# Noise Impact Assessment Report
# 29 Shirley Street, Byron Bay

LGC Properties Pty Ltd

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## Acoustics Glossary

| | |
|---|---|
| **A-weighting** | Correction to sound levels to mimic the response of the human ear at low sound frequencies. |
| **AADT** | Annual average daily traffic. The total traffic flow over a 24 hour period along a specific segment of road. |
| **Broadband sound** | Sound distributed across the whole audible frequency range. |
| **Decibel (dB)** | (1) Degree of loudness (2) A unit for expressing the relative intensity of sounds on a scale from zero for the average least perceptible sound to about 130 for the average pain level. A unit used to express relative difference in power or intensity, between two acoustic signals, equal to ten times the common logarithm of the ratio of the two levels, one of which is a standard reference value. |
| **dB(A)** | The A-weighted sound pressure level. |
| **Façade adjusted** | The noise level at 1m from a building façade is calculated by adding 2.5dB to the free-field noise level to account for sound reflected from the building façade. The external noise levels at the buildings facades are "façade-adjusted". |
| **Free-field** | Noise level without any reflected sound from buildings or other hard, reflective surfaces (except for the ground plane). |
| **Hz (Hertz)** | Hertz is the standard measure of the frequency of oscillations in a wave motion. The frequency is most often measured in cycles per second (cps) or Hertz (Hz). Frequency of 1 Hz is one cycle per second. |
| **Impulsive noise and impulsiveness adjustment** | Noise having a high peak of short duration or a sequence of such peaks. Impulsive noise is present if the difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2dB. Impulsiveness adjustment (penalty) of up to 5dB should be applied to the component noise level. |
| **$L_{Amax,T}$** | The maximum A-weighted sound pressure level occurring in a specified time period T in seconds. |
| **$L_{Aeq,T}$** | "Average-energy" sound level used in situations where sound varies over time. $L_{Aeq,T}$ is the A-weighted sound pressure level that has the same energy as the fluctuating sound over the time period T sec. |
| **$L_{A01,T}$** | Measure of the maximum sound level. $L_{A01,T}$ is a statistical parameter that is the A-weighted sound pressure level that is exceeded for 1% of the measurement time T. |
| **$L_{A10,T}$** | $L_{A10,T}$ is a statistical parameter that is the A-weighted sound pressure level that is exceeded for 10% of the measurement time T. |
| **$L_{A90,T}$** | Background sound level. $L_{A90,T}$ is a statistical parameter that is the A-weighted sound pressure level that is exceeded for 90% of the measurement time T. |
| **$L_{A10,18hr}$** | The arithmetic average of the 18 individual $L_{A10,1hr}$ values between 6:00am and 12:00am (midnight). It is a derived descriptor which is used as a main traffic noise descriptor in the Calculation of Road Traffic Noise (CoRTN) procedure developed by the UK Department of Environment, Welsh Office, HMSO, 1988 |
| **Noise** | Unwanted sound. |

| | |
|---|---|
| **Octave bands and 1/3 octave bands** | A range of frequencies whose upper frequency limit is twice that of its lower frequency limit. In acoustics, the audible spectrum (20Hz to 20kHz) is divided into 10 parts (octaves) with centre frequencies of 31.5Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz and 16kHz.<br><br>For more detailed frequency analysis, octave bands are further divided into more discrete bands. For examples, 1/3 octaves bands are is where each octave band is divided into three parts.<br><br>IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave band filters* |
| **Rating Background Level (RBL)** | Lowest tenth percentile of the $L_{A90,T}$ background noise levels over an assessment period. |
| **Sound power** | The sound energy radiated per unit time by a sound source, measured in Watts (W). |
| **Sound Power Level, $L_w$ (SWL)** | Logarithmic measure of sound power on a decibel scale, referenced to the human hearing threshold of $1 \times 10^{-12}$ W. |
| **Sound pressure** | The fluctuations in air, measured in Pascals (Pa). |
| **Sound Pressure Level, $L_p$ (SPL)** | Logarithmic measure of sound pressure on a decibel scale, referenced to the human hearing threshold of $2 \times 10^{-5}$ Pa. |
| **Tonal noise, tonality and tonality adjustment** | Tonal noise is characterised by one or more distinct frequency components (“tones”) that emerge audibly from the total sound. For example, distinct tones may be emitted by fans, saws, grinders and other equipment. Tonal noise is generally far more annoying than non-tonal noise. Presence of tonal sound (“tonality”) can be identified by analysing the sound levels in adjacent 1/3 octave bands.<br><br>AS1055.1-1997 and the DEHP Noise Measurement Manual 2013 provides guidance on how tonality should be assessed. If tonal components are clearly audible and they can be detected by 1/3 octave analysis (1/3 octave band exceeds neighbouring bands by at least 5dB), tonality adjustment (penalty) of up to 5dB should be applied to the component noise level. |
| **Weighted Sound Reduction Index ($R_w$)** | A single-number quantity which characterises the airborne sound insulation of a material or building element over a range of frequencies. |

## Vibration Glossary

| | |
|---|---|
| **Acceleration** | The rate of change of the speed of an element. |
| **Airborne vibration** | Structural vibration induced by low frequency sound. |
| **Airblast Overpressure** | The sudden increase in air pressure generated by a shock wave, produced when an explosive is detonated. |
| **Continuous vibration** | A vibration source that is continuous in nature during an assessment period (maybe constant or variable). |
| **Component Particle Velocity (component PV)** | The instantaneous particle velocity of a particle at each orthogonal component axis. |
| **Crest factor** | The ratio between the peak amplitude and the maximum RMS amplitude of a signal. |
| **Displacement** | The distance that an element moves away from its static position. |
| **Frequency** | Number of oscillations per second (in units of Hz). |
| **Geophone** | Transducer that converts ground or building motion into a voltage reading for measuring vibration levels. |
| **Impulsive vibration** | A vibration source (continuous or intermittent) which has a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of oscillation (depending on frequency and damping) |
| **Intermittent vibration** | Intermittent vibration can be defined as interrupted periods of continuous (for example, a drill) or repeated periods of impulsive vibration (for example, a pile driver), or continuous vibration that varies significantly in magnitude. |
| **Peak Component Particle Velocity (PCPV)** | The maximum instantaneous velocity of a particle in any one of the three orthogonal component axis directions during a given time interval. Also represented by the notation $v_i$ in DIN4150-3. |
| **Peak Particle Velocity (Resultant PPV)** | The maximum instantaneous velocity of a particle at a point during a given time interval being the vector sum of component velocities in three orthogonal directions (x, y, z). |
| **Peak Particle Acceleration (PPA)** | Maximum instantaneous particle acceleration (in units of $m/s^2$) recorded over the measurement interval. |
| **Velocity** | The instantaneous speed of an element, |
| **Vibration** | Vibration of the ground or of structures and buildings; that is, the oscillatory displacement of the ground or of structures and buildings. |

# 1. Introduction

## 1.1 Project Background

ATP Consulting Engineers (ATP) was engaged to carry out noise impact assessment for the proposed development at 29 Shirley Street in Byron Bay.

This report presents the results of the investigation of the acoustic constraints as potential vibration impacts on the proposed development imposed by the site location and proximity to the Murwillumbah railway line. In addition, the potential noise impact from the proposed development on the nearest noise sensitive places was assessed as per the requirements of the *Noise Policy for Industry (2017).*

## 1.2 Study Objectives

Study objectives are as follows:

- Site visit and establishment of an automated noise logger at the subject site to record the existing background noise levels and to obtain railway noise data.
- Site visit and establishment of an automated vibration logger at the subject site to record vibration data associated with the nearby railway line
- Assessment of potential noise and vibration impacts at the subject site associated with the nearby railway line.
- Calculation of the operational noise emissions associated with the activities at the development and assessment of the potential noise impact on the nearest noise sensitive places.
- Recommendation of noise mitigation measures to prevent noise impact from the activities associated with the established development on the nearest noise sensitive places.

## 1.3 Subject Site

The proposed development is located at 29 Shirley Street in Byron Bay within the Byron Shire Council (BSC) local government area on the land described as the following:

- Lot 1 on DP780935,
- Lot 10 on DP1153734,
- Lot 1 and 2 on DP582819,
- Lots 8 and 9, Section 52 on DP758207,
- Lot 7, 8 and 9 on DP841611,
- Lot 11 and 12 on DP1138310.

The site is located adjacent to the Murwillumbah railway line and is presented in Figure 1.1.

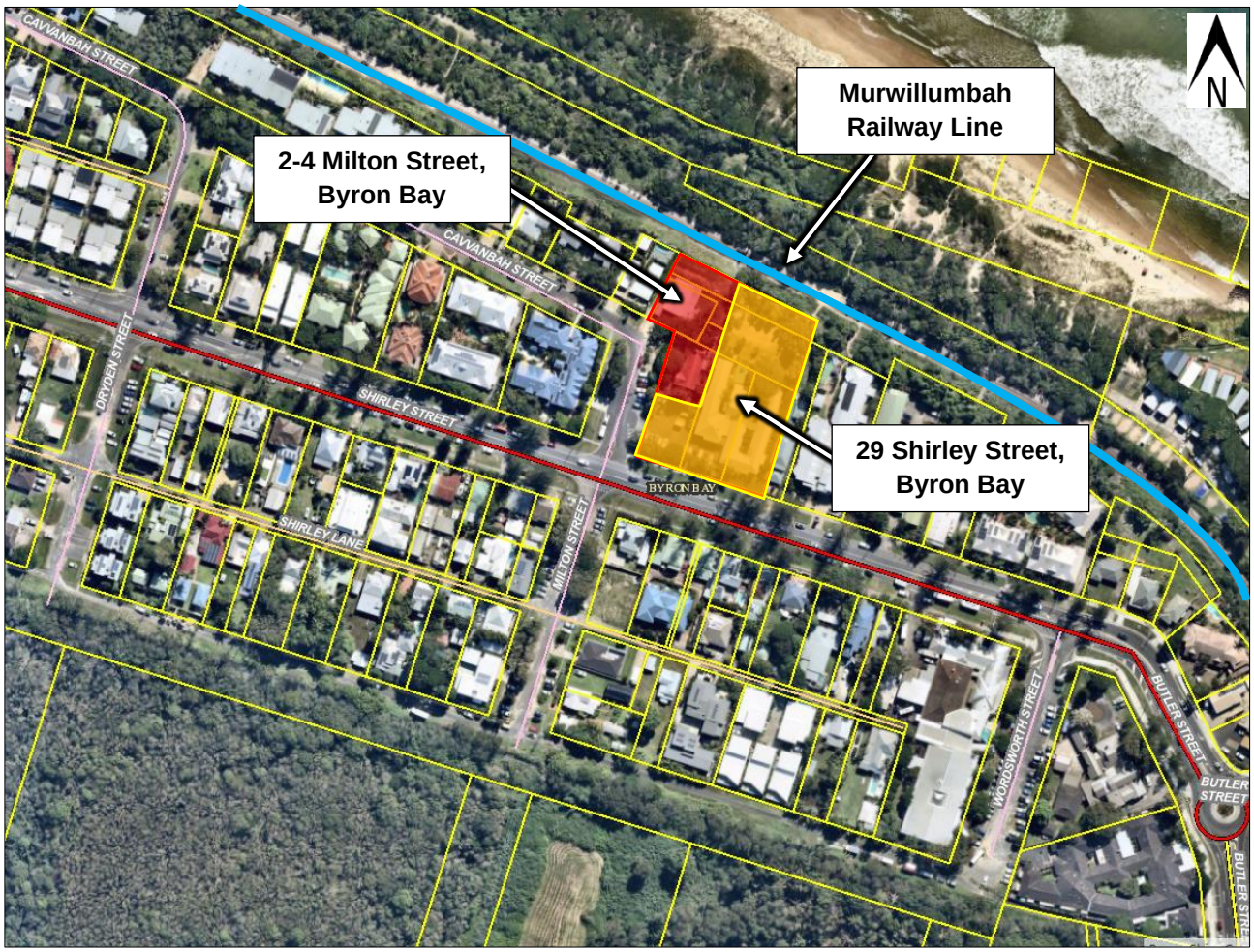



**Figure 1.1 Site location**

The Murwillumbah railway has closed and no longer serves as a rail corridor for passenger or freight trains. Clause 230 of the *Transport Administration Amendment (Closures of Railway Lines in Northern Rivers) Bill 2020* states that the rail line may only be leased for recreation, tourism or community and related purposes. The rail line is not capable of of accommodating heavy rail.

Currently, the only train operating on the railway line is the lightweight *Byron Solar Train* which has a non-exclusive license to run on these lines.

## 1.4 Proposed Development

The proposed development consists of three, three-storey building with 26 residential units:

- One level of basement car parking (78 Spaces);
- Ground floor containing nine units, pool and communal recreation area;
- Level 1 containing nine units;
- Level 2 containing eight units; and
- Roof deck containing nine rooftop terraces.

The site and floor plans of the proposed development are presented in Appendix A.

# 2. Existing Noise Amenity

## 2.1 Site-specific Noise Measurements

Noise monitoring was carried out at the subject site to obtain information about the existing light rail and background noise levels during day, evening and night time.

The noise measurement methodology is summarised in Table 2.1.

**Table 2.1 Noise measurements**

| | |
|---|---|
| **Relevant legislation, standards and guidelines** | The noise measurements were carried out in accordance with:<br>• Australian Standard AS 1055-2018 (*Acoustics – Description and measurement of environmental noise*);<br>• Australian Standard AS 2702-1984 (*Acoustics – Methods for measurement of road traffic noise*);<br>• Australian Standard AS 2377-2002 (*Acoustics – Methods for the measurements of railbound vehicle noise*); and<br>• International Standard ISO 3095:2013 (*Acoustics – Railway applications – Measurement of noise emitted by railbound vehicles*). |
| **Measurement locations** | The noise measurements were carried out at the subject site at 29 Shirley Street in Byron Bay. The noise logger was set up towards the north of the subject site, facing the Murwillimbah railway line.<br>The noise measurement location is presented in Figure 2.1.<br>Photos showing the unattended noise measurement location are presented in Appendix B. |
| **Measurement period** | Continuous noise monitoring was carried out 24 hours a day from 11 to 20 February 2022. |
| **Measurement equipment** | The following noise measurement equipment was used during the unattended measurements:<br>• Environmental noise logger – ARL Ngara (Serial No. #878157); and<br>• Calibration – RION NC-74 sound level calibrator (serial no. 34615224).<br>The noise measurement instruments conform to Australian Standard AS/NZS IEC61672.1-2019. Calibration was performed during set up and download of the data from the noise logger. The calibration drift was <0.1 dB(A). |
| **Meteorological conditions** | Rainfall was recorded during the the monitoring period. Data affected by rainfall was disregarded in determination of the average background noise levels and Rating Background Levels (RBL).<br>Full meteorological data[1] for the monitoring periods are presented in Appendix C. |

[1] Bureau of Meteorology (BoM) daily weather observations as recorded at the Byron Bay (Cape Byron AWS) meteorological station (058216).

| | |
|---|---|
| **Analysis of data** | **Light Rail Noise Assessment:**<br>The noise measurement data was analysed to determine the following light rail noise descriptors:<br>• **$L_{Aeq,pass\text{-}by}$:** The $L_{eq,pass\text{-}by}$ sound pressure level is the average energy noise level during the length of the time of the train pass-by event.<br>**Operational Noise Assessment:**<br>The noise measurement data was analysed to determine the following operational noise descriptors:<br>• **$L_{A90,T}$**: Background noise level during daytime (7am to 6pm), evening (6pm to 10pm) and nighttime (10pm to 7am).<br>• **RBL:** Rating Background Level during day-time (7am to 6pm), evening (6pm to 10pm) and night-time (10pm to 7am). The RBL was calculated from the $L_{A90,15min}$ noise levels using the procedure described in the NSW *Noise Policy for Industry*. The RBL noise levels are used to determine the Background Creep noise criteria as per Section 5 of this report |


**Figure 2.1 Noise measurement location**

## 2.2 Light Rail Noise Measurements

The Byron Solar Train operates at a maximum of twenty services per day. The loudest pass-by event recorded everyday during the noise measurement period, is presented in Table 2.2.

**Table 2.2 Measured railway noise levels**

| Date | Time of train pass-by | Railway noise level, dB(A) |
|---|---|---|
| | | $L_{Aeq,pass\text{-}by}$ |
| 12 Feb 2022 (Sat) | 5:05 PM | 64 |
| 13 Feb 2022 (Sun) | 3:06 PM | 64 |
| 14 Feb 2022 (Mon) | 12:18 PM | 62 |
| 15 Feb 2022 (Tue) | 11:17 AM | 62 |
| 16 Feb 2022 (Wed) | 11:09 AM | 65 |
| 17 Feb 2022 (Thu) | 5:17 PM | 64 |
| 18 Feb 2022 (Fri) | 11:18 AM | 62 |
| 19 Feb 2022 (Sat) | 5:17 PM | 65 |
| **Arithmetic average** | | **63** |

## 2.3 Operational Noise Measurements

The results of the background noise monitoring undertaken from 11 to 19 February 2022, and the RBLs, which were calculated as per the procedure in NSW *Noise Policy for Industry* are presented in Table 2.3 and Appendix D.

**Table 2.3 Measured background noise levels**

| Date | Background noise levels $L_{90}$ dB(A) | | | Assessment Background Levels (ABL) dB(A) | | |
|---|---|---|---|---|---|---|
| | $L_{90,11hr}$ day (7am–6pm) | $L_{90,4hr}$ evening (6pm–10pm) | $L_{90,9hr}$ night (10pm–7am) | $L_{90,11hr}$ day (7am–6pm) | $L_{90,4hr}$ evening (6pm–10pm) | $L_{90,9hr}$ night (10pm–7am) |
| 11 Feb 2022 (Fri) | — | — | 44 | — | — | 43 |
| 12 Feb 2022 (Sat) | 48 | 49 | 45 | 46 | 48 | 43 |
| 13 Feb 2022 (Sun) | 46 | 50 | 48 | 45 | 48 | 46 |
| 14 Feb 2022 (Mon) | 47 | 53 | 48 | 45 | 48 | 47 |
| 15 Feb 2022 (Tue) | 47 | 51 | 46 | 45 | 49 | 43 |
| 16 Feb 2022 (Wed) | 46 | 51 | 45 | 45 | 49 | 43 |
| 17 Feb 2022 (Thu) | 47 | 53 | 49 | 45 | 51 | 47 |
| 18 Feb 2022 (Fri) | 48 | 54 | 44 | 45 | 47 | 42 |
| 19 Feb 2022 (Sat) | 45 | 50 | 44 | 43 | 46 | 42 |
| **Arithmetic Average** | **47** | **51** | **46** | **—** | **—** | **—** |
| **Rating Background Level (RBL)** | | | | **45** | **48** | **43** |

**Data for periods of inclement weather were disregarded in determination of average noise levels.*

# 3. Light Rail Noise Impact Assessment

## 3.1 Railway Noise Criteria

The NSW *State Environmental Planning Policy (Transport and Infrastructure)* (SEPP) 2021 specifies internal noise levels which should be achieved in relation to railway pass-by events.

The applicable external noise triggers for residential land uses is presented in Table 3.1

**Table 3.1 Airborne railway noise limits for residential land uses**

| Sensitive receptor | Location | Period | Railway noise limits $L_{Aeq,pass\text{-}by}$ dB(A) |
|---|---|---|---|
| Bedroom | Indoors | Night (10:00pm – 7:00am) | 35 |
| Habitable rooms | | At any time | 40 |
| Bedrooms | Outdoors | Night (10:00pm – 7:00am) | 42 (35 + 7) |
| Habitable rooms | | At any time | 47 (40 + 7) |

The following is noted regarding the railway noise criteria:

- The *SEPP 2021* does not specify outdoor noise criteria for dwellings. However, the outdoor noise criteria have been derived from the internal criteria, assuming 7dB noise reduction by the building envelope with windows open[2].

## 3.2 Rail Noise Calculation Methodology

Light rail noise levels at the development were calculated using SoundPLAN noise propagation modelling software.

SoundPLAN calculates light rail noise using the Nord 2000 railway noise prediction method.

The assumptions and data used in development of the light rail noise propagation model are presented in Table 3.3.

**Table 3.2 Data and assumptions – Light rail noise model**

| | |
|---|---|
| **Terrain** | • Department of Natural Department of Natural Resources and Mines Airborne Laser Scanning (LiDAR) 1 metre data was used to determine the elevation of the development relative to the surroundings. |
| **Buildings** | • The existing buildings at 29 Shirley Street were included in the model, along with the buildings adjacent to the development site.<br>• The development layout is presented in Appendix A. |

[2] Typical noise reduction for windows partially open, *Planning for Noise Control Guideline*, QLD Dept. of Environment and Science (DES).

| | |
|---|---|
| **Light rail traffic** | • The Murwillimbah railway line currently only carries the light-weight Byron Solar Train.<br>• The Murwillimbah railway line has one rail line as it passes the development site.<br>• The assumed speed of the Byron Solar Train used for this assessment is 40 km/hr.<br>• The assumed length of the Byron Solar Train used for this assessment is 40m.<br>• Current light rail traffic volumes[3] on the line as it travels past the proposed development are as follows:<br>  ○ 7:00am to 10:00pm: 20 pass-by events (combined northbound and southbound direction); and<br>  ○ 10:00pm to 7:00am: No train pass-by events.<br>• No specific information related to future traffic predictions for the Byron Solar Train is available. It was assumed that no significant increase in volume, speed and vehicle type is expected within a 10-year planning horizon. |
| **Receivers** | • **Building Façades:** Receivers were attached to the façades of the building at a height of 1.5m above the first-floor level.<br>• SoundPLAN adds +2.5dB(A) to the calculated noise levels when the receivers are attached to the buildings, thus the tabulated light rail noise levels are façade adjusted.<br>• 1m grid spacing was used for calculation of noise contour maps. |
| **Calculation procedure** | • Nord 2000 |
| **Noise mitigation measures** | • Noise mitigation measures are discussed in further detail in Section 6 of this report. |

## 3.3 Light Rail Noise Model Validation

The light rail noise data recorded on site (as presented in Table 2.3) was used to validate the accuracy of the SoundPLAN model.

The results of the SoundPLAN model validation are presented in Table 4.3 and in Appendix E.

**Table 3.3 SoundPLAN light rail noise model validation results**

| Measurement location | Measured* $L_{eq,pass\text{-}by}$ dB(A) | Calculated* $L_{eq,pass\text{-}by}$ dB(A) | Difference dB | Validation factor |
|---|---|---|---|---|
| Noise logger | 63 | 63 | ±0 | N/A |

**Free-field*

Excerpt from the 3D SoundPLAN light rail noise propagation model is presented in Figure 3.1.

[3] Timetable for Byron Solar Train. Source: Byron Solar Train website – https://byronbaytrain.com.au/


Figure 3.1 3D light rail noise model – SoundPLAN excerpt

## 3.4 Light Rail Noise Propagation Results

### 3.4.1 External Façades

The calculated light rail noise levels at the most exposed façades of the future residential units at 29 Shirley Street, are presented in Table 3.4.

Table 3.4 Light rail noise levels at façades

| Location | Floor | Façade | $L_{eq,pass\text{-}by}$ assessment Day (7:00am to 10:00pm) | |
|---|---|---|---|---|
| | | | $L_{eq,pass\text{-}by}$ dB(A)* | Compliance with noise criterion of ≤47dB(A) $L_{eq,pass\text{-}by}$ |
| Unit 001 | G F | E | 49 | No |
| | | N | 50 | No |
| | | S | 7 | Yes |
| | | W | 24 | Yes |
| Unit 002 | | E | 45 | Yes |
| | | N | 49 | No |
| | | S | 7 | Yes |

| Location | Floor | Façade | $L_{eq,pass\text{-}by}$ assessment Day (7:00am to 10:00pm) | |
|---|---|---|---|---|
| | | | $L_{eq,pass\text{-}by}$ dB(A)* | Compliance with noise criterion of ≤47dB(A) $L_{eq,pass\text{-}by}$ |
| Unit 003 | | N | 47 | Yes |
| | | S | 7 | Yes |
| Unit 004 | | N | 46 | Yes |
| | | S | 3 | Yes |
| | | W | 43 | Yes |
| Unit 005 | | N | 51 | No |
| | | S | 40 | Yes |
| | | W | 58 | No |
| Unit 006 | | N | 63 | No |
| | | S | 48 | No |
| Unit 007 | | N | 62 | No |
| | | S | 41 | Yes |
| Unit 008 | | N | 62 | No |
| | | S | 42 | Yes |
| Unit 009 | | E | 59 | No |
| | | N | 62 | No |
| | | S | 42 | Yes |
| Unit 101 | F 1 | E | 49 | No |
| | | N | 51 | No |
| | | S | 10 | Yes |
| | | W | 30 | Yes |
| Unit 102 | | E | 35 | Yes |
| | | N | 47 | Yes |
| | | S | 10 | Yes |
| Unit 103 | | N | 48 | No |
| | | S | 10 | Yes |
| Unit 104 | | N | 47 | Yes |
| | | S | 8 | Yes |
| | | W | 45 | Yes |
| Unit 105 | | N | 58 | No |
| | | S | 41 | Yes |
| | | W | 57 | No |
| Unit 106 | | N | 62 | No |
| | | S | 43 | Yes |
| Unit 107 | | N | 62 | No |
| | | S | 42 | Yes |
| Unit 108 | | N | 62 | No |
| | | S | 41 | Yes |
| Unit 109 | | E | 59 | No |
| | | N | 62 | No |
| | | S | 43 | Yes |

| Location | Floor | Façade | $L_{eq,pass\text{-}by}$ assessment Day (7:00am to 10:00pm) | |
|---|---|---|---|---|
| | | | $L_{eq,pass\text{-}by}$ dB(A)* | Compliance with noise criterion of ≤47dB(A) $L_{eq,pass\text{-}by}$ |
| Unit 107 | F 2 | N | 61 | No |
| | | S | 46 | Yes |
| Unit 201 | | E | 51 | No |
| | | N | 55 | No |
| | | S | 17 | Yes |
| | | W | 40 | Yes |
| Unit 202 | | E | 51 | No |
| | | N | 50 | No |
| | | S | 17 | Yes |
| Unit 203 | | N | 50 | No |
| | | S | 16 | Yes |
| Unit 204 | | N | 50 | No |
| | | S | 13 | Yes |
| | | W | 48 | No |
| Unit 205 | | N | 65 | No |
| | | S | 46 | Yes |
| | | W | 57 | No |
| Unit 206 | | N | 61 | No |
| | | S | 47 | Yes |
| Unit 208 | | N | 61 | No |
| | | S | 46 | Yes |
| Unit 209 | | E | 58 | No |
| | | N | 61 | No |
| | | S | 47 | Yes |

**façade adjusted*

Tabulated railway noise levels are presented in Appendix F.

The maximum external $L_{eq,pass\text{-}by}$ noise levels at the development occurs at the northern façades of Unit 205 and is predicted to be 65 dB(A) $L_{eq,pass\text{-}by}$. Therefore a minimum 25 dB sound reduction is required through the building façades of the development. Further details of the construction requirements to meet the internal noise levels is provided in Section 6 of this report.

# 4. Operational Noise Impact Assessment

## 4.1 Nearest Noise Sensitive Places

The nearest noise sensitive places to the subject site are identified in Table 4.1.

**Table 4.1 Nearest noise sensitive places**

| Property description | Street address | Current use |
|---|---|---|
| Lot 10 DP1153734 | 1A Cavvanbah Street | Short-term accommodation |
| Lot 1 DP780935 | 2 Milton Street | Residential dwelling |
| Lot 1 on DP741161 | 3 Cavvanbah Street | Residential dwelling |
| Lot 1 DP582819 | 4 Milton Street | Residential dwelling |
| Lot 1 DP366084 | 20 Shirley Street | Commercial |
| Lot 1 SP68939 | 23-25 Shirley Street | Short-term accommodation |
| Lot 1 DP781456 | 24 Shirley Street | Commercial |
| Lot 1 DP827445 | 26 Shirley Street | Short-term accommodation |
| Lot 1 DP1090966 | 27 Shirley Street | Residential dwelling |
| Lot 1 DP942369 | 28 Shirley Street | Residential dwelling |
| Lot 1 DP390195 | 30 Shirley Street | Residential dwelling |
| Lot 2 DP390195 | 32 Shirley Street | Residential dwelling |
| Lot 2 DP317023 | 34 Shirley Street | Residential dwelling |
| Lot 1 SP72428 | 35-37 Shirley Street | Short-term accommodation |
| Lot 1 DP1085258 | 38 Shirley Street | Residential dwelling |

The nearest noise sensitive places are presented in Figure 4.1 together with the zoning map from the Byron Local Environmental Plan 2014.

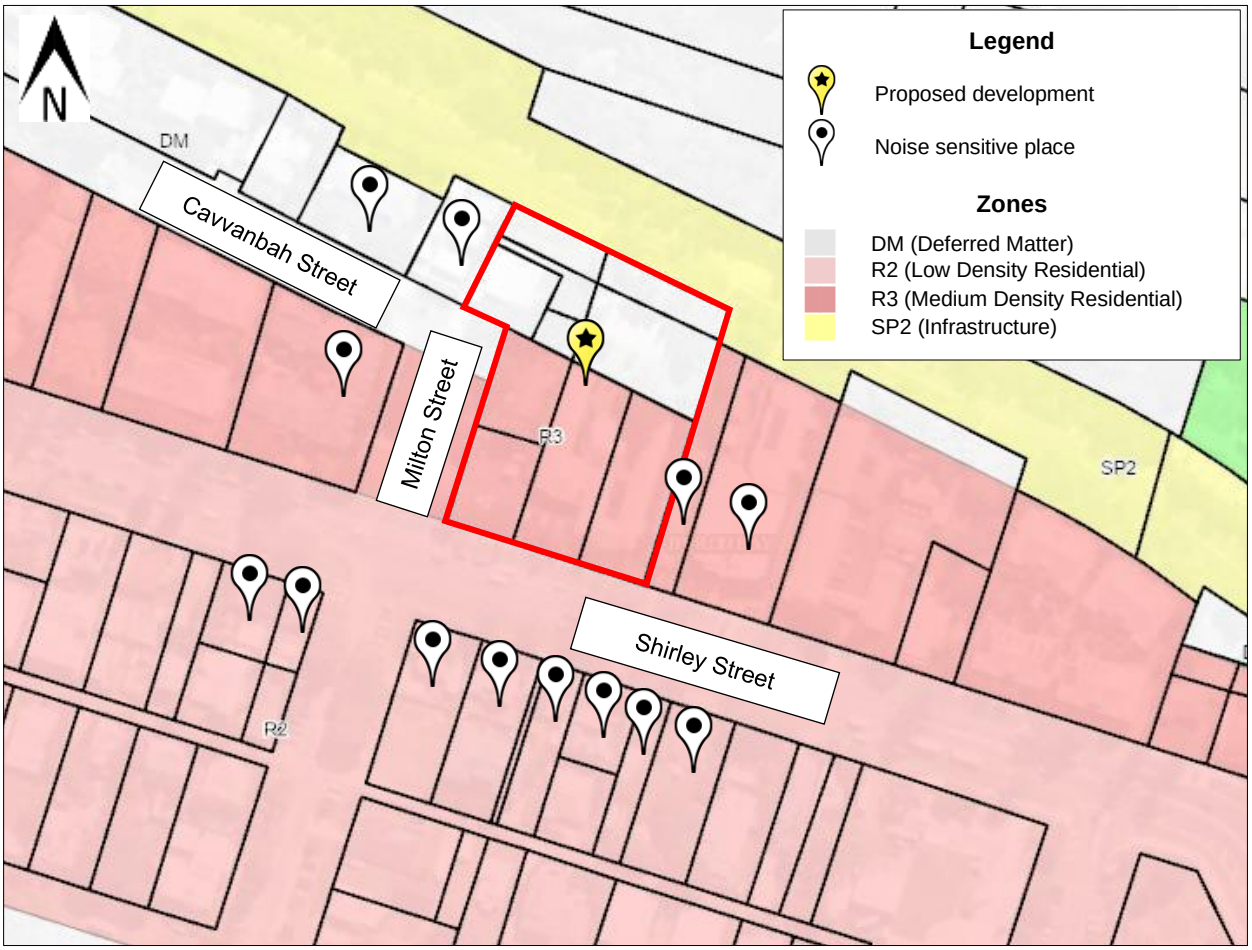



**Figure 4.1 Nearest noise sensitive places**

## 4.2 Operational Noise Criteria

The *Noise Policy for Industry* identifies three criteria for assessing the impact of noise from a premises:

- Intrusiveness noise levels – noise limits set relative to the existing background levels;
- Amenity noise levels – absolute noise limits set according to the surrounding land uses; and
- Maximum noise levels – maximum noise levels and number of events during night time.

### 4.2.1 Intrusiveness Noise Levels

Noise from the premises may generally be considered acceptable if the equivalent continuous A-weighted level of noise from the premises (represented by the $L_{Aeq}$ descriptor), measured over a 15-minute period, does not exceed the rating background noise level measured in the absence of all the noise from premises by more than 5 dB as presented in Table 4.2.

Table 4.2 Intrusiveness noise criteria

| Period | Intrusiveness noise level $L_{Aeq,15min}$, dB(A) | |
|---|---|---|
| Day | RBL + 5dB(A) | **50** (45 + 5) |
| Evening | RBL + 5dB(A) | **50** (45* + 5) |
| Night | RBL + 5dB(A) | **48** (43 + 5) |

** The noise levels featured higher RBLs during evening than daytime. This is likely due to dominance of noise from wildlife and is typical of areas adjacent to bushland. As per the procedure from Section 2.3 of the NSW Noise Policy for Industry, the intrusiveness noise limits for evening were set to be no greater than the limits for day time.*

The Rating Background Levels (RBL) considered in Table 4.2 are as per the noise measurements listed in Table 2.3 of this report.

Time of day is defined in the *Noise Policy for Industry* as follows:

- Day – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays;
- Evening – the period from 6pm to 10pm; and
- Night – the remaining periods.

### 4.2.2 Amenity Noise Levels

The *Policy* defines two planning noise levels:

- *Recommended amenity noise level* – the objective for total industrial noise at a receiver location
- *Project amenity noise level* – the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the *recommended amenity noise levels* for an area, a *project amenity noise level* applies for each new source of industrial noise as follows:

> *Project amenity noise level* for industrial developments = *Recommended amenity noise level* minus 5dB(A)

The *recommended amenity noise level* is set according to the surrounding land uses (receiver category) and the existing background noise levels. The receiver categories and typical existing background noise levels are presented in Table 4.3.

**Table 4.3 Residential receiver categories**

| Receiver category | Typical planning zoning – standard instrument | Typical existing background noise levels | Description |
|---|---|---|---|
| Rural residential | RU1 – primary production<br>RU2 – rural landscape<br>RU4 – primary production small lots<br>R5 – large lot residential<br>E4 – environmental living | Daytime RBL <40 dB(A)<br>Evening RBL <35 dB(A)<br>Night RBL <30 dB(A) | **Rural** – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse.<br>Note: Where background noise levels are higher than those presented in column 3 due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered. |
| Suburban residential | RU5 – village<br>RU6 – transition<br>R2 – low density residential<br>R3 – medium density residential<br>E2 – environmental conservation<br>E3 – environmental management | Daytime RBL<45 dB(A)<br>Evening RBL<40 dB(A)<br>Night RBL <35dB(A) | **Suburban** – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity. |
| Urban residential | R1 – general residential<br>R4 – high density residential<br>B1 – neighbourhood centre (boarding houses and shop-top housing)<br>B2 – local centre (boarding houses)<br>B4 – mixed use | Daytime RBL> 45 dB(A)<br>Evening RBL> 40 dB(A)<br>Night RBL >35 dB(A) | **Urban** – an area with an acoustical environment that:<br>• is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources<br>• has through-traffic with characteristically heavy and continuous traffic flows during peak periods<br>• is near commercial districts or industrial districts<br>• has any combination of the above. |

Note: This table is reproduced from Table 2.3 of the *Noise Policy for Industry*

Land zoning maps from the Byron Local Environmental Plan (LEP) 2014 indicate that the development site and areas to the west, south and east are zoned R3 (medium density residential) and R2 (low density residential).

Considering the above, the *recommended amenity noise levels* to be used in this assessment are presented in Table 4.4.

Table 4.4 Recommended amenity noise levels

| Receiver | Time of Day | Receiver category based on zoning and existing RBLs | Recommended amenity noise level $L_{Aeq,15min}$, dB(A) |
|---|---|---|---|
| R2 (Low density residential) R3 (medium density residential) | Day | Suburban residential | 55 |
| | Evening | Suburban residential | 45 |
| | Night | Suburban residential | 40 |

Then, considering the minus 5dB(A) adjustment to obtain the *project amenity noise level*:

> *Project amenity noise level* for industrial developments = *Recommended amenity noise level* minus 5dB(A)

The resulting *project amenity noise levels* are presented in Table 4.5.

Table 4.5 Project amenity noise levels

| Receiver | Time of Day | Recommended amenity noise level $L_{Aeq,15min}$, dB(A) | Project amenity noise level $L_{Aeq,15min}$, dB(A) |
|---|---|---|---|
| R2 (Low density residential) R3 (medium density residential) | Day | 55 | **50** (55 – 5) |
| | Evening | 45 | **40** (45 – 5) |
| | Night | 40 | **35** (40 – 5) |

### 4.2.3 Maximum Noise Levels

There is considerable published research into sleep disturbance caused by short duration or intermittent noise events. For example, sleep disturbance is addressed in the *Night Noise Guidelines for Europe* (World Health Organization, 2009). The *Night Noise Guidelines for Europe* states that the likelihood of awakening is related to the maximum instantaneous noise levels ($L_{Amax}$), ambient noise levels and number of events during night time. As a rule in planning for short-term or transient noise events, for good sleep over eight hours, the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45dB(A) $L_{max}$ more than 10-15 times per night. The corresponding external noise level, assuming partially closed windows, is 52dB(A) $L_{max}$, measured in the free field.

In accordance with the *Noise Policy for Industry*, detailed maximum noise level event assessment is required when the night time (10pm to 7am) noise levels from the premises exceed the following:

- $L_{Aeq,15min}$ 40dB(A) or the prevailing RBL plus 5dB, whichever is greater; and/or
- $L_{AFmax}$ 52dB(A) or the prevailing RBL plus 15dB, whichever is greater.

Considering the night time RBL of 43dB(A), the resulting noise limits are presented in Table 4.6.

Table 4.6 Maximum noise level criteria

| Time of Day | Noise limit, $L_{Aeq,15min}$, dB(A) | Noise limit, $L_{AFmax}$, dB(A) |
|---|---|---|
| Night | Criteria 1: 40dB(A)<br>Criteria 2: 48dB(A) (43 + 5)<br>Criteria 2 is applicable | Criteria 1: 52dB(A)<br>Criteria 2: 58dB(A) (43 + 15)<br>Criteria 2 is applicable |

## 4.3 Noise Propagation Modelling

### 4.3.1 Modelling Methodology

A 3D model of the site and surroundings was developed using SoundPLAN noise propagation software considering the proposed activities at the development and location relative to the nearest noise sensitive places.

The calculations were carried out as per the procedures specified in the International Standard ISO9613 (*Acoustics – Attenuation of sound during propagation outdoors*).

The calculation method for a single frequency is as follows:

$$L_S = [\ L_W + K_0\ ] - [\ A_{dI} + A_{div} + A_{gr} + A_{bar} + A_{atm} + d_{Lrefl} + d_{Lw}\ ]$$

Where:

| | |
|---|---|
| $L_S$ | Sound pressure for a single frequency |
| $L_W$ | Sound power of source |
| $K_0$ | Correction for propagation in limited spacial angle |
| $A_{DI}$ | Mean directivity correction |
| $A_{div}$ | Mean attenuation due to geometrical spreading |
| $A_{gr}$ | Mean attenuation due to ground effect |
| $A_{bar}$ | Mean attenuation due to screening |
| $A_{atm}$ | Mean attenuation due to air absorption |
| $d_{Lrefl}$ | Level increase due to reflections |
| $d_{Lw}$ | Correction due to source operation time |

The noise propagation losses are calculated as a combination of distance attenuation (geometrical spreading), screening, ground attenuation and other factors. More details are shown in Appendix G.

The parameters and assumptions considered in the 3D noise propagation model are described in Table 4.7.

Table 4.7 Data and Assumptions – Operational Noise Model

| | |
|---|---|
| **Terrain** | • Department of Natural Resources and Mines Airborne Laser Scanning (LiDAR) 1 metre data was used to determine the elevation of the development relative to the surrounds.<br>• Ground surface absorption factor of 0 was applied to all paved surfaces and 1 for all grassed areas. |
| **Buildings** | • The proposed residential development was included in the model along with neighbouring buildings.<br>• Development plans are included in Appendix A. |

| | |
|---|---|
| **Noise sources** | • Refer to Section 4.3.3 of this report. |
| **Receivers** | • Receivers were attached to the façades of the noise sensitive buildings at a height of 1.5m above each floor level.<br>• SoundPLAN adds +2.5dB(A) to the calculated noise levels when the receivers are attached to the buildings, thus the tabulated traffic noise levels are façade adjusted.<br>• 1m grid spacing was used for calculation of noise contour maps. |
| **Noise mitigation measures** | • The recommended noise control measures are discussed in Section 6 of this report. |
| **Distance attenuation** | • 3D model of the subject site and surroundings was developed using cadastral and survey data using SoundPLAN software. The source-receiver distances and geometrical spreading are automatically calculated in SoundPLAN to a high level of accuracy in accordance with the ISO9613 procedure.<br>• Separation distances and distance attenuation values are presented in Appendix G. |
| **Barrier attenuation / screening** | • Screening by walls and roofs was considered in the model. The screening was calculated in SoundPLAN in accordance with the ISO9613 procedure.<br>• Barrier attenuation / screening values are presented in Appendix G. |
| **Ground attenuation** | • Sound reflecting surfaces such as pavement are modelled with ground absorption coefficient of 0 (no absorption). Grassed and vegetated areas were modelled with ground absorption coefficient of 1 (100% absorption) in accordance with ISO9613.<br>• Ground attenuation values are presented in Appendix G. |

### 4.3.2 Noise Sources

The sound power levels, tonality/impulsiveness adjustment factors, and the operational scenarios for all noise sources considered in the model are presented in Table 4.8.

**Table 4.8 Details of operational noise sources**

| Operational noise source | Location | Sound power level dB(A) (re $10^{-12}$W) | Operational scenario | Tonality/ impulsiveness |
|---|---|---|---|---|
| AC condensers | Refer Figure 4.3 | One air conditioner per unit (26 total) – 65 dB(A) sound power each | Continuous operation 24 hours a day | +5 dB |
| Basement exhaust | Refer Figure 4.3 | Sound power level of 66 dB(A) at discharge point<br>This is equivalent to a sound pressure level of 60 dB(A) $L_{eq,adj,15min}$ measured at 1m from discharge point, including +5dB tonality adjustment | Continuous operation 24 hours a day | +5 dB |
| Pool equipment | Basement mechanical plant room | Pool pump – 65 dB(A) sound power | Continuous operation 24 hours a day | +5 dB |

| Operational noise source | Location | Sound power level dB(A) (re $10^{-12}$W) | Operational scenario | Tonality/ impulsiveness |
|---|---|---|---|---|
| Resident car parking | Basement parking ramp | Sound power of 90 dB(A) for car slowly accelerating (10-20 km/h) | Day (7am to 6pm)<br>– 40 car movements per hour<br>Evening (6pm to 10pm)<br>– 20 car movements per hour<br>Night (10pm to 7am)<br>– 10 car movements per hour | +5 dB |
| Basement carpark roller door | Basement carpark entrance | Roller door – 65 dB(A) sound power | Day (7am to 6pm)<br>– Operating 10 minutes per hour<br>Evening (6pm to 10pm)<br>– Operating 5 minutes per hour<br>Night (10pm to 7am)<br>– Operating 2.5 minutes per hour | +5 dB |
| Human voices | Ground level communal recreation pool area | Sound power of 79 dB(A) for 10 people[4] | Day (7am to 6pm)<br>– Continuous use<br>Evening (6pm to 10pm)<br>– Continuous use<br>Night (10pm to 7am)<br>– Not in use | n/a |
| Human voices | Rooftop terraces | Sound power of 79 dB(A) $L_{eq}$ for 10 people[4], per rooftop terrace (9 groups total)<br><br>Sound power of 92 dB(A) $L_{max}$ for 10 people[4], per rooftop terrace (9 groups total) | Day (7am to 6pm)<br>– Continuous use<br>Evening (6pm to 10pm)<br>– Continuous use<br>Night (10pm to 7am)<br>– Continuous use | n/a |

During night time, the activity at the proposed development which will produce short duration, intermittent noise events will be the patrons at rooftop terraces.

Extract from the 3D noise propagation model developed in SoundPLAN is presented in Figure 4.2 to Figure 4.5.

[4] Hayne, M.J., 2011, Prediction of noise from small to medium sized crowds, Proceedings of ACOUSTICS 2011.

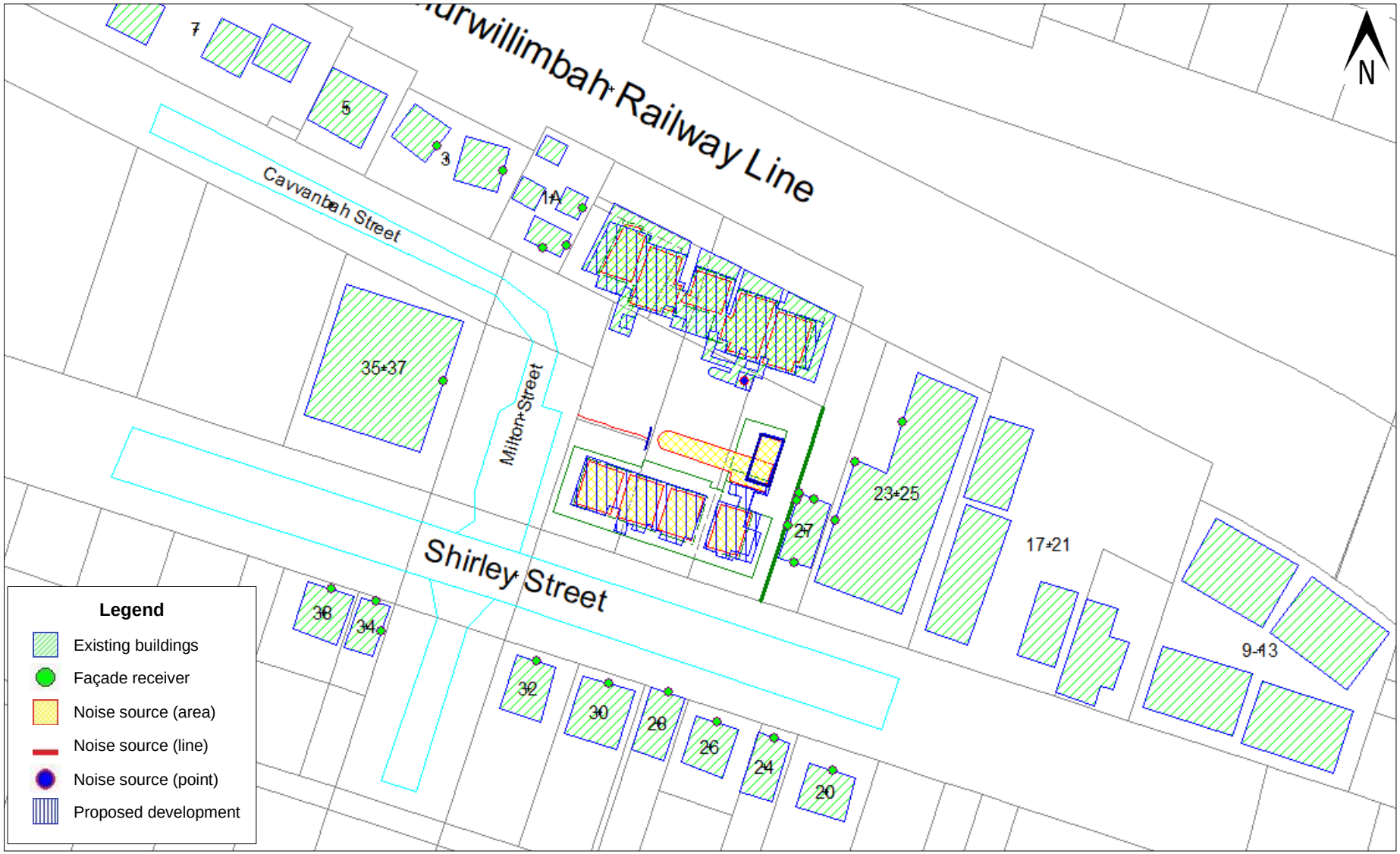



**Figure 4.2 3D operational noise model – SoundPLAN excerpt**

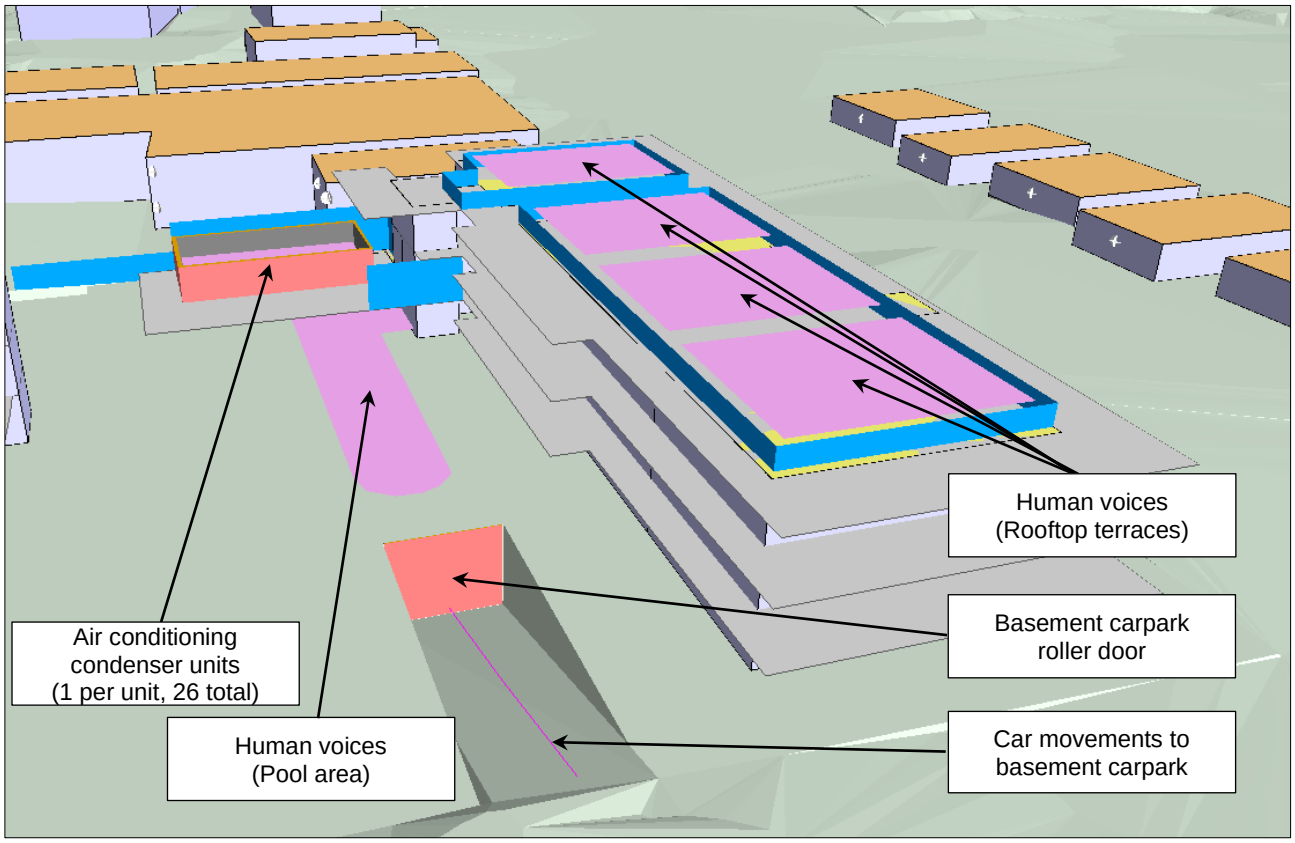



Figure 4.3 3D operational noise model – SoundPLAN excerpt (southern building)

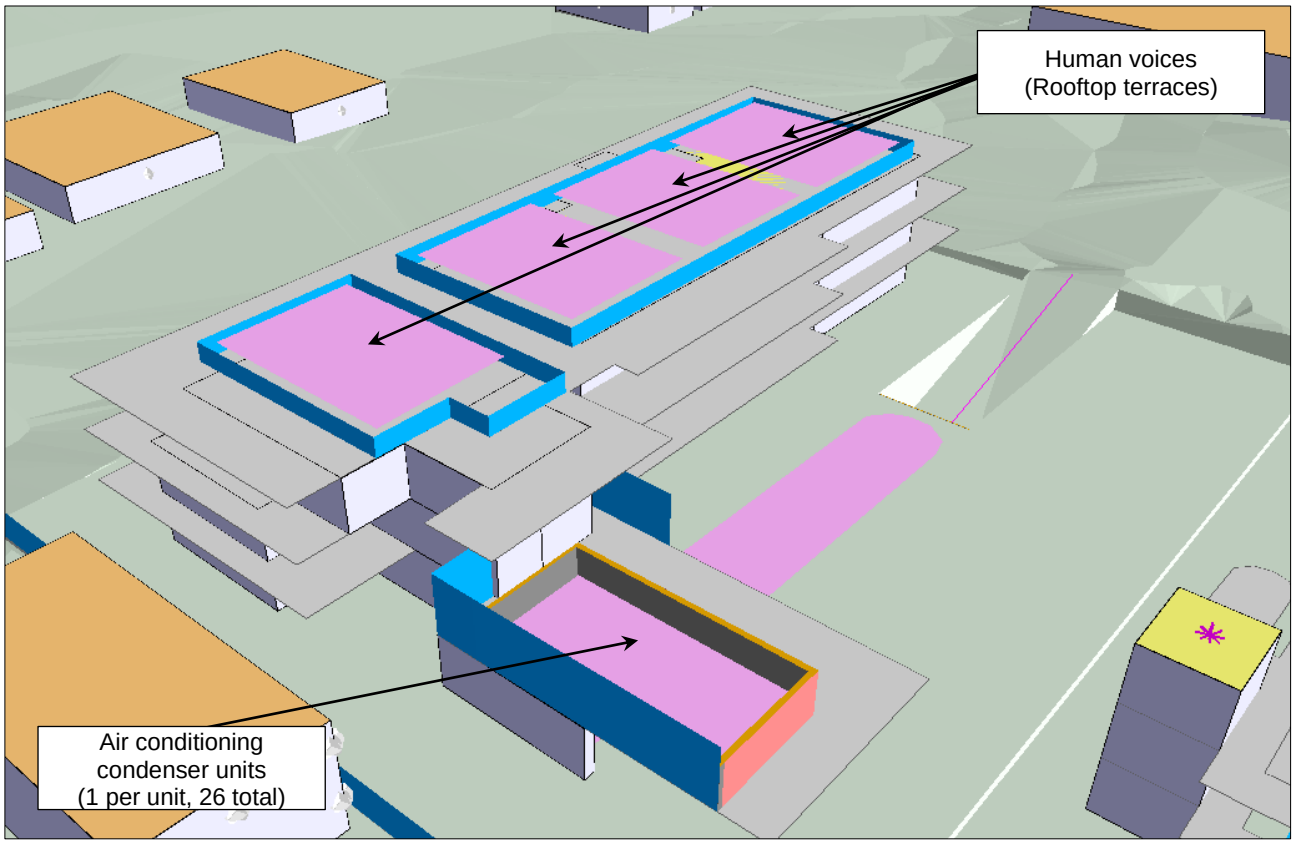



Figure 4.4 3D operational noise model – SoundPLAN excerpt (southern building)

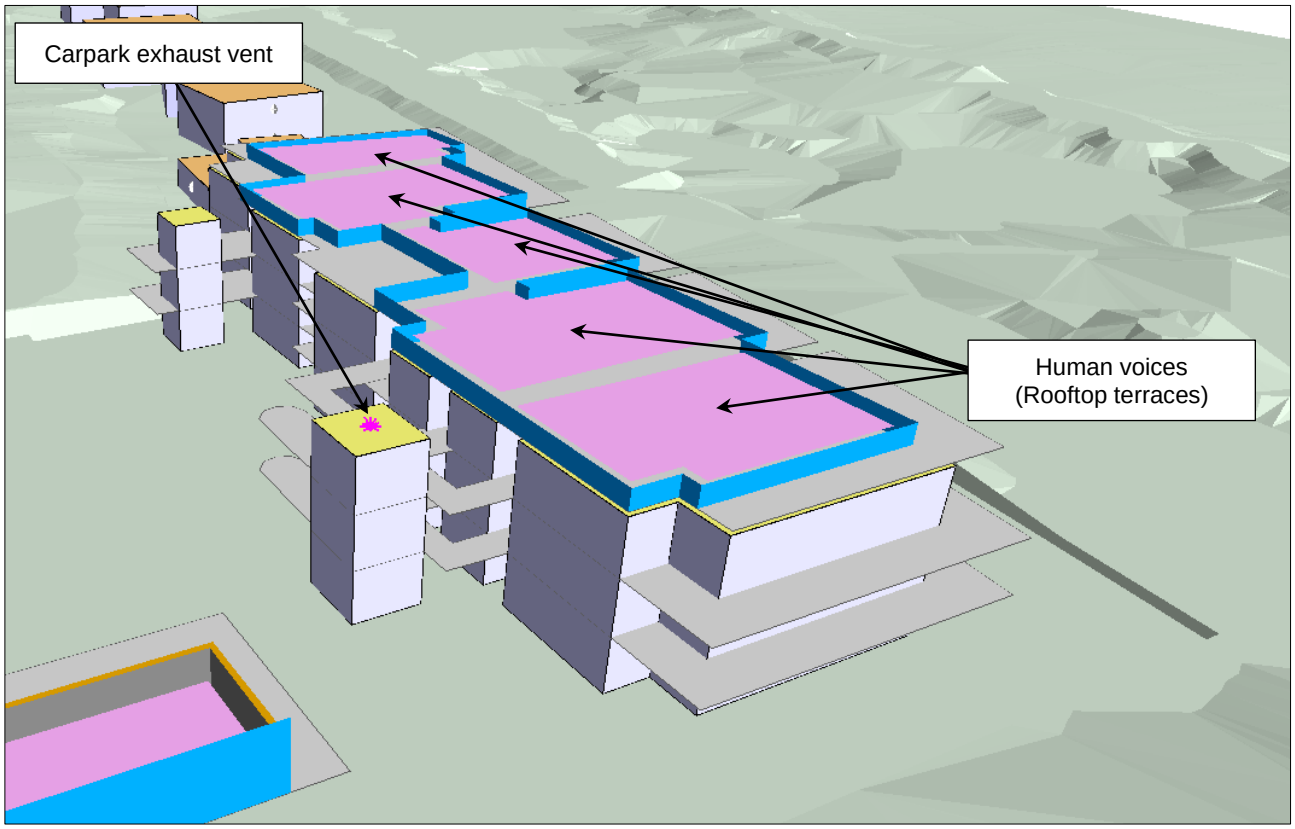



**Figure 4.5 3D operational noise model – SoundPLAN excerpt (northern building)**

### 4.3.3 Operational Noise Calculation Results

The $L_{eq}$ noise levels associated with the proposed development, assessed against the intrusiveness and amenity noise criteria, are presented in Table 4.9.

**Table 4.9 Calculated $L_{eq}$ noise levels**

| Receivers | Calculated noise levels, dB(A) | | | Compliance with noise criteria? |
|---|---|---|---|---|
| | $L_{Aeq,adj,15min}$ | | | |
| | Day (7am-6pm) | Evening (6pm-10pm) | Night (10pm-7am) | |
| **Intrusiveness noise criteria** | **50** | **45** | **40** | |
| **Project amenity noise criteria** | **55** | **45** | **40** | |
| **Night time criteria – $L_{eq}$ noise levels** | **–** | **–** | **48** | |
| 1A Cavvanbah Street | 34 | 33 | 32 | Yes |
| 20 Shirley Street | 29 | 29 | 29 | Yes |
| 23-25 Shirley Street | 39 | 39 | 37 | Yes |
| 24 Shirley Street | 30 | 30 | 30 | Yes |
| 26 Shirley Street | 31 | 31 | 31 | Yes |
| 27 Shirley Street | 40 | 40 | 38 | Yes |
| 28 Shirley Street | 32 | 32 | 32 | Yes |
| 3 Cavvanbah Street | 34 | 33 | 33 | Yes |
| 30 Shirley Street | 32 | 32 | 32 | Yes |
| 32 Shirley Street | 32 | 32 | 31 | Yes |
| 34 Shirley Street | 32 | 31 | 31 | Yes |
| 35-37 Shirley Street | 38 | 37 | 36 | Yes |
| 38 Shirley Street | 31 | 31 | 30 | Yes |

The maximum noise levels associated with rooftop terrace patrons at the proposed development during night time are presented in Table 4.10.

Table 4.10 Calculated $L_{max}$ noise levels

| Receivers | Calculated noise levels, dB(A) | Compliance with noise criteria? |
|---|---|---|
| | $L_{AFmax}$ | |
| | Night (10pm-7am) | |
| **Night time criteria – $L_{AFmax}$ noise levels** | **58** | |
| 1A Cavvanbah Street | 35 | Yes |
| 20 Shirley Street | 33 | Yes |
| 23-25 Shirley Street | 39 | Yes |
| 24 Shirley Street | 34 | Yes |
| 26 Shirley Street | 34 | Yes |
| 27 Shirley Street | 40 | Yes |
| 28 Shirley Street | 35 | Yes |
| 3 Cavvanbah Street | 38 | Yes |
| 30 Shirley Street | 35 | Yes |
| 32 Shirley Street | 35 | Yes |
| 34 Shirley Street | 35 | Yes |
| 35-37 Shirley Street | 39 | Yes |
| 38 Shirley Street | 35 | Yes |

Full SoundPLAN results, including tabulated $L_{eq}$ and $L_{max}$ noise levels, are presented in Appendix G. Noise contour maps are presented in Appendix H.

# 5. Light Rail Vibration Assessment

The NSW Department of Planning *Development near Rail Corridors and Busy Roads – Interim Guideline* identifies there are vibration criteria for both building damage and for human comfort which new developments should comply with.

## 5.1 Vibration Criteria

### 5.1.1 BS 7385-2:1993

British Standard BS 7385-2:1993 recommends maximum vibration levels which buildings can be subjected to, depending on the frequency and duration of the vibration and the type of building. The vibration descriptor is peak particle velocity (PPV) in mm/s in the x, y and z components. For unreinforced or light framed structures (residential or light commercial type buildings), there is a risk of vibration-induced cosmetic damage to the structure when the PPV of the predominant pulse exceeds 15mm/s at 4Hz or 50mm/s at 40Hz or above when measured at the base or foundation of the building.

The criteria are presented in Table 5.1 and in Figure 5.1.

**Table 5.1 Transient vibration guideline values – Minimal risk of cosmetic damage**

| Line | Type of building | Peak Component Particle Velocity[5] in frequency range of predominant pulse | |
|---|---|---|---|
| | | 4 Hz to 15 Hz | 15 Hz and above |
| 1 | Reinforced or framed structures, industrial and heavy commercial buildings. | 50 mm/s at 4 Hz and above | |
| 2 | Unreinforced or light framed structures, residential or light commercial type buildings. | 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz | 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above |

**Note:** Values referred to are at measured at the base of the building.

Note that the criteria for light-weight buildings (Line 2) is frequency dependent and penalises low frequency vibrations more heavily. Vibration velocities at each axis (X, Y and Z) are considered separately.

[5] Peak component particle velocity is the peak velocity in the X, Y and Z directions.

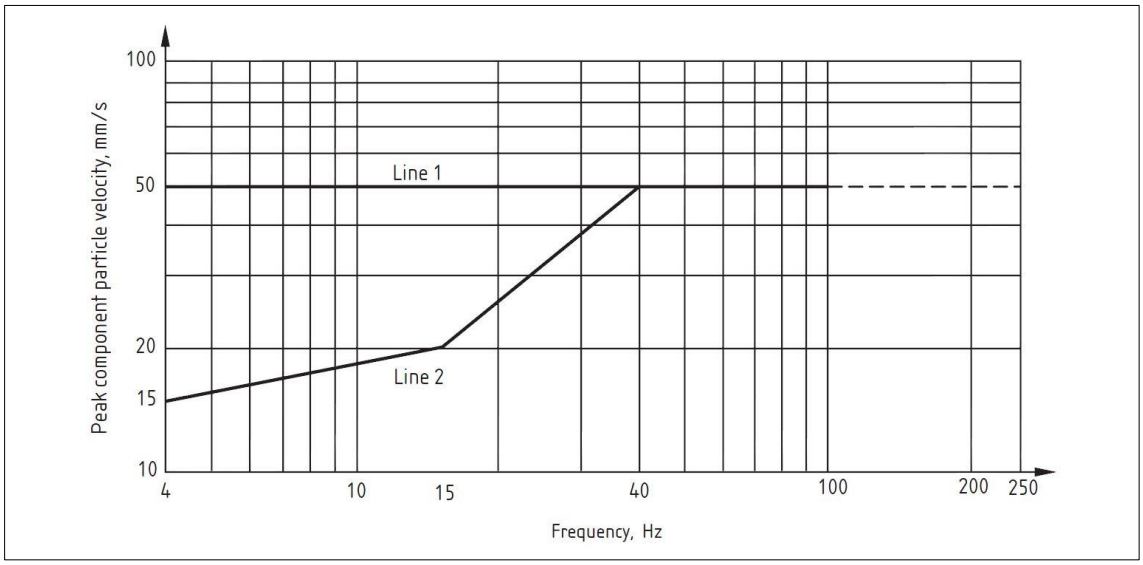



**Figure 5.1 Transient vibration guideline values – Minimal risk of cosmetic damage**

The standard states that at vibration values that are greater than two times the values given in Table 5.1, minor damage is possible, and at vibration greater than four times the values given in Table 5.1, major damage to a building structure may occur. Damage classifications from BS7385.1:1990 are presented in Table 5.2.

**Table 5.2 BS7385.1:1990 – Damage classification**

| Damage classification | Description |
|---|---|
| Cosmetic | The formation of hairline cracks on drywall surfaces or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in the mortar joints of brick/concrete block construction. |
| Minor | The formation of cracks or loosening and falling of plaster or drywall surface, or cracks through bricks/concrete blocks. |
| Major | Damage to structural elements of the building, cracks in support columns, loosening of joints, splaying of masonry cracks etc. |

The vibration limits apply only to transient (short term)[6] vibration that does not give rise to resonant responses in structures.

> *"Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance[7], especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%."*

The vibration limit is an idealised value that considers building vibration only. Other effects such as ground movement which could also lead to damage are not considered.

> *"Only the direct effect of vibration on buildings is considered. The indirect effects on the building structure due to ground movement, the movement of loose objects within buildings,*

[6] Transient vibration is a vibration caused by external force (e.g. movement of machinery or dropping of a pile hammer) which is sustained for a period of time under the influence of the external force and gradually dissipates when the activity causing the vibration stops

[7] Resonance occurs when the frequency of the external forced vibration coincides with the natural frequency of a structure. If set in motion, the structure will vibrate (oscillate about its equilibrium position) at its natural frequency. If an external force causes a building to vibrate and if the vibration frequency of the external force is in harmony with the natural frequency of the building the movement around the equilibrium will increase due to the resonance effect.

*the possibility of damage to sensitive equipment and the effect of vibration on people are outside the scope of this Part of BS 7385. This Part of BS 7385 does not consider the many other causes of cracking in buildings; cracking commonly occurs in building whether they are exposed to vibration or not."*

The soil condition and response of the soil to vibration can lead to damage to buildings, although is difficult to predict.

*"Depending on the type of ground, ground vibration can cause consolidation or densification of the soil, which has been known to result in differential settlement and consequent building damage. Loose and especially water-saturated cohesionless soils are vulnerable to vibration which may cause liquefaction. The loading transmitted to the soil through the foundations may reduce the vulnerability of the soil to such damage, but there are cases where the acceptable vibration limit may be set by considerations of soil-structure interaction, rather than distortion or inertial response of the building itself."*

The standard also provides general advice on important buildings in relation vibration limits.

*"Important buildings which are difficult to repair may require special consideration on a case-by-case basis. A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

### 5.1.2 DIN 4150-3:1999

German Standard DIN 4150-3:1999 gives guideline values for evaluating the effects of vibration on buildings. The vibration descriptor is peak particle velocity (mm/s) in the x, y and z components.

For dwellings and buildings of similar design and/or occupancy, there is a risk of vibration-induced cosmetic damage to the structure when the PPV of exceeds 5mm/s at 10Hz or 20mm/s at 100Hz or above when measured at the base or foundation of the building.

The criteria for short term vibration from DIN4150-3 are presented in Table 5.3 and in Figure 5.2.

**Table 5.3 Vibration criteria – DIN 4150-3 – No structural or cosmetic damage**

| Line | Type of structure | Peak Component Particle Velocity at the foundation at a frequency of | | |
|---|---|---|---|---|
| | | Less than 10 Hz | 10 Hz to 50 Hz | 50 Hz to 100 Hz |
| 1 | Buildings used for commercial purposes, industrial buildings, and buildings of similar design | 20 mm/s | 20 to 40 mm/s | 40 to 50 mm/s |
| 2 | Dwellings and buildings of similar design and/or use | 5 mm/s | 5 to 15 mm/s | 15 to 20 mm/s |
| 3 | Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order) | 3 mm/s | 3 to 8 mm/s | 8 to 10 mm/s |

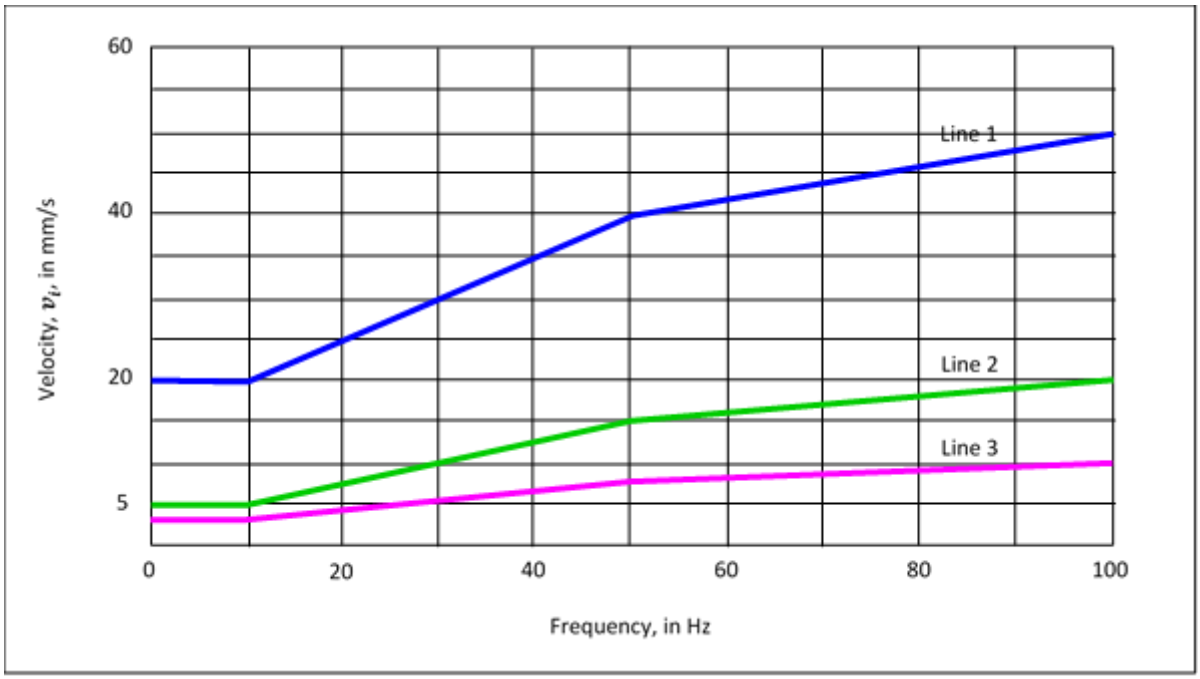



**Figure 5.2 Vibration criteria (DIN 4150-3) – No structural or cosmetic damage**

The vibration limit is frequency dependent and applies only to transient (short term) vibration that does not give rise to resonant responses in structures.

Like BS 7385-2, the vibration limits recommended in DIN 4150-3 do not take into account possibility of ground settlement as a means of causing damage. However, Appendix C of DIN 4150-3 does acknowledge that the effects of vibration on soil can be significant.

> *"Non-cohesive soil tends to settle, for instance when vibrating rams are used nearby to drive sheet piling. Vibration-induced foundation settlement can occur at vibration severities which are normally not expected to cause structural damage. For this to occur, the soil has to be very sensitive to vibration (as is non-cohesive, uniformly graded sand or silt, for instance), and the vibration has to be continuous or frequent."*

### 5.1.3 Assessing Vibration: A Technical Guideline (DECC 2006)

The NSW Department of Environment and Conservation (DECC) provides the document *Assessing Vibration: a technical guidline* which provides acceptable vibration dose values (VDV) which should be achieved from intermittent vibration sources such as railway trains.

The acceptable VDV ($m/s^{1.75}$) for residences during daytime, evening and night are provided in Table 5.4.

**Table 5.4 Vibration Criteria – Intermittent railway pass-by**

| Location | Daytime & evening | | Night-time | |
|---|---|---|---|---|
| | Preferred value | Maximum value | Preferred value | Maximum value |
| Residences | 0.20 | 0.40 | 0.13 | 0.26 |

## 5.2 Transmissibility of Vibration into Structures

Given the human comfort vibration criteria relates to the occupants inside the building, a conversion factor between the external vibration levels and the internal vibration levels is required.

Research by the United States Federal Transit Administration has identified that the ground vibration can be reduced by 10 dB as the vibration wave transfers its energy from the ground into the concrete foundations. Therefore, a coupling loss of 10 dB was applied between the external vibration levels and the internal vibration levels based on Table 10-1 of *Transit Noise and Vibration Impact Assessment (FTA-VA-90-1003-06)*.

The report also notes additional propagation effects such as efficient propagation of vibration in soil. The vibration measurements undertaken for this project were in sandy soil, which is known to transfer higher levels of vibration along the surface. As such, an additional 3 dB reduction in the vibration levels has been assumed to account for the efficient propagation of vibration effects present at the subject site at 29 Shirley Street.

Considering the total coupling loss of 13 dB, the ratio between the internal and external vibration levels can be calculated as per the following calculation:

$$10\text{dB} = 20\log_{10}\frac{v_{external}}{v_{internal}}$$

$$\frac{v_{internal}}{v_{external}} = 10^{\frac{-13}{20}} = 0.22$$

## 5.3 Vibration Measurement Methodology

### 5.3.1 Monitoring Location

A vibration logger was set up on site at 29 Shirley Street to determine the vibration levels from the adjacent Murwillimbah Railway Line and the Byron Solar Train, as presented in Figure 5.3 below and in Appendix B.

The measured vibration levels were adjusted to account for the difference between the distance from the railway track to the vibration logger and to the nearest point on the foundations of the future dwellings at 29 Shirley Street.


Figure 5.3 Vibration monitoring location

### 5.3.2 Monitoring Equipment

Vibration levels were measured with a Profound VIBRA vibration loggers fitted with tri-axial geophones. The geophones can detect vibrations from 0–100 mm/s and have frequency range of 1–150 Hz[8].

The instruments (vibration loggers) were set to record at 5 second measurement intervals. The following parameters were recorded:

- Peak Particle Velocity (PPV) – maximum instantaneous particle velocity (in units of mm/s) in the X, Y and Z directions recorded over the measurement interval.
- Peak Particle Acceleration (PPA) – maximum instantaneous particle acceleration (in units of $m/s^2$) in X, Y and Z directions recorded over the measurement interval.
- Dominant frequency of vibration (in units of Hz) in X, Y and Z directions over the measurement interval. The dominant frequency is determined by the zero-crossing method.
- Detailed velocity waveform in the time domain. Maximum of 4 waveforms are saved per hour for the events with the highest PPV.

[8] According to BS7385:1993 Part 1 (*Evaluation and measurement for vibration in buildings – Part 1: Guide for measurement of vibrations and evaluations of their effects on buildings*) most building damage from man-made sources occurs from 1 Hz to 150 Hz. Vibration levels of interest range from a few to several hundred millimetres per second depending on frequency.

The geometric axes were positioned as follows:

- X axis – Horizontal plane, parallel to boundary wall;
- Y axis – Horizontal plane, perpendicular to boundary wall; and
- Z axis – Vertical.

Unattended measurements were recorded during the monitoring period from 26 January to 4 February 2022.

## 5.4 Vibration Monitoring Results

The highest daily vibration levels recorded from the Byron Solar Train at 29 Shirley Street during the vibration monitoring from 26 January to 4 February 2021 are presented in Table 5.5.

**Table 5.5 Vibration monitoring results – 29 Shirley Street**

| Date | Axis | Maximum particle velocity (mm/s) | Frequency (Hz) | VRmax (mm/s) | Compliance with 5mm/s vibration limit |
|---|---|---|---|---|---|
| 26-Jan (Wed) | X | 1.08 | 44 | 2.02 | Yes |
| | Y | 0.91 | 29 | | Yes |
| | Z | 1.96 | 29 | | Yes |
| 27-Jan (Thu) | X | 1.03 | 19 | 1.69 | Yes |
| | Y | 0.96 | 23 | | Yes |
| | Z | 1.46 | 35 | | Yes |
| 28-Jan (Tue) | X | 0.64 | 53 | 2.42 | Yes |
| | Y | 0.71 | 55 | | Yes |
| | Z | 2.39 | 63 | | Yes |
| 29-Jan (Wed) | X | 1.21 | 46 | 2.30 | Yes |
| | Y | 1.02 | 29 | | Yes |
| | Z | 2.23 | 31 | | Yes |
| 30-Jan (Thu) | X | 1.17 | 44 | 2.10 | Yes |
| | Y | 1.28 | 33 | | Yes |
| | Z | 1.84 | 34 | | Yes |
| 31-Jan (Fri) | X | 0.92 | 38 | 2.12 | Yes |
| | Y | 0.88 | 28 | | Yes |
| | Z | 1.75 | 25 | | Yes |
| 01-Feb (Sat) | X | 1.13 | 46 | 1.87 | Yes |
| | Y | 1.08 | 31 | | Yes |
| | Z | 1.72 | 55 | | Yes |
| 02-Feb (Sun) | X | 1.10 | 51 | 2.16 | Yes |
| | Y | 1.18 | 32 | | Yes |
| | Z | 2.10 | 38 | | Yes |

| Date | Axis | Maximum particle velocity (mm/s) | Frequency (Hz) | VRmax (mm/s) | Compliance with 5mm/s vibration limit |
|---|---|---|---|---|---|
| 03-Feb (Mon) | X | 1.11 | 45 | 2.00 | Yes |
| | Y | 0.96 | 30 | | Yes |
| | Z | 1.88 | 41 | | Yes |
| 04-Feb (Tue) | X | 1.03 | 44 | 1.73 | Yes |
| | Y | 0.98 | 29 | | Yes |
| | Z | 1.48 | 34 | | Yes |

Graph of the vibration levels recorded at 29 Shirley Street over the monitoring period are presented in Figure 5.1.

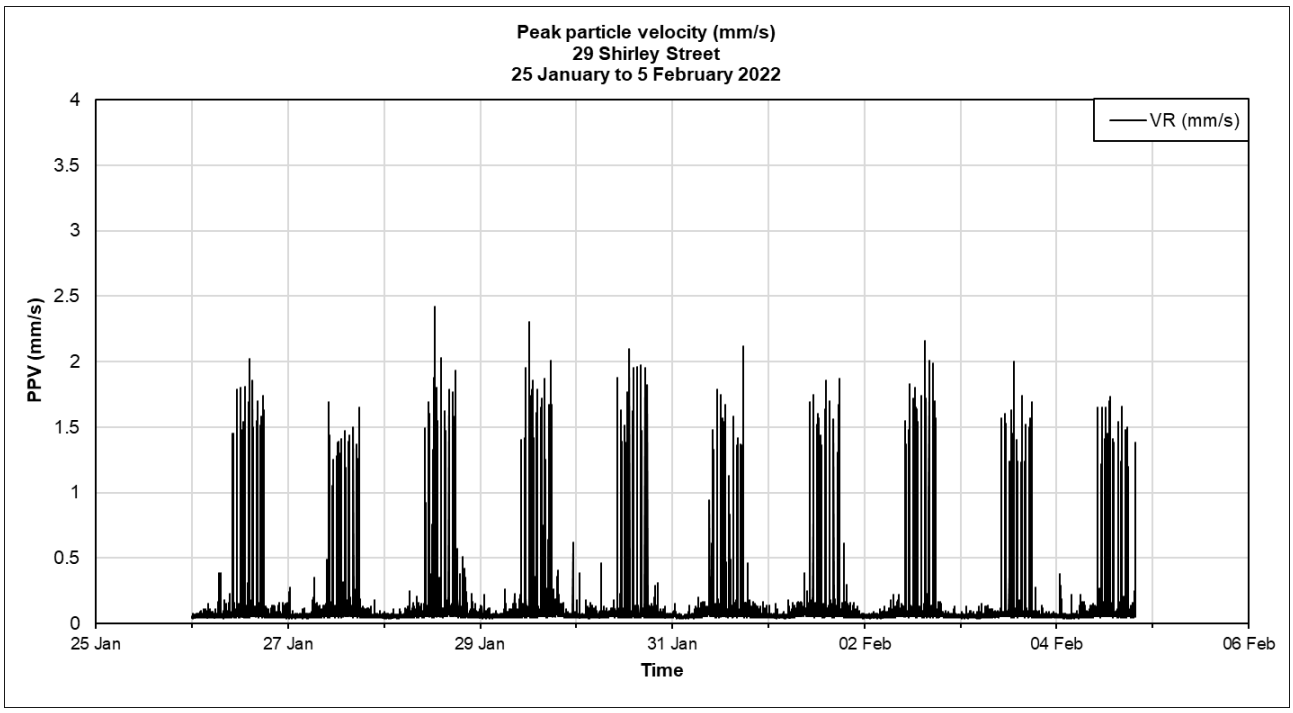



**Figure 5.4 Vibration monitoring results – 29 Shirley Street**

The highest vibration levels relative to the Byron Solar Train occurred on 28 January 2022 (Tuesday) when the peak particle velocity reached a maximum of 2.42mm/s $V_{Rmax}$, with highest component velocity of 2.39mm/s PCPV in the Z direction.

Plot of the vibration levels on 28 January 2022, in terms of resultant velocity, is presented in Figure 5.2.

Plot of the vibration levels during the time between 12:00am to 1:00pm, in terms of component velocity and frequency, are presented in Figure 5.3 and Figure 5.4.

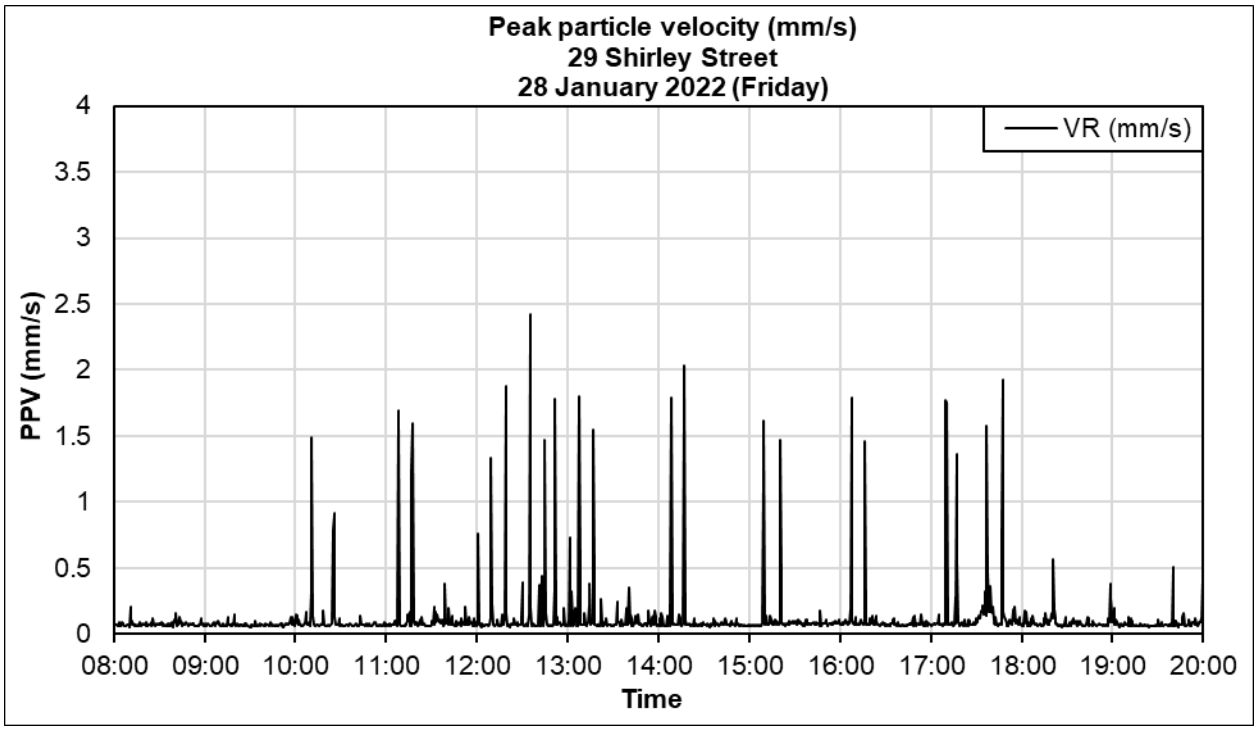



Figure 5.5 Highest PPV (mm/s) day – 29 Shirley Street

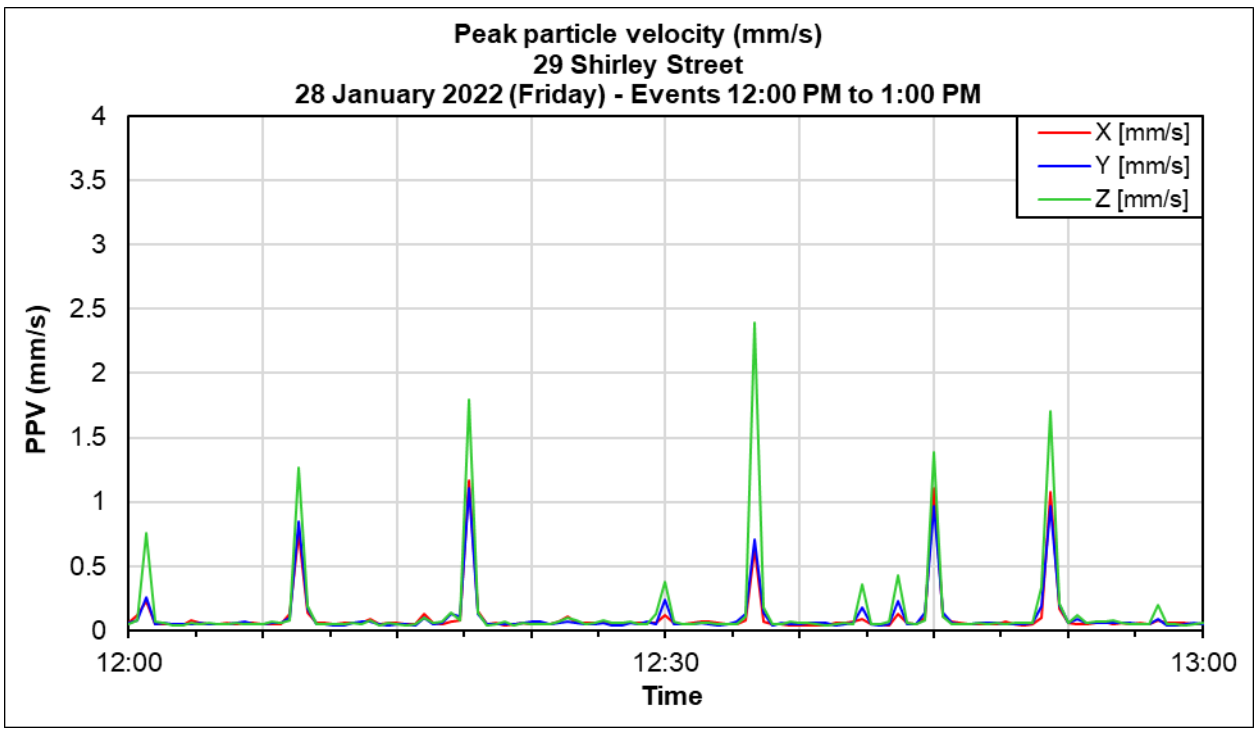



Figure 5.6 PPV (mm/s) – Highest hour – 29 Shirley Street

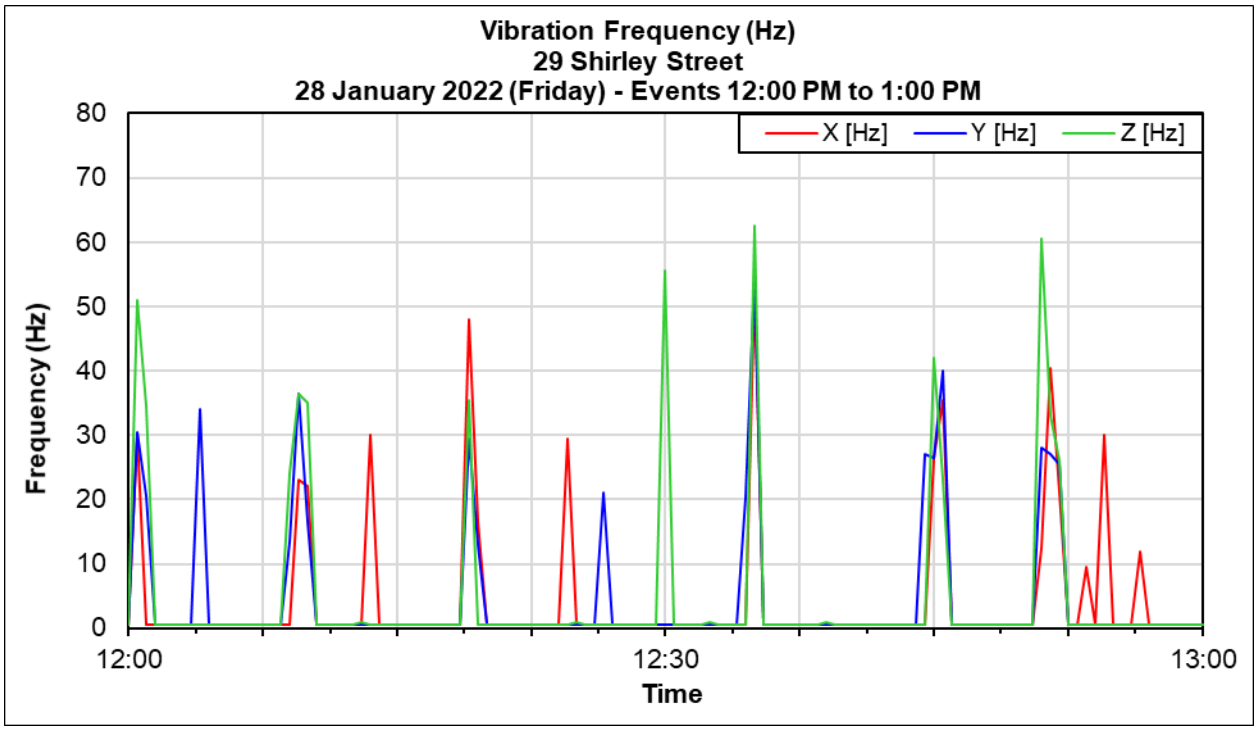



Figure 5.7 Vibration frequency (Hz) – Highest hour – 29 Shirley Street

## 5.5 Predicted Vibration Levels

A summary of the predicted vibration levels and vibration dose values at 29 Shirley Street is provided in Table 5.6.

Table 5.6 Predicted vibration levels – 29 Shirley Street

| Predicted maximum vibration levels – Building damage | Predicted vibration dose values – Human comfort |
|---|---|
| 0.46 mm/s | 0.21 $m/s^{1.75}$ |

When adjusted for distance attenuation and for the coupling loss factors, the maximum predicted vibration level at the future dwellings at 29 Shirley Street is 0.46 mm/s, which is well within the strictect 5 mm/s vibration limit for building damage.

When considering that the Byron Solar Train only operates during daytime and evening, the predicted vibration dose value must meet the maximum vibration limit of 0.4 $m/s^{1.75}$. Based on the vibration measurements conducted at 29 Shirley Street, and adjusted for distance attenuation and for coupling loss factors, the predicted vibration dose values for the occupants of the future dwellings at 29 Shirley Street is 0.21 $m/s^{1.75}$.

Therefore, the predicted vibration levels from the associated Byron Solar Train at the future dwellings at 29 Shirley Street, will comply with the strictest vibration limits for cosmetic and building damage, as well as the human comfort vibration dose values.

# 6. Discussion and Recommendations

## 6.1 Light Rail Noise Impacts

The proposed development is located adjacent to Murwillimbah Railway Line, upon which the Byron Solar Train operates and which has a potential to cause railway noise impacts on the development. Site specific noise measurements and detailed acoustic design calculations were carried out to assess railway noise impacts.

The noise measurements conducted indicate that standard construction will be appropriate for the southern building façades, however architectural treatment is required to the building envelope of the apartments located in the northern building.

Preliminary acoustic design specifications to mitigate railway noise from the Byron Solar Train at the proposed development are presented in Table 6.1.

**Table 6.1 Acoustic design specificatons – Railway noise mitigation**

| Location | Façade | Construction element | $R_w$ required | Recommended construction |
|---|---|---|---|---|
| Units 005, 006, 007, 008, 009, 101, 105, 106, 107, 108, 109, 201, 202, 205, 206, 208, and 209 | N | Windows | 31 | 6.76mm laminated safety glass in an acoustically sealed frame |
| | | External walls | 31 | Standard construction |
| | E, W | Windows | 26 | Standard 4mm float glass in an acoustically sealed frame |
| | | External walls | 26 | Standard construction |
| | S | Windows | 12 | Standard 4mm float glass with standard weather seals |
| | | External walls | 12 | Standard construction |
| | - | Rooftop | 26 | Metal roof sheeting (Colorbond over steel or timber purlin); Single layer of 10mm gypsum plasterboard internally. |

As per the NSW Department of Planning *Development near Rail Corridors and Busy Roads – Interim Guideline*, if internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia.

In relation to the predicted railway noise levels associated with the Byron Solar Train, the following units will require mechanical ventilation:

- Ground Floor:
    - Units 005, 006, 007, 008, and 009.
- First Floor:
    - Units 101, 105, 106, 107, 108, and 109.
- Second Floor:
    - Units 107, 201, 202, 205, 206, 208, and 209.

The mechanical ventilation system should be appropriately sized to ensure sufficient air circulation as per the requirements of AS 1668.2-2012. The ventilation should be designed so that the acoustic performance of the building envelope is not compromised.

## 6.2 Operational Noise Impacts

Detailed noise propagation modelling was carried out considering noise emissions from the proposed development including vehicle movements along the driveway area, mechanical plant (air-conditioning condenser units, basement exhaust, pool pumps), and patron noise from communal and private open spaces.

The following noise mitigation measures are recommended to protect the noise amenity at the nearest noise sensitive places:

- Use of the communal pool area must be limited to daytime and evening hours only (7:00am to 10:00pm).
- Noise barrier fences must be constructed at ground level along the eastern property boundary adjacent to the nearest residences to protect from noise from the communal outdoor recreation area (pool area).
    - The height and alignment of the acoustic barriers is presented in Figure 6.1.
- The mechanical plant for the proposed development, comprising of 26 A/C condenser unit, must be contained within a purpose built mechanical plant deck. Openings for access to the mechanical plant must only be on the northern, western and southern façades of the plant deck. Openings for ventilation may only be on the northern, western and southern façades of the plant deck. The eastern façade must be fully sealed. The sound pressure level measured at 1m from the openings on the northern, western and southern façades of the plant deck, including adjustment for tonality and impulsiveness, must not exceed 52dB(A) $L_{eq,adj,15min}$.
    - The height and alignment of the solid wall is presented in Figure 6.2.
- Solid balustrades are required at all rooftop terraces in order to screen noise to the nearest noise sensitive uses.
    - The height and alignment of the solid balustrades is presented in Figure 6.3.
- All acoustic barriers and acoustic screens must be constructed of a material with minimum superficial mass of 12.5 kg/m$^2$, such as concrete blockwork, brick, autoclaved aerated concrete, minimum 9mm thick compressed fibre cement sheeting, minimum 10mm thick toughened glass, minimum 25mm thick overlapping timber palings or approved modular wall system by Modular Walls, Poly-Tek or equivalent. There shall be no gaps on the surface and at the base of the acoustic barriers, unless required for drainage.

  Appropriate use of noise control measures must be implemented in the detailed design and construction stage for the ventilation openings, to ensure compliance with the 52dB(A) noise

limit at 1m from the northern, western and southern façades of the plant deck. It is recommended to install acoustic louvres to any ventilation openings of the plant deck.

All acoustic louvres must be ACRAN Acraflow 200 or Louvreclad Hudson Series 200, or equal and approved in order to provide sufficient ventilation to the mechanical plant.

- Should there be a need to locate mechanical plant at a location other than what has been assumed in this assessment, or should they have higher sound power levels than the values assumed in this assessment, then the mechanical plant and equipment need to be designed to comply with the noise criteria stated in Section 4.2 and an assessment by a qualified consultant be conducted prior to installation. The assessment should include verification that the plant and equipment installed complies with the criteria as stated in Section 4.2.
- In addition, the following general recommendations must be considered for the design and installation of all mechanical equipment:
    - Select equipment with low sound power levels;
    - Locate equipment as far away from noise sensitive areas as possible;
    - Construct solid acoustic screens or enclosures around equipment to screen it from noise sensitive areas;
    - Where equipment has directional noise characteristics, point equipment away from noise sensitive areas; and
    - Provide acoustic lining to inside of ventilation ducts and/or provide duct silencers.

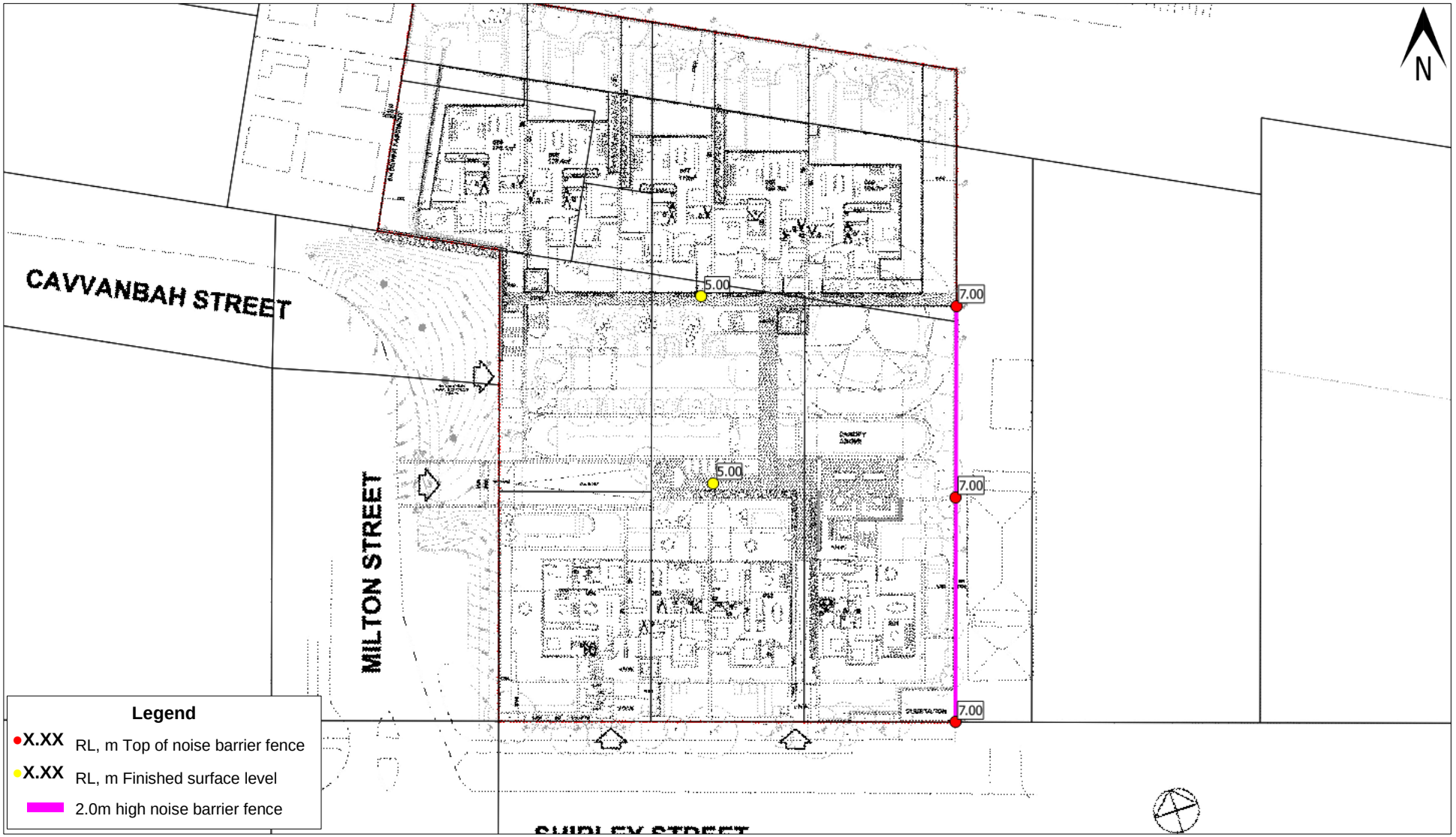



Figure 6.1 Ground level noise barrier fence alignment

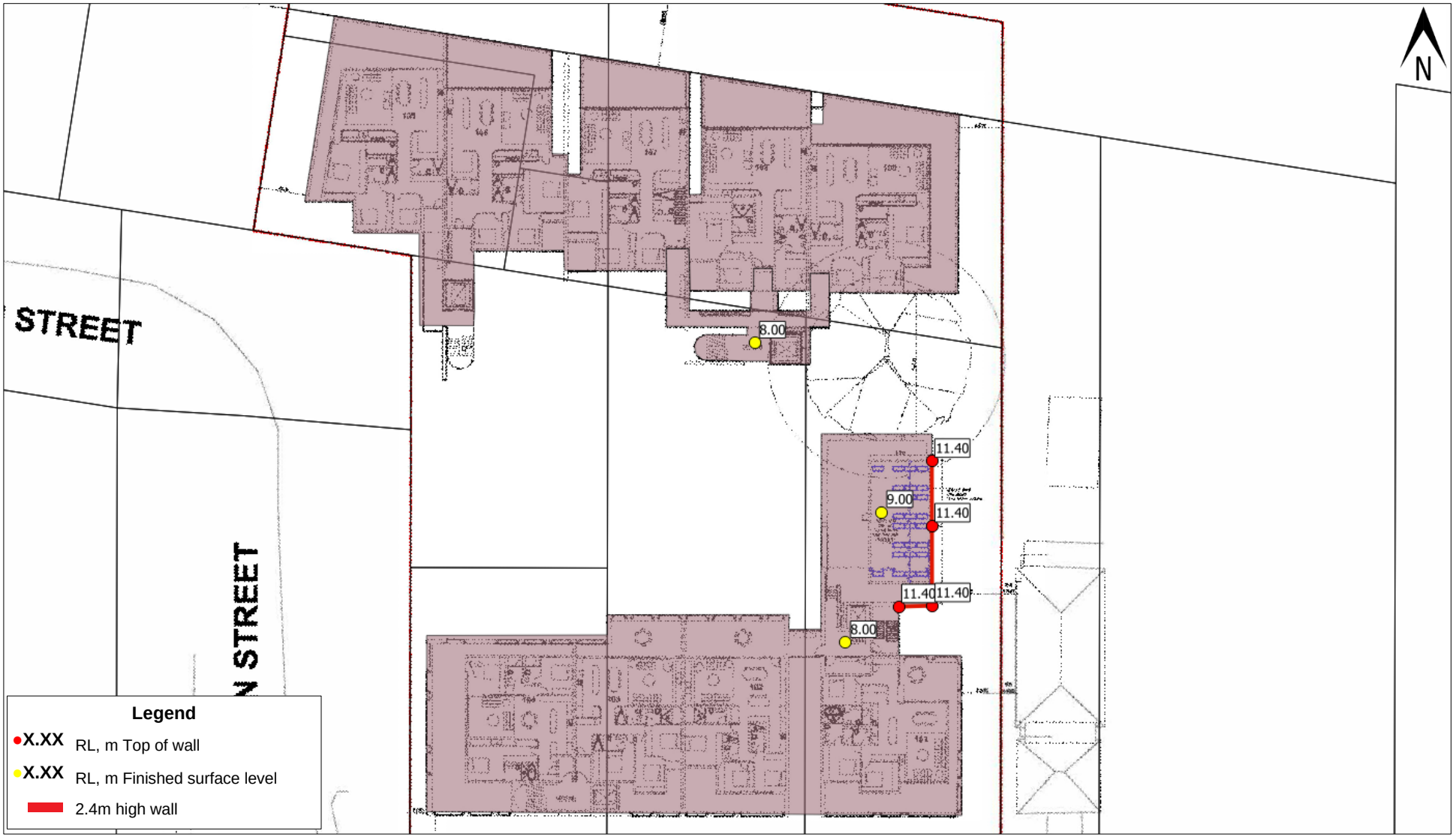



**Figure 6.2 First floor mechanical plant area wall alignment**


Figure 6.3 Rooftop terrace balustrades alignment

## 6.3 Light Rail Vibration Impacts

The proposed development is located adjacent to Murwillimbah Railway Line, upon which the Byron Solar Train operates and which has a potential to cause railway vibration impacts on the development. Site specific vibraiton measurements and detailed acoustic design calculations were carried out to assess railway noise impacts.

A vibration logger was set up on site at 29 Shirley Street to determine the vibration levels from the adjacent Murwillimbah Railway Line and the Byron Solar Train. The measured vibration levels were adjusted to account for the difference between the distance from the railway track to the vibration logger and to the nearest point on the foundations of the future dwellings at 29 Shirley Street.

Based on the measured vibration levels, and when adjusted for distance attenuation and for the coupling loss factors, the maximum predicted vibration level at the future dwellings at 29 Shirley Street is 0.46 mm/s, which is well within the strictect 5 mm/s vibration limit for building damage.

When considering that the Byron Solar Train only operates during daytime and evening, the predicted vibration dose value must meet the maximum vibration limit of 0.4 $m/s^{1.75}$. Based on the vibration measurements conducted at 29 Shirley Street, and adjusted for distance attenuation and for coupling loss factors, the predicted vibration dose values for the occupants of the future dwellings at 29 Shirley Street is 0.21 $m/s^{1.75}$.

Therefore, the predicted vibration levels from the associated Byron Solar Train at the future dwellings at 29 Shirley Street, will comply with the strictest vibration limits for cosmetic and building damage, as well as the human comfort vibration dose values.

# 7. Conclusions

Based on the results of the noise impact assessment for the proposed development at 29 Shirley Street in Byron Bay, the following conclusions are made:

***Light Rail Noise Impact Assessment***

- The results of the light rail noise assessment indicate that standard construction will be appropriate for the southern building façades, however architectural treatment is required to the building envelope of the apartments located in the northern building.
- Preliminary acoustic design specifications for the northern building are presented in Table 6.1 of this report.
- As per the NSW Department of Planning *Development near Rail Corridors and Busy Roads – Interim Guideline*, the following units will require mechanical ventilation:
    - Ground Floor:
        - Units 005, 006, 007, 008, and 009.
    - First Floor:
        - Units 101, 105, 106, 107, 108, and 109.
    - Second Floor:
        - Units 107, 201, 202, 205, 206, 208, and 209.
- The mechanical ventilation system should be appropriately sized to ensure sufficient air circulation as per the requirements of AS 1668.2-2012. The ventilation should be designed so that the acoustic performance of the building envelope is not compromised.

***Operational Noise Impact Assessment***

- The results of the operational noise impact assessment indicate noise impacts on the nearest noise sensitive premises associated with the patron noise from the communal open space, car movements and mechanical noise from A/C units.
- To prevent noise impact on the nearest noise sensitive places, the following noise control measures are recommended:
    - Use of the communal pool area must be limited to daytime and evening hours only (7:00am to 10:00pm).
    - 2.0m high noise barrier fences must be constructed at ground level along the eastern property boundary. The top RL and alignment of the acoustic barriers are presented in Figure 6.1 of this report.
    - The mechanical plant for the proposed development, comprising of 26 A/C condenser unit, must be contained within a purpose built mechanical plant deck. Openings for

access to the mechanical plant must only be on the northern, western and southern façades of the plant deck. Openings for ventilation may only be on the northern, western and southern façades of the plant deck. The eastern façade must be fully sealed. The sound pressure level measured at 1m from the openings on the northern, western and southern façades of the plant deck, including adjustment for tonality and impulsiveness, must not exceed 52dB(A) $L_{eq,adj,15min}$.

The wall on the eastern side of the mechanical plant area must be constructed to minimum 2.4m high. The top RL and alignment of the solid wall are presented in Figure 6.2 of this report.

- 1.2m high solid balustrades are required at all rooftop terraces. The top RL and alignment of the solid balustrades is presented in Figure 6.3 of this report.

  Appropriate use of noise control measures must be implemented in the detailed design and construction stage for the ventilation openings, to ensure compliance with the 52dB(A) noise limit at 1m from the northern, western and southern façades of the plant deck. It is recommended to install acoustic louvres to any ventilation openings of the plant deck.

  All acoustic louvres must be ACRAN Acraflow 200 or Louvreclad Hudson Series 200, or equal and approved in order to provide sufficient ventilation to the mechanical plant.

- Should there be a need to locate mechanical plant at a location other than what has been assumed in this assessment, or should they have higher sound power levels than the values assumed in this assessment, then the mechanical plant and equipment need to be designed to comply with the noise criteria stated in Section 4.2 of this report and an assessment by a qualified consultant be conducted prior to installation. The assessment should include verification that the plant and equipment installed complies with the criteria as stated in Section 4.2 of this report.

- In addition, the following general recommendations must be considered for the design and installation of all mechanical equipment:

  - Select equipment with low sound power levels;
  - Locate equipment as far away from noise sensitive areas as possible;
  - Construct solid acoustic screens or enclosures around equipment to screen it from noise sensitive areas;
  - Where equipment has directional noise characteristics, point equipment away from noise sensitive areas; and
  - Provide acoustic lining to inside of ventilation ducts and/or provide duct silencers.

***Light Rail Vibration Impact Assessment***

- The results of the light rail vibration assessment indicate that there will be no vibration impacts on the proposed dwellings.
- The predicted vibration levels at the nearest future dwellings will comply with the strictest vibration limits for human comfort (<0.4 $m/s^{1.75}$), and for building damage (<5 mm/s).

Provided the noise mitigation measures recommended in this report are fully implemented in the detailed design and construction, there will be no further acoustic constraints on the establishment of the proposed development at 29 Shirley Street in Byron Bay.

## 8. References


- Australian Standard AS1055.2018 *(Acoustics - Description and Measurement of Environmental Noise)*
- Australian Standard AS/NZS IEC61672.1-2019 (Electroacoustics - Sound level meters – Specifications)
- Australian Standard AS/NZS 2107:2016 *(Acoustics – Aircraft noise intrusion – Building siting and construction)*
- Byron Local Environmental Plan 2014
- NSW Department of Planning, *Interim Guideline – Development near Rail Corridors and Busy Roads*, 2008
- NSW EPA, *Noise Policy for Industry*, 2017
- NSW EPA, Road Noise Policy, 2011
- *State Environmental Planning Policy (Transport and Infrastructure) 2021*

## 9. Appendices

Appendix A – Development Layout

Appendix B – Site Photos

Appendix C – Meteorological Data

Appendix D – Noise Measurement Results

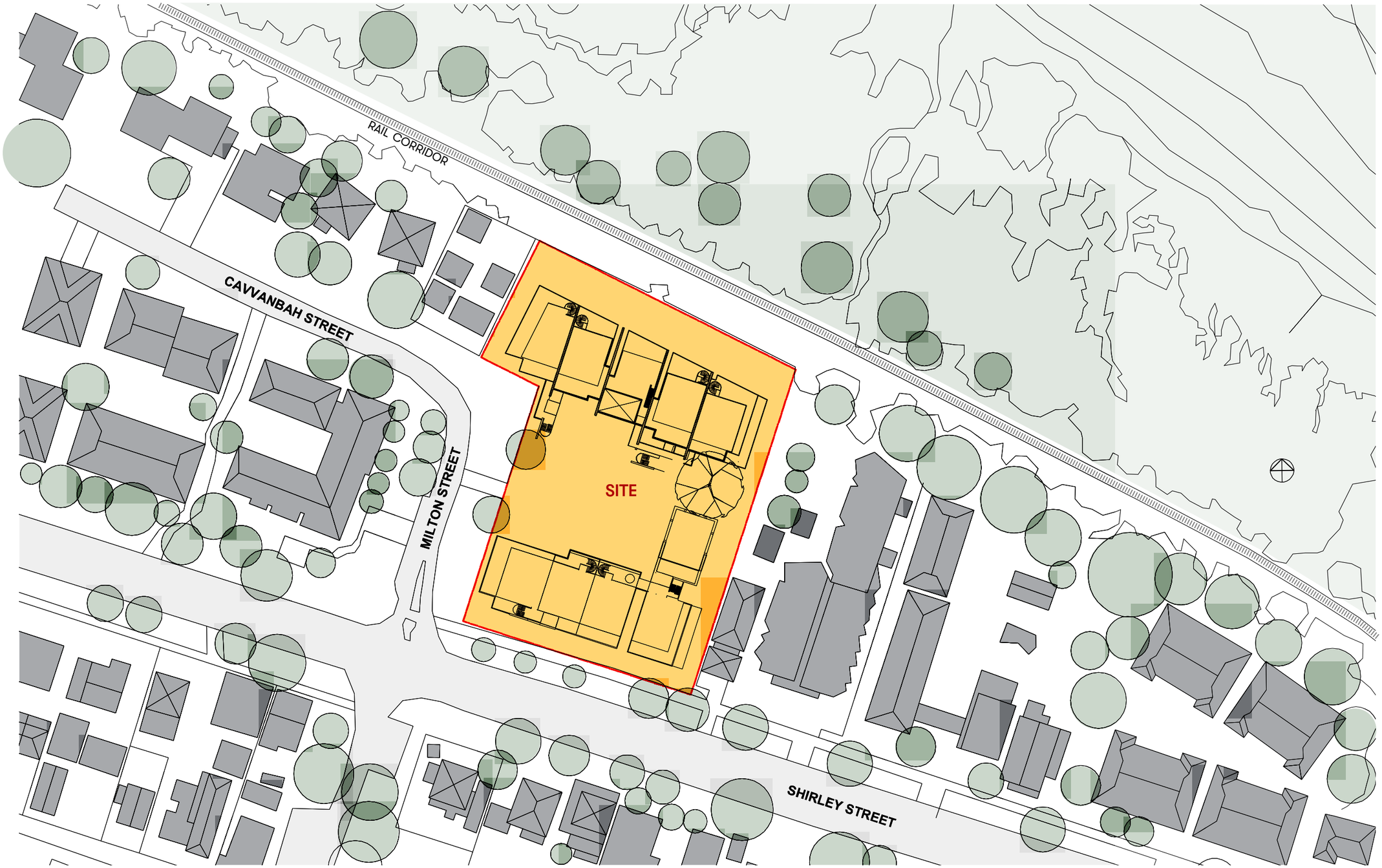
Appendix E – Tabulated Operational Noise Levels

Appendix F – Operational Noise Contour Maps

# Appendix A – Development Layout

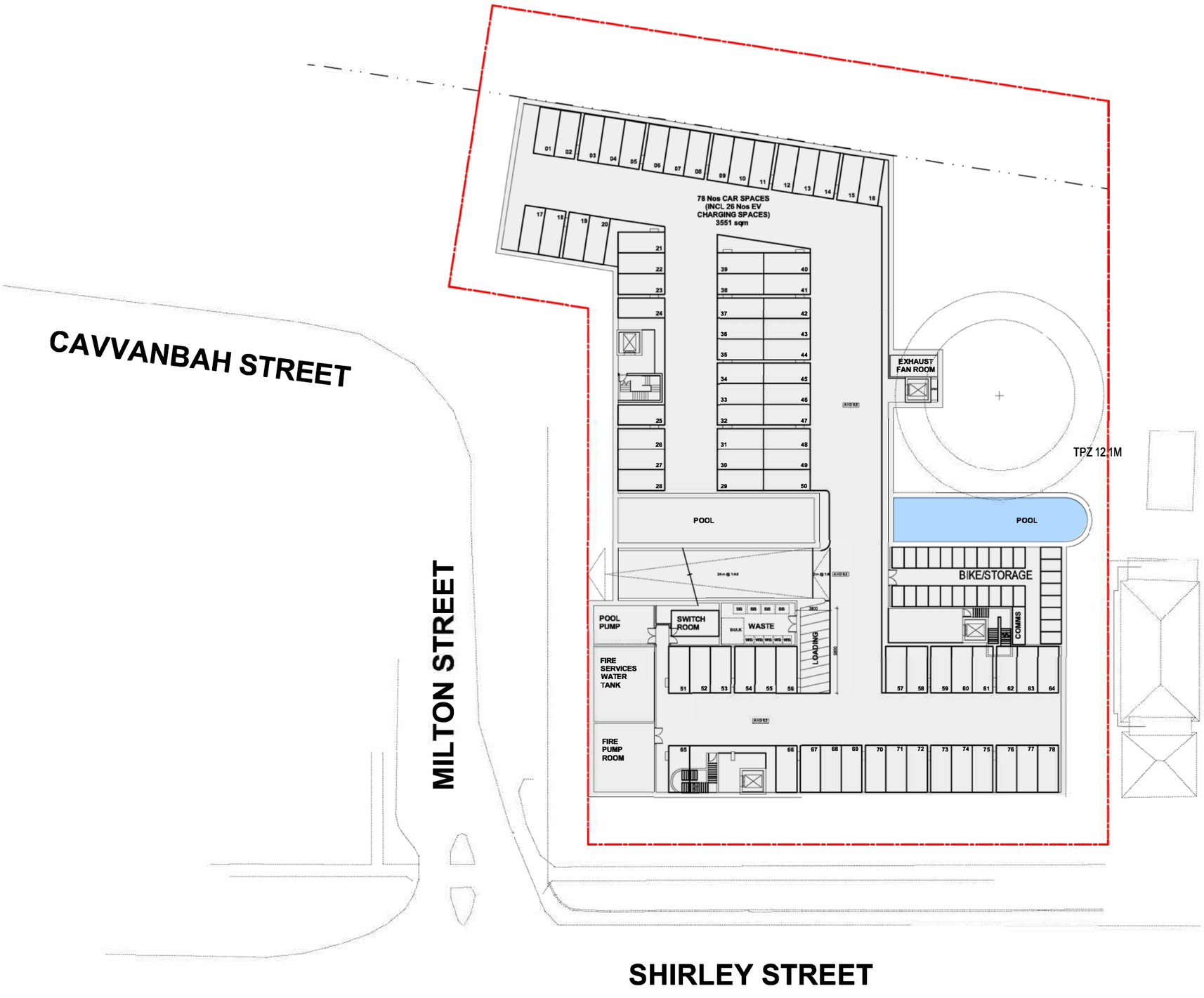
# Proposed Floor Plans

## Site Plan



# Proposed Floor Plans

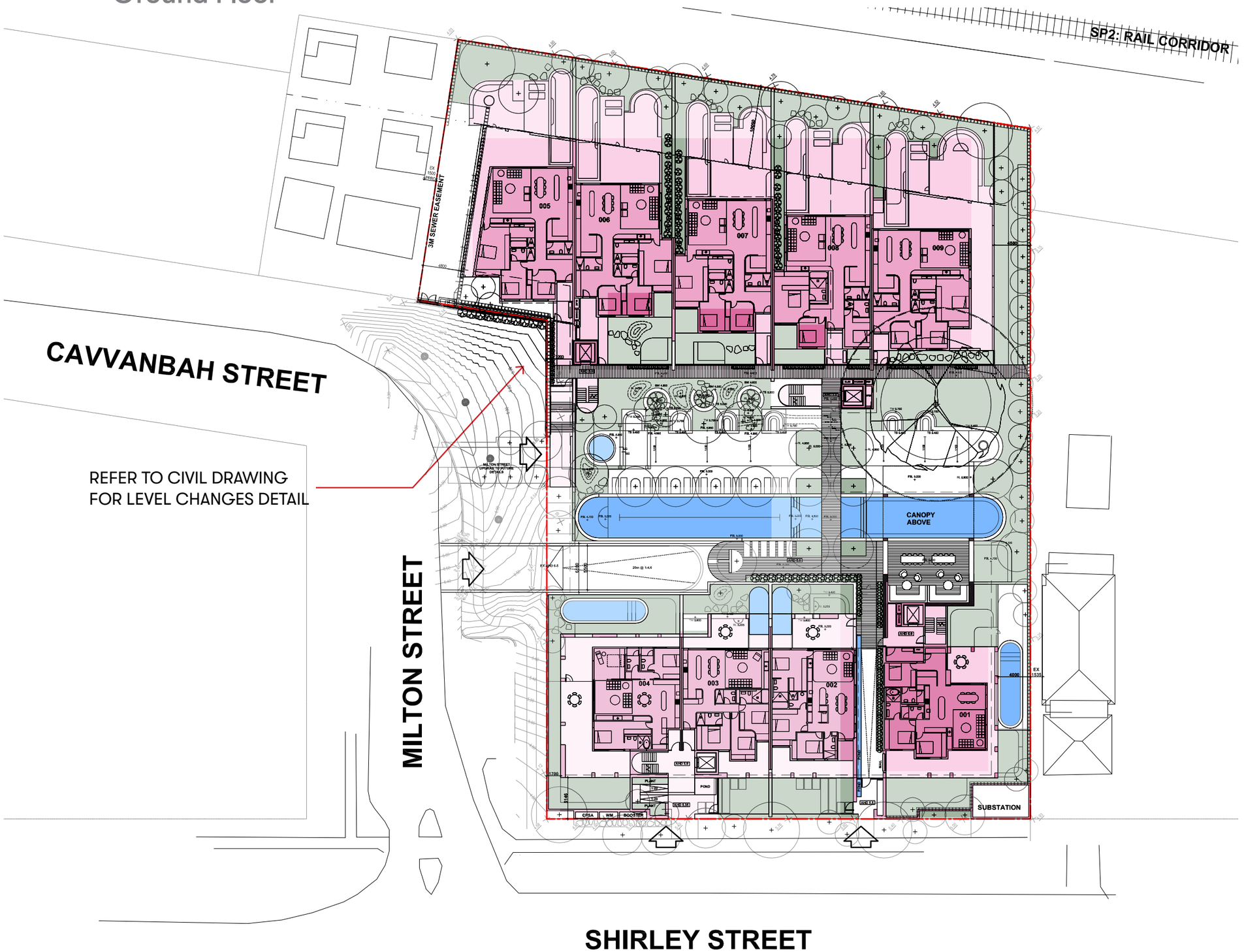
## Basement




SCALE 1:500

# Proposed Floor Plans

## Ground Floor




SCALE 1:500

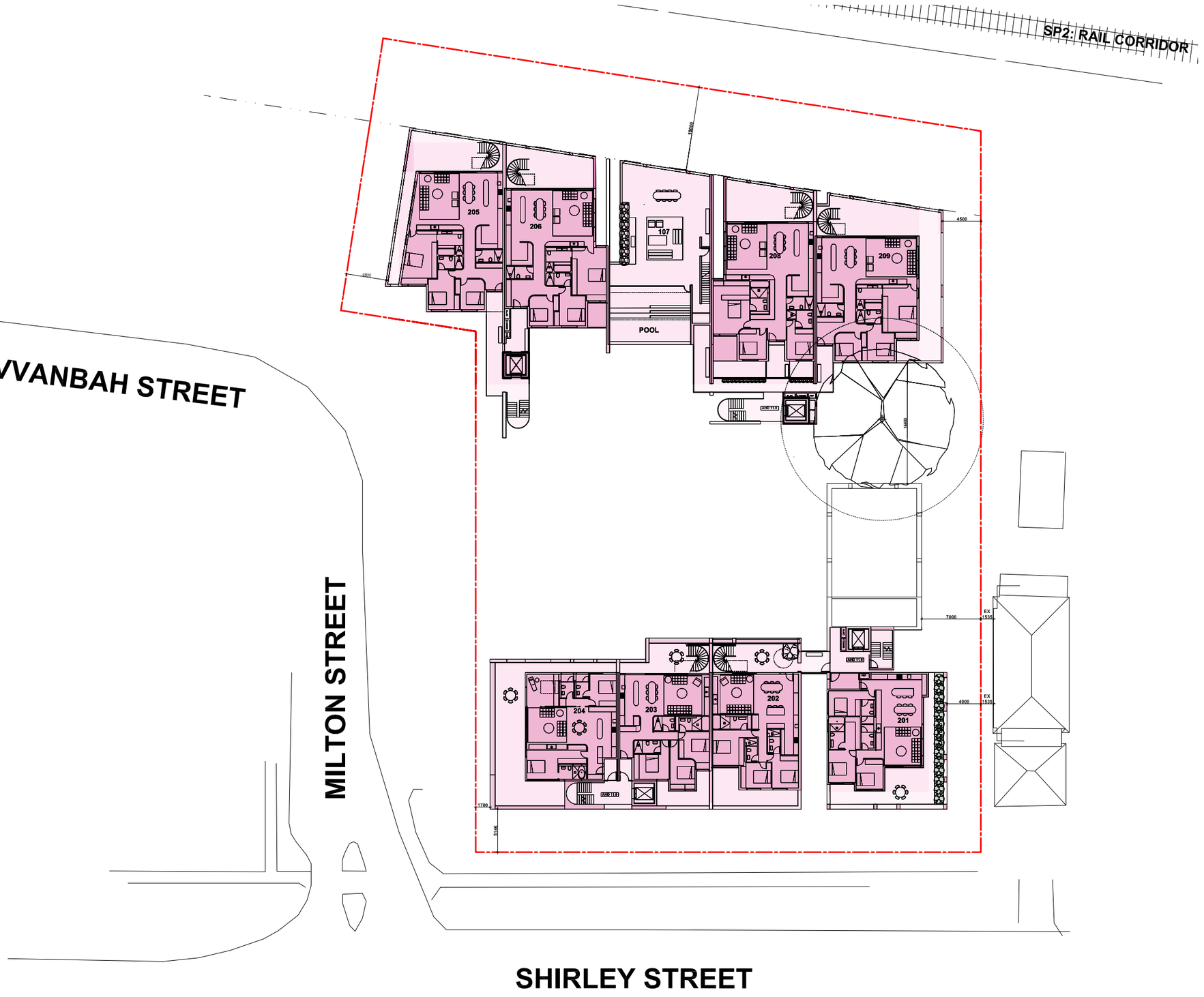
# Proposed Floor Plans

## Level 1


SCALE 1:500

# Proposed Floor Plans

## Level 2




SCALE 1:500

Vitale Property Group
29 Shirley St & 2-4 Milton St, Byron Bay

Development Application
22 July 2022

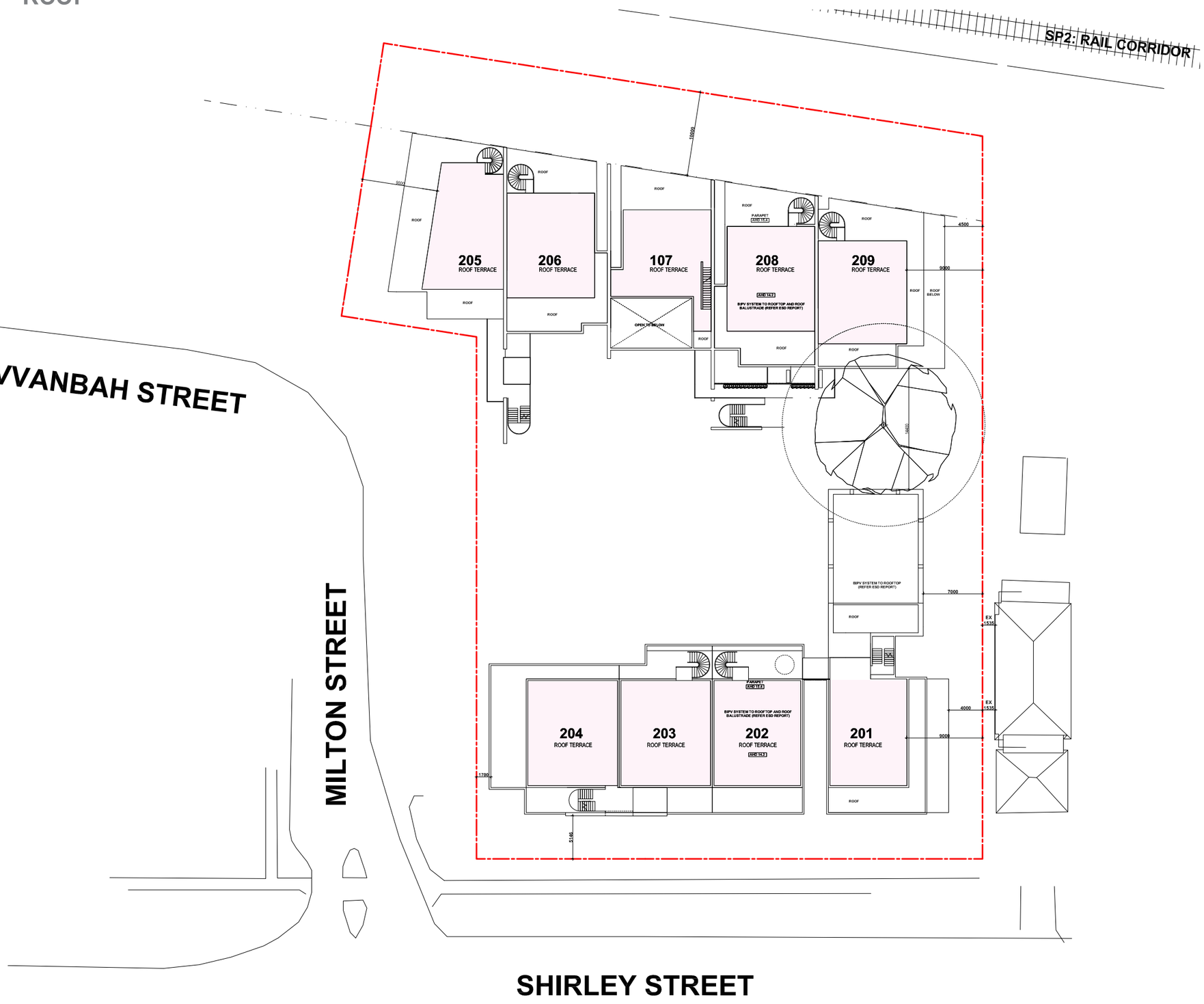
Project No
2555

**DA 1.14**

Hayball 25

# Proposed Floor Plans

## Roof




SCALE 1:500

Vitale Property Group
29 Shirley St & 2-4 Milton St, Byron Bay

Development Application
22 July 2022

Project No
2555

**DA 1.15**

# Appendix B – Site Photos

Photo 1: Measurement location at 29 Shirley Street

Photo 2: Measurement location at 29 Shirley Street

# Appendix C – Meteorological Data

# Byron Bay, New South Wales
# February 2022 Daily Weather Observations

Australian Government
Bureau of Meteorology

| Date | Day | Temps | | Rain | Evap | Sun | Max wind gust | | | 9am | | | | | | 3pm | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | | | | Dirn | Spd | Time | Temp | RH | Cld | Dirn | Spd | MSLP | Temp | RH | Cld | Dirn | Spd | MSLP |
| | | °C | °C | mm | mm | hours | | km/h | local | °C | % | eighths | | km/h | hPa | °C | % | eighths | | km/h | hPa |
| 1 | Tu | 23.0 | 31.5 | 0.2 | | | NNW | 39 | 16:48 | 26.5 | 83 | | NNE | 6 | 1005.3 | 29.4 | 74 | | NNE | 20 | 1002.6 |
| 2 | We | 23.9 | 29.9 | 2.2 | | | N | 48 | 17:10 | 26.3 | 92 | | | Calm | 1003.2 | 29.2 | 84 | | N | 15 | 1001.7 |
| 3 | Th | 22.1 | 23.4 | 24.6 | | | SSW | 70 | 15:57 | 23.3 | 98 | | SSW | 31 | 1001.3 | 21.6 | 99 | | SW | 33 | 1000.3 |
| 4 | Fr | 19.0 | 24.1 | 51.2 | | | S | 81 | 15:23 | 21.3 | 85 | | SSE | 37 | 1006.4 | 22.7 | 71 | | S | 50 | 1007.8 |
| 5 | Sa | 18.3 | 23.4 | 6.6 | | | SE | 85 | 21:20 | 23.0 | 63 | | S | 48 | 1011.3 | 19.6 | 91 | | SSW | 59 | 1011.6 |
| 6 | Su | 18.1 | 24.3 | 9.6 | | | SE | 76 | 01:12 | 21.8 | 72 | | SSE | 44 | 1014.7 | 22.7 | 67 | | S | 48 | 1015.3 |
| 7 | Mo | 17.4 | 24.1 | 1.6 | | | S | 69 | 16:21 | 19.7 | 82 | | SW | 28 | 1016.7 | 23.1 | 70 | | SE | 31 | 1015.0 |
| 8 | Tu | 17.1 | 24.6 | 0.8 | | | S | 59 | 23:05 | 18.1 | 88 | | SW | 28 | 1015.2 | 23.3 | 65 | | S | 28 | 1013.3 |
| 9 | We | 18.0 | 28.9 | 0.8 | | | ENE | 48 | 19:23 | 22.1 | 68 | | SW | 13 | 1013.8 | 27.7 | 56 | | E | 20 | 1011.7 |
| 10 | Th | 20.0 | 26.6 | 0 | | | ESE | 33 | 20:09 | 22.8 | 75 | | SW | 11 | 1013.4 | 26.3 | 61 | | SE | 17 | 1011.6 |
| 11 | Fr | 19.4 | 25.5 | 0 | | | S | 69 | 14:02 | 23.4 | 76 | | SW | 22 | 1011.7 | 24.6 | 71 | | S | 57 | 1010.0 |
| 12 | Sa | 19.3 | 23.9 | 8.0 | | | S | 80 | 13:58 | 19.9 | 95 | | SW | 24 | 1011.9 | 21.0 | 78 | | S | 57 | 1012.7 |
| 13 | Su | 17.3 | 25.2 | 22.8 | | | S | 61 | 23:05 | 19.4 | 89 | | SW | 22 | 1018.7 | 24.5 | 67 | | SE | 30 | 1018.9 |
| 14 | Mo | 18.9 | 24.0 | 4.0 | | | E | 50 | 16:16 | 20.8 | 88 | | SW | 20 | 1022.7 | 20.2 | 95 | | S | 26 | 1023.1 |
| 15 | Tu | 20.0 | 25.5 | 13.6 | | | E | 54 | 10:25 | 22.6 | 76 | | E | 26 | 1022.6 | 23.3 | 71 | | E | 28 | 1021.5 |
| 16 | We | 18.7 | 26.9 | 0.8 | | | SE | 44 | 02:53 | 21.6 | 87 | | SSW | 17 | 1019.1 | 25.3 | 65 | | ESE | 20 | 1016.8 |
| 17 | Th | 20.5 | | 0.2 | | | | | | 23.8 | 70 | | WNW | 2 | 1014.8 | 28.1 | 62 | | NE | 24 | 1011.9 |
| 18 | Fr | 21.7 | 28.3 | | | | NNE | 35 | 15:26 | 24.1 | 75 | | NNW | 6 | 1011.5 | 27.2 | 68 | | NNE | 22 | 1009.5 |
| 19 | Sa | 20.2 | 26.9 | 0.4 | | | SSE | 56 | 18:17 | 22.1 | 92 | | SW | 22 | 1015.3 | 26.3 | 73 | | SSE | 28 | 1014.7 |
| 20 | Su | 19.9 | 29.2 | 1.8 | | | ESE | 41 | 23:02 | 20.6 | 96 | | WSW | 19 | 1014.2 | 26.9 | 72 | | ENE | 17 | 1011.5 |
| 21 | Mo | 20.5 | 30.4 | 0 | | | NE | 35 | 15:30 | 25.1 | 76 | | NNW | 7 | 1011.1 | 29.5 | 63 | | NE | 26 | 1009.8 |
| 22 | Tu | 22.2 | 29.6 | 2.8 | | | E | 41 | 21:14 | 24.2 | 87 | | ESE | 6 | 1013.9 | 29.2 | 67 | | E | 20 | 1013.5 |
| 23 | We | 21.1 | 24.0 | 19.8 | | | NE | 70 | 06:25 | 21.9 | 95 | | N | 19 | 1015.3 | 21.8 | 98 | | SSW | 17 | 1014.0 |
| 24 | Th | 21.3 | 27.0 | 57.4 | | | ENE | 61 | 09:27 | 23.9 | 95 | | ENE | 28 | 1012.8 | 25.4 | 84 | | ENE | 24 | 1011.9 |
| 25 | Fr | 22.6 | 25.4 | 10.4 | | | ENE | 50 | 07:19 | 23.7 | 89 | | NE | 28 | 1011.0 | 24.9 | 83 | | ENE | 24 | 1009.1 |
| 26 | Sa | 22.2 | 25.4 | 4.6 | | | NNE | 59 | 15:14 | 23.8 | 89 | | NE | 37 | 1009.6 | 24.2 | 87 | | NE | 35 | 1008.5 |
| 27 | Su | 20.3 | 23.7 | 52.6 | | | NNE | 67 | 21:40 | 21.5 | 98 | | NNE | 30 | 1009.1 | 22.3 | 95 | | NNE | 28 | 1006.3 |
| 28 | Mo | 20.4 | 23.5 | 124.6 | | | N | 93 | 06:15 | 23.3 | 98 | | N | 39 | 1005.3 | 22.2 | 98 | | NNE | 22 | 1005.1 |
| **Statistics for February 2022** | | | | | | | | | | | | | | | | | | | | | |
| | Mean | 20.1 | 26.1 | | | | | | | 22.5 | 84 | | | 22 | 1012.6 | 24.7 | 76 | | | 29 | 1011.4 |
| | Lowest | 17.1 | 23.4 | | | | | | | 18.1 | 63 | | | Calm | 1001.3 | 19.6 | 56 | | N | 15 | 1000.3 |
| | Highest | 23.9 | 31.5 | 124.6 | | | N | 93 | | 26.5 | 98 | | S | 48 | 1022.7 | 29.5 | 99 | | SSW | 59 | 1023.1 |
| | Total | | | 421.4 | | | | | | | | | | | | | | | | | |

Observations were drawn from Byron Bay (Cape Byron AWS) {station 058216}

IDCJDW2022.202202 Prepared at 13:00 UTC on 7 Mar 2022

# Appendix D – Noise Measurement Results

## Unattended Noise Measurements
## 29 Shirley Street, Byron Bay

Environmental Noise Levels Day, Evening and Night

**Logger Location - Northern boundary of lot**

| | |
|---|---|
| ARL Environmental Noise Logger | |
| Logger Serial Number | 878157 |
| Measurement Title | 20220211_185521 |
| Measurement started at | 11/02/2022 18:55 |
| Measurement stopped at | 20/02/2022 16:56 |
| Frequency Weighting | A |
| Time Averaging | Fast |
| Statistical Interval | 15 min |
| Pre-measurement Ref. | 94.0 |
| Post-measurement Ref. | 94.0 |
| Engineering Units | dB SPL |

| | | $L_{Aeq,T}$ dB(A) | | | $L_{A01,T}$ dB(A) | | | $L_{A10,T}$ dB(A) | | | $L_{A90,T}$ dB(A) | | | Assessment Background Level, dB(A) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Day** | **D** | **E** | **N** | **D** | **E** | **N** | **D** | **E** | **N** | **D** | **E** | **N** | **D** | **E** | **N** |
| 11/02/2022 | Friday | — | — | 48 | — | — | 52 | — | — | 49 | — | — | 44 | — | — | 43 |
| 12/02/2022 | Saturday | 55 | 54 | 47 | 64 | 62 | 51 | 57 | 56 | 48 | 48 | 49 | 45 | 46 | 48 | 43 |
| 13/02/2022 | Sunday | 52 | 56 | 51 | 63 | 64 | 54 | 52 | 57 | 52 | 46 | 50 | 48 | 45 | 48 | 46 |
| 14/02/2022 | Monday | 52 | 56 | 51 | 62 | 60 | 54 | 53 | 57 | 52 | 47 | 53 | 48 | 45 | 48 | 47 |
| 15/02/2022 | Tuesday | 54 | 55 | 48 | 63 | 62 | 50 | 54 | 57 | 48 | 47 | 51 | 46 | 45 | 49 | 43 |
| 16/02/2022 | Wednesday | 50 | 56 | 47 | 59 | 63 | 51 | 50 | 57 | 48 | 46 | 51 | 45 | 45 | 49 | 43 |
| 17/02/2022 | Thursday | 51 | 56 | 51 | 61 | 62 | 54 | 51 | 57 | 51 | 47 | 53 | 49 | 45 | 51 | 47 |
| 18/02/2022 | Friday | 53 | 59 | 46 | 63 | 66 | 51 | 54 | 61 | 48 | 48 | 54 | 44 | 45 | 47 | 42 |
| 19/02/2022 | Saturday | 51 | 54 | 47 | 61 | 60 | 50 | 52 | 56 | 48 | 45 | 50 | 44 | 43 | 46 | 42 |
| **Average** | | **52** | **56** | **48** | **62** | **63** | **52** | **53** | **57** | **49** | **47** | **51** | **46** | **—** | **—** | **—** |
| | | | | | | | | | | | | | | **Rating Background Level dB(A)** | **45** | **48** | **43** |

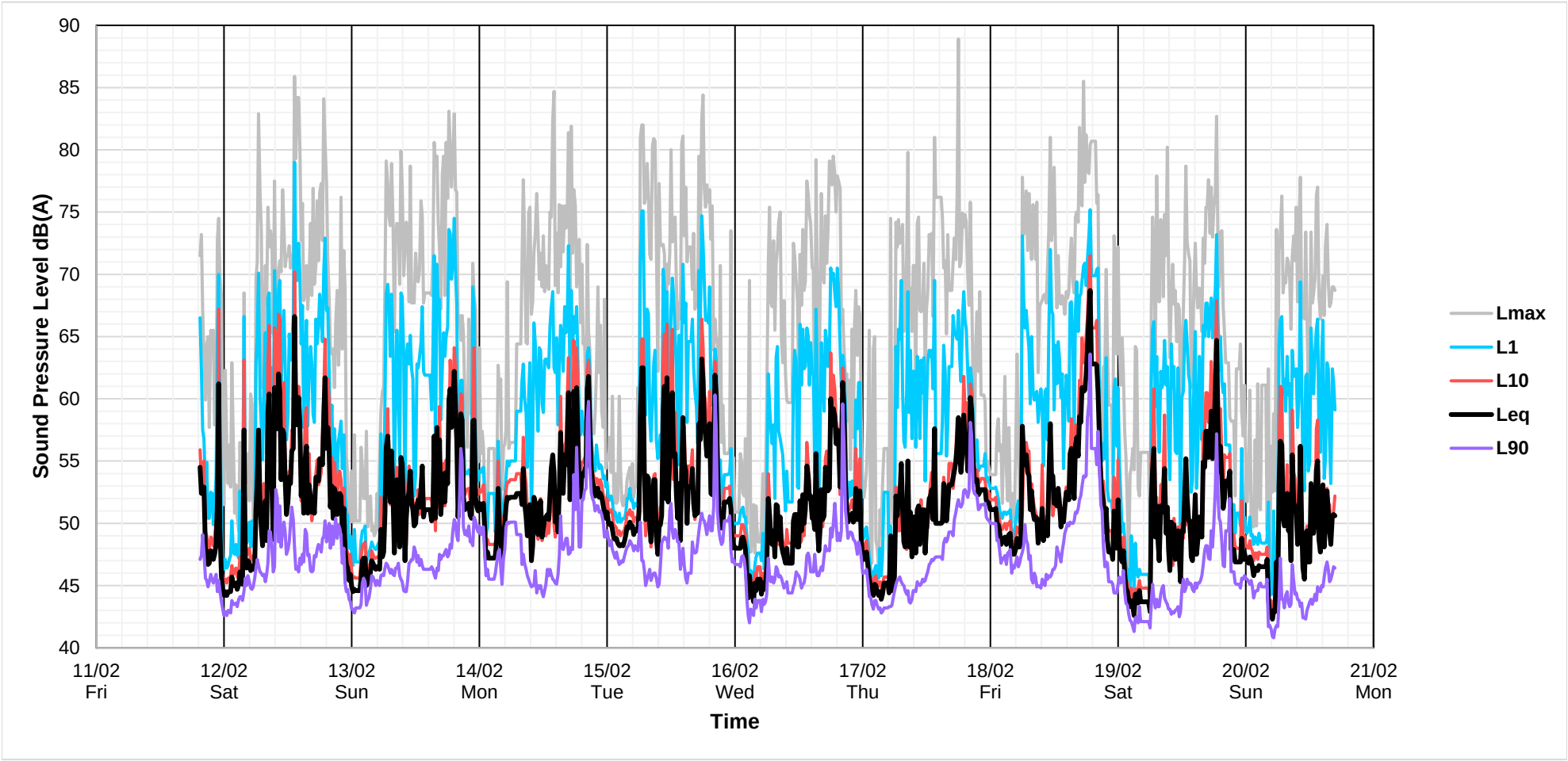
***Note***

— No noise data available

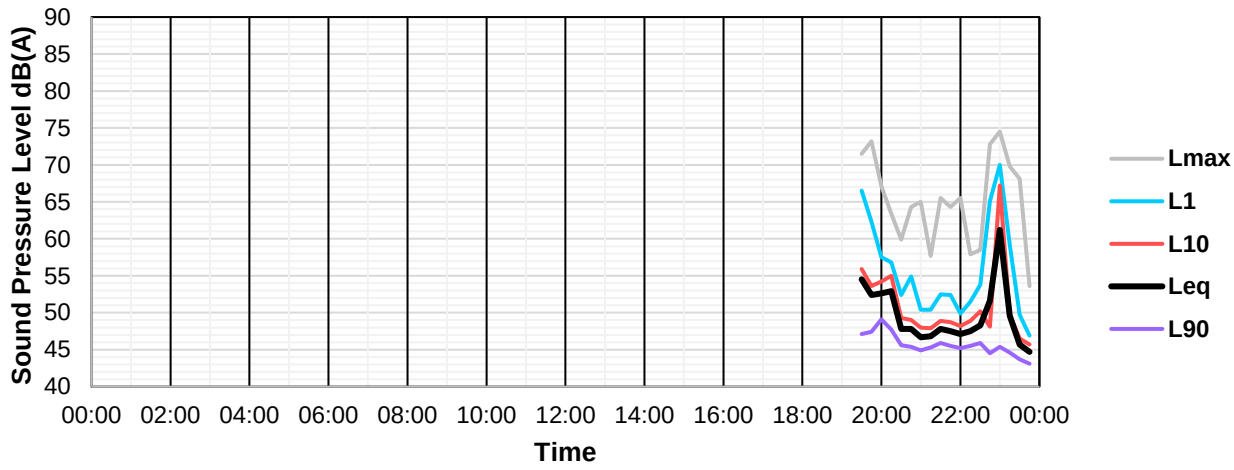
Day (D): 7:00am to 6:00pm
Evening (E): 6:00pm to 10:00pm
Night (N): 10:00pm to 7:00am

Rainfall recorded during this period

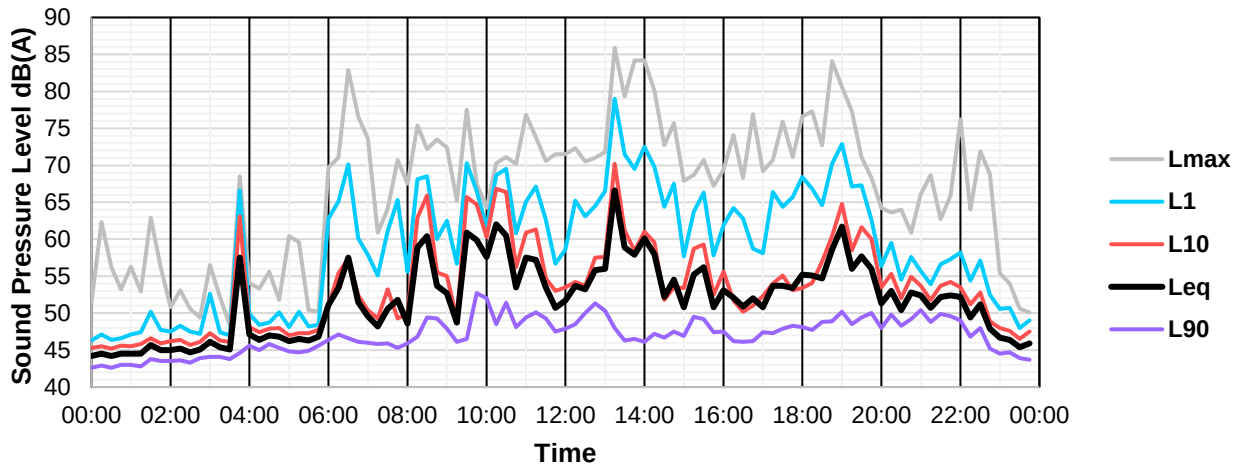
**Unattended Noise Measurements**
**11 to 20 February 2022**



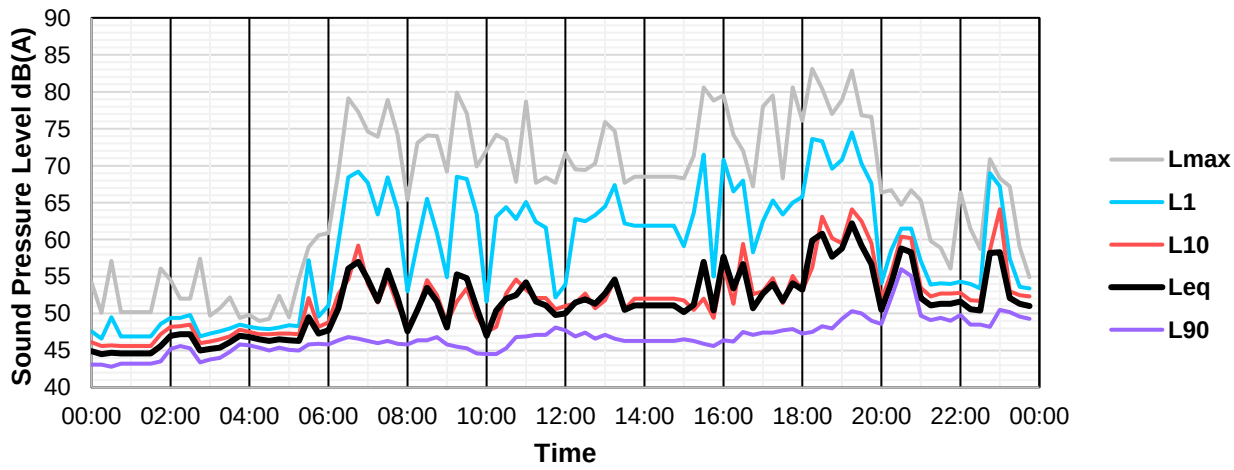
## Unattended Noise Measurements
## Friday 11 February 2022



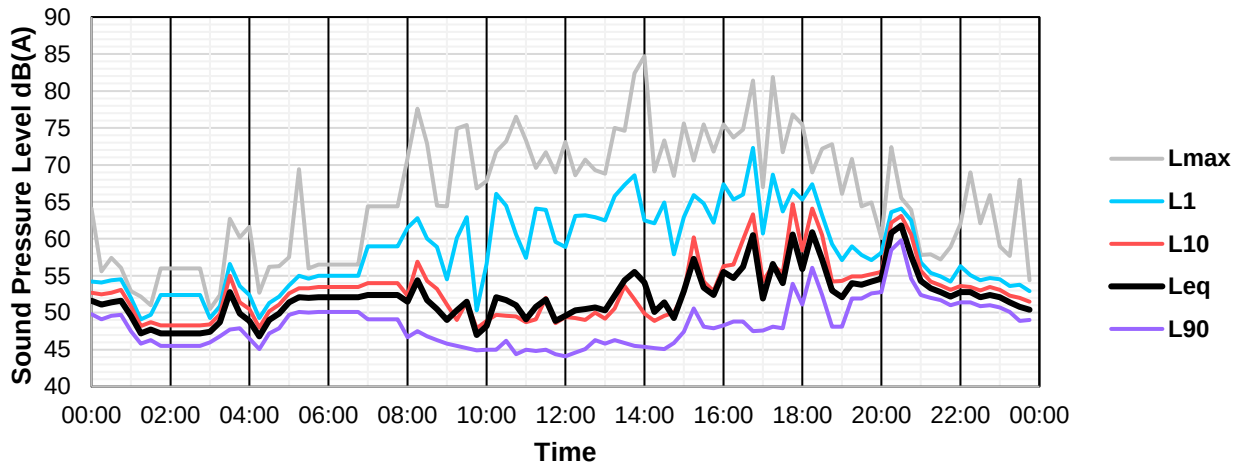

## Unattended Noise Measurements
## Saturday 12 February 2022



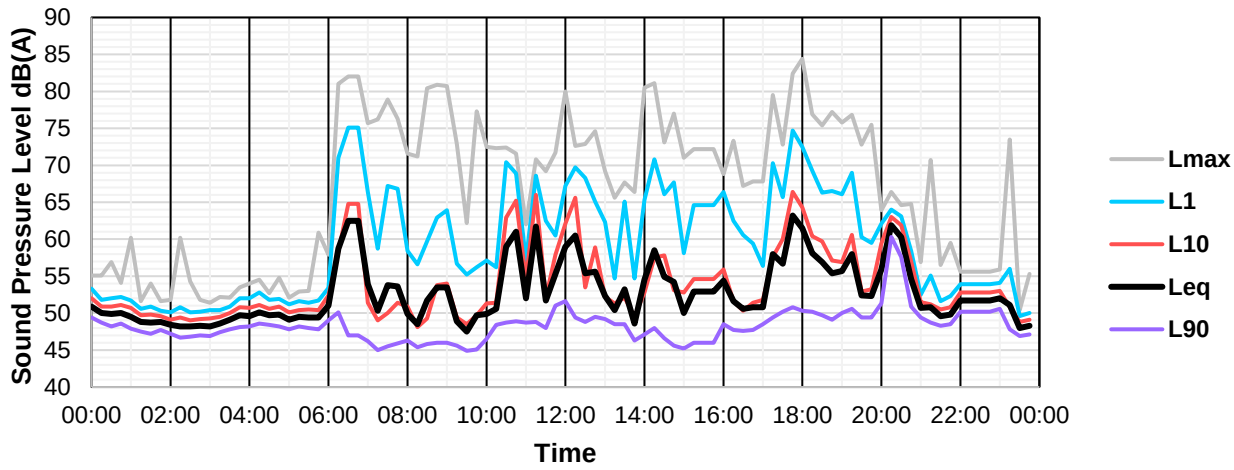

## Unattended Noise Measurements
## Sunday 13 February 2022



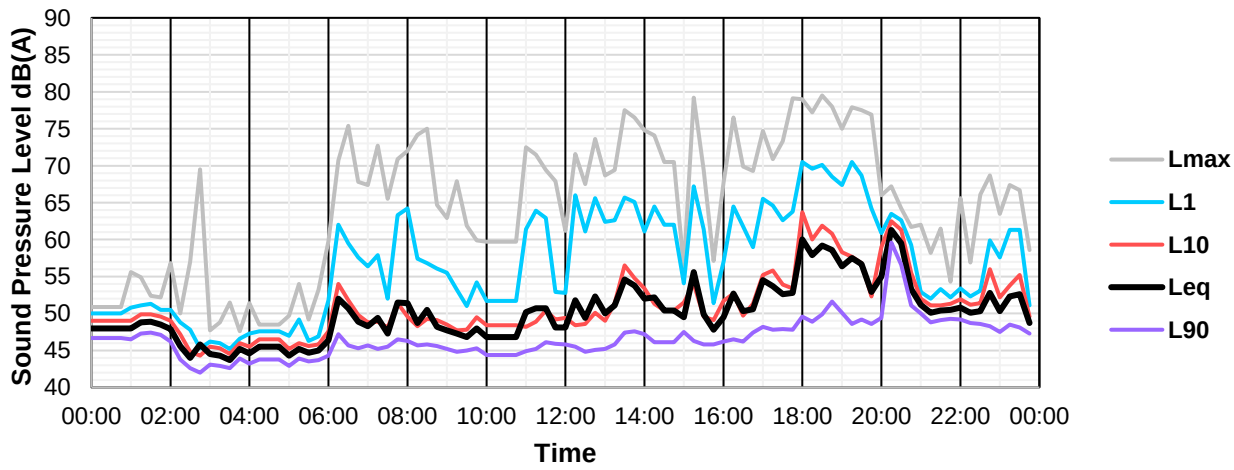
## Unattended Noise Measurements
## Monday 14 February 2022



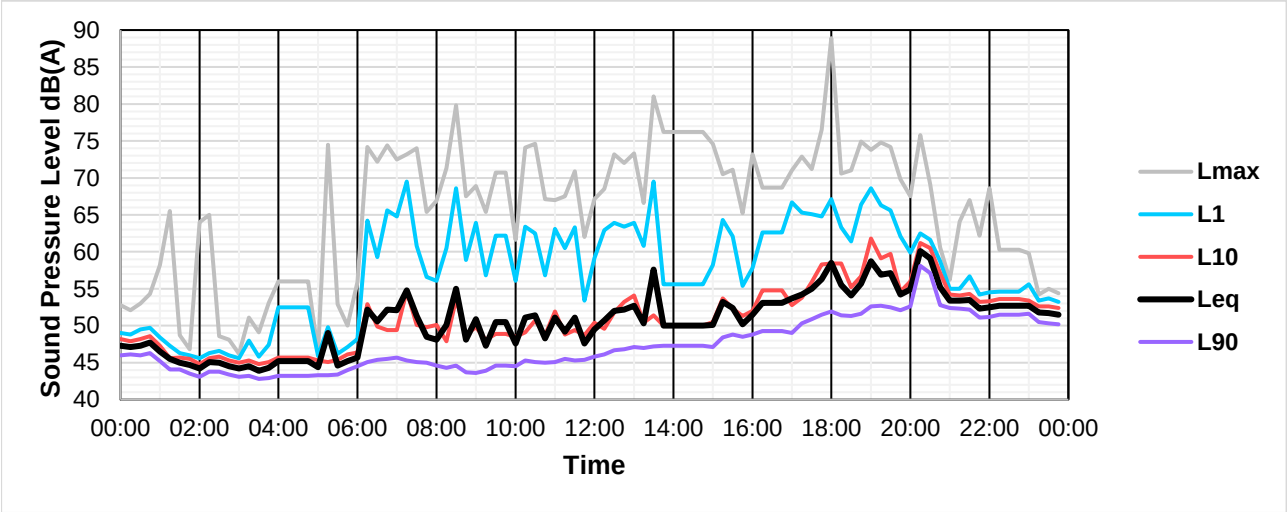

## Unattended Noise Measurements
## Tuesday 15 February 2022



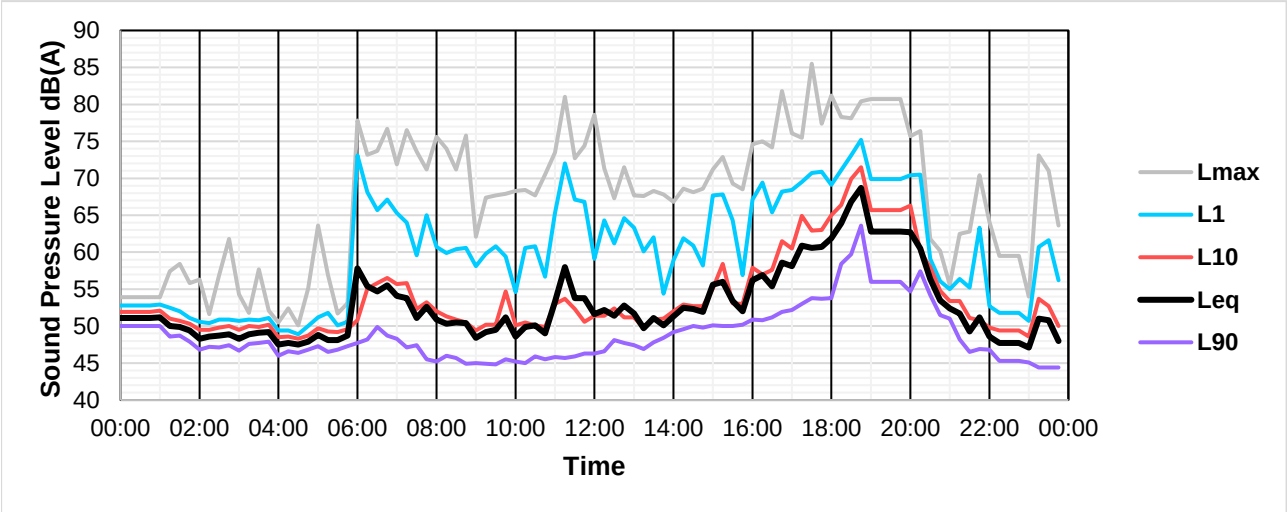

## Unattended Noise Measurements
## Wednesday 16 February 2022



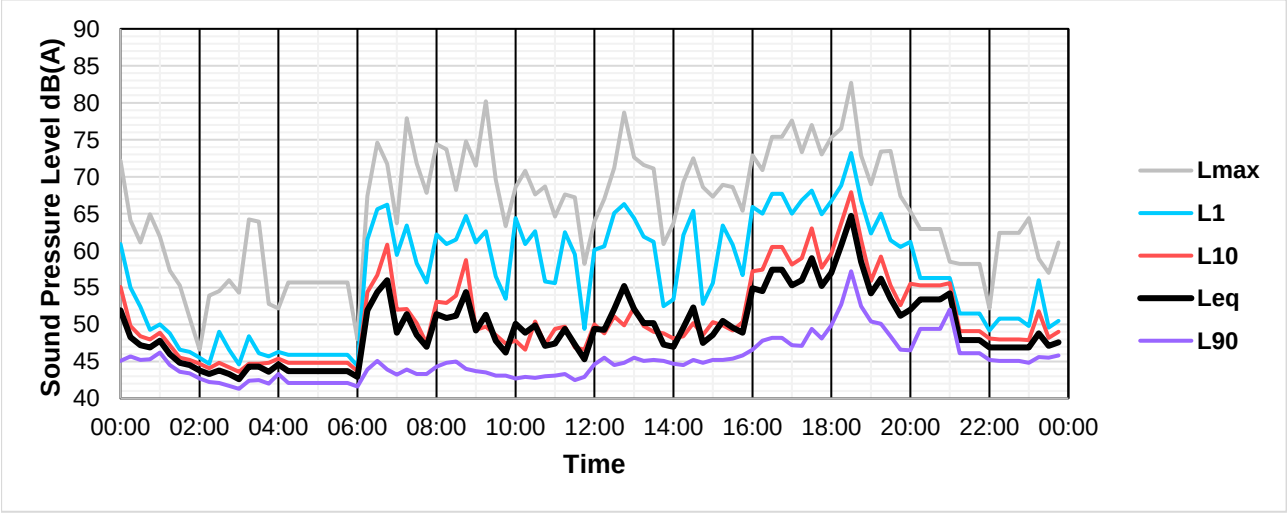
## Unattended Noise Measurements
## Thursday 17 February 2022



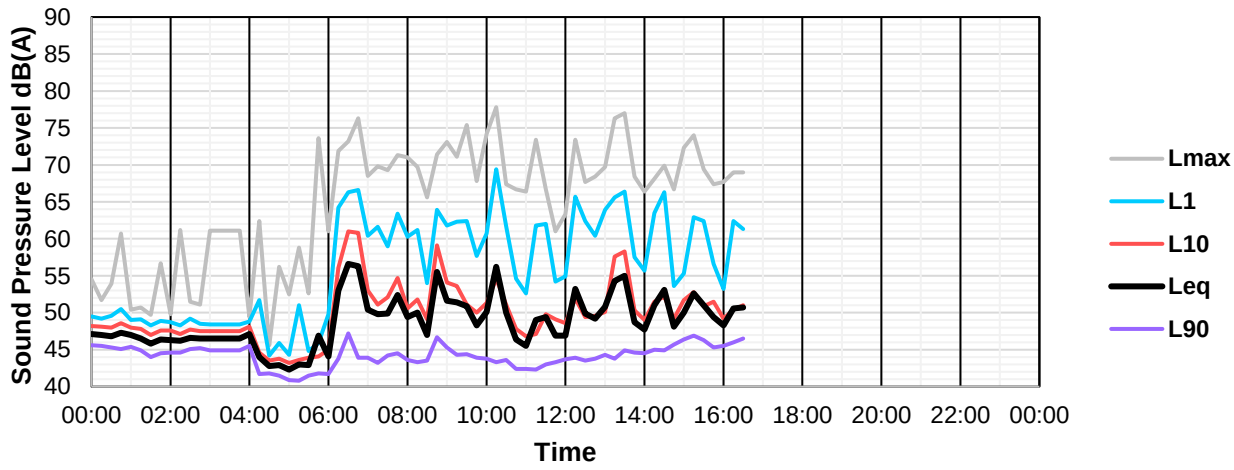

## Unattended Noise Measurements
## Friday 18 February 2022




## Unattended Noise Measurements
## Saturday 19 February 2022



## Unattended Noise Measurements
## Sunday 20 February 2022



# Appendix E – Railway Noise Validation Results

# Proposed Development
# 29 Shirley Street, Byron Bay
## Calculated Railway Noise Levels
## RNIA Validation

| Receiver Name | Leq,pass-by<br>dB(A) |
|---|---|
| RNIA_Validation | 63 |

# Appendix F – Tabulated Railway Noise Levels

# Proposed Development
# 29 Shirley Street, Byron Bay
## Calculated Railway Noise Levels
## Railway Noise Levels at External Facades

| Receiver Name | Floor | Facade | Leq,pass-by dB(A) |
|---|---|---|---|
| Unit 001 | GF | S | 7 |
| Unit 001 | GF | W | 24 |
| Unit 001 | GF | E | 49 |
| Unit 001 | GF | N | 50 |
| Unit 002 | GF | E | 45 |
| Unit 002 | GF | N | 49 |
| Unit 002 | GF | S | 7 |
| Unit 003 | GF | S | 7 |
| Unit 003 | GF | N | 47 |
| Unit 004 | GF | S | 3 |
| Unit 004 | GF | N | 46 |
| Unit 004 | GF | W | 43 |
| Unit 005 | GF | N | 51 |
| Unit 005 | GF | NW | 58 |
| Unit 005 | GF | S | 40 |
| Unit 006 | GF | N | 63 |
| Unit 006 | GF | S | 48 |
| Unit 007 | GF | N | 62 |
| Unit 007 | GF | S | 41 |
| Unit 008 | GF | S | 42 |
| Unit 008 | GF | N | 62 |
| Unit 009 | GF | S | 42 |
| Unit 009 | GF | E | 59 |
| Unit 009 | GF | N | 62 |
| Unit 101 | F 1 | S | 10 |
| Unit 101 | F 1 | W | 30 |
| Unit 101 | F 1 | E | 49 |
| Unit 101 | F 1 | N | 51 |
| Unit 102 | F 1 | S | 10 |
| Unit 102 | F 1 | E | 35 |
| Unit 102 | F 1 | N | 47 |
| Unit 103 | F 1 | N | 48 |
| Unit 103 | F 1 | S | 10 |
| Unit 104 | F 1 | W | 45 |
| Unit 104 | F 1 | S | 8 |
| Unit 104 | F 1 | N | 47 |
| Unit 105 | F 1 | S | 41 |
| Unit 105 | F 1 | NW | 57 |
| Unit 105 | F 1 | N | 58 |
| Unit 106 | F 1 | S | 43 |
| Unit 106 | F 1 | N | 62 |
| Unit 107 | F 1 | S | 42 |
| Unit 107 | F 1 | N | 62 |
| Unit 107 | F 2 | N | 61 |
| Unit 107 | F 2 | S | 46 |
| Unit 108 | F 1 | S | 41 |
| Unit 108 | F 1 | N | 62 |
| Unit 109 | F 1 | S | 43 |
| Unit 109 | F 1 | E | 59 |
| Unit 109 | F 1 | N | 62 |

# Proposed Development
# 29 Shirley Street, Byron Bay
## Calculated Railway Noise Levels
## Railway Noise Levels at External Facades

| Receiver Name | Floor | Facade | Leq,pass-by dB(A) |
|---|---|---|---|
| Unit 201 | F 2 | N | 55 |
| Unit 201 | F 2 | E | 51 |
| Unit 201 | F 2 | W | 40 |
| Unit 201 | F 2 | S | 17 |
| Unit 202 | F 2 | N | 50 |
| Unit 202 | F 2 | E | 51 |
| Unit 202 | F 2 | S | 17 |
| Unit 203 | F 2 | N | 50 |
| Unit 203 | F 2 | S | 16 |
| Unit 204 | F 2 | W | 48 |
| Unit 204 | F 2 | S | 13 |
| Unit 204 | F 2 | N | 50 |
| Unit 205 | F 2 | S | 46 |
| Unit 205 | F 2 | NW | 57 |
| Unit 205 | F 2 | N | 65 |
| Unit 206 | F 2 | N | 61 |
| Unit 206 | F 2 | S | 47 |
| Unit 208 | F 2 | S | 46 |
| Unit 208 | F 2 | N | 61 |
| Unit 209 | F 2 | S | 47 |
| Unit 209 | F 2 | E | 58 |
| Unit 209 | F 2 | N | 61 |

# Appendix G – Tabulated Operational Noise Levels

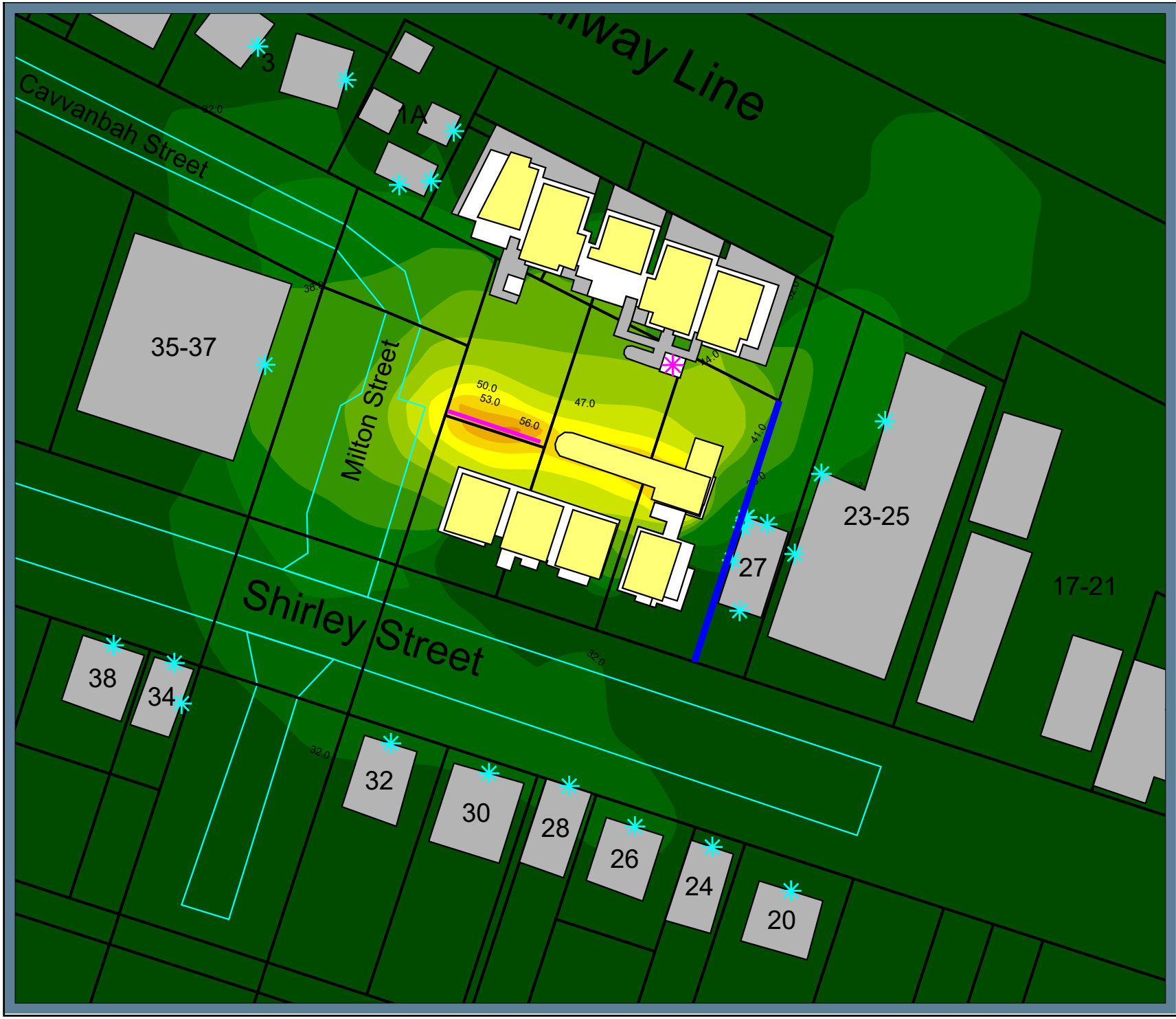
# 29 Shirley Street, Byron Bay
## Predicted Operational Noise Levels at Adjacent Uses
## From Activities at Proposed Development

| Receiver Name | Floor | Facade | Leq,adj,11h Day dB(A) | Leq,adj,4h Evening dB(A) | Leq,adj,9h Night dB(A) |
|---|---|---|---|---|---|
| 1A Cavvanbah Street | GF | SE | 34 | 33 | 32 |
| 1A Cavvanbah Street | GF | SE | 28 | 28 | 27 |
| 1A Cavvanbah Street | GF | SW | 34 | 33 | 31 |
| 20 Shirley Street | GF | N | 29 | 29 | 29 |
| 23-25 Shirley Street | GF | W | 36 | 36 | 35 |
| 23-25 Shirley Street | F 1 | W | 39 | 39 | 37 |
| 23-25 Shirley Street | GF | W | 34 | 34 | 33 |
| 23-25 Shirley Street | F 1 | W | 37 | 37 | 35 |
| 23-25 Shirley Street | GF | W | 28 | 28 | 26 |
| 23-25 Shirley Street | F 1 | W | 33 | 33 | 32 |
| 24 Shirley Street | GF | N | 30 | 30 | 30 |
| 26 Shirley Street | GF | N | 31 | 31 | 31 |
| 27 Shirley Street | GF | N | 35 | 35 | 33 |
| 27 Shirley Street | F 1 | N | 37 | 37 | 35 |
| 27 Shirley Street | GF | N | 35 | 35 | 33 |
| 27 Shirley Street | F 1 | N | 39 | 39 | 37 |
| 27 Shirley Street | GF | S | 25 | 25 | 24 |
| 27 Shirley Street | F 1 | S | 28 | 28 | 27 |
| 27 Shirley Street | GF | W | 35 | 35 | 33 |
| 27 Shirley Street | F 1 | W | 38 | 38 | 36 |
| 27 Shirley Street | GF | W | 36 | 36 | 34 |
| 27 Shirley Street | F 1 | W | 40 | 40 | 38 |
| 27 Shirley Street | GF | W | 36 | 36 | 34 |
| 27 Shirley Street | F 1 | W | 40 | 40 | 38 |
| 28 Shirley Street | GF | N | 32 | 32 | 32 |
| 3 Cavvanbah Street | GF | E | 30 | 30 | 30 |
| 3 Cavvanbah Street | F 1 | E | 34 | 33 | 33 |
| 3 Cavvanbah Street | GF | SE | 26 | 26 | 25 |
| 3 Cavvanbah Street | F 1 | SE | 32 | 32 | 31 |
| 30 Shirley Street | GF | N | 32 | 32 | 32 |
| 32 Shirley Street | GF | N | 32 | 32 | 31 |
| 34 Shirley Street | GF | E | 32 | 31 | 31 |
| 34 Shirley Street | GF | N | 32 | 31 | 31 |
| 35-37 Shirley Street | GF | E | 36 | 35 | 34 |
| 35-37 Shirley Street | F 1 | E | 38 | 37 | 36 |
| 38 Shirley Street | GF | N | 31 | 31 | 30 |

# 29 Shirley Street, Byron Bay
# Predicted Operational Noise Levels at Adjacent Uses
# From Activities at Proposed Development
# Night Time Lmax Assessment

| Receiver Name | Floor | Facade | Lmax,adj,9h Night dB(A) |
|---|---|---|---|
| 1A Cavvanbah Street | GF | SE | 35 |
| 1A Cavvanbah Street | GF | SE | 31 |
| 1A Cavvanbah Street | GF | SW | 34 |
| 20 Shirley Street | GF | N | 33 |
| 23-25 Shirley Street | GF | W | 36 |
| 23-25 Shirley Street | F 1 | W | 38 |
| 23-25 Shirley Street | GF | W | 36 |
| 23-25 Shirley Street | F 1 | W | 39 |
| 23-25 Shirley Street | GF | W | 30 |
| 23-25 Shirley Street | F 1 | W | 35 |
| 24 Shirley Street | GF | N | 34 |
| 26 Shirley Street | GF | N | 34 |
| 27 Shirley Street | GF | N | 35 |
| 27 Shirley Street | F 1 | N | 38 |
| 27 Shirley Street | GF | N | 35 |
| 27 Shirley Street | F 1 | N | 39 |
| 27 Shirley Street | GF | S | 26 |
| 27 Shirley Street | F 1 | S | 30 |
| 27 Shirley Street | GF | W | 34 |
| 27 Shirley Street | F 1 | W | 39 |
| 27 Shirley Street | GF | W | 35 |
| 27 Shirley Street | F 1 | W | 39 |
| 27 Shirley Street | GF | W | 36 |
| 27 Shirley Street | F 1 | W | 40 |
| 28 Shirley Street | GF | N | 35 |
| 3 Cavvanbah Street | GF | E | 36 |
| 3 Cavvanbah Street | F 1 | E | 38 |
| 3 Cavvanbah Street | GF | SE | 29 |
| 3 Cavvanbah Street | F 1 | SE | 36 |
| 30 Shirley Street | GF | N | 35 |
| 32 Shirley Street | GF | N | 35 |
| 34 Shirley Street | GF | E | 35 |
| 34 Shirley Street | GF | N | 35 |
| 35-37 Shirley Street | GF | E | 37 |
| 35-37 Shirley Street | F 1 | E | 39 |
| 38 Shirley Street | GF | N | 35 |

# Appendix H – Operational Noise Contour Maps




ATP CONSULTING ENGINEERS

ATP211137

**Proposed Development**
**29 Shirley Street, Byron Bay**

**Noise Levels Associated with Proposed Development**

**Ground Floor (1.8m AGL)**

Operational Noise Level
$L_{eq,adj,11hr}$ Day dB(A)

| | |
|---|---|
| | <= 32 |
| 32 < | <= 35 |
| 35 < | <= 38 |
| 38 < | <= 41 |
| 41 < | <= 44 |
| 44 < | <= 47 |
| 47 < | <= 50 |
| 50 < | <= 53 |
| 53 < | <= 56 |
| 56 < | <= 59 |
| 59 < | <= 62 |
| 62 < | <= 65 |
| 65 < | <= 68 |
| 68 < | <= 71 |
| 71 < | <= 74 |
| 74 < | <= 77 |
| 77 < | <= 80 |
| 80 < | |

**Legend**

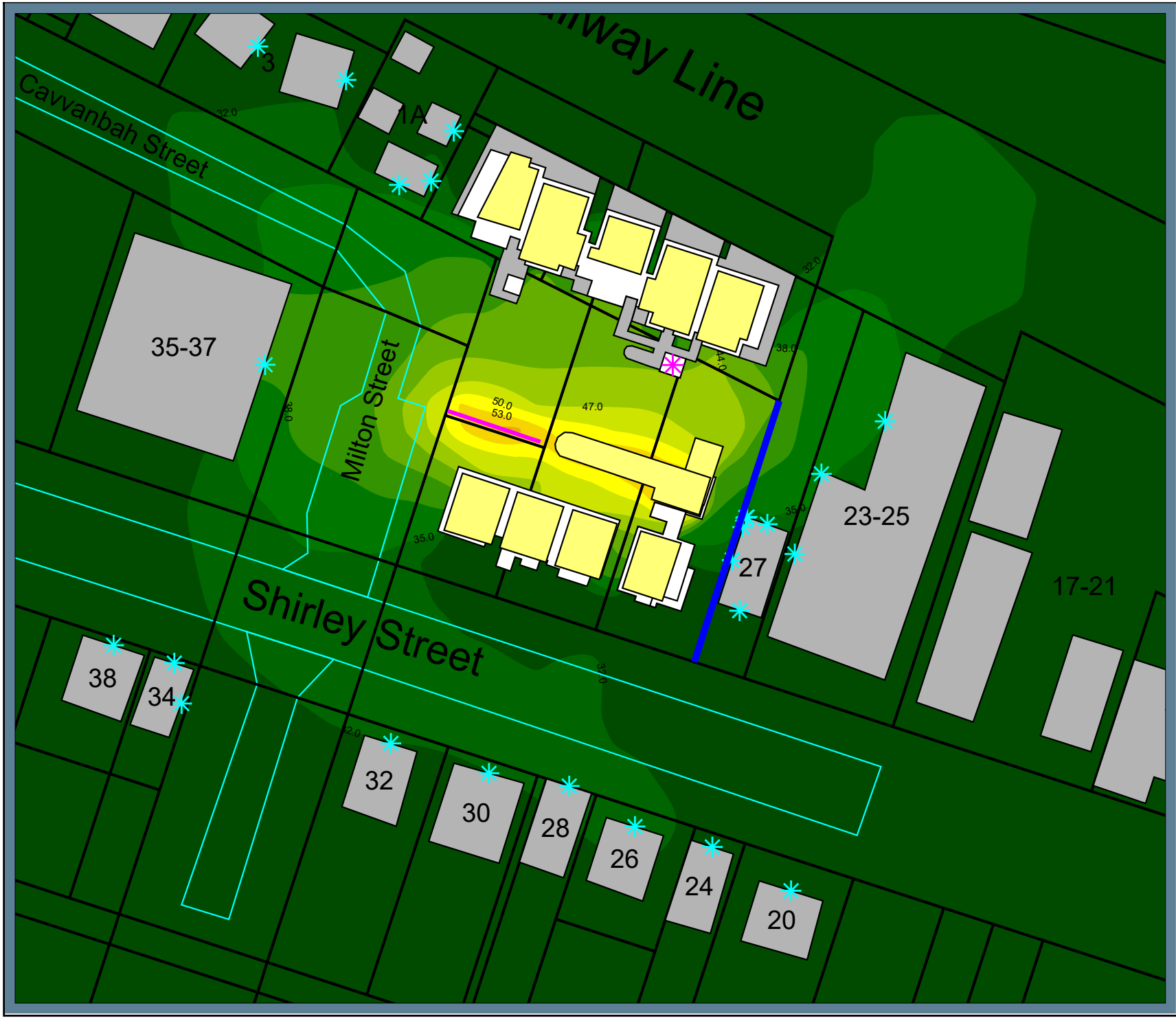
- Adjacent building
- Ground absorption
- Noise barrier fence
- Noise source (area)
- Noise source (line)
- Noise source (point)
- Point receiver
- Proposed development

**SCALE @ A4 1:1000**

0 4.5 9 18 27 36 45 m

N

Grid Spacing: 5m
Project Engineer: Aidan Daniels
Created: 21/07/2022
Processed with SoundPLAN 8.2




ATP CONSULTING ENGINEERS

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**Proposed Development**
**29 Shirley Street, Byron Bay**

**Noise Levels Associated with Proposed Development**

**Ground Floor (1.8m AGL)**

Operational Noise Level
$L_{eq,adj,4hr}$ Evening dB(A)

| | |
|---|---|
| | <= 32 |
| 32 < | <= 35 |
| 35 < | <= 38 |
| 38 < | <= 41 |
| 41 < | <= 44 |
| 44 < | <= 47 |
| 47 < | <= 50 |
| 50 < | <= 53 |
| 53 < | <= 56 |
| 56 < | <= 59 |
| 59 < | <= 62 |
| 62 < | <= 65 |
| 65 < | <= 68 |
| 68 < | <= 71 |
| 71 < | <= 74 |
| 74 < | <= 77 |
| 77 < | <= 80 |
| 80 < | |

**Legend**

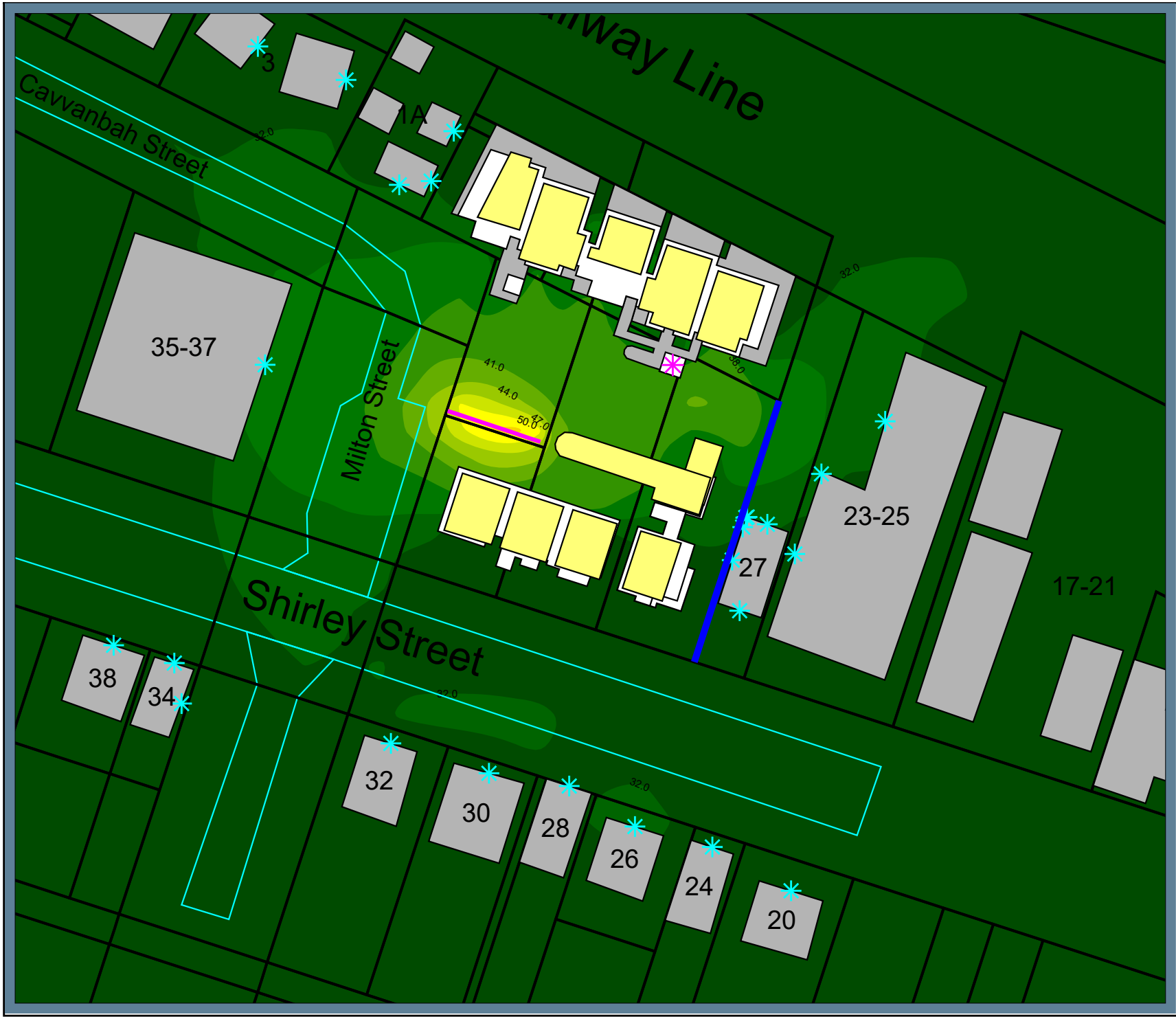
- Adjacent building
- Ground absorption
- Noise barrier fence
- Noise source (area)
- Noise source (line)
- Noise source (point)
- Point receiver
- Proposed development

**SCALE @ A4 1:1000**

0 4.5 9 18 27 36 45 m

N

Grid Spacing: 5m
Project Engineer: Aidan Daniels
Created: 21/07/2022
Processed with SoundPLAN 8.2




ATP CONSULTING ENGINEERS

ATP211137

**Proposed Development**
**29 Shirley Street, Byron Bay**

**Noise Levels Associated with Proposed Development**

**Ground Floor (1.8m AGL)**

Operational Noise Level
$L_{eq,adj,9hr}$ Night dB(A)

| | |
|---|---|
| | <= 32 |
| 32 < | <= 35 |
| 35 < | <= 38 |
| 38 < | <= 41 |
| 41 < | <= 44 |
| 44 < | <= 47 |
| 47 < | <= 50 |
| 50 < | <= 53 |
| 53 < | <= 56 |
| 56 < | <= 59 |
| 59 < | <= 62 |
| 62 < | <= 65 |
| 65 < | <= 68 |
| 68 < | <= 71 |
| 71 < | <= 74 |
| 74 < | <= 77 |
| 77 < | <= 80 |
| 80 < | |

**Legend**

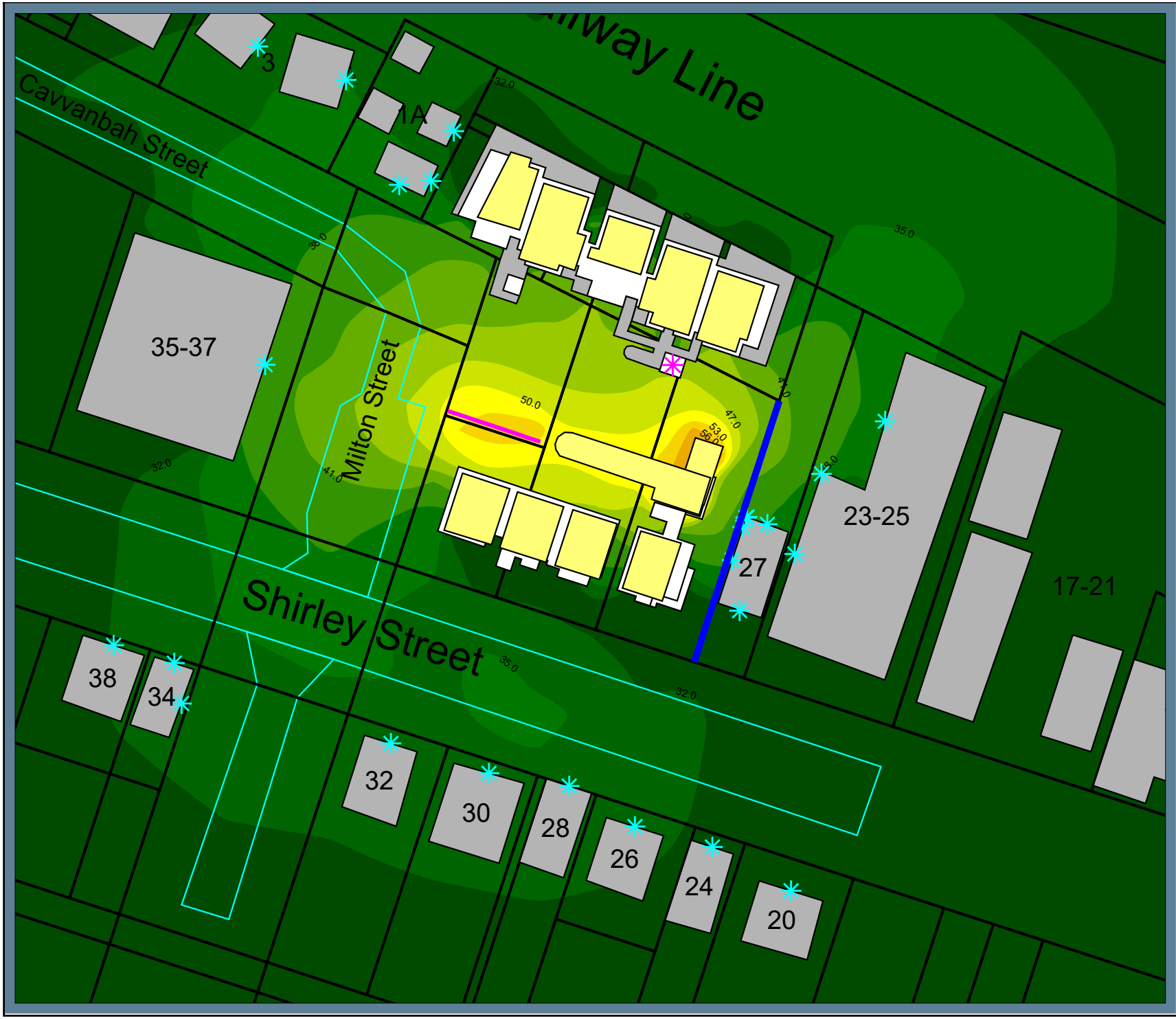
- Adjacent building
- Ground absorption
- Noise barrier fence
- Noise source (area)
- Noise source (line)
- Noise source (point)
- Point receiver
- Proposed development

**SCALE @ A4 1:1000**

0 4.5 9 18 27 36 45 m

N

Grid Spacing: 5m
Project Engineer: Aidan Daniels
Created: 21/07/2022
Processed with SoundPLAN 8.2

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**Proposed Development**
**29 Shirley Street, Byron Bay**

**Noise Levels Associated with Proposed Development**

**First Floor (4.6m AGL)**

Operational Noise Level
$L_{eq,adj,11hr}$ Day dB(A)

| | |
|---|---|
| | <= 32 |
| 32 < | <= 35 |
| 35 < | <= 38 |
| 38 < | <= 41 |
| 41 < | <= 44 |
| 44 < | <= 47 |
| 47 < | <= 50 |
| 50 < | <= 53 |
| 53 < | <= 56 |
| 56 < | <= 59 |
| 59 < | <= 62 |
| 62 < | <= 65 |
| 65 < | <= 68 |
| 68 < | <= 71 |
| 71 < | <= 74 |
| 74 < | <= 77 |
| 77 < | <= 80 |
| 80 < | |

**Legend**

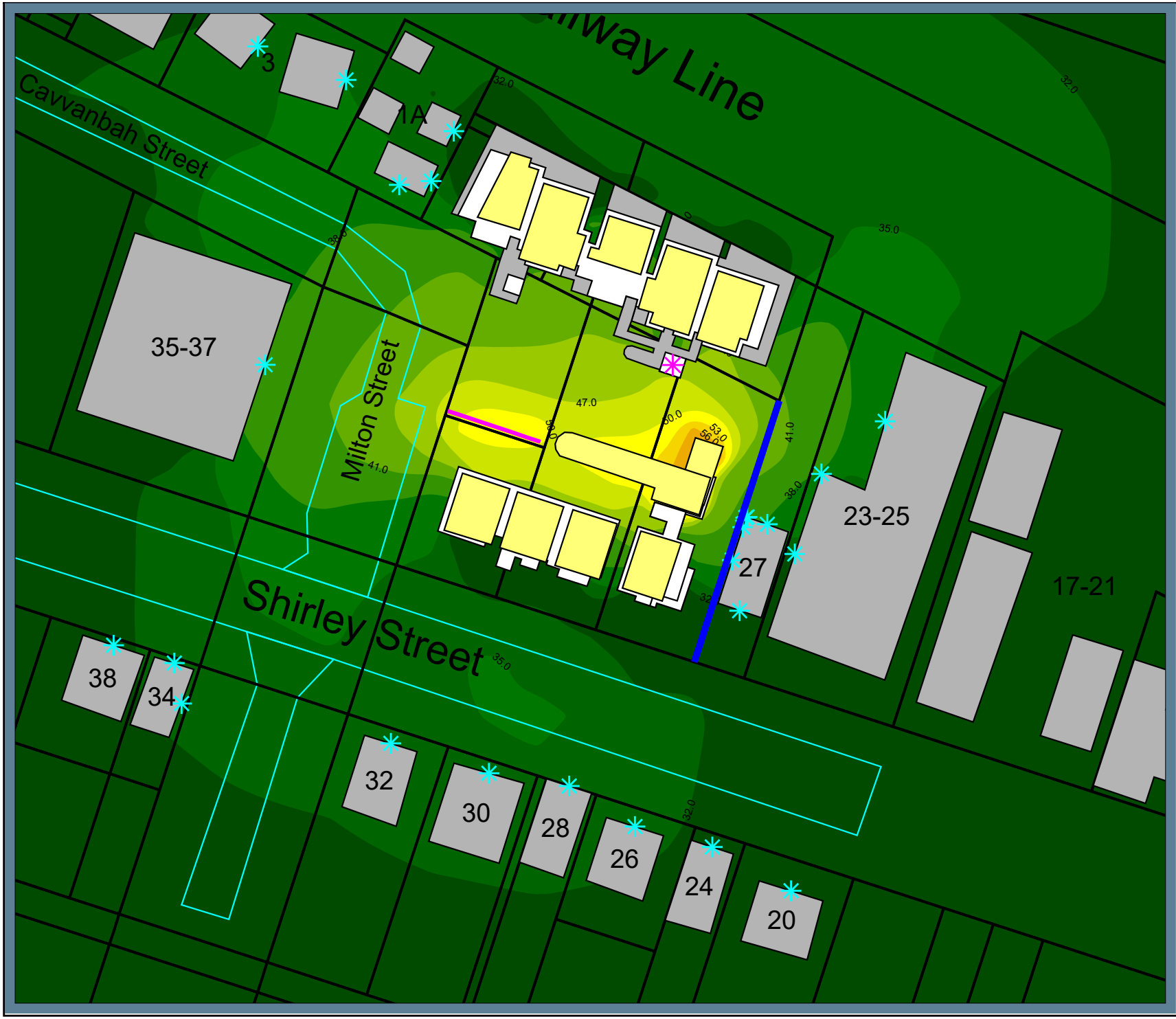
- Adjacent building
- Ground absorption
- Noise barrier fence
- Noise source (area)
- Noise source (line)
- Noise source (point)
- Point receiver
- Proposed development

**SCALE @ A4 1:1000**

0 4.5 9 18 27 36 45 m

N

Grid Spacing: 5m
Project Engineer: Aidan Daniels
Created: 21/07/2022
Processed with SoundPLAN 8.2

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**Proposed Development**
**29 Shirley Street, Byron Bay**

**Noise Levels Associated with Proposed Development**

**First Floor (4.6m AGL)**

Operational Noise Level
$L_{eq,adj,4hr}$ Evening dB(A)

| | |
|---|---|
| | <= 32 |
| 32 < | <= 35 |
| 35 < | <= 38 |
| 38 < | <= 41 |
| 41 < | <= 44 |
| 44 < | <= 47 |
| 47 < | <= 50 |
| 50 < | <= 53 |
| 53 < | <= 56 |
| 56 < | <= 59 |
| 59 < | <= 62 |
| 62 < | <= 65 |
| 65 < | <= 68 |
| 68 < | <= 71 |
| 71 < | <= 74 |
| 74 < | <= 77 |
| 77 < | <= 80 |
| 80 < | |

**Legend**

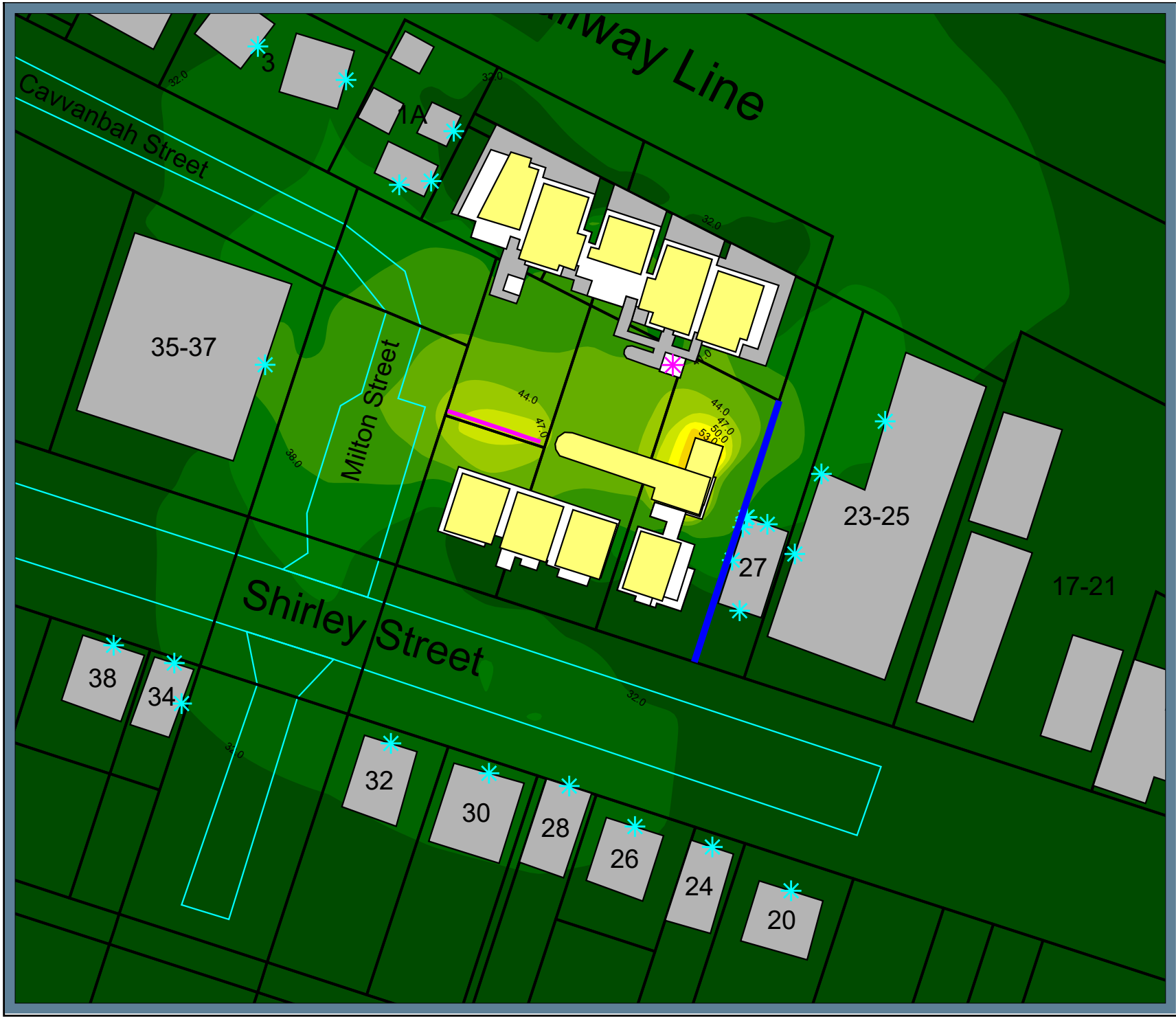
- Adjacent building
- Ground absorption
- Noise barrier fence
- Noise source (area)
- Noise source (line)
- Noise source (point)
- Point receiver
- Proposed development

**SCALE @ A4 1:1000**

0 4.5 9 18 27 36 45 m

N

Grid Spacing: 5m
Project Engineer: Aidan Daniels
Created: 21/07/2022
Processed with SoundPLAN 8.2




ATP CONSULTING ENGINEERS

ATP211137

**Proposed Development**
**29 Shirley Street, Byron Bay**

**Noise Levels Associated with Proposed Development**

**First Floor (4.6m AGL)**

Operational Noise Level
$L_{eq,adj,9hr}$ Night dB(A)

| | |
|---|---|
| | <= 32 |
| 32 < | <= 35 |
| 35 < | <= 38 |
| 38 < | <= 41 |
| 41 < | <= 44 |
| 44 < | <= 47 |
| 47 < | <= 50 |
| 50 < | <= 53 |
| 53 < | <= 56 |
| 56 < | <= 59 |
| 59 < | <= 62 |
| 62 < | <= 65 |
| 65 < | <= 68 |
| 68 < | <= 71 |
| 71 < | <= 74 |
| 74 < | <= 77 |
| 77 < | <= 80 |
| 80 < | |

**Legend**

- Adjacent building
- Ground absorption
- Noise barrier fence
- Noise source (area)
- Noise source (line)
- Noise source (point)
- Point receiver
- Proposed development

**SCALE @ A4 1:1000**

0 4.5 9 18 27 36 45 m

N

Grid Spacing: 5m
Project Engineer: Aidan Daniels
Created: 21/07/2022
Processed with SoundPLAN 8.2