TE TUPU NGĀTAHI
SUPPORTING GROWTH

Drury Arterial Network Assessment of Construction Noise and Vibration Effects

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1 Glossary of acronyms and defined terms

Table 1: Glossary of technical terms / acronyms

Acronym	Term
AEE	Assessment of Effects on the Environment
AT	Auckland Transport
AUPOIP	Auckland Unitary Plan Operative in Part
DIN	Deutsches Institut Fur Normung E.V. (German Institute for Standardisation)
BPO	Best Practicable Option
CNVMP	Construction Noise and Vibration Management Plan
FTN	Frequent Transit Network
FUZ	Future Urban Zone
NIMT	North Island Main Trunk
NoR	Notice of Requirement (under the Resource Management Act 1991)
NZUP	New Zealand Upgrade Programme
SH1	State Highway 1
SH22	State Highway 22
Waka Kotahi	Waka Kotahi NZ Transport Agency

Table 2: Glossary of defined terms

Term	Meaning
Auckland Council	Means the unitary authority in the Auckland Region.
Drury Package	Five Notices of Requirement for the Drury Arterial Network for Auckland Transport and Waka Kotahi NZ Transport Agency.

2 Executive Summary

Assessment undertaken

This report provides an assessment of construction noise and vibration effects for the Drury Package covering five Projects.

The report contains a review of the relevant construction noise and vibration criteria and discussion of the appropriate criteria and assessment methodology. Predictions for construction noise were carried out using the method recommended in NZS 6803 in accordance with the Auckland Unitary Plan – Operative in Part. The methodology includes modelling inputs in regard to a reasonable worst case scenario. Vibration emission radii have also been calculated to provide a reasonable worst case estimate at receivers.

The predicted effects are based on indicative information as provided by the Project team at the time of assessment. The noisiest items of equipment that are likely to be used for the Project are excavators, plate compactors and piling rigs. Whilst a piling rig is identified as the loudest equipment, it will only be used for bridge construction and not applicable for all designations

The proposed designation boundary has been assumed as the construction boundary, as a worst-case scenario when equipment is used right at the boundary line. This worst-case location is highly unlikely to happen and as road construction is linear, each receiver would only be affected for part of the overall construction duration. Furthermore, the proposed designation boundary does not necessarily represent the actual proximity of when a piece of equipment is operational.

Results in this report should be treated as the highest noise levels from the respective equipment that would occur infrequently, if at all, as equipment and activities move along the alignment and are not operational continuously. The noise levels provide an indicative prediction of the scale of potential effects based on one possible construction methodology.

Conclusions should be confirmed during the detailed design stage and equipment list updated for a Construction Noise and Vibration Management Plan which is recommended as a condition on the proposed designations. Receivers predicted to be affected by construction may not be present in the future due to the development of the surrounding areas. Similarly, new receivers may be present in the vicinity of the Project areas nearer the time of construction. Construction noise and vibration effects will need to be reassessed at the time of construction and managed at the receivers that are present at the time of construction.

An assessment for each NoR has been undertaken and assumes no concurrent construction works between designations. The assessment method is likely to over predict at facades and is deliberately conservative to represent the worst-case noise levels which may occur.

Results of assessment and recommended measures

Noise predictions have been made based on worst-case assumptions, at the nearest existing receivers, without mitigation. Due to the close proximity of the construction areas to the receivers, construction noise levels are likely to exceed the day-time and night time noise criteria during the worst-case scenario and mitigation measures will be required. The extent and duration of night-time construction for critical works required will be confirmed at detailed design.

NoR D1

Predictions indicate the highest mitigated noise level is predicted to be around 75 – 80 dB dB L_{Aeq} during drainage works with mitigation measures such as 1.8m barriers implemented. Operation of construction equipment will be intermittent in nature and overall average noise levels will be lower for most of the construction period. The applicable noise criteria could be exceeded at 25 receivers if noisy equipment operates close to the proposed designation boundary without mitigation.

Five receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

The most impacted receivers are generally located within 10m of the construction boundary and are likely to experience elevated noise and vibration levels. As such, predictions for construction noise and vibration along the project alignment indicate measures are required to manage and mitigate noise and vibration to a reasonable level. It is recommended that specific mitigation measures are identified within a Construction Noise and Vibration Management Plan (CNVMP) for controlling and reducing noise and vibration levels to meet the relevant criteria where practicable. Mitigation measures such as 1.8m barriers along active construction areas near the vicinity of receivers and selecting the use of lower vibration emitting equipment wherever possible should be considered as part of a CNVMP to control and manage construction noise and vibration levels to meet the relevant criteria where practicable.

As construction will occur several years in the future, receivers may have changed by then, with new and additional receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed at the time of construction and managed at the receivers that are present at the time of construction.

NoR D2

Predictions indicate the highest mitigated noise level is predicted to be around 80 -85 dB L_{Aeq} during drainage and pavement construction works with mitigation measures such as 1.8m barriers implemented. However, operation of construction equipment will be intermittent in nature and overall average noise levels will be lower for most of the construction period. The relevant noise criteria could be exceeded at 55 properties if construction occurs close to the proposed designation boundary without mitigation but reduced to 35 properties with mitigation implemented.

23 receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

Two of the 23 receivers predicted to exceed the DIN criteria are scheduled heritage building. These are adjacent to NoR D2 and are historical / sensitive properties. To control and minimise vibration levels at these buildings, the use of smaller or low vibration equipment should be considered as part of the CNVMP.

The most impacted receivers are generally located within 10m of the proposed designation boundary and are likely to experience elevated noise and vibration levels. As such, predictions for construction noise and vibration along the project alignment indicate measures are required to manage and mitigate noise and vibration to a reasonable level. It is recommended that specific mitigation measures are identified within a Construction Noise and Vibration Management Plan (CNVMP) for controlling and reducing noise and vibration levels to meet the relevant criteria where practicable.

As construction will occur several years in the future, receivers may have changed by then, with new and additional receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed at the time of construction and managed at the receivers that are present at the time of construction.

NoR D3

Predictions indicate the highest mitigated noise level is predicted to be around 75 -80 dB L_{Aeq} during drainage and pavement construction works with mitigation measures such as 1.8m barriers implemented. However, operation of construction equipment will be intermittent in nature and overall average noise levels will be lower for most of the construction period. The applicable noise criteria could be exceeded at 16 receivers if noisy equipment operates close to the proposed designation boundary without mitigation but reduced to 7 properties with mitigation implemented.

Five receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

The most impacted receivers are generally located within 10m of the proposed designation boundary and are likely to experience elevated noise and vibration levels. As such, predictions for construction noise and vibration along the Project alignment indicate measures are required to manage and mitigate noise and vibration to a reasonable level. It is recommended that specific mitigation measures are identified within a Construction Noise and Vibration Management Plan (CNVMP) for controlling and reducing noise and vibration levels to meet the relevant criteria where practicable.

As construction will occur several years in the future, receivers may have changed by then, with new and additional receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed at the time of construction and managed at the receivers that are present at the time of construction.

NoR D4

Predictions indicate the highest mitigated noise level is predicted to be around 70 - 75 dB L_{Aeq} during drainage and pavement construction works with mitigation measures such as 1.8m barriers implemented. However, operation of construction equipment will be intermittent in nature and overall average noise levels will be lower for most of the construction period. The applicable noise criteria could be exceeded at 11 receivers if noisy equipment operates close to the proposed boundary without mitigation but reduced to 8 properties with mitigation implemented.

Seven receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

The most impacted receivers are generally located within 10m of the proposed designation boundary and are likely to experience elevated noise and vibration levels. As such, predictions for construction noise and vibration along the Project alignment indicate measures are required to manage and mitigate noise and vibration to a reasonable level. It is recommended that specific mitigation measures are identified within a Construction Noise and Vibration Management Plan (CNVMP) for controlling and reducing noise and vibration levels to meet the relevant criteria where practicable.

As construction will occur several years in the future, receivers may have changed by then, with new and additional receivers in the vicinity due to increased development. Construction noise and vibration

effects will need to be reassessed at the time of construction and managed at the receivers that are present at the time of construction.

NoR D5

Predictions indicate the highest mitigated noise level is predicted to be around 75 - 80 dB L_{Aeq} during drainage and pavement construction works with mitigation measures such as 1.8m barriers implemented. However, operation of construction equipment will be intermittent in nature and overall average noise levels will be lower for most of the construction period. The applicable noise criteria could be exceeded at 72 receivers if noisy equipment operates close to the proposed designation boundary without mitigation but reduced to 57 properties with mitigation implemented.

45 buildings are predicted to receive vibration levels that would exceed the relevant DIN vibration criteria without mitigation.

The most impacted receivers are generally located within 10m of the proposed designation boundary and are likely to experience elevated noise and vibration levels. As such, predictions for construction noise and vibration along the Project alignment indicate measures are required to manage and mitigate noise and vibration to a reasonable level. It is recommended that specific mitigation measures are identified within a Construction Noise and Vibration Management Plan (CNVMP) for controlling and reducing noise and vibration levels to meet the relevant criteria where practicable.

As construction will occur several years in the future, receivers may have changed by then, with new and additional receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed at the time of construction and managed at the receivers that are present at the time of construction.

Conclusion

It is recommended a CNVMP is prepared before construction commences as its implementation will be the most effective way to develop measures to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options and management and monitoring strategies. Section 5.6 of this report provides details on what should be included in the CNVMP. This includes but not limited to identifying receivers where noise and vibration standards apply, management and mitigation options, procedures for monitoring, direct consultation and site-specific management schedules where required.

Low noise and low vibration machinery should be used where practicable. Noise barriers and enclosures will likely also be required in some locations. High noise and vibration generating activities should be scheduled for times when nearby buildings are not occupied or during the daytime. Depending on the final construction methodology and receivers in the vicinity, mitigation and management measures may also include the offer of temporary relocation. The appropriate mitigation measures will be determined on a case-by-case basis throughout construction using the CNVMP and/or site specific schedules as the implementation tool.

Overall, we consider that with the implementation of appropriate mitigation and management, the construction of the Projects would generate reasonable levels of noise and vibration.

3 Introduction

This report has been prepared for the Drury Arterial Network Notices of Requirement (NoRs) for Auckland Transport (AT) and Waka Kotahi NZ Transport Agency (Waka Kotahi) (the "Drury Package"). The NoRs are to designate land for future strategic transport corridors as part of the Supporting Growth Programme to enable the future construction, operation and maintenance of transport infrastructure in the Drury-Ōpāheke area of Auckland.

The Auckland Council Drury-Ōpāheke structure plan area is expected to grow over the next 30 years and is estimated to provide about 22,000 houses and about 12,000 jobs with a population of about 60,000. The Drury 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 Drury. This report assesses the traffic noise and vibration effects of the proposed Projects, that together comprise the Drury Package, as shown in Figure 3-1.

Table 3-1 Drury Package: Notices of Requirement and Projects

Notice	Project
NoR D1	Alteration to NZ Transport Agency designation 6707 - State Highway 22 (SH22) Upgrade
NoR D2	Jesmond to Waihoehoe West FTN Upgrade
NoR D3	Waihoehoe Road East Upgrade
NoR D4	Ōpāheke North-South FTN Arterial
NoR D5	Ponga Road and Ōpāheke Road Upgrade

The Drury Package has been developed through an alternatives assessment. Corridor alternatives and route refinements were assessed by a multi-disciplinary team against a programme wide Multi-Criteria Assessment. This assessment phase was completed in February 2020, and further design changes have been adopted through the Assessment of Environmental Effects (AEE) process for the Drury Package, in response to a range of construction and environmental considerations.

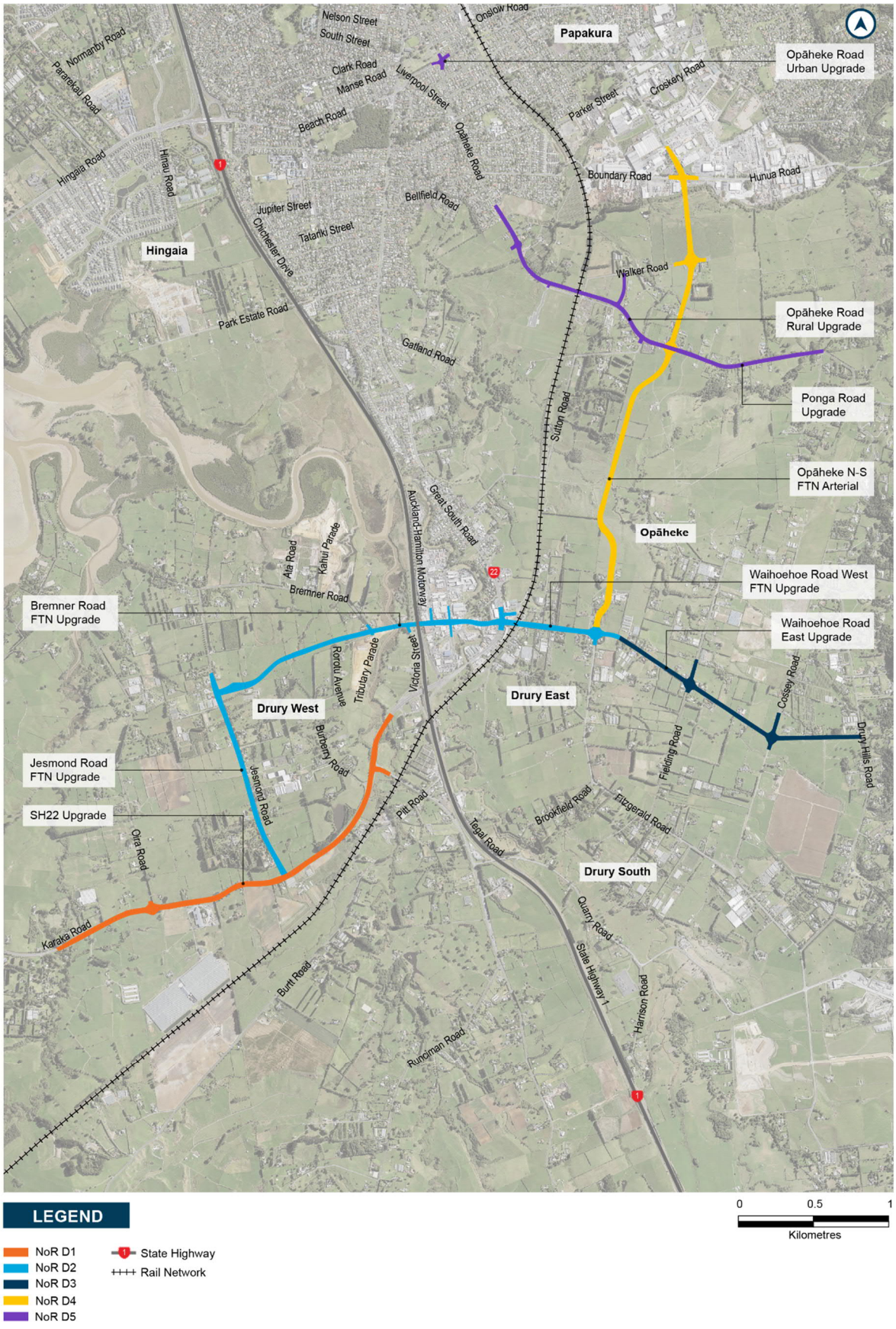


Figure 3-1 Drury Package Projects and Notices of Requirement

3.1 Background

Auckland is New Zealand's largest city, home to approximately 1.65 million people. In 2017, Auckland attracted 36,800 new residents; more than the rest of the country combined. The Auckland Plan 2050 – Development Strategy signals that Auckland could grow by 720,000 people to reach 2.4 million over the next 30 years. This will generate demand for more than 400,000 additional homes and require land for 270,000 more jobs.[1] Most of this growth will go into existing urban areas. However, around a third will go into future urban zone (FUZ) as identified in the Auckland Unitary Plan: Operative in Part (AUPOIP). The FUZ areas are "greenfields", that is, generally rural land identified to be urbanised over time.

The Supporting Growth Programme is a collaboration between AT and Waka Kotahi to plan transport investment in Auckland's future urban zoned areas over the next 10 to 30 years. AT and Waka Kotahi have partnered with Auckland Council, Manawhenua and KiwiRail Holdings Limited (KiwiRail) and are working closely with stakeholders and the community to develop the strategic transport network to support Auckland's growth areas.

The key objective of the Supporting Growth Programme is to protect land for future implementation of the required strategic transport corridors/infrastructure. As a form of route protection, designations will identify and appropriately protect the land necessary to enable the future construction, operation and maintenance of these required transport corridors/infrastructure. A designation is important as it provides certainty for the Requiring Authority that it can implement the work. It also provides property owners, businesses and the community with increased certainty regarding future infrastructure, so they can make informed decisions (if confirmed the designations will be identified in the AUPOIP). It can also significantly reduce long-term costs for local and central government and enable more effective land use and transport outcomes.

3.2 Drury Package

The Drury Package proposes an arterial network to support the expected future growth in Drury-Ōpāheke. The Drury Package comprises five separate Projects which together form the Drury Arterial Network. The network includes provision for general traffic, walking and cycling, and frequent public transport. Overall, the Drury Package aims to improve connectivity within and through the Drury-Ōpāheke area, providing high quality, safe and attractive transport environments.

Each Project within the Drury Package will be designated separately as follows:

- **NoR D1:** Alteration to Waka Kotahi NZ Transport Agency designation 6707 - State Highway 22 (SH22) Upgrade
- **NoR D2:** Jesmond to Waihoehoe West FTN Upgrade
- **NoR D3:** Waihoehoe Road East Upgrade
- **NoR D4:** Ōpāheke North-South FTN Arterial (Ōpāheke N-S FTN Arterial)
- **NoR D5:** Ponga Road and Ōpāheke Road Upgrade

[1] Draft Auckland Plan 2050 Development Strategy: https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/auckland-plan/development-strategy/future-auckland/Pages/what-auckland-look-like-future.aspx

3.3 Purpose and Scope of this Report

This report provides an assessment of construction noise and vibration effects associated with the construction of the Drury Package. This assessment has been prepared to inform the AEE for the NoRs.

The key matters addressed in this report are as follows:

- Description of the Projects as they relate to noise and vibration;
- Overview of the methodology used to undertake the assessment and identification of the assessment criteria and any relevant standards or guidelines;
- Identification and description of the existing and likely future noise environment;
- Description of the actual and potential positive effects of each Project;
- Description of the actual and potential adverse noise and vibration effects of construction of each Project;
- Recommended measures to avoid, remedy or mitigate potential adverse construction noise and vibration effects (including any conditions/management plan required); and
- Overall conclusion of the level of potential adverse construction noise and vibration effects of each of the Projects after recommended measures are implemented.

3.4 Report Structure

This report is structured to reflect the key matters listed above in Section 0.

In order to provide a clear assessment of each Project, descriptions and assessments have been separated to reflect each of the notices sought.

3.5 Preparation for this Report

Two site visits were carried out for an overview of the Projects. One undertaken with the Project Team on 3rd March 2020 and another with the relevant Council Specialists the following week to discuss and identify any potential issues.

A site visit was carried out on 17th July 2020 to Ōpāheke North South and Jesmond Road to survey private properties in greenfield areas and to identify usage of buildings.

The construction methodology for each NoR was reviewed and reference to AUPOIP, NZS 6806 and Waka Kotahi guidance was made (these documents are discussed further below).

4 Assessment Criteria

4.1 Construction Noise

Potential construction noise effects have been assessed in accordance with the applicable AUP noise rules. Rule E25.6.1(3) of the AUPOIP 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 construction 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) (as replicated in below), with some relaxation of the compliance requirement for certain times and durations. The construction noise standards provided by Rules E25.6.27(1) and E25.6.27(2) of the AUPOIP have been adopted for the purpose of this assessment.

The applicable construction noise criteria are detailed in Table 4-1 for sensitive receivers and in Table 4-2 for all other receivers.

In accordance with Section 25.6.27(4) of the AUPOIP, 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 AUPOIP. The long duration limits are detailed in Table 4-1 and Table 4-2 below.

Table 4-1 Construction noise criteria for sensitive receivers (outside of Business – City Centre Zone and the Business – Metropolitan Centre Zone)

		Maximum noise level dB >20 weeks	
Time of week	**Time period**	L_{Aeq} dB	L_{Amax} dB
Weekdays	06:30 – 07:30	55	70
	07:30 – 18:00	70	85
	18:00 – 20:00	65	80
	20:00 – 06:30	45	75
Saturdays	06:30 – 07:30	45	75
	07:30 – 18:00	70	85
	18:00 – 20:00	45	75
	20:00 – 06:30	45	75
Sunday and public holidays	06:30 – 07:30	45	75
	07:30 – 18:00	55	85
	18:00 – 20:00	45	75
	20:00 – 06:30	45	75

Table 4-2 Construction noise criteria for all other receivers (outside of Business – City Centre Zone and the Business – Metropolitan Centre Zone)

Time period	Maximum noise level L_{Aeq} dB >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 (as replicated above) do not apply for planned works in the road between the hours of 10pm and 7am where:

a) 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

b) the works cannot practicably be carried out during the day or because the road controlling authority requires this work to be done at night time; or

c) 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 4-1) do not apply for planned works in the road between the hours of 7am and 10pm where:

a) 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

b) 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 or approval from Waka Kotahi 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).

4.2 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.

Waka Kotahi and Auckland Transport have adopted different approaches for their Projects. Whilst Auckland Transport adopts the Auckland Unitary Plan for amenity levels, Waka Kotahi vibration criteria are adopted for a nation wide approach. Both have adopted DIN criteria for cosmetic building damage. These different criteria adopted for the Projects have been summarised in Section 4.2.4 and 4.2.5.

Potential exceedances of the amenity criteria will be considered when assessing the construction vibration effect on nearby receivers. However, it is recommended that the limits relating to human comfort detailed in Table 4-3 should be used as trigger for communication and consultation, and should be included in as part of the construction management plan(s) that will be prepared as part of the Projects. Therefore, construction vibration has only been assessed against the limits of Table 4-4 which relate to the avoidance of potential building damage.

4.2.1 Auckland Unitary Plan (Operative in Part)

The AUP OIP 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 Industrial 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 4-3 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 4-3 AUP-OIP 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

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

Deutsches Institut für Normung e.V. (German Institute for Standardisation) publishes standards including DIN 4150 that contain guideline 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 set out in Table 4-4.

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

Type of structure	Short term vibration			Long Term Vibration**	
	PPV at foundation, frequency of:			Vibration at horizontal plane of highest floor at all frequencies (mm/s)	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;
- a reduction in the bearing capacity of floors.

For dwelling type buildings (Table 4-4 – line 2) and structures sensitive to vibration (Table 4-4 – line 3), the serviceability is considered to have been reduced if:

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

These effects are deemed 'minor damage'.

Two historic buildings fall within 100m of the alignment for NoR D2 which are considered to be sensitive to vibrations.

4.2.3 British Standard 5228-2

British Standard (BS) 5228-2[2] 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 have been replicated in Table 4-5 below.

Table 4-5 Human perception of vibration levels

Vibration Level	Effect
0.14 mm.s^{-1}	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^{-1}	Vibration might be just perceptible in residential environments.
1.0 mm.s^{-1}	It is likely that vibration of this level in residential environments will cause complaints but can be tolerated if prior warning and explanation has been given to residents.
10 mm.s^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

4.2.4 Waka Kotahi State Highway construction and maintenance noise and vibration Guide

The Waka Kotahi *State highway construction and maintenance noise and vibration guide* provides criteria, as replicated in Table 4-6 below, based on the standards BS 5228-2 and DIN 4150-3. Due to a wide range of perception/annoyance sensitivities of people the two category criteria can be used to actively manage the effects of construction vibration.

The guide states construction should be managed to comply with the Category A criteria. If the construction vibration exceeds the Category B criteria then construction activity shall only proceed if there is appropriate monitoring of vibration levels and effects on those buildings at risk of exceeding the Category B criteria, by suitably qualified experts. This two category criteria is to facilitate a progressive management response to the increasing risks and effects during construction.

This criteria is applicable for NoR D1 only.

Table 4-6 Waka Kotahi construction vibration criteria

Receiver	Location	Details	Category A	Category B
Occupied PPFs	Inside the building	Night-time 2000h - 0630h	0.3 mm/s ppv	1 mm/s ppv

[2] British Standard 5228-2:2009 'Noise and vibration control on construction and open sites – Part 2: Vibration'

Receiver	Location	Details	Category A	Category B
		Daytime 0630h - 2000h	1 mm/s ppv	5 mm/s ppv
Other occupied buildings	Inside the building	Daytime 0630h - 2000h	2 mm/s ppv	5 mm/s ppv
All other buildings	Building foundation	Vibration - transient (including blasting)	5 mm/s ppv	BS5228-2 Table B.2
		Vibration - continuous		BS5228-2 50% of Table B.2 values

4.2.5 Auckland Transport construction vibration criteria

The following criteria are the recommended Project construction vibration criteria for both building damage and amenity applicable to NoR D2 to NoR D5

The two category criteria, similar to Table 4-6, 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 OIP, 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 4-7 Auckland Transport Construction vibration criteria

Receiver	Details	Category A	Category B
Occupied Activities sensitive to noise	Night-time 2000h - 0630h	0.3mm/s ppv	2mm/s ppv
	Daytime 0630h - 2000h	2mm/s ppv	5mm/s ppv
Other occupied buildings	Daytime 0630h - 2000h	2mm/s ppv	5mm/s ppv
All other buildings	At all other times	Tables 1 and 3 of DIN4150-3:1999	

Where compliance with the vibration standards set out in Table 4-7 is not practicable, and unless otherwise provided for in the CNVMP, a schedule will be required.

5 Assessment Methodology

Chapter Summary

Predictions of construction noise have been undertaken for the Projects in accordance with NZS 6803, and vibration emission radii determined (based on assumptions of construction type, activities and equipment as provided by the Project team). There are slight variations in activities and equipment used across the designations, but a reasonable worst-case approach has been assumed. For this assessment, a staging of construction within the Drury Package is uncertain and will be decided in the future. Each NoR construction methodology has been assessed separately and assumes 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 reassessed closer to the time of construction.

Minimum set back distances from receivers have been calculated for the loudest equipment and indicative activities to comply with a day-time noise criterion of 70 dB L_{Aeq} without mitigation. Similarly, for vibration, emission radii have been calculated for equipment causing the highest vibration levels.

Construction will occur several years in the future. Therefore, receivers may have changed by then, with new receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed at the time of construction.

A consistent approach has been adopted for the whole Drury Package as set out in this section. Each NoR construction methodology has been assessed separately and assumes 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 reassessed closer to the time of construction. Any buildings within the proposed designation footprint will be removed, as confirmed by the Project Team, and are not assessed.

Predictions of construction noise have been undertaken for the Projects in accordance with NZS 6803, and vibration emission radii determined (based on assumptions of construction type, activities and equipment as provided by the Project team) as set out in each of the NoR sections. There are slight variations in activities and equipment used across the designations, but a worst-case approach has been applied.

The proposed designation boundary has been assumed as the construction boundary as a worst case scenario when equipment is used right at the boundary line, which is highly unlikely to happen and not for any significant periods of time. Furthermore, the proposed designation boundary does not necessarily represent the actual proximity of when a piece of equipment is operational. Location of depots are also included within the designation boundary.

Predicted results were then assessed for potential construction noise and vibration exceedances against the relevant criteria for all currently existing receivers along the Project alignments. 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 criteria, it is vital that Best Practicable Option (BPO) appropriate mitigation and management measures are 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 5.6, which will be developed prior to commencement of construction, and updated as necessary throughout the duration of construction.

This approach is consistent with the Waka Kotahi "State Highway construction noise and vibration guide" and has been implemented successfully on previous major roading projects. This approach is also considered appropriate for Auckland Transport projects.

5.1 Construction Noise

Construction phases for each NoR are expected to occur for a minimum of 12 months. Predictions have been assessed against the noise criteria for greater than 20 weeks "long-duration" under NZS6803:1999 as presented in Table 4-1. It is expected the majority of noisy works will be carried out between 7am – 6pm on weekdays with probable night time and weekend works for critical pavement and surfacing stages as required.

Various construction activities and pieces of equipment will act as noise sources on site during construction works. A list of the most dominant noise sources based on the equipment list provided by the Project team has been compiled in Table 5-1 and an indicative sound power level for each construction type/activity has been provided in Table 5-2. These tables are based on the current indicative construction methodology and may not be inclusive of all equipment used nearer the time of construction such as for service relocations. Equipment tables will need to 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 also been calculated.

Whilst piling is identified as the loudest piece of equipment, it will only be used for bridge construction. As bridge construction will not impact the majority of receivers and not required for all designations, the next loudest source of plate compactor has been used in the assessment.

A computer noise model based on the loader operating continuously at the closest distance to receivers has been produced, for all work zones.

This method is likely to over predict at facades and is deliberately conservative to represent the worst-case noise levels which may occur.

5.2 Equipment Noise Levels

Table 5-1 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} daytime 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 in Table 5-1. Equipment list should be reassessed nearer the time at production of the CNVMP.

Table 5-1 Construction Equipment Sound levels and indicative compliance distance

Equipment	Source BS5228	Sound power level (dB L_{Aeq})	Minimum set back distance from receivers to comply with day-time limit (70 dB L_{Aeq}) without mitigation, meters (based on propagation over soft ground)
30T excavator	C.2.19	105	30
20T excavator	C.2.21	99	13
Roller Compactor	C.2.40	101	20
Tipper Truck	C.2.30	107	36
Loader	C.2.27	105	30
Vibratory Plate Compactor	C.5.29	110	45
Smooth Drum Roller	C.5.20	103	25
Paver	C.5.30	103	25
Bore Piling	C.3.2	115	73

Table 5-2 details the sound power levels from key construction activities/types. The equipment sound power levels in Table 5-1 have been combined according to the various construction types as presented in each NoR to provide an indicative activity sound power level. From this combined level a minimum set back distance at which compliance can be achieved has been determined.

Table 5-2 Activity Sound Power Levels and indicative compliance distance

Construction Type	Activity Sound power level (dB L_{Aeq})	Minimum set back distance from receivers to comply with day-time limit (70 dB L_{Aeq}) without mitigation, meters
Typical across all works	110	45
Bulk Earthworks	116	76
Drainage	117	95
Pavement construction	117	95
Bridge Construction	119	110

5.3 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 to provide offset distances. The offset distance that complies with the applicable criteria is considered to be the safe working distance. At this offset distance we consider it likely that compliance with the building damage vibration criteria would be achieved.

The prediction of construction vibration levels at this stage of the Projects are less reliable than the prediction of construction noise levels, due to the large number of variables that relate mostly to the exact ground conditions and energy delivered in the ground. 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 radius distances 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.

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 ground conditions at the different worksites are not known at this stage, so when calculating emission radii, we have assumed hard ground as this represents a worst case scenario.

Emission radii have been calculated and contours for the worst vibratory equipment as identified in Table 5-3 has been presented in Appendix 1. The emission radii have also been used to identify which receivers are located within these distances and therefore where an exceedance may occur for each NOR.

5.4 Equipment Vibration Levels

Generic vibration data for typical construction equipment used for the Projects has been sourced from BS 5228-2 and AECOM's database of measurements. Table 5-3 identifies the equipment anticipated to be used for the Projects which may generate higher levels of vibration and the indicative emission radii before the limits in accordance with DIN 4150 are exceeded.

Table 5-3 Vibration Sources and indicative emission radii

Equipment	Waka Kotahi	Auckland Transport		DIN 4150 emission radii	
	Daytime Occupied buildings Cat A 1 mm/s	Daytime Occupied buildings Cat A 2 mm/s	Historic and Sensitve (2.5 mm/s)	Residential (5 mm/s)	Commercial (10 mm/s)
Roller Compactor	42 m	21 m	17 m	8 m	4 m
Bore Piling	5 m	4 m	2 m	1 m	1 m
Excavator	24 m	12 m	10 m	6 m	2 m
Tipper Truck	5 m	2 m	2 m	1 m	0 m
Vibratory Plate compacter	6 m	3 m	2 m	1 m	1 m

The intensity of vibration received at a point at or within a structure will depend on:

- The type of vibration source
- Energy per blow or cycle
- Distance between source and receiver
- Ground conditions between the source and receiver
- Nature of the interface between the structure and ground
- Construction of the structure

5.5 Overview of Construction Effects

Construction effects due to noise and vibration are applicable to all Projects and are summarised in this section.

5.5.1 Construction noise

Table 5-4 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, facades may provide up to a 25 – 30 dB reduction, therefore assumptions and effects provided below are based on a conservative approach.

Table 5-4 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 such as Bunnings) 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 hearing 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 exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70 dB L_{Aeq}	Untenable for both office and residential 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 so that the effects on the nearest residential receivers are reduced. Similarly, scheduling construction for night-time in business areas would reduce effects on those businesses. Barriers will not be effective at all locations, particularly where receivers are 2 storeys or more. Where barriers are not going to be effective, the use of enclosures or local screening of equipment should be considered, especially for concrete cutting, 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 temporarily relocation to affected residents. Temporary relocation should be considered on a case-by-case basis and as a last resort.

5.5.2 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.

It is difficult to predict construction vibration effects of the Projects at this early stage as there are a number of variables that are not yet known or that are likely to change. For example, the ground conditions are unknown, and this will be major factor in vibration transmission. Different construction methods may be used, and vibration source energies will vary depending on the precise equipment selected.

Vibration monitoring should be carried out at specific locations as identified in the CNVMP and Schedules when works begin on site to determine actual equipment vibration levels and the attenuation provided by the local ground conditions. The emission radii should then be updated accordingly.

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/DIN criteria have been combined below and adopted for this assessment.

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

Vibration Level	Potential effects indoors
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 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 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 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.

Vibration Level	Potential effects indoors
	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 OIP 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 vibratory roller compactor, any receiver within 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 night-time, which may cause sleep disturbance. As such, high vibratory activities should be avoided at night-time works and careful management of type of equipment used at night should be included within the CNVMP (refer Section 5.6).

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 controlled through a CNVMP to limit potential vibration effects, and alternative equipment with lower vibratory effect should be used where practicable.

5.6 Management and Mitigation

5.6.1 Construction Noise and Vibration Management Plan (CNVMP)

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 are to be subject to 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.
- Procedures and timing of reviews of the CNVMP.

For NoR D1, further reference to the CNVMP requirements as set out in the Waka Kotahi "State highway construction noise and vibration guide" should be made.

5.6.2 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
- Any pre-condition survey of buildings predicted to receive vibration levels exceeding the amenity criteria, and approaching the DIN vibration limits, which document their current condition and any existing damage

5.6.3 Noise mitigation measures

Section 5.3 of the Waka Kotahi "State highway construction noise and vibration guide" sets out a hierarchy of mitigation measures, which are applicable to NoR D1 and is recommended for other designations, 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.
- 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.

A detailed list of available mitigation measures is provided in Section 5.3 of the NZTA guide and is not reproduced here. Mitigation measures for each activity should be listed in the CNVMP and Schedules. These measures could include future equipment and methodologies that are not yet available or widely utilised. A robust review of the CNVMP by Council through the Outline Plan process will ensure measures represent the BPO 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, careful equipment selection and use of noise barriers or localised screening (e.g. for concrete cutting) would be suitable management and mitigation measures and should be implemented where they are practicable or effective.

5.6.4 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.
- 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).

5.6.5 Building Condition Survey

A detailed building precondition survey should be undertaken by a suitably qualified engineer at all buildings where the Project building damage criteria may be exceeded prior to the start of construction. 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;
- 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.

5.6.6 Night Works

Night works have the potential to cause the greatest disturbance to residents and should be avoided where possible. However, it is likely that night works will be required at each zone of work during pavement construction stages. 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 D1: Alteration to Designation 6707 - State Highway 22 Upgrade

Chapter Summary

Noise predictions have been made based on worst-case assumptions, at the nearest existing receivers, without mitigation. Due to the close proximity of the construction areas to the receivers, construction noise levels are likely to exceed the day-time and night time noise criteria during the worst-case scenario. The extent and duration of night-time construction required will be confirmed at detailed design.

Construction will occur several years in the future. Therefore, receivers may have changed by then, with new receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed for existing receivers at the time of construction and appropriate mitigation measures developed further at that time.

The noisiest items of equipment that are likely to be used for the Project are plate compactors and piling rigs. With the exception of the piling rig which is used for bridge construction only in specific locations, the equipment is likely to be used in a number of areas throughout the construction period. A construction noise and vibration management plan will be required to mitigate and manage the potential noise and vibration levels. Indicative vibration emission radii distances have been predicted for the most vibratory equipment. Actual vibration levels are highly dependent on local conditions and the selection of machinery which will be decided at detailed design. Site specific/activity specific management schedules for receivers significantly impacted by noise and/or vibration will be required.

The highest unmitigated noise level is predicted to be around 85 - 90 dB L_{Aeq} during drainage works based on the noisiest item of plant (plate compactor) operating in the closest position to the receiver. The applicable noise criteria could be exceeded at 25 receivers if noisy equipment operates in this closest position to the receivers at the proposed designation boundary, which is highly unlikely. Operation of construction equipment will be intermittent in nature and for a limited duration of typically 3 days where works are located in the worst case location. Plate compactors are proposed only to be used for the drainage or pavement construction stages. Other equipment with lower sound power levels will generate lower noise levels under the worst case location and overall average noise levels will be lower for most of the construction period.

Five receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

It is recommended that a CNVMP is prepared prior to construction commencing to identify the appropriate mitigation measures for controlling noise and vibration levels to manage and meet the applicable criteria or reduce to a reasonable level. Mitigation measures such as 1.8m barriers along active construction areas and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable. With appropriate mitigation measure applied worst case noise levels at receivers could be reduced to 75 - 80 dB L_{Aeq} with number of receivers exceeding the applicable noise criteria reduced to 22.

6.1 Project Description

6.1.1 Project Overview

The State Highway 22 (SH22) Upgrade (NoR D1) consists of the widening of SH22 to a four-lane arterial with separated walking and cycling facilities. The Project extends approximately 3.08km from the State Highway 1 (SH1) Drury Interchange in the east, and the extent of the FUZ between Woodlyn Drive and Oira Road in the west. The intersections at Jesmond Road and Great South Road will be signalised

and a roundabout is proposed at Oira Road. An overview of the concept design is provided in Figure 6-1.

As the surrounding area is urbanised over time and alternative routes are implemented (particularly the proposed Pukekohe Expressway), the function of SH22 will change from a rural state highway to provide an appropriate urban arterial connecting the growth areas of Drury West to the wider network and centres, including providing a frequent transport bus network. This is likely to include a reduction in the speed limit to 50kph. SH22 will improve future connectivity to the proposed Drury West train station which currently forms part of the New Zealand Upgrade Programme (NZUP) project.

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

- Widening of SH22 from its current general width of 20m to enable a 30m wide four-lane road with separated walking and cycling facilities
- Localised widening around the existing intersections to accommodate for vehicle stacking and tie-ins and walking and cycling facilities/crossings
- Demolition and reconstruction of the existing Ngakoroa Stream Bridge
- Proposed new and extended culverts
- Three proposed stormwater wetlands
- Batter slopes and retaining to enable widening of the corridor, and associated cut and fill activities.

Figure 6-1 Overview of SH 22 Arterial Upgrade

6.1.2 Indicative Construction Methodology

An indicative construction methodology has been prepared to inform the assessment of the Project and is subject to change. The construction methodology for the proposal will be confirmed during the detailed design phase and finalised once a contractor has been engaged for the work.

A summary of the key components of the indicative construction methodology is outlined in Section 6.1.2.1 below. Refer to the AEE for further detail.

6.1.2.1 General Construction Overview

The construction phase of the Project is expected to be approximately 24 to 30 months in total.

It is anticipated that the works will be broken down into five separate construction zones based on the type of works required and the nature of the work environment. These anticipated zones are:

- **Zone 1**: Mercer St to Great South Road intersection
- **Zone 2**: Great South Road Intersection
- **Zone 3**: Great South Road Intersection to Jesmond Road Intersection
- **Zone 4**: Jesmond Road Intersection
- **Zone 5**: Jesmond Road Intersection to Oira Road Junction

6.1.2.2 Construction Methodology

All zones have the same construction activities, except zone 1, which includes extra bridge works. In all cases the general sequence of construction is likely to be:

1. Preconstruction works
2. Commence works on the one side of the carriageway
3. Construct earthworks
4. Bridge construction, construct abutments, piling, pilecap and abutment beam construction, install bridge beams and decking
5. Finishing works including barriers, settlement slabs, footpath and cycle path, handrails and screen
6. Construct new drainage
7. Construct new pavement to half of the road
8. Construct new footpath and cycleways
9. Move traffic onto the newly constructed road
10. Commence works on the other side of the carriageway
11. Construct earthworks
12. Construct new drainage
13. Construct new pavement to half of the road
14. Construct new footpath and cycleways
15. Finishing works for road and bridge

6.1.2.3 Plant and Equipment

Table 6-1 provides an indicative list of plant and equipment which may be required for the construction across the five zones.

Table 6-1 NoR D1 plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 20-30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Paver
Bridge-Construction	• Concrete truck • Excavator • Tip trucks • Cranes • Delivery trucks • Piling

6.2 Assessment of Construction Noise and Vibration

The following buildings have not been assessed as they are located within the proposed designation area and are proposed to be removed to provide for the Project:

- 102 Karaka Road
- 458 Karaka Road

6.2.1 Construction Noise

6.2.1.1 Potential Construction Noise Levels

Model predictions assuming the works along the designation boundary indicate there are 25 properties where the relevant noise criteria would be exceeded without mitigation.

Distances of receivers from the designation area boundary vary greatly along the road alignment with the closest receiver approximately 5m from drainage works.

Model predictions indicate the closest receivers could experience noise levels of up to 85 dB L_{Aeq} during drainage works, based on the noisiest item of plant (plate compactor) operating in the closest position to the receiver along the designation boundary, without mitigation. However, operation of construction equipment will be intermittent in nature and works in the worst case location typically last around 3 days. Whilst plate compactors have been identified as the noisiest equipment, they are only used as part of drainage works. Similarly, piling is carried out during bridge construction only and for limited durations. Other equipment with lower sound powers will generate lower noise levels and overall average noise levels will be lower for most of the construction period.

These results should be treated as the highest possible noise levels likely to be emitted from the respective equipment. These noise levels would occur infrequently, if at all, as equipment and activities move along the alignment and are not continuously operational. The noise levels provide an indicative prediction of the scale of potential effects based on one possible construction methodology.

6.2.1.2 Construction Noise Effects

The construction noise criteria are predicted to be exceeded at a number of receivers due to the close proximity to the potential areas of work. Closest receivers are 5m from the proposed designation boundary for drainage works with predicted unmitigated noise levels of around 85-90 dB L_{Aeq}.

The use of noisy items of equipment will likely be intermittent in nature during the relevant construction activities. Although the worst-case situations are not expected to be frequent, due to the setback distances to the majority of the proposed works, these noise levels could result in loss of concentration, annoyance, and a reduction in speech intelligibility. Table 5-4 gives examples of the potential effects on receivers at different noise levels.

Night time works at these noise levels are generally not acceptable at residential properties and the use of noisy equipment should be avoided to prevent sleep disturbance. If night-time works is required consultation and mitigation measures will be essential which may include an offer of temporary relocation for the most affected receivers to manage and mitigate adverse effects.

With effective mitigation and management measures in place, such as 1.8m barriers along active construction areas within the vicinity of receivers and, enclosures around noisy machinery noise levels can be reduced by up to 10dB at receivers on the ground floor. Resulting worst case noise levels could be reduced to 75 – 80 dB with mitigation implemented and 22 receivers exceeding the applicable noise criteria

In addition, the road construction is linear, and each receiver would only be affected for part of the overall construction duration. A CNVMP as detailed in Section 5.6, with site specific mitigation as required, should be prepared which sets out how to control noise levels and reduce adverse impacts on receivers.

6.2.2 Construction Vibration

6.2.2.1 Potential Construction Vibration Levels

Maps of the vibration contours based on the worst-case emission radii values of vibratory roller compactor are shown in **Appendix 1**. A list of building addresses predicted to exceed the relevant criteria are shown in Appendix 2.

Four dwellings may experience vibration levels above 5mm/s PPV exceeding the building cosmetic damage criteria for residential properties and one commercial building may experience vibration levels above 10mm/s PPV exceeding the DIN criteria for commercial properties. Predictions indicate a total of nine buildings may receive vibration levels above the amenity criterion of 1 mm/s PPV.

It should be noted that the vibration generating equipment will not be operating all of the time and may not operate right at the boundaries of the area of works.

It is not expected high level vibratory works such as the use of roller compactors or piling will be carried out during night-time. Noisy works should be limited to critical works only if required, and consultation and management plans will be essential.

6.2.2.2 Construction Vibration Effects

Initial predictions indicate that the Project building damage criteria may be exceeded at four residential buildings and one commercial building, in particular during the earthworks phase when the vibratory roller compactor is proposed for use. At buildings in close proximity to proposed designation boundary areas, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. A building condition survey should therefore be carried out before (during detailed design) and after construction works at properties where predictions indicate the relevant building damage criteria may be exceeded, to determine if any damage shown to have been caused by construction by the Project Team.

Section 5.5.2 details construction vibration effects on human perception, and section 5.6 on management and mitigation measures.

6.3 Conclusions

An assessment of potential construction noise and vibration effects has been undertaken for the Project. The predicted effects are based on indicative information as provided by the Project team 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.

The assessment indicates 25 properties are predicted to receive noise levels that would exceed the relevant criteria and five buildings are predicted to receive vibration levels that would exceed the DIN criteria. As such, predictions for construction noise and vibration along the project alignment indicate mitigation measures are required to manage effects on buildings in the vicinity of the works. Mitigation measures such as 1.8m barriers along active construction areas within the vicinity of receivers and selecting the use of lower vibration emitting equipment wherever possible can be considered as part

of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable.

A CNVMP should be prepared as it is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options and management and monitoring strategies Section 5.6 of this report provides details on what should be included in the CNVMP.

7 NoR D2: Jesmond to Waihoehoe West FTN Upgrade

Chapter Summary

Noise predictions have been made based on worst-case assumptions, at the nearest existing receivers, without mitigation. Due to the close proximity of the construction areas to the receivers, construction noise levels are likely to exceed the daytime and night-time noise criteria during the worst-case scenario. The extent and duration of night-time construction will be confirmed at detailed design.

Construction will occur several years in the future. Therefore, receivers may have changed by then, with new receivers in the vicinity due to increased development. Construction noise and vibration effects will need to be reassessed for existing receivers at the time of construction and appropriate mitigation measures developed further at that time.

The noisiest items of equipment that are likely to be used for the Project are loaders, plate compactors and piling rigs. With the exception of piling rigs which are used for bridge construction only in specific locations, the equipment is likely to be used in a number of areas throughout the construction period. A construction noise and vibration management plan will be required to mitigate and manage the potential noise and vibration levels. Indicative vibration emission radii distances have been predicted for the most vibratory equipment. Actual vibration levels are highly dependent on local conditions and the selection of machinery which will be decided at detailed design. Site specific/activity specific management schedules for receivers significantly impacted by noise and/or vibration will be required.

The highest unmitigated noise level is predicted to be around 90-95 dB L_{Aeq} during drainage and pavement construction works based on the noisiest item of plant (plate compactors) operating in the closest position to the receiver. The relevant noise criteria could be exceeded at 55 properties if noisy equipment operates in this closest position to the receivers at the proposed designation boundary, which is highly unlikely. Operation of construction equipment will be intermittent in nature and for a limited duration of typically 3 days where works are located in the worst-case location. Plate compactors are proposed only to be used for the drainage or pavement construction stages. Other equipment with lower sound power levels will generate lower noise levels under the worst case location and overall average noise levels will be lower for most of the construction period.

23 receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation. Two of the 23 buildings predicted to exceed the DIN criteria are scheduled heritage buildings. These are adjacent to NoR D2 and are historical / sensitive properties. To control and minimise vibration levels at these buildings, the use of smaller or low vibration equipment should be considered as part of the CNVMP.

It is recommended that a CNVMP is prepared prior to construction commencing to identify the appropriate mitigation measures for controlling noise and vibration levels to manage and meet the applicable criteria or reduce to a reasonable level. Mitigation measures such as 1.8m barriers along active construction areas, used of mufflers and engine covers on plant were appropriate and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable. With appropriate mitigation measure applied worst case noise levels at receivers could be reduced to 80 - 85 dB L_{Aeq} with number of receivers exceeding the applicable noise criteria reduced to 35

7.1 Project Description

The Jesmond to Waihoehoe West FTN Project (NoR D2) includes, an approximately 4.1km long four-lane FTN arterial route along Jesmond Road, through a new greenfields link between Jesmond Road and the existing Bremner Road, Norrie Road and Waihoehoe Road West. It primarily involves upgrading and widening existing transport corridors with the exception of the new link between Jesmond Road and the existing Bremner Road and the new bridge connection over Hingaia Stream.

Generally, a 30m wide transport corridor will be provided with two general traffic lanes, two bus lanes and separated walking and cycling facilities on both sides of the road corridor.

For assessment purposes, the Project has been separated into three sections, as shown in Figure 7-1, including: including:

- Jesmond Road FTN Upgrade;
- Bremner Road FTN Upgrade (including the Jesmond to Bremner link through the Auranga Development, Bremner Road and Norrie Road); and
- Waihoehoe Road West FTN Upgrade including the Great South Road intersection.

The indicative alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment will be refined and confirmed at the detailed design stage. Key features of the proposed upgrade common to each Project section include the following:

- A typically 30m wide road with four lanes and separated walking and cycling facilities
- Localised widening around the existing intersections to accommodate for vehicle stacking and tie-ins and walking and cycling facilities/crossings
- Batter slopes and retaining to enable widening of the corridor and/or wetland construction, and associated cut and fill activities
- Vegetation removal along the existing road corridor
- Areas identified for construction related activities including site compounds, construction laydown, bridge works area, the re-grade of driveways and construction traffic manoeuvring.

Further details of each Project section are provided below.

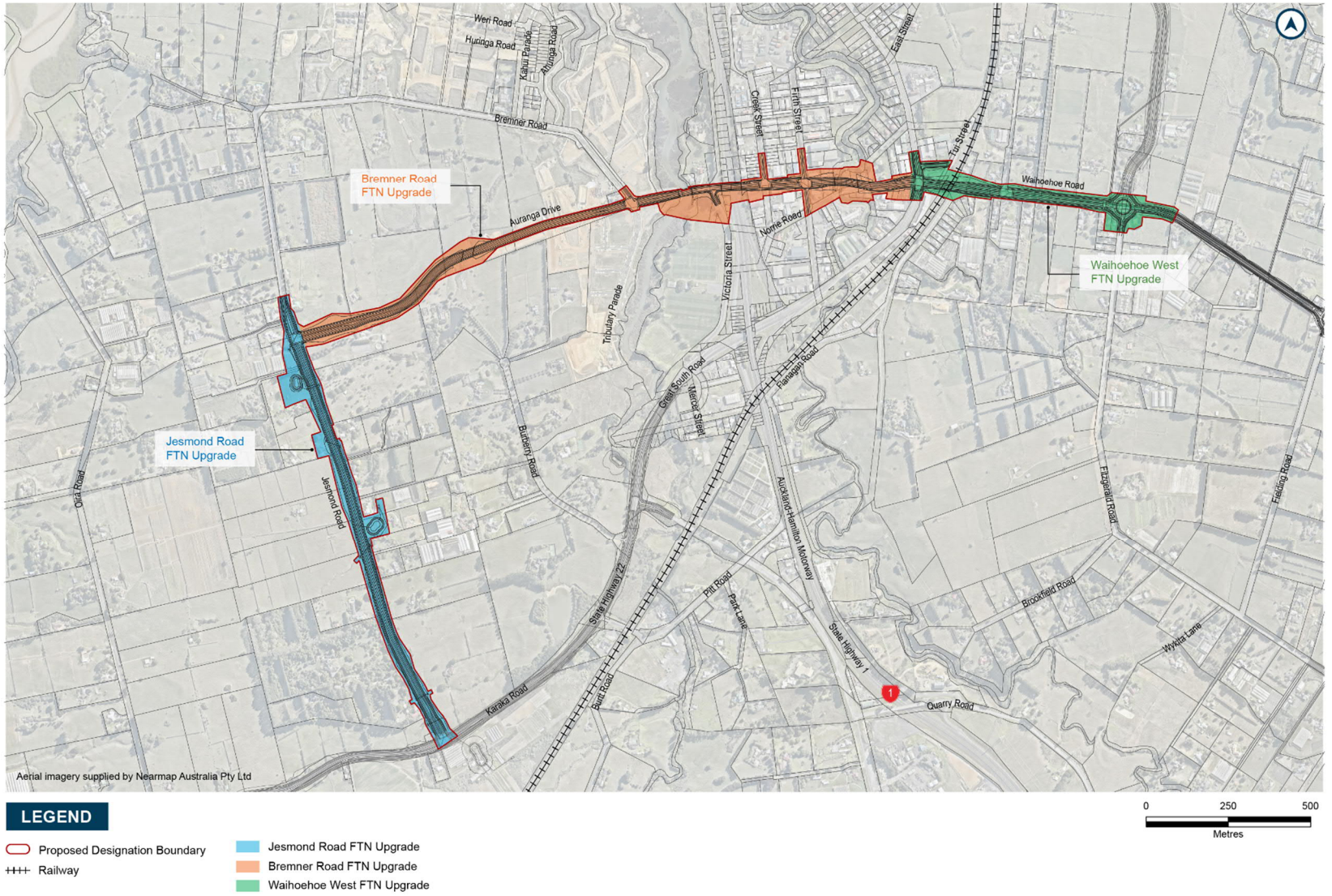


Figure 7-1 Overview of NoR D2

7.1.1 Jesmond Road Section

7.1.1.1 Section Overview

The Jesmond Road corridor provides greater accessibility via a north-south link that connects Bremner Road to the proposed Drury West Station and town centre, forming a key public transport and active mode spine through Drury West. An overview of the proposed design is provided in Figure 7-2.

As the surrounding area is urbanised Jesmond Road will become part of the proposed frequent public transport network providing key connections between Drury centres and train stations.

7.1.1.2 General Construction Overview

The Jesmond Road upgrade is estimated to take 12-18 months to complete with the works being a mix of earthworks, service relocation works, pavement construction and drainage. Most of the works are to be constructed in the existing Jesmond Road alignment, except for the new Jesmond Road/ Bremner Road intersection.

7.1.1.3 Construction Methodology

The general sequence of construction is likely to be:

1. Site establishment
2. Environmental controls
3. Services relocation and/ or protection works
4. Extend culverts and construct proposed stormwater wetlands
5. Construct earthworks
6. Construct new longitudinal drainage
7. Construct new pavement, widening works in available areas
8. Move traffic to newly constructed pavement areas and continue with the remaining widening works
9. Move traffic onto newly constructed pavement
10. Complete remaining tie in works, asphalt, signals, footpaths and cycle paths

7.1.1.4 Plant and Equipment

Table 7-1 provides an indicative list of plant and equipment which may be required for construction across the designation.

Figure 7-2 Overview of Jesmond Road Section

Table 7-1 NoR D2 - Jesmond Road Section - plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Plate compactor • Paver

7.1.2 Bremner Road Section

7.1.2.1 Section Overview

The Bremner Road FTN Upgrade section extends from Jesmond Road in the west, approximately 1.98km to the end of Norrie Road in the east. This section involves the construction of a new road from Jesmond Road to the existing Bremner Road referred to as the "Jesmond to Bremner Link" and widening, and direct connection via a new bridge over Hingaia Stream, of Bremner Road and Norrie Road to enable the four-lane FTN arterial. The functional intent of this section provides greater east-west accessibility that connects Jesmond Road to Great South Road will be signalised. The intersections with Jesmond Road and Great South Road are not included in this section extent (the Jesmond/Bremner intersection is included within the Jesmond Road FTN Arterial Upgrade Section and the Great South Road intersection is included with the Waihoehoe Road West FTN Upgrade Section).and town centre, forming a key public transport and active mode spine. An overview of the concept design is provided in Figure 7-3.

- Signalised intersections on Bremner Road with Auranga Road 1, Creek Street and Firth Street
- Between Jesmond and Bremner Roads (Jesmond to Bremner Link):
  - A new road from Jesmond Road to an unnamed stream at the Auranga Development.
  - Forming of two additional lanes for the FTN within the Auranga "Road 1" from the unnamed stream to Bremner Road)
- A new bridge over an unnamed stream within the Jesmond to Bremner Link
- Reconstruction and widening of the two existing bridges crossing Ngakoroa Stream and SH1
- A new bridge connection from Bremner Road to Norrie Road across Hingaia Stream

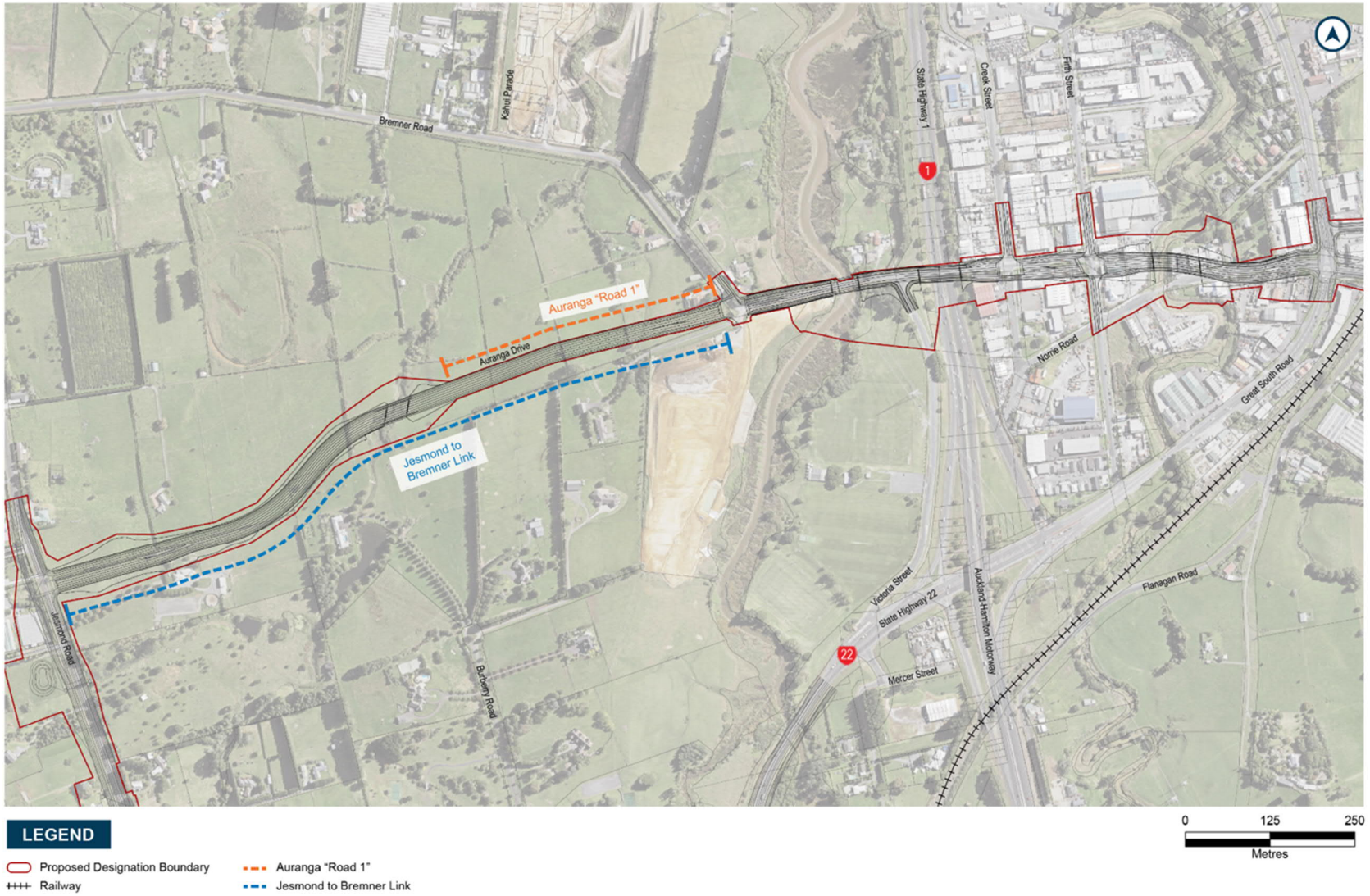


Figure 7-3 Overview of Bremner Road FTN Upgrade Section

7.1.2.2 General Construction Overview

The Bremner Road FTN upgrade is estimated to take 3 to 3.5 years to complete with the works being a mix of earthworks, bridge works, service relocation works, pavement construction and drainage. Some of the works are to be constructed online along the existing Bremner Road and Norrie Road alignment, and offline for the new Bremner Road FTN link from Jesmond Road to the existing Bremner Road turnoff.

The works along the whole alignment can be separated into three zones based on the general nature of the works involved:

- Zone 1 – Jesmond Road to Bremner Link within Auranga 1 Precinct (CH0 to CH650) (greenfield).
- Zone 2 – Auranga Road 1 - upgrade of local road within the Auranga development
- Zone 3 – Bremner Road from the bridge over Ngakoroa Stream to Great South Road.

7.1.2.3 Construction Methodology

Each zone has different construction activities depending on the type of work to be done and the surrounding environment. In all cases the general sequence of construction is likely to be:

1. Site establishment
2. Environmental controls
3. Services relocation or protection works
4. Implement traffic management to establish the construction zones in offline areas
5. Earthworks
6. Bridge construction
7. Construct new longitudinal drainage
8. Construct new pavement
9. Move traffic onto the newly constructed areas to enable finishing works
10. Complete asphalting, tie in works, footpath, cycleway, lighting and landscaping

7.1.2.4 Plant and Equipment

Table 7-2 provides an indicative list of plant and equipment which may be required for the construction across the three zones.

Table 7-2 NoR D2 – Bremner Road Section plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper

Construction Type	Construction Activity
	• Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Plate compactor • Paver
Bridge-Construction	• Concrete truck • Excavator • Tip trucks • Cranes • Delivery trucks • Piling rig

7.1.3 Waihoehoe Road West Section

7.1.3.1 Section Overview

The Waihoehoe Road West FTN Upgrade section extends from Great South Road in the west, approximately 800m east to just past Fitzgerald Road in the east and involves widening the existing two-lane rural road to enable the four-lane FTN arterial. The functional intent for the section provides a strategic east-west link between strategic north-south and east-west corridors (Norrie Road, Great South Road and the Ōpāheke N-S FTN Arterial) that connects Waihoehoe Road to the proposed Drury Central Station (and associated park and ride facilities) and town centre, forming a key public transport and active mode spine through Drury West. An overview of the concept design is provided in Figure 7-4.

In addition to those listed above, the key features of the Waihoehoe Road West Project section include:

- Realignment of Tui Street to Great South Road
- Upgraded and signalised intersection at Great South Road
- Reconstruction of the bridge crossing the NIMT rail line

Figure 7-4 Overview of Waihoehoe Road West Section

7.1.3.2 General Construction Overview

The Waihoehoe Road West FTN Arterial Upgrade is estimated to take 2 to 2.5 years to complete with the works being a mix of earthworks, bridge works, service relocation works, pavement construction and drainage. Most of the works are to be constructed online, in the existing Waihoehoe Road alignment.

7.1.3.3 Construction Methodology

The general sequence of construction is likely to be:

1. Site establishment
2. Services relocation and/ or protection works
3. Environmental controls
4. Implement temporary traffic management to realign traffic and establish work areas
5. Bridge construction, construct abutments, piling, pilecap and abutment beam construction, install bridge beams and decking, finishing works including barriers, settlement slabs, footpath and cycle path, handrails and screen
6. Commence works on the one side of the carriageway
7. Construct new culverts or extend existing ones
8. Earthworks
9. Install new stormwater drainage
10. Construct new pavement works
11. Construct the new cycleways and footpaths
12. Complete tie in works, footpath, cycle paths, lighting and landscaping

13. Divert traffic onto newly constructed pavement and bridge
14. Commence similar road and bridge works on the other side of the carriageway
15. Complete outstanding pavement works and remove any remaining temporary works
16. Install median kerbing, line marking, and street lighting
17. Complete road finishing works

7.1.3.4 Plant and Equipment

Table 7-3 provides an indicative list of plant and equipment which may be required for the construction across this area.

Table 7-3 NoR D2 ––Waihoehoe Road West - plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 20-30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Plate compactor • Paver
Bridge-Construction	• Concrete truck • Excavator • Tip trucks • Cranes • Delivery trucks • Piling Rig • Concrete Pump • Elevated Work Platform

7.2 Assessment of Construction Noise and Vibration

The assessment for NoR D2 has combined the three sections of this designation into one due to the consistent construction methodology adopted.

The following residential buildings are within the proposed designation boundary and will be removed to make room for the Project alignment and therefore have not been assessed:

- 1 Fitzgerald Road
- 6 Fitzgerald Road
- 41 Jesmond Road
- 188 Jesmond Road
- 18 Waihoehoe Road
- 115 Waihoehoe Road.

7.2.1 Construction Noise

7.2.1.1 Potential Construction Noise Levels

Model predictions assuming the works along the designation boundary indicate there are 55 buildings (25 residential and 30 commercial) where the relevant noise criteria would be exceeded without mitigation. Distances of receivers from the designation boundary vary greatly along the road alignment with the closest receptor approximately 4m from drainage works. With 9 buildings (4 residential and 5 commercial) location within the 73m radii of the minimum set back distance required for day time compliance of 70 dB L_{Aeq} for piling works.

Model predictions indicate the closest receivers could experience noise levels of around 90 - 95 dB L_{Aeq} during drainage and pavement construction works, based on the noisiest item of plant (plate compactor) operating in the closest position to the receiver along the designation boundary, without mitigation. Operation of construction equipment will be intermittent in nature and works in the worst-case location typically latest around 3 days. Whilst plate compactors have been identified as the noisiest equipment, they are only used as part of drainage works and pavement construction. Similarly, piling is carried out during bridge construction only and for limited durations. Other equipment with lower sound powers will generate lower noise levels under the worst-case location and overall average noise levels will be lower for most of construction duration.

These results should be treated as the highest possible noise levels likely to be emitted from the respective equipment. These noise levels that would occur infrequently, if at all, as equipment and activities move along the alignment and is are not operational continuously operational. The noise levels provide an indicative prediction of the scale of potential effects based on one possible construction methodology.

7.2.1.2 Construction Noise Effects

The construction noise criteria are predicted to be exceeded at a number of receivers due to their close proximity to the potential areas of work. Closest receivers are 4m from the proposed designation boundary for earthworks and predicted noise levels are around 90 -95 dB L_{Aeq} with the nosiest equipment being loader and plate compactor.

However, the use of these items of equipment will likely be intermittent in nature during the relevant construction activities. Although the worst-case situations are not expected to be frequent, due to the setback distances to the majority of the proposed works, these noise levels could result in loss of concentration, annoyance, and a reduction in speech intelligibility. The resulting noise levels indoors could also result in inability to hear conversations with each other and reduced productivity with office working being extremely difficult and not tolerable for long periods of time. Table 5-4 gives examples of the potential effects on receivers at different noise levels.

Night time works at these noise levels are generally not acceptable at residential properties and the use of noisy equipment should be avoided to prevent sleep disturbance. If night-time works is required consultation and mitigation measures will be essential which may include an offer of temporary relocation for the most affected receivers to manage and mitigate adverse effects.

With effective mitigation and management measures in place, such as 1.8m barriers along active construction areas within the vicinity of receivers and enclosures around noisy machinery, noise levels can be reduced by up to 10dB at receivers on the ground floor. Resulting worst case noise levels could be reduced to 80– 85 dB with mitigation implemented and number of receivers exceeding the criteria reduced to 35.

In addition, the road construction is linear, and each receiver would only be affected for part of the overall construction duration. A CNVMP as detailed in Section 5.6, with site specific mitigation as required, should be prepared which sets out how to control noise levels and reduce adverse impacts on receivers.

7.2.2 Construction Vibration

7.2.2.1 Potential Construction Vibration Levels

Maps of the vibration contours based on the worst-case emission radii values of vibratory roller compactor are shown in **Appendix 1**. A list of building addresses predicted to exceed the relevant criteria are predicted is provided in Appendix 2.

Two scheduled heritage buildings have been identified by the Project Team at 9 Cameron Place (Church) and 201 Jesmond Road (Aroha Cottage). Both may experience vibration levels above 2.5 mm/s PPV exceeding the building damage criteria for historical / sensitive properties. To control and minimise vibration levels at these buildings, the use of smaller or low vibration equipment should be considered as part of mitigation measures.

Nine dwellings may experience vibration levels above 5mm/s PPV exceeding the building damage criteria for residential properties and 12 buildings may experience vibration levels above 10mm/s PPV exceeding the DIN criteria for commercial properties. Predictions indicate a total of 62 buildings may receive vibration levels above the amenity criterion of 2 mm/s PPV.

It should be noted that the vibration generating equipment will not be operating all of the time and may not operate right at the boundaries of the area of works.

It is not expected high level vibratory works such as the use of roller compactors will be carried out during night-time. If night-time works is required extensive consultation and management plans will be essential.

7.2.2.2 Construction Vibration Effects

Our initial predictions indicate that the Project building damage criteria may be exceeded at two historic buildings, nine dwellings and 12 commercial buildings, in particular during the earthworks phase when the vibratory roller compactor is proposed for use. At buildings in close proximity to proposed designation boundary areas, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. A building condition survey should therefore be carried out before (during detailed design) and after construction works, at properties where predictions indicate the relevant building damage criteria may be approached, to determine if any damage is shown to have been caused by construction by the Project Team. Consultation and communications should be undertaken for all buildings where the criteria are predicted to be exceeded.

Section 5.5.2 provides further details on vibration effects and Section 5.6 on management and mitigation measures.

7.3 Conclusions

An assessment of the construction noise and vibration effects has been undertaken for the Project. The predicted 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 receivers as they exist at the time of construction.

The assessment indicates 55 buildings are predicted to receive noise levels that would exceed the relevant criteria and 23 buildings are predicted to receive vibration levels that would exceed the relevant DIN criteria. As such, predictions for construction noise and vibrations along the Project alignment indicate mitigation measures are required to manage effects on buildings in the vicinity of the works. Mitigation measures such as 1.8m barriers along active construction areas within the vicinity of receivers and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable.

Two scheduled heritage buildings are adjacent to NoR D2 and are historical / sensitive properties. To control and minimise vibration levels at these buildings, the use of smaller or low vibration equipment should be considered as part of the CNVMP.

A CNVMP should be prepared as it is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options and management and monitoring strategies. Section 5.6 of this report provides details on should be included in the CNVMP.

8 NoR D3: Waihoehoe Road East Upgrade

Chapter Summary

Noise predictions have been made based on worst-case assumptions, at the nearest existing receivers, without mitigation. Due to the close proximity of the construction areas to the receivers, construction noise levels are likely to exceed the daytime and night time noise criteria during the worst-case scenario. The extent and duration of night-time construction will be confirmed at detailed design.

Construction will occur several years in the future. Therefore, receivers may have changed by then, with new receivers in the vicinity due to increased development. Construction noise and vibration effects for existing receivers at the time of construction and appropriate mitigation measures should be developed further at that time.

The noisiest items of equipment that are likely to be used for the Project are loaders and plate compactors, The equipment is likely to be used in a number of areas throughout the construction period. and a construction noise and vibration management plan will be required to mitigate and manage the potential noise and vibration levels. Indicative vibration emission radii distances have been predicted for the most vibratory equipment. Actual vibration levels are highly dependent on local conditions and the selection of machinery which will be decided at detailed design. Site specific/activity specific management schedules for receivers significantly impacted by noise and/or vibration will be required.

The highest unmitigated noise level is predicted to be around 85-90 dB L_{Aeq} during earthworks based on the noisiest item of plant (plate compactor) operating in the closest position to the receiver. The applicable noise criteria could be exceeded at 16 receivers if noisy equipment operates in this closest position to the receivers at the proposed designation boundary, which is highly unlikely. Operation of construction equipment will be intermittent in nature and for a limited duration of typically 3 days where works are located in the worst-case location. Plate compactors are proposed only to be used for the drainage or pavement construction stages. Other equipment with lower sound power levels will generate lower noise levels under the worst case location and overall average noise levels will be lower for most of the construction period.

Five receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

It is recommended that a CNVMP is prepared prior to construction commencing to identify the appropriate mitigation measures for controlling noise and vibration levels to manage and meet the applicable criteria or reduce to a reasonable level. Mitigation measures such as 1.8m barriers along active construction areas, used of mufflers and engine covers on plant were appropriate and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable. With appropriate mitigation measure applied worst case noise levels at receivers could be reduced to 75 - 80 dB L_{Aeq} with number of receivers exceeding the applicable noise criteria reduced to 7

8.1 Project Description

8.1.1 Project Overview

The Waihoehoe Road East Upgrade (NoR D3) consists of the widening of Waihoehoe Road to a two-lane arterial with walking and cycling facilities from the proposed intersection with Ōpāheke North-South Arterial in the east, to Drury Hills Road in the east. The functional intent of the Project is to provide strategic east-west connectivity between the strategic north-south corridors (Great South Road, the Ōpāheke N-S FTN Upgrade (NoR D4) and Mill Road), providing multi-modal access to the wider network for the planned growth area as well as providing access to the existing Drury township and proposed rail station (an NZUP Project).

The eastern extent of the Project will tie into the future Mill Road corridor which forms a separate NZUP Project. The intersection with Ōpāheke North-South is proposed to be signalised, but this work forms part of NoR D2. Roundabouts are proposed at the intersections with Appleby Road and Cossey Road. An overview of the proposed design is provided in Figure 8-1.

Figure 8-1 Overview of Waihoehoe Road East Arterial Upgrade

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

- Widening of Waihoehoe Road from its current general width of 20m to enable a 24m wide two-lane cross-section including separated walking and cycling facilities
- Localised widening around the existing intersections to accommodate for the two proposed roundabouts
- Batter slopes to enable widening of the corridor, and associated cut and fill activities.

8.1.2 General Construction Overview

The Waihoehoe Road East Upgrade is estimated to take 2 to 2.5 years to complete with the works being a mix of earthworks, service relocation works, pavement construction and drainage. Most of the works are to be constructed online, in the existing Waihoehoe Road alignment.

8.1.2.1 Construction Methodology

The general sequence of construction is likely to be:

1. Site establishment
2. Services relocation and/ or protection works
3. Environmental controls
4. Implement temporary traffic management to realign traffic and establish work areas
5. Commence works on the one side of the carriageway
6. Construct new culverts or extend existing ones
7. Earthworks
8. Install new stormwater drainage
9. Construct new pavement works
10. Construct the new cycleways and footpaths
11. Complete tie in works, footpath, cycle paths, lighting and landscaping
12. Divert traffic onto newly constructed pavement and bridge
13. Commence similar road works on the other side of the carriageway
14. Complete outstanding pavement works and remove any remaining temporary works
15. Install median kerbing, line marking, and street lighting
16. Complete road finishing works

8.1.2.2 Plant and Equipment

Table 8-1 provides an indicative list of plant and equipment which may be required for the construction across the area.

Table 8-1 NoR D3 plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 20-30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Plate compactor • Paver

8.2 Assessment of Construction Noise and Vibration

The following residential buildings are within the proposed designation boundary and will be removed to make room for the Project alignment and therefore have not been assessed:

- 2 Appleby Road
- 188 Waihoehoe Road
- 272 Waihoehoe Road
- 251 Waihoehoe Road
- 26A Fielding Road

8.2.1 Construction Noise

8.2.1.1 Potential Construction Noise Levels

Model predictions which assume the works will occur along the designation boundary indicate there are 16 residential properties where the relevant noise criteria would be exceeded without mitigation. Distances of receivers from the designation area boundary vary greatly along the road alignment with the closest receptor approximately 7m from drainage and pavement construction works.

Model predictions indicate the closest receivers could experience noise levels of around 85 - 90 dB L_{Aeq} during earthworks, based on the noisiest item of plant (plate compactor) operating in the closest position to the receiver along the designation boundary, without mitigation. Operation of construction equipment will be intermittent in nature and works in the worst-case location typically latest around 3 days. Whilst plate compactors have been identified as the noisiest equipment, they are only used as part of drainage and pavement construction works. Other equipment with lower sound powers will generate lower noise levels under the worst-case location and overall average noise levels will be lower for most of construction duration.

These results should be treated as the highest possible noise levels likely to be emitted from the respective equipment. These noise levels that would occur infrequently, if at all, as equipment and activities move along the alignment and is are not operational continuously operational. The noise levels provide an indicative prediction of the scale of potential effects based on one possible construction methodology.

8.2.1.2 Construction Noise Effects

The construction noise criteria are predicted to be exceeded at a number of receivers due to the close proximity to the potential areas of work. The closest receivers are 7m from the proposed designation boundary for drainage and pavement construction works and noise levels of around 85 -90 dB L_{Aeq} are predicted.

The use of noisy items of equipment will likely be intermittent in nature during the relevant construction activities. Although the worst-case situations are not expected to be frequent, due to the setback distances to the majority of the proposed works, these noise levels could result in loss of concentration, annoyance, and a reduction in speech intelligibility. The resulting noise levels indoors could also result in inability to hear conversations with each other and reduced productivity with office

working being extremely difficult and not be tolerable for long periods of time. Table 5-4 gives examples of the potential effects on receivers at different noise levels.

Night-time works at these noise levels are generally not acceptable at residential properties and the use of noisy equipment should be avoided to prevent sleep disturbance. If night-time works are required, mitigation measures will be essential which may include an offer of temporary relocation for the most affected receivers to manage and mitigate adverse effects.

With effective mitigation and management measures in place, such as 1.8m barriers along active construction areas within the vicinity of receivers and enclosures around noisy machinery, noise levels can be reduced by up to 10dB at receivers on ground floor. Resulting worst case noise levels could be reduced to 75– 80 dB with mitigation implemented and number of receivers exceeding the criteria reduced to 7.

In addition, the road construction is linear, and each receiver would only be affected for part of the overall construction duration. A CNVMP as detailed in Section 5.6, with site specific mitigation as required, sets out how to control noise levels and reduce adverse impacts on receivers.

8.2.2 Construction Vibration

Maps of the vibration contours based on the worst-case emission radii values of a vibratory roller compactor are shown in **Appendix 1**. A list of building addresses predicted to exceed the relevant criteria are shown in Appendix 2.

Five dwellings may experience vibration levels above 5mm/s PPV exceeding the building damage criteria for residential buildings. Vibration levels at all commercial buildings are predicted to be below the 10mm/s criterion. Predictions indicate a total of 28 buildings may receive vibration levels above the amenity criterion of 2 mm/s PPV.

It should be noted that the vibration generating equipment will not be operating all of the time and may not operate right at the boundaries of the area of works.

It is not expected that high vibration generating works, such as the use of roller compactors, will be carried out during the night-time period. If night-time works are required, extensive consultation and management plans will be essential.

8.2.2.1 Construction Vibration Effects

Our initial predictions indicate that the building damage criteria may be exceeded at two residential buildings, in particular during the earthworks phase when the vibratory roller compactor is proposed for use. At buildings in close proximity to the proposed designation boundary, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. A building condition survey should therefore be carried out at those buildings before (during detailed design) and after construction works at receivers where predictions indicate the relevant building damage criteria may be exceeded.

Section 5.5.2 provides further details on vibration effects and Section 5.6 on management and mitigation measures.

8.3 Conclusions

An assessment of the construction noise and vibration effects has been undertaken for the Project. The predicted 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 receivers as they exist at the time of construction.

The assessment indicates 16 residential receivers are predicted to receive noise levels that would exceed the relevant criteria and five receivers are predicted to experience vibration levels that would exceed the DIN criteria. As such, predictions for construction noise and vibrations along the Project alignment indicate mitigation measures are required to manage effects on buildings in the vicinity of the works. Mitigation measures such as 1.8m barriers along active construction areas within the vicinity of receivers and selecting the use of low vibration emitting equipment wherever possible should be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable.

A CNVMP should be prepared as it is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options and management and monitoring strategies. Section 5.6 of this report provides details on what should be included in the CNVMP.

9 NoR D4: Ōpāheke North-South FTN Arterial

Chapter Summary

Noise predictions have been made based on worst-case assumptions, at the nearest existing receivers, without mitigation. Due to the close proximity of the construction areas to the receivers, construction noise levels are likely to exceed the daytime and night time noise criteria during the worst-case scenario. The extent and duration of night-time construction will be confirmed at detailed design.

Construction will occur several years in the future. Therefore, receivers may have changed by then, with new receivers in the vicinity due to increased development. Construction noise and vibration effects for existing receivers at the time of construction and appropriate mitigation measures developed further at that time.

The noisiest items of equipment that are likely to be used for the Project are loaders, plate compactors and piling rigs. With the exception of piling rigs which are used for bridge construction only in specific locations, the equipment is likely to be used in a number of areas throughout the construction period. A construction noise and vibration management plan will be required to mitigate and manage the potential noise and vibration levels. Indicative vibration emission radii distances have been predicted for the most vibratory equipment. Actual vibration levels are highly dependent on local conditions and the selection of machinery which will be decided at detailed design. Site specific/activity specific management schedules for receivers significantly impacted by noise and/or vibration will be required.

The highest unmitigated noise level is predicted to be around 80-85dB L_{Aeq} during earthworks based on the noisiest item of plant operating in the closest position to the receiver. The applicable noise criteria could be exceeded at 11 receivers if noisy equipment operates in this closest position to the receivers at the proposed designation boundary, which is highly unlikely. Operation of construction equipment will be intermittent in nature and for a limited duration of typically 3 days where works are located in the worst-case location. Plate compactors are proposed only to be used for the drainage or pavement construction stages. Other equipment with lower sound power levels will generate lower noise levels under the worst case location and overall average noise levels will be lower for most of the construction period.

Seven receivers are predicted to receive vibration levels that exceed the DIN criteria without mitigation.

It is recommended that a CNVMP is prepared prior to construction commencing to identify the appropriate mitigation measures for controlling noise and vibration levels to manage and meet the applicable criteria or reduce to a reasonable level. Mitigation measures such as 1.8m barriers along active construction areas, used of mufflers and engine covers on plant were appropriate and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable. With appropriate mitigation measure applied worst case noise levels at receivers could be reduced to 70 - 75 dB L_{Aeq} with number of receivers exceeding the applicable noise criteria reduced to 8.

9.1 Project Description

9.1.1 Project Overview

The Ōpāheke North-South FTN Arterial is a new 30m four-lane FTN arterial with separated walking and cycling facilities between Hunua Road in the north and Waihoehoe Road in the south.

The road traverses greenfields zoned FUZ, crossing approximately seven streams (or tributaries of streams) and areas of flood plain, providing a new north-south connection between Drury and Papakura. The intersection with Hunua/Boundary Roads will be signalised, and roundabouts are proposed at Ōpāheke Road / Ponga Road, Walker Road and Waihoehoe Road is also signalised however it. The intersection at Waihoehoe Road is not included in this Project extent (it is included within NoR D2). An overview of the proposed design is provided in Figure 9-1.

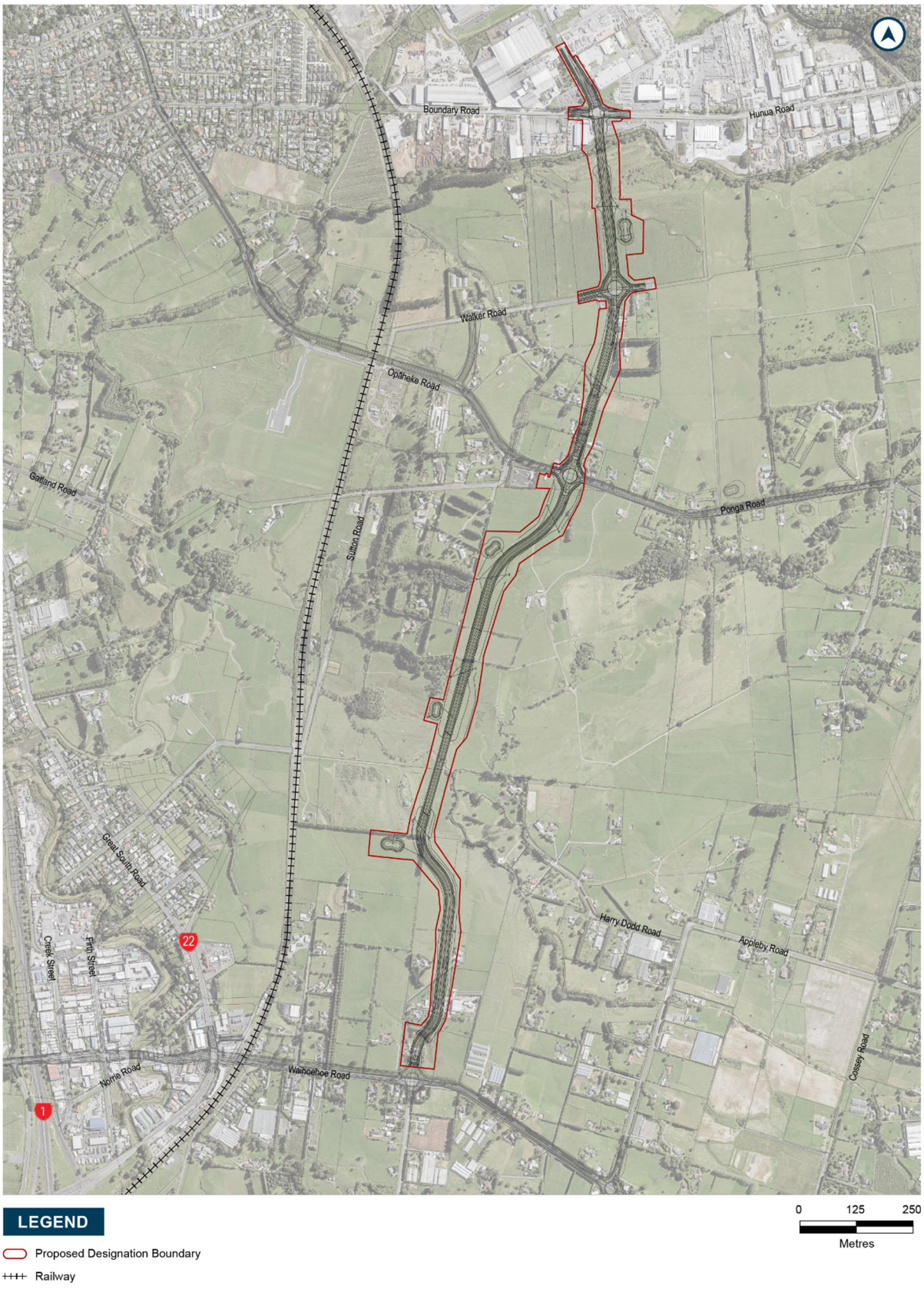


Figure 9-1 Overview of Ōpāheke N-S FTN Arterial Upgrade

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

- A new road to enable a 30m wide four-lane cross section including bus lanes and separate walking and cycling facilities
- Localised widening around intersections with existing roads to accommodate for vehicle stacking and tie-ins and walking and cycling facilities/crossings
- Proposed new culverts
- Four proposed stormwater wetlands
- Two proposed bridges over Waipokapū Stream (approximately 120m) and Waihoehoe Stream and floodplain (approximately 265m)
- Batter slopes and retaining to enable construction of the corridor, and associated cut and fill activities.

9.1.2 General Construction Overview

The Project is estimated to take 3.5 to 4 years to complete with the works being a mix of earthworks, bridge construction, drainage and stormwater wetlands construction, services relocation, and pavement construction.

The site and the associated construction works have been broken into three zones based on the general nature and scope of the work involved. These zones are:

- **Zone 1** - Boundary Road/ Hunua Road intersection works and Bridge 1
- **Zone 2** – South of Bridge 1 to Ponga Road/ Ōpāheke Road intersection
- **Zone 3** – South of Ponga Road/ Ōpāheke Road intersection to Waihoehoe Road

9.1.2.1 Construction Methodology

Each zone has different construction activities depending on the type of work to be done and the surrounding environment. In all cases the general sequence of construction is likely to be:

1. Site establishment
2. Environmental controls
3. Implement traffic management to establish the construction zones in offline areas
4. Service relocation and/ or protection works.
5. Bridge construction, construct abutments, piling, pilecap and abutment beam construction, install bridge beams and decking, finishing works including barriers, settlement slabs, footpath and cycle path, handrails and screen.
6. Earthworks.
7. Construct new drainage.
8. Construct new pavement to half of the road.
9. Construct new footpath and cycleways.
10. Move traffic onto the newly constructed road.
11. Construct new footpath and cycleways.
12. Finishing works for road and bridge.

9.1.2.2 Plant and Equipment

Table 9-1 provides an indicative list of plant and equipment which may be required for the construction across the three zones.

Table 9-1 NoR D4 plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 20-30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Paver
Bridge-Construction	• Concrete truck • Excavator • Tip trucks • Cranes • Delivery trucks • Piling Rig • Concrete Pump • Elevated Work platform

9.2 Assessment of Construction Noise and Vibration

The following residential buildings are within the proposed designation boundary and will be removed to make room for the Project alignment and therefore have not been assessed:

- 111 Walker Road
- 6 Ponga Road (Minor Dwelling)
- 68 Ponga Road (Minor Dwelling)
- 128 Waihoehoe Road
- 136 Waihoehoe Road

Oyster Capital Ltd has an agreement to purchase 116, 132 and 140 Waihoehoe Road. It has been confirmed in writing that they will remove all existing buildings on the properties before the development is started and before construction commences of the transport corridor. Therefore, the buildings on these properties have not been assessed.

9.2.1 Construction Noise

9.2.1.1 Potential Construction Noise Levels

Model predictions, assuming the works along the designation boundary, indicate there are 11 buildings where the relevant noise criteria would be exceeded without mitigation. Distances of receivers from the designation area boundary vary greatly along the road alignment with the closest receptor approximately 10 m from drainage and pavement construction works. With 3 buildings (2 residential and 1 commercial) location within the 73m radii of the minimum set back distance required for day-time compliance of 70 dB L_{Aeq} for piling works.

Model predictions indicate the closest receivers could experience noise levels of up to 85dB L_{Aeq} during earthworks, based on the noisiest item of plant operating in the closest position to the receiver, without mitigation. Operation of construction equipment will be intermittent in nature and works in the worst-case location typically latest around 3 days. Whilst plate compactors have been identified as the noisiest equipment, they are only used as part of drainage and pavement construction works. Similarly, piling is carried out during bridge construction only and for limited durations. Other equipment with lower sound powers will generate lower noise levels under the worst-case location and overall average noise levels will be lower for most of construction duration.

These results should be treated as the highest possible noise levels likely to be emitted from the respective equipment. These noise levels that would occur infrequently, if at all, as equipment and activities move along the alignment and is are not operational continuously operational. The noise levels provide an indicative prediction of the scale of potential effects based on one possible construction methodology.

9.2.1.2 Construction Noise Effects

The construction noise criteria are predicted to be exceeded at a number of receivers due to the close proximity to the potential areas of work. Closest receivers are 10 m from the proposed designation boundary for drainage and pavement construction works and predicted noise levels are around 80 - 85dB L_{Aeq} with the nosiest equipment being the loader and plate compactor.

However, the use of these items of equipment will likely be intermittent in nature during the relevant construction activities. Although the worst-case situations are not expected to be frequent, due to the setback distances of the majority of the proposed works, these noise levels could result in loss of concentration, annoyance, and a reduction in speech intelligibility. The resulting noise levels indoors could also result in inability to hear conversations with each other and reduced productivity with office working being extremely difficult and not tolerable for long periods of time. Table 5-4 gives examples of the potential effects on receivers at different noise levels.

Night time works at these noise levels are generally not acceptable at residential properties and the use of noisy equipment should be avoided to prevent sleep disturbance. If night-time works are required, mitigation measures will be essential which may include an offer of temporary relocation for the most affected receivers to manage and mitigate adverse effects.

With effective mitigation and management measures in place, such as 1.8m barriers along active construction areas within the vicinity of receivers and enclosures around noisy machinery, noise levels can be reduced by up to 10dB at receivers on ground floor. Resulting worst case noise levels

could be reduced to 70– 75 dB with mitigation implemented and number of receivers exceeding the criteria reduced to 8.

In addition, the road construction is linear, and each receiver would only be affected for part of the overall construction duration. A CNVMP as detailed in Section 5.6, with site specific mitigation as required, sets out how to control noise levels and reduce adverse impacts on receivers.

9.2.2 Construction Vibration

9.2.2.1 Potential Construction Vibration Levels

Maps of the vibration contours based on the worst-case emission radii values of a vibratory roller compactor are shown in **Appendix 1**. A list of building addresses predicted to exceed the relevant criteria are shown in Appendix 2.

Four dwellings may experience vibration levels above 5mm/s PPV exceeding the building damage criteria for residential buildings and three commercial buildings may experience vibration levels above 10mm/s PPV exceeding the DIN criteria for commercial properties. Predictions indicate a total of 24 buildings may receive vibration levels above the amenity criterion of 2 mm/s PPV.

It should be noted that the vibration generating equipment will not be operating all of the time and may not operate right at the boundaries of the area of works.

It is not expected high level vibratory works such as the use of roller compactors will be carried out during night-time. If night-time works is required extensive consultation and management plans will be essential.

9.2.2.2 Construction Vibration Effects

Our initial predictions indicate that the Project building damage criteria may be exceeded at four residential receiver and three commercial receivers, in particular during the earthworks phase when the vibratory roller compactor is proposed for use. At buildings in close proximity to proposed designation boundary areas, there is the potential for cosmetic damage to buildings (such as cracking) and annoyance from perception of vibration. A building condition survey should therefore be carried out before (during detailed design) and after construction works at buildings where predictions indicate the relevant building damage criteria may be approached, to determine if any damage has been caused by construction of the Project.

Section 5.5.2 provides further details on vibration effects and Section 5.6 on management and mitigation measures.

9.3 Conclusions

An assessment of the construction noise and vibration effects has been undertaken for the Project. The predicted 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 receivers as they exist at the time of construction.

The assessment indicates seven residential and four commercial receivers are predicted to experience noise levels that would exceed the relevant criteria and seven buildings are predicted to

receive vibration levels that would exceed the relevant DIN criteria. As such, predictions for construction noise and vibrations along the Project alignment indicate mitigation measures are required to manage effects on buildings in the vicinity of the works. Mitigation measures such as 1.8m barriers along active construction areas within the vicinity of receivers and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable.

A CNVMP should be prepared as it is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options and management and monitoring strategies. Section 5.6 of this report provides details on what should be included in the CNVMP.

10 NoR D5: Ponga and Ōpāheke Road Upgrade

Chapter Summary

Noise predictions have been made based on worst-case assumptions, at the nearest existing receivers, without mitigation. Due to the close proximity of the construction areas to the receivers, construction noise levels are likely to exceed the day-time and night time noise criteria during the worst-case scenario. The extent and duration of night-time construction will be confirmed at detailed design.

Construction will occur several years in the future. Therefore, receivers may have changed by then, with new receivers in the vicinity due to increased development. Construction noise and vibration effects for existing receivers at the time of construction and appropriate mitigation measures developed further at that time.

The noisiest items of equipment that are likely to be used for the Project are loaders, plate compactors and piling rigs. With the exception of piling rigs which are used for bridge construction only in specific locations, the equipment is likely to be used in a number of areas throughout the construction period. A construction noise and vibration management plan will be required to mitigate and manage the potential noise and vibration levels. Indicative vibration emission radii distances have been predicted for the most vibratory equipment. Actual vibration levels are highly dependent on local conditions and the selection of machinery which will be decided at detailed design. Site specific/activity specific management schedules for receivers significantly impacted by noise and/or vibration will be required.

The highest unmitigated noise level is predicted to be around 85- 90 dB L_{Aeq} during earthworks based on the noisiest item of plant operating in the closest position to the receiver. The applicable noise criteria could be exceeded at 72 receivers if noisy equipment operates in this closest position to the receivers at the proposed designation boundary, which is highly unlikely. Operation of construction equipment will be intermittent in nature and for a limited duration of typically 3 days where works are located in the worst-case location. Plate compactors are proposed only to be used for the drainage or pavement construction stages. Other equipment with lower sound power levels will generate lower noise levels under the worst case location and overall average noise levels will be lower for most of the construction period.

45 buildings are predicted to receive vibration levels that would exceed the relevant DIN vibration criteria without mitigation.

It is recommended that a CNVMP is prepared prior to construction commencing to identify the appropriate mitigation measures for controlling noise and vibration levels to manage and meet the applicable criteria or reduce to a reasonable level. Mitigation measures such as 1.8m barriers along active construction areas and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable. With appropriate mitigation measure applied worst case noise levels at receivers could be reduced to 75 - 80 dB L_{Aeq} with number of receivers exceeding the applicable noise criteria reduced to 57.

10.1 Project Description

As the Drury-Ōpāheke area is urbanised it is proposed to upgrade a 4.15km section of Ponga Road and Ōpāheke Road, from Great South Road in the north, to Jack Paterson Road and the future Mill Road corridor (which forms a separate NZUP Project) in the southeast, to a two-lane arterial with separated walking and cycling facilities. The functional intent of the Project is a multimodal corridor that provides access to the proposed Mill Road corridor, FUZ in Papakura and employment areas to the north. The Project has been separated into three sections as shown in Figure 10-1:

- Ponga Road Upgrade: from Ōpāheke Road to Jack Paterson Road
- Ōpāheke Road Rural Upgrade: from the northern extent of the FUZ to Ponga Road
- Ōpāheke Road Urban Upgrade: north of the FUZ.

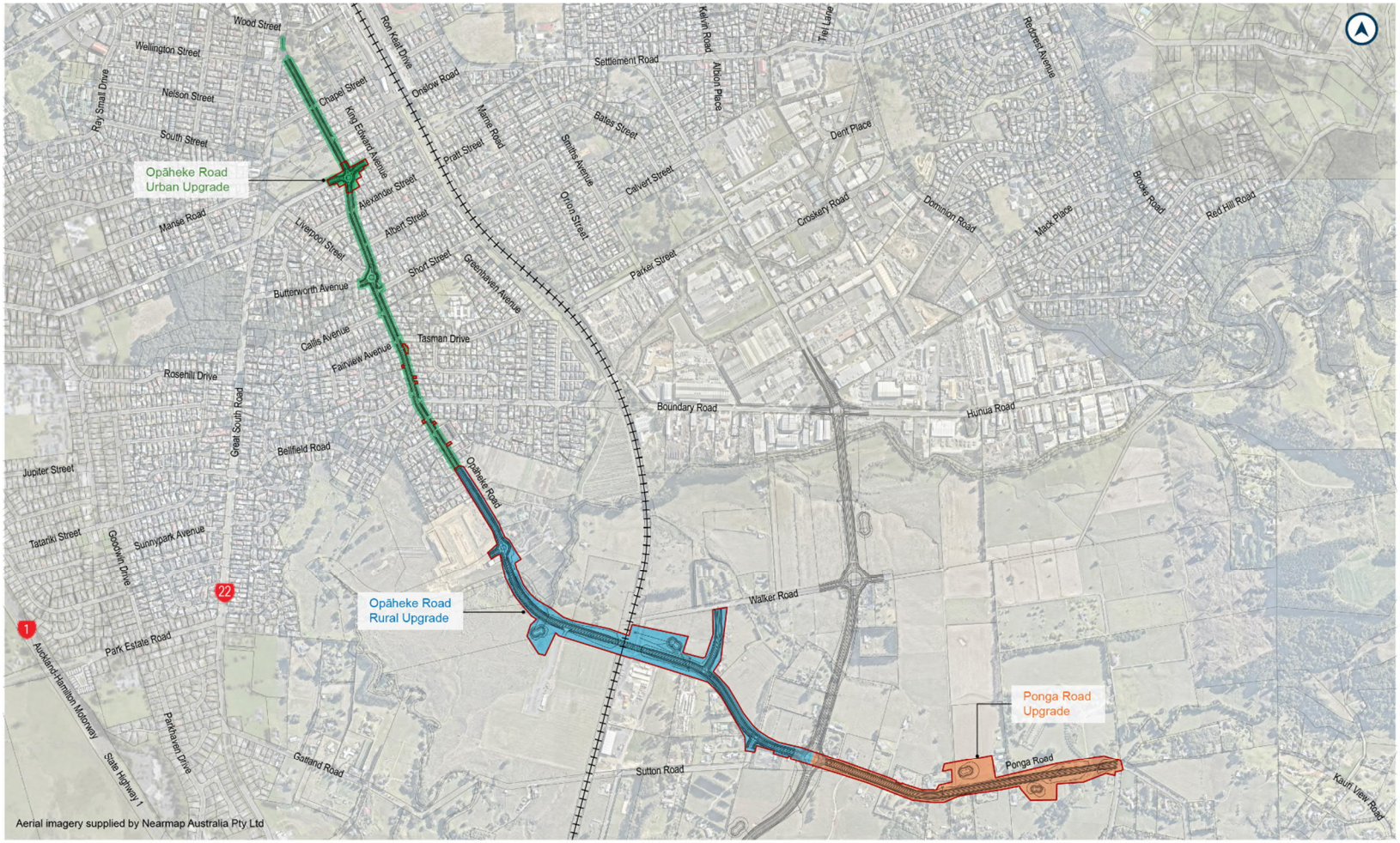
- While the overall plan for the urban area of Ōpāheke Road is to upgrade the walking and cycling facilities from Ōpāheke Road Rural Upgrade in the south to Great South Road, Papakura in the north, generally, the upgrade can fit within the existing road reserve, therefore only the areas affecting land outside the existing road reserve are proposed to be designated.

For the Ponga Road and the Ōpāheke Road Rural upgrade sections it is proposed to widen the existing roads to 24m two-lane urban arterials with separated walking and cycling facilities. As the Ōpāheke Road urban section is an existing and constrained urban environment, it is proposed to upgrade the existing road to a 20m two-lane urban arterial with separated walking and cycling facilities.

The indicative alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment will be refined and confirmed at the detailed design stage. Key features of the proposed upgrade common to each Project section include the following:

- A typically 24m or 20m wide road with two lanes and separated walking and cycling facilities
- Localised widening around the existing intersections to accommodate vehicle stacking and tie-ins and walking and cycling facilities/crossings
- Batter slopes and retaining to enable widening of the corridor and/or wetland construction, and associated cut and fill activities.

Further details of each Project section are provided below.



Works shown for the Ōpāheke Road Urban Upgrade outside of the proposed designation boundary are indicative and will be subject to a separate statutory approvals process (if required) in the future. Only those works within the designation boundary are assessed.

Figure 10-1 Overview of NoR D5

10.1.1 Ponga Road Upgrade Section

10.1.1.1 Section Overview

The Ponga Road Upgrade section is a 1km long upgrade extending from the proposed intersection with Ōpāheke North-South FTN Arterial in the west, to Jack Paterson Road in the east. In the future Ponga Road will tie into the proposed Mill Road corridor which forms a separate NZUP Project. An overview of the concept design is provided in Figure 10-2.

Figure 10-2 Overview of Ponga Road Arterial Upgrade Section

In addition to those listed above, the key features of the Ponga Road Upgrade section include:

- Roundabout tying into the proposed Ōpāheke N-S FTN Arterial (NoR D4) and Ōpāheke Road Rural Upgrade section
- A bridge over Mangapū Stream
- Extension of existing pipe culverts
- Two stormwater wetlands.

10.1.1.2 General Construction Overview

The Ponga Road upgrade is estimated to take 24-30 months to complete with the works being a mix of earthworks, bridge works, service relocation works, pavement construction and drainage. Most of the works are to be constructed online, in the existing Ponga Road alignment.

10.1.1.3 Construction Methodology

The general sequence of construction is likely to be:

1. Site establishment
2. Services relocation and/ or protection works
3. Environmental controls
4. Implement temporary traffic management to realign traffic and establish work areas
5. Commence works on the one side of the carriageway
6. Construct new culverts or extend existing ones
7. Earthworks
8. Install new stormwater drainage
9. Bridge construction
10. Construct new pavement works
11. Construct the new cycleways and footpaths
12. Complete tie in works, footpath, cycle paths, lighting and landscaping
13. Divert traffic onto newly constructed pavement and bridge
14. Commence similar road works on the other side of the carriageway
15. Complete outstanding pavement works and remove any remaining temporary works
16. Install median kerbing, line marking, and street lighting
17. Complete road finishing works

10.1.1.4 Plant and Equipment

Table 10-1 provides an indicative list of plant and equipment which may be required for the construction.

Table 10-1 NoR D5 plant and equipment summary

Construction Type	Construction Activity
Typical across all works	• Site facility • Light Vehicles • Hiab truck
Earthworks	• 20-30T Excavator • Compactor/Sheepsfoot roller • Water Cart • Tippers
Drainage	• 20T Excavator • Trench Shields • Tandem Tipper • Loader • Plate compactor
Pavement Construction	• Grader • Smooth Drum Roller • Tandem Tippers • Kerbing Machine • Plate compactor • Paver
Bridge Construction	• Piling Rig • Cranes

Construction Type	Construction Activity
	• Excavator • Concrete Pump • Concrete Truck • Elevated work platform

10.1.2 Ōpāheke Road Rural Upgrade section

10.1.2.1 Section Overview

It is proposed to widen, and realign a portion of, the existing road within the Ōpāheke Road Rural Upgrade section to a 24m urban arterial. The Ōpāheke Road Rural Upgrade section extends 1.6km from the extent of the FUZ in the north to Ponga Road in the south. An overview of the concept design is provided in Figure 10-3.

Figure 10-3 Overview of Ōpāheke Road Rural Section

In addition to those listed above, the key features of the Ōpāheke Road Rural Upgrade section include:

- Roundabouts at Bellfield Estate and Ōpāheke N-S FTN Arterial / Ponga Road
- Realignment of a section of Ōpāheke Road and grade separation of the NIMT to avoid the Waikato 1 watermain and Ōpāheke Sports Fields and to allow the bridge to be constructed offline
- New road connection to Walker Road (and closure of a section of the existing Ōpāheke Road – replaced by the new NIMT bridge)

- Two walking and cycling bridges adjoining each side of the existing Ōtūwairoa Stream road bridge
- Two stormwater wetlands. One is an extension of an existing wetland located within Ōpāheke Reserve.

10.1.2.2 General Construction Overview

The Ōpāheke Road Upgrade is estimated to take 2 to 2.5 years to complete with the works being a mixture of earthworks, bridge works, service relocation, pavement construction, and drainage.

10.1.2.3 Construction Methodology

The general sequence of construction is likely to be:

1. Site establishment
2. Services relocation and/ or protection works
3. Environmental controls
4. Implement temporary traffic management to realign traffic and establish work areas
5. Commence works on the one side of the carriageway
6. Construct new culverts or extend existing ones
7. Earthworks
8. Install new stormwater drainage
9. Construct new pavement works
10. Construct the new cycleways and footpaths
11. Complete tie in works, footpath, cycle paths, lighting and landscaping
12. Divert traffic onto newly constructed pavement and bridge
13. Commence similar road works on the other side of the carriageway
14. Complete outstanding pavement works and remove any remaining temporary works
15. Install median kerbing, line marking, and street lighting
16. Complete road finishing works

10.1.2.4 Plant and Equipment

Table 10-1 provides an indicative list of plant and equipment which may be required for the construction.

10.1.3 Ōpāheke Road Urban Upgrade section

10.1.3.1 Section Overview

While the overall plan for the urban area of Ōpāheke Road is to upgrade the walking and cycling facilities from Ōpāheke Road Rural Upgrade in the south to Great South Road, Papakura in the north, only the areas affecting land outside the existing road reserve are proposed to be designated and assessed as part of this assessment. The Ōpāheke Road Urban Upgrade section of NoR D5 includes the regrading of nine driveways along Ōpāheke Road and the upgrade of the Ōpāheke Road / Settlement Road intersection to a roundabout. An overview of the proposed designation areas is provided in Figure 10-2 NoR D5.

Figure 10-2 NoR D5 Overview of Ōpāheke Road Urban Section

The key features of the Ōpāheke Road Urban Upgrade section include:

- Upgrade of the Ōpāheke Road / Settlement Road intersection to a roundabout to provide for separated walking and cycling facilities, including crossing facilities
- Minor earthworks to accommodate the footpath and cycle path construction
- Re-grade of nine driveways to match the future modified cross elevation.

10.1.3.2 General Construction Overview

The Ōpāheke Urban Road Upgrade is estimated to take 12-18 months to complete with the works being a mixture of earthworks, service relocation, pavement construction, and drainage.

10.1.3.3 Construction Methodology

The general sequence of construction is likely to be:

1. Site establishment
2. Services relocation and/ or protection works
3. Environmental controls
4. Implement temporary traffic management to realign traffic and establish work areas
5. Roundabout construction
6. Construct new pavement works
7. Complete outstanding pavement works and removes any remaining temporary works
8. Install median kerbing, line marking, and street lighting
9. Complete road finishing works

An indicative list of plant and equipment required is found in Table 10-1.

10.2 Assessment of Construction Noise and Vibration

All three sections of NOR D5 has been assessed as one due to the indicative equipment used is expected to be the same regardless of location.

The following residential buildings are within the proposed designation boundary and will be removed to make room for the Project alignment and therefore have not been assessed:

- 17 Settlement Road
- 21A Settlement road
- 18 Ōpāheke Road
- 215 Ponga Road

10.2.1 Construction Noise

10.2.1.1 Potential Construction Noise Levels

Model predictions assuming the works along the designation boundary indicate there are 72 buildings (45 residential in rural areas, 25 residential in urban areas and 2 commercial properties) where the relevant noise criteria would be exceeded without mitigation. Distances of receivers from the designation area boundary vary greatly along the road alignment with the closest receptor approximately 6 m from drainage and pavement construction works. There are no buildings location within the 73m radii of the minimum set back distance required for day-time compliance of 70 dB L_{Aeq} for piling works.

Model predictions indicate the closest receivers could experience noise levels of up to 90 dB L_{Aeq} during drainage and pavement construction works, based on the noisiest item of plant operating in the closest position to the receiver, without mitigation. Operation of construction equipment will be intermittent in nature and works in the worst-case location typically latest around 3 days. Whilst plate compactors have been identified as the noisiest equipment, they are only used as part of drainage and pavement construction works. Other equipment with lower sound powers will generate lower noise levels under the worst-case location and overall average noise levels will be lower for most of construction duration.

These results should be treated as the highest possible noise levels likely to be emitted from the respective equipment. These noise levels that would occur infrequently, if at all, as equipment and activities move along the alignment and is are not operational continuously operational. The noise levels provide an indicative prediction of the scale of potential effects based on one possible construction methodology.

10.2.1.2 Construction Noise Effects

The construction noise criteria are predicted to be exceeded at a number of receivers due to the close proximity to the potential areas of work up to the proposed designation boundary line. Closest receivers are 6 m from the proposed designation boundary for earthworks and predicted noise levels are around 85- 90 dB L_{Aeq} with the nosiest equipment being loader and plate compactor.

However, the use of these items of equipment will likely be intermittent in nature during the relevant construction activities. Although the worst-case situations are not expected to be frequent, due to the setback distances to the majority of the proposed works, these noise levels could result in loss of concentration, annoyance, and a reduction in speech intelligibility. The resulting noise levels indoors could also result in inability to hear conversations with each other and reduced productivity with office working being extremely difficult and not be tolerable for long periods of time. Table 5-4 gives examples of the potential effects on receivers at different noise levels.

Night time works at these noise levels are generally not acceptable at residential properties and the use of noisy equipment should be avoided to prevent sleep disturbance. If night-time works are required mitigation measures will be essential which may include an offer of temporary relocation for the most affected receivers to manage and mitigate adverse effects.

With effective mitigation and management measures in place, such as 1.8m barriers along active construction areas within the vicinity of receivers and enclosures around noisy machinery, noise levels can be reduced by up to 10dB at receivers on ground floor. Resulting worst case noise levels could be reduced to 75-80 dB with mitigation implemented and number of receivers exceeding the criteria reduced to 57.

In addition, the road construction is linear, and each receiver would only be affected for part of the overall construction duration. A CNVMP as detailed in Section 5.6, with site specific mitigation as required, sets out how to control noise levels and reduce adverse impacts on receivers.

10.2.2 Construction Vibration

10.2.2.1 Potential Construction Vibration Levels

Maps of the vibration contours based on the worst-case emission radii values of vibratory roller compactor are shown in **Appendix 1**. A list of building addresses predicted to exceed the relevant criteria are shown in Appendix 2.

42 dwellings may experience vibration levels above 5mm/s PPV exceeding the building damage criteria for residential buildings and three commercial buildings exceeding vibration levels of 10mm/s PPV. Predictions indicate a total of 129 buildings may receive vibration levels above the amenity criterion of 2 mm/s PPV. This does not include vibration from potential construction on driveways along the proposed Ōpāheke Road Urban Upgrade alignment.

It should be noted that the vibration generating equipment will not be operating all of the time and may not operate right at the boundaries of the area of works. Works around urban Ōpāheke Road involves roundabout construction and resurfacing works and equipment used are typically expected to generate vibration level lower than indicated above.

It is not expected that high level vibratory works such as the use of roller compactors will be carried out during night-time. If night-time works are required extensive consultation and management plans will be essential.

10.2.2.2 Construction Vibration Effects

Our initial predictions indicate that the Project building damage criteria may be exceeded at 42 residential buildings and three commercial buildings, in particular during the earthworks phase when

the vibratory roller compactor is proposed for use. Of the 42 residential buildings, 21 are in the Bellfield estate and 15 within the Ōpāheke Road Urban upgrade area. At buildings in close proximity to proposed designation boundary areas, there is the potential for cosmetic damage (such as cracking) and annoyance from perception of vibration. A building condition survey should therefore be carried out before (during detailed design) and after construction works at properties where predictions indicate the relevant building damage criteria may be approached, to determine if any damage has been caused by construction of the Project.

Section 5.5.2 provides further details on vibration effects and section 5.6 on management and mitigation measures.

10.3 Conclusions

An assessment of the construction noise and vibration effects has been undertaken for the Project. The predicted 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 receivers as they exist at the time of construction.

The assessment indicates 72 receivers are predicted to experience noise levels that would exceed the relevant criteria and 45 buildings are predicted to receive vibration levels that would exceed the relevant DIN criteria. As such, predictions for construction noise and vibrations along the Project alignment indicate mitigation measures are required to manage effects on buildings in the vicinity of the works. Mitigation measures such as 1.8m barriers along active construction areas within the vicinity of receivers and selecting the use of lower vibration emitting equipment wherever possible can be considered as part of a CNVMP to control construction noise and vibration levels to meet the relevant criteria where practicable.

A CNVMP should be prepared as it is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options and management and monitoring strategies. Section 5.6 of this report provides details on what should be included in the CNVMP.

11 Conclusion

An assessment of the construction noise and vibration effects has been undertaken for the Projects based on 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 selection, the environment and receivers as they exist at the time of construction. The assessment of each proposed designation assumes no concurrent construction works between designations. Any receivers that may be impacted by more than one Project would be reassessed closer to the time of construction.

The assessment across all NoR's indicates exceedances of the noise and vibration criteria for both commercial and residential receivers. The most impacted receivers are generally located within 10m of the proposed designation boundary and are likely to experience elevated noise and vibration levels. As such, predictions for construction noise and vibration along the Project alignment indicate mitigation measures are required to manage and mitigate effects on buildings and people. Specific mitigation measures are to be detailed within a CNVMP to manage and mitigate noise and vibration levels to meet the relevant criteria, where practicable.

It is recommended a CNVMP should be prepared prior to construction commencing as it is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers. The CNVMP will provide detailed mitigation options, management and monitoring strategies for controlling noise levels to meet the applicable criteria or reduce to a reasonable level. Section 5.6 of this report provide details on what is expected within the CNVMP. Mitigation measures such as 1.8m barriers along active construction areas in the vicinity of receivers and Low noise and low vibration machinery should be selected where practicable. can be considered as part of a the CNVMP. Where receivers are located less than 10m from the proposed designation boundary direct consultation and the preparation of a site specific schedules are recommended.

High noise and vibration generating activities should be scheduled for times when affected receivers are not occupied or during the daytime. Depending on the final construction methodology, mitigation and management measures may also include the offer of temporary relocation. The appropriate mitigation measures will be determined on a case-by-case basis throughout construction using the CNVMP as the implementation tool.

Effects of construction noise and vibration levels have also been discussed. 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 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 cosmetic building damage criteria, and where construction methodology cannot be changed to reduce vibration levels, building conditions surveys are recommended.

Overall, we consider that with the implementation of appropriate mitigation and management, the construction of the Projects would generate reasonable levels of noise and vibration.

Appendix 1. Construction Vibration Contour Maps

Legend

NoR1 Designation Boundary

NoR1 Designation Boundary

Recievers

Building Type

Commercial

Residential

Shed

Date Printed: 27/01/2021 7:36 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

N

Revision	Author	Verified	Approved	Date
1	Author	DRAFT	DRAFT	dd/mm/yyyy

Title:

Supporting Growth

NoR D1 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

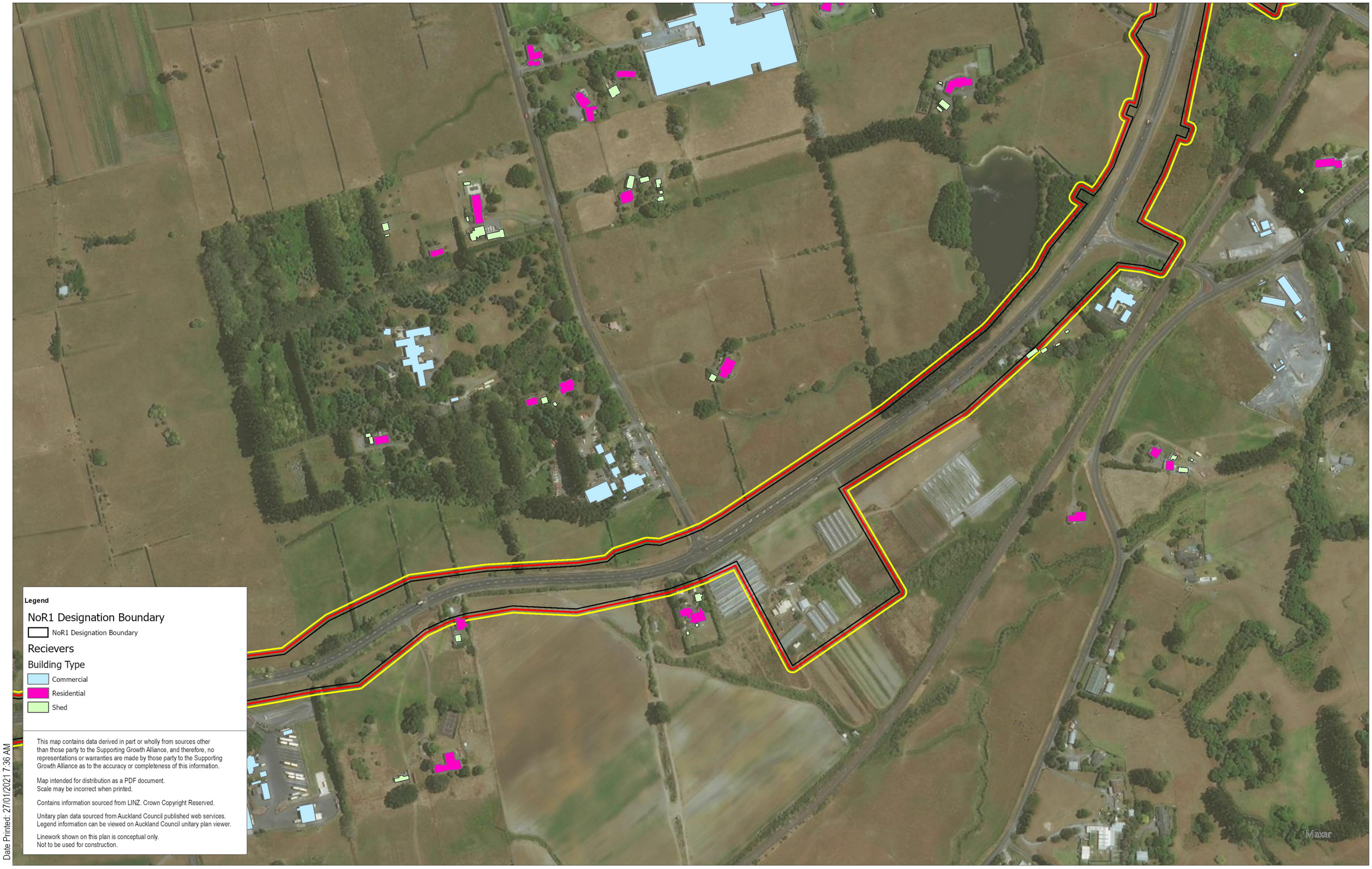
Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 001



Date Printed: 27/01/2021 7:36 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 002

Legend

NoR1 Designation Boundary

NoR1 Designation Boundary

Recievers

Building Type

Commercial

Residential

Shed

Date Printed: 27/01/2021 7:36 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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NoR D1 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 003

Legend

- NoR2 Designation Boundary
- Historic/Sensitive
- Not Assessed

Buildings

PPF

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s
- Historic / Sensitive 2.5 mm/s

Date Printed: 27/01/2021 7:37 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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NoR D2 - Vibration Contours

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Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 004

Legend

- NoR2 Designation Boundary
- Historic/Sensitive
- Not Assessed

Buildings

PPF

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s
- Historic / Sensitive 2.5 mm/s

Date Printed: 27/01/2021 7:37 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

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Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 005

Legend

- NoR2 Designation Boundary
- Historic/Sensitive
- Not Assessed

Buildings

PPF

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s
- Historic / Sensitive 2.5 mm/s

Date Printed: 27/01/2021 7:37 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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NoR D2 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
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Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 006

Legend

- NoR2 Designation Boundary
- Historic/Sensitive
- Not Assessed

Buildings

PPF

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s
- Historic / Sensitive 2.5 mm/s

Date Printed: 27/01/2021 7:37 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

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NoR D2 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
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Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 007

Legend

NoR3 Designation Boundary

Buildings

PPF

Commercial

Residential

Shed

Not Assessed

Vibration Contours (Long Term)

Commerical 10 mm/s

Residential 5 mm/s

Date Printed: 27/01/2021 7:35 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Title:

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NoR D3 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 008

Legend

- NoR3 Designation Boundary
- Shed
- Not Assessed

Buildings

PPF

- Commercial
- Residential

Vibration Contours (Long Term)

- Commerical 10 mm/s
- Residential 5 mm/s

Date Printed: 27/01/2021 7:35 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Title:

Supporting Growth

NoR D3 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
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Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 009

Legend

NoR4 Designation Boundary

Buildings

PPF

Commercial

Residential

Shed

Vibration Contours

Commerical 10mm/s

Residential 5mm/s

Date Printed: 27/01/2021 7:40 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Title:

Supporting Growth

NoR D4 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: Supporting Growth

Project: Drury Package

TE TUPU NGĀTAHI Supporting Growth

Discipline: GIS

Drawing No: SGA-XX-XX- 010

Date Printed: 27/01/2021 7:40 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

N

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Title:

Supporting Growth

NoR D4 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 011

Legend

NoR4 Designation Boundary

Buildings

PPF

Commercial

Residential

Shed

Vibration Contours

Commerical 10mm/s

Residential 5mm/s

Date Printed: 27/01/2021 7:40 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Title:

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NoR D4 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 012

Date Printed: 27/01/2021 7:40 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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NoR D4 - Vibration Contours

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Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 013

Legend

- NoR5 Designation Boundary

Buildings

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s

Date Printed: 27/01/2021 8:06 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Title:

Supporting Growth

NoR D5 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 014

Legend

- NoR5 Designation Boundary

Buildings

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s

Date Printed: 27/01/2021 8:06 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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NoR D5 - Vibration Contours

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Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 015

Legend

- NoR5 Designation Boundary

Buildings

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s

Date Printed: 27/01/2021 8:06 AM

Map Scale @ A3:1:4,000

0 0.03 0.06 0.12

Kilometres

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Title:

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NoR D5 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 016

Legend

- NoR5 Designation Boundary

Buildings

- Commercial
- Residential
- Shed

Vibration Contours

- Commerical 10 mm/s
- Residential 5 mm/s

Date Printed: 27/01/2021 8:06 AM

Map Scale @ A3:1:2,000

0 0.01 0.03 0.06

Kilometres

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Title:

Supporting Growth

NoR D5 - Vibration Contours

Working Plans of Te Tupu Ngatahi.
For the purpose of INTERNAL workshops (not for wider distribution)

Client: **Supporting Growth**

Project: **Drury Package**

TE TUPU NGĀTAHI Supporting Growth

Discipline: **GIS**

Drawing No: **SGA-XX-XX-** 017

Appendix 2. Addresses of Existing Buildings Exceeding Vibration Cosmetic Building Criteria

NOR D1

Receiver Address Exceeding Criteria	Type
200 Karaka Road	Residential
329 Karaka Road	
435 Karaka Road	
5 Burberry Road	
69 Mercer Street	Commercial

NOR D2

Receiver Address Exceeding Criteria	Type
201 Jesmond Road	Historic
9 Cameron Place	
101 Waihoehoe Road	Residential
125 Jesmond Road	
144 Bremner Road	
169 Jesmond Road	
235 Jesmond Road	
281 Jesmond Road	
288 Jesmond Road	
3 Fitzgerald Road	
31 Waihoehoe Road	
11 Bremner Road	Commercial
141 Jesmond Road	
22 Norrie Road	
222 Great South Road	
233 Great South Road	
236 Great South Road	
35 Firth Street	
38 Bremner Road	
38 Firth Street	
48 Creek Street	
5 Bremner Road	
64 Jesmond Road	

NOR D3

Receiver Address Exceeding Criteria	Type
31 Appleby Road	Residential
168 Waihoehoe Road	
201 Waihoehoe Road	
185 Waihoehoe Road	
432 Waihoehoe Road	

NOR D4

Receiver Address Exceeding Criteria	Type
48 Ponga Road	Residential
68 Ponga Road	
28 Ponga Road	
6 Ponga Road	
85 Boundary Road	Commercial
141 Boundary Road	
70 Hunua Road	

NOR D5

Receiver Address Exceeding Criteria	Type
1 Lorelei Place	Residential
10 Ōpāheke Road	
11 Ōpāheke Road	
114 Ōpāheke Road	
117 Ponga Road	
12 Ōpāheke Road	
126 Ponga Road	
13 Ōpāheke Road	
14 Alexander Street	
14 Ōpāheke Road	
14 Settlement Road	
145 Ponga Road	

Receiver Address Exceeding Criteria	Type
15 Ōpāheke Road	
16 Ōpāheke Road	
16 Settlement Road	
17 Ōpāheke Road	
17 Settlement Road	
18 Ōpāheke Road	
19 Ōpāheke Road	
2 Lorelei Place	
2 Ōpāheke Road	
20 Ōpāheke Road	
21 Settlement Road	
216 Ōpāheke Road	
23 Settlement Road	
25 Settlement Road	
3 Ōpāheke Road	
32 Ōpāheke Road	
4 Ōpāheke Road	
5 Ōpāheke Road	
56 Ōpāheke Road	
6 Ōpāheke Road	
7 Ōpāheke Road	
74 Ponga Road	
78 Ōpāheke Road	
8 Ōpāheke Road	
81 Ōpāheke Road	
9 Ōpāheke Road	
95 Ōpāheke Road	
97 Ōpāheke Road	
98 Ōpāheke Road	
99 Ōpāheke Road	
174 Ponga Road	Commercial
211 Ōpāheke Road	
223 Ōpāheke Road	