Rotokauri Strategic Infrastructure Designation

Design Report

Prepared for Hamilton City Council

Prepared by Beca Limited

19 September 2024

Hamilton City Council
Te kaunihera o Kirikiriroa

Contents

Appendices

Revision History

Revision Nº	Prepared by	Description	Date
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B	Beca	Issued for Client Approval	06 June 2023
C	Beca	Notice of Requirement	11 July 2023
D	Beca	Notice of Requirement	01 September 2023
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F	Beca	Final s92 revision	24 April 2024
G	Beca	Update to Figure 2-3 to reflect latest drawing revision	19 September 2024

Document Acceptance

Action	Name	Signed	Date
Rev A Prepared by	Skip Fourie – Transportation Kate McNeill / Ben Frost – Urban & Landscape Design Nick Tunnicliffe / Graeme Carlyon – Road & Civil Design Iain Smith – Stormwater Zac Lyon – Geotechnical Ryan Ainsworth – Project Management		29.04.2022
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Approved by	Craig Sharman		19.09.2024
on behalf of	Beca Limited		

1 Introduction

1.1 Purpose of this Report

The purpose of this Design Report is to set out the design principles and capture the outcomes that Hamilton City Council (HCC) aims to achieve on the 'Rotokauri Strategic Infrastructure Designation' (the Project). This report has been prepared to detail the design philosophy that has been used to establish transport corridors to justify the proposed designation boundaries for the Notice of Requirement (NoR).

This report forms part of and should be read in conjunction with the NoR and the corresponding concept design drawings and supplementary reports.

1.2 Project overview

This report has been prepared to support a NoR prepared by Beca Limited (Beca) on behalf of HCC. HCC requires land to be designated in Hamilton City for the construction and operation of the Project. This NoR proposes the designation of key transportation networks and strategic infrastructure corridors servicing the Rotokauri growth cell. The NoR and proposed designation if confirmed will:

1. Protect the land required to deliver key transportation and strategic infrastructure by HCC as the requiring authority.

2. Authorise the use of the land for the construction and operation of the infrastructure networks.

3. Facilitate planned urban growth within the Rotokauri growth cell by identifying the network in the District Plan.

Rotokauri is situated to the northwest of Hamilton as shown in Figure 1-1 below. Rotokauri is identified as one of four areas of future growth for Hamilton City. Future growth has been earmarked for the Rotokauri area since 1989. Since 2005 the area has been identified as a 'structure plan area', with the Rotokauri Structure Plan (RSP) notation in the Hamilton City District Plan (HCDP). Hamilton's Urban Growth Strategy (2023) identifies the Rotokauri area as one of the future neighbourhood development areas for the City.

The overall vision within the RSP is described as:

> *"The sustainable expansion of the City into Rotokauri, through a coherent, integrated and people-focused mixed-use development based on best practice urban design principles."*

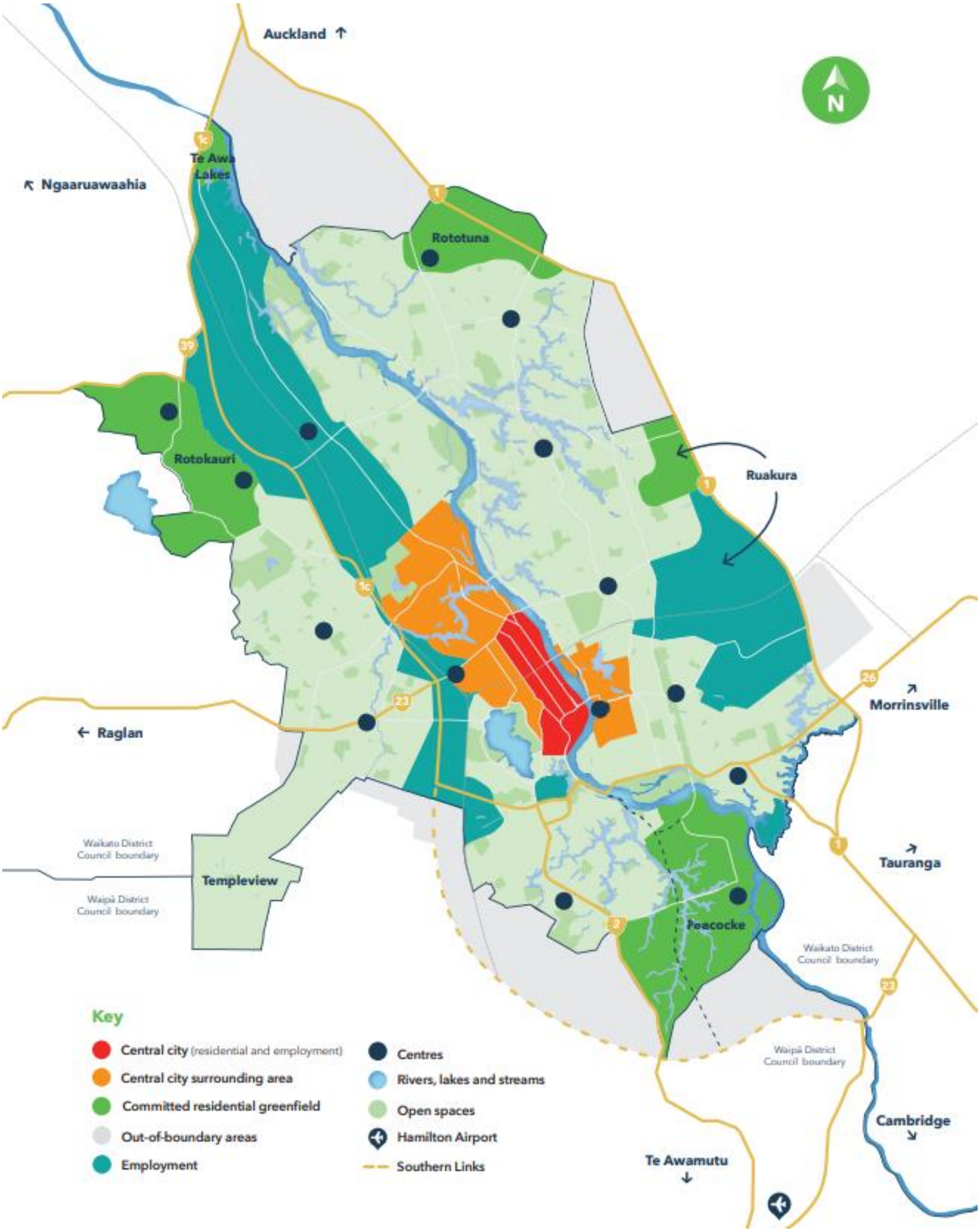

Figure 1-1: Rotokauri Development Location Plan (Source: Hamilton City Council Urban Growth Strategy, 2023)

The proposed designation as depicted in Figure 1-2 below covers a combined 5.8km length of corridors. This includes the design of a new 5.2km corridor relating to greenfield areas, and the widening of 600m of existing road to support future growth and development in Rotokauri.

This main north-south corridor commences in the north at the State Highway 39 (SH39) and Koura Drive roundabout and proceeds in a south-eastern direction to the proposed location of the future intersection with Te Wetini Drive.

There are also two east-west corridors (Te Kowhai East Road and Chalmers Road) that align with existing grade separated underpasses under State Highway 1C (SH1C). These link the Rotokauri growth cell to key transport destinations and the wider Hamilton City transportation network. Arthur Porter Drive is a strategic local (collector) road connection which will be extended to connect with the Earthmover Crescent roundabout.

The Project is comprised of the following:

1. Proposed major arterial – approx. 0.7km widening on Te Kowhai East Road (purple dash in Figure 1-2).

2. Proposed minor arterials – approx. 3.8km, north-south arterial and a portion of Te Kowhai East Road to connect to the existing corridor (red dash in Figure 1-2).

3. Proposed collector roads – approx. 0.8km Chalmers Road extension and Arthur Porter Drive north realignment (yellow dash in Figure 1-2).

4. Proposed local road – approx. 0.5km connection to Arthur Porter Drive realignment to provide continued access to industrial/commercial properties (blue dash in Figure 1-2).

5. Associated three waters infrastructure and network utilities.

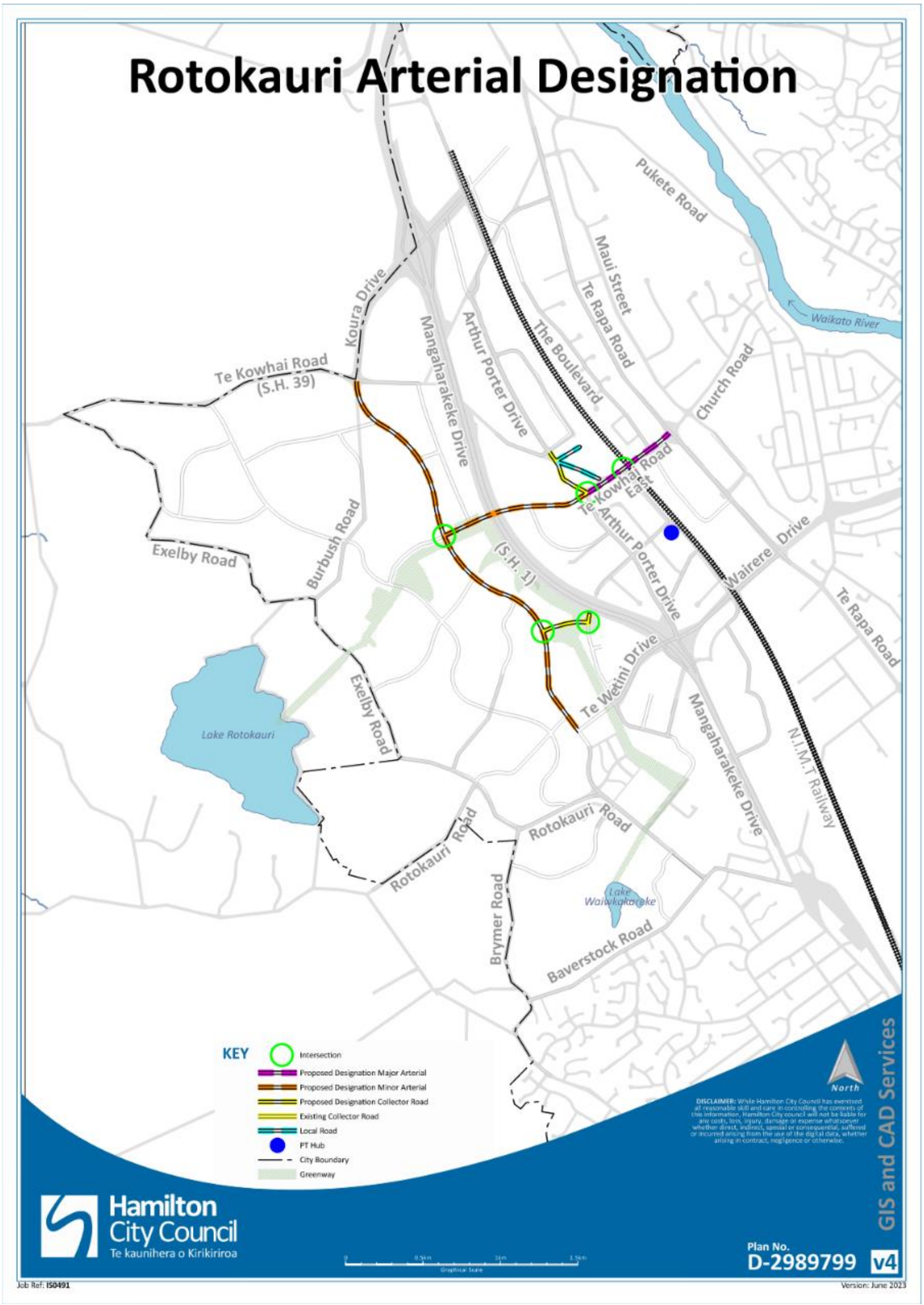

Figure 1-2: Proposed Rotokauri Arterial Network (Source: Hamilton City Council)

1.3 Purpose of the Designation

The purpose of the Designation is to secure the land and planning authorisations necessary to deliver a critical multimodal transportation and infrastructure network that will enable the full urbanisation of the RSP area and achieve the objectives set out in section 1.4 (Objectives). The proposed designation is intended to allow HCC, as the requiring authority, sufficient areas of land to protect key arterial network routes and infrastructure corridors. The Designation Purpose incorporates the following *outcome*:

Transportation and Infrastructure Network Description

> ***A key multimodal transportation and infrastructure network that supports an integrated and people-focused mixed-use development, providing for the associated spatial requirements of necessary infrastructure, network utilities, three waters and stormwater treatment, conveyance, and storage functions.***

1.4 Project Objectives

The following objectives have been developed for the Project. These reflect the integrated nature of the infrastructure corridor and adjacent land use.

1.4.1 Network and Function Objectives

To provide a well-integrated multi modal transportation network that promotes a wide range of safe, responsive, efficient, and sustainable transport modes including walking, cycling, and public transport. Opportunities for passenger transport and alternative transport modes which will reduce reliance on private motor vehicles through consideration and allowance for adaptive change in the future should be made where possible.

The network achieves through design improved accessibility and connectivity into Hamilton City that is consistent with the land use spatial framework, Rotokauri Structure Plan and achieves the strategic direction established by Access Hamilton.

1.4.2 Infrastructure Objective

To support the sustainable future urban land use development and growth needs in the North of Hamilton City of Rotokauri in accordance with the Rotokauri Structure Plan. This shall be achieved by requiring sufficient land to protect the Rotokauri Network corridor including areas for stormwater management. The corridor shall allow for the inclusion of purposeful, robust, and efficient infrastructure to occur; whilst providing confidence to the surrounding land use development of the extent of the network. Identification of a network corridor manages the risk of spatial conflicts and realises opportunities for effective integration with the surrounding established networks and the Rotokauri Greenway.

The corridors will facilitate:

1. an integrated transport system including the coherent form of intersections,
2. three waters infrastructure network,
3. the provision of key stormwater and flood management infrastructure and secondary flow corridors in accordance with local catchments and associated ICMPs,

4. Integrate with the Hamilton City Council Greenway designation for conveyance and management of stormwater and recreation connections,

5. provision for other network utilities,

6. a clear and consistent approach to the delineation of the edge of the corridors considering constructability, access requirements and ongoing maintenance.

1.4.3 Integration Objective

To enhance the accessibility within the network for people by achieving cohesion between the proposed development and existing communities in a well-planned and legible way. By applying urban design principles, the network should:

1. integrate to the future urban land use context,

2. provide connectivity between the Rotokauri Structure Plan area and the existing Hamilton City infrastructure network, Rotokauri hub and state highway network,

3. promote strong people-focused connections to the street environment.

1.4.4 Cultural Values, Character and Amenity Objective

To enhance the vitality of public spaces in a way that interacts positively with the multi modal transportation network and acknowledges the cultural identity of the area. A strong sense of community identity for Rotokauri is created through:

1. responding to the cultural identity and values of Rotokauri and the wider area,

2. create a distinctive sense of place for Rotokauri,

3. promote safe and enjoyable use of public space through the quality and design of the public open spaces,

4. incorporate, protect, and enhance the habitat of the receiving environments.

These objectives were developed and agreed with HCC staff in May 2021 as a consequence of refinement through the Detailed Business Case investigations.

1.5 Rotokauri Arterials Design and Function

1.5.1 Rotokauri Arterial Network

The Project is required to service the urbanisation of the Rotokauri growth cell in accordance with the RSP. The proposed designation routes depict the preferred alignments for the strategic network corridors (previously established by the RSP) and other key connections required to improve transport connectivity.

As illustrated in Figure 1-2 above the Project interacts with three other linear corridors within Rotokauri being the Te Rapa Section of the Waikato Expressway (the Expressway), the North Island Main Trunk Railway (NIMTR), and the Rotokauri Greenway corridor.

The Project has a high urban design focus contributing to HCC’s strategic objectives for land use planning, provision of urban growth infrastructure and economic development. Broadly, these include multimodal transportation facilities, bus stops, parking, spatial provisions for utilities network including three waters infrastructure, connections to recreational spaces and small amenity areas where there is a transition in land-use or context.

1.5.2 Stormwater management function

A core element of the proposed designation includes the associated stormwater facilities required to provide an appropriate level of treatment of road run-off such as rain gardens, wetlands and treatment swales. The designation if confirmed will authorise and allow adequate space for, and the construction and operation of stormwater facilities (as part of the infrastructure network).

Stormwater management areas are included within the proposed designation (i.e., artificial wetlands downstream of the road networks to collect road run-off). The proposed designation connects to the receiving environment watercourses. All stormwater management areas within the proposed designation have been designed to integrate with stormwater management for adjoining land.

A ‘maximum probable development sub-catchment approach’ has been adopted for initial concept design sizing of these devices for the proposed designation. The proposed designation is therefore sufficient to accommodate the stormwater needs of the Project with some flexibility for detailed design and integration with the catchment. This initial conceptual design will be subject to a further detailed design process prior to construction and further resource consents may be required at that stage depending on the final design.

This maximum probable development approach allows flexibility with staging of construction and allows portions of these areas to be formed early where necessary. The staging will depend on the rate of development in the receiving catchment and if private development agreements are negotiated between HCC and developers. As detailed designs are prepared and developer plans progress HCC will consider opportunities to improve integration and optimisation of stormwater facilities with surrounding land use.

1.5.3 Integration with the Rotokauri Greenway Designation

The proposed designation follows the existing Rotokauri Greenway corridor designation (2020), which is the major stormwater floodway and greenspace recreation network for the southern sector of the Rotokauri area. The Greenway corridor delivers on the Rotokauri ICMP and is a strategically important stormwater management element that supports the intensification and development of the Rotokauri area.

The stormwater areas included in the proposed designation are intended to work in conjunction with the Rotokauri Greenway facilities. They will provide stormwater treatment and flood storage as well as opportunities for active mode connections between the Rotokauri Arterial Network and the Greenway, enhancing recreation functions for both projects. Further descriptions and details of the Rotokauri Greenway and the interfacing aspects relevant to this proposal are outlined in Section 5 of this report.

1.6 Development context

The Project is situated in the northwest of Hamilton and is identified on the RSP. The Rotokauri growth cell is an existing greenfield area and has been signalled for urbanisation since 1989. Iterations of the RSP have been in place since 2005 providing a land use development blueprint that enables, and will in time, result in a predominantly residential urban environment. The growth cell currently sustains a mixture of remnant rural land uses (pastoral farming, cropping and rural lifestyle living) and transitional urbanisation landuses envisaged under the structure plan. The RSP provides for other urban activities including industrial, employment, educational, recreational, commercial (Suburban Centre) and associated network infrastructure as shown in Figure 2-8: RSP[1] of the HCDP.

The RSP requires the advanced or concurrent development of critical infrastructure to unlock the urbanisation planned in the catchment, including the designated Rotokauri Greenway corridor and the proposed Rotokauri Arterial Network. The Rotokauri Greenway is a necessary precursor to the construction of a significant component of the Rotokauri Arterial Network. On 12 December 2023, the Environmental Protection Authority accepted an application for resource consents to construct the Rotokauri Greenway and supporting infrastructure. The application is currently before an expert consenting panel appointed to determine the application under the COVID-19 Recovery (Fast-track Consenting) Act 2020.

Urbanisation is under way in the growth cell with various consents lodged and several obtained by adjacent landowners and developers. Particularly relevant to the Rotokauri Arterial Network are the subdivision consents granted to RDL (197 lots) and Te Wetini Developments (5 lots). It is acknowledged that a degree of integration between HCC as the requiring authority and the development community is necessary during this transitional development phase. As such, it is anticipated the Rotokauri Arterial Network may be refined in co-ordination with adjacent landowners in the future.

Timing and sequencing

While exact timing and sequencing of development within the RSP will be influenced by development demands, the following assumptions have been made in relation to the state of the environment:

- **The Greenway corridor**

Construction of the Rotokauri Arterial Network will not commence ahead of the construction of the Greenway corridor, as it is the first critical piece of infrastructure required to support urbanisation of the area, given the significant stormwater issues associated with Rotokauri. The construction of the Greenway will span several construction seasons involving significant bulk earthworks and associated effects which will be managed by a suite of designation conditions, resource consents, and associated management plans. The existence of the Rotokauri Greenway and associated wetlands should be assumed in all effects assessments.

- **Urban development**

Development planning is well advanced with three master plans prepared for large greenfield areas of Rotokauri[2]. This includes the Rotokauri North Structure Plan area at the northern extent of the proposed designation for which the zoning is now operative and development could commence at any time (subject to regional consents and the provision of other infrastructure). Other developers are progressing the design and construction of the Greenway corridor and roading networks (some of which includes delivering part of the NOR works), which will provide the necessary infrastructure for stormwater management, treatment and discharge, along with critical roading connectivity, to enable the urbanisation of a large portion of Rotokauri. It is therefore feasible to assume that urban development across the RSP will have advanced by the time the construction of the balance of the Rotokauri Arterial Network commences. It is noted that some master plans do not fully follow the RSP as they are seeking higher density developments, and zoning has / is also being contested. Developers' stormwater provisions are evolving and show a preference for piped systems.

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[1] https://hamilton.isoplan.co.nz/eplan/rules/0/17/0/0/0/79

[2] Refer Beca Urban and Landscape Design Framework (June 2023), Page 22, Figure 13 for Rotokauri Development Context map.

The Beca design team has tested developers' solutions where these have been made available and provided design information to these developers as and when they have requested it. Under the current programme, for much of the area, both the Greenway and the Arterials will need to be in place to unlock development; the Greenway to facilitate stormwater management and the Arterials to provide transport connections. Developers have looked at growth without the Greenway and are still considering options, but these are proving technically challenging and potentially costly. HCC has engaged with Hounsell Holdings Limited under a separate design contract to undertake the detailed design of the Greenway and the Arterials south of Te Kowhai East Road.

Key inputs will be the interaction between the developers' stormwater solutions and the road drainage, the cross culverts, overland flood routes, performance requirements set by ICMPs and the Greenway. Future subdivision designs will need to integrate into the Arterials stormwater network including the treatment wetlands. Developers will need to work with the HCC stormwater arrangement and to Waikato Regional Council's resource consenting requirements.

While the proposed designation sets out the location and form of major intersection locations, it is not prescriptive over intermediate intersection locations. These will be established in conjunction with the developers as part of their master planning exercises. HCC intends to implement a segregation strip to provide a level of control over developers' access to the corridors to protect the project objectives. Major junctions have been established with a good degree of certainty and allow for any necessary future upgrades from the modelled transport growth.

2 Transportation

2.1 Integrated Transport Assessment

Refer to the separate Integrated Transport Assessment (ITA) which has been prepared to accompany the NoR. Content has been duplicated here to capture key design elements. The ITA includes:

1. Existing transport conditions, traffic patterns, property access and crash records.
2. Predicted traffic flows and impact on the surrounding network.
3. Proposed road network against the transport elements of the HCDP including intersection and corridor form, and provisions for public transport, walking and cycling.
4. The appropriateness of the NoR from a transport engineering perspective.

The ITA used the Structure Plan (Figure 2-1), Access Hamilton, Hamilton Network Operating Framework (NOF) guidance as a starting point to inform the extent and demand for traffic capacity along the key corridors.

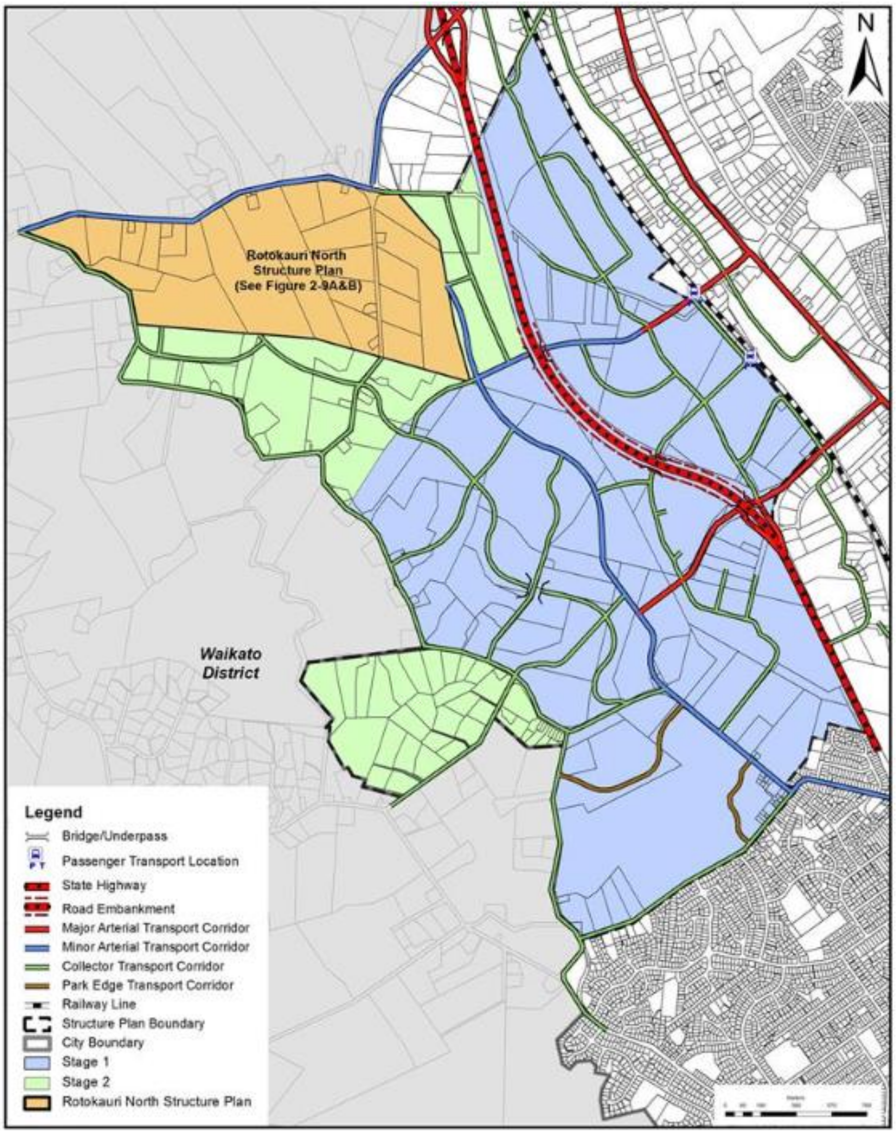


Figure 2-1 - RSP - Staging and Transport Network (Source: HCDP)

Included in the NoR are the following transport features:

- **General**
  - An extensive network of separated pedestrian, cycleway and micro-mobility pathways across all of the transport corridors, these vary from 1.8m – 2.8m.
  - Provisions for bus priority at intersections, where there could be potential delay to buses, to support and encourage use of public transport.

- **Major Roads**
  - Proposed Minor Arterials
  - Proposed Major Arterials
  - Proposed Collector Roads
  - Proposed Local Roads

- **Intersections**

  1. Te Kowhai and Minor Arterial (signalised)
  2. Arthur Porter Drive – Te Kowhai Road (signalised)
  3. Tasman Road – Te Kowhai Road (signalised)
  4. The Boulevard – Te Kowhai Road (signalised)
  5. Minor Arterial and Chalmers Road (signalised)
  6. Chalmers Road and Collector Road (priority)
  7. SH39, Te Kowhai Road / Burbush Road (connection to existing roundabout)
  8. Existing intersection, tie in only
  9. Arthur Porter Drive – new Local Road(s) (priority)
  10. Existing intersection, tie in only

Figure 2-2 below shows the locations of the above-mentioned intersections.

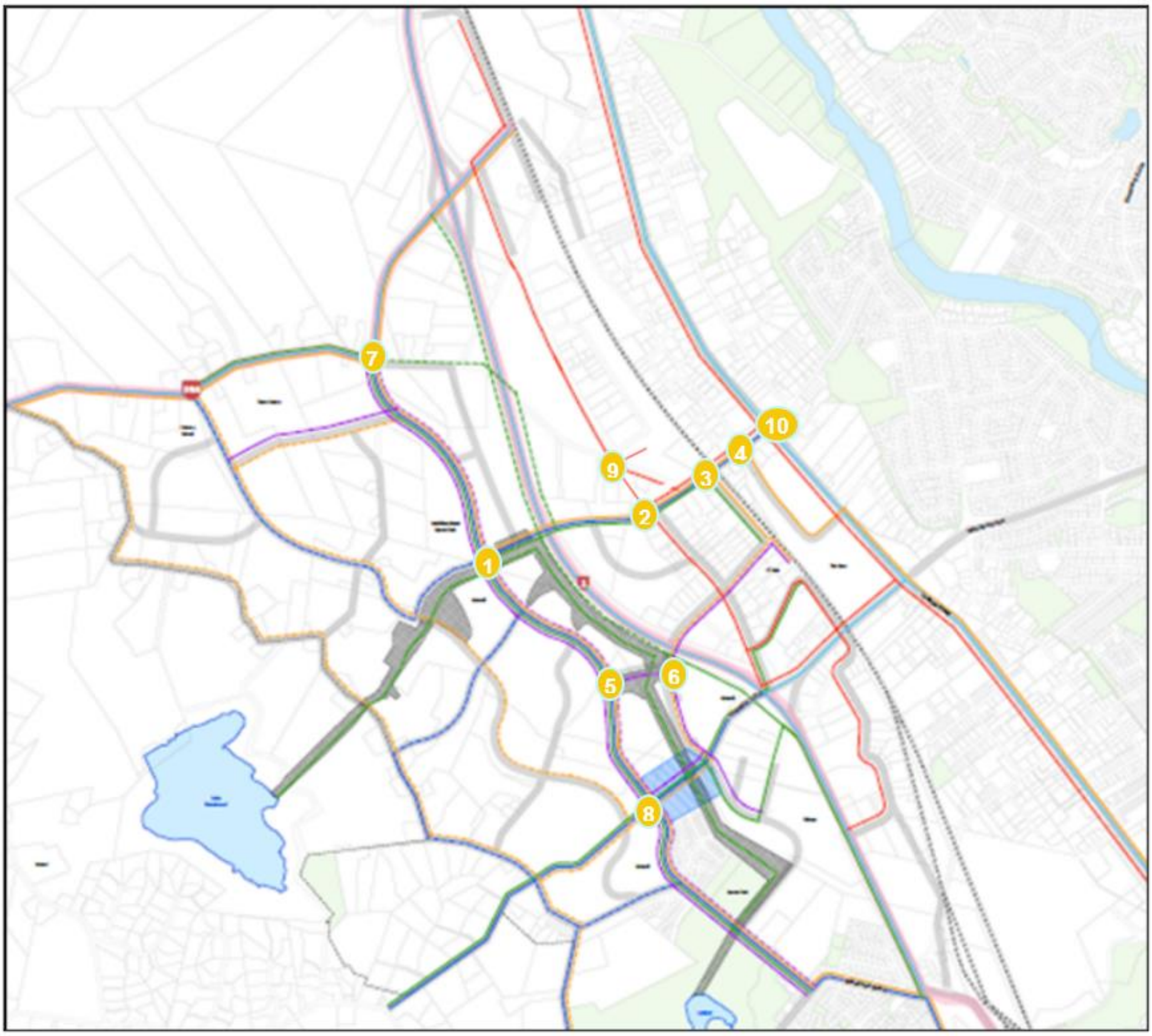


Figure 2-2: Proposed Designation Intersection Locations

2.2 Transport Network Elements

This section provides an account of the proposed designated transport network. Including comments on the following key elements:

- Corridor form
- Intersections
- Provisions for public transport
- Walking and cycling facilities

The assessment uses the UDLF layouts for ease of reference, including some more detailed cross section and intersection form layouts.

Provision for future vehicle access and active mode provisions has been considered throughout the corridor design. Specific detail is not considered within this ITA, this level of detail will be considered at a later stage.

2.3 Design Standards & Guidance

The following key design standards (not excluding others) have informed the development of the cross sections, intersections, and transport infrastructure:

- The Regional Infrastructure Technical Standards (RITS)
- District Plan – Design Guides
- HCC Urban Design and Landscape Guides
- Network Operations Framework (NOF)
- AUSTROADS standards - geometric road design, pedestrian, and cycle paths
- NZTA Pedestrian Planning and Design Guide
- AS/NZS 1428.1: 2009 Design for Access and Mobility.

2.4 Transport Network Corridors

The general road arrangement is shown in Figure 2-3. This identifies the following key proposed designation corridor descriptions and likely Waka Kotahi One Network Framework - Movement and Place classification (proposed):

- **Rotokauri Minor Arterial North** (3100.4, 3100.5) (new road)
  - High movement function (ONF M3) and a moderate place function (ONF P3)
- **Minor Arterial, Te Kowhai West Extension** (3101.3) (new road)
  - High movement function (ONF M3) and high place function (ONF P2)
- **Collector Road** (3121.1)
  - Moderate movement function (ONF M4), moderate place function (ONF P3)
- **Chalmers Road Extension** (3122.1)
  - High movement function (ONF M3), low place function (ONF P3)
- **Minor Arterial, Te Kowhai Road West Extension** (3101.3)
  - High movement function (ONF M3), moderate place function (ONF P3)
- **Collector Road, Arthur Porter Drive** (3102.2)
  - Low movement function (ONF M5), low place function (ONF P4)
- **Major Arterial, Te Kowhai Road East Upgrade** (3101.1, 3101.2)
  - High movement function (ONF M3), low place function (ONF P4)
- **Rotokauri Minor Arterial North, Commercial Centre** (3100.2)
  - High movement function (ONF M3), high place function (ONF P3)
- **Local Roads** (3125.1 & 3125.2)
  - ONF categorisation to be confirmed

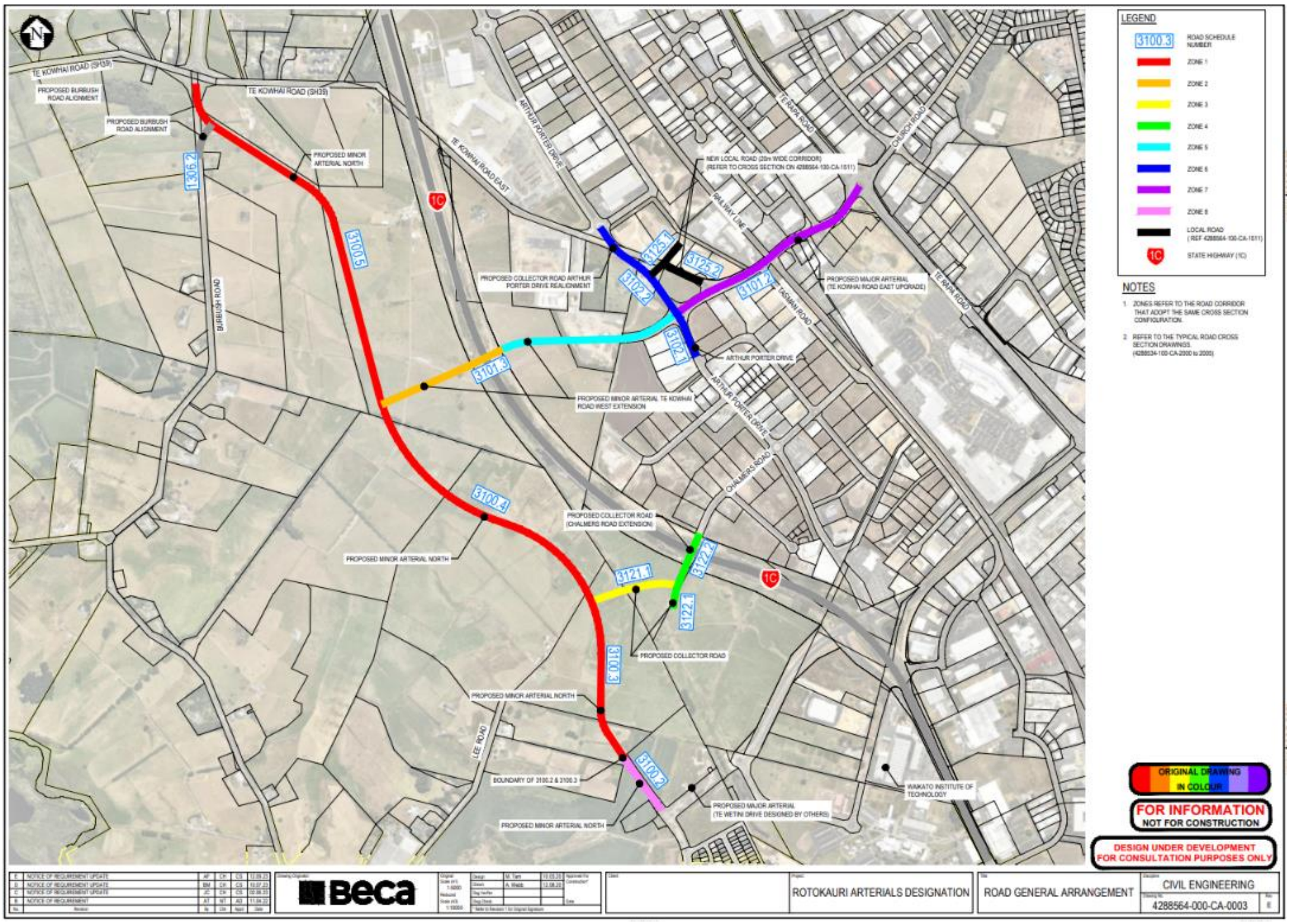


Figure 2-3: Proposed Designation Arrangement

2.5 Traffic Modelling

This section describes the traffic modelling undertaken for key intersections in the proposed designation area which includes use of the Waikato Regional Transportation Model (WRTM) and SIDRA modelling.

It is important to note that during the data extraction for the ITA, the WRTM did not reflect the recent population growth in the surrounding area. To address this, an uplift/sensitivity test was conducted to consider the expected higher densities in the region. As a result, the overall traffic volume in the SIDRA models used for each intersection was increased by an additional 30%. Furthermore, a scenario was simulated to evaluate the potential effects of the Medium Density Residential Standards (MDRS), assuming a general increase in traffic volumes by 20-30% for the purpose of this assessment.

These tests were necessary to check that the model outputs reflect potential traffic volumes in the region and could be used for effective transportation planning. It is noted that there is a higher degree of uncertainty than typical due to the multiple layers of information available, including Plan Change 12 promoting intensification, that was not known at the time of the transport assessment, which has not been incorporated into an updated strategic model for input into this assessment. This should be reviewed in future when more reliable travel demand forecasts become available.

2.5.1 WRTM

The WRTM forecast year 2051 land use model, incorporating land use assumptions which includes Rotokauri, was used to obtain predicted traffic data for use in the SIDRA intersection modelling.

The intersection modelling is a key component to understand the intersection formation and has been used to test various intersection layouts and options. SIDRA intersection modelling software was used to model the intersections. The WRTM 2051 future model was requested from and supplied by HCC. The extracted WRTM model data was assessed in terms of usable traffic volumes, specifically for the Rotokauri area.

Estimated daily traffic volumes on key transport links in 2051 from WRTM +30% are shown in Figure 2-4 below:

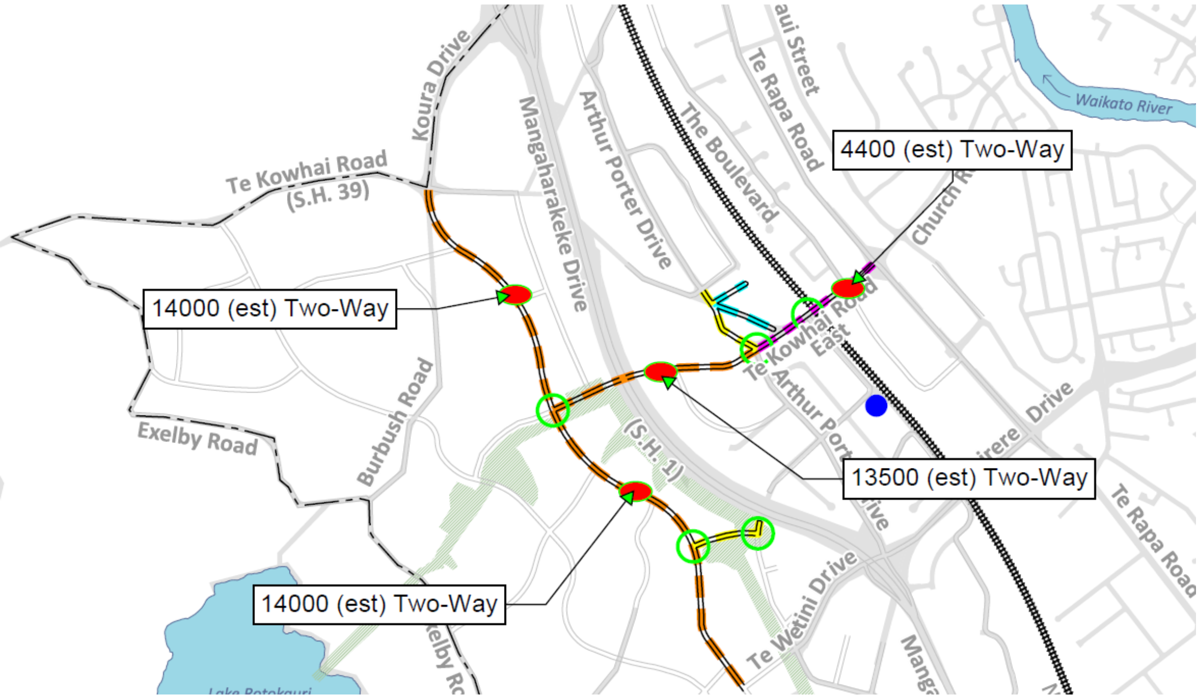


Figure 2-4: Daily Traffic Volumes 2051 (WRTM)

Model Data

Traffic data from the WRTM model was extracted for the 2051 future year. This includes:

- 2051 Annual Average Daily traffic (AADT) volumes
- 2051 Peak flows:
  - AM Peak, (BBAA – AM Peak model Land use)
  - Inter Peak, (BBIA – Inter Peak model Land use)
  - PM Peak, (BBPA – PM Peak model Land use).

The following outputs were extracted from the WRTM, shown in Table 2-1 and Table 2-2 that highlight the SIDRA model with and without the 30% uplift**.** This includes conversion of two-hourly peak period traffic data into peak hour traffic data.

Table 2-1: WRTM Traffic Flows Through Intersections

Intersection Description	AM Peak	Inter Peak	PM Peak	AADT
Te Kowhai and Minor Arterial	616	725	977	10,863
Arthur Porter Drive – Te Kowhai Road	688	666	1,110	10,038
Tasman Road – Te Kowhai Road East	888	745	1,548	3,287
The Boulevard – Te Kowhai Road East – Maahanga Drive	1,661	2,096	2,824	3,512
Minor Arterial and Collector Road	302	381	479	10,865
Chalmers Road and Collector Road	270	333	384	n/a

Table 2-2: WRTM Traffic Flows Through Intersections (30% Uplift)

Intersection Description	AM Peak	Inter Peak	PM Peak	AADT
Te Kowhai East Road – Minor Arterial	800.8	942.5	1270.1	14121.9
Te Kowhai East Road – Arthur Porter Drive	894.4	865.8	1443	13049.4
Te Kowhai East Road – Tasman Road	1154.4	968.5	2012.4	4273.1
The Boulevard – Te Kowhai Road East – Maahanga Drive	2159.3	2724.8	3671.2	4565.6
Minor Arterial – Collector Road	392.6	495.3	622.7	14124.5
Chalmers Road – Collector Road	351	432.9	499.2	n/a

From the traffic data, the PM peak has the highest demand flows across all intersections. Trip distribution and mode split between cars and trucks, has also been derived from the WRTM model. The heavy vehicle percentage is approximately 10% of all the modelled traffic volumes.

2.5.2 SIDRA Intersection Modelling

The following intersections were modelled:

- Signalised
  - Te Kowhai and Minor Arterial (T-junction)
  - Minor Arterial and Collector Road (T-junction)
  - Arthur Porter Drive and Te Kowhai Road (4-way crossing)
  - Tasman Road and Te Kowhai Road East (T-junction)
  - The Boulevard – Te Kowhai Road East - Maahanga Drive (4-way crossing).
- Priority Controlled
  - Chalmers Road and Collector Road (T-junction).

2.5.3 Modelling Scenarios

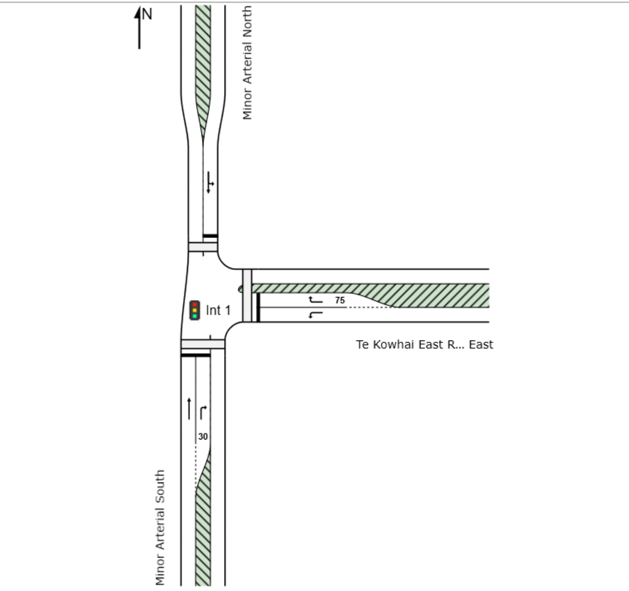
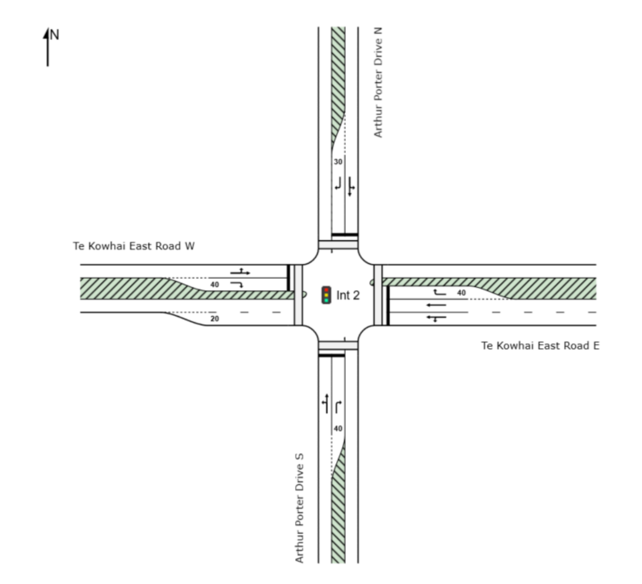
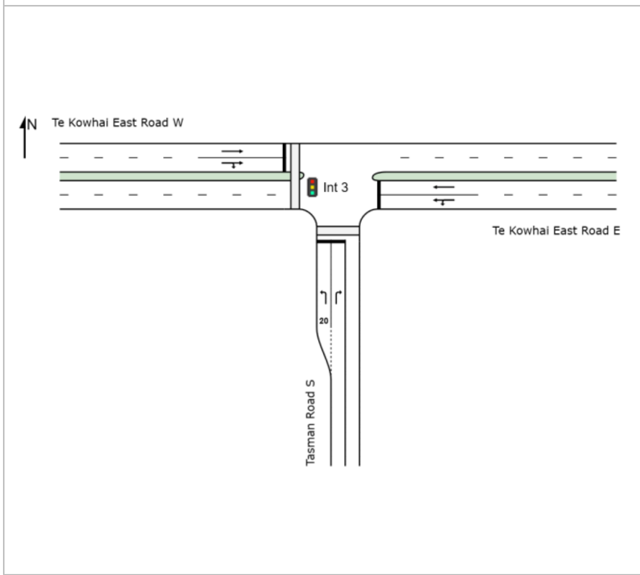
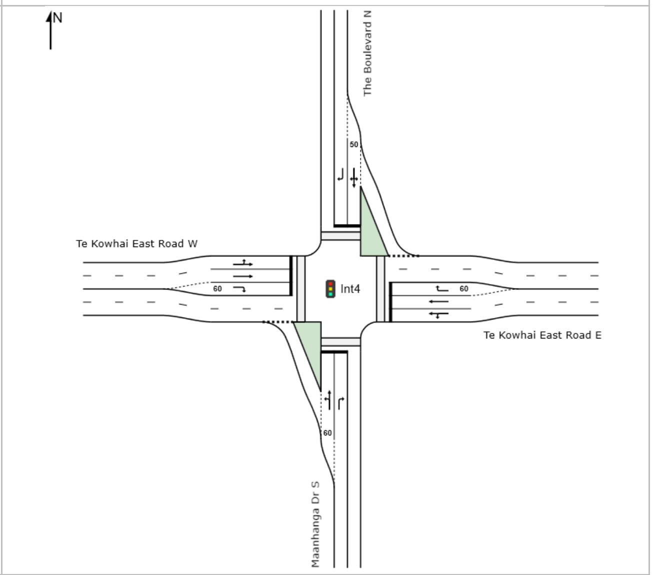
The scenarios tested included the following:

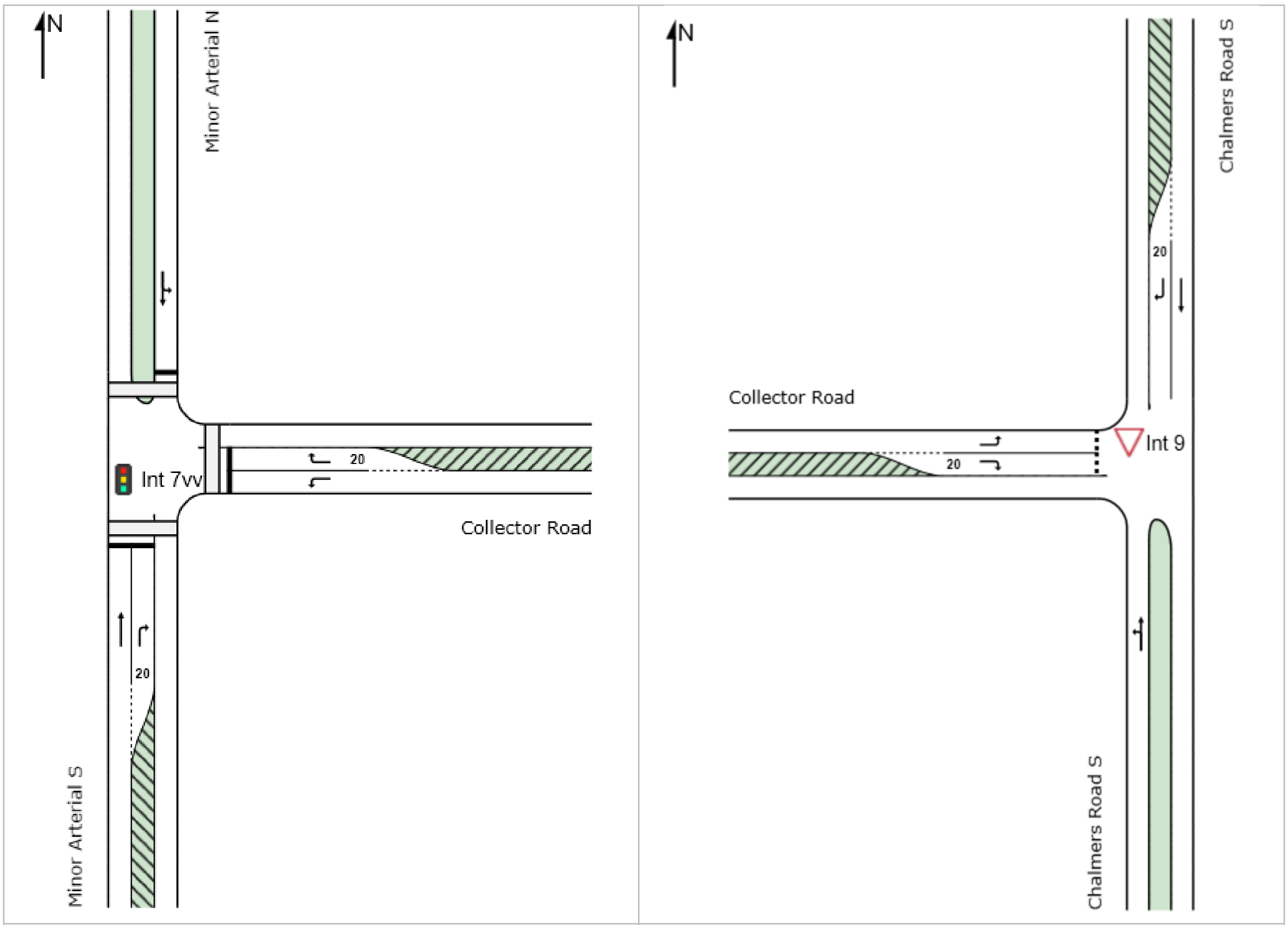
- 2051 Future Year
- PM peak period as the highest peak
  - Peak Hour Factor of 1.1
  - 10% HCV
  - Optimised signal phasing based on SIDRA software and manual adjustments.

The SIDRA signalised intersections were optimised utilising lane configurations and signal phasing optimisation.

2.5.4 SIDRA Intersection Layouts

The schematic SIDRA intersection layouts that have been modelled are shown below. The layouts are subject to adjustments.

	
Te Kowhai Road and Minor Arterial	Arthur Porter Drive – Te Kowhai Road
	
Tasman Road – Te Kowhai Road	The Boulevard – Te Kowhai Road – Maahanga Drive



Minor Arterial and Collector Road	Chalmers Road and Collector Road

Figure 2-5: SIDRA Intersection Layouts

2.5.5 Modelling Limitations

a) Modelling Years

Intersection modelling was agreed to only include the future year 2051 as the modelling scenario year. Interim modelling has not been undertaken due to the delivery timeframe uncertainty and that any interim modelling would possibly show a network modelling result before the proposed designation can be constructed.

b) Predicted Traffic Volumes

The modelling data and modelling undertaken is limited to how the traffic volumes might differ due to the high provision for active modes. Traffic volumes in future might be lower if active and public transport provisions result in higher non car mode share.

c) Queue Bypass and HOV lanes

The modelling has not modelled PT or HOV queue bypass lanes at the signalised intersections along the proposed designation. The form and extent of this would be determined during the next design stage.

d) Pedestrian and Cycle Volumes

Where possible we have included pedestrian crossing points at signalised intersections. The modelling is however not exhaustive in terms of cycle phasing. Pedestrian volumes have been assumed. Future design and assessment phases will include more detail on these elements.

2.5.6 Modelling Results

The intersection modelling summary results are detailed below for the 2051 future year scenario.

Table 2-3: Rotokauri Arterial Network SIDRA Modelling Results – 2051 (Without 30% Uplift)

No	Intersection	PM Peak Operation			
		Deg Satn (v/c)	Avg Delay (s)	Level of Service	95% Max Queue (m)
1	Te Kowhai – Minor Arterial	0.80	32	LoS C	47m
2	Arthur Porter Drive – Te Kowhai Road	0.66	35	LoS C	64m
3	Tasman Road – Te Kowhai Road E	0.57	12	LoS B	92m
4	The Boulevard – Te Kowhai Road E – Maahanga Drive	1.1	69	LoS E	197m
5	Minor Arterial – Collector Road	0.29	18	LoS B	25m
6	Chalmers Road – Collector Road	0.12	4.3	LoS A	5m

Table 2-4: Rotokauri Arterial Network SIDRA Modelling Results – 2051 (With 30% Uplift)

No	Intersection	PM Peak Operation			
		Deg Satn (v/c)	Avg Delay (s)	Level of Service	95% Max Queue (m)
1	Te Kowhai – Minor Arterial	0.75	35.0	LoS D	66m
2	Arthur Porter Drive – Te Kowhai Road	0.79	43.4	LoS D	116m
3	Tasman Road – Te Kowhai Road E	0.86	31.1	LoS C	296m
4	The Boulevard – Te Kowhai Road E – Maahanga Drive	1.09	84.7	LoS F	460m
5	Minor Arterial – Collector Road	0.37	18.5	LoS B	35m
6	Chalmers Road – Collector Road	0.17	4.3	LoS A	7m

Detailed modelling outputs for the individual intersections within the proposed designation area are provided in the ITA. The modelling shows most of the intersections to operate satisfactorily in the 2051 future year.

It is noted that The Boulevard / Te Kowhai Road East / Maahanga Drive intersection have over capacity constraints, which is influenced by the WRTM model predicting significantly high southbound traffic volumes from The Boulevard. A variety of layouts were tested for this intersection to improve the LoS by eliminating slip lanes in the northeast, southwest, or both. However, it was determined that retaining both slip lanes yielded the most favourable outcomes in terms of LoS for each leg. Once more accurate information is available it is anticipated that the signalised intersection could be optimised during the next design stage.

The SIDRA intersection results have facilitated the configuration of the civil design layouts (of the modelled intersections) as part of the proposed designation.

2.6 Pedestrians and Cyclists

Continuous off road / protected cycle facilities are proposed, these connect to key destinations along the corridor and the adjacent neighbourhoods. Crossing facilities and vehicle accessways needs to be considered in future design stages.

2.6.1 Major Arterial and Te Kowhai Road West Extension

To provide safe movement for active modes, a bi-directional cycle path is included on the south side of the road to connect key destinations and to limit crossings and conflicts in this industrial portion of the corridor.

2.6.2 Minor Arterial

Cycling and pedestrian access is proposed on both sides of the minor arterial corridor to enable connectivity between the residential catchment and key attractors such as possible education facilities, town centre, Wintec, and 'The Base'. The shared paths on the Greenway will primarily function as a recreational route while the minor arterial will provide direct access to properties and destinations on the corridor. Local intersections and vehicle accesses will generally be limited, in order to protect and prioritise pedestrian and cycle modes.

2.6.3 Collector Road

Separated cycle paths on each side of the Collector Road with mountable kerb between footpaths are proposed.

2.6.4 Te Kowhai Road East

A bi-directional cycle path is proposed on the south side of the road to connect key destinations and limit crossings to signalised intersections only.

2.6.5 Summary

The pedestrian and active mode facilities and connections as described in this report and the UDLF will provide a good level of service for pedestrians and cycling in the growth area.

2.7 Public Transport

2.7.1 Public Transport Facilities

A number of bus stop locations have been identified in the proposed designation transport network. The final location and details surrounding these stops will be detailed during the next stage. It is considered that more stops could possibly be added or relocated once more details on passenger volumes and the regional bus network is known.

2.7.2 Major Arterial and Te Kowhai East Road

This section of the corridor has been proposed as four lanes which will be able to provide Bus or HOV lanes on the outside of the midblock and at intersections. Intersections could also be prioritised to provide queue jumping with the provision of additional lanes.

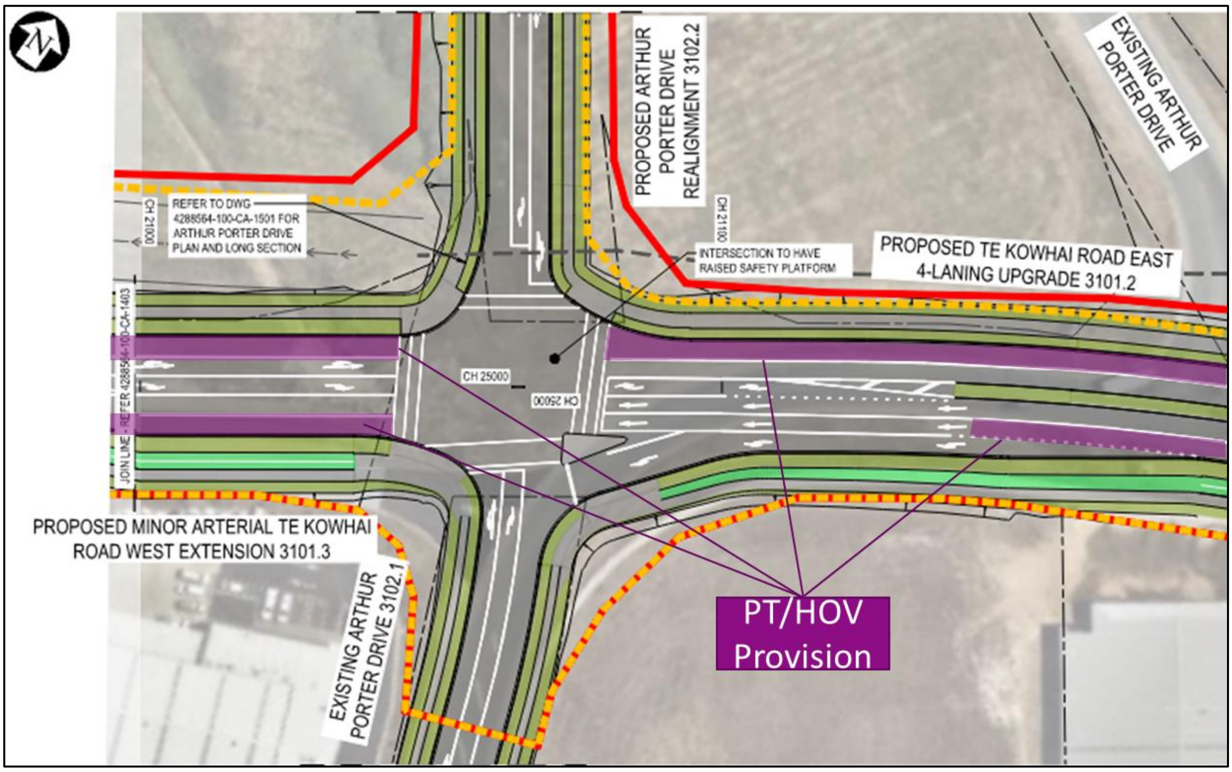


Figure 2-6: PT and HOV Provision at Arthur Porter Te Kowhai Intersection

2.7.3 Minor Arterial

The proposed designation network has provided public transport (HOV) queue jump lanes at the signalised intersections along the north south alignment of the Minor Arterial.

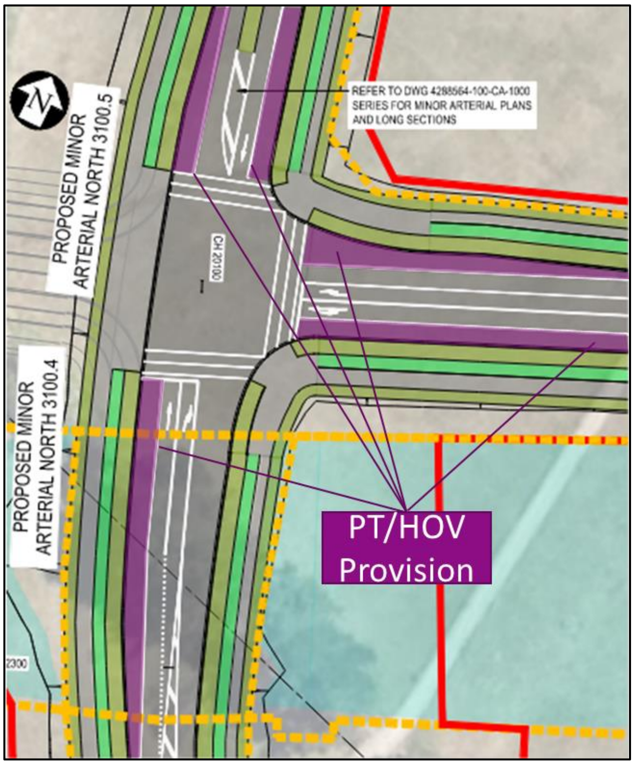


Figure 2-7: PT and HOV Provision at Minor Arterial and Te Kowhai West Intersection

Details of the PT and HOV lanes will be detailed during the next stage of the project.

2.8 Summary and Conclusions

The ITA has assessed the proposed new designated transport network for the Rotokauri area. The purpose of the ITA is to ensure that the transportation effects of the proposed designation area are well considered and that there is an emphasis on efficiency, safety, and accessibility along the road network by all transport modes, and that the adverse transport effects of the proposed designation have been avoided, remedied, or mitigated through sound design principles.

The ITA has identified a range of travel modes suitable to accommodate multimodal travel along the transport network. With these networks in place the transport system is expected to enable the proposed land use for the Rotokauri area.

The ITA also confirms that the cross-sections that have been prepared can accommodate the expected future traffic volumes, allow for buses to travel along them and provide for prioritised active modes.

The relevant transport strategy documents have been reviewed and the proposed designation transport network is broadly consistent with the policies and objectives.

Future planning and design stages, e.g., resource consent, will develop the design and staging of transport infrastructure further to support the development of land within the proposed designation area.

3 Urban and Landscape Design

3.1 General

The Urban and Landscape Design process including principles, considerations and design responses are captured in the project's Urban and Landscape Design Framework (ULDF). The ULDF report was developed as part of the proposed designation and NoR process to define, develop, and implement the urban and landscape concepts of the project with the aim of increasing modal change and land use integration for the transport corridors that achieves a compact urban form.

The ULDF considers how the place and movement functions of each corridor will deliver the best urban design and landscape outcomes for the project and the wider structure plan area. The ULDF breaks the project into zones and illustrates the composition of various design elements of each zone. When these elements are integrated into the design thinking of the corridor width and arrangement, they contribute to a safer, higher quality and integrated design that responds directly to place. The ULDF describes the vision and inspiration for urban design and landscape outcomes, provides a comprehensive analysis of the place and movement context for the new arterial road corridors, including social, cultural, and environmental factors.

3.2 Urban Design and Landscape Principles

The project corridor sits within a context of various land uses and built form including commercial, industrial, and residential and connects people to several key destinations and key amenities in Rotokauri. The Project aims to provide a safe and integrated network that provides multi-modal choice and a high-quality level of service that provides a positive contribution to people's lifestyle. The overarching vision outlined in the ULDF is "the sustainable expansion of the City into Rotokauri, through a coherent, integrated and people focused mixed use development based on best practice urban design principles".

This vision will be realised through the application of design measures (refer to Section 5.2 of the ULDF) associated with the following guiding principles:

3.2.1 Design for people

The design of the arterial road corridor requires a balanced approach between movement of modes and people to support a network that responds to people's lifestyle choices around how they wish to live, work and play. It is the ability to contribute to peoples both physical and mental health that has driven choice and driven the design to provide sufficient space for vehicles and active modes through prioritised intersections and separated space for cyclists and pedestrians that are safe for users. It is through this design approach that the network can establish a hierarchy of modes that help to create a comfortable and enhanced user experience.

3.2.2 Sustainable environments

The Project is situated within both an existing transport network and proposed network driven by greenfield residential development. It is important that while the existing network corridors are retrofitted to provide better connectivity across Rotokauri within an already constrained corridor, the new arterial roads in the proposed designation will demonstrate flexibility and respond to change in user requirements and land use interfaces over time. It is this need for more adaptable corridors that has been a main design driver for reducing impervious surfaces in the corridor through planting, providing flexible front and back berms to accommodate both services as well as space for furniture, native amenity planting and shade trees while reducing ongoing maintenance created by grassed berms and creating a more comfortable environment for users. These elements help achieve both positive ecological and social outcomes while not precluding growth of the corridor itself.

3.2.3 Integrated design

The design of the arterial roads respond to a need for cohesion of various land uses with the corridor to create an integrated, more sustainable transport network that provides modal choice for users and contributes to a higher level of amenity for neighbourhoods. Each zone identified in section 3.1 above, provides an interface treatment as outlined in the corridor sections in the ULDF that responds to the adjacent land use i.e., residential, industrial, and commercial. Although the design of these interfaces was, in areas limited to a back berm due to existing corridor width constraints, the ULDF provides recommendations for different interface treatments i.e., employment zone, commercial centre, gateway treatments and pause points that overlook the greenway. These treatment examples represent what a higher place function looks like as applied in areas of the network and contribute to a vibrant and active urban environment where streets themselves become public spaces of value.

3.2.4 Character and Amenity

The landscape of Rotokauri is defined by the strong ridgeline character and significant natural features such as Lake Rotokauri and Waiwhakareke Natural Heritage Park that highlight the once abundant natural landscape of Rotokauri. The aim is that the new corridor design will provide opportunities to enhance the cultural significance of place and identity in the continuing expansion of the built environment. This was a main driver for design considerations around corridor treatments, gateway designs and acknowledgment of significant landmarks and features through pause points and wayfinding elements. It is through this responsive design that the new corridor will provide a sense of continuity for the community while being sensitive to the existing context. This acknowledgement helps to preserve this history and contributes to placemaking drivers in the surrounding context.

The Te Aranga Design Principles (or an approved similar framework) will be drawn upon through the following design phases to provide connection to the Māori worldview and therefore support the cultural narrative of place.

3.2.5 Connected

The design of the arterial roads responds to a need for connectivity across an expanding network due to greenfield residential development to the west of Rotokauri. These new developments produce an increased demand on the network to connect to key destinations and amenities within Rotokauri. To manage this increased demand, the focus through the design of the corridors is to provide legible, accessible, and safe connections between residential neighbourhoods, suburban centres, recreational areas, and transit stops for pedestrians, cyclists and local road users and an elevated level of cross corridor connectivity between the city and the suburb, identified activity nodes and residential neighbourhoods. Where possible the design promotes uplift of active modes through addition of separated cycle and pedestrian facilities, high amenity provision including but not limited to rest areas, quality surfacing, lighting, and wayfinding to create an enhanced experience for users and transport choice for residents.

3.3 Application of design principles

Through the design decision making process, the application of the design principles described have been evaluated using a design decision check sheet to assess each zone against the objectives and principles set for the project and if they meet the measurable criteria set out in appendix two of the ULDF. This evaluation process highlights the purpose of the ULDF as a living document that will help guide future developers as to how they can apply the framework and help deliver good urban design and landscape outcomes in their own private developments.

Through the corridor design development for each zone outlined in section 3.1 above, the use of this check sheet has also informed several recommendations to the team for example:

1. Encouraging connections from suburb to city by utilising the stormwater network to provide access across the employment zone to the greenway. This design approach will facilitate a safe connection for users and influence the adjacent interfaces when the land is developed. For example, by including vehicle, pedestrian and cycle access through the connection, developers will be encouraged to face towards these connections. This will help activate the corridor edge, increase the street amenity, and increase passive surveillance over the space.
   This aids east-west connectivity across the corridor, something that has been challenging to achieve through the existing land use configuration and aligns with the design principles and measurables such as:
   a. to provide a tangible connectivity to areas of employment and industry
2. Supporting use of a piped stormwater network along the arterial network and utilising future wetlands and stormwater facilities as integrated treatment and passive recreation spaces to achieve a compact urban form, as opposed to wide swales along the length of the arterial. The use of pipes through the roading corridor where practicable reduces risk of potential severance of the corridor for all modes of transport and enables east-west connections for pedestrians across the corridor which supports measurables including:
   a. provision of space function for non-transport functions such as water management and recreation, as well as ecological diversity i.e., varied plant species or varied treatments for different areas that respond to the adjacent land uses i.e., rain gardens, swales, and tree planting.
   b. stormwater conveyance with pipes where practical, particularly in suburban centre location shall be piped to conserve space and improve access
3. A narrower corridor width and reduction of medians where possible to concentrate amenity to the edges of the corridor and provide flexibility in the berm space. This reduces the crossing widths for active modes, which provides a safer and more legible corridor with better utilisation of berm space to enhance amenity value through furniture and planting. This helps to create a more active interface of various land uses within the corridor and aligns with measurables including:
   a. higher investment in amenity focused on the edges of the corridor to encourage placemaking and active transport outcomes.

3.4 Urban Design Zones

The proposed Arterials corridor has been defined in the ULDF by 8 zones. These zones are depicted in Figure 3-1 summarised as below:

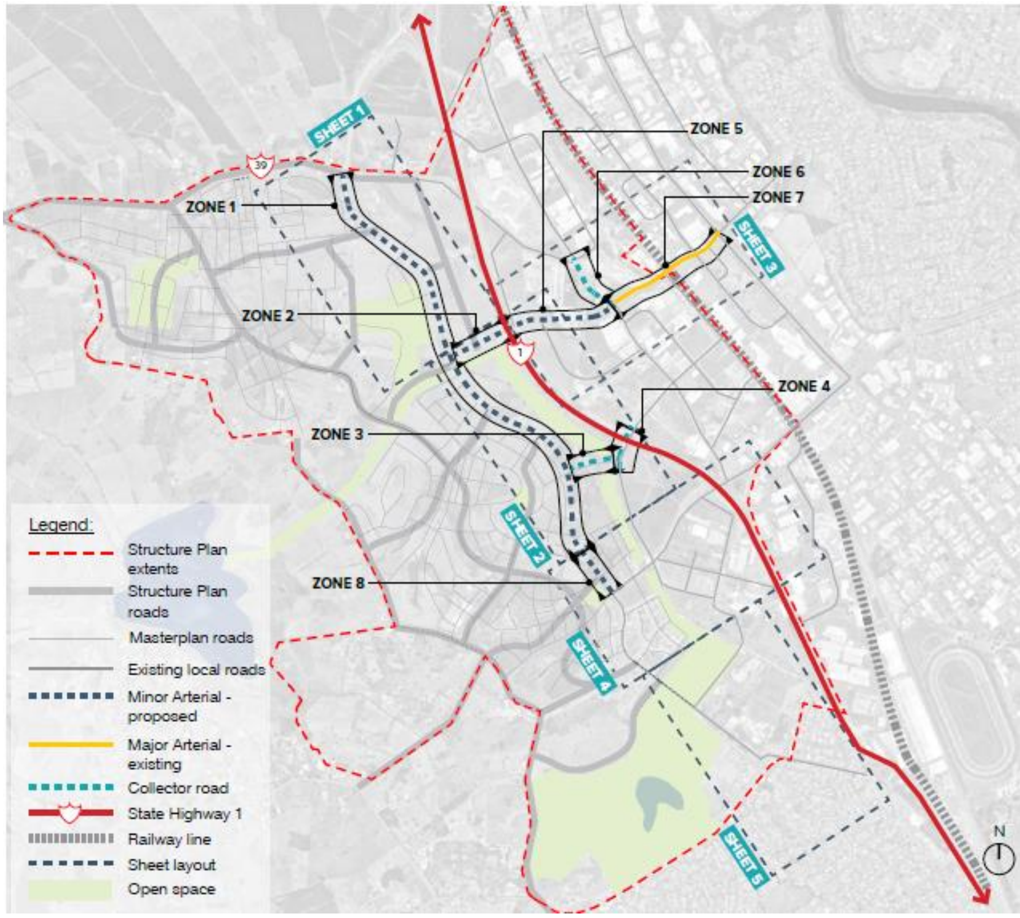


Figure 3-1: Rotokauri Arterial Network Zones (Source: Beca ULDF 2022)

1. **Rotokauri Minor Arterial North (3100.4, 3100.5)** *High movement function, moderate - high place function*

   This section of the corridor has a high movement function with two vehicle lanes and raised median to respond to employment zone interface that requires controlled access. This approach provides a high movement function with space for separated cycle and pedestrian facilities to provide safe active mode options for users as well as safe access to the several key destinations in this area of the network including a proposed sports park, schools, shops, employment zone and the greenway. South of Te Kowhai Road, the median is removed in response to the residential interface. This narrower corridor provides more amenity opportunities on the edges of the corridor for active modes.

2. **Minor Arterial, Te Kowhai West Extension (3101.3)** *High movement function, low - moderate place function*

   This extension of new road has a high movement function and low to moderate place function with two vehicle lanes and controlled/limited access to the network. The corridor provides mid-block crossing points for pedestrians and separated walking and cycling facilities. In response to the interface with the Greenway to the south and wetland to the north, there is no median which makes amenity provision on the edges that interface with these areas. Such amenity provision includes a shared path along the south side of the road that allows connection to the greenway and rest areas or increasing the quality of existing cycle facilities like the highway underpass by providing opportunity for artwork to enhance user experience and acknowledging local culture.

3. **Collector Road (3121.1)** *Moderate movement function, moderate place function*

This section provides a corridor with high movement function and high placemaking function with two vehicle lanes, controlled access for vehicles, and no parking provision or median that responds to the edge interface with a wetland or residential interface. This section has a narrower corridor and separated cycle and pedestrian facilities on both sides of the corridor which presents further opportunities for connection for users to adjacent spaces such as the Greenway and existing shared path alongside the State Highway.

4. **Chalmers Road Extension (3122.1)** *High movement function, low place function*

   This section of corridor provides two vehicle lanes, controlled access and no median that results in a narrower corridor and provides opportunity for cohesion between the adjacent greenway and employment zone. The corridor provides wide separation of the road with cycle paths and wide footpaths on both sides of the corridor with flexible back berms to provide amenity in the employment zone.

5. **Minor Arterial, Te Kowhai Road West Extension (3101.3)** *High movement function, low place function*

   This section of the corridor has industrial land use on both sides of the corridor and therefore a high movement function but low place function due to this interface and lack of amenity opportunity. To provide safe movement for active modes, a bi-directional cycle path is included on the south side of the road to connect key destinations and limit crossings to and conflicts in this industrial portion of the corridor with controlled access.

6. **Collector Road, Arthur Porter Drive (3102.2)** *High movement function, low place function*

   This section provides a two-lane vehicle corridor and flush median for turning movements which responds to the industrial land use on both sides of the corridor. There is no provision of cycle lanes however there are wide footpaths on both sides of the corridor and flexible front and back berms that make provision for low planting or services.

7. **Major Arterial, Te Kowhai Road East Upgrade (3101.1, 3101.2)** *High movement function, low place function*

   This existing section of the corridor has four lanes with wide bus or HOV lanes on the outside and is therefore high movement function. This includes a wide raised central median that responds to the adjacent employment and industrial interface. Due to this wide corridor and land use interfaces, the corridor has a low place function. The flexible berms provide opportunity for facilities and furniture while providing separation from the bi-directional cycle path and pedestrian footpath. This bi-directional cycleway concentrates active mode movement on the south side of the corridor where the main destinations are i.e. The Base and PT hub and reduces potential conflicts for active modes crossing the wide vehicle corridor.

8. **Rotokauri Minor Arterial North, Commercial Centre (3100.2)** *Mod movement function, high place function*

   This section of the minor arterial corridor embodies a high place function with large provision for high quality amenity space to incorporate outdoor dining, cultural narrative through surface treatments and artwork, a wide pedestrian movement zone, and street furniture. The high amenity value of this space promotes activation of the street, encouraging built form to address the corridor and frame the street edge aiding in a more legible corridor for users. This edge activation also helps create cohesion between the adjacent employment land use and greenway, providing connection to the wider network.

The road corridor narrows in this section (no median) and the separated cycle lane also narrows from 2.2m to 1.8m on both sides of the corridor. This will facilitate improved east-west connectivity across the minor arterial corridor and encourage slower cycle speeds through the commercial centre to support a more compact urban centre and high place function.

3.5 Design Standards and Guidelines

3.5.1 National

- Crime Prevention Through Environmental Design Principles, 2005 (Ministry of Justice)
- AS/NZS 1428.1: 2009 Design for Access and Mobility
- AUSTROADS standards as they relate to pedestrian and cycle paths
- NZTA Bridging the Gap, 2013
- NZTA Pedestrian Planning and Design Guide
- NZTA Landscape Guidelines, 2014
- One Network Framework (ONF)
- NZTA Cycle Network Guidance
- National Association of Transport Officials (NATCO) Urban Bikeway Design Guide)
- Auckland Transport Design Code for Cycling Infrastructure
- Te Aranga Design Principles
- Access Hamilton planning document

3.5.2 Local

a) Hamilton City Design Guide

The ‘Vista’ design guide outlines Hamilton’s expectations for better designed environments. A section on public spaces highlights 8 key design expectations. Open spaces should be defined by buildings, with logical movement routes and congregation spaces.

b) HCC Landscape Objectives and Policy

The purpose of landscape policies within Chapter 25.5 of the HCDP are ‘to provide a range of aesthetic, functional and ecological opportunities for environmental enhancement’ …. and ‘to reduce visual impacts and provide visual unity.’ The standards also recognise that landscaping can contribute towards improved ecology. The objective of the landscape policies is to ‘maintain and enhance amenity values within and around development, while contributing to local ecology and cultural connection where possible.’

The HCC Landscape objectives are focused mostly on visual mitigation of infrastructure through e.g., fencing and planting. The objectives therefore have only limited relevance to the project, which focuses on amenity and visual character that leads to a safer and more vibrant urban environment.

c) HCC Urban Design Objectives and Policy

The purpose of Urban Design policies is fundamental in delivering HCC’s Vision for a smart, liveable city, which is attractive, well-designed, and compact with a strong sense of place. Urban Design focuses on public frontages and spaces and addresses elements such as streetscape, walkability, sustainable design, mixed-use development, ‘active edges’ of building frontages, and people’s safety and accessibility.

The design principles identified within the plan also reflect New Zealand’s national Urban Design Protocol of which Hamilton City has been a signatory since 2006. The City Design Guide VISTA further outlines Hamilton's expectations for better designed environments – describing how a well-designed place should look, feel, and function.

Objectives, policies, rules, and assessment matters within the Urban Design Section 25.15 of the HCDP, along with other methods adopted by HCC, seek to facilitate and encourage subdivision and development design in a manner that will continually enhance the quality of the City's urban environments.

3.6 Assumptions and Constraints

3.6.1 Assumptions

The following key assumptions have been made in developing the design. Similarly, key decisions agreed with HCC and are also included below:

1. One way cycle lanes on the minor arterial and collector road corridors will be physically separated from traffic lanes and will be a minimum of 2.2m width except for the section of the minor arterial interfacing with the proposed commercial centre, where it will narrow temporarily to 1.8m in width for both sides of the traffic lanes to encourage slower speeds and reduce conflicts adjacent to a busy pedestrian zone.

2. Te Kowhai Road East will have a two-way cycleway on the south side of the traffic lanes to provide connection to 'The Base' and PT Hub through this industrial area. The cycleway will be a total width of 2.8m and provides the following benefits:

    a. combined pedestrian and cyclists crossing points helps to reduce the risk of intersection collision for cyclists while consolidating to one side of the road minimises the number of driveway conflicts along the corridor and reduces the number of times people walking and cycling need to cross the corridor.

    b. a 2-way cycleway reduces the overall width of an already constrained corridor in comparison to having a one-way separated cycleway on both sides.

    c. Condensing the cycleway to one side of the road respond directly to the industrial landuse and focuses amenity space which increases user experience. This generates of a higher mode share for cycling and e-mobility in an area that typically has limited 'activation'. These areas typically have larger land holdings that experience larger vehicles and less cycle access in comparison to residential areas or key destinations.

    d. Pedestrian footpaths and cycleways will be separated with a 65mm high 1:3 mountable kerb as per the Auckland Transport Code of Practice.

3. Note: There are several design elements that are considered mandatory to be able to implement a two-way facility on Te Kowhai Road East and include:

    a. Cycleway must be 'off-road' (setback from the roadway adjacent to the footpath)

    b. No uncontrolled right turns

    c. Raised tables with a 'combined crossing' markings (zebra and green strip) on all side roads.

d. A form of speed control (steep hump) at all high frequency driveways/entry points or painted surface markings and directional arrows.

e. Interactions at signalised intersections, side roads, and driveways can be effectively mitigated using the existing berm space to implement the mandatory requirements set out above.

4. Bus stops will be in-lane in major, minor and collector road corridors unless there is space locally for their provision as directed by HCC.

3.6.2 Other Considerations

The design of the major arterial Te Kowhai Road east extension is constrained to the existing corridor width. This influences the urban design and landscape outcomes (including urban mobility) that can be achieved within a limited space.

Three masterplans developed for the RSP area, prior to the project commencing has led to varying interfaces with the project. This creates risk and leads to ‘ad-hoc’ outcomes that may not meet the Structure Plan’s desired outcomes nor the guiding principles set out in the ULDF.

Te Wetini Drive, a proposed major arterial connecting to the project, is a developer led design excluded from the scope of the project. The function and proposed design of a major arterial through a proposed commercial centre limits the project's ability to determine the urban design and landscape outcomes for this important and central area of the structure plan.

4 Road and Civil Design

4.1 Key Objectives

Key objectives include:

1. Following the road hierarchy outlined in the RSP for Major and Minor Arterials, and for Collector Roads.

2. Following the route shown in the RSP and only departing from this route where design enhancements can be achieved. Note the departure from the RSP alignment on Arthur Porter Drive; where the alignment of the Southern section of Arthur Porter Drive (existing) has been previously constructed in a more easterly position than previously intended by the RSP as can be seen in the Figure 4-1 below. The location of the proposed intersection therefore has resulted in alignment D being selected as shown in Figure 4-1 for the Northern section of Arthur Porter Drive. This is included in the design plans and provides an improved geometric alignment to the intersection approaches. Further background to the selection of options can be found in the MCA analysis for selection of preferred alignment of Arthur Porter Drive. Refer to the Options Assessment - Appendix C of the NoR.

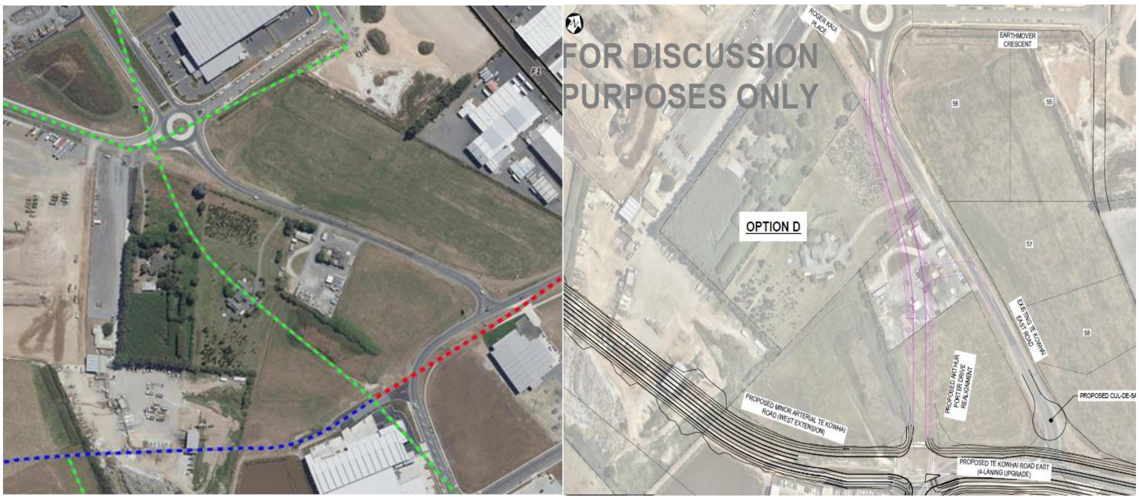


Figure 4-1:Alignment of Arthur Porter drive vs RSP alignment shown in green on left and the selected alignment option D on right (note Local Road connections are not shown)

3. Following the Network Operating Framework and Network Operating Plan for all modes through each zone.

4. Minimising cut / fill – acknowledging that most of the roads are likely to be in fill, and the adjacent Greenway will generate excess fill that will likely be able to be used.

5. Design levels – general ground appears it should be practical to achieve an efficient vertical alignment with relatively good interfaces with development sites.

6. Incorporating / aligning with developers' designs where these are available; particularly HJV in the southern end of the Minor Arterial. Designs have been tested where these have been made available by the developers.

7. Completing the design to a level suitable to determine the land required to be designated via the NoR.

8. Consider the operational limits for specific vehicles which will require access to each road within the proposed designation.

9. Consider the project objectives in relation to modal shift and how best to influence that.

4.2 Geometric Design standards

- Austroads and RITS are the primary geometric design standards that have been considered / implemented.
- Some degree of departures from best practice may have been applied to achieve planning outcomes. For example, carriageway widths have been reduced to encourage slow (safer) speeds and modal shift in line with HCC objectives started earlier in this report.

4.3 Design speed

- Major Arterials - 60 kph
- Minor Arterial and Collector Roads - allow for 50 kph
- Local Roads – generally outside of scope except for the connection off Arthur Porter Drive – design speeds will depend on level of service. Arthur Porter Drive – allow for 50kph
- Some areas may be 30 kph (geometric design for 50 kph and scale back posted speed limit with traffic control devices added)
- Design and posted speeds to be consistent with the HCC speed management plan.

4.4 Cross Section

Typical cross sections have been developed in conjunction with HCC including the following default parameters:

- Minor Arterial will have two traffic lanes, right turn lanes should be allowed for at key intersections, beyond that, developers will install their own.
- 3.50m wide carriageway lane widths.
- 0-0.75 m wide shoulder
- A flush median to accommodate turning traffic where practicable (2.5m or greater). Narrowing of median is required to accommodate additional lanes around intersections.
- A minimum 2.5 m wide footpath, width to be maximised where practical and combined with cycles for shared spaces in commercial areas.
- A minimum 3.0m wide footpaths at bus stops.
- Footpaths preferred to be separate from cycleways.
- Green space for amenity including berms at the boundary and kerbside and within median islands in some cases.
- Table 4-1 summarises the proposed carriageway cross-sectional dimensions adopted. These are to be read in conjunction with Typical Section Drawings 4288564-100-CA-2001-2005 in Appendix A.

Table 4-1: Proposed cross section widths

Zone	Road Name and Class	Traffic Lanes / shoulder / Median	Green space	Footpaths / Cycleways shared paths	Total Corridor Width excl. interface
1	Rotokauri Minor Arterial North	2 x 3.5 m single carriageway No shoulder	2 x 3 m grass berm /trees with indented parking 2 x 2 m back berm	1 x 3.0 m footpath (west) 1 x 2.0 m footpath (east) 2 x 2.2 m off road cycle path	29.4 m Option A 31.0 m Option B
2	Minor Arterial - Te Kowhai Road west extension	2 x 3.5 m single carriageway No shoulder	2 x 3.0 m grass berm /trees with indented parking 2 x 3 m back berm	1 x 3.0 m footpath (north) 1 x 3.0 m shared path (south) 2 x 2.2 m off road cycle path	29.4 m
3	Collector Road	2 x 3.5 m single carriageway No shoulder	2 x 3.0 m grass berm /trees 1 x 3 m back berm (north) 1 x 2 m back berm (south)	1 x 3.0 m footpath (north) 1 x 2.0 m footpath (south) 2 x 2.2 m off road 1-way cycle paths	27.4 m
4	Collector Road, Chalmers Road extn	2 x 3.5 m single carriageway No shoulder	2 x 2.2 m raised vegetated separator	2 x 2.0 m footpath 2 x 2.2 m off road cycle path	23.8 m
5	Minor Arterial, Te Kowhai Road extension west	2 x 3.5 m single carriageway No shoulder 1 x 3.0 m raised median	2 x 3 m grass berm /trees with indented parking 2 x 2 m back berm	2 x 2.0 m footpath 1 x 2.8 m off road cycle path (north) No cycle path (south)	26.8 m
6	Collector Road, Arthur Porter Drive	2 x 3.5 m single carriageway 2 x 0.75 m shoulder	2 x 2 m grass berm /trees with indented parking 2 x 2 m back berm	2 x 2.0 m footpath 2 x 1.4 m off road cycle path	23.0 m
7	Major Arterial, Te Kowhai Road East Upgrade	2 x 3.5 m dual carriageway 1 x 2.5 m raised median / right turn bay No shoulder	4 x 2 m green space + median planting where applicable.	2 x 2.0 m footpath 2 x 1.4 m off road cycle path	31.1 m
8	Minor Arterial North, commercial centre	2 x 3.5 m lanes/ in lane buses No shoulder	1 x 2.5 m planted strip 1 x 2.5 m planted strip / indented parking 1 x 1 m berm	1 x 5.7 m shared area at frontages 1 x 2.5 m footpath 2 x 1.8 m off road cycle lanes	24.8 m

Zone	Road Name and Class	Traffic Lanes / shoulder / Median	Green space	Footpaths / Cycleways shared paths	Total Corridor Width excl. interface
	Local Road (X & Y)	2 x 3.5 m single carriageway 2 x 0.75m shoulder	2 x 2.0 m grass berm 2 x 1.75 m back berm	2 x 2.0 m footpath	20.0 m

Cross sections have been developed in agreement with HCC. The above cross section widths have been selected as an initial concept to allow the proposed designation for land acquisition to be determined. Inherent in the selection of the cross section for each road, consideration has been made for the adjacent land use and access assumptions are listed below in Table 4-2.

A specific objective of HCC within Access Hamilton is to affect a target 29% modal shift from private vehicles to public transport and walking and cycling for the whole of Hamilton. For greenfield growth cells such as Rotokauri, there is a need to achieve a greater uptake of active modes and public transport and design corridors with facilities that encourage these modes over the use of private motor vehicles. Therefore, traffic lane elements within the road cross section have been specifically reduced to encourage modal shift. Operational efficiency will need to be considered at the next stage that may require some changes to the cross-section elements, say to facilitate access for large vehicles adjacent to commercial / industrial designated areas. Cross connectivity across the corridor in relation to the future land use will also need to be considered within the next stages.

It can be expected that the level of service will be affected by a lack of shoulder or widths where below desirable widths, where carriageway widths are minimised, this will impact some vehicle movements and potentially access for emergency services at peak times. Also, it is noted that some cycle lane widths are absolute minimum that is recommended in best practice guides, which may affect operational safety of their use.

4.5 Property Access

Consideration of property access for future land uses was discussed with HCC in the options assessment stage as it has implications for the design and continuity of separated walking and cycling facilities. Accessibility to existing properties along the route particularly in relation to established industrial and commercial land uses in the eastern portion of Te Kowhai East Road are maintained or suitable alternatives were explored, noting that several properties will be significantly affected and may require an alternative access provision.

For new arterial roads providing access to residential and employment areas, the general approach was to preserve the higher movement function of the corridor by limiting and controlling turning access which would otherwise disrupt and compromise the flow of people and goods. Provision of rear lane access along arterial corridors helps to achieve positive urban forms outcomes (active frontage/passive surveillance as specified in the Design Framework) and provide a safer journey for people walking, cycling & scootering along the corridor.

Each road has differing adjacent land use requirements which are summarised in the table below.

Table 4-2: Access Assumptions

Zone	Road	Land use – east/north side	Land Use – west/south side	Assumptions
1	Rotokauri North / South Minor Arterial	Residential / Potential Future Rotokauri sports park / community centre	Residential / Employment	Direct access may be required to employment areas but may be consolidated via centrally located access points. Access to residential areas is anticipated to be via rear lane – limiting direct driveway access onto the minor arterial. Direct access to the residential areas to the west will likely be limited to consolidated access points with the majority of future western residential access be provided via local roads developed in general accordance with the updated RSP as influenced by Plan change 7 including the connection of Burbush Road.
2	Minor Arterial - Te Kowhai East Road western side of the Expressway	Mix of employment / commercial and Stormwater management area to north	Greenway	Adjacent access will be limited on both sides to maintenance vehicles. Direct access to the frontage will be limited with rear access promoted via local road connection to the east of the stormwater management area.
3	Collector Road, Chalmers to minor arterial connection	Future Employment / Greenway	Residential	Potential for direct consolidated access to future employment / residential zones.
4	Collector Road, Chalmers Road extension	Stormwater management / cycleway	Greenway / cycleway / Residential	Access to Greenway / cycleway for maintenance vehicles. Access to residential properties is likely to be restricted due to the short length prior to the new intersection and available sightlines to the Chalmers Road Underpass.
5	Minor Arterial, Te Kowhai East Road extension westwards	Existing commercial	Future commercial	Direct Access to the minor arterial not provided.
6	Collector Road, Arthur Porter Drive	Commercial / Industrial	Commercial / Industrial	Direct commercial access required.
7	Major Arterial, Te Kowhai East Road East Upgrade	Commercial / Industrial	Commercial / Industrial	Left in left out for established commercial land uses with existing access required. Section is to be upgraded to four lanes with raised central median preventing right turn movements.
8	North/South, Minor Arterial adjacent to commercial centre	Commercial / industrial	Residential	Direct commercial access to be limited to activate the pedestrian frontage. Access to residential to be provided via local road connections and consolidated access.

Implications for the proposed designation where direct access is required for future developments include the space that may be necessary to facilitate vehicle turning into and out of private developments. While the road reserve is considered adequate to achieve the assumptions in the table above, larger vehicle access in commercial / industrial zones will require either significantly wider road space or wider accessways to turn into or from narrow carriageways. This will reduce the off-road space currently shown as allocated for pedestrians / cyclists / berms. However, this may only be limited for the space required at accessways, which to some degree will be able to be controlled by HCC:

- When approving future consent applications,
- By imposing access limitations when future developments are applied for such as ensuring centralised access is created within a development,
- Specifying a limited access roadway with alternative access to be provided via other roads in the area,
- Requiring segregation strips to be included with approved subdivision scheme plans.

HCC will seek to control the frequency and configuration of access on to the Arterials, encouraging developers to consolidate access to their developments.

4.6 Existing Topography

The design is based on survey of the area which was provided by Beca in July 2019. The survey was carried out using ground based total station for hard features to an accuracy of 20 mm and GNSS GPS for soft features to an accuracy of 50 mm. Lidar surface information is used elsewhere beyond topographic data which was acquired in 2008 having an average vertical accuracy of 90 mm. Figure 4-2 shows the extent of topographic survey obtained.

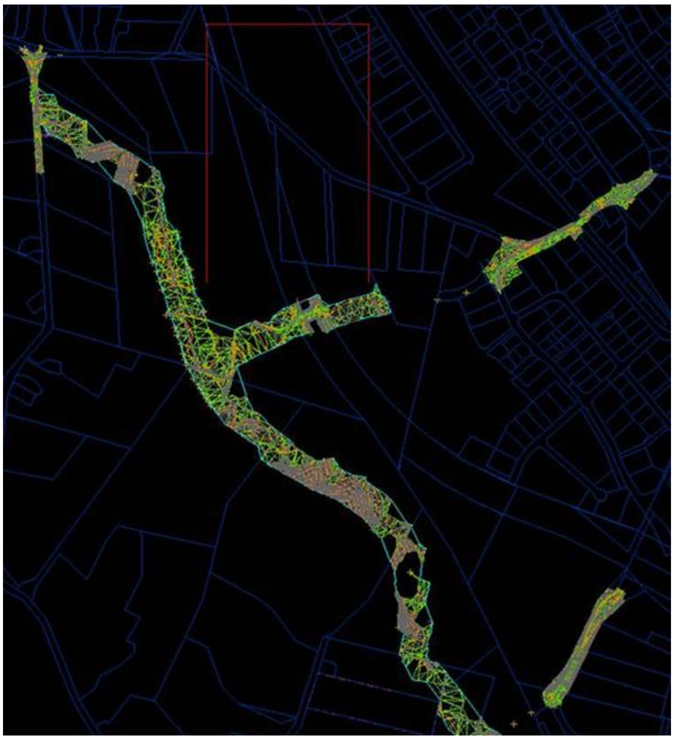


Figure 4-2 – Topographic survey extent

4.6.1 Waikato Expressway Bridges

The project is constrained by two bridges that form part of the existing Waikato Expressway. As-built drawings of the Waikato Expressway bridges were provided by Waka Kotahi NZTA. The ground beneath the bridges is higher than the designed carriageway levels, so the road will need to be cut to the new levels (as allowed for within the bridge design). In accordance with Waka Kotahi's Bridge Manual, a minimum clearance of 5.1m has been assumed for vehicles beneath the bridges (greater than the 4.9m minimum required by the manual), which has set the new carriageway levels. Note this constraint has driven the carriageway levels below the 100-year flood levels in the Greenway and Mangaheka Drain – refer to Section 5.7.2 Stormwater for further information.

The level and width constraints beneath the bridges will require further consideration at subsequent design stage(s), as the full cross-section width will not fit beneath the bridges at the design carriageway levels. It is likely that the active mode zone will need to sit above the carriageway, with levels and treatment between levels to be confirmed at subsequent design stages (as set out in Figure 4-3).

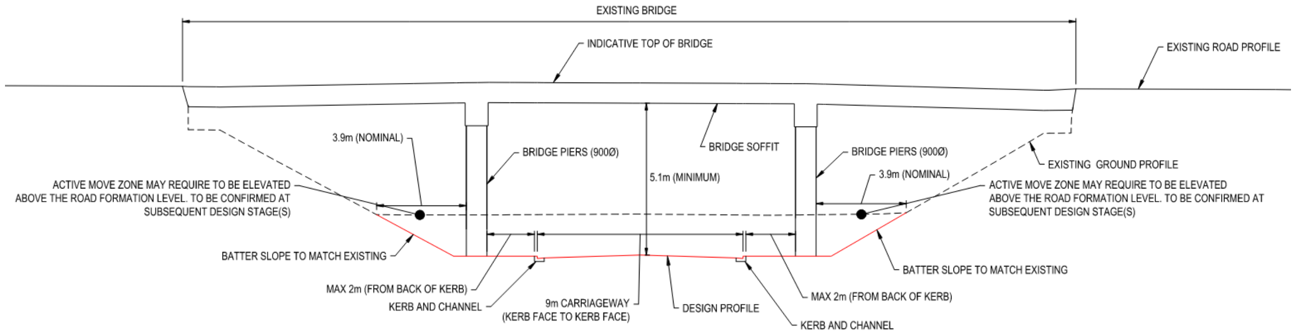


Figure 4-3 – Indicative Bridge Geometry

4.6.2 KiwiRail Level Crossing – Te Kowhai E Road

The Project crosses the KiwiRail main trunk railway line at the existing level crossing on Te Kowhai East Road. This level crossing currently has two traffic lanes and limited pedestrian protections.

HCC has an existing Deed of Grant based on the RSP and connections under the expressway capturing agreement to widen this level crossing to four lanes in the future – in line with the proposed designation. Initial communications with KiwiRail at the commencement of the Project considered this as feasible with a level crossing safety impact assessment (LCSIA) to be undertaken during detailed design.

KiwiRail has since undertaken an LCSIA of this crossing in its current form and HCC has funded an assessment of the proposed designation solution with the intent that two reports will be produced and provide a clear direction covering both the existing layout and implementation of the designation solution, potentially updating the Deed of Grant.

On 1 August 2023 HCC received confirmation from KiwiRail that the LCISA document is fit for purpose to be used in the 'So far as is reasonably practical' (SFAIRP) exercise. A draft SFAIRP report was prepared, and a meeting was held between stakeholders, KiwiRail and HCC to consider the SFAIRP report. The meeting concluded that all parties agreed with the SFAIRP findings and that the level crossing will continue to remain open for this Project, and the required safety mitigations (outlined in section 8 of the Final SFAIRP report) will be implemented.

The Final SFAIRP dated 16 February 2024 is attached to **Appendix O**.

Future discussions will be had with KiwiRail during the detailed design phase.

4.7 Project Datum and Coordinate System

The Project was surveyed to the NZTM coordinate system. Origin of Coordinates are A34X (LINZ geodetic database) (3H), 5818776.000mN, 1795304.100mE

Levels are in terms of New Zealand Vertical Datum 2016 (NZVD 2016). Origin of Levels: A34X (LINZ Geodetic Database) R.L. 56.0725m (1V). Various data sets including Lidar and the Greenway flood study work used the 'Moturiki 1953. vertical datum. Moturiki data is 300mm lower than NZVD 2016 which required this data to be shifted upwards accordingly.

4.8 Pavement Design

The design life for all road pavements shall be 40 years. While no pavement design has been completed, it is assumed that the pavement design can be provided for the cross-sectional width shown for each road within the Project, at the next stage.

4.9 Noise Assessment requirements

No noise bunds have been allowed for within the proposed designation. A separate noise assessment and report has been completed for the NoR.

4.10 Surfaces

Pedestrian footpaths have been assumed to be concrete paths. Default preference for roads is asphalt or SMA over chip seal depending on the road class and level of traffic. Concrete slabs have been assumed to be used for bus stop indents.

Commercial areas where higher standards are required to be achieved will be subject of a specific agreed surface. Urban design is likely to influence surface design at subsequent design stages in conjunction with approval from HCC.

4.11 Services

Anticipated bulk water supply – 450 mm diameter watermain along the full length of the main arterial in the berm, a 250 mm diameter watermain is anticipated from Te Wetini to the Rotokauri North development to service the areas along the way. Details to be confirmed at subsequent design stage(s).

There will be three sewer pump stations, the locations are nominated in the ICMP, one has been built. HCC has confirmed that these are not to be included in the NoR.

Provision for other utilities (electrical, communications etc.) is currently shown as within the berm, however the location of these is expected to be confirmed at subsequent design stage(s).

4.12 Footpaths

Footpaths which are shown in the typical sections for each zone shall be designed in accordance with the following specifications:

- NZTA Pedestrian Planning and Design Guide, and
- RITS.

Crossfall for footpaths should be no greater than 2% unless agreed in specific circumstances with HCC.

4.13 Design Vehicles

The design vehicle for intersection turning movements shall be designated vehicles defined in the RTS 18 – New Zealand on-road tracking curves for heavy motor vehicles. This includes the following vehicles shown in Table 4-3.

Table 4-3: Design Vehicles (from RTS 18 – New Zealand on-road tracking curves for heavy motor vehicles)

Zone	Road Class	Traffic Lanes / shoulder / Median
8 m Truck	A medium rigid truck is larger than vans and small light trucks. These trucks are generally used to transport small to medium consignments and are similar in length to a rubbish truck.	10 to 25 m radius
11.5 m Truck	A large rigid truck normally services large commercial and industrial retail operations.	12.5 to 25 m radius
18 m Semi-Trailer	This vehicle will be required to access certain industrial and commercial localities	12 to 25 m radius
12.6 m Tour Coach	At various connections for example the Wintec area.	12 to 25 m radius

The road network has been assessed with regards to the most likely largest vehicle that will be encountered for each part of the network. These have been summarised in Figure 4-4 (also refer to Appendix B) which shows for each intersection the design vehicle adopted and the location on each intersection these vehicles originate from.

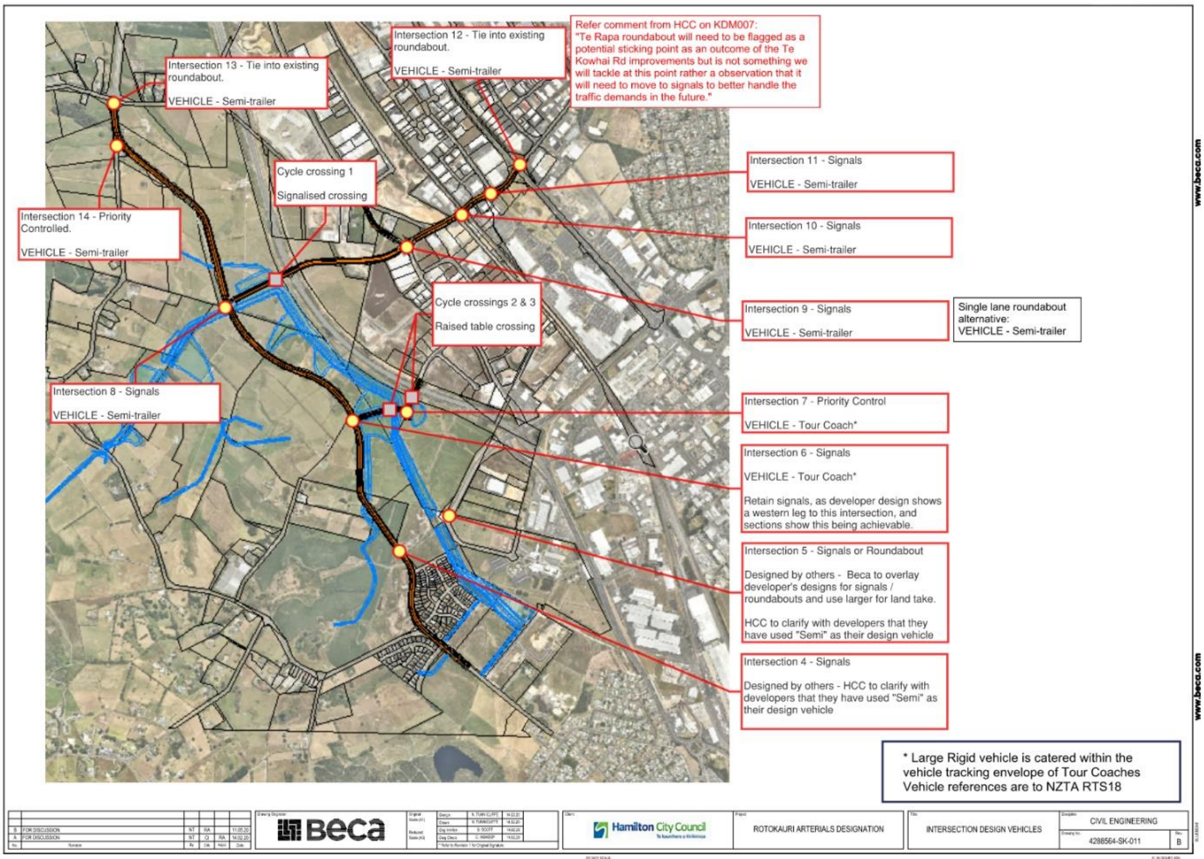


Figure 4-4 – Intersection Forms & Design Vehicle Allowances

4.14 Superelevation

No Superelevation is expected for the roads including Arterials due to the proposed design speed. Normal camber from the centreline is expected unless, a single cross fall will facilitate a specific drainage requirement. Superelevation if considered necessary by the RITS definition will be applied in accordance with Austroads Guide to Road Design Part 3.

4.15 Horizontal Alignment

The following horizontal alignment points are noted:

- The Arterial should be considered a High Standard Arterial Road (3.3.2, Guide to Road Design Part 3, Austroads) for the purpose of the design.
- Transition curves are not required.
- 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.

4.16 Vertical Alignment

Generally, and unless otherwise shown, the vertical geometric parameters shall be in accordance with the RITS. In summary the following parameters as follows:

The longitudinal grade for kerbs shall be:

- Minimum: 0.40%
- Maximum: 1:12
- Vertical curve length as per RITS
- Minimum length: 40 m

4.17 Sight distance

The sight distance requirements will be designed in accordance with AUSTROADS Part 3 and Part 4A. The following sight distance requirement applies for a 50 km/h posted speed zone:

- Stopping Sight Distance (SSD) = 55 m (RT=2.0, d=0.36)
- Approach Sight Distance (ASD) = 55 m (RT=2.0, d=0.36)
- Safe Intersection Sight Distance (SISD) = 97 m (RT=2.0, d=0.36)

During detailed design, the standard reaction time and friction factors adopted may be re-evaluated to meet other design constraints.

Vehicle crossing sight distance requirements have not been assessed (in line with HCDP requirements), because the location of the vehicle crossings is not known at this time. For a 50kph posted speed, and major or minor arterial classification, 120m would be the minimum sight distance required.

Sight distance at the existing rail crossing on Te Kowhai East Rd is not expected to reduce from the currently available sight distances.

4.18 Intersection Design

Intersections shall consider all modes of travel depending on the nature of the intersecting links.

Signalised Intersections have been weighed up against roundabout types with regards to vehicular traffic efficiency and cyclist safety and their footprint.

All signalised intersection forms will include a raised table or raised speed hump on approaches, the design of the speed calming measures will be designed in subsequent stages, including consideration for drainage.

The intersection types currently proposed are show in Figure 4-4.

4.19 Midblock Turning Facilities

Midblock turning facilities have been considered for light vehicles. Turning facility for heavy vehicles are not considered practical due to the tracking footprint. U-turn facilities will result in a reduction of the vegetation strips adjacent to the outside kerbs. The position and final details of such features will be determined in further design stages.

5 Stormwater

5.1 Design Standards and Reference Documents

The stormwater design was undertaken in accordance with and referencing the following key documents:

- Rotokauri Integrated Catchment Management Plan Water Quality Treatment, Morphum Environmental Ltd, 2016
- Rotokauri Integrated Catchment Management Plan, HCC, 2017
- Mangaheka Integrated Catchment Management Plan, Stormwater Modelling Report, CH2M Beca, 2017
- Regional Infrastructure Technical Specification (RITS), Section 4, Waikato LASS, 2018
- Mangaheka Integrated Catchment Management Plan (Version 4), HCC, 2019
- Greenway Notice of Requirement Appendix C - Rotokauri Greenway Design Report, Beca, 2019
- Waikato Stormwater Runoff Modelling Guide (TR2020/06), Waikato Regional Council, 2020
- Waikato Stormwater Management Guide (TR2020/07), Waikato Regional Council, 2020
- Te Rapa North ICMP - Model Build Report, Beca, 2021
- Te Rapa North Integrated Catchment Management Plan – Stormwater Management Devices, Beca, 2024

5.2 Existing Stormwater Management Documents

5.2.1 HCC Integrated Catchment Management Plans

The roads cross through three of HCC's ICMP zones. These ICMPs set out the high-level performance requirements for stormwater drainage and management practices within each zone. The ICMP boundaries do not necessarily align with topographical catchment boundaries and can overlap in part. This is because they were prepared at different times, but it is also inherent in the low-lying nature of the land (in combination with the modified original drainage routes) meaning drainage and flood routing can overlap and flow in different directions. More extreme, flood events often overflow into neighbouring catchments and diverge from the primary drainage route. However, the ICMPs are generally consistent with each other as stormwater management practices are generally consistent irrespective of catchment with some differences.

Generally, the ICMPs set out:

- the nature of each receiving environment, the main known issues for the catchment,
- objectives, targets and management practices to be adopted,
- the Best Practicable Option (BPO) and integrated management practices to address catchment issues and to achieve the objectives and targets,
- monitoring requirements for a development and its associated 'resource use' activities within the catchment, and,
- compliance requirements in accordance with the HCC Comprehensive Stormwater Discharge Consent.

The ICMP boundaries are shown on drawing CA-2101 and key points taken from each ICMP are listed below.

5.2.2 Rotokauri ICMP

Several technical reports were prepared to support the Rotokauri ICMP, the main ones referenced in the proposed arterial design are:

- Rotokauri ICMP– Three Waters Infrastructure – Integration Report, AECOM, 2016, and,
- Rotokauri ICMP Water Quality Treatment, Morphum Environmental Ltd, 2016.

The Rotokauri area and ICMP is divided into two geographic areas based on different receiving environments: the Northern Development area which drains into both the Ohote Stream and the Te Otamanui Stream, and the Southern Development area which drains to Lake Rotokauri. Each area has different management requirements reflecting the different receiving environments.

The dominant feature within the Southern Development area is the planned Rotokauri Greenway (and its associated wetlands) which will manage stormwater runoff prior to its discharge into Lake Rotokauri. The Greenway has already been designated by HCC and the road design draws information from its NoR reporting - particularly from the flood modelling and wetland sizing.

While the proposed designation crosses the eastern edge of the Northern Development area, it does not discharge road runoff into the Ohote Stream or Te Otamanui streams and so this part of the ICMP is less relevant to the proposed designation.

5.2.3 Mangaheka ICMP

The following technical reports form the Mangaheka ICMP have been used to inform the road design:

- Mangaheka Integrated Catchment Management Plan – Modelling Report, CH2M Beca, 2017,
- Mangaheka Water Quality Assessment, CH2M Beca, 2018, and
- Mangaheka Watercourse Assessment and Programme of Works, Morphum Environmental Ltd, 2017.

From these reports, the key aspects are:

- stormwater wetlands (named Devices 6 and 7) and their sizing,
- subcatchment boundaries and areas,
- that the Arthur Porter wetland is sized to manage the catchment upstream which includes parts of the roads covered by the proposed designation,
- downstream stream erosion measures and,
- flood levels and flows in the Mangaheka Stream.

The Arthur Porter wetland (location shown on drawing CA-2101 and in Figure 5-1) is a dual-purpose treatment/attenuation device within the Mangaheka ICMP. It is an existing wetland designed to treat and attenuate runoff from an existing built-up catchment that includes small sections of the designated roads. The wetland is approximately 3.7ha in area and serves a catchment of approximately 69ha in area (catchment F). This wetland was designed to TP10 and consented and constructed in 2014 prior to the Mangaheka ICMP being prepared. For more details on the performance of this wetland, refer Section 6, Water Quality Assessment (Beca, 2018) that forms Appendix C of the Mangaheka ICMP.

There are only approximately 500m of roads being designated within the Arthur Porter wetland catchment, most of which are existing roads. The proposed roading alignment moves significant sections of road into the adjacent catchment therefore, the amount of road carriageway draining to the Arthur Porter wetland will decrease (by approximately 400m^2) relative to existing.

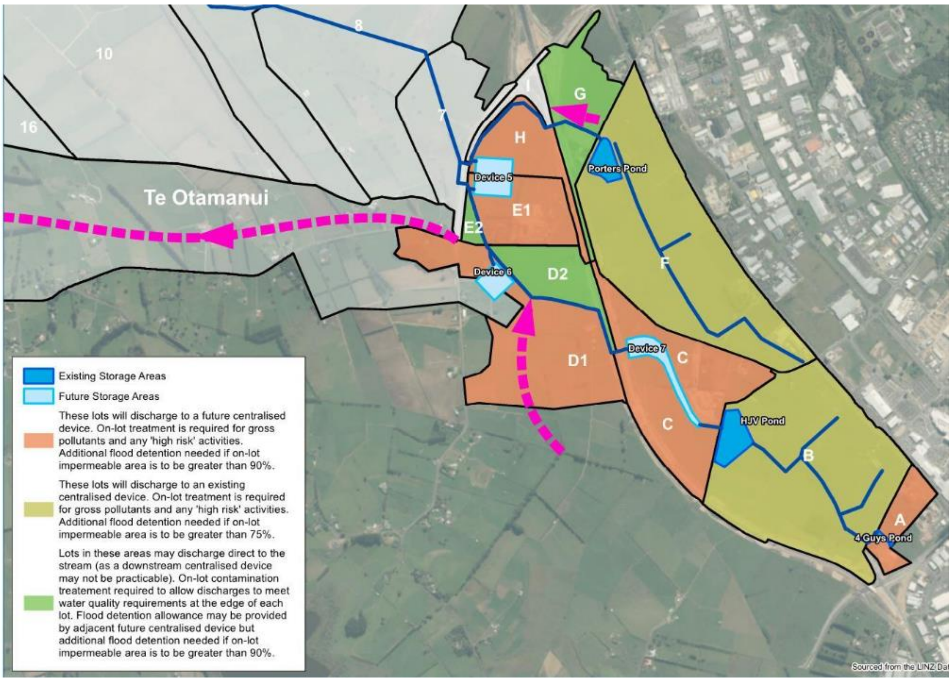


Figure 5-1 Catchment serviced by the Arthur Porter wetland, catchment F
(image taken from Figure 6-1 of the Mangaheka ICMP, the wetland is called Porters Pond on this image)

5.2.4 Te Rapa North ICMP (draft)

HCC's Te Rapa North ICMP is currently under development and as such has a draft status at the time of writing this report. However, as the proposed designation in the Te Rapa catchment only covers existing built roads and infrastructure, the requirements of the ICMP will not significantly impact the proposed designation footprint. The following technical reports have informed the proposed designation design:

- Te Rapa North ICMP - Model Build Report, Beca, 2021 and,
- Stormwater Management Devices Te Rapa ICMP, Beca, 2024.

From these reports, the key aspects are:

- the flood extents,
- that an end of pipe subcatchment scale wetland is preferred for water quality, attenuation, and extended detention for the existing developed area of this catchment and this includes the roads covered by this proposed designation,
- flood management is proposed by utilising storage within the existing stream floodplain in the greenfield area of the catchment, and
- measures proposed to restore and address increased stream erosion in the receiving environment that accommodates growth as well as addressing existing issues.

5.2.5 Greenway Designation

The Rotokauri Greenway physical extent (shown on the stormwater plan drawings as the light blue shaded zone, an example of which is shown in Figure 5-2) is a large, linear channel split into a series of five basins based around road crossings. It comprises of a primary "stream" channel set down in wide floodable berms and its primary purpose is to store flood water and mitigate flood impacts on Lake Rotokauri caused by subdivision developments that will drain to it.

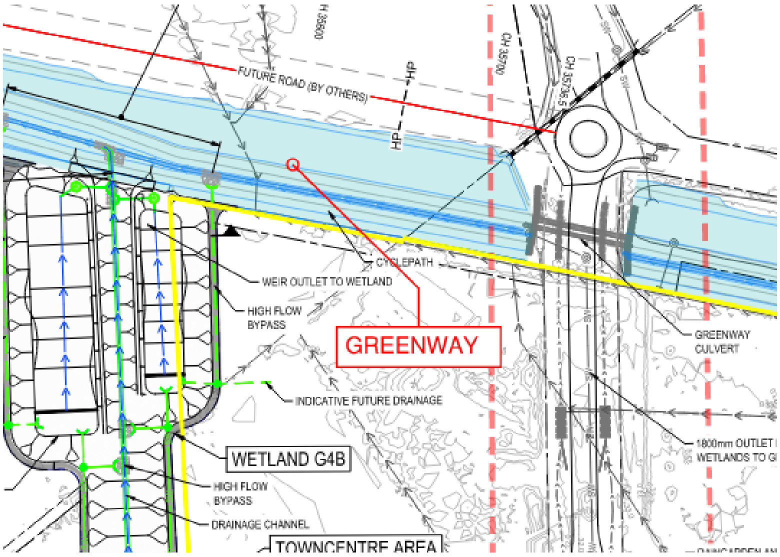


Figure 5-2– Example of how the Greenway designation (shaded blue) is shown on the stormwater drawings.

The basins are controlled by culverts beneath road crossings, two of which are in proposed designation. These culverts are intentionally designed to cause floodwater to back up into the basins thereby attenuating peak flows. The Greenway also incorporates ecological, downstream erosion mitigation and urban design aspects. Therefore, these issues, as they relate to the road culverts, are not addressed in this report as they have been covered under the Greenway designation. The sizing of these culverts is not fundamental to the proposed designation and will be addressed under resource consent applications for the Greenway.

Several wetlands are positioned adjacent to the Greenway and contribute to the overall flood mitigation but primarily address water quality and extended detention. Most of the wetlands were shown in the Greenway designation documents but were not included in the land designated. As several of these wetlands receive runoff from the proposed arterial roads, they are included in the proposed designation. The wetlands that do not receive runoff from the proposed roads are not included in the proposed designation and remain for future land developers to address. This also reflects the strategic significance of these wetlands to HCC in achieving positive stormwater management outcomes.

The wetlands included in the proposed designation have been developed further from that shown in the Greenway NoR based on initial consultation with developers. However, the fundamental wetland performance criteria remain unchanged from the Greenway NoR. These are covered in detail in the Greenway NoR Appendix C - Rotokauri Greenway Design Report (Beca, 2019). This report and the design behind it provides flood levels, subcatchment boundaries and storage volumes.

HCC (through an agreement with a land developer) is already advancing the designs for the first part of the Greenway upstream of the minor arterial crossing and this includes updated flood modelling.

Construction of the Greenway corridor will commence ahead of the Rotokauri Arterial Network, as it is a necessary precursor for conveying treated stormwater from the new treatment wetlands which form part of the proposed Rotokauri arterial designation. The construction of the Greenway will span several construction seasons involving significant bulk earthworks and associated effects which will be managed by a suite of designation conditions, resource consents, and associated management plans. The Greenway will link to adjoining subdivisions in terms of drainage and finished surface levels. However, the proposed designation has sufficient footprint to mitigate the road runoff in advance of the Greenway becoming operational should it need to.

5.2.6 Rotokauri North Development Area (Plan Change 7) Subcatchment ICMP

At the northern end of the proposed designation the minor arterial passes across land that is subject to a recent, private Plan Change (PC7). PC7 enables subdivision development of a large area of land mostly to the west of the minor arterial road. Only its eastern extents interface with the stormwater aspects of the proposed designation, this area is indicatively shown in Figure 5-3 below.

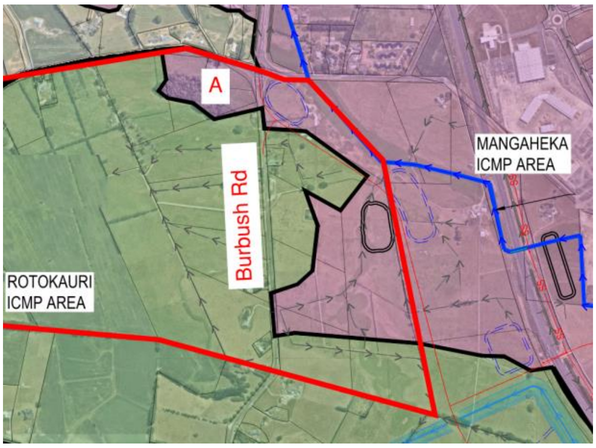


Figure 5-3 – Indicative extents of PC7 (red line) overlaid on the ICMP extents drawing. The proposed minor arterial road centreline is shown as the thin red line.

The PC7 extents mainly sit within the Rotokauri ICMP zone (both north and south development zones) but also crosses into the Mangaheka ICMP zone at its eastern extents. The developer has prepared their own subcatchment ICMP as part of the Plan Change process. This is detailed in the Rotokauri North Subcatchment ICMP, Tollemache Consultants Ltd, Sep 2021 and the associated Rotokauri North Subcatchment ICMP Stormwater System Report, BBO, Sep 2021.

These documents are generally consistent with the stormwater management proposed by this designation design but with some differences being:

- how the Greenway overland flow path is to be routed north,
- the location of Wetland D6A,
- the proposed routing of a small part of the catchment west of Burbush Rd (marked A in Figure 5-1 and shown hatched on drawing CA-2102).

Consultation was carried out with the PC7 designers prior to the plan change being approved. However, the proposed designation design has not adopted the PC7 arrangement for Wetland D6A (refer drawing CA-2403) given the unknowns relating the performance of the PC7 arrangement which remain unaddressed. However, should the PC7 layout be proven in later subdivision design and consenting then HCC and the developer can agree to change the location of wetland D6A and the designation altered at that time if necessary.

5.3 Catchments

5.3.1 Catchment Boundaries and Topography

The proposed designation mainly sits within two catchments: Rotokauri and Mangaheka with a short section of road in a third catchment, Te Rapa, where the proposed designation covers existing roads. These catchments are further broken down into subcatchments by the ICMPs and/or the Greenway NoR. These subcatchment boundaries are shown on drawing CA-2102. There are some inconsistencies between these boundaries, and the proposed designation has developed these further, particularly with regard to the wetland designs. However, the boundaries will only be finalised when the adjacent subdivisions are designed and the associated finished surface gradings are determined.

Although the subcatchments remain to be fixed, the flexibility to significantly change them is very limited by the following:

- Greenway basins – the flood attenuation provided by the Greenway is reliant on certain runoff volumes being routed into specific parts of the Greenway for attenuation. This therefore sets the size of each subcatchment that can drain into each Greenway basin. Significant changes from this would need to be reconfirmed in the Greenway flood model.
- Wetlands – these are sized on a percentage of its contributing catchment area in combination with providing sufficient storage to attenuate peak flows. Similarly, the depth of the wetland, and so footprint for a given volume, depends on if drainage can be routed into it while still being high enough to have an outlet above the downstream receiving watercourse. That is, the size of a wetland catchment can be limited by the feasible length of pipe runs that drain into it.
- Existing development often constrains drainage routing and wetland locations thereby limiting catchment extents.

In terms of the proposed designation, the catchment boundaries generally align with the highpoints in the road so not to draw in too much additional catchment. Although there are some areas where minor amendments to the catchment boundaries have been made, these are shown hatched on drawing CA-2102 and relate to:

- having a more detailed site understanding gained from both site investigations, survey and consultation with subdivision developers,
- reflecting site constraints such as clearance underneath the SH1C overbridges which forces low points,
- integrating existing built roads and drainage such as along Chalmers Road, and
- following HCC's direction for management efficiency.

The topography through which the proposed designation crosses is generally low lying with a low line of hills off to the west of the alignment and the SH1C embankment to the east of the main north-south minor arterial. Figure 5-4 is a rendered image of the wider topography with key features marked up for context. As well as the hills to the west, a depression in the form of a paleo channel can be seen running parallel to the proposed north-south minor arterial. The channel represents the historic watercourse route prior to farm development diverting drainage into Lake Rotokauri via the Rotokauri Drain. This paleo channel still acts as an overland flow path and is where overflows from the Greenway would still be routed.

Generally, the part of the Rotokauri catchment through which the proposed designation runs is undeveloped, rural farmland. Within the Mangaheka the land is a mix of undeveloped lots, rural land, and some historic residential lots mixed in with newer industrial areas. Te Rapa is mainly developed industrial and commercial land.

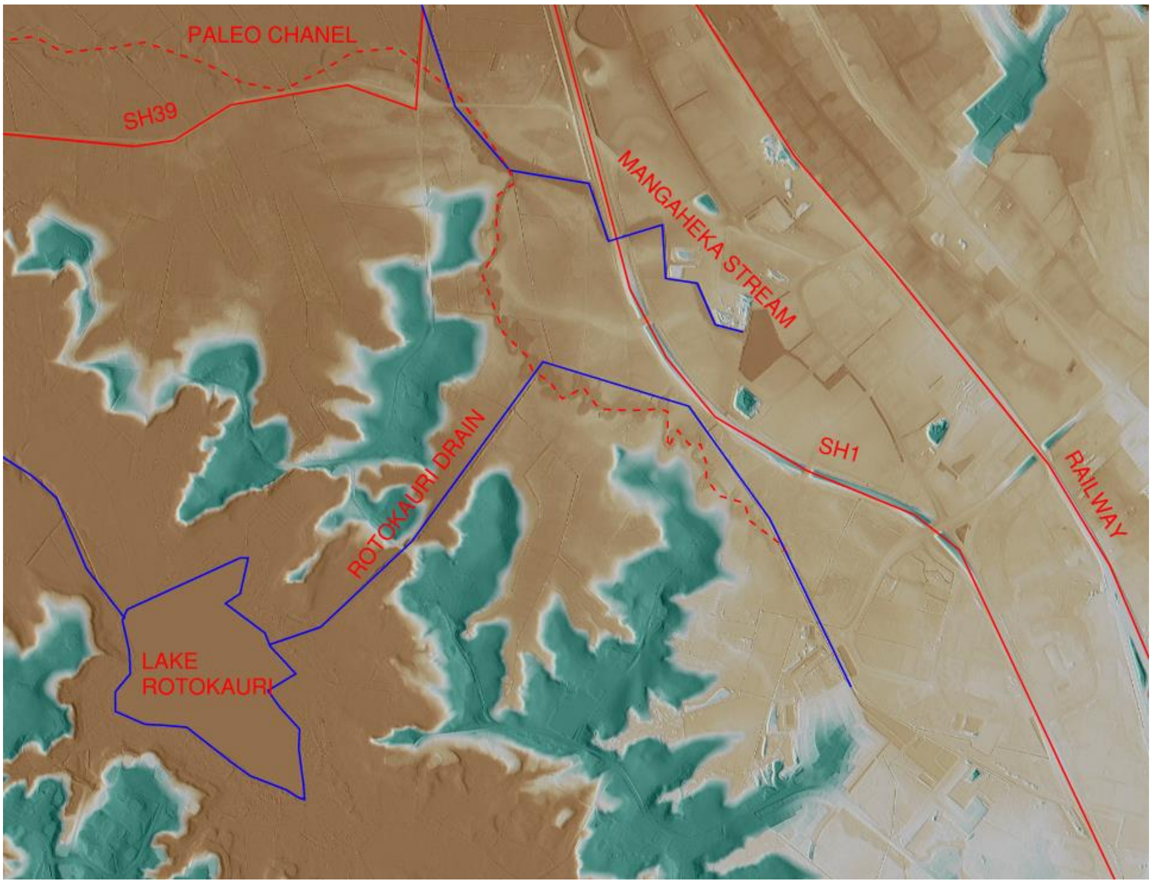


Figure 5-4 – Rendered view of the ground surface with key features marked up. The blue-green colour indicates elevated areas and the dark tan areas the lower lying land. The paleo channel is shown with the dashed red line.

5.3.2 Receiving Environments / Watercourses

The Rotokauri catchment is drained by the Rotokauri drain which outlets into Lake Rotokauri. The proposed roads south of chainage 12,550m (on the north-south minor arterial) will drain into the Greenway and from there to the Lake.

The Mangaheka catchment drains into the Mangaheka Stream. North of chainage 12,550m the roads drain into the Mangaheka Stream. Upstream (or east) of the Te Kowhai Road / SH1C underpass the Mangaheka Stream receives runoff from the HJV wetland that manages stormwater from the existing development upstream. Similarly, parts of Arthur Porter Drive drain to the north and into the Arthur Porter wetland.

The Te Rapa catchment, in this area, is almost fully developed with its drainage eventually outfalling into the Te Rapa stream just upstream of Ruffell Road.

The current Rotokauri, Mangaheka and Te Rapa Streams are all modified watercourses that look and function as farm drains.

5.3.3 Flood Extents

As the land is low lying, large areas are exposed to flooding in the 100yr and 10yr ARI storms. HCC has modelled the catchments across which the roads will run as part of its ICMPs and the Greenway NoR projects. Flood levels have been taken from these models to inform tailwater conditions and clearance to the roads.

The Greenway model has been updated under a separate HCC project as part of supporting resource consents for the Greenway. The flood extents shown on drawing CA-2103 are those from the original Greenway modelling as this latest modelling was not available at time of drafting this report.

5.4 Hydrology

The hydrology used for the design falls into two areas:

- That used for determining flood levels and volumes. For this, the ICMP models were referenced and so the hydrology used for these applies, and
- Road drainage design including pipes, channels, swales, and culverts use a mix of the Rational Method (RITS, 2018) and Waikato Stormwater Runoff Modelling Guideline, TR2020/06 (WRC, 2020). The Rational Method was used for the drainage network (pipe and open channel) sizing where catchments are small and TR2020/06 for culverts and wetland testing where the catchments are large.

5.4.1 Rainfall and Climate Change

Where the results from existing flood models have been used, the rainfall and climate change increases are already in those models. For Rotokauri NoR and Mangaheka models this is HCC old ITS rainfall with climate change allowance of a 2.1°C increase to 2090. However, the Rotokauri flood model was more recently updated under a separate project to HIRDS V4 rainfall, TR2020/06 hydrology and applied RCP 6 climate change increases.

The flood levels stated in Section 5.7.2 of this report are therefore to climate change scenario RCP 6 (for those reporting points associated with the Greenway) and to 2.1°C to 2090 (for those reporting points within the Mangaheka catchment).

The rainfall used for pipe, channel and culvert sizing has been taken from NIWA's HIRDs V4 and increased for climate change in accordance with the most recent Waikato Regional Council advice (summarised in RITS Update: Climate Change V3, Beca, 2019) and by applying the Ministry for the Environments' advised increases (MfE, 2018).

Future design and consenting stages will need to consider the implications of flooding to climate change RCP 8.5 as a flood sensitivity scenario. It is noted that HCC do not have an explicit policy requiring RCP8.5 to be used for infrastructure design. HCC do use RCP8.5 to understand flood hazard across the city but not necessarily for design. Modelling of the Greenway prior to the fast-track process used RCP6 and tested RCP8.5 as a sensitivity scenario. Therefore, adopting climate change to RCP8.5 for the purpose of design sizing remains for HCC to consider as part of a future resource consenting process.

The wetlands are sufficiently sized for the purposes of the proposed designation. Should future design and modelling show larger wetlands are needed as a result of HCC adopting RCP8.5 this will be negotiated with the adjacent landowner and/or alteration to the designation as appropriate.

5.4.2 Runoff Coefficients

Where the rational method has been used, the runoff coefficients have been set to 0.95 for impervious, and 0.3 for pervious areas with 0.8 for an average across the wider development areas.

5.4.3 Curve Numbers

Where the TR2020/06 has been used, the Curve Numbers (CN) applied are shown in Table 5-1. These have been taken from each ICMP.

Table 5-1: Curve Numbers

Area Description	CN
Mangaheka Catchment D pervious areas	70
Rotokauri North weighted residential	73.5
Mangaheka Catchment C weighted	95.4

Mangaheka Catchment D weighted	95.5
Impervious areas	98

5.4.4 Time of Concentration

The time of concentration has generally been conservatively and set to 10 minutes for all calculations. Culvert times of concentrations will likely be longer than this (and so peak flows lower) but as culvert size does not impact on the proposed designation extents, then this can be refined during future design stages that will likely also involve hydraulic modelling.

5.5 Design Criteria

The following sections list the key high-level criteria that were used for the proposed designation design as taken directly from the respective ICMPs. These documents contain more detailed criteria which have not been repeated below as these relate to future detailed designs so are not critical in setting the proposed designation.

5.5.1 Rotokauri (draining into the Greenway) ICMP

1. Treatment of road runoff is to be integrated into subcatchment scale treatment areas (i.e. wetlands) that also serve subdivisions.

2. Primary conveyance routes shall be in the form of “green corridors” and be designed as naturally lined open channels (grassed or planted depending on water levels and ecological enhancement opportunities). Gradients are to be at a minimum with slow drainage into the Greenway and maintain the natural catchment runoff response (as far as practical). These shall connect upstream subcatchment areas to the Greenway. Fish passage is to be maintained into these where they take the form of a naturalised stream.

3. Water quality treatment shall be provided via a two-stage treatment train to address contaminants but particularly to address nutrient loading into Lake Rotokauri. Primary treatment or “at source” devices are required with secondary treatment in the subcatchment scale wetlands attached to the Greenway. Together these are to achieve >70% Total Phosphorus (TP) removal with the primary treatment providing an average of 40% of that and wetlands an average of 50%. Total Suspended Solids (TSS) is to have an average of 90% removal.

4. The ICMP prefers saturated zone/bio-retention raingardens in series with wetlands, but other options are potentially available for the primary treatment. While not all areas of the catchment need to be routed through the primary treatment device, they are to be located in high contaminant load areas as a priority over lower load areas (such as in high traffic volume areas).

5. Wetlands shall be designed to provide for the full water quality volume, extended detention, and flood storage. The ICMP notes no other flow control is needed outside of that provided by the Greenway. There is some flexibility to adjust wetland locations along the Greenway basins, as required to integrate with development plans.

6. Flood management is provided by the Greenway in combination with the wetlands to attenuate the 2yr, 10yr and 100yr ARI peak flows.

7. Stream scour shall be mitigated by providing extended detention in the wetlands. Further channel remediation downstream of Exelby Rd as included in the Greenway designation.

8. Watercourses are to be protected and enhanced where practicable. Diversions should include ecological enhancement to improve biodiversity values and ecological connectivity to the wider catchment.

9. Culverts are to allow for fish passage with a series of design requirements including embedment and having flatter falls than 1:300.

10. Overland flow shall be along road corridors or in designated drainage reserves.

11. Soil rehabilitation shall be undertaken to reverse construction compaction effects and improve near surface soakage.

12. The design of general conveyance drainage that links existing drainage to new infrastructure can be in the form of open channels, pipes or both depending on site constraints and opportunities.

13. Drainage networks are to be designed to HCC's ITS (now the RITS).

5.5.2 Rotokauri north (not draining into the Greenway) ICMP

1. Generally, the same as noted in Section 5.5.1 but without the need for two-stage water quality treatment targeting TP and with a lesser TSS removal rate of >75%.

2. Attenuation and extended detention as per RITS (being the replacement of TP10 referenced in the ICMP).

5.5.3 Mangaheka ICMP

1. Water quality treatment shall be provided in centralised devices (i.e. wetlands) to a standard design performance (TSS >75% removal, no visible hydrocarbon sheen, temperature <23^{o}C, no gross pollutants, ammoniacal nitrogen <0.88gm/m^3, limits on micro-organisms, turbidity, colour, and dissolved oxygen) and otherwise in accordance with HCC's ITS (now the RITS).

2. Wetlands are to provide extended detention for stream erosion control.

3. Wetland areas are to be 3% of the contributing catchment area and provide 100yr ARI storage as per the volumes listed in the ICMP.

4. There shall be no increase in flood levels and peak flows in downstream receiving environments unless it can be demonstrated there is no significant adverse cumulative effect.

5. Attenuation shall be provided to match existing development peak flow for the 2 and 10yr ARI events. 100yr ARI attenuation shall be to 96% of existing peak flows for Device 6 and 73% for Device 7 (called Wetlands D6a, b & c and D7a, b & c on the proposed designation drawings).

6. The initial abstraction volume shall be retained, and pre-development runoff volume matched through reduced runoff practices and wider subcatchment management including soakage (where practical) and water reuse. Where this cannot be achieved, mitigation within the receiving environment will be required such as channel stabilisation and/or a financial contribution for a third party to undertake downstream erosion prevention.

7. Compacted soils shall be remediated to improve shallow surface infiltration.

8. Design of drainage in accordance with HCC's ITS (now RITS).

5.5.4 Te Rapa North (draft) ICMP

1. Treatment, extended detention, and peak flow attenuation are proposed to be provided by a subcatchment scale wetland downstream of Ruffell Road and additional flood storage provided within the existing stream floodplain.

2. Design in accordance with the RITS.

5.6 Assumptions

The following key assumptions and key HCC decisions were used and made in developing the design to address the above requirements and meet the project objectives:

1. Construction of the Greenway corridor will commence ahead of the Rotokauri Arterial Network, as it is a necessary precursor for conveying treated stormwater from several artificial wetland areas which form part of the proposed Rotokauri arterial designation. The construction of the Greenway will span several construction seasons involving significant bulk earthworks and associated effects which will be managed by a suite of designation conditions, resource consents, and associated management plans. This report has therefore been prepared on the basis that the Greenway is under way or completed and urbanisation is occurring at the time the Rotokauri Arterial Network construction commences. If the construction of the Greenway is staged, part of this will be to provide an outlet for the arterial road drainage at same level as the complete Greenway.

2. Drainage will be in accordance with the three ICMPs that cover the site.

3. HCC directed that road drainage should be piped where falls allow. The alternative being deep, wide swales running parallel to the roads but this would require substantial additional land take and present a significant physical barrier between road corridor and the adjacent subdivisions and as such is not preferred. However, the larger, main conveyance routes that serve large subcatchments upstream of the road are to be open channel in form.

4. The road vertical alignment and limited drainage falls mean areas of adjacent land will need to be filled rather than the road lowered in future design stages. This will allow the subdivision to tie into the road but also provide clear falls for secondary flow routing; result in elevated house floor levels clear of flooding and facilitate piped drainage (by providing cover) in lower lying areas. Filling of the wider subdivision areas will therefore need to maintain/allow for secondary flow path routing and offset any flood storage lost. It is also noted that flood levels in the Greenway relative to existing ground levels will likely mean these areas need to be filled however, this remains to be addressed in future subdivision designs and be confirmed through Greenway flood modelling.

5. The road drainage is to be integrated with the adjacent subdivision drainage, as far as this is practical. Several developers along the route are currently advancing their subdivision plans (and are at various stages of design) but in other areas there are no active plans to develop. Therefore, integration remains an ongoing design task and will carry on beyond the designation stage. The different timings involved mean there will be some inconsistencies between the different designs which will be resolved during later design. Future alterations to the designation may be needed if any future design changes are significant. This means that the road drainage will often need to allow to receive and convey runoff from upstream catchments.

6. Adjacent subdivision developments may not be constructed at the same time as the roads. If this were to occur, then temporary drainage will be needed until the subdivisions proceed.

7. As noted in the ICMPs, the nature of the existing underlying soils and relatively shallow depth to groundwater will make large scale soakage disposal of road stormwater unpractical. Catchpits and raingardens could be modified to include soakage sumps/cells to promote limited soakage. In these instances, pre-treatment would also be required. Soakage viability will need to be confirmed as part of subsequent resource consenting and detailed design stages. It is expected that the post development volume discharged will not therefore match the pre-development volume. Mitigation for this will need to be addressed in future resource consent applications. HCC determined that additional land for this is not to be included in the proposed designation at this stage.

8. Downstream mitigation for habitat loss, stream erosion and/or WRC Scheme Drain off-setting is not included in the proposed designation. This will be addressed separately between WRC and HCC as part of future resource consent applications and will apply the framework set out in the ICMPs and/or the Greenway designation.

9. Stormwater modelling to prove drainage performance will be carried out under future resource consent stages. However, the design references modelling carried out for the Greenway NoR, the Te Rapa ICMP and the Mangaheka ICMP to provide flood levels and storage volumes. Updated modelling for the Greenway is currently underway in a separate HCC project working towards obtaining resource consents for the Greenway. This modelling has incorporated the proposed wetland locations as shown on the proposed designation drawings and provided updated flood levels however, modelling was ongoing at the time for writing and so subject to change.

10. The Greenway culverts have not been designed/sized under this project as they will be covered by the Greenway design. The sizes set out in the Greenway NoR have been used to check road levels and pipe covers.

11. The key overflow path from the Greenway north into the Mangaheka catchment (identified in the Greenway designation conditions) will not be rerouted to run down the arterial road corridor and will remain for future subdivision developers to address and incorporate within their subdivision layout.

12. Only wetlands that receive runoff from the proposed roads will be included within the proposed designation. This leaves several wetlands identified in the Greenway NoR and ICMP documents to be designed and developed in the future as part of adjacent subdivision developments. These other wetlands are indicatively shown on the drawings to show the wider stormwater management context.

13. There are design alternatives available for the wetland outlets from that shown on the drawings, subject to HCC approval (such as using open channels/weirs, incorporating footbridges etc instead of using pipe and manhole outlets shown on the drawings). The option shown is in accordance with the RITS. As alternative arrangements will not impact the proposed designation extents, decisions on the final form can be deferred until later design stages.

14. Chalmers Road east of SH1C has been constructed falling towards the SH1C overbridge and so into the Rotokauri catchment. However, its piped drainage runs against this fall and back into the Mangaheka catchment. As it is not practical to regrade Chalmers Rd, secondary flow will follow the road under the overbridge and into the Greenway. This is a small area, but it was not accounted for in both the Greenway and ICMP modelling. However, the effects of this difference will not be

significant given the relative scale of the areas involved. The area is shown hatched on drawing CA-2102.

15. A localised area around Te Kowhai Rd east of SH1C will need to drain under SH1C and into the Rotokauri catchment like at Chalmers Rd. This is because a low point will be needed at the SH1C overbridge to achieve clearance beneath it. Therefore, a small area of road corridor will drain into the Greenway that was not included in the Greenway or ICMP modelling. This area is relatively minor compared to the full Greenway catchment and so the effects of this change will be minor. This area is shown hatched on drawing CA-2102.

16. A key drainage corridor running from the arterial road to the Greenway (approximately 200m north of Te Wetini Drive at ch10,980) will be included in the proposed designation in the form of an open channel. It will become a strategic drainage corridor conveying upstream flows to the Greenway. This then requires wetland G4 to be split in two across either side of the channel as drainage cannot cross the channel or pass over the culvert to a theoretical single wetland.

17. The watercourse diversion downstream of the HJV Pond and the new channel at wetland G4a/b will include stream habitat features in accordance with the Rotokauri and Mangaheka ICMPs.

18. Permanent culverts will be designed to convey the 100yr ARI flows without heading up above the edge of the road in accordance with the RITS. The exception being the Greenway culverts which will have different performance criteria than that specified in the RITS given the Greenway attenuation requirements. Temporary culverts can be designed with a lower level of service.

19. The roads will be graded to form low points at each culvert to provide known overflow locations in case of blockage or over-design events.

20. The stormwater management area called Device 6 from the Mangaheka ICMP will be divided into three separate wetlands (labelled on the drawings Wetlands D6a, b and c). This is primarily due to limitations of available fall; the arrangement of open channel drains that cannot be crossed; and steeper topography to the west of the arterial road.

21. Greenway wetland 8 (labelled on the drawings as Wetland G8) will be located away from the intersection and alongside SH1C to provide a better urban design outcome for the minor arterial intersection. The final location of the wetland could change subject to final development plans and the Greenway modelling. Any change would be addressed by a future alteration of the designation.

22. In catchments draining into the Greenway, a treatment train will be used to meet nutrient removal requirements under the ICMP. This will use saturated zone raingardens in series with wetlands, although other options are available such as standard raingardens, swales, proprietary filters etc. As the ICMP notes a preference for saturated zone raingardens, these have been shown.

23. Use of saturated zone raingardens means only 50% of the contributing catchment needs to be routed through them to achieve water quality outcomes. Other options give less-effective results and so require a higher percentage of the catchment to be treated, for example, standard raingardens give 84% and proprietary filters 100% (Morphum Environmental Ltd, 2016). Saturated zone raingardens therefore offer the greatest flexibility for future design.

24. Raingardens are shown spaced along the road corridor in accordance with the RITS rather than grouped into fewer, larger end of pipe raingardens. This is partially due to the limitations on pipe

falls. HCC also evaluated the additional footprint required for end of pipe raingardens against the reduced O&M costs these incur and elected to exclude widespread use of end of pipe raingardens. Consideration of end of pipe raingardens could still be developed as part of integration with adjacent subdivision designs. These would sit outside of the proposed designation.

25. For the purposes of the proposed designation, the drawings show how raingardens could fit within the designated road cross-section, but do not detail calculated raingarden lengths, numbers and spacings needed. The plan layout shown on the roads is indicative only and are not based on calculations as this will not impact on the extent of land required for the proposed designation given they are located in the berm and the lengths can be adjusted to suit. These items are matters for future design stages to determine.

5.7 Design Solutions

5.7.1 Basis of the Land Required

The extent of land required for the stormwater features is based on current, standard industry design practices and methodologies to provide a reasonable and robust basis for the proposed designation. It is not a detailed design and as such there remain issues and risks to be resolved in future design stages. Similarly, there are potential innovations that could be applied to minimise and optimise the design footprint. These can be explored in future design stages as the outcomes of these are not immediately obvious and design of these is yet to become standard industry practice. Much more detailed assessment and design is needed if these were to be adopted. For example, the use of wetland bio-filters could offer reduced wetland footprints and remove the need for roadside raingardens. Similarly, the final earthworks batter slopes will require detailed geotechnical assessment before they can be steepened from that assumed in this report (thereby offering reduced footprints).

The stormwater design solutions are shown on the drawings CA-2101 through CA-2801 and described below.

5.7.2 Road levels and Flood levels

Table 5-2 lists flood levels at key locations along the proposed roads. For the Greenway, these levels have been taken from HCC's modelling prior to the fast-track design. Earlier design was based on ICMP and Greenway NoR modelling with a subsequent update for the Greenway becoming available late in the design process. These levels are higher than reported in the previous Greenway NoR modelling because the newer modelling uses updated hydrology and catchment extents however, it remains to be optimised in future design stages. The flood level ranges reported in Table 5.2 represent different modelling scenarios. The first level relates to a catchment condition where the existing ground surface is maintained. This still has surface depressions in it where flooding is stored on the surface or where flood levels break out from the Greenway. This is called residual ponding. Subdivision development can be expected to fill these areas in. Therefore, a scenario has been tested where the Greenway has been "glass walled". This represents an ultimate development condition where the land has been filled so that all flooding is forced to be contained within the Greenway and associated wetlands (i.e. a scenario where developers do not offset any of the residual ponding lost). The latter scenario could see the Greenway minor arterial road crossing overflowing (albeit with relatively shallow depths).

Similarly, ponding will occur under the SH1C overbridges. Ponding here and the ability to design it out is limited given the fixed SH1C bridge levels in combination with the minimum clearance envelope beneath these structures and the flood levels in the Greenway. The potential for ponding to occur at the Te Kowhai East Road and Chalmers Road underpasses, the implications of this and how to manage the hazard appropriately needs to be dealt with by HCC during the Greenway and associated development designs.

However, should ponding occur here, there are alternative routes to the north and south that connect back into the wider city that are relatively flood free.

While the flood levels were taken from the last modelling available to Beca, we note that the Greenway fast-track development is modelling and designing in parallel to this process and this may have superseded the results reported here.

The RITS does not require roads to be clear of the 100yr ARI flood levels and the road design has been intentionally set with low points above the Greenway culverts (to create known, controlled overflow points) however, the performance of these and the road grading is subject to further modelling as part of a design progression through to construction (likely in combination with adjacent developments).

Table 5-2: 100yr ARI flood levels and road centreline/edge levels at selected locations along the roads (all in NZVD)

Ref	Location	Flood Level (mRL)	Location of Road	Road Level Centre Line (mRL)	Road Level Kerb Channel (mRL)
1	In the Greenway adjacent Wetlands 4a&b	32.2 - 32.6	Low point above Culvert 2	32.96	32.84
2	Upstream of Culvert 2[1]	31.4 - 32.8			
3	In the Greenway upstream of the Chalmers Rd crossing	32.2 - 32.6	Low point above Greenway culvert	32.19	32.07
			Low point at Chalmers Rd SH1C underpass	31.72	31.60
4	In the Greenway adjacent Wetland 6 / downstream of Chalmers Rd crossing	31.5 - 32	Ch11,800	33.83	33.55
			Low point at Chalmers Rd SH1C underpass	31.72	31.60
5	In the Greenway upstream of the minor arterial crossing	31.5 - 32	Low point above Greenway culvert	31.73	31.25
			Low point at Te Kowhai Rd SH1C underpass	31.02	30.73
6	Mangaheka Stream at Wetlands D6a&c	30.3	Low point at Culvert 9	31.00	30.72
			Low point at ch13,540	31.31	31.01
7	Upstream of Culvert 9[1]	30.4	Low point above Culvert 9	31	30.72
8	Downstream of Culvert 10	31.5	Low point at Culvert 10	32.81	32.53
9	Upstream of Culvert 10[1]	31.8			

[1] Based on HY-8 culvert calculation at peak flow with 100yr ARI tailwater conditions coinciding.

5.7.3 Road Drainage

The road is drained by a catchpit and pipe network which collects stormwater runoff from the carriageway, footpaths and berms and conveys it to stormwater management areas (either a wetland, swale, or end of pipe raingarden). The pipe network will be designed to convey 10yr ARI peak flows. However, there are some areas (between Wetlands G4A&B, upstream of culvert 10 and upstream of Wetland 7B) where pipes are not feasible due to a lack of available fall and/or cover. In these areas open channels have been used.

Pipes are preferred by Council for road drainage with open channels used for the major conveyance corridors. Given the flat nature of the land, open channels for road drainage would mean very wide and deep channels (approximately 1.5m deep, 10m wide) with the depth and therefore the width driven by cover to the pipes that drain into them rather than the channel capacity. This would require significant additional land and isolate the roads from the adjacent developments which is a poor urban design outcome impacting the integration of the road frontage with adjacent land. However, should future detailed design find that pipes are not large enough, then the options are:

- use larger pipes; or
- provide additional attenuation within the development (as has been done already in the RDL development opposite the Te Wetini intersection as indicated on drawing CA-2604); or
- install additional drainage pipes (twin systems); or
- use of open channels that are not within the proposed designation but are part of the subdivision design with agreement between the developer and HCC; or
- a mix of the above.

This would be agreed between the developer and HCC at the time of design.

The catchpit/manhole spacings shown on the drawings are indicative and will be fixed in later detailed design stages. This is because the spacings do not impact on the land required for the proposed designation. However, the longitudinal pipes have been sized and checked for falls and cover against the proposed road levels and outfall locations. Many pipes have relatively flat longitudinal gradients however, they still provide self-cleaning velocities in accordance with the RITS. The pipe routes have been sensitivity tested by examining long and indirect plan routes to understand the limits of feasible drainage runs (i.e. that long run pipe networks can reach the wetland forebays from the edges of the subcatchment while maintaining appropriate pipe fall and cover).

Where practical the drainage pipes have been sized to receive runoff from future developments upstream of the road.

Roads draining to the Greenway will pass through a treatment train with primary treatment in raingardens (refer Section 5.7.5 below) and secondary treatment in wetlands (refer Section 5.7.6 below). The final primary device type can change with detailed design provided treatment performance is achieved.

For those areas not draining to the Greenway, standard road catchpits capture runoff which is then conveyed to wetlands for treatment and attenuation. If the road serves an industrial zone, then additional gross pollutant traps will also need to be fitted in accordance with the RITS.

5.7.4 Subdivision Drainage

Indicative drainage runs are shown on the drawings to demonstrate how drainage can be routed from the wider subcatchment into the wetlands or connect to the main road drainage. It is noted that there will be more efficient plan routes available for these than those shown on the drawings. They show intentionally indirect plan routes to sensitivity test the limits of drainage in each subcatchment (by the same process as described under 5.7.3).

The long sections for these runs been reviewed to confirm falls and potential cover requirements. While piped drainage has mainly been shown, these drains could take the form of swales and open channels to suit the levels and layouts and urban design of future subdivisions. Similarly, raingardens in the wider subdivision areas are not shown but will be required where these drain to the Greenway.

The final drainage routes and designs remain the responsibility of the developers to determine and HCC to approve through the standard consenting and engineering approval process.

Where it is practical to do so, upstream drainage is shown on the proposed designation drawings connecting into the road drainage (shown either as headwalls on existing channels/low points or as pipe connections into manholes etc). The preliminary sizing of the road drainage has allowed for these catchments.

5.7.5 Raingardens

A treatment train is required where the road drains to the Greenway. The ICMP expresses a preference for saturated zone/bio-retention raingardens as the treatment device targeting nutrient treatment. Raingardens have therefore been shown along the road corridor on the drawings.

These raingardens have not been sized or spaced at this stage other than to confirm it is feasible to fit a raingarden into the front berm (generally being 3m wide) and to check that drainage levels can work. Two conceptual raingarden layouts have been shown on drawing CA-2503 that show options for pre-treatment of the road runoff to address sediment loading that could impact the raingarden. There are other alternatives such as blank catchpits with liners set upstream of the raingarden to act as a sediment trap. The final arrangement will be confirmed in future design stages. At this stage the design just demonstrates that raingardens in the proposed road corridor are feasible, but it is not intended to fix the final locations.

In two locations the road cross-section means the end of pipe raingardens are required and can be readily provided. These are at the Chalmers Road crossing of the Greenway and are shown in drawing CA-2402. These have been sized to be 2% of the contributing catchment areas and set below the incoming pipe invert level.

Raingarden 1 has a catchment area of 4,990m^2 and is 128m^2 in size. Raingarden 2 has a catchment area of 6,160m^2 and is 210m^2 in size. The proximity to the deep Greenway means these can be set down below the incoming pipe levels and still have an outfall above the bottom of the Greenway. As they are set down, the overall footprint shown on the drawings is larger than the treatment area as it accounts for batters and maintenance access.

5.7.6 Wetlands

Wetlands are spaced along the proposed designation to provide water quality treatment, extended detention, and attenuation/flood storage. The performance requirements for each wetland depends on which catchment it is located in, and these criteria are set out in each ICMP but are summarised below.

The naming of the wetlands shown on the drawings has been derived and shortened from the previous ICMP and the Greenway NoR documents. For example, Wetland D6 indicates this wetland was called “Device 6” in the ICMP. Similarly, the “G” in Wetland G8 stands for “Greenway” and matches “wetland pond 8” called up in the Greenway NoR documents.

For efficiency reasons Council is proposing to designate only the wetlands that receive runoff from the proposed roads and to designate the full-sized wetland that would serve the wider subcatchment once developed i.e. more than that needed for road runoff alone. Other wetlands that do not receive road runoff remain for land developers to design and include in their subdivision applications.

The wetlands have not been hydraulically modelled but are based on previous modelling undertaken as part of the ICMP or Greenway NoR.

a) Wetland Footprint

Wetland footprints have been determined by:

1. Achieving a minimum wetland area (as measured at the permanent water level) as a percentage of the contributing catchment. This has been set to 4% of the catchment area where the imperviousness in the catchment exceeds 70% and 3% when the overall imperviousness is less than 70 percent in accordance with TR2020/07 (WRC, 2020).

2. Providing the 100yr ARI volume required in each wetland as listed either in the ICMP or derived from the Greenway NoR design terrain model along with the 100yr flood levels. Note that where the wetlands have been split from a single wetland then this volume has been apportioned on a pro-rata basis by contributing subcatchment area.

3. Setting the permanent water level of the wetland above the invert level of the receiving watercourse and the estimated dry weather flow level within them. In combination with 100yr ARI flood levels this fixes how deep the wetland can be and so sets the footprint.

4. Considering the level of the pipe drainage entering the wetland.

5. Providing the extended detention volume (1.2 x the water quality volume) with a depth less than 350mm in accordance with the RITS.

6. Assuming batter slopes of 1V:5H. These would be steepened during detailed design when the full wetland bathymetry including shaping of batters to a more naturalised plan form can be done.

7. The overall earthworks footprint has been determined by modelling the earthworks surface in 12D software. The earthworks modelling goes down to the permanent water level only whereas the final design will have banded bathymetry below this level.

8. The Greenway project addresses the residual downstream erosion effects by way of providing mitigation to a stream reach downstream of Exelby Road. Similarly, the Mangaheka ICMP sets out downstream channel mitigation options for HCC to address as part of development mitigation for the wider catchment.

9. The wetland attributes including the contributing catchment extent, catchment areas, wetland percentages, extended detention volume and depth and the 100yr ARI volume stored are listed on the drawings CA-2601 through CA-2707. A typical wetland long section showing the shallow/deep marsh and pond areas is shown on drawing CA-2801.

10. For most of the wetlands, the percentage imperviousness of the catchment exceeds 70% except for Wetland D6a where a large reserve in its subcatchment will remain and so bring down the imperviousness.

11. Wetland G8 may have a large park within its catchment that would significantly reduce the percent imperviousness, however at the time of writing this could not be confirmed by HCC so it is assumed the catchment will be fully developed.

12. The remaining wetlands that are not included in the proposed designation are shown indicatively on the drawings to illustrate the wider catchment context.

b) Water Quality Volumes and Extended Detention

The Greenway wetlands provide the full water quality volume (WQV) below the permanent water level and not be otherwise reduced with the provision of extended detention. For wetlands within the Mangaheka Catchment (D6a, D6c and D7b) the WQV stored is halved as extended detention is provided.

All the wetlands provide extended detention in accordance with the RITS. To check the wetland footprint areas are sufficient, the extended detention volume (EDV) for Wetland D6c was routed in HEC-HMS resulting in a refined extended detention depth.

c) Flood Storage Volumes

The flood storage required in each wetland is set out in Table 5-3 below and the amount depends on which catchment the wetland is in. The 100yr ARI volumes used to size the wetlands have been taken from the Greenway NoR design and the Mangaheka ICMP modelling report. At the time, these projects did not have the adjacent, wider subdivision design information available (i.e. finished surface levels, gradings, layouts, drainage routes etc). Similarly, the Arterial designs have been prepared in advance of the subdivisions. Therefore, integrating the wetlands into the subdivisions remains to be completed in the future (such as would be done to support a resource consent application for each subdivision). This may result in small changes to the wetland sizing and if required, Council will then agree those to changes with the developer at that time of approving the subdivision design.

The storage volumes result from either attenuation of peak flows running off the catchment each wetland serves (in the case of the Mangaheka catchment wetlands) or a mix of runoff and inundation from floodwater spilling into them out of the Greenway (in the case of the Rotokauri/Greenway wetlands).

Inundation of the wetlands depends on the different hydrological timings involved. Runoff from the local catchment will likely fill the wetlands before the water level in the Greenway rises enough to inundate back over them. The Greenway basins are controlled by culverts at the downstream end of each basin. The restricted capacity of these culverts causes water to back up in the Greenway basins, filling from the downstream end in each basin and eventually water levels will spread over the wetlands.

Wetland G4 has been relocated from that shown in the Greenway NoR drawings after consultation with the landowner/developer. It has also been divided in to four connected areas that together combine to provide the required 100yr ARI flood storage. This recognises it is not practical to route drainage across the major conveyance channel or the culvert which divides this subcatchment. Wetlands G4a and b and the channel between them are included in the proposed designation with a remaining wetland area leftover for the upstream developer to implement. This remaining wetland is indicatively shown as two separate areas upstream and alongside the arterial road but the final layout will depend on the subdivision design and whether the developer extends the open channel further back into the catchment.

Wetland G6 is a combination of the Greenway NoR ponds 5 and 6 and has been designed to provide equivalent storage to these. This consolidation was agreed in consultation with the landowner/developer.

The wetlands in the Mangaheka catchment (D6a, b & c and D7a, b & c) have been determined by dividing the ICMP wetland into three based on site and drainage constraints. The total volume was then apportioned on a pro-rata basis by catchment area. Again, the full catchment could not be routed to a single wetland as flows would have needed to cross the Mangaheka drain.

Wetlands D6a, b and c and D7a, b and c have been similarly sized by dividing the ICMP volume on a pro-rata basis reflecting different subcatchment sizes.

For wetlands D6 a, b & c, the catchment boundaries have shifted slightly since the ICMP was carried out. Greenway Subcatchment 3 and the subcatchments west of Burbush Rd have altered the total catchment area and these are shown as the hatched zones on drawing CA-2102. This requires the total storage to be increased slightly to compensate and this is indicated as such in the below table.

Floodwater will back up into Wetland G8 via the outlet pipe that connects it to the Greenway as well as it filling with its own catchment runoff. The sizing and performance of this pipe will need to be proven in the future Greenway or wetland resource consenting process. However, needing a larger pipe to achieve this will not impact the land required given the two features adjoin each other and the Greenway is relatively deep.

Table 5-3: Minimum flood storage volumes for wetlands within Mangaheka catchment. These volumes are that between the permanent water level and the 100yr ARI flood level in the wetland

Previous Wetland Reference	Arterials Designation Wetland Reference	Catchment Area (m^2)	Flood Storage Required (m^3)	Volume in Proposed (m^3)
Device 6 (ICMP)	-	494,000[1]	36,000	-
Device 6 (increased)	-	522,700	38,092	38,331
	D6a	132,800	12,500	11,870[2]
	D6b	128,500	12,095	12,095
	D6c	143,400	13,497	14,366
	Remainder north of Mangaheka Stream	118,000	Nil[3]	-
Device 7 (ICMP)	-	384,000[4]	26,000	26,491
	D7a	127,890	11,110	11,110
	D7b	94,340	8,195	8,686[5]
	D7c	77,070	6,695	6,695
	Remainder along SH1C[6]	84,700	-	-

[1] This area includes land on the northern side of the Mangaheka stream and land within the Mangaheka Stream floodplain that will not drain to the wetlands meaning the sum of subcatchment areas for D6a, b & c will not sum to Device 6's area.

[2] The lower volume provided in wetland D6a is offset by a greater volume provided in wetland D6c.

[3] The ICMP allowed discharge from the remaining land without provision of attenuation. All the volume is provided in Device 6 located on the opposite side of Mangaheka Stream.

[4] Areas do not sum to that listed in the ICMP as the SH1C corridor will not be routed through the wetland as it has its own treatment swales.

[5] Volume is above the minimum and will be optimised in future design stages.

[6] Area not routed through wetlands.

Similarly, the volumes for the wetlands associated with the Greenway are summarised in Table 5-4 below. The volumes reported as "flood storage required" have been extracted from the Greenway NoR terrain model with the modelled 100yr ARI flood level overlaid. The design of the wetlands for the proposed designation are then set to provide this volume.

Table 5-4: Comparison of Greenway wetland volumes. These volumes are that between the permanent water level and the 100yr ARI flood level in the wetland

Previous Wetland Reference	Arterials Designation Wetland Reference	100yr ARI Flood Storage Required (m^3)	Volume in Proposed Wetland (m^3)
Wetland Pond 4	G4a&b + open channel		26,177
	G4c/d (future)	38,151[1]	11,974
	Subtotal		38,151
Wetland Pond 5		5,992	
Wetland Pond 6	G6	10,026	18,649[2]
Subtotal (Pond 5+6)		16,018	
Wetland Pond 7	G7	13,106	13,110
Wetland Pond 8	G8	10,306	21,883[3]

[1] Volume includes that stored in the indicative channel included in the model that connect the upper catchment to wetland pond 4.

[2] Volume is above the minimum and will be optimised in future design stages.

[3] Volume is significantly more than required as the incoming pipe network grading/cover and pipe sizing forces the wetland invert level deeper than that assumed in the Greenway NOR.

d) Wetland Features (Bathymetry, Forebays, Outlets, Spillways, Bypass, Access Track)

The wetland features will be designed in accordance with the RITS and are subject to confirmation in later detailed design.

The wetland bathymetry below the permanent water level (i.e. forebay, shallow/deep marsh areas, pools, and the perimeter safety bench etc) remains to be detailed in future design stages.

Bunds separating the forebay from the wider wetland may include a row of gabions as a permeable barrier to promote slow, even flow spreading from the forebay to wetland.

Outlet controls (orifice/weir) will be provided in removable steel plates set in a manhole as specified by the RITS. The outlet will include a submerged pipe to draw water from the bottom of the outlet pool to draw off cooler water. A valved outlet will be provided to drain the wetland down where levels in the receiving watercourse permit.

Emergency spillways will provide overflow routes into the downstream watercourses. In some locations these have been located at the end of the wetland to minimise the already significant land area required. In other locations these can be positioned in the forebay. Given Wetland G8 is isolated and not directly adjacent to a watercourse (the nearest being the Greenway on the other side of the road), its overflow will not be by a traditional broad crested weir type spillway. The overflow can be by a scruffy dome riser potentially with a reserve, secondary riser) and with overflows beyond this spilling onto the road, overtopping this and then flowing into the Greenway.

Provision of 4m wide maintenance access track has been allowed for around the perimeter of each wetland. Maintenance access would be from the nearest road or cycleway. A complete track around the full perimeter of the wetland is not necessarily required and detailed design may reduce this to only provide access to the forebay and the outlet.

High flow bypasses are required where flushing flows could damage the wetland or impact its performance by stripping the biofilm from the wetland. WRC's Stormwater Management Guideline (TR2020/07), Section 8.5.7.2, 3rd bullet notes:

> *"Situations where there is no requirement for extended detention must consider velocities through the wetland such that biological function is not adversely impacted. In those situations, the maximum velocity of stormwater through the wetland shall not exceed 0.1 m/s for up to the 2 year ARI event and 0.5 m/s for larger storm events. Where extended detention is required there is no need for velocity reduction consideration as the 24 hour discharge time period ensures low velocities."*

As extended detention is being provided in these wetlands, additional internal velocity considerations are not required. Further, the RITS design guide, Section 4.2.17.17 notes:

> *"Peak flow assuming a water level 1/3 of the way between NWL and EDL should be less than 0.05 ms $^{-1}$ in the WQV event to avoid sediment resuspension and stripping of biofilms".*

The term NWL is the normal (or permanent) water level and EDL is the extended detention water level. Using Wetland D6C as a test case, the velocity in the water quality event is well below this criterion (approximately 0.01m/s) as the width of the wetland is large relative to the small flow in a water quality event.

However, there are options available should future design determine additional velocity control measures and bypasses are required. Permeable forebay bunds in the form of a row of gabions or a rip rap bund could act to help distribute the flow evenly across the wetland. Flows over such a bund in 100yr ARI peak flow conditions for Wetland G6C gives a velocity of 0.48 m/s, less than the limit in WRC's guide noted above. This ignores the impact of backwater within the wetland, vegetation, and flow through the bund itself all acting to further reduce the velocity.

Piped bypasses are shown indicatively on the drawings for the Greenway wetlands where there is fall available to use pipes however, these could readily take the form of spillways direct from the forebay to the Greenway or internal channels (linking the forebay to the outlet pool). Several of the wetlands have footprints driven by storage volume rather than treatment area and so the bathymetry can be rearranged to accommodate a bypass channel from forebay to outlet pool while still fitting within the proposed designation.

The wetlands in the Mangaheka catchment also need to attenuate the 100yr ARI flows and therefore these cannot have external bypasses. Each of the Wetlands D6C, D7B and D6A can accommodate an internal bypass if the maintenance track were removed from one side only and the 1V:5H batters in the current design be steepened to 1V:4H. This arrangement does not impact on the overall wetland footprint from a water quality design perspective and does not reduce the storage available in the wetland. A typical arrangement for D7B is shown in Figure 5-5. Therefore, provision of high flow bypasses will not affect the land required for the proposed designation.

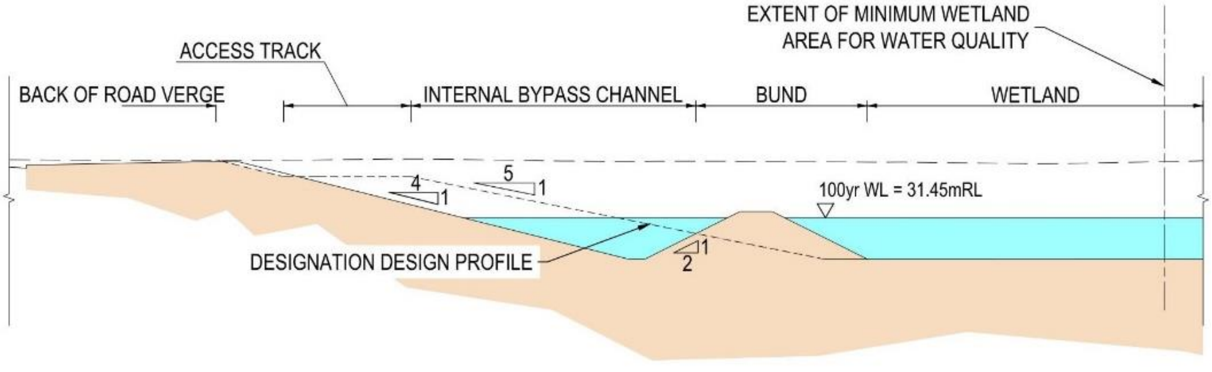


Figure 5-5: Potential internal bypass arrangement for Wetland D7B.

5.7.7 Culverts

Culverts are provided where the road needs to cross a watercourse. Generally, these are flat graded and embedded for fish passage requirements. Where double cell box culverts are needed for capacity reasons one of the cells will be set down lower than the other to act as the preferential low flow channel. The catchment areas and peak flow rates are shown in Table 5-5 below and other than culvert 10, the flow rates do not account for any upstream attenuation and so are conservative.

The culverts will be designed in accordance with the RITS, and details of the culvert levels and associated rip rap scour protection are provided on drawing CA-2500. The sizing is based on the peak flow applied with the maximum downstream tailwater set to the 100yr ARI flood level. This results in a conservative culvert sizing that will need to be modelled in future design stages. Given the little fall available in the drains the culverts have been sized with low head across them resulting in relatively large culverts. Generally, the size of the culvert does not drive the land required for the proposed designation and sizes remain to be confirmed by future hydraulic modelling and design. The performance and design of the Greenway culverts is detailed in the Greenway NoR documentation and have not been developed further from this.

Table 5-5: Culvert catchment areas and peak flows

Culvert ID	Purpose	Diameter / Width x Height	Catchment Area (ha)	Design Flow Q100 (m^3/s)
2	Provide drainage connectivity and conveyance for upstream development flows to the Greenway	Box 3 x 2	15.1	4.8
8	Temporarily maintain drainage connectivity until development occurs	Pipe 2 x 1.05 Ø	6.51	1.1
9	Provide connectivity and convey flood flows for the tributary farm drain to the Mangaheka Stream	Twin Box 2x1 + 2x1.5	13.77	4.3
10	Maintain the connectivity of the Mangaheka Stream and convey flood flows	Twin Box 2x1 + 2x1.5	7.7	5.71

[1] Includes 3.3m^3/s from the outlet of the HJV pond as taken from the Mangaheka ICMP model.

Culvert 8 is a temporary culvert in that it conveys a farm drain beneath the minor arterial road until upstream development occurs and diverts drainage into Wetland D6C after which the culvert is no longer required. The drain upstream of the culvert has limited capacity and flows more than this will overtop its northern bank and run overland towards the Mangaheka Stream. Similarly, there is a localised depression in the land that will pond floodwater. Both of which will act to reduce the peak flow rate that culvert 8 needs to convey. Future modelling may find that the culvert does not need to be a twin barrelled pipe.

Culvert 9 sits on the existing overland flow route from the Rotokauri Greenway. The culvert has not been sized to convey additional flow from this event however, the road has a low point above the culvert to allow overtopping such as in an overdesign event.

Riprap scour protection has been designed in accordance with Austroads' Guide to Road Design Part 5B – Open Channels, Culverts and Floodways.

5.7.8 Wetland Swales

There are three wetland swales included in the proposed designation where drainage cannot be routed to a wetland. These swales will provide water quality treatment and extended detention prior to discharge. The wetland swales are planted and designed to provide a minimum of 9 minutes of residence time during the water quality storm.

One swale is located just upstream of Culvert 8 and is needed as the culvert prevents drainage connecting into the piped network beyond it so another measure is needed for treatment where it would otherwise have been provided by Wetland D6C. However, this swale is only a temporary measure as once the land upstream of culvert 8 is developed then flows will be rerouted to the wetland and Culvert 8 can be removed or abandoned. The swale can then also be removed.

Wetland Swales 3 and 4 are located downstream of the end of pipe raingardens adjacent Chalmers Road crossing of the Greenway. They sit within the flood berm of the Greenway up against its banks. These provide secondary treatment in place of wetlands. Detailed water quality assessments as part of future resource consenting may show these are no longer required.

5.7.9 Temporary Open Channel Drains

Temporary drainage channels have been provided alongside the roads where either farm drain diversions are needed or where the road forms an embankment that could trap runoff and cause ponding. These drains sit inside the proposed designation but will become redundant once the development of adjacent land occurs and the subdivision drainage is provided. These will be filled in once development occurs. For this reason, these temporary drains have been sized to accommodate existing development runoff only.

Geotechnical advice recommends that the bank slopes be set 1V:3H for channels shallower than 2.5m and 1V:4H for channels deeper than 2.5m. The channels have been sized in an earthworks model to determine available longitudinal falls and the overall footprint. A typical section of a temporary drain is shown on drawing CA-2505.

5.7.10 Primary Conveyance Channels

There are two major conveyance channels within the proposed designation which both form part of HCC’s wider strategic drainage network, namely:

a) **Wetland G4a/b Channel (refer drawing CA-2401)**

This is a new channel running from the minor arterial at ch10,970m to the Greenway and it will convey upstream subcatchment runoff through to the Greenway without the need for piping 100yr ARI flows. It will become one of the “secondary, blue-green corridors” described in the ICMP and so will incorporate ecological features to create a naturalised stream channel. A typical section through the channel is shown on drawing CA-2505.

The plan-form shown on drawing CA- 2401 represents a simplified trapezoidal section modelled to confirm extents however, in its final form it is proposed to incorporate a low planted bench to create a floodable, planted berm and give the channel a gentle meander. Woody debris can be included in the design to promote ecological values. These features help to form a naturalised watercourse. The channel is graded to tie into the low flow channel in the Greenway and culvert 2 upstream. The channel depth (and therefore width) is driven by cover to culvert 2. Currently, the channel batters have been modelled with a 1V:5H slope. These are shown steepened to 1V:4H on the typical cross-section to create room for the berm and the meander. Given its depth, geotechnical advice limits the batters to a 1V:4H maximum (without providing additional slope stability measures).

The channel banks drop in height where it passes Wetlands G4a&b to allow flood water backing up from the Greenway to spread over both wetlands. The channel also provides significant flood storage so if this corridor were to be piped then Wetlands 4a&b would then need to increase significantly in footprint to offset the lost storage volume. HCC's preference is for this to be an open channel.

The channel outlet to Greenway can be in the form of an open channel confluence (requiring a footbridge for the cycleway) or via a culvert with the cycleway dropped down to form an overflow into the Greenway. High flows would overtop the cycleway as flood levels rise in the Greenway. The channel option better fits with the "green/blue" corridor concept than the culvert option which in turn could avoid the expense of a footbridge. An alternative low-lying crossing would need the safety risks associated with overtopping to be carefully managed. The open channel arrangement is shown indicatively on the drawings and as the final design does not impact the land required it remains to be confirmed in future design stages.

Upstream of the minor arterial the channel could continue further up into the wider subcatchment to provide a receiving drain for subdivision development. However, this remains the responsibility for developers to determine and HCC to approve. Other than a hollow at culvert 2's inlet, this wider upstream channel is not part of the proposed designation.

b) Mangaheka Stream Diversion (refer drawing CA-2404)

A small section of the Mangaheka stream between the Te Kowhai Road extension and the HJV Pond is proposed to be diverted to run alongside the road. A typical stream section is shown on drawing CA-2504.

This is needed to avoid creating an isolated lot bounded on three sides by the stream and the HJV Pond. It also offers the opportunity to address a significant historic problem with the stream: the existing channel is narrow with over-steep banks that are prone to collapse which in turn blocks the channel causing low flows to back up into the HJV Pond. This elevates water levels in the pond causing plants to die off and has prevented the intended wetland from establishing. The HJV Pond serves a significant catchment of industrial/commercial land, and it is an essential part of managing flood and water quality issues in the catchment. There have been historic difficulties in maintaining the existing watercourse with HCC recently intervening to regrade it to drop water levels in the pond. Therefore, the proposed diversion provides an opportunity to:

- improve the stability of the channel by benching and laying back its banks,
- provide ready maintenance access with its alignment alongside the road,
- increase the reliability of low flow drainage with a low flow channel that is resistant to scour,
- include habitat and ecological features,
- increase its capacity with a wider/benched cross-section,
- avoid creating an isolated lot that would be otherwise surrounded on three sides by the stream and the HJV Pond, and,
- avoid the existing stream being piped or built in (with back-to-back buildings) if it were to remain on its current alignment.

To achieve the above a significant corridor of land needs to be set aside compared to the existing channel. It could also be constructed offline from the existing drain but will need the HJV Pond outlet and spillway to be relocated to the new channel.

The stream diversion continues downstream of Culvert 10 to tie into the existing channel downstream. This allows for a flatter, stable batter to be formed across the end of Wetland D7B. The drawings apply the same cross-section as used upstream of the culvert. In the long term, the landowner has proposed the stream be diverted downstream of Culvert 10 to run alongside Te Kowhai Road and then down the SH1C boundary as is indicatively shown on drawing CA-2404. However, this downstream diversion is not part of the proposed designation and remains with the developer to seek approval for and implement in the future.

HCC has a design long section for the watercourse between the HJV Pond and the SH1C culvert and this has been referenced in setting the fall in the proposed channel and Culvert 10.

5.7.11 Overland Flow

Overland flow from the road corridor will follow the road alignment down the carriageway to low points at culverts where flooding would then pool on the road before overtopping the kerb and discharging into the receiving watercourse/floodplain.

The road geometry has been designed to create low points at each culvert to provide known, controlled overflow locations for up-catchment overdesign events or culvert blockage situations. The exception being culvert 8 that is a temporary culvert and until development occurs, will maintain its existing overland flow path from the existing farm drain north to the Mangaheka Stream.

The Greenway to Mangaheka overland flow path cannot run down the minor arterial carriageway due to limitations from the catchment boundary, pipe cover and the need for a low point above the Greenway culvert. Options for this overflow route are:

- maintain the existing flow path down the paleo drain/farm drain tributary of the Mangaheka Stream, or
- incorporate a new flow path through the PC7 development, or
- provide a separate corridor/drainage reserve set down from and running alongside the minor arterial road.

HCC have advised that the former two options are preferred, and no provision for the overland flow path is to be made in the proposed designation. This issue therefore is to be addressed as part of the PC7 subdivision development.

5.7.12 Subdivision Ground Levels

While final ground levels within the future developments adjacent the proposed designation remain the responsibility of respective developers to determine, there are several locations along the route where the land will need to be filled to develop the land. This will allow the surrounding land to tie into the proposed road levels, provide freeboard to 100yr ARI flood and achieve cover to piped drainage where it is currently lacking. In several areas the land is already relatively low lying and filling would be needed irrespective of the road design and levels.

5.7.13 Volume Control

Based on the underlying geology set out in the ICMPs, soakage disposal is not considered to be practical for disposal of road runoff. However, soakage can be investigated further during resource consenting to determine if it may be applicable in some areas. The roading will result in increased runoff volumes discharged to WRC drainage schemes. The scheme areas are shown in Figure 5-6 below. The Greenway designation has addressed this issue by providing channel stability/erosion protection works downstream of Exelby Road (provision to batter banks back and install check dams) however, this remains to be agreed between HCC and WRC for the Mangaheka catchment.

Volume control will therefore be managed in accordance with the ICMP which requires extended detention and otherwise any further residual effects offset by providing downstream channel improvements (such as the Greenway proposes downstream of Exelby Road) or with future contributions/agreements such as in the Mangaheka catchment.

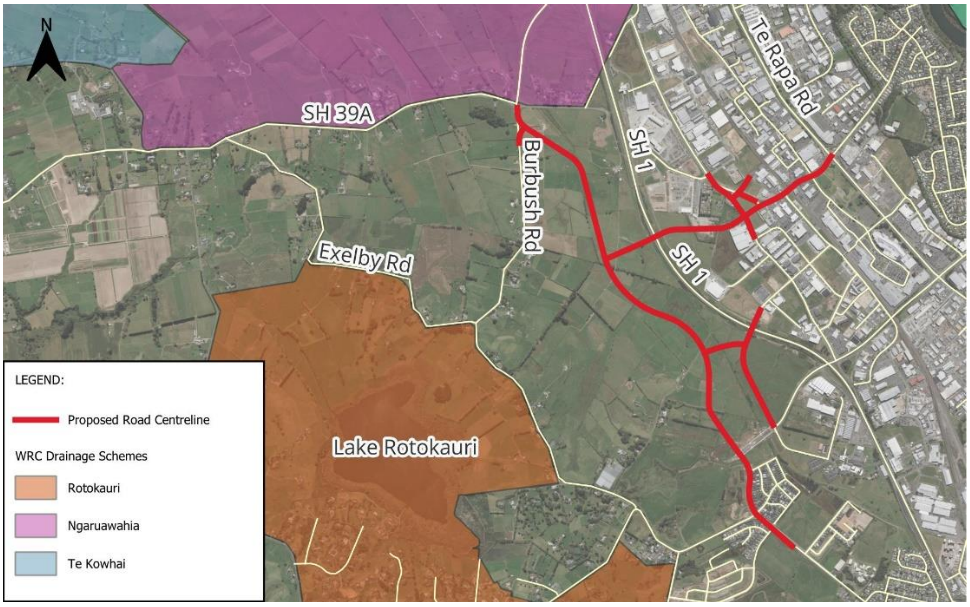


Figure 5-6: WRC drainage scheme areas downstream of shown shaded.

5.8 External Review

The stormwater design has been independently reviewed by Morphum Environmental Ltd. It is noted that some of the issues raised remain items to be addressed in future design stages. These are listed in Section 5.9 below.

5.9 Future Design Tasks

This design has been carried out to provide an integrated stormwater solution and identify the extent of proposed designation required for the proposed roads and selected subdivision scale wetlands. The design is appropriate for this proposed designation phase, but further assessment and design will need to be carried out, particularly as the adjacent subdivisions progress. Several items have been identified throughout the stormwater assessment as requiring further investigation as the design continues, these are:

1. Further geotechnical and hydrogeological investigations will be required as the design progresses to inform the design and understand localised groundwater conditions for the wetlands and to identify if there are opportunities to provide soakage disposal (of the initial abstraction volume).

2. Hydraulic modelling of the wetlands, diversions, and culverts to optimise the size of the infrastructure.

3. Flood level optimisation using HCC's updated flood model. Including refinement of wetland sizes, confirmation of ponding depths under the SH1C underpasses and testing culvert overtopping scenarios (such as culvert blockage conditions).

4. Update the drainage designs with tailwater conditions from the new HCC modelling.

5. Assess the use of wetland biofilters to avoid roadside raingardens and to minimise the overall wetland footprint.

6. Integrate with adjacent subdivision designs including the drainage networks as design develops. Further geometric and flood model runs may need to be undertaken prior to adopting any developer or landowner led alternative drainage/wetland/flood storage designs.

7. Design the internal wetland and major conveyance channel bathymetry, adding sinuosity to the wetland banks and confirming the bypass method.

8. Confirm WRC Scheme Drain performance requirements. Given the nature of the underlying land and its unsuitability for large scale soakage, increased volume will be discharged to downstream WRC Scheme Drains. WRC 10yr ARI extended detention to WRC's drainage scheme requirements may need to be provided within the stormwater management areas. Any additional measures to mitigate this will be negotiated with WRC and HCC separately.

9. Overland flow path design.

10. Confirming the amount of filling required for adjacent subdivisions relative to flood updated flood levels.

11. Setting the vertical alignment of the arterial road over the greenway relative to flood levels.

6 Geotechnical

6.1 Overview

This section summarises the geotechnical concept design completed in support of the Project. Much of this information is also presented in the Beca Rotokauri NOR Arterial Roads Geotechnical Review letter dated 22 July 2021.

The advice provided was prepared for the purpose of assessing a proposed designation corridor and to provide some early assessment of the likely earthwork requirements. The advice was prepared using limited site investigation data and is subject to revision as part of future design stages for the project.

Section 6.2 to Section 6.8 below sets out the current concept geotechnical engineering advice. Section 6.9 outlines the recommended design standards for future geotechnical design.

6.2 Topsoil

A 0.3m topsoil thickness is recommended to be allowed for in earthworks calculations. Stripped topsoil is expected to be able to be used as landscaping fill.

6.3 Fill Embankments

6.3.1 Overview

Fill slopes are expected to be required along approximately 4.5km of the alignment, predominantly over low-lying areas.

Fill embankments between 1m and 3.5m high are located between CH11280 to CH11660, CH11780 to CH11800, CH12160 to CH12260, CH12480 to CH12760, CH20580 to CH20620, CH21180 to CH21260 and CH30020 to CH301000.

Elsewhere fills are generally between 0.5m and 1m high.

6.3.2 Slope Stability

A slope profile of 3:1 (H:V) for all fill slopes is recommended to be adopted for proposed designation purposes.

A shallower profile may meet stability requirements, though will have to be assessed as part of preliminary design.

Undercutting is also likely to be required to remove surficial unsuitable materials in low lying areas, particularly in embayment's at the toe of hill slopes. The volume of both cut to waste and imported fill are recommended to include an allowance for undercutting unsuitable soils. An allowance to undercut fill embankment areas by between 0.25m to 0.5m is suggested to be allowed for provisional estimates of quantities.

Further specific investigation (if required) and assessment is recommended to be undertaken in subsequent design stages.

6.3.3 Settlement

Fill embankments may experience significant settlement where formed over weak and compressible soils. Settlement may be differential across the embankment footprint due to variations in thickness of weak and compressible soils.

Preloading (temporary overfilling) and/or staged construction of fill embankments areas are recommended to be considered as an option to reduce post-construction settlement affecting permanent infrastructure.

6.4 Cut Slopes

6.4.1 Overview

Cut slopes are expected to be required for a total of approximately 0.9km length of alignment. Cuts are expected to be approximately between 1.0m to 5.5m high between CH11120 to CH11200, CH11700 to CH11760, CH11820 to CH1880, CH13060 to CH13180, CH20200 to CH20360, CH35000 to CH35100 and CH20620 to CH20940.

Cuts generally less than 1m height are required at various locations where the road pavement is close to existing levels.

6.4.2 Slope Stability

A cut slope profile of 3:1 (H:V) is recommended to be adopted for proposed designation purposes. This will allow room for a cut off drain or similar be installed at the crest of the slope. Steeper cut slopes may still meet design requirements, though will require a future design assessment to confirm their stability.

6.4.3 Drainage

Surface drainage is recommended to be constructed above the crest of the cut slopes to intercept and control surface water runoff, reducing the risk of erosion and saturation of the cut slope. Intercepted water is recommended to be redirected to existing stormwater swales along the alignment.

6.5 Reuse of Site Won Materials as Engineered Fill

Cohesive material from cut areas are likely to be suitable for reused as engineered fill for embankments where adequately conditioned, often requiring drying to achieve an adequate relative density.

Materials excavated from the construction of swales is expected to be variably suitable for reuse due to the presence of organic materials and soft cohesive layers.

Imported granular fill materials may be needed to form a working platform at the base of embankments over weak ground.

6.6 Stormwater

6.6.1 Overview

Stormwater infrastructure is expected to comprise stormwater treatment swales, culvert crossings and diversion or conveyance swales connecting to existing stormwater infrastructure and the Rotokauri Greenway. Pipe diameters are expected to be between 0.75m and 1.5m diameter.

Typical fill heights at culvert locations are between 1.0m and 2.3m.

6.6.2 Slope Stability

Swales slopes less than 2.5m in depth are recommended to be profiled at 3:1 (H:V) for proposed designation purposes. Swale slopes greater than 2.5m deep may be required to be cut at a shallower profile, indicatively 4:1 (H:V) to satisfy stability requirements.

Liquefaction in a moderate to large earthquake event could induce lateral spreading ground movement within areas adjacent to these swales. This hazard will require further specific assessment and could require additional works to mitigate these effects.

6.6.3 Settlement

Proposed culverts may experience settlement in areas where additional loading is applied to weak or compressible ground. Settlement may also be differential over the length of the culvert pipe.

Preloading these areas or allowing for additional undercut and replacement with an engineered fill is recommended to be considered.

Further geotechnical investigation and assessment will be required at these locations.

6.7 Greenway Crossings

The alignment crosses Greenway infrastructure at CH12300 to CH12340 and CH30200 and CH130250. The alignment typically requires minor additional fill over these Greenway crossings.

The design of these crossings is expected to be covered in the Greenway project. The Greenway also crosses at Te Wetini Drive however this is expected to be designed by others.

6.8 Underpasses Beneath SH1C

6.8.1 Overview

The proposed alignment crosses beneath SH1C, through existing underpasses between CH20300 and CH20400 (Te Kowhai Bridge) and CH35000 and CH35100 (Chalmers Road Bridge).

The Asset Owner’s Manual for these bridges indicates a cut to a future road level has been allowed for in the design of both bridges, achieving a 5.1m minimum vertical offset between the bridge deck and future road level.

6.8.2 Bridge Embankment Design Review

Embankment design undertaken by Opus in 2010 assessed an approach embankment height of 6.5m at Te Kowhai Bridge and 7.0m at Chalmers Road Bridge.

The NoR proposed road level at the bridge crossing for Te Kowhai Bridge are similar to those assessed in Opus design, requiring some excavation at this location.

The NoR proposed road level at the bridge crossing for Chalmers Road Bridge may be up to 1m deeper than those assess in Opus design, though ground survey data is inaccurate at this location. Ground survey is recommended to be undertaken to confirm the accuracy of these measurements.

Temporary excavations will also be needed to excavate the existing materials and construct the road infrastructure pavements and drainage.

6.8.3 Proposed Excavation Effects

The excavation of ground at the toe of the bridge abutments will reduce the global stability of these slopes, relative to current slope profiles. The proposed roading may have an adverse effect on the bridge abutment stability where the required excavation exceeds the depth allowance assumed at that time or requires a greater width of excavation.

As noted above, ground survey is recommended to be completed at both bridge abutment locations to allow this potential adverse effect to be quantified during future design stages.

Retaining works could be needed where the proposed excavation is deeper or wider than previously allowed for, sufficient to reinstate the abutments to their original design performance. An influential design case is expected to be an ULS earthquake event.

6.9 Proposed Design Basis for Future Earthworks

The proposed Arterial Roads earthworks and drainage infrastructure is expected to achieve with standard cut and fill construction practices. Changes in expected ground conditions or changes in design may require potential ground improvements or retention structures being required.

The future design of the earthworks is expected to be designed in general accordance with the New Zealand Transport Agency Bridge Manual (2018) as outlined below.

6.9.1 Seismic Design

a) Site Subsoil Class

The site subsoil class has been assessed in accordance with NZ1170.5. A Site Subsoil Class D should be adopted reflecting a deep soil profile. The underlying Walton Subgroup materials can contain weakly cemented layer (often primary welded ignimbrites) but are typically interbedded with uncemented ignimbrite materials and alluvial soils of varying strength and density and are unlikely to meet the requirements of rock in order for a site Subsoil Class C to be applicable.

b) Seismic Loading

The Ministry of Business Innovation and Employment Guidance (MBIE, 2021) has presented standardised updated peak ground accelerations and earthquake magnitudes derived from the NZ Transport Agency Bridge Manal (2018). These are recommended to be adopted for liquefaction assessment and geotechnical design.

6.9.2 Slope Design

Slopes stability should be assessed in accordance with the New Zealand Bridge Manual (BM). Key design cases and Factory of Safety performance criteria is presented in Table 6-1.

Table 6-1: Global Stability FoS Performance Criteria

Load Case	Min. BM Factor of Safety	BM reference
Static long term and typical long term ground water.	1.5	BM Section 6.6.3
Static short term – construction	1.25	BM Section 6.4.1
Static short term – flood water levels	1.25	BM Section 6.4.1

Seismic DCLS	1.0 or less than 1.0 where within allowable displacements	BM Sections 6.6.2 and 6.6.3
Seismic SLS 1 and SLS 2	1.25	BM Section 6.6.3

Permanent slope displacements should be calculated as per Section 6.3.2 and Section 6.69 of the BM using three methods including:

- Jibson R.W., 2007. “Regression models for estimating co-seismic landslide displacements.”
- Ambrayses N. and Srbulov M., 1995, ‘Earthquake induced displacements of slopes.”
- Martin and Qui., 2008, “Effects of Liquefaction on Vulnerability Assessment” 1994 modified as per “NCEER Highway Project on Seismic Vulnerability of New and Existing Highway Construction.”

Allowable slope displacements are to be determined in later design stages.

7 Road Safety Audit

A Road Safety Audit review of the proposal was completed by Stantec in March 2022. The issues raised have been reviewed by the designer and actions agreed with HCC, with the proposed reply included in the draft response to the full audit included in Appendix C.

Many of the issues raised have been resolved and / or actions identified for developed in the next stage of detailed design. Formal close-out of the audit report will also be undertaken in conjunction with the reviewer.

8 Safety in Design and Risk

8.1 Safety in Design

A safety in design workshop was held with key stakeholders in September 2020. The register is attached in Appendix D. The key issues raised are summarised below:

8.1.1 Operational Requirements

For the next phase to resolve the concept for access widths for various vehicle types/land uses to adjacent land. Currently the NoR is the key purpose to allocate land for the purpose of roads.

8.1.2 Traffic Movements

Traffic movements at key tie in roads that are already constrained will affect the modal shift objectives if the proposed designation (which allows for modal shift) is not easy to access from adjacent existing road network.

8.1.3 KiwiRail – Road Crossing Safety

An at-grade crossing is proposed due to the constraints including cost of providing grade separation. Risk of future road rail crashes to be considered by the finders and KiwiRail. An LSCIA to be completed to highlight the risks at the next stage. Provision for barriers for both traffic and non-motorised users to be confirmed.

8.1.4 Potential Operational Issues

Consideration for operation requirements e.g., rubbish collection, street cleaning, public transport routes, heavy vehicle access, emergency services access may influence the final cross section. If this happens after the land is designated, then there may need to be some rationalisation of the space within the cross section. This will need to be fully understood in the next design phase or conditions applied for all land development consents.

8.2 Risk Review

The following risks are highlighted based on discussion with HCC and key stakeholders throughout the NoR phase:

8.2.1 Mana Whenua Engagement and Design Input

We have developed a platform for this engagement and detailed work to take place. We have shared and established a reasonable level of understanding of the project and its objectives. This leaves the project in a positive place to engage in more detailed discussion in the next phases of design and engagement. However, it is important that design engagement with Mana Whenua is robustly developed in the next design phases. Given the potential lag in time between this work and the next phase this is a risk and could be a need to revisit some of these matters. The project’s Cultural Impact Assessment (CIA) sets out how future engagement will be undertaken and how recommendations will be incorporated in the next phases of design.

The ULDF suggested the Te Aranga Māori Design Principles as framework to undertake design engagement in future stages. The Te Aranga principles are a set of outcome-based principles, founded on Māori values that provide practical guidance for enhancing outcomes for the design environment. Specific design principles for Kirikiriroa are understood to be currently being developed by HCC and Mana Whenua as a broader Cultural Values Assessment for the wider Rotokauri Growth cell to allow for broader implementation of the cultural identity for the Rotokauri area through the Arterials network, Greenway and other developments led by both HCC and the development community as part of the RSP. It is anticipated that these design principles will work in conjunction with the Te Aranga Māori Design Principles when they are finalised.

It is important Mana Whenua are engaged, possibly in a co-design approach, early in the next phase of the project to celebrate and enhance the cultural layers of Rotokauri through the Project. This will contribute to a sense of community identity and increase amenity for the area. The engagement should recognise the capacity of iwi to resource project inputs, and this will need to be planned and worked through with them.

8.2.2 Active Mode Uplift

There is a risk that sufficient uplift in active modes is not achieved for the network. The existing transport infrastructure of Rotokauri is focused on private vehicles as the main mode of transport. This has resulted in a network with limited options for active modes on the existing network however, the area has been identified for future growth under the RSP. As identified in the ULDF, the proposed design provided by the project is a series of designated corridors that are fit for purpose providing strategic well-considered multimodal transportation options, which provides the ability to construct and operate a key infrastructure network that supports growth within Rotokauri. The design allows for sufficient route protection whilst maximising opportunities for a people focussed design and strong sense of place in an integrated approach to the Rotokauri Arterial Network. With a vastly improved and designed multimodal network modal choice through separated walking and cycling facilities is facilitated and will encourage residents to use active modes for transport to key destinations across the network.

This is supported by the movement analysis within the ULDF which identifies how the network will respond to the mix of landuse within Rotokauri area employment opportunities, educational facilities, recreational and open space networks and a small suburban commercial centre. Linkages to other network facilities such as the transportation hub and connections to the broader HCC network can be considered in relation the HCC Network Operations Framework which may also see future projects initiated by HCC in the future to improve connectivity across the broader network. HCC's active mode share aspiration is 22% over 10 years as outlined in Access Hamilton and the Biking and Micromobility SSBC with a 7% target for public transport indicated by Access Hamilton.

Appendix Two of the ULDF explains the key design moves required, outline the key measures required by the design framework to achieve the objectives of the corridor i.e., the provision of separated cycleways, limited vehicle access onto Arterials, tree canopy cover, signage and wayfinding, prioritised intersections etc. It is these elements that contribute to a successful Arterials network and safety which in turn allow the higher uplift in active modes to be achieved.

If these elements are unable to be achieved, the network will not provide a safe and connected network and any development will continue to be designed around a network that still supports vehicles as the main form of transport. It is important that any barriers to achieving these elements are worked through in the following design phase to minimise this risk. The design outcomes and facilities ultimately provided via the network will also need to be supported by broader HCC educational programs to change behaviours and reduce the currently overrepresented use of private motor vehicles in favour of alternative modes.

8.2.3 Transport and Landuse Integration

The configuration of landuse outlined in the Structure Plan provides challenges to support a high modal shift. The location of employment and light industrial development and the existing expressway create severance between the new greenfield residential developments to the west and primary destinations / attractors to the east.

Whilst land use is outside the direct control of the project, Section Four of the ULDF outlines the design approaches and recommendations for improving interface treatment. This provides a guide to influence best possible outcomes for both council and developer design teams. These examples include consistent approaches to walking and cycling infrastructure, rest areas, street tree and planting (shade), surface treatments and low fencing for residential properties to retain visibility and access to the corridor.

An area of concern regarding transport and landuse integration (outside of the project scope) is the major arterial Te Wetini Drive interfacing directly with the commercial centre of the structure plan. A high movement function of the major arterial through the middle of the commercial centre will conflict with the high place function that would be expected in such an area. This could lead to impacts on safety and quality of the commercial centre.

8.2.4 Design and Frequency of Access

The developer masterplans within the structure plan area differ in density and connection to the arterial transport corridors. The design and frequency of vehicle access points along the corridors will impact on the safety and convenience of users along the minor arterial corridor. Limiting access to the Arterials will be a significant outcome for the project. The location of schools along the arterial will need increased scrutiny in this regard. Access requirements and conditions to development to be clarified at the next stage.

8.2.5 Low Place Function of Arterials

Arterials, in particular those running east-west Arterials will have, by default of adjacent landuse, a lower place function. The associated vehicle movements of these land uses (employment and light industrial) are likely to compromise safety and urban mobility outcomes. The proposed design has mitigated this through alignment and location as well as spatial allowances to facilitate higher levels of safety in the future design. This provision will need to be supported by an appropriate investment in amenity (i.e., tree planting, rest areas, artwork, lighting, signage etc) to support the project objectives. This needs to be reviewed further at the next stage.

8.2.6 Tree Planting & Services Corridors

A major constraint to achieving the amenity and character outcomes of the ULDF, such as avenue style tree planting, will be the location of services. Centralised service corridors in a consistent location will give certainty to designers and allow a consistent approach to elements above ground such as tree planting which will in turn reduce maintenance and renewal costs for the council. The ULDF has suggested underground service corridors are located under asphalt cycleways that can be replaced easily and cost effectively.

8.2.7 Land Acquisition

There is a risk that the land required for the project cannot be obtained e.g., near The Base, resulting in design compromises being required to the design philosophy. Should land not be acquired in all locations, as per the NoR, to the widths that have been recommended, there is likely to be a need to reallocate the space within the land that is made available. Also refer other related items below.

8.2.8 Operational Issues

Consideration for operation requirements e.g., rubbish collection, heavy vehicle access, emergency services access may influence the final cross section. If this happens after the land is designated, then there may need to have some reallocation of the space within the proposed cross section. For the next stage, discussions with operators and key stakeholders will be required to gauge whether the proposal will be functional.

8.2.9 Traffic Modelling

The traffic modelling makes prediction on traffic volumes and intersection performance for future development and as such could vary significantly from what is assumed. However, the level of traffic predicted can be revised at a later stage once the proposed designation is in place and some further development is implemented.

Traffic volumes are predicted to reach in the order of 11,000vpd in 2051. Should this number be exceeded then the predicted level of service will also likely be worse than the current prediction.

As the project is planning for future development this issue is always a risk. Therefore, ongoing review is recommended to ensure HCC expectations remain aligned with reality.

8.2.10 Council Implementation of Consent Conditions

Conditions need to be applied to all future developer consents to ensure the project objectives are met. There is a risk that pressure on HCC by developers in the future results is compromises to the required conditions in favour of the developer which needs to be safe guarded against.

8.2.11 Road Safety

The issues raised in the road safety audit are covered in Section 7 with the full audit presented in Appendix D. There is a risk that the issues raised are not addressed at future stages which may lead to operational safety issues that follow through into construction. The RSA has been responded to and it is expected that the next phases of the project will provide the opportunity to mitigate road safety risk.

8.2.12 Public Transport

The concept considers that for the roads with bus routes that in lane bus stops may be required. There is a risk that in lane stops create safety issues in the future where traffic volumes are higher than 3000vpd. However, it is considered that the cross-section width provided is adequate to accommodate bus bays if required once more details are developed. Therefore, while implementation may opt for in lane stops, the layout could be modified (to use bus bays) if ongoing safety issues are observed.

8.2.13 Cycling

The proposed cross section relies for the most part on all cyclists being off road – outside of the traffic lane. However, in all likelihood cyclists will still use the road when in doubt or simply because they don’t know the cycle paths exist. There is a safety risk of conflict, as highlighted by the safety audit team, that should be considered.

8.2.14 Narrow Road Widths

As highlighted in the RSA in section 7, narrow carriageway widths may contribute to safety issues such as large vehicles tracking over kerb lines into shared spaces.

8.2.15 Flood Modelling

The roads and wetlands will need to be tested in HCC’s flood models for performance, freeboard, and sizing. The Mangaheka model also uses old, legacy hydrology. There is a risk that changes could be needed as a consequence of future testing required support resource consent applications.

8.2.16 Drainage Falls

The nature of the existing low-lying land and unknown development earthworks levels/drainage designs mean there is a risk that drainage level of service needs to reduce, or changes be made to accommodate detailed designs. Similarly, the location of Wetland G8 requires complex drainage routing (with an overflow into the Greenway) that will need modelling. There is a risk that when modelled the design needs to change impacting on the works.

8.2.17 Wetland High Flow Bypasses

Wetland bypasses may be required, and these will need to be addressed in future design stages. There is a risk that these cannot be accommodated within the proposed designation footprint or in the proposed pipe network designs.

8.2.18 Wetland Establishment

Existing wetlands in the Mangaheka catchment have historic issues with plants not establishing due to poor/constrained downstream drainage keeping permanent water levels elevated in the wetland and pests (birds pulling out plants). There is a risk that similar occurs in the proposed wetlands, for those draining to the Greenway this is less of a risk given the depth of the Greenway.

8.2.19 Stormwater Volume Mitigation

Soakage is generally not feasible given poor underlying ground conditions so there is no way to reduce the volume discharged. There is a risk that this increased volume into WRC Scheme Drains cannot be readily mitigated and alternative arrangements need to be found (i.e., a financial contribution to stream mitigation works).

8.2.20 Stream Ecological Offsetting

There is a risk that additional ecological offsetting is required as an outcome of resource consenting and land outside the proposed designation needs to be found for this.

9 Constructability Considerations

Construction activities and staging have been assessed to inform the proposed designation boundary. The land requirement plans show the extent of the proposed designation boundary, with additional ‘interim’ areas identified for compounds and laydown areas are part of the temporary works to enable construction.

The key issues considered are:

1. Construction sequencing / staging of the Greenway in relation to the Arterial Roads (refer to Greenway Designation for details), especially cut / fill material considerations.

2. The extent of the temporary works that may be required to facilitate vehicle access, haul roads, contractor’s yards, and temporary drainage.

9.1 Construction Sequencing / Timing (incl. Greenway)

The construction of the Arterial Roads and associated works covered by the proposed designation will, for the purposes of this construction sequencing section, be assumed to be constructed as a standalone project. The general assumption for development of the Rotokauri Growth Cell is that the Greenway is to be delivered first, with road infrastructure and property improvements following later. This will provide a stormwater disposal route for the remainder of the development. The scenario considered is for the Greenway to be constructed in its entirety, followed by the Arterial Roads and services infrastructure before any property development(s) take place. Construction has been assumed to be completed as a single construction project.

It is noted that there are real synergies between the construction of the Greenway and Arterial projects that would benefit from a more integrated approach. Both projects require significant earthworks with the cut for the stormwater swale being a potential source of selected fill for the Arterial Roads. There is also understood to be developer demand for general fill to raise site levels.

Overall, a more integrated approach to the construction sequencing and phasing could provide significant benefits for HCC and the development community; when further clarity on funding and phasing are understood the construction sequencing should be revisited.

In reality, development in the Rotokauri Growth Cell is progressing rapidly and there are multiple property developers wishing to complete their developments in differing timeframes. Regardless, many of these will be completed in advance of completion of the overall Greenway / Arterial Road works. The developers themselves will need to deliver some or all of the Greenway / Arterial Road works to allow their developments to progress, so the developers’ readiness will drive the construction timing of both the Greenway and Arterial Roads.

For the Arterial Roads, which are primarily in fill, topsoil will need to be stripped and further undercutting may be required before fill is placed. Additional time may need to be allowed in the construction programme for preloading and settlement to occur should significant fill volumes / depths need to be placed. Volumes are considered below. It is likely that the contractors will seek to build the Stormwater Management Areas (wetlands) first, so these can be used as temporary sediment ponds during construction. Contractors will be required (as part of consent requirements) to prepare and adhere to a comprehensive Construction Environmental Management Plan and a Construction Erosion and Sediment Control Plan.

9.2 Cut / Fill earthworks

The Greenway will need to be in place, in part, in each development location, prior to completion of the Arterial Roads and property developments, such that stormwater can be treated and ultimately discharged to Lake Rotokauri. As a result of the cutting of the Greenway, it is assumed that there will be a significant volume of excess material generated and available as fill for the Arterial Roads (the majority of the Arterial Roads will require fill).

The construction of the Greenway will generate significant excess material, in the order of 700,000m^3. The Arterial Roads will require more than 100,000m^3 of fill. These figures are a high-level assessment only and do not include waste or compaction etc.

0.3m topsoil thickness has been allowed for in earthworks calculations, resulting in a volume of stripped topsoil that will need to be stored until it is able to be reused as landscaping fill in the landscaping phase.

Greenway fill will then be able to be placed on the Arterial Road corridor itself, minimising double-handling. The large area will also minimise storage height requirements. Once fill has been placed along the corridors, we expect little need to stockpile construction materials, and it has been assumed that any stockpiling will be able to be accommodated within the proposed designation boundaries as shown on the drawings.

9.3 Temporary works

The extent of the project boundary identified has considered traffic access points to public roads, haul roads, storage of materials, and contractors' yards.

It is very difficult to envisage how the overall development of the Rotokauri Growth Cell will play out over the coming years. This makes it difficult to make robust allowances for temporary works within the project boundary, however the following elements have been considered:

9.3.1 Access to the Site

The project boundary should secure the ability for the site to be accessed during construction. Access to public roads is feasible at the northern connection to SH39, the extension to Te Kowhai E Rd, the extension to Chalmers Rd, and the southern connection to the existing portion of Rotokauri Rd. Access to the site may also be possible via the Greenway access routes depending on overall sequencing / timing of the works. The project boundary, as proposed, therefore includes access provisions that would be considered adequate, and no further allowances are recommended.

9.3.2 Construction Management Areas

The project boundary includes sufficient area to support Construction Management activities, i.e., allow for contractors' site office, vehicle yards & materials storage. These would ideally be 1-2Ha each and located centrally to the project (to minimise travel / haul distances) as well as near each access point (to maintain control of the site).

Several additional areas have been proposed to be included within the project boundary. Areas that may be suitable have been identified at access points at the northern connection to SH39, Te Kowhai E Rd, and towards the southern connection to the existing portion of Rotokauri Rd. A central location has also been identified.

9.3.3 Haul Roads

Ideally, construction access routes and haul roads would run outside of the cross-section corridor. In reality, this would preclude the neighbouring developers from effectively utilising these strips and result in large areas of land required to be purchased (and ultimately maintained) by Council. Even if the proposed designation was to be rolled-back in these locations, it is unlikely that they would be returned to a state that enhances the surrounding land use (rather, they would remain as empty, unused land). It is therefore recommended to construct the Arterials from within the project boundary as proposed.

The Project boundary as proposed has been set using batter profiles in line with the geotechnical considerations and includes a small (3-5m offset) outside the base of the batters or stormwater management devices. This should be sufficient to allow construction vehicle movement outside of the finished pavement area and provide safe construction of batters without impacting on the batter toe or stormwater management device.

9.3.4 Greenway Construction

If the Greenway and Arterial Roads are built in parallel / sequentially with little delay between them, the ‘interim’ areas included within both the Greenway and proposed Arterial designations could be used for both the Arterial Roads. This would reduce the need to relocate site compounds between projects.

9.3.5 Deferred Construction of Stormwater Management Areas

There are large Stormwater Management Areas (SMAs) included within the proposed designation footprint that will serve both the Arterial Roads and the surrounding development catchment. If the Arterial Roads are constructed in advance of the surrounding developments, the areas proposed to be designated as SMAs could possibly be constructed in part to support the Arterial Roads only. This would commit a proportion of the proposed designation footprint initially, with the balance available for construction management purposes.

A

Appendix A – Typical Cross Section Drawings

Drawing Plotted: 17 Mar 2022 1:15 pm

Future Residential (controlled access)

2.0m Back berm

3.0m Footpath Utilities - indicative service location to be confirmed during detailed design

2.2m Cycle path

3.0m Raised planted strip / indented parking

3.5m General traffic lane

3.0m Treatment varies - Raised planted median / turning lane

3.5m General traffic lane

3.0m Footpath with street trees / indented parking

2.2m Cycle path

2.0m Footpath Utilities - indicative service location to be confirmed during detailed design

2.0m Back berm/ utilities

Future Residential (controlled access)

TYPICAL SECTION 1.1 - ROTOKAURI MINOR ARTERIAL NORTH (3100.4, 3100.5)
OPTION A, WIDTH 28.4m
SCALE N.T.S

Future Residential (controlled access)

2.0m Back berm

3.0m Footpath Utilities - indicative service location to be confirmed during detailed design

3.0m Raised planted strip

2.2m Cycle path

0.8m Seperator

3.5m General traffic lane

3.0m Treatment varies -Raised planted median / turning lane

3.5m General traffic lane

0.8m Seperator

2.2m Cycle path

3.0m Raised planted strip

2.0m Footpath Utilities - indicative service location to be confirmed during detailed design

2.0m Back berm

Future Residential (controlled access)

TYPICAL SECTION 1.1 - ROTOKAURI MINOR ARTERIAL NORTH (3100.4, 3100.5)
OPTION B, WIDTH 31.0m
SCALE N.T.S

NOTES

1. REFER TO DRAWING 000-CA-0003 FOR THE LOCATIONS OF EACH ZONE

DESIGN UNDER DEVELOPMENT FOR CONSULTATION PURPOSES ONLY

PRELIMINARY NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
D	NOTICE OF REQUIREMENT	BM	NT	DA	16.03.22
C	DRAFT FOR INFORMATION	AAW	NT	BS	12.08.20
B	UPDATE FROM INITIAL HCC REVIEW	HJC	NT	BS	15.06.20
A	FOR INFORMATION	KMT	NT	BS	15.05.20

Drawing Originator: Beca

Original Scale (A1) AS SHOWN	Design	M. Tam	10.03.20	Approved For Construction*
	Drawn	R Simpson	15.05.20	
Reduced Scale (A3) HALF SHOWN	Dsg Verifier	D Aldridge	16.03.22	
	Dwg Check	N Tunnicliffe	16.03.22	Date

* Refer to Revision 1 for Original Signature

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: TYPICAL ROAD CROSS SECTIONS SHEET 01

Discipline: CIVIL ENGINEERING

Drawing No. 4288564-100-CA-2000 Rev. D

Document No. 4288564-100-CA-2000.DWG

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Drawing Plotted: 17 Mar 2022 1:14 pm

Image File Source: \\Beca.net\projects\428\4288564\UDLA\Short List Options\Sections in PSD\Option 3a-5\jpeg\Option 3a-5_Section 1_Red Zone_Minor Arterial Residential-RevA.jpg
Revision A

ZONE 1

Future Residential (controlled access)

3.0m Flexible back berm (services, furniture or amenity planting)

3.0m Footpath Utilities - indicative service location to be confirmed during detailed design

2.2m Cycle path (One way)

3.0m Raised planted strip / indented parking

3.5m General traffic lane (bus stop in lane)

3.5m General traffic lane (bus stop in lane)

3.0m Raised planted strip / indented parking

2.2m Cycle path (One way)

2.0m Footpath Utilities - indicative service location to be confirmed during detailed design

3.0m Flexible back berm (services, furniture or amenity planting)

Future Residential (controlled access)

TYPICAL SECTION 1.2 - ROTOKAURI MINOR ARTERIAL NORTH (3100.3)
OPTION A, WIDTH 28.4m
SCALE N.T.S

ZONE 1

Future open space - Sports park (No vehicle access proposed)

2.0m Back berm

3.0m Footpath Utilities - indicative service location to be confirmed during detailed design

3.0m Raised planting strip

2.2m Cycle path

0.8m Separator

3.5m General traffic lane

3.0m Treatment varies - Raised planted median / turning lane

3.5m General traffic lane

0.8m Separator

2.2m Cycle path

3.0m Raised planting strip

2.0m Footpath Utilities - indicative service location to be confirmed during detailed design

2.0m Back berm

Future employment/light industrial (controlled access)

TYPICAL SECTION 1.2 - ROTOKAURI MINOR ARTERIAL NORTH (3100.3)
OPTION B, WIDTH 31.0m
SCALE N.T.S

NOTES

1. REFER TO DRAWING 000-CA-0003 FOR THE LOCATIONS OF EACH ZONE

DESIGN UNDER DEVELOPMENT FOR CONSULTATION PURPOSES ONLY

PRELIMINARY NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
E	NOTICE OF REQUIREMENT	BM	NT	DA	16.03.22
D	UPDATED SECTION 3100.3	BRM	-	-	25.01.22
C	DRAFT FOR INFORMATION	AAW	NT	BS	12.08.20
B	UPDATE FROM INITIAL HCC REVIEW	HJC	NT	BS	15.06.20

Drawing Originator: Beca

Original Scale (A1) AS SHOWN
Reduced Scale (A3) HALF SHOWN

Design	M. Tam	10.03.20	Approved For Construction*
Drawn	R Simpson	15.05.20	
Dsg Verifier	D Aldridge	16.03.22	
Dwg Check	N Tunnicliffe	16.03.22	Date

* Refer to Revision 1 for Original Signature

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: TYPICAL ROAD CROSS SECTIONS SHEET 02

Discipline: CIVIL ENGINEERING

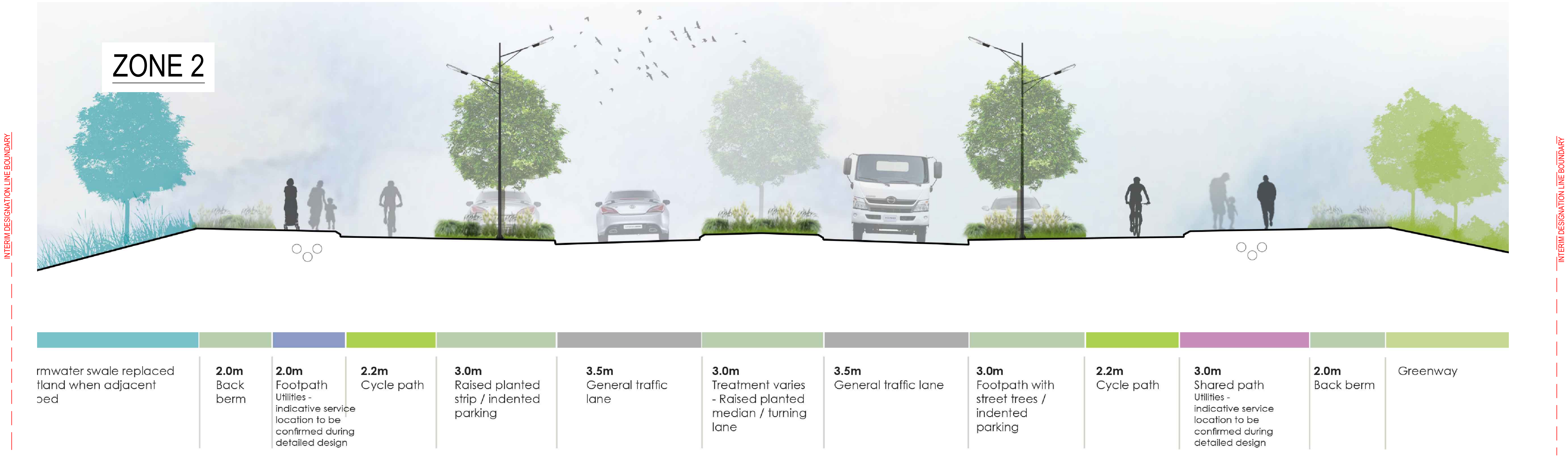
Drawing No. 4288564-100-CA-2001 Rev. E

Document No. 4288564-100-CA-2001.DWG

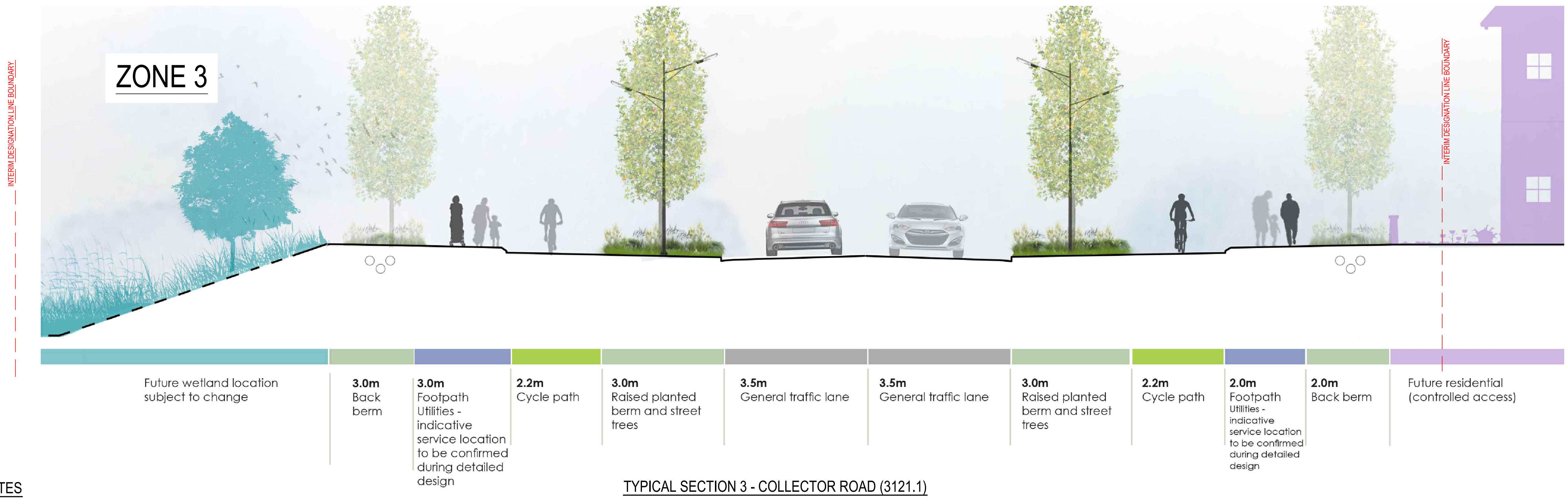
www.beca.com

DO NOT SCALE

IF IN DOUBT ASK.



TYPICAL SECTION 2 - MINOR ARTERIAL, TE KOWHAI ROAD WEST EXTENSION (3101.3)
OPTION A, WIDTH 29.4m
SCALE N.T.S



TYPICAL SECTION 3 - COLLECTOR ROAD (3121.1)
WIDTH 27.4m
SCALE N.T.S

NOTES

1. REFER TO DRAWING 000-CA-0003 FOR THE LOCATIONS OF EACH ZONE

Image File Source: \\Beca.net\projects\428\4288564\UDLA\Short List Options\Sections in PSD\Option 3a-5\jpeg\Option 3a-5_Section 4_Yellow Zone_Collector Road-RevA.jpg
Revision A

DESIGN UNDER DEVELOPMENT
FOR CONSULTATION PURPOSES ONLY

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
E	NOTICE OF REQUIREMENT	BM	NT	DA	16.03.22
D	UPDATED SECTION 3121.1	BRM	-	-	25.01.22
C	DRAFT FOR INFORMATION	AAW	NT	BS	12.08.20
B	UPDATE FROM INITIAL HCC REVIEW	HJC	NT	BS	15.06.20

Drawing Originator: Beca

Original Scale (A1) AS SHOWN	Design	M. Tam	10.03.20
	Drawn	R Simpson	15.05.20
Reduced Scale (A3) HALF SHOWN	Dsg Verifier	D Aldridge	16.03.22
	Dwg Check	N Tunnicliffe	16.03.22

Approved For Construction*
Date
* Refer to Revision 1 for Original Signature

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: TYPICAL ROAD CROSS SECTIONS SHEET 03

Discipline: CIVIL ENGINEERING

Drawing No. 4288564-100-CA-2002 Rev. E

DO NOT SCALE

IF IN DOUBT ASK.

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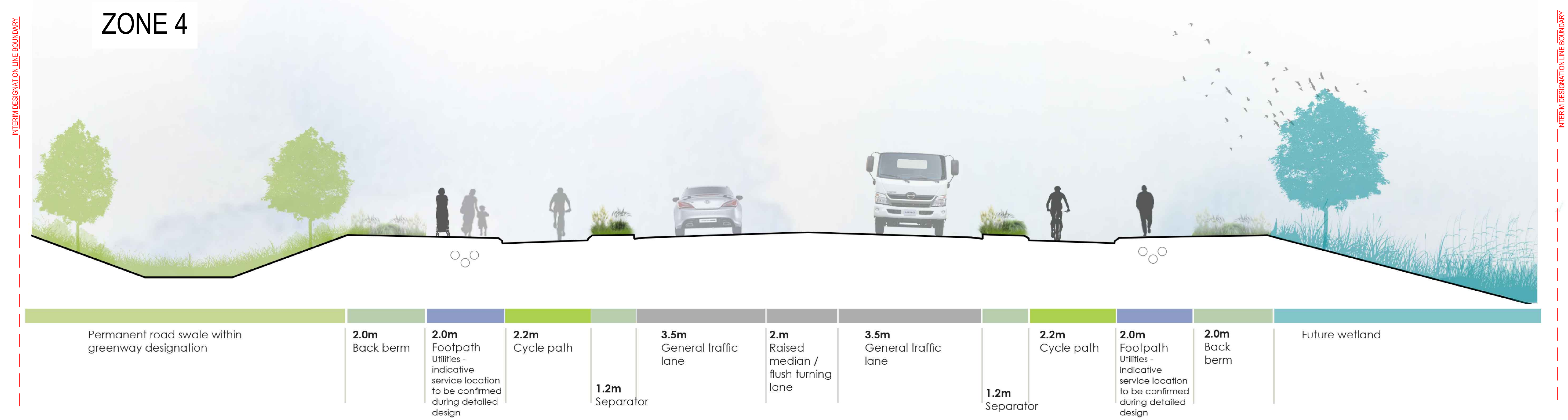
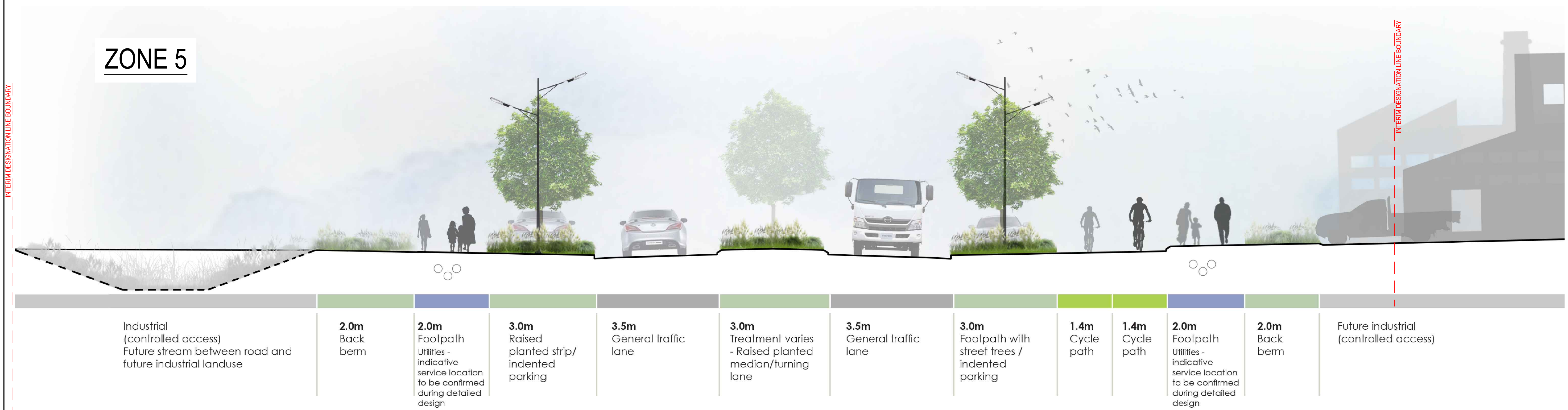
Document No. 4288564-100-CA-2002.DWG



TYPICAL SECTION 4 - COLLECTOR ROAD, CHALMERS ROAD EXTENSION (3122.2)

WIDTH 23.8m

SCALE N.T.S



TYPICAL SECTION 5 - MINOR ARTERIAL, TE KOWHAI ROAD WEST EXTENSION (3101.3)

WIDTH 26.8m

SCALE N.T.S

NOTES

1. REFER TO DRAWING 000-CA-0003 FOR THE LOCATIONS OF EACH ZONE

DESIGN UNDER DEVELOPMENT FOR CONSULTATION PURPOSES ONLY

PRELIMINARY NOT FOR CONSTRUCTION

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No.	Revision	By	Chk	Appd	Date
B	NOTICE OF REQUIREMENT	BM	NT	DA	16.03.22
A	DRAFT FOR INFORMATION	AAW	NT	BS	12.08.20

Drawing Originator: Beca

Original Scale (A1) AS SHOWN	Design	M. Tam	10.03.20
	Drawn	A Webb	12.08.20
Reduced Scale (A3) HALF SHOWN	Dsg Verifier	D Aldridge	16.03.22
	Dwg Check	N Tunnicliffe	16.03.22

Approved For Construction* Date

* Refer to Revision 1 for Original Signature

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: TYPICAL ROAD CROSS SECTIONS SHEET 04

Discipline: CIVIL ENGINEERING

Drawing No. 4288564-100-CA-2003 Rev. B

Document No. 4288564-100-CA-2003.DWG

DO NOT SCALE

IF IN DOUBT ASK

Drawing Plotted: 17 Mar 2022 1:12 pm

ZONE 6

Future industrial (controlled access)	2m Back berm	2.0m Footpath Utilities - indicative service location to be confirmed during detailed design	2m Grass berm with trees / indented parking	0.75m	3.5m General traffic lane	2.5m Median/ turning lane	3.5m General traffic lane	0.75m	2m Grass berm with trees / indented parking	2.0m Footpath Utilities - indicative service location to be confirmed during detailed design	2m Back berm	Future industrial (controlled access)

TYPICAL SECTION 6 - COLLECTOR ROAD, ARTHUR PORTER DRIVE (3102.2)
WIDTH 23.0m
SCALE N.T.S

ZONE 7

Existing industrial (controlled access)	Berm width varies	2.0m Footpath Utilities - indicative service location to be confirmed during detailed design	2.0m Raised planting strip	3.5m General traffic lane/bus lane	3.5m General traffic lane	2.5m Treatment varies Raised median / flush median turning lane	3.5m General traffic lane	3.5m General traffic lane/bus lane	2.0m Raised planting strip	1.4m Cycle path	1.4m Cycle path	2.0m Footpath Utilities - indicative service location to be confirmed during detailed design	Berm width varies	Existing industrial (controlled access)

TYPICAL SECTION 7 - MAJOR ARTERIAL, TE KOWHAI ROAD EAST UPGRADE (3101.1, 3101.2)
WIDTH 31.1m
SCALE N.T.S

NOTES

1. REFER TO DRAWING 000-CA-0003 FOR THE LOCATIONS OF EACH ZONE

DESIGN UNDER DEVELOPMENT
FOR CONSULTATION PURPOSES ONLY

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
B	NOTICE OF REQUIREMENT	BM	NT	DA	16.03.22
A	DRAFT FOR INFORMATION	AAW	NT	BS	12.08.20

Drawing Originator: Beca

Original Scale (A1) AS SHOWN	Design	M. Tam	10.03.20	Approved For Construction*
Reduced	Drawn	A Webb	12.08.20	
Scale (A3)	Dsg Verifier	D Aldridge	16.03.22	
HALF SHOWN	Dwg Check	N Tunnicliffe	16.03.22	Date

* Refer to Revision 1 for Original Signature

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: TYPICAL ROAD CROSS SECTIONS SHEET 05

Discipline: CIVIL ENGINEERING

Drawing No. 4288564-100-CA-2004 Rev. B

Document No. 4288564-100-CA-2004.DWG

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DO NOT SCALE

IF IN DOUBT ASK

ZONE 8

Future residential (controlled access)	1.0m Flexible back berm (furniture, services or ...	2.5m Footpath Utilities - indicative service location to be confirmed	1.8m Cycle path (One way)	2.5m Raised planted strip / indented parking	3.5m General traffic lane - bus stops in lane	3.5m General traffic lane - bus stops in lane	2.5m Raised planted strip	1.8m Cycle path (One way)	5.7m 1.7m frontage 3.0m pedestrian zone 1.0m furniture and kerb zone	Future commercial centre (controlled access)

TYPICAL SECTION 8 - ROTOKAURI MINOR ARTERIAL NORTH, COMMERCIAL CENTRE (3100.2)
WIDTH 24.8m
SCALE N.T.S

NOTES

1. REFER TO DRAWING 000-CA-0003 FOR THE LOCATIONS OF EACH ZONE

DESIGN UNDER DEVELOPMENT
FOR CONSULTATION PURPOSES ONLY

PRELIMINARY
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
C	NOTICE OF REQUIREMENT	BM	NT	DA	16.03.22
B	UPDATED CROSS SECTION 3100.2	BRM	-	-	25.01.22
A	DRAFT FOR INFORMATION	AAW	NT	BS	12.08.20

Drawing Originator: Beca

Original Scale (A1) AS SHOWN	Design	M. Tam	10.03.20
	Drawn	A Webb	12.08.20
Reduced Scale (A3) HALF SHOWN	Dsg Verifier	D Aldridge	16.03.22
	Dwg Check	N Tunnicliffe	16.03.22

* Refer to Revision 1 for Original Signature
Approved For Construction*
Date

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: TYPICAL ROAD CROSS SECTIONS SHEET 06

Discipline: CIVIL ENGINEERING

Drawing No. 4288564-100-CA-2005 Rev. C

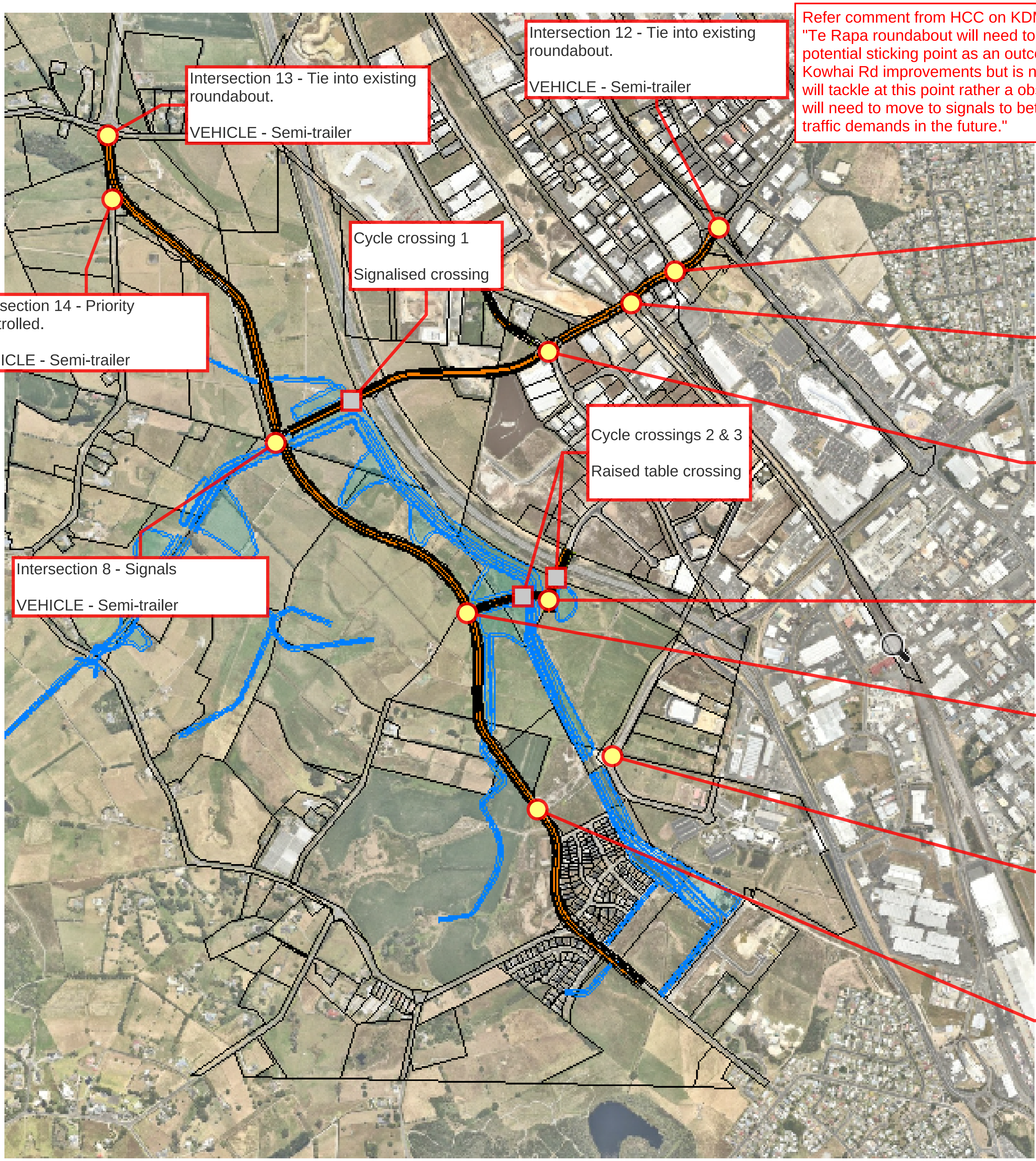
DO NOT SCALE

IF IN DOUBT ASK.

Document No. 4288564-100-CA-2005.DWG

B

Appendix B – Intersection Forms & Design Vehicle Allowances



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* Large Rigid vehicle is catered within the vehicle tracking envelope of Tour Coaches
Vehicle references are to NZTA RTS18

No.	Revision	By	Chk	Appd	Date
B	FOR DISCUSSION	NT	RA		11.05.20
A	FOR DISCUSSION	NT	CI	RA	14.02.20

Drawing Originator: Beca

Original Scale (A1)
Reduced Scale (A3)

Design	N. TUNNICLIFFE	14.02.20
Drawn	N. TUNNICLIFFE	14.02.20
Dsg Verifier	B. SCOTT	14.02.20
Dwg Check	C. INSKEEP	14.02.20

* Refer to Revision 1 for Original Signature

Client: Hamilton City Council Te kaunihera o Kirikiriroa

Project: ROTOKAURI ARTERIALS DESIGNATION

Title: INTERSECTION DESIGN VEHICLES

Discipline: CIVIL ENGINEERING

Drawing No. 4288564-SK-011

Rev. B

BLUEBEAM

DO NOT SCALE

IF IN DOUBT ASK.

C

Appendix C – Road Safety Audit

Sensitivity: General

ROTOKAURI ARTERIALS PRELIMINARY DESIGN ROAD SAFETY AUDIT

PREPARED FOR HAMILTON CITY COUNCIL

22/03/2022

Stantec

QUALITY STATEMENT

PROJECT MANAGER

James Caufield

ROAD SAFETY AUDIT TEAM LEADER

Nick Overdevest

PREPARED BY

Nick Overdevest ……… ……………………. 29/03/2022

CHECKED BY

Ian Carlisle ……… …………… 29/03/2022

REVIEWED BY

Ian Carlisle ……… …………… 29/03/2022

APPROVED FOR ISSUE BY

James Caufield … … …………… 29/03/2022

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PO Box 13-052, Armagh, Christchurch 8141
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REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
A	24/3/22	Draft for Review	NJO	IC	IC	JC
B	29/3/22	Final	NJO	IC	IC	JC

Hamilton City Council

Rotokauri Arterials Preliminary Design Road Safety Audit

CONTENTS

LIST OF TABLES

APPENDICES

1. Introduction

1.1 Safety Audit Definition and Purpose

A road safety audit is a term used internationally to describe an independent review of a future road project to identify any safety concerns that may affect the safety performance. The audit team considers the safety of all road users and qualitatively reports on road safety issues or opportunities for safety improvement.

A road safety audit is therefore a formal examination of a road project, or any type of project which affects road users (including cyclists, pedestrians, mobility impaired etc.), carried out by an independent competent team who identify and document road safety concerns.

A road safety audit is intended to help deliver a safe road system and is not a review of compliance with standards.

The primary objective of a road safety audit is to deliver a project that achieves an outcome consistent with Safer Journeys and the Safe System approach, which is a safe road system increasingly free of death and serious injury. The road safety audit is a safety review used to identify all areas of a project that are inconsistent with a Safe System and bring those concerns to the attention of the client so that the client can make a value judgement as to appropriate action(s) based on the risk guidance provided by the safety audit team.

The key objective of a road safety audit is summarised as:

'to deliver completed projects that contribute towards a safe road system that is free of death and serious injury by identifying and ranking potential safety concerns for all road users and others affected by a road project.'

A road safety audit should desirably be undertaken at project milestones such as:

- concept stage (part of business case);
- scheme or preliminary design stage (part of pre-implementation);
- detail design stage (pre-implementation or implementation); or
- pre-opening or post-construction stage (implementation or post-implementation).

A road safety audit is not intended to be a technical or financial audit and does not substitute for a design check of standards or guidelines. Any recommended treatment of an identified safety concern is intended to be indicative only, and to focus the designer on the type of improvements that might be appropriate. It is not intended to be prescriptive and other ways of improving the road safety or operational problems identified should also be considered.

In accordance with the procedures set down in the NZTA Road Safety Audit Procedures for Projects Guidelines - Interim release May 2013 the audit report should be submitted to the client who will instruct the designer to respond. The designer should consider the report and comment to the client on each of any concerns identified, including their cost implications where appropriate, and make a recommendation to either accept or reject the audit report recommendation.

For each audit team recommendation that is accepted, the client will make the final decision and brief the designer to make the necessary changes and/or additions. As a result of this instruction the designer shall action the approved amendments. The client may involve a safety engineer to provide commentary to aid with the decision.

Decision tracking is an important part of the road safety audit process. A decision tracking table is embedded into the report format at the end of each set of recommendations. It is to be completed by the designer, safety engineer, and client for each issue, and should record the designer's response, client's decision (and asset manager's comments in the case where the client and asset manager are not one and the same) and action taken.

A copy of the report including the designer's response to the client and the client's decision on each recommendation shall be given to the road safety audit team leader as part of the important feedback loop. The road safety audit team leader will disseminate this to team members.

1.2 The Project

The Rotokauri development area forms a key part of the future urban growth strategy for Hamilton and will provide for an eventual population of between 16,000 and 20,000 people.

The Rotokauri arterials project vision, objectives and urban design principles are largely driven by the Structure Plan and Access Hamilton. The project is understood to integrate with surrounding projects including adjacent greenway, Rotokauri North Sports Park and the existing residential masterplans within the Structure Plan area albeit not part of this audit. The project consists of predominantly new roads which require designation and some upgrades to existing roads, both designed as part of this project.

The project consists of the following:-

- The widening and extension of Te Kowhai Road East as major arterial corridor linking Te Rapa Road to Arthur Porter Drive Intersection,
- Extending the arterial network further west as a minor arterial connecting Te Kowhai Road East to a north-south spinal minor arterial road servicing the future Rotokauri development area,
- A north-south minor arterial road linking Te Wetini Road Intersection in the south (constructed by others) to Te Kowhai Road roundabout to the north.
- Chalmers Road is extended via an existing Waikato Expressway underpass as a collector road to connect the Rotokauri industrial node to the proposed north-south minor arterial road. This is a secondary connection between the Rotokauri development and the industrial/commercial node on the east side of the Waikato Expressway.
- Other improvements including a realignment of Te Kowhai Road East to tee up into a proposed Arthur Porter Drive intersection.
- All major intersections along the route will be signalised except for the following minor intersections:-
    - Burbush Road Intersection – Give-way priority
    - Te Kowhai Road Roundabout – No change
    - Chalmers Road/Collector Road Intersection – Give-way priority

The designers have clarified the following design parameters:

- The minor arterial route will be subject to a 40km/h posted speed (the SAT notes this differs from the Design Report). To reinforce lower speeds, the carriageway will be narrowed significantly with opposing lanes to be divided by physical landscaped medians.
- Conversely, the major arterial will be subject to a 50km/h posted speed. The arterial will be multilane in appearance and punctuated with regular and significant signalised intersections along the route including an at-grade rail crossing.
- All transport corridors will have a significant emphasis on active transport users where there are dedicated and segregated facilities on both sides of the roadway.

The Design Report indicates that the road geometry and associated design parameters will meet the requirements of the Austroads Guide to Road Design (GRD) series.

1.3 The Road Safety Audit Team

This road safety audit has been carried out in accordance with the NZTA Road Safety Audit Procedure for Projects Guidelines – Interim release May 2013, by:

Table 1-1: Road Safety Audit Team Members

Name	Position	Organisation	Element
Nick Overdevest	Senior Principal Transportation Engineer	Stantec	Safety Audit Team Leader
Ian Carlisle	Senior Principal Transportation Engineer	Stantec	Safety Audit Team Member

1.4 Previous Road Safety Audits

It is our understanding that no previous road safety audits have been undertaken for this project.

1.5 Scope of this Road Safety Audit

This is a road safety audit of the preliminary design stage of the project development described in Section 1.2 although the level of detail is similar to a concept design in many places.

The audit team were briefed by Ryan Ainsworth and assisted by his design team on 24th February 2022 via videoconference facilities followed by a site visit by the SAT. Subsequent to the site visit, the SAT were informed that the design would be updated to include Public Transport facilities of some description and that these details were to be forwarded at a later date. On receipt of the updated details, the SAT held a desktop audit meeting on 21st March 2022 to discuss the project concerns.

It is acknowledged that the current preliminary design is limited as to detail in several areas including but not limited to:-

- Intersection capacity and efficiency,
- Intersection sweep paths and sight lines,
- Streetlighting,
- Safety barriers,
- Signalisation
- Street signs
- Utilities,
- Land scaping,
- Staging
- Accessways,
- Pavement surfacing,
- Specific pedestrian/cycling crossing details and furniture,
- Specific speed control measures,
- Geometric data (such as superelevation and/or crossfalls) and pavement contours.
- Public Transport including bus lanes and bus bays
- No specific typical section information has been provided for Burbush Road and the Proposed Collector Road 3121.1
- Limited traffic modelling data has been provided – the Design Report only includes total intersection volumes which is not helpful in understanding traffic movements on any one leg.

Consequently, the RSA is necessarily only able to comment to a similar level of detail and covers issues at a level that is commensurate with the design.

It is noted that a road safety audit is not to be used as a substitute for design checking or peer review, nor is it a check on compliance with standards, drawings, specifications or Health and Safety in Design (SiD)aspects. In this respect, it is further highlighted that an audit is not intended to provide a check on the compliance of every element but provides an overview of the project and operation with respect to the safety of all road users.

Omission of a comment or concern on an issue in this report does not imply approval of any particular detail. Further safety audits will be carried out of the detailed design of other elements which may have some interdependency on geometry, and therefore may raise issues not already noted at this stage.

1.6 Report Format

The potential road safety problems identified have been ranked as follows.

The expected crash frequency is qualitatively assessed on the basis of expected exposure (how many road users will be exposed to a safety issue) and the likelihood of a crash resulting from the presence of the issue. The severity of a crash outcome is qualitatively assessed on the basis of factors such as expected speeds, type of collision, and type of vehicle involved.

Reference to historic crash rates or other research for similar elements of projects, or projects as a whole, have been drawn on where appropriate to assist in understanding the likely crash types, frequency and likely severity that may result from a particular concern.

The frequency and severity ratings are used together to develop a combined qualitative risk ranking for each safety issue using the concern assessment rating matrix in Table 1-3. The qualitative assessment requires professional judgement and a wide range of experience in projects of all sizes and locations.

In ranking specific concerns, the auditors have considered the objectives of the Safe System approach, i.e. to minimise fatal or serious injury crashes.

In undertaking this assessment, the Safety Audit Team have utilised the following descriptor tables to enable a fair and reasonable rating of the risks.

Table 1-2: Crash Frequency Descriptor

Crash Frequency	Indicative Description
Frequent	Multiple crashes (more than 1 per year)
Common	1 every 1-5 years
Occasional	1 every 5-10 years
Infrequent	Less than 1 every 10 years

Crash Severity is determined on the likelihood of a crash resulting in death or serious injury. The reader is advised that the severity of an injury is determined in part by the ability of a person to tolerate the crash forces. An able-bodied adult will have a greater ability to recover from higher trauma injuries, whereas an elderly person may have poor ability to recover from high trauma injuries. The auditors consider the likely user composition, and hence the likely severity of injury to that user.

Table 1-3: Concern Assessment Rating Matrix

Severity (likelihood of death or serious injury)	**Frequency** (probability of a crash)			
	Frequent	Common	Occasional	Infrequent
Very likely	Serious	Serious	Significant	Moderate
Likely	Serious	Significant	Moderate	Moderate
Unlikely	Significant	Moderate	Minor	Minor
Very unlikely	Moderate	Minor	Minor	Minor

While all safety concerns should be considered for action, the client or nominated project manager will make the decision as to what course of action will be adopted based on the guidance given in this ranking process with consideration to factors other than safety alone. As a guide a suggested action for each concern category is given in Table 1-4.

Table 1-4: Concern Categories

Concern	Suggested action
Serious	Major safety concern that must be addressed and requires changes to avoid serious safety consequences.
Significant	Significant safety concern that should be addressed and requires changes to avoid serious safety consequences.
Moderate	Moderate safety concern that should be addressed to improve safety.
Minor	Minor safety concern that should be addressed where practical to improve safety.

In addition to the ranked safety issues it is appropriate for the safety audit team to provide additional comments with respect to items that may have a safety implication but lie outside the scope of the safety audit. A comment may include items where the safety implications are not yet clear due to insufficient detail for the stage of project, items outside the scope of the audit such as existing issues not impacted by the project or an opportunity for improved safety but not necessarily linked to the project itself. While typically comments do not require a specific recommendation, in some instances suggestions may be given by the auditors.

1.7 Documents Provided

The SAT was provided with the following documents for this audit.

Table 1-5: Documents Provided to the SAT

Title	Project Number	Date	Revision	Number of Sheets
Drawing List	4288564-000-CA-0001	25/01/22	E	1
Roading Key Plan	4288564-000-CA-0002	12/08/20	C	1
Road General Arrangement	4288564-000-CA-0003	12/08/20	A	1
Minor Arterial – Plan and Long Section – Sheet 01 to 11	4288564-100-CA-1001 to 1011	16/03/22	E	11
Collector Road – Plan and Long Section – Sheet 01	4288564-100-CA-1201	16/03/22	E	1
Chalmers Road Extension – Plan and Long Section – Sheet 01	4288564-100-CA-1301	16/03/22	E	1
Te Kowhai Road – Plan and Long Section – Sheet 01 to 06	4288564-100-CA-1401 to 1406	16/03/22	E	6
Arthur Porter Drive 3102.2 – Plan and Long Section – Sheet 01 to 02	4288564-100-CA-1501 to 1502	16/03/22	E	2
Arthur Porter Drive 3102.1 – Plan and Long Section – Sheet 01	4288564-100-CA-1503	16/03/22	E	1
Burbush Road – Plan and Long Section – Sheet 01	4288564-100-CA-1601	16/03/22	D	1
Typical Road Cross Sections – Sheet 01 to 06	4288564-100-CA-2000 to 2005	Various	C/D/C/A/A/B	6
Rotokauri Arterials Designation – Design Report (excerpt only)		24/02/22	Draft	14
Summary of Intersection Design Vehicles	4288564-SK-11	11/05/20	B	1
Rotokauri Structure Plan (for information only)	D-3172823			1

1.8 Disclaimer

The findings and recommendations in this report are based on an examination of available relevant plans, the specified road and its environs, and the opinions of the SAT. However, it must be recognised that eliminating safety concerns cannot be guaranteed since no road can be regarded as absolutely safe and no warranty is implied that all safety issues have been identified in this report. Safety audits do not constitute a design review nor are they an assessment of standards with respect to engineering or planning documents.

Readers are urged to seek specific technical advice on matters raised and not rely solely on the report.

While every effort has been made to ensure the accuracy of the report, it is made available on the basis that anyone relying on it does so at their own risk without any liability to the safety audit team or their organisations.

2. Safety Concerns

2.1 Intersections

2.1.1 Chalmers Road Extension/Proposed Collector Road Intersection

Moderate

In the interim (until Chalmers Road future extension is constructed), the proposed intersection will have priority in favour of the Chalmers Road Extension with a stub formed to the south of the intersection. Conversely, operating flows to and from the intersection will only be to and from the proposed collector road. The SAT are concerned that without sufficient controls in place, movements are likely to engage the turning manoeuvres at a higher than desirable speed and without due consideration to opposing conflicting movements.

The SAT also notes that no provision has been made for cyclists and pedestrians to safely cross the proposed collector road. For consistency with the wider network, the intersection should accommodate a splitter island to cater for those vulnerable crossing movements.

Recommendation(s)

1. Consider installing a splitter island at the head of the intersection to ensure that opposing turning movements maintain lane discipline. Ensure that the splitter island is sufficiently wide enough to accommodate a refuge to cater for pedestrian/cycling crossing movements.
2. Provide pedestrian crossing facilities at all side road crossings.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is likely	Rating The safety concern is moderate
Designer response	Agree with the SAT comments. Timing of construction not yet known. Controls will need to be implemented should the intersection not be constructed in full. Crossing and island details to be resolved at the next design stage.	
Safety Engineer comment	Agree with both the SAT and the Designer's response, appropriate intersection controls and safe system treatments for vulnerable users need to be considered as the detailed design is developed.	
Client decision	Agree with SAT, however there is a need to update the NOR plans to cover two elements. - design reflects safety measures and avoid unnecessary submission at hearings - confirm designation footprint is sufficient meet the implementation of these measures	
Action taken	Crossing facilities and splitter islands have been provided in revised design drawings. Locations and extents to be confirmed at next design stage.	

2.1.2 Burbush Road Intersection

Moderate

Similar to the issues raised under item 2.1.1, the SAT are unsure what the proportion of turning flows are from Burbush Road. If turning flows predominately favours one direction over another (or flows are roughly equal), there is a risk that turning movements may cross the side road centreline at speed and into the path of an oncoming vehicle.

The SAT also notes that no provision has been made for cyclists and pedestrians to safely cross the Burbush Road. For consistency with the wider network, the intersection should accommodate a splitter island to cater for those vulnerable crossing movements.

Recommendation(s)

1. Consider installing a splitter island at the head of the intersection to ensure that opposing turning movements maintain lane discipline. Ensure that the splitter island is sufficiently wide enough to accommodate a refuge to cater for pedestrian/cycling crossing movements.
2. Provide pedestrian crossing facilities at all side road crossings.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is likely	Rating The safety concern is moderate
Designer response	Agree with the SAT comments. A splitter island could be accommodated within the land requirement. Review of crossing and island details to be resolved at the next design stage.	
Safety Engineer comment	Agree with both the SAT and the Designer's response, appropriate intersection form, priority directions and safe system treatments for vulnerable users need to be considered as the detailed design is developed. Ensure that there is suitable space within the designation boundary to accommodate the predicted travel types and directions.	
Client decision	Agree with SAT, however there is a need to update the NOR plans to cover two elements. - design reflects safety measures and avoid unnecessary submission at hearings - confirm designation footprint is sufficient meet the implementation of these measures	
Action taken	Crossing facilities and splitter islands have been provided in revised design drawings. Locations and extents to be confirmed at next design stage	

2.1.3 Right turn Protection

Minor

Similar to the above concerns, at all intersections, safety can be improved with the provision of a physical median adjacent to any right turning vehicle at either signalised or priority-controlled intersection/access.

While it is recommended that separation of the tracking of opposing movements is desirable at all locations, the SAT is most concerned with respect to signalised intersections on the major arterial where the road function intends high volumes of traffic to be catered for. Median islands at signalised intersections also provides space for signal pole placement and withoutthis space will require use of overhead signals.

Recommendation(s)

1. Provide physical median separation at all intersection points where opposing traffic streams track in close proximity to each other.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Designer response	Agree with the SAT comments. Islands will improve safety, but some intersections are already very constrained. This has not been considered in the current design in order to minimise land requirement as directed by HCC. Changes may possible but would need to be assessed at next design stage.	
Safety Engineer comment	Consider overhead mast arms and flush medians if insufficient space for a median island. Reducing through traffic speeds also help to reduce the severity of crashes but also helps to tighten vehicle tracking, so this supports the need for having raised intersections.	
Client decision	Agree with SAT comments. Review all intersections to introduce splitter islands and review with client Update the NOR plans to cover two elements. - design reflects safety measures and avoid unnecessary submission at hearings	

Recommendation(s)

	- confirm designation footprint is sufficient meet the implementation of these measures
Action taken	Physical separation is provided in revised design drawings. Extents to be refined at the next design stage

2.2 Geometry

2.2.1 Various Vertical Geometry Deficiencies along Chalmers Road Extension

Minor

The proposed vertical profile along Chalmers Road extension consists of a series of long-ish straights with interspersed with short and abrupt vertical curves (VC) at each vertical intersection point. The short sag and crest vertical curves vary with K=3 (Sag), K=2.3 (Crest) to K=4.7 (Sag). This has resulted in the following safety concerns: -

- The crest VC located in the vicinity of the proposed collector Road intersection, in combination with the proposed Road Safety Platform (RSP), results in approaching drivers unable to maintain safe stopping sight distances (SSD) in both directions. SSD is the distance to enable a normally alert driver, travelling at the design speed on wet pavement, to perceive, react and brake to a stop before reaching a hazard on the road ahead. Without SSD in place, drivers may brake late and come into contact with the object and/or swerve late into the opposing lane to avoid the object.
- Some vertical curves exceed minimum comfort criteria. A human being subjected to rapid changes in vertical acceleration feels discomfort. The level of discomfort, or, vertical acceleration only becomes critical in the design of sharp sag curves.
- The crest VC in combination with the RSP effectively obscures the roadway alignment ahead and in particular the left hand curve for eastbound movements on Chalmers Road.
- The SAT is aware of a Greenway corridor adjacent to the Chalmers Road extension. We understand that this corridor also acts as an emergency flooding route for certain rainfall return periods and intensities. Further, the surrounding topography appears flat with no discernible drainage corridors (ephemeral or otherwise). This implies that flooding may not be contained locally to the Greenway. Given that the proposed vertical profile appears to advocate levels and localised low spots lower than the surrounding topography, the SAT questions how resilience is built into the route. And more importantly, how vehicles will utilise the route from a safety perspective when the greenway is operating as a floodway.
- No specific information has been provided about the height of the existing overbridge relative to the extension. However, a bridge profile appears to be illustrated on the long section and measures 4.5m vertical clearance (assuming that the profile depicted is the underside of the structure). Although the vertical clearance is greater than a 4.25m high road legal vehicle, there is minimal safety buffer above a legal height vehicle to accommodate illegal over-height vehicles. The SAT believes the project should achieve a 4.9m minimum vertical clearance in this instance. For example, the Penrose Overbridge on the Auckland Motorway is the lowest bridge on the motorway network with 4.57m minimum vertical clearance. Since 2008, the Penrose Overbridge has been struck by illegal over-height vehicles approximately forty times resulting in occupant injury and sustained damage to the bridge structure. Alternatively, the height limit will need to be well signed with advance warning measures in place.

Recommendation(s)

1. Review vertical curves and adopt K values greater than the likely operating speeds for comfort, SSD and headlight criteria (where this can be practically achieved).
2. Ensure that the effects of low spots within the vertical geometry are understood and will not safely affect day to day operation of the route. If flooding is accepted, ensure that other countermeasures are in place to minimise disruption and safety implications for all through users including pedestrian and cyclists i.e. secondary flow paths, alternative routes, locally lifting of at least one pedestrian/cycle facility unimpeded by flooding.
3. Review the vertical geometry under the existing overbridge and ensure that adequate vertical clearance is achieved to minimise the potential for structure strikes.

Frequency **Crashes are likely to be occasional**	**Severity** **Death or serious injury is unlikely**	**Rating** **The safety concern is minor**
Designer response	Noted. Vertical geometry has been set to reasonably justify footprint only at this design stage. There are several competing drivers on vertical geometry incl. Stormwater, all of which will need refinement in subsequent design stage(s). Flood modelling is currently being updated by HCC under a separate project and remains to be optimised in future design stages. However, in one development scenario being tested has widespread filling to surrounding land to achieve freeboard to floor levels, pipe cover and secondary flow gradings within the developments. In this case, both minor arterial and collector road crossing could be overtopped in extreme events. Other development scenarios have flood levels lower than the current road levels. Similar overtopping could also occur in an overdesign or culvert blockage scenario. Therefore, provision for a low point at the Greenway crossings has been included to result in a controlled, known overflow location. We agree that further hazard management practices will be needed and the nature of these will depend on the refined flood performance. These will therefore be determined in future design stages. Bridge geometry indicative only, target clearance is 5.1m, HCC confirmed survey to be completed at subsequent design stage.	
Safety Engineer comment	Agree with the SAT, the designation design should adopt a more conservative, higher design speed to develop the required designation footprint.	
Client decision	Agree with SAT comments. Review vertical geometry for NOR and adjust accordingly especially for K values and bridge clearance. Flooding risks resolve at design phase Update the NOR plans to cover two elements. - design reflects safety measures and avoid unnecessary submission at hearings - confirm designation footprint is sufficient meet the implementation of these measures	
Action taken	Vertical geometry has been amended and improved. Bridge geometry has been reviewed, target clearance is 5.1m	

2.2.2 Poor Horizontal and Vertical Geometry Co-ordination — Minor

Where possible, horizontal and vertical geometry should be coordinated for appearance and safety. In principle, co-ordination means that horizontal and vertical curves should either be completely superimposed or completely separated. The related horizontal and vertical elements should be of similar lengths, with the vertical curve contained within the horizontal curve. This arrangement should produce the most pleasing, flowing three-dimensional result, which is more likely to be in harmony with the natural landform.

Where a crest curve restricts the driver's view of the start of the horizontal curve, a driver may be confused and turn incorrectly. The following is a list of poor horizontal and vertical geometric co-ordination that requires some form of intervention to improve readability of the roadway ahead:-

- Chalmers Road Extension (Station 35,168m) - The sharp crest VC (K=2.34) is below the minimum K value for crest curves (based on SSD requirements) for a design speed of 50km/h. criteria, and, obscures the horizontal curve beyond for eastbound movements. Also refer to item 2.2.1
- Proposed Minor Arterial North (Station 13,110m) – The crest VC (K=9.35) obscures the horizontal curve beyond for southbound movements.
- Proposed Te Kowhai Road West extension (Station 20,610m) – The crest VC (K=17.81) obscures the horizontal curve beyond for westbound movements.

Recommendation(s)

1. Improve horizontal and vertical geometry co-ordination.

Frequency Crashes are likely to be infrequent	Severity Death or serious injury is unlikely	Rating The safety concern is minor
Designer response	Noted. The road corridor will be urban by nature, so the vertical geometry has been set to justify the footprint only at this design stage. There are several competing drivers on vertical geometry incl. Stormwater, all of which will need refinement in subsequent design stage(s).	
Safety Engineer comment	While I understand the SAT concerns in a rural environment, this is less of a problem in a slower urban speed environment which has additional features like street lighting, trees and building to help define and explain the upcoming road geometry. That being said the geometry should reflect traffic speeds and volumes.	
Client decision	Agree with SAT comments - review design elements and rectify horizontal and vertical design Update the NOR plans to cover two elements. - design reflects safety measures and avoid unnecessary submission at hearings - confirm designation footprint is sufficient meet the implementation of these measures	
Action taken	Vertical geometry has been amended and improved.	

2.2.3 Insufficient Carriageway Width

Moderate

A number of routes propose a divided two-lane facility with a 3.5m wide carriageway in each direction between channelisation. The SAT acknowledges that the narrowing of the carriageway, together with median and roadside berm soft landscaping, will assist in reducing through speeds. However, the reduced carriageway widths and the absence of a shoulder may have other unintended safety consequences as follows:-

- Insufficient lateral space to provide an initial recovery area for any errant vehicle
- Insufficient lateral space to provide a refuge for stopped vehicles on a firm surface at a safe distance from traffic lanes (in fact would block the lane).
- Insufficient lateral space to provide a trafficable area for emergency use
- Insufficient lateral space to provide space for cyclists. The SAT acknowledges that on off-road facility is proposed in some cases and those that choose to remain on the carriageway are likely to be confident users who will own the space as opposed to sharing the space. Moreover, the use of the

cycle paths and conversely the use of the carriageway instead will be influenced by any provision for adjacent access. If no property access, then the level of service on the shared paths will be good.

- Insufficient clearance to lateral obstructions such as mature soft landscaping, signage, lighting columns etc
- Insufficient sight distance across the inside of horizontal curves
- May restrict turning tracked path at accesses (and intersections)

Of particular concern are areas where long uninterrupted lengths of reduced carriageway width is implemented in tandem with horizontal curves and/or where there is no intermittent roadside relief in the form of indented bus/parking bays.

For example of particular concern are the following lengths:-

- Proposed Minor Arterial North (3100.4) Station 11500m to 12250m
- Proposed Minor Arterial North (3100.5) Station 12440m to 13420m
- Proposed Minor Arterial Te Kowhai Road West Extension (3101.3) Station 20200m to 20950m

The retention of long lengths of narrow carriageway is likely to increase the risk of rear-end type crashes.

Recommendation(s)

1. Consider widening the divided carriageway to ensure that a breakdown vehicle can pull clear of a following vehicle to pass within the trafficable area.
2. Consult with first responders to ensure that the reduced width will not adversely impede access or prevent them from undertaking emergency operations within the transport corridor environment.
3. Where the carriageway is unable to be widened, ensure that there are sufficient and regular "relief" areas to pullover in the form of indented bus/car bays and or locally widened shoulders.
4. Ensure that the soft landscaping when mature within the roadside berm and median does not infringe on critical sight distances including intersection sight distances and active transport crossing sight distances (formal or informal).
5. Provide for the tracking path of design vehicles wherever turning movements are proposed.

Frequency Crashes are likely to be common	Severity Death or serious injury is unlikely	Rating The safety concern is moderate
Designer response	Agree with the SAT comments. The carriageway width has been developed in agreement with HCC. Recommend further discussion with HCC to highlight the risks and how they can be mitigated. To be resolved before the next design stage.	
Safety Engineer comment	Agree with the Designer's response, the identified risks can be resolved during the detailed design phase.	
Client decision	Appreciate SAT concerns however these measures are necessary manage speeds in this environment and promote mode shift. Design to review need for raised central island for extensive lengths and replace with flush median with regular islands - to allow for passing breakdown vehicles, emergency vehicle passing. Review visibility provisions, lateral space for berm features and vehicle tracking curves.	
Action taken	Design has been amended to demonstrate how mid-block treatments could be implemented to resolve these concerns. Location and extents to be determined as part of the next design stage.	

2.3 At-grade Rail Crossing

2.3.1 At-grade vs Grade Separated Rail Crossing — Significant

The SAT understands that as a result of the local closure of Ruffell Road at grade rail crossing to the north, the retention of the level crossing on Te Kowhai Road East will result in the only at grade crossing within the northern confines of Hamilton. And only one of five remaining level crossings retained (and maintained) by

HCC within the urban area. The others being Killarney Road in Frankton, Collins Road in Deanwell. Grey Street and Peachgrove Road in Claudelands.

The SAT questions whether the retention of an at-grade crossing at this location is the right safety outcome given the following:-

- The route is intended to be a Major Arterial with likely moderate to high traffic volumes.
- The closure of the Ruffel Road at grade rail crossing is likely to attract further flows to this corridor. We understand that these additional flows have not been represented in any traffic modelling undertaken to date.
- The additional flows generated by the Rotokauri development is likely to significantly impact on current flows. The SAT has noted that AM Peak queues currently extends across the railway line. These queues are primarily driven by capacity constraints at the Te Rapa Road intersection and to a lesser extent the preceding Maahanga Drive intersection.
- The modelled layouts in the Design Report do not appear to include the rail crossing. Inclusion of the rail crossing in the modelling will likely significantly affect intersection performance. The intersection will need to be linked to the rail crossing operation with appropriate phasing to ensure traffic is able to clear the rail crossing prior to barrier arms dropping. This includes the need to consider pedestrian phases clearances prior to a barrier call.
- The incorporation of the railway crossing into the adjacent Tasman Road signalised intersection will result in further intersection and network inefficiencies.
- The signalisation of Maahanga Drive intersection (in combination with no further capacity improvements to Te Rapa Road intersection as part of these works) may result in longer eastbound stationery times for queuing traffic. This increases the potential for vehicles to be caught out on the railway line when the signals/boom is triggered by an approaching train. Comparatively, the current roundabout on Maahanga Drive allows queuing vehicles to progressively move forward as gaps appear within the circulatory carriageway.
- Vulnerable users such as pedestrians and cyclists are likely to significantly increase in tandem with development. The proposed facility retains the at-grade crossing element and duplicates an additional facility on the northern side. Consequently, the exposure and severity outcomes are likely to increase significantly as development progresses. For the period of 2000 to 2015, over 60% of all recorded pedestrian and cycle collisions at rail level crossings resulted in a fatality. This proportion is much higher than for road crashes*[1] -. This is also consistent with international patterns of rail crashes resulting in much higher severities than road crashes, especially for pedestrians and cyclists who are more vulnerable without protection systems. In practice, very few pedestrian/cycle collisions with trains are ever minor or non-injury.
- The proposed pedestrian and cycle rail crossings are shown inactively as straight paths which is of concern in raising awareness to these users. It is recommended that barriers are provided for pedestrians and cycle crossings (Noting that some measures may require more road corridor). The SAT acknowledges that the existing facility has no recorded crashes over the last five years. However, CAS does not record near misses nor inappropriate crossing behaviour. The probability of an at-grade crossing related crash increases significantly given increased flows and lanes*[2] across the railway (from two lanes to four lanes). Further, any crash is likely to have a high severity outcome.
- Further to the safety deficiencies listed above, other beneficial outcomes associated with grade separation includes improved transport connectivity and accessibility, reduced community severance, reduced energy consumption and emissions through improved network efficiency,

*[1] data from the Ministry of Transport factsheets show that only 3% of pedestrian and cycle crashes on the road network result in fatality – From Design Guidance for Pedestrian & Cycle Rail Crossings (Developed for the NZ Transport Agency and KiwiRail by ViaStrada Ltd and Stantec Ltd - 2017)

*[2] From the NZ Transport Agency's Crash Estimation Compendium First edition, Amendment 1 Effective from 01/06/2018

Recommendation(s)

1. Undertake a Level Crossing Safety Impact Assessment (LCSIA) for vehicle **and** pedestrian users to confirm viability of a grade separated solution at the outset.
2. If an at-grade facility is reconfirmed ensure the following is considered:-

Recommendation(s)

- An emergency escape shoulder/median is provided for vehicles queuing within the inner lanes within and/or near the at-grade crossing.
- Resolve how the crossing will minimise the potential for either late or risk taking movements chicaning through the crossing to avoid the boom without compromising the ability for inner lanes having an emergency path to vacate the crossing at short notice if required.
- The vulnerable user crossing(s) is appropriately designed to ensure that the crossing controls in place are reflective of crossing frequency, awareness and compliance of the likely user (i.e. perceptions of risk vary and can be dependent on user demographic), trip purpose, user age and type, cycle and mobility device constraints/limitation, speed of user (i.e. where cyclists are concern, speed affects the distance available to react and respond to the presence of a rail crossing and any trains), and, user distractions, familiarity and complacency.
- Include rail crossing in intersection modelling and confirm that intersection will operate safely and efficiently.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is very likely	Rating The safety concern is significant
Designer response	Agree with SAT comments. Recommendations noted - to be considered at next design stage(s). HCC instruction was to retain at-grade crossing in line with their current Deed of Grant with KiwiRail. KiwiRail has agreed to have the LCSIA undertaken at the next design stage.	
Safety Engineer comment	The design lacks the mandatory controls for pedestrians and cyclists. A chicane layout with warning devices and automatic gates may need to be provided on both sides of the carriageway for active mode users. A LCSIA needs to be undertaken to inform the design process.	
Client decision	SAT comments are accepted. A LCSIA has been undertaken on the existing design and requires minor improvements. The crossing has a limited life without further improvements. A LCSIA recognising the NOR signalisation and associated walking and cycling improvements is required to give certainty that NOR measures will suffice and avoid a future rail crossing closure. Update the NOR plans to reflect the safety measures that address signalisation of intersection and rail crossing including appropriate walking and cycling chicane with automatic gates. Review with client any changes to NOR boundaries. - design reflects safety measures and avoid unnecessary submission at hearings - confirm designation footprint is sufficient meet the implementation of these measures	
Action taken	An at-grade facility is proposed to be maintained. Engagement with KiwiRail is still on-going; refer to the discussion within the NoR document for further detail. Design has been amended to incorporate additional safety measures for the at-grade facility.	

2.4 Active Transport Mode Users

2.4.1 Lack of connectivity

Significant

The SAT are concerned that there are a number of pedestrian and cyclist connectivity disruptions that may result in users choosing a path or action which is unsafe to do so. The following are a few examples of disconnects that may result in an adverse safety outcome: -

1. The cycle path comes to an abrupt end on the Te Kowhai Road West extension at Station 20410m LHS. The termination coincides with a proposed shared path connection on the west side of the Waikato Expressway and the change from bidirectional cycle lanes to cycle lanes on both sides of the road. The SAT is concerned that a cyclist progressing eastwards along the cycle lane (or from the Waikato

Expressway shared path) will be forced onto the narrow 3.5m wide carriageway, or, cross the median mid-block to access the segregated cycle lane facilities on the opposing side.

2. Further, the proposed Te Kowhai Road West extension bisects the existing Waikato Expressway shared path. It is unclear from the proposal how users on the shared path could cross the Te Kowhai Road West extension without physically crossing at-grade, or, diverting to the nearest formal crossing at the signalised intersection approximately 300m to the west (unlikely to do so).
3. Similarly, the proposed Chalmers Road extension bisects the existing Waikato Expressway shared path. It is unclear from the proposal how users on the shared path could cross the Chalmers Road extension without physically crossing at-grade, or, diverting to the nearest formal crossing at the Arthur Porter Drive roundabout approximately 440m to the north (unlikely to do so).
4. The proposed tie-in to Te Wetini Drive intersection contains some inconsistencies in terms of how the proposed segregated cycle lane and footpath ties into the intersection active transport facilities (consisting of a shared path only). Further, the SAT notes that the approach roadway will need to be modified to ensure that the approach and exit lane arrangements are consistent with each other. The SAT notes five no. lanes leaving the intersection (to be designed by others) vs two lanes from this project.
5. No connectivity has been provided across the left turn slip lane to connect active users between the proposed facilities on the south side of Te Kowhai Road East, and, the isolated splitter island servicing the signalised crossing across Porter Drive and Te Kowhai Road East.
6. It appears that cycle lane users on the southeast and southwest quadrants of the proposed Maahanga Road signalised intersection have priority over other users such as pedestrians and mobility impaired users. The arrangement should remove cyclist priority and reinforce a shared zone or give priority back to the pedestrians. Further, the pavement markings associated with the shared crossing across Te Kowhai Road East implies that there is a cyclist element to the crossing. The cycling element is inconsistent with the left turn slip lane(s) crossing arrangement and the pedestrian only facility on the north side of Te Kowhai Road East.

Recommendation(s)

1. Consider extending the Te Kowhai Road West cycle lane further east to provide an off-road facility for cyclists.
2. Consider how Waikato Expressway shared path users will safely cross the proposed facility given that there is an opportunity to cantilever a structure from the adjacent bridge to remove the potential for an at-grade crossing at this location.
3. Agree on extents of project and complete tie-in details.
4. Modify to ensure a combined cycle lane and footpath crossing is shown across the left turn slip lane.
5. For consistency with treatments on other intersections (and maintain user expectations), ensure that pedestrians retain priority adjacent to all crossing points or that these areas are marked as a shared zone. Ensure cyclist priority is removed. Review crossing locations and ensure that there is consistency across the crossing diaspora ensuring that all users are catered for.

Frequency **Crashes are likely to be infrequent**	**Severity** **Death or serious injury is very likely**	**Rating** **The safety concern is significant**
Designer response	Agree with SAT comments. Connection details (and coordination with Te Wetini Dr intersection and other developers) to be confirmed at the next design stage.	
Safety Engineer comment	Agree, details to be resolved at design stage.	
Client decision	Agree with SAT comments. 1 Review extension of off- road cycle facility 2 Install raised at grade signalised crossing for Waikato expressway shared path across Te Kowhai road arterial 3 complete ties ins on plans to reflect matching to existing environment 4 review and confirm measure can be introduced 5 changing to shared path zone provides better clarity	

Recommendation(s)

Action taken	Design has been amended to resolve these concerns. Connection details (and coordination with Te Wetini Dr intersection and other developers) to be confirmed at the next design stage

2.4.2 Bi-Directional Cycle Lanes

Moderate

Bidirectional cycle lanes are proposed for the major arterial section of Te Kowhai Road only which results in several concerns as follows:

- At all ends of the bidirectional facility there needs to be safe connections to the existing / proposed facilities beyond (see also 2.4.1 above)
- The use on bidirectional facilities on an isolated section but one-way lanes on each side of the road for all other roads results in an inconsistent approach and may be less readily understood by cyclists which may in turn lead to incorrect use or use of the road carriageway instead.
- Bidirectional facilities also create safety issues at accesses where drivers may not be expecting cyclists to be approaching from both directions.
- The SAT notes that the proposed cycle lane is located along the southern side of the corridor. This route requires the cyclist to negotiate multiple existing accessways and the Tasman Road intersection. If a bidirectional facility is pursued that the SAT believes that should the cycle lane may have fewer conflicts if placed on the northern side of the road.

Recommendation(s)

1. Consider the consistent use of one-way cycle facilities on both sides of the road on all roads.

Frequency **Crashes are likely to be occasional**		**Severity** **Death or serious injury is likely**	**Rating** **The safety concern is moderate**
Designer response	Noted. Tie in details to be resolved at subsequent design stage(s). The bi-directional cycleway vs separated cycle lanes on both sides has been considered through the design process to date. The use of the bi-directional cycleway aims to reduce cyclists' conflicts with vehicles accessing businesses along this major arterial road and puts the cycleway on the south side of the road where cyclists are likely to be accessing the main destinations i.e., the Base and PT Hub. The design rationale/benefits for a two-way cycleway were issued to HCC in KDM015 dated 27/08/2020 which includes design elements that are important to be able to implement the two-way facility correctly. These shall be explored in the next stage of design.		
Safety Engineer comment	Agree with the Designer's response.		
Client decision	No change to two way cycle facilities - agree with designer Plans however do need improvements to reflect concepts better. Where crossings do occur show priority for cyclists and pedestrians		
Action taken	No change made to two-way cycle facilities. Tie in details have been updated but will need to be reviewed at next design stage to reflect latest design standards.		

2.4.3 Active Modes Buffers to Parking

Moderate

Parking spaces are shown adjacent to cycle paths or shared paths in many locations. The opening of car doors in the face of an opposing path user is a significant safety risk and a buffer zone is required between a parked vehicle and a cyclist (normally 1 m is recommended).

Recommendation(s)

1. Provide a buffer area between parked vehicles and users of active mode paths.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is likely	Rating The safety concern is moderate
Designer response	Agreed. In most cases parking is shown within a 3.0m strip which should provide a sufficient buffer between car doors opening and active mode path users. The interface examples in the ULDF highlight this area as a space that will require people crossing the cycleway when they park. This is to be confirmed at the next phase of design.	
Safety Engineer comment	Agree with the Designer's response and recommend buffer zones to be marked accordingly.	
Client decision	Agree with designer response. Update plans with notes and mark areas where buffer zones will be applied	
Action taken	Sufficient berm width is available to provide buffer. Parking extents and buffers to be defined at next stage of design in conjunction with land use development.	

2.4.4 Zone 6 – No Cycle facility

Significant

No cycle facility is proposed on the Zone 6 cross-section. While a 0.75 m shoulder is proposed, this may not be adequate for cyclists particularly with consideration to the use by heavy vehicles.

Moreover, all other roads proposed will have a cycle facility except this area

Recommendation(s)

1. Provide a safe cycle facility on all roads.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is very likely	Rating The safety concern is significant
Designer response	Agree with SAT comments. Adding a cycle facility appears to be possible within the proposed land take. HCC's NOF shows Arthur Porter Dr as having 'No cycle priority' so on-road provision only has been made. All other corridors have a cycle function within the NOF. The majority of people coming from this direction are mainly going to the employment zone and likely to use the Minor Arterial and WEX shared path.	
Safety Engineer comment	While I agree with the SAT, the sections of Arthur Porter beyond this work are similar to those proposed so would need to either tie into the existing network or make sure that the proposed future facilities encourage cyclists to choose this route through the area. Either way this can be resolved at the detailed design stage.	
Client decision	Review design cross section concept for the realigned Arthur porter section to provide adequate shoulders that allow on road cycling and match the existing standard for Arthur porter drive.	

Recommendation(s)

Action taken	On-road provision only has been maintained within the design cross section. We note that the nature of the land requirement in this area could facilitate the inclusion of a cycle facility at the next design stage(s).

2.5 Network Capacity and Queuing

Significant

No modelling information has been provided related to the forecast performance of each isolated intersection and/or the network either now or in the future although it is understood that the designers have satisfied themselves of the satisfactory performance of each of the intersections on a stand-alone basis. The Designers indicated that each intersection on average achieved a LOS B to C for those intersections along the minor arterial network and adjacent collector road network, and, between LOS D and E for those intersections located on the Major Arterial network.

The Designers also stated that the capacity of the network as a whole has not been tested or understood.

The SAT observes that in the morning peak flow times, congestion on Te Rapa Road can result in substantial queues back up the Te Kowhai Road East corridor including effects on adjacent side roads such as Arthur Porter Drive, Tasman Road, The Boulevard and Maahanga Drive. Further, the approach traffic flows are likely to be quite unbalanced which may result in long delays on the side road approaches.

Long delays and queues can result in driver frustration, rat-running through alternative routes, acceptance of inappropriate gaps in traffic streams and nose to tail collisions particularly should queuing extend back where sight lines are less than desirable.

In this instance if queues on the west approach to the Te Rapa Road roundabout were to extend back to and beyond the existing rail crossing at any time (even for a brief time), there is a heightened risk of a high severity crash outcome related to at-grade rail crossings (previously highlighted under item 2.3.1).

Further, a network modelling approach is required to be undertaken to understand the quantum of rat-running occurring to avoid congestion along the Te Kowhai Road East corridor. An undesirable outcome are drivers rerouting through residential areas such as Baverstock and Rotokauri putting local communities at an unnecessary risk.

Further that SAT notes that the modelling needs to consider aspects of the design that will have detrimental effect on intersection performance and is concerned that these have not been included in the modelling to date (based on the intersection layouts shown in the Design Report), including :

- Bus lanes and priority phasing if used will affect the intersection performance. Also, the bus lanes are very short reducing the effectiveness of a bus entering and potentially resulted in unexpected congestion at the merge on the downstream section. Bus lanes have been included only at some intersections and inconsistently reducing the network benefits.
- Cycle phasing needs to be considered in the modelling.
- Lane allocation and number of lanes needs to be considered in the modelling eg bus lanes has reduced the number of lanes in places. Left turn lanes will need to share bus lanes (not turning left across bus lane as currently shown).
- Shared through and right turn lanes would result in poor capacity with right turners restricted through traffic.
- Allow for U-turns (see below)
- The Design Report shows that traffic volumes at the intersections of Minor arterial / Collector and Collector/Chalmers Street are similar and yet one intersection is to be signalised and the other priority controlled which appears inconsistent and needs to be checked.

Recommendation(s)

1. Confirm that the network is expected to perform adequately for the design year adopted.

Recommendation(s)

2. Confirm that any queuing imposed by each of the intersections is understood and that adequate sight distance is maintained to the back of the queues, and
3. Confirm that if queues consistently infringe onto the at-grade rail crossing at peak times, consider providing a grade separated rail crossing.

Frequency Crashes are likely to be common	Severity Death or serious injury is likely	Rating The safety concern is significant
Designer response	Noted. An ITA has been completed for the NoR which outlines the modelling summary and modelling output information: 1. We can confirm that 2051 modelling outputs show satisfactory results on intersection performance. 2. Queuing has been detailed in NoR ITA; we expect that some queuing is anticipated along Te Kowhai and Maahanga Drive for 2051 future year. Sight distance details to be resolved at the next design stage(s). However, the key risk areas - due to site constraints - are in Zone 7. 3. Based on the design of the intersection at Tasman, it is not expected that queueing to infringe on the rail network. Refer to 2.3.1 above.	
Safety Engineer comment	I disagree with the safety significance of this concern, except for the Te Kowhai Rd rail crossing queue, but that needs to be addressed through the level crossing design. That being said further review of the modelling is required to confirm or reject that there is enough capacity in the network to accommodate all road users and to highlight whether or not an additional connection across to Te Rapa Rd is needed to ensure travel times are both reliable and of a reasonable duration that road users remain on the arterial network and don't 'rat run' through residential areas.	
Client decision	Agree with safety engineer comments. Review modelling work. Test and confirm Te Rapa roundabout is not needing signals to manage flows or replaced with signalised intersection to avoid risks as identified. Updated NOR plans at Tasman/Te Kowhai level rail crossing showing improvements as per item 2.3 and commentary in NOR documents advising that signal coordination with rail signals is necessary to ensure traffic is managed at rail crossing to avoid queuing occurring.	
Action taken	The ITA has been updated to reflect changes in the design elements as per audit. Refer to 2.3.1 above for commentary on the rail crossing.	

2.6 Property Access

Significant

The Design Report states "*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*".

Furthermore, as part of the entry briefing meeting, the Designers advised that: "*the project will progress on the basis of not making any provision for accessways along the route and that lots suitable for subdivision would likely to occur outside this contract and will be driven by private enterprise. It is envisaged that where lot access is required, access will be rationalised on the basis of a single accessway servicing multiple lots to ensure that access can be co-ordinated in a safe and controlled manner and no direct property access. As part of this process, where physical medians occur, the median is likely to be removed locally to allow right turn in and out movements*".

The SAT is concerned that the uncertainty around property access provision has the potential to create significant safety outcomes depending on the location, frequency and layout of access.

If as implied by the design report, there are already known "significantly affected" properties then these should be understood now to avoid construction of a scheme that does not provide for property access (if indeed needed).

Considerations relevant to property access include:

- If access is to be left turn only, then consideration is needed to provision for U-turns (see below).is to be no If no needs to be once a median break is provided, vehicles may use these to u-turn where it is unsafe to do so, or, inappropriate given the lateral constraints imposed by the narrow carriageway i.e. due to lack of space some vehicles my undertake a multiple point turn to access the opposing lane. There is a risk that rear-end and/or side impact type crashes may increase as a result.
- The potential for uncontrolled additional side friction associated with right turning movements from adjacent properties will affect overall efficiency and safety.
- Tracking path of all vehicles at accesses.
- Effect on downstream network if movements are restricted.
- The provision of access will affect the level of service for cyclists on the cycle paths.
- Available sight distance affected by geometry and road streetscape.
- The type of cross-section adopted in zones with no physical median is interdependent of the form of access control proposed.

Recommendation(s)

1. Resolve how access will be controlled to ensure that access to the adjacent blocks of land will be provided in a safe and efficient manner.

Frequency **Crashes are likely to be common**	**Severity** **Death or serious injury is likely**	**Rating** **The safety concern is significant**
Designer response	Concerns noted. Future access to property will be subject to council consent processes that need to ensure safety and operational aspects are considered. Drawings to include notes that a segregation strip (or other suitable legal mechanism) will be included to allow HCC to control access to/from the corridors.	
Safety Engineer comment	Agree, issue to be resolved through the detailed design stages.	
Client decision	Intent is to control vehicle access to property along these corridors (Limited access corridors) access will be via local intersections with rear access servicing of lots fronting these corridors. Where existing access is approved adequate measures on pedestrian and cycling paths to indicate priority and manage conflict	
Action taken	Alternative access to one property on Te Kowhai E Rd has been included in the proposed designation. The design has been amended to demonstrate how mid-block treatments could be implemented to resolve these concerns.	

2.7 The Boulevard Pedestrians

Serious

No pedestrian connection is provided on the east side of The Boulevard. There is an existing footpath on the NE quadrant of the intersection with Te Kowhai Road which could be continued along The Boulevard, but the proposed intersection work will locate the road carriageway at or on the boundary.

Moreover, the proposed proximity of the boundary to the road immediately north of the proposed pedestrian crossing of the slip lane, will restrict the available intervisibility between pedestrians and approaching vehicles (on the basis that an obstruction could be built on the boundary). The SAT are not able to verify the actual sight distance available at the scale of drawing provided.

Recommendation(s)

1. Provide a footpath link along The Boulevard at least as far as the current footpath.
2. Provide adequate intervisibility between pedestrians and vehicles at the slip road crossing adopting the property boundary as a constraint.

Recommendation(s)

Frequency Crashes are likely to be common	Severity Death or serious injury is very likely	Rating The safety concern is serious
Designer response	We agree with the SAT comments. The current design is dictated to by lack of land available to make improvements. This has been specified by HCC. No footpath facilities exist, at all, on the eastern side of The Boulevard. The design provides like for like replacement of existing and anything further north is out of scope. HCC instruction was to work within existing corridor in this location and this introduces a number of constraints. To be resolved in the next design stage(s).	
Safety Engineer comment	With the increase in pedestrian and cycle facilities it is highly likely that there will be requests for HCC to install a new footpath on this side of the Boulevard, this designation alignment would preclude HCC from doing this in the future without purchasing land. Recommend reviewing the need for the left turn lane outside of the signals to help ensure future pedestrian connectively.	
Client decision	Review with asset teams the need of pedestrian facilities on both sides of the boulevard corridor and also extents fronting the PlaceMakers site. Collaborate with proposed changes of public transport, pedestrian and cycling provisions for Te Rapa/Te Kowhai intersection. Review Boulevard intersection design to provide better alignment within the available land footprint to provide agreed walking/cycle measures.	
Action taken	The design has been amended to demonstrate how these concerns could be resolved. There will be the need to refine design further (including review of levels) as part of the next design stage.	

2.8 U-Turning

Moderate

The long lengths of median divided road will create a demand for U-turns at any breaks in the median.

Depending on the access provisions this may be exacerbated by adjoining accesses (see above).

If the signalised intersections are relied upon to enable u-turns then allowance needs to be made for the safe phasing of the intersection to enable this movement.

If mid-block median gaps are provided for any reason, then adequate provision will need to be made to cater for all demands including U-turns.

Recommendation(s)

1. Ensure that the design makes provision for u-turning vehicles at any proposed or potential gaps in the median.
2. If signalised intersections are the preferred strategy to manage u-turning, extend the physical median up to the hold line and ensure that there is sufficient pavement width in front of the hold line to undertake the u-turn (and consider widening the opposing shoulder locally if not). And ensure that phasing is such that the left turn from the adjacent roadway remains on red to remove the potential for conflict with the u-turn movement.
3. If formalised mid-block right turn bays are the preferred strategy to manage u-turning, widen the physical median locally to accommodate a physical median protected right turn bay and ensure that the opposing roadside berm is indented sufficiently to allow the u-turn manoeuvre to proceed within a trafficable area.

Frequency Crashes are likely to be occasional	Severity Death or serious injury is likely	Rating The safety concern is moderate
Designer response	Agreed. The current design does not accommodate vehicles u-turning. 1. There are no significant gaps in the median, and it is proposed that no u-turning takes place at the intersections. Te Rapa and Arthur Porter Roundabouts can be	

Recommendation(s)

	used for u-turning movements or alternatively detouring to turn around. Further review to be undertaken at the next design stage. 2. see 1 above 3. see 1 above. Any u-turning movements will be considered, with median details, in the next design stage.
Safety Engineer comment	he design should take a wider look at the network to ensure appropriate permeability for property access across the area and any areas that has reduced access or require long alternative routes to gain access to those areas without u-turning then key intersections or locations might need to accommodate U turn manoeuvres. If that intersection is currently signalised, then the phasing will need to reflect this U turn desire or the intersection form potentially changed to a roundabout.
Client decision	Add No U turn signage at signalised intersections - not to be encouraged or catered for. The existing roundabouts on existing network provide opportunities for motorists to do this where they have made the wrong choice. There will be further development intersections and roads along the minor arterial that motorists can use to change direction if necessary. If shown a U turn is necessary, this will be considered at detailed design phase.
Action taken	Design of the minor arterial has been amended to demonstrate how mid-block treatments could be implemented to resolve these concerns. U turns at Intersections to be considered acceptable and incorporated at the next design stage.

3. Comments

The following comments are either:

- of a general nature; or
- cannot be related to any specific safety concern; or
- relate to previous safety concerns that may have been misinterpreted; or
- relate to subsequent design developments that could become safety concerns in a future safety audit; or
- relate to safety concerns that the designers are already aware of; or
- relate to design elements where the safety implications are not yet clear due to insufficient detail for the stage of the project.

These comments are included for the consideration of the designers and the client. Decision tracking tables are included to record responses, as attention paid to the comments may contribute to improving overall road safety.

3.1 Proposed overland flow path linking WHNP to Lake Rotokauri

The high level Rotokauri Structure Plan (Appendix C) appears to infer that the swale designation (legal instrument governing the overland flow path associated with the greenway) crosses the Rotokauri Designation project at key locations as follows:-

- The proposed collector road 3121.1,
- The Chalmers Road extension (south of the Waikato Expressway)
- Sidles against the south side of Te Kowhai Road West extension. For the majority, the swale appears to encroach through Te Kowhai Road West extension and over into the adjacent property, and
- Across the proposed Minor Arterial North 3100.4 near the Te Kowhai Road West extension intersection.

The SAT is unaware how the floodway would operate and under what conditions including frequency, duration and whether the route acts as a relief valve for WHNP or a wider catchment.

The SAT notes that where the proposal comes in close proximity to (and in some locations within) the swale, the vertical alignment is locally depressed and therefore could be subject to localised flooding and/or inundation.

If the proposal is an integrated solution where localised flooding is permitted to cross the roadway overland under certain conditions and return periods, then the SAT is concerned how vehicles and active transport mode users would interact with the roadway if the facility is either inundated or acting as a controlled spillway.

Further, under floodway operation, emergency access could be restricted to a large swathe of the development as the only unimpeded access not affected by the swale designation is a future access yet to be built linking Te Wetini Drive to Rotokauri Road (refer to high level Structure Plan under Appendix C).

Designer response	Noted. This is not an overland flow path as such but the primary mechanism for capturing and managing SW impacts from development on downstream. It is sized at 100yr ARI standard (so therefore a likelihood of occurring in any one year is 1% and 63% likelihood of occurring in a period 100yrs). Refer response to 2.2.1 about overtopping. The modelling is yet to be refined but in the conservative scenario only the minor arterial at Te Kowhai Rd extension intersection overtops (less than 100mm depth at the road CL, velocity x depth hazard is yet to be defined). Chalmers Rd crossing is almost overtopped. Further modelling is needed before final performance is known however, there remain other access routes into the area from north and south that do not rely on these crossings. Hazard management practices remain to be confirmed in later design stages.
Safety Engineer comment	Hazard management required during the detailed design stage.

Client decision	The safety risk can be addressed as part of the hazard management for the floodway and detailed design stage. All efforts to date have been made to ensure these corridors are lifeline corridors but mother nature will dictate if we have if right. Add commentary in NOR documents to consider a Hazard approach where its been identified likely hood of risk has potential to impact on safety for road users.
Action taken	Floodway design is fixed and cannot be changed to remove this risk. Ponding is expected to occur under the SH1C over-bridges in events larger than a 100yr ARI. Ponding and the ability to design it out in this location is limited given the fixed SH1C bridge levels, the minimum clearance envelope beneath the bridge and the flood levels in the Greenway. There is potential for ponding to still occur at the Te Kowhai and Chalmers underpasses. In the event this results in road closures, there are alternative transport corridors that remain open in the event of an emergency response.

3.2 Design Matters - Comment

The SAT highlights that there are many issues yet to be detailed at this stage of the project. As these matters may affect safety, they have been highlighted herein as a comment and note that in some cases the designation footprint may also be affected. Examples of these design issues are:

- Tracking Paths for design vehicles at accesses for all movements
- Tracking paths for vehicles at intersections for all movements
- Intersection modelling (see above).
- Bus lane lengths (upstream and downstream of intersections)
- Access locations and layout are yet to be determined (see below).
- Mid-block active mode crossings- none currently proposed and it is noted that the lang lengths between intersections will likely require safe mid-block facilities for all modes.
- Sight lines – check forward sightlines and intersection sight lines will be achieved and not influenced by adjacent landscaping.
- Lighting appropriate to the area to be lit with a high standard at intersections or other areas of conflict (noting that some roads do not include lighting which is understood to be a drafting error).
- Design checks on aquaplaning potential yet to be completed.
- Cycle path detail requires careful design in the vicinity of all conflict points with other travel modes at all intersections (either with road or footpath or other cycle paths) and accesses.

Designer response	Noted - these items will be carried forward to subsequent design stage(s).
Safety Engineer comment	Agree, these items required to be resolved in the design process.
Client decision	Agree these items will be required and resolved in the design phase. Commentary to be included in NOR documentation to reflect these matters
Action taken	The design has been amended to resolve many of these items. Detailed design stage will reconsider these items with potential design refinement. Proposed land development in conjunction with design/construction of the arterials will require review of all the items again.

4. Audit Statement

We declare that we remain independent of the design team, and have not been influenced in any way by any party during this road safety audit.

We certify that we have used the available plans, and have examined the specified roads and their environment, to identify features of the project we have been asked to look at that could be changed, removed or modified in order to improve safety.

We have noted the safety concerns that have been evident in this audit, and have made recommendations that may be used to assist in improving safety.

Signed -- Date 29/3/2022 --

Nick Overdevest, NZCE (Civil), MEngNZ, Principal Transportation Engineer, Stantec

Signed -- Date 29/3/2022 --

Ian Carlisle, BE (Hons), ME, CPEng, CMEngNZ, Principal Transportation Engineer, Stantec

5. Response and Decision Statements

System designers and the people who use the roads must all share responsibility for creating a road system where crash forces do not result in death or serious injury.

5.1 Designer's Responses

I have studied and considered the auditors' safety concerns and recommendations for safety improvements set out in this road safety audit report and I have responded accordingly to each safety concern with the most appropriate and practical solutions and actions, which are to be considered further by the safety engineer (if applicable) and project manager.

Signed Date 08.04.2022

Ryan Ainsworth, Project Manager, Beca Ltd

5.2 Safety Engineer's Comments (if applicable)

I have studied and considered the auditors' safety concerns and recommendations for safety improvements set out in this road safety audit report together with the designer's responses. Where appropriate, I have added comments to be taken into consideration by the project manager when deciding on the action to be taken.

Signed Date 9 May 2022

[Simon Crowther, NZCE (Civil), Senior Road Safety Engineer, Hamilton City Council]

5.3 Project Manager's Decisions

I have studied and considered the auditors' safety concerns and recommendations for safety improvements set out in this road safety audit report, together with the designer's responses and the comments of the safety engineer (if applicable), and having been guided by the auditor's ranking of concerns have decided the most appropriate and practical action to be taken to address each of the safety concerns.

Signed Date 8 September 2023

[Tony Denton, NZCE (civil), Strategic Transport and Planning unit Manager, Hamilton City Council

5.4 Designer's Statement

I certify that the project manager's decisions and directions for action to be taken to improve safety for each of the safety concerns have been carried out.

Signed Date 08 September 2023

Ryan Ainsworth, Project Manager, Beca Ltd – as per the "Action Taken" comment against each item.

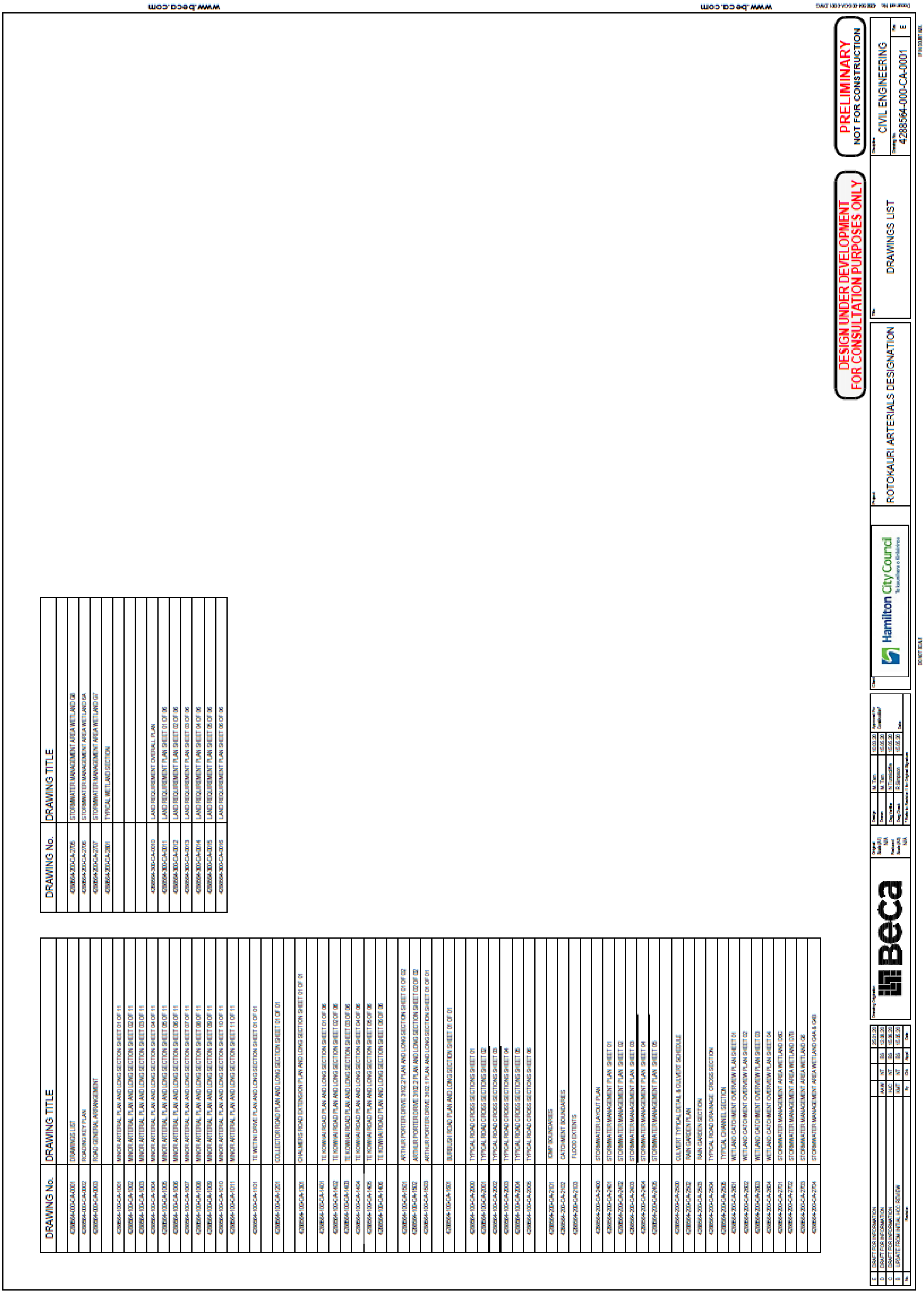
5.5 Safety Audit Close Out

The project manager is to distribute the audit report incorporating the decisions to the designer, safety audit team leader, safety engineer, and project file.

Date:.....................................


Appendices

Appendix A Audit Drawings



Appendix B Audit Documents

Beca

Rotokauri Arterials Designation - Design Report

Transport & Civil Sections of Design Report

Prepared for Hamilton City Council

Prepared by Beca Limited

24 February 2022

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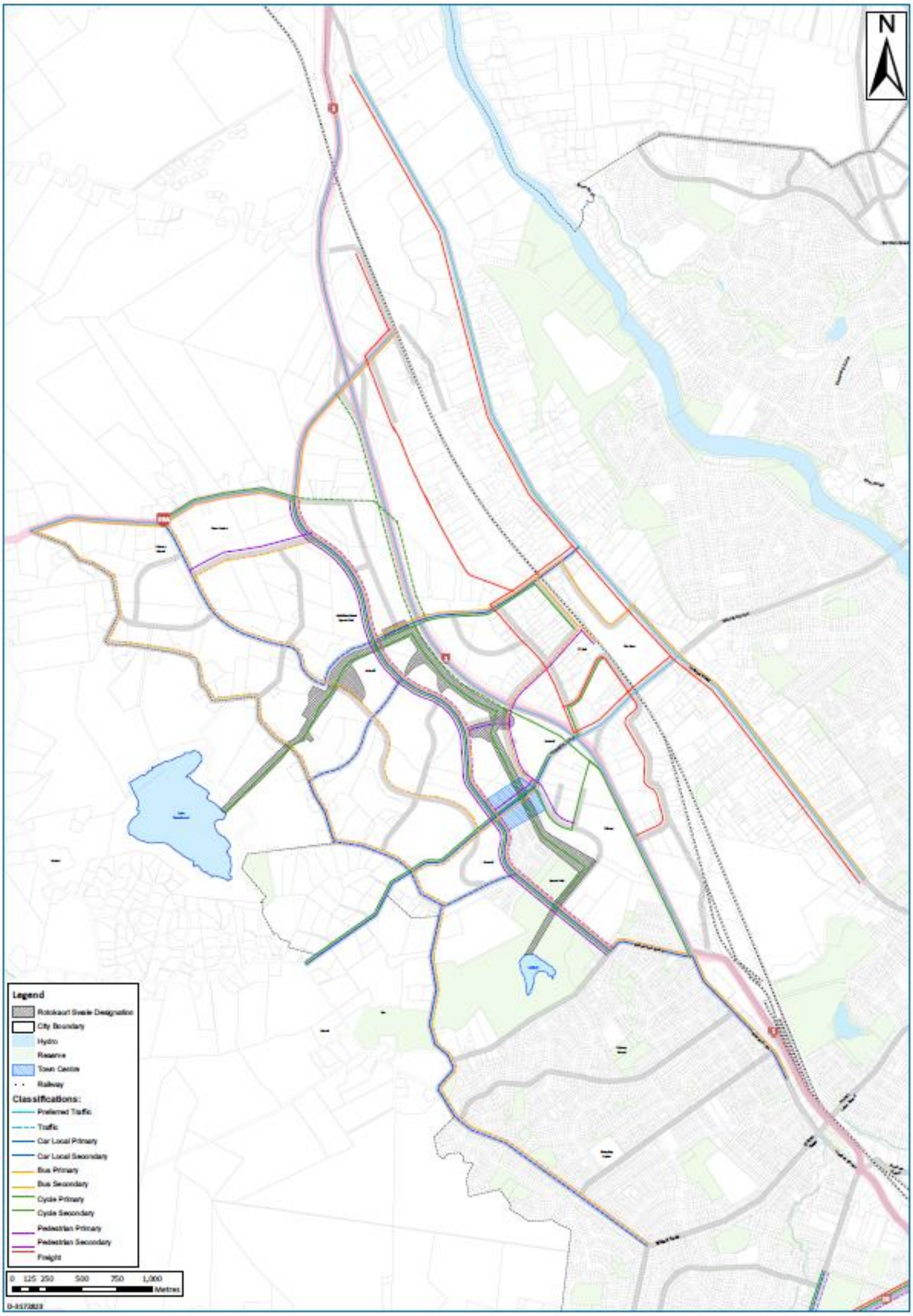
Appendix C Structure Plan



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D

Appendix D – Safety in Design Register

Safety in Design / Risk Register - Pre Design Phase

Author (Role):	Ryan Ainsworth (PM)	Job No:	4288564
Approved By:	Adrian Jones	Date	10.09.2020
Revision: ject Name:	Rotokauri Arterials Designation	tage of Design / Project:	Notice of Requirement (Concept / Prelim.)

(Note: minimum of 2 reviews per project)

RISKS ASSOCIATED WITH DESIGN ELEMENTS				Risk Matrix			PROPOSED & APPROVED MITIGATION MEASURES	Mitigated Risk & Resolution							RESIDUAL RISK	
Ref	Hazard (Guideword)	Cause & Outcome	Existing controls, if any	L	C	LR	Proposed Control (1 Eliminate, 2 Substitute, 3 Reduce, 4 Control)	L	C	LR	Risk Owner	Client Approved	Design Status	Date	Risk Owner	Action Required
1	**Design and Construction Phase**															
1.01	*Heights / Depths*	Deep excavations & steep cut/fill slopes (incl. at Greenway crossing points) - culverts, batters, subsidence, collapse of sidewalls onto workers, or workers fall into excavations, working on / compacting embankments	Batter slopes to be based on geotechnical advice. Consider maintenance requirements / access provisions also. Carry forward to next design stage	1	1	L	Construction methodology to consider installation of elements at depth prior to backfilling, trench shields, access, etc. Carry forward to construction.									
1.02	*Load / Force / Energy*	Striking buried utilities - damage to utilities and risk of harm to personnel, major outages if struck	Engage with utility providers to identify known services, particularly critical services infrastructure (e.g. WEL cable on old Arthur Porter Dr). Undertake utilities search prior to excavation. Protect / relocate services as required. Carry forward to next design	3	3	H	Carry forward to Detailed Design & Construction.									
1.03	*Interfaces External to the Project*	Developer interfaces: Stormwater devices (e.g. culverts) not required when development proceeds. Te Wetini long term temporary infrastructure being installed that may conflict with end state. Disgruntled developers impede progress.	Engage with developers continuously throughout the project, and incorporate design amendments as and when elements can be resolved	3	2	M	Carry forward to Detailed Design & Construction.									
1.04	*Size / Shape*	Spatial constraint during construction, affecting constructor access or complonmmises to users during construction.	Designation being prepared to secure sufficient space for construction	3	2	M	HCC to agree mechanism with surrounding landowner(s) outside of designation to secure land for construction. Carry forward until Construction, contractor to resolve.									
1.05	*Site Environment*	Poor/unstable ground conditions (incl. peaty ground) with no ability to change alignment. May lead to deep excavations.	Geotechnical advice to be refined as the project develops. Carry forward to next design stage.	2	3	M	Carry forward to Detailed Design & Construction.									
1.06	*Interfaces External to the Project*	Traffic movements at tie-ins (e.g. Burbush Rd realignment) and cross roads already constructed, as well as construciton laydown areas / site access, impact on businesses in developed areas - risk of harm to personnel	Clearly identify interface points, scope boundaries, access control & staging, and engage with affected parties early. Carry forward to next design stage.	3	3	H	Carry forward to Detailed Design & Construction.									
1.07	*Natural Environment*	CIA Outcomes - Iwi groups to be included as part of the on-going project / Blessing of the site / Ministerial sod turning / Iwi expectations	Monitor as project progresses. Allow time and budget for iwi input into next design stage(s) and construction.	3	2	M	Carry forward to Detailed Design & Construction.									
1.08	*Position / Location*	Underground services under traffic lanes - requires sequential installation or lane closure(s) to work on	Provide sufficient space in the cross section width to locate services corridors outside of traffic lanes. Specific provisions to be resolved at next design stage. Carry forward to next design stage.	3	3	H	CMP to resolve									
1.09	*Site Environment*	Protesters	Engagement with local landowners, community open days, to get community on board with project. Continue to engage in subsequent design stages.	1	3	M	CMP to resolve									
1.10	*Heights / Depths*	Fall from height - culvert headwalls	None	1	3	M	CMP to resolve									
1.11	*Hazardous Materials*	Contaminated sites/land e.g. asbestos	PSI undertaken at this design stage. DSI to be undertaken at subsequent design stage. Contractor management plans to consider how to manage unidentified discoveries	2	3	M	Carry forward to Detailed Design & Construction.									
1.12	*Site Environment*	Land required for the project cannot be obtained e.g. The Base, resulting in design compromises being required	Engage with landowners throughout the project and obtain agreement to the project as early as possible. Demonstrate the downside of not undertaking the upgrades.	2	4	H	CMP to resolve									
1.13	*Hazardous Materials*	Stockpiling / excavation / transport of materials (e.g. bulk excavation) creates dust/fumes etc.	Greenway cut to be placed in final Arterials location if possible. Secure sufficient land outside of designation for stockpile locations. Construction methodology to consider further (e.g. dust suppression).	3	2	M	CMP to resolve									
1.14	*Interfaces External to the Project*	MoE - location of school(s) unknown - risk of insufficient provisions made in the design	Continue to engage with institutional stakeholders throughout project and incorporate design amendments where possible	2	3	M	Carry forward to Detailed Design & Construction.									
1.15	*Interfaces External to the Project*	COVID impacts on supply & personnel	Monitor situation - construction phase far enough in the future that effects may have resolved by then	4	3	H	Carry forward to Detailed Design & Construction.									
1.16	*Site Environment*	Inclement weather creates delays or impacts adjacent areas, particularly where temporary solutions required in advance of permanent installations, including maintaining flow of existing pipe systems during construction	Allow sufficient programme duration to provide for weather delays. Temporary works design / construction staging to consider impacts outside of project (e.g. flooding, changes to OLFPs, existing pipe networks etc.)	3	2	M	CMP to resolve									
1.17	*Site Environment*	Discovery of underground features (archaeological features, bones, unknown objects) causes delays / rework / redesign	Undertake archaeological assessment, PSI / DSI at appropriate design stage(s) and gain HNZ authority prior to construction (if required)	2	3	M	CMP to resolve									
1.18	*Size / Shape*	Road widths excessively wide for pedestrian crossings - too long	Current design to provides sufficient land for intersection design to be refined at next design stage(s) - needs to provide balance between vehicle movements and active modes. Current widths are minimal.	1	3	M	Carry forward to Detailed Design & Construction. Staggered crossings may be required but are considered a low risk at this stage.									
1.19	*Position / Location*	Future developments create additional access / crossing locations in undesirable locations and impact on pedestrian / cycle routes. Orientation of retail centre that may conflict with the Arterials.	Include provisions / legal mechanisms to limit access onto the arterial corridors. Engage with developers continuously throughout the project, and incorporate design amendments as and when elements can be resolved	3	3	H	Carry forward to Detailed Design & Construction.									
1.20	*Site Environment*	Working near water - Greenway, farm drains	Identify waterways, clearly demarcate work site with sufficient buffer zone, no 'lone working' if work near waterways required.	2	3	M	Carry forward to Detailed Design & Construction.									
1.21	*Site Environment*	Fire Risks - Farmland / grass	Consider fire detection and fire fighting as part of construction management plans, including emergency routes and exits	1	3	M	Carry forward to Detailed Design & Construction.									
1.22	*Interfaces External to the Project*	Damage to existing infrastructure, trees, wetlands, lakes including erosion and sediment control	Consider construction access & segregation from existing as part of next design stage(s) and construction management plans	2	2	L	Carry forward to Detailed Design & Construction.									
1.23	*Natural Environment*	Development destroys ecological habitats for mudfish / lizards / bats etc. (and other flora / fauna)	Undertake ecological assessments. Develop management strategy for the wider Rotokauri catchment. Develop management plans specific to the project. Consider	1	3	M	Carry forward to Detailed Design & Construction.									
1.24	*Interfaces External to the Project*	Bridge clearance during construction - will limit the size and height of construction loads. Working around Expressway bridge abutments on a live road - risk of undermining road.	Current clearance will increase after Te Kowhai and Chalmers sections of road are built to their final levels - consider excavating these early as part of construction methodology. Undertake reviews of these structures at detailed design, in conjunction	3	3	H	Carry forward to Detailed Design & Construction.									
1.25	*Site Environment*	Consent conditions breached during construction	Define and agree construction management plans up front to cover all consent conditions	2	3	M	Carry forward to Detailed Design & Construction.									
1.26	*Timing*	Brownfields construction along Te Kowhai E Rd: Maintaining driveways, pedestrian footpaths and cycleways during construction, disruption to businesses	Clearly identify interface points, scope boundaries, access control & staging, and engage with affected parties early. Consider night works if appropriate. Carry forward to next design stage.	3	3	H	Carry forward to Detailed Design & Construction.									
1.27	*Site Environment*	Greenfields site - working on farmland - livestock	Clearly separate site from surrounding farmland. Maintain contact with surrounding farms to act quickly should an issue be discovered.	2	1	L	Carry forward to Detailed Design & Construction. Contractor to resolve.									
1.28	*Site Environment*	Security of construction equipment	Site security requirements to be determined prior to construction (i.e. allow suitable P&G in tender documentation)	3	2	M	Carry forward to Detailed Design & Construction.									
1.29	*Egress / Access*	Road widths affecting length of accessways for various vehicles	Conditions to limit access in some locations, HCC to impose conditions for developers consents to centralise access depending on landuse.	3	3	H	Review on a case by case basis and accommodate a carriageway with that optimises operational space, seek to combine accessways where feasible.									
1.30	*Position / Location*	road crossing of Kiwrail way, at grade remains risk of level crossing safety issues in the future.	Agreement to carry out an LCSIA	4	4	E	Carry forward to Detailed Design & Construction.									

Safety in Design / Risk Register - Pre Design Phase

Author (Role):	Ryan Ainsworth (PM)	Job No:	4288564
Approved By:	Adrian Jones	Date	10.09.2020
Revision: ject Name:	Rotokauri Arterials Designation	tage of Design / Project:	Notice of Requirement (Concept / Prelim.)
			(Note: minimum of 2 reviews per project)

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Ref	Hazard (Guideword)	Cause & Outcome	Existing controls, if any	L	C	LR	Proposed Control (1 Eliminate, 2 Substitute, 3 Reduce, 4 Control)	L	C	LR	Risk Owner	Client Approved	Design Status	Date	Risk Owner	Action Required
1.31	*Movement / Direction*	Consideration for operation requirements eg rubbish collection, street cleaning, public transport routes, heavy vehicle access, emergency services access may influence the final cross section. If this happens after the land is desination then there may need to ve some rationalisation of the space within the cross section. This will need to be fully understood in the next design phase or conditions applied for all land developement consents	None	3	2	M	Carry forward to Detailed Design & Construction.									
1.32	*Egress / Access*	On street parking provision in residentail areas. Depending on the type of developemnt some expectation that osp be provided to make up for on site reduced parking space may be encountered.	HCC to ensure residential developments have on site parking in accorance with planning requirements	3	2	M	Carry forward to Detailed Design & Construction.									
1.33	*Load / Force / Energy*	In lane bus stops impact on road safety - once traffic volumes increase.	Option to create bus bays where route risk is high	2	3	M	Review at next stage									
1.34	*Egress / Access*	Tight kerb-kerb widths creating marginal turning paths for large vehilces	Can review for use adjacent land use at the next phase - to be confirmed at DD	2	3	M	Review at next stage									
1.35	*Egress / Access*	Space at intersections where splitter islands not provided may result in faster speeds and conflict with opposing vehiles.	Review at the next stage - widen and add splitter islands if deemed necessary. Carriageway width will reduce speeds significantly.	2	3	M	Review at next stage									
1.36	*Egress / Access*	Carriageway width impacting emmergency services access due to traffic.	Discuss with emmergency services	3	3	H	Review at next stage									
1.37	*Egress / Access*	Impact to network is modal shift is not achieved, meaning more traffic on the roads creating greater congestion than anticipated, leading to low env benefits.	Traffic predictions are quite low for most of the roads - 2051 numbers up to 11,000vpd. So some potential fo mitigation by that timeframe to influence outcomes. Stagign of development also created an extended time period to ensure mitigation measures in palce.	3	3	H	Carry forward to review at the next phase - to be adressed at the Detailed Design phase.									
2	**Operation & Maintenance Phase**															
2.01	*Site Environment*	Wetland Areas - open water near children and play areas, children playing in raingardens, nuisance access into SW pipes		1	4	M	Carry forward to Detailed Design & Construction.									
2.02	*Position / Location*	Maintenance of rain gardens, planted medians / islands / berms, catchpits, mowing of grass berms, rubbish collections, sweeping of cycleways/roads/footpaths - interaction with traffic, pedestrians and cyclists	Consider maintenance frequency and metholodogy when selecting materials / products / vegetation at next stage(s) of design	1	1	L	Carry forward to Detailed Design & Construction.									
2.03	*Movement / Direction*	Traffic speed through intersections	Intersection form chosen to favour safety; consider raised table intersections in next stage(s) of design	2	4	H	Carry forward to Detailed Design & Construction.									
2.04	*Movement / Direction*	Arterial route traffic speed being excessive. Alternative routes being preferable to the Arterial yet not designed to service that volume of traffic (e.g. "rat runs"). Change to status quo in some areas could require changes in habits. Wide major roads built before the development occurs attracting high speed / dangerous drivers.	Amend legal speed and incorporate vehicle speed management devices as the development progresses. Communicate changes clearly to the community through construction and at completion.	2	4	H	Carry forward to Detailed Design & Construction.									
2.05	*Egress / Access*	Access to SW features, basins, Greenway and cycleways in safe manner.	If vehicle access is required then allowing for entry off the road to basins (spatial provision for maintenance access track made). And also allowing sufficient space around and ramp into base. Carry forward to next design stage(s).	2	3	M	Carry forward to Detailed Design & Construction.									
2.06	*Position / Location*	Location of main traffic controller box etc. could inadvertently introduce hazards during maintenance of traffic signals. Also traffic management requirements for maintenance	Consider at next stage(s) of design	2	2	L	Carry forward to Detailed Design & Construction.									
2.07	*Position / Location*	Maintenance of U/G services - limited space / risk of conflict with peds / cyclists / traffic	Consider services corridors / locations at next stage(s) of design	2	2	L	Carry forward to Detailed Design & Construction.									
2.08	*Movement / Direction*	Rail Crossing - Four lanes and active modes crossing rail with increasing rail movements. Future intensification of use not currently accounted for. Risk of pedestrian	Four-laning of level crossing secured as Deed of Grant with KiwiRail. Agreed preferred arrangement of Tasman Rd intersection with KiwiRail. Undertake LCSIA at next	3	4	H	Carry forward to Detailed Design & Construction.									
2.09	*Heights / Depths*	Slips / trips / falls - manhole covers (trip hazard, vehicle hazard), raingardens (falls), level crossing (trip hazard)	Consider appropriate specification of materials / products / edge protection at next stage(s) of design	2	2	L	Carry forward to Detailed Design & Construction.									
2.10	*Site Environment*	Parking - developers don't provide so vehicles park everywhere	Include parking requirements in development agreements, include provisions for active modes & PT within project to encourage mode shift, provide parking within cross	2	3	M	Carry forward to Detailed Design & Construction.									
2.11	*Site Environment*	CPTED issues - inadequate lighting, sight lines, facilities don't cover full journey meaning users could be encouraged toward existing unsafe routes, graffiti	Model lighting requirements at next design stage(s), highlight opportunities for high quality active mode facilities to tie into existing (and make recommendations for	2	3	M	Carry forward to Detailed Design & Construction.									
2.12	*Ergonomics*	Insufficient provision for access for all i.e. visually and physically impared	Consider correct placement / specificaiton / use of tactiles at next design stage(s)	2	3	M	Carry forward to Detailed Design & Construction.									
2.13	*Timing*	Signage & line marking degradation / deterioration results in unclear instruction to users going forward	Consider placement & specification of materials at next design stage(s)	2	4	H	Carry forward to Detailed Design & Construction.									
2.14	*Position / Location*	On street parking conflict between parked car passengers and live traffic flow	Limited on street parking provided; where this is included, sufficient width has been included in the cross sections	2	4	H	Carry forward to Detailed Design & Construction.									
2.15	*Movement / Direction*	Safety risk at driveways - vehicles, pedestrians, cyclists etc. Espeically for 2 way cycleway contra-flow riders.	Cross section width provides separation between modes at driveways. Mechanism to be in place to limit access onto Arterials (e.g. driveways)	2	4	H	Carry forward to Detailed Design & Construction.									
2.16	*Timing*	Development utilities needing to be installed after road	Engage with developers continuously throughout the project, and incorporate design amendments as and when elements can be resolved	3	3	H	Carry forward to Detailed Design & Construction.									
2.17	*Heights / Depths*	Roading / SW infrastructure interface creates hazard (e.g. steep slopes and watercourses at Greenway, wetland devices etc. in close proximity to roads / active mode corridors)	Consider edge protection / side protection at next stage(s) of design	2	3	M	Carry forward to Detailed Design & Construction.									
2.18	*Movement / Direction*	General traffic / cyclist / pedestrian user interations - risk of conflicts without dedicated cycle phasing.	Width has been included in the cross sections to provide suitable separation between mode corridors. Intersection footprint allows for details of crossing points to be resolved at resolved at subsequent design stage(s)	2	4	H	Carry forward to Detailed Design & Construction.									
2.19	*Site Environment*	Lowering of ground water from Greenway affecting exising properties	Review as part of Greenway project detailed design & groundwater effects assessment	2	3	M	Closed - considered as part of Greenway project.									
2.20	*Load / Force / Energy*	In lane bus stops impact on road safety - once traffic volumes increase.	Option to create bus bays where route risk is high	2	3	M	Review at next stage									
2.21	*Egress / Access*	Tight kerb-kerb widths creating marginal turning paths for large vehilces	Can review for use adjacent land use at the next phase - to be confirmed at DD	2	3	M	Review at next stage									
2.22	*Egress / Access*	Space at intersections where splitter islands not provided may result in faster speeds and conflict with opposing vehiles.	Review at the next stage - widen and add splitter islands if deemed necessary. Carriageway width will reduce speeds significantly.	2	3	M	Review at next stage									

Safety in Design / Risk Register - Pre Design Phase

Author (Role):	Ryan Ainsworth (PM)	Job No:	4288564
Approved By:	Adrian Jones	Date	10.09.2020
Revision: ject Name:	Rotokauri Arterials Designation	tage of Design / Project:	Notice of Requirement (Concept / Prelim.)

(Note: minimum of 2 reviews per project)

RISKS ASSOCIATED WITH DESIGN ELEMENTS				Risk Matrix			PROPOSED & APPROVED MITIGATION MEASURES	Mitigated Risk & Resolution							RESIDUAL RISK	
Ref	Hazard (Guideword)	Cause & Outcome	Existing controls, if any	L	C	LR	Proposed Control (1 Eliminate, 2 Substitute, 3 Reduce, 4 Control)	L	C	LR	Risk Owner	Client Approved	Design Status	Date	Risk Owner	Action Required
2.22	*Egress / Access*	Carriageway width impacting emmergency services access due to traffic.	Discuss with emmergency services	3	3	H	Review at next stage									
3	**Demolition Phase**															
3.01		None discussed / identified at this design stage				##				###						

Key;

C= Consequence 1) Low 2) Moderate 3) Significant 4) Major 5) Critical

L= Likelihood 1) Rare 2) Unlikely 3) Possible 4) Likely 5) Almost Certain

LR = Level L) Low M) Medium H) High E) Extreme

Notes: Hazards / risks considered are those that are project / site specific, non-standard / bespoke designs, special processes, high hazard risks (e.g. non 'business as usual' hazards) that have been identified at the time of the review(s). Other risks will continue to appear during the design life of the project and should be assessed and managed by appropriate parties.