# Eastern Busway
# EB2 and EB3 Residential

## Construction Noise and Vibration Effects Assessment

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Eastern Busway

# Quality Information

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# Terms and Definitions

**Table 1.** Terms and definitions.

| Term | Definition |
|---|---|
| EB2 | Eastern Busway 2 |
| EB3R | Eastern Busway 3 Residential |
| AUP(OP) | Auckland Unitary Plan Operative in Part |
| AEE | Assessment of Effects on the Environment |
| AT | Auckland Transport |
| AMETI | Auckland Manukau Eastern Transport Initiative |
| RRF | Reeves Road Flyover |

# Executive Summary

An assessment of noise and vibration from construction of the EB2 and EB3R Project has been carried out.

Construction noise has been assessed against the noise criteria set out in rule E.25.6.27 of the Auckland Unitary Plan, with a 5 dB penalty applied for construction works with a duration longer than 20 weeks. Construction vibration criteria have been taken from both the Auckland Unitary plan and the German standard DIN 4150-3:1999 standard and are summarised in terms of "Category A" and "Category B" criteria for the daytime and night-time.

Where works cannot practicably be carried out during the daytime, works during the night-time will be carried out. Reasons for night-time works include traffic requirements, safety requirements, and quality requirements.

Measures to avoid, remedy or mitigate noise and vibration from the works have been considered. Measures include (but are not limited to) implementation of a Construction Noise and Vibration Management Plan (CNVMP) and Schedules, advance communication of works with affected receivers, implementation of noise barriers, and building condition surveys.

The noise predictions indicate that:

- 15 commercial and 34 residential receivers could experience intermittent noise levels above the daytime noise criterion of 70 dB during typical construction activities at EB2.
- 1 commercial and 38 residential receivers could experience intermittent noise levels above the daytime noise criterion of 70 dB during typical construction activities at EB3R.

However, with effective mitigation in place, noise levels are predicted to comply with the 70 dB $L_{Aeq}$ noise criterion at surrounding receivers for the majority of the construction works. Where the noise criteria are predicted to be exceeded, the effects will be mitigated and managed through the CNVMP.

Night works have the potential to create significant noise effects if not managed appropriately, therefore they must be mitigated and managed through the CNVMP. Schedules will also be prepared for the night works.

Vibration from the works has been predicted and assessed. At a minimum, we recommend that a pre-construction building condition survey be carried out at all receivers where the Category B vibration criteria are predicted to be exceeded. The vibration amenity criteria are predicted to be exceeded at a number of properties during both daytime and night-time works. However, we note that the vibration predictions are conservative and vibration levels measured on site tend to be much lower than those predicted in the early stages of a project. The measures set out in the draft CNVMP must be implemented for the duration of the works to mitigate and manage effects from construction vibration.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers so that the BPO is implemented throughout the duration of construction. A draft CNVMP has been prepared and is included EB2 AEE Appendix 31 and EB3R AEE Appendix 22.

# 1 Introduction

## 1.1 Overview of the Eastern Busway Project

The Eastern Busway Project (the Project) is a package of works focusing on promoting an integrated, multi-modal transport system to support population and economic growth in south-east Auckland. This involves the provision of a greater number of improved public transport choices and aims to enhance the safety, quality and attractiveness of public transport and walking and cycling environments. The Project includes:

- 5km of two-lane busway
- New bridge for buses across Pakuranga Creek
- Improved active mode infrastructure (walking and cycling) along the length of the busway
- Three intermediate bus stations
- Two major interchange bus stations.

The Project forms part of the previous Auckland Manukau Eastern Transport Initiative (AMETI) programme (the programme) which includes a dedicated busway and bus stations between Panmure, Pakuranga and Botany town centres. The dedicated busway will provide an efficient rapid transit network (RTN) service between the town centres, while local bus networks will continue to provide more direct local connections within the town centre areas. The Project also includes new walking and cycling facilities, as well as modifications and improvements to the road network.

The programme includes the following works which do not form part of the Eastern Busway Project:

- Panmure Bus and Rail Station and construction of Te Horeta Road (completed); and
- Eastern Busway 1 (EB1) – Panmure to Pakuranga (completed).

The Eastern Busway project consists of the following packages:

- Early Works Consents – William Roberts Road (WRR) extension from Reeves Road to Ti Rakau Drive (LUC60401706); and Project Construction Yard at 169 – 173 Pakuranga Road (LUC60403744).
- Eastern Busway 2 (EB2) – Pakuranga Town Centre, including the Reeves Road Flyover (RRF) and Pakuranga Bus Station **(this Assessment)**
- Eastern Busway 3 Residential (EB3R) – Ti Rakau Drive from the South-Eastern Arterial (SEART) to Pakuranga Creek, including Edgewater and Gossamer Intermediate Bus Stations **(this Assessment)**
- Eastern Busway 3 Commercial (EB3 Commercial) – Gossamer Drive to Guys Reserve, including two new bridges, and an offline bus route through Burswood
- Eastern Busway 4 – Guys Reserve to a new bus station in the Botany Town Centre, including a link road through Guys Reserve.

The overall Project is shown in Figure 1 below.

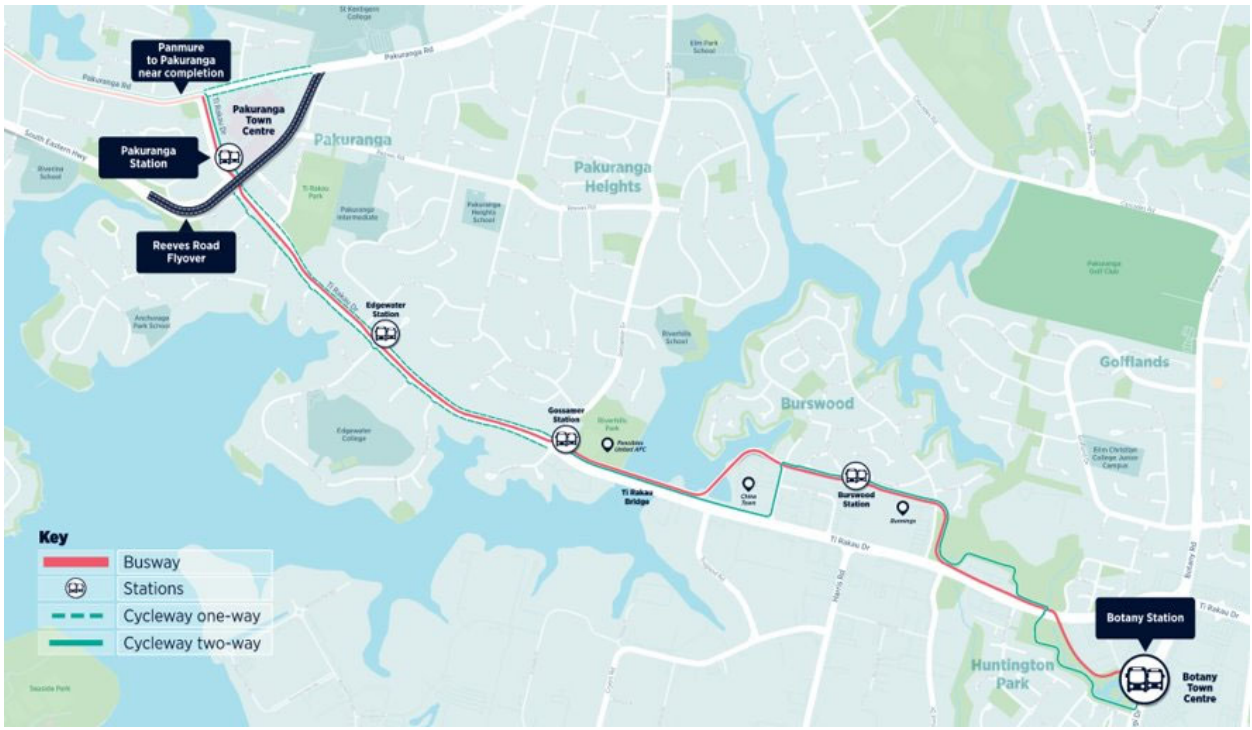



**Figure 1. Project alignment**

## 1.2 Project Objectives

The Project objectives are:

1. Provide a multi modal transport corridor that connects Pakuranga and Botany to the wider network and increases access to a choice of transport options;
2. Provide transport infrastructure that integrates with existing land use and supports a quality, compact urban form;
3. Provide transport infrastructure that improves linkages, journey time and reliability of the public transport network;
4. Contribute to accessibility and place shaping by providing better transport connections between, within and to the town centre;
5. Provide transport infrastructure that is safe for everyone; and
6. Safeguard future transport infrastructure required at (or in vicinity of) Botany Town Centre to support the development of a strategic public transport connection to Auckland Airport.

## 1.1 Specialist assessment

This report describes our assessment of the construction noise and vibration effects.

This noise and vibration assessment assesses whether, and to what extent, EB2/EB3R can be constructed so that adverse noise and vibration effects can be avoided or mitigated.

This construction noise and vibration assessment involves:

- Considering relevant noise and vibration criteria
- Measuring existing noise and vibration levels
- Predicting and assessing construction noise and vibration levels from EB2/EB3R

- Determining the areas that may be affected by EB2/EB3R
- Considering the measures required to avoid, remedy or mitigate potential construction noise and vibration effects.

# 2 Proposal Description

The below is a summary of the works proposed within the EB2 and EB3R packages. Refer to the AEE for additional detail on the works proposed.

## 1.3 Eastern Busway 2

The EB2 section of the Project commences from the intersection of Ti Rakau Drive and Pakuranga Road, connecting with EB1, and traverses east along Ti Rakau Drive to the intersection of SEART. The north-south extent of EB2 is between SEART and Pakuranga Road along Reeves Road and William Roberts Road. The main components of EB2 are described below.

### 1.3.1 Busway and Pakuranga Town Centre Bus Station

A segregated dedicated two-way busway is proposed along Ti Rakau Drive to provide prioritised access for bus services between Pakuranga Town Centre and Botany. From Pakuranga Road to SEART, the busway will run on the northern side of Ti Rakau Drive.

The proposed Pakuranga bus station is a key facility for services running to and from the Panmure Station Interchange, Howick, Highland Park, Eastern Beach, Bucklands Beach and Sunnyhills. The bus station will be located along the northern side of Ti Rakau Drive, on land currently occupied for Pakuranga Plaza and 26 Ti Rakau Drive. The bus station will feature two platforms and will contain a mixture of street furniture and structures, including bus shelters, electronic messaging signage and seating. New proposed pedestrian crossings will provide connections to the bus station and Pakuranga Plaza. Modifications to the Ti Rakau Drive median strip, landscaping, and general traffic lane reconfiguration will enable safe and efficient bus movement for the busway once it becomes operative.

### 1.3.2 Reeves Road Flyover (RRF)

The RRF will provide two general traffic lanes in each direction connecting SEART to Pakuranga Road, to reduce local traffic congestion along Pakuranga Road and Ti Rakau Drive. The RRF will start opposite Paul Place Reserve, pass over Ti Rakau Drive and Reeves Road, before finishing at a new intersection with Pakuranga Road. Traffic lanes for the RRF will be elevated and run through the centre of SEART, requiring the relocation of the SEART off-ramp to the north of the existing off-ramp.

### 1.3.3 Walking and Cycling Facilities

EB2 includes improvements to active transport infrastructure and connections. This includes a new cycleway, improved footpaths, and new pedestrian crossings. These works will improve the safety and connectivity of walking and cycling links across Pakuranga Town Centre.

### 1.3.4 Supporting Works

A range of works will be undertaken in support of the EB2 package. This includes the relocation of network utility services, new street lighting, earthworks, removal of vegetation, landscaping, stormwater upgrades, environmental restoration and mitigation and temporary construction sites.

## 1.4 Eastern Busway 3 Residential

The EB3R section of the busway is a continuation of EB2 from the intersection of SEART and Ti Rakau Drive, with the proposed dedicated busway proceeding centrally along Ti Rakau Drive towards

Gossamer Drive and Riverhills Park in the east. EB3R will largely occur within land vested as road or land currently owned by Auckland Transport. The construction of EB3R will take a staged approach to minimize disruption to the existing road network and its users. The main components of EB3R have been described below.

### 1.4.1 Edgewater and Gossamer Intermediate Bus Stations

EB3R includes two intermediate bus stations on Ti Rakau Drive, located within the vicinity of Edgewater Drive and Gossamer Drive. Both stations will have separate platforms for eastbound and westbound bus movements. A range of street furniture and structures will also be constructed, such as modular bus shelters pedestrian linkages, electronic messaging signage, seating and cycling storage facilities.

### 1.4.2 Western Bridge Abutment

EB3R includes construction of the western bridge abutment for a new future bridge across Pakuranga Creek . The abutment will be located within the area that is currently the southeastern section of Riverhills Park. Only the bridge abutment is included in the EB3R package of works. The remaining parts of the bridge will form part of the EB3C approval package.

### 1.4.3 Walking and Cycling Facilities

Provision has been made for walking and cycling along the route of EB3R. This includes footpaths and uni-directional cycleways located on either side of Ti Rakau Drive from SEART to Gossamer Drive. Signalised pedestrian crossings will be provided at key intersections along Ti Rakau Drive, including adjacent to the proposed Edgewater bus station.

### 1.4.4 Associated changes the road network

The proposed changes to the road network include lane arrangement and intersection reconfigurations and changes to the parking arrangement and access to Edgewater Drive Shops. Changes are also proposed to the access arrangements for residential properties along the EB3R alignment. New westbound lanes for general traffic will be established within the land which has been acquired by Auckland Transport and will be vested as road once it becomes operative, as the busway alignment replaces the existing westbound lanes.

### 1.4.5 Supporting Works

A range of works will be undertaken in support of the EB3R package. This includes the relocation of network utility services, new street lighting, removal of vegetation, earthworks, landscaping, stormwater upgrades, environmental restoration and mitigation and temporary construction sites.

# 3 Assessment criteria

## 3.1 Construction noise

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

The applicable construction noise criteria are detailed in Table 2 for sensitive receivers and in Table 3 for non-sensitive receivers.

As the works will take place over a time period longer than 20 weeks, a 5 dB penalty has been applied to the daytime dBA $L_{eq}$ noise limits for weekdays and Saturdays, in line with NZS 6803:1999.

**Table 2 Construction noise criteria for sensitive receivers**

| Time of week | Time Period | Maximum noise level (dBA) > 20 weeks | |
|---|---|---|---|
| | | $L_{eq}$ | $L_{max}$ |
| Weekdays | 6:30am – 7:30am | 55 | 70 |
| | 7:30am – 6:00pm | 70 | 85 |
| | 6:00pm – 8:00pm | 65 | 80 |
| | 8:00pm – 6:30pm | 45 | 75 |
| Saturdays | 6:30am – 7:30am | 45 | 75 |
| | 7:30am – 6:00pm | 70 | 85 |
| | 6:00pm – 8:00pm | 45 | 75 |
| | 8:00pm – 6:30am | 45 | 75 |
| Sundays and public holidays | 6:30am – 7:30am | 45 | 75 |
| | 7:30 am – 6:00pm | 55 | 85 |
| | 6:00pm – 8:00pm | 45 | 75 |
| | 8:00pm – 6:30am | 45 | 75 |

**Table 3 Construction noise criteria for non-sensitive receivers**

| Time period | Maximum noise level $L_{Aeq}$ dB > 20 |
|---|---|
| 07:30 – 18:00 | 70 |
| 18:00 – 07:30 | 75 |

The works area extends through the road corridor, various Business and Residential zones and the Open Space Informal Recreation zone, as shown in Appendix A. For the works that take place in the road corridor, rule E.25.6.29(1) of the AUP(OP) applies, meaning that noise from construction works within the road corridor must comply with the limits set out in Table 2 and Table 3 to be considered a permitted activity.

We note that since noise from the works are expected to exceed the limits at some receivers for longer 3 nights rules E.25.6.29(2), (4) and (4A) do not apply.

However, as per rule E25.6.29(3)(b) the noise criteria specified in Table 2 and Table 3 above do not apply to planned construction works that occur in the road between the hours of 7am and 10pm, and which because of the nature of the works and the proximity of receivers the noise generated cannot practicably made to comply with the relevant noise levels. This is provided that a Construction Noise and Vibration Management Plan (CNVMP) is provided to council no less than five days prior to works commencing.

As set out in 8.1, a draft CNVMP has been prepared for these works as a means to mitigate and manage construction noise and vibration effects. This is a requirement to qualify for the exemptions from compliance with the limits as allowed for in rule E25.6.29(3), as well as a requirement of rules E.25.6.29(2), (4) and (4A) had the Project not been disqualified because of the expected durations of exceedances.

## 3.2 Construction vibration

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

### 3.2.1 Auckland Unitary Plan (Operative in Part)

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

a. The limits set out in German 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 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 AUP:OP Table E25.6.30.1 Vibration limits in buildings**

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

Works generating vibration for three days or less between the hours of 7am to 6pm may exceed the limits in Table 4, but must comply with a limit of 5 mm/s peak particle velocity in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500mm of ground floor level at the foundation of a single storey building, where:

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

### 3.2.2 DIN 4150-3:1999 – Structural Vibrations: Effects of Vibrations on Structures

DIN 4150 contains guidelines on 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 5.

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 5 Vibration velocity guideline values for structures**

| 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 and/or use | 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 lunes 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 5 – line 2) and structures sensitive to vibration (Table 5 – 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'.

### 3.2.3 British Standard 5228-2

British Standard (BS) 5228-2: 2009 "Code of practice for noise and vibration control on construction and open sites" provides additional guidance on the human response to vibration, which is widely used in the assessment of effects of construction vibration. The vibration levels against perception as found in BS5228-2:2009 have been replicated in Table 6.

**Table 6 Human perception of vibration levels**

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

### 3.2.4 Recommended Construction Vibration Criteria

The following criteria are the recommended project construction vibration criteria for both building damage and amenity for EB2 and EB3R.

The two category criteria, detailed in Table 7, are designed to facilitate a progressive management response to the increasing risks and effects during construction. These criteria have been included in the proposed conditions, and they have also been set out in the draft CNVMP.

Category A sets the criteria for the amenity effects where vibrations may be perceived by occupants within a building, as adopted from the AUP, and can be used as 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 7 Recommended construction vibration criteria**

| Vibration Level | Time | Category A | Category B |
|---|---|---|---|
| Occupied activities sensitive to noise | Night-time 2000h – 0700h | 0.3mm/s ppv | 2mm/s ppv |
| | Daytime 0700h – 2000h. | 2mm/s ppv | 5mm/s ppv |
| Other occupied buildings | All other times | 2mm/s ppv | 5mm/s ppv |
| All other buildings | Daytime 0630h – 2000h | Tables 1 and 3 of DIN4150-3:1999 | |

Where compliance with the vibration standards set out in Table 7 is not practicable, and unless otherwise provided for in the CNVMP (refer 8.1), a Schedule (refer Section 8.2) will be required. The purpose of a Schedule is to set out the BPO for the management of noise and/or vibration effects from construction for specific activities or at specific receivers beyond the measures set out in the CNVMP.

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 Category A criteria may cause annoyance and adverse reaction from building occupants who mistakenly believe that their building is sustaining damage.

It is therefore recommended that the Category A criteria only be investigated, and applied, upon receipt of a complaint from an occupant of the building. The procedure for advance notice of works is set out in Section 8.5 and this is addressed in the proposed conditions and draft CNVMP.

# 4 Existing noise environment

## 4.1 Noise survey

Due to impacts on traffic from the Covid-19 pandemic in Auckland at the time of writing of this report, we consider that a site survey in the vicinity of EB2/EB3R would not measure noise levels representative of existing traffic. However, it is not considered essential to have carried out this survey, as any measured noise levels will have only served to establish baseline noise levels in the area and would not have impacted the outcomes of this assessment.

Furthermore, a noise survey was carried out across the EB2 and EB3R areas in 2018, which can still be used as a guideline to understand ambient noise levels across the EB2/EB3R area. The following sections detail the outcome of the 2018 survey.

## 4.2 Noise monitoring procedure

Noise survey equipment, meteorological conditions, data analysis and results are described below.

The noise monitoring was undertaken in general accordance with the relevant requirements of NZS 6801, 6802 and 6806. This meant the results could adequately inform the road traffic and construction noise assessments, whilst providing a robust baseline dataset for EB2/EB3R.

All measurement positions were selected to avoid reflections from buildings or extraneous factors which could influence the sound levels, where practicable. Measurement and calibration details required by NZS 6801 are held on file by AECOM New Zealand Limited.

Noise monitoring was undertaken at each location for approximately seven days, where possible. At locations ML3 and ML9, the duration was reduced to five days and one day respectively, due to vandalism. Note that results for ML12 have been excluded as this measurement location was outside of the EB2 and EB3R project areas.

**Error! Reference source not found.** shows the monitoring locations across the EB2/EB3R alignment. The measurement positions are shown on the map in Appendix A and are summarised in Appendix B.

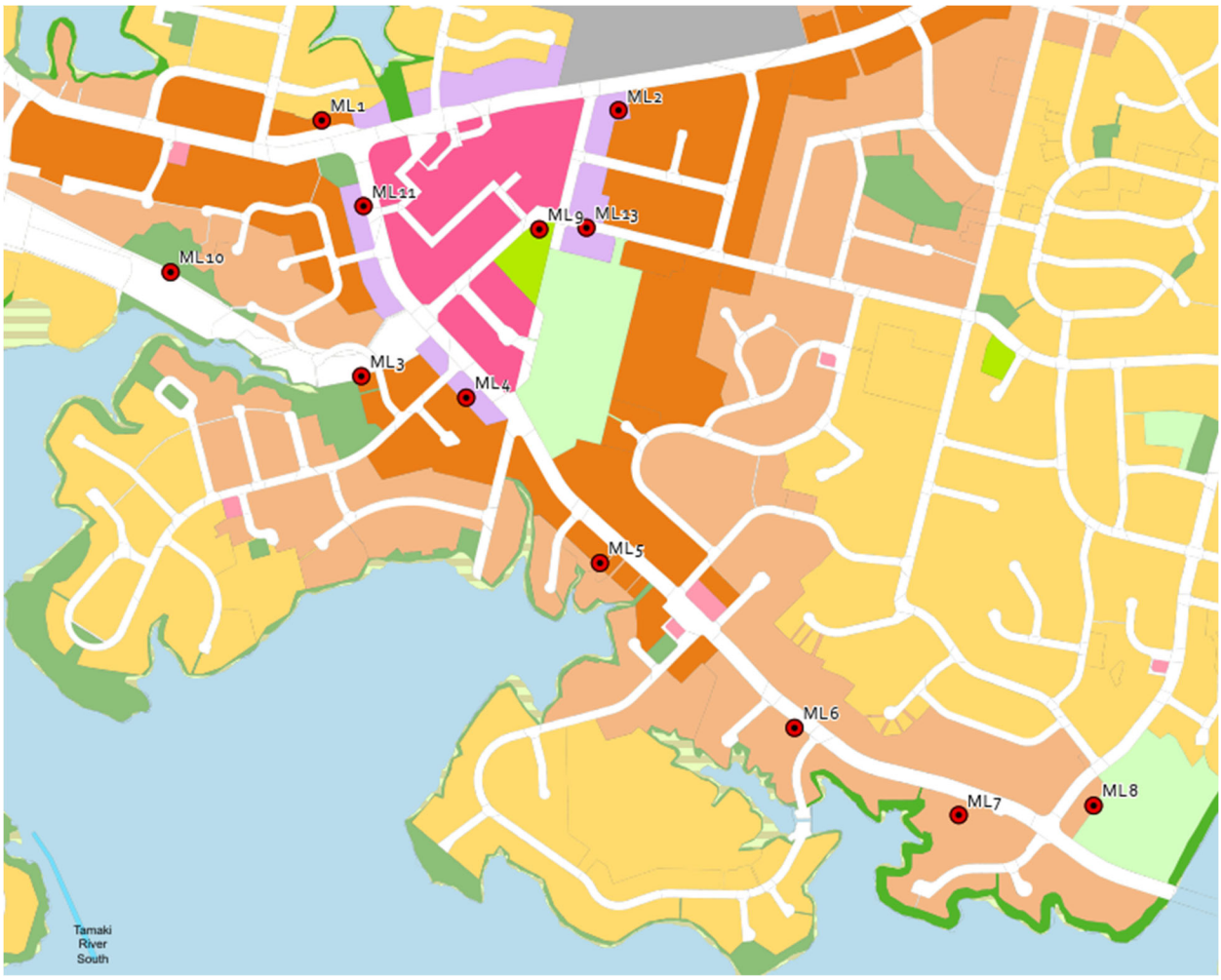



**Figure 2 Noise monitoring locations**

### 4.2.1 Meteorological conditions

During the surveys, meteorological data was obtained from Auckland, Mangere Ews (22719) weather station operated by NIWA. This is the closest station where data was available at an hourly sampling rate or better.

The meteorological data from this weather station was used to identify periods when conditions were likely to have been outside the meteorological restrictions given in NZS 6801, and noise data measured during these periods have been excluded from the noise analysis.

### 4.2.2 Data analysis

There is a natural variation in the noise environment throughout the day, and often significant variation between days. Areas close to traffic sources generally have a more consistent noise profile than locations dominated by natural sounds. Each day's data was analysed, and abnormal events were excluded.

For example, events such as a neighbour mowing the lawn will result in a clear "spike" in the noise levels, and while the exact source is not identifiable, it is clearly not road traffic. The $L_{Aeq(24h)}$ was then calculated for each day where there was sufficient data after unsatisfactory meteorological conditions and abnormal events were excluded. For unattended logger measurements, the energy average $L_{Aeq(24h)}$ over all valid days has been used.

### 4.2.3 Measurement results

A summary of the measured noise levels has been produced and is presented in the following section. The times in the tables showing the noise measurement results reflect the key periods for construction as assessed against the criteria in section 3. The ranges are based on measurements taken over week-long periods. Details of each measurement location are presented in noise monitoring forms, compiled in Appendix B.

#### *4.2.3.1 EB2*

The EB2 noise environment is generally dominated by road traffic noise from the surrounding network. However, noise from other sources is audible, particularly around the Pakuranga Plaza commercial area. There is a mix of residential, commercial, education and healthcare buildings in the area and some open recreation spaces. Ambient noise levels are considered typical for a mixed urban environment, close to major arterial roads.

Table 8 summarises the averaged 24-hour noise measurements taken at the measurement locations. A summary of the measured noise levels is presented in Appendix C**Error! Reference source not found.**.

**Table 8 Noise measurement results from 2018 survey around EB2**

| Location | Address | Observations | Noise level, dB $L_{Aeq(24h)}$ |
|---|---|---|---|
| ML1 | 80 Pakuranga Road | Faint noise present from Pakuranga Road | 52 |
| ML2 | 179 Pakuranga Road | Faint noise present from Pakuranga Road | 54 |
| ML3 | 12 Bolina Crescent | Road traffic noise dominant from Pakuranga Highway | 69 |
| ML9 | 13 Reeves Road | Road traffic noise dominant from Reeves Road | 60 |
| ML10 | Park off Pakuranga Highway | Road traffic noise dominant from Pakuranga Highway | 65 |
| ML11 | 7 Ti Rakau Drive | Traffic noise dominant from Pakuranga/ Ti Rakau intersection | 63 |
| ML13 | 17 Reeves Road, Pakuranga | Road traffic noise dominant from Reeves Road | 60 |

#### *4.2.3.2 EB3R*

The EB3R noise environment is dominated by road traffic noise from Ti Rakau Drive. There is a mix of residential and commercial uses in the area and an open recreation space in Riverhills Park and Ti Rakau Park.

The ambient noise levels are typical for a mixed urban environment, close to major arterial roads.

Table 9 summarises the averaged 24-hour noise measurements taken at the measurement locations. A summary of the measured noise levels is presented in Appendix C**Error! Reference source not found.**.

**Table 9 Noise measurement results from 2018 survey around EB3R**

| Location | Address | Observations | Noise level, dB $L_{Aeq(24h)}$ |
|---|---|---|---|
| ML4 | 47 Ti Rakau Drive | Road traffic noise dominant from Ti Rakau Drive | 51 |
| ML5 | 81 Ti Rakau Drive | Road traffic noise dominant from Ti Rakau Drive | 53 |
| ML6 | 143 Ti Rakau Drive | Road traffic noise dominant from Ti Rakau Drive | 61 |
| ML7 | 187 Ti Rakau Drive | Road traffic noise dominant from Ti Rakau Drive | 54 |
| ML8 | 174 Gossamer Drive | Road traffic noise dominant from Ti Rakau Drive | 54 |

# 5 Construction Noise and Vibration Assessment Methodology

## 5.1 Assessment methodology

Predictions of construction noise has been undertaken in accordance with NZS 6803. Noise levels were predicted using the ISO 9613-2:1996 "Acoustics – Attenuation of sound outdoors – Part 2: general method of calculation" prediction algorithm, implemented in SoundPLAN 8.2 computational modelling software.

The following factors were incorporated in the model:

- shielding and reflections from buildings;
- attenuation from noise barriers;
- site topography; and
- worst-case downwind conditions.

The construction methodology that this assessment is based on was provided by the Alliance construction team[1].

The proposed construction boundary was provided by the Alliance construction team. As a worst-case approximation, construction equipment has been assumed to be working along the edge of this construction area, at the closest position possible to adjacent receivers. We note that this is unlikely to be the case for the majority of the works, as equipment will operate over the whole footprint of the works and will move in a linear fashion as the works progress.

The construction works area used in the modelling is shown in the maps in Appendix A.

Predicted levels at existing receivers have been assessed against the applicable construction noise and vibration criteria. Potential effects of construction noise and vibration have then been considered and construction management and mitigation measures identified where appropriate. To avoid and/or minimise exceedances of the construction noise criteria, it is vital that Best Practicable Option (BPO) mitigation and management measures are utilised.

This report provides 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) as described in section 8.1. The final version will be confirmed and certified in accordance with the proposed conditions of consent prior to commencement of construction. It will be updated as necessary during construction.

We note that the assessment considers existing receivers. If there are any changes in land use or density in the environment surrounding the construction areas, this will need to be considered in the CNVMP at the time of construction.

## 5.2 Construction methodology

The information in this section has been taken from the draft construction methodology. The construction works will generally follow the sequence set out in this section for both EB2 and EB3R.

[1] *EB234 – Construction Methodology Draft Rev1, provided on 25th March 2022*

### 5.2.1 Site establishment works

Site establishment works include, but are not limited to:

- Traffic/ public management including, but not limited to:
  - Footpath closures/ deviations
  - Pedestrian crossing closures
- Existing Utility services location
- Site Access Points (SAP's) & Fencing:
- Compounds and offices

### 5.2.2 Protection and/ or relocation of existing network services

EB2/EB3R traverses key networks/services located within the proposed alignment. The key services within EB2/EB3R that require protection and relocation include:

- High voltage transmission lines[2];
- High pressure gas transmission pipelines;
- Bulk water supply and wastewater infrastructure;
- Local fibre optic communication cables;
- Fibre optic communication cables and telephone lines; and
- Electricity and gas distribution.

### 5.2.3 Earthworks

Earthworks involve clearing obstructions and vegetation, and then carrying out earthworks within the construction footprint.

### 5.2.4 Civil Works

The construction of EB2/EB3R will involve the installation of new civil infrastructure including but not limited to:

- Stormwater drainage/outfalls
- Utilities relocation (water, wastewater, electrical, communication, gas etc.)
- Utilities protection (water, wastewater, electrical, communication, gas etc.)
- ITS ducting
- Street lighting
- Shared paths
- Traffic services
  - Barriers
  - Signals
  - Signage
  - Lighting
  - CCTV
- Bus stations
- Urban design
  - Artwork

[2] Transpower will apply for the necessary consents to relocate their transmission lines.

    - Open spaces
    - Seating
- Landscaping
    - Planting & grassing.

### 5.2.5 Pavement works

The construction of EB2/EB3R will involve the construction of new pavements, widening and upgrading of the existing carriageway.

Construction of new pavements will involve:

- Subgrade preparation, including subgrade improvement works after civils activities and site access use, plus final trimming ready for granular layers
- Installation of geogrids and or geotextiles
- Placement of the subbase granular layer, or alternatively, placement of lean mix concrete as subbase layer

- Installation of pavement drains and kerbing
- Placement of the basecourse granular layer
- Membrane chip-seal sealing of the basecourse
- Placement of structural asphalt layers.

Widening and upgrading of pavements will involve:

- Removal and reconstruction of edge kerbing and pavement drainage as required
- Construction of new widened pavement areas, as detailed above
- Removal of existing carriageway running surface, through use of a road planer (miller)
- Removal and replacement of existing carriageways structural asphalt, through 'mill & fill' operations.

### 5.2.6 Bridge construction works (Reeves Road Flyover - RRF)

The RRF will be constructed from reinforced in-situ and precast concrete components. In-situ decks will be poured on top of precast concrete girders, supported on in-situ concrete piers and columns, which will be positioned above reinforced concrete bored piles. Abutments will be mechanically stabilized earth walls (MSE) with deck end spans resting on them.

Bridge construction will involve:

- Temporary traffic management, including changes to existing lane configurations and walking routes, plus safe entry and exit points into the work zone for construction traffic
- Relocation and / or protection of existing network utility services
- De-construction of existing structures, full or part thereof
- Temporary works, including amongst others, crane pads, course ways (access routes), staging (across public walkways / traffic lanes)
- Mechanically stabilized earth walls (MSE), abutment and approach ramp construction
- Bored piles at each pier position with access routes to each pier for piling rigs and cranes
- Concrete pile caps, followed by columns and pier headstocks, constructed at each pier location, and abutment beams on top of each MSE abutment

- Bridge beam erection, one span at a time and installed at night to allow for lane closures for beam delivery and crane positioning for lifting.
- Installation of new ducts for new services and ITS network
- In-situ deck pours, followed by ancillary works, including amongst others, barriers, movement joints, drainage, services and surfacing works

As space is constrained along the alignment, retaining walls are proposed to contain cut and / or fill batters. These retaining walls generally fall into (but are not limited to) three categories:

- Mechanically stabilised earth walls (MSE), mainly for approach embankments to bridge and flyover structures
- L shaped walls, (e.g. precast segments), tending to retain small heights
- Gravity walls, (e.g. mass blocks or components of), tending to retain small heights

### 5.2.7 Disestablishment

As zonal works are completed, dis-establishment of construction support facilities will commence.

These activities include, but are not limited to:

- Dismantling and uplifting of site compounds, satellite offices and SAP egress points
- Making good temporary occupied land, through either landscape planting, grassing or agreed usage
- Re-installation of facilities and traffic services temporarily removed or relocated
- Uplifting and removal off site of construction plant and equipment, surplus materials and spoil, temporary works items and perimeter fencing, lighting and signage
- Uplifting, removal and making good temporary traffic management and pedestrian / cyclist deviations

## 5.3 Night works

The Alliance construction team have advised that night works will be intermittent at each location they take place and will occur for a maximum of one month in any one area, with the exception of night works associated with the RRF which will take place intermittently over the course of three years.

Night works will only take place when works cannot practicably take place during the day. Reasons why night works must take place include traffic constraints, safety constraints, and quality assurance requirements, depending on the activity.

The night-time works for which sufficient detail is known to carry out noise predictions along with their durations are:

- Reeves Road Flyover construction (concrete pours and lifting) – 2 weeks per section of works, staged intermittently over 3 years in total
- Vegetation clearance – 2 weeks
- Pavement construction – removal of islands and grass medians – 2 weeks
- Relocation of existing houses – 1 week

Worst-case equipment that will be used during these works are:

- Pavement works:

    - Concrete saw
    - Paver
    - Compaction equipment
    - Excavator
- Reeves Road Flyover construction:
    - Concrete truck
    - Concrete pump
    - Cranes
- Vegetation clearance:
    - Chainsaw
    - Trucks

The results of the night works noise predictions are summarised and discussed in Section 9.

Other night-time works are proposed, but sufficient detail is not known at this stage to carry out noise predictions. These works are:

- Utility works within the road corridor
- Pavement works within the road corridor
- Site clearance works

Where sufficient detail is not currently known around other night-time works, noise predictions will be carried out in advance of those works once sufficient detail is available. If the predictions indicate that the night-time noise criteria will be exceeded at surrounding receivers, then a Schedule will be prepared for those works. Further details around Schedules are provided in Section 8.2.

Night works have the potential to create significant noise effects if not managed appropriately; therefore they must be mitigated and managed through the CNVMP.

# 6 Equipment Source Levels

## 6.1 Construction noise source levels

Construction for both EB2 and EB3R is expected to take place over a time period greater than 20 weeks. Predictions have been assessed against the noise criteria for greater than 20 weeks "long-duration" under NZS6803:1999 as presented in Table 2 and Table 3. It is expected that the majority of the works will be carried out between 7am – 6pm Monday to Saturday. It is also likely that night works will take place for works that cannot practicably take place during the day as set out in Section 5.3.

Table 10 details the sound power levels[3] from the likely significant noise sources as provided by the Alliance construction team. Noise levels at varying distances have also been provided, assuming 100% on-time over the assessment time period. The noise data has been taken from British Standard 5228-1:2009 "Code of practice for noise and vibration control on construction and open sites", manufacturers data or the AECOM database of noise measurements. Equipment selection at detailed design stage may include equipment with different sound power levels than those presented. The equipment list will be reassessed nearer the time of construction and updated in the CNVMP.

**Table 10 Construction equipment noise levels**

| Site Activity | Equipment | Sound power level (dBA SWL) | Noise level dB $L_{Aeq}$ | | | |
|---|---|---|---|---|---|---|
| | | | 5m | 10m | 20m | 50m |
| Site establishment (including utility works, demolition and clearing) | 6-Wheeler trucks | 107 | 85 | 79 | 73 | 65 |
| | 10Tn Excavator with rock breaker attachment | 116 | 94 | 88 | 82 | 74 |
| | Handheld concrete saw / chainsaw | 115 | 93 | 87 | 81 | 73 |
| | 10Tn Excavator | 107 | 85 | 79 | 73 | 65 |
| | 20Tn Excavator | 107 | 85 | 79 | 73 | 65 |
| | 500kg Plate compactor | 110 | 88 | 82 | 76 | 68 |
| Earthworks and civil works | 12Tn Steel roller compactor | 107 | 85 | 79 | 73 | 65 |
| | 6-Wheeler trucks | 107 | 85 | 79 | 73 | 65 |
| | 20T Excavator | 107 | 85 | 79 | 73 | 65 |
| | Mobile crane | 106 | 84 | 78 | 72 | 64 |
| Pavement Construction (including surfacing) | 6-Wheeler trucks | 107 | 85 | 79 | 73 | 65 |
| | Plate compactor, 500 kg | 110 | 88 | 82 | 76 | 68 |
| | Roller compactor, 12T | 107 | 85 | 79 | 73 | 65 |
| | Handheld concrete saw / chainsaw | 115 | 93 | 87 | 81 | 73 |
| | Bitumen sprayer | 101 | 79 | 73 | 67 | 59 |
| | Grader | 99 | 77 | 71 | 65 | 57 |
| | 12Tn Double Drum Steel Roller | 107 | 85 | 79 | 73 | 65 |
| | Concrete mixer truck | 107 | 85 | 79 | 73 | 65 |

[3] Sound power levels correlate to the energy emitted by the sound source.

| | | | | | | |
|---|---|---|---|---|---|---|
| Bridge Construction (Reeves Road Flyover) | Gantry crane | 95 | 73 | 67 | 61 | 53 |
| | Large crawler crane | 103 | 81 | 75 | 69 | 61 |
| | Bored piling rig | 111 | 89 | 83 | 77 | 69 |
| | 20T Excavator | 107 | 85 | 79 | 73 | 65 |
| | Concrete pump | 103 | 81 | 75 | 69 | 61 |
| | Concrete mixer truck | 107 | 85 | 79 | 73 | 65 |
| | 6-Wheeler trucks | 107 | 85 | 79 | 73 | 65 |

## 6.2 Construction vibration source levels

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 vibration emission radii. The offset distance that complies with the applicable criterion 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.

Vibration from a source transmits in a spherical pattern and reduces with distance. There will be a particular distance from each source at which the vibration level equals the relevant vibration criteria. This distance is called the 'emission radius'.

The vibration emission radii are presented in Table 11.

**Table 11 Vibration sources and indicative emission radii**

| Equipment | DIN 4150 short-term emission radii | | | Daytime amenity criterion (2 mm/s) | Night-time amenity criterion (0.3 mm/s) |
|---|---|---|---|---|---|
| | Commercial (20 mm/s) | Residential (5 mm/s) | Historic/Vibration sensitive (3 mm/s) | | |
| Roller Compactor (12T) | 2m | 8m | 14m | 21m | N/A |
| Roller Compactor (7T) | 1m | 6m | 8m | 12m | 45m |
| 20T Excavator | 1m | 5m | 8m | 12m | N/A |
| Tipper Truck | 1m | 1m | 2m | 2m | 16m |
| Vibratory Plate Compactor | 1m | 1m | 2m | 3m | 21m |
| Excavator with rock | 2m | 7m | 12m | 18m | N/A |

| | | | | | |
|---|---|---|---|---|---|
| breaking attachment | | | | | |

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

# 7 Overview of Potential Effects

### 7.1.1 Construction noise effects

Table 12 gives examples of the potential effects on receivers at different noise levels based on NZS6803 with the 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 12 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 would experience considerable disruption. | 50 to 55 dB $L_{Aeq}$ | Phone conversations would become difficult. Personal conversations would need slightly raised voices. Office work can generally continue, but 55 dB is considered by the experts to be a tipping point for offices. For residential activity, TV and radio sound levels would need to be raised. |
| 75 to 80 dB $L_{Aeq}$ | Some people may choose protection for long periods of exposure. Conversation would be very difficult, even with raised voices. | 55 to 60 dB $L_{Aeq}$ | Continuing office work would be extremely difficult and become unproductive. In a residential context, people would actively seek respite. |
| 80 to 90 dB $L_{Aeq}$ | Hearing protection would be required for prolonged 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 concrete sawing), during the daytime rather than night-time period, noise levels can be controlled so that the effects on the nearest residential receivers are reduced. Barriers will not be effective at all locations, particularly where receivers are

more than one storey. Where barriers are not going to be effective, the use of enclosures or local screening of equipment should be considered and implemented, where practicable. If noisy activities must take place during the night-time, and screening or other mitigation measures do not provide sufficient attenuation to meet the night-time noise criteria or are not practicable, it may be necessary to offer temporarily relocation to affected residents. Temporary relocation should only be considered on a case-by-case basis and as a last resort after all other measures are exhausted.

### 7.1.2 Construction vibration effects

The vibration effects associated with construction of EB2/EB3R has been considered in terms of human response to varying vibration magnitudes and building damage. However, in our experience the main concern for building occupants during construction is damage to the building itself.

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

Potential effects and human perception of the vibration levels found within the AUP (OP), and DIN criteria described above have been combined and presented in Table 13 and adopted for this assessment.

**Table 13 Potential vibration effects on human perception summary against AUP and DIN criteria**

| External Noise Level | Potential Daytime Effects Outdoors |
|---|---|
| 0.14 mm/s | The threshold of perception for stationary people. Just perceptible in particularly sensitive environments. |
| 0.3 mm/s | Can be just perceptible during normal residential activities, particularly for more sensitive receivers. Levels above may wake most people from their sleep.<br><br>This is the AUP(OP) limit for construction vibration generated at night-time for sensitive receivers. |
| 1 mm/s | Is typically tolerable with prior notification. Complaint or adverse reaction is likely in office or residential environments, particularly if there is no prior warning. What people actually feel would be subject to the source but could include a steady vibration from sources such as vibratory compaction, or a small jolt such as from 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.<br><br>This is the AUP(OP) limit for large construction projects generating vibration. |
| 5 mm/s | Unlikely to be tolerable in a workplace. Highly unsettling for both workplaces and dwellings. If exposure is prolonged, some people may want to leave the building |

| | |
|---|---|
| | Computer screens would shake and items could fall off shelves if they are not level.<br>This is the threshold below which no cosmetic damage will occur in the DIN standard. |
| 10 mm/s | Likely to be intolerable for anything other than a very brief exposure. |

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

At 0.3 mm/s the emission radii could be up to 140m from construction areas, and at this level people could feel slight vibrations especially during the night-time, which may cause sleep disturbance. High vibratory activities should therefore be avoided during the night-time and careful management of the type of equipment used at night is included in the draft CNVMP (refer Section 8.1).

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

# 8 Recommended Measures to Avoid, Remedy or Mitigate Effects

## 8.1 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 is to 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 the CNVMP. Accordingly, a draft CNVMP is attached in EB2 AEE Appendix 31 and EB3R AEE Appendix 22, and includes 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 EB2/EB3R;
- Identification of receivers where noise and vibration standards apply;
- Management and mitigation options, including alternative strategies adopting the BPO where full compliance with the relevant noise and/or vibration standards cannot be achieved;
- Methods and frequency for monitoring and reporting on construction noise and vibration, including:
    - Updating the predicted noise and vibration levels based on the final methodology and construction activities;
    - Confirming which buildings will be included in a pre and post building condition survey;
    - Identifying appropriate monitoring locations for receivers of construction noise and vibration;
    - Procedures to respond to complaints received on construction noise and vibration, including methods to monitor and identify noise and vibration sources;
    - Procedure for responding to monitored exceedances; and
    - Procedures for monitoring construction noise and vibration and reporting to the Auckland Council Consent Monitoring officer.
    - Procedures for maintaining contact with stakeholders, notifying of proposed construction activities, the period of construction activities, and handling noise and vibration complaints;
    - Contact details of the site supervisor or Project manager and the Requiring Authority's Project Liaison Person (phone, postal address, email address);
- Procedures for the regular training of the operators of construction equipment to minimise noise and vibration as well as expected construction site behaviours for all workers;
- Identification of areas where compliance with the noise and/or vibration standards will not be practicable and where a Schedule will be required;
- Procedures for how remedial works will be undertaken, should they be required as a result of the building condition surveys; and
- Procedures and timing of reviews of the CNVMP.

A draft CNVMP is provided in EB2 AEE Appendix 31 and EB3R Appendix 22. The draft CNVMP utilises all relevant information available at the time of writing of this assessment, as provided by the EBA construction team. It also includes the record of consultations and outcomes/actions of the consultations taken up to the date of writing of this assessment. The draft CNVMP will be finalised prior to commencement of construction and will be updated as necessary during construction.

## 8.2 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 will 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 approaching the Category B vibration limits, which document their current condition and any existing damage.

Schedules are likely to be required for (but not limited to):

- Te Tuhi
- Pakuranga Medical Centre
- Night-time works

Schedules will be prepared prior to the start of the construction works where sufficient detail about the works is known. Schedules will also be prepared prior to any works after construction has started where the construction methodology changes such that they are required.

## 8.3 Noise mitigation measures

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

- Managing times of activities to avoid night works and other sensitive times where practicable;
- Liaising with neighbours (including providing advance notice of works where the noise criteria are predicted to be exceeded) so they can work around specific activities;
- Selecting equipment and methodologies to restrict noise;
- Using screening/enclosures/barriers (as discussed in section 8.4); and
- Offering neighbours temporary relocation.

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

Some activities are likely to be set back a considerable distance from the nearest receivers and require very little or no mitigation to achieve compliance with the relevant Project noise limits. Alternative methodologies, 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.

## 8.4 Noise barriers

Temporary noise barriers can be used as an effective tool to reduce noise from site at the source and may reduce noise levels from the works by up to 10 dB at the ground floor.

Noise barriers or enclosures will be used where practicable in areas where the noise limits are predicted to be exceeded, and where they provide effective mitigation.

For a noise barrier to be effective it must physically obstruct line of sight between the noise source and receiver. Receivers on the first floor and above will be able to see over the noise barrier and it will provide little attenuation. Noise barriers would typically be in the form of fences lined with acoustic mats 1.8 metres high.

The noise barrier should be:

- Positioned to physically obstruct line of sight between the construction work and receiver; where this is practicable;
- Positioned as close as practicable to the noisy construction activity; and
- Abutted or overlapped to provide a continuous screen with no gaps at the base or between panels.

## 8.5 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 where practicable;
- Liaising with neighbours (including providing advance notice of works where the vibration criteria are predicted to be exceeded) so they can work around specific activities;
- Operating vibration generating equipment as far from sensitive sites as possible;
- Selecting equipment and methodologies to minimise vibration;
- Offering neighbours temporary relocation; and
- In specific situations, a cut-off trench may be used as a vibration barrier if located close to the source.

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

The draft CNVMP sets out a procedure to provide advance notice of works to receivers where they are predicted to fall within the vibration emission radii for amenity.

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

## 8.6 Building condition survey

A detailed building precondition survey should be undertaken by a suitably qualified engineer prior to the start of construction at all buildings where the daytime Category B criteria may be exceeded. This is

a requirement of the proposed conditions of consent. The survey shall include, but not be limited to, the following:

- Determination of building classification: commercial, industrial, residential or a historic or sensitive structure;
- Determination of building specific vibration damage risk thresholds; and
- Recording (including photographs) the major features of the buildings including location, type, construction (including foundation type), age and present condition, including existing levels of any aesthetic damage or structural damage.

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

## 8.7 Night works

Night works have the potential to cause the greatest disturbance to residents and should be avoided where practicable. However, as per section 5.3 the Alliance construction team have noted that night works will be required for a number of activities when works cannot practicably take place during the day.

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.
- Offer temporary relocation to neighbours if unreasonable noise and/or vibration levels cannot be avoided. This will be a last-resort option only to be explored when all other measures have been exhausted.

Noise predictions have been carried out based on information provided by the EBA construction team. The results of the predictions are summarised and discussed in Section 9.

As the predictions indicate that the night-time noise criteria will be exceeded at surrounding receivers, a Schedule will be prepared for the night-time works as per Section 8.2.

# 9 Predicted Levels and Effects

## 9.1 Predicted construction noise levels and associated effects

Predictions of noise from construction activities have been carried out for sensitive receivers across both EB2 and EB3R, during worst-case construction activities for each major stage of construction.

Table 14 sets out the minimum set-back distances required from the works to comply with the daytime construction noise criteria for each stage of the works, for both a reasonable worst-case scenario (e.g. concrete saw in use, 30% on-time with noise barriers, near edge of construction footprint) and a typical scenario (e.g. excavator in operation with noise barriers around the working site).

**Table 14 Required set-back distances for compliance with daytime noise criterion**

| Construction works stage | Worst-case equipment | Typical equipment | Required set-back distance for compliance with 70 dB $L_{Aeq}$ daytime noise criterion during reasonable worst-case scenario | Required set-back distance for compliance with 70 dB $L_{Aeq}$ daytime noise criterion during typical scenario |
|---|---|---|---|---|
| Site establishment (including utility works, demolition and clearing) | Handheld concrete saw/chainsaw, concrete breaker, 30% on-time, noise barriers around working site | 20T Excavator, noise barriers around working site | 13m | 9m |
| Earthworks and civil works | 20T Excavator, noise barriers around working site | 20T Excavator, noise barriers around working site | 9m | 9m |
| Pavement construction (including surfacing) | Concrete saw, 30% on-time, noise barriers around working site | Roller compactor, noise barriers around working site | 13m | 9m |
| Bridge construction works (RRF) | Bored piling rig | 20T Excavator, noise barriers around working site | 45m | 9m |

As can be seen in Table 14, for the worst-case scenarios, sensitive receivers up to 45m away from the works will potentially be exposed to construction noise levels above the daytime construction noise criterion during use of the piling rig for construction of the RRF, if no mitigation measures are in place.

Appendix D presents tables summarising predicted levels at receivers where the daytime noise limits are predicted to be exceeded for typical and worst-case construction activities across the wider EB2 and EB3R construction works. These levels are predicted for the scenario where works take place at the closest possible location to each receiver. The noise levels at receivers will reduce compared to those presented in Appendix D as the works progress. This is discussed in detail further below.

High noise generating activities, such as use of the concrete saw, will not take place for the entire duration of the works. For example, the construction team have advised that the concrete saw will be used for one week in total during demolition works and two days in total for pavement works at each works location.

Moreover, operation of construction equipment will be intermittent in nature at a given location. Construction will be linear so as the equipment moves away from receivers, noise levels will reduce.

During typical construction activities, the set-back distance for compliance with the daytime noise criterion reduces to 9m, assuming noise barriers are erected effectively around construction works. We consider this to be a more realistic and common scenario for works on site (compared to the modelled worst-case scenario) for assessing construction noise from the works.

In line with the above, we consider that during typical construction activities, noise from the works will be compliant with the daytime noise criterion for the majority of the daytime works at all locations.

For this to be true, it is important that mitigation is implemented effectively at working sites. Erection of noise barriers around working sites can reduce noise levels up to 10 dB at the ground floor. The effectiveness of the barriers is dependent on how the barriers are set up, i.e., no gaps. However, it should be noted that construction works will take place in the vicinity of a number of two storey dwellings across the project alignment. While noise barriers are effective at reducing noise at the ground floor, they will provide little to no attenuation to receivers above the ground floor, as line-of-sight to the works will be easily maintained.

It is also possible that the works may come within the set-back distance for compliance with the daytime noise criterion (9m) at some receivers intermittently, also exposing them to noise levels above the daytime criterion. For these situations, it is important that noise effects are managed through communication with affected receivers, for example by scheduling noisy works when nearby buildings are unoccupied and providing advance notice as mentioned above.

There will be times when construction works that are noisier than the typical works must take place, and implementation of mitigation may be restricted, leading to exceedances of the noise criteria at some receivers. For these scenarios, noise effects must be managed through effective communication with the affected receivers which will be managed by the CNVMP. In particular, scheduling of noisy activities when nearby buildings are unoccupied should be done when practicable and advance notice should be provided of these works.

As night-time works are required in close proximity to residential receivers, consultation and mitigation measures will be essential. The use of noisy equipment should be avoided where possible to prevent sleep disturbance. If the use of noisy equipment cannot be avoided during the night-time and the required reductions in noise cannot be achieved with noise barriers or other mitigation, it may be necessary to offer temporary relocation to the most affected residential receivers to manage and mitigate adverse effects. This will be determined on a case-by-case basis through consultation with the affected parties during production of any Schedules.

The most effective method to manage noise effects will be through implementation of the CNVMP. A draft CNVMP has been prepared. The CNVMP will be the primary method to ensure that the Best Practicable Options to mitigate noise and vibration are implemented, and that community engagement

is managed effectively. A CNVMP that is implemented effectively can significantly reduce the magnitude and frequency of adverse effects, while reducing the likelihood of complaints.

### 9.1.1 EB2

High noise-generating activities may not occur on the edges of the construction area modelled, but if they do, 18 commercial and 43 residential receivers could experience noise levels above 70 dB $L_{Aeq}$ during a worst-case scenario, i.e. when the concrete saw is in use with noise barriers placed around the working site while in use at the edge of the construction boundary. At the corresponding internal noise level, effects could include loss of concentration, annoyance, and reduction in speech intelligibility inside dwellings.

However, as noted above, this does not represent a typical scenario. During a typical scenario, i.e. use of the excavator with noise barriers around construction sites, 15 commercial and 34 residential receivers could experience intermittent noise levels above the daytime noise criterion of 70 dB $L_{Aeq}$. We note that these levels are predicted while works take place at the closest possible location at each receiver; in reality, noise levels will quickly reduce as the works progress and high noise generating activities are completed. Noise at this level can be tolerated provided that prior notification is given before high noise generating activities take place.

Appendix D sets out the noise levels predicted at receivers during both worst-case works and typical construction works. Effects at different noise levels are set out in Table 12.

Commercial receivers, such as Countdown and The Warehouse, have solid façades which could provide a reduction in noise levels up to 50 dB. Noise may be audible inside during high noise generating activities, but due to the nature of these businesses (busy retail with background music playing), construction noise levels should not impact business operations.

Other commercial receivers adjacent to the works, such as the Howick Local Board office and Caci Pakuranga, have glazed facades that are expected to reduce noise levels by 20 to 30 dB. Noise effects from worst-case construction activities adjacent to these receivers can include loss of concentration, annoyance, and reduction in speech intelligibility. However, as with the residential dwellings adjacent to the works, the worst-case levels are predicted while works take place at the closest possible location at each receiver; in reality, noise levels will quickly reduce as the works progress and high noise generating activities are completed. Noise at this level can be tolerated for short durations provided that prior notification is given before high noise generating activities take place.

With effective mitigation in place, noise levels are predicted to comply with the 70 dB $L_{Aeq}$ noise criterion at surrounding receivers for the majority of the construction works. Where the noise criteria are predicted to be exceeded, the effects will be mitigated and managed through the CNVMP.

### 9.1.2 Reeves Road Flyover Construction

Construction of the Reeves Road Flyover will involve use of the bored piling rig. Noise levels were predicted based on the piling rig operating at each pile location. Receivers where the modelling results indicated an exceedance of the daytime noise criteria are presented in Table 15.

**Table 15 Piling noise modelling results**

| Address | Name | Use | Noise Level, dB $L_{Aeq}$ |
|---|---|---|---|
| 2r Ti Rakau Drive | The Warehouse | Commercial | 86 |
| 11 Reeves Road | Bread of Life Christian Church | Commercial | 80 |
| 13r Reeves Road | Te Tuhi | Commercial | 78 |
| 3 Reeves Road | Gull | Commercial | 74 |
| 2 Cortina Place | Pita House | Commercial | 71 |

As shown in Table 15, exceedances of the noise criteria are predicted at 5 commercial receivers during use of the piling rig. Of these receivers, the most sensitive to noise are the Bread of Life Christian Church (during services and other occupied hours) and Te Tuhi.

During consultation, it was identified that the façade of Te Tuhi would only provide an estimated reduction of approximately 15 dB at the lobby/café area, due to the construction of the façade at the café and windows being left open for ventilation along the side of the lobby facing Reeves Road. Concerns around noise were also raised by Te Tuhi around the social room at the south-western corner of the building facing Reeves Road (where tai chi and yoga classes are occasionally held), and the offices at the north-western side of the building facing Reeves Road. Te Tuhi also flagged exhibitions coming up that will incorporate sound, for which they would require advanced notice of any noisy works.

Construction works must be mitigated and managed through the CNVMP at both the Bread of Life Christian Church and Te Tuhi.

### 9.1.3 EB3R

High noise-generating activities may not occur on the edges of the construction area modelled, but if they do, 2 commercial and 61 residential receivers could experience intermittent noise levels above 70 dB $L_{Aeq}$ during a worst-case scenario, i.e. when the concrete saw is in use with noise barriers placed around the working site while in use at the edge of the construction boundary. At this level, effects could include loss of concentration, annoyance, and reduction in speech intelligibility inside dwellings.

However, as noted above, this does not represent a typical scenario. During a typical scenario, i.e. use of the excavator with noise barriers around construction sites, 1 commercial and 38 residential receivers could experience intermittent noise levels above the daytime noise criterion of 70 dB $L_{Aeq}$. We note that these levels are predicted while works take place at the closest possible location at each receiver; in reality, noise levels will quickly reduce as the works progress and high noise generating activities are completed. Noise at this level can be tolerated provided that prior notification is given before high noise generating activities take place.

Appendix D sets out the noise levels predicted at receivers during both worst-case works and typical construction works. Effects at different noise levels are set out in Table 12.

There are a number of residential receivers along the EB3R route that are two or more storeys in height; noise barriers will provide little to no attenuation of noise at the upper levels of these properties. Therefore, construction noise effects must be managed at these properties through communication and consultation, including scheduling of noisy activities while buildings nearby are unoccupied.

With effective mitigation in place, noise levels are predicted to comply with the 70 dB $L_{Aeq}$ noise criterion at surrounding receivers for the majority of the construction works. Where the noise criteria are predicted to be exceeded, the effects will be mitigated and managed through the CNVMP.

#### 9.1.4 Night works

Night works anticipated during the EB2 and EB3R construction works are summarised in Section 5.3.

Noise predictions have been undertaken for works where sufficient detail was provided by the EBA construction team.

For the night-time vegetation clearance and pavement works, the noise predictions included a duration correction of 25% for use of the chainsaw and concrete saw respectively. For the night-time RRF works, a duration correction was not applied to the predicted noise levels. The predictions include noise barriers during use of the chainsaw and concrete saw but are not included during concrete pours due to practicability issues as indicated by the EBA construction team.

In summary, the night-time noise criteria are predicted to be exceeded at:

- 162 residential properties in EB2 during night-time RRF construction works
- 125 residential properties in EB2 and 164 residential properties in EB3R during night-time vegetation clearance works
- 127 residential properties in EB2 and 16 residential properties in EB3R during night-time pavement works.

The results of the predictions are summarised in Appendix D.

Relocation of existing houses will also be undertaken during the night-time. This activity involves a truck being loaded with the house to be relocated. The main noise source during this activity will be the truck engine. As the truck will need to enter private land, it cannot be counted as an activity taking place within the road corridor and must be assessed alongside the other night-time activities. However, we consider a truck engine to be a noise source that is regularly heard on roads during the night-time (unlike sources for the other night-time works). We understand that house removals typically only occur during the night-time in Auckland. Moreover, this is an activity that will progress along the entire EB2/EB3R alignment within only two weeks. Therefore, we consider noise from this activity to be acceptable.

Although exceedances of the night-time noise criteria are predicted, the location, duration and management of the works must also be considered when assessing noise effects.

All the predictions assume that the works are taking place at the closest possible location within the site footprint for each receiver. In reality, noise levels will reduce as the works progress.

The predictions are taken along the façade that is closest to the works. However, some parts of a given house will be less sensitive to noise than others, for example, garages fronting towards the road, and unoccupied living rooms.

Predictions are for noise on the external façade of the building since this is where the night-time noise criteria are applicable. However, it is internal noise that will be of most concern to residents during the night-time. The extent of the reduction of noise from outside to inside will depend on a range of factors, including the construction of the façade, the amount of glazing, and whether windows are left open or shut.

Possible effects that may arise from night works include disturbance, annoyance, and disruption of sleep. The extent of adverse effects will depend on the proximity of the works to each receiver on the night, the scheduling and duration of the works, and the plant items used on the night.

Careful scheduling of activities will be important to minimise noise effects at residential receivers during the night-time period. If noisy activities must take place during the night-time, if screening does not provide sufficient attenuation to meet the night-time noise criteria, and no other mitigation measures are practicable, it may be necessary to offer temporary relocation to affected residents. Temporary relocation should be considered on a case-by-case basis and as a last resort.

We note that the predictions that have been carried out for the worst-case night works are in terms of the $L_{Aeq}$ noise descriptor, which effectively quantifies the average noise received in a given time period. For typical works during the night-time, it is more likely that residents will be disturbed by short-term peaks in noise from site, for example an excavator striking the ground, or metal being dropped from a height. Noise of this type is dependent on factors that are difficult to predict like the specific activity at the time and the way that equipment is operated. It is therefore important that the noise management measures around site operations set out in the CNVMP are followed by all staff working during the night-time.

As set out in Section 8.7, Schedules for the night works should be prepared prior to the start of the night works.

Night works have the potential to create significant noise effects if not managed appropriately, therefore they must be mitigated and managed through the CNVMP and Schedules.

## 9.2 Predicted construction vibration levels and effects

Maps showing the predicted vibration emission contours during the worst-case daytime and night-time activities are provided in Appendix F. The activities modelled were:

- Use of 12T vibratory roller at the edge of the construction footprint during the daytime
- Use of 7T vibratory roller for the night-time pavement works

The construction footprint provided indicates that daytime construction activities will take place within 2m of commercial and residential structures for both EB2 and EB3R.

Use of the 7T vibratory roller is expected within 19m of residential receivers for EB2 and will not be used in the EB3R area. In line with this, no predictions of the night-time Category B criterion are predicted at any residential receivers.

At a minimum, we recommend that a pre-construction building condition survey be carried out at all receivers where the Category B vibration criteria are predicted to be exceeded. This has been addressed in the proposed conditions of consent.

A list of receivers where either the Category A or B criteria are predicted to be exceeded during daytime and night-time works is provided in Appendix E.

### 9.2.1 EB2

32 residential dwellings may experience vibration levels above the Category B vibration criteria if the roller compactor is used on the construction boundary in the closest position. Once the compactor is 8m away from the dwellings the Category B criterion will be met.

13 commercial buildings may experience vibration levels above 20 mm/s PPV, exceeding the DIN 4150 commercial building criterion if the roller compactor is used within 2m of the building.

### 9.2.2 EB3R

49 residential dwellings may experience vibration levels above the Category B vibration criteria if the roller compactor is used on the construction boundary in the closest position. Once the compactor is 8m away from the dwellings the Category B criterion will be met.

1 commercial building (Edgewater Shopping Centre) may experience vibration levels above 20 mm/s PPV, exceeding the DIN 4150 commercial building criterion if the roller compactor is used within 2m of the building .

### 9.2.3 Vibration amenity

The daytime vibration amenity criteria could be exceeded in buildings that are occupied during the works and are within 21 m of the roller compactor or within the emission radii identified for the other vibration generating equipment in Table 10. The effect on receivers would be subject to their respective proximity to the works but could include steady vibration from the roller compactor or a small jolt from an excavator which could rattle crockery and glassware.

As per section 3.2.1, the AUP (OP) states that works generating vibration for three days or less between the hours of 7am to 6pm may exceed the amenity limits, but prior notice must be given at least three days in advance, and the vibration must comply with the limit of 5 mm/s. This is set out in the draft CNVMP.

During the night-time pavement works, the night-time 0.3 mm/s amenity criteria may be exceeded at 30 residential properties during use of the 7T roller. Maps showing the vibration emission contours for night-time works are provided in Appendix F.

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

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

High vibration generating activities should not occur during the night-time in close proximity to residential receivers to avoid sleep disturbance.

The measures set out in the draft CNVMP must be implemented for the duration of the works to mitigate and manage effects from construction vibration.

# 10 Conclusions

Construction noise and vibration has been assessed for EB2 and EB3R in accordance with the requirements of the AUP and NZS 6803:1999.

Construction noise during the daytime is predicted to exceed the applicable criteria at a number of receivers along the EB2/EB3R alignment if high noise generating equipment (e.g. concrete saw) is used in the closest position to the receivers, even if mitigation measures are put in place. Should these exceedances occur, they will be intermittent and over a limited duration. The effects from these exceedances have been discussed in Section 9.1. Construction noise during the daytime is predicted to comply with the relevant criteria at surrounding receivers for the majority of the works. Where the noise criteria are predicted to be exceeded, effects will be managed through the mitigation and management measures set out in the CNVMP.

Construction noise during the night-time is predicted to exceed the relevant criteria at a number of properties. The extent of noise effects will be dependent on the location, duration and type of works taking place, as well as the construction of the affected buildings and locations of receivers within the buildings. Night-time works must be mitigated and managed appropriately through the CNVMP. Schedules should be prepared prior to the start of the night works.

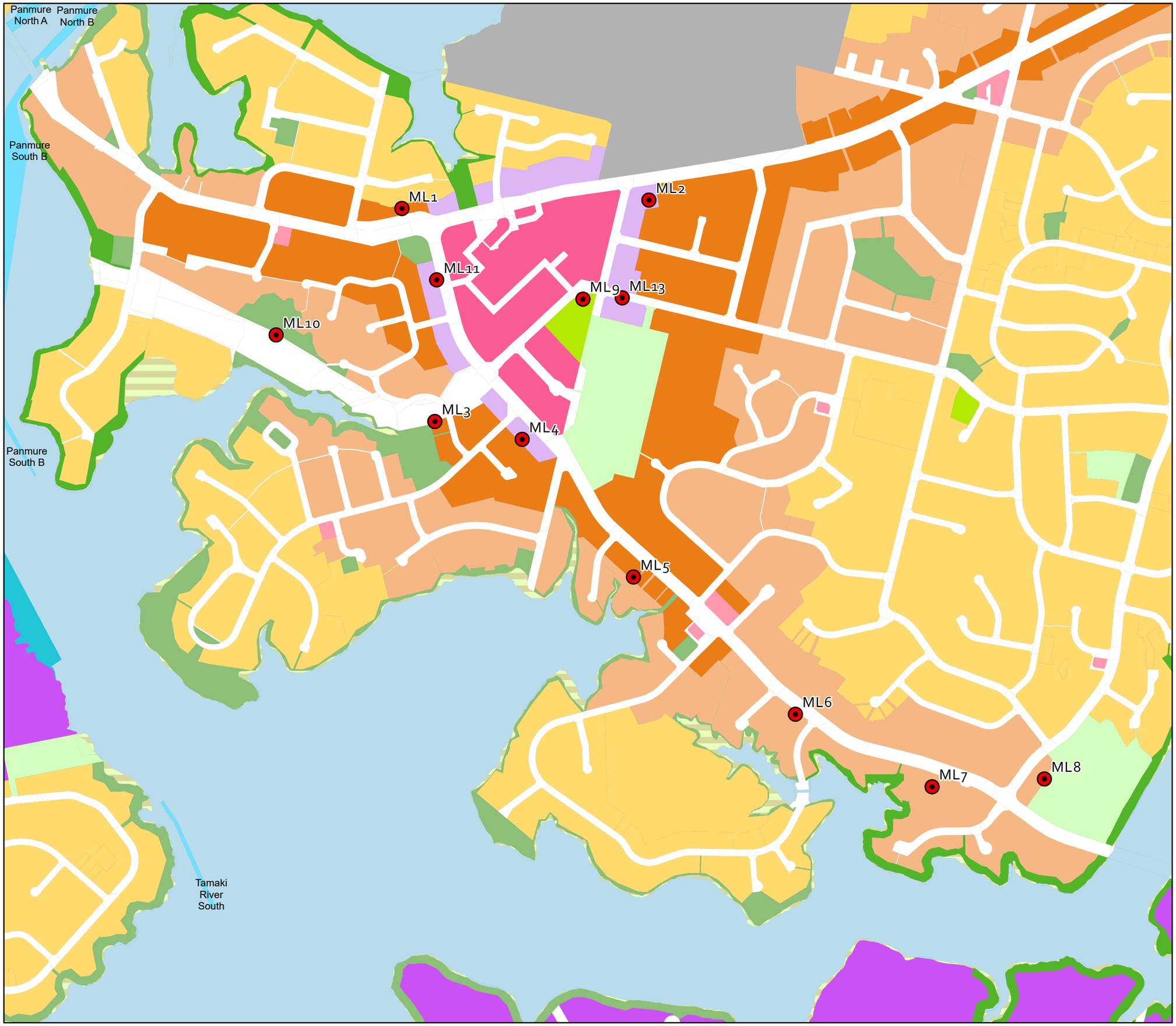
Construction vibration is predicted to exceed the DIN 4150 criteria at a number of commercial and residential buildings around EB2/EB3R if high vibration generating equipment is used on the construction boundary in the closest position to the receivers.

The daytime vibration amenity criterion is predicted to be exceeded at a number of buildings if high vibration generating equipment is used on the construction boundary in the closest position to the receivers and if they are occupied during the works. Use of the vibratory roller during the night-time is predicted to generate vibration that may exceed the night-time amenity criterion. Effects from these potential exceedances have been discussed in Section 9.2; vibration amenity effects must be managed through communication with affected stakeholders.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 8, to generally comply with the applicable limits as defined in the AUP. Where an exceedance is predicted at any receiver the effects will be mitigated and managed through a CNVMP.

A CNVMP is the most effective way to avoid, remedy or mitigate construction noise and vibration effects on receivers so that the BPO is implemented throughout the duration of construction.

# Appendix A – AUP Zoning




## Zones

- Residential - Mixed Housing Suburban Zone
- Residential - Mixed Housing Urban Zone
- Residential -Terrace Housing and Apartment Buildings Zone
- Open Space - Conservation Zone
- Open Space - Informal Recreation Zone
- Open Space - Sport and Active Recreation Zone
- Open Space - Community Zone
- Business - Town Centre Zone
- Business - Neighbourhood Centre Zone
- Business - Mixed Use Zone
- Business - Light Industry Zone
- Special Purpose Zone
- Coastal - General Coastal Marine Zone [rcp]
- Coastal - Mooring Zone [rcp]
- Coastal - Minor Port Zone [rcp/dp]
- Coastal - Coastal Transition Zone
- Road

## Measurement Locations

N



Map Creation Date: 3/8/2022

Author:



Eastern Busway Alliance

Fletcher | acciona | AECOM | Jacobs