

Waitemata Harbour Crossing Study 2008 Study Summary Report





Waitemata Harbour Crossing Study 2008

STUDY SUMMARY REPORT

-
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1. Executive Summary

1.1 Report Purpose

Organisations responsible for planning transport infrastructure around the Auckland Harbour (the Project Partners) decided to undertake the Waitemata Harbour Crossing Study, to identify the preferred location for an additional harbour crossing. Issues associated with the Wynyard Quarter Plan Change prompted the need to this matter to be given some urgency.

The study objective was:

“To identify the preferred option for delivering integrated, safe, responsive and sustainable cross-harbour travel between North Shore and the Isthmus to facilitate the future growth and development of the Auckland Region.”

Supporting this objective, a series of project objectives and functionality principles were derived. The overall theme was focused towards improving passenger transport links between North Shore City and the CBD, improving wider regional connectivity for all modes of travel and improving the resilience and flexibility of the transport network.

This report describes the study, which was carried out in two separate phases; phase 1 involved development of a long list of possible options for a new harbour crossing and a subsequent assessment to determine a short list. In Phase 2, the short listed options were refined and assessed in greater detail, from which a recommended option was identified for the new crossing.

1.2 Evaluation Framework

Given the policy background for New Zealand transportation projects, an LTMA / RLTS themed evaluation framework was developed as an assessment tool to initially determine short listed options, then which option was to be recommended. Key criteria within the evaluation framework were as follows:

- Economic Development and Regional Growth – covering consistency with the Regional Growth Strategy and economic growth;
- Connectivity – addressing connections between transport networks, functionality principles and flexibility;
- Environmental – sustainability issues and the key environmental criteria such effects on natural and built environments;
- Social & Community – measures of social severance and displacement of communities; and
- Implementation – relating to cost only in Phase 1, but extended to include risk, constructability, staging and flexibility in Phase 2.

1.3 Study Phase 1

The first task in Phase 1 was development of a long list of feasible options for the crossing. A key aspect of the study was to consider how to provide for both passenger transport and other modes crossing the harbour. Given the long term planning horizon for the project, the passenger transport element of the new crossing was optimised for electrified suburban rail. All options were developed recognising the potential future use of the existing Auckland Harbour Bridge.

The study identified 159 possible options for a new harbour crossing (plus a “do-nothing” option of no new crossing), with tunnels or bridges joining the same points considered to be two separate options. In addition, options were generated with intermediate connection points where possible; for example routes connecting Esmonde Road to SH16 (Port and Westbound) at Central Motorway Junction (CMJ) have possible connections at Onewa and Wynyard.

Once the option long list was finalised, options were evaluated to produce a short list. The first step focussed on the positive aspects of the options, namely economic development, regional growth and connectivity criteria, from which a reduced list of options was derived. Subsequently, the reduced option list was reassessed using a more refined assessment system and considered both positive and negative aspects of options.

Operational options, such as ferries, did not reach the short list as they did not satisfy the project objectives as effectively as other options. However, measures to optimise use of existing infrastructure and improve ferry services are likely to be implemented prior to a new harbour crossing.

The evaluation process concluded with a short list of options on three alignments, although the question of whether the crossing would be a bridge or a tunnel had not been settled. Ports of Auckland operational requirements rendered a bridge impractical from Princess Wharf eastwards, as the approaches would be too long to achieve the necessary height. However, alignments that would be suitable for rail by bridge were feasible to the west of Princes Wharf, given the gradients would have to be shallower than the existing bridge.

Phase 1 of the study concluded with the following option short list:

Option 1: Esmonde to Britomart

- Passenger transport (only) in a new tunnel or on a new bridge between Esmonde and Britomart, with possible connections at Onewa and Wynyard.
- General traffic on the existing Auckland Harbour Bridge
- Walking and cycling on either a new bridge or the existing Auckland Harbour Bridge (with appropriate modifications to the existing bridge.)

Option 2 Esmonde to Britomart & SH16

- Passenger transport in either a new tunnel or new bridge across the harbour, with tunnels to landside connections between Esmonde and Britomart. Possible connections at Onewa and Wynyard.
- General traffic in either a new tunnel, or new bridge (as well as on the existing bridge), with tunnels to landside connections between Esmonde and SH16 at either Wellington Street (Port and Westbound) or Newton (Westbound only). Possible connections at Onewa and Wynyard.
- Walking and cycling on either a new bridge or the existing Auckland Harbour Bridge (with appropriate modifications to the existing bridge.)

Option 3 Esmonde to Britomart & Grafton

- Passenger transport in a new tunnel between Esmonde and Britomart. Possible connection at Onewa.
- General traffic in a new tunnel between Esmonde and Grafton (as well as on the existing bridge) with possible connection at Onewa.
- Walking and cycling on the existing Auckland Harbour Bridge (with appropriate modifications to the existing bridge.)

A plan showing each of these options is included as Figure 1 overleaf.

1.4 Study Phase 2

Phase 2 of the study involved developing the short listed option concepts, assessments of performance and impacts against a range of criteria, then comparing options using the evaluation framework.

It was assumed that an electrified suburban rail operation crossing the harbour to North Shore would be similar to that currently proposed for the south side of the harbour. The rail network is planned to be enhanced with the introduction of the CBD rail loop. An important part of the CBD rail loop will be a City Centre rail station, probably in the vicinity of Albert Street / Wellesley Street. Hence for this phase of study the southern limit of the passenger transport element of the harbour crossing was taken to be Fanshawe Street / Quay Street, rather than Britomart.

LEGEND

- COMBINED PT AND GENERAL TRAFFIC
- PT ONLY
- GENERAL TRAFFIC ONLY



WAITEMATA HARBOUR CROSSING STUDY
OPTION SHORT LIST - FIGURE 1

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Although the future of passenger transport across the harbour may be rail, it was also recognised that buses would continue to be the dominant form of passenger transport across the harbour for the medium term at least. Therefore the study did consider how bus based passenger transport operations would continue until a rail based service commenced.

The importance of walking and cycling for cross harbour travel is highlighted in the project objectives and functionality principles. Neither mode is suited to tunnels, due to general environment, safety and amenity factors. Hence for tunnel options, it was assumed that both modes would be accommodated on the existing harbour bridge.

The western options 1 and 2 had alternative combinations of either a bridge or a tunnel crossing; as work progressed it became clear that other alternatives were possible, for example different tunnelling technologies (immersed tubes, cut and cover or driven) could suit different conditions. The alternatives for each option which emerged during Phase 2 of the study were as follows:

Option 1: Esmonde to Britomart

- Tunnel Option 1A: Cut and cover rail tunnel through Wynyard Quarter
- Bridge Option 1B: Rail bridge to west of Wynyard Quarter, passing over Westhaven Marina, then in tunnel beneath Wynyard Quarter. Walking and cycling on new bridge.
- Tunnel Option 1C: driven rail tunnel west of Wynyard Quarter, passing under Westhaven Marina, then in tunnel beneath Wynyard Quarter.

Option 2 Esmonde to Britomart & SH16

- Tunnel Option 2A: Cut and cover rail and road tunnels through Wynyard Quarter. Road link to SH16 (only) at CMJ
- Bridge Option 2B: Road and rail bridge to west of Wynyard Quarter, passing over Westhaven Marina; rail then in tunnel beneath Wynyard Quarter, road in tunnel to connect to SH1 and SH16. Walking and cycling on new bridge.
- Tunnel Option 2C: driven tunnel west of Wynyard Quarter, passing under Westhaven Marina, rail then in tunnel beneath Wynyard Quarter, road in tunnel to connect to SH1 and SH16.

Option 3 Esmonde to Britomart & Grafton

Two alternative layouts emerged during the concept development phase for Option 3, the differences relating to how the southern tie in for general traffic will be configured.

- Tunnel Options 3A & 3B; driven rail tunnel to Albert Street; driven road tunnel to Beach Road, cut and cover tunnel to Grafton.

Option 3B has the advantage of less complex construction, and also has the potential to serve a future link to the east. However, the route for port traffic from CMJ and the south would not be so beneficial, as it precludes a dedicated grade separated link for this movement and would revert to a layout similar to that which existed prior to the Grafton Stage 2 project.

As the study progressed, a third configuration for Option 3 emerged. Option 3C combined the rail route of Option 1C (through Wynyard) with the general traffic route to Grafton.

Once the option configurations were settled, assessments were made about option performance and impacts. Key results of these assessments were:

Economic Development and Regional Growth:

- All options have regional economic benefits
- Option 3A best performing, closely followed by Options 2C and 3B

Connectivity

- All options provide connectivity benefits for the regional transport network
- Passenger transport options improve connectivity between North shore and CBD
- On balance, all roading options provide a similar level of connectivity benefits
- Options 3A and 3B provide the greatest level of resilience to the existing harbour bridge as they connects with the Southern Motorway south of CMJ
- Options 2B, 2C and 3B provide best network flexibility; Options 2B and 2C allow existing road space on the harbour bridge to be either reallocated to their modes, remain as 'spare' capacity or retired from service, Option 3B would best suit a future AMETI connection.

Environmental

- Passenger transport only options result in the least environmental impact
- Environmental effects are considerable for all traffic options
- Option 3 provides most adverse construction effects

Social & Community

- All options offer social and community benefits

- Some options benefits are offset by adverse effects (both construction and long term) on communities
- Option 2C best scoring option

Implementation

- All options have implementation challenges (complexity, consenting, cost)
- Option 2B is the best performing option
- Option 3 is the most expensive and complex option to implement

Given the inherent uncertainties in a high level strategic study, the costing assessments can only be considered indicative in absolute terms at this stage. The range of indicative costs identified for the short listed options is shown in Table 1-1 below.

Option	Cost Range (Millions - 2008 values)
1A	1,000 - 1,200
1B	1,200 - 1,500
1C	1,000 - 1,200
2A	3,700 - 4,100
2B	3,100 - 3,500
2C	3,700 - 4,100
3A	4,700 - 5,100
3B	4,700 - 5,100

Table 1-1: Indicative Option Cost Range

1.5 Study Conclusion

The assessment work undertaken on each of the options for the Waitemata Harbour Crossing led to the following key conclusions:

- Improving passenger transport accessibility between North Shore City and the CBD was the first functional principle of the study. A passenger transport component to an additional crossing is therefore required.
- Given the desire for Wynyard Quarter to be re-developed with a high passenger transport mode share, it would be preferable for a dedicated passenger transport facility to access this area.

- Alternative vehicular connectivity would provide wider regional connections and benefits that passenger transport alone could not serve. This would maximise the broader economic benefits of a new crossing (agglomeration benefits).
- Options that provide additional vehicular connectivity also provide opportunities to reallocate road space on the existing harbour bridge for either dedicated public transport (bus lanes) or active modes (cycling and walking) as well as providing an alternative traffic route across the harbour during incidents and maintenance activities.
- Bridge options were not favoured due to their visual impact on the harbour and surrounding areas such as Westhaven Marina.
- Driven tunnel technology provides several advantages, including flexibility as to when the project is implemented. Options that incorporate rail and road could be constructed separately at different stages, although there would be savings in cost and disruption during construction if they were built together

The evaluation showed that for passenger transport alone, Option 1C was the best option. Option 1C provided high quality connectivity to key public transport nodes, including Wynyard Quarter. As noted above, with driven tunnel technology, Option 1C could be provided effectively independent to whatever option (if any) was adopted for additional road capacity.

The choice of road crossings then becomes one of no crossing (Option 1), an option in the vicinity of Wynyard Quarter (Option 2), or an option aligned with Grafton Gully (Option 3). Overall, the study found that:

- The best overall performing option in the evaluation assessment was Option 2C, although the scoring range between options was not large,
- The best performing option across a range of sensitivity tests which looked at different weightings for the five main criteria in the evaluation framework was Option 2C
- Where Option 2C was not the best option in individual tests it still scored highly compared to the alternative road options.
- The option that achieved the most balanced demand for general traffic between the new and existing crossings was Option 2C.

Based on the work undertaken, the conclusion of this study is that Option 2C, consisting of a new driven tunnel between Esmonde Road through Wynyard Quarter to the CBD for passenger transport, and from Esmonde Road to SH1 / SH16 at CMJ for general traffic, is the option which best meets the project objectives and functionality principles. Therefore, Option 2C should be adopted as the preferred route for a further Waitemata Harbour Crossing.



This option has sufficient flexibility to allow the passenger transport and general traffic components of the crossing to be constructed separately if desired, although there would be savings in cost and disruption during construction if they were built together.

2. Study Purpose and Process

2.1 Study Purpose

Prompted by the need to contribute to decisions about the Wynyard Quarter Plan Change notified by Auckland City Council, organisations responsible for planning transport infrastructure around the Auckland Harbour decided to undertake the Waitemata Harbour Crossing Study.

The study purpose is to determine the preferred location and form of future crossing required to ensure an appropriate level of accessibility is maintained for cross-harbour travel between the North Shore and the Isthmus, and to facilitate planned future growth and development of the region. The five partner organisations (Partners) responsible for this initiative are:

- Auckland Regional Council (ARC),
- Transit New Zealand (Transit),
- Auckland Regional Transport Authority (ARTA),
- Auckland City Council (ACC) and
- North Shore City Council (NSCC).

The Partners' objective in pursuing the Waitemata Harbour Crossing Study is:

“To identify the preferred option for delivering integrated, safe, responsive and sustainable cross-harbour travel between North Shore and the Isthmus to facilitate the future growth and development of the Auckland Region.”

The Partners appointed an Implementation Executive (IE) to manage the project, comprising officers from each member organisation. A Project Director was also appointed to support the IE. In October 2007, a consultant team of Sinclair Knight Merz (SKM), Connell Wagner and Zomac Planning, with other specialists, was appointed to carry out the study.

2.2 Study Process

The study was undertaken in two Phases; Phase 1 involved identification of all feasible options for the new harbour crossing (working in combination with the existing Auckland Harbour Bridge). These options were then evaluated to produce a short list of options which were developed and evaluated in more detail in Phase 2 of the study.

The study process in Phase 1 involved an Inception Meeting, followed by 2 workshops with members of the IE and consultant team. In Phase 2 a third workshop was held.

The purpose of each session is summarised as follows:

PHASE 1 - Generate Options

- Inception Meeting: knowledge and appreciation of project objectives, goals and functionality principles
- Workshop 1; develop option long list and evaluation framework
- Workshop 2; review option evaluation and agree option short list

PHASE 2 - Develop Options and Evaluate

- Workshop 3; review shortlisted option evaluation and finalise conclusions

In addition to these meetings, the IE and the study team met weekly to discuss the study and regular briefings were provided on a range of issues that emerged.

In Phase 2, each of the shortlisted options underwent a significant amount of development, to determine physical form and impacts. In tandem, assessment work was undertaken to inform the evaluation process. This information is summarised in later sections of this report and full details are included in a separate volume.

3. Project Objectives and Functionality Principles

3.1 Project Objectives

At the outset, the Partners determined that the project objectives would be as follows:

“Together, the Auckland Harbour Bridge (AHB), new crossing and connections will:

- *To facilitate development in an environmentally and socially sustainable manner and to encourage alignment with the strategic land use objectives of the Auckland Regional Growth Strategy;*
- *Provide a more resilient network and reduce the risks arising from accidents or structural failure associated with concentrating a high proportion of cross-harbour capacity on a single route;*
- *Provide a connection between the rapid transit networks on the North Shore and Auckland Isthmus, which as far as possible provides for future options for all types of passenger transport in the Auckland Region*
- *Provide accessibility for all modes, including commercial and general traffic, passenger and rapid transport, walking and cycling*
- *Improve cross-harbour accessibility and reduce the barrier effect of the Waitemata Harbour;*
- *Avoid, to the extent reasonable in the circumstances, adverse effects on the environment (including any adverse safety, social, community and ecological impacts) associated with the provision of the new crossing and any associated works;*

In pursuing these objectives the Project will be developed:

- *In accordance with the Land Transport Management Act.*
- *In accordance with the goals and shifts identified in the Auckland Sustainability Framework*
- *In accordance with the goals, objectives and policies of the Auckland Regional Land Transport Strategy*
- *In a manner that contributes to the implementation of regional strategies and policies.”*

3.2 Functionality Principles

Further work was carried out by the IE, to provide guidance about how the objectives and policy background would influence the project. A series of functionality principles were derived, which are summarised below:

- Future improvements to connectivity between the North Shore and the CBD will be provided predominantly by public transport and cross harbour passenger transport improvements will be given first priority.
- Future cross harbour connectivity will include sufficient general traffic lanes linking the North Shore and greater Auckland region to best meet wider regional connectivity needs and will be given second priority.
- Additional connectivity between the North Shore and the CBD by way of general traffic lanes would be advantageous and will be given third priority.
- Transport network robustness (ability to cope with change, e.g. removal and replacement of the AHB clip on lanes) is important
- Operational flexibility is also important

An important aspect of these principles is that they are prioritised, giving additional guidance about the type of outcomes desired. At Workshop 1, it was agreed to add the objective of providing accessibility for walking and cycling to the functionality principles as follows:

- Walking and cycling shall be provided for on either the new and/or existing harbour crossing.

Additional explanatory information around each of these principles was developed. The full list of functionality principles and explanatory text is included in Appendix A.

4. Evaluation Framework

An LTMA / RLTS themed evaluation framework was developed as the key decision making tool for the study. The objectives and functionality principles were used to define assessment criteria, initially in Phase 1 and then refined for Phase 2. Key aspects of the evaluation framework were as follows:

- Economic Development and Regional Growth – covering consistency with the Regional Growth Strategy and economic growth;
- Connectivity – addressing connections between transport networks, functionality principles and flexibility;
- Environmental – sustainability issues and the key environmental criteria such effects on natural and built environments;
- Social & Community – measures of social severance and displacement of communities; and
- Implementation – relating to issues such as cost, construction issues, funding and consentability (limited to cost only in Phase 1).

The full evaluation framework used in the study is included in Appendix B.

5. Study Phase 1 - Option Short Listing

5.1 Option Long List Development

The first task in Phase 1 was development of a long list of feasible options for the Waitemata Harbour Crossing. Four methods of generating options were used, as follows:

- How to connect transport networks
- Options identified in previous studies
- Opportunities generated by new technologies and operational options
- Independent expert review

All options were developed, recognising the current and potential future use and operation of the existing Auckland Harbour Bridge.

The regional passenger transport and roading networks were examined to explore logical ways they could be connected. Given the long term planning horizon of this project, it was important to consider future networks, taking account of planned improvements by ARTA, Transit and the City Councils.

Extensive work had been carried out previously on harbour crossing options. The 1997 ARC study examined nearly 40 options, each of which was included in the option long list.

In addition to formal studies commissioned by ARC and Transit a number of proposals have previously been developed from a range of sources, for example, replacing the existing AHB with a new bridge, and links to Bayswater. These ideas were also included in the option long list.

Increased transport capacity could be satisfied by ways which do not necessarily involve new fixed infrastructure. New technologies are continually emerging, and the study team examined which of these could possibly meet the project objectives. In addition, options which utilised the existing harbour bridge but in a different manner were also considered.

The list of new technologies and operational options included:

- Additional passenger ferry services
- New ferry services for vehicles, using roll-on, roll-off vessels
- Sky cabs
- Mono rail
- In vehicle guidance systems (which provide greater capacity by reducing headways between vehicles)

- Adding extra deck space to the existing bridge
- A one way pair system, i.e. building a new connection for travel in one direction and modifying the existing crossing for the contra-direction.

In addition to the work by the study team, an independent overseas review was undertaken to see if any other alternatives should be considered. The review suggested that future proofing passenger transport options for the introduction of suburban rail between the North Shore and the CBD was essential. Also, private sector participation in the implementation of a new crossing may be desirable. However, this process did not identify any other specific options which the study team had not identified.

In total, 159 possible options for a new harbour crossing (excluding the “do-nothing” option of no new crossing) were identified. Tunnel or bridges joining the same points were considered to be two options. In addition, options were generated where intermediate connection points were possible; for example routes connecting Esmonde Road to SH16 have possible connections at Onewa and Wynyard, taking the possible combination of options around this route from two (either a bridge or a tunnel) to 10.

5.2 Option Long List Evaluation

Once a long list of options for a new Waitemata Harbour Crossing had been completed, work commenced on determining which options would be short listed. The key decision making tool for this process was the evaluation framework described in Section 4. In Phase 1 of the study, this was applied in two stages; an initial assessment to reduce the very long list, then a more detailed assessment to conclude a shortlist.

Particular aspects that differentiated between options included:

Passenger Transport Access to the CBD and Rail Compatibility:

- Options that provided improved access to the CBD by way of an new exclusive passenger transport right of way scored higher than those that did not, that is, those that relied on use of the existing bridge.
- Passenger transport on the existing bridge would preclude suburban rail, due to gradients on the structure.
- Of the new passenger transport crossings, those that accessed the CBD from the west were considered better than those that accessed from the east, because:
 - Wynyard Quarter is an important consideration for passenger transport as it is the significant growth area on the Auckland side of the harbour and requires a high passenger transport service to realise its potential,

- Options that bring passenger transport to the east of Queen Street require buses to back track to the west of the CBD, to serve the higher level of demand on this side of the City (including the planned Wynyard Quarter development) **OR** services would be required on both the new crossing and the existing bridge. This suggests any options to the east of Queen Street need to be carefully considered with regards to passenger transport effects and whether buses would remain on the existing bridge.

This effectively removed from further consideration passenger transport options that:

- connected on the south side of the harbour west of the existing bridge, that is, to Te Atatu, Rosebank, Waterview, Pt Chevalier, Meola, Western Springs, SH16 at Newton (and not the CBD), and
- the operational type options.

Consistency with Regional Growth Strategy (RGS):

- Options that connected RGS intensification areas scored higher than those that did not. In this regard, connections with Bayswater/Stanley Point were considered a negative attribute as were those in the Lake Road corridor, as the Devonport Peninsula is not an identified growth area in the RGS.
- This effectively removed Lake Road options from further consideration.

Wider Network Connectivity and Resilience for General Traffic:

- Options that did not provide for wider network connectivity and resilience for general traffic by way of connections to the existing or planned future strategic network scored lower than those that did.
- This effectively removed from further consideration the operational options and those that only terminated at the edges of the harbour and hence provided little, if any, regional connectivity (Onewa, Westhaven, Wynyard, Queens, Tamaki).

Further assessment on the options led to the conclusion that the most favourable options for shortlisting were those described in the following section.

5.3 Option Short List Recommendations

The following options were carried forward from Phase 1 for further development:

Option 1: Esmonde to Britomart

- Passenger transport (only) in a new tunnel or on a new bridge between Esmonde and Britomart, with possible connections at Onewa and Wynyard.
- General traffic on the existing Auckland Harbour Bridge
- Walking and cycling on either a new bridge or the existing Auckland Harbour Bridge (with appropriate modifications to the existing bridge.)

Option 2 Esmonde to Britomart & SH16

- Passenger transport in either a new tunnel or new bridge across the harbour, with tunnels to landside connections between Esmonde and Britomart. Possible connections at Onewa and Wynyard.
- General traffic in either a new tunnel, or new bridge (as well as on the existing bridge), with tunnels to landside connections between Esmonde and SH16 at either Wellington Street (Port and Westbound) or Newton (Westbound only). Possible connections at Onewa and Wynyard.
- Walking and cycling on either a new bridge or the existing Auckland Harbour Bridge (with appropriate modifications to the existing bridge.)

Option 3 Esmonde to Britomart & Grafton

- Passenger transport in a new tunnel between Esmonde and Britomart. Possible connection at Onewa.
- General traffic in a new tunnel between Esmonde and Grafton (as well as on the existing bridge) with possible connection at Onewa.
- Walking and cycling on the existing Auckland Harbour Bridge (with appropriate modifications to the existing bridge.)

These options are shown on figure 1 overleaf.

INSERT FIGURE 1.

6. Study Phase 2 – Short Listed Option Development

Once the option short list had been agreed, Phase 2 of the study commenced with further investigation of the option concepts. A total of eight possible configurations were identified for evaluation, comprising:

- 3 configurations for Option 1,
- 3 configurations for Option 2,
- 2 configurations for Option 3.

Each configuration is described below. Several other variants were considered, but design development work and technical evaluation found that these 8 configurations were the most suitable for meeting the project objectives and functionality principles.

As in Phase 1, each option considered the potential use and operation of the existing Auckland Harbour Bridge.

6.1 Design Assumptions

Given the long term planning horizon for a project of this scale and an initial assessment of potential travel demand across the harbour, it was agreed that the configuration of the passenger transport element of the new crossing should be optimised for electrified suburban rail. It was assumed that the general standards and type of rail operation across the harbour and on North Shore would be similar to that currently proposed for the existing network.

It was assumed that the northern limit of rail infrastructure associated with the crossing alone would be Akoranga Station. On the south side of the harbour, the southern limit of rail element of the harbour crossing was taken to be Fanshawe Street / Quay Street, from where it may connect to the CBD loop.

New bridge options were considered with respect to the following criteria:

- Shipping clearances for a new crossing near the existing bridge should be not less than the current bridge navigation span of 44m over a length of 150m.
- Suburban passenger rail would restrict the maximum gradient to 3.5%; gentler gradients and more direct route to the city would make a new bridge more attractive than the existing bridge for walking and cycling.
- For this study, it was assumed that a cable stayed structure would be adopted for the main navigation span, with a series of balanced cantilever spans for the approaches

For walking and cycling, Transit New Zealand is currently planning to modify the existing bridge by adding a 2.7m cantilever on the outside of the existing clip-on structures. Either side of the crossing, the cycleways and walkways would tie into local walkways and cycleways. It was assumed that this would provide walking and cycling for all new crossing options involving tunnels.

6.2 Option 1: Esmonde to Britomart

6.2.1 Tunnel Option 1A

This option would commence at Akoranga Station and follow the western shore line of Shoal Bay, running alongside the existing Northern Motorway, past the Onewa Road interchange. No connection to the new route would be provided at Onewa Road, due to the separation from residential areas.

The tunnel would commence opposite the Stafford Road Interchange and cross the harbour to pass beneath Wynyard Quarter along the alignment of Daldy Street. This alignment takes advantage of the proposed Daldy Street Boulevard, described in the Wynyard Quarter Plan Change.

Two separate bored tunnels will be used, one northbound one southbound. A station will be provided along Daldy Street. The assumption has been made that the route would pass out of the station southwards, swinging onto the alignment of Fanshawe Street to join the CBD loop to the east of Wynyard Quarter.

6.2.2 Bridge Option 1B

This option would be similar to Option 1A between Akoranga Station and Onewa Road interchange. The route would then cross the harbour on a new bridge, to the east of the existing bridge.

The new bridge would be in a location that would suit shipping and leisure marine activities. It was considered that a bridge on any part of Wynyard Quarter would be unacceptable, as it would create too many constraints on development, as well as imposing significant adverse visual and amenity effects. Therefore the alignment had to cross Westhaven Marina, west of Wynyard Quarter.

A rail bridge would only require a narrow deck, (approximately 10 metres) given that it would only have to accommodate two rail lines; however it was recognised that the gentler gradients and more direct route to the city would make a new bridge more attractive than the existing bridge for walking and cycling.

The route across Westhaven Marina would necessitate re-configuration of the marina, including access to the harbour. Replacement berths and moorings would need to be provided in a re-planned marina.

Approaching Wynyard Quarter, the alignment would descend to enter a cut and cover tunnel commencing where the route crosses beneath Beaumont Street. The transition from bridge to tunnel would require an area in the south east quadrant of Westhaven Marina to be reclaimed, and some of the existing marine activities and industry relocated to other parts of the marina.

After passing beneath Beaumont Street, the alignment would continue east towards the CBD loop via Gaunt Street. This would allow a station to be provided in this area, close to the main employment area of Wynyard Quarter, and also within walking distance of commercial areas around Victoria Park.

6.2.3 Tunnel Option 1C

With the development of Option 1B, it was apparent that a route west of Wynyard Quarter may be advantageous for a tunnel, as it could avoid some of the impacts on Wynyard Quarter associated with Option 1A. Hence an additional tunnel option, 1C, was developed.

This option would be similar to Option 1A between Akoranga Station and Onewa Road interchange, namely following the western shore line of Shoal Bay, running alongside the existing Northern Motorway. From Onewa Road Interchange, the route would then cross the harbour in a new tunnel, to the east of the existing bridge, beneath Westhaven Marina and onto the line of Gaunt Street.

The vertical alignment for this option would permit use of a driven tunnel throughout, thereby avoiding the constraints of a cut and cover tunnel between Beaumont Street and Fanshawe Street. As with Option 1A, the tunnel would consist of two separate bores, for north and southbound trains.

6.3 Option 2 Esmonde to Britomart & SH16

6.3.1 Tunnel Option 2A

In this option, the passenger transport components would be similar to Option 1A, namely a rail based configuration commencing at Akoranga Station. In addition to connecting with the Northern Motorway, road connections to arterial routes would also be needed; Akoranga Drive & Fred Thomas Drive are proposed.

On the south side, connecting to SH16 at CMJ implies no more than 4 general traffic lanes would be needed for the new harbour crossing. There is insufficient capacity on the SH16 links within CMJ to justify more capacity on the crossing.

The new crossing would be located on either re-claimed land or structure at approximately the same level as the existing carriageway of the Northern Motorway as far as Onewa Road. Rail would be placed on the outside of the new road carriageway. Onewa Road interchange would need to include a connection to the new crossing, to allow traffic from Onewa Road to access SH16 on the south side of the harbour without using city streets.

South of Onewa Road, the new crossing would enter into driven tunnels with four separate bores, two for road and two for rail. The tunnel would cross the harbour to Wynyard Point, north of Jellicoe Street. The tunnels would continue through Wynyard Quarter with the rail tunnels entering a cut and cover station at Daldy Street. The road tunnels could continue as driven tunnel beneath Victoria Park.

The northbound tunnel would pass beneath Victoria Park Tunnel, then rise up to meet the northbound connection from SH16. An emergency / slow speed connection would be provided at the tie-in points, to allow all traffic on SH1 and SH16 to be diverted into, or away from, the new crossing during incidents or planned maintenance.

Walking and cycling would be provided for on the existing harbour bridge. New connections to existing networks for both modes would be provided from the structure limits to ensure a total network solution was achieved.

6.3.2 Bridge Option 2B

This option would combine the general arrangement of passenger transport on Option 1B, with general traffic lanes on a new bridge crossing.

The bridge restricted the possibility of linking the new crossing directly to SH16, due to vertical alignment problems. However, a link into SH1 in CMJ would be possible, in part because it would allow the Victoria Park Tunnel to be utilised as part of the new route. This concept requires an altered configuration at Esmonde Road, to make the link into the new crossing the main route from the Northern Motorway. Six general traffic lanes would be provided on the new crossing, as it would become the main state highway.

A connection from the new crossing to Onewa Road would be included, to permit direct links to SH1 south of the harbour from this route. The alignment of the new bridge crossing would be similar to Option 1B; the chief difference would be the much wider deck to accommodate the 6 general traffic lanes in addition to the rail corridor. Walking and cycling would be included on the new bridge.

The impacts on Westhaven Marina from this option would be similar to Option 1B, and the need for a reclaimed area in the south east quadrant of the marina would also remain. The route for rail

under Wynyard Quarter would be along Gaunt Street, as for Option 1B. The road route would enter into a cut and cover tunnel to cross Victoria Park, with the portal location just north of the Beaumont Street intersection.

This option would use the soon to be constructed Victoria Park Tunnel (VPT) for northbound traffic. A new cut and cover tunnel of similar size would be constructed for southbound traffic. This option would require some modification to the current VPT design, chiefly to the structural detailing at the northern end.

This configuration would effectively sever the existing crossing from the motorway network at Fanshawe Street. Therefore, its future use would be as a link between Fanshawe Street and Ponsonby to North Shore only. It is also possible that some sections of the existing bridge could be retired (for example the clip on structures) once the new crossing was complete, as the capacity requirements for general traffic across the harbour would be mainly provided on the new structure. Similarly, the existing approaches to the bridge could also be reduced in width.

6.3.3 Tunnel Option 2C

In the same way that development of the passenger transport only option led to a tunnel route west of Wynyard Quarter, it was also possible that the combined road and rail option could use a similar corridor. Hence an additional tunnel option, 2C, was developed.

The passenger transport component would be as Option 1C, with a driven tunnel taking rail across the harbour and onto the CBD rail loop, with an alignment at depth under Gaunt Street. A station at Wynyard would be provided along Gaunt Street, between Daldy and Halsey Streets.

The deep tunnel would allow a connection between the existing harbour bridge and the mid CBD connections at Cook Street and Wellington Street to be provided. With the new crossing taking the role of SH1, six general traffic lanes would be provided in the tunnel in addition to the rail crossing.

From Onewa Interchange, the new crossing would descend into a deep driven tunnel to cross the harbour, passing beneath Westhaven Marina and the intersection of the motorway ramps with Fanshawe Street and Beaumont Street. The tunnel would then start to climb to connect with SH1 and SH16 within CMJ.

In addition to the main route tunnel, another tunnel (cut and cover) would be constructed to link between the existing harbour bridge and Cook Street for southbound traffic. Victoria Park Tunnel would be used as a link from the Wellington Street on-ramp onto the existing bridge. The current harbour crossing could be modified (for example for use by buses, cyclists or pedestrians), or partially retired from use.

Walking and cycling would be provided for on the existing harbour bridge. New connections to existing networks for both modes would be provided as for Option 2A.

6.4 Option 3 Esmonde to Britomart & Grafton

6.4.1 Tunnel Option 3A

From Onewa Road interchange the route would descend into a driven tunnel to cross the harbour. The passenger transport and general traffic routes diverge just east of Princess Wharf. Both modes would be in separate tunnels. It is anticipated that a total of 4 bored tunnels would be used; 2 for general traffic and 2 for rail.

The passenger transport route would then follow Albert Street to join the CBD rail loop; the road tunnel would continue eastwards, passing beneath the intersection of Quay Street and Britomart Place. The route would continue in driven tunnel beneath the entry tunnel to Britomart Station, to an area around the Beach Road / Tangihua Street intersection, where cut and cover tunnel construction would be required. The route would then continue south generally along the line of Beach Road, to join the motorway just north of Grafton Road overbridge.

The terrain around the Grafton area constrains the way the new crossing would connect to the arterial network in this part of the CBD. Transit has plans to complete stage 3 of the Grafton Gully project, to provide better access to the Port from CMJ and the south. In this configuration, the grade separation for this movement is provided by a dedicated link from the motorway through to the north side of Stanley Street.

Connections from Option 3 to the CBD road network are via Beach Road to Alten Road and The Strand. This would involve 2 levels of underground construction to create the free flow connections from the new crossing to local roads and the motorway.

Walking and cycling would be provided for on the existing harbour bridge.

6.4.2 Tunnel Option 3B

An alternative tie-into the CBD arterial network was created with the introduction of a surface level roundabout to connect the new crossing to the arterial network. All other features of the option would remain the same as Option 3A.

This layout has the advantage of less complex construction, and also has the potential to serve a future link to the east. However, the route for port traffic from CMJ and the south would not be so beneficial, as it precludes a dedicated grade separated link for this movement and would revert to a layout similar to that which existed prior to the Grafton Stage 2 project.

7. Phase 2: Short Listed Option Evaluation

Once the concept designs for each short listed option was completed, each was subjected to more detailed assessment. Key issues arising from the assessment are described in this section.

7.1 Economic Assessment

7.1.1 World Class City Status

An independent panel was appointed to consider the extent to which the project would contribute to the “World Class City” status of Auckland, and which of the options were more suited to serve this status than others. The panel decided that the objectives of the Auckland Sustainability Framework provided useful guidance on the concept of World Class City status. They then concluded that bridge options did not meet the criteria listed under quality of environment. If the bridge options were located in the vicinity of the current bridge then they would not be viable in terms of urban design and would negatively impact on the waterfront.

Two of the three panel members concluded Option 3 was the preferred option for the following reasons:

- Provides a strong north/south link for traffic wishing to bypass CBD
- Best in terms of urban design
- Connections from a regional perspective are much better dealt with
- Maintains the platform for the evolving and emerging concepts for Waterfront 2040 and Westhaven

The other panel member concluded Option 2C was the preferred option because of:

- Positive impact on passenger transport connectivity into the CBD
- Positive impact on regional connectivity links to southern and Northern, north western motorway and to Grafton Gully
- Positive impact on freeing up capacity on existing Harbour Bridge for active modes due to the new crossing being the main route North/South and West/Port.

However it was stressed that Option 2C would only be preferred if the marine industry precinct was protected from any impacts of a tunnel.

7.1.2 Regional Economic Impacts

A high level assessment was undertaken of the wider economic benefits of the project to the region, beyond the more traditional assessment of transport schemes. A qualitative assessment was also made of the economic impact on Wynyard Quarter, given its relative importance to this study.

‘Agglomeration’ was the focus of the assessment. A simple interpretation is that agglomeration (firms locating in close proximity) causes increased productivity measured as an uplift in GDP per worker. The assessment concluded that agglomeration benefits in the region from the project would be around \$40 million per annum (2007 values).

In terms of differentiation between options, the assessment used outputs from transport models to investigate how each option would affect productivity. The assessment concluded that Options 2A and 2C were most beneficial, followed by Option 3. However, the differences between the options were relatively minor in the context of the regional economy.

All of the options were assessed to have both positive and negative impacts on Wynyard Quarter. Options 1 and 2 have positive impacts in terms of accessibility and negative impacts from local effects and influences, however these can be minimised by adopting tunnel options as opposed to a bridge. The main disadvantage of Option 3 is that fewer people travel to the Wynyard Quarter than in either of the other options. This would result in a reduced level of economic activity within the Wynyard Quarter area.

7.1.3 Impact on Port & Shipping Operations

The key points arising from the assessment of the impact of options on the port and on shipping were as follows:

Immersed tube tunnel construction would involve significant dredging activities on the harbour. Navigation issues would need to be addressed, and there would need to be agreement with PoA if dredge spoil were to be placed in POA reclamation areas. There would also be restrictions on leisure marine activity around construction zones.

Bridge options would have major impacts on the Superyacht base operations, as they would restrict access severely. Westhaven Marina would be substantially affected in terms of moorings, marina access and the race course starting area. While the marina could be re-configured, it would be difficult to ensure there was no overall loss of amenity.

Option 3 has potential road access implications for the Port, depending on design. There would also be effects during the construction period. Tunnel construction might also interfere with piles on old wharf areas, although deep driven tunnels are unlikely to encounter any significant problems.

7.2 Transportation Assessment

A comprehensive transport assessment was undertaken, supported by regional and local transport models. A forecast year of 2041 was adopted for analysis. The key effects found during the assessment are discussed below.

7.2.1 Regional Effects

An additional harbour crossing is a significant piece of transport infrastructure that will have regional transportation effects for passenger transport, general traffic and commercial vehicle travel. By 2041 there is forecast to be an increase in person trips across the harbour from the present day in the order of 80%. This growth occurs in both directions, but more so in the contra-peak direction.

Passenger transport is forecast to cater for an increased proportion of these trips in the peak periods with the cross harbour mode split for travel by passenger transport versus private car forecast to double from the present day 15% to approximately 30% in 2041. This highlights the importance of passenger transport as a mode for cross harbour traffic for the future.

The growth in trips across the harbour by private vehicles is lower than the growth in person trips in the peak directions, given the level of congestion predicted on the approach roads to the harbour.

Through the provision of an additional passenger transport station at Wynyard Quarter, Options 1 and 2 provide improved accessibility to the CBD and Wynyard Quarter for passenger transport users. Connecting North Shore City (via rail) directly with the wider Auckland rail network also provides opportunities for improved access to and from the North Shore and the rest of the Auckland Isthmus.

7.2.2 Connectivity and Network Resilience

Passenger transport connectivity to the CBD improved for each option. A dedicated Rapid Transit Network rail connection across the harbour provides an improved level of amenity for passenger transport users. Options with a rail station in the Wynyard Quarter (Options 1 and 2) provide additional benefits through the increase in accessibility to this area of the city which is identified for intensification.

From a regional connectivity perspective, the passenger transport only options (Option 1) provide an increase in regional passenger transport connectivity through the connection of rail to the North Shore. Options 2 and 3 offer similar region wide connectivity, however option 2B provides a smaller level of regional connectivity as it reduces the role of the existing harbour bridge to the point where traffic begins rerouting through local fringe areas to access the CBD.

An additional harbour crossing also allows for the provision of access across the harbour for walking and cycling. All options provide for these modes, either on the existing harbour bridge or on the new crossing as outlined in previous sections of this report.

Network resilience or route security is important given the current reliance on the existing harbour bridge. Whilst passenger transport only options provide some resilience to the existing crossing Options 2 and 3, which provide both passenger transport and road resilience, provide greater resilience. The CMJ network is under strain during peak periods and caters for significant volumes of traffic, Therefore Option 3 is considered to offer the greatest level of resilience to the existing harbour bridge as it connects with the southern motorway network further south than the alternative.

The ability of options to be compatible with future transport networks was also considered. Passenger transport options require the implementation of rail infrastructure on both sides of the harbour which would allow for expansion in the future as deemed appropriate by the region and ARTA. Options 2B and 2C provide six lanes across the harbour on the new crossing, where as Option 2A, 3A and 3B only provide four lanes. Options 2B and 2C therefore provide more relief to the existing harbour bridge and allow the opportunity for the existing road space to be either reallocated to their modes, remain as 'spare' capacity or retired from service.

For each option the analysis has indicated that an additional general traffic crossing in the form proposed can be accommodated by the surrounding North Shore City and Auckland CBD road network. Whilst there is predicted to be congestion in the form of delays and queues, the levels of this congestion are similar to those forecast without the additional crossing. The congestion predicted is also in the order of magnitude typical for arterial routes within a large urban environment.

7.3 Environmental Effects

7.3.1 Natural Environment Effects

The shellbanks of Shoal Bay and surrounding area provide very important high tide roosts for a range of shore birds. They also provide very significant breeding grounds for some species, including nationally rare species, especially the NZ dotterel. As a consequence, the entirety of Shoal Bay is zoned in the ARC's Regional Coastal Plan as Coastal Protection Area (CPA).

From the assessment undertaken, all options were considered to have moderate to strong negative effects, compared to the "do-nothing" alternative. However, this assessment was based on the concept designs as presented; as yet no mitigation works or design improvements have been undertaken to address the issues raised in the assessment.

Options 1A and 1B had the least impacts on the saline vegetation and shore birds of Shoal Bay. The level of adverse effects associated with either of these two options is generally negligible at the northern end of the project area, although the effects are likely to be relatively significant at the southern end (where the rail enters a tunnel).

A rationalised design, which would keep reclamation out of the City of Cork shellbanks and reduce the reclamation footprint at Sulphur Beach, would significantly improve this assessment. Other mitigation measures could include creation of alternative nesting sites. The impact of Option 2 and 3 are broadly similar in this area, due to the high degree of commonality in the concept designs in the northern sector.

7.3.2 Built Environment

7.3.2.1 Urban Form

For the urban form assessment, the process involved identifying key areas along the routes, and examining the urban and landscape context associated with each option in that area. Five areas were identified, with effects as follows:

- Northern Approaches (Shoal Bay):
- Harbour Crossing:
- Westhaven / St Mary's Bay:
- Wynyard Quarter:
- Grafton / Beach Road:

Key impacts on each of these areas were found to be as follows:

Northern Approaches (Shoal Bay)

The passenger transport only options (options 1A to 1C) will have only moderate impacts on the landscape and urban context in this area. Overhead wires for electric rail will have minor visual impact.

Options 2 & 3 have similar and very high adverse landscape effects, due to the wide corridor and degree of visual intrusion. However there are opportunities to substantially improve the design by locating the new route tight against the existing motorway. It would also be beneficial to construct longer bridges over stream mouths than would be necessary simply to accommodate water run-off.

Harbour Crossing

Tunnel options were neutral in terms of effects or engagement with the harbour. A tunnel will preserve the existing harbour landscape but travellers using tunnels will not experience crossing the harbour. A bridge (Options 1B and 2B) could be a major positive contribution to Auckland's urban form, but could also be an unsightly imposition. Success would depend on design issues, including:

- The lack of obvious landforms on each side to provide “contextual anchors”.
- The requirement for a complex alignment in order to achieve acceptable rail gradients.
- The proximity and awkward relationship of a new alignment with the existing bridge.

In urban design terms a cable-stayed bridge, similar to the Anzac Bridge in Sydney, would be preferred for a new bridge.

Westhaven Marina / St Mary's Bay

None of the tunnel options will effect the operation of Westhaven Marina. Bridge options would have visual amenity effects in St Mary's Bay, albeit confined to the area east of the Shelly Beach Road ridge and north of Jervois Road ridge. The quality of bridge design would influence whether visual impact is positive. For example, a view of Sydney Harbour Bridge is considered a positive asset.

Options 2B and 2C could reduce the width of motorway around the base of the St Mary's Bay cliffs. This would provide a modest improvement in amenity.

Wynyard Quarter

Cut and cover tunnels would affect Wynyard Quarter more than a deep driven tunnel. A cut and cover tunnel would require top down construction, and constrain development in and around the tunnel route. Advance construction of elements of the tunnel (foundation piles and decking), would mitigate these effects. Deep driven tunnels would be sufficiently deep so as to not compromise future building development.

The location of an underground station in Wynyard will influence the benefit in urban design terms. A Gaunt Street location is preferable (Options 1B, 1C, 2B, 2C), as it is more central and located on the best connected street in the Quarter. A Daldy Street location (Options 1A, 2A) is reasonable, being central to the Wynyard Quarter and located on one of the main axes.

Eastern tunnel options (Options 3A, 3B) eschew the opportunity to provide a rail station serving the inner west of the CBD.

Outlook to bridge options (Options 1B, 2B) from the western edge of Wynyard Quarter will be across Westhaven basin. The spatial separation between the bridge and the development will avoid dominance by the structure. Bridge abutments and reclamation will reduce the length of waterfront in the south-west corner. The new reclamation could be configured to create a new and active shore edge under the bridge.

Grafton / Beach Road

Options 3A and 3B require significant demolition in and around the Beach Road area. Post construction, Option 3A allows subsequent reconstruction of street frontages to Parnell Rise and Beach Road. Option 3B would reduce the amenity of this area as port traffic would be re-introduced to surface routes around The Strand.

Option 3B would extend the motorway corridor from lower Grafton Gully as far as Ronayne Street. The motorway will sever connection between Parnell and the CBD. There would be significant effects on the lower part of Constitution Hill reserve, through encroachment, landform excavation, loss of trees, and severing of connections through the reserve between the CBD and Parnell.

If either Option 3A or 3B was preferred, the future land form of this area could be reconsidered in the context of the new road network layout. This would best be resolved through a local master planning or other urban design process.

7.3.2.2 Noise

For Option 1 all road traffic would remain on the existing harbour bridge. Construction of a new rail tunnel would be limited to relatively noise insensitive areas. Noise effects would be similar to current levels, except for the natural increase in traffic over time, and rail noise would be well mitigated by the tunnel.

Option 2A transfers a significant proportion of road traffic from the existing bridge into a new tunnel and allows for rail traffic in the new tunnel. Removing some traffic from the existing bridge was considered a slight to moderate positive effect. Construction effects would be similar as for Option 1A.

Residential areas in St Mary's Bay and Northcote Point are in close proximity to the motorway and currently receive high to very high noise levels. Removing any traffic from the existing motorway would reduce noise levels for those residents.

Option 2B would move more the main flow onto SH1 south, onto a new bridge, which would also provide rail connection to the North Shore. Only city bound traffic (Ponsonby and Fanshawe St) would remain on the existing Auckland Harbour Bridge, thus greatly reducing noise impacts on residential areas in St Mary's Bay and Northcote Point.

Moving most of the traffic onto a bridge at a greater distance from residential areas would have a moderate to major positive effect in reducing noise levels. However, the new bridge would need to be designed with noise mitigation to shield traffic from residential areas. Bridge construction is likely to have slight negative effects on noise sensitive areas as it would occur above water at all times, as with Option 1B.

Options 3A and 3B would provide no noticeable reduction in traffic volumes in St Mary's Bay. Effects on Grafton Gully are likely to be neutral as most land uses in that area are not noise sensitive.

Ventilation of the tunnels would require design to insure compliance with relevant rules for noise and emissions can be achieved. For Option 3, this is particularly important as the tunnel is considerably longer than other options and therefore likely to require larger ventilation quantities.

7.3.3 Social and Community Effects

The key social and community effects associated with the short listed options are as follows:

Construction Period

All options will cause significant construction effects. Several residential areas in the study have experienced considerable construction effects in recent years, but a period of relative stability is likely to precede the new round of construction, with a large proportion of homes likely to change hands in this intervening period.

Bridge construction would affect residents overlooking the harbour along waterfront areas. Cut and cover tunnels would have greater effects than deeper driven tunnels. Options 3A and 3B will have potential construction effects on high-density residential developments on the final route from the port to Grafton. Spoil from the tunnels is likely to be moved via the main highways in close proximity to the tunnel entrances, with little effect on residents assuming management plans are in place.

There will be a regional economic effect from construction, with a boost to the regional labour market and a boost to businesses that contract to undertake work and supply goods and services. These will cause direct and induced flow-on effects.

Effects on recreation will include disruption to moorings and boating activity in Shoal Bay for all options. The two bridges will be likely to displace recreational activity temporarily on the harbour in iconic marine recreational areas. Construction of Bridge Options 1B or 2B will cause disruption to Westhaven Marina.

Health and Safety

The health of the population is a consequence of many effects on social well being, such as improved access to work and income. In this assessment, emphasis was placed on direct health effects from the project.

While the likelihood of a major accident or event on a bridge or in a tunnel is very low the potential impact on users is very high. Tunnel options have very limited access to escape an event or to access it with emergency vehicles. Bridges have some potential harbour access in an event.

In a large-scale city or regional emergency, a new crossing holds the possibility of an alternative route for emergency vehicles, particularly Options 2 and 3.

Effects on residents caused by tunnel emissions from ventilation shafts can be controlled in terms of prevailing air quality standards. In contrast, emissions from Option 2B will be the least manageable and to have the greatest potential health effect, particularly for residents and workers located close to the approaches to the bridge, or near the south end near Wynyard Quarter where vehicles will be climbing. Small health benefits from access to the existing bridge become possible for cyclists and pedestrians.

Economy and Employment

All options will boost the regional economy and employment. Road-rail options offer more potential social benefits through broader access across the entire region, making passenger transport only options somewhat less attractive in this regard.

Options 2B and 2C offer potential advantages to parts of the North Shore City such as Birkenhead and Northcote, where there are concentrations of lower social-economic status workers sensitive to the costs of travel. This advantage is due to additional gains in public transport by bus, and also to movements by private vehicles directly to Auckland City via the existing bridge that becomes less congested with the new crossing.

All options help overcome physical and psychological barriers of the present single road bridge to movement of people to work and study on either side of the harbour. Access to workers and skills is a potential constraint to economic development in North Shore City and Rodney District.

Transport Modes and Access

All options have the benefit of adding a rail mode for public transport between the North Shore and the CBD. However, Option 3 does not provide a direct new form of public transport to Wynyard Quarter. The passenger transport only options do not provide the same transport and access benefits as options which combine passenger transport and general traffic modes.

All options will give workers greater ability to access employment through greater mode choice and reduced travel time, and businesses the ability to draw from a larger labour market. Students will have improved access to points of study. Options 2 and 3 also have the additional advantage of providing additional access for freight vehicles.

All road options have the potential to create new traffic congestion on local and arterial roads leading into and out of the motorway system as well as congestion gains. The social consequence is some inconvenience to local residents and road users. The ultimate level of this effect will depend on how the new crossing is linked into other highways and associated infrastructure such as grade-separated crossings and interchanges.

All the options have the potential to support residential intensification around regional growth centres. Albany, Takapuna, Auckland CBD and Newmarket are likely to see residential and commercial intensification as a result of all the options through the rail component.

Amenity

Bridges options have the potential to affect the heritage character of the existing iconic bridge. They also have the potential to permanently alter navigation and recreation patterns in the harbour. Moorings and recreational activity around Northcote Point could also be affected.

The road-rail bridge will have substantial effects on part of the Westhaven Marina, affecting current recreational users and residential areas of St Mary's and possibly the Wynyard Quarter overlooking Westhaven. The St Mary's residents will already be experiencing effects from the development of Wynyard Quarter.

The ventilation shafts at each end of the tunnel options could also have amenity effects depending on how they are located and designed. Noise is likely with all options but their access points north and south already have ambient traffic noise so the effect will be minimised. Bridge options will have noise effects for residents overlooking that part of the harbour.

7.3.4 Implementation Assessment

Various factors associated with implementing each of the options were considered. Key points arising from the assessments are set out below.

Cost Comparison

Work undertaken on option costings focused on an appreciation of the magnitude of costs, drawing on previous assessments. Allowances for contractor's costs, design and management have been included, together with indicative property costs.

Given the inherent uncertainties in a high level strategic study, specific risk allocations were not possible. Therefore a global 30% estimation contingency was added. Accordingly, it is considered that the costing assessments are meaningful for option comparison but can only be considered indicative in absolute terms at this stage.

The range of indicative costs identified for the short listed options is shown in Table 7-1 below.

Option	Cost Range (Millions - 2008 values)
1A	1,000 - 1,200
1B	1,200 - 1,500
1C	1,000 - 1,200
2A	3,700 - 4,100
2B	3,100 - 3,500
2C	3,700 - 4,100
3A	4,700 - 5,100
3B	4,700 - 5,100

Table 7-1: Indicative Option Cost Range

Constructability

Constructability of each of the short listed options was tested from the perspective of complexity and risk. The key points arising for each option were found to be.

For Option 1A to Option 1C the key construction issues included:

- Complexity of cut and cover station in Wynyard Quarter including contaminated land issues.
- Future proofing for new developments
- Protecting existing building foundations for driven tunnels, including potential underpinning

For Option 2 (2A, 2B and 2C) key construction issues included those for Option 1, plus

- Working around live traffic to construct ramp connections to through alignment over operating motorway and interchanges.
- Protection of major utilities.
- Complex underground construction around operating VPT.
- Bridge crossing of harbour.

For Option 3A and 3B the key construction issues included those for Option 1, plus

- Long driven tunnel crossing of harbour,
- geology,
- Complex traffic management during underground construction beneath Beach Road
- Driven tunnel under existing building foundations and Britomart Access Tunnel - extensive underpinning may be required

Construction Flexibility

Whilst construction staging has not been examined in detail, each of the options allows for a number of different implementation sequences to be considered. Firstly the question of buses or rail in the new crossing needs to be considered. It would be difficult to convert a tunnel from busway to rail. There would also be a lengthy conversion period of a number of years in which buses would need to revert back to the existing bridge. Associated congestion and lack of priority would be a considerable concern.

The timing of implementing rail would be dependant on the inner city CBD loop and rail being provided on the North Shore. The passenger transport component of an additional crossing is likely to be part of one of these projects.

Consentability

All options were considered to be consentable under the provisions of the Resource Management Act. However the extent of built environment disruption for bridge Options 1B and 2B (the significant adverse effects on Westhaven Marina) is such that consenting these two options is likely to be controversial, expensive and lengthy. A similar situation applies to Option 2A because part of the tunnel section under the Daldy Street Boulevard will be cut and cover and the available width of road reserve (40m) is unlikely to be sufficient to accommodate all necessary works (for example road plus rail station).

Option 2C avoids the bulk of the Wynyard Quarter redevelopment area. The Option 3 alternatives all involve an order of magnitude impact on existing built structures, many of which are of very recent construction, greater than any other option and accordingly are deemed to be the most difficult to consent.

8. Short Listed Option Evaluation

Once the option investigations and assessments were completed, a comparison between options was undertaken using the evaluation framework described previously. The framework describes specific sources of information, which includes outputs from transport models, assessments of specific issues and reviews undertaken on wider matters, such as regional economic impacts. At each step an assessment was made using criteria listed in the framework, and then these were summarised into an overall score for each major evaluation framework aspect, as follows:

- Economic Development and Regional Growth
- Connectivity
- Environmental Sustainability and Urban Form
- Social and Community
- Implementation

Full details of the short listed option evaluation are included in the Phase 2: Short Listed Option Evaluation Report. The summary and conclusions are set out below.

8.1 Summary Results and Sensitivity Testing

The framework assessment summary is shown in table 8-1 below. This shows that Options 2 and 3 have highest level of benefits but also have greatest impact. Individual options have different strengths and weaknesses, but overall the comparison between options in many categories is close.

	Overall Assessment with Equal Weighting of Criteria within an Objective							
	1A	1B	1C	2A	2B	2C	3A	3B
1. Economic Development & Regional Growth	√	0	√	√	0	√+	√√	√+
2. Connectivity	0+	√	0+	√+	√+	√+	√+	√+
3. Environmental Sustainability & Urban Form	0-	X	0-	X-	X-	X-	XX	XX
4. Social & Community	√	0+	√+	√+	√	√√	√	√
5. Implementation	X-	X-	X	X-	X	X-	XX	XX

■ Table 8-1 Summary of Evaluation Results

Table 8-1 shows that, on balance, Option 2C scores highest. As the relative scoring was close, sensitivity testing was undertaken to investigate how important different weightings to key criteria were to the overall outcome.

In table 8-1, the weighting of the five key criteria is equal at 20% each. A range of tests were carried out with each of the five criteria given more emphasis using the weightings shown below (each of the four other criteria would then be weighted at 10%):

- Weighting A – 60% Economic
- Weighting B – 60% Connectivity
- Weighting C – 60% Environmental
- Weighting D – 60% Social & Community
- Weighting E – 60% Implementation

Table 8-2 below shows how the options rank from this series of tests.

	Overall Assessment Ranking							
	1A	1B	1C	2A	2B	2C	3A	3B
Equal weighting	6	8	3	2	7	1	5	4
Weighting A - 60% Economic Growth	6	8	5	4	7	2	1	3
Weighting B - 60% Connectivity	7	8	6	4	3	1	5	2
Weighting C - 60% Environmental Sustainability	2	3	1	5	6	4	8	7
Weighting D - 60% Social and Community	6	8	3	2	7	1	5	4
Weighting E - 60% Implementation	5	6	2	4	3	1	8	7

■ **Table 8-2 Summary of Sensitivity Results**

Table 8-2 shows Option 2C as top ranked for the majority of sensitivity tests. If economic growth is given a higher weighting, Option 3A becomes the highest ranked option, although Option 2C is next ranked option. If environmental sustainability is given higher weighting then Option 1C becomes the highest ranked. Option 2C is the highest ranked option with a general traffic component.

Overall, it is concluded that the results of the evaluation framework assessment, including the sensitivity testing, is that Option 2C is the highest ranked option.

8.1.1 Hybrid Option 3C

Once the initial assessment was completed, the study team were requested to consider a “hybrid” option, combining the passenger transport component of Option 1C (serving Wynyard Quarter) and the general traffic component of Option 3 (Grafton). Although separate routes for different modes had been previously discounted for environmental and cost reasons, there was sufficient commonality between the routes for both modes across the harbour to consider this as a variant of Option 3.

Table 8.3 shows the relative assessment of Option 3C by comparison with other options.

	Overall Assessment								
	with Equal Weighting of Criteria within an Objective								
	1A	1B	1C	2A	2B	2C	3A	3B	3C
1. Economic Development & Regional Growth	√	0	√	√	0	√+	√√	√+	√√
2. Connectivity	0+	√	0+	√+	√+	√+	√+	√+	√+
3. Environmental Sustainability & Urban Form	0-	X	0-	X-	X-	X-	XX	XX	XX
4. Social & Community	√	0+	√+	√+	√	√√	√	√	√+
5. Implementation	X-	X-	X	X-	X	X-	XX	XX	XX

■ **Table 8.3: Evaluation with Option 3C Results**

The change of passenger transport route to the Option 1C alignment brings Option 3C closer in the assessment to Option 2C, as the direct passenger transport connection to Wynyard Quarter is positive. However Option 2C still scores higher than Option 3C, due to environmental impacts and implementation issues. As with the previous assessment, Option 3C was then subjected to a sensitivity analysis, using different weights for the five main criteria. The results of this analysis are shown in Table 8-4 below:

Scenario	Overall Assessment								
	Ranking								
	1A	1B	1C	2A	2B	2C	3A	3B	3C
Equal weighting	6	9	4	3	8	1	6	5	2
Weighting A - 60% Economic Growth	6	9	6	5	8	3	2	4	1
Weighting B - 60% Connectivity	7	9	7	5	4	1	6	3	2
Weighting C - 60% Environmental Sustainability	2	3	1	5	6	4	9	8	7
Weighting D - 60% Social and Community	6	9	4	3	8	1	6	5	2
Weighting E - 60% Implementation	5	6	2	4	3	1	9	8	7

■ **Table 8-4: Sensitivity Analysis with Option 3C Results**

Table 8-4 shows that Option 2C retains its first place ranking for the majority of tests, but the Option 3C replaces Option 3A under the higher economic growth test.

In conclusion, it is considered that while Option 3C performs better than either of the other two Option 3 configurations, it is still not as highly ranked as Option 2C.

9. Tolling Assessment on Highest Ranked Option

Two tolling tests were carried out on Option 2C to gain some understanding of the potential for raising revenue by tolling. As such, it was assumed that the tolls would be 24-hour, but may vary by time of day.

The first test was with tolls on both directions only on the new general traffic crossing, and the second with tolls on both the new crossing and the existing harbour bridge. The toll levels were the same in both tests: \$5.00 both directions in the AM (7-9am) and PM (4-6pm) peak periods, and \$2.50 both directions in the Interpeak period (9am-4pm).

Given that a single toll level has been modelled using ART without any other analysis the results must be treated as preliminary at best. However, the tests indicated potential daily revenues of the order of \$150,000 by tolling the new crossing only, and \$500,000 with both crossings tolled.

If only the new crossing is tolled, there is significant diversion to the untolled harbour bridge, plus some increase in traffic on SH18. General traffic using the new crossing and the existing bridge reduce by 30-40% in all modelled periods and both directions. Tolling both the new crossing and the existing bridge on average halves the general traffic on them, while SH18 traffic shows some modest increases. In both tests passenger transport patronage in the morning peak (southbound direction) increases by about a quarter.

These tests have indicated that, at the toll levels used, the tolled facilities would be significantly underutilised. Also, the tests indicate that tolling the new crossing only could result in considerable diversion to the existing bridge with a subsequent reduction to revenue and to the performance of the network, and under-utilisation of the new facility.

Further work is required to determine a possible optimal range of toll levels for tolling either the new crossing alone or tolling both crossings. However, the initial results suggest that tolling could make a significant contribution towards the overall cost of the new crossing.

10. Conclusions

The Waitemata Harbour Crossing Study considered a wide range of options for developing a new harbour crossing to be operated in conjunction with the existing Auckland Harbour Bridge. The objective of the study was to identify the option that best met the project objectives and functional principles developed by the Project Partners.

In Phase 1, a long list of 159 options was developed, which were assessed using criteria agreed with the Project Partners. Three options were shortlisted, including one passenger transport only option (operating in conjunction with the Auckland Harbour Bridge) and two combined passenger transport / general traffic options. Given the long term planning horizon of the study and the regional focus on developing the rail network, the passenger transport component of the crossing was optimised for rail.

In Phase 2 of the study, concepts for each short listed option were advanced to allow assessments to be made of economic, social and environmental effects, at a strategic level of detail. The focus of these assessments was to identify the relative merits of each option, rather than determine an absolute level of effects. The assessment work led to the following key conclusions:

- Improving passenger transport accessibility between North Shore City and the CBD was the first functional principle of the study. A passenger transport component to an additional crossing is therefore required.
- Given the desire for Wynyard Quarter to be re-developed with a high passenger transport mode share, it would be preferable for a dedicated passenger transport facility to access this area.
- Alternative vehicular connectivity would provide wider regional connections and benefits that passenger transport alone could not serve. This would maximise the broader economic benefits of a new crossing (agglomeration benefits).
- Options that provide additional vehicular connectivity also provide opportunities to reallocate road space on the existing harbour bridge for either dedicated public transport (bus lanes) or active modes (cycling and walking) as well as providing an alternative traffic route across the harbour during incidents and maintenance activities.
- Bridge options were not favoured due to their visual impact on the harbour and surrounding areas such as Westhaven Marina.
- Driven tunnel technology provides several advantages, including flexibility as to when the project is implemented. Options that incorporate rail and road could be constructed separately at different stages, although there would be savings in cost and disruption during construction if they were built together

The evaluation showed that for passenger transport alone, Option 1C was the best option. Option 1C provided high quality connectivity to key public transport nodes, including Wynyard Quarter. As noted above, with driven tunnel technology, Option 1C could be provided effectively independent to whatever option (if any) was adopted for additional road capacity.

The choice of road crossings then becomes one of no crossing (Option 1), an option in the vicinity of Wynyard Quarter (Option 2), or an option aligned with Grafton Gully (Option 3).

Overall, the study found that:

- The best overall performing option in the evaluation assessment was Option 2C, although the scoring range between options was not large,
- The best performing option across a range of sensitivity tests which looked at different weightings for the five main criteria in the evaluation framework was Option 2C
- Where Option 2C was not the best option in individual tests it still scored higher than the alternative road options.
- The option that achieved the most balanced demand for general traffic between the new and existing crossings was Option 2C

Based on the outcomes described above, the conclusion of this study is that Option 2C best meets the project objectives and functional principles and therefore is recommended as the preferred route for a further Waitemata Harbour Crossing.

Appendix A Functionality Principles

Functionality Principles

The following principles are to be used for assessing the performance of new crossing options. The existing Auckland Harbour Bridge and any new crossing are to be considered together and planned to operate in a complimentary manner. Assessment of the performance of crossing options is to relate to the joint performance of the Auckland Harbour Bridge and the new crossing.

1. Future improvements to connectivity between the North Shore and the CBD will be provided predominantly by public transport and cross harbour passenger transport improvements will be given first priority.

Access to the CBD is currently provided by a mixture of public transport (rail, bus, and ferry), road, cycling and walking. Road access to the CBD is available through a limited number of entry points from both the motorway network and the regional arterial road network. The ability of the CBD to accommodate additional road traffic is limited, both by the capacity of the road network within the CBD and the availability of parking. Auckland City has recognised this, and has policies around the maximum number of vehicles it expects the road network to be able to accommodate.

Current investment in rail service improvements and electrification and in the Northern Busway will add significant capacity that will increase the accessibility of the CBD and which is in line with regional strategies of improved sustainability and reduced reliance on private motor vehicles.

In planning for the future of the CBD, substantive improvements in connectivity will therefore be provided through improvements to the public transport network rather than through increased road capacity.

Public transport improvements could include improvements to the frequency and quality of existing services, as well as new and improved facilities. Examples of planned improvements include development of Britomart as a through facility (rather than a terminal), and development of an inner city rail loop. Future connectivity from the North Shore is expected to be compatible with and complementary to these plans.

2. Future cross harbour connectivity will include sufficient general traffic lanes linking the North Shore and greater Auckland region to best meet wider regional connectivity needs and will be given second priority

Despite planned improvements in public transport connectivity, it will not be convenient or practical in terms of cost and trip duration to travel from all North Shore origins to all locations to the south – even during peak periods when public transport services are at their most prevalent. These trips, and those where the use of private vehicles is still a first choice, are expected to remain

a sizeable proportion of total cross harbour trips. Other trips, such as freight movements and commercial journeys can only be made by road.

Limited spare capacity on the strategic and regional arterial networks on both sides of the Harbour, together with the need to move towards a more sustainable transport system, mean it will be neither practical nor desirable to provide sufficient cross harbour road capacity to match demand. Any additional connectivity should therefore be provided to the best practicable standard, that is, in balance with the remainder of the Auckland road network, and in a cost effective manner.

3. Additional connectivity between the North Shore and the CBD by way of general traffic lanes would be advantageous and will be given third priority.

Given the above two functionality objectives, it should be noted that additional connectivity to the CBD by way of general traffic lanes would be advantageous. Such connectivity would be for the purpose of improving the robustness of the road network, as opposed to significantly increasing the capacity of the road network into the CBD.

4. Transport network robustness (ability to cope with change e.g. removal and replacement of the Auckland Harbour Bridge clip on lanes) is important

The connectivity between the northern part of the region and the central and southern parts of the region is currently primarily through a single direct crossing location (recognising that SH18 provides an alternate route of significantly greater distance and with limited spare capacity). As such, any event (sudden or planned) which removes capacity from the crossing will have a dramatic negative effect on cross harbour movement.

Climate change is expected to increase the long term risk of disruption to the network.

The ability of options to improve the robustness of both the road and public transport networks is considered very important, and will go a considerable way to reducing the connectivity risk which currently exists through being dependent upon a single direct crossing location.

5. Operational flexibility is also important.

This study will examine options that will address forecast future scenarios. Given the uncertainty around the future, it is considered important that options have operational flexibility.

Examples of desirable flexibility include the ability to cater for changing total demands, as well as demand patterns. For example, if public transport demand exceeds that for which buses can service, then the ability to convert to rail becomes critical. Similarly, if growth in the CBD (or other centres) is different to that forecast, the ability to adjust connectivity accordingly would be a significant advantage.



Appendix B Phase 2 Evaluation Framework

	Categories and Criteria	Considerations	Measures (note all evaluations to compare situations to do-minimum option)	Sources	LTMA, NZTS
1. Economic Development & Regional Growth					
1.1	World Class City Status	Extent to which the option contributes to world class city status; assessment of overall quality and ease of getting around the region provided by the option	Independent review of how option contributes to world class city status. Independent panel appointed.	Independent panel report see "Option Assessment Reports" volume.	Economic Development
1.2	Growth Strategy (RGS)	Extent to which the option is consistent with the RGS; that is provides and improves connectivity to RGS intensification areas (positive effect) and to non-RGS areas (negative effect)	Average vehicle and passenger transport generalised costs to (AM) and between (IP) RGS growth areas and compared with those to non-growth areas: <ul style="list-style-type: none"> ■ For trips from Hibiscus/North Shore and from the Isthmus ■ For contra-peak trips ■ For trips between selected areas (eg Albany-Newmarket, Takapuna-CBD) (IP) 	ART, APT transport models	Economic Development
1.3	Economic Growth Policy (AREDS)	Extent to which the option contributes to AREDS; that is, contributes to the overall economic growth and wellbeing of the region, and provides and improves access to areas of economic and employment importance, and ability to enhance movement of freight	Assessment of regional economic benefits, including agglomeration effects	Regional Economic Impact Assessment including agglomeration benefits – see "Option Assessment Reports" volume.	Economic Development
			Access to employment: Number of households within 30 min of employment by private vehicle and by passenger transport (AM): <ul style="list-style-type: none"> ■ For employment in sectors: Hibiscus, North Shore North, North Shore South, CBD, Isthmus West, Central, and East ■ For individual employment zones: Albany, North Harbour, Wairau, Takapuna, Wynyard Quarter, Newmarket, CBD fringe, Rosebank, Penrose, Waiouru /East Tamaki, 	ART, APT models	

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	Categories and Criteria	Considerations	Measures (note all evaluations to compare situations to do-minimum option)	Sources	LTMA, NZTS
			Mt Wellington, Airport		
			<p>Access to areas of economic importance: Average vehicles speeds:</p> <ul style="list-style-type: none"> ■ From northern sectors (Hibiscus, North Shore North, North Shore South) and specific areas (Albany, Wairau, Takapuna,) to individual centres (Port, CBD, CBD fringe, Airport, Rosebank, Newmarket, Penrose, Mt Wellington, Waiouru/East Tamaki) (AM) ■ From Isthmus sectors to individual centres (Albany/North Harbour, Wairau, Takapuna) (AM) ■ Between individual centres in Hibiscus/North Shore and Isthmus (IP) <p>Effects on Port operations (positive and negative), including:</p> <ul style="list-style-type: none"> ■ Land side access ■ Impact on shipping ■ Port operations 	<p>ART/SATURN models</p> <p>Land side access assessment by traffic team. Shipping and port operations assessment by Port Operations specialist– see “Option Assessment Reports” volume.</p>	

2. Connectivity					
2.1	passenger transport connectivity to CBD	Extent to which option improves passenger transport connectivity to CBD; new crossings with passenger transport to CBD improve connectivity over existing bridge	AM peak passenger transport trip numbers and travel times across harbour to/from CBD	ART, APT models	Accessibility and mobility
2.2	Wider regional connectivity	Extent to which the option improves wider network connectivity for general traffic; linkage with other strategic network	AM and IP general traffic trips across harbour and between regional sectors	ART/SATURN models	Accessibility and mobility
			Assessment of traffic operations: <ul style="list-style-type: none"> ■ Capacity versus demand (v/c ratio) ■ Delays at specific locations and routeing (i.e. key intersections on North Shore and in CBD) ■ Queue lengths at key intersections on North Shore and in CBD. 	SATURN model	
2.3	Providing for all modes	Cross-harbour rail capability; other modes including walking and cycle provision; providing for freight movements	How option provides rail capability in terms of alignment	Design team assessment	Accessibility and mobility; Safety and Security
			How option provides quality cross-harbour facilities for walk and cycle	Design team assessment	
			How option provides for freight / commercial traffic movements	Design and traffic team assessment	
2.4	Network resilience (existing crossing)	Extent to which the option adds to the resilience of the network; ability of network to operate if existing bridge failed	Assessment of how option contributes to network resilience, taking account of flow patterns, response plans for incidents (short and long duration), consequential effects on the surrounding network	Traffic Team assessment	Economic development; access and mobility
2.5	Network flexibility	Extent to which the option provides flexibility for future transport options and protects passenger transport corridor/s for the future; extent to which it offers flexibility for suburban rail opportunities for the future	Assessment of how option would future-proof the longer term strategic network, taking account of possible future changes to the strategic and arterial transport networks	Transport / Traffic team assessment	Accessibility and mobility

3. Environmental Sustainability & Urban Form					
3.1	Sustainability framework (ASF)	Environmental only; extent to which the option minimises environmental effects such as air quality / emissions, noise, etc from private vehicle travel	Amount of vehicle travel, vehicle-kilometres (VKT), AM and IP	ART model	Environmental sustainability
3.2	Natural environmental effects	Extent and significance of effects on coastal environment, emissions, ecological areas, heritage, views and vistas, and existing and future open space; negative and positive (opportunities); including effects during construction.	Assessment of how option creates long term effects and opportunities for environmental improvements	Natural Environmental Impact Assessment including coastal impact issues, flora and fauna – see “Option Assessment Reports” volume.	Environmental sustainability
			How option construction will impact on natural environment	Natural Environmental Impact Assessment including coastal impact issues, flora and fauna - see “Option Assessment Reports” volume.	
3.3	Built environmental effects	Extent and significance of land take, number of properties affected and specific areas; negative and positive (opportunities), including operational effects.	Assessment of how option creates long term effects and opportunities for environmental improvements	Built Environmental Impact Assessment including impact on key urban areas such as Wynyard Quarter see “Option Assessment Reports” volume.	Environmental sustainability
			How option construction will impact on built environment, including assessment of constraints in development proposals (i.e. Wynyard Quarter)	Built Environmental Impact Assessment including coastal impact issues, flora and fauna see “Option Assessment Reports” volume.	

4. Social & Community					
4.1	Trips by passenger transport and active modes	Extent to which the option encourages passenger transport and active mode trips; walk and cycle provision	passenger transport trips across the harbour	ART, APT models	Public health
			How option provides quality cross-harbour facilities for walk and cycle	Transport / Traffic team assessment	
4.2	Effects on community	Extent and significance in terms of severance, displacement, and disruption of communities and loss of amenity; including during construction	Assessment of how option creates long term effects	Community Impact Assessment - see "Option Assessment Reports" volume.	Environmental sustainability
			Ability to minimise effects during construction	Community Impact Assessment - see "Option Assessment Reports" volume.	

5. Implementation					
5.1	Cost	Consideration of broad-order construction costs and likely ongoing maintenance costs	Construction and maintenance costs (Review of 1997 costs)	Option costs assessment	
5.2	Construction flexibility	Extent to which there is flexibility in the sequencing of construction activities; constraints imposed on surrounding development	Assessment of construction flexibility and impacts on surrounding development	Design Team assessment	
5.3	Fundability	The extent to which the option can be funded, including alternative sources such as tolling and private sector involvement	Assessment of funding possibilities for each option	Funding option assessment - see "Option Assessment Reports" volume.	
5.4	Constructability	Degree of construction difficulty and risk	Assessment of construction difficulty	Design Team assessment- see "Option Assessment Reports" volume.	
5.5	Economic Efficiency	Efficiency of the options measured in terms of EEM evaluation procedures	Costs and benefits; BCR; NPV	ART/SATURN, APT transport models	
5.6	Consentability	Risk and difficulty of obtaining statutory approvals	Relative risks for each option arising changes which may occur from RMA processes, consent conditions, etc	Planning Team Assessment	