Marulan Stage 3 Residential Subdivision

Noise Impact Assessment

FDC Building Pty Ltd

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1 INTRODUCTION

Pulse White Noise Acoustics Pty Ltd (PWNA) has been engaged by FDC Building Pty Ltd to undertake an acoustic assessment for stage 3 of the residential subdivision which will involve Lot 23/DP1256090 and Lot 2/DP1136538.

This assessment will address the following:

- Potential surrounding environmental noise intrusion impacts on the development (i.e., traffic noise from the surrounding roadways and other external noise sources).
- Noise emissions to nearby receivers from the operation of the base building services, vehicle noise and other noise generating components.

This report will discuss the relevant acoustic criteria which have been adopted as well as the outcome of the assessment.

A list of acoustic terminology used in this report is included in Appendix A of this report.

1.1 Proposed Development

The proposed project involves Lot 23/DP1256090 and Lot 2/DP1136538 and is within the Goulburn Mulwaree Council local government area.

The proposed development seeks to extend the residential suburban area and ancillary roadways established in Stage 1 and Stage 2.

1.2 Site Layout

The project site is defined as a general residential (R1) as described in the NSW Planning ePlanning Spatial Viewer Zoning Maps.

The nearest noise sensitive receivers around the site are identified below.

Location 1: Existing residential dwellings located southeast of the site along Loseby Avenue.

Location 2: Existing active recreational area along Portland Avenue.

The site location is detailed in Figure 1 below.

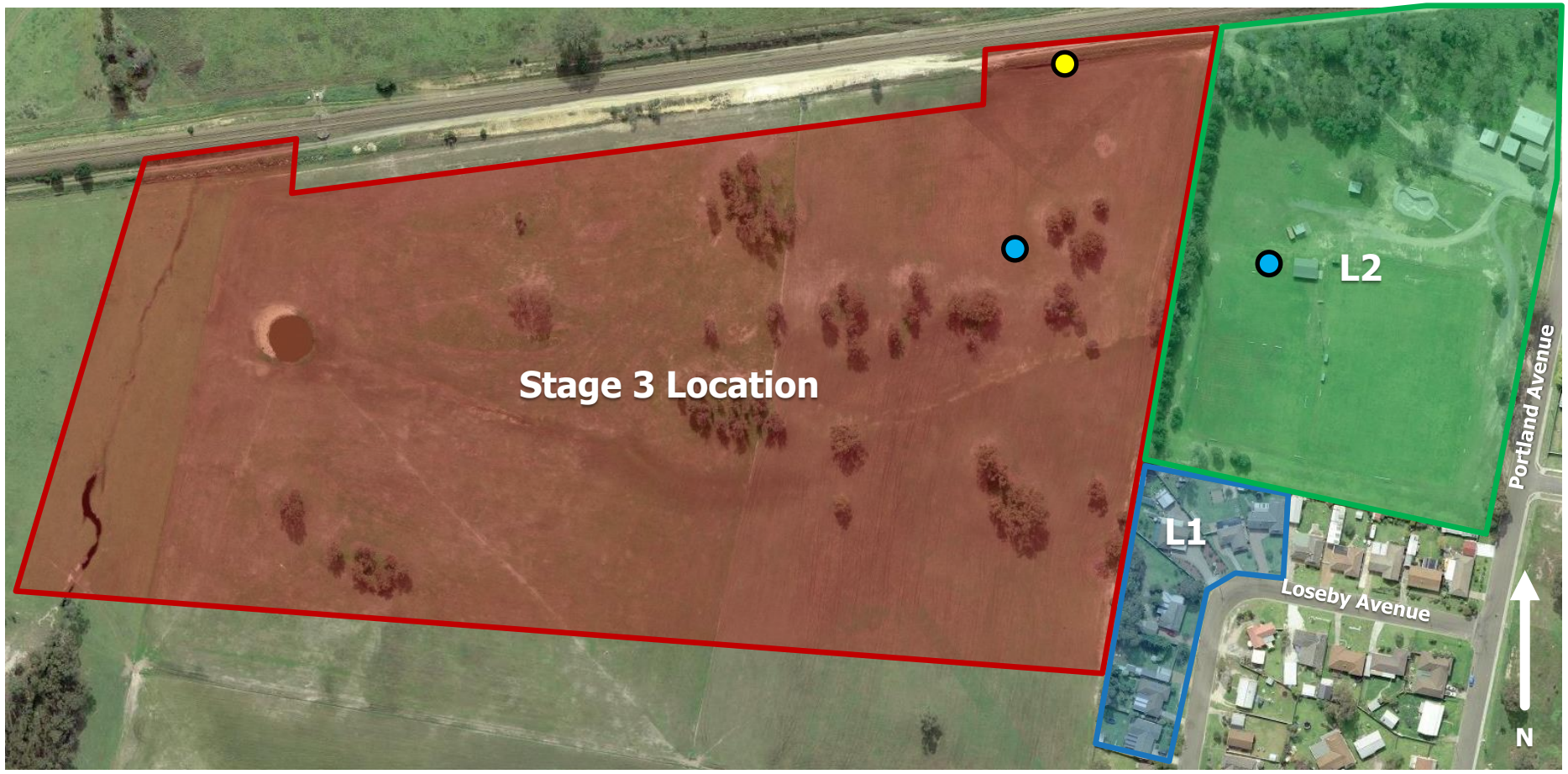


Figure 1 Site Map, Logger Location and Nearest Sensitive Receivers – Sourced from SixMaps NSW

Site Location | Active Recreation | Residential Receivers | Vibration Measurement Location | Attended Measurement Locations

2 EXISTING ACOUSTIC ENVIRONMENT

The site is located in proximity to The Hume Highway and is defined as a busy road carrying over 20,000 Annual Average Daily Traffic (AADT) number as per the RTA's *Traffic Volume Maps for Noise Assessment for Buildings on Land Adjacent to Busy Roads*. Based on the location of the site, assessment in accordance with the NSW *State Environmental Planning Policy Infrastructure 2021* (SEPP) is required and is included in Section 3.1.1.

2.1 Noise Descriptors & Terminology

Environmental noise constantly varies in level with time. Therefore, it is necessary to measure environmental noise in terms of quantifiable time periods and statistical descriptors. Typically, environmental noise is measured over 15 minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dBA, the "A" indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' arithmetic does not apply, e.g., adding two sound sources of equal values result in an increase of 3dB (i.e., 60 dBA plus 60 dBA results in 63 dBA). A change of 1 dB or 2 dB in the sound level is difficult for most people to detect, whilst a 3 dB – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the L_{Aeq}, L_{A1}, L_{A10} and L_{A90} noise levels. The L_{Aeq} noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period. It represents the level that the fluctuating noise with the same acoustic energy would be if it were constant over the measured time period.

The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels can be considered as the maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included as Appendix A.

2.2 Attended Noise Monitoring

The survey included an attended noise level measurement which was undertaken on the 14 June 2022. Testing was conducted during a period when there was no inclement weather. This allowed the existing noise levels at the site to be quantified.

The background noise level survey has been undertaken in compliance with the requirements of the Australian Standard *AS1055.1-1997: Acoustics—Description and measurement of environmental noise*.

The attended noise measurement was conducted using a Brüel & Kjær Type 2270 sound level meter (serial number 2679267). Calibration of the sound level meter was checked prior to and following the measurements using a Brüel & Kjær Type 4231 sound calibrator (serial number 3009148). The calibrator emitted a calibration tone of 94 dB at 1 kHz. The drift in calibration did not exceed ±0.5 dB. All equipment carries appropriate and current NATA (or manufacturer) calibration certificates.

The results of the attended acoustic survey are detailed in Table 1.

Table 1 Results of the Attended Noise Survey at the Site

Measurement Location	Time of Measurement [1]	$L_{Aeq, 15min}$ dB(A) [2]	Comments
Lot 23 DP1256090	4:45pm – 5:00pm	47	Noise during attended measurement primarily dominated by natural ambience. Noise from surrounding roadways including The Hume Highway is audible. Earthworks occurring approximately 300m from the measurement location.
Lot 7014 DP1025605	5:05pm – 5:20pm	42	Measurements were carried out adjacent to the site to break line of sight with ongoing earthworks. This was carried out to provide a more realistic acoustic description of the site's ambience.
The Hume Highway	5:30pm – 5:45pm	71	Traffic noise measurements were carried out along The Hume Highway. Measurement position was approximately 25m from the road.

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

3 ACOUSTIC CRITERIA

The acoustic criteria which have been adopted for this assessment are outlined below. All criteria have been separated into; *Noise Intrusion* (Assessment of building envelope), *Noise Emissions* (Assessment of noise to surrounding receivers) or *Acoustic Separation* (Assessment of noise within the building).

3.1 Noise Intrusion Criteria

External noise intrusion into the building will generally be via the building envelope (External wall, glazing or external roof). The design of the building envelope should be such that the requirements listed below are achieved.

3.1.1 The State Environmental Planning Policy (Infrastructure) 2021

The State Environmental Planning Policy (Infrastructure) 2021 (Infrastructure SEPP) was introduced to assist the delivery of necessary infrastructure by improving regulatory certainty and efficiency. The Infrastructure SEPP has specific planning provisions and development controls for various types of infrastructure, and also for developments located adjacent to infrastructure. In order to provide guidelines for this type of assessment (noise intrusion from road and rail traffic noise), the Department of Planning of the NSW Government has prepared a document titled *"Developments Near Rail Corridors and Busy Roads – Interim Guideline"* (DNRC & BR-IG).

The DNRC & BR-IG applies to development adjacent to rail corridors and busy roads. It can also provide a useful guide for all development that may be impacted by, or may impact on, rail corridors or busy roads. According to this document, busy roads are defined as follows:

- Roads specified in Clause 102 of the Infrastructure SEPP: Freeway, tollway or a transitway or any other road with an average annual daily traffic (AADT) volume of more than 40,000 vehicles.
- Any other road is defined as roads with an average annual daily traffic (AADT) volume of more than 20,000 vehicles.
- Any other road with a high level of truck movements or bus traffic.

According to Clause 2.99 (rail) and 2.119 (road) of the Infrastructure SEPP, if the development is for residential use, the consent authority must be satisfied that appropriate measures will be taken to ensure that the following L_{Aeq} levels are not exceeded (with windows and doors closed):

- In any bedroom in the building – 35 dBA $L_{Aeq(9hour)}$ between 10:00 pm and 7:00 am
- Anywhere else in the building (other than a garage, kitchen, bathroom or hallway) – 40 dBA L_{Aeq} at any time (i.e., $L_{Aeq(15hour)}$ and $L_{Aeq(9hour)}$).

If internal noise levels with windows or doors open exceed the criteria by more than 10 dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also meet the ventilation requirements of the National Construction Code (NCC).

Where windows must be kept closed, the adopted ventilation systems must meet the requirements of the national Construction Code and Australian Standard 1668 – *The use of ventilation and air conditioning in buildings*.

3.1.2 Australian and New Zealand Standard AS/NZS 2107:2016 Acoustics– Recommended design sound levels and reverberation times for building interiors

Since the *State Environmental Planning Policy (Infrastructure) 2007* does not provide a criteria for all occupancies possible within a residential apartment, the *Australian and New Zealand Standard AS/NZS 2107:2016 Acoustics– Recommended design sound levels and reverberation times for building interiors* is adopted as a supplement.

Recommended ambient noise levels and reverberation times for internal spaces are given in a number of publications including Table 1 of Australian / New Zealand Standard 2107:2016 "*Acoustics - Recommended design sound levels and reverberation times for building interiors*". Unlike the previous version of this Standard, this latest edition recommends a range with lower and upper levels (rather than "satisfactory" and "maximum" internal noise levels) for building interiors based on room designation and location of the development relative to external noise sources. This change has occurred due to the fact that sound levels below 'satisfactory' could be interpreted as desirable, but the opposite may in fact be the case. Levels below those which were listed as 'satisfactory' can lead to inadequate acoustic masking resulting in loss of acoustic isolation and speech privacy.

Internal noise levels due to the combined contributions of external noise intrusion and mechanical ventilation plant should not exceed the maximum levels recommended in this Standard. The levels for areas relevant to this development are given in table below. The mid to maximum points of the internal noise level ranges are generally adopted as the internal design noise criteria for the combined effect of mechanical services and external noise intrusion.

Table 2 AS2107 Design Sound Levels for Occupancies excluded from SEPP (Infrastructure) 2021

Type of occupancy/activity	Design Sound Level Range $L_{Aeq\ (Period)}$ [1] (dBA)	Time Period	Project Criteria $L_{Aeq\ (Period)}$ [1] (dBA)
Houses and apartments near major roads			
Kitchens	45 to 55	Anytime	**<55**
Washrooms and toilets	45 to 55	Anytime	**<55**
Common areas	45 to 50	Anytime	**<50**

Note 1: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound

3.1.3 Development Near Rail Corridors and Busy Roads – Interim Guideline

As the proposed development is in proximity to the railway line north of the site, the *Development Near Rail Corridors and Busy Roads – Interim Guideline* was adopted to determine if an acoustic assessment of rail induced noise and vibration is required.

Section 3.5.1 of the *Development Near Rail Corridors and Busy Roads – Interim Guideline* includes a guidance for the requirement of an acoustic assessment for noise and vibration based on the distance of the site from the railway line as shown in Figure 2 and Figure 3 respectively.

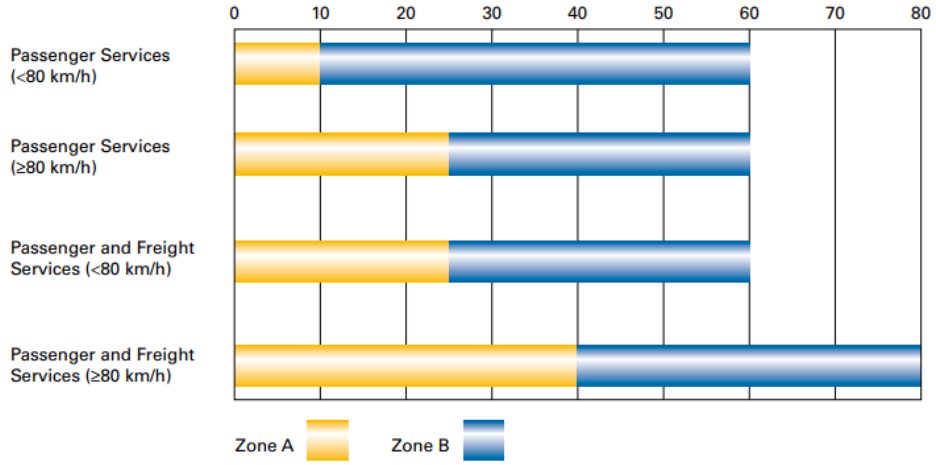


Figure 2 Noise Assessment Zones based on distance (m) of noise-sensitive development from operational track (not corridor)

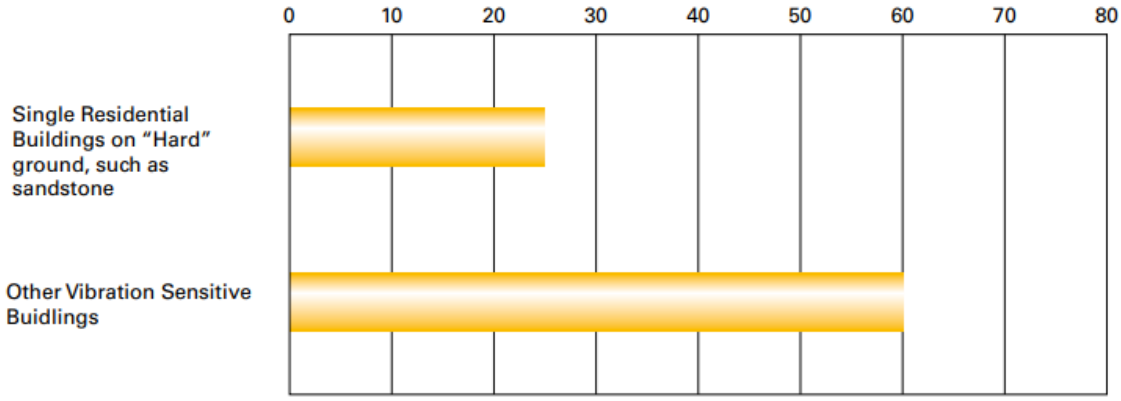
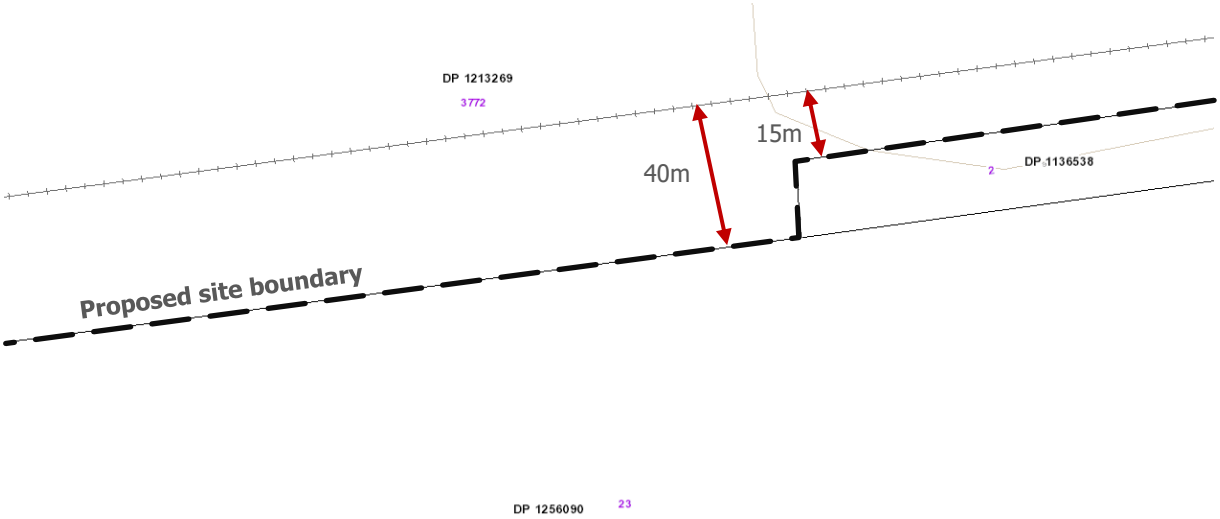


Figure 3 Vibration Assessment Zones based on distance (m) of sensitive development from operational track (not corridor)

The distance from the proposed site boundary to the railway line is depicted in Figure 4, and indicates that the site is within the distances required for noise and vibration assessments based on Section 3.5.1 of the *Development Near Rail Corridors and Busy Roads – Interim Guideline*. Therefore, a detailed assessment of noise and vibration resulting from trains is undertaken.

Figure 4 Distance of railway line to proposed site



3.2 Noise Emission Criteria

Noise emissions from the operation of the site impacting on the adjacent land users are outlined below. Noise emissions expected from the use of the site include mechanical services and communal areas.

3.2.1 Goulburn Mulwaree Development Control Plan (2007)

Based on the location of the proposed site, no specific noise regulations are specified. Therefore, the criteria established from the *NSW EPA Noise Policy for Industry (NPI) 2017* is adopted for the assessment of the proposed development.

3.2.2 NSW EPA Noise Policy for Industry (NPI) 2017

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The NSW EPA has recently released a document titled *Noise Policy for Industry* (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

3.2.2.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

3.2.2.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

Project amenity noise level for industrial developments is specified as the recommended amenity noise level (Table 2.2 of the NPI) minus 5 dB(A). To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels.

3.2.2.3 Area Classification

The NSW NPI characterises the "Rural Residential" noise environment as an area that has the following characteristics:

> *An acoustical environment that:*
>
> - *Is dominated by natural sounds, having little or no road traffic noise.*
> - *Generally characterised by low background noise levels.*

The surrounding residential receivers to the lot are located in an area defined as R5 (large lot residential). Therefore, the most appropriate zoning for the site and its surrounding receivers is *Rural residential*.

For residential and non-residential receivers in a suburban residential area, the recommended amenity criteria are shown in Table 3 below.

When the existing noise level from industrial noise sources is close to the recommended "Amenity Noise Level" (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area in line with the requirements of the NSW NPI.

Table 3 NSW NPI – Recommended L_{Aeq} Noise Levels from Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2] (dBA)
Residence	Rural	Day	50
		Evening	45
		Night	40
Industrial		When in use	70

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound

Note 3: As per section 2.6 of the Noise Policy for Industry, external noise levels 10 dB(A) above the internal noise levels apply

3.2.2.4 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions, derived from the measured data, are presented in Table 4. These criteria are nominated for the purpose of determining the operational noise limits for mechanical plant associated with the development which can potentially affect noise sensitive receivers.

For each assessment period, the lower (i.e., the more stringent) of the amenity or intrusive criteria are adopted, which are shown in bold text in Table 4.

It should be noted that assumed minimums for the rated background noise levels were adopted due to on-going earthworks occurring in proximity to the site and as a result, is not an accurate reflection of the existing acoustic ambience. Attended measurements yielded similar rated background noise levels during the day period, thus the use of assumed minimums does not create an overly conservative assessment.

Table 4 External noise level criteria in accordance with the NSW NPI

Location	Time of Day [1]	Project Amenity Noise Level, $L_{Aeq, period}$ (dBA)	Assumed Minimums $L_{A90, 15\ min}$ (RBL) [2] (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA)
Residential Receivers	Day	45	35	**40**	48
	Evening	40	30	**35**	43
	Night	35	30	**35**	38
Commercial Receivers	When in use	65	N/A	N/A	**68**

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am

Note 2: L_{A90} Background Noise or Rating Background Level.

Note 3: Project Noise Trigger Levels are shown in bold and underlined. These are the Intrusive Criteria only, as per section 2.4 of the Policy.

Note 4: Project amenity noise level has been adjusted based on existing traffic noise levels as per section 2.4.1 of the NSW EPA NPI.

3.2.3 Maximum Noise Level

In accordance with the NSW NPI, sleep disturbance is to be assesses in two stages addressing the likelihood of sleep disturbance and sleep awakening.

For the criterion addressing the likelihood of sleep disturbance, the NSW NPI recommends that the maximum noise level event should not exceed the following:

- 40 dB $L_{Aeq,\ 15\ minutes}$ or the prevailing RBL plus 5 dB, whichever is the greater; and / or
- 52 dB L_{AFmax} or the prevailing RBL plus 15 dB, whichever is the greater

As a result, the criterion of 52 dB L_{AFmax} is adopted as the criterion for the likelihood of sleep disturbance at all residences.

4 TRAIN VIBRATION ASSESSMENT

This section of the report details the suitable vibration criteria for possible impacts from the Main Southern railway line located to the north of the project.

4.1 Vibration Impact Criteria

The potential for vibration impact from a train pass-by on the lines to the north of the site has been assessed for both tactile vibration impact as well as ground borne vibration resulting in structure borne noise.

The suitable criteria for the assessment of tactile vibration and structure borne noise are detailed in the following sections.

4.1.1 Tactile Vibration Impacts

The Department of Planning *Development Near Rail Corridor and Busy Roads – Interim Guideline (DNRCBR)* references to *"Assessing Vibration – A Technical Guideline".*

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled *"Assessing Vibration – A Technical Guideline"*. (AVTG). The AVTG identifies railway induced vibration as intermittent in its' nature and is described as the following:

> *Sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by).*

The AVTG recommends that habitable rooms should comply with the criteria therein which is in line with the requirements of British Standard BS 6472:1992 "*Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)*".

The British Standard details suitable criteria for the assessment of intermittent vibrations to prevent adverse impacts on future residence.

Table 5 Intermittent vibration impacts criteria (m/s$^{1.75}$) 1 Hz-80 Hz, Vibration Dose Values (VDV)

Measurement Location	Daytime		Night-Time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	**0.20**	0.40	**0.13**	0.26

For the purpose of this assessment the *Preferred Values* detailed in the standard have been used as the criteria used in this assessment.

4.1.2 Structure Borne Noise

The borne vibration is the potential for audible noise to be generated as the result of vibration transferred through the building structure and emanating from the building surfaces (such as walls, ceilings and the like) as audible noise within the future residential dwellings within the development.

Potential structure borne noise impacts as a result of the proposed light rail has been assessed in accordance with the criteria detailed within the DNRCBR which includes the following:

> *Generally, ground borne noise is associated more closely with rail operations than roads. Where buildings are constructed over or adjacent to land over tunnels, ground-borne noise may be present without the normal masking effect of airborne noise.*
>
> *In such cases, residential buildings should be designed so that the 95th percentile of train pass-bys complies with a ground-borne LAmax noise limit of 40dBA (daytime) or 35dBA (night-time) measured using the "slow" response time setting on a sound level meter.*

As the railway line located to the north of the site is an above ground line and not within a tunnel the requirements for ground borne vibration is not required to be assessed based on the DNRCBR as detailed above.

As the Main Southern railway line is above ground, the impact of airborne noise on the future residence will be greater than the potential for structure borne noise levels. Providing suitable treatments for airborne noise impacts are included in the design of the project and tactile vibration levels comply with the relevant criteria then all relevant acoustic requirements will be achieved.

4.1.3 Vibration Measurements

This section of the report details the measured vibration levels associated with rail pass by at the location detailed in Figure 1 of this report.

The assessment included attended vibration measurements conducted on the 14th June, 2022. Vibration levels were measured using a Svan 958 type vibration meter and analyzer fitted with a triaxial accelerometer and included a minimum of 12 train pass by.

Obtained vibration levels included a number of train pass by which have been used to determine the period vibration exposure for the daytime and night-time periods Vibration Dose Values (VDV).

The results of the vibration level measurements including the calculations for VDV are detailed in Table 6 below.

Table 6 Calculated VDV

Location	Period	Criteria VDV $m/s^{1.75}$	Calculated VDV $m/s^{1.75}$
Future Residential Dwellings	Daytime	0.20	0.13
	Night-Time	0.13	0.09

Based on the results of the assessment of tactile vibration no additional acoustic treatment (or building vibration isolation) is required to comply with the relevant standards and ensure a suitable acoustic amenity for future occupants of the development.

5 OPERATIONAL ACOUSTIC ASSESSMENT

In addressing all the criteria shown above, each component of the development is assessed and presented below.

5.1 Building Envelope Assessment

5.1.1 Glazing Recommendations

The recommended sound transmission loss requirements required to satisfy the specified internal noise level criteria outlined above are summarised in Table 7 below.

Please note that these recommendations are also based on the floor details shown in the architectural drawings of the proposed development in Appendix C.

Table 7 In-principle Glazing Recommendations

Location	Minimum Glazing System Rating Requirements [1]	Indicative Construction [1]
Bedrooms along southern boundary *Along The Hume Highway*	Rw (C;Ctr): 29 (0;-3)	Windows with min. 6.00mm float/toughened glass
Living areas along southern boundary *Along The Hume Highway*	Rw (C;Ctr): 27 (0;-3)	Windows with min. 4.00mm float/toughened glass
Bedrooms along northern boundary *Along the Main Southern Railway*	Rw (C;Ctr): 37 (0;-3)	Windows with min. 12.38mm laminated glass
Living areas along northern boundary *Along the Main Southern Railway*	Rw (C;Ctr): 29 (0;-3)	Windows with min. 6.00mm float/toughened glass
Bedrooms along eastern/western boundary	Rw (C;Ctr): 35 (0;-3)	Windows with min. 10.38mm laminated glass
Living areas along eastern/western boundary	Rw (C;Ctr): 29 (0;-3)	Windows with min. 6.00mm float/toughened glass
All other buildings' façades *Applies to developments not along site boundary*	Rw (C;Ctr): 31 (0;-3)	Windows with min. 6.38mm laminated glass

Note 1: These are preliminary selections; they will be confirmed in the detailed design stage once the layouts and façade orientations are approved.

Please note for windows, this performance is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Therefore, it is recommended that the window manufacturer should confirm that the required sound insulation can be achieved. It is anticipated that the window system should comprise Q-Lon (or equivalent) or fin seals with deep C channels as part of the window track (i.e., Performance levels outlined above need to be achieved with glazed panels + frame + seals).

5.1.2 External Wall Construction

If external wall constructions are constructed either from existing concrete or a masonry construction, no further acoustic upgrading is required. If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

Any light-weight external plasterboard walls should be constructed from a construction with a minimum acoustic performance of Rw 50.

5.1.3 External Roof Construction

The required external roof and ceiling constructions for the project are required to include the following:

1. Concrete external roof construction – no additional treatments required.
2. Light Weight Construction – Install acoustic insulation within the external roof/ceiling cavity similar to a 75 mm thick 14 kg/m^3 insulation.

If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

5.2 External Noise Emissions from Engineering Services

At this stage of the project, the exact locations of key plant items, and the selection of items to be installed, have not been selected. As such, a detailed assessment of noise associated with engineering services cannot be undertaken.

All future plant and equipment are to be acoustically treated to ensure the noise levels at all surrounding receivers comply with noise emission criteria detailed within this report. Experience with similar projects indicates that it is both possible and practical to treat all mechanical equipment such that the relevant noise levels are achieved. Examples of the possible acoustic treatments to mechanical equipment includes the following:

- General supply and exhaust fans – general exhaust and supply fans such as toilet, kitchen, lobby and other small mechanical fans can be acoustically treated using acoustic flex ducting or internally lined ducting.

- Residential Condensers – The project may include external residential condenser units which will be located on balconies, or on roof-tops. Providing condenser equipment is selected using suitable noise level data, then acoustic treatments can be implemented such as screening and treatment to exhaust to ensure that the relevant noise emission criteria will be achieved.

Details of the required mechanical services equipment and acoustic treatments to ensure the relevant noise level criteria is achieved will be provided as part of the CC submission of the project.

Experience with similar projects indicates that the acoustic treatment of whatever mechanical equipment is to be installed on the project is both possible and practical.

5.3 Noise from Additional Traffic

Noise impacts from the increase in vehicle movements along the surrounding roadways is to be assessed in accordance with the NSW EPA Road Noise Policy (RNP) 2011.

A peak hour increase proposed for the number vehicles associated with the development will not exceed a 2dBA increase at the nearest residential receivers. As summarised in the NSW EPA RNP, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person and is therefore considered acoustically acceptable.

6 CONCLUSIONS

Pulse White Noise Acoustics Pty Ltd (PWNA) has been engaged by FDC Building Pty Ltd to undertake an acoustic assessment for the proposed residential subdivision which will involve Lot 23/DP1256090 and Lot 2/DP1136538.

As part of this assessment, we have undertaken a review of the building envelope and noise emissions from the use of the site. From this assessment we note the following:

- Vibration induced by train pass-by utilising the Main Southern railway along the northern boundary of the site has been assessed to ensure compliance and is presented in section 4.
- Minimum acoustic performances and associated indicative constructions for the building envelope have been provided in section 5.1 of this report. The recommended treatments have been provided to ensure compliance with the objectives presented in section 3.1.
- It is recommended that, prior to the issue of a Construction Certificate (CC), a detailed acoustic assessment is undertaken to ensure all cumulative noise from engineering services comply with the requirements as listed in section 5.2.

As such, we believe the proposal is acoustically acceptable and meets all the detailed acoustic criteria listed above.

Regards,

Brandon Nguyen Khuong
Acoustic Engineer
PULSE WHITE NOISE ACOUSTICS PTY LTD

APPENDIX A: ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:
	0dB(A) Threshold of human hearing 30dB(A) A quiet country park 40dB(A) Whisper in a library 50dB(A) Open office space 70dB(A) Inside a car on a freeway 80dB(A) Outboard motor 90dB(A) Heavy truck pass-by 100dB(A) Jackhammer/Subway train 110 dB(A) Rock Concert 115dB(A) Limit of sound permitted in industry 120dB(A) 747 take off at 250 metres
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ambient sound	The all-encompassing sound at a point composed of sound from all sources near and far.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Reverberation	The persistence of sound in a space after the source of that sound has been stopped (the reverberation time is the time taken for a reverberant sound field to decrease by 60 dB)
Air-borne sound	The sound emitted directly from a source into the surrounding air, such as speech, television or music
Impact sound	The sound emitted from force of one object hitting another such as footfalls and slamming cupboards.
Air-borne sound isolation	The reduction of airborne sound between two rooms.
Sound Reduction Index [R] *(Sound Transmission Loss)*	The ratio the sound incident on a partition to the sound transmitted by the partition.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.
Level difference [D]	The difference in sound pressure level between two rooms.

Normalised level difference [D_n]	The difference in sound pressure level between two rooms normalised for the absorption area of the receiving room.
Standardised level difference [D_{nT}]	The difference in sound pressure level between two rooms normalised for the reverberation time of the receiving room.
Weighted standardised level difference [$D_{nT,w}$]	A single figure representation of the air-borne sound insulation of a partition based upon the level difference. Generally used to present the performance of a partition when measured in situ on site.
C_{tr}	A value added to an R_w or $D_{nT,w}$ value to account for variations in the spectrum.
Impact sound isolation	The resistance of a floor or wall to transmit impact sound.
Impact sound pressure level [L_i]	The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine.
Normalised impact sound pressure level [L_n]	The impact sound pressure level normalised for the absorption area of the receiving room.
Weighted normalised impact sound pressure level [$L_{n,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in a laboratory.
Weighted standardised impact sound pressure level [$L'_{nT,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in situ on site.
C_I	A value added to an L_{nW} or $L'_{nT,w}$ value to account for variations in the spectrum.
Energy Equivalent Sound Pressure Level [$L_{A,eq,T}$]	'A' weighted, energy averaged sound pressure level over the measurement period T.
Percentile Sound Pressure Level [$L_{Ax,T}$]	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*