

COMPILATION REPORT

WELLINGTON PUBLIC
TRANSPORT SPINE STUDY

AECOM



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REGIONAL COUNCIL
Te Pane Matua Taiao



NZ TRANSPORT AGENCY
WAKA KOTAHI

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ME HEKE KI PŌNEKE
WELLINGTON CITY COUNCIL **Wellington**





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EXECUTIVE SUMMARY



Background

The Public Transport Spine Study (PTSS) is about determining what a future public transport solution for Wellington might be. The study was commissioned by Greater Wellington Regional Council, Wellington City Council and the New Zealand Transport Agency. These three agencies have worked in partnership throughout this study to ensure it is aligned with the economic and transport needs in Wellington City and the wider region.

A key action from the Ngauranga to Airport Corridor Plan (2008) was to provide major improvements to public transport to provide a high quality, reliable and safe service between the Wellington Rail Station and the regional hospital. The PTSS has investigated the feasibility of different options to achieve a step change in public transport delivery. It has taken a holistic view of the problem and potential solutions and has been guided by the principles of a Treasury Business Case. It sets out the relative merits of three options. A preferred option will be decided through public consultation and a separate decision making process.

The problem

The future problem¹ to be addressed by this study is defined as:

- In future years, too many vehicles and modes will share a constrained corridor resulting in longer and unreliable transport journey times which will worsen over time;
- There will be increased traffic congestion in the strategic and local road network and additional environmental impacts as a result of less mode share for public transport;
- There is the potential to unlock economic growth and productivity in Wellington through improved access;
- There will be diminishing returns from current and planned investment in public transport resulting from the uncertain nature and shape of long term future public transport systems.

The process

The PTSS approach has progressively narrowed down the number of options (long list, medium list, short list), with each stage providing a more detailed analysis of those options.

The option assessment was underpinned by findings from an international review of public transport systems which informed the study of the characteristics of different transport modes, success factors, design issues, constraints, available technology and procurement processes.

Transport modelling, using a suite of regional models and the latest land use and transport forecasts, has informed the assessment, along with a planning assessment, cost estimates, and an economic analysis.

Throughout the process key stakeholders have been consulted to test emerging directions and findings.

The Reference Case

A Reference Case (or base case) was developed to compare three options against. This includes all relevant projects in the Regional Land Transport Programme, including the Roads of National Significance (RoNS), integrated ticketing for public transport and the Wellington Bus Review.

Option development

A range of mode options were considered through the PTSS including:

- Personal rapid transit (small lightweight trams)
- Other bus on-street options such as mini-buses
- Mono-rail (elevated above the street)
- Other Light Rail Transit options including tram-trains running on both the heavy rail network and city streets
- Heavy rail (operating either at street level or underground)

¹ The problem was defined through the Treasury ILM process and further refined by the project team as the project progressed.

A range of route options were considered throughout the PTSS including:

- Alternatives to the Golden Mile between the Wellington Railway Station and Kent and Cambridge Terraces (such as the Terrace, Featherston Street, Victoria Street, Wakefield Street and along Jervois Quay)
- A secondary route through the CBD for some public transport services at peak times
- Extensions to the north, south and east.

The options

Through the study the modes and potential routes have been evaluated and refined through a sieving process to provide three mode options. The identification of potential routes and corridors has been based on an assessment of the demand for travel, current and future use of public transport and engineering feasibility. From 88 initial options, three final options have been tested. The three mode options considered as part of the short-list evaluation are:

Bus Priority

An enhanced bus network with greater priority at intersections and along key corridors, but using existing vehicle types.

Bus Rapid Transit (BRT)

Dedicated bus lanes for new high capacity vehicles as well as other system improvements to enhance frequency and journey times.

Light Rail Transit (LRT)

Dedicated lanes and tracks for new light rail vehicles as well as interchanges to transfer from other modes.

Options to extend the core public transport spine to the north, south and east were considered to identify where investment in public transport was best able to raise the proportion of people travelling by public transport. It was concluded that the focus of improvements should be on a southern route. This provides a split route from the Basin Reserve with one 'branch' travelling east via the Mt Victoria tunnel to Kilbirnie and the other 'branch' continuing via Adelaide Road to Newtown.

The combined mode and route options are detailed in the following section.



Bus Priority

- Golden Mile through CBD
- Kent/Cambridge Terraces through to Newtown
- Hataitai Bus tunnel to Kilbirnie
- Constable Street from Newtown to Kilbirnie

Definition, Staging and Benefits

Operates during peak periods using kerb side bus lanes and priority at intersections to bypass congestion on key corridors. Implemented where congestion affects bus journey time and reliability.

The service pattern and frequencies would remain the same as the Reference Case.

Able to be developed incrementally as opportunities arise and as resources are available. Starting in the CBD and working outwards along key corridor. Opportunities to construct priority bus lanes as part of other planned road construction projects would be taken wherever possible.

Estimated costs of constructing the Bus Priority Option would be about \$ 59 million (in 2012 dollars). Annual operating costs of running services are \$ 88 million which is similar to the Reference Case.

Forecast benefits over a 30 year period are equivalent to \$21 million (in 2012 dollars) and include:

- A three minute travel time saving (22 minutes total trip time) between Kilbirnie and the Wellington Railway Station (2031 morning peak).
- A three minute travel time saving (15 minutes total travel time) between Newtown and the Wellington Railway Station (2031 morning peak).
- A 3.2% increase in morning peak patronage from the south / south-east to the CBD in 2031.

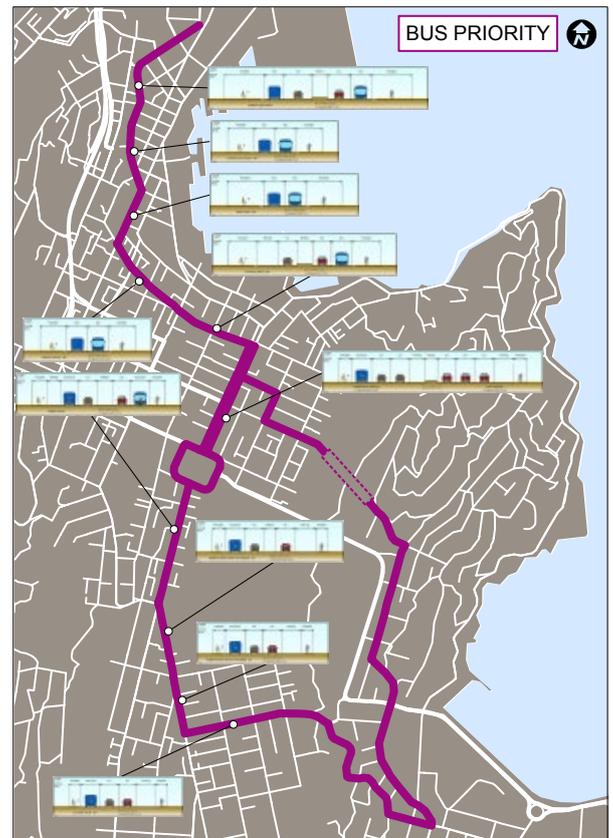
Economic Assessment

Benefit Cost Ratio of between 0.57 to 0.67 depending on the values assumed.

Environmental and Social Assessment

The impacts on pedestrians would be similar to that under the Reference Case. No change to the number of buses travelling through the CBD.

On-street parking would be removed during peak periods, which may affect nearby businesses.



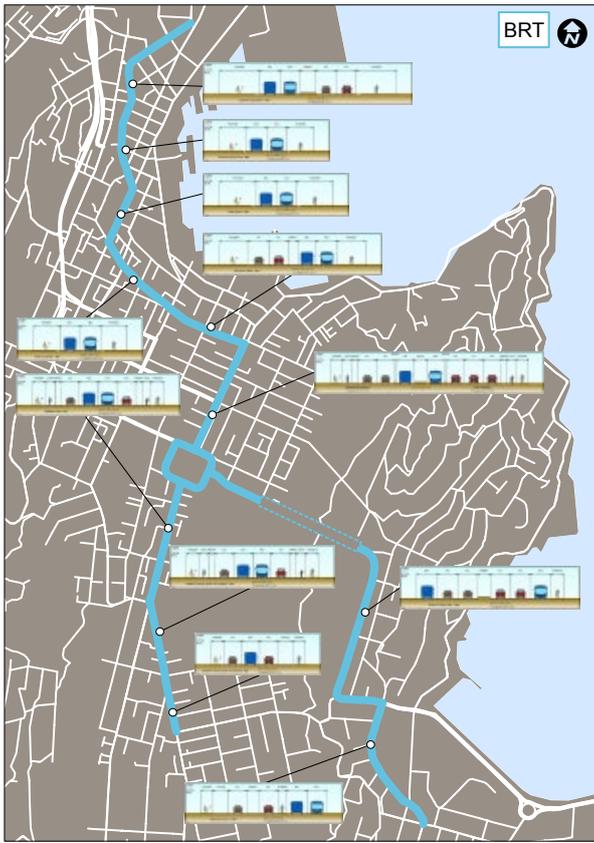
The impacts on existing properties and activities are minimal as bus lanes are largely within existing road corridors. However, along Constable Street widening would be required to provide peak period bus lanes. This could have moderate to significant social and environmental effects.

Bus Rapid Transit

- Golden Mile through CBD
- Kent/Cambridge Terraces through to Newtown
- To Kilbirnie along State Highway corridor through the Mount Victoria road tunnels and along Ruahine Street, Wellington Road and Kilbirnie Crescent
- Provides a secondary route along Featherston Street and Wakefield Street

Definition, Staging and Benefits

High capacity and high quality buses running on dedicated bus lanes with priority at signals, with potential for services to continue onto further destinations on local roads. Lanes along the median of the road or along one side of the road. In the CBD would operate during the day (7 am to 7 pm), outside of the CBD would be fulltime.



Services every two minutes between the Basin Reserve and the Wellington Rail Station, every four minutes on the eastern and southern branches (to Kilbirnie and Newtown).

Can be implemented in stages to provide better segregation and priority. Ultimately benefits are realised when the entire project is constructed and higher capacity vehicles replace buses on core routes.

The construction of the Basin Reserve bridge project (2014-16) and the Mount Victoria Tunnel duplication (2018-22) provides the ability to implement the Bus Rapid Transit to Kilbirnie.

Estimated costs for construction are about \$207 million (in 2012 dollars), including \$28 million of vehicle costs. Annual operating costs of running services \$83 million per year which is 6% lower than the Reference Case.

The forecast benefits of the Bus Rapid Transit option include:

- An 11 minute travel time saving (a 13 minute total trip time) between Kilbirnie and the Wellington Railway Station (2031 morning peak) and increased reliability.

- A six minutes travel time saving (a twelve minutes total trip time) between Newtown and the Wellington Railway Station (2031 morning peak) and increased reliability.
- A 7% increase in morning peak patronage from the south / south-east to the CBD in 2031.
- Potential for property values to increase around stops and along the corridor.

Economic Assessment

Benefit Cost Ratio of between 0.87 to 1.55 depending on the values assumed.

Environmental and Social Assessment

The option is not required to be fully segregated from pedestrian activity and is unlikely to create a barrier to pedestrians. This option would involve a decrease in the number of public transport vehicles along the Golden Mile which would benefit pedestrians crossing mid-block in the CBD.

A significant departure from the existing road configuration with some on-street parking being removed. This may affect nearby businesses, restricting access and servicing. Traffic movement will be disrupted in some key locations such as Willis Street, requiring vehicles to find other routes.

Some localised widening of the road corridor is required, with associated property impacts. More significant widening of the SH1 corridor between the duplicated Mount Victoria tunnel and Kilbirnie Crescent may also be required. This would impact on the Town Belt and other properties to a significant degree.

Other impacts such as noise and vibration are likely to be similar to the Reference Case and would be considered at the detailed design phase.



Light Rail Transit

- Golden Mile through CBD
- Kent/Cambridge Terraces through to Newtown
- To Kilbirnie through new tunnel(s) and along Ruahine Street, Wellington Road and Kilbirnie Crescent
- Provides a secondary route along Featherston Street and Wakefield Street

Definition, Staging and Benefits

High capacity and high quality Light Rail Transit travelling along a dedicated track with priority at intersections.

Exclusive public transport lanes in the CBD during the day (7am to 7pm) but other vehicles could be permitted after business hours, outside of the CBD would be fulltime

A dedicated Light Rail Transit tunnel through Mount Victoria provides a direct route to Kilbirnie separate to general traffic.

Most bus services from the south/south-east terminate at key interchanges (Kilbirnie and Newtown), requiring transfer to Light Rail Transit.

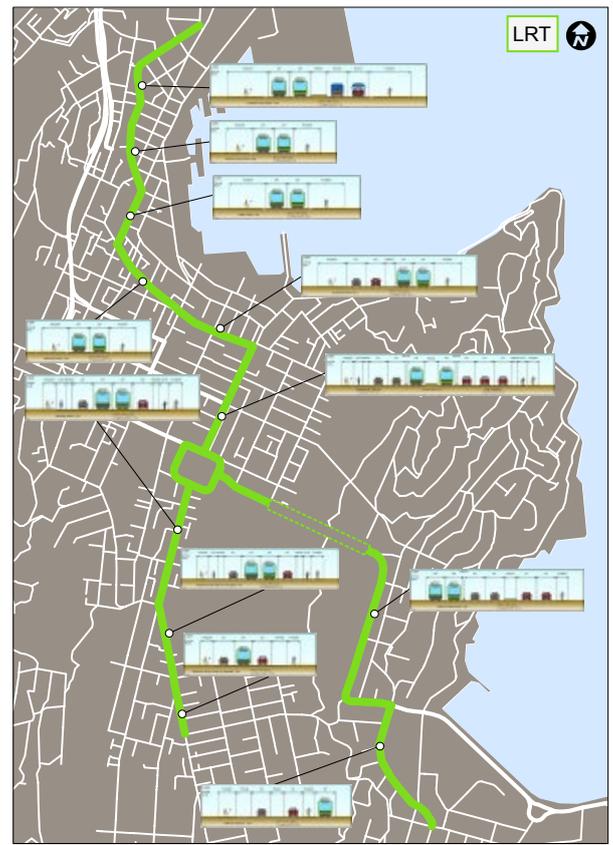
Two and a half minute frequency between the Wellington Rail Station to the Basin Reserve, five minutes on the south-eastern and southern branches (to Kilbirnie and Newtown).

The Light Rail Transit option would be best implemented in its entirety. At a minimum this would provide for the construction of one complete 'branch' of the Light Rail Transit route. The construction of the Basin Reserve bridge project (2014-16) would enable construction to Newtown and the Mount Victoria Tunnel duplication (2018-22) provides an opportunity to implement Light Rail Transit to Kilbirnie.

Estimated costs for construction are about \$940 million (in 2012 dollars), including \$88 million for vehicles. Annual operating costs of running services are similar to the Reference Case.

The forecast benefits of Light Rail Transit include:

- An 11 minute travel time saving (13 minutes total trip time) between Kilbirnie and the Wellington Rail Station (2031 morning peak) and increased reliability.



- A six minutes travel time saving (twelve minutes total trip time) between Newtown and the Wellington Rail Station (2031 morning peak) and increased reliability.

Potential for increases to property values around stations and along corridors.

Economic Evaluation

Benefit Cost Ratio of between 0.05 to 0.01 depending on the values assumed.

Environmental and Social Assessment

The Light Rail option is not required to be fully segregated from pedestrians. While the tracks would create a potential hazard for pedestrians, cyclists and wheel chair users, mitigation measures can be considered at a later stage. This option would result in a significant decrease in the number of vehicles along the Golden Mile and would benefit pedestrians crossing mid-block in the CBD.

A significant departure from the existing road configuration with some on-street parking being removed. This may affect nearby businesses, restricting access and servicing. Traffic movement will be disrupted in some key locations such as Willis Street, requiring vehicles to find other routes.

Some localised widening of the road corridor is required, with associated property impacts. More significant widening of the SH1 corridor between the duplicated Mount Victoria tunnel and Kilbirnie Crescent may also be required. This would impact on the Town Belt and other properties on Paterson Street to a significant degree.

Light Rail Transit vehicles can produce additional noise and vibration impacts through the interaction of the wheels and tracks. This is an issue that would be further considered at a detailed design phase.



Supporting Policy Interventions

The options each provide high quality and frequent public transport services that will require supporting policies and actions to deliver significant increases in patronage. One of the challenges facing all of the PTSS options is that of additional road capacity being delivered in the same timeframe which will compete with public transport, providing easier and faster travel to the CBD by car. A range of different scenarios have been tested to underline the implications and effects of potential interventions and how they assist in increasing patronage. These include:

- Commuter parking availability and cost
- The geographic distribution of population growth
- Timing of the RoNS programme
- Public transport fare levels.

The results reveal that implementing a range of other policy interventions can improve the viability of the options. The availability of commuter parking appears to be a key policy intervention and restraining any future increases in commuter parking, could result in up to a 7% increase in the share of trips for public transport in all the options.

The geographic distribution of population and economic growth is also an important factor that underpins future public transport patronage. Land use change, such as increased intensification around stations/stops can also result from investment in high quality public transport. It will be important that land use policies direct and allow future growth along the growth spine.

Public transport fares are a further tool that impact directly on passenger numbers as well as overall fare revenue. A decrease in fares would provide for increased passengers, but at the expense of revenue. Similarly an increase in fares would reduce the number of passengers, but increase revenue. It will therefore be important to consider what proportion of each option's cost can be recovered through fares without reducing forecast patronage.

Aligning of related policies and programs would be necessary to realise the full benefits of any of the options. The tests do however confirm that the relative order of benefits of the options remains the same as reported in the study.

Key Findings

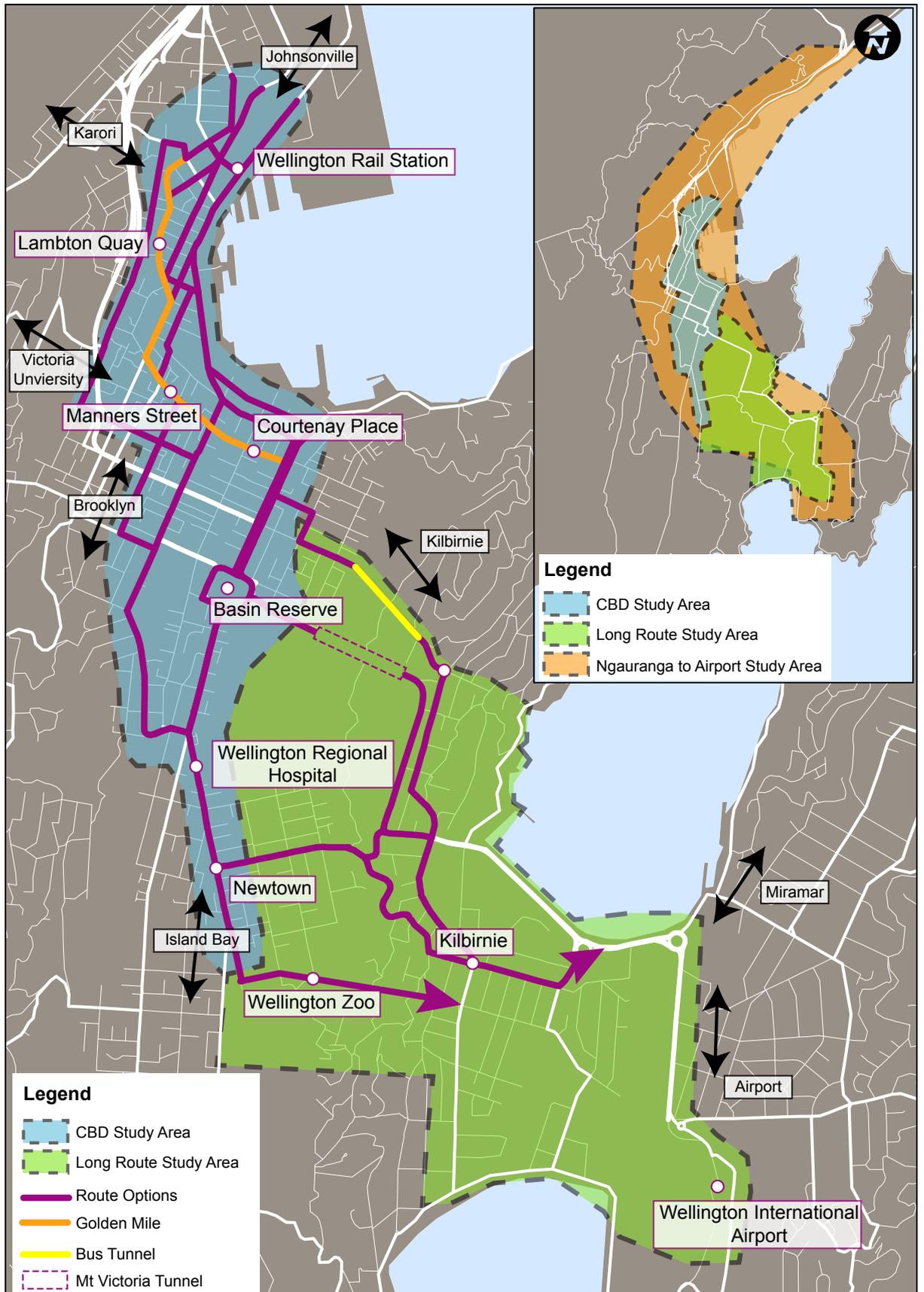
The key findings from the Study are:

- There is a need for future investment in public transport through central Wellington to achieve the goal of growing public transport mode share.
- A high quality, high frequency public transport spine has an important role within the Ngauranga to Airport Corridor, alongside RoNS, as part of a balanced long-term transport network for Wellington.
- There are opportunities to improve public transport mode share from the south and south-east of Wellington.
- Bus Rapid Transit provides the highest benefits to public transport users, followed by Light Rail Transit and Bus Priority.
- The cost of the most expensive option (Light Rail Transit) is almost five times that of the next most expensive option (Bus Rapid Transit).
- Bus Rapid Transit has the highest overall Benefit Cost Ratio (BCR), followed by Bus Priority then Light Rail Transit.
- The Bus Priority and Bus Rapid Transit option can be developed incrementally, however the optimal staging and timing for the Bus Rapid Transit and Light Rail Transit options are to be developed in one stage and completed around 2021.
- It is technically feasible to construct all of the options. For most of the route they can be accommodated within the existing road corridor. However, there are significant impacts on property from Bus Rapid Transit and Light Rail Transit options through Mount Victoria and along Ruahine Street and Wellington Road.

1. INTRODUCTION



Figure 1: Study Area



Background

The Wellington Public Transport Spine Study (PTSS) is a recommendation of the 'Ngauranga to Airport (N2A) Corridor Plan', 2008², which seeks improvements throughout the Corridor to provide a high quality, reliable and safe service along the Wellington growth spine (Wellington Railway Station to Wellington Regional Hospital). The PTSS will sit alongside the significant improvements to the Strategic Road Network that are now being considered as part of the RoNS programme.

This is a Compilation Report for the PTSS. It is the findings of a suite of Technical Notes and Reports prepared during the study including:

- Engagement Report
- Inception and Scoping Report
- International Review of Public Transport System
- Land Use Planning, City Wide and Corridor Review (MRCagney)
- Option Evaluation, Long List
- Option Evaluation, Medium List
- Transport Modelling Report (Greater Wellington Regional Council)
- Option Evaluation Results.

Study Purpose

The PTSS is a long term planning study and investigates the feasibility of different options to achieve a public transport step change. The PTSS is to:

- Build on a range of existing strategy documents that set out the vision for the region, the city and the role that passenger transport has in supporting those visions.
- Use the Treasury Business Case as an organising structure to guide the analysis and reporting.
- Identify and evaluate a range of options and routes within the study area.
- Research and use an international review of public transport systems for benchmarking the study findings.
- Use a suite of regional transport models, and the latest land use and transport forecasts to inform the assessment of options.
- Consult with key stakeholders to test the direction of the study and findings.

The purpose of the Study is to set out the relative merits of three preferred options, not to recommend a preferred option. This includes the benefits, costs, economics and policy levers associated with potential options for a high quality spine solution. A preferred option will be decided through public consultation and a separate decision making process.

Study Area

The study area is illustrated in Figure 1 on the opposing page and is a subset of the N2A Corridor Plan.

Whilst the core public transport spine was identified from the Wellington Railway Station to the Hospital, options to extend this to the north and south were also considered. The assessment of the study area to maximise potential increases in public transport patronage is detailed in 7.1 and resulted in the study area being extended to include the corridor to Kilbirnie.

Study Partners

This Study has been managed by Greater Wellington Regional Council (Greater Wellington) in partnership with the New Zealand Transport Agency (NZTA) and Wellington City Council (WCC).

Stakeholders

Two core groups were established to get feedback from key interested groups within the community.

The PTSS Reference Group, made up of representatives from:

- Wellington Inner City Residents and Business Association
- Wellington City Council Accessibility Advisory Group
- Wellington Civic Trust
- Wellington Retailers Association
- Public Transport Voice
- Wellington Property Council
- TransAction

The Transport Operator Advisory Group, made up of representatives from:

- NZ Bus
- Mana Coachlines
- Bus and Coach Association
- KiwiRail
- GW Rail

Updates were provided and feedback obtained through a number of meetings and technical briefing sessions. These were held regularly throughout the study development – a total of eight meetings from December 2011 through to April 2013.

Other key stakeholders - such as CentrePort, Wellington International Airport, Living Streets, Cycle Aware Wellington, Wellington Employers Chamber of Commerce, and others - were invited to attend meetings, where they had expressed an interest in understanding more of the technical detail of the study.

Feedback and input from these groups highlighted a range of considerations that have informed the study work. Issues such as connections to the north and south/east, capacity through the Golden Mile, and potential east-west tunnel locations were key discussion areas. Integration of the Public Transport Spine with the wider city and regional public transport network was another key theme often raised. The need for the different options to be evaluated consistently to allow an 'apples with apples' comparison of costs and benefits was also highlighted. It was also considered important that the study report covered the likely trigger points for change and the potential staging or sequencing of public transport improvements. These issues have been taken into consideration and are reflected in this study report.

A much wider list of stakeholder groups and interested individuals were kept updated on study progress via emails and the study website.

Treasury Better Business Case

The Treasury Better Business Case (TBBC) has been used as an organising structure to guide the analysis undertaken. The TBBC was introduced by Government in 2010 in response to the growing pressure of government funding and the need to make the right investment while getting the best value possible. Government projects and programmes over \$25 million must apply the BBC framework as part of the process of seeking cabinet support and funding.

The framework is also being applied to a growing number of projects outside Government where the proponents are likely to seek Government funding, and is to be adopted by NZ Transport Agency for major transport projects.

For this Study, the intent was not to complete an indicative business case, but to highlight a clear understanding of the problem that needs to be solved, the options, possible solutions and the benefits of those solutions.

A preliminary programme business case has therefore been the guiding principle for this Study. This is discussed further in Chapter 10.

International Review

The purpose of the International Review was to learn from the implementation of passenger transport systems overseas and develop case studies as reference points for the study. The International Review then provided input into option evaluation, option design and operational costs of the options developed.

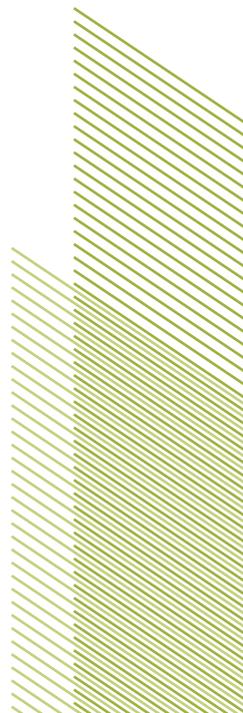
Thirty five case studies were investigated covering Personalised Rapid Transit (PRT), Bus Rapid Transit (BRT), Light Rail Transit (LRT) and Mass Rapid Transit (MRT) across Europe, the Middle East, North America, South America, Asia, Australia and New Zealand (Auckland Northern Busway). Further details of these case studies are presented in Appendix A and in the separate International Review Report.

Alternative Funding Study

An Alternative Funding Study was undertaken by Hill Young Cooper/Douglas Economics. The study:

- Identified funding tools
- Estimated the quantum of funding from each tool per year 30 year period
- Set out the suitability of funding tools in the Wellington context.

The Alternative Funding Study was completed in August 2013. It provided important research on the funding mechanisms that could be explored to fund transport across the city including public transport recommendations out of this Public Transport Study.



2. PUBLIC TRANSPORT IN WELLINGTON



History of Public Transport in Wellington

Rail

In the mid-1870s the first railway line from Wellington to Lower Hutt was constructed. This was followed by the construction of the Kapiti railway line from Wellington via Johnsonville in the early 1880s. A deviation to bypass Johnsonville was constructed in the mid-1930s and this became the North Island Main Trunk (NIMT). The NIMT was electrified to Paekakariki in 1940, followed by the systematic electrification of the other Wellington lines in the 1940s and 1950s. In 2009 and 2010 the Wellington Regional Rail Plan saw the introduction of the Matangi Electric Multiple Units and other regional infrastructure upgrades including extending the double tracking and electrification through to Waikanae.

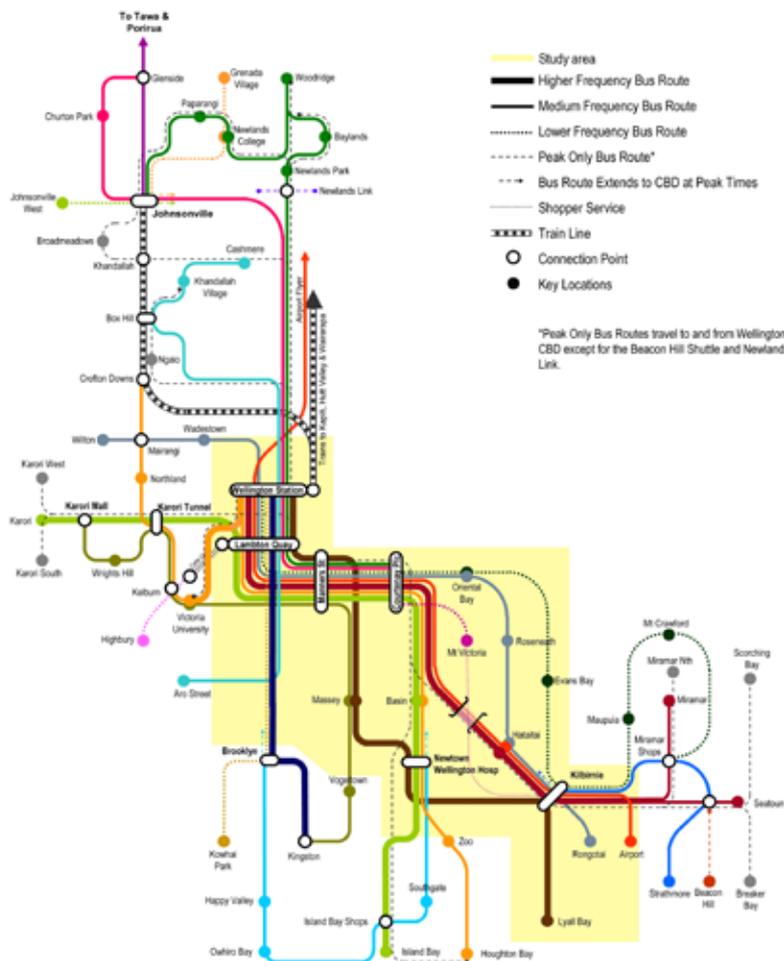
Tram/Bus

In August 1878, the first tram route was opened in Wellington with a service between Lambton Quay and the Basin Reserve. The trams were electrified in the early 1900s as other tram lines were added to create a network of routes to Aro Valley, Karori, Wadestown, Oriental Bay, Miramar, Seatoun, Lyall Bay, Island Bay and Brooklyn. In the late 1940s and early 1950s the tramways were converted to buses and trolley buses. The last tram ran in 1964.

Wellington Public Transport Network 2012

The public transport network has evolved since the mid-1870s to what it is today. Figure 2 illustrates Wellington City's public transport network.

Figure 2: Wellington Public Transport Network, 2012



Wellington Public Transport Studies

Comprehensive Transport Plan for Wellington

In 1963 American firm De Leuw Cather carried out a study into the long-range transportation needs of the Wellington Region on behalf of the City of Wellington. The resulting Comprehensive Transportation Plan focused on rail for public transport and recommended that rail provision in the CBD should be re-examined after completion of the Foothills Motorway. The motorway was completed in 1973 and today forms State Highway 1 providing road access to the CBD and suburbs to the south through the Terrace Tunnel (completed 1978).

Study of Public Transport Options Johnsonville-Wellington CBD Corridor

In 1993, Wellington City Council and Greater Wellington Regional Council commissioned the *Study of Public Transport Options Johnsonville-Wellington CBD Corridor*. This study focuses on the rail corridor between Johnsonville and the Wellington CBD and identifies public transport options for the northern suburbs. The study considered four scenarios; improvements to the existing rail services, replacement of rail with on street buses, replacement of rail with a guided busway and replacement of rail with light rail possibly extended into the CBD. The study also considered other modes of transport such as monorails and trolley buses, however these were discounted. The scenarios were assessed through a rigorous evaluation framework. The framework covered; capital costs, operating costs, user cost and benefits, road users, environmental and commercial impacts. The results were used for public consultation prior to Greater Wellington Regional Council determining future policy for services in the Johnsonville – Wellington CBD corridor

Light Rail Feasibility Study

In 1995, Wellington City Council and Greater Wellington Regional Council commissioned the *Light Rail Transit Feasibility Study* which considered the initial feasibility of providing a light rail system on the suburban rail network and through the CBD. The study identified a number of benefits that Light Rail Transit (Light Rail Transit) could provide Wellington. The study also identified route options, planning, environmental, legislative ownership and funding issues and provided an assessment of the financial and economic viability of converting the existing network to Light Rail Transit. The study tested a range of options against the conversion of the Johnsonville rail line to Light Rail Transit with it terminating at Wellington Railway Station. All options compared were deemed worthwhile. However resolution of a number of issues was required before a final choice could be made. These issues included funding, ownership, Resource Management Act implications and detailed community consultation. The study assumed that a Light Rail Transit route through the CBD would be an extension of the existing Johnsonville Route. Three route options through the CBD were identified with two alternate route sections. All three commenced at the west of the Railway Station and terminated in Courtenay Place.

North Wellington Public Transport Study

In 2005, Wellington City Council and Greater Wellington Regional Council commissioned the *North Wellington Public Transport Study*. The study identified options for future public transport in Wellington's northern suburbs and considered four scenarios; improvements to the existing rail services, replacement of rail with on street buses, replacement of rail with a guided busway and replacement of rail with light rail possibly extended into the CBD. The scenarios were compared to a base case of replacing the English Electric Units with Ganz Mavag and minimum rail improvements. Of these scenarios, the on street bus performed the best in terms of economic performance. However, due to expectations and associated risks the base case was recommended. This has now been implemented.

Ngauranga to Airport Study

In 2008 the *Ngauranga to Airport Study* was commissioned by Transit New Zealand (now New Zealand Transport Agency), in conjunction with Wellington City Council and Greater Wellington Regional Council. This was a multi modal study including provision of public transport. Part of the vision set out in the plan is that priority will be given to public transport and that public transport will provide a high quality, reliable and safe service along the Wellington growth spine and proposed the Public Transport Spine. This study is undertaken in the context of the N2A Corridor Plan and takes account of the investigations carried out in developing that plan.

Bus Operational Review

In 2009 Greater Wellington Regional Council commissioned the *Central Area Bus Operational Review*. The review covered public transport on the Golden Mile between Wellington Railway Station and Kent and Cambridge Terraces. The focus was to improve the efficiency and reliability of bus operations through the Wellington central area. The review identified current issues and options for improving the efficiency and reliability of bus services through the Golden Mile. Key priorities were identified for the short, medium and long term and an indicative improvement programme was recommended. Issues identified included; poor legibility due to the split route, insufficient stop capacity, variability in bus occupancy and passenger loading inefficiencies. Measures identified to address these issues include; investigation of suburban hubs and relocation of road space in the long term, integrated ticketing and bus stop layout and design in the medium term and bus priority and schedule reviews in the short term. The review concludes that significant opportunity exists to enhance public transport operation on the Golden Mile through a mixture of infrastructure and operation interventions.

Wellington City Bus Review 2011

In 2011/2012 the *Wellington Bus Review* identified operational inefficiencies of peak and off peak buses travelling through the CBD. It proposed changes to the bus network operation to lower bus congestion, reduce modal conflicts and improve reliability of journey time. This study is aimed at the short to medium term future. These improvements are taken account of in the Wellington Public Transport Spine Modelling as part of the Reference Case.

Strategic Context

There are a number of existing strategy documents that set out the vision for the Region, the City and the role that public transport has in supporting this vision.

The existing strategies make it clear that taking a passive approach will not be sufficient to enable public transport to support the economic and social objectives of the City or Region. It requires a more active approach to increasing the usage of public transport, including making it attractive in terms of price and service compared to car based alternatives and creating an urban environment within which public transport is accessible to people and links them to the key areas they need to go to.

Ngauranga to Airport Corridor Plan (2008)

The Ngauranga to Airport Corridor Plan states public transport must play a role in supporting access across the City from the north to the Regional Hospital and Wellington International Airport, as well as providing for access alongside other modes into and within the city. To do this effectively it must provide a network of services that enable people to move seamlessly across the network and between the different modes. It includes a specific action to investigate a public transport spine between the Railway Station and the Regional Hospital.

Regional Land Transport Strategy (RLTS) (2010)

The RLTS target is that public transport mode share will grow to 21%³ of all trips with an increase from 17 million peak period trips per annum in 2009/10 to 23 million per annum by 2020.

The Wellington RLTS refers to “Wellington City Council’s Growth Spine concept to encourage transit-oriented intensification of employment and housing along a key spine between Johnsonville and Wellington International Airport”.

Wellington Regional Strategy 2007

The Wellington Regional Strategy⁴ notes “Transport outcomes identified in this Strategy will play a significant part in facilitating the growth sought by the WRS. For example, new transport corridors, such as the Grenada to Gracefield link road and Johnsonville to Airport growth spine, will be key drivers for economic growth by improving connectivity between economic centres”. This has since been refreshed as the Wellington Regional Strategy 2012, which identifies this Study as a Committed Priority.

Urban Development Strategy (WCC 2006)

Wellington City Council has identified that the growth spine from Johnsonville to the Airport is critical to future economic growth within the City⁵. A key component of the Study is to compare how different public transport options will contribute to Wellington City Council’s objective of strengthening the Wellington City urban growth spine. High quality public transport has been identified as an important factor in ensuring the growth spine can support and will attract the densities desired in the City’s growth strategy.

3 Wellington RLTS 2010-2040

4 Wellington Regional Strategy 2007

5 WCC Urban Development and Transport Strategy



3. STUDY ENGAGEMENT



Purpose

The purpose of the initial engagement was to test the understanding of the key factors that make public transport systems high quality. To get the widest understanding possible, the views of public transport operators, users and non-users of public transport, students, inner-city residents, public transport advocates, resident association representatives, disability advocates and region-wide residents, among others, were canvassed.

Engagement with the public and interest groups has taken place throughout the study, with feedback from individuals and organisations being used as a check at each phase of the study.

Scoping Phase

During the scoping phase five different mechanisms were used to gather feedback. They were:

- Appreciative inquiries,
- Focus Groups,
- Online surveys,
- Market research street surveys, and
- Letters seeking feedback from identified stakeholders.

Key findings were that high quality public transport was expected to be reliable, frequent, efficient and well priced. People felt that public transport needed to become more attractive, mainly in terms of cost, but also in terms of time, than driving a car into town, have integrated ticketing with simple fare structures and further subsidies for students, along with an extension of the SuperGold card operating hours. Easier access to tickets was also supported, potentially using the same approach as pay and display car parks. Access was important, specifically for the elderly and disabled with their representatives, in particular, commenting that they simply wanted to be able to do what others took for granted – being able to access and use public transport.

Other aspects included the need for timetables to be better coordinated between modes to provide a more seamless network of public transport while drivers needed to be more polite, friendly, and courteous. There was interest in separating public transport from private motor vehicles and potentially splitting public transport services so express vehicles went on another route to multi-

stop vehicles. Some feedback even suggested prohibiting private motor vehicles from the central city, making the inner city a PT, walking and cycling-friendly zone.

No particular mode was identified as the solution for a future high quality public transport system; rather a combination of modes appeared logical by using the best of what was already available and adding in further elements, i.e. light rail, monorail, pods, trams, trains or even underground systems such as subways or metros.

While the study area was identified as extending from the current railway station to the hospital in Newtown, many people wanted to see the “spine” extend as far as Wellington airport.

People identified a range of locations from their overseas experience with quality public transport systems. They were seen as having reliable, efficient, frequent and integrated services. Australian systems identified were those in Sydney and Melbourne, Asian systems supported were those in Hong Kong, Tokyo and Singapore, North America earned praise for systems in San Francisco and New York and European systems identified included those in London, Amsterdam, Berlin and Paris.

While there were many suggestions of what could be done to improve the city’s public transport system, there were those who felt it was doing a pretty good job and was reasonably satisfactory. As long as it was reliable and reasonably priced, they were happy with what was already available.

Subsequent Phases

Two core groups were established to gather feedback from key interested groups within the community.

The PTSS Reference Group, made up of representatives from:

- Wellington Inner City Residents and Business Association
- Wellington City Council Accessibility Advisory Group
- Wellington Civic Trust
- Wellington Retailers Association
- Public Transport Voice
- Wellington Property Council
- TransAction

The Transport Operator Advisory Group, made up of representatives from:

- NZ Bus
- Mana Coachlines
- Bus and Coach Association
- KiwiRail
- GW Rail

Updates were provided and feedback obtained through a number of meetings and technical briefing sessions. These were held regularly throughout the study development – a total of 8 meetings from December 2011 through to April 2013. Other key stakeholders were identified and invited to attend some of these meetings, where they had expressed an interest in understanding more of the technical detail of the study. These other key stakeholders included CentrePort, Wellington International Airport, Living Streets, Cycle Aware Wellington, and Wellington Employers Chamber of Commerce.

Feedback and input from these groups highlighted a range of considerations that have informed the study work. Issues such as connections to the north and south/east, capacity through the Golden Mile, and potential east-west tunnel locations were key discussion areas. Integration of the Public Transport Spine with the wider city and regional public transport network was another key theme often raised. The need for the different options to be evaluated consistently to allow an ‘apples with apples’ comparison of costs and benefits was also highlighted. It was also considered important that the study report covered the likely trigger points for change and the potential staging or sequencing of public transport improvements. These issues have been taken into consideration and are reflected in this study report.

A much wider list of stakeholder groups and interested individuals were kept updated on study progress via emails and the study website.



4. STUDY APPROACH



Study Approach

This Chapter sets out a summary of the Study Approach. The Study Approach is discussed in further detail in the Inception and Scoping Report, February 2013 and in each of the subsequent documents i.e. Option Evaluation Long List Technical Note, Option Evaluation Medium List Technical Note, Transport Modelling Report and Option Evaluation Results Technical Note for the Short List Evaluation.

The Study Approach was developed to assess the feasibility of a range of long term options for providing a high quality public transport system in Wellington. It is consistent with Treasury Better Business Case guidelines in that the assessment progressively narrows down the number of options (Long List, Medium List, Short List), with each stage providing a more detailed analysis of those options. Throughout the process key stakeholders have been consulted to test the emerging directions and findings.

Each step of the study approach is discussed below.

1. Ngauranga to Airport Corridor Plan

This study was a recommendation of the Ngauranga to Airport Corridor Plan; to undertake a feasibility study for a high quality public transport system, including light rail. It provides the context in which this study has been undertaken.

Further details can be found in Ngauranga to Airport Corridor Plan, 2008.

2. Scope and Inception

This set out the approach to the study. It provided details of the overall problem to be addressed and the approach to address this problem. Two key parts of this stage were:

- To engage with Treasury on the process and definition of the problem through specific Investment Logic Mapping⁶.
- Comprehensive community engagement to understand the important characteristics of high quality public transport through the central city.

Further details can be found in: Inception and Scoping Report, February 2012 and Engagement Report, December 2011.

3. International Review of Public Transport Systems

The International Review was undertaken in parallel with the Scope and Inception stage. It drew on 35 studies across the globe to inform the study on modes and modal characteristics (e.g. vehicle capacities, capital and operational costs), success factors, design issues, constraints, technology and procurement/finance. The international review was used to inform all stages of the study.

Further details can be found in International Review of Public Transport Systems, February 2012.

4a. Long List Assessment

A long list of public transport options are assessed using the philosophy no stone should be left unturned. This highest level of assessment assessed each option in terms of:

- Attractiveness to user (reliability of mode; frequency and speed; likely perception of mode to user)
- Capacity of mode to support higher density development and attract developer investment
- Engineering feasibility (extent of gradient/topographical limitations and impact on land take)
- Capacity of mode to meet forecast demand in 2031 and serve key demand modes
- Financial viability (construction costs, maintenance cost, commercial)
- Environmental impact (extent of vehicle emission, noise, visual intrusion, impact on land values)
- Safety (pedestrian, personal).

Each of these criteria was scored and verified with stakeholders. The scores were underpinned by qualitative information through a specific city-wide and corridor planning review, horizontal and vertical alignment mapping, demand analysis and the international review.

Further details can be found in: Option Evaluation Long List, Technical Note, April 2012.

⁶ As part of the Treasury Better Business Case process a series of workshops identified the 'problem' the study is addressing as well as the 'benefits' that could result from addressing 'the problem'.

4b. Medium List Assessment

The options that passed through to the medium list assessment were subject to a more detailed technical assessment in terms of:

- Engineering assessment, which looked at the impacts of the various options from a design perspective, including the footprint of the vehicles, and how typically bus/train stops will impact on the corridors
- Social and environmental assessment, that considered the impact on the built and natural environment, and also cultural social aspects including the movement of people
- Statutory and planning assessment, which considered the suitability of the options against the visions, strategies and plans for Wellington, including the 'look and feel' and the functionality of the options
- Transport modelling, the forecast demand expectations for public transport over future years
- Operational and cost estimates to provide an indicative cost range of options.

Similar to the long list assessment, criteria were scored and verified with stakeholders.

Further details can be found in: *Option Evaluation Medium List, Technical Note, August 2012*

4c. Catchment Analysis to confirm study area for shortlist assessment

This stage reviewed the study area and examined the potential extensions to the study area to best provide for forecast travel demand between origins and destinations as part of the shortlist assessment. The assessment included:

- Highlighting catchments with the potential to deliver increases in the use of public transport.
- Analysing the potential demand for extended through services from the north and south.
- Analysing potential corridors and routes to connect between the Rail Station and Kilbirnie.

Further details can be found in the *Transport Modelling Report, June 2013 and Option Evaluation Technical Note, June 2013*.

4d. Short List Assessment

The short list options were assessed through:

- A physical feasibility assessment to define the required cross sections and changes to road infrastructure along alignments
- Cost estimates for construction and operations.
- Modelling of options using a suite of regional models and development of sensitivity tests to understand the sensitivity of results to changes in fiscal and strategic policy.
- Assessment of planning, social and environmental impacts, including impacts on businesses and residential property owners and aspects such as loss of parking and disruption to everyday business.
- Reporting in line with the requirements for a preliminary programme Treasury Business Case.

Further details can be found in the *Transport Modelling Report, June 2013 and Option Evaluation Technical Note, June 2013*.



5. THE PROBLEM AND DESIRED STATE FOR PUBLIC TRANSPORT



Overview

Prior to developing public transport solutions, it is important to clearly understand the current conditions, future forecast conditions, the problem that needs addressing, and the desired benefits of addressing the problem. This is a key requirement of the Treasury Better Business Case. This Chapter discusses each of those elements.

Current Conditions in 2012

The current conditions are:

- The Wellington public transport system exhibits varying degrees of congestion peak and off peak times along the Golden Mile and public transport spine corridor, “affecting the reliability and attractiveness of CBD bus services through the Golden Mile during peak commute periods”⁷.
- At peak times bus services are between 110 and 135 vehicles per hour in each direction along the Golden Mile between the Railway Station to Courtenay Place, putting strain on public transport infrastructure.
- Physical space is at a premium along the Golden Mile, limiting the opportunity to make even minor improvements by allocating additional space for existing public transport services.
- The current public transport system plays an essential role in providing for travel into the CBD and reducing the reliance on single occupant vehicles.
- The safety record along this corridor has come into question after a series of incidents involving buses and pedestrians.

Future Conditions in 2031

The future conditions forecast are:

- Between 2011 and 2031 Wellington City’s population is forecast to grow by 34,000⁸ people. Much of that growth is forecast around key identified growth points such as through the CBD and along Adelaide Road.
- There is significant investment in road capacity with the Roads of National Significance providing additional capacity for travel to the CBD with minimal additional public transport improvements proposed.
- Approximately 5,000 additional commuter car parks in the CBD are forecast to be required to accommodate car trips into the CBD.

Problem Definition

The problem was defined through the Treasury ILM process and further refined by the project team as the project progressed. The problem to be addressed by this study is defined as:

- In future years, too many vehicles and modes will share a constrained corridor resulting in longer and unreliable public transport journey times and worsening over time;
- There will be increased congestion in the strategic and local road network and additional environmental impacts as a result of less mode share for public transport;
- There is constrained economic growth and productivity in Wellington through constrained access;
- There will be reduced value for money and effectiveness for current and planned investment in public transport from the uncertain shape and nature of long term future public transport systems.

⁷ Wellington City Bus Review 2011

⁸ WTSM – Medium growth projection

Benefits of Addressing the Problem

The benefits of addressing the problems will be:

- Reduced travel times along the public transport spine
- Reliable journey times along the public transport spine
- Enhanced attractiveness and increased mode share for public transport
- Reduced overall congestion and environmental impacts in the roading network
- Enhanced value for money and effectiveness for investments in the public transport system

Strategic Interventions

To achieve these benefits, Strategic interventions were identified as:

- Incentivise use of public transport
- Match capacity to demand
- Reduce conflict between transport modes
- Manage land use and other policy levers to incentivise growth and public transport use along the Public Transport Spine
- Increase priority within the corridor for public transport



6. FUTURE DEVELOPMENT AND TRANSPORT TRENDS



Future Trends

The evaluation of options is based on future forecasts of development, transport infrastructure and changes in the cost of travel within the region. The growth and spatial distribution of population, households and employment within the region changes the number of trips made. Provision of new infrastructure, changes in public transport operation and the cost of travel influences the mode of travel and potentially final destination. The assumptions upon which the future forecasts rely are detailed in the Greater Wellington Regional Council Transport Modelling report. The report details the core assumptions which were applied to future year forecasting including forecast increases in development, changes in public transport and the improvements to the road network. Applying the future year assumptions has created a Reference Case against which all options can be compared to show how transport trends may change. The following provides a summary of changes.

Future Development

The scenario used for the study is based upon medium growth with Wellington City intensification, focussing development along the growth spine. In this scenario population in the region is forecast to increase by 55,000 to reach 526,000 by 2041. Growth occurs mainly in Wellington City (78% of growth) and Kapiti (22% of growth). The rest of the region remains relatively unchanged. Within Wellington City 32% of all growth occurs along the Spine with the majority occurring within the CBD.

Employment within the region is forecast to increase by 35,000 to reach 276,000 by 2041 with the majority of growth (70%) occurring in Wellington City. This underlines the focus of Wellington City and the CBD as the centre of employment. Within Wellington City 52% of all growth occurs along the Spine with most occurring within the CBD. This underlines the importance of the CBD as an employment destination which can be supported by passenger transport.

Future Projects Within The Region

The Reference Case includes future capital projects which are already committed, or are needed to maintain a minimum level of service over the evaluation period of 30 years. These improvements ensure that the transport system continues to provide a minimum level of service for underlying increases in transport demand. The major assumptions related to future projects within the region are related to State Highway projects and in particular the Roads of National Significance (RoNS). The current New Zealand Transport Agency timing for projects has been incorporated in all modelling.

Future changes to public transport include all programmed bus priority improvements, integrated ticketing and changes in services in line with the Wellington City Bus Review.

Impacts on Future Forecasts

The implications of future changes in population and the investment in highway projects can be assessed through changes in the Reference Case forecasts. Between 2011 and 2021 there is an increase in trips by public transport. However, between 2021 and 2031 there is an overall decrease in the use of public transport during the morning peak period. This forecast decrease in trips are due to the construction of additional road capacity through local improvements and the RONS's reducing the time taken to travel to the CBD.

Vehicle travel times into the CBD largely decrease during the period of 2011 to 2031 as new infrastructure is completed. The greatest improvement in vehicle travel time is for travel from Kapiti and Upper Hutt to the CBD. Taking 55 minutes in 2011, this journey is forecast to decrease by 6 minutes in 2031. There are small decreases (of 1 -2 minutes) in travel times from Miramar, Seatoun, the airport, and Kilbirnie. In comparison the time to travel to the CBD by most modes is forecast to increase. This increases the attractiveness of driving instead of taking public transport.

In summary, highway infrastructure schemes planned for construction between 2011 and 2031 result in improved travel times for people travelling to the Wellington CBD, whilst there are fewer equivalent improvements to public transport travel times.



7.THE OPTIONS



Range of options

The options considered included a range of potential routes and models, and combinations of each. At each stage of the evaluation and assessment, both mode and route options were assessed and refined.

Modal Options

The range of modal options considered through the PTSS have been placed into four categories representing similar characteristics.

Table 1 displays each mode by category and the stages of evaluation they were considered.

Each of these modes in terms of their definition and applicability is described in Appendix B.

The characteristics of each mode categorisation based upon information from the *International Review (February 2012)* are presented in table 2.

Table 1: Modes and modal categorisation

Categorisation	Mode	Long List	Medium List	Short List
Personal Rapid Transit	Personalised Rapid Transit	Yes	-	-
	People Parry Movers	Yes	-	-
Bus	Bus on-street	Yes	Yes	Yes
	Trolley bus on-street	Yes	-	-
	Mini-bus	Yes	-	-
	Bus Rapid Transit	Yes	Yes	Yes
	Guided O'Bahn	Yes	-	-
	Busway			
Light Rail Transit	Light Rail Transit	Yes	Yes	Yes
	Tram-train	Yes	Yes	-
	Mono-rail	Yes	-	-
Mass Rapid Transit	Heavy rail	Yes	Yes	-

Table 2: Typical Modal Characteristics from International Review

	Personal Rapid Transit	Bus	Light Rail Transit	Mass Rapid Transit
Vehicle capacity (standing + seating)	Low: 4 – 6	Medium: 60 – 150	Medium: 110 – 350	High: 140 – 280
Typical max passengers (per hour)	Low: 500	Low-Medium: 1,000 – 36,000	Medium: 3,500 – 20,000+	High: 30,000 – 90,000
Degree of segregation	Segregated	Non-segregated, partially segregated, Segregated	Non-segregated, partially segregated, Segregated	Exclusive right-of-way
Service frequency peak (seconds)	< 60	<60 – 600	40 – 90	20 – >40
Capital expenditure per km (NZ\$)	\$ 9 million - \$ 20 million	\$ 0.5 million – \$ 75 million	\$ 12 million - \$ 141 million	\$ 105 million
Operating speed (km/h)	40	40 – 100	60 – 120	80 – 120
Turning radii (m)	<10	7 – 13	10 – 25	>250
Power source	Electric, battery	Various (e.g. diesel, natural gas, hybrid, battery, electric)	Overhead, electric, battery, underground feed	Electric
Station spacing (m)	1,800	500 – 1,000	500 – 1,000	750 – 1,500
Key success factors	Short wait times Point-to-point travel times Completely segregated from other vehicles	Dedicated lanes (reduced conflicts with other vehicles/ pedestrians) Good passenger transport vehicles (brand, image)	Fully segregated from traffic / pedestrian environment Topographically suited to hilly terrain	Fully segregated
Key constraints	Low carrying capacity of vehicles Low operating speed, 40 km/h Driverless - only travel on pre-determined routes Must be segregated	Fleet size Lack of priority at signals if re-emerging back to public street	Vehicle length Integration with other traffic at intersections Funding Length of platforms Fixed infrastructure	Large turning radii Larger distance between stops than Light Rail Transit Potential greater severance Cost
Key operational issues	Large interchanges required for multiple vehicles arrivals. Typically no intermediate stops	Buses queue at bus stations – no overtaking room at stations unless designed as such Traffic signal priority at intersections	Fleet size to cater for peak demand Construction (re-routing traffic) Noise	Geometric curvature and gradient
Key design characteristics	Can integrate within existing urban fabric easier than heavier infrastructure	Spatial requirements / buffer zones between adjoining buildings	Integration with existing characteristics of City	Segregated and separated within own corridor

The Route Options

Route Options Considered

Throughout the study a range of routes, corridors and geographic areas have been considered. The geographic extent of the study has at all times been based on the entire region and forecast trip making within the region. The routes and corridors that have been considered has expanded and contracted at each stage based on forecast trip making coupled with the proportion of trips by public transport. There have been three main categories in the definition of routes:

- Options for routes within the CBD
- Extensions to the study area, confirming the areas to be connected by routes
- Alternative routes to connect areas to the CBD.

Table 3 displays the route options considered through the PTSS and the stages at which they were assessed in the study.

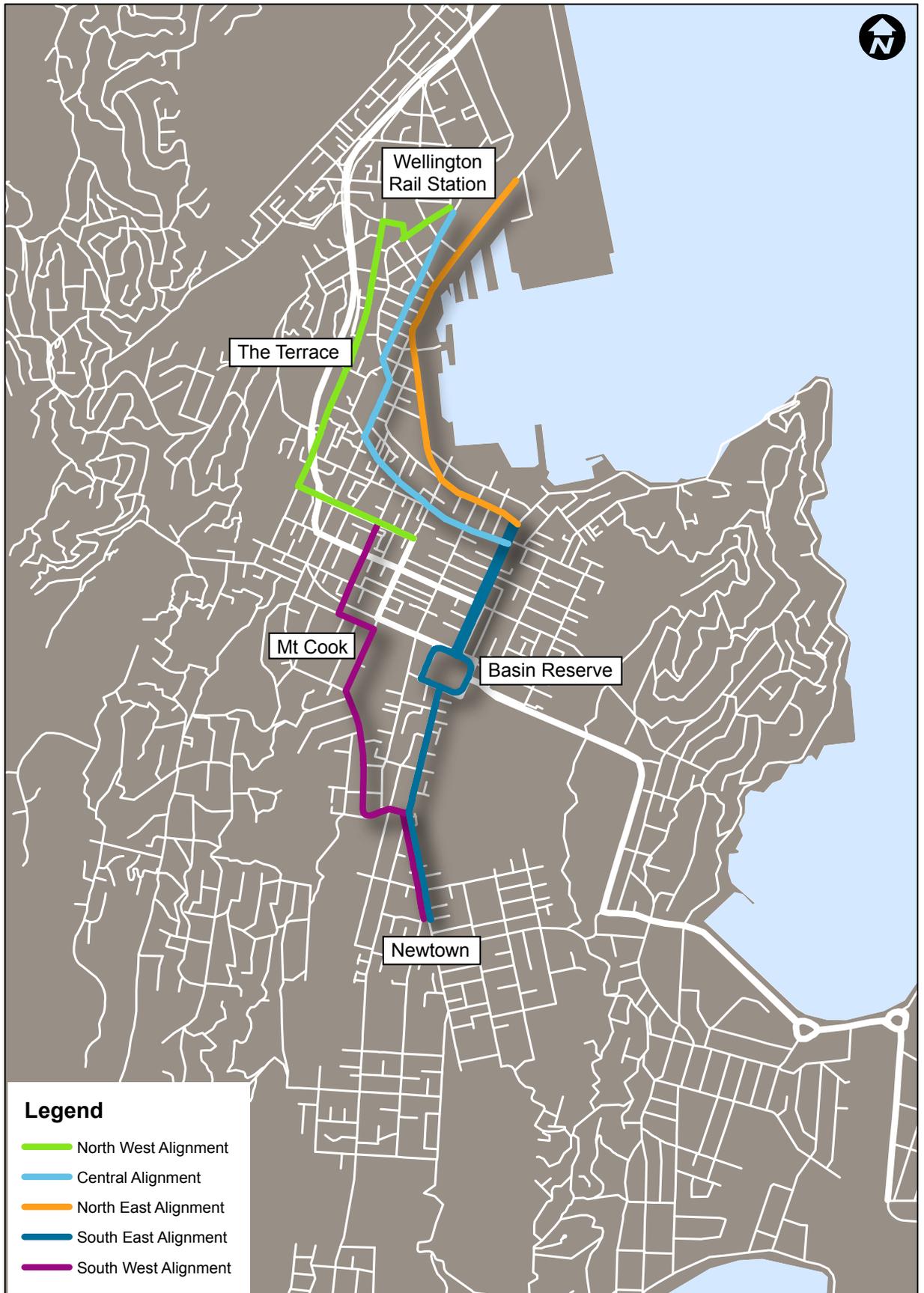
At the Long List and Medium List stages modes were assessed using similar routes. During the Short List evaluation routes were further refined to become mode specific including concept designs for cross sections and alternative alignments.

Table 3: Modes and modal categorisation

Categorisation	Route	Long List	Medium List	Catchment Analysis	Short List
CBD Routes (see Figure 2)	North-west	Yes	-	-	Yes
	Central	Yes	Yes	-	-
	North-east	Yes	Yes	-	-
	South-west	Yes	-	-	-
	South-east	Yes	-	-	-
	Underground	Yes	-	-	-
	Secondary	-	-	-	Yes
Extended Corridor Option	North (Johnsonville)	-	Yes	-	-
	North (Hutt Valley)	-	Yes	Yes	-
	South (Island Bay)	-	Yes	Yes	-
	East (Kilbirnie)	-	-	Yes	Yes
Alternative Routes	Hataitai bus tunnel	-	-	Yes	Yes
	Constable Street	-	-	Yes	Yes
	Mount Victoria tunnels	-	-	Yes	-
	Zoo tunnel	-	-		



Figure 2: Corridor Alignments



CBD Route Options

For routes within the CBD the Long List assessment considered:

- Capacity of mode to support higher density development and attract developer investment
- Engineering feasibility (extent of gradient/topographical limitations and impact on land take)
- Catchment area analysis, based on forecast demand in 2031 and the ability to support increased passenger transport capacity

Refer to *Long List Technical Note* for full details.

Figure 2 displays the five corridors defined within the CBD.

The conclusions of the analysis were:

The North-west Corridor:

The North-west corridor is along The Terrace. This corridor has constraining characteristics to service the CBD, based on topography, severance and supporting the CBD vision i.e. shifting the city from the west and away from the Golden Mile and waterfront. There are challenging and varying gradients (up to 11%) in places. There is a restricted catchment due to the motorway severance and height differences from the Golden Mile. The effective walking distance to the waterfront is unattractive, greater than 400 m. For these reasons The Terrace was discarded as a preferred public transport alignment, but considered as part of secondary bus services.

The Central Corridor:

The Central corridor traverses through a central alignment and serves a good catchment. The typical alignment is relatively flat, with no specific gradients. There are plenty of opportunities to increase capacity. For these reasons the central corridor is the preferred corridor to take a primary public transport route. There are a variety of sub-options that were tested such as Stout Street, and Featherston Street which are discussed further in the Option Results chapter.

The North-east Corridor:

A waterfront corridor does not align with the Ngauranga to Airport and Wellington City Council land use policy. It would move a public transport spine from the central city to an edge location leading to longer walking distances for many users.

The South-west Corridor:

The South-west corridor does not focus on a particular strong transport area that could respond to greater intensification. The catchment area is limited. Typically the alignment is on undulating terrain (gradients >10%) and has a number of sharp corners that pose issues for public transport modes that require larger turning circles. For these reasons the South-west area was discarded as the primary corridor for public transport but considered as a supplementary alignment for bus services.

The South-east Corridor:

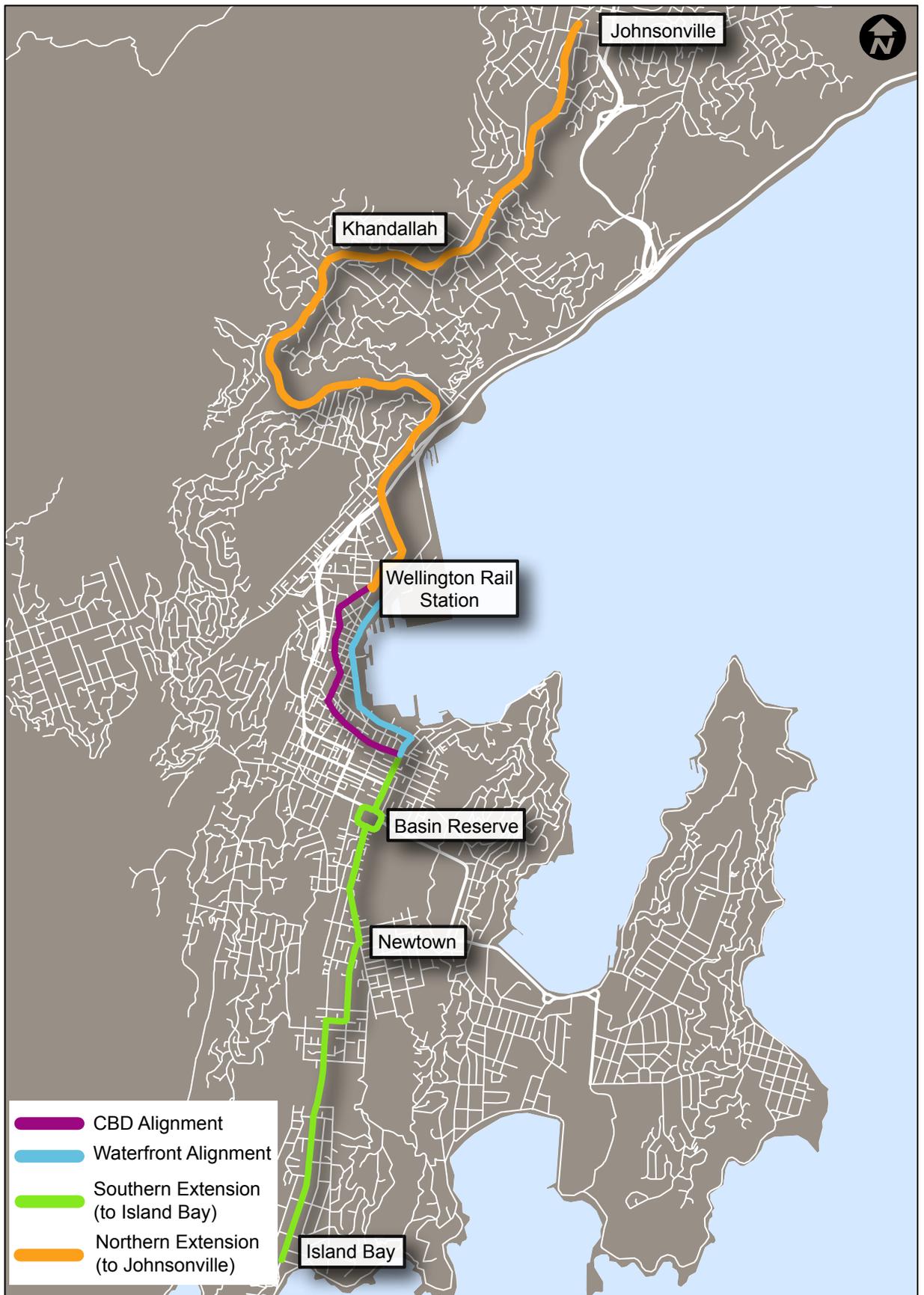
The south-east corridor has strong opportunities for higher density development and supports direct connections to Wellington Regional Hospital. The alignment is generally straight (other than the Basin Reserve) and the gradient does not exceed 2.6%, so conducive to rail based modes. This corridor has been taken forward for a primary public transport route within the CBD.

Underground and elevated options:

Underground and elevated options were explored. Underground options were discarded due to the costs of tunnelling, seismic considerations (in a potential liquefaction zone) and ground water issues next to the harbour, including the risk of floatation caused by uplift. Also, it is likely to have a smaller employment and population catchment due to the alignment being further from the centre of the development and limited station stops. From a resilience perspective an underground option would likely be far the most complex and costly to repair. Elevated options were discarded primarily for visual access and constrained space reasons.

Corridor	Good Catchment	Engineering difficulty	Policy alignment	Opportunity intensification
North-west	x	X	x	X
Central	√	√	√	=
North-east	=	√	X	=
South-west	x	X	=	X
South-east	√	√	√	√
Underground	x	X	√	x

Figure 3: Extensions to north and south



Extended Corridor Options

While the core spine was identified through the central city from the Railway Station to the Hospital and Newtown, options to the north and south were also a key consideration. Forecast person trip demand for the 2031 morning peak period was used to assess the potential for connections.

For connections to the north it was concluded:

- Most trips (86 %) from the north by all modes end in the CBD. There is little demand for travel through the CBD from the north by all modes.
- For those rail trips that end in the CBD, the majority complete their journey by foot, approximately 15% transfer onto a bus. This is because the average distance from the rail station to someone's final destination is relatively short (0.9 km), making walking the most attractive proposition in the majority of cases.
- There is already a high public transport modal share from the north (40 - 70 % from some origins). Providing a new public transport mode is likely to move these trips from rail to a new public transport mode rather than capture additional public transport mode share.
- Converting the Johnsonville line to Light Rail Transit has its own costs and challenges:
 - There would be significant costs for conversion (tunnel widening, platform lowering, additional passing loops)
 - There would be significant reductions in capacity given the size of vehicles required to run through the CBD, i.e. current Matangi four-car seat capacity is 490 passengers, whereas the capacity of Light Rail Transit two-car set suitable for city streets in the CBD is 180 passengers, unless additional vehicles and double-tracking was available
 - There would be significant service disruption during construction/conversion.

For these reasons, extending alternative public transport options such as Bus Rapid Transit/Light Rail Transit to the north beyond planned bus lanes on Hutt Road was discarded due to the lack of opportunity to increase public transport mode share, cost, capacity, and service disruption.

For connections to the south, it was concluded:

- There is relatively lower (for Wellington) public transport mode share of 30 - 40 % from the south/south-east to the CBD, so there is a good opportunity to capture additional public transport users.
- Extending the Light Rail Transit/Bus Rapid Transit to Newtown connects catchments along the Public Transport Spine to the CBD and the Regional Hospital.
- Extending the Light Rail Transit/Bus Rapid Transit to Kilbirnie (south east) would provide a direct, quick and frequent service to the CBD for passengers from the Miramar Peninsula and Kilbirnie, and remove the need for passengers to transfer between modes for a short length of their trip. It also offers the option of future services to the Regional Airport.

For these reasons, extending Bus Rapid Transit/Light Rail Transit to the south-east was considered to have merit as it could increase public transport mode share, and reduce overall travel time for public transport users.

Alternative Route Options

The potential options to connect between the west and the east of Mount Victoria were examined and refined to provide the final Short List routes. Each option was assessed against a range of criteria which included:

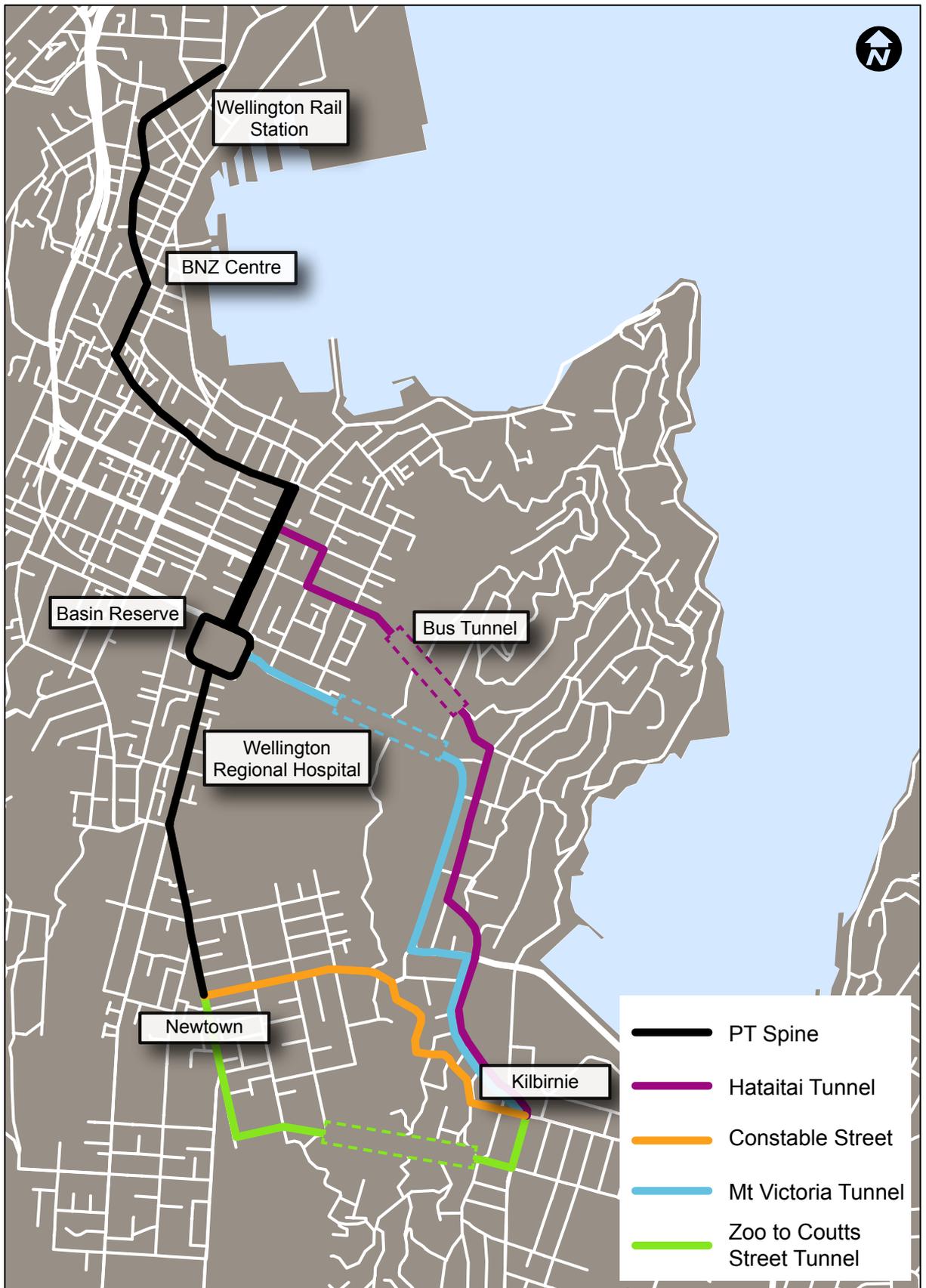
- The ability to provide an appropriate level of operation and service for chosen passenger transport modes
- Providing a direct and legible route to connect key origins and destinations
- Minimising the widening of corridors that will impact on properties.

a) Hataitai bus tunnel

This is the existing bus priority route through Mount Victoria, it is a single lane tunnel with traffic signals controlling the movement of buses. Access to the tunnel is through narrow residential and commercial streets with numerous driveways, parked cars and intersections. The limitation of a single lane tunnel coupled with potential impacts of providing additional capacity through narrow streets means that this route is not ideal for high capacity public transport. The use of the Hataitai bus tunnel has been maintained in the Bus Priority option only.



Figure 4: Route options to the east



b) Constable Street

This existing bus corridor connects Kilbirnie to Newtown via Constable Street and Crawford Road. This route links Kilbirnie to the hospital and CBD through the passenger transport spine. However, the route is both longer and slower than alternative routes, travelling through narrow residential and commercial streets with many driveways and intersections. To provide a high level of priority for public transport would require widening, removal of parking and would impact on properties the entire length of Constable Street as well as connecting roads. Because of this the focus of the Constable Street corridor is seen as a local bus connection and improvements are provided in the Bus Priority option only.

c) Mount Victoria tunnels

The existing Mount Victoria tunnel provides two way movement of traffic in narrow lanes, the approaches are congested during peak periods and the existing situation cannot provide for high quality, high capacity public transport. The New Zealand Transport Agency is planning for an additional tunnel (by 2022) and additional capacity on the approaches. The planned improvements provide an opportunity for the corridor to become a focus for public transport. Providing a corridor with few driveways, signal controlled intersections to provide priority as well as a direct link to the CBD connecting to the public transport spine at the Basin Reserve.

Forecasts suggest uncongested travel through the tunnels meaning that buses could travel with general traffic without experiencing delay. Providing the benefit of improved travel times without needing additional capacity. For light rail, it is not recommended or best practice for vehicles to run with general traffic through the tunnels. Additional systems would be required to address fire life safety and power issues through the tunnel, including bespoke light rail vehicles and additional signal management. These are also operational difficulties. Because of these potential difficulties the Light Rail Transit option provides for an additional tunnel. Both Bus Rapid Transit and Light Rail Transit options involve widening into the Town Belt. Whilst a significant impact, the potential benefits that this route could provide, means that it has been taken forward for evaluation.

d) Zoo Tunnel to Coutts Street

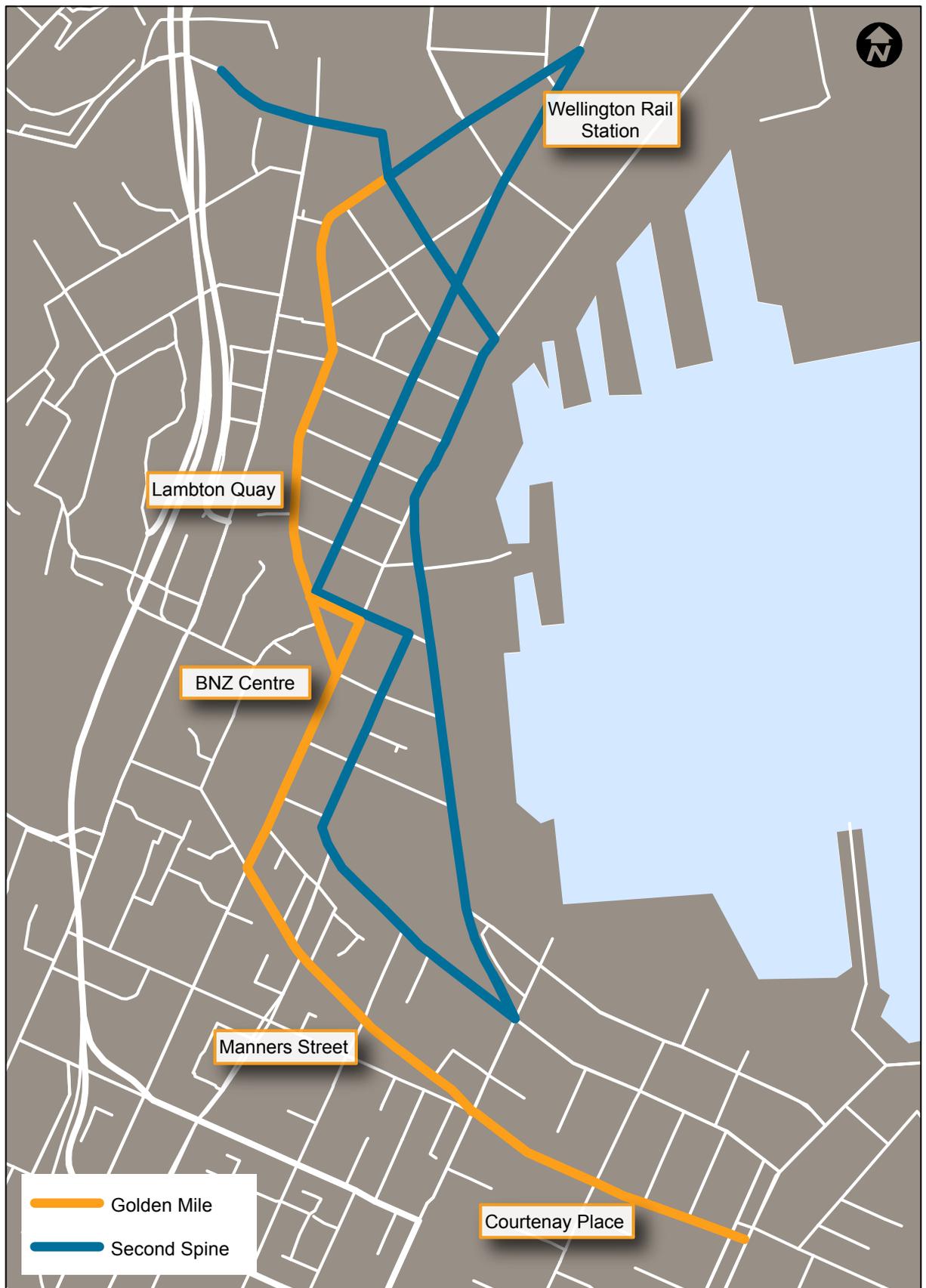
A potential route between the Wellington Zoo and Kilbirnie would provide a single spine option connecting Kilbirnie to Newtown and the CBD. This option was considered as an alternative route to providing a light rail transit tunnel through Mount Victoria but would require a tunnel of similar length and cost. If providing Light Rail Transit through this corridor the overall length of track would be less. However, the distance travelled and time taken on a journey from Kilbirnie to the CBD would be 800 metres and three minutes longer. Forecasting tests of similar routes between Kilbirnie and the CBD suggest that overall patronage would decrease and passengers would seek to use buses on alternative routes.

This route would travel along Riddiford Street through areas of heritage buildings, residential and commercial streets with many driveways and intersections. A double track would require significant widening impacting on buildings and properties, a single track would not provide a reliable high frequency service as there would be delays to allow vehicles to pass each other.

Because of the limitations within the corridor and the impact on travel time from Kilbirnie to the CBD, the Zoo tunnel route was considered less favourable compared to alternative routes. It has not been taken forward for evaluation.



Figure 5: Proposed peak period secondary public transport route



Secondary Routes

The need for a secondary route within the CBD during morning and evening peak periods was recommended in the Wellington City Bus Review, the Medium List evaluation and subsequent investigations. This route provides additional capacity during peak hours to ensure that public transport vehicles do not create queuing and congestion at stops and intersections. A capacity of around 60 public transport vehicles per hour was adopted as the practical capacity within a constrained corridor where there is little potential for a moving vehicle to pass a stationary vehicle.

Along the Golden Mile there are stretches where only a 2-way road is available, with few passing opportunities. These include Manners Street, parts of Lambton Quay and Willis Street. An added complication is that some sections are shared with general traffic and service vehicles. During the morning peak around 110 to 130 buses per hour are currently travelling each way on Lambton Quay, well over the adopted capacity of 60 buses per hour.

In the Bus Rapid Transit and Light Rail Transit options the secondary route is used to reduce congestion for vehicles travelling through the Golden Mile without widening or adding capacity. These options seek to reduce the number of vehicles through using higher capacity vehicles, removing general traffic on key sections and reconfiguring the existing road space. Even with these improvements and changes there would be up to 83 vehicles per hour travelling southbound on Lambton Quay and up to 66 vehicles travelling northbound. To reduce the number of vehicles below the threshold of 60 vehicles per hour along the Golden Mile, three potential options have been considered.

- Reroute some services from the Golden Mile during peak hours to reduce congestion by forming a secondary route
- Increase capacity along the Golden Mile by providing passing lanes at stations
- Terminate bus services from the north or west of Wellington at the Wellington Railway Station and transfer to other Spine services

Increasing capacity along the Golden Mile through the introduction of passing lanes at stations would require road widening within the constrained CBD corridor and would have significant effects on pedestrian areas, buildings and overall amenity as well as adding cost. Truncating services at the Wellington Rail Station, would require a transfer at the end of a journey, inconveniencing passengers and would provide a less attractive passenger transport system. For these reasons the use of a secondary route was considered preferable. Based on demand, a secondary route would only be required during peak periods.

Figure 5 displays the Golden Mile and proposed secondary route which has been adopted for the Bus Rapid Transit and Light Rail Transit options.



Final Options

Alignment and Cross Sections

Bus Priority

The Bus Priority option provides peak period bus lanes and priority at intersections to bypass congestion on key corridors. This builds on the current bus priority lanes running along the side of the road in some locations. The service pattern and frequencies would remain the same as the Reference Case (Figure 7).

From the Wellington Railway Station, the route follows the Golden Mile and Manners Street to Courtenay Place. It then travels down Cambridge and Kent Terraces, through the Basin Reserve and on to Newtown, as well as heading south-east through the Hataitai bus tunnel to Kilbirnie. Bus priority measures along the Constable Street and Moxham Avenue corridors are also included but would be implemented as required to respond to congestion and reliability issues.

Bus Rapid Transit

The Bus Rapid Transit option provides for dedicated bus lanes and priority signals for buses from the Wellington Rail Station to Newtown and Kilbirnie and potential for services to continue to further destinations on local roads (Figure 8). The dedicated bus lanes are positioned to avoid other vehicles turning movements and run either along the median of the road or along one side of the road. From the Wellington Railway Station, the Bus Priority option follows the Golden Mile from the Wellington Railway Station to the end of Courtenay Place. Bus only lanes would operate during the day (7 am to 7 pm), but other vehicles would be permitted after business hours. On Kent/Cambridge Terraces Bus Rapid Transit would travel alongside the central median to the Basin Reserve. From the Basin Reserve to Newtown, Bus Rapid Transit would continue to travel down the centre of the road. To Kilbirnie, Bus Rapid Transit would use the State Highway corridor through the duplicated Mount Victoria tunnel and along the widened Ruahine Street and Wellington Road.

The ability to use the future Mount Victoria tunnel duplication and widened State Highway 1 corridor is key to the benefits of this option. The flexibility of Bus Rapid Transit would also allow local services to make use of the facilities provided and Bus Rapid Transit services to travel beyond the core dedicated routes to other terminus points such as Island Bay and Miramar, using the local road network.

The Bus Rapid Transit option would operate frequent services during peak hours, providing services every two minutes between the Basin Reserve and the Wellington Rail Station, and every four minutes on the south-eastern and southern branches (to Kilbirnie and to Newtown).

The Institute for Transportation and Development Policy have produced a Bus Rapid Transit Standard providing measures against which existing and proposed schemes can be assessed. The combination of frequent services traveling along the central median and the level of priority and segregation from general traffic, define this option so that it meets many of the criteria in the Standard.

Light Rail Transit

The Light Rail Transit network would comprise approximately nine kilometres of rail tracks between the Wellington Rail Station and Newtown and Kilbirnie (Figure 9).

From the Wellington Railway Station, the Light Rail Transit option provides for dedicated lanes along the Golden Mile and Manners Street to Courtenay Place. Light Rail Transit lanes would operate during the day (7am to 7pm), but other vehicles would be permitted after business hours. On Kent/Cambridge Terraces Light Rail Transit would travel alongside the central median to the Basin Reserve. From the Basin Reserve, Light Rail Transit would continue down the centre of the road to Newtown. To Kilbirnie, Light Rail Transit would use a new dedicated tunnel through Mt Victoria and run alongside the State Highway corridor on Ruahine and Wellington Roads.

A key aspect of the network is a dedicated Light Rail Transit tunnel through Mount Victoria providing a direct route to Kilbirnie separate to general traffic. The requirement for an additional tunnel is based upon operational, engineering and fire and safety concerns (see section 7.2.3) as well as providing the fastest and most direct route.

The Light Rail Transit option also involves most bus services from the south/south-east terminating at key interchanges at Kilbirnie and Newtown, requiring passengers to transfer between bus and Light Rail Transit.

The Light Rail Transit would operate frequent services during peak hours, departing every two and a half minutes between the Wellington Rail Station to the Basin Reserve, and every five minutes on the south-eastern and southern branches (to Kilbirnie and Newtown).

Figure 6: Option Alignments

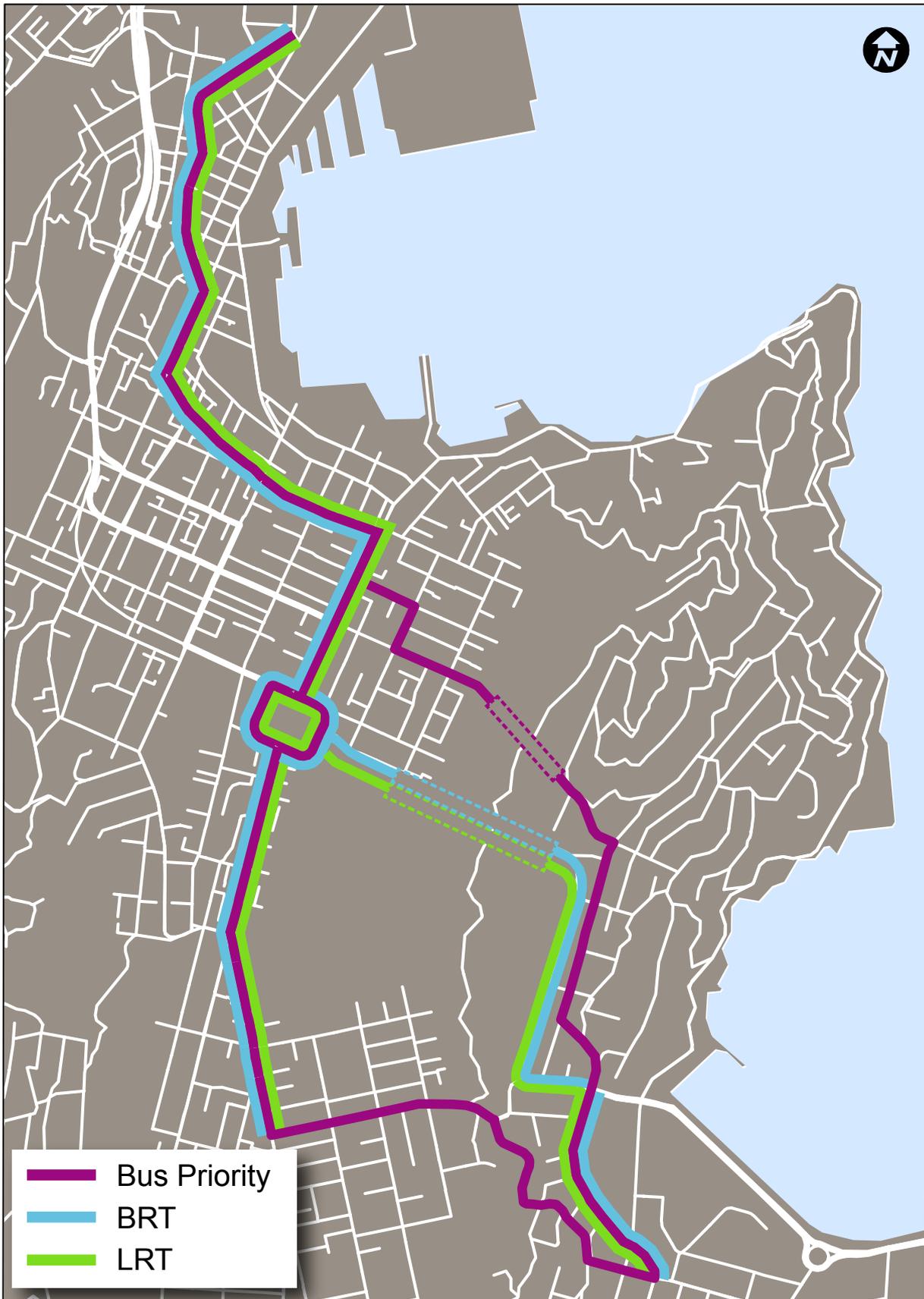


Figure 7: Bus Priority

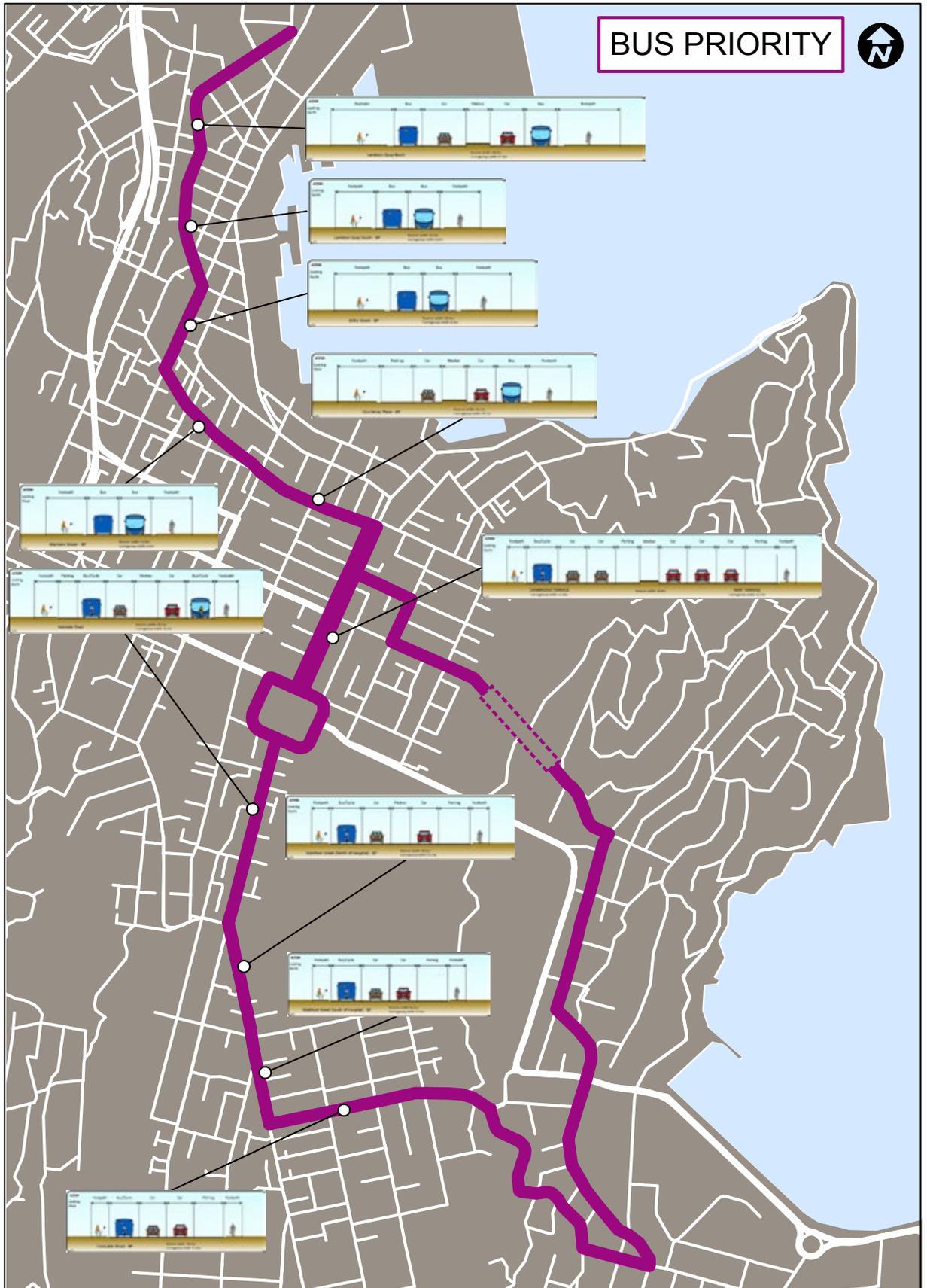


Figure 8: Bus Rapid Transit

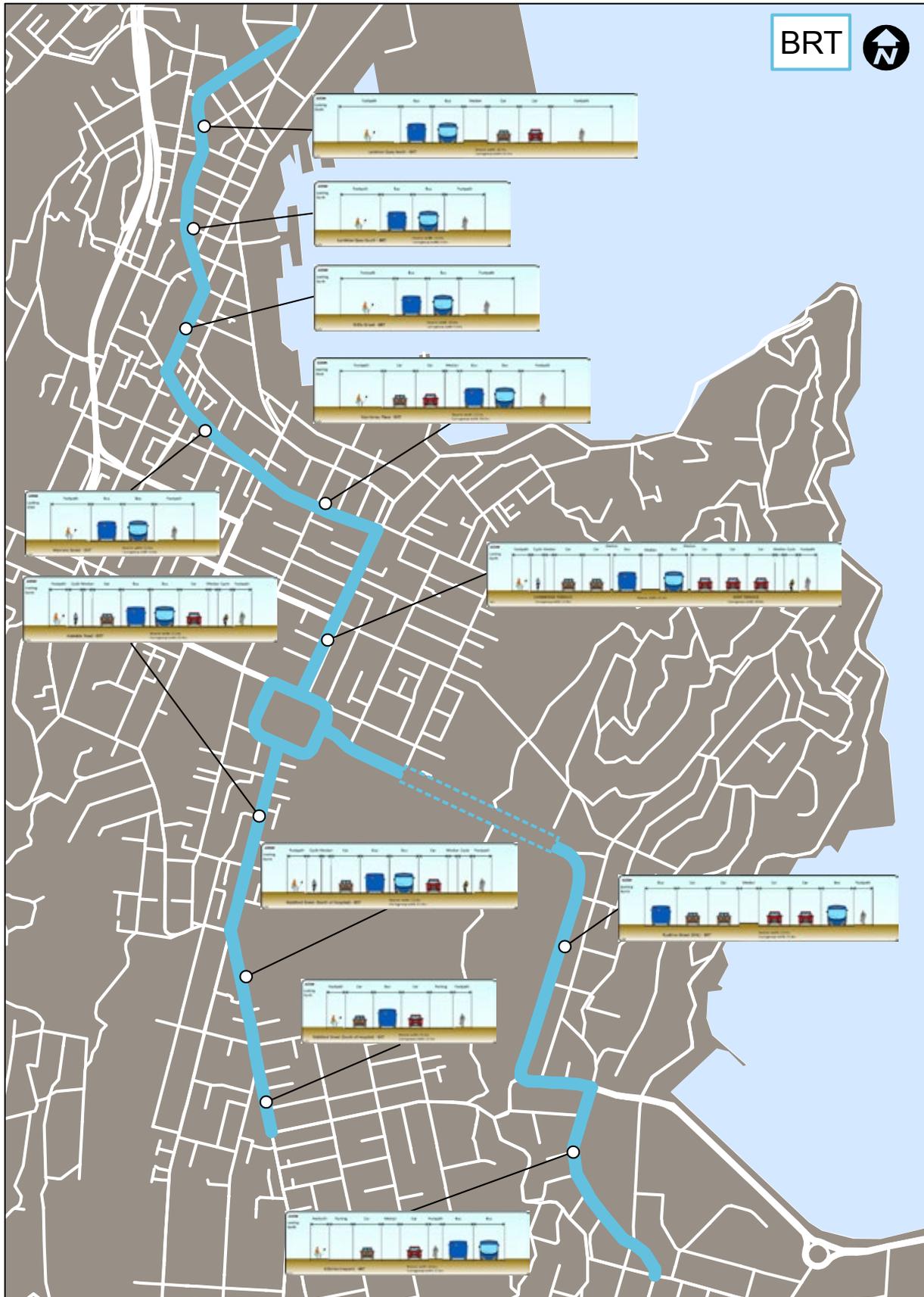
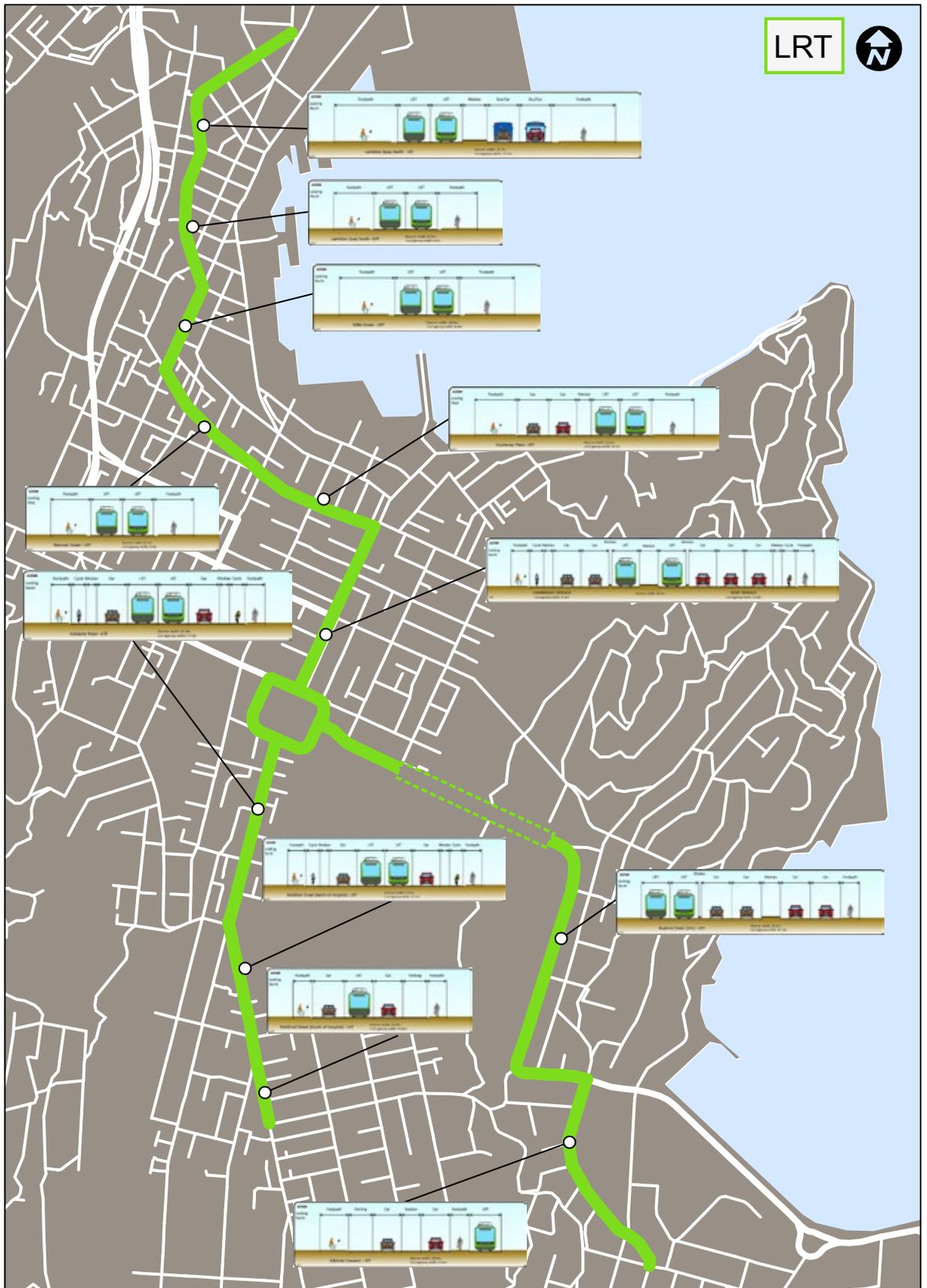


Figure 9: Light Rail Transit



Changes to Services

The three options (Bus Priority, BRT and LRT) include differing public transport services. The Bus Priority option retains the future public transport services from the Reference Case. The BRT and LRT options have revised services which seek to maximise the potential benefits of the options. A full description of changes to each service is detailed in the Transport Modelling Report, June 2013. Figures 10 and 11 display a summary of the revised services for the BRT and LRT options.

BRT Option

The BRT option will provide high capacity, high quality buses between Wellington Rail Station and Newtown and Kilbirnie. Although the BRT vehicles will differ from standard buses, they require no additional infrastructure, allowing them to travel on local roads. As a consequence, BRT services can be extended into the surrounding suburbs, including Miramar, Seatoun, Island Bay and Karori. Standard buses are also able to utilise the BRT routes through the city centre. As a consequence, the BRT services extend beyond the physical infrastructure provided, requiring fewer interchanges. For those suburbs that are not directly serviced via the BRT, feeder routes will connect at one of four interchange points along the BRT system.

LRT Option

The LRT option services will travel between Wellington Rail Station and Newtown and Kilbirnie. The LRT option provides a closed system network and LRT services are subsequently limited to where they travel. Feeder bus routes are required to service all trips to and from the public transport spine, replacing the services that previously ran along the spine



Figure 10: Wider Public Transport Network for BRT

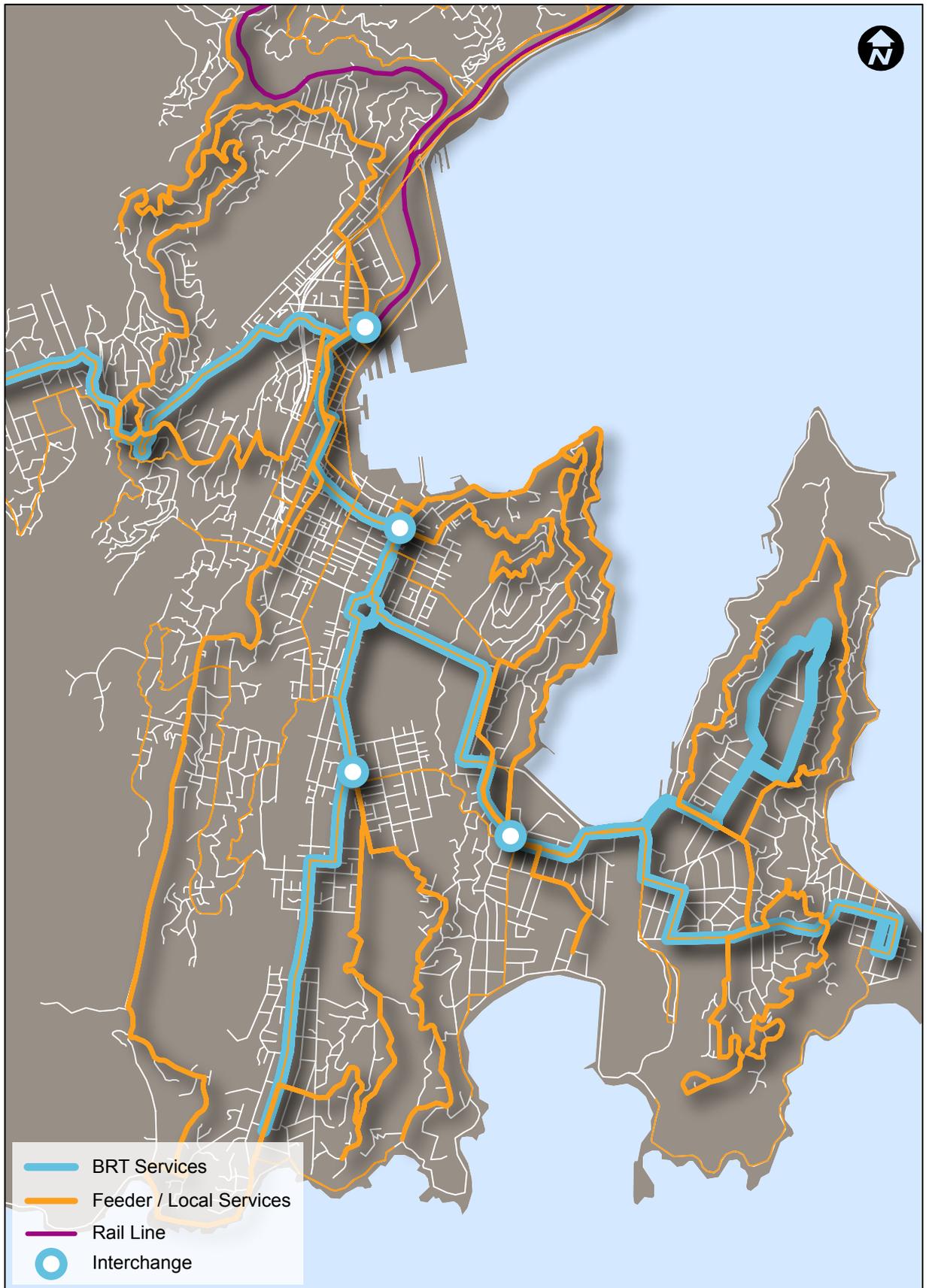
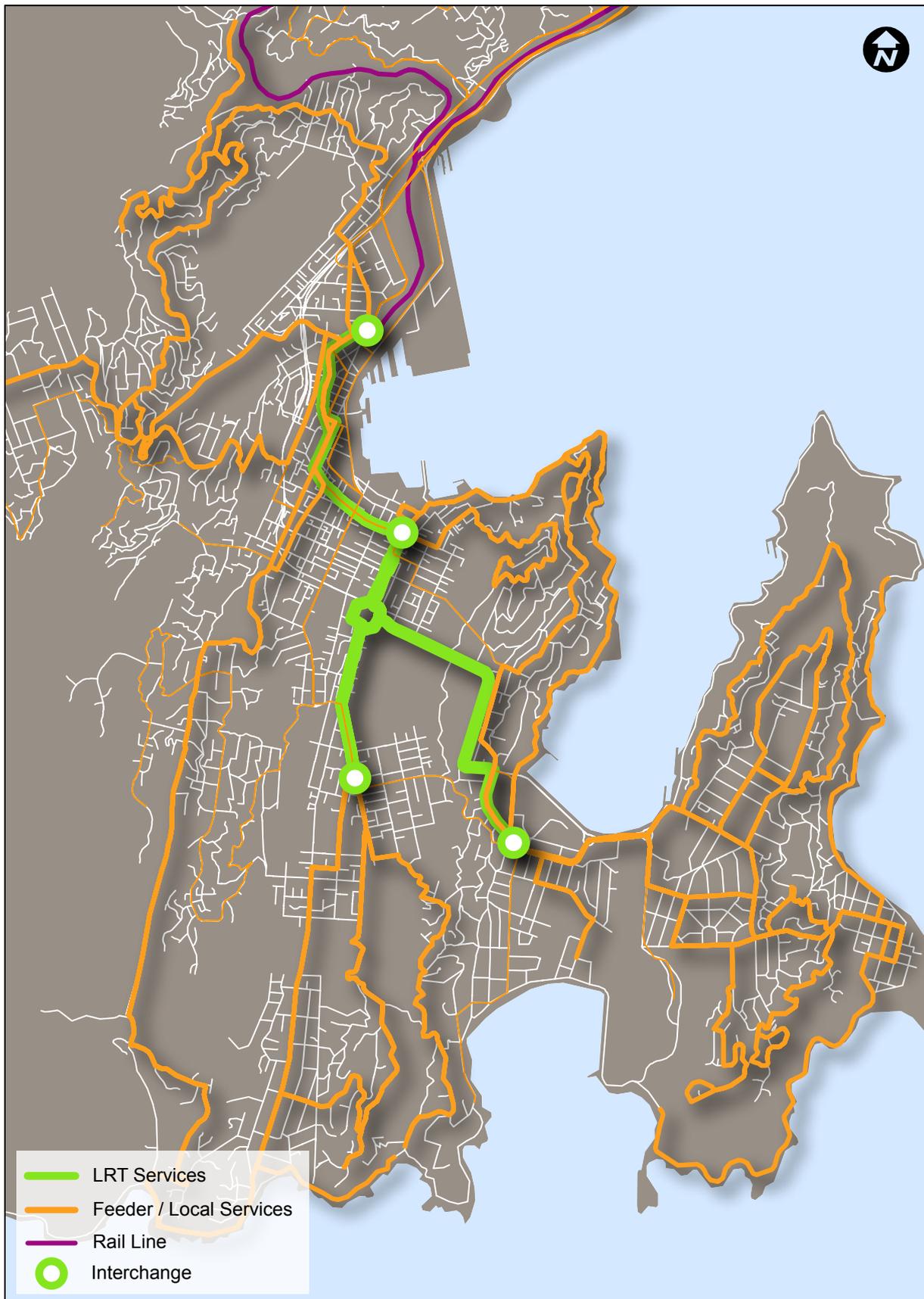


Figure 11: Wider public transport network for LRT



8. THE OPTION RESULTS



Option Results

The PTSS process progressively narrowed down the number of options (Long List, Medium List, and Short List) with each stage providing a more detailed analysis of those options as discussed in the study approach (Chapter 4.0). Chapter 8 briefly summarises the results of the Long List and Medium List and provides a fuller assessment of the Short List evaluation in line with the detail assessed with each stage.

Detailed results are contained in the *Option Evaluation Long List Technical Note*, *Option Evaluation Medium List Technical Note*, and *Option Evaluation Results Technical Note*.

Long List and Medium List Results

The initial modal assessment covers all the modes discussed in Chapter 7:

- Personal Rapid Transit (small lightweight trams, People Parry Movers, PODs)
- Bus (Bus on-street, Trolley bus on-street, Mini-bus, Bus Rapid Transit, Guided O’Bahn Busway)
- Light Rail Transit (Light Rail Transit, Tram Train, Mono-rail)
- Mass Rapid Transit (Heavy Rail)

For the long list each mode was assessed in terms of its:

- Attractiveness to user (reliability of mode; frequency and speed; likely perception of mode to user)
- Capacity of mode to support higher density development and attract developer investment
- Engineering feasibility (extent of gradient/topographical limitations and impact on land take)
- Capacity of mode to meet forecast demand in 2031 and serve key demand modes
- Financial viability (construction costs, maintenance cost, commercial)
- Environmental impact (extent of vehicle emission, noise, visual intrusion, impact on land values)
- Safety (pedestrian, personal).

The assessment was based on a range of information and research including a specific city-wide and corridor planning review, horizontal and vertical alignment mapping, demand analysis and the international review.

For the medium list a more detailed technical assessment was assessed in terms of:

- Engineering assessment, which looked at the impacts of the various options from a design perspective, including the footprint of the vehicles, and how typically bus/train stops will impact on the corridors
- Social and environmental assessment, the impact on the built and natural environment, and also cultural social aspects including the movement of people
- Statutory and planning assessment, which considered the suitability of the options against the visions, strategies and plans for Wellington, including the ‘look and feel’ and the functionality of the options
- Transport modelling, the forecast demand expectations for public transport over future years
- Operational and cost estimates to provide an indicative cost range of options.

The above long list and medium list criteria was scored by the study team and verified with stakeholders.

The top three options ranked taken forward for the Short List were:

Bus Priority

An enhanced bus network with greater priority at intersections and along key corridors, but using existing vehicle types. Low cost option.

Bus Rapid Transit

Dedicated bus lanes for new high capacity vehicles as well as other system improvements to enhance frequency and journey times. Medium cost option.

Light Rail Transit

Dedicated lanes and tracks for new light rail vehicles as well as interchanges to transfer from other modes. Medium to high cost option.

Short List Results

For the short list evaluation each option was considered in more detail and assessed in terms of:

- A physical feasibility assessment to define the required cross sections and changes to road infrastructure along alignments. Resulting in the short list definition, alignments and cross sections by mode.
- Planning, social and environmental impacts, including impacts on businesses and residential property owners and aspects such as loss of parking and disruption to everyday business.
- Reporting in line with the requirements for a preliminary programme Treasury Business Case.
- Modelling of options using a suite of regional models and development of sensitivity tests to understand the sensitivity of results to changes in fiscal and strategic policy.
- Operational and establishment cost estimates to provide an indicative cost range of options.
- An economic evaluation of the costs and benefits to provide a benefit cost ratio.

A full assessment of the evaluation of options is provided in the Option Evaluation Report.

Planning, Social and Environment Assessment

The planning assessment provides a high level evaluation of the potential planning, social and environmental impacts of the three public transport options. This includes an RMA assessment considering the consentability of the options. No specific assessments such as urban design, acoustic effects or social impact were undertaken.

The options are assessed in three parts:

The 'Golden Mile'

Bus Priority is considered straight forward from a consenting perspective, as it builds upon the existing configuration through the Golden Mile, although it introduces the removal of general traffic from Lambton Quay South to Taranaki Street. Managing the servicing of retail properties that rely on loading zones will need to be considered.

The differentiator from a planning perspective is in relation to Bus Rapid Transit and Light Rail Transit options, where at Lambton Quay North and Courtenay Place, these facilities are located entirely on one side of the road

for the core business part of the day with the other side being used for general traffic. The implication of this is that any stops or stations southbound will need to be located within the central median. In all other respects there is minimal social and environmental differentiation between the options, as all are located within the existing road reserve without the need for additional land or for footpaths to be reduced in size. While there will be the need for intersection reconfigurations for the Bus Rapid Transit and Light Rail Transit options these are likely to be accommodated with limited effects on accessibility.

The Southern Section

The southern section from Courtenay place to Newtown and Kilbirnie along Kent Terrace, Cambridge Terrace, Adelaide Road, Riddiford Street and Constable Street.

There has been an emphasis within this corridor of avoiding or minimising widening of the road reserve or carriageway widths. This has the implication that demands for the available road space are constrained when you need to provide for the public transport, general traffic, cycle lanes in some locations and footpaths with any additional road space being used for parking. In addition for Bus Rapid Transit and Light Rail Transit in the Kent/Cambridge Terraces, Adelaide Road and Riddiford Street sections, there is the need to accommodate stops or stations in the middle of the road where none currently exist. Additionally turning movements for general traffic need to be catered for.

In terms of matters such as pedestrian safety and accessibility, noise and visual amenity it is considered that these matters can be addressed and there is therefore no differentiation with all three options. It has also been assumed that any intersection widening can be appropriately designed with limited effects on the operation of adjacent land uses.

The most significant social and environmental issues are considered to be around the partial or total removal of existing parking, either permanently or in peak hour. With bus priority the primary changes are around the peak hour removal of parking. With Bus Rapid Transit and Light Rail Transit the loss of on street parking is much more significant and will have an effect on existing businesses that rely to some extent on on-street parking to operate. In addition, the visual nature of

the changes proposed for Bus Rapid Transit and Light Rail Transit in Riddiford Street and in relation to widening of Constable Street for Bus Priority, are significant issues to be weighed against the potential for public transport to enhance vitality.

Overall the Bus Priority option has minimal social and environmental effects as it builds upon the existing configuration with the exception of Constable Street where even for bus priority there is a limitation on available road space. The utilisation of the Canal Reserve will also need to be considered in the context of the intent of the Town Belt deed. The implementation of Bus Rapid Transit and Light Rail Transit will have much more significant effects and are a major change to what is currently in place.

The Eastern Section

The eastern section through to Kilbirnie via either the State Highway 1 (Eastern Corridor) or the Hataitai bus tunnel (depending on the option).

As with the Southern Alignment, the Bus Priority Option builds upon the existing alignment through Mount Victoria, the bus tunnel, Hataitai and through to Kilbirnie. Social and environmental effects for Bus Priority are considered to be minor, although there will be the loss of peak hour parking in Kilbirnie Crescent.

Bus Rapid Transit and Light Rail Transit are considered to have much more substantial effects. For Bus Rapid Transit the assumption has been made that buses will run with general traffic through the existing and/or duplicated Mount Victoria Tunnel. The major issue is encountered at Ruahine Street and Wellington Road where there is an additional requirement for road reserve and carriageway width over and above the four laning currently being progressed by the New Zealand Transport Agency. The assessed option has the implication that more Town Belt will be required for the corridor, while at Wellington Road sufficient space is required for additional lanes. There is also the loss of parking on Ruahine Street that has reasonable utilisation particularly on a Saturday when the Hataitai Park sporting facilities are in fullest use.

In most respects Light Rail Transit has similar effects to BRT. However there is a substantial difference between Bus Rapid Transit and Light Rail Transit at the Mount Victoria Tunnel where the option is to provide two new tunnel

bores south of the existing tunnel and in addition to the duplicate tunnel proposed to the north. Further land on the Town Belt is required for the approach and additional land would be required on Paterson Street.

Changes in People Travelling by Public Transport

A key goal is to provide better and more attractive public transport links to and from the CBD. The number of people travelling by public transport is a key measure of the effectiveness of the options.

Table 4 displays changes in the number of people travelling by public transport for the morning peak period (7-9 AM). The Bus Priority, Bus Rapid Transit and Light Rail Transit options have a marginal impact on regional figures as they are targeted at increasing public transport trips from the south and the east of the CBD rather than the entire region.

Table 5 displays the changes in trips to the CBD from key locations to the south and east. The largest increase for the Bus Priority option is between the CBD and Miramar. All areas have a relatively low, but consistent increase in patronage as the option provides a small, but consistent improvement in the level of service provided. The Bus Rapid Transit option increases patronage from areas experiencing the greatest improvements in public transport level of service. The largest increase is from Miramar which is serviced by direct Bus Rapid Transit services. There is a decrease in trips from the Mount Victoria / Hataitai area due to reduced buses travelling via the Hataitai bus tunnel. The Light Rail Transit option reduces patronage from areas where services require transfers, or there is a reduction in services such as Mount Victoria / Hataitai. Newtown and Kilbirnie experience increases in patronage as these areas have direct services providing faster travel times.

Table 4 Changes in regional patronage during the morning peak (7-9 AM)

	Reference Case	Bus Priority	Bus Rapid Transit	Light Rail Transit
2021 (regional)	35,600	+ 200	+ 700	+ 200
2031 (regional)	34,000	+ 300	+ 800	+ 300
2041 (regional)	35,200	+ 300	+ 900	+ 400

Table 5 Changes in trips to the CBD from key locations 2031 morning peak (7-9 AM)

	Reference Case	Bus Priority	Bus Rapid Transit	Light Rail Transit
Miramar	1,320	+ 60	+ 170	- 70
Kilbirnie	680	+ 40	+ 80	+ 90
Mount Victoria / Hataitai	790	+ 10	- 50	- 40
Island Bay / Berhampore	1,140	+ 30	+ 100	- 60
Newtown	790	+ 30	+ 90	+ 40

Changes in travel by public transport

The level of service provided by each option is a key consideration. The level of service was evaluated by analysing the time taken to travel along the Spine and the total time to travel to the CBD. Journey time reliability was qualitatively assessed by considering the level of priority, segregation and the number of vehicles within a corridor. The number of transfers forecast for each option was considered so as to provide a measure of connectivity and ease of use.

Changes in travel along corridors

The options have been developed to optimise the movement of public transport vehicles along the entire length of the route, from the start (Kilbirnie and Newtown) to the terminus at the Wellington Rail Station.

The time taken to travel from Kilbirnie to the Wellington Rail Station in the Reference Case is approximately 25 minutes. Bus Priority provides a small improvement (a total saving of 3 minutes) with the majority of travel time savings between Courtenay Place and the Wellington Rail Station (2 minutes). This recognises that existing and future planned bus priorities will be in place by 2031 and therefore, this option provides only small improvements. Bus Rapid Transit and Light Rail Transit provide a significant saving, almost halving the travel time (a saving of 12 minutes). This represents the benefit of the high level of priority and segregation and the alternative route via the State Highway network.

The time taken to travel from Newtown to the Wellington Railway Station in the Reference Case is approximately 18 minutes. The Bus Priority option provides a 3 minute travel time saving compared to the Reference Case indicating the benefit of bypassing congestion along the entire route. Bus Rapid Transit and Light Rail Transit options reduce travel time along the entire corridor by approximately a third (a saving of 6 minutes).

Changes in travel times to the CBD

The time taken to travel to the CBD includes the time sat in a vehicle as well as the time spent waiting, walking and any transfer between services. The time taken to travel to the CBD from locations in the south and the east were extracted from future forecasts. Overall, all options provided faster journeys to the CBD compared to the Reference Case.

During the morning peak period Bus Rapid Transit provided the fastest travel time for passengers (savings of up to 13 minutes Miramar to CBD), due to the level of priority, segregation and the services provided which do not require transfers. The Light Rail Transit option decreased journey times to a lesser extent where passengers were required to transfer between bus and light rail.

During the interpeak period the Bus Priority option provides no greater benefit than the Reference Case. This is due to the bus priorities being morning peak only. Bus Rapid Transit and Light Rail Transit in the interpeak provide similar, but smaller travel time savings, as there is less congestion on the road network and the level of

segregation provides fewer benefits.

Journey Time Reliability

Journey time reliability is a measure of how reliable the journey time between origins and destinations experienced by a traveller is. A qualitative assessment of reliability is based on an assessment of the level of priority, segregation and the number of vehicles within a corridor.

The Bus Priority option increases reliability by providing targeted bus priorities in locations which are congested. However, the Bus Priority option does not segregate buses from traffic and does not lead to a reduction in the buses travelling through the Golden Mile. For travel to/from the east through the Hataitai bus tunnel, buses mix with general traffic in residential streets which are unlikely to include bus priorities.

The Bus Rapid Transit/Light Rail Transit options provide a greater level of reliability because they are more segregated from traffic and through the CBD the number of vehicles on the Golden Mile decreases. This is likely to reduce the incidence of 'public transport congestion' with stopped public transport vehicles creating a bottleneck. Furthermore, for trips to/from the east the Bus Rapid Transit/Light Rail Transit options travel through the State Highway corridor. Light Rail Transit has a higher level of segregation in this corridor as it travels through Light Rail Transit only tunnels whilst Bus Rapid Transit travels with general traffic. Because of this high level of segregation and priority Light Rail Transit is likely to provide the highest level of journey time reliability.

Transfer passengers between modes

Transferring between services allows passengers to travel between origins and destinations that are not served by direct services. Integrated ticketing (provided in future forecasts) allows passengers to transfer at no additional financial cost. In the Reference case the highest number of transfers occurs at the Wellington Rail Station with a transfer between rail and bus providing an alternative to walking to access CBD destinations. In the 2031 morning peak forecast, the Bus Priority option is similar to the Reference Case, passengers transferring in Bus Rapid Transit increases by 1500 and Light Rail Transit 4000.

In the Bus Rapid Transit option the increase in passengers transferring (1300) is mainly at the Wellington Rail Station. This suggests that higher

frequency services, with increased priority provides a better interface with existing rail services. The increase in passengers transferring in the south and east is small (150). The Bus Rapid Transit option provides an open system as vehicles continue beyond the core dedicated infrastructure to other terminus points such as Island Bay and Miramar. This provides direct services without relying on passengers transferring.

In the Light Rail Transit option the increase in passengers transferring is split between the Wellington Rail Station (1800) and at the Newtown and Kilbirnie termini (2150). The increase in passengers transferring at the Wellington Rail Station, suggests that the option provides a better interface with existing rail services. The increase in passengers transferring in the south and east is due to the closed system nature of the Light Rail Transit option. Travel from beyond Newtown and Kilbirnie requires a change of mode between bus and light rail.

Changes in traffic flow on the Golden Mile

The proposed options seek to reduce congestion on the Golden Mile during the morning and afternoon peak periods. The Bus Priority option is similar to the Reference Case with the same number of public transport vehicles on the Golden Mile. However, providing additional peak period bus priority lanes would displace road traffic, providing total priority for public transport and decreased traffic volumes.

Bus Rapid Transit and Light Rail Transit reduce traffic along the Golden Mile in a variety of ways:

- Some bus services from the north are transferred onto a secondary route using Featherston Street and Wakefield Street
- Higher capacity vehicles are used on Spine routes reducing the required number of public transport vehicles on the Golden Mile to provide greater capacity
- General traffic is excluded from travelling with public transport along the Golden Mile during business hours (7 am – 7 pm) to provide total priority for public transport.

Assessment of pedestrians and cycling impacts

Pedestrians

The Bus Priority, Bus Rapid Transit and Light Rail Transit options do not include any physical barriers to movement along, or across roads and intersections for pedestrians. However, public transport priority lanes with vehicles moving at a different speed to general traffic may create safety issues for crossing pedestrians. Adequate medians and separation distances between general traffic and public transport vehicles would be required in any subsequent detailed designs.

Central raised medians are located on corridors that do not require priority turning movements into driveways and side roads. For Bus Rapid Transit / Light Rail Transit, these medians transform into stations where appropriate. These medians could act as pedestrian refuges and assist pedestrians in crossing the road.

Cycling

Although this is predominantly a public transport project, it has also aimed to deliver sections of the identified cycle routes. The Bus Priority option provides shared bus and cycle lanes on some sections and the Bus Rapid Transit and Light Rail Transit options include separated cycle lanes in strategic locations. Where there is sufficient road width, a 1.0m safety buffer is placed between the kerbside cycle lane and the adjacent general traffic lane. Cycle lanes are provided on Adelaide Road, Kent Terrace and Cambridge Terrace.

Key constraints for implementation

Key constraints that will impact on the ability for public transport vehicles to travel through each route alignment have been assessed. Required corridor widths for cross sections and vehicle tracking curves have been applied along the entire route from Kilbirnie and Newtown and through the CBD.

Bus Priority uses the same vehicles as the Reference Case and there are no issues relating to the potential for vehicles to travel along the route. In the Constable Street corridor there is a requirement for road widening, if bus lanes are to be provided, elsewhere bus lanes are provided at

the expense of parking or use existing road lanes.

Bus Rapid Transit may involve the use of articulated vehicles which means they are longer and can have larger turning radii than traditional buses in the City. This may result in similar issues and implications to the Light Rail Transit option when travelling through the CBD. Road widening is required along the Ruahine Street corridor as there is no potential to increase public transport capacity without widening.

Light rail vehicles are longer than traditional buses and have larger turning radii. The tracking curves analysis identified two key constraints within the CBD.

- Travelling southbound from Hunter Street to Customhouse Quay would require existing lane layouts to be altered so that vehicles can turn right into Customhouse Quay. The alternative is likely to require either the demolition of buildings, vehicles travelling on an alternative route, or one way running.
- The intersection of Willis Street and Manners Street is a constraint due to the narrowness of the corridor, size of intersection and the sharp turn involved. Traditional buses can traverse this turn. However, for articulated buses and Light Rail Transit, there is a constraint which may result in the need to demolish buildings.

Consistency with State Highway projects

All options are generally consistent with proposed future State Highway projects. Bus Priority has been allowed for in the Basin Reserve design and the grade separation at the Basin enables provision of priority required for the Bus Rapid Transit and Light Rail Transit options.

The Bus Rapid Transit and Light Rail Transit options will affect the future Mount Victoria tunnel duplication project. Both options propose further widening of Ruahine Street and will complicate the design of the Wellington Street and Kilbirnie Crescent intersections. An addendum to the scheme assessment report is being prepared to examine the design and impacts of additional public transport lanes.



Option Costs

The construction, establishment and annual operating costs of each option are fully documented in the appendices to the *Option Evaluation Report (Appendix E and F)* and summarised in the following sections.

Construction costs

Table 6 displays the estimated capital cost to construct and establish each option. Bus Priority is the lowest cost option, followed by Bus Rapid Transit (three and a half times more) and Light Rail Transit (sixteen times more). The major differences between the options occur as:

- The Bus Priority option costs are mainly associated with changes to road infrastructure.
- The Bus Rapid Transit and Light Rail Transit options include the costs of additional vehicles
- The Bus Rapid Transit and Light Rail Transit options include greater alterations to existing services
- The Light Rail Transit option includes additional costs for rail infrastructure, a depot and tunnels.

Cost of operating each mode

The operational costs of the options were developed based upon in-service hourly and kilometre costs. The in-service time and distance totals for the Reference Case and option were extracted from the Wellington Passenger Transport Model by mode. The Bus Priority option cost is similar to the Reference Case (\$88 million per annum) as the services and frequencies remain the same. Bus Rapid Transit has a lower cost (\$6 million per annum less), which is due to the optimisation of routes and services made possible through more consistent travel times. Light Rail Transit has a marginally higher cost (less than one million dollars per annum), this is due to the inclusion of track maintenance, additional staffing, and that total bus kilometres have not reduced enough to offset the growth in Light Rail Transit kilometres.

Economic Evaluation

The economic evaluation assessed the viability of the Bus Priority, Bus Rapid Transit and Light Rail Transit options against the Reference Case. These include benefits to public transport users (both new and existing), benefits to road users, the wider economic benefits that arise from the spatial concentration of economic activity and the benefits

of incurring cost of providing car parking (reduced cost). The evaluation process is fully documented in the Option Evaluation Report, including an explanation of the model inputs, the method of evaluation and key assumptions.

The evaluation was broadly carried out using the procedures developed by the NZTA and presented in the Economic Evaluation Manual at that time. Benefits and costs were calculated for a 30 year period and an 8% discount rate to provide a present day value (net present value). The ratio of total benefits to costs provides a Benefit Cost Ratio (BCR) allowing the value for money of each option to be compared.

To understand the robustness of the outcome key assumptions in calculating the Benefit Cost Ratio were varied in a number of sensitivity tests. These included:

- Reducing the construction costs (- 20%)
- Assuming a 6% discount rate and 40 year evaluation period, recognising the long term strategic nature of the options. (This has subsequently been adopted as part of the NZTA EEM)
- An alternative “behavioural cost” evaluation which uses perceived costs as the value of time. Traveller cost is based on the perceived value of time used in the transport model in calculating the total cost of travel. This is documented in the Greater Wellington Regional Council Modelling Report.

Table 7 displays the resulting evaluations including the assumed construction timeline for options, net present values for costs and benefits and resulting Benefit Cost Ratio.

The economic evaluation results can be summarised as:

- The Bus Priority option has the lowest cost followed by Bus Rapid Transit and Light Rail Transit
- The Bus Rapid Transit option provides the highest benefit (\$90 million) followed by Light Rail Transit (\$31 million) and Bus Priority (\$ 21 million)
- Bus Rapid Transit returns the highest Benefit Cost ratio (0.87) and is above 1.0 in all sensitivity tests
- The Benefit Cost Ratio for Bus Priority ranges between 0.57 and 0.81 depending on evaluation assumptions

- The Benefit Cost Ratio for Light Rail Transit is 0.05
- The sensitivity tests increase the Benefit Cost Ratio for each option but the relativity between them remains the same.

Table 6 Construction costs

Description	Bus Priority (\$ millions)	Bus Rapid Transit (\$ millions)	Light Rail Transit (\$ millions)
Road alterations	26	76	94
Alterations to existing services	2	15	52
Traffic management	6	19	25
Rails and power	-	-	119
Depots	-	-	23
Tunnels	-	-	316
General Allowances	15	34	65
Vehicles	-	28	88
Design and contingencies (20%)	10	35	156
TOTAL	59	207	938

Table 7 Economic evaluation

Assessment	Bus Priority	Bus Rapid Transit	Light Rail Transit
First Year of Benefits	2016/17	2017/18	2019/20
Total NPV Benefits (\$ million)	21	90	31
Total NPV Costs (\$ million)	36	104	671
Wider Economic Benefits (25%, \$ million)	4.1	18.0	6.1
EEM BCR	0.57	0.87	0.05
Sensitivity Tests			
Decreased costs (-20%)	0.78	1.27	0.06
Discount rate and evaluation period	0.81	1.49	0.05
Alternative Approach	0.67	1.55	0.10

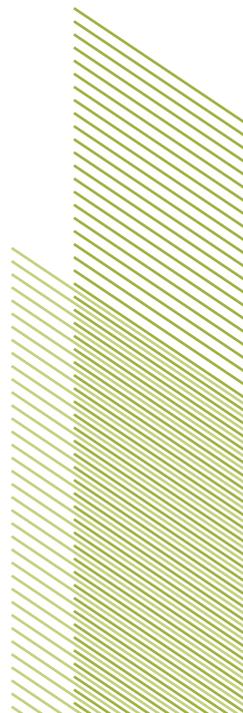


Summary of Option Results

Table 8: Summary of Option Evaluation Results

		Ref Case	Bus Priority	Bus Rapid Transit	Light Rail Transit
Option	km of dedicated route	–	10	9	10.2
	New vehicles	–	–	40	22
	New Depots	–	–	–	1
	Headway of service on Kent/Cambridge (mins at peak)	1.5	1.5	1.8	2.3
Cost	\$ CAPEX (million)	-	59	207	940
	\$ OPEX per annum (million)	88	88	83	89
Benefits	Passenger numbers: AM peak (in an hour)				
	2021 (regional)	35,600	35,800	36,300	35,800
	2031 (regional)	34,000	34,300	34,800	34,300
	2041 (regional)	35,200	35,500	36,100	35,600
	From Locations to CBD				
	Miramar	1320	1380	1490	1250
	Kilbirnie	680	720	760	770
	Mount Victoria / Hataitai	790	800	740	750
	Island Bay / Berhampore	1140	1170	1240	1080
	Newtown	790	820	880	830
	Travel Measures (2031 morning peak)				
	Travel times to CBD				
	From Kilbirnie	25	22	13	13
From Newtown	18	15	12	12	
Transfers					
Kilbirnie	160	280	210	1340	
Newtown	50	60	150	1020	
CBD	7790	7700	9100	9580	
Economic Assessment (BCR)	EEM	–	0.57	0.87	0.05
	Alternative Approach	–	0.67	1.55	0.10

		Ref Case	Bus Priority	Bus Rapid Transit	Light Rail Transit
Environmental and social assessment	Widening		Constable Street	Ruahine Street	Ruahine Street Paterson Street
	Parking		Peak Period	Removal in some locations	Removal in some locations
	Property Access CBD		Impacts during Peak period	Impacts during Working Hours	Impacts during Working Hours
	Planning, environmental and social impacts		Marginal	Significant	Very Significant
Potential broader impacts	Typical property price increase (Source: International Review)	-	Little attraction	Up to 20%	Up to 25%



9. STAGING OF OPTIONS



Staging of Options

The optimal staging of the three preferred options (Bus Priority, Bus Rapid Transit and Light Rail Transit) are outlined in Chapter 9. Contributing factors to the staging are typically three to five years required for planning, consultation and environmental approvals, and two years for pre-construction and procurement activities. Construction of each public transport option will depend on a variety of factors as outlined below.

Bus Priority

This option is able to be developed incrementally as opportunities arise and as resources are available. Staging would follow the direction given by the Wellington City Council bus priority plan, which starts in the CBD along the Golden Mile and works outwards along key corridors. In addition, opportunities to construct priority bus lanes as part of other planned road construction projects would be taken wherever possible. This includes the Basin Reserve Bridge and Adelaide Road upgrade projects.

Limited time would be needed for planning, consultation and environmental assessment along most parts of the route, as there is very limited impact on properties and businesses.

Constable Street is likely to be the last stage of development as it is of lesser overall priority due to low passenger demand. This stage has significant constraints due to the restricted road width and potential significant impacts on surrounding properties.

Bus Rapid Transit

As this option requires dedicated bus lanes to be placed in a different road layout, its staging needs to consider how it could be implemented to allow easy transition between road sections. It is also reliant on other road construction projects such as the Basin Reserve Bridge and Mt Victoria Tunnel duplication being constructed.

For those sections of the route where bus lanes are proposed along the median (Kent/Cambridge Terraces, Adelaide Road and Riddiford Street), a new road layout will be required. This will require a more detailed consideration for bus stops and stations compared to bus lanes on the left hand side of roads. This study has not considered in detail the final design, but has identified that there

are feasible solutions such as staggered stations or contraflow bus lanes on Kent/Cambridge Terrace.

The timing of the construction of the Basin Reserve bridge project is currently 2014-16, and the Mt Victoria Tunnel duplication is 2018-22. The Bus Rapid Transit route to Kilbirnie cannot be developed until these projects are in place.

From a demand perspective, patronage forecasts show that the Bus Rapid Transit route to Kilbirnie would have sufficient patronage to justify construction by 2021, whereas patronage on the Newtown route would indicate construction at a later timeframe.

A further factor to be considered is that the benefits of the Bus Rapid Transit option also rely on the introduction of higher capacity vehicles. The full benefit of these in reducing bus congestion along the Golden Mile, can only be realised once they are in full operation.

An incremental development of the Bus Rapid Transit option could be considered to provide sections of the route where transition is possible. However, the maximum benefits of Bus Rapid Transit are only realised when a complete system is operational and as such the ideal staging would be for the entire network to be developed in one phase.

Taking these factors into account the optimal staging and timing for completing the Bus Rapid Transit option in its entirety is by 2022.

Leading towards this timeframe, there are some measures that should be considered for early action:

- Construction of dedicated bus lanes in the Bus Rapid Transit option layout from Wellington Rail Station to Courtney Place. These can be developed independently of the other sections of the route.
- Purchase of any land parcels required.
- Ensuring that the Bus Rapid Transit option is factored into the planning and design of relevant RoNS projects and other land use and transport planning projects.

Light Rail Transit

As this option requires dedicated Light Rail Transit lanes to be placed in a different road layout, its staging needs to consider how existing bus services will be affected, until the network is fully operational. It is also integrally linked to the timing of other road construction projects such as the Basin Reserve Bridge and Mt Victoria Tunnel duplication.

For those sections of the route where Light Rail Transit lanes are proposed along the median (Kent/Cambridge Terraces, Adelaide Road and Riddiford Street), a new road layout will be required with stops along the median.

Existing buses using these corridors will only be able to use the dedicated Light Rail Transit lanes if they have doors opening on both sides, which is not likely to be a feasible solution. Alternatively, the network could be designed to provide an interim solution to accommodate a combination of contra-flow lanes and stations positioned to allow left hand doors.

The timing of the construction of the Basin Reserve bridge project is currently 2014-16, and the Mt Victoria Tunnel duplication is 2018-22. The Light Rail Transit route to Kilbirnie, which requires a new separate tunnel through Mt Victoria, would ideally be developed in the same timeframe as these projects to minimise cost and disruption.

From a demand perspective, patronage forecasts show that the Light Rail Transit route to Kilbirnie would have sufficient patronage to justify construction by 2021 (excluding economic viability), whereas patronage on the Newtown route would indicate construction at a later timeframe.

A further factor to be considered is that the benefits of the Light Rail Transit option also rely on the introduction of higher capacity vehicles at a high frequency. The full benefit of these in reducing bus congestion along the Golden Mile can only be realised once the Light Rail Transit option is implemented in its entirety.

Whilst an incremental development of the Light Rail Transit option could be considered, at a minimum this would have to provide for the construction of one complete 'branch' of the Light Rail Transit route. From a demand perspective this would be the route from the Wellington Rail Station to Kilbirnie, which has the highest forecast patronage.

Providing a short section of Light Rail Transit through the CBD would not be successful as this would require bus passengers to transfer close to their final destination.

However an incremental development approach would cause operational difficulties for existing buses. The existing high frequency No 1 bus route would continue to operate in this scenario and would either have a forced transfer to Light Rail Transit at the Basin Reserve or would have to run along the same corridor as Light Rail Transit. This would be a less preferable design solution that would be confusing for users and undermine the perception of a 'step-change'.

The maximum benefits of Light Rail Transit are only realised when a complete system is operational, and both 'branches' of the Light Rail Transit option are operational, providing a two and half minute frequency of service through the CBD, and allowing passengers to transfer in suburban locations. Once fully operational there would be few bus services remaining along the corridor.

Taking these factors into account the optimal staging and timing for the Light Rail Transit option is to be implemented in its entirety by 2022.

Leading towards this timeframe, there are some measures that should be considered for early action:

- Construction of dedicated public transport lanes in the Light Rail Transit option layout from Wellington Rail Station to Courtney Place. These can be developed independently of the other sections of the route.
- Purchase of any land parcels required.
- Ensuring that the Light Rail Transit option is factored into the planning and design of relevant RoNS projects and other land use and transport planning projects.
- Early development of a tunnel solution as part of joint project with the New Zealand Transport Agency for the Mt Victoria Tunnel duplication.



10. SUPPORTING POLICY INTERVENTIONS



Supporting Policy and Actions

The options provide a range of improvements which include increased ease of movement and priority through identified corridors using high frequency services to connect key locations. The concepts that each option represents has been tested and refined through the study to provide alternatives with a range of benefits and costs. However, infrastructure and service improvements provide only part of the solution. There is also a need to support the use of public transport through other policies and actions.

One of the challenges facing all of the options is that of increased road capacity being delivered in the same timeframe through the RoNS programme. The assessment of the future Reference Case revealed that in the future it would be faster to travel to the CBD by car and that the equivalent public transport trips became relatively slower over time.

To test the impact of potential policies and actions aimed at incentivising the use of public transport a number of sensitivity tests have been carried out. These include:

- The geographic distribution of population growth
- Public transport fare levels.
- Commuter parking availability and cost
- Timing of the RoNS programme

The results of the sensitivity testing reveals that implementing a range of other policy interventions can have a significant effect on overall public transport patronage and improve the viability of the options.

The geographic distribution of population and economic growth is an important factor that underpins future public transport patronage. Land use change, such as increased intensification around stations/stops can also result from investment in high quality public transport. It will be important that land use policies direct and allow future growth along the growth spine. The Reference Case land use forecast included planned intensification along the Wellington Growth Spine.

Public transport fares are a further tool that impact directly on passenger numbers as well as overall fare revenue. A decrease in fares would provide

for increased passengers, but at the expense of revenue. Similarly an increase in fares would reduce the number of passengers, but increase revenue. It will therefore be important to consider what proportion of each option's costs can be recovered through fares without reducing forecast patronage.

The availability of commuter parking appears to be a key policy intervention that is worthy of further investigation. Restraining the future availability of commuter parking to the same level as in 2011 could result in up to a 7% increase in the share of trips for public transport in all the options. This aligning of related policies and programs would be necessary to realise the full benefits of any of the options.

Policy Tests

Table 8 describes the key policy tests modelled to assess the impacts of policies and infrastructure investment on patronage and the resulting Benefit Cost Ratio.

Parking

In future forecasts the decision of whether to travel by car to the CBD is based upon comparative costs and perceptions of travel. Commuters driving to the CBD will take the future year cost to park into account with an assumption (in the model) that there is adequate parking available for all drivers.

This policy test imposes a cap which limits commuter parking to 2011 levels and tests a future where the choice of travel to the CBD by car takes into account a limited capacity for parking. Table 9 displays the effect of introducing the parking constraint in the Bus Rapid Transit and Light Rail Transit options. The effect is significant, increasing patronage by 1,600 – 2,100. This indicates that there are significant trips by car to the CBD which could be carried by public transport, if parking are not increased. The change in the Benefit Cost Ratio also highlights that the options provide significant benefits to users compared to the Reference Case.

Network Improvements

The future forecasts of travel in the Reference Case shows an increase in public transport patronage between 2011 and 2021 with a decrease between 2021 and 2031. This is due to the inclusion of substantial investment in the State Highway Network which is included in the 2031 assumptions. Projects such as

Table 9: Policy Test Details

Aspect	Base Assessment	Details
Parking	Future year costs and unrestricted parking	Cap the demand for total parking in the CBD to recognise that parking provision will not continue without limits. This is implemented based upon the adjustment of future parking costs.
Network Improvements	Planned investment program	Deferral of some key RONS projects beyond 2041 - Petone to Grenada, Transmission Gully , Mt Victoria Tunnel Duplication

Table 10: Changes in 2031 AM Patronage Due to Parking Capacity.

	Reference Case	Bus Rapid Transit	Light Rail Transit
Base PT Trips	34,000	+ 800	+ 300
Revised PT Trips	-	+ 2,100	+ 1,600
Base BCR	-	0.87	0.05
Revised BCR	-	1.29	0.12

Table 10 Changes in 2031 AM Patronage with the RoNS deferred

	Reference Case	Bus Rapid Transit	Light Rail Transit
Base PT Trips	34,000	+ 800	+ 300
Revised PT Trips	34,400	+ 800	+300
Base BCR	0.57	0.87	0.05
Revised BCR	-	0.70	0.02

the Mount Victoria Tunnel duplication, Petone to Grenada and Transmission Gully projects provide significant additional road capacity. This increase in road capacity leads to the forecast decrease in public transport patronage as there are decreases in the time taken to travel by car relative to public transport.

This test is designed to assess the benefits of the options if the planned investment in road capacity would be deferred until after 2041. The results have been compared against a Reference Case which also has this deferral to provide a comparative base.

Table 10 indicates that whilst deferring investment results in increased public transport patronage, it does not change the relativity between the options and the Reference Case. The inclusion of the options increases the patronage by the same amount, suggesting that they provide similar benefits across a range of base assumptions. The deferral of investment in the State Highway network provides a lower BCR for both options, suggesting that the additional capacity provided by the investment in roading projects offsets the reductions in road capacity, that are represented in the options.

11. TREASURY BETTER BUSINESS CASE



Preliminary Programme Business Case for the Wellington Public Transport Spine Study

Strategic Case: Refer to Section 11.1

Strategic Context

- This study was a recommendation from the Ngauranga to Airport Corridor Study, which was a multi-modal corridor study covering the Ngauranga Merge through the Wellington City CBD to Newtown, the Eastern Suburbs and Wellington International Airport.
- The Wellington PT Spine is identified in, and aligned to, both the Regional Land Transport Study (RLTS) and the Regional Passenger Transport Plan (RPTP).
- The PT Spine is a key strategic route to provide a high frequency and high quality public transport system for passenger transport between the Wellington Railway station and the Wellington Regional hospital. The original study has been extended to Kilbirnie which is a key growth node on the N2A corridor.

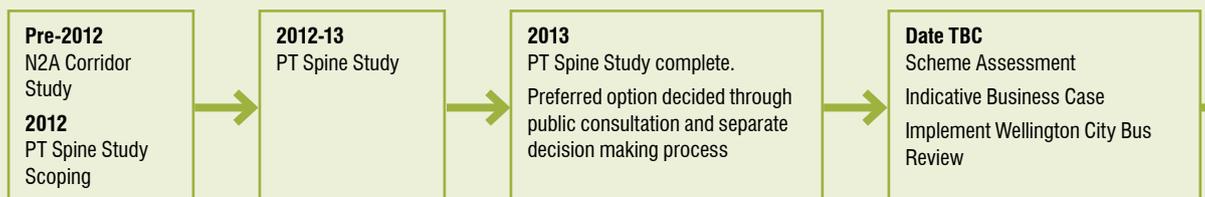
Investment Objectives and Case for Change

Objective 1: To Improve PT reliability and efficiency	
Existing arrangements	Golden Mile congested with buses at peak times.
Business Needs	To reduce bus congestion on Golden Mile and improve safety
Scope	PT from Station to Hospital (+ Kilbirnie)
Benefits	PT User and Road User Benefits
Risks	Low benefits, high costs
Constraints	Funding, Space, Capacity

Objective 2: To provide high frequency and high quality PT System	
Existing arrangements	Golden Mile congested with buses at peak times. Physical space a premium.
Business Needs	To meet future growth in PT Demand
Scope	Frequency <=5 minutes
Benefits	PT User & Road User Benefits
Risks	Low benefits, high costs
Constraints	Funding, Space, Capacity

Objective 3: To provide PT that is affordable	
Existing arrangements	GW/NZTA currently subsidise services with a farebox recovery of 55 %.
Business Needs	Maintain, or improve farebox recovery to assist achieving national target, 50%
Scope	Farebox recovery measured for Wellington region.
Benefits	Maintain or reduce subsidy.
Risks	Increased net OPEX
Constraints	Funding, Fares

Management Case: Refer to Section 11.5



Economic Case: Refer to Section 11.2

The Preferred Programme that best achieves the objectives

Dimension of Programme Choice:	Potential Programme Options			
	Reference Case	Do Moderate	Do Moderate plus	Do Maximum
Scope: What?	Existing bus service	Bus Priority	Bus Rapid Transit	Light Rail Transit
Service Solution: How?	Includes Wellington City Bus Review	Extend existing bus priority lanes	Create Bus Right of Way	Build Light Rail system
Service Delivery: Who?	GW/Private Sector	GW/WCC/NZTA	GW/WCC/NZTA	GW/WCC/NZTA/ Private Sector
Implementation: When?	Over next ten years' e.g. WCC bus review 2014	0-5 years	2022 (in its entirety)	Post 2022
Funding: How can programme be funded?	No change to existing subsidy	WCC/NZTA Capital Funding	GW/WCC/NZTA Capital Funding	GW/WCC/NZTA/ Private Sector

The Preferred Programme:

To be determined once a preferred option agreed subject to public consultation and a separate decision making process

Commercial Case: Refer to Section 11.3

The Potential Deal:

Bus priority and BRT have traditionally been funded by the NLTP once the Profile meets funding threshold and subject to NLTP funding constraints.

Overseas LRT schemes have in some cases been procured through other mechanisms such as PPP. Attractiveness typically depends on who takes revenue/patronage risks. Most PPP schemes currently assume availability payments with revenue risk taken by private sector.

Financial Case: Refer to Section 11.4

Indicative Programme Costs

Whole of Life Capital

- Bus Priority: \$ 59 m
- BRT: \$ 207 m
- LRT: \$ 737 – 938 m

Whole of Life Operating

- Bus Priority: \$ 88 m/yr
- BRT: \$ 83 m/yr
- LRT: \$ 89 m/yr

Affordability:

Summary funding requirements:

Capital

Bus Priority: \$ 59 m

BRT: \$ 207 m

LRT : \$ 737-938 m

BRT would require NLTP funding not currently identified.

LRT may require private funding.

OPEX already funded by rates/fares.

Alternative to Funding Study is a separate study and programmed for completion July 2013.

Date TBC
Scheme Assessment
Detailed Business Case

Date TBC
Implement short term measures
e.g. extend BP
Plan longer term measures e.g.
BRT, LRT

Achievability:

Once the overall programme business case is agreed by GW/WCC/NZTA individual projects will need detailed business cases which will be submitted to the funding agencies for funding approval. Implementation of each project will involve detailed design, procurement and construction.

Overview

The overall study results have been brought together and summarised in a preliminary programme Treasury Better Business Case (TBBC) framework, as set out on the opposing page. The TBBC was introduced by the National Infrastructure Unit in 2010 in response to the growing pressures on Government funding, recognised the need to focus on the right investment whilst getting the best value possible. Government projects over \$ 25 million must apply the TBBC framework as part of the process of seeking Cabinet support and funding. The TBBC is also being applied to a growing number of projects outside the government where the components are likely to seek government funding.

The TBBC has introduced a significantly higher test for planning and delivery of capital projects than has existed in the past. It requires more explicit and thorough analysis on the proposed investment. To that end as outlined on the opposing page it tests the three preferred solutions (Bus Priority, Bus Rapid Transit and Light Rail Transit) in terms of:

- Being supported by a robust case for change
 - **the strategic case**
- Maximising the value for money
 - **the economic case**
- Being commercially viable
 - **the commercial case**
- Being financially affordable
 - **the financial case**
- Being achievable
 - **the management case**

Each of these criteria is discussed further below.

Strategic Case

The purpose of the strategic case is to demonstrate that the investment proposal is well-aligned to government policy objectives, regional policy objectives and to organisational strategy. The strategic case should provide a robust and well evidenced case for change and clear specification of the investment objectives and required service needs. Key components of the Strategic Case (business needs, benefits) were developed through Service Logic and Investment Prioritisation workshops.

Strategic context

The Public Transport Spine Study was identified in the *Ngauranga to Airport Corridor Study (N2A)*. The N2A corridor study identified the public transport spine as a key strategic route that needs to provide a high frequency and high quality PT system for passenger transport. The N2A corridor study recommended that the PTSS should be undertaken to investigate public transport options in further detail between the Wellington Railway station and the Wellington Regional hospital. The Wellington Public Transport Spine is identified in, and aligned to, both the Regional Land Transport Study (RLTS) and the Regional Passenger Transport Plan (RPTP).

The original study has been extended to Kilbirnie which is a key growth node on the Wellington City Growth Spine to better support the strategic case. Kilbirnie is also a key strategic public transport route in the Regional Passenger Transport Plan.

Investment objectives and case for change

The Investment objectives are :

- To improve the reliability and efficiency of public transport within the Wellington CBD
- To provide a high quality and high frequency public transport system on the public transport spine
- To provide public transport that is affordable for passengers and ratepayers

Existing arrangements

- The Wellington public transport system exhibits varying degrees of congestion at both peak and off peak times along the Golden Mile and Public Transport Spine corridor, “affecting the reliability and attractiveness of CBD bus services through the Golden Mile during peak commute periods” .
- Physical space is at a premium along the Golden Mile, limiting the opportunity to make even minor improvements by allocating additional space for existing public transport services.
- The current public transport system plays an essential role in providing for travel into the CBD and reducing the reliance on single occupant vehicles.
- The safety record along this corridor has come into question after a series of incidents involving buses and pedestrians.

- Bus services in Wellington are currently provided on a commercial basis where possible. However, most services are provided on a subsidised basis. Subsidies are provided by the New Zealand Transport Agency and by Greater Wellington Regional Council on a 50/50 basis. The average farebox recovery ratio in the Wellington region is around 55%. The New Zealand Transport Agency’s farebox policy is targeting an improvement in farebox recovery nationally to an average of 50%.

Problem Definition

The problems with the Wellington public transport spine that must be addressed to meet business needs are:

- Longer and unreliable journey times, worsening over future years, for public transport resulting from too many vehicles and modes sharing a constrained corridor
- Increased congestion in the strategic and local road network and additional environmental impacts as a result of less mode share for public transport
- Constrained economic growth and productivity in Wellington
- Reduced value for money and effectiveness for current and planned investment in public transport from the uncertain shape and nature of the long term future public transport system.

Scope

The potential business scope involves improvements to public transport along the public transport spine from Wellington Railway Station to Wellington Hospital, as well as Kilbirnie.

The key service requirements are that travel times between key destinations should be improved as well as reliability of the service and frequency. This should be done in a way that improves safety of the transport system for all types of user including public transport users, car users, pedestrians and cyclists.

Key Benefits

The benefits of addressing the problems (Business Needs) will be:

- Reduced travel times along the public transport spine
- Reliable journey times along the public transport spine

- Enhanced attractiveness and increased mode share for public transport
- Reduced overall congestion and environmental impacts in the road network
- Enhanced value for money and effectiveness for investments in the public transport system

Key Risks

- Potential lack of political support for proposals
- Potential lack of funding available, particularly for higher capital cost options
- Early construction of road projects reduces public transport demand
- Public transport demand is lower than forecast, due to unforeseen circumstances
- Increased congestion for car users if public transport services are not properly integrated
- Slower than anticipated and unreliable journey times if right of ways not sufficient
- Fare revenues lower than forecast leading to lower farebox recovery
- Operating costs of public transport higher than forecast, due to unforeseen circumstances
- Capital costs of options higher than forecast, due to unforeseen circumstances

Key constraints

- Space in the corridor is at a premium due to the Wellington CBD geography located in a narrow strip between the hills and the port
- Funding constraints on the NZ Transport Agency and the National Land Transport Fund, rate payer funding from Greater Wellington Regional Council and Wellington City Council and user willingness to pay for fares.
- Affordability of tunnelling through Mount Victoria to get from the Basin to Kilbirnie

Assessment of options against the problem definition

Table 11 displays a summary of the option results against the problem definition developed through the ILM process.



Table 11: Comparison of options against problem definition

Longer and unreliable journey times, worsening over future years, for public transport resulting from too many vehicles and modes sharing a constrained corridor	
Bus Priority	<ul style="list-style-type: none"> – Peak period operation allows buses to bypass congestion on key corridors where congestion affects bus journey time. – Peak period bus lanes within the CBD would reduce conflict with general traffic at peak times. – Continuation of service patterns and frequencies is unlikely to address bus congestion along the Golden Mile unless higher capacity buses are used. – Results in a three minute travel time saving between Kilbirnie and the Wellington Railway Station and Newtown and the Wellington Railway Station (modelled 2031 morning peak).
BRT	<ul style="list-style-type: none"> – All day dedicated lanes with priority at signals result in buses travelling along semi-segregated corridors, bypassing congestion and providing a high level of reliability. – Travels with general traffic through the Mt Victoria tunnels increasing the risk of congestion impacting on trip reliability. – The use of high capacity buses, removal of general traffic, and a revised service pattern along with the use of a secondary spine within the CBD will reduce the overall number of buses on the Golden Mile to remove bus congestion. – Results in an 11 minute travel time saving between Kilbirnie and the Wellington Railway Station and a six minute travel time saving between Newtown and the Wellington Railway Station (modelled 2031 morning peak).
LRT	<ul style="list-style-type: none"> – Provides a high level of reliability and the ability to maintain a timetable due to LRT services travelling in a segregated corridor along the entire route. – The use of high capacity vehicles, removal of general traffic, a reliable timetable service and the use of a secondary spine within the CBD will remove congestion on the Golden Mile. – A dedicated Light Rail Transit tunnel through Mount Victoria provides a direct route to/from Kilbirnie separate to general traffic and potential congestion. – Results in an 11 minute travel time saving between Kilbirnie and the Wellington Railway Station and a six minute travel time saving between Newtown and the Wellington Railway Station (modelled 2031 morning peak). – Most bus services from the south/south-east terminate at key interchanges (Kilbirnie and Newtown), requiring a transfer for trips travelling along the Spine and creating a longer travel time.

Increased congestion in the strategic and local road network and additional environmental impacts as a result of less mode share for public transport

Bus Priority	A 3.2% increase in morning peak patronage from the south / south-east to the CBD in 2031 will reduce traffic slightly.
BRT	A 7% increase in morning peak patronage from the south / south-east to the CBD in 2031 would reduce traffic.
LRT	Less than 1% increase in morning peak patronage from the south/south-east to the CBD in 2031.

Constrained economic growth and productivity in Wellington	
Bus Priority	<ul style="list-style-type: none"> – Provides improved travel time to and through the CBD providing an improved level of service for travel along the Spine. – The International Review suggested property price increases to be marginal.
BRT	<ul style="list-style-type: none"> – Provides a high quality, high frequency public transport spine and supports future development along it. – Connects strategic destinations of the Wellington CBD, Regional Hospital and Kilbirnie/Mirimar/Wellington Airport with direct and frequent services. – Potential for property values to increase around stops and along the corridor. The International Review suggested property price increases to be in the region of 20%.
LRT	<ul style="list-style-type: none"> – Provides a high quality, high frequency public transport spine and supports future development along it. – Connects strategic destinations of the Wellington CBD, Regional Hospital and Kilbirnie with direct and frequent services. – Potential for property values to increase around stops and along the corridor. The International Review suggested property price increases to be in the region of 25%.

Reduced value for money and effectiveness for current and planned investment in public transport from the uncertain shape and nature of the long term future public transport system.	
Bus Priority	<ul style="list-style-type: none"> – Able to be developed incrementally as opportunities arise and as resources are available to realise benefits earlier. – Reallocating road space makes best use of existing infrastructure to minimise the costs of construction. – There are opportunities to construct priority bus lanes as part of other planned road construction projects. – Forecast benefits over a 30 year period are equivalent to \$21 million (in 2012 dollars) : – Benefit Cost Ratio ranges between 0.57 to 0.67.
BRT	<ul style="list-style-type: none"> – Can be implemented in stages to provide better segregation and priority over time. – Full benefits realised when the entire project is constructed and higher capacity vehicles replace buses on core routes. – Leverages off other planned road construction projects such as the Basin Reserve bridge project (2014-16) and the Mount Victoria Tunnel duplication (2018-22). – Provides improved certainty about the shape of a long term public transport system through the city. – Annual operating costs of running services are \$83 million per year which is 6% lower than the Reference Case. – Benefit Cost Ratio ranges between 0.87 to 1.55
LRT	<ul style="list-style-type: none"> – To gain benefits requires the construction of one complete 'branch' of the Light Rail Transit route. – Construction could be coordinated with the Basin Reserve bridge project (2014-16) and Mount Victoria Tunnel duplication (2018-22) to minimise construction disruption. – Provides improved certainty about the shape of a long term public transport system through the city. – Benefit Cost Ratio ranges between 0.05 to 0.01



Economic Case

The economic case is to demonstrate that all available options for delivering the required services and meeting the investment objectives have been thoroughly analysed. The preferred options should represent best value for money from a national economic perspective and under varying future scenarios.

The economic evaluation results are contained in section 8.4 and can be summarised as:

- The Bus Rapid Transit option provides the highest benefit (\$90 million) followed by Light Rail Transit (\$31 million) and Bus Priority (\$ 21 million)
- Bus Rapid Transit returns the highest Benefit Cost ratio (0.87) and is above 1.0 in all sensitivity tests
- The Benefit Cost Ratio for Bus Priority ranges between 0.57 and 0.81 depending on evaluation assumptions
- The Benefit Cost Ratio for Light Rail Transit is between 0.05 and 0.01 depending on evaluation assumptions

Commercial Case

The commercial case is to show that the preferred option will result in a transparent, accountable and sustainable procurement arrangement that achieves desired outcomes and provides value for money.

An initial assessment of the likely commercial viability of the proposed options is as follows:

Bus Priority

Bus priority measures can be funded by the NZ Transport Agency and Wellington City Council on a business as usual basis when the specific proposal meets funding requirements. Initial indications from the economic analysis are that each bus priority measure will need to be considered on its own merits to see which proposals meet funding requirements and should proceed. There is no cost to existing bus companies. Therefore such measures are likely to be commercially viable.

Bus Rapid Transit

In the past Bus Rapid Transit in other areas of New Zealand has been funded by the NZ Transport Agency from the National Land Transport Programme and in partnership with city and

regional council funding from rates. The North Shore Busway is an example. This could be commercially viable for the bus companies if the capital funding requirements could be met by the NZ Transport Agency, Wellington City Council and Greater Wellington Regional Council, or other alternative funding sources.

To be successful for capital funding the assessment of the project will need to meet the NZ Transport Agency's funding profile requirement, which is based on an assessment of Strategic Fit, Effectiveness and Efficiency.

Light Rail Transit

Light Rail Transit is a high capital cost option that involves a new light rail system and a complex change in bus service patterns to integrate with the light rail service. As a result Light Rail Transit systems overseas have in some cases been procured as a Public-Private Partnership (PPP). The commercial viability of a PPP would likely depend on the risk sharing proposed. Reliance on rates, fares or National Land Transport Programme funding is unlikely to be adequate. A range of broad-based alternative funding tools would need to be utilised to fund this option.

Financial Case

The financial case is an assessment that the preferred option can be funded and is affordable to both the Government and the organisational structure under various future scenarios.

A separate Alternative Funding Study is currently being undertaken and scheduled for completion in July 2013.

This should assist in informing the Financial Case. A summary of the funding requirements are:

Table 12: Funding Requirements

Option	Capital costs (millions)	OPEX costs (millions per annum)
Bus Priority	\$ 59	\$ 88
Bus Rapid Transit	\$ 207	\$ 83
Light Rail Transit	\$ 938	\$ 89

Management Case

The purpose of the management case is to demonstrate that the preferred option can be delivered successfully with best practice project and programme management. That includes setting the processes in place for change, risk and contract management as well as on managing the on-going delivery of expected benefits.

A preferred option will be decided through public consultation and a separate decision making process. A scheme assessment would cover aspects of the management case in terms of:

- the project mix
- key programme management arrangements
- key milestones
- the overall methodology
- the approach that will be taken to manage the programme on an on-going basis
- the achievability of the proposal and planning arrangements required to both ensure successful delivery and to manage programme risks
- the project governance structure
- initial project milestones



12.CONCLUSION



Conclusion

This document provides a summary of the Wellington Public Transport Spine Study carried out over an 18 month period. The study was undertaken on behalf of Greater Wellington and its partners the New Zealand Transport Agency and Wellington City Council.

An assessment of potential mode and alignment options has been considered through a selection process that has led to the identification of three potential options. At each stage of the selection process the options have been refined and reviewed, including extensions to the study area and the consideration of multiple corridors. The final evaluation (Short List) has been underpinned by transport model assessments developed specifically for this study to capture the latest land use and transport forecasts. The three options which serve the Newtown and Kilbirnie corridors are:

Bus Priority:

An enhanced bus network with greater priority at intersections and along key corridors, but using existing vehicle types.

Bus Rapid Transit (BRT):

Dedicated bus lanes for new high capacity vehicles as well as other system improvements to enhance frequency and journey times.

Light Rail Transit (LRT):

Dedicated lanes and tracks for new light rail vehicles as well as interchanges to transfer from other modes.

The key findings from the Study are:

- There is a need for future investment in public transport through central Wellington to achieve the goal of growing public transport mode share.
- A high quality, high frequency public transport spine has an important role within the Ngauranga to Airport Corridor, alongside RoNS, as part of a balanced long-term transport network for Wellington.
- There are opportunities to improve public transport mode share from the south and south-east of Wellington.
- Bus Rapid Transit provides the highest benefits to public transport users, followed by Light Rail Transit and Bus Priority.
- The cost of the most expensive option (Light Rail Transit) is almost five times that of the next most expensive option (Bus Rapid Transit).
- Bus Rapid Transit has the highest overall Benefit Cost Ratio (BCR), followed by Bus Priority then Light Rail Transit.
- The Bus Priority and Bus Rapid Transit option can be developed incrementally, however the optimal staging and timing for the Bus Rapid Transit and Light Rail Transit options is to be developed in one stage and completed around 2022.
- It is technically feasible to construct all of the options. For most of the route they can be accommodated within the existing road corridor. However, there are significant impacts on property from Bus Rapid Transit and Light Rail Transit options through Mount Victoria and along Ruahine Street and Wellington Road.

Table 13 International Case Studies Investigated

	Geography	Case Study
PRT	Europe	Heathrow, UK
	Middle East	Masdar City, UAE
	North America	West Virginia, USA
Bus Rapid Transit	Australia / Asia	<ul style="list-style-type: none"> – Beijing, China – Xiamen, China – Brisbane, Australia – Adelaide, Australia – Auckland, NZ
	Europe	<ul style="list-style-type: none"> – Rouen, France – Nantes, France
	North America	<ul style="list-style-type: none"> – Los Angeles, USA – Cleveland, USA – Denver, USA
	South America	<ul style="list-style-type: none"> – Bogota, Colombia – Curitiba, Brazil
Light Rail Transit	Australia / Asia	<ul style="list-style-type: none"> – Gold Coast, Australia – Melbourne, Australia – Hong Kong Island – Kagoshima, Japan
	Europe	<ul style="list-style-type: none"> – Bergen, Norway – Freiburg, Germany – Karlsruhe, Germany – Dublin, Ireland – Rouen, France – Eindhoven, Netherlands
	North America	<ul style="list-style-type: none"> – Minneapolis, USA – Portland, USA – San Diego, USA – San Francisco, USA – Seattle, USA – Vancouver, Canada
MRT	Australia / Asia	<ul style="list-style-type: none"> – Mumbai, India – Hong Kong – Republic of Singapore
	Europe	Lyon, France

APPENDIX B MODE DESCRIPTION AND APPLICATION



Appendix B1: Personal Rapid Transit



Stourbridge, UK

People Parry Mover

Definition: Lightweight trams and railcars that use flywheel energy storage (FES) to store energy for traction, allowing electric systems to operate without overhead wires or third rails.

Applicability: These units are generally smaller than Light Rail Transit and therefore carry few people. Suitable for fixed journey between a limited number of destinations.



Heathrow Terminal 5, UK

Personalised Rapid Transit

Definition: Pod cars are designed as personal vehicles typically carrying no more than three to six passengers per vehicle. Provides automated movement between multiple points.

Applicability: An emerging technology best suited to limited origin/destination networks. Does not handle interface with mass transit well due to wait times for pods, and linked capacity.

Appendix B2: Bus



Wellington, New Zealand

Bus on-street

Definition: Buses using traffic lanes within no priority lane treatments.

Applicability: Highly flexible mode that can operate at a local street level within the city centre as well as provide route services into suburbia



Wellington, New Zealand

Trolley Bus on-street

Definition: Trolley buses using traffic lanes within no priority lane treatments.

Applicability: Can operate at a local street level within the city centre as well as provide core route services into suburbia. The need for overhead power lines restricts use to specific, pre-planned routes



Mini-bus On Street

Definition: A mini-bus is a motor vehicle which carries more than 8 but not more than 16 seated passengers in addition to the driver.

Applicability: These vehicles are flexible enough to access most streets. They are usually used for special transport needs, or as a grid in hop-on-hop-off network, usually in third world countries



Credit Photo to - Arthur Akkermans

Bus Rapid Transit

Definition: A segregated facility which gives absolute right-of way priority to buses with high capacity vehicles and other improvements through a variety of traction powers available.

Applicability: A dedicated right of way may not fit into the profile of some city streets, although vehicles may run beyond dedicated lanes.



Adelaide, Australia

Guided O-Bahn Busway Elevated or Partially Elevated

Definition: A segregated busway design in which modified street buses enter and run on specially built track.

Applicability: Existing applications are related to route services in suburbia. Guided transitways are not easily compatible with pedestrians. Can leave the busway and operate similar to an 'on street bus'.



Appendix B3: Light Rapid Transit



Sydney, Australia

Monorail

Definition: Monorail operates on exclusive elevated segregated right of way.

Applicability: Few examples of application to commuter operations. Able to operate above street but expensive to run over extended distances in to the suburbs.



Seville, Spain

Light Rail Transit (Light Rail Transit)

Definition: A tram which normally runs on a dedicated alignment but can share road space with other users. Variety of traction power options available.

Applicability: More effective in dedicated reservations. Can extend beyond city centres by running on existing heavy rail tracks or tram lines.

Appendix B4: Mass Rapid Transit



Wellington, New Zealand

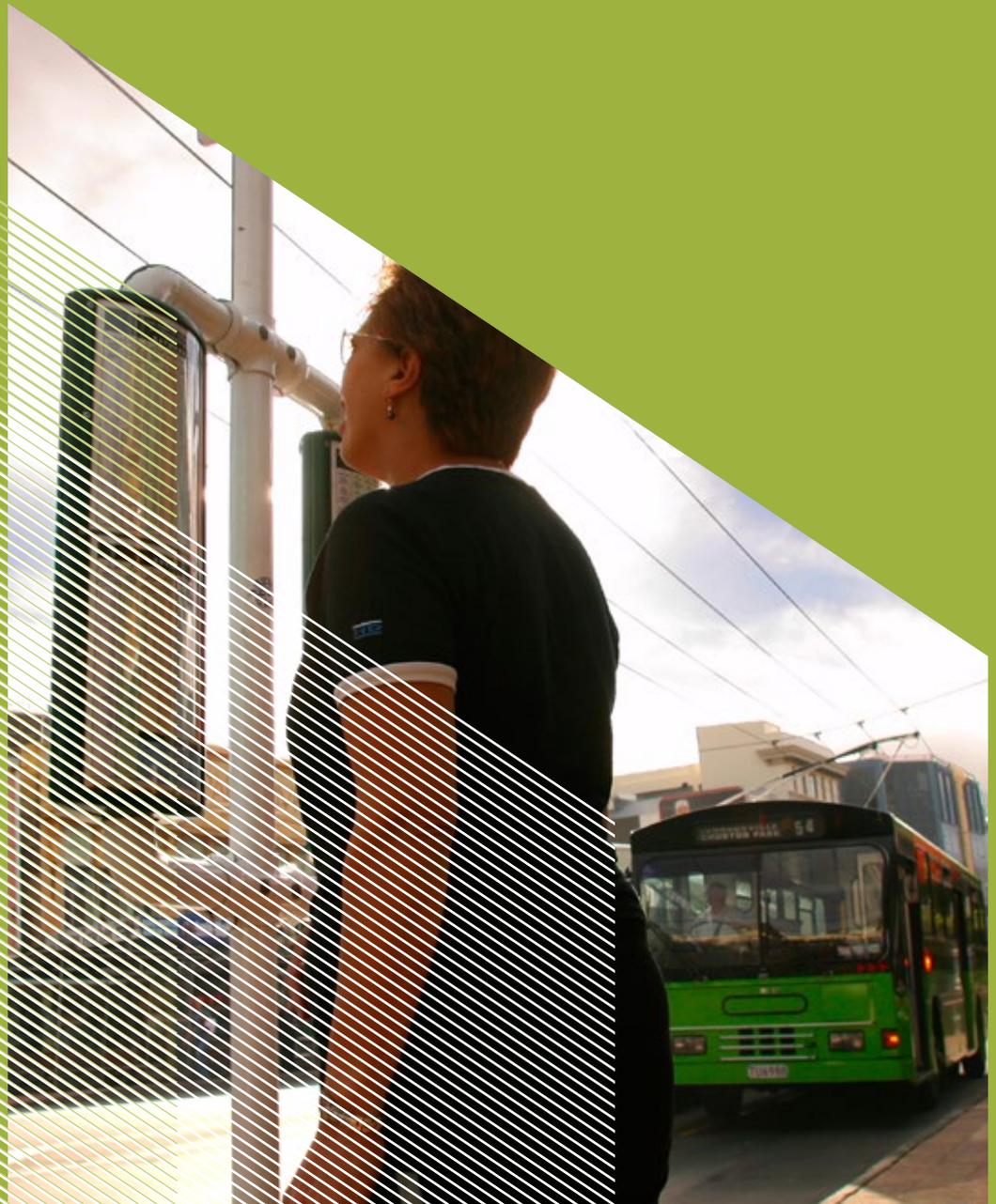
Heavy Rail / Metro

Definition: Heavy rail operates on a fixed segregated corridor which is generally placed in tunnel within city centres, although it is elevated in some cities with associated visual impacts.

Applicability: Opportunity exists to extend the existing rail network to provide commuters direct access through the city centre.



APPENDIX C OPTION COSTS



The following summary provides a breakdown of the current cost estimates. For each option, the costs involved are as follows:

- Bus Priority: An enhanced bus network with greater priority at intersections and along key corridors, but using existing vehicle types.
- Bus Rapid Transit (BRT): Dedicated bus lanes for new high capacity vehicles as well as other system improvements to enhance frequency and journey times.
- Light Rail Transit (LRT): Dedicated lanes and tracks for new light rail vehicles as well as interchanges to transfer from other modes. Dedicated tunnel through Mount Victoria.

	Distance	Cost	Cost/km
Bus Priority			
Wellington (Central) Public Transport Spine	5.7 km	\$16,149,000	\$2,833,000
Wellington (Southern) Public Transport Spine	1.3 km	\$5,946,000	\$4,574,000
Wellington (Southern) Public Transport Spine Constable	0.8 km	\$7,650,000	\$9,562,500
Wellington (Eastern) Public Transport Spine	2.5 km	\$14,062,000	\$5,625,000
General Allowances		\$5,000,000	
Design and Construction Contingencies	20%	\$9,761,000	
Total Construction Cost	10.3 km	\$58,568,000	\$5,686,000

Bus Rapid Transit			
Wellington (Central) Public Transport Spine	5.7 km	\$79,844,000	14,008,000
Wellington (Southern) Public Transport Spine	1.3 km	\$29,384,000	\$22,603,000
Wellington (Eastern) Public Transport Spine	2.5 km	\$25,566,000	\$10,226,000
General Allowances		\$37,800,000	
Design and Construction Contingencies	20%	\$34,519,000	
Total Construction Cost	9.5 km	\$207,113,000	\$21,801,000

Light Rail Transit			
Wellington (Central) Public Transport Spine	6.9 km	\$204,811,000	\$29,683,000
Wellington (Southern) Public Transport Spine	1.3 km	\$52,659,000	\$40,507,000
Wellington (Eastern) Public Transport Spine	2.5 km	\$37,661,000	\$15,064,000
General Allowances		\$486,536,000	
Design and Construction Contingencies	20%	\$156,333,000	
Total Construction Cost	10.7 km	\$938,000,000	\$87,663,000

Cost Excluding Victoria Rail Tunnels (incl. Contingency)	9.9 km	\$558,391,000	\$56,400,000
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The table below gives the potential range of costs for each option. The range is a 30% variation on the total construction cost.

Option	Total Construction Cost		
	Lower (-30%)	Estimate	Upper (+30%)
Bus Priority	\$40,998,000	\$58,568,000	\$76,138,000
Bus Rapid Transit	\$144,979,000	\$207,113,000	\$269,247,000
Light Rail Transit	\$656,600,000	\$938,000,000	\$1,219,400,000







