Lot 67 and 68 Myall Road, Garden Suburb

ACOUSTIC CONSULTANT REPORT

Noise and Vibration Assessment

3 November 2025

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Climate Active Carbon Neutral ORGANISATION

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1 Introduction

As part of the NSW Government's commitment to increasing the supply of affordable housing, Landcom has pledged to deliver 1,800 affordable rental housing dwellings by 2029 under the Housing Accord. As part of this commitment, Landcom intend to deliver 69 affordable housing dwellings across two lots within the Landcom Garden Suburb Project site. Landcom is seeking to deliver the proposal as 'development without consent' through the State Environmental Planning Policy (Housing) 2021 (Housing SEPP) by way of a Review of Environmental Factors (REF) under Part 5 of the Environmental Planning and Assessment Act 1979.

This Noise and Vibration Impact Assessment has been prepared by Renzo Tonin & Associates to accompany the REF.

2 Project Background

Landcom's Garden Suburb Project has been subject to a Development Application (DA/1284/2013) which was approved by the Hunter and Central Coast Regional Planning Panel on 20 December 2020, subject to deferred commencement conditions. The DA comprises the subdivision of lands and allows for development on the site for 66 residential allotments, 3 super lots & 3 conservation lots plus roads, landscaping, on-site detention and remediation works. Physical works have commenced on the subdivision. Lot 67 and 68 are two of the identified super lots and have been allocated for affordable housing and form part of the Garden Suburb Affordable Housing Project.

The overall site has recently been considered as part of a planning proposal to change the zoning of the site as well as building height and lot size under the Lake Macquarie LEP 2014. This change was undertaken to standardise the development controls for the site and remove the impediments to the site from the outdated Lake Macquarie LEP 1984 that was applicable to most of the land. This REF, development plans and specialist reporting has been undertaken concurrently with the rezoning to expedite the delivery of affordable housing at the site.

3 Proposed Development

To meet Landcom's commitment under the Housing Accord, Landcom is seeking to develop Lot 67 and Lot 68 for the purpose of affordable housing. The proposal includes a mix of terrace housing and residential flat buildings as well as associated servicing and landscaping. This will deliver 69 affordable housing dwellings comprising the following with 8 dwellings design to be adaptable:

Lot 67: 36 Dwellings

- 1B = 18 Apt.
- 2B = 9 Apt + 5 Terraces
- 3B = 3 Apt + 1 Terrace

Lot 68: 33 Dwellings

- 1B = 15 Apt.
- 2B = 12 Terraces
- 3B = 6 Apt.

The proposal will comprise of four built forms including two residential flat buildings and two townhouse developments, with each lot containing one residential flat building and one row of townhouses. The residential flat buildings have been positioned to address Myall Road and will be three storeys in height. The townhouses will address Premier Street and are to be two storeys in height.

Vehicular access to the site will be via Premier Circuit to the south. Each lot will be serviced by a vehicular driveway and onsite parking via basement parking beneath the residential flat buildings. To support the dwellings, a total of 19 parking spaces at Lot 67 and 18 parking spaces at Lot 68 are being provided. Accessible parking has also been included as part of the proposal.

Pedestrian access to the site will be via Trophy Avenue and Premier Circuit. Internal pedestrian paths are located within each lot, connecting the dwellings to communal open space, car parking, waste facilities and the external pedestrian network.

Landcom will deliver the affordable housing, and it is understood it will be managed in the future by a Community Housing Provider (CHP). It is anticipated that the affordable housing project will be delivered in 2028.

The proposed development site is in the Lake Macquarie Local Government Area within the Garden Suburb masterplan.

4 Site Information

4.1 Overall Site

The site of the whole subdivision is located in Garden Suburb, within the Lake Macquarie LGA. The property details are:

9A, 69 and 82 Myall Road, Garden Suburb, legally described as:

- Lot 1 DP 1168657,
- Lot 10 DP 1011323, and
- Lot 50 DP 1301215.

The site is irregular in shape and comprises a total area of approximately 38.88ha. Myall Road intersects the overall site within its northwestern portion. To reflect this, the site has been divided into two precincts, the northern precinct and the southern precinct. The northern precinct comprises Lot 1 DP 1168657 and is the land situated to the north of Myall Road. The southern precinct comprises Lot 10 DP 1011323 and Lot 50 DP 1301215 and is the land situated to the south of Myall Road.

The proposed affordable housing project is located within the southern precinct within Lot 50 DP 1301215.

The southern precinct comprises a mix of vegetated land and land that has been cleared to facilitate the approved residential subdivision under DA/1284/2013. The precinct has an approximate size of 37.15ha. The site is bound by Myall Road to the north, existing residential properties to the south and west and a sports field, hostel/aged care, some undeveloped vegetated land and the Newcastle Inner City Bypass to the east. A watercourse traverses the southern boundary of the site from east to west. The watercourse forms one of the tributaries of Winding Creek. This area of the site slopes upward from the south-western corner, toward Myall Road.

An aerial image illustrating the overall site and its features is included in Figure 1. The aerial image shows the recent site clearing in association with the approved residential subdivision.

Figure 1: Aerial View of Site (Source: NearMap. Image Date 17.08.2025)

4.2 Affordable Housing Site

The affordable housing site is located within the northern portion of Lot 50 within the southern precinct. The proposal will be developed across Lots 67 and 68 as shown in blue on the extract of the masterplan in Figure 2. These sites have been cleared of vegetation to accommodate future development. The sites are located on the southern side of Myall Road and will be accessible from vehicle via proposed internal access roads that will service the approved subdivision. The sites slope upward, toward Myall Road.

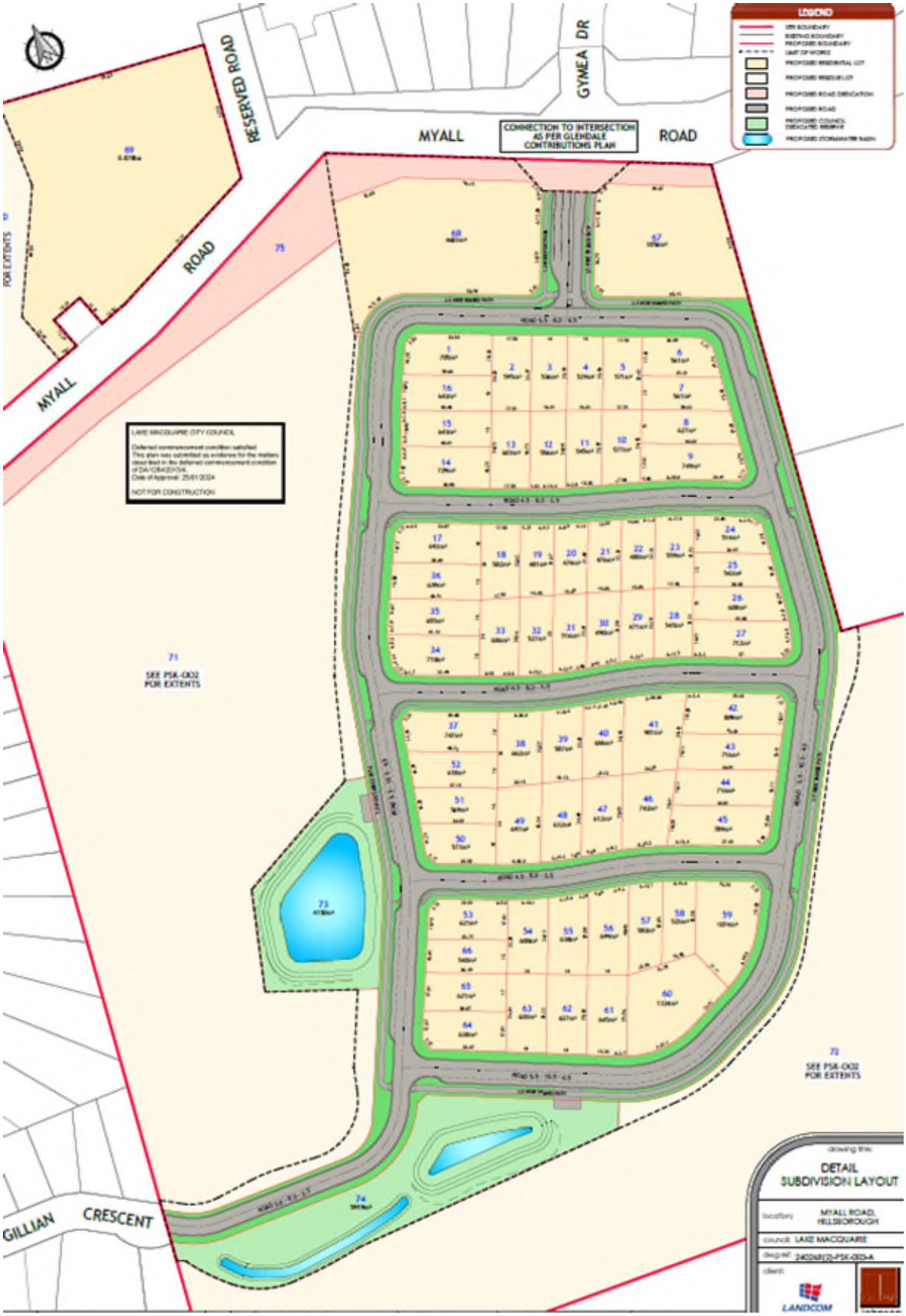


Figure 2: Extract of Detail Subdivision Layout (Source: ADW Johnson, 2023)

5 Methodology

This is a noise and vibration impact assessment which assesses the noise emissions from the site to the neighbours, the noise impact from the environment onto the development, and sets up the framework for the internal acoustic separation and the management of construction noise and vibration. Indicative measures are proposed for the mitigation of noise emissions, noise intrusion and internal acoustic separation, but these will be further developed during detailed design.

As a result of our assessment, the following potential acoustic items were identified:

1) External noise from road traffic on Myall Road impacting the receivers on site.
2) Noise from plant and equipment serving the development impacting adjacent residential receivers.
3) Noise from the adjacent sports fields impacting the future residential receivers.
4) Construction noise generated by the development.

A noise and vibration assessment is required in accordance with the relevant State, Council and legislative documents. This report presents an assessment of the above acoustic (noise and vibration) components in terms of the NSW State Environmental Planning Policy (Transport & Infrastructure) 2021, NSW Environmental Protection Authority (EPA) Noise Policy for Industry (NPfI) (2017), Australian Standard AS2107:2016 and NSW EPA Interim Construction Noise Guideline (ICNG) (2009).

Regarding acoustic privacy, this is generally satisfied through the requirements set by the National Construction Code - Building Code of Australia with which all new residential developments would need to comply.

Further detailed discussion of the identified acoustic factors is set out within this report. This assessment was based on architectural drawing set PD, dated 17.10.2025 by Hills Thalis architects.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

5.1 Site and Surrounds

Lot 67 is bound to the north by Myall Road, to the south by Premier Circuit, to the east by Trophy Ave and to the west by greenspace. Lot 68 is bound to the north by Myall Road, to the south by Premier Circuit, to the east by Lance Yorke Oval and to the west by Trophy Ave.

Long term noise monitoring was undertaken by Muller Acoustic Consulting (MAC) from 15th September 2025 to 23rd September 2025, inclusive (Reference: MAC252550-01RP1, dated October 2025). Additional attended measurements were undertaken by Renzo Tonin & Associates on the 15th of October 2025.

Figure 3: Site surroundings and monitoring locations

5.2 Measured and Predicted Noise Levels

MAC presented the results of traffic noise monitoring in their report (MAC252550-01RP1), excerpt below.

Table 1 Summary of Existing Road Traffic Noise Levels, dBA

Location	Day LAeq(15hour)	Night LAeq(9hour)	Day LAeq(1hour)	Night LAeq(1hour)	Day LA1(15hour)	Night LA1(9hour)
L1 Myall Road near Reserved Road (27m offset)	64	59	66	63	70	65
L2 Myall Road (14m offset)	67	63	69	67	74	69

Note: Day is the period from 7am to 10pm; Night is from 10pm to 7am.

Figure 4: Excerpt from Table 1 of MAC report MAC252550-01RP1

Section 5.3 of the MAC report (MAC252550-01RP1) predicts that the road traffic noise levels near the subject site would increase in the order of 0.6-0.7dB. Rounding the increase up to 1dB, the following table presents the assumed traffic noise levels.

Table 1: Future traffic noise levels – based on MAC long term unattended measurements and predicted increases

Noise Monitoring Location	Descriptor	Day[1] $L_{Aeq\ (15hour)}$	Night[2] $L_{Aeq\ (9hour)}$	Day[1] $L_{Aeq\ (worst\ 1hour)}$	Night[2] $L_{Aeq\ (worst\ 1hour)}$
L1: Myall Rd near Reserved Rd (27m offset)	L_{Aeq}	65	60	67	64
L2: Myall Rd (14m offset)	L_{Aeq}	68	64	70	68

Notes: Day, Evening & Night assessment periods are defined in accordance NSW EPA's Industrial Noise Policy as follows.

1. Day is defined as 7:00am to 10:00pm
2. Night is defined as 10:00pm to 7:00am

MAC also provided to Landcom the rating background and ambient levels from their monitoring, as summarised below. These monitoring locations are representative of the R1 residential receivers that share a boundary with Myall Rd.

Table 2: Measured Site Background (L_{A90}) and Ambient (L_{Aeq}) Noise Levels dB(A)

Noise Monitoring Location	Duration	Descriptor	Day[1]	Evening[2]	Night[3]
L1: Myall Rd near Reserved Rd (27m offset)	15.09.2025-23.09.2025	L_{A90}	56	46	30
		L_{Aeq}	64	61	59
L2: Myall Rd (14m offset)	15.09.2025-23.09.2025	L_{A90}	59	47	(29) 30
		L_{Aeq}	68	65	62

Notes: Day, Evening & Night assessment periods are defined in accordance NSW EPA's Industrial Noise Policy as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays
4. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

Long term unattended monitoring could not be undertaken on the site for this report due to the civil works underway on site (safety and security of the monitor and the data being affected by the works). As such, we have relied on the results of the MAC monitoring but supported by additional attended measurements undertaken by Renzo Tonin & Associates. The attended measurements undertaken by this office on the 15th of October showed a 17dB reduction in the background noise level between locations representative of the MAC measurements, and shielded locations within the nearby residential housing estates. These shielded locations will be representative of the levels anticipated at the R2 receivers south of Lot 68 and 67.

Table 3: Assumed Site Background (L_{A90}) Noise Levels dB(A)

Receiver Location	Descriptor	Day[1]	Evening[2]	Night[3]
Residential receiver R2 (south of Lot 67 and 68)	L_{A90}	42	(29) 30	30

Notes: Day, Evening & Night assessment periods are defined in accordance NSW EPA's Industrial Noise Policy as follows.

5. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
6. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
7. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays
8. Number in brackets represents the measured (actual) RBL value, which is below the minimum policy value of 30 dB(A) during the evening or night period or 35 dB(A) during the day period.

5.3 Use of Lance Yorke Oval for Soccer

Based on information provided by Leonard Allen (President of the local Soccer Club, which is responsible for the use of the Lance Yorke Oval), during the soccer season, the soccer fields can be used up to nominally 10pm during the week and 9am – 5pm on the weekends. In the off season, usage is less intense with approximately 2 evenings per week typically, but they are not restricted in the number of days the fields can be used.

Based on file data previously acquired by this office, typical worst-case usage would be from soccer games with spectators which are anticipated to have a sound power level (L_w) of 102dB(A)($L_{eq\ (15min)}$.

Training games without spectators are expected to be approximately 10dB less, i.e. approximately 90-92dB(A) $L_{eq(15min)}L_w$.

6 Assessment of Noise Intrusion and Vibration Impacts

This section presents the assessment of environmental noise impacts onto the site from its surroundings and the mitigation measures that are proposed to achieve appropriate internal noise levels in accordance with the necessary standards / statutory requirements, and those recommended for quality.

6.1 Noise Intrusion Criteria

This section presents the noise intrusion criteria relevant to the project. The outcomes of the assessment are the recommended treatments, outlined in Section 6.2.

6.1.1 State Environmental Planning Policy (Housing) 2021

The State Environmental Planning Policy (Housing) 2021 (HSEPP) includes requirements for Affordable Housing. This section presents a summary of the criteria applicable to the field of acoustics.

Chapter 2 – Part 1, Item 15g) requires the consent authority to consider that the affordable housing must consist of dwellings constructed to a standard that, in the opinion of the consent authority, is consistent with other dwellings in the area.

Chapter 2, Part 2, Division 6, item 43C requires consideration of quality design.

43C Consideration of design of residential apartment development

Before carrying out residential apartment development to which this division applies, the relevant authority must consider the following—

(a) the quality of the design of the development, evaluated in accordance with the design principles for residential apartment development set out in Schedule 9,

(b) the Apartment Design Guide.

Schedule 9 of the HSEPP outlines the design principles for residential apartment development.

From Schedule 9 *Design principles for residential apartment development*, the following parts are relevant to acoustics.

1 Context and neighbourhood character

> *(1) Good design responds and contributes to its context, which is the key natural and built features of an area, their relationship and the character they create when combined and also includes social, economic, health and environmental conditions.*

…

5 Landscape

> *(1) Good design recognises that landscape and buildings operate together as an integrated and sustainable system, resulting in development with good amenity.*
>
> *(2) A positive image and contextual fit of well designed development is achieved by contributing to the landscape character of the streetscape and neighbourhood.*
>
> *(3) Good landscape design enhances the development's environmental performance by retaining positive natural features that contribute to the following—*

(a) the local context,

(b) co-ordinating water and soil management,

(c) solar access,

(d) micro-climate,

(e) tree canopy,

(f) habitat values,

(g) preserving green networks.

(4) Good landscape design optimises the following—

(a) usability,

(b) privacy and opportunities for social interaction,

(c) equitable access,

(d) respect for neighbours' amenity.

(5) Good landscape design provides for practical establishment and long term management.

6 Amenity

(1) Good design positively influences internal and external amenity for residents and neighbours.

(2) Good amenity contributes to positive living environments and resident well-being.

(3) Good amenity combines the following—

(a) appropriate room dimensions and shapes,

(b) access to sunlight,

(c) natural ventilation,

(d) outlook,

(e) visual and acoustic privacy,

(f) storage,

(g) indoor and outdoor space,

(h) efficient layouts and service areas,

(i) ease of access for all age groups and degrees of mobility.

…

9 Aesthetics

(1) Good design achieves a built form that has good proportions and a balanced composition of elements, reflecting the internal layout and structure.

(2) Good design uses a variety of materials, colours and textures.

(3) The visual appearance of well designed residential apartment development responds to the existing or future local context, particularly desirable elements and repetitions of the streetscape.

6.1.2 State Environmental Planning Policy (Transport & Infrastructure) 2021

Clause 2.100 of the T&ISEPP relates to "Impact of rail noise or vibration on non-rail development". It applies to land "…in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration". Given the site is not adjacent to the rail corridor, a rail noise or vibration assessment under the T&ISEPP is not required.

Section 2.120 of the State Environment Planning Policy (Transport & Infrastructure) 2021 (effective 1 March 2022) (T&ISEPP) applies to development for residential accommodation that is on land in or adjacent to the road corridor for a road with an annual average daily traffic volume of 20,000 vehicles (based on the traffic volume data published on the website of Transport for NSW 'TfNSW'), and that the consent authority considers is likely to be adversely affected by road noise or vibration.

We have reviewed the TfNSW maps (Map 5A) and Myall Road is shown red, meaning that assessment of road traffic noise impacts from Myall Road is mandatory.

Figure 5 | Excerpt from TfNSW Traffic Volume Maps (from Map 15A)

Planning Circular PS21-018 nominates that: "The *Development near rail corridors and busy roads – interim guideline (ISEPP Guideline)*, assists in the planning design and assessment of development in, or adjacent to, rail corridors and busy roads." As such, it is a guideline that needs to be considered in accordance with the T&ISEPP, when the road carries in excess of 20,000 vehicles per day (which triggers the mandatory assessment). For this site, the road is documented by TfNSW as carrying >20,000 vehicles per day and so compliance is necessary.

Clause 2.120 relates to noise impacts from a busy road on residential accommodation – refer overleaf.

2.120 Impact of road noise or vibration on non-road development

(1) This section applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 20,000 vehicles (based on the traffic volume data published on the website of TfNSW) and that the consent authority considers is likely to be adversely affected by road noise or vibration—

(a) residential accommodation,

(b) a place of public worship,

(c) a hospital,

(d) an educational establishment or centre-based child care facility.

(2) Before determining a development application for development to which this section applies, the consent authority must take into consideration any guidelines that are issued by the Planning Secretary for the purposes of this section and published in the Gazette.

(3) If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded—

(a) in any bedroom in the residential accommodation—35 dB(A) at any time between 10 pm and 7 am,

(b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.

(3A) Subsection (3) does not apply to a building to which State Environmental Planning Policy (Housing) 2021, Chapter 3, Part 7 applies.

(4) In this section, freeway, tollway and transitway have the same meanings as they have in the Roads Act 1993.

Note: In respect of Item 3A) above, SEPP (Housing) 2021, Chapter 3, Part 7 relates to serviced apartments and so the exclusion is not relevant to this project. The development shall be designed for compliance with Item 3 internal noise levels.

In respect of Item 2 above, Planning Circular PS 21-018 was issued 02 December 2021 which requires a consent authority to "take into consideration this interim guideline to minimise the impacts of busy roads and railway corridors on residential and other sensitive developments". On that basis, the recommendations and clarifications contained within the ISEPP Guideline are still valid except where directly contradicted by the T&ISEPP (e.g. under the T&ISEPP it is mandatory to assess road traffic noise for roads carrying >20000 vehicles per day, whereas ISEPP and ISEPP Guideline refer to mandatory assessment for >40000 vehicles per day and only recommend assessment for >20000 vehicles per day).

6.1.3 Development near rail corridors and busy roads – interim guideline

The Guideline clarifies the time period of measurement and assessment. Section 3.4 '*What Noise and Vibration Concepts are Relevant*' and Table 3.1 of Section 3.6.1 confirms that noise assessment is based over the following time periods:

- Daytime 7:00am - 10:00pm $L_{Aeq(15hr)}$
- Night-time 10:00pm - 7:00am $L_{Aeq(9hr)}$

The noise criteria nominated in the T&ISEPP apply to internal noise levels with windows and doors closed. However as the preliminary noise assessment is based on measurements/predictions at external locations, equivalent external noise criteria has been established. The equivalent external noise criterion is used to determine which areas of the development may require acoustic treatment to meet the internal noise requirements of the T&ISEPP. The equivalent external goals have been determined on the following basis:

- The Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline' states: "*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*." The internal screening test with windows open is therefore 10dB(A) above the criteria explicitly outlined in the T&ISEPP. If that level is exceeded, then provision shall be made for alternative ventilation.
- The generally accepted noise reduction through an open window from a free-field external position is 10dB(A). Windows/doors are assumed to be open no more than 5% of room floor area, in accordance with the National Construction Code, Building Code of Australia (BCA) ventilation requirements.

Table 4 overleaf presents the T&ISEPP internal noise criteria along with the equivalent external noise level for residential premises, which shall be used as a screening test for consideration of noise impacts on the proposed apartments, specifically the need for alternative ventilation. Refer to section 6.2 for treatments.

Table 4: T&ISEPP noise criteria and ventilation screening test for new residential development

Room	Location	$L_{Aeq,\ 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am
Living rooms[1]	Internal, windows closed	40	40
	Internal, windows open	50	50
	External free-field (allowing windows to remain open)[2]	60	60
Bedrooms[1]	Internal, windows closed	40[3]	35
	Internal, windows open	50[3]	45
	External free-field (allowing windows to remain open) [2]	-	55

Room	Location	$L_{Aeq,\ 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am

Notes: 1. Requisite for 20,000AADT Roads only under T&ISEPP 2021.

2.Department of Planning's Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open for natural ventilation, then alternative ventilation is required. External screening levels have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the NCC/BCA requirements.

3. T&ISEPP does not define internal goals in Bedrooms during the daytime (only at night). In view of project quality, we have elected to apply the Living Room goals to Bedrooms during the daytime.

6.1.4 Australian Standard AS/NZS 2107-2016

For the residential portion, compliance with the T&ISEPP internal goals will also achieve compliance with AS2107:2016. The common areas are not governed by the T&ISEPP and so guidance is sought from Australian Standard AS2107:2016. The applicable criteria shall be based on AS/NZS 2107-2016 are presented below in Table 5. These goals are applicable to both road traffic noise and mechanical services noise. Mechanical noise impacts on bedrooms and private living spaces from central building equipment (which the resident has no control over) shall be designed to less than 30dB(A) Leq for residential amenity.

Table 5: Recommended design sound levels for different areas of occupancy in buildings

Type of occupancy/ activity	Design sound level (LAeq,t) range
7 RESIDENTIAL BUILDING	
Houses and apartments near major roads-	
Living Areas	35 to 45
Sleeping Areas (night time)	35 to 40
Work Areas	35 to 45
Undercover Carpark	<65

6.1.5 Internal noise goals from soccer

There are no formal policy requirements for noise emissions from the use of public open space for sporting activities. However, given some of the proposed homes are in very close proximity to the soccer pitch to the east, there is the possibility of the existing soccer use impacting residential amenity. Given that both housing and public sporting facilities are in need in most areas of NSW, it is important to strike a balance between both needs.

Whilst the NSW EPA Noise Policy for Industry (NPfI) is a useful policy for industrial type noises, it was designed for the management of facilities that emit industrial type noise and operate for commercial gain (not for the benefit of the community) and for uses that can occur at any time.

Noise from sporting facilities was addressed in the NSW EPA Environmental Noise Control Manual (ENCM). The NSW EPA Noise Guide for Local Government (2007) states that whilst the ENCM "…has been superseded by other DEC policy

documents… it may still be a useful source of information for councils developing a policy or dealing with a particular noise issue."

The ENCM Chapter 159 relates to noise from sporting activities.

ENCM Chapter 159 - Lawful Sporting Activities

For the purposes of this Guideline "lawful sporting activities" are broadly divided into three parts:

(i) athletic sporting events (see below),

(ii) motorised sporting events (see chapter 152),

(iii) shooting ranges (chapter 164).

ATHLETIC SPORTING EVENTS

Athletic sporting events involve crowds gathering to participate in or watch sporting competitions such as tennis, football and BMX races.

The primary sources of noise from such events are public address systems and crowd noise including arrival and departure.

The control of noise from public address systems is described in chapter 156.

The extent to which athletic sporting activities cause noise in residential areas can be minimised firstly by appropriate planning of the venue site. Thereafter, control usually is most equitably and effectively achieved by regulation of the frequency and duration of events

The following criteria should be considered as guidelines only and variations may be made according to local conditions

Time Restrictions

Where offensive noise occurs, athletic sporting events should be restricted to:

7 am to 6 pm any weekday

8 am to 6 pm Saturdays and Sundays

6 pm to 10 pm two nights per week excluding Sundays or Public Holidays

Where no offensive noise is likely to be caused, restrictions are not applicable.

The number of nights per week could be extended to all nights except Sunday if the intrusive noise level (LA10 for the activity measured over 15 minutes at the affected receiver) does not exceed the background noise level (LA90) by more than 5 dB(A) for new events or 10 dB(A) for existing activities.

- *No impulsive or intermittent correction shall be applied to the measured levels.*
- *The abovementioned hours may be extended to 11 pm provided intrusive noise does not exceed the background noise level. This applies to both new and existing activities.*
- *Noise should be inaudible between 11 pm and 8 am.*
- *Noise means noise from the sport itself and the associated activities including the use of sound reproduction equipment.*
- *Participants should be encouraged by the management to leave the premises quickly and quietly at night to lessen the likelihood of noise complaints.*

To allow for special events such as state, national or international competitions, the EPA will consider applications for extension of these times for up to three weekends per year.

By reference to the assumed background noise level for R2 receivers (shielded from Myall Road) for the Evening Period (30dB(A) L_{90} for 6-10pm) Chapter 159 Background + 10 criteria for existing sporting noise would propose a criterion of 40dB(A).

Soccer game noise is predicted to be approximately 63dB(A)$L_{eq(15min)}$ at the nearest residential façade on Lot 67. That would exceed the screening test of Background + 10. On that basis, it would be reasonable to recommend some upgrades to the façade of the proposed residential flat building, to protect the residential amenity of future occupants.

In order to design treatments, we propose a screening test of 40dB(A) $L_{eq(15min)}$ by reference to AS2107:2016 with a +5dB correction to the source noise level for variable characteristics (e.g. whistle blows). That is, the internal noise level when soccer is played would be in the order of 35dB(A) $L_{eq(15min)}$. Whilst AS2107 was designed for quasi-steady noise sources and soccer noise is variable, an internal variable noise level of 35dB(A) $L_{eq(15min)}$ is appropriate given the timing, frequency, and duration of sports noise, given that there are no state or local noise policies for existing sporting noise impacts on future residential development.
Refer to section 6.2 for treatments.

6.2 Noise intrusion assessment

The main noise impact onto the site is from road traffic noise on Myall Road (and to a lesser extent, on Trophy Ave), followed by sports noise from the use of Lance Yorke Oval. The following sections present the indicative treatments for compliance with the project internal noise goals as defined in section 6.1 (for road traffic noise and sport noise intrusion).

Noise calculations were performed using glazing design software developed by Renzo Tonin & Associates which take into account external noise levels, facade transmission loss and room sound absorption characteristics. The forms of constructions presented below are recommended to comply with the nominated acoustic criteria for the development. The North portion of the site is most affected by noise from Myall Road, whilst the East side of the Lot 67 residential flat building is most impacted by soccer noise.

To capture the impact of changes during detailed design, a review of environmental noise intrusion is to be undertaken during detailed design prior to construction documentation.

6.2.1 Glazing

To achieve the criteria outlined in Table 4 with windows closed, the following table presents the recommended glazing acoustic performances for the proposed development. There is no restriction on ability to open windows/doors. For the noise affected facades, they need to be closed to comply with the windows closed requirements. For rooms impacted by multiple facades, the highest rating specified shall be installed to the whole room. These are subject to review in detailed design.

Table 6 | Recommended acoustic performance of indicative glazing assembly

Zone	Room Description	Required Acoustic Rating of Glazing Assembly, R_w
North Façades to Myall Road (including rooms on corners)	Bedrooms	R_w 35
	Living Rooms	R_w 35
East Façade (facing soccer field), West Façade (facing the bush), and North and South glazing (facing into courtyard)	Bedrooms	R_w 32
	Living areas	R_w 32
South Facades of terraces (facing Premier Cct)	Bedrooms	R_w 28
	Living areas	R_w 28
All	Lobby	R_w 28

Notes:

The client is advised not to commence detailing or otherwise commit to partition construction systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of partition construction systems is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested partition construction systems, estimates or opinions. The advice provided here is in respect of acoustics only.

The information in this table is provided for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.

The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.

Before committing to any form of construction or committing to any builder, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction where only an "estimate" is available for the sound insulation properties of recommended materials.

The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site.

All openable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the Rw rating performance of the glazing to not be reduced.

The above glazing thicknesses should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.

Glazing Constructions to Achieve Acoustic Ratings

The following table presents glazing constructions to achieve the minimum acoustic ratings presented in Table 6 above.

Table 7 | Glazing Constructions to Achieve Acoustic Ratings

R_w Rating	Glazing System
R_w 28	Minimum 6mm float or toughened glass in an aluminium sliding window frame. Alternatively, indicative double glazing of 6/12/6 IGU.Q-lon seals full perimeter seals shall be installed (or equivalent). Or acoustic system to be determined in Detailed Design.
R_w 32	Minimum 6.38mm laminated glass in an aluminium sliding window frame. Alternatively, indicative double glazing of 6.38/12/6 IGU. Q-lon seals full perimeter seals shall be installed (or equivalent). Or acoustic system to be determined in Detailed Design.
R_w 35	Minimum 10.38mm laminated glass in an aluminium sliding window frame. Alternatively, indicative double glazing of 10.38/12/6 IGU. Q-lon seals full perimeter seals shall be installed (or equivalent). Or acoustic system to be determined in Detailed Design.

The table above outlines indicative treatments and associated acoustic ratings which achieve compliance with the project internal noise goals, showing that the development is capable of compliance with materials readily available in the local market. However, the above is subject to review during detailed design and should not be used for construction. It is the responsibility of the sub-contractor to provide laboratory test reports for the glazed systems

proposed for installation at the development site to show compliance with the acoustic ratings presented in minimum glazing thicknesses and R_w ratings in Table 7.

6.2.2 Roof

To achieve the criteria outlined in Section 6.1, the following table presents the recommended roof acoustic performances for the proposed development.

At this stage, we assume that the roof will be concrete, with thermal insulation.

Table 8 | Assumed acoustic performance of indicative roof/ceiling construction

SPACE	Room Description	Required Acoustic Rating of Roof Assembly, R_w
Metal Deck Roof (behind a parapet)	All	R_w 40+

Notes:

The client is advised not to commence detailing or otherwise commit to partition construction systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of partition construction systems is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested partition construction systems, estimates or opinions. The advice provided here is in respect of acoustics only.

The information in this table is provided for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.

The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.

Before committing to any form of construction or committing to any builder, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction where only an "estimate" is available for the sound insulation properties of recommended materials.

The supplier shall ensure that installation techniques will not diminish the Rw performance of the system when installed on site.

Roofing Constructions to Achieve Acoustic Ratings

The following table presents roofing constructions to achieve the minimum acoustic ratings presented in Table 8 above.

Table 9 | Typical Roof Constructions to Achieve Acoustic Ratings

R_w Rating	Typical Roofing System
R_w 40	Metal deck roof with Anticon blanket sandwiched under the roof sheets, with large airgap cavity with R3 insulation and 13mm plasterboard ceiling, or acoustic equivalent to be determined in Detailed Design.

The table above outlines indicative treatments and associated acoustic ratings which achieve compliance with the project internal noise goals, showing that the development is capable of compliance with materials readily available in the local market. However, the above is subject to review during detailed design and should not be used for

construction. It is the responsibility of the sub-contractor to provide laboratory test reports for the roof/ceiling systems proposed for installation at the development site to show compliance with the acoustic ratings presented in Table 8.

6.2.3 External walls

To achieve the criteria outlined in Section 6.1, the following table presents the recommended external wall acoustic performances for the proposed development.

Table 10 | Recommended acoustic performance of indicative external wall construction

Room Description	Required Acoustic Rating of Wall Assembly, R_w
West, North and South facades	R_w 50
Rooms with glass Rw28 or less	R_w 43

Notes:

The client is advised not to commence detailing or otherwise commit to partition construction systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of partition construction systems is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested partition construction systems, estimates or opinions. The advice provided here is in respect of acoustics only.

The information in this table is provided for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.

The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.

Before committing to any form of construction or committing to any builder, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction where only an "estimate" is available for the sound insulation properties of recommended materials.

The supplier shall ensure that installation techniques will not diminish the Rw performance of the system when installed on site.

Table 11 | Wall Constructions to Achieve Acoustic Ratings

R_w Rating	Wall System
R_w 43	Masonry (i.e. brick veneer, or concrete); or Minimum 9mm compressed fibre cement cladding, on minimum 92mm studwork with 13mm plasterboard internally and 75mm thick 11kg/m3 glass or mineral wool insulation, or acoustic equivalent determined during detailed design.
R_w 50	Masonry (i.e. brick veneer, or concrete); or Minimum 16mm compressed fibre cement cladding on steel studwork with furring channels/tophats (minimum air cavity 125mm), with 75mm thick 11kg/m3 glass or mineral wool insulation and 13mm plasterboard; or Acoustic equivalent determined during detailed design.

The table above outlines indicative treatments and associated acoustic ratings which achieve compliance with the project internal noise goals, showing that the development is capable of compliance with materials readily available in the local market. However, the above is subject to review during detailed design and should not be used for construction. It is the responsibility of the sub-contractor to provide laboratory test reports for the systems proposed for installation at the development site to show compliance with the acoustic ratings presented in Table 11.

6.2.4 Ventilation

Windows on the North, East and west façades of the residential flat buildings opening directly to outside would not comply with the ISEPP Guideline internal requirements when windows are open for natural ventilation. On that basis, they should be provided with alternative ventilation. However, the terrace homes are predicted to comply with windows open natural ventilation.

Whilst the project mechanical engineers Meinhardt is supportive of borrowing ventilation from another room, the typical apartments do not have enough south facing openings to ventilate the other rooms. Ventilation should be provided by fresh air fan/s or other system to be determined during detailed design.

6.2.5 Treatment of Private Open Space

In consideration of HSEPP Chapter 2 – Part 1, Item 15g), we have reviewed some of the neighbouring buildings fronting Myall Road from an acoustic perspective. In respect of private open space and openable windows near the roadside, there are typically no treatments to reduce road traffic noise from Myall Road.

We note that in the local area it is relatively common to have security fencing to the edge of the site (some with small plantings in front).

6.2.6 HSEPP Schedule 9 considerations

In respect of acoustics, whilst the site is sufficiently affected by road traffic volumes that a noise assessment under the T&ISEPP is mandatory and we have used the T&ISEPP and the associated ISEPP Guideline and nominated treatments for compliance in general. This is an appropriate control measure to the existing traffic noise impacts onto the site to ensure acoustic amenity for the future residents. This includes consideration of ventilation to noise affected facades.

There are a range of areas of communal open space that can be utilised by residents. This provides flexibility in use in terms of both time of day, and the types of activities being undertaken in the communal areas.

The acoustic separation requirements of NCC2022 are generally accepted as offering reasonable separation between adjacent sole occupancy units, although there is some conjecture in respect of floor impact insulation/isolation. On that basis, it is proposed that for the amenity of future residents, the acoustic separation of sole occupancy units shall be designed for compliance with NCC2022 (or later version depending on the CC date), with the exception that a small upgrade to the floor impact isolation rating over habitable rooms is recommended, to $L_{nT'w} \leq 55$. Refer to Section 8 for details.

7 Assessment of Noise Emissions

This section outlines the noise emission assessment.

7.1 Noise Emission Requirements

Noise emissions from vehicles being driven on the site and from mechanical plant and equipment, shall be managed in accordance with the NPfI.

Noise from additional traffic on the public road would normally be assessed in accordance with the NSW EPA Road Noise Policy 2011 (RNP). However, given this is a growth centre, it is assumed that the traffic volumes will already be included in the traffic modelling.

7.1.1 NSW EPA Noise Policy for Industry

The NSW EPA Noise Policy for Industry (2017) assessment usually has three main components:

- Controlling intrusive noise impacts in the short-term for residences;
- Maintaining noise level amenity for particular land uses for residences and other land uses (amenity); and
- Assessing night-time noise impacts on residential receivers for the potential for sleep disturbance.

In the event that particular assessment is undertaken, and trigger levels are found to be exceeded even after application of feasible and reasonable treatments, additional analysis would be required to determine the impact of the residual.

Intrusive noise trigger level

The intrusiveness trigger level is applicable to residential premises only. According to the NPfI, the intrusiveness of a noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor) does not exceed the background noise level measured in the absence of the source by more than 5dB(A).

The intrusiveness criterion is summarised as follows:

- $L_{Aeq,15minute} \leq$ Rating Background Level (RBL) plus 5dB

Table 12 | Measured Site Background (L_{A90}) and associated NPfI Intrusive trigger

Receiver Location	Descriptor	Day[1]	Evening[2]	Night[3]
Residential receivers R2 (to the south)	Background L_{A90}	42	30	30
	Intrusive Trigger, Background + 5dB(A) $L_{Aeq(15min)}$	47	35	35
Residential receivers R1 (to the north)	Background L_{A90}	56	46	30
	Intrusive Trigger, Background + 5dB(A) $L_{Aeq(15min)}$	61	51	35

Notes: Day, Evening & Night assessment periods are defined in accordance NSW EPA's Industrial Noise Policy as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays
4. NPfI nominates that if the evening is louder than the day, the project noise emission goals for the evening shall be set the same as the day.

In this instance, the site is in a growth area where land uses are undergoing significant change. Section 2.4.3 of the NPfI acknowledges that in these circumstances, background noise levels could be expected to change, and recommends that the impact of noise from an existing industry on a proposed new residential area should be made using the recommended amenity noise level for the residential land use, not the project intrusiveness noise level. However, based on the long and short term measurements taken near the site, we propose to utilise both intrusiveness and amenity.

Amenity noise trigger levels

The NPfI amenity trigger levels are designed to maintain noise level amenity for particular land uses, including residential and other land uses. The NPfI recommends base acceptable noise levels for various receivers, including residential, commercial, industrial receivers and other sensitive receivers in Table 2.2 of the NPfI. For this project, the neighbouring receivers are classified as Suburban residential receivers. Application of the suburban category is appropriate due to the development mix and zoning.

Table 13 | NPfI Amenity Criteria - Recommended L_{Aeq} noise levels from industrial noise sources [NSW NPfI Table 2.2]

Type of receiver	Indicative Noise Amenity Area	Time of day	Recommended amenity noise level LAeq(Period)
Residence	Suburban	Day	55
		Evening	45
		Night	40
Passive Recreation	-	When in use	50
Active Recreation	-	When in use	55

Notes: The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Types of receivers are defined as follows:

• suburban residential – see Table 2.3

• urban residential – see Table 2.3

Time of day is defined as follows:

• day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays

• evening – the period from 6 pm to 10 pm

• night – the remaining periods.

(These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.)

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 (NPfI Table 2.2) minus 5 dB(A)
- Project amenity trigger noise level $L_{Aeq(15min)}$ = Project amenity noise level for industrial developments $L_{Aeq(period)}$ plus 3dB(A). (Note: this is a screening test and the policy still permits period average assessment by review of particular operations)

The NPfI, Section 2.4.1 notes that the level of road traffic noise may provide acoustic masking to operational noise impacting receivers. It is only applicable where traffic noise is identified as the dominant noise source at the site; the existing traffic noise level is 10dB or more above the recommended amenity noise level for the area; and it is highly unlikely traffic noise levels will decrease in the future. The traffic noise levels acquired from the monitoring on the nearby site would not yield a relaxation of project noise emission goals.

On that basis, the Project Amenity Noise Levels are as shown in the following table.

Table 14 | Determination of Project Amenity Noise Levels and Project Amenity Trigger Levels

Receiver Reference	Description	Time of day		
		Day	Evening	Night
R1 (residential receivers to north)	Recommended amenity noise level $L_{Aeq(Period)}$	55	45	40
	Project amenity trigger level $L_{Aeq(15min)}$	55-5+3 =53	45-5+3=43	40-5+3 = 38
R2 (residential receivers to south)	Recommended amenity noise level $L_{Aeq(Period)}$	55	45	40
	Project amenity trigger level $L_{Aeq(15min)}$	55-5+3 =53	45-5+3=43	40-5+3 = 38
Passive recreation space to west	Recommended amenity noise level $L_{Aeq(Period)}$	50	-	-
	Project amenity trigger level $L_{Aeq(15min)}$	50-5+3=48	-	-
Active recreation space to east (Lance Yorke Oval)	Recommended amenity noise level $L_{Aeq(Period)}$	55	55	-
	Project amenity trigger level $L_{Aeq(15min)}$	55-5+3=53	55-5+3=53	-

Notes: **Bold** indicates use of the High Traffic correction to the project amenity noise level.

The recommended amenity noise levels refer only to noise from industrial sources. However, they refer to noise from all such sources at the receiver location, and not only noise due to a specific project under consideration. The levels represent outdoor levels except where otherwise stated.

Time of day is defined as follows (These periods may be varied where appropriate, for example, see A3 in Fact Sheet A.):

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays

Table 15 overleaf outlines the determination of the project noise trigger levels.

Table 15 | Determination of Project Noise Trigger Levels

Receiver Location	Descriptor	Day[1]	Evening[2]	Night[3]
R1 (residential receivers to north)	Intrusive Trigger, Background + 5dB(A) $L_{Aeq(15min)}$[4]	61	51	35
	Project Amenity trigger level $L_{Aeq(15min)}$	53	43	38
	Project Noise Trigger Level $L_{Aeq(15min)}$	53	43	35
R2 (residential receivers to south)	Intrusive Trigger, Background + 5dB(A) $L_{Aeq(15min)}$[4]	47	35	35
	Project Amenity trigger level $L_{Aeq(15min)}$	53	43	38
	Project Noise Trigger Level $L_{Aeq(15min)}$	47	35	35
Passive recreation to West	Intrusive Trigger, Background + 5dB(A) $L_{Aeq(15min)}$[5]	-	-	-
	Project Amenity trigger level $L_{Aeq(15min)}$	48	-	-
	Project Noise Trigger Level $L_{Aeq(15min)}$	48	-	-
Active recreation space to east (Lance Yorke Oval)	Intrusive Trigger, Background + 5dB(A) $L_{Aeq(15min)}$[5]	-	-	-
	Project Amenity trigger level $L_{Aeq(15min)}$	53	53	-
	Project Noise Trigger Level $L_{Aeq(15min)}$	53	53	-

Notes: Day, Evening & Night assessment periods are defined in accordance NSW EPA's Industrial Noise Policy as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays.
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays
4. Given the site is in an area undergoing significant change, project noise trigger levels shall be based only on the Project Amenity Noise Levels.
5. Intrusiveness criteria do not apply to Passive Recreation

Maximum noise level event assessment

Where the subject development/premises night time noise levels at a residential location exceed:

- $L_{Aeq,\ 15min}$ 40dB(A) or the prevailing rating background noise level (RBL) plus 5dB, whichever is greater, and/or
- L_{AFmax} 52dB(A) or the prevailing RBL plus 15dB(A), whichever is greater,

a detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.
Where there are noise events found to exceed the initial screening level, further analysis is made to identify:

- the likely number of events that might occur during the night assessment period
- Whether events exceed an 'awakening reaction' level of $L_{A1(1min))}$ 65 dB(A).

The only use of the site that is anticipated could result in noise events with the potential for sleep disturbance are from use of the driveway.
The sleep disturbance criteria for the project are presented in Table 16 .

Table 16 | Sleep disturbance criteria

Receiver	Sleep disturbance screening tests, 10pm - 7am, LA1,1min (or LAmax) = LA90(15min) + 15 dB(A) or 52dB(A) whichever is greater	LAeq, 15min = LA90(15min) + 5 dB(A) or 40dB(A) whichever is greater
R2 to the south	(30+15=45) 52	(30+5=35) 40

7.1.2 NSW Road Noise Policy

Assessment not required given the site is within the growth centre and the traffic volumes required to serve the site have already been included in the strategic planning.

7.2 NPfI Noise Emission Assessment

This section presents the outcomes of the assessment of noise emissions from vehicles being driven on the site and noise from mechanical plant and equipment, which shall be managed in accordance with the NPfI.
In the event that particular assessment is undertaken and trigger levels are found to be exceeded after application of feasible and reasonable treatments, additional analysis would be required to determine the impact of the residual. The Noise Trigger Levels are named so that they trigger an appropriate response but are not to be viewed as hard and fast targets.

Where necessary, noise amelioration treatment has been incorporated in the design to ensure that noise levels comply with the recommended EPA's INP noise emission criteria noted above. Indicative assessment of the mechanical plant noise emissions and use of the driveways has been included in Section 7.2.2 .

7.2.1 Mechanical plant – general advice

Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:

- Procurement of 'quiet' plant;
- Strategic positioning of plant away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises;
    - This has been done as much as usually feasible given the stage. Meinhardt have provided initial spatial planning and equipment noise levels. The indicative treatment advice is shown in the following section (to be refined during detailed design for CC);
- Commercially available silencers or acoustic attenuators for air discharge and air intakes of plant;
- Acoustically lined and lagged ductwork;
- Acoustic screens and barriers between plant and sensitive neighbouring premises;

All mechanical plant shall have the cumulative noise emissions reviewed prior to CC to ensure ongoing compliance; and Identified mechanical equipment shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 "Rotating and Reciprocating Machinery – Mechanical Vibration".

We recommend a full and detailed assessment with fully documented acoustic treatments be undertaken at the detailed design phase of the development, followed by construction/installation supervision of mechanical plant and equipment acoustic treatment. Compliance testing following the installation of the plant should also be undertaken.

We do not anticipate any significant vibration from the use of the site impacting surrounding receivers. Vibration isolation will be nominated as required for the comfort of the occupants of the site (typically for mechanical plant and equipment).

All mechanical plant shall comply with the criteria set hereby in this report and in accordance with SEARs.

7.2.2 Indicative assessment

Mechanical

The Building Services Consultants, Meinhart, have provided indicative services arrangements. Apartments shall be served by individual bathroom and kitchen fans and air conditioning condensers. Acoustic treatment of this distributed equipment would be undertaken during detailed design, but compliance is readily achievable given each item is small

and relatively quiet. Centralised plant is to be located in the common spaces and on the rooftop, but it is relatively limited (e.g. carpark and services room air supply and carpark exhaust for Lot 67).

Hydraulic plant

Detailed plant selections for hydraulic plant are not available at this time, but would typically include domestic hot and cold water, and fire pumps. Noise from such equipment is readily controllable with use of enclosures, and treated intake and exhaust air paths.

Electrical services

We do not anticipate any significant electrical services plant based on the provisional information currently available from Meinhardt.

Noise from vehicles being driven on driveway

Car access to the site is from two dedicated driveways on Premier Circuit (one each for Lot 68 and Lot 67). The basement has 18 car spaces in Lot 68 and 19 for Lot 67 and two motorbike spaces on each Lot. The Transport Consultant Report prepared by SCT Consulting for Landcom predicts 35 daily vehicle trips in each AM/PM Peak Hour. Noise impacts from vehicles being driven in the basement carpark are anticipated to be minimal and not require any specific acoustic treatments.

7.3 Noise from use of communal open space

Access to the Ground Communal Open Space would be available 24/7 for residents to step outside as is the case for any private balcony in a residential development to facilitate freedom of movement as is required. However, we anticipate that it is highly unlikely to be used at night and so would recommend only security lighting at night time. Further, if it were to be used at night, that it would be limited to quiet reflection which would not result in any significant noise emissions to neighbours or receivers within the building itself.

7.4 Noise from use of the loading dock

The loading dock on Lot 68 is proposed to serve the Council waste trucks, to retrieve waste from that lot. When not required for waste retrieval, it could be used for moving services etc.

In consideration of noise impacts to the residents of Lot 68, where feasible and reasonable, it would be preferable that waste is not retrieved prior to 7am or after 10pm, to avoid sleep disturbance.

Removal trucks and deliveries shall not use the loading dock prior to 7am or after 10pm.

Lot 67 waste room is closer to the street and on street waste retrieval is proposed. In consideration of noise impacts to the residents of R2 to the south and Lot 67, where feasible and reasonable, it would be preferable that waste is not retrieved prior to 7am or after 10pm, to avoid sleep disturbance.

Removal trucks and deliveries shall be requested not to attend prior to 7am or after 10pm.

8 Internal Acoustic Separation

As a minimum requirement, walls and floors and separation of services around sole occupancy units shall comply with the National Construction Code (NCC) / Building Code of Australia (BCA) 2022 or later, as relevant to the date of submission of the Construction Certificate. Specific constructions will be determined/refined in consultation with the client during the detailed design phase. This is relevant to the consideration of acoustic amenity required for the Housing SEPP.

NCC 2022 requirements - Class 2

The National Construction Code Series (NCC) 2022 - Volume 1, Building Code of Australia sets out the following acoustic provisions for Class 2 buildings:

F7D3 Determination of airborne sound insulation ratings

A form of construction required to have an airborne sound insulation rating must –

(a) have the required value for weighted sound reduction index (Rw) or weighted sound reduction index with spectrum adaptation term (Rw + Ctr) determined in accordance with AS/NZS ISO 717.1 using results from laboratory measurements; or

(b) comply with Specification 28.

F7D4 Determination of impact sound insulation ratings

(1) A floor in a building required to have an impact sound insulation rating must –

(a) have the required value for weighted normalised impact sound pressure level (Ln,w) determined in accordance with AS ISO 717.2 using results from laboratory measurements; or

(b) comply with Specification 28

(2) A wall in a building required to have an impact sound insulation rating must –

(a) for a Class 2 or 3 building be of discontinuous construction and

(b) (Class 9c)

(3) For the purposes of this Part, discontinuous construction means a wall having a minimum 20 mm cavity between 2 separate leaves, and

(a) for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and

(b) for other than masonry, there is no mechanical linkage between leaves except at the periphery.

F7D5 Sound insulation rating of floors

(1) A floor in a Class 2 or 3 building must have an Rw + Ctr (airborne) not less than 50 and an Ln,w (impact) not more than 62 if it separates –

(a) sole-occupancy units; or

(b) a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

(2) (Class 9c)

F7D6 Sound insulation rating of walls

(1) A wall in a Class 2 or 3 building must –

(a) have an Rw + Ctr (airborne) not less than 50, if it separates sole-occupancy units; and

(b) have an Rw (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and

(c) comply with F7D4(2) if it separates:

(i) a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or

(ii) a sole-occupancy unit from a plant room or lift shaft.

(2) A door may be incorporated in a wall in a Class 2 or 3 building that separates a sole-occupancy unit from a stairway, public corridor, public lobby or the like, provided the door assembly has an Rw not less than 30.

(3) (Class 9c)

(4) (Class 9c)

(5) Where a wall required to have sound insulation has a floor above, the wall must continue to –

(a) the underside of the floor above; or

(b) a ceiling that provides the sound insulation required for the wall.

(6) Where a wall required to have sound insulation has a roof above, the wall must continue to –

(a) the underside of the roof above; or

(b) a ceiling that provides the sound insulation required for the wall.

F7D7 Sound insulation rating of internal services

(1) If a duct or soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an Rw+Ctr (airborne) not less than –

(a) 40 if the adjacent room is a habitable room (other than a kitchen); or

(b) 25 if the adjacent room is a kitchen or non-habitable room.

(2) If a stormwater pipe passes through a sole-occupancy unit, it must be separated in accordance with (1)(a) and (b).

F7D8 Sound isolation of pumps

A flexible coupling must be used at the point of connection between the service pipes in a building and any circulating or other pump.

8.1 Summary of project minimum requirements

Residential apartments

Table 17 overleaf presents the NCC 2022 requirements for walls. It should be noted that R_w, $R_w + C_{tr}$ and $L_{n,w}$ are laboratory-measured values determined in accordance with ISO 10140 and ISO 717.1, from results in a controlled

environment. This is traditionally used as a design value. Typically, the performance of a particular building element under laboratory conditions will produce the same result every time, however this may not be the case for on-site measurements. On-site measurements are dependent on several factors including potential defects or deficiencies in construction on site, reverberation time and volume of receiving room, dimension of partition elements and other potential noise flanking paths. As such it is not practical to assume that the same level of acoustic performance can be achieved from on-site testing.

Verification methods F7V1, F7V2 in Part F7 of the NCC notes weighted standardised level difference ($D_{nT,w}$) or weighted standardised level difference with spectrum adaptation term ($D_{nT,w} + C_{tr}$) and weighted standardised impact sound pressure level ($L_{nT,w}$), as the in-situ measured airborne and impact sound insulation ratings respectively.

Table 17 |: Project sound insulation requirements for partition walls

One Side	Other Side	NCC 2022 Requirements	
		Airborne Sound Insulation Design Rating Field Rating	Impact Sound Insulation
Enclosed Habitable room [1,2]	Enclosed Habitable room [1,2]	$R_w + C_{tr} \geq 50$ $D_{nT,w} + C_{tr} \geq 45$	–
	Wet area [3]	$R_w + C_{tr} \geq 50$ $D_{nT,w} + C_{tr} \geq 45$	Discontinuous construction [5]
	Combined Living/Dining/Kitchen area	$R_w + C_{tr} \geq 50$ $D_{nT,w} + C_{tr} \geq 45$	Discontinuous construction [5]
Wet area [3]	Wet area [3]	$R_w + C_{tr} \geq 50$ $D_{nT,w} + C_{tr} \geq 45$	–
	Combined Living/Dining/Kitchen area	$R_w + C_{tr} \geq 50$ $D_{nT,w} + C_{tr} \geq 45$	Discontinuous construction [5]
Combined Living/Dining/Kitchen area	Combined Living/Dining/Kitchen area	$R_w + C_{tr} \geq 50$ $D_{nT,w} + C_{tr} \geq 45$	Discontinuous construction [5]
	Plant room, lift shaft	$R_w \geq 50$ $D_{nT,w} \geq 45$	Discontinuous construction [5]

Any separating wall of the occupancy	Public corridors & stairs, Lobby or Foyer and parts of a different classification	$R_w \geq 50$ [4] $D_{nT,w} \geq 45$	–
Hydraulic services shaft/riser	Enclosed Habitable room [1]	$R_w + C_{tr} \geq 40$	–
	Combined Living/Dining/Kitchen area	$R_w + C_{tr} \geq 40$	–
	Wet area [3]	$R_w + C_{tr} \geq 25$	–
Mechanical riser/ plant room	Adjacent Space	As required for noise control, min $R_w + C_{tr} \geq 40$	

Notes:

1. Enclosed habitable rooms include enclosed spaces such as bedrooms, but not combined kitchens opening into living and dining rooms.
2. Private hallways, stairs and entries inside apartment and studies are considered habitable spaces.
3. Wet areas include bathrooms, en-suites, and laundries.
4. Where a door is incorporated in a wall, the door assembly shall have an R_w not less than 30.
5. Discontinuous construction means wall system having a minimum 20mm clearance gap between two separate leaves. A staggered stud wall is not deemed as a discontinuous construction.

The following, Table 18 presents the NCC 2022 requirements for floors, and the RTA recommended ratings for floor impact insulation (which are slightly more stringent than the NCC minimum requirements).

Table 18 | Project sound insulation requirements for partition floors

Subject Floor	Floor Below	NCC 2022 Requirements		RTA Recommendation
		Airborne Sound Insulation Design Rating Field Rating	Impact Sound Insulation Design Rating Field Rating	Impact Sound Insulation [1] Design Rating Field Rating
Enclosed Habitable room [2,3]	Enclosed Habitable room [2,3]	R_w + Ctr > 50 DnT,w + Ctr > 45	Ln,w < 62 LnT,w < 62	Ln,w < 55 LnT,w < 55
	Wet area [4]	Rw + Ctr > 50 DnT,w + Ctr > 45	Ln,w < 62 LnT,w < 62	Ln,w < 55 LnT,w < 55
Wet area [4]	Habitable room [2]	Rw + Ctr > 50 DnT,w + Ctr > 45	Ln,w < 62 LnT,w < 62	Ln,w < 55 LnT,w < 55

	Wet area [4]	Rw + Ctr > 50 DnT,w + Ctr > 45	Ln,w < 62 LnT,w < 62	Ln,w < 55 LnT,w < 55
Sole Occupancy Unit	Plant room, lift shaft, public corridors & stairs, lobby or foyer and parts of a different classification	Rw + Ctr > 50 DnT,w + Ctr > 45	Ln,w < 62 LnT,w < 62	Ln,w < 55 LnT,w < 55

Notes:

1. Generally agreed amongst acoustic consultants that the impact performance requirement of NCC (Ln,w & LnT,w < 62) is not sufficient to provide a suitable level of acoustic amenity. An acoustic performance of Ln,w & LnT,w < 55 is recommended as the minimum floor impact performance, in line with the agreed position by the Association of Australasian Acoustical Consultants (AAAC) and its members.
2. Enclosed habitable rooms include enclosed spaces such as bedrooms, but not combined kitchens opening into living and dining rooms.
3. Private hallways, stairs and entries inside apartment and studies are considered habitable spaces.
4. Wet areas include bathrooms, en-suites, laundries and kitchen areas in open plan configurations.

NCC 2022, Specification 28 outlines a number of different "Acceptable forms of constructions for walls and floors". Use of Acceptable forms of constructions is not mandatory. The design team will determine the particular constructions during the detailed design stage (to be finalised prior to Construction Certificate), however based on previous projects it is anticipated that internal partitions around sole occupancy units will likely be a combination of concrete columns with Hebel and Stud (or plasterboard) partitions.

In respect of floors, isolated tiled floors in bathrooms would be capable of achieving the nominated ratings, given that they would have a suspended ceiling with large void below (for transfer of waste piping). In habitable areas, if apartments have set concrete soffits (i.e. no suspended ceiling) likely finishes (assuming column construction) would be floating timber floor on 5mm Regupol or similar, or a hybrid plank system with integrated underlay.

9 Construction noise assessment

This section presents the assessment criteria framework for construction noise, along with an in-principle assessment of construction activities based on typical methodologies, and an outline of noise management strategies to be employed during excavation and construction. This assessment will need to be refined into a detailed Excavation and Construction Management Plan after appointment of the builder, to take account of the specific equipment, methodologies and schedules proposed.

9.1 Environmental Protection Authority's Construction Noise Guidelines

The Environmental Protection Authority (EPA) released its Interim Construction Noise Guideline (ICNG) in 2009. This document is being referred to as EPA's standard policy for assessing construction noise on new projects.

The key components of the ICNG that can be incorporated into this assessment include:

1. **Use of LAeq as the descriptor for measuring and assessing construction noise.**

   In recent years NSW noise policies including EPA's NSW Industrial Noise Policy (INP) and the NSW Environmental Criteria for Road Traffic Noise (ECRTN) have moved to the primary use of LAeq over any other descriptor. As an energy average, LAeq provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the LA10 descriptor.

   Consistent with the latest guideline (ICNG) the use of LAeq as the key descriptor for measuring and assessing construction noise may follow a 'best practice' approach.

2. **Application of feasible and reasonable noise mitigation measures**

   As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

   Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects, including the cost of the measure.

3. **Quantitative and qualitative assessment**

   The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

   A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

   A qualitative assessment is recommended for small projects with a short-term duration where works are not likely to affect an individual or sensitive land use for more than three weeks in total. It focuses on minimising noise disturbance through the implementation of feasible and reasonable work practices, and community notification.

   Given the significant scale of the construction works proposed for this Project, a quantitative assessment is carried out herein, consistent with the ICNG's requirements.

4. Management Levels

Residences

Table 19 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied. The guideline intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 19 | Noise at residences using quantitative assessment

Time of Day	Management Level $L_{Aeq\ (15\ min)}$*	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside recommended standard hours	Noise affected RBL + 5dB(A)	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Based on the results of the noise monitoring near the site (previously done by others), Table 20 presents the construction noise management levels during standard construction hours.

Table 20 | Noise Affected Noise Management Levels - Standard Construction Hours

Receiver	RBL, L_{A90} Day (7am - 6pm)	Noise Management Level, $L_{Aeq(15min)}$
R2 residences to the South	42	RBL + 10 = 52

Sensitive Land Use

Table 21 below (reproduced from Table 2 of the ICNG) sets out the noise management levels for various sensitive land use developments.

Table 21 | Noise at other sensitive land uses using quantitative assessment

Land use	Management level, LAeq (15 min) – applies when land use is being utilised
Classrooms at schools and other educational institutions	Internal noise level - 45 dB(A)
Hospital wards and operating theatres	Internal noise level - 45 dB(A)

Places of worship	Internal noise level - 45 dB(A)
Active recreation areas	External noise level - 65 dB(A)
Passive recreation areas	External noise level - 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the 'maximum' internal levels in AS2107 for specific uses.

The nearest sensitive receivers are the Lance Yorke Oval (Active Recreation).

9.2 Construction source noise levels

This section presents a preliminary assessment of noise emissions from the construction stage, based on typical methodologies and equipment. A detailed assessment of construction noise will need to be undertaken during detailed design with input from the builder when there is more certainty on the equipment and methodologies that will be used to construct the building.

Table 22 | Typical construction equipment & sound power levels, dB(A) re 1pW

Plant item	Plant description	Sound power levels
Demolition, Excavation and Piling		
1.	Concrete saw	120*
2.	Excavator with hammer	120*
3.	Excavator with bucket	108
4.	Piling drilling rig	111
5.	Truck – cement mixer	108
6.	Concrete pump	102
7.	Concrete vibrator	100
8.	Bobcat	102

9.	Dump Truck	108
Construction		
10.	Powered hand tools	110*
11.	Delivery trucks	106
12.	Truck – cement mixer	108
13.	Cherry picker	102
14.	Concrete pump	105
15.	Concrete vibrator	100
16.	Tower Crane (Diesel)	105
17.	Air compressor - silenced	95

*Inclusive of 5dB(A) penalty for tonality/impulsiveness.

9.3 Predicted Noise Levels

Noise levels at any receiver location resulting from construction works would depend on the location of the receiver with respect to the area of construction, shielding from intervening topography and structures, and the type and duration of construction being undertaken. Furthermore, noise levels at receivers would vary significantly over the total construction program due to the transient nature and large range of plant and equipment that could be used.

Table 23 overleaf presents noise levels likely to be experienced at the nearby affected receivers based on the construction activities and plant and equipment associated with the proposed site. Levels are presented when the plant is located on both the far side of the site and the near side of the site (relative to the receiver) i.e. Near side is adjacent to the East boundary, whilst far side relates to the Western boundary.

Noise levels were calculated taking into consideration the distance between the construction works and the receiver locations but intervening structures have not been included in this preliminary study as there are none.

Predicted noise levels and assessment with reference to noise emission criteria is presented overleaf.

Table 23 | Predicted $L_{Aeq(15min)}$ noise levels for typical construction plant, Standard construction hours, Soccer receivers to East

Plant item	Plant description	Noise Management Level, $L_{Aeq(15min)}$	Predicted Construction Noise Levels, $L_{Aeq(15min)}$; Far side – Near Side
Demolition, Excavation and Piling			
1.	Concrete saw	51	90-102
2.	Excavator with hammer	51	84-102
3.	Excavator with bucket	51	72-90
4.	Piling drilling rig	51	75-93
5.	Truck – cement mixer	51	72-90
6.	Concrete pump	51	66-84
7.	Concrete vibrator	51	64-82
8.	Bobcat	51	66-84
9.	Dump Truck	51	72-90
Construction			
10.	Powered hand tools	51	74-92
11.	Delivery trucks	51	70-88
12.	Truck – cement mixer	51	72-90
13.	Cherry picker	51	66-84
14.	Concrete pump	51	69-87
15.	Concrete vibrator	51	64-82
16.	Tower Crane (Diesel)	51	69-87
17.	Air compressor - silenced	51	59-77

The predictions on the previous page show that all equipment working on the near side (3m from receiver) would result in the receivers being Highly Affected. On that basis, in accordance with the Interim Construction Noise Guideline, the builder should apply feasible and reasonable work practices to reduce the construction noise to the receivers, such as those outlined in Section 9.4. In addition, the detailed construction noise management plan (prepared after approval, with input from the building contractor on their methodologies, schedules, and equipment) should consider consultation with the Highly Affected receivers to determine less sensitive periods for noisy works and the consideration of respite periods (without that resulting in unreasonable extension of the construction period).

9.4 General noise management measures

The following general noise management measures are recommended for all receiver locations:

- Use less noisy plant and equipment, where feasible and reasonable.
- Plant and equipment must be properly maintained.
- Strategically position plant on site to reduce the emission of noise to the surrounding neighbourhood and to site personnel where feasible and reasonable.
- Avoid any unnecessary noise when carrying out manual operations and when operating plant.
- Any equipment not in use for extended periods during construction work must be switched off.
- Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be limited/avoided where possible.
- The offset distance between noisy plant and adjacent sensitive receivers is to be maximised where practicable.
- Plant used intermittently to be throttled down or shut down when not in use where practicable.
- Noise-emitting plant to be directed away from sensitive receivers where possible.
- Staging of construction works so as to erect solid external walls first and utilising them to provide noise shielding to the noise sensitive receivers. However, the structural integrity of the external walls should be investigated prior to implementing this measure and should be prioritised over the noise benefits.
- In addition to the noise mitigation measures outlined above, a management procedure will need to be put in place to deal with noise complaints that may arise from construction activities. Each complaint will need to be investigated and appropriate noise amelioration measures put in place to mitigate future occurrences, where the noise in question is in excess of allowable limits.

- Good relations with people living and working in the vicinity of a construction site should be established at the beginning of a project and be maintained throughout the project, as this is of paramount importance. Keeping people informed of progress and taking complaints seriously and dealing with them expeditiously is critical. The person selected to liaise with the community must be adequately trained and experienced in such matters.

10 Construction Vibration

This section presents the assessment criteria applicable to construction vibration, along with an in-principle assessment of vibration impacts from construction activities based on typical methodologies, and an outline of noise management strategies to be employed during excavation and construction. This assessment will need to be refined into a detailed Excavation and Construction Management Plan after appointment of the builder, to take account of the specific equipment, methodologies and schedules proposed.

Construction vibration is associated with three main types of impact:

- disturbance to building occupants;
- potential damage to buildings; and
- potential damage to sensitive equipment in a building.

Generally, if disturbance to building occupants is controlled, there is limited potential for structural damage to buildings. Vibration amplitude may be measured as displacement, velocity, or acceleration.

- Displacement (x) measurement is the distance or amplitude displaced from a resting position. The International System of Units (SI unit) for distance is the metre (m), although common industrial standards include mm.
- Velocity ($v=\Delta x/\Delta t$) is the rate of change of displacement with respect to change in time. The SI unit for velocity is metres per second (m/s), although common industrial standards include mm/s. The Peak Particle Velocity (PPV) is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis (x, y, and z) then the resultant PPV is the vector sum (i.e. the square root of the summed squares of the maximum velocities) regardless of when in the time history those occur.
- Acceleration ($a=\Delta v/\Delta t$) is the rate of change of velocity with respect to change in time. The SI unit for acceleration is metres per second squared (m/s2). Construction vibration goals are summarised below.

Construction vibration goals are summarised in the following sections.

10.1 Disturbance to Buildings Occupants

Assessment of potential disturbance from vibration on human occupants of buildings is made in accordance with the DECC '*Assessing Vibration; a technical guideline*' (DECC, 2006). The guideline provides criteria which are based on the British Standard BS 6472-1992 '*Evaluation of human exposure to vibration in buildings (1-80Hz)*'. Sources of vibration

are defined as either 'Continuous', 'Impulsive' or 'Intermittent'. Table 24 provides definitions and examples of each type of vibration.

Table 24 | Types of vibration

Type of vibration	Definition	Examples
Continuous vibration	Continues uninterrupted for a defined period (usually throughout the day-time and/or night-time)	Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).
Impulsive vibration	A rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.
Intermittent vibration	Can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer, this would be assessed against impulsive vibration criteria.

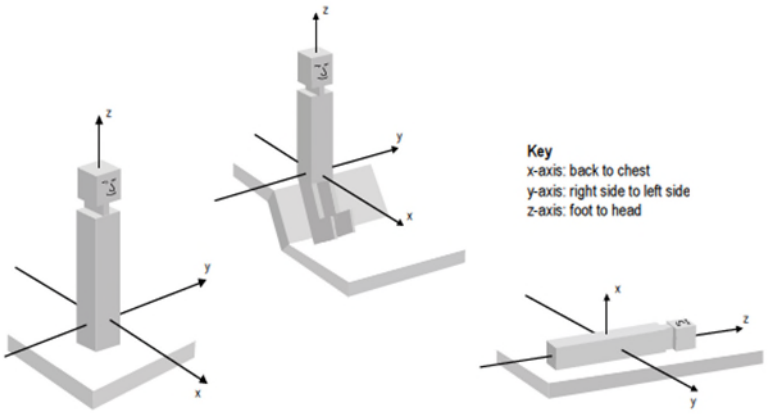
Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

The vibration criteria are defined as a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

> *'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'*

When applying the criteria, it is important to note that the three directional axes are referenced to the human body, i.e. x-axis (back to chest), y-axis (right side to left side) or z-axis (foot to head). Vibration may enter the body along different orthogonal axes and affect it in different ways. Therefore, application of the criteria requires consideration of the position of the people being assessed, as illustrated in Figure 6. For example, vibration measured in the horizontal plane is compared with x- and y-axis criteria if the concern is for people in an upright position, or with the y- and z- axis criteria if the concern is for people in the lateral position.

Figure 6: Orthogonal axes for human exposure to vibration



The preferred and maximum values for continuous and impulsive vibration are defined in Table 2.2 of the guideline and are reproduced in Table 25.

Table 25 | Preferred and maximum levels for human comfort

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020	0.014	0.040	0.028
Workshops	Day- or night-time	0.04	0.029	0.080	0.058
Impulsive vibration (weighted RMS acceleration, m/s^2, 1-80Hz)					
Critical areas[2]	Day- or night-time	0.005	0.0036	0.010	0.0072
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14

Offices, schools, educational institutions and places of worship	Day- or night-time	0.64	0.46	1.28	0.92
Workshops	Day- or night-time	0.64	0.46	1.28	0.92

Notes:
6. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
7. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above. Stipulation of such criteria is outside the scope of their policy and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472-1992

The acceptable vibration dose values (VDV) for intermittent vibration are defined in Table 2.4 of the guideline and are reproduced in Table 26

Table 26 | Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night-time[1]	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:
8. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
9. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous of impulsive criteria for critical areas. Source: BS 6472-1992

10.2 Building Structural Damage

Potential structural damage of buildings as a result of vibration is typically managed by ensuring vibration induced into the structure does not exceed certain limits and standards, such as British Standard 7385 Part 2 and German Standard DIN4150-3. Currently there is no existing Australian Standard for assessment of structural building damage caused by vibration energy.

It is noted that vibration levels required to cause minor cosmetic damage are typically 10 x higher than levels that will cause disturbance to building occupants. Many building occupants assume that building damage is occurring when they feel vibration or observe rattling of loose objects, however the level of vibration at which people perceive vibration or at which loose objects may rattle is far lower than vibration levels that can cause damage to structures.

Within British Standard 7385 Part 1: 1990, different levels of structural damage are defined:

- *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 mortar joints of brick/concrete block construction.*
- *Minor - The formation of large cracks or loosening of plaster or drywall surfaces, or cracks through bricks/concrete blocks.*
- *Major - Damage to structural elements of the building, cracks in supporting columns, loosening of joints, splaying of masonry cracks, etc.*

The vibration limits in Table 1 of British Standard 7385 Part 2 (1993) are for the protection against cosmetic damage, however guidance on limits for minor and major damage is provided in Section 7.4.2 of the Standard:

> *7.4.2 Guide values for transient vibration relating to cosmetic damage*
>
> *Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.*
>
> *Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.*

Within DIN4150-3, damage is defined as "*any permanent consequence of an action that reduces the serviceability of a structure or one of its components"* (p.4). The Standard also outlines:

> *"For buildings as in lines 2 and 3 of Tables 1, 4 or B.1, the serviceability is considered to have been reduced if, for example*
>
> - *cracks form in plastered or rendered surfaces of walls;*
> - *existing cracks in a structure are enlarged;*
> - *partitions become detached from load-bearing walls or floor slabs.*
>
> *These effects are deemed 'minor damage. " (DIN4150.3:2016, p.6)*

While the DIN Standard defines the above damage as 'minor', based on the definitions provided in BS7385, the DIN standard is considered to deal with cosmetic issues rather than major structural failures.

British Standard

British Standard 7385: Part 2 '*Evaluation and measurement of vibration in buildings*', can be used as a guide to assess the likelihood of building damage from ground vibration. BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur.

The cosmetic damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for certain particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

BS7385 is based on peak particle velocity and specifies damage criteria for frequencies within the range 4Hz to 250Hz, being the range usually encountered in buildings. At frequencies below 4Hz, a maximum displacement value is recommended. The values set in the Standard relate to transient vibrations and to low-rise buildings. Continuous vibration can give rise to dynamic magnifications due to resonances and may need to be reduced by up to 50%. Table 27 sets out the BS7385 criteria for cosmetic, minor and major damage.

Regarding heritage buildings, British Standard 7385 Part 2 (1993) notes that "*a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive*" (p.5).

Table 27 | BS 7385 structural damage criteria

Group	Type of structure	Damage level	Peak component particle velocity, mm/s		
			4Hz to 15Hz	15Hz to 40Hz	40Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	Cosmetic	50		
		Minor*	100		
		Major*	200		
2	Un-reinforced or light framed structures Residential or light commercial type buildings	Cosmetic	15 to 20	20 to 50	50
		Minor*	30 to 40	40 to 100	100
		Major*	60 to 80	80 to 200	200

Notes: Peak Component Particle Velocity is the maximum Peak particle velocity in any one direction (x, y, z) as measured by a tri-axial vibration transducer.

* Minor and major damage criteria established based on British Standard 7385 Part 2 (1993) Section 7.4.2

German Standard

German Standard DIN 4150 - Part 3 (2016) '*Vibration in buildings - Effects on Structures'* (DIN 4150-3:2016), also provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are generally recognised to be conservative.

DIN 4150-3:2016 presents the recommended maximum limits over a range of frequencies (Hz), measured at the foundations, in the plane of the uppermost floor of a building or structure or vertically on floor slabs. The vibration limits at the foundations increase as the frequency content of the vibration increases. The criteria are presented in Table 28.

Table 28 | DIN 4150-3:2016 structural damage criteria

Group	Type of structure	Vibration velocity, mm/s				
		At foundation in all directions at frequency of			Plane of floor uppermost storey in horizontal direction	Floor slabs, vertical direction
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that because of their particular sensitivity to vibration, cannot be classified under Groups 1 and 2 and are of great intrinsic value (eg listed buildings)	3	3 to 8	8 to 10	8	20

10.3 Damage to vibration sensitive equipment

Some high technology manufacturing facilities, hospitals and laboratories utilise equipment that is highly sensitive and susceptible to vibration, for example scanning electron microscopes and micro-electronic manufacturing facilities. In

addition, buildings housing sensitive computer or telecommunications equipment may require assessment against stricter criteria than those nominated for building damage.

Given that the adjacent premises are dwelling houses, it is highly unlikely any would contain vibration sensitive equipment.

10.4 Damage to buried services

Section 5.3 of DIN 4150-3:2016 also sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values, which apply at the wall of the pipe, are reproduced and presented in Table 29below.

Table 29 |: DIN 4150-3:2016 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Line	Pipe Material	Guideline values for vibration velocity measured at the pipe, mm/s
1	Steel, welded	100
2	Vitrified clay, concrete, reinforced concrete, prestressed concrete, metal (with or without flange)	80
3	Masonry, plastics	50
Note:	For gas and water supply pipes within 2 m of buildings, the levels given in Table 27 | BS 7385 structural damage criteria should be applied. Consideration must also be given to pipe junctions with the building structure as potential significant changes in mechanical loads on the pipe must be considered.	

For long-term vibration the guideline levels presented in Table 29 should be halved.

Recommended vibration goals for electrical cables and telecommunication services such as fibre optic cables range from between 50 mm/s and 100 mm/s. It is noted however that although the cables may sustain these vibration levels, the services they are connected to, such as transformers and switch blocks, may not. It is recommended that should such equipment be encountered during the construction process an individual vibration assessment should be carried out. This may include a specific CNVIS addressing impact on the utility and consultation with the utility provider to confirm specific vibration requirements.

10.5 Construction vibration assessment

The vibration generated from construction works will vary depending on the level and type of activity carried out at each site during each activity.

Potential vibration generated at receivers for this project will be dependent on separation distances, the intervening soil and rock strata, dominant frequencies of vibration and the receiver building's construction and structure. The recommended minimum working distances for vibration intensive plant are presented in Table 30, however these should be verified with site measurements

Table 30 | Recommended minimum working distances for vibration intensive equipment

Plant item	Minimum working distance, m			
	Cosmetic damage			Human disturbance
	Commercial and industrial buildings[1]	Dwellings and similar structures[1]	Sensitive structures (e.g. heritage)[1]	Residences Day[2]
Pneumatic Hammer	5-10	10	20	10
Bored Piling	5	5	10	10

Notes: 1. Criteria referenced from DIN 4150 Structural Damage - Safe Limits for Short-term Building Vibration.

2. Daytime is 7 am to 10 pm;

Site specific buffer distances for vibration significant plant items must be measured on site where plant and equipment is likely to operate close to or within the minimum working distances for cosmetic damage.

Unlike noise, vibration from construction activities is difficult to predict due to many variables from site to site, for example soil type and conditions; sub surface rock; building types and foundations; and actual plant on site. The data relied upon in this assessment (tabulated above) is taken from a database of vibration levels measured at various sites or obtained from other sources (eg. BS5228-2:2009). They are not specific to this project as final vibration levels are dependent on many factors including the actual plant used, its operation and the intervening geology between the activity and the receiver.

Some neighbouring residential receiver dwellings are within the safe working distances (R2 residential receivers to the south, which have not yet commenced construction) and so on site measurements will be required prior to/at the commencement of work to determine the site specific vibration impacts.

Whilst this in-principle assessment has shown that subject to management controls and results of attended measurements, vibration impacts can be managed in accordance with the relevant standards. A refined construction vibration management plan will need to be prepared as part of the detailed design phase, after appointment of the builder, when the methodologies and equipment are known (at this point they can only be assumed based on typical activities).

11 Conclusion

Renzo Tonin & Associates have completed an assessment of the potential noise impacts to and from the proposed residential flat buildings at Lot 67 and Lot 68 Myall Road, Garden Suburb.

Compliance with the T&ISEPP and ISEPP Guideline are mandatory and the criteria have been set. The in-principle treatments for compliance (such as glazing and external building shell recommendations) have been made in Section 6.2 above. The acoustic treatments will need to be confirmed during detailed design with input from the relevant subcontractors.

Recommendations to comply with noise emission criteria for the site, including in-principle treatments for mechanical plant (including vibration isolation for reciprocating plant), have been presented in Section 7.2.2 of this report. The in-principle assessment was based on preliminary layouts provided by the Building Services Consultant (Meinhardt). Whilst selections have not been provided, selections could also change during detailed design (due to design progression, procurement etc), and so a review of noise emissions and refinement of treatments will be required prior to construction certificate.

Ratings are nominated for the internal acoustic separation within the building in Section 8 based on the current NCC 2022. Treatments for compliance will be refined during detailed design but is readily achievable.

Guidelines for the management of construction noise and vibration have been outlined and an in-principle assessment of construction noise and vibration was undertaken. Management of construction noise and vibration within the proposed framework is feasible, subject to review prior to construction, with input from the builder on methodologies, placement of items, schedules and so on.

In conclusion, the proposed site is capable of complying with all relevant acoustic criteria through some standard and other specialised acoustic treatment and management, including the following:

- Upgraded glazing, external wall construction, and provision of alternative ventilation to mitigate ingress of road traffic noise, for the amenity of future residents. Refer Section 6.2 for treatments.
- The upgraded glazing and ventilation proposed for traffic noise control will also assist with mitigating noise from soccer being played on the adjacent fields for compliance with the proposed screening test.
- Use of acoustic treatments such as acoustic silencers, screens, vibration isolation and lined ductwork for the treatment of mechanical plant and equipment.
- Internal acoustic separation of apartments generally in accordance with the NCC, except for floor impact where a better rating is proposed between habitable rooms for acoustic amenity.