APPENDIX A:
Option Development

Option Development Summary

This *Appendix* provides more background to the scheme assessment process in which the six scenarios from the Inquiry-By-Design process have been have been developed to produce the six feasible options presented in this report. Specifically it records a number of variants considered for each option and summarises the key features for each variant that was considered by our team. The preferred variants have become the feasible options described in this options report.

Option A - Grade Separate On Grid

Option A1

SH1 westbound elevated on grid, geometry aligns with Dufferin Street grid.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Aligns with city grid.

Maintains built edge (square) of Basin Reserve.

Con's

Requires relocation of Crèche.

Proximity to Basin Reserve.

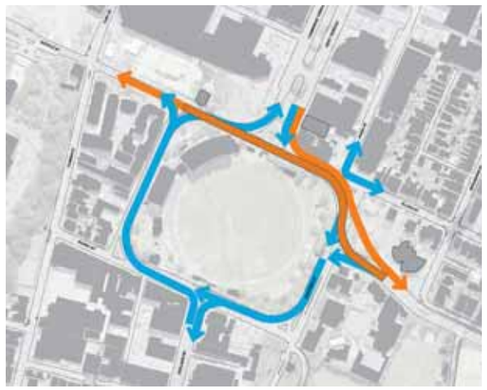
Loss of connection from Hania / Ellice Streets to Basin circulatory.

Requires demolition of buildings on Kent / Ellice corner.

Outcome

Developed further as Option A. ✓

Option A2



SH1 westbound elevated on grid, directly adjacent to Basin Reserve edge.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Aligns with city grid.

Crèche maintained in current location.

Con's

Proximity to Basin Reserve. Closer than A1.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Requires significant drop in level of Sussex Street to get under SH structure.

Requires demolition of buildings on Kent / Ellice corner.

Impacts on Basin built edge.

Outcome

Not developed further due to impacts / proximity to Basin Reserve. X

Option A3

SH1 westbound elevated on grid, directly adjacent to Basin Reserve edge. Local road northbound in tunnel under Memorial Park.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Aligns with city grid.

Crèche maintained in current location.

Sussex Street in tunnel under Memorial Park.

Con's

Proximity to Basin Reserve. Closer than A1.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Significantly more expensive than A2.

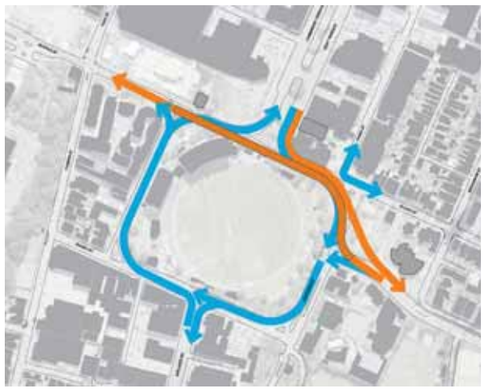
Requires demolition of buildings on Kent / Ellice corner.

Impacts on Basin built edge.

Outcome

Not developed further due to impacts / proximity to Basin Reserve. X

Option A4



SH1 westbound elevated on grid, structure incorporated into Basin Reserve edge.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Aligns with city grid.

May be possible to retain existing buildings on Kent / Ellice corner.

Crèche maintained in current location.

SH could be incorporated in extended bank or structure as part of Basin Reserve.

Con's

Proximity to Basin Reserve. Closer than A2.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Requires significant drop in level of Sussex Street to get under SH structure.

Impacts on Basin built edge.

Outcome

Not developed further due to impacts / proximity to Basin Reserve. X

Option B - Grade Separate Off Grid

Option B1

Elevated SH1 westbound off grid. SH1 Eastbound elevated east of Kent Terrace to provide connectivity to Hania Street / Brougham Street.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche maintained in current location.

Potential to retain buildings on Kent / Ellice corner.

SH traffic removed from Basin proximity.

All local connections around Basin retained.

Con's

More expensive than B5.

Impact on Memorial Park extension.

Possibly requires additional private property.

Height restriction on access under structures to Hania Street.

Does not align with city grid.

Impact of structure on Mount Victoria.

Does not reinforce outer (built) edge of Basin Reserve.

Outcome

Not developed further due to impacts on Mount Victoria and high costs. **X**

Option B2

Elevated SH1 westbound off grid with SH1 geometry aligning to Brougham Street grid . SH1 Eastbound elevated east of Kent Terrace to provide connectivity to Hania Street / Brougham Street.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche maintained in current location.

Potential to retain buildings on Kent / Ellice corner.

SH traffic removed from Basin proximity.

All local connections around Basin retained.

Alignment reinforces outer (built) edge of Basin.

Alignment creates more useable space under / adjacent to streets.

Con's

More expensive than B5.

Impact on Memorial Park extension.

Possibly requires additional private property.

Height restriction on access under structures to Hania Street.

Does not align with city grid.

Impact of structure on Mount Victoria.

Outcome

Not developed further due to impacts on Mount Victoria and high costs. **X**

Option B3

Options for the future use of this block of land are still to be agreed.

All the options have been developed with a view to incorporating either of these ideas (green space or building).

Outcome

Options for use of space still remain. ✓

Option B4

Elevated SH1 westbound off grid with connection to SH1 on northern edge of Memorial Park. SH1 Eastbound elevated east of Kent Terrace to provide connectivity to Hania Street / Brougham Street.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche maintained in current location.

Potential to retain buildings on Kent / Ellice corner.

SH traffic removed from Basin proximity.

All local connections around Basin retained.

Impact on Memorial Park minimised compared to other B options.

Con's

More expensive than B5.

Possibly requires additional private property.

Height restriction on access under structures to Hania Street.

Does not align with city grid.

Impact of structure on Mount Victoria.

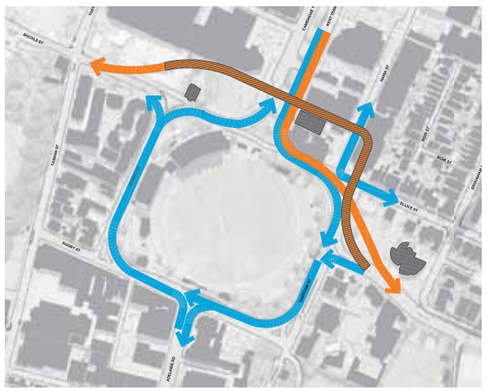
Does not reinforce outer (built) edge of Basin Reserve.

Option does not tie in to Buckle / Tory intersection therefore not meeting project boundary conditions.

Outcome

Not developed further as does not tie in to Buckle / Tory Street intersection. **X**

Option B5



Elevated SH1 westbound off grid with SH1 geometry aligning to Brougham Street grid . SH1 Eastbound at grade.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche maintained in current location.

Potential to retain buildings on Kent / Ellice corner.

Elevated SH traffic removed from Basin proximity.

Limited local connections around Basin retained.

Alignment reinforces outer (built) edge of Basin.

Alignment creates more useable space under / adjacent to streets.

Full access along Hania Street achieved.

Con's

Impact on Memorial Park extension.

Possibly requires additional private property.

Does not align with city grid.

Impact of structure on Mount Victoria. But reduced when compared to other B options.

Outcome

Developed further as Option B.	✓

Option C - At-Grade Off Grid

Option C1

At grade off grid SH1 westbound intersection and elevated SH1 structures between Kent Terrace and Patterson Street to retain connectivity between Hania Street and Brougham Street.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche maintained in current location.

At-grade solution removes elevated visual impact on Kent / Cambridge viewshaft.

Potential to retain buildings on Kent / Ellice corner.

Con's

Bridge structures provide minimal benefit for significant cost.

Requires additional private property.

Safety concerns for westbound SH traffic with downhill approach to Kent Tce. Intersection.

More road crossings for pedestrians, primarily those heading N-S.

Impact on Memorial Park.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Reduced efficiency when compared to grade separated options.

Outcome

Not developed further due to higher cost than C2 with minimal additional benefits. ✗

Option C2

At grade SH1 westbound off grid.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

At-grade solution removes elevated visual impact on Kent / Cambridge viewshaft.

Crèche maintained in current location.

Potential to retain buildings on Kent / Ellice corner.

Alignment reinforces outer (built) edge of Basin.

Fully at-grade solution.

Con's

Impact on Memorial Park extension.

Possibly requires additional private property.

More road crossings for pedestrians, primarily those heading N-S.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

More road crossings for pedestrians, primarily those heading N-S.

Outcome

Developed further as Option C. ✓

Option D - At-Grade on Grid

Option D

At grade SH1 westbound on grid.

Pro's

SH travel time reductions westbound.

Local road travel time reductions.

Aligns with city grid.

Crèche maintained in current location.

Minimal additional property required.

Fully at-grade solution.

Con's

No bus travel time reductions. Poor performance northbound.

No local road travel time reductions.

Poor performance for public transport northbound.

Proximity to Basin Reserve.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Requires demolition of buildings on Kent / Ellice corner.

Seven lanes of traffic in North-East corner of Basin.

Poor North-South pedestrian links.

At-grade SH traffic lanes across entrance to Basin.

Outcome

Developed further as Option D.	✓

Option D1

SH1 westbound elevated over local road on grid, as shown SH! Westbound joins into a Memorial Park tunnel.

Pro's

SH travel time reductions westbound.

Local road travel time reductions.

Aligns with city grid.

Crèche maintained in current location.

Minimal additional property required.

Con's

Proximity to Basin Reserve.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Requires demolition of buildings on Kent / Ellice corner.

Seven lanes of traffic in North-East corner of Basin.

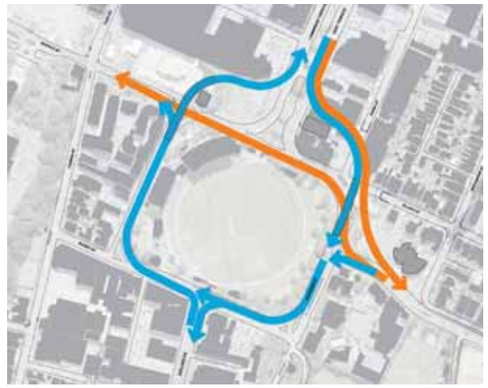
Safety concerns regarding at-grade pedestrian access into the Basin Reserve.

Outcome

Not being pursued further at this stage.	X

Option E - Grade Separate North-South

Option E



At grade SH1 westbound, elevated local road structure southbound and submerged local road structure northbound.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche maintained in current location.

No elevated structure providing visual impact on Kent / Cambridge viewshaft.

Potential to retain buildings on Kent / Ellice corner.

Con's

At-grade SH traffic lanes across entrance to Basin.

Trench structure on Sussex Street.

Elevated / submerged local roads.

Possibly requires additional private property.

More expensive than other grade separated options (A and B).

Trench structure creates barrier between Mount Victoria community and Basin Reserve.

Outcome

Developed further as Option E.	✓

Option F - Tunnel

Option F1

Westbound SH1 tunnel from east of Dufferin Street to west of Tory Street.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Crèche temporarily shifted then returned to existing location.

SH traffic removed from city environment.

Con's

Trench structure creates barrier between Mount Victoria community and Basin Reserve.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Requires demolition of buildings on Kent / Ellice corner.

Steep grades down in to tunnel.

Potential ecological impacts on underground stormwater system (not fully assessed).

Westbound vehicles lose 'experience' of city.

Unnatural westbound movement 'under' valley.

Only links with Memorial Park tunnel not at-grade Buckle Street.

Outcome

Developed further as Option F. ✓

Option F2

Option shows link from elevated structure (Option A) in to Memorial Park tunnel.

All options can link in to a tunnel under Memorial Park.

Outcome

Options for connection to Memorial Park still remain. ✓

Option F3

Westbound SH1 in trench in front of the Basin Reserve and then into a Memorial Park tunnel. Elevated pedestrian plaza over SH1 westbound in to the Basin Reserve. Southbound local traffic elevated over SH1 westbound.

Pro's

SH travel time reductions westbound.

SH travel time reductions eastbound.

Local road travel time reductions.

Bus travel time reductions.

Grade separated pedestrian connection in to Basin.

Crèche maintained in current location.

Con's

Visual impact of raised crossing in to Basin.

Westbound SH traffic dropped in to trench in front of Basin, and trench structure creates barrier between Mount Victoria community and Basin Reserve.

Loss of connection from Hania / Ellice Streets to Basin circulatory.

Elevated / submerged local roads.

Requires demolition of buildings on Kent / Ellice corner, although could be maintained in variant of option.

Outcome

Not developed further due to visual impact on Kent / Cambridge Tce and cost. X

Other Options

Brougham Street Option

Restoring of historic route around the Basin Reserve including SH1 southbound traffic travelling along Ellice Street and Brougham Street. SH1 westbound grade separate slightly off grid.

Outcome

Not developed further due to impacts on Mount Victoria community.	X

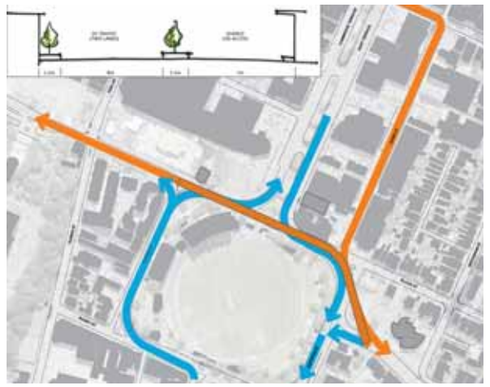
Tory Street Option

Removing SH traffic from Kent Terrace and down Tory Street and through Memorial Park instead. SH1 westbound grade separate off grid.

Outcome

Not developed further due to impacts on Tory Street.	X

Hania Street Option



Improved efficiency at Kent / Cambridge / Vivian intersection.

SH traffic removed from Kent Terrace and travels along Hania Street instead. SH1 westbound grade separated on grid.

Outcome

Not developed further due to on Hania Street.	X

APPENDIX B:
Cost Estimate Development

1. Basis of Estimate

The project is currently considering six options labelled A-F.

Following production of 'draft' estimates a Value Management Workshop involving the design team and key stakeholders was held on the 3rd of December 2009.

The estimates have been developed to comply with the NZTA Cost Estimation Manual SM014. The OE has been developed to provide an expected and 95th percentile cost for the purpose of comparing project options. The estimates have been developed based on preliminary designs, limited site information, and general information about the type of construction and scope of work. The design and estimate will be updated further once a preferred option has been selected.

The estimates have been prepared to the cost index as at September 2009.

The estimates presented here make no allowance for escalation (between September 2009 and the end of construction) or GST.

Comparability of Options

It should be noted that although the estimates have been prepared to provide a comparison of options, the estimate for Option F differs in that it includes the cost of a tunnel in front of the War Memorial with an exit portal located prior to Taranaki Street. Option F can not be constructed to tie in to an at-grade solution on Buckle Street. All other Options (A-E) tie in to the existing Buckle Street prior to the Tory Street intersection.

The Government is considering whether to construct a tunnel in front of the War Memorial.

The cost of constructing a tunnel in front of the War Memorial was estimated as part of a study (August 2007) undertaken for the Ministry of Culture and Heritage and an escalated version of this cost has been used to give a relative cost for Option F without the Memorial Park tunnel (see *Section 5 of this Appendix*). The cost of Option F without the Memorial Park tunnel and the associated BCR is relevant as the cost of the tunnel in front of the War Memorial is to be funded for reasons outside those considered by a BCR.

2. Assumptions for Estimates

The following section clarifies some of the assumptions made during the estimating process. They are divided into general assumptions common to all options and option specific assumptions.

General Assumptions

Property

Property estimates have been developed to provide the Nett property cost for each option. SM014 defines the Nett property cost as - *"the market value, at the base date, of any property purchased or required to be purchased for a project, less the market value of any surplus property. i.e. Nett Property only includes the corridor required."*

Through the area proposed as Memorial Park, property has only been included under the footprint of the road with a minimal (1-2m) offset.

The land area above tunnel structures has been included as a cost against those options.

Further detailed assumptions regarding property estimates are provided in the Basin Options Evaluation Strategy - Property (Opus, November 2009).

Professional Fees

Consultant and NZTA fees have been allowed for as follows:

- I&R - Consultancy fees - 6% of Total Construction, NZTA managed costs - 1% of physical works costs.
- D&PD - Consultancy fees - 5%, NZTA managed costs - 2%.
- MSQA - Consultancy fees - 5%, NZTA managed costs - 2%, Consent monitoring - 1%.

Environmental Compliance

Costs have been included here for environmental compliance during construction although it has been assumed that in most cases this will be relatively minor due to the urban nature of the site. Due to the excavation required for the tunnel option the environmental compliance has been doubled for this option. The cost of de-watering and ground water control has been included with the tunnel costs.

Acoustic noise barriers have not been included here but an allowance has been retained in the landscape section. Acoustic work currently underway will better define the extent of noise barriers required.

Earthworks

An allowance for building demolition has been included for each of the options. Archaeological investigations during construction have also been included under this section.

Ground Improvements

Have been based on previous contracts and no specific design has been undertaken due to the relatively early stage of the design process and limited geotechnical information available.

Drainage

Again detailed drainage work has not been undertaken and a parameter cost has been used. It is assumed that any adjustments to existing drainage will be minimal with new sumps and leads etc being connected into existing stormwater systems. Within the landscaping section there is an allowance in some areas to provide planting appropriate for stormwater treatment and attenuation. There has been no allowance to provide improvements to the attenuation and treatment of run-off in the study area.

Pavements and Surfacing

The estimate allows for asphalt surfaces on all roads. Low noise surfacing has been included as the surfacing on all structures. It has been assumed that areas of new carriageway will be built using a structural pavement. The make-up of these pavements has been based on a previous design for an intersection with vehicle movements in the order of 20-30,000vpd (AADT). No site specific pavement design has been undertaken. Resurfacing of existing roads has been included. No structural pavement rehabilitation has been included for existing roads.

Bridges

Bridges have been costed on a $ / m^2 basis based on preliminary concepts. No structural design has been undertaken. The rate used is $4000 / m^2 which reflects a level of design quality associated with providing a structure appropriate for the urban environment around the Basin Reserve. The rate for bridges has been based on engineering judgement, an assessment of expected bridge spans and curvature, as well as the likely structural form (box girder). Images that reflect the expected level of design quality and cross-section concept sketches on which this rate has been developed are included in *Figure B.1*.

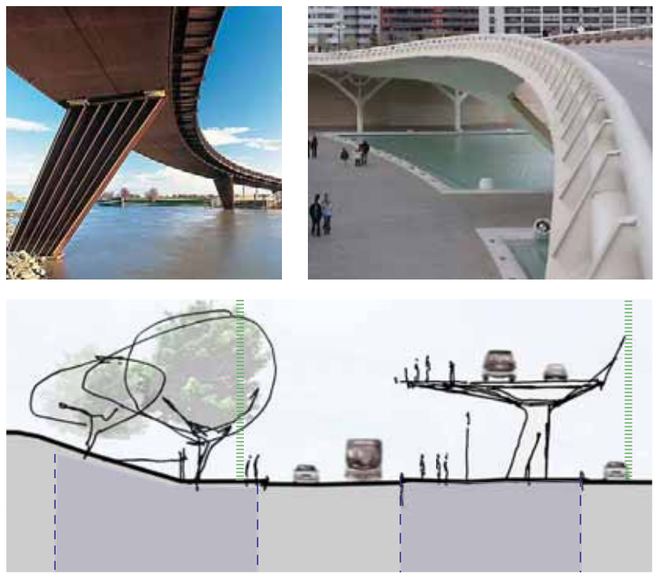


Figure B.1: Images of bridge typologies and concepts.

Following a preliminary constructability assessment it has been deemed unnecessary to include an additional allowance for temporary works associated with staging of the structures construction.

Costs for tunnels and trenches have been included under extraordinary construction costs.

Retaining Walls

Retaining wall costs included for Options A, B and E are for the approach abutment sections of the bridges. It is assumed that these sections will be constructed using reinforced earth and the rate included reflects a level of design quality associated with providing a structure appropriate for the urban area around the Basin.

Some retaining wall structures have been included under the landscape and urban design section where they are associated with achieving better urban design outcomes.

Traffic Services

These costs have been based on lump sum figures for new and existing intersection works including:

- Modification of the existing Vivian / Kent / Pirie intersection to provide for bus priority.
- Modification of the existing Rugby / Adelaide intersection.
- Modification of the existing Dufferin / Paterson intersection.
- Provision of a pedestrian crossing across the eastbound SH lanes in the vicinity of Dufferin / Paterson.
- Provision of bus priority pre-signals on Adelaide Road.

No specific design has been included for any of these intersections. This estimate has been based on work undertaken previously on the Rugby / Adelaide Road intersection as part of the WICB works. The cost of this work was approximately $300K.

Lump sum items have been included for lines and markings.

An allowance has been included for adjustments to street lighting where the existing roads are likely to be shifted. New street lighting has been included for sections of new road. An allowance for architectural lighting is included under landscape and urban design.

Service Relocations

Discussions have not yet been held with service authorities. Costs have been based on previous estimates prepared as part of the Meritec option.

Costs are estimated NZTA share for this work rather than total cost.

Landscaping and Urban Design

The landscaping and urban design work has sought to provide a scope that appropriately reflects the location and impact of the proposals with the aim to ultimately obtaining the necessary consents for the scheme. This is discussed further in Section 6 of this Appendix and has been debated during the Value Management Workshop. It has been agreed that the scale of works proposed is appropriate for the scheme.

The scope of works on which the estimate has been developed is illustrated in the drawings included in this Appendix.

There are a number of items included in this section of the estimate that would normally be included elsewhere, these include:

- Retaining wall structures;
- Bus shelters; and
- Acoustic barriers.

Traffic Management and Temporary Works

No specific design has been undertaken. The cost estimate has been built up based on parameter costs.

Preliminary and General

An allowance of 20% of the physical works cost has been included. There is no specific allowance for security as part of the estimate.

Extraordinary Construction Costs

Within this item the following has been included:

- Restoration, and where necessary relocation, of the Crèche building; and
- Tunnel and trench costs.

Option Specific Assumptions

Option A

To obtain a positive urban design outcome for Option A it is important that the space under the bridge on Ellice Street between Kent Terrace and Hania Street becomes an active and useable space. To achieve this it is important to restore a building edge and it has therefore been proposed to construct a building under the bridge structure. NZTA are currently investigating the practicality of this arrangement but for the basis of the cost estimate it has been agreed that the cost of the structure has not been included. The income generated from the rental of a property in this location is likely to cover the initial construction cost.

An allowance has been included for relocating the Crèche.

The estimate includes an allowance for a pedestrian / cycle bridge on the southern side of the bridge structure.

With Option A the cost for stairs and ramps associated with the pedestrian bridge on the elevated structure is included within the landscape and urban design section of the estimate. The structural cost of the pedestrian bridge is included under bridges.

Option B

Property costs allow for the purchase of a small portion of the Mitsubishi Motors property on the end of Cambridge Terrace. It is hoped that as the design develops the requirement for any of this property can be removed.

Option C

This option includes an allowance for retaining walls for State Highway (SH) traffic through vacant land between Tory and Cambridge Terrace to maximise the useable space within the park. In conjunction with these structures a pedestrian bridge over the SH has been included.

Option D

Includes an allowance for construction of a new signalised intersection between Sussex Street and the SH westbound.

Option E

This option requires the SH traffic to be dropped in to a trench in the vicinity of Ellice Street. This provides adequate clearance under the elevated local road. The cost associated with this trench could be removed should the decision be made to proceed with a tunnel under Memorial Park. This would alter the comparative cost of this option.

Option F

This option includes an allowance to temporarily relocate the Crèche building while the cut and cover tunnel is constructed. Following completion of the tunnel it will be returned to it's current location.

An item has been included for diversion of significant stormwater that currently runs centrally down Kent / Cambridge Terrace. The estimate provides for a diversion around the Basin (via Dufferin Street) for the pipes that currently run under the pitch. Alternative siphon options were deemed to be less likely to be consentable but may be considered further if this option progresses.

Option F makes no allowance for archaeological investigations between Tory and Taranaki Streets. It is expected that this could be a site of some archaeological interest.

3. Risk Assessment

A 'general' qualitative risk assessment has been undertaken for each of the options. The calculation of the contingency and funding risk has been undertaken using the Hong Kong method.

The contingency between the base and expected estimate for each of the options ranges between 17% and 30%, with four of the options currently below 20%. This is lower than would normally be expected at this stage of a project. We consider this lower risk profile appropriate as the base cost is expected to include adequate mitigation work (the scope of which have been tested through the value management workshop), although the risk of limited existing ground and services information remains.

4. Option Estimates

Costs of the various options have been calculated as per the NZTA Cost Estimation Manual (SM014). The following is a summary of the cost estimates for each option (the estimate for the options is attached to this *Appendix*):

Table B.1: Option Estimates

Option	Expected Cost	95th Percentile Cost
A	$75M	$100M
B	$88M	$117M
C	$52M	$67M
D	$37M	$49M
E	$100M	$130M
F	$158M Note 4	$217M Note 4

Notes:
1. Estimates have been prepared as at September 2009 cost index.
2. The estimates do not include escalation or GST.
3. The estimates have not been subjected to an external peer review.
4. Includes for construction of tunnel under Memorial Park through to Taranaki Street.

5. Option F Cost Excluding Memorial Park Tunnel

A previous study by Opus estimated the cost of providing a cut and cover trench for Memorial Park (New Zealand Memorial Park, SH1 Cut and Cover Trench Option, Cost Estimate, August 2007). This scheme involved realignment of Sussex and Buckle Street in to a trench and then a covered tunnel under Tory Street coming up to the intersection at Taranaki Street.

The expected cost of this scheme was $39.5M (as at second quarter 2007). This estimate made no allowance for property costs, NZTA managed costs, environmental mitigation (eg. noise fences) and park construction. When escalated to the Sept 2009 cost index this figure becomes $42.8M.

To enable Option F to be compared to the other options we have removed the cost for the Memorial Park tunnel from the expected cost of Option F. This gives the following:

Option	Expected Cost
F (excluding Memorial Park Tunnel)	$115M

It should be noted that the cost split boundary between the Basin Reserve and Memorial Park projects will need to be further defined.

6. Comparison to Feasibility Estimate

As part of the Ngauranga to Airport Strategic Study a Feasibility Estimate (FE) was produced for Option B3 (formerly Meritec Option H). This option gave an Expected Estimate of $34M (as at January 2007). When escalated to current dollars this figure becomes $37.5M. Of the current schemes this option relates most closely to Option A.

Item by Item Comparison

The following section discusses the differences between the FE and Option Estimate (OE) schemes. All costs presented in this section are base costs:

Property

The two additional (not already crown owned) property purchases included in the OE have a value of $2M. These properties could be avoided by the footprint of the project and are primarily being purchased as part of the mitigation / urban design proposals for the scheme. As these properties have now been assessed as being required for mitigation (through the development of the design) they were not included as part of the FE.

The remaining $7M is for property currently owned by NZTA. The property cost of crown owned land was not included in the FE.

Earthworks

There are two significant items that do not appear to have been included in the FE.

- Archaeology - $400K.
- Building demolition - $200K.

Bridges

The rate for bridges has been increased 29% from $3100 / m^2 to $4,000 / m^2. The basis for the rate proposed has been discussed in *Section 2 of this Appendix*.

The footprint of bridge structures has increased from 3500m^2 to 4500m^2 (excluding bridge approaches). This is due to the inclusion of a pedestrian / cycling facility on the south side of the structure which adds an additional 1000m^2. It should be noted that the Option B3 (FE estimate) proposals included bridge structures for both west and eastbound SH traffic but the design has been developed to only require a single structure for westbound SH traffic.

Traffic Services

The OE allows for modifications to a number of existing intersections that were not included in the FE. These include:

- Modify Vivian / Kent Intersection for bus priority.
- Modify Adelaide / Rugby intersection.
- Modify Dufferin / Paterson intersection.
- New controlled pedestrian crossing of SH eastbound to Dufferin Street.
- Bus pre-signals on Adelaide Road.

The total cost of this work is approximately $1M.

Service Relocations

The Meritec option (FE estimate) identified a cost of services relocation in the order of $460-$960K (December, 2000), Option H was at the top of this range. These figures escalated to June 2009 give a range of $660-1,300K. A figure of $1M has been used in the OE. This is considerably higher than the $400K included in the FE.

Landscaping and Urban Design

The scope of landscape and urban design treatment has been considered further since the draft estimates were produced. The Value Management Workshop has reiterated that the proposed extent of mitigation works seem appropriate for the project. It should be noted that:

- The proposed roading improvements are located in a dense urban and sensitive area of Wellington.
- We have used the urban design team to assist with the development of options that are sensitive to this.
- We have included the cost of proposed landscaping treatments forming part of each option. We have done some detailed thinking about the extent of work and employed a quantity surveyor with specialists skills in this area to assist with cost estimates. This design development has added as much as $8 to $12 million to the expected cost. We should not underestimate the cost of street scape (Auckland City Council spent $80 million on upgrading Queen Street).
- We have allowed for a thin uniform bridge structure that needs to accommodate eccentric piers and tight curves. This has increased the cost of the bridge by another $8 to $12 million over standard bridge structures.
- We are still able to undertake value engineering to challenge the cost of these items with a view to reducing the overall cost of the final design. However, this would need to be carefully balanced against what we might need to do by way of mitigation and remedy as part of the designation and consent process - or to keep your stakeholders on board.

The FE identified a cost for landscape treatment of $500K (compared to the current $8 to $12 million in this OE).

There are a number of aspects included in the OE that were not included in the previous FE. These include:

- Treatment of School and Government House entrance - approximate cost, $1.4M;
- Landscaping associated with new location of Crèche building - $1.8M; and
- Landscaping in areas of additional land purchase (mitigation works) - $0.9M.

Extraordinary Construction Costs

The OE includes a cost of $1.2M (relocation $600K and refurbishment $600K) relating to the relocation of the Crèche building. These costs are in addition to the amount included as part of the landscaping cost (described previously) for work in the vicinity of the building. The design on which the FE was based did not require the Crèche to be relocated and did not allow for it to be refurbished.

Percentage Items

The following items are all functions of the overall construction cost so are directly affected by any increases in construction cost:

- MSQA - Percentages used in OE were identical as for FE apart from a reduction in the NZTA managed costs from 3% to 2%.
- P&G - Same percentage applied (20%).
- I&R - Increased from 4% in FE to 8% in OE.
- D&PD - Reduced from 8% in FE to 7% in OE. This may reflect that the cost of resource consents was included in the D&PD stage as part of the FE.

Items with little change

Environmental Compliance - no change.

Pavement and surfacing - slight reduction from FE.

Traffic Management and Temporary Works - slight reduction from FE.

Risk Allowance

In the FE the Expected Estimate had a 30% contingency on the base estimate. The OE Expected Estimate includes a 17% contingency above the base estimate. This risk allowance has been discussed previously in *Section 3 of this Appendix*.

7. Estimate Comparison Summary

We have undertaken a quick assessment of the cost of providing a 'transport only' version of Option A. This is Option A with the following changes:

- Rate for bridge structure reduced to $3,100 / m^2.
- Landscaping and Urban Design provision reduced to $500,000.
- Removal of pedestrian / cycling facilities on the bridge structure.

These changes reduce the expected cost of Option A to $50M. It must be noted that it is highly unlikely that this 'transport only' solution would be successful through the consent process. The following table provides a basic summary of the differences between the three estimates:

Table B.2: Comparison of 'transport only' and previous cost estimate.

Strategy Study Feasibility Estimate (FE) for Option B3 (escalated to Sept 2009).		**$37.5M**
Addition of property cost for property already owned by the crown.	$8.3M	
Crèche relocation and refurbishment.	$2M	
Provision of additional Bus Priority measures.	$2M	
Option A 'transport only' Expected Estimate (Sept 2009).		**$50M**
Revised bridge cost ($4,000 / m^2) to better reflect urban nature of the site.	$5M	
Revised landscaping and urban design cost to adequately mitigate proposed scheme.	$12M	
Widening of bridge to provide walking and cycling facility and provision of stairs / ramps etc.	$6M	
Option A Expected Estimate (Sept 2009).		**$75M**

Notes:
Figures may differ from those stated in the previous section due to the inclusion of a risk allowance and allowance for percentage figures (eg. P&G and fees).

Option Estimate

Project Estimate

Basin Reserve Improvements Investigation

OE

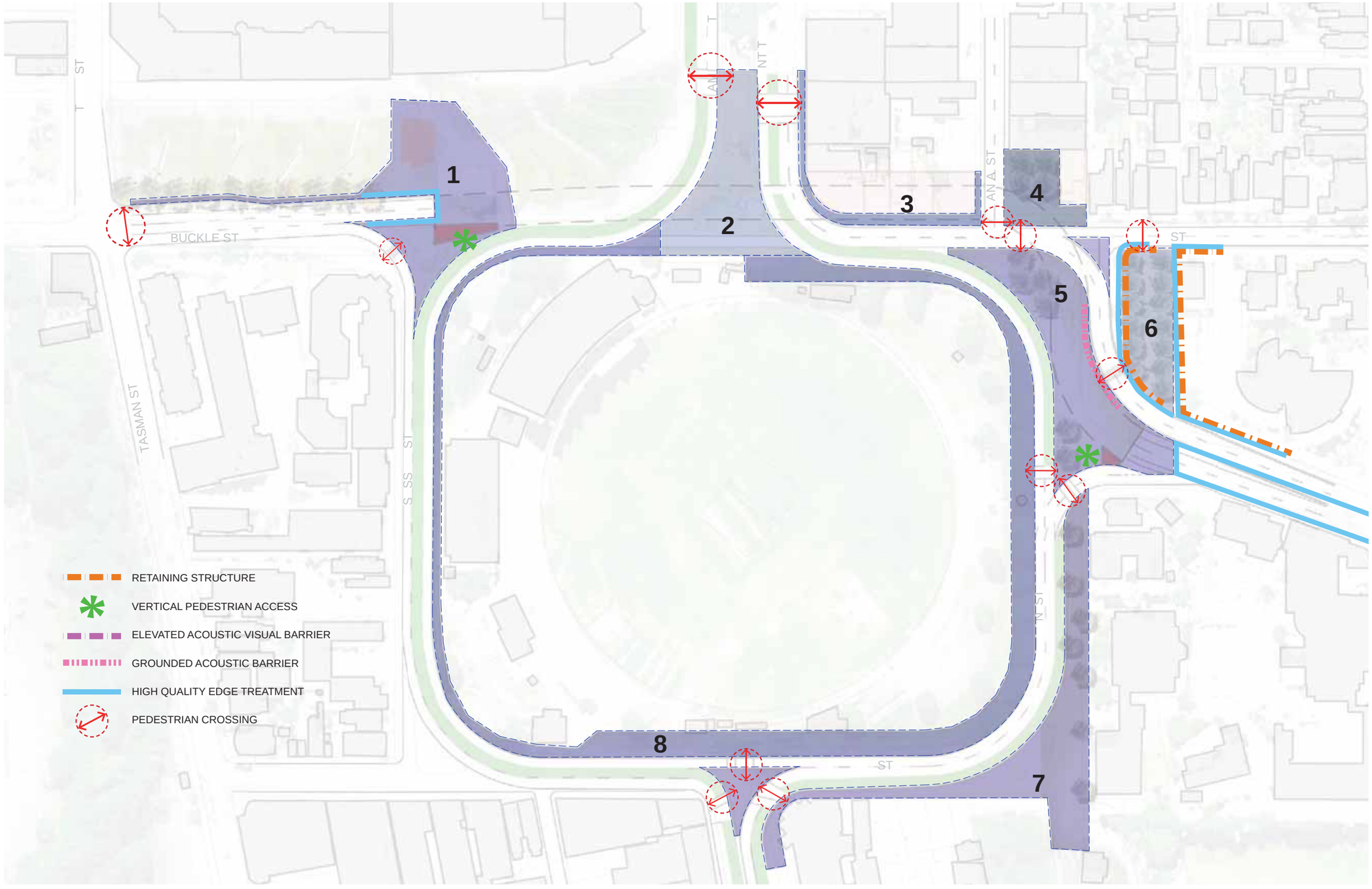
Item	Description	Option A Base Estimate	Option B Base Estimate	Option C Base Estimate	Option D Base Estimate	Option E Base Estimate	Option F Base Estimate
A	**Nett Project Property Cost**	**9,000,000**	**18,600,000**	**16,900,000**	**8,500,000**	**14,500,000**	**10,800,000**
	Investigation and Reporting						
	- Consultancy Fees	2,700,000	2,780,000	1,330,000	1,130,000	3,290,000	5,400,000
	- NZTA Managed Costs	900,000	930,000	450,000	380,000	1,100,000	1,800,000
B	**Total Investigation and Reporting**	**3,600,000**	**3,710,000**	**1,780,000**	**1,510,000**	**4,390,000**	**7,200,000**
	Design and Project Documentation						
	- Consultancy Fees	2,250,000	2,320,000	1,110,000	940,000	2,740,000	4,500,000
	- NZTA Managed Costs	900,000	930,000	450,000	187,902	1,100,000	1,800,000
C	**Total Design and Project Documentation**	**3,150,000**	**3,250,000**	**1,560,000**	**1,127,902**	**3,840,000**	**6,300,000**
	Construction						
	MSQA						
	- Consultancy Fees	2,250,000	2,320,000	1,110,000	940,000	2,740,000	4,500,000
	- NZTA Managed Costs	900,000	930,000	450,000	380,000	1,100,000	1,800,000
	- Consent Monitoring Fees	450,000	470,000	230,000	190,000	550,000	900,000
	Sub Total Base MSQA	**3,600,000**	**3,720,000**	**1,790,000**	**1,510,000**	**4,390,000**	**7,200,000**
	Physical Works						
1	Environmental Compliance	150,000	150,000	150,000	150,000	150,000	300,000
2	Earthworks	850,000	1,070,000	1,500,000	1,080,000	1,270,000	830,000
3	Ground Improvements	350,000	350,000	150,000	150,000	550,000	1,900,000
4	Drainage	770,000	900,000	750,000	750,000	770,000	760,000
5	Pavement and Surfacing	1,350,000	1,440,000	1,910,000	1,870,000	1,210,000	1,590,000
6	Bridges	18,000,000	17,600,000	300,000	0	6,480,000	0
7	Retaining Walls	3,000,000	3,000,000	0	0	710,000	0
8	Traffic Services	1,680,000	1,690,000	1,730,000	1,530,000	2,090,000	1,950,000
9	Service Relocations	1,000,000	1,000,000	1,000,000	1,000,000	2,000,000	6,200,000
10	Landscaping	8,340,000	9,960,000	9,840,000	7,980,000	9,250,000	8,110,000
11	Traffic Management and Temporary Works	700,000	710,000	500,000	500,000	720,000	920,000
12	Preliminary and General	7,480,000	7,710,000	3,690,000	3,140,000	9,130,000	14,990,000
13	Extraordinary Construction Costs	1,200,000	640,171	600,000	640,171	20,426,700	52,364,633
	Sub Total Base Physical Works	**44,870,000**	**46,220,171**	**22,120,000**	**18,790,171**	**54,756,700**	**89,914,633**
D	**Total Construction**	**48,470,000**	**49,940,171**	**23,910,000**	**20,300,171**	**59,146,700**	**97,114,633**
E	**Project Base Estimate (A+B+C+D)**	**65,000,000**	**76,000,000**	**45,000,000**	**32,000,000**	**82,000,000**	**122,000,000**
F	**Contingency** (Assessed/~~Analysed~~)	**10,210,000**	**12,344,034**	**7,816,000**	**5,489,615**	**18,093,010**	**35,945,622**
G	**Project Expected Estimate (E+F)**	**75,000,000**	**88,000,000**	**52,000,000**	**37,000,000**	**100,000,000**	**158,000,000**
H	**Funding Risk** (Assessed/~~Analysed~~)	**25,511,384**	**28,404,951**	**14,923,080**	**11,274,343**	**29,133,135**	**59,532,716**
I	**95th percentile Project Estimate (G+H)**	**100,000,000**	**117,000,000**	**67,000,000**	**49,000,000**	**130,000,000**	**217,000,000**

Date of Estimate	**22 December 2009**	**Cost Index, Sep 09**
Estimate prepared by	**Gareth McKay**	G. McKay
Estimate internal peer review by	**Keith Atkinson**	K. A. Atkinson
Estimate external peer review by		**Not Undertaken**
Estimate accepted by NZTA		

Note: (1) These estimates are exclusive of escalation and GST.

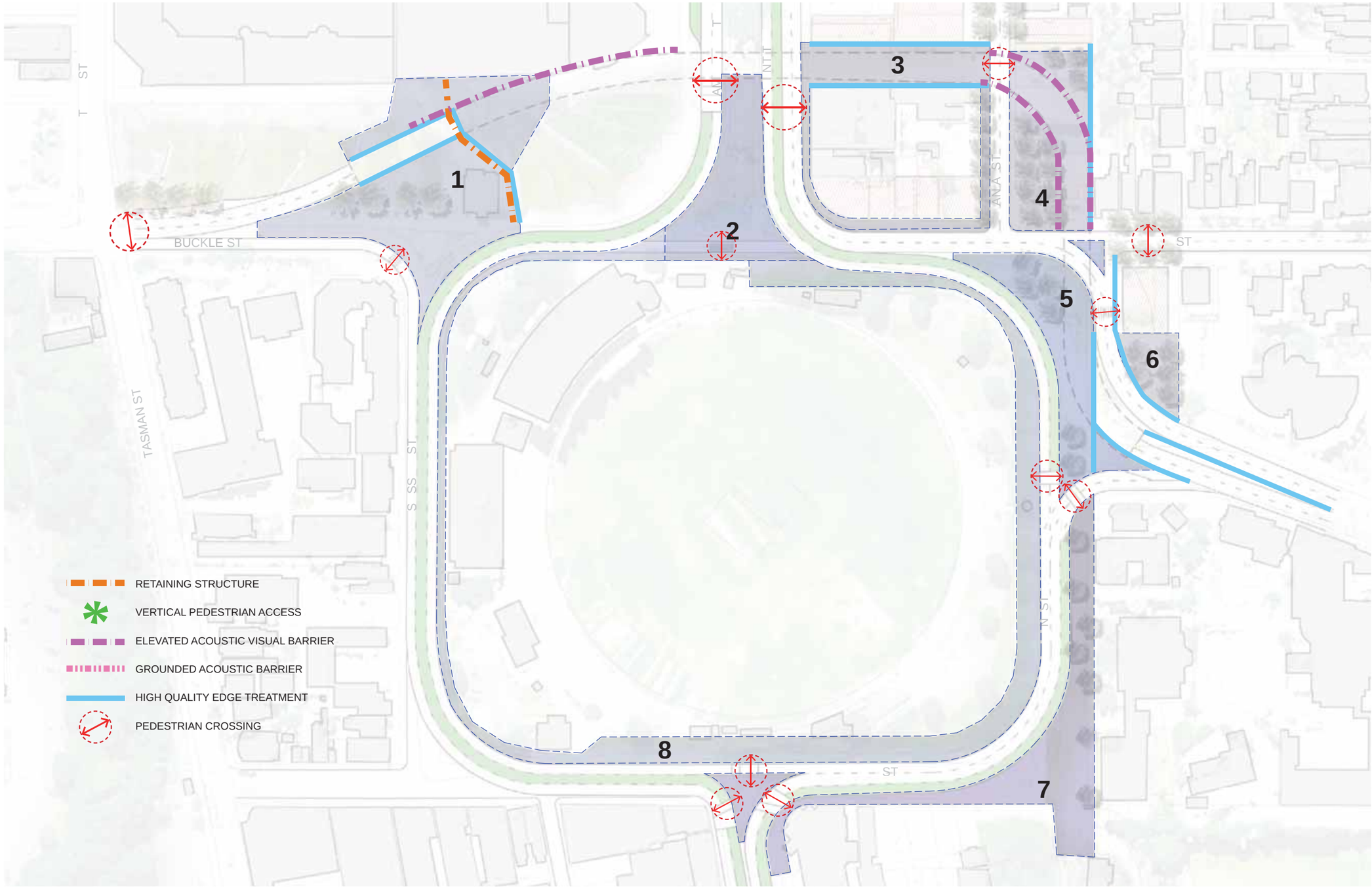
Drawings used as basis for estimate, including:

Landscaping Treatment Zones

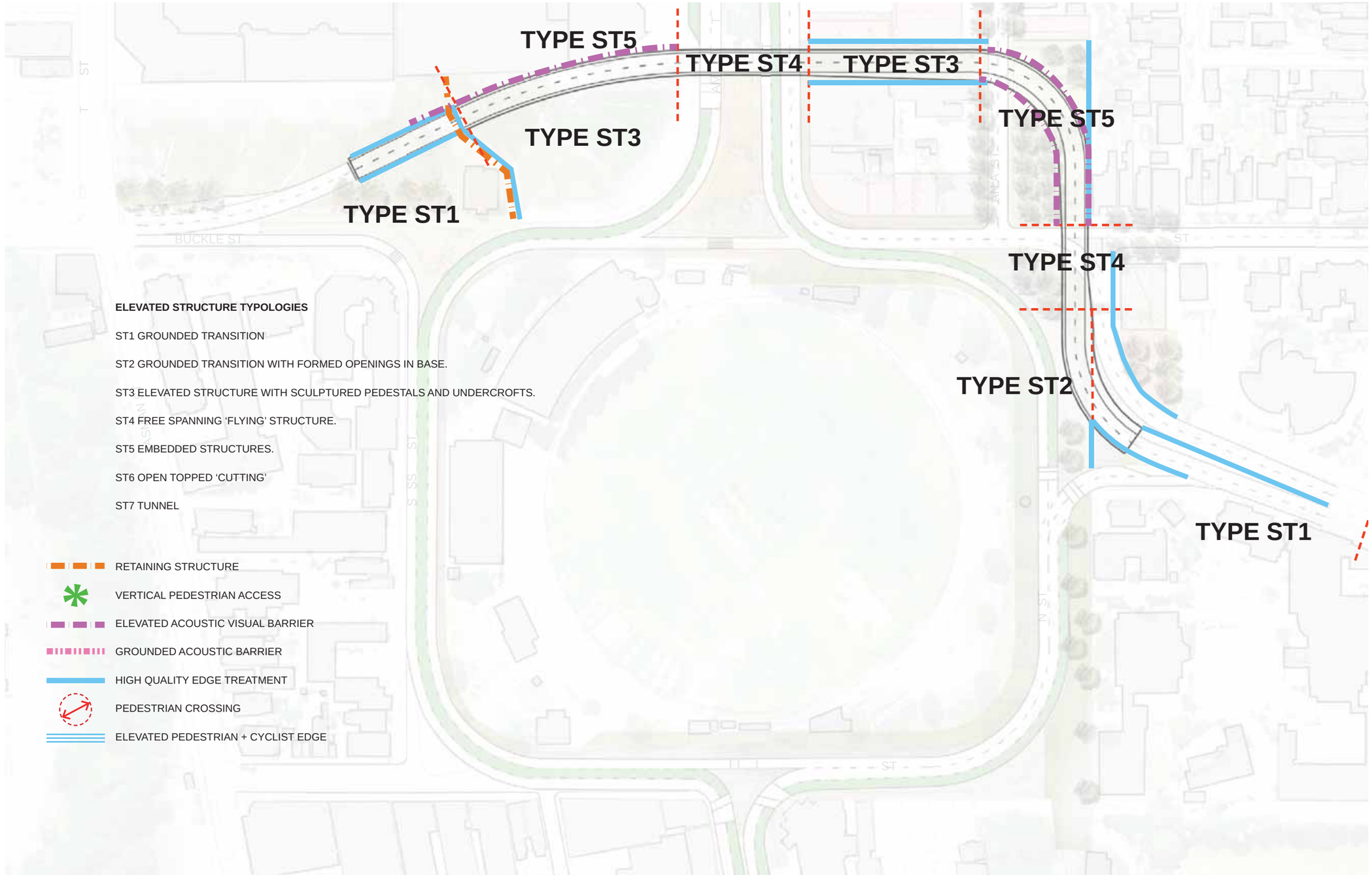


Option A - Zones

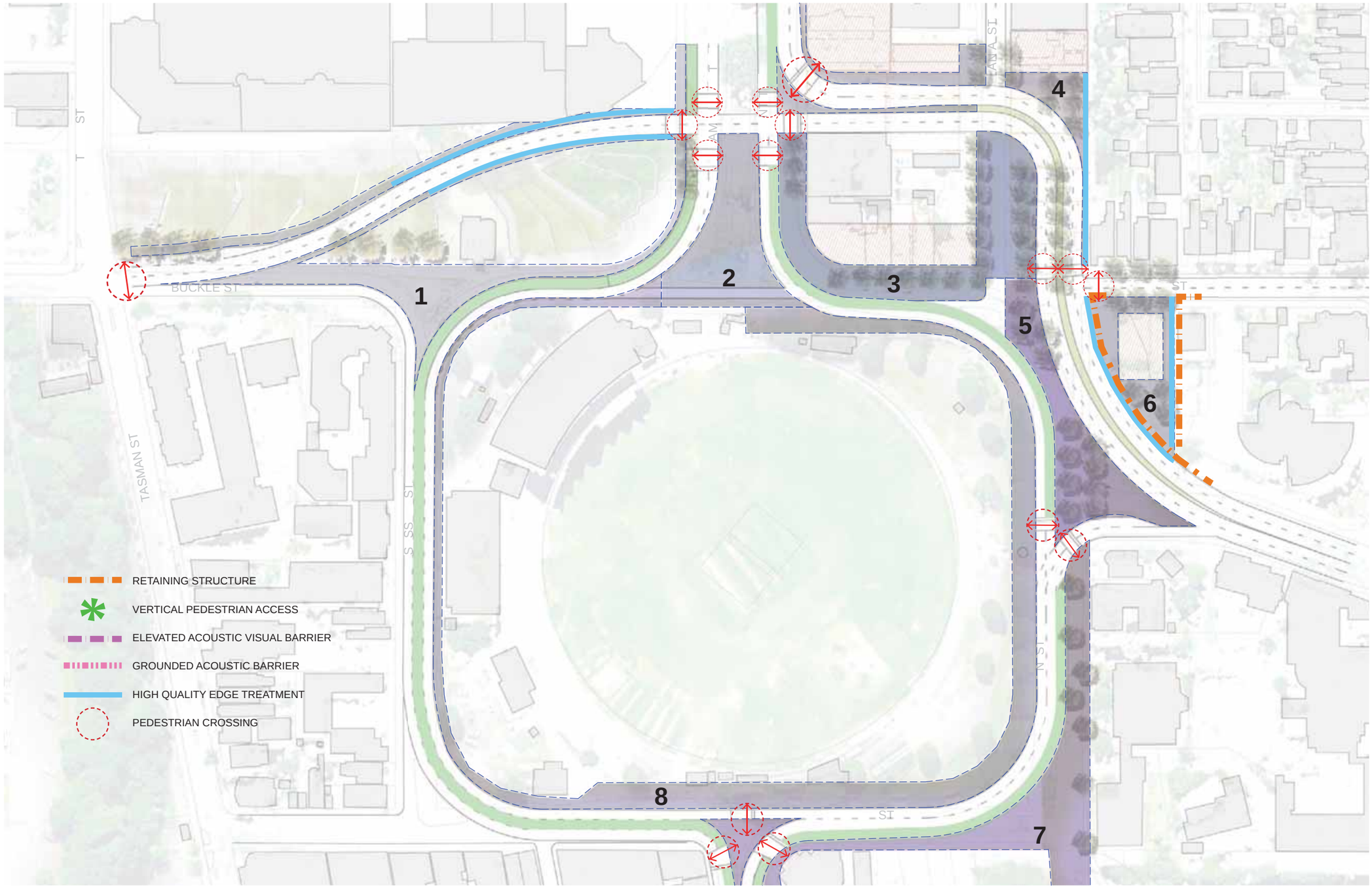
Option A - Elevated



Option B - Zones

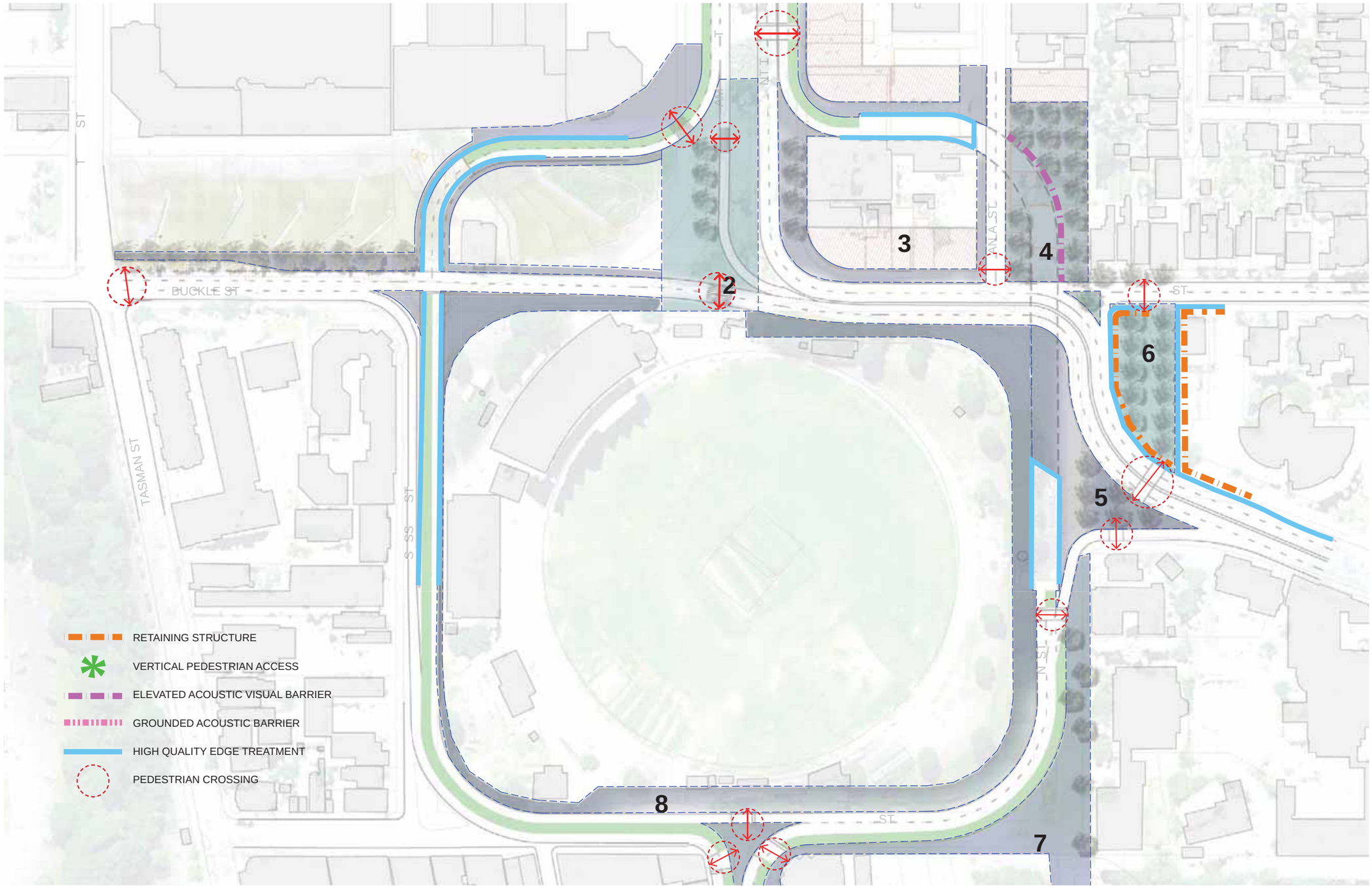


Option B - Elevated

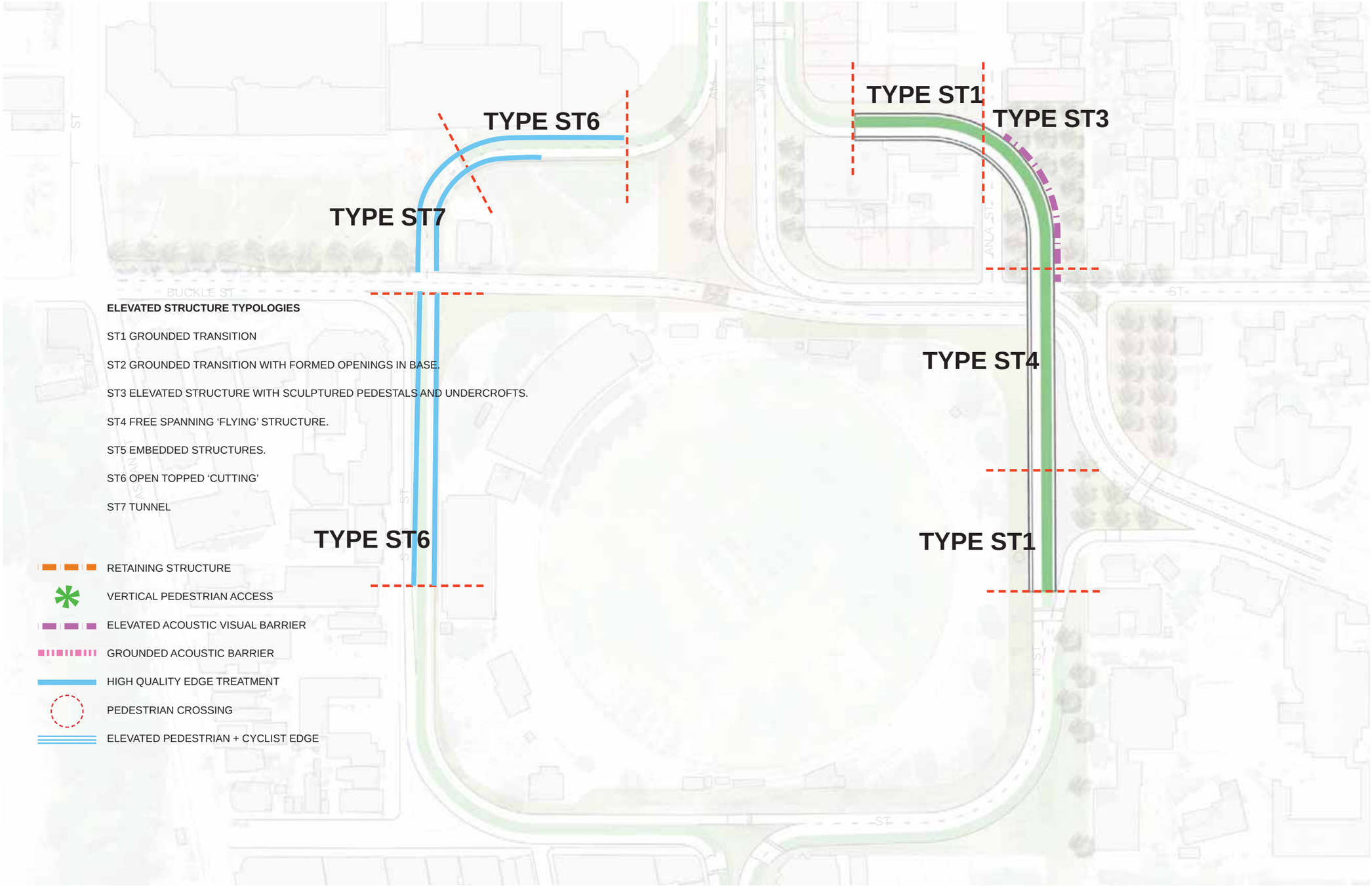


Option C - Zones

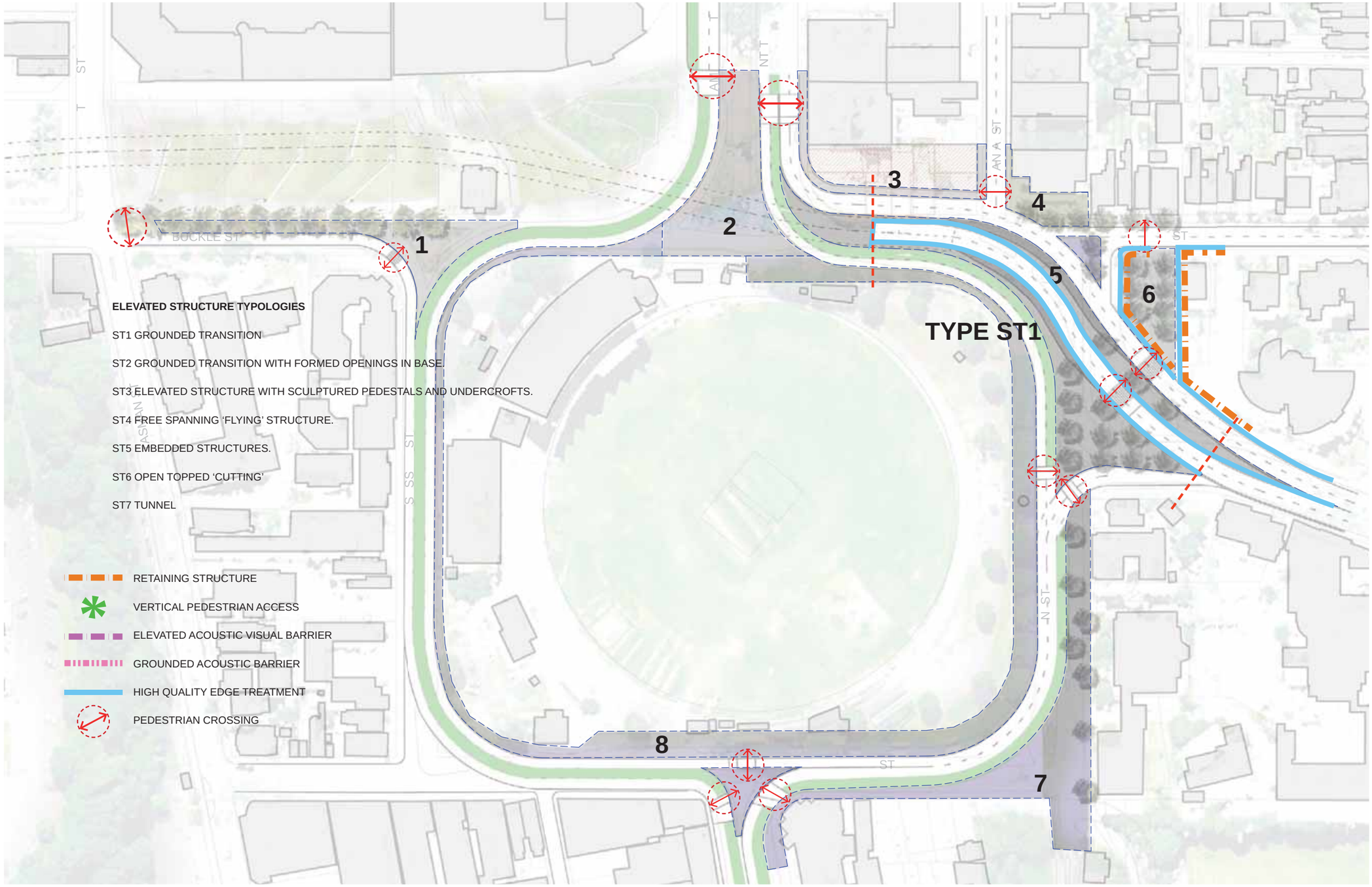
Option D - Zones



Option E - Zones



Option E - Elevated



Option F - Zones

Landscape Treatment Types

HARD LANDSCAPE	Type	Code	Description	Reference Images
	Type 1	HL1	Footpath asphalt, 300mm concrete kerb, sandblast finish	 HL1
	Type 2	HL2a HL2b	Large format stone paver on RC slab Small format on high capacity compacted substrate	 HL2
	Type 3	HL3	Limechip pavement trafficable shared surface. Allow for high quality edging formed from stone slab with concrete base.	 HL3
	Type 4		Retaining wall & ballustrade. High quality cast in-situ or precast concrete. Allow for shaped and complex formwork, off the form surface treatment and water or sand blasted finish.	 HL4d  HL4d  HL4d
		HL4a HL4b HL4c HL4d	1m 2m 3m Variable 1-3m	

SOFT LANDSCAPE	Type	Code	Description	Reference Images
	Type 1	SL1	Grass with high quality kerb on stone edging	 SL1
		SL2	High quality street planting with stormwater function. Swale planting for stormwater management.	 SL2  SL2

Landscape Types - Soft Landscape

ELEMENTS	Type	Code	Description	Reference Images
	Type 1	TR1	Trees in reinforced treepits, 5m^2 x 1m depth *Arborgreen* or similar. Include high quality wind shelter surround. Trees to be 3-4m (160 litre). Rate = $600m3 for Root Cell. only does not include: - geotextile or root barrier - soil medium - tree	 TR1  TR1  TR1
		TR2	Trees in grass - 2.25m^2 x 1m depth Trees to be 3-4m (160 litre). Allow for irrigation.	 TR2
	Type 2	BS	Bus Shelter. Adshell or similar in keeping with broader city network.	 BS

ELEMENTS	Type	Code	Description	Reference Images
	Type 3	VC1	Vertical circulation element 7.5m vertical transition Precast concrete treads Steel supporting structure and enclosure Allow for exterior quality lift and lift enclosure	 VC1
		VC2	6m vertical transition Precast concrete treads to stair Steel structure and precast concrete enclosure In-situ concrete switchback ramp and formed balustrade with sculpted form. Ramp length approx 75m.	 VC2
	Type 4	AB1	Elevated lightweight acoustic barrier / screen. Steel structured screen with some geometric complexity Assume extends 2m above roadway and drops 1m below	 AB1  AB1  AB1
		AB2	Mass based acoustic barrier. Shaped precast concrete form up to 3m with steel construction similar to AB1 from 3m to	 AB2  AB2

RATES BASED	Type	Code	Description	Reference Images
	Type 1	LG	Lighting. Feature lighting poles Feature lighting to structure	 LG  LG  LG  LG  LG
	Type 2	FTR	Furniture High quality seats, wind screens bins and bike racks, bollards	 FTR  FTR  FTR
	Type 3	DN	Drainage Grated strip drains	 DN

BUILDING	Type	Code	Description	Reference Images
	Type 1	BLDG	Allow for 6m high single floor retail / commercial space with high quality glazed frontage to street edge. Steel structure and pre-cast concrete with alum window units to non street frontages. Allow for additional acoustic and movement requirements associated with building below road structure.	

ROAD STRUCTURE	Type	Code	Description	Reference Images
	Type 1	ST1	**Grounded transition** This would apply to zones of at least 0m- 3m convergence. The structure would be embedded in the ground and integrated within a formed landscape. It would incorporate a solid base with high quality retained/ formed edges to all sides extending from the ground up to balustrade/ barrier height.	 
	Type 2	ST2	**Grounded transition with formed openings in base** This would extend from type 1, likely based in a formed landscape with varying topography. It would be predominantly solid but incorporate large formed openings across the structure forming arcade type spaces under the structure.	  

ROAD STRUCTURE	Type	Code	Description	Reference Images
	Type 3	ST3	**Elevated structure with sculptured pedestals and undercrofts** This would traverse a range of spaces including roads, pedestrian zones and potentially low buildings. It would be either central or asymmetrical conventional span pedestal structures with highly formed or articulated sub structures and pedestal forms. The emphasis is on providing high amenity ‘undercrofts’	     
	Type 4	ST4	**Free spanning ‘flying’ structure** This would traverse open space and cross long axes or view points. The design would include long spanning lightweight elements with elegant form and fine edges. Although high quality undercrofts are critical the emphasis is on achieving fine profile s from longer approach elevational readings.	   

ROAD STRUCTURE	Type	Code	Description	Reference Images
	Type 5	ST5	**Embedded structures** This would include structures that are visually embedded or enveloped in buildings.	   
	Type 6	ST6	**Open topped 'cutting'** This would apply to zones of convergence of grade separation under ground. It would include high quality shaped/ textured edges integrated with the landscape.	 
	Type 7	ST7	**Tunnel**	  

APPENDIX C:
Preliminary Economic Assessment of Feasible Options

1. Introduction

The following outlines the methodology and results of preliminary economic benefit / cost assessment carried out on the six feasible options for improvements to the road network surrounding the Basin Reserve. This assessment is intended to be indicative and give guidance on the relative strengths / weaknesses of each option.

Purpose

Whilst the initial intention was to carry out economic assessment on only the preferred scheme using the detailed Wellington CBD S-Paramics model, a need was identified to give an indication as to the benefit / cost ratios for each option for use in decision making prior to the outputs from the S-Paramics model being available. Therefore this assessment has been carried out for all options using the Wellington City SATURN model, a more strategic model which has its greatest strength in assessing strategic route choice decisions. The Wellington City SATURN model was used in place of the S-Paramics model for this preliminary assessment due to time constraints and the ability to carry out multiple model runs in a short space of time.

This economic benefits assessment should be considered preliminary and is likely to that they under estimate the economic benefits is due largely to the fact that these benefits were calculated using the Saturn model.

Overview

This report combines a number of technical notes developed for each area of economic assessment, including an assessment of the differences between SATURN and S-Paramics. A summary of the report structure is as follows:

- Section 2 outlines the assumptions used in the calculation of economic benefits and the discounting methodology applied. These assumptions will be kept consistent when final economic assessment is carried out.
- Section 3 presents the benefits and costs associated with travel time and vehicle operating costs and calculates a base BCR.
- Sections 4, 5 and 6 describe the methodology and results of assessing walking / cycling, public transport and safety benefits respectively.
- Section 7 presents the additional benefits associated with carbon dioxide, public transport and safety benefits and calculates an overall BCR.
- Section 8 investigates the likely differences between using the Wellington City SATURN model and the Wellington CBD S-Paramics model. This was done due to the likely under-representation of benefits in SATURN due to its more strategic nature. Benefits were then adjusted by the identified difference factors to see how this may affect the benefit / cost ratios for each option.

Proposed Additional Assessment

This assessment has highlighted the limitations of SATURN to show the detailed vehicle interactions that significantly affect the operation of the Basin Reserve. Therefore to gain a more accurate understanding of the benefits associated with the proposed options, more detailed investigation is required. It is proposed that all 6 options are modelled in the Wellington CBD S-Paramics model with 2016 and 2026 traffic demand. This will allow better understanding of the economic benefits in addition to highlighting any limitations in the options.

Do-Minimum Scenario

The do-minimum scenario, on which these economic assessments are based, retains the existing arrangement at the Basin Reserve and also includes the following upgrades which have been completed and / or are planned:

- Signalisation of Rugby Street / Adelaide Road intersection
- Courtenay Place / Taranaki Street slip lane removed
- Chaytor Street / Birdwood Street intersection signalised
- Buckle Street between Taranaki Street and Tory Street widened
- Wellington Road / Hamilton Road intersection adjusted
- Wellington Road / Evans Bay Parade intersection adjusted
- Dufferin Street / Paterson Street signal timing adjusted
- Bus Lanes on Adelaide Road and Kent / Cambridge Terrace

2. Economic Assumptions

The following assumptions have been made to determine the BCR values for the Basin Reserve Improvements using the Wellington City SATURN model:

- All the option analysis assumes time zero as 1st July 2010 and base date as 1st July 2009.
- All costs and benefits are discounted back to 2010 dollar terms.
- The construction start and end dates for the grade separated Basin Reserve project Options A, B, E and F has been assumed as 1st Sep 2012 and 1st Sep 2015 respectively with a construction period of 3 years. The at-grade Options C and D assume a 2 year construction period with construction start and end dates as 1st Sep 2012 and 1st Sep 2014 respectively. Therefore it is assumed that any option will begin construction in September 2012.
- The construction cost estimates have been distributed on a straight line basis over the construction period and have been divided by the number of years of construction to determine the number of construction payments. The collective pre-construction costs such as property, I&R, D&PD have been distributed evenly and are assumed to occur at 1st July 2010, 1st July 2011 and 1st July 2012.
- *Table C.1* includes the expected cost estimate used in this analysis. For further details on estimates refer to *Appendix B*.
- Annual benefits such as travel time, vehicle operating costs, carbon dioxide costs have been determined using SATURN model outputs for the forecast years 2016 and 2026 (based on model years). These benefits have been either interpolated or extrapolated to calculate the benefits for intermediate years.
- Travel time benefits have been determined using total travel time hrs / hr inclusive of congestion delay for use with the CRV value based on EEM. The standard Urban Arterial mix has been assumed for this project.
- Vehicle operating costs were determined using both the vehicle kilometres travelled and the fuel consumption outputs (litres / hr).
- The 30 year analysis period is assumed to start from the start of construction.
- The transport costs / benefits values beyond 2026 have been capped to year 2026 values.
- An 8% discount factor has been assumed for the economic analysis.
- No maintenance costs have been included in the analysis.
- The latest EEM update factors (as at February 2010) have been included in the analysis.
- Generally the economics reflect a number of time periods to a representative day or an average week. These time periods are used to determine the annual transportation costs. Annualisation factors were calculated for this project based on traffic count data at Terrace Tunnel and Mount Victoria Tunnel. Weekend and off-peak periods are based on a factor determined using inter peak period. *Table C.2* provides a summary of annualisation factors used for weekday and weekend periods.
- There has been no assessment of changes in PT usage due to the relatively small route section of the project area and relatively free flow conditions of PT through this area. Discussions with GWRC concluded that this option in isolation will have little impact on changes in passenger numbers using PT.

Table C.1: Expected Construction Cost Estimates for Different Options

Option	Expected Estimate for economic analysis ($)	Discounted Expected Estimate for economic analysis ($M), (NPV)
A	75,000,000	59.10
B	88,000,000	70.59
C	52,000,000	43.53
D	37,000,000	30.49
E	100,000,000	79.10
F	115,000,000	89.47

Notes on Estimates:

- Estimates have been prepared as at September 2009 cost index.
- The estimates do not include escalation or GST.
- The estimates have not been subjected to an external peer review.

- Option F does not include construction of a tunnel under Memorial Park through to Taranaki Street (refer *Appendix B Section 5* for more details).
- These figures are for economic purposes only and do not reflect the current range / uncertainty that exists at this scheme assessment stage of the project.

Table C.2: Hourly time period and Annualisation Factors

Time Period	Representative hrs / day in a week	Annualisation factor
Weekday AM Peak	2	245
Weekday Inter Peak	7	245
Weekday PM Peak	2	245
Weekday Off-peak / Night (0.30*IP)	13	245
Weekend / Holiday Day Time (1.13*IP)	8	120
Weekend / Holiday Night (0.36*IP)	15	120

3. Base Travel Time / VOC Economics Results

Assumptions

The Do-minimum for the project has been reviewed to ensure an accurate representation of the network without the scheme.

There is a proposed design presented in the main body of the Options Report to make the Vivian Street / Kent Terrace intersection more efficient. The benefits of this improvement have been quantified at a high level using a Sidra model. The benefits from this proposed change are reflected in the benefits presented below.

Travel Time / VOC Benefits

The travel time / VOC benefits for the options are shown in *Table C.3* below.

Table C.3: Summary of travel time / VOC benefits for each Option (NPV)

Option	Travel Time Benefits ($M)	Congestion Relief Benefits ($M)	Vehicle Operating Cost Benefits ($M)	Total Travel Time / VOC Benefits ($M)
A	39.11	5.04	9.60	53.75
B	39.11	5.04	9.60	53.72
C	29.77	2.48	10.58	42.83
D	25.18	0.03	7.93	33.14
E	37.06	4.12	12.56	53.74
F	36.10	4.63	13.03	53.76

Travel Time / VOC Benefits, Costs and the Base BCR

The total benefits, costs and the BCR for the options are shown in *Table C.4* below.

Table C.4: Total Benefits, Costs and BCR for each Option

Option	Total Benefits, NPV ($M)	Discounted Cost ($M)	Base BCR (based on Travel Time / VOC only)
A	53.75	59.10	0.9
B	53.72	70.59	0.8
C	42.83	43.53	1.0
D	33.14	30.49	1.1
E	53.74	79.10	0.7
F	53.76	89.47	0.6

Impact of RoNS

Preliminary assessment has shown an increase in the Base BCR associated with the implementation of all of the Wellington RoNS projects. The results of this preliminary assessment have not been presented here as they were undertaken using different assessment criteria to that used above. When economics are undertaken for the preferred option, the impact of the RoNS will be reassessed in more detail.

4. Public Transport Assessment

One significant benefit stream absent from discussion in this report is improvements to public transport operation. Due to the use of SATURN in this initial assessment, it has not been possible to assess the public transport benefits as SATURN does not model bus network operation in enough detail.

Despite this, an approximation of public transport benefits (refer *Table C.5*) has been used in *Section 7 of this Appendix* to quantify a range of overall benefits.

These figures have been calculated using the 2009 Wellington CBD S-Paramics models. Differences between the 'Do-Minimum' model and the option models were examined and growth to 2026 predicted to calculate these indicative results. As this assessment has been done with 2009 models and no future year models were used to predict the journey time savings, it is difficult to determine the accuracy of these results.

From this basic assessment, the 30 year benefits associated with bus travel time savings will be around $1M in the grade separated options. This does not include public transport reliability improvement which at most will double the bus travel time benefits. The public transport benefits associated with at-grade options (C and D) are significantly less due to the delay imposed at signalised intersections.

The economic evaluation manual states that public transport reliability benefits can be at maximum no more than the public transport travel time savings benefits. Therefore, assuming this reliability improvement is achieved in all options, the public transport benefits would be twice what have been shown.

When the options are assessed in S-Paramics using predicted future year traffic demand it will be possible to assess the public transport benefits more accurately.

Table C.5: Bus Travel Time Benefits (NPV)

Option	Bus Travel Time Benefits ($M)
A	0.95
B	0.767
C	0.53
D	0.09
E	0.95
F	0.95

5. Pedestrian / Cyclist Benefits

The following section outlines the methodology and results of a desktop study into the economic benefit associated with pedestrians and cyclists.

Process to calculate delay cost for each option

Firstly the data from the pedestrian count using video cameras was analysed. The major pedestrian and cyclist desire lines were identified by analysing the behaviour of pedestrians. The major desire line was found to be through the Basin Reserve between Kent and Cambridge Terrace and Adelaide Road. The second desire line was east-west between Patterson Street and Kent Terrace.

The crossing data from the count was then analysed to find the key crossing points where a large number of pedestrians were experiencing delay. Using the desire lines the key crossings were identified for each option.

Next the pedestrian demand for each crossing was calculated from the counts and summed into three periods:

- AM peak 07:00 - 09:00;
- Interpeak 09:00 - 16:00; and
- PM peak 16:00-18:00.

Demand at the crossings for the options was determined from existing (do-minimum) desire lines and it was assumed that the same pedestrian demand would exist for each desire line in each of the options. To calculate the delay to pedestrians the signal times at intersections were used from the SATURN models. This is why the pedestrian demand was broken into three periods so it would match the three model periods developed for each option. To find the signal delay the worst case was assumed, i.e. it was assumed that pedestrians arrive at the crossing just as the pedestrian green time has finished and therefore the delay to pedestrians is the wait time until the green time for motorists finishes and the next crossing opportunity is available.

To calculate the delay cost it was necessary to assume a distribution of pedestrian arrivals to each crossing during the signal sequence. It was assumed that pedestrian arrival is spread linearly throughout the delay cycle so that the average pedestrian delay is half of the signal delay time. This average pedestrian delay was then multiplied by the number of pedestrians wanting to cross during the period and the value of pedestrian delay for that period. It was assumed that in the AM and PM peak pedestrians were travelling to / from work and the value of delay was $6.60 / hr and in the IP pedestrians were travelling for non work purposes and delay was $4.25 / hr. These delay values were taken from Table A4.1 in the EEM.

Additional to the cost of delay at intersections it was identified that the options would have an effect on the travel distance for the east-west desire line. This effect was also taken into consideration for pedestrians. The sum of all crossing delays and the extra travel distance were summed to give the daily delay cost of each option.

Assumptions and Notes

The following assumptions were made in the analysis:

- All pedestrians and cyclists cross at the signalised crossing given the heavy traffic flows that discourages them from crossing away from intersections. This was checked using tables from the *Guidelines to the Selection of Pedestrian Facilities from NZTA*. It was found that pedestrian delay away from crossings was more than double that at intersections with the current traffic flows. This was taken to mean pedestrians would choose to cross at the signals.
- The desire lines remain constant over the whole period of analysis
- No safety benefits for cyclists and pedestrians have been captured as part of this analysis as it is assumed that these benefits will be captured as part of the overall safety benefits for the project.
- Potential benefits from improvement in pedestrian safety were not considered in this analysis.
- No future increases in pedestrian numbers have been considered for this assessment; however it is acknowledged that the Adelaide Road area is identified as a major growth node which will encourage increased pedestrian activity in the area.
- Increases in school rolls were not considered
- The effects of changes in traffic flow to the pedestrian demand were not considered.
- Assumptions were also made specifically for each option but have not been listed here.

Summary of findings

Table C.6 gives the annual delay costs for each option and the discounted benefit relative to the do minimum option.

The results show that the pedestrians and cyclists will be worse off under all of the options. This is more due to modelling tools than what will happen in practice and therefore these numbers cannot be relied upon. The Pedestrian delay at intersections is based on outputs from the SATURN model. Because the SATURN model has optimised the intersection performance for vehicles it will tend to decrease the delays for pedestrians. It is likely that during the final design of the scheme, the signals will be optimised to balance the needs of pedestrians and vehicles. This will increase the benefits for pedestrians and cyclists but at the expense and dis-benefit of vehicles.

Detailed simulation modeling will be undertaken in S-Paramics for the preferred option to ensure the benefits to pedestrians and cyclists are accurately replicated and maximised.

Table C.6: Summary of annual delay costs for each option

Option	Pedestrian Crossing ($)	Cyclist Crossing ($)	Extra Distance Delay Cost ($)	Total ($)	Relative Delay Benefit to Do Min ($)	Discounted Pedestrian / Cycle Benefits ($) (NPV)
Do Min	46,528	10,383	-	56,911	-	-
Option A	63,791	14,845	2,361	80,996	-24,085	-184,029
Option B	63,791	14,845	-3,710	74,926	-18,015	-137,647
Option C	56,911	13,723	-4,868	65,765	-8,854	-73,840
Option D	53,465	13,066	20,572	87,102	-30,191	-251,779
Option E	82,602	20,430	11,466	114,499	-57,587	-440,010
Option F	73,565	15,509	674	89,749	-32,838	-250,904

These 'benefits' have not been included in the economic assessment that follows because the values are insignificant when compared to the other costs and benefits involved.

6. Safety Benefits

The following section outlines the methodology applied in developing a crash analysis model for the Basin Reserve Improvements Project, the application of the model and results.

Overview

Crash costs associated with the Basin Reserve have been calculated for the do-minimum and proposed Options A, C and D under 2016 and 2026 scenarios as part of a crash model. As any improvement to the Basin Reserve will have a major influence on traffic patterns around central Wellington, the crash model has a wide scope as can be seen in *Figure C.1* below. The model considers key intersections and midblock locations where changes to traffic volumes are likely. This approach can be considered conservative as it takes account of sections on the network that will either improve or alternatively worsen as a result of traffic re-assignment caused by an option.

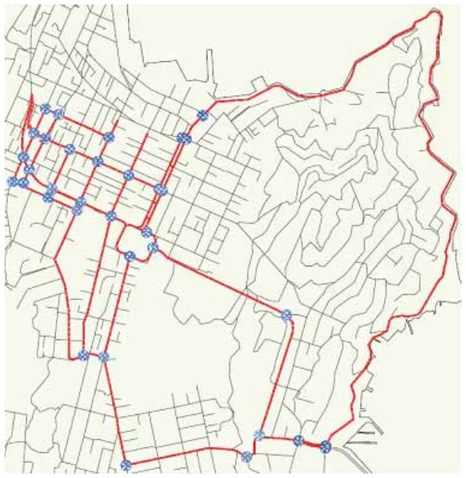


Figure C.1: Crash Model Extents

The crash model has assessed the network using the methods described by Section A6 of the Economics Evaluation Manual (EEM) Volume 1. Slight variations have been made to the standard methodologies due to the scope of the area considered and because the majority of the network will see no fundamental change in the options other than from the changes to the traffic volumes.

As the EEM methods require Average Annual Daily Traffic (AADT) volumes, the Wellington City Council (WCC) SATURN model has been used to assess the different scenarios. The SATURN model assesses the network across the AM, IP and PM peak periods.

Annualisation factors have been used to determine a 24 hour AADT value for the network sections considered by assuming a:

- 2 hour AM peak;
- 7 hour IP peak;
- 2 hour PM peak; and
- 0.30 x IP for off-peak hours (which include weekends).

Do-Minimum

The do-minimum crash costs have been determined using "Method A: Accident by Accident Analysis" as described in the EEM. This method relies on the existing crash history in the area highlighted in *Figure C.1*. The crash data has been extracted from the NZTA Crash Analysis System (CAS) for the period 1st April 2007 to 1st April 2009. This two year period reflects the time period following the opening of the Wellington Inner City Bypass (WICB). A 35m radius was used surrounding each intersection. Any intersection not considered as being of critical importance has been assumed to be part of a midblock section. Such examples include the Tasman Street / Rugby Street give way intersection. In addition the following assumptions have been required:

- Each midblock and intersection is assessed assuming "All Vehicle" types.
- Each midblock and intersection is assessed assuming "All movements".
- 2% annual growth (which is higher than the modelled traffic growth for the weekday peak periods of between 0.9 and 1.1%pa).

Options

To calculate the option costs a mixture of "Method A: Accident by Accident Analysis" and "Method B: Accident Rate Analysis" has been used. For the majority of the network being considered there is no fundamental change between the do-minimum and option as only traffic volumes will see variation. For these network sections the option crash cost was calculated using a $ / vehicle / km value determined from the do-minimum crash costs. In each option the $ / vehicle / km value was then multiplied by the new traffic volumes to generate the option cost.

The new road sections introduced as part of the options were assessed using "Method B: Accident Rate Analysis". Such new road elements include the proposed Basin grade separated link in Option A. The following accident prediction models have been used as part of this method:

- (3) Urban signalised cross-roads Conflict Model.
- (5) General urban mid-blocks 50-70 km / h.

Note that in the option analysis, crash costs for the bus lanes were not included. There is no available accident prediction model for such a facility in an urban environment. However in the final economics, the preferred option will be further assessed using the S-Paramics model.

Initial Results

Based on the above assumptions the following crash costs and subsequent annual benefits have been derived for each option as can be seen in *Table C.7* below.

Table C.7: Initial Predicted Crash Costs Per Annum

Scenario	2016 Crash Costs	2016 Crash Benefits relative to the Do-min	2026 Crash Costs	2026 Crash Benefits relative to the Do-min	Discounted Crash Benefits (NPV) ($M)
Do-min	$22,170,811	-	$23,839,396	-	-
Option A	$21,495,406	$675,405	$23,188,086	$651,310	7.83
Option C	$21,328,056	$842,754	$22,996,574	$842,823	8.88
Option D	$21,408,540	$762,271	$22,995,382	$844,015	9.60

The crash analysis for Options B, E and F has not been undertaken and is assumed to be similar to Option A.

As can be seen the benefits for the grade separated option (Option A) are lower than those for the at-grade options (Option C & D). Intuitively in *Table C.7* this is difficult to understand, particularly when the at-grade options introduce intersections into the network. However, after inspection of the SATURN outputs and from review of the crash model the following notes should be taken into consideration as possible explanations for this phenomenon:

The grade separated option brings significantly greater traffic volumes onto SH1 as opposed to other local roads.

"Method B" has under predicted the crash costs compared to what is happening now.

7. Overall Economics Results

Summary of Other Benefits

The assessments shown in *Section 3 of this Appendix* only take into account travel time benefits, congestion relief benefits and vehicle operating cost benefits. Initial assessment has also been completed on walking / cycling, safety and public transport benefits.

Due to the limited assessment done on walking and cycling it has been agreed that these benefits are excluded at this stage as the assessment has utilised SATURN modelling results which fail to provide the ability to maximise pedestrian and cyclist benefits.

The other benefits for the options are shown in *Table C.8* below.

Table C.8: Other Benefits Summary Table (NPV)

Option	Crash Benefits ($M)	Bus Travel Time Benefits ($M)	Carbon Dioxide Benefits ($M)	Other Benefits Total ($M)
A	7.83	0.95	0.38	9.16
B	7.83	0.767	0.38	8.977
C	8.88	0.53	0.42	9.83
D	9.60	0.09	0.32	10.01
E	7.83	0.95	0.50	9.28
F	7.83	0.95	0.52	9.3

Total Benefits

The total benefits for the options are shown in *Table C.9* below.

Table C.9: Total benefits for each option

Option	Total Travel Time / VOC Benefits ($M)	Other Benefits Total ($M)	Overall Project Benefits ($M)
A	53.75	9.16	62.91
B	53.72	8.977	62.697
C	42.83	9.83	52.66
D	33.14	10.01	43.15
E	53.74	9.28	63.02
F	53.76	9.3	63.06

Benefits, Costs and the Overall BCR

The total benefits, costs and the BCR for the options are shown in *Table C.10* below.

Table C.10: Total Benefits, Costs and BCR for each Option

Option	Total Benefits, NPV ($M)	Discounted Cost ($M)	Overall BCR
A	62.91	59.10	1.1
B	62.697	70.59	0.9
C	52.66	43.53	1.2
D	43.15	30.49	1.4
E	63.02	79.10	0.8
F	63.06	89.47	0.7

8. SATURN vs. s-Paramics

As final economic assessments will be carried out using the Wellington CBD S-Paramics model, an attempt to quantify the approximate difference between SATURN and S-Paramics has been undertaken.

This assessment used options A and C, coded with traffic in both S-Paramics and SATURN. Comparison of the S-Paramics and SATURN output was done only on equivalent statistics which each respective software package calculates in a same way.

Average Network Speed

The average network speed calculates an aggregate average speed for all vehicles on the network over the peak period. Whilst this is one of the only overall network statistics that is comparable between SATURN and S-Paramics, it is important to realise the fundamental differences between these two packages. SATURN models vehicle movements on an aggregate basis using speed / flow curves, whilst S-Paramics models every vehicle individually, taking an average achieved speed for each vehicle.

Comparison has shown that SATURN is under-representing the difference in average network speeds by between 0% and 4%.

Travel times

Four major routes have been assessed in SATURN and S-Paramics:

- SH1 Westbound from Evans Bay Parade to Willis Street;
- SH1 Eastbound from Willis Street to Evans Bay Parade;
- Basin Reserve Northbound; and
- Basin Reserve Southbound

By comparing the difference in travel time savings associated with Option A for each route, we can approximate how much the savings are being under / over represented. This methodology only assesses specific routes through the network, not the travel time associated with all vehicles.

The results of this analysis have shown that the SATURN is under-representing travel time savings by between 4% and 26%.

Delay

Whilst the comparison of delay would be useful, the different methods by which SATURN and S-Paramics define delay makes this comparison difficult.

Therefore, no delay comparison has been done.

Impact on Economic Benefit

A rough assessment of the differences in economic benefit associated with the identified under representation in SATURN has been carried out by testing the revised BCR value (that includes updated do-minimum and the Kent Terrace / Vivian Street intersection upgrade). Three components of benefits have been used in the economic assessment:

- Travel Time Savings;
- Congestion Relief Savings; and
- Vehicle Operating Cost Savings.

The model outputs affecting each of the three benefit components are;

- Travel Time Savings;
- Network Travel Time;
- Congestion Relief Savings;
- Network Delay;
- Vehicle Operating Cost Savings;
- Travel Distance;
- Average Speeds;
- Fuel Consumption; and
- Emissions.

The comparisons done have shown the disparity between SATURN and S-Paramics with relation to:

- Travel time on specific routes, which can be assumed to be representative of overall network travel time; and
- Average network speeds, which is directly related to vehicle operating costs and also delay.

Therefore, increasing the benefits associated with travel time, congestion relief and vehicle operating costs by the percentage of under-representation gives an approximation of what the benefits may be when the options are assessed in S-Paramics.

The increases applied have been done using a lower and upper estimate, as per *Table C.11*.

Table C.11: Upper and Lower Estimate of Increases

	Lower	Upper
Travel Time	4%	26%
Congestion Relief	0%	4%
Vehicle Operating Costs	0%	4%

This assessment has been done primarily using Option A, a grade-separated option. It may be the case with at-grade options that SATURN is over-representing the benefits due to an under-representation of delay associated with signalised intersections. Therefore, benefits may decrease in the S-Paramics assessment, not increase as shown in this sensitivity test.

It is our opinion that due to the detailed network representation and vehicle behaviour modelled in S-Paramics, it is the results from this modelling that will provide an accurate description of the benefit associated with the proposed options. Whilst SATURN provides an appropriate tool for the assessment of schemes such as strategic routes, complex vehicle interactions such as those at the Basin Reserve are much better suited to assessment in S-Paramics.

Due to the more strategic nature of the SATURN model, the results given showing the improvement to network operation as a result of the Basin Reserve upgrade are very much indicative and even sensitivity tests on these results may not be accurate.

Following the initial economic assessment it is expected that the benefit cost ratio for each option will fall within the following ranges;

Table C.12: Range of BCR's

Option	Lower Bound BCR	Base BCR	Upper Bound BCR
A	1.1	1.1	1.2
B	0.9	0.9	1.0
C	1.2	1.2	1.4
D	1.4	1.4	1.6
E	0.8	0.8	0.9
F	0.7	0.7	0.8

The results shown in *Table C.12* have been rounded to one decimal place, as is usual when reporting BCR's, all lower bound estimates with the exception of options B, E and F are above 1.0. With the upper bound estimates, option B also reaches above 1.0.

APPENDIX D:
Option Evaluation Methodology

Attachment 1: List of matters that could be considered in option evaluation

Project objectives:

1. Increase the efficiency of through-traffic between the Mount Victoria Tunnel and the Inner City Bypass and SH1 motorway.
2. Improve the efficiency, reliability and level of service of passenger transport services between Kent and Cambridge Terraces and Adelaide Road.
3. Improve safety for those who use the streets around the Basin Reserve.
4. Maintain or enhance the present level of service for local traffic between Kent and Cambridge Terraces and Adelaide Road and their connections to SH1.
5. Improve pedestrian and cycling access to and around the Basin Reserve, particularly addressing the need for pedestrians to cross significant traffic flows.

In developing options that meet these objectives, the project team must have due regard to:

1. Creating options that are economically efficient.
2. Ensuring the improvements around the Basin Reserve achieve a good strategic fit with the Government's RoNS.
3. Considering the Basin Reserve and the surrounding area which contain defining features such as the Basin Reserve itself, Government House, the planned NZ Memorial Park and the National War Memorial, education facilities and churches, buildings and spaces of high heritage character and value that create a unique sense of place.
4. Retaining the multi-functional nature of the area, including its social and community focus, and its role as a centre for recreational use, as well as the immediate roading network.
5. Recognising that the streets around the Basin Reserve hold a pivotal position in the state highway network (both within and beyond Wellington City), Wellington's urban growth and Wellington's arterial transport network.
6. Maintaining the urban design quality of the area.
7. Recognising the relationship to other projects including the Mount Victoria Tunnel refurbishment, the development of Adelaide Road and Buckle Street.

LTMZ / NZTS

- Assisting economic development.
  - Promotes accessibility to employment opportunities.
  - Promotes accessibility to, between and within key economic and knowledge centres.
  - Promotes general accessibility.
  - Promotes transport network resilience.
  - Promotes freight accessibility.
- Assisting safety and personal security.
  - Reducing accidents, injuries and deaths. Improving actual and perceived levels of security.
  - Promoting safety and personal security for vulnerable users (e.g. cyclist and pedestrian safety).
- Improving access and mobility.
  - Promotes connectivity.
  - Promotes availability of travel choices to key destinations.
  - Promotes general accessibility.
  - Promotes accessibility for those without access to a car.
  - Promotes public transport.
  - Promotes accessibility for people with disabilities.
- Protecting and promoting public health.
  - Promotes trips by active modes, walking, cycling.
  - Ability to manage emissions to air and water.
  - Ability to manage noise and vibration.
- Ensuring environmental sustainability.
  - Ability to manage emissions to air, water and land.
  - Ability to optimise the use of non-renewable resources.
  - Impact on heritage, cultural, visual, landscape and ecological sites.
  - Ability to manage energy efficiency and greenhouse gas emissions.
  - Ability to manage or reduce community severance.
- Supporting the growth strategy.
  - Promote relative accessibility to, within and between key Regional Growth Strategy growth centres.
  - Promote community coherence.
  - Ability to reinforce RGS urban form and growth patterns.
- Improving energy efficiency and reducing greenhouse gas emissions.
  - Ability to manage energy efficiency and greenhouse gas emissions.

Government Policy Statement

- Investing in the State Highway network, as a key to the efficient movement of freight and people.
- Generating better value for money from the Government's investment across all land transport activity classes and enhancing the economic efficiency of individual projects.

Resource Management Act

- Section 5: RMA Purpose:
  - Promote the sustainable management of New Zealand's resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while avoiding, remedying or mitigating adverse effects on the environment.
- Section 6: Matters of National Importance (shall recognise and provide for):
  - Preservation of the natural character of the coastal environment including CMA, wetlands, lakes and rivers and margins from inappropriate use and development.
  - Protection of outstanding natural features and landscapes from inappropriate use and development.
  - Protection of significant indigenous vegetation and significant habitats of indigenous fauna.
  - Maintenance and enhancement of public access to and along CMA, lakes and rivers.
  - Relationship of Maori and their culture and traditions with ancestral lands, water, sites, waahi tapu and other taonga.
  - Protection of historic heritage from inappropriate use and development.
  - Protection of recognised customary activities.
- Section 7: Other Matters (shall have particular regard to):
  - Kaitiakitanga / Stewardship.
  - Protection of significant indigenous vegetation and significant habitats of indigenous fauna.
  - Maintenance and enhancement of public access to and along CMA, lakes and rivers.
  - Relationship of Maori and their culture and traditions with ancestral lands, water, sites, waahi tapu and other taonga.
  - Protection of historic heritage from inappropriate use and development.
  - Protection of recognised customary activities.
  - Efficient use and development of natural and physical resources.
  - Efficiency of the end use of energy.
  - Maintenance and enhancement of amenity values.
  - Intrinsic values of ecosystems.
  - Maintenance and enhancement of the quality of the environment.
  - Finite characteristics of natural and physical resources.
- Effects of climate change
  - Benefits to be derived from the use and development of renewable energy.
- Section 8 Treaty of Waitangi
  - Take into account the Treaty of Waitangi.

Attachment 2: Evaluation criteria check list

Matters to be considered		Evaluation Criteria					Consultation
		Tangible	Intangible				
		Benefit Cost Ratio	Social and community	Urban form	Archaeology (including Building Heritage)	Environmental (Noise, Air quality, Ecology)	
PROJECT OBJECTIVES							
1	Increase the efficiency of through traffic between the Inner City Bypass and Mount Victoria Tunnel.	✓					
2	Improve the efficiency and reliability of passenger services between Kent / Cambridge Terrace and Adelaide Road.	✓					
3	Improve safety for those using the roading network within the vicinity of the Basin Reserve.	✓					
4	Maintain present level of service of local traffic between Adelaide Road and Kent and Cambridge terrace, and their connections to SH1.	✓					
5	Improve pedestrian access to and around the Basin Reserve and environs, particularly addressing the need for pedestrians to cross significant traffics flows.	✓					
PROJECT SPECIFIC THINGS THAT THE TEAM NEEDS TO HAVE DUE REGARD TO							
1	The Basin Reserve and surrounding environs which contain defining features such as the Basin Reserve itself, Government House, the proposed Memorial Park and the National War Memorial; a density of education facilities and churches; and buildings and spaces of high heritage character and value that create a unique sense of place.		✓	✓	✓	✓	
2	Retaining the multi-functional nature of the area including its role as a social and community foci, a centre for recreational use, and the immediate roading network.		✓	✓			
3	Recognising that the Basin Reserve occupies a pivotal position in the State Highway network (both within and beyond Wellington City), and on the urban growth spine.			✓			
4	Maintaining and enhancing the urban design quality of the area, through 'urban repair', connecting people and spaces, and building on the unique sense of place that exists.			✓			
LTMZ / NZTS							
1	Assisting economic development	✓					
2	Assisting safety and personal security	✓					
3	Improving access and mobility	✓					
4	Protecting and promoting public health	✓	✓				
5	Ensuring environmental sustainability			✓		✓	
6	Supporting the growth strategy	✓					
7	Improving energy efficiency and reducing greenhouse gas emissions	✓				✓	

	Matters to be considered	Evaluation Criteria					Consultation
		Tangible	Intangible				
		Benefit Cost Ratio	Social and community	Urban form	Archaeology (including Building Heritage)	Environmental (Noise, Air quality, Ecology)	
GOVERNMENT POLICY STATEMENT							
1	Investing in the State Highway network, as a key to the efficient movement of freight and people	✓					
2	Generating better value for money from the Government's investment across all land transport activity classes and enhancing the economic efficiency of individual projects	✓					
RMA MATTERS OF NATIONAL IMPORTANCE (SECTION 6)							
1	Promote the sustainable management of New Zealand's resources.		✓	✓	✓	✓	
2	Preservation of the natural character of the coastal environment			N / A			
3	Protection of outstanding natural features and landscapes			N / A			
4	Protection of significant indigenous vegetation and significant habitats of indigenous fauna					✓	
5	Maintenance and enhancement of public access to and along CMA, lakes and rivers			N / A			
6	Relationship of Maori and their culture and traditions with ancestral lands, water, sites, waahi tapu and other taonga		✓				✓
7	Protection of historic heritage				✓		
8	Protection of recognised customary activities		✓		✓		✓
RMA OTHER MATTERS (SECTION 7)							
1	Kaitiakitanga / Stewardship						✓
2	Protection of recognised customary activities		✓		✓		✓
3	Efficient use and development of natural and physical resources	✓	✓	✓	✓		
4	Efficiency of the end use of energy	✓					
5	Maintenance and enhancement of amenity values		✓	✓	✓		
6	Intrinsic values of ecosystems					✓	
7	Maintenance and enhancement of the quality of the environment		✓	✓	✓	✓	
8	Finite characteristics of natural and physical resources			✓	✓	✓	
9	Effects of climate change	✓					
10	Benefits to be derived from the use and development of renewable energy			N / A			
C. SECTION 8 TREATY OF WAITANGI							
1	Take into account the Treaty of Waitangi		✓	✓	✓	✓	✓

Want to find out more?

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