

# BRUNSWICK LEVEL CROSSING REMOVAL

## Operational Noise Assessment

**Prepared for:**

Level Crossing Removal Project (LXRP)

Level 9, 121 Exhibition Street

Melbourne 3000 VIC

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## BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Level Crossing Removal Project (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

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## Executive Summary

SLR Consulting Australia Pty Ltd (SLR) has assessed potential operational noise and vibration impacts associated with the proposed Brunswick Level Crossing Removal Project (Brunswick LXRP).

The assessment framework was established in accordance with *the Passenger Rail Infrastructure Noise Policy* (PRINP) and the Environment Protection Act 2017. Additionally, as the project is being referred under the Environment Effects Act 1978, this report informs an assessment of the operational noise emissions against the Ministerial guidelines for the Environmental Effects Statement (EES).

The existing noise environment is typical of a noise environment observed in inner suburban Melbourne and is generally dominated by rail traffic on the Upfield line, road traffic on roads adjacent to the receivers, along with commercial activities within the vicinity. Considering that there are eight existing level crossings within the project section, along with other pedestrian crossings and three train stations, numerous receivers along the Project currently experience noise effects from level crossing bells and train horns.

The design solution is a new rail bridge and will include new separated cycling and walking paths from Moreland Road (in the north) to Park Street (in the south) between Coburg and Parkville.

Noise modelling was undertaken using a 3-D noise modelling software and best-practice rail modelling algorithm. Conservative modelling inputs and assumptions were applied where possible to predict results for the proposed elevated rail scenario. The outcome of the rail operational noise assessment indicates that predicted noise levels at all receiver locations are below the PRINP investigation thresholds, and hence no exceedances of the PRINP thresholds are identified. A reduction in noise levels to most of the properties adjacent to the corridor is predicted due to the elevated design of the project alignment.

Based on the noise modelling outcomes and consideration to the existing environment, it is predicted that there are no significant adverse effects on substantial numbers of residents, due to extensive or major, long-term changes in noise conditions.

The Brunswick LXRP is also generally not foreseen to introduce any extensive or major adverse effects on the health or well-being of a human community. The existing level crossing bells, and the need for train horns at road crossings will be removed as part of the project, and hence the sensitive receivers adjacent to existing crossings are expected to benefit from the Brunswick LXRP in future.

The vibration screening assessment indicates that any vibration and ground-borne noise impacts (if any) are expected to be improved compared to the existing scenario from further dissipation of vibration energy due to the elevated design of the Brunswick LXRP.

The project proposes to replace three existing stations with two new stations in slightly different locations. This would result in noise environment associated with stations altered in certain locations along the corridor. Whilst there would be a net reduction in station-related noise across the corridor, as the project's detailed design phase progresses, noise emissions from station infrastructure are expected to be considered carefully via detailed acoustic modelling. Key design principles to be considered to minimise station noise emissions, including noise spill from public address system are provided in this report for further consideration. It is envisaged that adequate noise control measures, when implemented in line with General Environmental Duty (GED) requirements, would result in compliance with the established station noise criteria.

The Brunswick LXRP is currently undertaking further design work. It is expected that further acoustic assessments will be undertaken during the detailed design stage to ensure compliance with the project acoustic requirements and targets. LXRP have designed and delivered similar elevated rail level crossing removal solutions in the recent past, and this assessment and recommendations are in line with previous work done by LXRP on comparable projects.

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## 1 Introduction

The Level Crossing Removal Project (LXRP) has engaged SLR Consulting Australia Pty Ltd (SLR) to undertake an operational noise and vibration assessment of the proposed Brunswick Level Crossing Removal Project (Brunswick LXRP). This document provides an overview of the Brunswick LXRP, relevant acoustic requirements, assessment methodology and predicted outcomes for consideration.

The report focusses on the assessment framework, methodology and outcomes associated with the operational noise and vibration aspects of the Brunswick LXRP. Assessments relating to construction noise and vibration are not covered in this report.

## 2 Project Overview

The Victorian Government has committed to removing eight level crossings on the Upfield line, from Albion Street, Brunswick to Park Street, Parkville. The level crossings are located north of the Central Business District and west of Sydney Road, Brunswick. This is an existing railway line with existing impacts (noise, visual, amenity, traffic, safety) within a highly urbanised mixed-use environment.

The design solution is a new rail bridge and will include new separated cycling and walking paths from Moreland Road (in the north) to Park Street (in the south) between Coburg and Parkville.

Between Royal Park Station and Moreland Station works will provide retained earth walls at either end of a 2.1km elevated viaduct. The height of the viaduct will vary but ranges typically between 5-8m above ground level. Also, in this section will be two new train stations (replacing three existing stations) and a new separated cycling and pedestrian paths running the full length of the corridor. An overview of the existing configuration and the future configuration is shown in **Figure 1**.

OFFICIAL: Sensitive

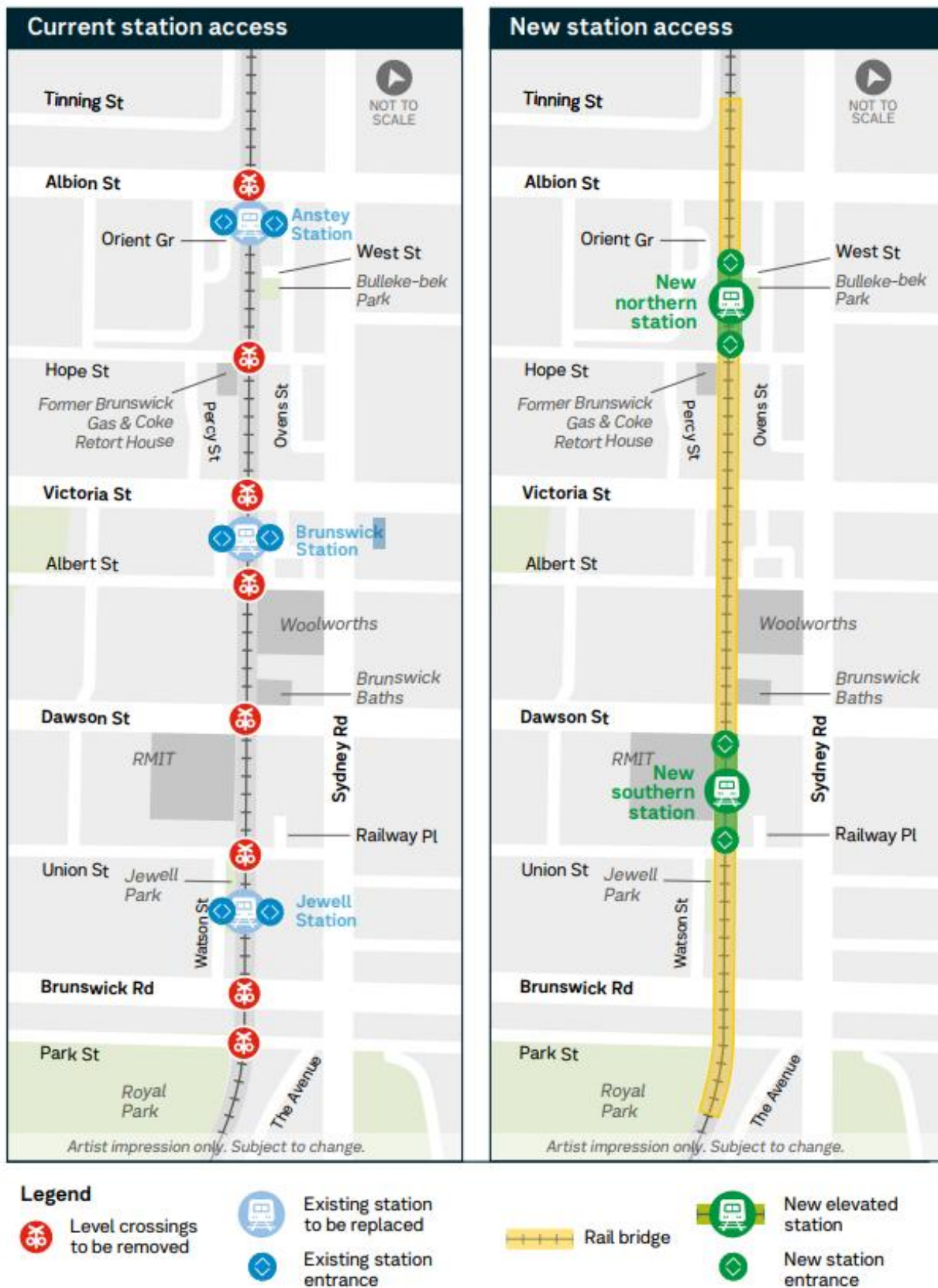


Figure 1 Level Crossing Removals as Part of the Brunswick LXRP

### 3 Sensitive Receivers

Sensitive receivers are locations where noise may cause disturbance or harm to people, such as homes, schools, childcare centres, and other places where individuals live, rest, or learn.

A project study area of approximately 300m on either side of the rail lines was established for this study. Noise levels from rail operations are typically expected to be significantly below the project thresholds (see **Section 5.1**) beyond this offset distance, and hence the study area adopted is deemed appropriate for this study.

The receivers were identified within the project study area via desktop review, and they consisted of the following:

- General residential uses with single dwellings along the alignment. These are generally older buildings within the project study area and are more than 95% of the sensitive receivers identified.
- Multistorey residential buildings, including townhouses and apartments facing the rail corridor which form approximately 5% of the receivers identified.
- Places of worship (less than 1% of the total receivers) such as Kingdom Hall of Jehovah's witnesses adjacent to the rail corridor.
- Educational receivers (less than 1% of the total receivers) including the RMIT University Brunswick campus.
- Aged care and accommodation facilities (approximately 1% of the receivers) including the Hope Aged Care Brunswick.

Note that all identified sensitive receivers as identified in the relevant policies and project requirements (detailed in this report) were considered for the assessment. No schools or hospitals were identified within the study area.

### 4 Existing Acoustic Environment

The existing acoustic environment at receivers adjacent to the rail corridor was quantified via unattended noise monitoring at representative locations along the project study area. The noise environment was observed to be typical for a noise environment observed in inner suburban areas and was generally dominated by rail traffic on the Upfield line, road traffic on roads adjacent to the receivers, along with commercial activities within the vicinity.

Considering that there are eight existing level crossings within the project section, along with other pedestrian crossings and three train stations, numerous receivers along the Project were observed to currently experience noise effects from level crossing bells and train horns.

Unattended noise monitoring was conducted during February 2023 at eight locations (see **Figure 2**) within the study area of the project. Eight locations were selected to provide representative noise monitoring along the corridor, while accounting for changes in background noise levels due to other background noise sources in the study area. The monitoring locations selected are adequate for determining existing noise levels, as well as to allow for calibration of the operational noise model.

Unattended noise monitoring was conducted over a period of 7-8 days. Details of each location and the noise logger used, along with the data are presented in **Appendix A** – note that specific addresses and photos of the noise loggers installed on private property have been removed for privacy reasons. All the noise loggers were calibrated with a NATA approved calibrator, and the measurements were undertaken in general accordance with AS 1055: 2018 *Acoustics - Description and measurement of environmental noise*.

**Table 1 Baseline Noise Monitoring Locations**

Location	Monitoring Address
1	Cameron St, Brunswick
2	Orient Grove, Brunswick
3	Lux Way, Brunswick
4	Wilkinson St, Brunswick
5	Dawson Street, Brunswick
6	Wilson Ave, Brunswick
7	Brunswick Road, Brunswick
8	The Avenue, Parkville



**Figure 2 Baseline Noise Monitoring Locations (Source: NearMaps) - Overview**

All monitoring equipment were generally positioned 1 m from any reflective surfaces (such as building facades or fences) in accordance with rail noise monitoring requirements.

The data for existing noise exposure during the day and night at these monitored locations are provided in **Table 2**. The variability in the measured levels were attributed to the proximity to the road and rail corridors. Note that these noise levels along with measured  $L_{max}$  levels are discussed further in **Section 7.1**.

The existing noise levels are reasonably high at few locations (example – Location 6 and 7) and are above the absolute threshold levels under PRINP (discussed in **Section 5.1.1**).

**Table 2 Existing Noise Levels at Monitored Locations**

No.	Location	Day Leq 16 hr, dBA	Night Leq 8 hr, dBA
1	Cameron St	62	55
2	Orient Grove	56	51
3	Lux Way	62	55
4	Wilkinson St	55	49
5	Dawson Street	61	58
6	Wilson Ave	66	60
7	Brunswick Road	68	62
8	The Avenue	55	45

Note: Leq is the equivalent continuous sound level over a given period of time, e.g. Day - Leq 16 hr, Night - Leq 8 hr. This is commonly referred to as the average noise level.

## 5 Assessment Framework

Different sources of noise are assessed using different criteria within Victoria. For example, noise from operational train movements is assessed to different criteria than fixed mechanical plant at station locations. The following statutory requirements will form the primary assessment framework for the Brunswick LXRP.

### 5.1 Operational Rail Noise Assessment

Passenger rail movements are not assessed against the Environmental Protection Act in Victoria due to the exemption provided in Section 251(B) of the Transport (Compliance and Miscellaneous) Act 1983. Instead, new and upgraded passenger rail infrastructure is assessed as described in the following section. Additionally, as the Brunswick LXRP is being referred under the Environment Effects Act 1978, the assessment also aims to address the following from the Ministerial Guidelines<sup>1</sup>:

*Potential for significant effects on the amenity of a substantial number of residents, due to extensive or major, long-term changes in visual, **noise** and traffic conditions.*

#### 5.1.1 Passenger Rail Infrastructure Noise Policy

Passenger rail noise within Victoria is assessed according to the *Passenger Rail Infrastructure Noise Policy* (PRINP, 2013).

<sup>1</sup> Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978, ed.8, 2023

The PRINP prescribes “investigation thresholds” for the assessment of rail noise impacts. These investigation thresholds are based on both the absolute noise levels and the change in rail noise level due to the project. The PRINP investigation thresholds “are provided to guide transport bodies and planning authorities when assessing the impacts of rail noise on nearby communities and exposure of people to passenger rail noise. They are not a limit on allowable noise emissions.”

The Brunswick LXRP is classified as a “redevelopment of an existing rail corridor” according to the PRINP. The relevant PRINP investigation thresholds are shown in **Table 3** below.

**Table 3 PRINP Investigation Thresholds for Redevelopment of an Existing Rail Corridor**

Time	Type of receiver	Investigation threshold(s), dB(A) external
Day (6am – 10pm)	<ul style="list-style-type: none"> <li>Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks</li> <li>Noise sensitive community buildings including schools, kindergartens, libraries</li> </ul>	65 $L_{Aeq}$ <b>and</b> change in $L_{Aeq}$ of 3 dB(A) or more or 85 $L_{Amax}$ <b>and</b> change in $L_{Amax}$ of 3 dB(A) or more
Night (10pm – 6am)	<ul style="list-style-type: none"> <li>Residential dwellings and other buildings where people sleep including aged person homes, hospitals, motels and caravan parks</li> </ul>	60 $L_{Aeq}$ <b>and</b> change in $L_{Aeq}$ of 3 dB(A) or more or 85 $L_{Amax}$ <b>and</b> change in $L_{Amax}$ of 3 dB(A) or more

### 5.1.2 Design Targets for Mitigation

Noise mitigation measures are considered where the noise levels are predicted to exceed the PRINP investigation thresholds shown in **Table 3**. Project Noise Level Targets (PNLTs) are used as the design targets for noise mitigation measures. Note that these are not mandatory limits, but targets to minimise noise, subject to mitigation measures being reasonable and feasible as guided by PRINP.

The PNLTs for the project are either the absolute threshold values under the PRINP or reducing the increase in noise levels to less than 3 dBA, whichever results in the best value for money for the public and the State. These targets are shown in **Table 4** below.

**Table 4 Project Noise Level Targets (PNLTs)**

Parameter	Project Noise Level Target (external)
Day period ( $L_{Aeq,16hr}$ ) noise level	65 dBA OR Increase in noise level to < 3 dBA compared to existing level
Night period ( $L_{Aeq,8hr}$ ) noise level	60 dBA OR Increase in noise level to < 3 dBA compared to existing level
$L_{Amax}$ noise level	85 dBA OR Increase in noise level to < 3 dBA compared to existing level

## 5.2 Station Operational Noise Assessment

### 5.2.1 Environment Protection Act 2017

The station operational assessment is required to identify compliance with the Environment Protection Act 2017 (EP Act) which came into effect in July 2021. The EP Act includes general environmental duty (GED) at its centre and it applies to all Victorians. GED requires that you must reduce the risk of harm from your activities:

- to human health and the environment
- from pollution or waste.

The expectation is that you will manage your activities to minimise the risk of harm to human health and the environment so far as reasonably practicable

#### 5.2.1.1 General Environmental Duty

GED requires proactive steps to be taken to eliminate or reduce the risk of harm to human health and the environment from pollution or waste. GED applies at all times, for any activity within commercial, industrial and trade premises, posing a risk of harm to human health and the environment.

The following sections of the EP Act apply to GED:

- Section 25(1) of the EP Act states that a person who is engaging in an activity that may give rise to risks of harm to human health or the environment from pollution must minimise those risks so far as reasonably practicable.
- Section 6 of the EP Act states that minimising risks of harm to human health and the environment requires the duty holder to eliminate risks of harm to human health and the environment so far as reasonably practicable and, if it is not reasonably practicable to eliminate those risks, then reduce those risks as far as reasonably practicable.
- Section 6(2) of the EP Act states factors to give regard to when determining what is reasonably practicable in relation to the minimising of risks to harm to human health and the environment.

The methodology in the design process to minimise noise shall involve consideration of all reasonably practicable measures as guided by *EPA Publication 1856 – Reasonably Practicable*, (September 2020). The guideline provides guidance as to the factors to consider when defining proportionate controls to minimise harm, as follows:

- Eliminate first: Can you eliminate the risk?
- Likelihood: What's the chance that harm would occur?
- Degree (consequence): How severe could the harm be on human health or the environment?
- Your knowledge about the risks: What do you know, or what can you find out, about the risks your activities pose?
- Availability and suitability: What technology, processes or equipment are available to control the risk? What controls are suitable for use in your circumstances?
- Cost: How much does the control cost to put in place compared to how effective it would be in reducing the risk?

The items above shall be considered when assessing the suitability of noise mitigation measures for the project. Any residual risks of harm shall then be compared against the Noise Protocol limits (as discussed in **Section 5.2.1.4**) and factors defined as unreasonable noise under the EP Act. If exceedances against Noise Protocol limits or unreasonable noise are still predicted, further mitigation measures shall be designed and implemented to ensure compliance with the noise emission requirements.

### 5.2.1.2 Environmental Reference Standards

The Environmental Reference Standard (ERS) is a new tool made under the EP Act. The ERS:

- identifies environmental values that the Victorian community want to achieve and maintain, and
- provides a way to assess those environmental values in locations across Victoria.

The ERS is made up of four main components in relation to ambient sound:

- **Environmental values:** These are the central parts of the ERS. An environmental value is a statement about a desired outcome for human health and the environment. For example, an ambient sound environment that supports child development and learning. Environmental values are the uses, attributes or functions of the environment that the Victorian community wants to achieve and maintain.
- **Areas of application:** The ERS defines the area or areas to which the environmental values, or specific indicators and objectives, apply. For example, most ambient sound indicators and objectives relate to specified land use planning zones.
- **Indicators:** These are usually defined in relation to each environmental value. The indicators are the parameters or markers used to assess whether environmental values are being achieved or maintained, or if they are threatened. For example ‘outdoor LAeq’ (‘outdoor LAeq,16h from 6 am to 10 pm’ or ‘outdoor LAeq,8h from 10 pm to 6 am’), which is a key indicator used for ambient sound (ERS Table 3.3).
- **Objectives:** These are the assessment benchmarks. An objective is the character, level, load, concentration or amount of an indicator used to assess whether an environmental value (or several environmental values) is being achieved, maintained or threatened. Most objectives are scientifically derived quantitative assessment levels or a prescribed scientific basis for assessment. For example, the ambient sound objective for ‘natural areas’ is ‘a sound quality that is conducive to human tranquillity and enjoyment having regard to the ambient natural soundscape’ (ERS Table 3.3).

**Table 5** presents the ERS environmental values relating to the ambient sound environment.

**Table 5 ERS Environmental Values Relating to the Ambient Sound Environment**

Environmental Value	Description of Environmental Value
Sleep during the night	An ambient sound environment that supports sleep at night
Domestic and recreational activities	An ambient sound environment that supports recreational and domestic activities in a residential setting
Normal conversation	An ambient sound environment that allows for a normal conversation indoors without the need to raise voices
Child learning and development	An ambient sound environment that supports cognitive development and learning in children

Environmental Value	Description of Environmental Value
Human tranquillity and enjoyment outdoors in natural areas	An ambient sound environment that allows for the appreciation and enjoyment of the environment for its natural condition and the restorative benefits of tranquil soundscapes in natural areas
Musical entertainment	An ambient sound environment that recognises the community's demand for a wide range of musical entertainment

For the purposes of 'areas of application' the ERS outlines a framework for assessing the ambient sound environment over a period of time based on the land use category of the area of assessment. **Table 6** presents the land use categories relating to the ambient sound environment.

**Table 6 Land Use Categories for the Ambient Sound Environment**

Land use Category	General Description	Planning Zones
Category I	An urban form with distinctive features or characteristics of taller buildings, high commercial and residential intensity and high site coverage.	Industrial Zone 1 (IN1Z) Industrial Zone 2 (IN2Z) Port Zone (PZ) Road 1 Zone (RDZ1) Capital City Zone (CCZ) Docklands Zone (DZ)
Category II	Medium rise building form with a strong urban or commercial character. Typically contains mixed land uses including activity centres and larger consolidated sites, and an active public realm.	Industrial Zone 3 (IN3Z) Commercial 1 Zone (C1Z) Commercial 2 Zone (C2Z) Commercial 3 Zone (C3Z) Activity Centre Zone (ACZ) Mixed Use Zone (MUZ) Road 2 Zone (RDZ2)
Category III	Lower rise building form including lower density residential development and detached housing typical of suburban residential settings or in towns of district or regional significance.	Residential Growth Zone (RGZ) General Residential Zone (GRZ) Neighbourhood Residential Zone (NRZ) Urban Floodway Zone (UFZ) Public Park and Recreation Zone (PPRZ) Urban Growth Zone (UGZ)
Category IV	Lower density or sparse populations with settlements that include smaller hamlets, villages and small towns that are generally unsuited for further expansion. Land uses include primary industry and farming.	Low Density Residential Zone (LDRZ) Township Zone (TZ) Rural Living Zone (RLZ) Green Wedge A Zone (GWAZ) Rural Conservation Zone (RCZ) Public Conservation and Resource Zone (PCRZ) Green Wedge Zone (GWZ) Farming Zone (FZ) Rural Activity Zone (RAZ)

Land use Category	General Description	Planning Zones
Category V	Unique combinations of landscape, biodiversity and geodiversity. These natural areas typically provide undisturbed species habitat and enable people to see and interact with native vegetation and wildlife	Natural areas are classified as land within Category V irrespective of the planning zones that apply to that land.
Category I, II, III or IV depending on surrounding land uses and the intent of the specific planning zone (which may have a diversity of uses) as specified in a schedule to the planning zone		Comprehensive Development Zone (CDZ) Priority Development Zone (PDZ) Special Use Zone (SUZ) Public Use Zone (PUZ)

For the ambient sound environment, for each land use category, the ERS sets out indicators and objectives. The objectives for each land use category are typical ambient sound level values and are neither noise limits nor noise design criteria. **Table 7** presents the indicators and objectives relating to the ambient sound environment.

**Table 7 Indicators and Objectives for the Ambient Sound Environment**

Land use Category	Indicators	Objectives
Category I	Outdoor LAeq,8h from 10pm to 6am	55 dBA
	Outdoor LAeq,16h from 6am to 10pm	60 dBA
Category II	Outdoor LAeq,8h from 10pm to 6am	50 dBA
	Outdoor LAeq,16h from 6am to 10pm	55 dBA
Category III	Outdoor LAeq,8h from 10pm to 6am	40 dBA
	Outdoor LAeq,16h from 6am to 10pm	50 dBA
Category IV	Outdoor LAeq,8h from 10pm to 6am	35 dBA
	Outdoor LAeq,16h from 6am to 10pm	40 dBA
Category V	Qualitative	A sound quality that is conducive to human tranquillity and enjoyment having regard to the ambient natural soundscape

### 5.2.1.3 Noise and Long-term Health

The *enHealth* 2018 document titled ‘*The health effects of environmental noise*’ by the Australian Department of Health has undertaken a comprehensive review of all available information that correlate noise levels with potential health effects. The study concludes the following:

*There is sufficient evidence of a causal relationship between environmental noise and both sleep disturbance and cardiovascular disease to warrant health-based limits for residential land uses:*

- *During the night-time, an evidence based limit of 55 dB(A) at the facade using the Leq,night, or similar metric and eight-hour night-time period is suggested.*
- *During the day-time, an evidence based limit of 60 dB(A) outside measured using the Leq,day, or similar metric and a 16 hour day-time period is suggested.*

Based on the report conclusions and limited correlations quoted in the report between noise levels and health effects, a day-time target of 60 dB  $L_{Aeq, 16\text{ hr}}$  and night-time target level of 55 dB  $L_{Aeq, 8\text{ hr}}$  is deemed by SLR as the target to assess long-term health effects for this project that are assessable under the EP Act (such as the Station infrastructure). These levels are higher than the noise limits established in **Section 5.2.1.4**, and hence achieving compliance with the Noise Protocol is expected to meet the minimum thresholds recommended by the *enHealth* guideline.

### 5.2.1.4 The Noise Protocol

Subordinate legislation – the Environment Protection Regulations 2021 (Regulations) and Environment Reference Standard (ERS) – have been released to support the new environment protection laws. The Regulations incorporate the “*Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues, Publication 1826*” (the Noise Protocol).

The Noise Protocol sets noise limits at sensitive land uses and there are separate noise limits for the day, evening, night and weekends, with the lowest limits normally applying at night. Definitions of day, evening and night periods used for determining noise limits under the Noise Protocol are provided in the Environment Protection Regulations, paragraph 116 and are reproduced in **Table 8**.

Under the Noise Protocol, noise limits are based on the land-use zoning of the area surrounding the residence, as defined by the relevant authority (see **Appendix B**), and on the measured background noise levels at the residence when those levels are especially high or low.

The Noise Protocol requires noise from fixed infrastructure (such as HVAC systems and generators) to be assessed for a 30-minute period and to be adjusted for character, including tonality, intermittency and duration. The adjusted noise level is compared with the noise limit to determine whether or not the premise complies with the limits.

**Table 8 Noise Protocol Definitions of Day, Evening and Night Periods for Commercial Noise**

Period	Day	Evening	Night
Monday to Saturday	7 am to 6 pm	6 pm to 10 pm	10 pm to 7 am the following day
Sunday and public holidays		7 am to 10 pm	

There are currently two new stations proposed along the study area – the new station in Brunswick north and the new station in Brunswick south. These station precincts are shown in **Figure 3** and **Figure 4** along with a representative nearest sensitive receiver for each station.



Figure 3 Location of Brunswick South Station



Figure 4 Location of Brunswick North Station

The noise-sensitive receiver used for the assessment for Brunswick South Station is identified to be in Union Street. Note that there are other sensitive receivers adjacent to the station (including the RMIT University) but the chosen sensitive receiver is the potentially most affected based on the noise limits established in accordance with the Noise Protocol. The established noise limits at this location will apply to all surrounding sensitive receivers around this proposed station to provide conservative noise limits (lower noise limits).

The noise-sensitive receiver used for the assessment for Brunswick North Station is identified to be on Bryant Street. Note that whilst there are other adjacent sensitive receivers nearby as identified in **Section 3**, the determined zoning levels on the chosen receiver is potentially the most stringent based on the noise limits established in accordance with the Noise Protocol. The established noise limits at this location will apply to all surrounding sensitive receivers around this proposed station to provide conservative noise limits (lower noise limits).

The zoning area within the required 70 m and 200 m radius from these properties are identified to be influenced by the residential development zones (Type 1), with influences from industrial, commercial, mixed use and transport zones.

Unattended noise monitoring has been undertaken at eight locations within the study area (see **Section 4**). Out of these locations, Location 5 (Dawson Street) was used to assess background noise levels within the proposed Brunswick South Station precinct, and Location 2 (Orient Grove) was used to assess background noise levels within the proposed Brunswick North Station precinct. The daily measured noise data at these locations are presented in **Appendix A**.

The determined zoning levels and established Noise Protocol noise limits are provided in **Table 9** and **Table 10**. The limits are assumed to be applicable to all sensitive receivers within the surrounds of the respective station areas for assessment purposes.

**Table 9 Noise Limits for Commercial Industrial and Trade Noise Emissions – Brunswick South Station**

Description	Noise Protocol Commercial and Trade Noise Limits (dBA)		
	Day (Mon – Sat; 7am – 6pm)	Evening (Mon – Sat; 6pm – 10pm) (Sun; 7am – 10pm)	Night (10pm – 7am)
Zoning Level	59	52	47
Background Level (L <sub>90</sub> )	49	45	41
Background classification	Neutral	Neutral	Neutral
<b>Noise Limit (L<sub>eq, 30min</sub>)</b>	<b>59</b>	<b>52</b>	<b>47</b>

**Table 10 Noise Limits for Commercial Industrial and Trade Noise Emissions – Brunswick North Station**

Description	Noise Protocol Commercial and Trade Noise Limits (dBA)		
	Day (Mon – Sat; 7am – 6pm)	Evening (Mon – Sat; 6pm – 10pm) (Sun; 7am – 10pm)	Night (10pm – 7am)
Zoning Level	54	48	43
Background Level (L <sub>90</sub> )	40	38	33
Background classification	Low	Low	Low
<b>Noise Limit (L<sub>eq, 30min</sub>)</b>	<b>52</b>	<b>46</b>	<b>41</b>

#### 5.2.1.5 Station PA Noise Emissions

The noise from human voice (e.g. passengers) are not assessed under the Noise Protocol. However, amplified voice via the PA systems is understood to be assessable under the Noise Protocol. Noise emissions from Station PA systems should be designed to be minimise so far as reasonably practicable.

Station PA noise thresholds for single announcements at the closest receivers were calculated based on preliminary assumptions around the number of announcements and the duration of each announcement. The established noise thresholds are presented in **Table 11**. These single announcement noise thresholds should be considered cumulatively with the noise emissions from any station building services, and as such, may need to be reviewed subject to the building services design. These Station PA thresholds are not set to achieve inaudibility at the closest receivers, but are established in accordance with the EPA Regulations.

**Table 11 Environmental Noise Spill Targets for Station PA**

Station	Noise Protocol Night Limit (L <sub>eq, 30 min</sub> dBA)	Number of Announcements	Duration of Each Announcement	Noise Threshold for a Single Announcement at the Closest Receiver (L <sub>eq, dBA</sub> )
Brunswick South Station	47	6	30 seconds	57
Brunswick North Station	41	6	30 seconds	51

Station PA systems will also have requirements associated with speech intelligibility and sound coverage across the platform and concourse areas. These aspects are not covered within this report, and these design requirements will be covered as part of the MTM OCS design package.

#### 5.2.1.6 Low Frequency Noise Guidelines

*EPA Publication 1996: Assessing low frequency noise* (June 2021) is a guideline document and applies to noise from commercial, industrial or trade premises.

It is stated within EPA Publication 1996:

*Sensitivity to sound varies greatly between individuals. The person investigating low frequency noise may not hear the sound that someone has reported. However, it may be audible by others. The perceived loudness of low frequency sounds increases rapidly with increasing noise level (measured in decibels). This means low frequency sounds only just above the threshold of hearing can be perceived as loud by some people (Moorhouse, Waddington and Adams 2011). This doesn't mean that any audible sound is unreasonable.*

*Characteristics that can increase the effects of low frequency noise, particularly how disturbing it is, include:*

- *the presence of tones (a sound with energy concentrated at one or two single frequencies, often described as a drone or hum)*
- *fluctuating noise level (rapid increase and decrease in noise level)*
- *frequency modulation (small variations in the frequency of the noise)*
- *rattles or vibration caused by low frequency noise.*

*Low frequency noise with tones can induce greater fatigue and can interfere with task performance more than low frequency noise without tones or with the tones masked by other noise (Leventhall, 2003).*

The assessment of low frequency noise using this Publication 1996 is separate from an assessment for compliance with the regulatory noise limits. Table 3 of Publication 1996 provides free-field, noise threshold criterion that the EPA recommends for outdoor measurements. These threshold levels are not set limits, rather, they are levels that if exceeded indicate a potential risk of problematic low frequency noise. The disturbance from low frequency noise depends on other factors, including:

- noise level.
- characteristics that can increase annoyance with the noise, for example, tonality, frequency modulation.
- ambient noise levels in the absence of the noise of concern.

The noise threshold values for outdoor low frequency noise (from the development under assessment) are detailed in Table 3 of Publication 1996 (reproduced in **Table 12**) and are based on the EPA assumed façade noise reductions.

**Table 12 Outdoor One-Third Octave Low Frequency Noise Threshold Levels from 10 Hz to 160 Hz**

Index	One Third Octave Frequency (Hz)												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Leq (dB)	92	89	86	77	69	61	54	50	50	48	48	46	44

Some of the lower-frequency values in **Table 12** are close to the typical threshold of hearing of a young healthy population<sup>2</sup>, indicating that for many other people (eg older people with normal age related hearing loss), compliance with the lower-frequencies in guidelines would likely correspond with the noise being inaudible .

Though the use of Publication 1996 is intended to “understand the risk of harm from the emission of low frequency noise”<sup>3</sup>, it does not define the levels that cause harm.

The assessment guideline values focus on a frequency range from 10 Hz to 160 Hz. It is acknowledged that noise predictions and assessment at these frequency ranges are typically not feasible at these early stages of the project. Noise emissions shall be assessed against the low frequency noise guidelines as the design develops and noise generating equipment models, and associated noise information are available for assessment.

### 5.3 Ground-Borne Noise and Vibration Guidelines

There is no Victorian policy for ground-borne noise and vibration from passenger rail movements. The receivers adjacent to the rail corridor are currently exposed to a level of vibration from the train pass-bys. Refer to **Section 7.2** for a vibration screening assessment of rail operations.

The GED obligations in relation to station operations apply to ground-borne noise and vibration effects. However, considering the likely location and nature of the plant items typically installed in train stations, no adverse ground-borne noise and vibration effects are anticipated, and hence no further assessment is warranted.

### 5.4 Summary of Noise Assessment Criteria

**Table 13** presents a summary of the types of noise generated as part of the project and the relevant assessment criteria and guidelines.

<sup>2</sup> Threshold of hearing is based on 18-25 year old, and who are in a normal state of health, and are free from all signs/symptoms of ear disease, no wax in the ear canal, have no exposure to undue exposure to noise, or exposure to potentially ototoxic drugs, or family hearing loss. Referenced from ISO 226: *Equal loudness level contours*, (2003).

<sup>3</sup> Noise Guidelines: Assessing low frequency noise (Publication 1996), June 2021: Section titled, ‘Introduction’, page 9

**Table 13 Summary of Noise Assessment Criteria and Guidelines**

Type of Noise Source	Description	Assessment Criteria and Guidelines
Train movements	Noise generated by trains moving along the rail tracks within the corridor	Passenger Rail Infrastructure Noise Policy
Train horns	Trains sounding their horns as they approach level crossings or entering/exiting stations	Exempt <sup>4</sup>
Level crossing bells	Noise from warning bells at level crossings	Exempt <sup>5</sup>
Train vibration	Ground-borne noise caused by train movements generating vibration which may result in regenerated noise within buildings	Exempt
Station fixed mechanical plant	Noise from mechanical plant such as fans and pumps located at stations	GED EPA Noise Protocol EPA Low Frequency Noise Guidelines
Station PA announcements	Noise from amplified speech associated with the arrival and departure of trains at stations	GED EPA Noise Protocol EPA Low Frequency Noise Guideline
Station fixed electrical plant	Noise from electrical infrastructure such as sub-stations located within the station precincts	GED EPA Noise Protocol EPA Low Frequency Noise Guideline

## 6 Assessment Methodology

A three-dimensional noise model was prepared using industry best-practice rail prediction algorithm. The noise parameters for assessment included:

- A-weighted Daytime noise levels between 6:00am – 10:00 pm ( $L_{Aeq, 16 hr}$ )
- A-weighted Night-time noise levels between 10:00pm – 6:00am ( $L_{Aeq, 8 hr}$ )
- A-weighted maximum noise level for 95<sup>th</sup> percentile of train pass-by during the Day or Night period ( $L_{Amax}$ )

<sup>4</sup> Note that train horn soundings will be significantly reduced due to the removal of level crossings.

<sup>5</sup> Note that no future level crossing bell noise will be present due to the removal of level crossings.

The modelling methodology and validation framework is shown in **Figure 5**. The input parameters are discussed in the following sections.

## 6.1 Modelling Scenarios

Noise assessments were based on the absolute noise levels and comparative noise levels. Noise levels were compared between the existing scenario, and the future elevated scenario. The following scenarios were considered for modelling purposes:

### Scenario 1 – Base case: At-grade existing alignment (Day<sub>-1</sub> – 2023 timetable)

- 1 day prior to project opening.

### Scenario 2 – Redeveloped railway: Elevated/proposed alignment (Day<sub>0</sub> – 2023 timetable)

- 1 day after project opening – The year 2023 was used as the current timetable is the latest state of knowledge.

Scenario 2 was compared with Scenario 1 to assess the noise impacts and compare the results against the PRINP.

## 6.2 Calculation Method

The *Nord 2000 – New Nordic Prediction Method for Rail Traffic Noise* prediction methodology was used for the assessment. This methodology uses multiple source heights, to represent the noise source locations more accurately, particularly for elevated sections of track that are partially shielded by the structure.

SoundPLAN version 8.2 software was used to implement the prediction methodology.

**Figure 5** describes the modelling methodology of rail noise operations.

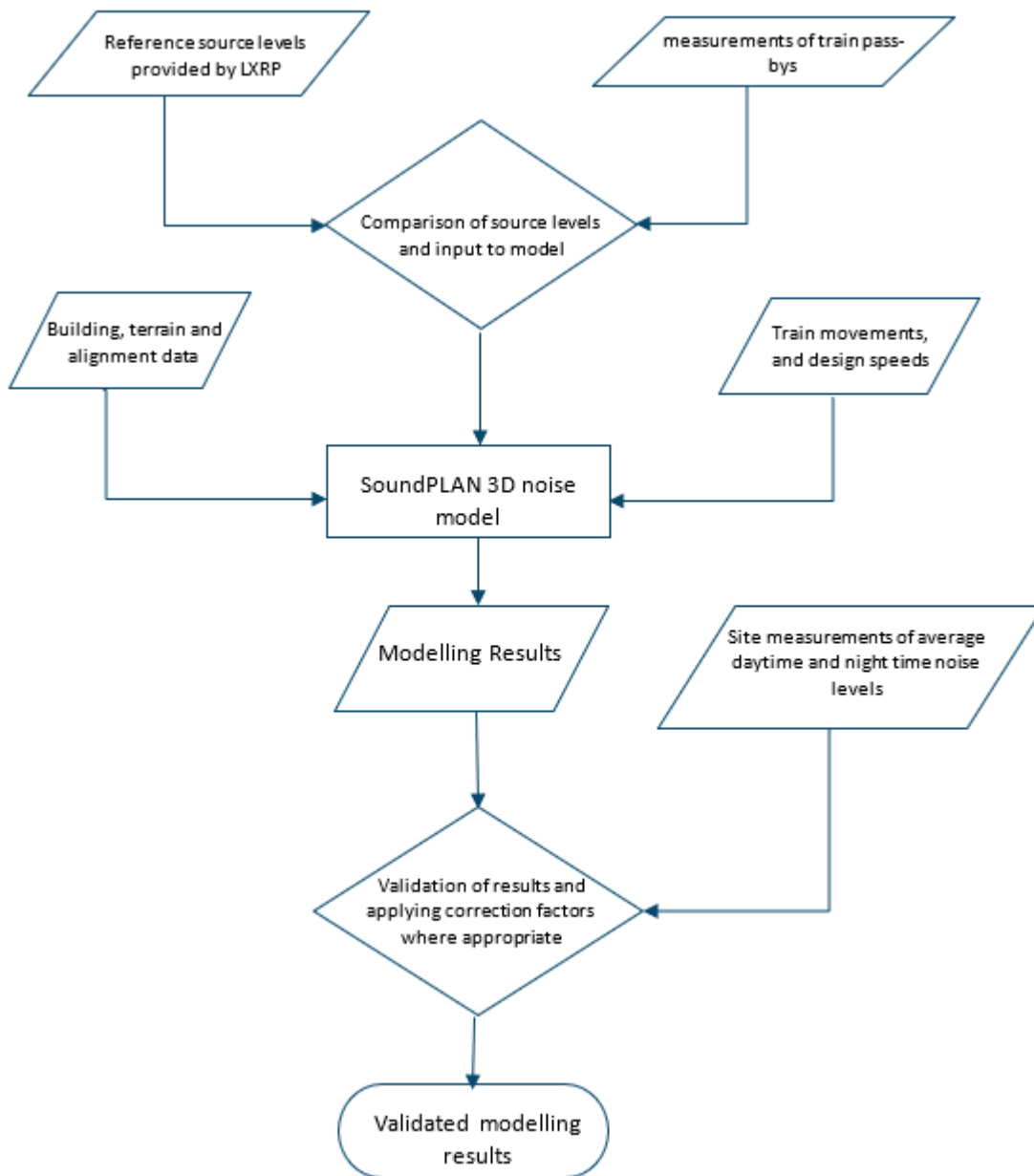


Figure 5 Modelling Methodology

## 6.3 Modelling Inputs

The following sections provide the details of the modelling inputs.

### 6.3.1 Source Noise Levels

Trains that currently travel in the corridor are electric passenger trains, otherwise known as Electric Multiple Units (EMUs). These trains are predominantly Comeng train sets. The reference Sound Exposure Levels (SELs) and  $L_{Amax}$  levels of the Comeng trains were used for all trains in this assessment. These reference noise levels at

80 km/h, and at 15m from source, are listed in **Table 14**. The reference noise levels of the trains travelling in the corridor were provided by the project, and indicates that Comeng train sets are louder than X'Trapolis train sets. Therefore, the source levels used for this assessment are considered conservative.

It is acknowledged that X'Trapolis 2.0 trains may progressively replace Comeng trains on the Upfield line in future.

Attended noise measurements were conducted by SLR previously at Coburg for the Bell to Moreland Project to obtain noise levels in 1/3 octave band frequencies. The measurements were conducted in accordance with Australian Standard AS2377-2002 *Acoustics – Methods for the measurement of railbound vehicle noise*. These measurements provided noise levels marginally higher (2-3 dB) than the reference levels. In order to remain conservative, the measured noise levels were proposed to be used for modelling purposes. These SEL and L<sub>max</sub> used are provided in **Table 14**.

**Table 14 Noise Levels at 80 km/h, 15m Distance and a Height of 1.5m/3.5m Above Rail Level**

Train Type	SEL dB(A)		Lmax dB(A)	
	LXRP Reference	Proposed level for modelling	LXRP Reference	Proposed level for modelling
Comeng	88	90	82	85

Noise levels were modelled in 1/3 octave band centre frequencies in accordance with the Nord 2000 algorithm. The 'a' and 'b' values for the algorithm are provided in **Table 15**.

**Table 15 Nord 2000 Rail Spectral Inputs**

Frequency	a	b
25 Hz	41.5	64.2
31.5 Hz	42.4	64.2
40 Hz	42.6	64.2
50 Hz	33.8	64.2
63 Hz	31.9	65.9
80 Hz	31.5	70.5
100 Hz	28.0	73.6
125 Hz	26.8	74.0
160 Hz	26.1	77.7
200 Hz	24.3	79.1
250 Hz	20.1	78.6
315 Hz	16.5	83.3
400 Hz	0.9	85.2
500 Hz	1.3	87.9

Frequency	a	b
630 Hz	16.8	95.4
800 Hz	27.5	94.7
1k Hz	29.9	92.5
1.25k Hz	31.6	91.4
1.6k Hz	42.1	90.7
2k Hz	40.6	90.7
2.5k Hz	36.8	89.8
3.15k Hz	32.8	86.8
4k Hz	30.2	85.6
5 k Hz	32.3	84.6
6.3 k Hz	34.0	81.9
8 k Hz	35.1	79.0
10 k Hz	28.7	79.0

### 6.3.2 Source Heights

The source heights (above rail head) used for modelling purposes are:

- 0.01 m (wheel / rail)
- 0.35 m (wheel)
- 0.7 m (wagon / engine)

### 6.3.3 Train Movements

The train movements in the corridor for the existing and future scenarios are presented in **Table 16**. The timetables are identical for both the existing and future (day after opening) scenarios. These train movements are based on worst-case weekday timetable.

**Table 16 Train Movements for Scenario 1 and Scenario 2**

Train Type	Day			Night		
	up	down	TOTAL	up	down	TOTAL
EMU	50	51	<b>101</b>	13	10	<b>23</b>

### 6.3.4 Train Lengths and Design Speeds

The model incorporates the train line speed for the project section on the Upfield line (for both existing and future alignment) of 80 km/hr. The speed restriction of 60 km/hr was also incorporated in the model for the curve between Royal Park Station and Park Street.

The train lengths are assumed to be 141 m (six car train set).

### 6.3.5 Building, Terrain and Rail Alignment

3D building and terrain data were obtained from SLR's subscription of Geoscape library of Lidar survey data. Google Earth® *street view* was also used to ensure that multi-storied buildings adjacent to the corridor (first row buildings) were incorporated in the model as far as possible. Buildings under planning, design or construction were included in the model where information was made available.

The ground absorption properties assumed for the model are as follows:

- Ground factor: 0
- Flow resistivity: 20000 kNs/m<sup>4</sup>
- Roughness class: Nil

The above values were assumed as a worst-case as it represents a hard reflective terrain.

The elevated rail alignment was modelled on preliminary designs and included structural screening including the edge barrier of the U-trough base structure which is part of the elevated design.

### 6.3.6 Track Correction

The existing tracks are ballasted and the model incorporated source levels from the existing track condition and hence no track correction was proposed to be applied for Scenario 1 (baseline at-grade), except for level crossing sections where a track correction of +3 dB was applied to account for the change in surface conditions.

The rail curvature from the Royal Park Station to Park Street was estimated to have a radius between 300 m to 500 m. Therefore, a correction of +3 dB was applied to both the existing and proposed rail alignments to account for the change in noise level due to wheel slippage and squeal.

The design trackform is understood to be ballasted trackform throughout the project extent with no turnouts or crossovers, and hence no other track corrections were applied in the model.

### 6.3.7 Facade Correction

Facade corrections were applied in accordance with Nord 2000 methodology implemented in the modelling software (equivalent to +2.5 dB correction). Calculated noise levels were considered with the facade correction incorporated.

### 6.3.8 Weather Assumptions

A 'neutral' weather condition (*DK Weather Statistics (Suppl.) 1 cl.*) was applied in accordance with Nord 2000 standard. This weather condition is prescribed as the preferred weather condition in Nord 2000 for assessments in densely populated suburban areas.

## 7 Rail Operational Assessment

Noise levels were predicted for individual sensitive receivers along the proposed rail alignment in order to determine any potential exceedances of noise levels against the thresholds provided in the PRINP. To identify potential exceedances, 455 sensitive use buildings comprising of 952 receiver points, were analysed with individual predictions. These receivers were generally first or second row sensitive receivers adjacent to the rail corridor. Based on the predictions, it was evident that other sensitive receivers further away from the rail corridor would experience rail noise levels below the absolute values of the PRINP thresholds.

Noise contour maps of both the existing and proposed future scenarios are provided in **Appendix C**. The results of the assessment indicate there are no predicted exceedances of the PRINP thresholds. The proposed future design is elevated in comparison to the existing at-grade alignment and incorporates the U-trough viaduct structure with a side parapet edge which offers shielding to most of the sensitive receivers considered.

Modelling indicates there is a predicted reduction in noise to the majority of receivers in close proximity to the proposed rail alignment. For receivers that are predicted to experience significant shielding effects from the viaduct structures (> 10 – 15 dB), there may be a possibility the structure-radiated noise from the viaduct may contribute to the overall noise emissions. In this regard, a maximum viaduct shielding loss of -10 dB was incorporated in the results in order to remain conservative with the predictions.

Whilst increases in noise levels were predicted for certain receivers much further away from the rail corridor, overall noise levels were predicted to be below the absolute thresholds in the PRINP. This means no exceedances of the PRINP investigation thresholds are predicted.

Based on the individual receiver points considered, **Figure 6** indicates the distribution of receivers within various noise level ranges for both the existing and the proposed scenarios. From these figures, it can be deduced that there is a general reduction in operational noise with the proposed design solution. More receivers appear to fall within the lower noise level ranges in the proposed scenario compared to the existing scenario, and likewise, relatively less receivers are present in the higher noise level ranges in the proposed scenario compared to the existing scenario.

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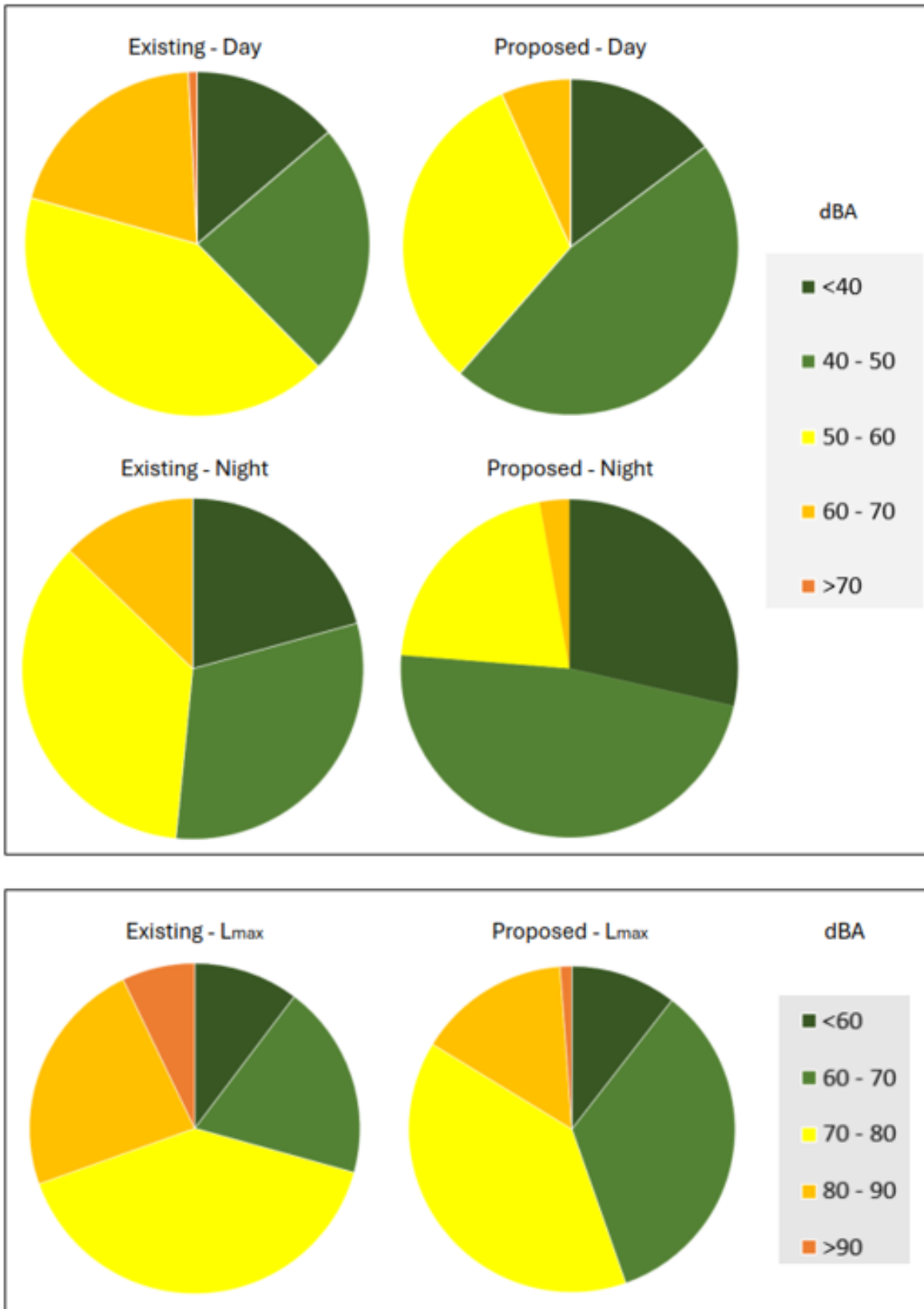


Figure 6 Distribution of Receivers within Noise Level Ranges

Number of receivers above the absolute PRINP thresholds were particularly investigated. **Table 17** presents the number of receivers above the absolute PRINP thresholds for both the existing and proposed scenarios.

**Table 17 Number of Receivers above PRINP Absolute Thresholds for Existing and Proposed Scenarios**

Category	Day period (threshold – 65 dBA)		Night period (threshold – 60 dBA)		L <sub>max</sub> (threshold – 85 dBA)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
Number of receivers above absolute threshold	84	14	122	27	159	61

**Table 17** shows that the number of receivers above the absolute thresholds reduce from 84 receivers to 14 receivers for the day threshold of 65 dBA, and from 122 receivers to 27 receivers for the night absolute threshold of 60 dBA, and from 159 receivers to 61 receivers for the maximum noise level threshold of 85 dBA.

Note that receivers above the absolute threshold do not necessarily indicate PRINP exceedances as the magnitude of change between existing and future noise levels must also be considered (see **Section 5.1.1**). For the receivers above the absolute threshold in the proposed scenario, **Table 18** shows the level of change in noise levels compared to the existing scenario. It can be seen the level of change is no greater than 3 dB for any receiver. Therefore, it can be concluded that no receivers are predicted to trigger the requirements for noise mitigation consideration under the PRINP.

**Table 18 Number of Receivers (above absolute PRINP threshold) Experiencing Noise Level Changes**

Noise level Changes (dBA)	Number of receivers Day period	Number of receivers Night period	Number of receivers L <sub>max</sub>
>-5	0	0	5
-5 to -4	0	0	4
-4 to -3	0	0	4
-3 to -2	0	4	1
-2 to -1	2	3	8
-1 to 0	3	8	10
0 to 1	7	9	14
1 to 2	2	3	9
2 to 3	0	0	6
3 to 4	0	0	0
>4	0	0	0
<b>TOTAL</b>	<b>14</b>	<b>27</b>	<b>61</b>

It is predicted that there are no significant adverse effects on substantial number of residents, due to extensive or major, long-term changes in noise conditions, based on the model outcomes and consideration to the existing environment.

The project is also generally not foreseen to introduce any extensive or major adverse effects on the health or well-being of a human community. The existing level crossing bells, and the need for train horns at road crossings will be removed as part of the project, and hence the sensitive receivers adjacent to existing crossings are expected to have a benefit from the project in future. However, the locations of the proposed stations are different compared to the existing stations, and these effects are discussed further in **Section 8**.

## 7.1 Model Validation

Noise levels were calculated at the baseline measurement locations using the existing scenario model to validate the modelling process and outcomes. The modelled  $L_{eq}$  levels are compared against the baseline measurement results in **Table 19**.

**Table 19 Comparison of Baseline Measurements vs Existing Model Results**

No.	Location	Measurement		Model		Day difference	Night difference
		Leq 16 hr dBA	Leq 8 hr dBA	Leq 16 hr dBA	Leq 8 hr dBA		
1	Cameron St	62.4	55.0	64.4	60.9	2	5.9
2	Orient Grove <sup>1</sup>	56.2	50.5	60.9	57.5	4.7	7
3	Lux Way	61.6	55.3	61.8	58.1	0.2	2.8
4	Wilkinson St <sup>1</sup>	54.8	49.4	60.1	56.7	5.3	7.3
5	Dawson Street	61.2	57.5	62.3	58.9	1.1	1.4
6	Wilson Ave	65.8	59.6	63.9	60.8	-1.9	1.2
7	Brunswick Road	68.4	62.4	65.9	62.4	-2.5	0
8	The Avenue	54.7	45.4	52.7	49.3	-2	3.9
<b>Average<sup>2</sup></b>						<b>-0.5</b>	<b>2.5</b>

1 – Location in proximity to existing train station.

2 – values from Locations 2 and 4 are not considered for model validation (average differences) due to the conservative nature of modelling.

Findings from the comparison are as follows:

- The predictions at Locations 2 and 4 were significantly high in comparison to measurements. This is attributed to the fact that these locations are closer to existing train stations and hence the train speeds are generally lower currently, than compared to the modelled speeds of 80 km/hr. Therefore, the model at these locations are considered conservative and over-predicts compared to the existing measurements. In this regard, these locations are not considered appropriate for assessing model validation.
- The model generally was anticipated to over-predict the levels. This was evident from the night-time noise levels comparison as the predicted levels were generally higher than the measured levels.
- During the day period, the measured levels were observed to be influenced by local road traffic and other extraneous noise events. Therefore, the average day levels across the locations were comparable with the predicted levels, indicating that the predicted levels may be marginally conservative.
- The comparison therefore indicated that the predicted levels were marginally conservative, and hence no validation or adjustment factors were included to the predicted results to ensure that the predicted noise impacts were conservative in nature (i.e. over predicting potential impacts).

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### 7.1.1 $L_{max}$ Validation

The existing environment has significant influences from train horns and level crossing bells as described in **Section 4**. During the selection of sites for baseline measurements, efforts were made to avoid the influence of train horns and bells at measurement locations, however it was not possible to completely avoid them due to the presence of three existing stations and eight level crossings along with other pedestrian crossings across the project alignment.

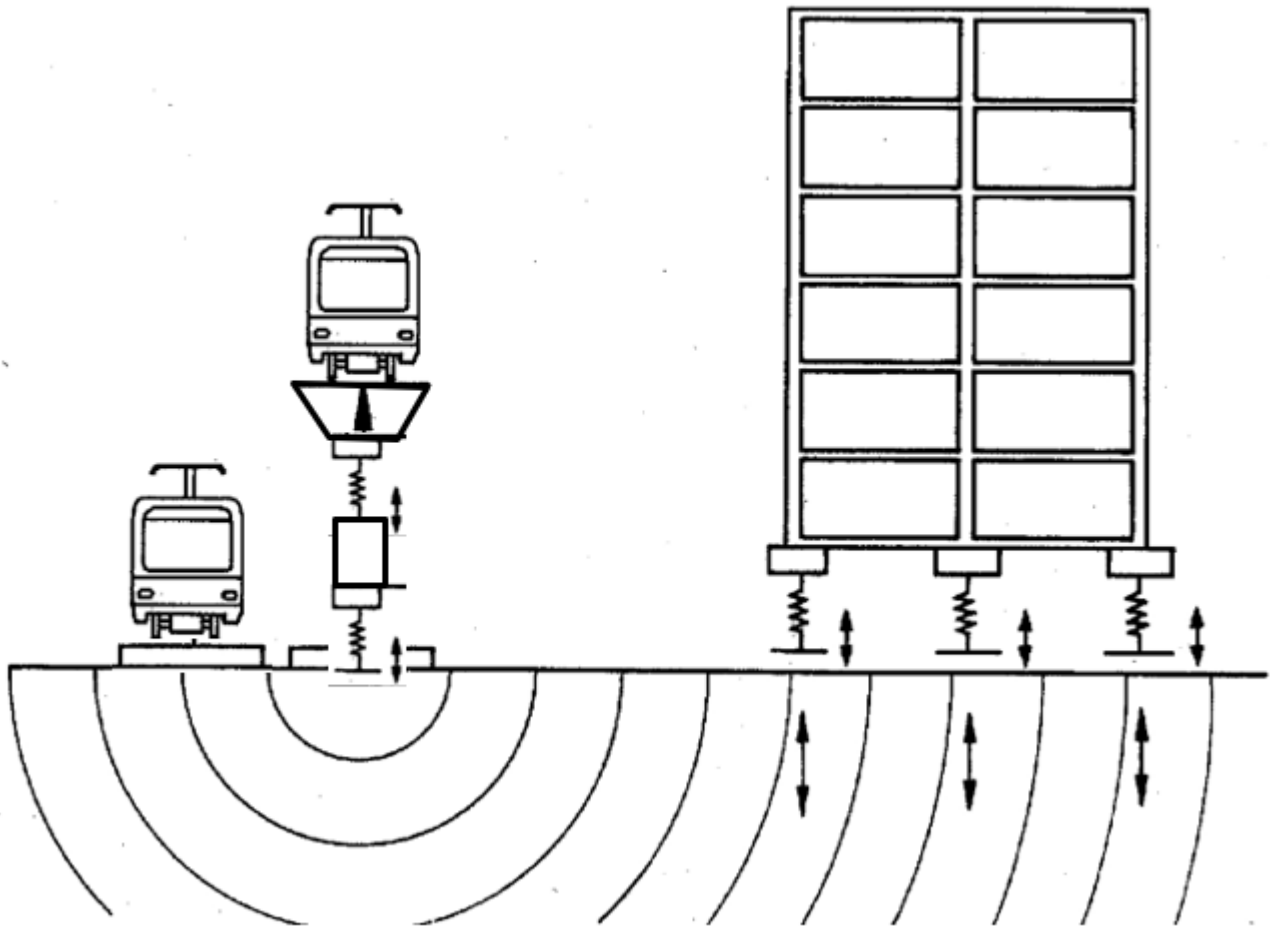
Data from measurement locations were analysed and filtered for train pass-by events based on a threshold of events exceeding 65-70 dB and having a typical vehicle pass-by signature. The  $L_{max}$  levels were then determined from these events for model comparison. However, these train pass-by events were dominated by train horns and/or crossing bells driving the  $L_{max}$  on each pass-by event, which were validated by listening to audio recordings. Train horns and crossing bells were not included in the model and assessment due to their use as a safety feature and hence the  $L_{max}$  levels were unable to be validated based on the baseline measurements.

$L_{max}$  levels derived from source measurements (described in **Section 6.3.1**) were used as a comparison at representative distances, and it was observed that the model  $L_{max}$  predictions generally agreed with the source pass-by measurements. As such, no validation or adjustment factors for  $L_{max}$  predictions were considered necessary.

Numerous receivers would experience lower  $L_{max}$  levels across the study area in future due to the removal of level crossings, which will remove the use of crossing bells and train horns at these locations.

## 7.2 Vibration Screening Assessment

Rail vibrations are generated as a function of the rail vehicle with heavy mass travelling on rails creating wheel-rail interaction. The vibrations then travel through the rail fixings, sleepers, ballast and enter the ground. These vibrations then propagate through the ground into buildings through building foundations where there are typically vibration losses due to coupling between structures and soil.



**Figure 7** Vibration Propagation from Trains

In an elevated rail scenario, there is typically more compacted ground in the form of embankment/retaining walls. These provide additional vibration paths where the vibration energy would dissipate further. In the case of the viaduct, the superstructure is coupled with the piers via bearings and the piers are piled into the ground both of which dissipate vibration.

Any vibration and ground-borne noise impacts (if any) are expected to be improved compared to the existing scenario of the train travelling at grade in direct contact with the ground. Therefore, no further operational vibration and ground-borne noise assessments are proposed to be undertaken for the proposed rail movements.

## 8 Station Noise Emission Assessment

The typical sources of noise emissions from stations assessable under the EP Act are as follows:

- Noise associated with station PA systems
- Noise associated with mechanical services
- Noise associated with electrical services

The detailed station architectural design and services strategy are typically only developed during the detailed design stage of the project. These details are therefore not available to undertake an acoustic assessment at the time of writing this report. Conceptual design measures based on industry best practice should be considered and implemented in line with standard station designs delivered on similar level crossing removal projects. It is envisaged that adequate noise control measures in line with the EP Act requirements would result in compliance with the established station noise criteria. Further assessment of station noise emissions with comparison to the Noise Protocol noise limits should be completed following detailed design work when layouts and equipment selections have been decided.

The stations PA systems should be carefully designed. Whilst meeting the necessary project speech intelligibility and sound pressure level spread requirements, the following should be considered by the design team:

- The speakers should be selected such that the directivity of the speakers minimise unnecessary noise spill outside the platforms and concourse areas.
- The location, orientation and number of speakers should be determined with the view to minimise environmental noise spill from the system.
- The speaker tapping should be kept at an optimal level to ensure the speaker output power does not exceed the necessary level.
- The amplifier system should have the ability for adequate gain control to minimise noise emissions where necessary.
- The Ambient Noise System (ANS) should be installed on the station PA system and the microphone should be carefully placed to ensure the dynamic gain control on the speakers work effectively in minimising noise during the quieter evening and night periods.

A qualified acoustic consultant should consider the above-mentioned recommendations and develop a 3-D acoustic model to assess environmental noise spill from PA systems. The model should incorporate the proposed station geometry, PA speaker layouts, speaker directivity and appropriate gain levels to predict noise emissions. Based on the noise emissions, the PA system should be iteratively optimised to ensure the noise spill meets the established Noise Protocol noise limits. The character of the automated announcements should also be investigated with MTM, and any tonal or impulsive characteristics of the announcements, if assessed to be impacting sensitive receivers, should be eliminated so far as reasonably practicable.

Whilst the above-mentioned recommendations form part of the design process, the sound system should also be calibrated as soon as possible after practical works completion to validate the design and modify the system as required to achieve compliance with the established Noise Protocol noise limits.

It is anticipated that with the above mitigation measures being carefully considered and implemented, the noise emissions from the station precincts would achieve the Noise Protocol noise limits (see **Section 5.2**).

It is acknowledged that the two proposed stations are located at different locations when compared to the three existing train stations. Therefore, there may be sensitive receivers who may experience intermittent train horn noise who may have previously not experienced them in as close proximity. Horn usage at stations are deemed necessary for safety purposes by Metro Trains Melbourne (MTM) and are not subjected to assessment under the PRINP. Whilst there is a net benefit across the corridor from train horns (due to the removal of level crossings), as the Project's detailed design progresses, options to minimise the use of train horn noise at the proposed stations should be considered.

## 9 Conclusion

SLR has undertaken an operational noise assessment for the proposed Brunswick Level Crossing Removal Project. The assessment framework was established in accordance with *the Passenger Rail Infrastructure Noise Policy* (PRINP) and the Environment Protection Act 2017. Additionally, as the project is being referred under the Environment Effects Act 1978, this report informs an assessment of the operational noise emissions against the Ministerial guidelines for the Environmental Effects Statement (EES).

The existing environment was quantified by unattended noise monitoring at eight locations distributed across the study area. The existing noise environment was observed to be dominated by existing rail noise, road traffic and surrounding commercial activities. Numerous receivers were also observed to be exposed to train horns and bells from existing level crossings.


Operational rail noise assessment was undertaken using 3D acoustic modelling. Noise levels were modelled for the existing at-grade scenario and the proposed elevated scenario. The modelled results were also validated against baseline noise measurements. The results indicated that the predicted future noise levels due to the elevated viaduct design were below the investigation threshold values of the PRINP, and hence no noise mitigation measures were recommended for operational rail noise. Operational vibration from trains is also expected to improve due to the proposed elevated rail alignment providing further pathways for vibration to dissipate towards the sensitive receivers.

Noise Protocol noise limits have been established for the new station locations. As the design of these stations progress, noise emissions should be assessed to achieve compliance with the established Noise Protocol noise limits and to minimise potential noise emissions so far as reasonably practicable. It is envisaged that standard noise control measures, when implemented in line with GED requirements, would result in compliance with the established station Noise Protocol noise limits.

The project is currently at the conceptual design stage. Further acoustic assessments are recommended to be undertaken during the detailed design stage to ensure compliance with the established project acoustic requirements and to minimise noise emissions so far as reasonably practicable in accordance with General Environmental Duty.

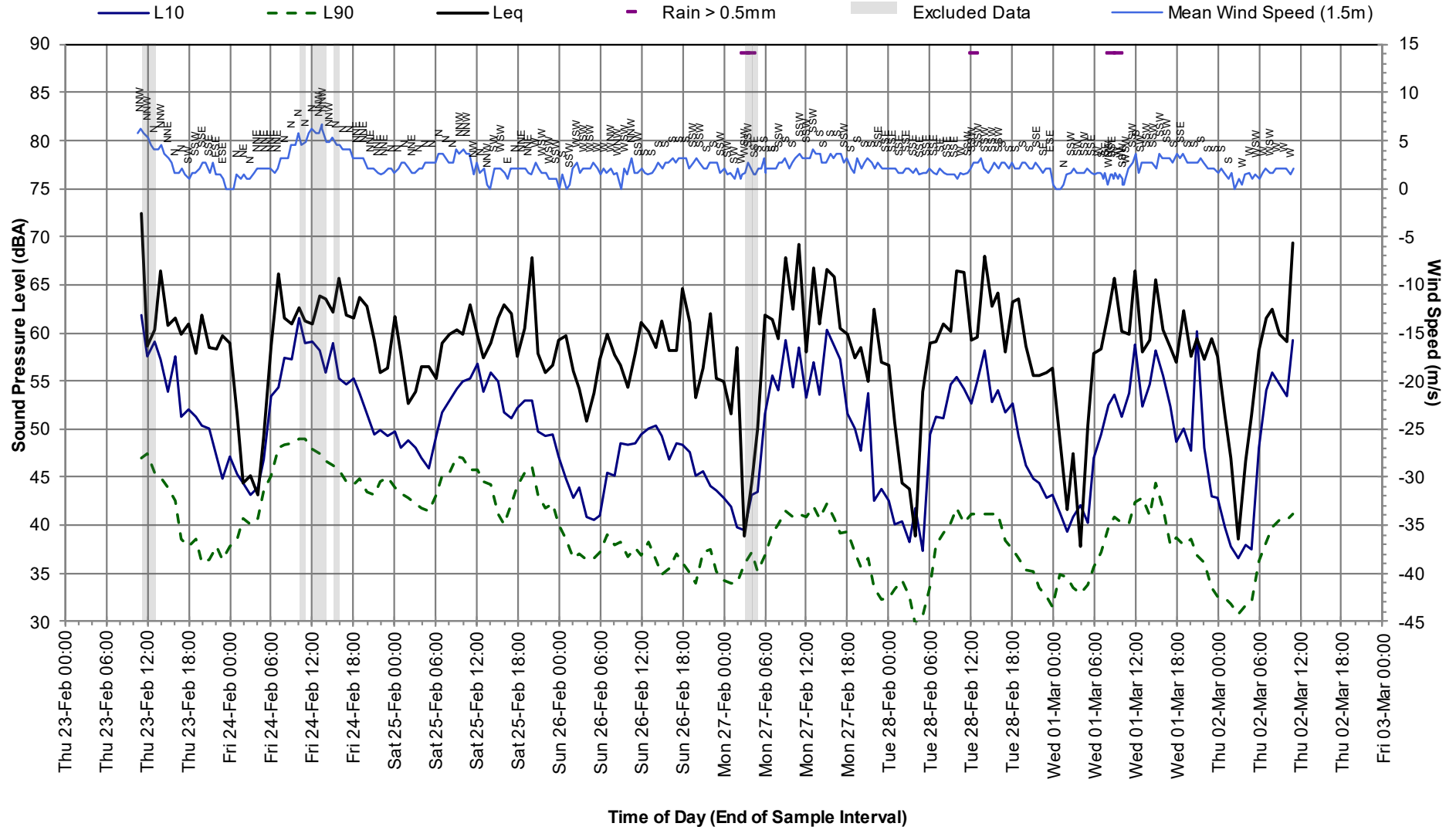
# Appendix A:


## Baseline noise measurements

Noise Monitoring Location		Location 1				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Cameron St Brunswick, VIC 3056	Device Type	ARL Ngara		More than 3 m from east façade, inside wire cage		
	Serial Number	8781BE				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Thu, 23 Feb 2023	42	37	41	61	55	<p style="text-align: center;">Removed for privacy reasons</p>
Fri, 24 Feb 2023	(47)	44	43	63	57	
Sat, 25 Feb 2023	44	44	38	61	57	
Sun, 26 Feb 2023	-	37	36	60	56	
Mon, 27 Feb 2023	41	36	33	64	54	
Tue, 28 Feb 2023	40	35	34	63	53	
Wed, 01 Mar 2023	41	37	33	62	55	
Thu, 02 Mar 2023	41	-	-	-	-	
<b>Minimum</b>	<b>40</b>	<b>35</b>	<b>33</b>	-	-	
<b>Overall Average</b>	<b>42</b>	<b>39</b>	<b>37</b>	62	55	

# Statistical Ambient Noise Levels

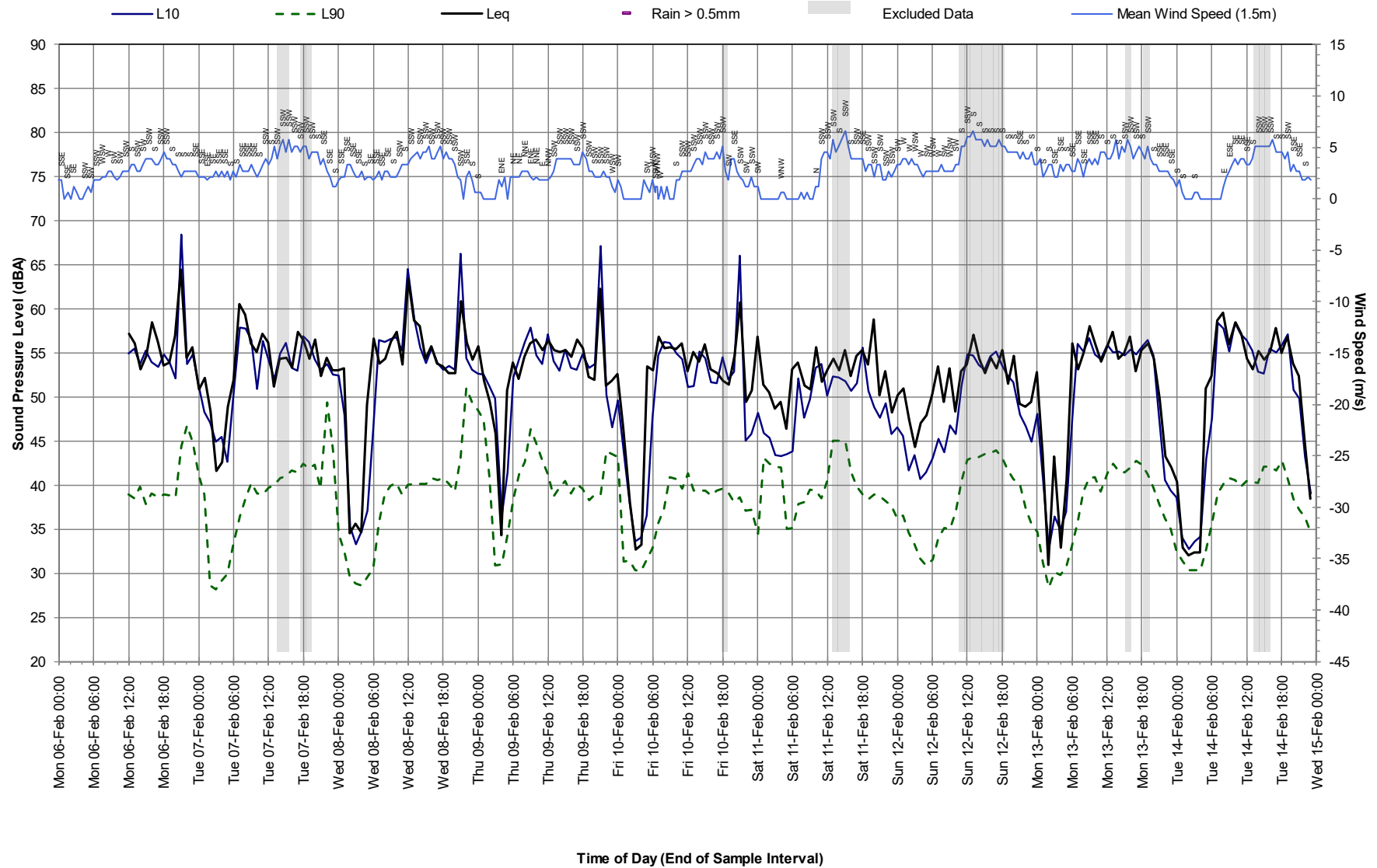
Location 1 - Cameron St Brunswick - Thursday, 23 February 2023

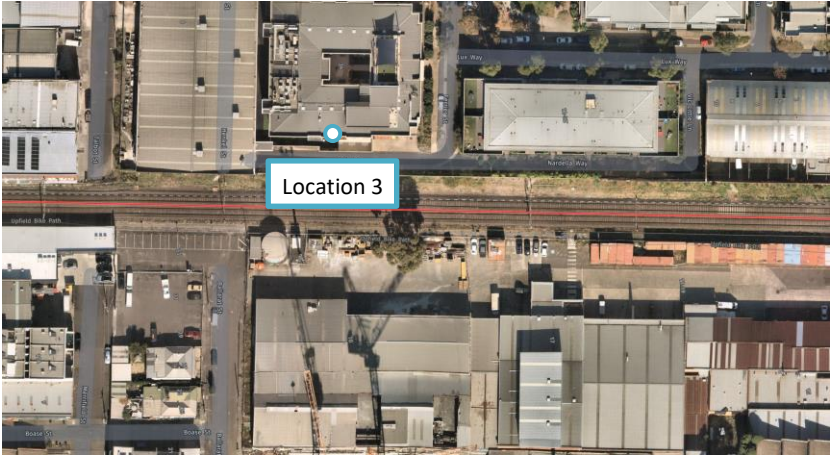


Noise Monitoring Location		Location 2				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Orient Grove, Brunswick VIC 3056	Device Type	ARL Ngara		Approximately 1 m from south façade		
	Serial Number	8781C7				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Mon, 06 Feb 2023	39	42	35	58	51	<p style="text-align: center;">Removed for privacy reasons</p>
Tue, 07 Feb 2023	(40)	43	33	56	52	
Wed, 08 Feb 2023	40	43	40	57	52	
Thu, 09 Feb 2023	41	40	34	56	50	
Fri, 10 Feb 2023	40	38	39	55	52	
Sat, 11 Feb 2023	(40)	39	34	54	49	
Sun, 12 Feb 2023	-	(38)	32	53	50	
Mon, 13 Feb 2023	41	38	33	55	46	
Tue, 14 Feb 2023	(41)	38	35	56	-	
<b>Minimum</b>	<b>40</b>	<b>38</b>	<b>32</b>	-	-	
<b>Overall Average</b>	<b>40</b>	<b>40</b>	<b>35</b>	<b>56</b>	<b>50</b>	

# Statistical Ambient Noise Levels

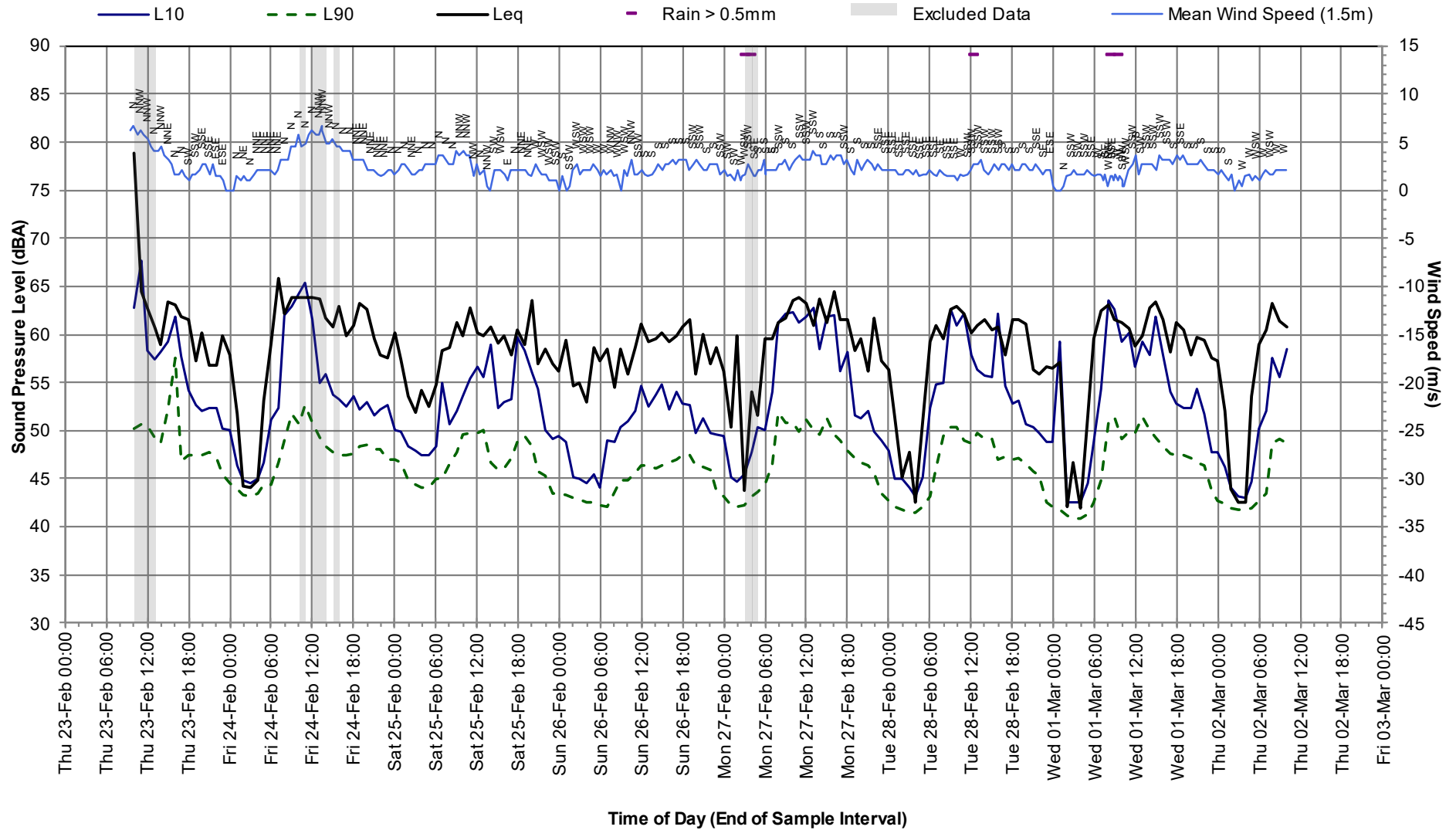
Location 2 Orient Grove - Monday, 6 February 2023




Noise Monitoring Location		Location 3				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Lux Way, Brunswick VIC 3056	Device Type	ARL Ngara		In corner of upper floor balcony on south boundary		
	Serial Number	8781CD				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Thu, 23 Feb 2023	(50)	47	44	61	56	<p style="text-align: center;">Removed for privacy reasons</p>
Fri, 24 Feb 2023	(49)	48	45	63	56	
Sat, 25 Feb 2023	48	47	43	60	57	
Sun, 26 Feb 2023	-	46	44	59	56	
Mon, 27 Feb 2023	50	46	43	62	55	
Tue, 28 Feb 2023	49	46	42	61	55	
Wed, 01 Mar 2023	50	47	42	61	55	
Thu, 02 Mar 2023	49	-	-	62	-	
<b>Minimum</b>	<b>48</b>	<b>46</b>	<b>42</b>	<b>-</b>	<b>-</b>	
<b>Overall Average</b>	<b>49</b>	<b>47</b>	<b>43</b>	<b>62</b>	<b>55</b>	

# Statistical Ambient Noise Levels

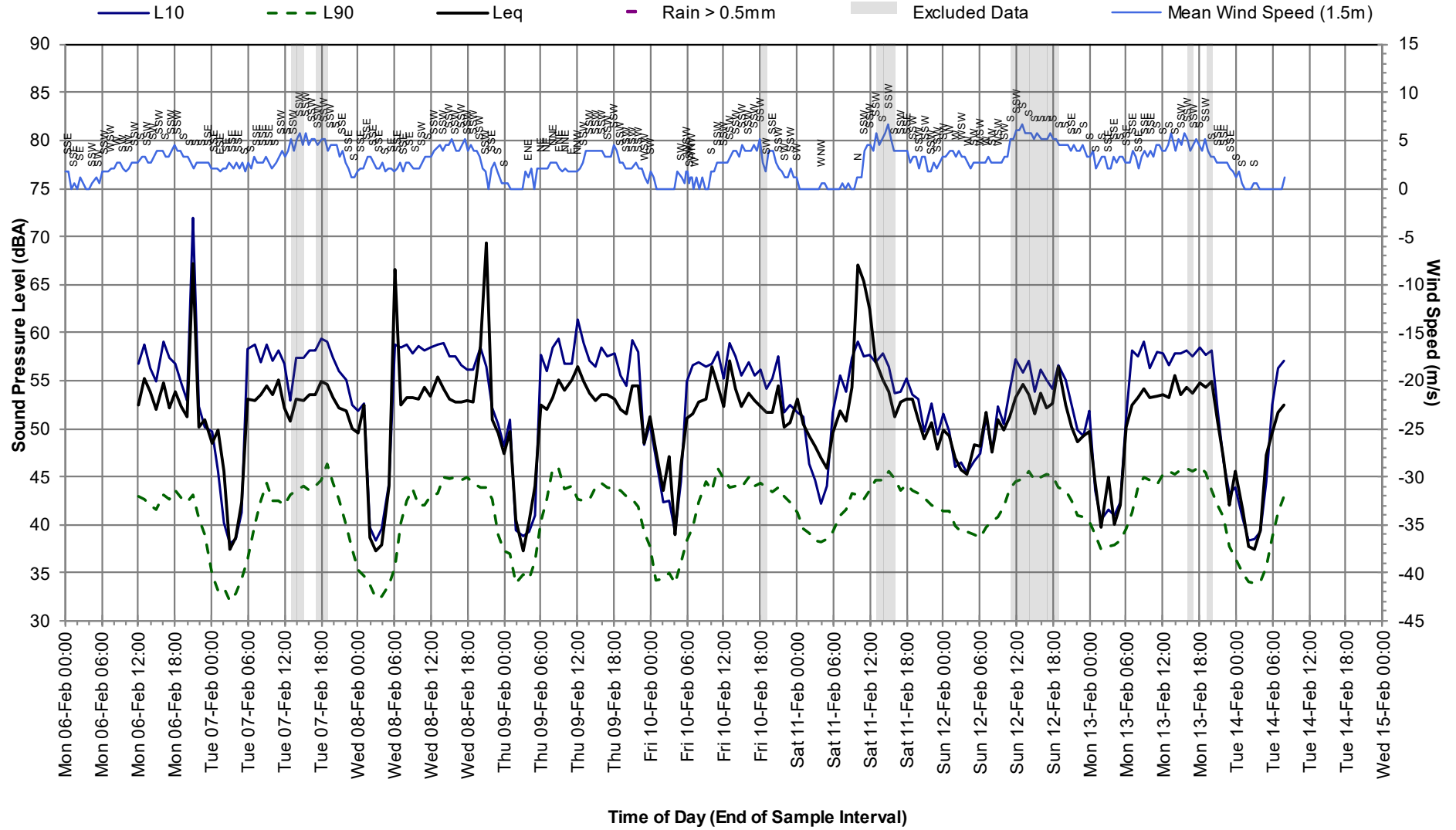
Location 3 - Lux Way Brunswick - Thursday, 23 February 2023




Noise Monitoring Location		Location 4				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Wilkinson St, Brunswick VIC 3056	Device Type	ARL Ngara		Approximately 1 m from fence, less than 3 m from east façade		
	Serial Number	878053				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Mon, 06 Feb 2023	43	42	35	58	48	<p style="text-align: center;">Removed for privacy reasons</p>
Tue, 07 Feb 2023	(43)	43	35	53	58	
Wed, 08 Feb 2023	44	44	37	59	48	
Thu, 09 Feb 2023	44	43	36	54	48	
Fri, 10 Feb 2023	44	44	40	54	50	
Sat, 11 Feb 2023	(43)	43	40	59	48	
Sun, 12 Feb 2023	-	(42)	39	52	47	
Mon, 13 Feb 2023	45	42	36	54	45	
<b>Minimum</b>	<b>43</b>	<b>42</b>	<b>35</b>	-	-	
<b>Overall Average</b>	<b>44</b>	<b>43</b>	<b>37</b>	<b>55</b>	<b>49</b>	

# Statistical Ambient Noise Levels

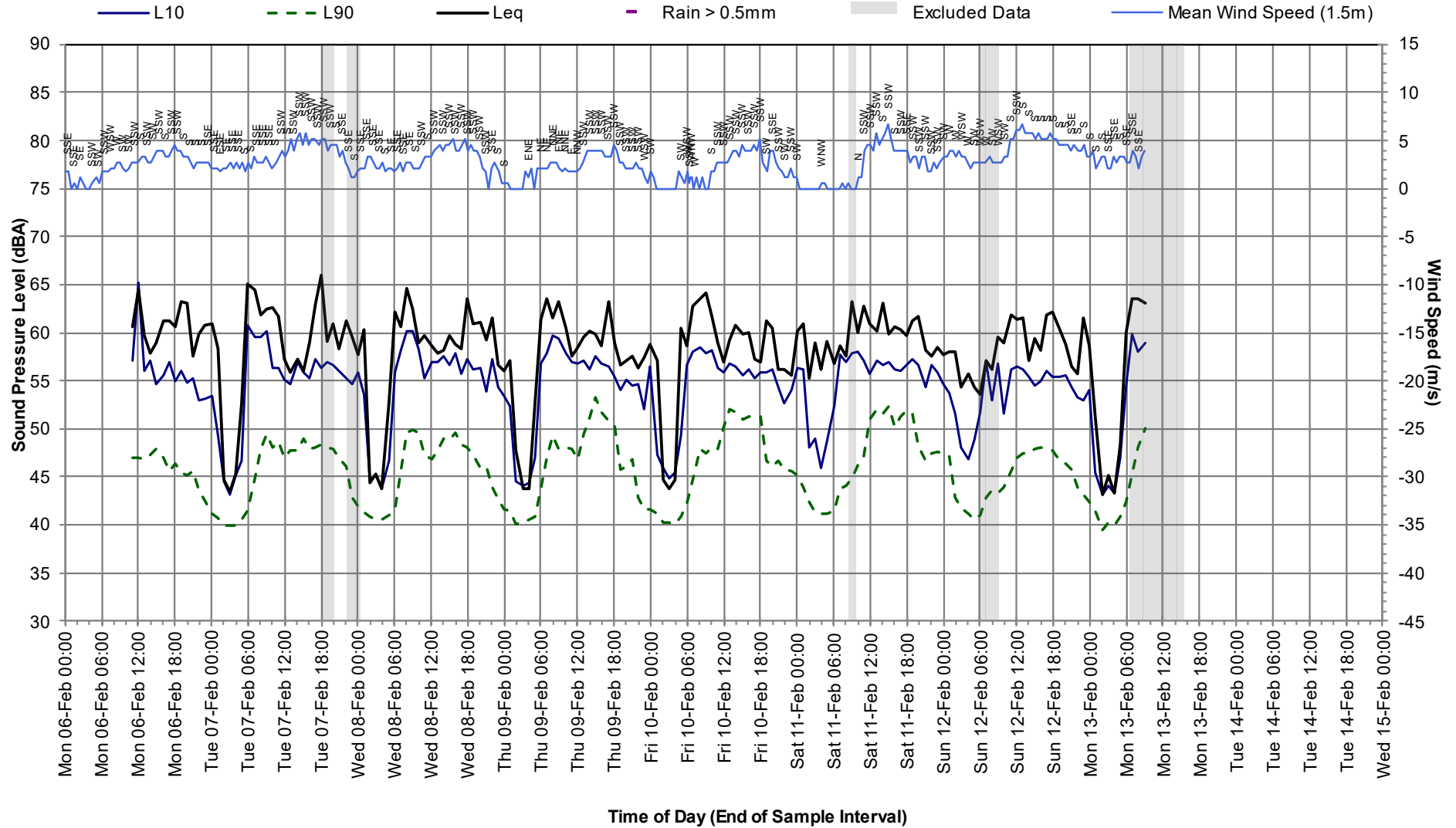
Location 4 - Wilkinson St- Monday, 6 February 2023




Noise Monitoring Location		Location 5				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Dawson St, Brunswick VIC 3056	Device Type	ARL Ngara		More than 3 m from any façade, near bush, close to car park		
	Serial Number	8781CD				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Mon, 06 Feb 2023	47	45	41	61	59	<p style="text-align: center;">Removed for privacy reasons</p>
Tue, 07 Feb 2023	(48)	47	42	61	57	
Wed, 08 Feb 2023	49	46	42	61	56	
Thu, 09 Feb 2023	50	45	41	60	57	
Fri, 10 Feb 2023	50	46	43	60	58	
Sat, 11 Feb 2023	(48)	48	44	61	57	
Sun, 12 Feb 2023		(45)	42	60	56	
Mon, 13 Feb 2023	49			63	-	
<b>Minimum</b>	<b>47</b>	<b>45</b>	<b>41</b>	-	-	
<b>Overall Average</b>	<b>49</b>	<b>46</b>	<b>42</b>	<b>61</b>	<b>57</b>	


# Statistical Ambient Noise Levels

Location 5 - Dawson St - Monday, 6 February 2023



Noise Monitoring Location		Location 6				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Wilson Avenue, Brunswick VIC 3056	Device Type	ARL Ngara		In corner of balcony, approximately less than 1 m from façade		
	Serial Number	8781C7				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Mon, 06 Feb 2023	44	45	39	67	60	<p style="text-align: center;">Removed for privacy reasons</p>
Tue, 07 Feb 2023	(44)	44	39	66	59	
Wed, 08 Feb 2023	45	43	41	66	59	
Thu, 09 Feb 2023	45	43	40	64	60	
Fri, 10 Feb 2023	45	44	40	65	59	
Sat, 11 Feb 2023	(44)	43	41	63	57	
Sun, 12 Feb 2023	-	(43)	40	63	64	
Mon, 13 Feb 2023	44	-	-	68	-	
<b>Minimum</b>	44	43	39	-	-	
<b>Overall Average</b>	44	44	40	66	60	

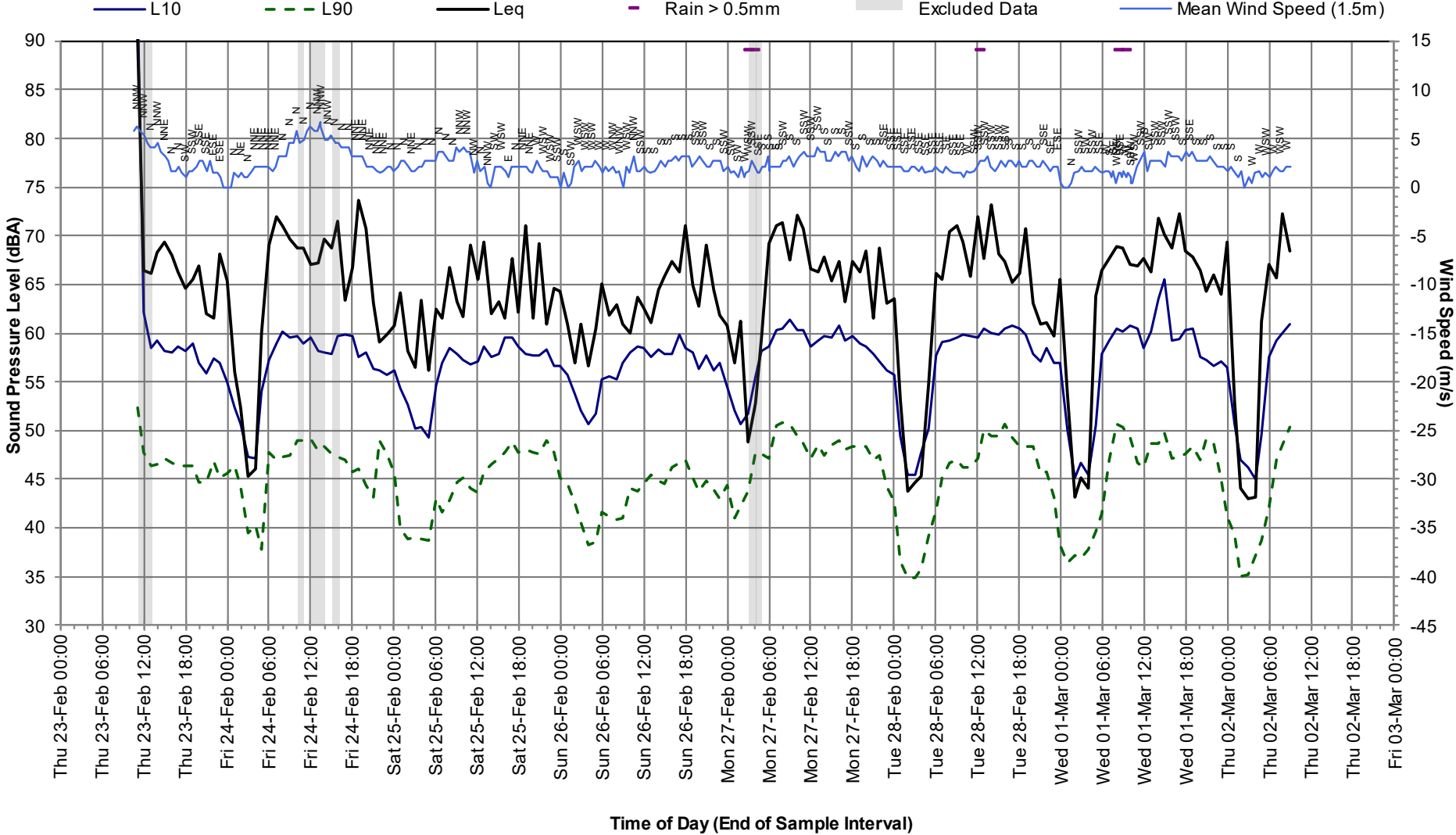



Noise Monitoring Location		Location 7				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
Brunswick Road, Brunswick VIC 3056	Device Type	ARL Ngara		Rear carpark (NW corner)		
	Serial Number	8781C7				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Thu, 23 Feb 2023	47	46	44	66	64	
Fri, 24 Feb 2023	(47)	46	41	69	61	
Sat, 25 Feb 2023	46	48	42	66	62	
Sun, 26 Feb 2023	-	44	45	65	65	
Mon, 27 Feb 2023	49	48	39	68	62	
Tue, 28 Feb 2023	48	47	40	69	62	
Wed, 01 Mar 2023	48	48	40	69	63	
Thu, 02 Mar 2023	49	-		70	-	
<b>Minimum</b>	<b>46</b>	<b>44</b>	<b>39</b>	<b>-</b>	<b>-</b>	
<b>Overall Average</b>	<b>48</b>	<b>47</b>	<b>42</b>	<b>68</b>	<b>62</b>	

Removed for privacy reasons

# Statistical Ambient Noise Levels

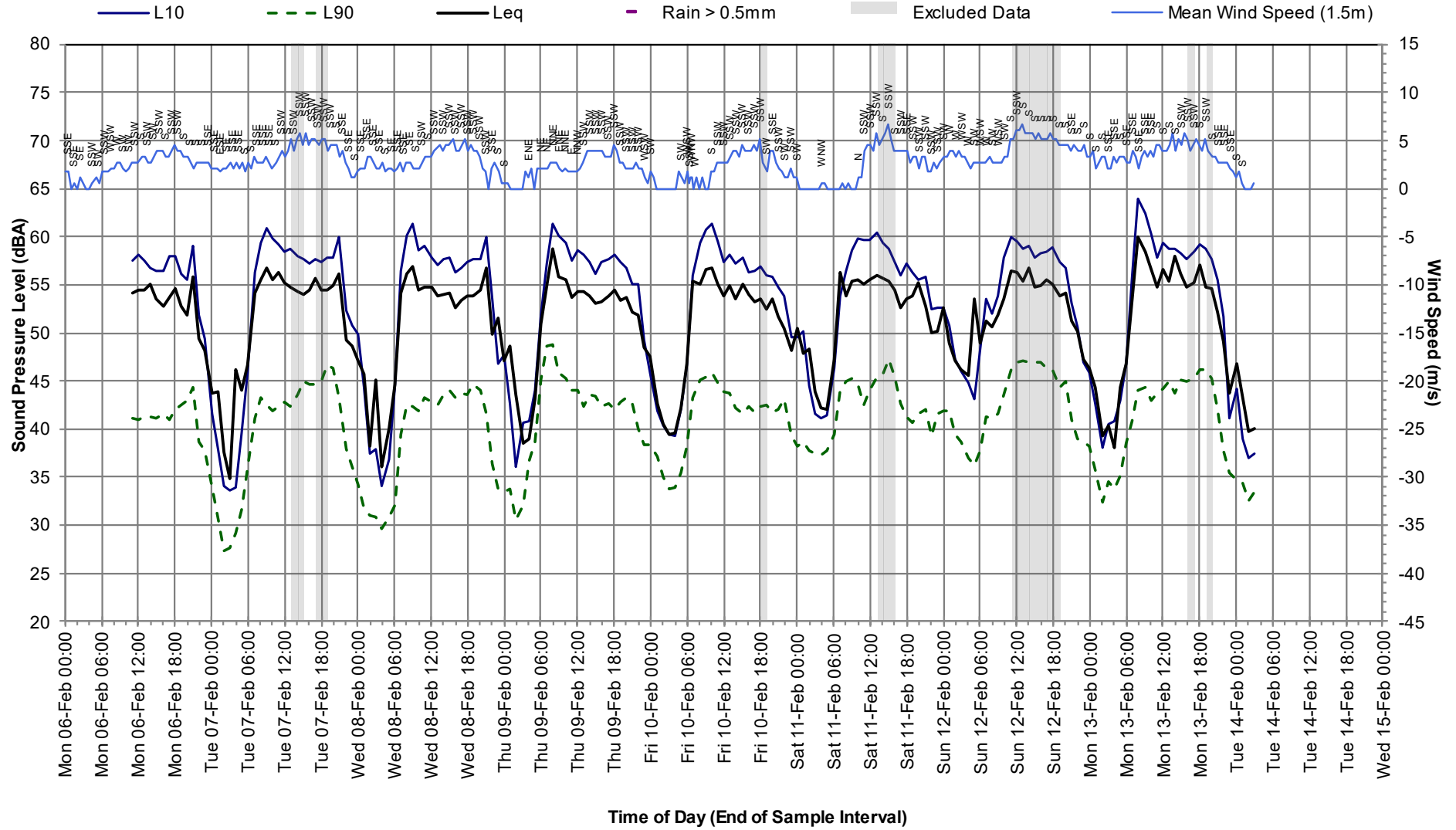
Location 7 - Brunswick Road - Thursday, 23 February 2023



Noise Monitoring Location		Location 8				Map of Noise Monitoring Location
Noise Monitoring Address	Noise Logger Device Info		Comments			
The Avenue, Parkville VIC 3052	Device Type	ARL Ngara		Approximately 2 m from north façade, less than 1 m from west façade. Close to fence line		
	Serial Number	8781DB				
Noise Logging Results		Noise Level (dBA)				Photo of Noise Monitoring
Date	L90 Day	L90 Evening	L90 Night	Leq 16 hr	Leq 8 hr	
Mon, 06 Feb 2023	41	42	33	54	45	<p style="text-align: center;">Removed for privacy reasons</p>
Tue, 07 Feb 2023	(43)	44	33	55	45	
Wed, 08 Feb 2023	43	42	37	55	48	
Thu, 09 Feb 2023	44	42	37	55	45	
Fri, 10 Feb 2023	44	42	39	54	47	
Sat, 11 Feb 2023	(44)	41	40	55	50	
Sun, 12 Feb 2023	-	(42)	36	54	44	
Mon, 13 Feb 2023	44	42	34	56	43	
<b>Minimum</b>	<b>41</b>	<b>41</b>	<b>33</b>	-	-	
<b>Overall Average</b>	<b>43</b>	<b>42</b>	<b>36</b>	<b>55</b>	<b>45</b>	

# Statistical Ambient Noise Levels

Location 8 - The Avenue - Monday, 6 February 2023







# Appendix B:

## Planning Map

# Planning Map











Brunswick

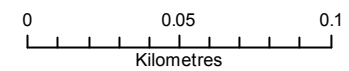
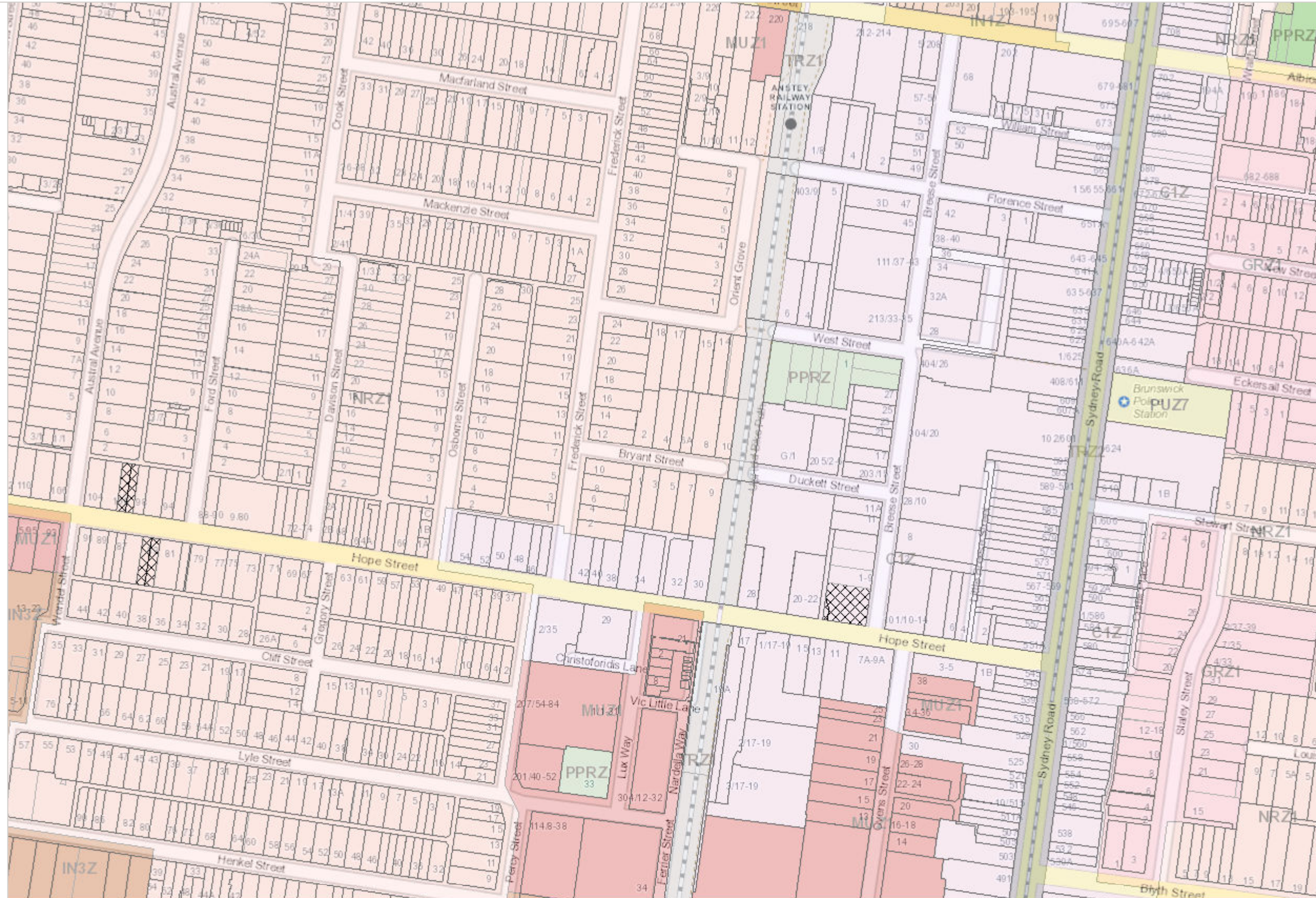
## Property

-  Properties
-  Parcel
-  Properties proposed
-  Parcel proposed

## All Zones

### Planning Scheme Zones

- Residential Zones**
-  MUZ - Mixed Use Zone
-  NRZ - Neighbourhood Residential Zone
-  GRZ - General Residential Zone
- Industrial Zones**
-  IN1Z - Industrial 1 Zone
-  IN3Z - Industrial 3 Zone
- Commercial Zones**
-  C1Z - Commercial 1 Zone
- Public Land Zones**
-  PUZ7 - Public Use Zone-Other Public Use
-  PPRZ - Public Park and Recreation Zone
-  TRZ1 - State Transport Infrastructure
-  TRZ2 - Principal Road Network



Map Projection: GDA 1994 VICGRID94  
Print Date: 2/10/2023



















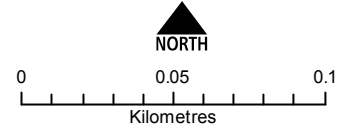
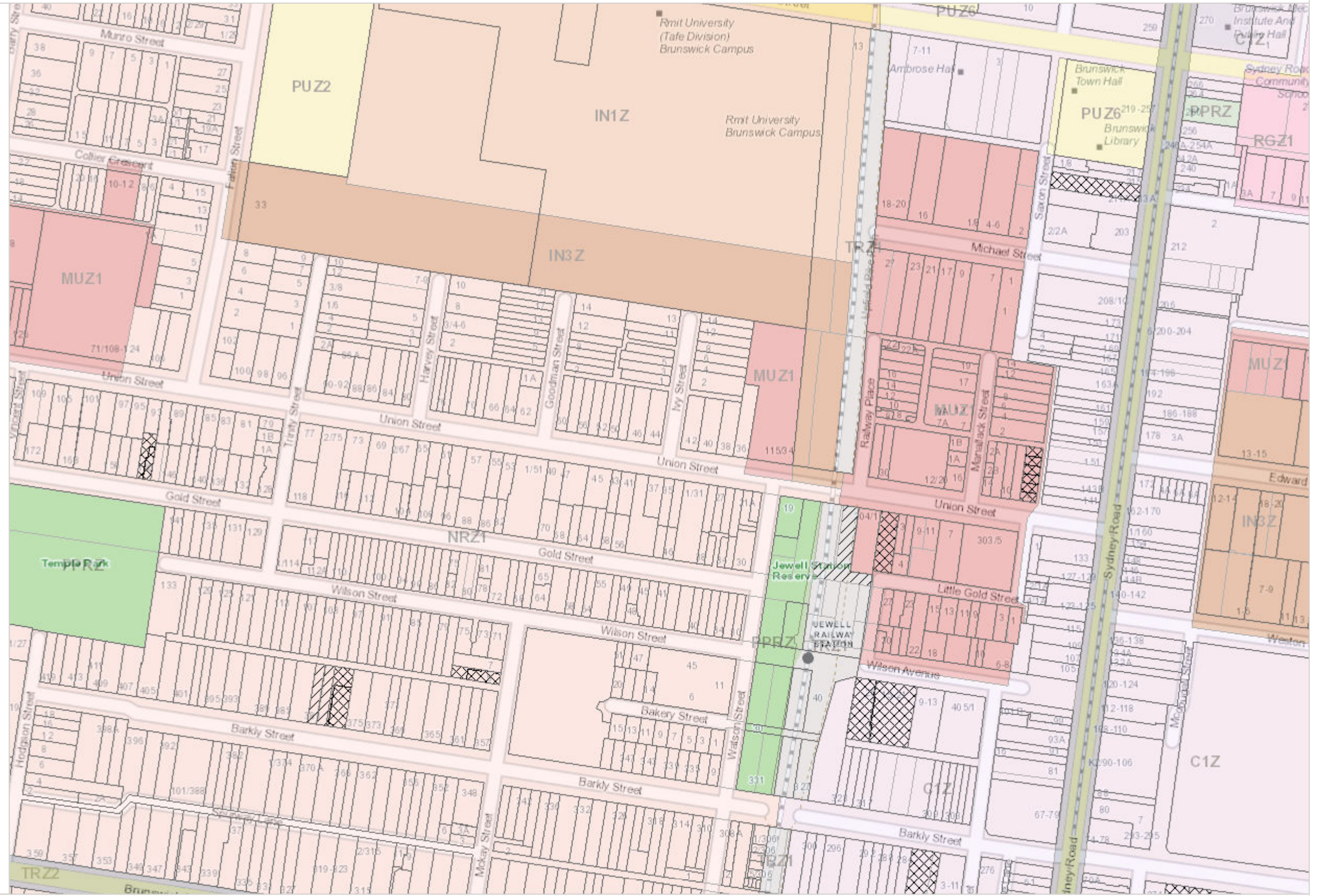
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# Planning Map

Brunswick

- Property**
-  Properties
  -  Parcel
  -  Properties proposed
  -  Parcel proposed
  -  All Zones
- Planning Scheme Zones**
- Residential Zones**
-  MUZ - Mixed Use Zone
  -  RGZ - Residential Growth Zone
  -  NRZ - Neighbourhood Residential Zone
  -  GRZ - General Residential Zone
- Industrial Zones**
-  IN1Z - Industrial 1 Zone
  -  IN3Z - Industrial 3 Zone
- Commercial Zones**
-  C1Z - Commercial 1 Zone
- Public Land Zones**
-  PUZ2 - Public Use Zone-Education
  -  PUZ6 - Public Use Zone-Local Government
  -  PPRZ - Public Park and Recreation Zone
  -  TRZ1 - State Transport Infrastructure
  -  TRZ2 - Principal Road Network



Map Projection: GDA 1994 VICGRID94  
Print Date: 2/10/2023



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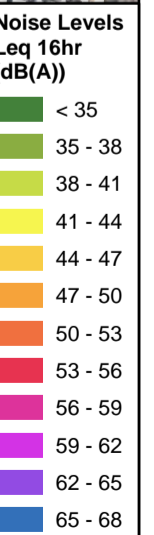
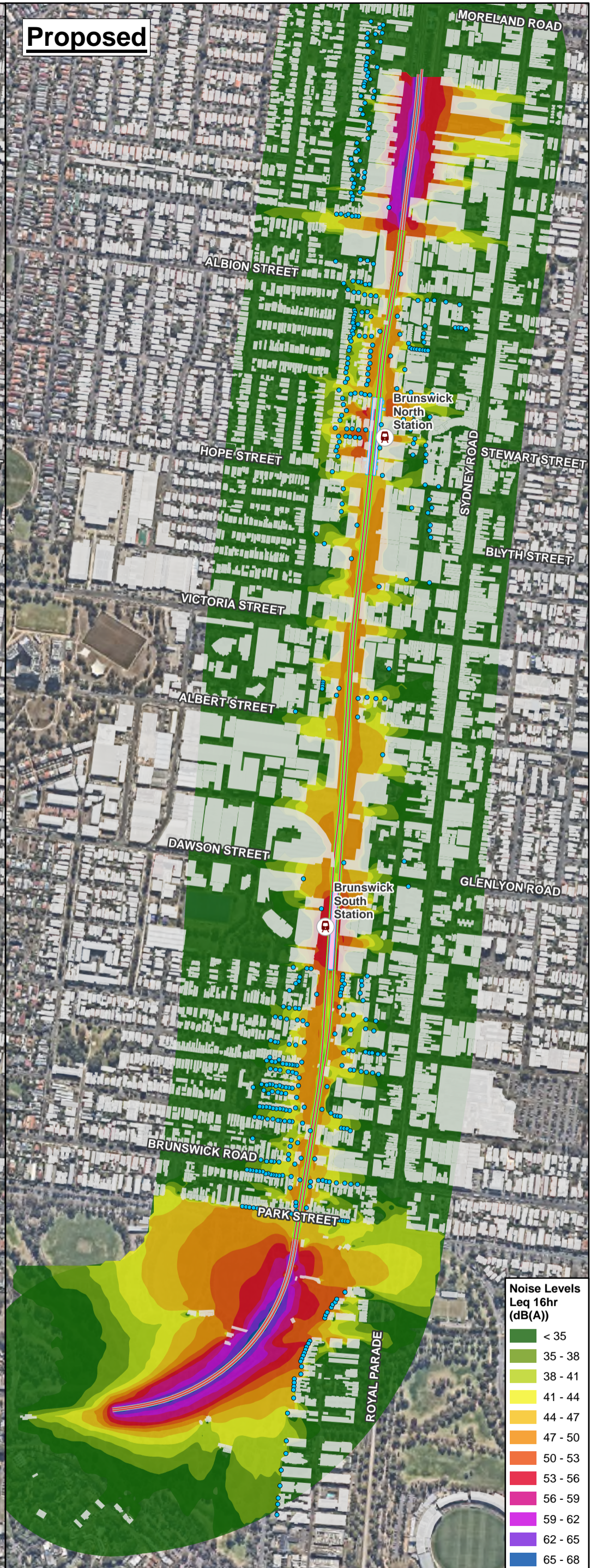
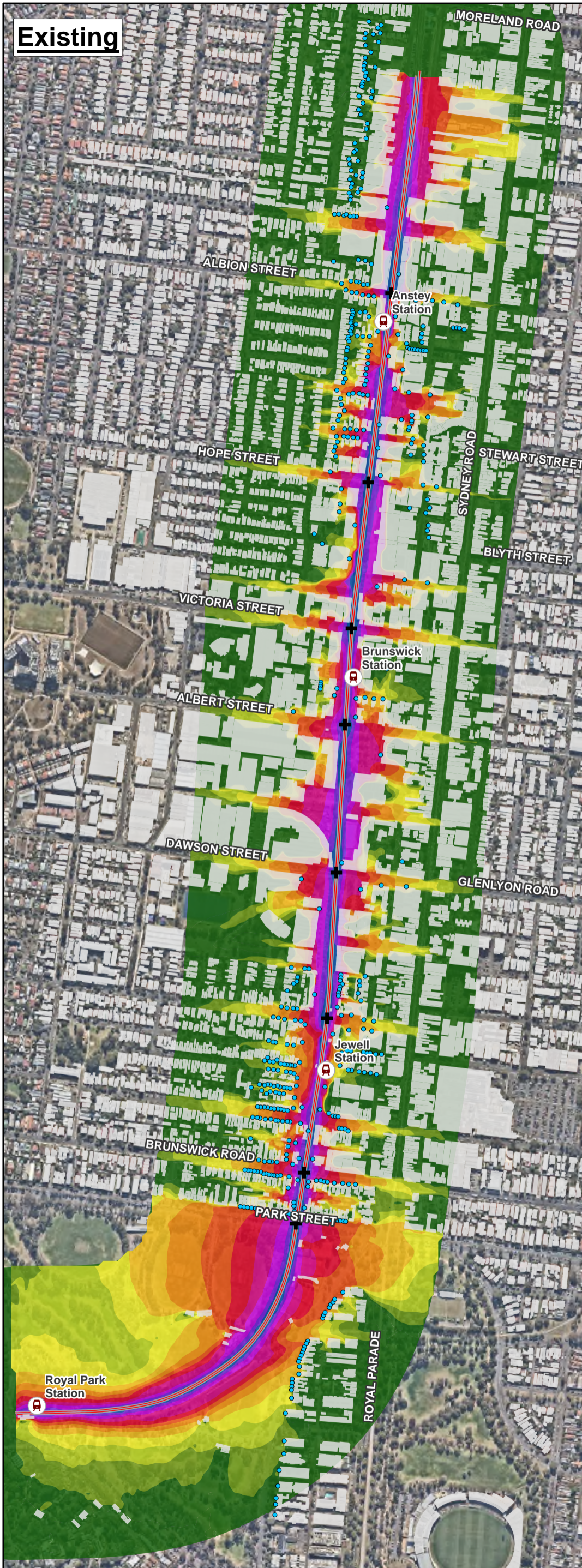
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# Appendix C:

## Noise Contour Maps

Existing

Proposed



Scale: 1:8,500 at A3  
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 03-Jul-2025  
Project Number: 640.30625

Service Layer Credits:  
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS  
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.  
Rail noise contours presented are calculated at 2 m above ground level.

**LEGEND**

- Point Receiver
- + Level Crossing
- Railway Emission Line
- Wall
- Railway Surface
- Floating Screen
- Building



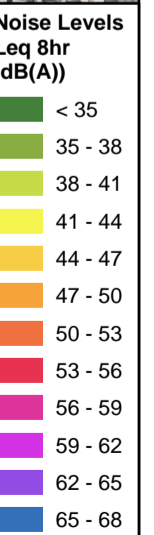
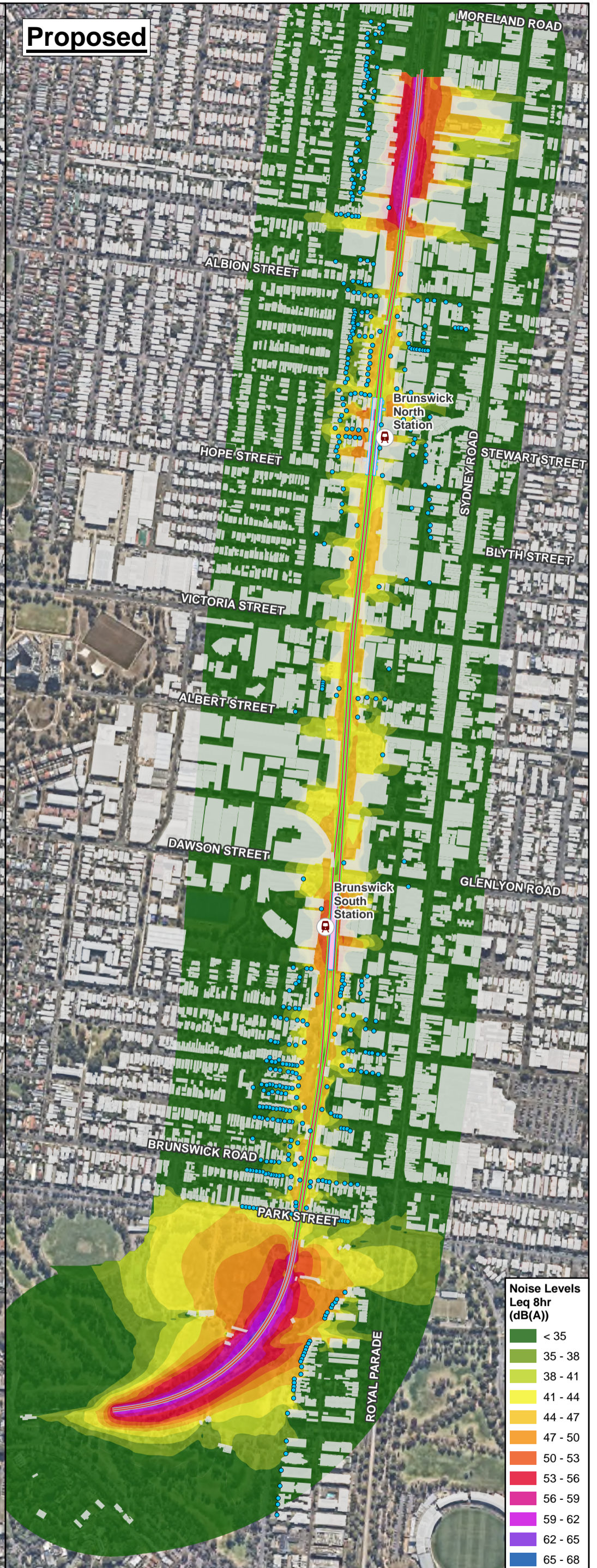
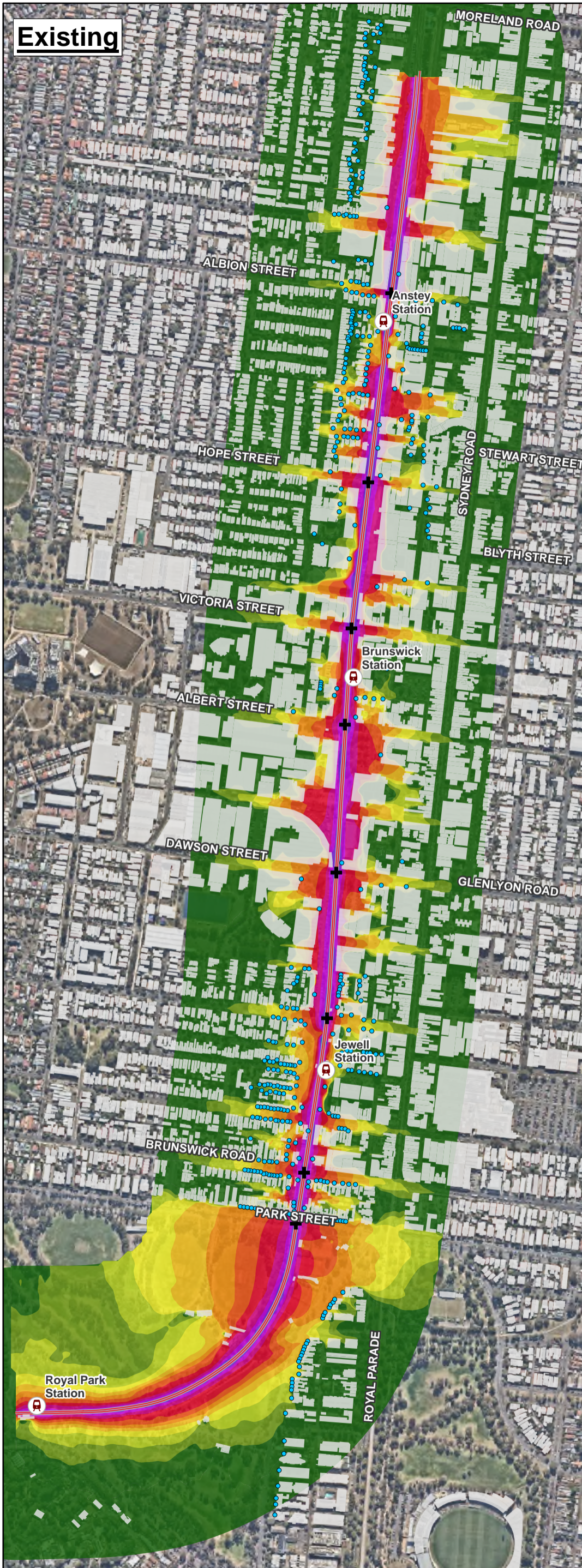
**BRUNSWICK LEVEL CROSSING  
REMOVAL PROJECT**

**RAIL NOISE CONTOUR – DAY**

Path: H:\Projects\SLR\640\MEL\640\MEL\_640\_30625\_00000\Brunswick Level Crossing noise assessment\06\_SLR\_Data\01\_CAD\GIS\GIS\Brunswick Level Crossing\An\Brunswick Level Crossing\An\aprx\64030625\_Brunswick\_Rail Noise Contour Day

Existing

Proposed



Scale: 1:8,500 at A3  
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 03-Jul-2025  
Project Number: 640.30625

Service Layer Credits:  
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS  
DISCLAIMER: All information within this document may be based on external sources. SLR Consulting Pty Ltd makes no warranty regarding the data's accuracy or reliability for any purpose.  
Rail noise contours presented are calculated at 2 m above ground level.

**LEGEND**

- Point Receiver
- + Level Crossing
- Railway Emission Line
- Wall
- Railway Surface
- Floating Screen
- Building

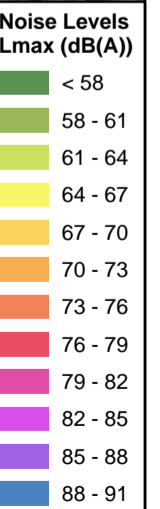
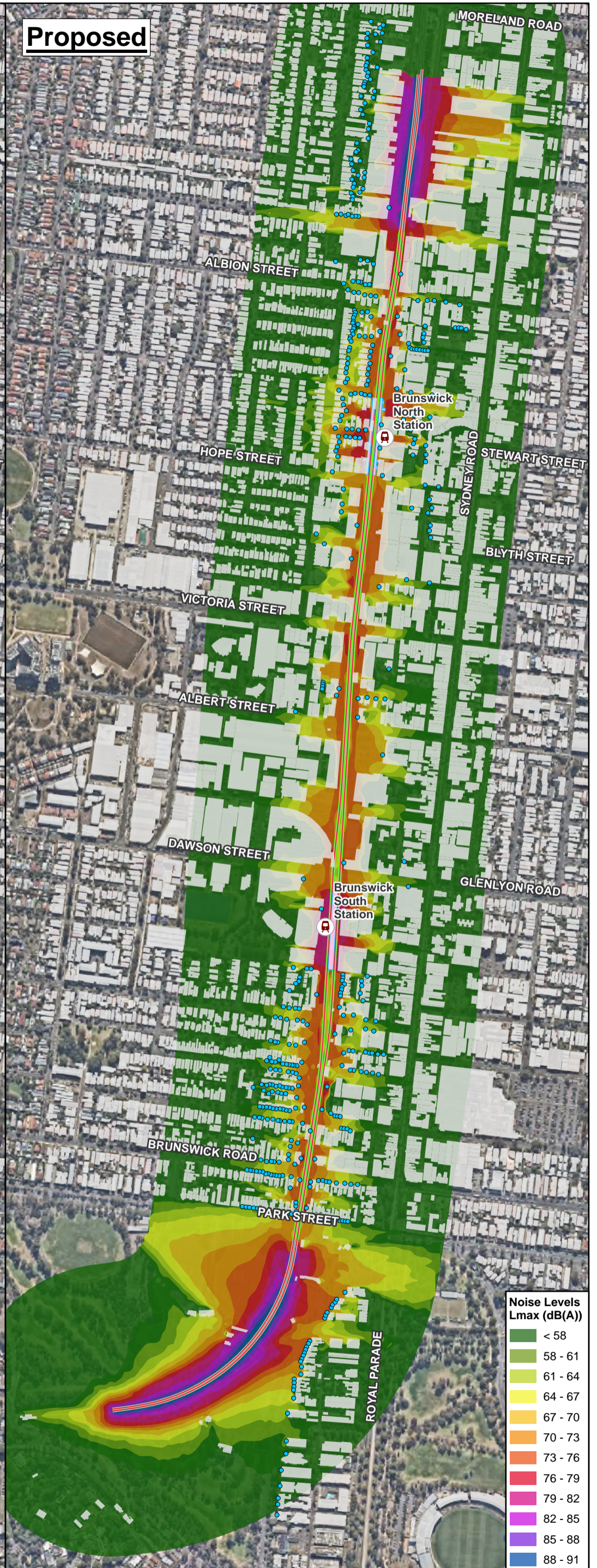
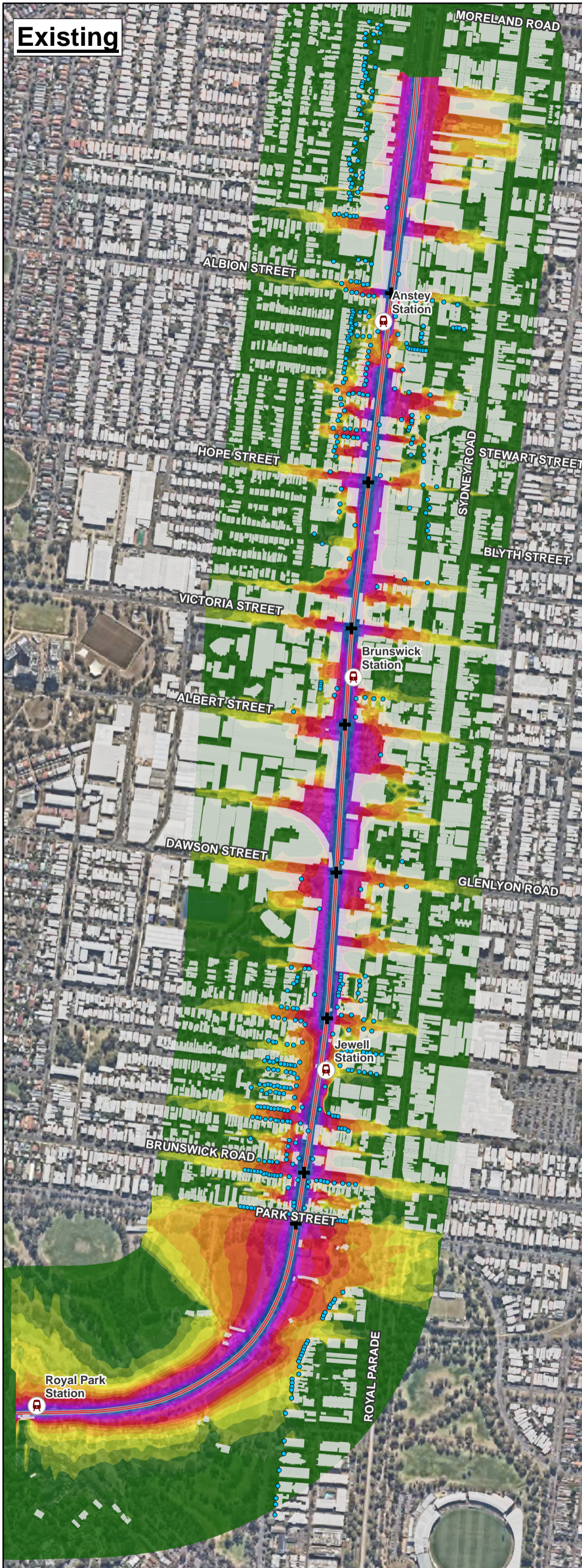
**BRUNSWICK LEVEL CROSSING  
REMOVAL PROJECT**

**RAIL NOISE CONTOUR – NIGHT**



Existing

Proposed



Scale: 1:8,500 at A3  
 Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 04-Jul-2025  
 Project Number: 640.30625

**SLR**

Service Layer Credits:  
 Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS

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Rail noise contours presented are calculated at 2 m above ground level.

**LEGEND**

- Point Receiver
- ⊕ Level Crossing
- ⊕ Railway Emission Line
- ⊕ Wall
- ▬ Railway Surface
- ▬ Floating Screen
- ▬ Building

**BRUNSWICK LEVEL CROSSING  
 REMOVAL PROJECT**

**RAIL NOISE CONTOUR – Lmax**

Path: H:\Projects\SLR\640\MEL\640\MEL\_640\_30625\00000\Brunswick Level Crossing noise assessment\06\_SLR\_Data\01\_CAD\GIS\GIS\Brunswick Level Crossing\An\Brunswick Level Crossing\An\aprx\64030625\_Brunswick\_Rail Noise Contour Lmax

