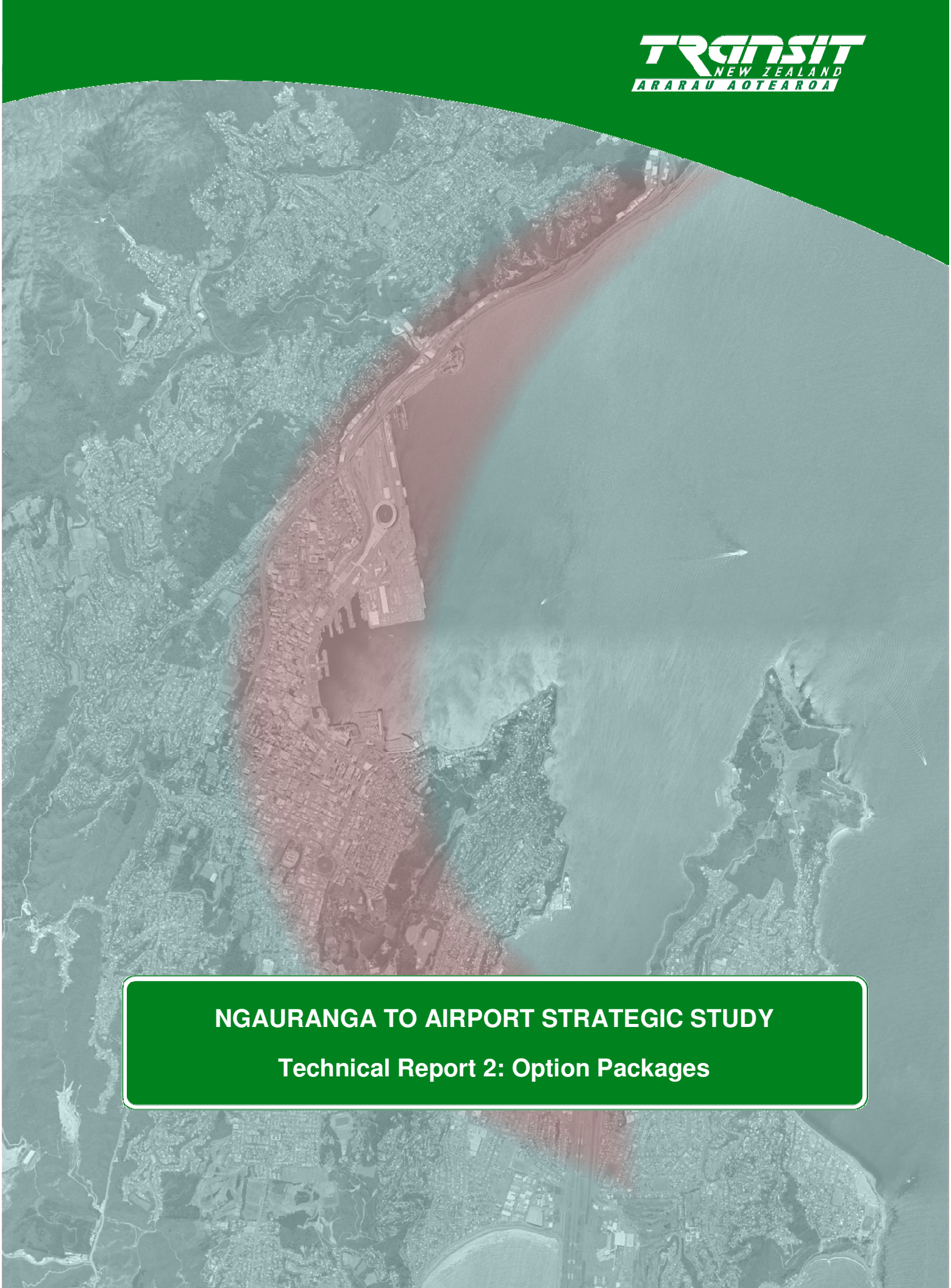

NGAURANGA TO AIRPORT STRATEGIC STUDY

Technical Report 2: Option Packages

Ngauranga to Airport Strategic Study

Technical Report Two: Option Packages

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Contents

Executive Summary

This report is one of several investigating ways to address the transport issues between the Western and Hutt Corridors to the north of Wellington and the Airport and Hospital to the south and east of the City, through the Wellington Central Business District (CBD) area. The purpose of the study is to identify the present and future transport needs and possible solutions that support land uses, social, business and recreational goals.

Based on the challenges identified in the Problem Framing Report, four transport packages have been developed aimed at meeting the vision statement (or problem statement) for the study:

> *"To deliver an integrated land transport system that supports the City's transport and urban development strategies (urban growth spine) and provides access to the CBD, airport, hospital and port."*

A key aspect of all of the four packages is the provision of a transport spine through the corridor with the different packages each providing a mix between catering for the needs of passenger transport and roading improvements. As inferred in the vision statement, the Study has sought to strengthen the Wellington City Council's urban growth spine and connect proposed growth nodes at Newtown, Kilbirnie and Johnsonville with the CBD. Accordingly, a major focus has been the development of packages that provide a high quality, reliable, frequent passenger transport system that connect and serve the growth nodes, particularly at Newtown.

In addition, each of the four packages envisages and assumes the provision for Travel Demand Management (TDM) as well as pedestrian and cycling facilities within and on the approaches to the CBD.

Package 1: Light Rail Spine (with no road improvements): Package 1 primarily consists of an enhanced passenger transport spine using a LRT system between the railway station and the hospital, plus minor bus improvements elsewhere on the roading network along with increased bus and train frequencies. Improvements are made at the expense and reallocation of existing road space.

The light rail system coupled with the TDM measures results in an increase in passenger transport trips in the region compared to the 2016 committed base along with the largest decrease in car trips of all the packages. Furthermore, those passengers travelling between Newtown and the railway on the LRT enjoy journey times that are twice as quick as the existing travel times using bus.

The need to ensure a suitable patronage on the LRT and hence a greater fare recovery requires competing bus services on the same route to be prevented which introduces the need for forced transfers at Newtown and Courtenay Place – which may actively discourage some passenger transport users. In addition, the need to reallocate existing road space to LRT results in some dis-benefits to general motorists.

Economic benefits associated with Package 1 are calculated to be $95 Million with expected infrastructure costs between $95 Million and $145 Million plus LRT vehicle and maintenance set-up costs of between $35 and $45 Million. Additional passenger transport operating costs to be subsidised by Greater Wellington are in the order of $40 to $45 Million per year

Package 2: Enhanced Bus Spine (with minor road improvements): Package 2 includes a segregated busway as the basis of an enhanced passenger transport spine between Newtown and the railway station with minor bus improvements to the north of the CBD and some bus and train service frequency improvements. In addition, minor roading improvements are proposed such as permitting tidal flow through the Terrace Tunnel, the widening of Ruahine Street (within its existing roading designation), improvements at the Basin Reserve and providing for improved bus and motor vehicle capacity along Adelaide Road, thereby ensuring the passenger transport route still passes through the growth node.

Passenger transport journey times between Newtown and the railway station are much faster than existing travel times. Morning inbound and evening outbound travel times to/from the CBD for general traffic decrease compared to the forecast travel times in 2016 without any interventions.

The busway minimises the need for transfers between modes allowing buses servicing the suburbs to continue their journey to and from the CBD and railway station. Avoiding these transfers, coupled with the limited roading improvements, maximises the number of people using passenger transport to and from the Eastern Suburbs in the morning peak period out of all the packages considered.

Roading improvements to assist southbound traffic during the morning peak periods will put additional pressure on operation of the Inner City Bypass. Furthermore, the reduction in northbound traffic lanes in the Terrace Tunnel as a result of the tidal flow system is forecast to reassign traffic onto the Waterfront route in the morning peak. Although tidal flow systems exist elsewhere in New Zealand and overseas, potential safety problems may exist given the gradient and curvature experienced with the Terrace Tunnel.

The widening of Adelaide Road to form the combined main passenger transport and primary motor vehicle route, coupled with the increased traffic volumes along Adelaide Road may inhibit the development of a high quality growth node to its full potential.

Economic benefits associated with Package 2 are calculated to be $230 Million with expected infrastructure costs between $100 Million and $160 Million. Additional passenger transport operating costs to be subsidised by Greater Wellington are $5 to $10 Million per year.

Package 3: Enhanced Bus and Roading Spines (with Tunnel Duplications): As with Package 2, central to Package 3 is the provision of a segregated busway between Newtown and the railway station to act as the enhanced passenger transport spine. In addition to bus lane priority measures to the north of the CBD, major roading improvements to provide a strong roading spine along the state highway are envisaged through the duplication of both the Terrace Tunnel and Mount Victoria Tunnel plus a grade separated interchange at the Basin Reserve. Increased bus and train service frequencies are also provided.

Passenger transport journey time trips between Newtown and the railway station reduce by between 9 and 12 minutes whilst motor vehicle journey times into the CBD in the morning peak periods from Ngauranga and the Airport reduce by between 3 and 5 minutes; outbound journey times in the evening peak reduce by between 1 and 2 minutes.

The provision of the roading spine reassigns traffic from parallel routes thereby reducing traffic flows around Evans Bay, Wallace Street and around the Waterfront. The reduction in southbound flows may permit the number of the southbound traffic lanes to be from three lanes to two. Nevertheless, the reassigned traffic puts additional pressure onto the Inner City Bypass.

The elevated structure for the grade separation of the Basin Reserve will be visually prominent and may be considered to affect the symbolic character and context of the Basin Reserve given its impact on the wider surroundings.

Economic benefits associated with Package 3 are calculated to be $362 Million with expected infrastructure costs between $450 Million and $730 Million. Additional passenger transport operating costs to be subsidised by Greater Wellington are between $40 and $45 Million per year.

Package 4: Enhanced Roading Spine (with minor bus improvements): Package 4 provides a minimum two lane north-south roading connection between Ngauranga and the Airport with a grade separated interchange at the Basin Reserve and the duplication of both the Terrace Tunnel and Mount Victoria Tunnel. Minor bus infrastructure improvements to tie into existing measures for the railway station to Newtown route are also proposed.

Passenger transport journey times between Newtown and the railway station are forecast to be less than the 2016 base travel times, but are still in excess 20 minutes. In contrast, motor vehicle travel time reductions to and from the CBD from locations such as Ngauranga and the Airport exceed those experienced by other packages.

Issues associated with the large infrastructure construction projects in the Package such as the grade separation of the Basin Reserve are similar to those discussed above for Package 3. Similarly, the associated traffic flow reductions on parallel routes such as the Waterfront permit a southbound lane to be removed to reduce severance between the city and the harbour. However, the reassigned traffic also puts additional pressure onto the Inner City Bypass.

Economic benefits associated with Package 4 are calculated to be $322 Million with expected infrastructure costs between $420 Million and $680 Million.

1 Introduction

1.1 The Project

Opus International Consultants (Opus) has been commissioned by Transit New Zealand on behalf of Transit New Zealand, Wellington City Council and Greater Wellington Regional Council to undertake a study to investigate options to address the transport issues between the Western and Hutt Corridors to the north of Wellington and the Airport and Hospital to the south and east of the City, through the Wellington Central Business District (CBD) area. Opus worked in partnership with and acknowledges the assistance of the following consultants. Arup undertook the traffic modelling using Greater Wellington Regional Council's strategic transport model and provided advice on light rail. Fraser Fleming Transport Planning carried out traffic modelling using Greater Wellington Regional Council's SATURN model. Alistair Aburn and Deyana Popova, from Urban Perspectives, provided assistance with key planning and urban design issues. Ian Clarke from Flow Consultants assisted the team with transportation advice.

The purpose of the study is to identify the present and future transport needs of the Ngauranga to Airport Transport Corridor and propose solutions that support land uses, social, business and recreational goals. Accordingly, the study investigates a range of transport modes including walking and cycling, passenger transport, the movement of goods (by road and rail), and private motor vehicle. A key element of the study is to understand and develop the relationship between urban form and transport corridors with the aim of ensuring the transport solutions support present and future proposals for urban intensification - often referred to as Transit Orientated Development. Given the recent completion of the Inner City Bypass, this section of SH1 was excluded from the study.

1.2 Scope and Purpose of Technical Report Two: Option Package

This Option Package technical report is one of several interim reports leading to a Corridor Management Plan for the study area. This report follows four previous reports: Phase 1 Consultation Report (July 2006); Problem Framing Report (August 2006); Golden Mile Capacity Assessment Report (August 2006); and Technical Report One: Description of Options (April 2007).

The purpose of this report is to describe the range of transport packages that have been developed to address the key issues defined in the Problem Framing Report while meeting the vision statement (or problem statement) for the study:

> *"To deliver an integrated land transport system that supports the City's transport and urban development strategies (urban growth spine) and provides access to the CBD, airport, hospital and port."*

Despite the packages being assessed for a period 10 years hence (2016), it is envisaged that the identified packages will go some way to meeting the transport needs of the Ngauranga to Airport corridor up to 2050. It is acknowledged however that elements of each package may need to be staged and constructed as funding becomes available.

Accordingly, this report provides a description of four packages of options that may help meet the future transport needs for the study area. While the report provides a list of known issues about these packages, the report does not attempt to undertake any detailed comparison of packages. Such an analysis will take place after consultation, which will provide additional information needed prior to completing the final assessment.

2 Overview

2.1 Philosophy and Package Development

Technical Report One set out a wide range of individual options for improving passenger transport, addressing the needs of general motor vehicle users as well as enhancing walking and cycling opportunities throughout the Ngauranga to Airport corridor. These options have been used to form a series of transport packages with the combinations guided by the need to address the problems identified in the Problem Framing Report, the above philosophy, as well as the results from the assessments of each of the options.

Based on the challenges identified in the Problem Framing Report, at the heart of each of the packages is the recognised need to accommodate an overall increase in the number of trips into Wellington. This is best served by increasing the level of 'penetration' and service offered by passenger transport to facilitate and encourage a change in transport mode. As such, the packages consider a range of passenger transport options with respect to catering for the identified increased transport demand. Furthermore, each of the packages embraces the need to cater and provide for active modes of transport, where appropriate, throughout the corridor.

Nevertheless, the packages have also sought to balance the passenger transport initiatives with the provision of general roading options where deemed suitable. As such, the packages provide a broad sweep and mix of passenger transport and roading options with the passenger transport initiatives developed on the basis of a greater or lesser provision of facilities along a passenger transport corridor. Similarly, roading options have been developed to ease 'choke points' on the network to a greater or lesser degree.

It should be noted that a number of individual options or concepts are repeated in some or all - for instance, it is important to note that all four packages include provision for Travel Demand Management (TDM), as well as pedestrian and cycling facilities within and on the approaches to the CBD as identified in Chapter 3. Furthermore, the first three packages all have a dedicated passenger transport spine running from the railway station through to the growth node in Newtown and the Hospital. Whilst each of the packages describes the form of the envisaged passenger transport spine within their relevant Chapters, many of the impacts of such a proposal are common to all three, and as such, are discussed separately in Chapter 4.

Each of the following Chapters contain descriptions of the relevant package, their impact on the transport network based on the traffic modelling their effect on urban design and form, the derived economic benefits from the transport package, and their gross costs.

- Chapter 5 Package 1: Light Rail Spine (with no road improvements).
- Chapter 6 Package 2: Enhanced Bus Spine (with minor road improvements).
- Chapter 7 Package 3: Enhanced Bus and Roading Spines (with Tunnel duplications).
- Chapter 8 Package 4: Enhanced Roading Spine (with minor bus improvements).

It should be noted that the 'packages' contain a range of 'projects' and that a number of the 'projects' have a range of 'options'. For the purpose of this report, and to enable the transport modelling along with the associated costs and benefits to be determined with some accuracy, only one 'typical option' has been included for each project within each package. A large range of options have been identified and discussed in Technical Report One, although even this list of options may not be exhaustive. Accordingly, in this report we describe the typical options that have been selected in some detail together with the likely benefits and costs. This has been done to enable comparisons to be made of the four packages in due course.

It is anticipated that once the corridor plan for the study has been selected, future studies of each project within the plan will investigate a range of options with a view to determining the preferred option.

2.2 Transport Modelling

As with the initial option modelling, two transportation models have been used: the GWRC Wellington Transport Strategic Model (WTSM), which extends over the whole region and has ability to predict future transport effects of a range of modes including passenger transport and walking; and the GWRC SATURN model (SATURN), which covers the study area in some detail and can be used to investigate the effects on general traffic within the City. The detailed results of the base 2001 and forecast 2016 network operation without any improvements are contained in Technical Report One. For completeness however, the forecast network performance of the 2016 base 'do-nothing' situation, upon which the packages are compared, are summarised below.

2016 Network Performance – Committed Base: The 2016 base model indicates that without any interventions, parts of the roading network can be shown to operate at or beyond their theoretical capacity at various times of the day. Operational conditions for traffic streams can be described in terms of Level of Service (LoS) - which can be based on a number of parameters such as average travel time, delays to traffic or traffic volumes with respect to available capacity. Those routes identified as operating at an extremely low LoS - E[1] and F[2] in 2016 within the study area are identified below and shown in Figure 2.1.

Morning peak period:

- Southbound traffic on SH1 between Ngauranga and Aotea operates at LoS F.
- Southbound traffic on Hutt Road on the approach to Kaiwharawhara and through to the Aotea Quay intersection has a LoS 'E.
- LoS F is experienced for southbound traffic through the Terrace Tunnel.
- Mount Victoria Tunnel operates at between LoS E and F for northbound flows. Wellington Road, between Evans Bay Parade and Ruahine Street, operates at LoS E/F.

[1] LoS E: Traffic volumes are at, or close to, capacity with virtually no freedom to select desired speed or to manoeuvre within the traffic stream.
[2] LoS F: Traffic flow exceeds that which can pass along a section of the road.

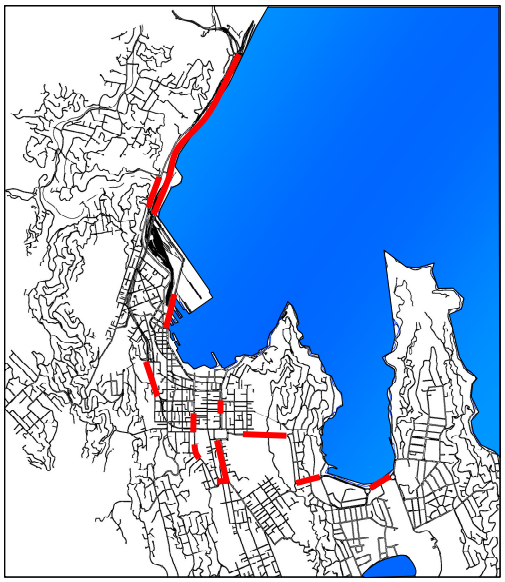

Figure 2.1: Parts of the Network expected operate with levels of service E and F in 2016
Source: - GWRC WTSM

- Northbound flows on Cobham Drive between Calabar and Troy Street has a LoS F.
- Northbound traffic along Adelaide Road between the Hospital and the Basin Reserve operates at LoS F, as does the southbound section on the approach to the Riddiford Street/John Street intersection. A northbound section of Wallace Street on the approach to Bidwill Street is forecast to operate at LoS E.
- Northbound flows on Kent Terrace tend to operate at LoS D and E whilst southbound movements on the northern part of Cambridge Terrace operate at LoS between D and F.
- Northbound sections of Jervois Quay are forecast to operate at LoS F.

Evening peak period:

- Northbound traffic on SH1 north of Aotea Quay is forecast to operate at LoS F.
- Along the Inner City Bypass to the Basin Reserve, northbound, the LoS varies between C and E.
- Mount Victoria Tunnel operates at a LoS E in both directions. Wellington Road between Ruahine Street and Evans Bay Parade operates between LoS D and E with LoS F along Cobham Drive at the northbound approach to the Cobham Drive and Evans Bay parade intersection.
- Adelaide Road is forecast to operate at LoS F on the approaches to the Basin Reserve and John Street intersections for northbound and southbound traffic respectively. Southbound traffic flows along Wallace Street operate at a LoS between B and E. Riddiford Street, north of Constable Street is forecast to operate at LoS E/F.

- Aotea Quay and Waterloo Quay, the LoS reduces to E and F for southbound traffic along sections of the waterfront on the approach to (and south of) Bunny Street.

The overall breakdown of trips by mode is shown in Table 2.1.

Table 2.1: Mode Split – Committed Base Model 2016

	Car	PT	Total	PT (%)
AM	176,600	31,200	207,800	15.0
IP	167,141	10,663	177,804	6.0
PM	206,539	26,829	233,368	11.5

Packages: Following on from the modelling of a number of individual options (reported upon as part of the Technical Report One), all four packages have been modelled for the study area to enable the project team to determine the likely impact on the regional and local transport network.

The results from each of the modelled packages are discussed within the relevant package Chapters, including comment on the redistributed traffic flow within the network as well as passenger transport usage.

The traffic flows and passenger numbers used when reporting the impact of the package on the transport network are based on two hour peak periods given the operation of the WTSM transport model.

As discussed further in Chapter 3, the impact of TDM measures on the transport network with respect to the reduction in motor vehicles on the roading network compared to the 2016 base model, has been incorporated within the transport modelling work for all Packages.

2.3 Economic Benefits

Economic benefits for each of the four packages have been derived from the Wellington Transport Strategic Model (WTSM) using the methodology developed by Greater Wellington. The project benefits associated for each of the packages quoted in each of the following Chapters are based on a 25 year period commencing in 2016 (with a 10% discount rate).

2.4 Package Costs

The costs provided for each of the packages are based on the infrastructure costs of the individual options as identified in Technical Report One being combined together in order to obtain a total sum. Where appropriate[3], some of these costs have been refined following further work since the initial Technical Report. In addition, where appropriate, the operational costs of enhanced passenger transport service frequencies have also been identified.

[3] A further review of construction methods for the 8-laning of SH1 between Ngauranga to the Airport has resulted in a new option which has the potential to reduce the overall estimated cost for this project.

3 Travel Demand Management, Walking and Cycling

3.1 Overview

The need to incorporate walking, cycling and travel demand management enhancements through the corridor is recognised and supported as a minimum requirement regardless of the various components making up each of the four packages. As such, each package takes account of a proposed pedestrian and cycling route hierarchy as noted below.

Whilst these hierarchy's are shown individually, it must be remembered that the different proposals for different mode of transport all interact with one another. Accordingly, it is important to appreciate and understand how each hierarchy interacts with one another as well as with other road user requirements, in particular passenger transport in, and on the approaches to, the CBD.

Furthermore, the study team is mindful of the work being carried out by WCC in developing their own specific walking and cycling strategies. These strategies should consider the proposed hierarchies and identified actions in more detail.

3.2 Travel Demand Management (TDM)

TDM initiatives envisaged for the City and Region are intended to help encourage a mode shift to alternatives to the car. TDM initiatives need to be undertaken in conjunction with providing enhanced infrastructure for walking and cycling, and passenger transport.

It is envisaged that a number of travel behaviour change projects throughout the Region will occur over the coming years regardless of this particular strategic study. As such, no additional costs for undertaking TDM measures beyond the $2.5 Million budgeted for as part of the Regional Travel Demand Management Strategy have been included within the packages. The behaviour change projects can be targeted and directed at the travel patterns and behaviour of the community or individuals within households, schools and workplaces. Advice contained in the Travel Behaviour Change Guidance Handbook[4] indicates that such measures may result in transfers from trips as car drivers to car passengers, passenger transport, walking and cycling.

In order to reflect shifts away from private motorcar usage and single vehicle occupancy as a result of travel behaviour change initiatives in the region and City, the transport model has been modified to reflect the potential reduction in car usage (as contained in the Travel Behaviour Change Guidance Handbook). As such, workplace travel plans are estimated to result in a 5% reduction in car drivers throughout the region in the morning and evening peak periods with household and community based initiatives resulting in a 3% reduction in car drivers during the inter-peak periods within the study area.

As noted above, other travel demand management initiatives such as improving infrastructure for walking, cycling and passenger transport, and their impact (particularly with respect to passenger transport) are discussed within this Chapter and within each of the packages. Land use changes

[4] Land Transport NZ/EECA Travel Behaviour Change Guidance Handbook. December 2004.

such as the development of growth nodes at Newtown and Kilbirnie and their role within TDM are of critical importance and are discussed at length within Technical Report One. Pricing initiatives however, such as road pricing or parking supply management techniques to discourage car use was beyond the brief of this study. Nevertheless, the power of car parking strategies to encourage more sustainable modes of transport is fully acknowledged, as is the need to consider local parking strategies in a regional context. As such, it is proposed that a regional approach to parking management in terms of supply and demand is considered wise.

3.3 Walking

Improvements to the pedestrian environment within the CBD are essential in order to establish lively and safe public spaces[5]. Regardless of the mode of transport used to travel to and from the city, pedestrian movement around the city is essential and public spaces need to be planned and designed to provide a pedestrian friendly environment with a high level of service for pedestrian movements.

In line with the proposed pedestrian route hierarchy for the City described in Technical Report One, improvements to assist pedestrian movements are aimed at specific routes as shown in Figure 3.1. Improvements include widening footpaths, high quality walking surfaces, good lighting, 'green waves[6]', security cameras, and walking space management[7]. It is envisaged that footpaths adjacent to a high quality passenger transport route through the CBD would be upgraded with respect to increased footpath widths. This would be done in conjunction with the reallocation of road space to passenger transport. Street-scaping costs associated with the passenger transport or pedestrian corridors have not been included within the overall estimates.

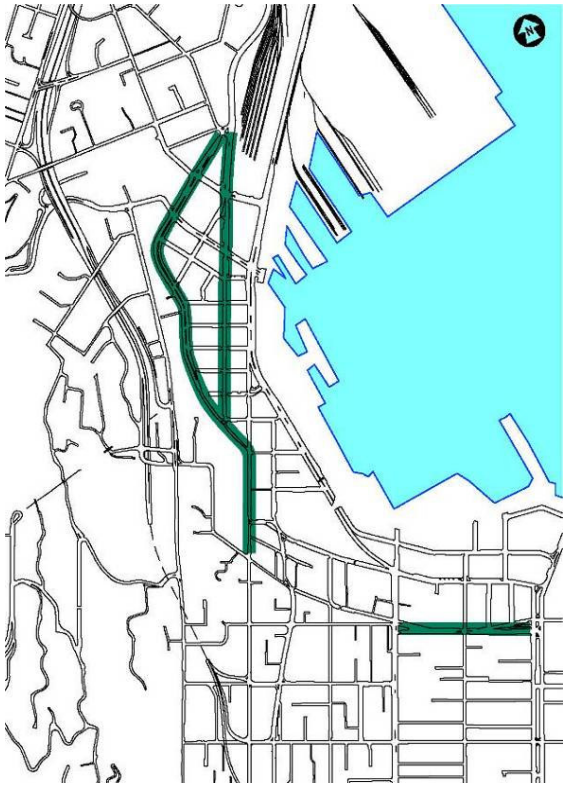

Figure 3.1: -Upgrade of Pedestrian Routes

It is proposed that access between the CBD and adjacent inner city residential suburbs (such as Newtown, Mount Victoria and Mount Cook) should be improved in order to ensure that the roading network around the CBD doesn't act as barrier to movement – particularly from locations where public health gains can be made by encouraging walking and cycling and reducing trips by motor

[5] City to Waterfront - Wellington. Gehl Architects. October 2004

6 Phasing traffic signals timed to accommodate platoons of pedestrians travelling between the railway station and CBD.

7 Careful control of sandwich boards, street furniture and other intrusions to maintain walk widths.

vehicles. Ideally, in residential areas adjacent to the CBD, the environment should be such that through walking (and cycling) forms the main competition to passenger transport.

Improvements to pedestrian crossing facilities such as reduced traffic signal cycle times at those key interchanges linking these pedestrian corridors[8] to minimise 'wait times' for pedestrians should be considered.

3.4 Cycling

Technical Report One identified the opportunity to use suitably designed wide bus lanes to accommodate cyclists along the key routes and corridors leading to and from the City. Whilst such an approach may limit the level of service experienced by cyclists given the need for buses to stop along the route, the provision of a suitably wide lane (ensuring minimal cyclist stress when buses pass cyclists) will assist cyclists given that during off-peak periods, cyclists may have unobstructed access and may also benefit from bus priority measures throughout the day.[9]

The provision of a LRT route however presents a slightly different set opportunities and challenges to the provision of appropriate cycle facilities. As such, the impact of rail lines set in the ground need to be considered along with best practice guidance to provide a wider space between LRT vehicles and cyclists than that which might be expected for general traffic.[10] Whilst sensitive design may overcome difficulties for LRT vehicles and cycles sharing a route through the use of a low kerb or different coloured or textured surfacing to segregate the two[11], it is likely that additional road space over that of a bus lane will be required to cater for cyclists.

Similarly for busways, their segregated nature means that they should be of sufficient width to allow clearances for cyclists. Opportunities should also be provided to allow cyclist to gain access to and from the busway where appropriate given the overall cycle network being developed by the City. However, the direct nature of the busway and separation from obstacles such as parked vehicles allows busways to provide a very valuable facility for cyclists subject to their suitable design.

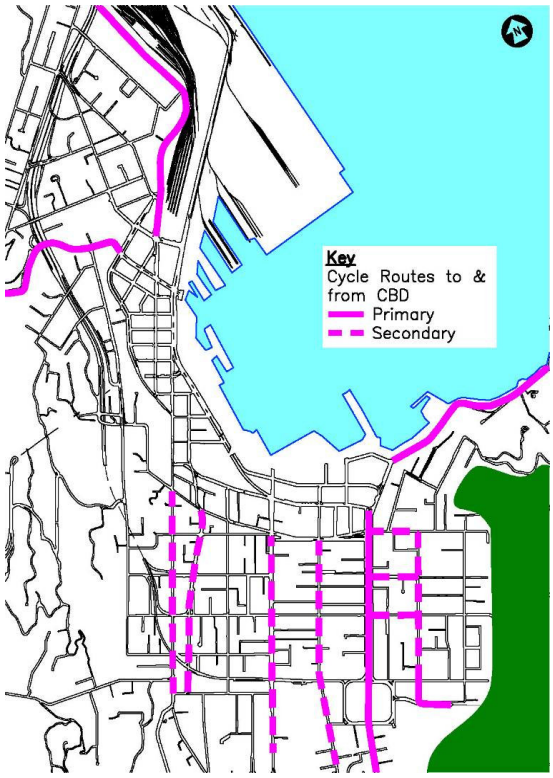

Figure 3.2: - Possible Cycling Route Hierarchy - approaches to the CBD.

[8] Refer to Technical Report One
[9] Land Transport NZ. Cycle Network and Route Planning Guide.
[10] CROW. Signup for the Bike 1994
[11] Cycle-friendly Infrastructure. IHT1996

Specific cycle routes in addition to those following passenger transport links, as indicated in Figure 3.2, should be planned in conjunction with the wider cycle strategies and plans being developed by Wellington City Council. As part of this, it is important to connect the two east-west running links that currently exist around the Waterfront and along the Inner City Bypass with each other in order to help provide a more continuous network.

As noted in Technical Report One, the provision of cycle parking facilities in the CBD is also essential.

4 Passenger Transport Spine: Railway Station to Newtown

4.1 Land Use and Transit Orientated Development

As noted in Technical Report One, the NZ Transport Strategy and the Regional Land Transport Strategy encourages a more integrated and sustainable approach to solving future transport needs. It encourages solutions that improve accessibility but without undue reliance on mobility, particularly the private motorcar. Integrating land use and transport is perhaps the most promising approach to reducing car-dependency and creating more sustainable solutions. Mixed-use high density development (which we refer to as growth nodes) not only encourages more walking and cycling as an alternative to the car, but makes passenger transport a more viable option. As such, as noted in the Technical Report One, there is an important mutually serving relationship between land use and transportation:

- "A high quality passenger transport system supports the development and success of growth nodes.
- Growth nodes create sufficient patronage to make the high quality passenger transport system viable and efficient."

Accordingly, a key focus of this strategy has been the development of options for providing high quality, reliable and frequent passenger transport system to connect and serve these growth nodes.

Figure 4.1 shows the projected dwelling density in 2051 within the study area, based on Wellington's future urban growth plans[13]. This plan assumes that just under half of all growth is expected in the central area along with the main growth nodes at Newtown, Kilbirnie and Johnsonville. Of the remaining half, a quarter is spread throughout the inner and outer residential areas and suburban sites and a quarter in greenfield and rural sites to the north. Urban density is known to impact on the efficiency of transport modes, as shown in Table 4.1.

To support the proposed growth nodes at Newtown and Kilbirnie, a high quality passenger transport corridor is required between the railway station and these nodes. Similarly, a successful passenger transport spine requires long term

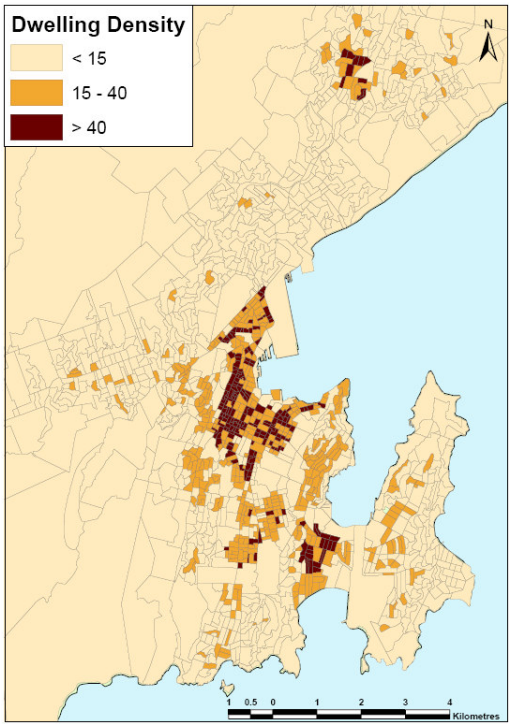

Figure 4.1: Dwelling Density per hectare within Study Area with Planned Growth Nodes by 2051[12]

[12] Given that Figure 4.1 only takes account of the development occurring in growth nodes, some of the other areas may experience 'darker shades' on the map compared to that shown.

[13] Wellington City Council. Wellington Urban Development Strategy Working Paper 9. Quantifying the Growth Spine. 2006

planning and committed land use strategies in place to provide the perceived 'permanence' required for land use development and growth.

Table 4.1: Urban Density required to Support Various Transport Modes

Residential Density Dwellings per Hectare	Commercial Density Employees per Hectare	Effective Transport Mode
More than 40	More than 450	Heavy and Light Rail
15 to 40	100 to 450	Bus
Less than 15	Less than 100	Private Vehicles

Source: - Hans Westerman, Cities for Tomorrow, Austroads

Given the existing commercial density within the CBD as reported in Technical Report One and the forecast development of the growth nodes, parts of a route between the CBD and Newtown/the Hospital by 2050 are meeting those indicators for light rail as shown in Table 4.1.

The development of a high quality passenger transport spine can be staged to match growth needs and plans. For example, the opportunity exists to link the CBD to Newtown in the first instance with extensions to the airport and Kilbirnie in the future if the growth node at Kilbirnie is of sufficient size and density to warrant the huge investment needed to extend the passenger transport spine. There are a number of serious physical constraints to be overcome to extend the high quality passenger transport spine to Kilbirnie. Such an extension is likely to be costly and significantly adversely affect the level of service provided for other motorised road users. Furthermore, significant urban growth at Kilbirnie will see a significant increase in car trips through Mount Victoria which can only be accommodated if the existing Mount Victoria Tunnel is duplicated.

In addition to the above, the concept of extending the LRT to the airport was investigated as part of the study, the results of which are included in Technical Report One. This investigation showed that it was not viable to extend the LRT to the airport given the very small number of passengers forecast to use it.

4.2 Mode Type

Whilst all four packages seek to connect the CBD with Newtown, different levels of passenger transport service are provided. These range from keeping the status quo to the provision of a segregated right-of-way for passenger transport. The status quo typically involves buses using the same road space as general vehicles; and although some bus lanes are provided at key locations for the exclusive use of buses, buses using these lanes must interact with parked vehicles, vehicles crossing and turning vehicles all of which have the potential to create delay. A segregated right-of-way or busway on the other hand included physical constraints that discourage or even prevent other vehicles using the same road space allocated to LRT or buses.

In addition to staging the extent and length of the high quality passenger transport route, it is also possible to stage the provision of the passenger transport mode. In this way, we could reserve the

road space (currently used by general traffic) for buses today while allowing a step change to light rail in future years as passenger numbers continue to increase.

The key issues associated with the different forms of passenger transport and associated infrastructure is detailed within Technical Report One.

A strategic consideration identified in the Problem Framing Report relates to facilitation and encouragement of a modal shift away from the private motor car and single occupancy vehicles, particularly for peak commuter traffic. As such, any passenger transport initiative needs to work hand in hand with incentives to get people out of their cars, rather than simply relying on an assumption that the provision of a high quality passenger transport system will automatically create a mode shift. As such, the study must ensure that any significant investment to enhance passenger transport systems, such as LRT, results in a significant mode shift from the private motor car. This is an important issue as experience from Perth and Sydney suggests that the "overriding evidence suggests that up to 70 percent of new rail patronage is diverted from bus."[14]

For Wellington, a meaningful increase in the number of people using passenger transport is likely if there is a step change in the level of service provided, particularly journey times[15], reliability, and if there is a change in urban form adjacent to the passenger transport corridor such as high quality intensification.

4.3 Transport Corridor Planning

As noted in Technical Report One, a high quality passenger transport route between the Railway Station and Courtenay Place is the most complex part of the route given:

- the need to be near the large number of people generators;
- the need to pass through a number of narrow streets (which are also heavily used by pedestrians);
- the over-reliance of a one-way system within the CBD; and
- the lack of a single 'spine' or corridor that would improve visibility and the connection between Lambton Quay and Courtenay Place.

Technical Report One provides several alternative routes to the one described and modelled as part of these packages. It should be noted that the final route selected, as well as mode type, will follow a more detailed scheme assessment study.

Furthermore, it is important that transport corridors that serve the growth nodes are located and designed in a way that does not sever spaces and places or prevent or discourage walking and

[14] Hensher D. A. A bus-based transitway or light rail? Continuing the saga of choice versus blind commitment. May 1999. Vol 8 No 3 September 1999 Roads and Transport Research
[15] Total journey times are door-to-door, including walk time, wait time (including wait time between mode transfers) and actual journey time.

cycling[16]. Successful overseas examples of nodes have therefore generally adopted the following principles:

- Growth nodes need to be served by roading arterials and these arterials should be located at the edge of the node to minimise severance. This leaves the more valuable land within the area for intensive development and free of barriers that prevent walking and cycling.
- High quality passenger transport (rail, guided bus or bus) routes should pass through the middle of the growth nodes.

For this reason, if the growth node along Adelaide Road between the Basin Reserve and the hospital is to be the quality needed to make the node successful and a development that Wellington is proud of, then large volumes of general vehicles will need to be discouraged from passing through the node. The ideal solution is for passenger transport to pass through the node along Adelaide Road and for other vehicles to be encouraged to use an upgraded Wallace Street.

In order to maintain the existing capacity for motor vehicles under such an approach, it would be necessary to widen Wallace Street to provide an additional two lanes, such that four lanes could be provided along Wallace Street and Taranaki Street. However this option, as identified in Technical Report One, would require approximately 35 properties to be acquired along with the relocation of some buildings on Massey Campus; car parking would also need to be restricted, particularly during the peak hours.

Despite the potential for landscaping and the redevelopment of the acquired land to mitigate some of the effects of such an option – which would be in accordance with the overall philosophy set down in Technical Report One, the character of the existing road may still be affected given the change from a residential street to a vehicle orientated road. Accordingly, the packages have sought to combine both passenger transport and motor vehicle requirements along Adelaide Road in acknowledgement of the need to protect heritage and urban form along Wallace Street.

Further to work contained in Technical Report One, the high quality passenger transport spine is not envisaged as progressing beyond Newtown within the time frames envisaged within this strategic study. Technical Report One identified the difficulties with providing a segregated passenger transport route (which is necessary in order to provide the high level of service and quality sought) through Newtown to the south and east. Furthermore, passenger transport numbers are forecast to be sufficiently low to be accommodated using existing buses along existing routes, perhaps with improved priority measures.

4.4 Passenger Transport Costs

For each of the packages, infrastructure costs associated with the proposed passenger transport measure have been separated out from operating costs. Total operating costs per passenger for LRT systems are typically higher than bus-based transit-ways[17]. Whilst it is acknowledged that costs need

[16] Passenger Transport Supportive Land Use and Urban Design Guidelines, Kingston Morrison (now SKM) December 1997

[17] Hensher D. A. A bus-based transitway or light rail? Continuing the saga of choice versus blind commitment. May 1999. Vol 8 No 3 September 1999 Roads and Transport Research.

to take passenger kilometres into account (given the usually longer nature of LRT systems), such comparisons need to be considered with respect to actual patronage rather than the capacity of the different modes of passenger transport. As such, for the LRT system to operate at a very regular frequency to provide the high quality of service required to achieve the needed step change, the LRT may not be full. Without forced transfers to prevent buses from competing with the LRT along the same route, it is unlikely that a LRT could come close to being at capacity whilst still maintaining a high frequency – thereby impacting on operational costs. Nevertheless, the operation costs associated with each of the packages have been considered and included within the respective Chapters of the report.

It should be noted that cost estimates included in each of the packages excludes the cost of any street-scaping work associated with passenger transport measures. This could add another $30 to $70 million depending on what was undertaken and the extent of the works.

In addition, Packages 1 to 3 have assumed the doubling of bus frequencies as part of the transport modelling in order to test the impact of the enhanced passenger transport provision. Whilst costs associated with such an increase in bus services are identified in each of the Package Chapters, in practice a balance between the benefits of additional services on certain routes at specific times of the day and the cost would need to be carried out at a detailed level in order to optimise services.

4.5 Other Passenger Transport Initiatives

Technical Report One identified a number of additional strategic interventions or concepts that are applicable to the delivery of the passenger transport spine (as well as network wide) in order to achieve improved reliability, reduced journey times, increased patronage and bus capacity. These include:

- Signal detection and bus activation at signals.
- Signal Management (SCATS) to link groupings and key bus corridors.
- GPS tracking, detection and route management.
- Bus stop capacity assessment and upgrade to improve current capacity and operational conditions (avoid queuing for bus stop).
- Consistent parking and loading strategy for key bus corridors.
- Enforcement strategy to be consistent with the parking, loading, traffic management and bus priority measures, including CCTV enforcement and compliance targets.
- Electronic ticketing on buses.

These general passenger transport measures and initiatives have not been included within each of the package costs as individual items as they would provide overall improvements for passenger transport across the entire network.

4.6 Other Issues

As indicated in Technical Report One, taxis have an important transport role in the City. Taxis can be more efficient than the private motor car in that they are better able to accommodate trip-chaining and reducing the need for car parking and traffic movements associated with finding a car park. Given the complementary role that taxis have with passenger transport and the desire to limit the number of private vehicles entering the CBD area which in turn adversely impacts on walkability, taxis (certainly those with multiple occupancies) could be permitted to use bus lanes.

4.7 Economic Benefits

The Wellington Urban Development Strategy indicates that the number of residents in the Newtown will increase from 570 people in 2001 to 3,648 by 2026 (and 4,860 by 2051). It is anticipated that the growth node at Newtown will allow mix-use medium to high density development. Such developments will not only result in an increase in residential population, but also an increase and change in employment patterns including office, recreation and retail. Using an assumption that the employment rates increase from the 2001 level of 53% to a level reflecting the 2001 employment rate in the central area of 60% by 2026[18], the number of residents living in the growth node that are employed increases from 303 in 2001 to 2,189 in 2026.

Furthermore, the development of the Newtown growth node will alter types of industry and employment located in this area. Employment in fields such as primary production, transport, storage and communications, social and government and cultural and recreational services can be expected to fall as these types of businesses locate to other suburbs. This will be offset by increased participation in areas such as retail trade, accommodation, cafes restaurants, with the largest increases expected to occur in business services and finance.

This change in industry and employment profile has a subsequent change in Gross Domestic Product (GDP). An estimate of GDP generated by businesses located in Adelaide Road for 2001 was $15 Million. With a projected increase in the number of residents and employment within the Newtown growth node from 2016 to meet the projected number of residents noted in the urban development strategy in 2026 and 2051, the GDP is forecast to increase by $95 Million between 2007 and 2032 as shown in Figure 4.2. In net present terms, this equates to an additional $28 Million in benefits as a result of the growth node.

[18] An increase in participation of 10% over the 25 year period

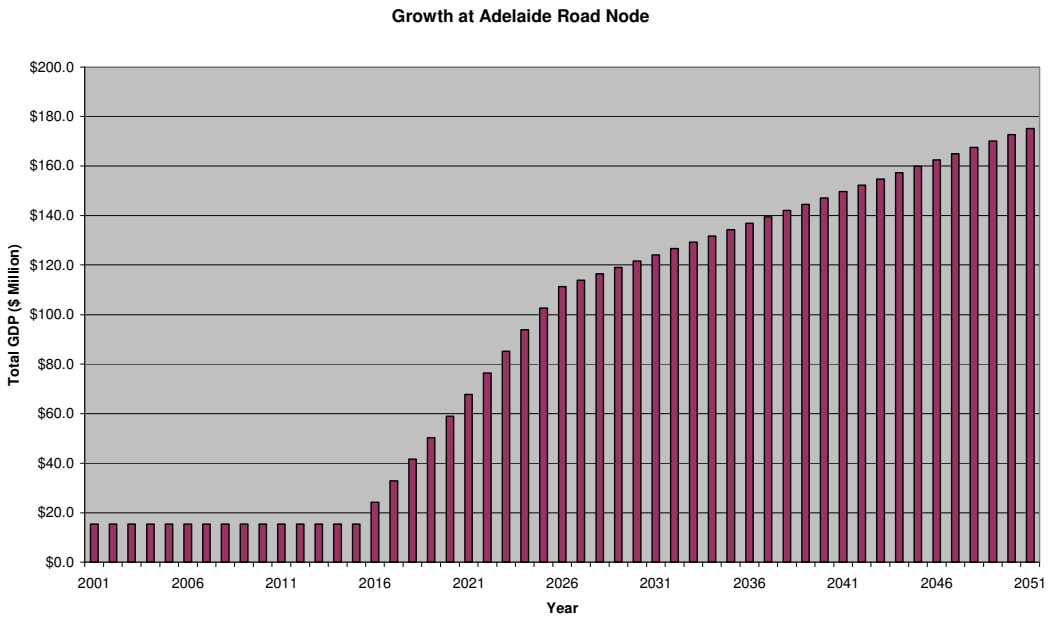

Figure 4.2 Change in Gross Domestic Product at the Newtown Growth Node

5 Package 1: Light Rail Spine (with no roading improvements)

5.1 Overview

Package 1 primarily consists of a high quality passenger transport spine in the form of a light rapid transit (LRT) system from the railway station through to the Newtown growth node and hospital. The spine also connects to bus lane improvements proposed on the northern approach to the city, for example along Thorndon Quay. Additional bus improvements are also provided on the eastern side of the city. A summary of the package is shown in Figure 5.1. The package also includes enhanced bus and train frequencies throughout the day.

To ensure a high quality service in which the LRT does not get 'caught-up' in general traffic, and hence have an impact on its reliability and level of service, it is envisaged that the LRT route will be segregated from general traffic, with only buses permitted to share the route within the CBD area along Lambton Quay i.e. to cater for services from Brooklyn or using Taranaki Street. Buses using Adelaide Road or the Mount Victoria Bus Tunnel would terminate at Newtown and Courtenay Place respectively to force passengers to transfer.

It is unlikely that a competing bus and LRT service along the same route would be viable given costs associated with the construction of the LRT system as well as the operational costs associated with the provision of two competing services. As such, the package envisages forced transfers at either the Hospital or Courtenay Place, albeit with a minimal time penalty for those changing from bus services from the south to the LRT.

5.2 Description of Modelled Package

LRT Spine: The route uses the Golden Mile and effectively follows the existing bus route. The key difference with the present bus route however is that the one-way bus system between Willis Street and Courtenay Place is replaced with a conventional two-way system. This two-way passenger transport corridor will help create a stronger spine to connect the Lambton Quay area with the Courtenay Place area.

Option P1 involves the construction of a light rail system along the western side of Lambton Quay (see Figure 5.2) with the remaining road space catering for wider and enhanced pedestrian footpaths, a one-way southbound general street-scaped vehicle lane and some parking for vehicles, taxis and other general vehicles.

South of Lambton Quay, the LRT route follows Hunter Street and Victoria Streets with a single one-way southbound lane provided along these two roads (albeit typically at the expense of car parking). In order to accommodate this change in travel patterns and movements through the CBD, it will be necessary to re-arrange Featherston Street to provide two-way movements. The proposed route through the CBD is shown in Figure 5.3 and reflects Option P1 from Technical Report One.

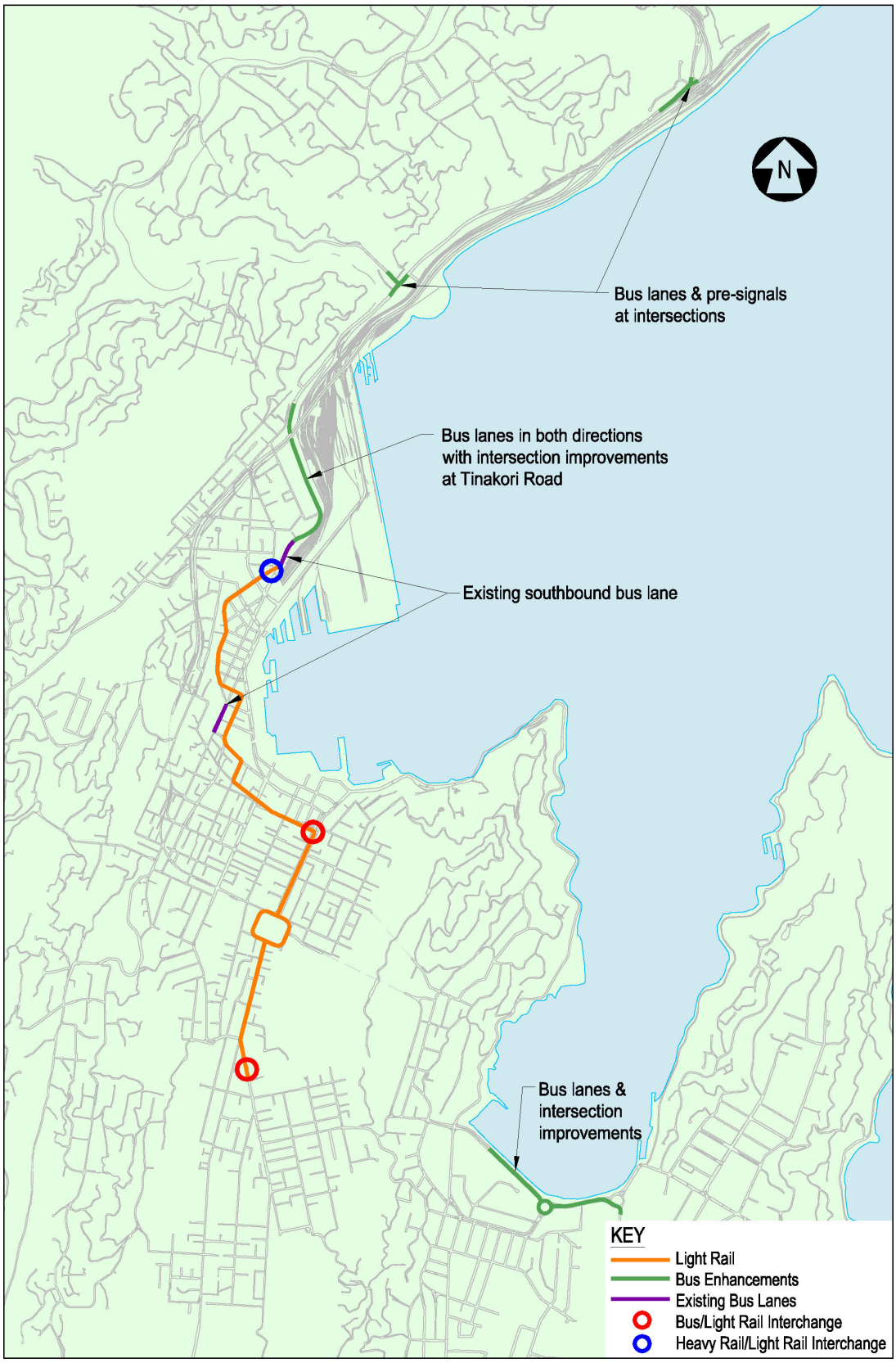

Figure 5.1 Package 1: Light Rail Spine (with no road improvements)

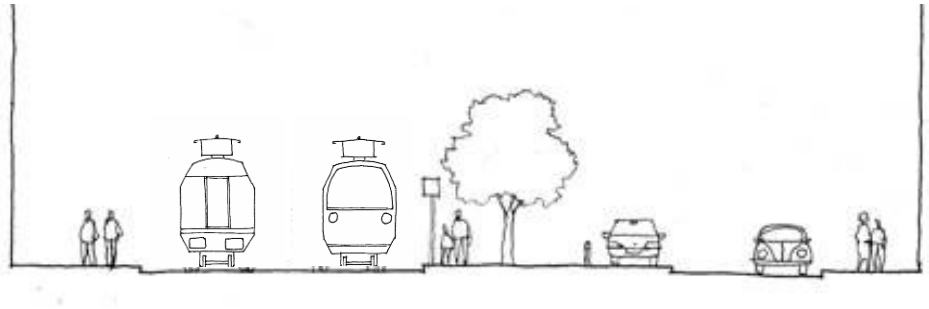

Figure 5.2: - LRT system and one-way south bound vehicle access lane along Lambton Quay *(looking north)*

As part of the need to provide a segregated route, it is also necessary to provide a one-way eastbound general traffic lane along Courtenay Place. An interchange[19] would be provided at Courtenay Place to allow bus/LRT transfers to take place.

Along Kent/Cambridge Terrace, the LRT route would run in the centre of the boulevard, alongside the existing central reservation, at the expense of car, taxi and coach parking. To the south around the Basin Reserve and Adelaide Road, the LRT route would need to be at the expense of existing general traffic lanes, thereby limiting road capacity in the main to a single lane in each direction along Adelaide Road and parts of the Basin Reserve.

It is envisaged that the passenger transport corridor would extend along Adelaide Road and Riddiford Street stopping approximately 200 to 300m of the Wellington Hospital with an interchange provided at this location to allow the transfer of bus passengers onto LRT.

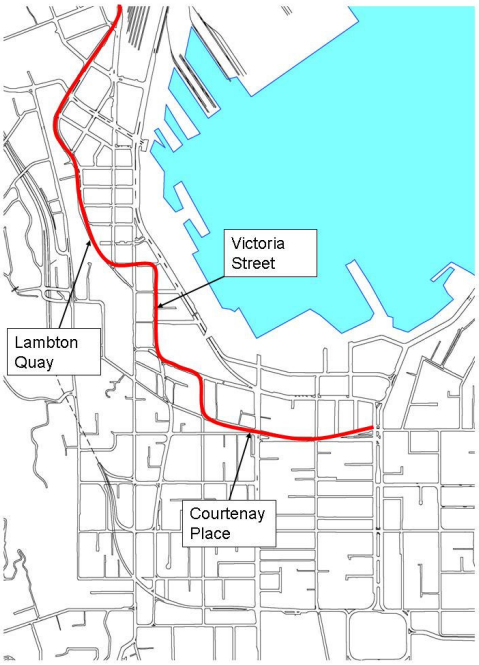

Figure 5.3: Route through the CBD

For the purposes of the transport model, a five minute headway for the LRT system has been assumed.

[19] Includes enhanced features like multiple covered platforms, real time information, ticket sales, bike storage and toilet facilities.

Bus Enhancements: As identified in Technical Report One, a number of passenger transport initiatives exist to extend the passenger transport spine to the north of the CBD. Given the decision as part of the North-Wellington Public Transport Study in 2006 to retain the rail corridor between the CBD and Johnsonville, bus patronage to the north-western suburbs is likely to increase given the catchment of the present rail service. In order to assist bus movements along this section of the spine, a number of enhancements along Hutt Road and Thorndon Quay are proposed, including bus lanes along Thorndon Quay from Moore Street to Tinakori Road[20], plus improvements on the approaches to intersections along Hutt Road aimed at assisting bus movements – for instance through the use of bus lanes and pre-signals at the Hutt Road intersections with Ngauranga Gorge, Kaiwharawhara Road and Tinakori Road.

Passenger transport improvements through to the Airport have also been identified through the use of bus lanes along sections of Cobham Drive (albeit not at the expense of traffic lanes) and pre-signals/slip lanes on the approaches to Troy Street and Calabar Drive roundabouts.

Increased Passenger Transport Frequencies: In order to provide an enhanced passenger transport service, train services to Kapiti and Hutt Valley are envisaged to be increased with 15min and 30min frequencies during the peak and off peak periods respectively.

Furthermore, the existing bus frequencies have been doubled to ensure that this mode of transport remains attractive and also to reduce mode transfer penalties between bus and light rail.

5.3 Network Performance

Overall, Package 1 results in an increase in the number and percentage of trips made by passenger transport in 2016 compared to a 'do nothing' option[21], with a corresponding decrease in car based trips. Forecast car trip numbers are however, still greater than those made in 2001.

Table 5.1 Mode Split

	2016 - Package 1				2016 - Base
	Car	**PT**	**Total**	**PT (%)**	**PT (%)**
AM	166,268	37,440	203,709	18.4	15.0
IP	164,626	12,111	176,737	6.9	6.0
PM	194,996	33,727	228,723	14.7	11.5

[20] At expense of some car parking to provide a lane for general traffic and a lane reserved for buses in each direction

[21] Refer to Table 2.1

Passenger Transport: Travel times between Newtown and the railway station, regardless of time of day or direction, are in the order of 9 to 10 minutes. As such, travel times are forecast to more than half when compared to the existing travel times or those forecast for 2016 without any of the proposed improvements to the transport network. These travel times are significant.

The forced interchange for passengers between bus and LRT at Newtown and Courtenay Place has a dramatic effect on passenger transport route choices. During the morning peak period, passenger numbers using bus services heading through Mount Victoria Bus Tunnel from Hataitai to the CBD reduce by 1000. Conversely, patronage from Kilbirnie through Newtown using Constable Street increases by 1400 passengers, with the vast majority of these continuing on into the CBD using the bus routes travelling via Wallace Street and Taranaki Street – in this way, avoiding forced transfers at Newtown. During the morning peak period, an additional 1200 passengers are forecast to use the northbound bus services along Wallace Street as opposed to an additional 500 passengers on the LRT route along Adelaide Road. Nevertheless, some 2300 passengers are forecast to head north using the LRT along Adelaide Road in the morning peak period compared to 1800 passengers on Wallace Street. Future studies should investigate the effect of forcing all bus passengers to LRT at Newtown, including those buses using Wallace Street.

As in the morning peak period for northbound (inbound) movements, Wallace Street experiences a larger increase in passenger numbers than Adelaide Road for the evening peak period for southbound (outbound) movements. However passenger numbers on the LRT are double the 800 using the bus on Wallace Street in the evening peak.

Boardings along the LRT are forecast to amount to approximately 9,800 passengers in the morning peak period and 8,800 in the evening. During the morning peak period, an additional 1500 southbound passengers are forecast to use the enhanced passenger transport service from the railway station through the CBD along Lambton Quay. It should be noted that the increased heavy rail patronage in Package 1 is 10% higher than that generated through Packages 2 and 3, potentially due to the fact that the LRT provides a better connection to the railway station than a bus based system. In the morning peak period, some 6,800 people are estimated to head south along Lambton Quay using passenger transport.

The increased rail frequency for the Kapiti and Hutt services are forecast to result in an increase of over a third of inbound passenger boardings during the morning peak, with an additional 2,700 passengers forecast to arrive at Wellington Railway Station.

The enhanced bus service frequency also result in a small increase in inbound passengers from the north, with a slight reduction in patronage on the Johnsonville rail line given the competition between the two modes of transport during the morning peak period. This trend may be reversed if LRT was extended to Johnsonville in future years given the penetration of the LRT into and through the CBD. In the evening peak period however, passengers are forecast to switch back to use heavy rail to head north rather than use the bus.

Roading: Motor vehicle travel times from the CBD out to the Airport in the south and Ngauranga Gorge to the north for the morning and evening peak typically increase by up to 3 minutes compared to the 2016 ‘do nothing’ base. Conversely, journey times from the airport to the CBD in both time

periods are forecast to decrease by over 2 minutes compared to the 2016 base case – due primarily to the reduction in traffic along the route as a result of the TDM initiatives and the LRT.

Southbound traffic flows along Hutt Road decrease by over 1700 vehicles in the morning peak period with downstream reductions experienced along Thorndon Quay, Waterloo Quay and the Waterfront. These reductions in southbound traffic flows are continued along Cable Street, Oriental Parade and Kent Terrace.

Northbound traffic flows along the Inner City Bypass and through the Terrace Tunnel during the morning peak period are forecast to decrease slightly, thereby reducing the impact on capacity issues at the Terrace Tunnel. However, traffic flows are forecast to increase along the Waterfront through to the Aotea on-ramp, and in particular along Customhouse Quay given the reduction in capacity along Lambton Quay for northbound traffic. During the evening peak period, southbound traffic flows along Aotea Quay through to the Waterfront increase with southbound flows through the Terrace Tunnel onto the Inner City Bypass decreasing.

Northbound traffic flows along Adelaide Road in the morning and evening period are forecast to increase slightly whilst flows along Wallace Street decrease. Traffic flows along Kent and Cambridge Terraces in both time periods are also forecast to decrease slightly.

Given the changes in permitted traffic movements in the CBD following the introduction of the segregated high quality passenger transport system, some localised changes to traffic flows occur. For instance, westbound motorists are forced to Wakefield Street and Taranaki Street as they re-route to avoid the 'eastbound only' Courtenay Place.

5.4 Key Achievements and Impacts

Whilst a number of general comments concerning light rail and the issues associated with it are made in Technical Report One, a number of specific observations can be made with respect to this package:

- A LRT system is likely to influence the quality and speed of required land use changes at Newtown to create higher-density mixed use development compared to a bus based system. As such, LRT is seen as a more permanent passenger transport investment by developers than simply providing bus lanes. This will assist in encouraging developers to make longer term economic commitments adjacent to the proposed route, and not just Adelaide Road, but also along Kent and Cambridge Terrace. While a dedicated right-of-way bus way system like that proposed for packages 2 and 3 is also likely to be seen as permanent and stimulating development, it may not be as effective as LRT.

- Light rail offers a step change in the quality of passenger transport provided for Wellington's southern suburbs. Given this step change, it may be economic for the density of land use within the growth node to be greater than presently envisaged.

- As light rail is guided and requires fewer vehicles to carry the same number of passengers per hour as buses, they are safer to operate in close proximity to pedestrians, including retail

corridors. This is of particular relevance given the number of recent pedestrian/bus conflicts along the Golden Mile.

- LRT use modern air-conditioned vehicles which are perceived by users as providing a higher quality service than buses, potentially increasing the overall mode share enjoyed by passenger transport. Given that the Package is at the expense of road space along its length, such a perception and hence any encouraged mode change may help lessen the impact on the remaining roading system.

- The gauge of the light rail system should be the same as heavy rail so as to enable the potential integration in future years to Johnsonville.

- A LRT system requires the provision of storage areas and specialist buildings and maintenance equipment for the vehicles.

- The reallocation of road space along the Golden Mile will alter vehicle routes and patterns, reduce car parking and alter some service vehicle access.

- Forced transfers for bus passengers at Newtown and Courtenay Place appear to discourage some users given the perceived time penalties associated with transfer. Regardless of this, the modelling forecasts that a shift from passenger transport routes from those requiring a transfer either at Newtown or Courtenay Place thereby putting pressure on those buses servicing the Eastern Suburbs but which use Wallace Street and Taranaki Street to reach the CBD. In essence, the parallel route along Wallace Street for the bus service competes strongly against the more direct LRT service using Adelaide Road. In order to minimise the impact of forced interchanges, transfers between modes need to be catered for in a high quality environment.

- The reallocation of road space from general traffic to the LRT system as well as alterations to permitted traffic movements (for instance along the Golden Mile) will result in a number of journeys by general motor vehicles becoming longer and slower, both through the CBD and along the Corridor.

- The increased rail frequency proposed along the Hutt and Kapiti Lines needs to be considered in terms of ensuring rail infrastructure is in place to allow such frequencies to operate and that sufficient locomotives and rolling stock exist to cater for the additional services (whilst still maintaining the existing level of service in terms of available seating etc). It is noted that infrastructure improvements to the Hutt and Western Rail Corridors, as well as to the 'Kaiwharawhara Throat' that currently limits the train frequency are being planned whilst the rail rolling stock is also being reviewed through the proposed Regional Rail Plan. Capital costs for this is not included in the report.

- Overall, a reduction in northbound motor vehicle occupants in the morning peak period from the Eastern Suburbs heading into the CBD using Mount Victoria Tunnel, Evans Bay Parade and Constable Street (i.e. the main routes from the Eastern Suburbs) is forecast. Whilst there is an increase in passenger transport numbers heading north in the morning peak from this area, there is a slight net reduction in the number of northbound people heading into the city

from the Eastern Suburbs during the morning peak period as a result of Package 1 compared to the 2016 base line movements.

- The package does little to assist access to and from the Eastern Suburbs including the proposed growth node at Kilbirnie. While there is potential to extend the LRT to the proposed Kilbirnie growth node in future years, such an extension will not be easy to achieve. Two options exist: through the current Mount Victoria Bus Tunnel or through Newtown. Either route would require substantial interaction with other vehicles which would minimise the benefits of such an extension. As discussed in Section 4 and used in Packages 2 and 3, an alternative approach is to use a high quality bus-based system that can allow feeder buses from other areas such as Kilbirnie to link into the system.

- Despite the reduction in southbound traffic flow along the Waterfront the existing three lanes of traffic is needed in order to meet forecast capacity requirements.

- The relocation of the main passenger transport routes through the CBD from Dixon Street, Manners Street and Willis Street onto Victoria Street, Wakefield Street and Cuba Street permits the old route to be reconfigured and enhanced to provide a better pedestrian environment.

5.5 Economic Benefits of Package 1

Economic benefits or dis-benefits are derived from both general motor vehicles as well as from passenger transport users as shown below. As indicated, negative benefits occur for general traffic overall as a result of the reduction of road space for their use and longer journey times.

Table 5.2 Benefit Indication

	Benefit Indication ($ Millions)
25 year passenger transport only benefits	111
25 year general vehicle benefits	- 16
25 year total benefits	95

Linking the growth node at Newtown is assumed to result in a full take up of the calculated increase in regional economic benefits of $95 million per year.

5.6 Package 1 Costs

A summary of the infrastructure costs to undertake the identified package of passenger transport improvements is shown in Table 5.3

Table 5.3 Infrastructure Cost Indication

Mode	Option	Cost Indication $ Millions	
		Expected	95%ile
Passenger Transport Corridor	Light Rail (Railway station to Newtown)[22]	95	146
	Bus priority measures	1	1
TOTAL		96	147

In addition to the infrastructure costs, it will be necessary to purchase light rail vehicles. Assuming the light rail system will operate with eight light rail vehicles, the capital cost of purchasing the vehicles and maintenance set-up costs will range from $33 Million to $43 Million.

Heavy rail infrastructure and rail rolling stock costs are either planned as being within the Regional Passenger Transport Programme or will be reviewed through the proposed Regional Rail Plan with funding availability through a number of sources including directly through On-Track, Greater Wellington and Land Transport NZ.

Operation costs[23]associated with the improvements to passenger transport services are shown in Table 5.4.

Table 5.4 Operation Cost Indication

Passenger Transport Mode	Operating Cost Indication ($ Millions/year)	
	Total	GWRC Subsidy[24]
LRT	7 to 15	1 to 2
Bus	207 to 231[25]	31 to 35
Heavy Rail	-	8

[22] Approximately half of the light rail infrastructure costs are associated with land and buildings for the required interchanges, maintenance and storage facilities.

[23] Based on existing passenger transport operation costs and research

[24] Assumes 70% of the operating costs are covered by fares and the remaining costs are split equally between Greater Wellington and Land Transport NZ

[25] Note: the cost of replacement buses are currently covered as part of the bus operational costs. Were the current bus fleet to be doubled to meet the need for a doubling of the bus frequencies, as a one off in order rather than as part of the operational costs, the cost would be in the order of $141 Million based on a cost of $300,000 per bus and a fleet of 470 buses.

6 Package 2: Enhanced Bus Spine (within minor road improvements)

6.1 Overview

Package 2 seeks to provide a balance between the provision of an improved passenger transport spine between the railway station and the growth node at Newtown through the provision of a segregated busway and limited improvements to the roading network to help ease the strain on parts of the wider network (see Figure 6.1). Beyond the main passenger transport spine between the railway station and Newtown, bus lane improvements are also envisaged to the north of the city along Thorndon Quay whilst improved passenger transport service frequencies for both buses and trains are also envisaged.

In addition to the above, some other pinch points within the network are also addressed. However, the major throttles for east-west motor vehicle travel on the State Highway at the Terrace Tunnel and Mount Victoria Tunnel are not addressed (albeit some easing is provided at the Terrace Tunnel for eastbound traffic in the morning period). By not removing the bottlenecks at the Terrace Tunnel and Mount Victoria Tunnel, Package 2 constrains vehicular traffic into and through the city. Whilst this leads to reduced induced traffic, it will also cause increased congestion and lower levels of service along the state highway compared with package 3.

6.2 Description of Modelled Package

Bus Enhancements: The proposed segregated bus route from the railway station to the eastern end of Courtenay Place follows the same route through the CBD as defined in Package 1 for the LRT (referred to as Option P1 from Technical Report One). Busways are physically segregated from the general traffic lanes except at intersections and a short length of Wakefield Street between Victoria Street and Cuba Street due to the limited road width.

As such, the busway will be located along the western side of Lambton Quay with the remaining road space catering for wider and enhanced pedestrian footpaths, a one-way southbound general traffic lane and some parking for service vehicles, taxis and other general vehicles as shown in Figure 6.2. Once the road space has been allocated for the busway, it can be utilised in any future upgraded passenger transport system such as LRT.

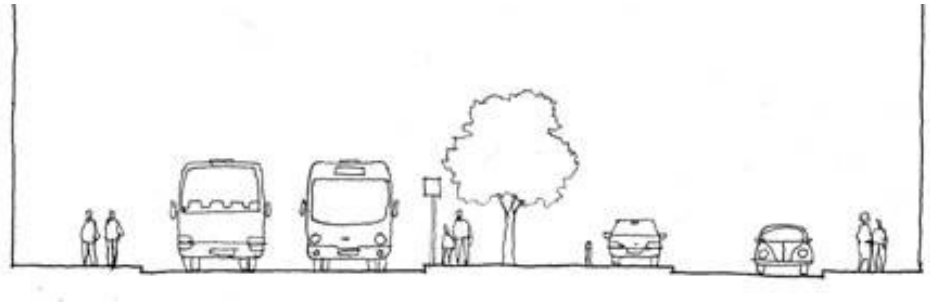

Figure 6.2: -Bus system and one-way south bound lane along Lambton Quay *(looking north)*

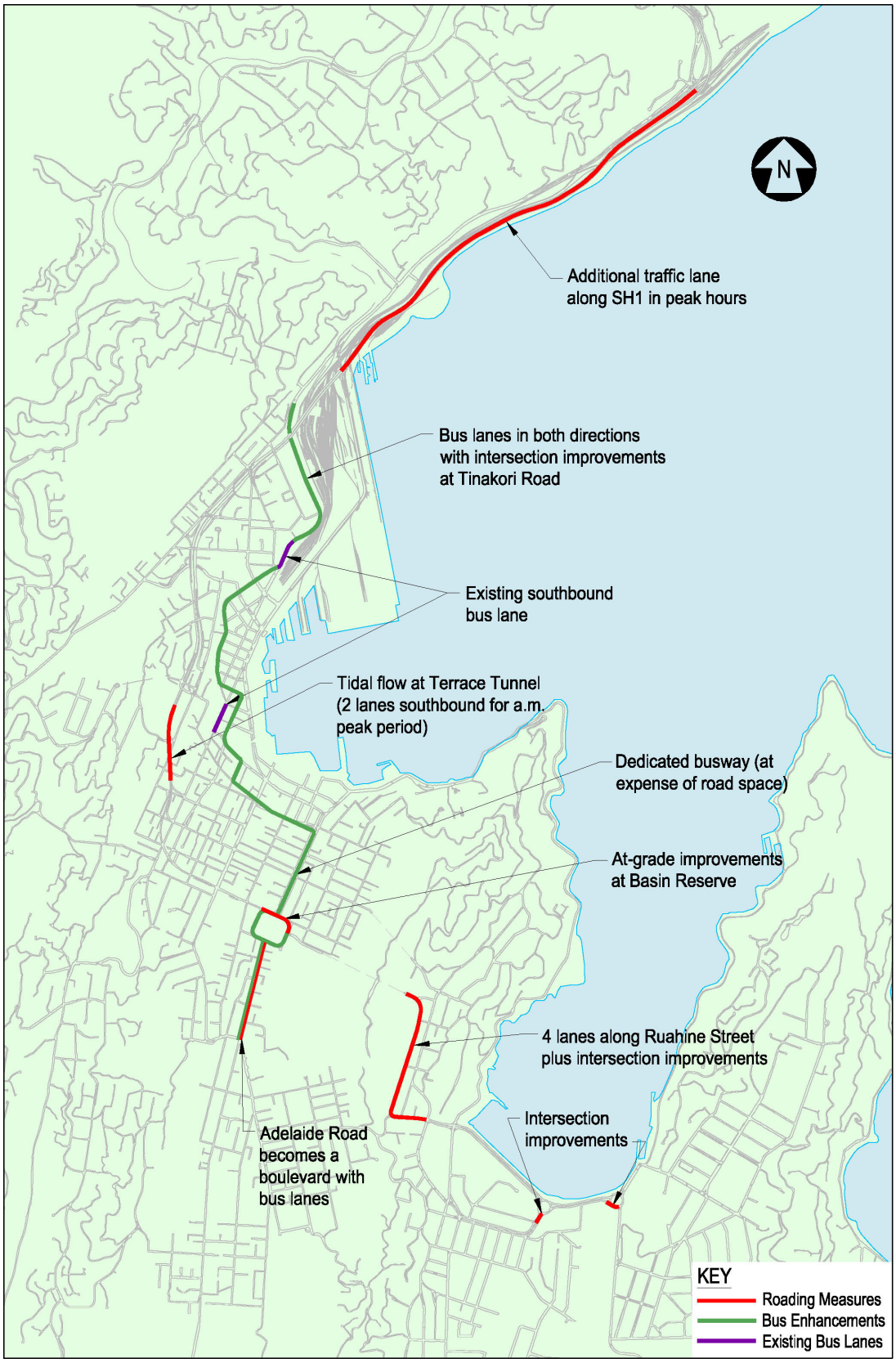

Figure 6.1: Package 2: Enhanced Bus Spine (with minor road improvements)

The route for the busway along the Golden Mile is as shown for the LRT in Figure 5.3. To improve journey times for buses through Courtney Place, signal controlled pedestrian crossings are recommended rather than the existing marked 'zebra' crossings which require vehicles to give way to pedestrian crossing movements and which can inhibit through bus movements.

Along Kent/Cambridge Terrace, the segregated bus lanes can either be provided in the central location adjacent to wide grass median, as in Package 1, or in the left hand traffic lane. Whilst the central location again reserves the space for future passenger transport upgrades, the position of bus doors (compared to the doors on LRT carriages which are on both sides) means that additional road space is required to provide bus stops sufficiently wide to accommodate waiting passengers.

Around the Basin Reserve, in conjunction with a revised at-grade arrangement (see Figure 6.4), the opportunity exists to provide dedicated bus lanes, albeit not segregated from the general traffic lanes.

In keeping with improving the general urban form in the area, it is proposed that Adelaide Road be widened and made into a boulevard to act as a natural continuation of Kent/Cambridge Terrace. Both passenger transport and general motor vehicle traffic will be permitted to use Adelaide Road which will consist of two lanes in each direction for general traffic plus bus lanes in each direction to help enhance passenger transport movements.

North of the CBD, bus improvements are similar to those initiatives identified for Package 1.

Increased Passenger Transport Frequencies: Improvements to passenger transport services are envisaged through a 20% increase in bus frequencies and 15 minute peak period train frequencies along the western corridor rail line.

Roading Improvements: Utilising Option A1 from Technical Report One, it is proposed that an additional traffic lane in each direction be provided along SH1 (between Ngauranga and the Aotea on and off-ramps) for use during the peak periods[26]. Similarly, a fourth lane will be permitted to operate for northbound traffic in the evening peak period only. Given the re-configuration of the existing motorway and the slight narrowing of the existing traffic lanes in order to accommodate this proposal, speed limits would be reduced to 80km/h during the peak time periods when the four lanes are in operation.

[26] The fourth lane will operate for southbound traffic during the morning peak period with the southbound carriageway reverting back to three lanes outside of this period.

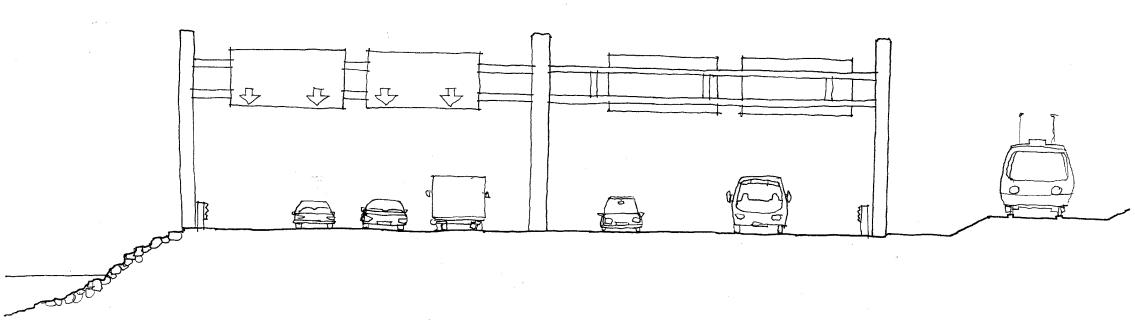

Figure 6.3 –Typical Cross-Section

It is proposed that the three lane Terrace Tunnel (with two lanes northbound and one lane southbound) would operate as a tidal flow system to allow 2 lanes southbound during the morning peak period to help match the increased capacity to the north. The Tunnel would return to its existing directional operation for the remainder of the time.

Improvements for westbound traffic using the State Highway at the Basin Reserve are proposed. A more direct route is provided around the northern side of the Basin Reserve to tie in with the re-aligned section of Buckle Street. Such an arrangement requires the demolition of some properties on the northern side of the Basin Reserve but allows a large park area to be provided in the triangular area bounded by the realigned State Highway, Cambridge Terrace and Kent Terrace.

In order to reduce the number of intersections and delay to westbound traffic on the State Highway, it is envisaged that vehicles from the north from Kent Terrace would still need to travel around the Basin Reserve in order to access the state highway when travelling west towards the Terrace Tunnel (see Figure 6.4).

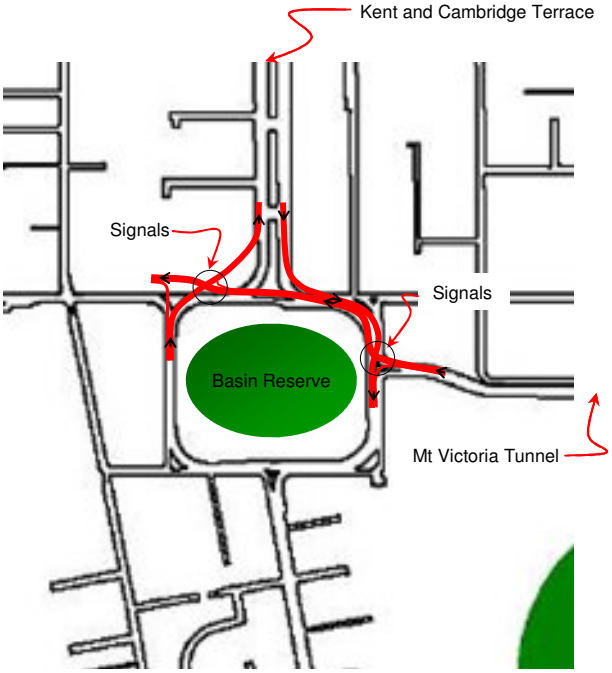

Figure 6.4: Alignment for One Way At Grade Option at Basin Reserve

As indicated previously, additional road space has been provided along Adelaide Road as part of the boulevard design with two lanes in each direction for general traffic along with an additional lane in each direction for buses

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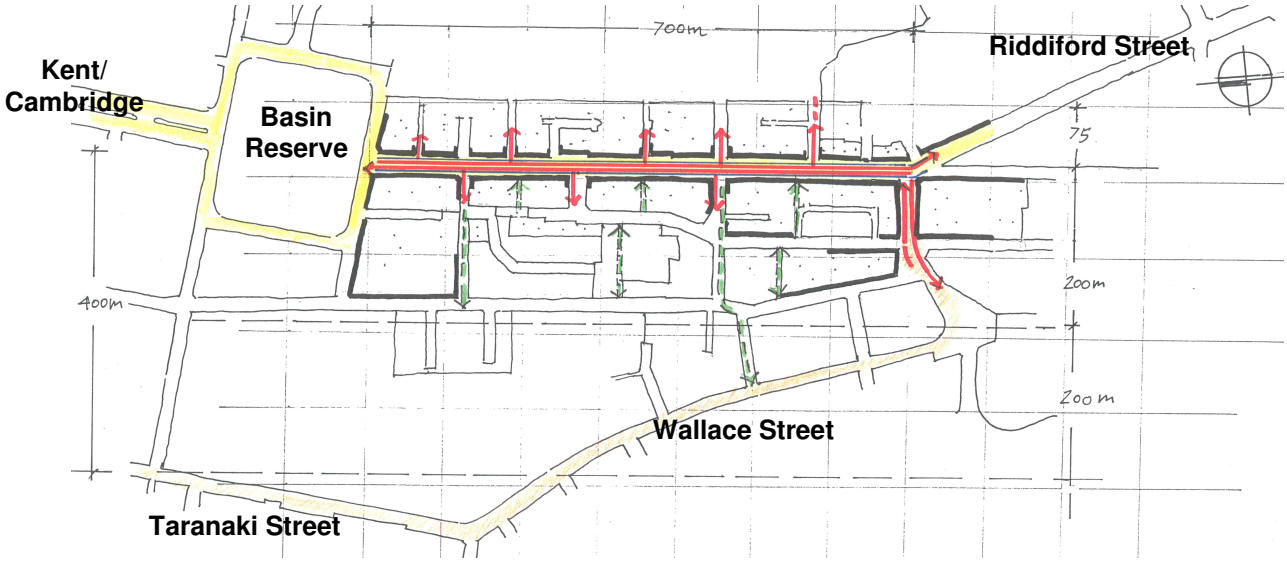

Figure 6.5: - Passenger Transport and Primary Motor Vehicle Route through Newtown Growth Node

Providing capacity for general vehicles in this area is important for the success of the Newtown growth node. The growth node will induce a significant number of trips within this area, and while a good proportion of these trips are expected to be by passenger transport, walking and cycling, many will also be by motor car. However, as noted previously and in Technical Report 1, permitting and encouraging large volumes of traffic onto Adelaide Road may limit the success of the growth node in this area.

On the eastern side of Mount Victoria, an additional two lanes are provided along Ruahine Street and Wellington Road in order to provide two lanes of traffic in each direction with traffic signals provided at the Ruahine Street/Goa Street and the Wellington Road/Ruahine Street intersections. There is a designation[27] for road widening along Ruahine Street and the additional width required for these additional lanes can generally be accommodated within this designation. Access between Ruahine Street and Taurima Street is restricted to only permit a left turn 'in' from the Mount Victoria Tunnel and a left turn 'out' from Taurima Street onto Ruahine Street. It is envisaged that the traffic signal controlled intersection at Goa Street will provide access from Hataitai to the City given the restriction on right turning traffic from Taurima Street.

Minor intersection improvements are also envisaged along Cobham Drive at Troy Street and Calabar Road with the provision of an extra approach lane on Troy Street to ease turning movements from Kilbirnie and a slip lane from Calabar to Cobham Drive to allow left turners from the airport the chance to access Cobham Drive without having to enter the roundabout with a merge on Cobham Drive just beyond the roundabout.

[27] Wellington City Council District Plan

6.3 Network Performance

The improved passenger transport facilities coupled with the TDM measures for Package 2 results in the passenger transport mode share increasing by approximately 2.3% across the region compared to the base 2016 scenario with larger increases during the morning and evening peak periods as shown below in Table 6.1. This is similar to Package 1.

Table 6.1 Mode Split

	2016 - Package 2				2016 - Base
	Car	**PT**	**Total**	**PT (%)**	**PT (%)**
AM	167,494	36,771	204,265	18.0	15.0
IP	164,747	11,978	176,725	6.8	6.0
PM	195,742	33,192	228,934	14.5	11.5

Passenger Transport: As a result of the measures introduced in Package 2, passenger transport travel times between Newtown and the railway station reduced by between 9 and 12 minutes (compared to the 2016 base case) depending upon direction and time of day.

The increased train service frequency is forecast to result in a 22% increase in in-bound (southbound) boardings along the Kapiti rail lines in the morning peak period. However, the provision of additional bus services to and from the north of the CBD is forecast to have a small detrimental impact on patronage along the Johnsonville rail line as the different services compete with one another, particularly in the morning period.

The combination of the TDM measures and improved bus facilities results in an increase in bus passengers particularly from the eastern suburbs with 500 additional passengers forecast to use the Mount Victoria Bus Tunnel during the two-hour morning peak period heading into the CBD and an additional 450 on Adelaide Road. In the evening peak period, Adelaide Road is forecast to be a more popular return journey route than the Mount Victoria Bus Tunnel.

600 to 700 additional bus passengers are expected to use the in-bound and outbound services to and from the CBD travelling along Hutt Road in the morning and evening peak periods respectively.

Roading: During the morning peak period, in-bound motor vehicle travel times to the CBD from the Airport and Ngauranga Gorge decrease by between two to four minutes from the 2016 base; however, the outbound travel times slightly increase by one minute. In the evening peak, travel times between the CBD and Airport are approximately the same as in 2016 base whilst travel times between the CBD and Ngauranga reduce by between one and two minutes.

The provision of the additional traffic lane along SH1 between Ngauranga and Aotea results in an additional 2,300 southbound vehicles forecast to use the state highway during the two hour morning peak period, with a corresponding reduction in traffic flows along Hutt Road. An additional 1,500 vehicles are forecast to continue along SH1 south of Aotea off-ramp with the remaining forecast to

leave the State Highway at the off-ramp. The resulting traffic flows using the off-ramp from SH1 to Aotea Quay results in the single lane off-ramp being at its theoretical capacity and consideration of a 2 lane off-ramp may be needed. During the evening peak, northbound flows along SH1 between Aotea and Ngauranga increase with a reduction in northbound traffic flows along Hutt Road.

During the morning peak and the operation of the tidal flow system at the Terrace Tunnel, southbound traffic reassigns itself from the Waterfront route and continues along the State Highway taking advantage of the two southbound lanes at the Tunnel. Southbound traffic volumes increase by over 50% through the Terrace Tunnel whilst also providing almost four minutes of travel time saving. Given the reduction in northbound capacity, northbound traffic reassigns itself around the network away from the Terrace Tunnel, gaining access onto the motorway interchanges to the north of the Tunnel including putting an additional 1,000 northbound vehicles onto the Waterfront route with vehicles reaching the Waterfront via Taranaki Street and Tory Street. Northbound traffic through the Tunnel is forecast to reduce by almost 40%.

In the evening peak period, without the two lanes southbound through the Terrace Tunnel, southbound vehicles divert from SH1 onto Aotea Quay rather than continue along the state highway. This results in southbound traffic flows along Jervois Quay being in the order of 4,500 vehicles over the two hour period, which is within the capacity of the current three traffic lane configuration but exceeding that which could be provided within a two lane arrangement with an acceptable level of service.

The additional southbound traffic using the tidal flow system through the Terrace Tunnel results in a large increase in traffic on the Inner City Bypass route, putting the southbound flows beyond the theoretical capacity of Vivian Street in the morning peak period.

In the evening peak, Bowen Street and Tinakori Road are forecast to experience large increases in traffic endeavouring to access SH1 at the Tinakori on-ramp. This additional traffic results in the section of Tinakori Road operating at its theoretical capacity.

The provision of four lanes for general traffic along Adelaide Road results in a large increase in traffic along Adelaide Road, particularly for northbound flows with a corresponding reduction in volumes along Wallace Street and Taranaki Street.

The re-distribution of traffic from the Waterfront for southbound vehicles during the morning peak is also forecast to reduce the number of southbound vehicles using Oriental Parade and Evans Bay Parade by 600 vehicles whilst the four laning of Ruahine Street encourages an increase in northbound vehicles to use Ruahine Street, typically at the expense of Evans Bay Parade. As with the other packages, with the implementation of traffic signals at Goa Street and Wellington Road over Ruahine Street, southbound traffic tries to redistribute itself onto Moxham Avenue to avoid the traffic signals along Ruahine Street (see Section 6.4). Despite the provision of two lanes in each direction (with the exception of the Mount Victoria Tunnel) from the Basin Reserve to the Airport, travel times in both directions for both the morning and evening peak are forecast to increase by between one and two minutes over this length compared to 2001 travel times.

The slip lane improvements at the Cobham Drive/Calabar Road roundabout may also cause some local redistribution of traffic near the Airport with traffic diverting from Broadway onto Caladonia and

Devonshire. As with Moxham Avenue, some appropriate local traffic calming to discourage rat running may be necessary.

6.4 Key Achievements and Impacts

The overall transport performance for the combination of options making up Package 2 (as reported above) should be considered in the light of the following impacts:

- A busway offers the opportunity to provide a high quality passenger transport corridor whilst reserving space for any future upgrade to a higher quality system such as LRT as and when growth and development along the growth spine demands it.
- The busway is fully compatible with the bus services currently passing through the Newtown growth node thus negating the need for any transfers.
- Over 7,000 passengers are forecast to use passenger transport southbound along Lambton Quay in the morning peak with a similar number northbound in the evening peak period; this patronage exceeds that forecast for Package 1 using both LRT and bus passenger numbers.
- The re-assignment of bus movements through the city centre presents an opportunity to improve Willis Street, Manners Street and Dixon Street in favour of a more pedestrian friendly environment in line with those outlined in Chapter 3.
- As identified for Package 1, the increased rail frequency proposed along the Kapiti rail line has to be considered in terms of ensuring rail infrastructure is in place to allow such frequencies to operate, and that sufficient locomotives and rolling stock exist to cater for the additional services (whilst still maintaining the existing level of service in terms of available seating etc). It is noted that infrastructure improvements to the Western Rail Corridors, as well as to the 'Kaiwharawhara Throat' that currently limit the train frequency are being planned whilst the rail rolling stock is also being reviewed through the proposed Regional Rail Plan.
- Overall, there is a reduction in the total number of northbound motor vehicle occupants in the morning peak from the Eastern Suburbs to and through the City along Constable Street, the Mount Victoria Tunnel and Evans Bay Parade compared to the 2016 base case. However, Package 2 forecasts a larger increase in northbound passenger transport movements from east of Mount Victoria into the city resulting in an overall net increase in movements between the Eastern Suburbs and the CBD.
- The provision of a two lane off ramp from SH1 to Aotea Quay would require the acquisition or relocation of the concrete silo located adjacent to the existing off-ramp.
- Whilst the Terrace Tunnel Tidal Flow option addresses the main demand into the City during the morning peak period, existing northbound flows exceed the single lane southbound flows thereby simply swapping one congestion problem for another (albeit at a lower level). As identified previously, this results in northbound traffic re-routing on to alternative roads through the City in order to head north.

- As indicated in the Technical Report One, the tidal flow system in a narrow road space also provides safety challenges.

- The re-designed Basin Reserve intersection allows a larger open space to be provided on the northern side of the Basin, albeit separated from the cricket ground by the realigned westbound road. Notwithstanding this, the option allows for improved and more direct pedestrian linkages to and from Kent and Cambridge Terrace in an improved urban environment.

- The re-designed Basin Reserve requires the demolition of a number of properties on the corner of Kent Terrace/Ellice Street, and will affect Compassion Crèche (c1814) at Buckle Street which is registered as an historic building[28]; and an English Elm, located on the corner of Dufferin Street and Paterson Street, which is registered as a notable tree.[29] Consents would be required for the removal of both.

- The re-routed State Highway traffic no longer passes in front of St Mark's Primary School and Wellington College thus providing a safer and improved environment for pedestrians and adjacent properties. Indeed, the removal of westbound state highway traffic from around three sides of the Basin Reserve will improve the environment around these roads as well.

- The development of a boulevard with the provision of a planted/tree lined median strip along Adelaide Road permits a more legible north-south spine connecting with Kent and Cambridge Terrace to be created. This approach however requires significant road widening.

- The widening of Adelaide Road to form the combined main passenger transport and primary motor vehicle route, coupled with the increased traffic volumes along Adelaide Road may inhibit the development of a high quality growth node to its full potential. Furthermore, care will be needed in the design to ensure that a wider vehicle oriented road doesn't 'segregate' the two sides of the street.

- The increase in traffic flows along Moxham Avenue in Hataitai (with the smaller increase in flows along Ruahine Street) indicates that traffic is forecast to try and use Moxham Avenue as a 'rat-run' to avoid the two additional sets of traffic signals at Goa Street and Wellington Road. In order to maintain and/or improve Moxham Avenue's current environment, and allow it to maintain a good level of service for the bus routes along this section of road, appropriate traffic management techniques such as 'speed cushions' that impact on general motor vehicles but not buses need to be installed in order to discourage the rat-run. Alternatives approaches include preventing the turning movement into Taurima Road or the removal of the traffic signals at Wellington Road/Ruahine Street – with the provision of a left turn in-out movement only. However, this will have an impact elsewhere on the network in Kilbirnie as traffic is diverted away from this intersection.

[28] Wellington City Council District Plan, Map Reference 16, symbol 42
[29] Wellington City Council District Plan, Map Reference 16, symbol 204

- The reassignment of bus passengers from one route to another from the Eastern Suburbs indicates the need to provide bus priority measures along Rongotai, particularly at the intersection with Evan Bay Parade where delays are forecast to occur.

6.5 Economic Benefits of Package 2

Economic benefits or dis-benefits are derived from both general motor vehicles as well as from passenger transport users as shown below in Table 6.2:

Table 6.2 Benefit Indication

	Benefit Indication ($ Millions)
25 year passenger transport only benefits	102
25 year general vehicle benefits	128
25 year total benefits	230

Linking the growth node at Newtown with the busway, rather than the LRT, is assumed to result in a 75% uptake of the calculated increase in regional economic benefits of $70 Million per year rather than the full $95 Million.

6.6 Package 2 Costs

The capital costs to construct the identified infrastructure improvements are shown in Table 6.3. It should be noted that the costs associated with streetscape costs and for walking and cycling initiatives have not been included in those shown below.

Table 6.3 Infrastructure Cost Indication

Mode	Option	Cost Indication $ Millions	
		Expected	95%ile
Passenger Transport Corridor	Busway and Bus Priority Measures (excluding Adelaide Road)	20	34
General vehicles	Ngauranga to Aotea 8-laning[30]	24	32
	Terrace Tunnel Tidal Flow	3	4
	Basin Reserve	7	12
	Ruahine Street to Airport	38	61
	Adelaide Road[31]	9	16
TOTAL		101	159

[30] Since Technical Report One: Description of Options, the costs to undertake this work have been revised to value shown in the Table.

[31] The cost of land associated with the Adelaide Road improvements (including the widening) are incorporated within the cost of the development of the growth node and not in the cost of this option. Expected costs for providing a boulevard with two lanes in each direction, rather than three lanes are shown.

As with Package 1, heavy rail infrastructure and rail rolling stock costs to improve service frequencies on the Kapiti rail line are either planned as being within the Regional Passenger Transport Programme or will be reviewed through the proposed Regional Rail Plan with funding availability through a number of sources.

Operation costs associated with the improvements to passenger transport services are shown in Table 6.4.

Table 6.4 Operation Cost Indication

Passenger Transport Mode	Operating Cost Indication ($ Millions)	
	Total	**GWRC Subsidy[32]**
Bus	41 to 46[33]	6 to 7
Heavy Rail	-	1[34]

[32] Assumes 70% of the operating costs are covered by fares and the remaining costs are split equally between Greater Wellington and Land Transport NZ

[33] Note: the cost of replacement buses are currently covered as part of the bus operational costs. Were the current bus fleet to be increased by 20% to meet the need for the increased frequencies, as a one off in order rather than as part of the operational costs, the cost would be in the order of $28 Million based on a cost of $300,000 per bus and an additional 94 buses.

[34] Increase in peak period services on the Kapiti rail line to 15 minute frequencies on weekdays based on proportion of existing trips using the line

7 Package 3: Enhanced Bus and Roading Spines (with Tunnel duplications)

7.1 Overview

Package 3 endeavours to further develop and utilise relationships between roading improvements and passenger transport initiatives beyond those identified in Package 2 in order to further increase access opportunities.

As with Package 2, central to the package is the provision of a high quality bus based passenger transport spine in the form of a busway from the railway station extending to the growth node at Newtown. In conjunction with the passenger transport infrastructure improvements and improved frequencies, a number of roading improvements are envisaged to provide relief to known pinch points, including those at the Terrace and Mount Victoria Tunnels. As such, the roading improvements go beyond those identified in Package 2 whilst enhanced passenger transport provision is also provided by extending the bus priority measures north along the Hutt Road at the expense of general vehicle capacity given the extra capacity along SH1 between Ngauranga and Aotea. The extent of all the options forming Package 3 is shown in Figure 7.1

7.2 Description of Modelled Package

Bus Enhancements: Infrastructure improvements, aimed at providing a high quality passenger transport spine, are the same as those identified in Package 2 with the exception of the Basin Reserve and Adelaide Road. A grade separated intersection at the Basin Reserve (see below) allowing free flowing east-west movements minimises delays to the north-south bus movements. Whilst no specific facilities for buses are provided around the Basin Reserve, a widened Adelaide Road (in the form of a boulevard) has dedicated bus lanes along its length in both directions in conjunction with two lanes for general traffic in each direction.

In addition to the measures identified north of the CBD along Thorndon Quay and Hutt Road, bus lanes are proposed along the entire length of Hutt Road thereby providing a continuous length of bus priority from Ngauranga into the City.

Increased Passenger Transport Frequencies: As with Package 1, in order to provide an enhanced passenger transport service, train services to Kapiti and Hutt Valley are envisaged to be increased with 15min and 30min frequencies during the peak and off peak periods respectively. Furthermore, the existing bus frequencies have been doubled together with the infrastructure improvements.

Roading Improvements: A number of the roading improvements identified in Package 2 are maintained in this Package, whilst a number of further up-grades are also identified.

As with Package 2, an additional traffic lane for use in the peak periods is proposed for SH1 between Ngauranga and Aotea Quay. An 80km/h speed limit is envisaged to operate during the morning southbound period with the additional traffic lane operating, and likewise for the evening peak period for northbound traffic.

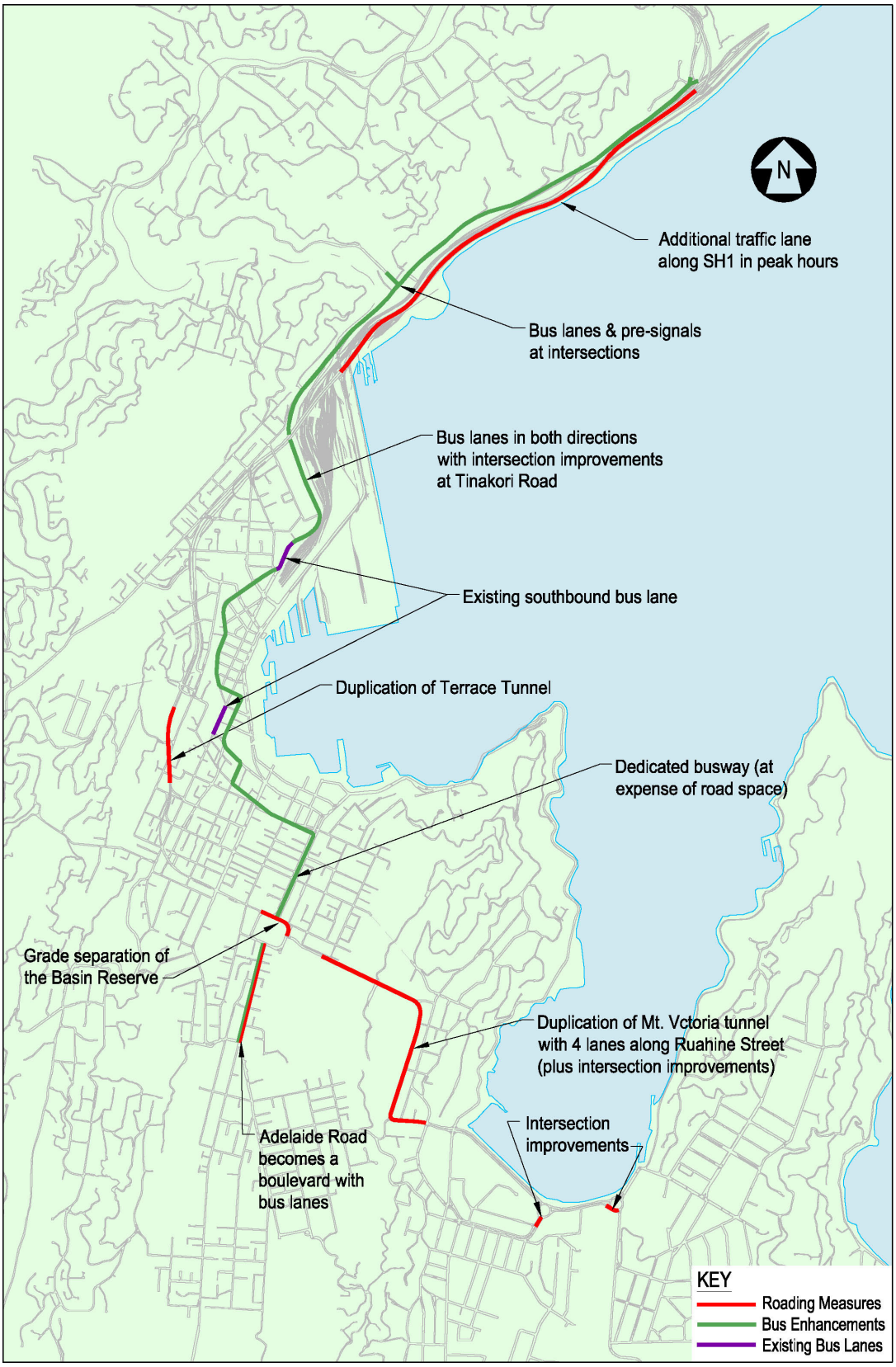

Figure 7.1 Package 3: Enhanced Bus Spine (with Tunnel duplication)

The package includes the duplication of both the Terrace Tunnel and Mount Victoria Tunnels with the additional tunnels envisaged to be located adjacent to the existing Tunnels (Options T2 and B2 from Technical Report One).

Linking the two tunnels via the existing Inner City Bypass arrangement is a grade separated interchange at the Basin Reserve. As shown in Figure 7.2, north-south traffic heads under the westbound elevated traffic lanes using their current arrangement around the Basin Reserve. The arrangement allows two lanes of traffic to head south along the State Highway and through the Mount Victoria Tunnel. On the eastern side of Mount Victoria, improvements proposed in Package 2 for the four laning of Ruahine Street and Wellington Road with intersection improvements at Taurima Road, Goa Street plus Ruahine Street/Wellington Road permits the two lanes of traffic in each direction to be provided along the entire length of the state highway.

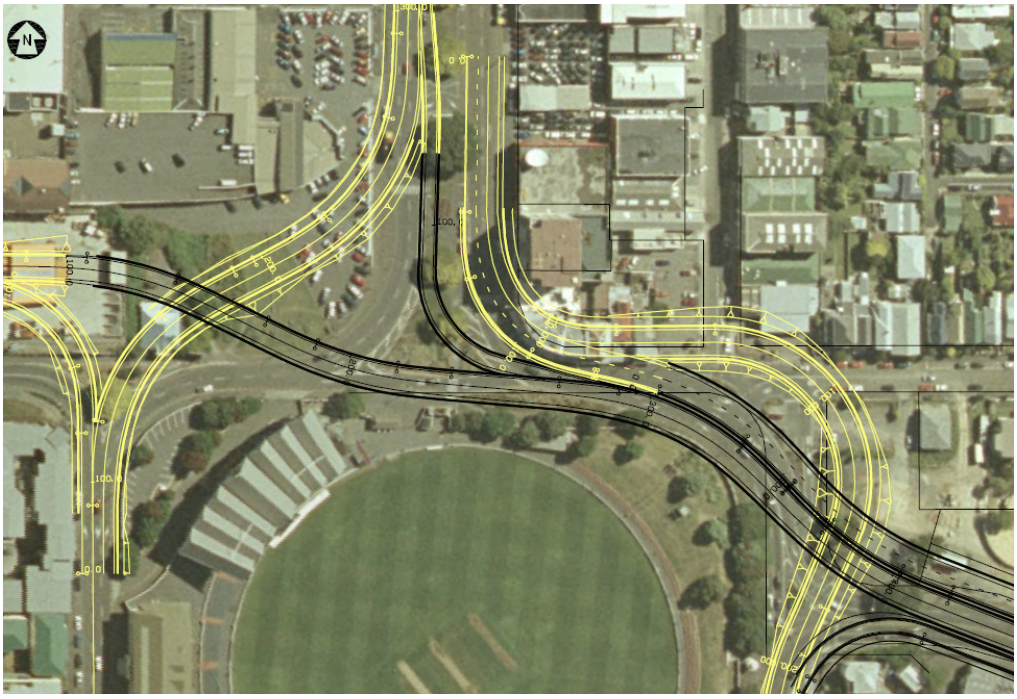

Figure 7.2: Potential Alignment for Grade Separated Option at the Basin Reserve

As with Package 2, minor intersection improvements along Cobham Drive at Troy Street and Calabar Drive are also proposed.

Adelaide Road is proposed to be made into a widened Boulevard with two vehicles lanes in each direction for general traffic and as well as one bus lane in each direction (giving six lanes in total).

7.3 Network Performance

As with Package 3, the enhanced passenger transport and TDM initiatives result in the passenger transport mode share increasing by 2.5% across the Wellington Region.

Table 7.1 Mode Split

	2016 - Package 3				2016 - Base
	Car	**PT**	**Total**	**PT (%)**	**PT (%)**
AM	166,941	37,726	204,667	18.4	15.0
IP	164,778	12,297	177,075	6.9	6.0
PM	195,389	34,100	229,490	14.9	11.5

Passenger Transport: The introduction of the passenger transport initiatives plus TDM measures, along with the removal of some of the choke points in the roading network combine in Package 3 to provide reductions in passenger transport travel times between Newtown and the railway station of between 9 and 12 minutes compared to the base 2016 case depending upon direction and time of day.

Increases in the order of 500 bus passengers over the two hour morning peak period in each direction are forecast to occur for both northbound and southbound movements along Kent/Cambridge Terrace and Adelaide Road. This is compared to the Mount Victoria Bus Tunnel which experiences an inbound increase in the morning peak of 400 passengers.

The bus lanes to the north of the CBD help encourage over an additional 1,000 bus passengers into the City via Thorndon Quay during the morning peak period whilst the enhanced rail services encourage over 1,200 inbound passengers to arrive at the railway station.

As with Package 2, the enhanced bus services forecasts that heavy rail patronage on the Johnsonville line will decrease in both the morning and evening periods as bus and rail services compete with another.

Roading: During the morning peak period, travel times are forecast to decrease by between three and five minutes for journey's into the CBD from the Airport and from Ngauranga compared to the 2016 base case; trips from the CBD to the Airport and Ngauranga however have very little change of between plus or minus 20 seconds. In the evening peak, travel times between the CBD and the Airport and Ngauranga are all forecast to reduce, regardless of direction, by between one and three minutes.

The provision of the additional lane along SH1 between Ngauranga and Aotea during the peak periods, along with the provision of bus lanes along Hutt Road at the expense of general vehicle lanes, has the impact of encouraging southbound traffic off Hutt Road onto the state highway in the morning peak, and northbound traffic from the Hutt Road onto the state highway in the evening periods. As a result, the state highway will operate at or close to capacity in each direction in the peak periods. Similarly, the reduction in general traffic lanes along the whole length of Hutt Road will result in parts of Hutt Road operating at or over capacity in the morning and evening peaks, for instance on the northbound approach to the Kaiwharawhara Road intersection in the evening peak.

The southbound traffic flows forecast to use SH1 result in the off-ramp at Aotea Quay and the two lanes at the Terrace Tunnel operating at or close to their theoretical capacity. Overall however, southbound flows along Aotea Quay and the Waterfront in the morning peak period are much reduced, potentially permitting a reduction in southbound traffic lanes from three to two. However, the additional traffic using the Terrace Tunnel southbound loads additional traffic onto the Inner City Bypass resulting in the route operating at or beyond its theoretical capacity.

The grade separation of the Basin Reserve coupled with increased roading capacity through Mount Victoria and along Adelaide Road results in both of these roads attracting additional northbound and southbound traffic in both the morning and evening peak periods. As such, during the morning and evening peak periods, the duplicated Mount Victoria Tunnel will operate at or beyond its theoretical capacity – as it currently does with a single lane in each direction, albeit with a better level of service than at present. The capacity increases at and around the Basin Reserve and the associated additional traffic results in reductions in traffic flows elsewhere on the network such as Wallace Street and Taranaki Street (although parts of these are forecast to still operate at close to their capacity) as well as along Evans Bay Parade where traffic volumes reduce by 900 vehicles in each direction over the two hour morning peak period.

Given the constraints at the Terrace Tunnel, as well as along the Inner City Bypass for northbound traffic during the morning peak period, some traffic reassigns itself from using the state highway from the Basin Reserve, and head north along Cambridge Terrace and around the Waterfront with an additional 400 vehicles forecast to head north along the Waterfront in the morning peak.

As with Package 2, Bowen Street and Tinakori Road are forecast to experience large increases in traffic endeavouring to access SH1 at the Tinakori on-ramp in the evening peak period. This additional traffic results in the section of Tinakori Road operating at its theoretical capacity.

The traffic signals along Ruahine Street are forecast to encourage some southbound vehicles to use Moxham Avenue rather than Ruahine Street having travelled through the Mount Victoria thereby creating a ‘rat-run’ through Hataitai.

7.4 Key Achievements and Impacts

Whilst the issues for Package 3 are similar to those identified for Package 2 (for instance with respect to the passenger transport corridor), the release of the pinch points at the Terrace Tunnel and Mount Victoria Tunnel along with other roading interventions have major implications on the overall network performance and urban form, as discussed below:

- As identified in Package 2, a busway offers the opportunity to provide a high quality passenger transport corridor whilst reserving space for any future upgrade to a high quality passenger transport system such as a light rail system at a future date. Furthermore, the busway negates the need for any transfers.
- As with Package 2, the new busway route through the CBD results in a reduction in services on some of the existing bus routes through the CBD providing an opportunity to improve the environment for pedestrians along these routes.

- As with Packages 1 and 2, the increased rail frequency proposed along the Hutt and Kapiti Lines needs to be considered in terms of rail infrastructure (including the 'Kaiwharawhara Throat') as well as locomotives and rolling stock.

- The provision of four lanes of traffic in the peak periods for traffic heading into and out of Wellington along SH1 between Ngauranga to Aotea provides the opportunity to reallocate the road space away from private motor vehicles for the parallel route of Hutt Road to buses. However, traffic flows along the general traffic lanes on Hutt Road are still sufficiently high that Hutt Road would operate at low level of service.

- As with Package 2, passenger numbers along Lambton Quay are higher than those forecast with LRT albeit slightly lower for northbound movements along Adelaide Road and Cambridge Terrace in the morning peak given the increase in bus passengers using alternative routes via Wallace Street.

- The provision of additional high capacity traffic lanes along SH1 plus the duplication of the Terrace Tunnel offers the potential to reduce the number of southbound traffic lanes along the Waterfront to two lanes. Northbound flows are still sufficiently high in the evening peak as to require three lanes in order to meet forecast demand.

- The elevated structure for the grade separation of the Basin Reserve will be visually prominent and be further emphasised due to its location at the termination point of the vista along Kent/Cambridge Terrace. It can also be considered to affect the perception, symbolic character and context of the Basin Reserve and will impact on the overall character of the wider surroundings. In addition to the impact from outside the ground, the grade separation will also have issues with respect to the quality of experience from within the Basin Reserve – from a visual, noise, and change to the existing character point of view and possibly have an impact on the use of the Basin Reserve as an open space with special significance.

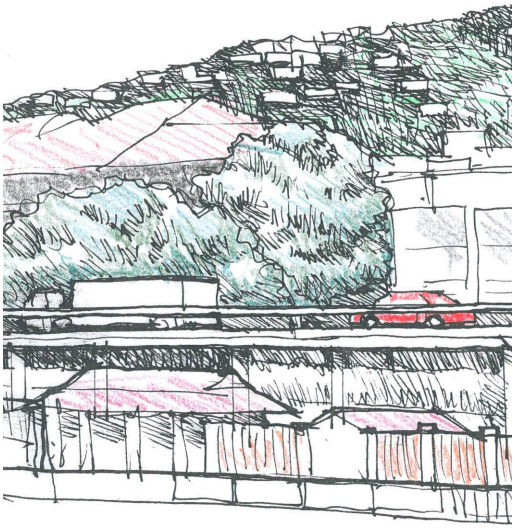

Figure 7.3 Artists impression of the grade separation above the existing northern entrance – looking from inside Basin Reserve

- Furthermore, a grade separated interchange at the Basin Reserve will act as a three-dimensional visual/physical barrier segregating Adelaide Rd from Kent/Cambridge Terrace. This in turn will affect the current continuity of visual experience and urban structure. As such, the elevated leg of the vehicle ramp connecting to Cambridge Terrace will bring significant changes to the existing character of the locality that might be difficult to effectively mitigate. Grade separation will also have an impact on visual and physical connectivity for

pedestrians in the area as well as on the ease and safety of pedestrian crossings between Kent and Cambridge Terrace at the southern end.

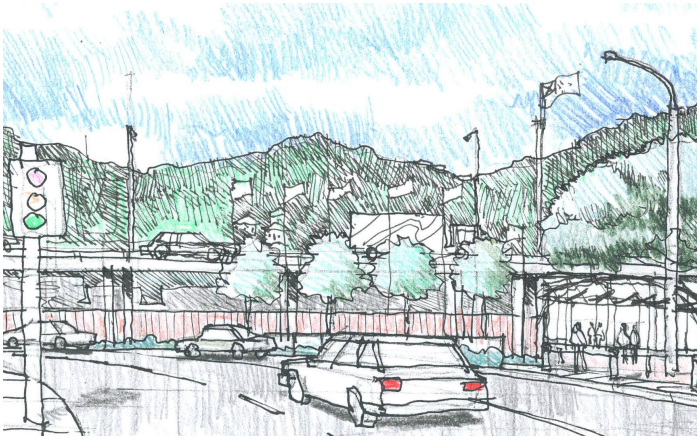

Figure 7.4: Artists Impression of the Grade Separation of the Basin Reserve – looking south from Kent Terrace

- It may be possible to mitigate some of these visual impacts by incorporating part of the elevated structure with a new grandstand for the Basin Reserve.

- The duplication of the Mount Victoria Tunnel opens up the eastern suburbs for further growth and residential development given the removal of the pinch point and the provision of good accessibility between the CBD and Kilbirnie, the Airport and Miramar. The package forecasts an increase in the number of both motor vehicle occupants and passenger transport users compared to the 2016 base. In order to control such development and limit inappropriate growth in certain area, WCC need to actively encourage the Kilbirnie growth node, and ensure that development occurs there, rather than elsewhere. Such directed growth would also assist with ensuring the extension of the high quality passenger transport corridor through to Kilbirnie in the future, probably via the Mount Victoria Bus Tunnel.

- The widening of Adelaide Road into a boulevard with six lanes of traffic (four for general traffic and two for passenger transport) provides a direct link between the CBD and hospital for all road users. This approach, whilst preventing the need to acquire houses on Wallace Street and reducing traffic impacts on Wallace Street and Taranaki Street, will require significant road widening at the expense of existing adjacent development. Although the wider street might promote higher buildings and therefore provide greater development opportunities, it may also be perceived as a barrier to movement and therefore affect the general functioning of Adelaide Road as an integrated street.

- The six lanes of traffic passing through the growth node will significantly reduce the walkability and amenity of the area, potentially making the growth node less viable and of lower quality.

- Subject to the impact of the grade separated structure at the Basin Reserve, the wide Boulevard may be perceived as a natural continuation of Kent/Cambridge Terrace thereby enhancing the legibility of the street and form of the City.

- As in Package 2, the re-assignment of traffic from SH1 to Moxham Avenue through Hataitai as a rat-run to avoid the delays at the two new sets of traffic signals results in the need to provide appropriate traffic management techniques in the area either through the provision of traffic calming aimed at motor vehicles (and not at the bus service) to discourage such a movement or through a change in the Wellington Road/Ruahine Street traffic signal controlled intersection to prevent delays occurring for State Highway traffic.

- Reduced traffic flows along Evans Bay Parade and Wallace Street present the opportunity for the current environment along these roads to be improved given the reduction in the car domination along these routes, providing an opportunity for improved and safer cycling conditions.

7.5 Economic Benefits of Package 3

As with other Packages, the economic benefits associated with Package 3 can be split into different components as shown in Table 7.2:

Table 7.2 Benefit Indication

	Benefit Indication ($ Millions)
25 year passenger transport only benefits	143
25 year general vehicle benefits	219
25 year total benefits	362

As in Package 2, linking the growth node at Newtown with the busway rather than the LRT is assumed to result in a 75% uptake of the calculated increase in regional economic benefits of $70 Million per year rather than the full $95 Million.

7.6 Package 3 Cost

The capital costs to construct the identified infrastructure improvements are shown in Table 7.3. It should be noted that the Technical Report identified the potential for some lower cost designs within these options, such as single lane duplication at the Terrace Tunnel with the existing Tunnel retained as currently operating. However, in order to provide a robust estimate, the full cost of options is included with the view that enhanced estimates based on a preferred design option would be further developed as part of any Scheme Assessment Report.

Furthermore, it should be noted that the costs associated with streetscape costs for walking and cycling initiatives have not been included in those shown below in Table 7.3

Table 7.3 Cost Indication

Mode	Option	Cost Indication $ Millions	
		Expected	95%ile
Passenger Transport Corridor	Busway and Bus priority measures (excluding Adelaide Road – see below)	20	34
General vehicles	Ngauranga to Aotea 8-laning[35]	24	32
	Terrace Tunnel Duplication[36]	161	268
	Mount Victoria Tunnel and Basin Reserve[37]	198	317
	Ruahine Street to Airport	38	61
	Adelaide Road[38]	9	16
TOTAL		450	728

As identified in Package 1, heavy rail infrastructure and rail rolling stock costs are either planned as being within the Regional Passenger Transport Programme or will be reviewed through the proposed Regional Rail Plan with funding availability through a number of sources including directly through On-Track, Greater Wellington and Land Transport NZ.

Operation costs associated with the improvements to passenger transport services are shown in Table 7.4.

Table 7.4 Operation Cost Indication

Passenger Transport Mode	Operating Cost Indication ($ Millions/year)	
	Total	GWRC Subsidy[39]
Bus	207 to 231[40]	31 to 35
Heavy Rail	-	8

[35] Since Technical Report One: Description of Options, the costs to undertake this work have been revised to value shown in Table 7.3

[36] Using a single lane duplication with restricted use (Option T3b from Technical Report One), the expected cost reduces to $78 Million, with a 95th%ile cost of $125 Million.

[37] Using the Pirie Street Tunnel option, the expected cost increases to upto $289 Million with a 95^{tth}%ilecost of$450 Million

[38] The cost of land associated with the Adelaide Road improvements (including the widening) are incorporated within the cost of the development of the growth node and not in the cost of this option. Expected costs for providing a boulevard with two lanes in each direction, rather than three lanes are shown.

[39] Assumes 70% of the operating costs are covered by fares and the remaining costs are split equally between Greater Wellington and Land Transport NZ

[40] Note: the cost of replacement buses are currently covered as part of the bus operational costs. Were the current bus fleet to be doubled to meet the need for a doubling of the bus frequencies, as a one off in order rather than as part of the operational costs, the cost would be in the order of $141 Million based on a cost of $300,000 per bus and a fleet of 470 buses.

8 Package 4: Enhanced Roading Spine (with minor bus improvements)

8.1 Overview

Package 4 primarily concentrates on providing a strong north-south roading link along the state highway by providing two lanes of traffic in each direction from the Urban Motorway through to the airport. The package endeavours to provide relief for existing and future pinch-points on the roading network with passenger transport initiatives aimed at enhancing existing bus infrastructure for services from the south and the north tying in with existing bus priority measures. Passenger transport improvements do not impact on the existing roading capacity (which is maintained) along the enhanced routes, although bus lanes are implemented at the expense of adjacent on-street car parking.

8.2 Description of Modelled Package

Bus Enhancements: Passenger transport infrastructure improvements are focussed on the main bus route approaches to the CBD along Kent and Cambridge Terrace and Thorndon Quay. Bus lanes are provided in both directions along the length of Kent and Cambridge Terraces (at present, a southbound evening peak bus lane exists over part of its length) as well as along Thorndon Quay between Moore Street and Tinakori Road. Improvements at the Tinakori Road/Hutt Road intersection are also envisaged in order to help give buses some priority.

Whilst additional passenger transport measures are more limited than those shown in Packages 1 to 3, a number of existing bus measures (as shown in Figure 8.1) already exist along the passenger transport spine from Newtown through the CBD. It is envisaged that these will be utilised as part of the passenger transport corridor.

Roading Improvements: Roading improvements mirror those contained within Package 3 - as shown in Figure 8.1. As identified previously, the Package envisages the duplication of both the Terrace Tunnel and Mount Victoria Tunnels with four lanes along Ruahine Street and Wellington Road (within the existing roading designation) and associated intersection improvements. The option also includes the grade separation of the Basin Reserve to allow a free westbound movement on the state highway over the north-south movement. Further north, SH1 between Ngauranga to Aotea is envisaged as being four-laned in each direction to allow an additional traffic lane during the peak periods, coupled with an 80km/h speed limit.

No changes to the existing traffic arrangements around Adelaide Road as part of the growth node concept are included within this Package.

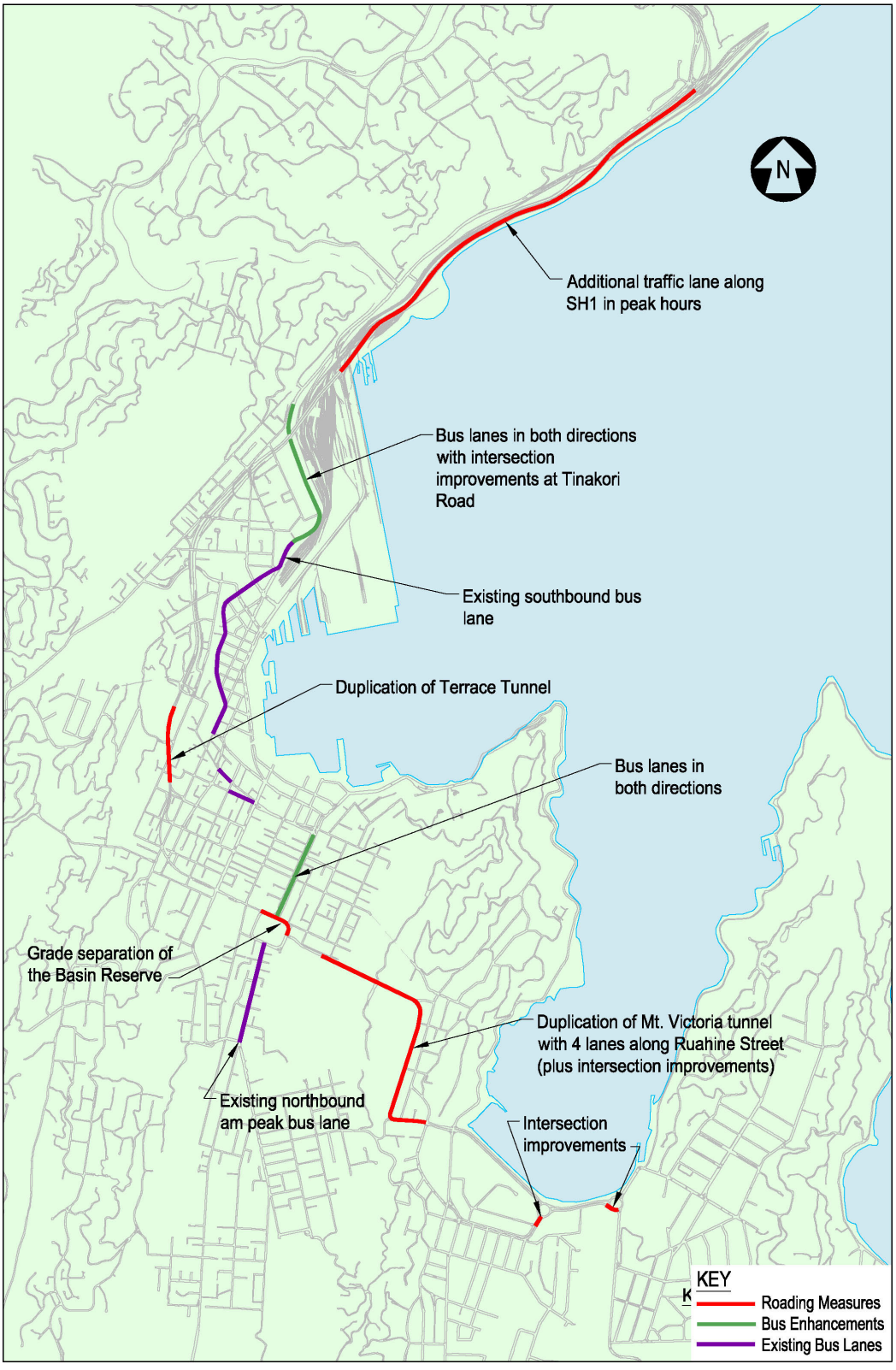
N
Additional traffic lane along SH1 in peak hours
Bus lanes in both directions with intersection improvements at Tinakori Road
Existing southbound bus lane
Duplication of Terrace Tunnel
Bus lanes in both directions
Grade separation of the Basin Reserve
Duplication of Mt. Victoria tunnel with 4 lanes along Ruahine Street (plus intersection improvements)
Existing northbound am peak bus lane
Intersection improvements
KEY
Roading Measures
Bus Enhancements
Existing Bus Lanes

Figure 8.1 Package 4: Enhanced Roading Spine (with minor bus improvements)

8.3 Network Performance

As shown in Table 8.1, the introduction of TDM techniques and the minor bus improvements results in an overall increase in passenger transport trips in the region by approximately 2% from the 2016 committed base. However, the overall passenger transport share for each of the time periods is the lowest of all the packages given the limited additional passenger transport infrastructure to support bus use.

Table 8.1 Mode Split

	2016 - Package 4				2016 - Base
	Car	**PT**	**Total**	**PT%**	**PT%**
AM	168,567	35,485	204,052	17.4	15.0
IP	165,281	11,549	176,830	6.5	6.0
PM	196,684	31,911	228,595	14.0	11.5

Passenger Transport: The improved roading network typically results in general traffic changing their trip patterns. This shift in travel assignment over the network coupled with specific improvements aimed at reducing delays and giving some priority to buses results in bus travel times between Newtown and the Railway Station decreasing by between 3 and 5 minutes compared to the 2016 base case depending upon direction and time of day. However, journey times exceed 20 minutes – this compares with less than 10 minutes for Package 1.

Passenger transport numbers increase given the reallocation of car drivers to alternative modes of transport as a result of TDM. The main increases in passenger transport usage are via the rail system to and from the north with lesser increases by bus along Adelaide Road to the south, and Hutt Road to the north. Bus passenger increases through the Mount Victoria Bus Tunnel during the morning peak periods are negligible.

A small decrease in rail patronage using the Johnsonville line may occur with losses typically being more than matched by increases on bus services in the area.

Roading: The provision of a much improved roading infrastructure, which has removed the pinch-points on the state highway, without any reallocation of road space to passenger transport results in improved journey times between Ngauranga and the CBD, and between the CBD and Airport (with the exception of the southbound trip from the CBD to the Airport which slightly increases with the package in both the morning and evening peaks. This is due primarily to the introduction of two new additional traffic signal controlled intersections along Ruahine Street at Goa Street and Wellington Road).

The removal of key capacity constraints along the state highway results in induced traffic occurring for flows into the city along SH1 during the morning peak period. For the morning peak period, southbound traffic north of Aotea is forecast to divert from Hutt Road and other local roads onto SH1. The duplication of the Terrace Tunnel results in 2,000 vehicles continuing along SH1 through the Tunnel. The combination of the 8-laning of SH1 between Ngauranga and Aotea Quay results in a reduction in 1,800 vehicles using Thorndon Quay or Waterloo Quay, with a corresponding reduction of traffic southbound along the Waterfront. It should be noted that although the Terrace Tunnel duplication encourages a high number of vehicles to continue along SH1, an additional 500 vehicles are still forecast to exit the state highway at the Aotea off-ramp putting pressure on the off-ramp capacity.

To the south of the CBD, the four laning of Ruahine Street and the Mount Victoria duplication results in over 2,000 additional vehicles using the Mount Victoria Tunnel in the morning peak period. A corresponding decrease in traffic flows along Evan Bay Parade is also forecast as a result of the duplication. In addition, some localised re-assignment of traffic southbound from Ruahine Street onto Moxham Avenue is forecast to occur as vehicles seek to avoid the new traffic signal controlled intersections along Ruahine Street.

During the evening peak period, northbound traffic on SH1 north of Aotea Quay on-ramp are forecast to divert from Hutt Road resulting in an additional 1900 northbound vehicles using SH1 and some 2,000 less vehicles using Hutt Road. Southbound traffic through the Terrace Tunnel increases by 2,000 vehicles as commuters from the northern part of the CBD use the state highway to head south rather than the Waterfront - which also reduces in southbound traffic movements. As with the morning peak period, the duplication of both the Terrace Tunnel and the Mount Victoria Tunnel results in traffic diverting away from the Waterfront, including Evans Bay Parade (in both directions) onto the state highway.

In both the morning and evening peak periods, the grade separation of the Basin Reserve is forecast to attract both northbound and southbound motorists to use Adelaide Road rather than Wallace Street and Taranaki Street to access both the Inner City Bypass and the CBD via Cambridge Terrace. The above results in Adelaide Road being at or close to its theoretical capacity whilst Wallace Street southbound is still forecast operate close to its capacity during the evening peak despite the reallocation of traffic.

8.4 Key Achievements and Impacts

In addition to the impacts identified previously in Package 3 for the grade separation of the Basin Reserve and the duplication of the Mount Victoria Tunnel (plus the four-laning of Ruahine Street), Package 4 results in a number of other aspects that need full consideration:

- In addition to the benefits accrued by motorists as a result of the enhanced north-south roading spine along the state highway, passenger transport users are also subject to improved conditions compared to the 2016 base without any improvements. For instance the free movement of north-south bus services at the Basin Reserve which helps reduce journey times between Adelaide Road and Kent/Cambridge Terrace.

- The additional numbers of passenger transport users forecast to use bus and trains as a result of TDM improvements results in the need to provide additional services, particularly along the bus route from Newtown and for rail services. As noted in the Golden Mile Capacity Assessment, without interventions along the Golden Mile, the additional bus services over this route can be accommodated but are likely to result in a reduction in the level of service in terms of trip times and reliability.

- The reduction in the amount of southbound traffic in both the morning and evening peak periods along the Waterfront provides an opportunity to reduce the number of southbound lanes from three to two lanes. Whilst a reduction of a single lane overall is a modest improvement in the attempt to provide greater connectivity between the City and the Waterfront, it still represents a valid and real attempt at improving conditions for pedestrians over this length of the Waterfront.

- The additional traffic forecast to use Adelaide Road as well as the four lanes route along Ruahine Street and the duplicated Mount Victoria Tunnel results in these roads operating at or beyond their theoretical capacity during the peak periods in 2016. As such, roads such as Adelaide Road will operate at a lower level of service than at present albeit with improvements on the approach to the Basin Reserve.

- The additional traffic re-assigned from the Waterfront along the state highway route loads an additional 1600 southbound vehicles on to the Inner City Bypass during the morning peak two hour period (with a similar increase in the evening peak hour) resulting in traffic flows in both directions being beyond the theoretical capacity of parts of the route. Similarly, traffic flows along the Motorway will be at or close to capacity.

- As with other packages involving the installation of traffic signals along Ruahine Street at Goa Street and Wellington Road, the increase in traffic flows along Moxham Avenue in Hataitai (with the smaller increase in flows along Ruahine Street) indicates that traffic is trying and use Moxham Avenue as a 'rat-run' to avoid the two additional sets of traffic signals. As such, it will be necessary to introduce appropriate traffic management techniques such as 'speed cushions' that impact on general motor vehicles but not buses in order to discourage this movement. Alternatives approaches include preventing the turning movement into Taurima Road or the removal of the traffic signals at Wellington Road/Ruahine Street - and the provision of a left turn in-out movement only. However, this will have an impact elsewhere on the network in Kilbirnie as traffic is diverted away from this intersection.

- The reduction in traffic flow around Evans Bay Parade provides for a much enhanced environment around this scenic approach to the City as well as a safer and more attractive route for cyclists.

- Because Package 4 does not include a high quality passenger transport spine between the CBD and Newtown, it is likely that the proposed growth node at Newtown will struggle to reach its full potential, and may even fail. As a consequence, much of Wellington's future growth will be forced into the suburbs creating great car dependency including longer and more frequent trips by car.

8.5 Economic Benefits for Package 4

Economic benefits or dis-benefits are derived from both general motor vehicles as well as from passenger transport users as shown below in Table 8.2.

Table 8.2 Benefit Indication

	Benefit Indication ($ Millions)
25 year passenger transport only benefits	34
25 year general vehicle benefits	288
25 year total benefits	322

The economic benefits associated with linking the growth node at Newtown are much more limited in Package 4 than for the other packages given the limited enhancements in passenger transport along the spine. Accordingly, an increase of only $20 Million in regional economic benefits out of the total $95 Million as a result of the proposed growth node has been assumed.

8.6 Package 4 Costs

The cost breakdown for the various options making up Package 4 is shown in Table 8.3. It should be noted that the Technical Report identified the potential for some lower cost designs within these options, such as a single lane duplication at the Terrace Tunnel with the existing Tunnel retained as currently operating. However, in order to provide a robust estimate, the full cost of options is included with the view that enhanced estimates based on a preferred design option would be further developed as part of any Scheme Assessment Report.

It should be noted that the costs associated with streetscape costs for walking and cycling initiatives have not been included in those shown below. No increased passenger transport operational costs are associated with Package 4.

Table 8.3 Cost Indication

Mode	Option	Cost Indication $ Millions	
		Expected	95%ile
Passenger Transport Corridor	Bus priority measures	1	1
General vehicles	Ngauranga to Aotea 8-laning[41]	24	32
	Terrace Tunnel Duplication	161	268
	Mt Victoria Tunnel and Basin Reserve	198	317
	Ruahine Street to Airport	38	61
TOTAL		422	679

[41] Since Technical Report One: Description of Options, the costs to undertake this work have been revised to value shown in the Table

9 Conclusions

9.1 Overview

1. Based on the challenges identified in the Problem Framing Report, four transport packages have been developed aimed at meeting the vision statement (or problem statement) for the study:

> *"To deliver an integrated land transport system that supports the City's transport and urban development strategies (urban growth spine) and provides access to the CBD, airport, hospital and port."*

2. A key aspect of all of the four packages is the provision of a transport spine through the study area with the different packages each providing a mix between catering for the needs of passenger transport and roading improvements. In addition, each of the four packages envisages and assumes the provision for Travel Demand Management (TDM) as well as pedestrian and cycling facilities within and on the approaches to the CBD.

9.2 TDM, Walking and Cycling

3. The introduction of TDM initiatives to support infrastructure planned for walking, cycling and passenger transport is essential to help promote changes in travel behaviour and to reduce reliance on the private motor car. Nevertheless, the predicted increase in the number of trips generated within the study area is more than the predicted reduction in car trips due to TDM and the development of alternative modes to the car. Even with TDM measures (and improvements to alternatives to the car), the forecast growth in car usage from 2001 to 2016 suggests that there is a need to invest in all modes of transport.

4. The study team is mindful of the work being carried out by WCC in developing their own specific walking and cycling strategies. Nevertheless, the creation of pedestrian and cycling route hierarchy's within the city (combined with identified passenger transport corridors) allows for the creation of improved facilities in which the needs of the specified road user has priority over other road users and for which certain standards should be met in order to provide the necessary and expected level of service.

9.3 Passenger Transport Spine

5. A key component of the study is the strengthening of Wellington City Council's urban growth spine. An appropriate way to promote and stimulate development in the proposed growth nodes of Newtown, Kilbirnie and Johnsonville is to provide a high quality passenger transport corridor between the CBD and these nodes.

6. Passenger transport improvements identified in each of the four packages (albeit to a greater or lesser degree) are aimed to helping support the growth node concept, particularly at Newtown. With care, long term planning and committed land use strategies in place, it is possible to stage the development of the high quality passenger transport spine to match

growth needs in terms of the length and extent of the high quality service as well as the form and type of passenger transport used to cater for the forecast patronage.

7. Nevertheless, it is important that the high quality passenger transport spine achieves its aims of reducing the number of private motor vehicle drivers and attracting sufficient patronage to help justify its implementation.

9.4 Package 1: Light Rail Spine (with no roading improvements)

8. Package 1 primarily consists of an enhanced passenger transport spine using a LRT system between the railway station and the hospital, plus minor bus improvements elsewhere on the roading network. Improvements are made at the expense and reallocation of existing road space.

9. The light rail system coupled with the TDM measures results in an overall increase in passenger transport in the region compared to the 2016 committed base along with a largest decrease in car trips of all the packages. Furthermore, those passengers travelling between Newtown and the railway on the LRT enjoy journey times that are twice as quick as the existing travel times using bus.

10. However, light rail systems have higher capital costs than other transit way systems with operating costs also typically higher. The need to ensure a suitable patronage on the LRT and hence a greater fare recovery requires competing bus services on the same route to be prevented which introduces the need for forced transfers at Newtown and Courtenay Place – which appear to, or can be expected to discourage some passenger transport users. The construction of the LRT at the expense of road space results in some dis-benefits to general motorists whilst potential future expansion of any LRT system is likely to require on-street running which will minimise the benefits associated with light rail systems.

11. Package 1 has the lowest overall benefits of all packages at $95 Million. Packages 1 and 3 have the greatest passenger transport benefits.

9.5 Package 2: Enhanced Bus Spine (with minor road improvements)

12. Package 2 includes a segregated busway as the basis of an enhanced passenger transport spine between Newtown and the railway station with minor bus improvements to the north of the CBD. In addition, minor roading improvements are proposed such as the tidal flowing of the Terrace Tunnel, the widening of Ruahine Street, improvements at the Basin Reserve plus the provision of additional peak hour traffic lanes along the state highway between Ngauranga and Aotea Quay.

13. Passenger transport journey times between Newtown and the railway station are less than existing travel times. Morning inbound and evening outbound travel times to/from the CBD for general traffic decrease compared to the forecast travel times in 2016 without any interventions.

14. The use of segregated busways minimise the need for transfers between modes of transport and allow buses servicing the suburbs to use the dedicated facility without enforcing transfers, as was required by Package 1. Avoiding transfers, coupled with the limited roading improvements, ensures that passenger transport numbers to and from the Eastern Suburbs in the morning peak period are forecast to increase the most out of all the packages.

15. The 8-laning of SH1 between Ngauranga to Aotea along with the tidal flow of the Terrace Tunnel to permit two lanes southbound in the morning peak periods results in the southbound lanes of the Inner City Bypass being put under pressure. Similarly, the reduction in northbound traffic lanes and capacity along the state highway at the Terrace Tunnel reassigns traffic onto the Waterfront route. Furthermore, although tidal flow systems exist overseas, potential safety problems may exist given the gradient and curvature experienced with the Terrace Tunnel.

16. The widening of Adelaide Road to form the combined main passenger transport and primary motor vehicle route, coupled with the increased traffic volumes along Adelaide Road may inhibit the development of a high quality growth node to its full potential.

17. Package 2 has the lowest infrastructure costs.

9.6 Package 3: Enhanced Bus and Roading Spines (with Tunnel Duplications)

18. As with Package 2, central to Package 3 is the provision of a segregated busway between Newtown and the railway station to act as the enhanced passenger transport spine. In addition to bus lane priority measures to the north of the CBD, major roading improvements to provide a strong roading spine along the state highway are envisaged through the duplication of both the Terrace Tunnel and Mount Victoria Tunnel plus a grade separated interchange at the Basin Reserve.

19. Passenger transport journey time trips between Newtown and the railway station reduce by between 9 and 12 minutes whilst motor vehicle journey times into the CBD in the morning peak periods from Ngauranga and the Airport reduce by between 3 and 5 minutes.

20. The provision of the roading spine reassigns traffic from parallel routes thereby reducing traffic flows around Evans Bay, Wallace Street and around the Waterfront. The reduction in southbound flows may permit the number of the southbound traffic lanes to be reduced to two from the existing three lanes. Nevertheless, the reassigned traffic puts additional pressure onto the Inner City Bypass.

21. The elevated structure for the grade separation of the Basin Reserve will be visually prominent and may be considered to affect the symbolic character and context of the Basin Reserve given its impact on the wider surroundings.

22. The provision of the duplication of both sets of Tunnels and the grade separation of the Basin Reserve results in the expected cost of Package 3 being over four times that of Package 2, and is the most expensive in terms of infrastructure costs of all the packages. It also however has the greatest overall benefits.

9.7 Package 4: Enhanced Roading Spine (with minor bus improvements)

23. Package 4 provides a minimum two lane north-south roading connection between Ngauranga and the Airport with a grade separated interchange at the Basin Reserve and the duplication of both the Terrace Tunnel and Mount Victoria Tunnel. Minor bus infrastructure improvements to tie into existing measures for the railway station to Newtown route are also proposed.

24. Passenger transport journey times between Newtown and the railway station are forecast to be less than the 2016 base travel times, but are only marginally better being above 20 minutes regardless of peak period or direction. In contrast, motor vehicle travel time reductions for journeys to and from the CBD from locations such as Ngauranga and the Airport exceed those experienced by other packages.

25. Issues associated with the large infrastructure construction projects in the Package such as the grade separation of the Basin Reserve are similar to those discussed above for Package 3. Similarly, the associated traffic flow reductions on parallel routes such as the Waterfront permit a southbound lane to be removed to reduce severance between the city and the harbour. However, the reassigned traffic also puts additional pressure onto the Inner City Bypass.

9.8 Economic Benefits

26. Table 9.1 provides a summary of the economic benefits calculated to occur as a result of the introduction of each of the four packages. In addition, the table provides a brief overview of forecast journey times for the different modes of transport over a number of routes.

9.9 Indication of Costs

27. A summary of the expected and 95th percentile costs for each of the four packages is shown below in Table 9.2.

28. Not include in the costs shown in Table 9.2 is streetscape work associated with the passenger transport or pedestrian corridors. The cost for this work is not insignificant with Auckland's Queen Street upgrade costing up to $36 million for example.

Table 9.1: Summary of Transportation Modelling

Packages	Travel Times			Economic Benefits ($ million)
	Passenger Transport (minutes) (AM peak)	General vehicles (minutes) (AM peak)		
	Newtown to Railway Station	Airport to CBD	Gorge to CBD	
2001 Base	25	9	14	N/C
2016 Committed Base	24	12	14	N/C
Package 1: Light Rail Spine	9	10	15	95
Package 2: Enhanced Bus Spine	15	10	10	231
Package 3: Enhanced Bus and Roading Spine	15	9	9	362
Package 4 : Enhanced Roading Spine	20	9	10	322

N/C = not calculated

Table 9.2: Summary of Package Costs

Package	Infrastructure Cost Indication $ Millions		Vehicle/Rolling Stock Costs	Operating costs – GWRC Subsidy
	Expected	95%ile	$ Millions	$ Millions/year
Package 1: Light Rail Spine	96	147	33 to 43	40 to 45
Package 2: Enhanced Bus Spine	101	159	0	7 to 8
Package 3: Enhanced Bus and Roading Spine	450	728	0	39 to 43
Package 4 : Enhanced Roading Spine	422	679	0	0