Appendix 12

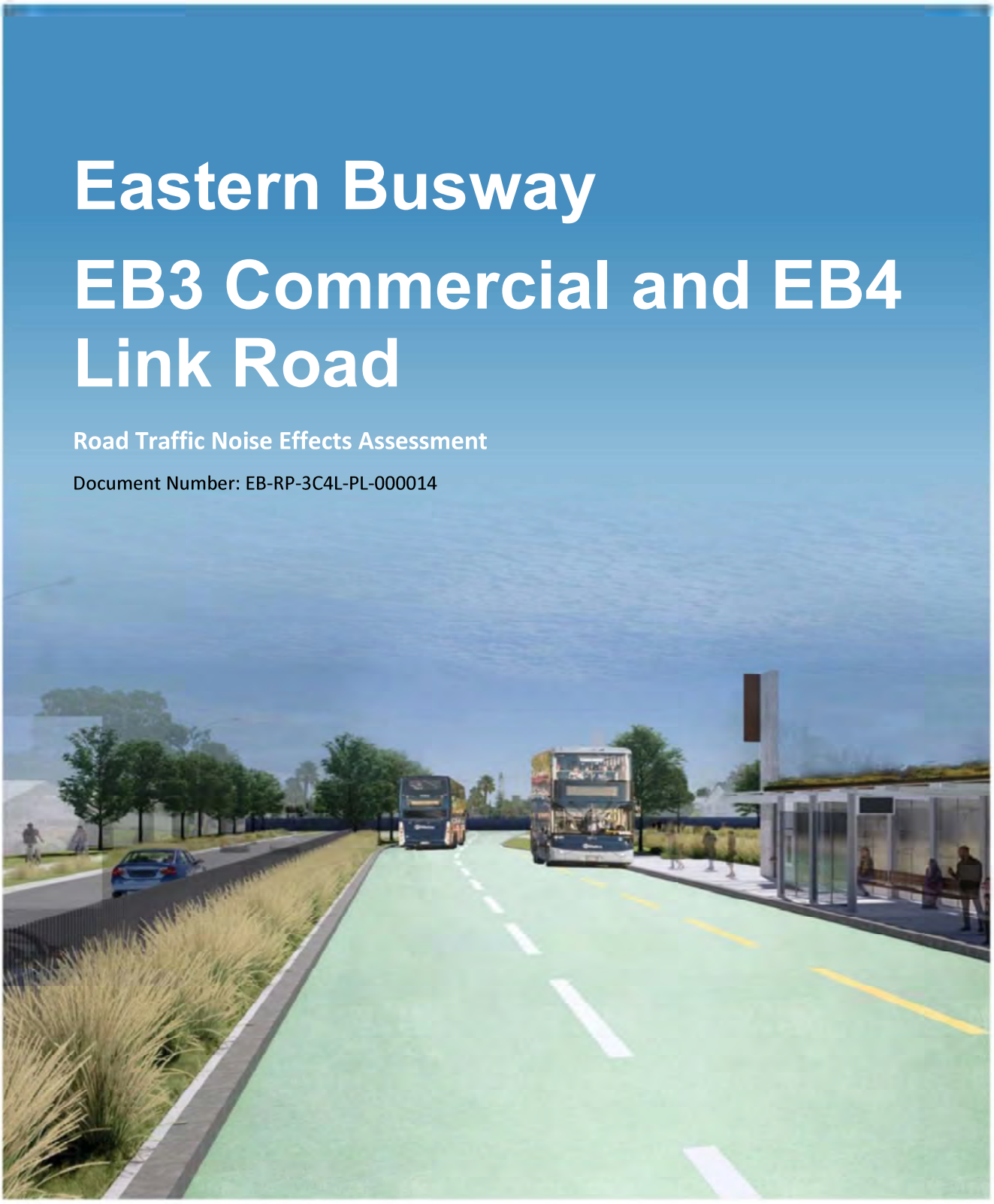
Operational Noise and Vibration Effects Assessment

Eastern Busway

EB3 Commercial and EB4 Link Road

Road Traffic Noise Effects Assessment

Document Number: EB-RP-3C4L-PL-000014



Eastern Busway

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Terms and Definitions

Term	Definition
AADT	Average Annual Daily Traffic
AEE	Assessment of Effects on the Environment
Altered Road	As defined in NZS 6806:2010 Section 1.5.2: *Subject to 1.5.4, an altered road means an existing road that is subject to the alterations of the horizontal or vertical alignment where at any assessment position at any one or more PPF meets criteria 1.5.2 (a) or (b)*
AMETI	Auckland Manukau Eastern Transport Initiative
AT	Auckland Transport
AUP(OP)	Auckland Unitary Plan (Operative in Part) (Updated 20 July 2023)
CoRTN	Calculation of Road Traffic Noise, which is a report setting out a road traffic noise prediction method
EB2	Eastern Busway Section 2
EB3C	Eastern Busway Section 3 Commercial
EB3R	Eastern Busway Section 3 Residential
EB4L	Eastern Busway Section 4 Link Road
$L_{Aeq(24h)}$	A-weighted equivalent continuous sound pressure level during a 24-hour period expressed in dB
PPF	Protected Premises and Facilities
The Guidelines	"Environmental Noise Guidelines for the European Region", published by the World Health Organisation (2018). https://www.euro.who.int/__data/assets/pdf_file/0008/383921/noise-guidelines-eng.pdf
%HA	Percentage of people "highly annoyed" (as defined in the Guidelines) at a given noise level.

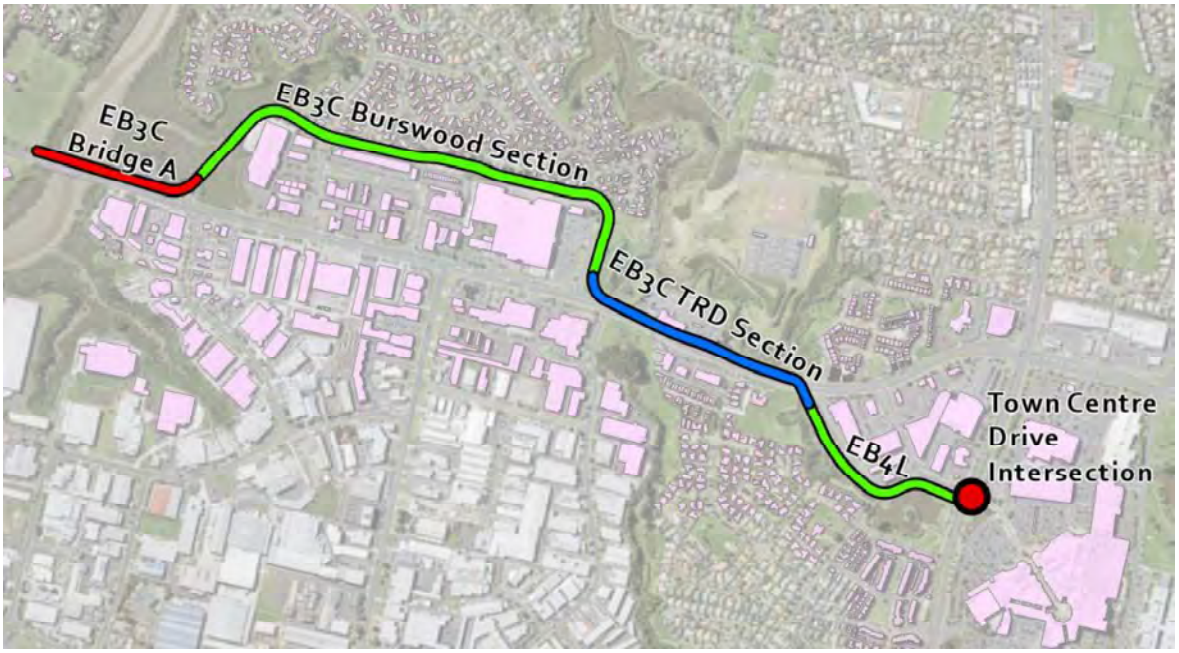
Executive Summary

The purpose of this Road Traffic Noise Assessment is to provide an assessment of the potential traffic noise effects of the Eastern Busway 3 Commercial (EB3C) and Eastern Busway 4 Link Road (EB4L) sections of the Eastern Busway Project (the Project). The assessment is in accordance with the requirements of the Auckland Unitary Plan Operative in Part (AUP(OP)) and New Zealand Standard 6806:2010 (NZS 6806).

Key elements of the proposed EB3C works include the construction of two bridges (Bridges A and B), noise walls and retaining walls, stormwater drainage, and a cycleway. The proposed EB3C bridge structures, new and upgraded stormwater outfalls and an area of reclamation will 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.

Different parts of the busway were assessed based on the below figure and table:



EB3C, EB4L and Town Centre Drive sections for assessment

EB4L includes works to improve the intersection at Te Irirangi Drive and Town Centre Drive (shown as the Town Centre Drive intersection on the figure above). The improvements will include features such as traffic signals, signs, pedestrian crossings, lane markings, new kerb alignment and pavement widening in Town Centre Drive to allow for an additional left turn lane. However, these improvements are not predicted to bring about any change to the noise environment in the local area and have not been considered further in this assessment.

Scope of noise assessment undertaken for EB3C, EB4L and Town Centre Drive

Section	Colour in Figure	Assessment
EB3C Bridge A	Red	Busway runs parallel to Tī Rākau Drive along this section. Although this section of busway constitutes an alteration to the horizontal alignment of the road, noise for this section did not require

Section	Colour in Figure	Assessment
		assessment against NZS 6806 because there are no Protected Premises and Facilities (PPFs) within 100m of this section. Noise from Tī Rākau Drive will dominate any noise generated from bus movements along this section.
EB3C Burswood Section	Green	Noise from buses along this section do not require assessment against NZS 6806 as the AADT is less than 2000 along this section of busway (in line with the minimum AADT requirements for Altered Roads under NZS 6806). Operational noise effects associated with buses using the busway in relation to surrounding dwellings have been considered using the ISO 9613-2:1996 algorithm.
EB3C Tī Rākau Drive (TRD) Section	Blue	Noise from general road traffic along this section of Tī Rākau Drive was assessed against NZS 6806 since the horizontal alignment of the road will change and there are PPFs within 100m of the altered section of road. The assessment found that the section of road did not meet the definition of an Altered Road under that standard, and therefore it did not require further consideration of noise mitigation under NZS 6806. Changes in traffic noise levels at all nearby PPFs are predicted to be negligible. Operational noise effects associated with buses using the busway in relation to surrounding dwellings have been considered using the ISO 9613-2:1996 algorithm applied to the prediction of noise from buses; it was found that noise from the busway would be dominated by road traffic noise along Tī Rākau Drive.
EB4L	Green	Noise for this section did not require assessment against NZS 6806 because there are no PPFs within 100m of this section and noise from Tī Rākau Drive will dominate any noise generated from bus movements along this section. Operational noise effects associated with buses using the busway in relation to surrounding dwellings have been considered using the ISO 9613-2:1996 algorithm applied to the prediction of noise from buses.

Noise effects from buses travelling along the busway for EB3C and EB4L, along with noise from buses idling and pulling away at the Burswood bus station were considered as part of this assessment.

In summary:

- Noise from buses along the busway (including the Burswood section) will be similar to or below existing ambient noise levels across all receivers for both EB3C and EB4L.
- Noise from buses idling and pulling away at the Burswood bus station is considered to be reasonable in the context of the existing noise environment while diesel buses are in use and as the bus fleet electrifies.
- Traffic noise levels from Tī Rākau Drive are predicted to either remain the same or decrease at all PPFs near the Tī Rākau Drive section of EB3C (as determined through the NZS 6806 assessment of traffic noise).
- The estimated number of highly annoyed people near the Tī Rākau Drive section of EB3C is predicted to decrease through construction of the Project compared to the Do-Nothing scenario (2048 design year but without the Project built).

1 Introduction

1.1 Overview of the Eastern Busway Project

The Eastern Busway Project (the Project) is a package of works focusing on promoting an integrated, multi-modal transport system to support population and economic growth in southeast 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 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)
- 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 (EB3 Commercial) – – 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 the Botany Town Centre, including a link road through Guys and Whaka Maumahara 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.

1.3 Specialist assessment

This report describes our assessment of road traffic noise effects associated with EB3C and EB4L once operational. Noise levels have been predicted and assessed in line with the methodology set out in New Zealand Standard 6806:2010 "*Acoustics – Road traffic noise*". Effects associated with predicted changes in noise levels as a result of EB3C and EB4L have also been assessed.

This assessment involves:

- Considering relevant noise criteria
- Measuring existing noise levels
- Predicting and assessing future road traffic noise from EB3C and EB4L
- Determining the areas that may be affected by EB3C and EB4L

- Considering the measures required to avoid, remedy or mitigate potential road traffic noise effects.

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 (NoRs). A full set of proposed plans is attached to the AEE.

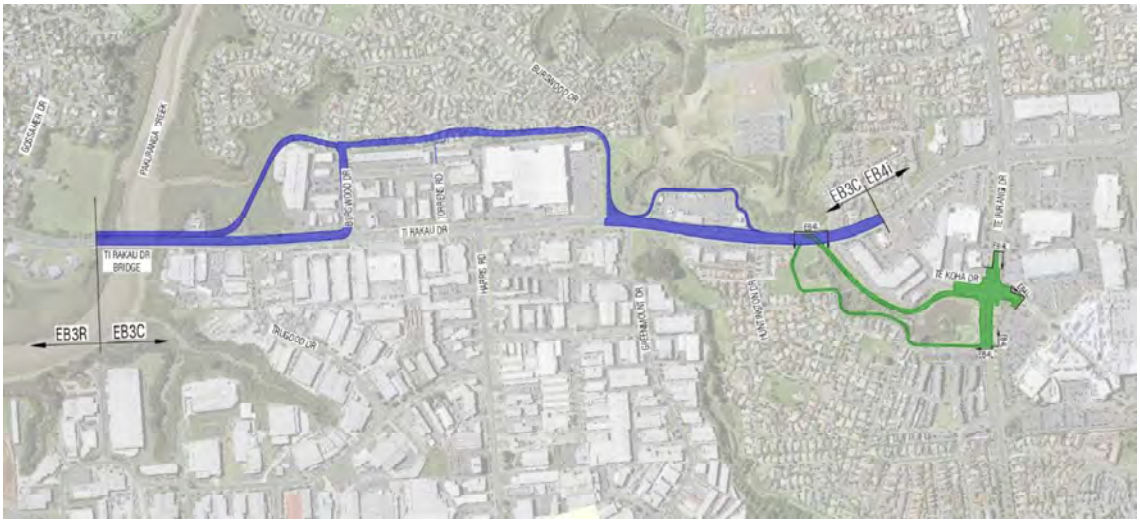


Figure 2-1 Eastern Busway 3 Commercial and 4 Link Road Project Extent

2.1 Eastern Busway 3 Commercial

The EB3C works will involve the establishment of an 'off-line' busway, cycleway and associated stormwater upgrades. The proposed works will take place within existing road reserves, Council reserves[1] and privately held land within the proposed works footprint (refer Figure 2). 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 a 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 a 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.

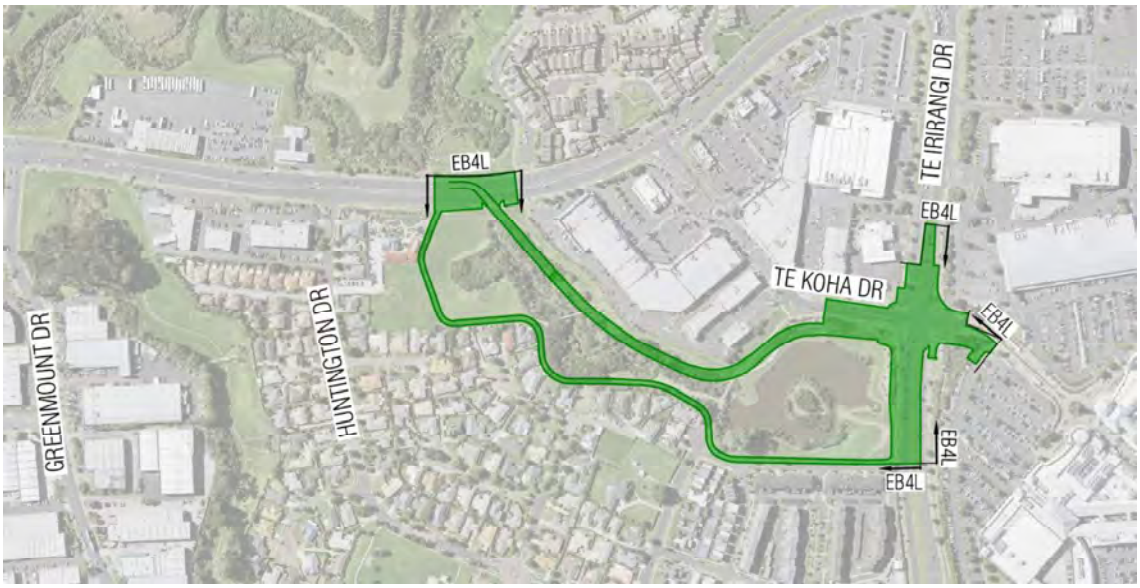


Figure 2-3 Eastern Busway 4 Link Road Project Area

3 Assessment Criteria

Chapter Summary

This chapter describes the noise criteria relevant to the assessment for each section of the EB3C and EB4L alignment, including explanations of the modelling scenarios and inputs for the NZS 6806 assessment, and the recommended noise criteria for noise from buses travelling along the busway.

Rule E25.6.33 of the (AUP(OP)) requires that new roads and altered roads that are within the scope of NZS 6806:2010[3] comply with the requirements of that Standard.

NZS 6806 provides criteria and an assessment method for road-traffic noise. It is a tool that provides performance targets and requires assessment of several different options for noise mitigation (often including barriers and low-noise road surfaces). These options are subject to an integrated design process in which the costs and benefits are considered. The performance targets in NZS 6806 are set to achieve reasonable noise levels, taking into account adverse health effects associated with noise on people and communities, the effects of relative changes in noise levels, and the potential benefits of New and Altered roads. NZS 6806 is an appropriate tool to assess traffic noise as it provides a suitable, tested traffic noise assessment and mitigation methodology and appropriate noise criteria.

NZS 6806 is not applicable to New and Altered roads predicted to carry less than an Annual Average Daily Traffic (AADT) of 2000 at the design year (as per section 1.3.1(b) of that standard), or where the change in noise level due to a project (i.e. the horizontal or vertical realignment of a road) does not reach certain thresholds of effects (e.g. a change of at least 3 dB for at least one Protected Premises and Facilities (PPFs), see Section 1.1). It also does not apply where there are no PPFs within 100m of the altered section of road (for urban areas).

Therefore, the only section of the busway where NZS 6806 is applicable is the EB3C Tī Rākau Drive section from Burswood Esplanade Reserve to Guys Reserve. The sections of busway through the Burswood suburb and from Guys Reserve to Te Irirangi Drive (EB4L) are predicted to carry an AADT less than 2000, and the section along the new Tī Rākau Bridge (Bridge A) does not have any PPFs within 100m.

We have assessed noise from buses only at PPFs along the busway (see Section 3.5). Based on our assessment, along the EB3C Tī Rākau Drive section, noise from buses is dominated by noise from existing road traffic. This is discussed further in Section 7.3.

Figure **3-1** shows the busway sections and how they have been split for the noise assessment. Table **3-1** summarises the assessments undertaken across the different parts of the busway, along with the justification for the assessment method.

[3] New Zealand Standard 6806:2010 Acoustics - Road Traffic Noise

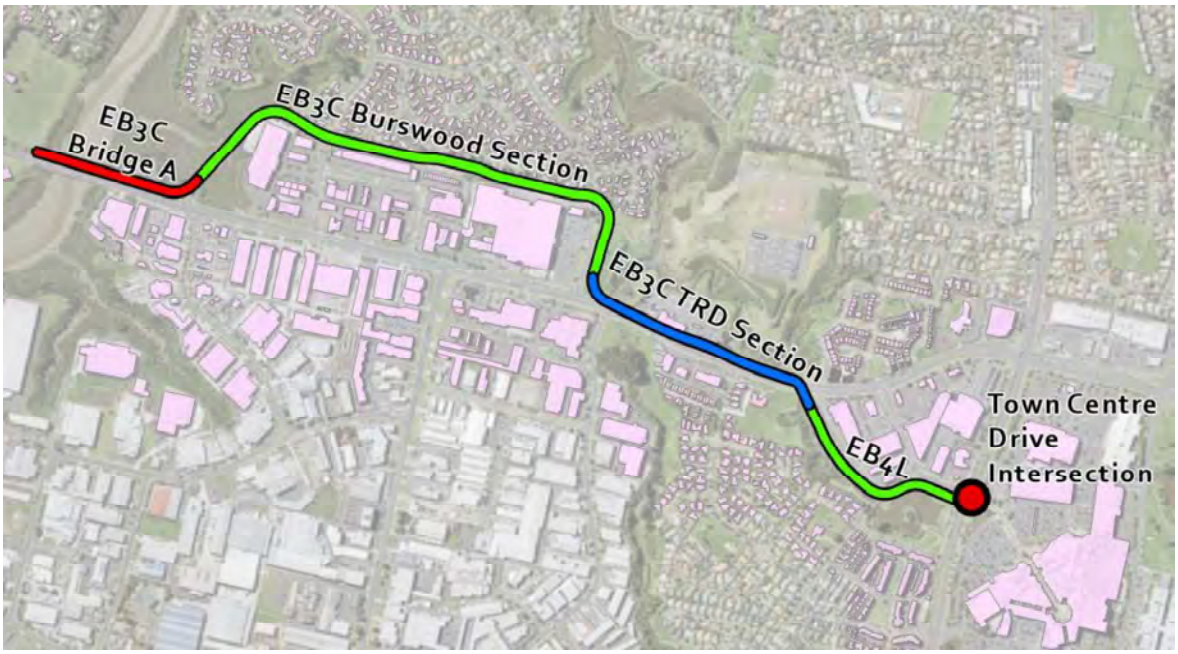


Figure 3-1 EB3C, EB4L and Town Centre Drive sections for assessment

Table 3-1 Noise assessments undertaken for EB3C and EB4L

Section	Colour in Figure	Assessment
EB3C Bridge 1	Red	Busway runs parallel to Tī Rākau Drive along this section. Although this section of busway constitutes an alteration to the horizontal alignment of the road, noise for this section did not require assessment against NZS 6806 because there are no Protected Premises and Facilities (PPFs) within 100m of this section. Noise from Tī Rākau Drive will dominate any noise generated from bus movements along this section.
EB3C Burswood Section	Green	Noise from buses along this section do not require assessment against NZS 6806 as the AADT is less than 2000 along this section of busway (in line with the minimum AADT requirements for Altered Roads under NZS 6806). Operational noise effects associated with buses using the busway in relation to surrounding dwellings have been considered using the ISO 9613-2:1996 algorithm.
EB3C Tī Rākau Drive (TRD) Section	Blue	Noise from general road traffic along this section of Tī Rākau Drive was assessed against NZS 6806 since the horizontal alignment of the road will change and there are PPFs within 100m of the altered section of road. The assessment found that the section of road did not meet the definition of an Altered Road under that standard, and therefore it did not require further consideration of noise mitigation under NZS 6806. Changes in traffic noise levels at all nearby PPFs are predicted to be negligible. Operational noise effects associated with buses using the busway in relation to surrounding dwellings have been considered using the ISO 9613-2:1996 algorithm applied to the prediction of noise from buses; it was found that noise from the busway would be dominated by road traffic noise along Tī Rākau Drive.
EB4L	Green	Noise for this section did not require assessment against NZS 6806 because there are no PPFs within 100m of this section and noise from Tī Rākau Drive will dominate any noise generated from bus movements along this section. Operational noise effects associated with buses using the busway in relation to surrounding dwellings

Section	Colour in Figure	Assessment
		have been considered using the ISO 9613-2:1996 algorithm applied to the prediction of noise from buses.

As most of the busway does not require assessment under NZS 6806, the only section which falls under the scope of NZS 6806 is the section of Tī Rākau Drive from Burswood Reserve to Guys Reserve as shown in Figure 3-2 and described as the EB3C Tī Rākau Drive (TRD) Section.

Figure 3-2 Section of EB3C assessable under NZS 6806, shown in red

As addressed in Section 6.1, the screening assessment showed that the EB3C Tī Rākau Drive (TRD) Section does not meet the definition of an Altered Road as per NZS 6806, as the Project will not sufficiently change the noise environment to warrant assessment of mitigation options. Sections 3.1 to 3.4 set out the criteria and inputs used in the screening assessment.

EB4L includes works to improve the intersection at Te Irirangi Drive and Town Centre Drive. The improvements will include features such as traffic signals, signs, pedestrian crossings, lane markings, new kerb alignment and pavement widening in Town Centre Drive to allow for an additional left turn lane. However, these improvements are not predicted to bring about any change to the noise environment in the local area and have not been considered further in this assessment.

3.1 Protected Premises and Facilities

NZS 6806 requires noise effects to be assessed at noise sensitive locations within set distances of EB3C TRD Section. These locations are known as Protected Premises and Facilities (PPFs) and include existing houses, schools, day-care facilities (including playgrounds that are part of these facilities) and marae.

Commercial and industrial premises do not fall within the definition of a PPF. Future (unbuilt) noise sensitive premises are also not PPFs, unless they have been granted building consent.

As EB3C and EB4L are in an existing urban area, PPFs are assessed if they are within 100 metres from the edge of the nearside traffic lane of the New or Altered road.

PPFs located outside of this area do not require assessment under NZS 6806, although potential noise effects are still controlled at receivers beyond 100 metres by virtue of noise criteria applying to the receivers nearest to the road.

3.2 Noise prediction scenarios

NZS 6806 specifies noise modelling of multiple scenarios to be undertaken, which include the following:

- The "Existing" noise environment, which is the ambient noise levels at the date of assessment
- A "Do-Nothing" scenario, which represents the traffic noise levels at the PPFs at the design year assuming no alterations are made to the existing road
- A "Do-Minimum" scenario, which represents the traffic noise levels at the PPFs at the design year with EB3C TRD Section implemented, but without any specific noise mitigation. Road surfaces, safety barriers and other structures which are required for non-acoustic purposes may provide incidental noise mitigation and are included in this scenario
- "Mitigation" scenarios (if required), which represent the traffic noise levels at the PPFs at the design year with various specific noise mitigation options implemented with the aim of achieving the noise criteria categories.

NZS 6806 requires the assessment of traffic noise at least 10 years after the opening of a New or Altered road. The year of completion of EB3C and EB4L has not yet been determined, but due to the availability of traffic modelling data, the year 2048 has been selected as the design year for assessment purposes. This decision was made in conjunction with the Project team.

3.3 "Altered" roads under NZS 6806

A roading project only qualifies as an "Altered" road if, at any one or more PPFs:

- The Do-Minimum noise environment would be greater than or equal to 64 dB $L_{Aeq(24h)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road traffic noise at that assessment position by 3 dB $L_{Aeq(24h)}$ or more at the design year, when compared with the Do-Nothing noise environment or
- The Do-Minimum noise environment would be greater than or equal to 68 dB $L_{Aeq(24h)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road traffic noise at that assessment position by 1 dB $L_{Aeq(24h)}$ or more at the design year, when compared with the Do-Nothing noise environment.

3.4 NZS 6806 noise criteria

NZS 6806 sets out three categories of noise criteria. The Category A criterion should be achieved as the first priority. If this is not practicable, the Category B criterion should be achieved. However, if it is not practicable to comply with Categories A or B, mitigation should be implemented to ensure that the Category C internal criterion is achieved. Category C does not protect outdoor amenity.

These criteria are only applicable if the section of the roading project in question qualifies as an "Altered Road" according to the definition set out in Section 3.3.

The applicable noise criteria are summarised in Table 3-2.

Table 3-2 NZS 6806 noise criteria

Category	Criterion	Altered Road
A	Primary	64 dB $L_{Aeq\ (24\ hr)}$
B	Secondary	67 dB $L_{Aeq\ (24\ hr)}$
C	Internal	40 dB $L_{Aeq\ (24\ hr)}$

The location selected for assessment purposes for each PPF is the façade most-affected by noise from the road being assessed and is 1.2 to 1.5 m above each floor level of interest.

3.5 Noise from buses

Rule E25.6.33 of the AUP(OP) refers to NZS 6806 for assessment of transport noise. However, bus volumes are not expected to reach 2000 AADT along the busway so guidance must be sought from other sources in order to assess effects of noise from buses where the busway separates from Tī Rākau Drive.

Although not applicable to noise from buses, the AUP(OP) maximum permitted noise levels for activities within residential zones can be used to inform the assessment of noise effects. This approach has been considered for this assessment as the busway will be a new noise source at the EB3C Burswood Section and the EB4L section of the alignment (as shown in Figure 3-1 above), as opposed to the rest of the alignment where the busway will primarily run along the existing Tī Rākau Drive (ie EB3C Bridge A and EB3C TRD sections, Figure 3-1).

The busway will be built alongside land currently zoned Residential in the Burswood area, and the busway will run through land currently zoned Open Space – Informal Recreation in Guys Reserve. The criteria for noise received at residential receivers adjacent to the busway will be the same in both instances, as the noise criteria set out in AUP (OP) Section E.25.6.2 (noise levels in Residential zones) and E.25.6.18 (noise between the Open Space and Residential zones) are identical.

The relevant criteria are reproduced in Table 3-3.

Table 3-3 Noise criteria for noise levels in residential zones

Time	Noise level
Monday to Saturday 7am – 10pm	50 dB L_{Aeq}
Sunday 9am – 6pm	
All other times	40 dB L_{Aeq} 75 dB L_{AFmax}

The Burswood bus station will be built on land that is currently zoned Residential – Mixed Housing Suburban in the AUP(OP). Therefore, the noise criteria set out in Table 3-3 are also applicable for noise generated at this bus station.

We understand that there are some buildings that are used as residential dwellings at 28 Torrens Road. Because these buildings fall within the Business – Light Industry Zone, they will be subject to the noise criteria for that zone, as set out in Table **3-4**.

Table 3-4 Noise criteria in the Business - Light Industry Zone (from AUP(OP) Rule E.25.6.5)

Time	Noise level
All times	65 dB L_{Aeq}

3.6 Road traffic vibration

Traffic vibration from new or upgraded roading projects is not generally expected to create issues. A key factor with new roads is the uniformity of the basecourse/pavement and the absence of near surface services. This is due to new or upgraded roads being designed to be smooth and even and avoiding vibration generated from passing traffic over uneven surfaces. Therefore, traffic vibration effects arising from operation of EB3C and EB4L has not been assessed.

4 Existing Noise Environment

Chapter Summary

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

It also provides a description of the key characteristics of the existing environment.

The existing noise 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.

PPFs are the most sensitive to potential operational noise effects. 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. PPFs that fell within the relevant assessment area are listed in Appendix C.

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

Birdsong was prominently heard during the attended noise survey at Guys Reserve.

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
- Guys Reserve (behind 25 Cottesmore Place) from the 10th to the 14th of March 2023, and an attended measurement undertaken from 6:15am to 9:15am on the morning of the 7th of August 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.

4.1 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.

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 200 Burswood and 29 Dulwich for approximately seven days. Note that due to a logger fault, morning results from 29 Dulwich Place on the 23 November 2022 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 4-1 Noise monitoring locations - EB3C and EB4L

Figure 4-2 Monitoring Location 1 - 29 Dulwich Place

Figure 4-3 Monitoring Location 2 - 200 Burswood Drive

Figure 4-4 Monitoring Location 3 - Guys Reserve

4.1.1 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.

4.1.2 Data analysis

There is a natural variation in the noise environment throughout the day and often significant 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.

4.1.3 Measurement results

A summary of the measured noise levels is presented below. Details of each measurement location are presented in noise monitoring forms, compiled in Appendix A.

Table 4-1 summarises the average noise levels recorded in the early-morning period between 6:30am and 7:15am, as this is the time during which worst-case noise levels will likely occur from operation of the busway as discussed in Section 7. Line charts showing the complete set of noise measurements are presented in Appendix B.

Note that the measurement results reported for Guys Reserve are from the attended measurement that was undertaken on the morning of the 7th of August 2023, as this survey obtained the most reliable noise data between the two surveys undertaken at this location.

Table 4-1 Noise measurement results from EB3C and EB4L – early-morning noise levels

Time (15 minute period)	200 Burswood Drive (by existing Burswood Drive)		29 Dulwich Place (near future Burswood bus station)		Guys Reserve		Bard Place Reserve*
	dB $L_{Aeq(15min)}$	L_{AFmax}	dB $L_{Aeq(15min)}$	L_{AFmax}	dB $L_{Aeq(15min)}$	L_{AFmax}	dB $L_{Aeq(15min)}$
6:30 am	54	75	50	70	56	60	58 - 66
6:45 am	57	79	49	69	56	62	
7:00 am	57	75	48	76	53	54	

**This measurement was undertaken in 2018 to support preparation of the AMETI Eastern Busway 2 and 3 Design and Consenting report (dated 4th March 2019).*

5 Road Traffic Noise Assessment Methodology

Chapter Summary
This chapter provides an overview of the methodology that was followed for the predictions, including descriptions of the various noise model inputs used for both the NZS 6806 assessment and assessment of bus noise, and uncertainties and limitations. An overview of traffic noise effects is also provided.

To determine the potential change in road traffic noise levels along the EB3C section of Tī Rākau Drive, the Do-Minimum (design year with Project) scenario has been compared with the Do-Nothing (design year without Project) scenario.

A screening assessment was carried out to determine whether the full NZS 6806 assessment is required to determine mitigation options for implementation.

Noise from buses along the length of the busway through EB3C and EB4L was assessed separately to vehicle noise along Tī Rākau Drive. Details of this assessment methodology are provided in Section 5.4.

5.1 Road traffic noise model

The road traffic noise modelling employs the "*Calculation of Road Traffic Noise*" (CoRTN) algorithm, as recommended in NZS 6806. The CoRTN methodology has been adjusted for New Zealand road surfaces in accordance with LTNZ Report No. 326[4] and the Waka Kotahi NZ Transport Agency's (Waka Kotahi) "*Guide to state highway road surface noise*"[5]. The model settings are described below in Table 5-1.

Table 5-1 Road traffic noise model settings

Parameter	Setting/source
Software	SoundPLAN 8.2
Algorithm	CoRTN
Order of reflections	1
Parameter	Noise level, dB $L_{Aeq\ (24\ hr)}$
Ground absorption	0.2 at commercial areas, 0.6 everywhere else
Receiver height	1.5 m above height of each floor
Noise contour grid	1.5 m height, 5 m resolution
Receivers and grid position	Free field

The CoRTN algorithm produces results for noise in terms of $L_{A10(18hr)}$. To convert these results to $L_{Aeq(24hr)}$, a minus 3 dB adjustment has been made. This adjustment has been implemented in the software in conjunction with the road surface adjustment detailed below.

The limitations and uncertainties of the prediction methodology, including input data, are discussed below.

[4] https://www.nzta.govt.nz/assets/resources/research/reports/326/docs/326.pdf
[5] https://www.nzta.govt.nz/assets/resources/road-surface-noise/docs/nzta-surfaces-noise-guide-v1.0.pdf

5.2 Input data

5.2.1 Traffic Data

All traffic data including AADT, percentage of heavy vehicles and posted speed limit has been sourced from the Project team. The existing scenario has been based on 2017 and 2018 data as provided by the traffic modelling team. 2048 has been selected as the design year, based on the availability of traffic modelling data. Traffic modelling methodology and results are described in the Integrated Transport Assessment.

The CoRTN model has been developed based on 18-hour traffic data. However, in accordance with the requirements of NZS 6806, traffic data has been entered as the 24-hour daily traffic (AADT), which results in noise levels in the order of +0.2 dB higher than would have been calculated by CoRTN based on the 18-hour AADT. The CoRTN model assumes that traffic is free-flowing, it does not apply to interrupted vehicle flows such as at an intersection, and for low volume roads under 5,000 AADT.

5.2.2 Topography

Topographic data for the Existing and Do-Nothing scenarios have been derived from Auckland Council's LiDAR at 1 m vertical resolution.

Topographic data for the Do-Minimum scenario were obtained from the Project team and are derived from LiDAR data at 1 m vertical resolution.

5.2.3 Buildings

The footprints and heights for all buildings and other structures were provided by the Project team and are based on building outlines sources from Land Information New Zealand (LINZ).

The Project team has provided details on properties that will be removed to make way for EB3C. These buildings are included in the Existing and Do-Nothing modelling scenarios but were removed for the Do-Minimum scenario. No buildings will be removed for EB4L.

5.2.4 Road alignments

Road alignments for the Existing and Do-Nothing scenarios were determined from Auckland Council sourced imagery, where centrelines were drawn along the road lengths. Road alignments for the Do-Minimum scenario was determined from the latest available CAD models provided by the Project team at the time, with centrelines drawn along the road lengths.

5.2.5 Road surfaces

The Existing, Do-Nothing and Do-Minimum road surface finishes were advised by the EBA team.

Road surfaces for all roads in all scenarios were modelled as asphaltic concrete (AC14) pavement type as per the reference design.

The procedure used to incorporate road surfaces in the model is as follows:

- In accordance with Transit Research Report 288, a minus 2 dB adjustment has been made for an asphaltic concrete road surface compared to CoRTN

- Surface corrections relative to asphaltic concrete have been made in accordance with LTNZ Research Report 326 and Waka Kotahi's "guide to state highway road surface noise". The combination of surface corrections for cars and heavy vehicles has been made using the equation in the Waka Kotahi guide
- The combined correction, including the adjustment from $L_{A10(18h)}$ to $L_{Aeq(24hr)}$, has been entered in the modelling software as a total road surface correction.

5.2.6 Safety barriers

Solid (e.g., concrete) safety barriers have been entered in the noise model as 1.0 m high barriers for the Do-Minimum scenario, in locations where they are proposed as part of the design.

5.2.7 Noise barriers

A 2.4m high noise barrier was already included in the reference design between the busway and the residential receivers to the north of the Burswood section by the Project design team. As such, this noise barrier has been considered to be part of the design for the purposes of assessing operational traffic-related noise effects associated with the busway. Figure 5-1 shows the extent of the proposed noise barrier (yellow line).

Figure 5-1 Noise barrier proposed by Project design team

An existing noise barrier at Piccolo Park Botany (415 Tī Rākau Drive) was included in all model scenarios. The noise barrier has an approximate height of 1.8m. The footprint of this noise barrier is shown in Figure **5-2**.

Figure 5-2 Existing noise barrier at Piccolo Park (415 Tī Rākau Drive)

Existing boundary fences of private properties have not been included in the noise model as their condition is unknown and they may not provide effective acoustic shielding. This means that for some properties, the predicted traffic noise levels in the model may be slightly higher than would be experienced in reality. However, the assessment process will identify properties which need new noise barriers erected or existing fences upgraded to provide adequate attenuation, as part of the mitigation appraisal.

5.2.8 Speed limits

A speed limit reduction is planned along the Project extents on Tī Rākau Drive prior to the 2048 design year, under the Do-Nothing scenario (60 km/h to 50 km/h). This speed limit reduction is planned separate to the Project. Therefore, the speed limit change is included in the Do-Nothing and Do-Minimum scenarios.

5.3 Uncertainties and limitations

The predicted road traffic noise levels presented in the following sections are based on a road traffic noise model developed in accordance with NZS 6806 and relevant guidance. The accuracy of the model is largely dependent upon the limitations of the available input data as detailed above. Uncertainties in the modelled noise levels can occur for a number of reasons. Uncertainties are typically related to the effects of topographical screening, appropriateness of the traffic data in terms of volumes of light and heavy vehicles, speeds (observed vs posted) and road surface type.

As stated, the model has been developed by the Project team based on 1 m vertical terrain resolution, which provides sufficient detail to accurately account for any acoustic shielding from localised topographical features.

The traffic data has been sourced from the Project team and it is accepted that the forecasting of future traffic flows may not necessarily reflect the actual flows when the Design Year is reached. The sensitivity of the noise predictions to changes in traffic data is not as significant as the effects of topographical screening. For example, if all other factors of the traffic data remain unchanged (speed and % of heavy vehicles), then a doubling or halving of the traffic data will only result in a 3 dB change which is only just perceptible by most people. A change in traffic volume data by +25 % or -25% will result in a 1 dB change in predicted noise level, which would be imperceptible.

The accuracy of the model can be quoted to a reasonable degree based on known validations of the CoRTN modelling algorithm and comparisons with measured existing noise levels. Generally, road traffic noise levels are quoted with an accuracy within 2 dB.

5.4 Assessment of noise from buses

Noise from buses has been assessed at dwellings adjacent to the busway alignment. Noise effects have then been assessed by comparing the predictions of noise from buses when the busway is constructed against existing ambient noise in the Burswood area.

The prediction algorithm set out in ISO 9613-2:1996 "*Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation*" has been used to predict noise from buses in the future scenario where the busway is constructed, as the CoRTN algorithm that NZS 6806 requires for adoption is not suitable for roads predicted to carry less than 2000 AADT. Noise effects from buses have been assessed based on the predictions of bus noise determined using this algorithm.

Sound power level data were taken from Laib *et al*[6]. This study set out to determine to what extent noise reduction could be achieved in urban areas using electric buses rather than diesel buses. As part of the study, sound power level measurements of an electric bus were taken and compared to sound power level measurements taken of a diesel and hybrid bus. It is understood that the measurements in this study were undertaken in accordance with ISO 10844:2011, which specifies that measurements be undertaken on asphaltic concrete, which is the same road surface finish that will be used for construction of the busway.

It was found in the study that both diesel and electric buses produce the same amount of noise when travelling at a speed of 50 km/h and above, since tyre and wind noise dominates engine noise at these speeds. The sound power level data of a bus travelling at 50 km/h as detailed in the study has been adopted for use in this assessment. This sound power level is equivalent for both a diesel and electric bus and is therefore representative for the whole period over which the bus fleet will transition from diesel to electric buses.

The following inputs were used in order to determine noise from the busway:

- Buses modelled as moving point sources along a line with sound power level of 104 dBA, travelling at 50 km/h, as per measurements set out in Laib *et al*
- Peak bus movements will occur between 7am-8am Monday to Friday as advised by the EBA traffic modelling team. Noise from bus movements during these hours were modelled in order to determine the worst-case $L_{Aeq(1h)}$ metric from the busway.

[6] Felix Laib, Andreas Braun, Wolfgang Rid, Modelling noise reductions using electric buses in urban traffic. A case study from Stuttgart, Germany., Transportation Research Procedia, Volume 37, 2019, Pages 377-384, ISSN 2352-1465, https://doi.org/10.1016/j.trpro.2018.12.206.

All other modelling inputs were the same as those set out in Table 5-1 (except for the calculation algorithm).

Noise levels have been predicted for a representative 15-minute period during the AM peak (7am – 8am) in the morning. The traffic modelling team have advised that the AM peak may occur before 7am (i.e., during the night-time assessment period according to the AUP (OP) noise criteria). Therefore, the worst-case situation where peak bus flows occur before 7am has been assessed.

24-hour L_{Aeq} levels could not be predicted as bus flows were only provided by the traffic modelling team for the AM (6:30am – 9:30am) and PM (3:30pm – 6:30pm) periods.

5.4.1 Noise from Burswood bus station

A bus station is planned near the centre of the Burswood section of the busway as shown in Figure 5-3.

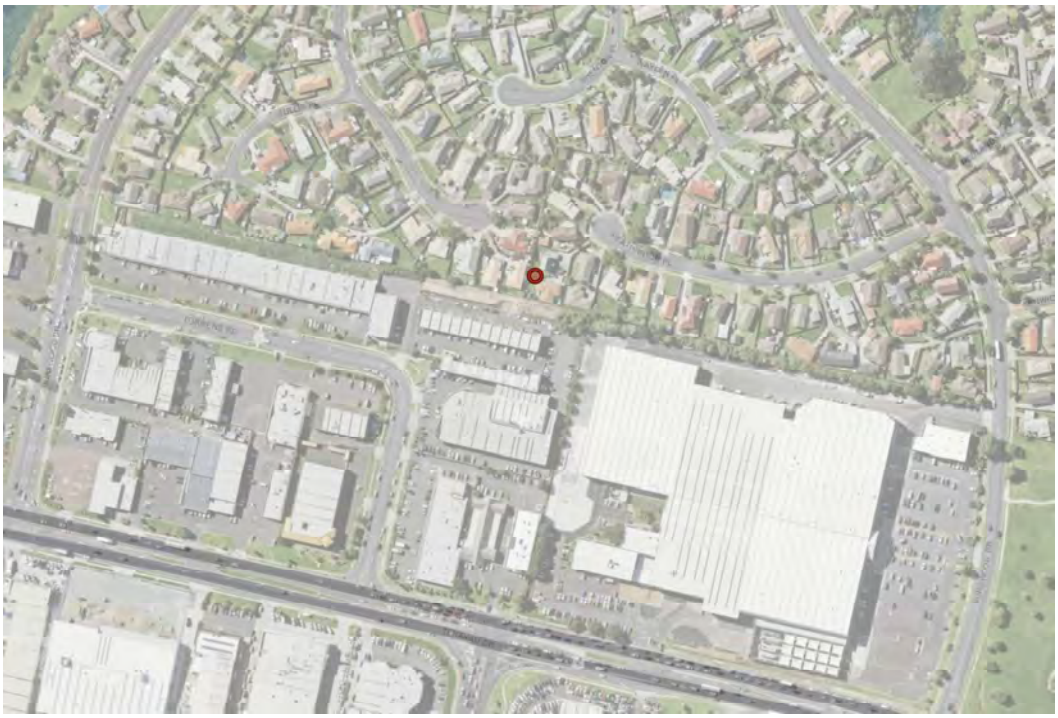


Figure 5-3 Approximate location of Burswood bus station

Generally, the most significant sources of noise at bus stops are when buses are either in idle or pulling away.

Noise from electric buses idling and pulling away will be greatly reduced compared to noise produced by diesel buses.

However, the bus fleet may not be fully electric by the time the Burswood bus station has been constructed. Therefore, the noise predictions consider a worst-case scenario in an interim year where diesel buses are still in use. A sound power level of 90 dBA SWL was used for the diesel buses idling and 100 dBA SWL for diesel buses pulling away.

Noise from buses at the Burswood bus station has been modelled in SoundPLAN 8.2 and has been assessed in Section 6.2 based on two scenarios; one where four diesel buses are idling simultaneously at the station, and one where a diesel bus is pulling away from the station. A reference time interval of 10

minutes was used for the buses idling, and a reference time interval of 10 seconds was used for a bus pulling away.

5.5 Overview of traffic noise effects

5.5.1 Changes in noise level

Adverse noise effects as a result of high levels of traffic noise may include sleep disturbance, loss of concentration, annoyance, a reduction in speech intelligibility and reduced productivity. The effects are not restricted to PPFs but would also affect future residential and other noise-sensitive developments as well which are not included in the NZS 6806 definition of PPF. Where new noise sensitive developments are established in the vicinity of a road, their design should take account of the potential noise effects and care should be taken to avoid or minimise them.

The magnitude of effects will largely depend on noise levels received in noise-sensitive spaces within buildings, although there are also potential annoyance effects associated with a loss of amenity when high noise levels are received in outdoor living or recreation spaces.

The subjective perception can generally be correlated with the numerical change in noise level. A 3 dB change in noise level is just perceptible to the majority of people. A 10 dB increase in noise level is subjectively considered to be a doubling of loudness resulting in a significant impact.

Table 5-2 Noise level change compared with general subjective perception

Noise level change	General subjective perception	Possible effect
1 – 2 decibels	Insignificant change	Negligible
3 – 4 decibels	Perceptible change	Slight
5 – 8 decibels	Noticeable change	Moderate
9 – 11 decibels	Halving/doubling of loudness	Significant
> 11 decibels	More than halving/doubling of loudness	Substantial

5.5.2 Effects from annoyance from traffic noise

People's response to noise can vary based on a number of factors. Research has been undertaken in the past in order to determine quantitively what people's response to noise is based on the level of sound exposure. The results from many of these studies were investigated and summarised as part of the "Environmental Noise Guidelines for the European Region"[7] (the Guidelines), published by the World Health Organisation (WHO). Although the report was developed by the WHO Regional Office for Europe, it can be considered applicable for other regions and is suitable for a global audience.

A key cause of effects from noise covered in the Guidelines is annoyance from road traffic noise. It is useful to understand how many people would be highly annoyed from traffic noise following construction of a given infrastructure project, since annoyance is a well-known effect from traffic noise, and it is estimated to be the second most burdensome health effect due to noise (after sleep disturbance) by the WHO.

[7] Environmental Noise Guidelines for the European Region, 2018, https://www.euro.who.int/__data/assets/pdf_file/0008/383921/noise-guidelines-eng.pdf

Estimation of the number of highly annoyed people from each noise modelling scenario can be used as an indicator of overall traffic noise effects from EB3C/EB4L across the population.

A systematic review and meta-analyses were undertaken (Guski *et al.*, 2017)[8] in order to determine a suitable regression curve to understand the relationship between noise exposure and the percentage of the population that would be considered "highly annoyed" by that noise level (%HA). The regression curve is plotted in Figure **5-4**.

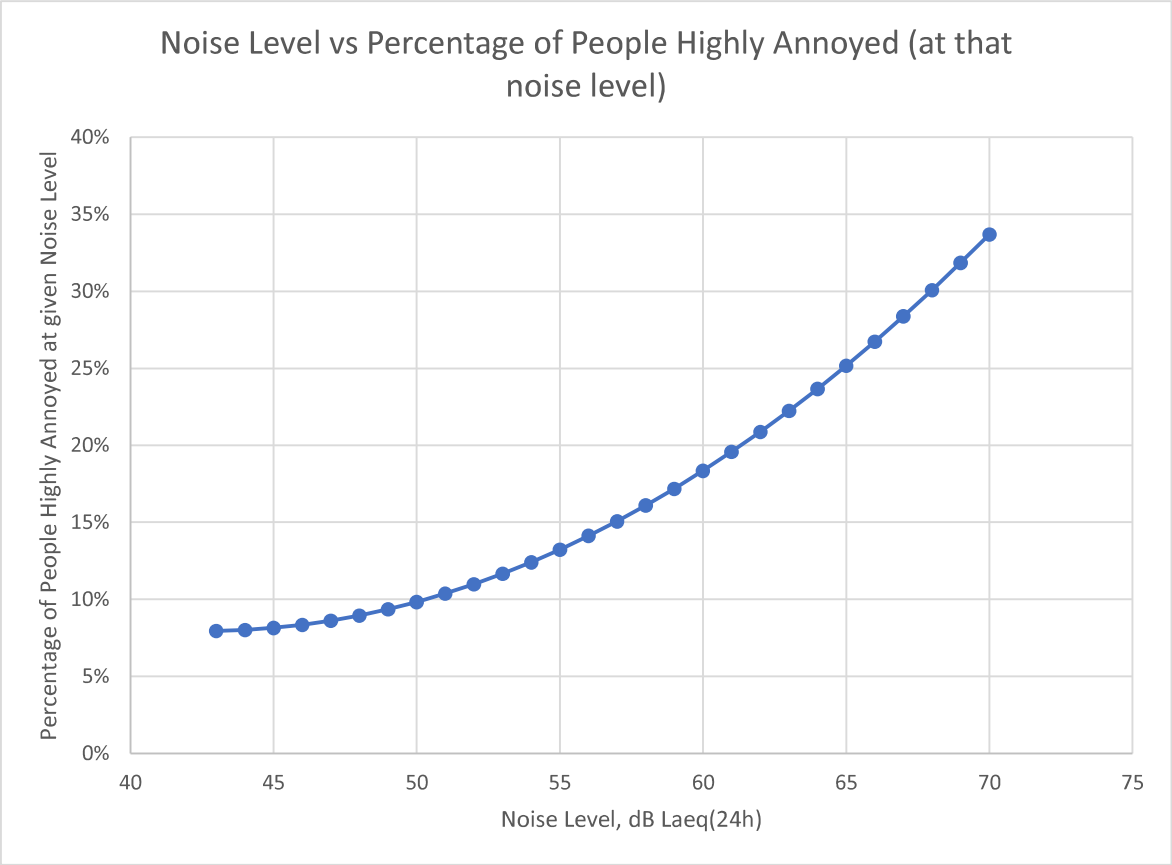


Figure 5-4 Noise level (dB LAeq) vs %Highly Annoyed

[8] Guski R, Schreckenberg D, Schuemer R. WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Annoyance. Int J Environ Res Public Health. 2017 Dec 8;14(12):1539. doi: 10.3390/ijerph14121539. PMID: 29292769; PMCID: PMC5750957.

The equation for the regression equation shown in Figure **5-4** is:

$$\%HA = 78.9270 - 3.1162 \times (L_{Aeq(24h)}+3) + 0.0342 \times (L_{Aeq(24h)}+3)^2$$

Adopting the regression equation, the count of potentially highly annoyed people can be calculated by multiplying the %HA for each noise level by the number of people estimated to be exposed to that noise level. Population estimations per dwelling were derived from information available from Statistics New Zealand[9].

This method was used to estimate the number of people highly annoyed in each modelling scenario (both with and without the project). For this calculation, the noise predictions included the surrounding road network beyond the Project extents. The results of this analysis are provided in Section 7.2.

[9] https://www.stats.govt.nz/information-releases/statistical-area-1-dataset-for-2018-census-updated-march-2020

6 Road Traffic Noise Assessment

Chapter Summary

This chapter presents the results of the traffic noise assessments for EB3C and EB4L. An assessment of road traffic noise along the Tī Rākau Drive section of EB3C was carried out in accordance with NZS 6806, for which it was found that noise mitigation does not need to be considered for this section of EB3C. Results of predictions for noise from buses both travelling along the busway and idling/pulling away from the Burswood bus station are also presented in this section.

This section presents the findings of the NZS 6806 screening assessment, the results of the noise modelling of buses, and the assessment of road traffic noise effects.

6.1 NZS 6806 screening assessment

Predicted road-traffic noise levels at all PPFs for the Existing, Do-Nothing and Do-Minimum scenarios are shown in Appendix C. The cells are colour coded according to the NZS 6806 category: Category A – green, Category B – orange, and Category C – red. A separate column shows the noise level change predicted between the Do-Nothing and Do-Minimum scenarios.

Noise contour maps showing indicative levels across a 200 m radius from the alignment are provided in Appendix D. Specific noise level values should not be taken directly from the contours as they are interpolated from a grid resulting in some localised inaccuracies.

Results are presented for:

- Existing scenario – Noise environment as it currently exists
- Do-Nothing scenario – Noise environment in the design year (2048), assuming that the Project is not built
- Do-Minimum scenario – Noise environment in the design year (2048), assuming that the Project is built.

For the Existing scenario, predicted noise levels at PPFs are between 44 dB $L_{Aeq(24hr)}$ and 67 dB $L_{Aeq(24hr)}$.

For the Do-Nothing scenario, predicted noise levels at PPFs are also between 43 dB $L_{Aeq(24hr)}$ and 66 dB $L_{Aeq(24hr)}$.

For the Do-Minimum scenario, predicted noise levels at PPFs are between 43 dB $L_{Aeq(24hr)}$ and 65 dB $L_{Aeq(24hr)}$.

For the ranges listed above, the highest noise levels are predicted where PPFs front directly towards Tī Rākau Drive, and the lowest noise levels are likely PPFs that are shielded behind other PPFs but still fall within the 100m assessment boundary.

A summary of the results is provided in Table 6-1.

Table 6-1 Summary of EB3C PPF categories

Category	Criteria	EB3C, Number of PPFs		
		Existing	Do-Nothing	Do Minimum
A	64 dB $L_{Aeq(24h)}$	56	56	56

Category	Criteria	EB3C, Number of PPFs		
		Existing	Do-Nothing	Do Minimum
B	67 dB $L_{Aeq(24h)}$	1	1	1
C	40 dB Internal $L_{Aeq(24h)}$	0	0	0
Total		**57**	**57**	**57**

As noted in Section 1.1, in order for the Tī Rākau Drive section of EB3C to qualify as an "altered road" under NZS 6806, one of the following criteria had to be met:

- The Do-Minimum noise environment would be greater than or equal to 64 dB $L_{Aeq(24h)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road traffic noise at that assessment position by 3 dB $L_{Aeq(24h)}$ or more at the design year, when compared with the Do-Nothing noise environment; or
- The Do-Minimum noise environment would be greater than or equal to 68 dB $L_{Aeq(24h)}$ and, if no specific noise mitigation was undertaken, the alterations would increase road traffic noise at that assessment position by 1 dB $L_{Aeq(24h)}$ or more at the design year, when compared with the Do-Nothing noise environment.

As shown in Appendix C, neither of the two criteria above were met at any PPF, therefore NZS 6806 does not apply, meaning that noise mitigation does not need to be considered for the Tī Rākau Drive section of EB3C under NZS 6806. Despite this, mitigation to address any operational noise-related effects from buses was still considered in the following sections.

6.2 Bus noise prediction results

Noise from buses has been predicted in terms of the $L_{aeq(1h)}$ metric at all PPFs along the busway alignment in line with the methodology set out in Section 5.4.

Noise levels from bus movements have been predicted for the AM peak. Note that the noise predictions are applicable across the entire period over which the bus fleet is anticipated to electrify because above a speed of 50 km/h, tyre and wind noise dominates over engine noise, meaning that diesel and electric buses generate the same amount of noise at and above 50 km/h. This means the only difference between diesel and electric bus noise for the purposes of assessment occurs when buses are idling and pulling away from Burswood bus station.

A map showing the predicted bus noise levels for PPFs across EB3C and EB4L has been prepared and is included in Appendix E.

The results of the predictions for noise from buses are presented in Appendix F. An assessment of effects is presented in Section 7.3 for noise from buses along the busway and Section 7.4 for noise from buses idling and pulling away at Burswood bus station.

6.2.1 EB3C

Noise from buses driving along the busway at the most affected PPF in EB3C (28 Burswood Drive) is predicted to reach up to 58 dB $L_{Aeq(15\ min)}$. Noise levels will reduce compared to this at other PPFs. Note that the predictions included the 2.4m high noise barrier as indicated in Section 5.2.7.

Noise from buses idling at the Burswood bus station has been considered in the noise model. The worst-case situation where four diesel buses are idling simultaneously has been considered, with a 50%

duration adjustment applied (as four buses are not expected to idle for more than 5 minutes simultaneously at the bus stop).

Noise levels from buses idling will comply with the daytime Residential zone criterion of 50 dB L_{Aeq} at all PPFs within this zone.

For buses idling, noise levels are predicted to reach:

- 47 dB $L_{Aeq(10min)}$ at 38 Heathridge Place (+7 dB exceedance of the night-time noise criterion)
- 45 dB $L_{Aeq(10min)}$ at 26 Dulwich Place (+5 dB exceedance of the night-time noise criterion)
- 42 dB $L_{Aeq(10min)}$ at 19 Heathridge Place (+2 dB exceedance of the night-time noise criterion)

Noise levels are predicted to be compliant with the night-time criterion at all other PPFs while buses are idling.

Noise from diesel buses pulling away was also considered in the noise model. The situation where one bus is pulling away was modelled, with a 30% duration adjustment applied. This was to account for the short nature of this noise event considered over a reference time interval of 10 seconds.

Noise levels during a given 10-second window during which diesel buses pull away are predicted to reach:

- 51 dB $L_{Aeq(10sec)}$ at 38 Heathridge Place
- 46 dB $L_{Aeq(10sec)}$ at 26 Dulwich Place
- 46 dB $L_{Aeq(10sec)}$ at 19 Heathridge Place
- 45 dB $L_{Aeq(10sec)}$ at 21 Heathridge Place
- 41 dB $L_{Aeq(10sec)}$ at 23 Heathridge Place

Noise levels will reduce at all other PPFs compared to the noise levels listed above.

Noise levels at 28 Torrens Road from buses idling and pulling away are predicted to comply with the 65 dB L_{Aeq} noise criterion for the Business – Light Industry Zone at all times.

6.2.2 EB4L

Noise from buses at the most affected PPFs in EB4L (25 and 27 Cottesmore Place and 175 Guys Road) is predicted to reach up to 48 dB $L_{Aeq(15\ min)}$. Noise levels will reduce compared to this at other PPFs.

7 Assessment of noise effects

Chapter Summary

This chapter provides an assessment of potential noise effects that may arise due to traffic noise after construction of EB3C and EB4L. In summary:

- *Noise levels are predicted to either remain the same or decrease at all PPFs near the Tī Rākau Drive section of EB3C.*
- *The estimated number of highly annoyed people near the Tī Rākau Drive section of EB3C is predicted to decrease through construction of the Project compared to the existing scenario.*
- *Noise from buses along the busway (including along the Burswood section) will be similar to or below existing ambient noise levels across all receivers for both EB3C and EB4L.*
- *Noise from buses idling and pulling away at the Burswood bus station is considered to be reasonable in the context of the existing noise environment while diesel buses are in use, and as the bus fleet electrifies.*

7.1 Noise effects from traffic along Tī Rākau Drive

NZS 6806 does not require consideration of effects in terms of the change in noise environment at any given PPF. To address this gap, the effects associated with the change in noise environment have been considered here in addition to the NZS 6806 assessment.

The Do-Nothing scenario and Do-Minimum scenario can be compared to determine the predicted noise level increase or decrease at PPFs along the EB3C section of Tī Rākau Drive. Figure 7-1 shows the predicted change in noise level at PPFs when comparing the Do-Nothing and Do-Minimum scenarios, along with the noise effect associated with each range of noise level changes (as summarised in Table 5-2).

Appendix C includes columns showing the predicted change in noise level when comparing the Do-Nothing and Do-Minimum scenarios, as well as the expected noise effect, at each PPF.

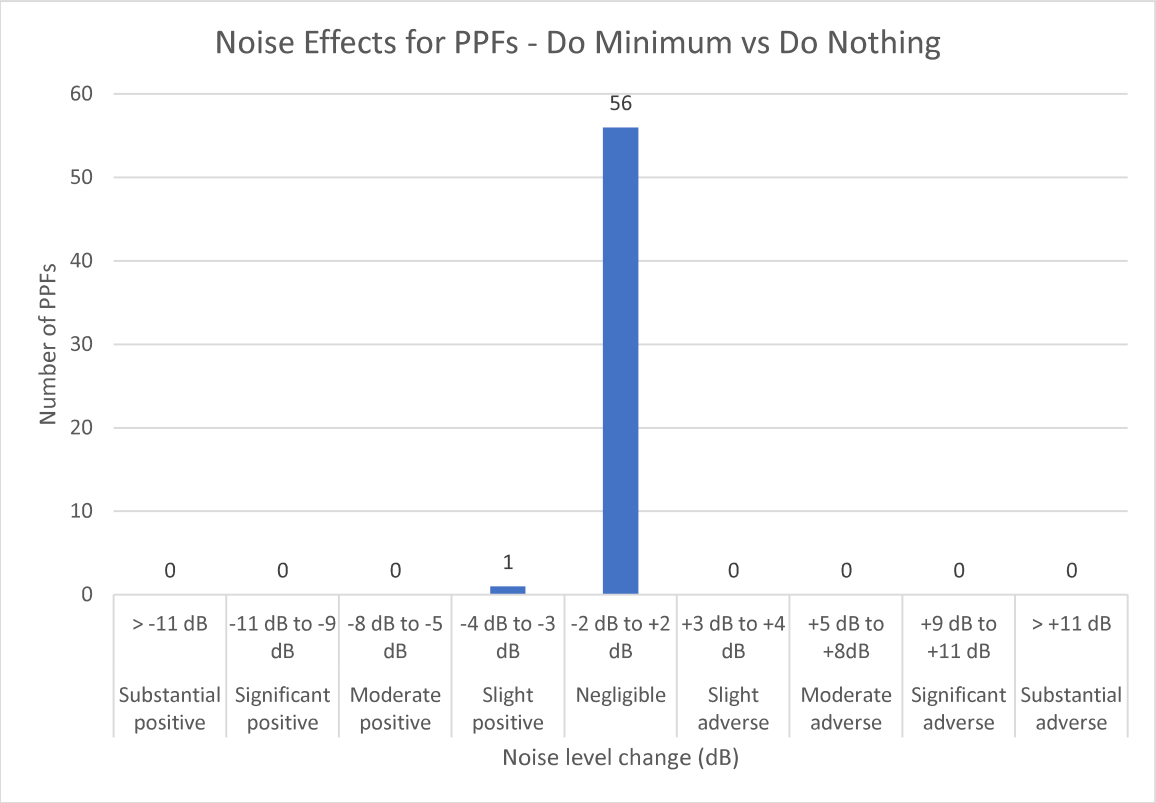


Figure 7-1 Changes in noise level – Do-Nothing Vs Do-Minimum, EB3C

Predictions indicate that changes in noise levels will be negligible at all PPFs.

The only exception is at Piccolo Park, located at 415 Tī Rākau Drive, where slight positive effects are predicted; this is a kindergarten and the assessment position was taken to be the most-exposed location on the playground. Noise levels at this PPF are predicted to reduce in the Do-Minimum scenario due to changes in the position of lanes along Tī Rākau Drive. The number of traffic lanes will reduce and move closer to the playground, which allows noise from the road to be more easily screened by the existing noise barrier.

7.2 Annoyance and other health effects from traffic noise from EB3C section of Tī Rākau Drive

Note that this assessment of annoyance has only been carried out for road traffic noise from the EB3C section of Tī Rākau Drive. Annoyance from traffic noise along the rest of the busway (including the Burswood section of EB3C) could not be calculated because the %HA regression equation we have adopted from the Guidelines (set out in Section 5.5.2) uses 24-hour noise predictions, whereas the data available for bus movements only covered the AM and PM peaks and did not cover bus movements over a 24-hour period. Despite this, noise effects from buses have still been considered and are discussed in Section 7.3.

Using the regression equation set out in Section 5.5.2, the count of people highly annoyed per 2 dB band from 50 dB L_{Aeq} to 70 dB L_{Aeq} has been estimated for the EB3C Tī Rākau Drive section. For this calculation, the entire surrounding road network was considered (in contrast to the predictions summarised in Section 7.1 where the road only within the Project extents was considered). The results are summarised in the table and figure below.

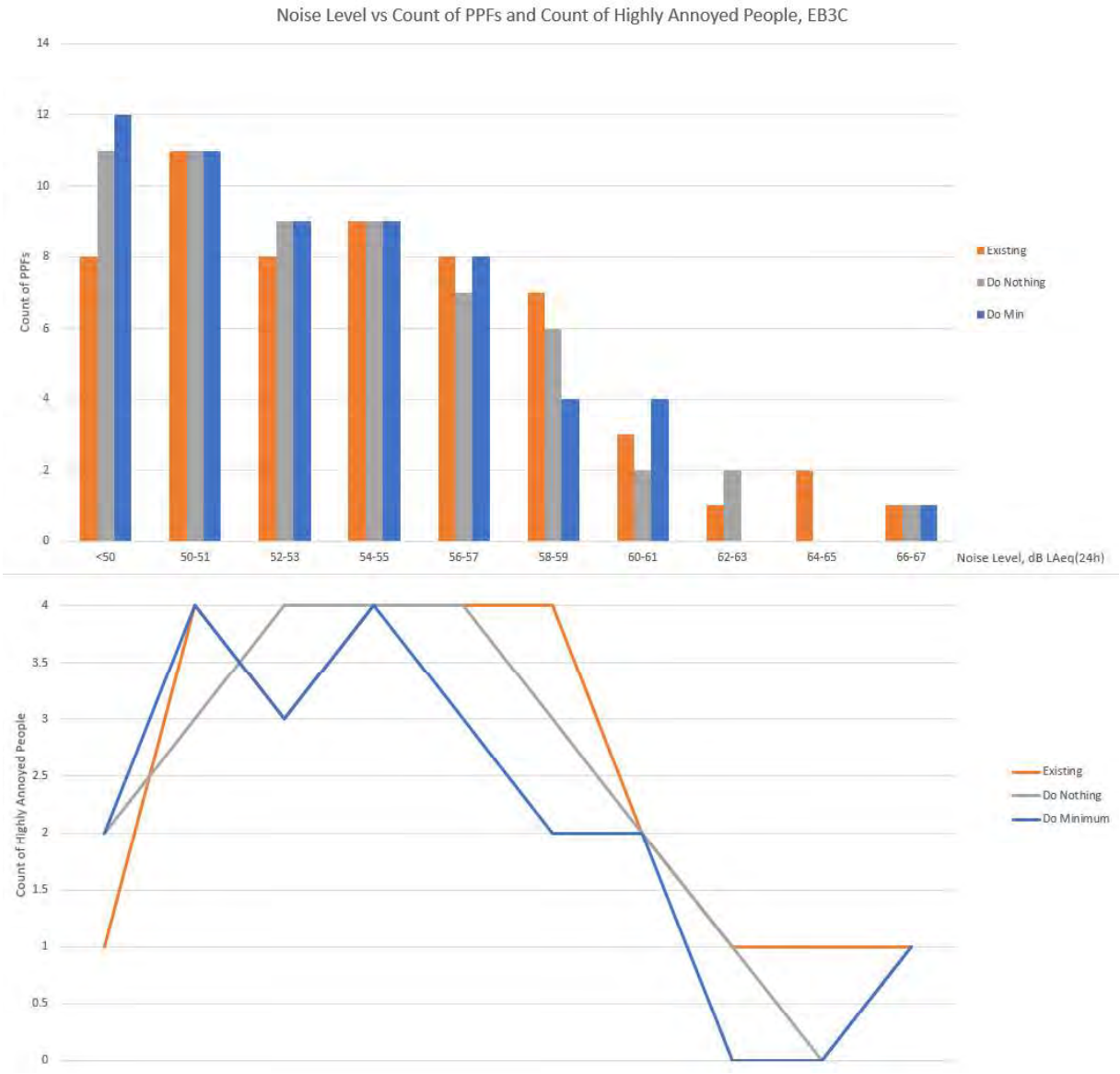


Figure 7-2 Noise level vs count of PPFs and potentially highly annoyed people for EB3C Tī Rākau Drive section

Table 7-1 Count of highly annoyed people per scenario for EB3C Tī Rākau Drive section

Existing	Do-Nothing	Do-Minimum
25	24	21

The results in the table show that with construction of the EB3C Tī Rākau Drive section, the number of highly annoyed people is estimated to reduce from the Do-Nothing scenario. The figure shows that most of the highly annoyed people fall between 50 and 60 dB L_{Aeq}.

We note that the number of highly annoyed people is estimated to reduce by one from the Existing to the Do-Nothing scenario; this is likely due to the planned speed limit decrease along Tī Rākau Drive.

The results above show that the estimated number of highly annoyed people in the local population will reduce compared to the Do-Nothing scenario after construction of EB3C.

The Guidelines summary recommendations recommend that noise levels should be reduced below 50 dB $L_{Aeq(24h)}$. They recommend that "policy-makers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values… [by] reducing noise at both the source and on the route between the source and the affected population by changes in infrastructure".

Noise at the source will be appropriately mitigated through implementation of a low noise road surface, asphaltic concrete AC-14. Construction of noise barriers along Tī Rākau Drive to mitigate traffic noise would be ineffective across a large number of PPFs as their performance would be compromised due to the large gaps needed for driveways.

There is a limit to the level of mitigation that can be applied to operational (road traffic) noise within the designation. Whilst the Project will be maintaining the current low-noise road surface, noise levels at a number of receivers will be above the WHO guidance due to their proximity to the existing roads.

Despite this, Table **7-1** shows that implementation of the Project will likely lead to a lower number of people in the area near the EB3C section of Tī Rākau Drive being annoyed by road traffic noise.

7.3 Noise effects from buses along the busway

The early-morning noise survey results as presented in Section 4.1.3 are re-produced in Table 7-2).

Table 7-2 Measured early-morning noise levels, averaged

Time (15-minute period)	200 Burswood Drive (by existing Burswood Drive)		29 Dulwich Place (near future Burswood bus station)		Guys Reserve	
	dB $L_{Aeq(15min)}$	L_{AFmax}	dB $L_{Aeq(15min)}$	L_{AFmax}	dB $L_{Aeq(15min)}$	L_{AFmax}
6:30 am	54	75	50	70	56	60
6:45 am	57	79	49	69	56	62
7:00 am	57	75	48	76	53	54

The noise predictions for buses travelling along the busway are presented in Appendix F. Noise from the busway is predicted to exceed the daytime and night-time AUP(OP) noise criteria at a number of receivers when measured at the closest residential receivers, through both the Burswood section of EB3C and through EB4L.

However, as shown in the table, ambient noise levels at all measured locations during both the early morning and daytime periods were already measured to be higher than both the daytime and night-

time AUP(OP) noise criteria at two out of the three locations. Therefore, we consider that a more appropriate method to assess noise effects from buses is to compare the predicted noise from buses at PPFs to the measured ambient noise levels from the survey.

Noise predictions were carried out for bus flows during the AM peak and have been compared against measured ambient noise levels between 6:30am and 7:15am for both EB3C and EB4L. During periods of lower bus volumes (e.g. in the afternoon and evening), noise levels from the busway will reduce to levels similar to or below the existing ambient noise levels in the area.

7.3.1 Noise effects from buses – EB3C

Noise levels at 28 Torrens Road from buses travelling along the busway are predicted to comply with the 65 dB L_{Aeq} noise criterion for the Business – Light Industry Zone at all times.

As shown in the noise survey results, ambient noise levels measured during the early morning at 200 Burswood Drive already reach approximately 57 dB $L_{Aeq(15min)}$. This noise level is similar to the worst-case noise levels predicted from buses driving along the busway.

PPFs that are set back from Burswood Drive and Tī Rākau Drive currently experience lower ambient noise levels in the early morning than those generally predicted from traffic noise along the busway in the future, as shown through the measurement of 49 dB $L_{Aeq(15min)}$ at 29 Dulwich Place.

Where PPFs currently front towards Burswood Drive, noise levels from the busway are predicted to be similar or less than existing ambient noise levels. This is shown in Appendix F, where predicted noise levels at PPFs facing Burswood Drive are similar to those that were measured at 200 Burswood Drive. For example, noise levels at 28 Burswood Drive are predicted to reach 58 dB LAeq during the early morning period (the highest predicted noise level from the busway), which is only 1 dB higher than the noise level measured at 200 Burswood Drive. A noise level change of 1 dB would not be perceived. Noise levels at all other PPFs facing Burswood Drive are predicted to be 55 dB L_{Aeq} or below.

Where PPFs are set back from Burswood Drive, noise levels from the busway could be up to 3 dB higher than existing ambient noise levels as measured in the early morning at 29 Dulwich Place. For example, as shown in Appendix F, noise levels at 18 Heathridge Place and 21 Dulwich Place are predicted to reach 51 dB $L_{Aeq(15\ min)}$ in the AM peak. Note that these predicted noise levels are the highest of PPFs that do not already front towards Burswood Drive. Where there would be a predicted noise level increase, this is predicted to be in the order of only 3-4 dB at most, which would be perceived as only a slight increase in noise level (as per Section 5.5.1).

Noise levels from the Tī Rākau Drive section of EB3C are predicted to reach up to 53 dB $L_{Aeq(15min)}$ during the AM peak at 53 Huntington Drive. This is 5-13 dB below the noise levels of 58-66 dB $L_{Aeq(15min)}$ measured at Bard Place Reserve in the 2018 noise survey. Based on this, we consider that noise from the busway will be dominated by existing noise from Tī Rākau Drive and could therefore only change the noise environment at PPFs near the Tī Rākau Drive section of EB3C by a negligible margin.

7.3.2 Noise effects from buses – EB4L

PPFs along Cottesmore Place and Guys Road near the EB4L section of the busway are predicted to experience noise levels up to 48 dB $L_{Aeq(15min)}$ during the AM peak in bus flows. While this noise level is above the night-time 40 dB L_{Aeq} criterion set out in the AUP(OP), it is approximately 5-8 dB below the measured ambient noise levels in the area during the early-morning period. Therefore, we consider that

noise from the busway will be negligible from EB4L at the nearest residential receivers (and Piccolo daycare receiver) when compared to existing ambient noise levels.

7.4 Noise from buses idling and pulling away at the Burswood bus station

Despite the predicted exceedances of the AUP(OP) daytime rules in the residential zone while diesel buses are idling (as set out in Section 6.2), we note that the measured ambient noise levels in the early morning (as set out in Table 7-2) are similar to the predicted noise levels.

To recap, the ambient noise level measured in the area near the Burswood station was 49 dB $L_{aeq(15min)}$ on average across the monitoring period. The highest noise level predicted from diesel buses idling is 47 dB $L_{Aeq(10min)}$ at 38 Heathridge Place, and the noise level during the 10-second window during which a bus would pull away was 51 dB $L_{Aeq(10sec)}$ at the same address. Therefore, noise from buses idling and pulling away is predicted to be reasonable in the context of the existing noise environment, and no further noise mitigation (beyond the noise wall and low noise road surface specified in the reference design) is proposed.

Furthermore, as the bus fleet electrifies, noise levels from buses idling and pulling away will reduce further from the predictions given in Appendix F. Once the bus fleet is fully electric, we expect that all noise from the bus stop will be negligible when compared to the ambient noise environment at the time of operation of the busway.

In summary, we consider that noise from buses idling and pulling away from the Burswood bus station will be reasonable.

7.5 Summary of assessment of noise effects

- Noise from buses along the busway (including the Burswood section) will be similar to or below existing ambient noise levels across all receivers for both EB3C and EB4L
- Noise from buses idling and pulling away at the Burswood bus station is considered to be reasonable in the context of the existing noise environment while diesel buses are in use, and as the bus fleet electrifies
- The Tī Rākau Drive section of EB3C does not meet the definition of an Altered Road under NZS 6806 and therefore does not qualify for further noise mitigation under that standard
- Traffic noise levels are predicted to either remain the same or decrease at all PPFs near the Tī Rākau Drive section of EB3C (as determined through the NZS 6806 assessment of traffic noise)
- The estimated number of highly annoyed people near the Tī Rākau Drive section of EB3C is predicted to decrease through construction of the Project compared to the Do-Nothing scenario.

7.6 Recommended measures to avoid, remedy or mitigate effects

The assessment of traffic noise effects is predicated on the following mitigation measures being implemented:

- Use of a low-noise road surface (asphaltic concrete) across the entire length of the EB3C and EB4L alignment
- Construction of a 2.4m high noise barrier along the northern side of the Burswood section of EB3C between Burswood Drive east and west (as shown in Figure **5-1**).

These mitigation measures are already incorporated into the reference design of EB3C and EB4L.

8 Conclusions

Road traffic noise has been assessed for EB3C and EB4L in accordance with the requirements of the AUP(OP) and NZS 6806.

Noise modelling for the Tī Rākau Drive section of EB3C has been carried out in line with the requirements of NZS 6806, and noise predictions have been carried out for the Existing, Do-Nothing and Do-Minimum scenarios.

The Tī Rākau Drive section of EB3C does not meet the definition of an altered road under NZS 6806, and therefore does not qualify for further consideration of noise mitigation under that standard.

An assessment of noise effects was undertaken for the Tī Rākau Drive section of EB3C, which showed that noise levels are predicted to change by a negligible margin at almost all PPFs as a result of the Project. An assessment of effects from annoyance was undertaken for the same section, which showed that the estimated number of people that will be highly annoyed from traffic noise will reduce compared to the existing scenario.

Noise from buses travelling along the busway is predicted to be similar to existing ambient noise levels across the length of the busway through EB3C and EB4L for the majority of receivers, including along the Burswood section. At EB3C, this is due to both existing road traffic noise from Burswood Drive, and the 2.4 m noise barrier providing screening along the Burswood section. At EB4L, this is due to existing road traffic noise from Tī Rākau Drive and Te Irirangi Drive.

Noise from buses idling and pulling away at the Burswood bus station is predicted to be reasonable when considered in the context of existing ambient noise levels from traffic.

We note that noise mitigation has been built into the design of the busway, through inclusion of the noise wall along the EB3C section of Burswood, and through selection of a low-noise road surface for the busway (asphaltic concrete). These factors contribute to lower noise levels predicted from operation of the busway. Furthermore, noise levels from buses idling and pulling away at the Burswood bus station are predicted to decrease as the bus fleet electrifies.

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				

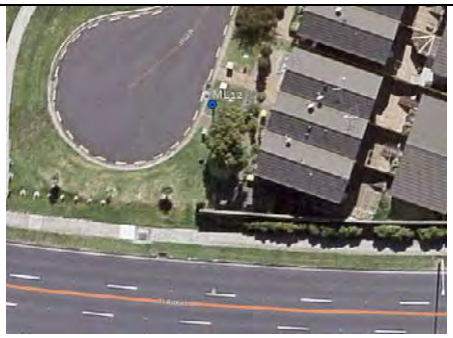


Photo A: View toward the source

Photo B: Photo of the road surface

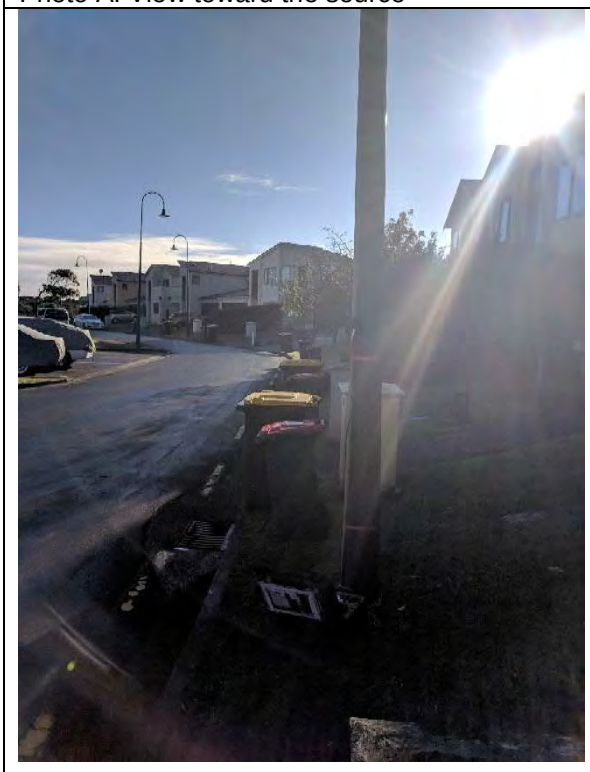
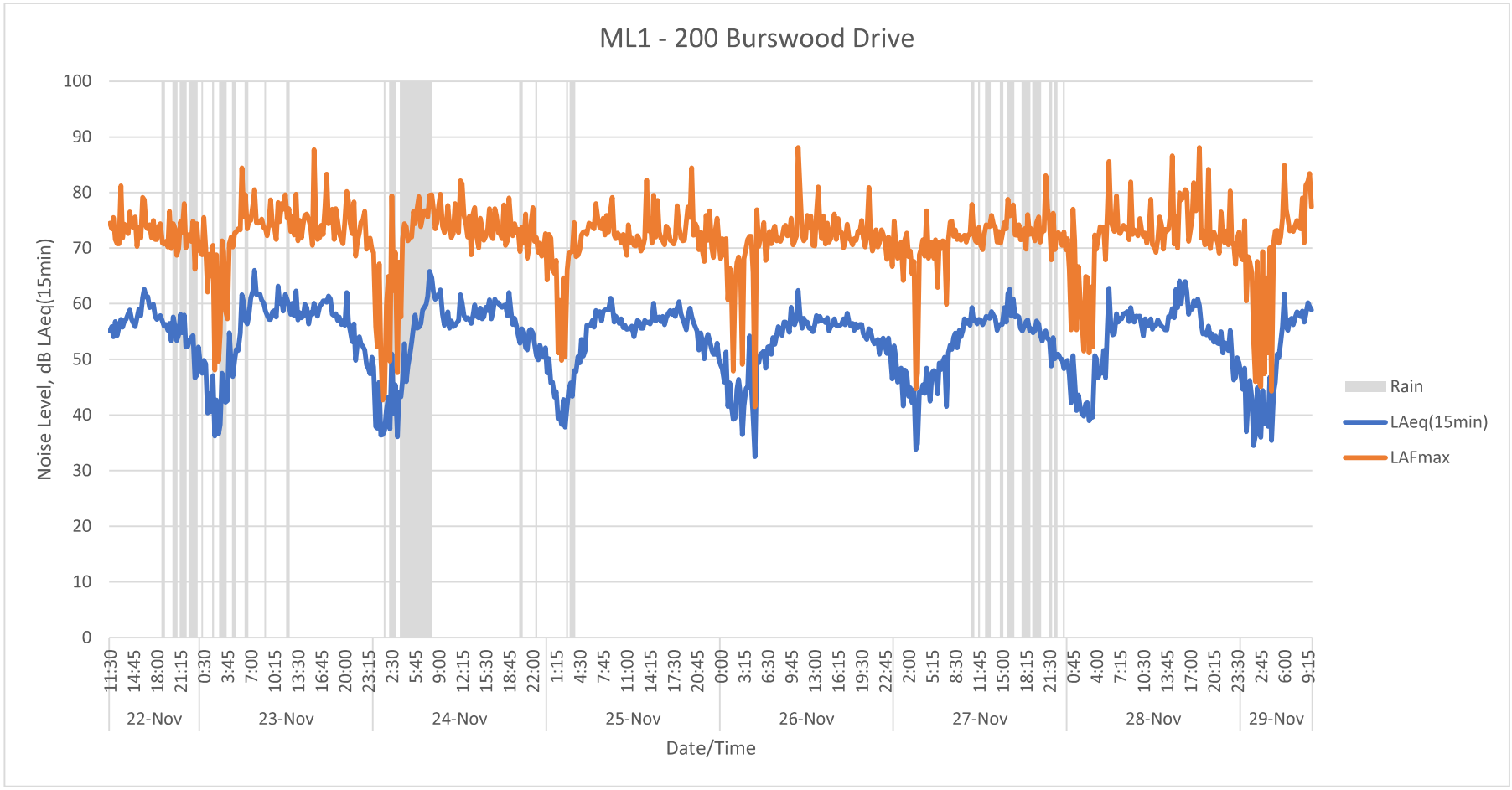
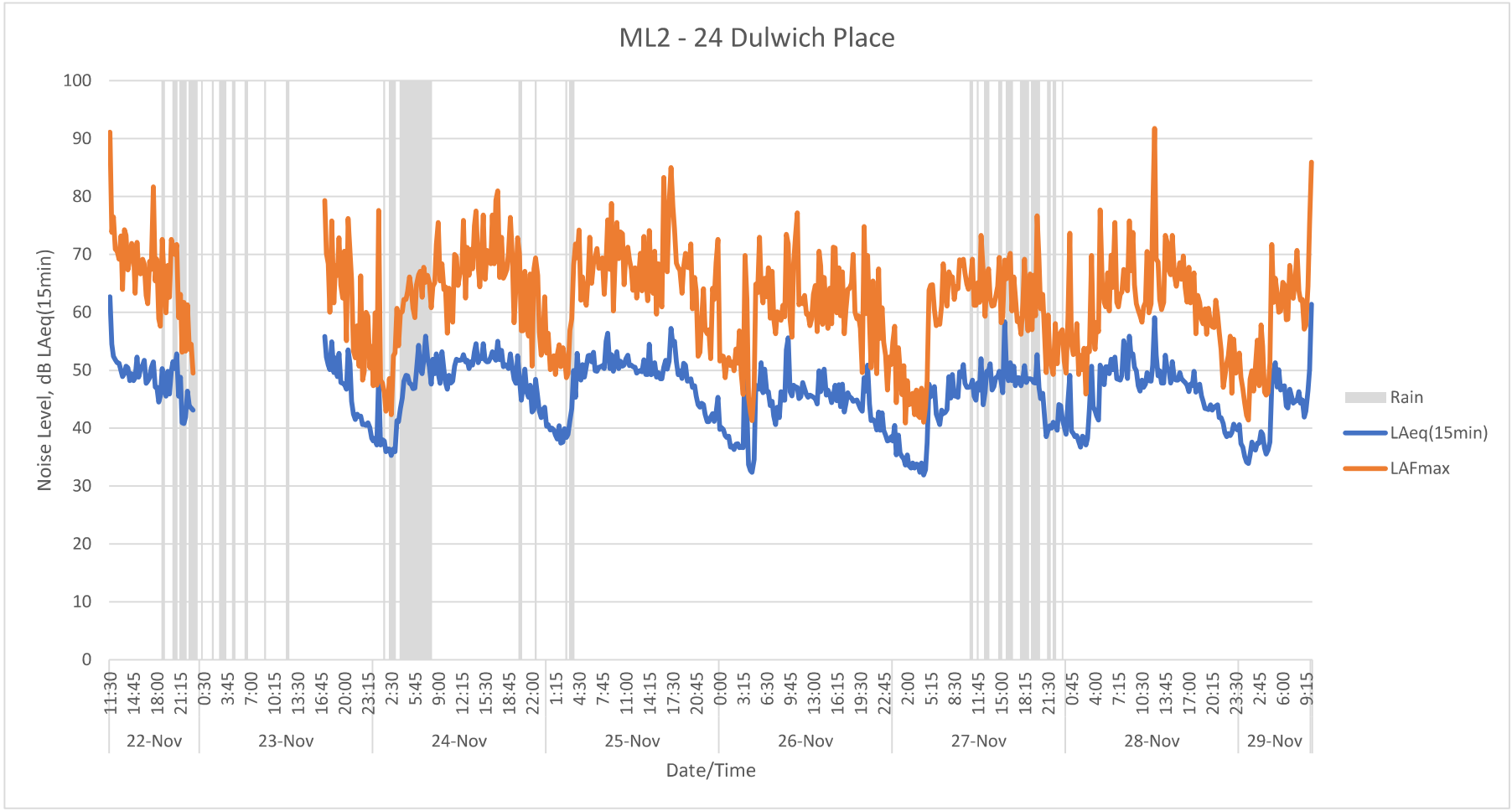


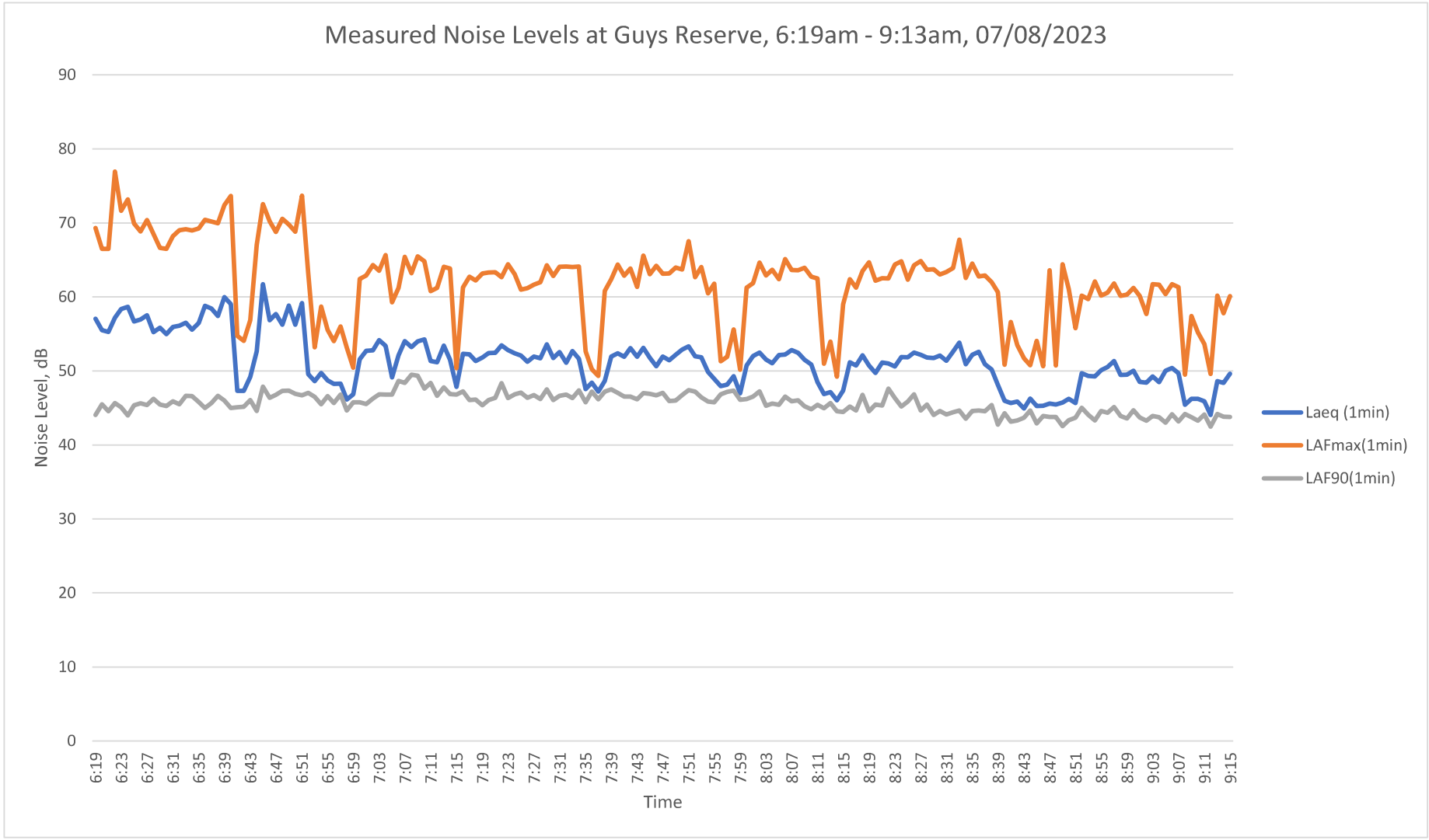
Photo C: Photo of the SLM (angle 1)

Photo C: Photo of the SLM (angle 2)

Appendix B - Noise Monitoring Results


ML1 - 200 Burswood Drive
Noise Level, dB LAeq(15min)
100
90
80
70
60
50
40
30
20
10
0
11:30
14:45
18:00
21:15
0:30
3:45
7:00
10:15
13:30
16:45
20:00
23:15
2:30
5:45
9:00
12:15
15:30
18:45
22:00
1:15
4:30
7:45
11:00
14:15
17:30
20:45
0:00
3:15
6:30
9:45
13:00
16:15
19:30
22:45
2:00
5:15
8:30
11:45
15:00
18:15
21:30
0:45
4:00
7:15
10:30
13:45
17:00
20:15
23:30
2:45
6:00
9:15
22-Nov
23-Nov
24-Nov
25-Nov
26-Nov
27-Nov
28-Nov
29-Nov
Date/Time
Rain
LAeq(15min)
LAFmax


ML2 - 24 Dulwich Place
Noise Level, dB LAeq(15min)
100
90
80
70
60
50
40
30
20
10
0
11:30
14:45
18:00
21:15
0:30
3:45
7:00
10:15
13:30
16:45
20:00
23:15
2:30
5:45
9:00
12:15
15:30
18:45
22:00
1:15
4:30
7:45
11:00
14:15
17:30
20:45
0:00
3:15
6:30
9:45
13:00
16:15
19:30
22:45
2:00
5:15
8:30
11:45
15:00
18:15
21:30
0:45
4:00
7:15
10:30
13:45
17:00
20:15
23:30
2:45
6:00
9:15
22-Nov
23-Nov
24-Nov
25-Nov
26-Nov
27-Nov
28-Nov
29-Nov
Date/Time
Rain
LAeq(15min)
LAFmax


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 - Noise Model Results - NZS 6806 Assessment

Eastern Busway

Address	Existing	Do Nothing	Do Minimum
	Noise level, dB LAeq(24h)		
53 Huntington Drive	67	66	65
66 Tiger Drive	60	59	58
415 Ti Rakau Drive	63	62	60
31-35 Spalding Rise	52	51	51
Piccolo Park Playground	64	63	59
64 Tiger Drive	59	58	58
62 Tiger Drive	59	58	58
6 Bunker Rise	54	53	53
60 Tiger Drive	58	57	57
56-58 Tiger Drive	58	57	57
8 Bunker Rise	53	52	51
51a Huntington Drive	59	58	57
54 Tiger Drive	57	56	56
51 Huntington Drive	55	55	54
118 Huntington Drive	55	55	54
4 Bunker Rise	50	49	48
84 Huntington Drive	54	53	53
116 Huntington Drive	55	54	53
102 Huntington Drive	54	53	53
100 Huntington Drive	54	53	53
98 Huntington Drive	53	52	52
19 Spalding Rise	52	51	51
104 Huntington Drive	53	52	52
17 Spalding Rise	52	51	51
49 Huntington Drive	53	52	52
106 Huntington Drive	53	52	52
96 Huntington Drive	53	52	51
27 Spalding Rise	48	47	47
29 Spalding Rise	50	49	49
114 Huntington Drive	52	51	50
14 Nagle Place	46	45	46
86 Huntington Drive	51	50	50
12 Nagle Place	46	45	45
112 Huntington Drive	51	50	49
45 Huntington Drive	51	50	49
110 Huntington Drive	50	49	49
108 Huntington Drive	50	49	49
25 Spalding Rise	48	47	47
23 Spalding Rise	49	48	48
88 Huntington Drive	50	49	48
82 Huntington Drive	49	48	48
5 Bunker Rise	48	47	47
13 Bunker Rise	48	47	47
7 Bunker Rise	48	47	47
9 Bunker Rise	48	47	47
3 Bunker Rise	48	47	47
64 Huntington Drive	49	48	48
4 Nagle Place	46	45	45
11 Bunker Rise	48	47	47
90 Huntington Drive	49	48	48
15 Spalding Rise	48	47	47
2 Nagle Place	46	45	45
72 Huntington Drive	48	47	47
94 Huntington Drive	48	47	46
92 Huntington Drive	47	46	45
74 Huntington Drive	45	44	43
78 Huntington Drive	44	43	43
80 Huntington Drive	44	43	43

Appendix D - Noise Contour Maps - NZS 6806 Assessment

Legend

Assessment area

PPFs

NonPPFs

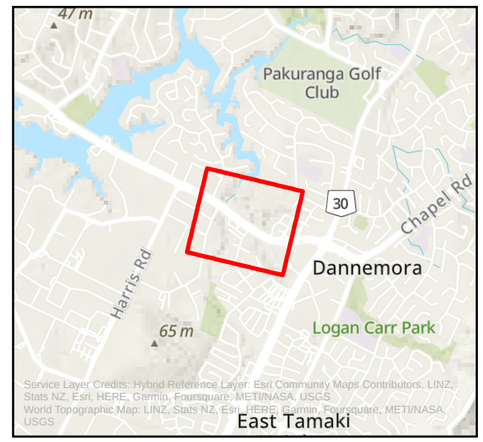
Road Existing

Noise Level, dB LAeq(24h)

- 55-60
- 60-65
- 65-70
- 70+

EB3C Traffic Noise Map
Existing Scenario

0 35 70 140 m



Map Creation Date: 29/03/2023

Author: Shivam Jakhu

Eastern Busway Alliance

Fletcher acciona AECOM Jacobs

Legend

Assessment area

PPFs

NonPPFs

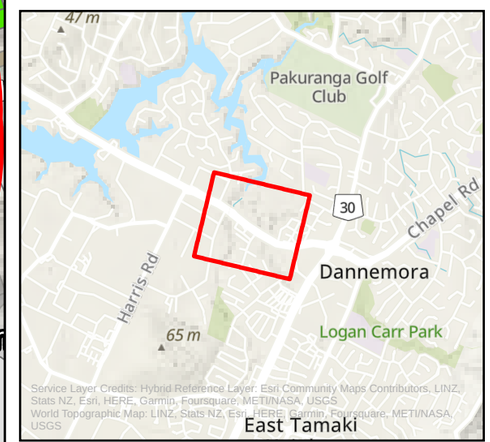
Road DoNothing

Noise Level, dB LAeq(24h)

- 55-60
- 60-65
- 65-70
- 70+

EB3C Traffic Noise Map
DoNothing Scenario

0 35 70 140 m



Map Creation Date: 29/03/2023

Author: Shivam Jakhu

Eastern Busway Alliance

Fletcher acciona AECOM Jacobs

Legend

Assessment area

PPFs

NonPPFs

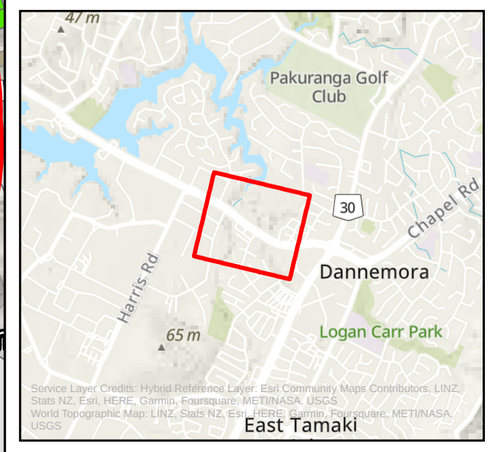
Road DoMinimum

Noise Level, dB LAeq(24h)

- 55-60
- 60-65
- 65-70
- 70-75
- 75+

EB3C Traffic Noise Map
DoMinimum Scenario

0 35 70 140 m



Map Creation Date: 29/03/2023

Author: Shivam Jakhu

Eastern Busway Alliance

Fletcher Acciona AECOM Jacobs

Appendix E - Map of Bus Noise Predictions

Legend

PPFs

NonPPFs

Road

EB3C

EB3C/EB4L Noise Map
Bus Traffic Noise
2048 year

N 0 25 50 100 m

Map Creation Date: 20/03/2023

Author: Shivam Jakhu

Eastern Busway

Legend

PPFs

NonPPFs

Road

EB3C

EB3C/EB4L Noise Map
Bus Traffic Noise
2048 year

N 0 25 50 100 m

Map Creation Date: 20/03/2023

Author: Shivam Jakhu

Eastern Busway

Legend

PPFs

NonPPFs

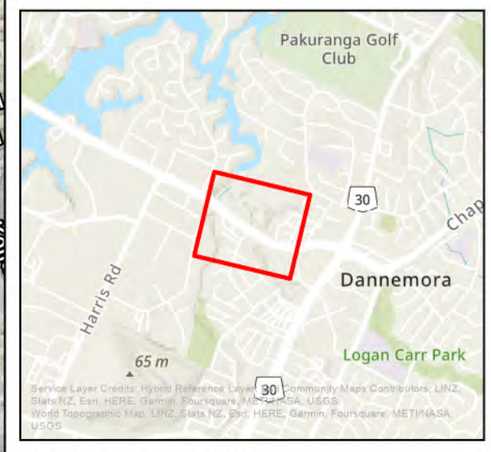
Road

EB3C

EB4L

EB3C/EB4L Noise Map
Bus Traffic Noise
2048 year

N 0 25 50 100 m



Map Creation Date: 20/03/2023

Author: Shivam Jakhu

Eastern Busway

Legend

PPFs

NonPPFs

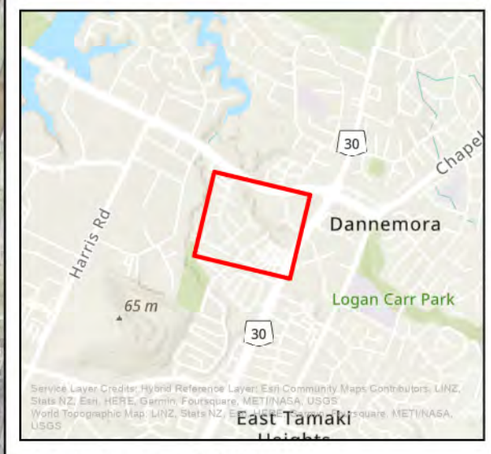
Road

- EB3C
- EB4L

EB3C/EB4L Noise Map
Bus Traffic Noise
2048 year

N

0 25 50 100 m



Map Creation Date: 20/03/2023

Author: Shivam Jakhu

Eastern Busway

Appendix F - Busway Noise Predictions

Address	Noise Level during AM Peak, dB LAeq(15min)
28 Burswood Drive	58
25 Burswood Drive	55
203 Burswood Drive	55
2 Torrens Road	55
53 Huntington Drive	53
5 Midvale Place	52
7 Midvale Place	52
198 Burswood Drive	51
2/203 Burswood Drive	51
415 Ti Rakau Drive	51
18 Heathridge Place	51
21 Dulwich Place	51
27 Burswood Drive	51
3 Midvale Place	50
38 Heathridge Place	50
12 Tullis Place	49
6a Tullis Place	49
19 Dulwich Place	49
1/9 Midvale Place	49
34 Burswood Drive	49
10 Heathridge Place	48
11 Tullis Place	48
26 Dulwich Place	48
175 Guys Road	48
25 Cottesmore Place	48
27 Cottesmore Place	48
196 Burswood Drive	48
51a Huntington Drive	47
36 Burswood Drive	47
9 Midvale Place	47
201 Burswood Drive	47
29 Cottesmore Place	47
19 Heathridge Place	46
66 Tiger Drive	46
20 Dulwich Place	46
1 Kenwick Place	46
17 Heathridge Place	46
22 Dulwich Place	46
32 Cottesmore Place	46
10 Tullis Place	46
31 Cottesmore Place	46
64 Tiger Drive	46
62 Tiger Drive	46
2 Kenwick Place	46
13 Heathridge Place	46
23 Cottesmore Place	45
60 Tiger Drive	45
56-58 Tiger Drive	45
3 Kenwick Place	45
51 Huntington Drive	45
34 Cottesmore Place	45
21 Heathridge Place	45
11 Heathridge Place	45
15 Heathridge Place	45

Address	Noise Level during AM Peak, dB LAeq(15min)
40 Cottesmore Place	45
54 Tiger Drive	45
9 Tullis Place	44
194 Burswood Drive	44
118 Huntington Drive	44
173 Guys Road	44
27 Heathridge Place	44
31-35 Spalding Rise	44
38 Burswood Drive	44
23 Heathridge Place	44
199 Burswood Drive	44
30 Cottesmore Place	44
31 Burswood Drive	44
116 Huntington Drive	44
28 Cottesmore Place	44
100 Huntington Drive	44
98 Huntington Drive	44
102 Huntington Drive	44
26 Cottesmore Place	44
7 Heathridge Place	44
24 Dulwich Place	44
38 Cottesmore Place	43
10 Saidia Place	43
36 Cottesmore Place	43
6 Bunker Rise	43
96 Huntington Drive	43
6 Heathridge Place	43
17 Dulwich Place	43
10 Midvale Place	43
33 Burswood Drive	43
6 Kenwick Place	43
12a Midvale Place	43
38 Davington Way	43
84 Huntington Drive	43
1/5 Kenwick Place	43
49 Huntington Drive	43
188 Guys Road	43
18 Dulwich Place	43
9 Ifield Court	43
104 Huntington Drive	43
8 Saidia Place	43
12 Midvale Place	43
9-17 Waihi Way	43
106 Huntington Drive	42
171 Guys Road	42
197 Burswood Drive	42
8 Bunker Rise	42
35 Burswood Drive	42
7 Ifield Court	42
86 Huntington Drive	42
161 Guys Road	42
8 Heathridge Place	42
8 Tullis Place	42
36 Davington Way	42

Address	Noise Level during AM Peak, dB LAeq(15min)
114 Huntington Drive	42
13 Cottesmore Place	42
90 Huntington Drive	42
88 Huntington Drive	42
60 Kirikiri Lane	42
192 Burswood Drive	42
6 Saidia Place	42
7 Tullis Place	42
5 Heathridge Place	42
195 Burswood Drive	42
15 Dulwich Place	42
25 Heathridge Place	42
6 Midvale Place	42
8 Midvale Place	42
112 Huntington Drive	42
37 Burswood Drive	42
24B Dulwich Place	42
108 Huntington Drive	42
4 Saidia Place	42
3 Ifield Court	42
5 Ifield Court	42
45 Huntington Drive	41
110 Huntington Drive	41
182 Guys Road	41
32 Davington Way	41
48-50 Tiger Drive	41
4 Bunker Rise	41
64 Huntington Drive	41
186 Guys Road	41
52 Tiger Drive	41
92 Huntington Drive	41
19-25 Waihi Way	41
16 Dulwich Place	41
94 Huntington Drive	41
24 Cottesmore Place	41
180 Guys Road	41
190 Burswood Drive	41
3 Tullis Place	41
40 Davington Way	41
10 Cottesmore Place	41
43 Huntington Drive	41
20 Lutana Place	41
14 Kenwick Place	41
2 Heathridge Place	41
3 Heathridge Place	41
7 Kenwick Place	41
62 Huntington Drive	41
22 Cottesmore Place	41
9 Saidia Place	40
58 Kirikiri Lane	40
1 Heathridge Place	40
12 Cottesmore Place	40
60 Huntington Drive	40
56 Kirikiri Lane	40

Address	Noise Level during AM Peak, dB LAeq(15min)
22 Lutana Place	40
9 Heathridge Place	40
47 Davington Way	40
19 Spalding Rise	40
12 Dulwich Place	40
54 Kirikiri Lane	40
178 Guys Road	40
17 Spalding Rise	40
7 Waylen Place	40
5 Kenwick Place	40
30 Davington Way	40
19 Shenton Place	40
18 Cottesmore Place	40
44 Tiger Drive	40
11 Cottesmore Place	40
18 Lutana Place	40
42 Tiger Drive	40