



TE TUPU NGĀTAHI
SUPPORTING GROWTH

North West Whenuapai Assessment of Construction Noise and Vibration Effects

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Table of Contents

1	Executive Summary	1
2	Introduction.....	6
2.1	Purpose and Scope of this Report.....	7
2.2	Report Structure	8
2.3	Preparation for this Report	8
3	Assessment Criteria.....	9
3.1	Construction Noise.....	9
3.2	Construction Vibration.....	11
3.2.1	Auckland Unitary Plan	11
3.2.2	DIN 4150-3:1999 – Structural vibrations: Effects of vibrations on structures....	12
3.2.3	British Standard 5228-2	13
3.2.4	Auckland Transport construction vibration criteria	13
4	Assessment Methodology.....	15
4.1	Construction methodology	15
4.1.1	Site establishment.....	15
4.1.2	Advance works.....	16
4.1.3	Main works	16
4.1.4	Finishing works and demobilisation	16
4.1.5	Plant and Equipment.....	16
4.2	Construction Noise.....	17
4.2.1	Equipment Noise Levels	18
4.3	Construction Vibration.....	19
5	Whenuapai Construction Effects	21
5.1	Overview of Construction Effects	21
5.1.1	Construction noise	21
5.1.2	Construction Vibration	22
5.2	Recommended Measures to Avoid, Remedy or Mitigate Construction Effects	23
5.2.1	Construction Noise and Vibration Management Plan.....	23
5.2.2	Schedules	24
5.2.3	Noise mitigation measures	25
5.2.4	Vibration mitigation	25
5.2.5	Building Condition Survey.....	25
5.2.6	Night Works	26
6	NoR W1: Trig Road North Upgrade	27
6.1	Project Corridor Features	27
6.2	Existing and Likely Future Environment.....	29
6.2.1	Planning context	29
6.2.2	Noise Environment.....	29
6.3	Assessment of Construction Noise and Vibration Effects	30

6.3.1	Construction Noise Effects	30
6.3.2	Construction Vibration Effects	30
6.4	Conclusions	31
7	NoR W2: Māmari Road Upgrade.....	32
7.1	Project Corridor Features	32
7.2	Existing and Likely Future Environment.....	34
7.2.1	Planning context	34
7.2.2	Noise Environment.....	34
7.3	Assessment of Construction Noise and Vibration Effects	34
7.3.1	Construction Noise Effects	34
7.3.2	Construction Vibration Effects	35
7.4	Conclusions	36
8	NoR W3: Brigham Creek Road Upgrade.....	37
8.1	Project Corridor Features	37
8.2	Existing and Likely Future Environment.....	39
8.2.1	Planning context	39
8.2.2	Noise Environment.....	39
8.3	Assessment of Construction Noise and Vibration Effects	40
8.3.1	Construction Noise Effects	40
8.3.2	Construction Vibration Effects	40
8.4	Conclusions	41
9	NoR W4: Spedding Road.....	42
9.1	Project Corridor Features	42
9.1.1	Spedding Road (West)	42
9.1.2	Spedding Road (East)	42
9.2	Existing and Likely Future Environment.....	44
9.2.1	Planning context	44
9.2.2	Noise Environment.....	44
9.3	Assessment of Construction Noise and Vibration Effects	45
9.3.1	Construction Noise Effects	45
9.3.2	Construction Vibration Effects	45
9.4	Conclusions	46
10	NoR W5: Hobsonville Road FTN Upgrade.....	47
10.1	Project Corridor Features	47
10.2	Existing and Likely Future Environment.....	49
10.2.1	Planning context	49
10.2.2	Noise Environment.....	49
10.3	Assessment of Construction Noise and Vibration Effects	50

10.3.1	Construction Noise Effects	50
10.3.2	Construction Vibration Effects	50
10.4	Conclusions	51
11	Conclusion	52

Appendices

No table of contents entries found.

Table of Figures

Figure 2-1: North West Local Package - Whenuapai – Overview of NoRs for Assessment.....	7
Figure 6-1 Overview of the Trig Road Upgrade.....	28
Figure 7-1 Overview of Māmari Road Upgrade.....	33
Figure 8-1 Overview of Brigham Creek Road Upgrade.....	38
Figure 9-1 Overview of Spedding Road.....	43
Figure 10-1 Overview of Hobsonville Road Upgrade	48

Table of Tables

Table 2-1: North West Whenuapai Assessment Package – Notices of Requirement and Projects	6
Table 3-1 Construction noise criteria for sensitive receivers (outside of Business – City Centre Zone and the Business – Metropolitan Centre Zone)	9
Table 3-2 Construction noise criteria for all other receivers (outside of Business – City Centre Zone and the Business – Metropolitan Centre Zone)	10
Table 3-3 AUP:OP Table E25.6.30.1 Vibration limits in buildings.....	11
Table 3-4 Vibration velocity guideline values for structures (DIN 4150)	12
Table 3-5 Human perception of vibration levels	13
Table 3-6 Auckland Transport Construction vibration criteria	14
Table 4-1 Indicative construction equipment	16
Table 4-2 Construction Equipment Sound levels and indicative compliance distance	18
Table 4-3 Activity Sound Power Levels and Compliance Distance.....	19
Table 4-4 Vibration sources and indicative emission radii	20
Table 5-1 Potential construction noise effects on receivers	21
Table 5-2 Potential vibration effects on human perception summary against AUP:OP /DIN criteria....	22
Table 6-1: Trig Road Upgrade Existing and Likely Future Environment	29
Table 7-1: Māmari Road Existing and Likely Future Environment	34
Table 8-1: Brigham Creek Road Upgrade Existing and Likely Future Environment	39
Table 9-1: Spedding Road Existing and Likely Future Environment	44

Table 10-1: Hobsonville Road FTN Upgrade Existing and Likely Future Environment49

Abbreviations

Acronym/Term	Description
AEE	Assessment of Effects on the Environment
AC	Auckland Council
AT	Auckland Transport
AUP:OP	Auckland Unitary Plan Operative in Part
FTN	Frequent Transit Network
FUZ	Future Urban Zone
NoR	Notice of Requirement (under the Resource Management Act 1991)
RMA	Resource Management Act 1991
SH16	State Highway 16
SH18	State Highway 18
Te Tupu Ngātahi	Te Tupu Ngātahi Supporting Growth Programme
Waka Kotahi	Waka Kotahi NZ Transport Agency
NZDF	New Zealand Defence Force
MoD	Ministry of Defence
PPC5	Proposed Plan Change 5

Glossary of Acronyms / Terms

Acronym/Term	Description
Auckland Council	Means the unitary authority that replaced eight councils in the Auckland Region as of 1 November 2010.
Whenuapai Assessment Package	Four Notices of Requirement and one alteration to an existing designation for the Whenuapai Arterial Transport Network for Auckland Transport.

1 Executive Summary

Construction noise levels have been assessed using the method recommended in NZS 6803 in accordance with the Auckland Unitary Plan. As construction of each Project is expected to last for more than 20 weeks, the “long-duration” noise limits are applicable.

Noisy activities will typically be carried out between 7am – 6pm on weekdays. Night time and weekend works will be limited and only occur for critical activities.

Construction vibration levels have been assessed against the requirements of the AUP, which refer to the criteria in DIN 4150-3:1999 for the avoidance of cosmetic building damage (DIN criteria). The AUP also details amenity criteria, which act as a trigger for consultation if predicted to be exceeded.

Construction noise setback distances and vibration emission radii have been determined (based on assumptions of construction activities and equipment) for each of the NoR sections. The construction boundary is assumed to be the edge of the proposed alignment. Affected receivers have been identified using construction noise setback distances and vibration emission radii. The construction noise setback distances and vibration emission radii were used to determine where any potential construction noise and vibration exceedances of the relevant criteria could occur. It should also be noted that the emission radii are conservative and vibration levels measured on site tend to be much lower than those predicted at the NoR stage of a project.

Potential effects of construction noise and vibration have then been assessed and construction management and mitigation measures identified where appropriate. To avoid and/or minimise exceedances of the Project construction noise and vibration criteria, Best Practicable Option (BPO) mitigation and management measures should be utilised.

NoR W1 Trig Road (North)

Results of assessment and recommended measures

Trig Road is currently located within a predominantly rural area with few dwellings in close proximity to the road. The noise environment is dominated by road traffic noise from vehicles on Trig Road, SH18 and the surrounding network as well as aircraft noise associated with the Whenuapai Air Base.

PPC5¹ and the Whenuapai Structure Plan indicate that the land surrounding Trig Road, to the north of SH18 is likely to be Industrial or Business Zones. This zoning would likely result in an increase in ambient noise levels. Where Residential Zones are likely, to the south of SH18, ambient noise levels would likely still increase as the area urbanises.

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 6m. With mitigation in place, as set out in Section 5.2, noise levels of up 80 dB L_{Aeq} could occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 80 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with

¹ Note PPC5 has now been withdrawn by Auckland Council, however land use assumptions are retained under Whenuapai Structure Plan.

lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Vibration levels could exceed the Category B criteria of 5mm/s PPV at two receivers prior to mitigation being implemented, if high vibration generating equipment, such as the roller compactor, is used on the construction boundary at the closest position to the receivers. At these receivers there is potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

Conclusion

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment are used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

NoR W2 Māmari Road

Results of assessment and recommended measures

Māmari Road is currently located within a predominantly rural area with few dwellings in close proximity to the road. The noise environment is dominated by road traffic noise from vehicles on Māmari Road as well as aircraft noise associated with the Whenuapai Air Base. The Whenuapai Structure Plan indicates that the land surrounding Māmari Road, to the east and west is likely to be Business Zone. This zoning would likely result in an increase in ambient noise levels as the area urbanises compared to the current rural nature.

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver, Timatanga Community School, at 2m. With mitigation in place, as set out in Section 5.2, noise levels of up 90 dB L_{Aeq} could occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Vibration levels could exceed the Category B criteria of 5mm/s PPV at four existing dwellings and the school prior to mitigation being implemented, if high vibration generating equipment, such as the roller compactor, is used on the construction boundary at the closest position to the receivers. At these receivers there is potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

Conclusion

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment are used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

NoR W3 Brigham Creek Road

Results of assessment and recommended measures

Brigham Creek Road runs through an existing rural environment at each end, with the middle section being a mix of town centre, industrial and suburban environments. The noise environment is dominated by road traffic noise from vehicles on Brigham Creek Road as well as aircraft noise associated with the Whenuapai Air Base. PPC5 and the Whenuapai Structure Plan indicate that Brigham Creek Road is likely to be surrounded by a mix of uses in the future with a Light Industrial Zone, Business Zones and Residential Zones proposed. This zoning would likely result in an increase in ambient noise levels as the area urbanises.

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 2m. With mitigation in place, as set out in Section 5.2, noise levels of up 90 dB L_{Aeq} could occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Vibration levels could exceed the Category B criteria of 5mm/s PPV at 34 receivers prior to mitigation being implemented, if high vibration generating equipment, such as the roller compactor, is used on the construction boundary at the closest position to the receivers. At these receivers there is potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

Conclusion

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment are used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

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NoR W4 Spedding Road

Results of assessment and recommended measures

Spedding Road is currently located within a predominantly rural area with few dwellings in close proximity to the road. PPC5, the Whenuapai Structure Plan and the I603 Hobsonville Corridor Precinct indicate that the land surrounding Spedding Road is likely to contain mostly industrial or business uses in the future with pockets of residential. Ambient noise levels are expected to increase as the area urbanises.

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 2m. With mitigation in place, as set out in Section 5.2, noise levels of up 90 dB L_{Aeq} could occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Vibration levels could exceed the Category B criteria at three existing dwelling and two commercial buildings prior to mitigation being implemented, if high vibration generating equipment, such as the roller compactor, is used on the construction boundary at the closest position to the receivers. At these receivers there is potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

The Whenuapai Aerodrome Heavy Anti-Aircraft Battery is scheduled as a Historic Heritage Place and is located across the properties at 4 Spedding Road and 92 Trig Road. Unmitigated vibration levels could exceed the DIN criteria for historical / sensitive structures. To control and minimise vibration levels at these structures the use of smaller or low vibration equipment will be required. A vibration management plan will be prepared in accordance with Rule E26.8.8 of the AUP.

Conclusion

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment are used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

NoR W5 Hobsonville Road

Results of assessment and recommended measures

Hobsonville Road is an existing urban corridor with development still occurring in the surrounding area. The noise environment is dominated by road traffic noise from vehicles on Hobsonville Road. Although development is still occurring in the area, ambient noise levels are unlikely to increase significantly above their current level.

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 2m. With mitigation in place, as set out in Section 5.2, noise levels of up 90 dB L_{Aeq} could occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Vibration levels could exceed the Category B criteria at 50 existing dwellings and 5 commercial buildings prior to mitigation being implemented, if high vibration generating equipment such as the roller compactor is used on the construction boundary at the closest position to the receivers. At these receivers there is potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

Conclusion

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment are used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

2 Introduction

This construction noise and vibration assessment has been prepared for the North West Local Arterial Network Notices of Requirement (**NoRs**) for Auckland Transport (**AT**) (the “Whenuapai Assessment Package”). The NoRs are to designate land for future local arterial transport corridors as part of Te Tupu Ngātahi Supporting Growth Programme (**Te Tupu Ngātahi**) to enable the construction, operation and maintenance of transport infrastructure in the North West Whenuapai area of Auckland.

The North West growth area is approximately 30 kilometres north west of Auckland’s central city. It makes a significant contribution to the future growth of Auckland’s population by providing for approximately 42,355 new dwellings and employment activities that will contribute 13,000 new jobs across the North West. Whenuapai is one of these growth areas, located between State Highway 16 (**SH16**) and State Highway 18 (**SH18**) and at present is largely rural (but Future Urban Zoned) with an existing community consisting of new and more established residential, business and local centre land uses. This growth area is expected to be development ready by 2018-2022 with 401 hectares to accommodate 6,000 dwellings. Furthermore, a Whenuapai Structure Plan was adopted by the Council in 2016 and sets out the framework for transforming Whenuapai from a semi-rural environment to an urbanised community over the next 10 to 20 years.

The Whenuapai Assessment Package will provide route protection for the local arterials, which include walking, cycling and public transport (including the Frequent Transit Network (**FTN**)), needed to support the expected growth in Whenuapai.

This report assesses the construction noise and vibration effects of the North West Whenuapai Assessment Package identified in Figure 2-1 and Table 2-1 below.

The Whenuapai Assessment Package comprises five separate projects which together form the North West Whenuapai Arterial Network. The network includes provision for general traffic, walking and cycling, and frequent public transport

Table 2-1: North West Whenuapai Assessment Package – Notices of Requirement and Projects

Corridor	NOR	Description	Requiring Authority
Trig Road North	NoR W1	Upgrade of Trig Road corridor to a 24m wide two-lane urban arterial cross-section with separated active mode facilities on both sides of the corridor.	Auckland Transport
Māmari Road	NoR W2	Extension and upgrade of Māmari Road corridor to a 30m wide four-lane urban arterial cross-section providing bus priority lanes and separated active mode facilities on both sides of the corridor.	Auckland Transport
Brigham Creek Road	NoR W3	Upgrade of Brigham Creek Road corridor to a 30m wide four-lane arterial cross-section with separated active mode facilities on both sides of the corridor.	Auckland Transport
Spedding Road	NoR W4	Upgrade of the existing Spedding Road corridor and new east and west extensions to form a 24m wide two-lane arterial with separated active mode facilities on both sides of the corridor.	Auckland Transport

Corridor	NOR	Description	Requiring Authority
Hobsonville Road (alteration to existing designation 1437)	NoR W5	Alteration of the existing Hobsonville Road designation 1437 to provide for the widening of the Hobsonville Road corridor between Oriel Avenue and Memorial Park Lane. Upgrade of sections of Hobsonville Road corridor to a 30m wide four-lane cross section with separated active mode facilities on both sides of the corridor Upgrade of sections of Hobsonville Road corridor to a 24m wide two-lane cross section with separated active mode facilities on both sides of the corridor.	Auckland Transport

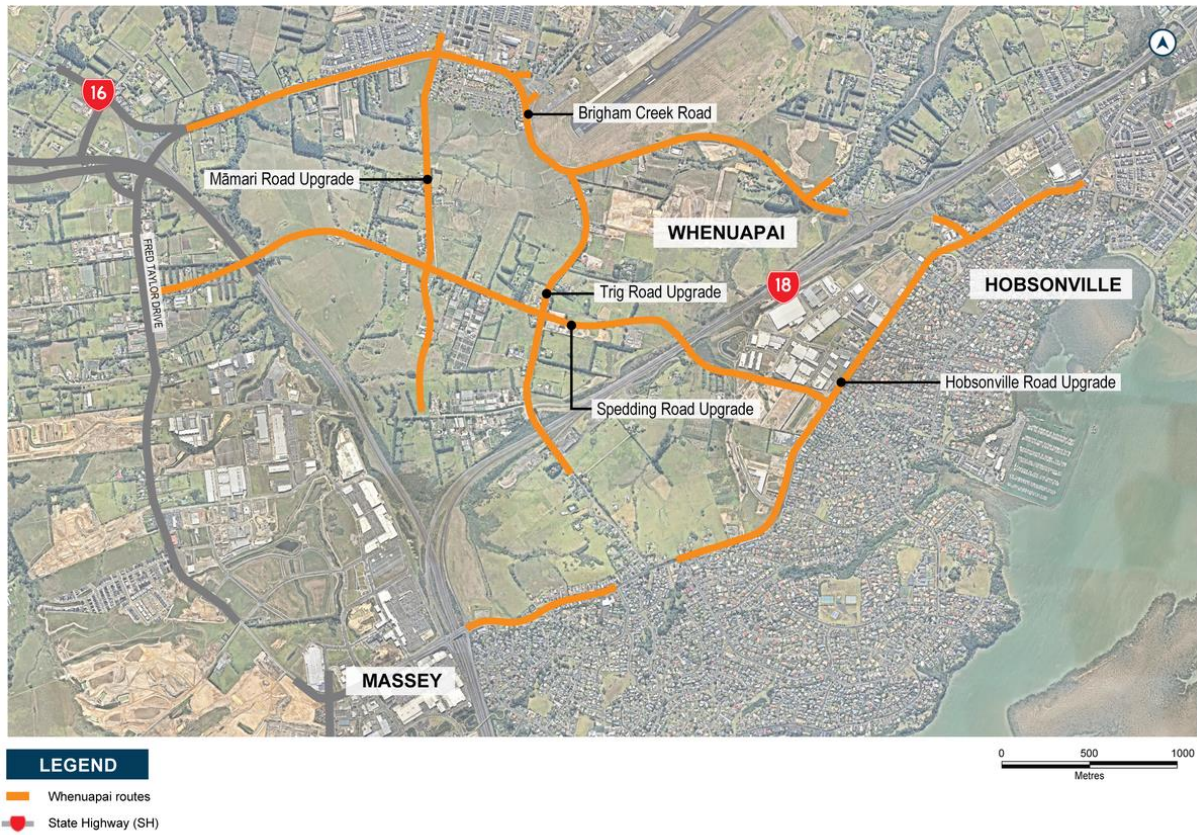


Figure 2-1: North West Local Package - Whenuapai – Overview of NoRs for Assessment

2.1 Purpose and Scope of this Report

This assessment forms part of a suite of technical reports prepared to support the assessment of effects within the Whenuapai Assessment Package. Its purpose is to inform the AEE that accompanies the four NoRs and one alteration to an existing designation for the Whenuapai Assessment Package sought by AT.

This report considers the actual and potential effects associated with the construction of the Whenuapai Assessment Package on the existing and likely future environment as it relates to the construction noise and vibration effects and recommends measures that may be implemented to avoid, remedy and/or mitigate these effects.

The key matters addressed in this report are as follows:

- a) Identify and describe the noise and vibration context of the Whenuapai Assessment Package area;
- b) Identify and describe the actual and potential construction noise and vibration effects of each Project corridor within the Whenuapai Assessment Package;
- c) Recommend measures as appropriate to avoid, remedy or mitigate actual and potential construction noise and vibration effects (including any conditions/management plan required) for each Project corridor within the Whenuapai Assessment Package; and
- d) Present an overall conclusion of the level of actual and potential construction noise and vibration effects for each Project corridor within the Whenuapai Assessment Package after recommended measures are implemented.

2.2 Report Structure

The report is structured as follows:

- a) Overview of the methodology used to undertake the assessment and identification of the assessment criteria and any relevant standards or guidelines;
- b) Description of each Project corridor and project features within the Whenuapai Assessment Package as it relates to construction noise and vibration;
- c) Description of the existing and likely future noise environment;
- d) Description of the actual and potential adverse construction noise and vibration effects of construction of each Project;
- e) Recommended measures to avoid, remedy or mitigate potential adverse construction noise and vibration effects; and
- f) Overall conclusion of the level of potential adverse construction noise and vibration effects of the Project after recommended measures are implemented.

This report should be read alongside the AEE, which contains further details on the history and context of the Project. The AEE also contains a detailed description of works to be authorised for the Project, likely staging 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 this assessment of construction noise and vibration effects. As such, they are not repeated here, unless a description of an activity is necessary to understand the potential effects, then it has been included in this report for clarity.

2.3 Preparation for this Report

The construction methodology and construction drawings for each NoR was reviewed and reference to the AUP:OP, NZS 6803 and DIN 4150 was made (these documents are discussed further below).

3 Assessment Criteria

3.1 Construction Noise

Potential construction noise effects have been assessed in accordance with the applicable AUP:OP noise rules. Rule E25.6.1(3) of the AUP:OP states that “The noise from any construction activity must be measured and assessed in accordance with the requirements of New Zealand Standard NZS6803:1999 Acoustics – Construction noise”. Rules E.25.6.27(1) and E.25.6.27(2) contain noise limits for sensitive and all other receivers.

Furthermore, Rule E25.6.29 specifies that construction noise levels for work within the road for construction, maintenance and demolition activities must meet the relevant noise levels in the relevant table E25.6.27(1) or E25.6.27(2). Noise levels from E25.6.27(1) and E25.6.27(2) have been adopted for the purpose of this assessment and are reproduced in Table 3-1 and Table 3-2 respectively.

In accordance with Section 25.6.27(4) of the AUP:OP, since the works will take longer than 20 weeks a 5dB reduction has been applied in all cases to noise limits in E25.6.27(1) and E25.6.27(2) of the AUP:OP. The long duration limits are detailed in Table 3-1 and Table 3-2 below.

Table 3-1 Construction noise criteria for sensitive receivers (outside of Business – City Centre Zone and the Business – Metropolitan Centre Zone)

Day of the week	Time period	Maximum noise level >20 weeks	
		dB LAeq	dB LAmax
Weekdays	6:30 – 7:30	55	70
	7:30 – 18:00	70	85
	18:00 – 20:00	65	80
	20:00 – 06:30	40	70
Saturdays	6:30 – 7:30	40	70
	7:30 – 18:00	70	85
	18:00 – 20:00	40	70
	20:00 – 06:30	40	70
Sunday and public holidays	6:30 – 7:30	40	70
	7:30 – 18:00	50	80
	18:00 – 20:00	40	70
	20:00 – 06:30	40	70

Table 3-2 Construction noise criteria for all other receivers (outside of Business – City Centre Zone and the Business – Metropolitan Centre Zone)

Time period	Maximum noise level dB L _{Aeq} >20 weeks
07:30 – 18:00	70
18:00 – 07:30	75

Exemptions to these levels are provided in Rule E25.6.29 (2) and E25.6.29 (3) where noise levels specified do not apply for planned works in the road between the hours of 10pm and 7am where:

- The number of nights where the noise generated by the works exceeds the relevant noise levels at any one receiver exceeds the relevant noise levels for 3 nights or less; and
- The works cannot practicably be carried out during the day or because the road controlling authority requires this work to be done at night; or
- Because of the nature of the works the noise produced cannot practicably be made to comply with the relevant noise levels.

Under E25.6.29 (3), noise levels specified (as replicated above in Table 3-1) do not apply for planned works in the road between the hours of 7am and 10pm where:

- The number of days where the noise generated by the works exceeds the relevant noise levels at any one receiver is 10 days or less; or
- Because of the nature of the works and the proximity of receivers the noise generated cannot be practicably made to comply with the relevant noise levels.

If situations fall under the exemption rules, then a copy of the works access permit issued by Auckland Transport will be provided to the Council five days prior to work commencing; or a construction noise and vibration management plan will be provided to the Council no less than five days prior to the works commencing in accordance with the applicable provisions of Standard E25.6.29(5).

3.2 Construction Vibration

The main objective of controlling construction vibration is to avoid vibration-related damage to buildings, structures, and services, in the vicinity of the works. Any adverse effects of construction vibration on human comfort would typically only be experienced for short durations, for most types of construction work.

It should be noted that the level of vibration perceived by humans, and the level of vibration that is likely to result in annoyance for some people, are magnitudes lower than the level of vibration capable of damaging structures. This means that vibration levels which readily comply with the building damage criteria will likely cause annoyance and adverse reaction from building occupants who mistakenly believe that their building is sustaining damage.

Potential exceedances of the amenity criteria will be considered when assessing the construction vibration effect on nearby receivers. It is recommended that the limits relating to human comfort detailed in Table 3-3 should be used as trigger for communication and consultation, and should be included in the construction management plan(s) that will be prepared as part of the Projects.

3.2.1 Auckland Unitary Plan

The AUP:OP contains rules relating to construction vibration that cover both building damage and amenity. Rule E25.6.30 states that construction activities must be controlled to ensure any resulting vibration does not exceed:

- a) The limits set out in German Industry Standard DIN 4150-3 (1999): Structural vibration – Part 3 Effects of vibration on structures when measured in accordance with that Standard on any structure not on the same site; and
- b) The limits set out in Table 3-3 in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building.

Table 3-3 AUP:OP Table E25.6.30.1 Vibration limits in buildings

Receiver	Period	Peak Particle Velocity (PPV mm/s)
Occupied activity sensitive to noise or vibration	Night-time 10pm to 7am	0.3
	Daytime 7am to 10pm	2.0
Other occupied buildings	At all times	2.0

Works generating vibration for three days or less between the hours of 7am to 6pm may exceed the limits in Table E25.6.30.1 Vibration limits in buildings above, but must comply with a limit of 5mm/s peak particle velocity in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground level at the foundation of a single storey building, where:

- (i) all occupied buildings within 50m of the extent of the works generating vibration are advised in writing no less than three days prior to the vibration-generating works commencing; and
- (ii) the written advice must include details of the location of the works, the duration of the works, a phone number for complaints and the name of the site manager.

3.2.2 DIN 4150-3:1999 – Structural vibrations: Effects of vibrations on structures

DIN 4150 contains guidelines on the vibration limits for buildings which, when complied with “will not result in damage that will have an adverse effect on the structure’s serviceability”. These limits are reproduced in Table 3-4.

Different criteria are given for “short-term” (transient) vibration sources such as blasting and impact piling, and “long-term” sources such as vibrocompaction. Note that the definition of “short-term” and “long-term” in DIN 4150-3:1999 differ from those in NZS 6803:1999 and do not strictly relate to the duration of the works, but rather how a building responds to the construction vibration. Short term vibration does not excite a structure (which would result in a significant increase in vibration), therefore vibration limits are higher than for long-term vibration.

Table 3-4 Vibration velocity guideline values for structures (DIN 4150)

Type of structure	Short term vibration**			Vibration at horizontal plane of highest floor at all frequencies (mm/s)	Long Term Vibration	
	PPV at foundation, frequency of:					PPV at horizontal plane of highest floor (mm/s)
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*			
Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50	40	10	
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15	5	
Structures that because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value	3	3 to 8	8 to 10	8	2.5	

* At frequencies above 100 Hz, the values given in this column may be used as minimum values

** The Standard defines short-term vibration as “vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated”. Long-term vibration is defined as all other vibration types not covered by the short-term vibration definition.

Clause 5.1 of DIN 4150-3 notes that a vibration level in excess of the DIN criterion does not necessarily result in building damage. The definition of ‘damage’ in DIN 4150-3 is: “any permanent effect of vibration that reduces serviceability of a structure or one of its components”.

Examples of a ‘reduction of serviceability’ include:

- The impairment of stability of the building and its components; and

- A reduction in the bearing capacity of floors.

For dwelling type buildings and structures sensitive to vibration, the serviceability is considered to have been reduced if:

- Cracks form in plastered surfaces of walls;
- Existing cracks in the building are enlarged; or
- Partitions become detached from loadbearing walls or floors.

Clause 4.5 of DIN 4150-3 states that these effects are deemed 'minor damage'. More than minor damage would be damage above and beyond the bullet points above.

3.2.3 British Standard 5228-2

British Standard (BS) 5228-2: 2009 "Code of practice for noise and vibration control on construction and open sites" provides additional guidance on the human response to vibration, which is widely used in the assessment of effects of construction vibration. The vibration levels against perception as found in BS5228-2:2009 have been replicated in Table 3-5 below.

Table 3-5 Human perception of vibration levels

Vibration Level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might just be perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaints but can be tolerated if warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

3.2.4 Auckland Transport construction vibration criteria

The following criteria are the recommended Project construction vibration criteria for both building damage and amenity applicable for all NoRs.

The two category criteria, detailed in Table 3-6, are to facilitate a progressive management response to the increasing risks and effects during construction.

Category A sets the criteria for the amenity effects where vibrations may be perceived by occupants within a building, as adopted from the AUP:OP, and an indicator of when communication and consultations should be initiated to manage effects. Category B are based on DIN 4150 building damage criteria for daytime.

Table 3-6 Auckland Transport Construction vibration criteria

Vibration Level	Effect	Category A	Category B
Occupied activities sensitive to noise	Night-time 2000h – 0630	0.3mm/s ppv	2mm/s ppv
	Daytime 0630h – 2000h	2mm/s ppv	5mm/s ppv
Other occupied buildings	Daytime 0630h – 200h.	2mm/s ppv	5mm/s ppv
All other buildings	All other times	Tables 1 and 3 of DIN4150-3:1999	

Where compliance with the vibration standards set out in Table 3-6 is not practicable, and unless otherwise provided for in the CNVMP (refer Section 5.2.1), a schedule (refer Section 5.2.2) will be required.

4 Assessment Methodology

A consistent approach has been adopted for the whole Whenuapai Assessment Package as set out in this section. It has been assumed that no concurrent project works will occur across the multiple areas where receivers may be subjected to impacts from more than one designation. Any receivers that may be impacted by more than one Project would be considered in the CNVMP closer to the time of construction. Any buildings within the proposed designation footprint will be removed in most cases, as confirmed by the Project Team, and are not assessed. If the corridor footprint is redefined through the design process this should be considered in the CNVMP.

Construction noise setback distances and vibration emission radii have been determined (based on assumptions of construction activities and equipment) for each of the NoR sections.

The construction boundary is assumed to be the edge of the proposed alignment. Affected receivers have been identified using construction noise setback distances and vibration emission radii. The construction noise setback distances and vibration emission radii were used to determine where any potential construction noise and vibration exceedances of the relevant criteria could occur. Potential effects of construction noise and vibration have then been assessed and construction management and mitigation measures identified where appropriate. To avoid and/or minimise exceedances of the Project construction noise and vibration criteria, Best Practicable Option (BPO) mitigation and management measures should be utilised.

This report proposes a framework for construction noise and vibration management such that the most effective and practicable methods for mitigation will be planned and implemented, taking into account the extent of predicted effects. At the core of this framework is the Construction Noise and Vibration Management Plan (CNVMP) in Section 5.2.1, which will be developed prior to commencement of construction, and updated as necessary throughout the duration of construction.

4.1 Construction methodology

An indicative construction methodology has been provided by the project team to inform the assessment of each of the NoR.

The outline is based on a generic construction project and has not taken into consideration any project specific scope of works, constraints or staging requirements that may be applicable for each project. The indicative construction programme assumes a linear construction sequence.

The construction methodology for the project is as follows:

4.1.1 Site establishment

- Site access construction;
- Tree removal and vegetation clearance;
- Remove footpath, streetlights, grass verge berm;
- Property/ building modification or demolition, including fencing, driveways and gates;
- Install environmental controls e.g. silt fencing, sediment retention ponds;
- Implement traffic management to establish the construction zones;
- Service protection works; and
- Construct access tracks/ haul roads (if any).

4.1.2 Advance works

- Relocation of utilities services; and
- Major earthworks to include the following:
 - Ground improvements, undercuts, embankment foundations;
 - Cut and fill works along the alignment to formation level, including preload if required; and
 - Remove preload upon settlement completion, and subgrade preparation.

4.1.3 Main works

- Minor earthworks (cut and fill);
- Remove verge and prepare subgrade formation;
- Construct new longitudinal drainage facilities;
- Construct new pavement, widening works in available areas;
- Move traffic to newly constructed pavement areas and continue with the remaining widening works;
- Pavement reconstruction or reconfiguration of existing road furniture;
- Complete tie in works, footpaths, cycleways, lighting and landscaping;
- Construct permanent stormwater wetlands;
- Construct new culverts including rip rap and headwalls;
- Install road safety barriers (if any); and
- Bridge construction works (if any) as follows:
 - Construct abutments;
 - Piling, pier, and headstock construction;
 - Install bridge beams and decking;
 - Install settlement slabs;
 - Retaining wall construction (if any);
 - Accommodation works; and
 - Install signage and lighting.

4.1.4 Finishing works and demobilisation

- Final road surfacing and road markings;
- Commission traffic signals (if any);
- Finishing works e.g. landscaping, street furniture, fencing and outstanding accommodation works;
- Move traffic to the final road configuration; and
- Practical completion and de-establishment.

4.1.5 Plant and Equipment

Table 4-1 provides an indicative list of plant and equipment which may be required for construction across each designation.

Table 4-1 Indicative construction equipment

Construction	Construction Activity
Typical across all works	<ul style="list-style-type: none"> • Site facility

Construction	Construction Activity
	<ul style="list-style-type: none"> • Light Vehicles • Hiab truck • Trucks
Earthworks	<ul style="list-style-type: none"> • 20-30T Excavator • Roller Compactor • Water Cart • Tippers • Stabilizers
Drainage	<ul style="list-style-type: none"> • 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor • Trucks • Water cart
Pavement Construction	<ul style="list-style-type: none"> • Grader • Water Cart • Smooth Drum Roller • Vibratory Roller • Tandem Tippers • Kerbing Machine • Concrete Truck • Plate compactor • Paver • Excavators
Bridge construction	<ul style="list-style-type: none"> • Concrete truck • Excavator • Tip trucks • Cranes • Delivery trucks • Pilling Rig • Concrete Pump • Elevated Work Platform

4.2 Construction Noise

Construction phases for each of the Projects are expected to occur for a minimum of 20 months. Predictions have been assessed against the noise criteria for greater than 20 weeks “long-duration” under NZS6803:1999 as presented in Table 3-1. It is expected that the majority of the works will be carried out between 7am – 6pm Monday to Saturday. There will be extended hours during summer

earthworks season (e.g. 6am to 8pm, Monday to Sunday), there is also the possibility of night works for critical activities (culvert construction and road surfacing).

Various construction activities and pieces of equipment will act as noise sources on site during construction works. An indicative construction equipment list has been provided by the project team to assess the noise and vibration effects. Given construction will occur in the future, the current methodology may not be inclusive of all equipment used nearer the time of construction. Equipment tables will need to be updated to reflect selection at the development of the management plan. A minimum set back distance from receivers to comply with day-time noise criterion of 70 dB L_{Aeq} without mitigation has been calculated.

4.2.1 Equipment Noise Levels

Table 4-2 details the sound power levels from the likely significant noise sources and the various receiver setback distances required to achieve compliance with the 70 dB L_{Aeq} day-time noise criterion without mitigation. The noise data has been taken from British Standard 5228-1:2009 “Code of practice for noise and vibration control on construction and open sites”, manufacturers data or the AECOM database of noise measurements. Equipment selection at detailed design stage may include equipment with different sound power levels than those presented. The equipment list should be reassessed nearer the time at production of the CNVMP.

Table 4-2 Construction Equipment Sound levels and indicative compliance distance

Equipment	Sound power level (dB L_{WA})	Free field noise level at varying distances (dB L_{Aeq})				Minimum Setback distance to comply with day-time criteria without mitigation, metres
		5 m	10 m	20 m	50 m	
30T excavator	105	86	80	73	66	30
20T excavator	99	80	74	67	60	13
Roller compactor	101	82	76	69	62	20
Tipper Truck	107	88	82	75	68	36
Loader	105	86	80	73	66	30
Vibratory Plate Compactor	110	91	85	78	71	45
Smooth Drum Roller	103	84	78	71	64	25
Paver	103	84	78	71	64	25
Grader	99	80	74	67	60	13
Bridge Construction Only						
Concrete Truck	107	88	82	75	68	36
Cranes	99	80	74	67	60	13

Equipment	Sound power level (dB L _{WA})	Free field noise level at varying distances (dB L _{Aeq})				Minimum Setback distance to comply with day-time criteria without mitigation, metres
		5 m	10 m	20 m	50 m	
Bore Pilling	115	96	90	83	76	73

Table 4-3 details the sound power levels for key construction activities, combining the equipment sound power levels detailed in Table 4-2 where multiple items of equipment may be operating simultaneously. Table 4-3 also details the minimum setback distance at which compliance can be achieved for each activity.

Table 4-3 Activity Sound Power Levels and Compliance Distance

Construction Type	Activity Sound Power Level (dB L _{WA})	Minimum set back distance from receivers to comply with day-time limit (70 dB L _{Aeq}) without mitigation, metres
Typical across all works	110	48 m
Earthworks	111	52 m
Drainage works	113	56 m
Pavement Construction	115	76 m
Bridge Construction	117	90 m

4.3 Construction Vibration

Vibration generation and propagation is highly site specific. The generation of vibration is dependent on the local site geology, the equipment being used, the nature of the works, and even the operator.

To account for the inaccuracy in the prediction of vibration, the likely worst-case vibration has been calculated based on the equipment and hard ground geology.

Vibration from a source transmits in a spherical pattern and reduces with distance. There will be a particular distance from each source at which the vibration level equals the relevant vibration criteria. This distance is called the 'emission radius'. The vibration criteria and emission radii for high vibration generating equipment are detailed in Table 4-4.

Table 4-4 Vibration sources and indicative emission radii

Equipment	Daytime Occupied Buildings (2 mm/s)	DIN 4150 emission radii		
		Historic and Sensitive (2.5 mm/s)	Residential (5 mm/s)	Commercial (10 mm/s)
Roller Compactor	21m	17m	8m	4m
Bore Piling	4m	2m	1m	1m
Excavator	12m	10m	6m	2m
Tipper Truck	2m	2m	1m	0m
Vibratory Plate Compactor	3m	2m	1m	1m

We recommend that vibration measurements are undertaken at specific locations as identified through the CNVMP and schedules at the commencement of construction activities to establish vibration propagation site laws for vibration generating equipment. This approach will confirm the emission radii used in this assessment and ensure the applicable criteria are complied with. It has been found on other major construction projects, that the measured vibration levels for a particular activity are much lower than those predicted during the assessment stage.

5 Whenuapai Construction Effects

5.1 Overview of Construction Effects

Potential construction noise and vibration effects are summarised in this section.

5.1.1 Construction noise

Table 5-1 gives examples of the potential effects on receivers at different noise levels based on NZS6803 with most exposed façades providing a 20 dB reduction. Depending on the construction of the house, façades may provide up to a 25 – 30 dB reduction, particularly those that are located within the Aircraft Noise Overlay that have been designed to mitigate aircraft noise levels, therefore assumptions and effects provided below are based on a conservative approach.

Table 5-1 Potential construction noise effects on receivers

External Noise Level	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level	Potential Daytime Effects Indoors
65 dB L _{Aeq}	Conversation becomes strained, particularly over longer distances	45 dB L _{Aeq}	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.
65 to 70 dB L _{Aeq}	People would not want to spend any length of time outside, except when unavoidable through workplace requirements	45 to 50 dB L _{Aeq}	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75 dB L _{Aeq}	Businesses that involve substantial outdoor use (for example garden centres) would experience considerable disruption.	50 to 55 dB L _{Aeq}	Phone conversations would become difficult. Personal conversations would need slightly raised voices. Office work can generally continue, but 55 dB is considered by the experts to be a tipping point for offices. For residential activity, TV and radio sound levels would need to be raised.
75 to 80 dB L _{Aeq}	Some people may choose protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60 dB L _{Aeq}	Continuing office work would be extremely difficult and become unproductive. In a residential context, people would actively seek respite.
80 to 90 dB L _{Aeq}	Hearing protection would be required for prolonged	60 to 70 dB L _{Aeq}	Untenable for both office and residential

External Noise Level	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level	Potential Daytime Effects Indoors
	exposure (8 hours at 85 dB) to prevent hearing loss.		environments. Unlikely to be tolerated for any extent of time.

With effective management of construction activities, which includes consultation and communication with affected parties and scheduling noisy works (such as piling activities), during the daytime rather than night-time period, noise levels can be controlled for each of the Projects so that the effects on the nearest residential receivers are reduced. Barriers will not be effective at all locations, particularly where receivers are more than one storey. Where barriers are not going to be effective, the use of enclosures or local screening of equipment should be considered and implemented, where practicable. If noisy activities must take place during the night-time, and screening or other mitigation measures do not provide sufficient attenuation to meet the night-time noise criteria or are not practicable, it may be necessary to offer temporary relocation to affected residents. Temporary relocation should be considered on a case-by-case basis and as a last resort.

5.1.2 Construction Vibration

The vibration effects associated with construction of the Projects are considered in terms of human response and building damage. However, in our experience the main concern for building occupants during construction is damage to the building itself.

Humans can generally perceive vibrations at a much lower level than when building damage is likely to occur. The adverse effects of construction vibration on building occupants may be significant in some buildings adjacent to the areas of works. Adverse effects may range from annoyance to loss of amenity or inability to carry out work. Vibration effects will reduce with distance from the source, and the level of vibration transmission into a building will depend on a number of factors, such as the foundation type and building construction.

Potential effects and human perception of the vibration levels found within the AUP:OP /DIN criteria have been combined below and adopted for this assessment.

Table 5-2 Potential vibration effects on human perception summary against AUP:OP /DIN criteria

External Noise Level	Potential Daytime Effects Outdoors
0.14 mm/s	The threshold of perception for stationary people. Just perceptible in particularly sensitive environments.
0.3 mm/s	Can be just perceptible during normal residential activities, particularly for more sensitive receivers. Levels above may wake most people from their sleep. This is the AUP:OP limit for construction vibration generated at night-time for sensitive receivers.
1 mm/s	Is typically tolerable with prior notification. Complaint or adverse reaction is likely in office or residential environments, particularly if there is no prior warning. What people actually feel would be subject to the source but could include a steady vibration from sources such as vibratory compaction, or a small jolt such as from

External Noise Level	Potential Daytime Effects Outdoors
	the movement of a large digger either of which could rattle crockery and glassware. Sleep disturbance would be almost certain for most people.
2 mm/s	Vibration would clearly be felt. However, it can typically be tolerated in indoor environments such as offices, houses and retail if it occurs intermittently during the day and where there is effective prior engagement. Effects experienced would be somewhere between levels of 1 and 5 mm/s. This is the AUP:OP limit for large construction projects generating vibration.
5 mm/s	Unlikely to be tolerable in a workplace. Highly unsettling for both workplaces and dwellings. If exposure is prolonged, some people may want to leave the building. Computer screens would shake and items could fall off shelves if they are not level. This is the threshold below which no cosmetic damage will occur in the DIN standard.
10 mm/s	Likely to be intolerable for anything other than a very brief exposure.

The AUP:OP sets the criteria for amenity at 0.3mm/s for night time and 2 mm/s during the day. Based on the worst-case source of a roller compactor, any receiver within a 21m radius of the construction area may experience vibration of 2 mm/s inside their property. Whilst at this level building damage is highly unlikely to occur, human perception may result in slight concerns but can generally be tolerated if activity occurs intermittently and with prior notice.

At 0.3 mm/s the emission radii could be up to 140m from construction areas, and at this level people could feel slight vibrations especially during the night-time, which may cause sleep disturbance. High vibratory activities should therefore be avoided, where practicable, during the night-time and careful management of the type of equipment used at night should be included within the CNVMP (refer Section 5.2.1).

Construction vibration effects generally have a short timeframe, typically a few days at a time. The use of high vibratory equipment, such as a roller compactor, should be managed through a CNVMP to limit potential vibration effects, and alternative equipment with lower vibratory effect should be used where practicable.

5.2 Recommended Measures to Avoid, Remedy or Mitigate Construction Effects

5.2.1 Construction Noise and Vibration Management Plan

Implementing noise management and mitigation measures via a CNVMP is the most effective way to control construction noise and vibration impacts. The objective of the CNVMP should provide a framework for the development and implementation of best practicable options to avoid, remedy or mitigate the adverse effects on receivers of noise and vibration resulting from construction.

E25.6.29(5) sets out the minimum level of information that must be provided in a CNVMP.

Accordingly, as a minimum, we recommend that the CNVMP should include the following content:

- Description of the works and anticipated equipment/processes;
- Hours of operation, including times and days when construction activities would occur;
- The construction noise and vibration standards for the Project;
- Identification of receivers where noise and vibration standards apply;
- Management and mitigation options, including alternative strategies adopting the BPO where full compliance with the relevant noise and/or vibration standards cannot be achieved;
- Methods and frequency for monitoring and reporting on construction noise and vibration, including:
 - Updating the predicted noise and vibration levels based on the final methodology and construction activities;
 - Confirming which buildings will be included in a pre and post building condition survey;
 - Identifying appropriate monitoring locations for receivers of construction noise and vibration;
 - Procedures to respond to complaints received on construction noise and vibration, including methods to monitor and identify noise and vibration sources;
 - Procedure for responding to monitored exceedances; and
 - Procedures for monitoring construction noise and vibration and reporting to the Auckland Council Consent Monitoring officer.
- Procedures for maintaining contact with stakeholders, notifying of proposed construction activities, the period of construction activities, and handling noise and vibration complaints;
- Contact details of the site supervisor or Project manager and the Requiring Authority's Project Liaison Person (phone, postal address, email address);
- Procedures for the regular training of the operators of construction equipment to minimise noise and vibration as well as expected construction site behaviours for all workers;
- Identification of areas where compliance with the noise and/or vibration standards will not be practicable and where a Site Specific Construction Noise and/or Vibration Management Schedule will be required;
- Procedures for how remedial works will be undertaken, should they be required as a result of the building condition surveys; and
- Procedures and timing of reviews of the CNVMP.

5.2.2 Schedules

In addition to a CNVMP, it may be necessary to produce Site Specific or Activity Specific Construction Noise and Vibration Management Schedules ("Schedules") where noise and/or vibration limits are predicted to be exceeded for a more sustained period or by a large margin. A schedule to the CNVMP provides a specific assessment of an activity and/or location and should include details such as:

- Activity location, start and finish dates;
- The nearest neighbours to the activity;
- A location plan;
- Predicted noise/vibration levels and BPO mitigation for the activity and/or location;
- Communication and consultation with the affected neighbours;
- Location, times and type of monitoring; and
- Any pre-condition survey of buildings predicted to receive vibration levels approaching the Category B vibration limits, which document their current condition and any existing damage.

5.2.3 Noise mitigation measures

A hierarchy of mitigation measures will be adopted through the CNVMP and Schedules (where produced), as follows:

- Managing times of activities to avoid night works and other sensitive times;
- Liaising with neighbours so they can work around specific activities;
- Selecting equipment and methodologies to restrict noise;
- Using screening/enclosures/barriers; and
- Offering neighbours temporary relocation.

By following this hierarchy, the BPO for mitigation will be implemented, whilst avoiding undue disruption to the community. In particular, temporary relocation of neighbours can cause significant inconvenience and should only be offered where other options have been exhausted and noise levels still require mitigation.

Some activities are likely to be set back a considerable distance from the nearest receivers and require very little or no mitigation to achieve compliance with the relevant Project noise limits. Alternative methodologies, such as careful equipment selection and use of noise barriers or localised screening (e.g. for concrete cutting) may be suitable management and mitigation measures and should be implemented where they are practicable and effective.

5.2.4 Vibration mitigation

Similarly to noise, a hierarchy of vibration mitigation measures will be adopted through the CNVMP and Schedules (where produced) as follows:

- Managing times of activities to avoid night works and other sensitive times (communicated through community liaison);
- Liaising with neighbours so they can work around specific activities;
- Operating vibration generating equipment as far from sensitive sites as possible;
- Selecting equipment and methodologies to minimise vibration;
- Offering neighbours temporary relocation; and
- In specific situations, a cut-off trench may be used as a vibration barrier if located close to the source.

In general, there are less options available to mitigate vibration propagation and insulate receiver buildings, compared to noise. Mitigation will therefore focus on scheduling of activities, effective communication with neighbours, and selection of appropriate equipment and methods, where practicable.

Appropriate vibration mitigation measures for each activity will be listed in the CNVMP and Schedules (where produced).

5.2.5 Building Condition Survey

A detailed building precondition survey should be undertaken by a suitably qualified engineer prior to the start of construction at all buildings where the daytime Category B criteria may be exceeded. The survey shall include, but not be limited to, the following:

- Determination of building classification: commercial, industrial, residential or a historic or sensitive structure;

- Determination of building specific vibration damage risk thresholds; and
- Recording (including photographs) the major features of the buildings including location, type, construction (including foundation type), age and present condition, including existing levels of any aesthetic damage or structural damage.

A post-construction condition survey of the same buildings shall be conducted when construction is completed, and any damage shown to have been caused by the Project construction rectified by the Project Team.

5.2.6 Night Works

Night works have the potential to cause the greatest disturbance to residents and should be avoided where possible. However, it is possible that night works will be required during the construction period for critical activities. Before night works are programmed, it is important to determine if there are alternative options that would avoid working at night and, if so, whether those options are technically and practicably feasible.

Where there are no practicable alternative options to night works, it may be necessary to implement enhanced noise and vibration management measures, but this will depend on the location of the worksite and the proposed activities.

When work must be carried out at night, it may be necessary to:

- Increase the frequency of communications with stakeholders;
- Carry out regular noise and vibration monitoring to confirm noise and vibration levels; or
- Offer temporary relocation to neighbours if unreasonable noise and/or vibration levels cannot be avoided.

6 NoR W1: Trig Road North Upgrade

6.1 Project Corridor Features

The Trig Road North Upgrade consists of widening the 20m road to a 24m wide two-lane cross section including cycle lanes and footpaths on both sides of the road. The project includes the upgrade of intersections with Speeding Road West and tie-ins with the SH18 On Ramps. The upgrade extends from the intersection with Brigham Creek Road to south of the SH18 off-ramp.

Key features of the proposed new corridor include the following:

- Widening of Trig Road from its current general width of 20m to a 24m wide two-lane cross section including separated cycle lanes and footpaths on both sides of the corridor;
- Localised widening around the existing intersections with Brigham Creek Road and Spedding Road to accommodate proposed roundabouts, and localised widening around the intersection of Trig Road with Northside Drive to accommodate a signalised intersection;
- Tie-ins with existing roads, stormwater dry ponds, wetlands and culverts;
- The addition of an active mode bridge to the existing bridge across SH18;
- Batter slopes to enable widening of the corridor, and associated cut and fill activities (earthworks);
- Vegetation removal along the existing road corridor; and
- Other construction related activities required outside the permanent corridor including the re-grade of driveways, construction traffic manoeuvring and construction laydown areas.

An overview of the proposed design is provided in Figure 6-1.



Figure 6-1 Overview of the Trig Road Upgrade

6.2 Existing and Likely Future Environment

6.2.1 Planning context

The Trig Road corridor runs through an existing rural environment, with the land either side of the corridor currently zoned FUZ under the AUP:OP. Proposed Plan Change 5 (PPC5) proposes to rezone the eastern side of Trig Road north of SH18 and the western side of Trig Road between Brigham Creek Road and Spedding Road as Business – Light Industry Zone. A heritage overlay is proposed at 92 Trig Road and 4 Spedding Road.

PPC5 does not extend to the west side of the corridor south of Spedding Road, however the Whenuapai Structure Plan (adopted by Auckland Council in 2016) identifies this area for business zoning. The Whenuapai Structure Plan identifies a potential Sports Park at the corner of Trig Road and Spedding Road.

The NZDF Air Base (Special Purpose - Airports and Airfields Zone) is located to the north of Trig Road on Brigham Creek Road. The airbase is designated (Designation 4310) for defence purposes by the Minister of Defence.

Table 6-1 below provides a summary of the Trig Road existing and likely future environment

Table 6-1: Trig Road Upgrade Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment ²	Likely Future Environment ³
Undeveloped greenfield areas	Future Urban Zone	High	Urban
New Zealand Defence Force Air Base	Special Purpose - Airports and Airfields Zone	Low	Urban

Please refer to the AEE for further information on the planning context.

6.2.2 Noise Environment

Trig Road is currently located within a predominantly rural area with few dwellings in close proximity to the road. The noise environment is dominated by road traffic noise from vehicles on Trig Road, SH18 and the surrounding network as well as aircraft noise associated with the Whenuapai Air Base.

PPC5 and the Whenuapai Structure Plan indicate that the land surrounding Trig Road, to the north of SH18 is likely to be Industrial or Business Zones. This zoning would likely result in an increase in ambient noise levels. Where Residential Zones are likely, to the south of SH18, ambient noise levels would likely still increase as the area urbanises.

² Based on AUP:OP zoning/policy direction

³ Based on AUP:OP zoning/policy direction

6.3 Assessment of Construction Noise and Vibration Effects

6.3.1 Construction Noise Effects

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 6m. High noise generating activities may not occur right on the construction boundary but if they do, 16 existing properties could experience unmitigated noise levels that exceed the daytime noise criterion. Details of all properties where the criteria could be exceeded are provided in Appendix A.

With mitigation in place, as set out in Section 5.2, noise levels of up to 80 dB L_{Aeq} could still occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility. We note that the existing receivers may not be present at the time of construction.

Future receivers constructed within 76m of the works could experience unmitigated noise levels that exceed the 70 dB L_{Aeq} noise criterion during high noise generating activities such as the pavement works.

Bridge construction is the noisiest activity that is currently proposed for the Trig Road Upgrade. It will only occur for a limited duration during bridge construction where Trig Road crosses SH18.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 80 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Night works may be required during construction of the bridge across SH18. If there are residential receivers in close proximity to any night-time works, consultation and mitigation measures will be essential. The use of noisy equipment should be avoided, where practicable, to prevent sleep disturbance. Any night-time works are likely to be limited in duration and will be managed through the CNVMP and a Schedule.

If PPC5 is approved and the zoning detailed in the Whenuapai Structure Plan is put in place outside of the area associated with PPC5, the area of the Project north of SH18 will be bordered by the Light Industry Zone or a different Business Zone. Residential receivers are unlikely to be constructed in the Light Industry Zone and will be limited in other Business Zones. Where residential receivers are constructed in the Business Zone they will be designed to meet the internal noise criteria as set out in the AUP:OP. In designing the buildings to meet the AUP:OP internal noise criteria, construction noise received internally will also be reduced.

6.3.2 Construction Vibration Effects

All of the existing receivers along the Trig Road corridor are residential type structures. Two existing dwellings may experience vibration levels above 5mm/s PPV, exceeding the Category B criterion for residential structures, if the roller compactor is used on the construction boundary in the closest position to them. The addresses of receivers where the Category B criteria may be exceeded are listed in Appendix B. Once the compactor is 8m away from the dwellings the Category B criterion will be met. All the other equipment identified in Table 4-4 can comply with the Category B criterion at all

other existing receivers. The Category B criteria would be met at future residential structures that are 8m or more from the proposed works and commercial structures that are 4m or more from the proposed works.

At buildings in close proximity to the proposed works, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration.

The vibration amenity criteria could be exceeded in existing or future buildings if they are occupied during the works and within 21 m of the roller compactor or within the emission radii identified for the other vibration generating equipment in Table 4-4. The effect on receivers would be subject to their respective proximity to the works but could include steady vibration from the roller compactor or a small jolt from a digger which could rattle crockery and glassware.

Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

High vibration generating activities should not occur during the night time in close proximity to residential receivers to avoid sleep disturbance, unless it is a critical activity and there is no alternative.

It should also be noted that the emission radii are conservative and vibration levels measured on site tend to be much lower than those predicted at the NoR stage of a project.

6.4 Conclusions

The predicted construction noise and vibration levels are based on indicative information provided by the Project Team, as set out in Section 4, and any conclusions in this assessment should be confirmed during the detailed design stage, taking account of the receivers as they exist at the time of construction.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment are used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

7 NoR W2: Māmari Road Upgrade

7.1 Project Corridor Features

Māmari Road is an existing semi-rural road that extends from the intersection of Brigham Creek Road and Totara Road in the north to the intersection with Spedding Road in the south. The proposed Māmari Road FTN upgrade will extend the existing corridor south to connect with Northside Drive.

The key features of the proposed Māmari Road Upgrade include the following:

- The widening of the existing Māmari Road corridor (north of Spedding Road) and a new section south of Spedding Road to Northside Drive to create a 30m wide four-lane urban arterial with separated cycle lanes and footpaths on both sides of the corridor;
- Three stream crossings over the Sinton Stream, Pikau Stream and another upper branch of the Pikau Stream stream;
- Tie-ins with existing roads, stormwater dry ponds, wetlands and culverts;
- Batter slopes to enable widening of the corridor, and associated cut and fill activities;
- Vegetation removal along the existing road corridor; and
- Other construction related activities required outside the permanent corridor including the re-grade of driveways, construction traffic manoeuvring and construction laydown areas.

An overview of the proposed design is provided in Figure 7-1.



LEGEND


-  Route Option
-  Project Boundary
-  Railway

Figure 7-1 Overview of Māmari Road Upgrade

7.2 Existing and Likely Future Environment

7.2.1 Planning context

The northern section of Māmari Road to Spedding Road is an existing road corridor (although a section of the road is a ‘paper road’). The eastern side is predominantly zoned under the AUP:OP as FUZ, with a portion of Residential – Single House Zone. The Single House Zone forms part of the NZDF Air Base designation (Designation 4310, Minister of Defence). The western side is also predominantly FUZ. The Whenuapai Structure Plan indicates that the FUZ land will be re-zoned medium residential to the north (east side of Māmari only) and business to the south.

The southern extension to Māmari Road extends across land which is zoned FUZ and is currently undeveloped and in rural use. The Whenuapai Structure Plan indicates that the FUZ land will be re-zoned for business.

Table 7-1 below provides a summary of the Māmari Road existing and likely future environment.

Table 7-1: Māmari Road Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment ⁴	Likely Future Environment ⁵
Residential	Residential	Low	Residential
Undeveloped greenfield areas	Future Urban	High	Urban
Timatanga Community School	Special Purpose - School Zone	Low	Urban

7.2.2 Noise Environment

Māmari Road is currently located within a predominantly rural area with few dwellings in close proximity to the road. The noise environment is dominated by road traffic noise from vehicles on Māmari Road as well as aircraft noise associated with the Whenuapai Air Base.

The Whenuapai Structure Plan indicates that the land surrounding Māmari Road, to the east and west is likely to be Business Zone. This zoning would likely result in an increase in ambient noise levels as the area urbanises compared to the current rural nature.

7.3 Assessment of Construction Noise and Vibration Effects

7.3.1 Construction Noise Effects

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver, Timatanga Community School, at 2m. High noise generating activities may not occur right on the construction boundary but if they do, 34 existing properties could

⁴ Based on AUP:OP zoning/policy direction

⁵ Based on AUP:OP zoning/policy direction

experience unmitigated noise levels that exceed the daytime noise criterion. Details of all properties where the criteria could be exceeded are provided in Appendix A.

With mitigation in place, as set out in Section 5.2, noise levels of up to 90 dB L_{Aeq} could still occur intermittently at the closest receivers, if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility. We note that the existing receivers may not be present at the time of construction. Timatanga Community school is likely to remain so will be present during construction. Based on the potential noise levels detailed above it will be necessary to consult with the school and schedule noisy activities for a time that will not disrupt classes.

Future receivers constructed within 76m of the works could experience unmitigated noise levels that exceed the 70 dB L_{Aeq} noise criterion during high noise generating activities such as the pavement works.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

If a critical activity has to be carried out during the night-time in close proximity to residential receivers, consultation and mitigation measures will be essential. The use of noisy equipment should be avoided where practicable to prevent sleep disturbance. Any night-time works are likely to be limited in duration and will be managed through the CNVMP and a Schedule.

If the zoning detailed in the Whenuapai Structure Plan is put in place the majority of land surrounding Māmari Road will be Business Zoned. Residential receivers will likely be limited in the Business Zones. Where residential receivers are constructed in the Business Zone they will be designed to meet the internal noise criteria as set out in the AUP:OP. In designing the buildings to meet the AUP:OP internal noise criteria, construction noise received internally will also be reduced.

7.3.2 Construction Vibration Effects

All of the existing receivers along the Māmari Road corridor are residential type structures. Four existing dwellings and the school may experience vibration levels above 5mm/s PPV, exceeding the Category B criterion for residential structures, if the roller compactor is used on the construction boundary in the closest position to them. The addresses of receivers where the Category B criteria may be exceeded are listed in Appendix B. Once the compactor is more than 8m away from the buildings the Category B criterion will be met. All the other equipment identified in Table 4-4 can comply with the Category B criterion at all other existing receivers. The Category B criteria would be met at future residential structures that are more than 8m from the proposed works and commercial structures that are more than 4m from the proposed works.

At buildings in close proximity to the proposed works, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from the perception of vibration.

The vibration amenity criteria could be exceeded in existing or future buildings if they are occupied during the works and within 21 m of the roller compactor or within the emission radii identified for the other vibration generating equipment in Table 4-4. The effect on receivers would be subject to their

respective proximity to the works but could include steady vibration from the roller compactor or a small jolt from a digger which could rattle crockery and glassware.

Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

High vibration generating activities should not occur during the night time in close proximity to residential receivers to avoid sleep disturbance, unless it is a critical activity and there is no alternative.

It should also be noted that the emission radii are conservative and vibration levels measured on site tend to be much lower than those predicted in the early stages of a project.

7.4 Conclusions

The predicted construction noise and vibration levels are based on indicative information to support this NoR and any conclusions in this assessment should be confirmed during the detailed design stage, taking account of the receivers as they exist at the time of construction.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment is used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

8 NoR W3: Brigham Creek Road Upgrade

8.1 Project Corridor Features

Brigham Creek Road is an existing arterial road that extends from the intersection with the SH16 in the west to the intersection with Hobsonville Road to the east. The proposed upgrade extends from the eastern side of the existing Totara Creek bridge in the west, to Kauri Road near the existing SH18 Brigham Creek Interchange in the east.

Key features of the proposed upgrade include the following:

- Widening of Brigham Creek Road from its existing two-lane arterial to a 30m wide four-lane arterial cross-section with walking and cycling facilities on both sides;
- Upgrades to intersections and tie-ins with Totara Road/Mamari Road, Trig Road and Kauri Road. All intersections along Brigham Creek Road are proposed to be signalised, with exception to the intersection of Brigham Creek Road and Trig Road which is proposed as a roundabout intersection;
- Tie-ins with existing roads, stormwater dry ponds, wetlands and culverts;
- Batter slopes to enable widening of the corridor, and associated cut and fill activities; and
- Vegetation removal along the existing road corridor.

An overview of the Brigham Creek Road Upgrade is provided in Figure 8-1

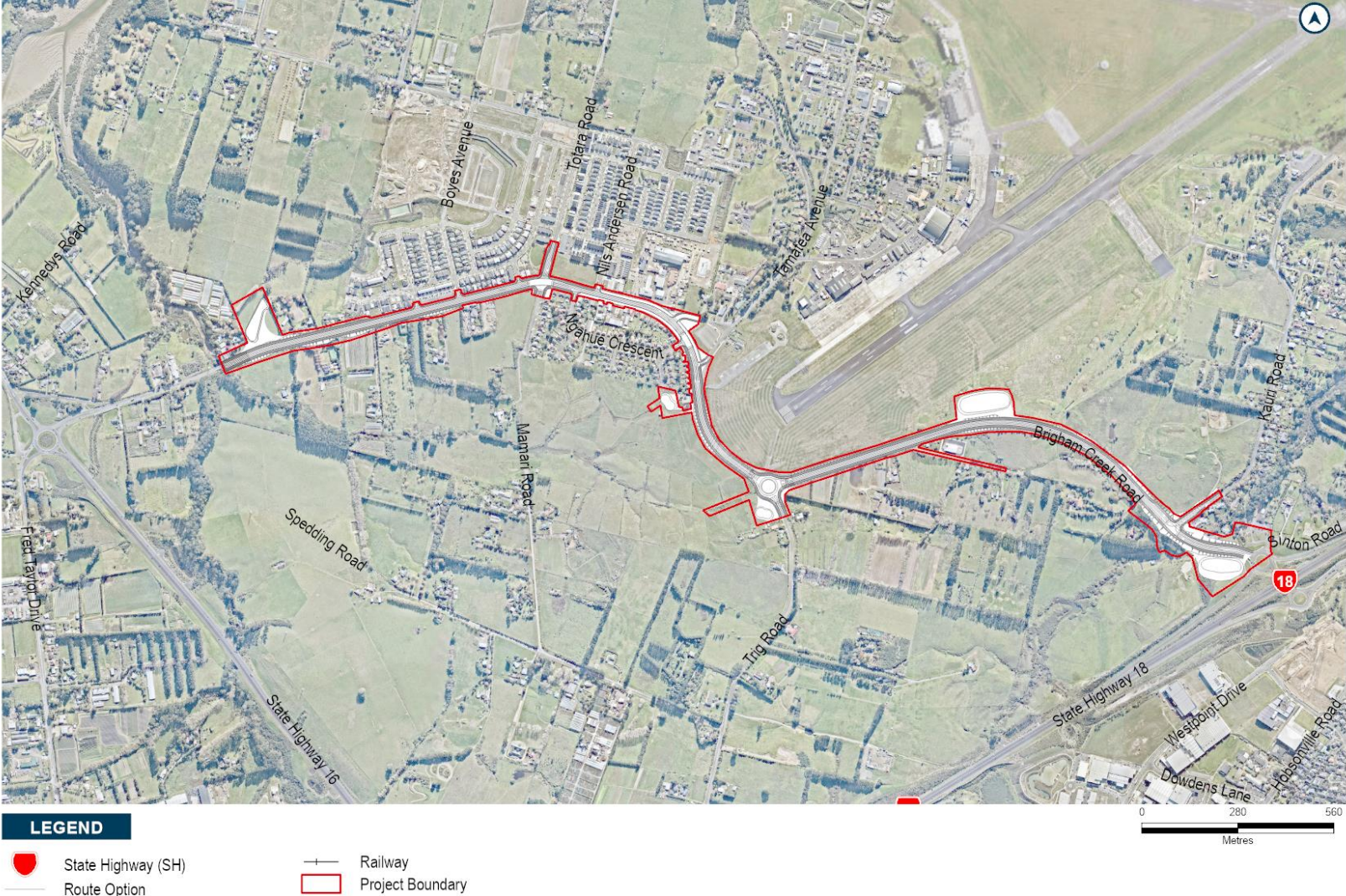


Figure 8-1 Overview of Brigham Creek Road Upgrade

8.2 Existing and Likely Future Environment

8.2.1 Planning context

The land adjacent to Brigham Creek Road is zoned under the AUP:OP as FUZ, except within the existing Whenuapai Centre (which is zoned under the AUP:OP for a range of residential and business zones) and the Whenuapai NZDF airbase. The airbase is designated (Designation 4310) for defence purposes by the Minister of Defence. The designation also includes the Residential – Single House Zone within the Whenuapai Centre.

PPC5 proposes to rezone the eastern portion of Brigham Creek Road on the south of the corridor to Business – Light Industrial zoning. The Whenuapai Structure Plan identifies medium density residential and business land uses to the south of Brigham Creek Road, with medium density residential land uses identified to the north.

Table 8-1 below provides a summary of the Brigham Creek Road existing and likely future environment.

Table 8-1: Brigham Creek Road Upgrade Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment ⁶	Likely Future Environment ⁷
Business	Business (Light Industrial)	Low	Business (Light Industrial)
	Business (Local centre)	Low	Business (Local centre)
Residential	Residential– Mixed Housing Urban Zone	Low	Residential
Open Space	Open Space –Informal Recreation Zone	Low	Open Space
Undeveloped greenfield areas (Future Urban Zone)	Future Urban	High	Urban
New Zealand Defence Force Air Base	Special Purpose - Airports and Airfields Zone	Low	Special Purpose – Airports and Airfields Zone

8.2.2 Noise Environment

Brigham Creek Road runs through an existing rural environment at each end, with the middle section being a mix of town centre, industrial and suburban environments. The noise environment is dominated by road traffic noise from vehicles on Brigham Creek Road as well as aircraft noise associated with the Whenuapai Air Base.

⁶ Based on AUP:OP zoning/policy direction

⁷ Based on AUP:OP zoning/policy direction

PPC5 and the Whenuapai Structure Plan indicate that Brigham Creek Road is likely to be surrounded by a mix of uses in the future with a Light Industrial Zone, Business Zones and Residential Zones proposed. This zoning would likely result in an increase in ambient noise levels as the area urbanises.

8.3 Assessment of Construction Noise and Vibration Effects

8.3.1 Construction Noise Effects

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 2m. High noise generating activities may not occur right on the construction boundary but if they do, 134 existing receivers could experience unmitigated noise levels that exceed the daytime noise criterion. Details of all properties where the criteria could be exceeded are provided in Appendix A.

With mitigation in place, as set out in Section 5.2, noise levels of up to 90 dB L_{Aeq} could still occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility. We note that the existing receivers on FUZ zoned land may not be present at the time of construction.

Future receivers constructed within 76m of the works could experience unmitigated noise levels that exceed the 70 dB L_{Aeq} noise criterion during high noise generating activities such as the pavement works.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

If a critical activity has to be carried out during the night-time in close proximity to residential receivers, consultation and mitigation measures will be essential. The use of noisy equipment should be avoided, where practicable, to prevent sleep disturbance. Any night-time works are likely to be limited in duration and will be managed through the CNVMP and a Schedule.

8.3.2 Construction Vibration Effects

The majority of the existing receivers along the Brigham Road corridor are residential type structures. 34 existing dwellings may experience vibration levels above 5mm/s PPV, exceeding the Category B criterion for residential structures, if the roller compactor is used on the construction boundary in the closest position to them. The addresses of receivers where the Category B criteria may be exceeded are listed in Appendix B. Once the compactor is 8m away from the dwellings the Category B criterion will be met. All the other equipment identified in Table 4-4 can comply with the Category B criterion at all other existing residential receivers.

There are existing commercial receivers along Brigham Creek Road between Māmari Road and Airport Road. All existing commercial receivers are located far enough from the proposed works for the Category B criterion to be met.

The Category B criterion would be met at future residential structures that are 8m or more from the proposed works and commercial structures that are 4m or more from the proposed works.

At buildings in close proximity to the proposed works, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration.

The vibration amenity criteria could be exceeded in existing or future buildings if they are occupied during the works and within 21 m of the roller compactor or within the emission radii identified for the other vibration generating equipment in Table 4-4. The effect on receivers would be subject to their respective proximity to the works but could include steady vibration from the roller compactor or a small jolt from a digger which could rattle crockery and glassware.

Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

High vibration generating activities should not occur during the night time in close proximity to residential receivers to avoid sleep disturbance, unless it is a critical activity and there is no alternative.

It should also be noted that the emission radii are conservative and vibration levels measured on site tend to be much lower than those predicted in the early stages of a project.

8.4 Conclusions

The predicted construction noise and vibration levels are based on indicative information to support this NoR and any conclusions in this assessment should be confirmed during the detailed design stage, taking account of the receivers as they exist at the time of construction.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment is used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through a CNVMP.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

9 NoR W4: Spedding Road

9.1 Project Corridor Features

Spedding Road is currently a primary rural collector connecting two low volume access roads with no exit roads that service several rural lots as well as Timitanga Community School along Māmari Road.

The Spedding Road Upgrade extends from a new intersection with Fred Taylor Drive, over SH16 to connect to the existing Spedding Road and Trig Road, and a greenfields portion from Trig Road over SH18 to tie into Hobsonville Road. This is comprised of the following two sections:

- Spedding Road West: the upgrade of the existing Spedding Road and new extension of Spedding Road to a two-lane arterial with separated active modes; and
- Spedding Road East: A new extension of Spedding Road to a two-lane arterial with separated active modes.

9.1.1 Spedding Road (West)

Key features of the proposed upgrade include the following:

- The upgrade of the existing 14m width corridor and formation of a new corridor to a 24m wide two-lane arterial cross section with separated cycle lanes and footpaths on both sides;
- A new roundabout at the intersection of Spedding Road West and Fred Taylor Drive in the west and tie-in to the western leg of the future Spedding Road / Mamari Road roundabout in the east (part of Spedding Road East);
- A direct active mode connection to the future Regional Active Mode Corridor, which is to be located along the southern side of SH16;
- A bridge crossing the SH16 North Western motorway in the vicinity of Totara Creek.
- Stormwater dry ponds, wetlands and culverts;
- Batter slopes to enable widening of the corridor, and associated cut and fill activities; and
- Vegetation removal along the existing road corridor.

Other construction related activities required outside the permanent corridor including the re-grade of driveways, construction traffic manoeuvring and construction laydown areas.

9.1.2 Spedding Road (East)

Key features of the proposed upgrade include the following:

- The upgrade of the existing 14m width corridor and formation of a new corridor to a 24m wide two-lane arterial cross section with separated cycle lanes and footpaths on both sides.
- Upgrade of intersections of Spedding Road with Trig Road and Māmari Road to roundabouts.
- Tie-in to Hobsonville Road Frequent Transport Network (**FTN**) project intersection.
- A bridge crossing the SH18 motorway, and a bridge crossing the Rawiri Stream.
- Stormwater dry ponds, wetlands and culverts.
- Batter slopes to enable widening of the corridor, and associated cut and fill activities.
- Vegetation removal along the existing road corridor

An overview of the proposed design is provided in Figure 9-1.

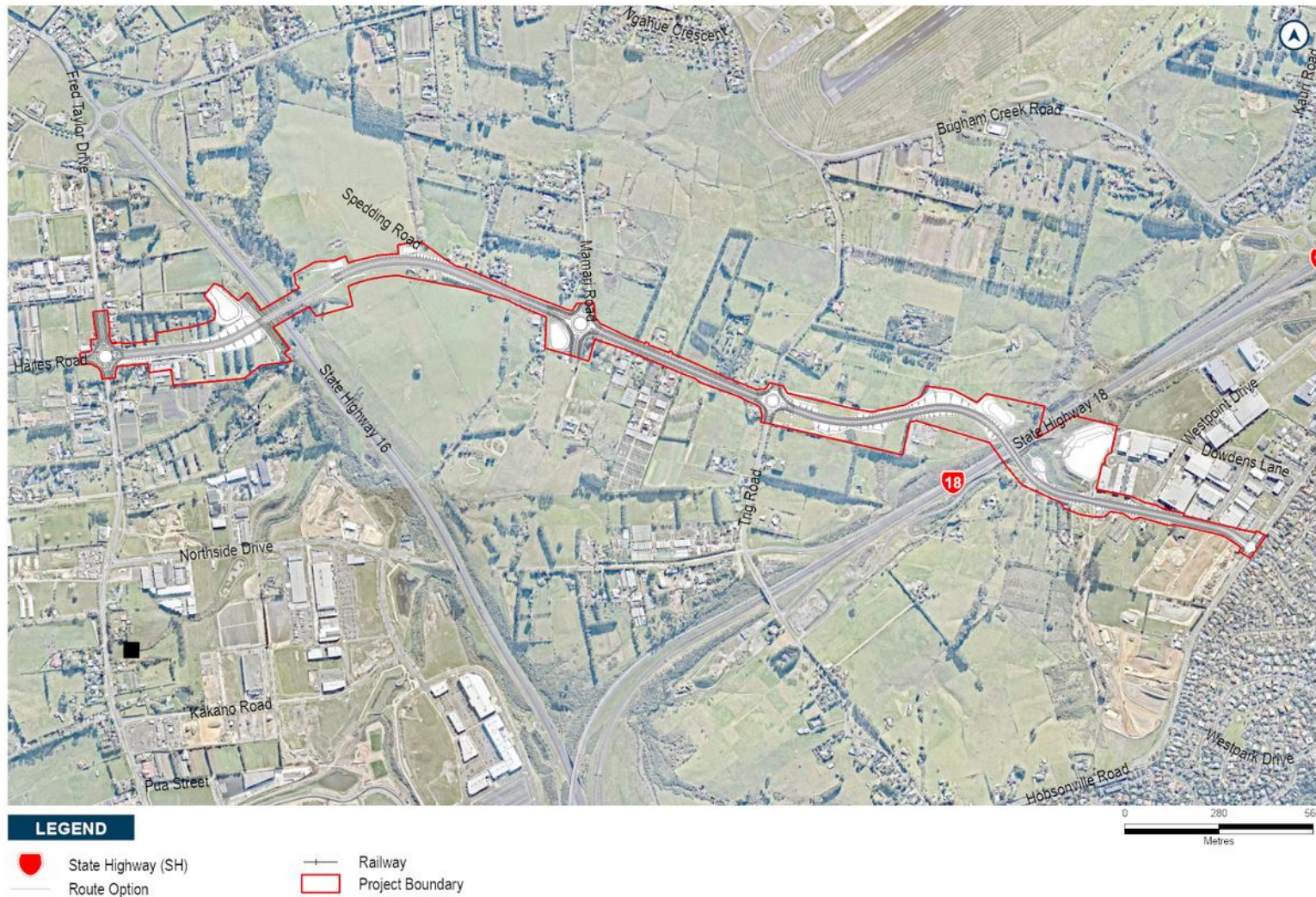


Figure 9-1 Overview of Spedding Road

9.2 Existing and Likely Future Environment

9.2.1 Planning context

- The land on either side of Spedding Road is zoned under the AUP:OP as FUZ, with the exception being the Business – Light Industry Zone within the Hobsonville Corridor Precinct.
- On the eastern end of the corridor PPC5 proposes to rezone the surrounding FUZ land to Business – Light Industry Zone in the north and Residential - Mixed Housing Urban Zone and Open Space – Informal Recreation zone in the south. The remainder of the land to the south of falls within the Hobsonville Corridor Precinct.
- PPC5 proposes a heritage overlay 4 Spedding Road and 92 Trig Road, which has legal effect under section 86B (3) (d) of the RMA. The overlay relates to four concrete gun emplacements and command post that made up the Whenuapai Aerodrome Heavy Anti-Aircraft Battery and are buried underground.
- The Whenuapai Structure Plan identifies the land surrounding the existing central section and proposed western end of the corridor for business.
- The western section of the proposed corridor extends across SH16 and the eastern section across SH18, both SH16 and SH18 are designated by Waka Kotahi for State Highway purposes (Designation 6741).

Table 9-1 below provides a summary of the Spedding Road existing and likely future environment.

Table 9-1: Spedding Road Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment ⁸	Likely Future Environment ⁹
Business	Business (Light Industrial)	Low	Business (Light Industrial)
Residential	Residential – Mixed Housing Urban	Low	Residential
Undeveloped greenfield areas (Future Urban Zone)	Future Urban	High	Urban

9.2.2 Noise Environment

Spedding Road is currently located within a predominantly rural area with few dwellings in close proximity to the road.

PPC5, the Whenuapai Structure Plan and the I603 Hobsonville Corridor Precinct indicate that the land surrounding Spedding Road is likely to contain mostly industrial or business uses in the future with pockets of residential. Ambient noise levels are expected to increase as the area urbanises.

⁸ Based on AUP:OP zoning/policy direction

⁹ Based on AUP:OP zoning/policy direction

9.3 Assessment of Construction Noise and Vibration Effects

9.3.1 Construction Noise Effects

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 2m. High noise generating activities may not occur right on the construction boundary but if they do, 44 existing receivers could experience unmitigated noise levels that exceed the daytime noise criterion. Details of all properties where the criteria could be exceeded are provided in Appendix A.

With mitigation in place, as set out in Section 5.2, noise levels of up to 90 dB L_{Aeq} could still occur intermittently at the closest receivers if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility. We note that the existing receivers may not be present at the time of construction.

Future receivers constructed within 76m of the works could experience unmitigated noise levels that exceed the 70 dB L_{Aeq} noise criterion during high noise generating activities such as the pavement works.

Bridge construction is the noisiest activity that is currently proposed for the Spedding Road works. It will only occur for a limited duration during bridge construction where Spedding Road crosses SH16 and SH18.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

Night works may be required during construction of the bridges across SH16 and SH18. If there are residential receivers in close proximity to any night-time works, consultation and mitigation measures will be essential. The use of noisy equipment should be avoided, where practicable, to prevent sleep disturbance. Any night-time works are likely to be limited in duration and will be managed through the CNVMP and a Schedule.

9.3.2 Construction Vibration Effects

Existing receivers along the Spedding Road corridor are a mix of residential and commercial structures. Three existing dwellings are predicted to experience vibration levels above the Category B criterion for residential structures. Two commercial buildings could experience vibration levels exceeding the Category B criterion if the roller compactor is used on the construction boundary in the closest position to them. The addresses of receivers where the Category B criteria may be exceeded are listed in Appendix B. Once the compactor is 4m away from the commercial buildings and 8m from the dwellings the Category B criterion will be met. All the other equipment identified in Table 4-4 can comply with the Category B criterion at all existing receivers. The Category B criteria would be met at future residential structures that are 8m or more from the proposed works and commercial structures that are 4m or more from the proposed works.

At buildings in close proximity to the proposed works, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration.

The Whenuapai Aerodrome Heavy Anti-Aircraft Battery is located across the properties at 4 Spedding Road and 92 Trig Road. The Battery consists of four concrete gun emplacements and a command post that are buried underground. The Battery is scheduled as a Historic Heritage Place, therefore the DIN historic/ sensitive criterion is applicable. The construction boundary abuts the heritage overlay. Predictions indicate that unmitigated vibration levels could exceed the DIN criteria for historical / sensitive properties. To control and minimise vibration levels at these structures the use of smaller or low vibration equipment will be required. Rule E26.8.8 of the AUP requires a vibration management plan to be prepared. In addition to detailing the proposed works and mitigation measures, the vibration management plan is required to set out a methodology for monitoring the proposed works to measure compliance with DIN criterion.

The vibration amenity criteria could be exceeded in existing or future buildings if they are occupied during the works and within 21 m of the roller compactor or within the emission radii identified for the other vibration generating equipment in Table 4-4. The effect on receivers would be subject to their respective proximity to the works but could include steady vibration from the roller compactor or a small jolt from a digger which could rattle crockery and glassware.

Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

High vibration generating activities should not occur during the night time in close proximity to residential receivers to avoid sleep disturbance, unless it is a critical activity and there is no alternative.

It should also be noted that the emission radii are conservative and vibration levels measured on site tend to be much lower than those predicted in the early stages of a project.

9.4 Conclusions

The predicted construction noise and vibration levels are based on indicative information to support this NoR and any conclusions in this assessment should be confirmed during the detailed design stage, taking account of the receivers as they exist at the time of construction.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration when high noise or vibration generating equipment is used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A vibration management plan will be produced for the Whenuapai Aerodrome Heavy Anti-Aircraft Battery that details the mitigation measures necessary to meet the DIN historic/ sensitive criterion.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

10 NoR W5: Hobsonville Road FTN Upgrade

10.1 Project Corridor Features

Hobsonville Road is an existing arterial corridor over 4km in length, extending from SH16 in the west to Hobsonville Point Road and Buckley Avenue / Squadron Drive in the east. The project extends from the intersection with Oriel Avenue in the west to the intersection Memorial Park Drive in the east and provides an important east-west connection from Westgate to Hobsonville. A section of the corridor adjacent to the intersection with Trig Road forms part of separate Te Tupu Ngātahi project and is not part of this assessment.

Key features of the proposed upgrade include the following:

- The upgrade of the section between Oriel Avenue and Luckens Road to a 30m wide four-lane arterial, and a 24m wide two-lane arterial from Luckens Road to Memorial Park Drive. Walking and cycling facilities will be provided on both sides along the entire length of the corridor;
- The upgrade of several intersections, more notably the intersection with Spedding Road East and Brigham Creek Road;
- Stormwater dry ponds, wetlands and culverts;
- Batter slopes to enable widening of the corridor, and associated cut and fill activities; and
- Vegetation removal along the existing road corridor.

An overview of the proposed design is provided in Figure 10-1.



Figure 10-1 Overview of Hobsonville Road Upgrade

10.2 Existing and Likely Future Environment

10.2.1 Planning context

Hobsonville Road is an existing urban corridor with land zoned under the AUP:OP as follows:

- The southern side of Hobsonville Road is largely zoned Residential – Mixed Housing Urban Zone, with a Business – Local Centre Zone located adjacent to the intersection of Hobsonville Road, Wiseley Road and Clark Road at the eastern end of the corridor; and
- The northern side of Hobsonville Road contains a variety of land uses. Adjacent land on the western end of the corridor is currently zoned Residential – Mixed Housing Zone between SH16 and Trig Rd (proposed for up zoning as part of PPC5), with FUZ land behind. Land to the east of Trig Road to Westpark Drive is currently zoned FUZ, with land then zoned Business – Light Industrial Zone to the east of Westpark Drive.

PPC5 proposes to re-zone the existing FUZ area to Residential – Mixed Housing Zone and Residential – Terrace and Apartment Building Zone.

The Hobsonville Road corridor is currently designated by AT for Transport Purposes (Designation 1437). Designation 1437 has been given effect to and it is proposed to alter this designation.

Table 10-1 below provides a summary of the Hobsonville Road existing and likely future environment.

Table 10-1: Hobsonville Road FTN Upgrade Existing and Likely Future Environment

Environment today	Zoning	Likelihood of Change for the environment ¹⁰	Likely Future Environment ¹¹
Business	Business (Light Industrial)	Low	Business (Light Industrial)
	Business (Local centre)	Low	Business (Local centre)
Residential	Residential - Mixed Housing Urban Zone	Low	Residential
Undeveloped greenfield areas (Future Urban Zone)	Future Urban	High	Urban

10.2.2 Noise Environment

Hobsonville Road is an existing urban corridor with development still occurring in the surrounding area. The noise environment is dominated by road traffic noise from vehicles on Hobsonville Road. Although development is still occurring in the area, ambient noise levels are unlikely to increase significantly above their current level.

¹⁰ Based on AUP:OP zoning/policy direction

¹¹ Based on AUP:OP zoning/policy direction

10.3 Assessment of Construction Noise and Vibration Effects

10.3.1 Construction Noise Effects

Receivers are located at varying distances from the construction boundary along the alignment with the closest existing receiver at 2m. High noise generating activities may not occur right on the construction boundary but if they do, 410 existing properties could experience unmitigated noise levels that exceed the daytime noise criterion. Details of all properties where the criteria could be exceeded are provided in Appendix A.

With mitigation in place, as set out in Section 5.2, noise levels of up to 90 dB L_{Aeq} could still occur intermittently at the closest receivers, if high noise generating activities occur on the construction boundary. At this level effects could include loss of concentration, annoyance, and a reduction in speech intelligibility. We note that the existing receivers may not be present at the time of construction.

Future receivers constructed within 76m of the works could experience unmitigated noise levels that exceed the 70 dB L_{Aeq} noise criterion during high noise generating activities such as the pavement works.

Operation of construction equipment will be intermittent in nature. Construction will be linear so as the equipment moves away from the receiver noise levels will reduce. The worst-case situations, where mitigated noise levels could reach 90 dB L_{Aeq} at the closest receivers, are not expected to be frequent, due to the setback distances to the majority of the proposed works and the use of equipment with lower source noise levels for large portions of the works. It is therefore predicted that mitigated noise levels can comply with the 70 dB L_{Aeq} noise criterion for most of the construction works.

If a critical activity has to be carried out during the night-time in close proximity to residential receivers, consultation and mitigation measures will be essential. The use of noisy equipment should be avoided, where practicable, to prevent sleep disturbance. Any night-time works are likely to be limited in duration and will be managed through the CNVMP and a Schedule.

10.3.2 Construction Vibration Effects

Existing receivers along the Hobsonville Road corridor are a mix of residential and commercial buildings. 50 existing dwellings may experience vibration levels above 5mm/s PPV and 5 existing commercial buildings may experience levels above 10mm/s PPV, exceeding the Category B criterion, if the roller compactor is used on the construction boundary in the closest position to them. The addresses of receivers where the Category B criteria may be exceeded are listed in Appendix B. Once the compactor is 8m away from the dwellings and 4m from commercial buildings the Category B criterion will be met. All the other vibration generating equipment identified in Table 4-4 can comply with the Category B criterion at all existing receivers. The Category B criteria would be met at future residential structures that are 8m or more from the proposed works and commercial structures that are 4m or more from the proposed works.

At buildings in close proximity to the proposed works, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration.

The vibration amenity criteria could be exceeded in existing or future buildings if they are occupied during the works and within 21 m of the roller compactor or within the emission radii identified for the other vibration generating equipment in Table 4-4. The effect on receivers would be subject to their

respective proximity to the works but could include steady vibration from the roller compactor or a small jolt from a digger which could rattle crockery and glassware.

Vibration can typically be tolerated inside buildings if it occurs intermittently during the day, is of limited duration and where there is effective prior engagement.

High vibration generating activities should not occur during the night time in close proximity to residential receivers to avoid sleep disturbance, unless it is a critical activity and there is no alternative.

It should also be noted that the emission radii are conservative and vibration levels measured on site tend to be much lower than those predicted in the early stages of a project.

10.4 Conclusions

The predicted construction noise and vibration levels are based on indicative information to support this NoR and any conclusions in this assessment should be confirmed during the detailed design stage, taking account of the receivers as they exist at the time of construction.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to generally comply with the applicable limits as defined in the AUP. Exceedances of the criteria could occur intermittently over a short duration if high noise or vibration generating equipment is used near occupied buildings. Where an exceedance is predicted at any receiver that exists at the time of construction, the effects will be mitigated and managed through the CNVMP and Schedules.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers.

11 Conclusion

An assessment of the construction noise and vibration effects has been undertaken for the Projects considering a reasonable worst case scenario. The predicted noise levels and effects are based on indicative information as provided by the Project team and any assessment conclusions should be confirmed during the detailed design stage, taking account of the final equipment selections, methodology and receivers as they exist at the time of construction.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 5.2, to comply with the applicable limits for the majority of the works. Exceedances of the criteria could occur intermittently across all NoR's, if high noise or vibration generating equipment is used near occupied buildings. The most impacted receivers are located within 10m of the construction boundary.

Night works will be limited to critical activities that can not be carried out at any other time.

A CNVMP will be prepared prior to construction commencing in accordance with Section 5.2.1 of this report. The CNVMP will provide a framework for the development and implementation of best practicable options to avoid, remedy or mitigate the adverse effects of construction noise and vibration on receivers that exist at the time of construction. Communication and consultation will occur with the affected receivers and a site specific schedule will be prepared if required.

Elevated noise levels should be avoided and mitigated where possible to reduce the likelihood of adverse effects such as loss of concentration, annoyance and sleep disturbance (for night works).

Whilst vibration levels at the Category A criterion of 2mm/s PPV can generally be tolerated if activity occurs intermittently and with prior notice, communication and consultation will be the key management measure to avoid annoyance and concern. Where vibration levels are predicted to exceed the Category B criteria, and where the construction methodology cannot be changed to reduce vibration levels, building conditions surveys are recommended.

Overall, construction noise and vibration can be controlled to reasonable levels with the implementation of appropriate mitigation and management measures.

Appendix A – Affected Receivers – Noise (Unmitigated)

NoR W1 Trig Road (North)

Address
82 Trig Road Whenuapai
96a Trig Road Whenuapai
90 Trig Road Whenuapai
96 Trig Road Whenuapai
43 Trig Road Whenuapai
57 Trig Road Whenuapai
84 Trig Road Whenuapai
86 Trig Road Whenuapai
1/84 Trig Road Whenuapai
73 Trig Road Whenuapai
67 Trig Road Whenuapai
94 Trig Road Whenuapai 0618
92 Trig Road Whenuapai
88 Trig Road Whenuapai
52 Trig Road Whenuapai 0618
33 Trig Road Whenuapai

NoR W2 Māmari Road

Address	Address
9 Māmari Road Whenuapai	1 Ripeka Lane Whenuapai
4 Māmari Road Whenuapai	51 Brigham Creek Road Whenuapai
6 Māmari Road Whenuapai	70 Trig Road Whenuapai
8 Māmari Road Whenuapai	5 Māmari Road Whenuapai
20 Māmari Road Whenuapai	53 Brigham Creek Road Whenuapai
24 Māmari Road Whenuapai	7 Tama Quadrant Whenuapai
22 Māmari Road Whenuapai	3 Ngahue Crescent Whenuapai
16 Māmari Road Whenuapai	7 Ngahue Crescent Whenuapai
18 Māmari Road Whenuapai	5 Ngahue Crescent Whenuapai
14 Māmari Road Whenuapai	9 Tama Quadrant Whenuapai
10 Māmari Road Whenuapai	5 Tama Quadrant Whenuapai
7 Māmari Road Whenuapai	2-10 Ripeka Lane Whenuapai
49 Brigham Creek Road Whenuapai	80 Trig Road Whenuapai

12 Māmari Road Whenuapai	72 Trig Road Whenuapai
30 Māmari Road Whenuapai	9 Ngahue Crescent Whenuapai
15 Māmari Road Whenuapai	3 Tama Quadrant Whenuapai
28 Māmari Road Whenuapai	7 Spedding Road Whenuapai

NoR W3 Brigham Creek Road

Address	Address
1-8/38 Brigham Creek Road Whenuapai 0618	50-52 Whenuapai Drive Whenuapai
40b-42c Brigham Creek Road Whenuapai	92 Whenuapai Drive Whenuapai
53 Brigham Creek Road Whenuapai	39 Brigham Creek Road Whenuapai
57 Brigham Creek Road Whenuapai	104 Whenuapai Drive Whenuapai
91 Brigham Creek Road Whenuapai	38 Whenuapai Drive Whenuapai
55 Brigham Creek Road Whenuapai	14 Airport Road Whenuapai
109 Brigham Creek Road Whenuapai	48 Whenuapai Drive Whenuapai
59 Brigham Creek Road Whenuapai	46 Whenuapai Drive Whenuapai
113 Brigham Creek Road Whenuapai	18 Brigham Creek Road Whenuapai 0618
49 Brigham Creek Road Whenuapai	112 Whenuapai Drive Whenuapai 0618
26-34 Whenuapai Drive Whenuapai 0618	8 Airport Road Whenuapai
123 Brigham Creek Road Whenuapai	5 Ngahue Crescent Whenuapai
38 Ngahue Crescent Whenuapai	4 Mamari Road Whenuapai
162 Brigham Creek Road Hobsonville	34 Ngahue Crescent Whenuapai
93 Brigham Creek Road Whenuapai	114 Whenuapai Drive Whenuapai 0618
105 Brigham Creek Road Whenuapai	2 Ruatea Street Whenuapai 0618
2 Māmari Road Whenuapai	96 Trig Road Whenuapai
1 Ripeka Lane Whenuapai 0618	4 Ngahue Crescent Whenuapai
111 Brigham Creek Road Whenuapai	46-60 Nils Andersen Road Whenuapai 0618
2-10 Ripeka Lane Whenuapai	24 Brigham Creek Road Whenuapai 0618
42d Brigham Creek Road Whenuapai	5 Kauri Road Whenuapai
51 Brigham Creek Road Whenuapai	77-85 Nils Andersen Road Whenuapai 0618
101 Brigham Creek Road Whenuapai	145 Brigham Creek Road Whenuapai
99 Brigham Creek Road Whenuapai	11-17 Maramara Road Whenuapai 0618
32c Brigham Creek Road Whenuapai 0618	1-4/46a Nils Andersen Road Whenuapai 0618
34b Brigham Creek Road Whenuapai 0618	4 Ruatea Street Whenuapai 0618
34d Brigham Creek Road	7 Ngahue Crescent Whenuapai
115 Brigham Creek Road Whenuapai	5-8/46a Nils Andersen Road Whenuapai 0618
34a Brigham Creek Road Brigham Creek	6 Ruatea Street Whenuapai 0618

Address	Address
103 Brigham Creek Road Whenuapai	6 Mamari Road Whenuapai
145a Brigham Creek Road Whenuapai	32 Ngahue Crescent Whenuapai
39a Brigham Creek Road Whenuapai	5 Boyes Avenue Whenuapai 0618
32c Brigham Creek Road	8 Ruatea Street Whenuapai 0618
32d Brigham Creek Road Whenuapai 0618	6 Ngahue Crescent Whenuapai
117 Brigham Creek Road Whenuapai	73 Trig Road Whenuapai
108 Brigham Creek Road	10 Ruatea Street Whenuapai 0618
2 Kauri Road Whenuapai	41-61 Nils Andersen Road Whenuapai 0618
121 Brigham Creek Road Whenuapai	69-71 Whenuapai Drive Whenuapai 0618
119 Brigham Creek Road Whenuapai	73-75 Whenuapai Drive Whenuapai 0618
95 Brigham Creek Road Whenuapai	1 Ruatea Street Whenuapai 0618
97 Brigham Creek Road Whenuapai	65-75 Nils Andersen Road Whenuapai 0618
125-127 Brigham Creek Road Whenuapai	2 Mcewan Street Whenuapai
1 Kauri Road Whenuapai	101 Whenuapai Drive Whenuapai 0618
36 Ngahue Crescent Whenuapai	9 Ngahue Crescent Whenuapai
3 Kauri Road Whenuapai	96a Trig Road Whenuapai
26 Brigham Creek Road Whenuapai 0618	89 Whenuapai Drive Whenuapai 0618
129 Brigham Creek Road Whenuapai	99 Whenuapai Drive Whenuapai 0618
20 Brigham Creek Road Whenuapai	85 Whenuapai Drive Whenuapai 0618
3 Boyes Avenue Whenuapai 0618	53-55 Whenuapai Drive Whenuapai
37 Ngahue Crescent Whenuapai	61-63 Whenuapai Drive Whenuapai
153 Brigham Creek Road	30 Ngahue Crescent Whenuapai
2-10 Harewood Street Whenuapai	59 Whenuapai Drive Whenuapai
3 Ngahue Crescent Whenuapai	2 Kainga Lane Whenuapai 0618
2 Ngahue Crescent Whenuapai	33-35 Whenuapai Drive Whenuapai
110 Whenuapai Drive Whenuapai 0618	65 Whenuapai Drive Whenuapai
58-88 Whenuapai Drive Whenuapai 0618	1 Joseph McDonald Drive Whenuapai 0618
102 Whenuapai Drive Whenuapai 0618	31 Whenuapai Drive Whenuapai
28 Brigham Creek Road Whenuapai 0618	93 Whenuapai Drive Whenuapai 0618
42 Whenuapai Drive Whenuapai	39 Whenuapai Drive Whenuapai
100 Whenuapai Drive Whenuapai 0618	31 Brigham Creek Road Whenuapai
106 Whenuapai Drive Whenuapai 0618	67 Whenuapai Drive Whenuapai
44 Whenuapai Drive Whenuapai	8 Mamari Road Whenuapai
98 Whenuapai Drive Whenuapai 0618	163 Brigham Creek Road Whenuapai
30 Whenuapai Drive Whenuapai	51 Whenuapai Drive Whenuapai

Address	Address
40 Whenuapai Drive Whenuapai	8 Ngahue Crescent Whenuapai
1 Maramara Road Whenuapai	2 Airport Road Whenuapai
50 Brigham Creek Road Whenuapai	73 Brigham Creek Road Whenuapai

NoR W4

Address	Address
98 Hobsonville Road Hobsonville	143b Fred Taylor Drive Whenuapai
90 Trig Road Whenuapai	119 Fred Taylor Drive Whenuapai
5a Spedding Road Whenuapai	180 Fred Taylor Drive Whenuapai
5 Spedding Road Whenuapai	2a Marina View Drive West Harbour
3 Spedding Road Whenuapai	231a Hobsonville Road Hobsonville
1/98 Hobsonville Road Hobsonville	243 Hobsonville Road Hobsonville
92 Trig Road Whenuapai	227 Hobsonville Road Hobsonville
6 Spedding Road Whenuapai	5-7 Workspace Drive Hobsonville
233 Hobsonville Road Hobsonville	8 Workspace Drive Hobsonville
1 Marina View Drive West Harbour	48-52 Westpoint Drive Hobsonville
231 Hobsonville Road Hobsonville	102 Hobsonville Road Hobsonville
2 Marina View Drive West Harbour	6 Rawiri Place Hobsonville
239 Hobsonville Road Hobsonville	4 Rawiri Place Hobsonville
229a Hobsonville Road Hobsonville	3 Workspace Drive Hobsonville
241 Hobsonville Road Hobsonville	135 Fred Taylor Drive Whenuapai
1a Marina View Drive West Harbour	15-19 Spedding Road Whenuapai
137 Fred Taylor Drive Whenuapai	14 Spedding Road Whenuapai
133 Fred Taylor Drive Whenuapai	10 Spedding Road Whenuapai
141 Fred Taylor Drive Whenuapai	1/121 Fred Taylor Drive Whenuapai
131 Fred Taylor Drive Whenuapai	117 Fred Taylor Drive Whenuapai
139 Fred Taylor Drive Whenuapai	8 Spedding Road Whenuapai
168 Fred Taylor Drive Whenuapai	143a Fred Taylor Drive Whenuapai

NoR W5 Hobsonville Road

Address	Address
321 Hobsonville Road Hobsonville	145e Hobsonville Road West Harbour
42 Hobsonville Road Hobsonville	159 Hobsonville Road West Harbour
255 Hobsonville Road Hobsonville	145a Hobsonville Road West Harbour
1/259 Hobsonville Road Hobsonville	17a Magdalen Place West Harbour

Address	Address
305 Hobsonville Road Hobsonville	33 Cyril Crescent West Harbour 0618
309 Hobsonville Road Hobsonville	6 Woodhouse Place West Harbour
2 Hendrika Court Hobsonville	5 Wiseley Road Hobsonville
295 Hobsonville Road Hobsonville	11 Magdalen Place West Harbour
19 Williams Road Hobsonville	5 Hendrika Court Hobsonville
45 Suncrest Drive West Harbour	38 Suncrest Drive West Harbour
303 Hobsonville Road Hobsonville	41/18 Williams Road Hobsonville
1-2/275 Hobsonville Road Hobsonville	17 Magdalen Place West Harbour
33/18 Williams Road Hobsonville	64 Hobsonville Road West Harbour
54 Hobsonville Road West Harbour	1-2/2 Wiseley Road Hobsonville
251 Hobsonville Road Hobsonville	12 Magdalen Place West Harbour
77 Hobsonville Road West Harbour	229 Hobsonville Road Hobsonville
1/383 Hobsonville Road Hobsonville	1/273 Hobsonville Road Hobsonville
2 Clark Road Hobsonville	1/4 Westpark Drive West Harbour
307 Hobsonville Road Hobsonville	1/323 Hobsonville Road Hobsonville
287 Hobsonville Road Hobsonville	1/25 Glucina Avenue West Harbour
289 Hobsonville Road Hobsonville	5 Bannings Way Hobsonville
1-2/279 Hobsonville Road Hobsonville	42-44 Suncrest Drive West Harbour
1-2/281 Hobsonville Road Hobsonville	2/163 Hobsonville Road West Harbour
311 Hobsonville Road Hobsonville	1/31 Glucina Avenue West Harbour
403 Hobsonville Road Hobsonville	1/133a Hobsonville Road West Harbour
291 Hobsonville Road Hobsonville	327 Bd10 Hobsonville Road Hobsonville
56 Hobsonville Road West Harbour	14 Woodhouse Place West Harbour
249 Hobsonville Road Hobsonville	20 Connemara Court West Harbour
4 Hendrika Court Hobsonville	15a Wiseley Road Hobsonville
1 Westpark Drive West Harbour	3 Seagrove Road West Harbour
1 Hendrika Court Hobsonville	10 Woodhouse Place West Harbour
283 Hobsonville Road Hobsonville	39 Suncrest Drive West Harbour
49 Hobsonville Road West Harbour	1/18 Hobsonville Road West Harbour
4 Clark Road Hobsonville	145b Hobsonville Road West Harbour
24-25/18 Williams Road Hobsonville	8 Hendrika Court Hobsonville
317 Hobsonville Road Hobsonville	13 Williams Road Hobsonville
201 Hobsonville Road Hobsonville	73 Hobsonville Road West Harbour
60 Hobsonville Road West Harbour	153d Hobsonville Road West Harbour
33 Hobsonville Road West Harbour	38/18 Williams Road Hobsonville

Address	Address
253 Hobsonville Road Hobsonville	29 Glucina Avenue West Harbour
247 Hobsonville Road Hobsonville	2/31 Glucina Avenue West Harbour
20 Hobsonville Road West Harbour	12 Woodhouse Place West Harbour
241 Hobsonville Road Hobsonville	22 Belleaire Court West Harbour
82 Hobsonville Road West Harbour	2/4 Westpark Drive West Harbour
39 Hobsonville Road West Harbour	1/18 Woodhouse Place West Harbour
319 Hobsonville Road Hobsonville	16 Woodhouse Place West Harbour
229a Hobsonville Road Hobsonville	16 Hendrika Court Hobsonville
41 Hobsonville Road West Harbour	155a Hobsonville Road West Harbour
147a Hobsonville Road West Harbour	37 Suncrest Drive West Harbour
22 Hobsonville Road West Harbour	24 Peterhouse Place West Harbour
75 Hobsonville Road West Harbour	83 Hobsonville Road West Harbour
147c Hobsonville Road West Harbour	379 Hobsonville Road Hobsonville
23/18 Williams Road Hobsonville	26 Peterhouse Place West Harbour
35 Hobsonville Road West Harbour	3-4/18 Williams Road Hobsonville
104a Hobsonville Road Hobsonville	8 Woodhouse Place West Harbour
2/2 Oreil Avenue West Harbour	153a Hobsonville Road West Harbour
17 Williams Road Hobsonville	36 Sailfish Drive West Harbour
21-22/18 Williams Road Hobsonville	17 Wiseley Road Hobsonville
19/18 Williams Road Hobsonville	3a Bannings Way Hobsonville
31 Hobsonville Road West Harbour	157b Hobsonville Road West Harbour
313 Hobsonville Road Hobsonville	20 Peterhouse Place West Harbour
243 Hobsonville Road Hobsonville	377a Hobsonville Road Hobsonville
181 Hobsonville Road Hobsonville	4 Wiseley Road Hobsonville
239 Hobsonville Road Hobsonville	327 Bd3 Hobsonville Road Hobsonville
58 Hobsonville Road West Harbour	14 Williams Road Hobsonville
199 Hobsonville Road Hobsonville	7 Hendrika Court Hobsonville
203 Hobsonville Road Hobsonville	9 Magdalen Place West Harbour
26-27/18 Williams Road Hobsonville	15 Magdalen Place West Harbour
55 Hobsonville Road West Harbour	17 Oreil Avenue West Harbour
149b Hobsonville Road West Harbour	1/28 Sailfish Drive West Harbour
26 Belleaire Court West Harbour	2/28 Sailfish Drive West Harbour
233 Hobsonville Road Hobsonville	1/8 Oreil Avenue West Harbour
29 Hobsonville Road West Harbour	15 Oreil Avenue West Harbour
205 Hobsonville Road Hobsonville	26 Connemara Court West Harbour

Address	Address
51 Hobsonville Road West Harbour	4a Marina View Drive West Harbour
231 Hobsonville Road Hobsonville	31 Cyril Crescent West Harbour 0618
1/2 Oreil Avenue West Harbour	14 Whiting Grove West Harbour
2a Fitzherbert Avenue West Harbour	7 Fitzherbert Avenue West Harbour
24 Belleaire Court West Harbour	387 Hobsonville Road Hobsonville
61 Hobsonville Road West Harbour	8 Oreil Avenue West Harbour
3 Hendrika Court Hobsonville	17b Oreil Avenue West Harbour
3 Westpark Drive West Harbour	273 Hobsonville Road Hobsonville
195 Hobsonville Road Hobsonville	1/38 Sailfish Drive West Harbour
53 Hobsonville Road West Harbour	15-16/18 Williams Road Hobsonville
395 Hobsonville Road Hobsonville	3 Marina View Drive West Harbour
34/18 Williams Road Hobsonville	11 Hendrika Court Hobsonville
6-10 Clark Road Hobsonville	10 Whiting Grove West Harbour
1 Marina View Drive West Harbour	35 Cherub Place West Harbour
277 Hobsonville Road Hobsonville	6 Optimist Place West Harbour
375 Hobsonville Road Hobsonville	10 Westpark Drive West Harbour
175 Hobsonville Road Hobsonville 0618	16-18 Clark Road Hobsonville
369a Hobsonville Road Hobsonville	30 Sailfish Drive West Harbour
373 Hobsonville Road Hobsonville	1/2 Wiseley Road Hobsonville
37 Hobsonville Road West Harbour	66 Hobsonville Road West Harbour
151d Hobsonville Road West Harbour	7 Starlight Cove Hobsonville
197 Hobsonville Road Hobsonville	27 Suncrest Drive West Harbour
381 Hobsonville Road Hobsonville	34 Sailfish Drive West Harbour
57 Hobsonville Road West Harbour	12 Whiting Grove West Harbour
151b Hobsonville Road West Harbour	7 Wiseley Road Hobsonville
299 Hobsonville Road Hobsonville	7 Optimist Place West Harbour
215 Hobsonville Road Hobsonville	5 Starlight Cove Hobsonville
267 Hobsonville Road Hobsonville	8 Optimist Place West Harbour
23 Hobsonville Road West Harbour	1/26 Peterhouse Place West Harbour
27 Hobsonville Road West Harbour 0618	14 Hendrika Court Hobsonville
8b Hobsonville Road Hobsonville	18 Woodhouse Place West Harbour
209 Hobsonville Road Hobsonville	15 Soling Place West Harbour
1/255 Hobsonville Road Hobsonville	35/18 Williams Road Hobsonville
151c Hobsonville Road West Harbour	13 Oreil Avenue West Harbour
1/257 Hobsonville Road Hobsonville	6 Louise Place West Harbour

Address	Address
2 Marina View Drive West Harbour	17 Belleaire Court West Harbour
301 Hobsonville Road Hobsonville	37 Cherub Place West Harbour
79 Hobsonville Road West Harbour	33 Cherub Place West Harbour
1/18 Williams Road Hobsonville	29 Cherub Place West Harbour
211 Hobsonville Road Hobsonville	155b Hobsonville Road West Harbour
47 Hobsonville Road West Harbour	9 Starlight Cove Hobsonville
26a Hobsonville Road West Harbour 0618	5 Seagrove Road West Harbour
43 Suncrest Drive West Harbour	5-6/18 Williams Road Hobsonville
2 Fitzherbert Avenue West Harbour	13 Magdalen Place West Harbour
44 Hobsonville Road	32 Sailfish Drive West Harbour
207 Hobsonville Road Hobsonville	10 Soling Place West Harbour
323 Hobsonville Road Hobsonville	15 Wiseley Road Hobsonville
6 Westpark Drive West Harbour	8a Hendrika Court Hobsonville
221 Hobsonville Road Hobsonville	21 Cherub Place West Harbour
151a Hobsonville Road West Harbour	19 Belleaire Court West Harbour
227 Hobsonville Road Hobsonville	153c Hobsonville Road West Harbour
59 Hobsonville Road West Harbour	31 Cherub Place West Harbour
3 Fitzherbert Avenue West Harbour	4 Whiting Grove West Harbour
4 Oreil Avenue West Harbour	1/19 Cherub Place West Harbour
217 Hobsonville Road Hobsonville	19 Magdalen Place West Harbour
383 Hobsonville Road Hobsonville	27 Cherub Place West Harbour
219 Hobsonville Road Hobsonville	7-8/18 Williams Road Hobsonville
403 Hobsonville Road Hobsonville	18 Connemara Court West Harbour
45 Hobsonville Road West Harbour	17 Soling Place West Harbour
1/46 Hobsonville Road West Harbour	325 Hobsonville Road Hobsonville
393 Hobsonville Road Hobsonville	12 Williams Road Hobsonville
16 Hobsonville Road West Harbour	8 Whiting Grove West Harbour
4a Hendrika Court Hobsonville	17 Westergrove Place West Harbour
223 Hobsonville Road Hobsonville	327 Bd9 Hobsonville Road Hobsonville
63 Hobsonville Road West Harbour	2/133a Hobsonville Road West Harbour
391 Hobsonville Road Hobsonville	6 Fitzherbert Avenue West Harbour
1/191 Hobsonville Road Hobsonville	11 Williams Road Hobsonville
213 Hobsonville Road Hobsonville	10 Wiseley Road Hobsonville
245 Hobsonville Road Hobsonville	3 Bannings Way Hobsonville
24a Hobsonville Road West Harbour	9 Williams Road Hobsonville

Address	Address
189 Hobsonville Road Hobsonville	2 Seagrove Road West Harbour
1/41 Hobsonville Road West Harbour	3/163 Hobsonville Road West Harbour
3a Wiseley Road Hobsonville	4 Woodhouse Place West Harbour
187 Hobsonville Road Hobsonville	13 Hendrika Court Hobsonville
18 Hobsonville Road West Harbour	157c Hobsonville Road West Harbour
169 Hobsonville Road West Harbour	22 Peterhouse Place West Harbour
291a Hobsonville Road Hobsonville	29 Suncrest Drive West Harbour
287a Hobsonville Road Hobsonville	15 Westergrove Place West Harbour
285 Hobsonville Road Hobsonville	35 Suncrest Drive West Harbour
327 Bd1 Hobsonville Road Hobsonville	3 Starlight Cove Hobsonville
30/18 Williams Road Hobsonville	10 Trig Road Whenuapai
3 Wiseley Road Hobsonville	379a Hobsonville Road Hobsonville
1/163 Hobsonville Road West Harbour	12 Soling Place West Harbour
3 Oreil Avenue West Harbour	85 Hobsonville Road West Harbour
225 Hobsonville Road Hobsonville	7 Magdalen Place West Harbour
185 Hobsonville Road Hobsonville	9 Wiseley Road Hobsonville
183 Hobsonville Road Hobsonville	127 Hobsonville Road West Harbour
203a Hobsonville Road Hobsonville	1/22 Peterhouse Place West Harbour
3a Hendrika Court Hobsonville	9-10/18 Williams Road Hobsonville
15 Williams Road Hobsonville	36 Suncrest Drive West Harbour
41 Suncrest Drive West Harbour	23b Wiseley Road Hobsonville
79a Hobsonville Road West Harbour	10 Oreil Avenue West Harbour
177 Hobsonville Road Hobsonville	12 Hobsonville Road West Harbour
303a Hobsonville Road Hobsonville	1/32 Glucina Avenue West Harbour
165 Hobsonville Road West Harbour	1 Bannings Way Hobsonville
133 Hobsonville Road West Harbour	13-14/18 Williams Road Hobsonville
62 Hobsonville Road West Harbour	127a Hobsonville Road West Harbour
1 Seagrove Road West Harbour	5a Bannings Way Hobsonville
17-18/18 Williams Road Hobsonville	27 Glucina Avenue West Harbour
1/39 Hobsonville Road West Harbour	11 Starlight Cove Hobsonville
14 Hobsonville Road West Harbour	15 Belleaire Court West Harbour
39/18 Williams Road Hobsonville	153b Hobsonville Road West Harbour
147f Hobsonville Road West Harbour	30 Suncrest Drive West Harbour
61a Hobsonville Road West Harbour	85a Hobsonville Road West Harbour
327 Bd2 Hobsonville Road Hobsonville	8 Louise Place West Harbour

Address	Address
43/18 Williams Road Hobsonville	25 Peterhouse Place West Harbour
22 Connemara Court West Harbour	26 Sailfish Drive West Harbour
24 Connemara Court West Harbour	5a Hanson Place West Harbour
6 Oreil Avenue West Harbour	18 Hendrika Court Hobsonville
157a Hobsonville Road West Harbour	19 Oreil Avenue West Harbour
2a Marina View Drive West Harbour	12 Wiseley Road Hobsonville
315 Hobsonville Road Hobsonville	29 Cyril Crescent West Harbour 0618
11 Oreil Avenue West Harbour	4 Louise Place West Harbour
5 Fitzherbert Avenue West Harbour	104 Hobsonville Road Hobsonville
1a Marina View Drive West Harbour	405 Hobsonville Road Hobsonville
193 Hobsonville Road Hobsonville	114 Hobsonville Road Hobsonville
8 Westpark Drive West Harbour	122 Hobsonville Road Hobsonville
28/18 Williams Road Hobsonville	397 Hobsonville Road Hobsonville
16 Williams Road Hobsonville	1c Wiseley Road Hobsonville
231a Hobsonville Road Hobsonville	82 Hobsonville Road
4 Fitzherbert Avenue West Harbour	1 Wisley Road Hobsonville
401 Hobsonville Road Hobsonville	106 Hobsonville Road Hobsonville
9 Hendrika Court Hobsonville	21 Hobsonville Road West Harbour
167 Hobsonville Road West Harbour	124 Hobsonville Road
161 Hobsonville Road West Harbour	71 Hobsonville Road West Harbour
6 Hendrika Court Hobsonville	102 Hobsonville Road Hobsonville
14 Clark Road Hobsonville	2 Dowdens Lane Hobsonville
40 Suncrest Drive West Harbour	8 Workspace Drive Hobsonville
143c Hobsonville Road West Harbour	102c Hobsonville Road Hobsonville
81 Hobsonville Road West Harbour	1-3/4 Workspace Drive Hobsonville
2/18 Williams Road Hobsonville	4 Laurenson Road Hobsonville

Appendix B – Affected Receivers – Vibration

NoR W1 Trig Road (North)

Address	Building Type
82 TRIG ROAD WHENUAPAI	Residential
96A TRIG ROAD WHENUAPAI	Residential

NoR W2 Māmari Road

Address	Building Type
9 Māmari Road Whenuapai	School
4 Māmari Road Whenuapai	Residential
6 Māmari Road Whenuapai	Residential
8 Māmari Road Whenuapai	Residential
7 Spedding Road	Residential

NoR W3 Brigham Creek Road

Address	Building Type	Address	Building Type
1-8/38 Brigham Creek Road	Residential	1 Ripeka Lane	Residential
40b-42c Brigham Creek Road	Residential	111 Brigham Creek Road	Residential
53 Brigham Creek Road	Residential	2-10 Ripeka Lane	Residential
57 Brigham Creek Road	Residential	42d Brigham Creek Road	Residential
91 Brigham Creek Road	Residential	51 Brigham Creek Road	Residential
55 Brigham Creek Road	Residential	101 Brigham Creek Road	Residential
109 Brigham Creek Road	Residential	99 Brigham Creek Road	Residential
59 Brigham Creek Road	Residential	32c Brigham Creek Road	Residential
113 Brigham Creek Road	Residential	34b Brigham Creek Road	Residential
49 Brigham Creek Road	Residential	34d Brigham Creek Road	Residential
26-34 Whenuapai Drive	Residential	115 Brigham Creek Road	Residential
123 Brigham Creek Road	Residential	34a Brigham Creek Road	Residential
38 Ngahue Crescent	Residential	103 Brigham Creek Road	Residential
162 Brigham Creek Road	Residential	145a Brigham Creek Road	Residential
93 Brigham Creek Road	Residential	39a Brigham Creek Road	Residential
105 Brigham Creek Road	Residential	32c Brigham Creek Road	Residential
2 Māmari Road	Residential	32d Brigham Creek Road	Residential

NoR W4 Spedding Road

Address	Building Type
135 Fred Taylor Drive	Residential
15-19 Spedding Road	Residential
98 Hobsonville Road	Residential
5-7 Workspace Drive	Commercial
8 Workspace Drive	Commercial

NoR W5 Hobsonville Road

Address	Building Type	Address	Building Type
321 Hobsonville Road	Residential	1 Hendrika Court	Residential
42 Hobsonville Road	Residential	283 Hobsonville Road	Residential
255 Hobsonville Road	Residential	49 Hobsonville Road	Residential
1/259 Hobsonville Road	Residential	4 Clark Road Hobsonville	Residential
305 Hobsonville Road	Residential	24-25/18 Williams Road	Residential
309 Hobsonville Road	Residential	317 Hobsonville Road	Residential
2 Hendrika Court	Residential	201 Hobsonville Road	Residential
295 Hobsonville Road	Residential	60 Hobsonville Road	Residential
19 Williams Road	Residential	33 Hobsonville Road	Residential
45 Suncrest Drive	Residential	253 Hobsonville Road	Residential
303 Hobsonville Road	Residential	247 Hobsonville Road	Residential
1-2/275 Hobsonville Road	Residential	20 Hobsonville Road	Residential
33/18 Williams Road	Residential	241 Hobsonville Road	Residential
54 Hobsonville Road	Residential	82 Hobsonville Road	Residential
251 Hobsonville Road	Residential	39 Hobsonville Road	Residential
77 Hobsonville Road	Residential	319 Hobsonville	Residential
1/383 Hobsonville Road	Residential	229a Hobsonville Road	Residential
2 Clark Road	Residential	41 Hobsonville Road	Residential
307 Hobsonville	Residential	147a Hobsonville	Residential
287 Hobsonville	Residential	22 Hobsonville Road	Residential
289 Hobsonville	Residential	104 Hobsonville	Commercial
1-2/279 Hobsonville	Residential	405 Hobsonville	Commercial
1-2/281 Hobsonville	Residential	114 Hobsonville	Commercial
311 Hobsonville Road	Residential	122 Hobsonville Road	Commercial
403 Hobsonville Road	Residential	397 Hobsonville Road	Commercial

Address	Building Type	Address	Building Type
291 Hobsonville Road	Residential		
56 Hobsonville Road	Residential		
249 Hobsonville Road	Residential		
4 Hendrika Court	Residential		
1 Westpark Drive	Residential		