Design Summary Report – DWP-TS-01 Geometrics

NKP-TAT-000-REP-CV-TS-000001

Document Control

Title: NKP-TAT-000-REP-CV-TS-000001 Design Summary Report – DWP-TS-01 Geometrics					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
12/08/22	001	Stage A	S 9(2)(a)		
19/10/22	002	Stage B			
16/02/23	003	Stage C			
02/05/23	004	Stage C, Revision 2			

Table of Contents

1 Project Introduction

1.1 Project Overview

Waka Kotahi NZ Transport Agency (Waka Kotahi) and the Te Ara Tupua Alliance (the Alliance) seek to deliver a safe and connected walking and cycling route between Wellington (Ngā Ūranga) and the Hutt Valley (Pito-One). The Ngā Ūranga ki Pito-One path project (the Project) will generally be on the seaward side of the existing road and rail transport corridor with the general site location shown in orange in Figure 1.1 below.

Figure 1.1 Site locality

Ngā Ūranga ki Pito-One is a 4.5km long shared path construction project, being procured via a pure Alliance mechanism. Our Alliance, Te Ara Tupua Alliance, includes HEB, Downer and Tonkin & Taylor Ltd (T+T) supported by Holmes, Isthmus and Boffa Miskell. Waka Kotahi have worked with Taranaki Whānui and Ngāti Toa Rangatira throughout the concept and consenting development of the Project and have well-established relationships. The key physical works aspects of the Project include:

- **Shared path:** A 4.5km long shared path formation with a typical 5.0m sealed surface width on existing and new reclaimed land and new coastal structures on the seaward side of the Hutt Valley railway line;
- **Ūranga (landings):** Six ūranga (landings), strategically located at key sites along the shared path's length, providing areas for landscaping, habitat creation, off-path multi-use areas, event use, rest and views.
- **Revetment:** A combination of concrete block and natural rock revetment adjoining the shared path and Ūranga;
- **Seawalls:** Approximately 700m of seawall and associated beach groynes and rock scour protection. Seawalls are located and designed to avoid shared path encroachment into high value ecological and sensitive gravel beach habitats;
- **Shared path bridge at Ngā Ūranga**: A new bridge providing access for shared path users over the railway at the Ngā Ūranga end of the Project. As outlined in the Te Ara Tupua Mana Whenua Values Plan, the mana and rangatiratanga of the esteemed Rangatira of Ngā Ūranga Pā, Te Wharepōuri, and his descendants, is proposed to be honoured through this shared path bridge;
- **Offshore habitats:** Provision of offshore habitats for coastal avifauna, constructed of naturalised rock forms located adjacent to key foreshore habitat areas;
- **KiwiRail traction station:** KiwiRail has a traction station located at Rocky Point that will be upgraded as part of the works. This is a key facility required for the operation of the existing rail network; and
- **Honiana Te Puni Reserve:** Enhancement of the existing reserve, including Tāwharau Pods, landscaping, street lighting and sculptures.

1.2 Purpose

The intent of this IFC Design Report is to document the key principles and overall philosophy of the geometric design, progressed to 100% design.

A summary of the design phases and review gates of the Project is outlined below:

- Stage A (30% design**):** Design work completed for the IPAA stage of the project, to allow for the TOC to be determined. The purpose of the Stage A review was to obtain feedback on the fundamental basis of design and design form.
- Stage B (70% design): The purpose of the Stage B review is to obtain feedback on detailed elements of design.
- Stage C (100% design): The purpose of the Stage C review is to confirm that Stage A and Stage B review comments have been addressed to Waka Kotahi satisfaction. No new feedback will be received except for new elements of the design.
- **IFC: Design documentation issued for construction.**

The below issues have been identified through the development of the design and are still current. They need to be resolved during future design stages in consultation with the relevant stakeholders:

- Design departure for the SH2 off-ramp. Refer to section 3.4.7.
- Minimum vertical curve length to be increased in Honiana Te Puni Reserve. Refer to section 3.4.7.1.
- Confirmation of the location of KiwiRail access gates. This includes formal approval of the design at the KiwiRail traction station. Refer to section 3.4.9.
- Tie-in with new Korokoro Stream bridge. The existing bridge over Korokoro Stream is to be replaced. The geometric design at this area has been based on the concept design for the Korokoro Stream bridge. Refer to section 3.4.2.2.

1.3 Work Package Scope

This design report covers the design process and assumptions for the geometric design of the Ngā Ūranga ki Pito-One shared path project.

The geometric design for the Project is covered in the work package DWP-TS-01. The scope of work includes geometric design for the horizontal and vertical geometry of:

- The southern tie-in to the existing shared path
- The shared path bridge at Ngā Ūranga, including the southern and northern ramps
- KiwiRail maintenance bays and access from the KiwiRail corridor onto the shared pathway
- SH2 off-ramp (KiwiRail access) realignment
- The shared path along the revetment and seawalls
- The shared zone, shared path and boat ramp through Honiana Te Puni Reserve west
- The tie-ins to Korokoro Stream bridge
- The northern tie-in to Pito-One to Melling shared path and tie-in to existing shared paths connecting to The Esplanade and Hutt Road

1.4 Related Design Features

The scope of the DWP-TS-01 work package does not include:

- Pavements and surfacing (refer to DWP-PS-01)
- Longitudinal drainage (refer to DWP-DR-01)
- KiwiRail permanent level crossing (refer to DWP-PS-02)
- Landscape, geometry and urban design at Ūranga (refer DWP-LS-01)
- Shared path bridge at Ngā Ūranga structural design (refer to DWP-BR-01)
- Shared path bridge at Ngā Ūranga MSE wall (refer to DWP-BR-02)
- Traffic services, fencing, and street lighting (refer to DWP-TS-02, DWP-TS-03, and DWP-TS-04)
- Design for replacement of the Korokoro Stream bridge (refer DWP-BR-03). The design for the replacement of the Korokoro Stream bridge is currently at concept design stage. To minimise rework, in this stage of the DWP-TS-01 work package the horizontal alignment for the approaches to the bridge have been developed off of the bridge concept design.
- Honiana Te Puni Reserve east (refer DWP-LS-91)

The key design interfaces with other work packages are detailed in Table 1.1 below.

Table 1.1: Key design interfaces within Te Ara Tupua Alliance

Reference	Title	Comment
DWP-TS-02	Traffic Services	This package includes: ▪ Paint markings, signage, ITS, FOG and bollards ▪ Road safety barriers along the State Highway 2 off-ramp
DWP-TS-03	Fencing	This package includes: ▪ KiwiRail boundary fence ▪ KiwiRail access gates
DWP-TS-04	Street Lighting and Electrical	This package includes: ▪ Street lighting ▪ Integration between street lighting and fencing
DWP-UN-01	Utilities	This package includes: ▪ Ducting, cabling, and cabinets providing connection to the ITS ▪ Jointing chambers and pull pits associated with the ITS
DWP-PS-01	Pavement and Surfacing	This package includes: ▪ Pavement design for the shared path, kerbs, concrete bridge deck, SH2 slip lane and KiwiRail maintenance bays
DWP-PS-02	KiwiRail Level Crossing	This package includes: ▪ All design for the KiwiRail permanent level crossing and access track
DWP-LS-01	Ūranga (soft landscape and urban design)	This package includes: ▪ All horizontal design of the Ūranga ▪ Vertical levels of the Ūranga
DWP-LS-02	Honiana Te Puni Reserve west (soft landscape, urban design)	This package includes: ▪ Static bollards in Honiana Te Puni Reserve west ▪ Landscaping through Honiana Te Puni Reserve west
DWP-LS-03	Furniture and Artwork	This package includes: ▪ Seating ▪ Integrated cycle racks ▪ Interpretative signage and panels, including wayfinding maps
DWP-BR-01	Bridge – Structure and Architecture	This package includes: ▪ Handrail and balustrade design along shared path bridge at Ngā Ūranga
DWP-BR-03 (TBC)	Korokoro Stream Bridge	This package includes: ▪ Design of all elements associated with the replacement of the Korokoro Stream bridge. Design for this is currently at concept level only.
DWP-SE-01	Seawalls	This package includes: ▪ Design of all elements of the seawalls ▪ Specification of the seawall locations

1.5 Definitions and Abbreviations

Definitions and abbreviations used in this report are defined in Table 1.2.

Table 1.2: Definitions and abbreviations used in this design report

Reference	Meaning
AADT	Annual Average Daily Traffic
AGRD	Austroads Guide to Road Design
AS/NZS	Australia/ New Zealand Standards
AT	Auckland Transport
CCTV	Closed Circuit Television
CMA	Coastal Marine Area
DRR	Design Review Record
DWG	Drawing
DWP-TS-01	This design work package, covering the geometric design of the Ngā Ūranga ki Pito-One shared path
HCC	Hutt City Council
HSiD	Health and Safety in Design
IFC	Issued for Construction
IPAA	Interim Project Alliance Agreement
ITS	Intelligent Transport Systems
km/h	Kilometres per hour
LGWM	Let's Get Wellington Moving
m	Metre
mm	Millimetre
MoTSaM	Manual of Traffic Signs and Markings
MRs	Minimum Requirements
MWSG	Mana Whenua Steering Group
N/A	Not Applicable
NDD	Normal Design Domain
PAB	Project Alliance Board
P2M	Pito-One to Melling

Reference	Meaning
RTS-18	New Zealand On-Road Tracking Curves for Heavy Motor Vehicles (Waka Kotahi, 2007)
SB	Southbound
SH2	State Highway 2
SME	Subject Matter Expert
SSD	Stopping sight distance
TBC	To Be Confirmed
TCD	Traffic Control Devices
TDM	Transport Design Manual – Engineering Design Code Cycling Infrastructure (Auckland Transport, 2022)
TMP	Traffic Management Plan
TOC	Target Outturn Cost
T+T	Tonkin & Taylor Ltd
WCC	Wellington City Council
Waka Kotahi	Waka Kotahi New Zealand Transport Agency

2 Design Criteria and Methodology

2.1 Project Objectives

Waka Kotahi is seeking to achieve the following overarching project objectives:

- **Mode Shift:** Unlocking the suppressed demand of people who would currently choose active travel modes but do not due to safety concerns.
- **Safety & Resilience:** Enhancing the resilience and safety of the transport corridor.

2.2 Design Objectives

The key geometric design objectives of the Project are to:

- Achieve the design performance criteria as set out in the Waka Kotahi MRs.
- Provide a 5.0m wide path for use by pedestrians, cyclists, and other micro-mobility users from Ngā Ūranga to Pito-One.
- Provide an interface between Te Ara Tupua Alliance work packages, Waka Kotahi and KiwiRail.
- Develop the geometric design in close relationship with the other disciplines in the Alliance to ensure the MRs are met.
- Integrate with the coastal engineering requirements and minimise impacts on KiwiRail, the CMA and the users of the path.
- Ensure drainage requirements are integrated into the horizontal and vertical alignment of the shared path.
- Accommodate maintenance, emergency and KiwiRail vehicle access to the shared path.
- Connect to existing paths at Ngā Ūranga and Pito-One, including the LGWM path south of the site, P2M shared path and The Esplanade cycleway and shared path upgrade.
- Provide a path that addresses safety in design considerations.

3 Geometrics Design Statement

3.1 Introduction and Description

From south to north, the key locations considered in the geometric design are summarised in Table 3.1 below.

Table 3.1: Key locations along the extent of the project

Variable	Description	Chainage
Southern tie-in	Tie-in to the LGWM shared path at Ngā Ūranga	Ch. 440 (Control Line RSTS01)
Ngā Ūranga to shared path bridge	Shared path between Ngā Ūranga and the shared path bridge.	Ch. 440 to Ch. 542 (Control Line RSTS01)
Shared path bridge at Ngā Ūranga	New shared path bridge at Ngā Ūranga, provides a connection for shared path users across the railway line	Ch. 542 to Ch. 788 (Control Line RSTS01)
KiwiRail slip lane	Exit lane providing access from State Highway 2 to the KiwiRail yard at Ngā Ūranga	~Ch. 700 (Control Line RSTS01)
Main shared path	Consistent shared path between the new shared path bridge at Ngā Ūranga and Honiana Te Puni Reserve	Ch. 788 to Ch. 4805 and 4820 to 5048 (Control Line RSTS01)
KiwiRail maintenance bays	Three parking and turnaround locations for KiwiRail maintenance vehicles	Ch. 875, Ch. 2950, and Ch. 4380 (Control Line RSTS01)
Honiana Te Puni Reserve west	Shared paths through reserve at Petone foreshore	Control Line RSTS02 and RSTS03
Boat ramp	Boat ramp in Honiana Te Puni Reserve west	Control Line RSTS04 and RSTS05
Korokoro Stream bridge	Concept design for bridge replacement across Korokoro Stream	Ch. 4805 to Ch. 4820 (Control Line RSTS01)
Northern tie-in	Tie-in to the new Pito-One to Melling shared path	Ch. 5048 (Control Line RSTS01)

The extent of the project, and these key locations, are shown indicatively in Figure 3.1.

Figure 3.1 Overview of the project site

3.2 Proposed Design Details

The design standards and specifications to be used for the geometric design are specified in Appendix A01 of the Minimum Requirements. These are summarised in Table 3.2 below in order of precedence.

Table 3.2: Geometric design standards and specifications used in the design

Document	Comment	Source	Version
Cycling Network Guidance: -Planning a Cycling Network -Designing a Cycling Facility		Waka Kotahi	Web version (accessed June 2022)
Traffic Control Device Manual (TCD) Part 10: Motorways and Expressways (Manual of Traffic Signs and Markings: Part III)		Waka Kotahi	2010
Technical Memorandum TM-2503: Guidelines for Edge Protection and Medians on Dual Carriageway Roads	Incorporating a Safe System Philosophy	Waka Kotahi	2013
New Zealand On-Road Tracking Curves for Heavy Motor Vehicles (RTS 18)		Waka Kotahi	2007
Guide to Road Design (All Parts)	Using NDD values unless otherwise stated in the Minimum Requirements	Austroads	Latest versions as at Sept 2022

Additional documents used in design of the shared path, though not explicitly specified in the Minimum Requirements, are detailed in Table 3.3 below.

Table 3.3: Additional documents used in the design

Document	Source	Version
Emergency vehicle access guidelines	New Zealand Fire Service	2015
HTPR Reserves Act Application	Beca, on behalf of Waka Kotahi	2020
Pedestrian Network Guidance	Waka Kotahi	Web version (accessed June 2022)
Technical Note TN169: Fencing and Edging Treatments for Cycling Infrastructure	Queensland Government	February 2019
Supplement to Austroads Guide to Road Design Part 6A: Paths for Walking and Cycling	Queensland Government	May 2020
Transport Design Manual	Auckland Transport	Latest versions as at Sept 2022
Local Path Design Guide	Auckland Council	Rev 1.2
New Zealand Cycle Trial Design Guide	The New Zealand Cycle Trial (Nga Haerenga)	August 2019 (5th Edition)
Design speeds and acceleration characteristics of bicycle traffic for use in planning, design and appraisal	Transport Policy	September 2010
Code of Practice for Land Development – Part C: Road Design and Construction	Wellington City Council	December 2012

3.3 Drawings and Documents

Design Drawings for this work package (DWP-TS-01), for this Stage C issue, are listed below. These drawings are published on InEight. The 3D model can be found in Revizto.

- **General Arrangement Plans**
  - NKP-TAT-000-DRG-CV-TS-111001 – Title Sheet
  - NKP-TAT-000-DRG-CV-TS-111101 – Drawing Index
  - NKP-TAT-000-DRG-CV-TS-111201 – Project Wide Shared Path – General Notes, Legends & Overall Plan
  - NKP-TAT-000-DRG-CV-TS-212501 – General Arrangement Plan & Long Section Sheet 1
  - NKP-TAT-000-DRG-CV-TS-212502 – General Arrangement Plan & Long Section Sheet 2
  - NKP-TAT-000-DRG-CV-TS-212503 – General Arrangement Plan & Long Section Sheet 3
  - NKP-TAT-000-DRG-CV-TS-212504 – General Arrangement Plan & Long Section Sheet 4
  - NKP-TAT-000-DRG-CV-TS-212505 – General Arrangement Plan & Long Section Sheet 5
  - NKP-TAT-000-DRG-CV-TS-212506 – General Arrangement Plan & Long Section Sheet 6
  - NKP-TAT-000-DRG-CV-TS-212507 – General Arrangement Plan & Long Section Sheet 7
  - NKP-TAT-000-DRG-CV-TS-212508 – General Arrangement Plan & Long Section Sheet 8
  - NKP-TAT-000-DRG-CV-TS-212509 – General Arrangement Plan & Long Section Sheet 9
  - NKP-TAT-000-DRG-CV-TS-212510 – General Arrangement Plan & Long Section Sheet 10
  - NKP-TAT-000-DRG-CV-TS-212511 – General Arrangement Plan & Long Section Sheet 11
  - NKP-TAT-000-DRG-CV-TS-212512 – General Arrangement Plan & Long Section Sheet 12
  - NKP-TAT-000-DRG-CV-TS-212513 – General Arrangement Plan & Long Section Sheet 13
  - NKP-TAT-000-DRG-CV-TS-212514 – General Arrangement Plan & Long Section Sheet 14
  - NKP-TAT-000-DRG-CV-TS-212515 – General Arrangement Plan & Long Section Sheet 15
  - NKP-TAT-000-DRG-CV-TS-112520 – General Arrangement Plan & Long Section RSTS03 – Shared Path
  - NKP-TAT-000-DRG-CV-TS-112530 – General Arrangement Plan & Long Section RSTS04 and RSTS05 – Boat Ramp
  - NKP-TAT-000-DRG-CV-TS-112540 – General Arrangement Plan & Long Section SH2 Off-Ramp

- **Typical Cross Sections**
  - NKP-TAT-000-DRG-CV-TS-114001 – Typical Cross Sections Sheet 1
  - NKP-TAT-000-DRG-CV-TS-114002 – Typical Cross Sections Sheet 2
  - NKP-TAT-000-DRG-CV-TS-114003 – Typical Cross Sections Sheet 3
  - NKP-TAT-000-DRG-CV-TS-114004 – Typical Cross Sections Sheet 4
  - NKP-TAT-000-DRG-CV-TS-114005 – Typical Cross Sections Sheet 5
  - NKP-TAT-000-DRG-CV-TS-114010 – Typical Cross Sections KiwiRail Traction Station Section and Maintenance Bays
- **Layout Details**
  - NKP-TAT-000-DRG-CV-TS-116101 – KiwiRail Traction Station Details
  - NKP-TAT-000-DRG-CV-TS-116102 – Intersection Layout Details

3.4 Design solution

3.4.1 Speed Environment

The design speeds adopted for each segment of the project are detailed in Table 3.4 below.

Table 3.4: Design speeds

Design Element	Location	Parameter	
		Cyclist Design Speed (km/h)	Vehicle Design Speed (km/h)
Main shared path	Control Line RSTS01, excluding the shared path bridge at Ngā Ūranga	30	15
Shared path bridge at Ngā Ūranga	Bridge Span Control Line RSTS01 Ch. 625 to 700	20	15
	Bridge Ramp Control Line Ch. 542 to 625 and Ch. 700 to 790	20 (up ramp) and 30 (down ramp)	15
Honiana Te Puni Reserve west	Control Line RSTS02	30	15
	Control Line RSTS03	20	15
Boat ramp in Honiana Te Puni Reserve	Control Line RSTS04	N/A	15
	Control Line RSTS05	N/A	15

The design speed of 20km/h at the bridge span was calculated using the assumption that the 85th percentile cyclist speed will be travelling at 3.89m/s for an 8% uphill grade and will be able to accelerate at a rate[1] of 0.231m/s^2 at the bridge span.

In the MRs, a minimum cyclist design speed of 30km/h for all elements except the bridge is specified. The design approach for the design speed refinement for each section of the path is outlined in the sections below.

[1] Transport Policy – Design speeds and acceleration characteristics of bicycle traffic for use in planning, design and appraisal.

3.4.1.1 Shared Path

The design speed of 30km/h has been retained for the main shared path for the following reasons:

- To provide a high level of service for cyclists and other micro-mobility users to promote the Project's mode shift objectives.
- To accommodate the higher likely speeds for commuter type cyclists/micro-mobility users.
- To align with the relatively straight and flat path geometry

To ensure cyclists and other micro-mobility users can travel safely at 30km/h design speed, the 5.0m wide shared path will operate as a separated path[2]. In the IPAA stage of the project, an options assessment of the path width was completed (refer Appendix A). A recommendation was made by the geometric design team to increase the path width from the consented 5.0m to 5.5m. However, due to consent and CMA constraints, the PAB endorsed a consistent path width of 5.0m, with opportunities to increase the path to be explored in detailed design.

3.4.1.2 Shared Path Bridge at Ngā Ūranga

As stated in the MRs, the design speed for the bridge shall be no less than 20km/h. This design speed was adopted into the MRs in the IPAA phase of the project for the following reasons:

- The shape of the bridge (the reversed curves in the horizontal alignment) limits sight distance. As such, sight distance requirements for a 30km/h design speed could not be achieved universally on the bridge. The radii of the reversed curves will discourage cyclists to travel at a speed higher than 20km/h.
- Uphill cyclists/micro-mobility users approaching the top of the bridge would likely be travelling below 30km/h. With bridge ramps at a 1 in 12 grade (8.3%), the design speed for uphill commuter cyclists/micro-mobility users (non-assist) is estimated to be travelling at about 20km/h[3].
- Cyclist/micro-mobility user operating speeds will likely be higher exiting the bridge ramps downhill with an design speed of 30-40km/h[2]. This downhill speed will be mitigated by the presence of intermediate platforms between ramps and pavement markings, as outlined in the DWP-TS-02 package. The horizontal geometry is also relatively straight departing from the bridge ramps which ensures clear sight lines in case of higher speeds exiting the bridge.

3.4.1.3 Honiana Te Puni Reserve west

The design speed along different paths through Honiana Te Puni Reserve west are detailed in Table 3.5 below.

[2] AGRD Part 6A (2021) Section 2.5 specifies a separated path where path user numbers are high and operating speeds are high.
[3] Austroads – Cycling Aspects of Austroads Guides Figure 4.1.

Table 3.5: Paths through Honiana Te Puni Reserve west

Control Line	Environment	Cyclist Design Speed (km/h)	Comment
Main shared path (Ch. 4350 to 5048 on Control Line RSTS01)	Separated path	30	Refer to section 3.4.1.1
Control Line RSTS02	Separated path with occasional vehicle access	30	Honiana Te Puni Reserve west (Control Line RSTS02) is designed to primarily operate as a separated path with infrequent vehicle access. Vehicle access will be restricted to authorised vehicles only[4]. The estimated volume of vehicles accessing the shared path is between one and five vehicles per day. Volumes will be restricted through the installation of retractable bollards at Ch. 45 and Ch. 270 – refer to the package DWP-TS-02 for further details. From Ch. 0 to Ch. 50 (at the boat ramp), the path width is 5.7m. The path width has been selected to optimise the retractable bollard spacing (refer to DWP-TS-02). From Ch. 70 to Ch. 280, the path width is 7.3m wide. This path width has been designed to utilise the existing road through this area, and to allow for safe operation of vehicles towing boats. Slow path users (including pedestrians) will be encouraged to keep to the seaward side of the path. This will be delineated by line markings and the installation of a ribbed profile between the fast and slow path users – refer to the DWP-TS-02 package for further information. Through this area, a cyclist design speed of 30km/h[5] has been adopted. Operating speeds for cyclists may need to reduce to below 30km/h when vehicles are present.
Control Line RSTS03	Shared path	20	Honiana Te Puni Reserve west (Control Line RSTS03) is designed as a 3.75m wide shared path. Path users will be separated by direction, not type. This design approach was taken into consideration that the connection path is a minor connection path between two higher volume paths. A design speed of 20km/h[6] along this path has been adopted.
Control Lines RSTS04 and RSTS05	Boat ramp	N/A	Vehicle access

[4] Authorised vehicles include KiwiRail, maintenance and emergency vehicles

[5] AGRD Part 6A (2021) Appendix A.3 specifies a 30km/h+ design speed for a separated path of this width.

[6] AGRD Part 6A (2021) Appendix A.2 specifies a 20km/h design speed for a shared path of this width.

Design Vehicles

Refer to Table 3.6 below for specific road design vehicles for the project.

Table 3.6: Design vehicles

Design Element	Design Vehicle(s)	Comment
Main shared path	RTS-18 Large Rigid Truck	Maintenance and emergency vehicle access
Shared path bridge at Ngā Ūranga		Emergency vehicle access
SH2 off-ramp (KiwiRail access)	19.45m Semi-trailer	KiwiRail maintenance access to the Ngā Ūranga construction yard
Honiana Te Puni Reserve west vehicle access	RTS-18 Large Rigid Truck and Car with skiff trailer[7]	Boat ramp and reserve vehicle access
KiwiRail maintenance bays (north and south)	KiwiRail Hi-rail design vehicle, EPC302 Isuzu FVZ (model FVZ1350A)	KiwiRail maintenance and operations requirements have been reviewed by KiwiRail.
KiwiRail maintenance bay (mid)	Ute[8]	Due to topography constraints, the mid maintenance bay can only be accessed by a ute vehicle. This has been raised with KiwiRail and will be followed by a formal approval process

Vehicle tracking and swept path analysis has been undertaken in accordance with RTS 18: New Zealand On-Road Tracking Curves for Heavy Motor Vehicles (2007). Refer to Appendix B for outputs. In all vehicle tracking (apart from tracking at the maintenance bays), a clearance envelope of 500mm from the body of the vehicle has been considered, this is compliance to the RTS18 standard. A 300mm clearance from the body of the vehicle was adopted at the maintenance bays due to the constrained environment. This is considered appropriate for the slow speed and low volume environment. There will also be a spotter at all maintenance activities. Alliance-wide discussions with KiwiRail are ongoing to confirm KiwiRail access gates requirements. Should design changes required as a result of the discussion, the design will be updated post-IFC stage. Operational assumptions informing the maintenance bay design are outlined in Section 3.4.8.

The KiwiRail access gate and boundary fence have been designed to accommodate the vehicle tracking and swept path analysis at the SH2 off-ramp. The fence and gate details are shown in DWP-TS-03.

Vertical ground clearance checks for the shared path bridge at Ngā Ūranga were undertaken using Autodesk Vehicle Tracking software. These checks show that the RTS-18 Large Rigid Truck design vehicle will have adequate ground clearance to drive over the bridge ramps and deck.

3.4.2 Typical Cross Sections

The typical cross sections for the Ngā Ūranga ki Pito-One shared path are detailed in drawings NKP-TAT-000-DRG-CV-TS-114001 to 114010.

Typical cross section details for the main shared path are summarised in Table 3.7 below.

[7] 95th percentile vehicle, as specified in AT TDM. 5.06m vehicle with 13.4m boat trailer. Boat trailer length is based on a standard rowing skiff trailer.
[8] 95th percentile vehicle, as specified in AT TDM. 5.06m vehicle. The specification of this vehicle has been informed by discussions with KiwiRail operations team to understand their vehicle fleet and operational requirements.

Table 3.7: Cross section typical widths – shared path

Location	Chainage	Total path width (m)	Clearance to landward edge of path (m)	Bi-directional cycle path (m)	Clearance between cycle path and footpath (m)	Footpath (m)	Clearance to seaward edge of path (m)
Shared path at southern tie-in	Control Line RSTS01: Ch. 440 to 542	4.0 to 5.0	VARIES	3.5 to 4.5			0.5
Shared path bridge at Ngā Ūranga	Control Line RSTS01: Ch. 542 to 788	5.2	0.25[9]	2.5	0.5	1.95	0.0
Shared path at seawalls	Control Line RSTS01: Ch. 2310 to 2445 Ch. 2825 to 3031 Ch. 3349 to 3473 Ch. 3580 to 3745 Ch. 3839 to 3918 Ch. 4072 to 4196	5.45 to 5.55[10]	0.5	2.5	0.5	1.5	0.7[11]
Shared path at revetments and ūranga	Control Line RSTS01: Ch. 788 to 2310 Ch. 2445 to 2825 Ch. 3031 to 3349 Ch. 3745 to 3839 Ch. 3918 to 4072 Ch. 4196 to 4803 Ch. 4821 to 5048	5.0	0.5	2.5	0.5	1.5	N/A

[9] Minimum pedal strike clearance of 250mm in range of pedal height (between 0 and 200mm) as specified in Waka Kotahi Cycling Network Guidance. A clearance of 300mm from the cyclist deflection rail, as required in Austroads Part 6A, is also achieved.
[10] The width of the shared path at the seawalls has been dictated by the construction of the seawalls. An option assessment to reduce the path width to 5.0m at the seawall was completed in Stage A of the DWP-SE-01 work package. However, retaining a wider path at the seawalls was endorsed. Refer to DWP-SE-01 for details.
[11] 0.7m clearance dictated by space requirements for installation of a kerb drain. Refer DWP-DR-01.

Location	Chainage	Total path width (m)	Clearance to landward edge of path (m)	Bi-directional cycle path (m)	Clearance between cycle path and footpath (m)	Footpath (m)	Clearance to seaward edge of path (m)
Korokoro Stream Bridge	Control Line RSTS01: Ch. 4805 and 4820[12]	6.0 (TBC)	0.5	3.0	0.5	2.0	N/A
Honiana Te Puni Reserve	Control Line RSTS02: Ch. 0 to 55	5.7	N/A	3.7[13]	0.0	2.0	N/A
	Control Line RSTS02: Ch. 55 to 220	7.3	N/A	5.3[14]	0.0	2.0	N/A
	Control Line RSTS03	3.75[15]	N/A	3.75			N/A
Shared path at northern tie-in	Control Line RSTS01: Ch. 4820 to 5048	4.0 to 5.0	0.5	3.5 to 4.5			N/A

[12] The new bridge over Korokoro Stream is currently at concept design stage therefore has not been included in this work package. The tie-in alignment of the main shared path at Ch. 4805 and Ch. 4820 has been designed based on the concept design. Realignment will be expected as further design of the Korokoro Stream bridge is progressed.
[13] The narrower path is due to no public vehicle access in this area (apart from emergency vehicles) and optimisation of the spacing between bollards (refer DWP-TS-02).
[14] The 5.3m path to accommodate either a bi-directional cycleway or a vehicle and a cyclist to be travelling simultaneously.
[15] Shared path, separated by direction not mode. The shared path width is designed based on the minimum shared path width in accordance with Austroads Part 6A and the Waka Kotahi Access Control Devices on Paths Design Guidance Note. Clearance to existing vegetation to be confirmed on site. Measurement taken between the outer edges of the flush kerbs on both sides of the path.

The typical cross section of the KiwiRail Slip Lane is shown in Table 3.8 below.

Table 3.8: Cross section typical widths – SH2 off-ramp

Location	Left shoulder (m)	Lane width (m)	Right shoulder (m)
SH2 off-ramp (KiwiRail vehicle access)	1.0	3.5 to 4.0	Varies (0m to 3.5m)

3.4.2.1 Total path width

The consented design was for a consistent 5.0m-wide shared path, consisting of an effective path width of 4.5m and a 0.5m clearance at the fence[16].

During the IPAA stage of design, an options assessment of the path width was completed.[17] Options to increase the minimum path width to 5.5m along the entire project extent were explored during the IPAA phase, refer Appendix A for details. Increasing the path width to 5.5m was recommended by the geometric design team; however, the alliance has decided to retain the path width of 5.0m to reduce the implications on the CMA footprint, cost of the project and risk of re-consenting. This has been communicated with external SME and safety has been considered through space allocation between slow and fast users on the 5.0m wide path. Opportunities to widen the path locally at critical areas have been explored during the PAA phase of design. The path width has been increased at the following locations:

- Along the main shared path adjacent to seawalls. The width of the shared path at the seawalls is 5.45 to 5.55m. An option assessment to reduce the path width to 5.0m at the seawall was completed in Stage A of the DWP-SE-01 work package. However, retaining a wider path at the seawalls was endorsed. Refer to DWP-SE-01 for details.
- Honiana Te Puni reserve between the boat ramp and the tie-in at the Honiana Te Puni reserve east (7.3 m path width). This is to allow sufficient width on the fast-user path for vehicles with a boat that will occasionally access this section of shared path.
- Across the shared path bridge at Ngā Ūranga
- Potentially across the Korokoro Stream bridge, this is to be confirmed during further design of the Korokoro Stream bridge at a later stage.

The path width is taken between the formed edges of the path as follows:

- Along the main shared path, the path width is measured from the new KiwiRail boundary fence to the outside face of the flush kerb at revetments and ūranga and to the outside face of the in-situ footing at seawalls.
- Along the shared path bridge at Ngā Ūranga, the path width is measured between the base of the balustrades.
- Through Honiana Te Puni Reserve, the path width is measured as the formed path between the outer edges of the flush kerbs.

[16] A minimum 0.5m clearance between cyclists and the fence is required as specified in Austroads Guide to Road design Part 6A – Paths for Walking and Cycling Section 5.2.

[17] In the IPAA stage of the project, an options assessment of the path width was completed (refer Appendix A). A recommendation was made to increase the path width from the consented 5.0m to 5.5m. However, due to consent and CMA constraints, the PAB endorsed a consistent path width of 5.0m, with opportunities to increase the path to be explored in detailed design.

3.4.2.2 Korokoro Stream Bridge

As part of the project, the existing Korokoro Stream bridge will be replaced. The replacement of the Korokoro Stream Bridge is being progressed in the DWP-BR-03 work package. At the time of this DWP-TS-01 IFC report, the DWP-BR-03 work package is at a concept design only. The vertical and horizontal geometry of the main shared path adjacent to the Korokoro Stream Bridge has been developed based on this concept design (refer Appendix C). As the DWP-BR-03 work package is progressed, the geometric design of the main shared path may need to be updated. If required, this will be progressed as a post-IFC change.

The width of the path across Korokoro Stream bridge is to be confirmed. The concept design to inform the consent is for a 6.0m wide bridge width. This width is indicative at concept design stage to inform property boundary discussions with HCC and KiwiRail. The minimum shared path width will be to be 5.3m

3.4.2.3 Project extent tie-ins

Project tie-ins with existing are summarised below:

- At the northern tie-in, the 5.0m shared path transitions to 4.5m at the Pito-One to Melling shared path interface (currently under construction).
- At the southern tie-in, the 5.0m shared path transitions to 4.0m to tie into the existing path width south of the project extent. The design ties into the existing ground level. The shared path south of the project is being upgraded as part of the LGWM programme. However, design of this path has not been completed, and construction timeframes are not confirmed.
- At Honiana Te Puni Reserve west, the 7.3m shared path transitions to 5.7m at the existing Honiana Te Puni reserve access road at Ch. 280 (Control Line RSTS02).The pedestrian path to be constructed as part of the Honiana Te Puni Reserve east project.
- At the SH2 off-ramp, the 5.0m wide off-ramp (including shoulder) transitions to 3.0m at the northern end to tie into the existing SH2 shoulder. The off-ramp widens from 5.0m to 8.0m at the southern end access gate and ties-into the existing ballast level. The southern end of the off-ramp aligns with the permanent level crossing (refer DWP-PS-02).
- At the link path to SH2 (The Esplanade) on-ramp, an existing link path is intersecting with the connecting shared path (Control Line RSTS03). The connecting shared path will be tying into the existing path width and level.
- At the link path to SH2 (The Esplanade) off-ramp, an existing link path is intersecting with the main path (Control Line RSTS01) at the northern end of the project. The main path will be tying into the existing path width and level of the link path.

3.4.3 Sight Distance

To ensure safe travel, the inter-visibilities of all approaching path users must be achieved. Bicycle SSD has been calculated in accordance with Section 5.7.1 of AGRD Part 6A and is outlined in Table 3.9 for each path segment.

Table 3.9: Bicycle path stopping sight distance

Design parameter	Location					
	Main shared path	Shared path bridge at Ngā Ūranga			Honiana Te Puni Reserve west	
		Span	Down Ramp	Up Ramp	Shared Path (Control Line RSTS02)	Connecting Path (Control Line RSTS03)
Design speed	30km/h	20km/h	30km/h	20km/h	30km/h	20km/h
Reaction time	2.5s	1.5s*	2.5s	2.5s	2.5s	2.5s
Grade	-3 to +3%	-1 to +1%	-8.3%	+8.3%	-2.6% to 2.6%	-3.5 to 3.5%
Coefficient of deceleration	0.16	0.16	0.16	0.16	0.16	0.16
Stopping sight distance	39 to 48m	18 to 19m	67m	20m	40 to 47m	22 to 26m
Stopping sight distance for two approaching cyclists	78 to 96m	36 to 38m	87m		80 to 94m	44 to 52m

** A reduced reaction time of 1.5s on the bridge span was adopted. Cyclists are likely to be more alert as they travel up the bridge ramps and onto the bridge span.*

These bicycle SSD has been checked along the project extent. These have been checked against both the existing and new design features. The key sight distance constraints have been identified at the shared path bridge at Ngā Ūranga and the connecting path (Control Line RSTS03) in Honiana Te Puni Reserve west. These have been addressed as follow:

- The bicycle SSD for the two-way cyclists on the Ngā Ūranga ki Pito-One bridge is restricted due to the reversed curve on the bridge. Therefore, a double yellow no-passing line (as shown in DWP-TS-02 work package) has been proposed on the bridge to keep cyclists in their lane. This will minimise the risk of head-on crashes with opposing cyclists due to the restricted visibility.
- SSD from the Honiana Te Puni Reserve connecting path (RSTS03) looking left onto the main path (RSTS01) is currently not achieved with the existing vegetation. This will be resolved and satisfied when vegetation is removed as part of the landscaping pack through Honiana Te Puni Reserve (refer DWP-LS-02).

To avoid conflict at this location, path users travelling along RSTS03 will be held at a "Give Way" control at both the intersection with RSTS02. This will be communicated through line markings and is detailed in the DWP-TS-02 package.

At all other locations, the sight lines meet the SSD requirements outlined in Table 3.9[18]. The sight lines have been communicated with the other work packages to ensure that the design does not interfere with the line of sight.

Path sight distances can be drastically reduced by vegetation and planting. The line of sight will be ensured in the planting plans specified in the package DWP-LS-01. The SSD will require the following to be included:

- Low planting species
- Removal of existing vegetation where sight lines are obstructed.

3.4.4 Horizontal Geometry

All path horizontal design elements within the project have generally been designed in accordance with AGRD Part 3 and Part 6A. The minimum design criteria required to be achieved are outlined below in Table 3.10.

Table 3.10: Shared path horizontal geometry

Design parameter	Location			
	Shared path	Shared path bridge at Ngā Ūranga span[19]	Honiana Te Puni Reserve west (Control Line RSTS02)	Honiana Te Puni Reserve west (Control Line RSTS03)
Design speed	30km/h	20km/h	30km/h	20km/h
Minimum horizontal radius[20]	25m	10m	25m	10m

3.4.4.1 Shared path bridge at Ngā Ūranga

The shared path bridge at Ngā Ūranga has the following horizontal design features:

- No horizontal curvature on the approach ramps.

An 'S' shape for the bridge, with curve radii at the centre of the path of 40.5m. This radius has been chosen to provide cyclists with adequate stopping sight distance to limit the risk of collision with oncoming cycle/pedestrian traffic as well as a traffic calming feature to mitigate cyclists travelling in excess of 20 km/h.

[18] Sight lines have been checked based on available aerial imagery and survey only. SSD has not been checked on site.
[19] A minimum horizontal radius has not been defined for the bridge ramps as there are no horizontal curves on the ramps.
[20] All horizontal radius is designed in accordance to AGRD Part 6A Table 5.6.

3.4.5 Longitudinal Vertical Geometry

The vertical geometry for the Ngā Ūranga ki Pito-One project is detailed in drawings NKP-TAT-000-DRG-CV-TS-112501 to 112540.

The longitudinal gradients have been designed in accordance with AGRD Part 6A Table 5.8 for the main path section and AT Transport Design Manual – Engineering Design Code Cycling Infrastructure Table 10 for the ramps on the shared path bridge at Ngā Ūranga[21]. The vertical curve lengths have been designed in accordance with AT Transport Design Manual – Engineering Design Code Cycling Infrastructure Figure 16.

The maximum longitudinal vertical gradient has been designed to ensure the lengths of the steep gradient do not exceed that specified within AGRD Part 6A and AT TDM standards. These are outlined in Table 3.11:

Table 3.11: Design longitudinal vertical gradient

Design parameter	Location				
	Shared path	Shared path bridge at Ngā Ūranga ramps	Shared path bridge at Ngā Ūranga span	Honiana Te Puni Reserve west	
				Shared Path (Control Line RSTS02)	Connecting Path (Control Line RSTS03)
Maximum grade[22]	5.0%	8.3% (1:12)	1%	5.0%	5.0%
Maximum length of gradient (m)	75	45[23]	N/A	75	75

The vertical design parameters applied for the project's active mode facilities are summarised in Table 3.12

Table 3.12: Shared path vertical curve length

Design parameter	Location				
	Shared path	Shared path bridge at Ngā Ūranga ramps	Shared path bridge at Ngā Ūranga span	Honiana Te Puni Reserve west	
				Shared Path (Control Line RSTS02)	Connecting Path (Control Line RSTS03)
Design speed	30km/h	30km/h	20km/h	30km/h	20km/h
Minimum vertical curve length	9m	9m	6m	9m	6m

[21] Waka Kotahi Cycling Network Guidance provides reference to the AT Transport Design Manual (TDM) – Engineering Design Code Cycling Infrastructure Table 10 for gradient design of shared paths.
[22] The maximum gradients are designed in accordance with the guidelines specified in Section 3.4.5.
[23] AT TDM – Cycling Infrastructure Table 10

3.4.5.1 Shared path bridge at Ngā Ūranga (name TBC)

The two bridge ramps have been designed with an 8.3% grade (1:12), with 3.0m-long flat landings at half-way points on each ramp. A vertical curve length of 2.0m has been adopted at the change of grade. As per the AT TDM standard, this is the absolute minimum vertical curve length at landings/rest areas. Provision of additional landings to meet NZ Building Code requirements[24] were not provided as these features do not align with current best practice for designing a shared path where cyclists are the main users. Further information supporting this approach on the design of shared path ramps is outlined in Shared Path Mobility Access Standards Memo, attached in Appendix D and in the case study of the Te Ara ki Uta Ki Tai cycleway in Auckland[25].

The above approach is considered compliant with the vertical alignment Minimum Requirements for the bridge[26] that state the "bridge ramp geometry shall be designed to accommodate all users in accordance with best practice and design standards".

The main bridge deck has been designed with a 1% longitudinal fall. This longitudinal fall was introduced during Stage C, to minimise ponding on the bridge deck. The longitudinal fall was achieved via the addition of a vertical curve length of 6 m with a peak at the middle (over the rail). The drainage design is detailed in the DWP-DR-02 work package.

The vertical clearance of the bridge is determined by the KiwiRail Track Standard T-ST-DE-5212. The minimum fixed structure clearance from top of rail is 5.5m. To allow future track adjustment, 100mm is added to this clearance. Therefore, the minimum vertical height of the bridge soffit is 5.60m above rail level.

3.4.5.2 Main shared path and Honiana Te Puni Reserve west

The vertical alignment on the main shared path is generally flat with some minor vertical grade changes to match the revetment and seawall design and to maintain a consistent 2.5% crossfall. The vertical alignment on the main shared path is generally flat with some minor vertical grade changes to match the revetment and seawall design and to maintain a consistent 2.5% crossfall.

As per the AT TDM standard, for design speed environments of 20 km/h and 30 km/h, the minimum vertical curve length where there is a change in longitudinal grade is 6m and 9m, respectively. In the IFC design, the minimum vertical curve length has been achieved throughout the project apart from the following locations:

- At the KiwiRail Traction Station (Ch. 2930 to Ch. 2960) –the vertical geometry is constrained. The path elevation is constrained by the seawall elevation and the requirement of providing a 20m long longitudinally flat geometry for the gate opening. Therefore, the vertical curve length achieved at this location is 5m.
- At the northern end tie-in of the main path (Ch. 4880 to Ch. 5048) – the path is undulating path with vertical curve lengths less than 9m. Further modelling will be undertaken with the latest existing ground survey to ensure vertical curve of a minimum of 9m is achieved.
- At the eastern end tie-in of the Honiana Te Puni reserve – the vertical curve length at this location is 5m long by modelling with the available existing survey. Further vertical curve length should be able to achieve during construction.
- At the locations where a change of gradient is <0.5% or a change of vertical elevation <10mm due to the requirement to tie-into the revetment or seawall will be considered as insignificant changes which will not pose as a safety concern

[24] Landings for every 750mm rise of ramp between landings
[25] Case study: https://www.nzta.govt.nz/walking-cycling-and-public-transport/cycling/cycling-standards-and-guidance/cycling-network-guidance/case-studies/auckland-te-ara-ki-uta-ki-tai-gradient-design-of-shared-path/
[26] NKP-TAT-000-REP-GE-NS-00001: Appendix A02 Geometric and Road Layout (Issue 1 November 2020) – Vertical Alignment MR2.5.2

3.4.6 Cross-sectional Vertical Geometry (Crossfall and Superelevation)

3.4.6.1 Shared Paths

The main shared path and the path through Honiana Te Puni reserve west have a typical single plane crossfall of 2.5% towards the seaward side of the path. The connecting path between the main shared path and the path in Honiana Te Puni reserve has a 2.5% crossfall towards either side with a crown at the centre of the path. The path over the shared path bridge at Ngā Ūranga has a 2.0% crossfall towards either side with a crown at the centre of the path. The shared path bridge has a lower crossfall than the main shared path to reduce the risk of cyclists losing control if crossing the camber, but the crossfall is sufficient to address drainage requirements.

Along the main shared path, no superelevation is proposed, in accordance with the Cycling Aspects of Austroads Guides (2007) document Section 7.5.3. For the design speeds of the path (20km/h or 30km/h), superelevation is not required on the horizontal curves (minimum 10m and 25m radii, respectively). Therefore, the crossfalls were predominantly determined based on the drainage requirements, in accordance with the Waka Kotahi MRs.

3.4.7 SH2 Off-ramp (KiwiRail Access)

The design includes the relocation of the existing SH2 off-ramp (KiwiRail access) north to accommodate for the shared path bridge at Ngā Ūranga. A KiwiRail Agreement in Principle for this off-ramp relocation is documented in the KiwiRail Compound Agreement[27]. The basic design criteria accepted in this compound agreement were:

- Geometrically match the existing access or improve where practical.
- Provide a secure access gate.
- Accommodate the design vehicle – 19.45m semi-trailer truck.
- Surface construction commensurate with predicated use.

The relocation design furthermore needs to allow for KiwiRail maintenance access across the tracks (refer DWP-PS-02) and upgrades to road safety barriers (refer DWP-TS-02).

The existing SH2 off-ramp (KiwiRail access) is marked with flushed shoulder markings with a “Private Vehicle Only” sign installed to discourage public vehicle access.

[27] KiwiRail Compound Agreement, refer Appendix H: Agreement in Principle

The relevant standards for motorway interchanges and the design philosophy are detailed in Table 3.13 below.

Table 3.13: Relevant standards for interchanges

Standard	Selected for the Project	Reasons
MOTSAM Part 3: Motorways and Expressways (Traffic Control Devices Manual Part 10)	No	The interchange design in the standard is targeted to roads with high traffic volumes that are accessible by the general public. This would result in the off-ramp being overdesigned for its required purpose.
AGRD Part 4A: Signalised and Unsignalised Intersection Section 5 – Auxiliary Lanes	No	The auxiliary lane design in the standard is targeted to a non-highway environment with high traffic volumes. This would result in the off-ramp being under-designed for a motorway with a 100km/h posted speed.
AGRD Part 4C: Interchanges Section 11 – Ramp Terminals (Figure 11.1b Minimum Treatment)	Yes	The "single lane exit ramp – minimum treatment" design in this standard is targeted for exits with low traffic volumes. This aligns with the expected traffic volume and the purpose of this off-ramp.

3.4.7.1 Vertical Geometry

The vertical alignment of the new SH2 off-ramp consisted of 3.5-4.0m wide lane width with a crossfall of 4.0% to match the existing SH2 carriageway crossfall. The shoulder (1.5-2.0m wide) including the clearances behind the guardrail and a 500mm wide dish channel has a maximum crossfall of 8.0%. The tie-in between the back of the dish channel and the existing path will be battered with a maximum of 1:2 slope.

3.4.7.2 Horizontal Geometry

The off-ramp will be used by authorised KiwiRail vehicles only. Access will be infrequent, with an estimated AADT of three vehicles per day[28]. As such, the realignment of the SH2 off ramp has been designed in accordance with AGRD Part 4C: Interchanges, Figure 11.1b.

3.4.7.2.1 Deceleration Distance

The new SH2 off-ramp has a deceleration distance of 122m. The deceleration distance of 122m is an improvement on the existing off-ramp deceleration distance of 110m (measured from where the shoulder is 3.5m wide to the existing KiwiRail access gate). However, it is not compliant with the AGRD Part 4C requirements.

Vehicles using the off-ramp will be required to come to a stop at the KiwiRail access gate. However, AGRD Part 4C does not provide deceleration distances for vehicles coming to a stop; the lowest exit speed that deceleration distances are provided for is 30km/h. A deceleration distance of 140m is specified for vehicles decelerating from a speed of 100km/h to 30km/h.

[28] The estimated volume from Cardno Integrated Transportation Assessment Ngā Ūranga ki Pito-One Shared Path (NZ0119141) 21/9/2020, Report Section 9.3

In lieu of a deceleration distance being provided for vehicles coming to a stop, the stopping sight distances (SSDs) for the off-ramp were calculated. The KiwiRail maintenance ute and a 19.45 m semi-trailer will require stopping sight distances of 165m and 195m[29], correspondingly. These distances are longer than the provided deceleration distance. Vehicles will be required to start decelerating prior to the off-ramp. The existing "Private Access Only" sign will be relocated to 145m from the start of the SH2 off-ramp to provide more warning to approaching vehicles.

Further lengthening of the off-ramp to comply with the AGRD Part 4C standard of a 140m deceleration distance would require the street light pole at Ch. 775 to be relocated back to the existing fence line. This would result in insufficient width for the required clearance of 4.0m between the guardrail and the centre of the KiwiRail tracks[30].

3.4.7.2.2 Diversion Taper

AGRD Part 4C requires the off-ramp to be tapered at 1:15 from the main alignment. The main function of the exit taper is to ensure the off-ramp can be identified by approaching vehicles at a reasonable distance.

The SH2 off-ramp design is parallel with the main alignment for the initial 50m with a taper of 1:25 thereafter. Providing a taper closer to 1:15 would significantly reduce the deceleration distance. A long deceleration distance is considered more important for vehicles to have sufficient length to decelerate to a stop. Furthermore, the "Private Vehicle Access" sign has been relocated 145m from the start of the off-ramp, and the off-ramp will be used by KiwiRail personnel, who will be familiar with the area.

3.4.7.3 Design Summary

The design parameters required for the SH2 off-ramp are summarised in Table 3.14 below.

Table 3.14: SH2 off-ramp design criteria

Design criteria	MR/ Standard Requirement	Existing	Design	Standard reference/ comment	Compliant
Design vehicle	19.45m semi-trailer	N/A	19.45m semi-trailer	Minimum Requirements	Yes
Deceleration length	140m	110m	122m	AGRD Part 4C Table 11.1	No
Off-ramp deviation taper	1:15	1:8	Varies (1:25 max)	AGRD Part 4C Figure 11.1b	Yes
Through road speed	100km/h	100km/h	100km/h	Speed on through road (SH2 Southbound)	N/A

[29] Reaction time (Rt) – 2.0 s (AGRD Part 3), Operating Speed (V) – 100 km/h (major road), Coefficient of deceleration – 0.36 (ute), 0.29 (19.45m semi-trailer), Longitudinal Grade – 0%
[30] In accordance with KiwiRail Project Agreement Clause 4.16

As a result, a design departure will be submitted to Waka Kotahi by the Alliance for formal approval. Key factors that will inform this design departure are:

- Low number of vehicles using the off-ramp.
- Clear visibility for vehicles approaching SH2 slip lane.
- Access restricted to KiwiRail maintenance traffic only (i.e. familiar users).
- Improvements to adjacent road safety barriers.
- Private Access Only signage relocated to warn SH2 vehicles of the site access. No further signage will be erected to avoid attracting attentions and to discourage the use of the off-ramp by general public.
- Physical site constraints.
- Adoption of a no 'net worsening' design philosophy of the existing SH2 off-ramp layout.

For the geometric design layout refer IFC drawing NKP-TAT-000-DRG-DV-TS-112540.

3.4.8 Maintenance Bays

There are three maintenance bays along the shared path. The locations and size of KiwiRail maintenance bays are specified in the MRs as follows:

- Piki Wahine Point (South) – nominally 10m x 10m
- Karanga Point (Mid) – nominally 10m x 5m
- Korokoro (North) – nominally 10m x 10m

An initial meeting with KiwiRail was held on 15 September 2022 to discuss the maintenance bay locations. The agreed design vehicle is the KiwiRail Hi-rail truck (Truck_EPC302 Isuzu FVZ). However, further investigation and design have shown that the mid maintenance bay is unable to accommodate the KiwiRail Hi-rail truck due to the steep grade (up to 40%) between the back of path and the KiwiRail track. KiwiRail has been updated with the findings on 18 April 2023 and this will progress with a formal departure/approval process.

The key assumptions used in the design of the maintenance bays are:

- Vehicles will access the bays predominately from the shared path via Honiana Te Puni Reserve in the north.
- All maintenance vehicle access to the shared path will be completed under an approved TMP. Where reversing of a vehicle on the shared path is required, a spotter will be present to ensure this occurs safely.
    - FVZ Hi-Rail vehicle access to the rail corridor from the shared path will be infrequent, with one vehicle per day on average or fewer than 365 vehicles per year.
- Maintenance works will primarily be completed using a ute[31].
- A ute will need to complete a 360 degree turn without reversing onto the shared path.
- Sufficient space is required for a FVZ Hi-Rail vehicle to park.

[31] 95th percentile vehicle, as specified in AT TDM. 5.06m vehicle, with a 6.450m kerb to kerb radius.

Since the consent design was completed, the locations of the maintenance bays have been refined. The design philosophy at each of the maintenance bays is detailed in Table 3.15 below.

Table 3.15: Maintenance Bay Locations

Maintenance Bay	Location
South	Location refined to provide a minimum 1m clearance between the maintenance bay and the existing revetment.
Mid	Location shifted in IPAA to keep the maintenance bay location next to the KiwiRail Traction Station building. The maintenance bay was located next to the Traction Station in the concept design. In IPAA, the KiwiRail Traction station building was shifted. The maintenance bay location was subsequently shifted to keep the bay next to the building. Access for a ute to/from the traction station gate. This is subject to approval with KiwiRail.
North	Location shifted north approximately 15m. In Stage B, the maintenance bay was located over the Wellington Water Bulk Water main access. The following additional benefits were gained from shifting the bay: ▪ Maintains proximity to the Hi-rail access point at Ch. 4415. ▪ Retains the same location as the existing concrete slab, used by maintenance vehicles. ▪ Provides space for a landscaped pedestrian path behind the maintenance bay. ▪ Provides proximity to the preferred access gate location. Access for a ute from the maintenance bay to the bulk water main will be required. This will be incorporated into the landscaping design (work package DWP-LS-02).

The location of the maintenance bays are detailed in Table 3.16 below.

Table 3.16: KiwiRail maintenance bays dimensions

Bay	Minimum Requirement				Design Refinement			
	Location	Alliance chainage	KR rail chainage	Sizing	Location	Alliance chainage	KR rail chainage	Sizing
South	Piki Wahine Point	Ch. 880	km5.785	Nominally 10m x 10m	Piki Wahine Point	Ch. 877 to 892	km5.788 to 5.806	10m x 15m
Mid	Karanga Point	Ch. 2735	km7.640	Nominally 10m x 5m	Rocky Point	Ch. 2949 to 2957	km7.852 to 7.862	No change
North	Korokoro	Ch. 4370	km9.275	Nominally 10m x 10m	Honiana Te Puni Reserve	Ch. 4375 to 4390	km9.287 to 9.302	10m x 15m

3.4.9 Access gates

At each maintenance bay location, a gate in the KiwiRail boundary fence is provided. The three gates are provided at:

- Ch. 868 – the gate may need to be located further south, to improve access to the gate from the level crossing and the rail corridor. Further discussions with KiwiRail will be required to confirm the gate location. The final gate location will be updated in DWP-TS-03 pack.
- Ch. 2950
- Ch. 4378

For further details on the location, type and design of the maintenance gates refer to the fencing work package (DWP-TS-03).

At all access gates, the level of the shared path is lower than the KiwiRail corridor. To ensure vehicle access between the KiwiRail corridor and the shared path at the access gates, the following have been provided:

- Batter slope from the KiwiRail corridor towards the shared path. The design batter slope for Piki Wahine Point, Karanga Point and Korokoro maintenance bays are shown in Table 3.17.
- A 40mm mountable kerb between the KiwiRail corridor and the shared path. The mountable kerb is provided to avoid water backflow onto the KiwiRail corridor and to avoid providing a crossfall that is too steep for the maintenance bay.
- 2.5% path crossfall across the shared path.
- Variable crossfall at the maintenance bays between 2.5% and 4.6%.

Table 3.17: KiwiRail maintenance bays access path gradients

Bay	Location	Alliance chainage	KR rail chainage	Batter Slope	Change in grade between KiwiRail corridor and shared path
South	Piki Wahine Point	Ch. 880	km5.785	-10%	12.5%
Mid	Karanga Point	Ch. 2950	km7.860	+18.5%[32]	16.0%
North	Korokoro	Ch. 4370	km9.275	+0.6%	1.9%

For the design of low-volume private ways, WCC's Code of Practice for Land Development – Part C: Road Design and Construction specifies a maximum grade of 25% for the straight path with a transitional grade of 12.5% up (above the path) or 8.3% down (below the path). The grades between the KiwiRail corridor and the shared path at the south and north maintenance bays are compliant with this design standard. A vertical clearance check has been undertaken at these locations to ensure scraping is mitigated for the design vehicle.

However, due to the existing steep batter at in the vicinity of the mid maintenance bay (up to 40%), the batter slope cannot be reduced to less than 18.5%, resulting in a combined change of grade of 16%. A vertical clearance check has been undertaken to ensure a ute can achieve this batter slope without scraping the vehicle. Initial communication has been undertaken with KiwiRail; this will be further progressed for formal approval process.

[32] An initial discussion with KiwiRail has been undertaken regarding the gradient of the access path. This will be progressed through a formal approval process.

3.4.10 Ngā Ūranga tie-in to the shared path bridge at Ngā Ūranga

The separated path transitions to a shared path design at Ch. 525 before joining the future LGWM/existing shared path further south at Ch. 440.

The Ngā Ūranga ki Pito-One shared path will replace the existing cycle lane that runs alongside the SH2 southbound carriageway. Cyclists will be encouraged to use the shared path; however, some cyclists are expected to continue cycling on the shoulder of SH2. In the Stage A design, a cycle lane connection from the SH2 shoulder to the shared path was included at Ch. 500 (Figure 32 below).

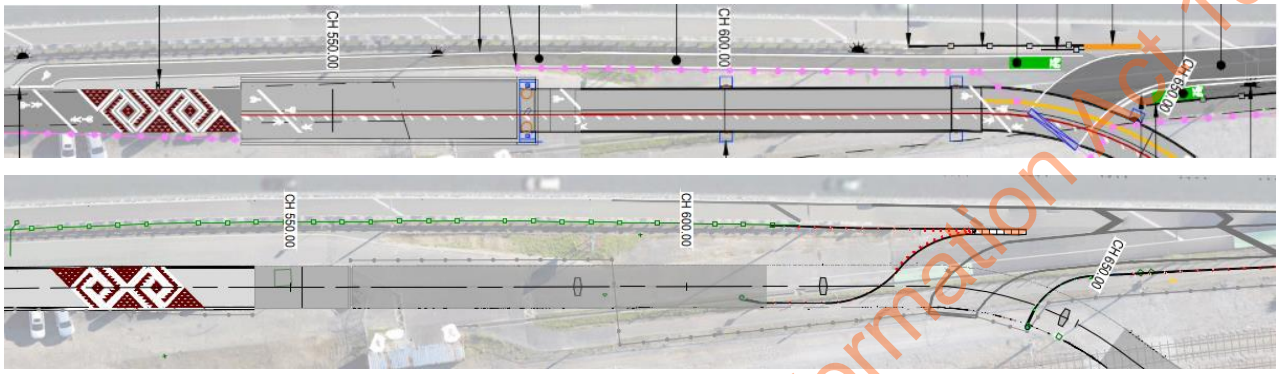


Figure 32 Cycle lane connection from SH2 to the shared path included at Stage A (above) and removed from IFC (below)

The cycle lane and cycle connection at the SH2 off-ramp (KiwiRail access) was removed to provide for the guardrail protection around the bridge pile. This change was requested by Waka Kotahi as part of the Stage A review process.

The LGWM scope of works includes cyclist provisions south of the shared path bridge at Ngā Ūranga, which would allow for cyclists to safely transition from the SH2 shoulder onto the shared path. Removing the cycle lane connection from the Ngā Ūranga ki Pito-One project had the following benefits:

- Allows for improved guardrail design around the bridge pile at Ch. 625 (refer DWP-TS-02 for details)
- Reduces cost to the Ngā Ūranga ki Pito-One project
- Reduces likely public frustration over the installation of a cycle lane connection that very few would be likely to use

Through discussions with Waka Kotahi, it has been agreed that the provision of a cycle lane connection is outside of the scope of this project. However, sufficient path clearance has been provided between the fence and the guardrail system should LGWM require to install a cycle connection in the future.

3.4.11 Honiana Te Puni Reserve west

The alignment through Honiana Te Puni Reserve west is shown in NKP-TAT-000-DRG-CV-TS-112515. Road markings, tactile delineation and signage for the path are detailed in DWP-TS-02.

Honiana Te Puni Reserve west (Control Line RSTS02) is a separated cyclist and pedestrian path, with infrequent vehicle access. Pedestrian space will be on the seaward side of the path and cyclists on the landward side. Vehicle access into Honiana Te Puni Reserve west will be restricted to authorised vehicles only via retractable bollards. The locations of the bollards are detailed in the traffic services work package (DWP-TS-02).

The path intersections in Honiana Te Puni reserve were generally designed for with a 2.5m[33] kerb radius in Stage C to reduce cyclist turning speeds. However, safety concerns were raised by the Waka Kotahi SME regarding the kerb radii at the following locations and changes have been made to address the safety risks:

- **North-eastern corner of Honiana Te Puni Reserve west connecting path (Control Line RSTS03) and the main shared path (Control Line RSTS01):** A safety risk was identified for westbound cyclists turning left onto the connecting path. Turning cyclists would need to significantly reduce their speed before navigating the tight turning radius. The fast-user section of the main path is only 3.0m wide, and there will be insufficient space for the straight through cyclist to overtake a cyclist waiting to turn when there is another cyclist travelling in the opposing direction. This will increase the likelihood of rear-ended crashes occurring on the main path. To address the safety risk, the radius of the corner has been increased to 6.0m[34].
- **South-eastern corner of Honiana Te Puni Reserve west connecting path (Control Line RSTS03) and the shared path (RSTS02):** A safety concern was raised for southbound cyclists turning left onto the Honiana Te Puni Reserve shared path. Cyclists making this manoeuvre will be travelling downhill, which may lead to loss of control if cyclists are required to decelerate harshly when negotiating with the tight kerb radius. Southbound cyclists approaching the intersection will have clear sightlines. Therefore, the kerb radius can be increased, allowing left-turning cyclists to turn freely when the Honiana Te Puni reserve path is clear. To address the safety risk, the kerb radius has been increased to match the existing path extent (6.5m radius).

Honiana Te Puni Reserve west connecting path (Control Line RSTS03) connects between the main shared path (Control Line RSTS01) and Honiana Te Puni Reserve west shared path (RSTS02). This is a 3.7m wide shared path, separated by direction of travel. Road markings and symbols will be installed to identify the travel direction and a fixed bollard will be installed at the southern end of the path to restrict vehicles access. The road markings and bollard are detailed in the traffic services work package (DWP-TS-02).

Considerations have been made for the tie-ins with the following shared paths:

- Ngā Ūranga ki Pito-One
- Honiana Te Puni Reserve east
- Pedestrian path intersecting Control Line RSTS03 at Ch. 20
- Pito-One to Melling

Following Stage C, a clash with the proposed path alignment and the piles of the SH2 overpass was identified. To address this clash, the main shared path (Control Line RSTS01) has been realigned between Ch. 4700 and Ch. 4800.

3.4.12 Boat Ramp

The Honiana Te Puni Reserve boat ramp has been designed as a two-way two-lane carriageway.
The width allows for two vehicles towing boats to pass. This is to ensure that vehicles on the shared path can turn into the boat ramp and minimise queueing of vehicles along the shared path (RSTS02). The shared path at this intersection, however, has been designed to allow for two vehicles to pass. This will require vehicles to pull into the slow path user space. The design vehicle speed in this area is 15km/h. To mitigate the aesthetic impact of the boat ramp, reinforced grass will be installed at midblock section, whereas asphalt pavement at the intersection to withstand the braking and turning movements. This is detailed in the DWP-PS-01 and DWP-LS-02 work packages.

[33] Austroads Part 6A Section 6.
[34] The kerb radius in accordance with Nga Haerenga The New Zealand Cycle Trail – The Cycle Trail Design Guide Grade 1 Easiest Path

4 Design Progression and Key Differences

4.1 Significant differences to the Consent Design

During the IPAA stage of design, various changes were made to the consent design (19 October 2020). These changes include, but are not limited to, the following:

- Shared path bridge at Ngā Ūranga
  - The bridge design was amended to provide 3.0m-long flat landings at half-way points on each ramp. This aligns with best practice for design of cycleways. However, this was a departure from the consent design, where landings were provided in accordance with the Building Code requirements for accessibility.
  - The horizontal radius on the bridge span was increased to 40.5m to provide cyclists with stopping sight distance to limit the risk of collision with oncoming cyclists/micro-mobility users/pedestrian traffic.
- Main shared path
  - The typical cross fall was increased from 2.0% to 2.5%.
- KiwiRail maintenance bays
  - The maintenance bay at Rocky Point was shifted to remain next to the KiwiRail Traction Station. Refer to section 3.4.7 for further information.

4.2 Significant differences to the Stage A Design

Since the Stage A submission (6 August 2022) various changes have been incorporated within the design. These changes include, but are not limited to, the following:

- Shared path bridge at Ngā Ūranga
  - Shortening of distance between landings to <45m
- KiwiRail slip lane
  - Removal of the existing SH2 off-ramp cycle lane
  - Realignment of the SH2 off-ramp geometry to suit guardrail changes
- Honiana Te Puni Reserve west
  - Tie-in between the Petone foreshore path and main shared path redesigned as a merge intersection
  - Access restricted to Honiana Te Puni Reserve west to authorised vehicles only
  - Honiana Te Puni Reserve west to operate as a fully shared zone
  - Boat ramp and access redesigned to allow for vehicle tracking of a 95th percentile car towing a 13.4m long rowing skiff

4.3 Significant differences to the Stage B Design

- Shared path bridge at Ngā Ūranga
  - Crossfall over the bridge reduced from 3.0% to 2.0%
  - 1% longitudinal fall added
  - Locations of the bridge piles have been refined
- KiwiRail slip lane
  - Lengthening of the SH2 off-ramp
- Main shared path
  - Removal of the longitudinal grade of the seawalls. This will reduce cost and constructability risks for the DWP-SE-01 and DWP-PS-01 work packages. The geometric design of the shared path has been adjusted to tie into the adjusted seawall levels.
- KiwiRail maintenance bays
  - Shape of maintenance bays squared up
  - Maintenance bay and gate locations refined to address clashes
  - Concrete slabs extended across the main shared path.
- Honiana Te Puni Reserve west
  - Layout of the Honiana Te Puni Reserve west access and boat ramp layout
  - Cyclist design speed through Honiana Te Puni Reserve west increased from 20km/h to 30km/h. Refer Section 3.4.1.3 for further details
  - Honiana Te Puni Reserve west to operate as a shared path (delineated with a ribbed profile) with restricted vehicle access instead of a shared zone
- Korokoro Stream bridge
  - Design updated to a 6m-wide new bridge. While the bridge does not sit within this scope, the tie-ins of the main shared path have been updated to minimise rework when detailed design for the Korokoro Stream bridge is completed.
- Northern tie-in
  - Path widened from 4.65m to 5.0m north of Korokoro Stream bridge. This allows for a fully separated path up to the tie-in with Pito-One to Melling
  - Path alignment straightened either side of the Powerco Gas building (Ch. 4930)
  - Northern tie-in with the Pito-one to Melling cycleway project has been confirmed. The vertical and horizontal levels have been refined accordingly.

4.4 Significant differences to the Stage C Design

- KiwiRail slip lane
  - Cross-section updated to accommodate for the service trench relocation and new drainage system (Refer to DWP-UN-01 and DWP-DR-01)
    - Main shared path
  - Minimum vertical curve length increased from 2m to 9m by realigning the revetment and back of shared path levels. This can be resolved at most locations except for the areas as specified in Section 3.4.5.2.
- KiwiRail traction station
  - Mountable kerb at traction station removed
  - Longitudinal grade along the length of the gate removed
  - Design vehicle updated from a Hi-rail vehicle to a ute
  - Providing an access path of 18.5% between the gate and the railway track for ute.
- KiwiRail maintenance bays
  - Horizontal radius at concrete slabs removed. This will allow for sliding of the gates, and improves constructability of the concrete slabs
- Honiana Te Puni Reserve west
  - Narrowing of paths through Honiana Te Puni Reserve west
  - Realignment of the main shared path between Ch. 4700 to Ch. 4800, to address the clash with the SH2 overpass bridge piles.

4.5 Design aspects to be resolved

The below issues have been identified through the development of the design and are still current. They need to be resolved during future design stages in consultation with the relevant stakeholders:

- Shared path bridge at Ngā Ūranga
  - Narrowing of the shared path bridge may be explored further in the DWP-BR-01 work package
- KiwiRail slip lane
  - Formal approval for the deceleration length design departure
  - Discussions with KiwiRail are ongoing to confirm the clearance requirements past the bridge piles
- Maintenance bays
  - Alliance wide discussions with KiwiRail are ongoing to confirm KiwiRail access gates requirements
- KiwiRail traction station
  - Formal approval of the design vehicle
  - Formal application and approval from KiwiRail for the acess path grade of 18.5% between the gate and the railway track
- Honiana Te Puni Reserve west
  - Increase in minimum vertical curve length to 9m.
  - Tie-in with new Korokoro Stream bridge. In this IFC design, the existing bridge over Korokoro Stream is to be replaced. The geometric design at this area has been based on the concept design for the Korokoro Stream bridge. The alignment between the shared path and the Korokoro Stream bridge will be confirmed when design of the Korokoro Stream bridge is completed.

5 Risk and Opportunity

5.1 Project Risks

Project risks identified during Stage C are set out in Appendix E. The project risks will be investigated further in the next stage of design.

5.2 HSiD

HSiD principles have been applied throughout the design phase and production of each work package. HSiD is relevant not only for the safety of patrons using the Ngā Ūranga ki Pito-One in its operational phase but is a mind-set applied across the whole of the project. Design impacts the safety of workers in terms of construction methodology and staging, and maintenance operations and access.

The HSiD considerations being incorporated into the design of Ngā Ūranga ki Pito-One are in relation to the full life cycle of the project from the earliest enabling works, through construction and integration with the other Ngā Ūranga ki Pito-One contracts, operations and maintenance and ultimately the demolition and disposal of assets.

A preliminary HSiD capture was undertaken at Tender and followed up by Alliance HSiD workshops in the IPAA stage of design to further review hazards and harm that can be eliminated or mitigated by design amendment.

A HSiD workshop was held for Stage B detailed design on 25 October 2022. This workshop focussed on the geometrics (DWP-TS-01), traffic services (DWP-TS-02), and landscaping (DWP-LS-01, DWP-LS-02 and DWP-LS-03) work packages. The workshop was attended by the Alliance (both design and construction teams) and Waka Kotahi SMEs. Details of the workshop are documented in Table 5.1 below.

Table 5.1: Stage B HSiD Workshop

Date	Work Packages	Attended by
25 October 2022	DWP-TS-01, DWP-TS-02, DWP-LS-01, DWP-LS-02, DWP-LS-03	Simon Kennett, Sam Bourne, Alistair Gordon, Jeremy O'Neill, Tess Breitenmoser, Aaron Miller, Jan Noering, Sean Burke, Justin Gisel, Elayne Gentry

During Stage C and IFC, HSiD discussions were paired with the DRR process. Through DRR workshops, HSiD was discussed between the Alliance and Waka Kotahi SMEs.

A register of HSiD considerations for all work packages has been developed – refer NKP-TAT-THW-REG-PC-NS-000001. The HSiD register filtered for this work package is attached in Appendix F.

6 Construction and Maintenance

6.1 Construction Stage Verification

- Construction set-out will be completed in accordance with the model.
- Construction tolerances will be confirmed at the next stage of design.
- Construction stage verification is to include any as-built changes as a result of on-site variations.

6.2 Maintenance and Handover Considerations

- Maintenance and handover consideratons are being progressed on an alliance-wide basis. An Operation and Maintenance plan will be completed by the Alliance prior to construction.
- Continued interface with KiwiRail will be required to confirm their operational requirements.
- The Alliance will ensure that all construction work packages and quality assurance documentation are completed prior to obtaining Practical Completion.

7 Compliance with Works Requirements

7.1 Compliance with Minimum Requirements

The geometric design for the shared path has been completed in accordance with the Te Ara Tupua – Ngā Ūranga ki Pito-One Minimum Requirements NKP-TAT-000-REQ-AM-NS-00001 (Waka Kotahi, 2022). The relevant sections of these Waka Kotahi Minimum Requirements for the Geometric package are outlined in Table 7.1 below.

Table 7.1: Relevant Waka Kotahi Minimum Requirements

Appendix	Title	Issue
Appendix A01	Standards Manuals and Guidelines	Issue 1, November 2020
Appendix A02	Geometrics and Road Layout	Issue 2, May 2022
Appendix A05	Bridges and Retaining Walls	Issue 2, May 2022
Appendix A08	Pedestrian and Cycle Facilities	Issue 1, November 2020
Appendix A11	Honiana Te Puni Reserve	Issue 1, December 2020
Appendix A12	Partnership with Mana Whenua	Issue 1, November 2020
Appendix A13	KiwiRail – Site Specific Requirements	Issue 1, November 2020
Appendix A15	Operations and Maintenance	Issue 1, November 2020
Appendix A16	ISCA Requirements	Issue 1, November 2020
Appendix A19	Emergency Egress and Response	Issue 1, November 2020

A summary of the geometric design with the project's Minimum Requirements is detailed in Table 7.1.

7.2 Departures

7.2.1 Minimum Requirements

Table 7.2 below outlines the departures from the Minimum Requirements. Each of these departures has been discussed with Waka Kotahi and KiwiRail and will be formalised through the design departure process.

Table 7.2: List of design departures from Minimum Requirements identified in Stage B and Stage C of design

Item	Minimum Requirement	Stage C Design Departures
Design speed	Minimum Requirements Appendix A02 Geometrics Road Layout Section 2.2.1 states: *"The design speed for the shared path shall be no less than 30km/h for all geometric elements except the bridge. The design speed for the bridge shall be no less than 20km/h."*	A design speed of 20km/h along the connecting paths in Honiana Te Puni Reserve has been adopted.
SH2 off-ramp cycle lane connection	Minimum Requirements Appendix A02 Geometrics Road Layout Section 1.2.1 states: *"The path replaces the existing path which runs alongside the SH2 SB carriageway. The connection from the existing path, the hard shoulder (SH2) and the modified KiwiRail access at the new bridge site will maintain the connection with the existing path south of the bridge ramp."*	The connection from the existing path, the hard shoulder (SH2) and the modified KiwiRail access at the new bridge site did not maintain the connection with the existing path south of the bridge ramp. This departure from the MRs was requested by Waka Kotahi as part of the Stage A review process[35], to allow for a better barrier system around the bridge pillars. In Stage C, an option to provide this connection was presented to Waka Kotahi. However, it has been confirmed that provision of a connecting path is not required.
Mid maintenance bay	Minimum requirements Appendix A02 Geometrics Road Layout Section 2.3.3 "*The KiwiRail Hi-rail design vehicle (Truck_EPC302 Isuzu FVZ) shall be used to define tracking at KiwiRail maintenance vehicle access and parking sites"*	Due to the significant vertical levels difference between the railway track and the back of the shared path. A steep battering of up to 18.5% is designed for KiwiRail vehicles to access from the rail track to the traction station. This is considered too steep for the KiwiRail Hi-rail design vehicle to access with sufficient vertical clearance. However, this gradient should allow KiwiRail ute maintenance vehicle to access.

[35] Email from E. Anand (Waka Kotahi SME) to J. Noering (Te Ara Tupua Alliance), subject: on Fwd: Te Ara Tupua Cycle Access from SH2 shoulder at Kiwi off-ramp on Thursday, 1 September 2022 3:47 pm

7.2.2 Standards

Table 7.3 below outlines the departures from the standards. Each of these departures has been discussed with Waka Kotahi and will be formalised through the design departure process.

Table 7.3: List of design departures from Standards identified in Stage C of design

Item	Standard	Stage C Design Departures
SH2 off-ramp deceleration distance	AGRD Part 4C: Deceleration distance for a design speed of 100 km/h at the through road is 140 m	A deceleration distance of 122 m is achieved. This is 30 m less than the existing deceleration distance and 60 m less than the AGRD Part 4C standard.

7.3 Compliance with Resource Consent

The alignment of the main shared path north of Korokoro Stream (Ch. 4800 to Ch. 5040) has been refined in Stage C of design. The path has been straightened and widened to achieve a consistent 5.0m path width for the full length of the project. There is one section of the path where the alignment is outside of the consented project footprint and designation boundary. This will require a minor alteration to the designation under s181(3) of the Resource Management Act. Written approval from KiwiRail is required. This was discussed with KiwiRail at a property meeting on 17 February 2023. Agreement with KiwiRail is part of an alliance-wide property discussion, for which discussions are ongoing.

The geometric design otherwise complies with the conditions of the resource consent (EPA210001).

8 External Review and Consultation

This section of the report documents the external reviews completed on this work package to date. External reviews have been completed on this work package at the following gates:

- Stage A design
- Stage B design
- Stage C design

8.1 Waka Kotahi

The Waka Kotahi reviews of the Stage A, Stage B and Stage C issue, with designer responses, are provided in a separate DRR - refer to NKP-TAT-000-DRR-CV-TS-000001 Revision 5. The review process is summarised in Table 8.1 below.

Table 8.1: Waka Kotahi review comments

Design stage	Waka Kotahi reviewers	Date provided to Waka Kotahi	Work package briefing	No. of comments received (high priority comments)	Follow up meeting with WK
Stage A	S 9(2)(a)	8 August 2022	17 August 2022	15 (0)	27 September and 30 September 2022
Stage B		20 October 2022	N/A	11 (1)	11 November 2022
Stage C		16 February 2022	N/A	17 (2)	9 March 2023

8.2 KiwiRail

The KiwiRail review of the Stage A and Stage C issue of this work package, with designer responses, is provided in a separate DRR - refer to NKP-TAT-000-DRR-CV-TS-000008 Revision 2. This work package has been issued to KiwiRail at the following gates:

- Stage A issued to KiwiRail on 8 August 2022. Six comments were received.
- Stage B issued to KiwiRail on 20 October 2022 for information only. Four comments were received related to the drainage design. These are being addressed by the alliance in the longitudinal drainage (DWP-DR-01) work package.
- Stage C issued to KiwiRail on 17 February 2023. No review comments were received.

No comments on the Stage C issue of this work package were received from KiwiRail. However, design changes of the access gate since Stage C was discussed with KiwiRail on 18 April 2023. The discussion will be ongoing and formal departure process will follow.

8.3 Hutt City Council

Design development discussions with HCC regarding the access and maintenance requirements for Honiana Te Puni Reserve west are ongoing. Stakeholder engagement with HCC is being completed on a project-wide basis and includes discussions related to this work package.

8.4 Wellington City Council and LGWM

Design development discussions with WCC and the LGWM team are ongoing. Discussions have particularly focused around the southern tie-in with the LGWM scope of works. Due to the staging of the projects, the Ngā Ūranga ki Pito-One design ties into the existing ground levels and path at Ngā Ūranga (Ch. 440).

9 Additional Design Considerations

9.1 Mana Whenua Values Integration

This section of the report outlines how the design elements in this work package respond to the Mana Whenua values. The values have been developed in partnership between the Mana Whenua Steering Group and the Alliance. Further details and background on the Values and their intent is set out in the Mana Whenua Values Plan.

The design response to the Values is set out in Table 9.1 below.

Table 9.1: Integration between Mana Whenua values and DWP-TS-01 design

Value	Description	Design Response
Ahi kā	To uphold the unique and fundamental role that mana whenua maintain across Te Whanganui-a-Tara	Overall, the project achieves this in multiple ways. The shared pathway ensures the connection of uri, the local community and path users with Te Whanganui-a-Tara and the natural environment. Ensuring that the traffic services provide for opportunities for cultural expression to promote the traditional narratives and histories of the area. Pavement markings which include cultural designs allows for this.
Muka Tangata	To recognise people as unique strands of interwoven fabric	The path has been designed to encourage use by a range of unique users – cyclists, pedestrians, bus users, recreational, commuters. The characteristics and preferences of each of these users is to be considered in the design of the project. Traffic services ensure management of traffic and direction of path users to ensure safety and protection from harm.
Pūmanawa	To use skills and knowledge for the benefit of the collective	The team involved in delivery of Ngā-Ūranga ki Pito-One is diverse and varied, made up of engineers, contractors, mana whenua representatives, design team, etc. The unique skills and knowledge of this team will help to deliver the project and ensure it best meets the needs of uri, the local community and path users.
Whakatauira	To lead by example	The path provides a facility for modal shift and improved resilience. The design of the traffic services will consider best practice to encourage active mode shift while providing for a safe and user-friendly pathway.
Tiaki Taiao	To recognise the role of people as an essential piece of the environment that we have an obligation to protect	Overall, the project achieves this by connecting uri, path users and the wider local community to Te Whanganui-a-Tara and the natural environment. Consideration for active mode shift and sustainability and resilience ensures that the pathway is a sustainable asset for the community.

9.2 Sustainability

Key sustainability considerations in this work package to date:

- Geometric alignment to maximise mode shift, encouraging people to cycle and walk, instead of driving
- Geometric alignment to achieve high levels of safety for pedestrians and cyclists.
- Geometric alignment designed where possible to match existing topography to minimise cut/fill

9.3 Future Adaptation

Future adaption for the geometric package has been investigated as part of other overlapping design packages (refer DWP-SE-01, DWP-RV-01, DWP-DR-01 and DWP-DR-02).

10 Applicability

This report has been prepared for the exclusive use of our client Waka Kotahi, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

11 Verification

Report prepared by:

S 9(2)(a)

.....

S 9(2)(a)
Transport Engineer

S 9(2)(a)

.....

S 9(2)(a)
Senior Transportation Engineer

Report reviewed by:

S 9(2)(a)

.....

S 9(2)(a)
Senior Civil Engineer

Report technical reviewed by:

S 9(2)(a)

.....

S 9(2)(a)
Transportation Engineer

Authorised for Te Ara Tupua Alliance by:

S 9(2)(a)

.....

S 9(2)(a)
Design Manager

Te Ara Tupua Alliance
Shifting gear to connect past, present and future

Appendix D: Shared Path Mobility Access Standards Memo

Memorandum

To:	Simon Kennett	**Date:**	4 May 2021
From:	S 9(2)(a)	**Our Ref:**	4670973
Copy:	Gerry Dance, S 9(2)(a)		
Subject:	Shared path mobility access standards – a case for change		

The scope and purpose of this memorandum is to outline the case for change to Section 6 of NZS 4121:2001 – Design for Access and Mobility – Buildings and Associated Facilities. Specifically, how gradient and landing standards apply to accessible routes to buildings vs shared paths outside of the road reserve. The case for change will then be considered by the Ministry of Business and Innovation (MBIE).

The following matters are discussed within this memorandum:

- The current 4121:2001 Standard
- Industry use of the 4121:2001 Standard
- Recent project examples
- The case for change

The Current 4121:2001 Standard

NZS 4121:2001 – Design for Access and Mobility – Buildings and Associated Facilities (the standard) is the standard used for designing and constructing accessible routes. The definition of an accessible route is contained in section 1 of the standard as follows:

> ***1.5.1 Definitions***
>
> *"Accessible route mean a route that is usable by people with disabilities. It shall be a continuous route that can be negotiated unaided by a wheelchair user, walking device or by a person with a guide dog. The route shall* ***extend from the street boundary and car parking area to those spaces within the building required*** *to be accessible to enable people with disabilities to carry out normal activities and processes within the building" (emphasis added).*

'Section 6 Footpaths, Ramps and Landings' contains the relevant standards that related to gradients and landings:

> ***6.2.2 Gradient***
>
> *"Where the longitudinal gradient of a footpath is steeper than 1 in 33 but does not exceed 1 in 20, then level rest areas shall be provided at intervals not exceeding 18m. These shall be not less than 1200mm in length".*
>
> ***6.2.3 Footpaths as ramps***
>
> *"Where the longitudinal gradient is steeper than 1 in 20, the access shall be treated as a ramp".*
>
> ***6.4.2.2 Gradient***
>
> *"The maximum gradient of a ramp other than a kerb or step shall be 1 in 12…"*
>
> ***6.5.1 Landings for ramps***

> *"Ramps requite levels platforms or landings at the top or bottom, wherever there is a change in direction, wherever doors open off them an at intervals not exceeding 9000mm…"*

It is also noted that handrails and upstand are required for all ramps – essentially accessible routes steeper than 1:20.

Industry use of the 4121:2001 Standard

Many design and engineering firms are applying the 4121:2001 Standard when designing offroad shared paths that do not directly provide access to buildings and cover considerable distance compared with typical accessibility ramps. This is partly due the lack of any other design guidance on shared path design (primarily gradients) and how to accommodate mobility access on muti-user pathways. Any off-road shared path appears to be deemed an 'accessible route' as per 4121:2001.

The key issues arising from implementation of the 4121:2001 standard are:

a) The landing platforms are identified as the primary hazard for cyclists – particularly the target audience of commuter cyclists (experienced and inexperienced). The platforms are designed to give wheelchair users and pedestrians a flat area to rest on when descending and ascending a steep gradient however the frequency of these required by the standard (every 9m) and short length (1.2m) of the platforms results in a 'bucking' motion that is uncomfortable while riding at or above a design speed of 20kph. A key issue is that the short length of the platforms is similar to the wheel base of a bicycle – this results in each wheel transitioning from two to eight percent at the same time. Given a cyclist travelling at a standard design speed of 20kph will encounter a platform every 1.6 seconds, the repetitive sensation of bucking is unsafe for users, particularly on paths that are not straight.
b) Inadequate landing provision for mobility impaired users. The combination of small landings on a through route that includes people on bikes is very uncomfortable for mobility impaired users. This puts mobility impaired users in conflict with faster users of the same path.
c) Overall length of the ramp/landing sequence is very challenging for mobility impaired users to access.
d) The lack of contrast between the platforms and pathway accentuates the discomfort for all users, particularly under bright lighting conditions and at dusk/night when the platforms are difficult to detect.
e) Handrails and upstands are omitted from shared path design despite being a requirement under 4121:2001.

The case for change

The 4121:2001 standard provides parameters for very slow speed environments around buildings and on ramps that have an overall short length. The 4121:2001 standard addresses building access and provides no guidance for muti-use paths for both cyclists and mobility equipment users that are 'accessible routes'. The application of the 4121:2001 standard is resulting in poor outcomes for both people on bikes and mobility/visually impaired users whom the standard seeks to provide for.

While the majority of shared paths that are designed use this standard the paths are relatively short encompassing 3-4 landings in sequence. The Glenn Innes to Tamaki Shared Path (GI2T) constructed in 2016, however, had several long sections up to 160m with 16-17 landings in sequence. Due to negative public feedback and safety concerns, Waka Kotahi and Auckland Transport (AT) commissioned several reports to investigate the issues raised. These were then

summarised in a Memorandum[1] by the AT Design office who provided recommendations for remedial work and new design standards for future stages – this review is appended to the back of this Memorandum. The recommendations in the AT Design Office report were adopted for GI2T Stage 2 – a excerpt of the drawings is provided in Attachment Two.

The consultation and design process for GI2T has also been summarised in a 'case study' by Waka Kotahi on their website[2].

The recommendations in the 2017 AT Memorandum drew from a broad literature review of international guidance and have now been adopted in the Transport Design Manual (TDM) Engineering Design Code at Auckland Transport (see – Attachment 1).

The evidence that informed the recommendations was based on both accessibility guidance on shared/mixed use paths in the United States and on-site testing with Be Accessible to determine an accessible length for specific gradients as well as landing requirements. Given shared paths have a transport function, rest areas or landings should be to the side and not in conflict with through movement of people – the landings also needed to be significantly larger to accommodate multiple users. In terms of gradients, it was determined on site that 5 flights of 9m ramps was achievable for people in wheelchairs, however the context and overall length of the shared path would ultimately filter different abilities. Repeated 9m ramps and 1.5m landings over a similar distance was seen as equally difficult for people in wheelchairs to navigate.

For people on bikes and scooters the 45m length between landings represents an 8.1 second gap at a design speed of 20kph which provides safer and more comfortable transition down the slope.

The following standards have been adopted by AT for shared paths:

Gradient

Running grades on shared-use paths should be designed to not exceed 5 percent (1:20) where possible.

Maximum lengths of grades before requiring a rest platform:

5% (1:20) for a maximum of 120m;

8.33% (1:12) for a maximum of 45m;

10% (1:10) for a maximum of 9m; and

12.5% (1:8) for a maximum of 3m.

Where the gradient falls outside of the thresholds specified above the maximum length shall be aggregated based on the percentage and length it falls within ie 6% for a maximum of 95m.

Note: Cycle design speed should be managed by change of direction, block length and other measures to prevent high differential speed when meeting pedestrians and other path users. Where the function of the path requires a design cycle speed greater than 25 km/h, separation should be provided.

Change in Gradient

Change of gradient should be made with a vertical curve of at least 10 m radius and at least 2 m long except at low speed crossing ramps.

**3 m landing excludes the length of a transition curve at each end.*

Platforms and Rest areas

Rest platforms are beneficial for all shared path users, particularly for people with mobility impairments that expend more effort to walk than other pedestrians. The frequency of rest areas is dependent on the terrain and maximum lengths of grade identified above.

The preferably length of a rest platform is 4m. The minimum length shall be 3m.

[1] Memorandum – Glen Innes to Tamaki Shared Path Review, 4 July 2017, S 9(2)(a)

[2] https://www.nzta.govt.nz/walking-cycling-and-public-transport/cycling/cycling-standards-and-guidance/cycling-network-guidance/case-studies/auckland-te-ara-ki-uta-ki-tai-gradient-design-of-shared-path/

A rest platform shall also be provided off the main pathway with a minimum width of 3m. This provides an opportunity for users to move off the path, instead of remaining on the path to stop and rest.

The off path rest area shall be located on the uphill left hand side where possible and accommodate accessible design for amenities such as benches, where provided.

Rest platform shall be less than 2% in grade.

Surface material

Where concrete is provided include a darker oxide above 5% to reduce glare.

International examples

International accessibility standards to buildings/premises are very similar to 4121:2001, however there are several key differences, most notably in the definition of what an accessible route is. Examples of standards/guides from several different countries are provided below:

United States of America

- **Americans with Disabilities Act 2010** (ADA) which contains a series of accessibility standards. Accessible routes are defined as:

  "Chapter 4: Accessible Routes[3]

  Accessible routes shall consist of one or more of the following components: ***walking surfaces*** *with a running slope not steeper than 1:20, doorways, ramps, curb ramps excluding the flared sides, elevators, and platform lifts. All components of an accessible route shall comply with the applicable requirements of Chapter 4"* [emphasis added].

- **Architectural Barriers Act 1968** (ABA) which is similar the above but applies only to facilities financed by federal funds in America.

  "Components of accessible routes include ***walking surfaces****, doorways, ramps, curb ramps, elevators, and, where permitted, platform lifts*[4]*" [emphasis added].*

A key issue is how shared use paths fit within the definitions, particularly given shared path cater for people on bikes and scooters. The appendices to standards in **Chapter 10: Outdoor Developed Areas** helpfully provide definitions of different paths/routes[5]. The shared path definition is as follows:

> *"A shared-use path is part of a transportation system in a public right-of-way that provides off-road routes for a variety of users. Even where the primary users may be bicyclists, skaters, or equestrians, shared-use paths typically are designed to serve pedestrians, including people using mobility devices such as manual or motorized wheelchairs. In addition to transportation uses, shared-use paths often provide recreational experiences. They may extend or complement a roadway network. For example, they may supplement on-road bike lanes, shared roadways, bike boulevards, and paved shoulders. Shared-use path design is similar to roadway design but on a smaller scale and for lower speeds. Whether located within a highway right-of-way, provided along a riverbank, or established over natural terrain within an independent right-of-way, shared-use paths differ from sidewalks and trails in that they are designed for a variety of users and serve both recreational and transportation purposes".*

[3] https://www.access-board.gov/ada/#ada-402

[4] https://www.access-board.gov/ada/guides/chapter-4-accessible-routes/#accessible-routes

[5] https://www.access-board.gov/aba/guides/chapter-10-outdoor/#key-differences-between-routes

Within Chapter 10 the route characteristics of different 'Pedestrian Route types' was outlined to help highlights the key elements/differences of design[6].

Route Characteristics

Pedestrian Route Type	Key Elements of Design Intent
Accessible route (AR)	Connects accessible elements and spaces of a building or facility on a site
Sidewalk—pedestrian access route (PAR)	• Parallel to roadway • Designed for pedestrians (not bicycles) • Sometimes part of the roadway
Trail	• Designed for the "recreation experience" • Does not connect elements and spaces on a site • Generally includes a trailhead • Has limited to no transportation function
Outdoor recreation access route (ORAR)	Connects outdoor constructed features and spaces within picnic and camping facilities, viewing areas, and trailheads **only**
Beach access route (BAR)	• Crosses the surface of the beach to the shoreline • Coincides with or is located in the same general area as pedestrian access points to the beach
Shared-use path (SUP)	• Intended for multi-use • Bicycle/transportation focus • Machined, layered surface (improved) • Located in either an "independent corridor" or public right-of-way

Technical requirements for Trail, ORAR, and BAR were provided but shared paths weren't originally included in the ABA standards. The trail standards are the same as the '**Designing Sidewalks and Trails for Access**' standard.

A supplementary notice[7] was issued on 2013 – excerpt below:

> ***Supplementary Notice on Shared Paths.***
>
> *The preamble to the proposed rule indicated that the proposed scoping and technical requirements for trails would apply to shared use paths. A shared use path is a multi-use path that is designed primarily for use by pedestrians and bicyclists for transportation and recreational purposes. Shared use paths are physically separated from motor vehicle traffic by an open space or barrier, and are either within the highway right-of-way or within an independent right-of-way. We subsequently decided to include shared use paths in the proposed accessibility guidelines for pedestrian facilities in the public right-of-way. See 78 FR 10110 (February 13, 2013).*

Key aspects of this decision meant that a 'pedestrian route' was required along shared paths. This required shared paths to have a maximum grade of 5% (with no maximum length specified) unless:

[6] https://www.access-board.gov/aba/guides/chapter-10-outdoor/#shared-use-paths

[7] https://www.access-board.gov/prowag/preamble-shared-use/#shared-use-path

- The access routes are contained within a street or highway right-of-way, the grade of pedestrian access routes shall not exceed the general grade established for the adjacent street or highway.
- There are physical or regulatory constraints

It is the view of this author that the standards for shared paths in this supplementary notice contradict and compromise the intent of the definition of shared paths and don't address the key issues for mobility impaired users related to gradients and landings. Landing requirements in the more recent supplementary note deliver worse outcomes than the trail based gradient standards. In addition, not having a length limits for the maximum 5% grade would further limit accessibility for people in wheelchairs.

In 2001 the US Department of Transportation released '**Designing Sidewalks and Trails for Access**, which was prepared in collaboration with the US Access Board. Chapter 14 Shared Use Path Design[8] contains guidance on gradients and landing among various matters. It is noted this guidance is similar to the route characteristics and standards applied to Trail route types by the US Access Board. It applies an accessibility focused approach to mixed use path design covering longer distances. The relevant sections on gradient and landings are as follows:

> ***14.5.1 Grade***
>
> *People with mobility impairments have a difficult time negotiating steep grades because of the additional effort required to travel over sloped surfaces. Manual wheelchair users may travel very rapidly on downhill pathways but will be significantly slower on uphill segments. Steep running grades are particularly difficult for users with mobility impairments when resting opportunities are not provided. Less severe grades that extend over longer distances may tire users as much as shorter, steeper grades. In general, running grades on shared-use paths should not exceed 5 percent and the most gradual slope possible should be used at all times.*
>
> *If steeper segments are incorporated into the shared-use path, the total running grade that exceeds 8.33 percent should be less than 30 percent of the total trail length. In addition, it is essential that the lengths of the steep sections are minimized and are free of other access barriers. Negotiating a steep grade requires considerable effort. Users should not be required to exert additional energy to simultaneously deal with other factors, such as steep cross slopes and change in vertical levels. When designing maximum grade segments, the following recommendations should be used:*
>
> - *8.3 percent for a maximum of 61.0 m (200 ft);*
> - *10 percent for a maximum of 9.14 m (30 ft); and*
> - *12.5 percent for a maximum of 3.05 m (10 ft).*
>
> *Although the recommended maximum grades are similar to those recommended in the 1999 AASHTO Guide for the Development of Bicycle Facilities, the maximum distances are* significantly shorter.
>
> *Rest intervals may be located on the shared-use path but should ideally be located adjacent to the path for the safety of all users (see Section 14.5.2).*

It should be noted that all US standards don't specify a maximum length for gradients of 1:20 (5%) and lower on an accessible route. By comparison the 4121:2001 standard requires landings at intervals between 9m intervals at grades between 1:12 and 1:20 and at 19m 1:20 and 1:33.

United Kingdom

Guidance/standards in the United Kingdom are quite variable. The Sustrans Guide below relates to 'free traffic route' (shared paths). For a 7% grade the maximum length is 30m.

[8] https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf/15chapter14.pdf

Gradients on traffic-free routes

Criteria	Gradient %	Gradient ratio
Desirable maximum	3%	1 in 33
Normal maximum up to 100m	5%	1 in 20
Limiting gradient up to 30m when there is no practical alternative	7%	1 in 14*
Desirable minimum gradient to ensure good surface water shedding	8%	1 in 12*

* Any gradients greater than 5% are considered a ramp (Inclusive Mobility, DfT 2002). Where these gradients are used, level-resting platforms must be introduced at regular intervals through the ramp.

Inclusive mobility guidance from The Department of Transport in the United Kingdom is significantly different with an 8% (1:12) grade over a 2m maximum length[9].

As described in Section 3.2, most guidelines specify **5 per cent (1 in 20)** as the preferred gradient and **8 per cent (1 in 12)** as the absolute maximum acceptable. There is a relationship between the length of a ramp and the gradient that people can manage; the longer the ramp the less severe the gradient that is feasible. One possible approach to this is, where a lengthy ramp is necessary, to design more frequent landings and lesser slopes for each successive segment.

BS 8300 states that a ramped approach should have the lowest practical gradient and should be within the limits shown in the table below.

Going of a flight	Maximum gradient	Maximum rise
Not exceeding 2m	1:12	167mm
Not exceeding 5m	1:15	333mm
Not exceeding 10m	1:20	500mm

The 'Cycle Infrastructure Guide' (2020)[10] by the Department of Transport in the United Kingdom also has arrange of different gradients for cycle tracks. It has a max gradient of 5% over a 30m length.

Table 5-8: Maximum length for gradients

Gradient %	Desirable maximum length of gradient (m)
2.0	150
2.5	100
3.0	80
3.5	60
4.0	50
4.5	40
5.0	30

5.9.8 Cycle routes along existing roads and paths will usually have to follow the existing gradient although there may be opportunities for signed diversions onto alternative routes to avoid the steepest uphill gradients, or to reduce gradients through earthworks where sufficient space is available.

5.9.8 Cycle routes along existing roads and paths will usually have to follow the existing gradient although there may be opportunities for signed diversions onto alternative routes to avoid the steepest uphill gradients, or to reduce gradients through earthworks where sufficient space is available.

5.9.9 As well as the length of the gradient, the speed of travel is another important factor to consider. Steep gradients can lead to high speeds for descending cyclists or low speeds for climbing cyclists, which can create hazards for all users of the route. Stopping distances also increase on down gradients in excess of 3%.

5.9.10 Where height differences at new build sites suggest longer lengths of gradients than those given in Table 5-8 earthworks designs should be adjusted or the horizontal alignment adjusted to limit the length or severity of the gradient. Level sections of 5.0m minimum length can be used between gradients to achieve compliance with Table 5-8.

[9] https://www.gov.uk/government/publications/inclusive-mobility

[10] https://www.gov.uk/government/publications/cycle-infrastructure-design-ltn-120

Ireland

The Design Manual for Urban Streets (May 2019 version 1.1) contains maximum and minimum gradients for all streets – excerpt below[11]. No maximum lengths are provided for different grades, however, designers are to consider the overall network context and placemaking outcomes for path gradients.

> *Maximum and Minimum Gradients*
>
> *In urban areas, it is likely that the comfort of vulnerable road users will be the determining factor for desirable maximum longitudinal gradients on streets. Part M of the building regulations advises that access routes with a gradient of 1:20 or less are preferred. Therefore a maximum gradient of 5% is desirable on streets where pedestrians are active.*
>
> *In hilly terrain, steeper gradients may be required but regard must be had to the maximum gradient that most wheelchair users can negotiate of 8.3%, although this should be limited to shorter distances. A designer may need to consider mitigation measures, such as intermediate landings, to ensure that pedestrian routes are accessible. This also needs to be considered at the network level and as a response to place making.*
>
> *The inclusion of streets that exceed these gradients may not be significant within a network where there are alternative routes that can be taken between destinations and where steeper gradients may in fact have placemaking benefits.*
>
> *A minimum longitudinal gradient of 0.5% is desirable to maintain effective drainage on streets. Care needs to be taken at vertical curves, and in particular at sag curves, to ensure that there is provision at level points of curves to allow surface water to run off the carriageway.*

Australia

The new definition of accessible path in **AS 1428.1:2021** Design for access and mobility, Part 1: General requirements for access — New building work:

> ***1.4.6 continuous accessible path of travel***
>
> *Uninterrupted path of travel to, into or within a building providing access to all accessible facilities.*

Again, there is an assumption within the standards that this only applies to short distances gaining access to buildings.

Victoria State Government 'Design for Everyone | Tracks, pathways, ramps and Stairs' contains standards relating to mobility access[12]. The definition is more specific in that it outlines the locations to connect an accessible path between:

> *"A continuous accessible path of travel is a fundamental requirement for equitable access to the built environment. This should be provided from any* ***car park, public transport or taxi set down area and property boundary to and through any buildings, facilities, installations and key elements within***

11 https://bicycleinfrastructuremanuals.com/manuals3/Ireland%20design%20manual%20for%20urban%20streets%20version%201.1%20low%20res.pdf

12 https://sport.vic.gov.au/publications-and-resources/design-everyone-guide/index-elements/tracks-pathways-ramps-and-stairs

> ***a site**. This route can consist of pathways, roadways, pedestrian crossings and ramps. It cannot incorporate any step, stairway, turnstile, revolving door, escalator, moving walk, or other impediment [emphasis added].*

Austroads (2017) Guide to Road Design Part 6A – Paths for Walking and Cycling is the primary transport guide used in both NZ and Australia. The relevant sections of the guide relating to gradient and landing are as follows:

> *5.4 Path Gradients*
>
> *As a general principle longitudinal gradients on paths for cycling should be as flat as possible. The potential hazard for cyclists due to high speeds on steep downgrades is as important as the difficulty of riding up the grade when determining maximum gradients on two-way paths.*
>
> *AS 1428.1:2009 and AS 1428.2:1992 have specific requirements for pedestrians, including wheelchair users, and require level rest areas at a specific spacing (see Table 5.8). While these standards were developed for pedestrian and wheelchair access to buildings and premises there is a need to consider their requirements with respect to the design of pedestrian inclusive paths. Where it is considered appropriate to provide compliant path gradients and flat landings the requirements of AS 1428.1 – 2000 should be incorporated into the path design.*
>
> *Designers should consult any jurisdictional guidelines; however, in the absence of such guides the following approach is suggested:*
>
> *• Where a path is proposed for a relatively short transverse pedestrian/cyclist overpass (e.g. across a road, creek or railway), it may be appropriate for it to be a shared path. For a shared path, the ramps should be provided with landings at a spacing that complies with AS 1428.1:2009. However, because these landings result in a reduction in cyclist comfort and convenience they may only be acceptable to cyclists if used over a relatively short length.*
>
> *• Where a gradient that requires landings under AS 1428.1:2009 is proposed on a path (including a longitudinal path on a road bridge) that has to provide for ramps greater than 200 m in length, the provision of standard landings may present an inconvenience or hazard for cyclists, particularly those travelling downhill. If there is a need for pedestrian landings in this situation they should be provided on a separated facility or outside the shared path, on both sides.*
>
> *5.4.1 Universal Access*
>
> *Where the topography of the road or area where a path is to be located does not allow path grades to meet the requirements of AS 1428.1:2009, designers, in Australia, may refer to the Australian Human Rights Commission's Advisory note on streetscape, public outdoor areas, fixtures, fittings and furniture (Australian Human Rights Commission 2013).*

The guidance in Austroads outlines the issues associated with providing accessibility landings on paths shared with people on bicycles. Austroads proposes several recommendations focusing on reduced frequency of landings and length. Commentary from the Australian Human Rights Commission, referenced in Austroads, is provided below. This reiterates that footpaths along the road corridor are not subject to Building Code standards.

Australian Human Rights Commission – FAQ | What is an accessible footpath?

> *"At this stage, however, the Premises Standards only apply to buildings covered by the various building classifications found in the Building Code of Australia. Public footpaths do not have a building classification, so while they covered by the definition of 'premises' they are not subject to the Premises Standards, but remain subject to the general non-discrimination provisions of the DDA.*

This means that there is no mandatory minimum technical compliance standard under the DDA that can be referred to in relation to footpaths"[13].

Netherlands

The Crow Manual for Bicycle Traffic is the primary guide for urban mobility in the Netherlands and is used universally by professional around the world. Walking and cycling paths are nearly always separated in the Netherlands, however there are gradient recommendations that apply to all paths. It states that the average gradient has a greater significance than the length of the incline. The severity of a slope (S) experienced by people can be calculated as the square of (average) gradient times the length of the incline, so S= $(H/L)^2 \times L = H^2/L$.

What this means is if the level (height) difference is doubled and the gradient is halved then the slope severity remains the same. The length of the incline will be four times as long. However if the level difference stay the same and the gradient is doubled, then the severity will also be doubled. The length of the incline will be halved. The higher the (S) number the greater the severity of a slope. Some examples are provided in the table below:

Table 3-5. Examples of height, length, gradient and severity of slopes

H (m)	L (m)	%	S (m)
2.50	31	8.0	0.200
5.00	250	2.0	0.100
5.00	125	4.0	0.200

Figure 1: Crow Manual - Slope severity examples.

The desirable slope severity of a shared path/cyclepath outside of the road corridor is S < 0.333. The maximum slope severity of a shared path/cyclepath outside of the road corridor is S < 0.750.

For comparison the grades in the Auckland Transport TDM have the following slope severity:

H (m)	L (m)	%	Slope severity
6.0	120	**5.0**	0.300
3.6	45	**8.0**	0.288
0.9	9	**10.0**	0.09
0.375	3	**12.5**	0.04

[13] https://humanrights.gov.au/our-work/disability-rights/frequently-asked-questions-access-premises

Memorandum

ISO 21542:2021 Building construction – Accessibility and usability of the built environment

This is the international standard for built environment accessibility. It includes standards for access to buildings, circulation within buildings, and egress from buildings. The content is similar to NZ 4121:2001.

There are no standards that reference shared paths. Section '6.3 Paths to Buildings' states that pedestrian paths [path or route to a building from the boundary of the site or from the parking area] should be separated from routes used by cyclists and motor vehicles.

Memorandum

Recommendations

The literature review of international guidance on both pathway accessibility and shared paths reveals a wide range of approaches both within and between countries.

There does appear to be general consensus on accessibility standards that apply from the roadway or carpark to buildings – these only apply to walking surfaces. Standards/guidance for shared paths is however more mixed with some standards/guidance applying the same building access standards, as per NZS 4121:2001, some use building accessibility standards with specific notes on context/topography to provide flexibility, while others have specific standards based on users and context.

It should be noted that there is acceptance in all countries that footpaths and shared paths along our streets and roads aren't required to be accessible regardless of the rationale.

The Auckland Transport TDM provides specific gradient and landing requires for both shared and cycle only paths. Given the topographical relief in the Auckland Region and NZ as a whole, it is recommended that specific standards/guidance like the AT TDM will provide better overall outcomes for all users. It should be noted that Be Accessible were involved in the development of the guidance, adopted from the GI to Tamaki recommendations, and this was also discussed with the AT Capital Projects Accessibility Group. As such it is recommended to adopt the AT TDM guidance.

The following options provide different approaches to incorporating the differences between cycle-only paths, shared paths, footpaths, and building access in the 4121:2001 standard:

Preferred Option

Amend definition of 'accessible route' to be explicit about it being for walking surfaces for building access only. Specific commentary on the context and length of path could be incorporated and that its excludes shared use paths. Waka Kotahi could then provide National Shared Path Guidance on gradients and landings consistent with AT. Cross-referencing could be used for clarity between the 4121:2001 standard and any National Guidance.

Secondary Option

Expand definition of 'accessible route' to include options for both building access and offroad paths between neighbourhoods or key destinations similar to the US Access board. Guidance for shared paths, consistent with AT, would be incorporated directly into the 4121 standard. Waka Kotahi cycle network guidance would refer to the 4121 standard.

In both options a Waka Kotahi technical note would be prepared outlining the changes to be distributed to the industry.

s 9(2)(a)
Associate | Walking and Cycling Specialist

Phone Number: s 9(2)(a)
Email: s 9(2)(a) @beca.com

ATTACHMENT ONE – EXCERPT FROM AUCKLAND TRANSPORT TDM ENGINEERING DESIGN CODE

Gradients that exceed 5% are undesirable because the ascents are difficult for many people on bikes to climb and the descents cause some to exceed the speeds at which they are competent or comfortable. On some shared paths, where terrain dictates, designers may need to exceed the 5% grade recommended for short sections.

Steep downhill grades need to be followed by an uphill grade to allow slowing. Conversely, steep uphill grades benefit from a downhill approach to gain momentum. Curves, intersections and obstructions at the bottom of a steep grade need to be protected, allowing safe braking and turning.

See Table below for preferred grade and grade lengths.

LANDINGS/REST AREAS FOR PEDESTRIANS ACCESSIBILITY

Landings for pedestrian accessibility can be uncomfortable for people on bikes. Where possible, cycle and pedestrian paths should be separated to avoid landings/rest areas on the cycle path. Pedestrian rest platforms shall be provided off the side of the cycle path. Where lengths of a route exceed the maximum gradients in Table 14 below, landings/rest areas should be provided. Rest platforms shall be provided both on the path and adjacent to the path. The platform width shall be equal to or greater than the width of the path – preferably 4 m in length where topography allows.

The minimum length shall be 3 m. For landing/rest areas only, the minimum vertical curve length may be reduced to 2 m for up to 45 m between landings. The portion of a vertical curve greater than 5% grade shall be included in the grade length for comparison with the maximum.

TABLE 10 GRADIENTS

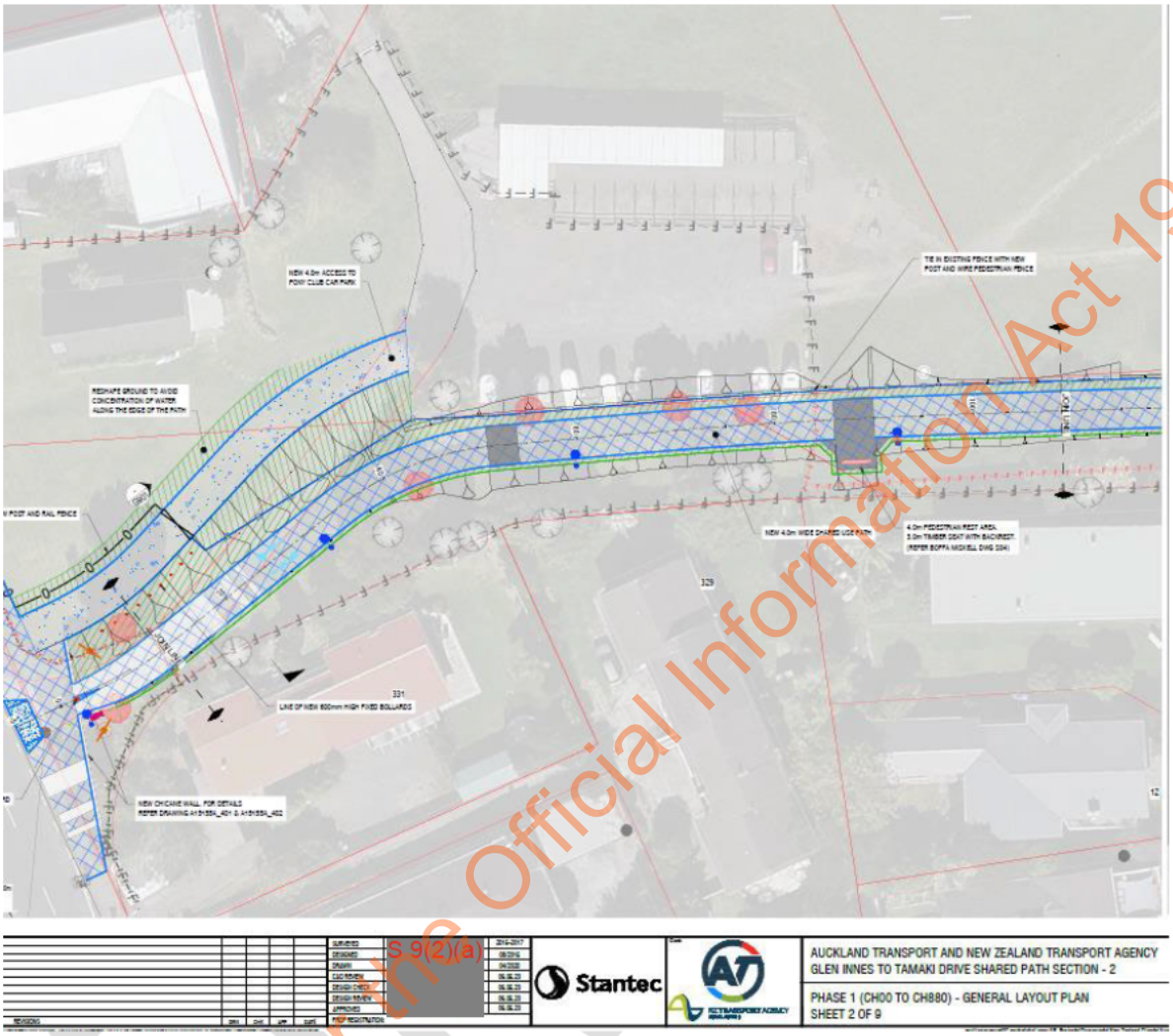
Use	Max. gradient	Preferred max. length
Cycles only	3% (1:33)	No limit
	5% (1:20)	240m (maximum)
	8.33% (1:12)	90m (maximum)
	10%	30m (maximum)
	12.5%	15m
Combined Cycle and pedestrian paths	3% (1:33)	No limit
	5% (1:20)	120m (between landings)
	8.33% (1:12)	45m (between landings)
	10%	9m (between landings)
	12.5%	3m (between landings)
Landings/rest areas	2%	3 m (minimum)*

Interpolation between values is permitted.
*3 m landing excludes a 2 m length of a transition curve at each end.

40 TDM | ENGINEERING DESIGN CODE

Memorandum

ATTACHMENT TWO – EXCERPT FROM GI2T STAGE TWO DRAWINGS SHOWING NEW STANDARDS BEING APPLIED.



S 9(2)(a)

Stantec

AUCKLAND TRANSPORT AND NEW ZEALAND TRANSPORT AGENCY
GLEN INNES TO TAMAKI DRIVE SHARED PATH SECTION - 2

PHASE 1 (CH00 TO CH880) - GENERAL LAYOUT PLAN
SHEET 2 OF 9