Appendix 15

Construction Noise and Vibration Effects Assessment

Eastern Busway

EB3 Commercial and EB4 Link Road

Construction Noise and Vibration Effects Assessment

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Eastern Busway

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Terms and Definitions

Table 0-1 Terms and definitions.

Term	Definition
EB3C	Eastern Busway 3 Commercial
EB4L	Eastern Busway 4 Link Road
AUP(OP)	Auckland Unitary Plan (Operative in Part) (Updated 20 July 2023)
AEE	Assessment of Effects on the Environment
AT	Auckland Transport
AMETI	Auckland Manukau Eastern Transport Initiative
BPO	Best Practicable Option
CNVMP	Construction Noise and Vibration Management Plan
PPV	Peak Particle Velocity
Tn	Tonne
dB	Decibel
LAeq	A-weighted, equivalent continuous sound level

Executive Summary

Overview

The purpose of this Construction Noise and Vibration Assessment is to provide an assessment of the potential noise and vibration effects of the Eastern Busway 3 Commercial (EB3C) and Eastern Busway 4 Link Road (EB4L) sections of the Eastern Busway Project (the Project).

Key elements of the proposed EB3C works include the construction of two bridges (Bridges A and B), a noise wall and retaining walls, stormwater drainage, and a cycleway. The EB3C bridge structures, new and upgraded stormwater outfalls and two areas of reclamation require works in the coastal marine area (CMA).

The proposed EB4L footprint traverses Guys Reserve and Whaka Maumahara Reserve and includes road widening at the intersection of Te Irirangi and Town Centre Drive. The works include a bridge structure (Bridge C), retaining walls, stormwater drainage, and a new walking and cycling pathway.

Assessment criteria

Construction noise has been assessed against the noise criteria set out in rule E.25.6.27 of the Auckland Unitary Plan (AUP(OP)), 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 AUP(OP) 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.

Summary of assessment

Measures to avoid, remedy or mitigate noise and vibration from the works have been considered. The conditions require measures which 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 modelling indicates:

- Noise levels at 16 residential and 9 commercial receivers are predicted to exceed the daytime AUP(OP) criteria during the EB3C main works (as defined in section 6.2.1).
- Noise levels at 2 commercial receivers are predicted to exceed the daytime AUP(OP) criteria during construction of Bridge A and Bridge B.
- Noise levels at 5 commercial and 5 residential receivers are predicted to exceed the daytime AUP(OP) criteria during construction of EB4L.

However, with noise mitigation implemented, noise levels are predicted to comply with the daytime 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 appropriately mitigated and managed through the CNVMP.

Where works cannot practicably be carried out during the daytime, works during the night-time will be carried out. Night works will only take place where required, and they will only take place over a limited duration of time.

Noise levels at a number of residential receivers are predicted to exceed the AUP(OP) criteria during night-time works:

- 32 residential properties during EB3C night-time long weekend works
- 226 residential properties during EB3C night-time pavement works
- 77 residential properties during EB3C early morning bridge construction works (concrete pours)
- 154 residential properties during EB4L early morning bridge construction works (concrete pours)

These properties are listed in Appendix D.

Night works have the potential to create adverse noise effects therefore they must be mitigated and managed through the CNVMP. The conditions require that Schedules will also be prepared for the night works to ensure adverse effects will be appropriately managed.

Vibration from the works has been predicted and assessed. The Category B vibration criteria are predicted to be exceeded at 15 residential receivers during EB3C works and 2 residential receivers during EB4L works. At a minimum, we recommend that pre-construction building condition surveys be carried out at these receivers. The vibration amenity criteria are predicted to be exceeded at a number of properties during both daytime and night-time works.

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 conditions require preparation of a CNVMP. The measures and methods that will be set out in the CNVMP for EB3C and EB4L 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 Best Practicable Option (BPO) is implemented throughout the duration of construction.

Overall, with BPO measures implemented, we consider that noise and vibration effects from construction of EB3C and EB4L will be reasonable.

1 Introduction

1.1 Overview of 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:

- 5 km of two-lane busway
- Two new bridges for buses across Pakuranga Creek (Bridges A and B)
- A new bridge for buses crossing Guys Reserve and Whaka Maumahara Reserve (Bridge C)
- 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 Tī Rākau 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
- Eastern Busway 3 Residential (EB3R) – Tī Rākau Drive from the South-Eastern Arterial (SEART) to Pakuranga Creek, including Edgewater and Gossamer Intermediate Bus Stations
- Eastern Busway 3 Commercial (EB3C) – which commences from Riverhills Park along Tī Rākau Drive to Botany, including two new bridges, and an offline bus route through Burswood (**this Assessment)**
- Eastern Busway 4 Link Road (EB4L) – Guys Reserve to Botany Town Centre, including a link road through Guys and Whaka Maumahara Reserves to Reserves to Te Irirangi Drive/Town Centre Drive intersection (**this Assessment**).

The overall Project is shown in Figure 1 below.

Figure 1-1 Project alignment

1.2 Project Objectives

The Project objectives are:

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

2 Proposal Description

The following sections provide a brief description of both EB3C and EB4L. These descriptions consist of the construction and operation of both EB3C and EB4L packages, with further details provided in the AEE and Notices of Requirement. A full set of proposed plans is attached to the AEE.

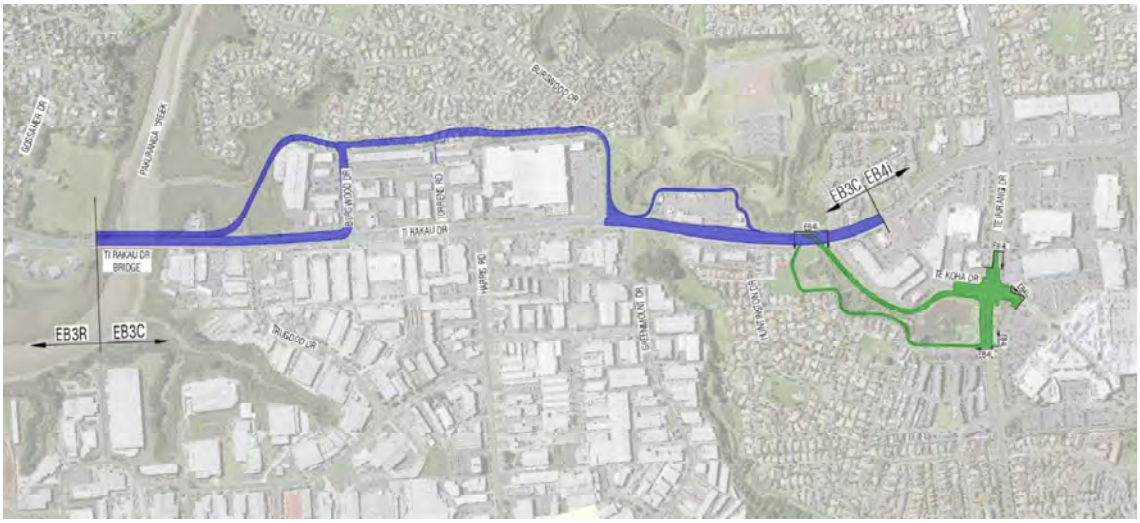


Figure 2-1 Eastern Busway 3 Commercial and 4 Link Road Project Extent

2.1 Eastern Busway 3 Commercial

The proposed EB3C works will involve the establishment of an 'off-line' busway, cycleway, and stormwater upgrades. These proposed works will take place within existing road reserves, Council reserves[1] and privately held land within the proposed works footprint (refer Figure 2-1). The extent of works for EB3C runs between Riverhills Park (i.e., adjacent to the terminus of the EB3R package) in the west to Guys Reserve in the east, through the suburbs of Burswood and East Tāmaki.

The busway will be largely off-line (i.e., outside the current Tī Rākau Drive corridor), first crossing Pakuranga Creek by way of a new two-lane bridge (Bridge A) including abutments[2] and scour protection. It will then cross a coastal headland at 242 Tī Rākau Drive (a Mobil branded service station), and then an embayment within which a retaining wall, and a 4m^2 coastal reclamation will be constructed. The busway will cross a second headland at 254 Tī Rākau Drive (currently occupied by a pet store), before crossing a mangrove filled bay to the west of 262 Tī Rākau Drive (the 'Chinatown' retail business) via a second bridge (Bridge B). Bridge B will include two abutments with scour protection. Bridge B will require construction of a reinforced embankment at its northern end which includes imported fill, rip rap and permanent wick drains, and 549m^2 coastal reclamation. In parallel, a retaining wall will be constructed to the eastern side of the embankment. Following this, the busway runs between the commercial area and residential area north of Tī Rākau Drive, crossing several residential sites. The busway also crosses Burswood Drive twice, with raised signalised crossings established to control both the busway and road traffic.

A new 'intermediate' style bus station will be established at Burswood, before the busway then crosses over Burswood Esplanade Reserve and onto a widened Tī Rākau Drive (by the Howick and Eastern bus

[1] Including Burswood Esplanade Reserve and Bard Place Reserve
[2] The western abutment and associated scour protection was included in the EB3R consenting package

depot). The busway will then run beside the eastbound lanes of Tī Rākau Drive, before crossing over Tī Rākau Drive to connect with EB4L at Guys Reserve.

The busway will include a new cycleway, which will largely run parallel to the busway for most of this section of the Project. The exceptions to this include Bridge B, between 254 Tī Rākau Drive and Burswood Esplanade (west) – for this section the cycleway will continue along Tī Rākau Drive before turning into Burswood Drive West, as well as where the cycleway runs behind the Howick and Eastern bus depot.

Other works included in EB3C are the relocation of existing utility services, the provision of new or upgraded stormwater infrastructure and open space upgrades. Stormwater works will involve new outfalls discharging to Pakuranga Creek (and its tributaries) and rain gardens.

Lastly, EB3C involves the establishment of two laydown areas, one at 242 Tī Rākau Drive and the other within the boundaries of Burswood Esplanade Reserve. Both laydown areas are located on land that will be occupied by the Project upon its completion.

Figure 2-2 Eastern Busway 3 Commercial Project Area

2.2 Eastern Busway 4 Link Road

The EB4L works will involve the establishment of an 'off-line' dedicated two-way busway, shared pathway, and stormwater upgrades. These works will take place in Guys Reserve, Whaka Maumahara Reserve, existing road reserve and Botany Town Centre land for the intersection improvements on Town Centre Drive.

EB4L commences south of Tī Rākau Drive, crossing through Guys Reserve, Whaka Maumahara Reserve and ending at the intersection of Te Irirangi Drive/Town Centre Drive.

The works will primarily involve the construction of a new two-way busway corridor which will run along the eastern side of Guys Reserve and Whaka Maumahara Reserve to provide access for bus services between Pakuranga and Botany. The two-way busway is designed to integrate with EB3C and be a continuation of the EB3C busway.

This section of the busway will feature a bridge (Bridge C) approximately 350m long. This bridge is needed due to the sloping topography of the Reserves.

The busway will then connect to Te Irirangi Drive, following alterations to the existing Te Irirangi Drive/Town Centre Drive intersection.

A shared pathway and minor retaining walls will also be constructed along the southern and western boundaries of Guys Reserve and Whaka Maumahara Reserve. The shared pathway will connect to existing walkways and will terminate at Te Irirangi Drive.

A new shared pathway and retaining wall will also be constructed along the western boundary of Te Irirangi Drive and is partially located within the Whaka Maumahara Reserve.

A new stormwater outfall (including riprap) will be constructed within Guys Reserve. The outfall will discharge stormwater over scour protection prior to its entry into a tributary of Pakuranga Creek. Additionally, a new stormwater connection will be constructed in Whaka Maumahara Reserve, adjacent to Te Irirangi Drive. This new connection will discharge via an existing outfall into the existing stormwater pond within the Reserve.

A construction laydown area will also be established within Guys Reserve, adjacent to Tī Rākau Drive and 415 Tī Rākau Drive. A second laydown area will be established in Whaka Maumahara Reserve, between the existing stormwater pond and Te Irirangi Drive. Construction access will also be gained from Te Koha Road beside VTNZ's vehicle inspection premise located at 451 Tī Rākau Drive.

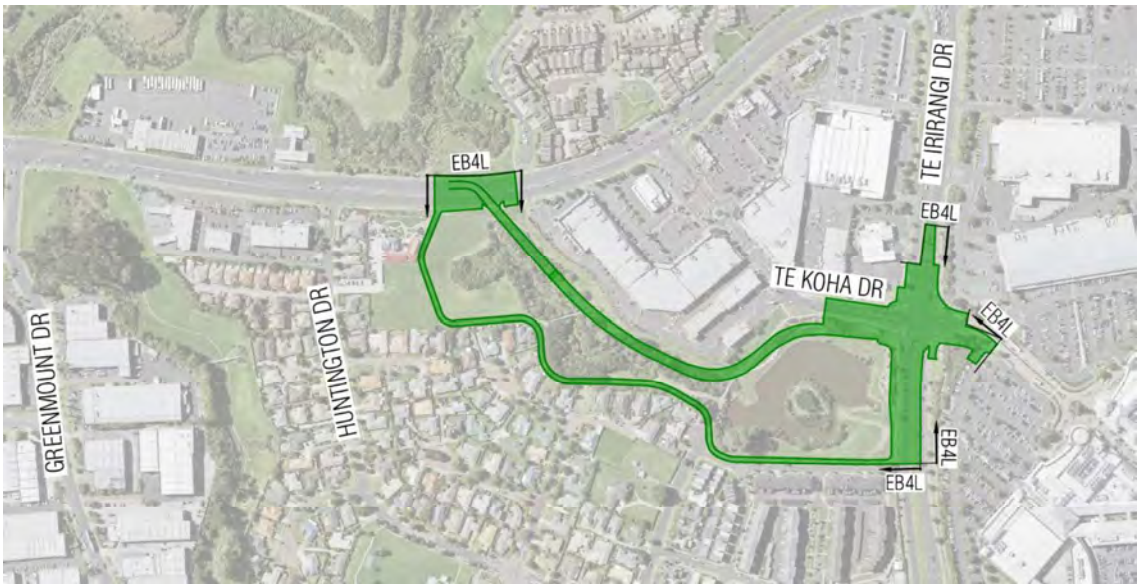


Figure 2-3 Eastern Busway 4 Link Road Project Area

3 Specialist Assessment

Chapter Summary
• *This report describes the assessment of construction noise and vibration effects associated with the construction of EB3C and EB4L sections of the Project.*

3.1 Assessment Content

This report describes our assessment of the construction noise and vibration effects for EB3C and EB4L.

This noise and vibration assessment assesses whether, and to what extent, EB3C and EB4L can be constructed so that adverse construction-related noise and vibration effects can be avoided or mitigated.

This construction noise and vibration assessment involves:

- Describing the relevant noise and vibration criteria
- Measuring existing noise levels
- Predicting and assessing construction noise and vibration levels for proposed works associated with EB3C and EB4L
- Determining the areas and receivers that may be affected by noise and vibration effects associated with construction of EB3C and EB4L
- Identifying the measures required to avoid, remedy or mitigate potential construction noise and vibration effects.

4 Assessment criteria

Chapter Summary

This chapter describes the noise and vibration criteria relevant to the assessment and sets out the recommended noise and vibration criteria to be adopted.

4.1 Construction noise

Potential construction noise effects have been assessed in accordance with the applicable AUP(OP) noise provisions. Activities that do not comply with the relevant permitted noise standards in E25.6 of the AUP(OP) would ordinarily (in the absence of a designation) require resource consent as a Restricted Discretionary activity (Rule E25.4.1(A2)). The following permitted standards are relevant:

- Standard 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"
- Standards E.25.6.27(1) and E.25.6.27(2) of the AUP(OP) set permitted 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 4-1 for sensitive receivers and in Table 4-2 for non-sensitive receivers. Activities sensitive to noise are defined in Chapter J of the AUP(OP).

These criteria reflect standard E25.6.27(1) and (2) but because 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} AUP(OP) permitted noise limits for weekdays and Saturdays, in line with NZS 6803:1999.

Table 4-1 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	75
	7:30am – 6:00pm	70	85
	6:00pm – 8:00pm	65	80
	8:00pm – 6:30am	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 4-2 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 EB3C and EB4L works area extends through the road corridor, the Business – Light Industry zone, the Residential – Mixed Housing Suburban zone, and the Open Space – Informal Recreation zone. The works within the Business – Light Industry zone, the Residential – Mixed Housing Suburban zone, and the Open Space – Informal Recreation zone are subject to the noise criteria listed above.

For the works that take place in the road corridor, Rule E.25.6.29(1) of the AUP(OP) applies instead, but this also provides that noise from construction works within the road corridor complies with the limits set out in Table 4-1 and Table 4-2 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 than 10 days or 3 nights, rules E.25.6.29(2), 3(a) and 4 (which would exempt the works from needing to comply with these standards) do not apply.

Although the exemption for works within the road corridor does not apply, the requirements for this exemption are still being complied with regardless as a CNVMP will be prepared for these works. Preparation of a CNVMP is a requirement to qualify for the exemptions from compliance with the limits as allowed for in rule E25.6.29(3), and it is also a requirement of rules E.25.6.29(2), (4) and (4A), had the Project not already been disqualified because of the expected durations of exceedances.

4.2 Construction vibration

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

4.2.1 Auckland Unitary Plan (Operative in Part)

The AUP(OP) contains rules and standards relating to construction vibration that cover both building damage and amenity. Activities that do not comply with the relevant permitted vibration standards in E25.6.30 of the AUP(OP) would ordinarily (in the absence of a designation) require resource consent as a Restricted Discretionary activity. Standard E25.6.30 provides 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 E25.6.30.1 (as reproduced in Table 4-3 below) in any axis when measured in the corner of the floor of the storey of interest for multi-storey buildings, or within 500 mm of ground level at the foundation of a single storey building.

Table 4-3 AUP:OP Table E25.6.30.1 Vibration limits in buildings

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

Rule E.25.6.30(1) also states that works generating vibration for three days or less between the hours of 7am to 6pm may exceed the limits in Table 4-3, 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.

4.2.2 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 4-4.

Different criteria apply to "short-term" (transient) vibration sources such as blasting and impact piling, and "long-term" sources such as vibrocompaction. Note that the definitions 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 short-term vibration limits are higher than for long-term vibration.

Table 4-4 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 lines 1 and 2 and are of great intrinsic value	3	3 to 8	8 to 10	8	2.5

** At frequencies above 100 Hz, the values given in this column may be used as minimum values*
*** The Standard defines short-term vibration as "vibration which does not occur often enough to cause structural fatigue, and which does not produce resonance in the structure being evaluated". Long-term vibration is defined as all other vibration types not covered by the short-term vibration definition.*

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

Examples of a 'reduction of serviceability' include:

- the impairment of stability of the building and its components
- a reduction in the bearing capacity of floors.

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

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

These effects are deemed 'minor damage'.

4.2.3 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 4-5.

Table 4-5 Human perception of vibration levels

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

4.2.4 Recommended Construction Vibration Criteria

The following criteria are the recommended project construction vibration criteria for both building damage and amenity for EB3C and EB4L.

The two categories, detailed in Table 4-6, are designed to facilitate a progressive management response to increasing risks and effects during construction. These criteria have been included in the proposed conditions and will be included in the 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(OP), 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 4-6 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 4-6 is not practicable, and unless otherwise provided for in the CNVMP (refer 9.1), a Schedule (refer Section 9.2) 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. This will be set out in the proposed conditions.

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 9.5 and this is addressed in the proposed conditions relating to the CNVMP.

4.3 Blasting

The EBA construction team have advised that blasting may be required as part of construction for EB3C. No blasting is required for construction of EB4L.

Regarding blasting, Section E25.6.31 of the AUP(OP) states:

1) The noise created by the use of explosives for any blasting activity measured at the boundary of the site on which the explosives are used must not exceed a peak sound pressure of 120 dB (L_{zpeak})
2) The noise created by the use of explosives for construction activities must not exceed a peak sound pressure level of 120dBC measured 1m from the façade of any occupied building.

If blasting were to occur, vibration from blasting would be required to comply with the DIN 4150 criteria set out in Table 4-4 as set out in the conditions.

Criteria for vibration and airblast from blasting activities are set out in the proposed conditions of consent. The airblast criteria have been adopted from Australian Standard AS 2187.2-2006 *Explosives – Storage and use – Use of explosives* and are as follows:

- Air overpressure from all blast events must not exceed 120 dB LZpeak at the facade of any occupied building measured and assessed in accordance with the provisions of AS 2187.2.
- Air overpressure from all blast events must not exceed 133 dB LZpeak at the facade of any unoccupied building measured and assessed in accordance with the provisions of AS 2187.2.

Blasting is discussed further in Section 6.2.1.3 and Section 9.7.

5 Existing noise environment

Chapter Summary

This chapter describes the noise monitoring procedure and measurement results that were used to quantify the existing noise environment.

5.1 Noise survey

The existing environment along the proposed EB3C and EB4L busway alignment varies reflecting differences in characteristics between suburban areas, busy arterial roads in commercial areas, and reserves.

Receivers most sensitive to noise are those occupying dwellings for residential use. These receivers are primarily in suburban areas adjacent to the EB3C Burswood and TRD sections, and EB4L. The noise environment in the suburban areas is currently dominated by road traffic noise from the closest major arterial roads (Tī Rākau Drive and Te Irirangi Drive).

The Burswood section of the busway also has an existing childcare centre (WonderKids Childcare and Preschool at 2 Torrens Road) and the business park at 28 Torrens Road, where it is understood some upstairs tenancies are occupied for residential use. The Piccolo Park childcare centre is also located at 415 Tī Rākau Drive, adjacent to part of Guys Reserve adjacent to Tī Rākau Drive.

Dwellings that are adjacent to the major arterial roads (such as those east of Bard Place Reserve and along Waihi Way) exist within a noise environment that is dominated by those arterial roads.

The busway also passes through reserves and through commercial areas. The noise environment in these locations is also dominated by road traffic noise by those major arterial roads.

In order to establish existing baseline noise levels in the suburban areas, site surveys were undertaken to measure the existing noise environment. Measurements were taken at:

- 200 Burswood Drive from the 22nd to the 29th of February 2023
- 29 Dulwich Place from the 22nd to the 29th of February 2023

Noise monitoring was also undertaken in 2018 near 76 Tiger Drive at Bard Place Reserve to support preparation of the AMETI Eastern Busway 2 and 3 Design and Consenting report (dated 4th March 2019). The monitoring undertaken in 2018 was consistent with the monitoring undertaken in 2022/2023.

5.2 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 baseline dataset for EB3C and EB4L.

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 both locations in the Burswood suburb for approximately seven days. Note that due to a logger fault, morning results from 29 Dulwich Place on the 23rd of November were not recorded. The issue was resolved on site, and measurements resumed later that evening.

Due to a logger fault, noise levels were only be recorded at Guys Reserve for three days for the measurement undertaken from the 9th of March 2023. Upon reviewing the noise data from this logger, it was identified that the noise levels recorded appeared to be contaminated by an extraneous noise source that could not be identified. In order to obtain reliable noise data in the early morning at this location, additional attended noise monitoring was undertaken on the 7th of August 2023.

The figures below show the monitoring locations for the EB3C and EB4L alignment. Details of the measurements are summarised in Appendix A, including the measurement undertaken in 2018 at Bard Place Reserve.

Figure 5-1 Monitoring location 1 - 29 Dulwich Place

Figure 5-2 Monitoring location 2 - 200 Burswood Drive

Figure 5-3 Monitoring location 3 - Guys Reserve

Figure 5-4 Monitoring location - 76 Tiger Drive

5.2.1 Meteorological conditions

During the surveys, meteorological data was obtained from Auckland, Mangere Ews 2 (43711) 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.

5.2.2 Data analysis

There is a natural variation in the noise environment throughout the day, and often large variation between days. 200 Burswood Drive was closer to the traffic sources and generally had a more consistent noise profile than 29 Dulwich Place where natural sounds were dominant. At Guys Reserve, noise from Tī Rākau Drive and Te Irirangi Drive was dominant, with sound from birdsong also prominent. Each day's data was analysed, and abnormal events were excluded.

The $L_{Aeq(24h)}$ noise metric (represents the equivalent continuous A-weighted sound level for a measurement over a 24h period) 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.

5.2.3 Measurement results

A summary of the measured noise levels has been produced and is presented in the following section. Details of each measurement location are presented in noise monitoring forms, compiled in Appendix A.

Table 5-1 summarises the averaged noise measurements taken at the measurement locations. 24-hour averaged noise levels are presented for all measurement locations, except for the measurement at Guys Reserve, where the noise level presented is the L_{Aeq} metric taken over a 3-hour period in line with the attended measurement undertaken on the 7th of August 2023.

A summary of the measured noise levels is presented in Appendix B.

Table 5-1 Noise measurement results

Location	Address	Observations	Noise level
ML1	200 Burswood Drive	Road traffic noise dominant from Tī Rākau Drive	57 dB $L_{Aeq(24hr)}$
ML2	29 Dulwich Place	Road traffic noise dominant from Tī Rākau Drive	49 dB $L_{Aeq(24hr)}$
ML3	Guys Reserve	Road traffic noise dominant from Tī Rākau Drive and Te Irirangi Drive	65 dB $L_{Aeq(3hr)}$ *
Tiger Drive	76 Tiger Drive	Road traffic noise dominant from Tī Rākau Drive	53 dB $L_{Aeq(24hr)}$

**This measurement was undertaken over a 3-hour period in the early morning from 6:15am to 9:15am.*

6 Construction Noise and Vibration Assessment Methodology

Chapter Summary

This chapter provides an overview of the methodology that was followed for the predictions, and an overview of the construction methodology that has been assessed (as provided by the EBA construction team).

6.1 Assessment methodology

Predictions of construction noise have 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
- worst-case downwind conditions.

The construction methodologies that this assessment is based on were provided by the EBA construction team[3][4].

The proposed construction boundary was provided by the EBA 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 C.

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 necessary and included in the conditions. To avoid and/or manage effects associated with exceedances of the construction noise and vibration criteria, it is vital that 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 magnitude of predicted effects. At the core of this framework is the CNVMP as described in section 9.1. The final version will be confirmed and certified in accordance with the proposed conditions 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 residential or commercial 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.

[3] Eastern Busway EB3C Commercial, Construction Methodology
[4] Eastern Busway EB4L Link Road, Draft Construction Methodology

6.2 Construction methodology for EB3C and EB4L

6.2.1 Main works

6.2.1.1 Site establishment works

Site establishment works include, but are not limited to:

- Traffic/ public management
- Identifying locations of existing utility services
- Site Access Points (SAP's) & fencing
- Establishment of laydown yard at 242 Tī Rākau Drive, Burswood Reserve, and Whaka Maumahara Reserve.

6.2.1.2 Protection and/or relocation of existing network services

EB3C and EB4L traverse key networks/services located within the proposed alignment. The key services within EB3C and EB4L that require protection and/or possible relocation include:

- High voltage transmission lines (including towers)
- Medium pressure gas pipelines
- Water and wastewater infrastructure
- Fibre optic communication cables
- Electricity and gas distribution
- Stormwater drainage

6.2.1.3 Earthworks

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

There is a possibility that basalt may be encountered within the alignment in the Burswood section of the EB3C alignment. This would most likely be removed using an excavator with a rock breaker attachment. These works would take place over a duration of approximately six weeks in total.

The construction team have been advised that in the unlikely event that the basalt is extensive, blasting may be considered to reduce the duration of impact to neighbouring residents. No details are yet available on whether blasting is required, but if it is, the proposed conditions require that mitigation and management measures for blasting are set out in the CNVMP. Section 9.7 sets out potential mitigation options that will be considered for blasting.

Blasting noise and vibration predictions have not been undertaken to date. If blasting is required, the conditions require that trial blasts are undertaken in order to determine predictions of noise and vibration from blasting. Data from the trial blasts will be used to inform mitigation and management measures to be implemented prior to further blasting activities. Factors such as blasting locations, charge weights and localised ground conditions will influence the outcomes of blasts and will be considered when mitigation and management measures are determined.

If blasting were to occur, it would involve the detonation of small charges to break up basalt that could otherwise not be broken up by an excavator-mounted rock breaker.

The EBA construction team have advised that rock breaking or blasting will not be required for construction of EB4L.

6.2.1.4 Civil Works

The construction of EB3C and EB4L 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.)
- Ducting
- Street lighting
- Shared paths
- Traffic services
    - Barriers
    - Signals
    - Signage
    - Lighting
    - CCTV
- Bus stations
- Urban design
    - Artwork
    - Open spaces
    - Seating
- Landscaping
    - Planting & grassing.

6.2.1.5 Pavement works

The construction of EB3C and EB4L 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
- Construction of subsoil drainage.

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.

6.2.1.6 Disestablishment

As sections of the 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.

6.2.2 Bridge construction works

Bridge A is the bridge that will run alongside Tī Rākau Drive from Riverhills Park to the Mobil service station. Bridge B is the bridge that will run from the Mobil service station to the northern end of Chinatown. Bridge C will be constructed for EB4L through Guys Reserve and Whaka Maumahara Reserve (refer General Arrangement drawings).

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, temporary staging across the CMA
- For Bridge A and Bridge B, temporary staging will consist of temporary driven tubular piles and structural steel work with a precast concrete deck. This will be removed after completion of the bridges
- Mechanically stabilized earth walls (MSE), abutments and approach ramp construction
- For Bridge B, construction of the northern abutment for Bridge B to the west of Chinatown (including reclamation)
- Bored piles at each pier position. For Bridge C, temporary steel casings will be used
- 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 possibly installed at night to allow for lane closures for beam delivery and crane positioning for lifting
- Insitu 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, but not limited to, fall into two categories:

- Mechanically stabilised earth walls (MSE), mainly for approach embankments to bridge 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.

6.3 Night works

Limited night-time works will occur during construction of EB3C and EB4L.

With the exception of house relocation works, night-time works are not currently planned along the Burswood section of the EB3C alignment. Night works for EB3C are planned along Bridge A and Bridge B, and on the Tī Rākau Drive section of EB3C.

Early morning concrete pours are proposed for EB4L as part of construction of Bridge C.

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

Night works will be managed through implementation of the CNVMP and Schedules, including consultation with affected receivers.

The night-time works for which sufficient detail is known to carry out noise predictions that could affect residential receivers, along with their durations and locations, are:

- Pavement construction – Asphalt paving (general) including maintenance – 4 weeks. This will take place along the stretch of Tī Rākau Drive between Burswood Drive (east) and Tiger Drive
- Structures – Concrete Pours – 2 weeks. This will take place along Bridge A, Bridge B and Bridge C.
- Long weekend works – 4 weeks. This will take place on Tī Rākau Drive south of Chinatown.

The pavement and structures works will not take place in one location continuously but will instead progress along the Project alignment over several nights.

Equipment that may be used during the night works include:

- Pavement works
    - Concrete saw
    - Paver
    - Compaction equipment (7T roller compactor)
    - Excavator
- Concrete pours for bridges
    - Concrete truck
    - Concrete pump
- Long weekend works
    - Excavator with rock breaker attachment
    - Paver
    - Compaction equipment

- Relocation of existing houses
    - Removal truck.

The results of the night works noise predictions are summarised and discussed in Section 10.2.3 and 10.2.7.

Relocation of existing houses along the Burswood section of the alignment will take place over one week. Relocation of existing houses will involve 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 strictly 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 occasionally 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 EB3C alignment within only one week. Therefore, we consider noise from this activity to be acceptable, and this has not been assessed further.

We note that although a rock breaker will be used for the long weekend works, these works will take place on Tī Rākau Drive sufficiently far from residential receivers, such that vibration will meet the night-time vibration criterion at the closest residential receiver.

The duration of night works will be limited where possible, with the use of the noisiest equipment (e.g. concrete saw, rock breaker) being restricted to usage before 10pm where practicable. The noisiest equipment will only be used if there are no other suitable alternative construction methods. Where this is not practicable, relocation of the worst-affected residential receivers during the night-time will be recommended if required. The noisiest equipment will not be used in proximity to the Burswood section of the EB3C alignment during the night-time.

Other night-time works are also proposed, but sufficient detail is not known at this stage to carry out noise predictions for those works. However, the loudest potential night-time works (use of the concrete saw and rock breaker within the Tī Rākau Drive section of the EB3C alignment) have been covered in this assessment, and we do not anticipate that other night-works will be more disruptive than these 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. This is set out in the proposed set of conditions. Further details around Schedules are provided in Section 9.2.

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

7 Equipment Source Levels

Chapter Summary

This chapter sets out the source noise levels used for the noise predictions, and the vibration emission radii used for assessment of construction vibration.

7.1 Construction noise source levels

Construction for EB3C and EB4L is expected to take place over a time period greater than 20 weeks (with works progressing linearly across the Project's alignment). Predictions have been assessed against the noise criteria applying to works occurring across a timeframe that is greater than 20 weeks "long-duration" under NZS6803:1999 as presented in Table 4-1 and Table 4-2. It is expected that the majority of the works will be carried out between 7am – 6pm Monday to Saturday. It is also likely that some night works will take place where works cannot practicably take place during the day as set out in Section 6.3.

Table 7-1 details the sound power levels[5] from noise sources for EB3C and Table 7-2 details the sound power levels from noise sources for EB4L. These are the equipment that are likely to generate the greatest noise during the construction works. Noise levels at varying distances have also been provided, assuming continuous operation of plant items during their use. 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. If changes occur, the equipment list will be reassessed nearer the time of construction and updated in the CNVMP.

Table 7-1 Construction equipment noise levels – EB3C

Activity	Equipment	Sound power level (dBA SWL)	Free-field 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
	20 Tn Excavator with rock breaker attachment	120	98	92	86	78
	Handheld concrete saw / chainsaw	115	93	87	81	73
	10 Tn Excavator	107	85	79	73	65
	20 Tn Excavator	107	85	79	73	65
	500 kg Plate compactor	110	88	82	76	68
Earthworks and civil works	12 Tn Steel roller compactor	107	85	79	73	65
	6-Wheeler trucks	107	85	79	73	65
	20 Tn Excavator	107	85	79	73	65
	Mobile crane	106	84	78	72	64
	6-Wheeler trucks	107	85	79	73	65

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

Pavement construction (including surfacing)	Plate compactor, 500 kg	110	88	82	76	68
	Roller compactor, 12 Tn	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
	12 Tn Double Drum Steel Roller	107	85	79	73	65
	Concrete mixer truck	107	85	79	73	65
Bridge construction	Impact piling rig	120	98	92	86	78
	Gantry crane	95	73	67	61	53
	Large crawler crane	103	81	75	69	61
	Bored piling rig	111	89	83	77	69
	20 Tn Excavator	107	85	79	73	65
	30 Tn 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

Table 7-2 Construction equipment noise levels - EB4L

Activity	Equipment	Sound power level (dBA SWL)	Free-field noise level dB L_{Aeq}			
			5m	10m	20m	50m
Site establishment (including utility works, demolition, clearing and earthworks)	6-Wheeler trucks	107	85	79	73	65
	10 Tn Excavator	107	85	79	73	65
	20 Tn Excavator	107	85	79	73	65
	12 Tn Steel roller compactor	107	85	79	73	65
	500 kg Plate compactor	110	88	82	76	68
Bridge construction	Large crawler crane	103	81	75	69	61
	Bored piling rig	111	89	83	77	69
	20 Tn 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
Pavement construction (including surfacing)	6-Wheeler trucks	107	85	79	73	65
	Plate compactor, 500 kg	110	88	82	76	68
	Roller compactor, 12 Tn	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
	12 Tn Double Drum Steel Roller	107	85	79	73	65
	Concrete mixer truck	107	85	79	73	65

7.2 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 inherent uncertainty associated with 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 7-3.

We note that the 12 Tn roller compactor will not be used for construction of the shared path for EB4L. The highest vibration-generating piece of equipment that will be used for those works will be the 7T roller.

Table 7-3 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 (12 Tn)	2m	8m	14m	21m	N/A
Roller compactor (7 Tn)	1m	6m	8m	12m	45m
20 Tn excavator	1m	5m	8m	12m	N/A
30 Tn 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 breaking	2m	7m	12m	18m	N/A

attachment (EB3C only)					
Driven steel tubular piling (EB3C only)	6m	22m	36m	54m	N/A

We recommend that vibration measurements are undertaken at works locations when construction activities commence 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.

8 Overview of Potential Effects – EB3C and EB4L

Chapter Summary

This chapter provides a general overview of construction noise and vibration effects based on the level of noise and vibration predicted to be received. As this is a general overview, the description of potential effects is the same for both EB3C and EB4L, and specific construction noise and vibration effects are not discussed in this section (they are addressed in Section 10).

8.1 Construction noise effects

Table 8-1 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 8-1 Potential construction noise effects on receivers

External Noise Level	Potential Daytime Effects Outdoors	Corresponding Internal Noise Level	Potential Daytime Effects Indoors
65 dB L_{Aeq}	Conversation becomes strained, particularly over longer distances.	45 dB L_{Aeq}	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.
65 to 70 dB L_{Aeq}	People would not want to spend any length of time outside, except when unavoidable through workplace requirements.	45 to 50 dB L_{Aeq}	Concentration would start to be affected. TV and telephone conversations would begin to be affected.
70 to 75 dB L_{Aeq}	Businesses that involve substantial outdoor use 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	60 to 70 dB L_{Aeq}	Untenable for both office and residential

	prolonged exposure (8 hours at 85 dB) to prevent hearing loss.		environments. Unlikely to be tolerated for any extent of time.

With appropriate management of construction activities, which includes consultation and communication with affected parties and scheduling noisiest 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 and commercial 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.

These considerations have informed the mitigation requirements included in this Assessment.

8.2 Construction vibration effects

The vibration effects associated with construction of EB3C and EB4L have 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 in some buildings adjacent to the areas of works 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 set by the AUP (OP) and DIN criteria described above have been combined and presented in Table 8-2 and adopted for this assessment.

Table 8-2 Potential vibration effects on human perception summary against AUP(OP) and DIN criteria

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

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

The AUP(OP) permitted standards for vibration amenity is 0.3mm/s at night-time and 2 mm/s during the daytime. 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 the activity occurs intermittently and with prior notice.

At 0.3 mm/s the vibration 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 9.1).

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

9 Recommended Measures to Avoid, Remedy or Mitigate Effects

Chapter Summary

This chapter provides a general overview of measures to avoid, remedy or mitigate noise and vibration effects associated with the construction of EB3C and EB4L. As this is a general overview, the measures are applicable for both EB3C and EB4L. Mitigation measures are set out in the conditions and include requirements to prepare and implement a CNVMP, Schedules, implementation of noise barriers, and building condition surveys. Mitigation specific to blasting and night-time works are also set out.

9.1 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.

Standard E25.6.29(5) of the AUP(OP) sets out the minimum level of information that must be provided in the CNVMP. In order to meet the requirements of the standard, the CNVMP must include:

- A description of the works and anticipated equipment/processes
- A requirement for preparation of notification letters that will be provided to all business and residents within 100m of the works describing:
    - The area affected by the work
    - Why the work is required to be undertaken at night (where relevant)
    - The times and days when the noise and vibration is likely to be generated
    - A contact name and number of the works supervisor who can be contacted if any issues arise
    - How noise and vibration complaints will be managed and responded to
- Hours of operation, including times and days when construction activities would occur
- The construction noise and vibration standards for EB3C and EB4L
- 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
    - 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.

9.2 Schedules

In addition to a CNVMP, Site Specific or Activity Specific Construction Noise and Vibration Management Schedules ("Schedules") will be prepared 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 receivers that will be exposed to noise/vibration during the night-time.

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.

9.3 Noise mitigation measures

A hierarchy of mitigation measures will be adopted through the CNVMP and Schedules (where required), 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 9.4)
- Offering neighbours temporary relocation.

By following this hierarchy, the BPO for mitigation of noise and vibration effects will be implemented, whilst avoiding undue disruption to the community. In particular, temporary relocation of neighbours

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.

9.4 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
- Abutted or overlapped to provide a continuous screen with no gaps at the base or between panels.

9.5 Vibration mitigation

Similar 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
- In specific situations, a cut-off trench may be used as a vibration barrier if located close to the source.

In general, there are fewer options available to mitigate vibration propagation compared to noise. Mitigation will focus on avoiding, remedying and managing vibration effects through appropriate scheduling of high-vibration activities, effective communication with neighbours, and selection of appropriate equipment and methods, where practicable.

The CNVMP will set 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 will be set out in the CNVMP and Schedules (where required).

9.6 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 NoR conditions. The survey shall include, but not be limited to, the following:

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

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

9.7 Blasting

The construction team have indicated that in the case that basalt is extensive through the Burswood area, blasting may be considered in order to minimise the period of disruption to residents from earthworks. Blasting would only be considered if all other options to excavate basalt are exhausted. Blasting would not take place during the night-time.

If blasting were to occur, a blasting contractor would need to be engaged, and noise and vibration effects would need to be carefully managed through the proposed CNVMP. This is set out in the proposed conditions.

It would be the responsibility of the blasting contractor to manage the blasting programme so that noise and vibration levels from blasting is compliant with the relevant noise and vibration criteria as set out in section 4.3.

The CNVMP will adopt the BPO by setting out specific mitigation and management measures. Measures that are proposed include conducting small trial blasts (in order to establish factors such as site-specific vibration propagation characteristics, air overpressure levels and required charge sizes), as well as management measures such as notifying affected receivers of the exact times of any planned blasts. The CNVMP would set out the process for advance communication with receivers including advance warning of blasts.

9.8 Night works

Night works have the potential to cause the greatest disturbance to residents and should be avoided where practicable. However, as per section 6.3 The EBA construction team has noted that night works

are likely to be required for a number of activities when works cannot practicably take place during the day.

We note that with the exception of house removals, night works are not currently planned along the Burswood section of EB3C.

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, the conditions require that a Schedule be prepared for the night-time works as per Section 9.2.

10 Predicted Construction Noise and Vibration Levels

Chapter Summary
This chapter summarises the predicted noise and vibration levels from construction based on the methodology set out in Section 6. Minimum set-back distances from the works for compliance with the criteria are provided, and results at receivers are summarised in Appendix D for noise and Appendix E for vibration.

10.1 Set-back distances for construction noise

Predictions of noise from construction activities have been carried out for sensitive receivers across EB3C and EB4L, during typical construction activities for each major stage of construction that is expected to occur.

Table 10-1 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 a typical construction scenario.

Table 10-1 Required set-back distances for compliance with daytime noise criterion – EB3C

Construction works stage	Typical equipment	Required set-back distance for compliance with 70 dB L_{Aeq} daytime noise criterion during use of typical equipment, no mitigation	Required set-back distance for compliance with 70 dB L_{Aeq} daytime noise criterion during use of typical equipment, with mitigation
Construction laydown yard establishment	20 Tn Excavator	30m	9m
Main works (including site establishment, earthworks, civil works, pavement works)	20 Tn Excavator	30m	9m
Bridge construction works (Bridge A and Bridge B)	Impact piling rig (with 10% duration correction) or 30T Excavator	40m	-*

**Note that noise barriers will not be able to mitigate noise from the tubular steel piling rig due to its height, so only the set-back distance for unmitigated use of the bored piling rig is provided.*

Table 10-2 Required set-back distances for compliance with daytime noise criterion – EB4L

Construction works stage	Typical equipment	Required set-back distance for compliance with 70 dB L_{Aeq} daytime noise criterion during use of typical equipment, no mitigation	Required set-back distance for compliance with 70 dB L_{Aeq} daytime noise criterion during use of typical equipment, with mitigation
Site establishment	20 Tn Excavator	30m	9m
Bridge construction (for Bridge C)	Bored piling rig	45m	-*
Shared Path construction	20 Tn Excavator	30m	9m

The set-back distances in Table 10-1 and Table 10-2 are the distances at which compliance with the noise criteria will be achieved.

With noise barriers implemented effectively around working sites, the set-back distance for compliance with the daytime noise criterion reduces from 30m to 9m for most stages of work.

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; for these dwellings, mitigation may be less effective on the second storey and above.

Addresses where the relevant noise limits are predicted to be exceeded are shown in Appendix D and are discussed further below.

10.2 Predicted construction noise levels

10.2.1 EB3C – Main works

During a typical construction scenario, i.e. use of the excavator with noise barriers around construction sites, 9 commercial and 16 residential receivers could experience noise levels above the daytime noise criterion of 70 dB L_{Aeq}. The residential receivers are located at:

- 28 Burswood Drive
- 21 Dulwich Place
- 198 Burswood Drive
- 18 Heathridge Place
- 203 Burswood Drive
- 38 Heathridge Place
- 201 Burswood Drive
- 12 Tullis Place

- 25 Burswood Drive
- 10 Heathridge Place
- 6A Tullis Place
- 27 Burswood Drive
- 196 Burswood Drive
- 2 Torrens Road
- 34 Burswood Drive
- 11 Tullis Place

The commercial receivers are located at:

- 380 Tī Rākau Drive
- 1/28 Torrens Road
- 3/28 Torrens Road
- 5/28 Torrens Road
- 245 Tī Rākau Dr
- 5/272 Tī Rākau Drive
- 386 Tī Rākau Drive
- 22 Torrens Road
- 16 Torrens Road

These exceedances are predicted for the scenario where the excavator is used at the closest location on site possible to each individual receiver. In reality, with effective noise barriers 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 as works progress along the Project alignment. Where the noise criteria are predicted to be exceeded, the effects will be further mitigated and managed through additional measures set out in the CNVMP required by the conditions. Discussion on noise effects is provided in section 11.1.

10.2.2 EB3C – Bridge A and Bridge B

The EBA construction team have advised that an impact piling rig will be used during construction of Bridge A and Bridge B over a total duration of approximately 8 months. 44 piles will be driven for the temporary construction deck, with each pile taking approximately 2 days to be driven. Individual pile drives will be short in duration, with each drive lasting several seconds. There will be up to 5 pile drives in a given half-hour period.

Based on the actual durations of pile driving, a duration correction of 10% was applied to the source noise level for the impact piling rig.

Construction of Bridge B will also involve use of typical earthworks equipment for construction of an MSE embankment to the north of Chinatown (e.g. excavators for placement of fill and placement of rip rap).

Receivers where the modelling results indicate exceedances of the daytime noise criteria during construction of Bridge A and Bridge B are presented in Table 10-3. The modelling assumes the use of noise barriers where they will provide effective screening during construction of the MSE embankment.

Table 10-3 Piling noise modelling results – EB3C

Address	Name	Use	Noise Level, dB L_{Aeq}
245 Tī Rākau Drive	Woodbine Marine ltd/ AFC Group Holdings ltd/ AFC Biotechnology Manufacturing Co ltd	Commercial	73
249 Tī Rākau Drive	Swimart Pool & Spa Services Pakuranga/ Family Boats/ Photofans	Commercial	71

Construction noise levels at all other receivers are predicted to comply with the daytime construction noise criterion during all other bridge construction works.

10.2.3 EB3C – Night works

Night works are anticipated during the EB3C construction works. Night works will only take place over a limited duration of time. Further detail on night-works is provided in section 6.3.

Noise predictions have been undertaken for works where sufficient detail and information on durations were provided by the EBA construction team, as set out in the EB3C and EB4L Construction Methodology reports.

Night-time works include:

- Pavement construction – use of a plate compactor along the stretch of Tī Rākau Drive between Burswood Drive (east) and Tiger Drive.
- Bridge construction – concrete pours along Bridge A and Bridge B (the predicted noise levels were adjusted to reflect an on-time of 30% during a representative monitoring period).
- Long weekend works – use of a concrete saw on the Tī Rākau Drive intersection south of Chinatown.

The predictions include noise barriers during use of the concrete saw but did not include barriers during pavement construction works due to practicability issues as indicated by the EBA construction team.

In summary, the night-time noise criterion is predicted to be exceeded at:

- 32 residential properties during night-time long weekend works
- 226 residential properties in EB3C during night-time pavement works
- 77 residential properties in EB3C during night-time bridge construction works

These properties are listed in Appendix D. Discussion of noise effects from night works is provided in Section 11.3.

10.2.4 EB3C – Construction laydown yard

Temporary construction laydown yards will be established in the Burswood Reserve and 242 Tī Rākau Drive. The temporary construction laydown yards will act as a handling point for spoil and imported aggregate. The laydown yard locations are shown in Figure 10-1 and Figure 10-2.

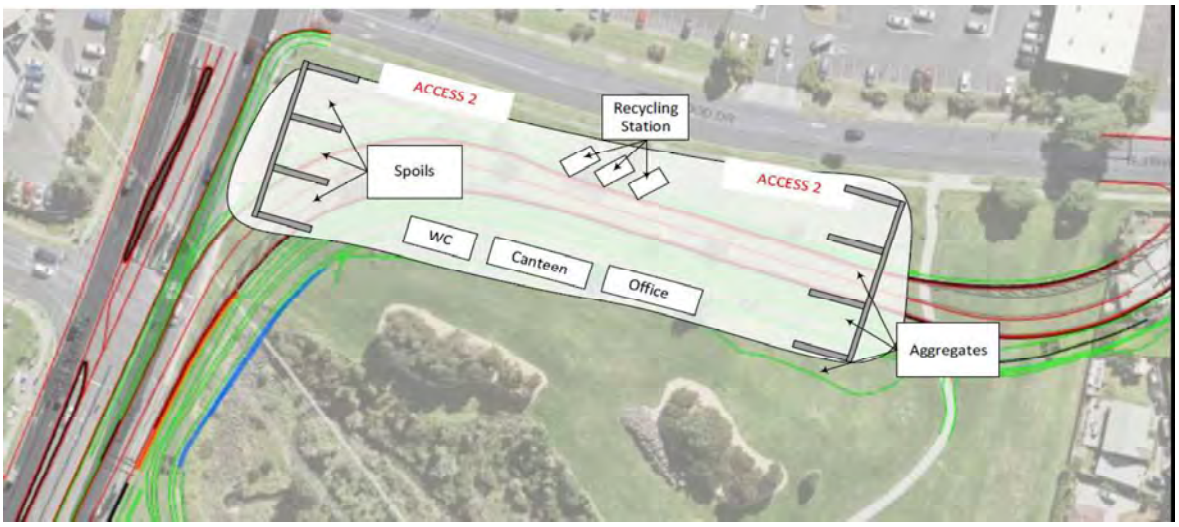


Figure 10-1 Laydown yard at Burswood Reserve

Figure 10-2 Outline of laydown yard at 242 Tī Rākau Drive

(Source: From Auckland Council GeoMaps, shown in light blue)

No receivers are expected to receive noise levels above the daytime construction noise criterion during establishment or daytime operation of either laydown yard.

Operation of the construction yards will occur during other night-time works. Operation of the yards during the night-time will only consist of deliveries involving loading and unloading of trucks.

Although the night-time noise criterion may be exceeded at residential receivers in proximity to the laydown yards during these activities, the level and character of the noise will be similar to that experienced at nearby receivers when heavy vehicles pass by on Tī Rākau Drive.

10.2.5 EB4L – Main works (construction of Bridge C)

The EBA construction team have advised that typical plant items for construction of EB4L will consist of the bored piling rig for construction of Bridge C, and use of the excavator during construction of the shared path. Table 10-4 summarises the addresses where exceedances of the daytime noise criteria are predicted during the EB4L main works. The predictions include noise barriers for use of the excavator, but do not include noise barriers for use of the bored piling rig.

Table 10-4 Construction noise modelling results for Bridge C – EB4L

Address	Name	Use	Noise Level, dB L_{Aeq}
451 Tī Rākau Drive	VTNZ	Commercial	90
451 Tī Rākau Drive	Tyre City	Commercial	81
451 Tī Rākau Drive	The Hub (rear access for loading)	Commercial	74
5 Te Koha Road	Botany Hunting and Fishing New Zealand	Commercial	71
451 Tī Rākau Drive	Repco	Commercial	71

Construction noise levels at all other receivers are predicted to comply with the daytime construction noise criterion during all other bridge construction works.

10.2.6 EB4L – Main works (shared path and laydown yard)

During a typical construction scenario, i.e. use of the excavator with noise barriers around construction sites, the daytime noise criteria are predicted to be exceeded at the following properties during construction of the shared path and laydown yard:

- 415 Tī Rākau Drive (Piccolo Park Early Learning Centre)
- 34 Cottesmore Place
- 26 Cottesmore Place
- 32 Cottesmore Place
- 175 Guys Road

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.

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.

10.2.7 EB4L – Early-morning concrete pours

The EBA construction team have indicated that early morning concrete pours will be required for construction of the Bridge C structure due to quality requirements. This work will involve the use of a concrete truck and concrete pump.

Noise predictions for this activity indicate that the 45 dB L_{Aeq} noise criterion will be exceeded at 154 residential receivers. Affected receivers are located in the Huntington Park and Golflands suburbs. These receivers are summarised in Appendix D.

10.3 Predicted construction vibration levels

Appendix E lists addresses where the Category A and B vibration criteria are predicted to be exceeded at receivers for EB3C and EB4L works. The activities modelled were:

- Use of 12 Tn vibratory roller at the edge of the construction footprint for the EB3C main works and Bridge C construction works during the daytime
- Use of 7 Tn vibratory roller for the EB3C night-time pavement works and EB4L shared path works
- Driven steel tubular piling during construction of Bridge A and Bridge B for EB3C.

The construction footprint indicates that daytime construction during the main works activities could take place within a metre of commercial and residential type structures in the worst-case scenario. Most construction activities will take place further from structures than this.

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.

We note that although the rock breaker could be used for night-time long weekend works, these works will only take place on Tī Rākau Drive south of Chinatown. These works will not occur within 150m of any residential receivers, therefore vibration from the use of the rock-breaker in the night-time is not predicted to be perceptible at any residential receivers.

10.3.1 EB3C

15 residential type buildings 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 8 m away from the buildings the Category B criterion will be met.

No commercial type buildings are predicted to receive vibration levels above 20 mm/s PPV DIN 4150 commercial building criterion.

Based on the location of the works, no exceedances of the commercial or residential DIN 4150 vibration criteria are predicted during the driven steel tubular piling works during temporary staging of the bridges.

10.3.2 EB4L

Two residential type buildings may experience vibration levels above the Category B vibration criteria if the 7 Tn roller compactor is used on the construction boundary for the shared path in the closest position. Once the compactor is 5 m away from the buildings the Category B criterion will be met. These buildings are:

- 34 Cottesmore Place
- 415 Tī Rākau Drive

No commercial type buildings are predicted to receive vibration levels above 20 mm/s PPV DIN 4150 commercial building criterion.

10.3.3 Vibration amenity

Appendix E lists properties where the Category A vibration amenity criteria could be exceeded during the construction works for EB3C and EB4L.

The daytime vibration amenity criteria could be exceeded in buildings that are occupied during the works and are within 21 m of the 12 Tn roller compactor, or within 12 m of the 7 Tn roller compactor, or within the emission radii identified for the other vibration generating equipment in Table 7-3. The effect on receivers would depend on 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 4.2.1, 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 as a permitted activity, provided that prior notice is given at least three days in advance, and the vibration must comply with the limit of 5 mm/s.

11 Assessment of Construction Noise and Vibration Effects

Chapter Summary

This chapter provides an assessment of potential noise and vibration effects that may arise due to construction of EB3C and EB4L.

Where exceedances are predicted, noise and vibration effects will be mitigated and managed through the conditions which require a CNVMP and (if necessary) Schedules. Implementation of the CNVMP will appropriately reduce the magnitude and frequency of adverse construction-related noise and vibration effects, while reducing the likelihood of complaints through implementation of mitigation and management measures.

Overall, with BPO measures implemented, we consider that noise and vibration effects from construction of EB3C and EB4L will be reasonable.

11.1 EB3C and EB4L main works

Table 11-1 has been produced to quantify the number of receivers that are predicted to experience each degree of noise effects. The table helps to provide an understanding of the overall impact of various phases of construction. The counts are derived from the noise predictions as set out in Section 10.2 and as summarised in Appendix D.

Table 11-1 Summary of noise effects at affected receivers during daytime works

External Noise Level, dB L_{Aeq}	Approximate Corresponding Internal Noise Level, dB L_{Aeq}	Potential daytime effects, outdoors	Potential daytime effects, indoors	EB3C			EB4L
				Main works - Count of receivers affected during use of excavator, without mitigation	Main works - Count of receivers affected during use of excavator, with mitigation	Bridge Construction works – count of receivers affected during use of the bored piling rig	Main works – Bridge C and shared path/laydown yard construction
65 - 70	45 - 50	People would not want to spend any length of time outside, except when unavoidable through workplace requirements	Noise levels would be noticeable but unlikely to interfere with residential or office daily activities.	35	22	4	13
70 - 75	50 - 55	Businesses that involve substantial outdoor use would experience considerable disruption.	Concentration would start to be affected. TV and telephone conversations would begin to be affected.	18	14	3	5

External Noise Level, dB L_{Aeq}	Approximate Corresponding Internal Noise Level, dB L_{Aeq}	Potential daytime effects, outdoors	Potential daytime effects, indoors	EB3C			EB4L
				Main works - Count of receivers affected during use of excavator, without mitigation	Main works - Count of receivers affected during use of excavator, with mitigation	Bridge Construction works – count of receivers affected during use of the bored piling rig	Main works – Bridge C and shared path/laydown yard construction
75 - 80	55 - 60	Some people may choose protection for long periods of exposure. Conversation would be very difficult, even with raised voices.	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.	22	4	0	2
80 - 85	60 - 65	Hearing protection would be required for prolonged exposure (8 hours at 85 dB) to prevent hearing loss.	Continuing office work would be extremely difficult and become unproductive. In a residential context, people would actively seek respite.	14	3	1	1
85 – 90+	65 – 70+	People would not want to spend any length of time outside, except when unavoidable through workplace requirements	Untenable for both office and residential environments. Unlikely to be tolerated for any extent of time.	11	4	0	1

While Table 11-1 is useful for quantifying the number of dwellings where particular noise levels are expected, it may not be reflective of the overall level of noise effects expected at receivers from construction. For example, if any given dwelling is unoccupied during the works (as we expect a number of dwellings to be when construction is taking place during daytime hours, given that those affected will be provided advance warning of works as a requirement of the CNVMP and conditions), then there will be no noise effects on receivers for that dwelling.

Also, noise effects must be considered in the context of the duration of exposure. Most of the works will not remain in one location continuously; works will generally progress linearly across the Project's alignment, so that noise levels and the corresponding effects at a given receiver will be variable and reduce as the works move away. Noise at levels that exceed the criteria can still be tolerated provided that prior notification is given before high noise generating activities take place.

It is possible that the works may come within the 9m set-back distance for compliance with the daytime noise criterion at some receivers intermittently, 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.

With effective noise barriers 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 further mitigated and managed through additional measures set out in the CNVMP required by the conditions.

We note that through early consultation, Piccolo Park raised that they are subject to the licensing criteria for centre-based ECE services[6]. These standards require that "*all practicable steps are taken to ensure that noise levels do not unduly interfere with normal speech and/or communication, or cause any child attending distress or harm"*. They also state "*Beware of environmental noise from outside the service such as roadworks or construction nearby and try to ensure that the negative effect is reduced where possible."* These requirements will be considered in the preparation of the CNVMP and any relevant Schedules.

11.2 High noise generating equipment

There will be times when high noise generating equipment will be used, and the ability to implement mitigation measures may be restricted, leading to exceedances of the noise criteria at some receivers.

High noise generating activities will not take place for the entire duration of the works, such as use of the concrete saw, concrete breaker, and chainsaw during the main works. These works will be completed within shorter timeframes compared to the rest of the construction programme.

For example, rock breaking may need to take place along the length of the Burswood busway section where basalt is encountered, however these works would take place over a duration of approximately six weeks in total. When these works take place, exceedances could occur intermittently at receivers in the vicinity of these works. However, operation of construction equipment will be intermittent at a given location, and construction will progress in a linear pattern so as the equipment moves away from receivers, noise levels will reduce.

Driven steel tubular piling will be undertaken for temporary staging of Bridge A and Bridge B; construction noise effects would be elevated while piles are being driven, but the pile drives will each only last several seconds, and pile drives would only occur up to 5 times within a given 30 minute period. These works would progress linearly along the alignment, and noise levels at affected receivers will reduce as the activity moves further away.

[6] https://www.education.govt.nz/early-childhood/licensing-and-regulations/the-regulatory-framework-for-ece/licensing-criteria/centre-based-ece-services/redownloadpdf

For these activities, noise effects can be appropriately managed through effective communication with the affected receivers which will be detailed in 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. High noise levels from construction can be tolerated for short durations provided that prior notification is given before high noise generating activities take place.

The most effective method to manage noise effects during use of particularly high-noise generating equipment will be through implementation of the CNVMP. The CNVMP will be the primary method to ensure that the BPO to mitigate noise and vibration is implemented, and that community engagement is managed effectively. A CNVMP that is implemented effectively will appropriately reduce the magnitude and frequency of adverse effects, while reducing the likelihood of complaints.

11.3 Night-time works

Although a large number of exceedances of the night-time noise criteria are predicted at receivers, 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 manage noise effects at residential receivers during the night-time period. If noisy activities must take place during the night-time beyond 10pm, and 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 through consultation with affected parties during production of any Schedules and will be employed 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.

Night works have the potential to create adverse noise effects if not managed appropriately, therefore they must be mitigated and managed through the CNVMP and Schedules. For example, the duration of night works will be limited where possible, with the use of particularly noisy equipment (e.g. concrete saw, rock breaker) being restricted to usage before 10pm where practicable. Where this is not practicable, relocation of the worst-affected residential receivers during the night-time will be recommended through the CNVMP. Recommended measures to avoid, remedy and mitigate effects from night works are set out in section 9.8.

11.4 Vibration effects

The vibration effects experienced at a given receiver will depend on the magnitude of vibration perceived. Table 8-2 sets out the expected effects for each level of vibration.

However, the emission radii set out for this vibration assessment are conservative, and vibration levels measured on site tend to be much lower than those predicted in the early stages of a project. Therefore, vibration effects at receivers across EB3C/EB4L will likely be lower than those set out in Table 8-2 based on the predictions.

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 conditions must be implemented for the duration of the works to mitigate and manage effects from construction vibration.

12 Conclusions

Construction noise and vibration has been assessed for EB3C and EB4L in accordance with the requirements of the AUP and NZS 6803:1999.

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, exceedances will be intermittent and over a limited duration, and effects will be appropriately 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. With the exception of house removals, night works are not currently planned along the Burswood section of EB3C. Night-time works will be mitigated and managed appropriately through the CNVMP. Schedules should be prepared prior to the start of night works and where identified as required through the construction phase; this requirement is set out in the proposed conditions set.

Construction vibration is predicted to exceed the DIN 4150 criteria at a number of commercial and residential buildings around EB3C 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 7 Tn vibratory roller during the night-time for EB3C pavement works 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 will be managed through communication with affected stakeholders in accordance with the measures specified in the CNVMP.

Construction noise and vibration can be mitigated and managed, utilising the measures set out in Section 9, to generally comply with the applicable permitted standards as defined in the AUP. Where an exceedance is predicted at any receiver the effects will be mitigated and managed through measures included in a CNVMP.

A CNVMP -as required by the consent conditions 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.

Overall, with BPO measures implemented, we consider that noise and vibration effects from construction of EB3C and EB4L will be reasonable.

Appendix A – Noise Monitoring Forms

NOISE MONITORING FORM - 29 Dulwich Place				
Summary				
Project name	Eastern Busway			
Project number	60604837			
Date / time	22/10/22, 11:45am			
Engineer(s)	Shivam Jakhu, Dhulkifl Ahmed			
Location (NZTM2000)	X	1769019	Y	5911772
Equipment				
Manufacturer	Rion			
Type	NL52			
Serial number	00898330			
Date of last calibration	29/11/2021			
Calibration drift pre/post				
Noise Environment				
Which assessment method is applicable? *I.e. NZS 6802:2008 Simple / Detailed or other.*	Simple			
General description of measured noise: specific and residual levels including comments on k_1 adjustment and contamination	Dominant noise source: Road noise from surrounding road network			
Any special audible characteristics (tonality, impulsivity etc.) and comment on k_2 adjustment	N/A			
Meteorological Conditions				
Wind speed and direction at microphone	<3 m/s			
Wind speed and direction at dominant source(s)	<3 m/s			
Precipitation	None			
Fog	None			
Temperature	22 °C			
Humidity	81%			
Percentage cloud cover	70-80%			
Site Conditions				
Microphone height	1.5m			
Distance to dominant noise source(s)	N/A			
Height of noise source(s)	Ground level			
Distance from any reflective surfaces	1.5m			
Intervening topography	Bund to the south of the measurement position			
Hard, mixed or soft ground	Soft			
Barriers between source(s) and microphone	N/A			
General comments and sketches				

Photo A: Measurement location

Photo B:

Photo C:

NOISE MONITORING FORM – 200 Burswood Drive					
Summary					
Project name	Eastern Busway				
Project number	60604837				
Date / time	22/10/22, 10:32pm				
Engineer(s)	Shivam Jakhu, Dhulkifl Ahmed				
Location (NZTM2000)	X	1768804	Y	5911835	
Equipment					
Manufacturer	Svan				
Type	957				
Serial number	20615				
Date of last calibration	25/11/2021				
Calibration drift pre/post					
Noise Environment					
Which assessment method is applicable? *I.e. NZS 6802:2008 Simple / Detailed or other.*	Simple				
General description of measured noise: specific and residual levels including comments on k_1 adjustment and contamination	Dominant noise source: Road noise from Burswood Dr. Other noise sources: Childcare centre				
Any special audible characteristics (tonality, impulsivity etc.) and comment on k_2 adjustment	Intermittent high pitch noise from animal deterrent next door				
Meteorological Conditions					
Wind speed and direction at microphone	<3 m/s				
Wind speed and direction at dominant source(s)	<3 m/s				
Precipitation	None				
Fog	None				
Temperature	21 °C				
Humidity	80%				
Percentage cloud cover	70-80%				
Site Conditions					
Microphone height	1.5m				
Distance to dominant noise source(s)	~10m				
Height of noise source(s)	Ground level				
Distance from any reflective surfaces	-				
Intervening topography	None				
Hard, mixed or soft ground	Mixed				
Barriers between source(s) and microphone	None				
General comments and sketches					
There is a childcare centre that will be active during the monitoring therefore noise from activities in the childcare centre may contribute to the overall noise recorded.					

Photo A: View toward the source

Photo B: View from the side

Photo C:

NOISE MONITORING FORM				
Summary				
Project name	Eastern Busway			
Project number	60644113			
Date / time	07/08/2023, 6:15am			
Engineer(s)	Shivam Jakhu			
Location (NZTM2000)	X	-36.931570	Y	174.908128
Equipment				
Manufacturer	B&K			
Type	2250			
Serial number	3009342			
Date of last calibration	22/11/2022			
Calibration drift pre/post	<0.1 dB			
Noise Environment				
Which assessment method is applicable? *I.e. NZS 6802:2008 Simple / Detailed or other.*	Simple			
General description of measured noise: specific and residual levels including comments on k_1 adjustment and contamination	Dominant noise sources: Road traffic noise from Te Irirangi Drive and Ti Rakau Drive, birdsong Other noise sources: Lawnmower in the distance near the hunting and fishing shop, and distant hammering from the construction site at 165 Guys Road.			
Any special audible characteristics (tonality, impulsivity etc.) and comment on k_2 adjustment	No adjustments made.			
Meteorological Conditions				
Wind speed and direction at microphone	<5 m/s			
Wind speed and direction at dominant source(s)	-			
Precipitation	0mm			
Fog				
Temperature	6 °C			
Humidity	-			
Percentage cloud cover	90%			
Site Conditions				
Microphone height	1.2m			
Distance to dominant noise source(s)	-			
Height of noise source(s)	-			
Distance from any reflective surfaces	-			
Intervening topography	Slightly hilly up/down.			
Hard, mixed or soft ground	Soft ground			
Barriers between source(s) and microphone				
General comments and sketches				

Photo A: View toward the microphone

Photo B:

Photo C:

NOISE MONITORING FORM				
Summary - 76 Tiger Drive				
Project name	AMETI EB 2&3			
Project number	60563280			
Date / time	28/6/2018			
Engineer(s)	Kieran Hill			
Location (NZTM2000) or	X	1769892	Y	5911274
Address	Park area adjacent to Pakuranga Highway, Auckland 2010			
Equipment				
Manufacturer	Svantek			
Type	958			
Serial number	20892			
Date of last calibration	8/12/2017			
Calibration drift pre/post	TBC			
Noise Environment				
What assessment are you doing?	NZS: 6806 ✓	NZTA Road Noise		
Are you more than 10m from an existing road kerb?	Yes ✓	No		
Away from trees	Yes	No ✓		
Are there any pot-holes, speed bumps, old surfaces, expansion joints, special surfacing etc?	n/a			
General description of measured noise: specific and residual levels including comments on k_1 adjustment and contamination	Dominant noise was from traffic on Ti Rakau Drive. Minor construction works occurring approx. 100 m away at time of deployment			
Any special audible characteristics (tonality, impulsivity etc.) and comment on k_2 adjustment	n/a			
Meteorological Conditions				
Wind speed and direction at microphone	-			
Wind speed and direction at dominant source(s)	-			
Precipitation	None			
Fog	No			
Temperature	15°C			
Humidity	Medium			
Percentage cloud cover	None			
Site Conditions				
Microphone height	1.5 m			
Distance to dominant noise source(s)	16 m			
Height of noise source(s)	-			
Distance from any reflective surfaces	6 m to building façade			
Intervening topography	-			
Hard, mixed or soft ground	Mixed			
Barriers between source(s) and microphone	n/a			
General comments and sketches				

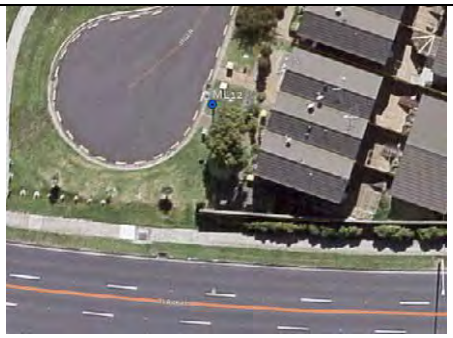


Photo A: View toward the source

Photo B: Photo of the road surface

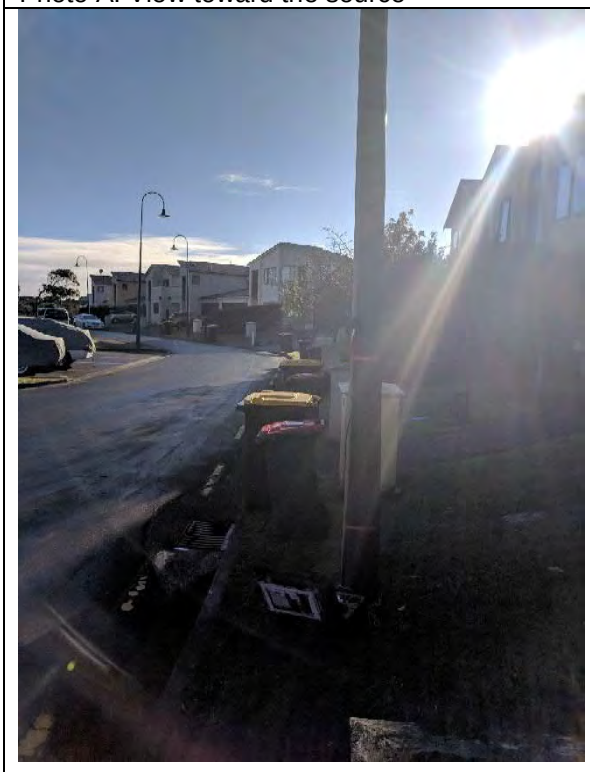
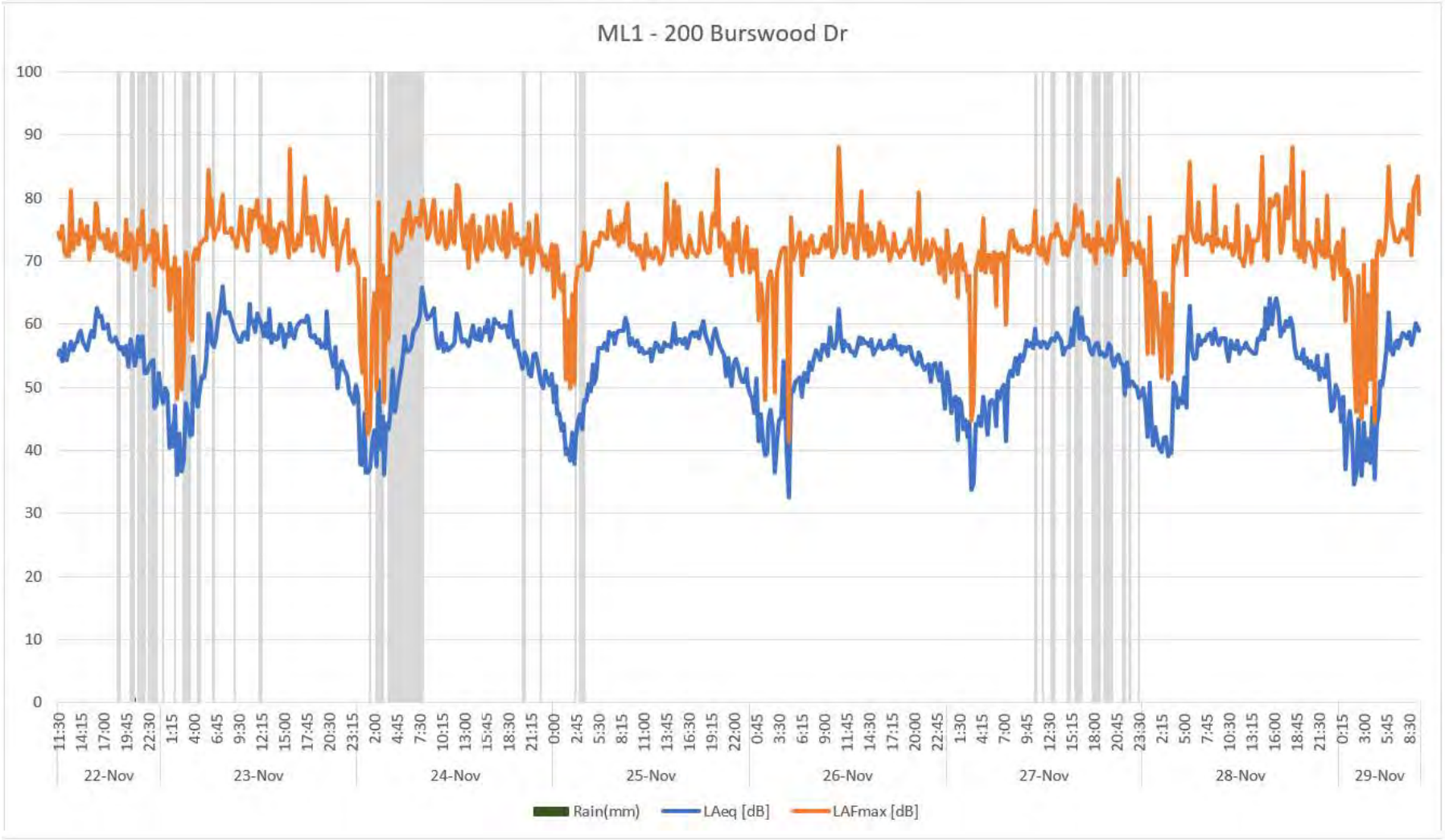
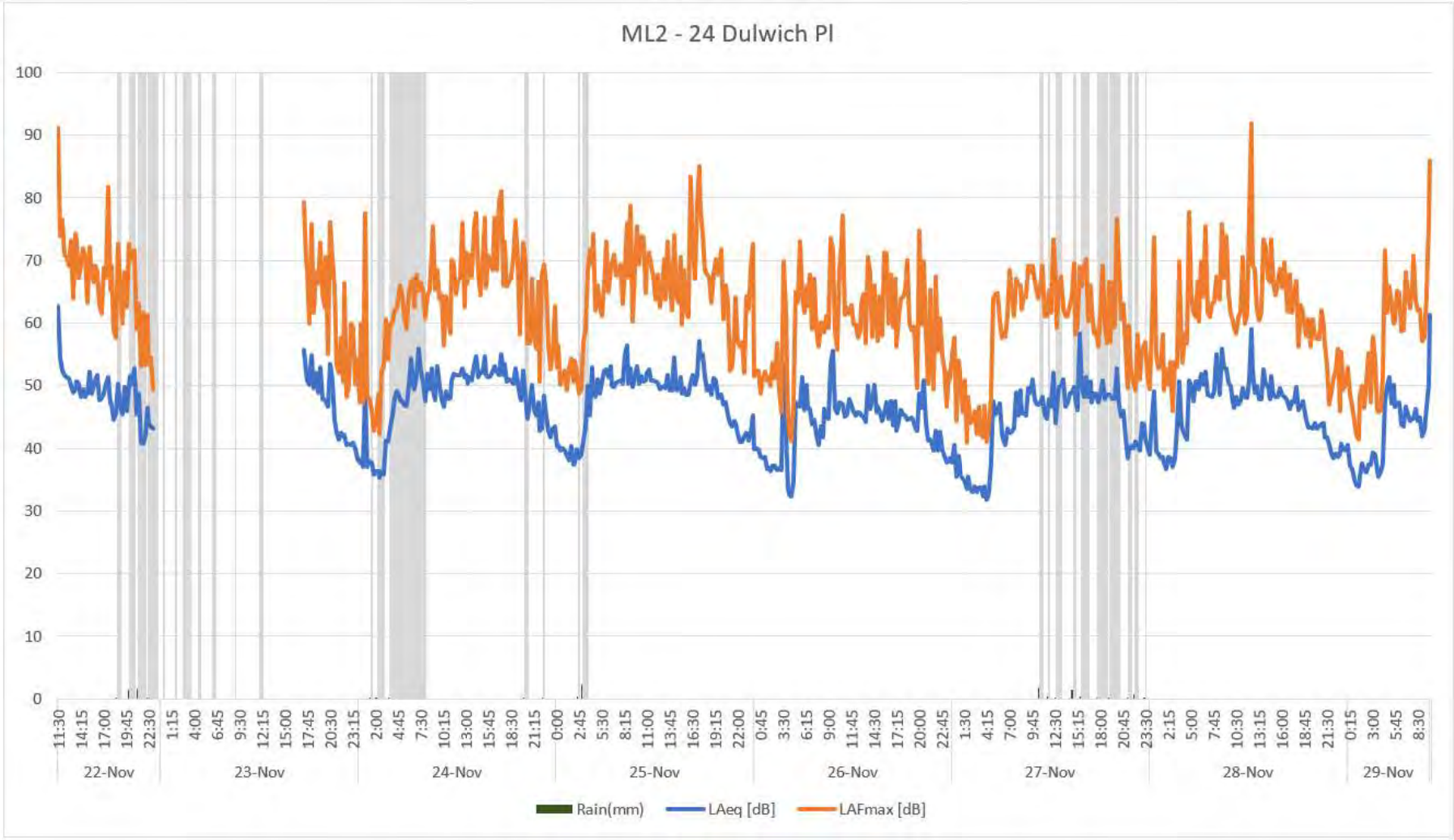


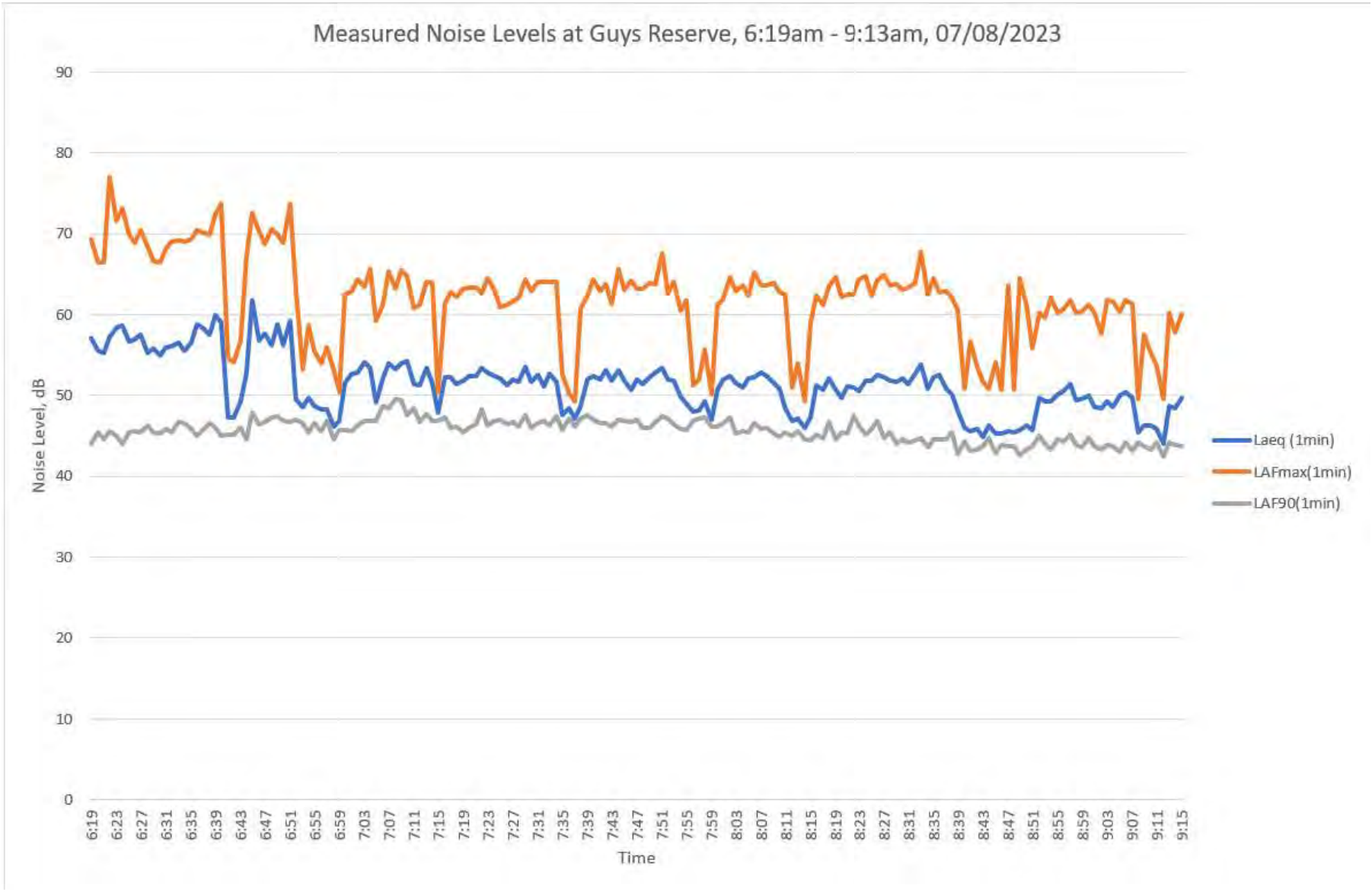
Photo C: Photo of the SLM (angle 1)

Photo C: Photo of the SLM (angle 2)

Appendix B – Noise Monitoring Results


ML1 - 200 Burswood Dr
100
90
80
70
60
50
40
30
20
10
0
22-Nov
23-Nov
24-Nov
25-Nov
26-Nov
27-Nov
28-Nov
29-Nov
Rain(mm)
LAeq [dB]
LAFmax [dB]


ML2 - 24 Dulwich Pl
100
90
80
70
60
50
40
30
20
10
0
22-Nov
23-Nov
24-Nov
25-Nov
26-Nov
27-Nov
28-Nov
29-Nov
Rain(mm)
LAeq [dB]
LAFmax [dB]


Measured Noise Levels at Guys Reserve, 6:19am - 9:13am, 07/08/2023
Noise Level, dB
90
80
70
60
50
40
30
20
10
0
6:19
6:23
6:27
6:31
6:35
6:39
6:43
6:47
6:51
6:55
6:59
7:03
7:07
7:11
7:15
7:19
7:23
7:27
7:31
7:35
7:39
7:43
7:47
7:51
7:55
7:59
8:03
8:07
8:11
8:15
8:19
8:23
8:27
8:31
8:35
8:39
8:43
8:47
8:51
8:55
8:59
9:03
9:07
9:11
9:15
Time
Laeq (1min)
LAFmax(1min)
LAF90(1min)

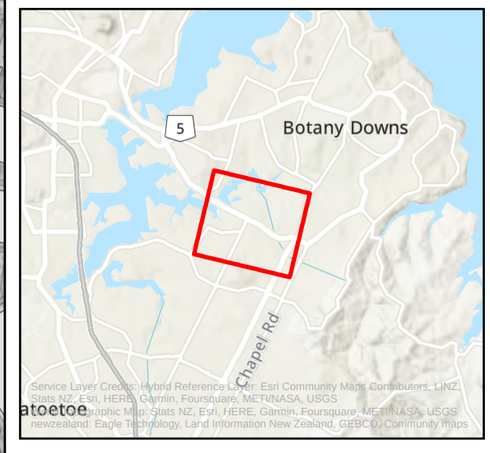
Appendix C – Construction Works Areas

Legend

- EB4L - Works Areas
- EB3C - Works Areas
- EB3C - Bridge Piling
- EB3C - Embankment
- Dwellings
- Other Buildings

EB3C/EB4L Construction Areas

0 105 210 420 m



Map Creation Date: 11/07/2023

Author: Vitalii Zaiets

Eastern Busway

Appendix D – Affected Receivers – Noise

EB3C Main Works – Excavator (Daytime)

Address	Residential/Commercial	Noise Level, dB L_{Aeq}
28 Burswood Drive	Residential	89
21 Dulwich Place	Residential	86
198 Burswood Drive	Residential	82
18 Heathridge Place	Residential	80
203 Burswood Drive	Residential	79
38 Heathridge Place	Residential	77
201 Burswood Drive	Residential	75
12 Tullis Place	Residential	74
25 Burswood Drive	Residential	73
10 Heathridge Place	Residential	73
6A Tullis Place	Residential	72
27 Burswood Drive	Residential	72
196 Burswood Drive	Residential	72
2 Torrens Road	Residential	72
34 Burswood Drive	Residential	72
11 Tullis Place	Residential	71
380 Tī Rākau Drive	Commercial	89
1/28 Torrens Road	Commercial	87
245 Tī Rākau Dr	Commercial	82
3/28 Torrens Road	Commercial	81
5/272 Tī Rākau Drive	Commercial	79
386 Tī Rākau Drive	Commercial	74
22 Torrens Road	Commercial	73
16 Torrens Road	Commercial	72
5/28 Torrens Road	Commercial	72

EB3C Main Works Bridge A and Bridge B Construction – Impact Piling Rig (Daytime)

Address	Residential/Commercial	Noise Level, dB L_{Aeq}
245 Tī Rākau Drive	Commercial	73
249 Tī Rākau Drive	Commercial	71

EB4L Shared Path and Laydown Yard – Excavator (Daytime)

Address	Residential/Commercial	Noise Level, dB L_{Aeq}
415 Tī Rākau Drive	Residential	79
34 Cottesmore Place	Residential	79
26 Cottesmore Place	Residential	74
32 Cottesmore Place	Residential	73
175 Guys Road	Residential	71

EB4L Bridge C – Bored Piling Rig (Daytime)

Address	Residential/Commercial	Noise Level, dB L_{Aeq}
451 Tī Rākau Drive	Commercial	>90
451 Tī Rākau Drive	Commercial	81
451 Tī Rākau Drive	Commercial	74
5 Te Koha Road	Commercial	71
451 Tī Rākau Drive	Commercial	71

EB3C Long Weekend Works – Concrete Saw (Night-time)

Address	Noise Level, dB L_{Aeq}
38 Davington Way	54
40 Davington Way	53
36 Davington Way	53
32 Davington Way	51
7 Ifield Court	51
9 Ifield Court	51
5 Ifield Court	51
3 Ifield Court	51
47 Davington Way	51
2 Ifield Court	50
43 Davington Way	50
30 Davington Way	50
41 Davington Way	50
16 Ifield Court	49
8 Ifield Court	49
6 Ifield Court	49
37 Davington Way	49
35 Davington Way	48
20 Lutana Place	48
11 Lutana Place	48
9 Lutana Place	48
10 Ifield Court	48
20 Davington Way	47
39 Davington Way	47
22 Davington Way	47
22 Lutana Place	46
45 Davington Way	46
12 Ifield Court	46
11 Ifield Court	46
5 Tullis Place	46
11 Tullis Place	46
2 Torrens Road	46

EB3C Pavement Works – Plate Compactor (Night-time)

Address	Noise Level, dB L_{Aeq}
37-41 Spalding Rise	86
74-78 Tiger Drive	84
53 Huntington Drive	73
31-35 Spalding Rise	71
29 Spalding Rise	68
68-72 Tiger Drive	68
415 Tī Rākau Drive	66
66 Tiger Drive	66
51a Huntington Drive	64
6 Bunker Rise	63
64 Tiger Drive	63
8 Bunker Rise	63
62 Tiger Drive	62
27 Spalding Rise	61
60 Tiger Drive	61
51 Huntington Drive	61
86 Huntington Drive	61
56-58 Tiger Drive	61
23 Spalding Rise	60
98 Huntington Drive	60
25 Spalding Rise	60
100 Huntington Drive	60
2 Nagle Place	59
4 Nagle Place	59
118 Huntington Drive	59
116 Huntington Drive	59
102 Huntington Drive	59
49 Huntington Drive	59
96 Huntington Drive	58
18 Nagle Place	58
54 Tiger Drive	58
90 Huntington Drive	58
88 Huntington Drive	58
16 Nagle Place	58
104 Huntington Drive	58
114 Huntington Drive	58
14 Nagle Place	57
45 Huntington Drive	57
6 Nagle Place	57
32 Spalding Rise	57
106 Huntington Drive	57
112 Huntington Drive	57
19 Spalding Rise	57

12 Nagle Place	57
15 Spalding Rise	57
28 Cottesmore Place	57
94 Huntington Drive	56
84 Huntington Drive	56
78 Huntington Drive	56
8-10 Nagle Place	56
32 Cottesmore Place	56
30 Cottesmore Place	56
108 Huntington Drive	56
26 Cottesmore Place	56
64 Huntington Drive	56
8 Saidia Place	56
110 Huntington Drive	55
10 Saidia Place	55
24 Cottesmore Place	55
47 Puma Drive	55
17 Spalding Rise	55
62 Huntington Drive	55
1 St Leger Close	55
8 Spalding Rise	55
11 Bunker Rise	55
9 Bunker Rise	55
45 Puma Drive	54
13 Bunker Rise	54
41 Puma Drive	54
43 Huntington Drive	54
4 Bunker Rise	54
34 Cottesmore Place	54
6 Saidia Place	54
43 Puma Drive	54
4 Saidia Place	54
92 Huntington Drive	53
2 Els Close	53
48-50 Tiger Drive	53
9 Saidia Place	53
7 Bunker Rise	53
4 Els Close	53
2 Saidia Place	53
22 Cottesmore Place	52
60 Huntington Drive	52
37 Puma Drive	52
31 Cottesmore Place	52
5 Bunker Rise	52
40 Cottesmore Place	52
82 Huntington Drive	52

5 Saidia Place	52
38 Cottesmore Place	52
39 Puma Drive	51
29 Cottesmore Place	51
7 Saidia Place	51
56 Huntington Drive	51
30 Spalding Rise	51
18 Cottesmore Place	51
52 Tiger Drive	51
20 Cottesmore Place	51
24 Puma Drive	51
3 Bunker Rise	51
27 Cottesmore Place	51
12a Midvale Place	51
16 Cottesmore Place	51
1/9 Midvale Place	50
28 Spalding Rise	50
13 Cottesmore Place	50
44 Tiger Drive	50
33 Puma Drive	50
12 Cottesmore Place	50
42 Tiger Drive	50
12 Midvale Place	50
14 Els Close	50
40 Tiger Drive	50
12 Els Close	50
1 Spalding Rise	50
36 Cottesmore Place	50
26 Spalding Rise	50
22 Puma Drive	50
1 Saidia Place	49
5 Lushington Place	49
7 Midvale Place	49
36 Tiger Drive	49
11 Lushington Place	49
15 Lushington Place	49
35 Puma Drive	49
14 Cottesmore Place	49
15 Puma Drive	49
10 Cottesmore Place	49
9 Cottesmore Place	49
23 Cottesmore Place	49
54 Huntington Drive	49
38 Tiger Drive	49
9 Spalding Rise	49
20 Spalding Rise	49

3 Saidia Place	49
8 St Leger Close	49
161 Guys Road	49
25 Cottesmore Place	49
10 Midvale Place	48
6 Els Close	48
37 Huntington Drive	48
28 Burswood Drive	48
7 Spalding Rise	48
11 Cottesmore Place	48
175 Guys Road	48
68 Huntington Drive	48
11a Kenwick Place	48
9 Lushington Place	48
25 Burswood Drive	48
35 Huntington Drive	48
13 Lushington Place	48
5 Spalding Rise	48
70 Huntington Drive	48
48 Huntington Drive	48
72 Huntington Drive	48
10 Els Close	48
5 Midvale Place	48
20 Puma Drive	48
3 Spalding Rise	48
6 St Leger Close	48
14-18 Spalding Rise	47
171 Guys Road	47
5 Cottesmore Place	47
6 Cottesmore Place	47
3 Midvale Place	47
8 Els Close	47
173 Guys Road	47
1/5 St Leger Close	47
5 Els Close	47
8 Cottesmore Place	47
9 Huntington Drive	47
12 Lushington Place	47
18 Puma Drive	47
12 Spalding Rise	47
42 Huntington Drive	47
153 Guys Road	47
10 Lushington Place	47
15 Kenwick Place	47
155 Guys Road	47
7 Quartley Place	47

11 Spalding Rise	47
38 Huntington Drive	47
16 Lushington Place	47
50 Huntington Drive	47
9 Kenwick Place	47
2 Kenwick Place	47
1 Kenwick Place	47
10 Spalding Rise	47
23 Puma Drive	46
27 Burswood Drive	46
7 Cottesmore Place	46
34 Burswood Drive	46
36 Burswood Drive	46
9-17 Waihi Way	46
8 Lushington Place	46
9 Midvale Place	46
16 Puma Drive	46
19 Kenwick Place	46
31 Huntington Drive	46
18 Huntington Drive	46
13 Puma Drive	46
3 St Leger Close	46
14 Kenwick Place	46
29 Huntington Drive	46
1 Quartley Place	46
8 Midvale Place	46
10 Heathridge Place	46
6 Kenwick Place	46
4 St Leger Close	46
188 Guys Road	46
14 Lushington Place	46
14 Spalding Rise	46
13 Quartley Place	46
30 Tiger Drive	46
170 Guys Road	46
6 Heathridge Place	46
178 Guys Road	46
180 Guys Road	46
182 Guys Road	46
15 Puma Drive	46
31 Burswood Drive	46
34 Huntington Drive	46
9 Quartley Place	46
7 Lushington Place	46
8 Kenwick Place	46

EB3C Bridge Construction Works – Concrete Pours (Night-time)

Address	Noise Level, dB L_{Aeq}
38 Davington Way	61
36 Davington Way	59
40 Davington Way	58
32 Davington Way	57
3 Ifield Court	56
47 Davington Way	56
5 Ifield Court	56
7 Ifield Court	55
9 Ifield Court	55
30 Davington Way	54
16 Ifield Court	51
39 Davington Way	51
6 Ifield Court	51
170 Gossamer Drive	51
176 Gossamer Drive	51
14 Wanaka Place	51
45 Davington Way	51
12 Wanaka Place	51
172 Gossamer Drive	51
8 Wanaka Place	51
10 Wanaka Place	51
43 Davington Way	51
20 Lutana Place	50
22 Lutana Place	50
2/162 Gossamer Drive	50
41 Davington Way	50
11 Ifield Court	50
2 Ifield Court	50
158 Gossamer Drive	49
11 Lutana Place	49
40 Riverhills Avenue	49
16 Wanaka Place	49
8 Ifield Court	49
165 Gossamer Drive	49
8 Ellesmere Crescent	49
18 Lutana Place	49
163B Gossamer Drive	49
1/162 Gossamer Drive	48
1/4 Ellesmere Crescent	48
171 Gossamer Drive	48
175 Gossamer Drive	48
37 Davington Way	48
16 Lutana Place	48
155 Gossamer Drive	48
169 Gossamer Drive	48
35 Davington Way	48
26 Davington Way	48
22 Wanaka Place	47

163A Gossamer Drive	47
7 Lutana Place	47
38 Riverhills Avenue	47
33 Davington Way	47
160 Gossamer Drive	47
157 Gossamer Drive	47
1/157A Gossamer Drive	47
167 Gossamer Drive	47
12 Ellesmere Crescent	47
173 Gossamer Drive	47
10 Ifield Court	47
14 Ellesmere Crescent	47
12 Ifield Court	46
2 Ellesmere Crescent	46
161 Gossamer Drive	46
9 Lutana Place	46
3 Wanaka Place	46
4 Okataina Street	46
14 Ifield Court	46
5 Okataina Street	46
3 Ellesmere Crescent	46
12 Davington Way	46
18 Davington Way	46
39 Riverhills Avenue	46
10 Ellesmere Crescent	46
4A Rotoiti Avenue	46
6 Okataina Street	46
43 Riverhills Avenue	46

EB4L Bridge C Construction Works – Concrete Pours (Night-time)

Address	Noise Level, dB L_{Aeq}
19-25 Waihi Way	76
175 Guys Road	69
27 Cottesmore Place	68
25 Cottesmore Place	67
29 Cottesmore Place	66
74-78 Tiger Drive	65
9-17 Waihi Way	65
32 Cottesmore Place	64
20-30 Oneroa Road	64
31 Cottesmore Place	63
34 Cottesmore Place	63
68-72 Tiger Drive	63
66 Tiger Drive	61
64 Tiger Drive	61
53 Huntington Drive	61
40 Cottesmore Place	61

30 Cottesmore Place	61
37-41 Spalding Rise	61
62 Tiger Drive	61
23 Cottesmore Place	60
36 Cottesmore Place	60
28 Cottesmore Place	60
171 Guys Road	60
60 Tiger Drive	60
10 Saidia Place	59
38 Cottesmore Place	59
8 Saidia Place	59
26 Cottesmore Place	59
56-58 Tiger Drive	59
28-38 Opito Way	59
6 Saidia Place	59
188 Guys Road	59
173 Guys Road	58
182 Guys Road	58
4 Saidia Place	58
54 Tiger Drive	58
13 Cottesmore Place	57
60 Kirikiri Lane	57
186 Guys Road	56
24 Cottesmore Place	56
12 Cottesmore Place	56
10 Cottesmore Place	56
1-19 Opito Way	56
22 Cottesmore Place	56
180 Guys Road	55
31-61 Kirikiri Lane	55
51a Huntington Drive	55
178 Guys Road	55
58 Kirikiri Lane	55
43 Huntington Drive	55
56 Kirikiri Lane	55
161 Guys Road	55
11 Cottesmore Place	55
54 Kirikiri Lane	55
9 Saidia Place	55
20 Cottesmore Place	54
18 Cottesmore Place	54
18 Nagle Place	54
16 Nagle Place	54
11 Lushington Place	54
45 Huntington Drive	53
7 Saidia Place	53

9 Cottesmore Place	53
2 Saidia Place	53
8 Cottesmore Place	53
14 Cottesmore Place	52
6 Cottesmore Place	52
50 Kirikiri Lane	52
5 Saidia Place	52
176 Guys Road	51
19 Spalding Rise	51
118 Huntington Drive	51
17 Spalding Rise	51
153 Guys Road	51
49 Huntington Drive	51
41-47 Haven Drive	51
155 Guys Road	50
51 Huntington Drive	50
16 Cottesmore Place	50
116 Huntington Drive	50
7 Lushington Place	50
64 Huntington Drive	50
40 Tiger Drive	50
36 Tiger Drive	50
48 Kirikiri Lane	50
40 Kirikiri Lane	50
31-35 Spalding Rise	50
157 Guys Road	49
46 Kirikiri Lane	49
13 Lushington Place	49
5 Cottesmore Place	49
7 Cottesmore Place	49
174 Guys Road	49
27 Kirikiri Lane	49
7 Bunker Rise	49
44 Kirikiri Lane	49
60 Huntington Drive	49
62 Huntington Drive	49
8 Bunker Rise	49
110 Huntington Drive	49
15 Lushington Place	49
112 Huntington Drive	49
42 Kirikiri Lane	49
155a Guys Road	49
1 St Leger Close	48
172 Guys Road	48
3 Bunker Rise	48
5 Bunker Rise	48

3 Lushington Place	48
23 Aclare Place	48
108 Huntington Drive	48
72 Huntington Drive	48
70 Huntington Drive	48
106 Huntington Drive	48
114 Huntington Drive	48
6 Bunker Rise	48
9 Bunker Rise	48
14 Nagle Place	48
38 Kirikiri Lane	48
104 Huntington Drive	48
40-62 Haven Drive	48
30 Spalding Rise	48
9 Lushington Place	48
36 Kirikiri Lane	48
12 Nagle Place	47
38 Tiger Drive	47
32 Spalding Rise	47
170 Guys Road	47
102 Huntington Drive	47
45 Puma Drive	47
5 Lushington Place	47
34 Kirikiri Lane	47
100 Huntington Drive	47
98 Huntington Drive	47
11 Bunker Rise	47
1 Saidia Place	47
25 Spalding Rise	47
8 Lushington Place	47
3 Saidia Place	47
32 Kirikiri Lane	47
9 Huntington Drive	47
96 Huntington Drive	47
30 Kirikiri Lane	47
3 St Leger Close	46
15 Kirikiri Lane	46
4/29 Haven Drive	46
23 Spalding Rise	46
151 Guys Road	46
29 Spalding Rise	46
78 Huntington Drive	46
15 Spalding Rise	46
10 Lushington Place	46
74 Huntington Drive	46
17 Lushington Place	46

Appendix E – Affected Receivers – Vibration

Daytime pavement works in Burswood section (EB3C)

Address	Exceeds Cat B?	Exceeds Cat A?
21 Dulwich Place	Yes	Yes
28 Burswood Drive	Yes	Yes
18 Heathridge Place	Yes	Yes
198 Burswood Drive	Yes	Yes
203 Burswood Drive	Yes	Yes
38 Heathridge Place	Yes	Yes
25 Burswood Drive	Yes	Yes
10 Heathridge Place	Yes	Yes
201 Burswood Drive	Yes	Yes
12 Tullis Place	Yes	Yes
6a Tullis Place	Yes	Yes
27 Burswood Drive	Yes	Yes
7 Midvale Place	Yes	Yes
11 Tullis Place	Yes	Yes
196 Burswood Drive	No	Yes
34 Burswood Drive	No	Yes
26 Dulwich Place	No	Yes
2/203 Burswood Drive	No	Yes
19 Dulwich Place	No	Yes
415 Tī Rākau Drive	No	Yes
5 Midvale Place	No	Yes
53 Huntington Drive	No	Yes
10 Tullis Place	No	Yes
27 Heathridge Place	No	Yes
194 Burswood Drive	No	Yes
199 Burswood Drive	No	Yes

Night-time pavement works along Tī Rākau Drive (EB3C)

Address	Exceeds Cat B?	Exceeds Cat A?
37-41 Spalding Rise	No	Yes
74-78 Tiger Drive	No	Yes
53 Huntington Drive	No	Yes
68-72 Tiger Drive	No	Yes
31-35 Spalding Rise	No	Yes
415 Tī Rākau Drive	No	Yes
29 Spalding Rise	No	Yes
51a Huntington Drive	No	Yes
66 Tiger Drive	No	Yes
27 Spalding Rise	No	Yes

Daytime pavement works in Guys Reserve (EB4L)

Address	Exceeds Category B?	Exceeds Category A?
34 Cottesmore Place	Yes	Yes
415 Tī Rākau Drive	Yes	Yes
31 Cottesmore Place	No	Yes
32 Cottesmore Place	No	Yes
30 Cottesmore Place	No	Yes
25 Cottesmore Place	No	Yes
40 Cottesmore Place	No	Yes
36 Cottesmore Place	No	Yes
26 Cottesmore Place	No	Yes
175 Guys Road	No	Yes
27 Cottesmore Place	No	Yes
29 Cottesmore Place	No	Yes
10 Saidia Place	No	Yes