# Auckland CBD Rail Link Business Case

# Alternatives Option Review

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# 1 Executive Summary

## *1.1 Review Summary*

In November 2010, the Auckland Mayor announced a rail tunnel was the preferred solution to provide greater public transport capacity into the Auckland CBT. This solution was recommended over a bus tunnel option based on the greater cost of the latter.

This review of the analysis that led to this conclusion found that the relative cost advantage of the rail solution had been overestimated by over $1.5 billion (net present value). This was made up of a $720M underestimation of the rail option and a $790M overestimation of the bus solution:

| | Rail Tunnel | Bus Tunnel |
|---|---|---|
| A basic but serious spreadsheet calculation error in the rail operating cost | +$140M | |
| The illogical exclusion the costed link to connect the Northern Busway into the Auckland CBD | +$240M | |
| A basic but serious spreadsheet calculation error in the bus tunnel operating cost | | -$50M |
| The unjustified and undocumented addition of a second 2-Lane bus tunnel | | -$230M |
| The illogical inclusion of the cost for the Dominion Road Bus Lanes into the bus options but not the rail options | | -$80M |
| The illogical assumption that the Central Bus Tunnel option needs 8 more busways to carry 60,000 bus passengers into the CBD while the recommended CBD Rail Link option excludes any investment to support a doubling of current patronage to 42,000 bus passengers. Applying a reasonable busway investment to both options changes the real capital cost | +$340M | -$400M |
| Applying the more reasonable stated cost for operating the bus tunnel | | -$30M |
| **Total Present Value Cost Change from Review Findings** | **+$720M** | **-$790M** |

This review of the options analysis also found:

- obtaining the cost calculation information used to support the CBD Rail Link was refused by Auckland Transport. The information was only provided after several months delay following the intervention of the Office of the Ombudsman.
- supporting transport modelling information and even basic patronage information (such as car, bus and rail commuter numbers for each option) is missing from this major transport business case when these are normally provided in transport proposals a tenth the size.
- questionable judgement that the transport benefits of the original rail and bus tunnel options would be similar.
- the evaluation process appears to include staff from KiwiRail, a commercial interested party, compromising the claim the evaluation was by impartial professionals.
- The business case Alternatives Paper omits key cost elements including a “2-Lane” bus tunnel being costed as TWO 2-Lane tunnels and that the CBDRL option success assumes as many additional bus passengers as rail passengers yet does not propose investing a cent towards supporting higher capacity bus services.
- The cumulative result of the above costing errors and logic flaws leads the Alternatives Paper and CBD Rail Link Business Case to incorrectly identify the CBD Rail Link option being cheaper than the Central Bus Tunnel option.

## *1.2 Review Conclusions*

The CBD Rail Link Business Case compared four alternative options and found best Rapid Transit solutions to be the rail and bus tunnel options because both:

*are broadly equally effective at delivering the required extra capacity into the CBD*

However the Business Case Conclusion recommends the CBD Rail Link option:

*because the CBD Rail Link costs are approximately 60% of those for a CBD bus tunnel*

This review of the option costing spreadsheet and other information shows the Alternatives Paper contains a number of arithmetic and unjustified design errors. The spreadsheet errors and design gaps alone mean the CBD Rail Link cost is actually **about 83%** of those the CBD bus tunnel. Even worse, the review finds that applying a reasonable level of CBD access busway investment to both options would have **led to a recommendation for the Central Bus Tunnel option**.

| | CDB Rail Link | Central Bus Tunnel | Rail % of Bus Cost |
|---|---|---|---|
| Original Business Case Costs | $1,520M | $2,640M | 58% |
| Correcting for Errors and Design Gaps | $1,900M | $2,280M | 83% |
| Correcting to provide reasonable busway access to CBD | $2,240M | $1,850M | 121% |

The Alternatives Paper also hides the fact that the Central Bus Tunnel option carries far more commuters on congestion free PT corridors than the CBD Rail Link option while being cheaper to both build and operate. The Central Bus Tunnel option is much fairer in providing a Rapid Transit service to more PT commuters across more of Auckland than any passenger rail system. In recommending the inferior rail tunnel option, the business case fails in meeting any objective to identify the best rapid transit solution for central Auckland.

It cannot go unnoticed that identified assumption errors and design gaps **do** have one constant theme . . . that they consistently advantage the recommended rail tunnel option over all other alternative options. Even the alternative option titles are wrong as the “CBD Rail Link” option is really just a rail tunnel while the “Central Bus Tunnel” option is really a huge Bus Rapid Transit system across central Auckland !

The deceptive elimination of the superior Central Bus Tunnel option has reduced the debate on to whether or not the rail tunnel should be built. Aucklanders do not know a Bus Rapid Transit tunnel is the superior third way to improve CBD Public Transport being. The consistent misrepresentation of passenger rail over Bus Rapid Transit is difficult to understand . . . until of course you read the title page and recognise the Auckland CBD Rail Link Business Case was “Prepared for KiwiRail and ARTA”.

# 2 Introduction

## 2.1 Purpose of this Review

This review examines the alternative options analysis undertaken as part of the KiwiRail/ARTA CBD Rail Link Business Case. It concentrates on the two Auckland CBD Rapid Transit alternatives that were rated highest, the CBD Rail Link (CBDRL) option and the Central Bus Tunnel (CBT) option. As the deciding difference between these options is the estimated build and operating costs, with the CBDRL option being 60% of the CBT option, this analysis has a specific focus on the validity of each option cost estimates.

Please note that the analysis and conclusion within this report are the authors own opinion.

## 2.2 Background to the Auckland Transport CBDRL Business Case

### 2.2.1 The Auckland Transport CBDRL Business Case

On the 24th November 2010, Auckland Mayor Len Brown announced the CBD Rail Link as the "*the most significant improvement to Auckland's transport network since the opening of the Auckland Harbour Bridge.*[1]"

The CBD Rail Link Business Case states "*The two highest ranked alternatives … were ranked in terms of cost effectiveness. The CBD Rail Link with 3 stations has costs in present value terms of $1,520m, which is approximately 60% of the present cost of $2,640m for the Central Area Bus Tunnel with 3 stations.*"[2] and therefore "*Therefore the benefit-cost ratio of the CBD rail link is approximately 70% higher than that of the Central Area Bus Tunnel - inversely proportional because the costs of rail are approximately 60% of those of the bus tunnel.*"[3]

The details supporting the Rail Link Business Case[4,5] recommendation of the CBD Rail Link (CBDRL) option as the best of the four CBD PT options considered are outlined in Appendix D – Alternatives Paper[4,6].

### 2.2.2 The Ministry of Transport Business Case Review

Following the release of the Auckland CBDRL Business Case, the Minister of Transport asked the Ministry of Transport (MoT) to undertake a review that was completed on 31st May 2011[7,8].

This review was conducted totally independent from the official MoT review team and process.

[1] Auckland Transport Press Release. URL: http://www.aucklandtransport.govt.nz/improving-transport/current-projects/Rail/Pages/CBDRailLink.aspx

[2] Auckland CBD Rail Link Business Case Section 3.5 Cost Assessment page 33

[3] Auckland CBD Rail Link Business Case Section 3.6 Conclusions page 34

[4] Downloadable from the Auckland Transport Web Site: http://www.aucklandtransport.govt.nz/improving-transport/current-projects/Rail/Pages/CBDRailLink.aspx

[5] See review Section 3.1 for key quoted extracts from the CBD Rail Link Business Case

[6] See review Section 3.4 for key quoted extracts from the Alternatives Paper (Appendix D)

[7] Downloadable from the Ministry of Transport Web Site: http://www.transport.govt.nz/ourwork/rail/aucklandcbdraillink/

[8] See review Section 3.6 for key quoted extracts from the MoT Review Documents

### 2.2.3 *Public Discussion of the CBDRL Business Case*

Almost all public discussion on the proposed CBD Rail Link tunnel has been between the proceeding with the recommended CBDRL option and whether improved surface bus services will meet future PT needs. There has been very little public discussion of actual option evaluation or of the rejected Central Bus Tunnel option. A search of "Central Bus Tunnel" on Google[9] only gives three website hits being:

Auckland Transport - the website holding the CBDR Business Case documents

Ministry of Transport – the website holding the MoT Review documents

Transportblog.co.nz – the major transport discussion web blog for Auckland Transport issues

Only one story in the New Zealand Herald even mentions the bus tunnel option. This comment piece[10] by regular transport commentator Brian Rudman includes the following statements (highlight added for emphasis):

> *Meanwhile, his [The Minister of Transport] bureaucrats have told Auckland to look more closely at bus-related alternatives, such as providing increased on-street priority for buses, a bus tunnel between Fanshawe St and Upper Symonds St (already dismissed by Auckland Transport as more expensive than the rail tunnel) and rationalising the bus terminal stops on the CBD.*
>
> *Government officials bemoan the lack of detailed investigation about the bus tunnel which "would have a much larger effect in removing buses from the city streets than the rail tunnel" and complain that "the on-surface bus route improvements option is not worked up into a specific scenario that could be evaluated and costed".*
>
> *Vaguely they conclude the latter "is likely to be significantly cheaper than the rail tunnel but there is no indication of how much cheaper ..."*
>
> . . .
>
> *To Aucklanders just seeking a reliable ride to and from work, this sort of theorising is just fantasyland musings. In a rebuttal of this "more bus" proposal, Auckland Transport's experts argued that without the rail loop, by 2041 Auckland would need exclusive busways, four-lanes wide, running out of the city.*
>
> *"In many circumstances in Auckland this would take the entire width of the roadway and effectively stop all general traffic from using those roads."*

[9] a common ad hoc measure of public impact.

[10] "Govt's head in the clouds - Auckland needs that rail loop" by Brian Rudman . 3rd June 2011, New Zealand Herald: http://www.nzherald.co.nz/transport/news/article.cfm?c_id=97&objectid=10729871

The web based "TransportBlog" has a much smaller audience but provides a continuous focus on Auckland Transport with daily articles. Even this site only mentions the Central Bus Tunnel option a few times. In particular, on the 6th June 2011[11], a blog titled "*City Rail Link: Questions & Answers*" that included the following (highlight added for emphasis):

> *Surely there's a cheaper alternative? More bus lanes? A bus tunnel?*
>
> *While more work certainly needs to be done to explore alternatives, what has been looked at so far certainly seems to rule out both a surface bus option and a bus tunnel option. The surface bus option simply could not handle the number of buses anticipated to be travelling into the CBD in 20-30 years time without creating enormously wide bus only streets that would be incompatible with the council's policy of creating a more pedestrian friendly downtown.*
>
> *In terms of a bus tunnel option, this was looked at in the business case but was dismissed because initial costings showed it to be more expensive than the rail tunnel. Not only that, but while the bus tunnel would obviously have a northern portal to connect with the busway on the North Shore, at its southern end significant bus only streets would need to be created to cope with the number of buses.*

**It is clear that, in so far as the Central Bus Tunnel option has been dismissed without any public debate. This is likely to be due to the CBDRL Business Case claim it has a much higher cost compared to the recommended CBD Rail Link.**

## *2.3 Why undertake a cost review of the Alternatives Paper options ?*

The author's has long term interest in public transport with a focus mainly on Wellington projects. However, interest in the CBDRL Business Case was triggered with the claim the rail option would be much cheaper than an equivalent Bus Rapid Transit (BRT) based tunnel. It is the author's experience that rail having a lower capital cost compared to BRT is very unusual for both New Zealand[12] and world-wide. An initial reading of the Alternatives Paper raised further questions, especially in relation to whether the bus tunnel costing was based on a 2-lane tunnel or TWO 2-lane tunnels.

The author commenced this review in November 2010 with the request of the costing calculation information. However, substantive analysis could not commence for some months due to the refusal of Auckland Transport to provide this information and the need for Ombudsman intervention to require it's release.

The following analysis is focussed on the **cost estimates** of the recommended CBD Rail Link (CBDRL) option and the alternative Central Bus Tunnel (CBT) option, the latter being discounted as being a viable option by the Business Case for being too expensive.

[11] "City Rail Link: Questions & Answers": http://transportblog.co.nz/2011/06/06/city-rail-link-questions-answers/

[12] The author's detailed reviews of similar recommendations in both the Wellington Passenger Rail Business Case (2002) and the North Wellington Public Transport Study (2006) showed both business cases were based on faulty bus and rail cost estimates.

## 2.4 Review Information Sources and Structure

The key source documents for this analysis are:

- CBD Rail Link Business Case[13]
- Alternatives Paper (Appendix D)[13]
- Rail and Bus Operating Assumptions (Appendix F) [13]
- The Alternatives Papers option cost calculation spreadsheet named "Alternatives Cost Model v4a.xls" obtained from Auckland Transport[14]
  Note the Alternatives Paper Table 7.1 on page 85 contains the net present capital and operating costs for highest rated CBD Rail Link and Central Bus Tunnel options. These summary figures are from cost calculation spreadsheet "Summary Tables" worksheet Cells C4 to D6.
- Memo from Auckland Transport to the Ministry of Transport Review called "Auckland-CBD-Rail-Responses-To-Second-Set-Of-Questions-From-The-Ministry-Of-Transport"[15]
- Other CBDRL Business Case documents from Auckland Transport and the MoT Review[15]

The following analysis is in following main parts:

- Part 1 - Key extracts from the above source documents that highlight statements on the CBD Rail Link and Central Bus Tunnel options
- Part 2 - Considered analysis of three obvious errors identified in the CBDRL Business Case
- Part 3 - Considered analysis of the different levels of CBD bus access between the CBDRL and CBT options.
- Results Summary, Other Issues and Conclusion

[13]Downloadable from the Auckland Transport Web Site: http://www.aucklandtransport.govt.nz/improving-transport/current-projects/Rail/Pages/CBDRailLink.aspx
[14]Note the intervention of the Office of the Ombudsman was required to have this information released.
[15]Downloadable from the Ministry of Transport Web Site:
http://www.transport.govt.nz/ourwork/rail/aucklandcbdraillink/

# 3 Key Statements Extracts from the CBDRL Business Case

## *3.1 Part 1a – Key Extracts from the CBDRL Business Case*

This section consists of key extracts from the CBD Rail Link Business Case that highlight the key elements of the CBD Rail Link (CBDRL) and Central Bus Tunnel (CBT) options. Note highlights and **bold highlight** has been added for emphasis.

**CBDRL Business Case - Executive Summary**

*The investigations reported here show that the CBD Rail Link as configured is economically viable under standard transport appraisal. Furthermore, the potential urban regeneration and* additional *growth that can be derived from investment in this infrastructure also makes it transformative for Auckland and New Zealand.*

*. . .*

***Resolving Auckland's Transport Issues also Unlocks Opportunities***

*Auckland is New Zealand's largest and fastest growing urban area. The current population of 1.3 million is projected to increase to around 2.2 million people by 2051. These additional people will bring extra transport demand with them. Current Ministry of Transport figures indicate that in Auckland there are on average approximately 640 privately owned vehicles per 1,000 people. If this trend remained stable, then even with more people living in inner city environments, there is potential for at least another half a million vehicles on the region's roads.*

*. . . Current population and economic growth rates mean Auckland's transport system, which is reliant on the road network, already faces significant constraints.*

*. . . Therefore, the current transport links into the CBD act like a funnel, getting progressively narrower as they approach the CBD, making the CBD the most congested area in Auckland. Current systems are either already at capacity (road), or will be at capacity within the next 10 years – less than 5 years for the rail network and up to 10 years on one or two inner city bus routes (with the other bus routes at capacity before then). To reap the full economic benefits of the projected population and employment growth, the transport network requires significant investment and management.*[16]

*. . .*

*There is lack of available space to provide for road network expansion. . . .*

*The massive opportunity that exists for Auckland is to unlock the existing capacity within the rail network to meet a significant proportion of the Cud's current and future transport needs. The rail network provides complementary capacity to support the road network and recent investments there, helping to improve journey times and reliability – therefore helping to optimise the region's transport network.*

*. . .*

*Growing demand for transport due to increasing employment and population in the Auckland region, and the Auckland CBD in particular, drives the need for high capacity, high quality transport infrastructure to underpin the ongoing development of Auckland's strategic role in the New Zealand national economy.*

[16] Auckland CBD Rail Link Business Case – Executive Summary pages 2 - 3

1. There is limited space to expand the Auckland CBD Road Network. However there is an alternative with a "*high capacity, high quality transport*" capacity through the Auckland CBD to meet the "*growing demand for transport*".

***Consideration of Alternatives***

*A comprehensive list of alternatives for providing sufficient transport capacity into and within the CBD to meet the challenge was considered during the preparation of the Business Case. This list was winnowed down to four options based upon the ability to deliver the required capacity into the CBD:*

- *On-surface bus capacity improvements*
- *A central area bus tunnel with 3 stations*
- *An expanded Britomart rail station*
- *A CBD rail tunnel with 3 stations (CBD Rail Link)*

*Multi-criteria analysis and cost-effectiveness analysis were used to rank the four main alternatives. These analyses concluded that the CBD Rail Link was ranked highest for cost effectiveness and impact because of the way the project unlocks the unused capacity that exists within the rail network.*[17]

. . .

2. Business Case Auckland CBD Rail Link, prepared for KiwiRail and Auckland Regional Transport Agency, claims "*Multi-criteria analysis and cost-effectiveness analysis were used to rank the four main alternatives.*" It further claims that "*the CBD Rail Link was ranked highest for cost effectiveness and impact because of the way the project unlocks the unused capacity that exists within the rail network.*"

## *3.2 Section 1 - Introduction*

***1.1 Objective***

*The overarching objectives for the CBD Rail Link project have been agreed to between KiwiRail, ARTA, Auckland City Council (ACC) and the Auckland Regional Council (ARC). The preparation of this Business Case is guided by these objectives:*

- *Support the desired future growth and development of the CBD and region;*
- *Optimise public transport patronage potential and accessibility to/from and within the CBD;*
- *Optimise efficiency and potential of the Rapid Transit network including integration with passenger transport, active modes and freight requirements; and*
- *Continue to develop Auckland rail as part of an integrated national rail network.*[18]

[17] Auckland CBD Rail Link Business Case – Executive Summary pages 4 - 5
[18] Auckland CBD Rail Link Business Case – Section 1 Introduction page 9.

3. The Business Case is guided by objectives "*agreed to between KiwiRail, ARTA, Auckland City Council (ACC) and the Auckland Regional Council (ARC).*" These objectives include:
 * "*Optimise public transport patronage potential and accessibility to/from and within the CBD*" and
 * "*Continue to develop Auckland rail as part of an integrated national rail network.*"

## *3.3 Section 3 - CBD Transportation Constraints and Alternatives Examined*

***3.3 Bus Network Constraints***

*Bus network constraints are different from those faced by the rail network. While rail has latent capacity within its own segregated corridor, buses share surface space with other modes, namely private vehicles, cyclists and pedestrians, competing for priority on the main corridors and, importantly, at at-grade intersections. Therefore, surface network constraints hold back the delivery of effective bus rapid transit services into the Auckland CBD.*[19]

*. . .*

4. The Business Case claims bus based options to improve Auckland Public Transport through the increased use of surface bus services are constrained by the congestion on roads into the Auckland CBD roads.

***3.4 Multi-criteria Analysis***

*Based upon the above discussions, four potential transport investment alternatives were brought forward for further analysis on a qualitative basis:*

- *On-surface bus capacity improvements*
- *A central area bus tunnel with 3 stations*
- *An expanded Britomart rail station*
- *A CBD rail tunnel with 3 stations (CBD Rail Link)*

*Multi-criteria analysis was used in the first instance as a coarse filtering mechanism to reduce the list of four alternatives down to two options capable of providing the depth of capacity, reliability and robustness to deliver the transport outcomes sought.*[20]

*. . .*

5. The CBD Rail Link Business Case "*Multi-criteria analysis was used . . . to reduce the list of four alternatives down to two options capable of providing the depth of capacity, reliability and robustness to deliver the transport outcomes sought.*"

*The Central Area Bus Tunnel and the CBD Rail Link, in spite of higher construction costs, score more highly than the On Surface Bus Route Improvements and the Britomart Terminus for the following reasons:*

- *The CBD Rail Link and Central Area Bus Tunnel come closest to fulfilling the requirements of the Rapid Transit Network by providing network backbone*

[19] Auckland CBD Rail Link Business Case – Section 3 CBD Transportation Constraints and Alternatives Examined page 30

[20] Auckland CBD Rail Link Business Case – Section 3 CBD Transportation Constraints and Alternatives Examined page 32

*along a dedicated high density corridor. Britomart is the constraint in the rail network, while surface bus schemes rely on sharing existing road space.*

- *On Surface Bus Improvements and Britomart Terminus both have capacity constraints attached to them, which limits the natural growth of patronage and prevents optimisation of patronage over time.*
- *Because of lower expected patronage growth, over time Britomart Terminus and the On Surface Bus Improvements will not have the same impact upon congestion, fuel consumption and emissions. These impacts were adjudged to lead to lower improvements in local air quality and fewer people being likely to adopt active travel modes.*
- *Conventional transport benefits are more likely to arise with the CBD Rail Link and the Central Bus Tunnel because each of these schemes promotes the reduction of traffic on the road network through patronage uptake. Separate corridors imply better journey times, while the removal of vehicles from the road at peak times potentially helps traffic flow and travel times on the roads. The CBD Rail Link is the only option with potentially significant non-transport benefits based upon additional development that gets undertaken around rail stations. Section 5 presents evidence and discussion of the potential role of these benefits in the case of the CBD Rail Link.*
- *The CBD Rail Link and the Central Bus Tunnel provide closer alignment with Auckland City Council's strategies for the CBD and Waterfront, in terms of connectivity, traffic improvements at street level, better pedestrian access, linkages between the waterfront and wider CBD, and environmental benefits within the CBD and surrounds.*

*Further discussion on the scoring differences between the four options listed in Table 3-2 can be found in Section 6.2 of the Alternatives Paper (Appendix D). As the two highest scoring options, the CBD Rail Link with three stations and the Central Area Bus tunnel with three stations were then compared for cost effectiveness to find the superior alternative, **assuming benefit delivery is similar**.*[21]

6. The CBD Rail Link and the Central Bus Tunnel options scored higher than the other options being the on Bus Surface Improvement and the Britomart Terminal options. The benefits for both the tunnel options are **assumed to be similar**.

***3.5 Cost Assessment***

*The two highest ranked alternatives from the Multi- Criteria Assessment were ranked in terms of cost effectiveness. The CBD Rail Link with 3 stations has costs in present value terms of $1,520m, which is approximately 60% of the present cost of $2,640m for the Central Area Bus Tunnel with 3 stations. Table 3-3 shows that these rankings are not sensitive to the choice of discount rate. Lower discount rates favour the CBD Rail Link more strongly over the bus tunnel, because the rail and bus tunnels are assumed to have similar construction periods.*[22]

[21] Auckland CBD Rail Link Business Case – Section 3 CBD Transportation Constraints and Alternatives Examined pages 32

[22] Auckland CBD Rail Link Business Case – Section 3 CBD Transportation Constraints and Alternatives Examined pages 33 - 34

***Table 3-3: Sensitivities of costs ($m PV, 2010 terms)***

| *Discount rate* | *CBD Rail Link with 3 Stations* | *Central Bus Tunnel with 3 Stations* | *Ratio of CBD Rail / Bus Tunnel* |
|---|---|---|---|
| *4% Real* | *$2,230* | *$3,750* | *59%* |
| *6% Real* | *$1,820* | *$3,120* | *58%* |
| *8% Real* | *$1,520* | *$2,640* | *58%* |

7. The CBD Rail Link Business Case estimates the Present Value cost of the CBD Rail Link at $1,520m while the Central Bus Tunnel cost is $2,640m. Based on these costings, the CBD Rail Link is only 60% of the Central Bus Tunnel based on these costings.

***3.6 Conclusions***

*The Alternatives Paper in Appendix D did not seek to quantify the benefits of either the CBD Rail Link or the Central Area Bus Tunnel. However, both alternatives are broadly equally effective at delivering the required extra capacity into the CBD, so a simplifying assumption is that the underlying benefits are comparable. Therefore the benefit-cost ratio of the CBD rail link is approximately 70% higher than that of the Central Area Bus Tunnel - inversely proportional because the costs of rail are approximately 60% of those of the bus tunnel. An alternative way of looking at this is to assume that the benefit cost ratios are broadly equivalent. Then, because the CBD Rail Link costs are approximately 60% of those for a CBD bus tunnel, the benefit stream attached to the bus tunnel would need to be around 1.7 times larger than the benefits for the CBD Rail Link.*

*A large part of the cost and performance advantage of the CBD Rail Link is due to the project releasing excess capacity currently residing in the rail network, which is unable to be realised due to the capacity constraints of the Britomart Terminus. In contrast, the bus tunnel option has to be built from scratch, and requires further investment out into the wider Auckland network to continue to deliver the benefits of the original investment. This accounts for the higher infrastructure and operational expenditure of the bus tunnel option compared to the rail option and therefore its lower performance.*[23]

8. Although the Business Case Alternatives Paper did not quantify the benefits of the either the CBD Rail Link or the Central Bus Tunnel. It claimed "*both alternatives are broadly equally effective at delivering the required extra capacity into the CBD, so a simplifying assumption is that the underlying benefits are comparable*".
9. The option analysis claims "*the bus tunnel option has to be built from scratch*" and that "*This accounts for the higher infrastructure and operational expenditure of the bus tunnel option compared to the rail option*".
10. As the CBR Rail Link Costs were estimated at 60% of the Central Bus Tunnel and assuming the benefits are the same the CBD Rail Link Business Case concludes the CBD Rail Link option has a benefit cost ratio 70% higher than the next best alternative of the Central Bus Tunnel.

[23] Auckland CBD Rail Link Business Case – Section 3 CBD Transportation Constraints and Alternatives Examined page 34

## 3.4 Part 1b – Key Extracts from CBDRL Alternatives Paper (Appendix D)

This section consists of key extracts from the Alternatives Paper that is Appendix D of CBD Rail Link Business Case. These extracts highlight the key elements of the CBD Rail Link (CBDRL) and Central Bus Tunnel (CBT) options.

The following are extracts from the "Alternatives Paper Appendix D" of the CBDRL Business Case, Prepared for KiwiRail and ARTA (highlights and **bold highlight** added for emphasis).

### *Alternatives Paper – Executive Summary*

. . .

***Transport Alternatives***

*The paper describes a comprehensive long list of transport alternatives for providing sufficient transport capacity into and within the CBD to meet the challenge. These alternatives were scored using a range of assessment criteria with both uniform and non-uniform weightings. Table E-1 summarises the assessment. The two highest scoring alternatives both require significant new underground infrastructure, with the CBD Rail Link with 3 stations being ranked highest for both sets of weights, while the Central Area Bus Tunnel with 3 stations is rated second highest.*[24]

. . .

11. The Alternatives Paper has the detailed analysis of the four options that KiwiRail and ARTA claims details the justification that the best option is the proposed CBD Rail Tunnel.
12. The Alternatives Paper Executive Summary reiterates the view that the two tunnel based options, the CBD Rail Tunnel and the Central Bus Tunnel score highest "*for providing sufficient transport capacity into and within the CBD*".

***CBD Rail Link***

*This alternative entails constructing an approximately 3.5 km double track underground rail line beneath the central business district from Britomart to the Western (North Auckland Line) near the existing Mount Eden Station (Figure E -1). Britomart would become a `through' station and up to three intermediate underground stations are proposed:*

- *Aotea*
- *Karangahape Rd*
- *Newton*[25]

. . .

13. The CBD Rail Link option "entails constructing an approximately 3.5 km double track underground rail line beneath the central business district from Britomart to the Western (North Auckland Line) near the existing Mount Eden Station".

[24] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – Executive Summary page 6
[25] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – Executive Summary page 6

*The theoretical maximum throughput of the CBD Rail Link is between 15 and 30 trains per hour in both direction (depending on the signalling system configuration), which with 6 car electric trains, corresponds to between 23,100 and 46,200 passengers per hour. The achievable capacity will depend however on both the capacity of the existing rail network beyond the CBD Rail Link and the available rolling stock fleet.*[26]

. . .

14. The rail tunnel option was predicted to have a maximum throughput of 15 to 30 trains per hour in both directions that "*corresponds to between 23,100 and 46,200 passengers per hour*". Note that 30 trains/hour (one train every 2 minutes) is at the limit of even advanced major metro rail systems.

***Central Area Bus Tunnel***

*This alternative entails* ***construction of 3km of double lane bus tunnel*** *under the CBD connecting the Newton area to the Harbour Bridge (Figure E-2). Buses on the key north-south corridors would enter the tunnel outside the CBD motorway network. The tunnel would have access from McKinnon Drive and Khyber Pass Road (at its southern end) and Fanshawe Street at its northern end. Three underground CBD area Bus stations would be provided; Wynyard, Civic and Symonds Street.*

*The Bus Tunnel would remove some 534 bus movements per hour (equivalent to a maximum capacity of around 37,000 passengers per hour) from the surface streets. However up to 100 buses per hour would remain on the surface, operating via Fanshawe Street, Britomart and Symonds Street, stopping at a restructured Britomart bus station and also serving the University, as well as 30 buses per hour in Queen Street.*

*In order to achieve the required bus throughput that the Central Area Bus Tunnel would be capable of delivering, extensive provision of both grade separated bus ways in the CBD Fringe as well as bus priority ("Quality Bus Lanes") measures further out from the CBD would be needed (Figure E-3). This level of bus infrastructure provision is significantly greater than currently planned and would also involve more tunnel infrastructure, such as a 30 metre vent stack at the end of Britomart.*[27]

. . .

15. The Alternatives Paper states the Central Bus Tunnel option "entails construction of approximately 3km of double lane bus tunnel under the CBD connecting the Newton area to the Harbour Bridge". This option is predicted to "remove some 534 bus movements per hour (equivalent to a maximum capacity of around 37,000 passengers per hour) from the surface streets."

***Cost Effectiveness Assessment***

*The two highest ranked alternatives from the Multi- Criteria Assessment were then ranked in terms of cost effectiveness.*

*The CBD Rail Link with 3 stations has present costs of $1,520m, which is approximately 60% of the present cost of $2,640m for the Central Area Bus Tunnel with 3 stations.*

[26] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – Executive Summary page 7
[27] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – Executive Summary pages 8 - 9

*This paper does not seek to quantify the benefits of either the CBD Rail Link with three stations or the Central Area Bus Tunnel with three stations. However, on the basis that both alternatives are equally effective at delivering the required extra capacity into the CBD from a strategic perspective, establishes a simplifying assumption that the underlying benefits of both are comparable. Therefore the benefit / cost ratio of the CBD rail link is approximately 1.7 times higher than that of the Central Area Bus Tunnel - inversely proportional because the costs of rail are approximately 60% of those associated with the bus tunnel.*[28]

16. The Alternatives Paper Executive Summary reiterates the analysis did **not** model or quantify the benefits but **assumes** both the rail and bus tunnels "*are equally effective at delivering the required extra capacity into the CBD from a strategic perspective*".
17. The cost effectiveness difference is between the option costs where "*The CBD Rail Link with 3 stations has present costs of $1,520m, which is approximately 60% of the present cost of $2,640m for the Central Area Bus Tunnel with 3 stations.*"
18. "*Therefore the benefit / cost ratio of the CBD rail link is approximately 1.7 times higher than that of the Central Area Bus Tunnel - inversely proportional because the costs of rail are approximately 60% of those associated with the bus tunnel.*"

***Discussion and Conclusions***

*On the basis of the calculations in this paper,* ***the CBD Rail Link clearly outperforms the Central Area Bus Tunnel option by a factor of approximately 1.7****, or 1.5 times if the cost of a North Shore bus connection is included with the rail option.*

*. . .*

*A large part of the cost and performance advantage of the CBD Rail Link is due to the project releasing latent capacity currently residing in the rail network, which is unable to be realised due to the capacity constraints of the Britomart Terminus. In contrast, the bus tunnel option has to be built from scratch, and requires further investment out into the wider Auckland network to continue to deliver the benefits of the original investment. This accounts for the higher infrastructure and operational expenditure of the bus tunnel option compared to the rail option and therefore its lower performance.*

[28] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – Executive Summary pages 9 - 10

*Overall, the CBD Rail Link tunnel with three stations is the best option to carry forward into the detailed business case. The CBD Rail Link unlocks existing capacity in the rail network and leverages off the substantial network infrastructure associated with 113 kilometres of track and 44 stations following the addition of the Manukau line and restoration of services to Huapai in 2011. By operating in its own dedicated corridor, further development of the rail network is not invasive on the road network in the way that ramping up dedicated bus infrastructure would be over the long term. The CBD Rail Link would also be more consistent with the development objectives sought for the CBD and waterfront areas, while supporting high density development at key nodes further out into Auckland.*[29]

19. The Alternatives Paper Executive Summary Conclusion is "*On the basis of the calculations in this paper, the CBD Rail Link clearly outperforms the Central Area Bus Tunnel option by a factor of approximately 1.7, or 1.5 times if the cost of a North Shore bus connection is included with the rail option.*" This superior benefit/cost ratio is totally based on the much higher cost estimate for the Central Bus Tunnel option.

***4 -Comprehensive List of Transport Measures***

*This section discusses the current suite of approved transport management tools and initiatives that are available to ARTA through its mandated strategy and planning documents. This comprehensive list of measures is summarised in Table 4-1. From this list, this section presents a concise set of alternative transport infrastructure investments that are considered to have sufficient transport capacity to support the population and growth forecasts for the Auckland CBD.*

20. The Alternatives Paper Section 4 has the detailed analysis of the options considered in the CBD Rail Business Case.

***4.4 Increased Bus Usage***

*An alternative approach to providing the CBD Rail Loop is to provide for the forecasted increase in public transport customers by increasing the capacity of the bus network.*[30]

*. . .*

21. "An alternative approach to providing the CBD Rail Loop is to provide for the forecasted increase in public transport customers by increasing the capacity of the bus network."

***4.4.2 2041 Bus Demand Without CBD Rail Link***

*To estimate the future impact of bus passenger transport without the CBD Rail Link, the following assumptions were made as part of a —most likely growth scenario for different modes in the morning peak 2 hour period between 2006/07 and 2041*

*. . .*

*. . .the demand for bus travel into the CBD in the 2 hour morning peak is estimated to increase by about 135%.*

*This broad growth assumption was checked against results from the APT model. For a 2041 scenario without a CBD rail loop or a Parnell rail station, the growth in bus demand is predicted to be 139%.*

[29] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – Executive Summary pages 10 - 11
[30] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, page 33

*The growth in bus demand will vary across the different bus corridors based on variations in underlying population growth within the corridor and the ability for trips to be made by rail. In particular, bus demand on the North Shore and Fanshawe Street corridor is likely to increase at a much stronger rate than other corridors.*

*. . .*

*The medium level increases in CBD bus flows by 2041 are illustrated in Figure 4-1, which are based upon APB&B calculations*

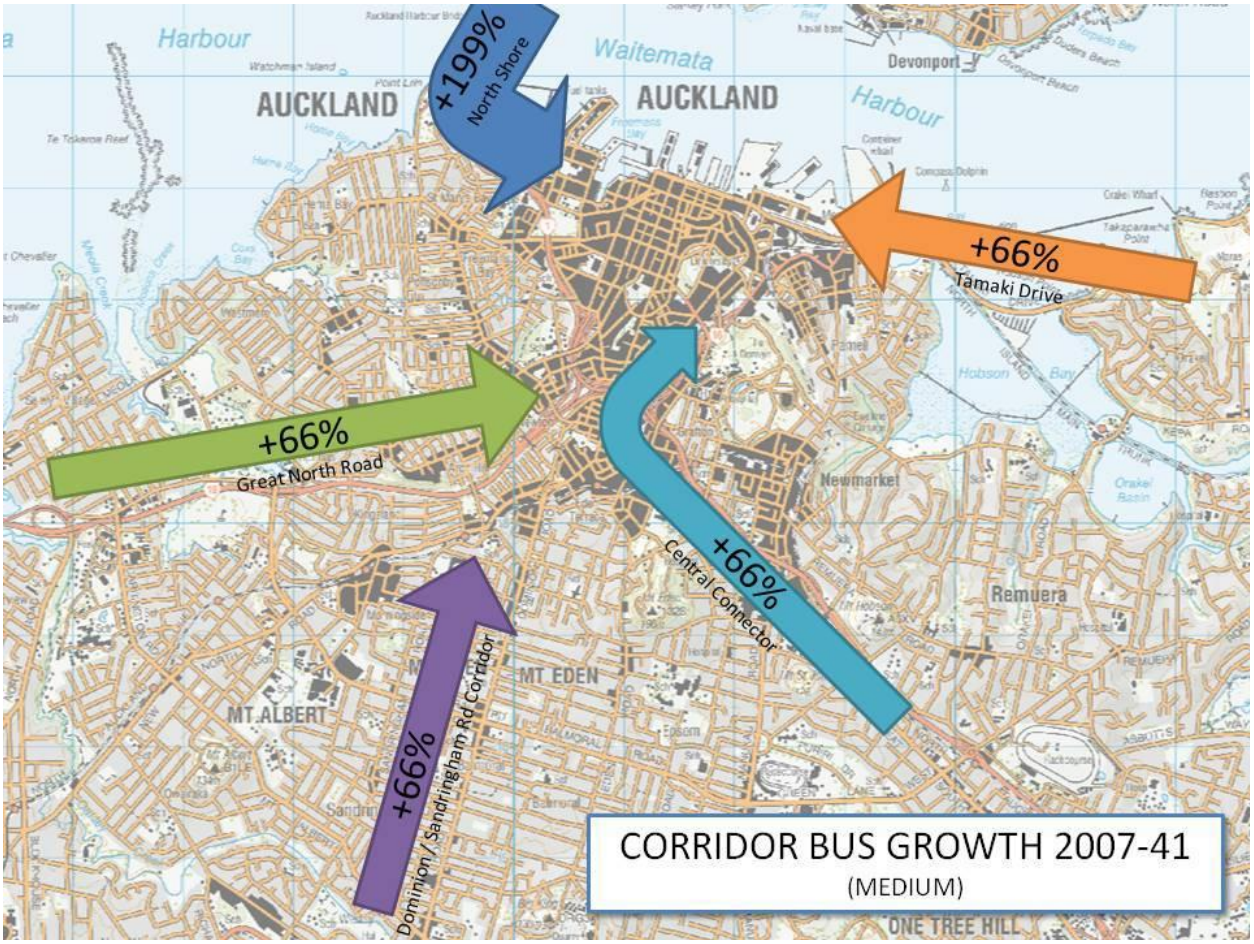



***Figure 4-1: Corridor Bus Growth 2007-2041***

*Table 4-3 below shows estimated bus flow capacity and future demands for these key CBD bus streets.*

| CBD Bus Street | Bus Capacity/hour | Future Practical | Capacity 2007 Bus Flows | Estimated Future Bus Flows/hr |
|---|---|---|---|---|
| *Fanshawe Street* | *150* | *125* | *92* | *250* |
| *Central Connector* | *220* | *200* | *124* | *206* |
| *Albert Street* | *130* | *110* | *66* | *110* |
| *Queen Street* | *50#* | *30* | *35* | *58* |

*Notes: # Queen Street bus capacity assessed as being at the lower end of bus lane warrant*

*As the table shows, on the current major bus streets in the Auckland CBD, projected bus flows will exceed their practical capacity in some case by substantial margins.*[31]

22. "For a 2041 scenario without a CBD rail loop or a Parnell rail station, the growth in bus demand is predicted to be 139%." "... bus demand on the North Shore and Fanshawe Street corridor is likely to increase at a much stronger rate than other corridors." In fact North Shore bus demand is expected to **triple** !

23. Note the shortfall in surface bus capacity (Estimate Future – Future Capacity):
Fanshawe Street bus capacity shortfall = 250 – 125 = 125 bus/hour
Central Connector bus capacity shortfall = 206 – 200 = 6 buses/hour
Albert Street bus capacity shortfall = 110 – 110 = 0 buses /hour
Queen Street bus capacity shortfall = 58 – 30 = 28 buses/hour
Therefore, **the total CBS Surface Bus Capacity shortfall is estimated at 159 buses/hour.**

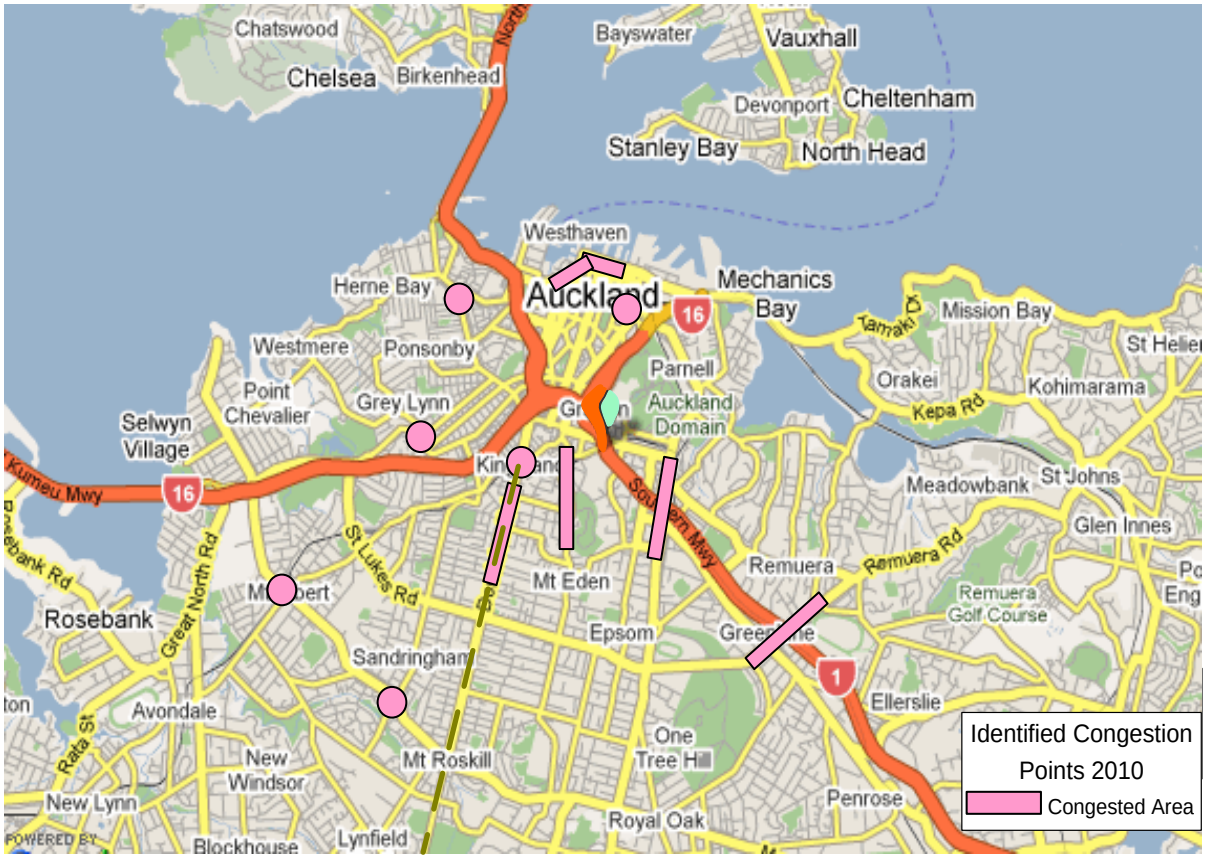
24. ". . . on the current major bus streets in the Auckland CBD, projected bus flows will exceed their practical capacity in some case by substantial margins."

### *4.4.3 Bus Capacity to the CBD*

*In addition to capacity limitations within the CBD, buses approach and depart the city on arterial and other road corridors shared with other vehicles. In contrast with the CBD Rail Link proposal, which proposes to make use of substantial spare capacity on three rail lines with exclusive priority over other surface modes, a surface bus rapid transit option by itself will be an inferior proposition if it has to share corridors with general traffic. Many of these corridors are already subject to significant congestion and delays at peak times.*

. . .

[31] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, page 43 - 45




*Whilst rail already has priority corridors, bus largely does not (except the Northern Busway). If buses are to provide the capacity increase necessary to accommodate the CBD's needs, it too will need dedicated rights of way. This study proposes that bus lanes alone will not be adequate to provide reliable bus service running conditions. We would instead put forward that Bus Rapid Transit (BRT) would be required over strategic parts of the road network to engender the levels of service (frequency and reliability) required if a system of bus routes were to form the core of the Rapid Transit Network. This would take the form of exclusive bus lanes (one in each direction) assumed to be in the median, widening to an effective 3 lanes at stations, where stations would be located approximately 800m apart.*[32]

25. Apart from the North Shore Busway, bus growth will also pressure already congested access ways into the CBD. The Alternatives Paper claims "*Whilst rail already has priority corridors, bus largely does not (except the Northern Busway). If buses are to provide the capacity increase necessary to accommodate the CBD's needs, it too will need dedicated rights of way.*".

26. "*This study proposes that bus lanes alone will not be adequate to provide reliable bus service running conditions. We would instead put forward that Bus Rapid Transit (BRT) would be required over strategic parts of the road network to engender the levels of service (frequency and reliability) required if a system of bus routes were to form the core of the Rapid Transit Network.*"
Note the benefits of the proposed BRT investment have not been modelled or quantified by the Alternatives Paper.

[32] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 45- 46

***4.5 Increased Bus Usage – On Surface Capacity Improvements***

***4.5.1 Description***

*This option would retain buses on surface streets within Auckland CBD and is aimed at investigating the extent to which the CBD street network could accommodate projected bus flows without grade-separation.*

*. . .*

*In contrast to the rail tunnel option in providing additional future passenger transport demand, which makes use of substantial unused capacity on the rail network's exclusive corridors, a surface bus rapid transit option operates on corridors shared with general traffic and with additional friction generated by at-grade intersections where buses are competing with other vehicle and pedestrian movements for signal phase time.*

*Bus rapid transit (BRT) aims to overcome these constraints by providing additional protection for buses from interaction with other vehicles through exclusive bus streets, bus bays and grade-separation to avoid surface intersections and can deliver passenger flows comparable to fixed track modes while retaining the flexibility benefits of buses.*

***4.5.2 Constraints to BRT***

*The potential to deliver surface bus rapid transit in the Auckland CBD is constrained by the potential capacity of key bus streets. Previous investigations have shown that key CBD bus streets and facilities, including Fanshawe Street, Queen Street and Albert Street have limited capacity*

27. The Alternatives Paper highlights the need for investment in Bus Rapid Transit (BRT) to enable improved surface access to and through the CBD for to provide increased bus service capacity.

***4.5.3 Rerouting and Through Routing***

*This option takes the opportunity to reroute some buses to and through the CBD to balance bus access to the CBD and capacity-constrained north-south CBD streets.*

*. . .*

*North Shore buses, expected to grow by some 200% to 332 buses per hour by 2041 in the medium scenario, would operate via two routes within the CBD – with some 50% of buses continuing on Fanshawe Street while the remaining half would (following completion of an additional Waitemata Harbour Crossing and Victoria Park Tunnel) make use of bus lanes on SH1 viaduct through Victoria Park to the Cook Street off-ramp. These buses would enter the CBD via Cook Street and Mayoral Drive using a new major surface bus station near the Civic Centre. An additional on-ramp from Cook Street to the Motorway off-ramp would be constructed to cater for outbound bus movements on the North Shore busway services.*

28. The Alternatives Paper predicts for "*North Shore buses, expected to grow by some 200% to 332 buses per hour by 2041 in the medium scenario*" with investments in

***4.7 Increased Bus Usage – Bus tunnels***

***4.7.1 Description***

*This alternative would separate the main flow of buses through the CBD by providing a bus-only tunnel beneath the city with purpose built, underground bus stations*[33]

29. The Central Bus Tunnel as an alternative way to "*separate the main flow of buses through the CBD*".

***4.7.2 Examples and Learnings***

*A number of cities with bus-based passenger transport systems have implemented fully or partly grade-separated bus solutions. Examples include Seattle's bus tunnel (now operating with mixed bus and light rail services) and Brisbane's busway system, which are described below.*

***a. Seattle***

*Seattle's Metro Bus Tunnel is 2.1km long and carries buses and light rail north-south beneath the city's central business district (see Figure 4-7, Figure 4-8 , Figure 4-9). The tunnel was opened in 1990 and was converted to dual-use (bus and light rail) in 2007. The tunnel is used by about one-quarter of buses entering the city centre. It has a potential capacity (in King County Metro's view) of 165 buses per hour in each direction and a practical capacity (again in King County Metro's view) in terms of balancing capacity with quality of service, of some 125 buses per hour (most recent data suggests a capacity of around 15,000 to 20,000 passengers per hour). However, demand projections from 2001 studies suggested potential bus flows of more than 200 per hour. The capacity of the tunnel itself is considered to be substantially higher than 165 buses per hour but is limited by station design and operation.*

. . .

[33] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, page 54

***Figure 4-9: Pioneer Square Station, Seattle***

*Air quality and ventilation concerns in the bus tunnel were addressed through use of a purpose-built fleet of dual power 18m articulated buses (see photo above) which switched to electric power in the tunnel. Since the tunnel was converted for LRT use, hybrid buses are used.*[34]

. . .

30. One example of an effective bus tunnel is in Seattle which uses two single lanes 2.1km tunnels and hybrid buses. Both these two tunnels have a 6.4m (21 foot) diameter giving a total cross-sectional area of 64.34m².

31. "*demand projections from 2001 studies suggested potential bus flows of more than 200 per hour. The capacity of the tunnel itself is considered to be substantially higher than 165 buses per hour but is limited by station design and operation.*"

*b. Brisbane*

*Brisbane's extensive busway system includes bus tunnels with underground busway stations in the city centre, at King George Square and Queen Street. The bus tunnels were intended to overcome surface capacity problems in the city centre and the South East Busway alone caters for some 200 buses per hour.*[35]

[34] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 55 - 57

[35] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 57 - 58

. . .

***Figure 4-12: Brisbane South East Busway Tunnel***

32. Another example is "*Brisbane's extensive busway system includes bus tunnels with underground busway stations in the city centre, at King George Square and Queen Street. The bus tunnels were intended to overcome surface capacity problems in the city centre and the South East Busway alone caters for some 200 buses per hour.*"
    Note the main Brisbane bus tunnel is a single 2-lane tunnel with a cross-sectional area of 83.6m$^2$.

#### *4.7.3 Operating Assumptions*

*For Auckland, a bus tunnel alternative would aim to overcome surface capacity constraints, most notably on the north-south axis by grade-separating buses from surface traffic (including pedestrians and bicycles). However, as with the Seattle and Brisbane examples, a bus tunnel could not practically cater for all bus movements in the CBD and a number of bus routes could be expected to remain on surface streets – a bus tunnel option could not remove all buses from city streets.*

*A bus tunnel would however, be compatible with the city's streetscape improvement objectives and would be more likely than a surface bus option to allow the city to cater for projected increases in pedestrian and cycle demand.*

*It is assumed that predominantly diesel buses would continue to be operated in Auckland and, for maximum flexibility, the tunnel would be designed (and ventilated) for diesel buses. The cost of ventilation and other mechanical, electrical and fire and life safety requirements of the bus tunnel could be reduced by use of hybrid or electric buses in the tunnel.*[36]

. . .

33. The Auckland Central Bus Tunnel option assumes current diesel buses, not environmentally friendly hybrid or electric buses, raising bus tunnel costs.

***4.7.5 Operational Evaluation***

*A two-lane CBD bus tunnel would have ample capacity to accommodate the expected up to 534 bus movements per hour (two directions) assuming no crashes or breakdowns. The capacity constraint for the bus tunnel would be the operation of the bus stations as well as the level of traffic congestion on the shared road corridors beyond the tunnel. Efficient operation of the bus stations would be critical and would require active management of bus and pedestrian movements. Bus stations of this type are proven technology in New Zealand, though operating costs are high.*

*However a bus tunnel of this length would require safe exits in the case of fire, necessitating fire-proof separation. Each separate direction would then need to allow passing in the case of breakdowns, so would probably need to be two lanes,* ***implying two by two-lane tunnels.***

*Extensive bus tunnels on the other hand are not used to date in New Zealand. In contrast to surface streets where options may exist for buses to bypass congestion, crashes or broken down buses, this may not be possible in a two-lane tunnel, so the efficient operation of the underground facilities would be susceptible to breakdowns and other incidents. In Seattle for example, a single bus breakdown has blocked southbound bus operations for 40 minutes during peak times.*

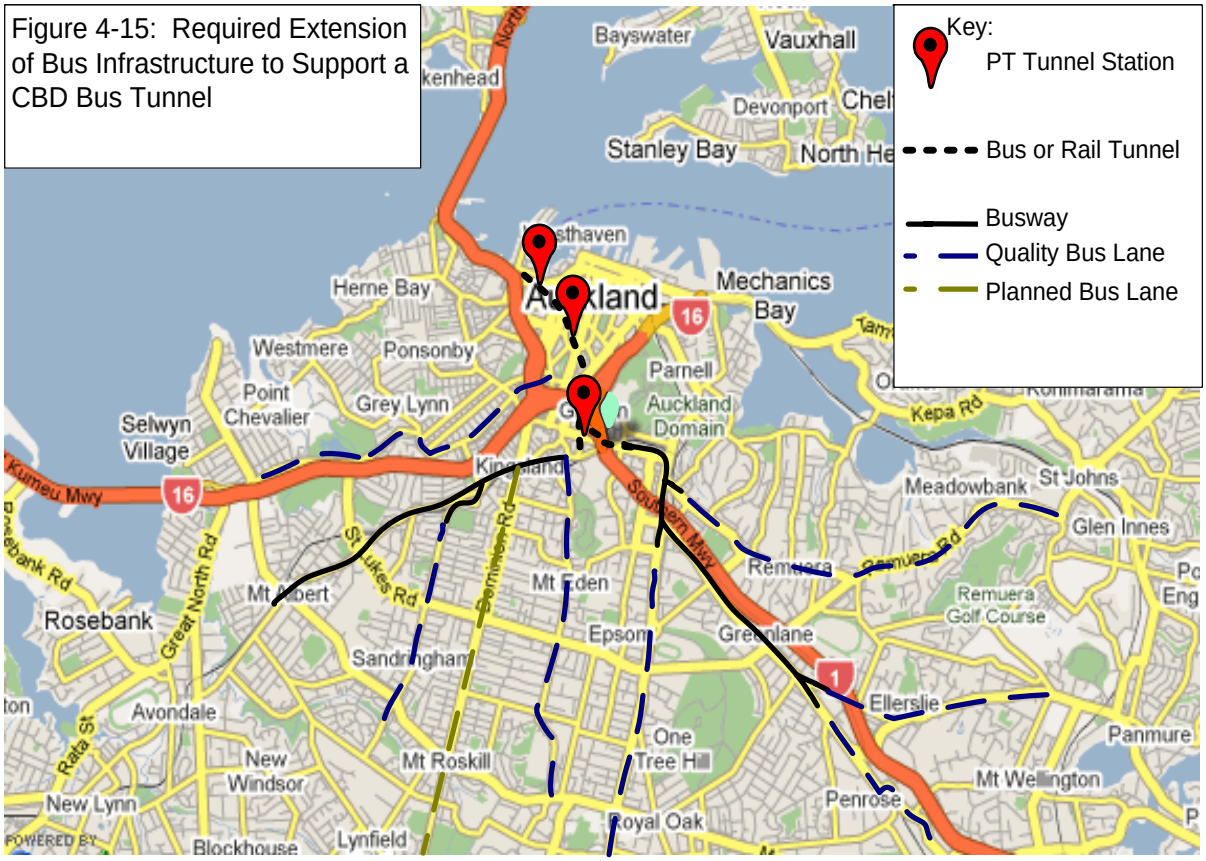
*In addition to BRT measures, such as grade separated junctions, being required in the CBD fringe areas to realise the bus tunnel throughput, it is likely that such measures will have to be extended further into the suburbs on a regular basis, in order to counter increasing traffic congestion on the routes leading to the tunnel where buses share road space with other traffic. Figure 4-15 provides an illustration of how the wider bus network would need to be extended over time to optimise a CBD bus tunnel.*[37]

. . .

[36] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 58 - 59

[37] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 61 - 62

Figure 4-15: Required Extension of Bus Infrastructure to Support a CBD Bus Tunnel




34. The Alternatives Paper states "***A two-lane CBD bus tunnel would have ample capacity*** *to accommodate the expected up to 534 bus movements per hour (two directions)". "The capacity constraint for the bus tunnel would be the operation of the bus stations as well as the level of traffic congestion on the shared road corridors beyond the tunnel."*

    But the same analysis later states "*Each separate direction would then need to allow passing in the case of breakdowns, so would probably need to be two lanes,* ***implying two by two-lane tunnels***." ?

35. The Alternatives Paper also claims "*In addition to BRT measures, such as grade separated junctions, being required in the CBD fringe areas to realise the bus tunnel throughput, it is likely that such measures will have to be extended further into the suburbs on a regular basis, in order to counter increasing traffic congestion on the routes leading to the tunnel where buses share road space with other traffic*" with a diagram showing 9 new busways !

***4.7.6 Strategic Evaluation***

*A bus tunnel option would be compatible with the city's streetscape improvement objectives and would be more likely than a surface bus option to allow the city to cater for projected increases in pedestrian and cycle demand. However significant amounts of land would be required for the underground bus tunnels. Significant land acquisition would probably be needed and in practice it may not be feasible or politically acceptable to construct bus stations of the size required for capacity purposes.*

*The bus tunnel option would remove some 70 percent of bus movements from surface streets, but more than 100 buses per hour would still need to be accommodated in city streets at peak times, for those more local routes for which the bus tunnel would not be an option; and to ensure efficient servicing of the city centre.*[38]

36. "A bus tunnel option would be compatible with the city's streetscape improvement objectives" . . . "The bus tunnel option would remove some 70 percent of bus movements from surface streets, but more than 100 buses per hour would still need to be accommodated in city streets at peak times".

***4.10 CBD Rail Link***

***4.10.1 Description***

*The proposed CBD Rail Link is an approximately 3.5 km double track underground rail line running beneath the central business district from Britomart to the Western (North Auckland Line) near the existing Mount Eden Station. Britomart would become a through' station and would be modified to suit this new purpose.*

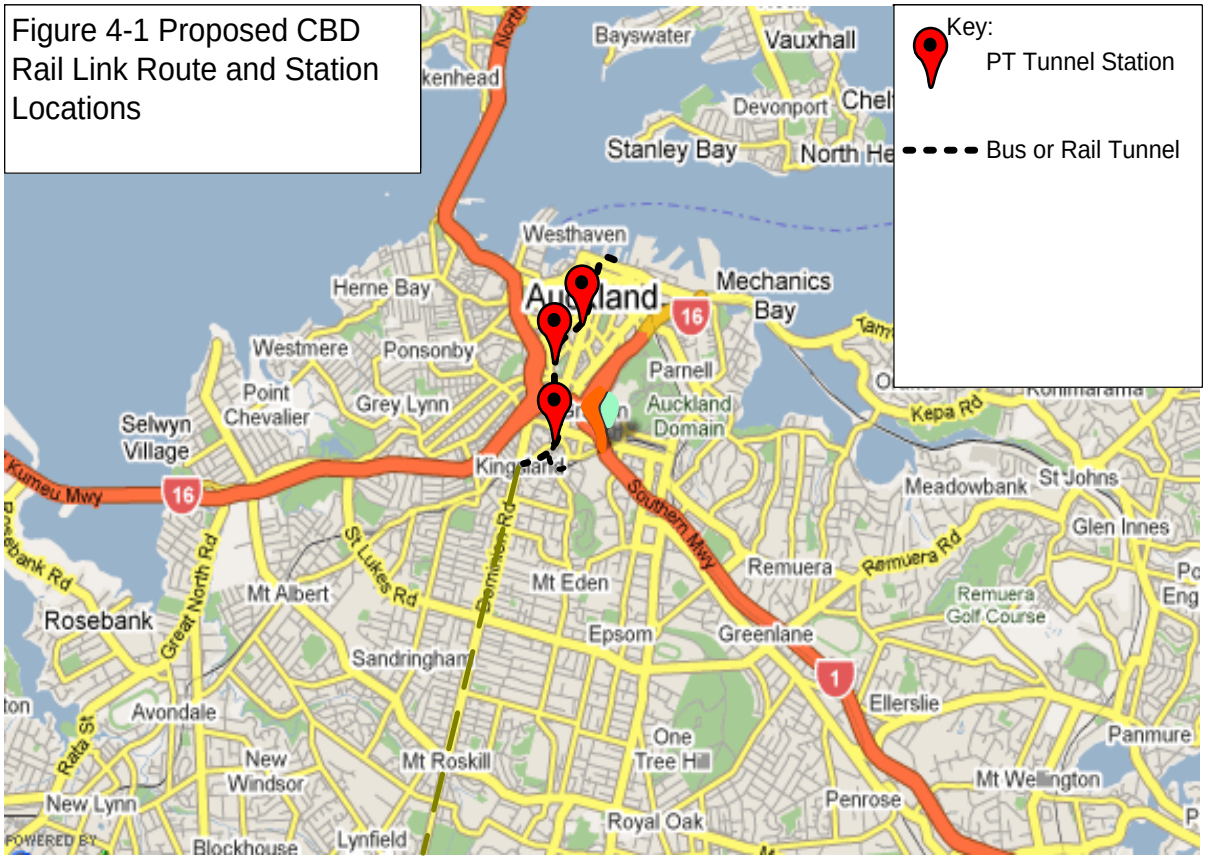
. . .

*The topography of central Auckland, together with the operational constraints for rail vehicles, results in the CBD Rail Link having steep gradients and deep underground stations over most of its route. There is an approximate 76 metre difference in elevation between Britomart and the Western line at Mt Eden and in addition the tunnels have to pass at sufficient depth beneath the Central Motorway Junction to avoid impacting motorway operations.*

*Twin tunnels, each having an outside diameter of approximately 7m, will be provided, connected by cross passages at a minimum spacing of 240m, for evacuation purposes.*

[38] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 4 Comprehensive List of Transport Measures, page 63

Figure 4-1 Proposed CBD Rail Link Route and Station Locations




37. "The proposed CBD Rail Link is an approximately 3.5 km double track underground rail line running beneath the central business district from Britomart to the Western (North Auckland Line) near the existing Mount Eden Station." It will be "Twin tunnels, each having an outside diameter of approximately 7m" giving a total cross-sectional area of 77m².

"The topography of central Auckland, together with the operational constraints for rail vehicles, results in the CBD Rail Link having steep gradients and deep underground stations over most of its route." In other words, as a rail route, the CBD Rail Link Tunnel is steep and its tunnels have to be deep.

***4.10.3 Impacts of CBD Rail Link.***

*In summary, the CBD Rail Link will:*

- *Provide greatly improved penetration of the CBD by rail, with most locations being within 500m of a station (see Figure 4-23). Table 4-6 shows the estimated CBD population and CBD jobs located within 500m of a railway station, with and without, the CBD Rail Link. It should be noted that all of the projected 2041 CBD population of 102,000 and 99% of the 122,000 CBD jobs projected forecast by the RLTS, will be within 500m or 10 minutes walk of a railway station.*

***Table 4-6: CBD Population and Jobs within 500m of a Railway Station***

| | 2016 | | 2041 (RLTS) | |
|---|---|---|---|---|
| | Popn. | Jobs | Popn. | Jobs |
| Without CBD Rail Link | 25536 | 38552 | 37788 | 55159 |
| With CBD Rail Link | 67737 | 79529 | 104850 | 121749 |

. . .

- *Enable a reduction in the number of bus services running into the CBD, by reconfiguring services in areas served by rail (for example New North Rd), to form feeder services to connect with rail services. This will free up CBD road lanes to provide more capacity for bus services from parts of the isthmus and North Shore, not served by rail.*

38. The "Impacts of CBD Rail Link" include: "Provide greatly improved penetration of the CBD by rail, with most locations being within 500m of a station"

39. Note two important assumptions with the CBDRL option:
 * both residential population **and** jobs close to the rail stations will grow by 25,000 due to the influence of the better service from the CBD Rail Tunnel; and
 * it would "Enable a reduction in the number of bus services running into the CBD, by reconfiguring services in areas served by rail (for example New North Rd), to form feeder services to connect with rail services."

***6 Evaluation of Alternatives***

*This section applies the criteria developed above to the most realistic set of alternatives, to sort through these investment options and find the projects that most closely align with the requirements of providing additional transport capacity into the CBD.*

***6.1 The Viable Set of Alternatives***

*The comprehensive list of thirteen transport policy measures highlighted in Table 4.1 and described in more detail in Section 4 is reduced to just four to go through the multi-criteria analysis. These four options consist of:*

- *Option 7 – increased bus usage on surface streets*
- *Option 9 – Central area bus tunnel with three stations*
- *Option 11 – Expanded Britomart terminus*
- *Option 13 – CBD Rail Link with three stations*

. . .

***6.2 Summary of Ranking***

*The four viable alternatives were scored at a workshop held on 10 August 2010, with the four projects carried forward qualitatively evaluated against the criteria developed in section 5, based upon the information and discussion presented in section 4. The outcome of this exercise is summarised in Table 6-1.*

***Table 6-1: Summary of Alternative Investment Ranking Exercise***

| *Alternative* | *Uniform Weight* | *Non- Uniform Weights* |
|---|---|---|
| ***On Surface Bus Route Improvements*** | *1.64* | *1.52* |
| ***Central Area Bus Tunnel- 3 Stations*** | *2.27* | *2.23* |
| ***Expanded Britomart Terminus*** | *1.64* | *1.67* |
| ***CBD Rail Link-3 Stations*** | *2.73* | *2.58* |

*The outcome of the assessment shows that the CBD Rail Loop with 3 stations and the Central Area Bus Tunnel with 3 stations score most highly, using both uniform and non-uniform weights. The other two options have lower scores in terms of delivering acceptable outcomes for the investment made.*

*Table 6-2 shows the scoring of the four alternatives against the assessment criteria, the results of which were used to generate the uniformly and non-uniformly weighted rankings.*

. . .

***Table 6-2: Detailed Assessment of Alternatives***

| *Alternatives* | *Support growth and develoment of the CBD* | *Optimise patronage and accessibility to/from and within the CBD* | *Align with Auckland City Council CBD Urban Design objectives* | *Optimise efficiency and potential of the Rapid Transit Network* | *Patronage Growth – peak* | *Patronage Growth – averaae* | *Minimises Whole of Life Costs* | *Minimise Disruption* | *Transport benefits – conventional* | *Non-Transport Benefits* | *Environmental/ Sustainability* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***On surface bus route improvements*** | *2* | *1* | *1* | *1* | *1* | *2* | *2* | *3* | *1* | *2* | *2* |
| ***Central Area Bus Tunnel & 3 Stations*** | *3* | *3* | *2* | *2* | *3* | *3* | *1* | *1* | *3* | *2* | *2* |
| ***Britomart as terminus with increased capacity*** | *2* | *1* | *1* | *1* | *2* | *2* | *2* | *1* | *2* | *2* | *2* |
| ***CBD Rail Link – 3 Stations*** | *3* | *3* | *3* | *3* | *3* | *3* | *1* | *2* | *3* | *3* | *3* |

40. The Alternatives Paper Evaluation was based on a range of Criteria and rated the CBDRL option highest followed by the CBT option.

***Section 7 - Cost Effectiveness Analysis***

*7.1 Summary*

*This section analyses the relative cost effectiveness of the two shortlisted options as a means of sharpening the ranking.*

*. . .*

*The CBD Rail Link with 3 stations has net present costs of $1,513m, which is approximately 60% of the net present cost of $2,640m for the Central Area bus tunnel with 3 stations.*[39]

***Table 7-1 Summary of Net Present Costs ($m NPV, 2010 terms, 8% Discount)***

| Alternative | CBD Rail Link with 3 Stations | Central Bus tunnel with 3 stations |
|---|---|---|
| **Total Net Present Cost** | *$1,520* | *$2,640* |
| **Capital Net Present Cost** | *$1,370* | *$2,390* |
| **Operating Net Present Cost** | *$150* | *$250* |

41. The most detailed costs in the Alternatives Paper had the CBD Rail Tunnel Capital Net Present Cost of $1,370M and Operating Net Present Cost of $150M.

***7.2 Assumptions and Parameters***

*The following assessment parameters were adopted for the analysis. . .*

*Bus tunnel construction costs are based on Auckland rail tunnel, pro-rated by cross-sectional area.*

*Cost of new rolling stock is brought through in discrete components based upon order batches As explained in Appendix F, 24 3-car sets are assumed by mid 2021 and an additional 26 sets by mid 2031.*[40]

*. . .*

42. The Alternatives Paper cost assumptions include that the "Bus tunnel construction costs are based on Auckland rail tunnel, pro-rated by cross-sectional area." Also 50 new 3-car trains are assumed to be purchased for the CBD Rail Link.

***7.3 Cost Assessment***

*Detailed design work has not been undertaken for Central Area bus tunnel. Instead, the assessment uses unit rates based on rail tunnels. Bus station costs have also been estimated. Bus estimates are therefore subject to uncertainty.*[41]

43. Also, the "Detailed design work has not been undertaken for Central Area bus tunnel. Instead, the assessment uses unit rates based on rail tunnels. Bus station costs have also been estimated. Bus estimates are therefore subject to uncertainty."
Note the costs of the Central Bus Tunnel option was not specifically calculated, pro rata estimates from the equivalent rail costs were used instead !

***Section 8 - Description of Benefits***

[39] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 7 Cost Effectiveness Analysis, page 85
[40] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 7 Cost Effectiveness Analysis, page 86
[41] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 7 Cost Effectiveness Analysis, page 86

*This paper does not seek to quantify the benefits of either the CBD Rail Link with three stations or the Central Area Bus Tunnel with three stations, but instead assumes that the benefits of both are comparable, say $B million present value. This is based upon the similarity of benefits achieved from the delivery of significant public transport capacity into the CBD.*

*The difference in costs is then sufficient to imply that the benefit / cost ratio is higher for the CBD Rail Link than for the Bus Tunnel, as shown below:*

- *CBD Rail Link benefit/cost ratio = $B / $1,520*
- *Bus Tunnel benefit/cost ratio = $B / $2,640*

*Therefore the benefit / cost ratio of the CBD Rail Link is approximately 1.7 times that of the Central Area Bus Tunnel - inversely proportional because the costs of rail are approximately 60%. On this basis at least, the Rail Link should be carried through to the main business case.*[42]

. . .

44. The Alternatives Paper also did not quantify the benefits of the rail and bus options **but assumed the rail and bus tunnel benefits are the same**.

***8.1 Conventional Transport Benefits***

*The CBD Rail Link with three stations and the Central Area Bus Tunnel with three stations both deliver passengers more widely around the CBD, in ways that are not subject to surface congestion. They therefore should have similar benefits in terms of decreasing travel time.*

45. The logic of similar benefits is "The CBD Rail Link … and the Central Area Bus Tunnel … both deliver passengers more widely around the CBD, in ways that are not subject to surface congestion. **They therefore should have similar benefits in terms of decreasing travel time.**"
Note that this emphasis on similar travel time benefits ignores four important factors with public transport:
* Travel Time is **not** the highest rated characteristic of quality public transport, reliability of travel time is usually rated higher in most surveys.
*Bus travel times are lower for equivalent capacity bus and rail services because when bus frequencies are higher, the average commuter waiting time is lower.
* Buses operating at frequencies of 5 minutes or less are also preferred because commuters do not have to plan to catch a specific service.
* With 6 more busways, totalling 45 kms, the Central Bus Tunnel option has much greater coverage of residential areas.

*The bus tunnel enables buses from the North Shore to pass through the CBD and link with the western edge. The CBD rail link does not provide this benefit, so an adjustment is needed to facilitate comparison. Without undertaking significant amounts of modelling, it is difficult to estimate any additional transport benefits of the North Shore bus connection.*

[42] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 8 Description of Benefits, page 87

*Instead, APB&B has estimated the cost of enhancing the CBD rail link alternative by adding an improved surface bus connection from the harbour bridge to the CBD. APB&B has estimated that such a connection should cost no more than $300 million (present cost $220 million). The difference in cost between CBD rail link and Central Area bus tunnel is $1,025 million in present value terms, which far exceeds the additional cost needed to provide the bus connection.*

*The benefit/cost ratio for the CBD rail link including North Shore bus connection is:*

*$B / ($1,520 + $220) = $B/$1,740, which is 1.5 times the ratio for the bus tunnel.*

*Taking account of the North Shore bus connection therefore does not change the conclusion that the rail link is the alternative with highest benefit cost ratio.*[43]

46. The Alternatives Paper identified that "The bus tunnel enables buses from the North Shore to pass through the CBD and link with the western edge. The CBD rail link does not provide this benefit, so an adjustment is needed to facilitate comparison." and that "APB&B has estimated that such a connection should cost no more than $300 million".

***8.2 Wider Economic Benefits***

The CBD Rail Link with three stations and the Bus Tunnel with three stations should have similar agglomeration benefits, as both provide high capacity connections to a few locations around the CBD.[44]

. . .

47. In terms of "Wider Economic Benefits, the CBD Rail Link with three stations and the Bus Tunnel with three stations should have similar agglomeration benefits, as both provide high capacity connections to a few locations around the CBD."

[43] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 8 Description of Benefits, page 87
[44] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 8 Description of Benefits, page 87

***Section 9 - Summary and Conclusions***

*This section summarises the rankings produced by the two different assessment methods, namely multi-criteria analysis and cost effectiveness analysis, relative to the descriptive benefits which were assumed to be reasonably consistent between the options. While there would clearly be differences in the benefit profiles between rail and bus, based upon service patterns etc, high capacity public transport infrastructure has a set of outcomes (and associated benefits) that it is trying to deliver. On the assumption that the benefits of both the CBD Rail Link and the Central Area Bus Tunnel are in this manner broadly equal, the CBD Rail Link is ranked highest by each method.*

*The inter-relationship between the three assessment methods is then discussed with the conclusion being reached, that if the assumption about equal benefits is relaxed, then the CBD Rail Link performs significantly better than the Central Area Bus Tunnel, in particular against the key RLTS objectives.*

*It is therefore clear that the CBD Rail Link should be subject to a detailed business case assessment.*[45]

48. The Alternatives Paper Conclusion states "On the assumption that the benefits of both the CBD Rail Link and the Central Area Bus Tunnel are in this manner broadly equal, the CBD Rail Link is ranked highest by each method."

    The Business Case Alternatives Paper concludes "It is therefore clear that the CBD Rail Link should be subject to a detailed business case assessment."`

## *3.5 Key Extracts from Rail and Bus Operating Assumptions (Appendix F)*

This section consists of key extracts from the Rail and Bus Operating Assumptions that is Appendix F of CBD Rail Link Business Case. These extracts highlight the key elements of the CBD Rail Link (CBDRL) and Central Bus Tunnel (CBT) options.

***Section 7 - Rail and Bus Operating Assumptions***

***7.2 Bus network changes with CBD Rail Link***

*. . .*

*The CBD Rail Link will allow bus demand on some CBD streets to be reduced or more effectively managed by replacing some of the line-haul function presently carried out by buses. The CBD Rail Link will not replace bus passenger demand on the Northern Busway services, which are expected to increase substantially, or much of the Auckland Isthmus, but will offer a more efficient alternative to bus travel for the south, west and east, allowing future patronage growth to be diverted from bus to train from these areas.*

*. . .*

*While the CBD Rail Link will offer a more attractive and efficient means of access to the CBD for most travellers, and will reduce the requirement for buses to continue to operate to the CBD from those areas served by rail, the need for buses to continue to serve the CBD (including those areas not directly benefiting from the CBD Rail Link) and projected growth in CBD transport demand (particularly from the North Shore) driven by population and CBD workforce projections, will mean that the total number of buses serving the CBD may not decrease substantially below current levels after the introduction of the CBD Rail Link.*

[45] Auckland CBD Rail Link BC –Appendix D Alternatives Paper – 9 Summary and Conclusions, page 89

*However, the implementation of the CBD Rail Link will allow the majority of future CBD travel demand, in those areas served by the rail network, to be accommodated on trains rather than on buses. While bus numbers in the CBD may not fall from current levels overall, the CBD Rail Link will allow Auckland City's plans for pedestrian and urban amenity improvements to be achieved more easily than under a scenario where future demand is overwhelmingly accommodated by bus.*

. . .

***7.3 Bus Operating Cost Savings from CBD Rail Link***

*The impact of the restructuring of the Bus Network outlined above are estimated to result in around 60 fewer buses being required in the morning peak period by 2041.*[46]

49. Appendix F of the CBD Rail Business Case estimates the CBD Rail Link option will "result in around 60 fewer buses being required in the morning peak period by 2041."

## *3.6 The Ministry of Transport Business Case Review*

This section consists of key extracts from the MoT CBDRL Business Case Review including MoT comments on the CBD Rail Link (CBDRL) and Central Bus Tunnel (CBT) options.

Following the release of the Auckland CBDRL Business Case, the Minister of Transport asked the Ministry of Transport (MoT) to undertake a review that was completed on 31st May 2011[47].

### *3.6.1 MoT Review of Alternatives Paper (WS8)*

The MoT Review included a paper, WS8[48], which looked at the business case Appendix D - Alternatives Paper with the paper including the following statements on the Central Bus Tunnel option (Highlight added for emphasis):

***2.1.2 Central Area Bus Tunnel***

*This option is described in section 4.7 of Appendix D of the Business Case. The tunnel would have access from McKinnon Drive and Khyber Pass Road at its southern end, at Fanshawe Street at its northern end and would pass under Aotea Square, with a station by the Auckland City Hotel.*

*This option was assessed to be compatible with the city's streetscape improvement objectives and would have ample capacity to accommodate the expected volume of traffic. It was assessed to be more expensive than a rail tunnel (around $3.5billon versus $2billon for the rail tunnel), because it would require more land acquisition and because of "likely ongoing changes to the road network to maintain scheme benefits in the face of increasing demand for road space". However, it is unclear how this cost estimate was calculated. It is also not clear whether it is based on a two-lane or a four-lane tunnel.*

. . .

[46] Auckland CBD Rail Link BC –Appendix F: Rail and Bus Operating Assumptions – 7 Bus Network Impacts of CBD Rail Link, pages 12 - 13

[47] Downloadable from the Ministry of Transport Web Site: http://www.transport.govt.nz/ourwork/rail/aucklandcbdraillink/

[48] Downloadable from the Ministry of Transport Web Site: http://www.transport.govt.nz/ourwork/rail/Pages/AucklandCityCentreRailLinkBusinessCaseReviewWorkstream8.aspx

**4.2 Quality of Alternatives**

The alternatives need to be sufficiently developed to be able to judge with reasonable confidence whether they are inferior or superior to the other alternatives. The CBD rail tunnel option has been analysed and costed to a significant level of detail, but the same is not the case for the other options.

There is a lack of information on the scale of impact that each of the alternatives would have. Where this information is available, it is not used on a comparative basis to inform the analysis. For example, it is evident that the bus tunnel would have a much larger effect in removing buses from the city streets than the rail tunnel, also it would serve a much larger catchment of commuters, but the two options are assumed to have equivalent reductions in buses.

. . .

***5 Conclusion***

*The constraints under which the APB&B Study Team had to put together the Business Case are acknowledged. However, the absence of a reasonably robust consideration of reasonably well-developed alternatives may be regarded as a fundamental deficiency of a business case that is intended to seek funding from Government. Based on the analysis presented, it is not clear to what extent the on-surface bus option is, or should be, part of the "do minimum" and to what extent it is a true alternative to the CBD rail tunnel. It is not possible to be confident that the preferred option represents the best use of scarce resources, even if it has a good ratio of benefits to costs.*

*It is not possible for this Working Group to carry out the work that is required to remedy all the short-comings of the evaluation of alternatives within the timeframe and resourcing available to it. It is likely that the work would take a number of months and would require the employment of consultants. A separate study should be commissioned for this purpose.*

50. The MoT Review is not confident in the Alternatives Paper analysis including the costs of the bus tunnel option. It recommends a significant amount of further work "*is required to remedy all the short-comings of the evaluation of alternatives*".

### *3.6.2 CBDRL Business Case Team Reply to MoT Review Comments*

Part of the MoT Review included release of the CBDRL Business Case Team response[49] to the MoT WS8 Review including the following statements:

***5. Assessment Methodology***

. . .

*Further WS8 fails to acknowledge that APB&B did in fact estimate costs for the two highest ranked options, namely CBD Rail Link with 3 Stations and Central Bus Tunnel with 3 stations. It is therefore incorrect to say that the methodology has added benefits to the inverse of ranked costs. Rather, the methodology has, for the two highest ranked options, undertaken a cost-effectiveness analysis that fixed benefits and compared costs. This approach concluded that the CBD rail link was more cost effective than a bus tunnel, and therefore that the CBD rail link should proceed to the next stage, more detailed business case assessment.*

[49] "CBD Rail Link Business Case- Responses to Second set of Questions from the Ministry of Transport" by APB&B

*Finally WS8 also fails to acknowledge that APB&B has estimated that the benefit-cost ratio for CBD rail link is in fact 1.77 times greater than the benefit-cost ratio for the next highest ranked alternative, namely Central Bus Tunnel.*

*Therefore APB&B considers that the WS8 criticism of the alternatives assessment process used in the Alternatives Paper is unfounded.*

. . .

***7. Conclusion***

*WS8 suggests that the CBD Rail Link Business Case is fatally flawed because of the absence of a reasonably robust consideration of reasonably well developed alternatives.*

*As outlined above, APB&B is of the firm belief that both the assessment process and the level of scoping of the alternatives was sufficient and appropriate for the consideration of alternatives. Therefore we consider that the findings of the Alternatives Paper to be robust.*

*Further APB&B considers that the criticism of the Alternatives Paper in WS8 is unsubstantiated and based on superficial and incorrect assertions, particularly around surface Bus Rapid Transit and the assessment methodology.*

*Therefore WS8 "s conclusion that further investigation of alternatives is required is our view both incorrect and unnecessary.*

51. The CBDRL Business Case Team led by consultants APB&B Project the findings of the MoT Review of the Alternatives Paper. They "*consider that the findings of the Alternatives Paper to be robust*" and that "*WS8 "s conclusion that further investigation of alternatives is required is our view both incorrect and unnecessary.*"

## *3.7 Part 1c – Alternative Options Costs and Other Key Information*

One surprising part of the CBD Rail Link Business Case is the nearly total absence of details costings, especially for the alternative options. Table 7-1 has the most detailed breakdown and this is only to capital and operating costs adjusted to Present Value (Refer to Comment 41). The justification for eliminating the CBT option is the Alternatives Paper claim is will cost $1,120M Net Present Value[50] more than the recommended CBDRL option.

This section is summarises information from the Economic Analysis Spreadsheet that provides the detailed cost breakdown for the alternatives option described in detail by the Alternatives Paper as well as how they were calculated.

### *3.7.1 Obtaining the Alternatives Paper Costing Spreadsheets*

The author's request for a copy of the original spreadsheets that contain calculations supporting the Alternatives Paper was initially refused but, after some months, and the intervention of the Ombudsman, it was finally received[51].

The information received included the "Alternatives Cost Model v4a.xls" spreadsheet from Auckland Transport. This included the cost calculations for the four Alternative options considered in the CBDRL Business Case and described in detail by the Alternatives Paper.

The "Alternatives Cost Model v4a.xls" spreadsheet has the following worksheets:

| **Worksheet Name** | **Comment** |
|---|---|
| Assumptions | Contains the main input costs and a number of key calculations are completed within this worksheet. Many rows have references to input documents. Connects to linked spreadsheet "CBD RL costs and discounting 230910v2.xls" for rail rolling stock numbers |
| Summary tables | Final Summary Worksheet. The key Net Present Value option cost figures detailed in Alternatives Paper Table 7-1 are from the table Cells B3 to G6. The conversion of Nominal Costs to Net Present Value costs are also performed for Capital (B10 to G43) and Operating (J10 to O43) |
| detail costing | Unknown purpose. Does not connect to other information. |
| CBD Rail Link | Calculates the CBDRL Option Nominal Capital and Operating costs over time. |
| Britomart Expansion | Calculates the Britomart Option Nominal Capital and Operating costs over time |
| Central areas Bus Tunnel | Calculates the CBT Option Nominal Capital and Operating costs over time |
| PB Total busway | Details the Busways and their Nominal costs for the CBT option |
| PB infra Cost calcs | Contains input costs for the PB Total busway worksheet |
| rolling stock calcs | Calculates the bus numbers for bus and rail options and this is linked onto the assumptions worksheet |
| superseded Calculations | Unknown purpose |

[50] The Unadjusted Cost difference is $2,127.

[51] Auckland Transport also did not respond to a subsequent request for further information on the CBDRL Business Case calculations and this failure is now the subject of another complaint to the Ombudsman.

### *3.7.2 Present Value Costs versus Nominal Costs*

The spreadsheet calculations are mainly in Nominal costs with conversion to Net Present Value only being undertaken on the totals using a percentage over time approach. Because the capital investment timeframes for both the CBD Rail Link and Central Bus Tunnel options are in the same timeframe, the Nominal costs can also be compared directly.

Table 7-1 Summary of Net Present Costs ($m NPV, 2010 terms, 8% Discount) [52]

| Alternative | CBD Rail Link with 3 Stations | Central Bus Tunnel with 3 stations |
|---|---|---|
| **Total Net Present Cost** | $1,520 | $2,640 |
| **Capital Net Present Cost** | $1,370 | $2,390 |
| **Operating Net Present Cost** | $150 | $250 |

The above table with Nominal costs added:

| Alternative | CBD Rail Link with 3 Stations | | Central Bus Tunnel with 3 stations | |
|---|---|---|---|---|
| | Net Present ($M) | Nominal ($M) | Net Present ($M) | Nominal ($M) |
| **Total Cost** | $1,520 | $3,576 | $2,640 | $5,703 |
| **Capital Cost** | $1,370 | $2,702 | $2,390 | $4,473 |
| **Operating Cost** | $150 | $874 | $250 | $1,229 |

This review examines these option costs and highlights the impact of any findings. Most of the option cost calculations are in nominal costs which are then converted to the Net Present Value costs outlined in both the business case and Alternatives paper. This report will show the Net Present and Nominal costs for Capital and Operating option costs are shown by way of the following standard table:

| Alternative | Alternatives Paper | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | | Net Present | Net Present | Nominal | Nominal |
| ***CBDRL*** | *Total Cost* | ***$1,370*** | ***$150*** | ***$2,702*** | ***$874*** |
| ***CBT*** | *Total Cost* | ***$2,390*** | ***$250*** | ***$4,473*** | ***$1,229*** |

[52] Alternatives Paper Page 85 and also refer to Comment# 41.

The following provide a standardised detailed view of the two main options from the costing spreadsheet (Note these are Nominal Costs):

### *3.7.3 Official CBD Rail Link Nominal Option Costs*

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| **PT Tunnel to improve CBD Capacity** | | | | | | | |
| Khyber Pass | Midtown | Gaunt St | | | $696 | $843 | $1,538 |
| CBD Tunnel Support Infra Costs | | | | | $93 | | $212 |
| CBD Tunnel Land Purchase Costs | | | | | $78 | | $78 |
| **PT Investment to Access CBD** | | | | | | | |
| Albany | Takapuna | Gaunt Street | | | | | |
| Khyber Pass | Broadway | Gt. South Road | | | | | |
| Newton | New North Road | Mt Albert | | | | | |
| Broadway | Remuera Road | St Johns Road | | | | | |
| Gt South Rd | Main H/Way | Ellerslie Panmure | | | | | |
| Broadway | Manukau Rd | Royal Oak | | | | | |
| Symonds Street | Mt Eden Rd | Hayr Rd | | | | | |
| New North Road | Dominion Road | Denbigh Ave | | | | | |
| Kingsland | Sandringham Road | Mt Albert Rd | | | | | |
| Kanrangahape Rd | Great North Rd | Pt Chevalier | | | | | |
| Great South Road | Rockfield Road | Church Street | | | | | |
| | | | | | | | |
| # new Busways | 0 | **Infrastructure Totals** | | | **$986** | **$843** | **$1,829** |
| | | | | | | Design | $314 |
| | | | | | | ***Infra Sub-Total*** | ***$2,143*** |

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| | | | | New Trains | 50 | $10 | $500 |
| | | | | New Buses | 102 | $0.58 | $59 |
| | | | | | | ***Vehicle Sub-Total*** | ***$559*** |
| | | | | | | **Total Capital** | **$2,702** |
| | | | | | | Operating Costs | $874 |
| | | | | | | **Grand Total** | **$3,576** |

### *3.7.4 Official Central Bus Tunnel Nominal Option Costs*

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| **PT Tunnel to improve CBD Capacity** | | | | | | | |
| Khyber Pass | Midtown | Gaunt St | | | $744 | $921 | $1,665 |
| CBD Tunnel Support Infra Costs | | | | | $93 | | $93 |
| CBD Tunnel Land Purchase Costs | | | | | $78 | | $78 |
| **PT Investment to Access CBD** | | | | | | | |
| Albany | Takapuna | Gaunt Street | | | | $120 | $120 |
| Khyber Pass | Broadway | Gt. South Road | $62 | $75 | $255 | $120 | $512 |
| Newton | New North Road | Mt Albert | $66 | $158 | | | $224 |
| Broadway | Remuera Road | St Johns Road | $115 | $30 | | | $145 |
| Gt South Rd | Main H/Way | Ellerslie Panmure | $28 | $30 | | | $58 |
| Broadway | Manukau Rd | Royal Oak | $72 | $30 | | $120 | $222 |
| Symonds Street | Mt Eden Rd | Hayr Rd | $99 | | | | $99 |
| New North Road | Dominion Road | Denbigh Ave | $78 | $45 | | | $123 |
| Kingsland | Sandringham Road | Mt Albert Rd | $49 | | $105 | | $155 |

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| Kanrangahape Rd | Great North Rd | Pt Chevalier | $94 | | | | $94 |
| Great South Road | Rockfield Road | Church Street | $48 | $15 | | | $63 |
| | | | | | | | |
| # new Busways | 9 | **Infrastructure Totals** | **$711** | **$383** | **$1276** | **$1281** | **$3650** |
| | | | | | | Design | $641 |
| | | | | | | ***Infra Sub-Total*** | ***$4291*** |
| | | | | New Trains | | | |
| | | | | New Buses | 311 | $0.58 | $180 |
| | | | | | | ***Vehicle Sub-Total*** | ***$180*** |
| | | | | | | **Total Capital** | **$4,471** |
| | | | | | | Operating Costs | $1,229 |
| | | | | | | **Grand Total** | **$5,701** |

# 4 Part 2 - Alternatives Paper Costing Errors

This section is an analysis of possible calculation and design errors that impact on the CBDRL or CBT option costs.

## *4.1 Why is the Rail Operating Cost so much less than the Bus OPEX ?*

Most studies have shown that equivalent rail and bus services usually have operating costs that are roughly similar to each other. Therefore the large difference between the CBDRL option with a Present Value of $150M ($874M Nominal) against the CBT option Present Value of $250M ($1,229M Nominal) is unusual. The CDBRL Business Case explains this as follows (**bold** added for emphasis):

> *A large part of the cost and performance advantage of the CBD Rail Link is due to the project releasing excess capacity currently residing in the rail network, which is unable to be realised due to the capacity constraints of the Britomart Terminus. In contrast, the bus tunnel option has to be built from scratch, and requires further investment out into the wider Auckland network to continue to deliver the benefits of the original investment.* ***This accounts for the higher*** *infrastructure and* ***operational expenditure of the bus tunnel option compared to the rail option*** *and therefore its lower performance.*[53]

The analysis of the "Alternatives Cost Model v4a TR Analysis 110625.xls" that contains the detailed alternatives costs analysis does not support this statement. In fact the cause of the cost difference appears to be a major calculation error with summation of the Rail Operation costs in Row 38 of the "CBD Rail Tunnel" worksheet.

The total rail operating cost is a summation of the estimated train operating costs for each year. The rail operating cost calculation formula for each year is:

> "=assumptions!$C$222*assumptions!$C$213* SUM($D$7:AG$7[54])"
>
> where:
> a) assumptions!$C$222 = Cost per train ($2.10M)
> b) assumptions!$C$213 = Number of Trains (24)
> c) SUM($D$7:AG$7[54]) = The increasing percentage of trains operating over time from 2021 to 2041

Examining the spreadsheet information identifies TWO errors in the formula. Firstly, b) is only the number of trains to be introduced by Year End 2022. The adjacent cell, assumptions!$C$214, contains the second purchase of 26 additional trains to be introduced by Year End 2032 as outlined in the assumptions section (Refer Comment 42). **Therefore the rail operating costs are for less than half the proposed number of trains in the CBDRL option**.

There is a second error in that c) the timeframe is the percentage across which the second purchase of 26 trains will be introduced. Therefore **the rail operating costs are calculated based on the timeframe across which the second set of trains will operate.**[55]

Also note this operating cost error is also found in the Britomart option.

**Finding such a major calculation error in a major published business case is obviously a serious issue.**

[53] Refer to Comment # 9.
[54] Note that this cell changes with the net result is each successive year being 5% larger from the previous.
[55] Note: a 2nd calculation error was identified in the Summation of the CBT Capital Costs but the effect is minor.

### 4.1.1 *Cost Impact of CDB Rail Link Operating Cost Error*

The net result of this error is to underestimate the rail operating costs by over $½ Billion in the CBDRL option !

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Alternatives Paper Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Rail Operating Cost Calculation Error | | $140 | | $689 |
| **CBT** | Rail Operating Cost Calculation Error | | | | |

The lower operating cost attributed to the CBDRL option is not "*due to the project releasing excess capacity currently residing in the rail network*" but to a spreadsheet calculation error. **Correcting the calculation error for rail operating costs in the rail option costings will mean a total Present Value project cost increase of $140M ($689M Nominal) to the CBDLR option !**

## 4.2 *Why is Bus Tunnel Operating BEFORE the tunnel is built?*

The bus tunnel operating costs are estimated at $9M/year and are a significant part of the overall operating costs for the CBT option.

The tunnel operating cost is calculated on an annual basis in row 28 of the "Central areas Bus Tunnel" Worksheet at $9M from year 2013 to 2041 giving an Nominal total of $261M. However, row 9 of the same worksheet stated the tunnel was to be constructed between 2016 and 2020. It seems strange that there are operating costs for a tunnel **before it is built**.

Examining the formula of the first cell in row 28 shows a likely calculation error:

= IF(D4>assumptions!C55,assumptions

Where:

Cell "assumptions!C55" = 2020 and is labelled "CBD Bus Loop Year of completion"

Cell "assumptions!$C$253" = 9 and is labelled "Bus Tunnel Operation - medium"

It would appear that the error is Cell "assumptions!C55" is not anchored meaning it does not connect to the completion year for all the other years and triggering the $9M tunnel operating cost **several years early !**

**Finding multiple major calculation errors in a major published business case raises serious questions on the quality of analysis.**

### 4.2.1 *Cost Impact of CBT option Tunnel Operating Cost Error*

The net result of this error is to significantly overestimate the bus operating costs in the CBT option:

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Alternatives Paper Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Bus Tunnel Operating Cost Error | | | | |
| **CBT** | Bus Tunnel Operating Cost Error | | -$50 | | -$72 |

**Correcting the calculation error for bus tunnel operating costs in the CBT option costings will mean an total Present Value project cost decrease of $50M ($72M Nominal) to the CBT option**

**This spreadsheet calculation error in the CBT option, combined with the larger calculation error for the CBDRL option, means the difference between the CBDRL and CBT options Present Value operating costs swap from Bus being $100M higher to rail being $90M higher!**

## *4.3 How many tunnels for the Central Bus Tunnel?*

The author's initial interest in this project was from the higher cost for the Central Bus Tunnel (CBT) option. This contrasts with other projects that compare equivalent Bus Rapid Transit (BRT) to rail alternatives where BRT is usually a significantly lower cost option.

### *4.3.1 ONE 2-Lane Bus Tunnel or is it TWO bus tunnels ?*

The CBD Rail Link Business Case does not mention the size of the bus tunnel, but the Alternatives Paper consistently describes the Central Bus Tunnel as a "2-Lane Tunnel" including:

- "*. . . 3km of double lane bus tunnel under the CBD . . .*" and "*2-lane Bus tunnel*" (Figure E-2)
  (Alternatives Paper– Executive Summary pages 8 - 9)
- "*2-lane Bus tunnel*" (Figure 4-14)
  (Alternatives Paper – 4 Comprehensive List of Transport Measures, page 60)
- "*A two-lane CBD bus tunnel would have ample capacity . . .*"
  (Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 61 - 62)
- Labelling the option as the "Central Bus Tunnel option", not the "Central Bus Tunnels option" (throughout the Alternatives Paper)

**However**, as noted in comment #34, there is one statement that hints this is not actually the real description of the costed tunnel:

> "*Each separate direction would then need to allow passing in the case of breakdowns, so would probably need to be two lanes, **implying two by two-lane tunnels***"
> (Alternatives Paper – 4 Comprehensive List of Transport Measures, pages 61 - 62)

This seemed a strange statement in relation to the other descriptions of the bus tunnel and required further investigation.

The Busway Costs are calculated in the Sheet "PB Total Busway" of the "Alternatives Cost Model v4a.xls" spreadsheet. The key bus tunnel cost calculation figures are in the "Assumptions" Sheet being C160 = 3.3km ("Length of Bus Tunnel") multiplied by C161 = $221M("unit cost of bus tunnel") C196 = $727,817,765.

The "unit cost of bus tunnel" is calculated in the "Assumptions" Sheet of the spreadsheet (edited copy below):

| Row | **Parameters** | | | |
|---|---|---|---|---|
| 2 | **(All $ Values are in $NZ)** | | | |
| 20 | Bus Loop tunnel costs have been based on Brisbane bus tunnel | | | |
| | | | | |
| 81 | **Capital Costs** | Unit | Value | Notes |
| 82 | Rail | | | |
| *94* | ***Infrastructure*** | | | |
| 95 | **Option1 Rail Loop (Indicative costs only)** | | | |
| 96 | Tunnel Length | km | 3.5 | From Simon Wood |
| 97 | Train Tunnel | $m | 688.1 | From Simon Wood |
| 98 | cut & cover, underpin | $m / km | $391.99 | |
| 99 | twin bore | $m / km | $101.53 | |
| 100 | cut & cover | $m / km | $150.13 | |
| 101 | | $m / km | $135.57 | |
| 102 | | | | |
| 154 | Bus | | | |
| 158 | **Dedicated Bus Tunnel** | | | |
| 159 | bus tunnel – bored | | | |
| 160 | Length of Bus Tunnel | km | 3.3 | ref |
| 161 | unit cost of bus tunnel | $m / km | $221 | scale up based on cross sectional area. Need two, 2-lane tunnels for safety reasons |
| 162 | | | | |
| 163 | Ventilation | $m / km | $5 | DA estimate |

As stated in the Alternatives Paper Section 7.2 Assumptions:

*Bus tunnel construction costs are based on Auckland rail tunnel, pro-rated by cross-sectional area.*

From Cell A20 of the Assumptions Sheet we can also see:

*Bus Loop tunnel costs have been based on Brisbane bus tunnel*

Cell C161 of the Assumptions Sheet, labelled "unit cost of bus tunnel" contains the formula "=C99*(15.2*5.5*2)/(2*PI()*7/2*7/2)"

The general Bus Tunnel calculation is:

$$\text{Bus Tunnel Cost per km} = C99 * \frac{15.2 * 5.5 * 2}{2 * PI() * 7/2 * 7/2}$$

$$* \frac{\quad}{\quad}$$

More specifically C161 contains the formula:

- Cell "C99" = the value of the "twin bore" rail tunnel cost =$101.53M
- "(15.2*5.5*2)" = Cross Sectional Area of the bus tunnel = 167.2m$^2$.
- "(2*PI()*7/2*7/2)" = Cross Sectional Area of the Rail Tunnel. The formula to convert a circle diameter into an area is *pir*$^2$(where r = radius = half the diameter). It seems there will be TWO rail tunnels, each with a 7 metre diameter and 38.5m$^2$cross-section. The total cross section area = 76.969m$^2$

Therefore:

$$\text{"Bus Tunnel Cost per km"C161} = 101.53 * \frac{167.2}{76.969} = \$221$$

= $221M/km (2.17 times larger than the CBR Rail Tunnel cost of $101.5M/km in C99).

But let us examine the calculation of the bus tunnel area. We can see from the picture, on page 26, that the Brisbane Bus Tunnel has a rectangular cross-section. Therefore to calculate the cross section of a rectangle is the width times the height = 15.2m * 5.5m = 83.6m$^2$ . . . slightly larger than the cross-section areas of both rail tunnels. But this amount is then doubled which means **the area must be for TWO 2-Lane Bus Tunnels** to give a total cross-sectional area of 167.2m$^2$ !

So the "2-lane Bus tunnel" described throughout Alternatives Paper for the Central Bus Tunnel option is actually costed as **TWO 2-Lane Bus Tunnels at $858.82 Million**[56].

[56] The cost being $727.8M for the Tunnels plus $65.5M (18%) design cost estimate.

### *4.3.2 Alternative Paper evidence for Two 2-Lane Bus Tunnels for Auckland*

Examining the justification of costing TWO 2-Lane bus tunnels in the CBT option must start with the supporting bus tunnel information from Alternatives Paper itself.

In fact the Alternatives Paper does not contain any evidence to justify the need to TWO 2-lane bus tunnels. On the contrary. It actually gives clear evidence only ONE 2-lane or TWO 1-lane tunnels are required because this describes the Brisbane and Seattle Bus Tunnels respectively. The Alternatives Paper also notes the relatively high capacities of both systems[57] (including that the bus capacity is not limited by the tunnel itself but by the bus stations).

### *4.3.3 The Boggo Road Bus Tunnel*

**From the opening of the Boggo Road Busway - Australia's longest busway tunnel.**

The longest current Bus Tunnel in Australasia is the Boggo Road Bus Tunnel in Brisbane. Key facts:

- The Tunnel is 2 kms long (longer than any station-to-station segment of the Central Bus Tunnel)
- It is a single 2-Lane Tunnel 15m wide and 8m high (approximate cross-section of 90m$^2$)

[57] Refer to Comments #31 and 32

The tunnel was designed by Transport consultants, SKM, described both on their company web page on Public Transport tunnels[58] and in a the Conference Paper presented by the designer[59] on construction of this tunnel. Neither document comments on any safety issues or passing problems from building a single 2-Lane tunnel. Any requirement need for TWO 2-Lane Tunnels is not even mentioned.

### *4.3.4 The Boston Urban Ring Phase 2*

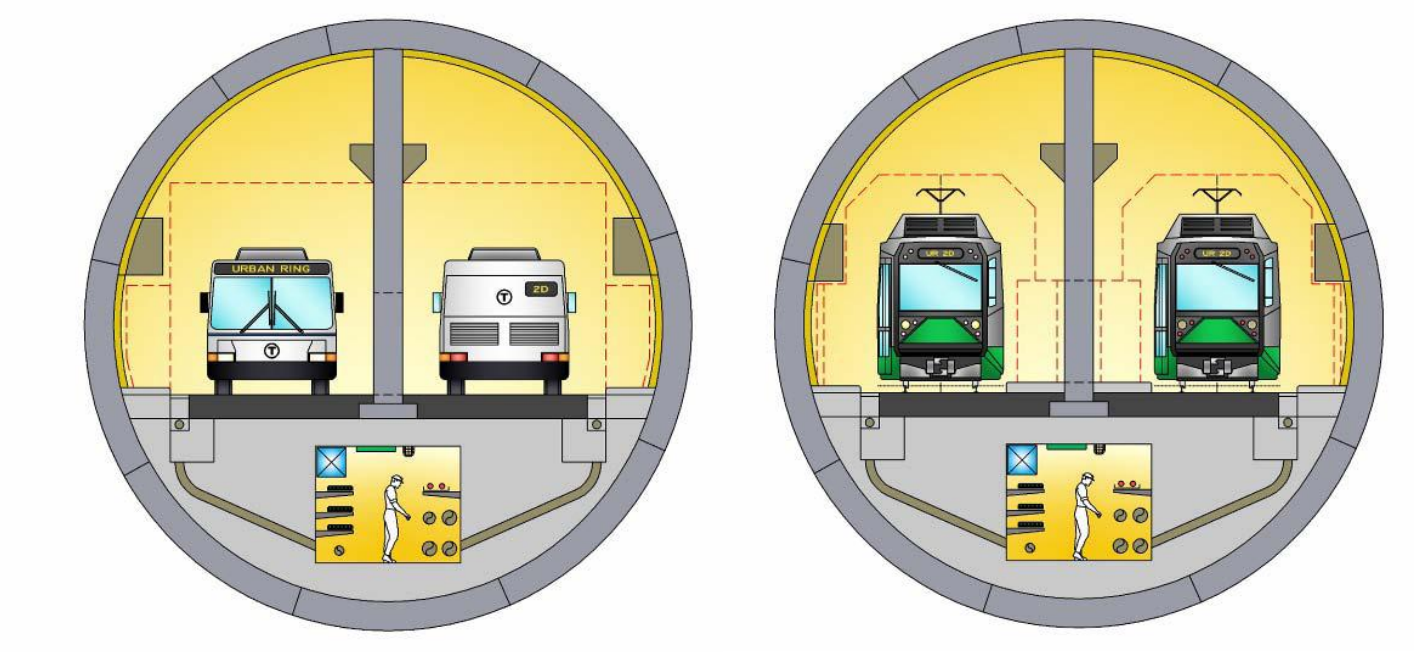
Providing even more detail on the implementation study reports for the Boston Urban Ring[60] that includes a major bus tunnel. Although on hold, this 2008 comprehensive report included a detailed analysis focussing on the justification for a bus tunnel vs. no bus tunnel.

Chapter 3 of the Draft Environmental Impact Report outlines the details of the various tunnel (and no tunnel) alternatives considered. It specifically states the minimum required dimensions for a single bus tunnel as 16' (4.88m) wide and 15' (4.57m) high including walkway for walking access. The report also clearly states the bus tunnel dimensions are the same or smaller than those required for either light or heavy rail . . . this is another report that confirms that buses can fit through the same size tunnels as required for rail !

[58] http://www.skmconsulting.com/Knowledge-and-Insights/Achieve-Articles/2009/Crowded-cities-going-to-ground.aspx

[59] "Shallow Cover Tunnel Under Heritage Listed Brick Buildings: Brisbane Boggo Road Busway Tunnel" by Ted Nye, Tunnel Designer Manager, Sinclair Knight Merz and Max Kitson, Senior Geotechnical Engineer, Sinclair Knight Merz

[60] See Massachusetts Department of Transport Website (http://theurbanring.eot.state.ma.us/documents.html) Draft Environmental Impact Report Section




The above report pictures show the size differences between buses and rail in a 2-lane tunnel.

The Boston Urban Ring Phase 2 Environmental Impact Report is also interesting for detailing other important aspects:

- It only considers using environmentally friendly buses such as hybrid-electric, CNG, etc.
- It highlights that bus tunnels can be steeper, the turns sharper and the stopping distances are shorter than required for any rail tunnel
- It notes the bus tunnel can be used by emergency vehicles if required.
- This 121 page report with specific sections on every element of bus tunnels, including a section on "Fire Life Safety", does not even consider a requirement for TWO 2-Lane tunnels for safety or any other reason !

### 4.3.5 *The Lincoln Tunnel XBL*

The busiest busway in the world (and the busiest single PT lane of any mode) is the Exclusive Bus Lane or XBL of the Lincoln Tunnel between New Jersey and New York. This single bus tunnel lane "*The lane operates weekday mornings between 6:15 and 10:00 a.m., accommodating approximately 1,700 buses and 62,000 commuters*" [61]. This also shows very high volumes can operating in a single bus lane successfully. Bus breakdowns in this tunnel are not identified as a significant issue.

### 4.3.6 *TWO Bus Tunnels are Not Justified*

The justification for the requirement for a second 2-lane bus tunnel is confused. The Alternatives Paper states it is needed "*to allow passing in case of breakdowns*" while the spreadsheet comment is "*for safety reasons*".

Nowhere in the world have TWO 2-Lane bus tunnels been found to be needed for congestion, safety reasons (or any other) reasons. The Alternatives Paper and real world experience **does not provide any evidence to justify the TWO 2-Lane bus tunnels costed into the CBT option**.

[61] Refer to Wikipedia for more information: http://en.wikipedia.org/wiki/Lincoln_Tunnel#Traffic_and_the_XBL

The issue of the Alternatives Paper consistently describing the TWO 2-Lane bus tunnels costed into the CBT option "a 2-Lane Tunnel" is more serious. **Using this false a description essentially hides the additional cost of the second bus tunnel in the CBT option without any justification or discussion and must be seen as downright deceit on the part of the Alternative Paper !**

### *4.3.7 Cost Impact of costing ONE 2-Lane Bus Tunnel*

It is clear from the examples provided above that one 2-Lane bus tunnel is all that is required for an effective Central Bus Tunnel.

Therefore, **doubling the Central Bus Tunnel is a design error without justification by the CBD Rail Business Case and the bus tunnel could be the same size as the rail tunnel:**

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Alternatives Paper Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Number of 2-Lane Bus Tunnels | | | | |
| **CBT** | Number of 2-Lane Bus Tunnels | -$230 | | -$429 | |

**Elimination of the additional 2-Lane Tunnel from busway tunnel design will mean a total project cost reduction of $230M to the CBT option.**

## *4.4 Why does the CBDRL option not provide for Bus Access from the Northern Busway ?*

Appendix F "Rail and Bus Operating Assumptions" Section 7.2 states "*CBD Rail Link will not replace bus passenger demand on the Northern Busway services, which are expected to increase substantially, or much of the Auckland Isthmus...*"

The Alternatives Paper itself predicts a **tripling of bus commuters from the Northern Busway** including that statement that "North Shore buses, expected to grow by some 200% to 332 buses per hour by 2041"[62]. However, the detailed description of the CBDRL option in section 4.10 of the Alternatives Paper does not mention any investment being required to support bus access for the Northern Busway[63] !

Interestingly, the Alternatives Paper does seem to address this issue in Section 8.1 of the Alternatives Paper stating "*The bus tunnel enables buses from the North Shore to pass through the CBD and link with the western edge.* ***The CBD rail link does not provide this benefit, so an adjustment is needed to facilitate comparison.***" The proposed adjustment is by "*adding an improved surface bus connection from the harbour bridge to the CBD. APB&B has estimated that such a connection should cost no more than $300 million (present cost $220 million)*".[64,65]

The problem with this approach is that this key element the PT capacity for the CBDRL option should be costed in section 4, along with the other PT elements of this option. It is not correct to raise (and discount) this separately from the rest of the option comparison[66]. The exclusion of the Northern Busway Link also implies it is optional to the CBDRL option but this position itself this defies logic given the predicted huge increase in bus passengers trying to access the CBD from the Northern Busway.

[62] Alternatives Paper Section 4.5.3 "Rerouting and Through Routing", page 48
[63] Refer to Comment #37
[64] Refer to Comment #46
[65] Assuming the $300M North Shore Busway Link would be built in the same timeframe as the rail tunnel, the Cost Estimation Model estimates the Present Value at $163M, not $220M.
[66] For example, the CBDRL option's top "1" rating for "Optimise patronage and accessibility to/from and within the CBD" along with the CBT option when it does not connect or support the Northern Busway ... surely a "2" rating would be more appropriate for an option with such an obvious deficiency.

In fact all options must cater for the predicted tripling of bus commuters from the Northern Busway, including the CBDRL option. The appropriate consistent approach is to include the Northern Busway Bus Link cost in the CBDRL option to provide this essential element of the whole design. Without this PT capacity in the CBDRL option it cannot be directly compared with the alternative options, such as the CBT option, that do provide a northern bus link.

The same logic also applies to the inclusion of a Termini at Takapuna for the CBT option that is also excluded from the CBDRL option when there is essentially no difference in the PT capacity being provided to the North Shore by either option. Again it appears obvious that the Takapuna Termini is required by both options.

### *4.4.1 Cost Impact of Adding Bus Capacity to CBDLR for the Northern Busway*

The CBDRL option discussion highlighted the capacity gap for this option to support the already identified increased capacity for the Northern Busway (ref comment #35). It even costed this investment at $300M ($163M Present Value). It is therefore obvious that this investment should also be included into the total cost of the CBDRL option.

As the bus based service to North Shore City is essentially the same for both the CBT and CDBRL options, the Takapuna Bus Termini[67] identified in the Alternatives Paper as being required for the CBT option must also be required for the CBDRL option for the same reason and this cost is included.

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Alternatives Paper Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Inclusion of Northern Bus Capacity | $240 | | $442 | |
| **CBT** | Inclusion of Northern Bus Capacity | | | | |

**Adding two bus capacity investments enable the rail option to support the Northern Busway will mean a total project cost increase of $240M for the CBDRL option.**

[67] Note the Takapuna Termini is estimated at $120M or $77M Present Value.

## *4.5 Are the Dominion Road Bus Lanes in all CBD options ?*

There is only a brief statement in the Alternatives Paper about the need for the CBT option "*BRT measures, such as grade separated junctions, being required in the CBD fringe*" . . . "*in order to counter increasing traffic congestion on the routes leading to the tunnel*" (Ref Comment #35). Figure 4-15 describes these busways but the key separately identifies the Dominion Road Busway as a "Planned Bus Lane".

The cost of the CBD "Access Busways" claimed to be required for the CBT option is found in the "PB Total Busway" worksheet of the Alternatives Cost Model spreadsheet. This worksheet lists nine different busways totalling $2 Billion ! The Dominion Road Bus Lanes is listed as "New North Road via Dominion Road" and is one of the busways is listed as being required is one from ending at Denbigh Ave.

However it does not seem logical that the costs of the Dominion Road busway be included in the CBT option cost but not in the CBDRL option. This is because:

- the busway is already planned and under discussion by the Auckland Council.
- Even more importantly, given the Dominion Road Busway serves an area far from any rail line, it is likely this busway will also proceed (or not) for both the CBT and the CBDRL options.

As the decision to proceed with the Dominion Road Busway will most likely be made separately from the Rapid Transit option for the CBD. If the busway does proceed, it would most likely proceed on its own merits, irrespective of the option chosen for the CBD. Therefore its costs should be included or excluded from both the CBDRL and CBT options.

### *4.5.1 Cost Impact of excluding the Dominion Road Busway Cost*

Given the Dominion Road costs are not likely to be different between the options, it should be excluded from the costs of all the costs.

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Alternatives Paper Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Remove Already Funded Dominion Road | | | | |
| **CBT** | Remove Already Funded Dominion Road | -$80 | | -$145 | |

**Elimination of the Dominion Road busway from all options will mean a total project cost reduction of $80M from the CBT option.**

## *4.6 Corrected CBD Rail Link and Central Bus Tunnel Option Costs*

The following provide a standardised detailed view of the two main options following the error corrections outlined in the previous sections (Note these are Nominal Costs):

### *4.6.1 Corrected CBD Rail Link Nominal Option Costs*

The changed costs to the correct (rail operating and inclusion of Northern Busway link) costs are highlighted:

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| **PT Tunnel to improve CBD Capacity** | | | | | | | |
| Khyber Pass | Midtown | Gaunt St | | | $696 | $843 | $1,538 |
| CBD Tunnel Support Infra Costs | | | | | $212 | | $212 |
| CBD Tunnel Land Purchase Costs | | | | | $78 | | $78 |
| **PT Investment to Access CBD** | | | | | | | |
| Albany | Takapuna | Gaunt Street | | | $300 | $120 | $420 |
| Khyber Pass | Broadway | Gt. South Road | | | | | |
| Newton | New North Road | Mt Albert | | | | | |
| Broadway | Remuera Road | St Johns Road | | | | | |
| Gt South Rd | Main H/Way | Ellerslie Panmure | | | | | |
| Broadway | Manukau Rd | Royal Oak | | | | | |
| Symonds Street | Mt Eden Rd | Hayr Rd | | | | | |
| New North Road | Dominion Road | Denbigh Ave | | | | | |
| Kingsland | Sandringham Road | Mt Albert Rd | | | | | |
| Kanrangahape Rd | Great North Rd | Pt Chevalier | | | | | |
| Great South Road | Rockfield Road | Church Street | | | | | |
| | | | | | | | |
| # new Busways | 0 | **Infrastructure Totals** | | | **$300** | **$120** | **$2,248** |

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| | | | | | | Design | $335 |
| | | | | | | ***Infra Sub-Total*** | ***$2,584*** |
| | | | | New Trains | 50 | $10 | $500 |
| | | | | New Buses | 102 | $0.58 | $59 |
| | | | | | | ***Vehicle Sub-Total*** | ***$559*** |
| | | | | | | **Total Capital** | **$3,144** |
| | | | | | | Operating Costs | $1,563 |
| | | | | | | **Grand Total** | **$4,707** |

### *4.6.2 Corrected Central Bus Tunnel Nominal Option Costs*

The changed costs to the correct (One 2-Lane bus Tunnel) costs are highlighted:

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| **PT Tunnel to improve CBD Capacity** | | | | | | | |
| Khyber Pass | Midtown | Gaunt St | | | $380 | $921 | $1,301 |
| CBD Tunnel Support Infra Costs | | | | | $93 | | $93 |
| CBD Tunnel Land Purchase Costs | | | | | $78 | | $78 |
| **PT Investment to Access CBD** | | | | | | | |
| Albany | Takapuna | Gaunt Street | | | | $120 | $120 |
| Khyber Pass | Broadway | Gt. South Road | $62 | $75 | $255 | $120 | $512 |
| Newton | New North Road | Mt Albert | $66 | $158 | | | $224 |
| Broadway | Remuera Road | St Johns Road | $115 | $30 | | | $145 |
| Gt South Rd | Main H/Way | Ellerslie Panmure | $28 | $30 | | | $58 |
| Broadway | Manukau Rd | Royal Oak | $72 | $30 | | $120 | $222 |
| Symonds Street | Mt Eden Rd | Hayr Rd | $99 | | | | $99 |
| New North Road | Dominion Road | Denbigh Ave | $0 | $0 | | | $0 |

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| Kingsland | Sandringham Road | Mt Albert Rd | $49 | | $105 | | $155 |
| Kanrangahape Rd | Great North Rd | Pt Chevalier | $94 | | | | $94 |
| Great South Road | Rockfield Road | Church Street | $48 | $15 | | | $63 |
| | | | | | | | |
| # new Busways | 8 | **Infrastructure Totals** | **$633** | **$338** | **$912** | **$1,281** | **$3,164** |
| | | | | | | Design | $554 |
| | | | | | | ***Infra Sub-Total*** | ***$3,717*** |
| | | | | New Trains | 0 | $10.00 | $0 |
| | | | | New Buses | 311 | $0.58 | $180 |
| | | | | | | ***Vehicle Sub-Total*** | ***$180*** |
| | | | | | | **Total Capital** | **$3,897** |
| | | | | | | Operating Costs | $1,157 |
| | | | | | | **Grand Total** | **$5,055** |

### 4.6.3 CBT option Capital Spreadsheet Calculation Error

Note that a third, more minor, spreadsheet calculation error was detected in the CBT option capital calculation. The annual capital summation formula on row 24 of worksheet "Central areas Bus Tunnel" incorrectly extends into the percentage rows 6 and 7. This error adds $2M to the nominal capital cost of the CBT option but only has minor impact on the capital Net Present Value.

### 4.6.4 Correction of the Alternatives Paper Errors

The correction of these calculation and design errors, results in the operating costs for the Central Bus Tunnel option options is significantly less than the CBD Rail Link option.

| Alternative | CBD Rail Link with 3 Stations | | Central Bus Tunnel with 3 stations | |
|---|---|---|---|---|
| | Net Present ($M) | Nominal ($M) | Net Present ($M) | Nominal ($M) |
| **Capital Cost** | $1,610 | $3,144 | $2,080 | $3,897 |
| **Operating Cost** | $290 | $1,563 | $200 | $1,157 |
| **Total Cost** | $1,900 | $4,707 | $2,280 | $5,055 |

With the correction of these errors, the Present Value costing gap between the CBDRL and the CBT options has dramatically reduced from $1,120M to only $360M Net Present Value.

Also note these corrections also change the visible PT components on the CBDRL option Diagram[68]:


[68] Correcting the CBT option does not change the CBT option Diagram

# 5 Where are the patronage numbers ?

Unusually, the published business case documents are almost totally devoid of the commuter patronage predictions for the options considered by the CBDRL Business Case and Alternatives Paper. Considering this is a public transport business case that claims a significant mode share shift, such information would be expected to have been provided as a matter of course.

However, this information was subsequently provided in a memo[69] from Auckland Transport to the Ministry of Transport's Review of the CBDRL Business Case and released with the MoT Review.

## *5.1 Patronage by mode for the CBDRL and CBT options*

The following table outlined the predicted patronage for the "Do minimum", CBDRL and CBT[70] options:

| Mode | 2011 | 2026 | 2041 | 2026 | 2041 | 2026 | 2041 |
|---|---|---|---|---|---|---|---|
| | Observed | Do Min | Do Min | CBDRL | CBDRL | CBT[70] | CBT[70] |
| Bus Pass | 23,180 | 35,334 | 49,428 | 26,581 | 42,814 | 37,270 | 60,415 |
| Private Vehicle Pass | 34,385 | 42,412 | 50,610 | 40,466 | 39,623 | 40,466 | 39,623 |
| Train Pass | 4,918 | 7,300 | 7,300 | 18,000 | 24,900 | 7,300 | 7,300 |
| Ferry Pass | 3,249 | 4,963 | 6,928 | 4,963 | 6,928 | 4,963 | 6,928 |
| Walking | 4,476 | 6,128 | 7,781 | 6,128 | 7,781 | 6,128 | 7,781 |
| Cycling | 838 | 1,145 | 1,453 | 1,145 | 1,453 | 1,145 | 1,453 |
| Total Persons | 71,044 | 97,272 | 123,500 | 97,272 | 123,500 | 97,272 | 123,500 |

The following is a percentage view of this information:

| Mode | 2011 | 2026 | 2041 | 2026 | 2041 | 2026 | 2041 |
|---|---|---|---|---|---|---|---|
| | Observed | Do Min | Do Min | CBDRL | CBDRL | CBT | CBT |
| Bus Pass | 33% | 36% | 40% | 27% | 35% | 38% | 49% |
| Private Vehicle Pass | 48% | 44% | 41% | 42% | 32% | 42% | 32% |
| Train Pass | 7% | 8% | 6% | 19% | 20% | 8% | 6% |
| Ferry Pass | 5% | 5% | 6% | 5% | 6% | 5% | 6% |
| Walking | 6% | 6% | 6% | 6% | 6% | 6% | 6% |
| Cycling | 1% | 1% | 1% | 1% | 1% | 1% | 1% |
| Total Persons | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

[69] Memo URL:http://www.transport.govt.nz/ourwork/rail/Documents/Auckland-CBD-Rail-Responses-To-Second-Set-Of-Questions-From-The-Ministry-Of-Transport.pdf

[70] Note that the Central Bus Option (CBT) was calculated from the CBDRL figures on the basis that it would deliver the same benefits as the CBDRL option (refer comment #6) but with the rail patronage of the Do Minimum option (bus passengers obviously taking up the rest of the PT capacity increase).

## 5.2 Mode shift from cars for CBDRL and CBT options

The above figures highlight the limited mode shift from cars to the tunnel options. Interestingly, for the CBDRL option to 2026, most of the extra rail passengers are ex-bus passengers !

| Mode | 2011 | 2026 | 2041 | 2026 | 2041 | 2026 | 2041 |
|---|---|---|---|---|---|---|---|
| | Observed | Do Min | Do Min | CBDRL | CBDRL | CBT | CBT |
| Private Vehicle Pass | 34,385 | 42,412 | 50,610 | 40,466 | 39,623 | 40,466 | 39,623 |
| Shift to PT | | 0 | 0 | **1,946** | 10,987 | **1,946** | 10,987 |

## 5.3 Level of CBD Car Congestion

The level of congestion in the already congested Auckland CBD is expected to increase as the number of commuters travelling by car into the CBD is predicted to be greater **under all options.** Surface bus passengers will experience the same level of CBD congestion at around 40K cars/day **in both the CBDRL and the CBT options**:

| Mode | 2011 | 2026 | 2041 | 2026 | 2041 | 2026 | 2041 |
|---|---|---|---|---|---|---|---|
| | Observed | Do Min | Do Min | CBDRL | CBDRL | CBT | CBT |
| Private Vehicle Pass | 34,385 | 42,412 | 50,610 | **40,466** | **39,623** | **40,466** | **39,623** |

## 5.4 Bus Patronage in the CBDRL and CBT options

Focussing on bus passengers, while the Do Minimum and CBT options obviously must support dramatically increased bus usage, the CBDRL option is also expected to have a major bus passenger increase:

| Mode | 2011 | 2026 | 2041 | 2026 | 2041 | 2026 | 2041 |
|---|---|---|---|---|---|---|---|
| | Observed | Do Min | Do Min | CBDRL | CBDRL | CBT | CBT |
| Bus Pass increase | 0 | 12,154 | 26,248 | **3,401** | **19,634** | 14,090 | 37,235 |
| % Bus Passengers | 33% | 36% | 40% | **27%** | **35%** | 38% | 49% |
| Train Pass increase | 0 | 2,382 | 2,382 | 13,082 | 19,982 | 2,382 | 2,382 |
| % Train Passengers | 7% | 8% | 6% | 19% | 20% | 8% | 6% |
| Total Persons | 71,044 | 97,272 | 123,500 | 97,272 | 123,500 | 97,272 | 123,500 |

Even when fully implemented, **the CBDRL option will only carry 1 in 5 commuters by (Rail) Rapid Transit while 1 in 3 will continue to arrive by surface bus**[71].

Even importantly, while the Do Minimum and CBT options have major challenges to support the much increased number of bus passengers (26K and 37K respectively), **the CBDRL option must also enable 20K more bus passengers to travel to work in the CBD every day**[72].

So, while the CBT option must enable access for 37K more bus passengers, **the CBDRL option must still support access for nearly twice the current number of bus passengers to and through an ever more congested Auckland CBD.**

[71] Again to note the CBDRL option does not contain **any** investment in bus access improvements.
[72] Another way of looking at this is, under the rail based option, for each additional rail passenger, there is an additional bus passenger.

## *5.5 Rapid Transit Capacity of the CBDRL and CBT options*

The Alternatives Paper recommends both the CBDRL and CBT options as providing the most effective future PT service because they remove large numbers of commuters from congested CBD surface streets. Interestingly, this approach being core to the business case, no specific figures are provided on the respective numbers of commuters who would actually be moved into the tunnels.

### *5.5.1 CBDRL option Passenger Capacity in Tunnel*

The Alternatives Paper only provides figures for the future maximum possible from a CBD rail tunnel, not the actual passenger rail capacity costed into the CBDRL option.

However, the figures released as part of the Ministry of Transport Review[73] give the CBD Rail tunnel peak period patronage figures as **18,000 by 2021 and 24,900 by 2041**.

### *5.5.2 CBT option Passenger Capacity in Tunnel*

Again, the Alternatives Paper does not provide any clear statement of the predicted bus passenger numbers that would use the bus tunnel but it gets close in the statement "*The Bus Tunnel would remove some 534 bus movements per hour (equivalent to a maximum capacity of around 37,000 passengers per hour) from the surface streets.*"[74] This averages to just over a bus every 15 seconds in each direction.

The Alternatives Paper also states "*The bus tunnel option **would remove some 70 percent of bus movements from surface streets**, but more than 100 buses per hour would still need to be accommodated in city streets at peak times, for those more local routes for which the bus tunnel would not be an option; and to ensure efficient servicing of the city centre.*"

Given the total bus patronage for the CBT option is 37,270 by 2021 and 60,415 by 2041 the above the Alternatives Paper statement "The bus tunnel option would remove some 70%" figure implies the bus tunnel 2 hour peak period patronage figures as **31,207 by 2021 and 47,400 by 2041**.

[73] Refer Review Section 5
[74] Refer to Comment #15

### *5.5.3 Which Option Moves the Most Commuters on Rapid Transit ?*

Combining the above figures with the total patronage figures previously released by Auckland Transport gives an indication of the effectiveness of the CBDRL and CBT options in moving PT passengers using a rapid transit tunnel based service.

**Rapid Transit patronage for the CBDRL and CBT options for 2026:**

| **2026 CBDRL option** | **Underground PT** | **Surface Rail** | **Surface Bus** | **Total Bus/Rail** |
|---|---|---|---|---|
| # Passengers | 18,000 | 0 | 26,581 | 44,581 |
| % Passengers | 40% | 0% | 60% | 100% |
| **% Rapid Transit** | **40%** | | | |
| **% Surface Bus** | **60%** | | | |
| **2026 CBT option** | **Underground PT** | **Surface Rail** | **Surface Bus** | **Total Bus/Rail** |
| # Passengers | 31,207 | 7,300 | 6,074 | 44,581 |
| % Passengers | 70% | 16% | 14% | 100% |
| **% Rapid Transit** | **86%** | | | |
| **% Surface Bus** | **14%** | | | |

**Rapid Transit patronage for the CBDRL and CBT options for 2042:**

| **2042 CBDRL option** | **Underground PT** | **Surface Rail** | **Surface Bus** | **Total Bus/Rail** |
|---|---|---|---|---|
| # Passengers | 24,900 | 0 | 42,814 | 67,714 |
| % Passengers | 37% | 0% | 63% | 100% |
| **% Rapid Transit** | **37%** | | | |
| **% Surface Bus** | **63%** | | | |
| **2042 CBT option** | **Underground PT** | **Surface Rail** | **Surface Bus** | **Total Bus/Rail** |
| # Passengers | 47,400 | 7,300 | 13,014 | 67,714 |
| % Passengers | 70% | 11% | 19% | 100% |
| **% Rapid Transit** | **81%** | | | |
| **% Surface Bus** | **19%** | | | |

The bus tunnel option can deliver over 80% of PT commuters by Rapid Transit (4 of 5) whereas the rail tunnel only moves about 40% (2 of 5) leaving the majority to rely on surface road bus services.

**It is clear that the CBT option is literally twice as effective as the CBDRL option in delivering more passengers into the CBD via rapid transit and in freeing up CBD surface streets from buses.**

## *5.6 More Detailed CBDRL and CBT Option Diagrams*

While the diagrams in the Alternatives Paper do provide some visibility of the differences between the alternative options, it is possible to further improve understanding by adding more details of the investment from the cost calculation spreadsheets. Also, given the whole point of investing in rapid transit is to avoid congestion, the addition of the Alternatives Paper Congestion Map will also help understand the respective ability of the different options to provide a fast, reliable PT service to commuters.

The following is a more detailed view of the Corrected CBT options:


The following is a more detailed view of the Corrected CBDRL options:

# 6 How Much CBD Bus Access from the South & West ?

The main demand into the CBD that currently cannot be met is from commuters from West and South Auckland who currently have difficulty getting into the Auckland CBD on PT.

## *6.1 Where is the bus access in CBD Rail Link option ?*

Even after inclusion of the Northern Busway access link, almost all the CBD Rail Link option infrastructure cost is for the CBD Rail Tunnel. However, the non-rail investment of $59M for 102 additional buses hints at a serious design gap in this solution.

In fact the CBDRL option, in contrast to the bus-based options, essentially assumes the current road network can cater for any increased bus-based patronage.

The lack of CBDRL option bus investment is clear when the proposed component of this option investment is overlaid with the predicted congestion map from the Alternatives Paper (see previous page).

### *6.1.1 Bus Passenger Patronage in the CBDRL option*

As previously outlined in review Section 5.4, there are 23,000 bus passengers already entering the CBD but **the CBD Rail Link option has this nearly doubling to 43,000 bus passengers per day !**

The discussion in Appendix F "Rail and Bus Operating Assumptions" Section 7.2 does outline the clear requirement for improved bus access even with the rail tunnel and Section 7.3 describing the limited reduction in buses under CBDRL option as follows:

> *The impact of the restructuring of the Bus Network outlined above are estimated to result in around 60 fewer buses being required in the morning peak period by 2041.*[75]

But, given the many pages on the design and costing of an upgraded passenger rail tunnel delivering 20,000 more passengers per day, the CBD Rail Line Business Case and the Alternatives Analysis is totally silent how the CBDRL option will provide for the 19,600 additional bus passengers !

### *6.1.2 Bus Access from the South/West*

**Both the CBDRL and CBT options face the same car road congestion levels faced by the bus services**[76]. The Alternatives Paper also outlines the real challenge of further increased congestion from more and more cars. The number of cars accessing the CBD is predicted to increase from 34K in 2011 to nearly 40K in 2041 for both the CBDRL and CBT option. This is such a problem that Alternatives Paper states (highlight added):

> *Whilst rail already has priority corridors, bus largely does not (except the Northern Busway).* ***If buses are to provide the capacity increase necessary to accommodate the CBD's needs, it too will need dedicated rights of way.*** *This study proposes that bus lanes alone will not be adequate to provide reliable bus service running conditions.*[77]

Based on this requirement in the Alternatives Paper, a significant investment in busways through identified congestion areas has been deemed essential for the bus based options. It therefore does not seem reasonable or even logical that the CBR Rail Link option must not also provide equivalent bus access for an additional 19,000 bus passengers for no busway investment at all[78] !

---

[75] Refer Comment #49.
[76] Refer Review Section 5.3
[77] Refer to Comments #25 and 26
[78] Another way of looking at this is, if the CBD can handle nearly 20K more bus passengers without major infrastructure investment, why proceed with a $billion rail investment that delivers about the same capacity ?

It seems more reasonable approach that **the CBDRL option requires some significant investment in busways to deal with the increased congestion** already described in some detail by the CBD Business Case. After all, it also relies buses providing increased capacity and "*If buses are to provide the capacity increase necessary to accommodate the CBD's needs, it too will need dedicated rights of way.*"

### *6.1.3 CBDRL option needs at least half the CBT option Busways*

The Alternatives Paper claims the CBT option requires $1,712M[79] of additional busways to provide bus access into the Auckland CBD. This would provide the bus capacity increase to support the 37K additional bus passengers. The CBDRL option needs to provide additional CBD access for 20K additional bus passengers

It is clear that the CBDRL option must to provide at least half the additional capacity of the CBT option. It would seem reasonable, for an initial estimate, **that the CBDRL option include half the additional busway investment of the CBT option as it is required to provide at least half the additional capacity.**

Also, the CBDRL option outlined a significant volume of bus passengers who would access the CBD via feeder bus services (ref comment #39). This will require a significant investment on bus interchange at key stations on the Auckland rail network. For this reason, the Newmarket Termini cost included in the CBT option, has also been included in the Revised CBDRL option as representative for the investment in bus-rail interchange investments.

It is also important to note that the this "Reasonable CBDRL option" **does not include any capacity within the CBD** to ensure a reliable PT service to the 20K bus passengers while the CBT can support some in the bus tunnel and underground stations. It is highly likely that some of the CBD bus priority measures outlined in the Surface Bus Capacity Improvements option is also required for the CBDRL option. **Therefore this cost addition of access busways to the CBDRL option is a minimum bus investment component.**

**Finally, the absence of discussion on how the required major increase surface bus capacity will be supported in the CBDRL option is a major deficiency that has yet to be brought to public attention.** The CBDRL option with basic CBD access busways is outlined in the following diagram:


[79]This figure excludes the cost of the planned Dominion Road Bus Lanes.

### *6.1.4 Cost Impact of Realistic CBD Rail Link option*

Provision of adequate bus access for the rail tunnel option (based on half the revised CBT access busway cost) will require a total project cost **increase of $540M**[80] **to the CBDRL option.**

Adding ½ the CBD Access Busways to the CBDRL option to Cost Summary Table should therefore be:

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Corrected Option Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Rail = 1/2 the CBT option Southern/Western Busways | $540 | | $997 | |
| **CBT** | Rail = 1/2 the CBT option Southern/Western Busways | | | | |

Adding the above cost change to the Corrected Options Costings outlined in Section 4.6

**Corrected Alternative Options Costings with CBT Busways added to the CBDRL option:**

| Alternative | CBD Rail Link with 3 Stations | | Central Bus Tunnel with 3 stations | |
|---|---|---|---|---|
| | **Net Present ($M)** | **Nominal ($M)** | **Net Present ($M)** | **Nominal ($M)** |
| **Capital Cost** | $2,150 | $4,141 | $2,080 | $3,897 |
| **Operating Cost** | $290 | $1,563 | $200 | $1,157 |
| **Total Cost** | $2,440 | $5,704 | $2,280 | $5,055 |

Adding even half the cost of CBD access busways to the CBDRL option **increases the total cost of the CBDRL option to $160M ABOVE the Present Value as the CBT option !**

The above indicates the different option investment in CBD access busways, to cater for surface bus passengers, is a decisive factor between the CBDRL and CBT options.

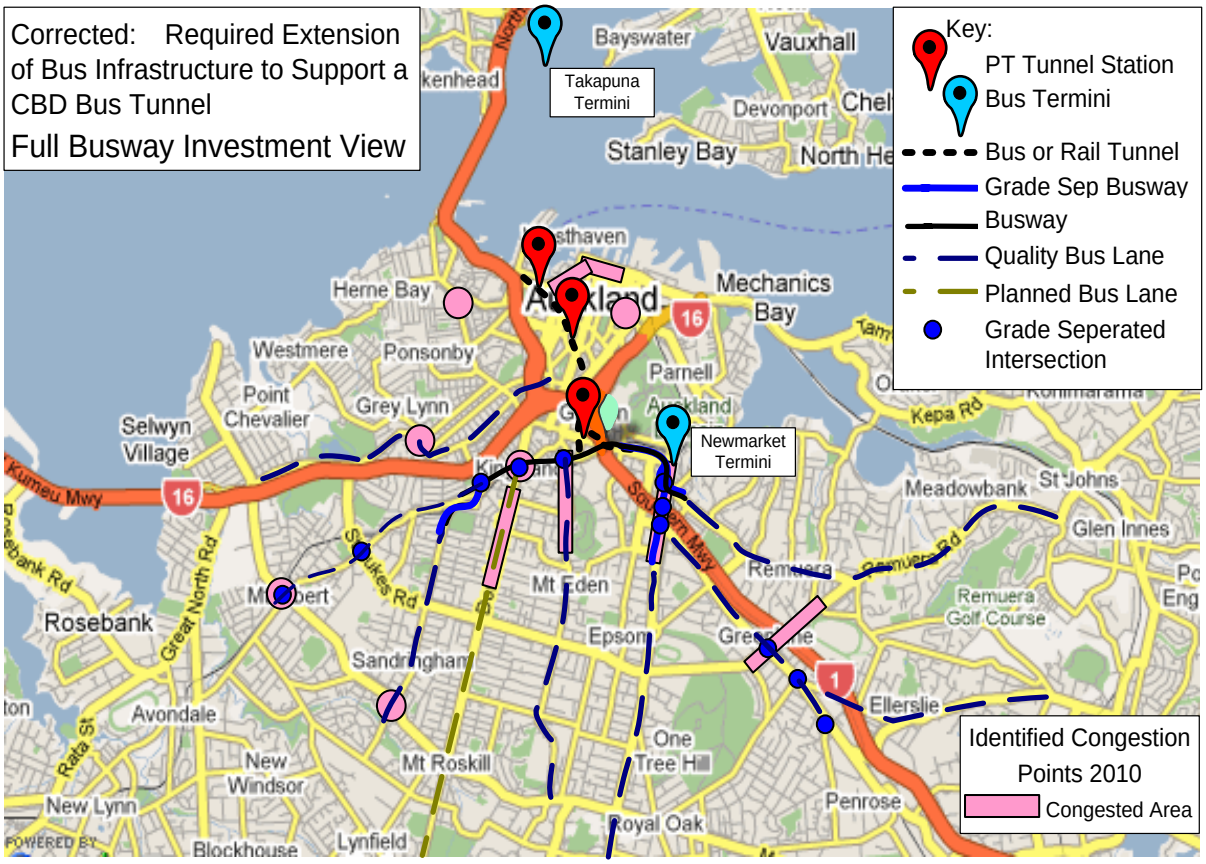
[80] Note that the this cost excludes any further investment in CBD bus capacity for the additional 20K bus passengers making this a very conservative cost estimate.

## 6.2 *Is there too much access for CBT option ?*

One paragraph in the Alternatives Paper (see comment 35) simply states:

> *In addition to BRT measures, such as grade separated junctions, being required in the CBD fringe areas to realise the bus tunnel throughput*[81].

The following diagram is from Section 5.6 and it clearly identifies the extensive range of "required BRT measures" in terms of grade busways, grade-separated busways and grade separated busway intersections and new bus termini:




The first point is the total lack of discussion within the Alternatives Paper on the $1,853M costed into the CBT option for busways to provide access into the CBD. Given this is the main source of excessive cost in the CBT option, and the multi-paragraph discussion on much smaller elements of different options, one would have though some more detailed analysis would be presented toward explaining the justification for this PT investment.

[81] With an accompanying diagram of proposed CBD Access busways.

### 6.2.1 *Are Eight More Busways Needed for the CBT option ?*

Of the Present Value cost $3,717M infrastructure cost[82] for the "Central Bus Tunnel" option, less than half this investment ($1,723M) is for the actual bus tunnel itself[83]. The main cost driver for the CBT option being significantly higher than the recommended CBDRL option is actually for the addition of **eight additional busways**[84] (totalling over 40km) the Alternatives Paper claims is required to provide bus access from areas to the south and west of the Auckland CBD.

In contrast, the Alternatives Paper predicts this the Northern Busway is ". . . expected to grow by some 200% to 332 buses per hour by 2041 in the medium scenario . . ."[85], but no additional infrastructure is identified other than a "Termini" at Takapuna ($120M).

Interestingly, Auckland's Northern Busway consists of "a two way 6.24 km road for buses, five stations, and 2.5 km of single bus lanes" built for a cost of only $300 Million[86]. This single busway example appears to deliver adequate bus capacity to the north of the Central Bus Tunnel, the need for so many busways to the south does not seem justified.

The Alternatives Paper also identifies the Brisbane Busway as a model for the Auckland Bus Rapid Transit (BRT) based solution that is the Central Bus Tunnel option. It is therefore instructive to examine the extent of busways implemented into the Brisbane CBD that has proven to deliver the required high capacity transit needed to meet the PT needs of the this city. Usefully, the Alternatives Paper includes a map of the Brisbane Busway network:

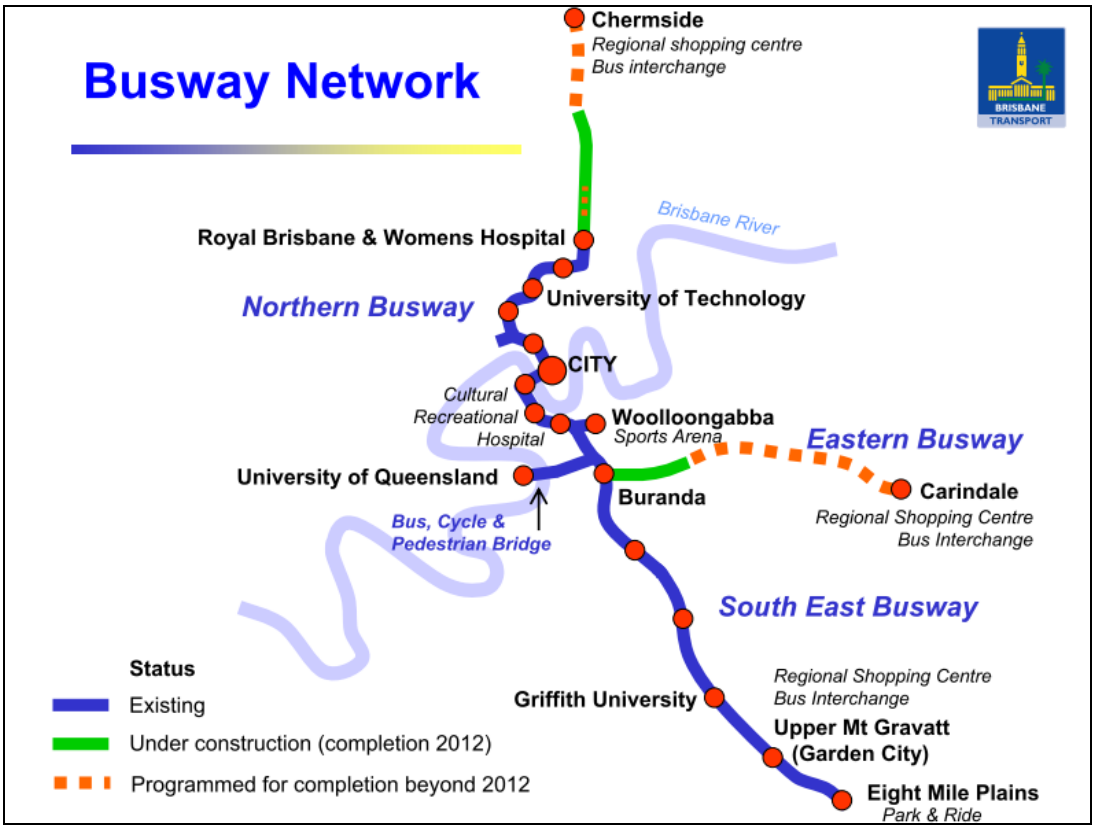



**Figure 4-10: Brisbane Busway Plan**
(Alternatives Paper Page 57)

[82] This is the Unadjusted Corrected Cost from the previous section
[83] The Unadjusted bus tunnel cost estimate is $1,723M versus the rail tunnel cost of $2,143M.
[84] In fact the CBT option costed **nine** additional CBD Access Busways but the planned Dominion Road Busway is considered a design error and assumed to proceed on it own merit as previously outlined in Section 0.
[85] Alternatives Paper, Section 4.5.3, page 48.
[86] NZTA Web Site http://www.nzta.govt.nz/network/projects/project.html?ID=15

The above shows, that Brisbane has built a very successful BRT based Rapid Transit System based on only **two** long grade separated busways into the CBD. In fact the total length of dedicated busways in Brisbane is about 24km. This 24km of busways already delivers a passenger volume into the underground CBD bus stations similar to that required for Auckland's CBT option. Brisbane's Transit Authority is now considering further measures, such as double articulated buses, to meet the ongoing patronage growth expected for its BRT system.

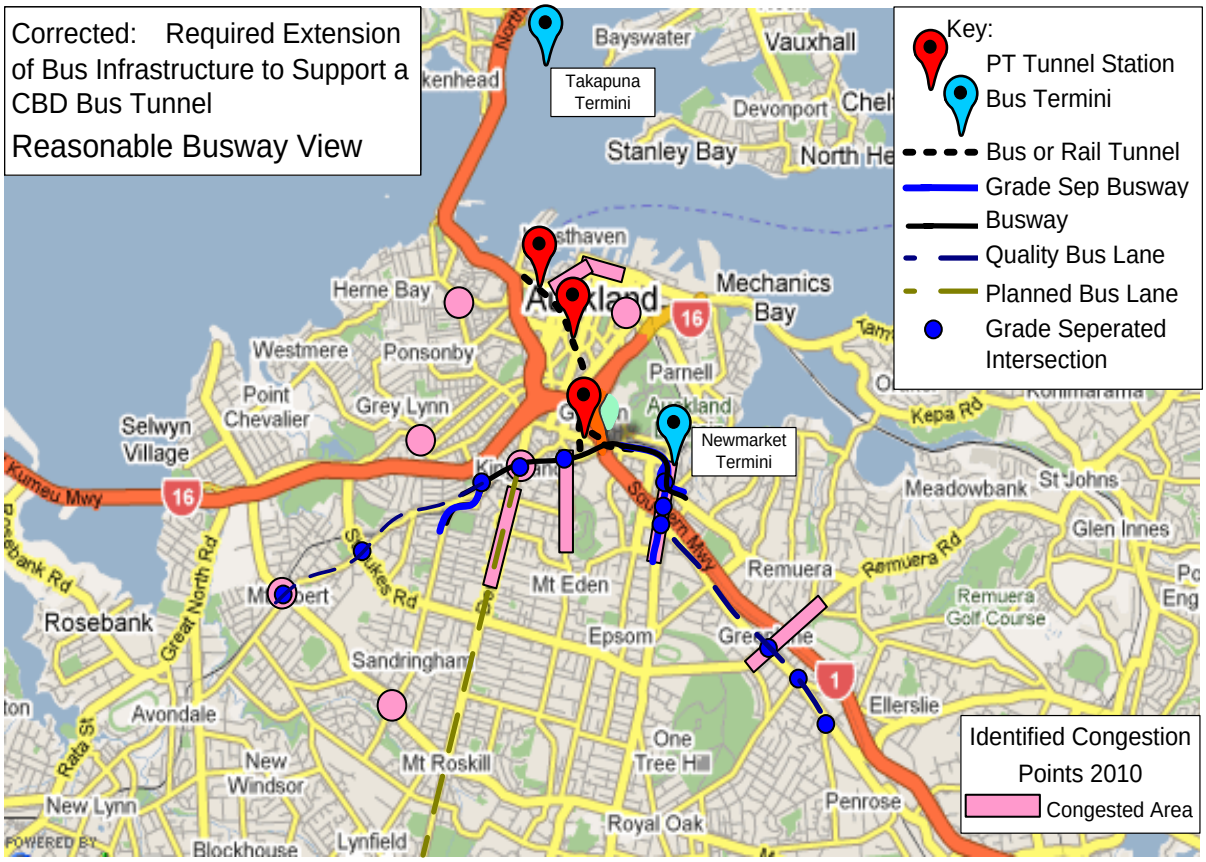
It is therefore difficult to understand the requirement a similar city such as Auckland to have **so many more busways** to the south and east of the CBD[87]. Including all the CBD Access Busways claimed to be required in the Alternative Analysis to the Northern Busway, CBD Bus Tunnel and Dominion Road Bus Lanes, will give Auckland over 56km of Busways . . . one of the largest busway systems in the world ! Lots of parallel busways into a CBD is **not** based on proven Bus Rapid Transit based best practice This is applying the sort rail transit thinking that is required for a light rail network solution[88].

There **are** real access issues to provide bus passenger access into the Auckland CBD for **all proposed options**, but Brisbane shows congestion can be avoided with a couple of well designed busways combined with underground CBD bus stations. In the case of Auckland it is likely that two additional grade separated busways, one to the south and one to the west, can deliver the required capacity to support reliable bus access in the CBD Central Bus Tunnel option.

The suburban routes can be reconfigured to use the either the busways directly or the motorways that connect to the busways via their own grade separated intersections.

[87] i.e. eight more busways in additional to the already planned Dominion Road improvements.
[88] It is interesting to note that the Alternatives Paper makes exactly this point about "Light Rail" in Section 4.8.

The more realistic Revised Central Bus Tunnel option is described below:




Also note the following:

- The proposed Onehunga Termini has been removed because it is unclear why such a facility would be required (it is not even at the end of any busway).

### 6.2.2 *Cost Impact of Reasonable Central Bus Tunnel option*

Elimination of excessive investment in extra busway capacity and the Onehunga Termini **will mean a total project cost reduction for the Central Bus Tunnel option of $400M Net Present Value.**

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Corrected Option Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Reduce CBT option to Reasonable Busways | | | | |
| **CBT** | Reduce CBT option to Reasonable Busways | -$400 | | -$734 | |

**Corrected Reasonable Busway Costings with ½ the CBT Busways added to the CBDRL option:**

| Alternative | CBD Rail Link with 3 Stations | | Central Bus Tunnel with 3 stations | |
|---|---|---|---|---|
| | Net Present ($M) | Nominal ($M) | Net Present ($M) | Nominal ($M) |
| **Capital Cost** | $1,610 | $3,144 | $1,680 | $3,163 |
| **Operating Cost** | $290 | $1,563 | $200 | $1,157 |
| **Total Cost** | $1,900 | $4,707 | $1,880 | $4,320 |

Reducing the excessive busway investment to the "Reasonable" investment in two major busways **reduces the total cost of the CBT option below the Net Present Value of the CBT option !**

The above highlights the impact of the excessive investment in CBD access busways as a deciding factor between the CBDRL and CBT options.

## 6.3 Are the Bus Tunnel Operating Costs Excessive ?

A major calculation error with the annual bus tunnel operating costs has already been identified[89]. But it is also interesting that the Assumptions worksheet of the costing spreadsheet holds **two estimates** for this cost.

**The estimate used is $9M/year** from Cells B253 & C253 is noted to be "*from Russell Turnbull email 24 Jul*". Also note that the rail "Infrastructure Operating Costs"[90], are $0M with the note "*Incorporated in Total operating cost per service-km value*".

However, nearby Cells B250 & C250 hold an alternative cost of $630,000/km which is noted to be "*Based on costings done for the F3 to Sydney Orbital Link Study and reported in SKM Working Paper No. 7 (March 2004). These costings have been escalated to 2010 prices and converted to NZ dollars. Lindsay*". Multiplying this amount by the length of the bus tunnel (3.3km) give **a much lower bus tunnel operating cost of $2.1M/year.**

A request to Auckland Transport for both the above reference documents resulted in the following:

- A copy of the Russell Turnball email was provided. It included the following comment:

  *5) Operating costs of the bus tunnel i.e. ventilation – say $8-10 million per annum*

- A copy of the "*SKM Working Paper No. 7 (March 2004)*" was not provided. In their responding letter, Auckland Transport stated:

  *Despite the efforts of the consultant team, they have been unable to locate a copy of this document and Auckland Transport does not hold a copy.*

As the Auckland Transport response does not provide the detailed estimation analysis expected for a major cost operating component of the CBT option, the obvious question is which estimate is more likely to be accurate ? As noted by Russell Turnball, the main part of operating the bus tunnel is providing ventilation to keep the tunnel clear of the bus engine fumes.

On the face of it, $9 Million per year seems very high . . . nearly $25,000/day appears to be a lot to pay to basically power a set of large extraction fans. Even after correcting for the calculation error, the bus tunnel costs are 16% of the total operating costs including running 300 urban buses.

Also, NZTA has confirmed the 10 year 2.5km, 6-lane car tunnels operating contract for the Waterview Connection has been signed at $16M/year. Given the much higher traffic volumes also involved, this also indicates the $9M/year estimate for a 2-lane bus tunnel is likely to be too high.

**The authors view is the lower cost of $2.1M/year is a more realistic cost** (still nearly $5,750/day) to power and operate the bus tunnel ventilation system. This lower cost is included into the "Reasonable CBT option" costing.

### 6.3.1 Cost Impact of Realistic Bus Tunnel Operating Costs

| Alternative | Cost Change from | Capital Cost | Operating Cost | Capital Cost | Operating Cost |
|---|---|---|---|---|---|
| | Corrected Option Cost Base | Net Present | Net Present | Nominal | Nominal |
| **CBDRL** | Revised Bus Tunnel Operating Costs | | | | |
| **CBT** | Revised Bus Tunnel Operating Costs | | -$30 | | -$145 |

Substituting the lower bus tunnel cost for the higher bus tunnel ventilation cost in the Central Bus Tunnel option **will mean a total project cost reduction for the Central Bus Tunnel option of $30M.**

[89] Refer Section 3.3
[90] This presumably includes the train tunnel costs.

# 7 Results of Costing Impact Review Analysis

In addition to the costing faults of the Alternatives Papers options described in the review Section 4, the CBD Rail Link Business Case designs have major option costing errors. The errors of over investment in busways for the CBT option and totally failing to make any provision for CBD bus access in the CBDRL option are each decisive in selection of the lowest cost Rapid Transit option.

## *7.1 Correcting Alternatives Paper Errors*

Section 4 of this review documents a number of errors in the CBDRL and CBT options as described in the Alternatives Paper and costed in the supporting Economic Spreadsheet. The following tables summarise the cost changes due to the identified spreadsheet calculation errors and design faults for the CBDRL and CBT options giving a "Corrected" option cost for each.

***CBDRL OPTION Total Cost***

| | | CBDRL (PV) Change | | CBDRL (Nom.) Change | |
|---|---|---|---|---|---|
| **Option** | **Name** | CAPEX ($M) | OPEX ($M) | CAPEX ($M) | OPEX ($M) |
| ***Alternatives Paper Cost Base*** | | ***$1,370*** | ***$150*** | ***$2,702*** | ***$874*** |
| | Rail Operating Cost Calculation Error | | +$140 | | +$689 |
| | Bus Tunnel Operating Cost Error | | | | |
| | Number of 2-Lane Bus Tunnels | | | | |
| | CBT option Capital Summation Error | | | | |
| | Remove Already Funded Dominion Road | | | | |
| | Inclusion of Northern Bus Capacity | +$240 | | +$442 | |
| *Total Cost Changes* | | *+$240* | *+$140* | *+$442* | *+$689* |
| **Corrected Total Costs** | | **$1,610** | **$290** | **$3,144** | **$1,563** |

***CBT option Total Cost***

| | | CBT (PV) Change | | CBT (Nom.) Change | |
|---|---|---|---|---|---|
| **Option** | **Name** | CAPEX ($M) | OPEX ($M) | CAPEX ($M) | OPEX ($M) |
| ***Alternatives Paper Cost Base*** | | ***$2,390*** | ***$250*** | ***$4,473*** | ***$1,229*** |
| | Rail Operating Cost Calculation Error | | | | |
| | Bus Tunnel Operating Cost Error | | -$50 | | -$72 |
| | Number of 2-Lane Bus Tunnels | -$230 | | -$429 | |
| | CBT option Capital Summation Error | | | -$2 | |
| | Remove Already Funded Dominion Road | -$80 | | -$145 | |
| | Inclusion of Northern Bus Capacity | | | | |
| Total Cost Changes | | -$310 | -$50 | -$576 | -$72 |
| **Corrected Total Costs** | | **$2,080** | **$200** | **$3,897** | **$1,157** |

## *7.2 Options Based on Corrected Figures with Reasonable Design*

Section 5 of this review examines the decisive issue of the investment in CBD bus access for the CBDRL and CBT options. The former has less than 10% of its total cost[91] allocated while the latter has 38% of its total cost[92] to improved bus access to the CBD.

**CBDRL option Corrected Total Costs** (with Reasonable Busways and CBDRL having 1/2 Busways)

| | | CBDRL (PV) Change | | CBDRL (Nom.) Change | |
|---|---|---|---|---|---|
| **Option** | **Name** | CAPEX ($M) | OPEX ($M) | CAPEX ($M) | OPEX ($M) |
| ***Corrected Cost Base*** | | ***$1,610*** | ***$290*** | ***$3,144*** | ***$1,563*** |
| | *Provide Reasonable Busways access to Auckland CBD*[93] | *+$340* | | *+$630* | |
| | *Revised Bus Tunnel Operating Costs* | | | | |
| *Total Cost Changes* | | *+$340* | | *+$630* | |
| ***Corrected & Reasonable Total Costs*** | | ***$1,950*** | ***$290*** | ***$3,774*** | ***$1,563*** |

**CBT option Corrected Total Costs** (with Reasonable Busways and CBDRL having 1/2 Busways)

| | | CBT (PV) Change | | CBT (Nom.) Change | |
|---|---|---|---|---|---|
| **Option** | **Name** | CAPEX ($M) | OPEX ($M) | CAPEX ($M) | OPEX ($M) |
| ***Corrected Cost Base*** | | ***$2,080*** | ***$200*** | **$3,897** | ***$1,157*** |
| | *Provide Reasonable Busways access to Auckland CBD* | *-$400* | | *-$745* | *$* |
| | *Revised Bus Tunnel Operating Costs* | | *-$30* | | *-$145* |
| *Total Cost Changes* | | *-$400* | *-$30* | *-$745* | *-$145* |
| ***Corrected & Reasonable Total Costs*** | | ***$1,680*** | ***$170*** | ***$3,152*** | ***$1,012*** |

### *7.2.1 Corrected and Reasonable Present Value Option Cost Summary*

Alternatives Paper Table 7-1 provided the most detailed published Present Value Costs[94] costs for the two leading CBD PT options. The following is the same table but with "Corrected and Reasonable" Alternative Present Value Costs and Nominal costs:

| **Alternative** | **CBD Rail Link with 3 Stations** | | **Central Bus Tunnel with 3 stations** | |
|---|---|---|---|---|
| | **Net Present ($M)** | **Nominal ($M)** | **Net Present ($M)** | **Nominal ($M)** |
| **Capital Cost** | $1,950 | $3,774 | $1,680 | $3,163 |
| **Operating Cost** | $290 | $1,563 | $170 | $1,012 |
| **Total Cost** | $2,240 | $5,337 | $1,830 | $4,175 |

The CBD Rail Link Business Case eliminates the CBT option because it calculated:

> *The CBD Rail Link with 3 stations has costs in present value terms of $1,520m, which is **approximately 60%** of the present cost of $2,640m for the Central Area Bus Tunnel with 3 stations.*

The above analysis shows this conclusion to be totally false and the CBT option is cheaper because:

> *The CBD Rail Link with 3 stations has costs in present value terms of $2,240m, which is **approximately 120%** of the present cost of $1,850m for the Central Area Bus Tunnel with 3 stations.*

[91] Actually, the Alternatives Paper has nothing but the Corrected CBDRL option baseline cost adds $442M Unadjusted required to link the Northern Busway.
[92] The Alternatives Paper has $1,998M but the Corrected CBDRL option baseline cost reduces this to $1,853M Unadjusted with the removal of the Dominion Road Busway cost.
[93] Note because to the approach to cost the CBT option busway access investment at half the CBT option access busways investment, this cost is therefore reduced in proportion to the reduced CBT option Busway Costs.
[94] Refer to Alternatives Paper Page 85 or Review Section 3.7.2.

## *7.3 Discussion of the CBDRL and CBT option evaluation*

It is clear that the deciding factor between the CBDRL and CBT options is the cost of providing bus access to the CBD to support the majority of PT commuters who will continue to use surface bus.

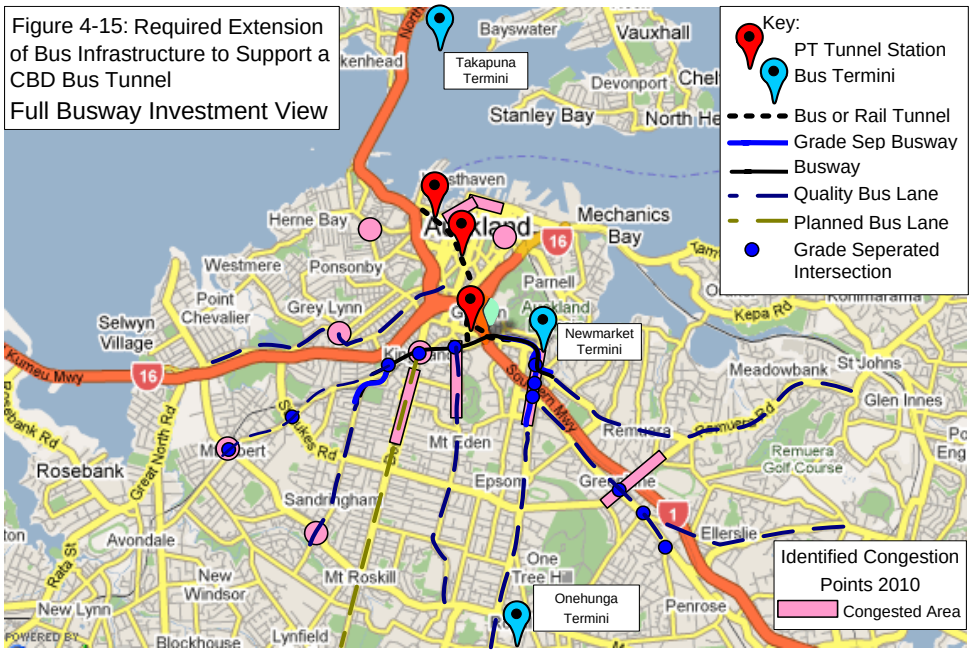
the capital costs from the Alternatives Paper logic of these two options, is summarised as:

| | Currently Observed | CBDRL Option[95] | | | CBT Option[95] | | |
|---|---|---|---|---|---|---|---|
| **PT element** | **Passengers** | **Passengers** | **Cost ($M)** | **Cost/pass** | **Passengers** | **Cost ($M)** | **Cost/pass** |
| Through CBD via Tunnel | 0 | 24,900 | $2,702[96] | $109K | 47,400 | $1,902[96] | $40K |
| Through CBD via surface bus | 23,180 | 42,814 | 0 | $0 | 20,314 | 0 | $0 |
| Access to CBD on bus | 23,180 | 42,814 | $442 | $10K | 67,714 | $2,140 | $32K |
| Access to CBD on rail | 4,918 | 24,900 | $0 | $0 | 7,300[97] | $0 | $0 |

[95] Option costs are "Corrected option" Costs
[96] includes PT Vehicle Costs
[97] To Newmarket and Britomart

In fact the Alternatives Paper recommended option claims that CBD bus access capacity can nearly double 43K passengers/day at minimal cost while upgrading CBD bus access capacity to 68K passengers/day requires over $2B. Just compare the alternative bus access diagrams:


**Proposed CBDRL option: 43K bus passengers to CBD**




**Proposed CBT option: 68K bus passengers to CBD**

There is an obvious logical conflict between the CBDRL option claim that a $2.7B investment is required for a rail tunnel to provide reliable PT into a contested CBD and the implied claim that the CBT option can still deliver the majority of PT users on surface bus services to the CBD for almost no investment at all ! If bus capacity can still be expanded so cheaply, then why invest in a rail tunnel at all ??

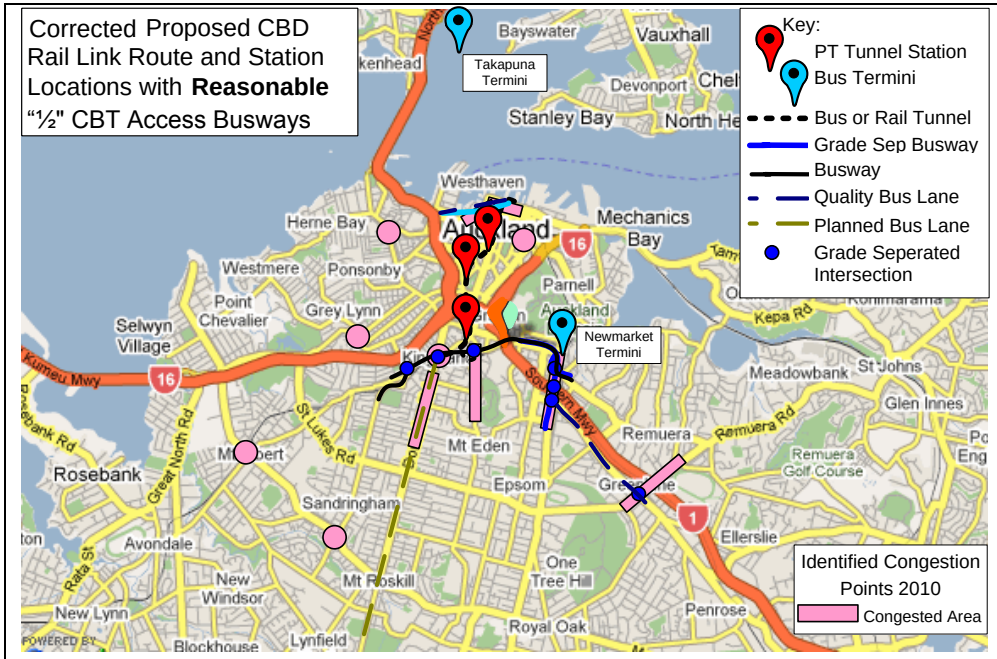
This review outlines and justifies a more reasonable and balanced design and costing that properly provides for an appropriate level of bus access in line with the required mode capacities for the CBDRL and CBT options.

The "Corrected and Revised" option capital costs appear to be much more consistent and logical:

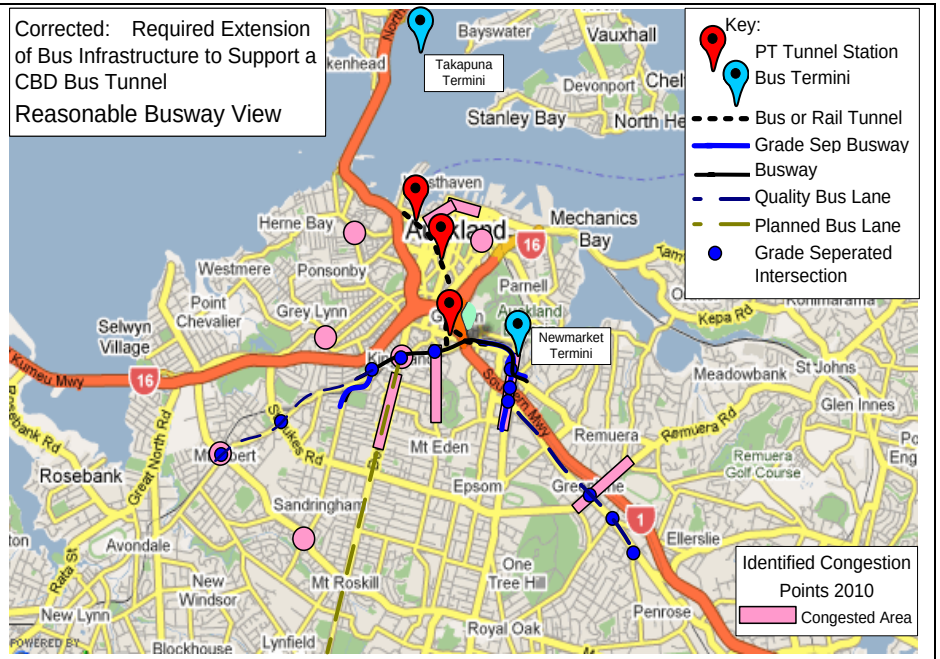
| | **Currently Observed** | **CBDRL Option**[98] | | | **CBT Option**[95] | | |
|---|---|---|---|---|---|---|---|
| **PT element** | **Passengers** | **Passengers** | **Cost ($M)** | **Cost/pass** | **Passengers** | **Cost ($M)** | **Cost/pass** |
| Through CBD via Tunnel | 0 | 24,900 | $2,702[99] | $109K | 47,400 | $1,902[96] | $40K |
| Through CBD via surface bus | 23,180 | 42,814 | 0 | $0 | 20,314 | 0 | $0 |
| Access to CBD on bus | 23,180 | 42,814 | $1,072 | $25K | 67,714 | $1,261 | $19K |
| Access to CBD on rail | 4,918 | 24,900 | $0 | $0 | 7,300[100] | $0 | $0 |

[98] Option costs are "Corrected option" Costs
[99] includes PT Vehicle Costs
[100] To Newmarket and Britomart

The result of addition of a minimum busway investment to the CBDRL option and the removal of the excessive bus access investment from the CBT option **totally changes the relative cost effectiveness between the two preferred options as described in the following diagrams:**




**Reasonable CBDRL option: 43K bus passengers to CBD**




**Reasonable CBT option: 68K bus passengers to CBD**

**The CBT option is clearly the lower cost Rapid Transit solution that provides the benefits outlined at length in the CBD Rail Link Business Case.**

## *7.4 Reasonable CBD Rail Link and Central Bus Tunnel Option Costs*

As outlined in the analysis above, the proposed investments outlined in the CBD Rail Link Business Case and detailed in the costing spreadsheets are not reasonable and, in some cases, logical. the following outline the detailed costing of proposed Revised CBDRL and CBT options.

### *7.4.1 Reasonable CBD Rail Link Nominal Option Costs*

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| **PT Tunnel to improve CBD Capacity** | | | | | | | |
| Khyber Pass | Midtown | Gaunt St | | | $696 | $843 | $1,538 |
| CBD Tunnel Support Infra Costs | | | | | $212 | | $212 |
| CBD Tunnel Land Purchase Costs | | | | | $78 | | $78 |
| **PT Investment to Access CBD** | | | | | | | |
| Albany | Smales Farm | Gaunt Street | $300* | | | $120 | $420 |
| Khyber Pass | Broadway | Gt. South Road | $31 | $38 | $128 | $120 | $316 |
| Newton | New North Road | Mt Albert | $33 | $79 | $0 | $0 | $112 |
| Broadway | Remuera Road | St Johns Road | $0 | $0 | $0 | $0 | $0 |
| Gt South Rd | Main H/Way | Ellerslie Panmure | $14 | $15 | $0 | $0 | $29 |
| Broadway | Manukau Rd | Royal Oak | $0 | $0 | $0 | $0 | $0 |
| Symonds Street | Mt Eden Rd | Hayr Rd | $0 | $0 | $0 | $0 | $0 |
| New North Road | Dominion Road | Denbigh Ave | $0 | $0 | $0 | $0 | $0 |
| Kingsland | Sandringham Road | Mt Albert Rd | $25 | $0 | $53 | $0 | $77 |
| Kanrangahape Rd | Great North Rd | Pt Chevalier | $0 | $0 | $0 | $0 | $0 |
| Great South Road | Rockfield Road | Church Street | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | |
| # new Busways | 2 | **Infrastructure Totals** | **$102** | **$131** | **$480** | **$240** | **$2,783** |

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| | | | | | | Design | $431 |
| | | | | | | ***Infra Sub-Total*** | ***$3,214*** |
| | | | | New Trains | 50 | $10.00 | $500 |
| | | | | New Buses | 102 | $0.58 | $59 |
| | | | | | | ***Vehicle Sub-Total*** | ***$559*** |
| | | | | | | **Total Capital** | **$3,774** |
| | | | | | | Operating Costs | $1,562 |
| * Includes design costs | | | | | | **Grand Total** | **$5,337** |

### *7.4.2 Reasonable Central Bus Tunnel Nominal Option Costs*

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| **PT Tunnel to improve CBD Capacity** | | | | | | | |
| Khyber Pass | Midtown | Gaunt St | | | $380 | $921 | $1,301 |
| CBD Tunnel Support Infra Costs | | | | | $93 | | $93 |
| CBD Tunnel Land Purchase Costs | | | | | $78 | | $78 |
| **PT Investment to Access CBD** | | | | | | | |
| Albany | Takapuna | Gaunt Street | | | | $120 | $120 |
| Khyber Pass | Broadway | Gt. South Road | $62 | $75 | $255 | $120 | $512 |
| Newton | New North Road | Mt Albert | $66 | $158 | | | $224 |
| Broadway | Remuera Road | St Johns Road | $115 | $30 | | | $145 |
| Gt South Rd | Main H/Way | Ellerslie Panmure | $28 | $30 | | | $58 |
| Broadway | Manukau Rd | Royal Oak | $72 | $30 | | $120 | $222 |
| Symonds Street | Mt Eden Rd | Hayr Rd | $99 | | | | $99 |

| Start | VIA | End | @ Grade Busway ($M) | Grade Sep Busway Intersections ($M) | Tunnel/Grade Sep Busway ($M) | PT Stations ($M) | Total Costs ($M) |
|---|---|---|---|---|---|---|---|
| New North Road | Dominion Road | Denbigh Ave | $0 | $0 | | | $0 |
| Kingsland | Sandringham Road | Mt Albert Rd | $49 | | $105 | | $155 |
| Kanrangahape Rd | Great North Rd | Pt Chevalier | $94 | | | | $94 |
| Great South Road | Rockfield Road | Church Street | $48 | $15 | | | $63 |
| | | | | | | | |
| # new Busways | 2 | **Infrastructure Totals** | **$206** | **$263** | **$912** | **$1,161** | **$2,541** |
| | | | | | | Design | $442 |
| | | | | | | ***Infra Sub-Total*** | ***$2,983*** |
| | | | | New Trains | 0 | $10.00 | $0 |
| | | | | New Buses | 311 | $0.58 | $180 |
| | | | | | | ***Vehicle Sub-Total*** | ***$180*** |
| | | | | | | **Total Capital** | **$3,163** |
| | | | | | | Operating Costs | $1,012 |
| | | | | | | **Grand Total** | **$4,175** |

# 8 Option Benefits

This analysis has focussed on the cost elements between CBDRL and CBT options. The reason is outlined in Alternatives Paper Section 8[101]:

> *This paper does not seek to quantify the benefits of either the CBD Rail Link with three stations or the Central Area Bus Tunnel with three stations, but instead assumes that the benefits of both are comparable, say $B million present value.* ***This is based upon the similarity of benefits achieved from the delivery of significant public transport capacity into the CBD.***

The relative effectiveness between the options is scored in Alternatives Paper Section 6[102].

## *8.1 Comparing Conventional Transport Benefits*

A comprehensive review of the criteria and scoring is not possible due to the lack of information provided in the Alternatives Paper. However, logic of the Conventional Transport Benefits scores can be critiqued to test the validity of the scoring process. As stated in Table 6-2:

| **Option** | **"Transport benefits – conventional" Score** |
|---|---|
| Central Area Bus Tunnel & 3 Stations | 3 |
| CBD Rail Link – 3 Stations | 3 |

The Alternative Paper explains why the CBDRL and CBT options have the same Conventional Transport Benefits Score:

> ***8.1 Conventional Transport Benefits***
>
> *The CBD Rail Link with three stations and the Central Area Bus Tunnel with three stations both deliver passengers more widely around the CBD, in ways that are not subject to surface congestion. They therefore should have similar benefits in terms of decreasing travel time.*

### *8.1.1 Differences in Service Frequency*

The CBDRL option is based on delivering a 15 minute train service based on 6-car trains. It also assumes that 11 buses are required to replace a single train.

Having 11 buses replace a 15 minute rail service also means a bus service that runs every 90 seconds ! A key feature of BRT solutions is the much higher frequency possible by buses . . . commuters love services where they do not have to schedule their journey or wait long for the next service. This also reduces commuter travel time for the CBT option because waiting time is reduced for higher frequency services.

[101] Refer Comment #44
[102] Refer Comment #40

### 8.1.2 *Differences in CBD Access*

Although both the CBDRL and CBT options "*both deliver passengers more widely around the CBD, in ways that are not subject to surface congestion*", as outlined in Section 5.5.3, the options deliver this capability to quite different percentages of PT commuters. This is summarised as follows:

| Option | 2026 %Congestion Free | 2026 %Surface Bus | 2041 %Congestion Free | 2041 %Surface Bus |
|---|---|---|---|---|
| CBDRL | 40% | 60% | 37% | 63% |
| CBT | 86% | 14% | 81% | 19% |

The Alternatives Paper evaluation scoring team appears to have forgotten that the CBDRL option still **only has 2 out of every 5 PT commuters** travelling into the CBD by rail tunnel while the CBT option combination of bus tunnel and rail to Britomart means **more than 4 of every 5 PT commuters** on congestion free Rapid Transit. **Even worse, the Alternatives Paper CBDRL option has no investment to improve surface bus access** meaning the current congested bus service can only be worse in a rail based future.

The logic outlined in Section 8.1 of the Alternatives Paper is not supported by their own patronage figures and the CBT option clearly superior in providing reliable PT on congestion free corridors.

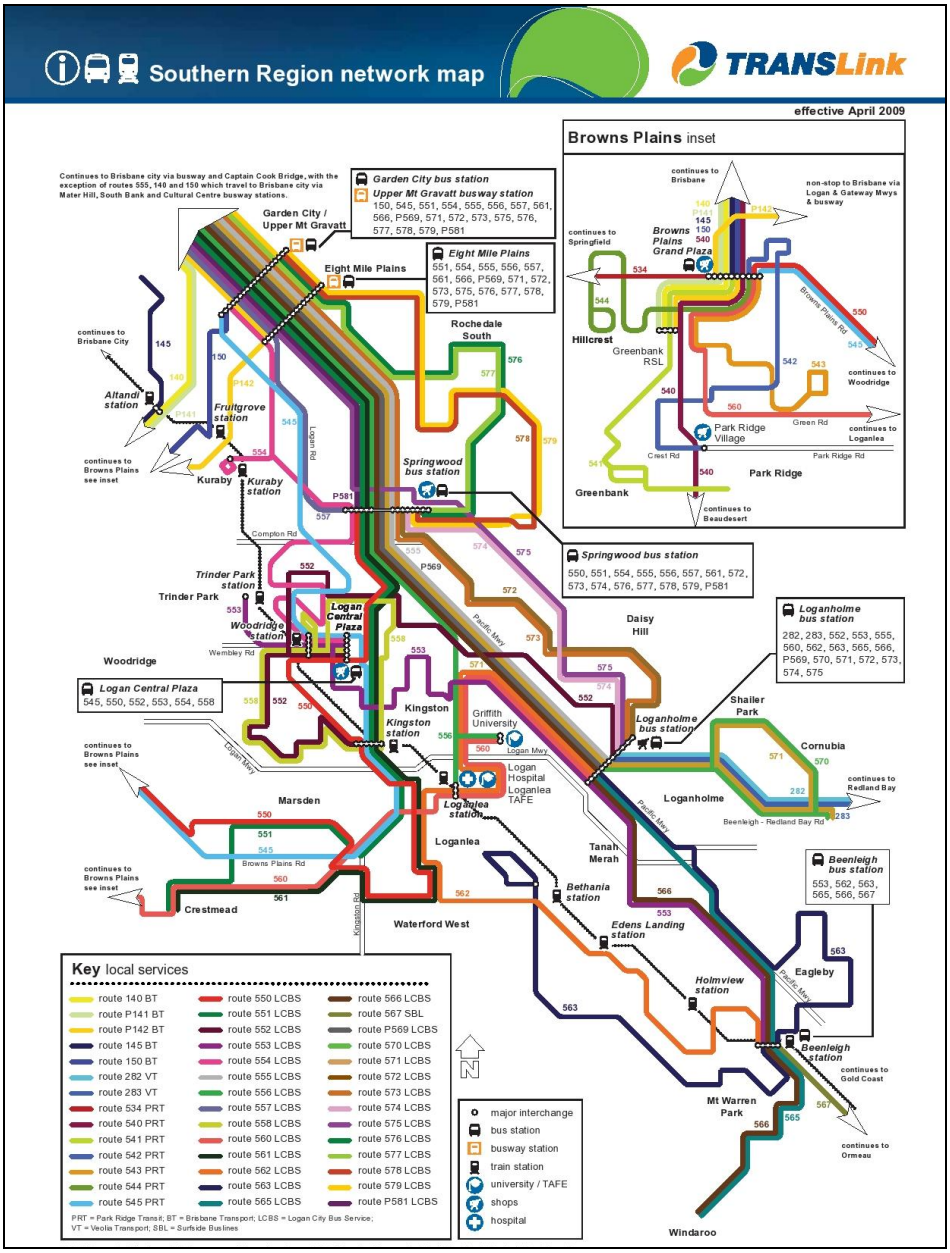
### 8.1.3 *Differences in Residential Coverage*

The Alternatives Paper does not discuss the limited access of rail to residential areas. In fact, the Business Case promotes the increased high density housing around railway stations to promote higher PT usage[103]. The Alternatives Paper also expects a large number of PT commuters will bus and train into Auckland.

Bus Rapid Transit has much greater penetration into where Aucklanders live and is more able to provide more direct home-to-work services. This is best illustrated by the following map of the PT services to South Brisbane that is served by the South-East Busway noted in the Alternatives Paper.

[103] The point of having the public go to the transport turns the whole point of public transport on its head. Surely a case of the mountain being brought to Mohammad.

There are both bus and rail services from South Brisbane but the better bus service coverage is clear:




There are clearly “winners and losers” in terms which Auckland suburbs will get easy access to Rapid Transit with the CBDRL option while the CBT option can provide much fairer access to all residential areas.

### *8.1.4 Conclusions on benefits comparison*

The CBT option is clearly superior to the CBDRL option in providing:

- a much higher service frequency
- superior access across residential areas and
- carries twice the number of PT commuters into the CBD on reliable dedicated Rapid Transit services.

The CBT option will obviously provide a much better rapid transit service than the rail solution. It is therefore cannot be valid to have given the CDBRL option the same high score for Traditional Transport Benefits earned by the CBT option.

## *8.2 Was the Alternatives Evaluation Impartial ?*

So who actually scored the benefits from the rail and bus based alternative options ?

This is stated in the CBDRL Business Case Consultants, in their response to the MoT Review of benefits in the Alternatives Paper:

> *APB&B "s methodology was designed to deal with the lack of a common denominator, because investment objectives have very different denominators. However, this is not a serious shortcoming because our methodology was designed to deal with different denominators by:*
>
> *Having a process of workshopping with ARTA and KiwiRail staff to agree scores for all options;*

It seems KiwiRail, an SEO and commercial transport operator with a direct financial interest in the outcome, had its own staff score the benefits of both the rail and bus based options ! How can such an alternatives evaluation so performed be truly viewed as accurate or impartially determined ?

Surely the direct involvement of KiwiRail in alternative option evaluation compromises the whole Business Case process !

# 9 Other issues with Alternatives Paper

During the analysis for the CBDRL Business Case, it's appendices (including the Alternatives Paper) and the supporting cost calculation spreadsheet, a number of other issues were identified that should also be noted.

## *9.1 Where is the Transport Modelling for the CBT option?*

The CBD Rail Link Business Case option Alternatives Paper has many deficiencies in claiming to having proposed and then reviewed the best alternative options. There are assumptions throughout the reports about the level of future congestion, respective mode share and more specific design elements such as whether the CBDRL option needs a bus connector between the Northern Busway and the CBD.

But by far the biggest failing in this analysis is the absence of transport modelling to validate the overall design of the alternative options. Modelling of the four leading alternative options would help answer many of the questions and points of dispute outlined by this analysis.

One major example is the claim, reviewed in Section 6.2, that nine additional busways costing $1.7B, are needed to provide adequate bus access for the 60,415 bus passengers while the CBDRL option can provide equivalent CDB access for 42,814 bus passenger at no cost ! This single design claim is the decisive cost difference between the two top options and modern transport modelling would likely confirm or discredit the validity of this approach.

The Alternatives Paper does note difficulties with using current models for the Auckland CBD. However, the author has seen transport studies a tenth the size of the CBD Rail Link Business Case with good quality transport modelling that adds important information to the decision making process.

Considering the scale of the investment, the apparent bias in the recommended option and the long term impact of these decisions, **it is simply not acceptable to have comprehensive transport modelling for all leading alternative options.**

## *9.2 Cost of the bus stations*

The above analysis has not addressed the different costs of the underground stations these being $307 for each 8 stop bus station which is based on the most expensive rail station (Karangahape Rd). In fact the cost of constructing the three bus stations constitutes over two-thirds of the total cost of the bus tunnel build.

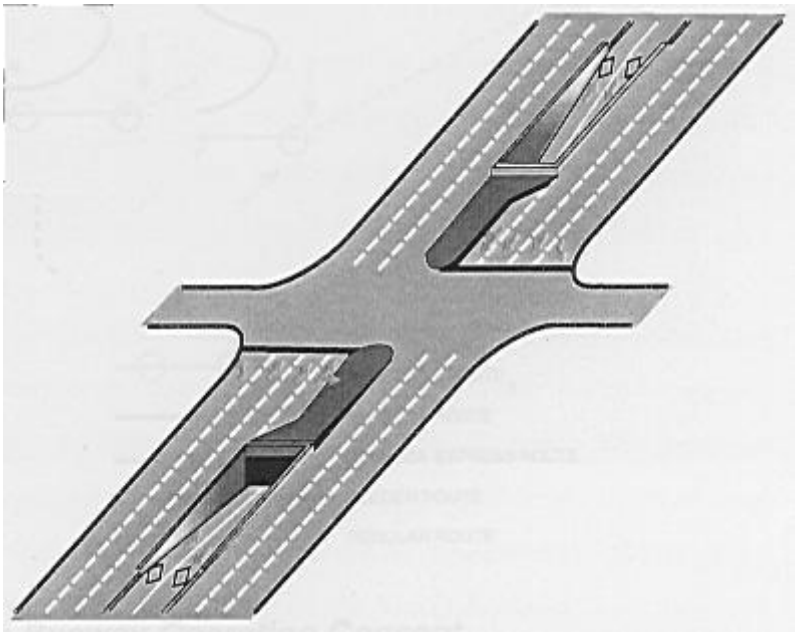
It does need to be noted that the CBDRL Business Case Appendix E "Construction Cost Summary" has nearly halved the cost estimates for all rail stations with the Karangahape Rd Station now estimated at $160M. This also means an equivalent Net Present Value cost reduction for the CBT option of $280M[104].

[104] $480M unadjusted Cost

## 9.3 Busway Intersection Costing

The Alternatives Paper outlined the need for a number of grade separated intersections to enable the busways to provide reliable access with the following diagram:

***Figure 4-3: Example of Grade Separated BRT Junction***



There are perhaps 10 such intersections ranging in length from l00m to 300m in length and costing between $15M and $45M.

The interesting point is these intersections are costed off “Assumptions” Worksheet Cell C166 Labelled “unit cost of 2 lane cut & cover” which, in turn, is costed from Cell C100 “Rail Tunnel Cut & Cover”

It is unclear whether this is an appropriate way to cost busway intersections when a 2 lane bridge may suffice, or that the cost is appropriately high or low compared to a more traditional bridge based intersection grade separation.

## 9.4 The other Bus Tunnel

The Alternative option CBT option describes the tunnel as 3.3km from Kyber Pass to Gaunt Street. But the “PB Total Busway” worksheet also lists 1.6km[105] of Kyber Pass from Nugent Street to Broadway as “Grade Separated Busway”. This is costed at $150.13M/km making a total cost of $240M, a very expensive section of busway.

Interestingly, the costing of this type of busway is also costed from the same Assumptions Worksheet Cell C100 “Rail Tunnel Cut & Cover” that was used by the previous section[106].

However, in addition to the question of whether it is appropriate to design & cost the “cut & cover” bus tunnel directly from an equivalent rail tunnel, is the observation that the bus tunnel is essentially continuous from Gaunt Street through to Newmarket Station[107] and new Bus Termini.

**Therefore the CBT option actually has a 5km long CBD bus tunnel with 4 Stations !**

[105] Identified in two parts in the spreadsheet.

[106] This cut & cover bus tunnel is directly based on the rail tunnel, without doubling the tunnels. That this bus tunnel in the CBT option adds to the issue outlined in Section 3.4 that the main bus tunnel should also be sized directly from the rail tunnel dimensions.

[107] See Section 10.1for an alternative to digging up Kyber Pass for this part of the bus tunnel.

## 9.5 Britomart Station Alterations

The CBDRL option Station costs are calculated in rows 12 to 15 for the following Stations:

- Britomart Station alterations
- Aotea
- Karangahape Rd
- Newton

Each row refers to an equivalent total station costs in "Assumption Worksheet Cells C104 — C107.

One unusual element of the CBDRL option cost calculation is row 12 of the "CBD Rail Link" worksheet "Britomart Station alterations" all have zero values. Appendix E "Construction Costs Summary" notes this cost is $81,357,621 but the Assumption Worksheet Cell C104 is blank (not zero). The supporting notes for this row state the figure is from "Peter Twomey paper 3Aug10" and the statement "included in alignment".

It could be that this cost is included elsewhere or has been missed in another calculation error. However, as Auckland Transport have refused to release the "Peter Twomey paper 3Aug10" requested under the OIA, the correct inclusion of the Britomart Station costs into the CBDRL option cannot be confirmed.

## 9.6 Exclusion of Finance and Depreciation Costs

The CBDRL Business Case bases its Alternatives Cost analysis on "Present Value"[108] investment cost. While this is valid for comparative purposes on the investment, no account has been taken of the financing costs differences between the options. This is important because the CBDRL option has a higher and earlier capital investment compared to the CBT option.

The rail vehicles in particular are more expensive and must be purchased for a 30 year life while cheaper buses only have a 15 year life. This combination of cost and time makes financing the rail vehicles considerably more expensive than the equivalent bus capacity.

There is a similar issue with capital depreciation. Good management practice is to maintain the capital investment and depreciation charges should ensure further ongoing asset maintenance funding is provided.

While the fixed infrastructure costs are similar for both the CBDRL and CBT options, the CBDRL is likely to have a much higher depreciation costs to maintain and replace the more expensive rail rolling stock at the end of its 30 year life. The alternative is to rely on a future major capital replacement to replace worn-out trains in 30 years time, the situation Wellington faced with its English Electric and will again with its Ganz-Mavag units in the next decade.

Excluding the finance and depreciation costs from the Alternative Paper analysis biases the option comparison because it incorrectly underestimates the true total cost of options with higher capital costs compared to those with lower . . . in this case being the CBDRL option being advantaged over the lower capital cost CBT option.

[108] See Wikipedia for more information http://en.wikipedia.org/wiki/Present_value

# 10 Was the Best BRT Design Proposed?

It was the Alternatives Paper that decided that "*bus lanes alone will not be adequate to provide reliable bus service running conditions*" and that "*Bus Rapid Transit (BRT) would be required over strategic parts of the road network ..would take the form of exclusive bus lanes (one in each direction)*"[109].

The above implies the only approach available for BRT are bus lanes or dedicated busways. In fact, Bus Rapid Transit solutions can include a whole range elements from "skip" bus lanes and bus priority at intersections to Integrated Traffic Systems (ITS) that controls all traffic signals[110] to specially built bus systems with every element designed to work together as in Curitiba, Brazil . . . a world renowned model for BRT.

As outlined in Section 6.2, the proposed size and distribution of dedicated busways does not show the Alternative Paper analysis has developed an appropriate, integrated Bus Rapid Transit design for the CBT option. The proposed design for the CBT option makes little use of bus flexibility such as being able to providing a layer of express services over the traditional "all stops" services utilising the ability of buses to pass each other. The opportunity for an Integrated Traffic Systems for the Auckland CBD bus services is also notable by its absence in all options.

## *10.1 The Western Busway*

Another key issue is the Alternatives Paper choice to build all the busways onto current major roads. An obvious busway design alternative not considered is building busways on rail corridor land. For example, why add a separate busway along the length of busy, congested, New North Road when there is an under used Western Rail Line "next door"[111] ?

A better design option is to convert the under-utilised rail line to a fully grade separated "Western Busway". This would run on the rail corridor from Mount Albert to the CBD Bus Tunnel entrance and on to Newmarket. This approach is hugely superior to the at-grade busway proposed for New North Road and the grade separated busway along Kyber Pass.

A Western Busway would have the following elements:

- Extend the CBD bus tunnel to the rail tunnel Western Line entrance points at Mt Eden;
- The Western Rail Line would be re-laid as a 2-way busway from Mount Albert to Newmarket. Some additional land purchases may be required to provide sufficient corridor width;
- The six at grade intersections to be changed to either fully grade separated intersections or to be closed during peak hours to provide uninterrupted bus travel during these periods
- Mid busway entry/exit points;
- Busway termination at Mount Albert;
- Support for high capacity transit to/from Eden Park to be included in the Western Busway design.

[109] Refer Comment #26.
[110] This gives BRT buses priority to keep on time. Such as system enables the Los Angeles "Metro-Rapid" System to carry tens of thousands per day on Wiltshire and Ventura Boulevards without even a continuous bus lane.
[111] Western Line only has limited use by rail freight.

This approach would mean the following elements in the Alternatives paper CBT option would no longer be required:

- The Kyber Pass to Broadway Grade Separated Busway ($300M)
- New North Road Busway ($264M)

The main advantages from rail line conversion is the majority of PT commuters from West Auckland, being bus passengers, get a Rapid Transit service with all the reliability and capacity of a dedicated, fully grade separated busway instead of the more limited at grade busway proposed for New North Road. There would be limited impact on minority of current rail passengers[112] who will generally also have a faster, more frequent direct bus service to the CBD.

It is not clear that the rail line itself must be totally removed. Because the Western Busway would only operate between perhaps 6am to 10pm, it may still be possible to operate night freight trains on the Western Line.

Other advantages of a Western Busway solution include:

- Building a Western Busway this option would avoid the New North Road community that would face major disruption during construction of the busway proposed by the CBT option;
- A Western Busway is better located to provide the very high capacity required to serve the major sports events at Eden Park.
- Western Line rolling stock would be transferred to the Southern and Eastern Rail Lines to provide a higher frequency rail service from South and East Auckland into Newmarket (for transfer to the Bus Tunnel) and Britomart.

In the past, the ARTA has cancelled bus routes that operate parallel to improving rail services. Not considering the reverse of this principle for the CBT option, even in passing, is another indication of the "rail-bound" thinking that seems to be behind the CBT option design of the Alternatives Paper.

### *10.1.1 Western Busway Costs*

Some preliminary costing has been completed on building a dedicated busway on the Western Line corridor. Approximately $650M is currently costed against building the Kyber Pass Grade Separated Busway (actually a cut-and-cover tunnel) and the New North Road Busway that is not required by the Western Busway design. **The preliminary costings indicate that the reallocation of busway investment cost will cover all or almost all the build costs to convert the Western Rail Line into the Western Busway.**

## *10.2 Future expansion options for the Bus Tunnel*

At this point in time Auckland faces a real choice between passenger rail and Bus Rapid Transit as the base mode for its Rapid Transit System. Both modes already have high capacity links into the CBD, from the South and West for Rail and from the North for BRT. As outlined above, both modes could potentially provide viable and cost effective rapid transit.

Therefore in addition the direct PT to CBD capabilities of the CBDRL and CBT option, the long-term implications and costs must also be considered. The reason is because the choice of rail or bus rapid transit, as the primary mode through the CBD, will also dictate the future PT expansion plans to the surrounding city.

[112] The Alternatives Paper describes the Western Line Seated Capacity at 2,700 and total Capacity = 4,620 in the Do Minimum option.

### *10.2.1 Costs of Rail Based Rapid Transit*

In recent years, Auckland RLTS includes a PT approach strategy has been largely based on expanding passenger rail. In the next 30 years (the timeframe for the CBDRL Business Case) the Regional Land Transport Strategy predicts PT will cost over $6B in capital and $12B in operating funding.

The reason why rail services so expensive is because this mode is track bound and requires its own continuous dedicated corridor. Commuter access is only possible at rail stations. The much more limited climbing and turning ability of rail vehicles also both raises costs and restricts route options[113]. Some of the already estimated future rail project costs planned for Auckland include:

- Rail to North Shore City: $2.7B[114]
- Rail to the Airport: $1.4B - $2.1B[115]
- Rail between Avondale and Southdown: $0.7B

Taking passenger rail across the Waitamata Harbour to North Shore is an example of huge costs required to extend passenger rail. The recent NZTA study looked at a number of different bridge and tunnel options for expanding road capacity but stated "The design of rail is constrained differently to road (having different geometric and gradient requirements). These constraints limit the ability to provide road and rail on the same structure." In other words, rail was considered so incompatible that an additional crossing for rail is assumed adding $2.7B to the overall cost.

It is clear that selection of the CBD Rail Link option also commits Auckland to further multi-billion dollar rail projects over the next decade. This is the time to pause and give some thought to the advantages of a Bus Rapid Transit based future that would come with selection of the CBT option instead of the CBDRL option.

### *10.2.2 Bus Rapid Transit for Auckland*

The key difference between BRT and rail is the inherent capability of buses to use current roading and highway infrastructure (current & Planned). Even dedicated Bus Rapid Transit corridors usually require no more than half the capital cost as equivalent rail services and, even then, only where there are congestion issues.

Continuing the Waitamata Harbour Crossing example, high capacity bus rapid transit could incorporated into any road based harbour crossing, bridge or tunnel, at a much smaller capital cost. This is already proven by the performance of the Northern Busway.

However, if a bus tunnel was selected for the CBD, the following further expansion options could be considered as extensions to Auckland BRT Rapid Transit:

To the North:

- If connected to a CBD bus tunnel, the Northern Busway is likely to provide sufficient capacity for some time to come (see Brisbane's South East Busway).
- Any new Waitamata Harbour Crossing, bridge or tunnel, could also support various appropriate levels of BRT without building an additional bridge or tunnel crossing.

[113]For example, grade separating a single road and rail intersection rail through New Lynn meant creating a kilometre-long open-cut trench up to 8m deep and cost $190M.
[114]"Additional Waitemata Harbour Crossing - Preliminary Business Case", Section 6.1.8 Analysis of rail option by PWC for NZTA 2010.
[115]"Planning for Rapid Transit Corridors in South West Auckland Metropolitan Region", ARTA (April 2008)

To the West:

- A busway based on the Western Line corridor could be extended at low cost further to the West along the current rail corridor to New Lynn and beyond as required. Extending the busway to Swanson could cost as little as $200M.
- The North-Western Motorway (SH 16 - Auckland to Kumeu) could have a busway connection near Kingsland to the Western Line Busway to provide a reliable bus access services to Western Springs and Te Atatu[116]

To the South:

- The Great South Road Busway could be extended to the Airport via a busway on a converted Onehunga Line corridor.
- State Highway 1 could be expanded by adding a Bus/Toll Lane through to Manakau providing a direct, reliable Bus Rapid Transit service to Auckland's second city. A bus-only connection to the Great South Road Busway would provide a relatively congestion free bus service even during peak hours possibly as far as Hamilton !

To the East:

- Similar to converting the Western Busway, a dedicated, grade separated busway Eastern Busway from Mount Wellington and Glenn Innes to Britomart and Auckland University could use a converted Eastern Rail Line. This would form the basis for Bus Rapid Transit to Mount Wellington and beyond to more distant East Auckland suburbs such as Pakaranga.

Within the CBD:

- Complete the $300M bus link from the Northern Busway to Britomart that was identified in the CBDRL option.
- Build another bus tunnel from the Victoria Park car tunnel, via Civic Square underground Bus Station to Auckland University and Carlaw Park to connect to the Eastern Busway. This would provide the East-West bus rapid transit link to complement the North-South bus tunnel with the major interchange underground near Aotea Square.
- Implement a Busway from Britomart to Newmarket providing a dedicated busway to the east of the Auckland CBD provide better access to the key Auckland University campus and a second BRT corridor to the Northern Busway.

In fact there are many effective Bus Rapid Transit options available to connect all parts of Auckland by Rapid Transit. The above ideas only scratch the surface of BRT options that could help Auckland public transport. A considerable amount of further study is required to truly identify the best range of BRT based solutions[117].

[116] The idea for a dedicated busway along the North-Western is already being promoted by the Henderson-Massey Local Board and other stakeholders. Refer to: http://www.stuff.co.nz/auckland/local-news/western-leader/5505119/Busway-idea-gains-support .
[117] A conclusion also reached by the MoT Review of the CBDRL Business Case as outlined in Comment #50

## *10.3 Bus Rapid Transit advantages vs. passenger rail*

The Alternatives Paper does outline some of the potential of Bus Rapid Transit and acknowledges this mode is able to provide rapid transit services equivalent to passenger rail. However, many of the advantages an Auckland BRT based public transport solution will have compared to traditional passenger rail are not properly highlighted. These include:

- the CBT option removes more buses from CBD surface streets and so is more supportive of the pedestrian friendly environment outlined in the Auckland Plan vision for the CBD.
- has more commuters on congestion free corridors providing a more comprehensive level of reliable rapid transit services.
- has more commuters on direct services without needing to interchange.
- has a larger commuter catchment to rapid transit with more commuters within walking distance of a service.
- being based on lower cost BRT Technology that is constantly improving:
    - Environmental friendly buses are commonly available but were not considered[118];
    - Intelligent Traffic Systems including GPS bus tracking;
    - Modern bus guidance such as used by the Phileas advanced guided bus;
    - Shorter vehicle lifespan enabled faster implementation of future improvements.
- able to provide a mixture of Express and All-Stops services on the same corridor with bus passing at bus stops and stations.
- more flexible with services able to be incrementally improved and/or expanded.
- less vulnerable to single points of failure and better able to route around problem areas. Not subject to complete service failure because buses are able to use normal roads.
- better able to provide PT capacity to special one-off events such as the Rugby World Cup.
- busways and other major BRT improvements can be built incrementally meaning benefits can be gained earlier and improvements made in later project stages based on the learnings from earlier stages.
- BRT services can leverage other roading investments and integrate with demand management systems such as managed highway toll lanes.
- congestion free corridors for BRT such as busways are also available to emergency services.
- lower future cost for Rapid Transit expansion (e.g. the harbour crossing and to Airport).

Finally, it must be remembered that less than 20% of commuters travel to work in the Auckland CBD. Bus Rapid Transit has greater ability than passenger rail to provide more cross-town PT services to the direct benefit the vast majority of Aucklanders who do not work in the CBD.

[118] New Zealand bus manufacturer Designline built and exported hybrid buses until it ceased trading !