TE TUPU NGĀTAHI
SUPPORTING GROWTH

North DBC

Appendix H – Design Report

Version 1.0

WAKA KOTAHI
NZ TRANSPORT AGENCY

New Zealand Government

Document Status

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0.1	6 April 2023	Draft for internal review
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Disclaimer

This is a draft document for review by specified persons at Auckland Transport and Waka Kotahi NZ Transport Agency. This draft will subsequently be updated following consideration of the comments from the persons at Auckland Transport and Waka Kotahi NZ 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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1. Introduction

This document forms Appendix H of the North Detailed Business Case and covers the principles behind the concept designs for the routes that form the proposed North transport network (refer to Figure 1-1). These concept designs provide an indicative footprint of the required physical works and were used as the basis for setting designations for route protection.

The concept designs were developed with technical inputs from a range of engineering specialities, notably: transport planning, geometrics, structural, geotechnical, stormwater, urban design and road safety.

The North Detailed Business Case identifies the transport network needed to support the forecast growth of north within the next 10 to 30 years. It is therefore anticipated the concept designs contained in this document will be revised and re-confirmed at the time of implementation to reflect any changes to standards, planning conditions, network demands, and/or any other construction related matters.

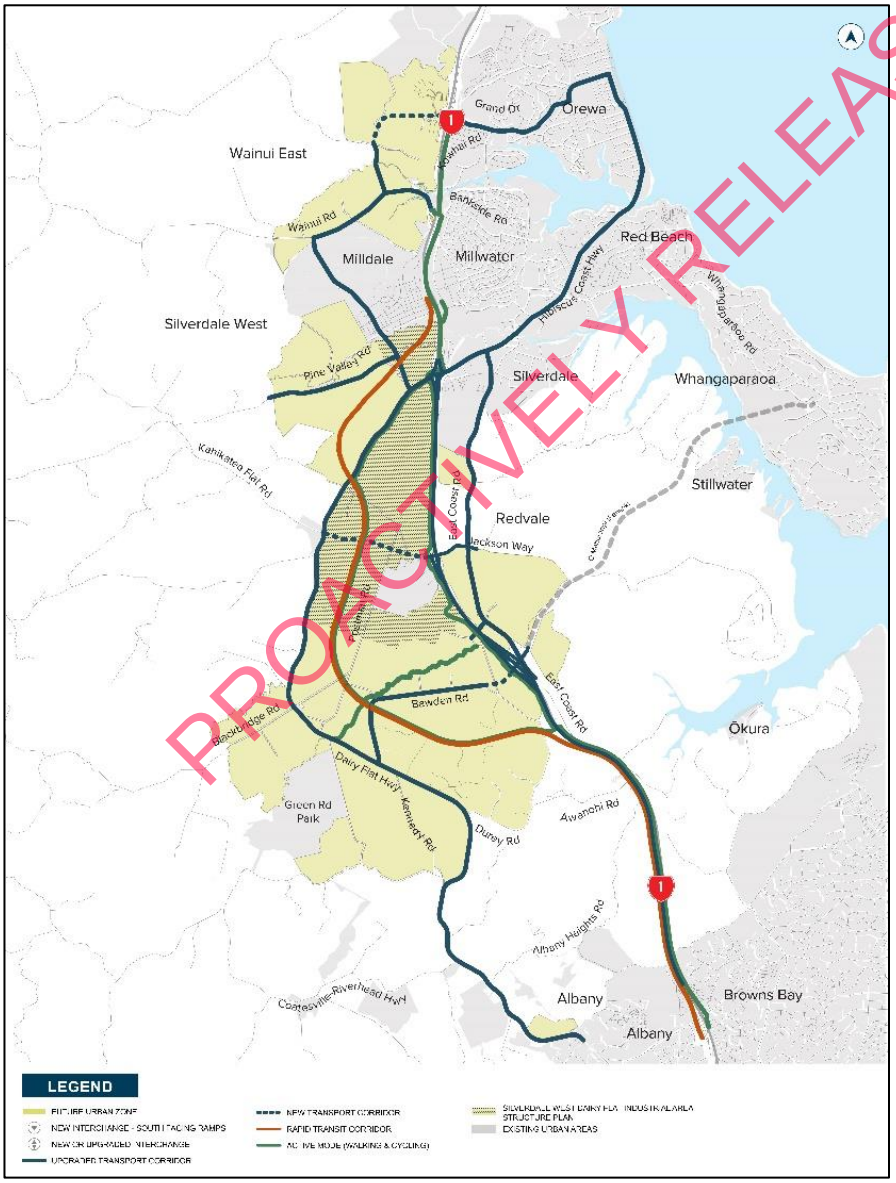


Figure 1-1: Transport network map for North Auckland

2. Approach to Design

Te Tupu Ngātahi Supporting Growth was 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 many years, and it is anticipated that the concept designs presented in this report will need to be revised at the time of implementation to reflect the standards, transport demands and requirements of the day.

Therefore, the design effort to support the option assessment process and cost estimation was limited to a level that supported the determination of designation footprint and effects, with generic assumptions made.

Design effort for the elements listed below are considered relevant for future detailed design and implementation phases, and therefore not considered in the development of route options and the concept designs presented in this report.

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

2.1 Interface with Other Projects

The North programme of works have interfacing requirements imposed by the projects and developments listed in Table 2-1 below. These are generally listed from north to south.

Table 2-1: Interfacing Projects

Project / Development Name	Interfacing Requirements
Ara Hills Development	• Future connection of Upper Orewa Road Extension to the development and onto Grand Drive.
Milldale Development	• Termination of the Wainui Road upgrade at Lysnar Road. • Proposed designation for New Argent Lane between Wainui Road and Old Pine Valley Road.
332 Wainui Road Development	• Wainui Road upgrade to avoid encroachment within that development.

Project / Development Name	Interfacing Requirements
Highgate Bridge	• New crossing that extends John Fair Drive over the northern motorway to Highgate Parkway. Impacts on the approach levels for the rapid transit corridor at Milldale station.
Argent Lane Extension Project	• Pine Valley East station for the rapid transit corridor • Upgrades to Dairy Flat Highway between New Pine Valley Road and the Silverdale interchange.
The Avenue	• Tie in for the southern end of the Dairy Flat Highway upgrade.

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, to produce plan positional and elevation 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 and elevations refer to the New Zealand Vertical Datum 2016.

2.2.2 Aerial Photography

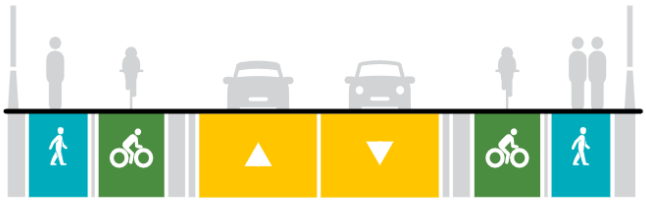
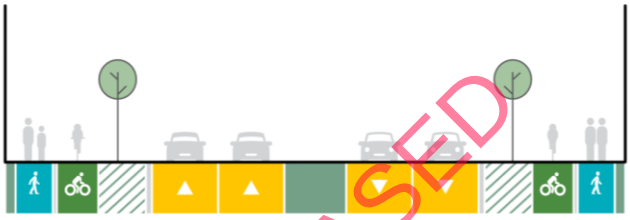
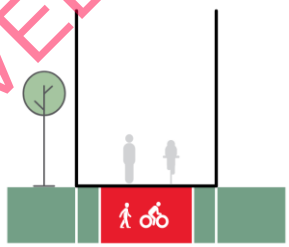
The aerial photography used for concept design development was provided by Nearmap Australia Pty Ltd. The imagery was captured in September 2022.

2.3 Corridor Form and Function

Table 2-2 summarises the general form and function of the corridors that make up the North transport network. Alternative, route-specific cross sections that are used are outlined in section 0 of this report, where relevant.

Table 2-2: Summary of General Corridor Form and Function

Description	Typical Cross Section
Two lane arterial – 24m cross section	

Description	Typical Cross Section
Two lane arterial – bridge – 18m cross section	
Four lane arterial – 30m cross section	
Four lane arterial – bridge – 24m cross section	
Active mode – 6m cross section	
Rapid transit corridor – 14m cross section	
Rapid transit corridor – 20m cross section	

2.4 Intersection Form and Function

Refer to the Transport Outcomes Report (Appendix G) of the North Detailed Business Case for intersection locations, types and form and function.

2.5 Access and Driveways

Specific design for regrading driveways was not carried out within the concept designs. Instead:

- The proposed horizontal and vertical position of the proposed roads was reviewed against property accesses or driveways,
- Adjustments to avoid significant impact to properties and driveways were assessed to comply with the AT Transport Design Manual in the first instance, and
- Where driveway compliance was not able to be achieved, designation of the entire property is proposed (except where such properties are in the Future Urban Zone).

2.6 Geometric Design

The key elements of roading geometric design are summarised in Table 2-3.

Table 2-3: Approach to Geometric Design

Design Element	Approach to Design	Comments
Cross section	As per section 2.3 of this report	Refer to section 0 of this report for alternative cross sections applied, where relevant.
Posted speed	50km/hr – arterial roads, typical 60km/hr – arterial roads, selected 80km/hr – rapid transit corridor 100km/hr – motorway	n/a
Design speed	Arterial roads Along existing: • Horizontal – 50km/hr • Vertical – 60km/hr (desirable), 50km/hr (min.) New: • Horizontal – 60km/hr (desirable), 50km/hr (min.) • Vertical – 60km/hr Rapid transit corridor Refer section 3.1 of this report Motorway Refer section 3.4 of this report	Consistent with AT Transport Design Manual (for arterial roads)

Design Element	Approach to Design	Comments
Horizontal alignment	Arterial roads • Minimum radius 120m for minimum curve length of 70m for 50km/h design speed • 220m minimum radius with a curve length of 100m for 60km/h design speed • 3.0% adverse crossfall applied Rapid transit corridor Refer section 3.1 of this report Motorway Refer section 3.4 of this report	Consistent with Austroads GRD Part 3: Geometric Design (for arterial roads)
Vertical alignment	Arterial roads • Grade – 8% (max.) • The design minimises height of earthworks embankments where possible whilst considering cut / fill volume balance and other constraints • Road finished surface levels are designed above flood levels with minimum freeboard requirements achieved Rapid transit corridor Refer section 3.1 of this report Motorway Refer section 3.4 of this report	Maximum grade as per AT Transport Design Manual without requiring specific treatment for pedestrian routes. Minimum crest curve as per Austroads GRD Part 3: Geometric Design. Governed by sight distance requirements. Minimum sag curve as per Austroads GRD Part 3: Geometric Design. Governed by comfort requirement and conforms with increased design speed of 60km/h.
Access and driveways	As per section 2.5 of this report	n/a
Signalised intersections	Intersection form and stacking lane details are as per the Transport Outcomes Report (Appendix G) of the North Detailed Business Case.	n/a
Roundabouts	Single lane roundabout Design speed 50km/hr • Inscribed circle diameter = 41m Design speed 60km/hr • Inscribed circle diameter = 55m Double lane roundabout Design speed 50km/hr • Inscribed circle diameter = 55m Design speed 60km/hr • Inscribed circle diameter = 65m	n/a
Uncontrolled intersections	Utilise the existing geometry as much as possible and allow for tie in with main road	Consistent with Austroads GRD Part 4A: Unsignalised and Signalised Intersections (for arterial roads)

Design Element	Approach to Design	Comments
Earthworks and retaining walls	As per section 2.7 of this report	n/a
Sight distances	Checks carried out for: • Stopping sight distance (SSD) • Approach sight distance (ASD) • Safe intersection sight distance (SISD)	SSD as per Austroads GRD Part 3: Geometric Design, Section 5.3 Table 5.5. ASD for at grade intersections as per Austroads GRD Part 4A: Unsignalised and Signalised Intersections, Section 3.2.1 Table 3.1 SISD as per Austroads GRD Part 4A: Unsignalised and Signalised Intersections, Section 3.2.2 Table 3.2
Active modes	Grades: • 5% (desirable) • 8% (max.) where topography is challenging, to avoid excessive earthworks. For this grade, platforms / rest areas will be required and these can be accommodated within the designation footprint (to be completed at detailed design / implementation phase, integrating with adjacent land use).	n/a

2.7 Geotechnical Design

Given the limited nature of design input, for route protection purposes only, geotechnical assessments completed for concept design make inferences on ground conditions based on a high-level desktop study. Consideration was given to mapped geology and the nearest available, relevant geotechnical investigation data.

Actual ground and hydrogeological conditions along the various alignments are uncertain at this time, and these will influence design development decisions prior to implementation. As such, ground investigation specific to each alignment needs to be carried out to provide the required degree of confidence in ground and hydrogeological conditions for detailed design.

2.7.1 Stability of Earthworks

The adopted batter slopes for earthworks, summarised in Table 2-4, are set based on regional experience and long-term performance observations of earthworks in this area of Auckland.

Later stages of design will be required to confirm adequate stability is achieved; informed by site-specific investigation and appropriate analyses.

Table 2-4: Earthworks Batter Slopes

Element	Batter Slope
All fill slopes	1V:3H
Cut slopes in Waitemata Group soils	1V:3H
Cut slopes in Northland Allochthon soils and Tauranga Group soils	1V:5H
Note: cuts within Waitemata Group rock and Northland Allochthon rock are not assessed as part of these concept designs (i.e., all cuts are conservatively assumed to be made in soil).	

Earthworks that deviate from the default batter slope angles in Table 2-4 are identified in section 0 of this report.

2.7.2 Retaining Walls

Retaining walls are proposed only at locations, where specific impacts to property, environmental constraints and topographic constraints need to be minimised / mitigated.

Given the limited geotechnical information available, an experience-based approach to retaining walls was adopted (i.e., considered geology, topography, whether in a cut or fill situation and constructability).

An indication of suitable wall types was made to inform costing and the construction method statement. Final decisions around retaining wall types will need to be made during the design / implementation phases once further ground investigations and survey are carried out.

2.8 Structures Design

Given the high-level nature of design input, for route protection purposes only, concept-level form and function assessments have been made for the structures along the proposed routes.

In this section, 'structures' refers exclusively to bridges (single- or multi-span). Retaining structures are covered in section 2.7 of this report and no culverts of sufficient size to be considered a 'bridge' were identified in the concept-level stormwater design.

2.8.1 Standards

The following design standards were referred to for concept design:

- Waka Kotahi NZTA Bridge Manual (3rd edition, amendment 4)
- Waka Kotahi NZTA Highway Structures Design Guide (1st edition)
- NZTA Research Report 364 – Standard precast concrete bridge beams

2.8.2 Bridge Form

The philosophy on bridge superstructure form is to utilise standard precast concrete girders with cast in situ topping slabs. The intention here is to propose bridges that can be designed and constructed using readily available building materials and standard forms.

Bridge skew angles are limited to a maximum of 30° relative to the infrastructure being crossed to maximise future design options. Typically, precast concrete girder type and box type bridge decks are only suitable for skews of 30° or less.

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.

2.8.3 Vertical Clearance

The adopted vertical clearances (the clear space below girders) are consistent with the Waka Kotahi NZTA Bridge Manual, per below:

- Bridges carrying a road over another road – 6.5m (min.) for over dimension routes and 5.0m (min.) elsewhere
- Bridges carrying a road over rapid transit corridor– 6.0m
- Bridges carrying a corridor over a river / stream – 1.2m freeboard to the 100-year return period flood level, with 16.8% rainfall increase (to match Ministry for the Environment representative concentration pathway (RCP) 4.5).

Adopted depth of structure for bridges varies depending on a bridge's location and function, but is typically between 2.0m and 2.5m.

2.8.4 Bridge Abutments

Vertical abutment walls (mechanically stabilised earth walls) or 1V:3H spill-through slopes have been adopted for bridge abutments. No specific design of vertical abutment walls nor analysis of spill-through slopes was carried out as part of concept design.

2.9 Stormwater Design and Flooding

Stormwater design includes four separate yet related considerations:

- Stormwater runoff capture/conveyance system design
- Treatment design (water quality mitigation)
- Water quantity design (hydrologic mitigation)
- 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 Auckland Unitary Plan Operative in Part 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

For urban road corridors, stormwater runoff will be collected by kerb & channel, catchpits and conveyed by conventional pipe systems.

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 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/or attenuation system.

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 development of a new or redevelopment of an existing high use road greater than 5,000m^2 as a controlled activity and stormwater 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 treatment systems are common practice to meet this stormwater treatment requirement.

For the North project, wetlands are the preferred stormwater treatment option. If a 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 Operative in Part - E10 defines the approach detention as either SMAF1 or SMAF 2. Stormwater Management Area Flow (SMAF) 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 the North project.

2.9.3 Flood Effect Mitigation

Flood effects resulting from the proposed works 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 1m^3 of fill in the floodplain equal to 1m^3 of offset storage as compensation.

It can be assumed that flood effects can be managed to an acceptable level through provision of bridges or larger culverts, (and/or lengthening and raising bridges) and this design is best carried out at the time of implementation when the adjacent land use is known.

Wetlands or dry ponds may be provided for flow attenuation if required for flood effect mitigation. AEE flooding assessment input (based off the Revision A design) is anticipated to inform required flood mitigation measures. These measures will be considered in Revision B design with proposed designation updated to allow for such measures.

3. Design Summary – Route Protected Corridors

This section describes the key design features for each corridor subject to route protection, and is organised in order of assigned notice of requirement (NoR).

3.1 New Rapid Transit Corridor (NoR 1)

Summary provided in Table 3-1 and general arrangement plans contained in Appendix A (drawings SGA-DRG-NTH-200-GE-2000 – 2300).

Table 3-1: New Rapid Transit Corridor (NoR 1) Design Summary

Element	Comments
Cross section	With reference to Table 2-2: • Rapid transit corridor – 14m cross section – between Albany Station and westward deviation from SH1 • Rapid transit corridor – 20m cross section – between westward deviation from SH1 to Dairy Flat Highway • Rapid transit corridor – 14m cross section- between Dairy Flat Highway and Milldale station (terminus)
Horizontal and vertical alignment	Between Albany Station and westward deviation from SH1: applies the existing (or near to) horizontal and vertical alignment of SH1. Between westward deviation from SH1 to Milldale station (terminus): as required to provide a deceleration coefficient of 0.15, and therefore maximise flexibility on station locations in the future.
Design speed	80km/hr – between Albany Station and Pine Valley East station 60km/hr - between Pine Valley East station and Milldale station (terminus). Required to enable tight curve on approach to Milldale station to avoid SEA and QEII land on the west side. Deemed acceptable given the relatively short distance between the two stations (~1.3km).
Interface with existing local roads	Severance of Wilson Road: • South leg of Wilson Road can be accessed via connection to Ashwood Avenue and then Dairy Flat Highway • North leg connects to Bawden Road Truncation of Grace Hill Drive. Grade separation at all other crossings with existing local roads.
Earthworks and retaining walls	Cut and fill slopes per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. Retaining wall locations indicated on the drawings.

Element	Comments
Bridges	Listed below from south to north: • Bridge 1 – Oteha Valley Road / Lucas Creek crossing – 360m long viaduct • Bridge 2 – Awanohi Road / Okura Creek crossing – 200m long viaduct • Bridge 3 – Bawden Road / Dairy Stream crossing – 340m long viaduct • Bridge 4 – Postman Road over alignment – 110m long bridge • Bridge 5 – crossing over tributary to Rangitopuni Stream (near the rear of 293 Postman Road) – 140m long bridge • Bridge 6 – Wilks Road over alignment – 150m long bridge • Bridge 7 – crossing over tributary to Rangitopuni Stream (near the rear of 1579 Dairy Flat Highway) – 120m long bridge • Bridge 8 – Pine Valley Road crossing / Pine Valley East Station platforms – 60m long bridge • Bridge 9 – crossing over Wēiti Stream culvert / avoidance of SEA and QEII Covenant (Kathy's Thicket) – 140m long viaduct Note: bridges carrying the route in NoR 8 and the route in NoR 11 over the alignment are covered within those concept designs (section 3.8 and 3.11 of this report respectively). Note: crossings over / under the rapid transit corridor for future collector roads are not included, given that the final locations of these is not yet known. Any future crossings and their requirements will be the responsibility of land developers or Auckland Transport once details of future collector roads are developed.
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. • Between Albany Station and westward deviation from SH1, treatment and conveyance provided by a 7m wide swale. • Between westward deviation from SH1 to Milldale station (terminus), 7 No. stormwater treatment / attenuation devices are proposed (design per AC GD01).

3.2 Milldale Station (NoR 2)

Summary provided in Table 3-2 and location plan contained in Appendix A (drawing SGA-DRG-NTH-200-GE-2600).

Table 3-2: Milldale Station (NoR 2) Design Summary

Design Item	Comments
Station form, function and provisions	Confirmed spatial and functional requirements include: • Station facilities (240m2) • Bus layover (~5000m2) • Drop-off /pickup and accessible spaces • Cycle parking (500 spaces) • Local bus connection (bus bays) – local bus drop-off (3x terminating and 2x through services) • Parking bays for on-demand vehicles and station operations/services
Earthworks and retaining walls	Minor earthworks may be required. Given the constrained site on which Milldale station is proposed and the level difference between the rapid transit corridor and SH1 and Ahutoetoe Road retaining walls are expected as follows: • Along the western (Ahutoetoe Road) side of the station – an approx. 8.5m high, 200m long bored pile cantilever retaining wall, each pile anchored back with 2 No. rows of ground anchors. • Along the eastern (SH1) side of the station – an approx. 3m high, 200m long bored pile cantilever retaining wall.
Stormwater	Water quality treatment and detention is required by the Auckland Unitary Plan, Activity A7 of Chapter E9 and Activity A5 of Chapter E8. Based on this, stormwater runoff from the station is conveyed to and treated by a proposed stormwater treatment / attenuation device adjacent to the Wēiti Stream (which is shared with the rapid transit corridor mainline) (design to AC GD01).

3.3 Pine Valley East Station (NoR 3)

Summary provided in Table 3-3 and location plan contained in Appendix A (drawing SGA-DRG-NTH-200-GE-2500).

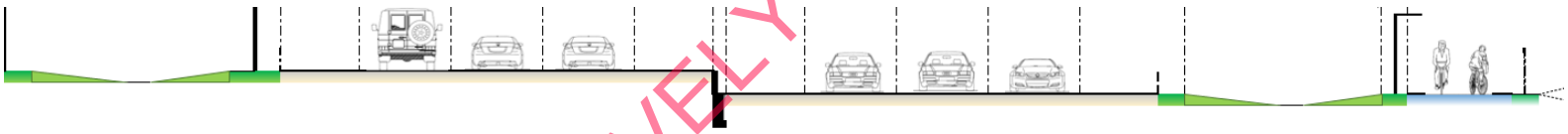
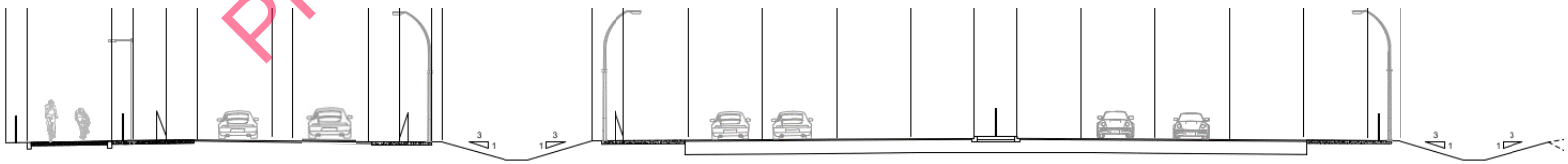
Table 3-3: Pine Valley East Station (NoR 3) Design Summary

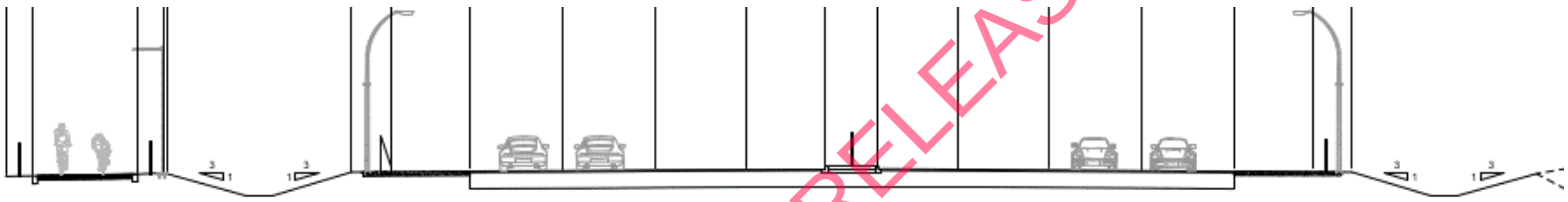
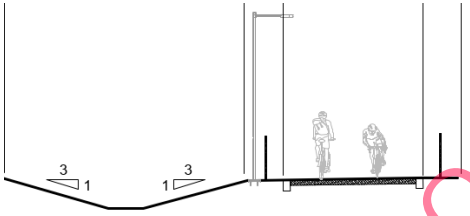
Design Item	Comments
Station form, function and provisions	Confirmed spatial and functional requirements include: • Park and ride (approx. 500 spaces); matching the existing provision provided at Hibiscus Coast station and is considered a reasonable provision in this location. • Station facilities (240m2) • Bus layover (~5000m2) • Drop-off /pickup and accessible spaces • Cycle parking (500 spaces) • Local bus connection (bus bays) – local bus drop-off (1x terminating and 3x through services) • Parking bays for on-demand vehicles and station operations/services
Earthworks and retaining walls	Fill slopes as per Table 2-4. No retaining walls are anticipated.
Stormwater	Water quality treatment and detention is required by the Auckland Unitary Plan, Activity A7 of Chapter E9 and Activity A5 of Chapter E8. Based on this, stormwater runoff from the station is conveyed to and treated by a proposed stormwater treatment / attenuation device within the station environs (design to AC GD01).

3.4 SH1 Improvements (NoR 4)

Summary provided in Table 3-4 and general arrangement plans contained in Appendix A (drawings SGA-DRG-NTH-200-GE-1000 – 1300).

Table 3-4: SH1 Improvements (NoR 4) Design Summary

Element	Comments
Cross section	Between Oteha Valley Road and Bawden Road (i.e., south of Redvale (Penlink) interchange), west on left side, east on right side: • 7m wide swale on the western side (shared with the rapid transit corridor; which is located beside the swale to the west, omitted from diagram below) • 3 No. 3.5m wide lanes northbound and the same southbound, with 3.0m wide nearside and offside shoulders • 7m wide swale on the eastern side • 4m wide active mode path on the eastern side  Between Redvale (Penlink) interchange and Wilks Road interchange, west on left side, east on right side: • 4m wide active mode path on the western side • Northbound service lane on the western side • 7m wide swale on the western side • 3 No. 3.5m wide lanes northbound and the same southbound, with 3.0m wide nearside and offside shoulders • 7m wide swale on the eastern side 

Element	Comments
	Between Wilks Road interchange and Silverdale interchange, west on left side, east on right side: • 4m wide active mode path on the western side • 7m wide swale on the western side • 3 No. 3.5m wide lanes northbound and the same southbound, with 3.0m wide nearside and offside shoulders • 7m wide swale on the eastern side  Between Silverdale interchange and Grand Drive interchange, west on left side, east on right side: • Existing SH1 corridor maintained • 7m wide swale on the eastern side • 4m wide active mode path on the eastern side  East Coast Road: • With reference to Table 2-2, upgrade to two lane arterial – 24m cross section Wilks Road: • With reference to Table 2-2, upgrade to four lane arterial – 30m cross section

Element	Comments
Horizontal and vertical alignment	Matches existing SH1, except on approach to new bridges where adjustments to vertical alignment are applied.
Design speed	110km. Service lane between Redvale (Penlink) interchange and Wilks Road interchange: 80km/hr
Interchanges	Upgrade of Redvale (Penlink) interchange: • Addition of north facing ramps • Enlargement of northbound off-ramp roundabout and eastern roundabout (to double lane roundabouts) (may require full replacement of these) • Addition of southbound off- / on-ramp roundabout (double lane roundabout) • Improvements to East Coast Road, including roundabout on the link road to Penlink • Replacement of bridge over the motorway and bridge over East Coast Road (due to width and length requirements for the corridor) • Active mode interchange New Wilks Road interchange: • South facing ramps only • Realignment of Wilks Road, between interchange and East Coast Road, provision of a double lane roundabout on East Coast Road and realignment of Jackson Way • Active mode interchange Upgrade of Silverdale interchange: • Enlargement of roundabouts • New two-lane bridge on north side of existing bridge • Active mode interchange

Element	Comments
Earthworks and retaining walls	Cut and fill slopes as per Table 2-4, with all cut slopes anticipated to be formed in: • Waitemata Group soils between Oteha Valley Road and Awanohi Road • Northland Allochthon and / or Tauranga Group soils north of Awanohi Road Retaining wall locations indicated on the drawings.
Bridges	Listed below from south to north: • Bridge 1a – active mode pathway – Oteha Valley Road / Lucas Creek crossing – 180m long viaduct • Bridge 1b – active mode pathway – Oteha Valley Road / Lucas Creek crossing – Masons Road approach ramp 150m long • Bridge 1c – active mode pathway – Oteha Valley Road / Lucas Creek crossing – Oteha Valley Road approach ramp 130m long • Bridge 2 – replacement Lonely Track Road bridge – 150m long bridge • Bridge 3a – Awanohi Road / Okura Creek crossing – northbound lanes – 170m long viaduct • Bridge 3b – Awanohi Road / Okura Creek crossing – southbound lanes – 170m long viaduct • Bridge 3c – active mode pathway Awanohi Road / Okura Creek crossing – 185m long viaduct • Bridge 4 – replacement Bawden Road bridge – 120m long bridge • Bridge 5 – active mode pathway – under Bawden Road (extension) – 30m long underpass • Bridge 6 – active mode pathway – SH1 crossing – 345m long bridge • Bridge 7 – Bawden Road (extension) over alignment at Redvale (Penlink) interchange – 80m long bridge • Bridge 8 – Bawden Road (extension) over East Coast Road at Redvale (Penlink) interchange – 50m long bridge • Bridge 9a – active mode pathway + service lane – Dairy Stream crossing – 180m long viaduct • Bridge 9b – Dairy Stream crossing – northbound lanes – 180m long viaduct • Bridge 9c – Dairy Stream crossing – southbound lanes – 180m long viaduct • Bridge 10 – active mode pathway – under Wilks Road – 30m long underpass • Bridge 11 – replacement Wilks Road bridge – 80m long bridge • Bridge 12 – active mode pathway – under Dairy Flat Highway – 30m long underpass • Bridge 13 – active mode pathway – SH1 crossing south of interchange – 330m long bridge

Element	Comments
	• Bridge 14a – active mode pathway – SH1 crossing north of interchange – 325m long bridge • Bridge 14b – active mode pathway – SH1 crossing north of interchange – Hibiscus Coast Highway approach ramp 165m long • Bridge 15 – Dairy Flat Highway over alignment on north side of Silverdale interchange – 80m long bridge • Bridge 16 – active mode pathway – earthworks avoidance between Johns Creek Crescent and Highgate Parkway – 380m long bridge • Bridge 17 – active mode pathway – SH1 crossing at Wainui Road – 230m long bridge • Bridge 18 – active mode pathway – earthworks avoidance between Millwater Parkway and north of Kowhai Road – 735m long bridge • Bridge 19 – active mode pathway – earthworks avoidance north of Kowhai Road – 250m long bridge • Bridge 20 – active mode pathway – earthworks avoidance south of Grand Drive – 260m long bridge
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. Treatment and conveyance provided by the proposed 7m wide swales, supplemented by 6 No. proposed stormwater treatment / attenuation devices (design per AC GD01).

3.5 New SH1 Crossing at Dairy Stream (NoR 5)

Summary provided in Table 3-5 and general arrangement plan contained in Appendix A (drawing SGA-DRG-NTH-100-GE-9000).

Table 3-5: New SH1 Crossing at Dairy Stream (NoR 5) Design Summary

Element	Comments
Cross section	With reference to Table 2-2: • Two lane arterial – 24m cross section • Two lane arterial – bridge – 18m cross section
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	Connection to Top Road on the western side (requires some realignment to facilitate tie in). Connection to East Coast Road (covered in NoR 13, refer to section 3.13 of this report)
Earthworks and retaining walls	Fill slopes as per Table 2-4. Retaining wall locations indicated on the drawings.
Bridges	Bridge 1 – SH1 crossing – 115m long bridge
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, stormwater runoff is conveyed to and treated by one proposed stormwater treatment / attenuation device on the western side and one on the eastern side (shared with NoR 13) (design to AC GD01).

3.6 New Connection Between Milldale and Grand Drive (NoR 6)

Summary provided in Table 3-6 and general arrangement plan contained in Appendix A (drawing SGA-DRG-NTH-100-GE-1000).

Table 3-6: New Connection Between Milldale and Grand Drive (NoR 6) Design Summary

Element	Comments
Cross section	With reference to Table 2-2: • Two lane arterial – 24m cross section • Two lane arterial – bridge – 18m cross section
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	Connection to local road at Ara Hills development at the north end. Roundabout connection to Russell Road. Connection to Wainui Road at the southern end (covered in NoR 10, refer to section 3.10 of this report).
Earthworks and retaining walls	Cut and fill slopes per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. Retaining wall locations indicated on the drawings.
Bridges	Listed below from south to north: • Bridge 1 – Orewa River crossing – 100m long bridge • Bridge 2 – crossing of a tributary to the Orewa River – 105m long bridge
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, stormwater runoff is conveyed to and treated by 3 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

3.7 Pine Valley Road Upgrade (NoR 7)

Summary provided in Table 3-7 and general arrangement plan contained in Appendix A (drawing SGA-DRG-NTH-100-GE-7000).

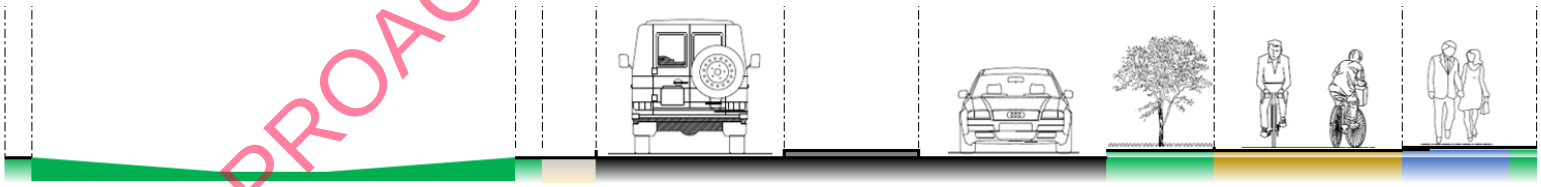
Table 3-7: Pine Valley Road Upgrade (NoR 7) Design Summary

Element	Comments
Cross section	With reference to Table 2-2: • Two lane arterial – 24m cross section • Two lane arterial – bridge – 18m cross section
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	Connection to Pine Valley Road at the western end. Roundabout connection to Young Access. Connection to Old Pine Valley Road at the eastern end, prior to Argent Lane roundabout.
Earthworks and retaining walls	Cut and fill slopes per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. Retaining wall locations indicated on the drawings.
Bridges	Listed below from west to east: • Bridge 1 – crossing of a tributary to the Wēiti Stream – 110m long bridge • Bridge 2 – Wēiti Stream crossing (of Young Access) – 35m long bridge
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, stormwater runoff is conveyed to and treated by 4 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

3.8 Upgrade to Dairy Flat Highway Between Silverdale and Dairy Flat (NoR 8)

Summary provided in Table 3-8 and general arrangement plans contained in Appendix A (drawing SGA-DRG-NTH-100-GE-5000 – 5400).

Table 3-8: Upgrade to Dairy Flat Highway Between Silverdale and Dairy Flat (NoR 8) Design Summary

Element	Comments
Cross section	Listed below from south to north: <u>Southern end to intersection with Postman Road / Blackbridge Road</u> • Four lane arterial – 30m cross section (per Table 2-2) • Four lane arterial – bridge – 24m cross section (per Table 2-2) <u>Intersection with Postman Road / Blackbridge Road to intersection with Richards Road</u> • Two lane arterial – 24m cross section (per Table 2-2) <u>Intersection with Richards Road to intersection with Horseshoe Bush Road, west on left side, east on right side</u> • 29m cross section, unique, cognisant of adjacent land use (rural on west side, future urban on east side)  • Two lane arterial – bridge – 18m cross section (per Table 2-2)

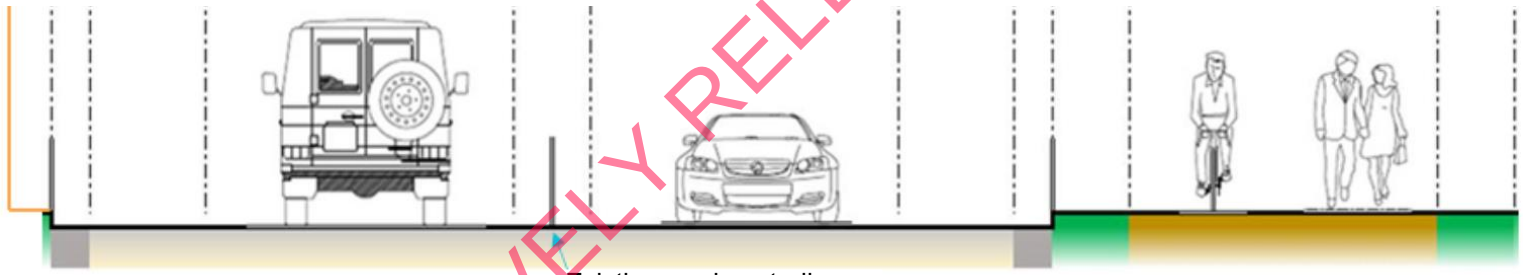
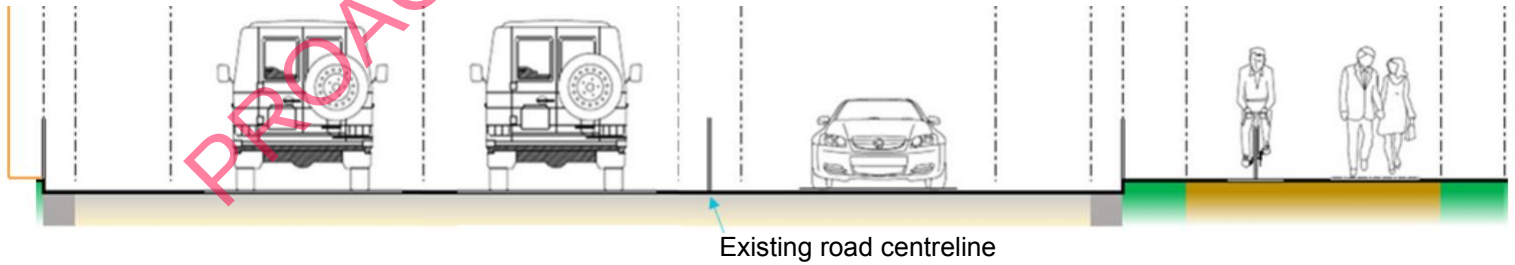
Element	Comments
	<u>Intersection with Horseshoe Bush Road to 1453 Dairy Flat Highway, west on left side, east on right side</u> • 27m cross section, unique, cognisant of adjacent land use (light industry on west side, future urban on east side)  <u>1453 Dairy Flat Highway to northern end</u> • Four lane arterial – 30m cross section (per Table 2-2) • Four lane arterial – bridge – 24m cross section (per Table 2-2)
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	Connection to Dairy Flat Highway (refer also to NoR 9, section 3.9 of this report) and Durey Road at the southern end. Priority controlled intersection connection with Goodland Drive. Roundabout connection to Kennedy Road. Priority controlled intersection connection with Bawden Road (stub of old alignment). Roundabout connection to new Bawden Road alignment (covered in NoR 12, refer to section 3.12 of this report). Roundabout connection to Green Road. Priority controlled intersection connection with Jeffs Road. Roundabout connection to Postman Road / Blackbridge Road. Priority controlled intersection connection with Richards Road.

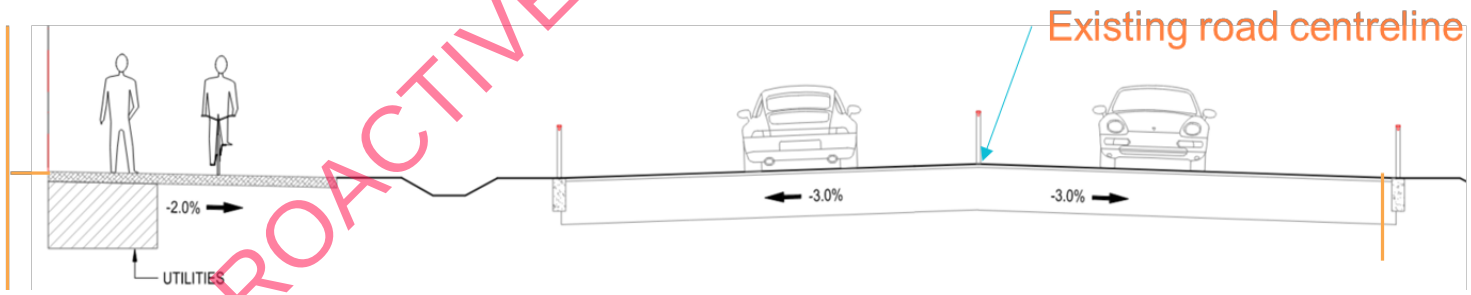
Element	Comments
	Roundabout connection to Landill Access Road. Signalised intersection with Horseshoe Bush Road. Signalised intersection with Kahikatea Flat Road / new link road (covered in NoR 11, refer to section 3.11 of this report). Roundabout connection to Wilks Road West / Wilks Road. Signalised intersection with New Pine Valley Road Connection to Dairy Flat Highway at Silverdale interchange (refer also to NoR 4, section 3.4 of this report) at the northern end. Note: connections to future collector roads are not included, given that the final locations of these is not yet known. Any future intersections and their requirements will be the responsibility of land developers or Auckland Transport once details of future collector roads are developed.
Earthworks and retaining walls	Cut and fill slopes as per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. Retaining wall locations indicated on the drawings.
Bridges	Listed below from south to north: • Bridge 1 – crossing of tributaries to Dairy Stream – 95m long bridge • Bridge 2 – crossing of a tributary to Dairy Stream – 85m long bridge • Bridge 3 – crossing of a tributary to Dairy Stream – 95m long bridge • Bridge 4 – crossing of a tributary to Rangitopuni Stream – 40m long bridge • Bridge 5 – crossing of a tributary to Rangitopuni Stream – 90m long bridge • Bridge 6 – crossing of alignment over the rapid transit corridor (NoR 1, refer to section 3.1 of this report) – 125m long bridge
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, stormwater runoff is conveyed to and treated by 10 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

3.9 Dairy Flat Highway Upgrade – Rural Section (Durey Road – Albany) (NoR 9)

Summary provided in Table 3-9 and general arrangement plans contained in Appendix A (drawing SGA-DRG-NTH-100-GE-8000 – 8200).

Table 3-9: Dairy Flat Highway Upgrade – Rural Section (Durey Road – Albany) (NoR 9) Design Summary

Element	Comments
Cross section	Listed below from south to north: Southern end (at Stevensons Crescent) to approx. 402 Dairy Flat Highway, west on left side, east on right side • 20.1m cross section, unique, cognisant of constrained corridor  Between approx. 402 Dairy Flat Highway and south of roundabout with Coatesville-Riverhead Highway, west on left side, east on right side • 23.6m cross section, generally matches existing provisions for traffic live lanes  Note: reduction in passing lane length; however, the residual effective passing lane length exceeds Austroads GRD Part 3: Geometric Design, Table 9.2 requirements (650m desirable lane length; noting that this route is not an 80km/hr corridor).

Element	Comments
	<u>Between north of roundabout with Coatesville-Riverhead Highway and roundabout with Potter Road, west on left side, east on right side</u> • 20.1m cross section, unique, cognisant of constrained corridor  <u>Between roundabout with Potter Road and northern end (south of Durey Road), west on left side, east on right side</u> • 28m cross section, unique, cognisant of adjacent land use (future urban on west side, rural on east side) 
Horizontal and vertical alignment	Matches existing situation, except on approach to roundabout at Albany Heights Road and Potter Road (where section 2.6 of this report is applied).
Design speed	Per section 2.6 of this report.

Element	Comments
Interface with existing local roads	Connection to Stevensons Crescent at the southern end. Priority controlled intersection connection with Hobson Road. Roundabout connection to Albany Heights Road (upgraded to this intersection form). Priority controlled intersection connection with Foley Quarry Road. Roundabout connection to Potter Road (upgraded to this intersection form).
Earthworks and retaining walls	Cut slopes as per Table 2-4; all cut slopes anticipated to be formed in Waitemata Group soils. Fill slopes per Table 2-4; noting that specific, large fill slopes opposite Hobson Road, south of Albany Heights Road intersection and between Albany Heights Road and Coatesville-Riverhead Highway intersections apply a 1V:2H slope angle to limit size and encroachment into adjacent features. Retaining wall locations indicated on the drawings.
Bridges	None.
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, stormwater runoff is conveyed to and treated by 6 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

3.10 Wainui Road Upgrade (NoR 10)

Summary provided in Table 3-10 and general arrangement plan contained in Appendix A (drawing SGA-DRG-NTH-100-GE-6000).

Table 3-10: Wainui Road Upgrade (NoR 10) Design Summary

Element	Comments
Cross section	With reference to Table 2-2: • Two lane arterial – 24m cross section • Two lane arterial – bridge – 18m cross section
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	Connection to Wainui Road at the western end. Roundabout connection to Upper Orewa Road (NoR 6, refer to section 3.6 of this report). Priority controlled intersection with Kowhai Road. Roundabout connection with the northbound SH1 off-ramp to Wainui Road. Connection to Wainui Road at the eastern end. Note: active mode pathway continues to new active mode pathway bridge over the motorway, adjacent to existing Wainui Road overbridge (NoR 4, refer to section 3.4 of this report).
Earthworks and retaining walls	Cut and fill slopes as per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. Retaining wall locations indicated on the drawings.
Bridges	Bridge 1 – Waterloo Creek crossing – 200m long bridge
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, stormwater runoff is conveyed to and treated by 2 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

3.11 New Connection from Dairy Flat Highway to Wilks Road (NoR 11)

Summary provided in Table 3-11 and general arrangement plan contained in Appendix A (drawing SGA-DRG-NTH-100-GE-3000).

Table 3-11: New Connection from Dairy Flat Highway to Wilks Road (NoR 11) Design Summary

Element	Comments
Cross section	Listed below from west to east: Kahikatea Flat Road to Postman Road • Two lane arterial – 24m cross section (per Table 2-2) • Two lane arterial – bridge – 18m cross section (per Table 2-2) Postman Road to Wilks Road interchange • Four lane arterial – 30m cross section (per Table 2-2) North-south legs of Dairy Flat Highway • Refer to "Intersection with Horseshoe Bush Road to 1453 Dairy Flat Highway, west on left side, east on right side" in Table 3-8 North-south legs of Postman Road • Matches existing
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	Connection to Kahikatea Flat Road at the western end. Signalised intersection with Kahikatea Flat Road / Dairy Flat Highway / new link road, with northern and southern connections to Dairy Flat Highway (NoR 8, refer to section 3.8 of this report). Roundabout connection to Postman Road. Termination of Wilks Road where it crosses the corridor (cul-de-sac provided). Priority controlled intersection with Runway Rise. Connection to Wilks Road interchange (NoR 4, refer to section 3.4 of this report) at the eastern end.
Earthworks and retaining walls	Cut and fill slopes as per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. No retaining walls proposed.
Bridges	Bridge 1 – crossing of alignment over the rapid transit corridor (NoR 1, refer to section 3.1 of this report) – 150m long bridge

Element	Comments
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, stormwater runoff is conveyed to and treated by 3 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01). Note: the eastern-most of these devices is located at the Wilks Road interchange, is shared with SH1 and is covered in the SH1 corridor (NoR 4, refer to section 3.4 of this report).

3.12 Bawden Road Upgrade + Extension (NoR 12)

Summary provided in Table 3-12 and general arrangement plan contained in Appendix A (drawing SGA-DRG-NTH-100-GE-7000).

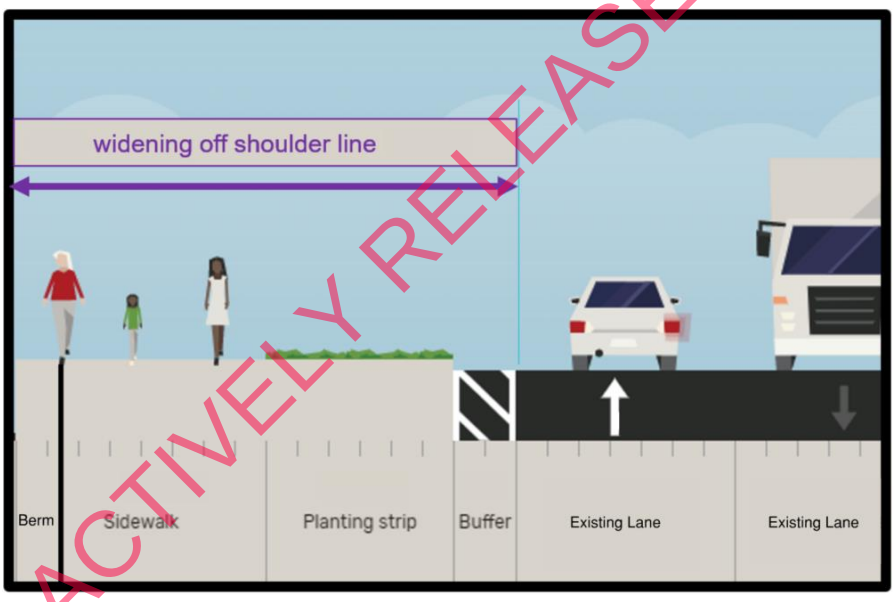
Table 3-12: Bawden Road Upgrade + Extension (NoR 12) Design Summary

Element	Comments
Cross section	With reference to Table 2-2: • Four lane arterial – 30m cross section • Four lane arterial – bridge – 24m cross section North-south legs of Top Road: • Matches existing
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.
Interface with existing local roads	New roundabout connection to Dairy Flat Highway at the western end. Priority controlled intersection with Dairy Stream Road. Priority controlled intersection with Oregon Park. Priority controlled intersection with Bobs Way. New roundabout connection to Top Road. Connection to Redvale (Penlink) interchange at the eastern end.
Earthworks and retaining walls	Cut and fill slopes as per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. No retaining walls proposed.
Bridges	Listed below from west to east: • Bridge 1 – crossing of a tributary to Dairy Stream – 70m long bridge • Bridge 2 – crossing of a tributary to Dairy Stream – 20m long bridge
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, stormwater runoff is conveyed to and treated by 8 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

3.13 East Coast Road Upgrade (NoR 13)

Summary provided in Table 3-13 and general arrangement plans contained in Appendix A (drawing SGA-DRG-NTH-100-GE-2000 – 2200).

Table 3-13: East Coast Road Upgrade (NoR 13) Design Summary

Element	Comments
Cross section	Listed below from west to east: Southern end to Wilks Road intersection • Two lane arterial – 24m cross section (per Table 2-2) • Two lane arterial – bridge – 18m cross section (per Table 2-2) Wilks Road intersection to Newman Road • 8.5m widening for active mode path only, unique  Newman Road to Silverwater Drive • Two lane arterial – 24m cross section (per Table 2-2) Silverwater Drive to Hibiscus Coast Highway • Active mode – 6m cross section (per Table 2-2) on the western side • Footpath – 2m wide on the eastern side
Horizontal and vertical alignment	Per section 2.6 of this report.
Design speed	Per section 2.6 of this report.

Element	Comments
Interface with existing local roads	Connection to East Coast Road improvements covered in NoR 4 (refer to section 3.4 of this report). Roundabout connection to Worsnop Way and new SH1 crossing at Dairy Stream (NoR 5; refer to section 3.5 of this report). Roundabout connection to Wilks Road (covered by NoR 4, refer to section 3.4 of this report). Connection to East Coast Road at the northern end (just north of Silverwater Drive). Note: active mode pathway continues independently and joins to Hibiscus Coast Highway.
Earthworks and retaining walls	Cut and fill slopes as per Table 2-4; all cut slopes anticipated to be formed in Northland Allochthon and / or Tauranga Group soils. Retaining wall locations indicated on the drawings.
Bridges	Bridge 1 – Dairy Stream crossing – 110m long bridge
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, stormwater runoff is conveyed to and treated by 4 No. proposed stormwater treatment / attenuation devices along the route (design to AC GD01).

4. Design Summary – Non-Route Protected Corridors

This section describes the key design features for two corridors where route protection for implementation is not deemed to be required:

- Hibiscus Coast Highway / Grand Drive Corridor Improvements
- Dairy Stream Active Mode Path

These are also referred to as 'Type A' corridors.

Only a limited, high-level design assessment was made for these corridors to develop the form of possible design solution. As such, the following design elements were not considered:

- 3D geometric design to inform earthworks volumes and verticality
- Stormwater design
- Structures design input on bridge form
- Geotechnical design input on ground conditions, earthworks recommendations and requirements for ground improvement
- Pavement design and road surfacing
- Street lighting
- Street furniture
- Road safety barriers
- Signs and line markings
- Traffic signal design
- Advanced Traffic Management Systems (ATMS) requirements
- Intelligent Traffic Systems (ITS)
- Landscape design
- Urban streetscape design features
- Vehicle tracking

4.1 Hibiscus Coast Highway / Grand Drive Corridor Improvements

Typical application of the 'four lane arterial – 30m cross section' per Table 2-2, with treatments required at key intersections.

The indicative design is expected to fit within the existing road reserve, based on a desktop study and an initial site visit to identify any significant constraints.

Refer to Appendix H2 for high-level design.

4.2 Dairy Stream Active Mode Path

Typical application of the 'active mode – 6m cross section' per Table 2-2.

Refer to Appendix H2 for high-level design.

4.3 New Argent Lane / New Pine Valley Road Corridor Improvements

Typical application of the ‘four lane arterial – 30m cross section’ per Table 2-2

The indicative design is expected to fit within the existing road reserve (and expected future road reserve as the Milldale development expands), based on a desktop study.

Refer to Appendix H2 for high-level design.

Appendix H1 – General Arrangement Plans – Route Protected Corridors

Appendix H2 – High-level Design – Non-Route Protected Corridors

Appendix H3 – Road Safety Audit Exemption