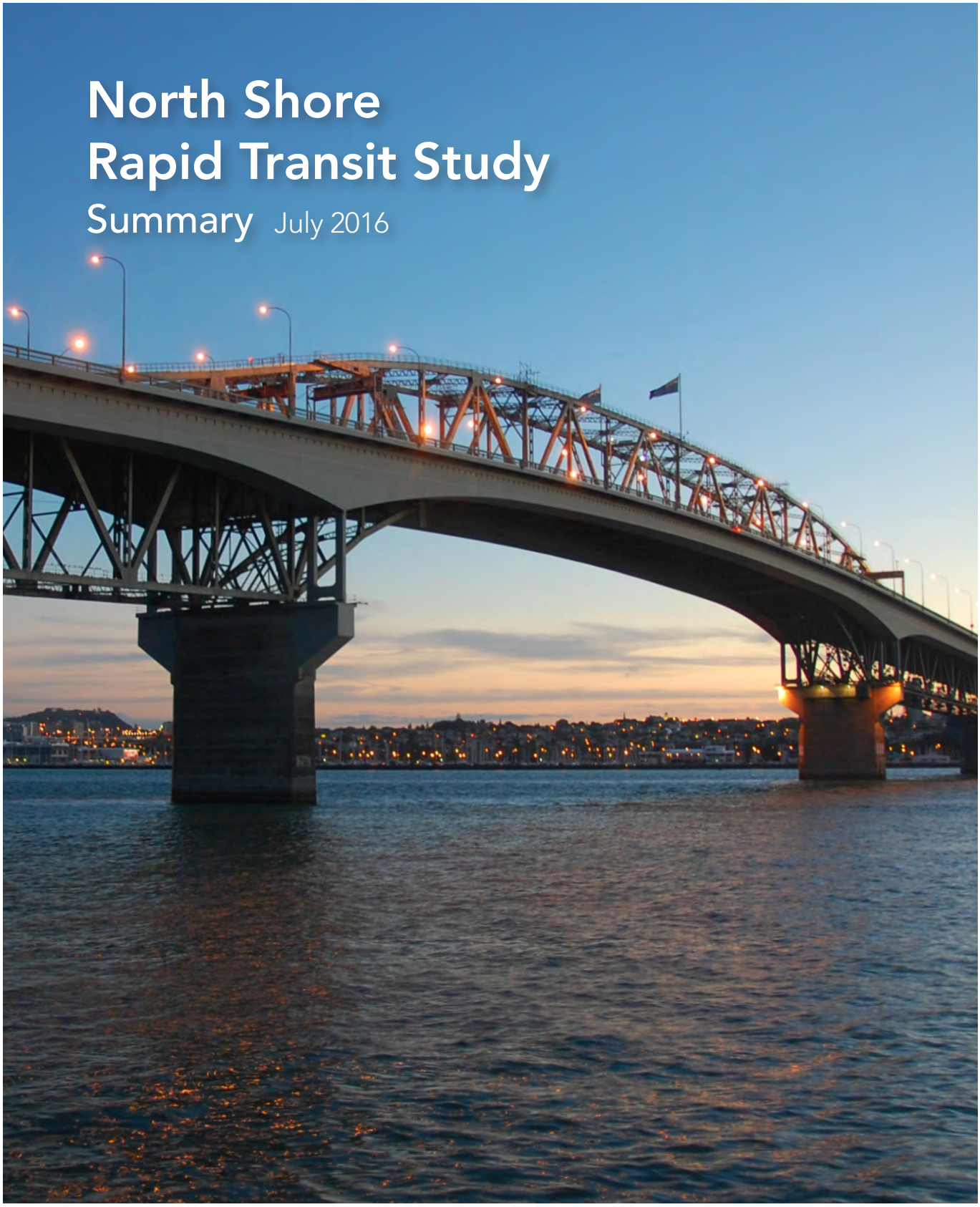
# North Shore Rapid Transit Study

## Summary July 2016



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# Contents

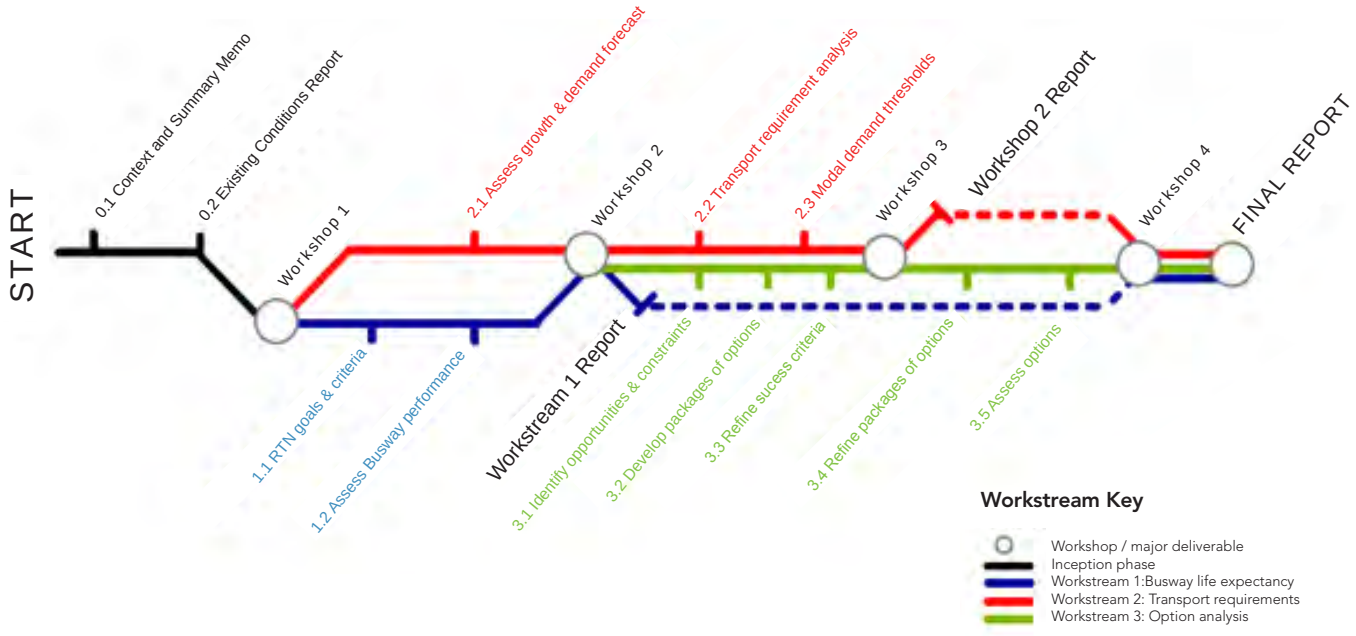
# 1 Purpose and Scope

Auckland Transport has been investigating the future public transport needs of the North Shore, as part of better-understanding the role and options for the Rapid Transit Network (RTN) in future cross-harbour transport plans. This document is a summary of three reports prepared as part of this study. These reports assessed the likely life expectancy of the current Northern Busway, updated the transport requirements from recent land use projection changes and (based on those two assessments) outlined a preliminary RTN mode option analysis.

This work was undertaken to inform the evidence base for future business cases for any North Shore RTN project. Further, more detailed investigations into these issues will continue in coming years, so this report represents the situation in mid-2016.

The study followed a process summarised in the diagram below:

The Northern Busway is the foundation of the current North Shore Rapid Transit Network (RTN). Investigations indicate that bus-only passenger transport is unlikely to be a long-term solution for the North Shore RTN. This raises the question as to what public transport mode could provide for long-term rapid transit demand.



# 2 Key changes since 2012

In 2012 the Land Use Preconditions for Rapid Transit in North Auckland Study assessed the timing and need for RTN on the North Shore. Developments in land use and transport planning require an update to this work and it is likely that more updates will be required given Auckland's significant rate of growth and change.

Land use planning assumptions have changed. The Unitary Plan is expected to increase infill capacity (by removing density controls), increase development capacity and accelerate greenfield land supply in Albany, Long Bay, Silverdale North, Silverdale South, Orewa West, Warkworth, Wellsford and Snells Beach. Metropolitan Centres are identified as Albany Centre and Takapuna. This is likely to increase the viability of, and requirements for, public transport in some areas of the North Shore.

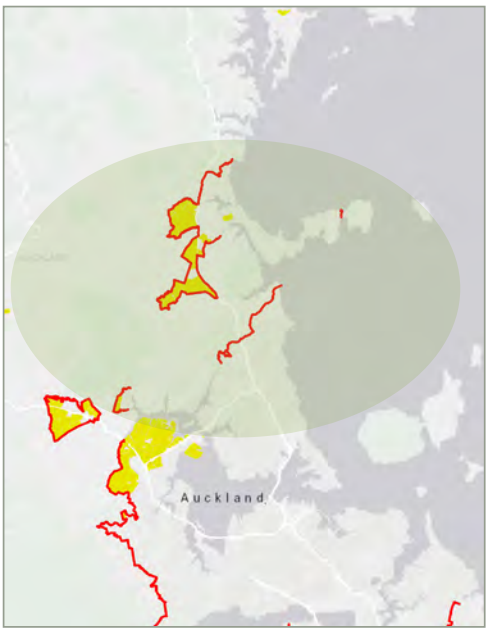
## 2.1 Land use planning

Following amalgamation, Auckland Council developed the Proposed Auckland Unitary Plan (PAUP) to provide for future urban growth by consolidating and revising pre-existing planning rulebooks.

The PAUP process is likely to result in further changes to planning policies, potentially including some liberalisation of density and building size controls and re-zoning of some areas. It has also resulted in changes to future greenfield land supply expectations.

We highlight three key changes:

**PAUP Future Urban Zones**




**First**, the PAUP aims to enable intensification of dwellings and employment in and around metropolitan and town centres. Albany and Takapuna have been rezoned as Metropolitan Centres, which enable building heights up to eighteen storeys and also remove other constraints on development, such as mandatory minimum parking requirements.

**Second**, greenfield land supply plans in the former Growth Concept have been progressed, and some new growth areas have been added. In particular, residential subdivision and development is currently proceeding in the Long Bay, Albany and Silverdale growth areas. Auckland Council's draft Future Urban Land Supply Strategy (FULSS) and the subsequent Future Urban Zone under the PAUP also include new greenfield growth areas.

**Third**, the PAUP makes some changes to controls on building size and dwelling density, as well as the spatial application of zones.

## 2.2 Public transport planning

### The New Network

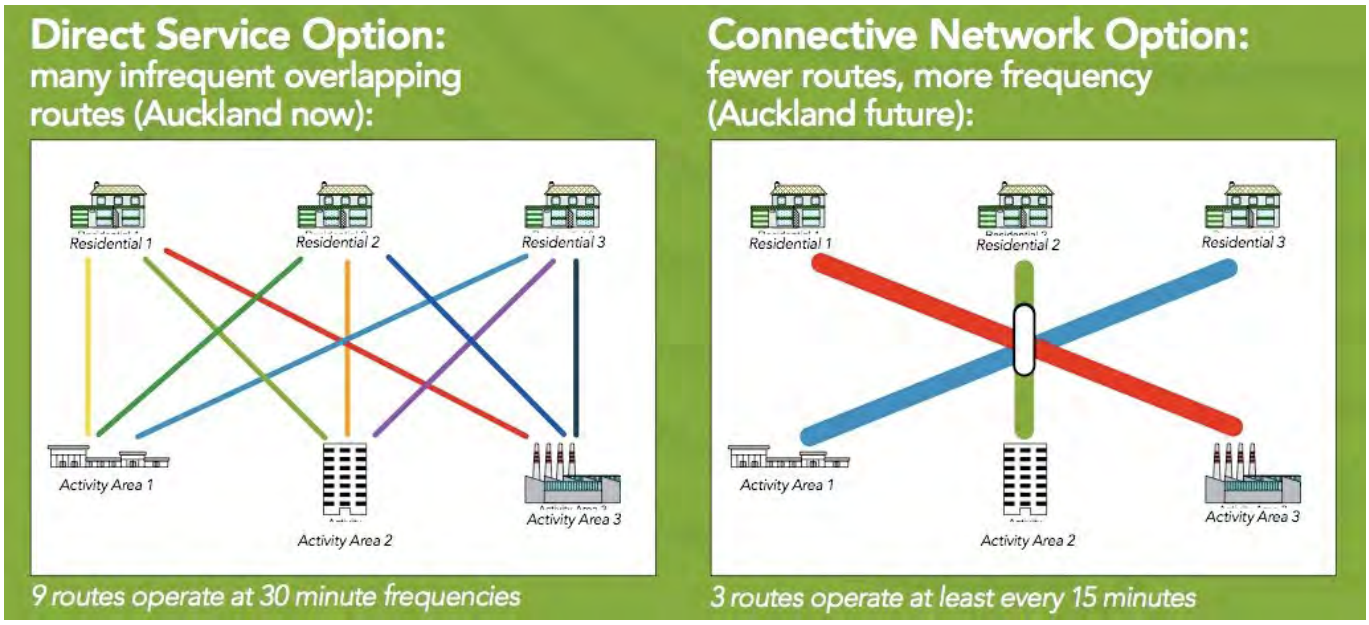
Since the 2012 study, Auckland Transport has undertaken a process to fundamentally redesign Auckland's public transport network.

The previous study was primarily based on the existing public transport network and service plan. This existing public transport network tries to provide everywhere-to-everywhere service, which results in a relatively complex network of routes operating at low frequencies.

In response to these issues AT has proposed to implement the 'New Network'. The New Network involved a major redesign of Auckland's public transport network. This focuses first on providing direct, high-frequency connections between major destinations, then using lower frequency local services to maintain coverage. These hierarchical service layers result in a simpler network with less duplication and much greater access to 'frequent' service (15 minutes or better, 7am–7pm). The New Network also changes the way services access and terminate in the City Centre.

Public transport planning principles have changed. There is a move towards an all-day frequent connected public transport network. The assumptions about service patterns from the 2012 report are no longer valid.

**General structure of the existing network (assumed in the 2012 study) versus the New Network**



More information is now available about the design, impact, and timing of key projects, including CRL, LRT, AWHC and as well as other public transport and major motorway projects.

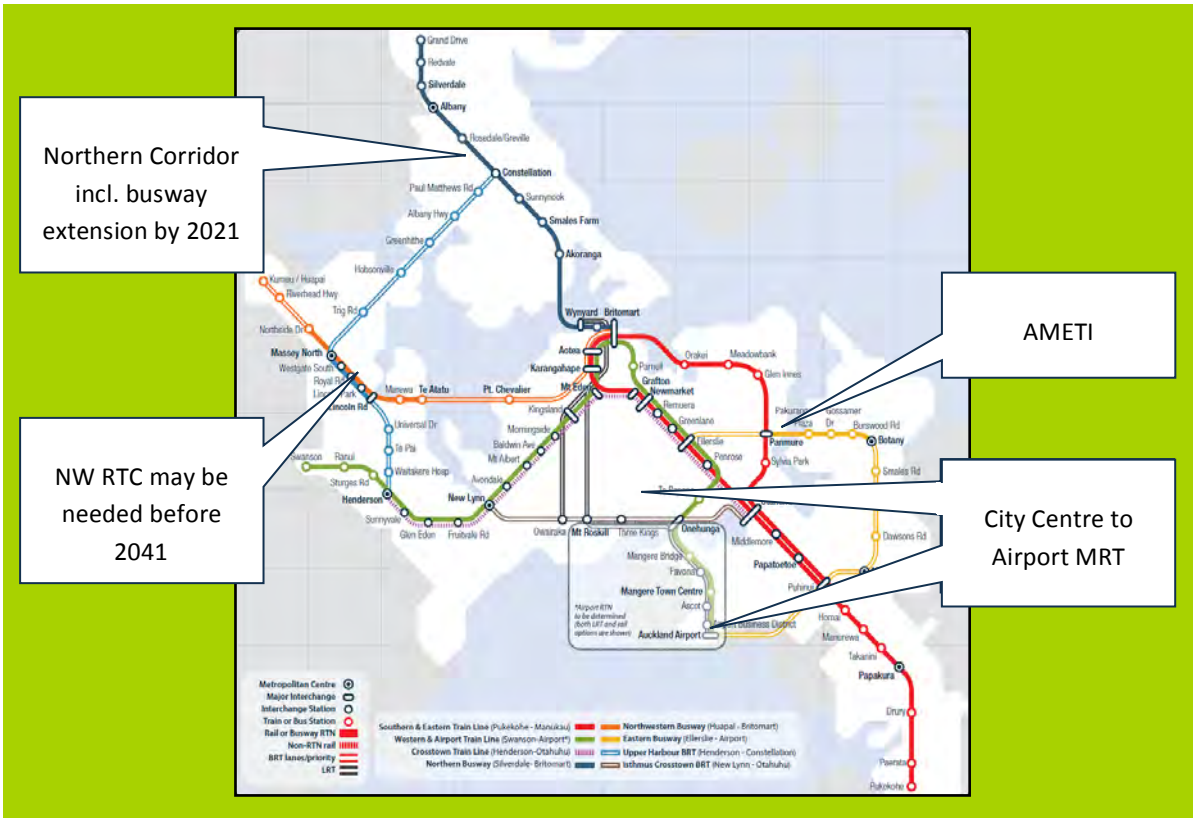
## 2.3 Transport infrastructure planning

Since 2010, a number of significant transport infrastructure projects have progressed to a stage such that more information about their design, timing and impact on a North Shore RTN is available. With the exception of Light Rail Transit (LRT), these projects were considered in the 2012 report but often with different views on timing.

With anticipated growth, these additional projects are expected to increase public transport capacity into the City Centre and put increased pressure on the limited corridor capacity of existing City Centre surface road corridors.

The Auckland Transport Alignment Project (ATAP) will make recommendations on these projects in the context of regional transport requirements.

**Potential Future Transport Investment**



## What's changed?

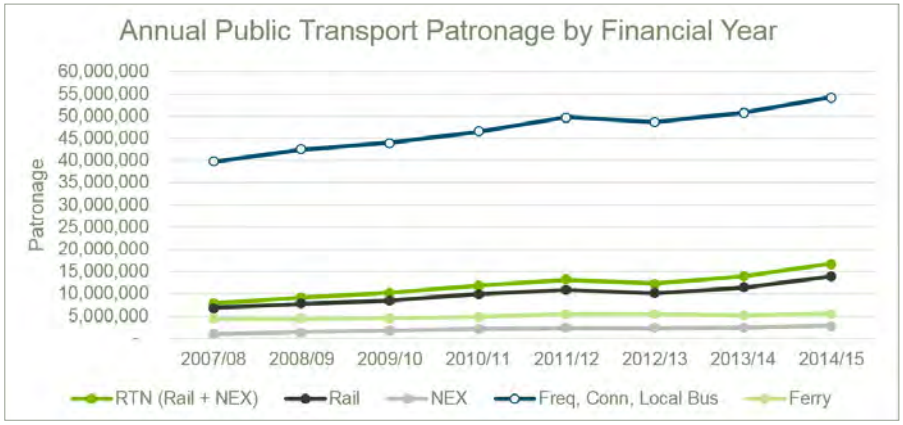
### 2.4 Public transport demand trends

Patronage is growing strongly on Auckland's rapid and frequent public transport networks. Northern Busway services continue to exceed initial demand forecasts. Public transport network changes and complementary land use changes will support ongoing rapid growth.

#### Public Transport Patronage Growth

The Auckland Region has experienced considerable growth in public transport patronage over the past five to ten years. This has benefited from notable improvements to public transport infrastructure and services such as double tracking and electrification of the rail network, the introduction of the AT HOP card, increased rolling stock capacity and double-decker buses.

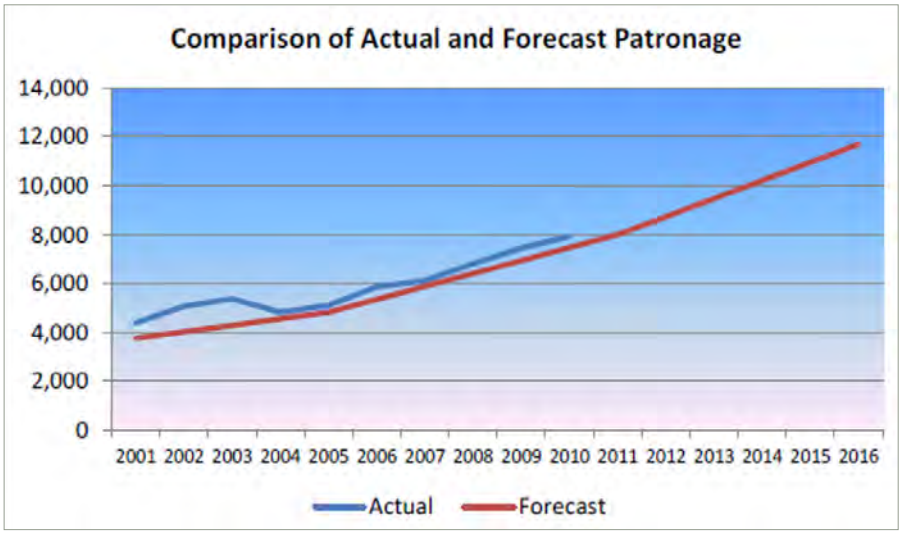
The current busway, using the SH1 alignment has established this trend on the North Shore and this growth continues in excess of forecasts (NEX are Northern Express services).




**Annual public transport patronage in Auckland by financial year**

#### Northern Busway's actual demand relative to predictions

The New Zealand Transport Agency commissioned a post-implementation report in 2012 for the Northern Busway that reviewed patronage outcomes and cost-benefit ratios relative to the various feasibility and planning studies that led to the construction of the busway. Actual patronage levels on the busway have been consistently higher than the pre-implementation modeled forecasts.




**Comparison of actual and forecast busway patronage (NZTA, 2012)**

# 3 Defining successful rapid transit

## 3.1 What is rapid transit?

The Rapid Transit Network, or RTN, as it relates to the overall public transport network is illustrated in the figure below, extracted from the Auckland Regional Public Transport Plan (RPTP). This shows that the Rapid Network is the highest level in the public transport hierarchy, exhibiting high frequency services all day (at least 7am to 7pm) every day (7 days a week) and operates on a dedicated right of way.

| Service Layers | Rapid | Frequent | Connector | Local |
|---|---|---|---|---|
| Defining features | All-day network | | | |
| Minimum Frequency | 15 minutes | | 30 minutes | 60 minutes |
| Operating hours | 7am-7pm, frequency may be less outside these hours | | | |
| Achieving speed and reliability | Dedicated Right of Way | Priority measures | Some priority measures | Generally no priority measures |

In addition, there will be some targeted services such as peak-only, school, rural and other single-destination services with frequency and service span determined by demand.

In summarising the intent and defining characteristics of the RPTP into a single definition, this report defines RTN as follows:

***"The RTN is intended to be the highest level exemplary public transport service that gives fast and consistent regional access, to provide a reliable and superior alternative to driving, in order to allow people to travel efficiently, reduce traffic and emissions".***

## 3.2 Overview of potential success criteria for an RTN

When considering what makes an RTN successful, the project team have considered both who might judge the perceived success and at what level the success is achieved. The success of an RTN can be defined as to its ability to deliver various categories of benefits.

In principle, an RTN, like other transport infrastructure, can have several types of benefits:

**Strategic benefits** related to the ability of the RTN to deliver higher-level outcomes identified in documents such as the Auckland Plan, which sets out aspirations for urban growth, and the Government Policy Statement on Land Transport Funding, which defines some strategic aims, such as congestion reduction on key urban corridors, which public transport infrastructure can address.

**Benefits for RTN users**, who may experience faster, more reliable, or more comfortable journeys as a result of upgrades to existing Public transport services.

**Benefits for non-users**, who may benefit from lower levels of traffic congestion due to people shifting from driving to Public transport, improved environmental quality as a result of lower levels of noise and emissions, or better employment access leading to improved economic performance.

**Operational benefits** that result from the fact that an RTN may be more effective or efficient in delivering transport services.

Core Criteria and Desirable Criteria are identified as follows:

| Core criteria | Desirable criteria |
|---|---|
| Aligns with current and future land uses | Improves urban amenity |
| High capacity | Quality fleet, stops/ stations, right of way |
| Good operational performance | High frequency and long span<br>Cost effective (per passenger km) |

# 4 Life expectancy of the existing busway

## 4.1 Key assumptions

The 'existing' busway has not been treated as a static entity. Planned development of the busway has been included in the assessment.

An Additional Waitemata Harbour Crossing would free-up road capacity on the Auckland Harbour Bridge for dedicated bus lanes. It is recognised that due to projected growth of heavy vehicle movements across the bridge (including double deckers), there will be a need to manage traffic on the bridge.

In this assessment the 'existing' busway is assumed to have programmed improvements in place including:

## By 2026:

2018: The New Network introduced with services routed to Britomart (NEX1) and Aotea-University (NEX2). Exclusively double decker, new frequencies.

Wynyard-Fanshawe project delivers integrated corridor/stop/routing pattern with extra capacity.

Midtown Public transport improvements – Learning Quarter/Midtown east-west bus corridor

Constellation and Albany Park and Ride (400 space extension)

Extension of the busway from Constellation to Albany (2021), including:

- Offline two way busway between Constellation and Albany.
- New northbound mainline platform at Constellation, removes most conflicting movements.
- New footbridge Constellation to Unsworth across motorway.
- Construction of a station in the vicinity of Rosedale

## 2026-2036:

Additional Waitemata Harbour Crossing. The assessment of the busway life-expectancy assumes dedicated full time bus lanes over the existing bridge from Akoranga station to Fanshawe St inbound, but from Fanshawe St to Onewa interchange only outbound.

Note that the demand modelling is based on a scenario that does not include the AWHC (ART model run ATAP CEE). Therefore the 2026-2036-2046 assessments of the life-expectancy of the busway show a best-case-scenario. An AWHC would enable more roadspace/capacity for buses.

General systemic growth in demand/bus numbers.

Extension of offline busway to Dairy Flat/Silverdale Future Urban area.

## 4.2 Findings

The assessment of the existing busway using forecast travel demand and the assumptions noted in 4.1 shows:

- A short term improvement due to the proposed investments in Fanshawe Street, Midtown east-west improvements and the proposed extension to Albany
- A subsequent degradation as demands increase
- Capacity in City Centre stops, corridors and termini is likely to be at capacity in the mid-2020s and over-capacity in the mid-2030s
- By the mid-2040s busway stations are also over-capacity

Below is a detailed assessment against the 'Core' RTN Success Criteria between 2016 and 2046 using forecast demands over this time:

Updated land use and patronage forecasts, understanding of the capacity of the City Centre to accept buses and operational understanding of busway stations results in the finding that the busway's life expectancy is likely to be reached earlier than previously forecast, possibly in the mid 2030s.

This assessment is also based on an AWHC increasing road capacity to enable priority bus lanes (though a decision on when an AWHC will be constructed has not yet been made).

| | Segment / Criteria | 2016 | 2026 | 2036 | 2046 |
|---|---|---|---|---|---|
| Alignment with Land Use | Strategic / whole of corridor | Moderately successful | Moderately successful | Moderately successful | Moderately successful |
| | Busway corridor (incl. AHB) | N/A | N/A | N/A | N/A |
| | Busway stations | Fair | Fair: Degraded by P&R expansion; improved by busway extension | Fair: Growth in population and jobs near busway stations | Fair (no changes identified) |
| | City stops, corridors and termini | Good | Good: Improved with Wynyard - Fanshawe project & NEX2 to Aotea / Universities | Good (no changes identified) | Good (no changes identified) |
| Capacity | Strategic / whole of corridor | Highly successful overall | Highly successful overall | Highly successful overall | Highly successful overall |
| | Busway corridor (incl. AHB) | Dedicated ROW within capacity; Motorway over capacity | Busway extension to Albany reduces exposure to traffic congestion | AWHC - dedicated bus lanes on AHB reduce exposure to traffic congestion | Good (no changes identified) |
| | Busway stations | Near capacity | Better network and busway extension improve capacity | Increasing bus volumes & dwell times: Additional 110 bph from Diary Flat? | Increasing demand not able to be accommodated? |
| | City stops, corridors and termini | Over capacity | New terminals & stops are at capacity with increased bus volumes | Increased bus volumes - over capacity | Increased bus volumes - over capacity |
| Operational Performance | Strategic / whole of corridor | Fair (speed and variability) | Fair (speed and variability) | Fair (speed and variability) | Fair (speed and variability) |
| | Busway corridor (incl. AHB) | Dedicated ROW good: Motorway poor | Busway extension to Albany improves speed & reliability | AWHC - dedicated bus lanes on AHB improve speed & reliability | Good (no changes identified) |
| | Busway stations | Good | Dwell times by double-deckers | Dwell times degraded by growth in demand | Dwell times degraded by growth in demand |
| | City stops, corridors and termini | Poor | Better bus priority on Fanshawe & Wellesley? | Growth in demand increased congestion at stops & terminals | Growth in demand degrades dwell times, speed & reliability |

# 5 Future transport requirements of the North Shore

While demand for travel within the North Shore accounts for nearly three quarters of total AM peak travel demands, half of the total demand from the North Shore to the rest of the region (intra-regional travel) is for journeys to the City Centre + Fringe + Newmarket zone.

## 5.1 Travel demands forecast from the North Shore

The Auckland Regional Transport (ART) model shows expected future travel demand. The modelled scenario (ATAP Common Elements) does not include the Additional Waitemata Harbour Crossing (AWHC) project.

The maps in this section show forecast travel demand, focussed on travel citybound across the Waitemata Harbour during the morning (AM) 2 hour peak period.

Of note is the need to provide public transport connectivity to destinations other than the North Shore itself is dominated by the need to provide City Centre access.


Total AM 2 hour peak travel demand from the North Shore study area to the rest of the Auckland region are shown in the following maps for 2013 and 2046.

Strong growth in travel demand is expected for trips originating in the Silverdale–Orewa area and for all trips to the City Centre + Fringe + Newmarket. Total demand across the Waitemata Harbour in the AM 2 hour peak is forecast to increase by 10,000 by 2046.

Focusing on travel across the existing Waitemata Harbour crossing, these maps show three primary corridors of demand from the North Shore:

- A 'spine' demand from Albany and north of this, currently using the SH1 corridor (including the busway)
- Onewa Road providing a link to the Birkenhead–Glenfield catchment
- Esmonde Road from Takapuna


A large proportion of trips from the North Shore terminate in the City Centre which has a highly constrained ability to receive additional private vehicle trips due to limited street and carparking capacity. As such, the number of private vehicle trips forecast is relatively static between 2013 and 2046.

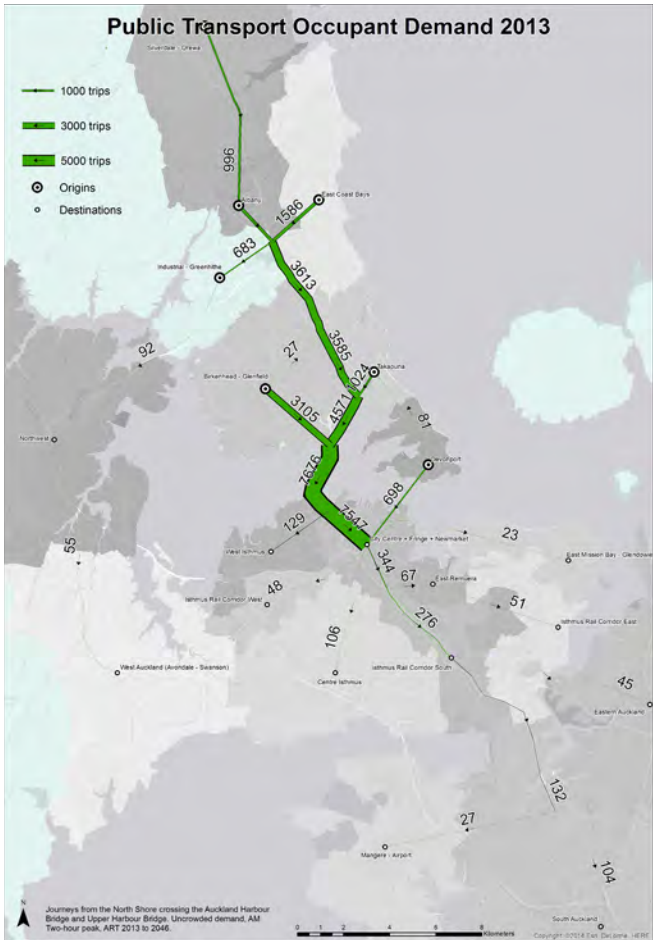
## Private vehicle demands

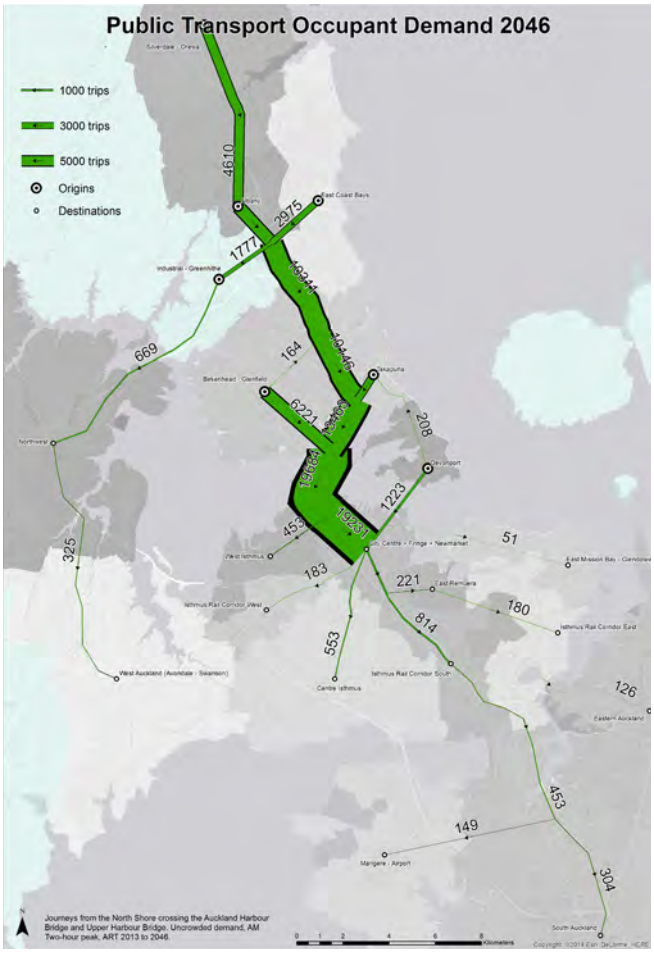
The maps below provide demand forecasts for AM 2 hour peak North Shore trips across the Waitemata Harbour in 2013 and 2046 via private vehicles. Private vehicle demand is not forecast to change between 2013 and 2046.


## Public transport demands

The maps below provide demand forecasts in 2046 AM 2 hour peak North Shore trips across the Waitemata Harbour in 2013 and 2046 via public transport. The public transport task is forecast to be in the vicinity of 20,000 in the peak 2 hours or 12,000 in the peak one hour.

Public transport is forecast to accommodate most, if not all growth in demand across the Waitemata Harbour.



Observed trends in public transport demands on the Waitemata Harbour Crossing have exceeded modelled demands over the last ten years. There is a risk that forecast demands may be exceeded and capacity thresholds reached earlier than predicted.

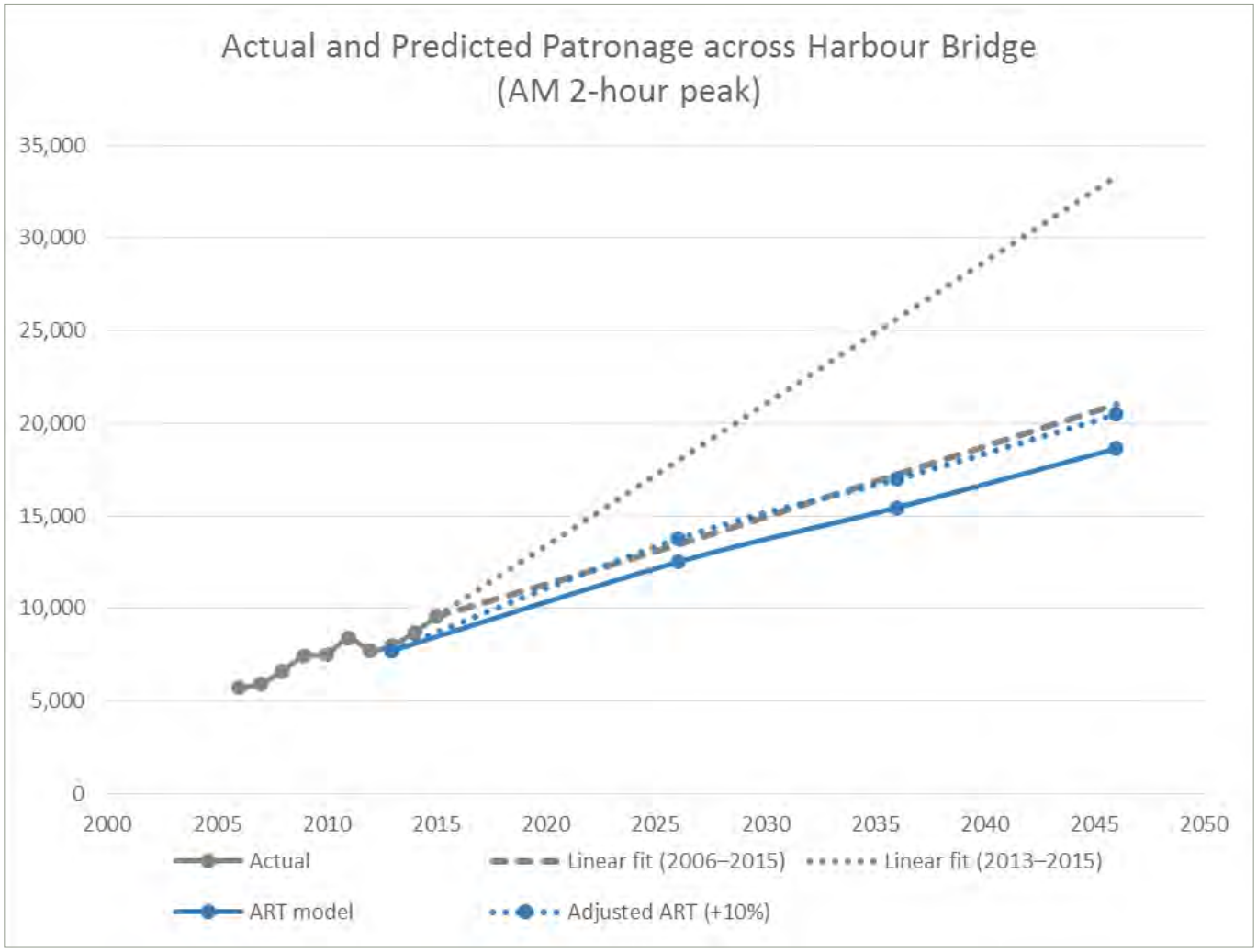
## 5.2 Testing the demand forecasts

The significant predicted growth in public transport mode share and decrease in private vehicle demand on the Waitemata Harbour Crossing and particularly to the City Centre + Fringe + Newmarket zone probably reflects physical constraints on the number of vehicles being able to access and park in the City Centre. This also reflects an extrapolation of recent observed trends in public transport patronage.

In interpreting this information, the following points are relevant:

- The majority of total trips from the North Shore across the harbour terminate in the City Centre. The ability of the road network and parking supply in the City Centre is not expected to increase to accommodate growth in vehicle trips.
- The AWHC project is primarily intended to improve capacity for strategic trips past the City Centre.
- The Figure below compares the modelled travel demands with historical patronage data for AM peak travel from the North Shore across the Waitemata Harbour crossing.
- The average annual increase in patronage in the last three years was significantly higher than the average annual public transport demand increase forecast from 2013 to 2026.
- While the three-year extrapolation is considered too short to inform a view on a 30 year forecast and is shown for context, the ten year extrapolation is considered a valid length of time to consider.
- By 2046, the ten year linear extrapolation is 13% higher than the ART model outputs, **which equates to bringing forward growth or the timing of a required change by about 5 years**.
- As noted previously, the model run used (ATAP Common Elements) does not include the Additional Waitemata Harbour Crossing (AWHC) project.

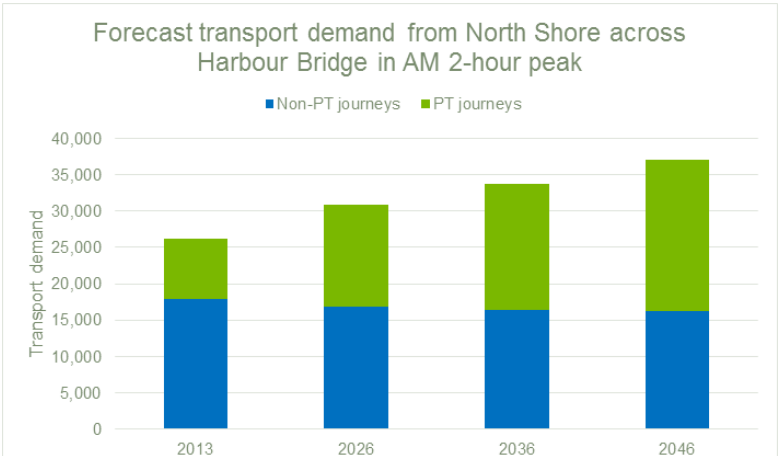
The ART model forecast appears to fall at the lower end of likely demand growth rates (as shown in the graph below). On this basis, and with the information available, it is considered prudent to assume for the purposes of defining the strategic 'task' for public transport, that the modelled forecasts are at the low end of the likely range. As a result, mode analysis used 13,000 people per hour as a peak direction demand estimate for 2046 instead of 12,000 in the model.



Public transport will play an increasingly important role in cross-harbour transport from the North Shore, becoming the dominant mode for ex North Shore trips in the AM peak by the mid 2030s.

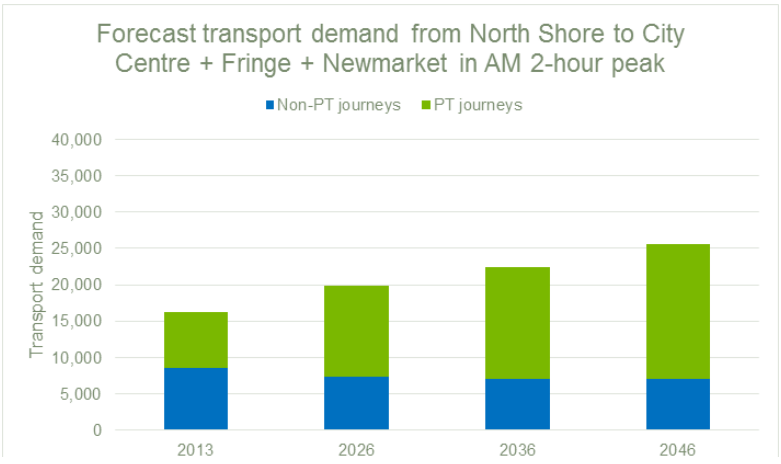
## 5.3 Mode share

At the present time around one third of all trips on the Waitemata Harbour crossing are public transport trips. By the mid-2030s public transport demand exceeds general traffic, though noting that this is based on a scenario that does not include the AWHC.




The figure below examines the forecast AM peak mode share specifically to the City Centre + Fringe + Newmarket zone.

- At present, mode share to the City Centre + Fringe + Newmarket zone is evenly split between general traffic and public transport from the North Shore.
- General traffic trips are expected to decline gradually over time in actual numbers and decline dramatically as a share of total trips.
- By the mid-2040s it is forecast that three quarters of trips from the North Shore to the City Centre + Fringe + Newmarket zone are expected to be on public transport.



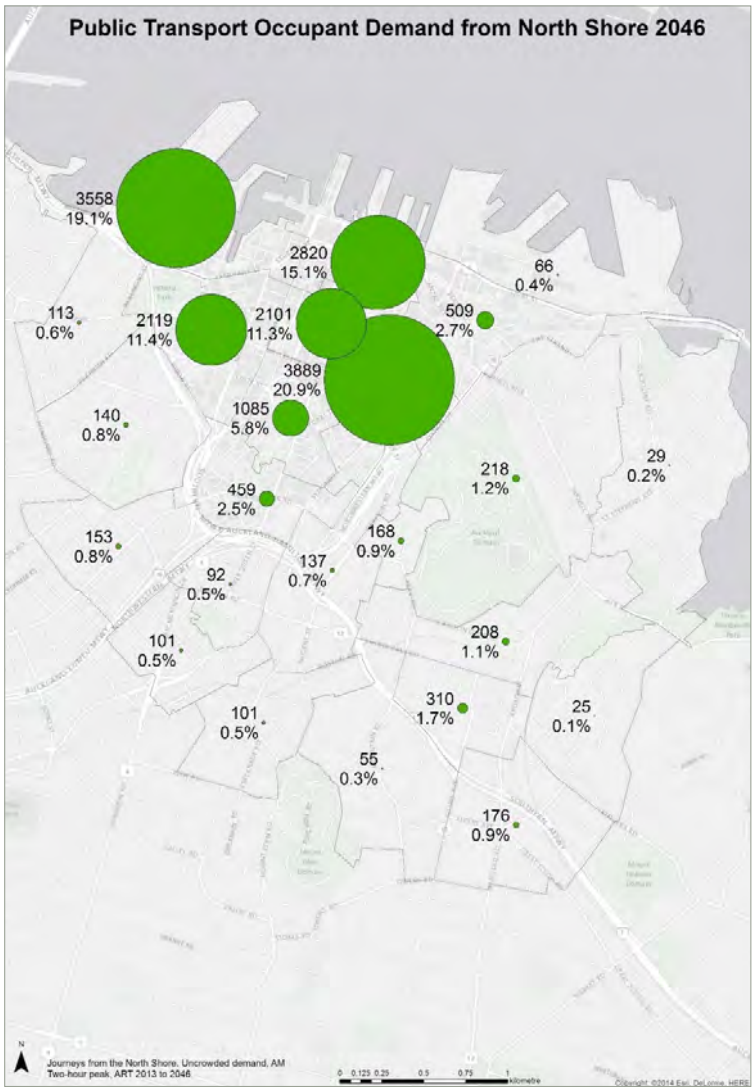
As illustrated in the Figure below, trip destinations are heavily focused on three areas:

- The City Centre Core, around Queen Street north of Wellesley Street
- Wynyard Quarter
- The Learning Quarter (universities)

The Victoria Quarter (west of Nelson Street) is also a key destination, to a lesser extent.

These zones together comprise around 78% of the public transport trips that are expected to terminate in the City Centre + Fringe + Newmarket zone in the 2046 AM peak.

In terms of transport requirements this pattern requires a mode that has the ability to deliver very large numbers of people to a small number of very densely used stations or stops within the City Centre.



A high capacity, high frequency RTN will be required connecting the North Shore with the City Centre, with the following characteristics:

- A mode that is able to to handle around 13,000 trips per hour
- A mode providing capacity for growth beyond the 2046 demand estimates
- RTN providing a direct connection from Onewa Road, Takapuna and Albany to the City Centre

## 5.4 Summary of public transport requirements

In addition, the following are also considered important:

- The ability to minimise the impact on urban quality and the City Centre's function as a place
- Consideration of a high capacity and high reliability mode north of Albany, depending on the form of greenfield growth
- A high capacity, flexible mode to serve the Birkenhead/Glenfield catchment, with a direct connection to the City Centre.
- A high capacity mode, or direct RTN connection to Takapuna as a Metropolitan Centre
- City Centre corridors and stations/stops that directly serve Wynyard, the City Centre core and the Learning Quarter
- A base network of frequent and local services connecting North Shore origins and destinations and connection to the RTN spine
- The ability to stage delivery and connect with related investments

### More than one mode potentially required

It is likely that more than one mode may be required, or desired to serve the public transport demand between the North Shore and the City Centre and Isthmus. This has an effect on mode choice and opens up potential options as spreading the total 13,000 peak one hour demand across more than one mode could be effective in managing the scale of intervention required.

The mix of modes also has the potential to form part of a staging strategy, right-sizing investment and only implementing higher cost and higher capacity modes and resulting infrastructure when required.

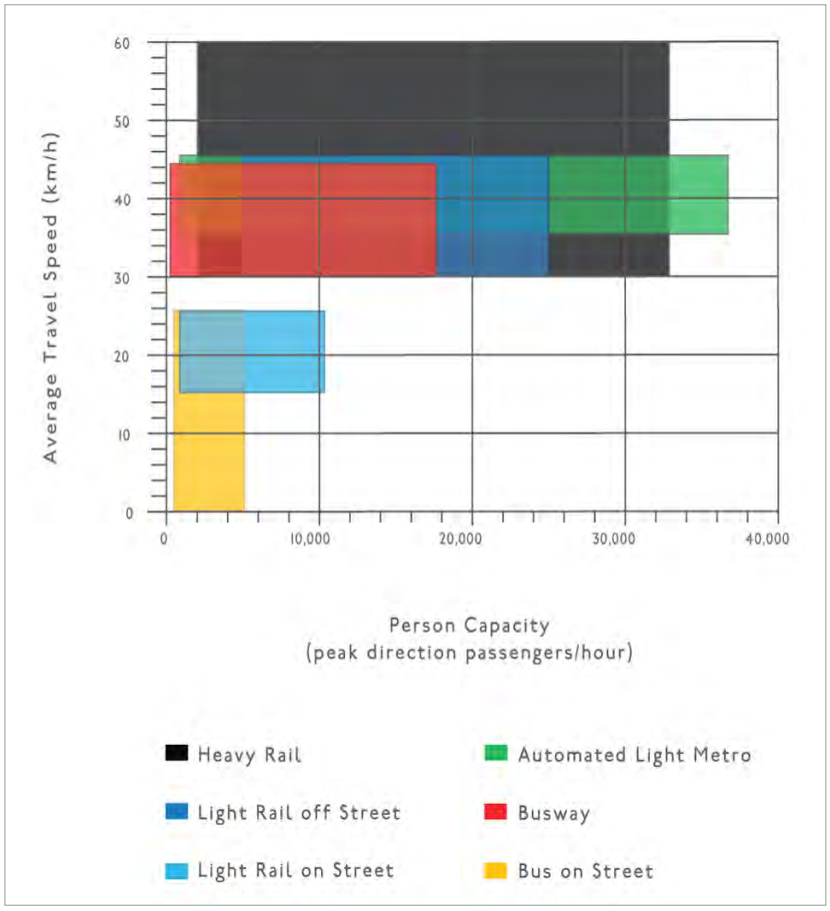
## 5.5 Modal demand thresholds

The table below presents the metrics identified for four modes of rapid transit service in Auckland in terms of their speed and capacity:

- Bus
- Light rail (LRT)
- Automated light metro (ALM)
- Heavy rail (HR)

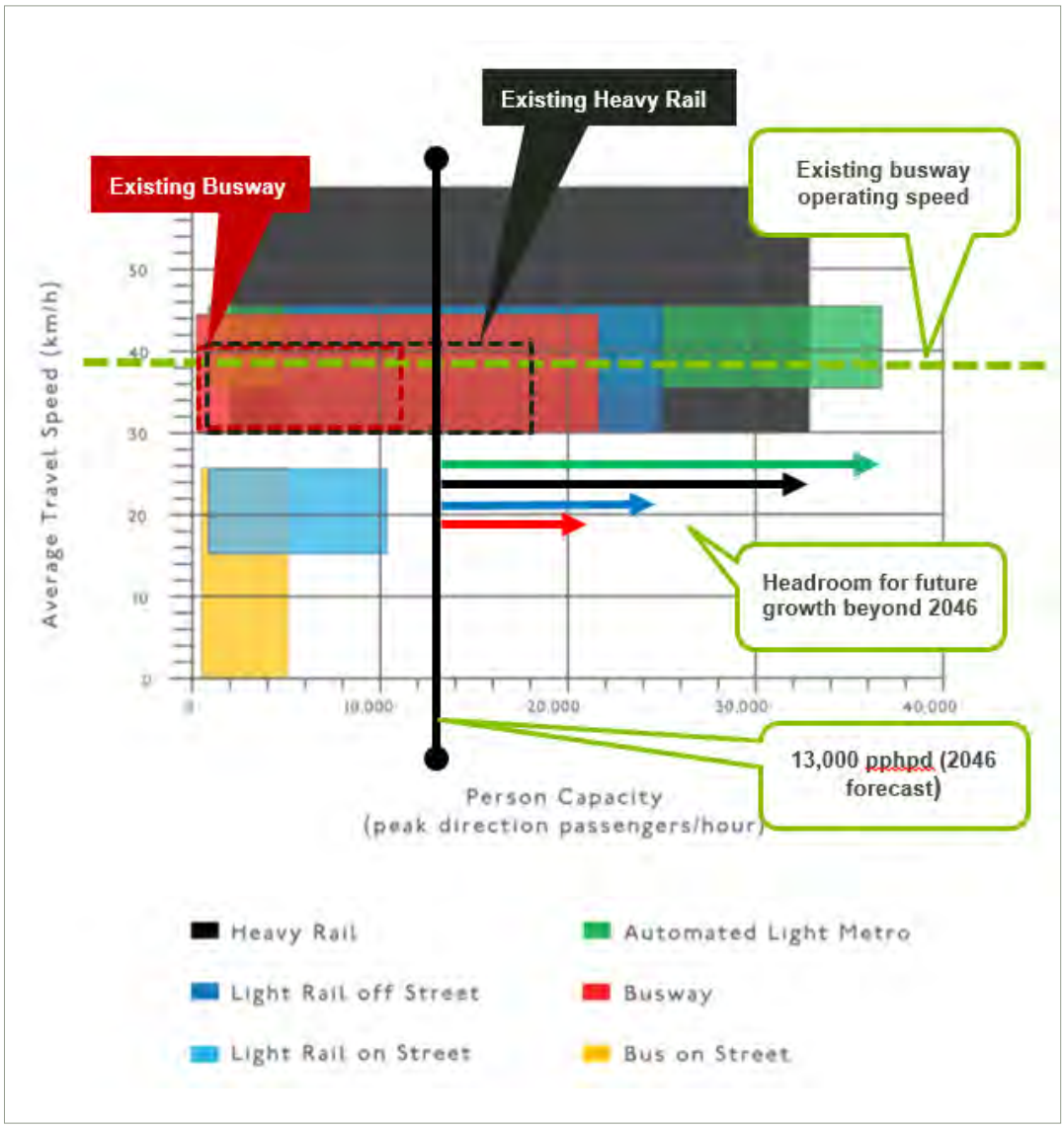
The purpose of this table is provide some depth and explanation to the technologies available and outline how each might be configured in an Auckland-specific context. The table has been developed using the Transit Capacity and Quality of Service Manual (TCQSM, 2nd Edition) adapted for Auckland's specific operating conditions.

Auckland has an existing busway and heavy rail operation, rolling stock and infrastructure and is developing specifications for potential light rail. Automated light metro and other variant options within a current technology do not have current or planned Auckland application and specifications are as a result drawn from applicable overseas examples.



In reviewing this figure, it is important to consider the scale of the transport task in the 2046 AM peak hour identified in Section 2:

- Total Waitemata Harbour crossing public transport demand: 13,000 per hour
- Public transport demand from north of Akoranga – harbour crossing: 6,000 per hour
- Public transport demand from north of Albany – harbour crossing: 2,700 per hour
- Public transport demand from Onewa Road – harbour crossing: 3,700 per hour
- Public transport demand from Takapuna – harbour crossing: 2,100 per hour



The figure above augments this diagram with some information of relevance:

- The existing northern busway's speed and capacity (potential and actual)
- The existing Auckland heavy rail speed and capacity
- An indication of the 'headroom' or spare capacity for growth beyond the current 2046 patronage estimates that each mode provides, noting that the last ten years' patronage growth rate has exceeded that forecast in ART by approximately 10%. An additional consideration is the investment horizon that is appropriate for an RTN investment, which is typically beyond 30 years.

### Emerging technologies

For the purposes of this study, the consideration of mode options has focused on known and proven technologies. The main task of this study is to define the transport task and the types of modes that may be capable of delivering this. It is acknowledged that technologies are emerging in relation to, for example, driverless vehicles and that a range of potential technologies exist in very small numbers or in isolated locations. The risk profile associated with suggesting such a direction would be very high at this stage and the project considered it appropriate to assess only technologies that are considered proven in similar environments or performing similar tasks to the task identified in this study.

Future investigation and planning may require consideration of a wider range of options, including advances in technology, changes to the timing and need for public transport crossing the harbour and the risks and opportunities that these present.

# 6 Potential network and mode options

As part of better understanding the future RTN opportunities, a series of potential network configurations were developed. These were not intended to be definitive or indicate a preference for any particular mode or network arrangement, but start to understand some of the constraints and issues each mode may have.

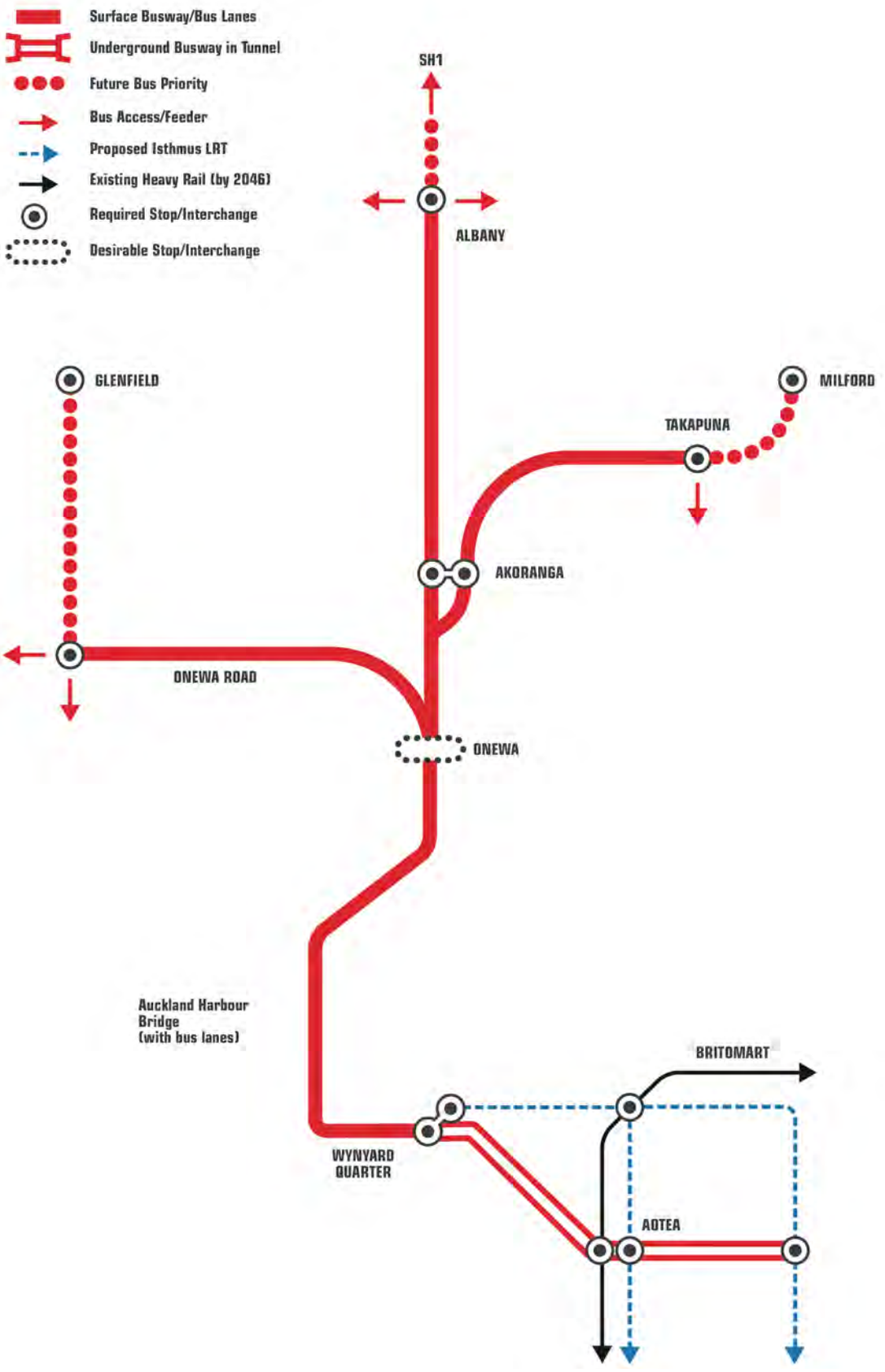
There are a range of mode and technology options that could meet the forecast demand. Each has different characteristics in terms of network integration, staging and performance.

## 6.1 Bus

The bus-only mode option is a flexible option in term of vehicle type and mode of operations. Key characteristics are likely to include:

- High capacity buses used on all three main corridors for the majority of the North Shore to City services to minimise the number of vehicles on city centre streets; these vehicles could be double-decker buses, or articulated or bi-articulated single-decker buses (with multiple doors for faster boarding and alighting). Vehicles could also feasibly be electric, or another alternative vehicle technology with low or no emissions.
- A trunk-and-feeder network on the North Shore, whereby only a limited number of trunk services would operate between the North Shore and the city centre on one of the three defined corridors, supplemented by local and crosstown services connecting destinations farther removed from the trunk routes.
- In the city centre, all North Shore buses would use a tunnel/ off street route underneath Wellesley St and terminate at the Learning Quarter; The bus tunnel is assumed to have three triple stops in each direction, with each stop having capacity for ~58 buses per hour, yielding a total capacity of approximately 175 buses per hour per direction through the tunnel.

Bus Network Option



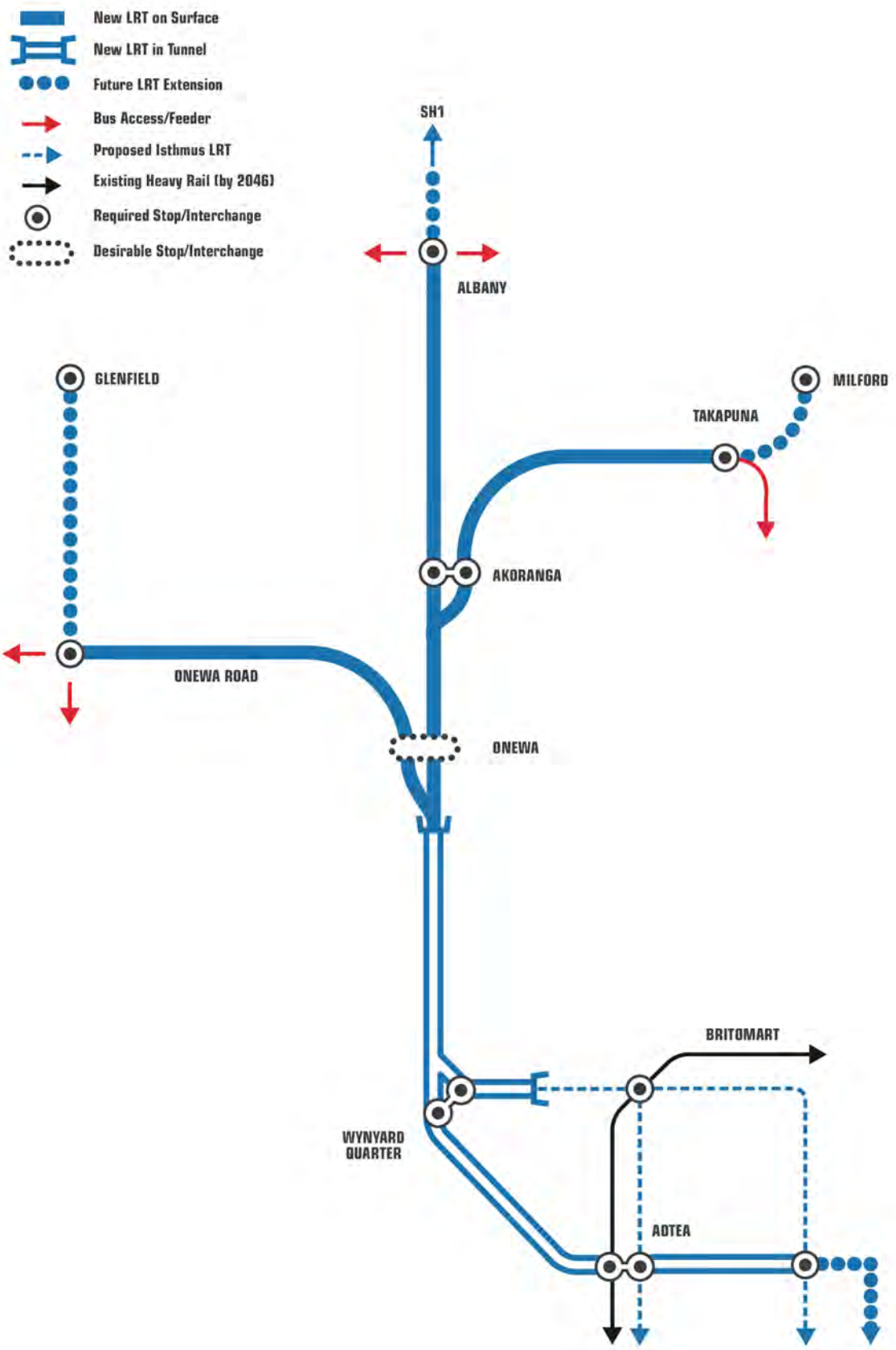
## 6.2 Light Rail

Light Rail Transit (LRT) refers to a broad range of 'tram-style' rail-based transit systems that have two defining characteristics: they are designed to be operable within an open-access road environment at street level, and they are typically not designed to operate on main line railways or mix with freight or other heavy rail trains. Light rail lines can operate within the road corridor in LRT lanes or within dedicated off-street 'light railway' corridors. A single line can operate across a mix of on-street and off-street running.

As it does not run to mainline heavy rail standards, LRT is capable of operating on track geometry that is considerably less constrained than heavy rail. LRT can be signalled at high frequencies, or operate on line-of-sight at lower frequencies/speeds.

Light rail systems can be entirely grade separated and never enter a public roadway environment; in this case they can resemble surface level metro systems with performance characteristics as good as or better than heavy rail.

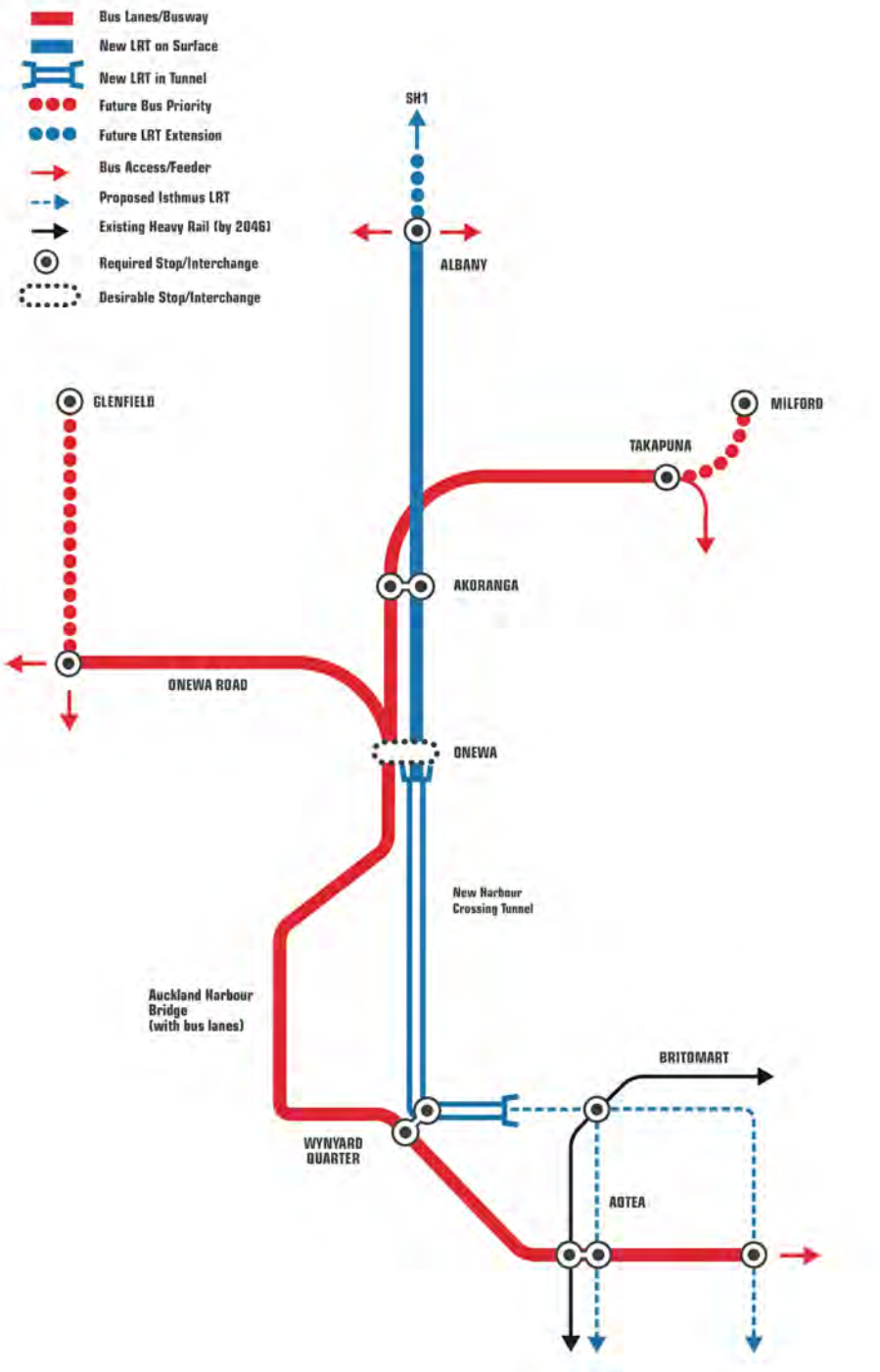
LRT Network Option



## LRT sub-options and variants

LRT to Onewa Road has been shown to introduce significant risks and display insufficient potential benefits to warrant its inclusion in the preferred LRT network option.

- Beyond Highbury the trip origins for the strong passenger volumes along this corridor are very dispersed and not well suited to LRT due to the need for a large proportion of passengers to transfer mode.
- A third branch with high frequencies (12 per hour) pushes a 2-track harbour crossing tunnel to the limit in terms of capacity at 29 trams per hour. This is likely to be a risk to operational performance due to uneven loadings on services in the peaks.
- Physical constraints: Connecting LRT from a harbour tunnel into Onewa Road is physically constrained and potentially high risk, depending on the alignment option chosen by NZTA for the tunnel. The NZTA is currently investigating options that connect to Onewa Road and Esmonde Road.




### On-street (only) LRT Option 1: Busway corridor only

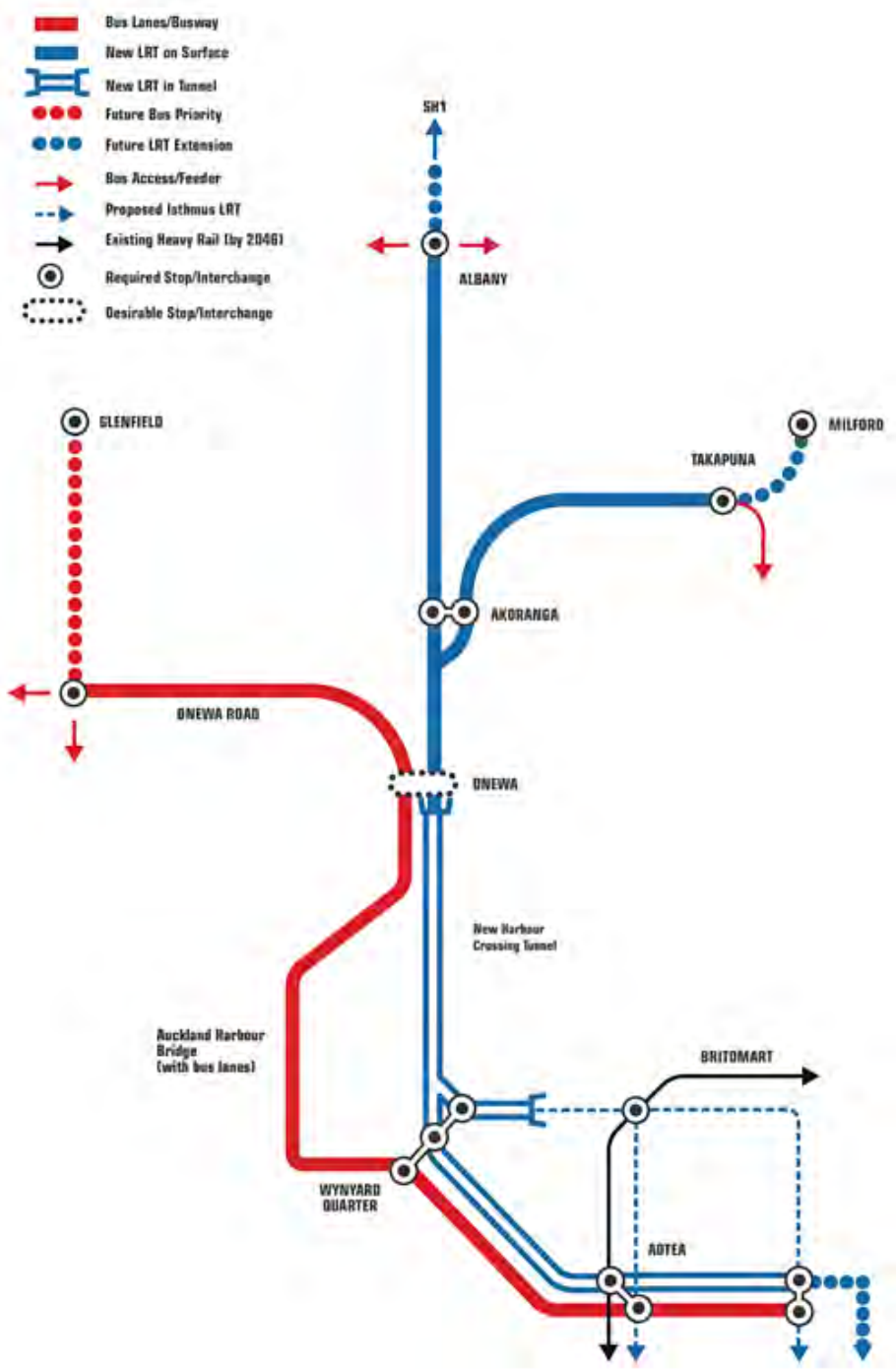
This sub-option would need to be served by 20 x 66m trams per hour in 2046 and therefore on street operation in city centre and 2 tracks under the harbour would be feasible, although approaching the upper limit of CBD on-street running potential (around 24 trams per hour).

This is a potential (relatively) low-cost initial LRT staging option deferring the need for a CBD tunnel to beyond 2046, and should be progressed as an 'LRT on-street' option.

## On-street plus Off-street LRT Option 2: Busway + Takapuna

2046 demands require 10 x 132m (long) trams per hour on the former busway corridor plus 7 x 66m trams per hour on the Takapuna corridor. The longer trams cannot run on-street in the city centre and therefore need to be accommodated in a new CBD tunnel with underground stations (as per the 'all LRT' option).

Takapuna services could interline with Dominion Road services via the city centre on-street tramway, while LRT services on the former busway corridor would serve the new CBD tunnel terminating at a Learning Quarter station, with a turnback/crossover allowing for efficient terminus operations.



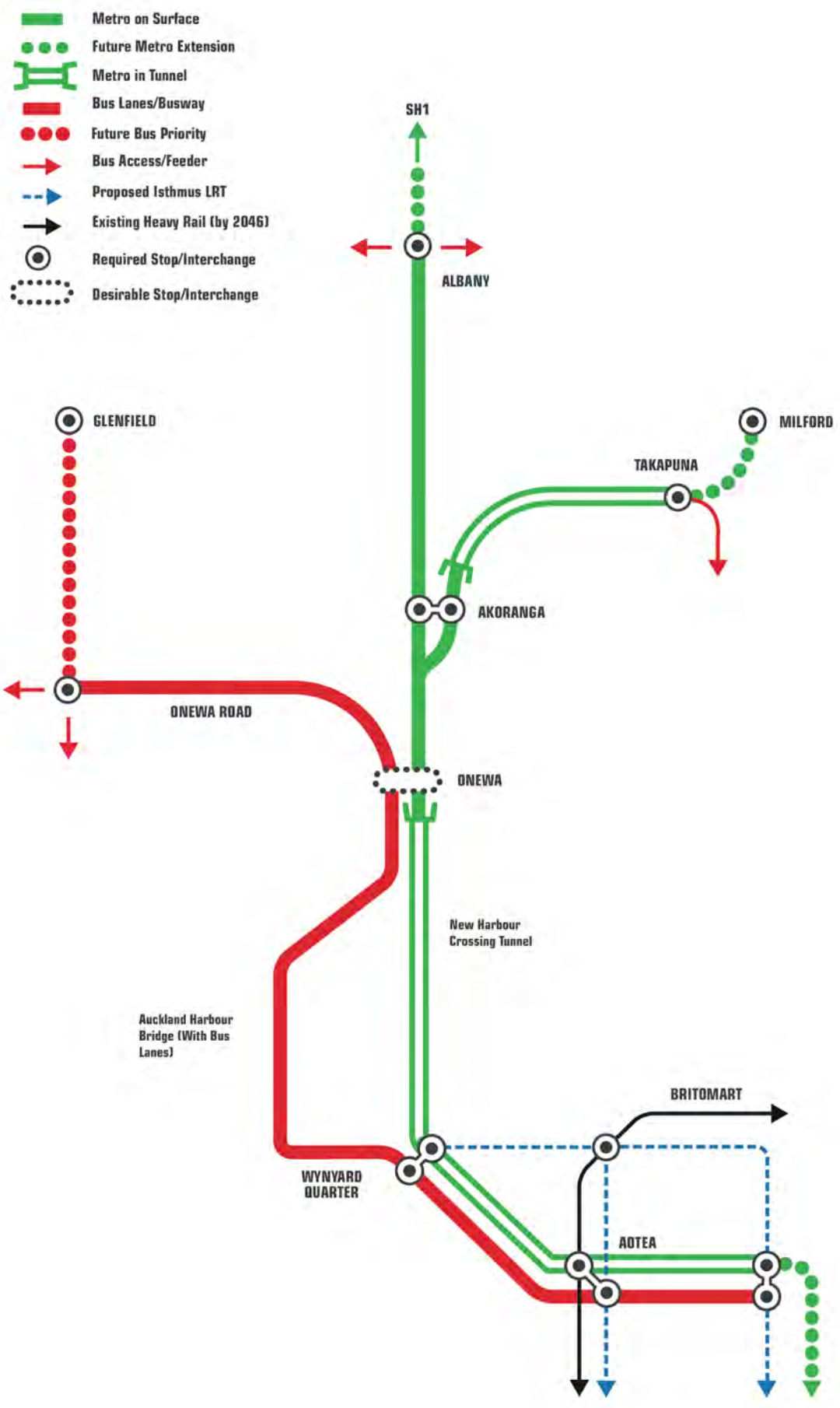
## 6.3 Metro Rail

For the purposes of this study, 'Metro Rail' means Automated Light Metro (ALM). ALM is a class of transit system developed in the late 20th century as an intermediary between Light Rail and conventional Heavy Rail. It refers to purpose-built urban passenger transit lines that can be constructed and operated more affordably than Heavy Rail based ALM systems, and is intended to provide high-frequency levels of service in suburban and urban environments.

### 6.3.1 Potential metro rail + bus network

The North Shore network under a metro rail mode option would entail:

- An off-street ALM on the converted busway and on a new route to Takapuna (with a future option for extension to Milford);
- Buses would still directly serve the western North Shore with 2 direct High Frequency bus services via Onewa Road (one to Beach Haven, one to Glenfield and beyond);
- All other buses would be rearranged with no direct bus services between the City Centre and North Shore on or east of the Northern Motorway corridor. Services would interchange in the City Centre.


Metro on Surface
Future Metro Extension
Metro in Tunnel
Bus Lanes/Busway
Future Bus Priority
Bus Access/Feeder
Proposed Isthmus LRT
Existing Heavy Rail (by 2046)
Required Stop/Interchange
Desirable Stop/Interchange
SH1
ALBANY
GLENFIELD
MILFORD
TAKAPUNA
AKORANGA
ONEWA ROAD
ONEWA
New Harbour Crossing Tunnel
Auckland Harbour Bridge (With Bus Lanes)
BRITOMART
WYNYARD QUARTER
AOTEA

## 6.4 Heavy Rail

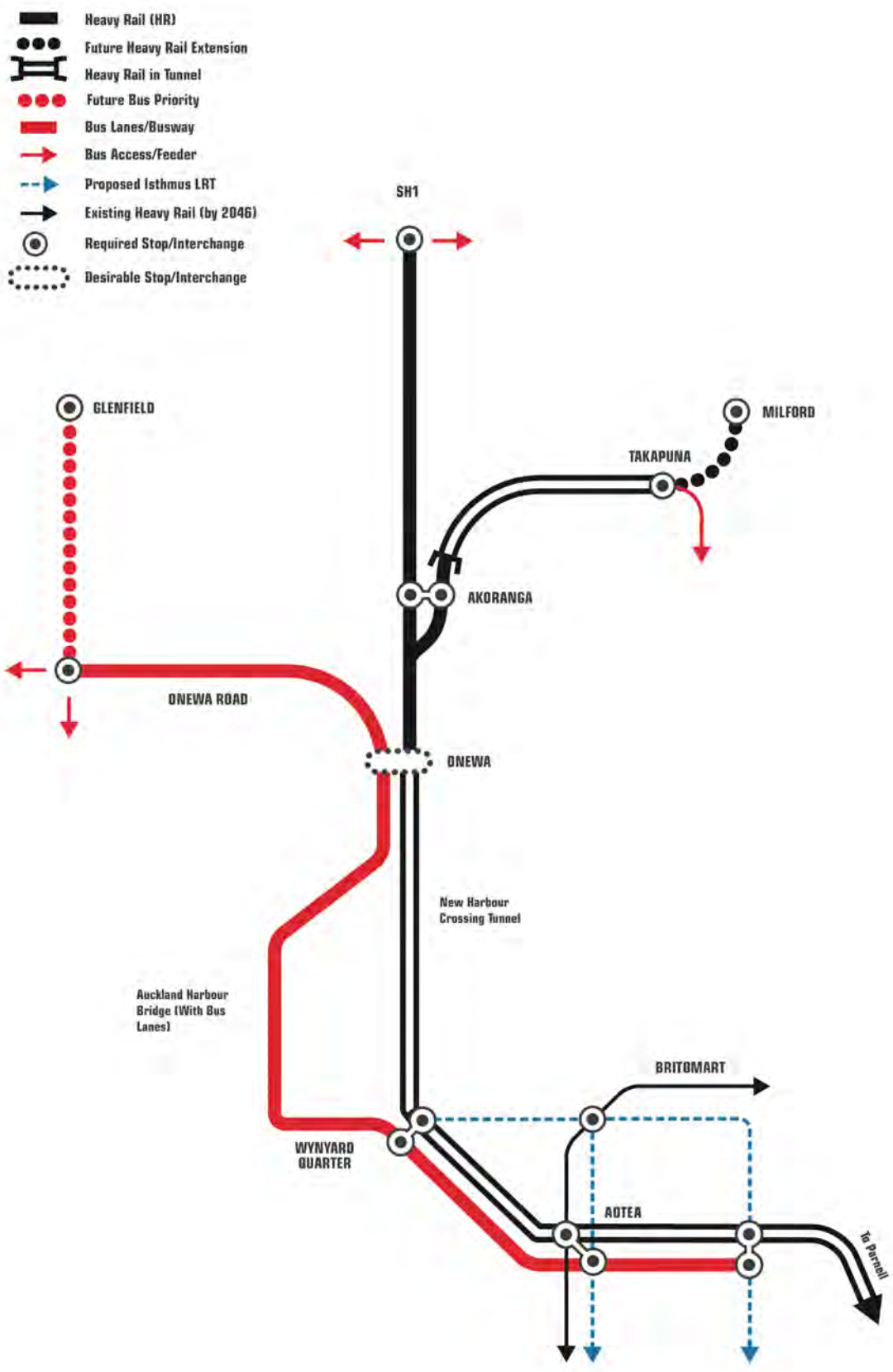
For the purposes of this study, Heavy Rail means narrow gauge electric passenger rail as is currently in operation in Auckland.


### 6.4.1 Potential heavy rail + bus network

The North Shore network under a heavy rail mode option would entail:

- A main railway line on the converted busway with a second branch on a new underground route from Akoranga to Takapuna (with future options for extension to Milford);
- Buses still directly serving the western North Shore with 2 direct High Frequency bus services via Onewa Road (one to Beach Haven, one to Glenfield and beyond);
- All other buses would be rearranged with no direct bus services between the City Centre and North Shore on or east of the Northern Motorway corridor; and
- Integration with other heavy rail lines in the City Centre.

Heavy Rail Network Map



# 7 Mode option conclusions

By assessing the conceptual networks outlined in Section 6, a number of preliminary findings were made. These are not intended to define a preferred mode or network at this stage as this will be the role of a future business case. The findings are intended help inform a future business case and highlight the likely outcomes each network might provide based on updated 2016 information and assumptions.

## 7.1 Bus-only network option findings

- The bus-only option would provide very good frequency and span.
- It is still a high cost solution due to the need for a city centre tunnel and terminal.
- Due to the scale required, the city centre tunnel would have significantly higher construction complexity and risk than rail-based modes.
- While it could provide for the forecast 2046 demands, it has less headroom for growth beyond 2046, even with a major city centre tunnel.
- Any growth beyond the currently forecast 2046 demands (based on current land use forecasts) could result in compromised operating performance earlier than 2046.

**Conclusion:** Bus-only is unlikely to be a long-term solution and still has very high costs, with very high construction complexity in the city centre, due to tunnels potentially being required, and limited capacity beyond 2046.
Note that buses will continue to provide the public transport solution for the immediate future and optimisation of the existing busway is stage one of any RTN solution.

## 7.2 Light rail network option findings

- LRT is likely to be the most flexible and stageable RTN mode. Staging can include, for example, initially operating from a busway/SH1 corridor to the city centre via a street-running tramway, moving to both on-street (e.g., from Takapuna) and off-street in a tunnel in the city centre (e.g., from the former busway/SH1 corridor) at a later stage.
- LRT is unlikely to be as costly as heavy rail north of the harbour and can operate almost entirely within the busway corridor geometric alignment.
- LRT could be integrated into the proposed isthmus LRT (through running or interlined).
- The On-street only LRT (inter-operable with Isthmus LRT) would only cater for up to half of North Shore demand in 2046 (the former busway corridor only). Onewa Rd and Takapuna would still need to be supported by bus.

- The On-street + Off-street LRT solution, requiring a CBD tunnel, could accommodate a larger proportion of overall North Shore demands by allowing for Takapuna and the lower East Coast Bays to be directly connected to the LRT network. A CBD tunnel would allow for for larger vehicles to operate on the former busway corridor, as the vehicles remain fully off street and free from signalling and street-running constraints resulting in significantly more capacity for growth.
- Note that through the course of this study, LRT to Onewa Road has been shown to introduce significant risks both operationally and physically, resulting in an LRT branch to Onewa not being recommended as part of the North Shore LRT network. Instead it would continue to be a Frequent Service (bus) corridor directly linked to the City Centre via enhance bus priority both on Onewa Road itself and on the Auckland Harbour Bridge.
- LRT, including its sub-options and staging options, performs best on balance against assessment criteria and should form part of future RTN investigations.

LRT is likely to be the most flexible and stageable, is a proven technology, and can be integrated into a planned wider network for addressing North Shore accessibility and capacity requirements. This study has found that LRT is likely to be the lowest cost, least risk solution.

## 7.3 Automated Light Metro (ALM) network option findings

- Automated Light Metro may perform very well operationally, with low operating costs, and can provide more than enough capacity in a flexible way to suit demand.
- This study found that there is no obvious wider interconnectivity potential with a wider RTN network.
- Implementation/technology risks exist due to more limited suppliers than LRT/heavy rail modes and the smaller number of proven locations compared to other options.
- This study found that there is no real staging potential as the full system from the city centre to at least Albany, including a North Shore depot, must be operational on day one as a fully self-contained system.
- While a city centre tunnel would be required, its geometric requirements mean it could operate on the busway alignment north of the harbour bridge, albeit with greater conversion complexity and disruption than LRT.

ALM includes many of the attributes of LRT and is cheaper than HRT but has limitations with connecting directly into the wider RTN (in the way that LRT or HRT could), making it a less suitable option.

## 7.4 Heavy rail network option findings

- Heavy rail has capacity to handle the transport task in a similar way to LRT and Metro, but with greater headroom for growth (assuming longer trains and higher capacity signalling in the future).
- Given Auckland's existing heavy rail operation, there is significant potential for wider network integration and therefore system-wide benefits by interlining a North Shore rail line with an existing Auckland rail line (e.g., the Southern Line). That is, heavy rail to the North Shore could provide wider regional rail network benefits by simplifying rail operations and unlocking overall rail capacity, if desired.
- Heavy rail has higher capital and operating costs, and higher construction risks. While a tunnel in the city centre is required (as for all other modes), heavy rail would also require significantly greater infrastructure north of the harbour bridge to regrade and partly rebuild the busway for heavy rail compliant geometry and structural/impact loads.
- There is no obvious staging potential, as a full line from Albany to Parnell via the city centre is required from Day One to address the identified busway deficiencies

Heavy rail comes with larger costs and limited stageability potential to address North Shore demands and RTN deficiencies (compared to all other options). However, it allows for longer-term wider regional rail network interconnectivity and capacity benefits.

## 7.5 Summary assessment table

The table below summarises the initial assessment findings against each of the criteria.

These are not intended to be definitive and will be tested further in any future business cases for North Shore RTN.

Assessment summary table

| Criteria | BUS | LRT (on street in city centre) | LRT (tunnel in city centre) | METRO (ALM) | HEAVY RAIL |
|---|---|---|---|---|---|
| Land use | NEUTRAL | NEUTRAL TO GOOD | GOOD TO V.GOOD | GOOD TO V.GOOD | GOOD |
| Unused capacity (headroom) | SMALL (10%) | SMALL TO MODERATE (17%) | LARGE (approx. 50%) | LARGE but scaleable (60%) | LARGE (37% to 50%) |
| Performance | POOR TO NEUTRAL | MODERATE TO GOOD | GOOD | VERY GOOD | GOOD |
| Urban Amenity | NEUTRAL | NEUTRAL | GOOD | VERY GOOD | VERY GOOD |
| Frequency/span | GOOD | MODERATE TO GOOD | MODERATE TO GOOD | GOOD TO V.GOOD | MODERATE |
| Capital cost<br>Operating cost | MODERATE TO HIGH<br>MODERATE TO HIGH | MODERATE (Stage 1)<br>MODERATE | MODERATE (Stage 2)<br>MODERATE | HIGH<br>LOW | HIGH TO VERY HIGH<br>HIGH |
| Technical (construction) risk | HIGH TO EXTREME in City Centre | LOW | LOW TO MEDIUM | LOW TO MEDIUM | MEDIUM TO HIGH |
| Stageability potential | GOOD | GOOD TO MODERATE | MODERATE | POOR | POOR |
| Network integration potential | LOW | MODERATE TO GOOD | MODERATE TO GOOD | LOW | HIGH TO VERY HIGH |
| Procurement and delivery | LOW | LOW | LOW | MEDIUM TO HIGH | LOW |

# 8 Next Steps

This work was undertaken to inform the evidence base for future business cases for any North Shore RTN project. Further, more detailed investigations into these issues will continue in coming years, so this report represents the situation in mid-2016.

Over coming years, the NZ Transport Agency and Auckland Transport will be working together on planning for the future of cross-harbour travel. Auckland Transport will be developing the business case to support investment in an appropriate RTN system for the North Shore that manages growth in passenger volumes and supports urban development.

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