New Zealand Transport Agency

Additional Waitemata Harbour Crossing

Preliminary Business Case

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NZ Transport Agency

Contents

Background reports to be read in conjunction with the Preliminary Business Case

Economic Assumptions and Scoping Report

Economic Benefits and Funding Options Report

Form Assessment Study Report

Form Assessment Drawings

Form Assessment Supporting Information

Transport and Traffic Model Report

Figures

Tables

Glossary

Abbreviation	Definition
AHB	Auckland Harbour Bridge
ARC	Auckland Regional Council
ARP:C	Auckland Regional Plan: Coastal
ART3	Auckland Regional Transport Model
ASP3	ARC's Land-use Model
AWHC	Additional Waitemata Harbour Crossing
BCR	Benefit-Cost Ratio
BOOT	Build, Own, Operate and Transfer
CBA	Cost-Benefit Appraisal
CBD	Central Business District
CGE	Computable General Equilibrium
CMA	Coastal Marine Area
CMJ	Central Motorway Junction
CPI	Consumer Price Index
D&C	Design and Construct
DBFO	Design, Build, Finance and Operate
DBOM	Design, Build, Operate and Maintain
DfT	United Kingdom Department for Transport
EAS	Economic Assumptions and Scoping
EEM	Economic Evaluation Manual
EMU	Electric Multiple Unit
EPT	Engineering and Planning Team
ET	Economics Team
FASR	Form Assessment Study Report
FED	Fuel Excise Duty
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GPS	Government Policy Statement
GST	Goods and Services Tax
HCV	Heavy Commercial Vehicle
HGMPA	Hauraki Gulf Marine Park Act
KPH	Kilometres Per Hour

Abbreviation	Definition
LOS	Levels of Service
LTMA	Land Transport Management Act
MED	Ministry of Economic Development
MVR	Motor Vehicle Registration and Licensing Fees
NPV	Net Present Value
NIP	National Infrastructure Plan
NIU	National Infrastructure Unit
NLTF	National Land Transport Fund
NLTP	National Land Transport Programme
NoR	Notice of Requirement
NPS	National Policy Statement
NPV	Net Present Value
NZIER	New Zealand Institute of Economic Research
NZTA	New Zealand Transport Agency
NZTS	New Zealand Transport Strategy
O&M	Operations and Maintenance
OD	Origin-destination
OE	Option Estimate
OECD	Organisation for Economic Co-operation and Development
PAYGO	Pay-as-You-Go
POAL	Ports of Auckland Limited
PPP	Public Private Partnership
PT	Public Transport
PV	Present Value
PwC	PricewaterhouseCoopers
RCC	Resource Cost Correction
RePEc	Research Papers in Economics
RFT	Request for Tender
RGS	Regional Growth Strategy
RLTS	Regional Land Transport Strategy
RMA	Resource Management Act 1991
RoNS	Roads of National Significance
RUC	Road User Charges
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SH	State Highway

Abbreviation	Definition
SKM	Sinclair Knight Merz
TBM	Tunnel Boring Machine
TDM	Transport Demand Management
TIF	Tax Increment Financing
TTMT	Traffic and Toll Modelling Team
UHB	Upper Harbour Bridge
VoT	Value of Time
VOC	Vehicle Operating Costs
VPD	Vehicles Per Day
WEB	Wider Economic Benefit
WTP	Willingness-to-Pay

Glossary of Terms

Term	Definition
Alignment	The route or position of an existing or proposed motorway.
Ambient Air	The air outside buildings and structures. It does not refer to indoor air, air in the workplace, or to contaminated air as it is discharged from a source.
Ambient Sound	The total sound existing at a specified point and time associated with a given environment. The ambient sound is usually a composite of sounds from several sources, near and far.
Amenity	Defined in Section 2 of the Resource Management Act 191 (RMA) as those natural or physical qualities and characteristics that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.
Archaeological Site	Defined in Part 2 of the HPA as any place in New Zealand that either: Was associated with human activity that occurred before 1990; or Is the site of the wreck of any vessel where that wreck occurred before 1990; and Is or may be able through investigation by archaeological methods to provide evidence relating to the history of New Zealand.
Anzac Bridge Concept	A concept developed by the ANZAC Centenary Bridge Group for a new two-tier, multi-modal harbour bridge linking Wynyard Point to Onewa Road.
Rob Roy Hotel	Also known as the Birdcage Tavern, Hotel or Birdcage Public House. The original Rob Roy Hotel was built in 1885-1886.
Coastal Marine Area	Defined in Section 2 of the RMA. The foreshore, seabed, and coastal water, and the airspace above the water: of which the seaward boundary is the outer limits of the territorial sea; and of which the landward boundary is the line of MHWS, except that where that line crosses a river, the landward boundary at that point shall be whichever is the lesser of: One kilometre upstream from the mouth of a river; or The point upstream that is calculated by multiplying the width of the river mouth by five.
Cut and Cover Tunnelling	A method of construction for tunnels where a trench is excavated and roofed over.
dBA	A measurement of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
Designation	Defined in Section 2 and Section 166 of the RMA.
Effect	Defined in Section 3 of the RMA.
Extension bridges	The two outer lanes on either side of the AHB which were added to the structure in 1969. Also commonly referred to as the extension bridges or clip-on lanes.
Gasworks Site	The block of MUZ land located at 90 Beaumont Street and comprising medium density residential apartments and a heritage building. Also known as Auckland Gas Company Administration Buildings, Beaumont Quarter or the Beaumont Quarter Apartments.
Groundwater	Natural water contained within soil and rock formations below the surface of the ground.
Heritage Site	A site that contributes to an understanding and appreciation of New Zealand's history and cultures. A heritage site can be derived from archaeological, architectural, cultural, historic, scientific and technological fields.

Term	Definition
Immersed Tube	An underwater tunnel composed of segments, constructed elsewhere and floated to the tunnel site to be sunk into place and then linked together.
Mainline	The principal route of transportation. For the purposes of this Project the mainline is the Additional Waitemata Harbour Crossing.
Motorway	Motorway means a motorway declared as such by the Governor-General in Council under section 138 of the Public Works Act or under section 71 of the Government Roading Powers Act 1989.
Network Resilience	Network resilience encompasses: Redundancy: the degree to which the transport system provides for functionally similar components which can serve the same purpose to ensure the system does not fail when one of the components fail (i.e. a number of similar routes are available with spare capacity). Diversity: the degree to which the transport system provides for a range of functionally different components to protect the system against various threats (i.e. alternative modes of transport are available). Autonomy (or security): the ability of the transport system to operate independently so that the failure of one component does not cause the others to fail. Strength: the ability of the transport systems to withstand an incident. Mobility: the level of service provided by the transport system in delivering travellers to their chosen destination(s). Safety: the degree to which the transport system protects users from harm or does not unduly expose them to hazards. Recovery: the ability of the transport system to recover quickly to an acceptable level of service with minimal outside assistance after an incident occurs.
Orams Marine	A boat building and servicing business located on the western edge of Wynyard Quarter at 144 Beaumont Street, Auckland Central. Also known as Orams Marine Village.
Pier	Refers to the piers associated with the bridge structure through the central sector.
Portal	Entrance way to bored and cut and cover tunnel sections.
Reclamation	As defined in the ARP: C, any permanent filling of an area previously inundated by coastal water either at or above MHWS mark, whether or not it is contiguous with the land, so that the filled surface is raised above the natural level of MHWS, and thus creates dry land, removed from the ebb and flow of the tide.
Sectors	North Sector: located on the North Shore, extending from the SH1/Esmonde Road Interchange in the north to Stokes Point/Northcote Point in the south. Central Sector: encompasses the Waitemata Harbour, extending from end of Northcote Point, on the North Shore to the coastal edge of Auckland City between Point Erin and Wynyard Quarter. South Sector: encompasses the areas above MHWS extending from Westhaven Drive and Wynyard Quarter in the North to the locality of the Cook Street/Wellington Street ramps on SH1 and the SH16 links in Auckland City.
Settlement	The gradual sinking of the ground surface as a result of the compression of underlying material.
Study Area	The area to which the project relates, extending from the SH1 Esmonde Road Interchange on the North Shore to the locality of the Cook Street/Wellington Street interchanges on SH1, and the SH16 links in Auckland City (i.e. the Central Motorway Junction (CMJ)).
Study Corridor	A corridor through the central sector of the study area within which all long list options are located.

Term	Definition
Swing Mooring	Consists of a buoy which is attached by chains to a heavy sinker which lies on the sea bed. Boats attached to the buoys will swing around in the water according to the direction of the tide.
Westhaven Marina	The predominantly Coastal Marina Area bound by the Waitemata Harbour to the north, Wynyard Quarter to the east, Point Erin to the west, and comprising Westhaven Drive and Z-Pier at the southernmost extent. Also known as Westhaven.
Wynyard Quarter	The area of reclaimed land and wharfs bound by the Waitemata Harbour to the north, Halsey Street and the Viaduct Harbour to the east, Fanshawe Street to the south and Westhaven Marina to the west. Also know as the Western Reclamation or Tank Farm.
Z-Pier	The area of land west of Wynyard Quarter extending north from Westhaven Drive in the southeast corner of Westhaven Marina and comprising the charter berths, public boat ramp, and associated car parks. Also referred to as Pier Z or Area Z.

1. Executive Summary

1.1 Purpose

The focus of this phase of the Additional Waitemata Harbour Crossing (AWHC) study is to provide information and analysis to assist with protecting the route for the additional crossing. The critical output of this Preliminary Business Case is the investigation of the options for form of crossing (as either bridge or tunnel).

Determination of form of crossing is a prerequisite to the future advancement of the case for the crossing itself, and the narrowing down of funding and procurement options. The issues of the case for the crossing, funding and procurement are explored at a high level in this Preliminary Business Case in order to provide context and focus for the discussion around form and to provide the starting point for further work.

Subsequent stages of investigation will have a broader focus on the wider transport issues and constraints that the AWHC may address with a view to commencing detailed work to justify the AWHC, and, as such, there is considerable scope to refine the estimates of benefits and costs in this plan.

1.2 Dimensions underpinning analysis

To inform the purpose listed above, there are five dimensions underpin the analysis in this Preliminary Business Case:

1. **Can the crossing be funded?** If our analysis considers that there is no capacity to fund the crossing, then further work on determining form is irrelevant.

2. **Confirm the need for an additional crossing.** While this does not impact on form of crossing, updating analysis from past studies, as well as providing new insights from all work streams in this project underpins the need to consider form of crossing.

3. **Can an additional crossing be built?** Constructability, consentability and operability all fundamentally affect form of crossing.

4. What are the timing options for an additional crossing? Timing considerations may affect option selection.

5. **What are the funding options?** On top of constructability and consentability, this project considers the comparative financial differences between forms of crossing, as well as how it is funded and who should pay for it.

The most critical of these dimensions in terms of form of crossing is the relative analysis of constructability, consentability and operability (dimension 3). The remaining dimensions provide wider context that may assist in refining determination of the preferred form.

1.3 Relationship of this Preliminary Business Case to Treasury and NZTA guidance

This Preliminary Business Case has been prepared in line with the NZTA's Economic Evaluation Manual (EEM) and the Treasury's Better Business Cases for Capital Proposals Toolkit. Both documents provide a framework for progressing analysis on the relative merits of the different forms for the crossing.

In considering the alignment of this Project with the Treasury and EEM guidelines, it must be noted that this Preliminary Business Case does not present a request for funding and does not represent the finalised and optimised case that would accompany a case for funding. It is, however, intended to take a significant step in developing that analysis, and on that basis, effort has been made to align the analysis with those guidelines.

The Treasury guidance requires a “Five Case Philosophy” for preparing a business case. These five cases require that a proposal:

1. is supported by a robust case for change – the **‘strategic case'**
2. maximises value for money – the **‘economic case'**
3. is commercially viable – the **‘commercial case'**
4. is financially affordable – the **‘financial case'**
5. is achievable – the **‘management case'**.

The Treasury states that the five cases are not discrete deliverables. They are embedded within the analysis and are an organising structure. The five cases map directly to the critical questions that are covered in this Preliminary Business Case as shown in Table 1 below:

Critical Dimension	Relevant Case per Treasury Guidance	Section in this report
Can the crossing be funded?	Financial Case	Funding Options
Confirm the need for an additional crossing	Strategic Case Economic Case	Description of Service Need Economics
Can an additional crossing be built?	Commercial Case Management Case	Economics and Finance Procurement Funding Options
What are the timing options?	Economic Case Financial Case Commercial Case Management Case	Economics and Finance Procurement Funding Options Timing
What are the funding options?	Economic Case Financial Case Commercial Case	Funding Options Procurement Economics and Finance

Table 1: Treasury Business Case Guidelines mapped to key project questions.

1.3.1 Can the crossing be funded and what are the funding options?

The AWHC will represent one of New Zealand’s largest infrastructure projects with the defined bridge option (in Present Value (PV) terms) costing $1.16 billion PV and the defined tunnel option costing $1.57 billion PV.

The National Land Transport Fund (NLTF) meets 100% of the cost of almost all state highway projects via a Pay-as-You-Go (PAYGO) method of financing – the costs of infrastructure projects are usually met from the revenues collected in the same year as construction. The NLTF presently pays out around $1.5 billion per year in state highway construction, maintenance and renewal. On this basis, the cost of either option could not be met from the NLTF using PAYGO alone without a significant increase in NLTF revenue, probably coupled with a reprioritisation of funds and forgoing expenditure on other projects.

However, there is considerable scope for the NLTF to meet a proportion of the cost of the crossing, with the remainder funded via debt. There are a number of viable options that exist for servicing and repayment of that debt, including tolls, or potentially covering the cost from future NLTF revenues.

Overall, debt markets for both public and private debt are expected to remain constrained in the short- to medium-term (to at least 2013/14). The appetite for government borrowing for many projects is also presently constrained due to self imposed borrowing limits. Longer term forecasts point to both the availability of debt and government constraints on borrowing improving over time.

There are also a number of alternative funding mechanisms available to provide either up-front funding, or service either public or private borrowing. These include tax increment finance (TIF) measures and rates funding.

Overall, no technical or financial reason is apparent as to why funding could not be available for the crossing. It is, however, unlikely that a single source of funds would meet the costs and decisions on availability of funds would also depend on the overall fiscal and economic situation at the time funds were sought, along with other transport and non-transport priorities.

1.3.2 Confirm the need for an additional crossing

The Auckland Harbour Bridge (AHB) represents a critical enabler of urban mobility for people and freight in the Auckland region. At present, the bridge handles approximately168,000 vehicles per day, making it critical to the economic wellbeing of Auckland and New Zealand.

There is a compelling need to consider additional capacity on State Highway 1 (SH1) between the Auckland central business district (CBD) and the North Shore as:

- The route already has a level of service (LOS) during peak times of E/F – the most congested measure.
- Population and travel demand growth is forecast to increase by around 22% (40,000 vehicles per day) by 2041, which will significantly impact on the ability of the route to provide economic benefits to commuters and freight.
- The resilience of the network is an ongoing concern in terms of:
    - Managing the future loads on the current AHB and associated maintenance needs
    - Providing an ability to manage and recover from significant network disruption, and
    - Adequately balancing the needs of CBD-bound commuters, public transport (PT) and port-bound freight, with north-south traffic that does not originate or terminate in the CBD.

The present value of the economic benefits associated with providing additional capacity, over a 30 year analysis period, is approximately:

- $300 million in travel time savings
- $80 million in decongestion benefits, and
- $9 million in travel time reliability benefits.

In addition to the transport benefits list above, present value benefits from agglomeration are around $250 million, and the modelling demonstrates movement in land-use to key growth nodes such as Takapuna, while continuing to grow other nodes such as the CBD.

The critical aspect of these benefits is that they are derived from an increase in capacity and connectivity over a reasonably small stretch of the network. Additional capacity or network optimisation in the CBD (including the ability to take additional traffic from the Northern Busway, Central Motorway Junction (CMJ) and North Shore connections would widen and deepen the economic benefits derived from the additional capacity attributable to an additional crossing.

The economic appraisals of major transport infrastructure schemes such as the AWHC cannot be deemed to fairly reflect their merits (or otherwise) unless explicit modelling of different subsequent economic activity and different subsequent transport investment decisions is undertaken. If the AWHC were considered as part of a particularly broad strategy of infrastructure investment then perhaps even modelling of population and demography would be required to capture the full spectrum of benefits.

1.3.3 Can an additional crossing be built?

Three key criteria, in addition to funding, underpin the question of whether a crossing can be built:

- Consentability
- Constructability
- Operability

1.3.4 Consentability

Both form options are potentially consentable, but a bridge has greater risks compared to a tunnel both in terms of timing and outcome. Because of the visual impact and intrusion on the Hauraki Marine Park, planning advice suggests that a bridge could take 1-2 more years to take through a consenting process.

In addition, planning advice strongly suggests the certainty of outcome for a bridge is much lower compared to a tunnel. This certainty of outcome takes two key forms:

- Probability of overall success in gaining consent; and
- Probability of a design that fully meets the NZTA's needs in terms of best value for money for the given form of crossing.

1.3.4.1 Constructability

Both options can be built and delivered using a mix of local and international skills and materials. The bridge would take 1-2 years less to construct than a tunnel, primarily because of the time to build and deploy the tunnel boring machine. While the tunnel is more expensive, both options have reasonably comparable use of local labour and expertise.

1.3.4.2 Operability

Both bridge and tunnel can be operated using standard practices commonly used both here and overseas. A tunnel entails higher operating costs over the life of the asset, due to the extra venting and safety requirements. The incrementally higher operating costs of the tunnel, however, are insignificant relative to the present value total cost of the two options.

1.3.5 What are the timing options?

A conceptual framework was developed to consider the ideal timing of the AWHC, which considers the following three broad areas:

- *The impact of timing on unlocking Auckland's economic development:* Accelerating the AWHC is more viable if it materially improves the speed with which Auckland's economic development improves. This would occur if the AWHC relieved congestion and allowed the transport network to support additional transport demand arising from the commensurate level of increased economic activity. The current modelling exercise indicates that additional complementary network reinforcement may be required over the longer-term in order to do this, and next stages of investigation should identify whether such complementary improvements are viable without undue expense. If so, then the case for the AWHC to be a major contributor to Auckland's economic development is stronger, and the case for undertaking it sooner is stronger.

- *The potential for the AWHC to act as a fiscal stimulus and to support the New Zealand heavy construction sector*: The broader construction sector in New Zealand is currently in a weak position, and bringing the AWHC forward may support the construction sector. However, in contrast the heavy construction sector is not in a weak position, and by the time any accelerated AWHC is consented and construction-ready, the construction sector may be in the midst of a cyclical upswing. The key questions that require further attention in next stages of the study are: (i) whether it would make a material difference to New Zealand's economic growth; (ii) whether that part of the construction sector warrants additional stimulus; and (iii) how much spare capacity exists to absorb extra work without creating cost pressures.

- *The effects of timing on the overall value for money of the AWHC:* If accelerating the AWHC results in materially lower costs or a better return on government investment, there may be an argument for bringing the construction start date forward. Financing for construction is unlikely to be available before 2014/15, and although short-term interest rates are presently very low, longer-dated debt, such as government 10 year bonds is less 'cheap', and so the 'low cost of financing' argument for bringing forward the project may be less persuasive. It is not clear what path construction prices in the post global financial crisis economy will take over the next decade, but if there is a sustained downturn in roading construction because of governments' high debt levels following the current stimulus packages then the New Zealand government could secure a relatively competitive price, pushing the BCR up relative to current construction timing.

Because of the higher consenting risk of a bridge (a bridge could take 1–2 more years to take through a consenting process than a tunnel and has a greater risk of not obtaining consent at all), a tunnel is more likely to proceed if acceleration is strongly desired. There may be additional benefits from accelerating the design, consenting, funding and construction of the AWHC, but this is far from certain, and it is not yet possible to suggest how large any potential benefits might be. Further analysis is required before a recommendation can be made.

If Auckland has a considerably different set of preferences to the New Zealand-focused analysis of benefits and costs, it may be appropriate that these preferences be backed up by a regional contribution towards achieving a different outcome.

1.3.6 Conclusion

The preliminary benefit-cost ratio (BCR) for the defined bridge and tunnel options is up to 0.6 for a bridge and 0.4[1] for a tunnel (including agglomeration benefits). These BCRs should be viewed in the context of the wider need for a new crossing and the potential funding opportunities and the work completed to date has further confirmed the viability of funding the infrastructure through a range of funding mechanisms. The present value cost difference of a bridge is $410 million less than a tunnel.

There are, however, other important factors in the analysis that are more difficult to quantify at this point that have the potential to partially close the gap between bridge and tunnel. These include issues such as visual, noise and air quality impacts for residents in the vicinity of a bridge, functionality for marine industry and marine recreational users of Westhaven and Wynyard and the fact that the Waitemata Harbour is part of the Department of Conservation–administered Hauraki Gulf Marine Park. These factors impact in particular on the ability to consent the crossing with minimal risk to the design approach that NZTA would wish to take for a given form of crossing.

While a large number of mitigation costs have been included in both options, the outcome and requirements imposed from a consenting process are riskier for a bridge compared to a tunnel. These risks are likely to have a greater impact under scenarios where the NZTA would like to advance the crossing in the medium as opposed to the long-term.

The funding options that are available for this project indicate that either form of crossing could be funded. In particular, there is sufficient capacity, especially given the level of toll revenues possible, to reflect any preference that the region may have to advance the more expensive tunnel option.

[1] See section 7 for more discussion on the agglomeration benefits relating to the BCR.

2. Project Objectives and Scope

The focus of the Additional Waitemata Harbour Crossing (AWHC) study is to provide information and analysis to assist with protecting the route for the additional crossing. The critical output of this Preliminary Business Case is the investigation of the options for form of crossing.

Determination of form of crossing is a prerequisite to the future advancement of the case for the crossing itself, and the narrowing down of funding and procurement options. The issues of the case for the crossing, funding and procurement are explored at a high level only in this Preliminary Business Case, in order to provide context and focus for the discussion around form and to provide the starting point for further work.

This Preliminary Business Case has been prepared in line with the NZTA's Economic Evaluation Manual (EEM) and takes into account the Treasury's Better Business Cases for Capital Proposals Toolkit. Both documents provide a framework for progressing analysis on the relative merits of the different forms for the crossing.

In considering the alignment of this Project with the Treasury and EEM guidelines, it must be noted that this Preliminary Business Case does not present a request for funding and does not represent the finalised and optimised case that would accompany a case for funding. However, it is intended to take a significant step in developing that analysis, and on that basis, effort has been made to align the analysis with Central Government guidelines.

The Treasury guidance requires a "Five Case Philosophy" for preparing a business case. These five cases require that a proposal:

1. is supported by a robust case for change – the **'strategic case'**
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The Treasury states that the five cases are not discrete deliverables. They are embedded within the analysis and are an organising structure.

2.1 Background - Organisational Overview

The NZTA is the Crown agency responsible for contributing to an affordable, integrated, safe, responsive and sustainable land transport system. This role involves:

- the planning and funding of land transport;
- the enforcement of laws, regulations and rules;
- the collection of revenue, and
- building, operating and maintaining land transport systems.

Effective roading infrastructure is vital to New Zealand's economic wellbeing. One of NZTA's roles in managing New Zealand's state highways includes the identification of and response to opportunities to improve safety, capacity and efficiency on our roads. One of the NZTA's key goals is to support economic growth and productivity throughout New Zealand.

2.2 Integrated Planning

Integrated planning is a key approach to meeting the requirements of the 2003 Land Transport Management Act (LTMA) and the Government Policy Statement (GPS). The benefits of an integrated transport planning approach are that:

- decisions relating to land-use, transport and urban design collectively contribute to the efficient use of public funds; and
- transport strategies and packages of activities are developed alongside land-use strategies and implementation plans.

Transport and land-use are intrinsically connected. Land-use activities result in movement of people and goods. The location and design of different land-uses strongly influence the distances people travel as well as the viability of PT, cycling and walking facilities. Patterns of development that reduce journey distances tend to provide greater travel choices.

Integrated land use/transport planning involves:

- considering the movement needs related to future growth when planning the transport system
- protecting future transport corridors and networks to support planned development
- considering the impact of urban growth on the wider transport network
- creating opportunities for better integration within and between transport modes
- making better use of existing infrastructure
- assessing the benefits and costs of transport packages as a whole, taking into account strategic and tactical factors
- developing a range of alternatives and options to achieve economic, social and environmental outcomes
- addressing both the supply-side (the need for additional transport system capacity) and the demand-side (reducing pressure on available capacity)
- responding appropriately to community aspirations and those affected by potential transport investments
- delivering solutions that represent value for money.

The Network Plan describes how integrated land-use and transport planning, and the objectives of the Government Policy Statement for Transport (GPS), will be achieved by the AWHC project.

It sets out the steps to determine the most effective investment in transport in Auckland over the next 20-30 years, considering:

- government priorities;
- affordability that is consistent with a sustainable investment model for Auckland;
- aligning investment levels available from government and other funding sources; and
- meeting expectations for growth levels and economic development.

The Network Plan describes the AWHC in the context of the upcoming Auckland Spatial Plan and that document's role in directing future land use planning and transport infrastructure investment. In particular, the Plan discusses the need to identify hose land-use patterns that are most likely to support and reinforce transport investments such as the AWHC (and vice versa), and take steps to ensure that land-use development does not compromise the transport network by diluting the benefits of existing and future investment.

3. Description of Service Need

The description of service need establishes the problem that this Preliminary Business Case is attempting to address. The aspects of service need explored focus on the need for an AWHC and the need to identify the preferred form.

3.1 Background

The AWHC Project (the Project) progresses the outcomes of previous studies undertaken for an AWHC. The 2008 Waitemata Harbour Crossing Study considered a wide range of options for developing a new harbour crossing, intended to operate in conjunction with the existing AHB.

In December 2009, the NZTA and KiwiRail served a number of Notices of Requirement (NORs) to seek designations within both Auckland City and North Shore City District Plans for the protection of land to allow the construction of both a driven twin tunnel road crossing and a driven twin tunnel rail crossing.

Following the outcome of the evaluation, the serving of the NORs and the publication of the Treasury's National Infrastructure Plan (NIP) in March 2010, the NZTA is further developing the Preliminary Business Case for the AWHC. The development of the Preliminary Business Case has been split into three separate, concurrent work streams; PwC and NZIER are delivering the economic advisory services, funding options and the overall Preliminary Business Case; Sinclair Knight Merz (SKM) and Flow Transportation Specialists (Flow) undertook the transport and toll modelling; and Beca and AECOM provided engineering, planning and design services. The project has built on previous studies and existing information to provide the NZTA with a more detailed engineering investigation of bridge and tunnel options, including capital and operational costs, connectivity, consentability, constructability and functionality.

3.2 Current AHB Corridor Constraints

The AHB, opened in 1959, is the only road crossing of the Waitemata Harbour near the CBD. The NZTA's long-term aspirations for the AHB focus on managing the main structure and extension bridges[2] to ensure that the bridge provides the connectivity needed to cater for all vehicles crossing the harbour.

To manage the transport demands of current and predicted future growth for freight, commuters and PT, there is a need to improve network capacity within this corridor. The AHB currently provides the only direct, cross-harbour vehicle link between the CBD and the North Shore.

The key elements contributing to the need to improve capacity and resilience within this part of Auckland's transport network are:

- Population growth and land-use intensification in the Region resulting in increases in total daily flows across the Harbour for light and heavy vehicle movements;
- The subsequent increase in demand for the use of the corridor which adversely impacts on the length and reliability of travel times;
- An increase in demand for the Northern Busway and a desire to create a passenger transport system that increases mode share (including rail);
- Reliance on a single structure (the AHB) as the only "cross-harbour" vehicle link between the CBD and the North Shore;
- Constraints in the long-term management of freight on the AHB; and
- An aspiration to provide cyclist and pedestrian access across the Waitemata Harbour.

[2] Sometimes referred to as clip-on lanes.

3.2.1 Expected Future Traffic Volumes

The AHB currently carries on average 168,000 vehicle trips per day. Traffic modelling forecasts[3], based on figures from 2008, for 2026 and 2041 indicate that vehicles trips across the Waitemata Harbour will continue to increase. The total vehicle trips per day across the AHB are predicted to increase by 18% between 2008 and 2026. Modest growth is predicted between 2026 and 2041, with 2041 flows predicted to be around 22% above the 2008 flows.

The daily traffic flows for 2008, and those predicted for 2026 and 2041 are shown in Table 2 below:

Auckland Harbour Bridge	2008 (Vpd)	2026 (Vpd)	2041 (Vpd)
Northbound	82,890	99,530	101,210
Southbound	85,260	98,300	103,990
Total Vehicle Trips	**168,150**	**197,830**	**205,200**

Table 2: Daily Cross-Harbour Vehicle Trips (in Vehicles per day (Vpd))

This increase in vehicles will impact on the productivity of both freight and commuter journeys to work. The current LOS during peak periods is at level E/F on the AHB, which represents the most congested LOS measured. As such, the crossing is one of most congested links within the Auckland network. The forecast growth in demand will further impact productivity, which will have implications for work choices, timing of freight trips, and will distort patterns of economic activity.

The effect of the Victoria Park Tunnel (VPT) changes (due in 2012) will relieve congestion in this approach to the AHB which will then make the AHB an area of capacity constraint during the contra-peak.

Providing a dedicated harbour crossing for rail would allow a significant improvement in PT across the harbour, providing benefits to the regional economy and the transport network. It is therefore necessary to continue the investigation of rail and to protect the ability for the future introduction of rail between the North Shore and the Auckland Isthmus. The timing for a harbour rail crossing is linked to the ability to connect to the rest of the Auckland rail network. The design of rail is constrained differently to road (having different geometric and gradient requirements). These constraints limit the ability to provide road and rail on the same structure. Any decision on the preferred cross-harbour alignment for rail should be undertaken in conjunction with decisions on the appropriate form for a road crossing so as to allow flexibility in the timing for provision of a rail crossing. For this reason, an AWHC which allows for the separation of the road and rail components best provides this flexibility and addresses the different design constraints.

3.3 Demand on the Northern Busway

The Northern Busway currently provides a dedicated, high capacity, passenger transport facility on the North Shore (between Albany and Onewa Road) and uses general traffic lanes over the AHB and bus lanes/shoulders into the Auckland CBD (with VPT). The Northern Busway has experienced strong growth in demand over the last five years and the number of services has increased during peak hours[4]. The Busway currently carries approximately 5,000 passengers per hour in the peak periods[5]. In 2009, a total of 185 buses operated daily along Fanshawe Street city bound in the morning peak (7 - 9am), with a peak hour flow of approximately 105 buses per hour.

[3] Additional Waitemata Harbour Crossing: Do-minimum Saturn Models, 15 September 2010.

[4] Northern Busway Corridor Capacity Study, August 2010.

[5] Page 2, Draft Northern Busway Corridor Capacity Study 2010 Update, August 2010.

Forecast demand for the Busway indicates that the morning peak hour flows into the CBD could increase to 250 buses per hour in 2041, representing a 138% increase over the 2009 volumes. This figure is the recommended target capacity for the Busway system, representing 12,000 passenger movements per hour[6]. However, achieving the target capacity is currently hindered by capacity constraints close to the CBD where the provision of dedicated bus facilities is more expensive and bus volumes are at their highest. One of the advantages of a new crossing would be the ability to have dedicated bus lanes across the AHB which would maintain a high level of trip reliability for passenger transport users.

The Northern Busway Corridor Capacity Study 2010 Update[7] provided recommended measures to improve CBD capacity for the Busway. The report identified that the development of additional bus infrastructure between the Northern Motorway and the CBD is critical for extending the life of the Busway.

Within the CBD, there is limited capacity to increase bus volumes, particularly on narrow streets. As the CBD grows, there will be an associated sustained growth in pedestrian activity with a resulting need to improve pedestrian priority in the CBD. Bus movements will impact on the ability to provide facilities as bus numbers increase. The potential future conflict between PT and urban amenity could be alleviated by shifting to PT systems that support higher densities and higher transit mode share (such as rail).

3.4 Network Resilience

A more resilient network is one that is:

- Able to deliver more reliable journey times through improved connectivity, traffic separation and increased capacity;
- Able to provide components which can change function to ensure the system does not fail if a component(s) fail;
- Able to deliver business-as-usual demand in a more diverse way;
- Subject to a lower risk of “catastrophic failure”;
- Able to limit the impacts of any network problems or failures; and
- Able to recover from any problems more quickly.

The AHB currently provides the only “cross-harbour” road link between the CBD and the North Shore. The alternative route across the Upper Harbour Bridge (UHB) is long (in terms of journey time) and travels around the western edge of the harbour via SH16. The Auckland Region is heavily reliant on the AHB for the transport of goods and people and this reliance will only increase as vehicle numbers increase. This growth is leading to network resilience becoming an increasingly important issue.

The NZTA’s long-term aspirations for the AHB focus on managing the main structure and extension bridges to provide the continuing connectivity needed to cater for all vehicles crossing the harbour. In 2006[8] the NZTA completed a structural assessment of the AHB extension bridges. Strategic management of the AHB will ensure its prolonged life as a critical link, however, indications for loading restrictions in the future will impact on its efficiency and ability to provide for future demand. This will have an increasing impact on the efficiency and effectiveness of freight movements between the Ports of Auckland and the North.

[6] Page 2, Draft Northern Busway Corridor Capacity Study 2010 Update, August 2010.

[7] Draft Northern Busway Corridor Capacity Study 2010 Update, August 2010.

[8] AHB Extension Bridge Strengthening Design Report, April 2009.

Any reduction in the capacity of the AHB due to major structural repairs or upgrading, incidents on the network, or damage from natural hazards would cause significant disruption to cross-harbour accessibility. There is strong evidence from international studies that where resilience is low, the potential economic impacts of a catastrophic failure can run into hundreds of millions of dollars[9].

3.5 Freight Management

Around 25% of all freight traffic in New Zealand occurs within the Auckland Region and therefore freight efficiency in Auckland has national implications[10]. The freight industry accounts for 6% of the regional GDP and 5% of employment. Almost all freight within the Region is transported by road (around 250 million tonnes in 2002)[11]. Road freight also dominates movements between Auckland and other regions, accounting for about 60% of total traffic (around 10 million tonnes in 2002). The Port of Auckland is New Zealand's busiest port, handling around 43% of the country's container trade[12]. Currently, any overweight vehicles utilising the Port of Auckland to travel north inter regionally (between regions) are required to cross the Waitemata Harbour either utilising the AHB or the UHB. The AHB corridor (bounded by Onewa Road ramps to the north and Fanshawe Street on/off-ramps to the south) is therefore a key cross harbour route for inter and intra (within the Region) regional freight.

In 2006, the Auckland Regional Council (ARC) prepared the Auckland Regional Freight Strategy to respond to the changing demands for freight as the region grows. The Strategy identified congestion as the key issue for the regional freight transport industry, along with the significant costs on the industry. The Strategy quotes a 1997 study[13] that estimated the annual congestion cost to Auckland's manufacturing and distribution sectors at around NZ$100 million due to delays and inefficiencies in the delivery of goods and services, and $185 million per annum in the overall Auckland economy.

The SH1 corridor between the CBD and the North Shore is a key part of the freight network and currently serves as the main connecting route between Northland and Waikato. In 2002, intra-regional freight accounted for 500,000 vehicles trips per day for the Auckland Region[14]. Historical records of heavy vehicle counts for the AHB indicate a 4% average compound growth until recently, with short-term fluctuations related to economic conditions and construction activity. The growth in freight transport has a close relationship with regional economic and population growth and therefore, as the Auckland region continues to grow, heavy vehicle numbers will also increase.

In recognition of the important role that the AHB plays in cross-harbour freight movement, the NZTA has prepared a Freight Management Strategy for the AHB[15]. The strategy sets out future management strategies for freight on the AHB and will assist, in the short-term, to manage the pressures facing the AHB. One of these pressures is the impact of heavy vehicles on the fatigue life and load capacity of the bridge decks.

These issues mean that the AHB is currently managed within a constrained environment including:

- Restrictions on use of the extension bridges by overloaded and high productivity vehicles if the AHB is identified as part of the High Productivity Vehicle network; and

- Restrictions on times of travel for over dimension vehicles.

In addition, heavy vehicles also elect not to use the single narrow lane on the truss bridge (created by 'tidal' lane arrangements) which redistributes heavy vehicles to other lanes on the AHB.

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9 PwC, Technical note dated 26 August 2010. References a 2010 study by Hyder (Network Resilience

and Adaptation) undertaken for the UK DfT.

10 *Auckland Regional Freight Strategy*, Auckland Regional Council, 2006.

11 *Auckland Regional Freight Strategy*, Auckland Regional Council, 2006.

12 *Draft Auckland Harbour Bridge Freight Management Strategy*, NZTA, September 2010.

13 Ernst & Young. (1997). *Alternative transport infrastructure investments and economic development for the Auckland region*.

14 Auckland Regional Freight Strategy 2006, Page 21.

15 AHB Freight Management Strategy, April 2010.

As freight vehicle numbers increase, compounded by increases in light vehicle numbers, these constraints will continue to affect freight efficiency on the AHB into the foreseeable future.

3.6 Active Modes

Walking and cycling access across the Waitemata Harbour is currently provided through ferry services. Pedestrians and cyclists are not permitted to travel across the AHB. The alternative for cyclists is a route west via SH16 and SH18.

The New Zealand Transport Strategy 2008 (NZTS), GPS on Land Transport Funding, Auckland Regional Growth Strategy (RGS) and the Auckland Regional Land Transport Strategy (RLTS) all seek to facilitate increased walking and cycling to promote environmental, health and economic benefits.

3.7 Future Transport Network Development

The predicted future growth of the Auckland Region will increase the demand for transport, placing further pressure on the already congested transport network. There is currently limited capacity on heavily congested parts of the existing roading network, which has the potential to diminish economic growth in the Region and inhibit connectivity between Auckland and the Northland, Waikato and Bay of Plenty regions. The transport corridor between the Auckland CBD and the North Shore, including the AHB, is a section of the network that will become increasingly congested.

There are a number of upgrades between the CBD and the North Shore either underway or proposed, including:

- Victoria Park Tunnel (VPT), will provide three lanes northbound (within the new tunnel) which will connect with the St Marys Bay section of SH1 where it will become five lanes northbound.
- Improved access to Wynyard Quarter involving the reconfiguration of Beaumont Street.
- Upgrades to Onewa Road including the continuation of an existing transit lane along Onewa Road and a shared cycle and footpath along the northern side of Onewa Road.
- A number of other local network changes have been identified as part of the draft AWHC Network Plan[16].

Previous studies recognised the contribution an additional crossing would make in improving the accessibility and resilience of the Auckland transport network and facilitating the predicted future growth in the region. Strategies for Auckland's transport network have sought to increase cross-harbour capacity including PT links between the North Shore and the CBD. These strategies identify the need for an AWHC and the need to identify and protect the route.

In addition, the proposed CBD rail loop represents a significant increase in overall network capacity benefiting both road and rail users of the Auckland region.

3.8 Addressing Future Constraints

The issues identified above present the context as to why providing additional cross harbour capacity is being considered. The economic impact of the do-minimum is effectively that economic activity is forgone, which can be demonstrated by the economic benefits of the crossing. In addressing the likely future constraints on the AHB, the NZTA has two potential options:

- Replace the AHB with a new crossing with increased capacity (i.e. a single crossing); or
- Supplement the AHB with an additional crossing.

[16] Draft AWHC Crossing Network Plan: Local Roads, September 2010.

Both of the above options would have the benefit of increasing the capacity of the road network. This would enable additional vehicles to cross the harbour in the peak hour, thereby reducing the duration of the peak period. They would also provide increased cross-harbour accessibility for all modes, including freight and general road traffic, rapid transit, walking and cycling. This would enable predicted future travel demands to be accommodated within the network. Improving the capacity and reliability of the transport network would encourage economic development and facilitate growth.

3.9 Wider impacts on the New Zealand economy and competitiveness

The cost-benefit appraisal (CBA) of the additional crossing is a "bottom up" analysis of the potential economic impact of the crossing. The analysis uses a well-established methodology to assess the direct benefits of transport projects.

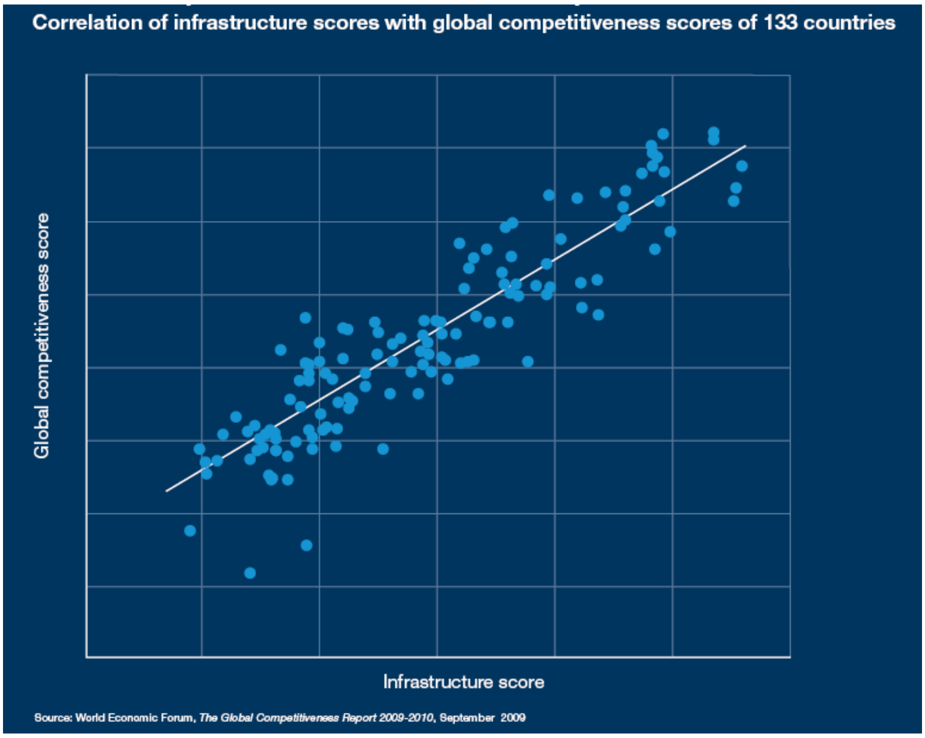
One potential criticism of this approach is that it may omit transformational economic impacts. These impacts are often very difficult to quantify, and as Eddington (2006) observes, "the evidence for such impacts is at best, unproven"[17]. There is, however, a strong body of economics literature on the potential economy-wide impact of transport investment.

Some of these gross domestic product (GDP) impacts have been traversed by the discussion on direct and wider economic benefits (WEBs) above, but there is some merit in considering the potential economic impact from a "top down" perspective. This top down view provides useful context and additional information, but it is important to note that by its very nature includes all of the economic impacts discussed using the conventional BCR and WEBs approach.

3.9.1 Infrastructure matters in terms of international competitiveness

There is a correlation between infrastructure investment and global competitiveness, as shown in the recent World Economic Forum Global Competitiveness Report 2009-2010 in Figure 1 below:

Figure 1: Correlation of infrastructure scores with global competitiveness scores



Source: World Economic Forum Global Competitiveness Report 2009/2010.

[17] Eddington Transport Study 2006, HM Treasury, p.133

New Zealand presently ranks 18th in overall global competitiveness, but 34th in terms of our infrastructure score. All countries with a higher overall competitiveness score also rank more highly than us in terms of infrastructure.

World-class infrastructure can give a country a competitive edge. Evidence indicates that infrastructure investment is positively related to the competitiveness of a country, but it is difficult to attribute causality[18]. A study in 1989 (Aschauer) found that for the United States economy a 1% increase in the stock of public sector capital could boost GDP by 0.38% to 0.56% annually. Subsequent studies suggest a weaker link between infrastructure and growth.

Although there is considerable variance in the empirical evidence, the studies are broadly consistent with the conclusion that a 1% increase in public capital stock could result in a one-off, sustained increase in GDP of 0.2% for a developed economy. The varying returns offered from these studies indicate the importance of targeting investment in the right place (Eddington Transport Review, 2006).

The AWHC will play a key strategic role in the future of the Auckland economy and that of New Zealand, given Auckland's major role in the national economy. It also sits alongside other major infrastructure investment proposals for the Auckland transport network including the CBD rail loop, Waterview Connection, and other rail projects. This suite of potential investment is of such scale and significance that it would be expected to impact economic growth across New Zealand.

A hypothetical estimate suggests that a $7 billion investment in a package of Auckland infrastructure would account for a 1.8% rise in the Crown's capital stock in 2026 (given a growth rate in capital stock similar to that seen over the last nine years). This step-up in capital stock would be expected to generate a step increase in GDP of around 0.36%.

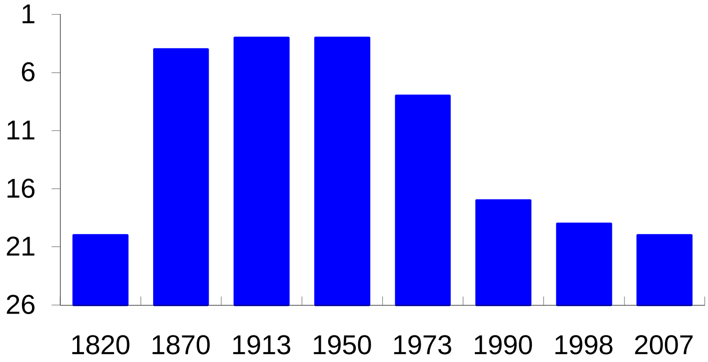
Assuming New Zealand's GDP grows at an average rate of 2.5% a year by 2026 (as recorded across the last business cycle (2000 to 2010), it will be approximately around $562 billion. An increase in GDP of 0.36% equates to $1 billion in stimulus to the national economy in the first year of an implemented package.

Within seven years, the undiscounted value of the additional GDP facilitated by a significant investment in Auckland infrastructure is $7.66 billion.

3.9.2 Relative economic performance matters

Typically, nations measure their economic development not only in nominal terms, but also relative to other nations. Essentially, we measure our wealth and performance against countries we want to be like. In New Zealand, we usually discuss our position relative to other Organisation for Economic Co-operation and Development (OECD) countries. In recent times, we have been in the bottom half of the developed OECD nations and much political debate has centred on how to return to the top half of OECD nations.

Figure 2: OECD rank on per capita basis

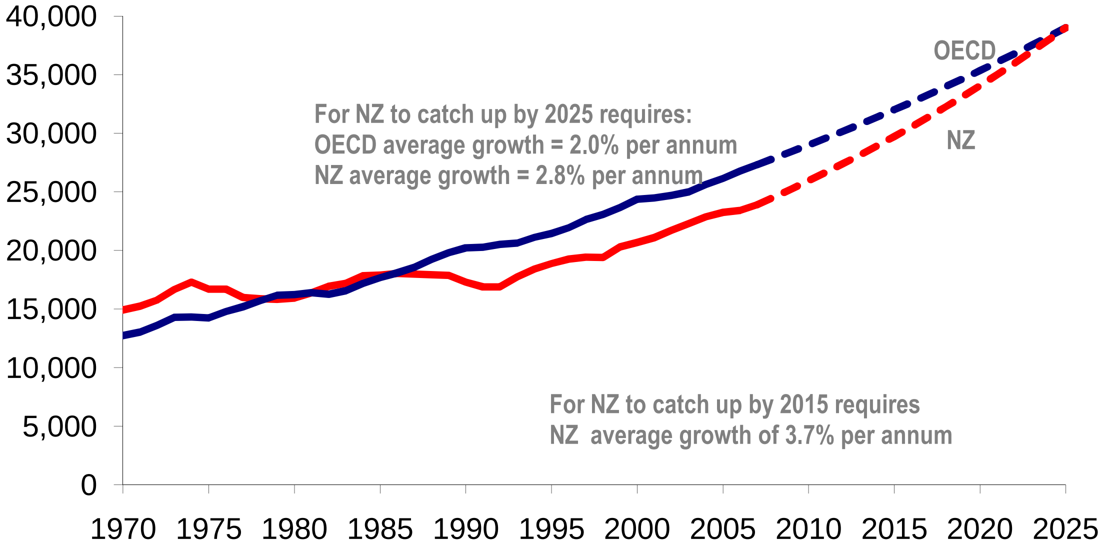


Source: OECD.

[18] That is, whether infrastructure quality causes an improvement in competitiveness, whether greater competitiveness causes more world-class infrastructure (because it is relatively more affordable), or whether some other factor(s) cause improvements in both competitiveness and infrastructure quality.

To return to the top half of the OECD, we not only have to grow our economy, we have to grow at a significantly faster rate than those countries ahead of us.

Figure 3: GDP per capita growth (US$)



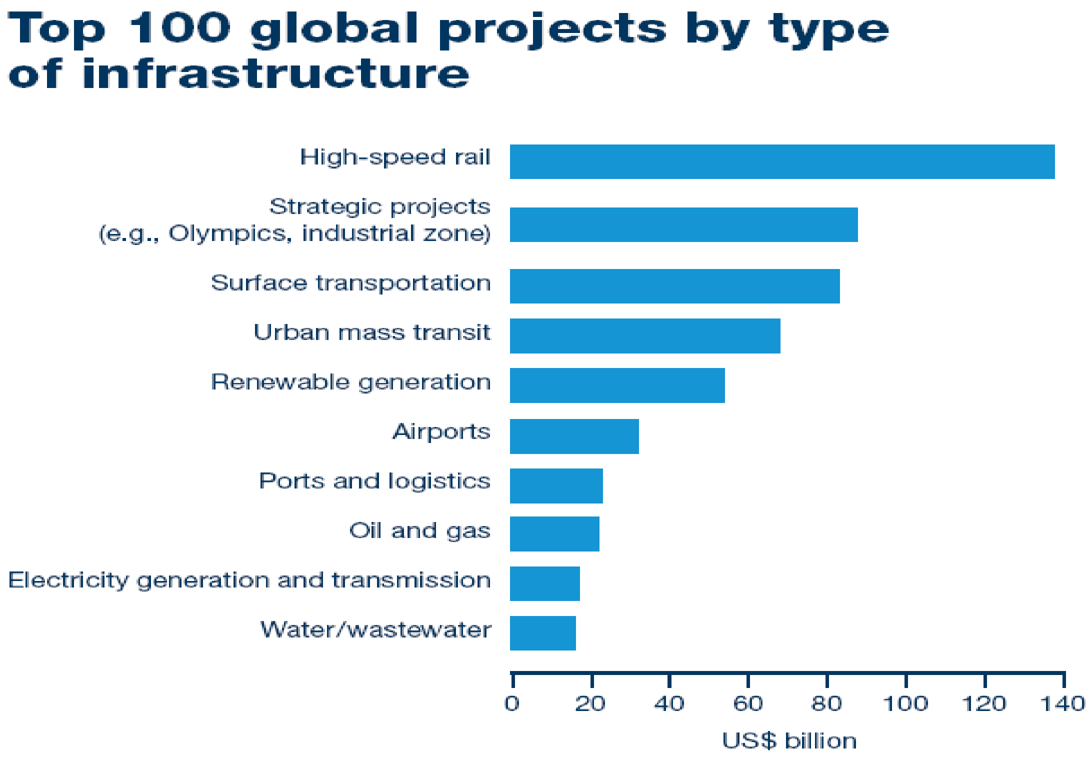
Source: OECD and ANZ National Bank.

3.9.3 Infrastructure investment is a key area of focus globally for economic development

As part of their plans to stimulate their economies, many countries - including Australia, China, Mexico, and the US - have announced plans to step up infrastructure spending. As they increasingly compete for business, nations, states, provinces, and cities are also investing in their infrastructure. The OECD estimates that the world's infrastructure investment needs for energy, road and rail transport, telecommunications, and water are likely to average 3.5% of world GDP through 2030, or about US$71 trillion.

The Asian Development Bank estimates that the payoff for US$8-trillion investment in Pan-Asian transportation, communications, and energy infrastructure would be real income gains of US$13 trillion over the next decade and beyond. Mature economies can maintain their competitive edge and continue to attract businesses and people only via continued infrastructure investments.

Figure 4: Top 100 global projects by type of infrastructure



Source: CG/LA Infrastructure, Top 100 Strategic Infrastructure Projects, November 2009.

The AWHC has been identified via the NIP as a part of New Zealand's response to the economic development issues outlined above.

4. Key Assumptions

Key assumptions for the Project that have been determined and are discussed and explained in this section. Particular reference will be made to the potential limits assumptions have had in the decision making process and any considerations that need to be made for future studies.

4.1 Assumptions around the Do-Minimum

The NZTA has an active management regime in place for the AHB which is focused on managing the main structure and extension bridges so that they will continue to provide the connectivity needed to cater for all vehicles crossing the harbour. As a result of the current strengthening work on the extension bridges (which will be completed in 2010) combined with active management, the NZTA expects to maintain the extension bridges indefinitely. This will involve some degree of ‘management’ of freight, which was not modelled in the ART3 analysis, and thus there are benefits from an additional crossing that are not included in the BCR. How great such benefits may be is not yet clear without further analysis.

The do-minimum scenario modelled is as outlined in the EAS Report in Appendix A. It generally involves:

- no further access restrictions on the existing AHB over-and-above today, and no additional maintenance or operating costs relative to the option scenario
- all projects in the RLTS are assumed to occur, including the CBD rail loop and the airport rail link (refer to Appendix H in EAS Report).

4.2 Assumptions around the Engineering Options

A workshop was held in June 2010 with representatives of the NZTA and each of the Project work streams to define the objectives, principles, assumptions and constraints of the project. The Project scope and design assumptions that resulted from this workshop are outlined below:

Scope Assumptions:

- New and existing motorway route CMJ to Esmonde Road.
- Northern motorway widening to 4 lanes from Northcote Road to Esmonde Road included.
- The existing bridge is retained. Additional capacity is provided by a separate adjacent structure. Reconfiguration of lanes on existing bridge included.
- Options generally follow concepts covered by Option 2 in 2008 study but form and location flexible. Options consider compatibility with Victoria Park Tunnel.
- General traffic, rail PT, bus PT, walking and cycling modes provided for.
- Full connectivity to be assumed (including Onewa connections).
- Rail - route between Gaunt Street Station (underground) and Akoranga Station (at grade).
- Rail - extent of rail infrastructure: Akoranga to Gaunt Street.
- Rail stations - no station at Onewa. Akoranga and Gaunt Street Stations assumed but design not required. Study area stops at the start of the stations. The Gaunt Street Station box is not included. The Gaunt Street Station termination is common to all options.

- Rail - for modelling – assume Gaunt Street rail station will connect to Sky City/Albert Street (CBD loop).
- Tolling includes cost estimates capital and operational work. Existing Toll System (back office) to be used.
- Property Acquisition/effects cost estimates are provided by NZTA/The Property Group based on land take plans.
- “Base” options:
    - all tunnel Notice of Requirements (NOR) alignment (driven/immersed tube options)
    - all bridge options are generally on the NoR alignment (south landing options)
    - bridge and tunnel (road bridge east of and adjacent to existing AHB and rail tunnel)
    - bridge and tunnel (on alignment to Wynyard).

Design Assumptions:

- AHB will not be removed.
- New road tunnel/bridge crossing 3 lanes each way.
- NoR concept design for Onewa Road and Esmonde Road interchanges best achieve project objectives, layout can be optimised if required in later preliminary and detailed design stages.
- Some network resilience is provided by slow speed traffic connections between existing bridge and SH1. Layout can be optimised if required in later preliminary and detailed design stages.
- New bridge navigation clearances to match existing AHB and/or to provide for Super Yachts at Wynyard Quarter.
- Walking and cycling modes are not suited to a tunnel. Will be provided on existing bridge lane for road tunnel options or on the new or existing bridge.
- A new building located at old ATTOMS (Auckland’s Traffic Management Centre) Stafford Road site will be required for road tunnel controls. Rail tunnel/bridge controls and costs provided by KiwiRail.
- New rail crossing with 1 commuter track each way.
- Electrified suburban rail vertical gradient between Akoranga and Gaunt Street is a maximum of 3.5% for Electric Multiple Units (EMUs).
- General standards and type of rail and units are similar to the electrified suburban rail proposed for the CBD loop. Excludes freight.
- Earliest implementation consideration of rail is dependent on the CBD loop (as per RLTS 2021).
- Retrofitting road tunnel to accommodate rail is not practicable/cost effective.
- General traffic and bus PT continue on the existing bridge.
- Victoria Park Viaduct is ultimately removed.

- Design life for works represented in options and design standards will not be changed by modelling or economic assessment time periods.
- Cost estimates are based on a design and construct (D&C) construction method.
- Operating and maintenance cost estimates to be over 30 year period from completion of construction.
- Tunnel Geometrics – Lane and Shoulder Widths :
    - 3-lane – 0.5+3.5+3.5+3.5+0.5 metres
    - 2-lane – 1.0+3.5+3.5+0.5 metres
- Tunnel Geometrics as per NoR:
    - Crossfall 2%
    - Vertical Clearance – 4.6 metres + 0.3 metres = total 4.9 metres
    - Sway Allowance 0.15 metres at 4.6 metre height
    - Design Speed – 90 kilometres per hour (kph) (posted 80 kph)
    - maximum grade – 5% mainline, 5% up ramps, 7% down ramps.
- Tunnel - Fire Life Safety design based on 2 hour hydrocarbon curve fire event. In accordance with the World Road Association (PIARC) systems and equipment 2007.
- Management of Harbour dredging limitations/issues – Ports of Auckland Limited (POAL) Maximum 50,000m³ per annum.

Part A of the Form Assessment Study Report (FASR) outlines the Project context based on the project objectives and principles as well as these Project scope and assumptions.

4.3 Assumptions for Economic Analysis

The following sections outline the key assumptions applied in the economic analysis, which is reported in section 7.

4.3.1 Development of the capital and operational cost estimates

Further information on the capital, maintenance and operating costs estimates is contained in the FASR in Appendix C. The cost estimates used throughout the economic analysis exclude cost escalation.

4.3.2 Transport modelling key assumptions

- Two levels of transport modelling were undertaken: regional transport modelling using the ART3 model for the CBA and toll modelling and more detailed operational modelling using the Simulation and Assignment of Traffic to Urban Road Networks (SATURN) model for assisting the design team with ensuring the specification of the AWHC options (e.g. connections to the rest of the transport network) were fit for purpose. (The SATURN modelling was not an input to the economic analysis). Full detail on the methodology and assumptions used for the modelling are Transport and Traffic Model Report in Appendix F. The key assumptions for the ART3 modelling are: generally all projects in the RLTS are assumed to occur, including the CBD rail loop by 2026, the airport rail link and the Northern Busway extension to Orewa by 2041.

- No further access restrictions on the existing AHB over and above today and no additional maintenance or operating costs in the do-minimum scenario relative to the option scenario.

- Sensitivity analysis was undertaken for a range of modelling inputs and assumptions:

  - Three land-use scenarios were considered and the transport modelling results did not vary greatly between these scenarios. Therefore, the RGS land-use was used, and it is the same for the do-minimum as for the option.

  - Three scenarios for other inputs were considered and the transport modelling results varied notably. The CBA is based on modelling that assumed increases in fuel prices, values of time, parking costs and PT fares, an improvement in vehicle efficiency and excluded transport demand management (TDM) effects.

  - Modelled travel time, VOC, CO^2 and PT benefits as per the EEM and estimated congestion and reliability benefits by applying fixed proportions to the travel time savings benefits based on a previous appraisal that modelled such impacts.

4.3.3 Key assumptions for the CBA and broader economic analysis

The CBA was undertaken in accordance with the NZTA's EEM. Key features and assumptions are:

- The appraisal used the variable matrix approach.

- Congestion and reliability benefits were not modelled; congestion and reliability benefits were assumed, and estimated as 26% and 3% of travel time benefits respectively (based on benefits from a recent evaluation in Auckland).

- An 8% real (inflation adjusted) discount rate is applied and sensitivity assessments of 4% and 6% undertaken.

- The baseline 30-year appraisal period (from start of construction) requirement was strictly adhered to, but was extended in a variety of ways for the 4% and 6% discount rate sensitivity assessment.

- Both crossing options were assumed to open in 2029, and a common 6-year construction period was assumed for both options so that the BCRs for both are comparable.

- Dollar values for impacts are as specified by the EEM.

- The agglomeration benefits were calculated using the procedure in the EEM, outputs from the transport modelling, and economic growth projections based on NZIER's economic forecasts tailored to suit.

- The UK DfT's procedure for estimating the WEB of 'increased output from imperfectly competitive firms' was applied under guidance from the NZTA National Office and included in the CBA as a sensitivity test.

- The visual impact appraisal used rough estimates of property numbers and property values within a potential visual catchment of the bridge, differentiated by high and medium impact, and applied to this was a range of hypothetical values (0%–20%) to represent a plausible range of visual detriment. The visual detriment was assumed to commence in 2025.

- Air pollution appraisal used a Ministry for the Environment guideline for assessing health effects depending on proximity to the bridge and tunnel. International literature identifies estimates on property values between 0.3%–3%, and an average property value of $900,000 was assumed.

- The noise impact appraisal was based on modelling by acoustic specialists who identified 133 more properties for the bridge option that experience a significant noise increase. The highest of all increases — 14 decibels — was applied to all properties, and valued at $442 per dB per household per year as per the EEM (the $410 EEM figure was updated by price index to align with a 2010 base year).

- The land-use modelling (using the Auckland Strategic Planning ASP3 model) assumes the same regional population and number of jobs for the do-minimum as for the option; i.e. any potential for improved infrastructure to attract people and/or jobs to the region is not modelled.
- BCRs are only produced for the non-tolled options, as the purpose of the toll modelling and financial analysis was not to determine the benefits and costs of tolling, but to address the question of how much revenue could be raised. BCRs for tolled scenarios will be undertaken in subsequent investigation stages.

Much of the economic analysis supporting the conventional CBA such as marina impacts and economic development considerations were informed by a range of sources, including from other teams in the study and from a series of literature reviews contained in the supporting reports.

4.4 Assumptions around the Funding and Preliminary Business Case

The assumptions used in the development of the funding sections of this Preliminary Business Case, which are discussed further in sections 6 and 10, are detailed below.

4.4.1 Development of the capital and operational cost estimates of each additional crossing option

The cost estimates have been prepared using best practice techniques as defined in accordance with the requirements set out in the NZTA Cost Estimation Manual (SM014)[19]. Based on the level of design undertaken on the project to date, the cost estimate is deemed to have OE status.

The tunnel and bridge option cost estimates are based on the project as described in section 5 and are limited to all physical works, from Northcote Road Interchange in the north to the CMJ tie-in at Wellington Street and St Marys Bay to Cook Street and Fanshawe Street connections.

The rail tunnel cost estimate has been prepared and is common to both the tunnel and bridge options. The rail option cost estimate includes all rail at-grade and tunnel works from Akoranga Bus Station in the north to Gaunt Street Station in the south but excludes the stations.

The cost estimate has been assessed assuming a D&C contract tendering procedure. The estimates have a cost base date of 1 November 2010 and all costs are expressed in New Zealand dollars.

Cost amounts are P50 values and are based on current cost estimates and include @Risk analysis in relation to the risk associated with estimation accuracy.

The following items are excluded from the OEs:

- Goods and Services Tax (GST);
- escalation;
- duplication of AHB utility services on the tunnel and new bridge crossings. Space is provided but not the services.

4.4.2 Operational and maintenance cost estimates for the AHB

Operational and maintenance cost estimates were provided by Auckland Motorways Alliance and are based on the total funding request for 2011/12 which includes costs out to 2020/21. Costs beyond this date have been held constant and escalated using the appropriate index.

Major capital works associated with the strengthening of the main truss structure have been estimated to cost between $12 million and $15 million and have been timed to occur in 2011/12.

[19] AWHC, Volume 1: Form Assessment Study Report, October 2010.

4.4.3 Traffic flows and tolling revenue used in funding analysis

The assumptions relating to traffic flows and tolling are detailed in the AWHC Transport and Traffic Modelling Report. The key assumptions include:

- There is the ability to toll either both or one of the crossings (i.e. no debate regarding the potential constraints of current legislation, such as the provision of an alternative free route);
- The following tolling strategies were modelled and included in the financial model to derive revenue for each scenario:
  - tolling of the new crossing only;
  - tolling of the AHB only; and
  - tolling of both the new crossing and the AHB.
- Tolls are uniform across the day, that is, variation by time of day will not be investigated;
- When both crossings are tolled, toll levels will be the same for both crossings;
- A range of toll levels for each strategy was modelled to determine the revenue and traffic flows;
- Each tolling scenario, which ranged from $2, $4, $6, $8, and $10, was increased by the consumer price index(CPI);
- HCVs were tolled at three times the level of light vehicles; and
- Each strategy and tolling level was modelled for two points in time being 2026 and 2041 with linear interpolation and extrapolation for other years.

4.4.4 Assumptions used for the funding model

In order to model the future costs associated with constructing, operating, maintaining and tolling the different options the following assumptions have been used:

Assumption	Source	Value
Financial Year End	30 June	Model assumption
Construction Start Date – Bridge	1 January 2021	Model assumption
Construction Start Date – Tunnel	1 April 2019	Model assumption
Construction End Date – Bridge	31 December 2025 (5 year construction period)	Model assumption
Construction End Date – Tunnel	31 December 2025 (6.75 year construction period)	Model assumption
Operations Start Date	1 January 2026	Model assumption
Operations End Date	31 December 2061 (35 year operation period)	Model assumption
Discount Date (time zero)	1 July 2010	Model assumption

Assumption	Source	Value
Discount Rate	8% (real)	Public Sector Discount Rates for Cost Benefit Analysis, issued by The Treasury, July 2008.
Escalation date	1 November 2010	Model assumption
Operating cost escalation rate - Resurfacing Costs	5.11% (average rate over the life of the project)	Bitumen Price Index (Statistics New Zealand)
Operating cost escalation rate - Non Resurfacing Costs	2.5%	Methodology for Risk-free Discount Rates and CPI Assumptions for Accounting Valuation Purpose, The Treasury, July 2010.
Capital cost escalation rate	4.77% (average average rate over the life of the project)	Construction Index (PPIQ.SNE, Statistics New Zealand)
Toll operating cost	$0.65 per transaction	NZTA memo from Henry Pretorius, Dated 22 July 2010.
GST	Excluded from all model inputs	Model assumption
Bond issuance	Five times rolling annual five year bond issuance from construction start date.	Model assumption
Finance issuance costs	30 basis points	Independent review of Commerce Commission's WACC proposal for Transpower, Professor R.R. Officer, Dr S Bishop, issued August 2010.
Interest cost	7.5%	As advised by NZTA.
Taxation (income)	Model does not currently have tax calculations due to public sector status.	Model assumption

Table 3: Timing and Economic Assumptions for the financial model

5. Summary of Options

This section outlines the process taken to identify the short-listed AWHC options that were subject to more detailed appraisal, and why the options involved retention of the current AHB.

5.1 Defining the bridge option and the tunnel option

The study involved a process to identify at least one specific short-listed bridge option and one short-listed tunnel option, the details of which can be found in the FASR. A long list of four tunnel options and four bridge options were developed that passed preliminary engineering considerations. A short-listing process considered a range of criteria relating to the constructability, operability, consentability and economic and funding considerations to culminate in the following two short-listed ('defined') AWHC options that were appraised in more detail:

1. Tunnel — bored road and rail tunnels, generally on the Notice of Requirement (NoR) alignment (Figure 5 below):

    - The road component of the defined tunnel follows the NoR alignment along the eastern side of the existing motorway from Esmonde Road Interchange in the northern sector of the study area to Northcote Point (the northern landing of the AHB). At Northcote Point the road enters two bored tunnels (three lanes in each tunnel) and crosses under the harbour on the NoR alignment to Wynyard Quarter. The bored tunnels traverse the southwest corner of Wynyard Quarter to Victoria Park before continuing in cut and cover tunnels and trenches to the CMJ.

    - The rail component is separated from road and follows the NoR horizontal alignment between the Akoranga Busway Station (near Esmonde Road Interchange) and Wynyard Quarter. It is at-grade from a future Akoranga Station (Esmonde) to Sulphur Beach (immediately south of Onewa Interchange) and then crosses under the harbour via two bored tunnels (one track in each direction) to a future train station at Gaunt Street in the Wynyard Quarter.

2. Bridge — road bridge west of the NoR alignment, with bored tunnels for rail on the NoR alignment (Figure 6 below):

    - The road component of the defined bridge follows the NoR alignment along the eastern side of the existing motorway from Esmonde Road Interchange in the northern sector of the study area to Northcote Point. At Northcote Point the road crosses the harbour on a bridge structure (3 lanes in each direction) west of the NoRs alignment to the vicinity of Z-Pier. The road alignment joins the existing motorway at this point before traversing Victoria Park in cut and cover tunnels and trenches to the CMJ.

    - The rail component is the same as the road tunnel option above.

The two options have the same rail crossing, and as such the distinction between the two options centres on the road-crossing component. A parallel work stream to this study — The Network Plan — undertook an assessment of the long-term capacity of the existing Busway and concluded that a rail crossing was not required within the timeframes considered for the CBA. As such, the transport modelling excluded the modelling of rail, and the CBA includes costs for the roading component of the crossings only (i.e. the cost for the rail tunnel is excluded).

Figure 5: Defined Tunnel Option Connections

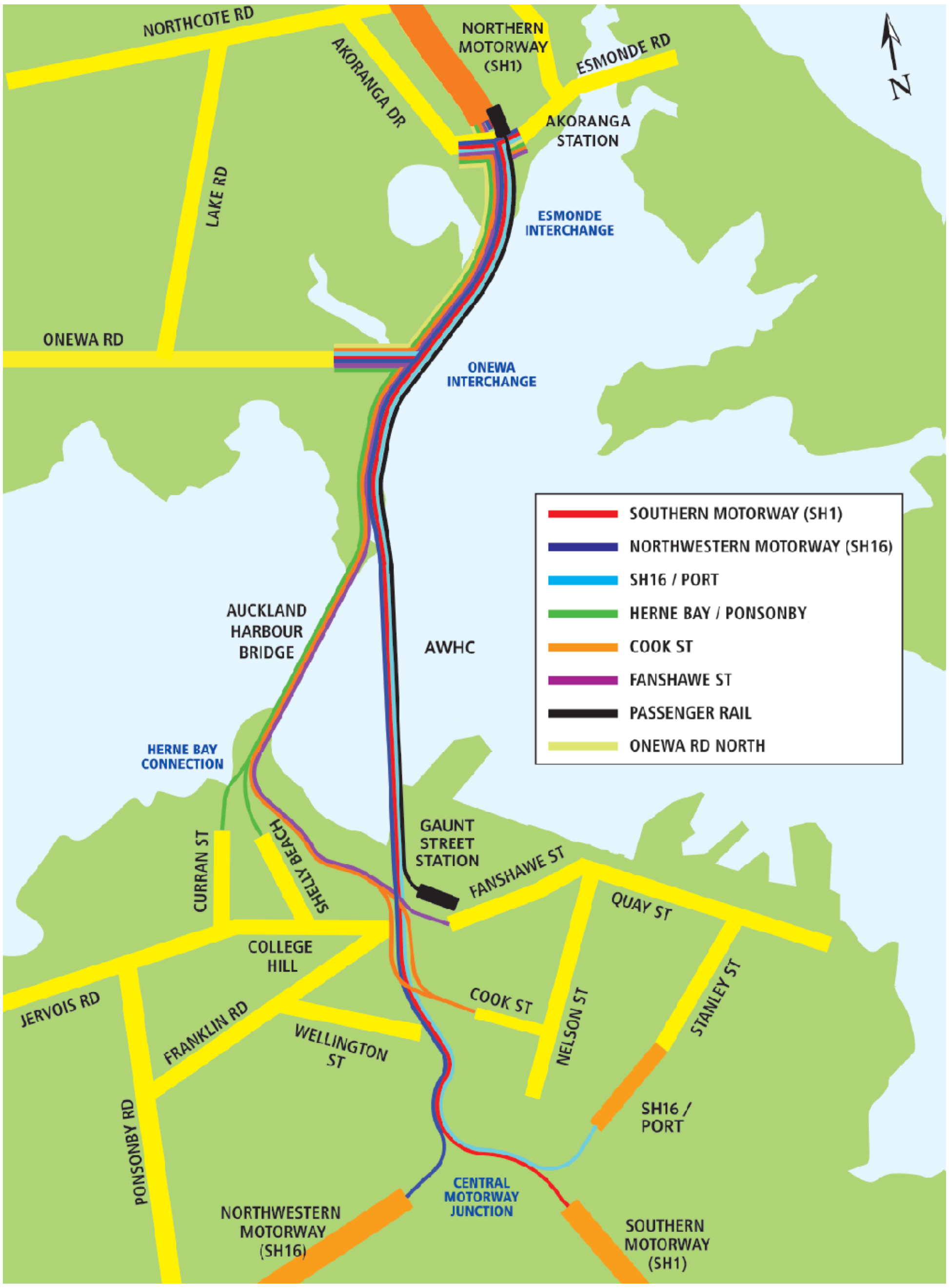
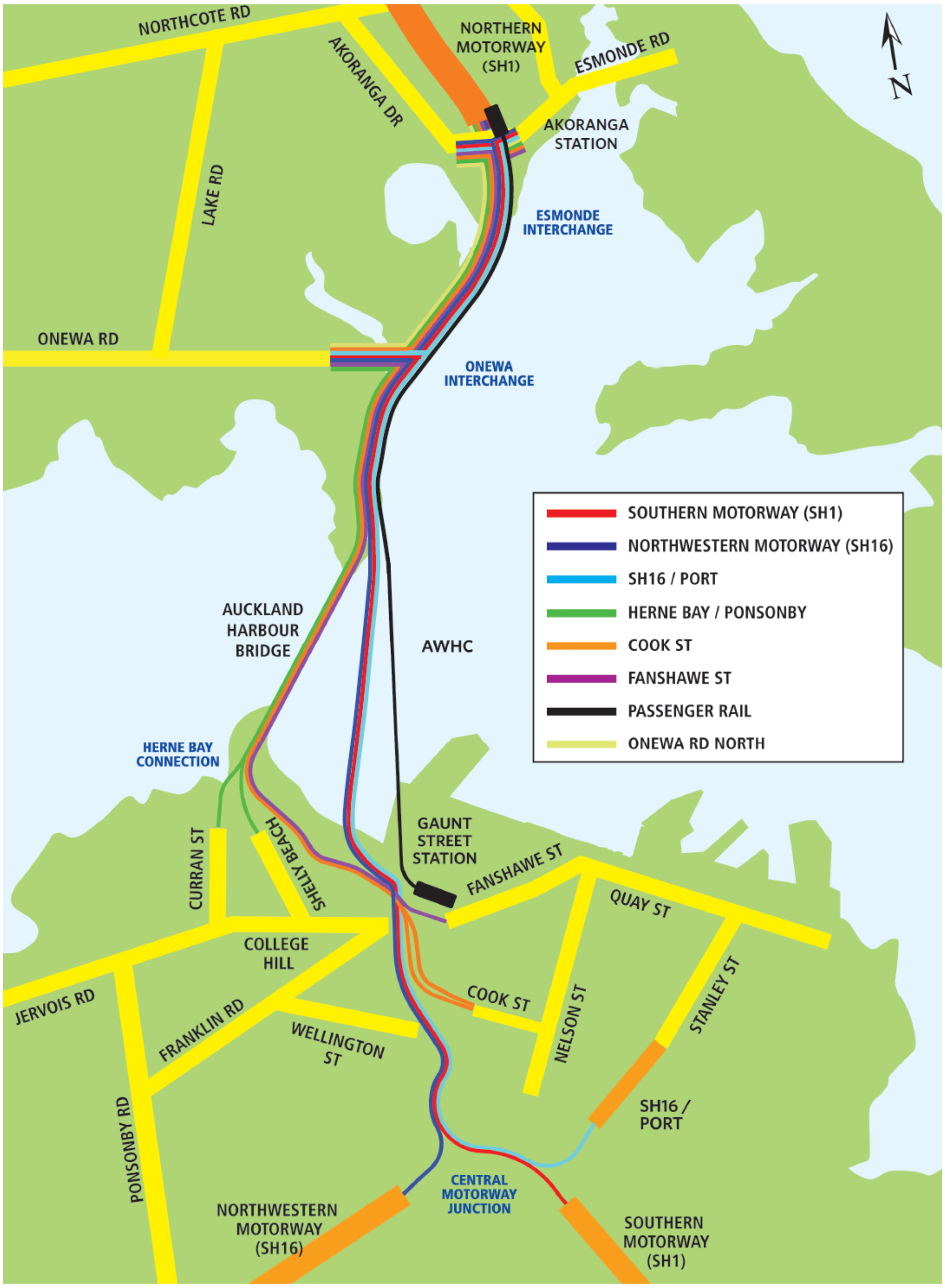


Figure 6: Defined Bridge Option Connections



5.2 Consideration of the retention of the AHB

There has been discussion about dismantling the AHB and constructing a new bridge to be the single (direct) road crossing between the CBD and the North Shore. This section considers the pros and cons of removing the AHB, and of supplementing the AHB with an additional crossing (be it bridge or tunnel).

5.2.1 Replacing the Existing Harbour Bridge with a New Crossing

This option would involve removing the existing AHB and providing an entirely new crossing that incorporates the capacity of the AHB and additional capacity to meet the demand for general traffic, PT, walking and cycling.

Replacing the 8-lane AHB with a new higher capacity crossing (say, 12-14 lanes) would deliver increased capacity within this corridor relative to the do-minimum scenario and has the potential to free up some land for other uses. Both the advantages and disadvantages of this option are discussed in Table 4 below:

Advantages	Consequences
Possible redevelopment of land associated with the motorway corridor along St Mary's Bay	Removal of the AHB creates an opportunity for redevelopment of land currently occupied by the motorway corridor along St Mary's Bay and Northcote Point. This is largely reclaimed land and its use is constrained by a number of heritage and natural features as well as amenity aspirations as identified by Auckland City. Under the Public Works Act 1981 and the Crown's land disposal processes, a legal process exists for determining who can acquire such land. It is likely that the land would be acquired by another public entity under this process. However, if not acquired by another public entity the Crown could dispose of it on the market. While there is some potential for commercial or high density residential development, development of the land is likely to be constrained by public space, heritage and amenity requirements.
Potential for a new "landmark"	Removing the AHB and replacing it with a new single crossing, creates the opportunity for the new crossing to become a "landmark" structure much in the way that the existing bridge is part of the existing fabric of Auckland.
Disadvantages	**Consequences**
The cost of removing the AHB and providing capacity in a new crossing	Construction of a new single crossing would be more expensive than retention of the existing AHB plus the construction of an additional crossing. If the AHB was removed, any reduced lane capacity would need to be accommodated within the new single crossing. After the construction of the new crossing, the demolition and removal costs of the existing AHB would need to be factored into the overall project cost. Demolition would also incur associated costs for restoration and remediation works on the harbour and coastal areas.
Forgoing the remaining life of the fully functional AHB	If the AHB is sustainably managed it can operate indefinitely. The AHB is being continually monitored and maintained to adapt to changing demands and will continue to be one of the most important links in the national state highway network. Decommissioning the AHB before it has reached the end of its useful life would constitute a substantial opportunity cost.
Reduced opportunity to improve network resilience	The replacement of the AHB with a new single structure would still mean only a single harbour crossing from the North Shore to the CBD. Network resilience and route security would not be materially improved, whereas it would be if an AWHC were to supplement the AHB.
Removing an iconic Auckland structure	The AHB has been part of the Auckland waterfront landscape for 50 years and is deemed to be part of what makes Auckland distinctive. The removal of the bridge is likely to cause considerable public interest. Considering the 'value' of the bridge as part of the functioning state highway system it would be difficult to justify its removal on the grounds of network improvement.

Table 4: Advantages and disadvantages of replacing the AHB with a new crossing

5.2.2 Supplementing the AHB with an Additional Crossing

This option involves constructing an additional crossing that would be operated in conjunction with the AHB.

In addition to delivering increased capacity and reliability within this corridor, the advantages and disadvantages created by this option are shown in Table 5 below:

Advantages	Consequences
Utilising the AHB in conjunction with an additional crossing to provide an integrated network solution	Constructing an additional crossing will allow separation of CBD and cross-city traffic. This will provide greater flexibility within the network with separate CBD connections. An additional crossing provides the opportunity to develop dedicated PT capacity within the network making use of the existing AHB. Additional direct bus access to and from the Northern Motorway, either alongside current access arrangements at Fanshawe Street or a new point further south (for example Cook Street), could be incorporated.
Providing the opportunity to increase network resilience	An additional crossing would reduce the reliance on the AHB as the only direct connection between the CBD and the North Shore and the concentration of a high proportion of cross-harbour capacity on a single route. A separate crossing provides an alternative route, reducing the risk of a partial or full closure of the corridor for planned or unplanned events. Together, the additional crossing and the AHB would improve transport security, resilience and route security.
Disadvantages	**Consequences**
Restrictions providing purpose built pedestrian and cycle facilities	An additional crossing in the form of a bridge has the advantage of providing purpose built facilities for pedestrian and cyclists on the structure. However, if the chosen form is a tunnel, then pedestrians and cyclist facilities would need to be provided on the AHB. This means that the facilities would not be purpose built.
Adding another structure to the harbour	An additional crossing in the form of a bridge has the disadvantage of creating an additional structure within the harbour neighbouring the AHB. This may conflict with the architectural form of the AHB (depending on design), and result in cumulative impacts on the character of the harbour. An additional crossing as a tunnel would not have these disadvantages.

Table 5: Advantages of supplementing the AHB with a new crossing

5.2.3 Preferred solution

For a new single bridge crossing the advantages (purpose built walking and cycling facilities, the potential for redevelopment of land, and the opportunity to create a “landmark”) come at a cost similar to providing an additional crossing as a tunnel. Therefore, construction of a new crossing with sufficient future capacity and demolition of the AHB, removal of the motorway and remediation could be more expensive than retention of the AHB and construction of an additional crossing.

In contrast, an additional crossing (whether a tunnel or a bridge) has a number of opportunities that cannot be delivered by replacing the AHB with a new single bridge crossing. These include the ability to provide an integrated network solution and the opportunity to increase network resilience. It also has the advantage of not precluding the replacement of the AHB in the future (if such a replacement was required). Therefore, the NZTA has chosen to supplement the AHB with an additional crossing as its preferred solution. The opportunity the AWHC presents is flexibility, resilience, and sustainability in terms of long term provision of the crossing.

6. Financial Analysis

6.1 Introduction

This section presents the financial case for the defined bridge and tunnel options. The financial analysis includes a summary of the cost of each option and sensitivity testing to identify how changes to key assumptions made during the compilation of the cost estimate impact the final cost of each option and the relative differences. Further financial analysis, including consideration of tolling options, is included in section 10. This section contains:

- An explanation of the financial model and its purpose;
- A description of the components of the financial model;
- A description of the assumptions used to quantify the components of the financial model;
- Analysis of the results of the financial model; and
- Sensitivity testing of the financial model results.

The financial analysis differs from the economic analysis in section 7 by considering the detailed cash flows, risks and costs. The financial analysis is intended to inform funding discussions within government (including any potential local government discussion) resulting from this Preliminary Business Case. The economic case will drive the comparison of form of crossing.

6.1.1 The financial model and purpose

The financial model presents a discounted cash flow analysis of each option. The cash flows included in the model provide an estimate of the hypothetical risk-adjusted cost of each option if they were to be procured by the NZTA using a Design, Build, Operate and Maintain contract.

The inputs to the model follow the construction cost estimates provided for each option for the Preliminary Business Case. The financial model has been developed by observing Treasury guidelines[20] and reflects modelling practices that are consistent with similar sized infrastructure projects from other jurisdictions.

The cash flows included in the analysis of each option are:

- Construction costs;
- Operational, recurrent maintenance and lifecycle maintenance costs; and
- Operational and capital related cost of risk.

Further details of the above costs are included in the methodology summary in section 6.1.2 below.

[20] Guidance that has been followed includes "Guidance for Public Private Partnerships (PPPs) in New Zealand, prepared by the National Infrastructure Unit of the Treasury, October 2009, Version 1.1" and "Better Business Cases for Capital Proposals Toolkit: Detailed Business Case, The Treasury, 2 July 2010."

The primary purpose of the financial model is to evaluate the whole-of-life cost of each option. The AWHC will be a nationally significant infrastructure asset and the procurement of the preferred option will likely have a significant impact on both national and regional transport budgets. The selection of the preferred option will have an impact on future generations who will bear the cost of maintaining and refurbishing the asset to ensure its ongoing use. To provide decision makers with an understanding of both the short, medium and long-term impacts of each option, the financial analysis considers the whole-of-life cost of each option across a 30 year operational life time. Each of the options differ in both the upfront capital investment, ongoing operational and maintenance cost and the cost associated with the uncertainty of each option and potential events that may give rise to additional cost. It is therefore important to evaluate each option across these different cost metrics to ensure that the different costs through time are considered as part of the evaluation of the preferred option.

Additionally, the financial model provides a benchmark against which to consider the estimated cost of the preferred option at future stages of the project.

6.1.2 Financial model methodology

The financial model relies on the development of a 'Reference Project' for each option. The Reference Project reflects the scope of each defined option as described in the FASR and summarised here as follows:

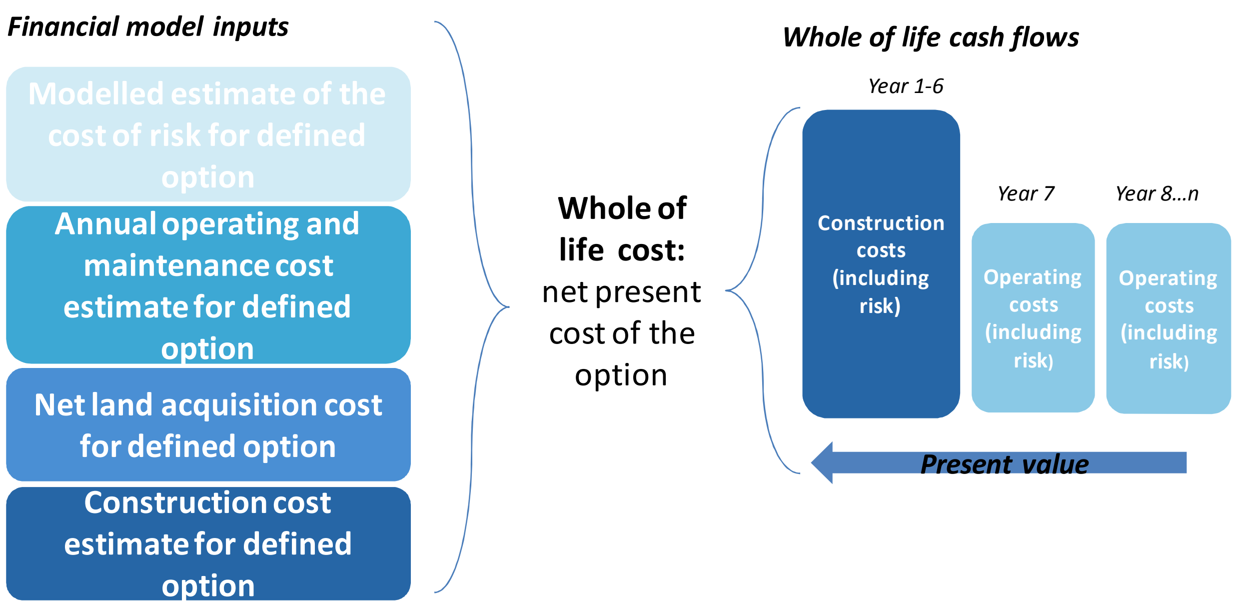
- Tunnel (Option T1): Bored tunnels for the road on the NoR alignment and road tunnel through Victoria Park;
- Bridge (Option B3(b)): Road bridge west of the NoR alignment and road tunnel through Victoria Park.

Both options assume an identical separately priced rail tunnel on the NoR alignment and therefore rail has been excluded from the comparison. Further discussion of the cost of the rail option is included in section 6.1.8.

The do-minimum option has different a different cash flow profile and has therefore been excluded from the discussion below. Please refer to section 4.1 for further discussion of the do-minimum option.

Figure 7 below summarises the financial model methodology, used to determine the whole-of-life cost of each option:

Figure 7: Whole-of-Life Costs of Each Option



6.1.2.1 Financial Model inputs

Details of the each of the financial model inputs are provided below with a summary of the input cash flows into the financial model provided at the end of the discussion. *Construction cost estimate for the defined option*

The cost estimates have been prepared using best practice techniques as defined in accordance with the requirements set out in the NZTA Cost Estimation Manual (SM014)[21]. Based on the level of design undertaken on the project to date, the cost estimate is deemed to have Option Estimate (OE) status. Full details of the assumptions, surrounding the construction cost estimates are included in section 4.

The total construction cost estimates in 2010 dollars for each option are:

Option	Defined Tunnel option (2010 $m)	Defined Bridge option (2010 $m)
Total construction cost estimate	4,600	3,400

Table 6: Construction cost estimate in 2010 dollars

Land acquisition costs

The land acquisition costs for each option have been provided by The Property Group. These have been provided in accordance with designs for the defined options prepared for the Preliminary Business Case. Calculation of costs including compensation has been prepared in accordance with relevant sections of the Public Works Act 1981 and utilising the 'before and after' valuation methodology. The costs, in Table 7 below, are summarised by acquisition costs (including tenancy costs) and proceeds from disposal of purchased property, which both include sales and legal fees.

The land acquisition cost estimates in 2010 dollars for the defined options are:

Option	Defined Tunnel option (2010 $m)	Defined Bridge option (2010 $m)
Total gross land acquisition cost	260	250
Total land disposal proceeds	50	50
Total net land acquisition costs	**210**	**200**

Table 7: Breakdown of land acquisition costs in 2010 dollars

Site, Design and Construction risk estimates

The site, design and construction risk estimates for each option are a modelled estimate of the cost of occurrence of risks associated with the defined options prior to commencement of operations. The risk values in Table 8 below are a result of the risk analysis discussed in section 8.

A P85 estimate has been provided in line with Treasury guidance[22]. P85 refers to the percentile of observation from the risk modelling undertaken which is discussed in further detail in section 8. Briefly, P85 refers to the 85th percentile. The percentile is the value at which x% of the outcomes from the risk modelling are less than the stated value. For the tunnel option below, this can be interpreted as meaning that 85% of the observed values from the risk modelling are less than $1,300 million (in total) and therefore the cost of risk to the project will be less than $1,300 million 85% of the time and greater than $1,300 million 15% of the time.

[21] AWHC, Volume 1: Form Assessment Study Report, October 2010.

[22] Better Business Cases for Capital Proposals Toolkit: Detailed Business Case, The Treasury, July 2010.

The P85 estimate of risk in 2010 dollars for the defined options are:

Option	Defined Tunnel option (2010 $m)	Defined Bridge option (2010 $m)
Site, Design and Construction risk cost	1,300	1,400

Table 8: P85 estimate of Site, Design and Construction risk for the defined options

Pre-Operations cash flows

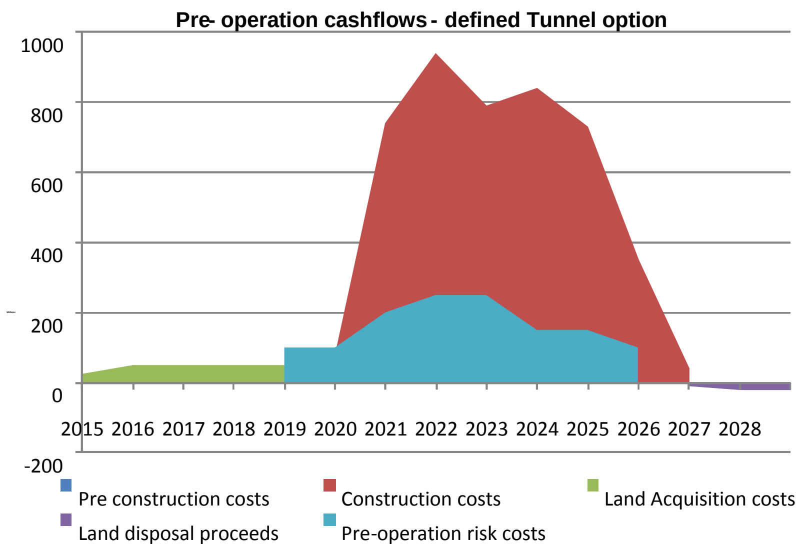
Construction costs, land acquisition costs, land disposal proceeds and site, design and construction risk costs are all pre-operation expenses to the NZTA under the defined options. The assumptions relating to the timing of construction and the length of construction programme estimates have an impact on both NZTA's budgetary requirements and the net present value of the defined options, as they impact when expenditure is expected to occur. A summary of pre-operations annual cash flow requirements for the defined options is provided in

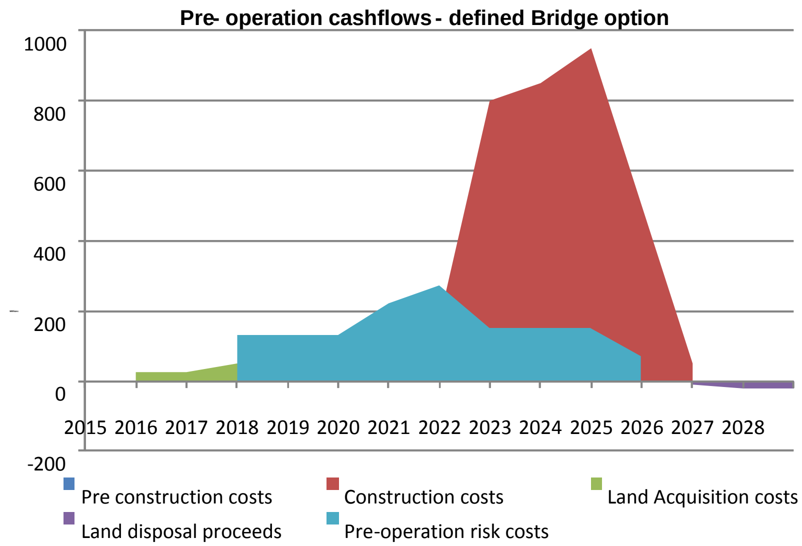
below:

Financial year ending June	‘14	’15	‘16	‘17	’18	‘19	’20	‘21	‘22	‘23	‘24	‘25	’26	‘27	‘28
Defined Tunnel option															
Pre-construction costs	**10**	20	15	15	20	20									
Construction costs						70	740	940	790	840	730	350	40		
Land acquisition costs	25	50	50	50	50	35									
Land disposal proceeds													(10)	(20)	(20)
Pre-operation risk costs					100	100	200	250	250	150	150	100			
Total costs	35	70	65	65	170	225	940	1,190	1,040	990	880	450	30	(20)	(20)
Defined Tunnel option															
Pre-construction costs			10	20	10	10	30								
Construction costs								170	800	850	950	500	50		
Land acquisition costs		25	25	50	50	50	50								
Land disposal proceeds													(10)	(20)	(20)
Pre-operation risk costs				130	130	130	220	270	150	150	150	70			
Total costs		25	35	200	190	190	300	440	950	1,000	1,100	570	40	(20)	(20)

Table 9: Total annual pre-operations costs for the defined options in 2010 dollars (millions)

Figure 8: Total annual pre-operations costs for the defined options





Operating and recurrent maintenance cost estimate

The operating and maintenance cost estimates are based on observations from similar recent projects both in New Zealand and overseas. These costs include general operations and maintenance costs such as, staff, cyclical maintenance, graffiti removal, light replacement and maintenance and electricity. They exclude the operations and maintenance costs associated with the motorways to the North and South of the main defined crossing asset (bridge or tunnel).

The operating and maintenance costs in 2010 dollars for the defined options are:

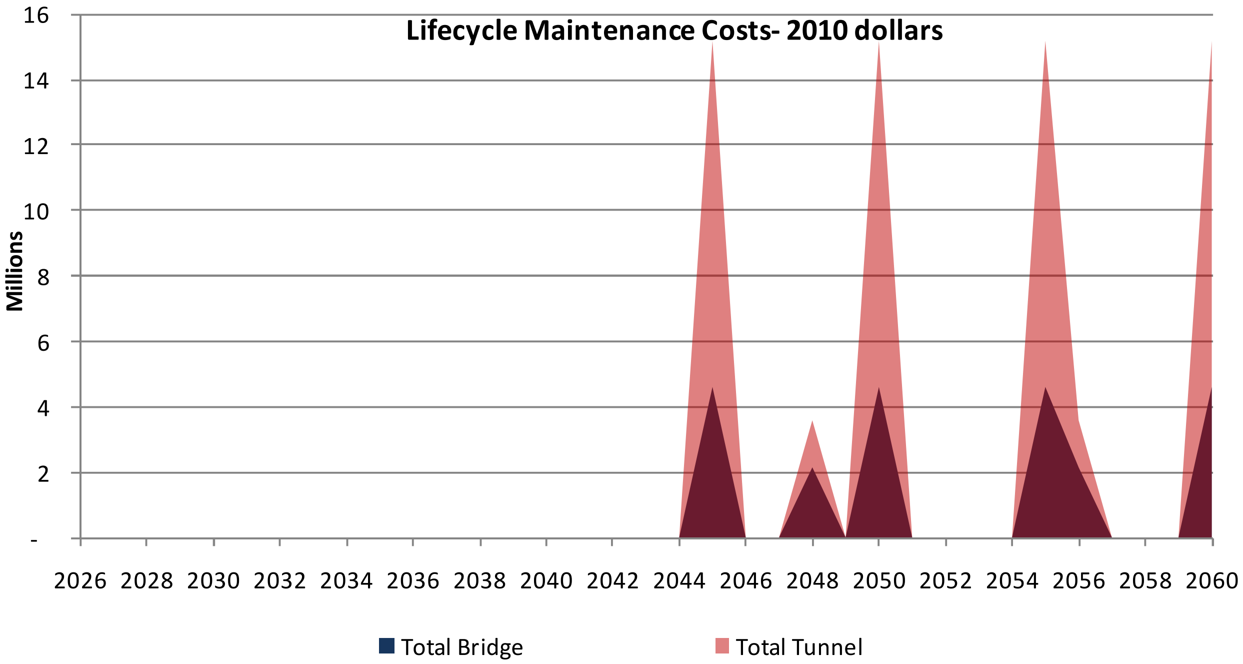
Option	Defined Tunnel option (2010 $m)	Defined Bridge option (2010 $m)
Annual operating and maintenance cost	20	4

Table 10: Annual operating and maintenance cost for the defined options

Lifecycle maintenance costs

Lifecycle maintenance cost estimates have also been provided for both of the defined options. These costs reflect those components of the asset constructed under each option that require regular replacement and refurbishment. Examples of these costs include road and pavement re-surfacing and mechanical plant replacement. These costs are incurred on a lumpy basis as illustrated in Figure 9 below and have therefore been annualised for discussion purposes.

Figure 9: Life cycle maintenance costs in 2010 dollars



The life cycle replacement cost for the defined options in 2010 dollars are:

Option	Defined Tunnel option (2010 $m)	Defined Bridge option (2010 $m)
Average annual life cycle replacement cost	6	2

Table 11: Annual operating and maintenance cost for each option

Operating risk cost estimate

As part of the risk analysis discussed in section 8, the cost of risk associated with operations, recurrent maintenance and life cycle maintenance was estimated by the project team for the defined options. The numbers in Table 12 below are P85 risk values and have been modelled in the same fashion as the construction risk estimate discussed above. The figures below are the total values for the 30 year operating period. Further discussion of the differences in risk estimates between the defined options is included in section 8.

Option	Defined Tunnel option (2010 $m)	Defined Bridge option (2010 $m)
Whole of project operating and maintenance risk costs	10	150

Table 12: Total operating and maintenance risk costs

6.1.3 Assumptions utilised in the financial analysis

For the purposes of this analysis, construction of the AWHC is expected to begin in ten years time and therefore assumptions have been made to provide an estimate of the future cost of each option. Details of the assumptions utilised in determining the cost of each option have been included in section 4.

6.1.4 Analysis of the results of the financial model

Analysis of the results of the financial model is presented in both a nominal and net present cost format. Due to the timing of each option (e.g. the length of construction) the total cost of each option is impacted by escalation and discount rate assumptions in a different manner which reflects the time value of money of each option. It should be noted that while the use of equivalent construction periods for the defined option is appropriate for the economic analysis, it is not appropriate for the financial analysis as the financial analysis follows the reference project and therefore needs to match the construction program cash flows provided by the EPT.

Table 13 below provides the total nominal cost of each option for all costs from the start of the construction period until the end of the 30 year operations period for the defined options (being 31 December 2056). Nominal costs represented the sum of all costs escalated (i.e. inflation adjusted) across the analysis timeframe.

Cost type	Tunnel option (Total Nominal $m)	Bridge option (Total Nominal $m)
Total capital cost	7,900	6,000
Total net land acquisition cost	270	270
Total operating and maintenance cost	1,720	400
Cost of the risk associated with each option at a (P85) level	2,300	2,000
Total cost	**12,190**	**8,670**

Table 13: Total Nominal Cost of each option

To identify the investment by NZTA today to purchase the defined options, the cash flows for each option have been discounted to 1 July 2010 using a discount rate of 8% and are presented below in Table 14:

Cost type	Tunnel option (Total NPC $m)	Bridge option (Total NPC $m)
Total capital cost	3,100	2,200
Total net land acquisition cost	190	170
Total operating and maintenance cost	160	40
Cost of the risk associated with each option at a (P85) level	840	850
Whole of life, risk adjusted NPC of the option	**4,290**	**3,260**

Table 14: The net present cost of each option

6.1.5 Evaluation of the cost of options

The analysis above illustrates that the bridge option has a lower total net present cost to the NZTA of $1,030 million (24%) when compared with the tunnel option. This is predominantly a result of the lower total capital costs and lower operating cost of a bridge when compared to the tunnel over the life of the project.

The higher cost of construction is directly due to the deployment of tunnel boring technology, which has a higher overall unit cost than bridge construction technologies. This cost is further compounded by a longer construction period for the tunnel (7 years compared with 5 years).

The higher operational and maintenance costs of a tunnel result from the need to use more expensive plant and machinery for tunnel management and operations, including air quality control, management of surface water within the tunnel and fire and emergency response systems. The impact on the whole-of-life cost of the maintenance and operational costs can be seen in Figure 10 below from years 2027 to 2055.

A discussion of the cost of risk for the project is included in section 8 with the difference in the net present cost reflective of the plausible additional planning and construction costs associated with the bridge option. Figure 11 below demonstrates this effect where the estimated additional costs associated with the planning risk of the bridge have a larger upfront cost impact than those estimated under the tunnel option, where as the tunnel option has higher operating period risks.

Figure 10: Total annual cash flows for the defined bridge option

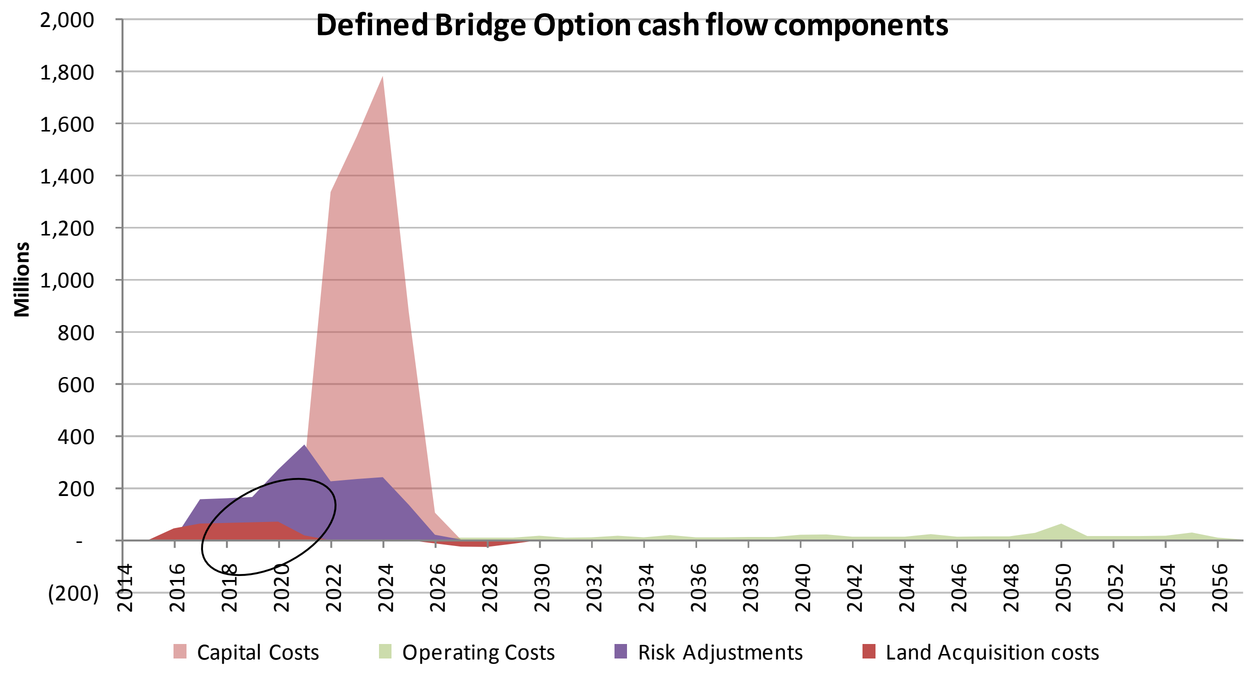


Figure 11: Total annual cash flows for the defined tunnel option

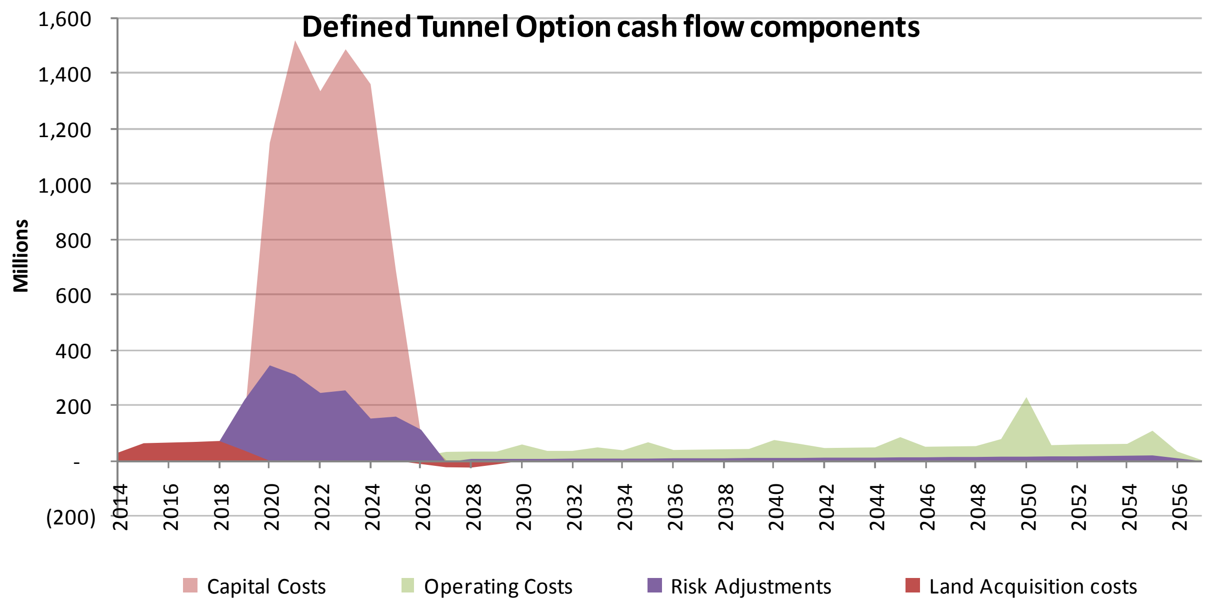
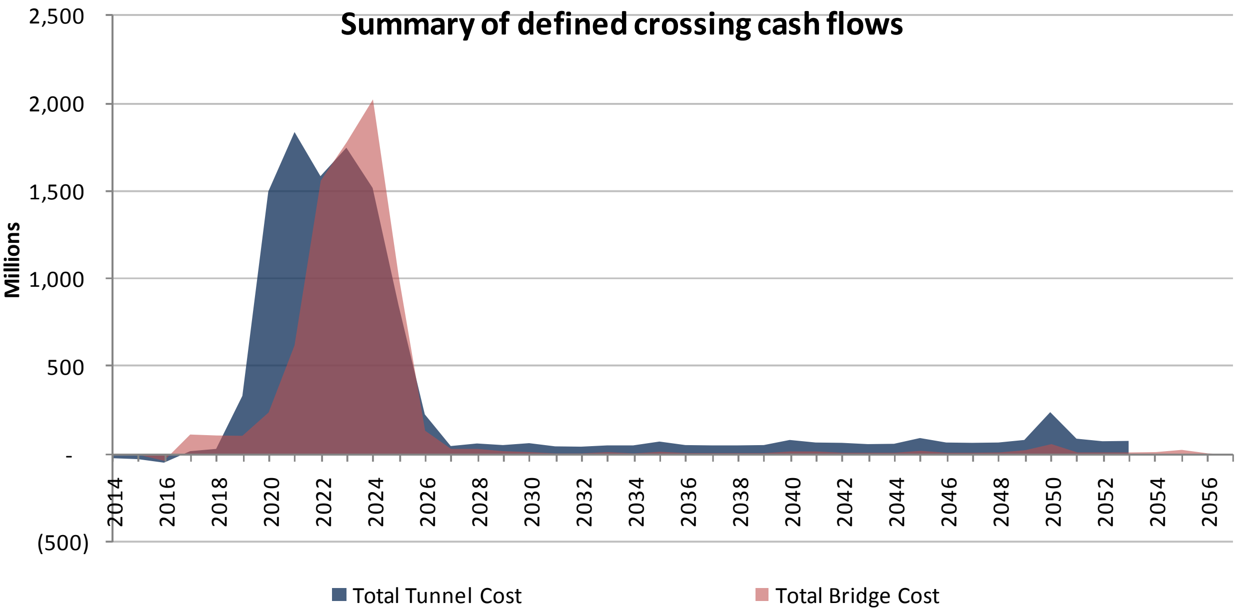


Figure 12: Total annual cash flows for the defined options combined



6.1.6 Sensitivity testing of the bridge and tunnel options

The forecasting of future costs always involves some degree of uncertainty, and in some situations the resulting measures of financial cost may be particularly sensitive to assumptions or predictions inherent in the analysis. Sensitivity analysis involves defining a range of values for an uncertain variable in evaluating and assessing the effects on the financial analysis of the assumptions or estimates within the defined range[23].

The purpose of the sensitivity analysis performed here is to identify any changes in assumptions that may result in a different outcome from the financial analysis of the defined options. Sensitivity analysis provides the Preliminary Business Case with an additional layer of robustness by stress testing assumptions to ensure that they are reasonable and do not disadvantage one option over the other.

The expectation prior to the sensitivity analysis being performed is that a change in an input variable such as the discount rate should have a similar, but not identical impact on the net present whole-of-life cost of each option. Where this expectation is not met, further investigation and analysis will be undertaken.

The assumptions utilised in the financial analysis have been discussed in section 4. The original assumptions and the values used in the sensitivity analysis are provided in Table 15 below:

[23] NZTA Economic Evaluation Manual, Volume 1, January 2010.

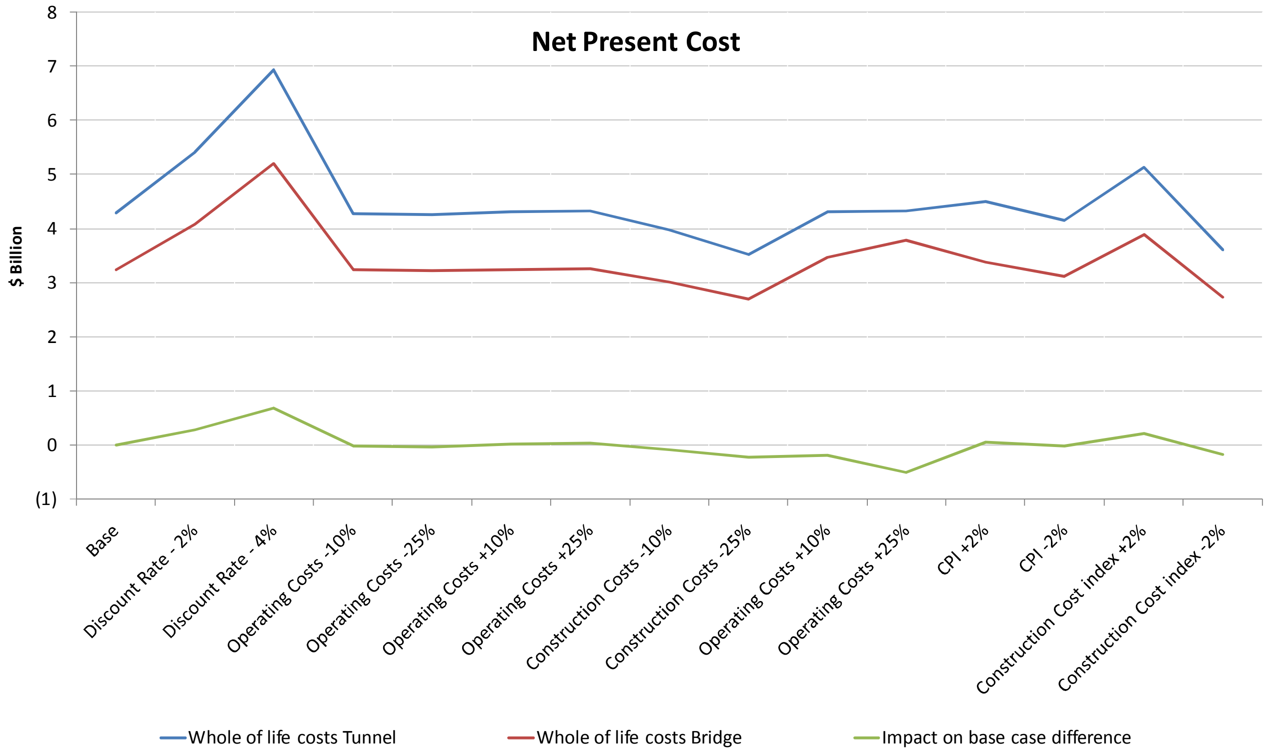
Original assumption	Value	Sensitivity test
Discount rate	8%	6%
Discount rate[24]	8%	4%
Operating and maintenance costs	OE estimates	-10%
Operating and maintenance costs	OE estimates	-25%
Construction costs	OE estimates	-10%
Construction costs	OE estimates	-25%
Consumer Price Index	2.5%	4.5%
Consumer Price Index	2.5%	0.5%
Construction cost index	4.77%	6.77%
Construction cost index	4.77%	2.77%
Operating and maintenance costs	OE estimates	+10%
Operating and maintenance costs	OE estimates	+25%
Construction costs	OE estimates	+10%
Construction costs	OE estimates	+25%

Table 15: Sensitivity testing scenarios

[24] Discount rate obtained from "Public Sector Discount Rates for Cost Benefit Analysis", prepared by the Treasury, July 2008. This rate is the real weighted average.

The results of the sensitivity analysis are provided in Figure 13 below:

Figure 13: Results of the sensitivity testing



6.1.7 Summary of the sensitivity testing preformed

The results of the sensitivity testing performed indicate that changes in the assumptions used to calculate the financial model impact the results in a manner that is consistent with expectations. The largest impact is caused when the discount rate is changed to 4%. This increases the difference between the defined options by approximately $830 million dollars. While this number is material it is a direct impact of the different timing of cash flows between the defined options. The defined tunnel option has both a longer construction period and higher operating and maintenance costs which are both impacted in the net present cost calculation by a lower discount rate.

While the changes in assumptions do result in changes to the outputs from the model, they do not change the overall evaluation of defined options along financial parameters and would not impact on the decision-making process. Therefore, no further analysis has been undertaken. It is also recommended that during future stages of the project that further sensitivity testing is undertaken to ensure the results from the financial analysis remain reasonable.

6.1.8 Analysis of rail option

The short-listing process undertaken for the Preliminary Business Case identified a rail tunnel as the defined option for rail. In addition to this, the current network plan has no immediate provision for rail between the CBD and the North Shore and no passenger rail service on the North Shore[25] based on the conclusion that during the period of the current Auckland RLTS (2010-2040), the Northern Busway is best positioned to provide rapid transit connections from the North Shore to the CBD. The analysis of the rail option does not therefore differentiate between the defined form options.

For the purposes of this analysis, it has been assumed that the rail option will not begin operations until at least 2040 and therefore a whole-of-life cost analysis similar to that for the defined options has not been provided. A summary of the estimated capital cost of the rail option is included in Table 16 below:

[25] Draft Northern Busway Corridor Capacity Study 2010 Update, August 2010.

Cost type	Total 2010 $m	Nominal $m	NPC $m
Rail	1,500	2,700	970

Table 16: Capital costs for the defined Rail option

Should decisions regarding rail be reconsidered in the future it is recommended that the whole-of-life cost of the rail option be readdressed as part of any future project analysis.

6.1.9 Whole-of-Life costs Do-Minimum Option

The do-minimum option has a different cash flow profile to the defined bridge and tunnel options because it has on-going and existing maintenance requirements and therefore discussion of the whole-of-life costs of this option has been performed separately.

The lifecycle planning process is the key process that must be implemented to optimise the long-term management strategies for the AHB, particularly with respect to maintenance of the structures. The key aspects that are considered in the lifecycle planning process include: fatigue life (steel structures), coatings life, concrete condition and deck surfacing. A detailed assessment of the current condition of these critical aspects and components forms the foundation to undertake the lifecycle planning process and identify long term funding requirements[26].

The operating and maintenance costs, including lifecycle maintenance costs have been prepared by Auckland Motorways and are based on the Auckland Harbour Bridge Operating Plan 2010. These costs are based on the NZTA budget and may not match the actual costs incurred in any period for operations and maintenance of the AHB, but provide the best estimate available. Operating and maintenance costs have been included for the 2012 financial year onwards.

The immediate priorities with respect to structural initiatives of the AHB rely heavily on the findings of the truss bridge structural analysis and on-going fatigue monitoring and assessment. During the development of the Preliminary Business Case, further work and analysis in this area was in progress and conclusions as to the future strategy with respect to freight management and its implications on the structural requirements for the AHB were being developed[27]. A preliminary estimate of $15 million for the strengthening work to the truss bridge has been provided and included in the cost estimates detailed in Table 17 below. It has been assumed that these costs are incurred in the 2012 and 2013 financial years.

Cost	Total whole of life cost 2010 $m	Total whole of life cost Nominal $m	Total whole of life cost NPV $m
Recurrent operations and maintenance	400	750	140
Lifecycle maintenance costs	15	20	15
Estimated total whole-of-life cost	**415**	**770**	**155**

Table 17: Summary of the whole of life costs for the do-minimum option

The analysis conducted for the Preliminary Business Case provides an indicative cost of the do-minimum option. Asset management and planning for the AHB is an on-going and evolving process. Therefore, it is recommended that any future analysis undertaken for this project should include a review of the most recent AHB operating plan and updates to the above analysis as necessary, in order to determine the cost of the do-minimum option that reflects the current level of information available.

[26] Auckland Harbour Bridge Operating Plan – 2010, pg 103.

[27] Auckland Harbour Bridge Operating Plan – 2010.

6.1.10 Conclusion

The analysis performed in this section identified that the defined tunnel option is $1,030 million more expensive than the bridge option on a net present cost basis. While the bridge option has a higher up-front estimated cost of risk, the tunnel option is more expensive due to higher construction, operating and maintenance costs.

The sensitivity analysis identified that the difference between the options is only materially impacted when the discount rate is reduced from 8% to 4% and this material change is in line with expectations when the different cash flow profiles of the defined options are taken into consideration. The evaluation of options along budget parameters is not therefore impacted by changes in modelling assumptions.

It is recommended that further analysis and financial modelling be undertaken as more detailed and up-to-date costs for the project are identified in order to confirm the funding requirements for the preferred option.

7. Economic Analysis

Section 7 presents the economic case for the defined bridge and tunnel options. The economic analysis differs from the financial analysis by considering impacts across all of society, rather than focusing on financial impacts to NZTA/government only. The economic analysis also considers, to the best extent possible, all impacts including non-market impacts.

The economic analysis aims to inform discussions on:

- the choice of form of an AWHC (i.e. a bridge or a tunnel)
- the potential full spectrum of economic benefits from AWHC options.

The following topics have been examined in addition to the conventional CBA to provide a fuller picture of the impacts of an AWHC:

1. agglomeration benefits
2. WEBs from 'increased output from imperfectly competitive firms'
3. local economic development impacts, especially relating to the Wynyard Quarter and Westhaven Marina
4. externalities such as visual impact, noise and air pollution
5. economic development considerations
6. network resilience benefits.

7.1.1 Form of crossing

As part of the option short-listing process the transport attributes able to be modelled in the Auckland Regional Transport (ART3) model were judged to be broadly equal:

I. **Capacity** is identical between bridge and tunnel, such as lane capacity and length, (and both form options retain the same future capacity for a rail crossing as a tunnel).

II. **Connectivity** between bridge and tunnel options is identical. The AHB will service the CBD, the AWHC will service through traffic (as well as Southern CBD/Newmarket) and links to the local transport network (including bus access) are of the same standard.

III. For the CBA, both options were assumed to open in 2029. Together the resulting **transport benefits, agglomeration benefits, economic development potential** and **network resilience** are considered broadly equal between either form of crossing.

The bridge and tunnel options do have some different transport attributes that were not modelled in ART3, and thus are not reflected in the BCR, such as the bridge having wider shoulders and potential ability to expand capacity at a later date (such as extension bridges).

The potential differences in economic benefits from the form of crossing relate to:

- the impact on Wynyard Quarter development
- impact on the functionality of Westhaven Marina
- visual impacts to residents
- noise and air quality externalities, and

- any possible impact on the ‘iconic’ nature of the Waitemata Harbour.

Real costs of consenting risk (i.e. delays in benefits accruing, compromises of design functionality, and/or cost escalation from scope creep to mitigate effects) are not explicitly considered because they are a function of the first-order impacts outlined here.

Although, in practice, a bridge would be quicker to construct than a tunnel, for the purpose of the CBA (and the NZTA’s rigid restrictions on appraisal period lengths) both options were assumed to take 6 years to construct. The undiscounted cost (in constant 2010 dollars) of the tunnel is expected to be $4.85 billion and the bridge $3.60 billion, an undiscounted cost difference of $1.24 billion. Because the conventional transport benefits and WEBs are the same for both forms of crossing the economic question is whether the tunnel option provides other present value (PV) benefits that sufficiently exceed the PV additional cost of a tunnel of $410 million (in 2010 dollars and at an 8% real/inflation-adjusted discount rate). The additional PV cost of the tunnel is approximately $580 million and $830 million at a 6% and 4% discount rate respectively.

The impacts of AWHC on the **Wynyard Quarter and Westhaven Marina** are an important aspect of the Region’s plans. Wynyard Quarter is a central plank of Region’s plans to create a waterfront that is more open and accessible to the public[28]. There are currently few locations where people can connect to the water’s edge, due to the operational needs of the port and industry and the traffic dominated environment, and there are no other locations for major mixed-use urban development near the CBD.

In addition to impacts on Wynyard Quarter development, the **visual impact** of a bridge has been considered as it is likely to be a material differentiating factor between bridge and tunnel options. The perceptions around the visual impacts of a bridge are likely to be subjective, and will be impacted by bridge design. Remaining key economic differentiators between the two forms of crossing, aside from the cost of the crossing itself, include the potential impacts associated with **air quality and noise pollution.**

A critical but unquantified consideration for the form of crossing is the fact that the Waitemata Harbour is part of the Department of Conservation–administered Hauraki Gulf Marine Park. A tunnel minimises the impact on the Park.

Table 18 below summarises the economic findings as they relate to the form of crossing.

Conventional CBA result	**Only cost differentiates in a conventional transport CBA** The PV additional cost of a tunnel is approximately $410 million (2010 dollars, at an 8% real/inflation adjusted discount rate). The additional PV cost of the tunnel is approximately $580 million and $830 million at a 6% and 4% discount rate respectively.
Land take	**No direct tangible impact on Wynyard Quarter development, and bridge requires more land** There are no direct tangible effects on the area under development by ‘Sea+City’ in the Wynyard Quarter (North of Pakenham Street) from either option. The broader Wynyard Quarter bounded by Fanshawe Street is affected by the land take in the southwest corner for a realignment of Westhaven Drive. The tunnel has a larger surface footprint on the Wynyard Quarter than the bridge because of the vent. Bridge option requires more reclamation into coastal marine boundary between Wynyard Quarter and Westhaven Marina in order to accommodate realignment of Westhaven Drive. This will affect access and recreation.
Marina	**Bridge causes some loss or displacement of berths** Bridge construction would interfere with operations of Westhaven Marina and result in temporary and permanent loss of boat berths valued at $384,000 PV. The cost to restore about 39 berths is $0.92 million, which is included already in the capital cost estimate for the bridge options. There is also a cost associated with the loss of the 39 berths during the construction period.
Public spaces	**Bridge could cause access problems to public spaces in Westhaven** Bridge would permanently alter amenity of Westhaven. This could discourage people from accessing the area by foot/cycle and affect realisation of long-term vision for waterfront.

[28] Auckland Waterfront Vision 2040, and its associated implementation documents (e.g. the Wynyard Quarter Plan Changes and the Waterfront Master Plan).

Z-Pier	**Both options cause temporary disruption; bridge has marginally greater long run effects** Both bridge and tunnel options would encroach on Z-Pier during construction. Both necessitate removal of boat charter and café businesses and a public boat launch ramp. These can be reinstated after construction is completed, although with greater loss of parking space with the bridge option.
Marine industry	**No impact from either bridge or tunnel** Bridge option chosen for consideration is approximately 300 metres from the western edge of Wynyard Quarter and 450 metres from where bridge crosses over the Westhaven breakwater, so as not to impact on future development of marine industry once constructed.
Transport connectivity	**Wynyard Quarter connectivity is not a differentiating feature between the bridge or tunnel options** The transport connectivity is not dependent on the form of crossing. Transport connectivity impact of AWHC on Wynyard Quarter can be seen as immaterial provided that the region still deploys the measures needed to meet the Wynyard Quarter mode share targets.
Visual	**Potential dis-benefits from visual intrusion is probably modest relative to the additional costs of the tunnel** Visual dis-benefits of bridge could be significant for about 950 existing residential properties and could be in the order of \$40 million –\$80 million in 2010 PV terms, excluding visual dis-benefits to future residences and other users in the Wynyard Quarter. This represents 10% - 20% of the additional PV cost of the tunnel. Visual impacts of tunnel are minimal relative to a bridge. It is difficult to robustly infer the materiality of visual impacts of the bridge option on the Wynyard Quarter development, but information to date suggests they would be no greater than those for existing residential properties. The visual impact of an additional bridge will not be material to the perception of Auckland as either a tourist destination or as a "world class city" that rates highly in international surveys as a desirable place to live.
Noise pollution	**Tunnel has marginally less noise pollution than a bridge** PV dis-benefits are estimated as being \$190,000 greater for the bridge than the tunnel, with about 130 more residential properties affected.
Air pollution	**Relatively minor impacts from bridge** PV dis-benefits are estimated as being between \$0.64 million –\$2.1million greater for the bridge than the tunnel.
Compatibility with wider government policy	**Impact on Hauraki Gulf Marine Park** A critical but unquantified consideration is the fact that the Waitemata Harbour is part of the Department of Conservation–administered Hauraki Gulf Marine Park. A tunnel minimises the impact on the Park.

Table 18: Summary of the economic findings as they relate to the form of crossing

7.1.2 Conclusion of economic analysis relating to the form of crossing

This analysis has shown that most of the differences economic benefits and dis-benefits associated with the choice of form are immaterial relative to the present value additional cost of the tunnel of \$410 million (at an 8% real discount rate, or \$1.24 billion, \$560 million and \$775 million at discount rates of 0%, 6% and 4% respectively[29]). The main areas of uncertainty and the areas that may most likely have a material impact on the choice of form on an economic basis relate to the visual impact/amenity of a bridge: specifically, visual intrusion and obstruction of existing residences; the impact on amenity in Westhaven Marina and Wynyard Quarter; the desirability of Auckland as a desirable place to live; and the impact a bridge may have on the Hauraki Gulf Marine Park.

[29] The cost figures relate to standard 30-year appraisal period; present value cost difference marginally increases when the appraisal period is extended a further 30 years.

The preliminary estimate of visual detriment of the bridge to existing residences does not exceed $80 million (present value). If the rest of the dis-benefits, which cannot at this stage be robustly estimated, have a present value of less than $330 million, the bridge would be more economic than a tunnel.

7.1.3 The potential full spectrum of economic benefits from AWHC options

In generating an analysis of the issues critical to determine the form of crossing, a CBA in line with the NZTA's accepted methodologies has been undertaken, which represents a starting point for consideration of the justification of the crossing itself. In considering this we note that:

- The costs of the project are suitable to allow a meaningful comparison between the preferred form options only.
- The attributes of the option designs are primarily designed to give meaningful comparison between two form options.

Given this, there is considerable scope for refining both costs and benefits in future analysis.

More detail on this section is contained in the EBFO Report. (Note that the figures may not add up due to rounding).

7.1.4 Conventional CBA results

The PV of conventional economic benefits and costs are outlined in

Table 19 with $400 million for both options. The present value costs are $1.57 billion and $1.16 billion for tunnel and bridge respectively, which are primarily (96%) construction cost.

Option	PV of benefits (excluding WEBs)	PV capital cost	PV maintenance and operating costs	PV of total costs
Bridge	$400m	$1,110m	$50m	$1,160m
Tunnel	$400m	$1,485m	$85m	$1,570m

Table 19: PV benefits (excluding WEBs) and costs (2010 dollars)

The breakdown of the benefit stream is incurred shown in Table 20 below, travel time savings accounting for about 75% of total $400 million:

All	Travel time	Congestion	Reliability	Vehicle operating costs (VOC)	Resource cost correction (RCC)	CO^2	Total
Car	$290m	$75m	$10m	$45m	-$70m	$2m	$350m
Heavy Commercial Vehicles (HCV)	$15m	$5m	$0m	$5m	$0m	$0m	$25m
PT							$25m
Total	**$305m**	**$80m**	**$10m**	**$50m**	**-$70m**	**$2m**	**$400m**

Table 20: Bridge conventional benefits (excluding WEBs) and interim costs (PV, 2010 dollars)

The conclusions and BCRs are reported in section 7.1.2, where the results of the WEBs are also integrated.

7.1.4.1 Agglomeration benefits

Agglomeration provides additional benefits to productivity that are not covered in conventional benefits. The NZTA's EEM warrants the agglomeration procedure for only large and complex urban transport activities in the major industrial and urban centres of New Zealand. The AWHC meets this condition. The wider agglomeration impacts to the Auckland region have been calculated following NZTA's EEM procedure, and land-use does not differ between the option and do-minimum scenarios. A summary of results is provided in Table 21 below for both of the modelled years[30].

		2026[31]			2041		
Territorial Authority[32]	**PV ($m) Prod. gain**	**Prod. gain $m**	**Prod. per worker $000s**	**Prod. gain per worker $**	**Prod. gain $m**	**Prod. per worker $000s**	**Prod. gain per worker $**
North Shore City	150	40	100	310	65	120	505
Auckland City	65	12	105	33	30	130	80
Rodney	15	4	95	95	6	120	140
Waitakere City	15	3	100	42	7	120	90
Manukau City	8	2	100	15	3	125	20
Papakura	1	0.2	95	10	0.4	120	17
Franklin	0.3	0.1	95	5	0.1	120	5
Total	**250**	**60**	**102**	**75**	**110**	**125**	**140**

Table 21: Summary of agglomeration results

Source: NZIER. 'Prod.' is 'productivity'. Figures may not add up due to rounding.

At 63% of the conventional benefits these results are considered relatively high considering that agglomeration benefits are often 20–25% of conventional benefits in appraisals overseas. This result is most likely caused by the application of this new procedure to a model such as the Auckland Regional Transport Model (ART3) which has such a high number of zones (512): many of the origin-destination (OD) pairs have low and infrequent traffic movements, which exaggerates the agglomeration benefits. Future additional analysis to aggregate the zones and to restrict the spatial scope of the modelled region for this procedure is required to refine the estimation of agglomeration benefits and the current estimate of $250 million can be regarded as an upper bound.

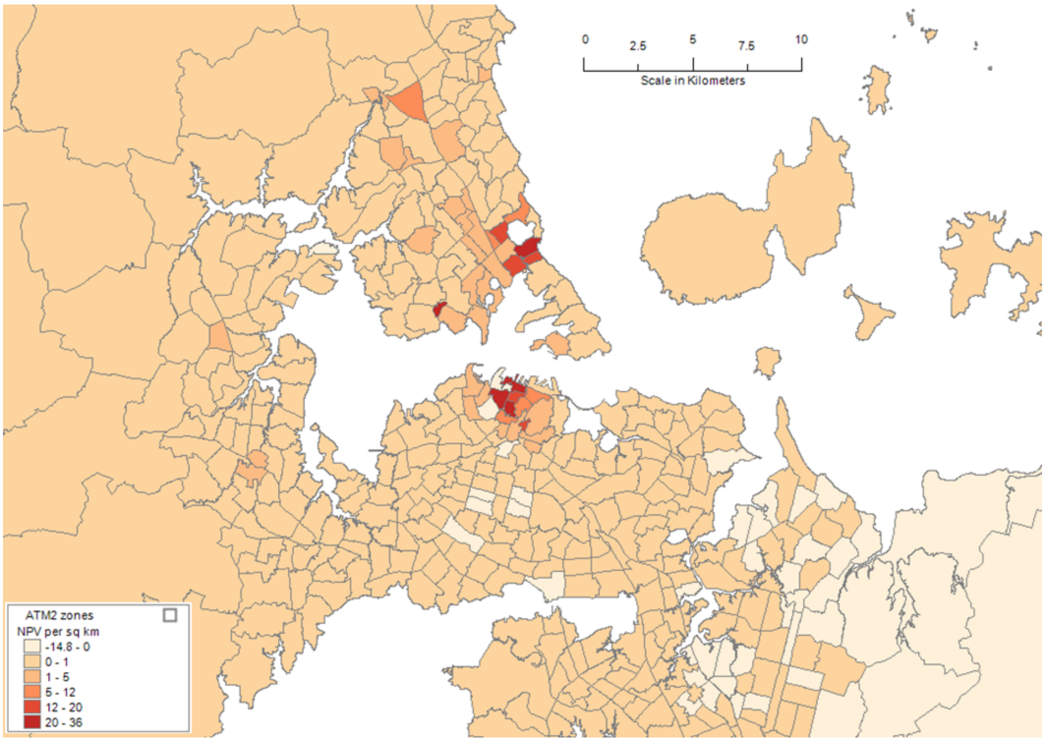
With respect to the current analysis, the largest benefits from agglomeration accrue to North Shore City with $40 million in 2026 alone. Auckland City has marked gains from the AWHC also with $12 million in benefits. The agglomeration gains among other territorial authorities are minimal as shown in Figure 14 below:

[30] There is a distinction between the years modelled using the transport model ART3 from the years the benefits are assumed to occur in for the CBA. Two years were modelled (2026 and 2041) and benefits are projected linearly between and after these modelled years. The decision as to the start date of benefits accruing is independent of the year 2026 modelled (in this case 2029). The agglomeration analysis, land-use modelling, and network performance assessment refer to the 2026 modelling, but these analyses represent the early years of benefits occurring (2029 and most of the 2030s).

[31] The years 2026 and 2041 were modelled, which is an independent decision from the year of opening assumed (2029 in this instance). The 2026 figures should be interpreted as a proxy for impacts in the early years of opening.

[32] Territorial Authorities no longer exist under the Auckland governance restructure. The analysis here represents the data available from Statistics New Zealand.

Figure 14: NPV of agglomeration gains per km^2



Source: NZIER.

7.1.5 Wider economic benefit: increased output from imperfectly competitive firms

A particular class of WEB is presently being considered by the NZTA. The UK Department for Transport's (DfT's) estimation procedure is used together with interim findings from the NZTA's current research on WEBs, which suggests that an 'imperfect competition up-rate factor' of 11% be applied to total user benefits of business journeys. This results in $15 million benefits for this WEB for both options.

The overall CBA results are in Table 22 below:

Option	Benefits (excl agglom)	Agglomeration benefits	Total Benefits (excl WEB)	Increased output from imperfectly competitive firms (WEB)	Benefits (incl WEB)	Costs
Bridge	$400m	Up to $250m	$650m	$15m	$665m	$1,160m
Tunnel	$400m	Up to $250m	$650m	$15m	$665m	$1,570m

Table 22: Summary of benefits and costs (PV, 2010 dollars)

Option	BCR excluding agglomeration	BCR including agglomeration
Bridge	0.3	Up to 0.6
Tunnel	0.3	Up to 0.4

Table 23: BCR results (cost estimates not finalised, and excludes agglomeration benefits)

The BCRs excluding agglomeration benefits are 0.3 for both the bridge and tunnel options respectively, but the tunnel is $410 million more costly in present value. With the agglomeration benefits as high as $250 million (depending on how the technical anomaly described earlier is resolved) the BCRs could be as high as 0.6 and 0.4 for bridge and tunnel respectively.

Moreover, the WEB of increased output from imperfectly competitive firms was $15 million, which is not enough to alter the BCRs at one decimal place.

Given that the sustainable management of the AHB will involve some restrictions on access for freight in the do-minimum that were not modelled in this study, there are relative benefits from an additional crossing that are not included in the BCR. Without further analysis it is unclear how significant these benefits may be.

A discount rate sensitivity assessment of 6% and 4% was undertaken using various scenarios to extend appraisal periods an additional 30 years. Conventional benefits and agglomeration benefits were projected forward an additional 30 years under the following three scenarios:

- *(a)* continue to grow at the same rate;
- *(b)* zero growth from year 31 (inclusive);
- *(c)* no benefits from year 31 (inclusive).

Costs were projected forward (for scenarios *a* and *b*) by continuing the same pattern of annual, 5-yearly, 8-yearly and 25-yearly costs.

Table 24 shows that this led to BCRs in the order of about 1 depending on how benefits were extended out between years 30–60. Table 25 shows that the cost difference between bridge and tunnel options increases to perhaps $570 million at a 6% discount rate and $800 million at a 4% discount rate.

	Scenario *a*	Scenario *b*	Scenario *c*
Tunnel 6%	0.9	0.8	0.5
Tunnel 4%	1.3	1.1	0.7
Bridge 6%	1.2	1.0	0.7
Bridge 4%	1.9	1.6	1.0

Table 24: Sensitivity analysis of BCRs of tunnel and bridge options (including agglomeration)

Discount rate	Scenario *a* and *b*	Scenario c
6%	$580m	$560m
4%	$830m	$775m

Table 25: Sensitivity analysis of incremental present value cost of tunnel over bridge

7.1.6 Network performance assessment

The transport modelling shows that the existing Auckland network is congested. The AWHC relieves pressure at one of the network's most significantly congested links. Travel time savings, reliability and congestion savings are estimated at $390 million PV (Table 24 above).

The study considered the potential for broader economic development benefits to occur that might be omitted from the conventional appraisal. These could be regarded as 'indirect benefits': a transport scheme that causes more firms, more inputs supplied between firms, more outputs supplied to consumers, more use of vehicles, etc, implies more trips and more travel. Modelling all aspects of this induced travel demand accurately and including the willingness-to-pay (WTP) for the extra transport as revealed by the relevant demand curve captures these indirect benefits in the transport CBA (as well as captures negative transport externalities such as increased congestion). However, there are technological limitations with existing modelling approaches to integrate such modelling of the transport network, the regional economy and land-use patterns.

The modelling results were used to make a preliminary assessment of the extent to which network-wide capacity could be substantially enhanced by an AWHC, and could be sustained for a sufficient length of time. Meeting this prerequisite could indicate the potential for firms to respond by lowering prices, increasing output, culminating in more use of the network, which would result in greater economic benefit omitted from standard appraisals.

Mean travel times from Albany, Wairau and Takapuna to the CBD decrease by about an average of 25% in the AM peak, and by about 18% on average south to north in the PM peak. For example, Wairau to CBD trips decrease from 19 minutes to 11 minutes in the 2026 AM peak (42% reduction), and from 21 minutes to 14 minutes in the 2041 AM peak (34% reduction). However, these corridor travel time improvements occur within congested conditions, and the corridors as a whole will continue to operate under LOS E/F (congested) conditions. This indicates the following:

1. Other complementary measures are probably required, such as expansion of capacity on related bottlenecks and road pricing, and the net economic benefits and economic development potential of the AWHC would be greater in that case.

2. For the given analysis and assumptions applied in this project — particularly that other complementary measures in the wider transport network are not undertaken — it is not obvious that additional 'indirect benefits' (from increased economic activity) could be omitted from the current conventional appraisal.

7.1.7 Potential long-term economic development impacts

An assessment was undertaken on the possible long-term effects of major transport infrastructure on Auckland's economic development potential. This assessment noted that just as past investment decisions have shaped current transport investment plans, decisions made on major transport infrastructure such as an AWHC now will shape investment in the future.

The key conclusion is that the best way for Auckland to develop in the medium-term is 'more of the same only better'. Transport planning undertaken during the mid-1950s put a strong focus on the development of a private transport (motorway) network and the subsequent land-use development trends was one of urban sprawl. Development of the motorway system stopped in the 1970s, and since then, Auckland's system has been playing catch up, to make its network match its form. In more recent times, a much stronger focus on PT initiatives has been apparent, with the development of rail and the introduction of the Northern Busway. Associated with this change in focus has been a greater emphasis on land-use intensification. Changing tack at this stage in Auckland's development by trying to force greater density is unlikely to do much for economic development. The locations will change slowly and are most likely to react best to a better functioning road network. Consideration of 'transformation' is likely to be applicable over the longer term rather than the shorter. The most fruitful economic development path is to make the existing mechanisms work. This effectiveness would support gradual shifts and changes in the pattern of economic activity responding to the network's potential. These changes are economic development.

The economic appraisals of major transport infrastructure schemes such as the AWHC cannot be deemed to fairly reflect their merits (or otherwise) unless explicit modelling of different subsequent economic activity and different subsequent transport investment decisions is undertaken. If the AWHC were considered as part of a particularly broad strategy of infrastructure investment then perhaps even modelling of population and demography would be required to capture the full spectrum of benefits.

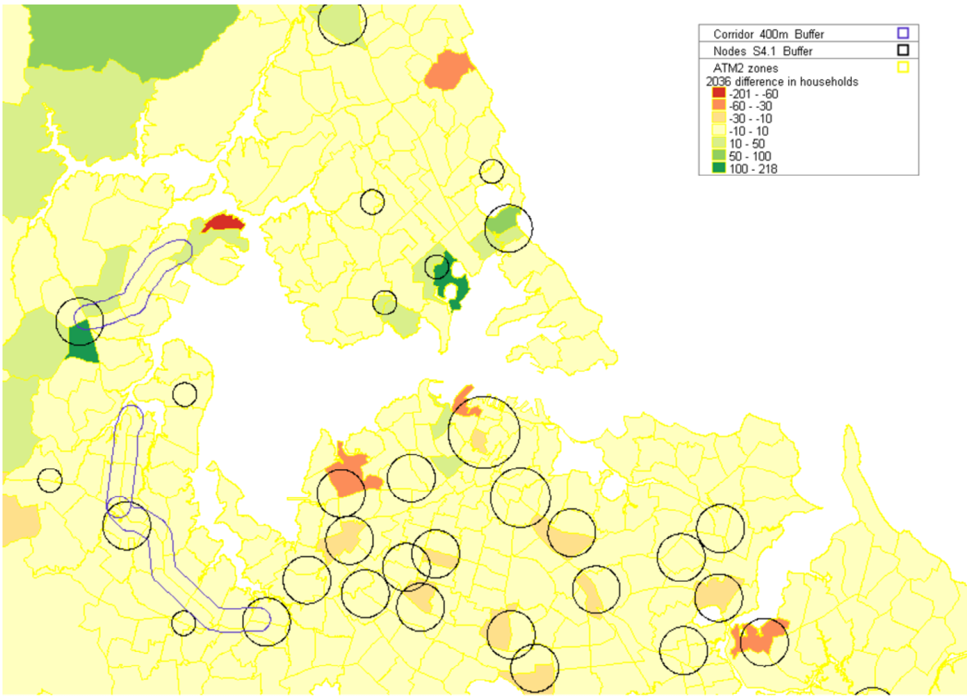
7.1.8 Land-use modelling results

The Auckland Strategic Planning (ASP3) land-use model was used to assess the possible changes in where households, population and employment might locate in different scenarios; in this case with and without an AWHC (in untolled scenarios only). Understanding the potential land-use implications and the possibility of unlocking areas for economic development is important for understanding the consequences of major infrastructure investment. It can identify issues that may need further consideration, and identify opportunities for subsequent development.

Figure 15 below contrasts the nodes and corridors from the current Auckland RGS/Plan Change 6 scenario, also called Scenario 4.1 (areas where intensification is desired) against the modelled household changes in 2036 between the AWHC do-minimum and option scenarios. It shows that the pattern of changes is closely correlated to the growth nodes and corridors envisaged by the region, except for the broad areas of growth in the southern North Shore. The changes in household numbers between the option and do-minimum are small relative to the underlying population growth in the region, and so changes should be interpreted as growth that is either faster than or not as fast as the do-minimum.

Increases (in green) are where the option scenario has more households than the do-minimum, with decreases (where the option scenario has fewer households than the do-minimum) being in red.

Figure 15: Difference in households in 2036 between the option and do-minimum scenarios

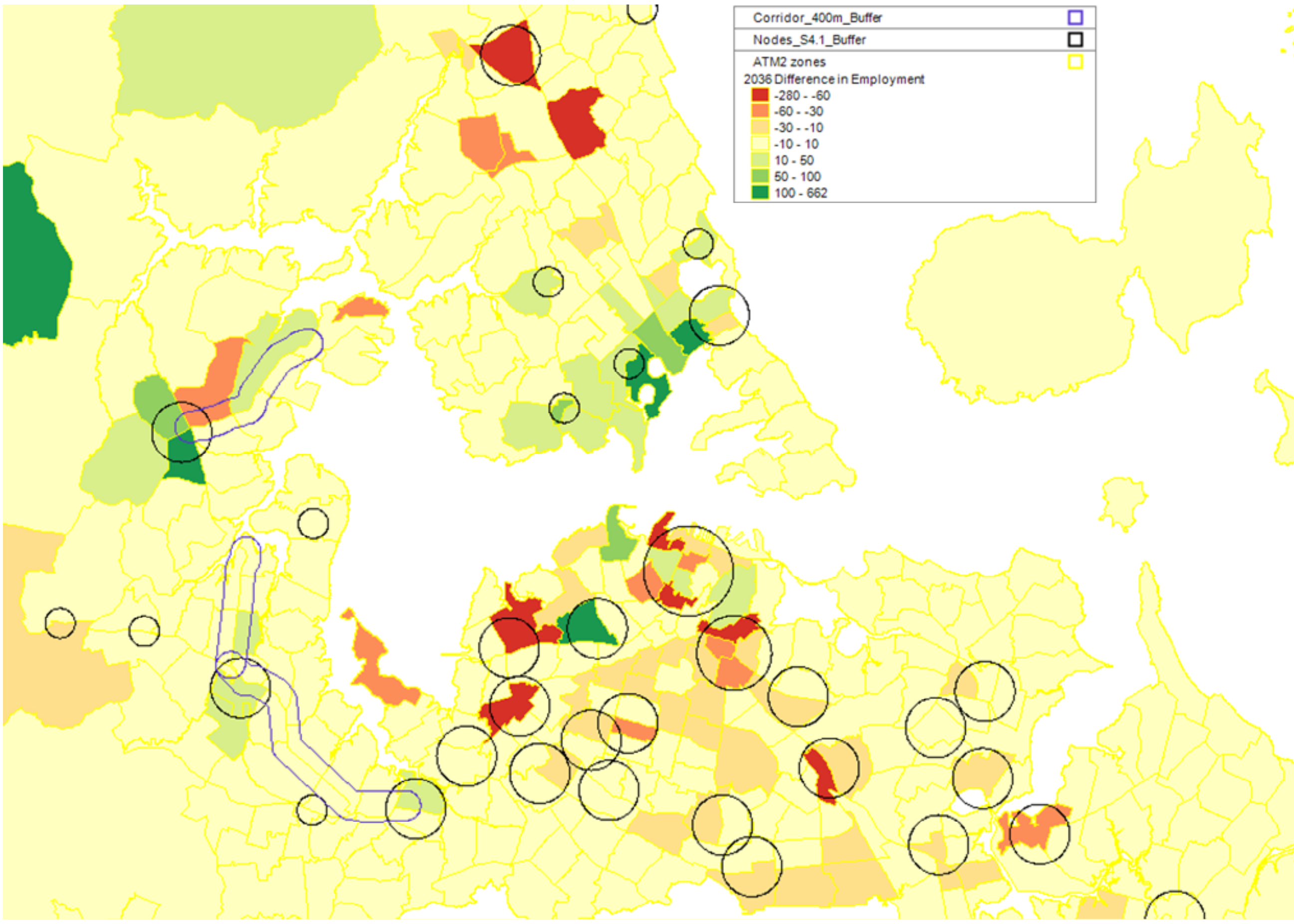


Source: Map by Prism Consulting with growth nodes and corridors supplied by ARC.

It can be seen that the effect on the nodes and corridors is mixed, but the areas that are growing faster are generally located in the growth nodes. Nodes on the North Shore and West Auckland gain households at a faster rate and other areas, such as Pakuranga, gain households at a slower rate than the do-minimum. The effect on the Isthmus nodes outside the CBD (the nodes near the bottom of the map) is small. The effect on Wynyard Quarter could perhaps be considered to be neutral relative to the do-minimum (or at least not dissimilar to the general pattern for the remainder of the CBD) provided that the region still deploys the measures needed to meet the Wynyard Quarter mode share targets (a localised issue that the regional transport model is not ideally suited to model). This caveat also applies for Figure 16 below relating to employment changes.

Figure 16 shows the same mapping of nodes and corridors from ARC's Scenario 4.1 overlaid on a map of employment changes in 2036 between the do-minimum and option scenarios. Increases (in green) are where the option scenario has more employment than the do-minimum, with decreases (where the option scenario has less employment than the do-minimum) being in red.

Figure 16: Difference in employment in 2036 between the option and do-minimum scenarios



Source: Map by Prism Consulting with growth nodes and corridors supplied by ARC.

Overall, it can be seen that the effect on the nodes and corridors is mixed; the nodes on the southern North Shore and West Auckland have higher employment growth in the option relative to the do-minimum, while those in the Isthmus have lower employment growth relatively. The exception is the Albany node which is modelled to have lower employment growth than the do-minimum as at 2036, but what is not captured in this map is that Albany is modelled to have greater accumulated growth than the do-minimum by 2051. This pattern of changes is closely correlated to the growth nodes and corridors envisaged in Scenario 4.1 by the region, except for the broad areas of growth in the southern North Shore. What is unclear is how much of the modelled growth in this area relates to capacity constraints on the Northern Motorway that might be upgraded if an AWHC were to occur. If a comprehensive package of roading improvements included good quality PT between the nodes it may help offset any detrimental effects on them of the roading improvements.

The overall pattern of changes for both households and employment — with the southern North Shore and West Auckland generally growing at a faster rate than the do-minimum and the Isthmus and the northern North Shore generally growing at a slower rate — is the key result. The areas growing faster are generally the areas earmarked by the region for growth. The overall pattern of change depends upon a balance of factors; taking the CBD as an example, the AWHC enables both better access to and from it thereby acting as a force to both attract new activities into it and disperse existing activities.

7.1.9 Network resilience impacts

Auckland gains considerably from increased network resilience. A 2010 study undertaken for the UK's DfT outlines ten key features of a resilient transport network:

- **Redundancy** – the transport system contains a number of functionally similar components which can serve the same purpose and hence the system does not fail when one component fails (for example, a number of similar routes are available with spare capacity).
- **Diversity** – the transport system contains a number of functionally different components in order to protect the system against various threats (for example, alternative modes of transport are available).
- **Environmental Efficiency** – a transport system which is environmentally efficient will be more sustainable, and capacity is less likely to be constrained due to environmental reasons.
- **Autonomy** – the components of the transport system are able to operate independently so that the failure of one component does not cause others to fail (for example, can the transport system operate safely in the event of a power cut?).
- **Strength** – the transport system's ability to withstand an incident (for example, how extreme a flood event can the system cope with?).
- **Adaptability** – or flexibility, can the transport system adapt to change and does it have the capacity to learn from experience (for example, an area-wide traffic management system can adapt to differing traffic conditions).
- **Collaboration** – information and resources are shared among components and/or stakeholders (for example, contingency plans in the event of an emergency and the ability to communicate with system users).
- **Mobility** – travellers are able to reach their chosen destinations at an acceptable LOS.
- **Safety** – the transport system does not harm its users or expose them, unduly, to hazards.
- **Recovery** – the transport system has the ability to recover quickly to an acceptable LOS with minimal outside assistance after an incident occurs.

When the EEM's full procedures are applied the conventional BCR should appropriately value the safety, mobility and environmental aspects of network resilience. However, the remaining aspects of network resilience are probably difficult to monetise appropriately because they are subject to significant uncertainty relating to the outcomes that could eventuate, the likelihood of those outcomes and the impact of those outcomes. Given the importance of the AHB to the functionality of the entire Auckland transport network, it can be reasonably argued that an additional crossing is one of the most critical projects in terms of improving the overall resilience of the Auckland network.

7.1.10 Conclusions of economic analysis of overall benefits of AWHC

An AWHC will make Auckland a more economically attractive city. A fundamental criterion for building a world-class city is the efficiency of its infrastructure. A properly configured AWHC will allow resources to flow more efficiently within the city and wider region. This would require the removal of key constraints on the availability of factors of production (particularly labour and land), regional production (firms' transaction costs fall), and consumption (households have a better leisure-labour choice or a wider choice of locations to live in). It will also improve the resilience of the Auckland transport network by providing redundancy and diversity in particular. This helps to make Auckland more flexible and better able to react to changes in external economic drivers (global preference changes, population growth, etc).

Just as past investment decisions have shaped current transport investment plans, decisions made on major transport infrastructure such as an AWHC now will shape investment in the future. The commitment in the mid-1950s put the region on a private transport (motorway) network was undermined by cessation of motorway development in the 1970s. Since rebuilding started Auckland's system has been playing catch up, to make its network match its form. In more recent times, a much stronger focus on PT initiatives has increased PT usage has been increasing, and will continue to play an important role. The most fruitful economic development path is to make the existing mechanisms work, and the best way for Auckland to develop in the medium-term is 'more of the same only better'. This effectiveness would support gradual shifts and changes in the pattern of economic activity responding to the network's potential. These changes are economic development.

The BCRs excluding agglomeration benefits are 0.3 for both the bridge and tunnel options respectively, but the tunnel is $410 million more costly in present value. With the agglomeration benefits as high as $250 million, the BCRs could be as high as 0.6 and 0.4 for bridge and tunnel respectively. Given that the AHB will involve some restrictions on access for freight in the do-minimum that were not modelled in this study there are benefits from an additional crossing that are not included in the BCR. Without further analysis it is unclear how significant these benefits may be. A discount rate sensitivity assessment of 6% and 4% led to BCRs between 0.5 – 1.9 depending on various scenarios to extend appraisal periods an additional 30 years.

However, a full economic appraisal of major transport infrastructure schemes such as the AWHC would entail explicit detailed modelling of the changes of economic activity and its associated impacts on transport demand and transport investment in an integrated manner. If the AWHC were considered as part of a broad strategy of complementary infrastructure investment then modelling of population and demography may also be required to capture the full spectrum of benefits.

The AWHC looks to promote land-use changes in the areas earmarked by the region for growth. The CBD continues to grow, but at a slightly slower rate, but other targeted growth nodes benefit from the increased connectivity offered by the crossing. In general, the land-use modelling shows that households and employment growth in the southern end of the North Shore and West Auckland grows at a faster rate. A reduction in Auckland's density arising from an AWHC should be interpreted as allowing the benefits of agglomeration and connectivity to be experienced over a wider area.

While the AWHC exhibits significant economic benefits, the rest of the network has been assumed to be unchanged. A wider and deeper stream of benefits than that shown here would undoubtedly be achieved through selected complementary wider transport initiatives.

8. Risk Assessment and Management

8.1 Introduction

This section outlines the processes behind identification and quantification of project risk completed as part of the Preliminary Business Case (including the preparation of the financial model). The quantitative analysis provides an estimate of the cost of risk so that the cost estimates analysed as part of the Preliminary Business Case reflect the element of uncertainty inherent in the information available at this stage of the project. The analysis also highlights those areas or activities that may present more risk than others allowing appropriate lead time to develop mitigation strategies.

During development of the Preliminary Business Case a number of opportunities for the project were identified. In some cases these required assumptions to be incorporated into the decision making process and in other cases a future opportunity exists for the project. Examples of these opportunities are discussed further at the conclusion of this section.

8.2 Background

The forecasting of the future costs of the alternative options for an additional crossing includes a degree of uncertainty and this will impact on the assumptions made throughout the Preliminary Business Case where financial and economic analyses have been undertaken. Each option considered may also be subject to different levels of risk and therefore a comparison of options needs to identify the level of risk associated with each option.

The NZTA EEM identifies two types of uncertainty that may occur in a transport activity:

- The size or extent of inputs to an analysis, such as the variation in construction, maintenance or operating costs; future traffic volumes, particularly due to model results, growth rates, and the assessment of diverted and induced traffic; travel speeds; road roughness; or accident reductions; and

- The timing and scale of unpredictable events, either from natural causes (such as earthquakes, flooding and landslips) or from man-made causes (such as accidental damage and injury from vehicle collisions).

To address the first area of uncertainty identified by the manual, where assumptions have been made in the economic and financial evaluations performed in the Preliminary Business Case, the outputs have been subject to sensitivity testing. The sensitivity testing undertaken involved defining a range of values for an uncertain variable and evaluating and assessing the effects on the evaluation performed.

To address the second area of uncertainty a quantitative project risk analysis has been performed which involved identifying the probability of occurrence of an unpredictable event or occurrence that may result in a change in the realised value of an assumption or input cost. The approach and results from this analysis are provided below.

In addition to the quantitative analysis of risk, the project team have identified opportunities that may exist for the project. These have been summarised at the end of this section.

8.2.1 Quantitative analysis of risk

8.2.1.1 Approach

For the Preliminary Business Case to provide a meaningful estimate of the cost to deliver each option it must include comprehensive and realistic pricing of all quantifiable and material risks associated with the construction and operation of the assets included in each option. Additionally, it is also important to view the risk analysis required for the Preliminary Business Case as part of the broader process of risk identification, allocation and management within the Project.

The execution of any large project is inherently complex, with a corresponding level of risk in delivery. The risk information for this Preliminary Business Case has been gathered and refined as part of the ongoing risk management function associated with the future stages of the project in the following three phases:

- Phase One – Preliminary risk identification and interviews with Project team;
- Phase Two – Structured risk quantification workshops; and
- Phase Three – Risk modelling using Monte Carlo analysis.

As a general approach, each phase discussed risk in relation to the following separate stages of the Project, combined with a separate subsequent consideration of risks for the Project as a whole. These Project components are:

- Site Risks (existing environment);
- Design risks;
- Construction risks;
- Operations and Recurrent Maintenance risks;
- Lifecycle maintenance risks; and
- Overall/holistic.

8.2.1.2 Phase One – Risk Identification

This phase involved preliminary risk identification and interviews with the Project team.

A desktop study of the project risk register, the NZTA Risk Management Process manual[33] and risk registers from other projects was performed to identify the population of possible risk to analyse in the risk workshops. This included mapping all risks from the wider project risk register to ensure those risks that have a potential cost impact on the project were included for analysis during the risk workshops. The project risk register includes both the risks that are specific to the delivery of the Preliminary Business Case and risks associated with the future delivery of the project. In contrast, the risk matrix utilised in the risk workshops and quantitative analysis only includes those risks associated with the future delivery of the project that have a potential cost or timing impact

Once the workshop risk matrix was developed it was reviewed during a series of interviews with senior Project team members and key consultants to ensure that all risks with an associated cost were included in the analysis.

8.2.1.3 Phase Two – Structured risk quantification workshops

A series of structured risk quantification workshops were held in September 2010 with key senior representatives from the Project Team.

During the workshops, risks were analysed across the previously defined project phases for discrete project sections being the Northern, Southern and Central sections and the Project as a whole. Risks were analysed and discussed based on the then current level of design and cost estimates.

The risk discussions focused on the potential magnitude of cost impacts of each risk associated with whole of asset life (i.e. for both the construction and operation of the Project). These cost impacts were based on the information available to the participants at that time, or where additional information would be readily available (i.e. study completion within a week). Risk discussions were prioritised based on:

- Materiality (single digit millions)
- Plausibility (likelihood of the event occurring).

For plausible risks, estimated financial impacts were then assigned based on the defined options.

[33] NZTA Risk Management Process Manual, Issued September 2004.

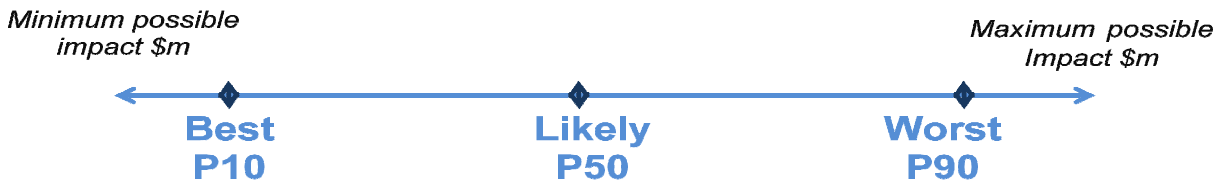
Analysis of the plausibility of a risk addressed the inherent risk likelihood and its consequence. Residual likelihood and consequences were then identified after factoring in reasonable risk mitigation activities and the costs applied for these mitigating activities within the cost estimate.

The expected impact of each risk was analysed and agreed by workshop participants across three scenarios being:

- The best case or P10, defined as having an approximately 10% chance that costs will be less than this amount, given an identified, plausible event(s) that may give rise to additional cost to the project;
- The most likely case or P50, defined as having an approximately 50% chance that the costs will be less (or more) than this amount given an identified, plausible event(s) that may give rise to additional cost to the project; and
- The worst case or unlikely impact or P90, defined as having an approximately 90% chance that costs will be less then this amount given an identified, plausible event(s) that may give rise to additional cost to the project.

The P10, P50 and P90 values are used to guide the risk assessment process as they reflect distinctly different impact points upon a continuum of outcome occurrences as illustrated in Figure 17 below:

Figure 17: Risk workshop impact assessment continuum



These values provide inputs into the Monte Carlo analysis which is discussed further below. They represent parameters upon which to conduct the Monte Carlo analysis and do not equate to the outputs from the analysis. The outputs from the Monte Carlo analysis are a function of, the probability of occurrence (x%), impact of risk occurrence (P10-P90 input values) and the sample distribution selected for the analysis.

Consideration was also given to where potential overlap may occur between cost or quantity uncertainty addressed within the cost estimate. The cost estimates provided for the Preliminary Business Case are also subject to risk and uncertainty and undergo Monte Carlo analysis to estimate this uncertainty. Prior to the risk workshops, participants reviewed and discussed the variability of cost estimates with the project cost estimators. This ensured that there was no double counting of risk costs between the project estimates and quantitative analysis of risk for the Preliminary Business Case.

8.2.1.4 Phase Three – Risk modelling using Monte Carlo analysis

The likelihood and consequence estimates provided in the risk workshops have been used as inputs to a risk model that simulates potential outcomes that are included in the costs of each option assessed in the Preliminary Business Case. Uncertainty is captured by assigning probability distributions to characterise uncertainty in financial outcomes. By utilising Monte-Carlo simulation, the model generates numerous potential outcome values(s), representing annual estimated risk costs.

The assessment of the impact of each risk from the Monte Carlo analysis has been performed by observing the 85th percentile (P85). The percentile is the value at which x% of the outcomes from the risk modelling are less than the stated value. For example if the 85th percentile for a particular risk was $10 million, this can be interpreted as meaning that 85% of the values from the risk modelling are less than $10 million and therefore the cost of risk to the project will be less than $10 million 85% of the time and greater than $10 million 15% of the time. The 85th percentile has been utilised in line with Treasury guidelines[34].

The risk modelling results were reviewed for reasonableness. Assessments of reasonableness were performed by comparing the discussions recorded in the risk workshops on risk occurrence and impact with the modelled cash flow impact on cost of each option (e.g. the resultant cash flow impact that the risk would have on the cost of each option as a percentage of the total cost category).

[34] Better Business Cases for Capital Proposals Toolkit: Detailed Business Case, The Treasury, July 2010.

Additionally the results of the ‘bottom-up’ quantification of risks performed in the workshop were reviewed by workshop participants from a ‘top-down’ perspective by analysing the risk modelling outputs. Workshop participants assessed the overall reasonableness of results based on their collective experience and judgement from previous projects.

8.3 Summary of Key Project Risks

As indicated above, a Project Risk Matrix has been developed for the project. The risk matrix is a risk management tool to capture risks identified and discussed during the risk assessment process.

The risk analysis discussed in this section has been performed at a preliminary stage of the project where the majority of cost information available is at a level of detail that is sufficient to satisfy the decision making process. Therefore, the classification of risks has been guided by the use of the risk ratings included in Table 26 below. This informs the Preliminary Business Case of those risks which may have a significant impact on the project in the future for the defined options. As further information becomes available, this will allow refinement of the risk analysis and quantification process.

Rating	Description	Modelled Cost Impact
Extreme	A risk that is a realistic threat of having a significant material impact to the successful implementation of the defined option.	>$200m
High	A risk that is a realistic threat of having a material impact to the successful implementation of the defined option.	>$100m- $200m
Medium	A risk that is a probable threat of having a moderately material impact to the successful implementation of the defined option.	>$50m - $100m
	A risk that is a possible threat of having a marginal impact to the successful implementation of the defined option.	<$50m

Table 26: Project Risk Matrix

A summary of the risk matrix is included in Table 27 below which includes all risks identified as having a modelled cost impact for the defined listed options. To inform the funding analysis in section 10, risks have also been allocated as either transferred or retained, to indicate if they would be managed by NZTA (retained) during project procurement or not (transferred).

Risks which do not have a modelled cost have been excluded from the information below. This was a result of the workshop participants identifying that the risk had a low probability or that the risk did not have a cost based on the costs allowed for in the cost estimate and the current level of information available.

Type of Risk	Description	Modelled Impact-Bridge	Modelled Impact-Tunnel	Comments on the difference between the bridge and the tunnel	Allocation
Site Risk					
Threat of Injunction	The risk of costs, delays, compensation and/or injunction from interested parties as a result of objection to the preferred option that results in an injunction.	**Medium**	**Medium**	The impact of this risk was assessed as materially equal between the defined options as the cost to mitigate this risk does not change between the options.	Retained
Existing Infrastructure Capacity	The risk that the movement of resources into the construction areas of the defined options places pressure on existing infrastructure resulting in additional cost (e.g. restrictions on nearby roading to transport materials and equipment to site).	**Low**	**Low**	The construction programmes for the defined options both include expected restrictions on programme delivery schedules which account for this risk and are reflected in define option cost estimates.	Retained
Adverse Weather	The risk that the site may be subject to adverse weather during construction from: a. Precipitation b. Wind/cyclone c. Flood d. Wave surges.	**Low**	**Low**	Both of the defined options are affected differently by adverse weather, with the bridge option have a slightly higher, but not materially different cost associated with this risk.	Transferred
Planning Approval Process	The risk that there is a delay to statutory approvals and additional resources are required to alleviate these delays. Delays may arise from events, processes or approvals such as the Resource Management Act (RMA) consent (designation (NOR) outline plan), building consent, the Environment Court, High Court or Court of Appeal).	**Extreme**	**High**	It was identified that the occurrence of this risk for the defined tunnel option is only likely to be associated with costal plan change. The defined bridge option has a number of different triggers which may result in the occurrence of this risk, which reflect its more observable impact on the surrounding environment. This has resulted in a higher risk assessment for the bridge option.	Retained

Type of Risk	Description	Modelled Impact- Bridge	Modelled Impact- Tunnel	Comments on the difference between the bridge and the tunnel	Allocation
Design Risk					
Changes to initial Design Specification (Post-Contractual Close)	A change in the specification of the design that results in a variation to the contract due to: • Change in policy /legislation; • The initial specification not meeting requirements (e.g. capacity) or is changed due to political pressure; • Errors or omissions identified and addressed; • Changes are required to the design due to impacts on surrounding areas (visual, environmental, noise); and • Impact on relocation of buildings/ services, utilities.	Extreme	Extreme	The impact of this risk for both options was identified as significant reflecting the expected time to construction commencement and the possibility of events giving rise to design changes during this time. The additional risk associated with the number of stakeholders who are affected by the project and may require design changes is also reflected in the risk rating. The defined options were not differentiated for this risk because the anticipated changes in design are expected to take place at connection points to the defined option and are therefore virtually equivalent between options.	Retained
Design Delayed	The risk of delay in completion of design and delays are unable to be made up during construction (which may be caused by incorrect road gradients, delay in information received from planners etc).	Low	Medium	The difference in risk impacts between the defined options is a function of the difference in design costs between the options.	Transferred
Extension of the Stakeholder Consultation Programme	The defined option requires additional consultation and communication with key stakeholders which leads to additional cost to satisfy stakeholder needs.	Low	Low	It was identified that management of communications for the defined options is not likely to be significantly different as there are a multitude of stakeholders with opposing views. To ensure successful delivery of the project, the defined options will both require project management to enter into dialogue with stakeholders to ensure that the final outcome reflects their needs.	Retained

Type of Risk	Description	Modelled Impact-Bridge	Modelled Impact-Tunnel	Comments on the difference between the bridge and the tunnel	Allocation
Construction Risk					
Project Cost Estimates	The risk that defined option costs differ to those that have been estimated (e.g. due to unhedged foreign exchange movement or an error impacting on the cost of the tunnel boring machine (TBM), steel and labour purchased from overseas).	**Low**	**Medium**	The difference in risk impacts between the defined options is a function of the difference in construction costs between the options.	Transferred
Project Programme Estimates	The risk that the time to complete pre-operations commencement phases of the defined option may be different from the estimated time (e.g. due to weather, or as a result of a hazard such as a fire in the tunnel from the TBM).	**Low**	**Medium**	The difference in risk impacts between the defined options is a function of the difference in programme estimates between the options.	Transferred
Resolution of Contractual Matters	The risk that the resolution of contractual matters with engaged parties, regarding variation to the contract(s), results in additional costs to NZTA.	**Extreme**	**Extreme**	The difference in risk impacts between the defined options is a function of the difference in total capital costs between the options.	Retained
Operations and Maintenance Risk					
Change in Operating Standards, Legislation, Regulations or Specifications	The risk that changes in operating standards, legislation and regulations require alterations to project operations and the possibility of additional capital cost to ensure compliance.	**Low**	**Extreme**	The difference between the cost impacts for the defined options is a result of the tunnel being subject to more onerous operational standards such as, emergency response access, restrictions on the transportation of hazardous goods and air ventilation management.	Transferred
Availability - Hazardous Goods	The risk that the crossing is unable to take hazardous goods, or that the crossing is closed due to a hazardous goods accident.	**Low**	**Medium**	The difference between the cost impacts for the defined options is a result of workshop participants observing the impacts of hazardous good transportation associated with local and international tunnel projects when compared with local and international bridge projects.	Transferred

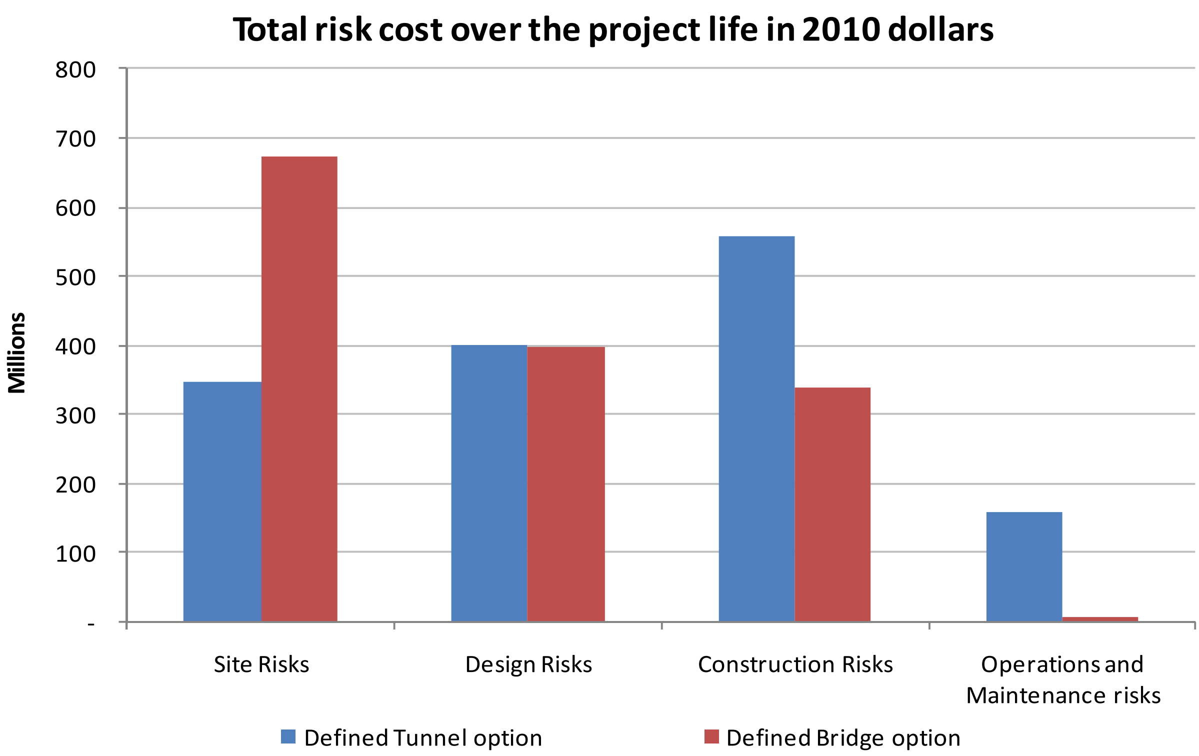
Type of Risk	Description	Modelled Impact-Bridge	Modelled Impact-Tunnel	Comments on the difference between the bridge and the tunnel	Allocation
Operations and Maintenance Risk					
Long-term Maintenance Frequency	The risk that requisite level of maintenance required is greater than that anticipated or more frequent than expected.	**Low**	**Medium**	There were only small immaterial differences between the defined options, reflecting the higher overall maintenance costs associated with the tunnel option.	Transferred

Table 27: Key Project Risks

8.4 Risk profiles of the defined options

Figure 18 summarises the differences between the defined options across the different risk categories of Site, Design, Construction, and Operations and Maintenance.

Figure 18: Total risk cost estimate over the project life in 2010 dollars



This figure demonstrates that overall the workshop participants identified the bridge option as having more site risk, largely associated with the planning and consentability issues of this option when compared with the tunnel option.

The defined options are similar in levels of design complexity and resultant level of design risk and therefore could not be differentiated under this parameter.

The construction risk associated with the defined tunnel option was quantified as both higher in cost and probability due to the lack of previous tunnelling experience in this region and higher underlying base costs of tunnelling construction upon which estimates of risk impact are based.

The operations and maintenance risk costs of the tunnel option are higher due to workshop participants anticipating that there will be greater opportunity for different types of risk to occur under the defined tunnel option and have a larger cost impact, than the bridge option. For example:

- It is anticipated that a hazardous goods explosion would have a significantly larger impact on the tunnel, than a bridge due to the confined space impact of an explosion and observations of the impacts of such events internationally;
- Anticipated and unanticipated maintenance closure requirements are expected to be higher under a tunnel option than a bridge option; and
- In general, the tunnel option has a larger plant and machinery component and safety management requirements, resulting in a higher underlying base cost upon which estimates of risk impact are based.

The total risk impact on a net present value basis is presented in Table 28 below:

Defined option	Total risk value (NPV) $m across the project life
Tunnel	840
Bridge	850
Difference	**(10)**

Table 28: Total risk value for the defined options

In summary, the defined bridge option presents a slightly higher risk option to the project when analysed on a total risk cost (whole-of-project life). This is a function of the expected up-front planning and site risk under the bridge option which offsets the higher construction risk under the tunnel option. It is expected that the bridge option will incur additional cost to mitigate the higher planning and site risk.

8.5 Opportunities for the Project

During development of the Preliminary Business Case, each work stream has identified different opportunities that exist for the project. These opportunities should be taken into consideration as the project progresses through later stages. Where opportunities were in scope for this Preliminary Business Case, they have been given adequate consideration to either allow a choice to be made between alternatives, which have been reflected in the assumptions underpinning the Preliminary Business Case, or determine that the opportunity is not sufficiently material to warrant further analysis at this stage of the project.

The types of opportunities that may exist include:

- Opportunities to change assumptions that have been used in the underlying analysis for the project;
- Opportunities that have a probabilistic chance of occurring (i.e. project risks with a negative cost) and;
- Opportunities to obtain further information to reduce the risk profile of the project;

Examples of the opportunities identified to date are provided in Table 29 below:

Opportunity title	Description
Changes in design assumptions - Tunnel	In order to inform the evaluation of the form options for the Preliminary Business Case within the timeframes allowed, a number of assumptions have been made regarding the D&C of the tunnel option. By changing these assumptions a number of non-material opportunities exist, where the definition of non material means that the opportunity would not change the evaluation of the tunnel option. Specific examples of these assumptions are provided below: Tunnel boring machine: The construction programme schedule allows for an additional TBM to be utilised during construction of the tunnel option. This has the following potential implications: • A decrease in the programme timeframe by 5 months; • An increase in the cost of construction for the tunnel option of approximately $100 million; • Higher construction programme risk due to a more logistically complex programme (e.g. retention of work force is more difficult, TBM launch sites are larger, collection, treatment and disposal of tunnel spoil requires larger temporary construction areas in already confined space, etc.) It was determined by the project team that the positive and negative impacts from the utilisation of an additional TBM were immaterial to the form decision and therefore the analysis in the Preliminary Business Case is based on the use of a single TBM. If relevant, further consideration of this opportunity will be undertaken as a later stage.

Opportunity title	Description
Changes in design assumptions - Bridge	In order to inform the evaluation of the form options for the Preliminary Business Case within the timeframes allowed, a number of assumptions have been made surrounding the D&C of the bridge option. By changing these assumptions a number of non-material opportunities exist, where the definition of non material means that the opportunity would not change the evaluation of the bridge option. An example of these type of assumptions is provided below: Cable stay structure: An opportunity exists to alter the cable stay structure so that the number of cable stays is reduced. Should this design be adopted, this has the potential to reduce the cost of the bridge option by approximately $35 million in 2010 dollars.
The provision of rail to the North Shore	The analysis and consideration of rail throughout the Preliminary Business Case was guided by the following assumptions: There is currently no provision for rail between the CBD and the North Shore and no passenger rail service on the North Shore[35]. During the period of the current Auckland RLTS (2010-2040), the Northern Busway is best positioned to provide rapid transit connections from the North Shore to the CBD, service growth areas around Albany and support growth in the sub-regional centres of Albany and Takapuna. After this time rail will be more suitable to support regional employment growth in centres outside the CBD. An opportunity exists for a North Shore passenger rail line to provide part of such an expansion with stronger connections between the key centres of Albany and Takapuna and the rest of the Auckland region. The opportunity to provide rail to the North Shore needs to be discussed within the context of wider regional rail network development and land-use intensification. A decision about the provision of rail to/from the North Shore should be made on the basis of aspects other that just corridor capacity which may include: • the potential for rail to connect with the rest of the Auckland rail network and provide significant improvements in cross regional travel opportunities; • rail’s role in shaping land-use patterns within the city; and • the impact of surface street bus movements in the CBD.

Table 29: Opportunities Identified

During development of the Preliminary Business Case a number of more general opportunities were identified and assumptions were made to allow the Preliminary Business Case analysis to take place. While these opportunities were not material to the decision making process for the Preliminary Business Case they may be considered further during future stages of the project. Further details of other opportunities are included in the FASR supporting the Preliminary Business Case.

[35] Draft Northern Busway Corridor Capacity Study 2010 Update, August 2010.

8.6 Conclusion

The objective of the above risk analysis was to identify and qualitatively assess risks that will influence decisions made in relation to the form options for the preliminary business case. Additionally, the risk analysis provides the project with an outline of the material risks that will require on-going management throughout future project stages.

The project is currently as a very early stage in its lifecycle. Scope, budget and schedule details will require significant development and refinement which will likely result in changes to information upon which risk analysis is performed. This means that the risk analysis may have a relatively short shelf-life and it is recommended that additional risk assessments be performed during each of the future project stages prior to commencement of operations. This has particular relevance where procurement options for the project are considered in more detail. During the procurement options analysis phase for the project, there will be greater focus on the allocation of risks to the party best able to manage them. The quantitative assessment and allocation of risk will impact on the budget constraints of the public sector and the risk premium required by the private sector. It is anticipated that the results from further analysis and studies will be available at this time to ensure the information available is sufficient to support the more detailed risk analysis warranted at this and other future stages of the project.

9. Procurement

9.1 Introduction

The following section provides a high level discussion of the possible procurement options for the project. Predetermined evaluation criteria are used to identify a short list of procurement options for future consideration and analysis in the Indicative Business Case for the project.

9.2 Procurement objectives

The following procurement objectives and evaluation criteria have been developed to guide the assessment of procurement options for the project.

Procurement objectives	Evaluation Criteria	Materiality (H/M/L)
Efficient Risk Management	The extent to which the procurement option manages, reduces or allocates material risks associated with the project to the party best able to manage them while minimising the Governments risk profile.	High
Value for Money to the Government	The extent to which the procurement option: • minimises whole-of-life cost of the project • optimises competitive tension • achieves appropriate risk allocation (particularly in relation to demand risk for tolled options) • maximises opportunities for design, construction and other (such as financing) innovation • minimises government project development and tender costs and resources • minimises external development and tender costs	High
Budget Certainty	The extent to which the procurement option minimises the likelihood of: • funding shortfalls during the pre-construction phase of the project, and; • cost over-runs (for the account of the government) during delivery of the project.	High
Market Interest	The extent to which the procurement option will attract a high level of participation from the market place, which is a function of: • market capacity relative to Project size; • success or otherwise of precedents (in New Zealand and overseas); • market players' perceptions regarding the cost of the process and likelihood of success.	Medium
Timely Delivery	The timeframe for physical delivery of the Project.	Medium
Flexibility - (Future Scope Changes)	The extent to which each procurement option assists the Government in managing and implementing changes to the functional requirements of the Project over time	Medium

Procurement objectives	Evaluation Criteria	Materiality (H/M/L)
Stakeholder Management	The extent to which the procurement option or contributes to minimising impacts of the project on: • Road users • Local residents • Community Stakeholders • Environmental Stakeholders • Government Stakeholders.	Medium

Table 29: Evaluation criteria

Evaluation

To facilitate the qualitative assessment of procurement methods against the evaluation criteria, the following rating system has been adopted:

Rating	Description
✓✓	Delivery model is extremely effective in satisfying the requirements of the criterion
✓	Delivery model is effective in satisfying the requirements of the criterion
-	Delivery model just satisfies the requirements of the criterion
×	Delivery model is ineffective in satisfying the requirements of the criterion
××	Delivery model is extremely ineffective in satisfying the requirements of the criterion

Table 30: Evaluation rating system

9.3 Procurement Options

The following procurement options have been identified as potentially applicable for the Project. These options include risk transfer to the private sector, and private sector participation in the delivery of the project, on a whole-of-life basis.

9.3.1 NZTA/New Zealand Government Funded D&C

The D&C model is the traditional form of government procurement for roading projects and, as such, will be used as a base case or reference project.

9.3.2 NZTA/New Zealand Government Funded Design, Build, Operate and Maintain (DBOM)

The DBOM model combines a D&C contract with an O&M contract which are procured in parallel. This results in the private sector taking the risks associated with D&C activities and O&M activities in a single contract with the public sector.

9.3.3 NZTA/New Zealand Government Funded Alliance

The Alliance model is essentially a collaborative, incentive driven method of contracting where all participants work co-operatively in an open manner with, ostensibly, a 'best for project' (not company) focus, sharing the risk and rewards for bringing the project, based on the principles of good faith and trust. The extent of risk borne by the private sector under this approach is limited, typically to the "profit" component of payment (with the balance of risks retained by the government. The alliance model is typically only used for Design and Construct contracts.

There are also other variants of the Alliance model which can be collectively termed relationship models, such as Early Contractor Involvement (ECI) model that have been included in the overall analysis of the Alliance model.

9.3.4 NZTA/New Zealand Government Funded Toll Road

Under this option, the Government may use any form of procurement as described above, but would maintain demand risk and tolling responsibilities. Toll management will be delivered via the Land Transport Registry Centre and National Toll System to the private sector. The accruing tolling revenue would be for the account of the government to repay project debt.

9.3.5 Privately funded Public Private Partnership (PPP)

Given the scale of the project, and opportunities for risk transfer to the private sector, there is merit in considering the use of a privately funded PPP model for the delivery of the project. Furthermore, the New Zealand Treasury's Capital Asset Management Planning policy requires consideration and assessment of alternative procurement models for any project with a whole-of-life costing in excess of $25 million. While private sector investment in the provision and operation of urban roads internationally has predominantly been repaid by user pays tolling, other means exist within the PPP delivery model for recompensing private providers for their costs.

The most recent experience is that of the United Kingdom where the use of "shadow tolls" has been adopted in relation to some privately provided road links. The private operator bears the risk of traffic volumes being insufficient to cover the costs of the project, with the Government bearing the risk of higher than expected traffic.

The alternative un-tolled PPP involves substituting toll revenues with availability payments (made by the NZTA) to repay the private sector's costs. The Availability PPP option essentially converts the capital expenditure payable under a D&C or DBOM into a flow of ongoing service payments which are linked to the availability and performance of the asset once the asset is operating.

Should a PPP model be identified for future consideration, the type of PPP model would need to be specified at that point in time. Identification of the preferred PPP model would need to consider matters such as:

- The appetite of debt and equity providers to take on demand risk;
- The ability to toll one or both crossings; and
- The amount of government funding in the form or an upfront contribution available.

9.4 Evaluation Methodology

9.4.1 Assessment against procurement evaluation criteria

Evaluation criteria linked to the procurement objectives for the project have been identified and assigned a 'materiality' ranking in order to reflect the government's priorities, as set out in Table 30 above.

An assessment of each procurement option against the evaluation criteria has then been undertaken in accordance with a qualitative rating system. The evaluation of options is supported by discussion below.

Given the importance of risk allocation to the evaluation of procurement options, the likely allocation of risk under each option has been identified to support the evaluation of these criteria.

This analysis has lead to an overall assessment of potential procurement options to be considered in detail as the AWHC project progresses.

9.4.2 Risk allocation analysis

Under each of the procurement options being considered, the risk to the NZTA under each of the design, construction, operation and maintenance phases of the Project, on a whole-of-life basis, will differ significantly.

Table 31 below provides a comparison of the allocation of key risks across the range of procurement options. A detailed risk allocation and quantification exercise will need to be undertaken once the form of crossing is selected and the preferred funding approach (e.g. NLTF, Tax or debt) is identified.

Risk	D&C	Alliance	DBOM	PPP	NZTA Run Toll road
Scope/specification risk	NZTA	NZTA	NZTA	NZTA	NZTA
Site availability and access	NZTA	NZTA	NZTA	NZTA	NZTA
Site condition risk	NZTA	NZTA / Private	NZTA	Private	NZTA
Land acquisition risks	NZTA	NZTA	NZTA	Shared	NZTA
Environmental approvals risks	NZTA	NZTA	NZTA	Shared	NZTA
Planning approvals risks	NZTA	NZTA	NZTA	Shared	NZTA
Design risks	Private	Shared	NZTA	Private	NZTA
Construction risks	Private	Shared	NZTA	Private	NZTA
Maintenance risks	NZTA	Shared	Private	Private	NZTA
Operating cost escalation	NZTA	Shared	Private	Private	NZTA
Obsolescence risk	NZTA	NZTA	NZTA	Private	NZTA
Competition risk	NZTA	NZTA	NZTA	Private	NZTA
Interface risks	NZTA	NZTA	Shared	Shared	NZTA
Change in legislation risks	NZTA	NZTA	NZTA	Shared	NZTA

Table 31: Risk allocation matrix

9.4.3 Evaluation of procurement options

The evaluation of procurement options has been performed taking into consideration the known complexities and risks of the project. No consideration has been made as to the difference that the preferred form option may have on the procurement option. It is anticipated that once the form option has been finalised then a more details assessment of procurement options would be undertaken to identify the preferred procurement option for the project.

The summary of the evaluation of procurement options is included in Table 32 below:

Evaluation Criteria	Materiality	D&C	DBOM	Alliance	Govt Toll Road	PPP
Efficient Risk Management	High	✗	✓	✓	✗	✓✓
Value for Money to the Government	High	-	✓	✓	✓	✓✓
Budget Certainty	High	✗	-	✗	-	✓✓
Market Interest	Medium	-	-	-	-	-
Timely Delivery	Medium	-	✓	-	-	✓✓
Flexibility - (Future Scope Changes)	Medium	✗	✗	✓	-	✓
Overall Ranking		Fifth	Second	Third	Fourth	First
Efficient Risk Management	High	✗	✓	✓	✗	✓✓
Value for Money to the Government	High	-	✓	✓	✓	✓✓
Budget Certainty	High	✗	-	✗	-	✓✓
Market Interest	Medium	-	-	-	-	-
Timely Delivery	Medium	-	✓	-	-	✓✓
Flexibility - (Future Scope Changes)	Medium	✗	✗	✓	-	✓

Table 32: Evaluation of procurement options

9.4.4 Qualitative analysis of the procurement options

This section sets out the key findings of the qualitative analysis for each of the options.

D&C

- This project has a high risk profile and therefore the requirement to efficiently manage risk through the procurement process is important. While the D&C model allocates risks to the party best able to manage them the high risk nature of this project and associated uncertainty around approvals and construction approaches reduces the effectiveness of risk transfer under this procurement method.

- The D&C contract is the standard form of procurement and does not offer any additional value for money over and above other forms of procurement. Value for money comes about through innovation and the D&C will provide opportunities for NZTA to encourage innovation through the tender phase. However, the level of innovation may be limited as it may be difficult for bidders to understand the design and construction complexities particularly associated with the Southern connection.

- The competitive tender process should provide the NZTA with access to the keen pricing for major works. The design and construction complexities and interface issues associated with the existing network are likely to result in a premium being priced in or future variation claims being made.

- The procurement of this contract will be one of New Zealand's largest infrastructure projects and therefore market interest will be strong under the majority of procurement models.

- With adequate planning there will be sufficient time to meet project timeframes under a D&C contract. While a D&C contract provides general incentives to deliver the project in a timely fashion, the payment mechanism does not prevent payments being made to the contractor until the project is operating and therefore does not maximise the incentive to deliver the project in a timely fashion.

- There may be significant changes in the design of the project given the complexity of the Southern connection. As such scope changes are likely and the D&C model can be costly for NZTA to implement such changes.

DBOM

- The risk allocation under a DBOM model is similar to a D&C however it allows for the up-front allocation of all operating and maintenance risks at the start of the contract which minimises the NZTA's overall risk profile.

- The level of innovation that exists for a D&C model is similar under a DBOM model with the additional incentive for the contractor to provide greater value for money to NZTA through opportunities to deliver innovative whole of life approaches.

- While budget certainty is similar for the D&C component for this kind of procurement, it is maximised through the appointment of an O&M contractor which minimises the Governments on going operations and maintenance cost risk.

- Refer to D&C comments for time to deliver, with the added incentive to complete construction in a more timely fashion to provide access to O&M cash flows.

- Refer to D&C comments for market interest.

- Refer to D&C comments for scope changes.

Alliance

- A relationship based approach with the contractor during the design phase increases the opportunity to understand the project complexities and to better identify, manage and mitigate risks. Should the Alliance convert to a D&C at any stage this locks in the risk transfer.

- Value for money and innovation opportunities are greater under an Alliance model due to the collaborative Alliance environment that allows all parties to modify the design and construction approach on an on-going basis. This can create incentive to be 'innovative' when dealing with risks and issues as they arise.

- An alliance provides no additional budget certainty to the Government as the pricing of the contract is completed in the absence of competitive tension.

- Refer to D&C comments for timely delivery.

- Refer to D&C comments for market interest.

- The Alliance model provides the greatest flexibility to implement scope changes. The Alliance model permits variations during the design and construction phases but the cost of any changes will be based on a cost plus regime.

Government Toll Road

- Depending on the nature of the underlying procurement contract, the risk allocation abilities of this procurement option will match those of a D&C contract.

- Depending on the nature of the underlying procurement method, value for money to the Government is likely to be similar to that of a D&C contract due to natural pricing pressures. There is likely to be less external development and tender cost requirements under this model than other tolled options due to the Government underwriting demand risk.

- Budget certainty has been evaluated as neutral under this model as it is dependent on the procurement model utilised.

- Refer to D&C comments for timely delivery.

- Refer to D&C comments for market interest.

- Refer to D&C comments for flexibility.

PPP

- The PPP model has similar risk allocation to a D&C, although as the private sector takes on fit for purpose risk and risk over the operating period, the PPP model should allow for better management of Design and Construction risk than the D&C model. Further, the project finance rigour of financiers will require the risk allocation to be clear and well understood prior to financing the project which will reduce the overall risk profile and ultimately cost to the public sector.

- Similar in nature to the D&C in terms of innovation and value for money, however, the PPP model tends to rely on a more interactive bid process which should assist in developing an understanding of complexities and also enable some modifications to the proposed design. PPP contracts provide greater value for money to the government as a pre determined cost benchmark must be beaten by the private sector. In beating this cost, the private sector usually delivers greater services for about the same cost, or the same service for less cost, both of which provide the government with value for money.

- The budget certainty is similar to a D&C contract. However, the private sectors non-recourse exposure would require the uncertainty of different design and construction risks to be addressed prior to financing the contract or requiring that a risk premium be included in the contract.

- There is increased tension for the project to be delivered on time under a PPP contract as the private sector do not have access to revenue streams prior to the start of operations. While PPP contracts generally have longer lead times this has not been considered due to the long lead times available for the procurement of the contract.

- Refer to D&C comments for market interest. The market interest for roading project is a function of the transfer of demand risk. In order to ensure adequate levels of market interest, recent roading projects have removed demand risk from the private sector. The more certain cashflow streams make the project more appetising to financers and generate more interest in the project.

- The PPP model requires the private sector to deliver works to meet output specifications. There is not expected to be any difficulty in scope definition and therefore this will not impact on the ability to raise finance. Scope changes under a PPP contract can be costly depending on the payment regime and impact on financing contracts.

9.4.5 Conclusion

On the basis of the above analysis, the recommended short-list of procurement options to be considered in more detail once the form of crossing is determined are:

- PPP
- DBOM
- Alliance; and
- Government funded toll road.

While a D&C contract appears to be the least attractive when evaluated against the pre-determined criteria in this section, it is likely that a D&C contact will be used as the basis for development of the future budget constraints and therefore will be taken into consideration by default.

This analysis has been undertaken at a high-level to suit the requirements of the Preliminary Business Case. It is important that future consideration is given to market appetite for this project under different procurement forms, including equity and debt players. It is therefore recommended that formal market sounding is conducted during the next stage of the project and includes discussions with the following experts:

- Design;
- Construction;
- Finance (equity and debt);
- Tunnelling (as appropriate); and
- Operations and maintenance.

Given the scale of the project and the lack of precedent for a project of this size in the New Zealand market, discussions should include local and international players. This will ensure that experience and knowledge is drawn from relevant projects and that the project is detected early by international players who may not currently have a significant presence in New Zealand.

10. Funding Options Analysis

10.1 Introduction

This section discusses the different potential options available to fund the AWHC. The scale of the crossing, in terms of its cost, means that it will be one of the most expensive infrastructure projects (in nominal terms) in New Zealand's history. This means that a range of funding options beyond funding via the NLTF warrant identification and discussion.

This section does not identify a preferred funding option as this depends on:

- Preferred form of crossing, and in particular whether there is a difference between the optimal form as indicated by the "national" economic and financial analysis and a strong local preference. This may suggest the need for a balance to be struck between a national and local contribution.

- Potential programming and sequencing with other national and local transport projects, and the degree to which revenues (including tolls, taxes, rates, excises and charges) can meet costs across the sector. In particular, it will be critical to determine whether the crossing will be:

    - Advanced through the conventional state highway planning and prioritisation process.

    - Declared a RoNS.

    - Part of a wider package of Auckland transport initiatives that may be jointly progressed between central and local government.

- Timing, and in particular, balancing the best time to build the crossing with the potential ability to raise debt in-line with the government's fiscal management targets.

A critical next step in terms of progressing the crossing will be to get some clarity around these issues as these will significantly assist in narrowing down the potential funding options.

10.2 Core Funding Options

Section 10.2 explores the funding options for the primary source of construction funds. These funding options investigate funding sources that could either fund the entire project, or contribute to the majority of construction costs.

10.2.1 National Land Transport Fund

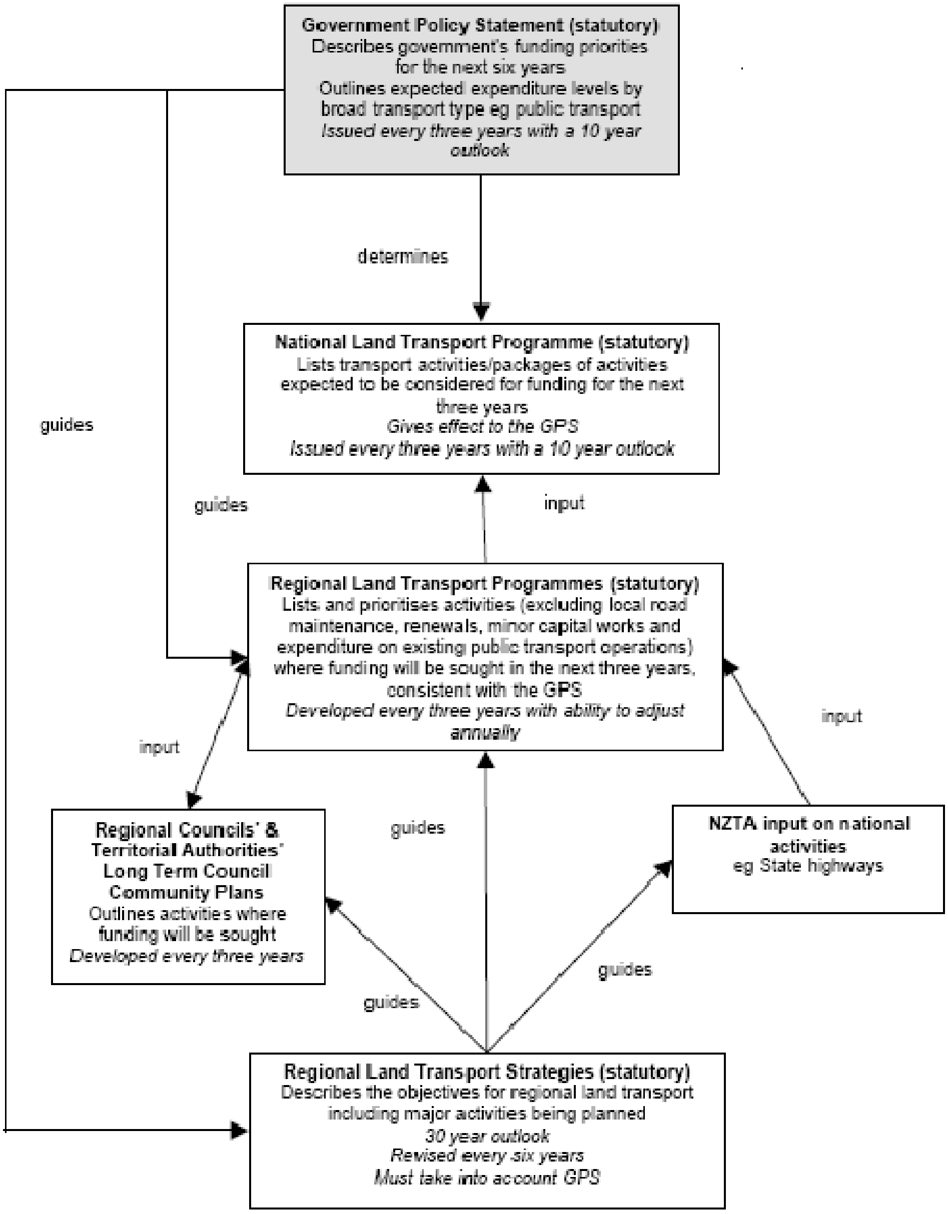
The conventional means of funding transport projects is via the NLTF. Priorities and desired outcomes for the Fund are determined via the GPS on Land Transport Funding.

The current GPS was issued in 2009 and covers all years up to and including the 2014/15 financial year, and includes indicative figures for 2015-2019. While the GPS covers a six year period, its release is timed to coincide with the beginning of a parliamentary term. As such, a new GPS covering the six years post the 2011 election must be released before 1 July 2012.

Under the LTMA 2003, the NZTA must give effect to the GPS in developing the National Land Transport Programme (NLTP). Similarly, the RLTS is also a critical part of the process for determining the spending in the NLTF.

Figure 19 below shows how the NLTF funding model works:

Figure 19: NLTF funding model



Source: GPS.

10.2.1.1 Funding sources

The NLTF is funded through three key sources:

- Fuel Excise Duty (FED)
- Road User Charges (RUC)
- Motor Vehicle Registration and Licensing Fees (MVR).

These funding sources are directly paid into the NLTF and are “fully hypothecated” (i.e. money is not spent on anything else) towards transport funding. The NLTF can be supplemented via other funding sources such as general taxation.

10.2.1.2 The AWHC’s fit with government priorities for NLTF funding

State highways are 100% funded via the NLTF (as opposed to local roads which are partly funded by the NLTF and partly funded by the local Road Controlling Authority). Within the State Highway Network, the Government has announced seven Roads of National Significance (RoNS), which are among the highest priority new construction projects. The GPS states that these projects must be fully taken into account when the NZTA develops the NLTP.

The key outcomes sought from the RoNS are to:

- reduce congestion
- improve safety
- support economic growth.

The RoNS firmly reflect the current government’s focus on utilising transport networks to enhance economic development. The GPS clearly shows this in terms of the short- to medium-term impacts sought:

- Impacts that contribute to economic growth and productivity.
- Improvements in the provision of infrastructure and services that enhance transport efficiency and lower the cost of transportation through:
    - Improvements in journey time reliability.
    - Easing of severe congestion.
    - More efficient freight supply chains.
- Better use of existing transport capacity.
- Better access to markets, employment and areas that contribute to economic growth.
- A secure and resilient transport network.

Other impacts

- Reductions in deaths and serious injuries as a result of road crashes.
- More transport choices, particularly for those with limited access to a car where appropriate.
- Reductions in adverse environmental effects from land transport.
- Contributions to positive health outcomes.

The current RoNS have an additional goal of being a critical part of the government's economic stimulus package designed to maintain economic activity during the recession caused by the Global Financial Crisis (GFC). In first announcing the RoNS, the Minister of Transport discussed a double economic impact of providing short-term economic stimulus via construction, combined with the infrastructure enabling longer-term economic development once completed.

10.2.1.3 Current funding levels

The GPS lists funding ranges for activity classes. The key activity class for the AWHC is – *New and improved infrastructure for State highways*. These funding levels are shown below in Figure 20:

Figure 20: Funding ranges for activity classes

Activity class	Allocations[3]	Funding ranges						Forecast funding ranges			
	08/09 $M	09/10 $M	10/11 $M	11/12 $M	12/13 $M	13/14 $M	14/15 $M	15/16 $M	16/17 $M	17/18 $M	18/19 $M
New and improved infrastructure for State highways	864	800 1150	825 1150	850 1150	875 1150	900 1175	950 1200	950 1275	975 1300	1000 1325	1025 1350
Renewal of State highways	202	190 230	190 230	200 240	210 250	220 260	240 280	250 290	260 300	280 320	290 330
Maintenance and operation of State highways	279	270 335	280 345	280 345	300 365	320 385	330 395	350 415	370 435	390 455	410 475
New and improved infrastructure for local roads	231	150 250	150 250	150 250	175 275	175 275	175 275	200 300	200 300	200 300	200 300
Renewal of local roads	216	200 240	210 250	220 260	230 270	240 280	250 290	270 310	280 320	300 340	310 350
Maintenance and operation of local roads	237	200 265	210 275	220 285	230 295	250 315	260 325	280 345	290 355	310 375	330 395
Road policing	283	285 295	295 305	305 314	315 325	325 335	335 345	340 350	355 365	365 375	375 385
Public transport services	191	185 215	195 225	205 235	220 250	230 260	240 270	255 285	270 300	280 310	295 325
Public transport infrastructure[4]	144	20 100	20 100	20 100	20 70	20 70	20 70	25 80	25 80	25 80	25 80
Demand management and community programmes	55	40 55	40 55	40 55	40 55	40 55	40 55	40 60	40 60	40 60	40 60
Walking and cycling facilities	18	10 25	10 25	10 25	10 28	10 28	10 28	12 30	12 30	12 30	12 30
Sector training and research[5]	6	5 7	5 7	5 7	5 7	5 8	6 8	6 8	6 8	6 8	6 8
Domestic sea freight development	6	0 2	0 1	0 1	-	-	-	-	-	-	-
Rail and sea freight	2	0 2.5	0 1	0 0.5	-	-	-	-	-	-	-
Transport planning	39	34 40	32 38	30 36	30 35	30 35	30 35	30 35	30 35	30 35	30 35
Management of the funding allocation system (including performance monitoring)[6]	38	33 39	31 38	29 35	32 36	33 37	34 38	35 39	36 40	38 42	39 43

Source: GPS.

Given the project is already in the current state highway plan, as well as those signalled in the NIP, it is very unlikely that the current levels of funding in the activity class (including applying the $25 million per annum increment beyond 2018/19) would support the AWHC in addition to other construction activity.

Therefore, the options available for funding the AWHC via the NLTF's traditional funding sources (FED, RUC, MVR) would most likely involve either reprioritisation from other activity classes, or an increase in revenue from these sources.

10.2.1.3.1 Reprioritisation

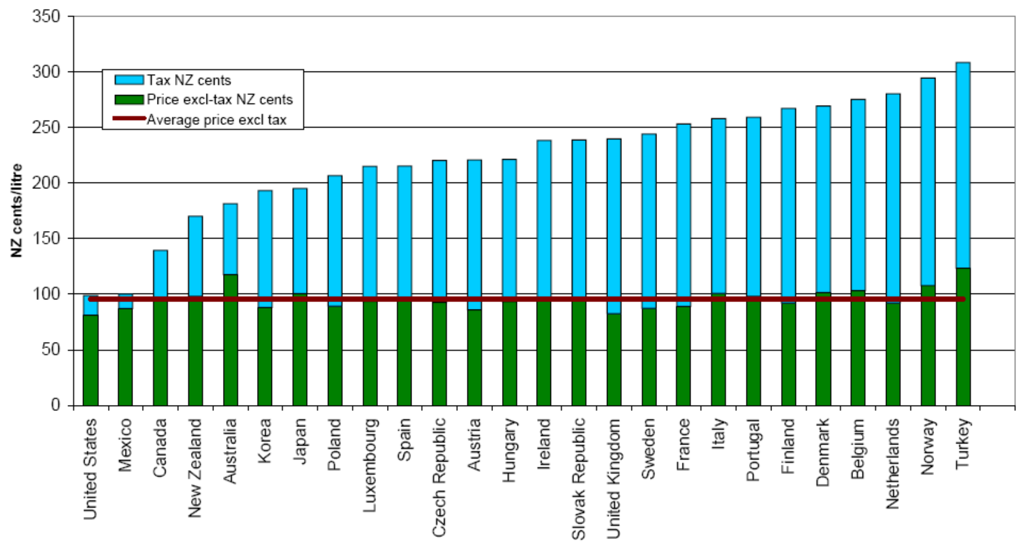
It is unlikely that sufficient funding could be freed up via reprioritisation. This is due to the dominance of the new state highway funding, and the likelihood that the remaining activity classes contain a high degree of non-discretionary spending to maintain a minimum level of asset health.

10.2.1.3.2 Potential for extra revenue from FED and RUC

A potential alternative funding source may include additional revenue from transport users via FED and RUC. While specifically tying an increase in transport revenue to a regional project has proved problematic in recent times (in particular the regional fuel tax proposals), the fundamental question is whether transport revenue is sufficient to deliver on national economic priorities, and whether increasing transport taxes is the most economically efficient way of addressing infrastructure funding shortfalls.

A 2009 MED comparison on petrol tax indicated that New Zealand has one of the lowest petrol tax rates in the OECD. In addition, New Zealand consumers are not burdened with above average petrol prices when taxation is excluded, or overall. The results of the study are summarised in Figure 21:

Figure 21: Prices and Taxes in OECD Countries, December Quarter 2009



Source: Ministry of Economic Development.

New Zealand has lower petrol prices excluding tax than in Australia and Norway, two countries we are often compared to. Pre-tax petrol prices in New Zealand are similar to those in Canada and Japan, and slightly higher than in the United States (which has the lowest prices), and the United Kingdom.

New Zealand has the fifth lowest petrol tax in the OECD, and the fourth cheapest petrol price overall. Critically, the majority of countries modelled here have both higher competitiveness and infrastructure scores based on the World Economic Forum assessment discussed earlier in this Preliminary Business Case.

Analysis on 2010 fuel taxation levels of these OECD countries shows that New Zealand's taxation levels are relatively low on a broad scale. However, they are high in comparison to the United States and Canada, two countries that have traditionally maintained particularly low petrol prices. This is highlighted in

Country	Local Currency		Percentage	
	Local Currency		Percentage	
	Total Petrol Tax (cents/l)	Petrol Price/l	Tax Charged	Difference from New Zealand
United Kingdom	0.710	1.096	65%	21%
United States	0.106	0.705	15%	-29%
Canada	0.320	1.005	32%	-12%
New Zealand	0.739	1.695	44%	

Table 33 and Table 34, which compare petrol and diesel fuel tax rates, respectively, in the United Kingdom, United States, Canada and New Zealand.

Country	Local Currency		Percentage	
	Local Currency		Percentage	
	Total Petrol Tax (cents/l)	Petrol Price/l	Tax Charged	Difference from New Zealand
United Kingdom	0.710	1.096	65%	21%
United States	0.106	0.705	15%	-29%
Canada	0.320	1.005	32%	-12%
New Zealand	0.739	1.695	44%	

Table 33: Year end May 2010 average petrol tax

New Zealand levies a higher rate of tax on petrol than Canada or the United States, but a significantly lower rate than the United Kingdom.

Country	Local Currency		Percentage	
	Total Diesel Tax (cents/l)	Petrol Price/l	Tax Charged	Difference from New Zealand
United Kingdom	0.558	0.955	58%	45%
United States	0.125	0.732	17%	4%
Canada	0.252	0.949	27%	14%
New Zealand	0.126	0.973	13%	

Table 34: Year end May 2010 average diesel tax

New Zealand levies lower rates of tax on diesel (via RUC) than any of the other three nations compared in Figure 21.

Using data from the Ministry of Transport, a 2% increase in FED and RUC provides a NPV revenue increase over 30 years of $614 million.

10.2.2 Crown borrowing funded by future fuel tax revenues

An alternative scenario to conventional NLTF funding is to borrow against future NLTF revenues. The current NLTF model is a PAYGO model where the revenues collected in one year are spent on projects that are undertaken in that year. This model can reasonably accommodate stable infrastructure development profiles, but runs into difficulty where a government is looking to accelerate infrastructure development in the short-term, with a corresponding reduction in additional infrastructure at a later date. It also has difficulty in accommodating particularly expensive individual projects such as AWHC while maintaining “business-as-usual” spending.

If the government believed that, in the long-term, revenues from FED and RUC were to be higher than the long-term costs of constructing, operating and maintaining transport networks, then there would be an opportunity to service construction debt over the long-term from transport revenues.

In considering this funding option, there are three key considerations:

- Ability of the Crown to raise funds.
- Desirability of the Crown borrowing against future transport revenues.
- Competing pressures.

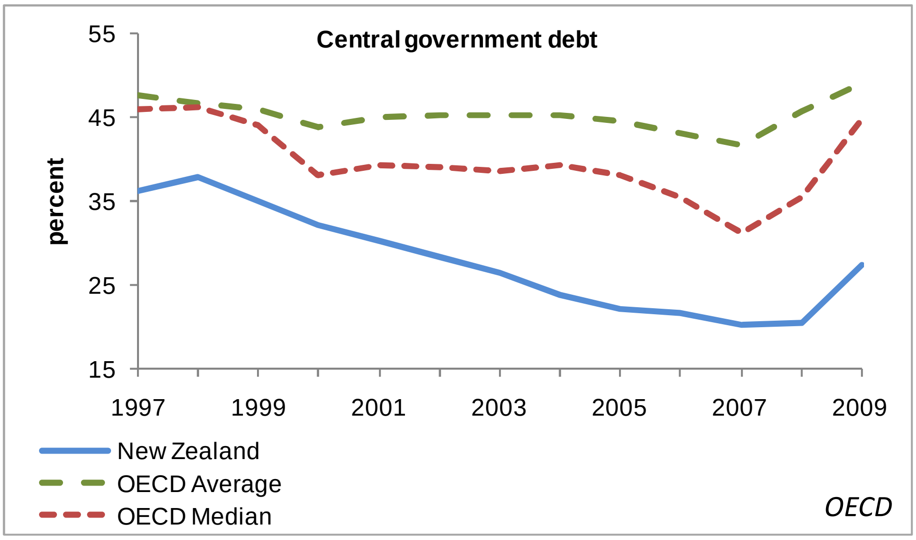
10.2.2.1 Ability of the Crown to raise funds

A key fiscal goal of the Government is to reduce Gross Sovereign Issued Debt less Core Crown Financial Assets (“net debt”) to no more than 20% of GDP by 2020. The long-term objective of reducing debt and improving net worth aims to better position New Zealand against economic shocks.

The Government is currently well under the 20% threshold, with net debt of $26.6 billion at 30 June 2010 (14.1% of GDP). However, one implication of the global economic slowdown has been a surge in Government spending as a share of GDP. In the year to June 2011, net debt is expected to rise by 50%, to $40 billion (19.6% of GDP). By 2013, net debt is forecast to rise to over 25% of GDP.

As shown in Figure 22, New Zealand has historically had lower levels of central government debt (a slightly different measure to net debt) compared to other nations in the OECD:

Figure 22: Time Series of OECD Central Government Debt as a Percentage of GDP



Source: OECD.

In a global sense, the New Zealand government is well-positioned, in comparison to other sovereign borrowers, to take on more debt. Moreover, New Zealand's comparatively high levels of interest paid on government stock, combined with our transparent accounting practices and being seen traditionally as a "safe" investment option does mean that we may be a comparatively attractive borrower as global investment funds recover.

In terms of the government's own fiscal management targets, its current level of borrowing (over $200 million per week) is presently not consistent with the principles of sound fiscal management as outlined in the Fiscal Responsibility Act. 2010 Budget forecasts have indicated that the government will return to being consistent with these principles by 2014/15. We can therefore expect an option of Crown borrowing to be feasible over the current timelines for the AWHC project.

10.2.2.2 Desirability of the Crown borrowing against future transport revenues

There are two key dimensions to desirability of this funding option, with both related to the full hypothecation of FED and RUC to the NLTF.

The first dimension is any precedent effect for other transport projects from this type of funding option and the fact that the majority of the NLTF will still operate on a PAYGO basis. It is critical that this funding option not undermine the established method of land transport funding. It is not considered that such an approach would be problematic on this front as:

- Central government has already raised sovereign issued debt for both the ALPURT B2[36] and Harbourlink projects and has agreed to raise it for Tauranga Eastern Link;
- The projects are still effectively funded by fully hypothecated transport revenues; and
- The financing method would fit neatly with other procurement options including public private partnership (PPP) as potentially a shadow tolling approach (on availability), which is discussed below in section 10.3.

The second dimension is that the borrowings, serviced by a fully hypothecated revenue source other than taxation mean that they have no impact on net debt. In other words, there is no negative impact on the government's fiscal targets associated with financing the AWHC in this way. This places the AWHC in a favourable position relative to other potential candidates for debt funding on the Crown's balance sheet, as most would have a negative impact on the government's net debt measure.

10.2.2.3 Competing pressures

The AWHC is effectively a discretionary spending item, and if the Crown's debt position continues to be tight, it may not be a high enough priority relative to other sectors to raise debt.

10.2.3 Crown borrowing and repayment via general taxes

This funding option is effectively the same as the approach discussed above, except repayment of debt would be funded by general taxation. The government has, in recent years, funded many significant transport priorities, at least partly, through debt repaid by taxes. The Kiwirail turnaround plan, Auckland rail electrification and a number of projects prior to full hypothecation, all used taxpayer funds.

The principal issue with this funding option is that the borrowings would have a negative impact on net debt and as such, this would only be a superior option to the approach above if the long-term NLTF revenues could not support borrowing.

10.2.4 Private Finance (PPP)

The following discussion on the use of private finance focuses on the use of a PPP. The type of PPP project referred to here is one in which the public sector follows the NIU's guidelines[37] and undertakes a procurement process to select a private sector partner to Design, Build, Finance and Operate (DBFO) a distinctive piece of roading infrastructure.

There are different types of PPPs that can be utilised for roading infrastructure procurement with the main distinction based on the transfer of demand risk to the private sector. Where demand risk is transferred to the private sector, this is

[36] ALPURT B2 is a SH1 Northern Motorway Extensions between Albany and Puhoi.

[37] Guidance for PPPs in New Zealand, Prepared by the NIU of the Treasury, October 2009.

likely to occur in the form of a user pays toll road or a Build, Own, Operate and Transfer (BOOT) PPP procurement model. Where demand risk is retained by the public sector, this may take the form of an availability style PPP, or DBFO model. Under this model, the private sector is remunerated for making the road available and the public sector may operate a user pays tolling system to fund the payments to the private sector. The discussion below focuses on a generic PPP contract where the private sector is reimbursed over a period of time, usually longer than 25 years for the construction, funding and subsequent operation and maintenance of a defined piece of roading infrastructure which may or may not include the transfer of demand risk.

As a RoNS under the NIP, the AWHC would receive due consideration during the development of the NLTP which may result in the allocation of funds towards the project's development. The construction period of the AWHC is likely to be between 5 and 6.5 years. During this time the construction costs will represent a significant proportion of the total NLTP's allocation for new and improved infrastructure for state highways. The impact on available funding may be minimised through the mechanism of a PPP contract. While the contract may require an up-front contribution from the government, the amount of this contribution will place less demand on both the NLTF and tax base when compared to other forms of procurement where the bulk of the projects costs are paid prior to and at the commencement of operation of the asset.

The reduced demand on scarce public funding is one of the more visible advantages of a PPP contract but it is not the main driver of value for money to the public sector. The mechanism of the PPP contract allows the government to plan for the future with greater budget certainty as both construction and operation costs are fixed over a greater period of time and in some cases may be lower than under traditional forms of procurement. A report[38] prepared by Allen Consulting Group for Infrastructure Partnerships Australia in 2007 reviewed a number of closed PPP transactions and traditional procurements and identified that PPP contracts also reduce construction costs by introducing scope for construction cost efficiencies within a PPP framework. This is a consequence of the private sector managing the cost and time risks and of a significant amount of design work being completed before signing the contract, reducing the potential for scope changes after the contract is signed. The higher level of design development and focus on required outcomes leads to greater cost certainty for the public sector.

The argument for greater cost certainty was also supported by an authoritative study[39] of a representative basket of Australian PPPs and traditional procurements by the University of Melbourne in 2008 for the Australian National PPP Forum. This study was expressly designed to address criticisms of pro-PPP bias levelled at earlier studies and found "PPPs delivered projects for a price that is far closer to the expected cost than if the Project was procured in the traditional manner."

Further research has also been undertaken by HM Treasury[40] which identified that from a sample of 61[41] operational PPPs in the UK, 88% were completed on time or early, and with no construction cost overruns being borne by the public sector. Previous research had shown that 70% of non-PPP projects were delivered late and 73% ran over budget.

The reduction in cost uncertainty is also brought about by the finance structure in place under a PPP contract. A study of PPP projects in Australia completed by PwC in 2010 found that the provision of equity capital and non-recourse debt finance, coupled with the transfer of risk to the private sector, results in financiers requiring a more rigorous analysis of project costs and risks. This has resulted in better management of delivery schedules, design changes and cost slippage which ultimately allows bidders to reduce the cost associated with uncertainty in the bid price. The study also found that the PPP model delivers efficiencies by encouraging bidders to take a whole-of-life approach to evaluating costs. The competitive tension that occurs during the bidding phase of a PPP contract requires bidders to optimise the trade-off between increased capital costs and lower maintenance/lifecycle costs in order to provide the most value for money to the public sector and achieve contract award.

10.2.5 Potential PPP issues in the New Zealand context

The key issue with a PPP for the AWHC is its scale and the lack of any other transport PPPs currently underway in New Zealand. The market is likely to view both issues as significant risk factors, and further communication with the market is recommended to understand their concerns in this regard. These concerns have been overcome in other jurisdictions

[38] Allen Consulting Group, Duffield, CF and Raisbeck, P. (2007). Performance of PPPs and Traditional Procurement in Australia. Melbourne, Infrastructure Partnerships Australia.

[39] *Report on the performance of PPP projects in Australia when compared with a representative sample of traditionally procured infrastructure projects* University of Melbourne, 17 December 2008.

[40] PFI: Meeting the investment challenge, HM Treasury, July 2003.

[41] This represents approximately 10% of all completed PPP's as at the date of the report.

where there is a pipeline of other transport PPPs projects and such a pipeline is likely to make the market more attractive to overseas players which will in turn increase competition in the local market.

To date, the only transport PPP that has been significantly explored is the Rodney District Council's Penlink project. At the time of writing, the status of this project is unclear, although it is understood that there is a good degree of market interest in the project. Under the new Treasury Capital Asset Management requirements there could be a number of other projects that are considered for PPP. There are a number of other potential PPP candidates that can be moved in advance of AWHC to provide the market with more certainty over such a large project.

10.3 Supplementary funding options

Section 10.3 explores the funding options that can either:

- Supplement primary sources of construction funds; or
- Be used as a way of repaying or off-setting primary sources of finance.

10.3.1 Toll funding

There are presently two active toll roads in New Zealand:

- the Northern Gateway toll road (ALPURT B2 north of Auckland) operated by the NZTA as an electronic free flow toll road; and
- Route K (Tauranga) operated by Tauranga City Council, as a non-free flow toll road (i.e. cash and barriers)

Two additional roads have been identified as toll roads when/if they get built:

- Penlink (Rodney District Council)
- Tauranga Eastern Link (Tauranga, NZTA).

It is also possible that other RoNS could proceed as toll roads.

Historically, toll financing in New Zealand (incorporating analysis of the Harbourlink project in Tauranga and also the original Western Ring Route tolling proposal) has, at best only contributed to a portion of the construction costs of the roads. The strongest performing of the planned toll roads have, at best, contributed just over 50% of the cost of construction.

The reasoning behind this comparatively low contribution to the cost is best described by Erik Amdal of the Norwegian Public Roads Administration. Amdal (2006) undertook a panel data analysis across all the Norwegian toll operators (a total of 42 toll roads with a mix of urban, rural, free flow and attended plaza) to understand toll financing and operating costs. The critical part of the analysis from a New Zealand perspective was the limited viability of toll roads where counter-peak flows were not strong.

Toll funding in New Zealand has a number of key characteristics which are discussed below in 10.3.1.1 – 10.3.1.5.

10.3.1.1 Toll rates

Toll roads in New Zealand have typically been modelled on two types of charge, a revenue maximising charge and a "balanced toll" which is usually marginally lower than the revenue maximising toll and designed to get greater throughput of traffic (it reduces diversion and therefore tends to have a marginally higher BCR).

Balanced toll rates on projects worked on to date are around the $2 per vehicle mark for cars.

10.3.1.2 Adjustment

While there is no established policy on toll rate adjustment, current practice is to adjust tolls by the CPI. The theory behind this approach is to maintain the cost of the toll relative to other living costs. This adjustment mechanism could, potentially be inconsistent with both Treasury and Auditor General Guidance on user charges in the public sector, which place restrictions on charging above the cost of production.

10.3.1.3 National toll system

A National Toll System is run by the NZTA out of the Land Transport Registry Centre in Palmerston North. This system is set to run tolls for all NZTA operated toll roads. It is not, at present, responsible for Route K (and this would not make sense unless Route K became an electronic free flow toll road). The status of roads not operated by NZTA, be they operated by other road controlling authorities, or privately operated state highways (e.g. PPP projects) has not been worked through by the NZTA at present.

10.3.1.4 Transaction charge

The transaction charge is the per use operating cost of using the toll road. The charge is taken out of the toll prior to the revenue being used to repay construction debt. The charge includes fixed costs (e.g. Transport Registry Centre staff, servers, website etc) and variable costs (e.g. data costs). The current transaction charge is $0.65 per transaction. This can, however, be expected to reduce as tolled volume increases (and there are more transactions to spread the fixed costs over). Transaction charges in Australia and Norway (see Amdal 2006) are much lower than the current New Zealand transaction charge.

10.3.1.5 The AWHC as a tolled project

The AHWC has three key aspects that make tolling attractive as a funding option.

Firstly, if the tolled portions were to be funded by debt, the cost of that debt would not impact negatively on the government's fiscal targets as it would be net debt neutral (i.e. the debt would be fully covered by a hypothecated revenue source).

Secondly, a forecast high utilisation in both directions of the crossing means it would in theory be able to contribute a much higher proportion of construction costs compared to other tolled projects in New Zealand. Further analysis of this is included in section 10.4 below.

Its third attraction is its wider contribution made to the network of toll roads in New Zealand. The absolute volumes carried on the AWHC would, most likely result in a significant reduction across the board in the toll transaction charge. Reduced transaction charges, depending on how the NZTA choose to apply them will:

- Make the National Toll System financially viable (it is presently being subsidised out of the NLTF by $3 million -$4 million per annum).
- Increase the amount of revenue for subsequent toll roads can service through reduced operating costs.
- Potentially reduce debt retirement time of existing toll roads if the NZTA choose to apply the new transaction charge across all toll toads.

The key issue with the AWHC as a tolled project is the treatment of the current harbour crossing. The LTMA requires that all users of a toll road have a free alternative to using that road. The logical alternative would be the AHB. However, the proximity of the AHB has three critical concerns:

- The level of traffic diversion from the tolled new crossing to the untolled AHB significantly impacts on the amount of revenue collected and reduces the effectiveness of the new crossing.
- With the current plans for the AWHC connecting through traffic, and the AHB connecting the CBD, congestion in the CBD will increase with through traffic mixing in CBD streets.
- LOS on the Northern Motorway for traffic prepared to pay the toll are less than desirable as that traffic would mix with traffic attempting to use the free route.

The LTMA allows the tolling of an existing road, provided that road is "physically and operationally integral" to the new, tolled road. This provision was tested as part of the development of the Harbourlink tolling proposal in Tauranga, and it is a reasonable assumption that the AHB could be considered physically and operationally integral to the new crossing. However, it is extremely unlikely that the UHB would be considered to be a viable free alternative route, particularly for CBD bound traffic. Therefore, any toll strategy would need to consider:

- Whether there is a strong case for tolling the existing crossing, including:
  - Network performance for both CBD bound and through traffic.
  - Diversion impacts and trip suppression.
  - Shifts to alternative modes, particularly PT, and whether that contributes to the RLTS.
- Whether some free capacity should be provided on the AHB.
- Whether there is a strong case for amending the LTMA.

10.3.2 Rates funding

Rates could be a potential complement to one of the core funding measures. The new crossing will most likely be designated a state highway and, as such, the argument for rates funding in isolation of wider considerations would be very difficult to make taking a principles-based approach. We are unaware of any recent state highway project that has also attracted funding via rates.

The BCR and analysis effectively considers the benefits and costs to New Zealand of each of the options of the AWHC. In effect, it takes a New Zealand perspective for the use of funds collected from New Zealanders.

While the BCR considers and monetises regional economic development issues, and where possible quantifies commercial and residential land value impacts, it does not account for more qualitatively-based regional preferences for a certain look for the Waitemata harbour. It also effectively places nationally-agreed weightings on certain factors such as land-value impacts, and these weightings may be more, or less important to the region.

Where Auckland has a considerably different set of preferences to the New Zealand-focused analysis of benefits and costs, it may be appropriate that these preferences be backed up by a regional contribution towards achieving a different outcome.

10.3.3 Value Capture mechanisms

Value capture techniques "capture" the increase in private land values generated by new public investment through a land related tax to pay for that investment or other public projects. Value capture refers to the process by which all or a portion of increments in land value attributed to "community interventions" rather than landowner actions are programmed in advance and recouped by the public sector.

Value capture is a type of PPP where the private sector compensates a public agency for the cost of a facility that generates economic value.

For transport-related investments, projects can increase adjacent land values which generate a windfall for private landowners. Public agencies can capture a portion of that windfall through any of the following methods:

- local improvement districts
- public-private development of adjacent land
- traffic impact fees
- TIF districts

- buying privately held land near transportation hubs that is zoned for low-density use on the open market, increasing the designated use density, then selling the land back to private developers on the open market, capturing the capital gain resulting from both the increase in designated use density and the presence of the transportation hub.

Auckland is already operating a type of value capture mechanism through CBD targeted rate funding. A targeted rate to fund development projects in the CBD was introduced for residential and non-residential ratepayers in the CBD in 2004 for a 10-year period.

The intention of the targeted rate is that it will be used exclusively for projects to enhance the CBD and is expected to provide $175.5 million over the 12 years to 2016 to transform and revitalise the CBD. The targeted rate is applicable to CBD ratepayers only and applies to both the businesses and residents who are the property owners who will benefit most from Auckland City's CBD 'Into the Future Strategy'.

10.3.4 Tax Increment Financing

Since the 1950s, TIF has been used throughout the United States to fund a range of infrastructure and economic development projects. It has been used for water and wastewater upgrades, transport projects, emergency services, environmental remediation projects and town centre revitalisation initiatives.

A TIF programme usually begins when a local authority designates a geographic area as a 'TIF district'. The TIF district usually encompasses an area that is underperforming or in need of revitalisation and infrastructure upgrades. The intent is to demonstrate a public commitment to the viability of any area and thereby encourage complementary private sector investment.

To qualify for TIF, the area and infrastructure must meet certain requirements - typically detailed in TIF enabling legislation and supporting regulation and guidelines. These requirements are aimed at ensuring TIF-funded infrastructure and urban development/redevelopment deliver genuine benefits to the TIF district and broader community. In the TIF district, a tax 'base' is established. This is usually the existing property tax base 'frozen' at pre-TIF levels - alternatively it could be this tax base indexed by some factor over time (e.g. the rate of inflation).

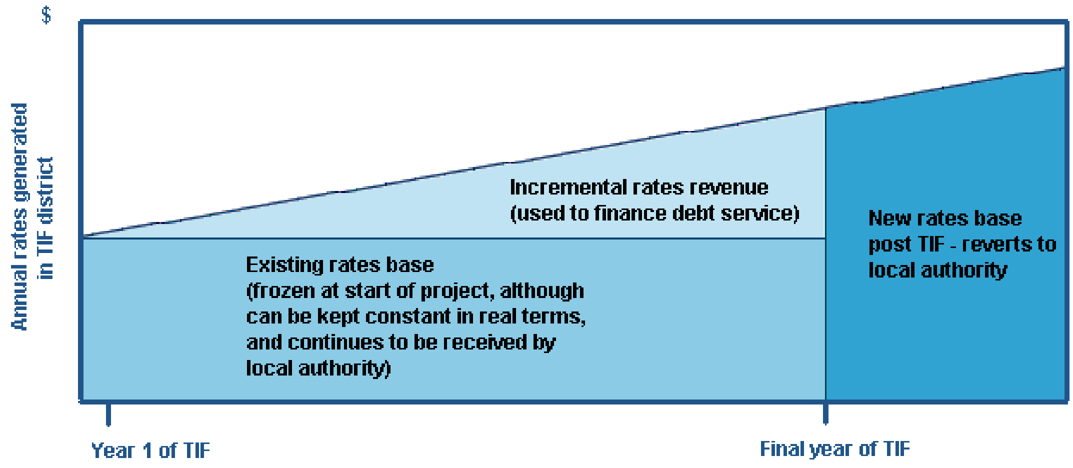
The TIF district becomes operational when the local authority borrows funds (usually via issuing bonds) and undertakes investments in eligible infrastructure and development in the district. These investments can involve varying levels of public and private partnership arrangements, and can apply to a range of economic development and infrastructure projects and programmes.

As time goes on, these investments lead to higher levels of economic activity and property appreciation - which in turn, leads to growth in the district's tax revenue. For property owners, there is no new tax or rise in property taxes - the TIF bonds are repaid from the uplift in property values created by the improvements.

The difference between the tax revenue and the tax base in each future year is called the incremental value, and a proportion of this increment is assigned to the local authority to service its TIF debt (usually TIF bonds). When the debt is retired, the TIF ceases to exist.

Figure 23 outlines the TIF model. The incremental rates revenue (shown by the triangle above the existing tax base) is used to repay the debt incurred in providing the infrastructure that generated incremental rates revenue. At the end of the TIF term, the total tax revenue for the area reverts back to the local authority and the general rating pool. TIF terms can range from 5-25 years, depending on the nature and scale of development.

Figure 23: TIF Model



Source: PwC Report, April 2008, Tax Increment Financing to fund infrastructure in Australia.

10.4 Funding options evaluation criteria

10.4.1 Funds availability

Options are more favourable where funds are more plentiful. As noted above, it is highly unlikely that there will be sufficient funds available within the NLTF to fully support the construction of the AWHC. Therefore, it is extremely likely that construction will need to be supported by either public or private debt. As discussed above, public debt in terms of both availability and desirability (i.e. consistency with prudent fiscal policy) is currently constrained.

The 2010 Budget forecasts a return to the principles of sound fiscal management (as required by the Fiscal Responsibility Act) by 2014/15. Essentially, this entails the government undertaking less borrowing to support operating spending, which may provide space for additional debt to support construction.

Private debt and equity remain reasonably constrained based on recent market soundings for public infrastructure projects in Australasia, but current trends point to an easing of this constraint.

10.4.2 Value for money/net cost to funders

In general, tax or NLTF funding via PAYGO represents the lowest overall cost of building a specific item of infrastructure as there is no debt servicing component. However, in a wider cost to government sense, the size of the AWHC represents a significant opportunity cost to other areas of priority expenditure.

Public debt is traditionally cheaper than private sector debt, but experience with PPPs has shown that this differential can be overcome through other efficiencies and innovation.

10.4.3 Fit with transport funding models

Given the profile of the project, the potential precedent effect of any funding approach is an important consideration. NLTF funding represents the most conventional approach, followed by debt-funded construction supported by either tolls or taxes. All other approaches represent untried and untested funding approaches in New Zealand for transport funding of state highways. However, all approaches discussed here have been used successfully overseas.

10.4.4 Linkages with Central Government fiscal and economic targets

Central government has a clear objective of focussing public funds to lift New Zealand's productivity. The economic discussion contained earlier in this report demonstrates the economic benefits of the AWHC to the Auckland and New Zealand economy. The key consideration with these criteria is whether the funding models are consistent with what central government is looking to achieve from that funding source.

Clearly, the AWHC is consistent with the NLTF. The AWHC is also compatible with the raising of public debt due to the potential to have a low net debt impact. It is also favourable economically and fiscally and the ongoing operating costs of the crossing as a percentage of total costs are low, when compared to other potential debt-funded capital projects including prisons, hospitals and military equipment.

10.4.5 Linkages with Local Government roles

The AWHC will be a state highway. What is less clear at this stage is the status of the AHB once the additional crossing is build. Historically, local government has not paid for state highways, though roading infrastructure, funded by rates, is a core council business.

10.4.6 Incidence

The incidence discussion is essentially one of equity and user pays, with effectively four ultimate potential funders of the crossing:

- Users of the crossing through tolls
- Auckland residents through either rates or targeted value capture mechanisms
- Road users through fuel taxes and RUC
- Taxpayers through the general tax system (GST, income tax, company tax, etc).

The question of incidence is potentially one of the most important principles-based criteria when considering the form of crossing option. In essence, the BCR determines the "best" form of crossing in a national sense. In other words, it conceptually defines what either New Zealand road users or New Zealand taxpayers should pay for. The BCR, while incorporating local benefits in terms of travel time savings etc, is much less sensitive to local preferences and values.

Where local preferences are demonstrably different than the conclusion drawn by the BCR, it may be appropriate to consider mechanisms where those that get the direct benefit of the form of crossing pay a greater proportion.

10.4.7 Intergenerational impacts

As discussed earlier, the PAYGO nature of the NLTF means that future generations effectively get the benefit of toady's infrastructure investment, funded by today's road users. PAYGO remains equitable across generations as long as new infrastructure continues to be built at approximately the same rate.

One of the key equity benefits of debt financing that is repaid over time (through tolling, taxes or rates) is the intergenerational transfer that occurs. Effectively, road users in 25 years time who get the benefit of the additional infrastructure are contributing to the cost of construction.

10.5 Evaluation

10.5.1 Core funding options

While a number of variants are discussed here, the principal choices for construction funds are NLTF, taxes or debt. Distinction is between public and private debt is discussed in Table 35 and Table 36:

	NLTF	Taxes	Debt
Availability of funds	Fundamental problem. The NLTF under current settings will at best only partially meet the cost of the AWHC.	Fundable, but short to medium term operating cost pressures effectively mean tax funding would be debt funding.	Fundable but considerable short to medium term pressure in both public and private debt markets. Forecasts indicate more space by 2014.
Value for Money	Cheapest cost of funds, but significant opportunity cost to the rest of the transport sector.	Debt funding in the short term means no opportunity for efficiency. Significant opportunity cost to other areas of spending across government.	Highest cost of funds, with public sector being cheaper than private debt. However, opportunity costs are lowered substantially and PPP mechanisms can overcome cost of debt through other efficiencies.
Fit with transport funding models	Strongest fit.	Weakest fit, especially in light of full hypothecation decision in 2006/07.	Compatible, especially if funded by tolls. Other options for meeting the cost of debt are more novel in the New Zealand context, but have international precedent.
Linkages with central government priorities	Would require revision of the GPS, but overall minimal impact on wider policy settings.	Significant impact.	Would require revision of the GPS, but likely to become progressively more compatible post 2014/15 due to easing of fiscal pressure.
Fit with local government role	Compatible.	No impact.	Dependent on repayment source but most likely compatible.

	NLTF	Taxes	Debt
Incidence	Wider road users pay. Least flexible payment mechanism if regional needs are different to national needs.	Least connection with those that directly benefit from the crossing and also not flexible.	Most flexible opportunity to arrive at a funding option that balances New Zealand, Auckland and individual benefit.
Intergenerational impacts	Current funders provide future capacity but no long-term financial liability for construction cost.	Current funders provide future capacity with long-term financial liability for construction cost as construction would still need to be debt-funded.	Future funders pay a share of construction cost, but long-term financial liability for that cost too.

Table 35: Core Funding Options

10.5.2 Supplementary funding options

	Tolls	Rates	Value Capture/TIF
Availability of funds	Modelling suggests good WTP on all scenarios, including tolling both AWHC and AHB.	Rates in Auckland remain under pressure, with many competing priorities.	If tied with a clear benefit associated with form of crossing, this could be an attractive funding source.
Value for Money	Those that get the benefit of the crossing pay.	If linked to form of crossing, it offers some benefit, but this value is spread throughout Auckland unless a levy is charged on CBD/North shore.	If linked to form of crossing, those that benefit from the form of crossing pay.
Fit with transport funding models	Strongest fit.	Moderate fit given AHB may become a local road.	Not used in New Zealand, but good international evidence of ability to contribute.
Linkages with central government priorities	Consistent.	Moderate fit given AHB may become a local road.	Good fit given AHB may become a local road and that central government is seeking innovative financing approaches, especially with the recently released Capital Asset Management policy.

Tolls	Rates	Value Capture/TIF	Tolls
Fit with local government role	Consistent.	Moderate fit given AHB may become a local road.	Good fit given AHB may become a local road and that central government is seeking innovative financing approaches, especially with the recently released Capital Asset Management policy.
Incidence	Those that get the benefit of the crossing meet costs.	Moderate fit as cost is spread throughout Auckland (without differential charges) but benefit accrues to a smaller number of Aucklanders.	If tied with a clear benefit associated with form of crossing, this could be an attractive funding source.
Intergenerational impacts	See debt funding discussion.	See debt funding discussion.	See debt funding discussion.

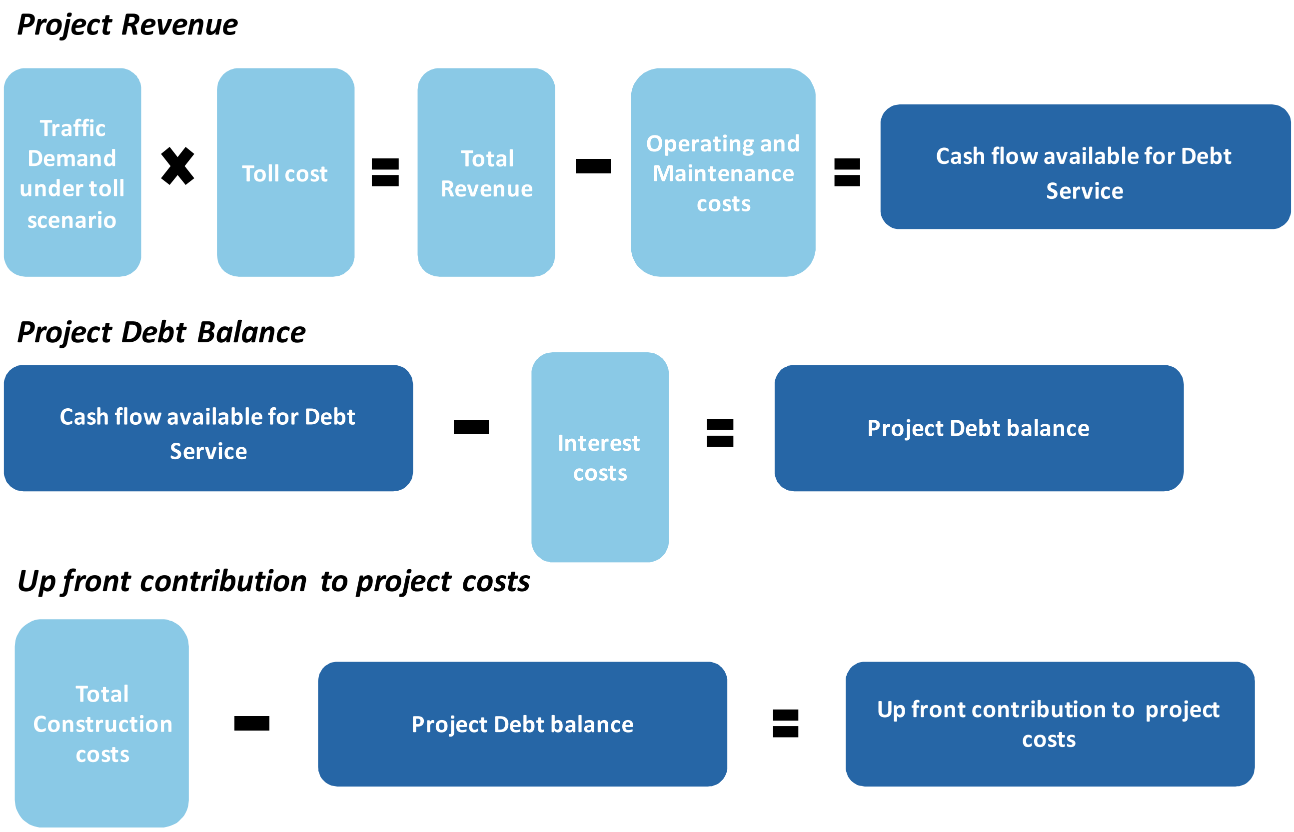
Table 36: Supplementary Funding Options

10.6 Analysis of tolling and debt structures of the AWHC

To further inform the discussion of possible funding options investigated as part of the preliminary business case, the outputs from the toll modelling[42] have been utilised as a revenue stream from which to support the issuance of government debt. This analysis identifies the level of debt that can be supported under different tolling scenarios and where there is a shortfall the required up-front contribution from the government to fund the total project cost. The relationship is demonstrated in Figure 24.

[42] Additional Waitemata Harbour Crossing Final Transport and Traffic model report.

Figure 24: Derivation of the up-front contribution to project costs



A financial model has been developed that holds the results of the toll modelling constant for each scenario and then back solves for the project debt balance.

As part of the transport and traffic modelling, three tolling scenarios were modelled as follows:

- Tolling the new crossing only;
- Tolling the existing crossing only; and
- Tolling both crossings.

Under each of these scenarios the changes in demand were analysed for incremental levels of tolls, being $2, $4, $6 and $8.

Given the preliminary stage of the project and the limited information available, to undertake this analysis it was necessary to make a number of assumptions. In addition to the assumptions previously detailed in section 4, the analysis assumes:

- Land acquisition costs are materially equivalent between the defined options and under the majority of procurement methods would be paid for by NZTA;
- The maintenance and operational costs to operate the AHB are excluded from the analysis as they are equal between the defined options;
- Where the level of tolling revenue supports the issuance of debt over the project life (i.e. the level of net revenue (cash available for debt service) to service principal and interest payments after accounting for operating and maintenance costs), government bonds are issued from the start of construction and each corresponding year after that until operations commence;

- When the debt balance is exhausted, the government contribution is made until all up-front (construction) project costs are paid;
- Where an up-front contribution is required, the model maximises the debt balance so that no surplus funds are available on the last day of operations;
- A sculpted debt profile has been adopted, meaning that where excess cash is available it is utilised to minimise debt and, where there is a deficit, additional bonds are issued to support expenses;
- To reflect commercial practice, interest is capitalised during the construction period;
- Only the cost of those risks allocated to the private sector (transferred) have been included in the analysis. Refer to section 8 for more details;
- Current laws regarding the provision of a free alternative route and any debate associated with the ability to toll one or both crossings have been excluded from this analysis; and
- Additional costs have been included for tolling infrastructure.

10.6.1 Results of the funding analysis for different tolling and crossing scenarios

Figure 25 below provides the results of the initial analysis for 6 different scenarios, being the two defined options and the three tolling scenarios for each of the tolling options discussed above.

Figure 25: Net present cost of the up-front contribution to government costs

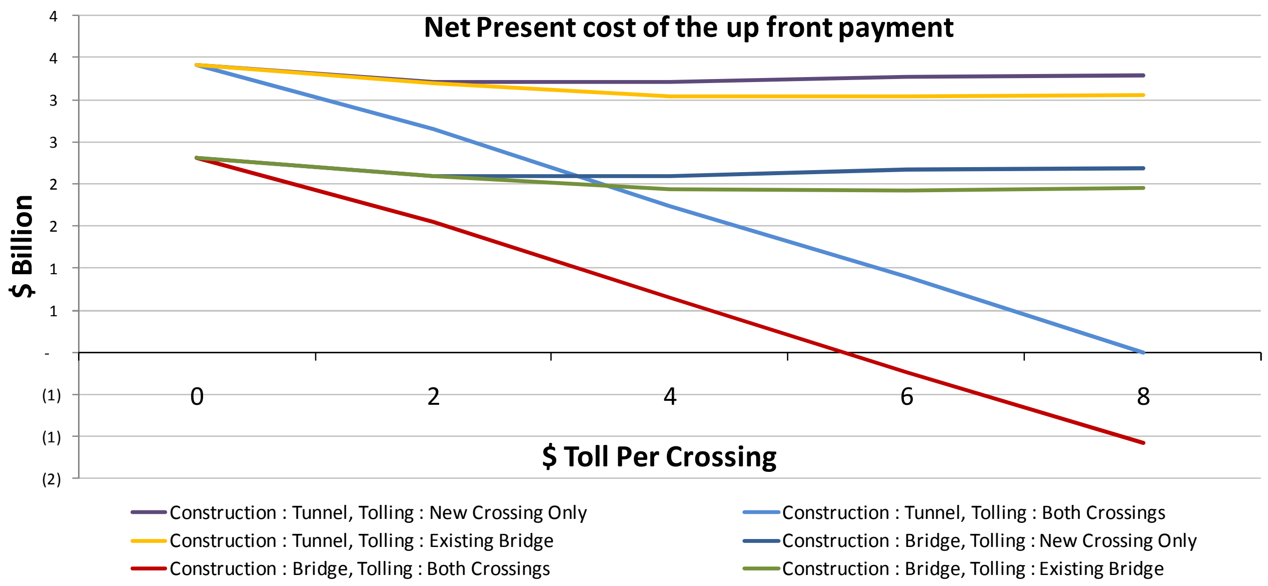


Figure 25 illustrates that the tolling revenue is restricted by the changes in demand under different tolling scenarios. Where both crossings (i.e. existing AHB and either the defined bridge or tunnel) are tolled, the project moves closer to a point of self funding. Where only one crossing is tolled, traffic is diverted to the toll free crossing which has a material impact on toll revenues and ultimately the ability to raise debt to fund the project. Under single tolled crossing scenarios, the majority of tolling revenue is expenses on maintenance costs and therefore the ability to issue debt is significantly restricted and the total debt balance is immaterial to the total project cost.

Further discussion of the toll modelling and the impacts of diversion to the toll free route is included in the AWHC Final Transport and Traffic model report.

Sensitivity testing of the funding model results

To understand how the above analysis may change if assumptions are changed, sensitivity analysis has been performed on the above results. The sensitivity testing follows the principles of the NZTA Economic Evaluation manual as discussed in section 7, where all but one of the assumptions are held constant in order to understand if the results of the above analysis would change in a manner that does not match expectations.

The assumptions that have been tested are as follows:

Original assumption	Value	Sensitivity test
Discount rate	8%	6%
Discount rate	8%	4%
Traffic Flows	As per traffic modelling	+10%
Traffic Flows	As per traffic modelling	+25%
Traffic Flows	As per traffic modelling	- 10%
Traffic Flows	As per traffic modelling	- 25%
Tolling costs	65 cents	-25%
Tolling costs	65 cents	-50%
Tolling costs	65 cents	-75%
Finance costs	7.5%	9.5%
Finance costs	7.5%	11.5%
Operating costs	As provided by the EPT	-10%
Operating costs	As provided by the EPT	-25%
Construction costs	As provided by the EPT	-10%
Construction costs	As provided by the EPT	-25%
CPI	2.5%	4.5%
Construction cost index	4.77%	6.77%
Construction cost index	4.77%	2.77%

Table 37: Sensitivity testing of the funding options

The sensitivity testing has been performed for the above scenarios with tolling levels at $4, $6 and $8 to determine if changes to input variables would produce different results from the financial analysis and result in different conclusions being drawn. The results are presented below:

Figure 26: Net Present cost of the up-front payment - $4 tolling scenario

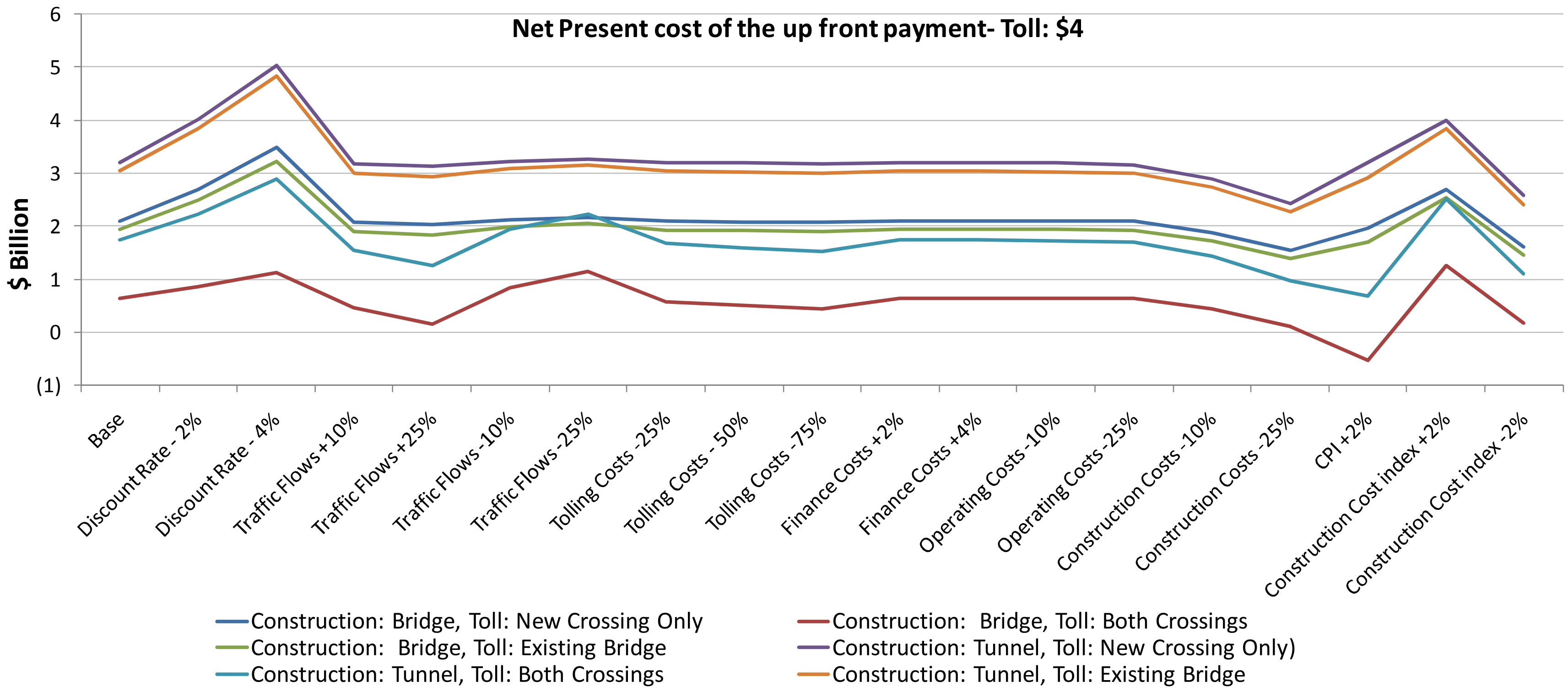


Figure 27: Net Present cost of the up-front payment - $6 tolling scenario

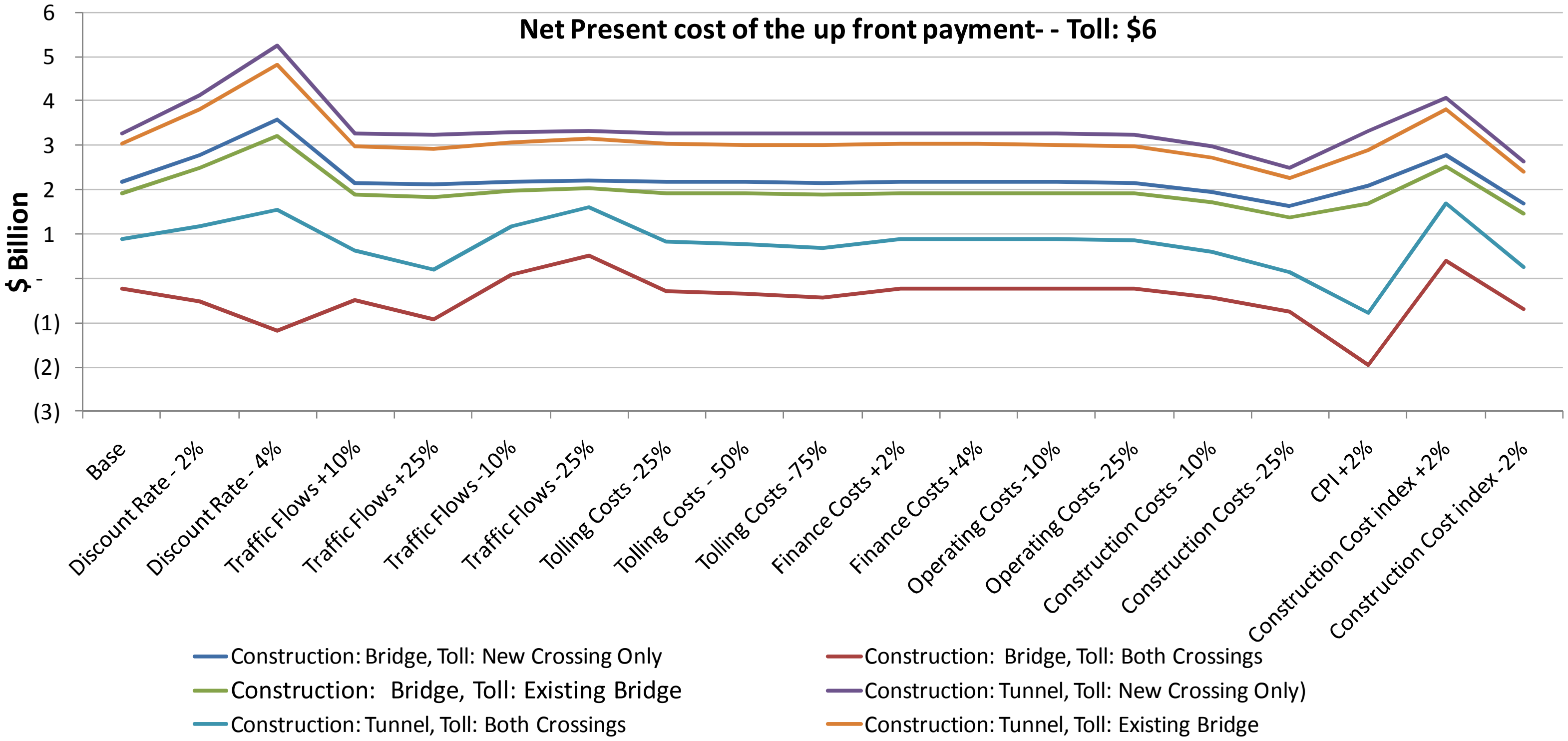
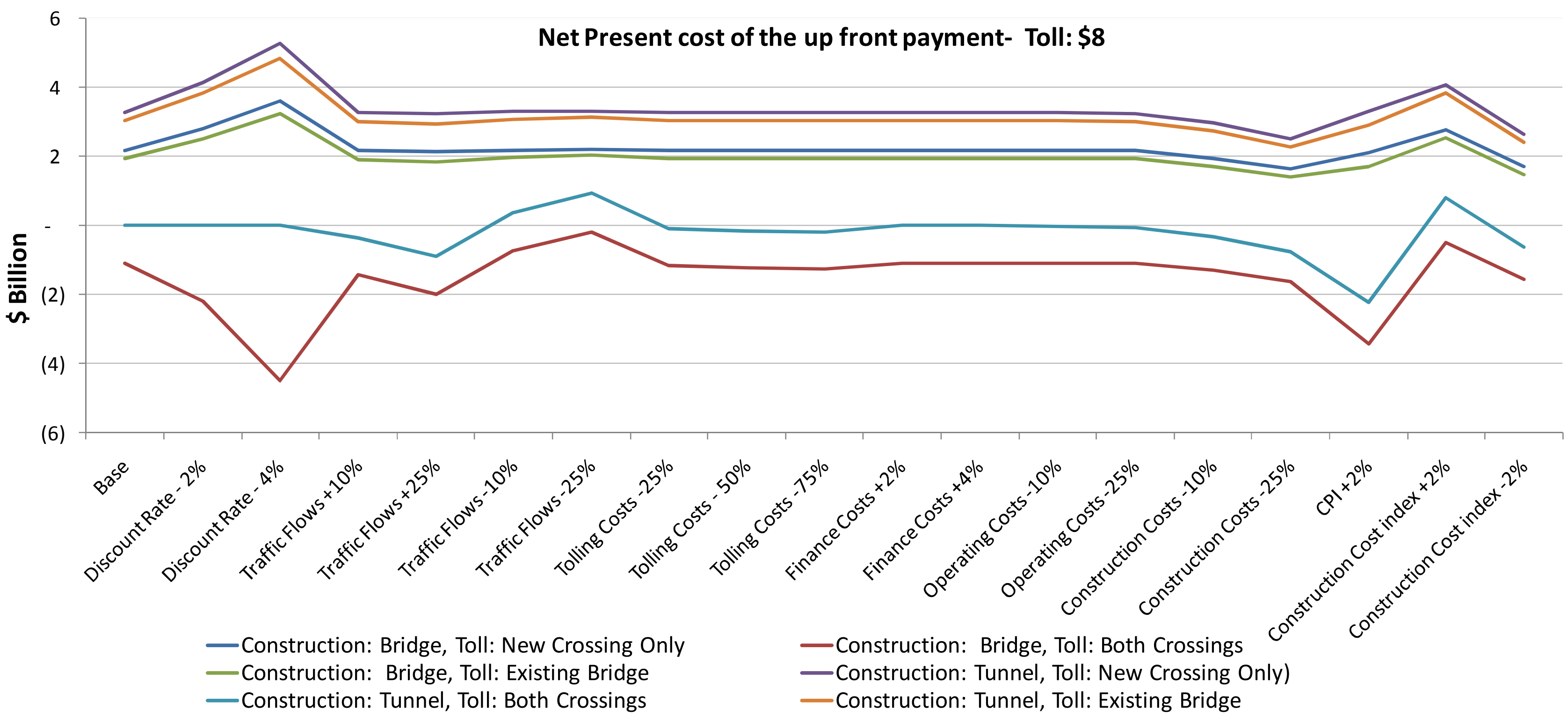


Figure 28: Net Present cost of the up-front payment - $8 tolling scenario



The sensitivity testing performed above confirmed the conclusion from the base case modelling that the amount of cash available for debt servicing is only material when both crossings are tolled. The impact of the changes in traffic flows under the $8, construct Tunnel and toll both crossings scenario being the case in point where a 25% reduction in traffic flows takes the up-front payment from approximately zero to $1 billion, demonstrating the impact that changes in traffic flows have on the level of debt that can be serviced.

For the scenarios where only one crossing is tolled, only significant shocks, such as changes to the discount rate and changes in the cost of construction have a materially observable change in the up-front payment requirement from the government. The effect of having a toll free crossing available is the most significant factor for these scenarios, with the toll modelling suggesting that a the majority of traffic would opt for the toll free route restricting the amount of revenue available to service debt after paying for maintenance and operational costs.

In addition to the sensitivity testing performed above, further analysis has been undertaken on the impact of changing the operating period to 35 years. The results of this analysis have been included on the following pages.

Figure 29: Net present cost of the up-front contribution to government costs- 35 year operating period

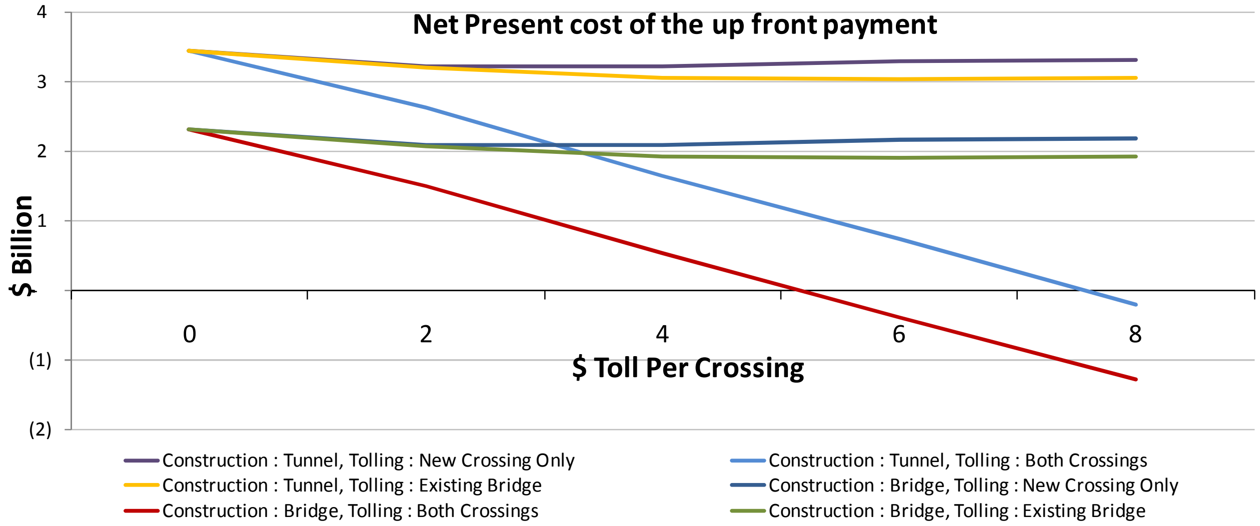


Figure 30: Net Present cost of the up-front payment - $4 tolling scenario- 35 year operating period

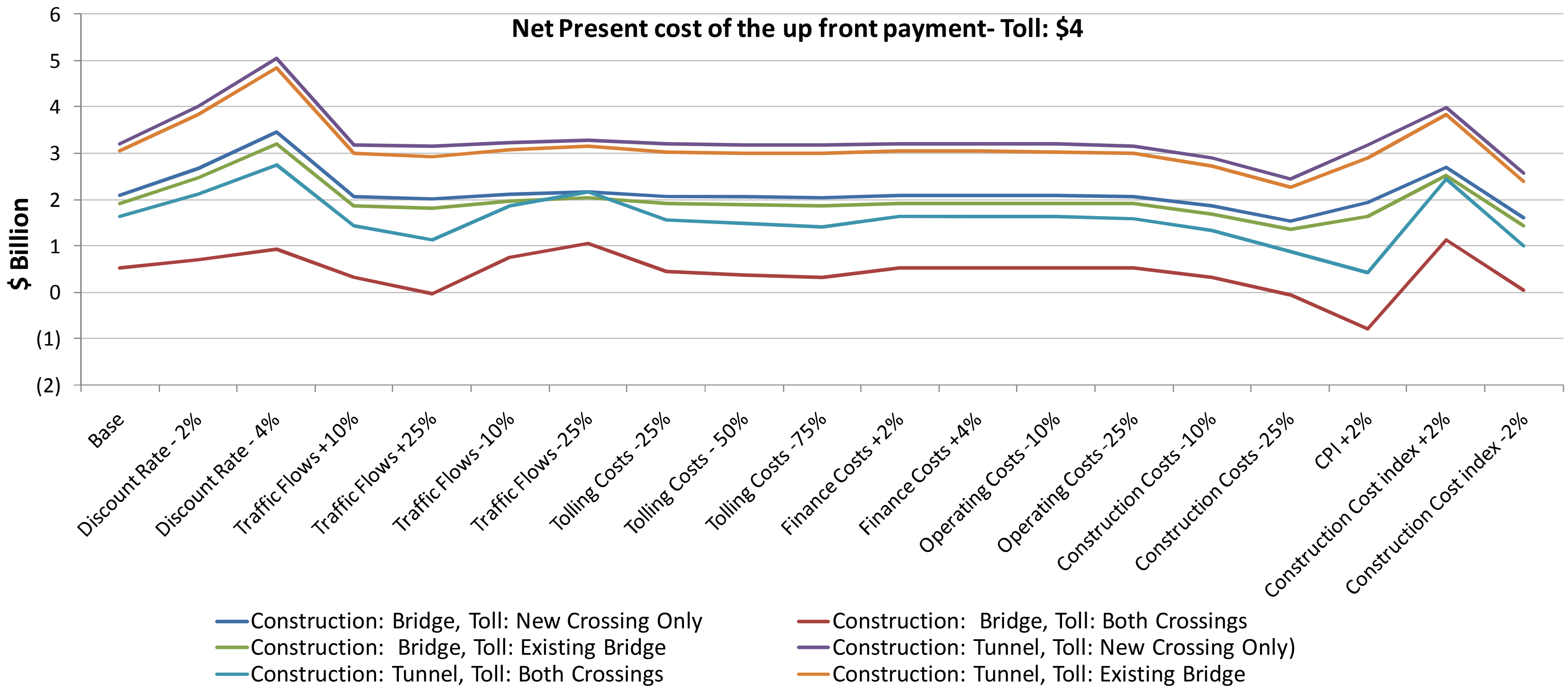


Figure 31: Net Present cost of the up-front payment - $6 tolling scenario – 35 year operating period

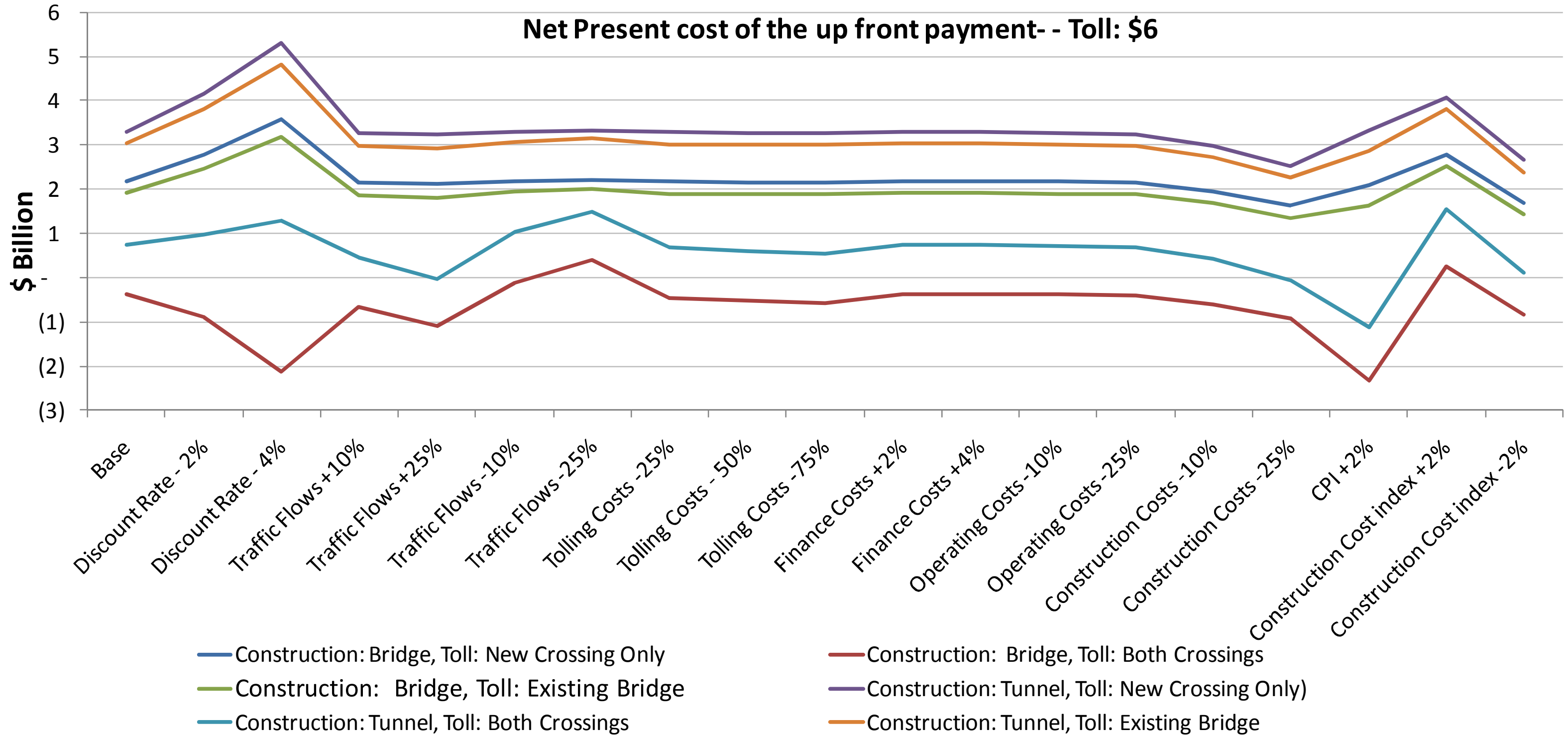
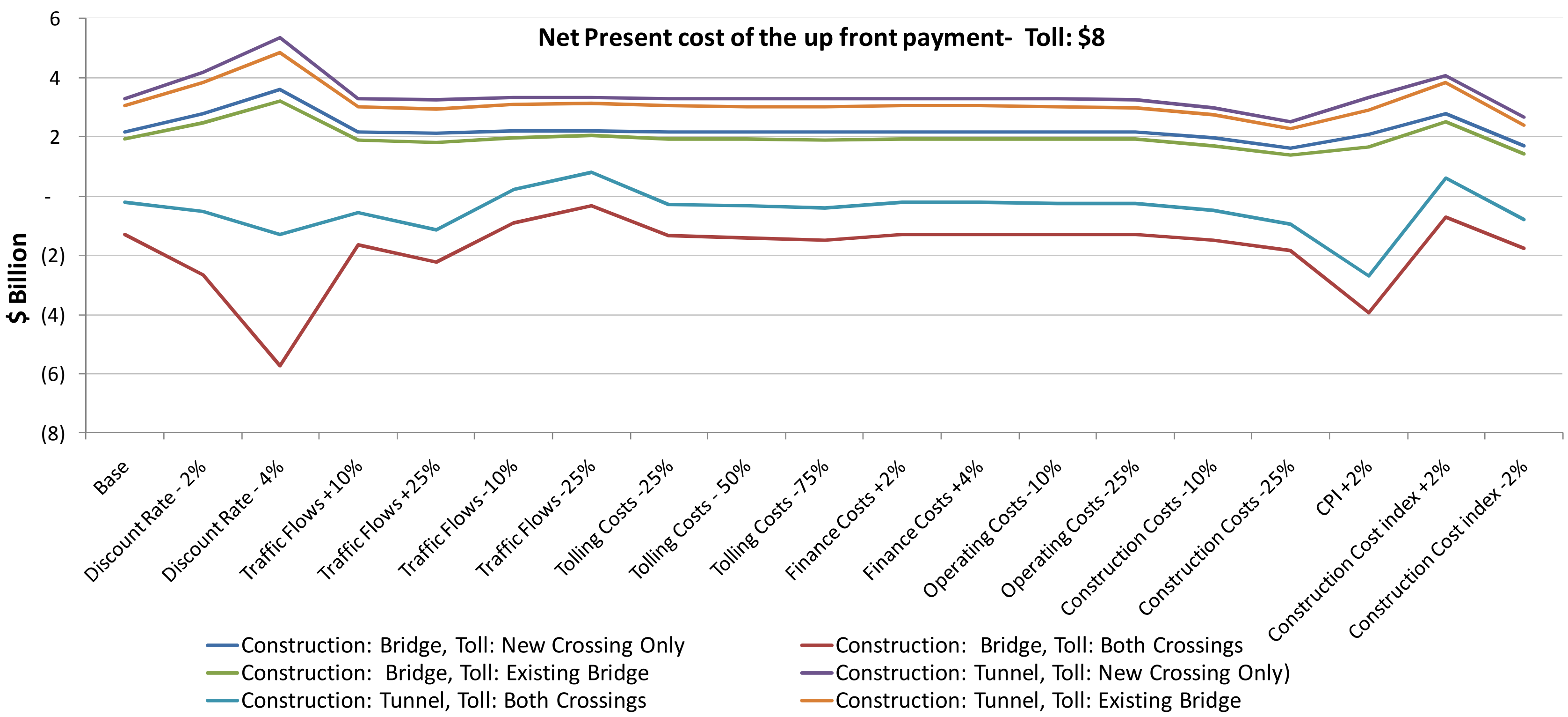


Figure 32: Net Present cost of the up-front payment - $8 tolling scenario - 35 year operating period



The 35 year operating period has the impact of lowering the overall up-front payment required from the government for the scenarios under which the project is able to take on material amounts of debt and self fund the project costs ($6 and $8 tolling scenarios where both crossings are tolled). For those scenarios where the debt balance is immaterial (single crossing scenarios) the change in the operating period does not have a significant impact on the up-front payment for the project.

While the funding analysis has identified that a toll on both crossings is required to make a material change in the cost of the project to the government, it has also highlighted how sensitive this testing is to the tolling and traffic modelling. Therefore it is recommended that this analysis is updated at future stages in the project to reflect changes in traffic patterns and updates to traffic modelling assumptions. Changes to these underlying considerations and inputs into the funding model may have a material impact on future project funding decisions.

10.7 Conclusion

To understand the ability of the project, including both of the defined options, to service different debt funding levels, over 900 scenarios have been modelled and analysed. From this analysis it is clear that there is a strong relationship between the need to fund both crossings and the ability of the project to fund itself through toll revenue. This is a direct function of the assumptions made in the traffic and toll modelling with regards to diversion of travellers to the toll free crossing under scenarios where only one crossing is tolled.

Given the assumptions made for both the funding model and the traffic and toll modelling, the analysis has identified that where both crossings are tolled the government would not be required to make an up-front payment for the project under the defined bridge option where tolling is set at $6 per crossing and under the defined tunnel option where the tolling is set at $8 per crossing.

While the sensitivity testing has demonstrated that the conclusions drawn from the financial model do not change when the given traffic flows are manipulated, the funding model has demonstrated that the assumptions relating to tolling and traffic flows are critical. Therefore, it is recommended that further analysis of traffic modelling and tolling be undertaken to inform future decisions regarding funding of the project. This analysis should be performed in combination with updated funding scenarios that reflect the current cost of debt and liquidity of the debt markets.

11. Implementation and Timing

The modelling and discussion in this report assume that the AWHC, in whatever form, will not commence construction before 2020. This is an assumption that is worth investigating further. In particular, there may be arguments for accelerating the AWHC. This section first examines what factors might influence the commencement date of the AWHC, and then discusses the implications for the choice of form of crossing.

The three broad factors that affect the ideal timing of the AWHC are:

- The impact of timing on unlocking Auckland's economic development;
- The potential for the AWHC to act as a fiscal stimulus and to support the New Zealand heavy construction sector; and
- The effects of timing on the overall value for money of the AWHC.

We discuss each of these factors below. It should be noted that further analysis will be required before any firm conclusions regarding timing can be made. The purpose of this section is to set up a conceptual framework that can be used for future work on this topic.

11.1 Economic development factors

The economic analysis in section 7 highlighted the importance of transport infrastructure to the economic health of the Auckland region, and thus the broader New Zealand economy. The AWHC will assist goods, services and people to flow more freely around the region, providing economic efficiency gains. It will also contribute to Auckland being a more globally competitive city.

If it can be shown that accelerating the AWHC would materially improve the speed with which Auckland's economic development improves, there may be merit in considering an earlier construction date. This in turn is largely determined by the extent to which an AWHC removes barriers to the region's growth; the bottleneck that is already occurring on the AHB and the wider roading network (which is set to worsen over time). The greater the congestion, and the sooner it reaches a critical state as measured by a serious deterioration in travel times and/or congestion/unreliability, the greater the urgency to relieve it.

Some initial factors to consider on this issue are as follows:

- Economic growth potential does not change rapidly. Structural change in an economy can take decades to materialise. For example, the major economic reforms of the 1980s in New Zealand did not immediately create a more efficient economy. Indeed some commentators believe that we are still seeing the lagged effects of these reforms filtering through the economy. Therefore, it is unlikely that Auckland's economic potential would be significantly accelerated if an AWHC was put in place a few years earlier than initially expected.
- An additional crossing would only relieve congestion if the wider area network could cope with any additional transport demand arising from the commensurate level of increased economic activity. The current modelling exercise indicates that additional complementary network reinforcement may be required over the long-term to harness the full benefits from an additional crossing. This project's focus has largely centred on the form of crossing, rather than on overall network constraints. A more in-depth analysis of the potential for wider network optimisation may reveal further insights into the extent to which congestion could be removed and potential economic growth unlocked.

- The impacts of an accelerated AWHC on the development of the Wynyard Quarter is another relevant factor for consideration. Based on existing plans, 2018 is a critical date for Wynyard Quarter development, when business and residential occupancy almost doubles. While it would be impossible to complete a crossing by this date, it may be possible to have some of the more disruptive aspects of a crossing completed by this date under an accelerated programme. These could include the turnaround of a Tunnel Boring Machine (using Victoria Park) or landing works for bridges.

The next stage of investigation would seek to identify major limitations to the AHB and identify whether complementary improvements to the network that unlock non-marginal improvements in transport connectivity (i.e., marked improvement in travel times/congestion, and/or more travellers being supported for a given level of travel times and congestion) are viable without undue expense. If that investigation finds that those conditions hold, then the AWHC could be demonstrated as a major contributor to Auckland's economic development, and the case for accelerating it is stronger.

11.2 The role of AWHC as a fiscal stimulus

The broader construction sector in New Zealand is currently in a weak position. The New Zealand government, as with many overseas governments, has sought to provide a boost to the flagging construction sector and the wider economy by bringing forward major roading and other infrastructure construction projects. It could be argued that bringing the commencement date on AWHC forward could provide further stimulus to the New Zealand heavy construction sector.

Some important considerations around this argument are:

- Announcing an accelerated programme for such a large infrastructure investment and potentially committing to further infrastructure spend subsequently would provide confidence to construction firms. This may persuade them – at the margin – to retain staff rather than making them redundant, due to the high transaction costs associated with 'hiring and firing' workers.

- It is not the entire construction sector in New Zealand that is facing difficulties. The residential and commercial building sub-sectors are certainly suffering. NZIER forecasts these parts of the construction industry to shrink significantly over the next 12-18 months before recovering gradually as household and business confidence improves. But the heavy construction sector has not contracted to the same degree. Indeed, what Statistics New Zealand label the 'Other construction' sector (covering infrastructure work) grew by 12.0% (nominal) in the year to March 2009, 5.6% in the year to March 2010 and is forecast to grow 13.7% in the year to March 2011.

- The construction sector is cyclical in nature. While growth in the 'other construction' sector is expected to ease, it will remain positive over the 2011-2015 period, supported by the existing fiscal stimulus package, the Rugby World Cup, and the Christchurch earthquake reconstruction. There may not be significant spare capacity to absorb major new projects without cost inflation. In fact, it is not unthinkable that by the time any accelerated AWHC is consented and construction-ready, the construction sector may be in the midst of a cyclical upswing.

- The key skills required to build an AWHC and the supporting network are unlikely to be the same as those used in the building sector. Therefore, the scope for workers to easily transfer between the building and heavy construction sector may be limited. This could point to skilled labour shortages.

- The AWHC is predicted to require a significant workforce for construction. There are around 121,000 workers in the broader construction sector in New Zealand[43], and of this there are 34,200 in Auckland alone. Notwithstanding the comment above about not all construction workers being the same, this does provide a sense of scale of the sector. Whether or not the AWHC would make a material difference to the sector as a whole warrants further consideration.

- We also need to consider the proportion of domestic capital and labour required to build an AWHC. Not all labour and materials will be sourced from within New Zealand. Imports of labour or materials will act as a drag on GDP rather than increase it.

[43] Source: Statistics New Zealand Business demographics data, year to February 2009.

Overall, it is a truism that a fiscal injection around the AWHC will provide support to the heavy construction sector. However, the key questions that require further attention in the next stage of this project are:

I. Whether it would make a material difference to New Zealand's economic growth

II. Whether that part of the construction sector warrants additional stimulus

III. How much spare capacity exists to absorb extra work without creating cost pressures.

Another option for further analysis is computable general equilibrium (CGE) modelling. This technique would allow a more precise estimation of the impacts of an AWHC on regional and national GDP after taking into account the flow-on effects of the growth in the capital stock and changes in resource costs and availability.

11.3 Value for Money

A further important consideration regarding the optimal timing of the AWHC relates to value for money. If it can be shown that accelerating the construction of AWHC would result in materially lower costs or a better return on government investment, there may be an argument for bringing the construction start date forward. Some key considerations in this respect relate to:

- Availability of financing
- Cost of financing
- Cost of construction.

11.3.1 Availability of financing

Funds availability is discussed in detail in the Economic Benefits and Funding Options Report. The key considerations in the context of Section 10 are whether any of the core funding options of NLTF, public, or private debt are markedly influenced by timing.

At present, all three funding sources are constrained and are likely to remain so in the short- to medium-term, negating any possibility of immediate progression (though such an option is extremely unlikely for planning and design reasons). The NLTF is also likely to remain constrained over the long-term for a project of this size, meaning that without an increase in revenue, the NLTF will probably only be able to part fund the AWHC, regardless of timing.

Public and private debt markets are gradually recovering from the GFC. While private debt markets are more constrained than they were pre GFC, market soundings taken for other projects in Australasia point to a more positive outlook for private debt compared to a year ago. This trend is expected to continue, but the extent to which private debt would support a project of this size is unclear.

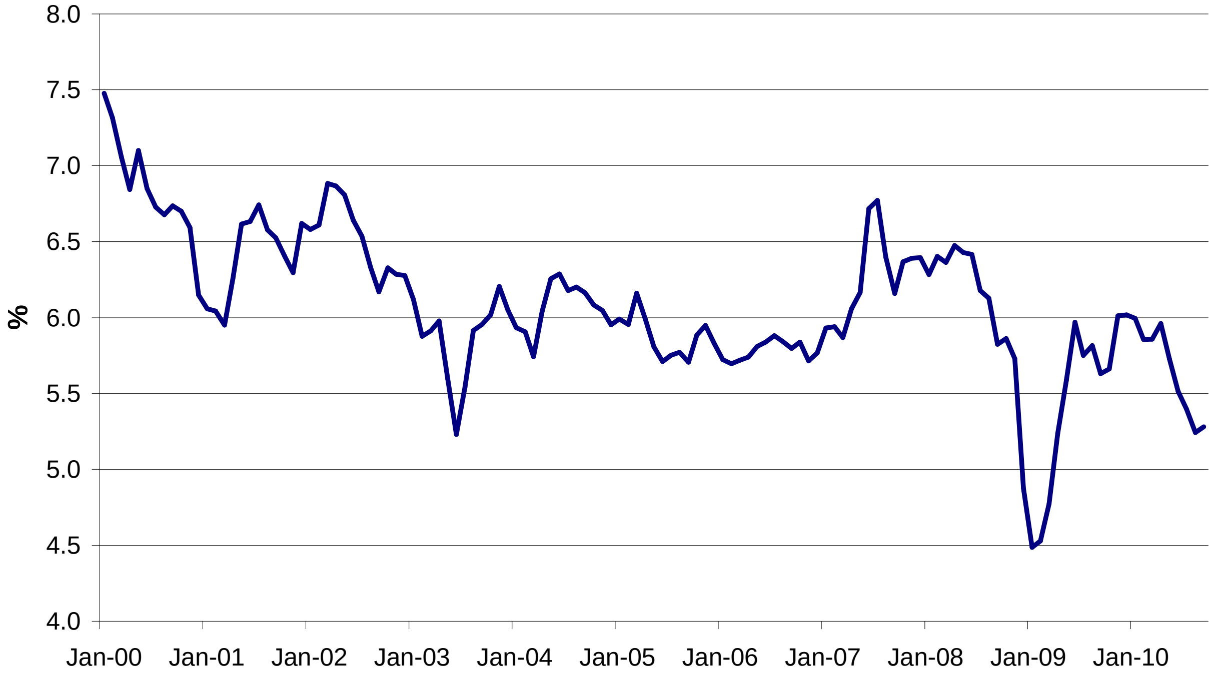
The public debt market could support the project, but the project is unlikely to be able to be supported within the government's borrowing programme until 2014/15 at the earliest due to the need to meet other operating and capital priorities.

Given these considerations, the availability of funding is not likely to be a strong argument for accelerating sooner than 2014/15.

11.3.2 Cost of financing

One consideration on timing will be interest rates paid on both public and private debt – the cost of financing the AWHC. Short-term interest rates in New Zealand are presently at very low rates, for both public and private debt. However, longer-dated debt, such as government 10 year bonds, while low by historical standards, remains a significant issue when considering the cost of projects.

Figure 33: 10 year government bond rates %



Source: RBNZ.

11.3.3 Construction costs

Given that much of the material required to build an AWHC will be purchased in global markets, the future path of cost escalation, both in terms of the timing of escalation and its growth rate, could have a significant bearing on the overall costs of an AWHC.

Compared to fairly robust construction price escalation over the past decade, construction prices in the post- GFC economy have been relatively soft, both in New Zealand and overseas. There remains some price growth in the sector, but this is significantly attributable to the economic stimulus packages many countries have implemented. It is not yet clear what path construction process will take over the next decade, that is, whether they will remain suppressed for an extended period or whether they will resume their pre-crisis growth rates.

Some possible scenarios are:

1. **A quick bounce back:** if the global construction sector does not experience a significant or synchronised slowdown, construction prices may return to pre-GFC rates. The ongoing demand for commodities from fast-growing emerging economies such as China and India may support such a scenario, although this would probably need to be accompanied by a recovery in some of the major developed economies.
2. **A short-term soft patch:** a possible gap may occur between the cessation of various governments' economic stimulus packages and an upturn in labour and construction material costs as economies recover.
3. **A longer term global downturn in roading construction:** Globally, many roading projects have been brought forward as part of stimulus packages. Governments have also borrowed extensively to fund such stimulus. Credit downgrades in governments that are running much higher debt to GDP ratios than New Zealand may result in some governments being unwilling or unable to fund major roading projects following the current stimulus packages.

Should scenarios 2 or 3 eventuate, the possibility of the New Zealand government securing a relatively competitive construction price may eventuate, which could push up the project BCR relative to the current construction timing.

11.4 Form of crossing

All the timing issues discussed above are not impacted by the form of crossing with the following exceptions:

- Constrained debt markets mean that it is likely to be more difficult and costly to source funding for larger projects than smaller ones. So funds may be available for constructing a bridge sooner than a tunnel, as the bridge is some $410 million cheaper in PV terms than a tunnel. Relevant considerations are: in what years is a bridge potentially financeable whereas a tunnel is not; and are the (form) options likely to be construction-ready and consented by this time in any case?

- Impacts on Wynyard Quarter and Westhaven during the construction process are likely to be less intrusive for a tunnel rather than a bridge. If the most significant impacts of a tunnel can be completed before 2018, the year in which business and residential occupancy is expected to almost double[44], then the subsequent impacts of the tunnel are unlikely to have a bearing on Wynyard Quarter development. Bridge construction may continue to impact on Wynyard Quarter amenity, particularly residential development in 2020.

- A bridge is more likely to have a greater proportion of domestic economic stimulus compared to a tunnel as the TBM, which represents a significant cost, is procured offshore. Specialised labour to operate the machine may also need to be ‘imported’, reducing the impact on the fiscal stimulus on the domestic labour market.

The key issue with timing in terms of form of crossing is related to consenting risk. On balance, and subject to funds availability, a tunnel presents a lower consenting risk than a bridge. The analysis undertaken in this study indicates that a bridge could take 1-2 more years to take through a consenting process than a tunnel and has a greater risk of not obtaining consent at all. A tunnel, therefore, is more likely to proceed if acceleration is strongly desired.

11.5 Summary

There are a number of factors that need to be examined when considering the optimal timing on the AWHC. There may be additional benefits from accelerating the design, consenting, funding and construction of the AWHC. However, they are far from certain, and it is not yet possible to suggest how large any potential benefits might be. Further analysis is required before any recommendation could be made.

[44] Based on analysis by PwC for Sea+City.

12. Social and Environmental Analysis

This section provides summary of the identified potential effects in relation to the construction and operation of the defined bridge and the defined tunnel as detailed in Part D of the FASR. The effects assessed include socio-cultural, physical, ecological and natural environment effects. The focus is on those identified effects that differentiate between the defined bridge and the defined tunnel, those identified effects that present a significant consenting risk and those that represent a significant departure from the effects identified as part of the NoRs for Option 2C (Refer Section 1.1.2 in the FASR for a description of Option 2C). In addition, there are some effects that cannot yet be quantified or fully understood due to the present level of design.

12.1 Coastal Processes and Ecology

The assessment of coastal processes and ecology indicates that there are no significant ecological environmental differences for works associated with either of the defined options on the southern side of the Waitemata Harbour (the Southern and Central Sectors). Although significant works are required for the bridge option (in particular construction of bridge piers), the environmental differences between the two options are not considered to be significant. Overall, the coastal processes and ecological effects associated with the southern and central sectors of the project are considered minor and manageable.

In the northern sector, both of the defined options result in significant changes to the physical nature of the western shore of Shoal Bay. Both options will potentially result in significant cumulative effects on ecology and coastal processes as a result of reclamation. The principal changes arise from the construction of temporary and permanent reclamations. Potential mitigation measures (as outlined in Section 19.7 of Appendix D in the FASR) will provide for adequate mitigation of these adverse effects.

Both of the defined options result in significant impacts on coastal ornithological resources from the loss of foraging and roosting areas in Shoal Bay (as a result of reclamation and construction associated with reclamation and bridges). Given the magnitude of loss and the high quality of foraging habitat, the effect is considered to be more than minor in magnitude. For both defined options, effects can be avoided or managed in a similar manner as for the Northern Busway project (refer Section 19.7 in Appendix D in the FASR).

Both of the defined options result in significant impacts on water quality from storm water and sediment discharge, disturbance and disposal (as a result of reclamation and construction associated with reclamation and bridges). For both defined options, effects can be avoided or managed though management techniques (such as storm water and construction management plans).

The comparative assessment indicates that the majority of the coastal processes and ecological concerns arising from the implementation of either the defined bridge or the defined tunnel will occur in Shoal Bay. The most significant effects will occur between Sulphur Beach and the Onewa Road Interchange. These effects can be mitigated through a suitable environmental enhancement mitigation package. Overall, and taking into account the mitigation options available, the degree of adverse effects to the physical and ecological character of Shoal Bay is relatively the same for both the defined tunnel option and defined bridge option.

12.2 Air Quality

The assessment of air quality indicates that the degree of adverse effects on human health is similar for both options. The longest section of surface road associated with the defined bridge (through the central sector) is more than 200 metre away from sensitive receptors. Vehicle exhaust emissions on surface roads associated with the defined bridge thus only impact on a nominally larger residential catchment than the defined tunnel. Whilst the defined bridge will have a significant impact on a limited number of properties within the southern sector (because of the combination of tunnel portal emissions with surface road emissions in this location), this does not equate to a difference in the degree of adverse health effects associated with the options as the population densities within the affected residential properties is low and these impacts can be adequately mitigated.

12.3 Groundwater and settlement

Both defined options would have similar ground water and settlement effects in the northern and southern sectors as a result of the construction of cut-and-cover tunnels and trenches in these areas. Whilst the defined tunnel, unlike the defined bridge, would likely adversely affect some buildings in Wynyard Quarter as a result of settlement from the bored tunnels, these effects would be localised and can likely be mitigated.

12.4 Contamination

The motorway corridor within the northern sector has been constructed on land reclaimed for this purpose. Both the defined tunnel and the defined bridge involve disturbing land through this sector and therefore the effects from contamination would be similar for both options.

In the southern sector, the risk of impacts from contaminated land and groundwater for both the defined options are similar and, based on experience from the construction of the Victoria Park Tunnel, these risks can be managed during construction and operation.

12.5 Landscape and Visual

The visual assessment has identified that a major new crossing, whether a bridge or a tunnel, will result in significant landscape and visual effects. Both the defined bridge and the defined tunnel result in significant adverse visual effects for both motorists and residents. This is notwithstanding that the environment in the northern and southern sectors has been modified over the years to provide a transport corridor. Both the defined tunnel and the defined bridge result in very high adverse effects on landscape and natural character due to the considerable extension of infrastructure and reclamation associated with each option. In the northern sector this includes significant effects on the coastal edge and intertidal areas, with consequential effects on landscape quality, character and amenity. In the southern sector this includes additional reclamation along the interface between Westhaven and the motorway corridor and for the bridge, impacts on the existing character of Westhaven Marina.

The bridge is a large structure and will therefore have high visual impact. The magnitude of impact will depend on the relative size of the bridge within the view and the sensitivity of the view. The landings/approaches at both ends of the bridge (Northcote and St Marys Bay), will have landscape and visual effects of a degree of significance such that they present a potential flaw. That is, because the effects are so significant and there is little opportunity to reduce these effects through either mitigation or refinement of the design. These effects are combined with significant effects on the statutory protected viewshaft from Mt Eden and effects on Westhaven Marina. The effects identified for the bridge are likely to apply to any form of bridge in this location as there are critical elements associated with a bridge which are common to any design (i.e. the landings, piers, embankments at the northern sector, and bulk). In addition, the location of the defined bridge has been selected through iteration to minimise adverse effects (for all effects) in the southern sector. Therefore, any changes in the alignment of the bridge may reduce the adverse visual effects for some viewing audiences, only to increase them for others. A bridge on any alignment will still present significant effects for the residents at St Marys Bay and Northcote.

A potential positive attribute of the bridge includes the scale and length (compared with the AHB) and the opportunity for the bridge to provide a different view of the city and the harbour while minimising/distracting from the motorway transport corridor. Given the subjective nature of visual effects, however, it is accepted that not everyone will appreciate the new bridge and for some people a second bridge will be regarded unfavourably regardless of the design. This positive attribute would not outweigh the significant adverse effects associated with the bridge.

The adverse visual effects associated with the tunnel are more localised than the bridge. The adverse effects of the tunnel within the northern sector are, like the bridge, identified as a potential flaw. However, the key difference between the bridge and the tunnel in this location is that adverse visual effects from the tunnel relate to the works between where the tunnel emerges into trench and the Esmonde Road Interchange. Through the remainder of the northern sector the tunnel is not visible. In contrast, the bridge works occur along the entire length of this sector. The most significant effects for the tunnel are associated with vent stack and related infrastructure. The current design of these elements is based on a worst case and therefore the vent stack is between 25- 35 metres in height and likely to be a dominant element in views. Further air quality modelling is likely to enable the stack to be reduced in height and there is also the ability to treat tunnel portals. Therefore, there are opportunities to refine the design and reduce the consenting risk associated with landscape and visual effects for the tunnel.

12.6 Heritage and Archaeology

The heritage and archaeological assessment indicates that the degree of adverse effects on heritage values is relatively the same for both the defined tunnel and the defined bridge. These effects can largely be mitigated (i.e. through relocation of heritage buildings). However, some works may result in permanent effects (i.e. loss of scheduled trees).

In the northern sector there is potential for the proposed works to impact on the slipway and posts in the intertidal area near Esmonde Road. Given the construction footprint is relatively the same for both options in this location, the degree of resulting effects on heritage values will be similar. It is possible that these effects could be avoided in refining the design of the options.

Within the southern sector, both the defined tunnel and defined bridge will impact on Victoria Park (a historic reclamation site, Maori heritage site and location of scheduled trees) and the adjoining streets (which are listed Maori Heritage sites). The degree of resulting adverse effects on heritage values are expected to be similar for both options as the construction footprint through this area is relatively the same.

For both options there is potential for impacts on recorded archaeological remains to the south of Victoria Park because of the realignment of the Orakei Sewer Main through this area. Vibration associated with the realignment of the Freemans Bay Stormwater Main has the potential to impact on the Gas Company Buildings. The degree of adverse effects will be similar for both the defined tunnel and defined bridge because the realignment of services is similar under both options.

There is little opportunity to avoid effects on heritage buildings through the southern sector given the constrained nature of the motorway corridor (i.e. heritage buildings are positioned directly to the east and to the west of the current motorway alignment). As such, both the defined tunnel and defined bridge will have significant adverse effects on the heritage values associated with the Rob Roy Hotel, Campbell Free Kindergarten and Victoria Park Markets. If the effects on the heritage buildings in the southern sector can be adequately mitigated, the removal of the Victoria Park Viaduct as part of the AWHC project will have a positive effect on heritage values. This positive effect will form part of the assessment undertaken for statutory and planning approvals.

12.7 Noise and Vibration

The assessment of noise and vibration indicates that the construction and operation of the defined tunnel generally has less impact on potentially affected premises when compared to the defined bridge, in terms operational and construction noise and vibration. Although the construction noise and vibration effects of the defined bridge option may be more significant than the defined tunnel option, the operational effects of the defined bridge option are still less than the ‘do minimum’ scenario.

For the northern sector of the works, there is little to distinguish between the two defined options for either construction or operational noise and vibration. However, for the central sector, the enclosure of construction equipment (the TBM) and operational traffic within the defined tunnel means that there is no emission of noise from either construction or operation to affected properties from the actual crossing of the harbour. For the southern sector, both options require significant earthworks to provide the proposed cut-and-cover tunnels and trenches, and both are likely to result in exceedances of construction noise and vibration criteria.

There are no significant differences between the rail alignments proposed for the defined bridge and defined tunnel. Therefore, in terms of the comparison of effects, there is no significant benefit or disadvantage attributable to either of the options.

12.8 Land-Use and Community

An assessment of land-use and community impacts indicates that the defined options both result in impacts on public access to and along the Coastal Marine Area (CMA) (including access to marine facilities in coastal locations) during construction (short- to medium-term) and land operation (long-term). Assuming that alternative temporary locations can be found for marine facilities during construction, these effects can largely be mitigated. Solutions to accommodate facilities in the long-term will also be necessary to ensure access to recreation and the CMA is retained. Both options will provide access along coastal edges through the provision of a cycle and pedestrian way between the northern and southern sectors of the study area, providing for long-term accessibility to and along the CMA.

Both defined options will have adverse effects on the existing business areas. These effects will be limited to the construction phase, such that the degree of effects on the viability of business within the study area will be minimal. During construction, business will relocate. Whilst some of these businesses may not return to the area on completion of the Project, other marine related businesses are likely to move into the area.

During construction, the defined tunnel and defined bridge options will adversely affect access to open space given that both options traverse Victoria Park. However, there will be significant benefits associated with either option in the long-term as a result of the removal of the Victoria Park Viaduct which will increase opportunities for the use of the Park for recreational purposes.

The effects of the defined bridge option on Westhaven Marina (which is a key part of Auckland's identity and one of the largest marinas in the Southern Hemisphere) is a key factor differentiating between the options. There is potential for these impacts to have significant adverse effects on the function, amenity and social long-term effects of Westhaven Marina during the construction phase and in the long-term. Construction works within the marina can however be carefully managed to minimise the degree of disruption. In order to effectively mitigate effects on Westhaven there is a need to engage with key stakeholders. The development of a comprehensive plan that provides for the reconfiguration of Westhaven in a manner than best utilises the available water space and integrates with the master plan and wider development plans for the waterfront would assist to mitigate any such effects in the long-term.

12.8.1 Impacts on the Future Vision for the Waterfront

A long-term vision has been prepared for the Auckland Waterfront to create an area that is open and accessible to the public while still providing for the needs of the port and marine industry. This vision is set out in the Auckland Waterfront Vision 2040, and the statutory and non-statutory documents (e.g. the Wynyard Quarter Plan Changes and the Waterfront Master Plan) that seek to implement this vision. The key elements of this vision (within the study area) provide for:

- Redevelopment of Wynyard Quarter;
- Dedicated areas for the fishing and marine industries;
- Recreational and commercial marine activities at Westhaven Marina;
- Public access to and along the waterfront; and
- Open space linked by waterfront promenades.

The defined tunnel mostly avoids adverse effects on these elements and where there are effects (e.g. to access in the south western corner of Wynyard Quarter or vent stacks which are visible from public space), these can be mitigated through reinstatement and incorporating principles of good urban design. Therefore, the defined tunnel will not reduce the ability to realise the Region's aspirations for its waterfront and the ability to realise those ambitions.

The design of the defined bridge has sought to minimise potential adverse effects on the surrounding area. However, the defined bridge will result in increased noise, reduced air quality, shading, a widened motorway corridor and the presence of structures which combine to permanently alter the amenity of the waterfront. This will significantly affect the ability to realise Region's aspirations for its waterfront and will impact on the Region's ability to realise those ambitions.

12.9 Consentability Discussion

Consentability (or consenting risk) is the relative ability to gain the necessary statutory planning or RMA approvals to construct and operate a tunnel or a bridge.

The RMA sets the framework for assessing effects associated with the use and development of natural and physical resources. Within the RMA framework, the key elements that inform the consentability of a project are:

- Assessment against Part 2 of the RMA including the purpose of the Act (Section 5), the Matters of National Importance (Section 6), Other Matters (Section 7), and the Treaty of Waitangi (Section 8);
- Assessment against the relevant national, regional and district policy documents; and

- Actual and potential effects on the environment.

The relevant planning framework under the RMA includes the Auckland Regional Plan: Coastal (ARP:C) and the national and regional policy documents (including the Hauraki Gulf Marine Parks Act (HGMPA) which has the effect of a national policy statement).

The policy framework provides clear direction to protect the natural character and values of the harbour. Consequently, any works within the harbour will face challenges in obtaining consents. Acknowledging the importance of State highway network and in particular the objectives of this project, substantial changes in the planning framework are unlikely to be undertaken without a substantial shift in direction requiring the support of stakeholders including the Auckland Council and Iwi.

The assessment indicates both options generate impacts on Shoal Bay (from the degree of reclamation) which are significant and present consenting risks. Although opportunities exist with both options to mitigate effects, an additional crossing of any form will require modifications to the planning provisions of the ARP:C to better enable work in this area.

As well as the above effects in the northern sector, the defined bridge has additional effects on the natural character and amenity values of the wider harbour and significant effects associated with the bridge approaches at both ends (with less opportunities to mitigate these effects when compared to a tunnel). The defined bridge in combination with the AHB will have a significant adverse cumulative effect on the natural character of the inner harbour environment. This means that the consenting risk associated with a bridge option is significantly higher than a tunnel with respect to the following matters:

- The effect of an additional bridge within this study corridor, situated in the Waitemata Harbour which is a nationally significant resource.
- The effects of an additional bridge on the natural character, landscape and amenity values of the harbour (including recreation).
- The ability to integrate the bridge approaches with Northcote Point and the constrained environment within the southern sector.
- The consistency of the bridge option with the national and regional policy framework, including Part 2 of the RMA (s 6 matters of National importance), The New Zealand Coastal Policy Statement, and also the HGMPA and the objectives and policies of the ARC Coastal Plan.
- The ability to reduce reclamation (temporary and permanent) and associated severance within the southern sector.
- The consistency of the bridge option with the Region's aspirations for its waterfront and the impacts on Regions ability to realise those ambitions.
- The effect the bridge and bridge approaches on the amenity values of the public realm and residential environments particularly within the southern sector.

A tunnel in comparison, by its nature being below ground, largely avoids effects on the harbour.

A bridge option is likely to be inconsistent with key matters inherent in the National and Regional Policy framework, and there is little or no opportunity for any redesign or improvements to the bridge concept to provide better for consistency with these matters. Any further design refinement or substantive changes to the bridge design (or landing points or approach arrangements) is unlikely to provide any significant opportunity to reduce consenting risk as bridge option definition sought to optimise a design in terms of impacts within the bounds of the scope and objectives of this study. Improvements to the quality of the design of the overall bridge structure through the main harbour area will not significantly avoid remedy or mitigate the effects on the natural character or amenity values or provide for consistency with the statutory and policy framework as it will not avoid the cumulative effects of an additional structure on the natural character of the inner harbour environment.

In concluding, it is recognised that under the current planning framework, the likelihood of not obtaining consent for an additional bridge is significantly greater than for a tunnel, such that it is "improbable" under the existing statutory and policy environment. This represents a significant consenting risk.

12.10 Constructability Discussion

Both the tunnel and bridge options have complex staging and sequencing in the northern sections. The shorter construction duration for the bridge option offers reduced construction impacts and increased project cost benefit. Other differences between the options are minor in terms of a comparative constructability assessment apart from a greater earthworks volume and increased building settlement risk associated with the tunnel option. However, these areas are not significant differentiators in determining the form of any additional crossing.

Both options provide similar opportunities for future refinement or investigation to improve constructability matters.

12.11 Operability Conclusion

There are three significant differences between the defined tunnel and bridge options in terms of operability:

- The bridge option provides reduced risk in the event of a major incident (e.g. fire) and greater recovery resilience in the event of unplanned closures.
- The Road Safety Audit has identified the vertical gradient tie-in to the CMJ as serious and significant concerns for tunnel and bridge options respectively. The tunnel gradient is considered a potential design challenge due to the resulting likelihood of crashes, whereas the likelihood is significantly reduced for the bridge option.
- The tunnel option operation and maintenance cost is $15 million per annum more than the bridge option.

12.12 Overall Conclusion

The FASR comprises a summary and documentation of the planning and engineering investigations undertaken to inform the Preliminary Business Case for the AWHC. These investigations build on earlier studies to confirm:

- detailed engineering investigation of tunnel and bridge options, including constructability and both capital and operational costs based on an OE level design;
- operability, including connectivity and functionality; and
- consentability, including planning and consenting risk.

The FASR defines in broad terms the form, location and design attributes of a bridge and a tunnel option to allow consideration of the relative merits of these options in terms of consenting risk, constructability issues, operational functionality and cost. The report has detailed the option development, option definition, and evaluation of the defined options.

For the purposes of informing the Business Case, the study concludes:

1. In terms of constructability, both options are substantially the same or similar apart from the shorter construction duration for the defined bridge option. Other differences are marginal or minor and they cannot reasonably be differentiated at this stage.
2. In terms of operability, our assessment concludes that:
    a. Compared to the defined bridge, the defined tunnel has greater operational and maintenance costs (an estimated average difference of $15 million per annum over the life of the infrastructure) and more impacts on the network due to unplanned closures.
    b. The CMJ connection (for both options) creates some design challenges that will require revisiting to address safety within the network. A safety audit identified these as significant for the defined bridge and serious for the defined tunnel.
3. A rail crossing can be provided separately and on a different timeframe, as required, under both options. However, the route of such a crossing may need further consideration in-line with the policy direction to connect to areas of intensification.

4. The cost of the tunnel has always been acknowledged as being greater than that of a bridge. The analysis and cost estimates confirm the OE P50 cost differential between the options of approximately NZ$1.247 billion.
5. In terms of consentability, the options have been assessed on their respective environmental impacts and an overall judgement made of their ability to meet the purpose and principles of the RMA and the wider national and regional policy framework. The assessment concludes that:
    a. In an overall assessment, the bridge has more significant adverse effects (than the tunnel) which are less able to be mitigated; and
    b. Having regard to the relevant legislation, national and regional policy framework, including the Auckland City waterfront strategy, the bridge is likely to attract a significantly greater degree of risk of achieving consents than the tunnel.

It is important to note that the defined bridge option sought to reduce impacts of an additional crossing within the bounds of the scope and objectives of this Study. Therefore, any further design refinement or substantive changes are unlikely to reduce the consenting risk.

There are a number of further actions that will better inform these investigations and preliminary conclusions; in particular, further consultation with stakeholders particularly the Auckland Council and Iwi.

Appendix A: Economic Assumptions and Scoping Report

A.1 Summary

A.1.1 Purpose of report: get the analytical framework right

The objective of this project is to recommend the form of an AWHC as being either a bridge, a tunnel or a combination by 31 October 2010.

NZIER and PwC have been tasked to deliver this interim report that:

- considers the full spectrum of benefits that the AWHC options will enable;
- proposes methodologies and assumptions for our assessment for approval by NZTA and its independent advisors;
- assesses the validity of the regional development models, plans and growth projections that will be used as inputs into the economic investigation of the AWHC; and
- outlines a proposed methodology for developing a debt funding model.

The output of this report will determine the range of net benefits of the AWHC that will be estimated or qualitatively appraised. This material will then be fed into the Preliminary Business Case to support the progression of the AWHC through its subsequent development, consent, D&C phases.

The priority on recommending a bridge or tunnel option by 31 October 2010 governs the scope of factors that can be considered in the economic appraisal and the level of detail. This report contrasts factors and assessment practises that might ideally be covered to appraise the full spectrum of economic benefits from AWHC options against what is necessary and achievable in the timeframes and scope of this project. This 'gap analysis' approach will help to support the extent that any caveats need to be issued with the appraisal, and what factors may need to be considered in subsequent appraisals.

A.1.2 Transformational transport projects have a wide range of benefits

Major infrastructure projects deliver benefits to the local, regional and national economies in a multitude of ways. By reviewing the international literature on the benefits of transport projects, we have identified three categories of benefits:

1. **Direct benefits –** benefits accruing to those already travelling for a given trip occurring regardless of the transport scheme. Examples are savings in travel times, VOCs, accidents and environmental impacts which occur as a direct impact of shorter travel times due to the new transport project.
2. **Indirect benefits –** benefits that occur through the wider economy that manifest themselves via transport behaviours. Examples related to this induced travel — and induced trip generation (person trips as opposed to vehicle trips) in particular — include improved accessibility across the transport network and improved opportunities for more profitable trade among businesses, input suppliers and their higher value customers, workers' labour supply decisions and household's preferences as to where to locate.
3. **WEBs –** additional benefits arising from market frictions and market externalities, such as agglomeration economies, improved levels of competition and corrections for the 'non-internalising' of income tax.

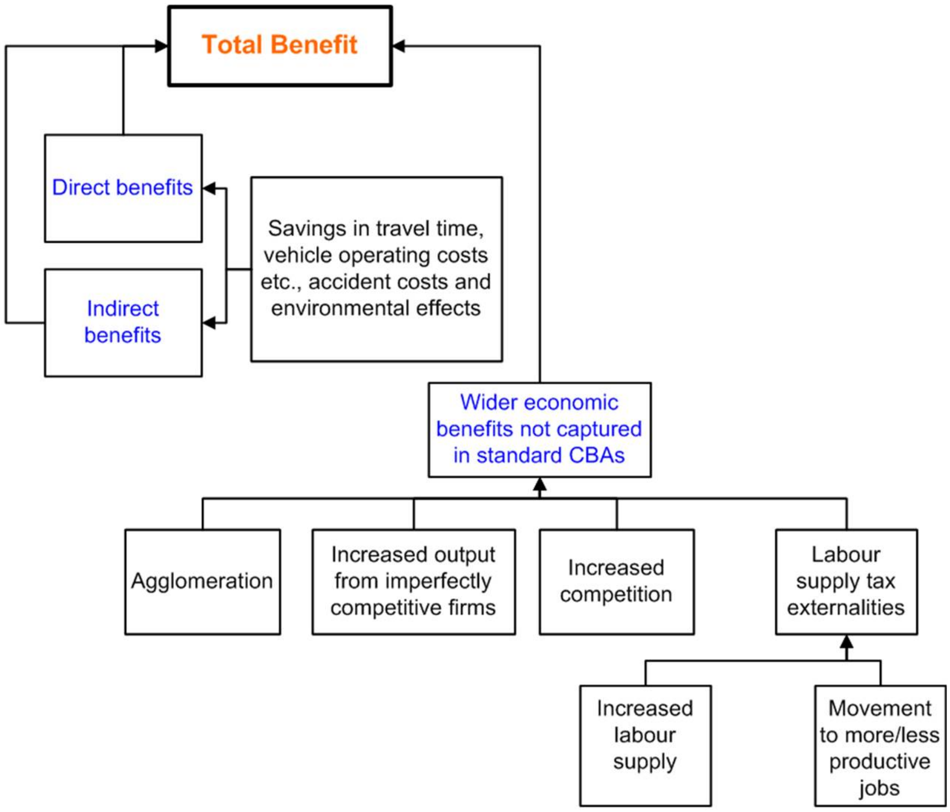
A.1.3 ...but a wider range of complicating factors to take account of...

Unlike many typical transport projects, it would seem unsatisfactory to consider from the outset that a project like the AWHC would have no material impact on the demand for travel, the structure of the regional and/or national economy, the need for other infrastructure, or the land-use and population/demographic make-up on the greater Auckland region or even New Zealand as a whole.

A.1.4 ...many of which are not captured in conventional CBA

The direct benefits identified above are relatively easy to identify and measure for typical projects, but CBA can quickly become a very difficult tool to use when a scheme has complex interactions with other transport schemes and with the determinants of travel across the region. Indirect benefits are harder again to assess if the project vastly relieves congestion and has non-marginal impacts on land-use, the structure of the regional economy and transport demand. The WEBs are conceptually simple to understand but are difficult to robustly quantify in practice. Indirect benefits and WEBs are rarely included in any quantitative sense in CBAs of transport projects, as shown in Figure 34 below.

Figure 34: Categories of project benefits



Source: NZIER.

A.1.5 This can lead to understated BCRs

The practical consequences of omitting quantitative estimates of the WEBs and extensions above is that the calculated BCRs of transformational transport projects will be lower than they should be. This in turn may affect choices about whether or not to proceed with an additional crossing. If the decision is indeed to proceed, the relative BCRs of the bridge or tunnel options may be distorted. It also has important communications impacts: an artificially low BCR will be a much harder 'sell' to taxpayers or potential funders.

A.1.6 Our analysis will attempt to capture at least some of these benefits

Using a decision framework based on criteria such as the degree of consensus in the international literature, workable methodologies, data availability and materiality, we have reached the conclusions in Table 38 below regarding the extent of the benefits that we plan to estimate:

Benefit	Ideally would be appraised? Should be included in conventional CBA?	Appraised? Included in rapid CBA?	Team[45]	Comment
Direct benefits				
Reduced travel times	√	√	TTMT	Direct from transport model.
VOC savings	√	√	TTMT	Direct from transport model.
Other speed-related benefits	√	√	TTMT	Marked up based on other studies.
CO^2 benefits/dis-benefits	√	√	TTMT	Omission of land-use dispersion and trip generation will overstate net benefits.
Limitations of existing route	√	X		Determining best response to managing AHB in absence of AWHC is out of scope.
Crash savings (or dis-savings)	√	X		Not possible in the time available. Probably immaterial to bridge vs. tunnel decision and to the overall BCR. BCR could go up or down.
Other benefits	√	X		Rapid/indicative CBA focuses on impacts judged to be highly material to the BCR and to the bridge vs. tunnel decision.
Indirect benefits				
Improved accessibility	√	X		No induced trip generation modelled.
More goods and services traded in economy	√	X		No induced trip generation modelled.
Land-use changes	X /√	X /√	ET	Case for including in CBA, but not excluded from this CBA; appraised and reported separately.
Increased labour supply and more/less productive jobs	X	X		Too complex to model, so not best practice. No induced trip generation modelled.

[45] Key: 'ET' is Economics Team; TTMT is Transport and Toll Modelling Team; EPT is Engineering and Planning Team.

Benefit	Ideally would be appraised? Should be included in conventional CBA?	Appraised? Included in rapid CBA?	Team	Comment
Indirect benefits				
Complementary benefits with other transport schemes/strategies	√	X		Ideal, but difficult at best of time. Not possible in the time available.
Network performance interpreted	√	√	ET	Preliminary assessment of transformational potential.
Wider economic benefits				
Agglomeration effects	√	√	ET	Will use EEM procedure with fixed land-use.
Increased competition	X	X		No evidence or procedures available.
Increased output from imperfectly competitive firms	X	√	ET	NZTA National Office will supply necessary guidance on required parameter values.
Tax externalities from increased labour supply and more/less productive jobs	X	X		Too complex in time available to model the travel behaviour in the first instance.
Other economic factors				
Localised economic development	X /√	X /√	ET	Impacts around the Wynyard Quarter will be considered. Consenting issue rather than CBA issue.
Visual impact of bridge	X /√	X /√	ET	Insufficient time to undertake a WTP survey. We will review previous overseas attempts to monetise such impacts.
Costs				
Capital, maintenance and operating	√	√	EPT	Supplied by EPT, but not 100% estimated until after CBA finished.
Financing and procurement			ET	

Table 38: Proposed actions for the Economic Benefits and Funding Options Report

We propose to undertake an international literature search of previous attempts at valuing such impacts overseas and assess how relevant this may be for recommending a bridge or tunnel option in this project.

We have identified the estimation procedures that we will implement and believe that they are feasible within the time, budget and data constraints that we face for this project.

A.1.7 Caveats: Key limitations to the CBA

Although our proposed approach represents a significant improvement on the conventional CBA process usually carried out for transport projects, there remain caveats that decision makers should be aware of when considering the implications of the forthcoming BCR. These arise because of the rapid or indicative nature of the CBA at this initial planning stage of an AWHC. These include:

- **No additional economic trade assumed:** The BCR for the AWHC does not take into account any potential for additional goods and services to be traded throughout the economy because the appraisal ignores any potential for additional trips to be generated. In our view, more goods and services traded throughout the economy because of a transport scheme necessitates increased trip generation of a commensurate order. Depending on the extent that an additional crossing alleviates congestion, on overall capacity of the network to cater for any additional trips and on the preservation of capacity for higher value trips (without being crowded out by additional lower value trips) there is the potential for substantial indirect benefits to be omitted.

- **Specific AHB issues are outside scope:** The appraisal assumes that the AHB will be 'actively managed' to ensure functionality is maintained and no truck restrictions on AHB will be modelled. If the AHB were to be subject to additional access restrictions and/or maintenance costs in the business-as-usual scenario then this would understate the benefits of an AWHC.

- **A strategic road-network assessment has not been considered:** The appraisal has not considered:

    - any significantly complementary relationships with other potential road transport schemes that relieve urban transport congestion (that is, whether the presence of an additional crossing makes it economically viable to relieve remaining congestion);

    - the role the Waitemata Harbour crossings have in enabling the economic development potential sought by the RoNS programme, particularly the high-priority Auckland to Whangarei corridor. The crossings would do this by catering for the increased frequency of trips that the investment in this corridor must be seeking to generate; however, the modelled intra-regional transport flows are based on land-use and population inputs that are invariant to transport investment (invariant not just to the AHWC, but to all transport investment over the appraisal period) and inter-regional transport flows assumed are based on historical growth rates applied to current traffic levels (again invariant to transport investment).

- **We note that the cost estimates are indicative:** they are suitable for relative comparisons between crossing options only**.**

Appendix B: Economic Benefits and Funding Options Report

Disclaimer: the detailed contents of this section were accurate at the time of writing, but were subject to ongoing revision. The figures in the final Business Case supersede the results reported here.

B.1 Summary

The purpose of this report is to outline key inputs for the Preliminary Business Case for the AWHC. This report focuses on:

- the relative economic benefits between the different options for a crossing, namely bridge or tunnel;
- the potential ways in which a crossing might be funded.

In generating an analysis of the issues critical to determine the form of crossing, we have provided CBA in-line with the NZTA's accepted methodologies.

This report represents a starting point for a third critical question, the justification of the crossing itself. In considering this we note that:

- The costs of the project are suitable to allow a meaningful comparison between the preferred form options only.
- The benefits (and the types of actions that generate the benefits) are also designed to give meaningful comparison between two form options.

Given this, there is considerable scope for refining both costs and benefits in another round of analysis.

B.2 Introduction

The AWHC is a key enabler that has the potential to improve urban mobility across the Auckland network. The earlier AWHC EAS Report recommended that the following topics be examined in addition to the conventional CBA to provide a fuller picture of the impacts of an AWHC:

- Agglomeration benefits
- The WEBs from 'increased output from imperfectly competitive firms'
- Local economic development impacts, especially relating to the Wynyard Quarter and Westhaven Marina
- Externalities such as visual impact, noise and air pollution
- Economic development considerations
- Network resilience benefits.

This report looks at these effects and aims to inform discussions on:

- The recommendation on the form of an AWHC (i.e. a bridge or a tunnel)
- The potential full spectrum of economic benefits from AWHC options.

B.3 Form of crossing

As part of the option short-listing process, the majority of key differentiators from an economic benefits perspective have turned out equal, namely:

i. **Capacity** is identical between bridge and tunnel (and both form options retain the same future capacity for a rail crossing as a tunnel).

ii. **Connectivity** between bridge and tunnel options is identical. The AHB will service the CBD, the AWHC will service through traffic (as well as Southern CBD/Newmarket) and links to the local transport network (including bus access) are of the same standard.

iii. Both options were assumed to open in 2029. Together the resulting transport **benefits, land-use impacts and agglomeration benefits** are considered neutral between form of crossing.

iv. The impacts from taking **waterfront land** for a bridge were carefully considered, and the preferred bridge option was chosen to minimise these impacts. In particular, the southern approach of the bridge landing at Z-Pier has significantly reduced the risk of impacting on the maritime industry at Wynyard Quarter and on maritime navigation. There are no other direct tangible effects on Wynyard Quarter additional to the tunnel option.

Remaining key economic differentiators between the two forms of crossing, aside from the cost of the crossing itself, include the potential impacts associated with **visual impacts, air quality and noise pollution**. Air quality and noise dis-benefits are found to be insignificantly greater for the bridge option at $0.8 million – $2.3 million PV. Regarding visual impacts:

- visual intrusion dis-benefits to existing residential properties from the bridge could potentially be in the order of $40 million – $80 million PV.
- people's responses to the visual impacts of the bridge are subjective and will differ across individuals and across communities.
- the detailed visual properties of a bridge have not been outlined and clear visual perspectives are not available making it difficult to robustly infer the materiality of visual impacts of the bridge option on the Wynyard Quarter development.

Advice from experts on tourism and brand value is that the visual impact of an additional bridge may not be material to the perception of Auckland as either a tourist destination or as a "world class city" that rates highly in international surveys as a desirable place to live.

Other considerations that have not, or cannot be, monetised include:

i. **Network resilience:** The form that the additional crossing is finely balanced in terms of this benefit. A tunnel is unlikely to be affected by surface events such as extreme weather or a ship strike (lower risk of event), while historically events affecting tunnels tend to take longer to resolve compared to bridges (higher cost of event).

ii. **Auckland's visual branding:** Advice from experts on tourism and brand value is that the visual impact of an additional bridge is unlikely to be material to the perception of Auckland, either as a destination or as a "world class city" that rates highly in international surveys as a desirable place to live. Auckland has an iconic bridge that is part of the city's history. An additional bridge could be designed well to complement the vista containing the AHB and an additional tunnel would maintain the city's sightlines to and around the AHB.

iii. **Compatibility with wider government (central and local) policy:** A critical but unquantified consideration is the fact that the Waitemata Harbour is part of the Department of Conservation – administered Hauraki Gulf Marine Park. A tunnel minimises the impact on the Park.

At an 8% real (i.e. inflation adjusted) discount rate the PV additional cost of a tunnel versus a bridge is $478 million (2010 dollars; the cost estimate was not finalised at the time of writing). It is approximately $640 million and $860 million at a 6% and 4% discount rate respectively.

B.4 Full spectrum of economic benefits from AWHC options

The AWHC is a key enabler to cope with a growing Auckland and the associated transport demand. The transport modelling clearly shows that the existing Auckland network is constrained.

The AWHC relieves pressure at one of the network's most significant areas of congestion.

i. Mean travel times between Albany, Wairau and Takapuna to the CBD decrease by an average of about 25% and 18% in the AM and PM peak flow directions respectively. Travel time savings, reliability and congestion savings are estimated at $324 million PV.

ii. Excluding agglomeration benefits, the BCR of the tunnel option is 0.2 and the BCR of the bridge option is 0.3. The cost estimates are yet to be finalised, so these BCRs are interim. Agglomeration benefits are estimated, but the assumptions on which these are based raise technical issues with the results. Resolving this anomaly was out of scope. What can be said is that benefits could be up to $257 million PV. The additional crossing works both ways on this effect: firms may choose to leave the central city area to obtain cheap land without losing the agglomeration benefits associated with denser central cities. The WEB of increased output from imperfectly competitive firms was equal to $14 million and $13 million for the bridge and tunnel options respectively. This is not enough to alter the BCRs at one decimal place.

iii. A discount rate sensitivity assessment the BCRs depends on various scenarios to extend appraisal periods an additional 30 years.

iv. The transport connectivity of the Wynyard Quarter can be seen as not being materially affected by an AWHC provided that the region still deploys the measures needed to meet the Wynyard Quarter mode share targets.

The AWHC also unlocks land-use changes in the areas earmarked by the region for growth. The CBD continues to grow at a slightly slower rate than the do-minimum scenario, but other targeted growth nodes benefit from the increased connectivity offered by the crossing. In general, the land-use modelling shows that the southern end of the North Shore and West Auckland gain households and employment. A reduction in Auckland's density arising from an AWHC should be interpreted as allowing the benefits of agglomeration and connectivity to be experienced over a wider area.

In addition, Auckland gains considerably from increased network resilience. A 2010 study undertaken for the UK's DfT outlines ten key features of a resilient transport network. The AWHC's characteristics are compatible with all ten features and it is potentially one of the most significant contributors to the resilience of the Auckland network.

This project assumed that there are no further access restrictions on the existing AHB over and above those in place today, and no additional maintenance or operating costs relative to the option scenario. The benefits of an AWHC will be understated if there are limitations to the operation of the AHB not considered here.

While the AWHC exhibits significant economic benefits, the connections between both the new and existing crossing to the remainder of the arterial network remain constrained. A wider and deeper stream of benefits than that shown here would undoubtedly be achieved through selected wider transport initiatives.

We expect that an AWHC would have positive impacts on Auckland's long-run growth potential. It should make Auckland a more economically attractive region and will allow resources to flow more effectively around the region.

B.5 Funding options

The intention of Section 4, in the Economic Benefits and Funding Options Report, on funding options is to identify the potential options that could be used to either fully or partially meet the cost of the AWHC. Two types of funding options are considered:

- **Core funding options:** The primary sources of construction funds; and
- **Supplementary funding options:** Those options that could either partially contribute to initial construction funds, or offset the costs of primary funding.

Funding will be discussed in greater detail in light of the Preliminary Business Case financial information. However, we make the following observations about potential funding packages:

- It is unlikely that the NLTF can do anything more than partially fund the crossing – regardless of the form of the crossing.
- There is nothing at this stage to suggest that the level of debt able to be raised would constrain the choice of crossing. Either debt by itself, or debt combined with NLTF funds, could meet the cost of either a bridge or tunnel.
- The broad tolling options modelled and fully discussed in the Preliminary Business Case are at a level that allows consideration of both forms of crossing, in conjunction with another repayment source.
- Local authority-based funding mechanisms could be an important way of reflecting local priorities.

With these observations in mind, it seems likely that a combination of debt and NLTF funding would be the most appropriate means of providing construction funds. This debt could either be public or private.

NLTF funding would be supported by traditional revenue sources. Meeting the cost of the debt could be done through a combination of tolls, rates and taxes, with the balance between the three determined based on a policy decision on balancing who benefits from the crossing and who pays for it. In this case, preferences for a tunnel would ideally attract a greater proportion of local funding compared to a bridge.

Appendix C: Form Assessment Study Report

C.1 Introduction

An AWHC operated in conjunction with the AHB has been identified by the NZTA as the most appropriate solution to provide flexibility, resilience, and sustainability for the provision of future access across the Harbour.

A 2008 AWHC Study recommended a preferred route for an AWHC to be operated in conjunction with the AHB. The recommended option consisted of two bored tunnels with three lanes in each direction for road traffic and two separate single track bored tunnels for rail passenger transport. The NZTA and KiwiRail subsequently served a number of NoRs for designations within both Auckland City and North Shore City District Plans for the protection of land to allow the construction of the preferred crossing.

The NZTA is developing a Preliminary Business Case for an AWHC, building on previous studies (including the 2008 study) and existing information to help confirm or revise the nature and appropriate form of a crossing taking into account the transport, economic, social and environmental setting. The Preliminary Business Case will provide a greater level of robustness to enable decisions that lead up to the construction of an AWHC.

C.2 The Form Assessment Study

The Form Assessment Study (which is the subject of this report) has been undertaken to inform the Preliminary Business Case as to the most appropriate form of an additional crossing from a planning, engineering, and cost perspective. It comprises a summary and documentation of the planning and engineering investigations of tunnel and bridge options (that extend from the Esmonde Road Interchange in the north to the CMJ in the south). These investigations build on earlier studies to confirm:

- detailed engineering investigation of tunnel and bridge options, including constructability and both capital and operational costs based on an OE level design;
- operability, including connectivity and functionality; and
- consentability, including planning and consenting risk.

The initial phase of the Study involved the development of a long list of possible bridge and tunnel options and the evaluation of these options. This process resulted in a tunnel option and a bridge option being 'defined' as follows:

- **Defined Tunnel:** Bored tunnels for road and rail generally following the alignment of the recommended option from the 2008 AWHC Study (and adopted for the NoRs); and
- **Defined Bridge:** Road bridge landing in vicinity of Northcote Point in the north and Z-Pier in the south and rail bored tunnel generally following the alignment of the rail component of the recommended option from the 2008 AWHC Study.

The FASR does not exclude a particular tunnel or bridge but defines in broad terms the form, location and design attributes of a *bridge* and a *tunnel* option to allow consideration of the relative merits of these options in terms of consenting risk, constructability issues, operational functionality and cost. The attributes of the options reflect the guiding project principles (defined by the project scope and objectives) and provide for further design and refinement to a level adequate for the purpose of cost estimation and evaluation.

In regards to rail, the Study indicates that a rail crossing can be provided separately and on a different timeframe, as required, under both options - however the route of such a crossing may need further consideration in line with the policy direction to connect to areas of intensification.

C.3 Cost

The **cost** of the defined tunnel has always been acknowledged as being greater than that of a bridge.

The analysis and cost estimates confirm the Option Estimate P50 cost differential between the options of approximately NZ$1.247 billion.

C.4 Constructability

To determine **constructability,** the defined options were assessed in terms of the ease or difficulty of construction.

The assessment indicates that both the tunnel and bridge options have complex staging and sequencing in the northern sections and complex civil works to construct the southern connections. The shorter construction duration for the bridge option (with a construction programme duration of 5 years, compared with 6 years and 9 months for the tunnel) offers reduced construction impacts and increased project cost benefit.

Other differences between the options relate to greater importation and removal of earthworks material and increased building settlement risk associated with the tunnel option. These matters equate to only a nominal difference in construction complexity and cost and are not significant differentiators in determining the form of any additional crossing.

Overall, both options have similar complexity and cost with respect to constructability and provide similar opportunities for further design refinement or investigation to improve these constructability matters.

C.5 Operability

To determine **operability**, the defined options were assessed in terms of network resilience and operational and maintenance costs.

The assessment indicates that compared to the defined bridge, the defined tunnel has greater operational and maintenance costs (an estimated average difference of $15 million per annum over the life of the infrastructure).

The defined bridge offers a slightly greater degree of network resilience with fewer impacts on the road network due to planned or unplanned closures (e.g. fire) as full carriageway closures can likely be avoided given the effective carriageway width of four lanes. The bridge has greater recovery resilience in the event of unplanned closures.

The Road Safety Audit has identified the vertical gradient tie-in to the CMJ as serious and significant concerns for tunnel and bridge options respectively. The tunnel gradient is considered a particular design challenge due to the resulting likelihood of crashes. This will require revisiting to address safety within the network. Further design and refinement may assist to address some of the safety concerns associated with the tunnel option. However, given the confined nature of the study area it is unlikely that any such refinement could be undertaken without resulting in significant additional effects and cost implications.

C.6 Consentability

To determine **consentability** (or consenting risk), the defined options were assessed based on their respective environmental effects and an overall judgement made of their ability to meet the purpose and principles of the RMA and the wider national and regional statutory and policy framework.

The relevant planning framework under the RMA includes the ARP:C and the national and regional policy documents (including the HGMPA which has the effect of a National Policy Statement (NPS)). The policy framework provides clear direction to protect the natural character and values of the harbour. Consequently, any works within the harbour will face challenges in obtaining consents. Acknowledging the importance of State highway network and in particular the objectives of this project, substantial changes in the planning framework are unlikely to be undertaken without a substantial shift in direction requiring the support of stakeholders including the Auckland Council and Iwi.

The assessment indicates both options generate impacts on Shoal Bay (from the degree of reclamation) which are significant and present consenting risks. Although opportunities exist with both options to mitigate effects, an additional crossing of any form will require modifications to the planning provisions of the ARP:C to better enable work in this area.

As well as the above effects in the northern sector, the defined bridge has additional effects on the natural character and amenity values of the wider harbour and significant effects associated with the bridge approaches at both ends (with less opportunities to mitigate these effects when compared to a tunnel). The defined bridge in combination with the AHB will have a significant adverse cumulative effect on the natural character of the inner harbour environment. This means that the consenting risk associated with a bridge option is significantly higher than a tunnel. A tunnel in comparison, by its nature being below ground, largely avoids effects on the harbour.

A bridge option is likely to be inconsistent with key matters inherent in the National and Regional Policy framework, and there is little or no opportunity for any redesign or improvements to the bridge concept to provide better for consistency with these matters. Any further design refinement or substantive changes to the bridge design (or landing points or approach arrangements) is unlikely to provide any significant opportunity to reduce consenting risk as bridge option definition sought to optimise a design in terms of impacts within the bounds of the scope and objectives of this study. Improvements to the quality of the design of the overall bridge structure through the main harbour area will not significantly avoid remedy or mitigate the effects on the natural character or amenity values or provide for consistency with the statutory and policy framework as it will not avoid the cumulative effects of an additional structure on the natural character of the inner harbour environment.

In conclusion, it is recognised that under the current planning framework, the likelihood of not obtaining consent for an additional bridge is significantly greater than for a tunnel, such that it is “improbable” under the existing statutory and policy environment. This represents a significant consenting risk.

Appendix D: Transport and Traffic Model Report

D.1 Summary

This report sets out the work undertaken for the transport and toll modelling contract for the AWHC. The contract is one of three relating to the project and significant interactions were required between this contract and those relating to planning and engineering and development of the economic Preliminary Business Case. Reference should be made, as necessary, to the reports arising from these workstreams.

The modelling approach has been to develop a transport modelling system which uses the ART3, a more detailed SATURN traffic model, and a multi-user class assignment model based on the ART3 road assignment.

These models have the capability to:

- Analyse the impacts of crossing options on transport demands and mode choice sufficient for undertaking economic analysis in accordance with the EEM
- Provide transport network information sufficient to support an analysis of wider regional and local economic benefits (and this will be agreed with the ET)
- Provide information on the operational traffic effects of the crossing options
- Forecast the impacts of tolling of cross harbour movements on total travel demand, route choice and mode switch
- Forecast levels of demand under various tolling scenarios sufficient for utilisation in an initial analysis of the viability of tolling to support a Preliminary Business Case.

D.2 Introduction

SKM and Flow were appointed by the NZTA to undertake the transport and toll modelling required for the assessment of the AWHC Project. This is one of three concurrent contracts, with the others being planning and engineering services, being undertaken by Beca/Aecom and economics advisory services, being undertaken by PwC/NZIER.

D.3 Project Objectives

The NZTA's particular objectives for the AWHC project (i.e. the three contracts combined) are:

'To contribute to an affordable, integrated, safe, responsive and sustainable land transport system within the Auckland region by providing a cross-harbour motorway route between the Central Motorway Junction and Esmonde Road that will:

- Encourage economic development and facilitate growth in-line with the strategic land-use objectives of the Auckland RGS;
- Improve cross-harbour accessibility and reduce the barrier effect of the Waitemata Harbour;
- Provide an additional transport route to the existing Auckland Harbour Bridge (AHB) to provide a more resilient network and reduce risks associated with concentrating a high proportion of cross-harbour capacity on a single route; and
- In conjunction with other harbour crossings, improve opportunities for cross-harbour accessibility for all modes, including commercial and general road traffic, passenger and rapid transport, walking and cycling.

KiwiRail's particular objectives for the AWHC project are:

'To encourage and maintain safe and efficient rail passenger transport services within the Auckland region by providing a cross-harbour rail route between Gaunt Street and Akoranga Station that will:

- Encourage economic development and facilitate growth in line with the strategic land-use objectives of the Auckland RGS;
- Provide for improved cross-harbour accessibility and reduce the barrier effect of the Waitemata Harbour;
- Provide greater opportunity for the development of a rail network on the North Shore connecting with the Auckland Isthmus;
- Allow for stations which are easily accessible and serve the needs for existing and future communities; and
- Contribute to providing a more resilient cross-harbour transport network and reduce risks associated with concentrating a high proportion of cross-harbour capacity on a single route.'

D.4 Modelling Purposes

The purposes of the transport and toll modelling contract were defined in the request for tenders (RFT) as to provide detailed information in the following areas:

- An analysis of the impacts of crossing options on transport demands and mode choice sufficient for undertaking economic analysis in accordance with the NZTA's EEM;
- Transport network analysis sufficient to support an analysis of wider regional and local regional benefits;
- The impact of tolling of cross harbour movements on total travel demand, route choice and mode switch; and
- Levels of demand under various tolling scenarios, sufficient for utilisation in an initial analysis of the viability of tolling sufficient to support a Preliminary Business Case.

D.5 Modelling System

The modelling system set up for this project needed to encompass the capability to:

- Forecast with confidence and reliability overall travel demands by mode and their sensitivity to land-use and a range of other demand-influencing factors;
- Evaluate the operational impacts on the road system of the preferred crossings strategy;
- Evaluate the benefits of road tolling strategies and their contribution to project financing; and
- Forecast rail and bus service patronage and the relationship of demand to capacity.

The overall structure of the modelling system is:

- ART3 for forecasting crossing harbour demands and passenger transport modelling, linked to
- A SATURN for the operational traffic assessments, and
- Adapting the ART3 road assignment with multi-user classes by WTP segments for the toll modelling.

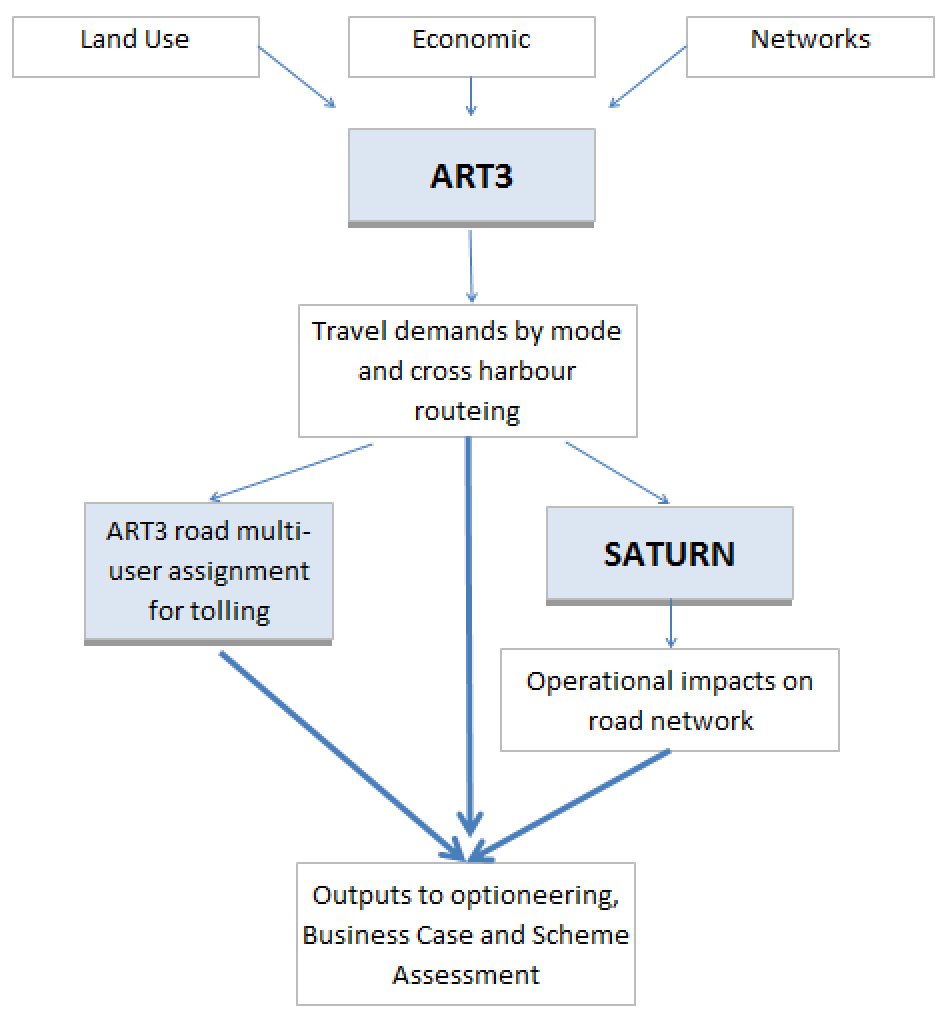
Hence, ART3 was used for the first and last of the above points, the SATURN model for the second point, and for the tolling tests, the third point, the ART3 road assignment was adapted by introducing multi-user classes and differential values of time representing the WTP of each class.

A key part of our approach was to review the inputs to ART3 and then propose a set of inputs for sign-off with NZTA. As part of this, three future land-use scenarios and three sets of economic and strategy inputs have been modelled with the do-minimum forecasts.

ART3 vehicle trip matrices were passed to the SATURN model with the ART3 2-hour matrices converted to peak 1-hour SATURN matrices using profiles of count data within the study corridor.

The modelling system is illustrated in Figure 35 along with the inputs to and outputs of the models.

Figure 35: Modelling Procedures



D.6 Model Development

D.6.1 ART3 Model

The performance of the base year 2006 ART3 model and the 2011 forecast were reviewed, particularly in terms of travel across the Waitemata Harbour for both traffic and passenger transport.

A key purpose for the 2011 review was to ascertain the performance of the model where there have been changes to the network of relevance to the project since 2006. These are the Northern Busway and the completion of motorway links within CMJ.

As part of the review a range of adjustments to ART3 were investigated aimed at achieving the best possible comparisons with observed data, the outcome of which was to retain the model as received from the ARC, that is, with no modifications. Given the set project timeframe this investigation process was constrained to the time available within the overall programme. The adjustments considered were largely minor intersection and motorway adjustments.

The outcome of this is documented in the report "WS3.3 ART3 Model Validation Report Final", dated 10 August 2010, which concluded with the following:

- In conclusion, the original ART3 validation in 2006 for the whole of Auckland and for the cross-harbour context demonstrates that the model provides a sound basis for forecasting cross-harbour demands and the project appraisal. The further update of this validation on the most recent data demonstrates also reassuring outcomes in terms of its sensitivity to the growth in Auckland and the network changes made since 2006.

- Nevertheless, as with any model of this nature, the strengths and weaknesses of the validation and verification – particularly on specific links - should be recognised and corresponding care taken in its use and when interpreting specific model outputs.

- As such the model is considered fit for purpose for this study, that is, for the modelling purposes set out in the study brief, and that it is capable of undertaking the modelling tasks it has been designed for.

The peer review of this report concluded:

- Overall, we concur with the conclusion that the model is acceptable, that it generally forecasts increases/decreases in flow for 2011 in line with observed, and that as with any strategic model, the strengths and weaknesses (particularly for individual links) should be considered when interpreting and applying model outputs.

D.6.2 SATURN Model

The development and validation of the base SATURN models are documented in the report "WS3.3 SATURN Model Validation Report Final", dated 20 August 2010.

The model was originally developed in 2001 to evaluate the Upper Harbour projects along SH18. It was updated by Flow in late 2009, early 2010 for the purposes of the SH18 Strategic Transport Improvements Study and also for the evaluation of proposals along SH1 between Greville Road and Oteha Valley Road. For this project it was expanded to include:

- The Southern Motorway, from CMJ south to the Newmarket Viaduct;

- Grafton Gully, from CMJ east to the Parnell Rise/Stanley Street/Beach Road/The Strand intersection; and

- Takapuna and Milford.

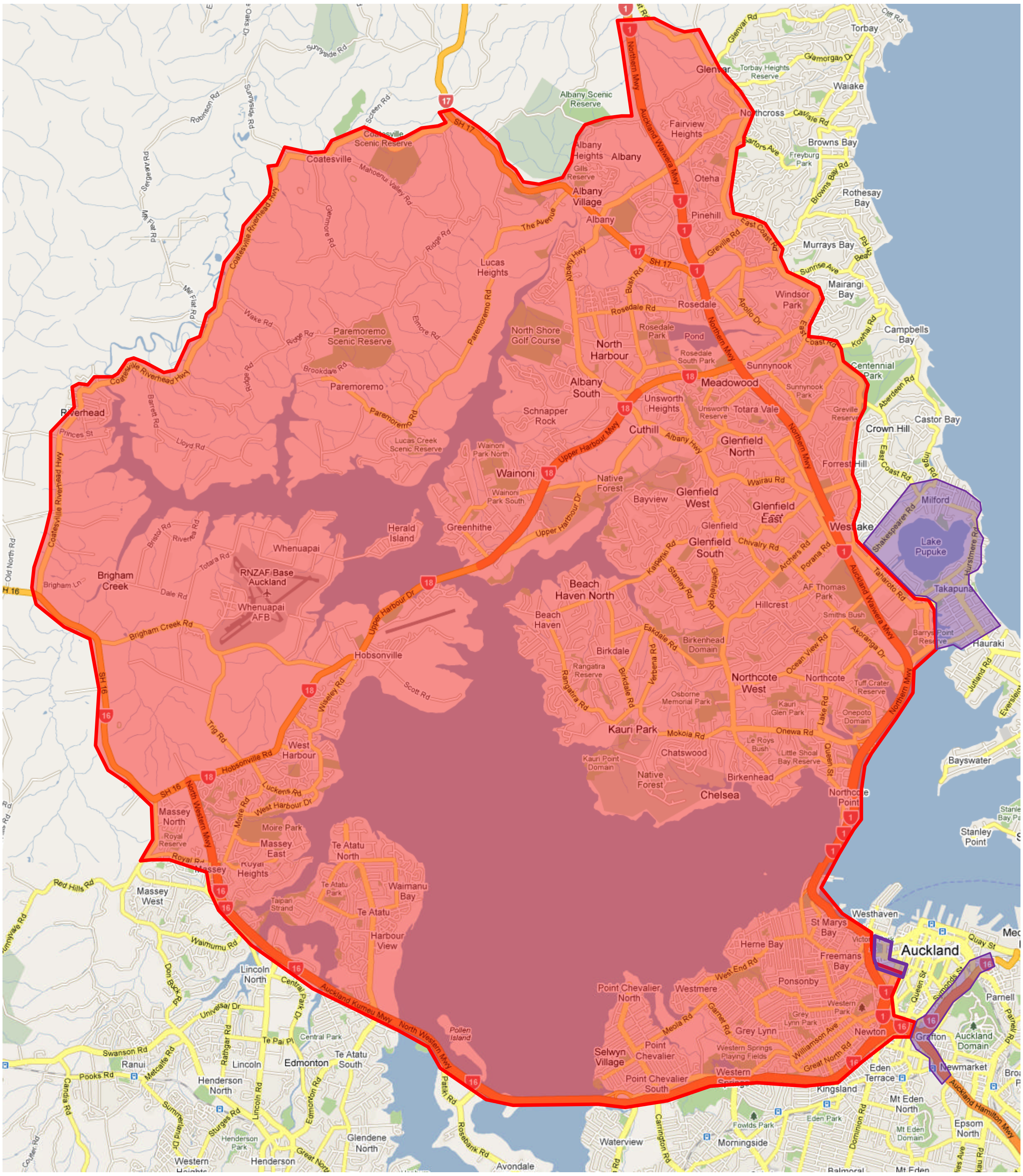
The full model extent is shown in Figure 36.

The prior demands have been taken from the ART3 model and subject to matrix estimation, in order to improve the level of validation.

The validation report concludes with:

- The report has demonstrated that the model meets the guidelines and requirements set in the New Zealand New Zealand Economic Evaluation Manual (EEM). Link count and journey time validation results show that the model performs satisfactorily, compared with conditions observed on site. In conclusion, this report has demonstrated that the model developed gives a sufficiently accurate representation of the areas of the road network likely to be most directly and immediately affected by the proposed Additional Harbour Crossing. The model is therefore considered to be able to be taken forward to be used to assess the operational performance of the options under consideration.

Figure 36: SATURN Model Extent with Extensions Highlighted



D.6.3 ART3 Multi-User Class Assignment Model for Tolling

As tolling of the road crossing(s) influences both overall cross-harbour traffic demands and car users' choices of cross-harbour route, ART3 has been used to estimate the effects on traffic demands, while the detailed impacts of the tolling options on route choice have been determined with a multi-user class assignment model. Hence, ART3, which has a single-class assignment for the demand-supply iterations, was run with tolls included, to produce the vehicle demands, which were then passed to the toll model for the multi-class assignment.

This multi-class assignment toll model was developed by adapting the ART3 road assignment model with the introduction of multi-user classes and differential values of time (VoT) representing the willingness-to-pay (WTP) of each class. This has made use of the ART3 car and HCV demands by purpose creating appropriate market segments.

As noted in the toll modelling scoping note (refer Section D.9.1) the WTP segments and their VoT used are based on those developed for NZTA's toll modelling for the Transmission Gully project in Wellington. A total of 12 segments were created and implemented in the model.

D.7 Do-minimum Forecasting

D.7.1 Introduction

The future years modelled were 2026 and 2041. Year 2026 is close to the possible opening year of a new crossing and year 2041 is about 30 years from now, and there are 15 years between each. Additionally, the ARC had previously modelled in these years, either for specific projects or for the Regional Transport Strategy (2041 was the main model year for this).

D.7.2 Inputs to Forecasting

A range of inputs are required for the forecasting which are considered under the following four categories. In each case, these were reviewed and agreed with the ARC, the other workstreams and NZTA as appropriate.

D.7.3 Transport networks

The future do-minimum transport networks are documented in Appendix A.

D.7.4 Land-Use

The process for developing the future land-use inputs is documented in Appendix B and a summary of the outcomes is in Appendix C.

D.7.5 Economic and Strategy Inputs

The economic and strategy inputs to ART3 were reviewed and recommendations made for the forecasting for the project. These are documented in Appendix D.

D.7.6 ART3 Do-minimum Forecasting

The outcomes of the ART3 do-minimum forecasts are documented in Appendix E. This records the modelling undertaken for the do-minimum forecasts and provides some summary and specific statistics for the region, relevant screenlines and cross-harbour travel. The reasons for the differences between the results of the model runs are discussed, followed by conclusions and a recommendation in respect of the option forecasting.

D.7.7 SATURN Do-minimum Forecasting

The operation of the future do-minimum SATURN models for the years 2026 and 2041 are set out in Appendix F. This sets out the predicted changes in demand flows and the locations where congestion is forecast in these future years, for a scenario without the AWHC.

D.8 Option Forecasting

D.8.1 Options Modelled

Three options were modelled in both ART3 and SATURN and the third was chosen as the basis for evaluation purposes. Descriptions of the three options are documented in Appendix G. Note that for transport modelling there is no difference between a bridge or a tunnel.

D.8.2 ART3 Option Forecasts

The outcomes of modelling the final option (bridge or tunnel) are documented in Appendix H.

It presents key results from the modelling of the option for the region, relevant screenlines and cross-harbour travel making comparisons between the option case and the do-minimum case.

D.8.3 SATURN Option Forecasts

The operation of the future networks in 2026 and 2041, with the AWHC, was set out in Appendix I.

This summarises the changes in traffic demands across the Harbour, without and with the project, and the increases in traffic able to cross the Harbour per hour as a result of the AWHC. It also sets out the predicted journey times along the motorway, without and with the project, demonstrating the congestion that can be expected to occur for both scenarios.

D.9 Toll Modelling

D.9.1 Toll Modelling Scope

The agreed scope of the toll modelling is documented in Appendix J. This covers the purpose and objectives of tolling, the overall approach to the toll modelling, the tolling strategies considered and the model outputs to be provided.

Three toll strategies were modelled:

- Tolling the new crossing (AWHC) only,
- Tolling the existing bridge (AHB) only, and
- Tolling both the new crossing and the existing bridge.

Each was modelled in years 2026 and 2041 with toll levels of $0, $2, $4, $6, and $8 (all-day in each direction).

D.9.2 Toll Modelling Results

Results of the toll modelling are given in Appendix K. They cover flows and revenues, cross-harbour vehicle and PT flows, screenline flows, vehicle demands by sector and travel times.

D.10 Model Outputs

D.10.1 Outputs for the Design Team

Traffic flows and queues were provided from the SATURN model to assist with option refinement.

D.10.2 Outputs for the Option Assessment and Scheme Assessment Report

Information on traffic flows, patronage, and network performance have been provided for the option assessment and Scheme Assessment Report.

D.10.3 Outputs for the Preliminary Business Case

For the Preliminary Business Case these have included:

- Outputs from the benefit-cost analysis (see below);
- Outputs for the agglomeration benefits, including:
  - 24-hour trip and cost matrices, and
  - zonal employment data;
- Outputs for the assessment of land-use effects:
  - The standard trips and costs provided from ART3 to the land-use model (ASP3.2);
- Outputs related to network performance, including:
  - Road times, speeds and LOS on specified routes,
  - Car, HCV and PT flows on cross-harbour links, and
  - Average speeds between specified sectors and economic centres.

D.10.4 Benefit Cost Analysis

BCRs have been calculated using the procedures in the EEM as far as possible, but in a simplified manner in order to fit with the project timelines. A variable demand matrix-based approach has been used, encompassing both roading and passenger transport, using the ART3 model outputs.

The details of this are given in Appendix L and the results of the analysis are in Appendix M. The analysis to date has used the 50% costs and will shortly be updated using the 100% costs. Along with this the assumptions to date on the construction periods for bridge and tunnel will be revised. The results will then be included in Appendix M.