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ARTA
Auckland Regional Transport Authority

Prepared for Auckland Regional Transport Authority

Planning for Rapid Transport Corridors in South West Auckland Metropolitan Region

Draft Final Report

Executive Summary

April 2008

- **Draft Final Report - Vol 1 of 3**
- **Executive Summary**

Planning for Rapid Transit Corridors in South West Auckland Metropolitan Region

Prepared for

Auckland Regional Transport Authority

By

Beca Infrastructure Ltd (Beca)
Parsons Brinckerhoff (PB)

April 2008

Revision History

Revision Nº	Prepared By	Description	Date
A	Richard Steel	1st Draft for ARTA comment	13 March 2008
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DISCLAIMER:

The costs presented in this report are rough order costs ONLY for the purposes of option comparison. The indicative order of accuracy for the estimated construction costs is considered to be + / - 30-50% and are not accepted or to be used for actual project costings.

May 2008

Document Acceptance

Action	Name	Signed	Date
Prepared by	Richard Steel		17 April 08
Reviewed by	Claire Neville		17 April 08
Approved by	Richard Steel		17 April 08
on behalf of	**Beca Infrastructure Ltd**		

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Abbreviations

ACC	Auckland City Council
AMETI	Auckland Manukau Eastern Transport Initiative
APT	Auckland Passenger Transport (Model)
ARC	Auckland Regional Council
ART	Auckland Regional Transport (Model)
ARTA	Auckland Regional Transport Authority
LCN	Local Connector Network
LRT	Light Rail Transit
LTNZ	Land Transport New Zealand
MCC	Manukau City Council
NIMT	North Island Main Trunk Line
NZTS	New Zealand Transport Strategy
OBL	Onehunga Branch Line
ONTRACK	New Zealand Railway Corporation
PT	Passenger Transport
PTNP	Passenger Transport Network Plan
QTN	Quality Transit Network
RLTS	Regional Land Transport Strategy
RT	Rapid Transit
RTC	Rapid Transit Corridor
RTN	Rapid Transit Network
SH	State Highway
TNZ	Transit New Zealand

1 Introduction

1.1 Background

Auckland Regional Transport Authority (ARTA) commissioned Beca Infrastructure Limited (Beca) in association with Parsons Brinckerhoff (PB) in April 2007 to provide professional services for the Planning of Rapid Transit Corridors (RTC) in the South West Auckland Metropolitan Region.

A key driver for the commission was the requirement for ARTA to give effect to specific policies of the Regional Land Transport Strategy (RLTS); namely:

- Policy 4.1.3: Investigate future rapid transit in the rapid transit corridors shown in map 7.4 and, if the studies confirm that rapid transit is appropriate, protect the ability to implement rapid transit in these corridors (responsible agency ARTA)
- Policy 4.1.4: Ensure that investment in the rapid transit system supports the regional growth strategy (responsible agency ARTA)

Certainty about the future RTC and modes in the south west is required to ensure the design of major roading and rail projects in the area are done in an integrated way and are not delayed in particular the Manukau Harbour Crossing project. Other considerations have included the significant growth in the study area especially at the airport and surrounding areas.

This planning study has had the purpose of:

- Providing ARTA with sufficient information to enable choices to be made about the desired Rapid Transit Network (RTN) in the southwest Auckland metropolitan region.
- Identifying, evaluating and selecting preferred options for developing the RTN in the southwest Auckland metropolitan region.
- Specifying the steps necessary to develop the preferred RTN in this area

The Study has a long-term strategic focus, looking ahead for a time period similar to that for the Regional Growth Strategy that is to 2050, with modelling of transport demand to 2041.

The Study has been conducted as a two stage process.

- First Stage - Selection of preferred options (for rapid transit (RT) to Auckland Airport) with clear advice provided to ARTA on whether or not they should request Transit (TNZ) to proceed with the foundation strengthening measures for the Manukau Harbour Crossing to enable a future RT connection. The selection of preferred options was based on the first stage evaluation and reported in September 2007[1].
- Second Stage - Evaluation of the preferred options (within the remainder of the study area). The second stage evaluation reported herein has included network modeling using the Auckland Regional Transport (ART) and Auckland Passenger Transport (APT) models.

[1] Manukau Harbour Crossing and Airport Access

1.2 Study Area

The study area is shown in Figure 1 and covers the south and west Auckland Isthmus and western Manukau. It is drawn to include the connecting point in the northwest between the Western Rail Corridor (North Auckland Line) between Mount Albert and Avondale and the connecting point of State Highway SH20 and SH16 at Waterview.

Figure 1 - Study Area

1.3 Stakeholder Involvement

Stakeholder feedback has been obtained from meetings with stakeholders held on 31 May, 31 July 2007 and 27 September 2007.

The key stakeholders invited to attend the meetings were; Auckland Regional Council (ARC), Auckland City Council (ACC), Manukau City Council (MCC), ONTRACK, Transit New Zealand (TNZ), Auckland Airport and Land Transport New Zealand (LTNZ).

1.4 First Stage - Manukau Harbour Crossing and Airport Access

The report on the Manukau Harbour Crossing and Airport Access provided an overview of the study work completed to August 2007 and included:

- The different passenger transport markets and travel patterns relevant to the Manukau Harbour Crossing and Airport.
- The technical issues associated with rapid transit options affecting the Manukau Harbour Crossing.

- Recommendations on:
  - The desirability of proceeding with foundation strengthening measures for the Manukau Harbour Crossing.
  - The option(s) for future rapid transit access to the airport

1.4.1 First Stage Findings

The first stage investigations of demand to the airport and across the Manukau Harbour and the evaluation of modal options concluded that, on the basis of existing data and study assessments, rail was the preferred modal choice for the Manukau Harbour Crossing and airport access.

As a heavy rail mode imposes "worst case" design requirements it also provided flexibility for further or future consideration of alternative modes as a means to manage the uncertainties associated with long term planning.

A range of four different bridge options for a future rapid transit crossing of the Manukau Harbour were examined. It was concluded that there were potential financial and technical benefits to carrying out enabling works to strengthen the foundations of the new Transit motorway bridge (MHX) to enable a rail crossing to pass directly under MHX over part of its length.

1.4.2 First Stage Decisions

Subsequent to the receipt of the advice on the Manukau Harbour Crossing and Airport Access ARTA made the decision to request TNZ to strengthen the foundations (where coincident bridge foundations occurred). This decision will enable additional loading to be carried in the event that a future rapid transit design solution is chosen that involves a rapid transit route directly below the roadway structure over the central spans. TNZ was also requested to put measures in place to maintain clearances to enable an alternative option.

In addition to the above decision and actions ARTA also requested TNZ to investigate the opportunity to accommodate a future rapid transit corridor within existing crown owned land and along the favoured western side of SH20 between MHX and Walmsley Road.

As a result of those further investigations ARTA has requested TNZ to proceed with alignment changes to the extent that they can be accommodated within the current Manukau Harbour Crossing project.

1.5 Second Stage Reporting

This Executive Summary (Vol 1) is supported by a separately bound Main Report (Vol 2) and Appendices (Vol 3). The Appendices include technical notes and working papers issued during the study together with the Manukau Harbour Crossing and Airport Access report.

The purpose of the second stage reporting is twofold:

- to record the work undertaken subsequent to the report providing advice on the Manukau Harbour Crossing and Airport Access, which includes the results of transport modelling and detailed evaluation of the preferred RTN options; and
- to integrate the findings of this subsequent work with the earlier study reports and advice; and to provide ARTA with clear information on the preferred form of a rapid transit to serve Auckland's growth in the south west region, and the progression of network development towards this future state.

2 Rapid Transit Modes and Characteristics

This section provides a brief overview of the alternative rapid transit modal options considered during the early stages of the study and the key characteristics of the three modal options; rail, LRT and busway that have been evaluated in detail during the second stage of the study.

2.1 Rapid Transit Modes

During the early stages of the study a high level review of rapid transit modes included consideration of guided bus "O-bahn" systems, continuously elevated rail systems, such as monorails (e.g. Darling Harbour), high speed dedicated passenger rail systems, and high speed exotic systems such as maglev. All of these systems were discarded from detailed consideration on the basis that:

- They were incompatible with Auckland's existing heavy rail and bus based rapid transit network.
- In the context of Auckland's passenger transport demand they did not offer advantages in operating characteristics, capacity or cost.

The study has considered unguided busway, light rail and suburban heavy rail as three alternative RT modes. As defined by the Passenger Transport Network Plan (PTNP), a rapid transit mode must be in a dedicated right-of-way with intersection grade separation from other transport modes, particularly the general road traffic stream.

All three mode options have different characteristics in terms of their theoretical and effective capacities and the levels of service offered.

2.2 Characteristics of Modal Options

The base case, against which all three rapid transit modes and a variety of network options have to be assessed, includes conventional bus based QTN levels of service operating on the existing and planned roading network. It is therefore relevant to identify the capacity of QTN services in comparison with the alternative rapid transit modes.

2.2.1 Capacity of QTN Bus Services

Conventional buses operating on existing road networks without priority may have a maximum capacity of up to 3000 passengers per hour; however this will depend on the typical loadings achieved.

For buses using bus lanes (i.e. on street priority measures) typical capacities are quoted as up to 4,000 passengers per hour (London).

For buses using bus shoulders on the motorway higher capacities may be achievable but these will be dependant on the way in which intersections are treated and the availability and location of terminal space. No benchmark information has been identified however a maximum capacity of 5,000-6,000 passengers per hour may be achievable.

2.2.2 RTN Characteristics

The characteristics listed in Table 1 provide a broad summary of some of the key characteristics of existing international RT systems.

Table 1 - Examples of RTN Characteristics

Busway	LRT	Rail
Patronage Capacity per hour per direction		
2,000-10,000 for western nations	4,000-25,000	8,000-40,000 (high end capacity refers to high speed, high frequency and longer distances between stations. Capacity of Auckland network may be less than 20,000 without network wide upgrading.)
Energy Source		
Diesel (low sulphur) and CNG most common. Can be electric trolley bus Emerging - Biodiesel/diesel blends, Hybrids, Fuel Cell	Electric	Electric, Diesel
Practical Patronage Capacity per Vehicle (including standing)		
60-75 standard bus 140-170 articulated bus	150 – 200 per vehicle	120-200 per car
Theoretical Land Use "best fit"		
Suits cross-regional routes, express routes and routes serving lower density areas	Suits medium distance, medium demand corridors and applications in central metropolitan areas	Suits high volume corridors generally with relatively longer distances between stations
Average Speed (higher speeds in range refer to longer station spacings)		
20-50kph	30-50kph	35-70kph

The three modes have differing alignment design criteria and Table 2 summarises the horizontal and vertical alignment design criteria which have governed the concept alignments developed for the network options.

Table 2 – Minimum Alignment Standards for Mode Options

Item	Unguided Busway	LRT	Heavy Rail
Operating Speed km/h	90	70	80
Gradients			
short sections, %	12%	7%	2% (1:50)
extended sections, %	8%	5%	1.7% (1:60)
Horizontal Curve Radius			
normal operating speed	325-450	330	450
low speed operation	25-30	25	100

Note: Busway values based on Northern Busway; LRT are representative values and may vary with the specific system design; heavy rail based on ONTRACK standards

The desirable and minimum clearance envelopes for busway, LRT and heavy rail options are broadly similar and for the purposes of this phase of the study the "worst case" envelope which provides for a 2 lane busway with a 10m width and 6m height clearance has been adopted when developing concept solutions and indicative cost estimates.

With the exception of the corridor section between Onehunga and Hillsborough, the terrain within the study area is generally not a constraint on vertical alignment nor a significant differentiator of construction cost.

With the exception of the Onehunga - Hillsborough section, heavy rail horizontal and vertical alignment standards have been adopted for the concepts solutions where route corridors are common.

3 Network Options

3.1.1 First Stage Option Development

The first stage assessment was progressed around two main themes and a total of six network options. The titles for the four rail network options reflect their key points of differentiation in the context of the first stage focus on the airport access:

- Busway/LRT theme
  - 1A. Busway network supporting heavy rail RTN (concept design for busway options allows for progression to LRT)
  - 1B. LRT network supporting heavy rail RTN
- Heavy Rail theme
  - 2A. North Access to Airport
  - 2B. North East Access to Airport
  - 2C. East Access to Airport
  - 2D. Airport Loop connection

The number of themes and options was the practical maximum that could be considered consistent with study resources.

It should be noted that Options 2A, 2B and 2C represent less developed (reduced length and growth centre connectivity) networks compared to Options 1A, 1B and 2D.

Having regard to a strong preference for a fully developed and integrated RTN with good connectivity and provision of a choice of modes to maximise PT demand, the first stage assessment concluded that rail was the preferred modal choice for the Manukau Harbour Crossing and airport access.

The preferred airport access arrangement was to provide for RT corridor access from the north (SH20A) and the east (SH20B).

3.2 Options for Second Stage Assessment

Although in practice the preferred RTN will be constructed progressively it was concluded that for the second stage assessment only the complete network options would be modelled and evaluated as the key study purpose was to identify the preferred network corridor that should be protected rather than the sequence of network development. The networks for the second stage option evaluation are illustrated in Figures 2 – 6 at the end of this section.

The following paragraphs identify the base or "Do Minimum" option against which the preferred options were evaluated; together with the refinements made to the first stage options and a brief description of their ultimate development.

Do Minimum

The Do Minimum has included the following expected development of the passenger transport network in the period to 2041:

- integrated ticketing across the passenger transport network;

- the Passenger Transport Plan (PTP) rail and bus services in a three-layered system of Rapid Transit Network (RTN), Quality Transit Network (QTN) and Local Transit Network (LTN) with stations matching these quality levels and incorporating park and ride;
- extensions to the passenger rail system including electrification, the Manukau Rail Link (MRL), rail in the AMETI corridor, the CBD rail loop and a rail link to Onehunga from the Southern Line; and
- the projected rail service plan for 2041 in terms of service connections and frequencies.

Option 1A – Busway network supporting heavy rail RTN

The busway commences at New North Road with QTN services operating from New North Road including connections through to the Pt Chevalier Shops.

The ultimate development would be two-lane busway running from New North Road parallel and north of SH20 in the Avondale-Onehunga corridor; parallel to SH20 between Onehunga and the SH20A interchange; parallel to SH20A (George Bolt Memorial Drive) and parallel to SH20B (Airport-Puhinui); there would be a busway connection between Onehunga and the Southeastern Highway and the busway from the intersection of SH20/ SH20B would connect through to Manukau City Centre parallel to SH20 and connect with AMETI.

Option 1B – LRT network supporting heavy rail RTN

The LRT commences with a LRT/Heavy rail interchange in the vicinity of Avondale Station.

The ultimate development would be separated two-way LRT running parallel and north of SH20 between Avondale and Onehunga, parallel to SH20 between Onehunga and the SH20A interchange, parallel to SH20A (George Bolt Memorial Drive) and parallel and to the south side of SH20B (Airport-Puhinui); there could be a LRT connection from Onehunga to Penrose Station along the Onehunga Branch Line route or this could remain a heavy rail connection (re-opening of the OBL is planned in the short term); the LRT would extend from the SH20/SH20B intersection parallel and north of SH20 to Manukau City Centre and would connect to AMETI.

Option 2A – North Access to Airport (from Onehunga)

This option was deleted from the second stage evaluation as it was in effect a component of the progressive development of Option 2C to form Option 2D.

Option 2B – Rail North East Access to Airport (from Otahuhu)

The ultimate development would be dual track heavy rail running parallel with SH20 in the Avondale-Onehunga corridor, between Onehunga and Southdown connecting with the Southern Rail Corridor, and a rail connection between Otahuhu and the SH20/SH20A interchange along the line of an old designation, now in housing; then parallel with SH20A to access the Airport from the north; a decision on whether to retain the OBL would be required when the Onehunga-Southdown link is constructed.

Option 2C – Rail East Access to Airport (from Puhinui)

The ultimate development would be dual track heavy rail running parallel with SH20 in the Avondale-Onehunga corridor, between Onehunga and Southdown connecting with the Southern

Rail Corridor, and a rail connection between Puhinui Station and Auckland Airport running parallel to SH20 and SH20B; a decision on whether to retain the OBL would be required when the Onehunga-Southdown link is constructed. A future provision could be made for a direct connection between the Airport and the Manukau Rail link which could be extended to AMETI.

Option 2D – Rail Airport Loop (from Puhinui and Onehunga)

The ultimate development would be dual track heavy rail running parallel with SH20 in the Avondale-Onehunga corridor, parallel to SH20 between Onehunga and SH20A, and parallel with SH20A to the Airport; rail connection between Puhinui Station and the Airport running parallel to SH20 and SH20B; the opening of a heavy passenger rail connection between Penrose and Onehunga on the OBL is assumed. A provision could be made for a direct connection between the Airport and the Manukau Rail link which could be extended to AMETI.

Figure 2 - Option 1A - Busway Supporting Heavy Rail RTN

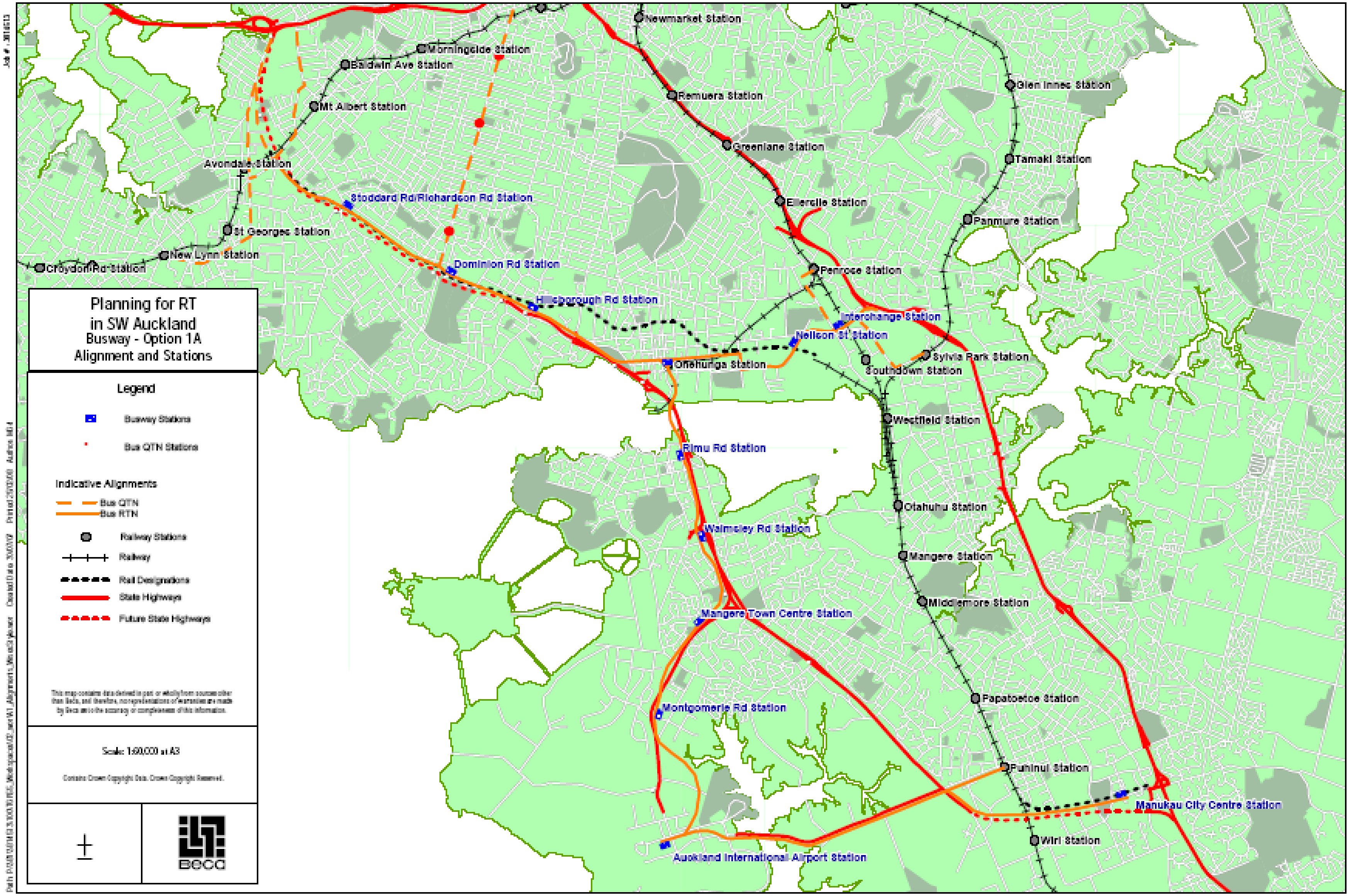


Figure 3 - Option 1B – LRT Supporting Heavy Rail RTN

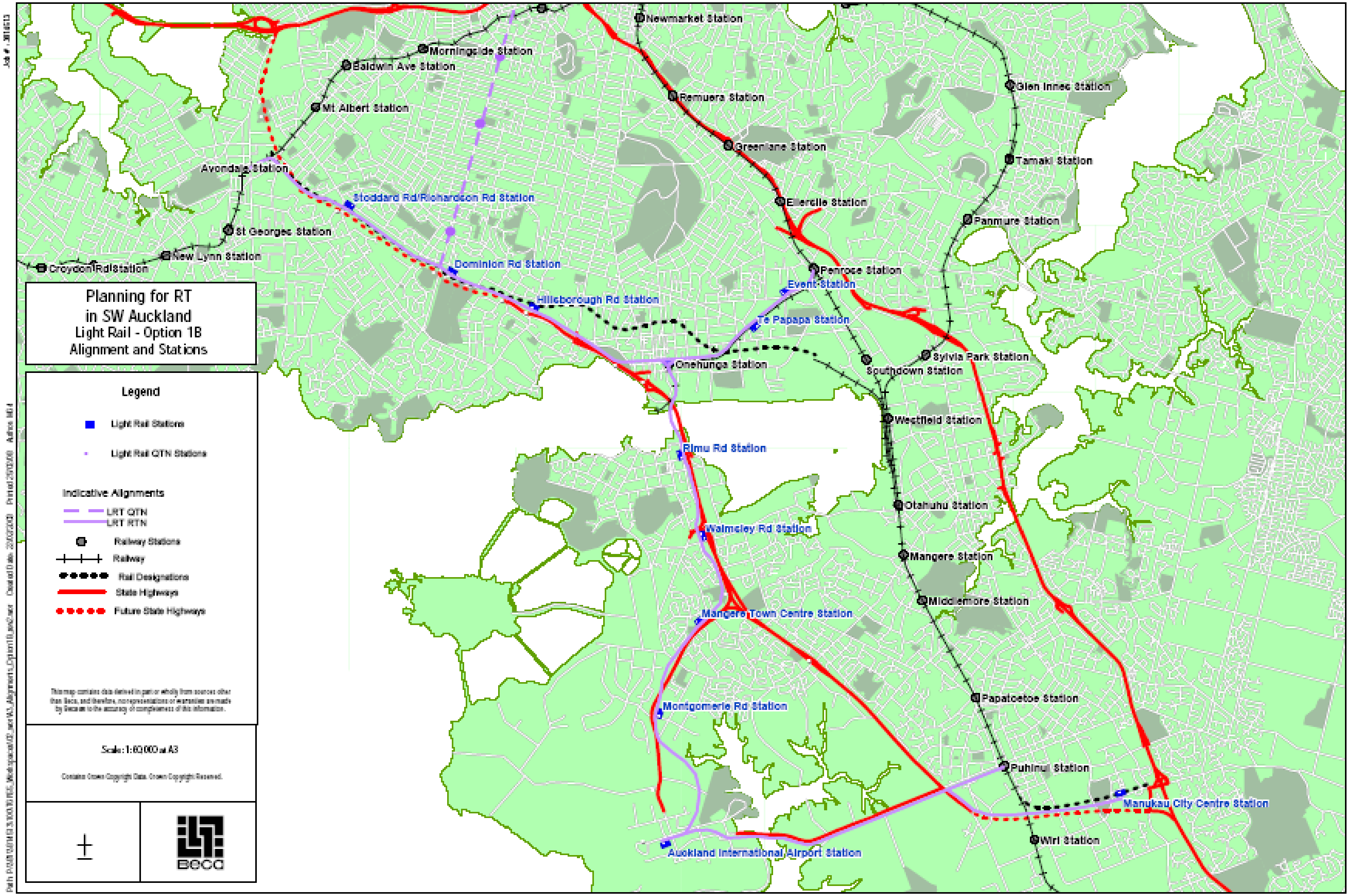


Figure 4 - Option 2B – Rail North East Access to Airport (from Otahuhu)

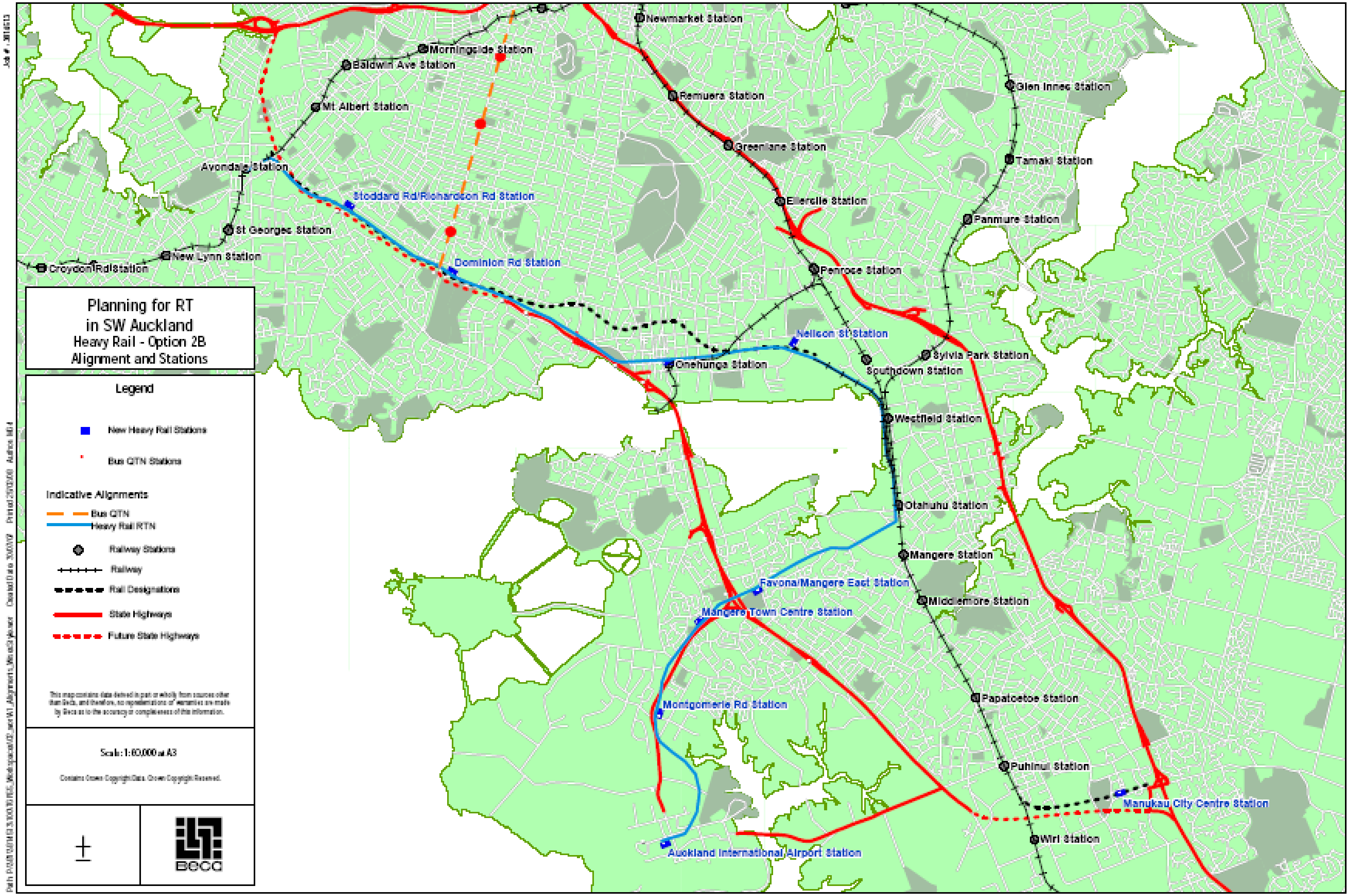


Figure 5 - Option 2C - Rail East Access to Airport (from Puhinui)

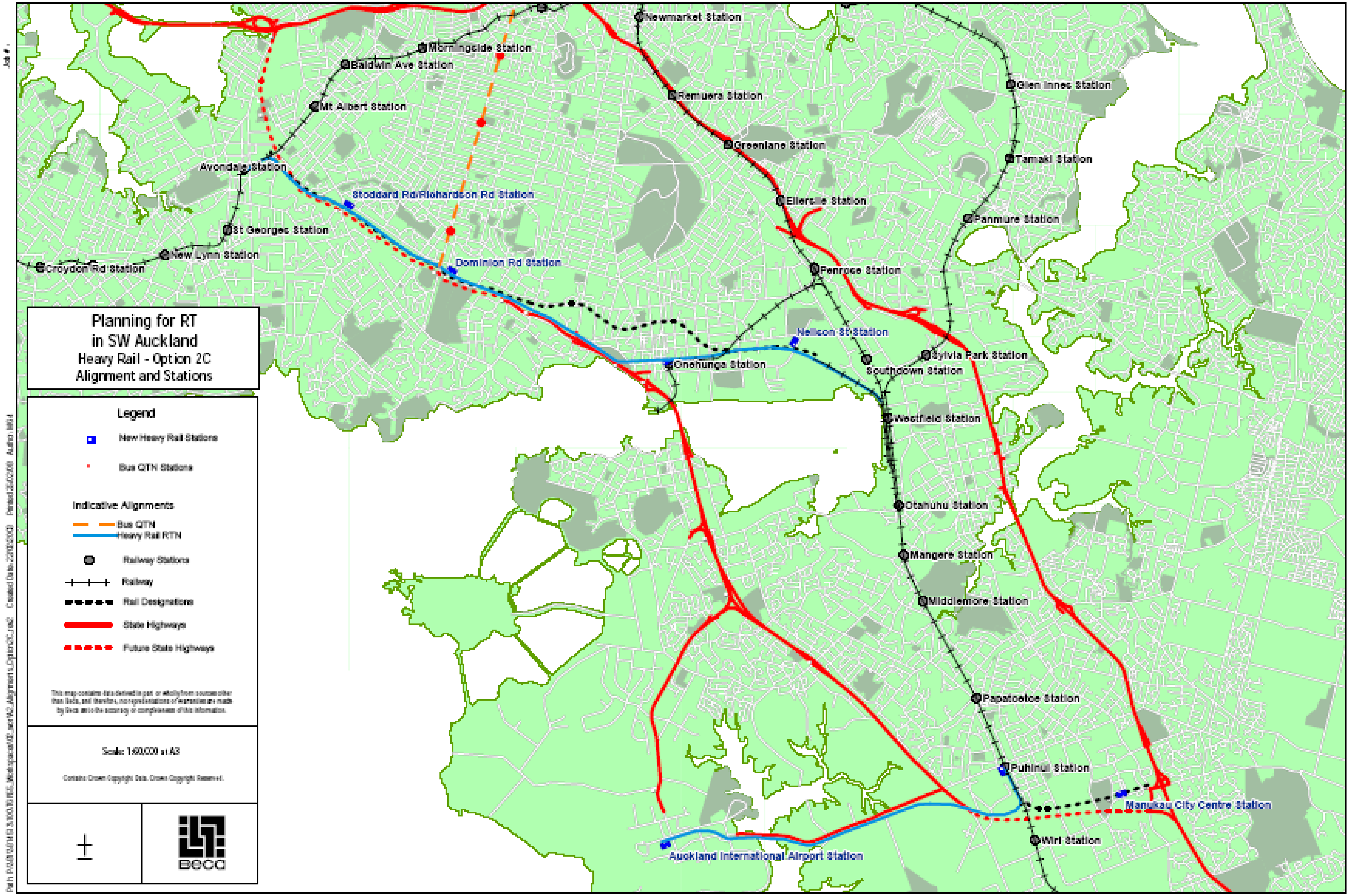
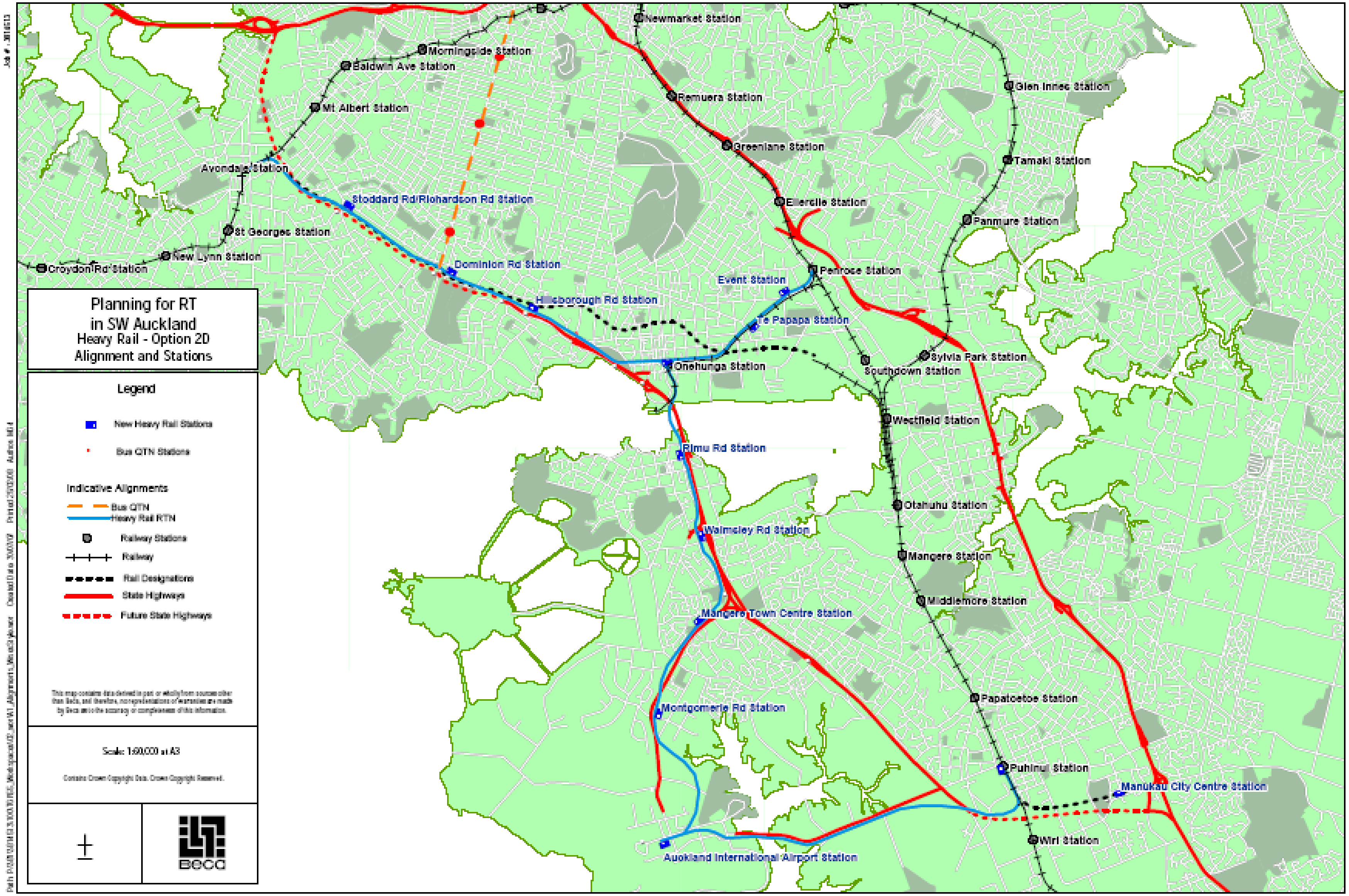


Figure 6 - Option 2D - Rail Airport Loop (from Puhinui and Onehunga)



4 Travel Demand

4.1.1 General

There is a lower level of demand between 500 and 1000 passengers/hour/peak direction, depending on mode, below which a rapid transit service frequency cannot be maintained without operating peak services below capacity. This level has been regarded by the study as a lower limit of demand needed to justify any further study consideration of a rapid transit service or need to protect a corridor. Depending on mode, a substantial operating subsidy is likely to be required at these levels of demand.

International examples indicate 5,000 to 10,000 passengers/hour/peak direction are needed for services to cover their financial operating costs depending on mode. However on an economic basis, where urban congestion is a factor, decongestion and environmental externality benefits will make services economic to operate at a lower level of utilisation.

It should be noted that the effectiveness of "do minimum" options, which include bus shoulder lanes and interchange improvements to improve bus movements through interchanges, can have a significant impact on the assessment of economic efficiency and the time at which the level of demand will support the investment in a RT right of way.

In the first stage assessment patronage demand was derived from existing information and previous ART/APT modelling which included a modelled air passenger component and no modelling was undertaken.

In the second stage assessment patronage flows have been modelled by ARC using the APT model and the modelled flows for the RTC route and service options defined under section 3. There was uncertainty regarding the validity of the modelled air passenger demand and as a result this component was excluded from second stage modelling and estimated externally. The modelled passenger demands for each network option, excluding air passenger demand, are compared in Table 3.

Table 3 – PT Flows on RTC Links for Modelled Options, AM 2h Peak Period Trips 2041

RTC Link	Base Network	1A Busway	1B LRT	2B – Rail NE Airport	2C – Rail E Airport	2D – Rail N&E Airport
SW Area Network						
Avondale - Onehunga						
East of Avondale	-	1,800	900	3,900	4,000	4,600
West of Onehunga	-	3,900	4,050	4,150	4,150	3,900
Onehunga – Penrose	-	1,200	2,100	-	-	5,350
Onehunga - Southdown	-	-	-	5,100	5,250	-
Manukau Crossing	-	2,100	2,150	-	-	2,000
Otahuhu - Favona	-	-	-	2,200	-	-
Airport – North Access	-	750	1,100	700	-	1,150
Airport – East Access	-	550	1,000	-	1,000	900
Other RTC Links						
W Line, Avondale	9,500	9,250	9,500	9,850	9,850	9,700
W Line, Mt Albert	9,500	9,250	9,500	8,150	8,150	8,050
S Line, S of Newmarket	13,800	13,150	12,150	12,500	12,350	12,850

RTC Link	Base Network	1A Busway	1B LRT	2B – Rail NE Airport	2C – Rail E Airport	2D – Rail N&E Airport
S Line, S of Penrose	13,800	13,100	13,200	12,000	11,800	13,000
S Line, S of Westfield	14,850	14,500	13,500	18,450	18,350	15,900
S Line, N of Puhinui	11,600	11,600	11,000	12,600	12,050	11,800
Manukau Rail Link	4,000	4,050	4,300	5,000	5,000	4,900
AMETI Line, E of MCC	1,400	1,400	1,400	1,700	1,750	1,700
Dominion Road (QTN)	1,950	2,350	4,200	1,700	1,700	1,700

Note: excludes air passenger demand

As part of the modelling of demand two service specification variants were tested for Options 2C and 2D, to provide continuity of rail services between AMETI and the airport via Puhinui and, for 2D, to route services between the CBD, Onehunga and the Airport back up the Southern Line to the CBD, forming a loop service, rather than terminating the airport service at Puhinui. The effects of these service variants on the modelling outputs are reported in detail in the Main Report and did not have a material effect on the ranking of the options. These variants have not been used in the evaluation except where noted otherwise and are depicted as 2C* and 2D*.

4.1.2 Comparison with First Stage Assessment

The rail AM 2h peak passenger flow across the Manukau Crossing estimated in the first stage was 2,100 trips with 1,500 bus trips on QTN/LCN services. This compares closely with the RTC modelled services in Table 3 of 2,000 rail and 1,600 bus trips (Option 2D).

The first stage demand assessment indicated 1,100 PT passengers to the airport excluding the air passenger component. The second stage modelling excluding the air passenger demand gives between 1,060 and 1,090 peak period PT patronage, with little variation between options.

4.1.3 Air Passenger Demand

The externally estimated air passenger demand is between 1,300 and 1,400 trips/hour (2,600 – 2,800 for 2 hour AM peak) for 2041. The externally estimated mode split is consistent with international examples. To fully investigate airport user travel behaviour would require significantly more information than is currently available. Such additional information would ideally be supplied by a well designed market survey of traveller preferences and choices, leading to a structured model of air traveller mode choice. Given the significance of the air passenger demand with respect to total PT demand in the vicinity of the airport it is recommended that this be done at an appropriate time.

For the busway option, Option 1A, all air passenger PT demand in the RT corridors is assumed to route via the busways in the vicinity of the airport. For LRT and heavy rail options, part of the PT demand is met by bus services, so the percentage of air passengers using the RT modes is slightly lower.

The estimated air passenger demand adds significantly to the modelled PT flows in the vicinity of the airport but further from the airport, air passenger demand is a smaller proportion of estimated PT travel in the RT corridors. Table 4 contains the combined modelled and externally estimated air passenger PT demand assigned to network sections for each network option, and also shows the percentage of air passenger PT demand on each of those sections.

Table 4 – Addition of Air Passengers to Modelled PT Corridor Demands

RTC Link	1A Busway	1B LRT	2B – Rail NE Airport	2C – Rail E Airport	2D – Rail N&E Airport
Avondale - Onehunga					
Gt North - Dominion	1,950	1,200	4,100	4,200	4,820
Dominion - Onehunga	4,950	4,800	4,450	4,450	4,240
Onehunga – Penrose	1,200	2,350	0	0	6,200
Onehunga - Southdown	0	0	5,450	5,600	0
Manukau Crossing	3,400	3,350	0	0	3,260
Otahuhu - Favona	0	0	4,400	0	0
Airport – North Access	2,510	2,850	3,010	0	2,850
Airport – East Access	1,200	1,500	0	2,550	1,400
Air Passengers % of Total					
Avondale - Onehunga					
Gt North - Dominion	8%	25%	5%	5%	5%
Dominion - Onehunga	21%	16%	7%	7%	8%
Onehunga – Penrose	0%	11%			14%
Onehunga - Southdown			6%	6%	
Manukau Crossing	38%	36%			39%
Otahuhu - Favona			50%		
Airport – North Access	70%	61%	77%		60%
Airport – East Access	54%	33%		61%	36%

Overall, air passengers are estimated to contribute around 70,000 p-km to the 2h AM peak, or 3% to 4% of total regional demand in 2041.

4.2 Demand Sensitivity

The demand modelling and externally estimated air passenger demand was estimated on the same basis as in the ART/APT models. The models assume the real cost differentials and other perceptions that influence transport choice behaviour remain as at present.

Taking a long term view, there is significant uncertainty that cost structures will remain unchanged either because of resource scarcity and long term international market demand, foreign exchange movements, Government policy regarding the pricing and supply of transport and inputs such as fuel, changing land use intensity and feedbacks between transport infrastructure supply and land use, and changing personal preferences and behaviour. A current example of such uncertainties is current movements in global fuel prices and increasing awareness of potential "peak oil" issues.

An estimate has been made of the sensitivity of the mode split calculated in the ART/APT model to changes in several influencing factors on overall travel demand, the concentration of demand in the RTC corridors and on the relative attractiveness of modes. The sensitivity has been carried out for typical 10 km car trip. This estimate has used modelled inter-zonal trip numbers, times, distances and fares for a random sample of OD pairs and using the ART mode split model to analyse sensitivity. The estimated impacts of varying a number of cost and other influences on PT travel demand are shown in Table 5.

Table 5 – Summary of Factors Affecting Mode Split – Sample of Trip OD Pairs

Factor	Change	PT Mode Split	PT Mode Split Change
Base mode split for sample trips		12.1%	
Private Transport Factors:			
Car ownership decrease	5% to 10% of trips "captive"	14.6%	+ 21%
Road pricing	10 cents/km	17.9%	+ 48%
Energy prices for private transport; carbon trading	Double in real terms, no change in PT fare	19.1%	+ 58%
Demographic Factors:			
Population grows at high or low Stats NZ projections	± 15% by 2051	Overall proportionate PT market increase or decrease	
Land use concentration	Urban density increased on transport corridors as ARTA Urban Density proposals	Not calculated, but increase in percentage of population within walking distance of a RTC	
PT Service Design Factors:			
PT Journey Speed	Reduce in-vehicle time by 25%	13.0%	+ 8%
Service Frequency	Reduce access, waiting and transfer time by 25%	13.7%	+13%

The overall conclusion is that by 2050 there could easily be a doubling in PT mode split from a combination of factors that increase the price and constrain the demand for private transport.

It is also more likely that factors will combine to increase the PT mode split than to move in the other direction – in other words we are moving from an era of low cost and relatively unconstrained private transport into an era where costs are likely to increase through resource scarcity or public policy or both. This should be taken as an indication that there is a considerable risk of uncertainty when attempting to provide demand forecasts over a 30+ year time scale.

5 Costs

5.1 Cost Basis

5.1.1 Cost Components

The four main cost components of the proposed network options are;

- Construction costs – the cost of constructing the physical infrastructure including engineering costs;
- Infrastructure maintenance costs – the annualised cost of routine and periodic infrastructure maintenance including renewals;
- Land costs – the net cost of land required for a nominal 15m wide designation. These exclude compensation costs; and
- Operating costs – of the passenger transport services from modified model outputs including vehicle maintenance, ticketing systems and stations operations including access charges.

All costs are based on or indexed to 2007 prices.

The following paragraphs briefly summarise the basis and coverage of the above cost components.

5.1.2 Construction Costs

The construction cost estimates have been prepared specifically for the purposes of comparing options and extensive use has been made of desk top concept design and quantities estimation and historical cost data. As a consequence no reliance should be placed on these estimates for any purpose other than comparisons. An indicative order of accuracy for the estimated construction costs is considered to be +/- 30-50%. Infrastructure Maintenance Costs

5.1.3 Land Costs

The estimates do not attempt to differentiate the cost of land that may lie within existing designations as the extent to which alignments may lie within existing designations will not be known until detailed alignment investigations are complete. The estimates do not attempt to anticipate differential increases in land value above the general rate of inflation or arising from changes in zoning and use.

5.1.4 Operating Costs

The operating cost structure in the APT model is suitable for comparative purposes only and not intended to be used for detailed system costing. A more rigorous estimate of operating costs will be required during the next stage of network planning.

The cost structure and values used in the model for LRT were found to be the same as for heavy electric rail and were just placeholder values. Consequently LRT costs have been calculated externally and the estimated operating cost for LRT is approximate and probably has a wider margin of error than the bus and heavy rail operating costs.

In addition it was found that 5 sets (10 cars) per train were automatically coded within the model for the heavy rail services. The effect was to exaggerate the operating costs for rail and again operating costs have been estimated externally.

5.2 Cost Summary

Table 6 provides a summary of the construction, land, maintenance and operating costs by network option.

Table 6 – Cost Summary

Network Option	Network Length km	Construction Cost	Maintenance Cost	Land Cost	Net Operating Cost	
					/Pass	/Pass-km
1A. Busway	32.2	$1,972M	$9.7M/yr	$108M	$4.2	$0.22
1B. LRT	31.0	$2,141M	$10.9M/yr	$108M	$12.7	$1.12
2A. Rail - North Access to Airport	21.6	$1,707M	$8.5M/yr	$68M		
2B. Rail - NE Access to Airport	20.1	$1,442M	$8.3M/yr	$80M	$14.9	$0.71
2C. Rail - East Access to Airport (from Puhinui)	18.9	$1,446M	$6.9M/yr	$61M	$17.4	$0.71
2D. Rail - Airport N&E Loop	29.1	$2,178M	$9.6M/yr	$89M	$19.9	$1.07

Note: Option 2A not modelled and net operating costs not determined.

6 Option Evaluation

The evaluation framework used to compare the performance of the five network options against the "do minimum" base case has been derived from a series of objectives which reflect the New Zealand Transport Strategy, Auckland's Regional Land Transport Strategy and study specific objectives with emphasis on those objectives that differentiate the network options.

The first stage evaluation was carried out largely on a qualitative basis as no traffic and passenger transport network modelling had been carried out at that time. The second stage evaluation has been able to utilise the quantitative modelling outputs. The Main Report contains the detailed evaluation of network option performance against each objective.

The evaluation framework has provided the basis for a systematic analysis of each modelled option. It also provides an important but not complete basis for identification of the preferred RT network. In this regard equal, if not greater, importance should be attached to the strategic network-wide issues of mode selection, network development and progression, and associated risks and opportunities. The following overall evaluation assessment should therefore be read in conjunction with the discussion on strategic issues and risk and opportunity assessment in Section 7.

6.1 Overall Assessment of Objectives

The overall assessment of the Options is summarised in Table 7. It should be noted that the assessment against objectives only provides an indication of comparative performance based on very limited modelling and indicators derived from modelling outputs. It has not been possible within study resources to fully investigate or optimise the performance of individual options.

Table 7 - Summary of Option Scores against Objectives - Unweighted Attributes

Objective		1A Busway	1B LRT	2B Rail NE	2C Rail East	2D Rail Loop
E.1	Integration	47	43	51	41	**62**
E.2	PT Performance	27	34	34	33	**37**
E.3	Sustainability	18	18	16	15	**19**
E.4	Contribution to RGS	32	38	43	44	**45**
E.5	Economic Development	39	38	50	47	**54**
E.6	Safety and Personal Security	15	12	**20**	**20**	19
E.7	Access and Mobility	**72**	46	61	42	55
E.8	Public Health	21	10	28	**29**	22
E.9	Environmental Sustainability	30	29	**42**	41	38
	Average Score	*33*	*30*	*38*	*35*	***39***
	Total Score	*301*	*268*	*344*	*312*	*352*
	Ranked Total (5 = best)	*2*	*1*	*4*	*3*	*5*

Table 7 indicates that when all the scores for the individual objectives are combined without weights the heavy rail options perform the best and have scores above those for the busway and light rail options for almost all objectives.

Within the heavy rail options, Option 2D with the more comprehensive connections to the airport and the existing rail network has the highest score followed by Option 2B.

6.2 Sensitivity Testing

In order to assess the robustness of these conclusions, an assessment was made of the impacts of changing the weight assigned, both within and between the individual components. The results of the sensitivity testing indicate that the findings from the main appraisal are broadly robust with Options 2D and 2B having the top rankings in all the tests.

6.3 Cost Effectiveness

6.3.1 Costs for Effectiveness Evaluation

The capital, maintenance and operating costs of the project have been described in Section 5, and are summarised in Table 8. Capital costs have been annualised which allows an estimate of total annual costs to be made on a reasonably consistent basis. The annualisation of the capital costs has been made assuming 25-40 year repayment periods dependent on normally accepted design life; 25 years for busway, 30 years for LRT and 40 years for rail, discounted at 7.5 per cent.

Table 8 - Estimated Maintenance, Operating and Capital Costs ($ millions 2007)

	1A Busway	1B LRT	2B Rail NE	2C Rail East	2D Rail Loop
Right of Way Maintenance Costs	1.9	5.6	3.6	3.4	5.2
Station Maintenance Costs	8.0	7.0	6.0	4.0	4.0
Operating Costs	9.1	21.5	23.7	30.1*	34.5*
Total Operating and Maintenance Costs	**19.0**	**34.1**	**33.3**	**37.5**	**38.4**
Revenues	4.1	3.5	5.5	5.4	4.9
Net Operating costs	5.0	18.0	18.2	24.7*	29.4*
Net Annual Operating and Maintenance Costs	**14.9**	**30.6**	**27.8**	**32.1**	**33.5**
Capital Costs	1,972	2,141	1,442	1,446	2,178
Annualisation of Capital Costs	178	181	114	115	173
Total annual costs	**193**	**212**	**142**	**147**	**207**

Note: * for the modified service pattern described in Section 4.1.1.

Options 2B and 2C have the lowest combined capital and operating costs, mainly reflecting that they represent less developed (reduced length and growth centre connectivity) networks compared to Options 1A, 1B and 2D

6.3.2 Measuring Cost Effectiveness

A simple measure of cost effectiveness has been developed which links the scores from the evaluation against objectives with the costs of the scheme. The measure is the average cost of achieving a point in the evaluation framework and the results of this evaluation are set out in Table 9.

Table 9 - Measures of Cost Effectiveness

	1A Busway	1B LRT	2B Rail NE	2C Rail East	2D Rail Loop
Total annual costs	193	212	142	147	207
Total scores from evaluation framework	301	268	344	311	352
Total scores/costs (points per $m)	1.6	1.3	2.4	2.1	1.7
Total costs/scores ($m per point)	0.6	0.8	0.4	0.5	0.6
Ranking	2	1	5	4	3

In terms of this simple test of cost effectiveness, measuring annual costs against the scores generated from the evaluation framework, Option 2B scores the most highly. Again it is worth noting that Option 2B represents a less developed (reduced length and growth centre connectivity) networks compared to Options 1A, 1B and 2D. Of the three fully developed networks Option 2D scores more highly than Options 1A and 1B.

6.4 Impact of Air Passenger Demand

As noted previously demand for PT by air passengers is not well represented in the APT network model and was excluded from the modelling analysis in favour of a separate spreadsheet based estimate. Similarly the foregoing evaluation has been undertaken excluding air passengers. The distribution of air passenger demand within the Auckland Region is similar to that for general travel demand but with more concentration in the CBD due to hotel accommodation and on the Auckland Isthmus and the North Shore, and proportionally less emphasis on West and South

On this basis the overlay of air passenger onto the demand for PT in general in the SW sector is not considered to have a material impact on the foregoing comparative evaluation and ranking of options.

6.5 Input to Preferred Network Selection

As noted under section 6.1 the evaluation framework has provided a systematic analysis of each modelled option and the assessment of cost effectiveness has similarly provided a rational basis for identification of the preferred network option. However; as also noted equal, if not greater, importance should be attached to the strategic network-wide issues of mode selection, network development and progression, and associated risks and opportunities. The following section addresses these issues and includes a consolidation of the overall assessment and concludes with the identification of the preferred mode and network option.

7 Influence of Strategic Issues Risks and Opportunities

7.1 Strategic Issues

The Main Report contains a comprehensive discussion of wider network development and connectivity issues within and beyond the study area and provides an understanding of their influence on the selection of a preferred mode and network. Issues considered include the risks and opportunities related to mode selection, network development and sequencing, and external policy, economic and demographic influences; any of which may affect the long term development of the Auckland rapid transit network.

The discussion of those issues has been used to inform an assessment of the consequence to the differing mode and network options of a range of strategic risks and opportunities.

7.2 Risks and Opportunities

At this stage of project development there is insufficient detail to reliably assess the likelihood or place a value on consequence of each risk and opportunity. The approach taken has been to identify the potential consequences associated with the different modes and network options on a qualitative basis and provide an indicative assessment of the mitigation potential afforded by those different mode and network options.

It should be noted that route section risks and opportunities, such as engineering risks, do exist but in most cases these are common to the different mode options within the route section. As a consequence route risks and opportunities are generally not seen as a differentiator between network options.

Table 10 presents the strategic risks and opportunities that are considered to differentiate the mode and network options. The qualitative comparison of mitigation potential has been scored on a simple basis and the scores are unweighted. Should weighting be considered appropriate the following factors are deemed to have a generally higher level of importance and are reflected in the highlighted risks and opportunities in Table 10:

- The uncertainties associated with long term (30+ years) demand forecasts, the potential impacts of future policy changes, funding availability and technology changes.
- Given that the desirable alignment standards, spatial requirements and construction costs of the three modes are broadly similar, protecting a "worst spatial" and "best demand" case retains the greatest flexibility to respond to uncertainty.
- The opportunity to reduce the interaction between freight and passenger traffic on the existing rail network through shared infrastructure use in the south west region.

The mitigation potential is scored on the basis that:

- 0 = least mitigation potential
- + = reasonable mitigation potential
- ++ strong mitigation potential

Table 10 – Risk and Opportunity Matrix

Risk/Opportunity	Consequence	1A Bus - way	1B LRT	2b Rail NE	2c Rail East	2d Rail Loop
Public/stakeholders favour an option different from the study findings because of perceptions	Public and media outcry	+ Good publicity for North Shore Busway	0 No experience of LRT in Auckland	++ Strong support from Campaign for Better Transport		
Demand exceeds system capacity for any reason including demand impacts of peak oil and climate change policy	Requires change to higher capacity mode or major system upgrade/ duplication	0 Least ultimate capacity	+	++ Highest ultimate system capacity		
Demand is less than forecast for any reason	Higher operating cost per passenger and possibly inappropriate choice of mode	++ Lowest operating cost per passenger	0	+		
Operating costs become unaffordable for any reason including lack of demand, economic downturn etc	Financially unacceptable to continue rapid transit operation	++ Most easily converted to link with existing roads or possible HOT operation	0	+		
Operating costs not well known and/or underestimated	Operating subsidy requirement uncertain and potentially higher than expected	+ Good experience of bus operations	0 no experience	+ Good experience of rail operating costs		
Urban densification does not occur because of changes in growth strategies	More difficult to serve travel demand with PT and with RT in particular	++ Most suitable for dispersed urban form	+	0		
SW network frequency/capacity limited because of wider network constraints or dependencies	Reduced patronage and higher operating cost per passenger	0 Bus based systems limited by CBD capacity	++ New mode and route to CBD	+ CBD Loop not constructed – more reliance on shuttle services with interchanges, 2D by-passes Otahuhu – Southdown (Westfield) section	+	++
Wider network PT capacity constrained by increased freight demand and constraints on NIMT and NAL	Existing rail RT network capacity constrained	0 No freight capability, constraint on rail freight link	0 No freight capability, constraint on rail freight link	+ Option 2D provides potential for more complete alternative route for freight	+	++

Risk/Opportunity	Consequence	1A Bus - way	1B LRT	2b Rail NE	2c Rail East	2d Rail Loop
Land required for RT network is no longer obtainable due to blocking development or use	Unable to provide RT	0	0	+	+	++
				Part of corridor already designated and easier to underground – 2D potential to use part of SH20 designation		
Land use changes and development positively support RTN	Capture PT demand before travel habits established	0	0	+ Higher capacity stations likely to attract more development		
Land costs increase because of land use and property value changes	Increase in cost may require change in concept solution (e.g. undergrounding) with possible increased costs	+ More flexible geometric standards	0	+	+	++
				Part of corridor already designated and easier to underground – 2D potential to use part of SH20 designation		
Fragmented network development because of funding constraints or difficulties securing continuity of route designation before construction	Disconnected elements of the network constructed out of sequence	++ Able to locate buses on road between dedicated busway sections	+ Able to locate LRT within road reserve between dedicated sections	0 Heavy rail can only run on separated ROW		
Scores (+)		**11**	**6**	**12**	**12**	**16**

7.3 Consolidated Assessment of Findings and Preferred Option

7.3.1 Consolidated Assessment

The evaluation against objectives in section 6 indicates that although the busway performs well in terms of Access and Mobility, in part reflecting the greater accessibility to PT services, the overall scores for the busway and the LRT options are relatively low.

The heavy rail options perform well both in aggregate and in relation to the specific objectives identified. Option 2D with the full airport loop gives good results in relation to the integration of the PT network and in its support for the Regional Growth Strategy and for economic development in general and overall achieves the highest score of the three rail options.

Similarly the preceding risk and opportunity assessment favours rail as the preferred mode and Option 2D as the preferred network.

Cost effectiveness favours rail as the preferred mode over LRT and busway. The cost effectiveness of the rail options favours option 2B which is ranked above 2C and 2D but as noted previously Options 2B and 2C are both less developed networks. Of the three complete networks the cost effectiveness of Option 2D is ranked above Options 1A and 1B.

7.3.2 Preferred Mode and Network Option

With regard to the overall option costs an early base assumption for the study was that while construction cost should not constrain network options, network options should not be an order of magnitude greater in scale, complexity or cost than other currently proposed transport infrastructure developments. For the purposes of this report a similar approach is assumed for operating costs.

The concept engineering solutions are consistent with the solutions and costs for other current or proposed transport infrastructure developments and operating subsidies are an established funding requirement for existing rail PT. The future operating costs per passenger-km although higher are not inconsistent with current levels.

For the purposes of a strategic decision to protect a corridor for future rapid transit development it is considered reasonable to assume that the construction and operating costs for the preferred rail mode and preferred network option, Option 2D will be affordable, and the difference in cost effectiveness compared to other options is offset by the additional benefits, and the potential to better manage strategic issues and risks and opportunities. This assumption needs to be confirmed by ARTA.

On this basis rail is therefore the preferred mode and the preferred network option is Option 2D as illustrated on page 13. The main network sections comprising Option 2D are:

- Avondale to Onehunga
- Onehunga to Penrose
- Airport to Onehunga
- Puhinui to Airport

The possible sequence for network development is discussed in the following section.

8 Implementation Pathway

8.1 Sequence of Network Development

There are several permutations for the sequencing of development of network option 2D. The starting section could be Airport-Puhinui, to give an early airport rail link, or Avondale-Onehunga, if this were more cost effective for the Southern Isthmus in conjunction with Onehunga to Penrose, followed by Onehunga-Airport. Alternatively, construction could be from the north from Penrose to Onehunga, then Onehunga-Airport, with the Avondale-Onehunga and Airport-Puhinui links to follow.

Not all of these sequences have been modelled, and such modelling should form part of the further development of the project, but the modelling that has been carried out to date allows a rough estimate of the passenger flows and the incremental construction cost per peak passenger as a crude indicator for cost-effectiveness of sequencing.

In developing this sequencing for Option 2D, it has been assumed that at least one of the access links north of the Manukau would need to be developed in advance of the Manukau Crossing, that is either Avondale-Onehunga or Penrose-Onehunga . In each case a below-ground station is envisaged at Onehunga, and the Onehunga-Penrose section is the full grade separation and double tracking of the route, not just the proposed opening of the line to passenger operation at surface level in 2009.

Table 11 - Demand Related Cost Effectiveness of Sections

Network Section and Sequence	Construction Cost $M	Cumulative Cost $M	Peak Section Demand (AM Peak Passengers)	$/Passenger '000s
Airport Eastern Access and Avondale-Onehunga-Penrose(or Southdown) first				
(i) Puhinui – Airport	471	471	2,500	190
(ii) Avondale - Onehunga	729	1200	4,500	160
(iii) Onehunga - Penrose	271	1471	4,500	60
(iv) Onehunga - Airport	707	2178	3,300	210
Penrose to Onehunga, followed by Onehunga to Airport				
(i) Penrose – Onehunga	271	271	1200	230
(ii) Onehunga – Airport	707	978	3000	240
(iii) Airport - Puhinui	471	1449	1000	470
(iv) Avondale - Onehunga	729	2178	4800	150

Table 11 indicates that on the basis of this simple prioritisation based on cost effectiveness it is better to establish the eastern access to the Airport first. This gives the best initial connectivity, lower spend per peak passenger, and achieves an airport connection at a capital outlay of $471 M rather than at $978 M in the second sequencing. The Avondale to Onehunga corridor is relatively high passenger volume and would be second to or equal with establishing an initial airport connection and possibly constructed in conjunction with Onehunga to Penrose

A connection from Onehunga to the Airport could be established with just the Avondale to Onehunga connection completed but more likely would be done following a Penrose to Onehunga connection.

It would be premature to attempt to develop a sequence for network development in more detail until more detailed planning investigations have been completed and the required corridor and station locations protected.

In the next stages of planning a more detailed assessment should consider prioritisation on a wider range of factors including congestion and economic development benefits. The opportunity to put in place land use changes and policies that positively support the RTN development also has the potential to change demand patterns and network development priorities.

8.2 Timing of Network Development

The study has taken a long term strategic view, considering RTN needs for the next 35+ years and the primary focus has been on establishing the pattern and volume of future demand for RT services in order to identify where corridor protection measures are required.

The timing of network development is dependent upon a wide range of factors that are outside the resources of this study to consider in detail, and the timing of physical network development is considered to be of secondary importance to the timing of the next stage of network planning and the putting in place of measures to protect RT alignments and station locations.

The light industrial developments that are currently taking place alongside the SH20A corridor, the pressures to develop Onehunga Town Centre and the challenges of consenting in sensitive urban and coastal areas exemplify the challenges that will face the protection of the preferred RT corridors. Such pressures and challenges exist now and will only increase with time and have the potential to foreclose on future RTN development.

For these reasons it is recommended that the next stage of network planning should commence as early as possible and that the scope of such planning should take into account the issues and factors discussed in the remainder of this section.

8.3 Key Issues Arising from This Study

8.3.1 Rail Designation and Freight Potential

In section 7 the assessment of strategic risks and opportunities has included the potential benefits arising from the availability of the existing rail designation between Avondale and Southdown, and the potential benefits of a shared freight and passenger RTN. These factors have influenced the ranking of the preferred option. Availability of the existing designation between Avondale and Hillsborough for rail PT services and future freight demand throughout the Option 2D network will both have a significant influence on the timing and physical development of the RTN. Investigation of these issues should precede further planning.

8.3.2 Sequence of Network Development

As stated under section 8.1 the suggested sequence of network development has used a crude indicator of cost-effectiveness to identify potential sequencing. In the next stages of planning further modelling and a more detailed assessment should consider prioritisation based on a wider range of factors including congestion and economic development benefits. The opportunity to put in place land use changes and policies that positively support the RTN development should also be investigated as it has the potential to change demand patterns and network development priorities.

8.3.3 Cost Effectiveness and Affordability

As stated under section 7.3.1 the selection of the preferred mode and network has been based on the assumption that the construction and operating costs will be affordable, and the difference in cost effectiveness compared to other options is offset by the additional benefits, and the potential to better manage strategic issues and risks and opportunities.

When commitment is made to construct part or all of the proposed RTN in the south west region it will have long term implications for funding requirements including operating costs. Consequently the above assumption should be reviewed in the context of region wide demands for public infrastructure and services and long term funding options and projections. It is recommended that such a review should be undertaken prior to any commitment to construction.

8.3.4 Risks Opportunities Assumptions and Dependencies

Section 7 has drawn attention to a wide range of strategic issues, risks, opportunities and dependencies that underpin the assessment of modes and network options and the identification of the preferred mode and network option. The next stage of network planning should include a review and update of all of these factors including more detailed investigation of critical issues.

8.3.5 Onehunga to NIMT Connection

Option 2D connects to the NIMT line at Penrose, on the current alignment of the Onehunga Branch Line. However the Onehunga to Southdown link and existing designation potentially facilitates improved east west network connections and also provides more direct access to the existing freight facilities.

In the next stage of network planning it is recommended that these two options are considered in more detail prior to a commitment to protect the Onehunga to Penrose link.

8.3.6 Status of Concept Alignments

All of the concept alignments developed for this study have been developed on a desktop basis only, using readily available existing information. Consequently the alignments have not been investigated in any detail and in particular they have not been compared with potential alignment alternatives within the identified corridors. Alignment alternatives along the identified corridors could improve cost effectiveness or improve PT amenity value or reduce land costs or mitigate consenting issues.

As part of the next stage of network planning it is anticipated that appropriate feasibility study level investigations will be required as a precursor to protecting the required land.

8.4 Legislative Framework

The current legislative framework relevant to planning and implementation includes, in particular, the Resource Management Act 1991 (RMA) and Land Transport Management Act 2003 (LTMA). While other legislation may be relevant (e.g. Building Act, Public Works Act) these two Acts are particularly important in terms of planning (land use/transport integration, route protection, and consenting) and for funding.

These instruments pose some problems for the long term protection of infrastructure corridors and while the opportunities for their use should be exhausted first it may be appropriate to also assess whether there is a case for legislative amendments or even new statutes (e.g. a specific Empowering Act) to enable protection of the preferred route.

A detailed review of the options and mechanisms for long term corridor protection is recommended.

8.5 Planning Phase

This section provides a brief summary of the possible planning phase activities, in addition to the recommended actions in the preceding sections, necessary to complete the planning for RTN development in the south west region.

The purpose of the next stage of rapid transit network development will be to advance the definition of the network to a stage where land requirements are defined in sufficient detail to enable protection of the planned future development.

The Planning Phase, assuming a conventional designation process under existing legislation, contains the following three key steps.

8.5.1 Scoping

At the early stages of planning and implementation a key risk may lie in not understanding the full implications of the network development. It is recommended that a scoping process be undertaken to identify the implications, resolve unknowns where possible and identify in a progressive level of detail the tasks that must be undertaken to complete the planning and implementation. A comprehensive checklist for a scoping process is provided in the Main Report.

8.5.2 Concept Development

The scope for this step would be informed by the scoping document and would be expected to include public and key stakeholder consultation and would lead to a shortlist of preferred concept solutions together with updated benefit and cost assessments. The updated benefit assessments would include updating demand forecasts.

Once a commitment is made to proceed with implementation, even with decision hold points, it is possible that this will trigger changes to land usage, urban form and the like, that could influence demand projections. It will be important to progressively update the underlying land use models to allow the APT model (or its successor) to evaluate potential increases in patronage.

It would not be expected to include detailed geotechnical investigations but would include topographic surveys of critical areas, assembly of buried services information, and the initial identification of economic, environmental and social impacts.

8.5.3 Investigation

Detailed assessments would be made of the shortlisted concept options and would include economic and financial evaluations. Particular attention would be paid to the constructability and impact of construction on public facilities and private buildings.

The final outputs of the planning phase would be the route designation, cost and benefit assessments and recommendations on the criteria that should be used to determine when design and construction phases should proceed.

Although alternatives to the existing legislative processes may simplify some of the above activities experience suggests that the scope of work outlined above will be necessary to define the network land requirements.