TE TUPU NGĀTAHI
SUPPORTING GROWTH

VOLUME 4

Takaanini Level Crossings Assessment of Traffic Noise Effects

October 2023

Version 1.0

WAKA KOTAHI NZ TRANSPORT AGENCY

New Zealand Government

Document Status

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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
AC14	Asphaltic concrete
AEE	Assessment of Effects on the Environment report
AT	Auckland Transport
AUP-OP	Auckland Unitary Plan: Operative in Part
A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
BPO	Best Practicable Option
CRL	City Rail Link
dB	Decibel. The unit of sound level.
KiwiRail	KiwiRail Holdings Limited
L_{A90}	The A-weighted sound level exceeded for 90 % of the measurement period, measured in dB. Commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
$L_{Aeq(24h)}$	The L_{Aeq} sound level averaged over a 24-hour period from midnight to midnight.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period. Usually measured with a fast time–weighting i.e. L_{AFmax}
N/A	Not Applicable
NIMT	North Island Main Trunk rail line
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
NPS	National Policy Statement
NPS-UD	National Policy Statement on Urban Development
NoR	Notice of Requirement
NoR1	Notice of Requirement 1: Takaanini Level Crossings Project (Spartan Road, Manuia Road, Manuroa Road, and Taka Street)
NoR2	Notice of Requirement 2: Takaanini Level Crossings Project (Walters Road)
NZS6801	New Zealand Standard NZS 6801:2008 *Acoustics – Measurement of environmental sound*
NZS6802	New Zealand Standard NZS 6802:2008 *Acoustics - Environmental Noise*
NZS 6806	New Zealand Standard NZS 6806:2010 *Acoustics - Road-traffic noise - New and altered roads*

Acronym/Term	Description
PPF	Protected Premise and Facility in accordance with NZS 6806
RMA	Resource Management Act 1991
Te Tupu Ngātahi	Te Tupu Ngātahi Supporting Growth
TLC / the Project	Takaanini Level Crossings Project
Waka Kotahi	Waka Kotahi New Zealand Transport Agency

Executive Summary

This report assesses traffic noise effects for the Takaanini Level Crossings Project (**TLC / the Project**) to inform the Assessment of Effects on the Environment (**AEE**) for two Notices of Requirement (**NoRs**) being sought by Auckland Transport (**AT**).

Methodology

We applied the following methodology to the traffic noise assessment for Project:

- The noise criteria categories of NZS 6806 Acoustics – Road-traffic noise – New and altered roads (**NZS 6806**);
- Noise effects (both positive and adverse) through determining the noise level changes due to the Project; and
- Noise effects based on the number of people potentially highly annoyed based on the noise levels with the Project (and any mitigation) in place.

The Project provides for both road crossings and active mode crossings only. While active mode crossings would not normally be assessed using NZS 6806, we have included this assessment to show the difference in traffic noise levels due to the closure of two roads.

We understand that low noise road surface material Asphaltic Concrete (**AC**) is proposed to be used on all roads apart from the service lanes. The service lanes carry low traffic volumes at a low speed, and therefore have only negligible effects on the overall traffic noise level.

We used computer noise modelling to predict existing, and future traffic noise levels (both without and with the Project in place). Noise levels were predicted for each individual Protected Premise and Facility (**PPF**) and also as noise level contours over a wider area.

The National Policy Statement on Urban Development (**NPS-UD**) enables higher density dwellings for sites adjacent to the Project. We anticipate that:

- Zoning within a walkable catchment of the Takaanini rail station will enable, at a minimum, apartment buildings of six storeys; and
- Beyond walkable catchments, residential zoning will provide for three dwellings up to three storeys in height (subject to meeting the relevant development standards).

While we have not assessed the potential noise levels received by possible future dwellings, we have commented on the likelihood of any potential changes to the mitigation options if more intensive development were to eventuate.

Mitigation recommendations

We have assessed all existing PPFs within 100m of the Project designation boundary. Overall, the Project will generally result in improved traffic noise levels.

The exception is Manuia Road, where a new road bridge will be constructed adjacent to a residential area. Here, noise levels are predicted to increase significantly, and noise levels are predicted to be within Category C if no mitigation is implemented.

Overall, we recommend the implementation of low noise road surface, in this instance the proposed base road surface. This mitigation will also benefit any future sensitive receivers, e.g. where the NPS-UD enables higher density dwellings along the alignment.

In addition, we recommend higher barriers on the bridge at Manuia Road, and a noise barrier extending from the bridge some 60m to the east, to reduce noise levels at the most affected PPFs closest to the bridge. This will reduce the noise levels for all PPFs to within Categories A and B.

Effects analysis

We compared the result of the individual traffic noise level predictions with the noise criteria categories A, B and C of NZS 6806, and calculated the anticipated noise level change due to the Project for each crossing, as well calculating the number of people potentially highly annoyed for the entire Project.

The aim is to achieve the lowest practicable traffic noise level where the Project would otherwise result in an adverse effect on the noise level experienced by sensitive receivers (PPFs).

Overall, the change in noise level is predicted to be minimal due to the traffic generation itself. However, many dwellings are intended to be removed to make space for the Project. The removal of the first row of houses will result in noticeable to significant noise level changes to PPFs behind. Mostly, those PPFs would still receive noise levels within Category A (the preferred noise criteria category), however, a small number of PPFs would receive a noticeable noise level increase and/or noise levels within Category B or C.

For the majority of PPFs (255 of the total of 343 PPFs assessed across all crossings), the noise level changes due to the Project will be insignificant (ranging from +2 to -2 dB). A further 62 PPFs are predicted to receive noticeable to significant noise level reductions due to road closures and the elevation of the bridges providing shielding to houses below. The remaining 26 PPFs are predicted to receive noticeable to significant noise level increases, mostly where a new road crossing is constructed at Manuia Road, or where houses around the new bridges are removed, which reduces shielding of traffic noise for houses behind.

Should more intensive housing be developed adjacent to the Project, the design of these new houses would need to take account of the anticipated noise environment. That would be assisted by the fact that low noise road surface is recommended for all crossings.

Summary of Assessment of Effects and Recommendations

Effect	Assessment	Recommendation
Traffic noise – all crossings	All crossings are located in well-established residential and commercial areas. PPFs include dwellings, childcare centres and a retirement care home. Only existing PPFs have been assessed in detail. The largest adverse effects are anticipated from: - The removal of the first row of house around the works. This will leave PPFs behind exposed to traffic noise. - The new road crossing introduced at Manuia Road, an area where currently no road exists - The gradient of traffic approaching the bridge, which is in part mitigated by the bridge edge barrier. The largest positive effects are anticipated from: - The closure of Spartan and Manuroa Roads and replacement with active mode bridges. - The edge barriers providing shielding of traffic when at the bridge crest above the houses	Mitigation is already assumed in the form of low noise road surface. Any future intensification of noise sensitive activities around the crossings should take account of the noise environment and provide suitable sound insulation and ventilation on construction. Any existing PPFs receiving noise levels within Category C (Taka Street crossing) should be investigated for building modification mitigation
Manuia Road crossing	This crossing is the only new road bridge in an area where none currently exists. The introduction of a new noise source will cause noticeable to significant increases in traffic noise levels, and some PPFs are predicted to receive noise levels in Category C.	In addition to the use of low noise road surface, the bridge edge barrier to the south is recommended to be increased in height to 1.5m, and be extended from the bridge edge as a 2m barrier for approximately 60m to the east

1 Introduction

1.1 Purpose and scope of this Report

This Assessment of Traffic Noise Effects report (**Report**) has been prepared to inform the Assessment of Effects on the Environment (**AEE**) for two Notices of Requirement (**NoR**) being sought by Auckland Transport (**AT**) for the Takaanini Level Crossings Project (**TLC / the Project**) under the Resource Management Act 1991 (**RMA**). The Project proposes to construct five new bridges across five project areas: NoR 1 relates to four of the proposed project areas (referred to as Spartan Road, Manuia Road, Manuroa Road and Taka Street) while NoR 2 relates to the remaining project area (referred to as Walters Road). Specifically, this report considers the actual and potential effects associated with the construction and operation of the TLC on the existing and likely future environment as it relates to construction noise and vibration effects and recommends measures that may be implemented to avoid, remedy and/or mitigate these effects.

This Report should be read alongside the AEE, which contains further details on the history and context of the TLC. The AEE also contains a detailed description of works to be authorised within each NoR, and the typical construction methodologies that will be used to implement this work. These have been reviewed by the author of this Report and have been considered as part of the assessment of construction noise and vibration effects. As such, they are not repeated here. Where a description of an activity is necessary to understand the potential effects, it has been included in this Report for clarity.

1.2 Report Structure

The structure of this Report is set out in Table 1 below. The assessment considers the actual and potential effects of the NoRs as a whole in the first instance. Where required, the assessment then focusses on the actual and potential effects arising within individual project areas (i.e., Spartan Road, Manuia Road, Manuroa Road, Taka Street which falls within NoR 1 and Walters Road which falls within NoR 2). Where appropriate, measures to avoid, remedy or mitigate effects are also recommended.

Where the individual project areas are discussed, sub-sections are arranged by project area in geographical order along the North Island Main Trunk line (**NIMT**) moving north to south.

Table 1: Report Structure

Sections	Section number
Description of the TLC	0
Overview of the methodology used to undertake the assessment and identification of the assessment criteria and any relevant standards or guidelines	4
Identification and description of the existing and likely receiving noise environment	5.2
Assessment of general traffic noise matters for the overall TLC network	6.2, 6.3, 6.4
Overall conclusion of the level of potential adverse construction noise and vibration effects of the TLC.	8

2 Project description

The overall Project proposes the removal and/or replacement of four existing road over rail level crossings at Spartan Road, Manuroa Road, Taka Street and Walters Road in Takaanini. As further

discussed in the AEE, the Project responds to functionality and safety issues anticipated at these crossings from the increasing number of train movements along the NIMT. The Project and indicative design also take into account the long-term planned expansion of the NIMT from the current two rail tracks to up to four tracks. The increased rail frequency will lead to greater barrier arm down-time and therefore increased severance and congestion in the area.

The Project primarily involves the construction of five new bridges to support safe and reliable east-west transport movement across the NIMT in Takaanini. This includes dedicated active mode bridges at Spartan Road and Manuroa Road, and two-lane arterial road bridges with active mode facilities at Manuia Road, Taka Street and Walters Road. Manuia Road is a new east-west connection in the network, acting as a replacement for vehicular trips that would have used the closed Spartan and Manuroa Road level crossings. The bridges and associated works/improvements are located across five project areas and will be progressed as two NoR packages (refer to Figure 1 and Table 2).

The indicative design has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final design will be refined and confirmed at the detailed design stage. Key features of the works common across project areas include the following:

- Bridge structures across the NIMT with a vertical clearance from existing ground level to road surface of approx.7.8m; and
- Works to tie in with existing roads.

Further details of each project area are provided in the following sections below.

Table 2: The TLC project areas and NoR packages

NoR Reference	Project area	Description	Requiring Authority
Takaanini Level Crossings Project NoR 1	**Spartan Road**	Closure of the existing level crossing, construction of a new bridge with walking and cycling facilities across the NIMT and associated works.	Auckland Transport
	Manuia Road	Construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	
	Manuroa Road	Closure of the existing level crossing, construction of a new bridge with walking and cycling facilities across the NIMT and associated works.	
	Taka Street	Closure of the existing level crossing, construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	
Takaanini Level Crossings Project NoR 2	**Walters Road**	Closure of the existing level crossing, construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	

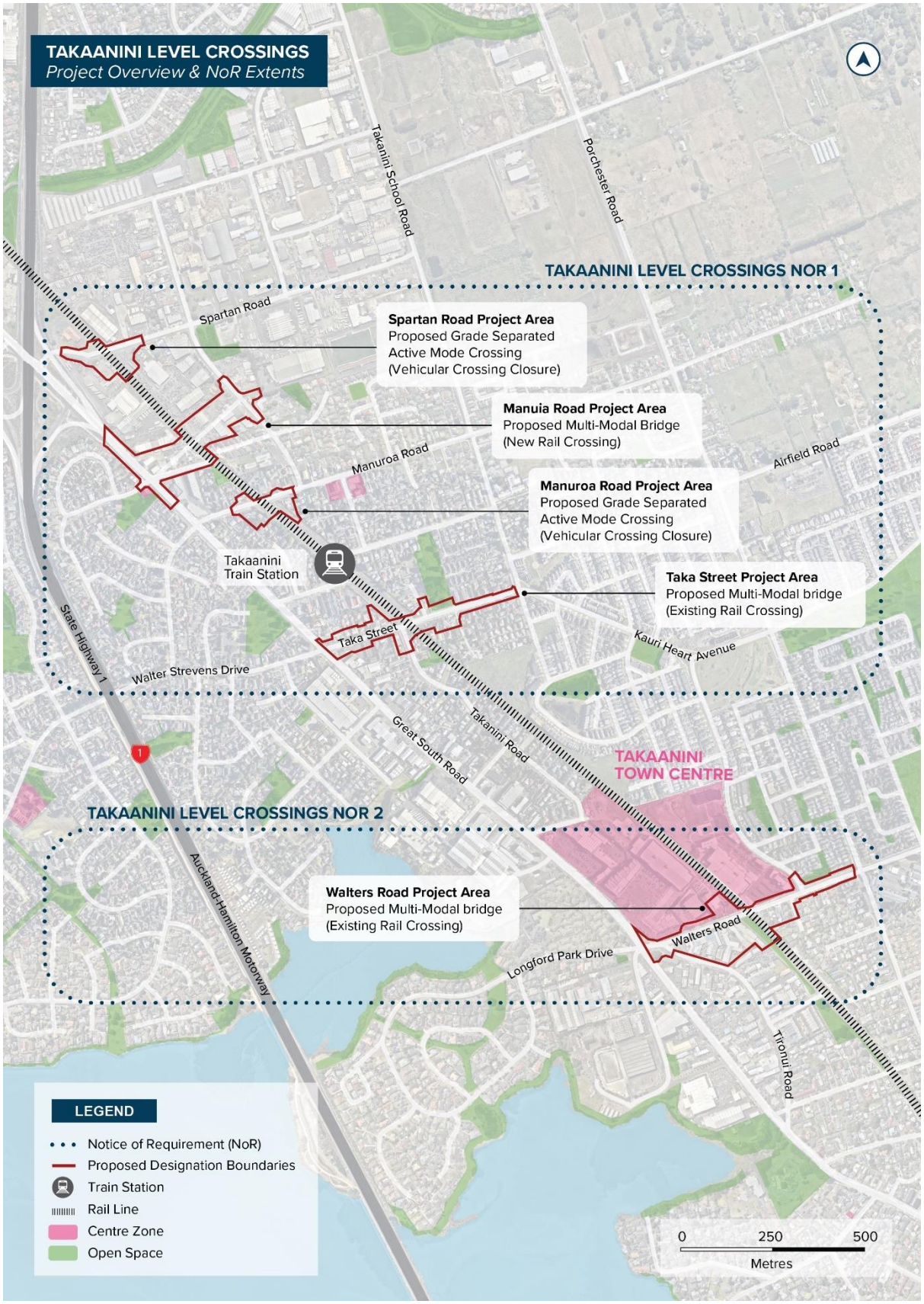


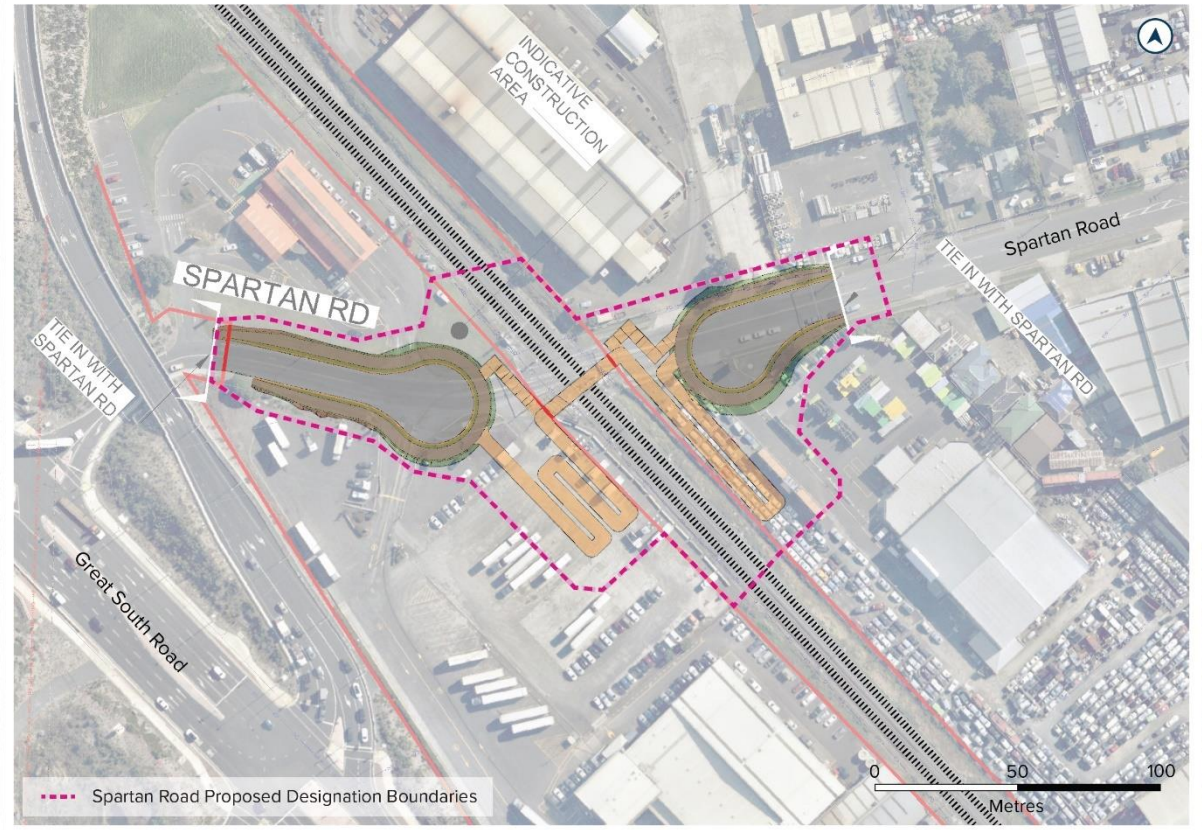
Figure 1: Overview of the Project, project areas and extent of NoRs

2.1 NoR 1 – Spartan Road, Manuia Road, Manuroa Road and Taka Street

2.1.1 Spartan Road project area

As set out in Table 3 below, the proposed works within the Spartan Road project area include closure of the existing level crossing and replacement with a new active modes bridge across the NIMT.

Table 3: Overview of Spartan Road project area

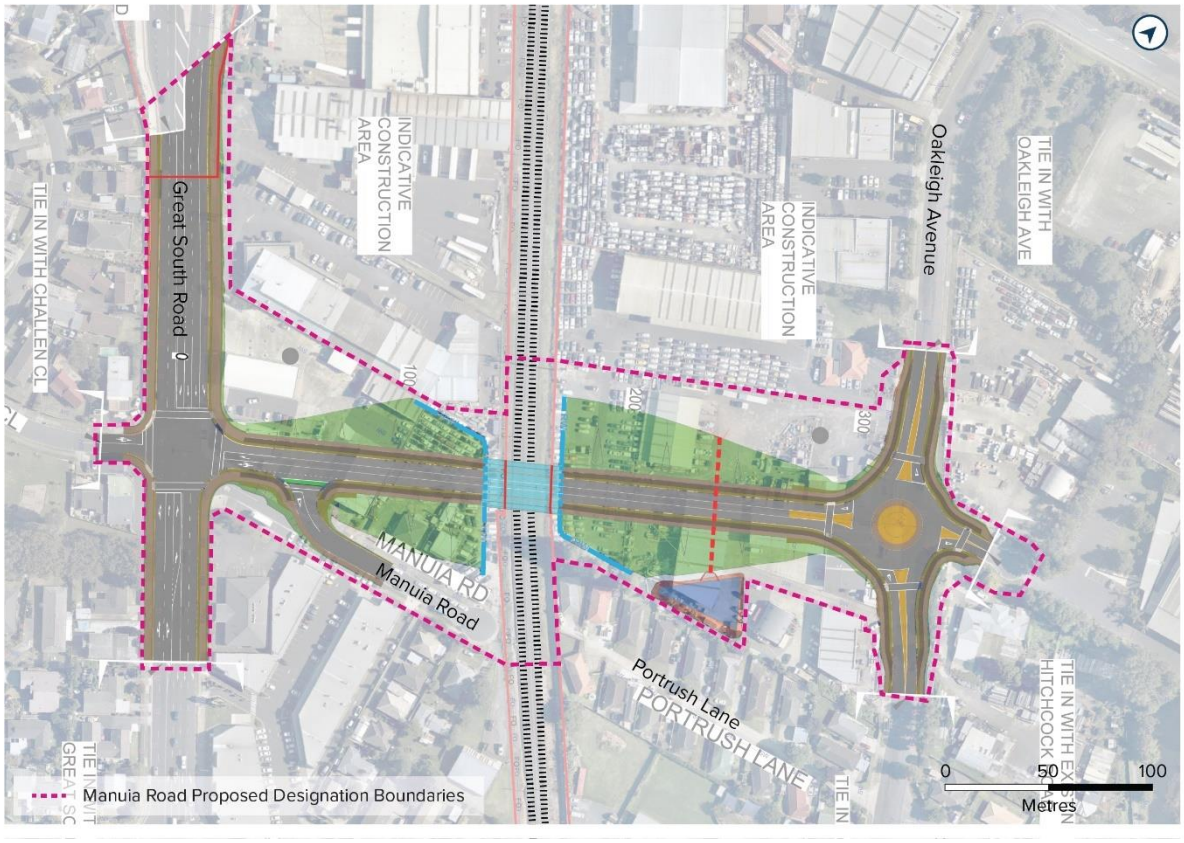
NoR 1 - Spartan Road project area	
	
Key features	
Overview	• Closure of the existing road corridor to vehicular traffic across the NIMT. • Construction of an active mode bridge across the NIMT. • Construction of cul-de-sacs (accommodating footpaths) and works to tie into the existing corridor on either side of the NIMT along Spartan Road. • Ramps and stairs will connect to the bridge on either side (east and west) of the NIMT and will tie into the cul-de-sacs.
Other structures	• None
Other road closures / cul-de-sacs	• None
Speed environment	• 50km/h (where it is trafficked)

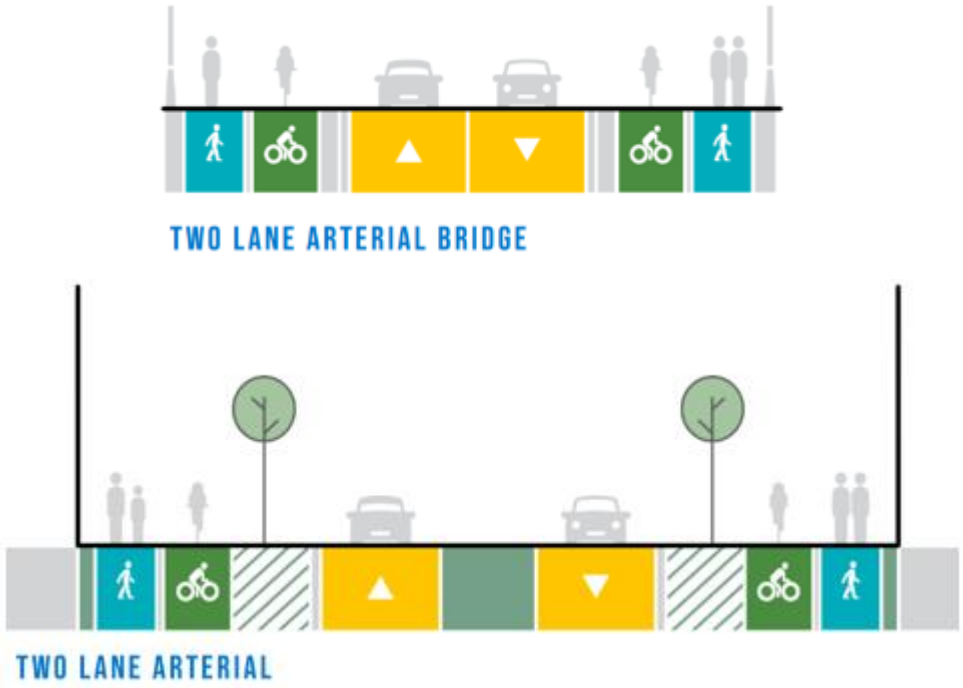
Access lanes	• None
Intersections	• None
Stormwater infrastructure	• Kerb and channel along road edge
Typical cross sections	

2.1.2 Manuia Road project area

As set out in Table 4 below, the proposed works within the Manuia Road project area include construction of a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lane in each direction and active mode facilities.

Table 4: Overview of the Manuia Road project area

NoR 1 – Manuia Road project area	
	
Key features	
Overview	• There is currently no existing east-west corridor / level crossing across the NIMT in this project area. • Construction of a new arterial road bridge across the NIMT accommodating two lanes (one in each direction) and separated active mode facilities. • Construction of new arterial road corridors tying into either side of the bridge (east and west of the NIMT) accommodating two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls (either side of the NIMT)
Other road closures / cul-de-sac	• Reconstruction of existing cul-de-sac at Hitchcock Road (east of the NIMT) to tie into the new intersection at Oakleigh Avenue/ Manuia Road / Hitchcock Avenue (as described below) and upgrade with footpath.
Speed environment	• 50km/h
Access lanes	• Existing Manuia Road will be reconfigured into an access lane for remaining properties, tying in with the new Manuia Road corridor/ bridge (west of NIMT).
Intersections	• Upgrade of the existing Great South Road/ Challen Close/ Manuia Road intersection to provide for signalisation, footpath upgrades and tie in works with the existing roads.

	• New roundabout intersection at Oakleigh Avenue/ Manuia Road / Hitchcock Avenue with active mode facilities and tie in works.
Stormwater infrastructure	• Stormwater culvert and associated flood offset storage area • Kerb and channel along road edge *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

2.1.3 Manuroa Road project area

As set out in Table 5 below, the proposed works within the Manuroa Road project area include closure of the existing level crossing and replacement with a new active modes bridge across the NIMT.

Table 5: Overview of the Manuroa Road project area

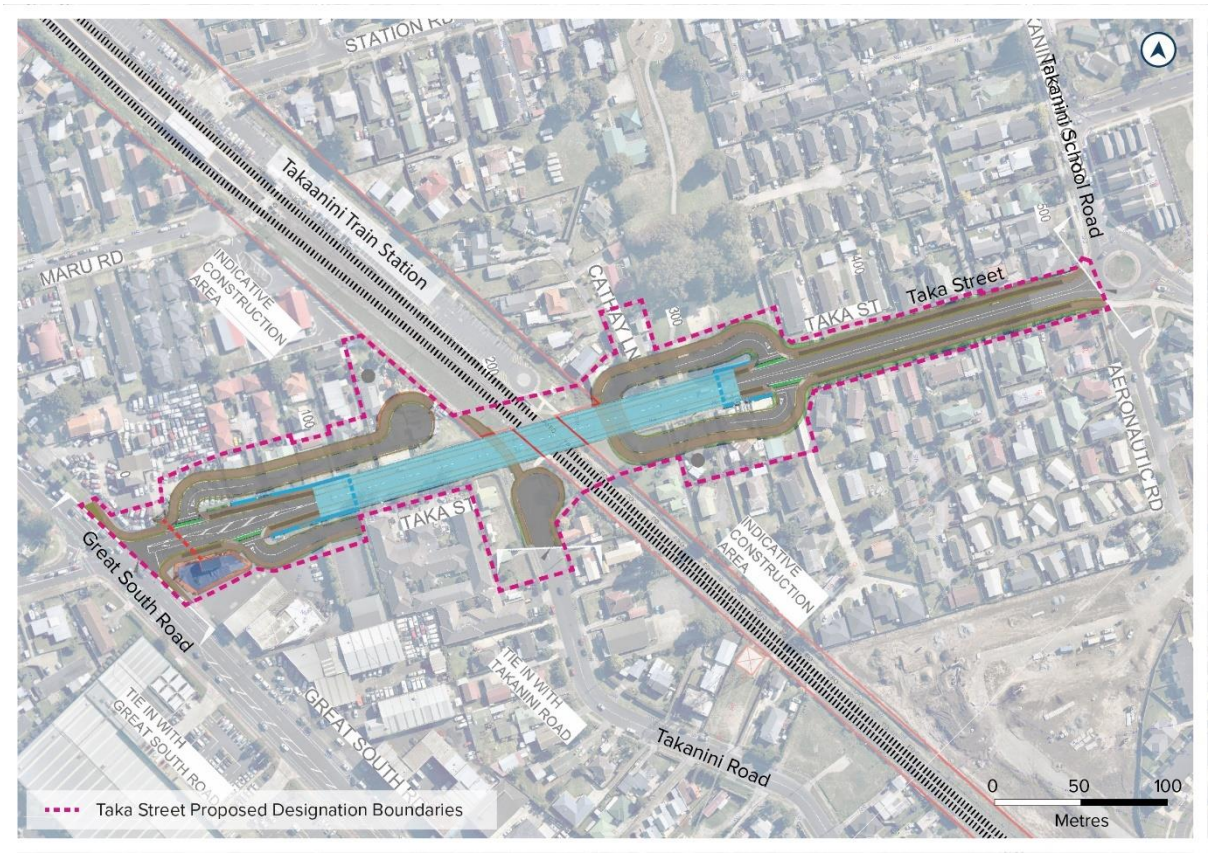
NoR 1 – Manuroa Road project area	
	
Key features	
Overview	• Closure of the existing road corridor to vehicular traffic across the NIMT. • Construction of an active mode bridge across the NIMT. • Construction of cul-de-sacs (accommodating footpaths) and works to tie into the existing corridor on either side of the NIMT along Manuroa Road. • Ramps and stairs will connect to the bridge on either side (east and west) of the NIMT and will tie into the cul-de-sacs.
Other structures	• None
Other road closures / cul-de-sac	• None
Speed environment	• 50km/h (where it is trafficked)
Access lanes	• None
Intersections	• None
Stormwater infrastructure	• Kerb and channel along road edge

Typical cross sections	

2.1.4 Taka Street project area

As set out in Table 6 below, the proposed works within the Taka Street project area include closure of the existing level crossing and replacement with a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lane in each direction and active mode facilities.

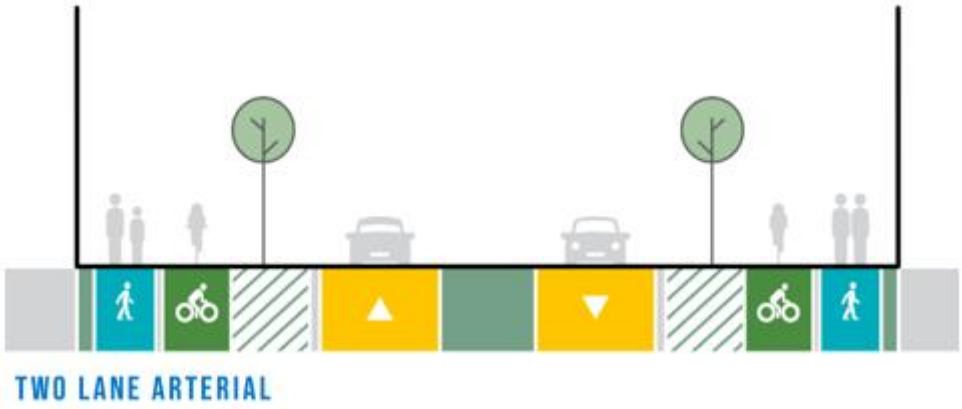
Table 6: Overview of the Taka Street project area

NoR 1 – Taka Street project area


Key features	
Overview	• Construction of an arterial road bridge across the NIMT accommodating two vehicle lanes (one in each direction) and separated active mode facilities. • Construction of arterial road corridors tying into either side of the bridge and existing intersections (east and west of the NIMT). The corridors will accommodate two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls
Other road closures / cul-de-sac	• Closure of existing Takanini Road (north) to vehicular traffic at the intersection with Taka Street bridge i.e., no through-traffic provision. Replacement with a cul-de-sac and works to tie into the existing corridor of Takanini Road to the south. Active modes connection from Takanini Road to Takaanini Station (under the new Taka Street bridge).
Speed environment	• 50km/h

Access lanes	• Construction of four access lanes:
	  • Construction of a new access lane (cul-de-sac) located west of the NIMT and north of the Taka Street road corridor. It accommodates a footpath on the northern side and bi-directional traffic. The access lane will tie in with the Taka Street corridor and allows access to existing properties to remain and Takaanini Station.
	  • Construction of a new access lane located west of the NIMT and south of the Taka Street road corridor. It accommodates a footpath on the southern side and bi-directional traffic. The access lane will tie in with the Taka Street corridor and allows access to existing properties to remain.
	  • Construction of two access lanes located west of the NIMT (north and south of the Taka Street road corridor and looping under the new Taka Street bridge). They accommodate a footpath on the outer edge and bi-directional traffic. The access lane(s) will tie in with the Taka Street corridor and allows access to existing properties to remain including Takaanini Reserve and Cathay Lane.

Intersections	• None
Stormwater infrastructure	• Stormwater culvert and associated flood offset storage area • Kerb and channel along road edge *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

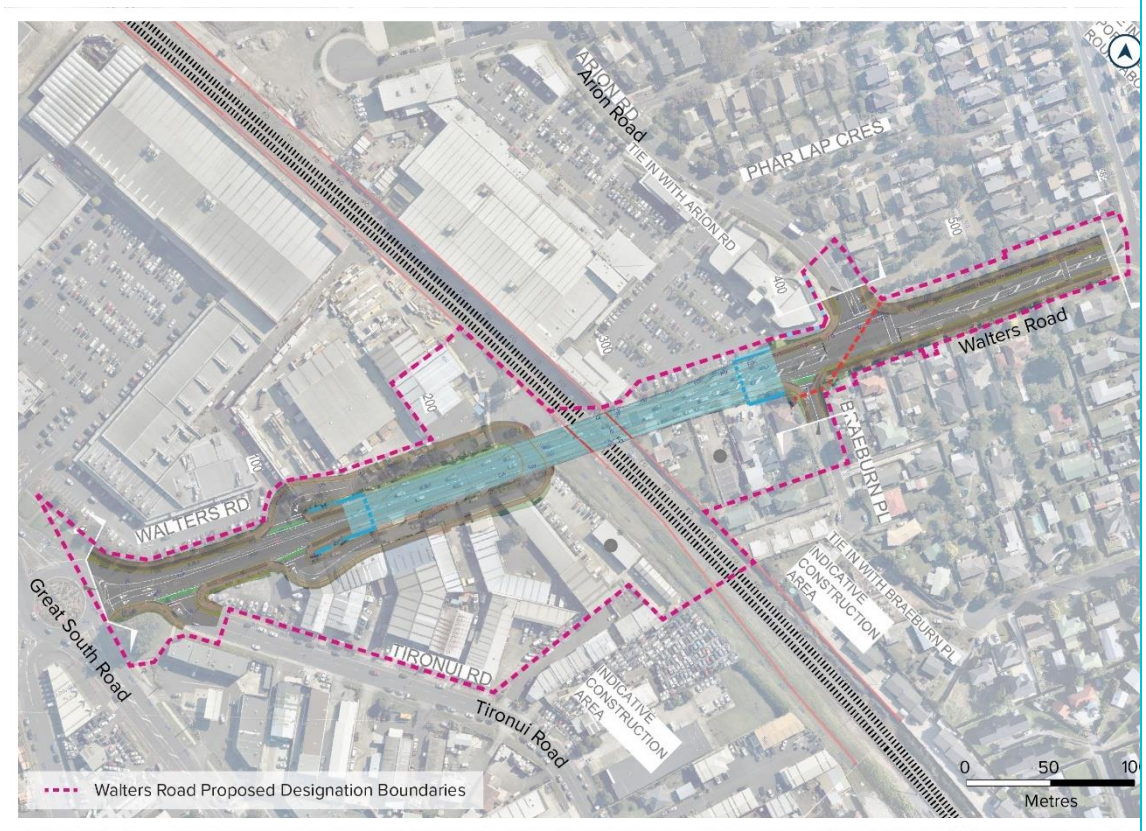


2.2 NoR 2 – Walters Road

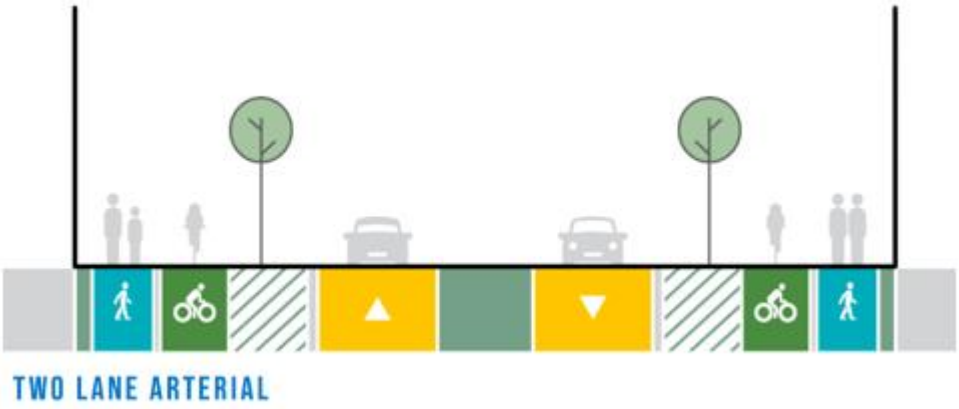
2.2.1 Walters Road project area

As set out in Table 7 below, the proposed works within the Walters Road project area include closure of the existing level crossing and replacement with a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lanes in each direction and active mode facilities.

Table 7: Overview of Walters Road project area

NoR 2 – Walters Road project area


Key features	
Overview	• Construction of an arterial road bridge across the NIMT accommodating two vehicle lanes (one in each direction) and separated active mode facilities. • Construction of arterial road corridors tying into either side of the bridge and existing intersections (east and west of the NIMT). The corridors will accommodate two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls
Other road closures / cul-de-sac	• None
Speed environment	• 50km/h
Access lanes	• Construction of two access lanes located west of the NIMT (north and south of the Walters Road corridor and looping under the new Walters Road bridge). They accommodate a footpath on the outer edge and bi-directional traffic. The access lane(s) will tie in with the Walters Road corridor and allows access to remaining properties.
Intersections	• Upgrade of the existing Arion Road / Walters Road intersection to provide for footpath upgrades and works to tie into existing Arion Road. • Upgrade of the existing Braeburn Place / Walters Road intersection to provide for footpath upgrades and works to tie into existing Braeburn Place. • Upgrade of the existing Tironui Road / Walters Road intersection to provide for footpath upgrades and works to tie into existing Tironui Road.
Stormwater infrastructure	• Stormwater culvert • Kerb and channel along road edge *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

	 TWO LANE ARTERIAL

3 Noise performance standards

A new designation is sought to enable the construction, operation, and maintenance of the Project. Therefore, we have reviewed a variety of criteria and standards and have recommended noise performance standards that in our opinion should apply to the NoRs.

3.1 Guidelines and Standards reviewed

We reviewed the following guidelines and standards for the assessment of operational noise:

- Auckland Unitary Plan Operative in Part (**AUP-OP**), specifically Rule E25.6.33 relating to transport noise and referencing New Zealand Standard NZS 6806:2010 (**NZS 6806**), and
- NZS 6806:2010 Acoustics – Road-traffic Noise – New and altered roads.

Active mode bridges as proposed for Spartan and Manuroa Roads do not generate traffic noise and would therefore not fall under the provisions of NZS 6806. The use of active mode facilities is not normally assessed in regard to noise generation because:

- Any noise generation is temporary while people move through the area;
- Noise levels are low compared with other noise sources such as roads or rail and represent a normal and expected use of pedestrian and cycle facilities that are not required to comply with any noise limits; and
- The use of these facilities is not controlled by the road controlling authority (here AT) and any issue would fall under different provisions (e.g. noise generation on the footpath may be a police matter).

However, as the bridges will replace existing roads, and lead to the closure of these roads, they do have an effect on the surrounding road network. Therefore, to quantify the effect of the proposed road closures, we have assessed the two active mode bridges provisionally against NZS 6806 and the change in noise level as well as included them in the overall assessment of the number of people potentially highly annoyed.

3.2 NZS 6806

NZS 6806 has been adopted as the appropriate standard for the assessment of traffic noise across New Zealand and compliance is also required under the AUP-OP and therefore has been adopted by AT.

The intent of NZS 6806 is to provide a pragmatic approach to the use of noise mitigation. This approach includes the requirement that a roading project needs to have a noticeable noise effect before mitigation is considered, and that any mitigation needs to achieve a noticeable reduction in noise level.

NZS 6806 sets criteria to be applied to traffic noise assessments where a project trigger certain thresholds. The Standard and its triggers are briefly explained below.

- **Assessment Positions** are described as “Protected Premises and Facilities” (**PPF**). PPFs include:

dwellings (including those that have building consent but are not built yet), educational facilities and their playgrounds within 20m of any school building, boarding houses, retirement villages, Marae, hospitals with in-patient facilities and motels/hotels in residential zones.

Any potential future dwellings that are not yet consented are not PPFs. Given the current well-developed character of the Project area, we consider that our predictions for the existing PPFs will also cover future additional development. Businesses and industrial operations are not PPFs as they are not considered noise sensitive and are often noise generators in their own right.

- **Assessment Extent** is 100m from the edge of the carriageway (i.e. the kerb) for urban areas.
- **Assessment Areas** are areas which combine PPFs that would benefit from the same mitigation (e.g. noise barriers). For this Project, assessment areas coincide with the five crossing corridors.
- **Design Year** is a year 10 to 20 years after opening of the Project. Since the implementation year is not yet clear (as these NoRs are being assessed as a route protection project) the Project team chose the design year of 2048.
- **Noise Criteria Categories** are set out in NZS 6806 for 'new' and 'altered' roads. This Project consists of altered roads for all crossings except Manuia Road, which is a new road. The noise criteria categories are set out in Table 8 below.

Table 8: Noise criteria categories

Category	New Road	Altered Road dB $L_{Aeq(24h)}$
A (primary external noise category)	≤ 57	≤ 64
B (secondary external noise category)	57 – 64	64 – 67
C (internal noise category)	40 (Provided the external noise level is > 64)	40 (Provided the external noise level is > 67)

The applicable category at any PPF depends on the best practicable option (**BPO**) test, by progressively applying the noise criteria categories to determine which can practicably be achieved. NZS 6806 is clear that preference is to be given to structural mitigation (i.e. mitigation within the road) over building modification mitigation. NZS 6806 therefore requires achievement of the lowest external noise level with practicable structural mitigation, before considering building modification to mitigate internal noise levels.

- **Applicability of the Standard:** There are two steps that must be followed to determine whether an assessment is required to be carried out in accordance with NZS 6806. The first step in this process is to determine if a proposal includes roads defined in the Standard as a 'new road' or as an 'altered road'. This Project would generally fall into the altered road category, with the exception of the Manuia Road bridge, which introduces the road bridge into an area currently without road and may therefore fall under the new road category.

The second step is then to determine whether the standard would further apply to the Project with respect to clause 1.5.2 for altered roads. In summary, the standard applies only when the Do-minimum noise environment is compared to the Do–nothing noise environment, and either of the following occurs:

- the Do-minimum noise environment is greater than or equal to 64 dB $L_{Aeq(24h)}$ and noise levels are predicted to increase by 3 dB, or;
- the Do-minimum noise environment is greater than or equal to 68 dB $L_{Aeq(24h)}$ and noise levels are predicted to increase by 1 dB.

For this Project, two of the roads where a road bridge is proposed (Taka Street and Walters Road) would be considered “altered roads”. Those where the roads are converted into cul-de-sac and only active mode bridges are proposed (Spartan and Manuroa Roads) would not generate sufficient noise level increases for the Standard to apply. Manuia Road is a new road and therefore the Standard applies in any event.

- **Assessment Scenarios** are the various operational scenarios that we assess and compare. The Standard includes the following scenarios:
  - Existing noise environment: consists of the current road layout and traffic volume.
  - Future Do-nothing scenario: consists of the existing roads as for the existing noise environment, with traffic volume at the Design Year (2048). This scenario assumes that all level crossings remain open irrespective of the increase in rail traffic which would make this option likely impracticable.
  - Future Do-minimum scenario: consists of the proposed Project at the Design Year (2048), without any specific noise mitigation. This scenario means that the only barriers included are solid safety barriers (e.g. on the bridges), which are required for reasons other than noise mitigation. Low noise road surface such as Asphaltic Concrete (**AC14**) is proposed as the “base” road surface for all roads of these NoRs apart from the service lanes (which carry negligible traffic volumes at low speeds and therefore have no effect on the overall noise levels), and is included in the Do-minimum scenario. Local roads that are not proposed to be altered by the Project are not included in the assessment.
  - Future Project with mitigation: consists of the proposed Project roads at the Design Year (2048), and includes any mitigation that is designed specifically to reduce noise levels (where required). Note that no different road surface material was considered for any of the Project areas. We understand that for strength and skid resistance reasons, AC14 is the quietest suitable surface for bridges and highly trafficked roads. The alternative of Stone Mastic Asphalt (**SMA**) produces more noise. Porous asphalt is unsuitable for the gradient to the bridges and the intersections with other local roads and is therefore not a practicable solution here.
- **Mitigation Requirements** are set out in the Standard based on the BPO. Mitigation is split into:
  - Structural mitigation (road surface, barriers, bunds); and
  - Building modification mitigation (improvement of building façades and ventilation, subsequent to the implementation of the structural mitigation, generally only considered for PPFs receiving noise levels within Category C).

Any mitigation should achieve a noticeable noise level reduction of an average of 3 decibels within each assessment area.

3.3 Subjective perception of noise level changes

The subjective impression of changes in noise can generally be correlated with the numerical change in noise level. While every person reacts differently to noise level changes, research shows a general correlation between noise level changes and subjective responses.[1] Table 9 shows indicative subjective responses to explain the noise level changes discussed in this report.

The perception of these noise level changes generally applies to immediate changes in noise level, as would be the case for a new road. This is not the case for this Project as existing roads are proposed to be modified in a minor way (with the exception of Manuia Road which is assessed as a new road). However, people may subjectively have an annoyance reaction to a greater or lesser degree, depending on their perception of the Project.

Table 9: Noise level change compared with general subjective perception

Noise level change	General subjective perception[2]	Effects description[3]
1–2 decibels	Insignificant/imperceptible change	None/Not Significant
3–4 decibels	Just perceptible change	Not Significant to Slight
5–8 decibels	Appreciable to clearly noticeable change	Moderate to Substantial
9–11 decibels	Halving/doubling of loudness	Substantial to Very Substantial
>11 decibels	More than halving/doubling of loudness	Very Substantial

Noise is measured on a logarithmic scale, meaning that a doubling in traffic volume (e.g. from 10,000 vehicles per day (vpd) to 20,000 vpd) results in a noise level increase of 3 decibels, a just-perceptible change. A tenfold increase in traffic volume (e.g. from 10,000 to 100,000 vpd) would result in a noise level increase of 10 decibels, which would sound twice as loud.

3.4 Annoyance effects

People's responses to a particular level of road traffic noise can vary greatly. Many studies have been carried out overseas in an attempt to determine a general relationship of response to noise of a residential community as a whole.

1 For instance, LTNZ Research Report No. 292: Road traffic noise: determining the influence of New Zealand Road surfaces on noise levels and community annoyance, Table 18.

2 Based on research by Zwicker & Scharf (1965); and Stevens (1957, 1972).

3 Based on the Guidelines for Environmental Noise Impact Assessment, iema, Nov 2014.

The most notable studies include that of Schultz[4] and those of Miedema and Oudshoorn[5], as shown in Figure 2. These studies combined the results of several different studies to produce a 'curve' of the percentage of people highly annoyed (%HA) versus external noise level (L_{dn})[6]. The studies were for different transportation noise sources including trains, road traffic and aircraft. Only the curve for road traffic noise is shown.

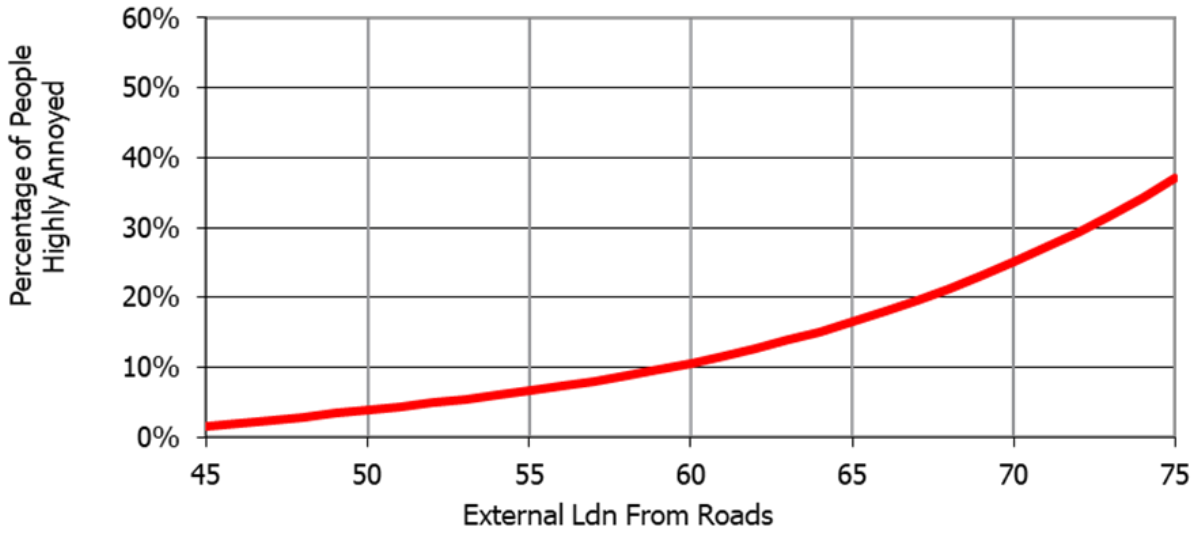


Figure 2: Miedema & Oudtshoorn Dose-Response Relationship

The curve shows that about 10% of people may be highly annoyed at an external road traffic noise level of 57 dB $L_{Aeq(24h)}$ (equivalent to 59 dB L_{dn}), which is the upper end of the NZS 6806 Category A for new roads. For an external noise level of 64 dB $L_{Aeq(24h)}$ (equivalent to 66 dB L_{dn}), the upper end of Category B for new roads and Category A for altered roads, 18% of people may be highly annoyed. At 67 dB $L_{Aeq(24h)}$ (equivalent to 69 dB L_{dn}), the upper end of Category B for altered roads, 23% of people may be highly annoyed.

Accordingly, using BPO mitigation to achieve the lowest practicable noise levels will ensure better amenity for people and also that a smaller number of people would be annoyed by road traffic noise.

Using the descriptor of the number of people highly annoyed allows a comparison of population responses over a wider area. We have used this measure to represent a comparison from the existing situation to the proposed Project situation over the area affected by the change in traffic flows due to the closing of some level crossings and the upgrade or construction of others, not just in the directly affected roads but also the surrounding ones.

Our assessment is based on Statistics New Zealand information,[7] which shows that for the Papakura local board area (into which the Project falls) there are approximately 3.4 people per household.

4 Schultz T J (1978) "Synthesis of social surveys on noise annoyance" J.Acoust. Soc. Am. 64, 2, 337-405.

5 Miedema, H M E and Oudshoorn, G M (2001) "Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals." Environmental Health Perspectives 109 (4) 409 – 416.

6 L_{dn} levels can be generally converted into $L_{Aeq(24h)}$ by subtracting 2.5 dB. This is based on an analysis of noise logging data of a large number of New Zealand roads, split into road type, and analysing the diurnal variation of traffic noise. The correction was arrived at by comparing the $L_{Aeq(24h)}$ and calculated L_{dn} levels.

7 https://www.stats.govt.nz/information-releases/2018-census-population-and-dwelling-counts/

4 Assessment methodology

4.1 Preparation for this Report

We commenced work on this Project in August 2022. In summary, we undertook the following work in preparation for this Report:

- Review information from other technical specialists, namely traffic, construction, design and planning amongst others;
- A site visit of all Project areas within the NoRs in October 2022;
- Ambient noise levels surveys in the Project areas;
- Meeting with the design team on 29 September 2022; and
- Computer noise modelling and vibration predictions.

Where we rely on information provided by other experts, this is noted in the Report.

4.2 Methodology

We have assessed traffic noise effects on people based on:

- The noise criteria categories of NZS 6806 based on traffic on the Project roads only;
- The change in noise level causing adverse and positive effects depending on magnitude of change (on a population basis), based on traffic on the Project and other local roads in the area that would have an effect on the overall noise levels, to show a more realistic outcome. Note that rail noise is not included in the predictions (for the reasons discussed in the assumptions below); and
- The potential for people to be highly annoyed by the resulting traffic noise levels over the wider area, again based on both Project and local roads, but excluding rail noise.

The reason for the three-pronged approach is that in some circumstances, the effects of a noise level increase can be small (e.g. a noise level increase of less than 3 decibels). At the same time, the resulting noise levels can be very high, particularly adjacent to existing major roads, and cause (potentially further) adverse effects for residential use. Similarly, gauging the effect on the wider community, particularly for a project where the overall traffic movements will change significantly through the change in access across the rail, can best be shown through the annoyance scale.

4.3 Assumptions

To undertake our work, we had to make some assumptions:

- We have based our assessment of the overall noise level on road traffic numbers only. There is little detail available for future rail volumes and types, and current information is also limited, which means that including rail noise into the overall predictions would result in a high level of uncertainty.
- The Do-nothing scenario assumes that all level crossings are open for traffic to pass through. This is unlikely to be a viable option given the disruption to traffic due to the extended periods of the rail crossings being closed during rail passes. We note that the Transport team has assessed a further “Do-nothing” scenario which assumes that all crossings would be closed. We have not included this scenario in our acoustic assessment because:

a) We understand it is not a viable option that could occur in real life, due to the impact on traffic in the area; and
b) The results would indicate unrealistically large effects based on increase in noise level comparing the (Do-nothing) “all closed” and (Do-minimum) “new crossings” scenarios.

- Our computer modelling is based on information from the transportation specialists of the Project.
- The closure of Spartan and Manuroa Roads and replacement with active mode bridges only is understood to result in a redistribution of traffic across the network. For instance, the industrial (heavy vehicle) traffic will likely use Manuia Road crossing instead. This change in traffic behaviour has been included in our assessment through the “change in noise level” and “number of people highly annoyed” assessments.
- We have assumed that all existing buildings within the proposed designation boundary will be removed. We have therefore not assessed these as PPFs (if that definition would apply because of their current use). Should they be retained and occupied after construction, traffic noise effects on them will need to be assessed.

- Given the recent NPS-UD 2020 and the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021, while we comment on effects on currently existing PPFs potentially affected by traffic noise, we are aware that many of the sites neighbouring the Project areas may be redeveloped in the future, with higher density residential development. In relation to our traffic noise assessment, that means that any future houses will need to take account of the proposed changed environment enabled by these NoRs and potentially insulate or design their houses accordingly.

4.4 Computer noise modelling

The propagation of traffic noise is affected by multiple factors, such as:

- Terrain elevations, including shielding from intervening terrain and exposure due to elevation;
- Ground condition, including absorptive ground such as meadows or hard reflective ground;
- Atmospheric conditions, including wind or temperature inversions; and
- Road parameters, including road surface, traffic speed, vehicle types and gradient.

Because of the multiple factors and their interaction, computer noise modelling is a vital tool in predicting traffic noise impacts in the vicinity of major roads and for the determination of mitigation measures. Modelling enables a comprehensive and overall picture of noise impacts to be produced, taking into consideration all factors potentially affecting noise propagation.

We used the software SoundPLAN, which is an internationally recognised computer noise modelling programme. In summary, SoundPLAN uses a three-dimensional digital topographical terrain map of the area as its base. In addition, we entered data into the model for existing buildings, proposed earthworks edges and ground absorption within the assessment area. We digitised road traffic noise sources, with road lanes located on the terrain file, for the existing/Do-nothing scenario and the Do-minimum scenario (refer to Section 3.2).

The SoundPLAN model implements the calculation algorithms of the “Calculation of Road Traffic Noise” (**CoRTN**) methodology which is referenced in NZS 6806 in Section 4.1.2. The calculation algorithms take account of the factors set out above, including relevant atmospheric and ground conditions within appropriate parameters.

We have used the adjustments for New Zealand road conditions, specifically road surface types, as set out in the Waka Kotahi "Guide to state highway road surface noise," V1.0, January 2014, Table 2.1.[8] Therefore, modelling results can be compared with the relevant criteria without further adjustment.

To verify the accuracy of the computer model, we used the long duration measurement results from the noise level surveys set out in Section 5.2.1 to verify that the computer model calculates noise levels within satisfactory tolerances (see Table 10). The short duration surveys are not suitable for such verification as there are a number of other noise sources in the area that affect short duration surveys but have less of an effect on the long duration survey.

Table 10: Computer noise model verification

Position	Location	Derived Level	Predicted Level	Difference
		dB $L_{Aeq(24h)}$	dB $L_{Aeq(24h)}$	decibels
MP1	2 Takanini Road	65	63	-2

A comparison of the measured and predicted levels shows that there is good agreement between measured and predicted levels for most of the positions, with a difference of no more than 2 decibels. This accuracy fulfils the requirements of NZS 6806 which states in Section 5.3.4.2 (of NZS 6806): *"The difference between measured and predicted levels should not exceed ± 2 dB."*

The measured noise levels are higher as they include effects from train passes and the warning bells.

4.4.1 Individual receiver noise levels

We have assessed noise effects at all PPFs. We have included predicted noise levels for all PPFs, for all scenarios, in the tables in Appendix B of this Report. The locations of these dwellings are shown in the drawings in Appendix C of this Report.

Noise criteria categories for the PPFs are shown as a graphic representation by colouring the buildings with a colour scale, showing buildings receiving noise levels within NZS 6806 Category A in green, Category B in orange and Category C in red. Any buildings not shown in these three colours on the figures are outside the assessment area, or are not PPFs, e.g. garages, sheds or business premises, or buildings to be removed for the Project.

4.4.2 Noise contour plans

Noise contour plans are a useful tool to obtain a graphical overview of a project area including currently vacant land that may be developed in the future. The contours are calculated by SoundPLAN by interpolating a large number of individual points. Therefore, noise contour maps should not be used to "read" noise levels for specific locations. For individual noise levels specific for each PPF, the receiver noise levels in the tables should be used (refer to Appendix B).

Noise contour plans are contained in drawings in Appendix C of this Report. These plans show interpolated noise level bands at 5 decibel intervals from 55 dB to 70 dB $L_{Aeq(24h)}$.

[8] NZTA Guide to state highway road surface noise v1.0, 2014. Table 2.1: New Zealand road surface adjustments, relative to AC-10 for speeds of 40km/h and above.

4.5 Potential options to mitigate traffic noise effects

There are broadly three mitigation options that can be applied to manage road traffic noise, and are discussed in NZS 6806:

- The choice of **road surface material**, a mitigation option that reduces noise at the source (especially for roads with speeds above 40-50 km/h where the road-tyre interaction is the controlling noise source rather than engine noise);
- The installation of **noise barriers** either on the roadside or on the property boundary; and
- The inclusion (for new builds) or retrofitting (for existing buildings) of **Building Modification Mitigation** (e.g., alternative ventilation to enable windows and doors to remain closed, improved joinery and/or glazing, or, in rare cases, the installation of additional wall and ceiling lining).

NZS 6806 states:

> *The noise criteria are intended to address the adverse effects of road-traffic noise on people. Land-use planning is the preferred method of avoiding these effects. Where this is impracticable, the Standard sets out procedures and methods of the prediction, measurement and assessment, and guidelines for mitigation of road-traffic noise in accordance with the duty to adopt the best practicable option*[9]

This indicates that NZS 6806 deals with the residual noise effects after land-use planning has been implemented (or where it has been omitted in the planning stage).

Generally, mitigation is implemented from source to receiver. This means that the road surface is the first choice of mitigation measure as it protects the largest extent of receivers. Second are barriers placed either on the road edge or the property boundary. Barriers protect the area behind them, so are not suitable to shield upper floors of multi storey buildings, however, they are suitable to protect ground floors and outdoor living areas where these are facing a road. Lastly, building modification can be implemented to existing PPFs where these are not sufficiently designed to reduce internal noise levels. Building modification is the last choice as it only protects individual living areas, does not protect outdoor areas and has no benefit to the wider community.

Where future developments are not yet implemented, the road controlling authorities and developers often have a shared responsibility to implement reasonable and appropriate mitigation.

Overall, for this Project, the choice of road surface material for the traffic lanes is the most important and effective noise mitigation measure. We understand that as all roads would carry more than 10,000 vehicles per day, AT will use AC14, a low noise road surface. This has been our assumptions for our predictions.

Barriers are unlikely to be generally practicable as access to many individual residential sites will need to be maintained. Therefore, barriers may not be BPO in this context.

The recommended low noise road surface will benefit not only the existing PPFs, but also any new noise sensitive development that may be established through the NPS-UD. Should intensification occur adjacent to the Project, as is anticipated, then other road noise mitigation would be limited. Barriers are unlikely to be BPO in an urban/suburban context and would only protect the ground floor. Higher floors would overlook any barrier. Therefore, it would be most appropriate to design any future sensitive buildings with the road (and rail) noise environment in mind. This would include appropriate

[9] NZS 6806:2010, Section 1.1.1

façade materials to reduce noise transmission into rooms and providing alternative ventilation for the closest houses to ensure that a suitable internal noise environment can be achieved while having fresh air intake and cooling available.

5 Existing and likely environment

5.1 Planning Environment

The overview of project and approach to assessing the likely receiving environment sections of the AEE outline the key attributes of the existing and likely future environment of the Project across each of the five project areas.

We note that the proposed project areas are located within a predominantly urban landscape which will evolve over time and is likely to experience change before the implementation of the Project. The NPS-UD enables higher density dwellings within a walkable catchment of rapid transit stops. Four of

the proposed project areas (Manuia Road, Manuroa Road, Taka Street and Walters Road) are within a walkable catchment of Takaanini Train Station. In the context of this Project, it is anticipated that the following urban intensification will take place in line with proposed Plan Change 78 to the AUP-OP:

- Zoning within a walkable catchment of a rapid transit stop in the Project areas will enable, at minimum, apartment buildings of six storeys: and
- Beyond walkable catchments, residential zoning will provide for three dwellings up to three storeys in height (subject to meeting the relevant development standards).

Should higher density housing have been established, this would not have an effect on the assessment of traffic noise mitigation, given that mitigation options are limited to low noise road surface. Any potential new dwelling construction should take account of the fact that they are next to an existing high flow road and rail with existing high noise levels and incorporate appropriate design such as locating sensitive rooms away from the road and allowing for good façade design and ventilation provisions into any such dwellings.

5.2 Existing noise environment

The existing noise environment provides a baseline for assessing noise effects. Effects can be assessed by quantifying the noise levels and noise level changes that people would experience due to the implementation of a project. The change in noise environment can be interpreted in relation to subjective responses of people and possible annoyance. In addition, measured noise levels are used to verify the computer noise model (refer Section 4.4).

The existing noise environment for the NoRs is controlled by traffic on the existing roads and rail movements on the NIMT.

5.2.1 Surveys

We undertook short duration (15 minute) attended noise level surveys on 21 November 2022 between 13:30 hrs to 15:00 hrs, in the vicinity of the Project. As traffic distribution over the day is known, the short duration survey results can be used to derive a 24-hour traffic noise level.

In addition, we measured long duration noise levels over a 9-day period at 2 Takanini Road. The high L_{AFmax} values clearly show the influence of the rail crossing signal and train passes, with regular levels above 90, and at times above 100 dB L_{AFmax}. A summary of the survey data is included in Appendix A of this Report.

The location of the surveys is shown in Figure 3

.

Figure 3: Noise survey locations

All noise level survey results are shown in Table 11.

Table 11: Noise survey results

Meas. Position	Location	Duration	Measured noise level	Derived noise level
			dB $L_{Aeq(T)}$	dB $L_{Aeq(24h)}$
MP1	2 Takanini Road	9 days	65	n/a
MP2	16 Portrush Lane	15 mins	50	48
MP3	31 Walters Road	15 mins	67	65

5.2.2 Modelling

In addition to measuring the noise levels at a few locations along the Project, computer noise modelling enables the prediction of existing noise levels at all PPFs.

We have calculated the noise levels received by all PPFs. There are 343 PPFs within these NoRs. We have assessed the PPFs for each crossing project area separately. The number of PPFs for each corridor is shown in Table 12. Note that three PPFs are assessed in both the Manuroa Road and Manuia Road corridors, therefore the combined number of PPFs in the Table 12 below is 346.

Table 12: Number of PPFs at each crossing corridor

Project areas	Number of PPFs
Spartan Road (NoR 1)	2
Manuia Road (NoR 1)	33
Manuroa Road (NoR 1)	85
Taka Street (NoR 1)	141
Walters Road (NoR 2)	85

Predicted existing noise levels at the PPFs adjacent to major existing roads (especially Spartan, Manuroa, and Walters Roads) showed that the ambient noise level is strongly affected by traffic on the roads. Smaller roads (Taka Street) and where no current crossing exists (Manuia Road) have noticeably lower noise levels.

Note that we did not model the rail noise or noise from the warning bells. The rail operations are intermittent and therefore are difficult to combine with the steadier road noise. All crossing locations are affected by rail noise which, depending on the number and type of trains, can be significant at times as shown in the survey summary in Appendix A of this Report.

6 The TLC NoRs – Overall network

This section assesses common or general traffic noise matters across the entire TLC network i.e., the combination of road closures and/or grade separated crossings across the five project areas. This section also recommends measures to avoid, remedy, or mitigate actual or potential adverse effects considering the network as a whole. Project area-specific matters are further discussed in the following Report sections where necessary.

6.1 Buildings within designation

The following Table 13 shows the buildings that are within the proposed designation. We have not assessed these buildings further as the assumption is that AT needs to acquire the parcels of land that these buildings are located on and will demolish the buildings.

Table 13: Sensitive buildings inside designation (not assessed)

Address	Address
8 Manuia Road (NoR 1)	1/12 Manuroa Road (NoR 1)
1/15, 2/15, 3/15, 4/15, 5/15 Manuroa Road (NoR 1)	17 Manuroa Road (NoR 1)
1 and 2/6, 1/10, 1/12, 1 and 2/16 Taka Street (NoR 1)	2/18, 22 Taka Street (NoR 1)
14 Taka Street (childcare centre) (NoR 1)	15, 19, 23, 31 and 33 Taka Street (NoR 1)
21, 23, 27 Walters Road (NoR 2)	20A, 25 Walters Road (two childcare centres) (NoR 2)
15 – 17 Walters Road (Education facility) (NoR 2)	

6.2 Assessment of traffic noise effects

Each crossing will cause different noise effects arising from the Project.

Where roads are closed and only an active mode bridge constructed, traffic noise will significantly reduce. That is the case for Spartan and Manuroa Roads.

Where an existing crossing is replaced with a new traffic bridge, the noise source will be elevated above the ground, which, for single storey dwellings, would result in a slight reduction in traffic noise level. The main noise source from traffic is the road-tyre interaction. When this source is elevated and well shielded by solid edge barriers, then the traffic noise will reduce. Where there are multi storey dwellings, the bridge may bring the noise source closer, and noise levels may increase. This is the case for Taka Street and Walters Road.

Where a new crossing is established in an area that currently has none, the noise level will increase noticeably. That is the case for Manuia Road.

Both Spartan and Manuia Roads are located in areas with predominantly business uses, and any PPFs are at some distance. However, for Taka Street and Walters Road, PPFs are adjacent to the Project corridors and will experience changes to the noise environment.

Each of the crossings has a different environment in terms of sensitivities and ambient noise levels. Therefore, we discuss each one separately below.

6.2.1 Spartan Road

The existing Spartan Road level crossing will be closed and replaced with an active mode bridge. This means that traffic volumes will reduce from about 8,000 vehicles per day to less than 2,000 vehicles per day. The area is heavily industrialised with predominantly heavy vehicles on the road. There are only two PPFs in this area.

6.2.1.1 NZS 6806

The number of PPFs is summarised in Table 14, individual traffic noise levels for the two PPFs are provided in the table in Appendix B of this Report, and figures showing the location of the PPFs are included in Appendix C of this Report.

The PPFs are located in the business zone, and currently receive elevated traffic noise levels. With the closing of the crossing, traffic will reduce significantly, but the high percentage of heavy vehicles (nearly 50%) will remain. This means that the noise levels will still remain elevated.

The Project does not cause a sufficient effect to qualify as an Altered Road (refer to Section 3.2).

Table 14: Summary of NZS 6806 assessment

Scenario	Number of PPFs NZS 6806 Categories		
	Category A	Category B	Category C
Existing	0	1	1
Do-nothing	0	0	2
Do-minimum	2	0	0

6.2.1.2 Change in noise level

Noise effects can be described based on the change in noise level with and without the Project. For the comparison of noise levels, we have included the Project and other local roads in the area that would have an effect on the overall noise levels. Note that rail noise is not included in the predictions.

Due to the road closure and significant reduction in traffic volume, we predict a noticeable reduction in noise level of 5 dB due for both PPFs. Heavy vehicles will continue to control the noise environment.

6.2.1.3 Mitigation options

Overall, we do not recommend any noise mitigation in this area as the Project results in a clearly noticeable reduction in noise level.

6.2.1.4 Effects assessment

The closure of the Spartan Road crossing and converting Spartan Road into a cul de sac results in a noise level reduction at the two PPFs. The character of the noise will not change and remain controlled by traffic, including trucks, on the road entering the neighbouring business area, and rail noise.

Overall, we consider the effects from the closure to be moderately positive.

6.2.2 Manuia Road

The Manuia Road crossing establishes a new road in an area that currently has no access across the NIMT. PPFs are located to the south of the crossing, and at either end where the road connects with the local road network.

Our predictions do not include rail noise, so while the existing and future predicted noise levels appear relatively low, they would be more elevated due to rail noise effects.

6.2.2.1 NZS 6806

This crossing is assessed against the new road criteria of NZS 6806. This means that no Do-nothing scenario is assessed, and the existing situation is compared with the Do-minimum scenario.

The number of PPFs is summarised in Table 15, individual traffic noise levels for the 34 PPFs are provided in the table in Appendix B of this Report, and figures showing the location of the PPFs are included in Appendix C of this Report.

The PPFs are located away from major roads at present (but close to the NIMT), and traffic noise levels are relatively low. With the new crossing open, noise levels are predicted to increase for most PPFs, for many by noticeable to significant margins. Traffic noise levels would remain within Category A and B for the majority of PPFs, however, 3 PPFs[10] are predicted to receive noise levels within the low end of Category C (up to 65 dB $L_{Aeq(24h)}$).

Mitigation options are limited due to the height of the bridge. One mitigation option would be to increase the height of the barrier along the southern bridge edge to 1.5m and extend the barrier onto the embankment at a height of 2m, which would reduce the noise levels at the most affected houses by up to 5 dB. With this mitigation in place, all PPFs are predicted to receive noise levels within Categories A or B.

While trucks will be visible above the 2m barrier (as will be some larger cars or vans), their noise is included in the CoRTN predictions through the percentage of heavy vehicles. At the posted speed of 50km/h, road tire interactions are the main noise source (particularly for trucks) and therefore the barrier will be effective in reducing noise levels. In addition, for the majority of trucks, engine and exhaust noise will be at a level below 2m and therefore will be well shielded. Therefore, we consider that the recommended 2m barrier is sufficient.

10 12, 14 and 16 Portrush Lane

Table 15: Summary of NZS 6806 assessment

Scenario	Number of PPFs NZS 6806 Categories		
	Category A	Category B	Category C
Existing	34	0	0
Do-minimum	12	19	3
Mitigation Option (barrier)	14	20	0

6.2.2.2 Change in noise level

We predict a significant increase in noise level for some PPFs close to the new road. Since the road will be elevated on a bridge with edge barriers, noise to the ground floor will be well mitigated where the bridge is highest and affect PPFs more where it connects with the ground level.

Nevertheless, with the recommended barrier mitigation in place, noise level increases can be reduced for the most affected receivers from 12 dB to 8-10 dB. The shift can be seen in the Figure 4 below.

Figure 4 shows the number of PPFs in each of the change in noise level bands discussed in Table 9. This shows that without mitigation 22 PPFs would have a noticeable to significant noise level increase, while another nine PPFs would have a perceptible noise level increase. The remaining PPFs would receive similar noise levels as if the Project were not to go ahead. With mitigation, no PPF would receive noise level changes above 11 dB, with most sitting in the noticeable change band (5 to 8 dB).

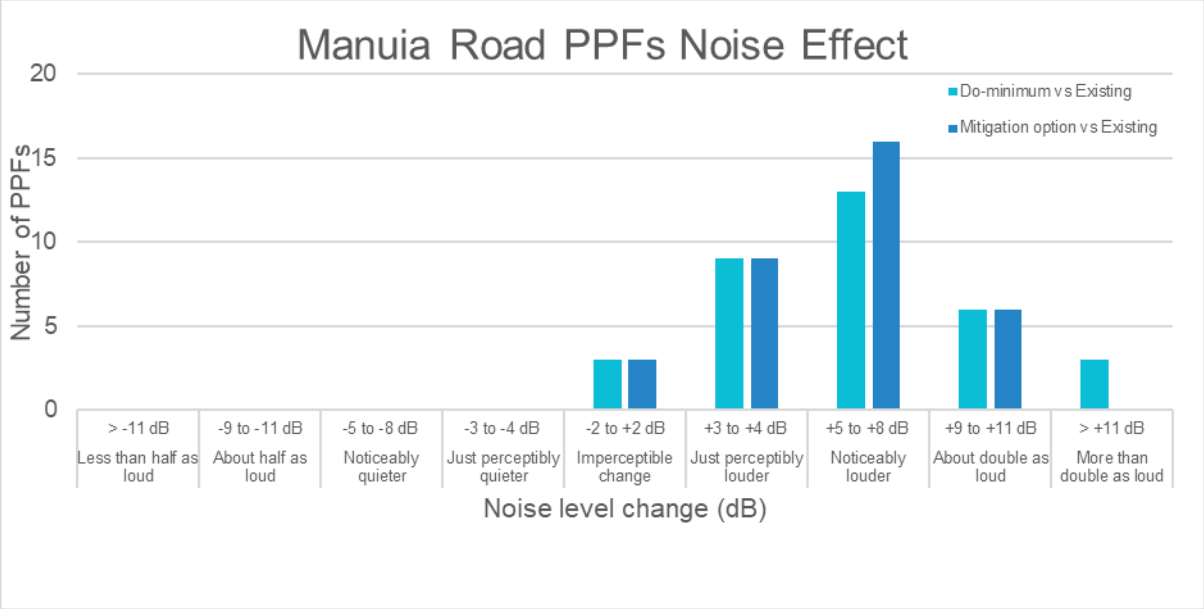


Figure 4: Change in noise level

6.2.2.3 Mitigation options

Without mitigation, only a small number of PPFs (12, 14 and 16 Portrush Lane) would receive noise levels at the low end of Category C. The road is elevated in this area and edge barriers will be provided on the bridge. In addition, the road will be surfaced with AC. There are only limited additional options that would be practicable that can be used to mitigate the noise level further.

We recommend that the bridge barrier at the south side of the bridge is increased in height to 1.5m, and that a 2m barrier is installed extending along the southern edge of the embankment towards the east for approximately 55m. These barriers are predicted to reduce the noise levels sufficiently to ensure that all PPFs receive noise levels within Categories A or B, and that the noise level change is reduced.

6.2.2.4 Effects assessment

The introduction of a new road into the area will result in a change in character for some of the houses in Portrush Lane, and a clearly noticeable noise level increase. While rail noise already affects the area, the intermittent occurrence cannot be directly compared with the more constant road traffic noise. Therefore, the effects from the new Manuia Road are considered to be substantial adverse for the dwellings in Portrush Lane, even with the inclusion of mitigation.

6.2.3 Manuroa Road

The existing Manuroa Road level crossing will be closed and replaced with an active mode bridge. This means that traffic will be diverted away from the road, and only local residents' traffic will use the remaining service lanes.

Adjacent to the NIMT north of Manuroa Road is a complex of several childcare centres (located at 18 Manuroa Road and 6 Oakleigh Avenue). While these centres will continue to be affected by rail noise, there will be a reduction in road traffic noise as described below.

6.2.3.1 NZS 6806

The number of PPFs is summarised in Table 16, individual traffic noise levels for the 85 PPFs provided in the table in Appendix B of this Report, and figures showing the location of the PPFs are included in Appendix C of this Report.

The closing of the road for through traffic results in a significant reduction in noise level, with all PPFs predicted to receive traffic noise levels within Category A because of the Project, compared with current noise levels for a small number of PPFs in Categories B and C.

Table 16: Summary of NZS 6806 assessment

Scenario	Number of PPFs NZS 6806 Categories		
	Category A	Category B	Category C
Existing	76	3	6
Do-nothing	75	1	9
Do-minimum	85	0	0

6.2.3.2 Change in noise level

We predict a significant reduction in noise level for six PPFs due to the road closure. A further 9 PPFs would have a noticeably noise level reduction, while another 20 PPFs would have a perceptible noise level reduction. The remaining PPFs would generally receive similar noise levels as if the Project were not to go ahead.

Figure 5 shows the number of PPFs in each of the change in noise level bands discussed in Table 9.

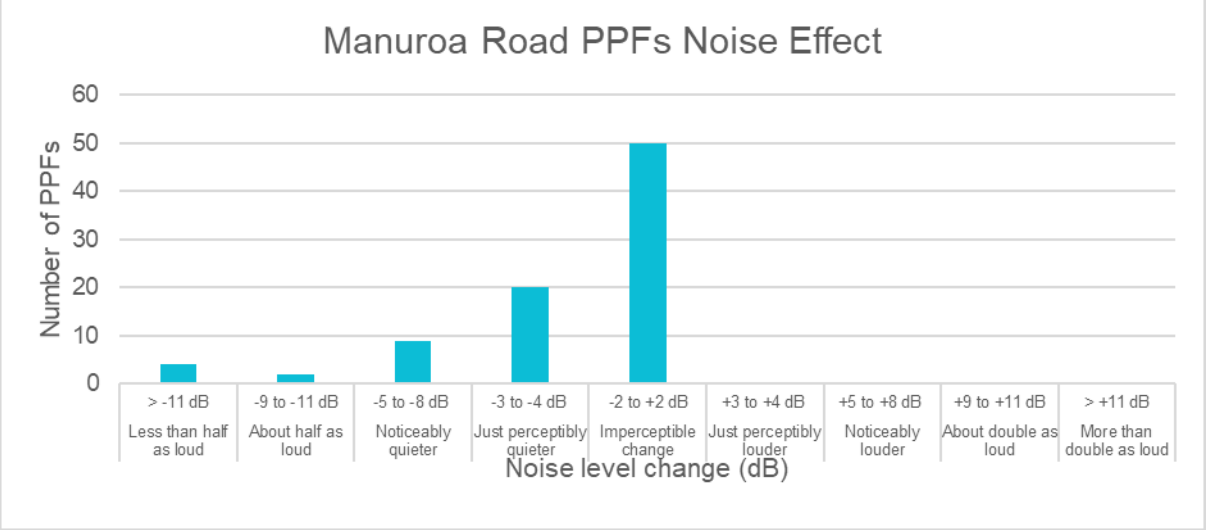


Figure 5: Change in noise level

6.2.3.3 Mitigation options

We do not consider mitigation necessary as the Project will result in various degrees of noise level reduction for most PPFs and all PPFs will receive noise levels within Category A.

6.2.3.4 Effects assessment

Given that the character of the noise will not change, with the environment controlled by traffic and rail noise, we consider the overall effect of the Project to be overall slightly to moderately positive.

6.2.4 Taka Street

The existing Taka Street level crossing will be replaced with a road bridge. The Taka Street bridge will extend over 230m and will therefore be elevated for a large extent. Any existing single storey

dwellings will be well shielded by the bridge structure itself. However, if the area is developed with multi storey dwellings, these will be less shielded from road traffic noise on the bridge. Given that these new dwellings would be developed near the NIMT and the new Taka Street crossing, we anticipate that they will be well insulated and provide ventilation to allow for a suitable indoor noise environment.

On the corner of Taka Street and Takanini Road is the Takanini Care Centre, a retirement village. The building is single storey and somewhat shielded from the NIMT.

6.2.4.1 NZS 6806

The number of PPFs is summarised in Table 17, individual traffic noise levels for the 141 PPFs are provided in the table in Appendix B of this Report, and figures showing the location of the PPFs are included in Appendix C of this Report.

The PPFs are close to Taka Street, Takanini School Road and some to the NIMT. Traffic noise levels are relatively low, with the majority of PPFs currently receiving traffic noise levels in Category A. Over time, with increased traffic, noise levels would increase and a number of PPFs receive noise levels in Categories B and C. With the new bridge in place, and the anticipated redistribution of traffic across the wider area, noise levels would generally remain similar, with only limited change predicted.

Overall, the effect of the new road on the traffic noise level at the PPFs is low, with the majority of PPFs receiving noise levels in Category A, and a similar number of PPFs would receive noise levels in Categories B and C as would be the case if the Project does not go ahead.

Only three PPFs are predicted to receive noise levels in Category C, as they would if the Project was not going ahead. We recommend that these PPFs are assessed for Building Modification Mitigation to receive a suitable internal noise level of 40 dB $L_{Aeq(24h)}$.

Table 17: Summary of NZS 6806 assessment

Scenario	Number of PPFs NZS 6806 Categories		
	Category A	Category B	Category C
Existing	137	4	0
Do-nothing	126	11	4
Do-minimum	127	11	3

6.2.4.2 Change in noise level

We predict only very limited changes in noise level due to the works, with the vast majority of PPFs (137 of the total 141) predicted to receive no perceptible noise level changes. A small number of PPFs are predicted to receive perceptible to noticeable noise level increases ranging up to 7 dB. All of these PPFs are predicted to receive noise levels within Category A.

Figure 6 shows the number of PPFs in each of the change in noise level bands discussed in Table 9.

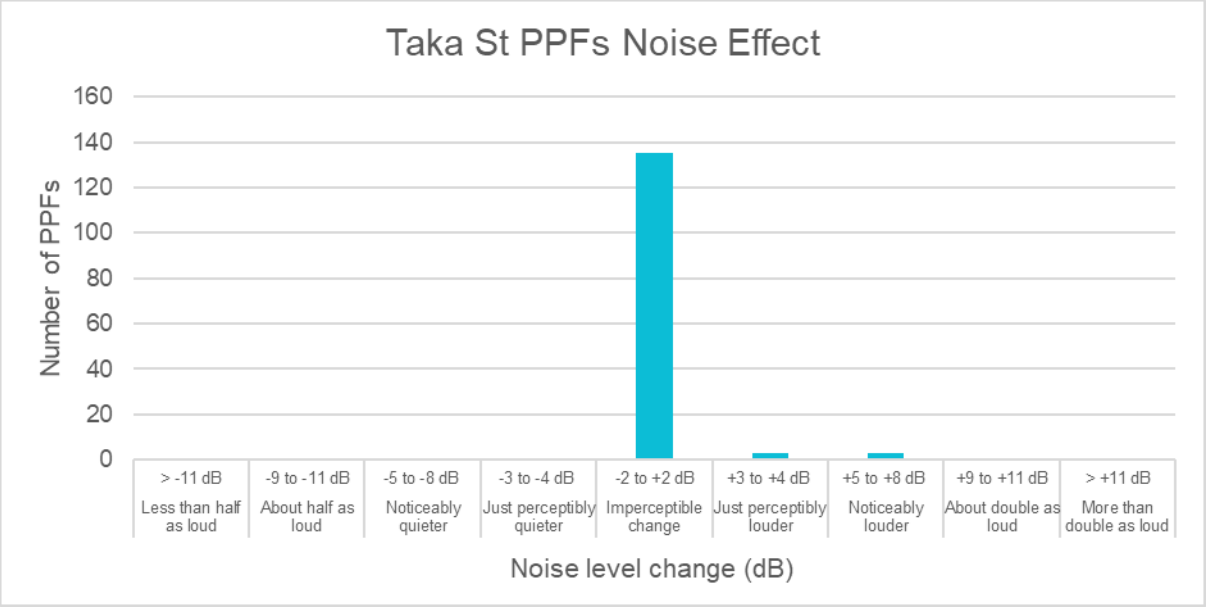


Figure 6: Change in noise level

6.2.4.3 Mitigation options

Only a small number of PPFs (1 and 2/14 Takanini School Road and 42 Taka Street) are predicted to receive traffic noise levels at the low end of Category C, and all will receive a slight noise level reduction due to the Project. There are no suitable structural mitigation options beyond the use of low noise road surface, which is already proposed. Barriers would need to be between 2.5 and 3.5m high to achieve sufficient noise level reduction, and still allow for site access. This is not considered a practicable solution in a suburban environment. We have therefore recommended that these three PPFs be investigated for building modification mitigation.

Those PPFs with the highest noise level increases of 6 to 7 dB (8/6, 10B and 2/12 Taka Street) are all predicted to receive noise levels in Category A.

Given that the road is elevated in this area and with edge barriers, and that the road will be surfaced with Asphaltic Concrete, there are limited additional practicable options that can be used to mitigate the noise level further. We do not recommend any mitigation beyond the design of the bridge including solid TL5 edge barriers. TL5 barriers have been modelled at a 1.5m acoustically effective height.

Any future multi storey dwellings should take account of the high noise environment created by the NIMT and road and be designed accordingly.

6.2.4.4 Effects assessment

A small number of PPFs is predicted to receive clearly noticeable noise level increases. However, the character of the noise will remain the same as current, controlled by road and rail traffic. The majority of PPFs will receive only imperceptible noise level changes. Overall, we consider the effect of the Project to be slightly adverse in this area.

6.2.5 Walters Road

Walters Road crossing will be replaced with a road bridge. The Walters Road bridge will extend over 250m and will therefore be elevated for a large extent. Any existing single storey dwellings will be well

shielded by the bridge structure itself. However, if the area is developed with multi storey dwellings, these will be less shielded from road traffic noise on the bridge. Given that these new dwellings would be developed in close proximity to the NIMT and the new Walters Road crossing, we anticipate that they will be well insulated and provide ventilation to allow for a suitable indoor noise environment.

There are two childcare centres, one north of Walters Road and west of the NIMT, and the other south of Walters Road and east of the NIMT.

6.2.5.1 NZS 6806

The number of PPFs is summarised in Table 18, individual traffic noise levels for the 85 PPFs provided in the table in Appendix B of this Report, and figures showing the location of the PPFs are included in Appendix C of this Report.

PPFs are close to Walters Road (which is a major road at present) and the NIMT and currently experience elevated traffic noise levels. While the majority of PPFs receive traffic noise levels in Category A, 15 are predicted to receive noise levels in Categories B and C if the Project does not go ahead (i.e. the Do nothing situation).

The redistribution of traffic across the wider area will result in a reduction in traffic volume and therefore traffic noise in the future, with a further reduction with the Project when the traffic is elevated and shielded by the structure.

Overall, all PPFs are predicted to receive noise levels in Category A.

Table 18: Summary of NZS 6806 assessment

Scenario	Number of PPFs NZS 6806 Categories		
	Category A	Category B	Category C
Existing	83	2	0
Do-nothing	70	11	4
Do-minimum	85	0	0

6.2.5.2 Change in noise level

We predict that 14 PPFs would receive a perceptible noise level increase of 3 to 4 dB, and three (3 Phar Lap Crescent and 5 and 7 Arion Road) a noticeable to significant noise level increase of 6 to 9 dB. All of the PPFs predicted to receive the highest noise level increases will also receive noise levels from the Project road in Category A.

No noticeable change is predicted for 55 PPFs and a perceptible to noticeable reduction for 13 PPFs.

Figure 7 shows the number of PPFs in each of the change in noise level bands discussed in Table 9.

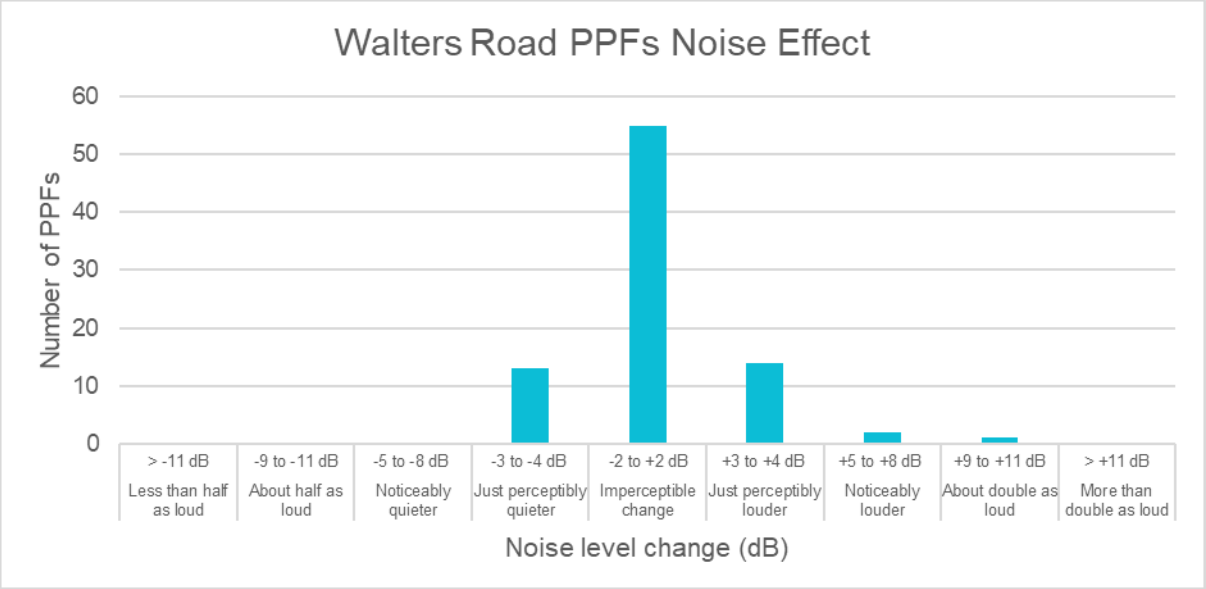


Figure 7: Change in noise level

6.2.5.3 Mitigation Options

All PPFs are predicted to receive noise levels in Category A, and most will receive a noise level reduction or no change in traffic noise level. Therefore, we do not recommend any additional mitigation beyond the use of solid 1.5m TL5 edge barriers on the bridge.

6.2.5.4 Effects assessment

While a small number of PPFs are predicted to receive noticeable to significant noise level increases, the vast majority would receive no significant change in noise environment. The character of the noise will not change to current, with road traffic and rail controlling the environment. Overall, we consider the Project to have a slightly adverse effect in this area.

6.2.6 Summary

6.2.6.1 NZS 6806

The number of PPFs is summarised in Table 19, individual predicted noise levels at all PPFs are shown in the tables in Appendix B of this Report, and figures showing the location of the PPFs are included in Appendix C of this Report. Note that the below table provides a combination of altered and new road categories due to Manuia Road crossing qualifying as a new road.

Table 19: Summary of NZS 6806 assessment

Scenario	Number of PPFs		
	NZS 6806 Categories		
	Category A	Category B	Category C
Existing	329	7	7
Do-nothing	304	20	19

Scenario	Number of PPFs		
	NZS 6806 Categories		
	Category A	Category B	Category C
Do-minimum	311	26	6
Mitigation option	313	27	3

6.2.6.2 Change in noise levels

Figure 8 shows the number of PPFs in each of the change in noise level bands discussed in Table 9. This shows that the vast majority of all PPFs (320 of the total 376 PPFs) would receive no noticeable change in noise level. Similar numbers of PPFs would receive noticeable change in traffic noise level, with 20 receiving increases and 36 decreases.

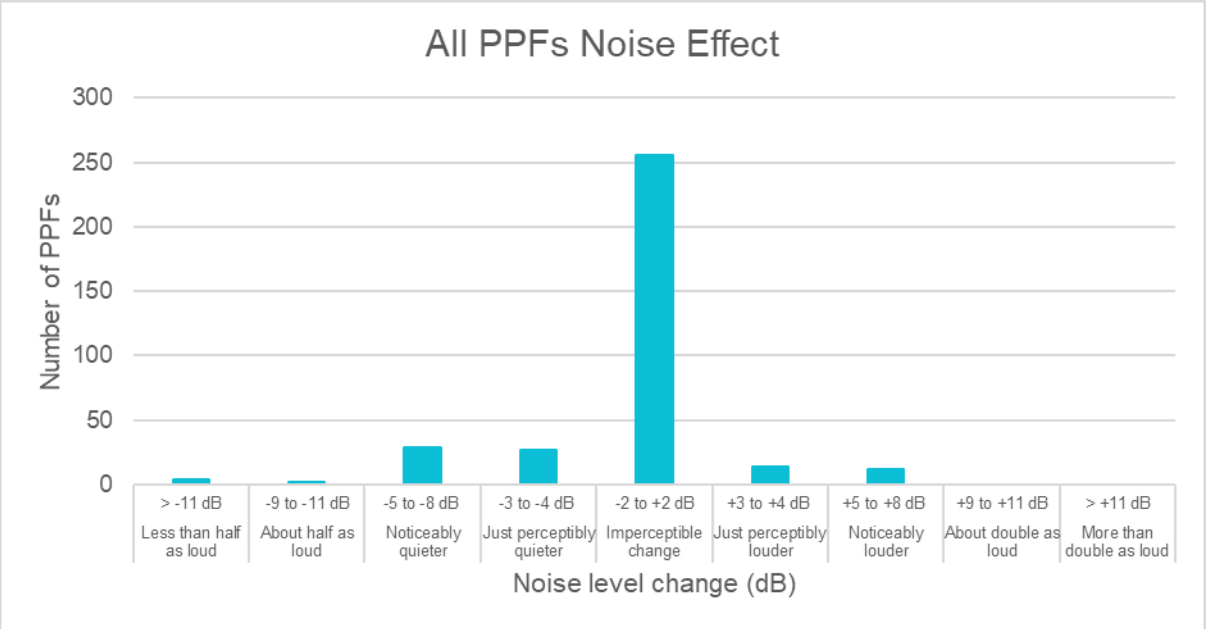


Figure 8: Change in noise level

6.3 Number of people highly annoyed

As described in Section 3.4, we have determined the number of people potentially "highly annoyed" by the noise effects of the Project, by comparing the results of the existing and Do-nothing scenarios with the results of the Do-minimum scenario and the mitigated scenario (whereby mitigation is included for Manuia Road, with all remaining crossings representing the Do-minimum situation), for the wider area.

The total number of residents in the assessment area, based on a dwelling occupancy of 3.4 people per household, is 1,234 people. Based on this number, we have provided the percentage and number of people that may be highly annoyed by noise from the roads.

Our results are summarised in Table 20 below.

Table 20: Number of people highly annoyed

Scenario	Number of people highly annoyed	Percentage of the total assessed population highly annoyed
Existing	143	11.5%
Do-nothing	179	14.5%
Do-minimum	168	13.6%
Mitigation Option 1 (at Manuia Rd)	167	13.5%

Table 20 shows that the number of people highly annoyed by road traffic noise would reduce slightly with the Project compared with it not going ahead.

The number of persons in Table 20 does not take account of any potential increase in population from now to the design year (2048). Depending on where the intensification occurs the relationship of the above numbers may change.

6.4 Potential qualitative effect of the Project

As discussed earlier, our assessment of effects on people is generally quantitative, relating to the noise level received in the future and the change in noise level experienced due to the Project. There are also several qualitative aspects that affect how people perceive the acoustic effects of a Project. Some of those are discussed below.

The Project will result in a change in noise environment for the area around Manuia Road where the Project consists of a new road. It introduces a new man-made noise source into an area that is currently only little affected by traffic noise. While the noise levels can generally be reduced to a reasonable level with the mitigation proposed, the change in character will be clearly noticeable and may cause annoyance to people in the area.

The Project as a whole will result in a redistribution of traffic, much of its heavy vehicles, onto roads that previously may not have been as affected. While this does not result in a change in character to the environment, and therefore lesser effects on people, people may feel annoyance about this change. Traffic is currently the main noise source for most of the PPFs and will remain so with the Project.

The World Health Organisation has identified that noise levels above 50 dB L_{Aeq} may cause adverse health effects. Exposures to high noise levels can lead to effects such as a reduction in sleep quality, awakenings, annoyance, lack of concentration, which in turn can lead to an impact on people's health. This means that as levels increase further, more focus is applied to management, mitigation and land use planning to reduce effects.

We consider that the 50 dB L_{Aeq} threshold is not an appropriate noise limit in the context of the Project assessed but provides an indication of overall effects in addition to the quantitative assessment undertaken. Most PPFs currently experience similar or higher noise levels, and the Projects enable the design and implementation of mitigation.

Based on the above, all vehicle bridges are proposed to be surfaced with low noise road surface either as part of the Project, and barriers are recommended for the new bridge at Manuia Road. Within the constraints of the designations, there are only limited mitigation options that can be applied in an urban context. This means that there is a shared responsibility between the road controlling authority and any future developers should higher density housing be constructed in the vicinity of the crossings.

Another aspect of people's reaction to a Project relates to habituation, i.e. "getting used to" the change and level in noise environment. This occurs over time. Any change in environment due to the introduction of a new road, or redistribution of traffic from one location to another, may cause initial disturbance to people. However, over time, people become accustomed to the sound (both level and location), pay less attention to it and the response will diminish.

7 Other noise sources

7.1 Traffic related noise sources

Traffic noise is not only generated by traffic movements on the road (controlled by the road-tyre-interaction for speeds above 40 – 50 km/h). Other aspects can also have an impact on road traffic noise but are not covered by NZS 6806 or the Calculation of Road Traffic Noise (refer Section 3.2).

These include:

- Gradients (e.g. approaching a bridge) that cause traffic to slow down and speed up, resulting in a change in engine noise characteristics when decelerating and accelerating;
- Bridge joints where traffic needs to pass over a metal piece or vertical discontinuities which may cause a bump/impact of the tire; and
- Trucks using engine brakes as they approach an intersection (e.g. coming off a bridge).

Each of these causes may influence traffic noise generation. Generally, the character of the traffic noise changes to include a tonal (e.g. engine braking) or impact (e.g. bridge joints) component or cause a noise level or character change (e.g. traffic accelerating or, engine braking).

Good design can reduce the change in noise level or character. For instance, the design of bridge joints is important in the reduction of impulsive noise. The joints should be smooth and interlocking, with absorptive materials in the cavity below. In addition, where the road surface meets the joint, this transition should be even.

The above aspects should be taken into consideration during the detailed design of the Project to ensure that unnecessary and unreasonable noise generation is avoided.

7.2 Rail related noise sources

The NIMT runs through the Project. Rail noise has not been modelled in relation to this Project and is not part of the consenting process. We anticipate with the opening of City Rail Link (**CRL**) and the proposed four tracking of the southern rail network, that the frequency of trains will increase on the network. This is one of the reasons the level crossings are to be closed and grade separated. The increase in rail frequency would occur irrespective of the Project going ahead.

A function of the Project is that the warning signals currently used at the level crossings will no longer be required. We have measured the noise level from the warning signals. They have a level of 86 dB L_{AFmax} at a distance of 4 metres. While the warning signals only operate for a brief period while the crossing arms move up or down, the signals are relatively loud and have a tonal component which makes them more annoying than other noise sources.

Removing the warning signals will have a positive overall effect on the PPFs closest to the crossing (including the retirement village and childcare centres).

7.3 Design related noise

The bridges will result in a reverberant area below the bridge deck. When trains pass below the bridge, noise levels may increase due to sound bouncing around the sides of the bridge, the underside of the bridge deck and the rail.

The potential for a reverberant field can be reduced by good design, e.g. by providing for absorptive or diffuse materials on the sides and underside of the bridge. While there are no sensitive receivers close to the bridges, sound can travel further and cause disturbance, particularly at night-time when other sounds are lower.

We recommend that the detailed design of the bridges takes account of the above to reduce reverberant noise becoming an issue.

8 Conclusions

We have prepared an assessment of traffic noise effects for the Project based on NZS 6806, in relation to the change in noise level and the potential annoyance effects from the resulting noise levels.

All existing PPFs within 100m of the Project have been considered in the assessment. Buildings that are within the proposed designation have not been assessed as it is assumed that these buildings will not remain once the Project has been implemented.

We have prepared a comparison of the predicted traffic noise levels in the Do-nothing scenario (design year without the Project) and the Do-minimum scenario (with the Project), and also with mitigation where recommended. Table 21 below provides a summary of the assessment of traffic noise effects across the NoRs and mitigation measures to manage potential effects.

Table 21:Summary of effects, assessment, and recommendations

Effect	Assessment	Recommendation
Traffic noise – all Crossings (NoR 1 and NoR 2)	All crossings are located in well-established residential and commercial areas. PPFs include dwellings, childcare centres and a retirement care home. Only existing PPFs have been assessed in detail. The largest adverse effects are anticipated from: - The removal of the first row of house around the works. This will leave PPFs behind exposed to traffic noise. - The new road crossing introduced at Manuia Road, an area where currently no road exists - The gradient of traffic approaching the bridge, which is in part mitigated by the bridge edge barrier. The largest positive effects are anticipated from: - The closure of Spartan and Manuroa Roads and replacement with active mode bridges. - The edge barriers providing shielding of traffic when at the bridge crest above the houses	Mitigation is already assumed in the form of low noise road surface. Any future intensification of noise sensitive activities around the crossings should take account of the noise environment and provide suitable sound insulation and ventilation on construction. Any existing PPFs receiving noise levels within Category C (Street crossing) should be investigated for building modification mitigation)
Traffic noise – Manuia Road crossing (NoR 1)	This crossing is the only new road bridge in an area where none currently exists. The introduction of a new noise source will cause noticeable to significant increases in traffic noise levels, and some PPFs are predicted to receive noise levels in Category C.	In addition to the use of low noise road surface, the bridge edge barrier to the south is recommended to be increase in height to 1.5m, and be extended from the bridge edge as a 2m barrier for approximately 55 to the east

1 Appendix A – Long duration noise level survey summary

Logger Measurements

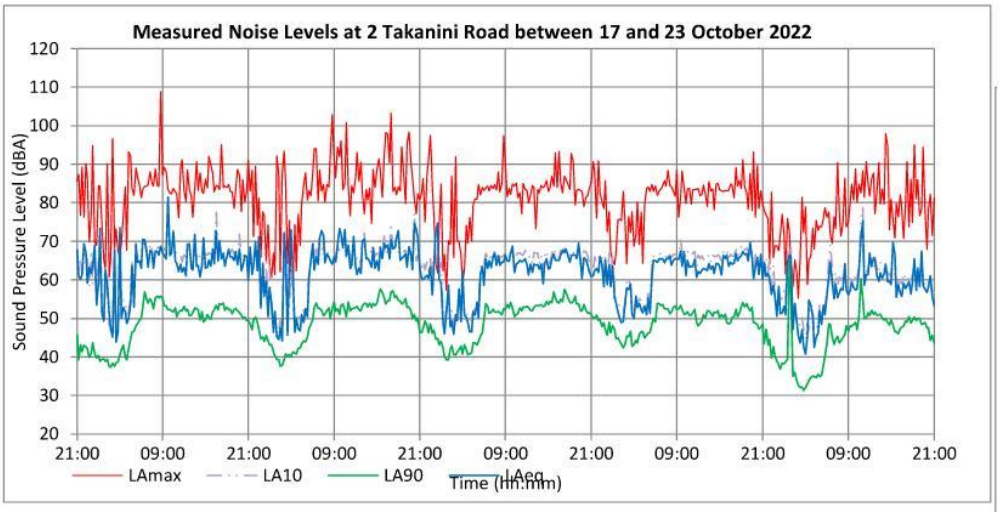
MARSHALL DAY Acoustics

Date:	Thursday, 10 November 2022
File name:	\\mdnasap01.marshallday.co.nz\Auckland\JOBS\2022\20220759\03 Survey Data & Measurements\20221017_Logger deploy _ 2 Takanini Rd\ARL data at 2 Takanini\[2 takaanini Logger
Job number:	20220759
Job name:	Takaanini Level Crossings
Initials:	OL
Measurement Dates:	17 Oct to 23 Oct 2022
Weather during Measurement:	Weather throughout the survey duration was fine and no adjustment was required.
Notes:	L10 values have been arthimetically averaged

OVERVIEW SUMMARY SHEET

	Noise Level, dB	L_{Aeq}	L_{A10}	L_{A95}	
Day	Lowest	43	46	35	64
(0700-1800)	Average	66	64	50	83
	Highest	82	79	60	109
Evening	Lowest	56	58	46	71
(1800-2200)	Average	66	66	52	85
	Highest	73	78	58	103
Night	Lowest	41	45	31	55
(2200-0700)	Average	63	58	44	75
	Highest	75	77	65	98

$L_{Aeq\ 24\text{-}hr}$ 65 dB



2 Appendix B – Individual noise level predictions for all PPFs

2.1 Spartan Road (NoR 1)

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
32 Spartan Road	GF	68	70	63
34 Spartan Road	GF	67	70	63

2.2 Manuia Road (NoR 1)

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$	Mitigation Option 1 dB $L_{Aeq(24h)}$
1 Challen Close	GF	46	64	64
3 Challen Close	GF	42	58	58
5 Challen Close	GF	41	45	45
60 Challen Close	1.FL	47	59	59
66 Challen Close	GF	40	48	49
1/62 Challen Close	GF	40	55	55
2/62 Challen Close	GF	46	60	60
1/64 Challen Close	GF	40	55	56
2/64 Challen Close	GF	43	61	61
21 Great South Road	GF	49	60	60
23 Great South Road	1.FL	52	59	59
9 Manuia Road	GF	51	55	54
9 Manuia Road	GF	47	61	60
1/7 Manuia Road	GF	46	63	62
2/7 Manuia Road	GF	47	57	57
3/7 Manuia Road	GF	48	55	55
15 Oakleigh Avenue	GF	45	62	63
18 Oakleigh Avenue	GF	44	57	55
4 Portrush Lane	GF	45	61	60
6 Portrush Lane	GF	45	62	60
7 Portrush Lane	GF	47	57	56
8 Portrush Lane	GF	45	64	62
9 Portrush Lane	GF	47	57	57
10 Portrush Lane	GF	45	64	63
11 Portrush Lane	GF	48	58	57
12 Portrush Lane	GF	47	65	63
13 Portrush Lane	GF	49	59	57
14 Portrush Lane	GF	47	65	62

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$	Mitigation Option 1 dB $L_{Aeq(24h)}$
15 Portrush Lane	GF	50	60	59
16 Portrush Lane	GF	45	65	61
17 Portrush Lane	GF	48	64	61
9 Tulloch Place	GF	42	57	56
1/7 Tulloch Place	GF	43	50	50
2/7 Tulloch Place	GF	41	58	58

2.3 Manuroa Road (NoR 1)

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
2 Beaumaris Way	GF	59	61	50
4 Beaumaris Way	GF	55	57	49
1/3 Beaumaris Way	GF	50	52	48
2/3 Beaumaris Way	GF	42	44	48
6A Beaumaris Way	GF	50	53	48
6B Beaumaris Way	GF	47	49	45
21 Great South Road	GF	49	51	60
23 Great South Road	1.FL	52	54	59
25 Great South Road	GF	53	55	56
29 Great South Road	GF	63	65	52
33 Great South Road	GF	57	59	49
120 Great South Road	GF	69	72	51
124 Great South Road	GF	62	64	51
126 Great South Road	GF	51	53	46
130 Great South Road	GF	49	51	47
132 Great South Road	GF	49	51	48
1/27 Great South Road	GF	59	61	54
2/27 Great South Road	GF	53	55	49
1/128 Great South Road	GF	51	53	48
2/128 Great South Road	GF	52	54	48
9 Manuia Road	GF	51	53	55
3/7 Manuia Road	GF	48	50	55
4/7 Manuia Road	GF	49	51	52
6 Manuroa Road	GF	68	71	50
18 Manuroa Road	GF	60	63	51
18 Manuroa Road	GF	52	54	50
18 Manuroa Road	GF	60	62	56
18 Manuroa Road	GF	66	68	51
19 Manuroa Road	GF	51	53	48
20 Manuroa Road	GF	69	71	48

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
23 Manuroa Road	GF	60	62	46
24 Manuroa Road	GF	53	55	51
25 Manuroa Road	GF	47	49	45
25 Manuroa Road	GF	58	60	47
26 Manuroa Road	GF	57	59	48
27 Manuroa Road	GF	58	61	46
28 Manuroa Road	GF	58	61	48
1/21 Manuroa Road	GF	67	70	48
2/21 Manuroa Road	GF	58	60	48
1/5 Manuroa Road	GF	68	70	50
2/5 Manuroa Road	GF	60	62	49
3/5 Manuroa Road	GF	56	58	50
4/5 Manuroa Road	GF	53	55	47
5/5 Manuroa Road	GF	50	52	46
6/5 Manuroa Road	GF	54	56	50
1/8 Manuroa Road	GF	68	71	50
2/8 Manuroa Road	GF	57	59	52
3/8 Manuroa Road	GF	53	55	54
2/10 Manuroa Road	GF	68	70	51
2/10 Manuroa Road	GF	55	57	55
2/12 Manuroa Road	GF	57	59	53
20A Manuroa Road	GF	67	70	48
27A Manuroa Road	GF	46	48	45
28A Manuroa Road	GF	45	47	47
4A Manuroa Road	GF	62	64	51
4B Manuroa Road	GF	53	55	50
6A Manuroa Road	GF	60	62	51
6B Manuroa Road	GF	54	57	53
1/13 Matawalu Place	GF	48	50	45
2/13 Matawalu Place	GF	54	56	48
1/14 Matawalu Place	GF	49	52	49
2/14 Matawalu Place	GF	49	51	45
2/15 Matawalu Place	GF	49	51	46
2/15 Matawalu Place	GF	56	58	49
1/17 Matawalu Place	GF	52	54	50
2/17 Matawalu Place	GF	58	60	51
2/10 Matawalu Place	GF	48	51	47
2 Oakleigh Avenue	GF	51	53	50
2 Oakleigh Avenue	1.FL	58	60	53
5 Oakleigh Avenue	GF	51	53	50
6 Oakleigh Avenue	GF	49	51	55
6 Oakleigh Avenue	GF	49	51	57

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
7 Oakleigh Avenue	GF	50	52	50
5A Oakleigh Avenue	GF	48	51	46
12A Princess Street	GF	46	48	45
12B Princess Street	GF	46	48	45
12D Princess Street	GF	50	52	47
14A Princess Street	GF	45	47	44
14B Princess Street	GF	47	49	44
14C Princess Street	GF	50	52	46
14D Princess Street	GF	50	52	46
3 Tulloch Place	GF	44	46	47
5 Tulloch Place	GF	43	46	47
1/7 Tulloch Place	GF	43	46	50
2/7 Tulloch Place	GF	41	43	58

2.4 Taka Street (NoR 1)

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
1 Walter Strevens Drive	GF	48	51	54
159 Great South Road	GF	46	48	53
4 Walter Strevens Drive	GF	48	50	54
160 Great South Road	1.FL	45	47	54
11 Maru Road	GF	41	43	48
5/9 Maru Road	1.FL	44	46	51
6/7 Maru Road	1.FL	46	48	54
4/7 Maru Road	1.FL	43	45	47
4/5 Maru Road	GF	43	46	51
41 Taka Street	GF	44	47	50
38 Taka Street	GF	64	67	66
30A Taka Street	GF	46	48	49
32 Taka Street	GF	46	49	50
32A Taka Street	GF	50	52	52
34 Taka Street	GF	52	55	54
24 Taka Street	GF	49	52	51
24A Taka Street	GF	47	50	49
26 Taka Street	GF	43	46	47
26A Taka Street	GF	44	47	47
28 Taka Street	GF	44	47	47
28A Taka Street	GF	44	46	47
37 Taka Street	GF	45	48	49
25 Taka Street	GF	50	53	56

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
29 Taka Street	GF	47	49	53
45 Taka Street	GF	63	66	65
1/36 Taka Street	GF	64	67	65
2/22 Takanini School Road	GF	44	47	46
1/22 Takanini School Road	GF	42	45	45
40 Taka Street	GF	64	67	65
42A Taka Street	GF	52	55	54
42 Taka Street	GF	66	69	68
44 Taka Street	GF	65	68	67
2/14 Takanini School Road	1.FL	66	69	68
1/14 Takanini School Road	GF	66	69	68
16A Takanini School Road	GF	53	56	55
16 Takanini School Road	GF	55	58	57
1/18 Takanini School Road	GF	46	49	48
2/18 Takanini School Road	GF	49	52	51
44A Taka Street	GF	51	54	53
54 Taka Street	GF	47	50	50
56 Taka Street	GF	44	47	46
58 Taka Street	GF	43	46	45
62 Taka Street	GF	44	46	46
3/22 Takanini School Road	GF	44	47	47
24 Takanini School Road	GF	41	43	44
41 Taka Street	GF	44	47	49
49G Taka Street	GF	43	46	46
30 Taka Street	GF	46	49	49
2/20 Takanini School Road	GF	47	49	49
1/20 Takanini School Road	GF	43	46	46
3/29 Aeronautic Road	GF	45	48	48
2/35 Aeronautic Road	GF	50	53	51
57D Taka Street	GF	63	66	65
1/35 Aeronautic Road	GF	50	53	52
67 Taka Street	GF	63	66	65
4/29 Aeronautic Road	GF	43	46	47
4/33 Aeronautic Road	GF	42	45	45
3/33 Aeronautic Road	GF	42	45	45
2/29 Aeronautic Road	GF	44	46	47
3/31 Aeronautic Road	GF	45	48	47
2/33 Aeronautic Road	GF	43	46	46
2/31 Aeronautic Road	GF	43	46	46
57 Taka Street	GF	48	51	51
57B Taka Street	GF	49	52	52
49C Taka Street	GF	64	67	66

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
49B Taka Street	GF	49	51	51
2/55 Taka Street	GF	50	53	52
49A Taka Street	GF	64	67	65
1/55 Taka Street	GF	64	67	65
57C Taka Street	GF	63	66	65
15 Takanini School Road	GF	44	46	46
6 Takanini Road	GF	43	46	48
2/4 Takanini Road	GF	49	52	50
4 Takanini Road	GF	45	47	50
5 Cathay Lane	GF	47	50	50
3 Cathay Lane	GF	49	52	52
3 Cathay Lane	GF	51	54	54
1/18 Taka Street	GF	55	58	55
3/18 Taka Street	GF	51	54	53
4 Cathay Lane	GF	49	51	52
4A Cathay Lane	GF	47	49	51
6 Cathay Lane	GF	43	46	48
8 Cathay Lane	GF	45	48	50
9 Cathay Lane	GF	46	49	50
3/12 Taka Street	GF	45	48	53
10B Taka Street	GF	45	48	60
8/6 Taka Street	GF	43	45	61
10C Taka Street	GF	43	46	52
4/12 Taka Street	GF	46	49	52
2 Takanini Road	GF	54	56	54
21 Taka Street	GF	54	56	57
7A Takanini Road	GF	41	43	46
7 Takanini Road	GF	44	46	47
9-11 Taka Street	GF	59	61	60
3/6 Taka Street	GF	48	51	61
6/6 Taka Street	GF	42	44	52
27 Taka Street	GF	45	48	50
35 Taka Street	GF	50	53	57
49F Taka Street	GF	45	47	49
49E Taka Street	GF	46	49	50
43 Taka Street	GF	49	52	54
1/33 Aeronautic Road	GF	42	45	45
3/35 Aeronautic Road	GF	43	46	46
1/29 Aeronautic Road	GF	42	45	46
1/31 Aeronautic Road	GF	42	45	45
4/31 Aeronautic Road	GF	42	45	45
4/55 Taka Street	GF	46	49	48

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
3/55 Taka Street	GF	49	52	52
57A Taka Street	GF	48	50	50
47 Taka Street	GF	62	65	64
49D Taka Street	GF	50	53	52
8 Walter Strevens Drive	GF	48	50	53
1/6 Walter Strevens Drive	GF	39	41	43
2/2 Walter Strevens Drive	GF	48	50	54
1/2 Walter Strevens Drive	GF	46	49	53
1/6 Walter Strevens Drive	GF	40	42	44
5/7 Maru Road	1.FL	43	45	49
4/9 Maru Road	1.FL	43	45	50
6/9 Maru Road	1.FL	46	48	54
5/6 Taka Street	GF	42	45	54
4/6 Taka Street	GF	46	48	54
7/6 Taka Street	GF	43	45	54
2/12 Taka Street	GF	44	47	58
3/4 Takanini Road	GF	51	53	51
2/36 Taka Street	GF	55	58	58
1 Airfield Road	1.FL	48	51	51
1 Airfield Road	1.FL	50	53	53
1 Airfield Road	1.FL	54	57	55
1 Airfield Road	1.FL	55	58	57
11 Airfield Road	1.FL	40	42	44
2 Fuselage Lane	1.FL	54	56	56
4 Fuselage Lane	1.FL	52	55	55
6 Fuselage Lane	1.FL	52	55	54
10 Kauri Heart Avenue	1.FL	51	54	53
30 Aeronautic Road	1.FL	54	57	56
3 Kauri Heart Avenue	1.FL	45	48	48
28 Aeronautic Road	1.FL	52	55	54
1 Peat Way	1.FL	48	51	51
3 Peat Way	1.FL	40	43	43
5 Peat Way	1.FL	40	43	42
7 Peat Way	1.FL	38	41	41

2.5 Walters Road (NoR 2)

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
70 Walters Road	1.FL	57	60	52
33 Calumet Way	1.FL	43	47	40

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
168 Porchester Road	1.FL	64	68	59
172 Porchester Road	1.FL	50	54	45
172 Porchester Road	1.FL	52	55	46
174 Porchester Road	1.FL	47	50	42
176 Porchester Road	1.FL	47	51	42
180 Porchester Road	1.FL	45	49	41
145 Porchester Road	1.FL	54	58	49
147 Porchester Road	1.FL	52	56	47
29 Calumet Way	1.FL	48	52	43
25 Calumet Way	1.FL	39	42	36
151 Porchester Road	1.FL	47	50	42
151 Porchester Road	1.FL	45	48	40
5 Phar Lap Crescent	1.FL	53	56	48
3 Phar Lap Crescent	1.FL	52	55	47
11 Phar Lap Crescent	1.FL	55	59	49
7 Phar Lap Crescent	1.FL	52	55	46
19 Phar Lap Crescent	1.FL	59	62	54
21 Phar Lap Crescent	1.FL	57	61	52
29 Phar Lap Crescent	1.FL	44	48	41
178 Porchester Road	1.FL	45	49	41
164A Porchester Road	GF	51	55	46
43 Walters Road	GF	50	54	46
45 Walters Road	GF	46	49	43
1/160 Porchester Road	GF	45	48	42
2/160 Porchester Road	GF	48	51	44
166 Porchester Road	GF	64	68	59
41 Walters Road	GF	63	67	58
4 Braeburn Place	GF	48	51	44
37A Walters Road	GF	51	54	47
39 Walters Road	GF	63	67	58
17 Phar Lap Crescent	1.FL	61	65	56
23 Phar Lap Crescent	1.FL	46	49	41
49 Walters Road	GF	48	51	43
2/162 Porchester Road	GF	52	56	47
178 Porchester Road	1.FL	45	49	41
149 Porchester Road	1.FL	39	42	36
41 Walters Road	GF	51	54	46
158A Porchester Road	1.FL	48	51	46
158 Porchester Road	GF	44	47	41
15 Phar Lap Crescent	1.FL	66	69	60
168 Porchester Road	1.FL	63	66	57
176 Porchester Road	1.FL	47	51	42

PPF Address	Floor	Existing scenario dB $L_{Aeq(24h)}$	Do-nothing scenario dB $L_{Aeq(24h)}$	Do-minimum scenario dB $L_{Aeq(24h)}$
170 Porchester Road	1.FL	53	56	47
31 Calumet Way	1.FL	54	58	50
70 Walters Road	1.FL	54	58	49
149 Porchester Road	1.FL	51	54	45
27 Calumet Way	1.FL	39	43	36
23 Calumet Way	1.FL	40	43	37
153 Porchester Road	1.FL	45	48	41
155 Porchester Road	1.FL	43	46	40
9 Glenburn Place	GF	47	50	44
39 Walters Road	GF	51	54	46
23 Phar Lap Crescent	1.FL	55	58	49
25 Phar Lap Crescent	1.FL	53	57	48
49 Walters Road	GF	51	54	46
49 Walters Road	GF	57	60	52
3 Braeburn Place	GF	50	52	51
1/3 Braeburn Place	GF	51	53	51
5 Braeburn Place	GF	49	50	46
7 Braeburn Place	GF	48	49	45
2 Braeburn Place	1.FL	55	56	54
31 Walters Road	GF	64	65	59
33 Walters Road	GF	65	68	62
33A Walters Road	GF	53	55	49
6 Braeburn Place	GF	50	52	49
8 Braeburn Place	GF	45	47	46
10 Braeburn Place	GF	46	48	47
6A Braeburn Place	1.FL	51	54	49
37 Walters Road	GF	64	67	59
35 Walters Road	GF	64	67	60
7 Arion Road	1.FL	55	57	51
3 Arion Road	1.FL	63	66	58
5 Arion Road	1.FL	56	58	52
3 Arion Road	1.FL	63	66	57
13 Phar Lap Crescent	1.FL	62	65	56
13 Phar Lap Crescent	1.FL	62	65	56
9 Phar Lap Crescent	1.FL	53	57	48
9 Phar Lap Crescent	1.FL	52	56	47
7 Phar Lap Crescent	1.FL	49	52	44
1 Longford Park Drive	GF	47	50	49
2 Longford Park Drive	GF	50	52	51
1/162 Porchester Road	GF	46	49	42
164B Porchester Road	GF	54	57	48

3 Appendix C – Noise level contours

SGA TAKAANINI

Overview Map

Map Legend

Altered Road (dB $L_{Aeq(24h)}$)

- < 64 Category A
- 64 - 67 Category B
- > 67 Category C

New Road (dB $L_{Aeq(24h)}$)

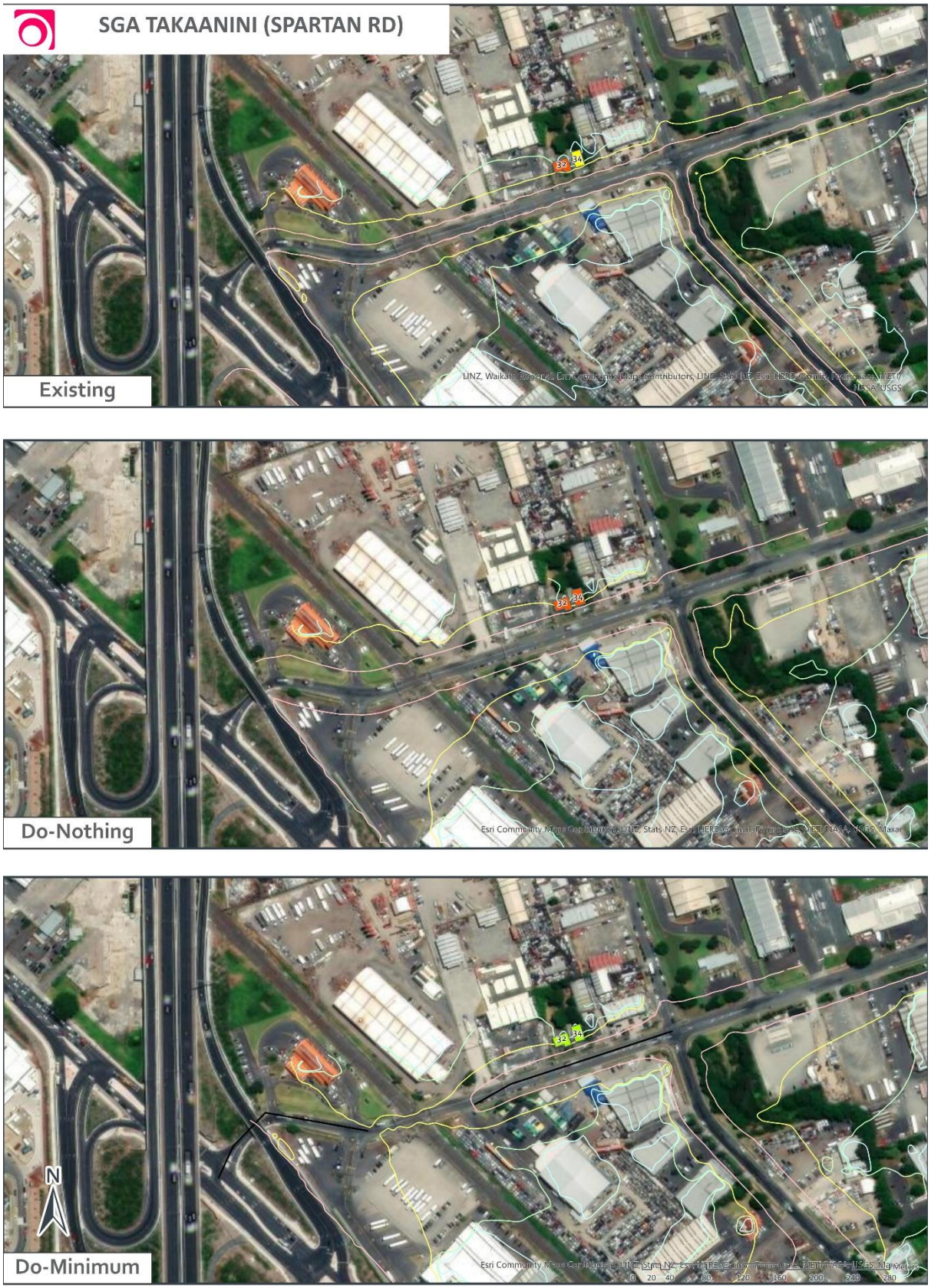
- < 57 Category A
- 57 - 64 Category B
- > 64 Category C
- Building to be removed

Noise wall

- Noise protection wall
- Project Roads

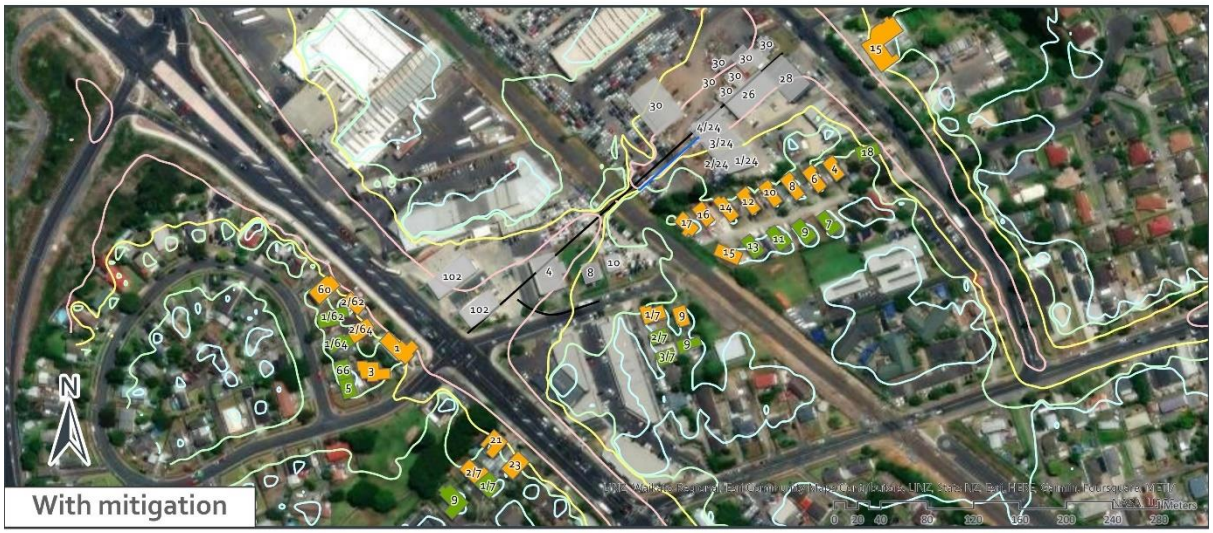
Contours dB $L_{Aeq(24)}$

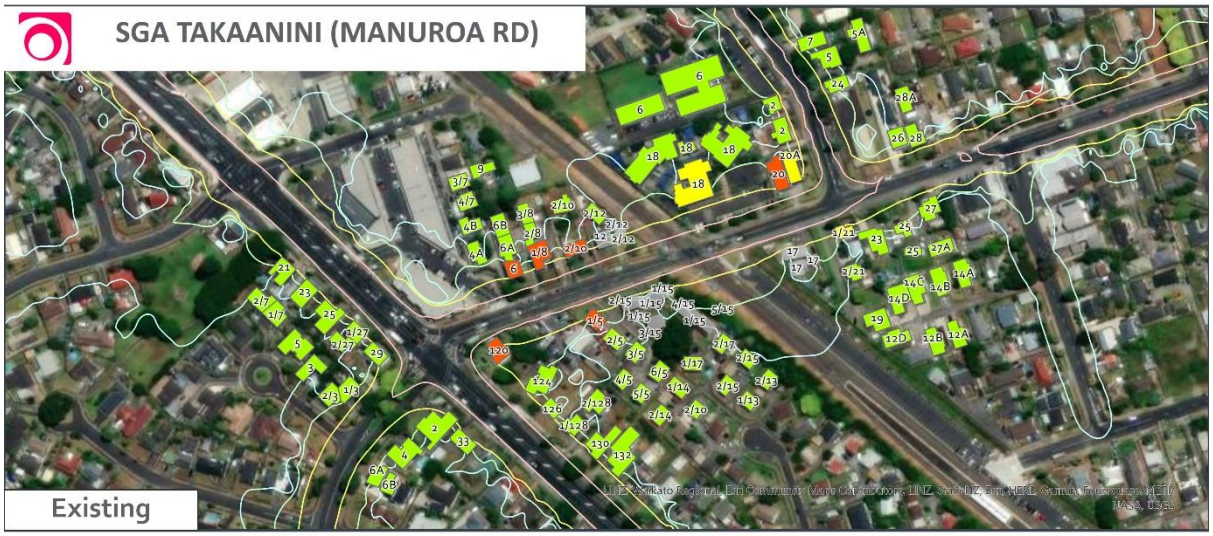
- 55
- 60
- 65
- 70


SGA TAKAANINI (SPARTAN RD)
Existing
Do-Nothing
Do-Minimum
N
0 20 40 80 120 160 200 240 280


SGA TAKAANINI (MANUIA ROAD)
Existing


Do-Minimum


N
With mitigation


SGA TAKAANINI (MANUROA RD)
Existing


Do-Nothing

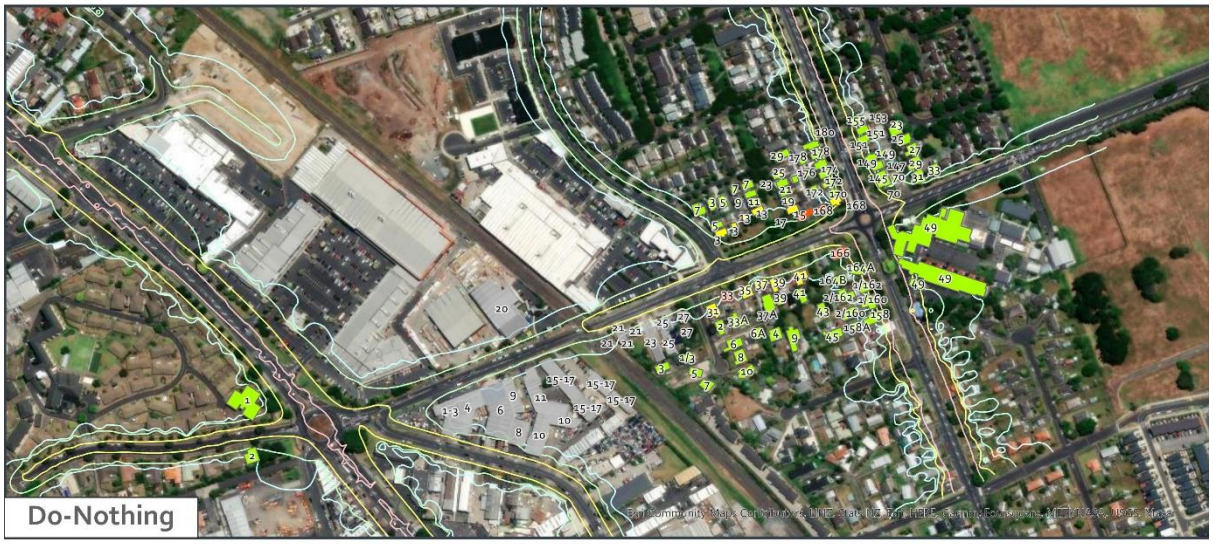

N
Do-Minimum


SGA TAKAANINI (TAKA ST)
Existing


Do-Nothing


N
Do-Minimum


SGA TAKAANINI (WALTERS RD)
Existing


Do-Nothing


N
Do-Minimum