Appendix C4 Queenstown Town Centre Preliminary Design Philosophy Statement

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QUEENSTOWN TOWN CENTRE DETAILED BUSINESS CASE

PRELIMINARY DESIGN PHILOSOPHY STATEMENT

PREPARED FOR THE WAKA KOTAHI NZ TRANSPORT AGENCY

September 2020

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QUALITY STATEMENT

PROJECT MANAGER

s 9(2)(a)

PROJECT TECHNICAL LEAD

s 9(2)(a)

PREPARED BY

Various Authors

CHECKED BY

s 9(2)(a)

REVIEWED BY

s 9(2)(a)

APPROVED FOR ISSUE BY

s 9(2)(a)

QUEENSTOWN
134a Gorge Road, Queenstown 9300
TEL +64 3 366 7449

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ABBREVIATIONS

Abley	Abley Consultants
ARC	Auckland Regional Council
ARI	Average Recurrence Interval
AS/NZS	Joint Australian and New Zealand Standards
Aurora	Aurora Energy Limited
CBR	California Bearing Ratio
CPAA	Concrete Pipe Association of Australasia
DBC	Detailed Business Case
DEM	Digital Elevation Model
DPS / PDPS	This Preliminary Design Philosophy Statement
FOS	Factor of Safety
GIS	Geographic Information Systems
HIRDS	High Intensity Rainfall Design System
HW	Headwater
IBC	Indicative Business Case
LHS	Left Hand Side
LiDAR	Light Detection and Ranging
LOS	Level of Service
MASH	Manual for Assessing Safety Hardware
MOTSAM	Manual of traffic signs and markings
NIWA	National Institute of Water & Atmospheric Research
NZBC	New Zealand Building Code
NZS	New Zealand Standard
ONCR	One Network Road Classification
ORC	Otago Regional Council
QLDC	Queenstown Lakes District Council
RHS	Right Hand Side
RSA	Road Safety Audit
SBC	Strategic Business Case

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SSD	Stopping Sight Distance
Waka Kotahi	Waka Kotahi NZ Transport Agency
TL	Test Level
TW	Tailwater
US SCS	United States Soil Conservation Service
VPD	Vehicles per Day

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Waka Kotahi NZ Transport Agency

Queenstown Town Centre Detailed Business Case

Preliminary Design Philosophy Statement

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1. Introduction

1.1 Background

In 2018 Waka Kotahi NZ Transport Agency contracted Stantec, WSP (at the time WSP-OPUS), Abley, and Jasmax to prepare the Queenstown Town Centre Detailed Business Case (DBC) and the Frankton to Queenstown Single Stage Business Case (SSBC).

This document has been prepared to record the concept design philosophy for the road/street links included in the Queenstown Town Centre DBC. A separate document has been prepared for the Frankton to Queenstown SSBC (provided separately). Both business cases build on previous works related to the improvements of the road network within Queenstown and Frankton.

The project scope is shown in Figure 1-1 and Figure 1-2.

1.2 Purpose

The purpose of this design philosophy statement is to provide technical information to support the Queenstown Town Centre DBC. This document provides more detail than would normally be found in a DPS, as the designs presented are important in setting a context for the Town Centre.

1.3 Project Areas

Two distinctive areas have been identified within the Queenstown Town Centre; the Town Centre area and the Town Centre alternative route (hereafter referred to as "Arterials").

The Town Centre area is shown on Figure 1-1. It includes 28 streets.

The design approach embraces the Historic Core, defined as a block between Stanley Street, Shotover Street, Botanic Gardens, and the Lake. This part of Queenstown has a relatively flat topography allowing the designs to facilitate walking, cycling, and mobility devices.

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Figure 1-1: Scope Area: Town Centre

The Arterials are defined in the *Queenstown Masterplan – the Queenstown Arterials* and they provide a Link between One Mile Roundabout and Frankton Road following a route along Thompson Street, Man Street, Henry Street, and Melbourne Street, as shown on Figure 1-2.

As part of the DBC, a length from Dublin Street to Hay Street was looked at in detail. The link from Hay Street to Glasgow Street is being designed as part of the Lake View Development, and the link from Thompson Street to the relocated One Mile Roundabout has been retained as per the Masterplan design.

The approach used for the Arterials varies from that of the Town Centre. The design of the streets forming Arterials presented in the QTC Masterplan was used as the starting point and successive changes were made to better align the proposed design with the DBC objectives, improve safety and permeability. The function of this route is to provide a higher level of connectivity and to accommodate through-town movements. This does not mean that the design is vehicle focused; the carriageways have been narrowed, on-street parking removed, and footpaths widened where practicable. These changes enhance the pedestrian environment, while retaining relatively unconstrained vehicle movement. Retaining structures are required along this route to support both the road and the existing properties.

The three new links (Melbourne-Henry, new Memorial Street link, and the link between Thompson St and Fernhill Road) will require significant engineering works.

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Figure 1-2: Scope Area: Arterials

The *Queenstown Masterplan* included the street treatment, hierarchy, indicative cross-sections, and defined the extent of the 3 stages of the Arterials. The DBC has redefined the lengths of Arterials Stage 2 and Stage 3. The Masterplan identified Stage 2 as from the intersection of Henry/Gorge Road through Memorial Street to the Man Street / Camp Street intersection (regardless of the intersection form). Stage 3 was identified as Man Street / Camp Street intersection to One Mile Roundabout. The DBC approach has instead considered the construction staging of the Arterials and adjacent projects (Lake View) – refer to Figure 1-2 and Table 1-1 for details of the redefined extents of the three stages.

For the DBC the Stage 3 Arterial has been adopted as developed under the Masterplan. To ensure linkage is provided to the layouts proposed by others (Brecon Street – Streetscape Design, Lake View Design) upgrades to Man Street were added. Furthermore, some additional design work has been included to ensure the One Mile to Thompson Street link provides a continuous design.

Table 1-1: Arterial Stages

Arterial Stage	Stage Extent
Stage 1	Frankton Road (including the intersection) To Gorge Road (including ½ double-T intersection)
Stage 2	Gorge Road (including ½ double-T intersection) To Hay Street (including modifications to the signs and markings at the intersection)
Stage 3	Hay Street To Glenorchy Road (including One Mile Roundabout) Stage 3 is further split:
	Hay Street to Glasgow Street – designed by Beca as part of Lake View
	Thompson Street Link (Roundabout to Glasgow Street) – designed by Beca as part of the Masterplan

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2. Design Principles - Queenstown Town Centre

2.1 Design Process

The design process has consisted of workshops, meetings, and charettes. The street cross sections were developed from the Movement and Place framework which developed a user hierarchy for each street.

A function of each street was established, the balance between transport modes was discussed at a street and a network level to ensure both connectivity and ease of movement within the Town Centre. The design then followed the following process:

Topology -> cross section -> customization -> layout -> review -> change (loop) -> final design

2.2 Design Standards and Guidelines

The primary Standards used are listed below:

- Queenstown Town Centre Public Realm Design Guidelines (QLDC)
- NZTA Pedestrian Planning and Design Guide (PPDG)
- NZTA Cycle Network Planning (CNG) Guide
- Austroads Guide to Road Design (AGRD) Parts 1 to 8
- Austroads Guide to Traffic Management (AGTM) Part 6: Intersections, Interchanges and Crossings
- NZTA Manual of Traffic Signs and Markings (MOTSAM) Part I: Traffic Signs
- NZTA Manual of Traffic Signs and Markings (MOTSAM) Part II: Markings
- Land Transport NZ – RTS 18 NZ on-road tracking curves for heavy motor vehicles.
- Road Design Specifications for over dimension loads (Heavy haulage Association) (https://www.hha.org.nz/about/for-engineers/)

Local design Standards and references to be considered:

1) Queenstown Lakes District Council – Land Development and Subdivision Code of Practice
2) Queenstown Lakes District Council – District Plan: Section 14 Transport Rules
3) Queenstown Lakes District Council – District Plan: Appendix 7; Traffic Design Standards A7
4) Queenstown Lakes District Council – Proposed District Plan.

2.3 Design Objectives

As the population of Queenstown and Frankton increases, more stress is put on the road network. While the roads and streets wind around the hilly terrain and create an attractive fit for the environment, the vehicle demand is nearing capacity. The Business Case aims to improve the capacity of the wider network by targeting a shift in demand to public transport. Achieving this will facilitate the delivery of a functioning traffic network.

The Public Realm Design Guidelines dictate numerous parameters and set criteria for the Town Centre, the Historic Core, and the Lakefront. The proposed designs build on these considerations, but also attempt to implement the holistically re-structured road network.

The DBC investment objectives are:

1) Provide more efficient and reliable access for people and goods that:
   - Sustainably manages high growth
   - Reduces reliance on private vehicle travel
   - Enables enhanced land use
2) Is adaptable to change and disruption
3) Enhances the liveability and quality of the natural and built environment
4) Enhances safety with a goal of Vision Zero

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By promoting public transport and high capacity vehicles the reliance on private vehicles within Queenstown area will be gradually reduced. Lowering the speeds in the Town Centre and pedestrianizing the Historic Core should increase the demand for alternative modes of transport: walking, small mobility, cycling. The quality-of-life objectives are proposed to be met by upgrading connectivity, improving amenities, providing convenient facilities (bike parking), services (toilets and changing rooms), and allowing for a street design that can morph and adopt to cater for various events and activities

2.4 Road Environment

2.4.1 Speed, and traffic management

- The Town Centre will have a posted speed and design speed of 40 km/h, with the Historic Core having expected operating speeds under 30 km/h.
- The Arterials should have a posted speed of 40 km/h and design speed of 50 km/h.
- To enable wider footpaths on-street parking needs to be minimised to levels consistent with the QLDC Parking Strategy and acceptable to residents within the Town Centre.
- As proposed in the Queenstown Parking Strategy 2019; approximately half of the on-street parking is to be removed from Shotover Street, Stanley Street, and the majority of on-street parking from streets forming the Arterials; loading bays are proposed to be retained (although may be relocated).
- The Arterials should form the preferred route for Over Dimension Vehicles (ODV), noting that ODVs are still allowed to use Frankton Road, Stanley Street, Shotover Street, Gorge Road, and Lake Esplanade
- As part of the proposed Manawa Development, Ballarat Street (north of Stanley Street) will be closed to general traffic.

2.4.2 Space allocation – General Requirements

The use of the road corridor has been developed through the Movement and Place framework[1]. Four main functions are proposed for the streets within the Town Centre. Topologies discussed in the Technical Note #9 were initially derived from the Masterplan. However, as more detail was made available through the modelling a need for changes became apparent. The modal shift proposed as part of the DBC requires implementation of a more persuasive displacement of the private vehicles from Queenstown. To achieve this goal the Masterplan Topologies were transposed into a set of *typical cross sections* (paragraph 2.4.3 and 2.4.4). For the Arterials, the Safe Systems Approach was implemented; intersection layouts and cross sections used were modified.

- Primary Typology - Streets with enhanced pedestrian realm
  Streets offering a balance between vehicular and cycle/pedestrian use providing necessary vehicular access to places of interest, car parks, commercial and residential plots. The carriageways remain demarcated, to promote separation between vehicles and vulnerable users.
- Primary Typology - Shared zones with either delineated corridors for small and delivery vehicles, or delivery-only
  People-centric areas built on the principles of liveability, convenience, flexibility of space used to walk, shop, talk and play. These streets encourage walking, cycling, on-street café set-ups, allow for the conversion of the urban space into markets or to host events. The use of space can vary over the week but also over a day. While the vehicular access is not entirely restricted, by taking out the demarcation drivers no longer assume priority and slow their speed to negotiate their way with other users.
- Secondary Typology - Public Transport orientated streets
  These streets are the main corridors to/from/through the town. The high capacity of these streets is achieved by modal shift e.g. high occupancy vehicles rather than increased number of lanes. It is critical that these routes remain operational and (as much as possible) free flowing to retain attractiveness of public transport.
- Tertiary Typology
  These streets are movement orientated, allow for commercial and freight operations, and serve through traffic.

[1] Movement and Place - "The Movement and Place (M&P) approach recognises that transport links perform two functions: movement of people and goods and serving as a place (a destination in its own right). This way of thinking ensures that while we are planning for and developing our network, we are considering the needs for movement and placemaking simultaneously." (VicRoads website)

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For the Public Transport orientated streets

- The preferred width of the footpaths is 3.0 m, and where the road corridor allows their width is recommended to be maximised. It is recognised that some constraints exist in the Town Centre and widening of the footpaths may result in the need for retaining embankments. In such scenarios a further cost-benefit analysis is recommended to select appropriate but not overengineered pedestrian provision.
- Cyclists are encouraged to share the lanes and signage will be marked to communicate this intent.
- Bus lane width is limited to 3.2 m (due to cyclists sharing the bus lane – wider lanes may encourage overtaking manoeuvres).
- Traffic lane width, where an adjacent bus lane is present, shall be 3.5 m (allows for buses to pull out of bus stops and use traffic lane if needing to pass a stopped bus in front).
- Elsewhere traffic lanes of the redesigned streets shall be between 3.00 m and 3.25 m wide, although widening on curves should be considered.

For the enhanced pedestrian realm streets

- Cyclists are encouraged to share the lane and sharrows[2] will be marked to communicate this intent.
- Traffic lanes of the redesigned streets shall be between 3.00 m and 3.25 m wide, although widening on curves should be considered.
- While parking is discouraged in the Town Centre, loading and mobility bays are located across the area to retain accessibility; these bays in general are 2.3 m wide.
- Coach drop-off/pick-up and idling bays should be considered and retained at popular tourist destinations (e.g. Steamer Wharf).

For the Shared Zones

- In general, all modes need to be considerate of other users; cars and cyclists need to give way to pedestrians.
- While parking is discouraged in the Town Centre, loading and mobility bays are located across the area to retain accessibility; these bays are 2.3 m wide.
- Some shared zones will have a lane delineated (one-way) to encourage vehicles to stick to a single file (in locations where frequent access is required, e.g. car parks).

2.4.3 Typical Cross Sections – Town Centre

The preferred street typologies outlined in the Masterplan have been reviewed, modified, and tailored to achieve the objectives for each street.

The proposed modern street design is centred around the function of the street and is not linked to the street name nor the corridor width. Four (4) distinctive typical cross sections[3] have been incorporated, noting that a single street may have a few different treatments proposed over its length.

The cross sections are based on typologies:

- Public Transport orientated streets cross section ***XA*** - Level separated footpaths with a narrow-lane carriageway and bus lanes and/or indented bus stop bays.
- Enhanced pedestrian realm streets cross section ***XB*** - Level separated footpaths with a narrow-lane carriageway two- or one-way.
- Shared Zones cross section ***XC*** - Level non-separated areas with delineated vehicular paths.

[2] A sharrow is a street marking (a bicycle with two chevrons above it) installed in the travel lane to indicate where people should preferably cycle, sharrows are not currently a legal road marking in New Zealand.
[3] Some streets do not follow any of these sections, and have layouts tailored to meet specific objectives: e.g. Athol Street (bus hub), Church Street (mix use due to the underground car park access), Marine Parade (to blend the design with the existing section of the waterfront), Earl Street (to service the hotel and retain on-street parking).

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- Shared Zones cross section ***XD*** - Level non-separated, pedestrian-orientated shared zones which allow for a limited vehicular access, e.g. private to/from car park and commercial vehicles – delivery.

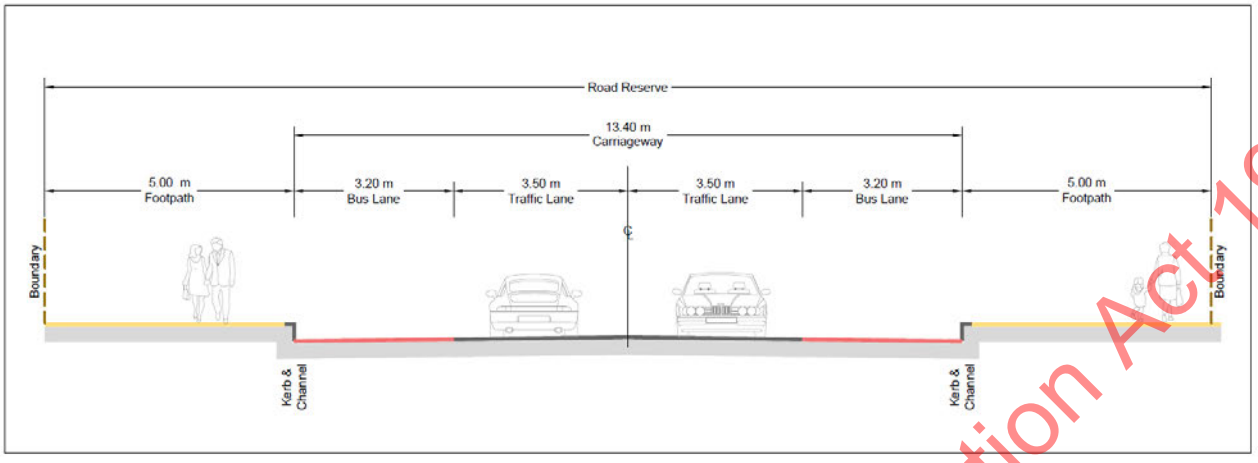

Figure 2-1: Public Transport orientated streets cross section ***XA***

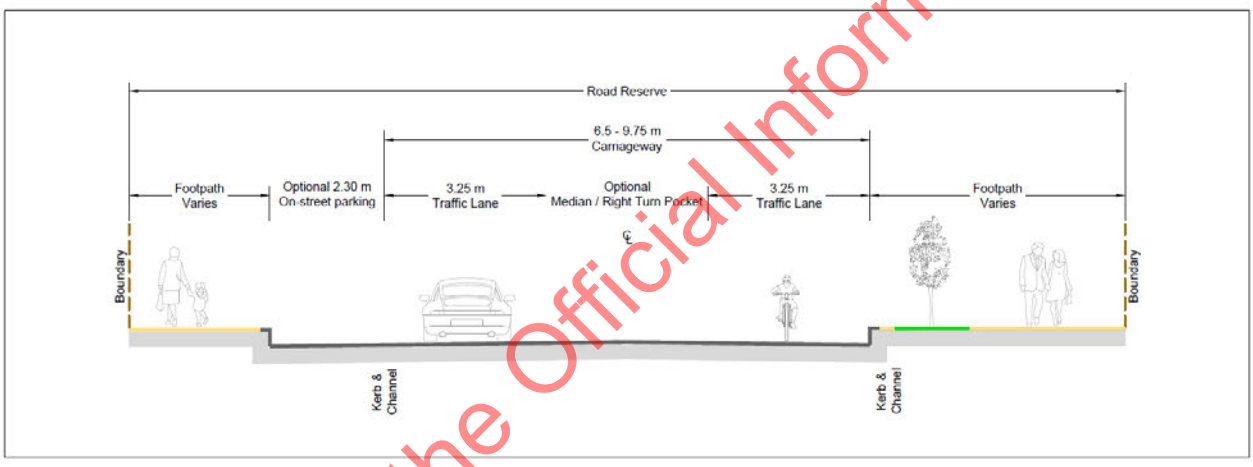

Figure 2-2: Enhanced pedestrian realm streets cross section **XB**

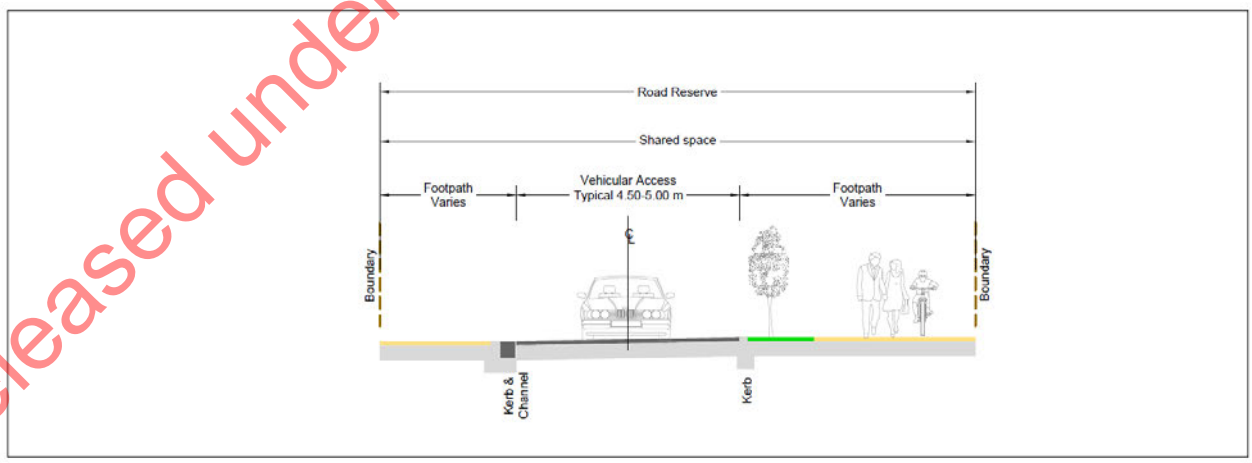

Figure 2-3: Shared Zones cross section **XC**

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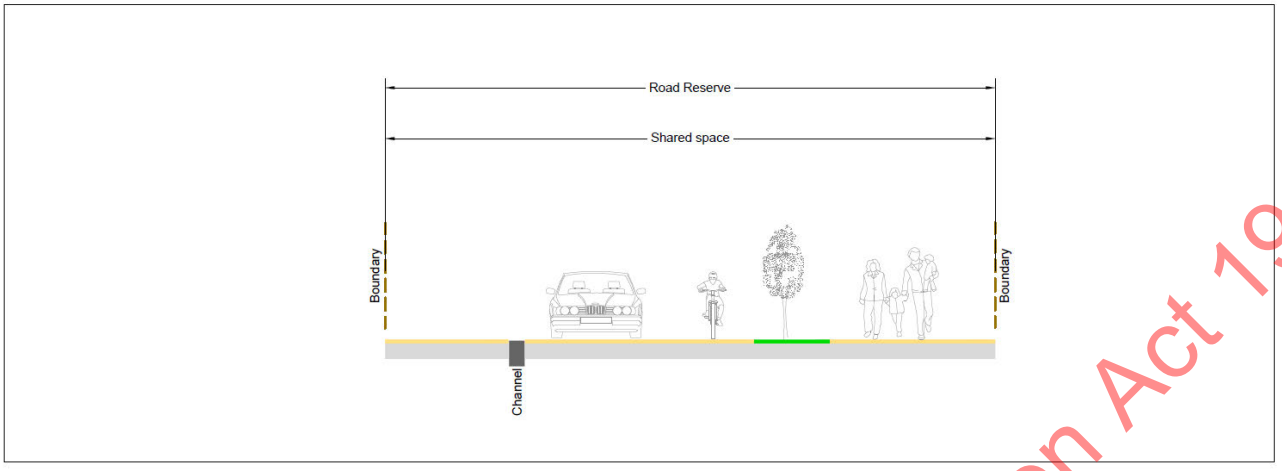

Figure 2-4: Shared Zones cross section **XD**

2.4.4 Typical Cross Sections – Arterials

The preferred cross section varies slightly between the three Stages of the Arterials; however, the Detailed Business Case tries to unify the approach and link some of the parameters with the SH6A (Frankton Road) upgrades (e.g. lane widths).

The desired lane width is 3.25 m for both ahead and turning movements, where practicable a 2.5 m wide flush median should be provided to accommodate any turning traffic. Footpath widths should be maximised, and typically be at least 2.5 m wide. The terrain and road boundary constraints may locally affect the available width or prove that any widening will be prohibitively expensive.

For Stage 1 the desired cross section should consist of:

Minimum 3 m wide Footpath, 0.75 m shoulders, 3.25 m lanes, and 2.5 m wide flush median.

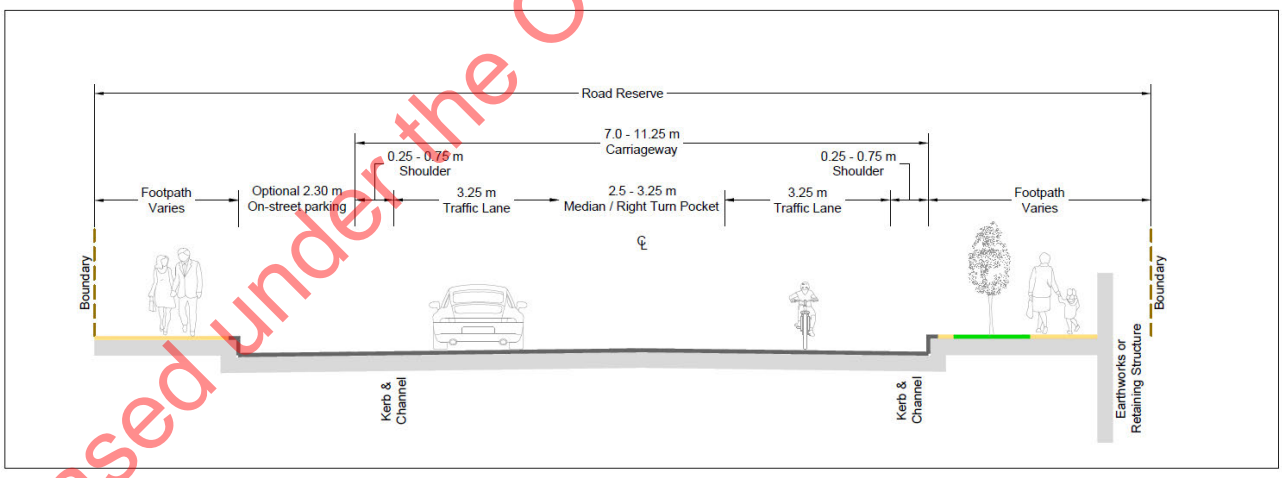

Figure 2-5: Stage 1 – Melbourne Street and Henry Street

For Stage 2 the desired cross section should consist of:

- Minimum 4.00 m wide Footpath, 0.75 m shoulders, 3.25 m lanes, and 2.75 m wide flush median.
- The shoulders can be reduced to 0.25 m at the intersections.

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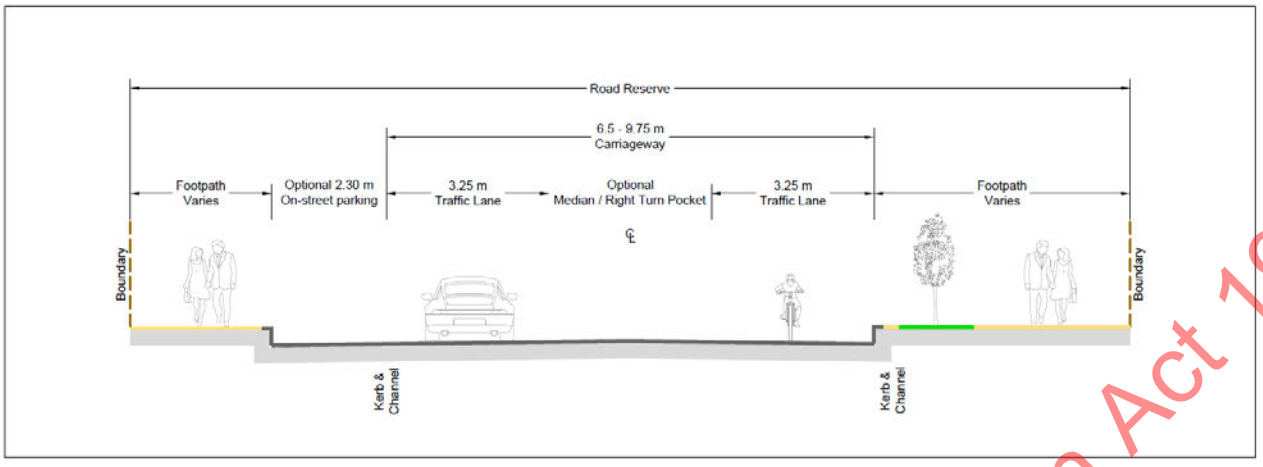

Figure 2-6: Stage 2 – Memorial Street and Man Street

For Stage 3 the desired cross section should consist of:

- For the Hay Street to Glasgow Street section:
  - Minimum 5.00 m wide Northern Footpath, no shoulders, 3.25 m lanes, and 3.25 m wide flush median
  - The median is likely to be entirely occupied by the R-turn pockets.

For the Glasgow Street to Fernhill Roundabout section:

- Minimum 1.50 m wide Northern Footpath, 1.25 m shoulders, 3.25 m lanes, and a median
- The median is likely to be entirely occupied by the R-turn pockets.

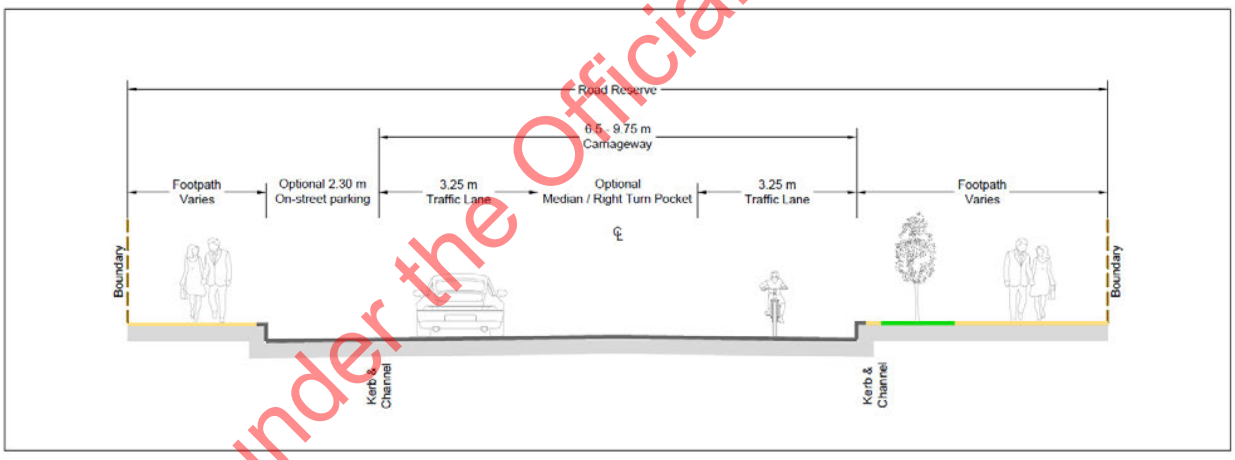

Figure 2-7: Stage 3 – Thompson Street (adopted from Lake View by Beca)

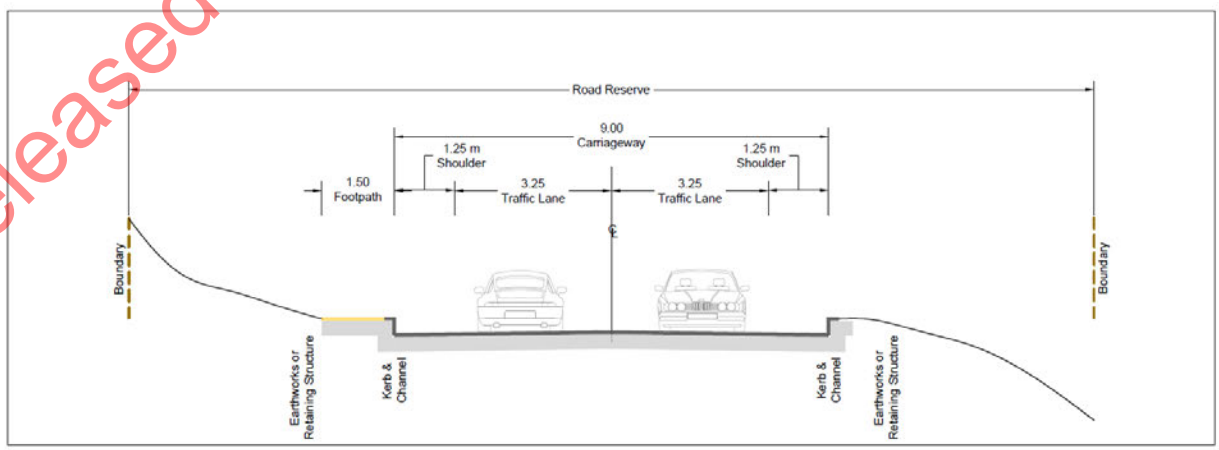

Figure 2-8: Stage 3 – Roundabout Link Road (adopted from Masterplan by Beca)

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2.4.5 Clearance to furniture and vulnerable users on streets with separated carriageways

The proposed lane widths (3.2 m) allow for a 90% Passenger Vehicle. When turning it is expected that buses will temporarily encroach into the opposing lane. At signal-controlled intersections, the stop lines must be sufficiently set-back to allow for this intrusion, while on the non-controlled intersections the bus driver will have to judge the timing of the manoeuvre to ensure its safety.

Streets carrying public transport traffic and over-dimension vehicles shall have a minimum clearance compliant with the Heavy Haulage Association's *Road Design Specifications for Over-dimension Loads* requirements (6.5 m high and 11.5 m wide envelope). The following Streets should allow for over-dimension loads:

- Frankton Road
- Stanley Street
- Shotover Street
- Gorge Road
- Beach Street (From Shotover Street to Brunswick Street only)
- Lake Esplanade

2.4.6 Permeability

Mid-block pedestrian crossings should not be encouraged on the arterial routes, instead protected pedestrian crossings should be incorporated within the signalised intersections. A single signal controlled mid-block pedestrian crossing should be considered in front of the Man Street car park on Shotover Street. In addition, up to four raised zebra crossings should be considered along Lake Esplanade

To improve connectivity and permeability an overpass should be considered at Ballarat Street.

The Wakatipu Active Travel Network (WATN) designs indicate a need for a pedestrian crossing in the vicinity of Glasgow Street. Unfortunately, the WATN proposed layout is not compatible with the Arterials. A raised pedestrian crossing is provided west of Glasgow Street to cater for the desired movements identified by the Active Travel team.

2.4.7 Bus Stop Locations

Bus stops should be provided at sufficient spacing to create a 15-minute walk neighbourhood and should be designed to the QLDC COP requirements. It is proposed that the following locations and criteria are considered for locating bus stops:

2.4.7.1 Criteria selection

Bus stops locations should be selected based on a several factors:

- Bus stops should be provided at existing bus stop locations (although can be relocated or modifies).
- In urban cores, bus stops should be provided approximately every 400 metres, and be located near intersections and pedestrian crossing points.
- Bus stops feed to key trip generators within a reasonable (preferably <5 minutes) walk distance.
- Bus stops should be provided on flat ground, where feasible, to facilitate boarding and alighting, especially for people with reduced mobility.

2.4.7.2 Public Transport Bus Stops

- Frankton Road, opposite Copthorne Hotel
- Millenium
- Garden Court
- Upper Stanley St
- Blue Peaks
- Stanley Street PT Hub – stops A-F

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- Steamer Wharf/Crowne Plaza (east)
- Steamer Wharf/Crowne Plaza (west)
- Rydges Hotel (east)
- Rydges Hotel (west)
- YHA Lakefront
- Ben Lomond (at realigned One Mile Roundabout)
- Hay Street (east)
- Hay Street (west)
- Boundary St
- Hylton Place (east)
- Hylton Place (west)
- Gorge Rd, outside vet
- Gorge Rd, past Warren Park
- Industrial Place (south)
- Industrial Place (north)

Figure 2-9: Indicative Bus Stop Locations within the Queenstown Town Centre

2.4.7.3 Footpath widths adjacent to Bus Stop

- Wide footpaths to be provided in the vicinity of the Public Transport Hub area, ideally 5 m wide

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- Elsewhere the footpaths should be maximised, and ideally more than 3 m wide.

2.4.8 Parking and Drop-off Zones

In accordance with the Queenstown Parking Strategy 2019, and Technical Note # 9 most of the current on-street parking availability will be removed. Localised parking should still be provided at selected locations to retain operations of and accessibility to some properties (e.g. near St Joseph Church, along Earl and Camp Streets, pockets on Shotover Street). As many businesses do not have back lane access loading bays must be provided and should ideally be located at their current location or near-by.

Drop-off/pick-up areas should be established for the St Joseph's School.

2.5 Alignment Geometry and Other Considerations

2.5.1 Town Centre

2.5.1.1 Horizontal Alignment

There are no specific requirements for Town Centre horizontal alignments. Most of the streets are straight or near straight. The only significant curvature exists at the southern end of Shotover Street, where the design is constrained by the available right of way and existing buildings. No minimum horizontal curve radii have been selected for this low speed environment.

2.5.1.2 Vertical Alignment

The vertical alignment should match existing elevations. Where the cross sections vary from existing, accesses to the residential and commercial properties should be proposed as step-free; this may require carriageway elevations to be modified. Changing footpath crossfall may be appropriate, but the crossfall should be limited so as not to introduce a trip hazard or inaccessible surfaces for disabled users.

2.5.1.3 Superelevation

No superelevation is required for any of the Town Centre streets.

2.5.1.4 Mid-block pedestrian crossings

Mid-block pedestrian crossings shall be provided on Stanley Street and Shotover Street to improve interconnectivity of the Town Centre. Indicative locations have been identified as desirable: -

- Shotover Street – in front of number 58
- Stanley Street – in front of number 57
- Gorge Road – in front of number 41B
- Gorge Road – in front of number 61
- Lake Esplanade – in front of number 38 (zebra)
- Lake Esplanade – in front of number 76 (zebra)
- Lake Esplanade – in front of the car park, near the roundabout (zebra)
- Thompson Street – in front of number 4A

Mid-block signalised pedestrian crossings are to be co-ordinated with traffic signals at Rees Street, Camp Street, and Gorge Road.

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Figure 2-10: Locations of mid-block pedestrian crossings within Queenstown

2.5.1.5 Access to properties

Consideration must be given to ensure that accessibility to properties is upgraded or maintained.

2.5.2 Arterials

Arterials provide an improved access to and through the town, increased Economic Performance, Improved liveability, and visitor experience in the Town Centre by reassigning the traffic from the Historic Core to the new corridor, freeing the Town Centre for pedestrians.

The Arterials objectives are:

1. To bring traffic into the town.
2. To allow through-traffic to avoid the Town Centre.
3. To provide access to existing and planned car parks.
4. To act as an arterial route, but to be an urban street and not an expressway.
5. To support liveability, amenity, and supporting pedestrianised Town Core by limiting through traffic within the Town Centre.

2.5.2.1 Horizontal Alignment

The Arterials, while arterials by name, should be considered a *Local Urban Road* (3.3.4, Guide to Road Design Part 3, Austroads) for the purpose of the design. Considering the mountainous and urban character of Queenstown the design criteria selected allows for the application in a challenging terrain.

- Transition curves are not required.

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- The minimum horizontal radius should be 56 m, (absolute minimum 49 m).
    - On steep downgrades the minimum curve radius should be increased by 10% for each 1% increase in grade over 3%.
- The minimum length of the horizontal curve should be 45 m.
- Curve widening should be considered as per Austroads Section 3, Table 7.13.

2.5.2.2 Vertical Alignment

The vertical alignment should match existing elevations. Where the cross sections vary from existing, accesses to the residential and commercial properties should be proposed as step-free; this may require carriageway elevations to be modified.

- The longitudinal grade should be
    - Minimum: 1.0% (0.5% absolute minimum)
    - Maximum: 12%
- Vertical curves
    - Minimum length: 30m
    - Minimum Radii (K-value) as per Table 2-1.

Table 2-1: Minimum K value

Element	Reaction Time	Coefficient of deceleration	Minimum k value	Austroads Reference
Crest curves at midblock sections	2.0	0.36	6.8	Austroads Section 3, Table 8.7
Crest curves at intersections	2.0	0.36	10 (SSID = 97 m)	Austroads Section 4A, Table 3.2
Sag curves	N/A	N/A	6 – desirable 5 – absolute min.	Austroads Section 3, Figure 8.9

2.5.2.3 Superelevation

No Superelevation is required for any of the Arterials; however, it may be practicable to consider it where steep grades are present (either mainline or sideroads) to provide smooth tie-ins or increase safety.

2.6 Access to properties

Consideration must be given to ensure the accessibility to properties along the route is maintained, noting that several properties will be significantly affected and may require alternative access provision.

2.7 Intersection Design

Intersections within Town Centres are unavoidable; they provide connectivity but also lead to conflicts between movements and diverse types of users. The design of the pedestrian crossings should consider additional on/in footway traffic lights for pedestrians.

Two approaches have been taken to prioritize pedestrian traffic depending on the nature of the intersecting links:

- Signalised Intersections with Barnes Dance (an all-pedestrian phase) has been requested by the client and should be provided for streets using typical cross sections XA and XB. The design of the pedestrian crossings should consider additional on/in pavement traffic lights for pedestrians
- Unsignalised Intersections: raised tables and shared zones should be provided for streets using typical cross sections XC and XD. Where kerb returns are provided, kerb buildouts should be considered to minimise the crossing distance.

To improve pedestrian safety signalised intersections are proposed at the following locations (the list is inclusive of existing signalised intersections that will be modified to improve provision for pedestrians):

- Stanley Street/Frankton Road
- Stanley Street/Sydney Street

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- Stanley Street/Ballarat Street
- Stanley Street/Shotover Street
- Shotover Street/Camp Street
- Shotover Street/Brecon Street/Rees Street
- Shotover Street/Beach Street
- Frankton Road/Dublin Street/Melbourne Street
- Melbourne Street/Sydney Street
- Melbourne (Henry) Street/Gorge Road/Memorial Street
- Memorial Street/ Camp Street/Man Street/Duke Street
- Man Street/Brecon Street

All other intersections within the Scope Area are not proposed to be signalised but use other means to prioritize pedestrian and public transport movements.

Figure 2-11: Locations of signalized intersections within Queenstown

2.7.1 Operations, ITS, and Modelling

Further detail on the approach to operations and ITS is provided in separate technical notes.

2.7.1.1 Design standards and Guidelines

The following standards and guidelines are applicable:

- Queenstown Business Case Transport Modelling Contract 201828

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- Waka Kotahi P43 Specification for Traffic Signals
- Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings Management (AGTM06-20)
- Austroads Guide to Traffic Management Part 9: Transport Control Systems – Strategies and Operations (AGTM09-20)
- Austroads Guide to Traffic Management Part 10: Transport Control – Types of Devices (AGTM10-20)

2.7.2 Geometric Design

The intersection geometry will be influenced by the cross sections of the joining streets and the vehicle used for swept path tracking.

This philosophy sets the following design and check vehicles for the affected streets and roads within the project area. The Design Vehicle needing to be accommodated (inclusive of 0.5 m shy line) without any encroachments, while the Check Vehicle may encroach into opposing lanes as its infrequent occurrence should have only minimal impact on safety or the performance of the intersection.

The typical corner radii used is expected in the region of 3.0 m (where L-turn is allowed), where buses and shuttles are expected the radii shall be increased to accommodate the required vehicle and in general be no less than 6.0 m. Where Public Transport is expected the radius should not be smaller than 9.0 m to ensure smooth operation of Public Transport.

Table 2-2: Design and check vehicles for Town Centre streets and intersections

	Design Vehicle	Check Vehicle
Athol Street	12.5m Bus/Tour Coach	N/A
Ballarat Street (north of Stanley Street)	N/A Closed off.	N/A
Ballarat Street (between Athol Street and Stanley Street)	12.5m Bus/Tour Coach	N/A
Beach Street (From Brunswick Street to Shotover Street)	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension
Beach Street (Elsewhere)	90% Passenger Vehicle	Refuse vehicle and 8m Medium Rigid Truck
Brecon Street (the Duke Street end)	12.5m Bus/Tour Coach	N/A
Camp Street	12.5m Bus/Tour Coach	N/A
Church Street	90% Passenger Vehicle	12.5 m Bus/Tour Coach
Cow Lane	90% Passenger Vehicle	Refuse vehicle and 8m Medium Rigid Truck
Earl Street	90% Passenger Vehicle	12.5m Bus/Tour Coach
Gorge Road	12.5m Bus/Tour Coach	Over Dimension
Hallenstein Street	90% Passenger Vehicle	12.5m Bus/Tour Coach
Lake Esplanade	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension
Mall Street	Pedestrian Area	90% Passenger Vehicle
Man Street	12.5m Bus/Tour Coach	N/A

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	Design Vehicle	Check Vehicle
Marine Parade	90% Passenger Vehicle	Refuse vehicle and 8m Medium Rigid Truck
Rees Street	90% Passenger Vehicle	Refuse vehicle and 8m Medium Rigid Truck
Searle Lane	Pedestrian Area	90% Passenger Vehicle
Shotover Street	12.5m Bus/Tour Coach and ~18mm Bendy-Bus	Over Dimension
Stanley Street	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension

Table 2-3: Design and check vehicles for Town Arterial streets and intersections

Street/Road	Design Vehicle	Check Vehicle
Frankton Road	12.5m Bus/Tour Coach and ~18m m Bendy-Bus	Over Dimension
Melbourne Street (Henry Street)	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension
Sydney Street	11m Rigid Truck	12.5m Bus/Tour Coach
Gorge Road	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension
Shotover Street	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension
Memorial Street (realigned)	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension
Man Street	12.5m Bus/ our Coach	N/A
Camp Street	12.5 m Bus/Tour Coach	N/A
Thompson Street (including link to roundabout)	12.5m Bus/Tour Coach and ~18m Bendy-Bus	Over Dimension

2.7.3 Signalised Intersections – Layouts

2.7.3.1 Frankton Road Intersection

- Background

  This intersection is key to the Arterials operations. It diverges the inbound flows between Dublin Street, Melbourne Street, and Frankton Road (towards Stanley Street). Public transport vehicles should be given priority and be directed towards Stanley Street. Conversely, the private vehicles should be encouraged to continue towards Melbourne Street.

- Layout

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Figure 2-12: Frankton Road – Melbourne Street intersection

2.7.3.2 Sydney Street Intersection

- Background

  Sydney Street provides a pedestrian and vehicular link between Queenstown Hill and the Botanic Gardens. To retain this connectivity, but maintain Melbourne St priority, this intersection must be upgraded to a signal-controlled intersection.

- Layout

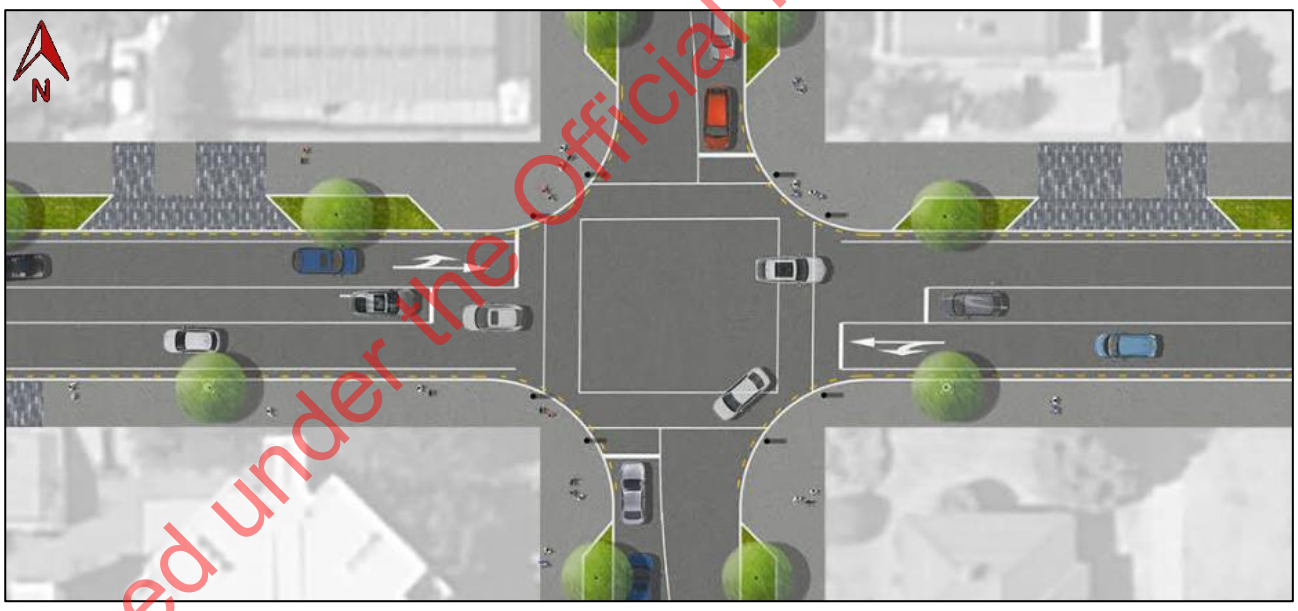

Figure 2-13: Melbourne Street -Sydney Street intersection

2.7.3.3 Gorge Road Intersection

- Background

  One of the elements looked at as part of the Detailed Business Case was the review of the design of Stages 1 and 2 of the Arterials. The key element to this assessment was the selection of the best performing configuration of the Arterials/Gorge Road intersection. The shortlist of layouts was provided by the Masterplan an included 4-arm intersections and a double-T intersection.

  The modelling concluded that a double-T intersection can accommodate the predicted flows, however with some modifications (e.g. increased queue lengths). The layout of the intersection was modified to accommodate the queues and turning movements, in addition some improvements have been made to the accessibility to commercial plots.

- Layout

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Figure 2-14: Gorge Rd – (realigned) Memorial Street intersection

Figure 2-15: Gorge Rd – Shotover Street – Henry Street intersection

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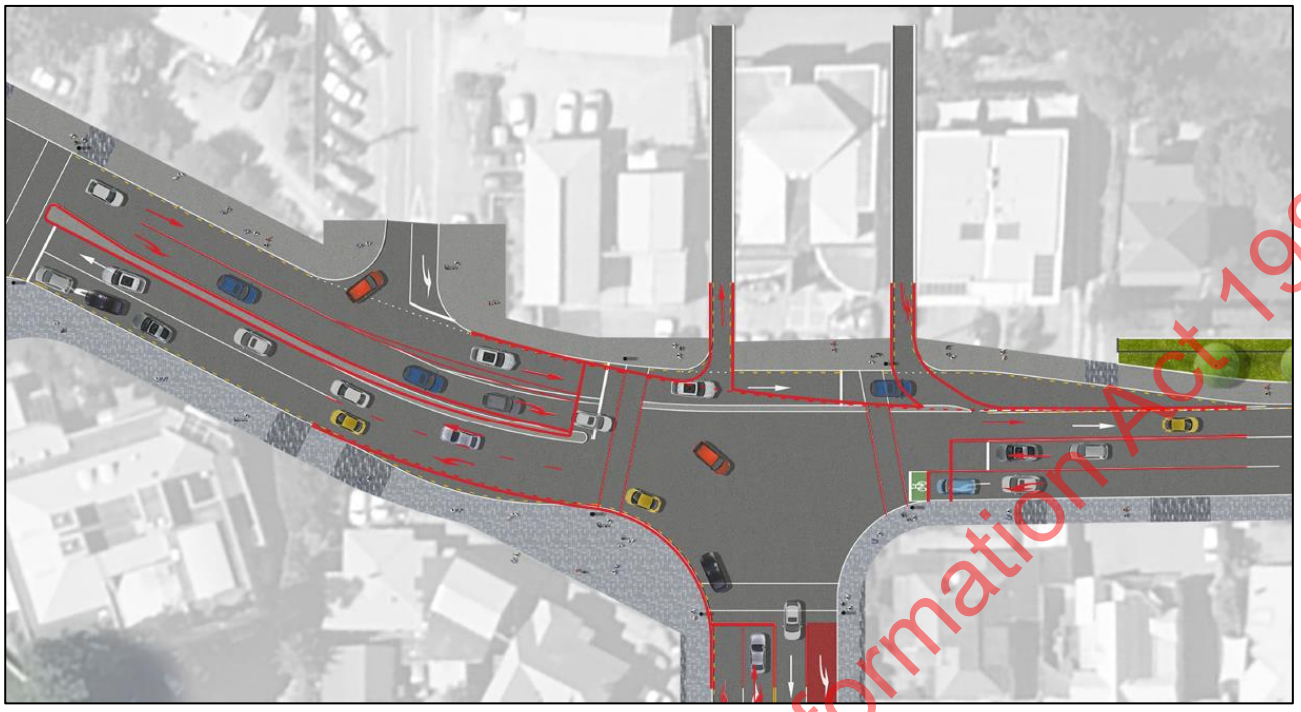

Figure 2-16: Gorge Rd – Shotover Street – Henry Street intersection: Alternative Arrangement Overlay

2.7.3.4 Camp Street Intersection

- Background

  The non-typical 5-arm Camp Street intersection is expected to carry substantial flows both along the Memorial-Man axis and towards the Skyline Gondola.

- Layout

Figure 2-17: Memorial Street/Camp Street/Man Street/Duke Street intersection

2.7.3.5 Brecon Street Intersection

- Background

  The Brecon Street intersection has been designed as part of the Queenstown Streetscapes project. However, the intersection needs to be shifted towards the Town Centre to accommodate the required 5 m wide footway. Limited modifications to the lane widths at the tie-ins will also be required.

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- Layout

Figure 2-18: Man Street – Brecon Street intersection

2.7.3.6 Beach Street – Shotover Street Intersection

- Background

  The Beach Street intersection has been partially included in the Queenstown Streetscapes project. However, the intersection has been proposed to be signalised to allow safe access to Beach Street for pedestrians coming from the South. The 3-arm intersection will also provide safe egress from Beach street for vehicles exiting the shared zone.

- Layout

Figure 2-19: Beach Street – Shotover Street Intersection

2.8 Street Designs

The following Town Centre Street designs are based on the previously discussed criteria.

2.8.1 Athol Street

2.8.1.1 Street function

A public transport orientated street.

Athol Street is located south of the proposed Public Transport Hub building. It will serve as a long-distance bus, coach, and shuttle/tourist operator (e.g. ski-, hotel-) loading/disembarking area. A pedestrian plaza is

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proposed both on the PT Hub side and on the opposite side of the road. As high pedestrian flows are anticipated, a raised zebra crossing links the two plazas to prioritize foot traffic. Waiting areas should be installed for passengers, both inside the PT Hub and in the vicinity of bus stops. The plaza design provides for bike racks allowing people to change the mode of transport, however covered facilities should also be considered as part of the PT Hub – either in addition to or as a replacement for the open-air facility.

2.8.1.2 Street layout

The street shall be one-way S-E direction, with sufficient carriageway width for safe bus manoeuvring. A few drop-off stalls for taxi/ride-hailing should also be provided.

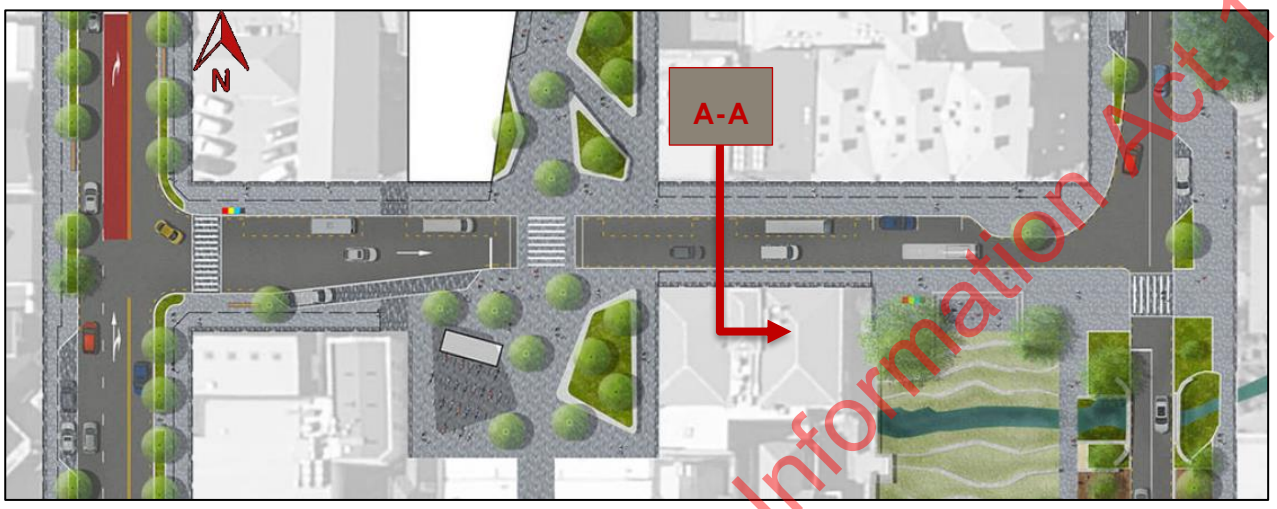

Figure 2-20 Athol Street

Cross section widths are indicated in the table below.

Table 2-4: Athol Street cross section

Cross Section	Footpath	Bus Stop / Parking	Carriageway	Parking	Footpath
Section A-A	4.5 m	3.2 m	4.0 m	-	2.4 m

2.8.2 Ballarat Street (north)

2.8.2.1 Street function

A street with enhanced pedestrian realm or a shared zone.

A new cul-de-sac providing access to properties and pedestrian connectivity between the Town Centre and Queenstown Hill.

2.8.2.2 Street layout

The street shall form a two way no-exit link with a turning head near the existing wide property access. A new pedestrian bridge is proposed over Stage 1 to provide a safe connectivity for residents and visitors.

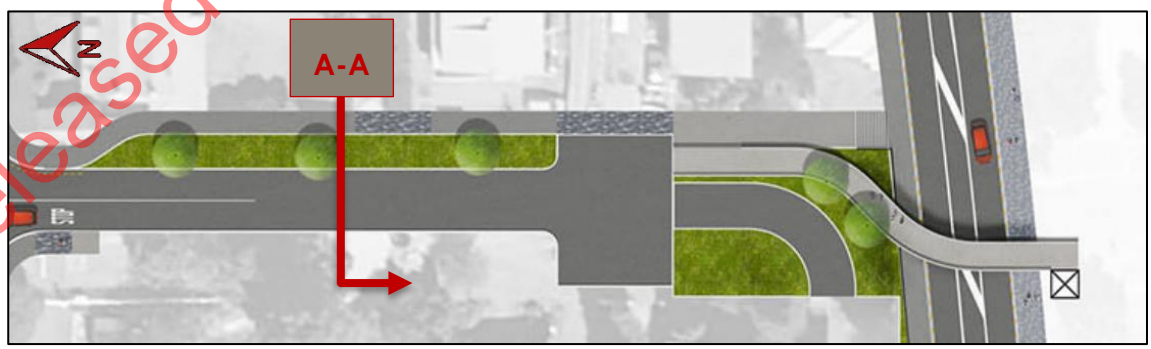

Figure 2-21 Ballarat Street

Cross sections are provided in the following table:

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Table 2-5: Ballarat Street cross section

Cross Section	Footpath	Landscape	Carriageway	Landscape
Section A-A	2.5 m	3.8 m Varies	6.8 m	Varies

2.8.3 Ballarat Street (south)

2.8.3.1 Street function

A street with enhanced pedestrian realm or a shared zone.

A public transport orientated street, with a shared zone. Although Orbus PT services will make minimal use of Ballarat Street, it will be heavily used by longer distance and tourist services.

Ballarat Street will form one of the main pedestrian routes within the Town Centre, connecting the Manawa site, PT Hub and Athol Street Hub with the town core and the lake side. Due to the presence of buses a homogeneous shared zone would not be safe, and a clear demarcation is proposed over the eastern section of the street.

2.8.3.2 Street layout

The street shall be two-way, however the carriageway width over the section between Camp Street and Athol Street must be reduced to the width matching that of the bridge.

The northern section will offer a sufficient carriageway width for safe bus manoeuvring out of Athol Street.

Unless a new bridge structure is provided, the one-way section will function similarly to the current layout as the bridge parapets restrict the usable width and channelize movement flows. An opportunity exists to replace the bridges with a single structure allowing for a wider and a more homogeneous shared zone.

Figure 2-22 Ballarat Street

Cross sections are provided in the following table.

Table 2-6: Ballarat Street cross section

Cross Section	Footpath	Loading	Carriageway	Loading	Footpath
Section A-A	7.0 m 4.7 m	- 2.3 m	6.4 m 6.4 m	- 2.3 m	5.3 m 3.0 m
Section B-B	Shared zone with landscaping		Width as existing over the bridge	Shared zone with landscaping	

2.8.4 Beach Street

2.8.4.1 Street function

Beach Street will be a shared zone. Design work has been progressed as part of the QLDC Town Centre streetscape improvement work.

Beach Street forms a pedestrian route linking the PT Hub with the Steamer Wharf and provides accesses to numerous boutique shops and restaurants. Due to the underground car park exit onto Cow Lane, the street must accommodate passenger vehicles, in a one-way direction towards the intersection with Shotover Street. Beach Street is also proposed to accommodate cyclists (from/to Fernhill).

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2.8.4.2 Street layout

The layouts incorporate Beca detailed designs for Streetscape, with minor modifications at the tie-ins. The layouts incorporate the cross-section **XD** (section towards Camp Street), and **XC** (between Cow Lane and Shotover Street)

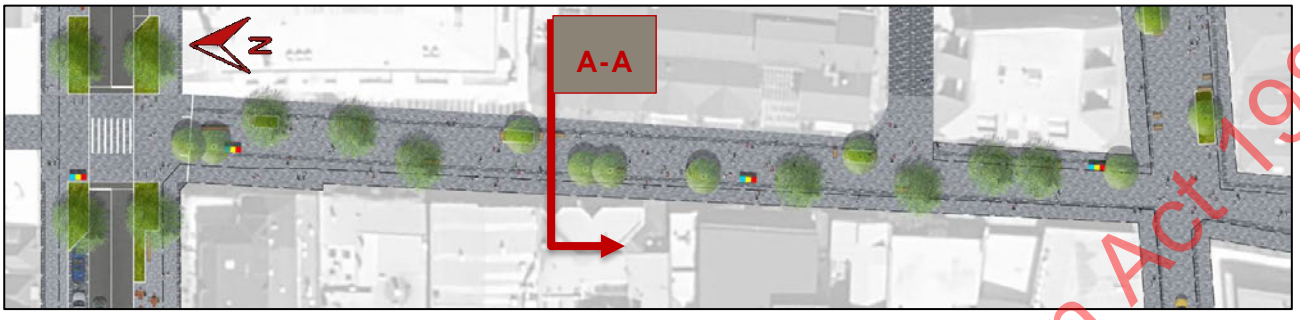

Figure 2-23 Beach Street - Camp Street to Rees Street

Figure 2-24 Beach Street - Rees Street to Shotover Street

Cross sections are shown below:

Table 2-7: Beach Street cross section

Cross Section	Shared Zone
Section A-A	11 m
Section B-B	14.5 m

2.8.5 Beetham Street (north)

2.8.5.1 Street function

A street with enhanced pedestrian realm or a shared zone.

A new cul-de-sac providing access to properties.

2.8.5.2 Street layout

The street shall form a two way no-exit link with a turning head near the existing property access at the bottom of the link. It is proposed that the existing perpendicular parking is retained, however the drop-off pick-up for St Joseph's School is relocated to Hallenstein Street.

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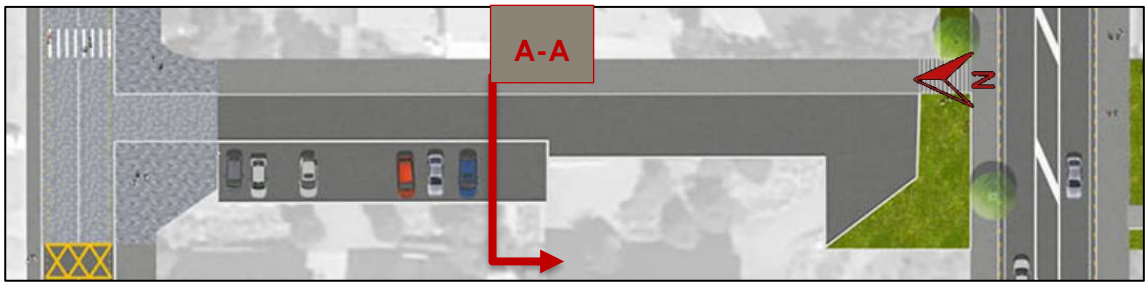

Figure 2-25 Beetham Street (north)

Cross sections are provided in the following table.

Table 2-8: Beetham Street (north) cross section

Cross Section	Footpath	Carriageway	Parking	Landscape
Section A-A	3.5 m Varies	6.8 m	As existing (~4.8 m)	Varies

2.8.6 Beetham Street (south)

2.8.6.1 Street function

A street with enhanced pedestrian realm or a shared zone.

A new cul-de-sac providing access to properties.

2.8.6.2 Street layout

The street shall form a two way no-exit link with a turning head near the existing property access at the top of the cul-de-sac. Existing accessibility to the properties is proposed to be retained.

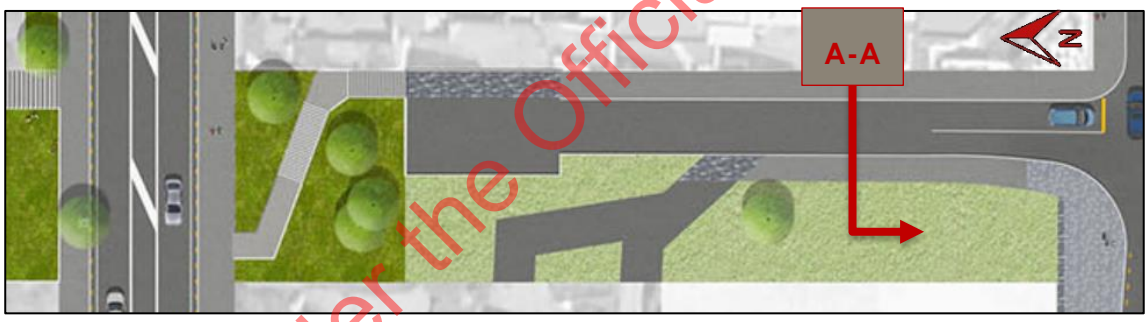

Figure 2-26 Beetham Street (south)

Cross sections are provided in the following table.

Table 2-9: Beetham Street (south) cross section

Cross Section	Footpath	Carriageway	Footpath	Landscape
Section A-A	2.5 m	5.4 m	2.5 m	Varies

2.8.7 Brecon Street

2.8.7.1 Street function

A street with enhanced pedestrian realm. Design work has been progressed as part of the QLDC Town Centre streetscape improvement work.

This street provides a pedestrian link from the Gondola to the Town Centre and provides access to a few boutique shops and restaurants in its lower section. The stairs provide the most direct access to Man Street, however, may be perceived as a barrier for the disabled residents and visitors. A lift is proposed within the re-designed stairs to accommodate pedestrians needing assistance.

2.8.7.2 Street layout

This road has two distinctive sub-sections:

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- Gondola to Man Street (designed by Beca) – cross section **XB**, retaining the vehicular access to the Gondola and improving pedestrian provision
- Man Street to Duke Street – stairs, elevator, and landscape area (originally designed by Beca, however the design was reviewed slightly and modified to tie in to Duke Street). Please refer to 2.8.13 for the discussion on Duke Street.

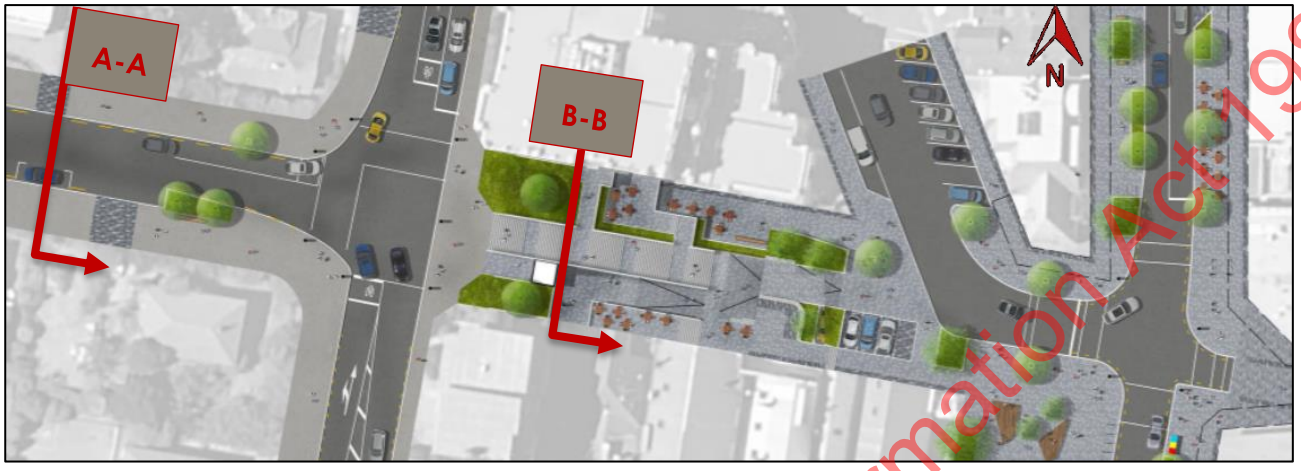

Figure 2-27 Brecon Street

Table 2-10: Brecon Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A (by others)	4.8 m	-	7.0 m	2.5 m	6.0 m
Section B-B (by others)	Stairs and elevator				

2.8.8 Camp Street

2.8.8.1 Street function

A street with enhanced pedestrian realm, with a shared zone area.

Camp Street provides the primary carriageway access to the Historic Core. Apart from a short section adjacent to the proposed plaza the traffic is separated from the pedestrians enabling vehicular access to car parking, hotels, underground car park and the police station. The street offers limited on-street parking, taxi/ride-hailing stalls, and a short section of a westbound segregated cycleway. In addition, this street is part of the Active Travel link connecting to the Wakatipu Active Travel Network (WATN) – Route C5 near the intersection with Memorial Street. WATN – Route B3 starts at Park Street/Lake Wakatipu Drive, however; Park Street, a section of the Coronation Drive, and a link to Camp Street are proposed to be upgraded as part of the Queenstown Streetscapes by LANDLAB and Beca to provide route linkage within the town.

The section of the road near the plaza (Ballarat Street) shall act as a shared zone, giving priority to pedestrians.

2.8.8.2 Street layout

This road has three distinctive sub-sections:

- Isle Street to Beach Street – cross section **XB**, retaining the vehicular access the Town Core
- Beach Street to Church Street – cross section **XB**, and **XC** in front of the Village Green
- Church Street to Earl Street – non typical cross section allowing for a bidirectional cyclist movement and one-way car traffic. The last section, across the creek and up to Coronation Drive provides pedestrian and cyclists connection only and has been designed by Beca.

The existing roundabout near the church should be upgraded, retaining the ability for vehicles to turn around without doing the full loop around the street block, and maintaining the access to the police and underground car park. A roundabout will also effectively manage priorities between pedestrian, cyclists, and vehicles.

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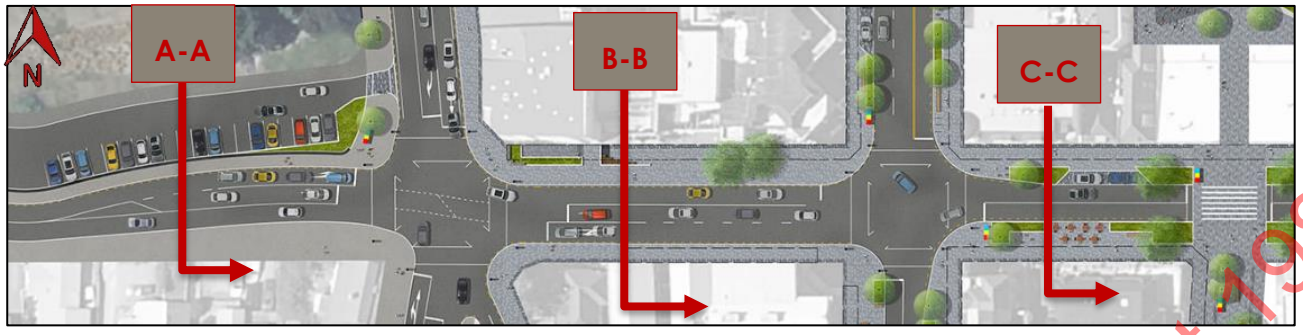

Figure 2-28 Camp Street - Isle Street to Beach Street

Figure 2-29 Camp Street - Beach Street to Church Street

Figure 2-30 Camp Street - Church Street to Earl Street

Cross sections are shown below:

Table 2-11: Camp Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	2.0 m	-	9.75 m	-	Varies min 3.5 m
Section B-B	Varies min 3.0 m	-	10.2 m (as existing)	-	3.0 m
Section C-C	3.8 m	3.0m Loading bay	6.4 m	2.3 m	4.7 m
Section D-D	4.5 m	2.3m	6.4 m	2.3 m	4.5 m
Section E-E	5.2 m	2.3m	5.0 m	2.5 m cycleway (westbound)	4.1 m

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2.8.9 Church Street

2.8.9.1 Street function

A shared zone.

Currently Church Street is dominated by on-street parking. To create more public space, it is proposed that virtually all on-street parking is removed (retaining a few loading and disabled parking bays), and half of the street is converted into a shared zone allowing for flexibility in its use. The section towards the lake provides an access to the underground car park.

2.8.9.2 Street layout

The street is a shared zone with mixed cross sections **XB**, **XC**, and **XD**. An unnamed lane, providing connectivity between Searle Lane and Earl Street, crosses Church Street at its midpoint. To promote this link, and prioritize pedestrians, a raised table should be provided, as per the current layout.

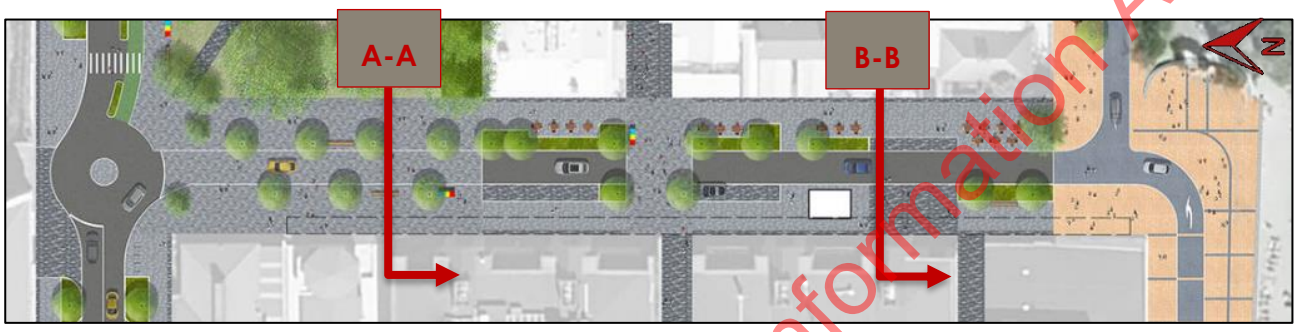

Figure 2-31 Church Street

Cross sections are shown below:

Table 2-12: Church Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	20.0 m Shared zone				
Section B-B	5.8 m Shared Zone	2.3 m Mobility bays	5.0 m Shared Zone With delineation	-	7.5 m Shared Zone

2.8.10 Coronation Drive

2.8.10.1 Street function

Coronation Drive offers mostly local access to adjacent properties and minimal through traffic. It is proposed to convert this street into a cul-de-sac, however allowing emergency and special vehicles to enter Stanley Street through a shared zone. This could be achieved using collapsible bollards to ensure public does not use this section of the road.

Demarcating a lane for emergency vehicles, should help pedestrians identifying the path these vehicles will take and be able to step out of the way when required. In-pavement lighting should be considered in the next design phases.

2.8.10.2 Street layout

The section of the Coronation Drive from the police station to Stanley Street is proposed to be a shared zone, with a demarcated route for the emergency vehicles only. A turning area is required to retain accessibility to a few residential and commercial plots located on Coronation Drive South-East of the police access.

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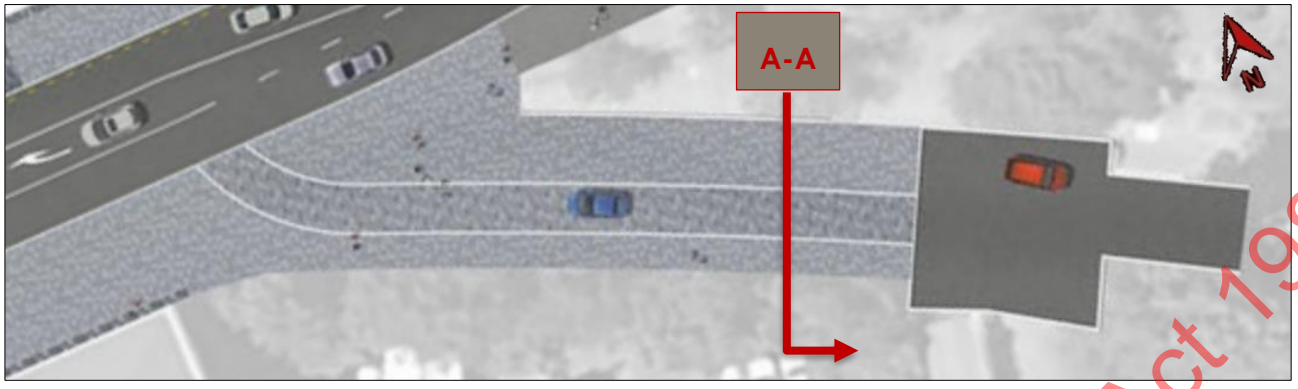

Figure 2-32: Coronation Drive, turning area in front of the police station

Cross sections

Table 2-13: Coronation Drive cross section

Cross Section	Footpath	Marked Lane	Footpath
Section A-A	Width as available within shared zone	3.5 m emergency vehicle lane within shared zone	Width as existing within shared zone

2.8.11 Cow Lane

2.8.11.1 Street function

A shared zone.

This lane gives access to the underground car park and rear access to a few properties as well as bars and restaurants. It is proposed to retain the function of this link and provide only minor improvements i.e. surfacing and street furniture.

2.8.11.2 Street layout

This lane should be paved between the buildings and be considered a shared zone. A detailed review of current loading areas should be undertaken, and formalised bays agreed with property owners.

Figure 2-33: Cow Lane

Cross sections are provided below:

Table 2-14: Cow Lane cross section

Cross Section	Shared Zone
Section A-A	4.3 m
Section B-B	6.3 m

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2.8.12 Dublin Street

2.8.12.1 Street function

A street with enhanced pedestrian realm.

Dublin Street provides one of the main accesses to the Queenstown Hill area – a residential neighbourhood with access to walking trails. Only minimal changes are proposed to this street; upgrade to carriageway and pedestrian provisions between the modified intersection on Frankton Road, and Hallenstein Street

2.8.12.2 Street layout

The carriageway layout remains unchanged; however, footpaths are widened to improve pedestrian connectivity.

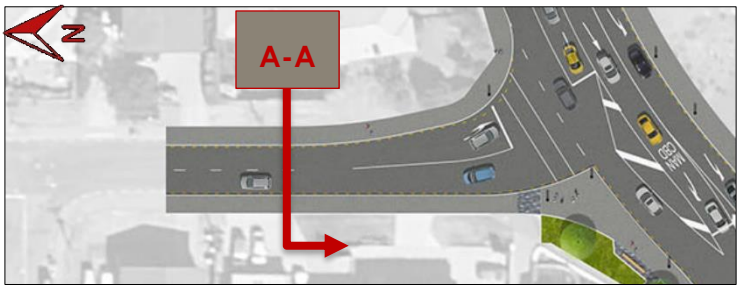

Figure 2-34 Dublin Street

Cross sections are shown below:

Table 2-15: Dublin Street cross section

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	2.5 m	-	7.5 m	-	2.5 m

2.8.13 Duke Street

2.8.13.1 Street function

A street with enhanced pedestrian realm, and public transport considerations.

Duke Street is a one-way link between Memorial Street and Shotover Street which serves as an access to hotels and a pick-up/drop-off area for shuttles and tourist transport (e.g. ski, or heliskiing shuttles, etc.). While this road tends to act as a rat-run, there is no justifiable transport need for this link to carry any through traffic.

2.8.13.2 Street layout

The street was remodelled during the Sofitel construction and no changes are proposed to this link, except for the short section on the approach to the Brecon Street intersection. Angled parking is retained while the loading bay is slightly relocated and formalised.

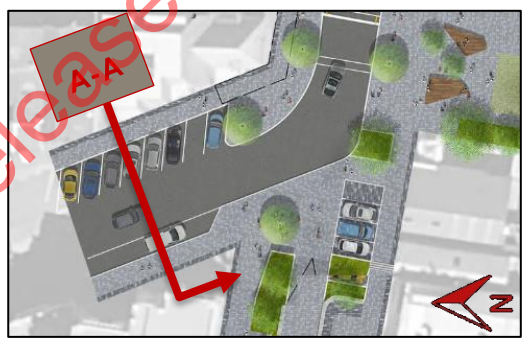

Figure 2-35: Duke Street

Cross sections

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Table 2-16: Duke Street cross section

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	2.7 m	5.3 m	6.5 m varies	2.3 m Loading bays	3.0 m

2.8.14 Earl Street

2.8.14.1 Street function

A street with enhanced pedestrian realm.

The function of Earl Street will change, from a de-facto car park to a pedestrian and cyclist friendly link allowing access to/from the Hotops Rise shared path (designed by others).

The widened path on the eastern side of the street and the added softscape should alter the perception of this link. Earl Street needs to provide access to the Novotel (including coach, shuttle, and deliveries), the design should retain the existing arrangement while removing the angled parking. On the western side of the street some angled parking is retained in line with the QLDC parking strategy.

2.8.14.2 Street layout

A separated, one-way carriageway has been provided due to the presence of angled parking (reversing) and accesses to the hotel. This link in general complies with cross section XB, although caters for 60˚angled parking. The lane width is wider than typical to allow for the required aisle width. The layout assumes that the northern kerbline is retained and southern (sun exposed) footpath is improved.

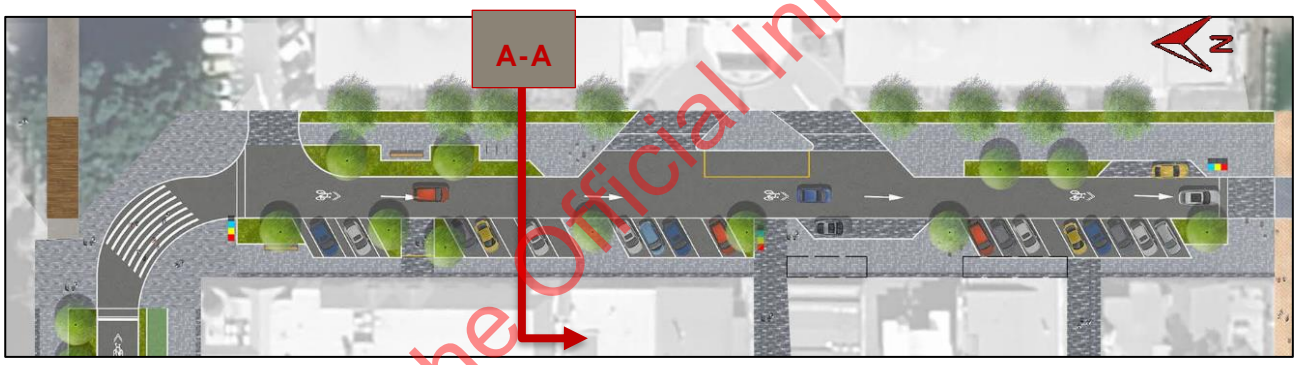

Figure 2-36: Earl Street

Cross sections are provided below.

Table 2-17: Earl Street cross section

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	2.7 m Excluding landscape	-	5.0 m	4.8 m	2.4 m

2.8.15 Frankton Road

2.8.15.1 Street function

State Highway 6A.

2.8.15.2 Street layout

The street shall, over its eastern section, consist of a single lane in each direction, an inbound bus lane, and a flush median. A short bus lane is proposed just prior to Suburb Street – it then transitions into an all-purpose lane towards Stanley Street west of Suburb Street.

The section towards the Town Centre should accommodate a single lane in each direction and upgraded bus stops for each direction.

The Stage 1 Arterials design extends through to Suburb Street to enable tie-ins for the horizontal geometry of the new Frankton/Melbourne intersection.

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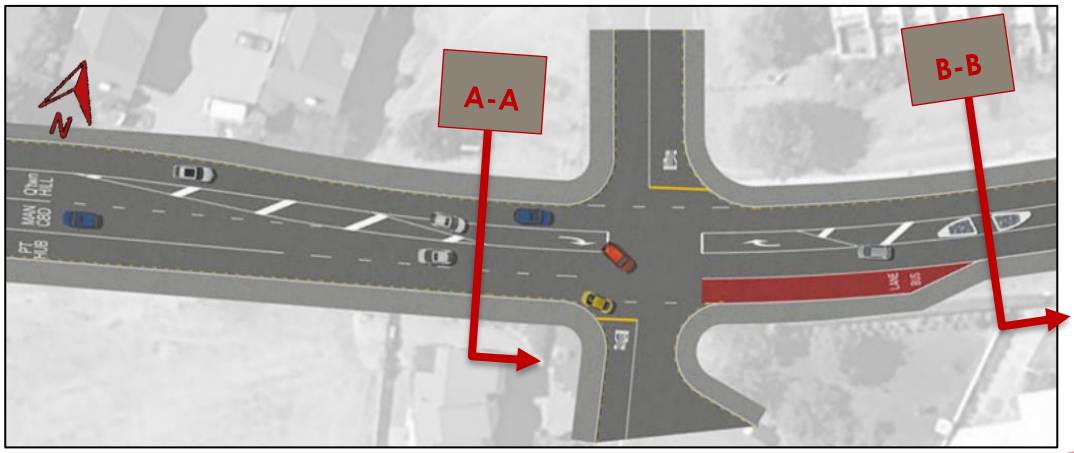

Figure 2-37: Frankton Road (Towards Frankton)

Table 2-18: Frankton Road cross sections

Cross Section	Footpath	-	Carriageway	Bus lane Turning lane	Footpath
Section A-A	3.0 m (varies)		9.25 m (2.5 m median) (lane widening on curves)	3.2 m	2.5 m
	Footpath	Cycleway	Carriageway	-	Shared Path
Section B-B	3.0 m (varies)	1.85 m	9.35 m (2.5 m median)		4.0 m

2.8.16 Hallenstein Street

2.8.16.1 Street function

A street with enhanced pedestrian realm.

This alternative route currently provides an informal bypass of the Town Centre for commuters between Arthurs Point and Frankton and access to Queenstown Hill. It is marked as the preferred route to the airport; however, it is not fit for large vehicles. Hallenstein Street provides access to several residential plots and the St Joseph School. An upgraded drop-off pick-up facility for the school will be provided, however, the layout needs to be discussed with and accepted by the school in the next design phases.

2.8.16.2 Street layout

With the reshaping of Beetham Street (north), some of St Joseph's School parking and drop-off facilities will be lost. Additional facilities on Hallenstein Street, including a bus stops (for school buses) must be provided- the layout must be prepared in coordination with the school. To improve safety, all affected side roads are proposed to operate as stop controlled intersections.

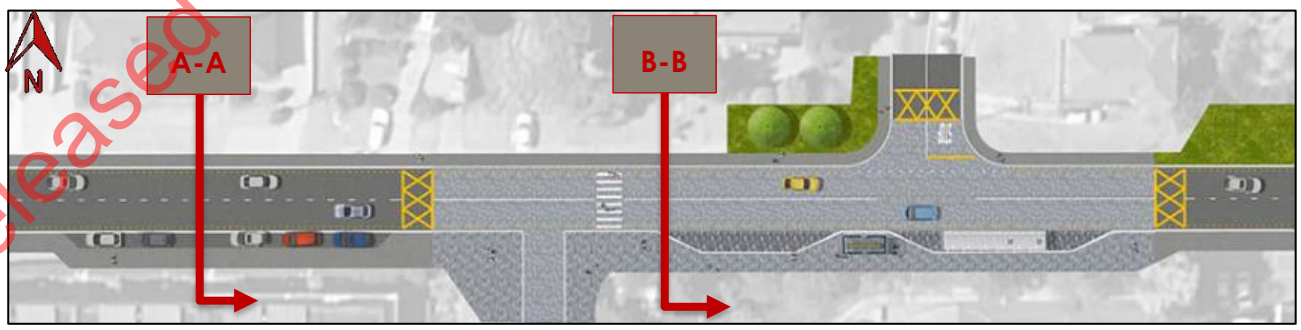

Figure 2-38: Hallenstein Street school drop off

Cross sections are provided below:

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Table 2-19: Hallenstein Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	1.5 m	-	6.5 – 7.0 m	2.3 m	Varies 1.5 m
Section B-B	1.5 m	-	6.5 – 7.0 m	2.5 m Bus bay	Varies Min. 2.45 m

2.8.17 Henry Street

2.8.17.1 Street function

Forms Arterial: Stage 1.

2.8.17.2 Street layout

The street forms a continuation of Melbourne Street. The street must consist of a single lane in each direction, a flush median, and a shoulder. However, to ensure the carriageway and the footpath can fit within this heavily constrained section, it is proposed that the shoulder width is reduced compared to the Melbourne Street section. Retaining structures must be provided to support the road and up-hill properties.

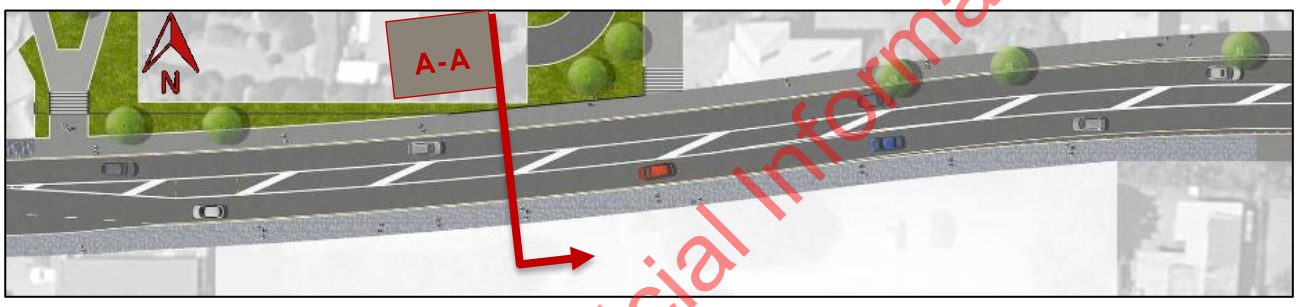

Figure 2-39: Henry Street

Cross sections are shown below:

Table 2-20: Henry Street cross sections

Cross Section	Footpath	Shoulder	Carriageway	Shoulder	Footpath
Section A-A	4.0 m (varies)	0.25 m	9.0 m	0.25 m	2.0 m (varies)

2.8.18 Lake Esplanade – Recommended Option

2.8.18.1 Street function

A street with enhanced pedestrian realm.

The third access to the town is provided through Lake Esplanade. This low-speed link terminates at the One-Mile Roundabout from which Fernhill, Sunshine Bay and Glenorchy can be reached. This street is bound by St Omer's park on the lake side, thus giving access to visitors to the Park, the Steamer Wharf, and Ben Lomond trails. The hill side is scattered with hotels. The Lake Esplanade is proposed to have a limited, strategically distributed on-street parking. Footpaths should be widened and enhanced.

2.8.18.2 Street layout

The lanes are to be narrowed, and three new formal crossing points installed to enhance accessibility to the park. The coach drop-off/idling area adjacent to the Wharf is worth retaining, considering the width of the carriageway is sufficient to preserve this.

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Figure 2-40: Wharf Area - Beach Street leading to Lake Esplanade

Figure 2-41: Lake Esplanade – West of Brunswick Street

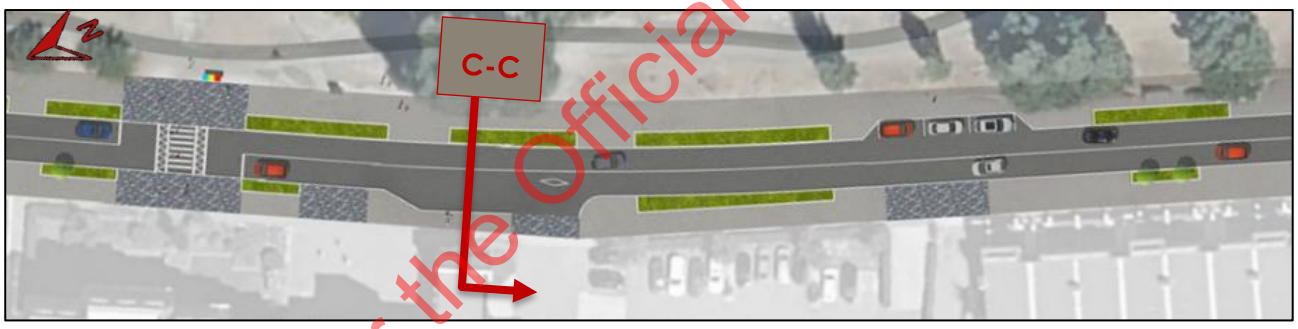

Figure 2-42: Lake Esplanade – Ridges Lakeland Resort Area

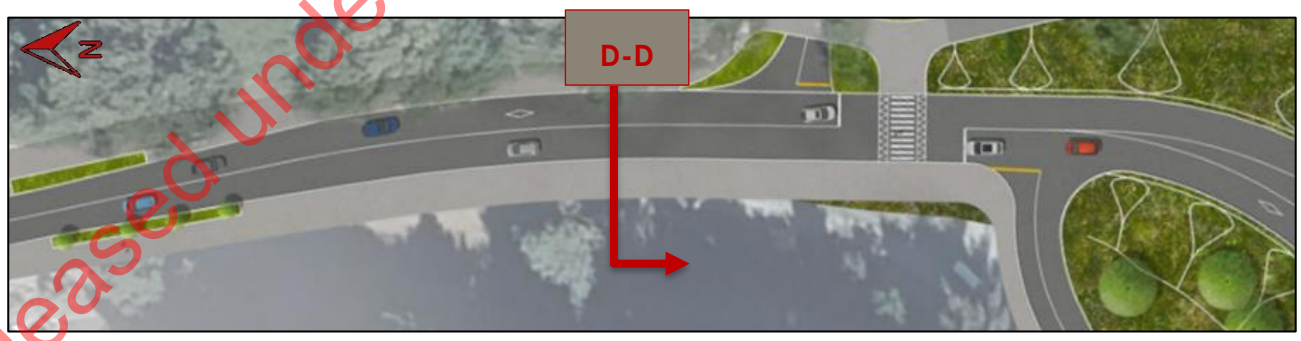

Figure 2-43: Lake Esplanade – Tie in to realigned One Mile Roundabout (Arterials Stage 3)

Cross Sections.

Table 2-21: Malaghan Street cross section

Cross Section	Footpath	Parking/Bus Bays	Carriageway	Parking/Bus Bays	Footpath
Section A-A	3.0-4.5 m Varies	3.0 Bus / Loading	6.4 m	-	3.0-4.5 m Varies

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Cross Section	Footpath	Parking/Bus Bays	Carriageway	Parking/Bus Bays	Footpath
Section B-B	3.0-6.0 m Varies	2.3	6.4 m	-	3.0-4.5 m Varies
Section C-C	3.0-6.0 m Varies	2.3	6.4 m	2.7 m match existing	3.0-4.5 m Varies
Section D-D	3.0-4.5 m Varies	-	8.0 m	-	3.0-4.5 m Varies

2.8.19 Lake Esplanade – Alternative Arrangement

2.8.19.1 Street function

A public transport orientated street.

This alternative arrangement for Lake Esplanade is proposed to have a considerable number of on-street parking removed in and replaced with an inbound bus lane. Any additional width gained should be reallocated to footpaths. It is proposed that on-street parking provision from YHA to the roundabout is retained to cater for Park and Trails visitors. This option provides additional resilience to peak traffic during busy/holiday periods and ensures the reliability of the bus services.

2.8.19.2 Street layout

The lanes are to be narrowed, and three new formal crossing points installed to enhance accessibility to the park. Consideration should be given to retaining the existing kerblines over the full length of Lake Esplanade, however localised widening/narrowing of the cross section may need to take place in next design stages. A continuous bus lane from the roundabout to the Crowne Plaza bus stop is proposed to prioritise Public Transport. In addition, a PT "queue-jump" is proposed at the end of the bus lane. The coach drop-off/idling area adjacent to the Wharf is worth retaining, considering the width of the carriageway is sufficient to preserve this.

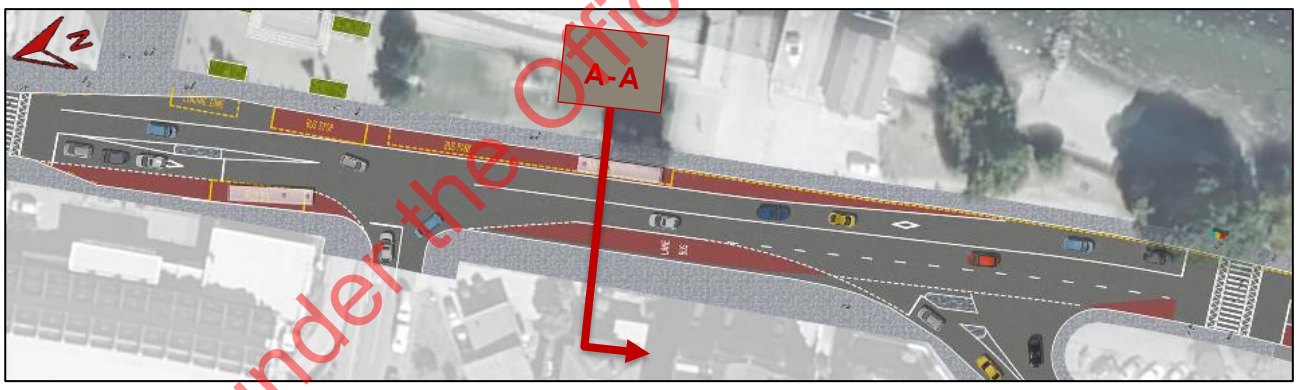

Figure 2-44: Lake Esplanade – Town End

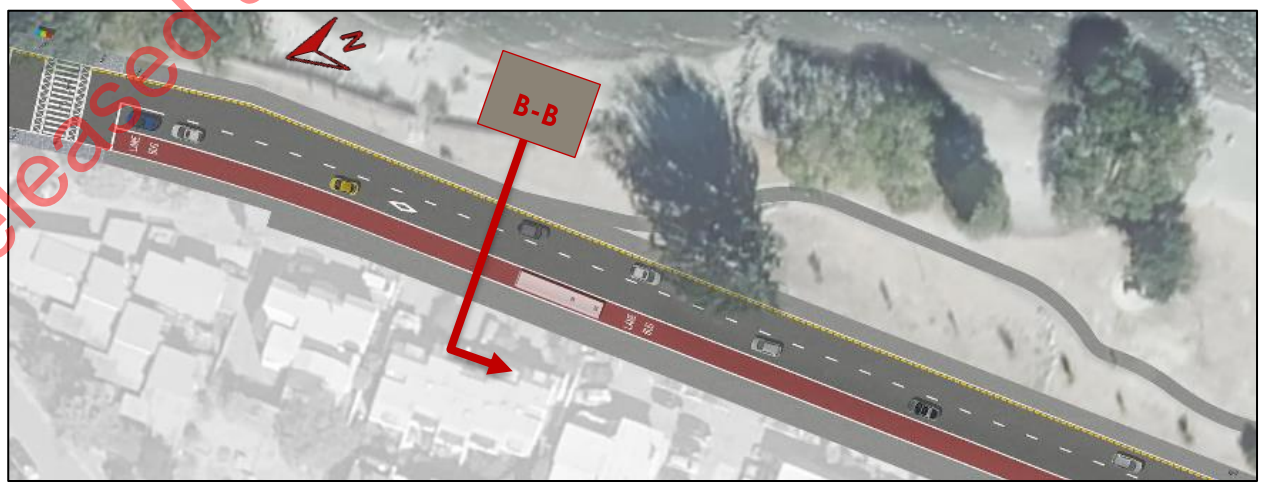

Figure 2-45: Lake Esplanade – Mid-block A

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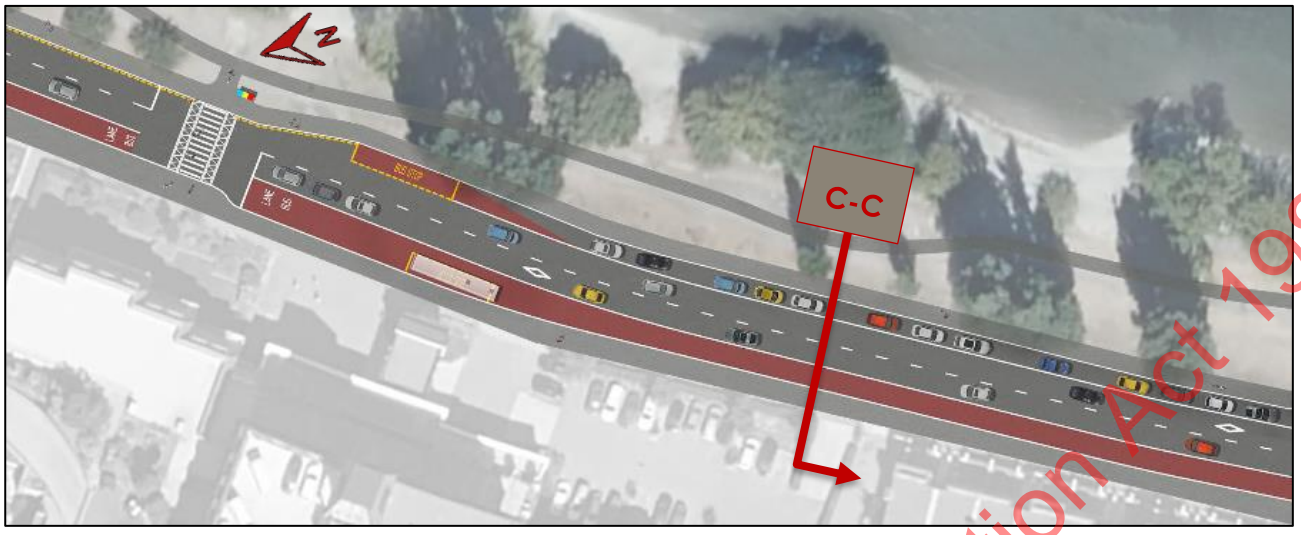

Figure 2-46: Lake Esplanade – Mid-block B

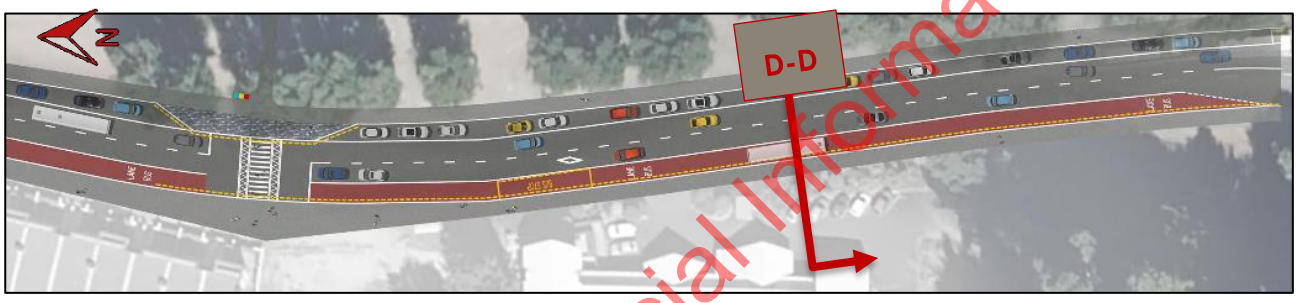

Figure 2-47: Lake Esplanade – Fernhill End

Cross sections are indicative as the existing carriageway width varies. A mix of sections **XA** and **XB** is proposed to provide critical public transport priority while retaining some of the on-street parking.

Table 2-22: Lake Esplanade cross sections

Cross Section	Footpath	Parking	Carriageway	Bus lane	Footpath
Section A-A	Varies	Varies ~3.0 m Coach drop off	6. 7m	3.2 m Bus lane	Varies
Section B-B	Varies	-	6.7 m	3.2 m Bus lane	Varies
Section C-C	Varies	Varies Min. 2.5 m	6.7 m	3.2 m Bus lane	Varies
Section D-D	Varies	Varies Min. 2.5 m	6.7 m	3.2 m Bus lane	Varies

2.8.20 Lake Esplanade – Alternative Arrangement: Minimal Option

2.8.20.1 Street function

No change to the street function.

2.8.20.2 Street layout

This arrangement is similar to the recommended option considering the parking is proposed to be reduced and made compliant with the QLDC Parking Strategy and any area gained through the removal of parking should be allocated to footways, softscape, and targeted amenity enhancements. However, the changes will not result in the narrowing of the carriageway and the kerblines will only locally be realigned.

This represents a low-cost option that could be progressed in short to medium term.

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2.8.21 Malaghan Street

2.8.21.1 Street function

A street with enhanced pedestrian realm or a shared zone.

A new cul-de-sac providing access to properties.

2.8.21.2 Street layout

The street shall form a two way no-exit link with a turning head near the existing graded area.

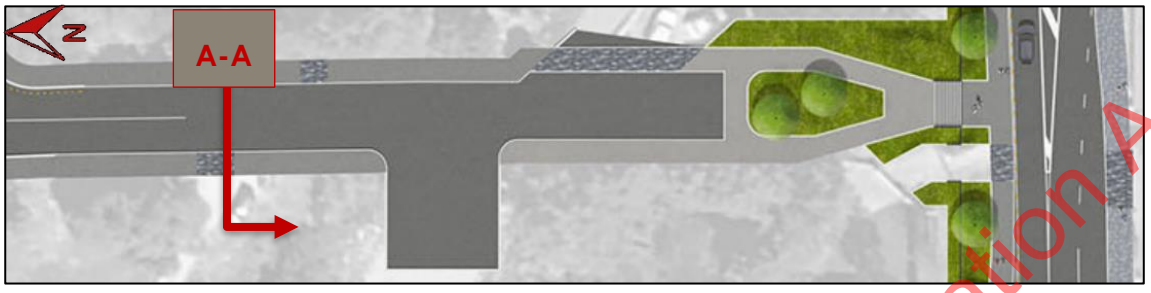

Figure 2-48 Malaghan Street

Cross sections are provided in the following table.

Table 2-23: Malaghan Street cross section

Cross Section	Landscape	Footpath	Carriageway	Footpath	Landscape
Section A-A	Varies	2.5 m	7.4 m	2.5 m	Varies

2.8.22 Man Street

2.8.22.1 Street function

Arterial.

Man Street provides a partial relief to Shotover Street, between Stanley Street and Lake Street. The steepness of the latter discourages heavy goods vehicles and visitors, and the alternative (via Brunswick Street) required a 170˚ turn, which can only be performed by small vehicles. At the same time Man Street provides the most direct access to the Gondola and the future Lake View development. An underground car par is accessible from Man Street, and few new hotels are proposed to have access from it. By widening the Footpaths, the street is expected to be more attractive to the pedestrians.

2.8.22.2 Street layout

A slight reduction in the carriageway width is proposed; sufficient to accommodate two narrower lanes and a wide median (noting it will be entirely utilised by the right turn pockets between Camp Street and the underground carpark). This will allow for widening of the existing narrow southern footpath to just over 2 m, and the northern footpath to around 4 m.

Figure 2-49: Man Street

Cross sections are provided below:

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Table 2-24: Man Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	2.1 m Varies due to topography	-	9.4 m	-	3.5 m Varies due to topography
Section B-B	2.1 m Varies due to topography	-	9.4 m	-	3.5 m Varies due to topography

2.8.23 Marine Parade

2.8.23.1 Street function

A shared zone.

This street forms part of the waterfront – a pedestrian centred area linking the Great War Memorial with the Wharf. This section should not be changed, noting that modifications at the tie-ins with Church Street and The Mall (these are discussed in following paragraphs respectively) will be required.

2.8.23.2 Street layout

A wide, shared zone, with a one-way traffic provision through a pavement colour delineated lane – cross section **XC**. The loading bay serving commercial plots is not well placed but has been considered essential to the local businesses and is proposed to be retained.

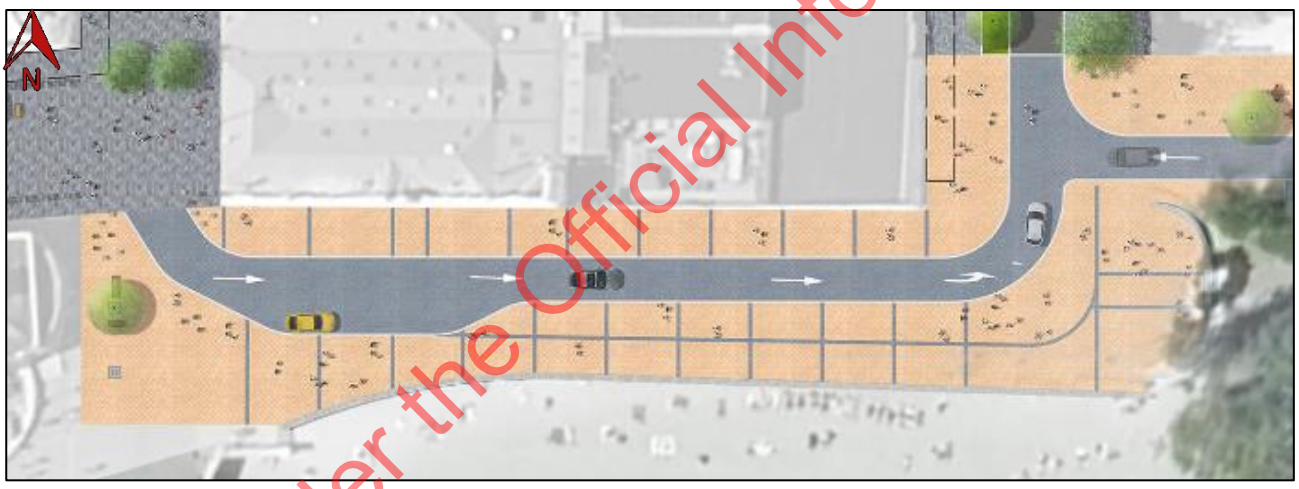

Figure 2-50: Marine Parade Existing Section

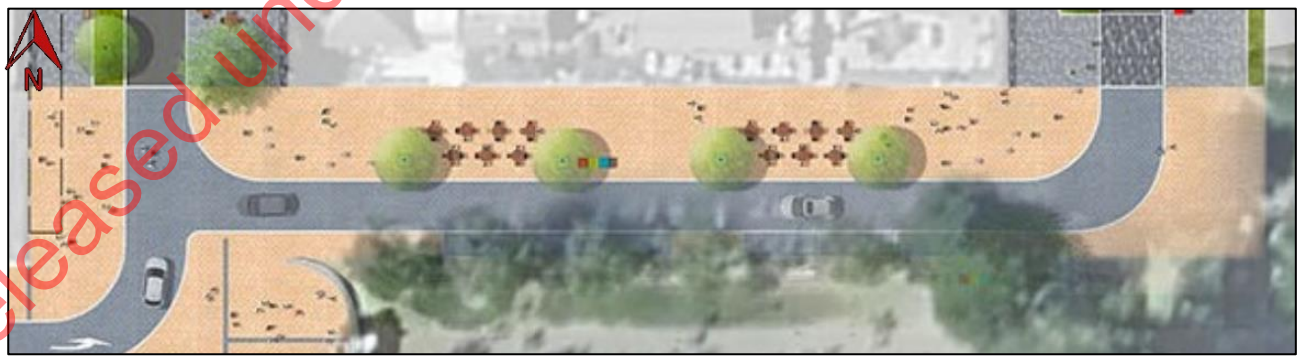

Figure 2-51: Marine Parade

There are no changes proposed to the section of Marine Parade between Church Street and Queenstown Mall. The section between Church Street and Earl Street is proposed to have a similar treatment as the existing Marine Parade shared zone, including surface type and colour selection.

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2.8.24 Melbourne Street

2.8.24.1 Street function

Arterial.

2.8.24.2 Street layout

Melbourne Street provides single lane travel from Frankton Road, through the new link, to Henry Street.

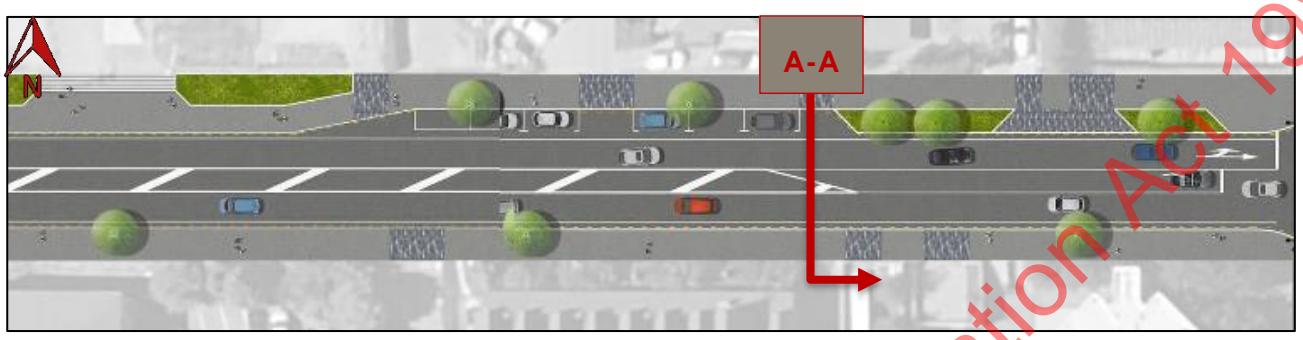

Figure 2-52: Melbourne Street

Cross Section	Footpath	Parking	Shoulder	Carriageway	Shoulder	Parking	Footpath
Section A-A	4.5 m	2.3 m	0.75 m	9.0 m (2.5 m median)	0.75 m	-	2.4 m

2.8.25 Memorial Street – Recommended Option

2.8.25.1 Street function

Arterial.

2.8.25.2 Street layout

The street links Man Street with Gorge Road and provides for single lane vehicle movements in each direction.

Figure 2-53: Memorial Street

Cross sections are provided below:

Table 2-25: Memorial Street cross sections

Cross Section	Footpath	Shoulder	Carriageway	Shoulder	Footpath
Section A-A	5.0 m	0.75 m	9.75 m	0.7 5m	3.0 m (varies)

2.8.26 Memorial Street – Alternative Arrangement

2.8.26.1 Street function

A street with enhanced pedestrian realm.

This arrangement is required in a scenario where the construction of Arterial Stage 2 is delayed.

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Memorial Street currently offers angled parking along the recreational grounds and an access to a car park on Camp Street. To improve vehicle access along this link, the removal of the on-street parking (side-friction) and a correction to the curve next to the Memorial Hall are proposed. This link should offer a more direct access to/from the Gondola (and in consequence discourage the route via Shotover Street). A wide, deck-like Footpath overlooking the recreational grounds is proposed to support the active travel route which connects thought the off-street carpark at Camp Street. The footpath on the opposite side of the carriageway is quite narrow and cannot be enhanced without further encroachment into the Grounds.

2.8.26.2 Street layout

It is proposed that the street has a 6.4 m carriageway, with appropriate widening on the bend, and generous footpaths. As discussed above, a section of footpath in front of Malaghan House is narrow however the new footpath on the other side of the road should complement the design and make it pedestrian friendly.

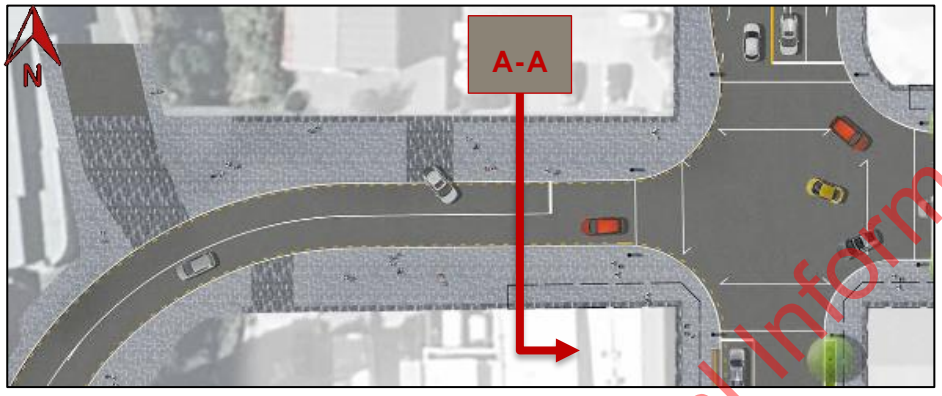

Figure 2-54: Memorial Street onto Stanley Street

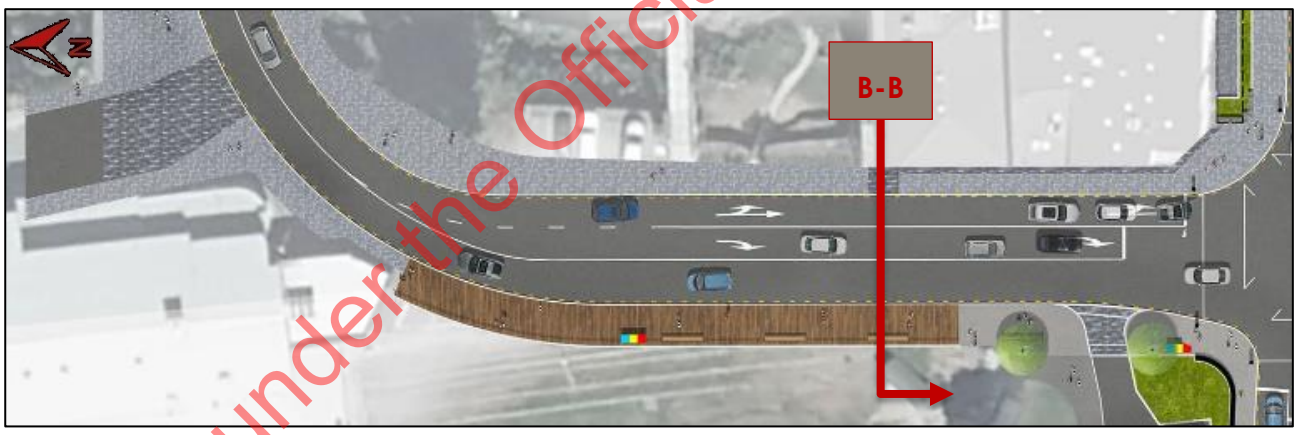

Figure 2-55: Memorial Street

Cross sections are provided below:

Table 2-26: Memorial Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A [Stanley Street]	7.0 m	-	7.0 m	-	Varies Min. 4.0 m
Section B-B	2.5 m Narrows down near Jucy	-	11.0 m Varies as retaining existing kerb	-	4.0 m boardwalk

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2.8.27 Rees Street

2.8.27.1 Street function

A street with enhanced pedestrian realm. Rees Street provides a critical active travel linkage between the Gondola and Town Core, and has been developed as part of the Active Travel business case. It serves numerous cafés, eateries, and shops and links the two main pedestrian tracts: The Mall and Beach Street.

2.8.27.2 Street layout

The street layout has been adopted from Queenstown Streetscapes (by LANDLAB and Beca), and conforms to the cross section **XC/XD**, as it still serves as a vehicular access to both Beach Street and Marine Parade yet forms a revitalized shared area.

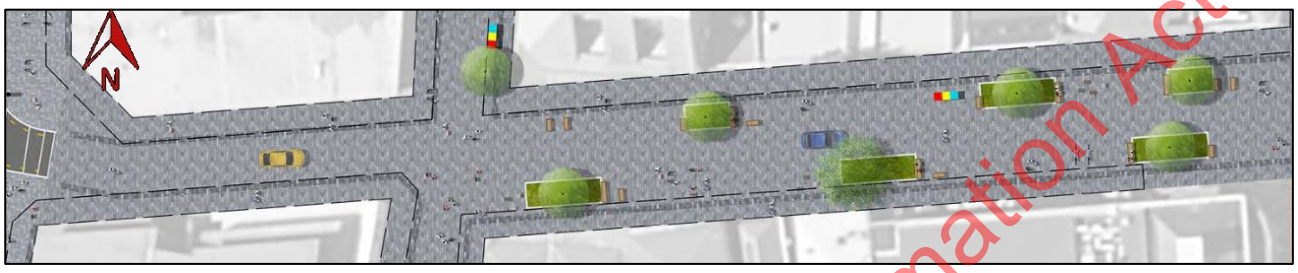

Figure 2-56: Rees Street

2.8.28 Searle Lane

Street function

A shared zone.

This picturesque lane offers access to a few discrete cafés, bars, and restaurants. Re-paving this pedestrian link should make it more welcoming. The vehicle movements are limited to delivery vehicles with a morning time only restriction which appears appropriate as patrons are expected to arrive for lunch and in evenings. Retaining the brick finish of the short spur connecting to The Mall should be considered to preserve their uniqueness.

2.8.28.1 Street layout

The layout remains unchanged, with new pavers proposed between the building façade, stairs, and other features currently present in the corridor.

Figure 2-57: Searle Lane and its links

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Cross section **XD** is the best fit for this lane. The width varies.

2.8.29 Shotover Street

2.8.29.1 Street function

A public transport orientated street.

Shotover Street is currently a key through route for traffic going towards the west (e.g. Glenorchy, Fernhill). While alternatives exist, Lake Street and Brunswick Street are very steep and not accessible to all vehicle types. Public Transport is expected to use Shotover Street frequently, linking the routes to Fernhill and Lake View.

While improvements to the public realm are essential, a clear delineation between footpaths and the carriageway is required to provide a safe balance between efficiency of traffic flows and pedestrian connectivity. A few signal controlled crossings in addition to signalised intersections are proposed to improve the safety of pedestrians crossing the street.

Cyclists are expected to follow the parallel Beach Street, however, are not prevented from using Shotover Street.

2.8.29.2 Street layout

Only a moderate change to the street layout is proposed: widening of the footpaths and removal of some on-street parking. Narrower through lanes should provide sufficient capacity for through traffic while further reducing the operating speeds through the Town Centre.

Figure 2-58: Shotover Street

Figure 2-59: Shotover Street

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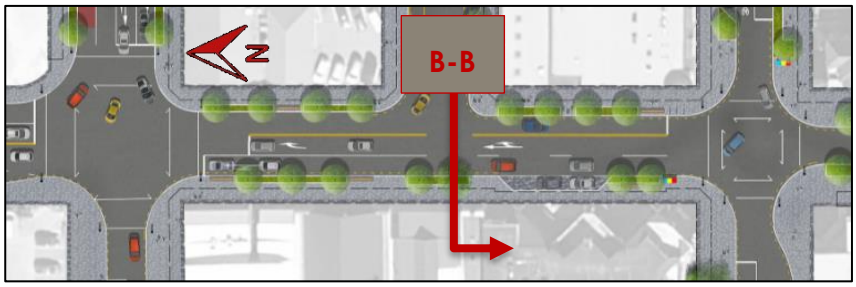

Figure 2-60: Shotover Street

Cross section **XB** is proposed; this allows for enhancements of the public realm and footpaths, while allowing the through traffic to be carried with efficiency.

Table 2-27: Shotover Street cross sections

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	Varies Min. 4.0m	2.3 m	6.4 m	2. 3 m	Varies[4] Min. 4.0 m
Section B-B	Varies Min. 4.0m	2.3 m	9.6 m	2.3 m	Varies Min. 4.0 m

2.8.30 Stanley Street – Preferred Option

The Public Transport Hub will not require provision for private vehicles, as such a bus only section will be established between Ballarat Street and Shotover Street. A section of Stanley Street connecting to Memorial street will be converted into a dead-end (although the ability to allow PT vehicles to use this space will not be precluded), which form this takes will depend on the accessibility requirements to the proposed developments on either side of this link. This section could be converted into a pedestrian plaza, with a Public Transport only through traffic provision allowing a direct access to the Arterials for buses.

Figure 2-61: Public Transport Hub

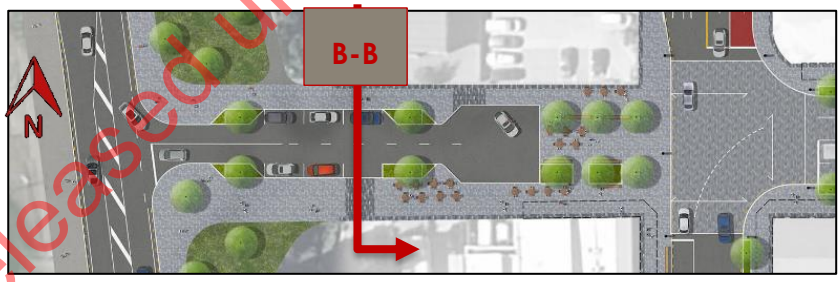

Figure 2-62: Stanley Street link off the realigned Memorial Street

Due to the new character of this link, a non-typical cross section is proposed.

[4] Due to road boundary constrains and properties being develop at the property boundary localized short sections of narrow footpath are expected, e.g. near the S-bend.

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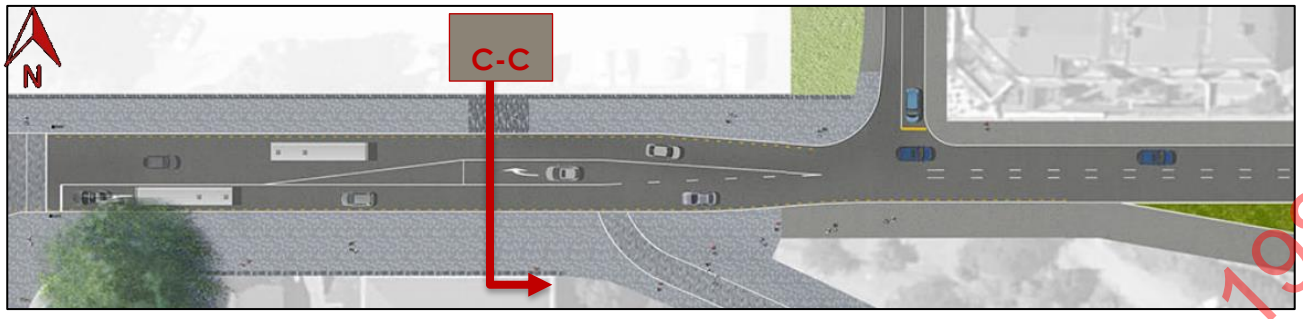

Figure 2-63: Stanley Street between Ballarat Street and Beetham Street

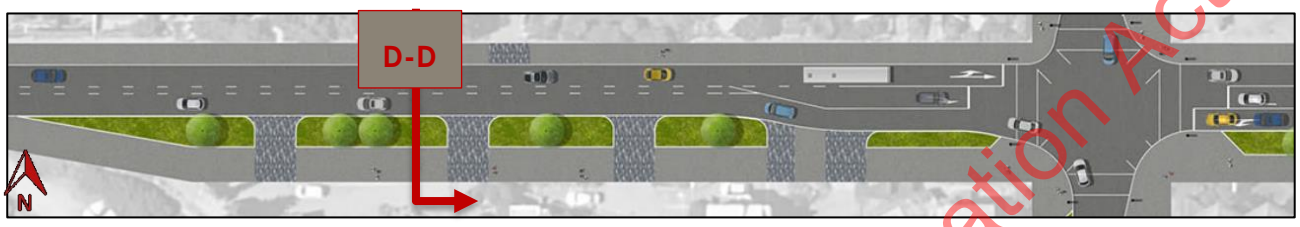

Figure 2-64: Stanley Street between Beetham Street and Sydney Street

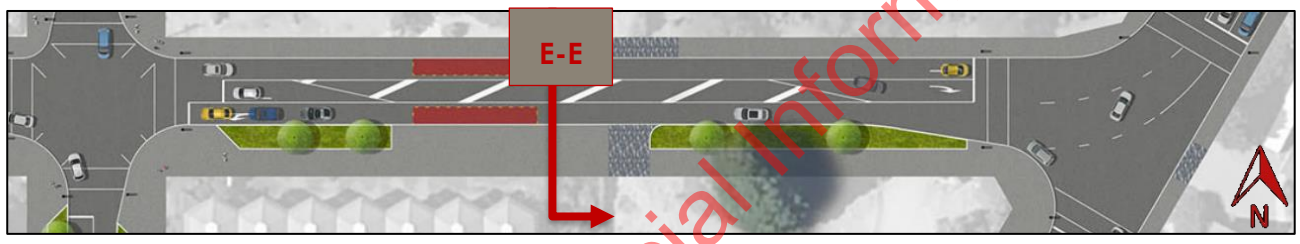

Figure 2-65: Stanley Street between Sydney Street and Frankton Road

Cross Sections.

Table 2-28: Stanley Street cross sections

Cross Section	Footpath	Lanes/ Bus bays	Carriageway	Lanes/ Bus bays	Footpath
Section A-A	5.0 m	3.2 m	7.0 m	3.2 m	5.0 m
Section B-B	3.0 m	3.2 m	~10.5 m (retain existing kerblines)	-	3.0 m
Section C-C	5.0 m	3.5 m	3.2 m Right Turn Pocket	3.5 m	5.0 m
Section D-D	3.0 m Varies	3.25 m	3.2 m Wide Centreline	3.25 m	3.0-9.0 m Varies
Section E-E	3.0 m Varies	3.25 m	3.25 m Central Median	3.25 m	3.0-7.5 m Varies

2.8.31 Stanley Street – Alternative Arrangement

2.8.31.1 Street function

A public transport orientated street.

Stanley Street forms part of the Public Transport Hub.

The function of Stanley Street will be modified between Coronation Drive and Shotover Street. An on-street public transport hub identified through the masterplan and this DBC provides for six bays with a potential to add additional two East of Ballarat Street. With the priority shift (from cars to public transport), provision of dedicated bus lanes and widening of the pedestrian facilities are required.

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2.8.31.2 Street layout

Figure 2-66: Stanley Street – Public Transport Hub

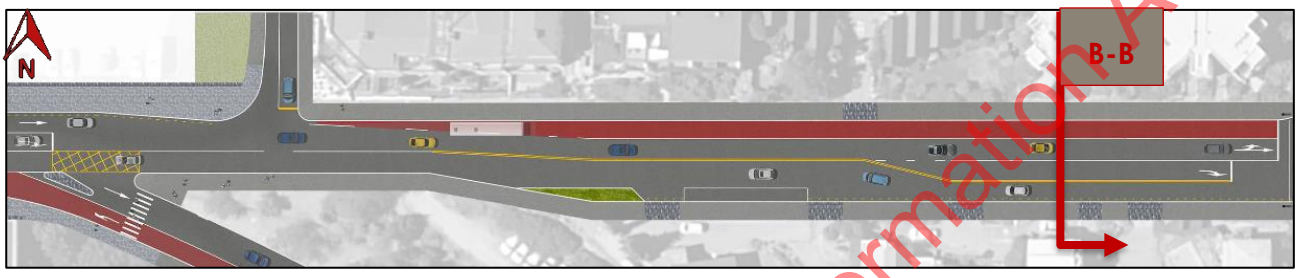

Figure 2-67: Stanley Street – Public Transport Priority

Due to the new character of this street section **XA** is used, noting that the bus separation can be fully accommodated only in one direction.

Table 2-29: Stanley Street cross sections

Cross Section	Footpath	Bus Lanes/bays	Carriageway	Bus Lanes/bays	Footpath
Section A-A	5.0 m	3.2 m	7.0 m	3.2 m	5.0 m
Section B-B	3.0 m	3.2 m	~10.5 m (retain existing kerblines)	-	3.0 m

2.8.32 Sydney Street

2.8.32.1 Street function

A street with enhanced pedestrian realm.

Sydney Street provides accesses to several hotels and acts as the most direct link between Hallenstein Street and Coronation Drive. Being relatively flat it offers comfortable pedestrian/cycle connectivity between the Queenstown Hill area and the Botanic Gardens and Town Centre.

2.8.32.2 Street layout

As part of the intersection improvements a moderate enhancement to Sydney Street is proposed. To visually narrow the lanes, while retaining the existing kerb lines, formalised on-street parking stalls with an increased width is proposed. The parking is broken with landscaped areas encroaching into the carriageway to encourage lower speeds. Planters currently placed in the median can be retained as they provide a unique street character.

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Figure 2-68: Sydney Street

Only minor changes are proposed to the cross section, with the kerb lines retained except for the landscape buildouts. The recommended width of the lanes is 3.5 m and the width of parking bays adjusted as required not to affect kerbs.

Table 2-30: Sydney Street Cross Section

Cross Section	Footpath	Parking	Carriageway	Parking	Footpath
Section A-A	3.7 m	3.4 m	7.0 m	3.2 m	3.0 m

2.8.33 The Mall

2.8.33.1 Street function

A pedestrian mall and shared zone.

The Mall functions as Queenstown's 'High Street' and carries pedestrian traffic only. Many buildings have verandas providing limited shelter from elements, noting that these do not extend over the full width of the street.

2.8.33.2 Street layout

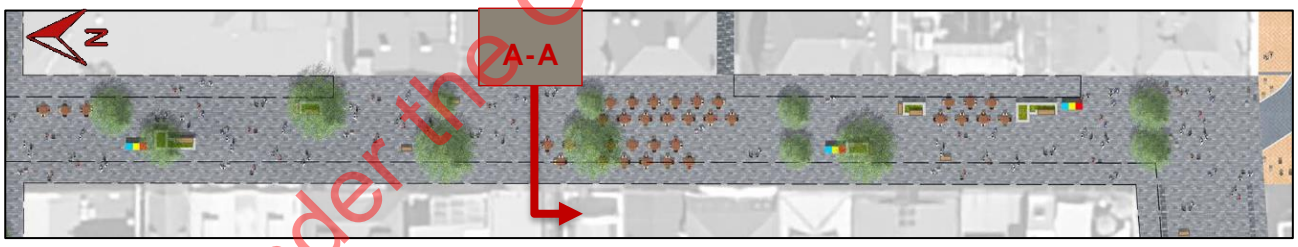

Figure 2-69: The Mall

Cross sections

There is no change proposed to the existing cross section, however a surface upgrade is recommended to align the pavement type and texture with that of the revitalized Town Centre.

Table 2-31: The Mall cross section

Cross Section	Pedestrian Zone
Section A-A	12m (Typical)

2.8.34 Templeton Way – Alternative Design

2.8.34.1 Street function

A shared zone.

This arrangement is required in a scenario when the construction of Arterial Stage 2 is delayed.

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Templeton Way offers access to the library and to the Boundary Street Car Park. In addition, the squash court and Memorial Centre are serviced by this one-way link. The bridge over the creek has a pronounced crest and limits the use of Templeton Way by larger vehicles, but this encourages pedestrian traffic to/from the car park. As a result, this link operates more like a shared zone - it is proposed to retain this character.

2.8.34.2 Street layout

By changing the intersection form at Memorial Street, a further reduction in vehicular traffic is expected. An opportunity exists to remove road markings and change the surfacing to formalize this link as a primary pedestrian shared zone.

Cross sections

Retain as existing, or upgrade to a more formal shared zone.

2.8.35 Thompson Street

2.8.35.1 Street function

Arterial.

2.8.35.2 Street layout

Thompson Street should consist of single lane each direction, a flush median, and a shoulder. The layout has been adopted from the *Lake View* development drawings by Beca.

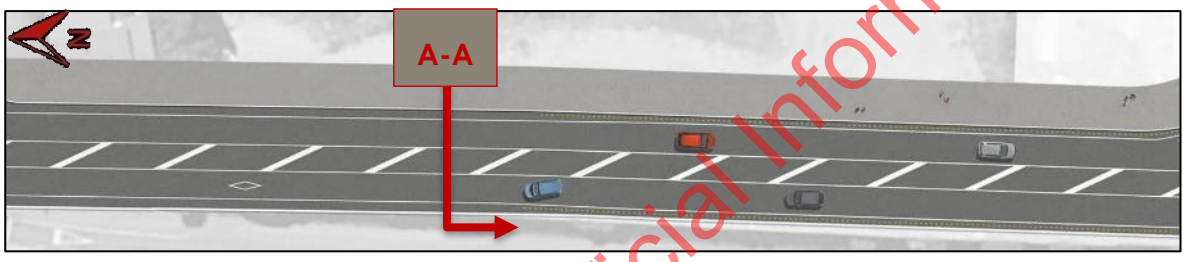

Figure 2-70: Thompson Street

Cross sections are shown below

Table 2-32: Thompson Street cross sections

Cross Section	Footpath	Shoulder	Carriageway	Shoulder	Footpath
Section A-A	5.0 m	1.00 m	8.5 m	0.355 m	-

2.8.36 Thompson Street (link)

2.8.36.1 Street function

Arterial.

2.8.36.2 Street layout

Thompson Street link to the roundabout should consist of a single carriageway with generous shoulders, and a Footpath on the northern side.

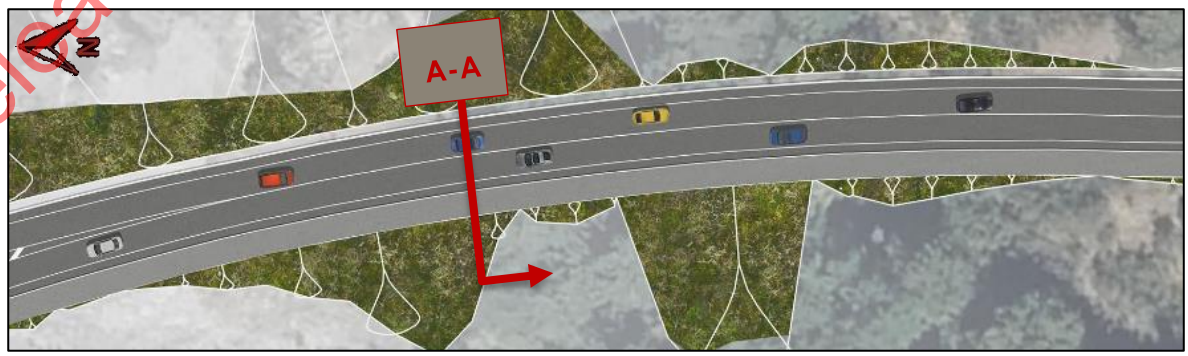

Figure 2-71: Thompson Street (link)

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Cross sections are shown below:

Table 2-33: Thompson Street cross sections

Cross Section	Footpath	Shoulder	Carriageway	Shoulder	Footpath
Section A-A	-	1.25 m	6.5 m	1.25 m	2.5 m

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3. Signs and Markings

Signage should be clear, legible, and understandable for road users. The design work to date has sought to ensure that layout of the proposed road changes can be signed in a straightforward manner.

Signage and road marking must comply with MOTSAM, wayfinding signs must comply with the Queenstown Town Centre Public Realm Design Guidelines.

3.1 Design Standards and Guidelines

The following standards and guidelines are applicable to the road signs and markings design:

- Land Transport Rule: Traffic Control Devices 2004 (including amendments)
- NZ Transport Agency Traffic Control Devices Manual
- NZ Transport Agency Manual of Traffic Signs and Markings, Parts 1 and 2.

No unusual or bespoke situations requiring non-standard application of signs or marking are anticipated.

> ### Additional requirements for the Town Centre
>
> Additional themed way-finding signs should be provided throughout the Town Centre, additional plates for historic locations and buildings to be stylised as per the landscaping project guidelines, and Queenstown Town Centre Public Realm Design Guidelines.

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4. Pavement

4.1 Design standards and Guidelines

The following standards and guidelines are applicable to the pavement design:

- NZ Transport Agency New Zealand Guide to Pavement Structural Design 2017.
- Austroads Guide to Pavement Technology.

4.2 Preliminary pavement design findings

A Structural AC design has been adopted for most streets. As the traffic volumes are expected to be high, including heavy vehicles and commuter traffic the NZTA M10:2014 Specification for Dense Graded and Stone Mastic Asphalts classification of Very Heavy has been adopted, as some of the movements will be either climbing, descending and low speed.

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 and Waka Kotahi's Supplement and traffic information taken from the business case modelling.

The subgrade bearing capacity has been based on recent experiences in the local area with a design CBR of 6% being adopted for the feasibility level designs.

The pavement configuration is 160 mm of Structural AC, 350 mm of unbound granular materials over a subgrade CBR 6.

Note: that this preliminary pavement design is based on local knowledge and expertise and is for feasibility purposes only. Pavement design will need to be confirmed through detailed design with pavement test pits, materials testing and detailed pavement design.

Layer Type	Layer Characteristics	Thickness [mm]	Modulus [MPa]	Ev/Eh	Critical Strain	Damage (%)	Allowable HVAG	Allowable ESA	Details
Asphalt	AC14	160	3200.0	1.00	208	N/A	N/A	N/A	
Granular	gravel	70	190.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	151.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	120.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	95.000	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	76.000	2.00	N/A	N/A	N/A	N/A	
Subgrade	User Defined	0	60.000	2.00	416	7.167E-003	3.586E+009	2.510E+009	

Figure 4-1: Austroads output

4.3 Pavement Design Geotechnical Testing requirements

Geotechnical testing required for pavement design.

- Existing section of road:
  - Falling Weight Deflectometer
  - One pavement pit every 100 m (minimum 3 pavement pits per link)
    - Logging for each pit
    - Soaked CBR
    - Atterberg limits on basecourse every second pit or material change
    - Grading of the basecourse and subbase

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        - Scala penetrometer in the base of the test pit
- Greenfields section:
    - One test pit every 100 m down to proposed subgrade level (minimum 3 test pits per link)
        - Scala penetrometer in the base of each test pit
        - Soaked CBR from each pit
        - Logging for each pit

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5. Lighting

5.1 General Lighting Design Requirements

All lighting design shall be completed in accordance with the QLDC Southern Light technical specifications, NZTA (M30 and M26) and the applicable parts of AS/NZS 1158 (lighting for roads and public spaces). All new lighting equipment (luminaires, poles, and mounting hardware) shall comply with the durability and performance requirements of NZTA M26 (poles) and M30 (luminaires). The new equipment shall be on the relevant NZTA approved pole and LED luminaire lists.

5.2 Existing Infrastructure

Wherever possible new lighting poles will be specified to achieve the maximum optimal design spacings, however this may be not practical in areas where there is existing infrastructure. If there are existing power poles (and overhead lines) present it may not be possible to use new lighting poles, and in such cases the use of power pole mounted bracket arms may be required to support the new LED luminaires. Where this is required the design shall take into account any particular electricity network company rules and procedures including maintaining adequate safety clearances between the new lighting equipment and the existing overhead power lines.

5.3 Lighting Design Deliverables

The final lighting design deliverables shall include lighting layout drawings (showing all new luminaire locations, luminaire descriptions, pole types and dimensions) and a design report detailing all the design methodology and calculation results. Other design deliverables including specifications, schedule of prices and engineer's estimates can be provided if required by the client.

5.4 Main Arterial Lighting

The main arterial route(s) shall be provided with Category V lighting in accordance with AS/NZS 1158.1.1 (Vehicular traffic (Category V) lighting - Performance and design requirements) based on the selection criteria listed below in Table 2.1 (extracted from AS/NZS 1158.1.1). The client shall confirm what subcategory (V1 to V4) of lighting is applicable.

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TABLE 2.1

CATEGORY V LIGHTING AND TYPICAL APPLICATIONS

Typical applications		Lighting subcate
Description of road or area type	**Operating characteristics**	
al or main roads in central and regional activity centres ital and major provincial cities, and other areas with abutting traffic generators	—Mixed vehicle and pedestrian traffic —High to very high vehicle volume —High to very high pedestrian volume —Moderate to low vehicle speeds —Stationary vehicles alongside the carriageway —Through and local traffic —High traffic generation from abutting properties	V1
al roads that predominantly carry through traffic from gion to another, forming principal avenues of unication for traffic movement, with major abutting generators	—Mixed vehicle and pedestrian traffic —High vehicle volume —High pedestrian volume —Moderate to high vehicle speeds —Stationary vehicles alongside the carriageway —Through and local traffic —High traffic generation from abutting properties	V2
ays, motorways and expressways consisting of divided ays for through traffic with no access for traffic between hanges and with grade separation at all intersections	—Vehicle traffic only —High to very high vehicle volume —High speeds	V3
al roads that predominantly carry through traffic from gion to another, forming principal avenues of unication for traffic movements	—Mixed vehicle and pedestrian traffic —Moderate to high vehicle volume —High pedestrian volume —Moderate to low vehicle speeds —Stationary vehicles alongside the carriageway —Through and local traffic —Moderate traffic generation from abutting properties	
rterial or principal roads which connect arterial or main to areas of development within a region, or which carry directly from one part of a region to another part	—Mixed vehicle and pedestrian traffic —Moderate traffic volume —Low pedestrian volume —Moderate to low vehicle speeds —Low traffic generation from abutting properties	V4* or V5
is the minimum subcategory recommended for application in New Zealand.		

Figure 5-1: Category V lighting and typical applications

Once the applicable subcategory has been confirmed detailed design will be carried out based on achieving the applicable light technical parameters (LTPs) provided in table 2.2 which has been extracted from AS/NZS 1158.1.1 and pasted below. The applicable design areas shall include any straight sections, curves, intersections, and other specified locations (such as splitter islands, pedestrian refuges, and converging/merging traffic lanes).

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TABLE 2.2

VALUES OF LIGHT TECHNICAL PARAMETERS FOR CATEGORY V LIGHTING

2	3	4	5	6	7	8	9
Light technical parameters							
For straight sections, curves and intersections						For intersections and other specif locations	
verage riageway inance[c,d] $(\bar{L})$ cd/m²	Overall uniformity[a,d] (U_o)	Longitudinal uniformity[d] (U_L)		Threshold increment[e] (TI)	Surround verge illuminance[d] (E_s)	Point horizontal illuminance[c,d] (E_{Ph})	Illuminance (horizontal) uniformity[e] Cat V (U_{E1})
		In Australia	In New Zealand	%	%	lx	
1.5	0.33	0.5	0.3	20	50	15	8
1.0	0.33	0.5	0.3	20	50	10	8
0.75	0.33	0.5	0.3	20	50	7.5	8
0.5	0.33	0.5	0.3	20	50	5	8
0.35	0.33	0.5	0.3	20	50	3.5	8

for U_o may be less than 0.33, provided the corresponding value for $\bar{L}$ is 10% or more above the specified minimum, but shall in no c

ubcategory recommended for application in New Zealand.

ntained.

ved by being greater than or equal to the applicable table value.

ed by being less than or equal to the applicable table value.

Figure 5-2: Values of fight technical parameters for category V lighting

5.5 Local Roads Lighting

The local roads shall be provided with Category PR lighting in accordance with AS/NZS 1158.3.1 (Pedestrian area (Category P) lighting - Performance and design requirements) based on the selection criteria listed below in Table 2.1 (extracted from AS/NZS 1158.3.1). The client shall confirm what subcategory (PR1 to PR6) of lighting is applicable.

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TABLE 2.1

LIGHTING SUBCATEGORIES FOR ROAD RESERVES IN LOCAL AREAS

1	2	3	4	5	6
Type of road or pathway		**Selection criteria[a,b]**			**Applicable lighting subcategory[c,d]**
General description	**Basic operating characteristics**	**Pedestrian/ cycle activity**	**Fear of crime**	**Need to enhance amenity**	
Collector roads or non-arterial roads which collect and distribute traffic in an area, as well as serving abutting properties	Mixed vehicle and pedestrian traffic	N/A	High	N/A	PR1
		High	Medium	High	PR2
		Medium	Low	Medium	PR3[f] or PR4[f]
		Low	Low	Low	PR5
Local roads or streets used primarily for access to abutting properties, including residential, commercial and industrial precincts		N/A	High	N/A	PR1
		High	Medium	High	PR2
		Medium	Low	Medium	PR3[f] or PR4[f]
		Low	Low	Low	PR5
		N/A	N/A	N/A	PR6[e]
Common area, forecourts of cluster housing		N/A	High	N/A	PR1
		High	Medium	High	PR2
		Medium	Low	Medium	PR3[f] or PR4[f]
		Low	Low	Low	PR5

Figure 5-3: Lighting subcategories for road reserves in local areas

Once the applicable subcategory has been confirmed detailed design will be carried out based on achieving the applicable light technical parameters (LTPs) provided in table 3.3 which has been extracted from AS/NZS 1158.3.1 and pasted below. The applicable design areas shall include the road reserve width (along the full length of each roadway) and other specified areas including intersections, splitter islands, pedestrian refuges, and local area traffic management devices (LATMs).

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TABLE 3.3

VALUES OF LIGHT TECHNICAL PARAMETERS FOR ROADS IN LOCAL AREAS

1	2	3	4
Lighting subcategory	Light technical parameters (LTP)		
	Average horizontal illuminance[a,b] ($\bar{E}_h$) lx	Point horizontal illuminance[a,b] (E_{Ph}) lx	Illuminance (horizontal) uniformity[c] Cat. P (U_{E2})
PR1	7	2	8
PR2	3.5	0.7	8
PR3[e]	1.75	0.3	8
PR4[d,e]	1.3	0.22	8
PR5[d,e]	0.85	0.14	10
PR6[d]	0.7	0.07	10

Figure 5-4: Values of fight technical parameters for roads in local areas

5.6 Public Activity Areas and Shared Spaces

Any public activity areas (including shared spaces and bus interchange areas with a mixture of vehicles and pedestrians) shall be provided with Category PA lighting in accordance with AS/NZS 1158.3.1 (Pedestrian area (Category P) lighting - Performance and design requirements) based on the selection criteria listed below in Table 2.3 (extracted from AS/NZS 1158.3.1). The client shall confirm what subcategory (PA1 to PA3) of lighting is applicable.

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TABLE 2.3

LIGHTING SUBCATEGORIES FOR PUBLIC ACTIVITY AREAS (EXCLUDING CAR PARKS)

1	2	3	4	5	6
Type of area or activity		Selection criteria[a,b]			Applicable lighting subcategory
General description	Basic operating characteristics	Night time vehicle movements	Fear of crime	Need to enhance amenity	
Areas primarily for pedestrian use, e.g. city, town, suburban centres, including outdoor shopping precincts, malls, open arcades, town squares, civic centres	Generally pedestrian movement only	N/A Medium Low	High Medium Low	High Medium N/A	PA1 PA2 PA3
Transport terminals and interchanges, service areas[c]	Mixed pedestrian and vehicle movement	High Medium Low	High Medium Low	High Medium N/A	PA1 PA2 PA3

Figure 5-5: Lighting subcategories for public activity areas

Once the applicable subcategory has been confirmed detailed design will be carried out based on achieving the applicable light technical parameters (LTPs) provided in table 3.5 which has been extracted from AS/NZS 1158.3.1 and pasted below. The applicable design areas shall include the road reserve width (along the full length of each area) associated with pedestrian only areas and any shared spaces and bus interchanges where there is a mixture of pedestrian and vehicle movements.

TABLE 3.5

VALUES OF LIGHT TECHNICAL PARAMETERS FOR PUBLIC ACTIVITY AREAS (EXCLUDING CAR PARKS)

1	2	3	4	5
	Light technical parameters (LTP)			
Lighting subcategory	Average horizontal illuminance[a,b] ($\bar{E}_h$) lx	Point horizontal illuminance[a,b] (E_{Ph}) lx	Illuminance (horizontal) uniformity[c] Cat. P (U_{E2})	Point vertical illuminance[a,b,d] (E_{Pv}) lx
PA1	21	7	8	7
PA2	14	4	8	4
PA3	7	2	8	2

Figure 5-6: Values of light technical parameters for public activity areas

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5.7 Pedestrian (Zebra) Crossings:

All newly formed pedestrian (Zebra) crossings shall be provided with Category X lighting in accordance with AS/NZS 1158.4 (Lighting of pedestrian crossings) based on the selection criteria listed below in Table 3.4 (extracted from AS/NZS 1158.4). The client shall confirm what subcategory (X1 to X2) of lighting is applicable.

TABLE 3.4

SUBCATEGORY SELECTION CRITERIA FOR PEDESTRIAN CROSSING LIGHTING

Subcategory of road lighting	Pedestrian volumes on crossing	Applicable lighting subcategory
Category V	High	X1
Category V	Low	X1
Category P	High	X1
Category P	Low	X2

Figure 5-7: Lighting subcategories for pedestrian crossings

Once the applicable subcategory has been confirmed detailed design will be carried out based on achieving the applicable light technical parameters (LTPs) provided in table 3.5 which has been extracted from AS/NZS 1158.4 and pasted below. The applicable design areas shall include the full extents of the marked crossing on the road, 3m wide surrounds (at each end of the crossing) and a vertical plane corresponding to the centreline of the crossing.

TABLE 3.5

VALUES OF LTP FOR NEW ZEALAND PEDESTRIAN CROSSINGS
(Calculations based on the light output from pedestrian crossing luminaires only)

1	2	3	4	5
Lighting subcategory	Light technical parameters			
	Point horizontal illuminance—Marked crossing*† (E_{Ph}) lx	Point horizontal illuminance—Surrounds*† (E_{Ph}) lx	Point vertical illuminance—Marked crossing*† (E_{Pv}) lx	Glare control and UWLR
X1	30	10	20	See Clause 3.3.5(d) and (e)
X2	20	6	12	

Figure 5-8: Values of LTP for New Zealand pedestrian crossings

The following illustration (Figure 3.5) has been extracted from AS/NZS 1158.4 and pasted below to provide a visual representation of each applicable design area including the point vertical illuminance requirements.

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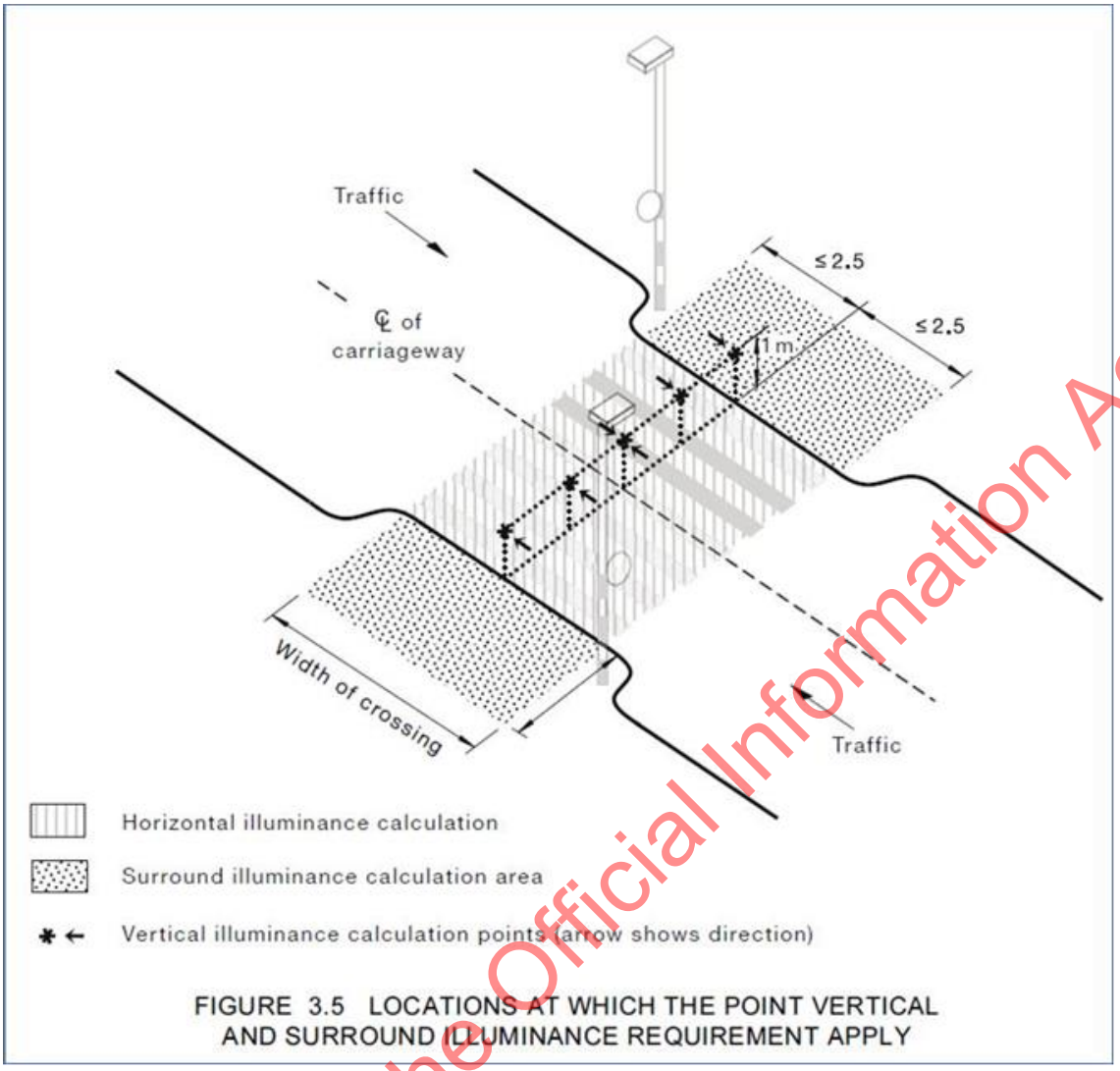

Figure 5-9: Locations at which the point vertical and surround illuminance requirement apply

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6. Geotechnical Design

No geotechnical assessment has been undertaken for streets in the Queenstown Town Centre.

The historic geotechnical testing for the Queenstown Arterials has been reviewed. Project Manawa, comprising new QLDC buildings and associated commercial spaces, is proposed between Beetham Street and Gorge Road. The geology along Melbourne Street is expected to comprise the schist bedrock of Queenstown Hill at a depth of approximately 20 m, overlain by silty lake deposits at depth with at alluvium and beach deposits to surface level. Refer to the preliminary geotechnical assessment report (PGAR).

6.1 Design Standards

The embankments and retaining walls shall be designed in accordance with the following Standards:

- The Waka Kotahi NZ Transport Agency Bridge Manual
- NZS 1170.5:2004.
- New Zealand Building Code
- MBIE - Earthquake geotechnical engineering practice Modules 1- 3

6.2 Geotechnical Investigations

Pavement test pits are proposed along the length from Dublin Street to Gorge Road, with additional pits above the Project Manawa site where the road is not adjacent to proposed retaining walls. Borehole investigations are proposed at the Project Manawa site between Beetham Street and Gorge Road. A line of boreholes is proposed along Melbourne Street to inform the design of the wall, and a second line of boreholes up slope is proposed to inform the anchor design.

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7. Structural Design

Retaining walls are expected to be required in several locations:

- Melbourne Street
- Henry Street
- Memorial Street
- Man Street
- Thompson Street
- Thompson Street Link to the roundabout
- A few locations around the roundabout

Due to the expected retained height required (up to 8 m) it is expected that these walls will be anchored, with anchors angled and penetrating into the schist bedrock.

7.1 Design Standards

The embankments shall be designed in accordance with the following Standards:

- The Waka Kotahi NZ Transport Agency Bridge Manual
- NZS 1170 Part 0, Part 1, and Part 5
- New Zealand Building Code, B1, Structure and B2 Durability
- Relevant material standards for the retaining wall type.
- MBIE - Earthquake geotechnical engineering practice Module 6: Earthquake resistant retaining wall design

7.2 Investigations

A line of boreholes is proposed along Melbourne Street to inform the design of the wall, and a second line of boreholes up slope is proposed to inform the anchor design.

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8. Structural Design - Overpass

8.1 Design Standards

The overpass shall be designed in accordance with the following Standards:

- The NZ Transport Agency Bridge Manual
- NZS 1170 Part 0, Part 1, and Part 5
- New Zealand Building Code, B1 Structure, B2 Durability, F4 Safety from falling
- NZS 3101: Parts 1 and 2: 2006 Concrete Structures Standard
- SNZ TS3404:2018 - Durability required for steel structures and components
- NZS 3404: Parts 1 and 2: 1997 - Steel Structures Standard
- NZS 5431:2016 - Structures steelwork - Fabrication and erection

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9. Utilities and Services Stormwater Design

The Waka Kotahi NZ Transport Agency Stormwater Treatment Standard for Road Infrastructure sets the framework for stormwater management and aims to "provide the best practice for both stormwater quantity and quality control in the absence of local requirements or where local requirements are limited, Waka Kotahi will undertake to demonstrate environmental responsibility".

The following stormwater aspects shall be considered for the project to provide sufficient information to enable the processing of resource consent applications.

Table 9-1 Stormwater Considerations

Stormwater Aspect	Significance
Pavement drainage quantity and quality	Development of stormwater treatment concepts and their impact on off-road land requirements
Wider catchment issues	Flooding impacts

Ideally the discharge of water in the future needs to be looked at from a larger land use development perspective. This is beyond the scope of the detailed business case.

The stormwater system should be designed to meet the QLDC requirements for primary systems. Secondary system requirements should be considered as part of any larger land use development perspective.

Table 9-2 Stormwater Levels of Service for Design

Stormwater System	QLDC	Waka Kotahi	NZ Building Code (E1)
Primary System (pipes)	20-year return event	10-year return event	10-year return event
Secondary System (Overland flowpath)	100-year return event plus 150 mm freeboard	100-year return event plus 150 mm freeboard	50-year return event plus 500 mm freeboard

9.1 Design standards and Guidelines

The following standards and guidelines are applicable to the stormwater design:

- Draft P46 State Highway Stormwater Specification, NZ Transport Agency, 2015
- Stormwater Treatment Standard for State Highway Infrastructure, NZ Transport Agency, 2010

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10. Landscaping

Street amenity is created along the arterial including both street trees and low-level shrubs and groundcover plantings. Topographical and property boundary constraints vary along the Stage 1 arterial and the landscape design proposals vary to suit.

The top portion on the flatter section of Melbourne Street allows the greatest opportunity for soft landscape treatments. Street trees are located on both sides of the street and generous sections of low planting is provided on the northern side. Median planting is not practical as the turning requirements into existing properties and businesses is maintained. In the section between Sydney Street and Beetham Street trees are proposed both sides with some pockets of low-level planting is proposed adjacent to some retained on street parking. The retaining wall at the interface with St Joseph's Parish is reformed with a new entrance stair to provide the transition from the footpath up to the front of the church. Some planting is retained and reformed around the street interface with the church.

The steeper section of the arterial leading down from the parish church to the my-pad hotel is a simplistic and function design, some street trees are proposed but generally in this section minimal widths of the street do not allow for additional planting. Towards the bottom of the slope and the Malaghan Street cul-de-sac opportunities for soft landscape interventions are present including street trees and low-level planting over retaining structures and changes of level.

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11. Environmental and Social Factors

Social and environmental screen documents are not provided as part of this delivery and have been included in the Arterials Fast Track Consenting/Designation process which is running in parallel.

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12. Construction Method Statement

Given the current level of design input construction methodology and buildability has not been considered in detail. The following factors are an indication of what should be considered further in detailed design:

- Temporary access to construct retaining walls
- Temporary laydown and site facilities areas
- Overall traffic management and maintenance of access to businesses, properties, and the general Town Centre area during construction
- Particular access to the church and school
- Materials to be used and methodology for transporting to and within the site.

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Appendix C5 Frankton Preliminary Design Philosophy Statement

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FRANKTON TO QUEENSTOWN SSBC AND FRANKTON SSBC

PRELIMINARY DESIGN PHILOSOPHY STATEMENT

PREPARED FOR THE WAKA KOTAHI NZ TRANSPORT AGENCY

October 2020

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This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

QUALITY STATEMENT

PROJECT MANAGER

s 9(2)(a) [redacted]

s 9(2)(a) [redacted]

s 9(2)(a) [redacted]

PROJECT TECHNICAL LEAD

s 9(2)(a) [redacted]

APPROVED FOR ISSUE BY

s 9(2)(a) [redacted]

DUNEDIN
Level 3 John Wickliffe House, 265 Princes Street, Dunedin 9016
TEL +64 3 477 0885, FAX +64 3 477 0616

REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
1	05/06/20	Draft	s 9(2)(a) [redacted]	s 9(2)(a) [redacted]		
2	4/10/20	Final	s 9(2)(a) [redacted]	s 9(2)(a) [redacted]	s 9(2)(a) [redacted]	[redacted]

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Waka Kotahi NZ Transport Agency

Frankton to Queenstown SSBC and Frankton SSBC

Preliminary Design Philosophy Statement

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1. Introduction

1.1 Background

In 2018 Waka Kotahi NZ Transport Agency (Waka Kotahi) contracted Stantec, WSP, Abley, and Jasmax to prepare the Queenstown Town Centre Detailed Business Case (DBC) and the Frankton to Queenstown Single Stage Business Case (SSBC). The scope of the business case was extended to include the SH6 Grant Road to Kawarau Falls Bridge SSBC in late 2019 and the SH6 Frankton Ladies Mile Highway, which will further be referred to as the Frankton SSBC

This document has been prepared to record the preliminary design philosophy for the SH6A Frankton to Queenstown and SH6 Frankton as part of those SSBC's. A separate document has been prepared for the Queenstown Town Centre DBC (provided separately). Both business cases build on previous works related to the improvements of the road network within Queenstown and Frankton.

The project scope is shown in Figures 1-1 to 1-4 below.

1.2 Purpose

The purpose of this design philosophy statement is to provide technical information to support the Frankton to Queenstown and Frankton SSBC's.

1.3 Project Areas

The following locations display the preferred options at a high scale.

- A map showing the Ladies Mile Highway/SH6 road network is provided in Figure 1-1.
- A map showing the Frankton Flats/SH6 area road network is provided and Figure 1-2 and Figure 1-3.
- A map showing Frankton Road/SH6A and road network is provided in Figure 1-4.

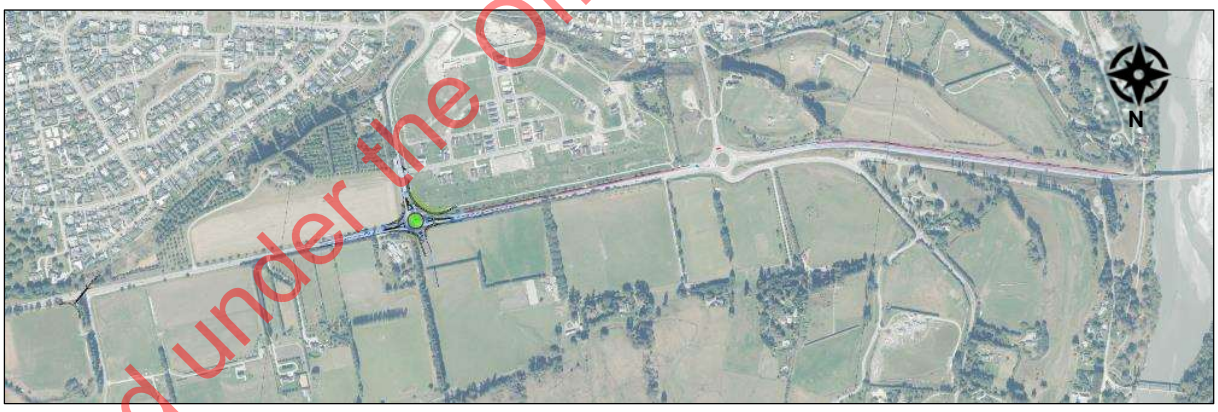

Figure 1-1: Ladies Mile Highway/SH6

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Figure 1-2: Frankton-Ladies Mile Highway/SH6

Figure 1-3: Kawarau Road/SH6

Figure 1-4: Frankton Road/SH6A

1.4 Posted Speed Limits

The existing posted speed limit on the state highways ranges from 100 km/h through to 50km/h as follows:

- SH6 Ladies Mile changes from 100 km/h to 80 km/h at RP 983/7.84 east of the Stalker Road roundabout.
- SH6 Frankton-Ladies Mile Highway changes from 80km/h to 50 km/h at RP 983/11.48 east of Joe O'Connell Drive.
- SH6 Kawarau Road changes from 50 km/h to 70 km/h at RP 996/0.24 south of the Frankton bus exchange and continues south of the Kawarau Falls Bridge.

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- SH6A Frankton Road changes from 50 km/h to 70 km/h at RP 0/0.35 just west of Yewlett Crescent.
- SH6A Frankton Road changes from 70 km/h to 50 km/h at RP 0/4.51 east of The Point Apartments.

All local roads within the scope of the business case are posted at 50km/h, with the exception of Lower Shotover Road, which is posted at 80 km/h.

Through Waka Kotahi's national speed limit review process, it is understood that SH6 Ladies Mile will reduce to 80 km/h, SH6 Frankton will go to 60 km/h and SH6A Frankton Road will reduce to 60 km/h, however these speed limit changes are yet to go through formal consultation and approval processes.

1.5 Existing Services

Existing services within the project area include:

- Watermain
- Wastewater
- Stormwater
- Underground and overhead high voltage power cabling – Aurora Energy, PowerNet and Transpower
- Underground and overhead low voltage power cabling – Aurora Energy and PowerNet
- Vodafone fibre optic cable
- Spark communications cables including fibre optic
- Gas – Rockgas

It should be noted that underground services may not be accurately recorded and care should be taken at investigation, detailed design and construction stages to locate all underground services to minimise health and safety risks and outages.

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2. Design Philosophy

2.1 Public Transport

During the option development and assessment phase of the Frankton to Queenstown SSBC it was recognised that the topographical, geotechnical and property constraints of the SH6A Frankton Road corridor did not easily allow for physical widening of the road corridor to provide bus priority. The physical widening required to accommodate bus lanes over the full length of Frankton Road would result in significant social (loss of housing and property), environmental, and financial (approx. $400M) impacts.

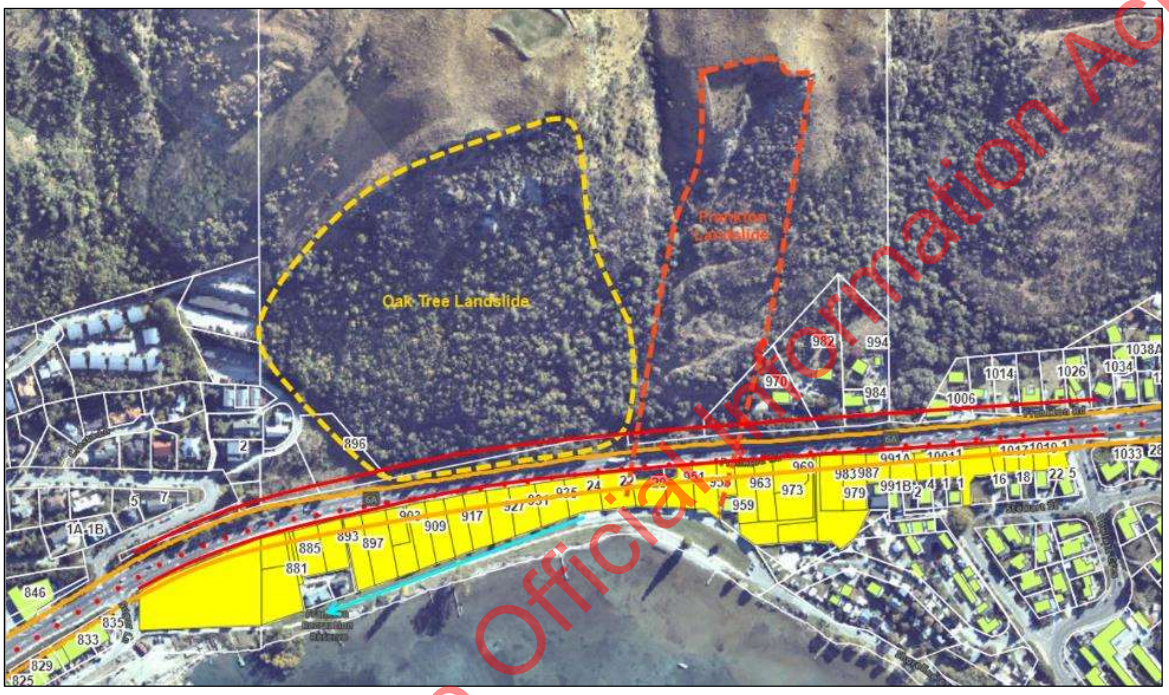

Figure 2-1: SH6A Frankton Road Geotechnical (landslide) constraints and property impacts of widening

The design philosophy was therefore developed to:

- provide physical bus priority (lanes) on SH6 in Frankton, where there are less topographical, geotechnical and property constraints.
- control traffic on SH6A to free-flowing levels of traffic, using the SH6/6A intersection as a 'valve'.
- provide virtual and targeted physical bus priority along SH6A.
- to provide overall bus priority and travel time reliability.

This is in line with the scope of the Frankton to Queenstown SSBC and the Design Process as described in Section 12.12 of the RFT.

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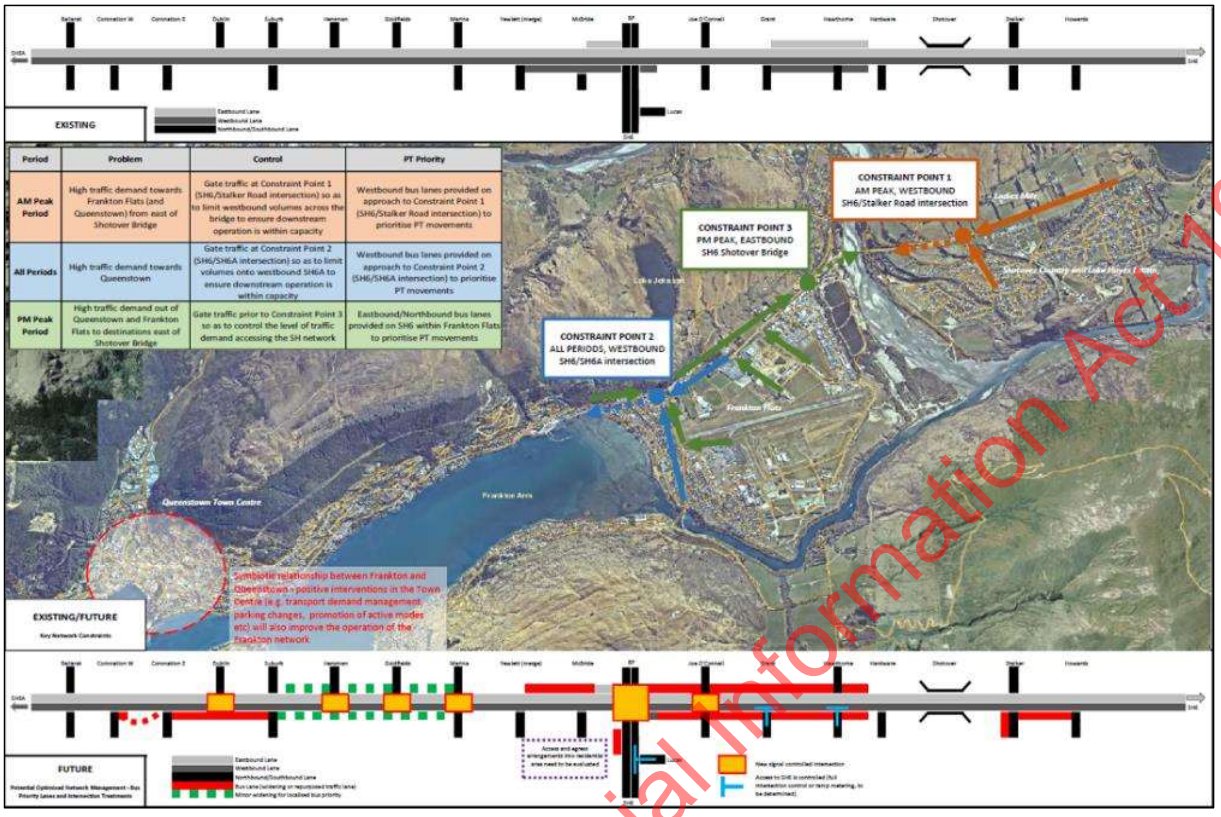

Figure 2-2: Overarching Public Transport Approach for Frankton and Frankton to Queenstown

Overall, the design response to increased travel and public transport demand in the future is to increase the capacity of on road public transport and to then provide an off-line system (likely a gondola) once the SH6A corridor has reached capacity.

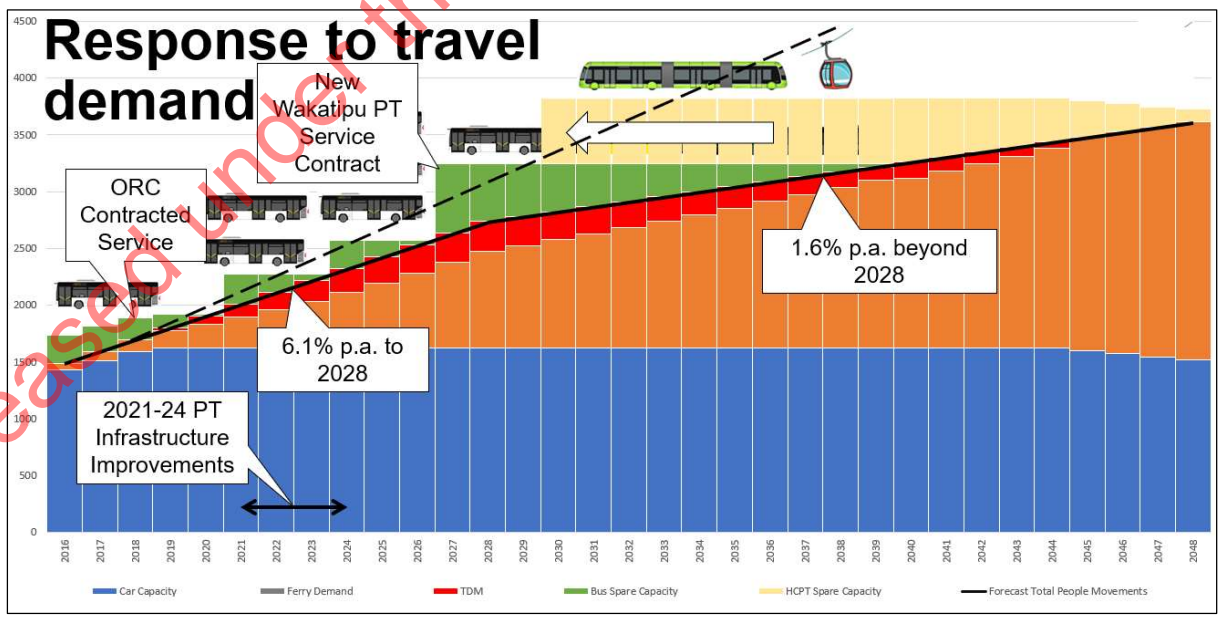

Figure 2-3: Response to travel demand

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Figure 2-4: Overarching Design Philosophy for Frankton and Frankton to Queenstown

Detailed technical and modelling information can be found in the following technical notes:

- Technical Note #42 SH6A (Frankton Road) Bus Signal and Virtual Priority
- Technical Note #35 SH6/SH6A Operation and Future Performance
- Technical Note #38 SH6 Frankton East Corridor Operation and Future Performance
- Technical Note #39 SH6 Frankton Southern Corridor Operation and Future Performance
- Technical Note #30 High Capacity Public Transport

2.2 Walking and Cycling

The design philosophy for walking and cycling is to provide a series of connected shared paths across Frankton that integrate with the Active Travel business case work and provide safe crossings as discussed in the technical notes above.

Frankton also includes the philosophy of including both on-road and off-road cycle facilities to provide facilities for 'strong and fearless' and 'enthused and confident' riders, while encouraging more of the 'interested but concerned' riders.

Due to previously discussed space constraints, where on road cycle lanes and bus lanes overlap, cyclists and buses will share the bus lane, as is done in other New Zealand cities such as Christchurch.

On SH6A the eastbound cycle lane will be retained and expanded on as there is no continuous path on the hillside of Frankton Road due to steep grades and land availability constraints. The shared path on the lakeside of Frankton road will be widened to between 3.0m and 4.0m depending on constraints.

Improved crossing points on Frankton Road (signalised intersections and crossings) will provide improved and safer access to public transport. The shared path along the lakeside will act as a collector for pedestrians and cyclists travelling to and from Queenstown Hill to and from Queenstown and Frankton with connections to Frankton Track. Frankton Track, as part of the Active Travel Network, will provide a through route for commuters between Frankton and Queenstown.

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3. Preliminary Design

3.1 Design Standards, Guidelines and Specifications

A list of design standards, guidelines and specifications applicable to this project are specified below:

- NZTA, RTS 18 – NZ on road tracking curves for heavy vehicles (2007)
- NZTA, Manual of Traffic Signs and Markings (MOTSAM) (2010)
- Austroads Guide to Road Design Part 3: Geometric Design (2017)
- Austroads Guides to Road Design Part 4A: Unsignalised and Signalised intersections (2017)
- Austroads Guides to Road Design Part 4B (2015)
- NZ Heavy Haulage Associations Road Design Specifications for Over dimension Loads
- Waka Kotahi NZ Transport Agency New Zealand Guide to Pavement Structural Design 2017
- Austroads Guide to Pavement Technology
- Waka Kotahi NZ Transport Agency 2017 New Zealand Guide to Pavement Evaluation and Treatment Design
- NZTA M10:2014 Specification for Dense Graded and Stone Mastic Asphalts

3.2 Objectives

Population of Queenstown and Frankton increases every year, which leads to high stress of the road network and town access. In recent years Frankton has developed rapidly and in doing so drawing in more and more people into the area. The connections within Frankton impact the flow on the narrow access into Queenstown.

To improve the flow of traffic, major intersections are to be updated with practical signal designs to impact the congestion. In the Frankton Flats area public transport lanes will run alongside traffic lanes on both sides of the highway and will connected with the proposed Frankton transportation hub, which is a part of this scope. SH6A will apply bus priority where appropriate and can work within the existing corridor to improve flow.

Pedestrians and cyclists will have safe access into Queenstown and Frankton areas with the use of cycle lanes and 3-4m wide shared paths.

3.3 Design Process

The proposed design is aimed at improving traffic flow in current and future scenarios. This requires building signalised roundabouts (as the preferred intersection configuration) to improve general traffic flow and allow room public transport services to expand in Frankton (the Frankton Technical Notes #37 to #42 refer), with the exception of the SH6/6A intersection, for which a large signalised T-intersection has been selected (Tech Note #35 refers).

The corridor between the intersections has subsequently been developed to support bus lane. Bus lanes will be present from Ladies mile highway through to Frankton and Frankton into Queenstown, there will also be bus lanes heading south down Kawarau Rd which are already partially in place.

3.3.1 Cross Sections

Ladies Mile Highway: Through the section along Ladies mile highway the road carriageway typical cross section includes existing eastbound 3.3m lane and varying shoulder widths between 0.5m and 3.0m. The new works that will be added are: a 1m median that tapers to 2.5m on roundabout approach, two westbound lanes 3.3m each, an eastbound traffic lane 3.3m, a 3.2m bus lane , and a 1.5m shoulder. See typical cross section 3-1.

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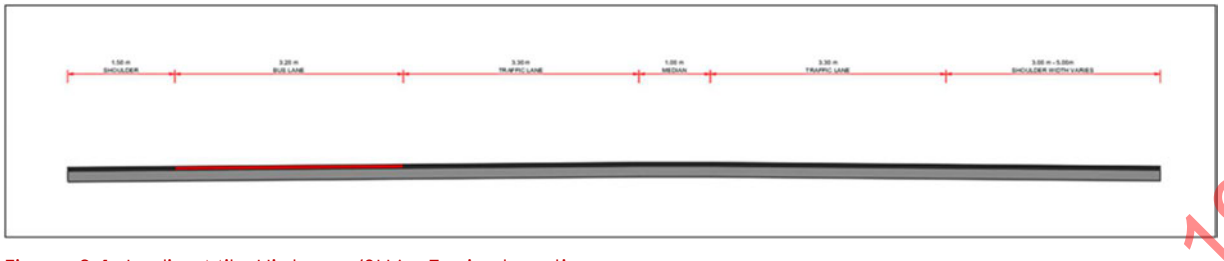

Figure 3-1: Ladies Mile Highway/SH6 – Typical section

Frankton to Ladies Mile: Along Frankton Road/SH6 there are 3 roundabouts within the scope of the SSBC. Two existing roundabouts: at Grant Road and Hawthorne Drive, are proposed to be modified to signalised configuration. The intersection at SH6/6A will be replaced by a fully signalised intersection. Between these intersections the typical cross sections comprise of: a 3.0m shared path, kerb and channel, 1.5m cycle lane, 3.25m bus lane, 3.25m traffic lane, 2.5m median, 3.25m traffic lane, 3.25m bus lane, 1.5m cycle lane. See typical cross section 3-2.

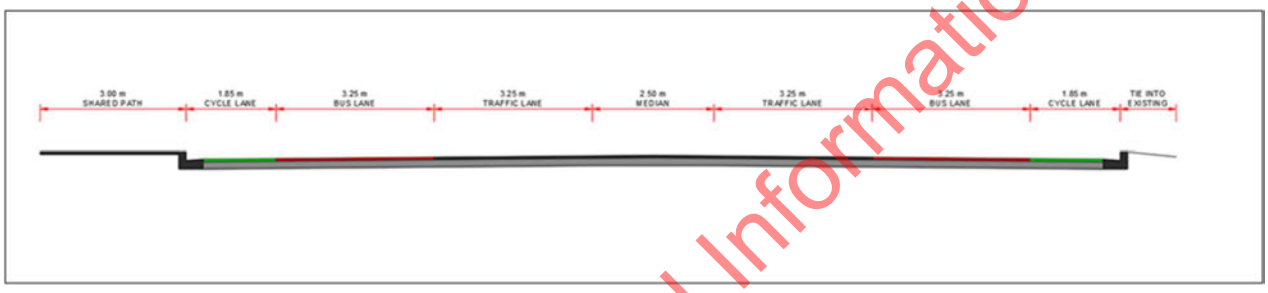

Figure 3-2: Frankton-Ladies Mile Highway/SH6 – Typical section

Frankton to Queenstown: Frankton Road/SH6A Queenstown access road has a limited width corridor and bus lanes are proposed only in areas where the addition will not result in encroaching onto other land properties. On the south side of the highway a shared path will be provided. Cyclists can also use the dedicated road cycle lane and bus lanes, where those are proposed to be added. Side road intersections are to be upgraded to allow for better flow of traffic and provide safer accesses for road uses.

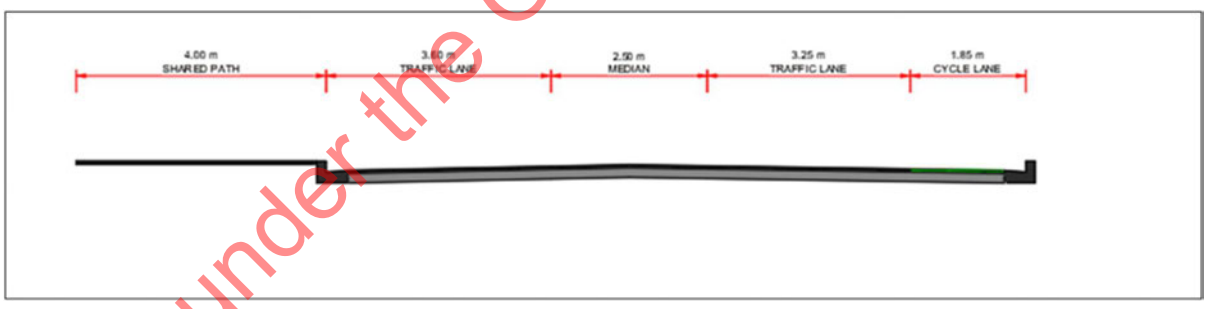

Figure 3-3: Frankton Road/SH6A – Typical section

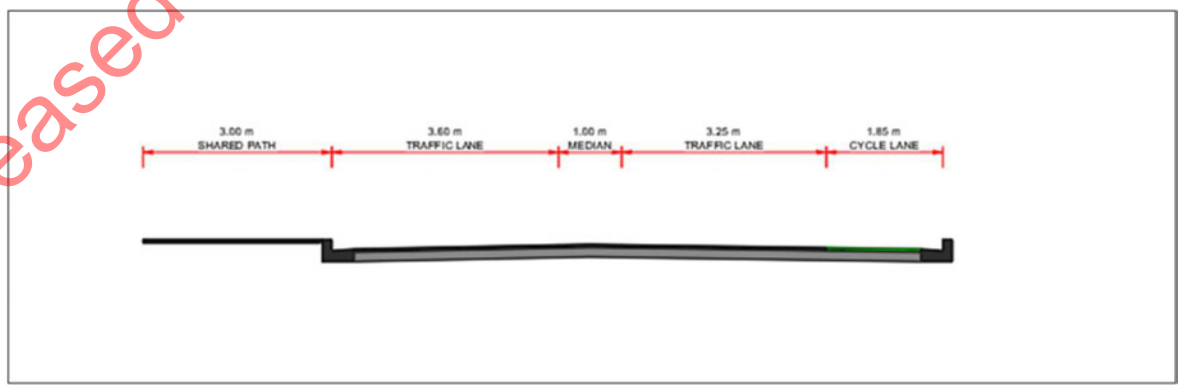

Figure 3-4: Frankton Road/SH6A – Typical section 2 – Constraints in corridor

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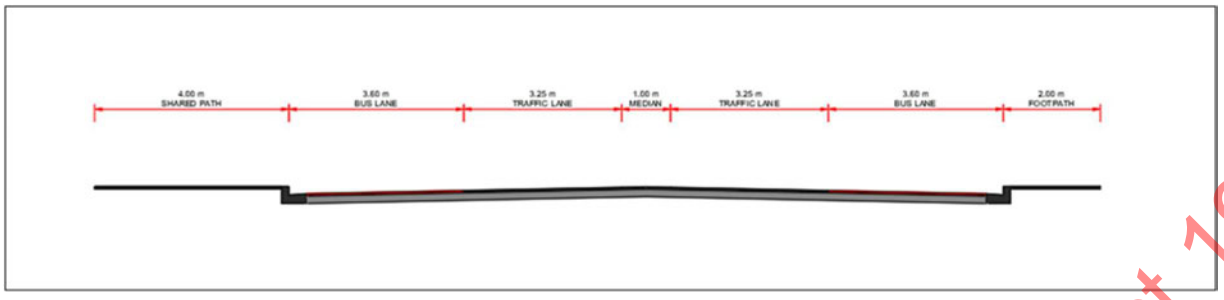

Figure 3-5: Frankton Road/SH6A – Typical section 3 – Wide corridor area with bus lanes

3.3.2 Horizontal Alignment

Changes to the horizontal alignment along SH6 and SH6A are required due to the widening and intersection upgrades. These alternations must be confirmed in the detailed design phase and once the survey is completed. Any additional factors that could cause a need to change the alignments must also be considered. Horizontal alignment will be design in accordance with Austroads.

3.3.3 Vertical Alignment

Vertical changes will be made to align with design standards and site distances etc. The airport operating envelope may create a requirement to lower the level of Kawarau Road at the runway end. It is understood Waka Kotahi already have some preliminary concepts for this, should the work be confirmed.

For other changes it will mostly remain the same level.

Any vertical designs or changes will be in accordance with Austroads.

3.3.4 Design Vehicles

Road geometry shall be designed to accommodate the movement of the vehicles specified in the table below Figure 3-1. The design vehicles specifications are defined in RTS 18.

Table 3-1: Design Vehicles

Road Classification	Design Vehicle and Length	Tracking Type
Arterial	19m Semi-Trailer	A
Collector	12m Rigid Truck	A
Local Roads	8m Rigid Truck	A

3.3.5 Intersections

Intersection geometry shall be designed to accommodate the movements of vehicles specified in Table 3-1.

3.3.6 Design Speed

The designs will be in accordance with then current/proposed Waka Kotahi's speed limit.

3.3.7 Over Dimension Route

Over dimension routes will accommodate the following clearance envelope specifications:

- Vehicles that have a 10m wide load with an allowance for a possible off-centre load.
- Typical minimum vertical clearances over roadways and pedestrian/cycle paths in accordance with AGRD part 3 'Table 8.1'.
- Comply, where possible, with the design requirements of the NZ Heavy Haulage Associations Road Design Specifications for Over dimension Loads.

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3.4 Traffic Services

3.4.1 Signs and Markings

All traffic signs and pavement markings will be designed in accordance with Manual of Traffic Signs and Markings (MOTSAM).

3.4.2 Safety Barriers

The instalments of safety barriers will be considered where necessary, during the design development. Any barrier that is installed will be incompliance with NZTA M23 guidelines.

3.4.3 Traffic Signals

Traffic signals will be designed in accordance P43 Specification for Traffic Signals.

3.5 Pavement Design

Refer to the Queenstown Town Centre DBC, Frankton to Queenstown and Frankton SSBC Preliminary Pavement Design Report as part of this business case reporting. Below is a summary of the pavement design parameters.

Table 3-2: Preliminary Pavement Design Summary

Layer	Arterials	SH6A	SH6	Bus Lanes	SH6/6A Junction	Frankton Hub
Subgrade CBR	6%	8%	6%	5%	10%	5%
Subbase (AP65)	200mm	220mm	330mm	350mm	400mm	200mm
Basecourse (AP40)	150mm	180mm	170mm	180mm	180mm	150mm
Surfacing	160mm AC	40mm AC	40mm AC	40mm AC	170mm AC	120mm AC

3.6 Stormwater - Frankton

The new intersection layout at BP corner, along with the upgrades to the road along SH6 will require updating the reticulated stormwater system.

The reticulation will collect both road runoff and storm water discharge from development area adjacent to the road.

The discharge point is into the newly construction storm water outfall near McBride Street. As part of the Frankton Flats Stormwater Project the pipeline and outlet were designed with sufficient capacity to accept anticipated flows from this catchment.

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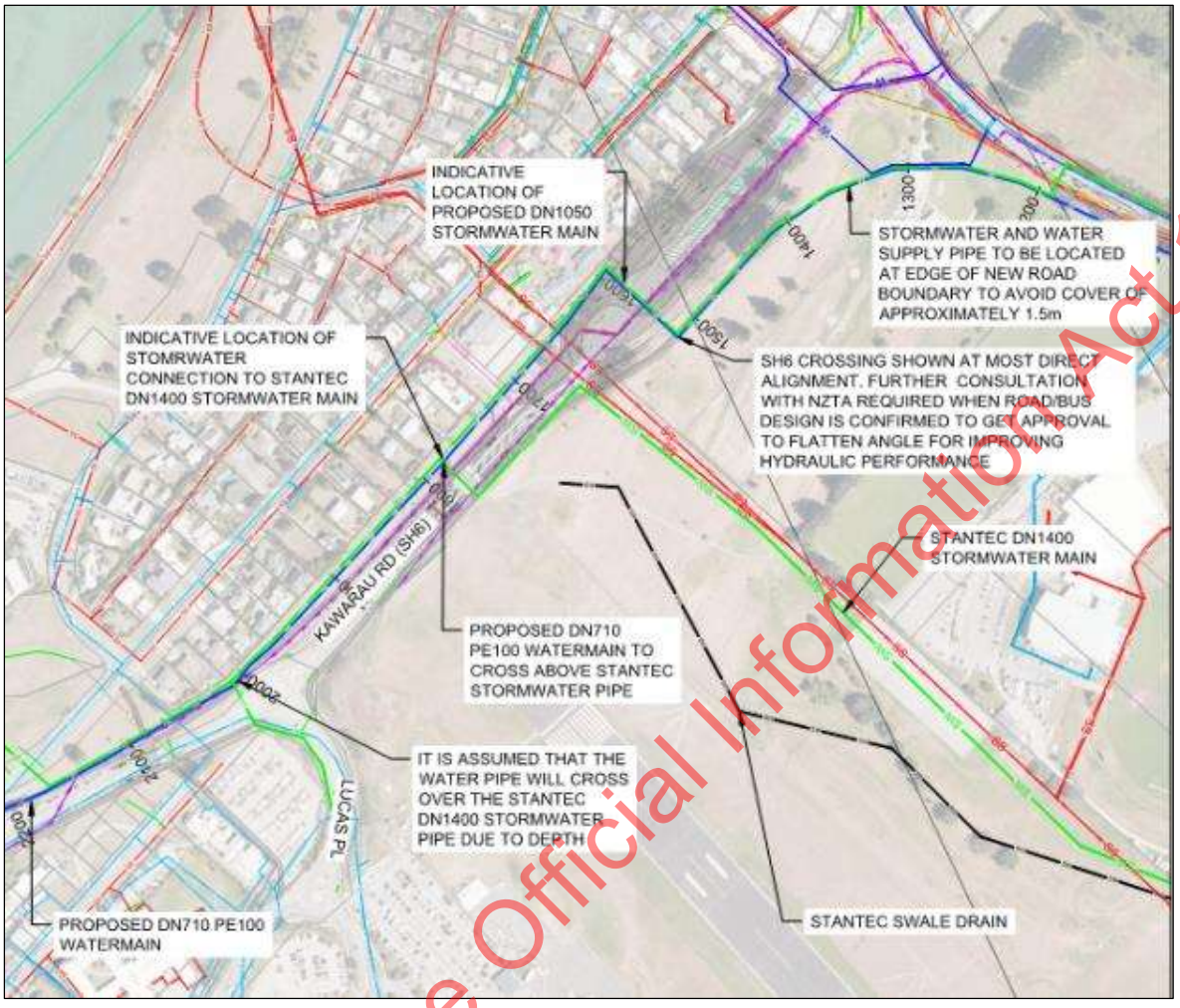

Figure 3-6: Snip from Water Supply and Stormwater requirements released to Frankton Flats Stormwater Project for Stormwater coordination

3.6.1 Design Intent

With the potential for clashes with other services and pedestrian underpasses, the intention is to position the storm water pipe (and possible water supply pipe) as close to the new road boundary as possible and would allow for amenities such as a shared path to be constructed over it to ensure the space is not wasted.

Further east toward Grant Road, with less stormwater run-off flow to accommodate, it is anticipated that swales will be able to be constructed to accept road runoff. This will provide pre-treatment to that section of road before the flow enters the reticulated system. Unfortunately, the current design does not allow for extensive use of swales, so proprietary treatment devices are likely to be necessary where runoff enters the stormwater network directly.

For acceptance of storm water flow from development areas, it is intended that they will be following the QLDC requirements for attenuation and treatment before discharging into the Waka Kotahi provided trunk network.

3.6.2 Design Storm and Flows

The Frankton Flats Stormwater Strategy Update April 2018 (Stantec NZ) notes that there is unlikely to be sufficient overland flow paths through the area likely to discharge into the redeveloped stormwater system. As such the design of the pipeline must accommodate a 100 year ARI peak flow, which results in the need to provide larger pipes. The typical Waka Kotahi design requirement for 10 year ARI (with secondary overland flow) would require a pipe size of approximately DN1050.

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The design storm using HIRDS V4 RCP6.0 2081-2100 gives a rainfall intensity of 73.7 mm/h. This latest HIRDS rainfall update is a significant increase over the HIRDS V3 (2.1 degree) rainfall intensity of 58.9 mm/h.

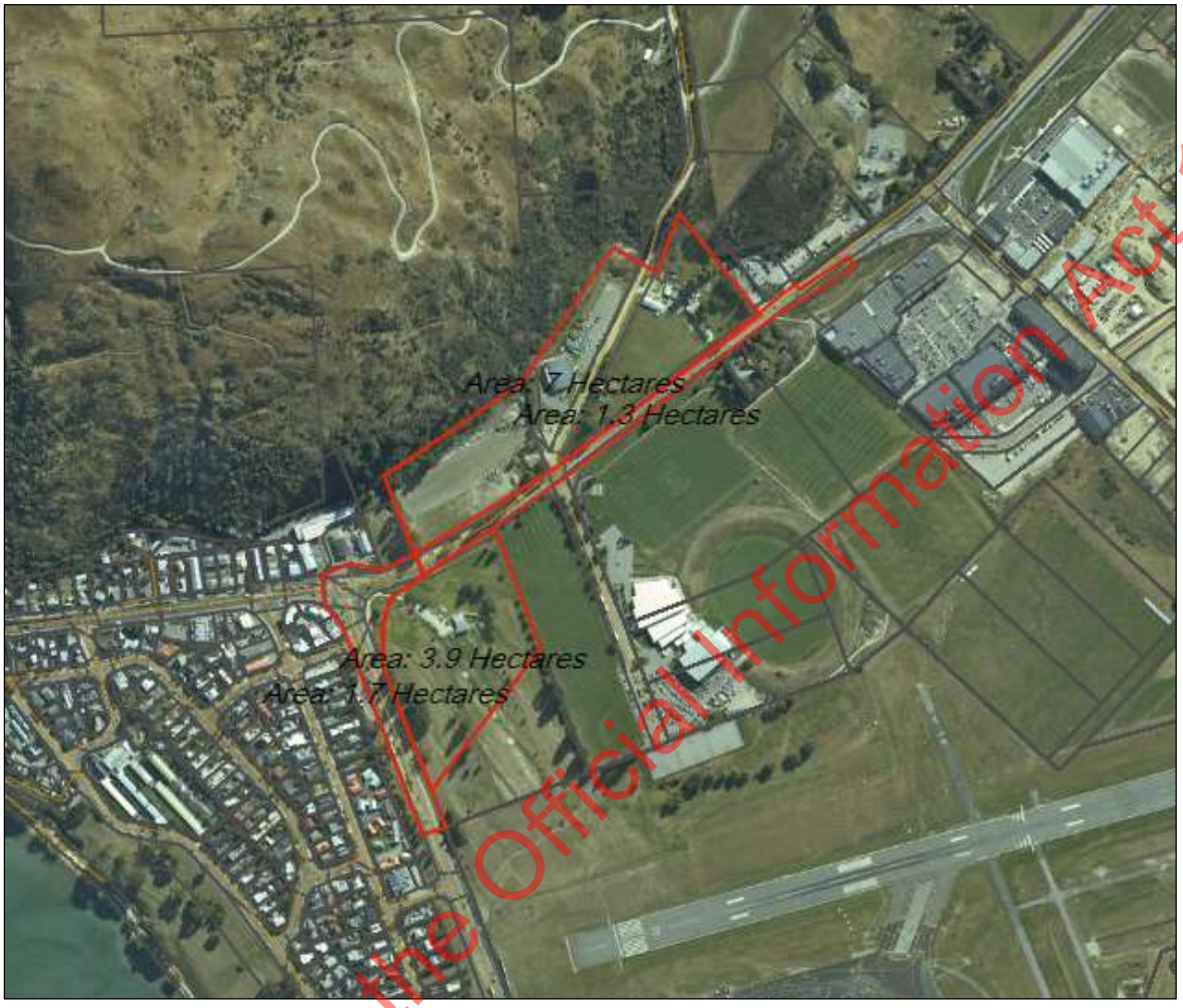

Figure 3-7: Areas Discharging into SW pipeline

Table 3-3: Areas flow rate summary

Area	Description	Size (Ha)	C value	Rainfall Intensity (mm/h)	Q (m^3/s)
1	Development north of SH6	7	0.6	73.7	0.86
2	SH6 from BP corner to Grant Rd	1.3	0.8	73.7	0.22
3	Golf Club Corner (undeveloped)	3.9	0.6	73.7	0.48
4	New roundabout and road to Stantec Stormwater	1.7	0.8	73.7	0.28
Total					1.83

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3.6.2.1 Attenuation of Development Sites

Where overland flow is to discharge downstream, it is a QLDC requirement that no more than the pre-development levels do so. This means that whatever the pre-development site runoff coefficient is, will be what is necessary to design both the attenuation structures and the size of the Waka Kotahi stormwater pipe.

For the purpose of this report an assumption of a pre-development C value is 0.3.

This means the discharge is halved for the 100 year ARI.

3.6.3 Design Pipe Sizes

For the two potential design scenarios, there are differing pipe sizes required.

3.6.3.1 Full 100 year ARI Runoff from the Catchment Area

The section of pipeline between Grant Road and the BP Roundabout will require a DN 975 pipe.

The section of pipeline between the BP Roundabout and the Frankton Flats Stormwater Project SW pipe will require a DN 1200 pipe.

3.6.3.2 Attenuated 100 year ARI Runoff from the Catchment Area

The section of pipeline between Grant Road and the BP Roundabout will require a DN 825 pipe.

The section of pipeline between the BP Roundabout and the Frankton Flats Stormwater Project SW pipe will require a DN 1050 pipe.

3.6.4 Recommendation for Costing

With the unknowns of detail around the development areas and the final road design, the preceding information can only be treated as concept level. However there seems to be contingency in using the full 100 year ARI runoff flows to calculation the pipe sizes required.

It is recommended that a pipeline of DN 1200 is used for costing purposes.

The refinement of the design over time is likely to lead to a change in design, with the introduction of swales where possible. In this instance, some of the pipelines upstream will decrease, but there will be cost in having parallel treatment alongside the pipe.

3.7 Environmental & Social Responsibility Issues

Refer to the Frankton to Queenstown and Frankton Social & Environmental Responsibility Screens in a separate Appendix to this business case reporting.

3.7.1 Frankton

The Social and Environmental Responsibility Screen identified that the following technical assessments will be required for Frankton as the project advances:

- Noise impact assessment – current and future noise environment in relation to the Humphrey Street Extension.
- Assessment of the effects of the loss of open space on both sides of SH6 from the Public Transport Hub some
- As identified for the other business cases, a 'global' archaeological authority for the works should be considered.
- Preliminary Site Investigation / Detailed Site Investigation with regards to potentially contaminated sites.

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Table 3-4: Broad summary of effects associated with each option

	Risks and Impacts				LOW / MEDIUM / HIGH
Option	Natural Environment	Cultural and Historic Heritage	Human Health	Social	Landscape and Urban Design
Frankton traffic calming					
McBride Street					
SH6/6A Roundabout					
Public Transportation Hub					
Ross Street to Kawarau Falls Bridge					
Lucas Place					
SH6/Humphrey Street					
Humphrey Street Link					

3.7.2 Frankton to Queenstown

In terms of matters identified in through the Social and Environmental Responsibility Screen the following technical assessments will be required as the project advances, depending on the option chosen (options identified in Table 3-5 below). Note that there may be other Council projects advanced concurrently that may address some of these issues (i.e. Project Manawa for Queenstown Town Centre). Understanding the necessary mitigation in a number of areas (particularly noise) is considered critical.

- An ecological assessment will be required with regards to the activity in proximity to/within Lake Wakatipu (Option 4)
- Archaeological/Heritage impact assessment (Options 2-4)
- Arbour cultural assessment on those Protected Trees in proximity to the route or to be removed as part of the project (Option 4)
- Cultural Impact Assessment (potentially – may be avoided through engagement with Iwi)
- Noise impact assessment – current and future noise environment, mitigation (Options 2-4).
- Preliminary Site Investigation / Detailed Site Investigation with regards to potentially contaminated sites along the arterial route.
- Landscape / urban design assessment with regards to the impacts of the project on the existing streetscape (Options 2-4)
- Lighting impact assessment (both in terms of streetlighting but also in relation to the light spill from vehicles) (Options 2-4)

Additional to this, other likely technical assessments required include:

- Geotechnical assessment – retaining structures, cuts and fills.

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Table 3-5: Broad summary of effects associated with each option

	Risks and Impacts				LOW / MEDIUM / HIGH
Option	Natural Environment	Cultural and Historic Heritage	Human Health	Social	Landscape and Urban Design
1 - Do Min					
2 - Virtual Priority					
3 - Trackless Tram					
4 - 4 Laning					

3.8 Travel Demand Management Measures

Travel Demand Management performs a key role as one of the 3 pillars of investment for the Queenstown Integrated Transport Outcomes:

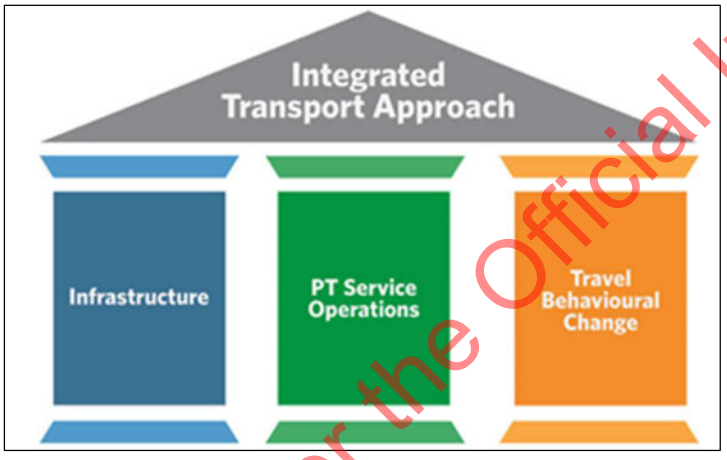

Figure 3-8: Three pillars of investment

Refer to **Technical Note #22 Update: Queenstown Travel Demand Management Scoping** and the Queenstown Travel Demand Management Scoping Study for further details.

Table 3-6: Travel Demand Management Programme for Queenstown

WBS #	Travel Demand Management Programme	Quick win	Year 1	Year 2	Year 3	Organisation(s) responsible for delivery	Could be delivered by the TMA when established
1	**Policy**						
1.1	***Region-wide strategies***						
1.1.1	Develop a sustainable transport vision for Queenstown					QLDC	
1.1.2	Car-free tourism					MBIE, DQ, QLDC, Waka Kotahi	

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WBS #	Travel Demand Management Programme	Quick win	Year 1	Year 2	Year 3	Organisation(s) responsible for delivery	Could be delivered by the TMA when established
1.1.3	Mobility co-ops for outlying areas e.g. Arrowtown, Lake Hayes (research and blueprint)					QLDC, Waka Kotahi	
1.1.4	Car-share policy					QLDC	
1.2	Park and ride study					QLDC	
1.3	Require travel plans for new developments, large employers and significant trip generators					QLDC	
1.4	Require new developments to provide infrastructure that supports and encourages use of sustainable transport (new developments, outlying areas that generate trips into Queenstown)					QLDC	
1.5	Require travel plans for events as part of consent/ traffic impact assessments					QLDC	
1.6	Charging for parking that is currently free or cheap					QLDC	
1.7	Freight management plan					QLDC	
1.8	TDM for emergencies (eg weather, crashes, natural disasters)					QLDC, ORC, Waka Kotahi, Civil Defence	
1.9	Car-free town centre and residential areas					QLDC	
1.10	Promote Queenstown as a Sustainable Tourism Destination (as options become available)					DQ	
1.11	Airport Access Study and travel plan					Queenstown Airport, QLDC	
1.12	Understand current levels of service for walking and cycling					QLDC	
1.13	***Considering wider trips***						
1.13.1	Advocate for travel plans for tourist destinations eg Routeburn Track, Milford Sound, Arrowtown, Wanaka, ski resorts, the Gondola					QLDC, ORC, Waka Kotahi	
1.13.2	Self-drive Permit Study (to protect sensitive areas)					MBIE, Waka Kotahi, MoT	
2	**Travel planning and behaviour change initiatives**						
2.1	Continue and enhance the school travel plan programme					QLDC, MoE	
2.2	Cycle/scooter training (adults and children)					QLDC, Police	
2.3	Community travel plans (eg Lake Hayes, Shotover, Jacks Point)					QLDC, ORC	

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WBS #	Travel Demand Management Programme	Quick win	Year 1	Year 2	Year 3	Organisation(s) responsible for delivery	Could be delivered by the TMA when established
2.4	Awards/ rating scheme (eg cycle/scooter-friendly employer or destination, link in with existing reward schemes or rewards for mode-shift/ car free journeys)					QLDC	☐
2.5	Gamifying mode shift within travel plans (to encourage mode shift for residents and tourists)					QLDC, TMA	☐
3	**Wayfinding improvements (digital and physical)**						
3.1	Wayfinding and Information Provision Audit and Design Guide (including wayfinding for public transport, key destinations, facilities, routes, parking)					QLDC with TMA input, Waka Kotahi	
3.2	Smooth walking/wheeling routes & CCS disability action links	☐				QLDC and TMA	☐
4	**Transport Management Association (TMA)**						
4.1	***Set up***						
4.1.1	Establish itself (mission, values, brand, set up Incorporated society, confirm board of directors)					TMA	☐
4.1.2	Write Business Plan and Funding Plan					TMA	☐
4.1.3	Agree membership fees & recruit members					TMA	☐
4.1.4	Establish potential revenue sources (Parking brokerage and event management plans)					TMA	☐
4.1.5	Recruit staff to run the TMA and its activities; includes office rent and annual insurance cost					TMA	☐
4.2	***Action plan***						
4.2.1	Develop Communication Plan (document co-ordination, communication channels, stakeholder matrix etc)					TMA	☐
4.2.2	Develop website and promotional material about the TMA itself to raise the profile of the TMA and communicate to people what it's going to do					TMA	☐
4.2.3	Fund raising (depending on the level of funding secured from the NZ Transport Agency)					TMA	☐
4.2.4	Co-ordinate submissions on on-going projects, policies and strategies					TMA	☐
4.3	***Set up programmes***						

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WBS #	Travel Demand Management Programme	Quick win	Year 1	Year 2	Year 3	Organisation(s) responsible for delivery	Could be delivered by the TMA when established
4.3.1	Guaranteed ride home scheme	☐				TMA	☐
4.3.2	Luggage logistics action plan	☐				TMA	☐
4.3.3	Journey Planning App/Travel amalgamator	☐				TMA	☐
4.3.4	Set up bike share/E-bike share connecting key destinations and hotels					QLDC, TMA	☐
4.3.5	Dynamic ridesharing/carpooling	☐				TMA	☐
4.3.6	Mobility Lab (based on Arlington, Virginia, USA)					TMA	
4.3.7	Identify sustainable transport workforce deficits and establish programmes to run the sustainable transport sector eg bicycle technician, e-bike and e-scooter servicing, sustainable transport ambassador programmes, cycle skills training, bus driver workforce planning and development					TMA	☐
4.4	***Documenting the data gaps***						
4.4.1	Work with partners and confirm what information the businesses/ member organisations are willing to share; identify what data should be collected					TMA	☐
4.4.2	Create an inventory of existing bus and shuttle services; understand current situation; agree if and how to collaborate; identify potential partnerships; make it happen					TMA	☐
4.4.3	Set up events register for Queenstown (for event travel demand management)	☐				TMA	☐
4.4.4	Data inventory and gap analysis (establish what data is available and where there are gaps in the data)					TMA	☐
4.4.5	Understand and establish a register of transport jobs in Queenstown (to identify gaps)					TMA	☐
4.5	***Better information provision***						
4.5.1	Collate and communicate transport information on getting around without a car through the TMA website (using tools like the Bus map movie and travel scenarios)	☐				TMA	☐
4.5.2	Marketing of car-free holidays (information to support this on the TMA website)					TMA, DQ	☐

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WBS #	Travel Demand Management Programme	Quick win	Year 1	Year 2	Year 3	Organisation(s) responsible for delivery	Could be delivered by the TMA when established
4.6	***Advocacy***						
4.6.1	Advocate for/ support enhanced public transport service to the airport					TMA	☐
4.6.2	Advocate for changes to bus timetables/routes to better meet the needs of users	☐				TMA	
4.6.3	Gain commitment from the businesses to develop their own travel plans/ work on travel plan activities together through the TMA					TMA	☐
4.6.4	Advocate for/ support high quality branded bus stops (eg iconic bus stops)					TMA	☐
4.6.5	Advocate for inclusion of bike technicians and others in the Immigration NZ skills shortage visa category to support sustainable transport	☐				TMA	☐
4.6.6	Gain commitment from the tourism industry in the delivery of the plan (DQ, travel agents, tour providers)					TMA, DQ, MBIE	☐
4.6.7	Advocate for improved access to bus/ferry ticketing					ORC, TMA	
4.6.8	Advocate for supplier contracts to be reviewed and updated to include metrices to capture quality of service					TMA, ORC	
4.6.9	Advocate for Queenstown to adopt the Sustainable Travel Town vision					TMA	
4.6.10	Advocate for Queenstown to become a Blue Zone					TMA, DHB	

3.9 Long Term Maintenance Requirements

The proposed works for Frankton and Frankton to Queenstown follow standard civil transport construction methods and therefore the long term maintenance requirements are similar to those of the existing network.

3.9.1 Pavement and Surfacing

In line with Aspiring Highways strategy to surface SH6 in Frankton with asphalt, the proposed designs are all asphalt surfaced. The SH6/6A intersection and Frankton hub pavements are structural asphalt to deal with heavy vehicle stresses and loadings and effectively becomes a 'perpetual pavement'. This will allow for milling and re-asphalting of the wearing course (top layer) that will enable more efficient and less disruptive maintenance in the long term.

3.9.2 Traffic Signals

With an increase in the number of traffic signals on the Queenstown network (17 sets for Frankton and Frankton to Queenstown), and additional sets in Queenstown Town Centre the number of signals in Queenstown will be reaching a critical mass that could sustain specialist traffic signal technical and

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maintenance skills in the Queenstown and Central Otago Area and this should be discussed further with Aspiring Highways.

Discussions with the Wellington Traffic Operations Centre (WTOC) indicate that they have the capacity and capability to continue to manage and operate the Queenstown traffic signals. The setting up of a QTOC to operate the traffic signals would be cost prohibitive as discussed in **Technical Note #36 Application of Intelligent Transport Systems (ITS) in Queenstown.** To ensure WTOC are equipped to operate and optimise Queenstown's signalised traffic system, it is essential that a thorough Network Operating Plan (NOP) is prepared for the Queenstown area. This would provide the required information about network functions so that WTOC can prioritise traffic accordingly.

3.9.3 Retaining Structures

Existing Fortrac™ retaining structures along Frankton Road do not have the required coverage of vegetation as a result of there being no topsoil in the layer immediately below the geotextiles. The geotextiles are not UV resistant and are breaking down in a number of locations, which will lead to instability of the retaining structures and SH6A Frankton Road. There are also some lower quality retaining structures along Frankton Road that are rotating out resulting in collapse of the footpath at 2 locations currently.

Proposed retaining of the widened shared path and/or Frankton Road will resolve these issues and reduce likely long term maintenance and careful consideration to the finishing of the new retaining structures should be done at pre-implementation.

3.10 Proposed Construction Method

3.10.1 Frankton

The recommended option for Frankton consists of seal widenings (for bus priority) and intersection upgrades, with the SH6/6A intersection being a significant upgrade to the current arrangement.

The intersection upgrades, with the exception of SH6 Howards Drive roundabout and SH6/6A, all have sufficient corridor width to maintain traffic flows during construction.

Part of the SH6/6A intersection can be constructed offline (in the golf course) while the remainder will need to be constructed over the existing intersection. Approximately 35,000 vehicles pass through the SH6/6A intersection on an average day. To limit the inconvenience to adjacent businesses and disruption to traffic some works should be undertaken at night.

Likewise, the Frankton bus exchange will need to remain functional during the upgrade and the construction will need to be staged to minimise disruption to the bus services and coordinated with operators.

3.10.2 Frankton to Queenstown

The recommended option for Frankton to Queenstown largely consists of standard pavement surfacing and traffic signal installations along with the installation of new retaining walls.

The retaining wall construction methods will need to be considered in detail during geotechnical investigation and assessment and pre-implementation. Due to space constraints along SH6A Frankton Road careful management of pedestrians and cyclists on the shared path will be necessary and will likely require a shared path diversion onto Frankton Road.

Frankton Road effectively has 3 lanes, 2 traffic lanes and a flush median, so maintaining two-way traffic is practical while lane or shared path diversions are in place. Maintaining two-way traffic on Frankton Road is critical to the operation of Queenstown.

Aspiring Highways have the following restrictions on the Queenstown State Highway Network:

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All areas of the network are subject to restrictions before, after and during public holidays, as well as sometimes being subject to restrictions due to school holidays, cultural and other events that increase the activity on the network. Work on weekends or overnight is subject to approval by TMC or MCM

			RP from	RP to	Times
Urban Peak	**Queenstown**	SH6 Arrow Junction to Jacks Point All of SH6A	0983/0.0 0000/0.0	0996/8.2 0000/6.9	7am to 8pm
	Wanaka	All of SH84 SH6 Albert Town to Airport	0000/0.0 0881/9.5	0000/2.6 0893/7.5	
Elevated Peak	**Queenstown & Wanaka (area as above)**	Due to exceptionally high traffic during commuter times on SH6A, during the elevated peaks in the morning (7 - 9am) and evening (4 - 6pm), no lane shifts, narrowing or Stop/Stop will be allowed, on top of standard peak restrictions listed above.			7am to 9am 4pm to 6pm

These times are the default times as specified by the area Traffic Control Plan. Exceptions may sometimes be made if agreed to by the TMC (Commuter or Town Peaks) or the MCM or SNM (any peak areas)

Disruptive activities like trenching across Frankton Road for traffic signal cable ducting will need to be considered to be done at night, although noting that these works will be largely in built up areas with nearby residences and visitor accommodation.

3.10.3 Sequencing

The interventions in Frankton and on Frankton to Queenstown need to be sequenced so that the network operates efficiently and that unnecessary delays are not induced into either PT services, or general traffic that could discourage the uptake of PT.

The SH6/6A intersection is the key to the Frankton and Frankton to Queenstown network and needs to be completed prior to the signalising of SH6A Frankton Road, and in particular the SH6A Marina and new Marina intersections. Other intersections may be sufficiently far enough along Frankton Road from the SH6/6A intersection not to induce significant congestion and delays with elevated traffic volumes prior to the completion of the SH6/6A intersection that will reduce traffic volumes to free flow levels.

The new SH6A Marina West intersection will need to be completed before the SH6A Sugar Lane/Marina Heights intersection signals can be installed as this will allow the right turn into the Marina to be removed at the Sugar Lane intersection and associated capacity improvements. Should the Sugar Lane intersection progress prior to the new Marina West intersection then vehicles may queue back from the Sugar Lane intersection to the SH6/6A intersection as a result of reduced capacity of the intersection.

The upgrading and signalising of Joe O'Connell and Hansen Road, and the bus lanes leading into the SH6/6A intersection will need to follow the SH6/6A intersection so that these interventions operate in co-ordination with the SH6/6A intersection.

Interventions on Ladies Mile, Hawthorne Drive intersection, Grant Road intersection and Humphrey Street intersection can be progressed independently of the SH6/6A intersection, but the bus lanes will not operate effectively until the SH6/6A intersection is completed.

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Dunedin
Level 3 John Wickliffe House, 265 Princes Street
Dunedin 9016
PO Box 13-052, Armagh
Christchurch 8141
Tel +64 3 477 0885
Fax +64 3 477 0616

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Appendix C6 Preliminary Pavement Design Report

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QUEENSTOWN TOWN CENTRE DBC, FRANKTON TO QUEENSTOWN AND FRANKTON SSBC

PRELIMINARY PAVEMENT DESIGN

PREPARED FOR THE WAKA KOTAHI NZ TRANSPORT AGENCY

August 2020

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QUALITY STATEMENT

PROJECT MANAGER

s 9(2)(a)

PROJECT TECHNICAL LEAD

s 9(2)(a)

PREPARED BY

s 9(2)(a)

REVIEWED BY

s 9(2)(a)

APPROVED FOR ISSUE BY

s 9(2)(a)

DUNEDIN
Level 3 John Wickliffe House, 265 Princes Street, Dunedin 9016
TEL +64 3 477 0885, FAX +64 3 477 0616

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1	06/08/2020	Final	s 9(2)(a)	s 9(2)(a)		s 9(2)(a)

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Waka Kotahi NZ Transport Agency

Queenstown Town Centre DBC, Frankton to Queenstown and Frankton SSBC

Preliminary Pavement Design

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ATTACHMENTS

Preliminary Pavement Design Modelling Outputs

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1. Introduction

1.1 Background

The preliminary pavement design has been prepared based on local knowledge and expertise to inform the detailed and single stage transport business cases for Queenstown as described herein and the pavement designs are for feasibility purposes only.

Detailed pavement design including pavement test pits, materials testing and detailed analysis will be required during the pre-implementation phase.

1.2 Project Areas

The project areas consists of:

- Queenstown Town Centre DBC – incorporating the Historic Core, Town Centre Zone, Hallenstein Street, Gorge Road, Lake Esplanade and proposed Arterials
- Frankton to Queenstown SSBC – SH6A from SH6/6A Junction through to Suburb Street
- Frankton SSBC (incorporating the SH6 Grant Road to Kawarau Falls Bridge SSBC) – SH6 Ladies Mile through to Kawarau Falls Bridge, and Humphrey Street.

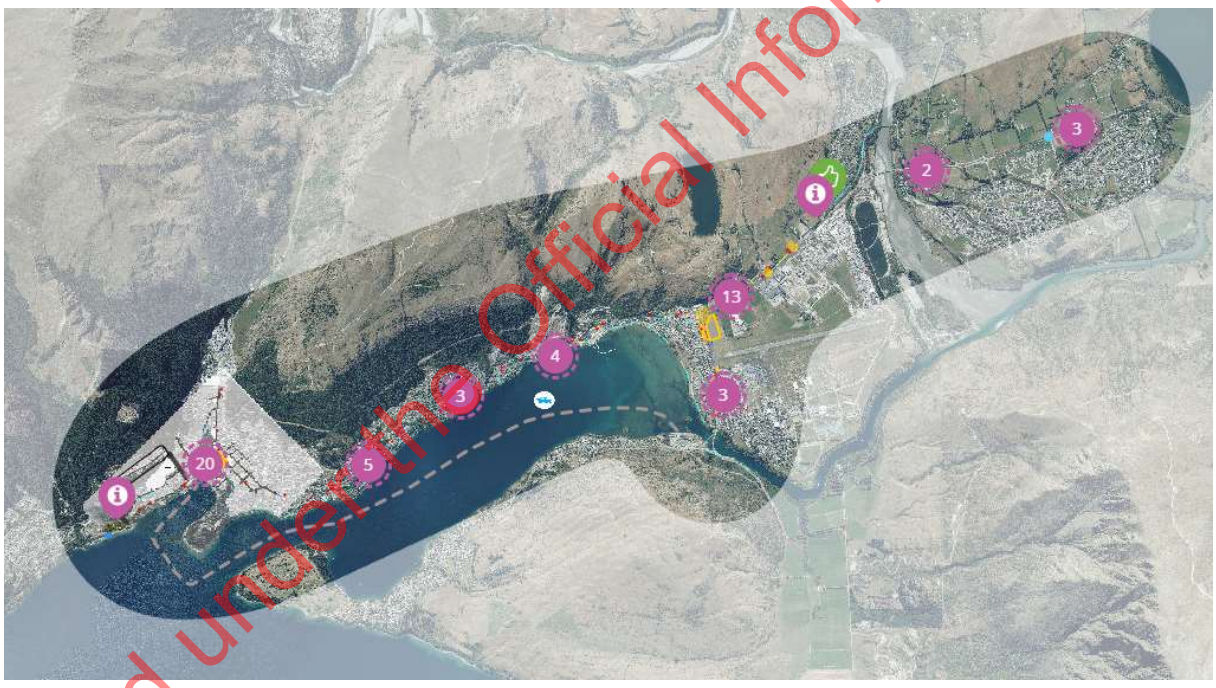

Figure 1 – general extent of business cases

1.3 Pavement Design Standards and Guidelines

The following standards and guidelines are applicable to the pavement design:

- Waka Kotahi NZ Transport Agency New Zealand Guide to Pavement Structural Design 2017
- Austroads Guide to Pavement Technology
- Waka Kotahi NZ Transport Agency 2017 New Zealand Guide to Pavement Evaluation and Treatment Design

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2. Queenstown Town Centre

2.1 Arterials Pavement Design

Preliminary pavement designs have been suggested for the arterial routes.

The high stress areas have been modelled using a AADT of 17,000vpd, 8% heavy vehicles and a growth rate of 3.5%.

As such a Structural AC design has been adopted. As the traffic volumes are expected to be high including heavy vehicles and commuter traffic the NZTA M10:2014 *Specification for Dense Graded and Stone Mastic Asphalts* classification of *Very Heavy* has been adopted, as some of the movements will be either climbing, descending and low speed.

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Waka Kotahi's Supplement and traffic information taken from the business case modelling.

The subgrade bearing capacity has been based on recent experiences in the local area with a design CBR of 6% being adopted for the feasibility level designs.

The pavement configuration is 160mm of Structural AC, 350mm of unbound granular materials over a subgrade CBR 6.

Layer Type	Layer Characteristics	Thickness [mm]	Modulus [MPa]	Ev/Eh	Critical Strain	Damage (%)	Allowable HVAG	Allowable ESA	Details
Asphalt	AC14	160	3200.0	1.00	208	N/A	N/A	N/A	
Granular	gravel	70	190.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	151.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	120.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	95.000	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	76.000	2.00	N/A	N/A	N/A	N/A	
Subgrade	User Defined	0	60.000	2.00	416	7.167E-003	3.586E+009	2.510E+009	

Figure 2 - *Arterials pavement design Austpads output*

3. Frankton to Queenstown

3.1 Frankton Road (SH6A)

A preliminary granular pavement design for general section of Frankton Road construction was undertaken utilising figure 8.4 from Austroads Pavement Design Guide.

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transits NZ's Supplement and traffic information taken from the NZTA RAMM database.

The traffic volume consisted of 25,034 vehicles of which 4.8% are classified as heavy vehicles and a design life of 25 years. A growth rate of 3.5% has been used as the capacity of the road is expected to be limited to 27,000vpd.

The subgrade bearing capacity has been based on recent projects in the Queenstown area which sowed reasonable subgrade strengths on average i.e. CBR 8. These will need to be confirmed during the detailed design stage and the pavement depth adjusted as required.

To prevent subgrade rutting a total granular depth of 400mm (180mm AP40, 220mm AP65) would be required, excluding 40mm of DG10 surfacing.

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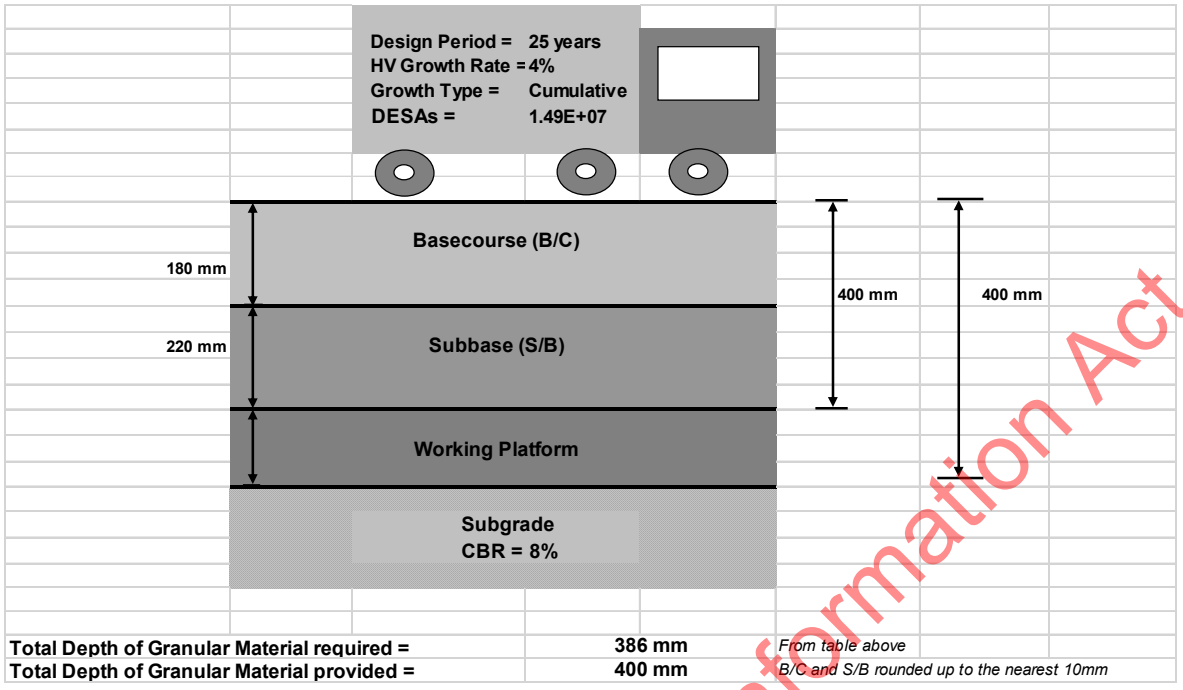

Figure 3 - *SH6A pavement design algorithm output*

4. Frankton

4.1 SH6 Frankton

A preliminary granular pavement design for general section of Kawarau Road construction was undertaken utilising figure 8.4 from Austroads Pavement Design Guide.

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transits NZ's Supplement and traffic information taken from the NZTA RAMM database.

The traffic volume consisted of 18,000 vehicles of which 4.8% are classified as heavy vehicles and a design life of 25 years. A growth rate of 3.5% has been used as the capacity of the road is expected to be limited to 27,000 VPD.

The subgrade bearing capacity has been based on insitu Scala penetrometer testing undertaken at the proposed subgrade depth. This resulted in a very soft subgrade layer being determined i.e. CBR 5

These will need to be confirmed during the detailed design stage and the pavement depth adjusted as required.

To prevent subgrade rutting a total granular depth of 500mm (170mm AP40, 330mm AP65) would be required, excluding 40mm of DG10 surfacing.

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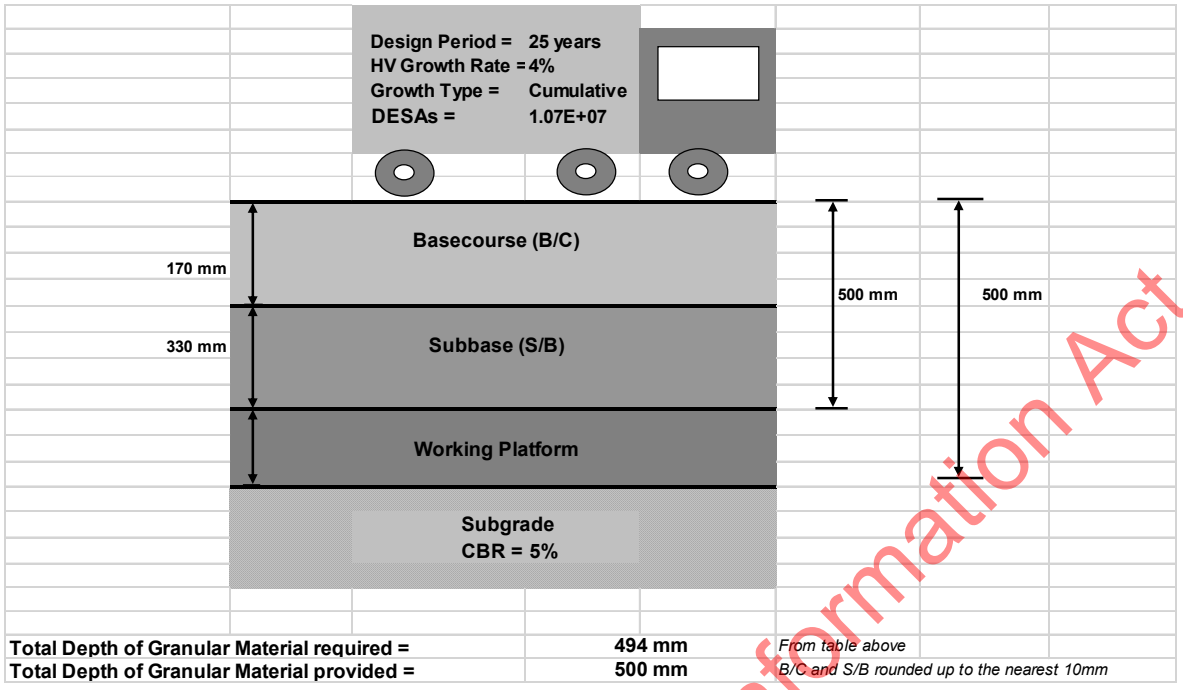

Figure 4 – *SH6 pavement design algorithm output*

4.2 Bus Lanes

A preliminary granular pavement design for the SH6 Kawarau Road Bus Lane widening was undertaken utilising figure 8.4 from Austroads Pavement Design Guide.

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transits NZ's Supplement and traffic information taken from the NZTA RAMM database.

The traffic volume consisted of 888 buses and freight heavy vehicles and a design life of 25 years.

A traffic growth rate of 3.5% was utilised as the capacity of the road will reached utilising a higher growth rate.

The subgrade bearing capacity has been based on insitu Scala penetrometer testing undertaken at the proposed subgrade depth. This resulted in a very soft subgrade layer being determined i.e. CBR 5

To prevent subgrade rutting a total granular depth of 530mm (180mm AP40, 350mm AP65) would be required, excluding 40mm of DG10 surfacing.

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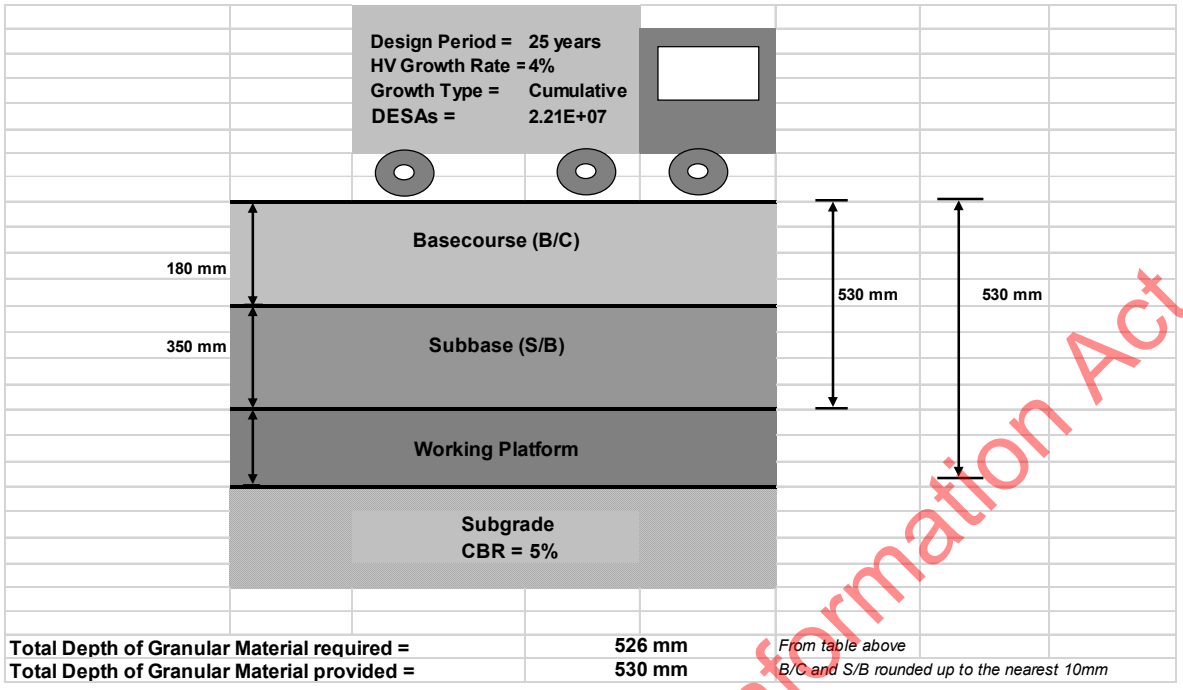

Figure 5 – *SH6 bus lane pavement design algorithm output*

4.3 SH6/6A Junction

A conservative pavement design has been adopted based on existing projects in the area with similar traffic movements, similar heavy vehicle movement and slow-moving traffic.

As such the same Structural AC design that was recently used on the Tuckers Beach Intersection has been adopted for feasibility purposes. As the traffic volumes are expected to be high including heavy vehicles and commuter traffic the NZTA M10 classification of Very Heavy has been adopted, as some of the movements will be either climbing, descending and low speed.

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transits NZ's Supplement and traffic information taken from the NZTA RAMM database.

The subgrade bearing capacity has been based on recent experiences in the local area with a design CBR of 10% being adopted for the feasibility level designs.

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Layer Description	Depth - mm	Modulus	Circly CDF	Notes
AC14 Surfacing	50	2300 MPa	7.46E-31	NZTA M10 Traffic Category - Very Heavy
AC20	70	4000 MPa	1.00E+00	NZTA M10 Traffic Category - Very Heavy - High Fatigue Base, Including G4 Membrane
DG 14 High Fatigue Layer	50	2700 MPa		
New M4 Basecourse	180	400 MPa		New Basecourse Material
New AP65 Subbase	400	200 Mpa		
Subgrade CBR - 10%	∞		4.48E-05	Subgrade CBR shall be ≥ 10% - This is engineered hardfill

Figure 6 - *SH6/6A Junction design table*

4.4 Frankton Bus Hub

A preliminary granular pavement design for the proposed Bus Hub was undertaken utilising Austpads design software

The design traffic was calculated using Austroads, Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transits NZ's Supplement and traffic information taken from the NZTA RAMM database.

The traffic volume consisted of 165 buses/heavy vehicles and a design life of 25 years.

A traffic growth rate of 7% was utilised.

The subgrade bearing capacity has been based on insitu Scala penetrometer testing undertaken at the proposed subgrade depth. This resulted in a very soft subgrade layer being determined i.e. CBR 5

The pavement Configuration is 120mm of Structural AC, 350mm of unbound granular materials over a subgrade CBR 5%.

Layer Type	Layer Characteristics	Thickness [mm]	Modulus [MPa]	Ev/Eh	Critical Strain	Damage (%)	Allowable HVAG	Allowable ESA	Details
Asphalt	AC14	120	3200.0	1.00	247	N/A	N/A	N/A	
Granular	gravel	70	348.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	236.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	160.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	109.00	2.00	N/A	N/A	N/A	N/A	
Granular	gravel	70	74.000	2.00	N/A	N/A	N/A	N/A	
Subgrade	User Defined	0	50.000	2.00	599	3.933E-003	2.771E+008	1.940E+008	

Figure 7- *Frankton bus hub pavement design Austpads output*

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5. Trackless Tram

A preliminary pavement design for Trackless Trams was produced for the feasibility stages of the project.

The input criteria for the analysis was as follows.

- Tyre type was a super single or industrial single tyre, pressure was calculated from first principles based on guidance provided in the Austroads Design Guides Part 2 – Appendix J Procedures for Evaluation of Pavement Damage Due to Specialized Vehicles. The modelling software Circly was used to undertake modelling and tyre/axle configuration
- The loaded weight of the 3-car set was 51 tonnes spread across 3 axels

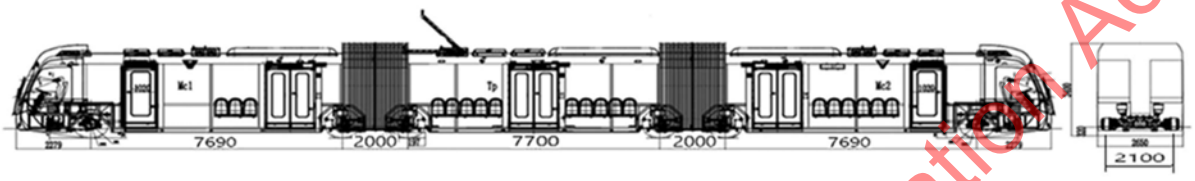

Figure 8 – *Trackless Tram axle arrangement*

Due to the high point loads of the single tyre configurations deep pavement incorporating modified layers and structural AC was required.

This resulted in a pavement including approximately 200mm of Structural AC, between 100 and 200 mm of Foamed Bitumen stabilised pavement and a subgrade ranging between a CBR of 3 and 6 as worst-case scenarios for the purposes of checking sensitivity. A full granular pavement was assessed, this required 200mm of Structural AC and 930mm of granular material over the subgrade layer.

Anecdotal information was provided via CRRC Corporation Limited on the pavement configuration utilised in China for similar operations, the pavement configurations detailed below were very similar to the options provided by CRRC.

The table below outlines, and options assessed.

Layer	Granular	Granular	800MPa FBS	800MPa FBS	400MPa FBS	400MPa FBS
Subgrade CBR	3%	6%	3%	6%	3%	6%
Granular Layer	930mm	600mm	150mm	100mm	300mm	200mm
Surfacing	200mm AC	200mm AC	200mm AC	200mm AC	200mm AC	200mm AC

Table 5-1 – Trackless Tram preliminary pavement design options

The preferred option requires further analysis through detailed design with confirmation of design parameters from the tram manufactures.

6. Preliminary Pavement Design Summary

Preliminary pavement design summary

Layer	Arterials	SH6A	SH6	Bus Lanes	SH6/6A Junction	Frankton Hub
Subgrade CBR	6%	8%	6%	5%	10%	5%
Subbase (AP65)	200mm	220mm	330mm	350mm	400mm	200mm
Basecourse (AP40)	150mm	180mm	170mm	180mm	180mm	150mm
Surfacing	160mm AC	40mm AC	40mm AC	40mm AC	170mm AC	120mm AC

Table 6-1– Preliminary Pavement Design Summary

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7. Pavement Design Geotechnical Testing

Geotechnical testing required for pavement design based on the 2017 New Zealand Guide to Pavement Evaluation and Treatment Evaluation:

- Falling Weight Deflectometer
- Intersection i.e. traffic signals or roundabouts
  - Minimum of 3 pavement/test pits
    - Logging
    - Soaked CBR
    - Atterberg limits on basecourse every 2nd pit or materials change
    - Grading of the basecourse and subbase
    - Scala penetrometer in the base of the pit
- Existing section of road:
  - Minimum of one pavement pit every 100m (minimum of 3 pavement pits)
    - Logging
    - Soaked CBR
    - Atterberg limits on basecourse every second pit or material change
    - Grading of the basecourse and subbase
    - Scala penetrometer in the base of the test pit
- Greenfields section:
  - One test pit every 100m down to proposed subgrade level (minimum of 3 test pits)
  - Scala penetrometer in the base of each test pit
  - Soaked CBR from each pit
  - Logging for each pit

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Attachments

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Preliminary Pavement Design Modelling Outputs

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PAVEMENT DESIGN USING AUSTROADS 2004

Project/ Task File No.	Bus Lanes - Kawarau Road	Sheet No.	1	of
Project Description	New Pavement	Office	QT	
	Oct-19	Computed:	GCO	Oct-19
		Checked:	RG	6/08/2020

DESIGN TRAFFIC CALCULATIONS

Refer to Austroads (2004), Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transit's NZ Supplement

Design Parameters

Note: Data is required to be inputted in all blue cells

Design Period	(P)	25	*years*
Annual Average Daily Traffic	(AADT)	888	*veh/day*
Direction Factor	(DF)	1	
% Heavy Vehicles	(%HV)	100	%
Lane Distribution Factor	(LDF)	1	*Refer Table 1 in Tables Tab for guidance*
Heavy Vehicle Growth Rate	(R)	3.5	%
Traffic Load Distribution		Austroads Urban	*Select TLD from drop down list*
Cumulative Growth Factor	(CGF)	38.9	
Arithmetic Growth Factor	(AGF)	35.5	
No. of Axle Groups per Heavy Vehicle	(N_{HVAG})	2.5	*axle groups per heavy vehicle*

	Cumulative	Arithmetic	
Design Traffic (N_{DT}) =	3.16E+07	2.88E+07	**Heavy Vehicle Axle Groups**

(N_{DT} = 365 x (AADT*DF) x %HV/100 x LDF x GF x NHVAG), Austroads (2004) equation 7.1

DESIGN TRAFFIC FOR FLEXIBLE PAVEMENTS

Presumptive Damage Index Values for the TLD selected

Damage Index	Value
ESA/HVAG	0.7
ESA/HV	1.8
SARa/ESA	1.1
SARs/ESA	1.6
SARc/ESA	12

	Cumulative	Arithmetic
Design No. of ESA of Loading (DESA) =	2.21E+07	2.01E+07

(DESA = ESA/HVAG x NDT), Austroads (2004) equation 7.4

The DESA is the design traffic for unbound granular pavements with thin bituminous surfacing (defined as <40mm thick) for use in Figure 8.4 or 8.5 of Austroads (2004) and (Austroads 2006) respectively

For other flexible pavements, the design number of Standard Axle Repetitions (DSAR) for each distress type is;

		Cumulative	Arithmetic
DSARa = DESA x SARa/ESA	DSARa =	2.43E+07	2.21E+07
DSARs = DESA x SARs/ESA	DSARs =	3.53E+07	3.22E+07
DSARc = DESA x SARc/ESA	DSARc =	2.65E+08	2.42E+08

TYPE OF TRAFFIC GROWTH

Type of traffic growth to be used in the Design ? Cumulative *Select from drop down list*

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OPUS INTERNATIONAL CONSULTANTS LTD
PAVEMENT DESIGN USING AUSTROADS 2004

OPUS

Project/ Task File No.	Bus Lanes - Kawarau Road	Sheet No.	3	of
Project Description	New Pavement	Office		
	Oct-19	Computed:	GCO	Oct-19
		Checked:	RG	6/08/2020

This spreadsheet calculates pavement depth for granular pavements with thin bituminous surfacing (<40mm thick). Calculations for 10^5<DESAs <10^8 are based on Figure 8.4 of Austroads (2004).Calculations for 10^3 <DESAs <10^5 are based on Figure 8.5 of Austroads (2006).

Note: Data is required to be inputted in all blue cells

DESIGN CBR

Design CBR 5 %

DESIGN TRAFFIC

Which Traffic Data Would You Like to Use? DESAs as calculated from the TRAFFIC worksheet *Select from drop down list*

If you have selected 'DESAs as calculated from the TRAFFIC worksheet' in the box above, then please leave the box below blank

User Defined DESAs Leave cell blank by pressing delete once while in the box

Note: Fig 8.4 of Austroads (2004) and Fig 8.5 of Austroads (2006) in only valid for DESAs between 10^5 and 10^8 DESAs. If the DESAs entered into the above box is outside of these limits, the value will be rejected and a new value within the limits must be entered

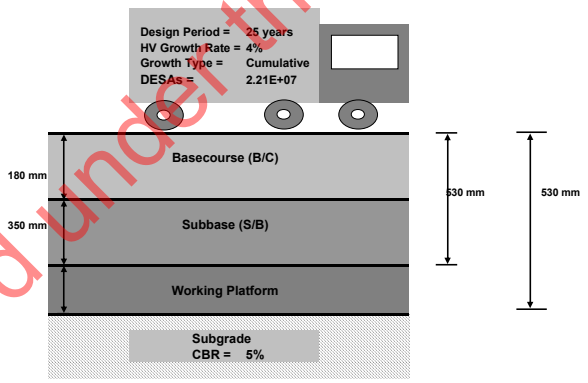
PAVEMENT DESIGN

DESA for use in the Design	2.21E+07
Traffic Growth Used	Cumulative

CBR	Thickness of Granular Material*	Minimum Base Thickness*	Subbase Thickness	Working Platform Suggested*	Working Platform Thickness (mm) (Designer to Specify)	TOTAL Thickness
(%)	(mm)	(mm)	(mm)			(mm)
1	1153	178	975	Yes		**1153**
2	846	178	668	Yes		**846**
3	693	178	514	Yes		**693**
4	595	178	417	No		**595**
5	**526**	**178**	**347**	**No**		**526**
6	473	178	295	No		**473**
7	432	178	254	No		**432**
8	399	178	220	No		**399**
9	371	178	193	No		**371**
10	347	178	169	No		**347**
30	178	178		No		**178**

** From Fig 8.4 or Fig 8.5 as appropriate*
** The New Zealand Supplement to the Austroads Pavement Manual states that subgrades with an in-situ CBR of less than 3 require a working platform. Methods of doing this in Transit's order of preference are: 1) Stabilise the subgrade to a depth of at least 150mm; 2) Place a geotextile separation layer between the subgrade and the subbase; 3) Install a sacrificial layer of granular material of depth 150mm. Refer New Zealand Supplement Section 8.2.1. Where a granular working platform is selected as the preferred option for use in light traffic situations (10^3 <DESA<10^5) the depth of the granular platform can be reduced to 100mm.*

SUGGESTED PAVEMENT DESIGN
Note: The suggested pavement design below makes no consideration of the contribution of a thin AC layer (<40mm) to the pavement composition



Total Depth of Granular Material required =	**526 mm**	*From table above*
Total Depth of Granular Material provided =	**530 mm**	*B/C and S/B rounded up to the nearest 10mm*

Notes:
1. The basecourse and subbase depths suggested above have each been rounded up to the nearest 10mm. Dependant upon the input parameters, the total pavement depth provided in the suggested pavement design may be between 2mm and 18mm thicker than the required pavement depth as determined above
2. If the surfacing is AC and less than 40mm thick, it may be considered to contribute to the total thickness of granular material, but does not affect the required thickness of base. Chip seals are considered to make no contribution to the required thickness of granular materials
3. The designer shall consider rounding and construction tolerance issues, layer thicknesses (and material type) and the structural contribution of an AC layer (if pres in the final pavement composition

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Project Details

This sheet contains the top level information for the current project.

Project Name:	bus hub
Location Name:	
Report Generated:	2020-08-06 11:23:13 AM
Completed On:	2020-07-28 06:49:06 AM
Design Date:	27/07/2020
AustPads version:	v3.1
APADS version:	1.0a
Chainage:	
Comments:	
Designer:	s 9(2)(a) [redacted]
WMAPT (°C):	0
Design Speed (km/h):	0
Cemented Material Fatigue Reliability Factor:	0.50
Asphalt Fatigue Reliability Factor:	9.00
Pavement Layers:	7
Load Type:	Standard Axle Design

Load Summary

Standard Axle Design

Radius [mm]:	92.1
Contact Stress [kPa]:	750
Design Traffic (HVAGs):	1.09E+06
ESA/HVAG:	0.7
Design Traffic (ESAs):	763000

Pavement Details

LayerType	LayerChar	Thickness [mm]	Modulus [MPa]	CriticalStrain	Poisson's Ratio
Asphalt	AC14	120	3200.0	247	0.40
Granular	gravel	70	348.00	N/A	0.35
Granular	gravel	70	236.00	N/A	0.35
Granular	gravel	70	160.00	N/A	0.35
Granular	gravel	70	109.00	N/A	0.35
Granular	gravel	70	74.000	N/A	0.35
Subgrade	User Defined	0	50.000	599	0.45

Pavement Performance

LayerType	LayerChar	Thickness [mm]	Modulus [MPa]	CriticalStrain
Asphalt	AC14	120	3200.0	247
Granular	gravel	70	348.00	N/A
Granular	gravel	70	236.00	N/A
Granular	gravel	70	160.00	N/A
Granular	gravel	70	109.00	N/A
Granular	gravel	70	74.000	N/A
Subgrade	User Defined	0	50.000	599

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Layer Material Information

Asphalt:

Name:	AC14
Thickness[mm]:	120
Vertical Modulus[MPa]:	3200.00
Ev/Eh:	1.00
Poisson's Ratio:	0.40
Volume of Binder[%]:	10.80
K:	3908.48
Bulk Density[t/m3]:	2.00
Shift Factor:	6.00
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	348
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	236
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel

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Thickness[mm]:	70
Vertical Modulus[MPa]:	160
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	109
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	74
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Subgrade:

Name:	User Defined
Thickness[mm]:	0
Vertical Modulus[MPa]:	50
Ev/Eh:	2.00
Poisson's Ratio:	0.45

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Volume of Binder[%]:	
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

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Project Details

This sheet contains the top level information for the current project.

Project Name:	Arterials
Location Name:	Queenstown
Report Generated:	2020-08-06 08:03:23 AM
Completed On:	2020-07-28 06:26:12 AM
Design Date:	27/07/2020
AustPads version:	v3.1
APADS version:	1.0a
Chainage:	
Comments:	
Designer:	s 9(2)(a) [redacted]
WMAPT (°C):	0
Design Speed (km/h):	0
Cemented Material Fatigue Reliability Factor:	0.50
Asphalt Fatigue Reliability Factor:	9.00
Pavement Layers:	7
Load Type:	Standard Axle Design

Load Summary

Standard Axle Design

Radius [mm]:	92.1
Contact Stress [kPa]:	750
Design Traffic (HVAGs):	2.57E+07
ESA/HVAG:	0.7
Design Traffic (ESAs):	17990000

Pavement Details

LayerType	LayerChar	Thickness [mm]	Modulus [MPa]	CriticalStrain	Poisson's Ratio
Asphalt	AC14	160	3200.0	208	0.40
Granular	gravel	70	190.00	N/A	0.35
Granular	gravel	70	151.00	N/A	0.35
Granular	gravel	70	120.00	N/A	0.35
Granular	gravel	70	95.000	N/A	0.35
Granular	gravel	70	76.000	N/A	0.35
Subgrade	User Defined	0	60.000	416	0.45

Pavement Performance

LayerType	LayerChar	Thickness [mm]	Modulus [MPa]	CriticalStrain
Asphalt	AC14	160	3200.0	208
Granular	gravel	70	190.00	N/A
Granular	gravel	70	151.00	N/A
Granular	gravel	70	120.00	N/A
Granular	gravel	70	95.000	N/A
Granular	gravel	70	76.000	N/A
Subgrade	User Defined	0	60.000	416

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Layer Material Information

Asphalt:

Name:	AC14
Thickness[mm]:	160
Vertical Modulus[MPa]:	3200.00
Ev/Eh:	1.00
Poisson's Ratio:	0.40
Volume of Binder[%]:	10.80
K:	3908.48
Bulk Density[t/m3]:	2.00
Shift Factor:	6.00
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	190
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	151
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel

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Thickness[mm]:	70
Vertical Modulus[MPa]:	120
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	95
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Granular:

Name:	gravel
Thickness[mm]:	70
Vertical Modulus[MPa]:	76
Ev/Eh:	2.00
Poisson's Ratio:	0.35
Volume of Binder[%]:	0.00
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

Subgrade:

Name:	User Defined
Thickness[mm]:	0
Vertical Modulus[MPa]:	60
Ev/Eh:	2.00
Poisson's Ratio:	0.45

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Volume of Binder[%]:	
K:	
Bulk Density[t/m3]:	2.00
Shift Factor:	
Nonlinear Flag:	Linear
K1[MPa]:	
K2[-]:	
K3[-]:	
Emin[MPa]:	
Emax[MPa]:	
Residual Compaction Stress[kPa]:	

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PAVEMENT DESIGN USING AUSTROADS 2004

Project/ Task File No.	SH6 - Kawarau Road	Sheet No.	1	of
Project Description	New Pavement	Office	QT	
	Aug-20	Computed:	GCO	Aug-20
		Checked:	RG	Aug-20

DESIGN TRAFFIC CALCULATIONS

Refer to Austroads (2004), Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transit's NZ Supplement

Design Parameters

Note: Data is required to be inputted in all blue cells

Design Period	(P)	25	*years*
Annual Average Daily Traffic	(AADT)	18000	*veh/day*
Direction Factor	(DF)	0.5	
% Heavy Vehicles	(%HV)	4.8	%
Lane Distribution Factor	(LDF)	1	*Refer Table 1 in Tables Tab for guidance*
Heavy Vehicle Growth Rate	(R)	3.5	%
Traffic Load Distribution		Austroads Urban	*Select TLD from drop down list*
Cumulative Growth Factor	(CGF)	38.9	
Arithmetic Growth Factor	(AGF)	35.5	
No. of Axle Groups per Heavy Vehicle	(N_{HVAG})	2.5	*axle groups per heavy vehicle*

	Cumulative	Arithmetic	
Design Traffic (N_{DT}) =	1.54E+07	1.40E+07	**Heavy Vehicle Axle Groups**

(N_{DT} = 365 x (AADT*DF) x %HV/100 x LDF x GF x NHVAG), Austroads (2004) equation 7.1

DESIGN TRAFFIC FOR FLEXIBLE PAVEMENTS

Presumptive Damage Index Values for the TLD selected

Damage Index	Value
ESA/HVAG	0.7
ESA/HV	1.8
SARa/ESA	1.1
SARs/ESA	1.6
SARc/ESA	12

	Cumulative	Arithmetic
Design No. of ESA of Loading (DESA) =	1.07E+07	9.80E+06

(DESA = ESA/HVAG x NDT), Austroads (2004) equation 7.4

The DESA is the design traffic for unbound granular pavements with thin bituminous surfacing (defined as <40mm thick) for use in Figure 8.4 or 8.5 of Austroads (2004) and (Austroads 2006) respectively

For other flexible pavements, the design number of Standard Axle Repetitions (DSAR) for each distress type is;

		Cumulative	Arithmetic
DSARa = DESA x SARa/ESA	DSARa =	1.18E+07	1.08E+07
DSARs = DESA x SARs/ESA	DSARs =	1.72E+07	1.57E+07
DSARc = DESA x SARc/ESA	DSARc =	1.29E+08	1.18E+08

TYPE OF TRAFFIC GROWTH

Type of traffic growth to be used in the Design ? Cumulative *Select from drop down list*

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Project/ Task File No.	SH6 - Kawarau Road	Sheet No.	3	of
Project Description	New Pavement	Office		
	Aug-20	Computed:	GCO	Aug-20
		Checked:	RG	Aug-20

This spreadsheet calculates pavement depth for granular pavements with thin bituminous surfacing (<40mm thick). Calculations for 10^5<DESAs <10^8 are based on Figure 8.4 of Austroads (2004).Calculations for 10^3 <DESAs <10^5 are based on Figure 8.5 of Austroads (2006).

Note: Data is required to be inputted in all blue cells

DESIGN CBR

Design CBR 5 %

DESIGN TRAFFIC

Which Traffic Data Would You Like to Use? DESAs as calculated from the TRAFFIC worksheet *Select from drop down list*

If you have selected 'DESAs as calculated from the TRAFFIC worksheet' in the box above, then please leave the box below blank

User Defined DESAs Leave cell blank by pressing delete once while in the box

Note: Fig 8.4 of Austroads (2004) and Fig 8.5 of Austroads (2006) in only valid for DESAs between 10^3 and 10^8 DESAs. If the DESAs entered into the above box is outside of these limits, the value will be rejected and a new value within the limits must be entered

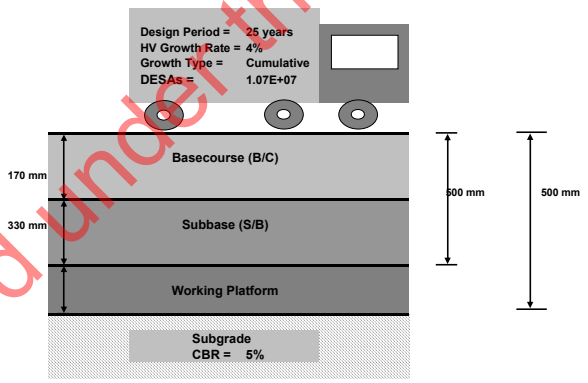
PAVEMENT DESIGN

DESA for use in the Design 1.07E+07
Traffic Growth Used Cumulative

CBR	Thickness of Granular Material*	Minimum Base Thickness*	Subbase Thickness	Working Platform Suggested*	Working Platform Thickness (mm) (Designer to Specify)	TOTAL Thickness
(%)	(mm)	(mm)	(mm)			(mm)
1	1085	168	917	Yes		**1085**
2	796	168	628	Yes		**796**
3	651	168	484	Yes		**651**
4	560	168	392	No		**560**
5	**494**	**168**	**327**	**No**		**494**
6	445	168	278	No		**445**
7	407	168	239	No		**407**
8	375	168	207	No		**375**
9	349	168	181	No		**349**
10	327	168	159	No		**327**
30	168	168		No		**168**

** From Fig 8.4 or Fig 8.5 as appropriate*
** The New Zealand Supplement to the Austroads Pavement Manual states that subgrades with an in-situ CBR of less than 3 require a working platform. Methods of doing this in Transit's order of preference are: 1) Stabilise the subgrade to a depth of at least 150mm; 2) Place a geotextile separation layer between the subgrade and the subbase; 3) Install a sacrificial layer of granular material of depth 150mm. Refer New Zealand Supplement Section 8.2.1. Where a granular working platform is selected as the preferred option for use in light traffic situations (10^3 <DESA<10^5) the depth of the granular platform can be reduced to 100mm.*

SUGGESTED PAVEMENT DESIGN
Note: The suggested pavement design below makes no consideration of the contribution of a thin AC layer (<40mm) to the pavement composition



Total Depth of Granular Material required = **494 mm** *From table above*
Total Depth of Granular Material provided = **500 mm** *B/C and S/B rounded up to the nearest 10mm*

Notes:
1. The basecourse and subbase depths suggested above have each been rounded up to the nearest 10mm. Dependant upon the input parameters, the total pavement depth provided in the suggested pavement design may be between 2mm and 18mm thicker than the required pavement depth as determined above
2. If the surfacing is AC and less than 40mm thick, it may be considered to contribute to the total thickness of granular material, but does not affect the required thickness of base. Chip seals are considered to make no contribution to the required thickness of granular materials
3. The designer shall consider rounding and construction tolerance issues, layer thicknesses (and material type) and the structural contribution of an AC layer (if pres in the final pavement composition

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PAVEMENT DESIGN USING AUSTROADS 2004

Project/ Task File No.	6-XT014.40/245GX	Sheet No.	1	of
Project Description	Pavement Design Spreadsheet	Office	QT	
	Jun-19	Computed:	GCO	17/06/2019
		Checked:	RG	20/06/2019

DESIGN TRAFFIC CALCULATIONS

Refer to Austroads (2004), Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transit's NZ Supplement

Design Parameters

Note: Data is required to be inputted in all blue cells

Design Period	(P)	25	*years*
Annual Average Daily Traffic	(AADT)	70	*veh/day*
Direction Factor	(DF)	1	
% Heavy Vehicles	(%HV)	100	%
Lane Distribution Factor	(LDF)	1	*Refer Table 1 in Tables Tab for guidance*
Heavy Vehicle Growth Rate	(R)	5	%
Traffic Load Distribution		Other	*Select TLD from drop down list*
Cumulative Growth Factor	(CGF)	47.7	
Arithmetic Growth Factor	(AGF)	40.0	
No. of Axle Groups per Heavy Vehicle	(N_{HVAG})	6	*axle groups per heavy vehicle*

	Cumulative	Arithmetic	
Design Traffic (N_{DT}) =	7.32E+06	6.13E+06	**Heavy Vehicle Axle Groups**

(N_{DT} = 365 x (AADT*DF) x %HV/100 x LDF x GF x NHVAG), Austroads (2004) equation 7.1

DESIGN TRAFFIC FOR FLEXIBLE PAVEMENTS

Presumptive Damage Index Values for the TLD selected

Damage Index	Value
ESA/HVAG	0.5
ESA/HV	1
SARa/ESA	1
SARs/ESA	1
SARc/ESA	1

	Cumulative	Arithmetic
Design No. of ESA of Loading (DESA) =	3.66E+06	3.07E+06

(DESA = ESA/HVAG x NDT), Austroads (2004) equation 7.4

The DESA is the design traffic for unbound granular pavements with thin bituminous surfacing (defined as <40mm thick) for use in Figure 8.4 or 8.5 of Austroads (2004) and (Austroads 2006) respectively

For other flexible pavements, the design number of Standard Axle Repetitions (DSAR) for each distress type is;

		Cumulative	Arithmetic
DSARa = DESA x SARa/ESA	DSARa =	3.66E+06	3.07E+06
DSARs = DESA x SARs/ESA	DSARs =	3.66E+06	3.07E+06
DSARc = DESA x SARc/ESA	DSARc =	3.66E+06	3.07E+06

TYPE OF TRAFFIC GROWTH

Type of traffic growth to be used in the Design ? Cumulative *Select from drop down list*

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CIRCLY Version 5.0u (8 April 2013)

   Layer no.  1 is INCLUDED in max. CDF calculation
   Layer no.  2 is INCLUDED in max. CDF calculation
   Layer no.  4 is INCLUDED in max. CDF calculation
Job Title: Trackless Trams

Damage Factor Calculation

Assumed number of damage pulses per movement:
   One pulse per axle (i.e. use NROWS)

Traffic Spectrum Details:

   ID: Trackless Title: Trackless Trams

   Load   Load         Movements
    No.   ID
    1     ESA75-Full   8.86E+06

Details of Load Groups:

   Load   Load        Load        Load            Radius    Pressure/    Exponent
    No.   ID          Category    Type                      Ref. stress
    1     ESA75-Full  SA750-Full  Vertical Force     92.1    0.75         0.00

   Load Locations:
   Location   Load        Gear          X          Y      Scaling     Theta
    No.       ID          No.                             Factor
    1         ESA75-Full   1          -165.0        0.0   1.00E+00      0.00
    2         ESA75-Full   1           165.0        0.0   1.00E+00      0.00
    3         ESA75-Full   1          1635.0        0.0   1.00E+00      0.00
    4         ESA75-Full   1          1965.0        0.0   1.00E+00      0.00

Layout of result points on horizontal plane:
   Xmin:  0   Xmax:  165   Xdel:  165
   Y:     0

Details of Layered System:

   ID: Trackless Title: Tram

   Layer  Lower    Material     Isotropy   Modulus    P.Ratio
    No.   i/face   ID                      (or Ev)    (or vvh)  F          Eh         vh
    1     rough    QT AC14      Iso.       3.62E+03   0.40
    2     rough    AC20         Iso.       4.00E+03   0.40
    3     rough    Gran_300     Aniso.     3.00E+02   0.35      2.20E+02   1.50E+02   0.35
    4     rough    Sub_CBR6     Aniso.     6.00E+01   0.45      4.14E+01   3.00E+01   0.45

   Performance Relationships:
   Layer  Location Performance  Component  Perform.   Perform.  Traffic
    No.            ID                     Constant   Exponent  Multiplier
    1     bottom   QT AC14      ETH         0.003800    5.000     1.000
    2     bottom   AC20         ETH         0.003366    5.000     1.000
    4     top      Sub_2004     EZZ         0.009300    7.000     1.000

   Reliability Factors: Not Used.

   Details of Layers to be sublayered:
   Layer no.  3:  Austroads (2004) sublayering

Automatic layer thickness design:
   Layer number to be designed:  3
   Minimum thickness:  0
   Maximum thickness:  5000

Results:

   Layer  Thickness  Material     Load          Critical       CDF
    No.              ID           ID            Strain
    1       50.00    QT AC14      ESA75-Full    -1.06E-05      1.52E-06
    2      150.00    AC20         ESA75-Full    -1.37E-04      9.99E-01
    3      261.47    Gran_300                    n/a           n/a
```

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```
4          0.00     Sub_CBR6      ESA75-Full      3.48E-04       9.11E-04
```

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CIRCLY Version 5.0u (8 April 2013)

   Layer no.  1 is INCLUDED in max. CDF calculation
   Layer no.  2 is INCLUDED in max. CDF calculation
   Layer no.  4 is INCLUDED in max. CDF calculation
Job Title: Access Ramp

Damage Factor Calculation

Assumed number of damage pulses per movement:
   One pulse per axle (i.e. use NROWS)

Traffic Spectrum Details:

   ID: Tuckers Title: Westbound On Ramp

   Load    Load          Movements
    No.    ID
    1      ESA75-Full    7.46E+06

Details of Load Groups:

   Load    Load          Load          Load              Radius     Pressure/     Exponent
    No.    ID            Category      Type                         Ref. stress
    1      ESA75-Full    SA750-Full    Vertical Force      92.1      0.75          0.00

   Load Locations:
   Location    Load          Gear          X           Y        Scaling      Theta
    No.        ID            No.                                Factor
    1          ESA75-Full     1          -165.0        0.0     1.00E+00      0.00
    2          ESA75-Full     1           165.0        0.0     1.00E+00      0.00
    3          ESA75-Full     1          1635.0        0.0     1.00E+00      0.00
    4          ESA75-Full     1          1965.0        0.0     1.00E+00      0.00

Layout of result points on horizontal plane:
   Xmin:  0   Xmax:  165   Xdel:  165
   Y:     0

Details of Layered System:

   ID: Tuckers Title: Structral AC

   Layer  Lower    Material    Isotropy   Modulus    P.Ratio
    No.   i/face   ID                     (or Ev)    (or vvh)   F          Eh         vh
    1     rough    AC14        Iso.       2.30E+03   0.40
    2     rough    AC20        Iso.       4.00E+03   0.40
    3     rough    Gran_200    Aniso.     2.00E+02   0.35       1.50E+02   1.00E+02   0.35
    4     rough    Sub_CBR10   Aniso.     1.00E+02   0.45       6.90E+01   5.00E+01   0.45

   Performance Relationships:
   Layer  Location Performance  Component  Perform.   Perform.   Traffic
    No.             ID                     Constant   Exponent   Multiplier
    1     bottom   AC14        ETH         0.004600   5.000      1.000
    2     bottom   AC20        ETH         0.003366   5.000      1.000
    4     top      Sub_2004    EZZ         0.009300   7.000      1.000

   Reliability Factors: Not Used.

   Details of Layers to be sublayered:
   Layer no.  3:  Austroads (2004) sublayering

Automatic layer thickness design:
   Layer number to be designed:  2
   Minimum thickness:  0
   Maximum thickness:  5000

Results:

   Layer  Thickness  Material    Load        Critical     CDF
    No.              ID          ID          Strain
    1       50.00    AC14        ESA75-Full   9.06E-06    7.46E-31
```

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2	134.59	AC20	ESA75-Full	-1.42E-04	9.85E-01
3	400.00	Gran_200		n/a	n/a
4	0.00	Sub_CBR10	ESA75-Full	2.31E-04	4.40E-05

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Project/ Task File No.	Frankton Road - Options Level Assessment	Sheet No.	1	of
Project Description		Office	QT	
	Jul-05	Computed:	GCO	22/10/2019
		Checked:	RG	22/11/2016

DESIGN TRAFFIC CALCULATIONS

Refer to Austroads (2004), Pavement Design - A Guide to the Structural Design of Road Pavements Section 7 & Transit's NZ Supplement

Design Parameters

Note: Data is required to be inputted in all blue cells

Design Period	(P)	25	*years*
Annual Average Daily Traffic	(AADT)	25034	*veh/day*
Direction Factor	(DF)	0.5	
% Heavy Vehicles	(%HV)	4.8	%
Lane Distribution Factor	(LDF)	1	*Refer Table 1 in Tables Tab for guidance*
Heavy Vehicle Growth Rate	(R)	3.5	%
Traffic Load Distribution		Austroads Urban	*Select TLD from drop down list*
Cumulative Growth Factor	(CGF)	38.9	
Arithmetic Growth Factor	(AGF)	35.5	
No. of Axle Groups per Heavy Vehicle	(N_{HVAG})	2.5	*axle groups per heavy vehicle*

	Cumulative	Arithmetic	
Design Traffic (N_{DT}) =	2.14E+07	1.95E+07	**Heavy Vehicle Axle Groups**

(N_{DT} = 365 x (AADT*DF) x %HV/100 x LDF x GF x NHVAG), Austroads (2004) equation 7.1

DESIGN TRAFFIC FOR FLEXIBLE PAVEMENTS

Presumptive Damage Index Values for the TLD selected

Damage Index	Value
ESA/HVAG	0.7
ESA/HV	1.8
SARa/ESA	1.1
SARs/ESA	1.6
SARc/ESA	12

	Cumulative	Arithmetic
Design No. of ESA of Loading (DESA) =	1.49E+07	1.36E+07

(DESA = ESA/HVAG x NDT), Austroads (2004) equation 7.4

The DESA is the design traffic for unbound granular pavements with thin bituminous surfacing (defined as <40mm thick) for use in Figure 8.4 or 8.5 of Austroads (2004) and (Austroads 2006) respectively

For other flexible pavements, the design number of Standard Axle Repetitions (DSAR) for each distress type is;

		Cumulative	Arithmetic
DSARa = DESA x SARa/ESA	DSARa =	1.64E+07	1.50E+07
DSARs = DESA x SARs/ESA	DSARs =	2.39E+07	2.18E+07
DSARc = DESA x SARc/ESA	DSARc =	1.79E+08	1.63E+08

TYPE OF TRAFFIC GROWTH

Type of traffic growth to be used in the Design ? Cumulative *Select from drop down list*

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OPUS

Project/ Task File No.	Frankton Road - Options Level Assessment	Sheet No.	3	of
Project Description		Office		
	Jul-05	Computed:	GCO	1/10/2016
		Checked:	RG	22/11/2016

This spreadsheet calculates pavement depth for granular pavements with thin bituminous surfacing (<40mm thick). Calculations for 10^5<DESAs <10^8 are based on Figure 8.4 of Austroads (2004).Calculations for 10^3 <DESAs <10^5 are based on Figure 8.5 of Austroads (2006).

Note: Data is required to be inputted in all blue cells

DESIGN CBR

Design CBR 8 %

DESIGN TRAFFIC

Which Traffic Data Would You Like to Use? DESAs as calculated from the TRAFFIC worksheet *Select from drop down list*

If you have selected 'DESAs as calculated from the TRAFFIC worksheet' in the box above, then please leave the box below blank

User Defined DESAs Leave cell blank by pressing delete once while in the box

Note: Fig 8.4 of Austroads (2004) and Fig 8.5 of Austroads (2006) in only valid for DESAs between 10^5 and 10^8 DESAs. If the DESAs entered into the above box is outside of these limits, the value will be rejected and a new value within the limits must be entered

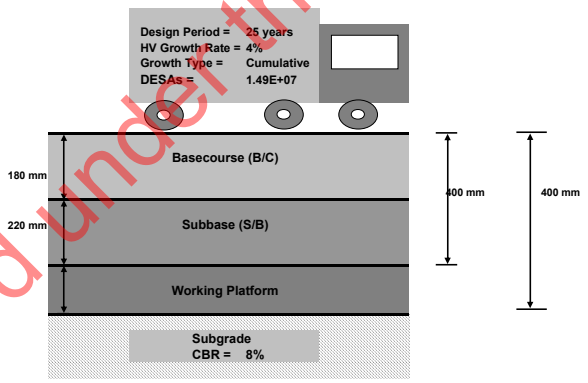
PAVEMENT DESIGN

DESA for use in the Design	1.49E+07
Traffic Growth Used	Cumulative

CBR	Thickness of Granular Material*	Minimum Base Thickness*	Subbase Thickness	Working Platform Suggested*	Working Platform Thickness (mm) (Designer to Specify)	TOTAL Thickness
(%)	(mm)	(mm)	(mm)			(mm)
3	670	173	498	Yes		**670**
4	576	173	403	No		**576**
5	509	173	336	No		**509**
6	458	173	286	No		**458**
7	418	173	246	No		**418**
8	**386**	**173**	**213**	**No**		**386**
9	359	173	186	No		**359**
10	336	173	164	No		**336**
11	317	173	144	No		**317**
12	300	173	127	No		**300**
13	285	173	112	No		**285**
30	173	173		No		**173**

** From Fig 8.4 or Fig 8.5 as appropriate*
** The New Zealand Supplement to the Austroads Pavement Manual states that subgrades with an in-situ CBR of less than 3 require a working platform. Methods of doing this in Transit's order of preference are: 1) Stabilise the subgrade to a depth of at least 150mm; 2) Place a geotextile separation layer between the subgrade and the subbase; 3) Install a sacrificial layer of granular material of depth 150mm. Refer New Zealand Supplement Section 8.2.1. Where a granular working platform is selected as the preferred option for use in light traffic situations (10^3 <DESA<10^5) the depth of the granular platform can be reduced to 100mm.*

SUGGESTED PAVEMENT DESIGN
Note: The suggested pavement design below makes no consideration of the contribution of a thin AC layer (<40mm) to the pavement composition



Total Depth of Granular Material required =	**386 mm**	*From table above*
Total Depth of Granular Material provided =	**400 mm**	*B/C and S/B rounded up to the nearest 10mm*

Notes:
1. The basecourse and subbase depths suggested above have each been rounded up to the nearest 10mm. Dependant upon the input parameters, the total pavement depth provided in the suggested pavement design may be between 2mm and 18mm thicker than the required pavement depth as determined above
2. If the surfacing is AC and less than 40mm thick, it may be considered to contribute to the total thickness of granular material, but does not affect the required thickness of base. Chip seals are considered to make no contribution to the required thickness of granular materials
3. The designer shall consider rounding and construction tolerance issues, layer thicknesses (and material type) and the structural contribution of an AC layer (if pres in the final pavement composition

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Dunedin
Level 3 John Wickliffe House, 265 Princes Street
Dunedin 9016
PO Box 13-052, Armagh
Christchurch 8141
Tel +64 3 477 0885
Fax +64 3 477 0616

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