WAKA KOTAHI
NZ TRANSPORT AGENCY

DRURY ACCESS RAMP PROJECT

Appendix P – Noise and Vibration Assessment

Revision No: A

Published Date: 13/07/2023

Author: Raditya Putra

Reference: 523844-W00001-REP-EN-0007

New Zealand Government

More information

NZ Transport Agency
June 2021

If you have further queries, call our contact centre on 0800 699 000 or write to us:

NZ Transport Agency
Private Bag 6995
Wellington 6141

This document is available on the NZ Transport Agency's website at **http://www.nzta.govt.nz**

Document Control

Rev No	Date	Description	Author	Reviewer	Verifier	Approver
A	2023-03-10	First Draft	R Putra	S Wilkening		

CONTENTS

Appendices

Figures

Tables

Abbreviations

Abbreviation	Term
AEE	Assessment of Environmental Effects
AUP	Auckland Unitary Plan (Operative in Part 2016)
BPO	Best Practicable Option (in accordance with Section 16 of the RMA)
CNVMP	Construction Noise and Vibration Management Plan
NIMT	North Island Main Trunk
NOR	Notice of Requirement
P2B	SH1 Upgrades Project between Papakura to Bombay
RMA	Resource Management Act 1991
SH1	State Highway 1 Motorway, the Southern Motorway
SH22	State Highway 22, Great South Road
SUP	Shared Use Path

the Project	Proposed Access Ramp at Drury Interchange
Waka Kotahi	Waka Kotahi NZ Transport Agency

EXECUTIVE SUMMARY

This report comprises an assessment of construction noise and vibration, and traffic noise, to support the Proposed Access Ramp at Drury Interchange (the Project).

This assessment of effects has been undertaken as follows:

Construction noise and vibration

- Noise was assessed in accordance with NZS6803:1999 *Acoustics – Construction Noise*. This standard is referenced in the Auckland Unitary Plan (Operative in Part) 2016 (AUP) and the Waka Kotahi "State Highway Construction and Maintenance Noise and Vibration Guide", V1.1, August 2019 (Waka Kotahi Guide 2019)
- Vibration was assessed in accordance with the Waka Kotahi Guide 2019, which establishes two sets of criteria; Category A generally for human amenity which act as trigger levels for consultation and communication, and Category B to avoid cosmetic building damage. This is achieved by ensuring compliance with the provisions of the German Standard DIN 4150-3:1999 *Structural Vibration - Part 3: Effects of Vibration on Structures*. The Waka Kotahi Guide 2019 also allows for the application of the British Standard BS 5228-2:2009 *Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* at unoccupied buildings.
- Construction noise is assessed based on likely and anticipated equipment and methodologies as provided by the client. For each piece of equipment likely to be used, relevant sound power data was obtained from Standards or previous measurements, and levels combined to "activity specific" noise levels that take account of the spatial and temporal placement and operation of equipment items.
- Construction vibration is assessed based on prior measured vibration levels of high vibration generating equipment. Much of this equipment was able to be measured at previous stages of the P2D project (i.e. Stages 1A and 1B1) and has been used for this report.
- We have recommended mitigation, which would be included in the CNVMP, to manage construction noise and vibration effects and reduce levels experienced at neighbouring buildings.
- Potential adverse effects of the Project are likely if night-time construction is required. The most affected dwellings are at 74 Mercer Street, should night-time vibro piling works be undertaken.

Traffic noise

- There are no Protected Premises and Facilities (PPFs) within 100m of the edge of the proposed access ramp.
- The ramp traffic will have little overall effect on receivers further from the road as the main noise source is SH1 with its significantly higher traffic volume.
- Therefore, traffic noise did not require a detailed assessment.

With the adoption of the management and mitigation measures for construction noise and vibration, and traffic noise, the potential noise and vibration effects of the Project are considered to be reasonable.

1 INTRODUCTION

1.1 Project Background Drury Interchange

This Report supports the application lodged by Waka Kotahi NZ Transport Agency (Waka Kotahi) for the construction of a new southbound access ramp at Drury Interchange (The Project).

The proposal is considered in the context of the Papakura to Bombay Project (P2B). P2B is a Waka Kotahi project set to improve the safety and functionality of State Highway 1 (SH1) and provide for long term growth in the south of Auckland. Waka Kotahi has structured P2B in to five stages. The most pertinent of these is Stage 1B1, which pertains to the approved upgrades of Drury Interchange. Stage 1B1 was approved under the COVID-19 Recovery (Fast Track Consenting) Act 2020 ("FTA").

In addition, the proposed site for the Project interfaces the following consented and future developments in the area:

- Future development areas in Drury which are detailed in section 2.1 below;
- Realigned SH1 corridor and SH22 / Great South Road as consented in Stage 1B1 of the Papakura to Drury ("P2D") project by Waka Kotahi;
- Future proofing works along North Island Main Trunk (NIMT) rail corridor by KiwiRail as part of Papakura to Pukekōhe (P2P) rail electrification works; and

1.2 Project Description Drury Centre Access Ramp

The proposal is for the construction of a new southbound access ramp from SH1 to provide direct connection to future development areas in Drury Town Centre. The approximate location of the proposed off-ramp in relation to the surrounding existing and planned environment is referred to in the AEE and shown in Figure 1-1below.

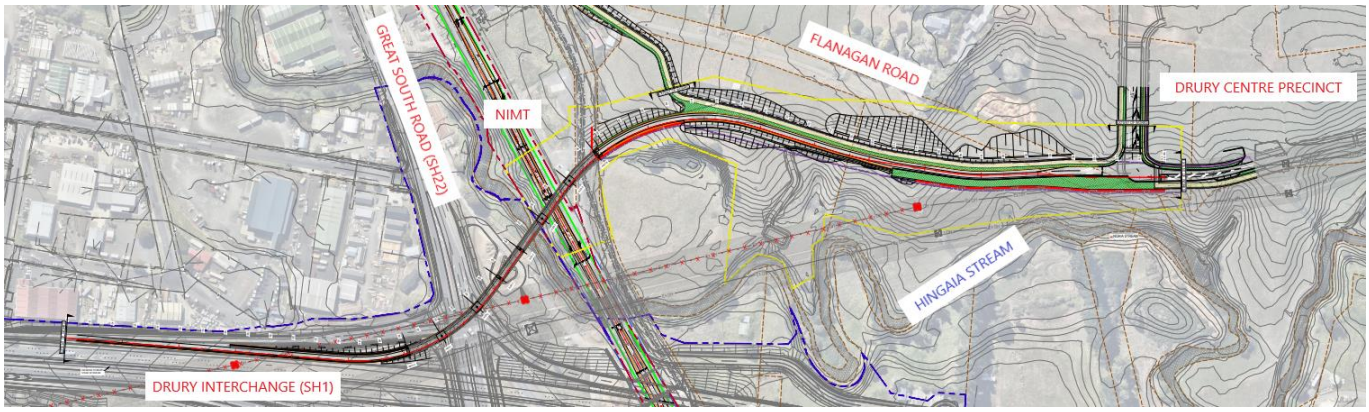


Figure 1-1 Indicative location plan of the Drury Access Ramp

In relation to construction noise and vibration, the following are proposed for the Project:

- Construction of a 245m long seven span structure bridge from southbound lane of SH1 to an area off Flanagan Road;
- Foundation piling works for bridge support; and
- Establishment of a left-hand shoulder lane on the bridge with a minimum width of 2m and right -hand shoulder 1m in width.

In relation to traffic noise, the following is proposed for the Project:

- Operation of a 245m long seven span structure bridge from southbound lane of SH1 to an area off Flanagan Road.

The Project takes place within the existing Flanagan Road (considered as a local road in the AUP) and existing services and utilities, which include: 1200mm diameter underground Waikato watermain parallel to the NIMT corridor; underground sewer and watermain pipes along Flanagan Road; and high voltage overhead lines located directly above the proposed ramp, which is planned to be removed.

1.3 Purpose of this Report

This report on noise and vibration forms part of a suite of technical reports prepared for the Project. Its purpose is to inform the AEE for:

- NoR for alteration to the existing Designation 6706 for which Waka Kotahi is the Requiring Authority under section 181 of the RMA; and
- Resource consent application for national environmental standard matters under NES-CS and NES-F; and
- Resource consent application for regional matters under the AUP.

This report assesses the construction noise and vibration effects and briefly discusses the traffic noise effects of the Project and recommends mitigation or management measures to address any actual or potential adverse effects.

The report will:

- Describe the existing ambient noise environment and identify the relevant sensitive receivers in that environment within the Project area.
- Assess the effects on the identified areas or structures affected by the proposed works.
- Recommend mitigation and management measures to address potential adverse effects of construction of the Project.

In assessing the effects related to noise and/or vibration, the main elements associated with the proposed works that are assessed in this report are:

- During the construction phase, the effects of:
  - Earthworks, piling, and bridge construction.
  - Potential night-time works at the existing motorway offramp.
- During the operation phase, the effects of:
  - Traffic noise from vehicles along the access ramp.

2 EXISTING ENVIRONMENT

The following is an overview of the existing ambient noise environment in the Project area. A detailed overview of the existing environment can be found in **Appendix A**.

The existing noise environment from traffic on existing roads provides a baseline for assessing noise effects. Effects can be assessed by quantifying the noise levels that people would experience due to the implementation of a project. The change in noise environment can then be interpreted in relation to subjective responses of people and possible annoyance.

2.1 Planning Environment

2.1.1 Designations

The primary designation which covers the majority of the Project corridor is Designation 6706, which is described in **Table 2-1** below. The corresponding planning environment maps are contained in **Appendix N**.

Table 2-1 The Designation in the Project area

Reference No.	Requiring Authority	Designation and Purpose	Location	Conditions
Designation 6706	Waka Kotahi	Motorway purposes between Auckland and Hamilton	SH1, north of Takanini interchange to the south of Quarry Road, Drury	Construction noise and vibration conditions on Stage 1B1 (refer Appendix B1)

There are a number of designations that overlap the Project corridor, which are described in **Table 2-2** below. The corresponding existing environment maps are contained in **Appendix N**.

Table 2-2 Overlapping designations in the Project area

Reference No.	Requiring Authority	Designation and Purpose	Location
Designation 6302	KiwiRail	NIMT Railway Line	South of the Drury Interchange.
Designation 6566	Watercare Services Ltd	Water supply purposes – pump station and associated structures	Flanagan Road and NIMT

2.1.2 Plan Change 48

Private Plan Change 48 (PC48) was approved by Auckland Council to rezone approximately 95 hectares of land from Future Urban to 35.5 hectares of Business: Metropolitan Centre Zone, approximately 51.8 hectares of Business Mixed Use Zone surrounding the Metropolitan Centre and, 7.4 hectares of Open Space: Informal Recreation Zone at Drury known as PC48 – Drury Centre Precinct. PC48 considered the potential for a future southbound off ramp into Drury Centre Precinct.

2.1.3 Papakura to Drury (P2D)

The overall works for Stage 1B1 were approved under the FTA on 12th November 2021, which included planning approvals for various upgrades at Drury Interchange, such as the realignment and raising of the interchange towards the east, new bridges over State Highway 22 (SH22), a new off-road Shared Use Path (SUP), additional shoulders and associated stormwater infrastructure. For brevity, the relevant approvals can be summarised as follows:

- Regional and district resource consents granted to Waka Kotahi for the construction and operation of the project. Granted for Stage 1B1 on 12 November 2021 in accordance with the FTA:

  Land use consents LUC60391712;

  Groundwater consent WAT60391714;

  Stream works consent LUS60391713;

  Coastal works consent CST60391716 and

  Discharge consents DIS60391717 and DIS60391718.

- Decision on compliance for the State Highway 1 Papakura to Drury South State Highway 1 improvements (Listed Project LP15) – Transmission Line works under clause 3 of Schedule 6 of the FTA.\

2.2 Receiving Environment

The existing receiving environment contains a combination of residential and business uses in addition to areas of undeveloped residential, informal recreation and business zones.

An industrial area is located northeast of the works. Most of the buildings are commercial, with a small number consisting of more sensitive activities, such as the Keith Hay Homes office, Benchtop Direct factory and Horticentre offices. The Drury Presbyterian Church is located approximately 200m north of the Project.

A large portion of land south of the Project is undeveloped which will consist of future residential and commercial developments in accordance with the Drury Town Centre masterplan. The development will be carried out by Kiwi Property Group. Any dwellings existing in the Kiwi Property Group site will be removed to allow for the Town Centre development. Therefore, our assessment has not taken into account future impacts on the current dwellings. In any event, there are no existing dwellings within 100m of the alignment on any Kiwi Property sites, with the exception of a dwelling at the northern end of 108 Flanagan Road which is about 77m from the closest traffic lane. While we understand that this dwelling will be removed prior to construction of the Project as it will be affected by the construction of a shared use path, we have discussed it in case it still exists during the early phases of the Project.

The area to the southwest, beyond SH1, while zoned residential, is currently rural in character. There are a childcare centre, and riding facility to the west of SH1.

Another area to the west is a new residential subdivision which is currently under development. The dwellings are located at significant distance from the Project, with the closest dwelling at 320 metres from the edge of the ramp.

2.3 Surveys

We undertook short duration attended noise level surveys on 10 June 2020 between 2.00pm and 3.30pm, within the vicinity of the Project, and at significant distances from the Project (refer **Table 2-3)**. These surveys were carried out during Covid-19 restrictions, and therefore may represent lower than normal traffic volumes. As traffic distribution over the day is known, the short duration survey results can be used to derive a 24-hour traffic noise level.

One long duration noise level survey was undertaken in September 2020, approximately 500m north of the Project area. A logger was installed and measured noise levels continuously. The measured data was analysed, and 24-hour noise levels determined. A summary of the long duration survey is included in **Appendix A**.

All noise level survey results are shown in Table 2-3.

Table 2-3: Noise level survey results – 24 hour levels

Location	Start time	Duration	Measured noise	Derived noise level
			dB $L_{Aeq(T)}$	dB $L_{Aeq(24h)}$
168 Flanagan Road	2.00pm	15 min	71	69
Pitt Road	2.45pm	15 min	56	54
Tegal Road	3.20pm	15 min	61	59
33 Bremner Road	Logger	7 days	n/a	66

Noise levels are relatively unaffected by changes in traffic volume. To effect a 3dB noise level change, the traffic volume would have to double. To achieve a 1dB noise level change, a 30% change in traffic volume is required. Since traffic volumes only change marginally year on year, we consider the noise levels measure in 2020 to still be valid when describing that the ambient noise environment is affected by traffic noise.

Overall, the environment is affected by traffic noise from SH1 as would be expected for locations next to a highly trafficked road.

3 ASSESSMENT OF EFFECTS

3.1 Construction Noise and Vibration

The following sections discuss the potential adverse impacts from construction noise and vibration associated with the Project works on neighbouring buildings. Further detail on the assessments is provided in **Appendix B**.

This assessment of effects has taken into consideration the statutory requirements described in Section B1 of **Appendix B** in respect of the impact of construction noise and vibration.

3.1.1 Performance standards

Some parts of the Project will be constructed within the existing boundary of Designation 6706. Those sections that are outside the existing designation will be constructed based on the same methodology and with the same equipment, and have also been assessed under the same provisions as set out in the designation.

Noise and vibration conditions set out the performance standards.

In summary:

- Construction noise is assessed in accordance with NZS6803:1999 Acoustics – Construction Noise. This standard is referenced in the AUP and the Waka Kotahi "State Highway Construction and Maintenance Noise and Vibration Guide", V1.1, August 2019 (the Waka Kotahi Guide). Daytime noise standards are 75 dB L_{Aeq} and 90 dB L_{AFmax}. Night-time noise standards are 45 dB L_{Aeq} and 75 dB L_{AFmax}.
- Construction vibration is assessed addressing both amenity and the avoidance of building damage:
  - One set of standards has reference criteria for human amenity which act as trigger levels for consultation and communication.
  - The other set of standards are designed to avoid cosmetic building damage. This is achieved by ensuring compliance with the provisions of German Standard DIN 4150-3:1999 "Structural Vibration - Part 3: Effects of Vibration on Structures". Waka Kotahi vibration standards also allow for the application of the British Standard BS 5228-2:2009 "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration" at unoccupied buildings.

Refer to Section B1 of **Appendix B** for the full wording of the conditions.

As the noise and vibration effects of works inside the existing designation are already authorised, the effects of those works do not have to be assessed, and we have focused on those that are outside the designation. We note, however, that the management of noise and vibration effects within the existing designation will be confirmed through an Outline Plan of Works (OP) process and will include the preparation and implementation of a CNVMP for the overall works and Schedules to the CNVMP (Schedules) for specific activities and receivers, in accordance with Condition CNV.1.

The criteria set out in the above designation conditions are appropriate this Project also. We have therefore assessed the construction noise and vibration effects from Project works against them.

3.1.2 Assessment Methodology Overview

This section provides an overview of the assessment methodology used to assess the construction noise and vibration effects of the Project. Further detail on the assessment methodology is provided in section B2 in **Appendix B**.

We recognise that most of the works will occur inside the existing designation and would therefore not be subject to the rules of the AUP. Nevertheless, as construction moves along the alignment, receivers would be unaware of the location of the works inside or outside the designation and experience noise and vibration irrespective of the location. Therefore, we have assessed construction noise and vibration of all works equally.

To assess the construction noise and vibration effects of the Project, the following methodology is used:

- Construction noise is assessed based on likely and anticipated equipment and methodologies as provided by the client. For each piece of equipment likely to be used, relevant sound power data was obtained from Standards or previous measurements, and levels combined to "activity specific" noise levels that take account of the spatial and temporal placement and operation of equipment items.
- Construction vibration is assessed based on prior measured vibration levels of high vibration generating equipment. Much of this equipment was able to be measured at previous stages of this Project (i.e. Stages 1A and 1B1).
- We have recommended mitigation, which would be included in the CNVMP, to manage construction noise and vibration effects and reduce levels experienced at neighbouring buildings.

3.1.3 Noise

3.1.3.1 Predicted Noise Levels

We have predicted construction noise levels based on experience with similar projects, specifically Stage 1B1 of the Project, and in similar circumstances. The list of equipment and its respective sound power levels used as the basis of our predictions is set out in Table B-1 in **Appendix B**. It is important to keep in mind that this list is a "best estimate" of equipment that is likely to be used. Although the contractor may use different size or type of plant, from experience on other infrastructure construction projects we consider that noise emissions will be similar for each combined activity.

We used the noise levels in Table B-1 to predict combined "activity sound power levels" (Table B-2 in **Appendix B**). The activity sound power level takes account of the fact that not all items of equipment would operate in the same area and at the same time, that some activities are intermittent and therefore have a time component to them, and that some works move along the alignment while others are stationary.

From the activity sound power levels, we then determined the distance at which the 75 dB L_{Aeq} day-time noise criterion can be complied with, without noise barrier mitigation.

We recommend that the predictions be updated for the CNVMP to reflect the proposed scope of works and buildings that exist at the time of construction. Section 16 of the RMA applies, and the Best Practicable Option (BPO) will need to be implemented to manage noise effects on all areas, irrespective of compliance.

The following activities have been used to determine noise levels at the closest receivers. These are the activities we consider having the greatest impact on construction noise.

- Earthworks may generate noise levels up to 75 dB L_{Aeq} within 50m of operations where direct line-of-sight occurs between buildings and earthworks. Given the closest dwelling is 320m away from works, we predict compliance with the 75 dB L_{Aeq} noise limit at all closest dwellings. Closest occupied commercial buildings are 70m from the works. Noise levels are predicted to be up to 65 dB L_{Aeq}. A currently existing dwelling at 108 Flanagan Road is about 77m from the closest works. While this dwelling is likely to be removed as part of the wider works in the area, if it did still exist at the time of construction, as it is at a distance beyond 50 metres, we predict compliance with the 75 dB L_{Aeq} noise criterion.
- Construction of MSE retaining walls is limited to three locations. One retaining wall to the west of the existing off ramp and the other two south of Flanagan Road. The location of the closest MSE retaining wall is at least 370m from the closest dwelling and 70m from the closest occupied commercial building. If the dwelling at 108 Flanagan Road was till present during construction of the Project, it will be 85m from the MSE wall. Vibratory rolling is required to construct the MSE retaining walls. We predict compliance with the relevant noise criteria at all receivers.
- Bridge construction works, including piling, particularly the installation of bridges across Great South Road and the NIMT, may be undertaken at night-time and therefore may have additional adverse effects on closest residents. Closest dwellings to the proposed bridge are at distances of more than 320m, and therefore noise

levels can generally be controlled to a reasonable level (55dB L_{Aeq}). The industrial area northeast of the works consists of limited number of occupied commercial buildings. We recommend that bored piling be utilised instead of impact or vibratory piling as far as practicable, to reduce noise and vibration levels.

- Construction of access staging over Hingaia Stream, including vibro piling.
- Construction of structures and pavements is less noisy than bulk earthworks. These activities have the potential to generate noise levels of above 75 dB L_{Aeq} within 25m of the works. We predict that construction of the structures and pavement outside the designation can comply with the noise standards.

We predicted noise levels from construction and determined setback distances where compliance with the Project standards can be achieved (refer to section B1 in **Appendix B**).

We recommend management and mitigation of noise emissions in accordance with best practice as set out in the Waka Kotahi Guide, for all works irrespective of location or compliance with criteria. There is an overriding requirement to apply the best practicable management and mitigation option irrespective of compliance with relevant noise limits.

3.1.3.2 Recommended Mitigation

We recommend that a CNVMP is prepared and implemented. Should specific works such as those at night-time be required and noise levels may exceed the relevant limits, a Schedule should be prepared (refer section 3.1.5 of this report).

We recommend that bored piling be utilised instead of impact or vibratory piling as far as practicable, to reduce noise and vibration levels.

3.1.3.3 Noise effects

The closest buildings to the works are the commercial buildings at the industrial area to the northeast. The closest buildings are unoccupied show homes. Occupied commercial buildings (e.g. offices, factories) are located further away from the works (approximately 70m).

The works are located far from any dwellings. The closest dwelling to works outside the existing designation is 74 Mercer Street, which is also a Childcare. We anticipate that majority of the works would generally occur during daytime. All dwellings are predicted to receive noise levels that readily comply with the relevant daytime limits.

Night-time works may be required for piles located close to Great South Road and the NIMT.

The closest dwellings to the works are predicted to receive noise levels up to 50 dB L_{Aeq} if night-time bored piling works are undertaken at the existing motorway offramp. Any such works would be limited in duration, to individual one or two night works only rather than several consecutive nights.

When works occur at the existing motorway offramp, predicted noise levels at occupied commercial buildings to the northeast are predicted to be between 65 and 70 dB L_{Aeq}.

Daytime

Noise levels affect people in their place of residence or work. Construction noise is inherently higher than ongoing operational noise, which is reasonable due to its limited duration.

Generally, construction noise is assessed in relation to people inside buildings. It is assumed that people will choose to not spend any extended periods in an outdoor area next to high noise construction activities. It is also assumed that people will keep their windows and doors closed to reduce internal noise levels. Generally, New Zealand dwelling facades reduce noise levels by 20 to 25 decibels. We have assumed conservatively a noise level reduction of 20 decibels. How people may react to the noise levels predicted is shown in section B2.1.2 in **Appendix B**.

In summary, the closest dwellings to the works are predicted to receive façade noise levels up to 50 dB L_{Aeq} for short periods as they are located at significant distance from the works. If vibro piling is required for the foundations of the

access staging, the closest dwelling to the works is predicted to receive façade noise levels up to 54 dB L_{Aeq}. All of these noise levels are well within the relevant daytime noise limits, and at times below the existing ambient noise levels from traffic on SH1.

Buildings in the Drury industrial area northeast of the works are of varying construction and appear to generally contain non-noise sensitive uses, with limited number of buildings which may contain offices. It is unlikely that construction will cause any adverse effects on those working at the Drury industrial area.

The closest occupied commercial buildings facing the works are predicted to receive façade noise levels up to 70 dB L_{Aeq} for short periods, with noise levels generally between 65 and 70 dB L_{Aeq}. Any occupied commercial buildings without line of sight to the works are predicted to receive noise levels around 60 dB L_{Aeq} during busy periods, and noise levels below 60 dB L_{Aeq} for normal construction works. That means that for buildings facing Great South Road and the existing motorway offramp, there may be some impacts on an office work environment which can be mitigated by closing doors and windows while works are closest. Compliance with the noise limits can be achieved at all receivers.

Night-time

The noise level received inside a noise sensitive space (e.g. bedroom) will depend on the external noise level, sound insulation performance of the façade (particularly the glazing) and room constants (such as the room dimensions and surface finishes). These factors can vary widely.

Noise levels at the closest dwellings may be up to 54 dB L_{Aeq} if vibro piling is required at night-time. With windows closed, internal noise levels will be typically acceptable, as detailed in section B2.1.3 in Appendix B.

3.1.4 Vibration

3.1.4.1 Predicted Vibration Levels

We have determined the likely construction equipment to be used for the works. We then assessed which of the construction methodologies and plant would cause the highest vibration levels. For that equipment, we have determined relevant vibration level data from previous measurements carried out by MDA, the British Standard BS 5228-2:2009 and the Transport Research Laboratory Report referenced by that standard.

Our predictions are based on regression curves of vibration level at various distances for vibratory rollers and vibro piling rigs. We then applied a 100% safety margin to the regression curve derived from the measured data, to take account of ground condition uncertainty, making the predictions conservative. The regression curves (including safety margin) for vibratory rollers and vibro piling are shown in section B2.2 and Figure B-5-1 in **Appendix B**. Vibro piling may only be used for the construction of the access staging, which is localised.

The activities that pose the greatest risk of the exceeding vibration criteria (human annoyance and building damage as set out in the Waka Kotahi guidelines) are vibratory rolling and vibro piling. Other construction activities, while also generating vibration, would do so at a much lower level and are predicted to comply with the relevant criteria.

In summary, any dwellings within 7m of vibro piling and 15m of vibratory roller use are at risk of the Category B (building damage) criteria being exceeded. Where dwellings are more than 45m from vibro piling and 55m from vibratory roller use, the Category A (amenity) vibration criteria can be complied with. These distances are lower for commercial buildings.

The closest dwelling to the works is 320m away, therefore all dwellings will receive vibration levels readily compliant with both Category A and Category B criteria. This also applies to the Drury Presbyterian Church located approximately 180m north from the closest works.

The closest buildings at the industrial area to the northeast of the works consist of unoccupied show homes at about 30m. Compliance with Category A and B criteria will be achieved at the unoccupied show homes. The closest occupied commercial buildings are at least 70m away from the works. Therefore compliance with Category A and B criteria will be achieved at all occupied receivers in the industrial area.

The Project standards are significantly more stringent at dwellings during the night and have the potential to be exceeded at distances greater than 200m from the night-time works. There are no dwellings within 320m of the works. On this basis, vibration intensive activities adjacent the existing motorway offramp should be generally scheduled for the daytime wherever practicable.

There are two existing watermains near the proposed piling works. Information on the watermains has been obtained from work we have carried out for the NIMT bridge outlined in Table 3-1 below.

We assume that the Watercare 1200 watermain is a concrete pipe in good condition. We assume that the Watercare Double Rising Wastewater and Veolia 450 Watermain are both plastic pipes in good condition.

Table 3-1: Pipe details in the vicinity of the works

Utility	Predicted min horizontal clearance	Requested min horizontal clearance to Utility Owner	Material	Approx. depth below construction work level
Watercare 1200 Watermain (WW-03)	1.5m	1.5m	Concrete Lined Steel	1.6m
Watercare Double Rising Wastewater (WW-01 and WW-02)	1.35m	1.0m	315OD and 450OD PE	6.2m
Veolia 450 Watermain (VW-01)	1.4m	1.0m	450OD PE	1.4m

Based on the measurements we carried out, for bored piling, compliance with the vibration limits can be achieved at distances of 1 metre. Vibro piling shall not be used within 3 metres of plastic pipes. The closest piling location is at least 7m from the watermains and wastewater pipes, therefore compliance with the vibration limits will be achieved provided piling locations are not moved. Vibratory rollers used for construction of the MSE walls are located at least 7m from the closest watermains. At this distance, compliance with the vibration limits will be achieved.

3.1.4.2 Recommended Mitigation

We recommend that vibro piling is avoided at distances within 3 metres of plastic pipes, or within 1 metre of concrete pipes.

3.1.4.3 Vibration effects

Vibration levels can be perceived well below a level at which cosmetic building damage may occur. For structural damage to occur, vibration levels would need to be magnitudes higher than the levels at which vibration can be perceived. People tend to react to low vibration levels, and it is important to inform residents in the vicinity of the works of the potential for construction vibration to be felt.

Section B2.2.3 and Table B-6 in **Appendix B** show how people in residential and office environments may react to various vibration levels. These effects do not consider less sensitive uses such as factories or manual work areas (e.g. the industrial uses north of Great South Road).

Overall, given the distance of the closest sensitive buildings to the works, and with appropriate site management and mitigation (refer to section 3.1.5 of this report), we consider that the effects from construction vibration are within a reasonable range and would not cause adverse effects.

3.1.5 Construction Noise and Vibration Mitigation and Management

Good noise and vibration management is essential in reducing adverse effects as far as practicable, irrespective of compliance with the relevant criteria.

The most effective way to control construction noise and vibration is through good on-site management and communication between managers and other staff. Management and mitigation measures are most appropriately set out in a CNVMP, which would be used to manage works on site and sets out how the construction contractor interacts with the neighbouring affected parties. The CNVMP should also follow the approach outlined in the Waka Kotahi Guide. This includes a requirement for high noise and vibration risk construction projects to have an independently peer reviewed CNVMP and include a comprehensive risk-based quality assurance programme to ensure risks are appropriately managed.

The CNVMP should also include information set out in NZS6803:1999 such as:

- Summary of the Project noise standards contained within this assessment.
- Summary of assessments/predictions contained within this assessment.
- General construction practices, management and mitigation that will be used for the Project.
- Noise management and mitigation measures specific to activities and/or receiving environments, particularly for high noise and/or vibration activities, and all night-time works.
- Monitoring and reporting requirements.
- Procedures for handling complaints.
- Procedures for review of the CNVMP throughout the period of Project works.

The CNVMP will be implemented on site for each specific area of work. The CNVMP should be prepared when more detail is available. In addition to the CNVMP, Waka Kotahi standard procedures for the management of noise and vibration should be implemented for all noise and vibration emissions from construction activities, irrespective of the construction occurring inside or outside the designation. These will be relied on to avoid, remedy and mitigate adverse effects where appropriate.

In addition, Schedules are a useful tool in determining how the noise and vibration effects from specific activities or in specific areas will be managed and potentially affected parties communicated with. Schedules are prepared where noise or vibration is measured or predicted to exceed the noise and/or vibration standards. The Schedules would contain communication, management, and mitigation specific to a certain task or area. They would be attached to the CNVMP, providing additional information that would sit alongside the general management and mitigation options within the CNVMP. For this Project, we anticipate that schedules may only be required if night-time piling is necessary.

3.2 Traffic Noise

As identified earlier, there are no PPFs within 100m of the edge of the Project, and therefore NZS 6806 does not apply.

The ramp traffic will have little overall effect on receivers further from the road as the main noise source is SH1 with its significantly higher traffic volume. We understand that the ramp is estimated to carry between 5,250 and 6,775 vehicles per day, less than a tenth of the traffic on SH1. This means that the ramp traffic will not contribute to the overall traffic noise level received by the nearby dwellings, and therefore does not have any noticeably effect.

The dwelling at the northern end of 108 Flanagan Road is owned by Kiwi Property and earmarked for removal. Should the dwelling at the northern end of 108 Flanagan Road still exist while the ramp is already in use, the predicted

traffic noise level is well below 30 dB $L_{Aeq(24h)}$. The relevant noise criterion is 64 dB $L_{Aeq(24h)}$. This means that NZS 6806 does not apply to this dwelling.

Therefore, traffic noise did not require a detailed assessment.

4 RECOMMENDATIONS

Based on the consideration of the statutory framework/requirements set out in Section 1 of this report and the assessment of potential adverse construction noise and vibration effects on the environment, the following mitigation and management measures are recommended:

4.1 Construction Noise and Vibration

We recommend that construction noise and vibration management and mitigation is required through the preparation and implementation of a CNVMP. Where specific construction activities may result in an exceedance of the noise and vibration standards, Schedules should be prepared. The Schedules would contain communication, management and mitigation specific to a certain task or area. They would be attached to the CNVMP, providing additional information that would sit alongside the general management and mitigation options within the CNVMP.

As night-time construction vibration standards are significantly more stringent at dwellings and have the potential to be exceeded at distances greater than 200m from the night-time works, we recommend that vibration intensive activities adjacent residential areas should be generally scheduled for the daytime wherever practicable.

4.2 Traffic Noise

There are no PPFs within 100m of the edge of the proposed access ramp, and the ramp traffic will have no material impact on the overall noise level from SH1. No mitigation is required.

5 CONCLUSION

This report has been prepared to provide an assessment of noise and vibration effects during construction and operation of the Project. The Project has no significant effect on neighbouring residential and commercial buildings. The closest dwelling is 320m from the works, and the closest occupied commercial building 70m. With best practice management of on-site construction noise and vibration, levels can comply at all receivers during daytime. Should night-time works be required, we recommend that no vibration inducing activities are undertaken and that only bored piling is used at night-time.

These effects can be managed or mitigated by preparing and implementing a CNVMP, and for specific activities preparing and applying Schedules. Overall, the effects from the Project will be relatively low as the ambient environment is already impacted by traffic noise, and construction noise levels would be only marginally higher for most of the works.

Traffic noise will have no material impact on the overall traffic noise level due to the significantly larger traffic volume on SH1 and the large distance of closest sensitive receivers.

In summary, we consider that the proposed access ramp can be constructed and operated within reasonable noise levels.

APPENDIX A – AMBIENT NOISE LEVEL SURVEY SUMMARY

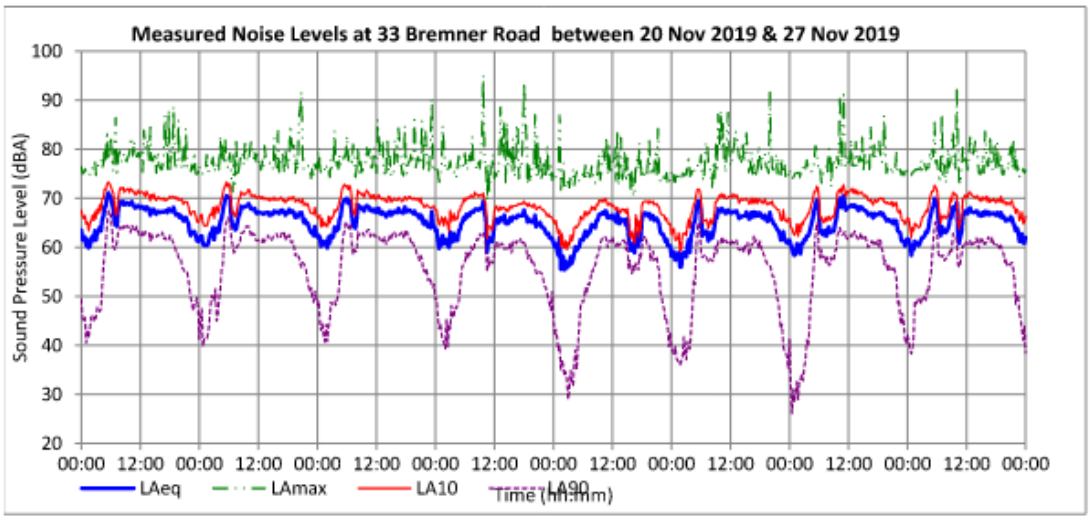
Logger Measurements

Date:	Monday, 7 September 2020
File name:	I:\JOBS\2019\20190430\03 Survey Data & Measurements\20190430 MM Stage 1 Logging\[33 Bremner Road Summary Sheet.xlsx]Logger_Summary
Job number:	20190430
Job name:	SCI Papakura to Bombay Stage 1A
Initials:	SW
Measurement Dates:	Wednesday, 20 November 2019 to Wednesday, 27 November 2019
Weather during Measurement:	No adjustment required
Notes:	33 Bremner Road

OVERVIEW SUMMARY SHEET

	Noise Level, dB	L_{Aeq}	L_{A10}	L_{A90}	L_{Amax}
Day (0600-1800)	Lowest	59	61	49	70
	Average	67	69	61	78
	Highest	71	73	67	95
Evening (1800-2200)	Lowest	63	67	49	73
	Average	66	69	58	78
	Highest	68	70	63	94
Night (2200-0600)	Lowest	55	59	26	72
	Average	64	66	46	76
	Highest	71	73	66	90

$L_{Aeq\ 24\text{-}hr}$ 66 dB



APPENDIX B – CONSTRUCTION NOISE AND VIBRATION

B1. Designation Conditions

Construction noise and vibration management plan	
CNV.1	(a) A Construction Noise and Vibration Management Plan (CNVMP) shall be prepared prior to the Start of Construction for a Stage of Work and submitted to the Manger for information. (b) A CNVMP shall be implemented during the Stage of Work to which it relates. The purpose of the CNVMP is to provide a framework for the development and implementation of the Best Practicable Option for the management of construction noise and vibration effects to achieve the construction noise and vibration standards set out in Conditions CNV.2 and CN.3 to the extent practicable. To achieve this purpose, the CNVMP shall be prepared in accordance with Annex E2 of the New Zealand Standard NZS6803:1999 'Acoustics – Construction Noise' (NZS6803:1999) and the Waka Kotahi State highway construction and maintenance noise and vibration guide (version 1.1, 2019), and shall as a minimum, address the following: (i) description of the works and anticipated equipment/processes; (ii) hours of operation, including times and days when construction activities would occur; (iii) the construction noise and vibration standards for the Project; (iv) identification of receivers where noise and vibration standards apply; (v) management and mitigation options, and identification of the Best Practicable Option; (vi) methods and frequency for monitoring and reporting on construction noise and vibration; (vii) procedures for communication and engagement with nearby residents and stakeholders, including notification of proposed construction activities, the period of construction activities, and management of noise and vibration complaints; (viii) contact details of the Project Liaison Person; (ix) 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; (x) identification of areas where compliance with the noise [Condition CNV.2] and/or vibration standards [Condition CNV.3] Category A or Category B will not be practicable and the specific management controls to be implemented and consultation requirements with owners and occupiers of affected sites; (xi) procedures and requirements for the preparation of a Schedule to the CNVMP (Schedule) for those areas where compliance with the noise [Condition CNV.2] and/or vibration standards [Condition CNV.3] Category A or Category B will not be practicable and where sufficient information is not available at the time of the CNVMP to determine the area specific management controls [Condition CNV.1(c)(x)];

(xii) procedures and trigger levels for undertaking building condition surveys before and after works to determine whether any cosmetic or structural damage has occurred as a result of construction vibration;

(xiii) methodology and programme of desktop and field audits and inspections to be undertaken to ensure that CNVMP, Schedules and the best practicable option for management of effects are being implemented; and

(xiv) requirements for review and update of the CNVMP.

(c) (d) The CNVMP shall address the specific measures for 168 Flanagan Road recommended in the report of Marshall Day Acoustics dated 15 October 2021.

Noise Criteria

CNV.2

Construction noise from the Project shall be measured and assessed in accordance with the NZS 6803:1999 and shall, as far as practicable, comply with the following criteria:

Day of week	**Time**	**dB $L_{Aeq(15min)}$**	**dB L_{Amax}**
Buildings containing activities sensitive to noise			
Weekdays	0630 – 0730	60	75
	0730 – 1800	75	90
	1800 – 2000	70	85
	2000 – 0630	45	75
Saturdays	0630 – 0730	45	75
	0730 – 1800	75	90
	1800 – 2000	45	75
	2000 – 0630	45	75
Sundays and Public Holidays	0630 – 0730	45	75
	0730 – 1800	55	85
	1800 – 2000	45	75
	2000 – 0630	45	75
Other occupied buildings			
All days	0730 - 1800	75	n/a
	1800 - 0730	80	n/a

Vibration Criteria

CNV.3

(a) Construction vibration shall be measured in accordance with ISO 4866:2010 Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures and shall comply with the vibration standards set out in the following table as far as practicable.

Table CNV.1 Construction vibration criteria

Receiver	Details	Category A	Category B
Occupied Activities sensitive to noise	Night-time 2000h-0630h	0.3 mm/s PPV	1mm/s PPV
	Daytime 0630h-2000h	1mm/s PPV	5mm/s PPV
Other occupied buildings	Daytime 0630h-2000h	2mm/s PPV	5mm/s PPV
All other buildings	At all other [sic] times Vibration – transient	5mm/s PPV	BS 5228-2 Table B.2*
	At all other [sic] times Vibration – continuous	5mm/s PPV	BS 5228-2* 50% of Table B.2 values

**BS 5228-2:2009 'Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration'*

(b) Where compliance with the vibration standards set out in Table CNV.1 is not practicable, and unless otherwise provided for in the CNVMP, then the methodology in Condition CNV.4 shall apply.

(c) If measured or predicted vibration from construction activities exceeds the Category A criteria, construction vibration shall be assessed and managed during those activities.

(d) If measured or predicted vibration from construction activities exceeds the Category B criteria those activities must only proceed if vibration effects on affected buildings are assessed, monitored and mitigated.

CNV.4

(a) Unless otherwise provided for in a CNVMP, a Schedule to the CNVMP (Schedule) shall be prepared, in consultation with the owners and occupiers of sites subject to the Schedule to the CNVMP, when:

(i) construction noise is either predicted or measured to exceed the noise standards in Condition CNV.2;

(ii) construction vibration is either predicted or measured to exceed the Category A standard at the receivers in Condition CNV.3.

(b) The purpose of the Schedule is to set out the Best Practicable Option for the management of noise and/or vibration effects of the construction activity beyond those measures set out in the CNVMP. The Schedule shall include details such as:

(iii) construction activity location, start and finish times;

(iv) the nearest neighbours to the construction activity;

(v) the predicted noise and/or vibration level for all receivers where the levels are predicted or measured to exceed the applicable standards in Conditions CNV.2 and CNV.3;

(vi) the proposed mitigation;

(vii) the proposed communication with neighbours; and

	(viii) location, times and types of monitoring. (c) The Schedule shall be submitted to the Manager for information at least 5 working days, except in unforeseen circumstances, in advance of Construction Works that are covered by the scope of the Schedule and shall form part of the CNVMP.

B2. Construction assessment methodology

B2.1.1 Noise Predictions of noise levels

Table B-1 shows the sound power levels for representative equipment likely to be used for the construction. Our predictions of construction noise were based on the below levels.

Table B-1 Construction Equipment Noise Levels

Activity	Plant type	Sound power level (dB L_{WA})
MSE Retaining Wall Construction	Vibratory roller Concrete trucks Crane On road trucks	108 107 106 100
Earthworks	Dump truck Hydraulic excavator Bulldozer Compactor Water truck	106 113 114 112 105
Bridge foundations (piling)	Rotary piling rig Concrete trucks	111 107
Concrete foundations and structures	Crane Concrete pump Vibratory pokers Concrete trucks	106 100 114 107
Pavement preparation	Vibratory roller Water trucks	108 105
Access staging foundations	Piling rig with vibro hammer	116
Surfacing	Paver Road rollers Asphalt delivery trucks	113 106 108

Activity	Plant type	Sound power level (dB L_{WA})
Yard activities	Vehicle movements	102
	Material handling	105
	Administration area	50
	Workshop	80

We used the above noise levels to predict combined “activity sound power levels” (refer Table B-2 below).

From the activity sound power levels, we then determined the distance at which the 75 dB L_{Aeq} day-time noise criterion can be complied with, without noise barrier mitigation.

Table B-2 Activity Sound Power Levels and Compliance Distance

Activity	Activity Sound Power Level	Distance at which compliance with day-time limit (75 dB L_{Aeq}) is achieved without noise barriers
	dB L_{WA}	metres
Earthworks	115	50
Bored piling	111	35
Typical retaining wall construction	107	25
Structures (bridges)	110	30
Pavement construction (for road)	110	30
Staging area/construction yard	100	10

B2.1.2 Daytime noise effects

How people may experience noise inside or outside a building is described in Table B-3 below. That table does not take account of non-sensitive activities such as factories, storage spaces and similar uses. Also note that the predicted noise levels are below the lowest level of “effects” discussed in the table, with a predicted level of 54 dB L_{Aeq} at the closest dwelling.

Table B-3 Potential noise effects for varying noise levels

External Façade Noise Level dB L_{Aeq}	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level dB L_{Aeq}	Potential Daytime Effects Indoors
Up to 65	Conversation becomes strained, particularly over longer distances.	Up to 45	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.
65 to 70	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	45 to 50	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75	Businesses that involve substantial outdoor use (for example garden centres such as Bunnings) would experience considerable disruption.	50 to 55	Face to face and phone conversations and TV watching would continue to be affected. Office work can generally continue.
75 to 80	Some people may choose hearing protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	55 to 60	Phone conversations would become difficult, and Face to face conversations would need slightly raised voices. For residential activities TV and radio sound levels may need to be raised. Continuing office work may become difficult.
80 to 90	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	60 to 70	Face to face conversations would require raised voices. In a residential context, people may actively seek respite if these levels are sustained for more than a period of a few hours. Concentration would start to be affected, continuing office work would be difficult and may become unproductive.

B2.1.3 Night-time noise effects

The Construction Noise Standard (NZS 6803) recommends noise limits assessed at 1m from the external façade of a building, assuming a façade sound level difference of 20 decibels. However, a 20-decibel reduction is particularly conservative for modern buildings. The sound insulation performance can be measured, or generally be estimated with knowledge of the façade glazing type as follows:

- Sealed glazing: 30 decibels façade sound level difference.
- Closed windows (openable): 20 – 25 decibels façade sound level difference.
- Open windows: 15 decibels façade sound level difference.

Table B-4 provides guidance on the potential night-time effects inside sensitive spaces, depending on the external noise level and façade glazing type. The potential effects are colour coded as follows:

Typically acceptable

Sleep disturbance for some occupants

Sleep disturbance for most occupants

Table B-4 Night-time noise levels in bedrooms of dwellings

External Noise Level (dB L_{Aeq})	Estimated Internal Noise Level (dB LAeq)			
	Sealed glazing	Openable windows (modern building)	Openable windows (older style building)	Open windows
70 – 75	40 – 45	45 – 50	50 – 55	55 – 60
65 – 70	35 – 40	40 – 45	45 – 50	50 – 55
60 – 65	30 – 35	35 – 40	40 – 45	45 – 50
55 – 60	25 – 30	30 – 35	35 – 40	40 – 45
50 – 55	20 – 25	25 – 30	30 – 35	35 – 40
45 – 50	15 – 20	20 – 25	25 – 30	30 – 35

B2.2.1 Prediction of construction vibration levels

Figure B-5-1 below shows the regression curves for vibration levels from vibratory piling (red) and vibratory rollers (blue). The regression curves were derived from numerous measurements, and a 100% safety margin applied.

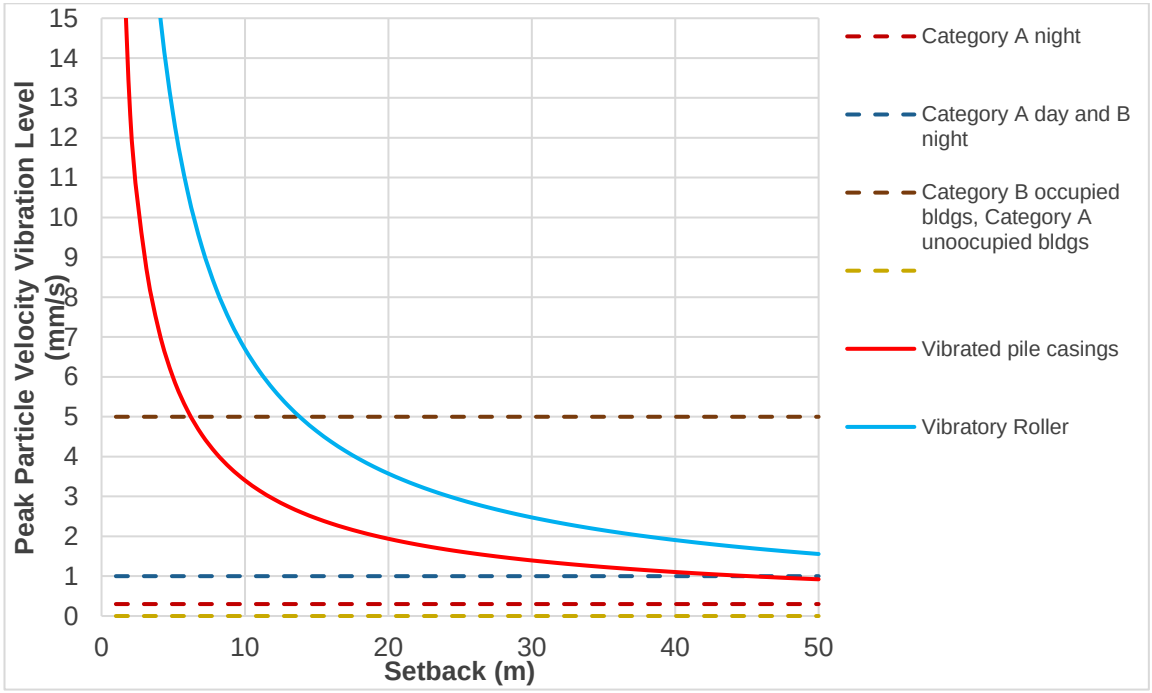


Figure B-5-1 Vibration Regression Curves

B2.2.2 Envelope of vibration effects

There is a risk that the Project criteria may be exceeded at the unoccupied showhomes where vibratory rollers are used for the compaction of new traffic lanes or the MSE retaining walls.

The risk categories in **Table B-5** relate to the risk of exceeding the Project criteria at various distances from the vibration inducing works. The "all other buildings" zone has been calculated under the worst-case assumption that all these buildings are light weight structures. The risk categories are defined as follows:

- High Risk — Predicted to exceed Category B criteria as well as Category A criteria.
- Medium Risk — Predicted to exceed Category A criteria but comply with the Category B criteria.
- Low Risk — Predicted to comply with Category A and B criteria.

Table B-5 Activity and risk zones

Equipment	Risk Zones		
	Occupied Dwellings (Residential)	Other Occupied Buildings (Commercial)	All Other Buildings
Vibratory Roller	High: < 15 m Med: 15 – 55 m Low: > 55 m	High: < 15 m Med: 15 – 40 m Low: > 40 m	High: < 5 m Med: 5 – 15 m Low: > 15 m
Vibropiling	High: < 7 m Med: 7 – 45 m Low: > 45 m	High: < 7 m Med: 7 – 20 m Low: > 20 m	High: < 5 m Med: 5 – 10 m Low: > 10 m

B2.2.3 Vibration effects

How people may experience vibration inside residences or offices, is described in **Table B-6** below. That table does not take account of non-sensitive activities such as factories, storage spaces and similar uses.

Table B-6 Vibration effects

Vibration level (mm/s PPV)	Potential effects indoors
0.14	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	Vibration might be just perceptible in residential environments This is the AUP limit for construction vibration generated at night-time for sensitive receivers.
1	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents. What people feel would be subject to the source/activity (i.e., continuous motion or a one off event) and associated frequency (i.e., fast or slow vibration), 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. Vibration at this level could rattle crockery and glassware. Sleep disturbance would be almost certain for most people.
2	Vibration would clearly be felt in all situations. Can be tolerated in indoor environments such as offices, houses and retail, where it occurs intermittently during the day and where there is effective prior engagement. This is the AUP limit for occupied buildings for construction projects generating vibration.
5	Unlikely to be tolerable in a workplace or residential environment without prior warning and explanation. If exposure was prolonged, some people could want to leave the building affected. Computer screens would shake, and light items could fall off shelves.

Vibration level (mm/s PPV)	Potential effects indoors
	This is the AUP limit for construction activities generating vibration for three days or less between the hours of 7:00 am – 6:00 pm
10	Likely to be intolerable for anything more than a very brief exposure.

Drury Access Ramp Project

Aurecon Group Limited
Level 3, 110 Carlton Gore Road
Newmarket, Auckland 1023