TE TUPU NGĀTAHI
SUPPORTING GROWTH

Appendix A – Assessment of Alternatives

Assessment of Alternatives

WAKA KOTAHI NZ TRANSPORT AGENCY

AT

New Zealand Government

TE TUPU NGĀTAHI
SUPPORTING GROWTH

Takaanini Level Crossing Project

Appendix A – Assessment of Alternatives

October 2023

Version 1.0

WAKA KOTAHI NZ TRANSPORT AGENCY

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Glossary of Defined Terms and Acronyms

We note that 'Takaanini' (with double vowels is used throughout the Report Acknowledging the ongoing kōrero and guidance from Manawhenua on the cultural landscape. 'Takanini' is used where reference is made to a specific and existing named place (e.g., Takanini Road, Takanini Town Centre etc.). Manawhenua is also used throughout the Report as while gifting the programme name as Te Tupu Ngātahi, Manawhenua confirmed this was an appropriate spelling (capital 'M' and one word). Notwithstanding this, the term is spelled as two words in other fora and the proposed designation conditions – Mana Whenua.

Acronym/Term	Description
AT	Auckland Transport
AUP:OP	Auckland Unitary Plan: Operative in Part
CFAF	Corridor Form Assessment Framework
CPTED	Crime Prevention through Environmental Design
DBC	Detailed Business Case
EAST	Early Assessment Sifting Tool
FTN	Frequent Transit Network
IBC	Indicative Business Case
ISTN	Indicative Strategic Transport Network
MCA	Multi-Criteria Assessment
MDRS	Medium Density Residential Standards
NIMT	North Island Main Trunk
NoR	Notices of Requirement
NPS:FW	National Policy Statement for Freshwater Management
NPS-UD	National Policy Statement on Urban Development
PBC	Programme Business Case
PWA	Public Works Act 1981
RASF	Roads and Streets Framework
RMA	Resource Management Act 1991
RNIP	Rail Network Investment Programme
SME	Subject Matter Expert
South FTN	South Frequent Transit Network
TDM	Transport Design Manual
Te Tupu Ngātahi	Te Tupu Ngātahi Supporting Growth
TFUG	Transport for Future Urban Growth
TG	Takanini Group

Acronym/Term	Description
TLC/ the Project	Takaanini Level Crossings Project
VKT	Vehicle Kilometres Travelled
Waka Kotahi	Waka Kotahi NZ Transport Agency

1 Introduction

1.1 Purpose of this report

This Assessment of Alternatives report has been prepared by Te Tupu Ngātahi Supporting Growth (**Te Tupu Ngātahi**) to support the Notices of Requirement (**NoR**) for the Takaanini Level Crossings Project (**TLC / the Project**). The Project seeks to protect land to enable the construction, operation, and maintenance of transport infrastructure to enable grade-separated east-west movements over the North Island Main Trunk (**NIMT**) rail line in Takaanini across five project areas (outlined in Table 1-1 below and shown in Figure 1-1). Auckland Transport (**AT**) is the Requiring Authority for the NoRs under the Resource Management Act 1991 (**RMA**).

Table 1-1 - TLC project areas and recommended interventions

Project area	Recommended interventions	Requiring Authority
Spartan Road	Closure of the existing level crossing, new active modes bridge crossing across the NIMT and associated works.	Auckland Transport
Manuia Road	New multi-modal bridge crossing over the NIMT and associated works.	
Manuroa Road	Closure of the existing level crossing, new active modes bridge crossing across the NIMT and associated works.	
Taka Street	Grade-separation of the existing level crossing with a new multi-modal bridge crossing over the NIMT and associated works.	
Walters Road	Grade-separation of the existing level crossing with a new multi-modal bridge crossing over the NIMT and associated works.	

Section 171(1)(b) of the RMA requires that when making a recommendation on an NoR, a territorial authority shall consider whether adequate consideration has been given to alternative sites, routes, or methods of undertaking the work in circumstances where the requiring authority does not have an interest in the land sufficient for undertaking the work; or where it is likely that the work will have significant adverse effects on the environment. There are several principles for a requiring authority to apply and adhere to when undertaking an assessment of alternatives. Of note are the following:

- The process should be adequately transparent and robust, and clearly recorded so that it can be understood by others;
- An appropriate, but not necessarily exhaustive range of alternatives should be considered; and
- The extent of options considered, and the assessment of these options, should be proportional to the potential effects of the options being considered.

AT does not currently have an interest in all of the land required for the Project and is accordingly required to give adequate consideration to alternatives. This report summarises the process of identifying and assessing alternatives for the Project. In doing so, the report details the reasons that the preferred sites, routes, and methods were chosen over other options.

Figure 1-1 - TLC project areas and recommended interventions

1.2 Project Context

There are currently four public road level crossings in the Takaanini area where Spartan Road, Manuroa Road, Taka Street, and Walters Road cross the NIMT (see Figure 1-1). Each of these east-west routes experiences congestion, severance, and an elevated level of safety risk as a result of the level crossings and the operation of barrier arms to allow for rail operations. Conversely, the level crossings also limit the operational capacity of the NIMT. Without intervention, these existing issues will be exacerbated by planned increases in rail service frequency, the planned four-tracking of the NIMT, and urban growth resulting in continued increases in east-west travel demand in Takaanini.

To address these issues, the TLC proposes the removal of the four existing level crossings and a replacement network of grade-separated east-west crossings of the NIMT as shown in Table 1-1 and Figure 1-1. By removing conflict between the road corridors and the NIMT, the TLC will result in a safer, better connected, and more resilient road and rail networks in Takaanini.

1.3 Report Structure

Table 1-2 summarises the structure of this report.

Table 1-2 - Report Structure

Section		Description
2	Business Case context	Summarises the business case process which has identified the need for the TLC and underpinned much of the optioneering process.
3	Assessment Methods	Summarises the methods used to identify and develop alternatives, and to assess them.
4	Process Overview	Provides a project-specific chronology of the optioneering process documented through sections 5-8.
5	Gap Analysis – setting the scene	Sets out the changes which occurred between business case stages in the 2019-2022 period which inform the context for project-specific optioneering.
6	Initial consideration of physical form	Documents the initial high-level consideration given to the physical form of grade-separation to inform the scope of network optioneering.
7	Network Optioneering	Documents optioneering of network scenarios which informed the recommended number and location of grade-separated crossings.
8	Further consideration of physical form	Documents the detailed consideration of the physical form of grade-separation undertaken after network optioneering.
9	Final retesting of Walters Road physical form	Documents final retesting of the Walters Road physical form options undertaken in mid-2023 following direction from the AT Board.
10	Network Refinement	Documents refinements made to preferred options through concept design.
11	Preferred Network	Summarises the preferred network resulting from the process followed from sections 5-10 in terms of the number and location of grade-separated crossings, their physical form, and alignments.
12	Consideration of alternative methods	Outlines the consideration of alternative statutory methods and the reasons why designation is the preferred route protection mechanism.

2 Business Case context

2.1 Summary of Te Tupu Ngātahi business case process

Te Tupu Ngātahi was formed to investigate, plan, and undertake route protection for the strategic transport networks needed to support growth in Auckland over the next 30 years. These networks are developed through a business case process, and route protection is generally secured subsequently through designations under the RMA. The TLC is one of the projects identified by Te Tupu Ngātahi through the business case process. The alternatives assessment for the TLC documented in this report was undertaken initially as part of the business case process.

The Te Tupu Ngātahi business case process is iterative, and has comprised:

- A **Programme Business Case (PBC)** which was completed in 2016 and identified a high-level draft preferred transport network across all of Auckland's growth areas;
- Four **Indicative Business Cases (IBC)** which were completed in 2019 for the Warkworth, North, North-West, and South areas, each identifying an Indicative Strategic Transport Network (**ISTN**); and
- Nine **Detailed Business Cases (DBC)** which were completed between 2020-2023, each covering a package of projects derived from the wider ISTN. One DBC specifically covered the TLC (see Figure 2-1).

The analysis in each successive business case becomes more detailed and spatially focused, with each building on the last. The initial focus at the PBC and IBC stage is on identifying networks at a regional and sub-regional level. The focus subsequently localises to a project-specific level of analysis at the DBC stage. The optioneering process for the TLC documented in this report is therefore largely derived from the TLC DBC options assessment, which in turn used earlier IBC analysis and the ISTN as a starting point.

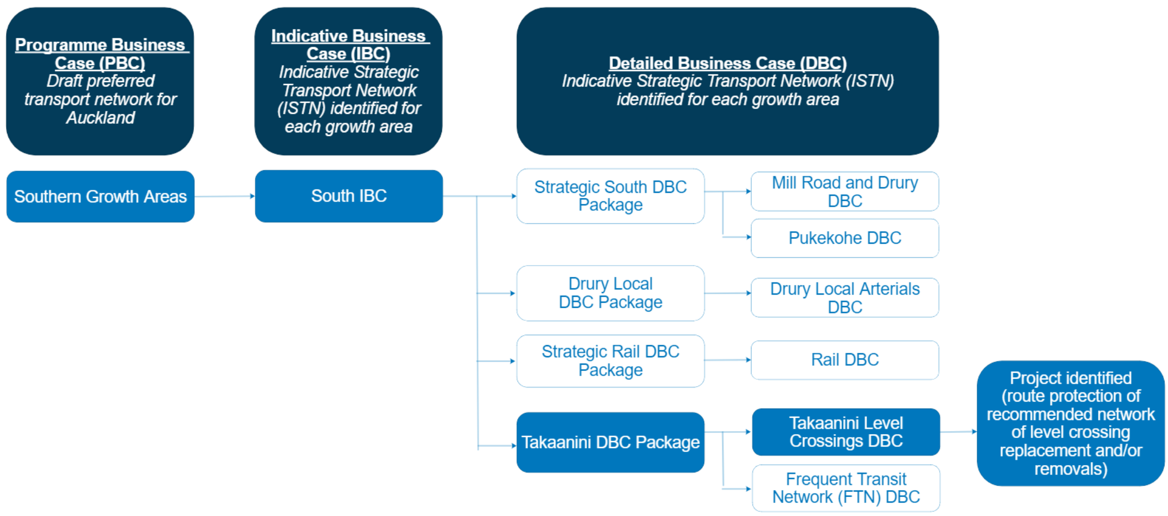


Figure 2-1 - Business case process leading to the identification of TLC

As shown in Figure 2-1, the TLC DBC was undertaken in parallel with other DBCs progressing other parts of the ISTN – in particular, the South Frequent Transit Network (**South FTN**) DBC. Because both the TLC and South FTN considered east-west crossings of the NIMT, some aspects of early optioneering were undertaken concurrently between the two projects. This is noted where relevant in this report.

2.2 South IBC recommendations on the TLC

As noted above, the ISTN identified through the South IBC was the starting point for further option assessment through DBCs. The South IBC was itself the subject of an extensive optioneering process in 2018-2019. This process, as it related to the TLC, is summarised as follows:

- The initial IBC option longlist comprised some 484 network and corridor options for transport interventions for the entire southern growth area. This was narrowed down to an amalgamated longlist of 151 options following a screening process, which were sorted according to relevant modes/intervention categories for shortlisting;
- The relevant shortlist category for the TLC at the IBC stage was referred to as ‘Takaanini East-West Crossings’, which was defined as connections “improv[ing] connections over the rail corridor as well as support[ing] the closure of level crossings to improve safety and road efficiency”.
- This Takaanini East-West Crossings grouping comprised five network scenarios, each of which comprised different combinations of grade-separated road crossings of the NIMT, closures of existing level crossings, and upgrades of adjoining roads. The five shortlisted scenarios were referred to as follows and are shown in Figure 2-2:
  - **Option EW9B** – including grade-separated crossings at Rangi Road, Taka Street, and Walters Road; and level crossing closures at Spartan Road and Manuroa Road;
  - **Option EW9E** – including grade-separated crossings at Manuroa Road and Walters Road, and level crossing closures at Spartan Road and Taka Street;
  - **Option EW9J** – including grade-separated crossings at Taka Street and Walters Road, and level crossing closures at Spartan Road and Manuroa Road;
  - **Option EW9K** – including grade-separated crossings at Rangi Road and Walters Road, and level crossing closures at Spartan Road, Manuroa Road, and Taka Street; and
  - **Option EW9Ka** – including grade-separated crossings at Rangi Road and Walters Road, realignment of Popes Road, and level crossing closures at Spartan Road, Manuroa Road, and Taka Street.

The five shortlisted scenarios were tested through a Multi-Criteria Assessment (**MCA**) process (see section 3.3.2 for a general summary of the MCA methodology) and were subject to feedback through a public engagement process. Following this process, **option EW9B** (see Figure 2-2) was identified as the preferred scenario at the IBC stage.

Consequently, option EW9B was incorporated into the ISTN which was made public in mid-2019 (see Figure 2-3). Option EW9B was therefore the starting point for further option assessment undertaken as part of the TLC DBC.

For clarity, the South IBC recommendation for the TLC comprised the following elements (see Figure 2-2 and Figure 2-3):

- **Three grade-separated crossings – a new crossing at Rangi Road, and grade-separations of existing level crossings at Taka Street and Walters Road; and**
- **Closures of existing level crossings at Spartan Road and Manuroa Road.**

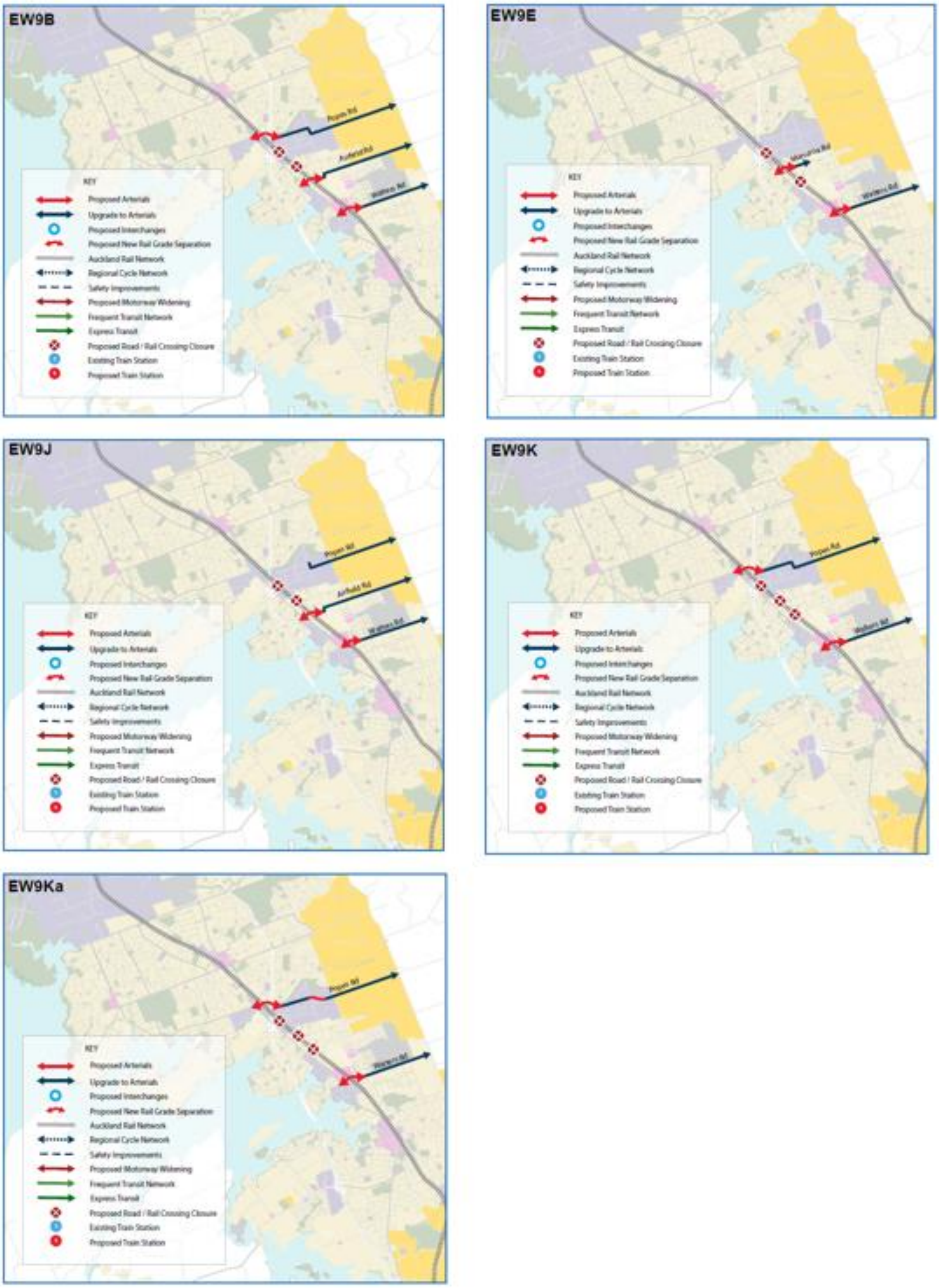


Figure 2-2 - Takaanini East-West Crossings shortlisted scenarios assessed at the IBC

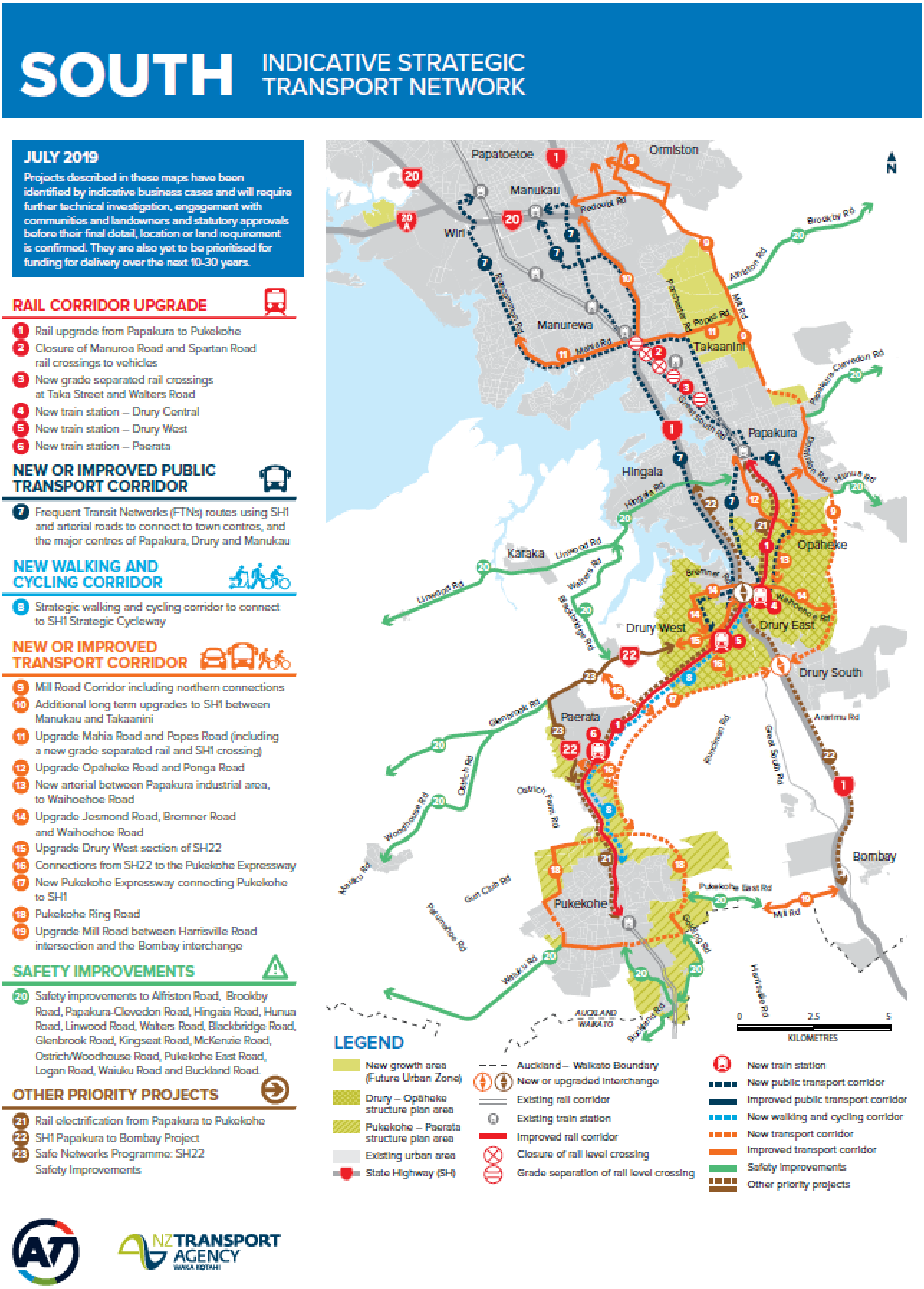


Figure 2-3 - South ISTN map – note Takaanini east-west crossing inclusions at annotations 2 (closure of Spartan and Manuroa Road level crossings), 3 (grade separation of Taka Street and Walters Road level crossings), and 11 (new grade-separated crossing at Rangi Road).

3 Assessment Methods

This section provides a summary of the methods used in the alternatives assessment process that are documented throughout this report. In particular:

- The use of gap analysis to identify the required scope and context for optioneering;
- Methods used to develop options to be assessed; and
- Methods to assess options.

3.1 Gap Analysis

As summarised in section 2, the South IBC recommended a number of interventions relating to Takaanini level crossings for inclusion in the ISTN. As shown in Figure 2-1, the TLC DBC advances this subset of projects from the ISTN, and thus uses the ISTN as a starting point for further optioneering.

The first optioneering stage is a gap analysis which captures the contextual changes that have occurred between the IBC and DBC processes. This process recognises that the IBC was completed in 2019, that changes in the Project context have occurred in the intervening period; and that such changes could change the scope of optioneering required for the DBC and/or the merits of conclusions in the IBC.

The contextual changes identified in the gap analysis that are pertinent to further optioneering for the TLC are set out in section 5 of this report. The contextual changes set out in section 5 inform the scope of optioneering documented in the remainder of the report.

3.2 Option Development

3.2.1 Scenario Development Approach

Given that the TLC deals with a number of interdependent transport interventions in close network proximity, a scenario development approach was used for the purposes of identifying options at the network optioneering stage (see section 7). In short, this means that 'options' assessed at that stage comprised different combinations of network interventions (i.e. grade separations or level crossing closures) rather than variations on individual alignments. The aim of this process was to compare different network scenarios with a view towards identifying the preferred number and general location of level crossing interventions.

3.2.2 Option Form and Function Considerations

3.2.2.1 Structures

The physical form and extent of structures within individual TLC options was generally informed by design inputs derived from relevant AT and KiwiRail design standards, and strategic considerations such as future-proofing for NIMT four-tracking. These inputs inform design parameters such as vertical and horizontal clearances, and vertical geometry. Key design parameters assumed for structures that are part of individual options are documented throughout this report.

3.2.2.2 Corridor Form and Function process

The form and function of midblock road cross-sections assumed for individual TLC options was identified through applying the Corridor Form and Function (**CFAF**) process. This process is designed to enable Project Teams to select appropriate form and function options from a set of modular cross-sections, ensure a consistent methodology is followed in defining form and function requirements, and ensure that all modes of transport are considered.

The CFAF output recommends traffic capacity, bus priority measures, walking and cycling facilities and other corridor elements which influence the corridor footprint. All modes are considered in the development of the cross-section, however facilities for all modes may not necessarily be provided. The resulting cross-section forms the basis for the corridor width.

The form and function of a corridor is determined using a combination of 'place' and 'movement' significance:

- **Place factors** consider the existing land use, future land use plans and trip generators present in the catchment area. It also includes an assessment of the future density of residential, industrial, or mixed land use and local/regional trip attraction areas e.g. metro stations, schools, hospitals.
- **Movement factors** consider the hierarchy of the corridor in the regional road network (Public Transport network, strategic freight network), modal priorities for the corridor and existing and future traffic volumes to determine the future typology and recommendations for a corridor function. Movement is considered at both local and network levels to ensure that duplication of facilities is avoided, and the corridors have targeted modal functions.

Figure 3-1 provides an overview of CFAF process. The iterative nature of the process allows for high stakeholder and owner engagement and an efficient design process. Note that during the development of the DBC, the CFAF was revisited when necessary to address identified constraints and design considerations. Any modifications were taken back through the endorsement process to maintain corridor alignment.

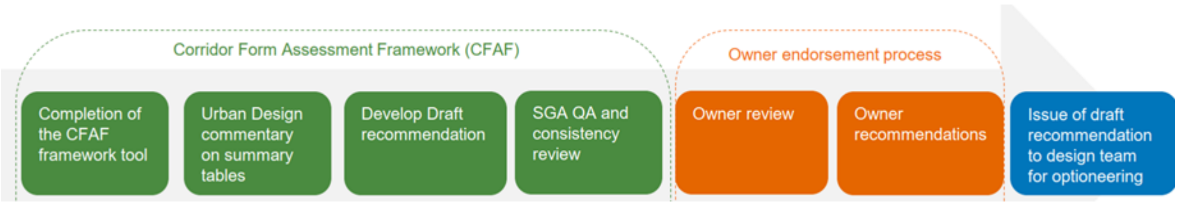


Figure 3-1 - Corridor Form and Function

3.2.2.3 Intersection Assessment

Concurrently with the CFAF process, an assessment to identify assumed the form and function of intersections within individual options is undertaken – generally a choice between roundabouts or signalisation. The purpose of this process is to identify the indicative intersection controls and subsequent footprint implications. A range of factors are considered in this assessment including safety, the required level of service, future transport demands, site-specific constraints, and land use integration. For each intersection control chosen, design features are considered to ensure that the intersection meets the needs of different users safely and effectively and responds to the site-specific factors.

The intersection assessments have been consolidated to consider the key intersections – specifically arterial-to-arterial or arterial-to-collector roads. Intersections with local roads are generally priority-controlled intersections and are assumed to remain priority-controlled in the future.

3.2.2.4 Stormwater Design

To meet the Project objectives, sufficient land needs to be protected to enable the future construction, operation, and maintenance of the required transport infrastructure. The option development process has therefore considered stormwater management methods to meet likely catchment needs and achieve the future regulatory requirements.

The type and location of stormwater infrastructure was based on a stormwater philosophy developed for the Project and Te Tupu Ngātahi and which seeks to achieve the following objectives:

- Provide stormwater treatment and retention / detention for new impervious surfaces;
- Re-use and re-purpose existing infrastructure where possible;
- Enhance with green infrastructure and incorporate with urban design; and
- Provide treatment of existing surfaces where possible, including where existing runoff mixes with new prioritising high loading areas such as intersections.

It is noted that this approach sets out the overarching stormwater management philosophy and rationale for proposed stormwater management treatment across the Project areas in the context of relevant stormwater related statutory requirements. This approach will be further developed through future consenting and the detailed design process.

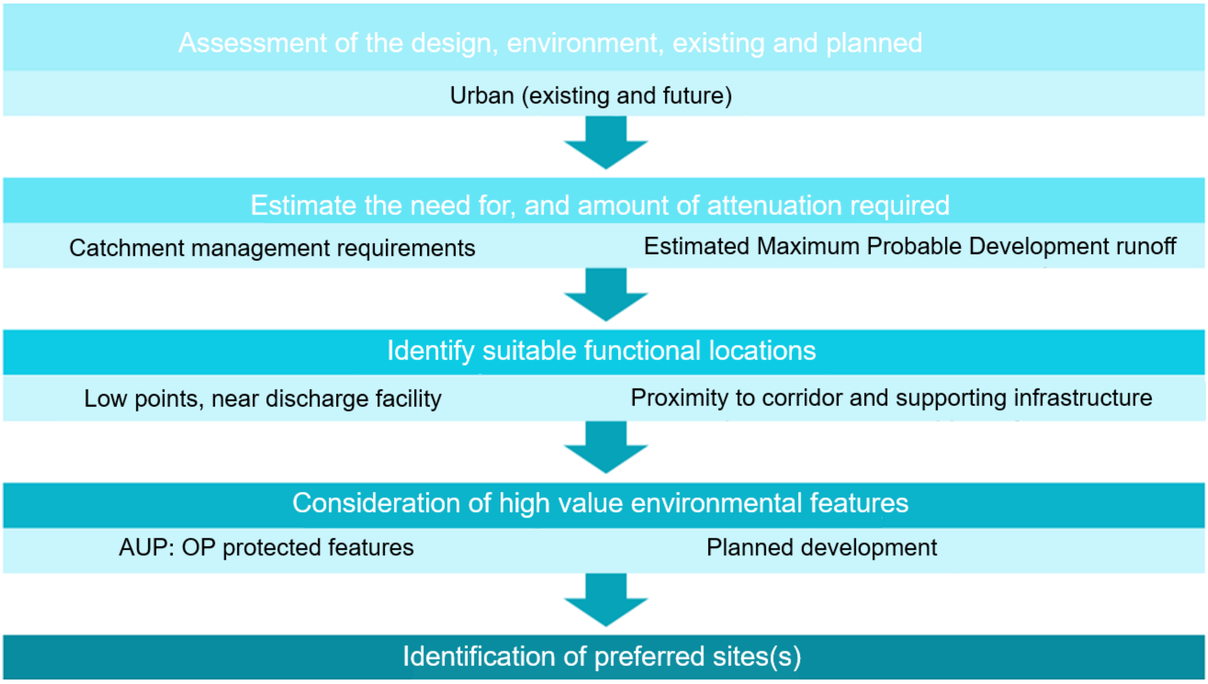


Figure 3-2 - Stormwater infrastructure design and location approach

The process for identifying stormwater treatment form and location is summarised in Figure 3-2.

The type of stormwater management device in turn was identified based on a general framework which considered:

- The surrounding existing and planned land-use;

- Form of the transport route;
- Road hierarchy; and
- How connectivity to adjacent properties would be provided.

This approach is summarised in Table 3-1 below.

Table 3-1 - Stormwater system design approach

Design Environment	Conveyance	Treatment	Retention	Detention (Attenuation)	Diversion
Existing Urban – footpath and cycleway within existing road reserve	Pits and pipes	Discharge across berm	Raingarden	Wetland / pond	N/A
Existing Urban – increased road reserve and road upgrade	Pits and pipes	Raingardens or treatment wetland / pond, or as a lesser preference, proprietary treatment devices	Raingarden	Wetland / pond	N/A

3.2.3 Constraint Mapping

Following the gap analysis, an Auckland Unitary Plan (**AUP:OP**) map review and constraint mapping exercise was also undertaken. The purpose of this exercise was to gather information on potential constraints to inform the identification, development, and refinement of alignment options.

The Project Team identified a study area for each TLC corridor identified in the IBC. The study area was informed by the gap analysis and an initial review of key constraints including:

- Geological conditions;
- Natural hazards such as flooding;
- Contours and potential earthworks requirements;
- Strategic land use plans including live zoning, future urban areas and structure plans;
- Identified sensitive areas through the AUP:OP overlays, conflicts with critical services and special purpose zones; and
- Environmental constraints.

Study areas were typically 100m wide. However, subject matter experts (**SMEs**) were advised to use their discretion if they considered there were any relevant constraints located outside of the study area.

The specialist subject matter areas of the SMEs involved in the constraint mapping exercise are identified below:

- Ecology;
- Landscape and visual effects;
- Archaeology and built heritage;
- Stormwater and flooding;
- Planning / land use / social impacts;

- Urban design;
- Geotechnical; and
- Cultural values – Manawhenua had an opportunity to identify constraints and opportunities as part of the constraint mapping exercise.

Constraints were mapped on Te Tupu Ngātahi GIS with comments on the constraints recorded. The identified constraints were reviewed and discussed at a workshop attended by the Project Team and SMEs and have been used to inform much of the subsequent optioneering.

3.3 Option Assessment

3.3.1 Multi-Criteria Assessment

An MCA Framework was developed at a Programme-wide level by Te Tupu Ngātahi, in consultation with AT, Waka Kotahi, and Manawhenua. The MCA Framework was the primary method used to assess and compare options for the TLC. It was used in the assessment of options for the physical form of grade-separation (see sections 6, 8, and 9), as well as network optioneering (see section 7) which considered network scenarios to determine the number and location of TLC crossings.

The MCA Framework assessment criteria developed by Te Tupu Ngātahi are summarised at Table 3-2 below and are included in full in Appendix A. The MCA process requires options to be scored by relevant subject matter experts (**SME**) on an eleven-point scoring scale (see Table 3-3). As part of this scoring process, SMEs are required to provide commentary and rationale for their assessment.

In identifying preferred options through the MCA process, aggregate scoring or weighting of MCA criteria were not produced. This ensured that preferred options were reached through balanced consideration of all criteria, and that the MCA would not prejudice further feedback received through the engagement process from Project partners, stakeholders, and the public.

Table 3-2 - Te Tupu Ngātahi MCA Framework – Assessment Criteria

MCA topic	No.	Criterion	Measure
Investment Objectives			See Appendix A for investment objectives.
Heritage	1a	Heritage	See MCA Framework appendix (Appendix A) for detailed explanation of measures for each criterion.
	1b	Manawhenua[1]	
Socio-economic impacts	2a	Land use futures	
	2b	Urban design	
	2c	Land requirement	
	2d	Social cohesion	
	2e	Human health and wellbeing	
Natural Environment	3a	Landscape and Visual	
	3b	Stormwater	
	3c	Ecology	

[1] Note Manawhenua did not wish to score this criterion numerically, and accordingly it was excluded from scoring.

MCA topic	No.	Criterion	Measure
	3d	Natural Hazards	
Transport	4a	Transport System Integration	
	4b	User Safety	
Construction Impacts	5a	Construction impacts on utilities / infrastructure	
	5b	Construction Disruption	
	6	Construction costs / risk / value capture	
Non-Scored Criteria		Stakeholder / Project partner feedback	
		Policy Analysis	
		Indicative costs	
		Mana Whenua	

Table 3-3 - Te Tupu Ngātahi MCA Framework –Scoring Scale

	-5	-4	-3	-2	-1	0	1	2	3	4	5
Type	Adverse					Neutral					Positive
Magnitude	High				Low		Low				High
Significance	Regional				Local		Local				Regional
Extent	Substantial				Low		Low				Substantial
Duration	>20 years				<1 year		<1 year				>20 years

3.3.2 Early Assessment Sifting Tool

The Early Assessment Sifting Tool (**EAST**) was developed by Waka Kotahi and is intended for the high-level assessment of longlist options in a business case process to narrow them down to a shortlist for MCA assessment (using frameworks such as the MCA Framework developed by Te Tupu Ngātahi outlined above). By definition, the assessment undertaken through the EAST is 'coarse' and high-level and is intended primarily to rule out fatally flawed options rather than provide a detailed assessment of viable options. The EAST tool was used in the initial consideration of physical form of grade separations (see section 6).

The criteria assessed through the EAST tool are summarised in the table below.

Table 3-4 - Summary of EAST tool criteria

Criterion	Subcriterion	Explanation
Investment objectives		Option is scored on a 1-5 scale against the investment objectives developed through the business case, with 1 denoting a low positive benefit, and 5 denoting a high positive benefit.

Criterion	Subcriterion	Explanation
Practical feasibility	Technical	Option is scored on a 1-5 traffic light scale in terms of relative ease or complexity of implementation from a technical perspective, where a 1 denotes ease/simplicity; and a 5 denotes high complexity.
	Safety and design	Option is scored on a 1-5 traffic light scale in terms of the associated health and safety risk at design, operation, and maintenance, where a 1 denotes lowest risk, and a 5 denotes highest risk.
	Consentability	Option is scored on a 1-5 traffic light scale in terms of the expected ease or complexity of consenting, where a 1 denotes ease / simplicity; and a 5 denotes high complexity.
Scheduling / programming		An estimated delivery timeframe for the option is estimated.
Cost		The broad capital cost of the option is estimated (from a range).
Key risks and uncertainties		The key risks and uncertainties of the option are identified.
Climate change	Mitigation	Option is identified as either having a reducing / increasing / neutral effect on enabled emissions / vehicle kilometres travelled.
	Adaptation[2]	Option is scored on a yes / no / uncertain scale in terms of whether the completed asset will be exposed to climate-related risks.
Environment and social responsibility	Key risks	The key environmental risks and uncertainties of the option are identified.
	Can risks be mitigated / how?	The ability to mitigate key environmental risks is assessed at a high level.
Fatal flaws		From the above assessment, a high-level assessment of whether there are any 'fatal flaws' associated with the option is completed.

4 Process Overview

The TLC Project has required several stages of alternatives assessment. This staged approach reflects that multiple aspects of alternatives have required consideration, namely:

- The **number** of east-west crossings needed in the TLC network, and which transport modes should be accommodated;
- The **locations** for east-west crossings in the TLC network;

[2] Scored on a yes-no-maybe scale of whether the option will be exposed to climate risk.

- The **physical form of grade separation** for the TLC network – whether grade separation of road and rail is to be achieved by raising or lowering roads, or raising or lowering rail; and
- The **alignment** and **physical extent** of each east-west crossing in the TLC network.

It is not possible to identify a preferred network for the TLC without assessing all of the above aspects of alternatives. Decisions on each of these aspects have flow-on effects for the others, and as a result have required consideration in a careful sequence. This sequenced assessment is documented from sections 5 through to 10 of this report.

Table 4-1 sets out the general optioneering process that has been followed. The purpose of each step in the chronology and key decision points reached at each stage are noted. References to relevant sections of this report in which each aspect of optioneering has been documented is included in the table for ease of navigation.

Table 4-1 - Alternatives Assessment Chronology

Report section		Aspect assessed	Purpose of step in optioneering chronology and key decision points
5	Gap Analysis – setting the scene	Overall scope of optioneering required	Captures the contextual changes that have occurred between the IBC and the DBC, and the extent to which those changes require IBC recommendations (see section 2) to be revisited. This process recognises that the IBC was completed in 2019, and that contextual changes that occurred in the intervening period could change the scope of optioneering required for the DBC and / or the merits of IBC conclusions. Key considerations in the gap analysis were retesting IBC conclusions in terms of the requirement for three east-west crossings in the network, and the locations of those crossings (Rangi Road, Taka Street, and Walters Road). **Key Decision Points – Confirmation of the number of crossings needed in the TLC network, and whether further assessment of their location, alignment, and physical form would be needed.**
6	Initial Consideration of Physical Form	Physical form of grade separation	Following confirmation of the number of crossings needed in the TLC network, the physical form of grade separation was considered at a high level. The merits of four methods of achieving grade-separation – road-over-rail, road-under-rail, rail-over-road, and rail-under road – are described and assessed at a high level using the Waka Kotahi EAST tool. The primary purpose of this high-level assessment was to inform the scope of options for the subsequent network optioneering stage of the assessment which considers the location of crossings (see section 7). It is necessary to have first assessed the physical form of grade separation at a high level, because this informs the types of options that need to be assessed at the network optioneering stage. In particular, grade separation via rail grade changes generates different options to grade separation via road grade changes. The initial assessment at this stage was high level, and only sufficient to inform the scope of network optioneering. The physical form of grade separation is revisited in more detail subsequent to the network optioneering stage (see sections 8 and 9). **Key Decision Points – Confirmation of the initially preferred form of grade separation to be assumed for network optioneering purposes (see section 7), in particular whether grade separation is likely to be achieved via rail grade changes or road grade changes.**

Report section		Aspect assessed	Purpose of step in optioneering chronology and key decision points
7	Network Optioneering	Number and location of crossings	The network optioneering assessment seeks to confirm the preferred number and location of crossings for the TLC, being guided by the required number of crossings (see section 5), and the initial preference for the form of grade separation (see section 6). This assessment was undertaken through a scenario development approach in which 'options' assessed comprise different combinations of network interventions (i.e. grade separations, level crossing closures, or entirely new crossings). Each network scenario was assessed using the MCA Framework. **Key Decision Points – Confirmation of the preferred number and location of crossings.**
8	Further Consideration of Physical Form	Physical form of grade separation	Following confirmation of the preferred number and location of crossings at the network optioneering stage (see section 7), the physical form of grade separation was considered in greater detail. Given the conclusions reached at section 6, this consideration was limited to an assessment of the merits of a road-over-rail bridge compared with a road-under-rail underpass. These options were compared using the MCA Framework, and retested multiple times. **Key Decision Points – Confirmation of the preferred physical form of grade separation.**
9	Final retesting of Walters Road physical form		
10	Network refinement	Alignment and physical extent of crossings	Following confirmation of the preferred number, location, and physical form of crossings from sections 5-9, section 10 documents the process of option refinement which has informed the preferred alignment and physical extent of each crossing. This considered form and functional elements, as well as refinement of concept design and alignments in each location. **Key Decision Points – Confirmation of the preferred alignment and physical extent of each crossing.**

5 Gap Analysis – setting the scene

5.1 Context

As noted in section 3.1, the first stage of optioneering for the DBC is a gap analysis which considers the contextual changes which have occurred between the IBC and DBC processes. This process recognises that the IBC was completed in 2019, that changes in the Project context have occurred in the intervening period, and that such changes could change the scope of optioneering required for the DBC and/or the merits of conclusions in the IBC. The purpose of the gap analysis is therefore to test the validity of the IBC conclusions, and in doing so identify the scope of further optioneering needed for the DBC (and by extension to inform the NoRs).

It is again noted for clarity that the IBC recommendations being retested in the gap analysis are as follows (see Figure 2-2 and Figure 2-3):

- **Three grade-separated crossings – a new crossing at Rangi Road, and grade-separations of existing level crossings at Taka Street and Walters Road; and**
- **Closures of existing level crossings at Spartan Road and Manuroa Road.**

5.2 Key contextual changes – IBC to DBC

The key contextual changes that are relevant to the consideration of alternatives for the TLC identified as part of the gap analysis are summarised below in Table 5-1. While much of this analysis took place at the outset of the DBC in late 2021-early 2022, some commentary has been added subsequently for full context.

Table 5-1 - Key contextual changes relevant to the TLC between the IBC and DBC processes

Contextual change	Relevance
Growth and Land Use	
Legislation and policy directing councils to enable increased housing supply	The National Policy Statement on Urban Development (**NPS-UD**) and the Medium Density Residential Standards (**MDRS**) (legislated through the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021) set clear direction for councils to enable increased housing supply in high-growth areas. Auckland Council's subsequent response came in the form of Plan Change 78 (**PC78**) which was notified in August 2022, which proposed upzoning for the Takaanini area. This signals that transport demands in the Takaanini area will continue to grow.
Updates to Auckland Forecasting Centre (**AFC**) growth scenarios	The DBC considered changes in land use assumptions and utilises the most current land use assumptions available from the AFC. Since the completion of the IBC, there have been updates to growth scenarios used in Auckland which are reflected in this DBC. Scenario I11.6 has been used in this DBC which is consistent with current regional models, and no significant changes have been identified in comparison with the previous version I11.4 which was used in the IBC. This signals that the transport demands previously assessed in the IBC are likely to remain valid.
Ongoing urban growth in Takaanini	The Project Team has monitored the ongoing residential and commercial development and intensification in and around Takaanini.
Transport and Climate Change legislation and policy	
Government Policy Statement on Land Transport (**GPS**) 2021 (and indicative GPS 2024)	The current GPS signals greater focus on projects that provide for better travel options / mode shift to sustainable modes and contribute to a low-carbon transport system that supports emissions reduction. This direction is further strengthened in the indicative 2024 GPS which elevates emissions reduction to being the overarching focus for transport investment.

Contextual change	Relevance
Passage of the Zero Carbon Act (and parallel amendments to the RMA)	The Climate Change Response (Zero Carbon) Amendment Act 2019 set in place a framework for emissions reduction comprising a long-term target of net-zero greenhouse gas emissions by 2050, and a system of quintennial emissions budgets and Emissions Reduction Plans (**ERP**) as 'stepping stones' to the long-term target. The first ERP, published in 2022, sets a target of reducing vehicle kilometres travelled (**VKT**) by 20 percent by 2035 through providing better travel options. In parallel, sections 70A and 104E of the RMA have been amended to enable the consideration of greenhouse gas emissions on climate change in both plan-making and consenting decisions. Furthermore, sections 61, 66, and 74 of the RMA have been amended to require that local authorities must have regard to ERPs and national adaptation plans when making and amending regional policy statements, regional plans, and district plans. Finally, the NPS-UD, sat under the RMA, sets an objective that New Zealand's urban environments support reductions in greenhouse gas emissions; and a related policy requiring planning decisions to contribute to well-functioning urban environments, which are defined as environments which (among other things) support reductions in greenhouse gas emissions, and are resilient to the effects of climate change. All of the above considerations place an increased onus for transport projects to demonstrate how they contribute to greenhouse gas emissions reduction.
Related transport strategies and projects	
NZ Rail Plan and Rail Network Investment Programme (**RNIP**)	The NZ Rail Plan is a non-statutory strategy to inform investment in New Zealand's rail network. The RNIP in turn is an investment programme setting out investment in the national rail network over the next 3-10 years through the National Land Transport Programme. Both documents reference four-tracking of the NIMT in Auckland and level crossing removals as key objectives.
Decision to progress Mahia Road and Popes Road corridors separately	The ISTN (see section 2) recommended that a grade-separated connection at Rangi Road progressed as part of the TLC should form part of a wider east-west connection with Mahia Road to the west and Popes Road to the east. Following the IBC, it was identified following discussion with SMEs that Mahia Road would be progressed as a separate shorter-term project by AT and would form no further part in Te Tupu Ngātahi optioneering. A further decision made in the scoping of DBCs was that the upgrade of Popes Road to the east would be further investigated through the South FTN DBC, and not as part of the TLC.
Changes in environmental planning context	
New NPS for Freshwater Management and Indigenous Biodiversity	In addition to the NPS-UD discussed above, new NPS's on Freshwater Management (**NPS-FM**) and Indigenous Biodiversity (**NPS-IB**) have come into effect since the completion of the IBC. The Project Team have considered the implications of these in the process of developing and assessing options to the extent relevant (noting that the NPS-IB has only come into effect recently).

Contextual change	Relevance
Updated flooding data from Auckland Council Healthy Waters	Flooding data from Auckland Council Healthy Waters has been updated since the IBC. This has informed the development and assessment of DBC options.

The contextual changes summarised in Table 5-1 directly informed the scope of optioneering required for the TLC DBC. In particular:

- Changes in transport and climate change policy result in an increased onus on transport projects to demonstrate how they contribute to greenhouse gas emissions reduction, both in terms of embodied and enabled emissions. Consequently, a key recommendation of the gap analysis was to **give further consideration to the viability of the Rangi Road option identified in the IBC**, which was noted as being a large and complex option with a relatively high level of embodied carbon likely associated with its construction;
- The decisions regarding the process for progressing the adjoining Mahia Road and Popes Road corridors further prompted a need to consider the validity of the Rangi Road option;
- The strategic direction for rail set out in the Rail Plan and RNIP demonstrate that the TLC remains well aligned with wider aspirations to achieve four-tracking of the NIMT in Auckland and remove level crossings from the rail network; and
- The land use changes signalled by the NPS-UD, MDRS, and PC78 will likely result in continued growth and increased travel demand in the Takaanini area which further underlines the need for the TLC.

In light of the above findings and the interdependencies between Rangi Road and the grade separation of other crossings, the Project Team prepared a more detailed technical assessment on the merits of retesting the Rangi Road option. This is summarised at section 5.3 below.

5.3 Rangi Road assessment

During the South IBC, Rangi Road was recommended as a multi-modal corridor with regional significance in the future network. This corridor formed part of the preferred South FTN route and would also serve as a key industrial connection in the Takaanini network. The Rangi Road connection, in conjunction with the adjoining Mahia Road and Popes Road routes, was proposed as a strategic east-west connection (see Figure 2-3).

The proposed Rangi Road connection was anticipated to comprise of a large viaduct structure, approximately 365m in length. It had an overall span of approximately 520m from an eastern abutment at Rangi Road over SH1, Papakura Stream, and across the NIMT to the western abutment. The viaduct would then follow along an embankment to an at-grade signalised intersection at Great South Road. Figure 5-1 shows an indicative visualisation of the Rangi Road viaduct.

While providing improved access to the Takaanini area to the east of the NIMT / SH1, it was recognised that there could be adverse impacts on existing movement and place functions of Great South Road and the surrounding area, west of SH1. This is due to the potential level of impact caused by a viaduct of this scale on the receiving environment.

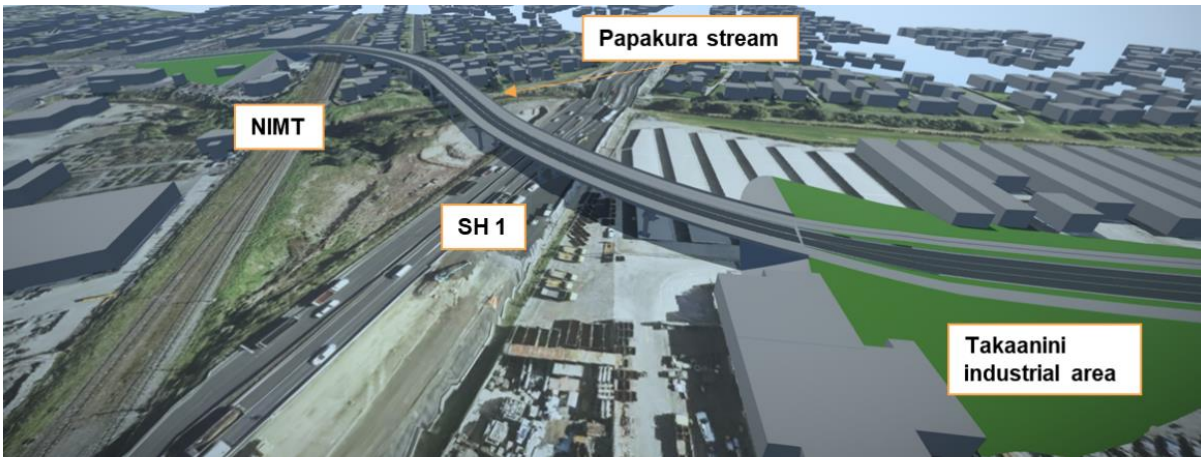


Figure 5-1 - Indicative visualisation of Rangi Road viaduct as recommended in the South IBC

A high-level assessment against key transport outcomes was undertaken to assess the need for the Rangi Road connection in the future transport network. The outcomes are summarised in Table 5-2.

Table 5-2 - Summary of the Rangi Road transport assessment

Criteria	With Rangi Road viaduct	Without Rangi Road viaduct	Can outcomes be met without the viaduct?
Supporting Growth	Able to support growth in Takaanini future urban areas Able to support employment growth expected in the Takaanini industrial area Adverse impact on movement and place on Great South Road, Manurewa East	Potential reduced uptake of industrial land Unable to support employment growth expected in the Takaanini industrial area	No – alternative needed to provide access for the Takaanini industrial area Further optioneering recommended
Access	Less traffic pressure on other east-west connections such as Alfriston Road	Increased traffic on Alfriston Road and Taka Street Potential to reduce public transport reliability An increase in overall Vehicle Kilometres Travelled (VKT) due to rerouting of industrial trips	No - unless an alternative option can achieve this outcome Further optioneering recommended
Mode Shift	No significant change in mode shift expected as improved public transport accessibility is offset by improved access for general traffic Misalignment with Auckland RTN Study to improve access to Te Mahia Station – reduced opportunity to achieve mode shift outcomes	No significant change in mode shift expected	Yes
Safety	Separates industrial traffic (heavy freight) away from residential routes, reducing	Safety impacts on vulnerable road users in residential / local areas, due to heavy traffic	No – alternative need to provide access for the Takaanini industrial area

Criteria	With Rangi Road viaduct	Without Rangi Road viaduct	Can outcomes be met without the viaduct?
	impact on vulnerable road users in residential / local areas There will be increased traffic near Mahia Road and Great South Road as this is where the viaduct is expected to land (western side). This will result in increased conflict	routing around residential streets.	to separate industrial traffic and residential traffic Further optioneering recommended
Freight	Provides a separate industrial connection	Reduced access to industrial area Increased heavy vehicle movements on future bus routes and the local network	No - unless an alternative option can achieve this outcome Further optioneering recommended
Resilience	Alternative access to industrial area reducing pressure on other key east-west routes and future bus routes	Increase pressure on the remaining east-west routes	No - unless an alternative option can achieve this outcome Further optioneering recommended

In addition to the above assessment, a test was undertaken to understand the impact of reducing the number of east-west connections from three (the number of crossings proposed under the ISTN) to two in the network between the Papakura Stream and Subway Road. This resulted in significantly increased congestion on other parts of the network.

5.4 Implications for further assessment

The above assessment confirmed a number of key parameters which have informed the scope of all subsequent optioneering documented in this assessment.

- A **direct industrial connection is needed** to provide for access and transport resilience in the Takaanini network;
- A **minimum of three east-west connections** are needed south of Papakura Stream and north of Subway Road to serve the Takaanini area;
- Further optioneering should be undertaken **to identify an alternative(s) to the Rangi Road viaduct** which can achieve transport outcomes whilst reducing adverse effects on the surrounding built environment;
- Further optioneering should **take a network approach** to determine different combinations of level crossing interventions in order to fully understand the optimal combination of infrastructure to support the outcomes sought; and
- There are interdependencies between the interventions at all crossings, meaning that network scenarios throughout the entire TLC area should be retested (including previous recommendations for Spartan Road, Manuroa Road, Taka Street, and Walters Road as summarised in section 2).

6 Initial Consideration of Physical Form

6.1 Context

Optioneering in the TLC DBC commenced with an initial assessment of the physical form of grade separation to be assumed for subsequent network optioneering. This broadly considered four means of achieving grade separation of road and rail:

- Raising the railway – i.e. rail-over-road;
- Lowering the railway – i.e. rail-under-road;
- Raising the road – i.e. road-over-rail; or
- Lowering the road – i.e. road-under-rail.

The purpose of this analysis was to set out the ways in which grade separation could be physically achieved, and to identify an interim preference for the physical form of grade separation. This step was a necessary precursor to network optioneering (see section 7) because different forms of grade separation generate different types of network options – grade separation via rail grade changes for example generate different options to grade separation via road grade changes. Following the network optioneering stage, the physical form of grade separation is considered further (see sections 8 and 9).

This analysis considered a range of information in identifying an interim form preference, including:

- Recommendations of studies undertaken prior to the DBC for level crossing grade-separation in Takaanini; and
- High-level DBC option development derived from basic engineering design parameters, and assessment using Waka Kotahi's EAST tool (see section 3.3.2).

6.2 Consideration of rail grade changes

As noted in the methodology above, rail grade changes – raising or lowering the railway – were considered as methods for achieving grade separation. In considering the merits of rail grade changes, both previous (pre-DBC) studies and assessment undertaken through the DBC process were considered.

6.2.1 Recommendations of previous (pre-DBC) studies

The Project Team identified four previous studies which have considered or discussed rail grade changes as a means of achieving road-rail grade separation in Takaanini dating back to 2014. These are summarised in Table 6-1.

Table 6-1 - Previous (pre-DBC) studies considering rail grade changes

Study	Relevant options considered	Conclusions
Takanini / Opaheke / Drury / Karaka Integrated Transport and Land Use Strategy (Urbanism Plus, 2014)	None	Study did not consider a rail grade change option on the basis it would be "unviable due to significant cost, disruption of train services, and potential constraints on future capacity" (p. 22).
Rail Crossing Grade-Separation Feasibility Study (Aurecon, 2014)	Three options were assessed at a high level for Walters Road, Taka Street, and Manuroa Road: • Road-over-rail; • Rail-under-road; and • Combination of road-over-rail and rail-under-road.	Options were assessed using a range of criteria including online impacts (for road and rail), impacts on surrounding areas and properties, and a range of construction impacts including complexity and disruption, costs, and construction duration. For all three locations, rail grade changes were not favoured and were scored less favourably on all construction-related criteria. The study also scored rail grade changes poorly on impacts on rail and rail-adjacent areas due to risks/impacts associated with poor ground conditions in

Study	Relevant options considered	Conclusions
		Takanini. However, rail grade changes were identified as being less impactful on surrounding properties. The study also noted that the interdependencies between each site needed to be considered for rail grade options given their proximity, and that the implications of additional rail tracks would need to be considered in future work.
Level Crossing Removal Options Investigation – Walters Road (RIC, 2016)	The following options pertained to grade-separating the Walters Road level crossing only: • 2A – Rail-over-road • 2B – Rail-under-road • 2C – Rail offline (under or over) • 3A / 3B – Combination options (i.e. lower rail/raise road; or raise rail/lower road).	Options 2A and 2B both not preferred on basis of construction complexity/disruption to rail operations (12-18 month block-of-line), higher costs associated with ~1km-long / 7m high/deep structures, and visual effects. Option 2C not preferred on the basis of very high land costs and business disruption effects. Options 3A / 3B not preferred on basis that they combine negative aspects of other options.
South Indicative Business Case (Te Tupu Ngātahi, 2019)	The following options pertained to grade-separating all Takaanini level crossings: • MT14 – Rail-under-road trench • MT14A – Rail-over-road viaduct	Both options MT14 and MT14A were not progressed at the longlist stage and not advanced to the shortlist on the basis that they provided only localised transport benefits and would result in very high construction costs and complexity. MT14A was identified as having significant visual effects and requiring a costly relocation of overhead line equipment. MT14 was identified as having lower visual effects but very high costs due to groundwater and settlement effects and peat soils.

From the above summary, it can be seen that none of the reviewed studies favour rail grade changes as a means of achieving road-rail grade separation in Takaanini. However, further work on rail grade change options was undertaken through the DBC process given that these earlier studies were all relatively high-level exercises.

6.2.2 Further DBC analysis

The design parameters for the development of options for rail grade change options in the DBC were derived from KiwiRail Standard T-ST-DE-5200 Track Design and are summarised in Table 6-2. These parameters are applicable to both rail-over-road and rail-under-road options.

Table 6-2 - Rail grade change option design parameters

Parameter	Value
Design Speed	100km/h
Vertical curve radius (for 100km/h)	3500m (K=35)
Desirable maximum gradient	1:80 (1.25%)

Parameter	Value
Absolute maximum gradient without operational restrictions	1:32 (3.125%)
Maximum gradient for yards, sidings, and station platforms	1:200 (0.5%)
Vertical clearance (taking account of structure depth)	7.6m

These design parameters indicate that:

- The average horizontal length required to ramp up or down to the required vertical clearance is approximately 1000m. The four Takaanini level crossings fall within a 3400m section of the NIMT, with an average distance of 850m between them. Accordingly, there is insufficient length between level crossings for the NIMT to be raised over each road individually. This was demonstrated through a design test assessing the requirement to grade-separate Walters Road in isolation, which showed the 1200m distance to the next level crossing northwards (Taka Street) is not sufficient for the rail to both return to grade and ramp up again to clear Taka Street. This finding holds for all four level crossings given that the remaining level crossings are closer to each other. Accordingly, it is assumed that the NIMT would need to be raised over / lowered under all crossings in the area on / in a single structure (other than Walters Road which could be grade-separated in isolation with a rail grade change);
- It is not possible for a rail-over-road viaduct structure to clear the Spartan Road level crossing due to its proximity to the SH1 rail underpass which is a hard constraint approximately 250m to the north of Spartan Road. Similarly, it is not possible for a rail-under-road trench to clear the Spartan Road level crossing due to its proximity to the Papakura Stream which crosses the NIMT approximately 400m north of Spartan Road; and
- Having regard to the above, the resultant structure would comprise a rail viaduct or trench of approximately 3700m in length and generally 7.6m in height between the SH1 rail underpass in the north and returning to grade approximately 900m north of Papakura Station (see Figure 6-1). The viaduct would clear three of the four Takaanini level crossings (Manuroa Road, Taka Street, and Walters Road), and the existing site of Takaanini Station. Spartan Road would need to be closed.

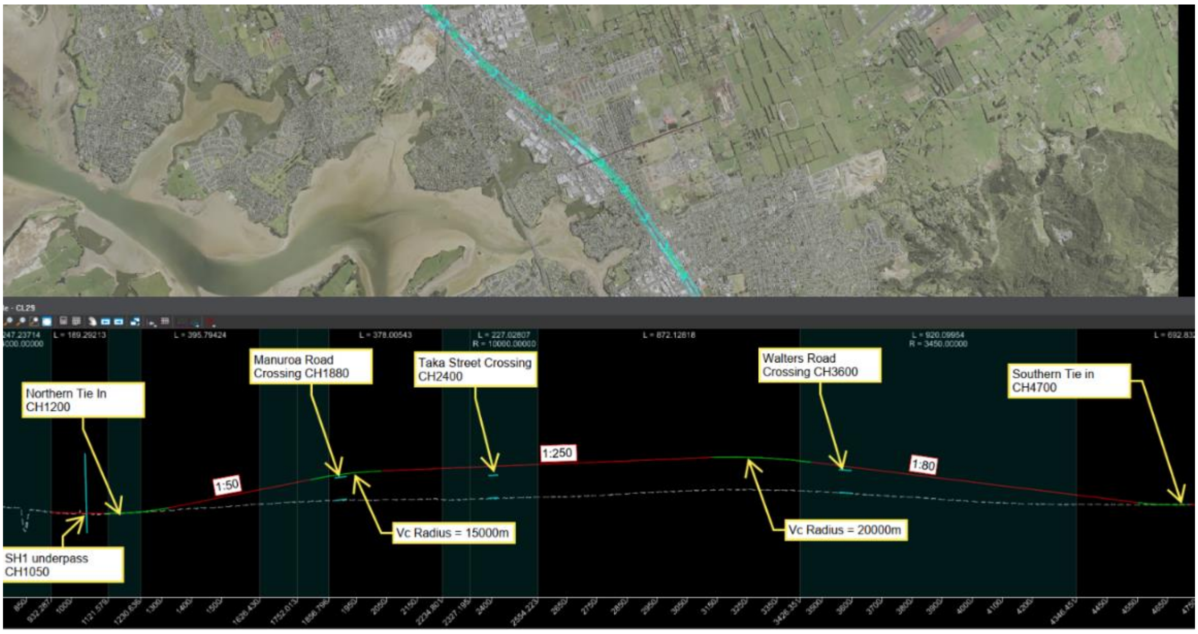


Figure 6-1 - Longitudinal section and plan view for rail-over-road viaduct option

The resultant options – a rail-over-road viaduct (viaduct) and rail-under-road trench (trench) were assessed using Waka Kotahi's EAST tool. As noted in section 3.3.2, the EAST tool is intended for the high-level assessment of broad ranges of options to narrow from a longlist down to a shortlist for MCA assessment. The results of the EAST assessment for the rail grade change options are summarised below.

Table 6-3 - Summary of EAST assessment for rail grade change options

Criterion	Subcriterion	Rail-over-road viaduct	Rail-under-road trench
Investment objectives		4 (positive)	4 (positive)
Practical feasibility	Technical	5 (complex)	5 (complex)
	Safety and design	2	2
	Consentability	5 (complex)	5 (complex)
Scheduling / programming		5+ years	5+ years
Cost		>$50m	>$50m
Key risks and uncertainties		For both options – high construction cost and complexity anticipated, particularly given ground conditions. Uncertainty as to how these options will interact with KiwiRail plans, particularly four-tracking.	
Climate change	Mitigation	Reduce (i.e. anticipated to result in fewer enabled emissions / VKT)	
	Adaptation	Uncertain – not yet assessed.	
Environment and social responsibility	Key risks	Large construction disruption and landscape / visual impact.	Groundwater, settlement risk, large construction disruption.
	Can risks be mitigated / how?	Yes – bridge height may be commensurate with surroundings in the future environment given NPS-UD and MDRS; construction method will need to minimise disruption as much as possible.	Yes – groundwater treatment needed; construction method will need to minimise disruption as much as possible.

Criterion	Subcriterion	Rail-over-road viaduct	Rail-under-road trench
Fatal flaws		Both options were not progressed at the IBC stage (see Table 5-2) given the risk and reward ratio was assessed as not worth pursuing further.	
Summary of recommendation		Not progressed – do not progress either option given scale, complexity, cost, construction disruption, and risk. Likely limited benefits relative to costs. Both options also not progressed in the IBC.	

In addition to the EAST assessment, the Project Team assessed the rail grade options from first principles and similarly recommended that these options do not progress prior to detailed options assessment (i.e. an MCA) for the following reasons:

- The rail viaduct was not progressed on the basis that it would be highly disruptive to rail operations, costly and complex to construct relative to alternatives, and would result in significant visual effects and land requirements over a lengthy section of the NIMT; and
- While perhaps the best outcome in terms of visual effects, the rail trench was not progressed on the basis that it would be highly disruptive to rail operations, and correspondingly more costly and complex to construct compared with the rail viaduct given the groundwater effects and risk associated with a 3.7km underpass in peat.

The same general conclusions hold with the option of a rail viaduct or trench to grade-separate Walters Road in isolation.

While less costly than the above options by virtue of shorter length, rail grade change options associated with Walters Road in isolation remain highly disruptive to rail operations, costly and complex to construct, and will still impose significant visual effects (in the case of a viaduct) and / or groundwater effects and risk (in the case of a trench).

6.2.3 Conclusion

The implications of the above analysis are that rail grade changes were ruled out as a means of achieving grade-separation. Accordingly, this analysis has ruled out two of the four general methods for achieving grade-separation.

6.3 Consideration of road grade changes

As noted in the methodology outlined above, road grade changes – raising or lowering the road – were considered as methods for achieving grade separation. In considering the merits of road grade changes, both previous (pre-DBC) studies and assessment undertaken through the DBC process were considered.

6.3.1 Recommendations of previous (pre-DBC) studies

The Project Team identified seven previous studies which have considered or discussed road grade changes as a means of achieving road-rail grade separation in Takaanini dating back to 2006. These are summarised in Table 6-4.

Table 6-4 - Previous (pre-DBC) studies considering road grade changes

Study	Relevant options considered	Conclusions
Takanini Grade Separation Feasibility Study – Manuroa and Walters Road (Beca, 2006)	Bridge (road-over-rail) option only	Feasibility study only – concluded that a road-over-rail bridge is feasible and would have immediate benefits. Identified a need for further geological assessment given likelihood of settlement and stability issues.
Takanini Road/Rail Grade-Separation Investigation Traffic Report (Beca, 2007)	Bridge (road-over-rail) option only	Focus of these reports was on identifying the combination of crossings which should be grade-separated rather than the form of options – both assumed road-over-rail bridges.
Takanini / Ōpaheke / Drury / Karaka Integrated Transport and Land Use Strategy (Urbanism Plus, 2014)	Bridge (road-over-rail) option only	
Rail Crossing Grade-Separation Feasibility Study (Aurecon, 2014)	Three options were assessed at a high level for Walters Road, Taka Street, and Manuroa Road: • Road-over-rail; • Rail-under-road; and • Combination of road-over-rail and rail-under-road.	Options were assessed using a range of criteria including online impacts (for road and rail), impacts on surrounding areas and properties, and a range of construction impacts including complexity and disruption, costs, and construction duration. For all three locations, the road-over-rail option was favoured, and were scored more favourably on all construction-related criteria; as well as on rail impacts. However, they were scored less favourably for road impacts and for impacts on surrounding properties. The study also noted that in the Walters Road location, access to the town centre needed to be considered for a road-over-rail option in future work.
Transport for Future Urban Growth (Urbanism Plus, 2016)	Bridge (road-over-rail) option only	Focus of this report was on identifying the combination of crossings which should be grade-separated rather than the form of options – both assumed road-over-rail bridges.
Level Crossing Removal Options Investigation – Walters Road (Rail Infrastructure Consultants, 2016)	1A – Road-over-rail bridge 1B – Road-under-rail bridge 1C-1F – Road offline alternatives	Option 1A considered relatively straightforward from an engineering perspective – main concerns relate to property impacts and visual effects. Option 1B not preferred on basis that it had difficult challenges related to underground structure and drainage from an engineering perspective, property impacts, but reduced visual effects. Various offline options not preferred on basis of increased property impacts.
South Indicative Business Case (Te Tupu Ngātahi, 2019)	Bridge (road-over-rail) option only	Focus of the IBC was on identifying the combination of crossings which should be grade-separated rather than the form of options – assumed road-over-rail bridges.

From the above summary, it can be seen that two of the seven studies directly compared road-over-rail bridges with road-under-rail underpasses, and both identified preferences for bridges. Of the remaining studies, bridges were assumed as a basis for either feasibility assessment or scenario-based network optioneering seeking to identify the number and location of crossings rather than their physical form. Given these limitations, further work on road grade change options was undertaken through the DBC process.

6.3.2 Further DBC analysis

The design parameters for the development of options for road grade changes in the DBC are summarised in Table 6-5. These parameters are applicable to both road-over-rail and road-under-rail options.

Table 6-5 - Road grade change design parameters

Parameter	Value
Typical road cross-section (derived from corridor form and function assessment summarised in 5.4 above)	24m mainline; 18m for bridge or underpass sections
Horizontal clearance envelope	28.8m minimum (for NIMT four-tracking)
Maximum span (bridge only)	35m
Vertical clearance	Bridge – 7.8m from ground level to road surface (incorporating 5.5m rail vertical clearance) Underpass – 7.5m from underpass centreline to rail track (incorporating 6m road vertical clearance)
Design speed	50km/h
Vertical grades	Desirable maximum grade of 8%; minimum of 0.5%
Minimum crest curve	K = 6.8
Minimum sag curve	K = 6

Road-over-rail bridge and road-under-rail underpass options were developed based on these parameters. As with the rail grade change options, the road bridge and underpass options were assessed at a high-level using Waka Kotahi's EAST assessment tool. The results of this assessment are summarised in Table 6-6.

Table 6-6 - Summary of EAST assessment for road grade change options

Criterion	Subcriterion	Road-over-rail bridge	Road-under-rail underpass
Investment objectives		4 (positive)	4 (positive)
Practical feasibility	Technical	4 (complex)	5 (complex)
	Safety and design	2	2
	Consentability	3	4 (complex)
Scheduling / programming		0-2 years	2-5 years
Cost		>$50m	>$50m
Key risks and uncertainties		High construction cost and complexity expected, although the	High construction cost and complexity expected – less than

Criterion	Subcriterion	Road-over-rail bridge	Road-under-rail underpass
		least costly and complex of the four forms of grade-separation.	rail grade change options but more than a road-over-rail bridges.
Climate change	Mitigation	Reduce – (i.e. anticipated to result in fewer enabled emissions / VKT)	
	Adaptation	Uncertain – not yet assessed.	
Environment and social responsibility	Key risks	Landscape and visual impacts on surrounding environment, construction disruption.	Groundwater settlement risk, significant construction disruption, and CPTED concerns.
	Can risks be mitigated / how?	Yes – bridge height may be commensurate with surroundings in the future environment given NPS-UD and MDRS, construction method will need to minimise disruption as much as possible.	Yes – groundwater treatment required careful design to ensure safety for active modes (passive surveillance), construction method will need to minimise disruption as much as possible.
Fatal flaws		None identified	None identified
Summary of recommendation		Progress as interim preferred form for purpose of scenario-based network optioneering.	Not preferred but not yet discounted – no fatal flaw identified, but option not preferred given greater cost and construction disruption anticipated compared with a bridge.

6.3.3 Conclusion

Based on the above assessment, a road-over-rail bridge was identified as the interim preferred form option for the purpose of informing subsequent scenario-based network optioneering.

6.4 Interim preferred physical form of grade separation

This interim assessment of options for the physical form of grade separation documented through section 6 consider all four broad options for how road-rail grade-separation can be achieved – raising and lowering of the rail and raising and lowering of the road. The results of the assessment are summarised below.

Table 6-7 - Interim preferred physical form of grade separation – summary of assessment outputs

Option	Recommendation	Summary of commentary
Rail-over-road viaduct	Not progress	• Rail gradients require 1km of ramping to achieve required vertical clearances. • Not possible to grade-separate at Spartan Road given proximity of SH1 interchange and Papakura Stream. • 3.7km structure needed to clear three level crossings – only Walters Road could be done in isolation. • Highest construction disruption, visual effects (in the case of a viaduct), and costs – **hence not progressed prior to further assessment.**
Rail-under-road trench	Not progress	

Option	Recommendation	Summary of commentary
Road-over-rail bridge	Preferred / progress as interim preferred form	• Key geometric parameters – gradients, clearances over rail, bridge deck width, ability to future-proof for four-tracking. • Need to maintain access to adjacent properties via access lanes. • Achieves investment objectives and is anticipated to have the least construction complexity, costs, risks, and impacts. • **Preferred through this assessment / progressed as the interim preferred form** for the purpose of scenario-based network optioneering – to be retested through MCA.
Road-under-rail underpass	Not preferred / not discounted	• Similar geometric parameters to a bridge. • Higher costs, complexity, risk, resilience concerns compared with a bridge. • Likely greater construction disruption compared with a bridge. • **Not preferred / not discounted in this assessment** – to be retested through MCA (see section 8).

Two important caveats are noted at this point in the process:

- The road-over-rail bridge option preferred through this assessment was adopted as the basis for network optioneering – in other words, the options for different combinations and locations of grade-separations are assumed in network optioneering (see section 7) to be road-over-rail bridges. However, it is noted that locational choices for road crossings in this subsequent optioneering are not dictated by whether the physical form of the crossing is a bridge or underpass. The only form options that have not been progressed at this point are rail grade changes, meaning that all subsequent optioneering looks at east-west road grade changes, and not north-south rail grade changes; and
- As noted at section 6.1 above, this interim preference for the physical form of grade-separation will be retested in greater detail following network optioneering assessment (see sections 8 and 9). In other words, the number and location of grade-separations will be confirmed before the form is confirmed.

7 Network Optioneering

7.1 Context

Following on from the initial consideration of physical form, the network optioneering stage of assessment broadly sought to confirm the preferred number and location of interventions for the TLC. As noted at section 3.3.1, this was undertaken through a scenario development approach in which 'options' assessed comprised different combinations of network interventions (i.e. grade separations, level crossing closures, or entirely new crossings).

The outcomes of the gap analysis (discussed in section 5 above) informed the direction of the network optioneering process. In particular, the gap analysis pointed towards the need for at least three east-west connections in the TLC network; and for at least one of those to provide access to and from the Takaanini industrial area. Moreover, the initial consideration of physical form (discussed at section 6 above) indicated that grade separation would be undertaken via road grade changes rather than rail grade changes, most likely by road-over-rail bridges (to be confirmed subsequently in sections 8 and 9).

On this basis, network optioneering to determine the preferred number and location of east-west connections was undertaken sequentially in the following parts:

- **Part One: Industrial Area Assessment** – focused on identifying an appropriate east-west connection for the Takaanini industrial area; and
- **Part Two: South of Industrial Area Assessment** – identifying the remaining east-west connections required to serve the remainder of Takaanini to the south of the industrial area.

Figure 7-1 shows the general extents for the Part One and Part Two assessments.

7.2 Part One: Industrial area assessment

7.2.1 Option Development

Part One of the assessment focused on providing access to and from the Takaanini industrial area. It considered the area bound by Manuroa Road (southernmost east-west access to the industrial area) and the northern extent of the industrial area (refer to Figure 7-1).

As summarised in section 2, the ISTN was the starting point for the development of scenarios to be tested. With only one east-west connection required to serve the industrial area (as per the outcomes of the gap analysis, refer to Section 5), the IBC recommendation to grade separate Taka Street and Walters Road was adopted as an underlying assumption across all scenarios assessed in Part One. As such, the Part One assessment focussed on testing Rangi Road, Spartan Road, and Manuroa Road as the potential connections for the industrial area (see Figure 7-1).

Three scenarios were developed and assessed, testing each of Rangi, Spartan, and Manuroa Roads in the network (see Table 7-1 and Figure 7-2). Each option was developed to follow the following high level design parameters:

- 24m corridor width (two lanes) with active mode facilities (following CFAF assessment as described in Section 3.2.2.2);
- Maximum vertical grade of 8%;

- Vertical clearance of 7.8m over the NIMT; and
- Posted speed limit of 50km/h.

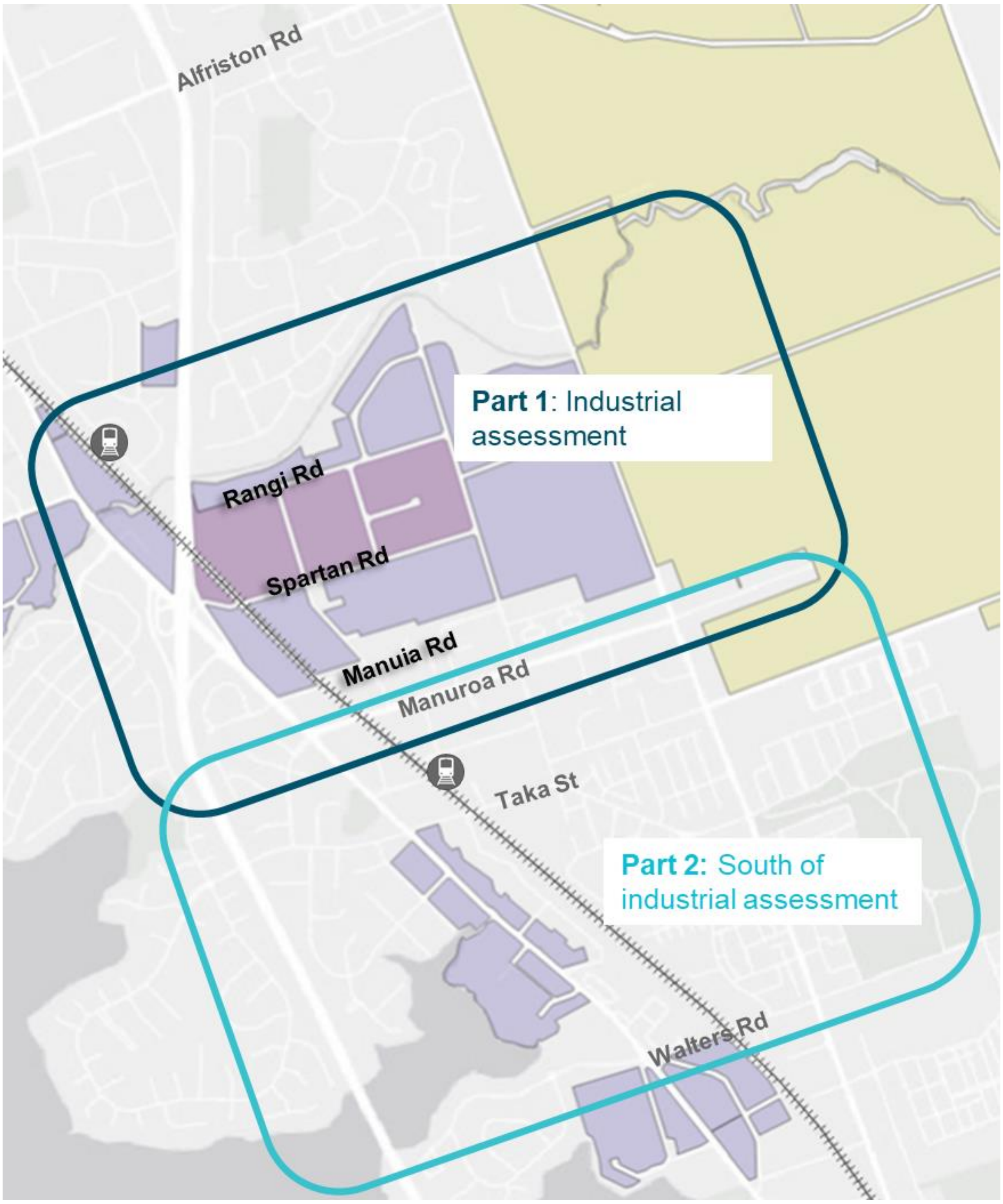


Figure 7-1 - High-level network optioneering assessment extents

Table 7-1 - Part One: Industrial Assessment – Network Scenarios

East-West Crossings	Scenarios		
	Scenario 1: IBC Recommended (Rangi Road)	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Alfriston Road (Existing)*	**Open**	**Open**	**Open**
Rangi Road	**Open**	**N/A**	**N/A**
Spartan Road	**Closed**	**Open**	**Closed**
Manuroa Road	**Closed**	**Closed**	**Open**
Taka Street	**Open**	**Open**	**Open**
Walters Road	**Open**	**Open**	**Open**

Figure 7-2 - Locations of potential grade-separated crossings at Rangi Road (option 1), Spartan Road (option 2), and Manuroa Road (option 3)

7.2.2 Option Assessment

Following the methodology outlined in section 3.3.1, the above scenario options were assessed using the MCA Framework. Table 7-2 summarises the assessment outcomes.

Table 7-2 - Summary of Part One Industrial Area MCA assessment

Criteria	Scoring		
	Scenario 1: IBC Recommended (Rangi Road)	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Investment Objective 1: Safety			
Investment Objective 2: Travel Choice			
Investment Objective 3: Resilience			
Investment Objective 4: Access			
Land Use Futures			
Urban Design			
Land Requirement			
Social Cohesion / effects			
Human Health and Wellbeing			
Transport system integration			
User safety			
Ecology			
Historic Heritage			
Landscape / Visual			
Stormwater			
Natural Hazards			
Construction impacts on utilities / infrastructure			
Construction disruption			
Construction costs / risk			

The key findings from the MCA assessment for each network scenario are summarised in Table 7-3.

Table 7-3 - Key findings from Part One Industrial Assessment MCA

Network Scenario	Key findings
Scenario 1 (Rangi Road)	• Performed well against the investment objectives, transport system integration, and user safety criteria. • Scored moderate to highly adverse for landscape/visual, urban design, stormwater, and construction. • Structure would require sufficient clearance of various constraints in the area such as nationally significant electricity transmission infrastructure, the SH1 Takaanini interchange, the NIMT, and the Papakura Stream. The resultant scale of the structure

Network Scenario	Key findings
	would be significant, would be difficult to integrate with the surrounding environment, and would involve a larger amount of impervious surface. • Disruption of the Takaanini interchange during construction was also anticipated and minimising impact on the Papakura Stream was considered a potential challenge. • Anticipated to have the highest capital and embodied carbon cost of all the scenarios. • Overall, the potential high adverse effects of the Rangi Road bridge structure were considered to outweigh the strategic transport benefits of the option.
Scenario 2 (Spartan Road)	• Did not perform as well as the other scenarios against investment objective two (providing travel choice) due to the surrounding land use. • In the event Spartan Road was grade-separated, the current restriction on right turns onto Great South Road would remain. Accordingly, traffic (including heavy industrial traffic) would be diverted southwards to Taka Street given that Manuroa Road is closed in this scenario. The option was therefore scored as highly adverse for human health and wellbeing due to the likely diversion of heavy vehicles and industrial traffic into a more sensitive, predominantly residential context south of the industrial area. • Overall, grade separation at Spartan Road would either need a complementary solution (i.e., a second access to the industrial area that allows right turning out to Great South Road), an acceptance that industrial traffic would use residential routes, or an acceptance of riskier manoeuvres undertaken at the interchange by north-bound traffic, • Option was also identified as likely having construction challenges and complexities. The Spartan Road context is particularly constrained by the location of the SH1 off-ramp which would necessitate a novel structure (i.e. such as a spiral bridge so as not to interfere with the Takaanini interchange) or deviation from typical engineering structure (i.e., acceptable grades for active modes and/or vehicular traffic) to avoid reconstruction of the SH1 off-ramp. • Overall, an option at Spartan Road was considered unlikely to achieve the full-movement requirements expected of a fundamental east-west connection in the network and could not maximise positive transport outcomes compared to the investment required and adverse effects on the receiving environment.
Scenario 3 (Manuroa Road)	• In this scenario there would be greater reliance on Manuroa Road, as the main east-west connection for traffic out of the industrial area due to the closure of Spartan Road and would be expected to provide for not only northbound traffic but also southbound traffic. As such, an increase in heavy vehicles into a predominantly residential context could be anticipated. • Risks associated with diversion of heavy traffic noted at the Takaanini Train Station and various early childcare centres (**ECE**) in the vicinity of Manuroa Road. It was also considered that the anticipated increase of industrial traffic into a more sensitive receiving environment could potentially be negatively received by the community and stakeholders. • Accordingly, this scenario was also not required, and would likely require a complementary solution.

Overall, all three scenarios assessed had significant adverse effects and a clear preferred scenario could not be identified. Therefore, the Project Team determined that alternative options should be further explored before complementary options to the above scenarios were considered.

7.2.3 Further Option Development

With no clear preferred scenario between Scenarios 1 to 3 (as described in section 7.2.2 above), further possible alternatives between Papakura Stream and Manuroa Road were explored (refer to Figure 7-3 below). The potential corridor options and subsequent scenarios developed still needed to consider that the purpose of the Part One assessment is to identify a connection for the Takaanini industrial area. Thus, the background assumptions for the previous scenarios remain (i.e., Taka Street and Walters Road are open).

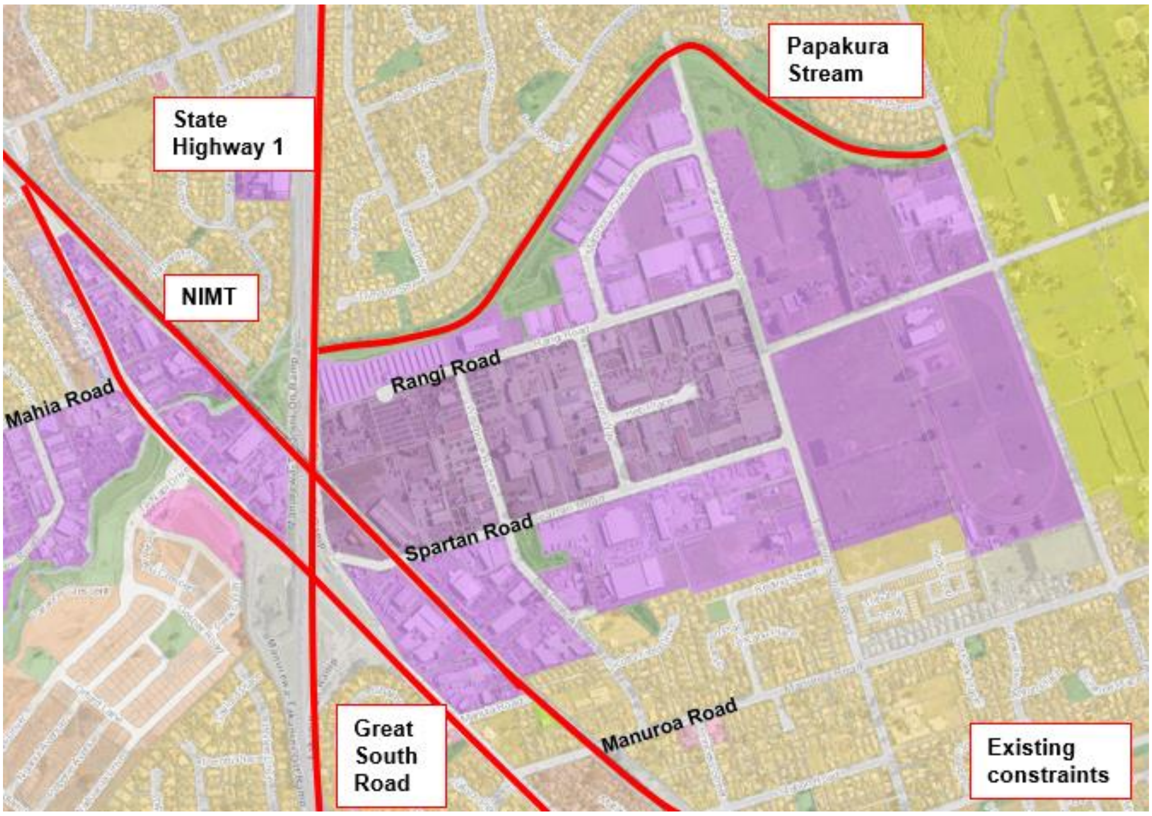


Figure 7-3 - Extent of additional option development for Part One Industrial Assessment

To limit the further options to be assessed, options that do not resolve the effects identified in the initial Part one assessment were not considered. These included any connection:

- Over SH1 as this will have similar anticipated effects as the Rangi Road scenario;
- To Great South Road via the existing Spartan Road as this will have little difference to the Spartan Road scenario; and
- From Manuroa Road onto Great South Road via a different alignment and will still result in industrial traffic diverting through the residential area.

The options developed are illustrated in Figure 7-4 and described in Table 7-4 - Part One Industrial assessment - additional option descriptions below. Each option was developed to the following design parameters:

- 24m corridor width (two lanes) with active mode facilities (following CFAF assessment as described in section 3.2.2.2);
- Maximum vertical grade of 8%;
- Vertical clearance of 7.8m over the NIMT;
- Posted speed limit of 50km/h; and
- Horizontal curve minimum radii of 120m.

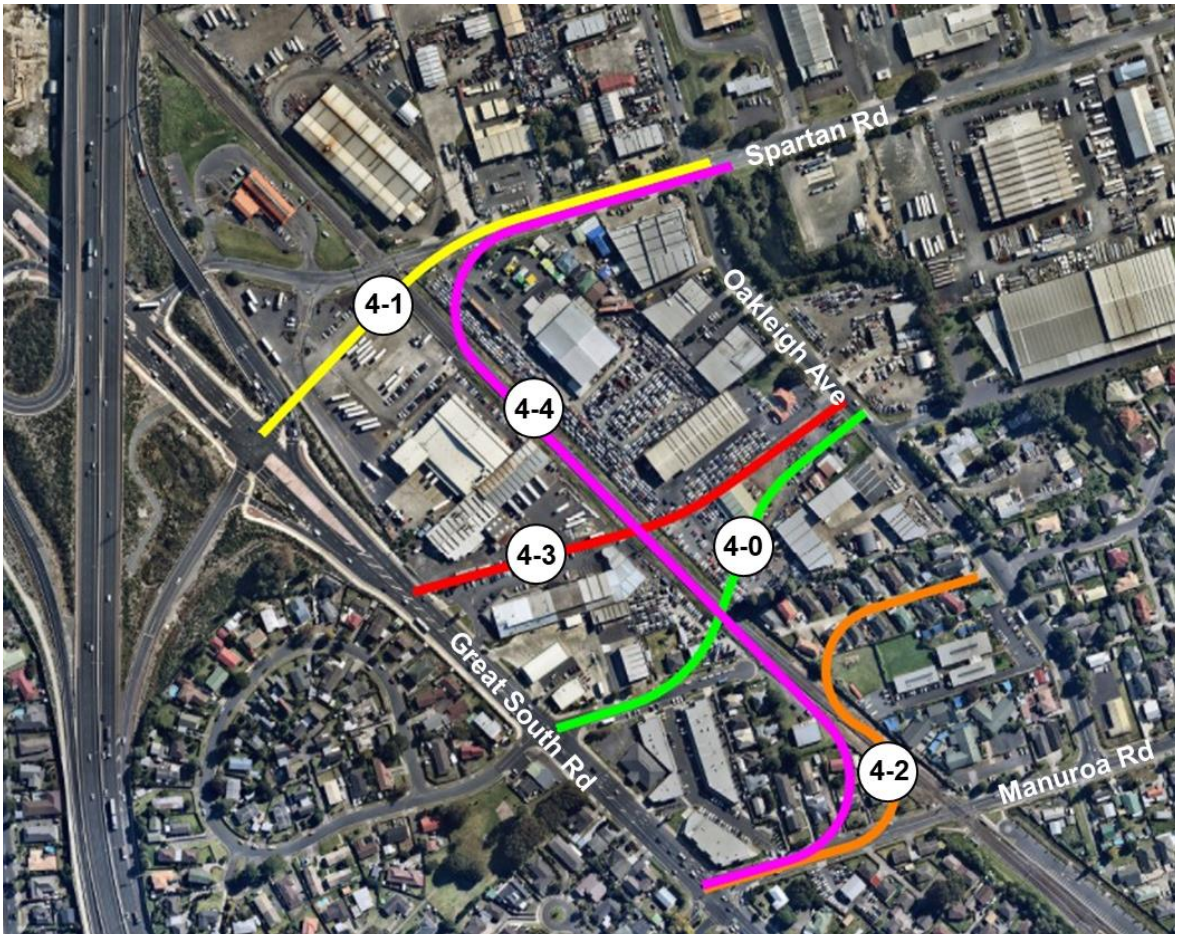


Figure 7-4 - Part One Industrial Assessment - additional options developed

Table 7-4 - Part One Industrial assessment - additional option descriptions

No.	Option	Description
4-0	Connection using Manuia Road	Connection from Oakleigh Avenue through to Manuia Road and onto Great South Road (**GSR**) to reduce industrial / heavy traffic through residential area.
4-1	Option to connect to SH1 off-ramp intersection	Spartan Road alternative to resolve turn restriction issue with existing intersection with GSR. Intersection with GSR is moved and consolidated with SH1 southbound (**SB**) offramp (exact arrangement to be determined during route refinement).
4-2	Manuroa Road to Portrush Lane	Portrush Lane to Manuroa Road (west) to reduce industrial/heavy traffic through residential zoning. Involves a lengthened structure located over the NIMT corridor. Maintains existing intersection with GSR and Oakleigh Avenue.
4-3	Connection from Hitchcock Road to Great South Road	New road alignment through industrial zone at interface with SH1 interchange. New intersection with GSR and Oakleigh Avenue.
4-4	Manuroa Road to Spartan Road	Spartan Road to Manuroa Road (west) to maintain Spartan Road as industrial/heavy traffic through route. Maintains existing intersection with GSR and Spartan Road alignment. Involves a lengthened structure located over the NIMT corridor. Maintains existing intersection with GSR and Oakleigh Avenue.

Table 7-5 - Part One industrial assessment – network scenarios

East-West Crossings	Scenarios				
	Scenario 4-0	Scenario 4-1	Scenario 4-2	Scenario 4-3	Scenario 4-4
Alfriston Road (Existing)*	Open	Open	Open	Open	Open
Rangi Road	N/A – Does not currently exist and is not proposed in these options.				
Spartan Road	Closed	Closed	Closed	Closed	Closed
Manuroa Road	Closed	Closed	Closed	Closed	Closed
Connection 4-0	Open	N/A	N/A	N/A	N/A
Connection 4-1	N/A	Open	N/A	N/A	N/A
Connection 4-2	N/A	N/A	Open	N/A	N/A
Connection 4-3	N/A	N/A	N/A	Open	N/A
Connection 4-4	N/A	N/A	N/A	N/A	Open
Taka Street	Open	Open	Open	Open	Open
Walters Road	Open	Open	Open	Open	Open

7.2.4 Further Option Assessment

Following the methodology outlined in section 3.3.1, the five additional options were assessed using the MCA Framework. Table 7-6 summarises the assessment outcomes.

Table 7-6 - Summary of Part One Industrial Area – additional options MCA assessment

Criteria	Scoring				
	4-0	4-1	4-2	4-3	4-4
Investment Objective 1: Safety					
Investment Objective 2: Travel Choice					
Investment Objective 3: Resilience					
Investment Objective 4: Access					
Land Use Futures					
Urban Design					
Land Requirement					
Social Cohesion / effects					
Human Health and Wellbeing					
Transport system integration					

Criteria	Scoring				
	4-0	4-1	4-2	4-3	4-4
User safety					
Ecology					
Historic Heritage					
Landscape / Visual					
Stormwater					
Natural Hazards					
Construction impacts on utilities / infrastructure					
Construction disruption					
Construction costs / risk					

The Project Team reviewed and compared the scenarios and in summary identified that:

- **Scenario 4-0,** connection using Manuia Road, performed the best against the investment objectives. It also performed the best for the transport criteria, transport system integration, and user safety. This scenario was also anticipated to have only low to very low adverse impacts;
- **Scenario 4-3,** connection from Hitchcock Road to Great South Road performed similarly well against the investment objectives as Scenario 4-0, though scoring slightly less for Investment Objective 3. This is due to Scenario 4-3 being within a closer proximity to the interchange, thus increasing the likelihood of vehicles queuing back to the interchange and consequently impacting the state highway. It is anticipated to have only low to very low adverse impacts; and
- **Scenarios 4-1, 4-2 and 4-4** scored highly adverse on at least one criterion. Scenario 4-1 was anticipated to have high construction disruptions due to the connection to the state highway off-ramp. Scenario 4-2 restricts and impacts the potential for future rail expansion due to its parallel alignment with the NIMT, and consequently scores poorly for construction impacts on utilities / infrastructure. This was also the case for Scenario 4-4 which in addition scored highly adverse for stormwater due to the extensive new pavement required generating large water quality effects.

Overall, the assessment identified that Scenario 4-0 and Scenario 4-3 could deliver the outcomes sought in providing for industrial traffic without diversion through the residential area. Both scenarios did not have any anticipated highly adverse effects unlike the other additional scenarios, or the previous scenarios assessed. However, as Scenario 4-0 with the connection at Manuia Road would be located further away from the Takaanini interchange it was considered to provide slightly greater network resilience and greater traffic benefits. Accordingly, Scenario 4-0 is the preferred scenario.

7.2.5 Outcome of Part One Assessment

The Part One assessment has focused on providing access to and from the Takaanini industrial area. A total of eight options were assessed in two stages (see sections 7.2.2 and 7.2.4). From this assessment, **the emerging preferred option for this part of the network was identified as Scenario 4-0 – Manuia Road**.

7.3 Part Two: South of the industrial area

The Part Two assessment comprised two sub-parts:

- First a transport network review was undertaken to understand the requirements for east-west connectivity south of the industrial area in light of the outcomes of the Part One assessment. The assessment involved sensitivity testing Walters Road as one of the three east-west connections and whether there were any other alternative options to consider between Taka Street and Subway Road; and
- A subsequent assessment was undertaken to understand what was required to complete the rest of the network between Manuroa Road and Taka Street.

The assessment undertaken for each sub-part are discussed in the following sections.

7.3.1 Connections between Taka Street and Subway Road – option development

The Part One assessment identified Manuia Road as the preferred connection for the industrial area. The Manuia Road option effectively replaces the Rangi Road connection identified in the ISTN. A transport network review was subsequently undertaken to establish whether the other IBC recommendations of closing Manuroa Road and grade-separating both Taka Street and Walters Road remained valid in light of the outcomes of the Part One assessment.

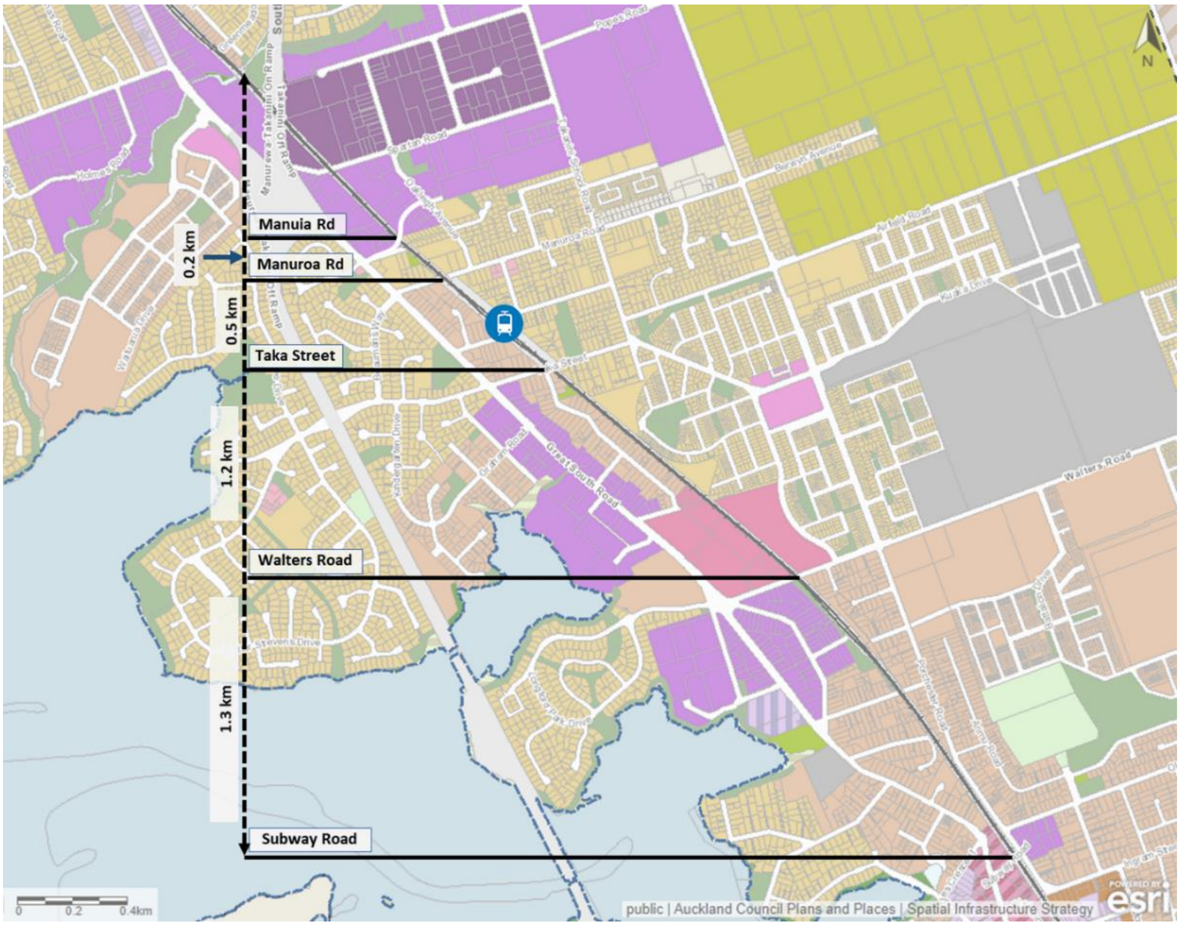


Figure 7-5 - East-west crossings in the existing Takaanini network

The transport network review initially identified that:

- The distance between Walters Road and the adjacent east-west crossing across the NIMT is 1.3km to the south at Subway Road and 1.2km to the north at Taka Street. Removing Walters Road from the network would result in a significant gap in the east-west connectivity (refer to Figure 7-5); and
- Tironui Road pedestrian level crossing located approximately 300m south of Walters Road is anticipated to be removed as part of Auckland Transport's pedestrian level crossing programme. Walters Road is planned to be the alternative route for active mode users.

It was therefore established that an east-west crossing between Taka Street and Subway Road would be required for optimum east-west accessibility for the community, noting that locating a crossing too close to Taka Street or Subway Road would still leave a gap in the network (see Figure 7-5). Based on these connectivity considerations, five options in addition to the existing Walters Road alignment were developed for assessment (see Figure 7-6).

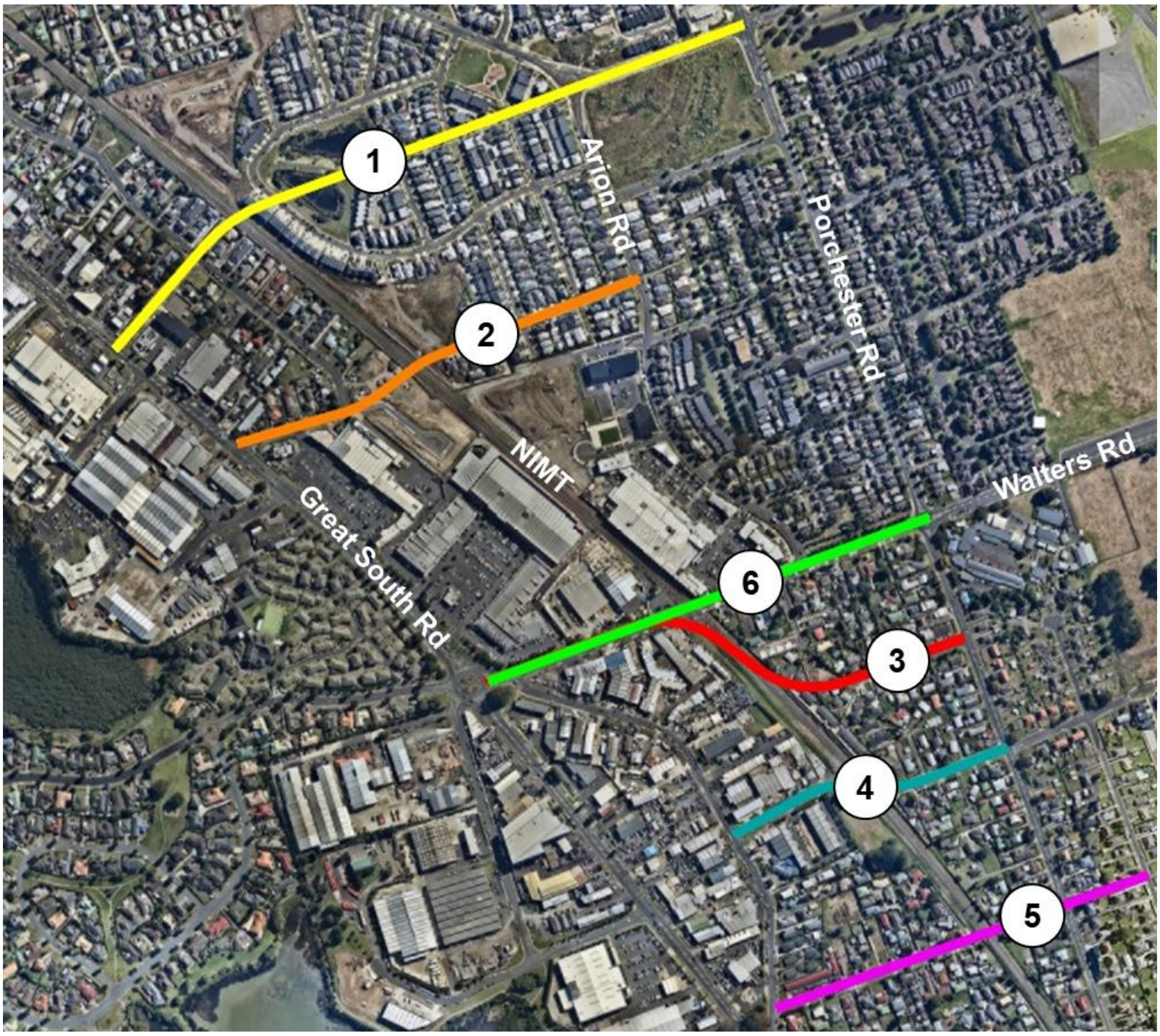


Figure 7-6 - Options between Taka Street and Subway Road

Table 7-7 - Description of options between Taka Street and Subway Road

No.	Option	Description
1	Kauri Heart Avenue	Connects Porchester Road to GSR via Kauri Heart Avenue, Taukari Road and Beach Road
2	Glenora Road to Kapia Drive	Connects Arion Road to GSR via Kapia Drive and Glenora Road
3	Glenburn Place	Connects Walters Road to Porchester Road via Glenburn Place
4	Tironui Station Road	Connects the two ends of Tironui Station Road
5	Waterview Road	Connects the two ends of Waterview Road
6	Walters Road	Grade separation of Walters Road

Table 7-8 summarises the wider network assumed for each of the above options having regard to the outputs of the Part One assessment.

Table 7-8 - Network scenarios for options between Taka Street and Subway Road

East-West Crossings	Scenarios					
	Option 1 (Kauri Heart Avenue)	Option 2 (Glenora to Kapia)	Option 3 (Glenburn Place)	Option 4 (Tironui Station Road)	Option 5 (Waterview Road)	Option 6 (Walters Road)
Alfriston Road (Existing)*	**Open**	**Open**	**Open**	**Open**	**Open**	**Open**
Spartan Road	**Closed**	**Closed**	**Closed**	**Closed**	**Closed**	**Closed**
Manuia Road	**Open**	**Open**	**Open**	**Open**	**Open**	**Open**
Manuroa Road	**Closed**	**Closed**	**Closed**	**Closed**	**Closed**	**Closed**
Taka Street	**Open**	**Open**	**Open**	**Open**	**Open**	**Open**
Connection 1	**Open**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Connection 2	**N/A**	**Open**	**N/A**	**N/A**	**N/A**	**N/A**
Connection 3	**N/A**	**N/A**	**Open**	**N/A**	**N/A**	**N/A**
Connection 4	**N/A**	**N/A**	**N/A**	**Open**	**N/A**	**N/A**
Connection 5	**N/A**	**N/A**	**N/A**	**N/A**	**Open**	**N/A**
Connection 6 (Walters Road)	**Closed**	**Closed**	**Closed**	**Closed**	**Closed**	**Open**

7.3.2 Connections between Taka Street and Subway Road – option assessment

The options summarised in Tables Table 7-7and Table 7-8 were assessed using the MCA Framework. The outcomes of the assessment are summarised in Table 7-9 below.

Table 7-9 - Summary of MCA assessment for options between Taka Street and Subway Road

Criteria	Scoring					
	Option 1 (Kauri Heart Avenue)	Option 2 (Glenora to Kapia)	Option 3 (Glenburn Place)	Option 4 (Tironui Station Road)	Option 5 (Waterview Road)	Option 6 (Walters Road)
Investment Objective 1: Safety						
Investment Objective 2: Travel Choice						
Investment Objective 3: Resilience						
Investment Objective 4: Access						
Land Use Futures						
Urban Design						
Land Requirement						
Social Cohesion / effects						
Human Health and Wellbeing						
Transport system integration						
User safety						
Ecology						
Historic Heritage						
Landscape / Visual						
Stormwater						
Natural Hazards						
Construction impacts on utilities / infrastructure						
Construction disruption						
Construction costs / risk						

The Project Team reviewed and compared the scenarios and in summary identified that:

- **All scenarios** performed well against the investment objectives as grade separation would improve safety, provide travel choice benefits through dedicated walking and cycling facilities and increased network resilience. **Scenarios 3 and 6** performed best against the access investment objective as all other corridor options reduced the connectivity to the Town Centre on Walters Road, severing neighbourhood connectivity;
- **All scenarios** were anticipated to have high adverse impact for construction costs /risk / value capture due to the potential construction complexity. However, it was anticipated that these effects and construction challenges could be mitigated through further design refinements;

- Similarly, **all scenarios** were anticipated to have high adverse impact for natural hazards due to the peat ground conditions and potential settlement effects that would need to be considered. However, these challenges and the potential associated adverse effects were also anticipated to be able to be mitigated through further design refinements;
- **Scenario 1** was anticipated to have very high adverse impact against stormwater as it would pass through two newly constructed wetlands that are designed to manage the runoff from nearby residential comprehensive development. Given the high adverse impact, Scenario 1 was not progressed on this basis.
- **Scenarios 2, 4 and 5** were not preferred as the corridor options were anticipated to have high adverse effect on human health and wellbeing due to additional traffic being diverted through residential areas. These diversions could be avoided with the corridor options in Scenarios 3 and 6; and
- **Scenarios 3 and 6** were anticipated to have similar benefits and effects due to both providing access to the Town Centre on Walters Road and minimising diversion through residential areas. However, Scenario 6 would better integrate with the transport system being an existing road and thus less human health and wellbeing effects and stormwater impact due to less new pavement required. It was also preferred from an urban design perspective as it is better aligned with the surrounding land use and potentially provides a stronger and legible east-west link.

Given the above, **Scenario 6 (Walters Road) was identified as the preferred option** for the area between Taka Street and Subway Road.

7.3.3 Connections between Manuroa Road and Taka Street – option development

Network optioneering to this point has confirmed that Manuia Road (see section 7.2.5) and Walters Road (see section 7.3.2) are two of the three east-west connections required – Manuia Road would be the northernmost crossing serving the Takaanini industrial area, and Walters Road would be the southernmost crossing within the TLC extent. Hence, a crossing between Manuia Road and Walters Road was the final part of the network to be assessed.

Taking the same approach as previous assessments, three scenario options were developed for the combination of replacement and / or closure of Manuroa Road and Taka Street (see Table 7-10 and Figure 7-7).

Table 7-10 - Network scenarios for options between Manuroa Road and Taka Street

East-West Crossings	Scenarios		
	Option 1 Manuroa Road Only	Option 2 Taka Street Only	Option 3 both Manuroa and Taka
Alfriston Road (Existing)	**Open**	**Open**	**Open**
Spartan Road	**Closed**	**Closed**	**Closed**
Manuia Road	**Open**	**Open**	**Open**
Manuroa Road	**Open**	**Closed**	**Open**
Taka Street	**Closed**	**Open**	**Open**

East-West Crossings	Scenarios		
	Option 1 Manuroa Road Only	Option 2 Taka Street Only	Option 3 both Manuroa and Taka
Walters Road	**Open**	**Open**	**Open**

Figure 7-7 - Options between Manuroa Road and Taka Street (N.B. Options 5, 6, and 7 in the figure correspond with options 1, 2, and 3 in the text.

7.3.4 Connections between Manuroa Road and Taka Street – option development

The three options for connections between Manuroa Road and Taka Street were assessed using the MCA framework. The assessment outcomes are summarised in Table 7-11 below.

Table 7-11 - Summary of MCA assessment for options between Manuroa Road and Taka Street

Criteria	Scoring		
	Option 1 Manuroa Road Only	Option 2 Taka Street Only	Option 3 both Manuroa and Taka
Investment Objective 1: Safety			
Investment Objective 2: Travel Choice			
Investment Objective 3: Resilience			
Investment Objective 4: Access			
Land Use Futures			
Urban Design			
Land Requirement			
Social Cohesion / effects			
Human Health and Wellbeing			
Transport system integration			
User safety			
Ecology			
Historic Heritage			
Landscape / Visual			
Stormwater			
Natural Hazards			
Construction impacts on utilities / infrastructure			
Construction disruption			
Construction costs / risk / value capture			

The Project Team reviewed and compared the scenarios and in summary identified that:

- **Option 3** scored the best in the transport criteria and performed the strongest against all the investment objectives. However, it was also anticipated to have the greatest adverse effects given that two bridge structures would be involved. This included enabled and embodied carbon as with more road capacity provided, the more traffic likely to be induced. The scenario was considered more impactful and requiring more investment for minimal added benefits compared to what could be achieved in Scenario 2 (with one connection);
- **Option 1** was the least preferred from an investment objective perspective, especially around resilience, due to its proximity to the Manuia Road intersection. The Manuroa Road connection could impact intersection operations with potential of impacting the Takaanini interchange; and
- **Option 2** scored more favourably than Scenario 3 against the investment objectives and was the preferred scenario for Land Use Futures and Social Cohesion criteria. This is anticipated to have less land requirements and the least adverse effects of all three scenarios. Overall, it was

considered that this scenario would still achieve positive transport outcomes and provide for its anticipated function in the network, without having as much impact as Scenario 7.

Given the above, **Option 2 (Taka Street) was identified as the preferred option** for the area between Manuroa Road and Taka Street.

7.4 Active mode connectivity

The combination of assessments undertaken in Parts One and Two of network optioneering (documented above in sections 7.2 and 7.3) has resulted in the following three multi-modal grade-separated connections being recommended as part of the TLC network:

- Manuia Road;
- Taka Street; and
- Walters Road.

The resultant wider network scenario is summarised in Table 7-12.

Table 7-12 - Emerging preferred network following Part One and Part Two assessments

East-West Crossings	Scenario 6
Alfriston Road (Existing)	**Open** (existing grade-separated and part of Takaanini FTN route)
Spartan Road	**Closed** (existing level crossing to be closed)
Manuia Road	**Open** (new grade separation over the NIMT where there is no existing level crossing)
Manuroa Road	**Closed** (existing level crossing to be closed)
Taka Street	**Open** (existing level crossing over the NIMT to be grade separated)
Walters Road	**Open** (existing level crossing over the NIMT to be grade separated)

In the scenario above, Spartan Road and Manuroa Road would be fully closed with no provision for east-west movements across the NIMT for any mode of transport. It was considered at this point that there may be merit in considering whether active mode connections should be provided at these locations.

A transport assessment was undertaken which explored several factors to understand whether active mode connections would be needed in these locations. This included an understanding of the spacing between the east-west active mode connections with both Spartan Road and Manuroa Road included and excluded in the active mode network (see Figure 7-8). Table 7-13 summarises the transport assessment findings for active mode demand at each location.

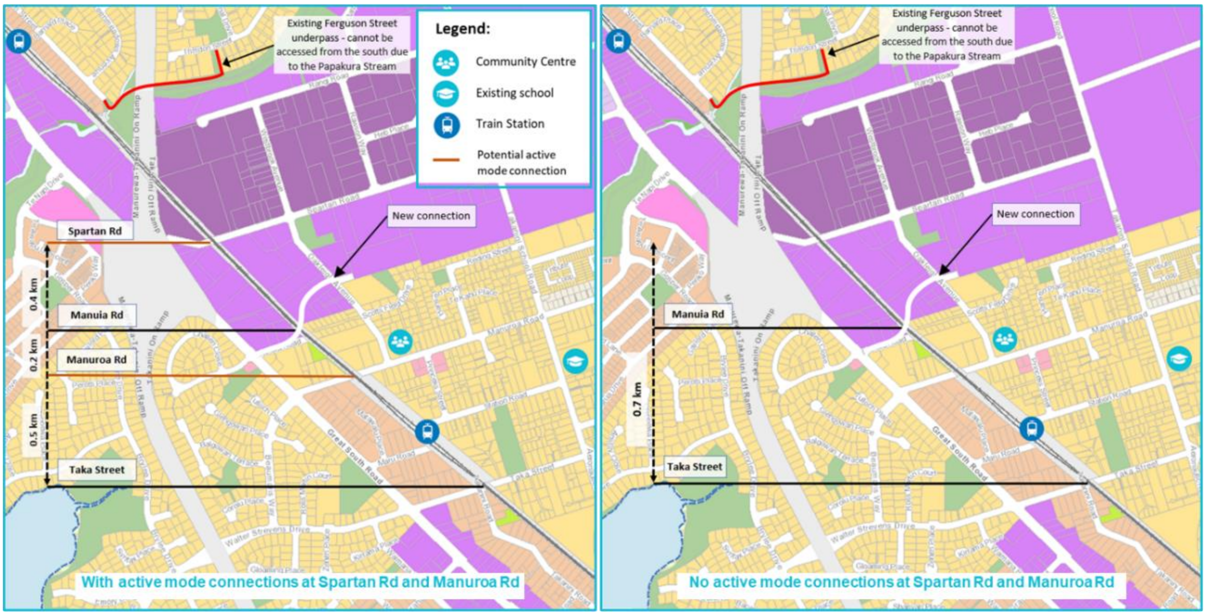


Figure 7-8 - East-west active mode connections with Spartan Road and Manuroa Road included and excluded in the network

Table 7-13 - Summary of active mode transport assessment findings

Factors explored in assessment	Spartan Road	Manuroa Road
Land use	Business – Heavy Industry or Business – Light Industry Zone Expected to remain industrial with the potential to intensify in the future. This would indicate an increase in walking and cycling demand for this east-west connection in the future.	Residential – Mixed Housing Suburban or Residential – Mixed Housing Urban Zone A childcare centre, neighbourhood centre, community centre, Takaanini School and Takaanini Train Station are in the vicinity of the existing level crossing. This indicates a need for a walking and cycling connection at this location so people can easily access the community centre and facilities within the vicinity. It is also expected that the land use surrounding the Takaanini Station may intensify due to emerging policies around the NPS-UD and the MDRS. This would further increase the need for an active mode connection at Manuroa Road in the future.
Connectivity	Current facilities: Footpaths on both sides of the corridor. No existing cycling facilities. Future facilities: Western section of Spartan Road connects with GSR which is expected to have separated walking and cycling facilities on both sides of the corridor. A Spartan Road active modes bridge would enable connectivity to the Southern Path access point, located at the SH1 northbound off ramp at the Takaanini interchange.	Current facilities: Footpaths on both sides of the corridor. No existing cycling facilities. Future facilities: Western section of Manuroa Road connects with GSR which is expected to have separated walking and cycling facilities on both sides of the corridor. In the future, it is expected that a potential east-west active mode connection at Manuroa Road will enable access to the Takaanini Train Station. Takaanini Train Station master planning is currently underway and there will be future opportunities to integrate an east-west active mode connection at Manuroa Road with the station.

Factors explored in assessment	Spartan Road	Manuroa Road
Forecast pedestrian and cyclist counts	2018: 80 pedestrians and 40 cyclists per day 2028: 240 pedestrians and 130 cyclists per day 2048+: 410 pedestrians and 250 cyclists per day The walking and cycling demand is expected to increase over the next 30 years. Hence, an active mode connection at Spartan Road will accommodate the expected demand and increase east-west connectivity in the network.	2018: 180 pedestrians and 10 cyclists per day 2028: 200 pedestrians and 30 cyclists per day 2048+: 540 pedestrians and 60 cyclists per day The walking and cycling demand is expected to increase over the next 30 years. Hence, an active mode connection at Manuroa Road will accommodate the expected demand and increase east-west connectivity in the network.
Diversion routes – additional distance if closed	Without an active mode connection at Spartan Road, pedestrians and cyclists wishing to travel between Te Mahia and the Takaanini industrial area are expected to travel an additional 600m. This is equivalent to approximately 7 minutes of additional walk time. This diversion distance and additional journey time is undesirable / inconvenient and may reduce the number of people shifting towards active modes.	Without an active mode connection at Manuroa Road, pedestrians and cyclists wishing to travel between GSR near Challen Close and east of the rail line are expected to travel an additional 300m (walk time of approximately 4 minutes). This is further exacerbated if through movement via the Takaanini Train Station is not permitted in the future. Pedestrians and cyclists are expected to travel an additional 450m (walk time of approximately 5.5 minutes) to St Aidans Reserve. These diversion distances and additional journey duration are considered undesirable / inconvenient and may reduce the number of people shifting towards active modes.

The assessment concluded that there is a strong case for providing east-west active modes connection at both Spartan Road and Manuroa Road for the reasons identified above.

7.5 Emerging preferred network – number and location of crossings

The emerging preferred network in terms of the number and location of crossings is shown in Figure 7-9 and is summarised in Table 7-14 below. The main difference between this network and the ISTN is that Rangi Road is no longer recommended and has been replaced by Manuia Road, which will provide access to the Takaanini industrial area.

Table 7-14 - Summary of network optioneering outcomes

Assessment	Outcomes
Part One: Industrial area assessment	• Manuia Road identified as the preferred east-west connection to serve the Takaanini industrial area.
Part Two: South of the industrial area assessment	• Walters Road identified as the southernmost east-west connection in the network (between Taka Street and Subway Road). • Taka Street identified as an east-west connection to serve the area south of the industrial area between Manuia Road and Walters Road.

Assessment	Outcomes
Active mode connectivity assessment	• Active modes connections recommended at Spartan Road and Manuroa Road.

Figure 7-9 - Emerging preferred network (number and location of crossings)

7.6 Engagement

Following identification of the emerging preferred network as described above, feedback was sought from the community, owners, and Project partners.[3] The Project-specific feedback received from engagement process is summarised in Table 7-15. The table also comments on the implications of the feedback received at this stage for subsequent assessment.

Table 7-15 - Feedback received during engagement

Connection / project area	Feedback	Implications for subsequent assessment
Spartan Road	• Highlighted the importance of the Spartan Road connection to local businesses and freight, serving as a key industrial route for many. • Some feedback received considered that the closure would make traffic flow worse in an already busy area.	• No further corridor optioneering required – previous assessment process for why Spartan Road was not preferred as an east-west connection within the network. This includes the engineering constraints at this location and likely sub-optimal transport outcomes. • Manuia Road proposed in the network considered sufficient for traffic flow and as an alternative to Spartan Road.
Manuia Road	• Concerns on how this new crossing could improve traffic flow be a sufficient replacement for the closure of both Spartan Road and Manuroa Road in the network. • Concerns expressed of the potential land acquisition along Oakleigh Avenue required for the connection and loss of street parking. • Need to consider the capacity of the new Manuia Road connection / bridge and Oakleigh Avenue to support heavy vehicle traffic.	• No further corridor optioneering required – previous assessment sets out process for how Manuia Road has emerged as an option and can achieve transport outcomes. • Option refinement process (see section 10) can respond to some of the concerns raised regarding property impacts, loss of street parking and capacity for heavy vehicles.
Manuroa Road	• Highlighted that the Manuroa Road was widely used by the community and is an important point of access for park and ride users at Takaanini Station. • Some concerns on the replacement crossing at Manuroa Road only being for active modes and the impact on traffic congestion.	• No further corridor optioneering required – previous assessment sets out process for how Taka Street and Manuia Road were preferred options for providing east-west connectivity over Manuroa Road. • Option refinement process (see section 10) can help address concerns on access to the train station.
Taka Street	• Feedback received generally supportive of the Taka Street connection. • Need to consider design of the connection to minimise land requirements, support heavy vehicle traffic and upgrading current infrastructure such as overhead wires.	• No further corridor optioneering assessment required – option refinement process can respond to some of the concerns raised minimising land requirements (see section 10). • Noted that Taka Street is not considered the main connection for heavy vehicles.
Walters Road	• Concerns raised on the impact a grade separated crossing would have on surrounding properties, particularly if it took the form of a bridge rather than an underpass.	• No further corridor optioneering assessment required – previous assessment sets out why Walters Road is the preferred connection in the network. • Physical form of grade separation considered further in subsequent assessment (see sections 8 and 9).

[3] It is noted that engagement with Manawhenua was ongoing throughout the network optioneering process with the Project Team regularly presenting on progress and outcomes via the monthly Te Tupu Ngātahi Southern Manawhenua hui. Owner SMEs were also engaged with throughout the process to advise on key considerations and provide feedback.

8 Further Consideration of Physical Form

8.1 Context

As set out in the process overview section at section 4 of this report, the preferred physical form of grade separation was considered in greater detail following the network optioneering and engagement process. Given the conclusions reached through the initial assessment of physical form options (see section 6 of this report), this consideration was limited to an assessment of the merits of a road-over-rail bridge (**bridge**) compared with a road-under-rail underpass (**underpass**). The MCA Framework developed by Te Tupu Ngātahi was again used as the main tool for comparing the options. The Walters Road project area was used as the case study for this assessment.

8.2 Option development

8.2.1 Bridge option

The bridge option was developed to a concept level of design based on parameters set out in Table 8-1. Concept illustrations and indicative plans were produced (see Figure 8-1 and Figure 8-2).

Table 8-1 - Key design parameters for Walters Road bridge option

Parameter	Value
Typical road cross-section	18m on bridge, 24m on adjoining road corridor (defined through applying CFAF process outlined in section 3.2.2.2)
Horizontal Clearance	28.8m (to provide for NIMT four-tracking)
Vertical Clearance	7.8m from ground to road surface (incorporating 5.5m rail vertical clearance)
Maximum grade	8%
Minimum grade	0.5%
Minimum crest curve	K = 6.8
Minimum sag curve	K = 6

The resultant structure is a 250m multi-span bridge, with a total longitudinal extent above existing ground levels of approximately 330m. The bridge contains sufficient horizontal and vertical clearances to accommodate KiwiRail's proposed four-tracking of the NIMT and meets all relevant AT Transport Design Manual (**TDM**) standards. In addition to the bridge structure, the concept design provides for:

- Upgrade of adjoining sections of Walters Road between Great South Road and Porchester Road;
- Tie-ins to existing Walters Road intersections with Great South Road, Tironui Road, Braeburn Place, Arion Road, and Porchester Road; and
- At-grade access lanes adjacent to and underneath the proposed bridge to the west of the NIMT to replace access lost by the grade-separation of Walters Road.

Figure 8-1 - Walters Road bridge concept design visualisation

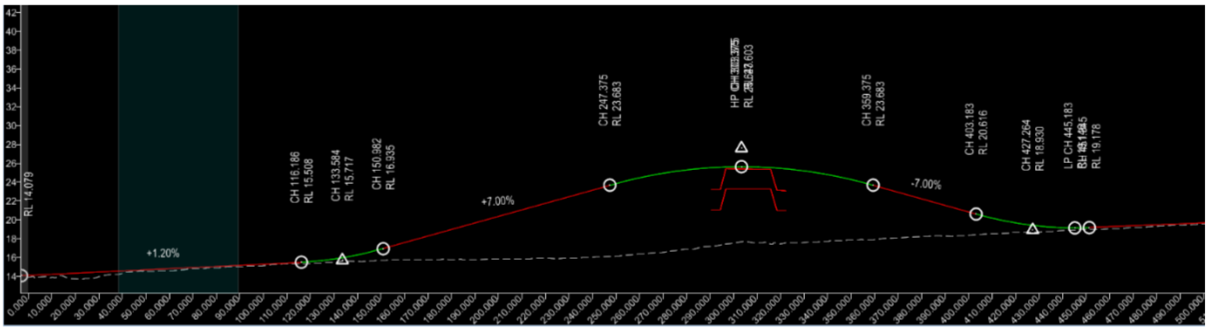


Figure 8-2 - Walters Road bridge concept design longitudinal section

8.2.2 Underpass option

The underpass option was developed to a similar concept level of design based on parameters set out in Table 8-2. Concept illustrations and indicative plans were produced (see Figure 8-3 and Figure 8-4).

Table 8-2 - Key design parameters for Walters Road underpass option

Parameter	Value
Typical road cross-section	18m on bridge, 24m on adjoining road corridor (defined through applying CFAF process outlined in section 3.2.2.2)
Horizontal Clearance	28.8m (to provide for NIMT four-tracking)
Vertical Clearance	7.5m maximum depth from road level to rail level, with 6m vertical clearance
Maximum grade	8%
Minimum grade	0.5%
Minimum crest curve	K = 6.8

Parameter	Value
Minimum sag curve	K = 6

The resultant structure is an underpass trench with a total longitudinal extent below existing ground levels of approximately 315m. The bridge contains sufficient horizontal and vertical clearances to accommodate four-tracking of the NIMT and meets all relevant AT TDM standards. The extent of the underpass that is 'enclosed' is approximately 90m, which provides for four-tracking of the NIMT, at-grade access lanes, and prop beams above the underpass.

In addition to the underpass structure, the concept design provides for:

- Upgrade of adjoining sections of Walters Road between Great South Road and Porchester Road;
- Tie-ins to existing Walters Road intersections with Great South Road, Tironui Road, Braeburn Place, Arion Road, and Porchester Road;
- At-grade access lanes adjacent to and underneath the proposed bridge to the west of the NIMT to replace access lost by the grade-separation of Walters Road; and
- Assumes that a temporary rail diversion would be required to enable construction of the underpass.

Figure 8-3 - Walters Road underpass concept design visualisation

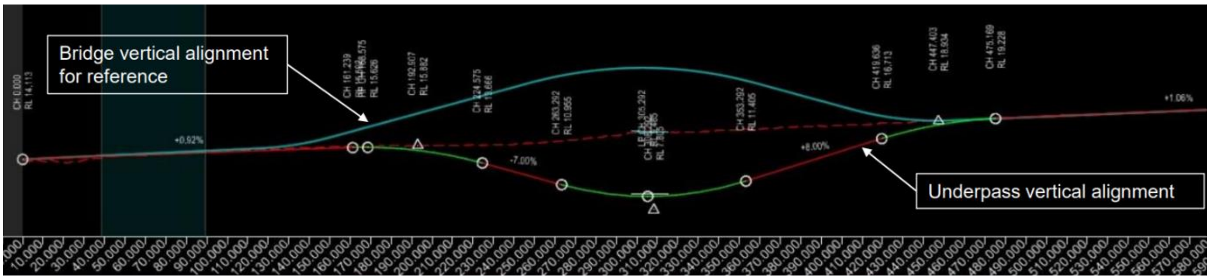


Figure 8-4 - Walters Road underpass concept design longitudinal section

Assumed ground conditions and implications for underpass concept design

The form of the trench structure for the underpass option assessed in the MCA was based on a conceptual arrangement accounting for known ground conditions. The ground conditions adopted as the basis for MCA assessment were based on review of publicly available site investigation data from the New Zealand Geotechnical Database, and recent project experience in similar ground conditions. Due to the absence of site-specific data, a single geological profile was adopted for the purposes of MCA assessment. Assumed ground conditions informed the key features of the trench structure concept design adopted for the purposes of MCA assessment. Details of the assumed ground conditions and concept design trench structure are summarised in Appendix B.

The concept design assumptions documented in Appendix B were considered suitable for the purposes of route protection option assessment.

8.3 Option assessment

The bridge and underpass options were assessed using the MCA Framework developed by Te Tupu Ngātahi. The MCA scoring is summarised at Table 8-3.

Table 8-3 - Walters Road grade separation form – MCA scoring

Criteria	Scoring	
	Bridge	Underpass
Investment Objective 1: Safety		
Investment Objective 2: Travel Choice		
Investment Objective 3: Resilience		
Investment Objective 4: Access		
Land Use Futures		
Urban Design		
Land Requirement		
Social Cohesion / effects		
Human Health and Wellbeing		
Transport system integration		

Criteria	Scoring	
	Bridge	Underpass
User safety		
Ecology		
Historic Heritage		
Landscape / Visual		
Stormwater		
Natural Hazards		
Construction impacts on utilities / infrastructure		
Construction disruption		
Construction costs / risk / value capture		

From the above MCA assessment and accompanying commentary, the following key differentiators between the options were identified (in the order assessed):

- **Investment objectives** – Both options scored the same against three of the four investment objectives relating to safety, travel choice, and accessibility defined in the DBC – both options were scored as positive for these objectives. Under the resilience objective, the bridge option was preferred over an underpass given that an underpass is more susceptible to flooding;
- **Urban design** – The bridge option was scored as a neutral impact – the scale and interface impacts of a bridge were assessed as being balanced out by the positive effects of east-west connectivity and reduced community severance. The underpass was not preferred. While the same positive effects as a bridge were identified in terms of promoting east-west connectivity, the underpass option was assessed as being a poorer outcome in terms of Crime Prevention through Environmental Design (**CPTED**) given the personal safety risks associated with the underpass as a movement predictor, entrapment zone, isolated area; and the relatively poorer outcomes in terms of lighting, sightlines, surveillance, perceived safety, potential for vandalism/graffiti, and noise/air quality. Moreover, the underpass was assessed as a poorer outcome for active modes given the noise and air quality issues for active mode users associated with enclosed spaces;
- **Land requirements** – Both options were scored the same against the land requirement criterion given the broadly similar third-party land requirements. Notwithstanding this, the underpass will require some additional land not otherwise required for a bridge related to the temporary rail diversion assumed as part of the construction methodology for an underpass (see construction disruption below), and to allow for sufficient space for a 10m offset between the underpass trench excavation and remaining buildings to reduce the risk of damage;
- **Landscape and visual** – The underpass option was preferred on this criterion given that it would have lower overall visual impacts compared with a bridge. The underpass will still have localised visual effects, will represent a new feature in the environment, and will introduce a grade change. The bridge will also introduce a grade change and was less preferred given the greater visual impact (without mitigation) of a bridge structure in the context of commercial, industrial, and

residential surroundings. Both options result in a disconnect between the road and adjacent properties, and will affect the outlook from adjacent properties and roads;

- **Stormwater** – The bridge option was preferred under this criterion on the basis that an underpass would likely require flood pumping in all events, exceeding the capacity of existing stormwater infrastructure. The bridge was also noted as potentially affecting existing overland flow paths;
- **Natural Hazards** – The natural hazards assessment considered the risks posed by ground conditions. Much of the alignment was assumed to be underlain by soft peat and alluvium (large thickness of >10m), which is susceptible to settlement if loaded or if groundwater level is lowered. This ground condition presents an elevated settlement risk profile for an underpass compared with a bridge, and the potential for ground movement may impact existing infrastructure and service surrounding the site (including the NIMT) if not controlled. The bridge option presents less settlement risk than an underpass, but settlement and seismic loading considerations may limit embankment heights. In summary, the bridge option was preferred under this criterion;
- **Construction impacts on utilities/infrastructure** – The bridge option was preferred under this criterion on the basis that an underpass would necessitate relocation of an existing stormwater pipe, local utilities, and a fibre cable not otherwise required by a bridge. The level of disruption for the rail corridor was also greater for an underpass (note this is also addressed below in construction disruption);
- **Construction disruption** – The bridge option was preferred under this criterion given that the assumed construction methodology for a bridge would be limited to disruptions to local property access and road traffic, with relatively limited rail disruption. The underpass option was not preferred on the basis that the construction methodology was assumed to require either prolonged closure of the NIMT (exceeding the duration of a typical block-of-line), or temporary realignment of the NIMT which would result in greater land requirements (see above); and
- **Construction costs/risk** – The underpass option has a significantly elevated cost and risk profile compared with a bridge. To prevent groundwater drawdown during construction, continuous temporary or permanent cut-off walls will be required for the full length on both sides of the excavation (as noted in section 8.2.2 above); and the excavation will cross the rail corridor resulting in rail disruption (as noted under construction disruption) and a need to relevel the rail lines. Effective groundwater seepage cutoff may be difficult to achieve and may require additional work and cost, and extensive monitoring will be required. A bridge was assessed as having a lower cost and risk profile, with the main risks identified relating to the unknown depth to rock for bridge piles, and potential settlement implications at bridge approach embankments. Finally, it is noted that the DBC cost estimates completed following the MCA confirmed that an underpass would cost more than a bridge. In summary, the bridge option was preferred under this criterion.

8.4 Preferred physical form of grade separation

On the basis of the above assessment, the **bridge** option was identified as the technically preferred physical form of grade separation at Walters Road.

The Project Team also considered the applicability of the MCA findings at Walters Road for other grade separation locations – in particular in the Taka Street and Manuia Road project areas. The key constraints identified in the above assessment for the Walters Road underpass option relating to ground conditions, construction complexity, lack of resilience, and urban design and safety concerns for the community were also considered relevant at the Taka Street and Manuia Road project areas; and no material differentiating factors for assessment in these locations were identified. Accordingly, bridges were similarly recommended as the preferred physical form of grade separation in those locations. Underpass options were not considered further at this stage of assessment.

9 Final retesting of Walters Road physical form – June-September 2023

9.1 Context

The assessment documented from sections 5-8 of this report informed the technically preferred options for the TLC identified in the DBC as of 30 May 2023 – both in terms of the number and location of grade-separated crossings of the NIMT for the future network; and the physical form of grade-separation. The optioneering process **to this point** is summarised in the figure below.

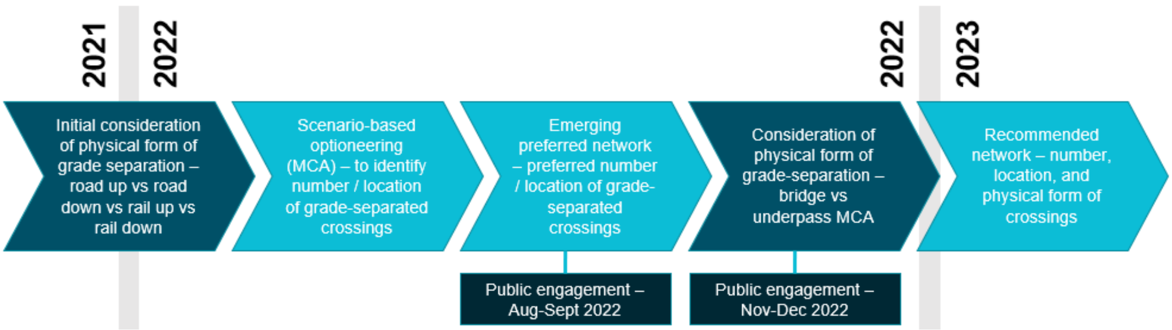


Figure 9-1 - TLC optioneering process to May 2023

A decision on endorsing the recommended DBC options was sought from the AT Board in May 2023. At this time, the Board approved the DBC recommendations as they related to four of the five project areas – Spartan Road, Manuia Road, Manuroa Road, and Taka Street. Immediately prior to the AT Board meeting, new design and technical information was received by AT regarding a potential alternative underpass design for the Walters Road crossing proposed by the Takanini Group (**TG**).[4]

Consequently, the Board's decision as it related to the Walters Road project area was deferred to enable further consideration of the merits of bridge and underpass options in this location, in addition to the optioneering already completed and documented at section 8. The Board's instruction to further consider these matters was to allow time for the additional design and technical information provided by TG to be evaluated and considered by the Project Team together with TG experts, and to allow for further Local Board and community engagement on these matters.

The Project Team has therefore retested previous optioneering as it relates to the physical form of grade separation at Walters Road in response to these concerns, and in light of the new information received. To that end, this section of the report documents:

- New information received from TG (see section 9.2);
- The Project Team's consideration of the new information, in particular the implications of new information in the context of MCA assessment previously undertaken (see section 9.3);
- Retesting of the previous MCA assessment responding to the above considerations and recommendations (see section 9.4); and
- Further engagement undertaken following the May 2023 Board direction (see section 9.5).

9.2 New information received

New information received from TG experts comprised the following:

- Reports from Riley Consultants Limited dated 16 May 2023 outlining an alternative underpass design ('the first TG underpass') developed for the Walters Road location. The reports contain design drawings and commentary on comparative land requirements, costs, and constructability of the first TG underpass as compared with the bridge option preferred in the assessment by Te Tupu Ngātahi;
- Two reports by Coffey Geotechnics NZ Limited from 2011 and 2012 documenting ground investigations undertaken for the 30 Walters Road site; and
- One report provided by Richard Knott Limited dated 26 July 2023 comparing bridge and underpass options from an urban design and visual effects perspective.

The information contained in the above reports was discussed extensively in meetings between Te Tupu Ngātahi and TG experts.

[4] A collective entity comprising Takanini Village Limited, Tonea Investments Limited, the Takanini Business Association, and associated local community groups.

9.3 Implications of new information for assessment

9.3.1 Alternative underpass designs

May 2023 – First TG Underpass

The first TG underpass option documented in the May 2023 Riley reports differed from the underpass concept assessed and not progressed earlier by Te Tupu Ngātahi (described and documented in section 8.2.2 of this report). The key differences in design parameters between Te Tupu Ngātahi and the first TG underpass option are outlined in Table 9-1 below.

Table 9-1 - Differences in design parameters between Te Tupu Ngātahi and TG

Design Parameter	Te Tupu Ngātahi Underpass	First TG Underpass
Maximum underpass depth	7.5m	7.05m
Minimum vertical clearance	6m	5.05m
Minimum grade	0.5%	0%
Maximum grade	8%	8%
Minimum crest curve	K=8	K=5
Minimum sag curve	K=6	K=3
Four-tracking provided for?	Yes	No
Resultant longitudinal extent	315m	255m
Road cross-section width	18m	20.9m

TG experts considered that their underpass design would require less land than the underpass concept developed by Te Tupu Ngātahi and would be less costly and complex to construct than assumed by Te Tupu Ngātahi. On this basis, TG experts considered that the TG underpass should be considered as a viable option in the optioneering process undertaken by Te Tupu Ngātahi and that the preference for a bridge over an underpass identified in assessment to date should be revisited.

Te Tupu Ngātahi engineers analysed the TG underpass in detail and identified that the benefits claimed by the TG experts in terms of the compactness in its underpass design were a function of its shorter overall length. This length in turn is a function of the assumed vertical geometry – i.e. depth, vertical clearances, grades, and vertical curves. The analysis undertaken by Te Tupu Ngātahi found that the vertical geometry parameters assumed in the TG underpass were not compliant with relevant standards in AT's TDM. The noncompliant parameters are summarised in Table 9-2 below.

Table 9-2 - Vertical geometry parameters of the options compared with AT TDM standards

Design Parameter	AT TDM standard	Te Tupu Ngātahi Underpass	TG Underpass
Minimum vertical clearance	**6m preferred**	6m	5.05m
Minimum grade	**0.5%**	0.5%	0%
Maximum grade	**8%**	8%	8%
Minimum crest curve	**K=6.8**	K=8	K=5
Minimum sag curve	**K=6**	K=6	K=3

Table 9-2 demonstrates that the claimed greater compactness of the TG underpass design relies on noncompliance with design standards, which would require departures from AT TDM standards to approve. Te Tupu Ngātahi experts did not consider that seeking an NoR on the basis of a noncompliant concept design was appropriate at the current stage of design given that it would limit future design flexibility, and 'lock in' a design with inherent vertical geometry flaws and resultant safety and resilience risks. This view was tested with relevant AT subject matter experts, who agreed that it was appropriate to include risk allowances for design uncertainty at the designation stage. They further noted that lodging an NoR based on minimum or noncompliant dimensional design standards would be unacceptable to AT given the risk of the ultimate design failing to fit within the designation boundaries.

Conversely, adoption of compliant design parameters consistent with those used by Te Tupu Ngātahi would result in a near-identical project extent and land requirement (noting that the underpass concept developed by Te Tupu Ngātahi provides for some flexibility in design by slightly exceeding minimum standards for vertical curves as shown in Table 9-2).

Table 9-1 further identifies differences in provision for future rail widening between the two options. In short:

- The underpass option developed by Te Tupu Ngātahi explicitly provides for the four-tracking of the NIMT as an integral design consideration and project design requirement. The rail 'bridge' over the underpass trench was assumed at 28.8m in width to match the horizontal clearance required for four rail tracks, and vertical geometry provides for AT TDM-compliant vertical clearances beneath the rail formation; and
- Conversely, the TG underpass option does not explicitly provide a rail 'bridge' over the underpass trench with sufficient width for four rail tracks, but rather assumes that additional tracks could be retrofitted in future. Given the minimum vertical clearance identified in Table 9-1 and Table 9-2, retrofitted tracks would not achieve AT TDM-compliant vertical clearances below the rail, which would present a safety and network resilience risk.

For these reasons, the TG underpass as proposed in May 2023 was **not** considered a viable option. Accordingly, it has not been considered further in the optioneering process undertaken by Te Tupu Ngātahi.

September 2023 TG Underpass

Following extensive discussion regarding these vertical geometry concerns with Te Tupu Ngātahi experts, Riley Consultants provided a revised TG underpass design concept in September 2023. Table 9-3 shows that the revised TG underpass achieves compliance with the relevant AT TDM standards. This in turn results in an additional 30m of length as compared with the initial May 2023 TG underpass, in turn negating much of the claimed advantage of the earlier design in terms of land requirements and associated cost savings.

It is understood that the revised TG underpass also provides sufficient horizontal and vertical clearances to allow for four-tracking.

Table 9-3 - Vertical geometry parameters of revised TG underpass compared with earlier options and AT TDM standards

Design Parameter	AT TDM standard	Te Tupu Ngātahi Underpass	First TG Underpass	Revised TG underpass
Minimum vertical clearance	**6m preferred**	6m	5.05m	6m
Minimum grade	**0.5%**	0.5%	0%	0.5%
Maximum grade	**8%**	8%	8%	8%
Minimum crest curve	**K=6.8**	K=8	K=5	K=6.8
Minimum sag curve	**K=6**	K=6	K=3	K=6
Resultant longitudinal extent		315m	255m	285m

The remaining 30m difference between the lengths of the revised TG underpass and the underpass developed by Te Tupu Ngātahi are attributable to differences in assumed vertical curves. As noted above, the underpass design developed by Te Tupu Ngātahi slightly exceeds minimum standards for vertical curves to provide for an appropriate level of future detailed design flexibility, while the revised TG underpass simply adopts minimum standards. As noted above, AT SMEs did not favour lodging an NoR on the basis of minimum standards with no risk margin or allowances for design uncertainty.

Te Tupu Ngātahi experts consider that a near-identical length to the revised TG underpass would be achieved by adopting the same minimum standards, and that this would be possible in future within a designation footprint informed by the more conservative vertical curves. In short, the options are considered near identical for all intents and purposes.

Accordingly, the revised TG underpass has **not** been considered further in the optioneering process undertaken by Te Tupu Ngātahi, as it is not materially different from an option that has already been assessed and not progressed in section 8 above.

9.3.2 Geotechnical information

Review of Coffey report data

The two reports by Coffey Geotechnics New Zealand Limited (Coffey reports) provided by TG experts were reviewed by Te Tupu Ngātahi geotechnical engineers and hydrogeologists. This review concluded that the data contained in these reports enabled some refinement of the ground profile assumed in the bridge vs underpass MCA undertaken for the Walters Road grade-separation in September 2022, as documented in section 8.2.2 of this report (which was derived from publicly available site investigation data). The changes in assumed ground profile are summarised in Table 9-4.

Table 9-4 - Changes in ground profile assumed as a result of the Coffey reports

MCA Ground Profile	Revised Ground Profile
0 – 2 m bgl: Fill	0 – 1.8 m bgl: topsoil and v stiff silt and clay

MCA Ground Profile	Revised Ground Profile
2 – 12 m bgl: Peat [Ardmore Member]	1.8 – 7.0: organic silt / clay with common rootlets and occasional woody fragments [Ardmore Member]
	7.0 – 8.5: soft to firm silt / clay [Holocene Alluvium]
	8.5 – 9.8: Organic clayey silt with common rootlets, “spongey” [Ardmore Member?]
	9.8 – 11.0: soft silty clay [Takaanini Formation]
12 – 18 m bgl: soft clay [Takaanini Formation]	11.0 – 25.3: very stiff silty clay [Takaanini Formation] *14.0 – 15.0: firm to stiff silt / clay* *16.2 – 18.8 loose silty sand* *18.8 – 19.7: firm amorphous peat*
18 – 30 m bgl: stiff alluvium [Takaanini Formation]	
	25.3 – EOH: medium dense silty sand [Takaanini Formation]
Unknown depth to top of Waitematā Group rock	
Groundwater level assumed at 2 m bgl	Groundwater level assumed at 1.5 m bgl

From a design perspective, the geotechnical and hydrogeology experts considered that this revised ground profile could enable some reduction in the sheet piling depth for underpass sections requiring less than 5m of excavation – the previously assumed 13m (as set out in section 8.2.2) can be reduced to 10m. This has been estimated by Te Tupu Ngātahi cost estimators to result in a $610,000 cost saving, which is negligible in the context of the project cost estimate generally.

The change in assumed ground profile was not considered to justify any change to the assumed piling requirements for deeper secant piled wall sections at this stage of design (see below).

Implications of these changes for the MCA assessment are documented at section 9.4.

Validity of TG underpass piling assumptions

Both TG underpass concepts are understood to assume narrower and shallower piling to the underpass option developed by Te Tupu Ngātahi (see Table 9-5).

Table 9-5 - Piling assumptions adopted in Te Tupu Ngātahi and TG underpass concepts

Design Parameter	Te Tupu Ngātahi Underpass	TG Underpasses
Assumed pile depth	23m	15m
Assumed pile diameter	900mm	750mm

TG experts considered that less conservative piling assumptions were appropriate based on the ground conditions at a single Cone Penetration Test (**CPT**) location at 30 Walters Road near the NIMT documented in the Coffey reports. This CPT shows a reduced peat depth and layers of dense sand that are not present in the assumed ground profile adopted by Te Tupu Ngātahi. TG experts considered that this ground condition justified the less conservative piling assumptions, which in turn would result in significant cost savings as compared with the piling assumptions adopted by Te Tupu Ngātahi (addressed further under costs at section 9.3.3 below).

Te Tupu Ngātahi geotechnical and hydrogeology experts did not agree based on a single CPT location that it was appropriate to adopt narrower and shallower piling assumptions at this stage of design, and further noted that the required depth to achieve groundwater cutoff was the more relevant consideration in determining pile depth and sizing. On this basis, Te Tupu Ngātahi experts consider that its piling assumptions (as documented in section 8.2.2 above) remain valid (with the exception of the adjustment to sheet piling depth at shallow excavation depths described above).

Additionally, Te Tupu Ngātahi cost estimators and constructability experts did not agree that adopting the less conservative piling assumptions relied on in the TG underpass design would result in the level of cost savings assumed by TG experts.

The implications of the new information provided by the Coffey Reports and subsequent discussions are that the piling assumptions underpinning the original MCA assessment undertaken by Te Tupu Ngātahi for Walters Road – particularly for the cost and natural hazards scoring – are still considered appropriate by Te Tupu Ngātahi experts. Accordingly, while acknowledging the minor shift in sheet piling requirements, no fundamental change in piling assumptions is assumed to be merited.

9.3.3 Cost Estimates

Cost estimates for the various TG underpass designs were provided in the Riley reports. Based on these estimates, TG experts considered that an underpass could be constructed at less cost than that estimated by Te Tupu Ngātahi; and therefore, that the difference in cost between a bridge and an underpass had been overstated by Te Tupu Ngātahi in its technical recommendations in May 2023.

While noting that different underpass options have been costed by the respective project teams, Te Tupu Ngātahi has considered the Riley costings and notes that there is a fundamental difference in cost estimation approach between the two sets of estimates. Te Tupu Ngātahi cost estimates followed Waka Kotahi Cost Estimate Manual SM014 (**SM014**), which is industry standard for business cases. This approach requires the use of industry cost databases by professional cost estimators to obtain rates and apply them to material quantities derived from concept design. The manual also requires allowance for project development and pre-implementation costs, a range of additional physical works items including environmental compliance, and contingency. The Riley estimates by contrast use bespoke rates obtained from contractors applied to material quantities derived from the TG underpass designs; and exclude a number of the additional cost allowances required to be included under SM014.

Accordingly, Te Tupu Ngātahi experts consider that the two sets of cost estimates are not directly comparable, and that the TG costings are likely to materially underestimate the construction cost of an underpass. Irrespective of cost estimate methodology for an underpass, Te Tupu Ngātahi experts consider that the bridge option remains considerably less costly than an underpass. Given the above, Te Tupu Ngātahi experts consider the MCA assessment under the cost criterion remain valid. Accordingly, no fundamental change in overall costings is assumed to be merited.

9.3.4 Construction Disruption

The Riley reports include construction programmes for the TG underpass options and assume an overall construction duration of between 12-18 months for the underpass works. The high-level construction methodology which informed the MCA undertaken by Te Tupu Ngātahi estimates a duration of approximately 2.5 – 3 years for either a bridge or an underpass and includes wider network integration works beyond the bridge or underpass itself. The longer duration in the construction methodology proposed by Te Tupu Ngātahi reflects more conservative assumptions, but ultimately is not a significant differentiator between a bridge and an underpass.

However, Te Tupu Ngātahi and TG construction methodologies differ materially in their approach to managing NIMT rail closures to enable construction of an underpass. In short, the TG methodology assumes works within the rail corridor can be undertaken within a 14-day block-of-line period, while the assessment undertaken by Te Tupu Ngātahi assumes the need for either construction of a temporary rail diversion to reduce disruption or a need for further prolonged closure of the NIMT during construction. Te Tupu Ngātahi assessment favours temporary rail diversion following consultation with KiwiRail. The assumed need to provide for a temporary rail diversion informed the initial MCA assessment under the land requirement and construction disruption criteria in particular.

While consultation with KiwiRail has identified that there are a range of possible means of managing rail closures, the preferred methodology remains a temporary rail diversion. Moreover, KiwiRail noted that a 14-day block-of-line period was likely to be an unacceptable solution given the significance of the NIMT for freight. On this basis, Te Tupu Ngātahi experts remain of the view that the assumptions underpinning the MCA assessment under the land requirement and construction disruption are appropriate.

9.3.5 Urban Design and Visual Effects

The report provided by TG's urban design expert outlined a preference for an underpass over a bridge on the basis that an underpass would have a lesser visual effect, would maintain greater visual connectivity at ground level, and that CPTED and personal security concerns could be mitigated by the limitation of the enclosed extent of the underpass to 30-40m and design features including egress stairs.

Te Tupu Ngātahi urban design expert reviewed the above report and did not consider that it materially changed the earlier MCA urban design assessment. In particular, it remained Te Tupu Ngātahi urban designers' expert view that an underpass was not preferred due to CPTED and personal safety issues – a lack of surveillance, visibility, and outlook; susceptibility to vandalism and graffiti, and susceptibility to noise and air quality effects. Moreover, it was noted that the 30-40m enclosed extent assumed in the TG underpass design would not provide for four-tracking of the NIMT, (as discussed at section 9.3.1 above), or adequate space for at-grade access lanes above the underpass (described in section 8). TG's assumptions regarding limitations of enclosed extent were therefore incorrect. Given that the underpass option developed by Te Tupu Ngātahi provides for both four-tracking of the NIMT and at-grade access lanes above the underpass, the enclosed extent is approximately twice the length of the TG underpass. This in turn has informed the urban design scoring, and the continued preference for a bridge by the Te Tupu Ngātahi urban design expert.

Te Tupu Ngātahi landscape and visual effects expert also re-examined earlier assessment of the merits of bridge and underpass options in light of the TG assessment, and the same general findings and conclusions were reached – that a bridge would have a greater visual effect than an underpass, that both options would introduce grade changes and result in a disconnect between the road and adjacent properties and would affect the outlook from adjacent properties and roads. Moreover, the reassessment emphasised that the effects of a bridge or underpass is anticipated in the context of an existing urban environment with two intersecting transport corridors (road and rail).

Implications of these matters for the MCA assessment are documented at section 9.4.

9.4 Retesting of previous MCA outputs

The MCA assessment of physical form options for grade-separation at Walters Road (documented in section 8) has been retested in light of the new information documented above and in discussion with TG experts. Given the scope of new information provided to Te Tupu Ngātahi, the retesting was limited to six MCA criteria – urban design, land requirement, landscape and visual effects, natural hazards, construction disruption, and construction risk. Remaining criteria scoring was not considered to be materially changed by the new information.

Table 9-6 - Retesting of Walters Road MCA assessment

Criteria	Previous MCA scores		Commentary
	Bridge	Underpass	
Urban design			As noted at 9.3.5, no fundamental changes to urban design rationale or assessment as a result of the TG assessment. No change in scores or commentary.
Land requirement			As noted at 9.3.1, Te Tupu Ngātahi experts do not agree with TG experts that an underpass can be made meaningfully more compact while remaining AT TDM-compliant. Accordingly, no change in scores. It is noted for completeness that while both options are scored the same on an 11-point scale, Te Tupu Ngātahi remains of the view that an underpass will require additional property associated with temporary rail diversion to enable construction, and to provide for offset between the underpass trench and remaining buildings to reduce risk of damage. Accordingly, a bridge will require less land than an underpass.
Landscape / visual			As noted at 9.3.5, the landscape and visual criterion was revisited in light of the TG assessment. This reassessment resulted in no change in scoring, noting that an underpass would have lower visual effects than a bridge; but that both options would represent grade changes, introduce a disconnect between the road and adjacent properties, and affect the outlook of adjacent properties and roads.
Natural hazards			As noted at 9.3.2, the geotechnical data provided by TG experts enabled some refinement of the ground profile resulting in changes to sheet piling depth assumptions for excavations of less than 5m, but not for secant wall piling depth assumptions at greater than 5m. Other aspects of the previous assessment were considered to remain valid with the new geotechnical data – high groundwater table and large combined thickness of soft peat and alluvium present an elevated settlement risk profile for an underpass when compared with a bridge. Accordingly, no change in the preferred option or scoring differential between the two options.
Construction disruption			As noted at 9.3.4, no fundamental changes to Te Tupu Ngātahi assumptions regarding construction method as a result of the TG assessment, in particular the preference for a temporary rail diversion to manage rail disruption.
Construction cost / risk			As noted at 9.3.3, no fundamental changes to Te Tupu Ngātahi assumptions regarding the costs of the bridge and underpass options as a result of the TG assessment. Te Tupu Ngātahi still estimates that an underpass is still around twice the cost of a bridge, and as noted above there remains an elevated settlement risk profile for an underpass when compared with a bridge. Accordingly, no change in the preferred option or scoring differential between the two options.

9.5 Further engagement

Following the 30 May AT Board direction, Te Tupu Ngātahi undertook further engagement activities in parallel with the additional technical analysis documented above. The outcomes of this engagement were considered alongside the additional technical analysis in confirming a recommendation for the physical form of grade separation at Walters Road and are summarised below.

9.5.1 Public engagement – physical form assessment and visuals

In June 2023, Te Tupu Ngātahi undertook further public engagement. This included updated collateral on the Te Tupu Ngātahi website with further information on the alternatives assessment for bridge and underpass options, and several new visual simulations for three of the proposed crossing locations (see Figure 9-2). The intent was to communicate the reasoning for the earlier recommendation by Te Tupu Ngātahi of a bridge as the physical form of grade separation, and to give a better idea as to the scale and appearance of the recommended structures.

An additional public open day was held at the Takaanini Community Hub on 24 June 2023, which was attended by approximately 30-40 people including several elected members and potentially affected landowners. Key matters discussed with members of the community included the rationale for the scale of bridge structure shown in the visualisations, the effects of grade separation on access to the Takanini Town Centre development, and the extent to which ground conditions had been a determinative factor in identifying a preference for a bridge over an underpass. Some local residents also raised questions regarding proposals at other TLC project areas, in particular the suitability of a pedestrian bridge at Manuroa Road. Te Tupu Ngātahi experts in attendance discussed these matters at length with community members.

Figure 9-2 - Visualisation of proposed Walters Road bridge presented in June 2023 engagement

9.5.2 Local Board engagement

Te Tupu Ngātahi representatives met with the Papakura Local Board on 9 August. The purpose of this meeting was to communicate the reasoning for the earlier recommendation of a bridge by Te Tupu

Ngātahi as the physical form of grade separation, to present new visualisations to give a better idea as to the scale and appearance of the recommended structures, and to provide updates on the retesting process and new technical information provided by TG. AT representatives again met with the Papakura Local Board on 20 September to present the findings of a separately commissioned independent peer review of the technical analysis undertaken by Te Tupu Ngātahi.

It is understood that the Papakura Local Board has reserved its position in terms of identifying a clear preference for either a bridge or an underpass at Walters Road but has received and acknowledged the technical information presented in the meetings. Moving forward, the Local Board has noted an expectation of continued communication by AT, Te Tupu Ngātahi, and KiwiRail with the community regarding decision-making on the form of grade separation at Walters Road.

9.5.3 Manawhenua engagement

The Project Team maintained its monthly Hui with Manawhenua representatives through the mid-2023 engagement period. In the Hui held during this period, the Project Team sought to keep Manawhenua representatives up-to-date with the outcomes of the AT Board and ongoing discussion with TG, sought feedback on the visual simulations prior to public engagement, and generally sought further feedback on views regarding the form of grade-separation.

Manawhenua continue to have concerns with both options. For the bridge option, concerns were noted regarding the scale and visual impact of the proposed structure. For the underpass option, concerns were consistently raised regarding flooding risk and associated safety and resilience issues, the underlying ground conditions, and the greater cost of an underpass relative to a bridge. Value-for-money and intergenerational equity were noted as concerns for both options also noting the relatively large costs associated with each. Overall, Manawhenua continued to express a preference for the bridge option in light of the above.

9.6 Conclusion

Following completion of the retesting and re-evaluation of the physical form of grade-separation, as well as the further engagement activities, it was confirmed that **a bridge remains the preferred physical form of grade separation at Walters Road**. The complete process documented above is summarised in Figure 9-3 below.

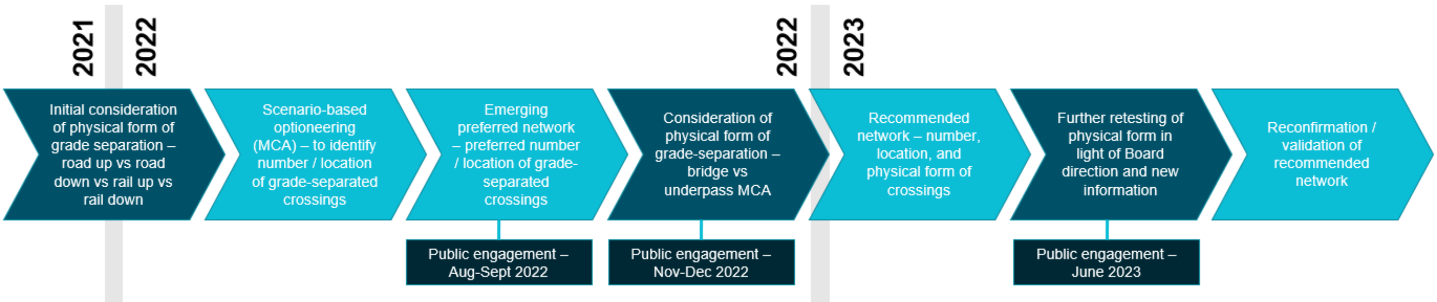


Figure 9-3 - Full TLC optioneering process including June-September 2023 retesting and further engagement

10 Network Refinement

10.1 Context

Following confirmation of the preferred number, location, and physical form of crossings on the TLC network, the final step of the alternatives assessment was the process of option refinement which has informed the preferred alignment and physical extent of each crossing identified in the above steps. This analysis included consideration of:

- The **transport form and function** of the corridors to inform the physical extent;
- Options for the **route refinement** of each east-west crossing on a case-by-case basis with a view to avoiding identified constraints where possible; and
- Feedback received from technical specialists, affected landowners, Manawhenua, Project partners on concept designs and resultant further refinements.

10.2 Transport Form and Function

10.2.1 Corridor Form and Function

The CFAF process described at section 3.2.2.2 has been used throughout the optioneering process to identify the indicative width of corridors for assessment. This process was repeated at the network refinement stage to confirm the cross-sections for concept design. As part of this process, SMEs were consulted for endorsement allowing for high engagement and design efficiency.

The assessment identified that a two-lane arterial corridor with active mode facilities should be adopted for each of the multi-modal crossings – i.e. Manuia Road, Taka Street, and Walters Road. The resultant cross-section is 24m in width, with a reduction to 18m recommended for the bridge sections over the NIMT (see Figure 10-1).

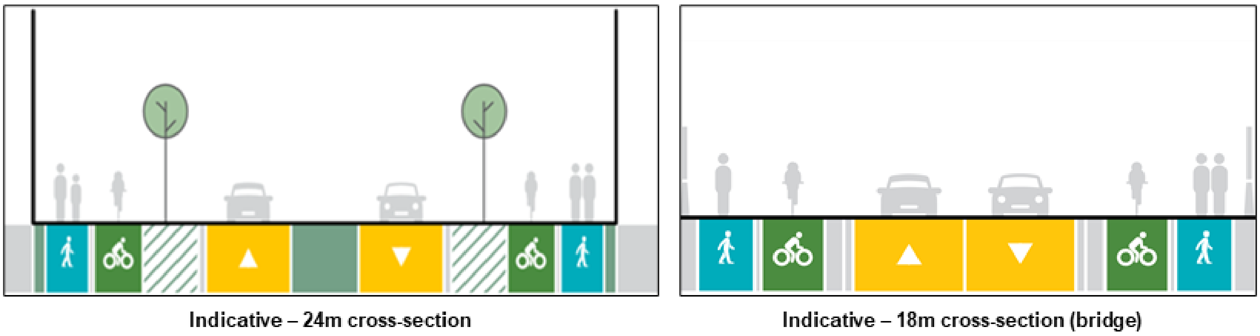


Figure 10-1 - Indicative cross-sections for multi-modal corridors (Manuia Road, Taka Street, Walters Road)

For the active mode corridors at Spartan Road and Manuroa Road, the CFAF assessment identified an indicative cross-section of 4.6m for the bridge sections (see Figure 10-2).

Figure 10-2 - Indicative cross section - active modes corridors

10.2.2 Intersection Form

In parallel with the CFAF, the intersection assessment process described in section 3.2.2.3 was undertaken to identify the likely future intersection form and function of intersections in the preferred TLC network. It is noted that some of the intersections are to be assessed as part of the South FTN Project. The recommendations are set out in Table 10-1 and shown in Figure 10-3 below.

Table 10-1 - TLC network – indicative intersection forms

Intersection	Recommendation	Comment
Spartan Road		
Spartan Road / Great South Road	Retain signalised intersection.	Cul-de-sac works will mean less traffic will use these intersections – hence no works proposed.
Spartan Road / Westbrook Avenue	Retain priority intersection.	
Manuia Road (new connection)		
Great South Road / Manuia Road	New signalised intersection	Signalisation recommended due to volumes associated with new connection, existing lane arrangement on GSR, and land use.
Manuia Road / Oakleigh Avenue / Hitchcock Road	New single lane roundabout	Single-lane roundabout recommended for new intersection given proposed lane layouts on all three legs, traffic volumes, and land use.
Manuroa Road		
Manuroa Road / Great South Road	Retain signalised intersection	Cul-de-sac works will mean less traffic will use these intersections – hence no works proposed.
Manuroa Road / Oakleigh Avenue	Retain priority intersection	
Taka Street		
Taka Street / Great South Road	Retain signalised intersection	Will remain as a signalised intersection. Upgrade of the intersection is provided for as part of the South FTN Project and is not part of the TLC works.
Taka Street / Kauri Heart Avenue	Retain existing single lane roundabout	This is a recently upgraded intersection and physical works for the TLC will end prior to the intersection.

Intersection	Recommendation	Comment
Walters Road		
Walters Road / Arion Road	Retain existing signalised intersection	Adjacent commercial and residential land use.
Walters Road / Great South Road	Retain existing multi-lane roundabout	Will remain as a multi-lane roundabout – no works proposed.
Tironui Road / Walters Road	Left in left out	Located approximately 40m from the Walters Road roundabout. Provides access to the industrial/ commercial area.

Figure 10-3 - TLC network – indicative intersection forms

10.3 Route refinement

10.3.1 Manuia Road route refinement

10.3.1.1 Alignments assessed

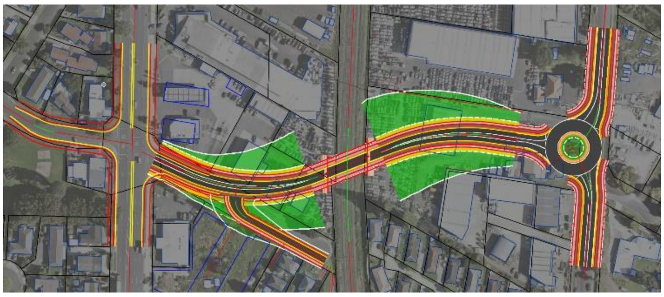
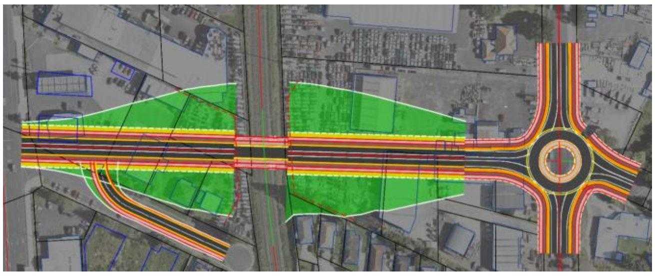
The Manuia Road connection is the only proposed corridor in the emerging preferred network where there is no existing level crossing or road alignment over the NIMT to use. As it is a new connection between Great South Road and Oakleigh Avenue, several different alignments were explored that had differing impacts. Alignment options were developed that could utilise existing infrastructure and integrate with land use planning. This included consideration of:

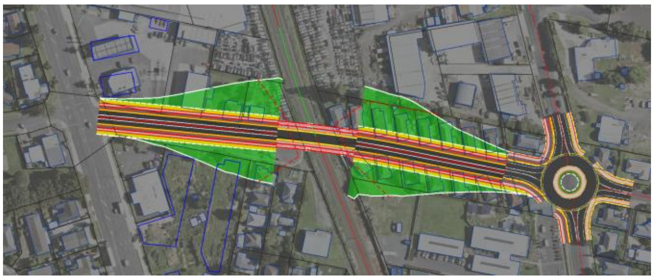
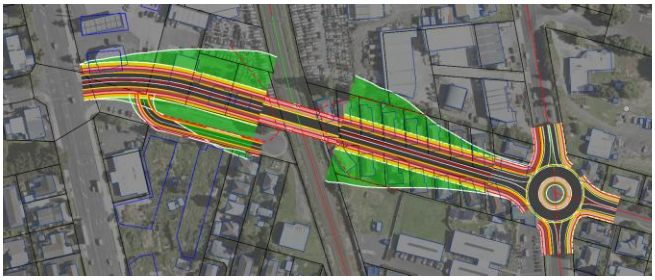
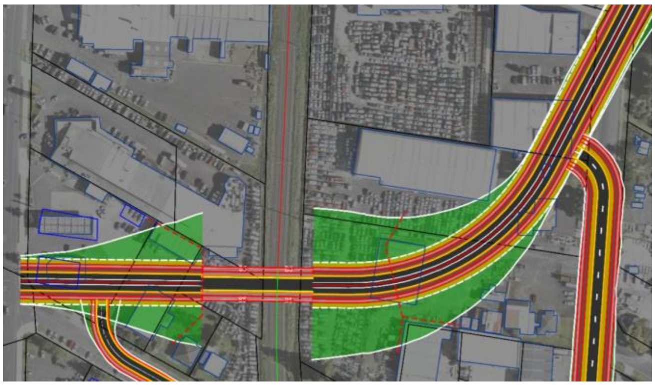
- Opportunities to connect to existing intersections – e.g., Challen Close / Great South Road, Oakleigh Avenue / Hitchcock Road, Oakleigh Avenue / Scotts Field Drive, and Oakleigh Avenue/Spartan Road);
- Opportunities to utilise existing roads, particularly Manuia Road and / or Portrush Lane; and
- Key constraints and land use considerations.

The resultant alignment options are set out at Table 10-2 below. Each adopted the following design parameters:

- 24m corridor width (two lanes) with active mode facilities (following CFAF assessment as described in sections 3.2.2.2 and 10.2.1);
- Maximum vertical grade of 8%;
- Vertical clearance of 7.8m over the NIMT;
- Posted speed limit of 50km/h; and
- Horizontal curve minimum radii of 120m.

Table 10-2 - Manuia Road Route Refinement Options

Option	Design	Description
1		Maximise use of existing Manuia Road and intersection form with GSR. High skew structure crossing of NIMT.
2		Realigns intersection with GSR to safer form. Tie in with existing intersection with Hitchcock Road (to be changed to roundabout). Access provided to existing properties on southern side of Manuia Road.

Option	Design	Description
3		Maximise use of existing Manuia Road and intersection form with GSR. Tie in with Portrush Lane and existing intersection with Scotts Field Drive (to be changed to roundabout). Removes access to all existing properties on Manuia Road. High skew structure crossing of NIMT.
4		High skew structure crossing of NIMT. Realigns intersection with GSR to safer form. Tie in with Portrush Lane and existing intersection with Scotts Field Drive (to be changed to roundabout). Access provided to existing properties on southern side of Manuia Road.
5		Transport oriented alignment prioritising industrial movement to/from NE. Realigns intersection with GSR to safer form. Access provided to existing properties on southern side of Manuia Road.

10.3.1.2 Route refinement assessment

Following the methodology outlined in section 3.3.1, the above route refinement options were assessed using the MCA Framework. Table 10-3 summarises the assessment outcomes.

Table 10-3 - Summary of Manuia Road route refinement MCA assessment

Criteria	Scoring				
	1	2	3	4	5
Investment Objective 1: Safety					
Investment Objective 2: Travel Choice					
Investment Objective 3: Resilience					
Investment Objective 4: Access					
Land Use Futures					
Urban Design					

Criteria	Scoring				
	1	2	3	4	5
Land Requirement					
Social Cohesion / effects					
Human Health and Wellbeing					
Transport system integration					
User safety					
Ecology					
Historic Heritage					
Landscape / Visual					
Stormwater					
Natural Hazards					
Construction impacts on utilities / infrastructure					
Construction disruption					
Construction costs / risk					

The Project Team reviewed and compared the options. In general, it was noted that all options scored favourably against the investment objectives, and that the key differentiators between the options were in urban design, land requirement, social cohesion, user safety, construction disruption, and construction cost criteria. The specific findings are summarised in Table 10-4.

Table 10-4 - Key findings from Manuia Road route refinement MCA assessment

Option	Key findings from Manuia Road route refinement MCA assessment
1	• Avoided impacts on Portrush Lane and residential zoned land to the south of the alignment. • However, has a heavily skewed alignment which means that it scores less favourably in the urban design, user safety, construction disruption, and construction costs criteria. • In general, the skewed alignment was considered to result in poorer safety outcomes and greater construction challenges.
2	• Option 2 was anticipated to provide the greatest overall benefit. The alignment would involve a shorter and single-tangent bridge over the NIMT compared to the other options which was considered to involve slightly less constructability and engineering challenge. • Option 2 also scored the best for urban design and user safety due to it being the most direct and legible route. It was considered that the alignment would introduce infrastructure that could provide a clearer delineation between the industrial zoned land (to the north) and residential zoned land (to the south), thereby alleviating reverse sensitivity issues between industrial and residential land uses. While the alignment results in a triangle of residual industrial zoned land, this land was still considered usable post completion of the Project (see Table 10-4). • The localised impact on industrial zoned land over residential land was also acknowledged as a key differentiator in favour of Option 2. Overall, Option 2 involves larger but fewer and less complex properties compared to Options 3 and 4 which both impact residential land on Portrush Lane and community facilities to the south of Portrush Lane. Option 2 also provides for access to the existing Scout Hall and shopping complex to the south of Manuia Road residential, which are directly impacted by Options 3 and 4.

Option	Key findings from Manuia Road route refinement MCA assessment
3 4	• Options 3 and 4 were anticipated to have the greatest land requirement, with greater impact on existing residential land uses and established homes with no real additional benefits when compared with the other options. • One differentiator in favour of these options is that a Portrush Lane alignment provides stronger delineation between residential and industrial zoned land and minimises impact on industrial-zoned land. However, it was noted that the wider Takaanini industrial area has a supply of undeveloped light industrial-zoned land. • An alignment along Portrush Lane also brings infrastructure accommodating heavy vehicles and industrial traffic closer to the established residential area to the south.
5	• Considered to provide the most direct connection into the existing industrial area. • However, it is expected to have the worst urban design outcomes due to its lack of legibility, severance of industrial land, and large residual parcels left behind. • It is also anticipated to have the greatest ecological effect as it could impact the ecological features adjacent to Oakleigh Avenue and Hitchcock Road (a partially piped tributary of the Papakura Stream).

For the reasons summarised above, the assessment identified **Option 2** as the preferred alignment for Manuia Road (see Figure 10-4).

Figure 10-4 - Manuia Road Option 2 alignment in relation to AUP:OP zoning

10.3.1.3 Engagement

Following identification of the preferred alignment for Manuia Road, feedback was sought from technical specialists, affected landowners, Manawhenua, and Project partners. The following feedback was received:

- Specific concerns from landowners on property impacts and rationale for the Manuia Road connection in general;
- Questions raised on the potential interface of the new infrastructure and surrounding environment; and

- Questions from Manawhenua during the Southern Manawhenua hui around how effects such as stormwater quality, flooding, social impact, and visual impact would be addressed.

The Project Team considered that the feedback received could be addressed through further engagement with landowners and proposed conditions (e.g., the outline plan process and management plan requirements) as discussed in the Assessment of Effects on the Environment (**AEE**).

10.3.2 Taka Street route refinement

10.3.2.1 Concept Design Development

The network optioneering process identified Taka Street as a preferred corridor for a multi-modal connection. The indicative corridor assessed at the network optioneering stage followed the existing Taka Street alignment. Prior to exploring and developing any potential alignments for the Taka Street route refinement process, the Project Team revisited the constraints and land use mapping for this area. The key constraints and relevant land use considerations are shown in Figure 10-5 below.

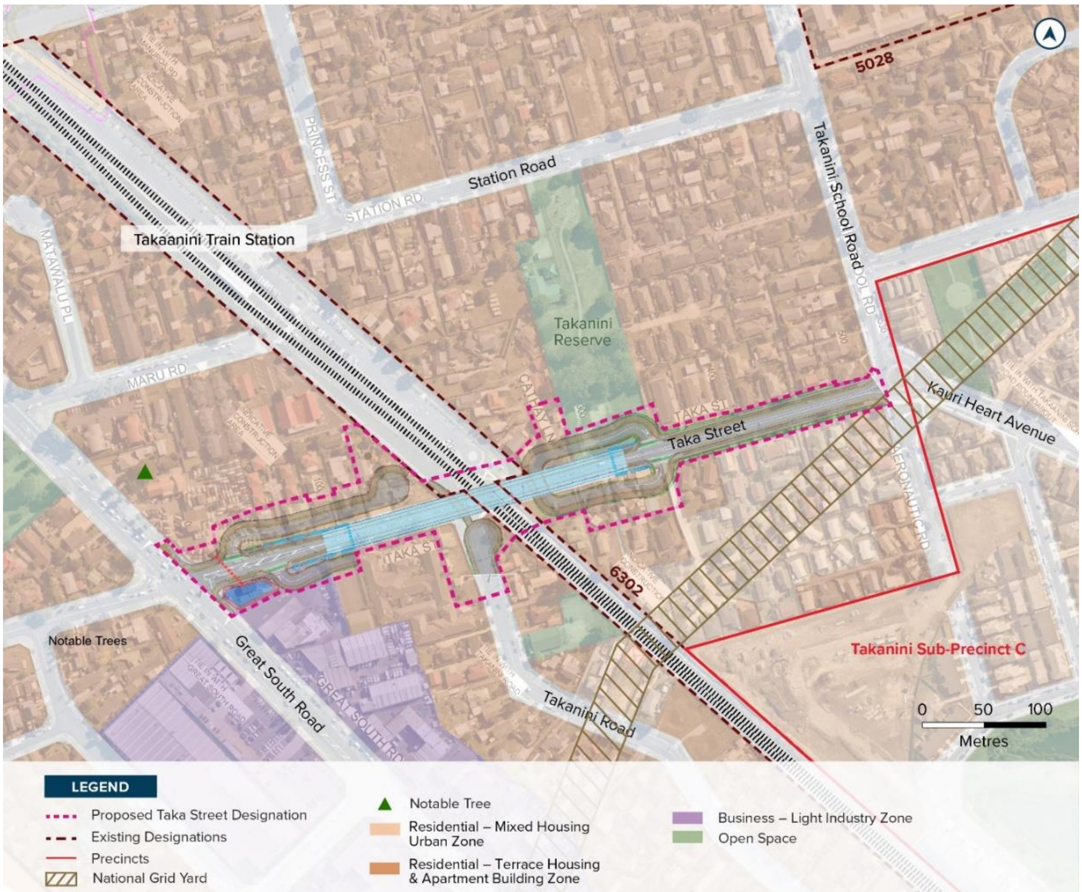


Figure 10-5 - Taka Street land use and constraints map

In summary, the following features were noted:

- **Eastern side of the rail line** – Predominantly residential with a number of long driveways that services a group of properties. There is the Takaanini Reserve on the northern side adjacent to Cathay Lane. Takaanini Train Station is also located north of the existing level crossing. Access to properties as well as Takaanini Reserve and Takaanini Train Station needs to be considered; and
- **Western side of the rail line** – Mixed residential and commercial properties. Of particular note is a care centre and church on the southern side of Taka Street, and an ECE on the northern side of

Taka Street. There is also an existing pedestrian accessway connecting Taka Street to Maru Road to the north (along the Train Station). Access to properties needs to be considered. Takanini Road needs to be carefully considered to ensure adequate access is maintained.

Following on from the constraints review, alignment variations to gain enough clearance for the bridge to cross the rail line were considered between Great South Road (to the west) and Takanini School Road (to the east). Considering the constraints identified above, the property impacts associated with deviation, and the general preference to utilise existing infrastructure, the Project Team considered that there was no strong evidence to develop offline variations of the alignment. An 'online' design was therefore developed (see Figure 10-6).

As part of the route refinement process, the supporting works and infrastructure required to integrate the new connection with the surrounding environment were also identified. These included:

- Provision for at-grade access lanes to provide vehicular and pedestrian access to properties impacted by the grade separation (See Figure 10-6); and
- Confirmation that the existing Takanini Road could not connect to the proposed Taka Street bridge structure. As such, Takanini Road was recommended to incorporate a cul-de-sac head, with provision for future connectivity to Takaanini Train Station via active modes.

Overall, these supporting works have been indicatively designed to minimise additional property requirements, avoid identified constraints and use existing infrastructure / alignments as much as practicable.

10.3.2.2 Engagement

Following confirmation of the preferred online alignment for Taka Street, feedback was sought from technical specialists, affected landowners, Manawhenua, and Project partners. The following feedback was received:

- Specific concerns from landowners on property impacts;
- Questions on how existing and future connectivity to Takaanini Train Station would be provided for, particularly safe and legible connections;
- Concerns on the loss of direct interface between Takaanini Reserve and Taka Street and the loss of existing park amenities such as the skate park and established trees; and
- Whether the existing ECE could realistically operate in future considering the proposed access arrangements, anticipated impact on carparking, construction noise, and location in relation to the new infrastructure. However, discussions with the ECE operator also provided further context on its current role in the community, the demographics and intake they provide for, and the ECE's relationship with other social infrastructure such as the aged care centre and Takanini School.

Considering the feedback above, particularly relating to connectivity to Takaanini Train Station and the existing ECE, the Project Team revisited the indicative design for the access lanes, specifically north of the Taka Street alignment. While bespoke access lane arrangements were explored, land requirement and disruption could not be fully avoided. Moreover, modifying the indicative design to retain the ECE would compromise the ability to:

- Extend the access lane further east (i.e., past the ECE) and provide for active modes (shared walking and cycling facilities) that can connect and integrate with the Takaanini Train Station which can provide a wider community benefit;
- Provide for sufficient landscape treatment along the access lane and achieve a positive interface between the new bridge alignment and remaining adjacent properties;

- Avoid creating "pinch-points" along the length of the bridge alignment. For example, if due to the limited space between the ECE and the new bridge only a footpath can be accommodated to connect to Takaanini Train Station. This arrangement could result in entrapment zones or publicly accessible spaces that are not legible as public spaces; and
- Minimise constraints for future construction methodology. As above, the "pinch points" that could result from retaining the ECE is likely to limit the space available for future equipment, provide temporary access during construction and the process for undertaking the works.

On this basis, the Project Team did not favour further revisions to the access lane design. Similarly noting the feedback above relating to Station connectivity and the interface with the Takaanini Reserve, the northeastern access lane was also widened to accommodate active modes and provide for sufficient landscape treatment along the access lane. The resultant concept design is shown below at Figure 10-6.

The Project Team considered that the remaining feedback received could generally be addressed through further engagement with landowners and proposed conditions (e.g., the outline plan process and management plan requirements) as discussed in the AEE.

Figure 10-6 - Taka Street concept design incorporating at-grade access lanes

10.3.3 Walters Road route refinement

10.3.3.1 Concept Design Development

The network optioneering process identified Walters Road as a preferred corridor for a multi-modal connection. The indicative corridor assessed at the network optioneering stage followed the existing Walters Road alignment. Prior to exploring and developing any potential alignments for the Walters Road route refinement process, the Project Team revisited the constraints and land use mapping for this area. The key constraints and relevant land use considerations are shown in Figure 10-7 below.

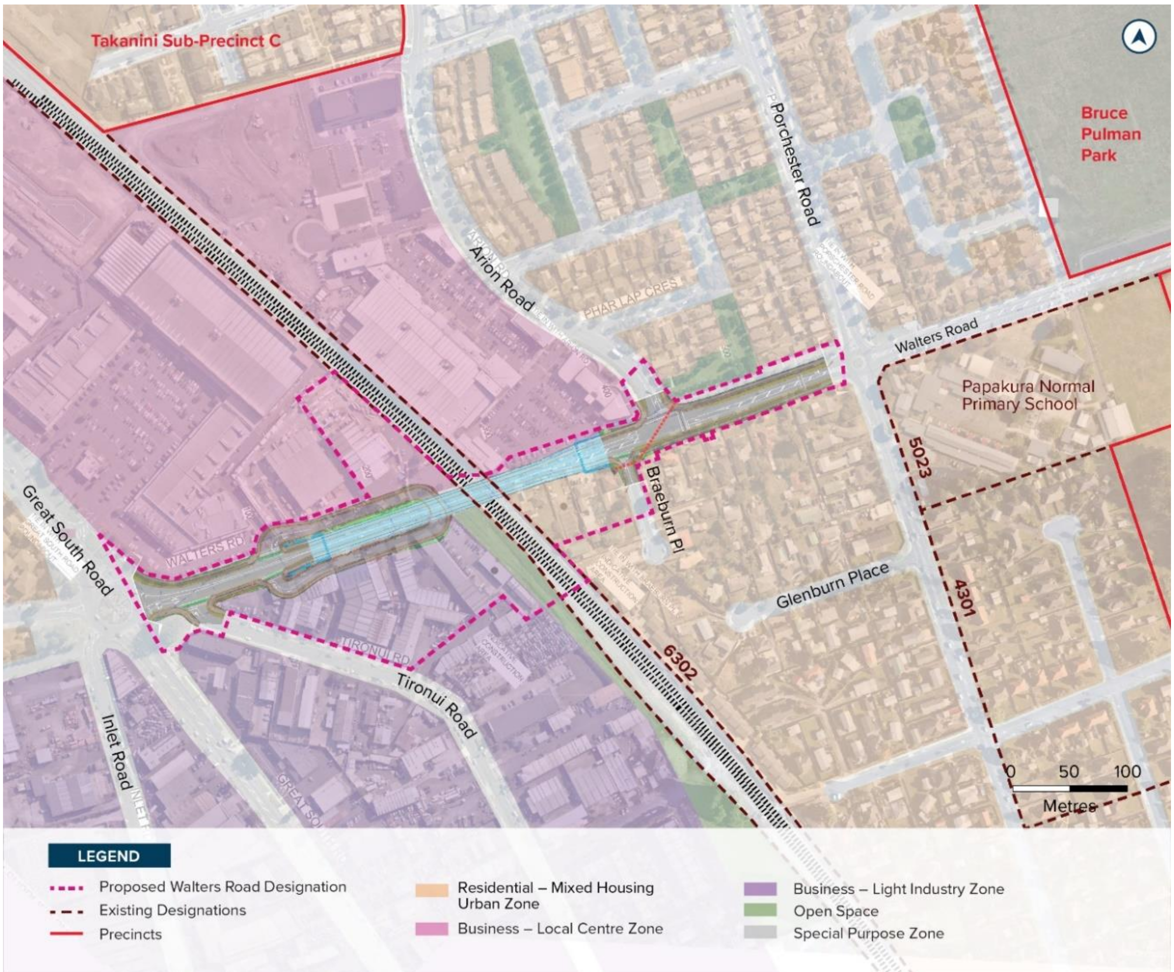


Figure 10-7 - Walters Road land use and constraints map

In summary, this identified the following considerations:

- **Eastern side of the rail line** – The southern side is predominantly residential whereas the northern side has a large shopping complex. This shopping complex should be avoided where possible to minimise the associated property risks and impact on community amenity. There is also an existing ECE on the southern side of Walters Road. The existing intersections of Arion Road and Braeburn Place need to be carefully considered to ensure adequate access is maintained; and
- **Western side of the rail line** – both sides of Walters Road are predominantly commercial land uses. This includes an ECE, Carters and shopping centre on the northern side of Walters Road, and automotive, marine, and paint-related related businesses on the southern side of Walters

Road. It is also noted that there is an established trade training and education centre on the southern side of Walters Road.

Following on from the constraints review, alignment variations to gain enough clearance for the bridge to cross the rail line were considered between Great South Road (to the west) and Porchester Road (to the east). Considering the constraints identified above, the property impacts associated with deviation, and the general preference to utilise existing infrastructure, the Project Team considered that there was no strong evidence to develop offline variations of the alignment. An 'online' design was therefore developed (see Figure 10-8).

Figure 10-8 - Walters Road concept design incorporating at-grade access lanes

As part of the route refinement process, the supporting works and infrastructure required to integrate the new connection with the surrounding environment were also identified. For Walters Road, this was predominantly new access lanes west of the rail to provide sufficient access to remaining properties. The access lanes have also been indicatively designed to minimise additional property requirements, avoid identified constraints and use existing infrastructure as much as practicable.

10.3.3.2 Engagement

Following confirmation of the preferred online alignment Walters Road, feedback was sought from technical specialists, affected landowners, Manawhenua, and Project partners. The following feedback was received:

- Specific concerns from landowners on their property impact;
- Concerns on the interface with the new infrastructure and the Takanini Town Centre;
- Specific concerns regarding the physical form of grade separation, in particular the merits of the proposed bridge as compared with an underpass (addressed in sections 8 and 9);
- Recommended closure of Braeburn Place with Walters Road and instead connecting it through to Glenburn Place;

- Retaining or providing alternative access for businesses with heavy vehicles (such as Carters and Mitre 10 Mega);
- Further consideration of what properties are impacted as some buildings may be on separate sites but are connected to buildings impacted by the access lanes; and
- Recommended retention of the existing established Oak Tree (street tree) at the intersection of Walters Road and Great South Road.

In response, the Project Team noted that:

- The Oak Tree was identified as a feature that could be retained and provided for as part of the indicative design;
- The Braeburn Place recommendation was considered to be out of scope for the TLC; and
- The remaining matters raised were matters that could more appropriately be addressed through further engagement with landowners and the proposed conditions (as discussed in the AEE).

10.3.4 Manuroa Road route refinement

10.3.4.1 Concept Design Development

The network optioneering process recommended the closure of Manuroa Road to vehicular traffic requiring cul-de-sacs on either side of the rail line. However, active mode connections would also be provided for at this location.

Figure 10-9 - Manuroa Road land use and constraints map

Similar to the process undertaken for the multi-modal connections (as discussed above), the Project Team revisited the constraints and land use mapping for the Manuroa Road area prior to exploring and developing any potential alignments. The key constraints and relevant land use considerations are shown in Figure 10-9. In summary, the following considerations were identified:

- **Eastern side of the rail line** – The southern side is predominantly residential and provides access to the Takaanini Train Station. Connectivity to and integration with the station should be prioritised. The northern side comprises mainly of a site with three ECE facilities and residential land uses; and
- **Western side of the rail line** – The northern and southern side of Manuroa Road is predominantly residential with some businesses (e.g., car yard to the south and a local shopping centre to the north). There are two notable trees located within private property to the south.

Considering the constraints identified above and AT's TDM standards for culs-de-sac, an indicative concept design was developed (see Figure 10-10). A linear active mode connection that followed the existing road alignment was not practical in this case because the vertical clearance over the NIMT and best-practice design standards (e.g., suitable grades for active modes) to be met would likely result in a long / extended connection that impacts on property access along the road. The proposed ramp arrangements provide for a smaller works footprint.

One of the key considerations for the Manuroa Road active modes connection location was integration with the Takaanini Train Station which sits on the southern side. The design of the active mode connections also provides the flexibility for a bridge with stairs or lifts. For the culs-de-sac, the preference was to follow the existing road alignment as much as practicable except where property impact or identified constraints could be minimised by shifting slightly offline (e.g., the western cul-de-sac). The location and flexibility requirements in the design of this crossing have been discussed and agreed with AT SMEs.

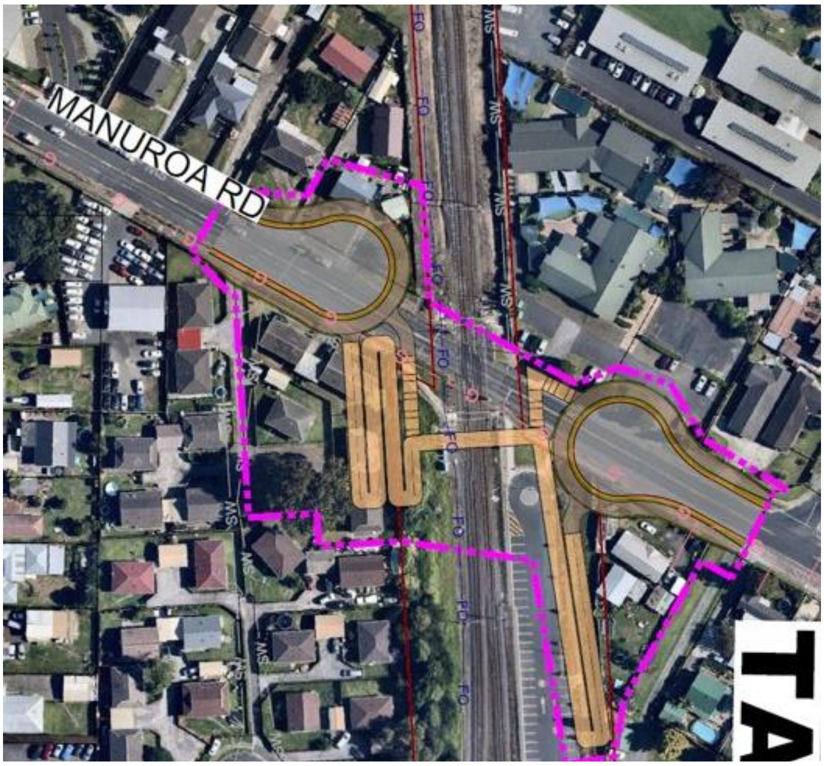


Figure 10-10 - Manuroa Road active mode connection concept design

10.3.4.2 Engagement

Following confirmation of the concept design, feedback was sought from technical specialists, affected landowners, Manawhenua, and Project partners. The following feedback was received:

- Specific concerns from landowners on their property impact;
- Consideration of users with different mobility requirements and weather conditions in the design of the ramps;
- Retention as much as practicable of the two notable trees within private property; and
- Consideration of how the proposed infrastructure could provide for additional community benefits / outcomes i.e., being multi-functional and not just transport infrastructure.

In response, the Project Team noted that:

- In relation to the notable trees, the infrastructure itself avoids locating over these trees. However, there is potential for these trees to be impacted during the construction process given their proximity to the proposed infrastructure. As above, the infrastructure is proposed on the south of Manuroa Road to better integrate with Takaanini Station, and the ramp location is constrained with the NIMT to the east and existing dwellings to the south. Changes to the ramp design at this stage is likely to result in further property impacts without further reduction in risk to the trees. Accordingly, no further changes in the indicative design were recommended; and
- The remaining matters raised were matters that could more appropriately be addressed through further engagement with landowners and the proposed conditions (as discussed in the AEE).

10.3.5 Spartan Road route refinement

10.3.5.1 Concept Design Development

The network optioneering process recommended the closure of Spartan Road to vehicular traffic requiring culs-de-sac on either side of the rail line. However, active mode connections would also be provided for at this location.

Similar to the process undertaken for the multi-modal connections (as discussed above), the Project Team revisited the constraints and land use mapping for the Spartan Road area prior to exploring and developing any potential alignments for the active mode connections. The key constraints and relevant land use considerations are shown in Figure 10-11. In summary, the following considerations were identified:

- **Eastern side of the rail line** – The northern side comprises predominantly heavy industrial zoned land and the southern side is light industrial zoned. These sites accommodate industrial warehouses, industrial yards, and trade suppliers. The sites are frequented by heavy vehicles and access for these sites is important to consider; and
- **Western side of the rail line** – The northern side comprises of the VTNZ site while the southern side comprises of the Halls distribution centre. The VTNZ site is frequented by a range of vehicles while the Halls site is frequented mainly by heavy vehicles. Access for these sites is also important to consider.

Following a similar process to Manuroa Road above (see section 10.3.4), the concept design for the Spartan Road active connection crossing was developed as shown in Figure 10-12. A linear active mode connection that followed the existing road alignment was also not practical in this context due to the clearance and grade requirements and likely resulting impacts on property access along the road. The proposed ramp arrangements provide for a smaller works footprint.

The location for the culs-de-sac and active mode connection at Spartan Road considered where property impacts including impacts on buildings and access could be avoided. The location and flexibility requirements in the design of this crossing have been discussed and agreed with AT SMEs.

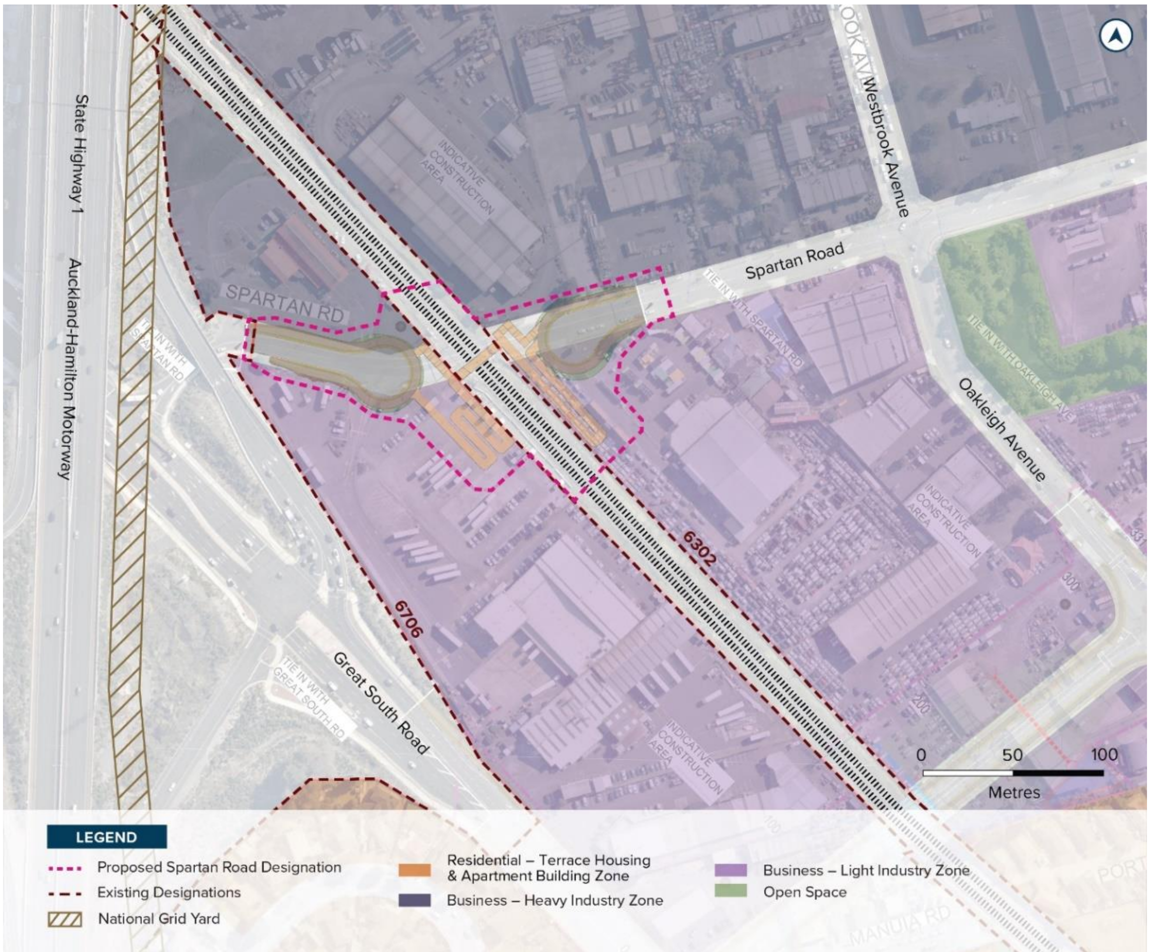


Figure 10-11 - Spartan Road land use and constraints map

10.3.5.2 Engagement

Following confirmation of the concept design, feedback was sought from technical specialists, affected landowners, Manawhenua, and Project partners. The following feedback was received:

- Specific concerns from landowners regarding property impacts;
- Consideration of users with different mobility requirements and weather conditions in the design of the ramps; and
- Consideration of the surrounding industrial context of the infrastructure and urban design recommendations to revise the ramp designs so they are closer to the Spartan Road desire line, and provide improved visibility, legibility and better address CPTED concerns. Further opportunities were also identified to reduce the number of switchback landings and overall distance in the western ramps which could improve usability for active modes.

Most matters raised were matters that could more appropriately be addressed through further engagement with landowners and the proposed conditions (as discussed in the AEE). However, the Project Team revisited the indicative design in light of the urban design feedback received in the last point above. As such, slight modifications were made to achieve an improved ramp design outcome as shown in Figure 10-12 below.

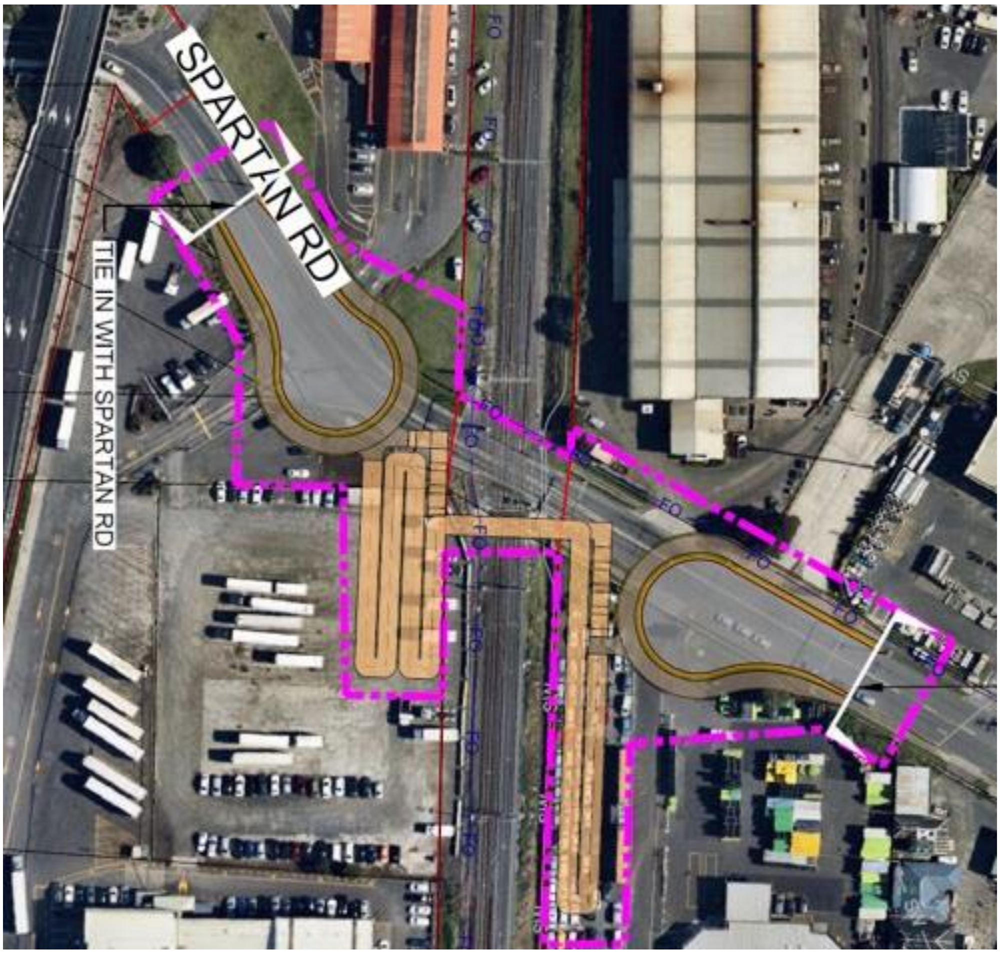


Figure 10-12 - Spartan Road active mode connection concept design

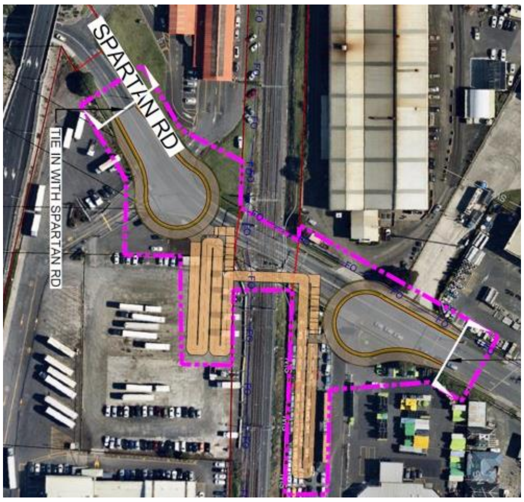
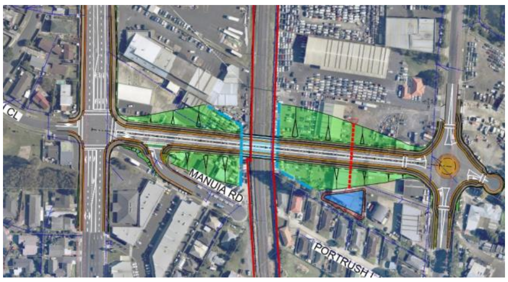
11 Preferred Network

Following the optioneering process documented in this report, the preferred options comprising the full TLC network were finalised and provided to AT for its final decision-making processes. The preferred option provided to AT and ultimately confirmed by the AT Board was informed by the consideration of:

- The **number** of east-west crossings needed in the TLC network, and which transport modes should be accommodated;
- The **locations** for east-west crossings in the TLC network;
- The **physical form of grade separation** for the TLC network – whether grade separation of road and rail is to be achieved by raising or lowering roads, or raising or lowering rail; and
- The **alignment** and **physical extent** of each east-west crossing in the TLC network.

The preferred network is summarised in Table 11-1, and mapped in Figure 11-1.

Table 11-1 - TLC Preferred Network Summary

Project area	Recommended interventions	Concept design
Spartan Road	Closure of the existing level crossing, new active modes bridge crossing across the NIMT and associated works.	
Manuia Road	New multi-modal bridge crossing over the NIMT and associated works.	

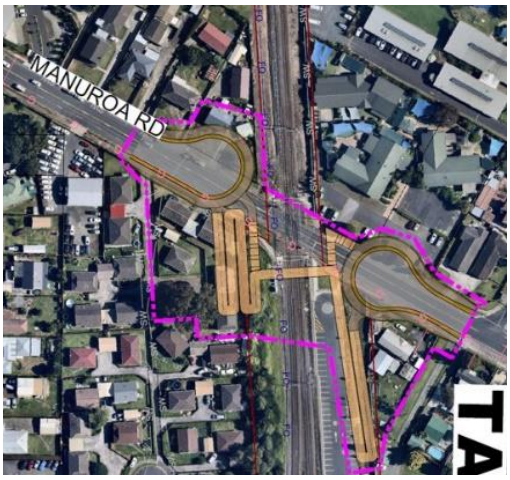
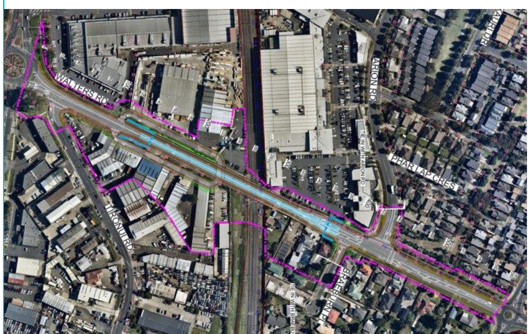
Project area	Recommended interventions	Concept design
Manuroa Road	Closure of the existing level crossing, new active modes bridge crossing across the NIMT and associated works.	
Taka Street	Grade-separation of the existing level crossing with a new multi-modal bridge crossing over the NIMT and associated works.	
Walters Road	Grade-separation of the existing level crossing with a new multi-modal bridge crossing over the NIMT and associated works.	

Figure 11-1 - TLC Preferred Network

12 Consideration of alternative statutory methods

As part of the consideration of alternatives, the alternative statutory methods to enable route protection and future implementation of the Project have been assessed in accordance with section 171(1)(b) of the RMA. Methods were considered in light of a range of contextual elements including project strategic importance, project urgency/timing, and project complexity risk profile. The methods considered included:

- Designations;
- Resource consents;
- Structure Planning and Plan Changes
- Landowner/developer negotiations; and
- Traditional property acquisition.

The assessed strengths and weaknesses of these statutory methods in the context of the TLC are summarised in Table 12-1 below.

Table 12-1 - Strengths and weaknesses of statutory methods in the TLC context

Method	Summary of strengths and weaknesses in the TLC context
Designations	• Prevents development that would prevent/hinder the proposed works within the designation boundaries. • Negates need for land use consents to implement works otherwise authorised by section 9(3) of the RMA – however regional consents need to be applied for separately. • Has interim effect from the time of lodgement. • Can provide for long-term route protection through extended lapse periods. • Can maintain design flexibility – less detail may be provided at lodgement, and further detail to be provided to the territorial authority subsequently at the Outline Plan stage prior to construction. • Provides certainty to affected landowners and the ability to request early buy-out from the requiring authority. • Does not require all land needed for the project to be purchased prior to lodgement (unless early buy-out is requested and approved) – property costs can be spread over period between NoR lodgement and the implementation of the work. • Additional areas required for construction can be rolled-back after works are completed. • Requiring authority retains decision making power. • High level of information required to support. • Exposure to contingent liability, and ultimately requires requiring authority to purchase land within footprint under the Public Works Act 1981 (PWA) – i.e. designation does not resolve property acquisition aspects of route protection. • Planning 'blight' – affected property owners may be unwilling or unable to maintain or develop properties when designated.
Resource Consents	• Resource consents do not prevent development that would otherwise prevent/hinder the proposed works – not a 'route protection' mechanism. In lieu of a route protection mechanism, all land needed for the project would need to be purchased before lodgement (see 'Traditional Property Acquisition' below). • Land use consents under section 9(3) of the RMA would need to be sought individually and not aggregated in the form of a designation. • Unable to utilise Outline Plan process – less design flexibility than a designation.
Structure Planning / Plan Changes	• Mechanisms within Structure Plans and Plan Change Precincts such as indicative roads and frontage setbacks have historically functioned as alternative route protection measures in lieu of designations. However, these mechanisms provide weaker protection from precluding development than designations, and do not specifically authorise the works – accordingly resource consents would ultimately be needed to authorise works, at which time all land needed for the Project would need to be purchased (see 'Traditional Property Acquisition' below).

Method	Summary of strengths and weaknesses in the TLC context
	• Some activities required for the works are enabled under the Strategic Transport Corridor Zone and within roads under the E26 Infrastructure provisions of the AUP:OP. However, given that much of the land required for the Project is subject to other zoning and existing land uses, a Plan Change would be required. This would be less practical than simply lodging an NoR, and would require earlier land purchase (see 'Traditional Property Acquisition' below).
Landowner / Developer Negotiation	• While alternative route protection mechanisms can be negotiated with landowners and developers (as above), ownership within the TLC project area is fragmented – over 190 properties are either partially or fully required for the Project. Negotiations requiring the concurrent agreement of this number of parties would likely be impractical. • As above – alternative route protection mechanisms provide weaker protection from precluding development than designations, and do not specifically authorise the works. Accordingly, resource consents would ultimately be needed to authorise works, at which time all land needed for the project would need to be purchased (see 'Traditional Property Acquisition' below).
Traditional Property Acquisition	• Not considered appropriate because property is typically purchased closer to construction when more detailed design is available – full property costs incurred immediately for a project that may not be implemented for a long period of time. • Purchasing land ahead of detailed design may result in too much or too little land being acquired with little flexibility between permanent and temporary requirements. • Would need to be accompanied by resource consents to authorise works.

Having considered the relative strengths and weaknesses of the various route protection mechanisms outlined in Table 12-1, **designations** were identified as the preferred route protection method for the Project, with AT as the Requiring Authority. Designations were considered the most logical and effective method to protect the route in an evolving environment because they:

- Provide certainty to all parties including the community, affected landowners, and developers;
- Are a well-recognised and understood tool for route protection which links with future land acquisition processes through the Public Works Act 1981 (**PWA**);
- Maximises flexibility for future implementation – provides for progression of detailed design and implementation at the appropriate time;
- Negates the need for additional land use consents to implement works otherwise authorised under section 9(3) of the RMA;
- Will continually provide for ongoing future operation and maintenance requirements as well as construction works;
- Reduces future cost risk in cases where route protection and associated land purchase can be undertaken prior to upzoning and / or development which induces a land value increment; and
- Provides protection of the land from development that would prevent / hinder the Project from the time of lodgement. This is particularly relevant in the Takaanini context which is already experiencing significant intensification.

1 Appendix A: MCA Framework

Well being	MCA topic	#	Criteria	Measure
Investment Objectives	Investment Objectives		Takaanini Level Crossings	**I.O 1 - Safety** – Provide improvements at level crossings that contribute to a transport network free from deaths and serious injuries **I.O 2 - Travel Choice** – Support mode shift by improving active mode facilities and rail capacity **I.O 3 - Resilience** – Support network resilience for Takaanini and improved reliability for the Southern Rail Line **I.O Access** – Improve east-west connections to enable improved access to economic and social opportunities.
Cultural	Heritage	1a	Heritage	*Extent of effects on:* *Sites and places of valued heritage buildings, trees (with heritage value) and places;* *Sites and places of archaeological value;* *Sites and places of European cultural heritage value; and* *Sites and places of significance to Manawhenua.*
Social	Socio-economic impacts	2a	Land use futures	*To what extent will the option impact on the future development of land (within the corridor, adjacent to it and impacted by it – i.e. consider all 3 scales), in relation to:* *Underlying existing urban structure (block and street pattern);* *Integration with the future landuse scenario (aligning housing delivery with infrastructure delivery);* *Size and shape of potential development parcels to enable appropriate building typologies;* *Ability to consolidate residual land; and* *Access that does not prevent neighbouring development.*

Well being	MCA topic	#	Criteria	Measure
		2b	Urban design	*To what extent does the option support a quality urban environment (both current and future planned state)? particularly relating to:* *Context and planned place making considerations;* *An inviting, pleasant and high amenity public realm;* *Open space integration;* *Active interface between public and private realm; and* *Scale of long term impact on the amenity and character of the surrounding environment.*
		2c	Land requirement	*Scale of public / private land (m^2 / number of properties / special status of impacted property) required to deliver the option.*
		2d	Social cohesion	*Impact on connectivity/accessibility for the existing urban areas including access to:* *Employment;* *Other communities or within the same community;* *Shops/services/other community and cultural facilities/'attractors';* *Severance of the existing community (including consented);* *Scale of effect on existing community facilities and open space; and* *Public access to the coast, rivers and lakes.*
		2e	Human Health and Wellbeing	*Will the option potentially affect any sensitive land uses nearby or consented (adjacent residential, childcare centres, hospitals, rest homes, marae and schools)? particularly relating to:* *Air Quality;* *Contaminated Land; and* *Noise and Vibration.*

Well being	MCA topic	#	Criteria	Measure
Environmental	Natural Environment	3a	Landscape/visual	*Will the option have visual effects?* *Extent of effects on:* *The natural landscape and features such as streams, coastal edges, natural vegetation and underlying topography – acknowledging planned changes to area in light of urban land use/zoning; and* *Natural character and outstanding natural features/landscapes including geological features (mapped and protected features).*
		3b	Stormwater	*Impact of operational stormwater (both quantity and quality) on the receiving environment, including:* *Potential flooding effects of the option within the catchment; and* *Extent and consequences of likely mitigation measures.*
		3c	Ecology	*Extent of effects on:* *Significant indigenous flora;* *Significant habitats of indigenous fauna;* *Indigenous biodiversity;* *Stream/waterway ecology; and* *Coastal environment (e.g. CMA).*
		3d	Natural Hazards	*Extent of effect on adverse geology, including:* *Steep slopes;* *Seismic impacts; and* *Other resilience risks (low level infrastructure near coastlines, inundation areas).*
Economic	Transport	4a	Transport system integration	*The extent to which the option achieves the following:* *Integration with wider network and between modes;* *Resilience to operational incidents or short term life-line access disruption; and* *Reduces the need to travel increase access to non-car choices.*
		4b	User Safety	*Extent of safety effects on all transport users, including:* *People in public transport;* *People walking or cycling; and* *People in private vehicles*

Well being	MCA topic	#	Criteria	Measure
	Construction impacts	5a	Construction impacts on utilities/infrastructure	*Requirements for relocation/design of existing infrastructure, including* *Consideration of safety impacts;* *Risk of continuity of service over construction;* *Engagement with utility providers; and* *Opportunities for integration with other bulk infrastructure.*
		5b	Construction Disruption	*Construction impacts on people and businesses regarding:* *Traffic & noise;* *Earthworks related effects including dust;* *Quality of life and amenity; and* *Economic impacts on businesses/community/town centres.*
	Cost & Construction Risk	6a	Construction costs and risk	*Assessed cost for construction of options including:* *Complexity and risk in construction (including consideration of constructability);* *Complexity in programme; and* *Cost and complexity of safely undertaking works (including works on contaminated land).*

2 Appendix B: Assumed ground conditions and implications for Walters Road underpass option design

Assumed ground conditions informed the key features of the trench structure concept design adopted for the purposes of MCA assessment are summarised below:

- 0-2m below ground level (**bgl**) – Fill;
- 2-12m bgl – Peat [Ardmore Member];
- 12-18m bgl – Soft Clay [Takaanini Formation];
- 18-30m bgl – Stiff Alluvium [Takaanini Formation];
- Unknown depth to the top of Waitematā Group rock; and
- An assumed groundwater level of 2m bgl.

These assumed ground conditions informed the key features of the trench structure concept design adopted for the purposes of MCA assessment as follows:

- For the central section of trench with a total excavation depth ranging from 5-9m bgl:
  - 900mm diameter soft/hard reinforced concrete bored pile secant walls to support the excavation at a depth of 21m bgl, with every fourth (hard) pile extended to 28m bgl;
  - Temporary props at 2.5m vertical centres to support the excavation;
  - A floor slab of 1.2m thick reinforced concrete, with the deepest road level being approximately 7.5m bgl;
  - Steel screw piles at 5m centres beneath the road centre line to a depth of 23m bgl; and
  - A permanent prop at the top of the wall or reinforced concrete bridge deck slab to support the NIMT.
- For the ends of the trench where total excavation depth is less than 5m bgl:
  - Temporary excavation to 2m depth along the trench alignment;
  - 13m deep temporary sheet pile wall for excavation support and construction groundwater cut-off;
  - A temporary prop to support the excavation;
  - Permanent reinforced concrete floor (0.8m thick) and cantilever walls (0.6m thick); and
  - Steel screw piles under the flood on a 5m grid to a depth of 23m.
- Steel screw piles beneath the road centre line to a depth of 23m bgl.

These concept design assumptions were considered suitable for the purposes of route protection option assessment for an underpass set out in section 8.