TE TUPU NGĀTAHI
SUPPORTING GROWTH

Appendix E
Design Report
Pukekohe DBC

May 2023

Version 1.1

WAKA KOTAHI
NZ TRANSPORT AGENCY

New Zealand Government

Document Status

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Revision Status

Version	Date	Reason for Issue
0.1	14th April 2023	Draft for internal review
1.0	24st April 2023	For Waka Kotahi and Auckland Transport review
1.1	18th May 2023	Issued for IQA

Disclaimer

This is a draft document for review by specified persons at Auckland Transport and the New Zealand Transport Agency. This draft will subsequently be updated following consideration of the comments from the persons at Auckland Transport and the New Zealand Transport Agency. This document is therefore still in a draft form and is subject to change. The document should not be disclosed in response to requests under the Official Information Act 1982 or Local Government Official Information and Meetings Act 1987 without seeking legal advice.

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Acronym/Term	Description
AC	Auckland Council
AGRD	Austroads Guide to Road Design
AMC	Active Modes Corridor/Connection
ASD	Approach Sight Distance
AUP	Auckland Unitary Plan
AT	Auckland Transport
DBC	Detailed Business Case
LIDAR	Light Detection and Ranging
MSE	Mechanically Stabilised Earth
NIMT	Northern Island Main Trunk (Rail)
NZGD	New Zealand Geotechnical Database
NZTA / WK	Waka Kotahi New Zealand Transport Agency
NZTM	New Zealand Transverse Mercator
SGA	Te Tupu Ngātahi Supporting Growth Alliance
SMAF	Stormwater Management Area Flow
SSD	Stopping Sight Distance
TDM	Transport Design Manual

1 Introduction

This document has been prepared as Appendix H of the Pukekohe Detailed Business Case (DBC). It has been prepared to document the design development principles behind the concept designs within the Pukekohe transport network. The concept design is then used as a basis of designation setting as it provides the likely footprint of the new infrastructure.

The design report has been developed with technical inputs from a wide range of engineering design specialities including traffic, geometric, geotechnical, stormwater, urban design, road safety and structures.

The Pukekohe DBC identifies the construction of the transport network to support Pukekohe's forecast growth within the next 15 to 25 years. It is therefore anticipated the concept design contained in this document will be revised and reconfirmed at that time of implementation to reflect any changes in standards, planning conditions, network demands, and/or any other construction related matters.

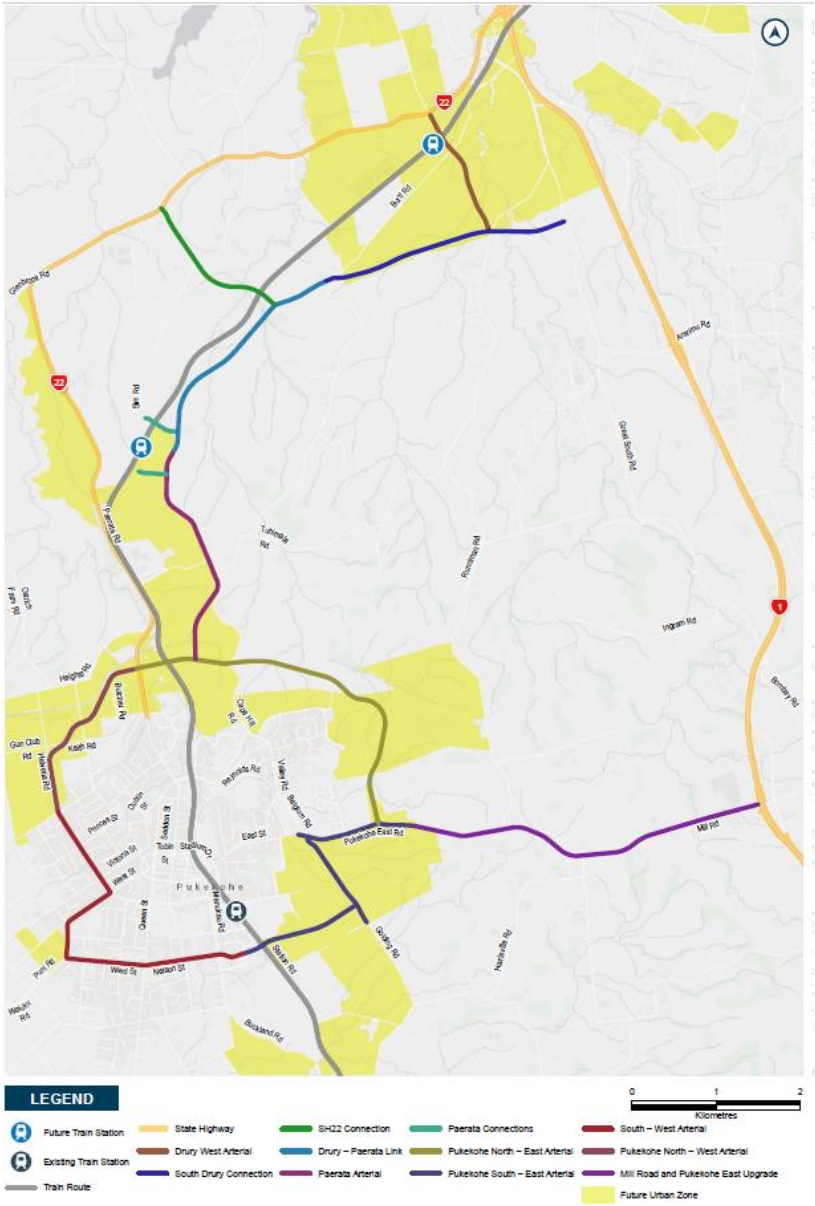


Figure 1-1: Pukekohe scope of works

2 Approach to design

Te Tupu Ngātahi Supporting Growth Alliance (the Alliance) has been established to provide route protection of strategic transport infrastructure to support the future growth of Auckland. As such, most of the projects within the Programme will not be constructed for several years, and it is anticipated that the preliminary design will need to be revised at that time to reflect the standards, transport demands, and requirements. Therefore, the design to support the option assessment process and the cost estimate will be limited to a level that supports the designation footprint, effects, and a number of generic assumptions will be made.

There are several design elements that will not be considered in the development of designs for both the concept and recommended option design development as they will not inform the assessment of effects. The design elements where there will be no specific design developed are as follows:

- Pavement design and road surfacing
- Street lighting
- Road safety barriers
- Utilities design
- Signs and line markings
- Traffic signal design
- Advanced Traffic Management Systems (ATMS) requirements
- Intelligent Traffic Systems (ITS)
- Landscape design, and
- Urban streetscape design features.

2.1 Interface with Other Projects

The Pukekohe programme of works have interfacing requirements imposed by the projects and developments listed in

Table 1 - Interfacing Projects

Project / Development Name	Interfacing Requirements
KiwiRail Drury West Railway Station Ngaakooroa – Transport Interchange and accessways Notice of Requirement	• Future connection with Drury West Ngaakooroa Rail Station
KiwiRail Paerata Station Designation	• Future connection with Paerata Rail Station
Kiwi Rail/ Auckland Transport NIMT 4 tracking and Active Modes Corridor (AMC)	• 4 tracking and AMC space allocation were taken into consideration when designing structures over the NIMT.
Paerata Rise – Grafton Downs development	• Interface with Sim to Sim Connection. The intent is for the new road to connect with Paerata Rise development

SH1 Papakura to Bombay Motorway Project	• Connection with Future Mill Road Bombay interchange improvements • Future connection with proposed Drury South Interchange at SH1 / Great South Road
SH22 Drury upgrade	• Tie in with Karaka Road (SH22) / Jesmond interchange and SH22 works near Sim Road

2.2 Topographical survey and aerial photography

2.2.1 Topographical survey

Light detection and ranging (LiDAR) is an optical remote-sensing technique that uses laser light to densely sample the surface of the earth, producing highly accurate x, y, z measurements. LiDAR data was provided by Land Information New Zealand (LINZ) and has been used to develop the preliminary design for the road corridors part of this package.

New Zealand Transverse Mercator (NZTM) projection is the coordinate system for the project. The vertical datum is named AUK46, obtained from Auckland Council.

2.2.2 Aerial photography

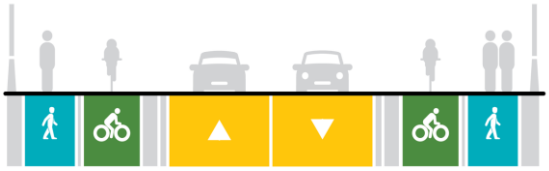
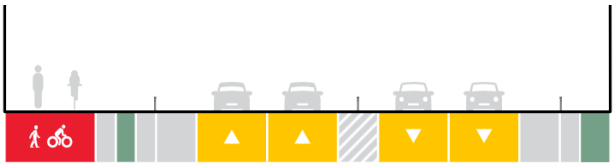
The aerial photography is provided by Nearmap Ltd at an image resolution of 6.0cm ground sampling distance (GSD). The orthophotography flown over the southern area twice yearly, imagery at present is from 2021 - 2022.

2.3 Corridor form and function

Table 2 provides a summary of the general form and function of the Pukekohe corridors. Alternative corridor cross sections used are outlined where relevant.

Table 2 Summary of the form and function

Road corridor	Typical cross section
Four lane arterial – 30m cross section	

Road corridor	Typical cross section
Two lane arterial – 24m cross section	
Two lane arterial bridge – 18m cross section	
Four lane high speed rural – 30m minimum cross section	
Two lane high speed rural – 24m minimum cross section	

2.4 Intersection Form and Function

Figure 2-1 provides a summary of the proposed intersection forms. Refer to the Appendix G Transport Outcomes Report within the Detailed Business Case for further details regarding intersection form and function of the corridor.

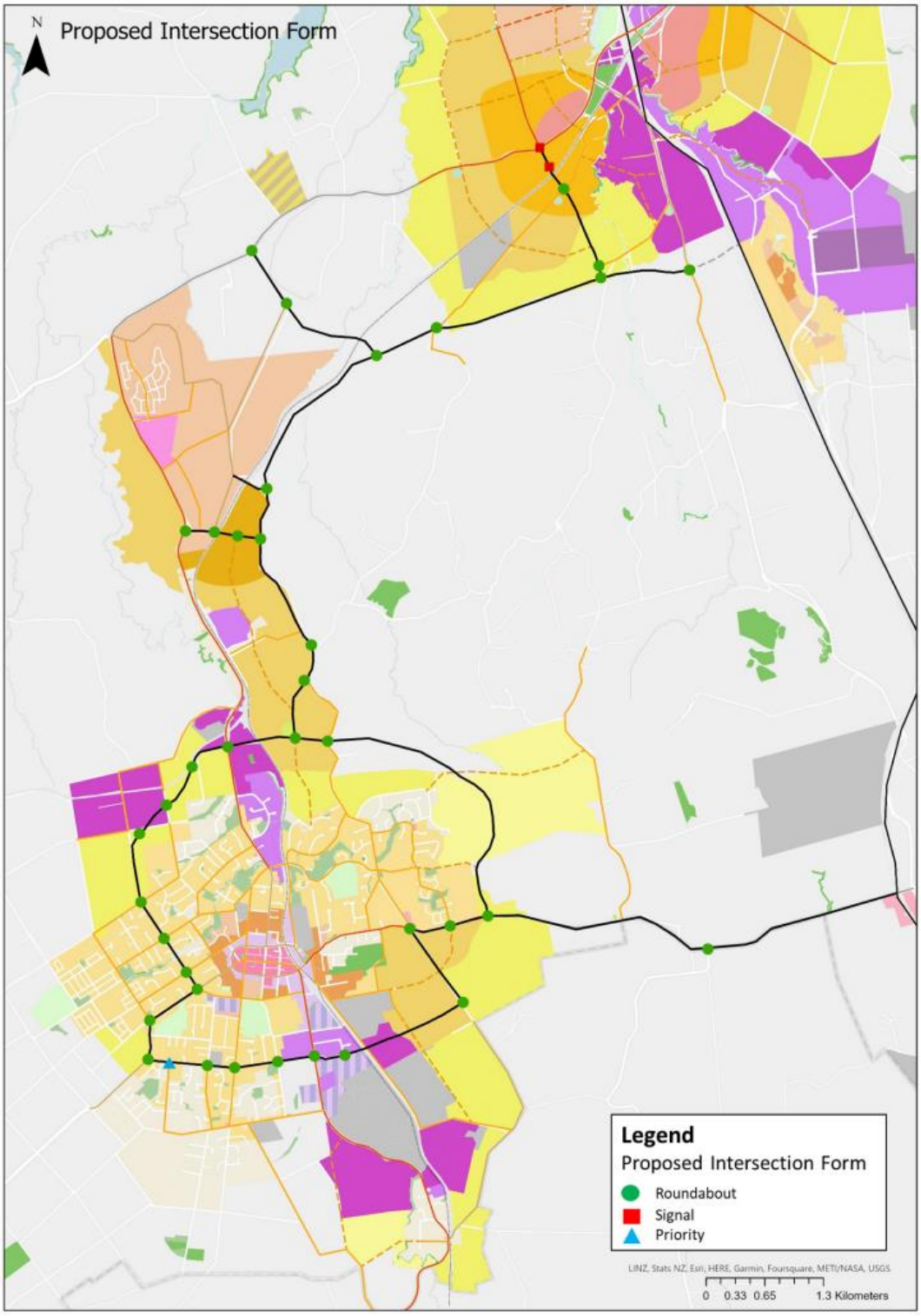


Figure 2-1: Pukekohe indicative intersection forms

2.5 Access and driveways

The need to restrict turn movements into accessways to left-in left-out varies and the design and designation allow flexibility for the exploration of different solutions as best suited for the location and land use, at a time when implementation is planned.

Specific design for regrading driveways has not been carried out for this preliminary level of design. However the effect on existing driveways has been assessed in conjunction with the proposed horizontal and vertical position of the road and road cross-sections. Adjustments to avoid significant impact to properties and driveways are accessed to comply with the TDM in the first instance. Where driveway compliance is not able to be achieved, this has generally resulted additional designation to provide required driveway grading.

2.6 Clearance Envelope

The following clearance envelopes have been taken into consideration when designing Pukekohe, as set out in Table 3.

Table 3 Clearance envelope

Items	Clearance envelope	Considerations
Road over Road	8m vertical clearance and horizontal clearance to accommodate existing road cross section	8m vertical clearance would accommodate an over dimension (OD) vehicle route
Road over stream	Bridge crossing – 3.0m vertical clearance (stream flood level to road surface)	Vertical clearance consisting of: • 1.2m freeboard to bridge structure soffit in accordance with bridge manual • 1.8m allowance for bridge structure
Road over rail	Absolute minimum horizontal clearance per Figure 2-2. 30m desirable minimum horizontal clearance 7.8m absolute minimum vertical clearance 8.0m desirable vertical clearance	Absolute minimum horizontal clearance varies to accommodate rail four tracking scenarios as shown below on Figure 2-2. Absolute minimum vertical clearance consisting of: • 5.5m rail vertical clearance, according to KiwiRail standards as shown below on Figure 2-2 • 0.2m rail height above sleepers/ballast • 2.1m for bridge superstructure (deck + beam) and surfacing

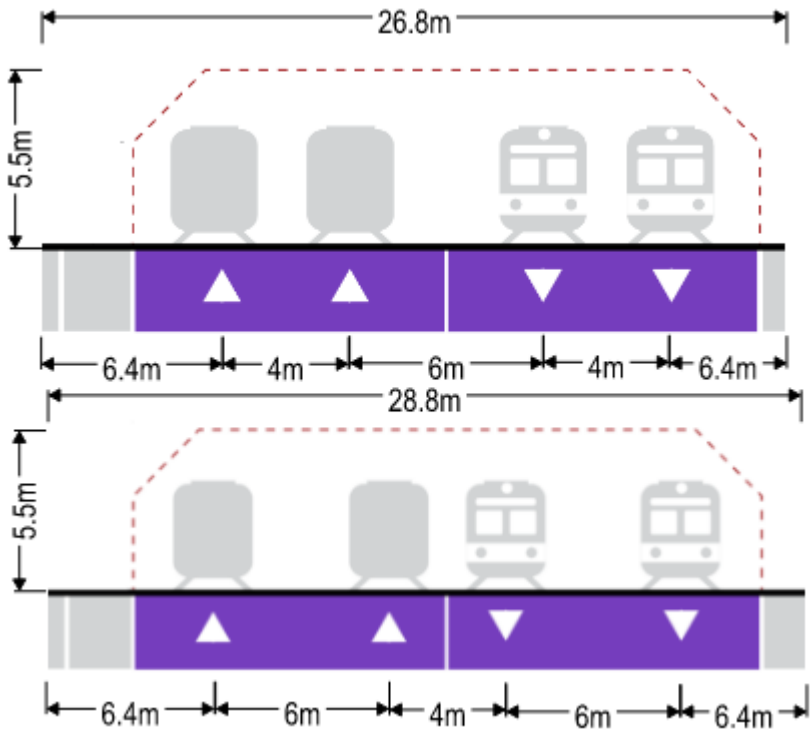


Figure 2-2 Absolute minimum clearance requirements for four-tracking, with two future tracks to one side of existing tracks (top) and a future track to either side of existing tracks (bottom).

2.6.1 Roading geometric design

Table 4 describes the general elements of the geometric design from a roading point of view.

Table 4 Approach to geometric design (general elements)

Design element	Approach to design	Comments
Cross section	As per section 2.3 of this report	
Clearance envelope	As per section 2.6 of this report	N/A
Accessway and driveways	As per section 2.5 of this report	N/A
Signalised intersections	Intersection form and stacking lanes details are as per Appendix C Transport Outcomes Report.	Splitter islands are to be added on the mainline corridor in a case by case scenario assessed by the designer.
Uncontrolled intersections	To utilise the existing geometry as much as possible.	N/A
Slope embankment and retaining walls	As per section 2.7 of this report.	• N/A

Table 5 describes the key elements of the geometric mid-block design at a 50km/hr posted speed.

Table 5 Approach to geometric design - 50kph

Design element	Approach to design	Comments
Posted Speed	50 km/hr	N/A
Design Speed	Horizontal – 50 km/hr Vertical – 60 km/hr*	As per TDM Geometric design *Excludes tie in with existing roads where Approach Sight Distance (ASD) minimum requirements for 50km/hr design speed
Horizontal alignment*	Minimum radius 120m for minimum curve length of 70m. This allows 3.0% adverse crossfall to be applied.	As per AGRD Part 3
Vertical alignment	Grade: • Desirable 5% • Maximum 8% Minimum crest curve: • K=11.8 Minimum sag curve: • K=6 Minimum length: • 40m	Maximum grade as per TDM without requiring specific treatment for pedestrian routes. Minimum crest curve and sag curve as per AGRD Part 3.
Single lane roundabout	ICD of 41m for single lane roundabout within existing urbanised area.	The typical section of an ICD of 41m consists of a 11m central island radius and 9.25m circulating carriageway width.
Multi lane roundabout	ICD of 55m for multilane lane roundabout within existing urbanised area.	The typical section of an ICD of 55m consists of a 13.2m central island radius and 14.3m circulating carriageway width.

Table 6 describes the key elements of the geometric mid-block design at a 60km/hr posted speed.

Table 6 Approach to geometric design (60kph)

Design element	Approach to design	Comments
Posted Speed	60 km/hr	N/A
Design Speed	Horizontal – 70 km/hr Vertical – 70 km/hr	As per TDM Geometric design
Horizontal alignment* *Excludes design specific to intersections and accessways	Minimum radius 200m for minimum curve length of 140m. This allows no greater than 5% superelevation to be applied and that a spiral is not required.	As per TDM Geometric design adverse crossfall not permitted on roads with design speed greater than 50 km/h. As per TDM Geometric design maximum super-elevation should be limited to 5% in areas where pedestrian movements are prevalent. As per SHGDM minimum radius of 280m for maximum superelevation application of 5%

Vertical alignment	Grade: • Desirable 5% • Maximum 8% Minimum crest curve: • K=19.1 Minimum sag curve: • K=13	Maximum grade as per TDM without requiring specific treatment for pedestrian routes. Minimum crest curve and sag curve as per AGRD Part 3.
Single lane roundabout	ICD of 55m for single lane roundabout within existing urbanised area / Future Urban Zone	The typical section of an ICD of 55m consists of a 18m central island radius and 9.25m circulating carriageway width.
Multi lane roundabout	ICD of 65m for multilane lane roundabout within existing urbanised area.	The typical section of an ICD of 65m consists of a 20m central island radius and 12.35m circulating carriageway width.

Table 7 describes the key elements of the geometric mid-block design at a 80km/hr posted speed.

Table 7 Approach to geometric design (80kph)

Design element	Approach to design	Comments
Posted Speed	80 km/hr	N/A
Design Speed	Horizontal – 90 km/hr Vertical – 90 km/hr	As per TDM Geometric design
Horizontal alignment* *Excludes design specific to intersections and accessways	Minimum radius 450m for minimum curve length of 230m. This allows no greater than 5% superelevation to be applied and that a spiral is not required. Exclusion is existing curves with radius <450m and superelevation > 5%.	As per TDM Geometric design adverse crossfall not permitted on roads with design speed greater than 50 km/h. As per TDM Geometric design maximum super-elevation should be limited to 5% in areas where pedestrian movements are prevalent. As per SHGDM minimum radius of 450m for maximum superelevation application of 5%
Vertical alignment	Grade: • Desirable 5% • Maximum 8% Minimum crest curve: • K=42.9 Minimum sag curve: • K=21	Maximum grade as per TDM without requiring specific treatment for pedestrian routes. Minimum crest curve and sag curve as per AGRD Part 3.
Single lane roundabout	ICD of 65m for single lane roundabout within existing rural area.	The typical section of an ICD of 65m consists of a 22m central island radius and 9.25m circulating carriageway width.

Multi lane roundabout	ICD of 73m for multilane lane roundabout within rural area.	The typical section of an ICD of 73m consists of a 24m central island radius and 12.35m circulating carriageway width.

2.7 Geotechnical design

2.7.1 Slope stability

No numerical analysis has been carried out in this phase of design, with assessment based on review of recent and historic investigation data. Stability of slopes has been assessed based on the mapped geomorphology, and the performance of similar geological areas.

1V:3H slopes have been adopted as the default batter for cut and fill slopes to meet maintenance requirements for most of the alignment. Within the Auckland region, similar slopes have been widely utilised successfully in soils that do not have known slope instability issues.

The exception to this is where the alignment crosses alluvial, or swamp deposits as shown on the geological map. In this scenario, embankment side slopes of 1V:4H have been adopted and not the general 1V:3H applicable for the remainder of the soils in the Pukekohe area. Alluvial deposits may be highly variable and incorporate soft layers, with a low bearing capacity and potential for toe failures; excess settlement is likely and liquefaction possible. The swamp deposits are expected to include peat and organic soils and their adverse characteristics are likely to be worse. Some soils with these adverse characteristics may be present in other associated deposits (eg fan deposits and, terrace deposits) but their extent is expected to be significantly less and persevering with 1v:3h embankment slopes is recommended.

2.7.2 Retaining walls

Vertical retaining walls have been placed where necessary to limit impact on properties and manage topographic constraints. Fill walls have been assumed to be constructed using generic mechanically stabilised earth techniques.

Given the limited geotechnical information available, the form of retaining walls has not been determined, with the most suitable wall types identified to inform the construction method statement and cost estimation.

Final decisions around wall type will be undertaken during subsequent design phases once further site investigation is carried out.

2.7.3 Bridge abutments

Vertical abutment walls have been adopted as the default approach to bridge abutments within the existing urbanised/industrial area. The vertical abutment walls have been assumed to be constructed using mechanically stabilised earth walls.

No specific design of abutment walls slope stability has been carried out during this phase of design.

2.8 Structures design

The following design standards have been referenced for this design:

- The NZTA: Bridge manual 3rd edition published, Revision 4
- The NZTA: Highway structures design guide 1st edition
- NZTA Research Report 364: Standard precast concrete bridge beams

Given the high-level nature of design input, the route protection philosophy is that no preliminary or detailed design is undertaken for the structures, but only concept form and function.

Bridge skew angles are limited to a maximum of 30 degrees relative to the service being crossed to maximise future design options. Typically, girder type and box type bridge decks are only suitable up to skews of 30 degrees.

Bridge Span Articulation definition is as follows:

- Single span bridges up to a maximum span of 35 m
- Multi-span bridges for spans in excess of 35 m, or as dictated by geometric constraints.

2.9 Stormwater Design and Flooding

Stormwater design includes four separate yet inter-related considerations:

- Stormwater runoff capture / conveyance system design,
- Treatment design (water quality mitigation),
- Water quantity design (hydrologic mitigation and attenuation) and
- Flood effect mitigation (peak flow increase and displacement effects).

Each of these stormwater design features are prescribed for management within Auckland Council Guidelines and/or required by the Unitary Plan - Operative in Part (AUP:OP).

The Auckland Design Manual, the Auckland Transport Design Manuals and the Unitary Plan are the key documents that govern the stormwater design approach. For road corridors under NZTA jurisdictions, relevant Waka Kotahi NZTA's design standards will be applied, including NZTA P46 Stormwater Specification.

In general, the key stormwater objectives are to provide stormwater treatment and retention/detention for new impervious surfaces, re-use and re-purpose existing infrastructure, enhance with green infrastructure and provide treatment of existing surfaces where possible, including where existing runoff mixes with new prioritising high loading areas such as intersections.

2.9.1 Stormwater runoff capture and conveyance

The Road Drainage chapter of the Auckland Transport Design Manual sets out the performance requirements for stormwater capture and conveyance systems for local roads in Auckland. The details of this system shall be developed and confirmed at the resource consent application phase of the project. The approach for each new road section will typically require a kerb and channel along the road edge with a concrete barrier at the bridge sections to intercept road runoff. The intercepted flow will be captured in catchpits and conveyed via a new piped network to a stormwater treatment,

detention, and attenuation system. Where swale conveyance is a suitable option, this approach has been taken instead of kerb and channel conveyance systems.

2.9.2 Stormwater treatment and hydrologic mitigation

Stormwater runoff is considered polluted when flowing from high vehicle use impervious areas. The Auckland Unitary Plan (AUP), chapter E9 considers the construction of roads, up to 5000m² of new impervious road area, as a permitted activity and treatment is required in accordance with Guidance Document 2017/001 Stormwater Management Devices in the Auckland Region (GD01). Raingardens/bioretention systems, planted or grassed swales, wetlands and proprietary cartridge treatment systems are common practice to meet this requirement.

In Pukekohe project, wetlands are the preferred stormwater treatment option. If wetland is not feasible due to space or flood plain constraint, treatment swales, proprietary SWMDs or linear SWMD (i.e. raingarden), will be used.

Hydrologic mitigation refers to the detention and slow release of stormwater runoff to prevent downstream erosion. The Auckland Unitary Plan E10 defines the approach detention as either SMAF1 or SMAF 2. SMAF is an acronym for Stormwater Management Area Flow and generally refers to control overlay in the unitary plan where the requirement is identified based on downstream environment sensitivity. However, AUP:OP chapter E8 contains a trigger for restricted discretionary activities that require SMAF 1 hydrologic mitigation regardless of being in the SMAF control overlay or not.

High-use road water quality treatment requirements and SMAF hydraulic mitigation requirements are considered when sizing wetlands for Pukekohe project.

2.9.3 Flood effect mitigation

Flood effects can arise by blocking overland flowpaths, adding new impervious area (reducing the soil storage capacity) and by displacing flood storage, typically by filling earth in the floodplain. Two approaches are available to assessing and mitigating flood effects:

1. Utilising the existing Auckland Council Flood model to calculate the effects and iterate a mitigation solution that could include, offset storage, culverts or both.
2. Providing a compensatory volume of 1m³ of fill in the floodplain equal to 1m³ of offset storage as compensation.

All earthworks in flooded regions are potential sources of flood effects and may require mitigation. Flood effects and mitigation is discussed in greater detail in the Flood Assessment of Environmental Effects (AEE).

3 Drury West Arterial

Table 8 describes the key elements of the Drury West Arterial design. Refer drawings SGA-DRG-STH-002-GE-1000 in Appendix E1 of this report for general arrangement plan.

Table 8 Drury West Road design

Design item	Comments
Posted speed	50kph
Cross section	Four lane arterial – 30m from SH22 / Jesmond Road intersection to Burtt Road Two lane arterial - 24m cross section from Burtt Road interchange
Horizontal alignment	• Minimum radius of 200m applied.
Vertical alignment	Grades: • 5% maximum • 0.5% minimum Transition curves: • Minimum Crest K-value of 12 • Minimum Sag K-value of 14
Intersections	• Karaka Road (SH22) / Jesmond Road • Tie in with NZUP SH22 Upgrade Intersection • Drury West Station • Tie in with Drury West Ngateoroa Station Rail Station Park N' Ride • Burtt Road • New roundabout to be provided
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. An exemption is 1V:4H embankment batters around the alluvial deposits (Ngakoroa stream) surrounding the 100m long bridge.
Bridge design	75m long new bridge over existing N.I.M.T rail line and future 4 tracking. 27m long new bridge over existing stream. 100m long new bridge over flood plain. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 3 wetlands are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

4 South Drury Arterial

Table 9 describes the key elements of the South Drury Arterial design. Refer drawings SGA-DRG-STH-002-GE-2200 and SGA-DRG-STH-002-GE-2300 in Appendix E1 of this report for general arrangement plan.

Table 9 South Drury Arterial Road design

Design item	Comments
Posted speed	50kph
Cross section	Two lane arterial - 24m two lane cross section as per Table 2.
Horizontal alignment	• Minimum radius of 300m applied.
Vertical alignment	Grades: • 5% maximum • 0.5% minimum Transition curves: • Crest K-value of 30 • Sag K-value of 25
Intersections	• New roundabout at Drury West / Runciman intersection • New Roundabout and T-intersection at South Drury / Burtt Road intersection
Embankment slope	Alluvial and swamp deposits predominantly underlie the alignment between the two new roundabouts. A 1V:4H embankment batter is recommended on these deposits and the surrounding area of the new 90 m bridge. The remainder of the soils in this region can follow the default design of 1V:3H.
Bridge design	65m long new bridge over existing stream. 90m long new bridge over existing stream. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 5 wetlands are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

5 SH22 Connection

Table 10 describes the key elements of the SH22 Connection design. Refer drawing SGA-DRG-STH-002-GE-2400 in Appendix E1 of this report for general arrangement plan.

Table 10 SH22 Connection design

Design item	Comments
Posted speed	80kph
Cross section	Two Lane high speed rural 24m cross section as per Table 2.
Horizontal alignment	Minimum radius of 450m applied.
Vertical alignment	Grades: • 5% maximum (except 50m length at 7.7% to match existing on Sim Road) • 0.5% minimum Transition curves: • Crest K-value of 42.9 • Sag K-value of 21
Intersections	• New roundabout at intersection with Sim Road • New roundabout at intersection with SH22 • New roundabout at intersection with Drury-Paerata Link Proposed Corridor
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. The exemption is 1V:4H embankment batters around the alluvial deposits which surround the 80m long bridge.
Bridge design	80m long new bridge over existing stream. 35m long new bridge over existing N.I.M.T rail line and future 4 tracking. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater runoff capture and conveyance	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 2 wetlands and 3 treatment swales are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

6 Drury-Paerata Link

Table 11 describes the key elements of the Drury-Paerata Link design. Refer drawings SGA-DRG-STH-002-GE-2100 and SGA-DRG-STH-002-GE-2200 in Appendix E1 of this report for general arrangement plan.

Table 11 Drury-Paerata Link design

Design item	Comments
Posted speed	80kph
Cross section	Two Lane high speed rural 24m cross section as per Table 2.
Horizontal alignment	Minimum radius of 450m applied.
Vertical alignment	Grades: • 7.22% maximum • 1.25% minimum Transition curves: • Crest K-value of 25 (at approach to Burtt Road Intersection) • Sag K-value of 22
Intersections	• New roundabout at intersection with SH22 connection • New roundabout at intersection with Paerata Connections (Sim to Sim Connection corridor) and Sim Road (where Paerata Arterial commences)
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. 1V:4H embankment batters are suggested to the west of the roundabout at intersection with SH22, and some of the surrounding area to the 135m new bridge due to the alignment crossing over the Oira Creek which has alluvial deposits.
Bridge design	135m long new bridge over existing stream and flood plain. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 3 wetlands and 4 treatment swales are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

7 Paerata Arterial

Table 12 describes the key elements of the Drury-Paerata Link design. Refer drawings SGA-DRG-STH-002-GE-2000 and SGA-DRG-STH-002-GE-2100 in Appendix E1 of this report for general arrangement plan.

Table 12 Paerata Arterial Road design

Design item	Comments
Posted speed	50kph
Cross section	CH0 to CH650 (Intersection with Cape Hill Road) - Two Lane arterial 24m cross section as per Table 2. CH650 (Intersection with Cape Hill Road) to CH 3000 - Two Lane arterial 24m cross section with cross-section width re-allocated as shown below due to being located at the urban / rural edge 
Horizontal alignment	Minimum radius 120m.
Vertical alignment	Grades: • 5% maximum (excluding one 50m length 6-8%) • 0.9% minimum Transition curves: • Crest K-value of 8 • Sag K-value of 7
Intersections	• New roundabout at intersection with Paerata Connections (Sim to Sim Connection corridor) and start of Sim Road (where Drury-Paerata Link ends) • New roundabout at intersection with Paerata Connections (Paerata Rail Station Corridor) • Replace Tuhimata Road T-intersections with single four leg roundabout • New roundabout at intersection with Cape Hill Road
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. An exemption is 1V:4H embankment batters at the intersection with the Pukekohe North East Arterial due to the swamp deposits.
Bridge design	No bridges proposed for this corridor.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10.

Design item	Comments
	3 wetlands are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

8 Paerata Connections

Table 13 describes the key elements of the Paerata Connections design. Refer drawing SGA-DRG-STH-002-GE-3000 in Appendix E1 of this report for general arrangement plan.

Table 13 Paerata Connections Road design

Design item	Comments
Posted Speed	50kph
Cross section	Two lane arterial 24m cross section as per Table 2. Median and berm widths to vary along corridor to tie into adjacent intersections and bridge.
Horizontal alignment	Minimum radius of 120m.
Vertical alignment	Grades: • 8% maximum • 2% minimum Transition curves: • Crest K-value of 12 • Sag K-value of 6
Intersections	• New roundabout at intersection with Drury Paerata Link and start of Sim Road (where Paerata Arterial commences) • New roundabout at intersection with existing Sim Road (Paerata Arterial Corridor)
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H.
Bridge design	35m long new bridge over existing N.I.M.T rail line and future 4 tracking. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. Based on this, 2 wetlands are proposed and their design will be in accordance with AC GD01.

9 Pukekohe North-East Arterial

Table 14 describes the key elements of the Pukekohe North-East Arterial design. Refer drawings SGA-DRG-STH-002-GE-4000 and SGA-DRG-STH-002-GE-4100 in Appendix E1 of this report for general arrangement plan.

Table 14 Pukekohe North East Arterial design

Design item	Comments
Posted speed	50kph (CH0-1200) 6kph (CH1200-4400)
Cross section	Two lane arterial 24m cross section as per Table 2.
Horizontal alignment	Minimum radius of 225m.
Vertical alignment	Grades: • 7% maximum • 0.5% minimum Transition curves: • Crest K-value of 17 • Sag K-value of 16
Intersections	• New roundabout at intersection with Paerata Road (SH22) • New roundabout at intersection with Paerata Arterial • New roundabout at intersection with Cape Hill Road
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. 1V:4H embankment batters have been applied the area that ties in with Paerata Arterial due to the swamp deposits.
Bridge design	95m long new bridge over existing N.I.M.T rail line and future 4 tracking. 60m long new bridge over existing stream and flood plain. 47m long new bridge over existing stream and flood plain. 80m long new bridge over existing stream and flood plain. 60m long new bridge over existing stream and flood plain. 60m long new bridge over existing stream and flood plain. 95m long new bridge over existing stream and flood plain. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 2 wetlands are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the

Design item	Comments
	existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

10 Pukekohe South-East Arterial

Table 15 describes the key elements of the Pukekohe South-East Arterial design. Refer drawings SGA-DRG-STH-002-GE-5000 and SGA-DRG-STH-002-GE-5100 in Appendix E1 of this report for general arrangement plan.

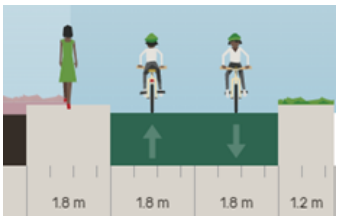
Table 15 Pukekohe South East Arterial design

Design item	Comments
Posted speed	50kph
Cross section	Two lane arterial 24m cross section as per Table 2.
Horizontal alignment	Minimum radius of 120m.
Vertical alignment	Grades: • 11% maximum (matching existing as agreed with AT) • 0.2% minimum (matching existing) Transition curves: • Crest K-value of 8 (matching existing as agreed with AT) • Sag K-value of 5 (matching existing as agreed with AT)
Intersections	• New roundabout at intersection with Svendsen Road / Crosbie Road / Wrightson Way • New roundabout at intersection with Golding Road • Upgraded roundabout at intersection of Golding Road / Pukekohe East Road • New roundabout at intersection of Pukekohe East Road and Pukekohe North-East Arterial
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. The exemption is 1V:4H embankment batters around the channel of alluvial deposits which run parallel to the stream south of the Golding Road roundabout.
Bridge design	65m long new bridge over existing N.I.M.T rail line. Clearance envelope per Section 2.6 and structural design to comply with structural requirements Section 2.8.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 5 wetlands are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.

11 Pukekohe South-West Arterial

Table 16 describes the key elements of the Pukekohe South-West design. Refer drawings SGA-DRG-STH-002-GE-6000 and SGA-DRG-STH-002-GE-6100 in Appendix E1 of this report for general arrangement plan.

Table 16 Pukekohe South-West Arterial Road design

Design item	Comments
Cross section	Cross-section as below to provide bi-directional cycleway and walking facility within existing urban environment.  As per Auckland Transport Technical Note Cycleway Delivery Scope and Design Standards (22/04/2022) • Berm can be reduced from 1.2m to absolute minimum of 0.6m • Cycling facility can be reduced from 3.6m to absolute minimum of 3m.
Horizontal alignment	Unchanged from existing
Vertical alignment	Unchanged from existing
Intersections	Unchanged from existing
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H.
Bridge design	No bridges proposed for this corridor.
Stormwater runoff capture and conveyance	The general solution for this design will be to intercept flow in the kerb and channel on either side of the road as it flows away from the road high point and into the existing stormwater pipe network. Where driveway grade away from the road, the new bi-directional cycleway and pedestrian footpath would also need to be graded away from the road (with a new stormwater collection system to tie into the existing stormwater pipe network). Refer image below.

Design item	Comments
Stormwater treatment	No route protection of stormwater wetlands for the new bi-directional cycleway and pedestrian footpath along the existing road corridors due to the uncertainty of the cycle facilities ever being built. From a stormwater perspective, looking at if only the intersections are upgraded / constructed to allow for change in form and safety upgrades. These areas are expected to have a hardstand area less than 5000m² and not located in a SMAF overlay, meaning hydrologic mitigation is not required. If hardstand are is greater than 5000m² it would be a restricted discretionary (RD) activity under the AUP:OP E8 (SMAF retention/detention will be required) and potentially need to comply with AUP:OP E36 (attenuate 1%AEP and 10% AEP).

12 Pukekohe North-West Arterial

Table 17 describes the key elements of the Pukekohe North-West Arterial design. Refer drawing SGA-DRG-STH-002-GE-7000 in Appendix E1 of this report for general arrangement plan.

Table 17 Pukekohe North-West Road design

Design item	Comments
Posted Speed	50kph
Cross section	Two lane arterial 24m cross section as per Table 2. Median and berm widths to vary along corridor to tie into adjacent intersections and bridge.
Horizontal alignment	Minimum radius of 150m.
Vertical alignment	Grades: • 5% maximum • 0.55% minimum Transition curves: • Crest K-value of 7 • Sag K-value of 7
Intersections	• New Heights Road / Gun Club Road T-intersection • New roundabout at intersection with Gun Club Road • New roundabout at intersection with Butcher Road
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. The exception is 1V:4H embankment batter slopes on Helvetia Road which is underlain by alluvial deposits.
Bridge design	No bridges proposed for this corridor.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 3 wetlands are proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.
Flood effect mitigation	Flood mitigation will be assessed, and mitigation proposed at a more advanced design phase

13 Mill Road Upgrade

Table 18 describes the key elements of the Mill Road upgrade design. Refer drawings SGA-DRG-STH-002-GE-8000 and SGA-DRG-STH-002-GE-8100 in Appendix E1 of this report for general arrangement plan.

Table 18 Mill Road design

Design item	Comments
Posted speed	80kph
Cross section	Four lane high speed rural minimum 30m cross section as per Table 2. Median and berm widths to vary along corridor to tie into adjacent intersections and bridge.
Horizontal alignment	Minimum radius of 320m applied to match existing.
Vertical alignment	Grades: • 7% maximum • 0.5% minimum Transition curves: • Crest K-value of 20 (matching existing) • Sag K-value of 20 (matching existing)
Intersections	• New roundabout at intersection with Harrisville Road • Tie in with Bombay interchange
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. The exception is 1V:4H embankment batter slopes at the eastern edge which is underlain by alluvial deposits of the Ngaakooroa Stream.
Bridge design	No bridges proposed for this corridor.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. Based on this, swales are proposed

14 Pukekohe East Road Upgrade

Table 19 describes the key elements of the Mill Road upgrade design. Refer drawings SGA-DRG-STH-002-GE-5100 and SGA-DRG-STH-002-GE-8000 in Appendix E1 of this report for general arrangement plan.

Table 19 Pukekohe East Road design

Design item	Comments
Posted speed	80kph
Cross section	The existing road will remain with wire rope provided and a new 4m wide shared path on the southern side separated by berm or stormwater swale
Horizontal alignment	Unchanged from existing
Vertical alignment	Unchanged from existing
Embankment slope	The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H.
Bridge design	No bridges proposed for this corridor.
Stormwater	Water quality treatment, detention and SMAF hydrology mitigation is required by the Auckland Unitary Plan, Activity A7 of Chapter E9, Activity A5 of Chapter E8 and Activity A7 of Chapter E10. 1 swale is proposed and their design will be in accordance with Auckland Council GD01. The location of each wetland has been decided firstly by the geometric low points in the road longitudinal alignment. The wetlands are all placed on the downhill side of the road so the wetlands can outfall to a downstream point relative to the road location on the existing terrain slope. Each wetland is located such that floodplain, ecological features and important property features are avoided as much as possible.