53	10,500	1,070	1,550	559,000	97,700
	SV-3	53	10,500	1,070	1,550	560,000	97,700
	SV-4	51	10,910	1,240	1,710	560,000	97,700
	SV-5	53	10,560	1,090	1,590	560,000	97,700
	SV-6	53	10,610	1,120	1,600	560,000	97,700
	SV-7	53	10,520	1,060	1,580	560,000	97,700
	SV-8	53	10,510	1,070	1,550	560,000	97,700
IP	Do Min	62	5,700	110	490	351,000	86,300
	SV-1	62	5,710	120	500	351,000	86,300
	SV-2	62	5,680	100	490	351,000	86,300
	SV-3	62	5,680	100	490	351,000	86,300
	SV-4	61	5,780	140	510	352,000	86,300
	SV-5	62	5,700	110	500	351,000	86,300
	SV-6	62	5,710	110	500	351,000	86,300
	SV-7	62	5,700	110	500	351,000	86,300
	SV-8	62	5,690	110	490	352,000	86,300
PM	Do Min	50	12,540	1,690	2,060	620,000	112,900
	SV-1	50	12,500	1,660	2,060	620,000	112,900
	SV-2	50	12,420	1,620	2,030	619,000	112,900
	SV-3	50	12,410	1,610	2,030	620,000	112,900
	SV-4	48	12,900	1,760	2,320	619,000	112,900
	SV-5	50	12,400	1,600	2,050	619,000	112,900
	SV-6	50	12,500	1,650	2,060	620,000	112,900
	SV-7	50	12,360	1,550	2,050	619,000	112,900
	SV-8	50	12,420	1,610	2,040	620,000	112,900

Table 8-2: NWSM Network Statistics for Remodelled Options during All the Peaks (Updated Model)

Peak	Option	Average Speed (km/h)	Travel Time (pcu hrs/hr)	Total Delay (pcu hrs/hr)	Network Queue (pcu hrs/hr)	Travel Distance (pcu kms/hr)	Total Trips (pcus)
AM	Do Min	51	10,710	1,090	1,730	549,000	96,870
	SV-2a	52	10,590	1,040	1,690	548,000	96,870
	SV-2b	49	11,160	1,130	1,870	551,000	96,870
	SV-3a	52	10,580	1,040	1,690	548,000	96,870
	SV-3b	50	11,140	1,130	1,850	552,000	96,870
	SV-8a	52	10,590	1,040	1,680	549,000	96,870
	SV-8b	50	11,150	1,130	1,850	552,000	96,870
IP	Do Min	58	6,080	110	805	355,000	85,870
	SV-2a	59	6,060	98	805	354,000	85,870
	SV-2b	58	6,150	120	820	356,000	85,870
	SV-3a	59	6,060	97	805	355,000	85,870
	SV-3b	58	6,160	118	820	356,000	85,870
	SV-8a	59	6,080	100	805	355,000	85,870
	SV-8b	58	6,170	125	825	357,000	85,870
PM	Do Min	47	13,000	1,430	2,250	611,000	112,000
	SV-2a	48	12,800	1,370	2,200	610,000	112,000
	SV-2b	47	12,900	1,420	2,200	607,000	112,000
	SV-3a	48	12,800	1,360	2,190	610,000	112,000
	SV-3b	47	13,160	1,430	2,280	612,000	112,000
	SV-8a	48	12,800	1,370	2,200	610,000	112,000
	SV-8b	42	14,230	1,370	2,170	590,000	112,100

It is observed that all options except SV-4 have similar average speeds across all the peaks. As expected the 30km/h speed restrictions along The Esplanade in SV-4 have resulted in a lower average speed. In the AM and IP peaks, the Cross Valley Link (CVL) Options (SV-2, SV-3 and SV-8) have the least network travel time with Option SV-7, four laning The Esplanade including the Estuary Bridge the next shortest. In the PM peak, the CVL options still perform well, however SV-7 has the least travel time.

In addition to being the slowest option, SV-4 behaves the poorest in all the network statistics with the highest total delays and network queues throughout all three peak periods. This is to be expected considering the speed reduction on The Esplanade and on Jackson Street without providing an alternate route.

SV-7 has the least amount of total delay in the AM and PM peaks, followed closely by the CVL options. In the inter peak nearly all the options have identical delays. Only SV-1 and SV-4 have greater delays. For network queues, again the CVL options perform the best for all peaks followed by Option SV-5, full four laning of The Esplanade.

Overall, the network statistics seem to show that the CVL options perform the best overall in the AM and inter peaks while Option SV-7 performs the best in the PM peak.

The results of the updated models general show slower average speeds and higher travel times than the earlier model. Queues are similar in the AM and PM but slightly higher in the IP in the new NWSM. Travel Distance is comparable as are the total Trips.

8.1.2 Traffic Volumes

SATURN outputs showing the change in traffic volumes between the options and the Do Minimum scenarios are contained in Appendix O. Table 8-3 summarises the modelled flows predicted by NWSM for the options and Do Minimum in 2031 in the earlier model and Table 8-4 shows this for the updated model. Figure 8-1 and Figure 8-2 show the locations of where the counts were taken. These figures also show the extent of the difference between the options and the Do Minimum. The volumes presented are in vehicles and not pcus. A summary of the volumes in each peak period has been included in Appendix P. It should be noted that, in the updated model table, the three options denoted with 'a' represent the option as described, while those with 'b' also include Esplanade depowering.

The CVL options show a significant increase in flows on Wakefield Street with approximately 15,000 vehicles per day opting to use the Cross Valley Link. The CVL options consistently show a reduction of traffic on The Esplanade to approximately 17,000-18,000 vehicles per day, a reduction of approximately 5,000-6,000 vehicles per day. The difference plots in Appendix O indicate that the remaining vehicles are diverting from Railway Avenue, north of Wakefield Street. A concern regarding the CVL options is that the number of vehicles on Randwick Road increases significantly, increasing the exposure to the children who attend the primary school on this road. However, the modelled traffic volumes on Randwick Road only increase with the HCV restriction in Option SV-8.

The introduction of the traffic signals on The Esplanade in Option SV-1 cause modelled traffic volumes to decrease slightly on this road and on Randwick Road and the Estuary Bridge. The Esplanade depowering in Option SV-4 causes a significant reduction on these roads with over half of the traffic volumes being diverted elsewhere. Partial four laning of The Esplanade in Option SV-6 result in little to no change at these locations.

Full four laning of The Esplanade, Option SV-5, causes an increase of 1200 vehicles per day at the west end of The Esplanade, 400 more vehicles per day at the east end of The Esplanade and 600 fewer vehicles per day over the Estuary Bridge. This indicates that some vehicles are crossing the river at other locations and accessing The Esplanade from the side streets west of Cuba Street.

As expected, four laning of The Esplanade including the Estuary Bridge, Option SV-7, causes increases in traffic volumes on The Esplanade and Estuary Bridge ranging from 1,100 to 2,200 vehicles per day. Modelled volumes on Randwick Road also increase by approximately 600 vehicles.

Consistent with earlier volume comparisons in section 4.3, volumes produced by the updated model show that generally, with the exception of The Esplanade West, have increased over those produced by the earlier model.

The CVL with depowered esplanade options (those denoted with a 'b') show a significant volume reduction on The Esplanade when compared to the CVL only options (those denoted with an 'a') as is shown in Table 8-4. At the West end of The Esplanade, ADTs have reduced by 13,900, 13,400 and 13,200 vehicles (66%, 65% and 64%) in SV2b, SV3b and SV8b respectively. The east end of The Esplanade shows a similar flow reduction, 12,800 vehicles in SV2b (70%), 12,400 vehicles in SV3b (69%) and 11,900 vehicles in SV8b (68%). The Estuary Bridge shows less of a reduction, 10,700, 10,200 and 9,700 vehicles, which equates to 47%, 46% and 47% for options SV2b, SV3b and SV8b respectively. A corresponding increase in flows is seen on Wakefield Street where SV2b shows 9,200 additional vehicles (61%), SV3b shows 8,600 additional vehicles (53%) and SV8b shows 7,900 additional vehicles (46%). This in effect demonstrates that depowering The Esplanade would promote the use of a cross valley link option.

Table 8-3: Option ADT's from SATURN Actual Flows (Earlier Model)

No	Road	2031 Traffic Flows (vpd)								
		Do-Min	SV-1	SV-2	SV-3	SV-4	SV-5	SV-6	SV-7	SV-8
1	The Esplanade West	26,800	25,700	23,800	23,400	12,700	28,000	26,800	29,000	23,600
2	The Esplanade East	23,400	21,800	18,400	18,000	11,700	23,800	22,200	25,100	17,400
3	Estuary Bridge	26,900	25,100	21,100	20,600	18,400	26,300	25,400	28,000	19,600
4	Randwick Road	16,300	15,900	15,500	15,600	15,900	16,200	15,800	16,900	16,700
5	Whites Line East	20,300	21,300	25,600	26,200	25,000	20,800	21,100	20,200	26,000
6	Wakefield Street West	1,600	1,700	14,800	15,100	2,000	1,600	1,600	1,500	15,400
7	Wakefield Street East	500	510	14,300	510	530	510	510	510	510
8	Railway Corridor	N/A	N/A	N/A	14,900	N/A	N/A	N/A	N/A	15,700

Figure 8-1: Diagram of Traffic Flow Locations

Table 8-4: Option ADT's from SATURN Actual Flows (Updated Model)

No.	Road	2031 Traffic Flows (vpd)						
		Do-Min	SV-2a	SV2b	SV-3a	SV3b	SV-8a	SV8-b
1	The Esplanade West	24,700	21,000	7,100	20,500	7,100	20,600	7,400
2	The Esplanade East	23,800	18,400	5,600	17,900	5,500	17,500	5,600
3	Estuary Bridge	28,500	22,900	12,200	22,200	12,000	20,800	11,100
4	Randwick Road	17,700	16,300	24,000	16,000	23,400	17,700	23,800
5	Whites Line East	20,500	25,400	25,200	16,200	21,800	17,500	22,200
6	Wakefield Street West	1,460	15,000	24,200	15,500	24,200	16,200	24,200
7	Wakefield Street East	770	15,200	24,400	16,200	24,800	17,200	25,100
8	Railway Corridor	N/A	N/A	N/A	16,200	24,800	17,200	25,100

Figure 8-2: Diagram of Traffic Flow Locations

8.1.3 Level of Service

Table 8-5 shows the changing Level of Service (LOS) produced from the earlier model along three of main corridors in Hutt City, as was provided for the Do Minimum in Section 4 and Table 8-6 shows this for the updated model. To maintain consistency and comparability, the modelled speeds from the 2031 option SATURN models are compared to the free flow speeds (FFS) identified in the Do Minimum[9]. However, capacities have been adjusted to account for the increase in lanes for Options SV-5 to SV-7 and the operational change to Wakefield Street in the Cross Valley Link options. In accordance with the SATURN model links with double lanes will have a capacity of 3,400 pcu/hr and when operational changes are made to Wakefield Street it will have an increased capacity of 1,600 pcu/hr. As with the levels of service provided for the Do Minimum, this information is best used when considering the change in LOS, not the LOS itself, due to modelled speeds generally being higher than actual speeds.

In general, the options perform at a higher level of service or remain the same as the Do Minimum network. The exceptions to this are:

- Option SV-3 has been given an automatic LOS of F along Whites Line East in the westbound direction during the PM peak because the volume has exceeded the capacity;
- Option SV-4 performs at a lesser level of service at five locations / directions in both the AM and PM peak periods. Of particular note is the performance shown at The Esplanade during both peak AM and PM peak periods which reduced to LOS E. Randwick Road also performs worse than the Do Minimum in the southbound and northbound directions during the AM and PM peaks, respectively;
- For SV-1 and SV-6 the westbound approach to Cuba Street on The Esplanade drops to a LOS of B in the AM peak; and
- In SV-8 the westbound approach to Cambridge Terrace on Whites Line East drops to a LOS of B in the AM peak.

Most of the applied options have a positive effect on the LOS of the Estuary Bridge.

As was noted in section 4.4.2, the updated model generally performs similarly or slightly better than the earlier model at the locations reported. This trend continues when comparing the updated options to those modelled earlier.

The depowered Esplanade options (those denoted with a 'b') show, in the AM peak, performance worsening in the eastbound direction reverting from LOS B to A, effectively reverting to the Do Minimum performance. Performance on Randwick Road and Wakefield Street both show a reduction, corresponding to the flow increase noted in section 8.1.2, particularly in the PM period where Randwick Road shows a LOS of C. While the depowered Esplanade options do show a reduction in performance, the worst LOS being C, these options still provide acceptable performance.

[9] The modelled free flow speed in Option SV-4 was reduced on The Esplanade as part of the option (to depower The Esplanade). Options SV-2, SV-3 and SV-8 also have changes to modelled free flow speeds; however, these changes increased the FFS. The Do-Minimum free flow speed was maintained for comparison to show the change in LOS perceived by the driver once the option is in place.

Table 8-5: 2031 Do Minimum and Option AM and PM Peak Link LOS (earlier SATURN Model)

	Link	Direction	Do-Min	SV-1	SV-2	SV-3	SV-4	SV-5	SV-6	SV-7	SV-8
AM Peak	**The Esplanade** (approaching Victoria St Intersection)	EB	B	B	B	B	E	A	A	A	B
		WB	B	A	A	A	C	A	A	A	A
	The Esplanade (approaching Cuba St Intersection)	EB	B	B	B	A	E	A	B	A	A
		WB	A	B	A	A	E	A	B	A	A
	Estuary Bridge	EB	B	B	A	A	A	B	B	A	A
		WB	C	C	B	B	B	C	C	A	B
	Wakefield Street (approaching Cuba St Intersection)	EB	A	A	A	A	A	A	A	A	A
		WB	A	A	A	A	A	A	A	A	A
	Randwick Road (south end)	NB	A	A	A	A	A	A	A	A	A
		SB	A	A	A	A	A	A	A	A	A
	Randwick Road (north end)	NB	A	A	A	A	A	A	A	A	A
		SB	B	B	A	A	C	B	B	B	A
	Whites Line East (approaching Cambridge Terrace Intersection)	EB	B	A	B	B	A	B	A	B	B
		WB	A	A	A	A	A	A	A	A	B
PM Peak	**The Esplanade** (approaching Victoria St Intersection)	EB	B	B	B	B	E	A	A	A	B
		WB	C	A	C	C	C	A	A	A	C
	The Esplanade (approaching Cuba St Intersection)	EB	B	B	B	B	E	A	B	A	B
		WB	B	B	B	B	E	A	B	A	B
	Estuary Bridge	EB	C	C	B	B	B	C	C	A	B
		WB	C	B	B	B	A	B	B	A	B
	Wakefield Street (approaching Cuba St Intersection)	EB	A	A	A	A	A	A	A	A	A
		WB	A	A	A	A	A	A	A	A	A
	Randwick Road (south end)	NB	A	A	A	A	B	A	A	A	A
		SB	A	A	A	A	A	A	A	A	A
	Randwick Road (north end)	NB	A	A	A	A	B	A	A	A	A
		SB	A	A	A	A	A	A	A	A	A
	Whites Line East (approaching Cambridge Terrace Intersection)	EB	A	A	A	A	A	A	A	A	A
		WB	C	C	C	F	C	B	C	C	A

Legend LOS Improves LOS Worsens

Table 8-6 :2031 Do Minimum and Option AM and PM Peak Link LOS (Updated SATURN Model)

	Link	Direction	Do Min	SV-2a	SV-2b	SV-3a	SV-3b	SV-8a	SV-8b
AM Peak	**The Esplanade** (approaching Victoria St Intersection)	EB	B	A	B	A	B	A	B
		WB	B	A	A	A	A	A	A
	The Esplanade (approaching Cuba St Intersection)	EB	B	A	A	A	A	A	A
		WB	A	A	A	A	A	A	A
	Estuary Bridge	EB	B	A	A	A	A	A	A
		WB	C	B	A	B	A	A	A
	Wakefield Street (approaching Cuba St Intersection)	EB	A	A	B	A	B	A	B
		WB	A	A	A	A	A	A	A
	Randwick Road (south end)	NB	A	A	A	A	A	A	A
		SB	A	A	A	A	A	A	A
	Randwick Road (north end)	NB	A	A	B	A	B	A	B
		SB	B	A	B	A	B	A	B
	Whites Line East (approaching Cambridge Terrace Intersection)	EB	B	B	B	A	A	A	A
		WB	A	A	A	A	A	A	A
PM Peak	**The Esplanade** (approaching Victoria St Intersection)	EB	B	A	A	A	A	A	A
		WB	B	A	A	A	A	A	A
	The Esplanade (approaching Cuba St Intersection)	EB	B	A	A	A	A	A	A
		WB	B	A	A	A	A	A	A
	Estuary Bridge	EB	C	B	A	B	A	B	A
		WB	B	B	A	B	A	B	A
	Wakefield Street (approaching Cuba St Intersection)	EB	A	A	A	A	A	A	A
		WB	A	A	A	A	B	A	B
	Randwick Road (south end)	NB	A	A	B	A	B	A	B
		SB	A	A	A	A	A	A	A
	Randwick Road (north end)	NB	B	B	C	B	C	B	C
		SB	B	B	B	B	B	B	B
	Whites Line East (approaching Cambridge Terrace Intersection)	EB	A	A	B	A	B	A	B
		WB	A	A	A	A	A	A	A

Legend LOS Improves LOS Worses

8.1.4 Journey Times

The route used to analyse the modelled journey times has been taken along The Esplanade and Waione Street from east of the Petone Interchange to west of Randwick Road, as depicted in Figure 8-3.

Figure 8-3: Journey Time Route along The Esplanade and Waione Street

Figure 8-4 to Figure 8-11 show modelled travel times along The Esplanade for the 2031 Do Minimum and option models in the AM and PM peaks for both the earlier and updated SATURN models. The Esplanade was selected as this route is common to all options, whereas the particular options vary in length so are difficult to compare. A4 size copies of these graphs, including graphs of the inter peak travel times, have been included as Appendix Q.

The westbound journey times in the AM and PM peaks are relatively consistent for all options, with the exception of SV-4, which has a 30km/h speed restriction on The Esplanade. In the PM peak, Option SV-4 has a large spike in travel time near the Petone Interchange indicating that there are significant delays at this point. Options SV-6 and SV-1 are slightly slower than the Do Minimum in the AM peak. In the PM peak SV-1, SV-6 and Do-Min consistently travel at the same speed. The fastest overall journey times are SV-8 and SV-3 in the AM peak, and SV-7 and SV-8 in the PM peak.

The updated model westbound travel time graphs show similar trends as noted in section 4.4.3. Compared to the earlier model, the AM peak period is significantly quicker (ranging from two to two and a half minutes) and the IP and PM periods are 50 to 70 seconds slower.

The depowered Esplanade options (those denoted with a 'b') show a similar journey time increase Westbound in the updated model, in comparison to the other options, to that of SV4 in the earlier modelling. As would be expected, the reduced speeds on The Esplanade have a significant impact on journey times along this route.

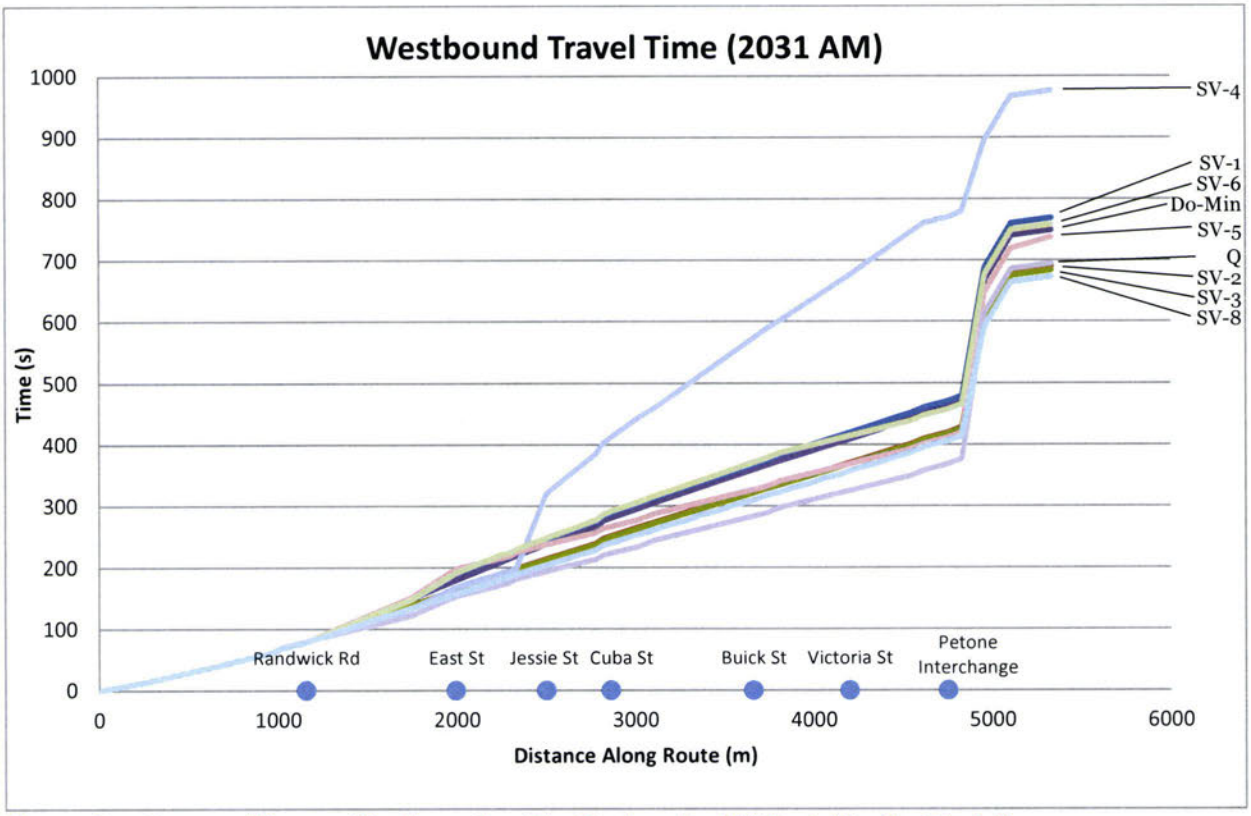

Figure 8-4: Journey Times – Westbound on The Esplanade, AM Peak (Earlier Model)

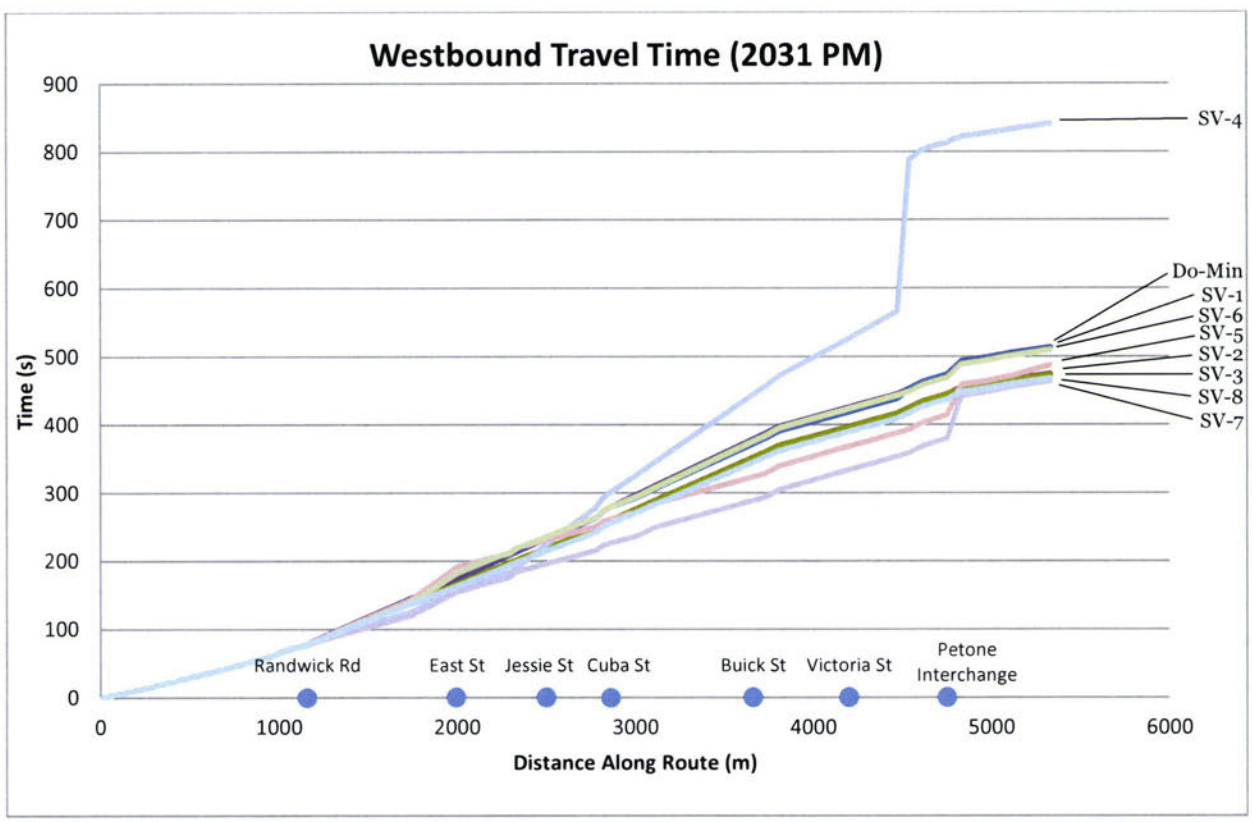

Figure 8-5: Journey Times – Westbound on The Esplanade, PM Peak (Earlier Model)

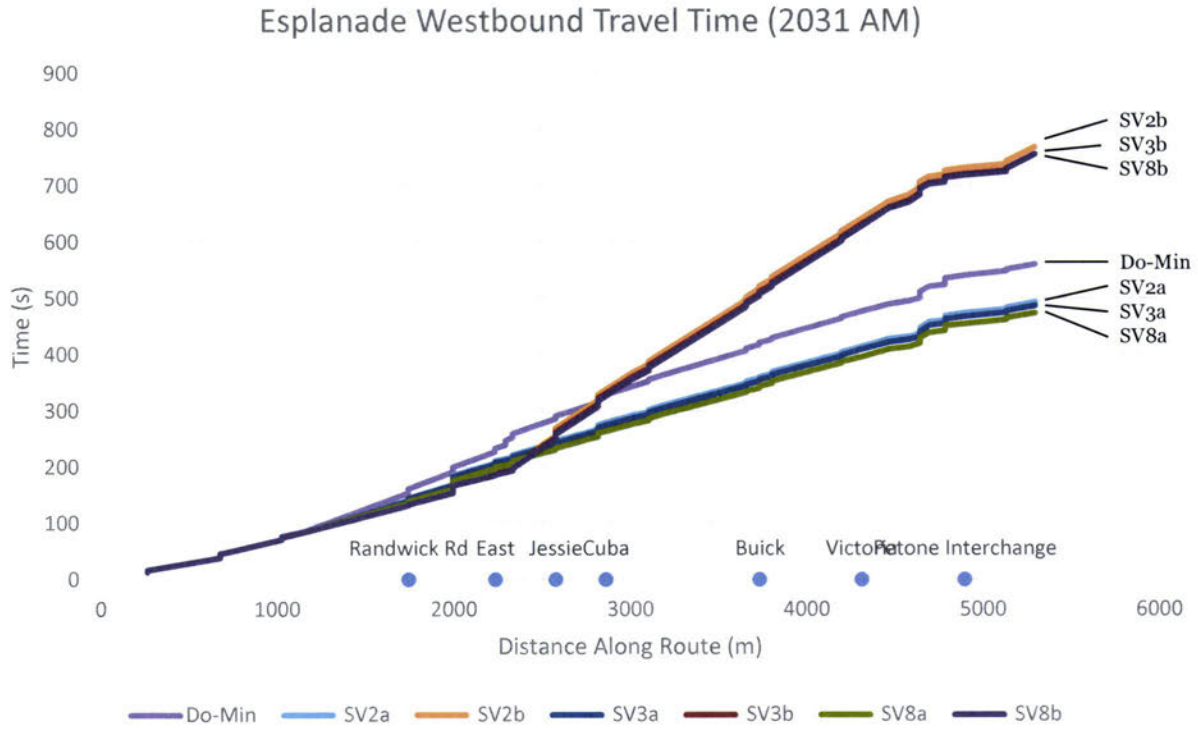

Figure 8-6: Journey Times – Westbound on The Esplanade, AM Peak (Updated Model)

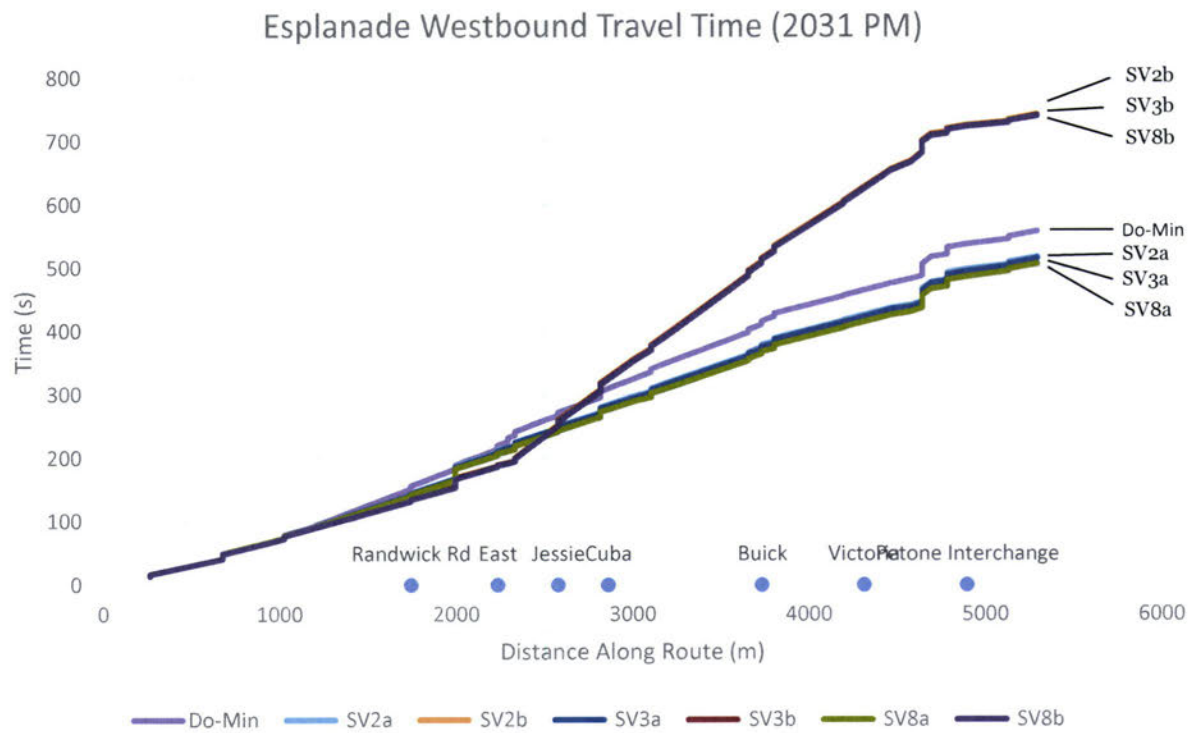

Figure 8-7: Journey Times – Westbound on The Esplanade, PM Peak (Updated Model)

As in the westbound direction, the Option SV-4 has the longest journey time in both the AM and PM peaks. Again Option SV-1 is slightly slower than the Do Minimum in the AM peak. In the PM peak SV-1 and SV-6 are both slower than the Do Minimum.

SV-7 and SV-8 have the fastest modelled travel times in the AM peak and the fastest overall journey times are SV-8 and SV-3 in the eastbound direction in the PM peak. This is a mirror image of what occurs in the westbound direction.

Overall, the fastest journey times along The Esplanade occur under SV-7 (the full double laning including the Estuary Bridge) and CVL (SV-2, SV-3 and SV-8) options. SV-7 is generally faster because the double laning has increased the capacity along The Esplanade whereas the CVL options are quicker because there are less flows along The Esplanade. For all options, major delays occur at the Petone interchange in the westbound direction, this is especially true during the AM peak. The signalised intersection at Cuba Street is also a point of delay in both directions. Additionally SV-4 experiences delays at Jessie Street because this is the location where the 30km/h speed restrictions begin. In general all options except SV-1, Sv-4 and SV-6 perform consistently better than the Do Minimum.

The updated model eastbound journey time graphs show similar trends as noted in section 4.4.3. Compared to the earlier model, the AM peak period is significantly slower (ranging from three to three and a half minutes) and the IP and PM periods are two and a half to three minutes seconds slower.

As with the westbound direction, the depowered Esplanade options (those denoted with a 'b') show a similar journey time increase eastbound in the updated model, in comparison to the other options, to that of SV4 in the earlier modelling. As would be expected, the reduced speeds on The Esplanade have a significant impact on journey times along this route.

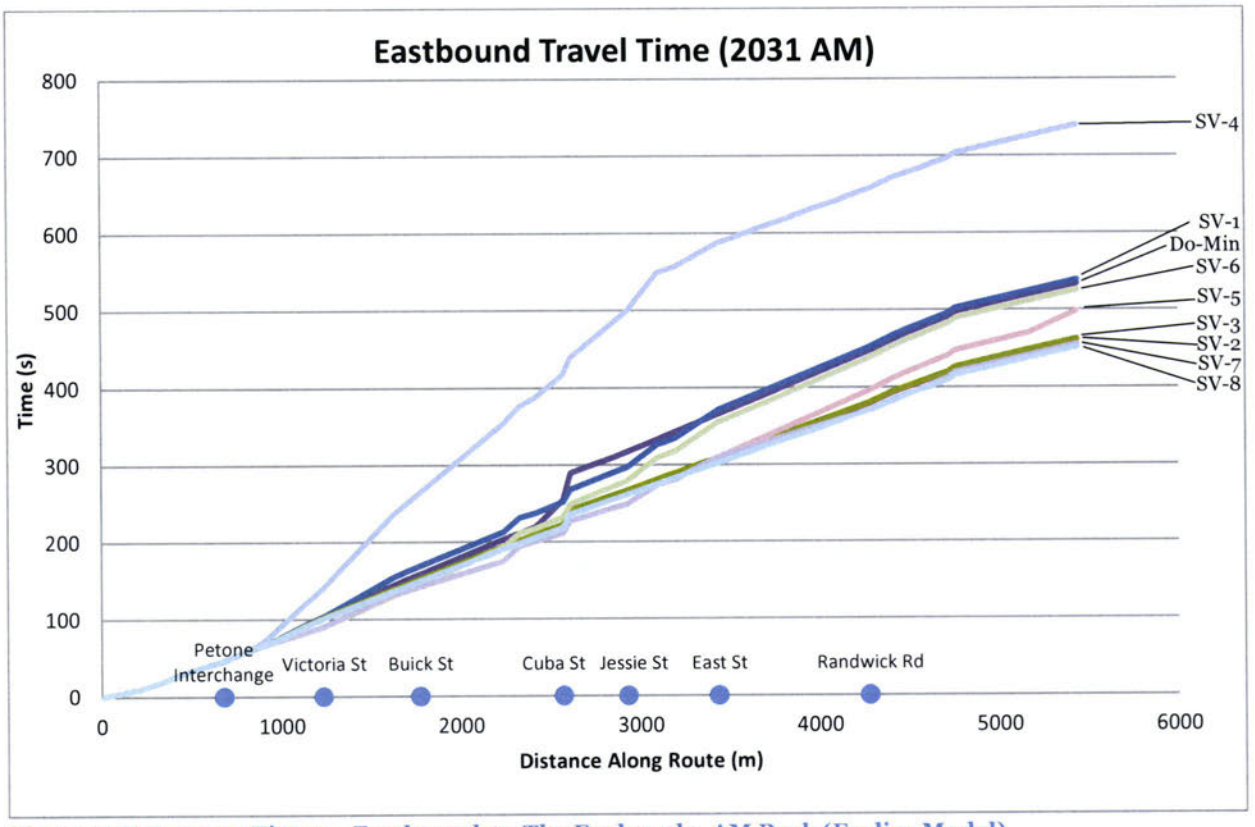

Figure 8-8: Journey Times – Eastbound on The Esplanade, AM Peak (Earlier Model)

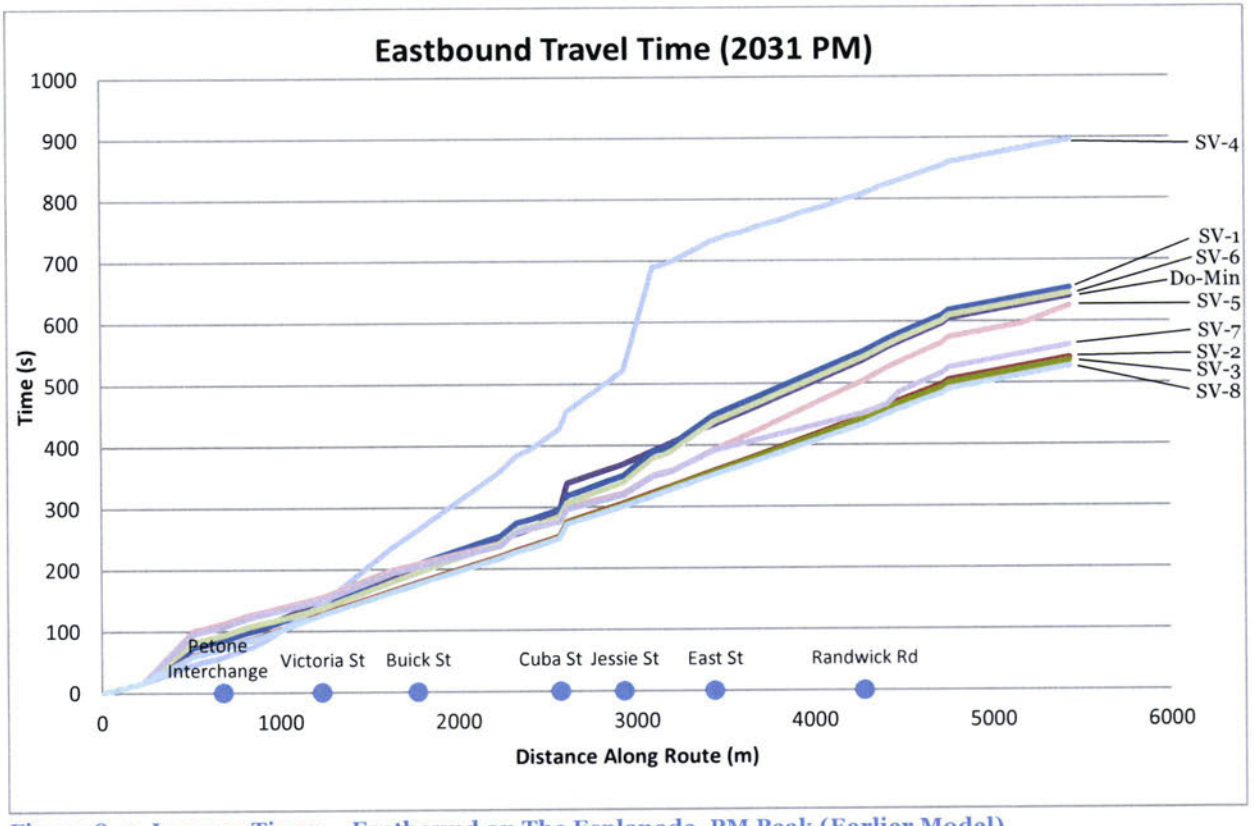

Figure 8-9: Journey Times – Eastbound on The Esplanade, PM Peak (Earlier Model)

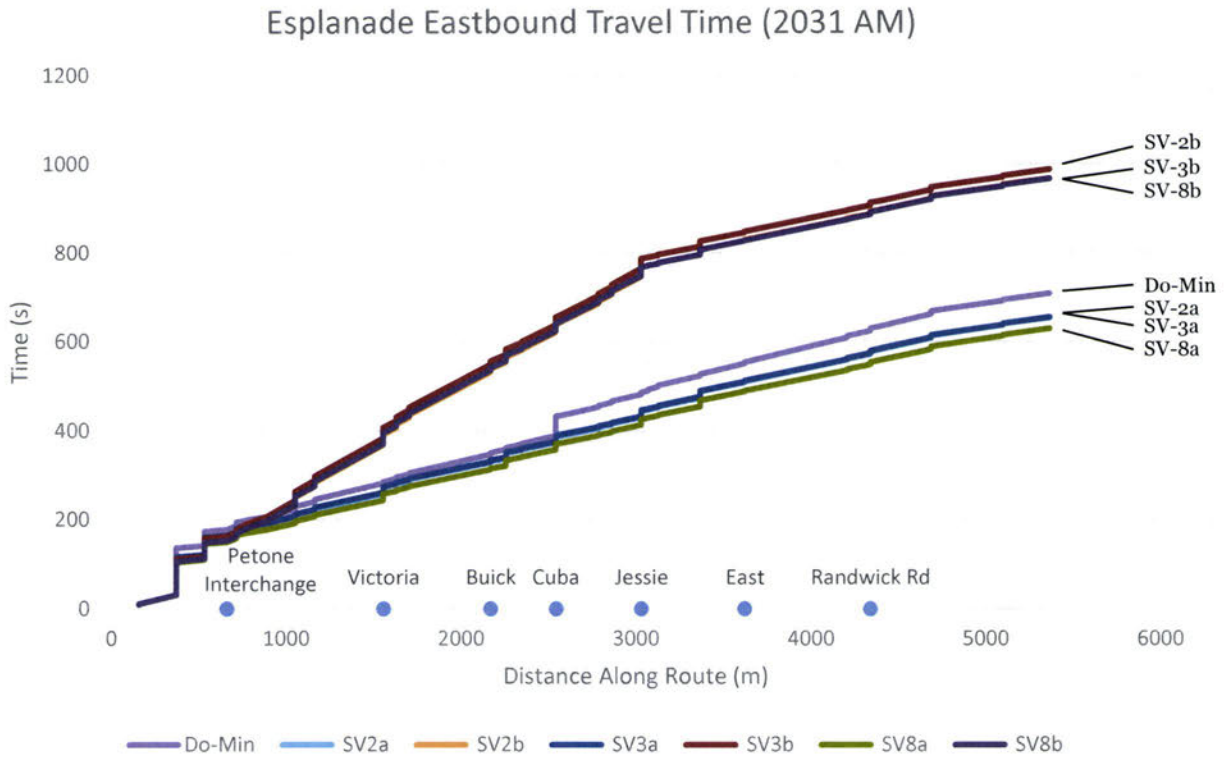

Figure 8-10: Journey Times – Eastbound on The Esplanade, AM Peak (Updated Model)

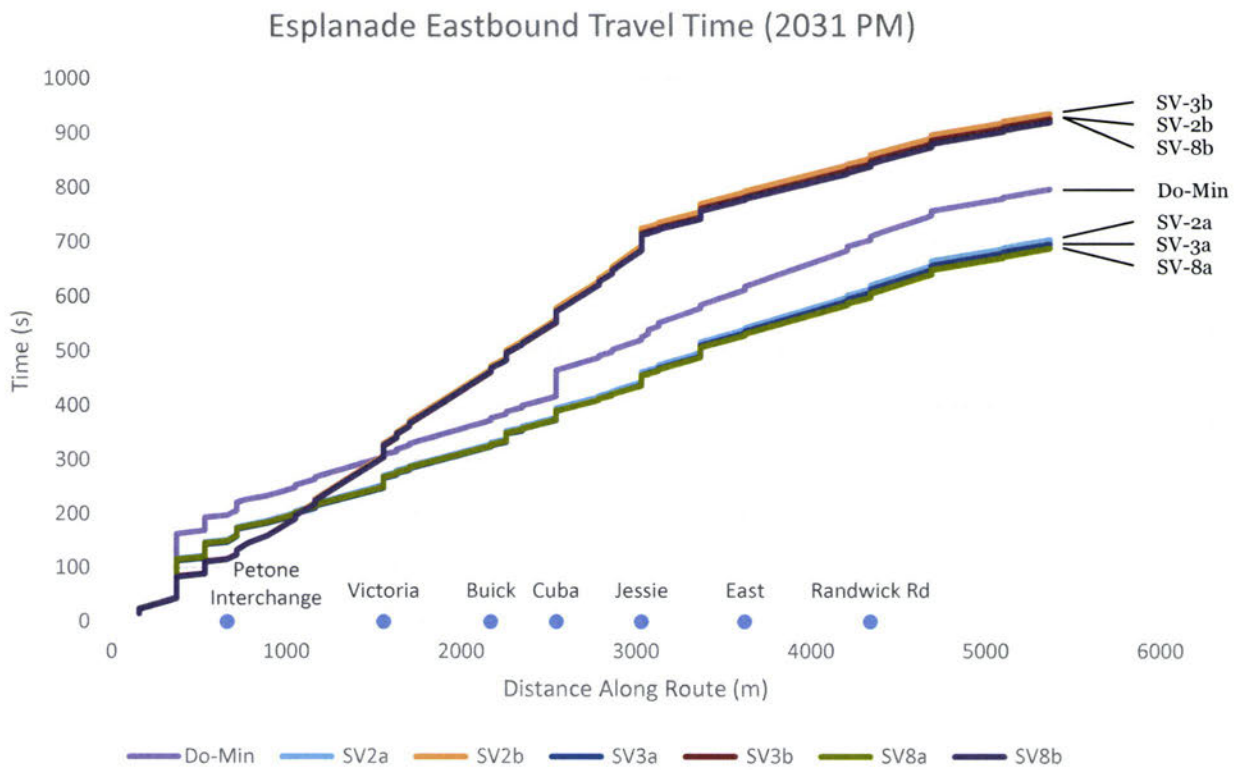

Figure 8-11: Journey Times – Eastbound on The Esplanade, PM Peak (Updated Model)

9 Cost Estimates

9.1 Cost Estimates

This section focuses on the methodology used to produce the Feasibility Estimate (FE) for the seven options. The estimates attached in Appendix R have been prepared and reviewed in accordance with NZTA's 'Cost Estimation Manual' (SM014).

9.2 Assumptions and Exclusions

The following section identifies the assumptions made during the estimating process. The cost estimates have developed based on preliminary designs, limited site information as well as general information about the type of construction and scope of work. The FE is formed using the design drawings contained within Appendices J through M.

In order to create a complete estimate it was necessary to make the following assumptions:

- NZTA managed costs have allowed for costs associated with the project (managed by NZTA) and are not part of the NZTA's administration costs such as partnering meetings. No provision has been made for extraordinary circumstances such as Environment Court appeals;
- Residential property estimates have been assumed by obtaining unit rates of affected land from the Quickmap database;
- The value of property currently owned by GWRC and KiwiRail have been derived based on their current land use as identified in the Hutt City District Plan. The relevant pages of the district plan are provided in Appendix S. The rates applied to each land use are provided below:
  - River Recreation = $\$10/m^2$
  - General Recreation = $\$27/m^2$
  - General residential = $\$115/m^2$
- All rates have been assumed to be at June 2013;
- A fixed percentage of the total construction cost has been assumed to estimate the investigation and design fees that might be required. In reality this could vary due to the size and scale of the schemes, particularly if programmed in isolation;
- Lump sum estimates have been included for service relocations. As no service investigation has been undertaken, there is a large degree of uncertainty associated with these costs at this point in the project;
- The design used as the basis for the cost estimate has not been subject to a safety audit. If there are any significant findings this could have a bearing on the estimate;
- A lump sum allowance for landscaping / urban design has been included. However, this does not allow for significant urban design mitigation since the potential scope of this work is unknown at this point;
- The options include a significant amount of new pavement markings. It has been assumed that an overlay on the existing pavement is required to allow for new pavement marking;
- In addition to new street lighting, a cost for upgrading all existing lanterns has been included in the estimates;
- For Options SV-1 and SV-4 to SV-7, where on-road cycle facilities have been provided, the Great Harbour Way cost has been excluded;

- Along with replacement fencing, a noise fence has been included between the road and rail for Option SV-3; and
- Costs for replacement of the Cuba Street overbridge for both SV-2 and SV-3 and replacement of the Randwick Road overbridge for SV-3 have been included in this project.

The following items have been excluded from the FE's

- GST;
- Escalation beyond the time the estimates were prepared;
- Sunk Costs; and
- Operational costs associated with the project outcome (i.e. maintenance costs).

9.3 Quantitative Risk Assessment

A quantitative risk assessment has been undertaken to derive the:

- Base or Expected Estimate to determine the NZTA managed contingency
- 95%ile estimate to determine the appropriate funding risk

The cost estimates consist of scoped work (the Base Estimate) and uncertainty (the risk element). At the beginning of a project, the level of knowledge is limited and there is a high level of uncertainty. With an increasing level of knowledge the uncertainty reduces.

The percentage range of uncertainty in the Base Estimate has been determined on a section-by-section basis (across the project by each line item in the estimate). Individual risks have not been quantified.

The option estimates are attached in Appendix R of this report and a summary has been presented below in Table 9-1.

Table 9-1: Summary of Cost Estimates

Options		Expected Estimate ($M)	95th Percentile Estimate
SV-1	Esplanade Improvements	30.4	42.1
SV-2a	White Lines Cross Valley Link	57.6	82.6
SV-2b	White Lines Cross Valley Link with Esplanade Depowering[11]	88.0[10]	124.7[10]
SV-3a	Railway Alignment Cross Valley Link	63.6	87.5
SV-3b	Railway Alignment Cross Valley Link with Esplanade Depowering[11]	94.0[10]	129.6[10]
SV-4	Esplanade Depowering[11]	30.4	42.1
SV-5	Esplanade Four Laning – Full	35.4	48.2
SV-6	Esplanade Four Laning – Partial	31.3	43.0
SV-7	Esplanade Four Laning including Bridge	54.4	74.1
SV-8a	Railway Alignment CVL with HCV Restriction[12]	63.6	87.5
SV-8b	Railway Alignment CVL with HCV Restriction[12] and Esplanade Depowering[11]	94.0[10]	129.6[10]

[10] These costs are based on the addition of cost from the relevant CVL option and SV-4, the Depowered Esplanade Option. This should be considered to be the worst case costs as there may be cost savings found due to economies of scale by carrying out these works together.
[11] No additional costs have been identified for traffic calming measures as the exact nature of these measures are unknown at this point.
[12] No additional costs have been identified for HCV restriction on the Estuary Bridge. It is assumed that this would be a low cost measure (e.g. signage) that would be enforced by local police initially to improve the uptake of the rule change. It is assumed that any advertising campaigns or marketing would come from existing budgets.

10 Economic Analysis

10.1 Assumptions

An economic analysis for each of the options has been carried out in accordance with the NZTA's Economic Evaluation Manual (EEM). The economic analysis calculation sheets are included for each option in Appendix T. The key assumptions used in the economic evaluation are:

- All costs and benefits have been discounted to 01/07/2013 (time zero);
- A 6% discount rate has been used to discount the costs and benefits to the time zero over a 40 year analysis period;
- The latest update factors and vehicle operating costs (July 2012 base date) have been applied in accordance with the EEM;
- SATURN outputs across the AM, inter peak and PM peak hours have been used to forecast the travel time, vehicle operating and CO_2 emission costs;
- CO_2 emission costs are assumed to be 4% of the vehicle operating costs;
- Crash cost benefits are assumed to be 5% of the total transportation benefits;
- A four year construction period has been assumed for all options with construction commencing 01/01/2020;
- Traffic disruption costs during construction have not been included; and
- No allowance for maintenance costs has been made.
- The annualisation factors used in this assessment are provided in Table 10-1

Table 10-1: Summary of annualisation factors

Peak Period	Days per year	Hours per day	Annualisation Factor (of Inter Peak)
AM Peak	240	2	Modelled
Inter Peak	240	7	Modelled
PM Peak	240	2	Modelled
Off-Peak	240	13	0.33(x IP)[13]
Weekend Peak	120	7	1.08(x IP)[7]
Weekend Off-Peak	120	7	0.32(x IP)[7]

[13] These are generic from previous modelling and should be updated at scheme assessment stage

10.2 BCR Values (Earlier Modelling)

The benefit cost ration (BCR) for each option, as per the earlier modelling results, is summarised in Table 10-2 below:

Table 10-2: Summary of construction costs and Payments used in the Economic Analysis

Options		Benefits (NPV) ($M)	Cost (NPV) ($M)	BCR
SV-1	Esplanade Improvements	-0.06	18.6	0.0
SV-2	White Lines Cross Valley Link	59.1	35.2	1.7
SV-3	Railway Alignment Cross Valley Link	58.1	38.8	1.5
SV-4	Esplanade Depowering	-155.7	18.6	-8.4
SV-5	Esplanade Four Laning – Full	36.8	21.6	1.7
SV-6	Esplanade Four Laning – Partial	-2.0	19.1	-0.1
SV-7	Esplanade Four Laning including Bridge	53.0	33.2	1.6
SV-8	Railway Alignment CVL with HCV Restriction	51.4	38.8	1.3

10.3 Wider Economic Impacts

A preliminary estimate of the possible Wider Economic Impacts (WEIs) which might be generated by the main alternative options was prepared. This appraisal has been provided in Appendix U. Because the appraisal is only at a preliminary stage the WEIs have not been calculated directly. Their estimation, which is intended to provide an initial indication of the possible scale of these benefits, is based on information derived from other projects. These percentages were only applied to those options that have positive benefits.

Traditionally WEIs are only considered for project with a capital value greater than $200 million. While the cost of this project is below this threshold it is envisaged that this project would be completed in conjunction with the P2G link road, which is valued above this constraint. Consequently these WEIs are based on cumulative benefits from the P2G project. Without building the Petone to Grenada link road, it will be difficult to realise these benefits.

The three elements of WEI's analysed are agglomeration benefits, impacts of imperfect competition and labour supply benefits. Following the approach set out in the NZTA Note General Circular– Funding: No 13/06, agglomeration benefits can be added to conventional economic benefits in estimating the base BCRs. The other two WEI components, imperfect competition benefits and labour supply benefits, are to be considered as a sensitivity test. As the P2G link is included in both the options and the do min, the agglomeration benefits are specific to the PFR options.

Table 10-3: Effect of Agglomeration Benefits

Options	Transportation Benefits ($M)	Agglomeration %	Agglomeration Benefits ($M)	Total Benefits for Base BCR ($M)	BCR
SV-2	59.1	16%	9.5	68.6	1.9
SV-3	58.1	16%	9.3	67.4	1.7
SV-5	36.8	25%	9.2	46.0	2.1
SV-7	53.0	25%	13.2	66.2	2.0
SV-8	51.4	16%	8.2	59.7	1.5

The imperfect competition benefits and labour supply benefits are 5% and 1% of the transportation benefits, respectively, for all options.

Table 10-4: Effect of Imperfect Competition and Labour Supply Benefits

Options	Transportation Benefits ($M)	Imperfect Competition ($M)	Labour Supply ($M)	Total Benefits ($M)	BCR
SV-2	68.6	3.0	0.6	72.1	2.0
SV-3	67.4	2.9	0.6	70.9	1.8
SV-5	46.0	1.8	0.4	48.2	2.2
SV-7	66.2	2.6	0.5	69.4	2.1
SV-8	59.6	2.6	0.5	62.8	1.6

10.4 Updated Economics

As described previously, the NWSM model has undergone a recalibration exercise and the Cross Valley Link (CVL) options have been rerun using this updated model. The CVL options have only been rerun in the 2031 forecast year and thus it is not possible to update the economic assessment. To provide some idea of the relative benefits generated from the updated modelling the 2031 costs are presented in this section.

Tables 10-5 and 10-7 show the 2031 year benefits in terms of travel time costs, congestion relief value, vehicle operating costs and CO_2 emission costs for the earlier and updated models respectively. Tables 10-6 and 10-8 show the percentage difference of the options compared to the do min and give an idea of the benefits which are generated. The key comparison is that of the travel time costs as this produces the bulk (generally ~80%) of the benefits.

Table 10-5: 2031 Modelled Costs (Earlier Model)

Options	Travel Time Costs ($M)	Congestion Relief Value ($M)	Vehicle Operating Costs ($M)	CO2 Costs ($M)
Do Min	1,438.7	48.1	1,186	47.4
SV1	1,439.3	48.1	1,186.1	47.4
SV2	1,434.5	47.2	1,184.8	47.4
SV3	1,434.4	47.1	1,185.3	47.4
SV4	1,451	50.2	1,188.6	47.5
SV5	1,436.4	47.7	1,185.4	47.4
SV6	1,439	48.1	1,186	47.4
SV7	1,435.3	47.4	1,184.8	47.4
SV8	1,434.9	47.1	1,185.6	47.4

Table 10-6: 2031 Modelled Costs Percentage Difference (Earlier Model)

Options	Travel Time Costs	Congestion Relief Value	Vehicle Operating Costs	CO2 Costs
SV1	-0.04%	0.00%	-0.01%	0.00%
SV2	0.29%	1.87%	0.10%	0.00%
SV3	0.30%	2.08%	0.06%	0.00%
SV4	-0.85%	-4.37%	-0.22%	-0.21%
SV5	0.16%	0.83%	0.05%	0.00%
SV6	-0.02%	0.00%	0.00%	0.00%
SV7	0.24%	1.46%	0.10%	0.00%
SV8	0.26%	2.08%	0.03%	0.00%

Table 10-7: 2031 Modelled Costs (Updated Model)

Options	Travel Time Costs ($M)	Congestion Relief Value ($M)	Vehicle Operating Costs ($M)	CO2 Costs ($M)
Do Min	1,438.6	50.7	1,151.8	46.1
Option 2a	1,433.1	49.7	1,150.4	46
Option 2b	1,446.6	51.6	1,153.8	46.2
Option 3a	1,434.4	50	1,150.8	46
Option 3b	1,449.2	52.1	1,155.5	46.2
Option 8a	1,435	50	1,151.4	46.1
Option 8b	1,480.8	60	1,152.3	46.1

Table 10-8: 2031 Modelled Costs Percentage Difference (Updated Model)

Options	Travel Time Costs	Congestion Relief Value	Vehicle Operating Costs	CO2 Costs
Option 2a	0.38%	1.97%	0.12%	0.22%
Option 2b	-0.56%	-1.78%	-0.17%	-0.22%
Option 3a	0.29%	1.38%	0.09%	0.22%
Option 3b	-0.74%	-2.76%	-0.32%	-0.22%
Option 8a	0.25%	1.38%	0.03%	0.00%
Option 8b	-2.93%	-18.34%	-0.04%	0.00%

The CVL options in the updated model show travel time cost improvements ranging from 0.25% in option 8a to 0.38% in option 2a. This is in line with the same options as previously modelled. The Esplanade depowered options show negative travel time benefits as expected and in line with the earlier modelling of SV4 option which also had a depowered esplanade. Option 8b however performs significantly worse than the options 2b, 3b and the earlier SV4.

This analysis shows little variation in the benefits anticipated for each of the options when compared to the earlier assessment, and accordingly the BCR analysis is considered to remain valid. The only except to this is the congestion relief for Option 8b, where a difference of 18% is observed. As noted above, the majority of benefits are derived from travel time costs, and the congestion relief represents a much smaller portion of the combined benefits.

While BCR analysis was not able to be carried out using the updated modelling for options 2b, 3b and 8b, from the travel time costs it can be seen that these options would produce a negative BCR compared to the do minimum scenario. Option 2b and 3b would likely show greater benefits compared to the depowering alone in SV4. It should be noted that while the depowered esplanade options show negative transport benefits, these don't take into account other benefits such as improved amenity which may make such an option desirable despite the transport dis-benefits.

11 Land Requirements

Varying amounts of properties are required to implement the 8 options analysed. The identified land requirements in this section take into consideration the full road width including shoulders and central medians. The Cross Valley Link options (SV-2, SV-3 and SV-8) require the most property. The options considering four-laning of The Esplanade require less property or no property at all. No land acquisition has been assumed for construction of the Great Harbour Way as this occurs on the foreshore.

Options SV-1, SV-4 and SV-6 do not require acquisition of any property as these works occur within the apparent road reserve or existing carriageway.

Option SV-2 requires acquisition of several properties on either side of the new bridge and near the new connection to the roundabout at Randwick Road and Whites Line West:

- Approximately 10 square metres is required from the property on the southwest corner of Tama Street and Wakefield Street to create a cul-de-sac at the south end of Tama Street;
- Two properties at the east end of Wakefield Street (100 Wakefield Street and 2A Mudie Street) will need to be purchased and their buildings removed in order to accommodate the new bridge structure. Three properties at the west end of Whites Line West will also need to be purchased for this reason. Those are 1 and 3 Whites Line West and 37 Richmond Grove; and
- 51, 53 and 55 Whites Line West will also need to be acquired to build the connection between Whites Line West and the Randwick Road / Whites Line East roundabout.

Option SV-3 and SV-8 require the most property including private properties, frontages and a pump station.

- On the west side of the rail bridge along the rail corridor, the following properties would be required to create the roadway:
    - A pump station at 56 Wakefield Street;
    - 58, 60 and 62 Wakefield Street;
    - One unit at 64 Wakefield Street, a subdivided lot, would require removal of the building and purchase of the associated land;
    - Approximately 70 square metres of 66 Wakefield Street would be needed to build the roadway. This would require removal of some outbuildings on the property; and
    - Approximately 1.5 metres of the remaining properties that back onto the north of the railway line on the west side of the river would be required.
- On the east side of the rail bridge along the rail corridor, the following properties would be required to create the roadway:
    - Five properties of Housing NZ would need to be acquired: Units 2, 3 and 4 at 26 Richmond Grove and Units 5 and 6 at 22 Richmond Grove;
    - 1A and 2 Fuller Grove;
    - A small portion of 1 Fuller Grove that would result in the removal of an outbuilding.; and;
    - Approximately 50 square metres at 31 Trevethick Grove that would result in the removal of an outbuilding.

- The new road would also use some land that is currently used for Trevethick Grove, a local road accessing several properties. Thus, 13 Trevethick Grove and a portion of 14 Trevethick Grove would be required to realign the existing road.

The current design used for Options SV-5 and SV-7 requires that several buildings on the south side of The Esplanade may need to be removed between Fitzherbert Street and Richmond Street. These are the TS Tamatoa Sea Cadets building, the Jetty Café and Rowing Club and the Heretaunga Boating Club. Two of these buildings are heritage buildings and would their removal would be discouraged. However, this has been costed for as a 'worst case scenario'. As these buildings are on land owned by Hutt City Council, approximate costs of relocating the tenants of the buildings were assumed instead of land acquisition costs. There are opportunities in the design of these options to allow the buildings to remain; however, this would result in reduced traffic movements at several intersections and thus the benefits currently achieved may decrease, however costs would also decrease. Further discussion on the heritage buildings is provided in Section 14.

The property requirements noted above are based on the current designs. As the designs are refined the property requirements may change. Opportunities to minimise the amount of land required may be identified. Opportunities to improve the streetscape and enhance urban design of the desired option may also be identified as it progresses.

Property acquisition presents a risk where land has not previously been subject to designation.

Net property costs have been included in the cost estimates contained in Section 9 of this report.

12 Urban Design

A preliminary Urban Design Assessment has been completed on the eight options. This was a desktop based analysis identifying the issues and opportunities of the various options considered from an urban design perspective. The views and assessment presented in this section are those of Kevin Brewer, Registered Architect with Brewer Davidson and the Urban Designer for this and the Petone to Grenada project. In addition to the information presented in this section, the location of the Petone to Grenada connection with State Highway 2 was also discussed in the full assessment which been provided in Appendix G.

This urban design assessment covers the area from the SH2 Interchange in the west to Seaview in the east to a Preliminary Feasibility Report standard. The assessment compares The Esplanade and Cross Valley Link options against urban design best practice and the project objectives.

12.1 Cross Valley Link Options

The rail alignment option (SV-3) is preferred from an urban design perspective. Wakefield Street west of Cuba Street is low in amenity and can accommodate the arterial road.

The western footbridge to Ava Station can be linked directly to the replacement Cuba Street overbridge and avoid a pedestrian crossing on the CVL. The possibility of transfers to the busy bus routes on Cuba Street becomes a possibility. The Fitzherbert Street signalised intersection can provide access to the eastern rail footbridge.

From an urban design perspective the railway alignment is the preferred option between Hutt River and Randwick Road to avoid effects on a residential street. This can be confirmed and further developed if the CVL is taken to a Scheme Assessment stage.

Randwick Road can be used as a medium term solution to providing a cross valley link but the Railway/Elizabeth Street alignment is the preferable long term option to avoid Moera Village, Randwick Primary School and the church/marae at York Street corner.

12.2 Esplanade Options

The option preference is based on the desire to disperse traffic between The Esplanade and CVL to integrate land use and transport improvements.

If the CVL is not included then Option SV-1 is preferred as it retains parking on the northern kerb that supports mixed use intensification along The Esplanade. Options 5, 6 & 7 all remove parking on the northern kerb in the Plan Change 29 Petone West area. Connecting the existing westbound double lanes through to Hutt Road is supported as it increases capacity without compromising land use intensification. The general traffic lanes and Hutt Roundabout design in SV-6 is preferable to SV-1.

Dispersing traffic is also preferred to allow the SV-1 cross section east of Nelson Street with parking on the northern kerb and a single carriageway in each direction. The cycling lanes are a potential transport benefit. The more important urban design goals are to retain parking and a single lane in each direction to keep the road narrow and slow speeds.

The increase in signalised intersections with pedestrian crossings at Victoria Street, Buick Street, Cuba Street, Jessie Street and Kirkcaldy Street as well as pedestrian calls at Bay and Patrick Streets will dramatically improve connectivity to the foreshore. This pattern is consistent in all Esplanade options.

However, a crossing facility at the western end of the Plan Change 29 area is desired given the planned land use intensification and the desirability of Korokoro Gateway Park. Victoria Street is 855 metres from Hutt Road so allowance for a future pedestrian crossing near Hutt Road should be allowed for as part of wider transport improvements.

The existing balance of buildings, car parking and open space along the foreshore boardwalk is ideal so the retention of the T.S. Tamatoa and Jetty Café buildings is preferred. This is only an issue for the four laning in Options SV-5 and SV-7 which are not preferred from an urban design perspective.

12.3 Conclusion

Objectives 2 and 5, identified in Section 1.6, for the project read:

- Support the economic growth and development of the Hutt Valley by improving connectivity within the region; and
- Enhance the linkage between the sea and Petone for all users.

The important land use issues are the regional importance of Seaview as a heavy industrial and scientific research area, and mixed use intensification at Petone.

These two land use issues have contrasting transport requirements. Seaview will remain largely dependent on private vehicles especially to SH2 and P2G links. Petone will have a balance of private vehicle and public transport needs, but encouraging patronage of rail is a strategic goal. Therefore the walk or cycle route to Petone Rail Station and to a lesser degree Petone Wharf (no current commuter service operating) becomes important.

Petone's growth is different to fringe suburban growth. It is typically higher value, start up business growth and medium density urban residential development that is important to establish in the Hutt Valley. It is important to develop higher value employment where people live in the Hutt Valley. This reduces people having to travel to Wellington CBD for these job types so is a long term transport benefit.

Urban nodes with foreshore edges are rare in New Zealand cities, so this is one of the reasons for Petone's success. Connection to the amenity provided by The Esplanade foreshore is critical to attracting businesses and residents to higher density development.

There are land use and transport benefits of dispersing traffic to the Dowse and Petone interchanges along a combination of The Esplanade and CVL route upgrades.

Dowse Interchange is located between the Petone and Hutt urban nodes so is a better route for general traffic and HCVs in particular. This reduces traffic along The Esplanade and Hutt Road protecting walking and cycling linkages to the foreshore and Petone Rail Station. In addition, general eastern suburb growth will have a more direct link to SH2 along the CVL route reducing traffic along Randwick Road.

Conversely the full Petone Interchange will pull traffic along The Esplanade and Hutt Road severely affecting the growth potential of Petone. These are the same issues faced with Customhouse Quay severing the city and waterfront in Wellington's CBD. The response has been to form an inland state highway and encourage buses as an extension of the rail route along the 'growth spine'. A four lane road with no parking to slow vehicles severing a growth node and foreshore could become a bigger and bigger mistake as time goes by. A combination of CVL and The Esplanade routes should be a strategic planning response not a decision driven by cost benefit ratios.

Therefore the preferred option(s) from an urban design perspective are:

- In Stage 1 of development, Option SV-1 should be implemented with two general vehicle westbound lanes at Petone West. Also pedestrian connections across The Esplanade at Petone West be included;
- This should be followed by Option SV-3 CVL railway alignment (with a caveat that the best linkage to a future Elizabeth Street link may alter that choice);
- Directly linking the Dowse Interchange to the CVL should be Stage 2 of development as it provides direct access to SH2.
- The Elizabeth Street connection should be addressed in the final stage (Stage 3). This will divert the Seaview HCV flows away from the Moera Village, Randwick Primary School and the church/marae on York Street;
- Options for the Grenada link to Dowse Interchange or ramps north of Petone Interchange be investigated further to direct through traffic away from Petone West;
- Options to connect Ava Rail Station to the replacement Cuba Street overbridge be investigated for pedestrian access and possible bus/rail transfers; and
- Confirmation that the Great Harbour Way will be the route for all cyclists travelling south to Ngauranga so that linkages to The Esplanade and Hutt Road can be planned.

13 Geotechnical Requirements

Opus has undertaken a review of available literature, interpretation of aerial photographs, and engineering geological reconnaissance mapping. The preliminary geotechnical appraisal has involved the following:

- A desk study of regional geology and hazard maps.
- A review of past relevant geological and geotechnical reports, and the results of previous investigations.
- A desk study of the potential for contamination along the route.
- Site reconnaissance visits by our engineering geologist, Doug Mason, and our principal geotechnical engineer, P. Brabhaharan.
- Appraisal of the geotechnical issues that may influence the development of route alignments.
- Recommendations for development of the route.
- Consideration of a strategy for carrying out geotechnical investigations.

13.1 Geomorphology and Geology

Within the Hutt Valley, the geomorphology is characterised by flat, low-lying coastal and alluvial terrace surfaces. The urban areas of Petone, Lower Hutt, Gracefield and Seaview have been developed on this land. The Cross Valley Link (CVL) route is proposed to cross the Hutt River near the Ava Rail Bridge. In this area, the river is approximately 120m wide and consists of a gravel channel that grades downstream into finer grained deposits (marine sands and estuarine muds) near its mouth between Petone and Seaview.

The geology of the Wellington region has been mapped by the Institute of Geological and Nuclear Sciences at 1:50,000 scale (IGNS, 1996) and 1:250,000 scale (IGNS, 2000). These maps indicate that the proposed CVL route crosses land that is underlain by marginal marine sediments and alluvium of the Holocene age.

13.2 Hazards

13.2.1 Contaminated Land

Contaminated site information for sites in the vicinity was obtained through Greater Wellington Regional Council's selected land use register (SLUR). The SLUR is a database of sites that have, or may have, been used for activities and industries from the Hazardous Activities and Industries List (HAIL) established by the Ministry for the Environment. The information provided is indicative only of the levels of contamination and expected contaminants.

A summary of contaminated sites in close proximity to the CVL route is provided in Table 13-1 and a map of these sites are provided in Appendix V.

Table 13-1: Contaminated Site Summary

Site (GWRC File No.)	Proximity to Route	Age / Closure	Nature of Land Use	Identified/Potential Contaminants
Ex Ados Chemical Co Ltd (SN/03/090/02)	0 m	-	Resins/synthetics manufacture	Hydrocarbons, solvents
Ex General Motors / Mitre 10 Mega (SN/03/115/02)	20 m	1984	Motor vehicle workshops	Hydrocarbons
Ex Turnbull and Jones Ltd; Currently Acme Engineering (SN/03/091/02)	0 m	1940s-1978; Current	Electrical manufacturing, iron and steel works	Asbestos, metals
Ex Turnbull and Jones Ltd; Currently Hutt Valley Polytech (SN/03/092/02)	0 m	1940s-1978; Current	Electrical manufacturing, iron and steel works	Asbestos, metals
Pacific Container Park (SN/03/127/02)	170 m	Current	Transport depot: storage/use/disposal of hazardous substances	Hydrocarbons, solvents
Ava Park landfill (SN/03/151/02)	0 m	1940s – unknown	Refuse landfill	Hydrocarbons, metals, landfill gas
Mobil Ludlam (SN/03/119/02)	0 m	1995 – current	Service station	Hydrocarbons

Records of asbestos are only held for 2 of the sites listed in Table 13-1 above (the ex-Turnbull and Jones factory buildings on Wakefield Street). However, given the age and nature of land use at the remaining sites in the project area, asbestos may be present at a number of these sites.

The 2011 National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES), sets out a framework for assessing the risks associated with land contamination. The NES requires a Preliminary Site Investigation (PSI), comprising a detailed desk study, to be undertaken in the first instance to classify the nature and distribution of potentially hazardous land uses in the project area and to develop the scope of necessary intrusive investigations and laboratory chemical testing to quantify the hazard posed by soil contaminants. The distribution of potentially contaminated sites in the project area shows that land contamination could pose significant issues for the route options under consideration, and therefore we recommend a PSI be undertaken in conjunction with developing concepts for the P2G and CVL routes should they be progressed. This will be followed at a later stage by detailed site investigations and laboratory testing, when the preferred alignments have been selected.

13.2.2 Seismicity

The project area lies within the Wellington region, which is exposed to a high level of seismicity. The region has a number of major active faults and a subduction zone associated with the active

plate boundary between the Pacific and Australian plates. These structures are capable of generating large earthquakes of magnitude 7.5 to 8+, and together these represent earthquake sources that contribute significantly to the seismic hazard in the Wellington region. The principal active faults within 20km of the site are the Wellington Fault, Moonshine Fault, Wairarapa Fault and Ohariu Fault. The characteristics of these faults are provided in Table 13-2.

Table 13-2: Active faults in the vicinity of the site

Fault Name	Direction from site	Expected Magnitude - Mw	Recurrence Interval (years)
Wellington Fault	West	7.5	840
Moonshine Fault	West	7.1	2,000
Wairarapa Fault	East	8.2	1,200
Ohariu Fault	West	7.5	2,500

In addition, the subduction interface between the Pacific and Australian plates has the potential to generate very large magnitude earthquakes (M_w 8.2-8.6) that would generate strong ground shaking in the Wellington region (Holden and Zhao, 2011).

13.2.3 Liquefaction

A liquefaction hazard study for the Wellington Region was carried out by Works Consultancy Services (now Opus) in 1992 and the results of the study were published by the Wellington Regional Council (WRC, 1993). This study indicates a variable liquefaction potential across the site, from low to high, which reflects the variable compositions of the alluvial, marine and fan deposits.

Liquefaction will occur when submerged loose to medium dense granular materials and silt are subjected to ground shaking. Liquefiable materials such as loose to medium dense silt, sand and gravel are likely to be present in the area, particularly around the Petone foreshore and along the Hutt River.

The groundwater table at Petone is likely to be about 2 m deep (Works Consultancy Services, 1996a) and this part of the site may therefore be susceptible to liquefaction. The Cross Valley Link being considered is located in areas of variable potential for liquefaction, ground subsidence and lateral spreading.

13.2.4 Tsunami

The Petone Interchange area, The Esplanade and the Cross Valley Link are exposed to tsunami hazards according to the Wellington Regional Council tsunami evacuation zones. The Cross Valley Link would be exposed a lower height tsunami inundation than The Esplanade.

13.3 Engineering Issues and Solutions

If the Cross Valley Link progresses it is likely to involve at grade or low height embankments along Wakefield Street, embankments and a bridge across the Hutt River flood plain and low height embankments to the east of the river.

Key engineering features of the CVL routes are:

- Large areas of road pavement at present ground level along Wakefield St and Whites Line West;
- New bridge over Hutt River, upstream of or alongside the Ava Rail Bridge; and
- Small embankments and retaining walls at the approaches and abutments to the new bridge.

The principal issues for the Cross Valley Link route are summarised in Table 13-3.

Table 13-3: Key Geotechnical Issues for the Cross Valley Link Route

Location	Road Form	Key Geotechnical Engineering Issues	Risk Management Measures and Possible Concepts
At-grade along Wakefield St and Whites Line West	» Road on existing ground	» Proximity to active Wellington Fault. » Variable ground conditions. » High groundwater levels, including artesian groundwater. » Liquefaction hazard in earthquakes and impact on embankments and structures. » Potentially contaminated ground.	» Geotechnical investigations to confirm ground and groundwater conditions and liquefaction hazard. » Geological investigations to confirm location, width, characteristics and form of the Wellington Fault zone. » Locate structures away from fault zone. » Undercut of soft ground and drainage measures.
Hutt River crossing	» Bridge » Retaining walls » Embankments	» Foundation conditions for bridge and retaining walls on alluvial deposits. » Artesian groundwater pressures. » Instability of bridge abutments and embankments due to liquefaction and lateral spreading in earthquake events.	» Geotechnical investigations to confirm ground and groundwater conditions and liquefaction hazard. » Pile foundations to support bridge structure. » Pile construction to resist artesian groundwater pressure and prevent aquifer contamination.

The geotechnical issues described above in Table 13-3 can be resolved through:

- An appropriate level of geotechnical investigations;
- Early consideration of issues during concept development and preliminary design; and
- Integrated consideration of the geotechnical issues with the development of the project, to achieve an appropriate road form, reduce construction costs, reduce potential hazards and improve the overall performance and resilience of the new road.

14 Resource Management Issues

A preliminary assessment of the planning restraints associated with the eight options has been completed and provided in Appendix W. The assessment considers:

- Affected land uses;
- Physical and environmental constraints;
- Zoning requirements;
- Heritage buildings and trees;
- District council plan requirements; and
- Regional council plan requirements.

From a planning perspective, it is considered that there are two main options with variations within these options. Those are Esplanade Improvements options and Cross Valley Link options. These are discussed in the following sections. A summary of the various possible consents necessary has also been provided.

14.1 Esplanade Improvement (SV-1, Sv-4, SV-5, SV-6, SV-7)

Option SV-1 is currently planned as upgrading The Esplanade predominantly within the legal road reserve. This option will impact on a small section of land in front of the War Memorial, a heritage building. For this reason, a heritage building consent may be required. The works will occur adjacent to a Special Recreation Activity Area zone (Petone Beach) and encroach slightly into the recreational space. This type of zone has a number of applicable rules that relate to Option SV-1 including changes to utilities, transport and earthworks. The encroachment of works into the Special Recreation Activity Area is the main trigger for resource consent.

Options SV-4, depowering The Esplanade, and SV-6, four laning The Esplanade to Victoria Street, have the same resource consenting issues as SV-1. However, SV-6 does encroach further into the Special Recreation Activity zone than SV-1.

Option SV-5 provides four lanes along the full length of The Esplanade to the Estuary Bridge. In addition to the requirements for SV-1, this option would require additional heritage building consents and demolition consents as it would require the removal or relocation of the TS Tamatoa Sea Cadets Building and the Jetty Café and Rowing Club.

Option SV-7, four laning of The Esplanade and the Estuary Bridge, shares all of the same planning requirements as SV-5 and SV-1. The bridge construction would likely trigger additional resource and demolition consents and is not likely to be a permitted activity under GWRC Regional Plans.

14.2 Cross Valley Link (SV-2, Sv-3, SV-8)

Option SV-2, the Whites Line alignment, mainly follows the existing roads that have a wide legal corridor. Most of the improvements will be located within the legal road which is the responsibility of the Hutt City Council. There are sites outside of the legal road, approximately eight residential properties, which would be affected as buildings on those sites would need to be removed. The construction of a bridge across the Hutt River would also require consents from GWRC in terms of not being permitted under various Regional Plans. These consents would largely be a discretionary activity and the likelihood of full public notification is very high.

Options SV-3 and SV-8 follow the railway alignment to create a Cross Valley Link. Some of the improvements will be performed within the legal road area that is the responsibility of the Hutt City Council. The rest of the alignment will require the construction of a new road that will impact on existing housing and recreational activity areas. Resource consent will be required as well as changes to the existing railway designation. There are a number of sites affected that will need to be purchased and houses/housing demolished. The construction of a bridge across the Hutt River will also require consents from GWRC.

14.3 Summary

Table 14-1 provides a quick overview of what kind of approval or consent applications might be required for each of the proposed options.

Table 14-1: Overview of the required approval or consent applications for each option

Option	Planning Requirements						
	Public Works Act	Designation	Resource Consent	Outline Plan	Certificate of Compliance	Heritage Building Consents	Demolition permits
SV-1	No	No	**Yes**	No	No	**Yes**	No
SV-2	**Yes**	No	**Yes**	No	No	No	**Yes**
SV-3	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**
SV-4	No	No	**Yes**	No	No	**Yes**	No
SV-5	No	No	**Yes**	No	No	**Yes**	**Yes**
SV-6	No	No	**Yes**	No	No	**Yes**	No
SV-7	**Yes**	No	**Yes**	No	No	**Yes**	**Yes**
SV-8	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**

15 Maintenance Issues

Only concept designs have been prepared to date, current and future maintenance issues have not been considered in detail. However, the options that propose additional traffic lanes will make maintenance easier as lanes can be closed and opened to maintain traffic flow. This is not currently possible in some sections due to the single lane configuration. A general list of maintenance issues that will arise from each option is provided below in Table 15-1. It should be noted that this list is not comprehensive it is just to provide an indication of the types of maintenance issues that will arise.

Table 15-1: General List of Possible Maintenance Issues

Maintenance Issues		Option							
		1	2	3	4	5	6	7	8
Extra maintenance cost	Additional traffic lanes					✓	✓	✓	
	New specialised lanes e.g. cycle, bus	✓			✓				
	Widening road					✓	✓	✓	
	New road			✓					✓
	New bridge structure		✓	✓					✓
	Widening existing bridge structure							✓	
	New traffic lights	✓	✓		✓	✓	✓	✓	
	Modified road marking and signage	✓	✓	✓	✓	✓	✓	✓	✓
	New roundabout		✓	✓					✓
	Road layout changes	✓	✓	✓	✓	✓	✓	✓	✓
	New parking provisions[14]			✓					✓
	Off-road shared use path (GHW)					✓	✓	✓	
Additional lane allows for easier maintenance			✓			✓	✓	✓	

Future development and refinement of the designs during the scheme assessment/design stages should consider maintenances issues in further detail. It is anticipated that the project improvements will be maintained as part of the existing Hutt City Council maintenance programme.

[14] Parking provisions have not been quantified. May need to provide parking at another site to account for parking removed from four laning options (SV-5 and SV-7).

16 Option Evaluation

A high level assessment has been undertaken in order to combine the various assessment elements of the project in order to illustrate the relative differences between the various options and the existing situation. The evaluation was based on the project objectives provided in Section 1.6. Each objective is comprised of sub-sections which allows for a more detailed assessment of the options against the objectives. Where possible the assessment has been expressed in monetary terms however most criteria can only be evaluated in a qualitative manner.

It must be noted that this evaluation has been carried out by transport engineers and planning specialists, not individual specialists from each discipline. The full results from this assessment are attached in Appendix X and a summary of its outcomes are shown in Table 16-1.

Table 16-1: Summary of Options Analysis

Option	Maximise Value for Money	Facilitate Economic Growth	Enhance Resilience	Minimise Environmental Impacts	Enhance Linkage between Sea and Petone
SV-1	Minimal effects. Negative BCR	Little to no effect	No change	Minimal effects	Improves access
SV-2a	Positive effects and BCR	Positive effects	Enhanced resilience	New bridge has impacts	Reduces severance
SV-2b	Negative effects and likely negative BCR	Positive effects	Enhanced resilience	New bridge has impacts. Positive for access to the seafront	Reduces severance
SV-3a	Positive effects and BCR	Positive effects	Enhanced resilience	New bridge has impacts while new road may have social effects	Reduces severance
SV-3b	Negative effects and likely negative BCR	Positive effects	Enhanced resilience	New bridge has impacts while new road may have social effects. Positive for access to the seafront	Reduces severance
SV-4	Negative effects and BCR	Negative effect	No change	Minimal effects. Positive for access to the seafront	Greatly improves access
SV-5	Overall positive effects and BCR	Some positive effects	No change	More pavement and heritage effects	Worsens severance
SV-6	Minimal effects. Negative BCR	Overall positive effects	No change	Minimal effects	Improves access
SV-7	Overall positive effects and BCR	Some positive effects	No change	Improved bridge has impacts. More pavement and heritage effects	Worsens severance
SV-8a	Overall positive effects and BCR	Overall positive effects	Enhanced resilience	New bridge has impacts while new road may have social effects. Positive for The Esplanade	Reduces severance
SV-8b	Negative effects and likely negative BCR	Overall positive effects	Enhanced resilience	New bridge has impacts while new road may have social effects. Positive for The Esplanade and positive for access to the seafront	Reduces severance

16.1 Maximise Value for Money

This assessment shows the CVL options (SV-2, SV-3 and SV-8) as well as the options that involve double laning the whole length of The Esplanade (SV-5 and SV-7) all achieve the objective of maximising value for money. This is because these are the options that give a positive BCR. The other options all have negative BCRs and subsequently do not meet this objective.

16.2 Facilitate Economic Growth

The improved network capacity and additional cross corridor connection also help CVL options achieve the second objective of facilitating economic growth. The full double laning options have a smaller effect on facilitating economic growth. They do provide an improved connection to the P2G link road but they also negatively impact on the availability of street parking. This may lead to growth in Petone but may negatively impact growth elsewhere due to reduced accessibility. SV-5 which is only partially double laned has minimal impact on street parking and maintains accessibility. Consequently it has a positive influence on economic growth. SV-1 has improved accessibility but its ability to enable economic growth is limited. The depowering in SV-4 has a significant negative impact on growth and subsequently does not meet this goal.

16.3 Enhance Resilience

The additional cross corridor connection provided by the CVL options give them a high rating in the enhance resilience objective. The additional capacity provided on The Esplanade by SV-5, SV-6 and SV-7 does improve the networks resilience slightly. All other options do not improve the networks resilience and subsequently don't satisfy this objective.

16.4 Minimise Environmental Impacts

The CVL options and SV-7, which involve constructing a new or wider bridge, will impact the waterways, Iwi and ecology. The full double laning options also encroach on the Petone Settlers Museum, which is a heritage building. Overall The Esplanade improvement options, except SV-7, tend to have lower environmental impacts than the others.

16.5 Enhance Linkage between the Sea and Petone

The double laning options increase the flow along The Esplanade and subsequently have the potential to increase severance and congestion. In contrast the CVL options divert traffic away from the water front and reduce congestion. Additionally the new signals in SV-1 and SV-4 improve the accessibility of the sea. Overall the CVL options best satisfy this objective as the lower volumes help reduce severance between Petone and the sea.

16.6 Comparison with Petone to Grenada Project Objectives

P2G is a related, but separate transportation project. The relationship between the Seaview Links options and the P2G project objectives is shown below:

Enhance local, regional and national economic growth and productivity for people and freight;

Improve connectivity between the lower Hutt Valley and Johnsonville and Porirua

Reduce journey times and improve journey time reliability between the lower Hutt Valley, Ngauranga and Porirua, and on the Wellington State Highway network;

The CVL options could all be considered to support these three objectives, through the provision of an upgraded connection across the lower valley floor. The Esplanade depowering option does not achieve these objectives, as it introduced increased travel times between Seaview and the P2G project.

Enhance safety of travel on the Wellington State Highway network;

Enhance resilience of the Wellington State Highway network;

No options under consideration support these objectives, as the projects are focused on the Hutt City local road network.

Manage the immediate and long term social, cultural, land use and other environmental impacts of the Project on the Wellington region and its communities by, so far as practicable, avoiding, remedying or mitigating any such effects through route and alignment selection, expressway design and conditions;

This objective is considered not relevant to the CVL options.

By developing and constructing a cost efficient new road alignment to expressway standards between SH2 in the lower Hutt Valley and SH1 north of Ngauranga

This overarching objective is not met by any of the improvements.

This analysis shows that the Seaview to Petone options can partially support the P2G project objectives, but do not meet the overall project requirement for a new link road.

17 Assessed Options

NZTA standards for feasibility studies require that a preferred option is selected. In this case there are several options that have the potential to be progressed and may be taken forward for more detailed investigation depending upon the aspirations of HCC and NZTA.

The economically feasible options include the two full Esplanade four laning options (SV-5 and SV-7) as well as the CVL options (SV-2, SV-3 and SV-8). Of these options, the CVL options were considered to better meet the project objectives due to the positive effects of enhancing resilience and improving access between Petone and the sea. These options also facilitate economic growth. However it must be noted that the provision of a new bridge structure may have environmental and cultural impacts.

SV-3a (called SV-3 hence forward) was selected as the option that would be assessed at a greater detail in this report as it had a positive BCR, promoted economic growth and improved resilience. Although SV-2a (called SV-2 hence forward) has the highest BCR and lowest cost it also requires greater land acquisition, which carries a risk to the project. SV-2 also necessitates the removal of more greenspace so has the greater adverse environmental effects. Because of these issues SV-3 was selected over SV-2. SV-3 also diverted traffic away from The Esplanade so in turn enhancing the linkage between Petone and the sea. Additionally from an urban design perspective SV-3 was identified as the best solution.

The following sections of the report therefore use SV-3 in assessing the social and environmental effects, LTMA assessment and the NZTA profile assessment. While SV-3 has been selected in this report, in the future all economically feasible options should be considered in the future stages of this project.

18 Social and Environmental Assessment

This section documents the assessment of the potential social and environmental effects of the assessed option, SV-3. Consideration has been given to effects both during construction and on completion of the improvements. The assessment subjectively identifies the magnitude of the potential effects before mitigation. This assessment completed using the Transit NZ PSF/13 form, and populated according to the accompanying Transit NZ PSG/13.

The *Degree of Effect* is intended to describe the potential magnitude of the effects of each option. The four categories are as follows:

- High (**H**): Permanent, serious and widespread adverse effects and/or opportunities for social and environmental improvement. Adverse effects to be avoided; opportunities to be actively pursued.
- Medium (**M**): Major, medium-term adverse effects and/or opportunities for social and environmental improvement. Where cost-effective, adverse effects to be avoided and opportunities pursued (significant mitigation may be required).
- Low (**L**): Limited, short-term adverse effects and/or opportunities for social and environmental improvement. Where cost effective, adverse effects to be avoided or mitigated and opportunities pursued (mitigation may be required).
- Irrelevant (**NA**): No effect and/or opportunity. No action required.

The following tables should be updated as the project progresses.

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Noise Construction noise, traffic noise, maintenance noise, presence of sensitive receivers (homes, schools, hospitals etc.)	• Construction noise may disturb local communities. • Additional bridge maintenance (and possibly paving) noise from existing. • Should be minimal change in overall traffic noise. Some locations might get busier but other locations will have less traffic to offset this.	L L L			
Air Quality Dust, air pollution, greenhouse gas emissions, odour.	• Dust and air pollution from construction will need to be mitigated. • CO_2 emissions may reduce as a result of the improvements due to the easing of congestion.	L L (+ve)			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Water resources Sedimentation, contaminants in road run off, climate change impacts (sea level rise and changing rainfall patterns), impacts on sensitive water bodies, changing hydrological cycles and water flow patterns.	• Requires new bridge structure. Construction effects will require mitigation. • Additional paving of road near rail line. Road run off will require mitigation.	M M			
Erosion and sediment control Soil slips, landslides, water erosion (raindrop, sheet, rill gully, tunnel, channel) and wind erosion (dust)	• As above.	M			
Social Responsibility Social severance, social interaction, connectivity	• Improved connectivity through the provision of additional routes. • Reduced social severance.	M (+ve) M (+ve)			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Culture and Heritage Wahi tapu, and Statements of Identified Maori Interests, archaeological sites, historic buildings, places, trees and special features	• Cultural effects due to bridge over Hutt River may be present.	L			
Ecological Resources Significant vegetation, fauna passage, habitat protection, special trees, reinstatement of vegetation, slope stabilisation, use of low-growth vegetation to reduce maintenance costs.	• No ecological effects are expected.	N/A			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Spill response and contamination Spills from vehicle accidents, on-site storage of fuels, excavations of contaminated soils/ clean fill	• Possible contamination effects further investigation required. • Mitigation measures should be in place for possible construction effects.	L L			
Resource efficiency In situ pavement recycling, energy efficiency, initiatives to reduce waste to landfill, use of local materials.	• Use of local quarry material may be possible.	L (+ve)			
Climate Change: adaptation and mitigation Sea level rise, greenhouse gas emissions, increase incidence of flooding and coastal storms	• A more efficient road will reduce congestion and greenhouse gas emissions.	L (+ve)			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Visual quality Landscaping, retaining walls, noise walls, views from roads and neighbouring properties, use of plants to reduce maintenance costs.	• New bridge structure over Hutt River may effect visual quality	L			
Vibration Construction and maintenance vibration, pavement surface, heavy traffic vibration, presence of sensitive features including historic buildings and features.	• Should be minimal change in overall vibration. Some locations might get busier but other locations will have less traffic to offset this.	L			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Land use and transportation integration Integration of land use and development with transport networks, reverse sensitivity, access management.	• Provides more direct link for eastern suburb growth • Reduced congestion on The Esplanade encourages growth in Petone and on foreshore	M (+ve) M (+ve)			
Urban design Context sensitive design, including aesthetics of structures (refer to PSG/12).	• Urban Design assessment has been completed which identifies a range of effects and opportunities for mitigation.	M			
Public health Stress to individuals and community, personal security, cycling and walking opportunities.	• Reduced congestion is likely to reduce stress to individuals and the community. • Footpath to be provided along the new road and bridge increasing the pedestrian facility network.	L (+ve) L(+ve)			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Cycling Infrastructure On highway cycle lanes, segregated cycle path adjacent to SH, links to local cycling network.	• No change to cycle specific infrastructure however provides the opportunity to provide improved cycle facilities.	N/A			
Cycle Crossing Facilities Shared cycle/pedestrian crossing at traffic signals, widened traffic island to accommodate cyclists where cycle route crosses SH, dropped crossings.	• No change to cycle specific infrastructure.	N/A			
Walking Infrastructure New or widened footway, connections to local road footways.	• Footpath to be provided along the new road and bridge increasing the pedestrian facility network.	M (+ve)			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Pedestrian Crossing Facilities Signalised crossings, traffic islands, dropped crossings, pedestrian desire lines	• Existing pedestrian crossing facilities to be maintained. Improvements possible on The Esplanade.	N/A			
Bus Related Infrastructure Bus laybys, hard standings, build-outs into carriageway at bus stop.	• No bus stops are present on the route however new crossing opportunity provides additional options for the future • Reduced congestion on The Esplanade will improve bus journey times and level of service	L(+ve) L(+ve)			

Social and Environmental Screen			Social and Environmental Assessment		
Issue Social and environmental issues	**Effects** Describe the potential social and environmental effects of the opinion, including where the option may improve social and environmental outcomes.	**Degree of effect** H/M/L/ NA	**Requirements** List all legal requirements and relevant social and environmental objectives	**Addressing effects and meeting requirements** List actions to be taken to meet specific social and environmental requirements and objectives and address all effects identified. Include an estimated cost.	
				Specific Actions	Estimated cost ($)
Priority Lanes Potential to include bus, freight, HOV lane either through the reallocation of existing road space or new construction to make certain modes more efficient and widen travel choice.	• No opportunity at present as it is not currently a bus route, however, provides additional route options for freight.	L(+ve)			
Traffic Management Potential for ITS, variable message signing, variable speed management, ramp signalling.	• ITS signage could be implemented if necessary to better manage flows, movements, etc.	L (+ve)			

19 Resilience Assessment

The assessed option (SV-3) which includes the CVL will enhance resilience during operation by providing an additional link across the river in the southern part of Hutt Valley. This will provide an alternate route in the event of an emergency, crashes or during maintenance.

The link would also enhance resilience in natural hazards. Being away from the coast, the route will be less vulnerable to tsunami, and particularly storm surge and high winds. In earthquake events, the route will still be susceptible to liquefaction. However, the route will be more resilient because:

1. The route will be predominantly located on flat ground, and therefore the effects of liquefaction will be predominantly sand boils and subsidence of the ground. These are far less damaging to road links than lateral spreading towards the river and harbour as in the case of The Esplanade / Waione Street link. This was evident in Christchurch in the Canterbury earthquakes. The performance of the road could be further enhanced by reinforcing the road subgrade with geogrids. The road will continue to provide access, although may be uneven, and can be quickly restored by reinstating the pavement.

2. The link across the Hutt River will still be vulnerable to liquefaction and lateral spreading, but because the bridge will be newly built, the abutments and approaches can be strengthened by a stronger structure or by ground improvement to make the link across the river resilient to earthquakes (Brabhaharan, 2014). This has been used on bridges on the Christchurch Southern Motorway as well as the current reconstruction of the Ferrymead Bridge in Christchurch.

3. The SV-3 would be designed follow current standards and engineering best practice including the provision of adequate drainage to mitigate flood risk.

In summary, the new cross valley link would substantially enhance resilience of access in the southern part of the Hutt Valley.

20 Land Transport Management Act Assessment

20.1 Policy Context

The Land Transport Management Act 2003 (LTMA) is the main statute for New Zealand's land transport planning and funding system. The purpose of this act is "to contribute to an effective, efficient and safe land transport system in the public interest". It aims to achieve this by supporting the objectives of the Government Policy Statement (GPS) by making specific requirements for the preparation of Regional Land Transport Strategies.

The LTMA requires the Minister of Transport to issue a GPS every three years. This enables the Minister to guide the NZTA and the land transport sector on the short-midterm outcomes and objectives that the crown wishes to achieve. The LTMA requires NZTA to assess all potential projects against the GPS and the relevant Regional Land Transport Strategy (RLTS).

Proving that a project that aligns well with the objectives stated in the GPS and RLTS is important in ensuring that projects such as this progress. This project will also be assessed against the Hutt Corridor Plan, which is a derivative of the RLTS that is directly linked to the aim of this project. The following chapters outline how the preferred option supports the vision and objectives presented in these documents.

20.2 Government Policy Statement

The Government Policy Statement on Land Transport Funding 2012/13-2017/18 (July 2011) details the government's aspiration and funding priorities in the short to midterm period. At the present time economic growth and productivity is a major priority for the government. Subsequently there are three areas focus listed in the GPS:

- Economic Growth and Productivity
- Value for Money
- Road Safety

The GPS also highlights the need to improve the local road network by addressing opportunities to ease congestion and capacity constraints as well as improving journey time reliability and improve safety. To achieve this the GPS proposes "improving the condition and/or operation of key routes that are important in providing access to areas of employment or economic growth, and routes that carry significant amounts of freight". This description accurately describes many of the roads discussed in the project area, especially The Esplanade.

20.3 Wellington Regional Land Transport Plan

The Regional Land Transport Plan 2015 (RLTP) for the Wellington Region has been developed by Greater Wellington Regional Council to set out the strategic direction for land transport in the Wellington region for the next 10 to 30 years. It is a statutory document, which replaces the earlier Regional Land Transport Strategy 2010-40. The RLTP outlines a number of strategic objectives for transport projects in the region with respect to economic growth safety, resilience and liveability. The key actions which are implemented out by this project are also presented. Consequently this demonstrates that the Seaview Links project will contribute towards achieving many of the objectives detailed in the RLTP as shown in Table 20-1.

Table 20-1: List of Regional Land Transport Outcomes that are Satisfied by the Preferred Option

Strategic Objective	Key Action
Economic Growth	
A high quality, reliable public transport network	• Bus priority measures and other supporting road network improvements
A reliable and effective strategic road network	• Build safety improvements on roads • Improved pedestrian and cycling safety • Measures to reduce congestion • Advocate for mode shift
An effective network for the movement of freight	• Advocate and provide commuter mode shift • Advocate for infrastructure improvements along regionally significant priorities
Safety	
A safe system for all users of the regional transport network	• Build safety improvements on roads • Improved pedestrian and cycling safety
Resilience	
An increasingly resilient transport network	• Advocate for mode shift
Liveability	
A well planned, connected and integrated transport network	• Advocate for infrastructure improvements along regionally significant priorities • Advocate and provide commuter mode shift • Bus priority measures and other supporting road network improvements
An attractive and safe walking and cycling network	• Improved pedestrian and cycling facilities • Improved pedestrian and cycling safety
An efficient and optimised transport system that minimizes the impact on the environment	• Advocate and provide commuter mode shift • Measures to reduce congestion • Improved pedestrian and cycling facilities

20.4 Hutt Corridor Plan 2011

The Hutt Corridor Plan 2011 (HCP) was developed to be consistent with the RLTS. The Hutt Corridor is the transport corridor formed by State Highway 2 (SH2) between Ngauranga and Te Marua, Upper Hutt. The HCP sets the long term vision for this section and includes major connecting arterial routes and key public transport, walking and cycling connections.

One of the significant issues identified in the HCP is the future capacity concerns along the link between SH2 and Seaview/Gracefield. It also proposes the P2G link road which will add further strain on the existing connection along The Esplanade. To counter this, the HCP has indicated that improvements will need to be carried out. The P2G project will largely address these problems through the redesign of the linkage with SH2 in Petone, however the preferred option for this project will addresses the proposed infrastructure improvements and will in turn help achieve the HCP objectives which are listed below:

- Provide for current and future growth pressures (population/employment/freight) in the Hutt Corridor;
- Reduce severe congestion on the road network, including the Petone Esplanade/SH2 intersection;
- Improve the mode share of walking, cycling and public transport;
- Improve accessibility for all modes;
- Improve route security and network resilience; and
- Improve road safety throughout the corridor.

21 NZTA Assessment Profile

The assessment profile associated with the project has been evaluated in accordance with the requirements of NZTA's Planning & Investment Knowledge Base. This appraisal will assist the projecting being included in the Regional Land Transport Programme. NZTA currently considers funding based on how well the project aligns with the following three areas:

- Strategic Fit of the problem, issue or opportunity that is being addressed;
- Effectiveness of the proposed solutions; and
- Economic efficiency of the proposed solution.

The project has been assessed against the above three criteria by assigning a rating of high, medium or low. The strategic fit evaluation considers how well the project aligns with the NZTA's strategic investment direction and the effectiveness assessment looks at the extent to which the project will achieve the potential identified in the strategic fit. The efficiency rating refers to the BCR.

The following sections set out ratings given to the assessed option.

Strategic Fit: **Medium**

Improvements to this corridor will contribute to economic growth and productivity in the region by improving travel time, reliability and reducing congestion. However, as this corridor is not directly part of the RoNS programme and only affects connectivity between the Hutt area and SH2, this project only achieves a medium strategic fit.

Effectiveness: **High**

This project increases the effectiveness of a strategic component of the region's transportation system. In particular the project improves travel time and reliability for motorists.

Efficiency: **Low**

At this early stage in the project development, and without consideration of WEIs, the BCR including agglomeration benefits for this option is 1.7. Thus the economic efficiency rating is low. There is some uncertainty surrounding the population growth, employment and forecasted land use in the area. Therefore in the next stage of the project a sensitivity analysis should be carried to understand the impact any variations will have on the option's BCR (e.g. low and high growth scenarios).

This rating (MHL) classifies the option as a priority 6 project. NZTA awards funding to projects based on their evaluated priority (1 to 11) thus this project is in the middle of that range.

22 Opportunities and Risks

Through the development of this PFR, a range of opportunities and risks which should be considered going forward have been identified. The following list highlights the key items which should be considered further in the next stages of the project:

- The NWSM used in evaluating the options was calibrated but at this stage is yet to be validated[15], due to lack of count data and the tight timeframes around the associated studies. This is a risk in that it leaves uncertainty around the results which have been produced out of this model. This has since been resolved with the update to NWSM but only the CVL options have been rerun;
- Sensitivity tests should be performed to further evaluate any identified preferred options and the assumptions that have been taken forward in this work. For example, the modelled outputs were completed using the medium growth scenario in WTSM. As the projected land use around Hutt City could have large variance in growth in the future, it would be prudent to assess the outputs using the low and high growth scenarios;
- This project has assumed that the Petone to Grenada project will be built in the base modelling and economic assumptions. A particular alignment has also been assumed from the Petone to Grenada PFR. It may be necessary to assess the preferred option(s) with and without P2G and using the most up to date information from the Scoping Report, or Scheme Assessment Report once completed;
- A link from Seaview to any Cross Valley Link option through the decommissioned railway line to remove HCVs from Randwick Road and encourage the use of the CVL may require further consideration and/or modelling;
- Staging of options to best achieve the project objectives may be considered. If one of the CVL options was chosen to be progressed, The Esplanade Improvements option (SV-1) may be implemented first to improve accessibility to the foreshore. This would require a longer term commitment to the scheme by Hutt City Council;
- The modelling of options SV5 and SV-7 (four laning of The Esplanade) has been completed with the assumption that several foreshore buildings affected (TS Tamatoa Sea Cadets building, Jetty Café and Rowing Club and Heretaunga Boating Club) could be removed or relocated. There have been variations to these options developed that do not require the removal of these buildings but turning movements from Fitzherbert, Sydney and Nelson Streets would be restricted (left-in / left-out only). These variations will reduce project cost estimate by $3.5M but may also reduce benefits. If one of these options was identified to be progressed, modelling and assessment of the option without removing the buildings could be performed;
- Potential contaminated land sites identified in Appendix V may require preliminary site investigations to determine whether or not this is a risk and should be considered in the next stages of the project;
- Provide a direct link from the Dowse Interchange to Wakefield Street for any CVL options that may be progressed so as to enable benefits to be realised sooner;
- The impact on SH2 has not been considered and subsequent changes to the interchanges have not been included in the cost estimate. Therefore possible changes to interchanges should be identified and have costs quantified if they were progressed as part of this project;

[15] Northern Wellington SATURN Model Update Model Calibration and Validation Report, SKM 2013

- Even with CVL the flows along The Esplanade are around the threshold for double laning (ADT >17,000). Therefore in conjunction with the CVL double laning The Esplanade or flow reduction measures should be considered; and
- A safety review should be carried out on the project to identify any significant safety concerns.

23 Conclusions and Recommendations

The feasibility assessment undertaken for a link to Seaview builds on previous work completed for NZTA and HCC.

Traffic modelling has been carried out with the P2G link road and found that this project will likely increase traffic on The Esplanade by approximately ten percent in the year 2031. This additional volume may require changes to the Hutt City transport network in order for them to achieve operational efficiency. The predicted traffic increase on The Esplanade also suggests that The Esplanade cannot be depowered without some other scheme in place to alleviate traffic volumes. While the forecast numbers with and without the P2G link road may not be excessive, it should be noted that the modelled volumes in the base year for 2011 are less than the existing volumes identified by the HCC traffic counting programme. While the HCC volumes may be more recent (from 2012 or 2013) and have not been seasonally adjusted, they are consistently higher than those in the model. Should this project progress to scheme assessment, further assessment and refinement around the traffic modelling should be undertaken.

Eight options were developed and modelled to address the demands of the future traffic volumes with the P2G link road and to address the project objectives agreed by HCC and NZTA. Of these options five have positive benefit cost ratios greater than one. However, several of the options with positive BCRs do not address, or worsen, some of the other intentions for the project such as reducing severance and improving access to the foreshore. A number of these options meet or exceed the other criteria set forth and there is potential for elements of options to be combined to find the best solution.

The urban design assessment identified Esplanade Improvements and the Railway Alignment for a Cross Valley Link as preferred options depending on the alignment of the P2G link road and the resulting interchanges with SH2 and the Petone/Hutt Valley.

If this project is progressed it is recommended that the preferred option(s) are determined and clear, consistent objectives identified. Further work should include:

- Modelling with varying growth assumptions to determine economic risk associated with the project;
- Detailed analysis of WEI's for the options once the preferred option for P2G has been identified; and
- Investigation of staged solutions on The Esplanade and CVL corridor.

Progressing the project to the scheme assessment stage once the P2G preferred option has been identified will enable HCC to continue to develop the design and identify an optimal solution. During the next stage of work, further consideration of the urban design issues, stakeholder and community inputs, and planning issues should be undertaken.

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Appendix A – Stakeholder Engagements

Appendix B – HCC Cycle Lanes and Shared Paths

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Report to:

Hutt City Council

THE NATIONAL ECONOMIC BENEFITS PERMITTED BY THE CROSS-VALLEY LINK

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1 Executive Summary

This report analyses a proposed Hutt City transport project, the Cross Valley Link (CVL). We investigate the wider economic impacts to Petone West of increased amenity due to the CVL, and consider the relevance of these impacts to the NZTA's funding criteria.

There is a sound indication that the CVL would have wider economic benefits for Petone West. However, the area of transport, urban form and economic activity is currently being researched in New Zealand, and to date there is too little evidence to draw absolute estimates based on causal relationships of how reductions in traffic, especially heavy traffic will increase amenity, increase urban density and attract overseas migrants.

The resource and time allocated to the present study has not allowed us to review the international research. This might include specific analysis of the impacts of diverting heavy traffic from desirable environments. Therefore, there is further work that could be done in this area to develop stronger, defensible arguments by analysing similar natural experiments elsewhere in the world. Such a thorough analysis would require commensurate resourcing. But even the most conservative scenario suggests further work is merited.

1.1 Wider economic benefits of improved access to Seaview/ Gracefield

Access to Seaview/ Gracefield – the Wellington region's primary manufacturing base - is crucial to the effectiveness and growth of businesses that require industrial land. Growth in the Seaview/ Gracefield area is expected to continue, which will affect access if nothing is done. SKM's *Ngauranga Triangle Strategy Study* identifies two options for improving access to Seaview/ Gracefield.[1] [2] These are:

- a new Petone Interchange, which will connect a proposed Petone Grenada Link (PGL) to the Hutt City local road network
- developing the CVL as an east-west link from the new Dowse Interchange on SH2.

How this access is delivered affects the community and growth prospects of Petone. The PGL will improve access to Seaview/ Gracefield from SH1, but will also increase congestion along The Petone Esplanade and reduce access to the Petone foreshore. This will reduce The Esplanade's amenity, negatively impact on the HCC district plan objective of making

[1] SKM (22 January 2010). The Ngauranga Triangle Strategy Study, Short list options assessment report, Final. Report prepared for the NZTA.

[2] SKM's (22 January 2010) study also includes a 'do minimum' option. However, this alternative will not permit increased amenity and the necessary conditions for the urban densification will not be present.

Petone foreshore into a "special recreational area", and restrict the opportunities for mixed use urban intensification and development.

The potential impacts of the CVL depend on the support received for it from HCC and NZTA, and HCC's willingness to promote Petone and to designate Petone West as a mixed use zone. Subject to this support, the CVL would complement the Petone Grenada Link by taking traffic off The Esplanade, and could improve the amenity value of the Petone foreshore. Were this to happen, we expect the increased amenity would attract people to live and work in this area, increasing urban density and supporting higher economic growth. We construct two scenarios based on local, national and international evidence to characterise these benefits.

A substantial proportion of the benefits to Petone West are additional to those enumerated in SKM's economic analysis of the CVL.[3] We find that the CVL is likely to meet the NZTA's test to be recognised as national strategic significance. The present value of economic benefits to the nation from increased activity in Petone due to the CVL, net of SKM's travel time and vehicle operation cost (VOC) savings, would range between $348 million and $461 million in 2008 dollar terms. This suggests a ratio of the wider economic benefits to costs to of the CVL of between 5.3 and 7.0. If the CVL permits only one third of this additional activity, the present value range between $99 million and $136 million.

Further research would be required to better characterise the likely magnitude of benefit that is at risk if the CVL does not go ahead. Nonetheless, even under the most conservative scenario, our estimates suggest further work is merited.

1.2 Background

Seaview/ Gracefield is a principal industrial employment area in the Wellington Region:

- it accounts for 25 percent of the region's employment in manufacturing
- it is a major part of regional capacity in wholesale, warehousing and transport services
- it is an essential element in the national distribution network.

There is a regional commitment to an industrial base in Seaview/ Gracefield[4]. The area also has the best regional capacity for industrial expansion. Maintaining and expanding this base

[3] SKM (21 January 2010). The Ngauranga Triangle Study: Cross Valley Link Project Feasibility Report, Revision B. Report prepared for the NZTA.

[4] Through the Wellington Regional Strategy and the HCC district plan, which identifies the Seaview-Gracefield area as a "special business area".

is an important contributor to achieving the government's vision for national economic growth, by providing a significant cluster of innovative manufacturing industries.

Access to Seaview/ Gracefield is crucial to the effectiveness and growth of businesses that require industrial land. Expected growth in the Seaview/ Gracefield area means new transport infrastructure to ensure efficient access it is necessary.

1.3 Are there wider economic benefits of the CVL to Petone West?

The PGL and CVL projects affect regional and national interests in terms of securing access to the Seaview/ Gracefield industrial area, economic value added in Petone West and the amenity value of the Petone foreshore (The Esplanade).

Department of Labour research shows immigrants are attracted to New Zealand by its lifestyle, environment and employment opportunities. National immigration data also show that people are attracted to New Zealand when the economy is stronger, that is, when GDP grows more quickly. These increases in national GDP reflect higher economic activity spread across the country. We believe it is logical that the increases in immigration (both from internal and external sources) will be concentrated in those areas where the increased amenity and GDP growth is located, as these areas will be the most attractive in terms of vibrancy and work opportunities.

Improving the amenity and urban form due to the CVL will increase Petone West's attractiveness. This will lead to increases in urban density, increasing productivity and output. It is likely that the population and employment increases will come from immigrants and New Zealanders overseas attracted to Petone, as well as retaining highly skilled people in New Zealand. Furthermore, Petone's improved urban form will help achieve Wellington City's growth potential both as a high functioning satellite to Wellington city and by relieving pressure associated with further population or employment densification in Wellington City.

The increased flow of immigrants and retention of skilled workers living in Petone represents a gain to the nation. These people will generate additional activity rather than a transfer of activity from another region, thereby delivering a positive net contribution to the nation.

The CVL development will also contribute to maximising the potential of Wellington Harbour. Petone is a unique environment within the Wellington region and New Zealand. The development of Petone permitted by the CVL will enhance the attractiveness of the Wellington region (and New Zealand), for example, to innovative manufacturing business and international tourists. We have not attempted to enumerate these potential benefits.

1.4 Petone mixed use intensification scenarios

We focus our argument on the fact that economic activity in Petone West could increase substantially with a sympathetic approach to mixed use intensification, as perhaps exemplified in Remuera residential and commercial areas, Newmarket residential and in parts of Wellington City.[5] In addition, Petone's unique character and the demographic base in the Wellington region are likely to be substantial boosters to the economic activity permitted by this development.

We specify two development scenarios for Petone West using data on Petone's current urban form and capacity and standard urban analyses based on New Zealand and international evidence. The first scenario shows that, with designation for mixed use, the Petone West area would progress by 2026 to the density achieved in a 'Town Centre with a Premier Bus Service' as designated in the ARC's Regional Policy Statement. This would see 6,500 people employed in the area, an increase of around 4,100 on the present, and 2,800 residents who are all additional. There are no residents in this area at present.

The second scenario shows intensification of the area to its full potential, and that would be achieved by 2046. In 2046 there would be 13,700 people employed, an increase of 11,300. There would be 11,500 residents. Under this scenario the numbers achieved by 2026 amounts to 5,100 people employed and 2,800 residents. These scenarios are sound estimates of the significant opportunity for expanded residential and economic activity (a higher density urban area).

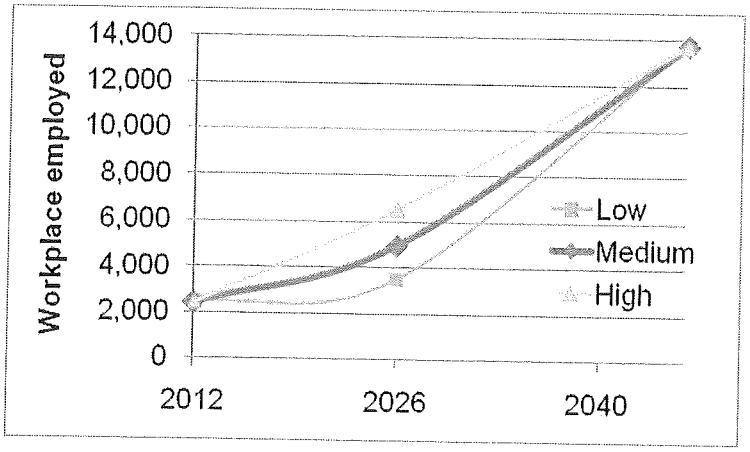
We use a conservative approach to estimate the benefits that stem from these scenarios, and analyse how sensitive the results are to our modelling assumptions. The basic analysis is of the intensification from 2012 to 2046, and this derives the expected level in 2026. The sensitivity analysis then explores the projected figures for 2026 and tests for variations in:

- the timeframe over which the benefits accrue
- the pace at which increased density and economic growth occurs
- the proportion of the increased economic activity from additional national employment
- the net impact, taking into account current levels of employment and the value of time and vehicle operating cost savings captured in the SKM analysis.
- the additional activity that is potentially at risk if the CVL does not go ahead.

[5] The analysis does not consider additional benefits to the region that will accrue from reduced traffic along The Esplanade. The significance of the area to Hutt City and the Wellington Region means that the final shape of The Esplanade would be subject to much consultation. However, based on the importance of prime waterfront land to a region's attractiveness, we expect that there would be benefits and these benefits would be substantial.

We focus on the medium growth profile under which employment grows steadily out to its potential at 2046. Figure 1.1 also shows low growth profile that mirrors Wellington City's employment density growth between 2001 and 2006, and a high growth profile.

Figure 1.1 Workplace employed under alternative growth scenarios to 2026 and 2046



The medium growth profile out to 2026 gives employment of approximately 5,000, which equates to approximately 2,500 additional workers.

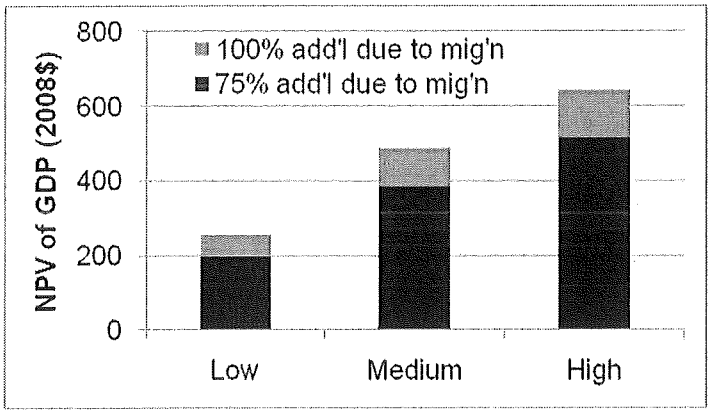
The evidence base developed within the scope of this research is not sufficient for us to forecast the degree to which moving traffic off The Esplanade will lead to the development and increased activity characterised above. However, without the CVL it is likely that around one third of the Petone West area will be unsuitable for the mixed use development. We assume this is a lower limit for the additional contribution of the CVL.

If the CVL permits Petone West to add 2,500 people employed by 2026 this will increase the GDP in 2026 by $160 million (expressed in 2008$ purchasing power). Tracking the expansion of the workforce from 2012 to 2026, we estimate the net increase in GDP in each year. Discounting that GDP stream to 2010, we estimate the additional labour would generate GDP with a net present value of $487 million.[6]

We expect 100% of the workers to be additional, and due to migration into the region and country. As a sensitivity test, if only 75% of Petone's growth is additional due to migration, the net addition to national GDP would have an estimated present value of$386 million.

[6] All monetary values are in 2008 dollars, discounted at an 8 percent rate.

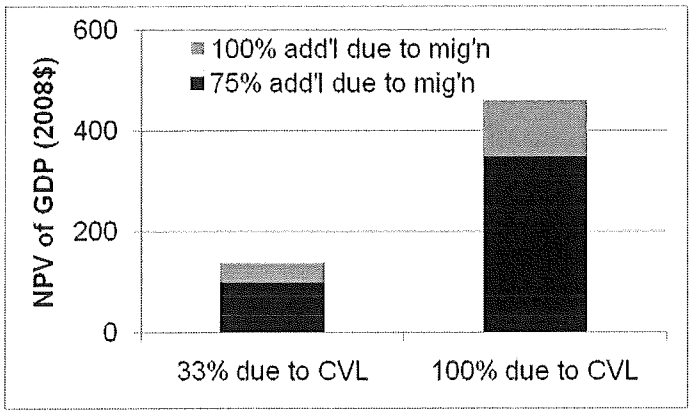
Figure 1.2 Net present value of (gross) additional GDP, 2026 medium growth profile



Deducting SKM's estimated benefits of $26.3 million for the CVL option including the PGL, gives a net wider economic benefit of $461 million in the medium case where the CVL is critical to this development and the net employment increase is all covered by additional migrants. This gives a ratio of the wider economic benefits to costs to of the CVL of 7.0. This is a strong estimate of wider regional and national benefits.

If the CVL permits one third of the estimated GDP to 2026, this would equate to a net present value of $162 million. Deducting SKM's estimated benefits of $26.3 million for the CVL option including the PGL, gives a net wider economic benefit of $136 million in the medium case. This gives a ratio of the wider economic benefits to costs to of the CVL of 2.1.

Figure 1.3 Net present value of (gross) additional GDP due to CVL, 2026 medium growth profile



1.5 Is the CVL of national strategic significance?

Very little of the wider benefit of intensification from Petone West's development are captured in SKM's assessment. These (net) wider economic benefits could legitimately be included if recognised as a national strategic factor. We consider the case for such recognition below.

Can the CVL be categorised as a national strategic factor?

The CVL fits both categories of national strategic factors in the NZTA's Economic Evaluation Manual (EEM). The CVL will secure access to one of Wellington's major industrial clusters, and will indirectly permit the development and expansion of Petone West.

Have the estimated wider economic benefits already been counted?

SKM's study estimates the benefits of the CVL to the lower Hutt Valley area in terms of travel time and vehicle operating cost savings. We could not get a breakdown of benefits of the CVL accruing specifically to Petone West. However, we expect that most of these benefits are for people transiting through Petone West, and would not accrue to people living or working at Petone West.

To be conservative, however, the net figures reported above deduct the entire benefit figure estimated by SKM. Thus, the estimated (net) wider economic impacts do not double count any of the benefits estimated in the SKM study. Rather, by netting out the entire benefits to the lower Hutt Valley area, we are likely to have substantially over-compensated and therefore our net figure is likely to under-estimate the net wider economic benefits to Petone West.

Will the CVL divert economic activity or add to the national economy?

The CVL will divert heavy traffic from Petone, thereby:

- permitting mixed-use developments in Petone West and increasing the amenity of The Esplanade and Petone foreshore.
- attracting and retaining high skilled people in the New Zealand economy
- allowing regional economic integration and development

While these benefits will manifest in a number of ways, we outline the potential economic impact of densification that results from this sort of transformation of Petone. Collectively these factors will change the urban form in Petone, permitting higher density which is associated with higher economic growth. These effects of these developments are instrumental in attracting and retaining high skilled people in the New Zealand economy. By

adding to New Zealand's economic capacity in Petone, the CVL will yield an additional economic benefit to the nation, the region and to Hutt City.

Do the CVL's wider benefits materially affect its relative importance?

SKM's analysis uses a narrower set of measures than the standard EEM framework permits. SKM's BCR of between 0.2 and 0.4 for the CVL options suggest that the CVL would have a significantly lower priority for national funding than the PGL. Acknowledging the wider economic benefits of increased amenity and improved urban form in Petone, which are created in Petone but contribute to the nation, has material impact on the relative importance of the CVL.

Would road users and the community value the types of benefits the CVL permits?

The EEM's approach to measuring wider economic benefits is based on an average or 'typical' project. This would under-estimate the impacts of a high value intensification project such as the Petone development. We use a scenario approach that draws specifically on local and national data to more accurately estimate the likely impact of Petone development permitted by the CVL.

There is a body of international evidence – and BERL is currently contributing to the New Zealand research – showing that intensified residential and commercial activity result in higher land values. That is, land transport users and the wider community are willing to pay for transport improvements permitting such intensification. Although we have not tested this in New Zealand, it is both plausible and empirically supported in the international literature that residents and businesses place a greater value on locations with higher amenity value.

The CVL will have a demonstrable impact on the Petone and national economy, and both road users and the wider community will place a measurable monetary value on these impacts. For example, over time, higher value, dense urban settlements tend to have higher economic growth rates and labour force participation. This will lift land values in Petone, reflecting the willingness of residents and businesses to pay for such development.

Contents

2 Introduction and background

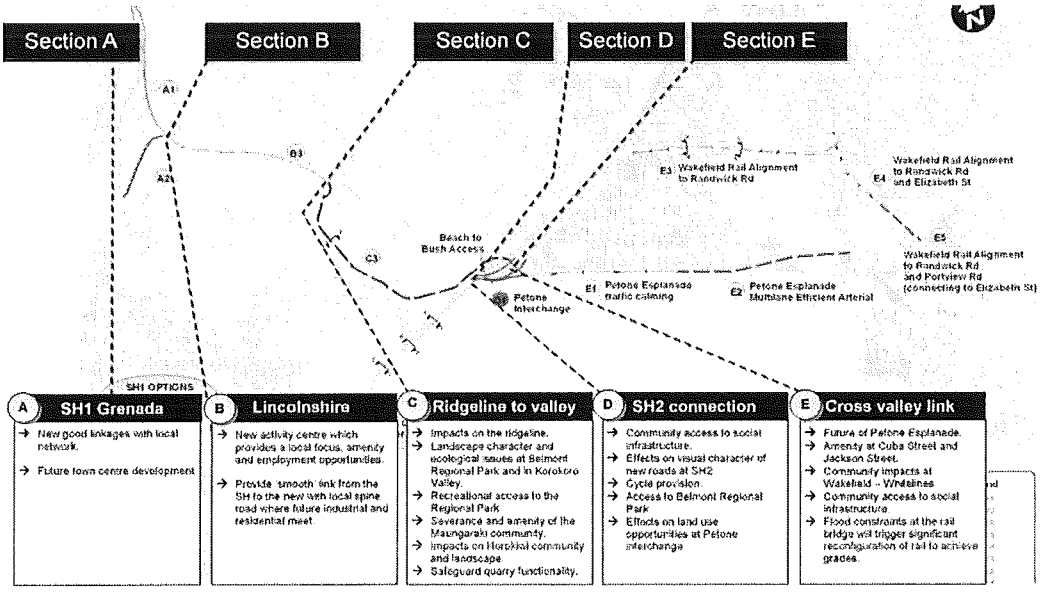
This report investigates the wider economic impacts to Petone West of increased amenity due to the CVL, and consider the relevance of these impacts to the NZTA's funding criteria. The benefits that we identify, analyse and measure can be realised providing Lower Hutt City, as well as fully supporting the CVL:

1. changes the planning designation in West Petone to to mixed use, and promotes development in West Petone to realise the potential of this re-designation.
2. Is able to achieve the increased frequencies in passenger transport services justified by the increased population density.

In addition to the information from SKM's economic assessment on the PGL and CVL, this report is completed on the basis of the knowledge and information accumulated by BERL to date in a range of studies of transport, infrastructure and urban development. This report shows that there is a sound basis for claiming benefits of urban development consequent on decreasing traffic from the Petone foreshore to the CVL.

2.1 Ngauranga Triangle Strategy Study

The New Zealand Transport Agency (NZTA), Hutt City and Wellington City have been working in partnership to develop a transportation plan to support activities and improve accessibility in the Ngauranga Triangle area. This area runs from Ngauranga to Tawa; from Ngauranga to Dowse; and from SH2 in the Petone/Hutt area across to Seaview/Gracefield.



Source: SKM Triangle Study, Figure 7.1, p. 63

This transportation plan has Regional significance for a number of reasons. These reasons include the fact that on the one hand Seaview/ Gracefield is a major regional centre for warehousing, distribution and industry, and on the other hand the access from Seaview/Gracefield to main routes is across The Esplanade of Petone Beach. Petone Beach is the main harbour beach in the Wellington Region.

Key projects in this transportation plan are The Petone Grenada Link (PGL), and The Cross Valley Link (CVL). These projects are detailed in two reports by SKM in January 2010: Ngauranga Triangle Strategy Study: Detailed Technical Report, and Ngauranga Triangle Strategy Study: CVL Project Feasibility Report. The latter report has options with and without the PGL. The estimated scale and SKM's estimated Benefit Cost Ratio (BCR) of these two projects differ considerably.

1.	*The Petone Grenada Link*	PV Cost (2008): $250.0 million.	BCR: 0.8[7]
2.	*CVL:*	PV Cost (2008): $65.6 million.	BCR: 0.2-0.4[8]

In light of the BCRs obtained without the inclusion of national strategic factors, the Petone Grenada Link Road could well have a high priority, while the CVL would have a significantly lower priority.

SKM's (22 January 2010, page 1 and page 4) CVL feasibility report describes the CVL as "a 2 lane, 70km/h Cross Valley Link (CVL) that will travel through Petone and connect Hutt Road and Whites Line East" and states the CVL

> "will provide improved access between SH2 and the Seaview area and alleviate some of the congestion issues that are seen on The Esplanade during peak times. Reducing congestion on The Esplanade will allow the area to be redeveloped and the foreshore to be better integrated into the Petone Central Business District (CBD)."

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[7] SKM (22 January 2010). Table 4.34, page 71. Note: this table labels the 1.3 figure as a "BCR". It is calculated, however, as the ratio of costs to benefits (a CBR). Using the underlying figures in this table would give a BCR of 0.77. We round this figure to 0.8, so as to be consistent with SKM's one decimal place reporting style.

Table 4.34 also refers to "2008 Capital Costs", but in the text it notes that the "capital cost" of the 'do minimum' option includes "includes annual and periodic maintenance over a 20 year period". It is unclear if maintenance costs are included in the other options; we assume that the figures have been calculated consistently and include such costs. Therefore, net present value of the "capital cost" may be interpreted as the project's present value cost, which would be appropriate as it is used to construct a BCR.

[8] SKM (21 January 2010). Table 10-6, page 24. Note: this table lists the total of the PV of Benefits for the CVL option including the PGL as $26.3 million. This is inconsistent with the figures in this table and the reported BCR. In our analysis we use the sum of the listed benefits (in PV terms), being $26.3 million, which is consistent with the reported BCR.

The CVL is expensive and does not have a high funding priority based on SKM's economic analysis. SKM conclude that "it is only viable to construct the CVL if it is accompanied by the construction of the Petone to Grenada Link Road" (SKM 21 January 2010, page 1). However, according to the feasibility report, if the CVL is not built, then increased traffic on The Esplanade will necessitate an upgrade. The cost of the CVL will be only marginally greater than upgrading The Esplanade.

The CVL enables amenity and economic regeneration benefits to the foreshore and surrounding environs including Seaview/ Gracefield. These have not yet been quantified but potentially could make the CVL economically justified.

The current high-level vision for the foreshore requires greater detail added so that an economic analysis can be undertaken to quantify these amenity and economic regeneration benefits. Based on our current understanding the size of these amenity and economic regeneration benefits do not need to be large to justify this project.

The CVL could be further extended to Parkside Road at some future date. This would enable efficient access to the Wainuiomata Hill Road utilising Hutt City Council's intersection improvements on Parkside Road. Further, the CVL has synergies with the Petone Grenada Link Road and is complemented by the Petone onramp signalling. SkM (21 Janauary 2010, page 6) notes "[r]eductions in the volumes on The Esplanade as a consequence of traffic calming and the CVL will allow better integration of the foreshore with the Petone CBD".

SKM undertook a series of sensitivity tests of the proposed package of projects. These tests show increased traffic volumes on key roads in the study area. This increases the economic justification for the Petone Grenada Link Road and improves the rationale for the CVL.

The package that is being proposed to support development aspirations and address network issues in the study area has been compared with the transportation studies and policy documents and plans from Greater Wellington, Hutt City and Wellington City Council and the New Zealand Transport Agency. There is a good alignment between the package and these planning documents.

For example, the Regional Land Transport Strategy (RLTS) proposes a Petone to Grenada and CVL Road. These projects are key projects of the proposed transportation package. In addition, the Lincolnshire Farm Structure Plan anticipates the Petone Grenada Link Road to support development in this area. Similarly many of Hutt City Council's planning and strategy documents have anticipated the CVL.

2.2 Scope of this report

This report complements the analysis taken in the Ngauranga Triangle study. It considers how the CVL could affect the amenity and urban form in Petone West, and the wider economic benefits that are likely to stem from improvements to these considerations.

The CVL will divert traffic from The Esplanade, so some of the areas and environs in Petone West are expected to be substantially re-developed to deliver major regional benefits. These benefits will arise through mixed-use development and enhanced amenity from the beach environment.

Figure 2.1 Petone West

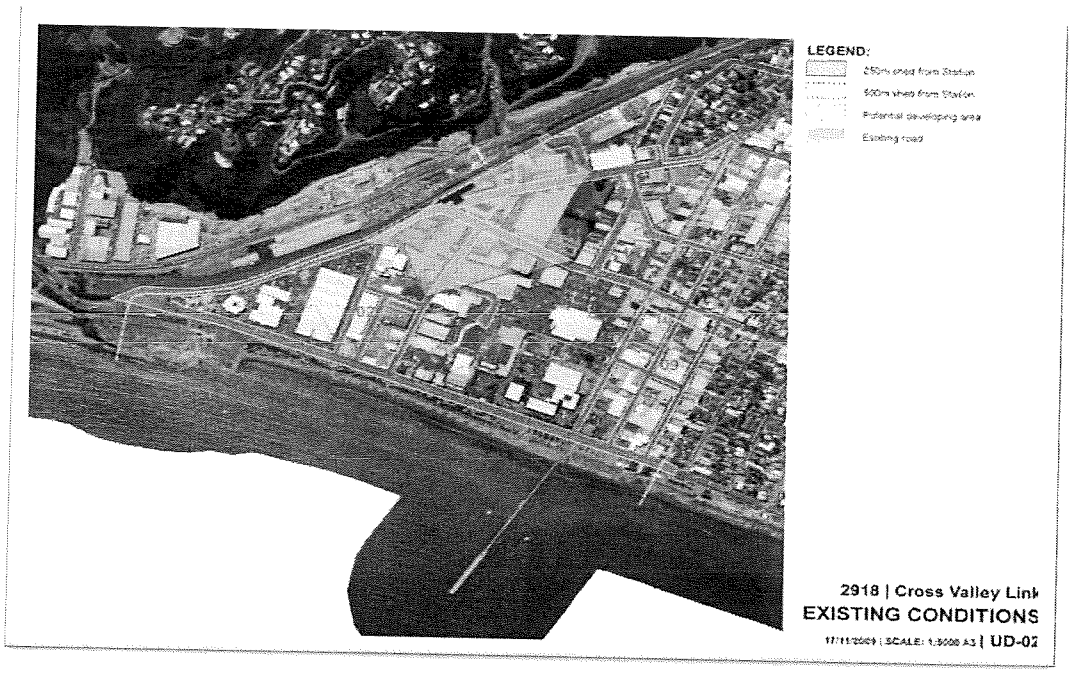
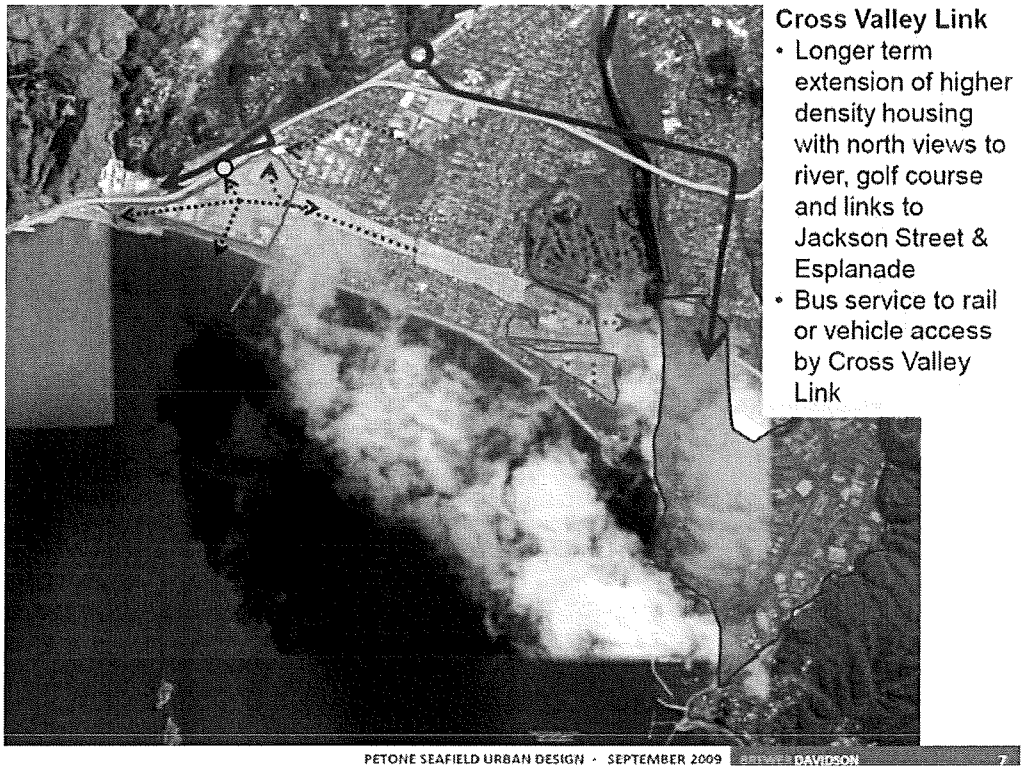


Figure 2.1 shows the Petone West Area, where the CVL will take traffic off the foreshore and enable increased mix use and higher densities around public transport, especially Petone Station.

Figure 2.2 shows the potential impact areas of the CVL (represented by the red arrow); with Petone West the blue shaded area and Seaview/ Gracefield the purple shaded area. Jackson Street is in the pink, which we have not considered along with The Esplanade, where there would be significantly lower traffic volumes with the CVL. Another impact we have not considered is the potential to develop the Eastern end of The Esplanade, where traffic calming due to the CVL would improve the potential for higher density housing and some commercial uses.

Figure 2.2 Cross Valley Link



3 Rationale behind CVL

The CVL will provide a number of benefits for the regional economy that were not considered in the original strategy study. This section outlines the underlying logic behind choosing to build the CVL project.

3.1 Link with regional strategy

According to the Wellington Regional Strategy, the Wellington Region should retain its industrial base, while growing its technical and professional base.

Seaview/ Gracefield / Petone is a principal area of industrial employment in Wellington Region. This industrial hub had at Census 2006 employment of about 13,000 people who are largely concentrated in manufacturing, warehousing, transport and distribution. This is a core element in the Regional economy and depends on efficient access for its viability.

The 5,100 workers in the Seaview/ Gracefield area complement the 8,800 in the Petone/Alicetown area and have a similar industry profile.

The Seaview/ Gracefield / Petone area had 25 percent of Wellington Region's employment in manufacturing. Manufacturing is a 'core driver' industry in New Zealand regional economies and consequently, like primary production and tourism, is a key determinant of the total size of the economy (BERL Regional Database). The area also has 22 percent of the regional employment in wholesale trade and 14 percent of the employment in storage and transport. Wholesale trade, warehousing and transport are important facilitating service components of the regional economy and an essential element in the national distribution network.

The Seaview/ Gracefield / Petone area therefore makes a strong contribution to the Wellington region and national economy directly through manufacturing, and indirectly providing warehousing and transport services to the regional economy.

3.2 Regional capacity for growth

The Seaview/ Gracefield area has a large part of the region's capacity for industrial expansion. Nearly one-half of the Region's vacant industrial land is in Hutt City, as is 420 ha with low coverage, which has the capacity for intensification. Much of this area is in Seaview/ Gracefield.

Within the Seaview/ Gracefield area, we believe some specific capacity for increased activity includes:

- 12 ha of further land available from Centreport at Seaview; and
- A further 10 ha can be released for brownfield development over time at Seaview.

Additionally industrial employment expansion in Petone can include an area of 12 ha of land at Cornish Street and Hutt Road that will become available once the realignment of SH2 and the Dowse / Petone interchange work is completed. This expanded industrial area would be complementary with mixed use intensification in Petone West, which could be generated by the CVL.

3.3 Importance of access

It is essential to have effective access from Seaview/ Gracefield to SH2 and SH1 in order to maintain and grow the Regional industrial base and for effective national inter-connectedness with the industrial bases in other countries. This imperative is recognised in The Greater Wellington Regional Council (GWRC) Regional Freight Plan (2007) which is a subsidiary document that supports the RLTS.

The Regional Freight Plan recognises that, "*efficient freight transport is a cornerstone of a prosperous region.*" This document acknowledges the importance of the Ngauranga Triangle study area in terms of freight movement: *"Particularly significant volumes of goods flow between the Wellington City CBD / CentrePort, Gracefield / Petone and Porirua. From a freight perspective, improvements to the road network should be focused on increasing efficiency between these areas."*

The Regional Freight Plan also states that "*the Gracefield / Seaview area of Lower Hutt contains around 50 percent of the industrial floor space in Lower Hutt and Wellington. While much of the Gracefield Spur railway line has been removed in recent years, it is appropriate that the rail corridor itself is protected to ensure its potential for future use is maintained. This is consistent with the WRS aim to improve transport connections between key commercial centres in the region.*"

There is already congestion restricting access from Seaview/ Gracefield to SH2 and SH1 and this will become very significant with expansion of activity in this industrial and distribution area.

3.4 Improved access options

The two options to maintain and improve access from Seaview/ Gracefield to SH2 and SH1 relevant to this report are (1) upgrading The Esplanade and (2) the CVL.

SKM's analysis outlines the benefits and costs of the CVL, with and without the PGL. SKM estimates travel time and VOC savings with a PV of between $10.5 million ($26.3 million with the PGL) and a PV cost of $65.6 million. This implies a BCR of between 0.2 and 0.4.

Initial traffic modelling in the *Ngauranga Triangle Strategy Study* indicates that the Petone Grenada link, by itself with no CVL, will increase the traffic flow on The Esplanade by 3,000 vehicles per day (VPD) in 2016 and by 5,000 VPD in 2026. This option would have a negative impact on HCC's objective of developing the Petone Foreshore Focus Area.

The Esplanade upgrade has a PV cost of $90.3 million and a BCR of 0.54.[9] In comparison, the CVL had a PV cost of $65.6 million. The CVL costs around three quarters of the Esplanade upgrade, but has a slightly lower BCR of 0.4 if completed with the PGL and a much lower BCR of 0.2 if it is an independent project.

However, the CVL enables amenity benefits and economic regeneration benefits to the foreshore and surrounding environs by diverting traffic from the Petone Esplanade. This will permit better pedestrian access to the foreshore, which is a focus area for both Lower Hutt and for the Wellington Region. The CVL will also facilitate mixed-use intensification at the western end. The proximity of the Petone train station will support the increase in residential density at the western end of Petone, as shown by FoRST-funded BERL research into New Zealand land use and travel patterns, a finding which is reinforced in the international literature.[10]

3.5 Mixed use intensification

The CVL would divert traffic from The Esplanade, which could enhance the enjoyment and functionality of this Regional Focus Area. This can enable amenity benefits and economic regeneration benefits at either end of The Esplanade, the foreshore, and surrounding environs.

Recent BERL research has demonstrated that New Zealanders value high urban density living and working environments. BERL's preliminary results from a FoRST funded project on transport and urban form shows a statistically significant positive relationships between density and both residential land values and commercial/industrial land values.

The area already has three zoning designations that allow considerable building heights as follows: General Business: 12 metres; Petone Commercial: 30 metres; Petone West: 30

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[9] SKM (22 January 2010). Table 4.42, page 85. See footnote 7 for a discussion of SKM's use of "capital cost".

[10] BERL (2010) Passenger Transport and Land Values Drivers and Linkages - Literature Review. Report to FoRST.

meters. There has been some consideration given to transforming the Petone West area into a Mixed Use Activity Area. Mixed use intensification is beginning to take place in this Petone West area with warehousing and other activities being joined by cafes, restaurants and offices. There is already at least one office block of approximately 30 metres under construction.

We also expect pressure for higher-density residential developments in this area. The attractions of the area include access to the foreshore and the possibility of improved access to public transport (PT) links, through the Petone rail station and bus services. These give better connectivity to Hutt City centre, the rest of the Hutt Valley, Wellington City, the airport and thus nationally. These attractions will be improved by the CVL taking some of the traffic flows from Petone West. In other words the CVL can facilitate pursuit of the mixed use intensification benefits in Petone West. Improved access and intensification will also yield regional and national benefit by maximising the potential of Wellington Harbour.

In order to realise the intensification benefits, designation changes and/or complementary investments will be required to reduce separation of the urban area from the foreshore and from PT at the interchange of the Petone railway station and bus services. These changes would encourage intensification of this Petone West area, attract more population and generate significant economic, social and environmental benefits.

3.6 Attracting population for regional growth

The four most common reasons migrants chose New Zealand were the relaxed pace of life, the environment, family, and employment opportunities (Department of Labour, 2009).[11]

3.1 Reasons migrants chose New Zealand

Reasons	Percent
Relaxed pace of life or lifestyle	44.2
Climate or the clean green environment	39.6
A better future for my children	39.0
Employment opportunity	28.3
Friendly people	27.6
Safety from crime	26.8
Join family members	22.6
Easy access to outdoor or sporting activities	22.4
Educational opportunities	18.1
Marry or live with a NZ spouse or partner	16.0
Political stability	14.7
Economic conditions	13.4
To study	10.2
Accompany family members	7.4
Other	4.3

Source: Department of Labour (2009).

[11] Department of Labour (2009) New Faces, New Futures: New Zealand. Findings from the Longitudinal Immigration Survey.

BERL has also found that New Zealand's greatest areas of strength for attracting international students are its living environment, immigration policy, and tuition and living costs. This finding is reinforced by the international literature, for example, Mazzarol and Soutar (2002) and Yang (2007)[12,13]

The attractiveness of New Zealand, especially in terms of the rate of economic growth achieved, has been associated with increased rates of net inward migration. It therefore seems logical to assume that a change that facilitates quality residential and business development in a region will also tend to attract migrants to settle in that region.

The CVL will facilitate potentially significant growth in quality residential and business development in the Petone West area. While some of this growth will come from other areas within the Wellington Region and Lower Hutt (diversion) a proportion will come from outside the region or be new businesses generated by the activity. However, we believe there are a number of economic incentives that will direct new migrants to Petone rather than Wellington City. Petone's improved urban form will likely:

- lift productivity and incomes in Petone, that will act – at the margin - as pull factors to Petone
- Petone is ideally located to be a high functioning satellite settlement that will help achieve Wellington City's growth potential, and such a role will further enhance Petone's liveability[14]
- Relieve pressure associated with further population or employment densification in Wellington City, such as increased land values and congestion. That is, Petone will be relatively more affordable.

Section 4.5 considers the level of inward migration that a moderate growth scenario would attract. We foreshadow here that these levels are modest and realistic relative to the annual flows of migrants to New Zealand and the movement of recent migrants out of Auckland to other parts of the country. The latter effect creates opportunities for new migrants in the gateway city of Auckland, which further reinforces the likelihood that the CVL will support

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[12] Mazzarol, T., & Soutar, GN. (2002). "Push-pull" factors influencing international student destination choice. *The International Journal of Educational Management*, 16, 2, pp.82–90.

Yang, M. (2007). What attracts mainland Chinese students to Australian higher education? *Studies in Learning, Evaluation, Innovation and Development*, 4, 2, pp.1–12.

[13] Norman, D; Wu, J; and Leung-Wai, J. (2009). *In Depth Country Research – China*. BERL report to Education New Zealand.

[14] The NSW's metropolitan transport strategy "City of Cities" emphasises the crucial role of an integrated city system to permit optimal growth. A core part of this strategy is that wider Sydney acts as a networked entity, with strong satellite cities supporting the core. In this view, the cities are not competitors but critical components in a wider system that act to relax the growth constraint at the centre.

additional population and employment. For example, BERL (2007) found that most new migrants arrived in the gateway cities of Auckland and Christchurch, but as their duration of residence in New Zealand increases, the new migrants were likely to move to the rest of New Zealand.[15]

We believe it is reasonable to conclude that the economic logic behind these factors and the modest estimated annual inward migration figures required, indicate that Petone's increased attractiveness would bring new migrants. This will add to the nation's economic base permitting greater national growth. These people will increase New Zealand's resident population and generate additional activity rather than a transfer of activity from another region, thereby delivering a positive net contribution to the nation.

[15] Slack A, Wu J and Nana G (2007). Fiscal impacts of immigration 2005-06. BERL report to the Department of Labour.

4 Economic analysis

Many of the benefits outlined in the previous section are difficult to estimate in terms of hard numbers. However, one potential major outcome of the CVL project that can be measured with a level of certainty is the potential transformation of Petone West into a Mixed Use Activity area.[16]

This section explores the potential intensification of Petone West under two scenarios, and also explores the extent to which the resulting economic activity and benefits can be shown to be additional to the Regional and national economies, rather than diverted from elsewhere. Assumptions are made as to the mix between commercial activity and residential activity in the present zones of General Business, Petone Commercial, and Esplanade West.

4.1 Petone urban density

Historically Petone has been a community with a relatively high residential density, due mainly to some streets with small section sizes, and a number of 'boarding houses' and the like. This density has been complemented in recent years with increased commercial (retail, office etc) development, and apartments. This mixed use has in turn supported increased cafes, restaurants and quality retail. This change is well-advanced down Jackson Street west of Cuba Street and in the west through to The Esplanade.

The Census Area Unit (CAU) called Petone Esplanade has an area of 94 hectares, and at Census 2006 had 2,358 residents and 5,296 people employed. This is an average residential density of 25/ha; a people employed density of 56/ha; and thus a total urban density of 81/ha. For New Zealand urban areas, this is quite a high density. A typical suburban area would have a density of 20/ha, and the 'town centres' of Hutt City and Upper Hutt have average densities of 40 and 58/ha respectively.

The Petone density is not unusual for quality urban areas in New Zealand, nor is it likely to stay as low as it is now. Projections in the Wellington Transport Model indicate that by 2026, density in the Petone Esplanade CAU will be 100/ha. Comparisons with some other urban densities are shown in Table 4.1.

[16] Other areas where we believe there is a net benefit but cannot measure with certainty include the Petone East area, the Foreshore and Jackson Street.

Table 4.1 Urban densities in Petone and Wellington areas

Census Area Unit	Hectares	Density per hectare			Residents (%)
		Residents	Employed	Total	
Petone Esplanade	94	25	56	81	31
Thorndon-Tinakori	211	18	59	77	23
Johnsonville North	63	64	16	80	80
Hutt City central	237	4	36	40	10
Upper Hutt central	43	8	50	58	14
Willis St - Cambridge Tce	103	56	192	248	23
Lambton	99	91	518	609	15

Source: Statistics New Zealand

The main points to notice are that the Petone density is at present well below central city densities. However it is also notable that Petone has a good balance of residents to people employed, as does Thorndon and Willis St- Cambridge Tce.

Two Auckland areas that combine well a high urban density with attractive open space, trees etc are Newmarket residential at 80 residents/ha, Remuera residential at 40 residents/ha, and Remuera employment area at 180 people employed/ha.

Perhaps the main point is that New Zealand is no longer made up of low density residential suburbs with towns and cities of commercial and industrial employment. Mixed use is becoming the accepted norm in quality, productive areas.

4.2 Two intensification scenarios

There is plenty of scope for increased urban density within the height limits imposed by the current zoning designations. We therefore outline the present urban density in Petone West and then outline two simplified scenarios as follows:

The first scenario uses the parameters of residential and employment densities given in the ARC Regional Policy Statement for a 'Town Centre' able to support a 'Premium Bus Service' (see Appendix 1). It estimates the expected residents and expected employees in the walk-up zones around the Petone railway station and bus interchange. The GDP generated by this workplace employment population is estimated using an industry profile of employment typical of this type of urban area.

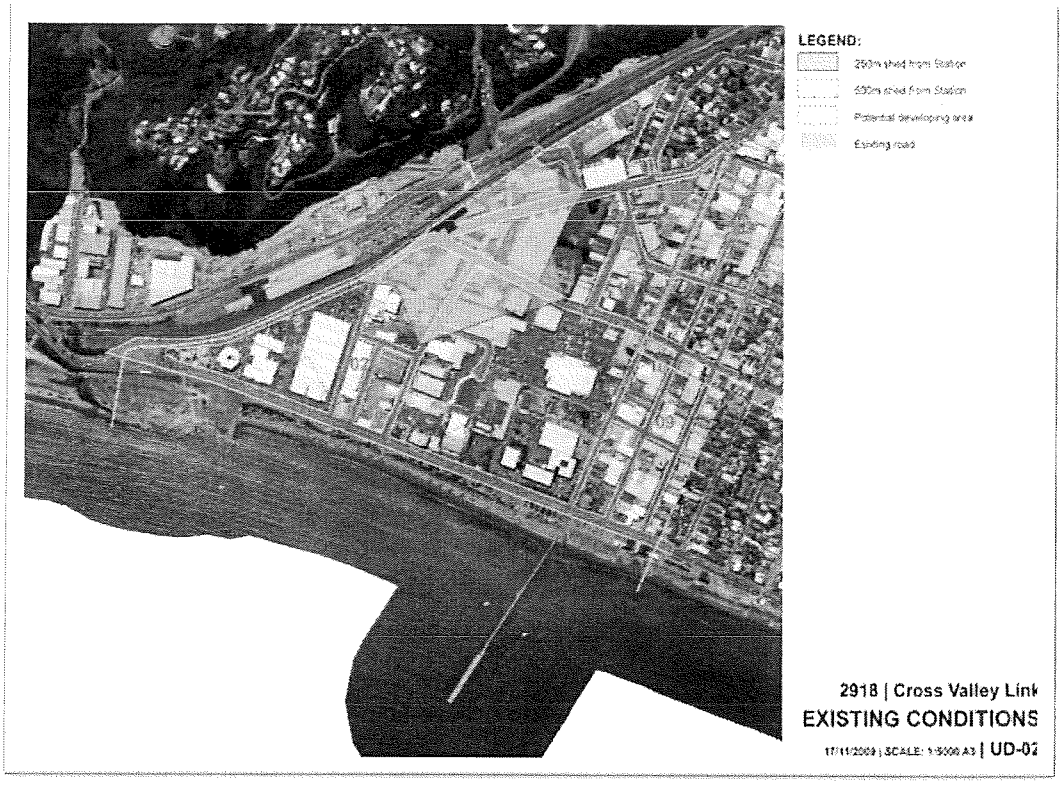
The second scenario investigates existing zoning and draws up an estimate of Gross Floor Area that could be developed if these areas were designated 'mixed use'. The development area is centred on Petone railway station, and the area's layout changed to retain main existing buildings and develop others over time, consistent with the present zoning requirements. A scenario of proportions of commercial and residential floor area in each

zone is developed. This scenario should be thought of as a relatively long-term potential urban capacity of the Petone West intensification area.

4.3 Mixed use Scenario 1: Intensification to ARC RPS level

This scenario uses the parameters of residential and employment densities given in the ARC Regional Policy Statement for a 'Town Centre' able to support a 'Premium Bus Service'. It estimates the expected residents and expected employees in the 0-200 metre walk-up zones around the Petone railway station and bus interchange of 12.5 hectares, and the 200-400 metre walk-up zone of 37.5 hectares.[17] The analysis of intensification is completed for the area on the eastern side of the railway line. In future, in may be that this will encourage developments and mixed use intensification on the western side, also. We have not included the potential benefits for the western side in this study.

Figure 4.1 Scenario 1: increased intensification to ARC RPS level



[17] In fact the Petone West area will have a better PT service than that. The combination bus and commuter train service could more approximate a 'Rapid Transit' level of PT provision in the ARC RPS classification. The assumptions of 'Town Centre' and 'Premium Bus Service' parameters are thus conservative.

Estimate of residents and workplace employed

Making assumptions as to the likely share of land for residential compared with retail/commercial/industrial use, we have applied the RPS densities to those areas. The scenario indicates that there would be about 2,800 residents, and 6,500 people employed in this 50 hectare area. This level assumes a town centre level of density served by a premium bus service. The amenity improvements and mixed use designation will cause the density to reach this level by 2026.

The proximity to a high quality passenger transport interchange at the Petone train station will be significantly higher quality and frequency of service than the assumed 'Premier Bus Service'. This factor will continue to drive the people employed above the 2026 level and towards its capacity at 2046. However, we remain conservative and estimate the impacts based on the RPS densities in 2026.

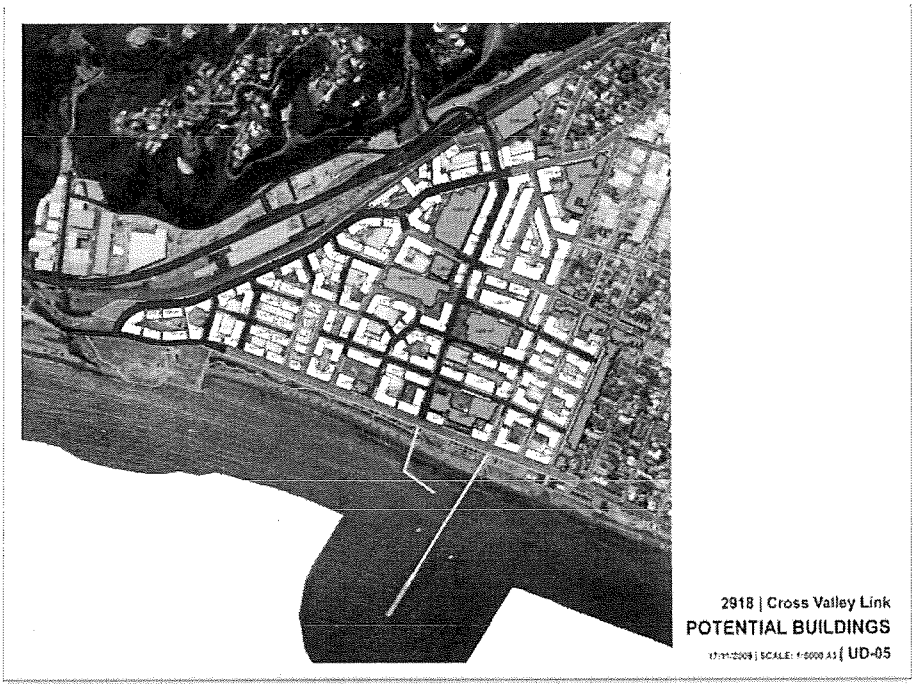
The combined residential and people employed in 2026 totals 9,300 people in the urban area of50 hectares. This is a few more than the 7,700 in the Petone Esplanade area of 99 hectares. The total urban density in the intensified Petone West area would be 186 per hectare, well below the densities in Wellington CBD areas. Interestingly these assumptions result in the ratio of residents to total urban occupants that is similar to the present Petone Esplanade ratio of about 30 percent. This is a good balance in an urban area.

The Petone West development zone will have employees in a range of industries including retail, business services, and some higher-value industrials. The GDP generated per employee would be expected to be an average of at least the national average of approximately $80,000 per year

4.4 Mixed use Scenario 2: Optimum application of Current Zoning

This scenario investigates existing zoning and draws up an estimate of Floor Area (FA) that could be developed if these areas were designated 'mixed use'. It makes assumptions as to the proportion of residential and commercial floor area that would be applied in each zone and uses that to estimate the capacity of the FA for residents and employees.

Figure 4.2 Scenario 2: Estimated Gross Floor Area



The analysis process:

- Uses maps and aerial photos to measure and estimate the possible capacity of workplace employment in existing buildings.
- Uses as a base the Current Zoning for building height and applies mixed use ratios to the buildings in each Zone taking into account the shape of the 250 metre and 500 metre 'shed' from the railway station interchange. It assumes higher residential proportions in the area facing the foreshore.
- It then explores the shape of the development area including additional street connections, and new, additional buildings. (Existing substantial buildings are assumed to stay.) For the new buildings it estimates the Ground Floor Area (GFA), the number of levels and thus the FA in the building. This gives the potential capacity to accommodate residents, and/or workplace employed.

This process can be thought of as estimating the long-term potential capacity of the area under mixed use designation with the current zoning restrictions on building height.

Estimate of residents and workplace employed

The estimate of the GFA of existing buildings is 181,000 m^2. Most buildings are one or two-storey and the total estimated floor area is 263,000 m^2. This is estimated to have a capacity for about 9,000 people employed.[18] Our analysis of meshblock data from the 2006 Census indicates that actual employment was substantially below capacity at around 2,430 workers. There are a number of existing substantial buildings assumed to remain in place, and these account for about one-half of the estimated present employment capacity. This employment will be augmented by the additional buildings in the mixed-use development area.

The proposed capacity is summarised for the present zoning and proposed mixed use designations as shown in the tables. The first table shows that if all 104 proposed buildings were completed to the size and capacity possible under the suggested mixed-use zoning parameters, there would be capacity for up to 13,720 people to be employed in offices in these proposed buildings, of whom around 11,290 are net additions.

Table 4.2 Employment capacity of Petone West Mixed-use zones

Mixed use Zones : Employed capacity	Building numbers	Proposed ground floor area	Proposed building levels	Proposed floor area	Office floor area	Office floor area	Employed capacity
		GFA m^2		**FA m^2**	**%**	**m^2**	**30 m^2/ employed**
Station (250m zone)	18	23,323	7	155,801	75%	116,851	3,895
Petone Commercial zone	20	36,375	7	231,220	75%	173,415	5,780
Esplanade West Business zone	51	61,171	7	418,820	25%	104,705	3,490
General Business zone	15	22,167	3	66,501	25%	16,625	554
Total proposed capacity	**104**	**143,036**		**872,341**		**411,596**	**13,720**

The second table shows that on the same basis of present zoning and assumed mixed-use designations, there would be capacity in the 104 proposed buildings in the Petone West development area for 11,500 residents. These residents are all additional; as at the 2006 Census there were no usual residents in the study area.

[18] This number is probably greater than the present number employed mainly in warehousing and retail which is quite extensive. Future employment is likely to be more intensive commercial and offices.

Table 4.3 Residential capacity of Petone West Mixed-use zones

Mixed use Zones : Residents capacity	Building numbers	Proposed ground floor area	Proposed building levels	Proposed floor area	Residents floor area	Residents floor area	Residents capacity
		GFA m^2		FA m^2	%	m^2	40 m^2/ resident
Station (250m zone)	18	23,323	7	155,801	25%	38,950	974
Petone Commercial zone	20	36,375	7	231,220	25%	57,805	1,445
Esplanade West Business zon	51	61,171	7	418,820	75%	314,115	7,853
General Business zone	15	22,167	3	66,501	75%	49,876	1,247
Total proposed capacity	**104**	**143,036**		**872,341**		**460,746**	**11,519**

It is interesting to note that this Mixed-Use Scenario 2 modelling has resulted in the ratio of additional residents to total additional urban occupants of about 45 percent, which reflects an expected attraction of the area to residential aspects of the mixed-use development.

With strong residential population growth also, there would be a relatively high share of employment in retail and personal services. These industries generate a lower GDP per worker than business services. The average GDP generated per employee in scenario two could be expected to be approximately $65,000 per year, which is lower than scenario one.

4.5 Additional employment and economic activity in the area due to CVL

The realistic, medium-range expectation is that the intensification of the area will reach its full potential by 2046. In 2046 there would be 13,700 people employed, an increase of 11,300. There would be 11,500 residents. These scenarios are sound estimates of the significant opportunity for expanded residential and economic activity (a higher density urban area).

Below we consider the possible economic impacts from the transformation of Petone West into a mixed use urban form. We use a conservative approach to estimate the benefits that stem from the sort of transformation characterised in the two scenarios above. We also show how sensitive the results are to our modelling assumptions. The sensitivity analysis uses a mid-point between the two scenarios and examines:

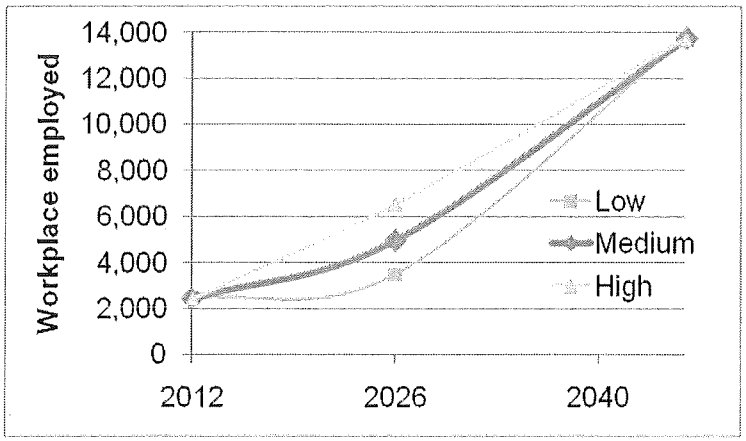
- the timeframe over which the benefits accrue
- the pace at which increased density and economic growth occurs
- the proportion of the increased economic activity from additional national employment
- the net impact, taking into account current levels of employment and the value of time and vehicle operating cost savings captured in the SKM analysis.
- the additional activity that is potentially at risk if the CVL does not go ahead.

This development scenario reaches the full potential by 2046. A realistic medium growth profile out to 2026 gives employment of approximately 5,000 under the second scenario,

which equates to just over 2,500 additional to the 2,400 employed in the area in the base case.. It is also useful to model the benefits at 2026 as this gives consistency with the SKM analysis. To test sensitivity to timing and rate of growth we complete a sensitivity analysis at 2026.

Figure 4.3 show the employment growth that will stem from the intensification scenario, plus the sensitivity tests at 2026 that reflect a low growth profile that mirrors Wellington City's employment density growth between 2001 and 2006. The high growth profile reflects the growth in employment if Petone West reaches the employment density expected under the first scenario of 6.500 workers by 2026.

Figure 4.3 Workplace employed under alternative growth scenarios to 2026 and 2046



Additional external migrants

We estimate the additional economic activity per year (before deducting SKM's estimated benefits) from the additional workers attracted to Petone West. This activity is due to the 2,500 additional workers in 2026. Table 4.4 shows the number of additional workers attracted to New Zealand in order to reach the 2,500 level by 2026 if the densification begins from 2012. For example, Petone would attract and employ around 180 workers each year on average.

Table 4.4 Additional workers supported under various growth profiles by 2026

	% of workers that are additional migrants	
Growth profile	100%	75%
Low	80	60
Medium	180	140
High	290	220

Appendix 1 estimates that the Wellington Region's recent experience is of a net inflow of about 1,200 international migrants per year. Therefore, the estimates above of the additional workers are of a realistic scale when compared to the current net inflow. Thus, we believe it is realistic that 100 percent of the additional workers would be additional migrants to New Zealand (or from other parts of New Zealand, thus facilitating the inward flow of migrants by creating opportunities for new migrants).

We also complete a sensitivity analysis to measure the impact on the wider economic benefits if the employees are only 75% additional due to migration.

Additional economic activity due to increased amenity and urban intensification

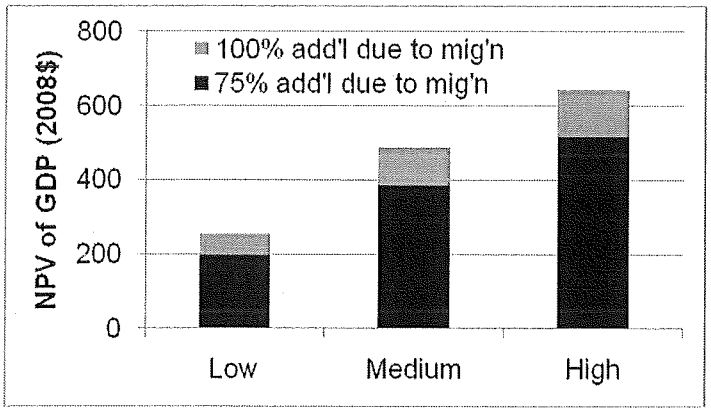
We assume that the average GDP generated per employee is $65,000 per year. This is the lower bound of the two scenarios. Thus, the additional 2,500 employees would generate an additional GDP about $160 million in the year 2026. This is an undiscounted figure and is not net of the annual travel time and VOC savings. This step is completed below.

Present value of additional activity (in 2008dollar terms)

We have tracked expansion of the workforce from 2012 to 2026, and estimated the net increase in GDP from the additional people employed in each year. Discounting that GDP stream to 2010, we estimate the additional labour would generate GDP with a net present value of $487 million[19].

We expect 100% of the workers to be additional, and due to migration into the region and country. As a sensitivity test, if only 75% of Petone's growth is additional due to migration, the net addition to national GDP would have an estimated present value of$386 million.

Figure 4.4 Net present value of (gross) additional GDP, 2026 medium growth profile



[19] All monetary values are in 2008 dollars, discounted at an 8 percent rate.

Additional economic activity due to the CVL

The evidence base developed within the scope of this research is not sufficient for us to forecast the degree to which moving traffic off The Esplanade will lead to the development and increased activity characterised above. Without the CVL it is likely that around one third of the Petone West area will be unsuitable for the mixed use development. We use this is as lower limit for the additional contribution of the CVL. Below we examine the wider benefits where the additional activity due to the CVL is between 33.3 percent and 100 percent.

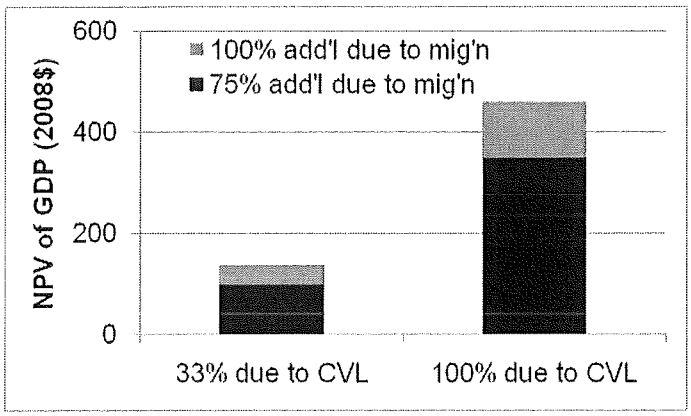
Adjusting for potential double counting of benefits captured in the SKM analysis

The figures calculated above are based on the economic activity generated by additional workers in the re-developed Petone area permitted by the CVL. SKM's potentially captures some of the benefits to residents and workers located in Petone West in terms of travel time and VOC savings. Therefore, to avoid any potential double counting we adjust the (gross) figures above to indicate the possible scale of the CVL's additional economic benefits.

SKM estimated benefits of $10.5 million from the CVL excluding the PGL and $26.3 million for the CVL option including the PGL. Deducting the higher of these two figures gives a net wider economic benefit of $461 million under the 2026 medium growth profile with 100% of the net increase in jobs covered by the migrant flow and due to the CVL. (If only 75% of the net increase is covered by the migrant flow, the net present value would be $348 million.) With the expected medium outcome, the ratio of CVL's additional economic benefits to its costs is 7.0. This is a strong estimate of regional and national benefits.

If the CVL permits one third of the estimated GDP to 2026, the estimated benefits after deducting SKM's figures are between $99 million and $136 million in the medium profile. This gives a ratio of the wider economic benefits to costs of between 1.5 and 2.1.

Figure 4.5 Net present value of (gross) additional GDP due to CVL, 2026 medium growth profile



5 National significance of urban intensification

The NZTA's EEM requires that to meet its funding criteria, a project's benefits must stem from additional activity rather than a transfer of activity from another region, thereby delivering a positive net contribution to the nation. That is, to be counted as benefits from the NZTA's point of view, it must not be a zero sum game where the project simply moves activity from one area to another. Below we outline the logic and evidence that support the case for including the wider benefits of the CVL as an additional benefit, and which make this project one of national strategic significance under the NZTA's EEM framework.

5.1 Wider economic benefits of transport infrastructure

The BERL approach to assessing the CVL's potential additional economic benefits is broader than is accounted for by agglomeration economies. Until recently, agglomeration economies were the only wider economic benefits accepted by NZTA within the methodology of their EEM.

The most recent release of the EEM (January 2010) allows for the inclusion of a broader set of benefits (Section A10, National Strategic Factors). In defining national strategic factors (Section A10.5) the EEM says they are *'national benefits that are valued by road users or communities, but which are not captured elsewhere in the activity evaluation'*.

The manual suggests that in many cases, *'roading activities, particularly large ones, are sometimes inappropriately described as 'strategic' if they cannot be justified by the road user benefits and intangible effects described elsewhere in the manual'*. BERL is well aware that at the higher levels of NZTA and of the Infrastructure Unit in The Treasury, there is a large degree of cynicism about any benefits that are claimed to be 'strategic'.

5.2 Is CVL-related urban intensification a national strategic factor?

The EEM, at section A10.5, provides some opportunity for interpreting urban intensification benefits as national strategic factors in the criteria set as follows.

'*National strategic factors may be incorporated as benefits in the evaluation of an activity where they:*

- have a material impact on an activity's importance
- comprise national economic benefits (not transfers of benefits between different localities)
- have not been counted in the core analysis

- would be valued by land transport users and the wider community (that is, road users and the wider community would be willing to pay for them, were they able to do so.)'

Below we outline how the CVL meets each of these tests and should be considered a project of national strategic significance.

Categorisation of the CVL as a national strategic factor

We begin by noting that the CVL fits both categories of national strategic factors in the NZTA's Economic Evaluation Manual (EEM). The CVL will secure access to one of Wellington's major industrial clusters, and will indirectly permit the development and expansion of Petone West.

The estimated wider economic benefits have not already been counted

SKM's study estimates the benefits of the CVL to the lower Hutt Valley area in terms of travel time and vehicle operating cost savings. We could not get a breakdown of benefits of the CVL accruing specifically to Petone West. However, we expect that most of these benefits are for people transiting through Petone West, and would not accrue to people living or working at Petone West.

To be conservative, however, the net figures reported above deduct the entire upper benefit figure estimated by SKM. Thus, the estimated (net) wider economic impacts do not double count any of the benefits estimated in the SKM study. Rather, by netting out the entire benefits to the lower Hutt Valley area, we are likely to have substantially over-compensated and therefore our net figure is likely to under-estimate the net wider economic benefits to Petone West.

The CVL is unlikely to divert economic activity within the national economy

The CVL will divert heavy traffic from the Petone foreshore. This will increase the attraction of Petone West for mixed-use developments and The Esplanade for amenity development. As noted above, these benefits may manifest in a number of ways that are not accounted for in SKM's economic evaluation but which are permitted by the NZTA's evaluation framework. For example, this type of urban amenity is instrumental in attracting and retaining high skilled people in the New Zealand economy. Encouraging the migration of overseas born people and New Zealanders overseas to Petone adds to New Zealand's economic capacity.

We find that the required level of external migration required under a medium growth profile using conservative assumptions is realistic. While the additional workers projected by 2026 could reasonably entirely come from external migrants or returning New Zealanders, we

examined a lower level of additionality. We show that if 75 percent of the increase in workers is from external migrants, the net present value of the gross economic impact on GDP by 2026 is over five times the cost of the CVL.

The CVL's wider benefits materially affect its relative importance

SKM's analysis using a narrow set of measures than the standard EEM framework permits. SKM's BCR of between 0.2 and 0.4 for the CVL options suggest that the CVL would have a significantly lower priority for national funding than the PGL. Acknowledging the wider economic benefits of increased amenity and improved urban form in Petone, which are created in Petone but contribute to the nation, has material impact on the relative importance of the CVL. The scenarios in section 4 demonstrated that the CBR would imply a very high priority for the CVL project.

Road users and the community value the types of benefits the CVL permits

Section A10.4 of the EEM details its process for estimating agglomeration benefits of transport investment. But we believe that even if the standard EEM approach were augmented with its recommended agglomeration measure that the EEM approach would likely underestimate the impacts of Petone's intensification. The EEM approach estimates the impact of density on productivity (by industry) using agglomeration elasticities.[20] These elasticities reflect that average effect of a 'typical' project. Applying such a measure to an above average project would dilute its impact. That is, this approach would underestimate the marginal impact of a clearly defined, high value project, such as the development of Petone West would likely have.

Therefore, our scenario approach is more appropriate to estimate the likely impact of the development in Petone permitted by the CVL. The results of that analysis indicated the CVL will permit substantial urban intensification – lifting both residential and employment densities. Table 5.1 shows that New Zealand residents, and more specifically people in the Wellington region, are increasingly willing to live and work in the core and central areas of our major cities. To some degree, the increased land values in these areas are likely to reflect the increased amenity of urban intensification.

[20] Graham DJ and Mare DC (2009) Agglomeration elasticities in New Zealand. NZTA research report 376.

Table 5.1. Change in urban densities in CBD areas

CBD Areas	Land Area	2001 Resident Population		2006 Resident Population	
	Ha.	*Number*	*Density /ha*	*Number*	*Density /ha*
Central Wellington	715	21,735	30.4	27,036	37.8
Wellington core	201	6,729	33.4	9,294	46.1
Central Auckland	1,007	25,395	25.2	37,515	37.2
Auckland core	209	6,783	32.4	15,144	72.4

Source: BERL, Statistics NZ

CBD Areas	2001 Workplace Employed		2006 Workplace Employed		Total Urban Density People/ha.	
	Number	*Density /ha*	*Number*	*Density /ha*	2001	2006
Central Wellington	65,268	91	73,443	103	122	141
Wellington core	49,641	246	57,183	284	280	330
Central Auckland	81,441	81	95,439	95	106	132
Auckland core	42,654	204	47,013	225	236	297

Source: BERL, Statistics NZ

There is a body of international evidence – and BERL is currently contributing to the New Zealand research – showing that intensified residential and commercial activities are associated with higher land values. There is also clear evidence that land transport users and the wider community are willing to pay for transport improvements that permit such intensification. Although we have not tested this in New Zealand, it is both plausible and empirically supported in the international literature that residents and businesses place a greater value on locations with higher amenity value. Therefore, the CVL will have a demonstrable impact on the Petone and national economy, and both road users and the wider community will place a measurable monetary value on these impacts.

Over time, higher value, dense urban settlements tend to have higher economic growth rates. Combined with higher rateable land values, reflecting the willingness of residents and businesses to pay for such development, this will permit further investment into the City and region's infrastructure, contributing to a virtuous growth cycle. For example, by increasing the attractiveness of the region, international cruise ships to Wellington may schedule longer stop-overs, thus encouraging international tourists to New Zealand to book longer trips.

5.3 Migration, regional development and national benefits

Below we consider how the increased attractiveness and intensification supported by the CVL will affect migration, regional economic development and national economic growth.

The international evidence shows that countries and regions that make themselves more attractive to residents and migrants can generate population growth. In turn, population growth increases urban population density, productivity and economic growth. This is endogenous growth and therefore does not come at the expense of other areas in the country or region. Appendix 1 and Appendix 2 outline the arguments and evidence for the links between economic attractiveness and migration, and urban density and productivity.

This two-pronged approach to regional development was a result of integration of geographic and economic disciplines and was captured in the two complementary phrases "People follow Jobs" and "Jobs follow People". Adding the adjective 'quality' before the People and the Jobs gives a better understanding of the proven concepts.

The main positive of attracting quality people into the country and the region is that economic development of this type gives real gains and is not a 'zero-sum game' of development of one area at the expense of another. A recent Department of Labour publication shows the economic impact of increased migration.[21]

The benefits from increased urban density through mixed use, mid-rise development with open space are best seen in areas like Newmarket and Remuera in Auckland and to some extent in parts of central Wellington. Developments in the Jackson Street and the western Esplanade in Petone are beginning to move in this direction. Urban density in the Esplanade Census Area Unit (CAU) is already at a healthy 81 people per hectare. This compares with just 41 per hectare in Hutt Central CAU.

The benefits of higher density include:

- employment in higher-value industries like business services, the creative industries rather than more-extensive manufacturing and warehousing
- a broader range of employment opportunities resulting in higher labour force participation rates.

In a transport sense, the advantages of density include a high level of use of active modes (and of public transport) in the journey to work, because of the 'nodal' nature of residential and workplace locations. The higher level of personal services, community services, quality retail etc. within the community can reduce the journeys for other purposes also.

These factors together can significantly lift household incomes and improve the quality of life and social aspects of a community.

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[21] Nana, Dr Ganesh, Kel Sanderson and Rob Hodgson, *Economic impacts of immigration: Scenarios using a computable general equilibrium model of the New Zealand economy*, Department of Labour, Wellington. 2009.

Wellington's demographic booster

The Wellington Region's effective development requires Petone integrate as a high functioning satellite settlement. Its character and lower land values, combined with increases amenity and mixed used densification will increase it as a target for migrants. The impact of such immigration is likely to be particularly pronounced for the Wellington region. Compared to the rest of New Zealand, the Wellington Urban area's population tends to be younger, more highly educated and more highly paid, and more diverse in terms of ethnicity and nationality.[22]

For example, almost 70 percent of Wellington City's population in 2006 was working aged (15-64 years old). This was the highest proportion in the country, and was above the national average of just under two thirds (66.2 percent).

Table 5.2 Proportion of an area's population by age (2006 Census)

Age band	Auckland City	Wellington City	Rest of the North Island	Christchurch City	Rest of the South Island	New Zealand Total
0-9	14.4%	13.7%	14.6%	12.3%	12.5%	13.9%
10-14	7.5%	7.0%	8.2%	6.5%	7.2%	7.6%
15-19	7.7%	7.5%	7.3%	7.4%	7.3%	7.5%
20-24	8.1%	8.2%	5.5%	7.9%	6.0%	6.7%
25-39	23.1%	23.7%	18.2%	21.1%	18.5%	20.4%
40-64	29.8%	30.5%	32.3%	31.1%	34.1%	31.6%
65-74	5.1%	5.2%	7.6%	6.6%	7.7%	6.6%
75+	4.3%	4.2%	6.4%	6.9%	6.6%	5.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: BERL, Statistics NZ

Wellington also has a relatively high proportion of skilled workers, reflecting the concentration of government, business services, education, creative, and high value manufacturing industries in the area.

[22] The Wellington Urban Area covers the four local authority areas of Wellington City, Porirua City, Lower Hutt City and Upper Hutt City.

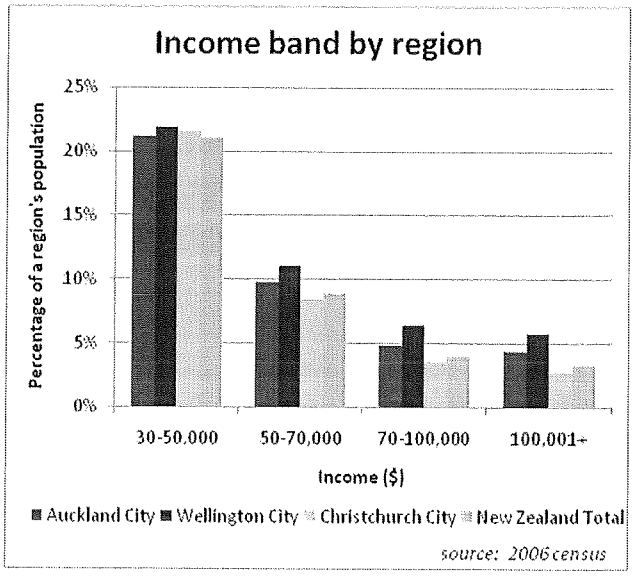
Table 5.3 Proportion of an area's population by occupation (2006 Census)

Occupation	Auckland City	Wellington City	Rest of the North Island	Christchurch City	Rest of the South Island	New Zealand Total
Managers	11.0%	11.1%	8.1%	14.2%	8.0%	9.3%
Professionals	11.0%	15.0%	8.0%	15.5%	7.5%	9.6%
Technicians	9.3%	9.8%	6.7%	13.2%	6.6%	7.9%
Sub-total	**31.4%**	**35.9%**	**22.8%**	**42.9%**	**22.1%**	**26.7%**
Clerks	8.1%	9.1%	6.3%	11.4%	6.2%	7.1%
Service and Sales Workers	8.2%	9.2%	8.6%	15.4%	9.5%	8.8%
Primary Sector Workers	0.8%	0.6%	6.6%	2.0%	8.3%	4.2%
Trades Workers	5.0%	4.6%	5.9%	8.6%	5.9%	5.5%
Machine Operators	3.9%	3.0%	5.5%	7.5%	6.5%	4.9%
Labourers	3.6%	3.2%	4.1%	6.7%	4.8%	4.0%
Not Elsewhere Included	3.5%	3.3%	4.0%	5.4%	3.5%	3.7%
No occupation	35.5%	31.0%	36.1%	55.4%	33.2%	35.0%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: BERL, Statistics NZ

In terms of industry concentration, more than one third (36 percent) of Wellington City's population were managers, professionals or technicians (which are largely high-skilled occupations), compared to just under one third (31 percent) in Auckland City. In absolute terms, almost 101,000 people worked as managers, professionals or technicians in Wellington City. The equivalent number was just over 76,000 in Christchurch City.

With a large, highly skilled working age population, Wellington City is the highest earning area in New Zealand. It has the greatest proportion of people (nearly one person in eight) in the higher income brackets ($70,000+ p.a.) and one in three people earn above the average wage compared to one in four nationally.



At the higher end, 5.8 percent of Wellington City employees had incomes of at least $100,000. This compared to 4.4 percent in Auckland City, 2.8 percent in Christchurch City, and 3.3 percent nationally.

Wellington City is ethnically diverse, attracting both short-term migrants (generally for study) and long term-migrants who are well immersed within the local labour market. Over one quarter (27.6 percent) of Wellington City's residents were born overseas, compared to just over one in five nationally.

Notably, Wellington City has the highest proportion of immigrants from the UK, Ireland, European Union and North America.

Table 5.4 Proportion of an area's population by country/region of birth (2006 Census)

Country/region of birth	Auckland City	Wellington City	Rest of the North Island	Christchurch City	Rest of the South Island	New Zealand Total
Australia	1.5%	1.6%	1.5%	1.7%	1.6%	1.6%
Pacific Islands	8.6%	4.0%	1.1%	1.3%	0.5%	3.4%
UK and Ireland	6.4%	7.1%	6.1%	6.6%	5.7%	6.2%
EU and Nth America	2.7%	3.0%	1.9%	2.7%	2.2%	2.4%
Asia	14.3%	6.0%	2.3%	6.3%	1.7%	6.2%
Other	3.8%	2.1%	1.4%	1.5%	1.0%	2.1%
Total overseas born	37.5%	24.0%	14.3%	20.2%	12.8%	22.0%
NZ born	57.3%	72.4%	80.7%	76.6%	83.7%	73.5%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: BERL, Statistics NZ

Immigrants from the UK, Europe and America have above average incomes (amongst migrants but also generally) and tend to stay in New Zealand for longer than other migrant groups.

Table 5.5 Proportion of an area's population by duration of residency (2006 Census)

Overseas born, years in NZ	Auckland City	Wellington City	Rest of the North Island	Christchurch City	Rest of the South Island	New Zealand Total
Less than 5	33%	27%	27%	33%	31%	31%
Between 5 and 14	30%	22%	20%	24%	20%	26%
15 or more	32%	47%	49%	39%	45%	39%
Not specified	5%	4%	4%	4%	4%	4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Therefore, migrants attracted to Wellington are likely to contribute more economically and to stay longer, and therefore the investment that attracts them here will pay off more and over a longer period.

Regional economic development and international tourism

Over time, higher value, dense urban settlements tend to have higher economic growth rates. Combined with higher rateable land values, reflecting the willingness of residents and businesses to pay for such development, this will permit further investment into the City and region's infrastructure. This will enable a virtuous growth cycle attracting residents, employment and increased business opportunities. This could be particularly important to Wellington's tourism sector, and therefore its national economic contribution.

For example, around 50 cruise ships come to Wellington per year, delivering between 80,000 and 100,000 tourists who contribute an estimated $38 million to the national

economy.[23] However, almost all of these cruise ships berth for one day only, giving their passengers limited opportunity to visit wider Wellington. By increasing the attractiveness of the region, international cruise ships to Wellington may schedule longer stop-overs, encouraging international tourists to New Zealand to book longer trips and who will contribute more to the Wellington and national economies.

An expanded tourism market attracted to Petone's mixed use development would also create its own additional infrastructure requirements. Given the nature of the visitors that could be attracted, this could support, for example, the construction and operation of a five star hotel in Petone or Hutt City. This would have major economic benefits to the construction industry and an ongoing benefit through the accommodation and hospitality industries.

However, we do not attempt to include these potential benefits in the economic analysis above. Were such impacts to occur they would add to the benefits quantified in section 4.

[23] BERL estimates based on Cruise New Zealand's (2008) report on the economic impact of cruise ships to New Zealand and Wellington.

6 Summary

The stepwise improvement of the Petone West area consequent on the traffic diversion to the CVL can substantially improve a major asset of the Region, namely Petone beach, foreshore and environs; encouraging higher incomes and improved quality of life and amenities for its residents.

This in its way will make Wellington Region more attractive to residents and migrants, and can be expected to further retain and attract at least sufficient people to bring about the population increase in the Petone foreshore area. It is likely in fact that it will contribute to the broader attraction of population to the Region resulting in increased economic growth across the region and thereby contributing to national economic growth.

The regional and national benefits will include higher economic productivity and incomes; a greater use of environmentally-friendly active modes and PT for transport; and more compact, diverse, dynamic communities in the mixed use development areas. It will also ensure the infrastructure and urban form is conducive to maintaining an innovative manufacturing industrial base. It also has the potential to draw additional high value tourists to the region, who will stay longer and contribute more to the New Zealand economy.

The indirect impacts permitted by the CVL constitute additional benefits to the nation that are not counted in the standard EEM approach. These additional benefits have a material impact on the relative importance of the CVL project, and these benefits would have demonstrable value to road users and the community. We believe that the evidence and arguments in this report show that meet the CVL meets the NZTA's test to be recognised as national strategic significance.

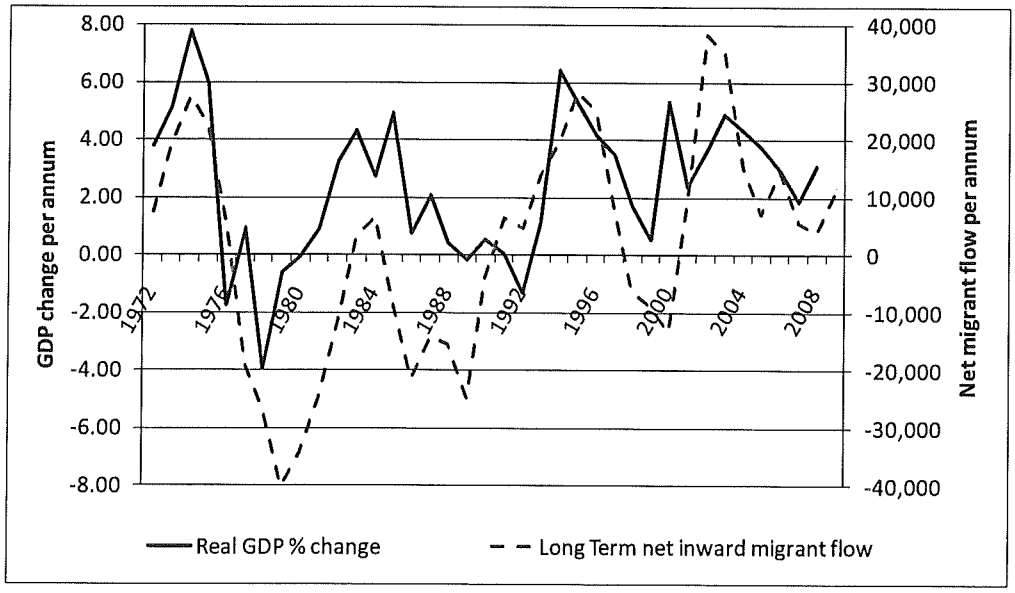
Appendix 1: Economic attraction and migration

New Zealand 'normally' experiences a net inward flow of overseas migrants. However, from time-to-time New Zealand also experiences a net outward flow of migrants overseas, sometimes substantial ones. We have explored the fundamental proposition that growth attracts inward migration by plotting and analysing the relationship between the annual percent change in real GDP and the annual net migrant flow over the period 1972 to 2008. We find a strong relationship showing that higher GDP growth appears to cause higher migrant inflow.

During the period 1972 to the present the net inward migration flows have ranged between a net outflow of 40,000 people in a year in 1979, (the second oil shock) and a net inflow of 40,000 people in a year in 2002 post 9/11 and when there was a large Asian student influx. This is highlighted below in Figure 6.1.

The strength of the New Zealand economy appears to be a major factor determining the rate of net migrant inflow. By plotting the strength of the economy, measured by the percentage change in real GDP, from 1972 to 2008 it appears that the GDP change is related to the net migrant flow for much of the time.

Figure 6.1 Net inward migration and GDP growth, 1972 to 2008



The figure indicates that periods of higher GDP are associated with higher net inward migration flows. Our statistical analyses show that higher GDP growth

appears to be a strong and highly significant cause of higher migrant inflow. We believe our analysis supports the fundamental proposition that increased growth results in increased net inward migration, increasing New Zealand's total population.

The implication of this historical relationship is that for every one percent increase in GDP the migrant inflow has increased by 0.2 percent of the resident population. Since the resident population is approximately 4.3 million people a one percent increase in real GDP per annum increases the net migrant inflow by about 8,600 people. The downside is that if average GDP growth falls below two percent to three percent per annum, the net migrant flow is negative. (If GDP growth was zero the migrant outflow would average 15,000 to 25,000.)

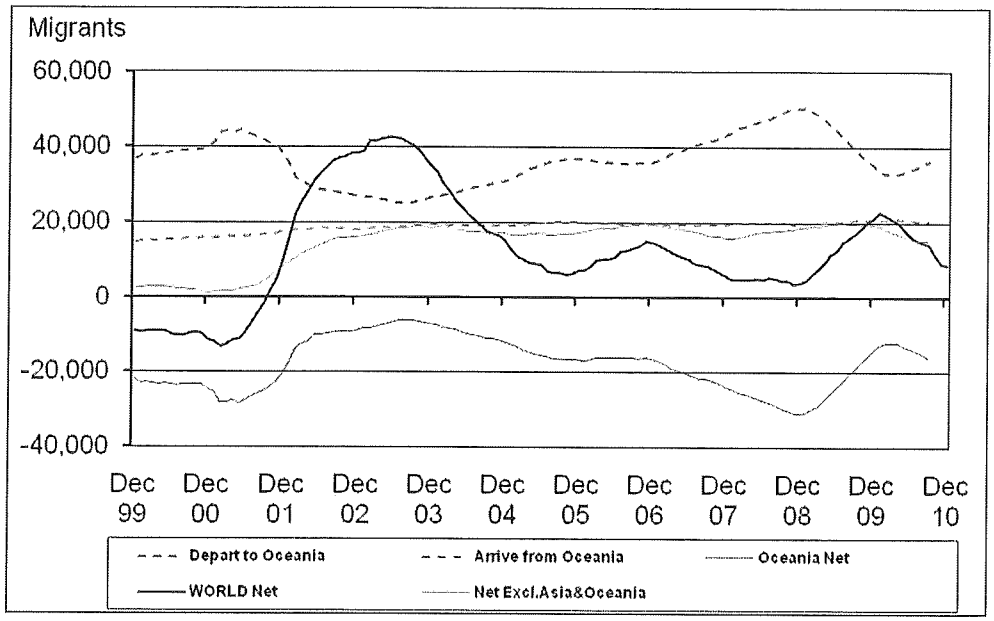
Implications for regional growth and migration

New Zealand's experience from 1972 to the present is one of 'grow and they will come'. The numbers who will come are quite substantial, namely in the tens of thousands.

The gross migrant inflow from Europe and North America grew from 28,000 in 1999 to 40,000 in 2002 and has remained at about that level until the GFC. Given relatively stable gross migrant inflows from main world regions, the changes in net migrant flows are now more likely to be caused by changes in the number of New Zealanders leaving, rather than changes in the gross migrant inflow.

Figure 6.2 shows that the main recent change has been a reduction in departures to Oceania (mainly Australia) which is reflected in the net outflow to Oceania, and then in the net inflow from the world.

Figure 6.2 Net migration patterns by world region, 1999 to 2009



The main implication of this set of findings is that any change to infrastructure, facilities and services that makes New Zealand a more desirable place for people to stay in or to come to is likely to increase the net inward migrant flow. This migrant flow will tend to enable the potential population growth to be realised. As this in turn realises the economic growth, this implies that this process of regional development is not a zero-sum game, but creates actual addition to regional GDP.

Sources of population for regional residence and work

The findings are that if the economy is strong (and presumably if the country or the region is in some other way attractive), then measurably more people will stay in, and/or move to the region. The successful completion of the CVL will improve the economic base in the Hutt and the urban intensification is also likely to lift the Region's GDP as well as its liveability. Thus, there is a strong case that the CVL is a credible driver of additional population growth for the region and the nation.

The sources of an increase in future regional population numbers are:

- the net natural increase in the region's existing population; and
- the net inward migration to the region, both internal (within New Zealand) and international.

Statistics New Zealand projects

Net Natural Increase

The average annual net natural increase on the Wellington Region's population from 2001 to 2006 was 3,440 per year. In June year 2007 the increase was 3,830 and in June year 2008 it was 3,990. This firm increase reflects the national situation where there has been a change in behaviour for some years that is seeing a significant increase in the birth-rate now. This is not a temporary 'spike' but can be shown to be an evolutionary change in behaviour towards a higher birth-rate spread across a greater number of age groups of women. At the other end of life, there is strongly increasing work participation in the 60's and 70's age groups and this appears to be associated with a slightly declining rate of deaths per 1,000 people.

There is therefore strong evidence here that the Wellington Region's net natural increase on its present population will continue to be at least the present level of approximately 4,000 per annum. This implies that from 2006 to 2026, the addition to the present population from its net natural increase would be approximately 80,000 people.

This increase will be modified by the Region's level of net outward or inward migration over the period.

Net Migration

The two aspects to be considered are internal migration (from within New Zealand) and international migration.

Wellington Region's net internal migration flow over the last 30 years (6 censuses) has moved from a relatively high net outflow of 1,870 per annum 1976 to 1981, to a steady inflow of 370 per annum from 1996 to 2001. In the latest period 2001 to 2006, the net flow was about zero. The long term trend for Wellington has therefore been to move from an outflow to an inflow. The trend in Canterbury has been similar. Auckland region on the other hand has moved steadily from a net internal inflow of 4,000 per annum in 1976 to 1981, to a net internal outflow of over 3,500 per annum from 2001 to 2006.

We do not have the data for the international migration into Wellington Region, but we do have the figure for the total migration flow, internal and international. The figure for the average for the period 2001 to 2008 is a net annual inflow of 1,211 people. Given that Wellington Region's internal migration figures 2001 to 2006 were

about zero flow, this implies that the region's international migration created a net inflow of about 1,200 people per year.

This information indicates that it is highly unlikely that the net migration flow will reduce Wellington region's population in 2026 below that created by the net natural increase to the population between now and 2026.

Availability of people to increase population

Without completing a full demographic description of New Zealand behaviour changes, the summary situation of people that could be available is:

The population in 2006 was nearly 450,000.

- If the net natural increase continues at 4,000 per annum the regional population in 2026 would be 530,000
- If there was a net outward migration of 1,250 per annum there would be a population in 2026 of 505,000.
- If Wellington region added a net inflow from migration of 1,250 per annum this would add 25,000 to the population on top of the natural increase. This is a population of 555,000.
- There has recently been a net inflow from migration of about 1,200 per annum. If the recent attractiveness of the Wellington Region is maintained or increased, it is highly probable the region could have a population of 555,000 by 2026.

Attracting inward migrants

There is a strong international migrant inflow especially from Europe and North America at a rate of about 40,000 to 42,000 per year. There is also now a steady outflow of internal migrants from Auckland at a rate of 3,500 per year. Some of these will be earlier international migrants moving on after a period of settling and assessment.

The challenge to Wellington region is how to attract some of these migrants. Two questions then arise: who is moving, and why are they moving?

The Statistics New Zealand *Survey of Dynamics and Motivation for Migration in New Zealand* (2007) reveals some answers. The dominant occupation among people who moved to other regions (as opposed to within their own region), was managers, administrators, and legislators, (around 23 percent). This was followed by

professionals (18 percent) and then technicians and associate professionals (14 percent). In other words, the occupations of people who move to other regions are overwhelmingly managers, professionals and associate professionals – skilled workers (55 percent).

As for why people move, the largest shares leaving the Auckland Region do so for employment reasons, followed by social reasons (e.g. due to the start or end of a relationship, or to set up their own home), and then environmental reasons.

Appendix table 1 Reasons why people leave selected New Zealand Regions

Region of previous residence	Most common main reasons ranked		
	First	Second	Third
Auckland	Employment	Social	Environment
Waikato	Employment	Social	Environment
Bay of Plenty	Employment	Social	-
Wellington	Social	Employment	Environment
Canterbury	Social	Employment	-
Otago	Employment	Social	-

Those leaving Wellington do so mostly for social reasons, followed by employment and then environmental reasons.

An attractive environment like that of Petone, with good local job opportunities, no need to commute long distances to work, and excellent public transport into Wellington CBD if required, is likely to attract migrants from the rest of the country, including some of the 3,500 leaving Auckland each year.

Appendix 2: Intensification and productivity

Below we examine Town Centre intensification around a transport node. We consider how improved transport access associated with the CVL and Petone development scenarios might reflect the sort of Town Centres in Auckland Region that are targeted to be served by Premium Bus Services.

The Auckland Regional Council (ARC) has developed a set of density parameters for Town Centre developments.[24] The average parameters expected for such a Town Centre in Auckland Region is 30 dwellings per hectare, or 150 employees per hectare, or some combination. (Note that 30 dwellings per hectare would imply residential density of, say, 50 to 80 residents per hectare.) The densities are expected to be higher in the 0 to 200 metre radius catchment, declining for the 200 to 400 metre catchment, and declining further for the 400 to 800 metre catchment. The total catchment for each Town Centre is of the order of 200 hectares.

It is useful to show some of the areas in Wellington Region that have densities of a similar order, and the contrast with the much higher densities in the CBD.

Appendix table 2 Comparative residential and workplace densities, 2006

	Area	Residents	Workplace Employed	Residents	Workplace Employed	Total
	Hectares	*No.*	*No.*	*Density per hectare*		
Zones with higher employment density						
Petone Esplanade *	94	2,358	5,296	25.0	56.2	81.3
Thorndon - Tinakori	211	3,691	12,347	17.5	58.6	76.1
Porirua Central (part)	42	0	3,260	0.0	77.6	77.6
Zones with higher residential density						
Johnsonville North	63	4,041	991	64.1	15.7	79.9
Waterloo West	29	1,813	374	61.5	12.7	74.2
Other zones of interest : actual density 2006						
Existing 'Town Centres' with low residential density to date						
Upper Hutt Central	43	329	2,197	7.6	50.8	58.4
Hutt Central	237	973	8,627	4.1	36.5	40.6
Highest density CBD zones						
Lambton	99	8,950	51,042	90.9	518.2	609.1
Willis St - Cambridge Tce	103	5,792	19,826	56.2	192.5	248.8

* Note: By 2026, Petone Esplanade density is projected in the WTSM model to be over 100 per hectare. These are comprised of 34 residents and 66 workplace employed.

[24] These are included in Appendix H-1 of their Regional Policy Statement (RPS).

Johnsonville North and Waterloo West have residential densities at the level implied in the RPS Town Centres. The Petone Esplanade CAU has a combination of moderately high residential and workplace densities, giving the 2006 total density of over 80 per hectare. Note that the Petone area referred to is 94 hectares in size, so it is not only the high-density heart. The expectation of employment densities for mixed use areas dominated by workplace employment fall somewhere between these existing zones, and the density in CBD areas.

The densities implied by the Auckland RPS for these town centres would seem to be quite feasible for Wellington 'satellite' town centres.

The expected impacts from increased density in Petone are that the workplace employment profiles and the residential profiles and behaviour will reflect that seen in other higher density areas. Below we focus on the outcomes for the industry employment profile and labour productivity.

Industry employment and labour productivity

The profile of employment by industry in areas of high density as in the inner Auckland and Wellington Cities are compared with the average for Auckland City as a whole, and a particular study area, Glen Innes-Panmure, in the table below.

Appendix table 3 GDP per employee by industry profile

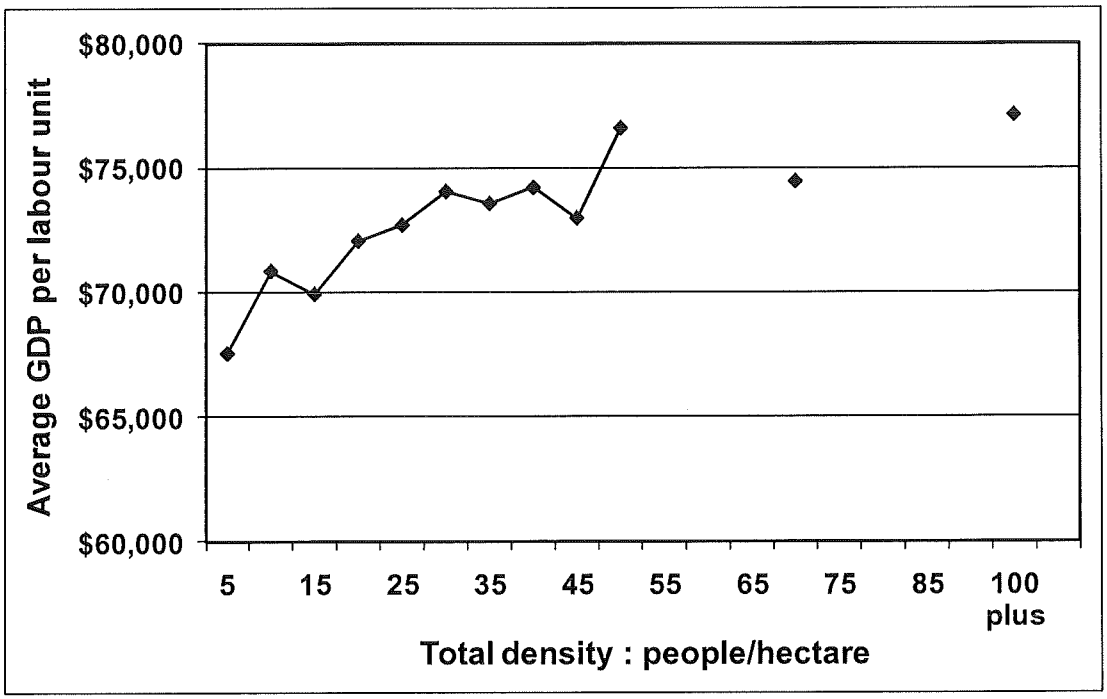
Industry	New Zealand GDP per Employee: 2001 *($1996)*	Industry Employment Profiles: Glen Innes Panmure Residents 2001	Auckland City Residents 2001	Central Auckland City work-places 2001	Inner Wellington Residents 2001
Primary	$49,567	1	1	0	0
Manufacturing & Construction	$57,264	23	15	6	5
Wholesale Trade	$82,323	9	9	7	5
Retail Trade	$27,413	12	10	8	6
Accommodation, Cafes and Restaurants	$18,524	5	5	7	7
Transport, Storage & Communications	$72,650	7	6	8	5
Business Services & Finance	$105,904	16	23	38	37
Social & Government	$40,900	15	18	18	25
Cultural, Recreational & Personal Srvs	$34,226	6	7	8	10
Not Elsewhere Included	$61,485	8	6	0	0
Total	**$50,872**	**100**	**100**	**100**	**100**
Average GDP per employee		$59,571	$62,326	$68,844	$66,385

The main point to note is that in the lower density areas the relatively low generators of GDP per employee – the manufacturing and construction industries – is 15 percent to 23 percent, and is only five percent to six percent in the inner city. In contrast the relatively high generators of GDP per employee, the business services and finance industries' employment is only 16 percent to 23 percent in the lower density areas, and is 37 percent to 38 percent in the high density inner cities.

This effect overall shows through in the weighted average GDP per employee that was $59,571 in Glen Innes-Panmure and $66,385 to $68,844 per employee in the inner cities.

This effect has been plotted also for all CAUs in Auckland Region at the time of the 2006 Census. Figure 6.3 shows that for areas with an average total density of under 20 people resident and/or at workplaces per hectare, the average GDP generated is under about $70,000 per labour unit. (Note: these figures are on a higher base than those above, so the comparison only holds within each example.) As the total density increases to 60 or 70 per hectare the industry profile of employment changes such that the average GDP generated is over $75,000 per labour unit.

Figure 6.3 GDP per labour unit by urban density, 2006



As well as increases in labour productivity at higher density our empirical work also shows that there are very significant increases in labour force participation rate in areas with higher density. This is undoubtedly because the greater range of employment opportunities, especially in business services. This allows more people to find employment that fits their lifestyle.

Hutt City Council

Report for Petone Esplanade

Capacity Study

May 2012

Contents

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Appendices

1. Executive Summary

A study has been undertaken of The Esplanade in Petone to: review the present traffic conditions, estimate the future traffic flow, assess any deficiencies and provide appropriate solutions for any deficiencies.

The following deficiencies were identified by the study:

- Cuba Street traffic signals are at capacity in the eastbound direction and additional lane capacity is required
- Waione Bridge will reach capacity within 10 years at existing growth rates. The capacity will be reached earlier if the proposed Petone to Grenada link is constructed
- Cycle facilities are poor
- Side road traffic can only exit at present due to the existing congestion on The Esplanade and the level of reverse priority that exists
- Pedestrian connectivity to the foreshore area could be improved
- Poorly defined off street parking areas.

The level of improvement works on The Esplanade is also linked to the outcome of other proposed improvements in the regional road network. The proposed construction of the Petone to Grenada Link is expected to increase traffic flows on The Esplanade by up to 10% which will require capacity improvements. However the construction of a Cross Valley Link is expected to decrease traffic flows on The Esplanade by around a third and as a result no capacity improvements on The Esplanade would be required.

Three alternative options have been identified to look at the long term requirements of The Esplanade.

Option A: Overall Concept

This option retains the two lane nature of The Esplanade but maximises the existing capacity by making improvements to the Cuba Street signals and signalising other key intersections. On road cycle facilitates are provided together with the off road Great Harbour Way cycle and pedestrian facilities. This option also includes improved parking areas along the foreshore and increased planting.

Option B: Four Laning

This option includes four laning of The Esplanade which will require a bridge duplication of the Waione Bridge. Key intersections will need to be signalised. The Great Harbour Way cycle facility will need to be constructed as there will be no on road cycle facilities and all on road parking will have to be removed to allow for the four laning. The four laning will improve the traffic capacity but will reduce the other amenities of the area and westbound queuing in the morning peak will still occur unless improvements are made on SH2.

Option C: Cross Valley Link

Increased capacity can be achieved in an east-west direction by creating another separate road link in the network. The best location for such a link is the extension of Wakefield Street to Whites Line West, known as the Cross Valley Link. This option will require a new river crossing and upgraded intersections

along the route. It is recommended that if this option was preferred that the Cuba Street traffic signal improvements were still undertaken as a stand alone project and thought given to the Great Harbour Way.

The components and cost of each option are provided in the tables below. The preliminary benefit cost ratio (BCR) of each option, together with the individual components of each option is also provided.

Table 1 Option Summary

Component of Option	Cost	Preliminary BCR
Option A: Overall Concept	**$10,480,000**	**7.2**
Cuba Street Improvements	$630,000	93
Victoria Street Signals	$1,100,000	0.9
Great Harbour Way – SH2 to Waione Bridge	$2,060,000	6.6
Signalising Other intersections (5), providing on road cycle way, parking improvements, improved planting	$6,690,000	-1.3
Option B: Four Laning	**$38,020,000**	**2.9**
Duplicate Bridge	$26,820,000	2.7
Four Laning, including signals at intersections	$9,140,000	
Great Harbour Way – SH2 to Waione Bridge	$2,060,000	6.6
Option C: Cross Valley Link	**$48,080,000**	**2.9**
Cuba Street Improvements	$20,000	100+
Cross Valley Link*	$46,000,000	1.6*
Great Harbour Way – SH2 to Waione Bridge	$2,060,000	6.6

*The economic analysis for he Cross Valley Link is a rough order BCR only and is not as accurate as the remaining BCR's in his table

Council will be able to make a better informed decision after the completion of three other studies that are either underway or in the process of being commissioned. These are:

- HCC Network Resilient Study currently being undertaken
- HCC Seaview-Gracefield Multimodal Transport Needs and Links Study due to be tendered shortly
- NZTA Project Feas bility Report for the Petone to Grenada Link due to be tendered shortly

Presently there are already intersection capacity issues on The Esplanade, particularly at Cuba Street. With natural growth the mid-block capacity will be reached in around 10 years' time, however the proposed Petone to Grenada Link will potentially accelerate the growth and additional capacity will be required sooner

A benefit comparison has been undertaken for the three options identified. A ranking between 1 to 4 has been provided for each option for the alternative benefits of each options, without consideration to cost. The scoring system (and colours) is based on the following:

- 1 – red – dis-benefits over the existing
- 2 – yellow – neutral – similar to existing
- 3 – pale green – positive benefits to existing
- 4 – dark green – major positive benefits to existing

The table below includes non-monetary benefits that the benefit cost ratios do not include. Also the relative construction costs are not included in the relative benefits of each component tabulated below.

Table 2 Overall Benefits of Options

Option:	Traffic Benefits	On road Cycle Benefits	Off Road Cycle Benefits	Parking Benefits	Pedestrian Access Benefits	Network Resilience Benefits	Foreshore Amenity Benefits	Weighted Overall Benefits
Option A: Overall Concept	3	4	4	3	3	2	3	3.1
Option B: Four Laning	4	1	4	1	2	2	1	2.1
Option C: Cross Valley Link	4+	3	4	3	3	4	4	3.6

As can be seen, cost excluded, the most desirable option is Option C, the revised Cross Valley Link.

2. Introduction

The Esplanade in Petone is a major arterial providing access from Eastbourne, Wainuiomata and south-eastern part of Lower Hutt to State Highway 2 (SH2). In addition it is a recreation area with access to the beach and is used by recreational cyclists, walkers and beach users.

Presently the traffic volumes are around 30,000 vehicles per day on this two lane, median divided road. At this volume the road would be at capacity. The Cross Valley Link was considered to divert some of the traffic from The Esplanade; however the economic analysis undertaken in November 2009 showed that the project was not economically justifiable.

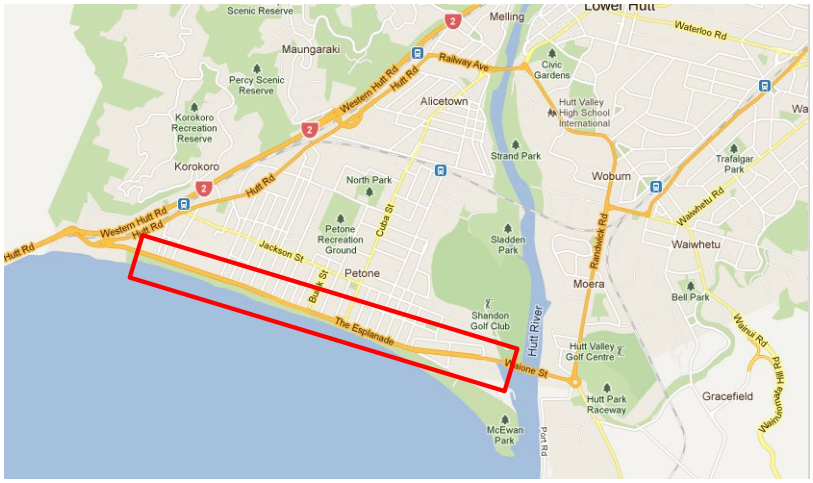
The Great Harbour Way project aims to promote a Walkway and Cycleway around Wellington Harbour. The aim is that there will be a continuous, safe, signposted wa kway and cycleway around the whole perimeter of the Harbour from Fitzroy Bay in the east to Sinclair Head in the west. Petone Foreshore is part of the project. In addition to recreational cyclists, many cyclists use The Esplanade to commute to Wellington. These two types of cyclists have different requirements.

Dune planting has been occurring over the past few years by volunteers to assist in protecting the sand on Petone Beach and to stop it from blowing over the seawall. The dunes will eventually hold the sand on the beach side and reduce the amount of wind swept sand on the road and what builds up within the median strip. The dunes are still too young at this stage to alter the landscape.

As a result of all these alternative activities and conflicting users, Hutt City Council has commissioned a high level overview study of The Esplanade.

The extent of the study area is shown below:

Figure 1 Study Area



The section of road under investigation extends from the SH2 on and off ramps along The Esplanade into Waione Street and the Hutt Estuary Bridge. The bridge itself is not in the study area. A roundabout

is at each end of the road, outside the study area. At the western end is the Hutt Road roundabout which connects the Hutt Road with The Esplanade and the SH2 Petone on and off ramps. At the eastern end is the Hutt Park Roundabout which connects Waione Street to Randwick Road and Seaview Road.

The Esplanade has many intersections along it and comprises a major arterial link route between Eastbourne, Wainuiomata and the south eastern part of Lower Hutt to SH2. The road has a traffic volume of approximately 30,000 vehicles per day with a posted speed limit of 50 km/h.

Apart from two intersections along The Esplanade, all intersections are T intersections. This is because the road has the geographic boundary of the sea on the southern side.

There is one signalised intersection along the stretch of road at Cuba Street and one signalised pedestrian crossing to the east of Victoria Street. All other intersections are priority controlled.

Figure 2 The Esplanade, east of Cuba Street

Petone beach is used for recreational purposes including fishing at Petone Wharf, dog walking in the dog walking areas, running, walking and cycling. The beach is used not only by Petone residents, but also residents from the Hutt Valley and Wellington. Many people come to the dog walking areas from outside the area, as there are not many public places that you can walk your dog without a lead.

Figure 3 Recreational Beach Users

3. Traffic Patterns

Hutt City Council undertook a series of traffic counts using tube counts between 3 and 20 December 2010. These have been supplemented by the New Zealand Transport Agency's traffic count database for the state highway network together with manual intersection surveys at key locations. Historic data has been provided for the permanent count station on the Hutt Estuary Bridge, at the eastern end of the study area.

3.1 Daily Vehicle Flows

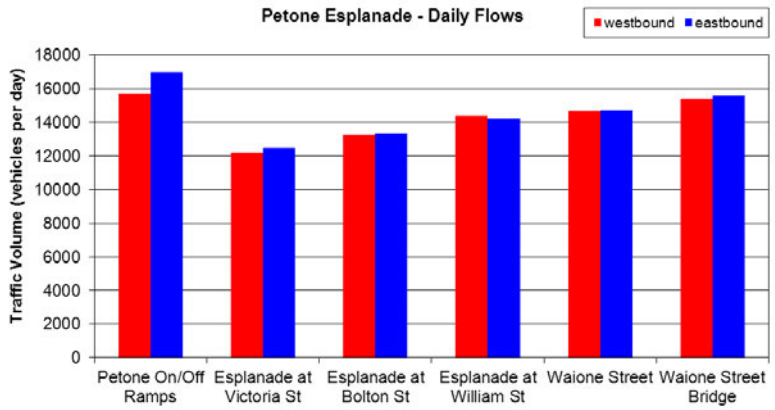
The daily flows at key locations within the study have been extracted and are provided below.

Table 3 Daily Average Flows on Weekdays (ADT's)

Location	Northbound / Westbound	Southbound / Eastbound	Bothways
SH2 Petone On / Off Ramps	16,800	15,590	32,390
The Esplanade at Victoria Street	11,110*	12,260	23,370
The Esplanade at Bolton Street	13,340	13,190	26,530
The Esplanade at William Street	14,530	14,090	28,620
Waione Street	14,530	14,550	29,080
Hutt Estuary Bridge	15,500	15,480	30,980
Te Puni Street	1,680	1,490	3,170
Cuba Street	2,670	2,590	5,260

* The actual count is estimated to be 800 to 1000 vehicles higher due to the traffic counter under counting in the morning peak due to slow moving vehicles

Figure 4 Daily Flows – Petone Esplanade



The flows on the Petone on and off ramps are divided between The Esplanade and the Hutt Road. The daily volumes suggest that of the 32,400 vehicles per day on the ramps, around 9,000 use the Hutt Road and the remaining use The Esplanade to reach their final destination.

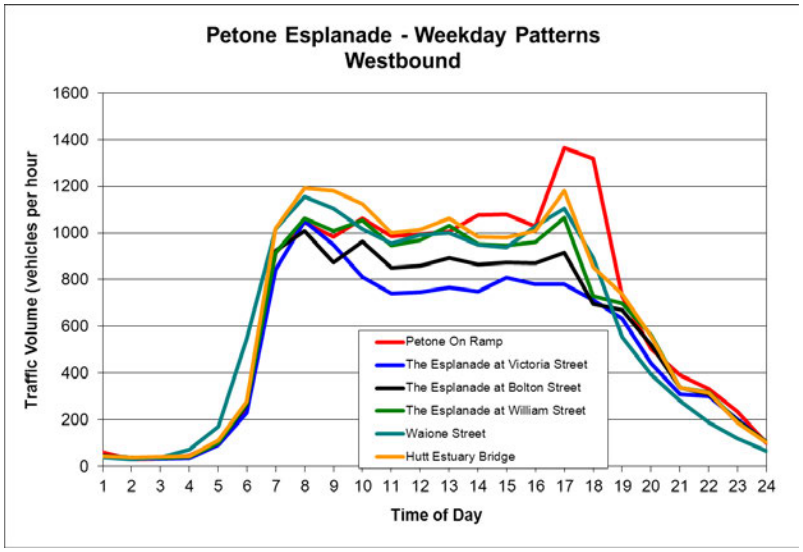
Traffic volumes on The Esplanade gradually increase from west to east, reaching maximum flows on the Hutt Estuary Bridge, with 30,000 vehicles per day. This is extremely high for a 2 lane road.

Traffic flows on the side roads are significantly lower with Cuba Street carrying 5,300 vehicles per day, Te Puni Street with 3,200 vehicles per day. The remaining streets are likely to carry between 1,000 and 2,000 vehicles per day.

3.2 Hourly Vehicle Flows

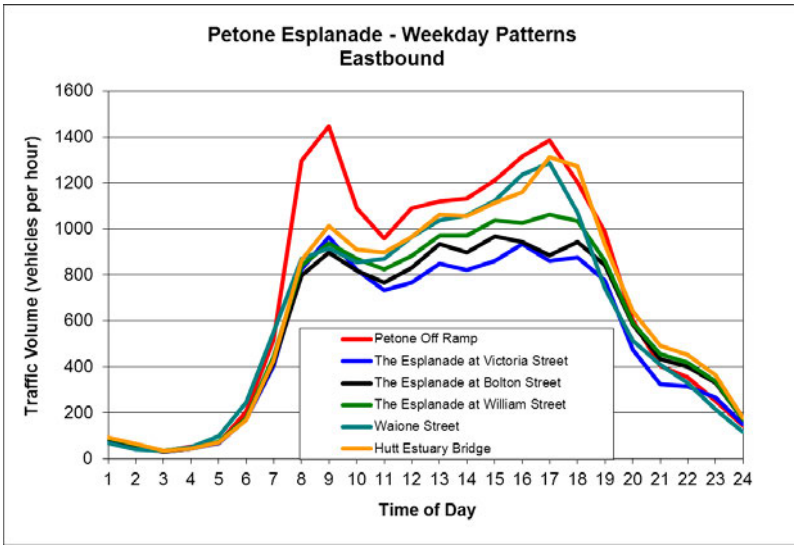
The hourly flow patterns have been extracted for the key locations and graphed to determine the peak hour profiles. The Tuesday to Thursday average has been used to show a typical weekday.

Figure 5 Weekday Patterns – Westbound



Excluding the Petone off ramp, which feeds the Hutt Road as well as The Esplanade, the peak flows occur on the Hutt Estuary Bridge.

Figure 6 Weekday Patterns - Eastbound



Again, excluding the Petone on ramp, the peak flows occur on the Hutt Estuary Bridge.

Excluding the Petone motorway ramps, the flows all tend to display the similar characteristics, with a relatively flat profile throughout the day. The traffic flows do not show typical peak periods during the morning and evening commuter periods that are typical for a major arterial road. The flows show patterns that are more associated with local roads. This is probably due to the road being at capacity during the peak periods and the dependence on The Esplanade for commercial vehicles to the Seaview industrial area and other commercial sites during the day.

Typically arterial roads will have peak flows around 10 percent of the ADT, however on The Esplanade the peak is around 7.5 percent of the ADT.

3.3 Yearly Vehicle Patterns

Data has been extracted from the permanent count site on the Hutt Estuary Bridge to determine the yearly patterns and if the traffic counts undertaken are representative of the year.

Due to problems with the counter, there was no data in April 2010 and limited data in December 2010. The hourly flows for each weekday of the year, excluding public holidays, are provided below:

Figure 7 Yearly Morning Patterns on the Hutt Estuary Bridge

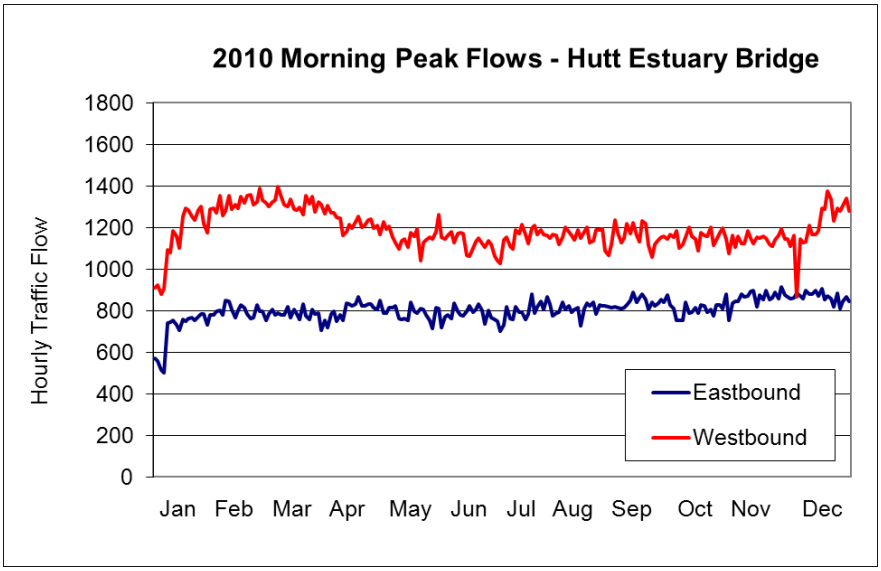
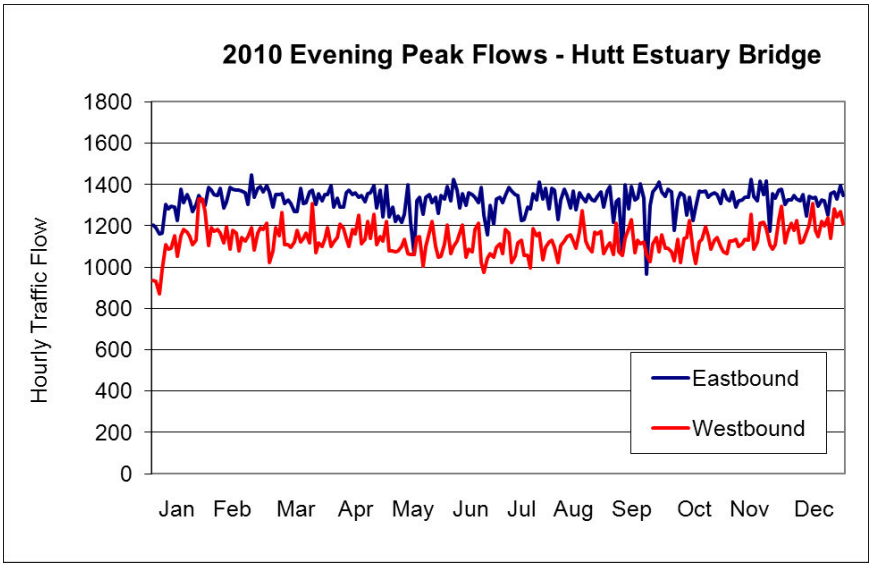


Figure 8 Yearly Evening Patterns on the Hutt Estuary Bridge



As one would expect, the hourly flows are lowest in January when many commuters are still on summer holiday. The flows are relatively steady with lower flows during the winter months, which match trends in other parts of New Zealand.

The data for the above graphs can be summarised as follows:

Table 4 Yearly Flow Patterns

	AM Westbound	AM Eastbound	PM Westbound	PM Eastbound
Average	905	358	1131	1324
60 percentile	923	366	1143	1349
70 percentile	933	372	1164	1358
80 percentile	952	385	1185	1368
85 Percentile	963	392	1201	1375
90 percentile	984	397	1220	1386
Maximum	1069	450	1329	1447
December volume	945 (77%)	401 (93%)	1190 (82%)	1314 (35%)
February Volume	911 (50%)	372 (70%)	1147 (63%)	1351 (63%)

The tabulated December volume coincides with the tube surveys undertaken by Hutt City Council and the tabulated February volume coincides with the manual intersection surveys undertaken by GHD as part of this study. The tube counts undertaken in December 2010 generally represent the 80th percentile and needs to be factored by 1.02 to reach the 85 percentile count. The February counts generally represent the 65 percentile and needs to be factored by 1.04 to reach the 85 percentile count.

Figure 9 Traffic on Waione Street – Evening Peak

3.4 Intersection Vehicle Turning Counts

Classified manual turning movement counts were undertaken at key intersections on The Esplanade. These were undertaken continuously between 6:45 and 8:15 and 16:00 and 18:00. The intersections closest to SH2 were counted until 9:00. The surveys were undertaken between Tuesday and Thursday during the two week period 15 February to 24 February 2011.

The flows have been factored by the annual factor to represent the yearly 85 percentile flow.

The results are shown in Appendix A.

3.5 Heavy Commercial Vehicles

A significant number of heavy vehicles use The Esplanade as this route is the main connector between the Seaview-Gracefield industrial area and SH2.

The automatic traffic counters classify the data into 12 classifications. The results were provided at an ADT level only. The counting was undertaken using the Austroads classification system, where Class 1 is short base 2 axle vehicles which are typically cars and vans. Class 2 includes short base vehicles that are towing. The remaining classes are a combination of truck and trailer units. Generally Classes 3 to 12 are commercial vehicles however some commercial vans may be included in Class 1 and 2.

Table 5 Daily Average Flows on Weekdays (ADT's)

Location	Proportion Class One and Two	Total Daily Flow	Total Commercial Vehicles
The Esplanade at Victoria Street	88.0%	23,370	2,800
The Esplanade at Bolton Street	88.8%	26,530	2,970
The Esplanade at William Street	88.6%	28,620	3,260
Hutt Estuary Bridge	88.6%	30,980	3,530

As can be seen, there are over 3,500 commercial vehicles on the Hutt Estuary Bridge on a typical day.

The proportion of commercial vehicles during the entire day is higher than the peak periods due to the influence of the industrial areas of Seaview and Gracefield.

The proportion of commercial vehicles does not vary.

3.6 Traffic Growth

The Lower Hutt traffic model has been used to extract growth rates from various key locations around Petone. The resulting annual growth rates at various sites are tabulated below:

Table 6 2010-2026 Modelled Annual Growth

Annual Growth	Eastbound / Northbound	Westbound / Southbound	Bothways
The Esplanade- Victoria to Buick	0.5%	1.2%	0.8%
The Esplanade - Cuba	0.5%	1.1%	0.7%

Hutt Estuary Bridge	0.3%	1.1%	0.6%
Ewen Bridge	0.6%	0.9%	0.7%
Melling Link	0.5%	0.6%	0.6%
SH2 South of Petone	0.3%	1.6%	0.8%
SH2 North of Petone	0.1%	1.7%	0.7%

The annual growth rates are significantly lower than those provided as default growth rates in the New Zealand Transport Agency's Economic Evaluation Manual, which is 2% for urban arterials in the Wellington Region.

The lower growth rate in the eastbound direction could be due to a capacity restraint at the Hutt Park Roundabout.

3.7 Vehicle Queue Lengths

Significant queuing occurs on The Esplanade and the side roads.

The Esplanade, westbound – queuing mainly occurs at the western end, due to the capacity restraint of the Petone on ramp. Traffic from The Esplanade merges with the traffic from the Hutt road and forms a single lane. The queue lengths are worst in the morning commuter peak period. Observations show that the queuing can start as early as 7:00 am, and can extend beyond King Street, some 1.5 km. This extent of queuing often coincides with bad weather or an incident on the SH2. On a day by day basis the queues tend to extend to around Petone Wharf. Observations on Thursday 24 February showed that by 7:30 am the queues had reached Victoria Street (around 1.0 km) and by 7:45 am they had extended to Sydney Street (around 1.2 km). At 8:30 am they were still at Victoria Street. The queuing which occurs results in vehicles driving down Jackson Street and using the streets closest to the western end to gain access to SH2, such as Te Puni Street.

The Esplanade, eastbound – queuing in the eastbound direction occurs throughout the afternoon, particularly between 15:00 pm and 18:00 pm. Significant queuing occurs at the Cuba Street traffic signals, with static queues observed beyond Buick Street (around 300 m). Observations show that the queuing results in reverse priority, where vehicles on The Esplanade then give way to side road traffic, enabling them to exit. This occurrence results in the traffic on The Esplanade then queuing behind the stationary vehicle and similar occurrences of reverse priority control occurring downstream. The effect continues all the way to Te Puni Street.

Hutt Road – queues at the Hutt Road / The Esplanade roundabout extend in the morning peak period as vehicles are not able to physically leave the intersection due to queuing from the SH2 on ramp. Furthermore, there is still a significant volume of vehicles using the SH2 off ramp, which has priority over these vehicles. Queues often extend beyond the Jackson Street roundabout.

Te Puni Street – Queuing occurs during the morning peak period as vehicles try to avoid the queuing on The Esplanade. Right turning vehicles are able to give way to eastbound vehicles only and use the bus lane to enter the westbound direction. Queues are frequently 10 to 15 car lengths long, but tend to dissipate fairly quickly as they only need to give way to one direction of traffic.

Victoria Street – Queuing in the evening peak has been observed as much as 10 to 12 cars at periods where the reverse priority is not occurring when the travel speeds on The Esplanade are above 30 kph.

Kirkcaldy Street – Queues were observed during the evening peak of around 4 to 5 vehicles on the southern approach at 17:00 pm, as this coincided with the finishing times of the local businesses that access this street.

3.8 Travel to Work

A large proportion of the traffic flow on Petone Esplanade is made up of commuters travelling to work, particularly during the morning and evening peak periods.

The New Zealand Census is undertaken at 5 yearly intervals. The database includes travel to work data at area unit level by mode of transport. An analysis of the data has been undertaken to determine the work address of residents living in Petone, Eastbourne, Wainuiomata Gracefield and Waterloo.

It should be noted that numbers that are too small for confidentiality reasons are not included in the database, so occasionally individual numbers do not equal to the total. The table also does not include car passengers, walking, cycling and motor cycling. The totals do not include employees that worked from home, did not work on census day or not elsewhere included.

A higher proportion of vehicles travelling to Wellington from Eastbourne, Gracefield and Wainuiomata would use The Esplanade for their route. Some Petone residents would use Jackson Street and the Hutt Road to gain access to SH2 and Waterloo residents have an even greater choice of access routes.

Table 7 Employees Travelling to Wellington to Work (2006)

Residential Address	Drove Car	Public Transport	Total
Petone	483	447	1071
Eastbourne	444	165	807
Wainuiomata	861	363	1419
Gracefield	240	210	498
Waterloo	663	810	1662
Total	2690	1995	5460

As can be seen, a large proportion of employees travelling between the areas tabulated and Wellington City take public transport. The lowest proportion is those from Wainuiomata, which makes the largest proportion of drivers on the Esplanade.

Between 7:00 am and 9:00 am there are around 2000 vehicles travelling westbound on The Esplanade travelling towards SH2. Around 1800 of these are cars and vans. Based on Table 7, it can be assumed that the majority of the westbound vehicles on The Esplanade during the morning peak are commuters.

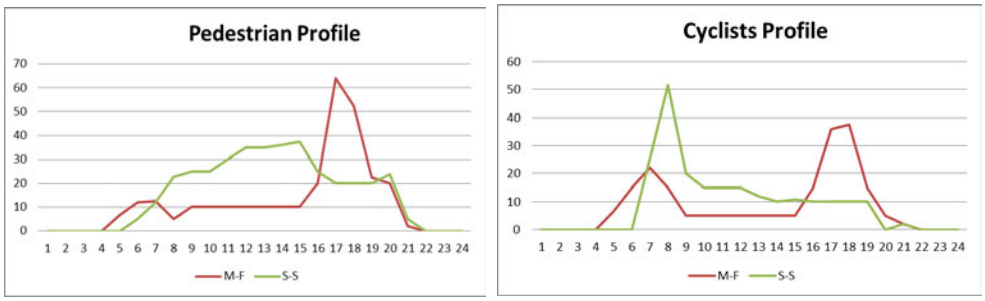
Between 16:00 pm and 18:00 pm there are around 1800 vehicles coming off the Petone off ramp driving onto the Esplanade. A further 870 vehicles turn onto the Hutt Road.

3.9 Pedestrian and Cycle Volumes

A series of surveys have been undertaken at different times of the day for both a week day and a weekend day to estimate the pedestrian and cycle volumes along the foreshore area of Petone Esplanade.

The resulting profiles are shown below:

Figure 10 Estimated Pedestrian and Cycle Patterns



This profile was made from 30 observations at different times of the week.

It is estimated that the average daily total of pedestrians and cyclists is 260 and 180 respectively.

Figure 11 Pedestrians and Cyclists on the Foreshore

4. Parking Areas

4.1 On Street Parking

The Esplanade has on street parking on the northern side of the road for most of its length. Generally this parking is unrestricted and vehicles are able to park here for free with no time restrictions. Time restrictions occur at a few carparks outside John's Fish Market (between Te Puni and Victoria Street). The Foreshore Diary (at Bay Street) has started erecting signs encouraging non-customers not to park outside their dairy.

Some limited on street parking is formed on the southern side. Some of it occurs where the cycle lane has widened enough for vehicles to park here. Generally the demand is low except for the area adjacent to Jetty Café (opposite Sydney Street).

The right turning bay for vehicles exiting Beach Street is often used by westbound trucks parking short term to use the Foreshore Dairy on the corner of Bay Street. This often occurs during the morning peak periods.

Most of the on street parking bays have not been marked and imply continuous parking areas between driveways and intersections. As a result, the number of cars able to park in each area varies depending on how close vehicles park to each other. The number of vehicles able to park in each area has been estimated based on different vehicle spacing, as shown below:

Table 8 On Street Parking Availability

Length of Carpark:	5.5 m	6.0 m	6.5 m
Hutt Road to Nevis Street	40	37	32
Te Puni Street to Victoria Street	34	32	29
Victoria Street to Fitzherbert Street	3	3	3
Fitzherbert Street to Sydney Street	1	1	0
Sydney Street to Nelson Street	6	5	5
Nelson Street to Richmond Street	9	8	8
Richmond Street to Bay Street	6	5	4
Bay Street to Beach Street	3	3	3
Beach Street to King Street	3	3	3
King Street to Queen Street	1	1	1
Buick Street to Bolton Street	5	3	3
Bolton Street to Tory Street	3	2	2
Aurora Street to Oriental Street	4	4	3
Oriental Street to William Street	4	4	3

Length of Carpark:	5.5 m	6.0 m	6.5 m
William Street to Patrick Street	4	4	4
Patrick Street to Collins Street	2	2	2
Collins Street to Jessie Street	4	4	3
East Street to Kirkcaldy Street	28	24	22
Kirkcaldy Street to East Street	13	11	11
Kirkcaldy Street to Hutt Park Roundabout	18	14	12
Jessie Street to Kirkcaldy Street	27	24	22
Sydney Street to Bay Street	40	37	33
Total	**258**	**231**	**208**

The total number of on street carparks between Hutt Road and Waione Street varies between 208 and 258 depending on how people park, with the most likely number being around 230 spaces.

4.2 Off Street Parking

There are a series of off street parking areas on the southern side of The Esplanade. Generally they all contain angle carparking spaces. These have been described below:

- Water Ski Club Rooms – a large parking area is formed at the very west of The Esplanade and is accessed via a driveway 100 m east of the Hutt Road roundabout. The large carpark is used to accommodate cars and boat trailers during the summer months, in particular Sundays which is club day. The adjacent Rowing Club also uses this carpark and on several times of the years they hold Rowing Regatta's when this carpark is overflowing. The large grass area opposite The Hutt Road is used by the Gypsy Fair 3-4 times a year. Some smaller parking areas are also available along the driveway.
- Wharf Carpark – adjacent to Petone Wharf is a parking area with access opposite Victoria Street. Cars generally angle park here. Mid way along the carpark is a vehicle access to the beach. During peak parking this access is blocked with parked cars.
- Jetty Café – a small carpark is located adjacent to Jetty Café. Directly in front of this area is also some on street parking that is used by customers.
- Heretaunga Boating Club – limited parking is available here. The club organises Regattas several times over summer and holds club days. During these times the walkway between the clubrooms and the seawall is often occupied with boats.
- Opposite Beach Street is a 120 m length of wide seal that forms a casual parking area. During the mornings (week days and weekends) a coffee kiosk locates here. The carpark is used for short term commuters getting a coffee on their way to work. Wheel stops prevents parked cars from spilling over into the walkway area. The kerb is mountable the entire length so there are no strict driveway locations. This is the closest parking area adjacent to the landscaped area opposite Bay Street where there are changing facilities, showers and BBQ's for general public use.

- Opposite Queen Street is a 50 m length of seal with marked angle carparks. Adjacent to the kerb is low planting such that there is a distinct entry and exit location.
- Opposite Bolton Street is a 60 m length of seal with marked angle carparks. Adjacent to the kerb is low planting such that there is a distinct entry and exit location.
- Bolton Street to Tory Street has a 65 m length of seal where vehicles park. Some landscaping and planting separates from the area opposite Bolton Street. To the east is the Petone War Memorial.
- Tory Street to Cuba Street has a 45 m length of seal where vehicles park. To the west is the Petone War Memorial.
- Opposite Aurora Street is a tapered triangular length of seal that measures around 100 m in length. Only around 40 m can be used for parking and this area generally is only used if the remaining areas are full.
- Opposite Jessie Street is another triangular length of seal measuring 90 m. The widest point is around 20 m in width allowing parking to occur along around 60 m. East of this is a Children's Playground area.
- Adjacent to Marine Parade is a small marked carpark which serves the Children's play area. It accommodates 13 carparks.

Many of the parking areas are casual with unformed carparking areas and access points. These could be better formed, but would possibly have a reduction in overall parking. The capacity of the parking areas vary based on the spacing of cars. As many of the areas are unmarked, or have very faded markings, the parking can be hap-hazard and not efficient. The spacing between the parked cars will alter the capacity of the parking areas. The number of vehicles able to park in each area has been estimated based on the width of the parking spacing.

Table 9 Off Street Parking Availability

Width of Carpark:	3.0 m	3.5 m	4.0 m
Opposite Sydney Street to Richmond Street	14	12	10
Opposite Beach Street	39	33	29
Opposite Queen Street	14	12	10
Opposite Bolton Street	13	11	10
Bolton Street to Tory Street	21	18	15
Tory Street to Cuba Street	16	14	12
Opposite Aurora Street	18	15	13
Opposite Jessie Street	25	21	19
Children's Play Area	13	13	13
Total	**215**	**184**	**162**

The total number of off street carparks along Petone Foreshore varies between 160 and 215 depending on how people park, with the most likely number being around 180 spaces.

4.3 Parking Demands

Parking demands vary throughout the week. During a typical weekday the areas on the western and eastern ends are used by employees in the various adjacent businesses. Parking demands in the middle section get high on weekends. During the summer months, vehicles park on The Esplanade to use the beach. In winter months many people stay in their cars and admire the views and scenery.

The parking area adjacent to Petone Wharf gets busy during weekends and summer evenings as this is adjacent to the dog walking area and residents from throughout Lower Hutt use this area to walk their dogs.

Special events such as the Winter Carnival and Guy Fawkes night attract vehicles from throughout the Hutt Valley and even Wellington. During these times parking is at a premium and not only are all parking areas within the foreshore occupied, but so are the side roads.

5. Other Roading Studies

5.1 Petone to Grenada Link

The New Zealand Transport Agency (NZTA) has undertaken a study of the Ngauranga Triangle in 2009. The purpose of the study was to develop an integrated long-term transport strategy for the "triangle" between SH1, SH2 and a possible connection between them.

The proposed Petone to Grenada Link is a four lane divided road with adequate shoulder width for cyclist use linking SH1 at Tawa to SH2 using a new Petone Interchange. It is designed to have an operating speed of 70 kph and is expected to cost around $250 M. Presently it has a BCR of around 1.8 and NZTA are pursuing it as it relieves congestion on a SH1 along a section where SH1 is a road of national significance (RONS).

The Draft Hutt Corridor Plan has the link fully operational in 2018.

Figure 12 Petone to Grenada Link

The Petone to Grenada link is estimated to carry around 25,000 vpd, with around 10% heavy commercial vehicles, even though the gradients are as high as 9% in some areas. The modelling work undertaken shows that the Petone to Grenada Link will increase traffic flows on The Esplanade by around 3,000 vehicles per day. While the report states "…the modelling work undertaken to assess this impact shows that the increase in daily traffic flow will not significantly worsen current levels of congestion and delay". This is not considered to be correct as various parts of the road are at capacity now.

The road requires reconstruction of The Esplanade / Hutt Road / SH2 interchange. The proposal has a westbound slip lane from Petone Esplanade for State Highway traffic which bypasses the roundabout. This lane widens to two lanes at the main Petone Interchange with one lane dedicated to Wellington bound traffic and one to access the Petone Grenada Link. This will reduce queuing here as vehicles using the Petone to Grenada link to access SH1 will not need to merge with SH2 traffic.

Presently there is very little traffic that flows from The Esplanade to the Hutt Road, with 50 vehicles recorded in the evening peak, and less than 10 vehicles per hour in the morning peak period. The existing on ramp flows are only 700 vehicles per hour in the morning peak due to the lack of capacity on

SH2. The actual demand is higher. During the evening peak this increases to 1150 vehicles per hour. Under the proposed design, this traffic still only has a single lane.

The details of the proposed new interchange are shown below:

Figure 13 Proposed Upgraded Petone Interchange

As this project is part of a RONS project, it only requires a BCR higher than 1 to be considered for funding.

5.2 Cross Valley Link – 2009 Study

The Lower Hutt District Plan (pre 1989 amalgamation) contained a designation for a Cross Valley Link that would connect Wakefield Street to Whites Line West and Whites Line East with a new river crossing. However Government legislation in the 1980s required that projects were either proceeded with, or removed from District Plans. The designation was subsequently removed.

In 2009, the Cross Valley Link was re-assessed as part of the Ngauranga Triangle Study as it improves the traffic connection to the Seaview / Gracefield industrial area, Wainuiomata and the Eastern Bays. The assessment was undertaken on a two lane divided road with provision for cyclists that connects Seaview-Gracefield to SH2 at the new Dowse Interchange.

The 2009 study of the Cross Valley Link follows the railway line and includes a new interchange on Whites Line East. This alignment was considered to have less impact on the residential properties on Whites Line West

Figure 14 Cross Valley Link – 2009 Alignment

Appendix A of the detailed Technical Report undertaken for the Ngauranga Triangle Study showed that 7 alternative options were tested for the Cross Valley Link. The tests were numbers, as follows:

- Test 7 –Traffic calming on the Esplanade and Jackson Street, 30 kph
- Test 8 – Cross Valley Link, 70 kph, following Wakefield Street
- Test 9 – Cross Valley Link, 70 kph, following railway line
- Test 10 - Four laning of Udy and Cuba Streets. 70 kph
- Test 11 - Cross Valley Link, 70 kph, with traffic calming on the Esplanade and Jackson Street
- Test 13 – combination of 7 and 10
- Test 16 – Four laning of The Esplanade, 70 kph
- Test 17 – Alternative eastbound route and traffic calming on the Esplanade and Jackson Street. Speed limit on The Esplanade 70 kph westbound and 30 kph eastbound.

It was considered that Option 8 and 9 were essentially the same in the model, so Option 9 was not tested, even though the railway line alignment was considered better for residents. The railway alignment required additional intersection configurations and potential delay which is not included in the analysis.

The network wide travel times for each option is provided below:

Table 10 Summary of CVL Modelling Options (2016 total network travel times)

Option:	DMIN	7	8 / 9	10	11	13	16	17
AM peak	6577.5	6622.3	6572.2	6548.8	6621.6	6609.8	6555.6	6563.1
Interpeak	3730.6	3760.1	3705.0	3728.8	3740.7	3742.6	3683.6	3712.1
PM peak	6992.0	7023.5	6984.3	6980.7	7066.2	7006.8	6958.1	6995.7

Test 11 was carried forward for full economic assessment even though in 2016 it had negative benefits and the options without traffic calming on The Esplanade had benefits.

The 2009 study estimated the cost of the Cross Valley Link to be around $80 M with a BCR of 0.3.

The 2009 study predicted that the Cross Valley Link will attract 21,000 vehicles per day in 2016. This will lead to a reduction in traffic on The Esplanade of approximately 10,000 vehicles per day. The estimate assumed that the speed limit on The Esplanade would be reduced to 30 kph to improve the beach amenities.

The modelling work undertaken shows that around 2,000 additional vehicles per day will be attracted to Randwick Road with the Cross Valley Link. The report states "this increase in traffic volumes will need to be managed to limit any adverse effect on the local community".

Figure 15 Change in Traffic Flows with Cross Valley Link

The report states that *"the Seaview-Gracefield area is the region's primary industrial area. Growing congestion on The Esplanade provides poor connectivity to SH2. This poor connectivity adds to the cost of business undertaken in Seaview-Gracefield….. The Cross Valley Link would enable the populations of the Eastern Bays and Wainuiomata to be better integrated into the greater Wellington region."*

The Report also states that "*many of the benefits of the Cross Valley Link can be achieved by upgrading The Esplanade but the costs of this upgrade to maintain and improve the levels of service required for access to the region's industrial hub at Seaveiw-Gracefield area is expensive, if not more expensive than building the Cross Valley Link*." This can be interpreted that should the Cross Valley Link not be built, then Petone Esplanade needs to be widened, at a greater cost.

The economic analysis has given this project a strategic fit of "low", however, Section G5.6 of the NZTA Planning, Programming and Funding Manual also says that a project should be given a rating of "high" if "*there is a major contribution to national economic growth and productivity on freight routes or tourism*" and it is an "*urban arterial critical for maximizing access to significant markets, areas of employment or economic growth*". The Esplanade carries over 3,500 commercial vehicles a day and therefore it could be considered to have a strategic fit of "high". Projects with a strategic fit of "low" require a BCR greater than 4.0 in order to get subsidy from NZTA. Projects with a strategic fit of "high" only require a BCR greater than 1.0 to get funding.

5.3 Cross Valley Link – 2012 Study

In early 2012, HCC commissioned GHD to undertake a revised cost estimate of the recommended alignment of the Cross Valley Link from the 2009 study – namely a link that followed the railway line. The cost estimate review showed that this alignment is not achievable due to the change in road level between the railway line, the proposed road and the residential houses backing onto the road, together with the intersection arrangements required at the Randwick Road location.

The previous alignment is now the favoured alignment as shown below.

Figure 16 Revised Cross Valley Link Alignment

Updated cost estimates have been undertaken for this alignment in 2012 and have been set at $46.0 M.

It is also considered that the road should have a 50 kph speed limit and that The Esplanade posted speed limit should remain at 50 kph without any traffic calming. This option has not been modelled, but is similar to Test 8. The outputs of Table 10 have been used to update the economic analysis which results in a very rough order BCR of 1.6.

The concept drawings of the revised Cross Valley Link are provided in Appendix C.

6. Congestion Monitoring

6.1 Levels of Service

The capacity of a roadway varies according to a wide range of influences including the road type, location in the network and the nature of adjoining land uses. Urban roads are limited by the capacity of downstream intersections, whereas the capacity of rural roads is principally determined by alignment and road geometry.

The term Level of Service is provided to characterise operational conditions within a traffic stream and their perception by motorists and passengers. Six Levels of Service (LOS) are defined with A representing the highest level, and F the worst. As traffic volumes increase, the level of service decreases. The following general statements describe the various Levels of Service.

- LOS A describes primarily free-flow operations. Vehicles are seldom impeded in their ability to manoeuvre in the traffic stream. Delay at intersections is minimal.
- LOS B represents reasonably unimpeded operations at average travel speeds. The ability to manoeuvre in the traffic stream is only slightly restricted and delays are not bothersome.
- LOS C represents stable operations; however, ability to manoeuvre and change lanes in midblock locations may be more restricted than in LOS B, and longer queues, adverse signal coordination, or both may contribute to lower average travel speeds.
- LOS D borders on a range in which small increases in flow may cause substantial increases in approach delay and hence decreases in arterial speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes, or some combination of these.
- LOS E is characterised by significant delays and average travel speeds of one-third the free-flow speed or less. Such operations are caused by some combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections, and inappropriate signal timing.
- LOS F characterises arterial flow at extremely low speeds, from less than one-third to one-quarter of the free-flow speed. Intersection congestion is l kely at critical signalised locations, with long delays and extensive queuing.

For most design or planning purposes LOS C or D are usually used.

6.2 The Esplanade

The capacity on The Esplanade, being an urban road, is based on the capacity of the intersections on the route. The only controlled intersections on The Esplanade are the roundabout at the Hutt Road, signals at Cuba Street and the Hutt Park Roundabout. Presently there are capacity restraints at the Hutt Road and Cuba Street intersections. Furthermore side road delays are increasing as gaps reduce on The Esplanade.

Level of service E is reached when side road delays reach an average of 35 seconds per vehicle and delays at a signalised intersection reach 55 seconds per vehicle.

Petone Esplanade works as two one way streets due to the raised median island that runs along most of its length. The gaps in the median island however create localised pinch points due to vehicles making

U-turns. Observations show that while a vehicle is waiting to make a U-turn, larger vehicles often can not pass them.

The capacity of a merge is considered to be 1485 vehicles per hour. Therefore the capacity of Petone Esplanade at the intersections where there is a merge to one lane is 1485 vehicles per hour.

Present peak hour flows along The Esplanade vary between 1,000 and 1,200 vehicles per hour. The flows on the Hutt Estuary Bridge however are around 1,400 vehicles per hour in the evening peak.

As reported in Section 3.6, the Lower Hutt Transport Model estimates a traffic growth of around 0.8% per annum along Petone Foreshore. However the westbound growth is estimated to be higher, at 1.2% per annum. Both rates are lower that historic growth in the Wellington region.

Table 11 Effect of Growth

Flow	Growth	Flow in 10 years	Flow in 15 years	Flow in 20 years
1,200	0.8% pa	1300	1350	1400
1,200	1.2% pa	1350	1420	1490
1,400	0.8% pa	**1510**	**1570**	**1620**
1,400	1.2% pa	**1570**	**1650**	**1740**

With modelled growth rates of around 0.8% per annum, The Esplanade flows will not reach capacity in the foreseeable future. However the capacity on the Hutt Estuary Bridge will be reached within 10 years.

Figure 17 Traffic on the Hutt Estuary Bridge – Evening Peak

If the Petone to Grenada Link is constructed, the analysis undertaken for the Ngauranga Triangle Study shows that around 3,000 vehicles per day will be added to The Esplanade. This additional flow will result in The Esplanade having no spare capacity.

7. Carriageway Designs

7.1 Existing Road Widths

The kerb to kerb widths along the Esplanade at various locations are tabulated below. The widths include parking and cycle facilities.

Table 12 Existing Esplanade Carriageway Cross Sections

Location	Kerb to Kerb	Westbound direction	Median	Eastbound Direction
West of Nevis Street	17.5 m	6.8 m	4.5 m	6.2 m
Te Puni to Victoria	17.1 m	6.5 m	4.3 m	6.2 m
Richmond to Bay	17.1 m	6.6 m	4.3 m	6.2 m
King to Queen	17.7 m	6.5 m	4.8 m	6.4 m
Bolton to Tory	18.9 m	6.9 m	5.1 m	7.0 m
Aurora to Oriental	19.1 m	7.5 m	4.4 m	7.2 m
Patrick to Collins	19.0 m	6.9 m	4.5 m	7.6 m
East of Kirkcaldy	24.5 m	8.5 m	7.8 m	8.2 m
Hutt Estuary Bridge	8.2 m	4.1 m	0.1 m	4.1 m

As can be seen, generally the overall width of the road is around 18 m, with all widths greater than 17.1 m.

7.2 Existing Footpath Widths

The existing footpath widths have been measured along the Esplanade at various locations on each side of the road. The widths are tabulated below:

Table 13 Existing Esplanade Pedestrian Walking Widths

Location	Width	Comment
West of Nevis Street	1.5 m	Off road gravel track, no sealed footpath adjacent to beach
Victoria to Fitzherbert	1.8 m	
Sydney to Nelson	3.1 m	Pinch point at Jetty Café. The rowing club frequently block the walking area with their boat stands. Sand also builds up along the path here.
Richmond to Bay	Varies	Landscaping, BBQ area and ramps. Minimum width at ramps is 1.7 m. Bollards are spaced at 1.0 m adjacent to the public toilets
Beach to King	2.5 m	Wide parking area with a pedestrian area adjacent to sea wall. Narrowest point is 2.3 m

Location	Width	Comment
Queen to Bolton	2.3 m	Behind Settlers Museum is 3.1 m due to the sea wall being further south.
Bolton to Tory	2.5 m	Wide parking area, however between the sea wall and the seating areas is only 2.5 m. Footpath beside War Memorial is 2.6 m between the two walls
Cuba Street	2.1 m	Sea side divided due to landscaping feature. The narrowest point beside the bollards is only 1.1 m. Between feature and kerb is 2.8 m
Oriental to William	2.4 m	Low planting adjacent to sea wall restricts available width to 2.4 m. A large traffic sign restricts the width to 1.7 m
Jessie to East	1.8 m	Area beside Children's play area between kerb and fence measures only 1.8 m and is narrower by the zebra crossing due to signs
Hutt Estuary Bridge	1.5 m	Shared pedestrian and cycle facility on southern side on. Where there are lighting poles, the width reduces to 1.1 m.

The sea wall and adjacent off street shared pedestrian and cycle facility runs between Victoria Street and Jessie Street.

West of Victoria Street is the Wharf carpark which has a pedestrian area separated from the cars by bollards. The width of this is 2.5 m. West of the carpark is a gravel, off road, shared pedestrian and cycle track that measures 1.8 m. There is no sealed footpath on the southern side of The Esplanade in this area. The gravel path connects to a small carparking area that has a shared driveway with the water-ski clubrooms and rowing clubrooms adjacent to SH2. Cycle access to the Hutt Road is provided via a subway underneath the SH2 on and off ramps.

As can be seen, the desired minimum width for a cycle lane for the Great Harbour Way is not met with the existing cross sections.

7.3 Cycle and Pedestrian Standards

The New Zealand Supplement to the Austroads Guide to Traffic Engineering Practice, Part 14: Bicycles provides minimum cycle lane widths. The Guide recommends that on road cycle lanes are a minimum of 1.5 m wide, with an adjacent traffic lane not less than 3.5 m wide. The cycle lane width should be increased to 1.8 m if on street parking is provided. The Guide also provides widths for off road cycle paths. For a shared pedestrian and cycle path, it recommends a minimum of 4.5 m with an absolute minimum of 3.5 m. This is less than the Great Harbour Way design standard of a 3.0 m wide facility.

A 0.2 to 0.5 m clearance is required to objects such as a sea wall.

Footpath widths vary depending on the type of user. The Austroads Guide to Traffic Engineering Practice Part 13 – Pedestrians, recommends a minimum width of 1.8 m to accommodate wheelchair users. High pedestrian areas have a recommended width of 2.4 m.

7.4 Great Harbour Way

The Great Harbour Way/ Te Aranui o Pōneke is a walking and cycling route around Wellington Harbour from Fitzroy bay in the east to Sinclair Head in the west. Once completed, it will provide a continuous, safe, signposted 72-kilometre route for walkers and cyclists around the entire perimeter Wellington Harbour. Few, if any, opportunities exist elsewhere in the world to walk or cycle the entire coastline of a major city harbour, continually touching the water's edge

The optimal goal of the GHW is to establish a shared two-way pathway immediately adjacent to the coast thus requiring a relatively wide path along the seaward side of existing roads. The GHW design standard has a minimum path of 3.0 m wide to allow for the free flow of two-way multi-use users. Paths will need to be wider than 3.0 m in high use areas such as promenades. The design standard also states that an absolute minimum path of 2.6 m would allow for two cyclists to pass comfortably or two pedestrians and one cyclist.

Figure 18 shows an example of an off road facility where pedestrians and cyclists share a directional off road facility.

Figure 18 Shared Off Road Pedestrian / Cycle Facility in Brisbane

7.5 Cross River Capacity

The Hutt River is a natural barrier for west-east movements in Lower Hutt. Presently there are four river crossings in the area of Lower Hutt as tabulated below:

Table 14 Hutt River Bridges

	Number of Lanes	December 2010 Daily Flow		Flow per Lane, peak direction
		Westbound	Eastbound	
Hutt Estuary Bridge	2	14,240	14,300	14,300
Ewen Bridge	4	18,200	19,830	9,900
Melling Bridge	3	12,440	11,640	11,640
Kennedy Good Bridge	2	11,440	11,420	11,440

Total	11	56,320	57,190

As can be seen the Hutt Estuary Bridge carries more traffic per lane than the other Hutt City Bridges. It carries significantly more than the Ewen and Melling Bridges per lane, which are the closest bridges. This is partially due to the larger catchment areas of Wainuiomata, Seaview and Eastbourne on the southern part of the valley, but also because the Ewen and Melling Bridges serve the CBD and the additional delays in the CBD encourage motorists in the areas around Waterloo to use Randwick Road and Petone Esplanade to connect to SH2.

The Silverstream Bridge is on the boundary with Upper Hutt City, some 8 km upstream from the Kennedy Good Bridge

7.6 Alternative Cross Sections

Alternative cross sections have been derived which result in different levels of service for different road users. These have been provided in Table 15. It should be noted that his table is generic only and minor changes may be needed to accommodate specific intersections.

The first two columns show the required lane with to provide on road cycle facilities for a two lane road. The second column is the first with reduced median width to allow for westbound right turning lanes.

The third and fourth columns provide the widths for a four lane road. As can be seen, there is no room within the exiting road reserve for on road cycle lanes. Localised road widening would also be required to accommodate westbound right turning bays.

Table 15 Alternative Cross Sections

	Improved Cycle Facilities	Improved Cycle Facilities with Turning Lanes	Four Lanes	Four Lanes with Turning Lanes
Westbound cycle lane	1.5	1.5	-	-
Westbound traffic lane 1	3.5	3.5	4.3	3.8
Westbound traffic lane 2		2.8	3.5	3.5 + 3.0
Median island	4.6	1.8	1.8	0.5
Eastbound traffic lane 2			3.5	3.5
Eastbound traffic lane 1	3.5	3.5	4.3	3.8
Eastbound cycle lane	1.8	1.8		
On Street Parking	2.5	2.5		
Total	17.4	17.4	17.4	18.1

Lane two can either be a turning lane, or a second lane in the requirement of The Esplanade being four laned. However, if the Esplanade was four laned, additional turning lanes would be required at the major intersections, and this would encroach onto the median island and also require localised road widening.

8. Intersection Capacity

Key intersections along the Esplanade have been assessed using Sidra. The growth rate used has been 1.2 percent per annum, which is the growth rate for the westbound direction of traffic based on the Lower Hutt Transport Model. It should be noted that the eastbound growth is lower. Taking the higher growth, the analysis is conservative. In actual fact, the reported delays could take longer to arrive. It should be noted that the previous growth rate in the Wellington region has been around 2.0 percent per annum.

8.1 Te Puni Street

The existing intersection of Te Puni Street and The Esplanade consists of a give way priority controlled intersection. The eastbound approach consists of just one lane. However, a dedicated left turn short lane is provided for traffic turning into Te Puni Street. There is street side parking on the eastbound approach with minimum clearance provided to the intersection. The westbound approach consists of two lanes, which includes a bus lane. A dedicated right turn short lane of roughly 40m is provided for the traffic turning into Te Puni Street from The Esplanade.

The existing and future traffic volumes have been assessed in Sidra. The results show that the traffic on Te Puni Street has delays of around 70 seconds per vehicle in the morning peak in 2011. This will increase to over 300 seconds per vehicle by 2021.

During the surveys, it has been observed that vehicles performing U-turns hold up traffic along the eastbound direction if it is followed by a heavy vehicle. This phenomenon has not been modelled in Sidra

8.2 Fitzherbert Street

The existing layout at Fitzherbert Street and The Esplanade is a give way controlled intersection. There are two westbound lanes along The Esplanade and one eastbound lane. One of the westbound lanes is a bus lane only during the morning peak period. Turn bays are provided to and from Fitzherbert Street. Fitzherbert Street has a single approach lane and all movements need to share this lane.

It should be noted that there is a signalised pedestrian crossing present in close proximity to the west of the intersection.

The intersection analysis shows that the traffic on Fitzherbert Street has delays of around 30 seconds per vehicle which will increase to over 50 seconds per vehicle by 2021.

8.3 Victoria Street

The existing intersection at the corner of Victoria Street and the Esplanade is a four way priority controlled intersection. The major approach is the East to West approach (Along the Esplanade). The intersection is currently priority (give way) controlled. The westbound approach consists of two lanes, with the right lane being a bus lane. There are right turn bays are provided. The eastbound approach consists of only one lane with a dedicated left turn bay into Victoria Street.

Observations show that vehicles are already taking very small gaps in the traffic flow and vehicle brakes and horns are often heard at this intersection.

It is considered that an option would be to signalise one of the three intersections at the western end of the Esplanade in order to undertake the following:

- Improve safety
- Channelise traffic through a single intersection, rather than Fitzherbert, Te Puni and Victoria Streets

It is considered that Victoria Street would be the best intersection to signalise as it has more scope for widening due to the large adjacent carpark in private property and it ties in with the Wharf carpark directly opposite, making it a cross intersection.

The alternative layout has been assessed using Sidra. A traffic growth rate of 1.2 percent per annum has been used for the calculations. It has also been assumed that there will be a shift of 50 percent of the right turning traffic and 30 percent of the left turning traffic from Fitzherbert Street and Te Puni Street to the Victoria Street intersection.

While the vehicles on The Esplanade will be delayed at the new traffic signals, the overall effect is a reduction in travel time due to the reduction in side road delay on Te Puni Street and Fitzherbert Street.

8.4 Buick Street

The existing layout at Buick Street and The Esplanade is a give way controlled intersection. There is one lane in each direction on The Esplanade with short turning bays into Buick Street. Buick Street has a single approach lane which widens to two lanes at the intersection. Observations show that vehicles make U turns at this intersection by turning into Buick Street and using the gap in the Buick Street median to then exit from Buick Street in the opposite direction.

There is a zebra pedestrian crossing west of the intersection, at Queen Street.

The analysis shows that right turning traffic on Buick Street has delays of around 50 seconds per vehicle in 2011 which increases to 130 seconds per vehicle in 2021 during the evening peak.

Observed delays during interpeak periods and weekends can be high due to the number off shoppers that use this street together with people visiting the water pump at the Jackson Street end of Buick Street.

An alternative layout, which would improve the access from the side road is to signalise the intersection. Signalising the intersection and including pedestrian facilities, will allow the removal of the pedestrian zebra crossing west of the intersection. U turn facilities can not be provided due to the location of the Settlers Museum. It is therefore recommended that the Buick Street design retains the ability for vehicles to make a U-turn in a two-step process.

The alternative layout has been assessed using Sidra. A traffic growth rate of 1.2 percent per annum has been used for the calculations. While the side road delays have reduced, the signals introduce delay to the through vehicles. However, the platooning effect of the signals will enable the priority intersections downstream to have better access.

8.5 Cuba Street

The existing intersection at the corner of Cuba Street and The Esplanade is controlled with traffic signals. There are two westbound lanes and a dedicated 50 m long right turn lane. There is only one eastbound lane together with a short left turn bay into Cuba Street.

The queue lengths are up to 165 m during the morning peak and 420 m in the evening peak on the western approach. The queues result in a stop start over the length of The Esplanade as reverse priority starts to occur. This results in other delays that Sidra is not able to calculate.

An alternative layout has been assessed which utilises the existing carriageway. The alternative includes and additional eastbound through lane by altering the left turn lane to a combined left and through. Parking will need to be removed downstream so that the two through lanes can merge into one.

If the proposed alternative layout is to be implemented, Sidra demonstrates that the queue lengths in the western approach will be less than the queue lengths currently observed up to the year of 2021, or an increase in 12 percent flows. However, by 2026, the queue lengths will be 1500 metres long.

Residents in side roads east of the intersection have stated that the signals provide breaks in the traffic to allow them to exit their street. Without the signals the traffic flow would be uniform and the gaps too small for vehicles to enter the traffic flow. The signals provides periods of long gaps in the traffic as the signals turn red at different phasing.

8.6 William Street

The existing layout at William Street and The Esplanade is a give way controlled intersection. There is one lane in each direction along The Esplanade with short turning bays into the side road. William Street has a single approach lane which is shared for left and right turning traffic.

It should be noted that there is a zebra crossing between William Street and Patrick Street.

The analysis shows that the right turning traffic on William Street has delays of around 60 seconds per vehicle which will increase to over 220 seconds per vehicle by 2021.

8.7 Kirkcaldy Street

The existing layout at Kirkcaldy Street and The Esplanade is a give way controlled intersection. There is one lane in each direction on The Esplanade with a short turning bays into Kirkcaldy Street. Kirkcaldy Street has a single approach lane which has enough width for two cars to queue beside each other at the intersection. Due to the exit merge lanes, the analysis has allowed right turning vehicles to make the movement in two stages. The first giving way to the near side traffic, and then waiting in the merge lane prior to merging with the far side traffic.

Due to the merge lanes, the delays on the side road are still at acceptable levels in the future.

8.8 Jessie Street

The existing layout at Jessie Street and The Esplanade is a give way controlled intersection. There is one lane in each direction on The Esplanade with a short turning bays into Jessie Street. Jessie Street has a single approach lane which widens to two lanes at the intersection.

It should be noted that there is a pedestrian crossing immediately east of the intersection.

The analysis shows that the right turning traffic on Jessie Street has delays of around 55 seconds per vehicle which will increase to over 90 seconds per vehicle by 2021.

Signalising the intersection will allow the removal of the pedestrian zebra crossing east of the intersection if pedestrian facilities are provided at the intersection.

8.9 Summary

The total travel time for each intersection has been tabulated for 2021 for both the existing intersection layout and the signalised option. Table 16 shows the total intersection travel time (vehicle hours per hour) for the various intersections in the existing layout and proposed layout for 2021 assuming a 1.2 percent per annum growth. It should be noted that the travel times report below are based on analysis undertaken in SIDRA and are based on isolated intersection operation. The delay to The Esplanade traffic will reduce if the signals are all co-ordinated, however side road delays may increase as a result. Overall the total intersection travel times should reduce with co-ordination.

Table 16 Total Intersection Travel Time - 2021

	Existing		**Signalised/Improved**	
	AM	PM	AM	PM
Te Puni	22.56 veh-hr/hr	1.47 veh-hr/hr	2.49 veh-hr/hr	0.87 veh-hr/hr
Victoria	1.82 veh-hr/hr	3.62 veh-hr/hr	5.11 veh-hr/hr	6.96 veh-hr/hr
Fitzherbert	0.59 veh-hr/hr	1.15 veh-hr/hr	0.47 veh-hr/hr	0.56 veh-hr/hr
Buick	0.55 veh-hr/hr	2.64 veh-hr/hr	10.17 veh-hr/hr	9.12 veh-hr/hr
Cuba	7.96 veh-hr/hr	116.43 veh-hr/hr	7.57 veh-hr/hr	20.13 veh-hr/hr
William	1.07 veh-hr/hr	2.18 veh-hr/hr	18.73 veh-hr/hr	8.82 veh-hr/hr
Jessie	0.78 veh-hr/hr	2.16 veh-hr/hr	15.68 veh-hr/hr	14.34 veh-hr/hr
Kirkcaldy	7.63 veh-hr/hr	1.86 veh-hr/hr	17.97 veh-hr/hr	15.61 veh-hr/hr
TOTAL	42.96 veh-hr/hr	131.51 veh-hr/hr	78.19 veh-hr/hr	76.41 veh-hr/hr

As can be seen, the signalised intersections increase the overall travel time at some of the intersections along The Esplanade, but reduce the delay at others. Those with increased delays are due to The Esplanade traffic having to stop to clear the side roads. The delay experienced by the side roads does not offset the delay to the through traffic. The installation of signals will also reduce the effect of reverse priority which exists presently, which increases the delays occurring at present. The effect of the reverse priority can not be successfully modelled using the intersection performance software Sidra. Rather this will require a micro-simulation model.

The improvements to the Cuba Street signals and installing signals at Victoria Street are the only two locations where the overall travel time is reduced.

9. Alternative Options Considered

Consideration has been given to alternative options for The Esplanade, including:

- Signalising intersections
- Closing the various gaps in the median island
- Allowing full movements at all intersections so that U-turns are no longer required
- Improving cycle facilities
- Implementing the Great Harbour Way
- Improving the parking areas
- Alternative methods of improving pedestrian crossing facilities
- Four laning of The Esplanade
- Construction of the Cross Valley Link

Each component has its own advantages and disadvantages. Consideration was given to the main objective of this study which was to maintain a high level of capacity for vehicles while improving the amenities of Petone Foreshore. All modes of transport and users of the area were to be considered, including pedestrians crossing the street, beach parking, local traffic, through traffic and freight movements.

9.1 Option A - Overall Concept

This option retains the two lane nature of the road but maximises the existing capacity by making improvements to the Cuba Street signals and signalising other key intersections. On road cycle facilitates are provided together with the off road Great Harbour Way cycle and pedestrian facilities. This option also includes improved parking areas along the foreshore and increased planting. The kerbs are located so that future four laning could be undertaken if required.

The preferred overall package includes:

- Provide additional capacity at the Cuba Street signalised intersection
- Signalise the Victoria Street, Buick Street, Jessie Street and Kirkcaldy Street intersections and provide pedestrian crossing facilities at these locations
- Remove the midblock zebra crossings and install signalised crossing at Bay Street
- Full on-road cycle facilities for the entire length of The Esplanade, stoping on the western side of the Waione Bridge
- Allowance for the Great Harbour Way
- Improved parking facilities along the foreshore to better define the parking areas and control the movement of cars on and off the foreshore

The overall concept is provided in Appendix B.

The concept results in a loss of available space for parking due to additional lanes needed at the signalised intersections and altered kerbs, however the parking will be better managed than at present as each space will be clearly identified.

The overall concept results in 392 carparking spaces, being 223 on street marked spaces and 169 marked off street spaces. The existing parking capacity varies between 370-470 depending on how people park.

The concept is able to be staged by implementing the most important components first, namely the improvement of the Cubs Street traffic signals and installing the Victoria Street traffic signals.

9.2 Option B - Four Laning The Esplanade

This option includes four laning of the Esplanade which will require a bridge duplication of the Waione Bridge. Key intersections will need to be signalised. The Great Harbour Way cycle facility will need to be constructed as there will be no on road cycle facilities and all on road parking will have to be removed to allow for the four laning. The four laning will improve the traffic capacity but will reduce the other amenities of the area and westbound queuing in the morning peak will still occur unless improvements are made on SH2.

This option will require the following improvements to allow for safe access to the residential streets across a four lane road.

- Signalise the Victoria Street, Buick Street, Jessie Street and Kirkcaldy Street intersections and provide pedestrian crossing facilities at these locations
- Remove the midblock zebra crossings and install signalised crossing at Bay Street
- Allowance for the Great Harbour Way
- Improved parking facilities along the foreshore to better define the parking areas and control the movement of cars on and off the foreshore

All cycling would be expected to transfer to the Great Harbour Way as there is no available width for on road cycle facilities.

This option can be constructed after Option A, should additional mid-block capacity be required after the implementation of Option A.

Alternatively all the non-signalised intersections along the foreshore may have to have turns restricted to left in left out only. This would have the effect of improving safety as cars would not need to turn right across two moving lanes, but will increase the traffic volumes on the parallel route of Jackson Street, which is traffic calmed as it a local shopping street that already acts as a through route for rat-running vehicles. Encouraging additional traffic onto Jackson Street is considered to be unacceptable.

The westbound queues in the morning peak at SH2 will remain as the two lanes will need to merge to a single lane and then merge with the SH2 traffic.

9.3 Option C – Cross Valley Link

Increased capacity can be achieved in an east-west direction by creating another link. The best location for such a link is the extension of Wakefield Street to Whites Line West, colloquially called the Cross Valley Link. This option will require a new river crossing and upgraded intersections along the route.

Details of this option are provided in Section 5.3.

It is recommended that if this option was preferred that the Cuba Street traffic signal improvements were still undertaken as a stand-alone project and thought given to the Great Harbour Way.

9.4 Cycle Improvements

Alternative options have been reviewed for implementing cycle improvements.

While the Council is committed to the Great Harbour way, over half the cost of the GHW is between on the coastal track between East Street and Waione Bridge, or about 25% of the length. Presently there are high users along the Beach frontage, but significantly less in the coastal track between the beach and Waione Bridge.

The GHW consideration in this study does not include the Waione Bridge as it is not feas ble to construct a 3.5 m path across the river without constructing another bridge.

The study area finishes on the western end of the Waione Bridge. There are no adequate facilities for pedestrians or cyclists on the Bridge. Both the traffic lanes and footpath are narrow. Cyclists use the footpath for safety purposes, but need to dismount if they meet people in the opposite direction, or if there are people fishing on the bridge.

Figure 19 Pedestrian Facilities on Waione Bridge

The approach to the bridge is also narrow, as shown below. North of the carriageway is a grass berm where an off road cycleway could be provided.

Figure 20 Narrow Lanes West of Waione Bridge

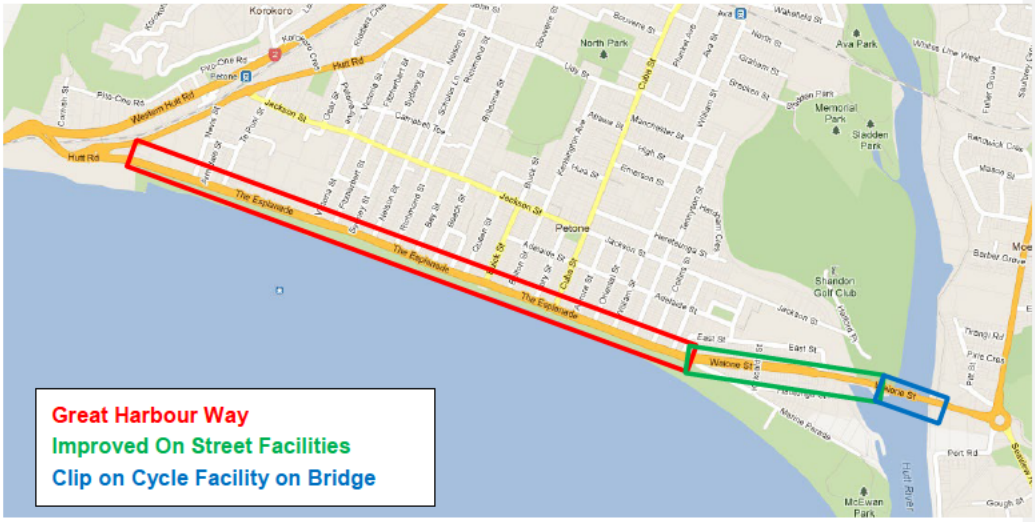
An on road cycle lane is provided between Marine Parade and East Street east, however some of the westbound markings stop and start and are not continuous and result in vehicles parking on the cycle lanes. In particular is the area around the service station where the on road cycle lanes become “no man’s land”

Figure 21 “No Man’s Land” at Marine Parade

Figure 17 in Section 7.5 shows the Waione Bridge, in particular the services on the northern side. It is considered that this structure could be used to build a platform for cyclists only to separate them from the traffic lanes, thereby increasing the vehicle capacity of the bridge and also removing the cyclists that choose to use the southern footpath, and therefore improving the pedestrian amenities.

Figure 22 shows an alternative to improving cycle facilities to the Great Harbour Way.

Figure 22 Low Cost Cycle Improvements



The red section in the above figure shows where The Great Harbour way can be constructed in an area of high cycle and pedestrian use, which will benefit both users. This should be a two way facility. The green section would have improved on road facilities, with a suitable crossing location where the red meets the green to enable cyclists to easily go from the off road facility to the on road facility, particularly for eastbound cyclists. The blue area shows where the additional bridge improvements could be made. Signposting would be required to direct cyclists to the existing road crossing facilities underneath the existing bridge abutments.

10. Construction Costs

The construction costs for the three alternative options outlined in Section 9 have been estimated, together with the individual components to allow for an indication of staging costs and partial option construction, if this is deemed to be more suitable to Council's budgets.

10.1 Option A – Overall Concept

Cost estimates have been undertaken for Option A is tabulated below:

Table 17 Option A Construction Costs

	Cost
Full Cuba Street Improvements	$630,000
Victoria Street Signals	$1,100,000 (including $230,000 land costs)
Great Harbour Way	$2,060,000 (not including Waione Bridge)
Signalising Other intersections (5), providing on road cycle way, parking improvements	$6,690,000
Total	$10,480,000

The bulk of the Cuba Street benefits can be achieved from minor road marking at a cost of around $20,000.

10.2 Option B - Four Laning The Esplanade

The Option A design includes an allowance for the central median to be adjusted at a later date such that The Esplanade could be later widened to four lanes due to ongoing growth. To four lane the road, the proposed cycle lane and parking would be removed and changes made to the median islands, together with a second river crossing.

The cost of four laning The Esplanade, including the construction of the Great Harbour Way, is estimated at around $37,300,000, including $26,820,000 for a duplicate bridge and approaches.

The cost of four laning after Option A has been implemented has been estimated at $28,080,000.

10.3 Option C - Cross Valley Link

A detailed updated costing was undertaken of the Cross Valley Link for Hutt City Council in January 2012. The costing was based on the following:

- A new river crossing between Wakefield Street and Whites Line west
- A roundabout at the intersection of Hutt Road and Wakefield Street
- Minor intersection improvements along Wakefield Street
- Minor intersection improvements along Whites Line East
- A fourth approach to the Randwick/Whites Line West roundabout

Option C includes the upgrade of the Cuba Street signals and the Great Harbour Way and its costs are summarised below:

Table 18 Option C Construction Costs

	Cost
Cuba Street Improvements	$20,000
Cross Valley Link	$46,000,000
Great Harbour Way	$2,060,000
Total	$48,080,000

It should be noted that the Great Harbour Way does not include improved cycle facilities on road, in particular over the Waione Bridge.

10.4 Cycle Improvements

The construction costs of the alternative cycle improvements mentioned in this report are tabulated below:

Table 19 Cycle Improvement Construction Costs

	Cost
Great Harbour Way – SH2 to East Street	$900,000
Great Harbour Way - East Street to Waione Street though Hikoikoi Reserve	$1,160,000
Great Harbour Way - Total	$2,060,000
On Road Facilities - East Street to Waione Street	$30,000
Clip on Cycle track on Waione Bridge	$800,000

It should be noted that the Great Harbour Way does not include improved cycle facilities on road, in particular over the Waione Bridge.

11. Economic Analysis

The NZTA Economic Evaluation Manual (EEM) provides information on how to calculate a benefit cost ration for a roading project

A BCR is the ratio between the project cost and the project benefits over a 30 year period. The travel time benefits are converted to dollars based on parameters provided in the EEM. A BCR must be above 1.0 to be economically viable. Most roading projects in New Zealand require a BCR above 4.0 to get subsidy funding from NZTA. Projects with a BCR above 4.0 are considered to have an economic efficiency rating of 'high'. A BCR between 2.0 and 4.0 is medium and between 1.0 and 2.0 s considered 'low'. A BCR below 1.0 is considered inefficient.

Simplified economic evaluations have been completed to compare the benefits and costs of the options considered. The analysis generally assumes a time zero of 1 July 2011 and a 2015 construction year. Alternative construction years will provide alternative BCR's

The project benefits are based on travel time savings using output from the Sidra analysis and walking and cycle benefits based on the length of the improvements and the daily flows summarised in Section 3.9.

Construction costs are based on those in Section 10.

At this stage, vehicle safety assessments have not been undertaken, so only cycle crash related benefits are included in the evaluations.

11.1 Option A - Overall Concept

The economic analysis for Option A as described in Section 9.1 is has been undertaken, and summarised below:

Table 20 Option A - Economic Evaluation

Item	Overall Concept
Travel time savings	$48.8 M
Cycle Benefits	$2.5 M
Pedestrian Benefits	$8.3 M
Cycle Safety Benefits	$0.1 M
Total Net Benefits	$59.6 M
Estimated Cost	$10.5 M
Total PV Costs	$8.3 M
Benefit-cost ratio (BCR)	7.2
Construction Date	2015

The option returns a benefit-to-cost ratio of 7.2, and therefore would rate as 'high' in terms of economic efficiency.

11.2 Option B - Four Laning The Esplanade

Three sets of economic analysis for four laning of The Esplanade has been undertaken, being:

- The four laning occurs in 2016 on the existing layout
- The four laning occurs in 2016 assuming that the Cuba Street and Victoria Street intersections were already improved
- The four laning occurs after Option A is complete should additional mid block capacity be required at a later date.

The EEM was used to estimate the mid-block travel time using first principles. The average speed before and after four laning has been calculated at 51 and 55 kph respectively.

The BCR is summarised below:

Table 21 Option B - Economic Evaluation

Do minimum =	Existing	Cuba/Victoria	Option A
Intersection Travel Time Savings	$37.1 M	-$10.9 M	
Mid Block Travel Time Savings	$33.9 M	$33.9 M	$33.9 M
Cycle Benefits	$2.1 M	$2.1 M	
Pedestrian Benefits	$7.2 M	$7.2 M	
Cycle Safety Benefits	$ 0.1 M	$ 0.1 M	
Total Net Benefits	$80.5 M	$32.5 M	$33.9 M
Estimated Cost	$38.0 M	$36.8 M	$28.1 M
Total PV Costs	$27.9 M	$27.0 M	$20.6 M
Benefit-cost ratio (BCR)	2.9	1.2	1.6
Construction Date	2016	2016	2016

The option returns a benefit-to-cost ratio of 1.2 if the GHW is constructed as part of it, and therefore would rate as 'low' in terms of economic efficiency. If the GHW was not constructed, the BCR would reduce to 0.8 due to the cycle and pedestrian benefits no longer being included.

11.3 Option C - Cross Valley Link

Determining the travel time benefits from a Cross Valley Link is outside the scope of this report, however values have been extracted from the various reports undertaken for the Cross Valley Link in other studies and have been modified to enable a rough order BCR to be estimated.

The detailed analysis undertaken in the NZTA study included dis benefits to the traffic on The Esplanade due to traffic calming and a reduced speed limit. The initial option analysis provided preliminary data for

2016 only and showed that the best option in terms of travel time savings was the Link with no traffic calming. However this option was never carried forward. Estimating the network wide effects for alternative years has been undertaken to do a preliminary analysis on the Cross Valley Link Project with no traffic calming on The Esplanade. The economic analysis below provides a rough order BCR only and is not as accurate as the remaining BCR's in this report as full analysis has not been undertaken.

The economic analysis for the Cross Valley Link by itself and the full Option C which includes the Great Harbour Way and the Cuba Street improvements has been undertaken, and summarised below:

Table 22 Option C - Economic Evaluation

Item	Cross Valley Link Only	Option C
Travel Time Savings	$39.3 M	$39.3 M
Vehicle Operating Cost Savings	$14.4 M	$14.4 M
Cuba Street Benefits		$38.4 M
Cycle Benefits		$2.5 M
Pedestrian Benefits		$8.3 M
Cycle Safety Benefits		$0.1 M
Total Net Benefits	$53.7 M	$102.3 M
Estimated Cost	$46.0 M	$48.1 M
Total PV Costs	$33.8 M	$35.3 M
Benefit-cost ratio (BCR)	1.6	2.9
Construction Date	2016	2016

The option returns a benefit-to-cost ratio of 1.6, and therefore would rate as 'low' in terms of economic efficiency.

11.4 Cycle Improvements

The economic analysis for alternative cycle improvements has been undertaken for alternative cycle schemes, namely:

- Great Harbour Way between SH2 and Waione Bridge
- Great Harbour Way between SH2 and Waione Street and a clip on facility on the Waione Bridge
- Great Harbour Way between SH2 and East Street, on road cycle facilities to Waione Bridge and a clip on facility on the Waione Bridge

It should be noted that a clip on facility form would not conform to the GHW minimum width of 3.5 m.

Table 23 Great Harbour Way Economic Evaluation

Item	Great Harbour Way	Great Harbour Way including Waione Clip on facility	Partial Great Harbour Way and on road improvements
Cycle Benefits	$2.5 M	$2.7 M	$2.3 M
Pedestrian Benefits	$8.3 M	$9.0 M	$7.5 M
Cycle Safety Benefits	$0.1 M	$0.1 M	$0.1 M
Total Net Benefits	$10.8 M	$11.8 M	$10.0 M
Estimated Cost	$2.1 M	$2.9 M	$1.7 M
Total PV Costs	$1.6 M	$2.3 M	$1.4 M
Benefit-cost ratio (BCR)	6.6	5.2	7.3
Construction Date	2015	2015	2015

The Great Harbour Way returns a benefit-to-cost ratio of 6.6. If the bridge platform was included in the GHW BCR, the BCR would reduce to 5.2. Using on road facilities through the Hikoikoi reserve area increases the BCR to 7.3.

All the alternatives rate as 'high' in terms of economic efficiency.

11.5 Short Term Intersection Improvements

The economic analysis for the intersection improvements as described in Sections 8.3 and 8.5 has been undertaken, and summarised below:

Table 24 Intersection Improvements Economic Evaluation

Item	Victoria Street	Cuba Street	Combined Package
Travel time savings	$0.8 M	$59.1 M	$61.7 M
Total Net Benefits	$0.8 M	$59.1 M	$61.7 M
Estimated Cost	$1.1 M	$0.6 M	$1.7 M
Total PV Costs	$0.9 M	$0.6 M	$1.7 M
Benefit-cost ratio (BCR)	0.9	93	36
Construction Date	2015	2012	2012

Signalising the Victoria Street intersection returns a benefit-to-cost ratio of 0.9, and therefore would rate as 'low' in terms of economic efficiency.

Undertaking the full improvements at the Cuba Street signals, including cycle facilities, returns a benefit-to-cost ratio of 93, and therefore would rate as 'high' in terms of economic efficiency. However, it is not recommended to do this as a stand alone package, as the vehicle speeds on Cuba Street west of the intersection will increase and the existing reverse priority will no longer take place. Vehicles on side roads will find it increasingly difficult to exit. Implementing the signals at the Victoria Street intersection

will provide a “green wave” effect and mitigate this effect. It is therefore recommended that if the Overall Concept is not undertaken, then the combined package is constructed.

Signalising the Victoria Street intersection and improving the Cuba Street intersection together returns a benefit-to-cost ratio of 36, and therefore would rate as ‘high’ in terms of economic efficiency.

12. Possible Staging of Option A and Option B

Option A can be staged to allow funding for this project to be staggered. If additional capacity is required in the future, or due to a sudden rise of traffic flow from external influences such as the Petone to Grenada Link, then Option B can be implemented also.

Stage One

Immediate improvements could be undertaken at the Cuba Street signals. The improvement for the eastbound traffic, particularly in the afternoon and evening, will result in faster travel speeds and less reverse priority on The Esplanade. Therefore it is recommended to implement these improvements together with signalising the Victoria Street intersection to enable 'green' waves to occur along the foreshore making it easier for side road traffic to get gaps. When the signals are red on The Esplanade, a gap in the traffic will allow side road traffic to exit.

Stage Two

Improvements can be made to the walking and cycle facilities as soon as funding becomes available. It is recommended to construct the Great Harbour Way between the Kiosk and the State Highway 2. The on road cycle facilities between the Kiosk and the Waione Bridge should be improved as discussed in Section 9.4. It is recommended to assess the feasibility of a cycle platform on the services adjacent to the Waione Bridge which will remove cyclists from the road and also ensure that the footpath on the southern side of the bridge is for pedestrians only.

Stage Three

Stage three involves an upgrade of the remaining sections of the road. These improvements include installing traffic signals at Buick Street, Jessie Street, Kirkcaldy Street and pedestrian signals at Bay Street and Patrick Street.

All of the zebra crossings on The Esplanade will be removed, so that pedestrians can still easily access the beach at one of the above intersections, but they will not have their existing "right of way" which causes continuing congestion to the vehicles during peak pedestrian times.

The remaining intersections will remain in their current form of control.

Stage three will also include the implementation of a green on-road cycle way to complement the Great Harbour Way as many cycle enthusiasts do not want to cycle on a shared cycle and pedestrian facility.

Stage Four

The timing of Stage Four is dependent on growth and other roading projects such as the Petone to Grenada Link or the Cross Valley Link. As growth continues additional mid-block capacity will be required. This can be achieved through either four laning of The Esplanade, or construction of the Cross Valley Link. Both have the same BCR if constructed after the Stage Three.

Appendix A

Intersection Turning Flows

Morning Peak 7:45 - 8:45

Evening Peak 16:30 - 17:30

Appendix B

Option A Concept

Appendix C

Option C Concept

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Document Status

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