23-47 Villiers Street, North Melbourne

Acoustic Report for Town Planning Application

Volta Acoustics

ABN 34 664 446 628
Level 11, 470 Collins St
Melbourne VIC 3000
Wurundjeri Country
voltaacoustics.com.au

Document Control

Project	23-47 Villiers Street, North Melbourne
Prepared for	Sentinel BTR Manager Pty Ltd
Prepared by	Volta Acoustics Pty Ltd Level 11, 470 Collins Street Melbourne, VIC, 3000 Wurundjeri Country
Project No.	P23071
Revision	01
Date	28/08/2024

Revision	Date	Comment	Author	Reviewer
01	28/08/24	TP Issue.	LW	DCC

Australia is home to the oldest continuing living culture on earth. Volta Acoustics acknowledges that this project will take place on Indigenous land, and we wish to recognise them as the Traditional Owners of this land.

Table of Contents

1_Introduction

1.1 Purpose

Volta Acoustics have been engaged by Sentinel to provide acoustic engineering services for the proposed residential BTR development located at 23-47 Villiers Street, North Melbourne.

The purpose of this report is to identify the acoustic design criteria and regulatory requirements applicable to the project, to provide preliminary recommendations to achieve the identified criteria, and to assist the town planning application.

1.2 Reference Documents

The following documentation has been considered during the preparation of Town Planning Application acoustic report:

- Environment Protection Regulations (EPR) 2021, S.R. No 47/2021.
- EPA Victoria Publication 1826.4 "*Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*". (1st July 2021).
- Australian Standard AS 2021:2015 Acoustics - Aircraft Noise Intrusion - Building Siting and Construction, March 2015.
- EPA Victoria Publication 1254.2 "*Noise control guidelines*".
- Architectural drawings set– Architectus dated 28th August 2024.

2_Project Overview

2.3 Project Description

The subject site is situated on a 6,528m2 plot located at the current address of 23-47 Villiers Street, North Melbourne. The development comprises two multi-storeys residential BTR buildings (i.e. Building A and Building B), including the following arrangement:

Building A – Villiers St

- Basement – car parking and storage.
- Lower Ground 2 – car parking and storage.
- Lower Ground 1 – staff car parking, waste room, storage, communal amenities, bike storage and apartments.
- Ground – vehicle access, car parking, storage, services, residential lobby, leasing office and apartments.
- Level 1 – apartments, communal amenities including a yoga studio, movie and music room and services.
- Level 2 – Apartments
- Level 3 to Level 10 Apartments
- Roof level – Rooftop services

Building B – Harcourt St

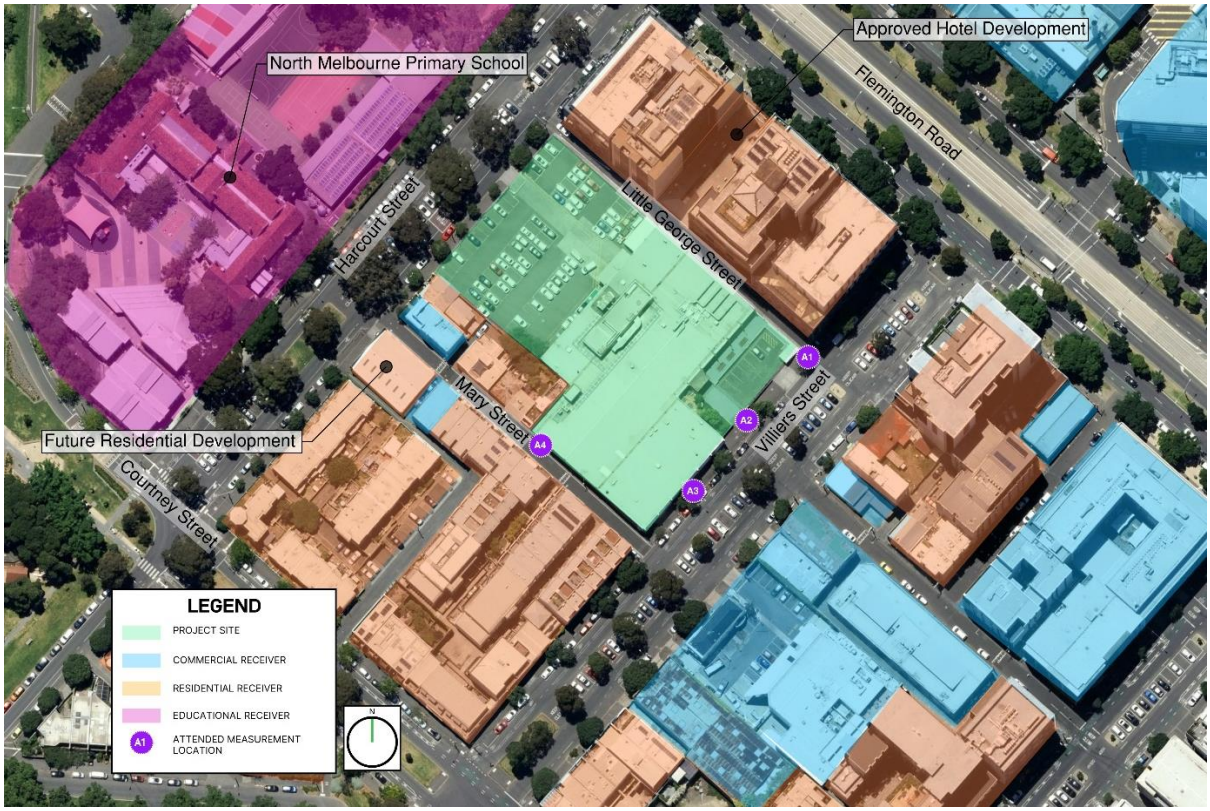
- Basement – Carparks, storage, pump rooms and services rooms
- Lower Ground 2 – apartments, car parking, storage, and plant room below.
- Lower Ground 1 – vehicle access, loading bay, waste room, services including the main switch room and substation, residential lobby, bike storage, communal amenities and apartments.
- Level 1 – apartments, communal amenities including gym and resident lounge and services including pool plant.
- Level 2 – Pool, roof terrace, apartments.
- Level 3 to Level 10 Apartments
- Roof level – Rooftop services

2.4 Site Location

Figure 1 below shows the project site (in green) and surrounding environment. Features of particular note for consideration include:

North:	North Melbourne Primary School across Harcourt Street.
East:	Multi-storey residential, student accommodation buildings, across the Little George Street.
South:	A mix of commercial and multi-storey residential buildings across Villiers Street.
West:	A mix of commercial and residential buildings.

Figure 1: Subject site and surrounds



Source: Google Earth & Volta Acoustics

2.5 Nearest Noise Sensitive Area

The subject site is mainly surrounded by residential receivers. The assessment will consider all nearby sensitive areas as summarised in the above section. Particularly, attention will be given to the residential apartment buildings situated along Little George Street, where apartments align in elevation with the rooftop plant area of the proposed development.

2.6 Key Acoustic Considerations

Environmental noise emission

- Loading dock operations: Efforts should be made to regulate the noise generated by the loading dock entrance on Little George Street. Guidance on mitigating noise impact from loading dock operations, truck deliveries, and waste removal activities affecting residential areas can be found in EPA Victoria Publication 1254.2. Refer to Section 4.2.3 and Section 4.2.4 for details.
- Mechanical plant located on the rooftop, substation and carpark entry door: Once more details about the final equipment selection are provided, special attention will be given to manage the noise impact from commercial equipment on nearby residential areas. Refer to Section 4.2.1 and Section 4.2.2 for more details. For further guidance on noise mitigation strategies, acoustic advice is offered in Section 5.1.
- Leasing office: Noise emission associated with the leasing office within the ground floor of the development is anticipated to be relatively minor compared to the primary residential areas, given its smaller scale. As such, it poses minimal risk of disturbing nearby residential dwellings. Nonetheless, any noise arising from this tenancy should be thoroughly evaluated during the later stages of the design process.
- Swimming pool: The assessment of patron noise will be conducted in subsequent design phases to guarantee minimal disturbance to the residents of the development. In addition, EPR2021 delineates prohibited times for operating swimming pool equipment. Given that the pool plant is proposed to be housed within the building, mitigating noise impact on the surroundings can be effectively managed through facade design strategies.

External noise intrusion

The proposed development is impacted by noise from the following major sources in the surrounding environments:

- Distant traffic noise from Flemington Road.
- Local traffic noise from Harcourt Street and Villiers Street.
- Mechanical noise from nearby commercial premises.
- Tram noise on Flemington Road. It is understood Tram No. 58 and No. 59 operate on this road.

To ensure optimal internal comfort, the acoustic design of the development's facade must effectively mitigate each of these noise sources. Helicopter noise has not been factored into the acoustic assessment as there is no requirement to do so under the Melbourne Planning Scheme.

Internal noise criteria applicable to the development are provided in Section 4.3. An assessment of external noise intrusion and initial recommendations for the building envelope acoustic performance is provided in Section 5.2.1.

3_Noise Survey

An environmental noise survey was conducted by Volta Acoustics (VA) around the proposed development site. The purpose of the noise survey was to determine the existing ambient noise, impact from traffic and rail activity, and background noise levels present at the site.

Attended measurements were conducted on the following dates:

- Attended: 8th February 27th February and 5th March 2024.

The measurement results have been used to establish the environmental noise emission criteria and aid in determining required building envelope acoustic performance to protect future amenity. Measurement results are provided in Section 3.3 of this report.

3.1 Equipment

The following equipment was used for the noise survey:

- NTI XL3 Sound Level Meter, S/N A3A-00549-D1.
- Pulsar Acoustic Calibrator, Model 105, S/N 100360.

A calibration check was performed before and after each measurement set, and no significant drift was observed.

3.2 Measurement locations

Noise measurements were conducted at the locations presented in Figure 1 and correspond to:

A1: Intersection of Villiers Street and Little George Street.

A2: East façade of the development, on the curb of Villiers Street.

A3: East façade of the development, on the curb of Villiers Street.

A4: Mary Street, shielded from traffic on Flemington Road.

3.3 Attended Noise Survey Results

Attended (short-term) noise measurements were conducted at the development site to evaluate the noise environment surrounding the development.

The results of the measurements, including ambient (L_{Aeq}), maximum ($L_{Amax,F}$) , traffic (L_{A10})and background (L_{A90}) noise levels, are presented in Table 1 below.

Table 1: Summary of Measured Attended Ambient (L_{Aeq}), Maximum ($L_{Amax,F}$), traffic (L_{A10}) and Background (L_{A90}) Noise Levels.

Location	Date & Time	Duration mm:ss	Recorded Noise Level - dB			
			$L_{Aeq,t}$	L_{AFmax}	$L_{A90,t}$	$L_{A10,t}$
A3	08/02/2024 01:42	10:00	51	74	45	49
	08/02/2024 01:52	10:00	47	60	45	49
	27/02/2024 12:20	10:00	54	70	49	56
	27/02/2024 12:30	10:00	55	70	48	58
	05/03/2024 20:32	14:47	54	68	49	57
A2	05/03/2024 20:18	06:03	54	73	51	56
A1	05/03/2024 20:25	05:12	58	70	53	62
A4	05/03/2024 20:51	05:00	53	67	46	55

4_Criteria, Legislation & Guidelines

4.1 Melbourne Planning Scheme

The relevant information pertaining to the subject site in accordance with Clause 58.04-3 is outlined below:

'Objectives:

To contain noise sources in developments that may affect existing dwellings or small second dwellings.

To protect residents from external and internal noise sources.

Standard:

Noise sources, such as mechanical plants should not be located near bedrooms of immediately adjacent existing dwellings or small second dwellings.

The layout of new dwellings and buildings should minimise noise transmission within the site.

Noise sensitive rooms (such as living areas and bedrooms) should be located to avoid noise impacts from mechanical plants, lifts, building services, non-residential uses, car parking, communal areas and other dwellings.

New dwellings should be designed and constructed to include acoustic attenuation measures to reduce noise levels from off-site noise sources.'

The standard has been taken into account and addressed in the following sections:

- Noise emissions from the site must be controlled and adhere to EPA noise limits. Details are provided in Section 4.2 and acoustic recommendations are made in Section 5.1.
- Façade design will address noise impacts on residents, with further details outlined in Section 4.3 and Section 5.2.

4.2 Noise Emission from Site

4.2.1. Noise from commercial operators

Within Victoria, noise emissions from commercial premises are governed by the Victorian EPA Environment Protection Regulations (EPR) 2021 and supporting Publication 1826.4 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues* (Noise Protocol).

The Noise Protocol prescribes procedures for determining the statutory environmental noise limits which apply at noise sensitive locations, such as residential areas. The assessment of site noise emission limits contained in this section has been carried out in accordance with the Noise Protocol procedures.

Operating time periods applicable to noise emission limits are defined in the EPR (Part 5.3, Division 3, Regulation 116) in relation to noise emitted from commercial, industrial and trade premises. These periods are reproduced below:

Table 2: Time periods for commercial noise limits – commercial, industrial and trade premises

Period	Applicable Days	Applicable Times
Day	Monday to Saturday (except public holidays)	07:00 to 18:00
Evening	Monday to Saturday	18:00 to 22:00
	Sunday and public holidays	07:00 to 22:00
Night	All days	22:00 to 07:00

The limits of permissible noise at noise sensitive areas (residential receivers) applicable to this project are outlined in Table 3 below.

Noise limits are determined in accordance with Part 1 of the Noise Protocol considering the following factors:

- The time of day (day, evening or night).

Proportions of land use for residential, industrial, and commercial uses in the immediately adjacent area (see

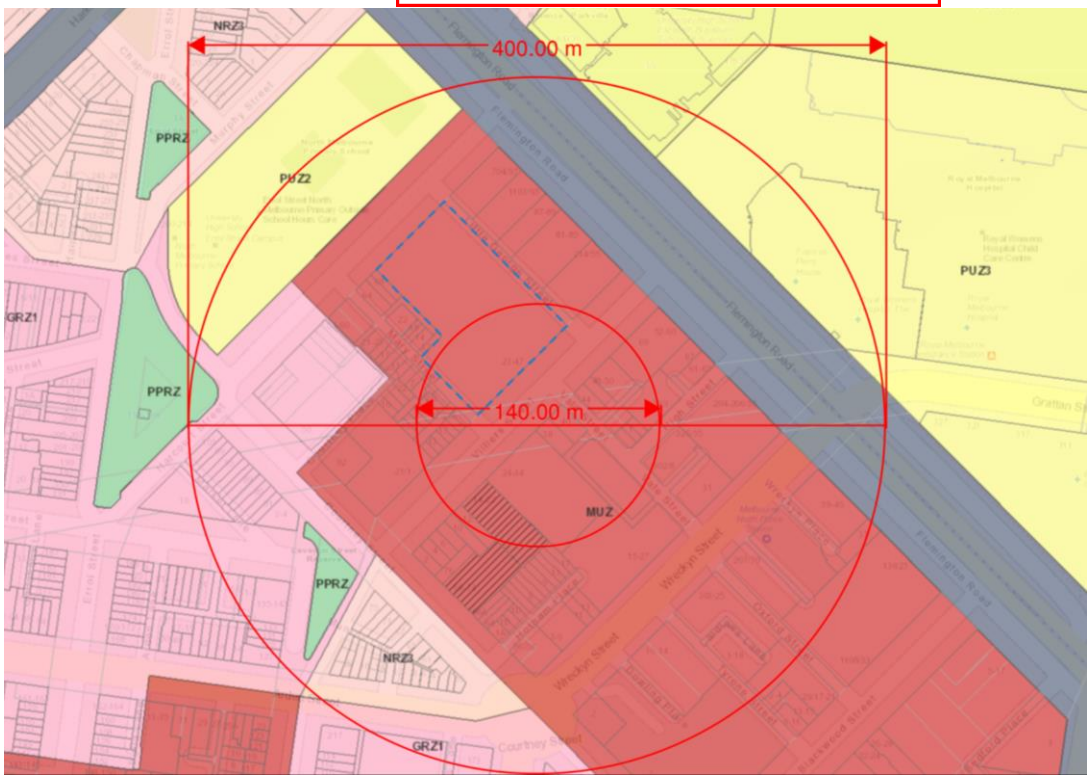
- Figure 2), for the nearest noise sensitive area (see Figure 1).
- Zoning levels (ZL's) determined in accordance with Noise Protocol Part I-A 1.1.
- Existing background noise level values measured at the nearest sensitive area. Refer to Section 3.3 for details.

Table 3: Permissible plant noise limits at nearest sensitive receivers as per EPA Noise Protocol

Period	Measured Background Level L_{A90} dB(A)	Zoning Level dB(A)	Background Category	Noise Limit[1] dB(A)
Day	48	58	'Neutral'	58
Evening	46	51	'Neutral'	51
Night	45	46	'High'	48

Note 1: For equipment solely used in relation to emergencies (e.g. fire pumps, smoke spill fans, stair pressurisation fans), the relevant noise limit applicable to the testing or maintenance this equipment is increased by 10 dB for day period and by 5 dB for evening and night periods.

Figure 2: Planning Victoria Map



Source: Planning VIC / VA

4.2.2. Noise from fixed domestic plant

Within Victoria noise emissions from domestic mechanical plant are governed by the Victorian EPA Environment Protection Regulations (EPR) 2021 and supporting Publication 1973 *Noise guideline: Assessing noise from residential equipment*.

Publication 1973 offers prohibited times when noise from residential equipment must be inaudible within a habitable room within any other residence, regardless of whether any door or window giving access to the room is open.

Prohibited Times – Heating Equipment

Prohibited times for fixed residential equipment for heating (including central heating, a hot water system or a heat pump, air conditioner or split system used for heating), the prohibited times for noise to be heard in any other residence are:

- Monday – Friday 10 pm – 7 am
- Weekends and public holidays 10 pm – 9 am

Prohibited Times – Cooling Equipment

For an air conditioner, evaporative cooler or split system used for cooling, prohibited times are:

- Monday – Friday 11 pm – 7 am
- Weekends and public holidays 11 pm – 9 am

Non-Prohibited Times

During the day and evening (non-prohibited times), it is expected that domestic plant will not present unreasonable noise emission provided it:

- does not exceed the background noise level by more than 5 dB
- is free of clearly noticeable rattles or vibrations
- is free of prominent tonal, impulsive, or intermittent noise characteristics

4.2.3. Delivery trucks / loading docks

EPA Victoria Publication 1254.2 "*Noise control guidelines*" includes the noise control guidelines for deliveries to shops and similar commercial properties when there is the risk of impact to residential premises.

Appropriate deliveries schedules as per EPA's guidelines are presented in Table 4 below. It is suggested that deliveries follow the guideline schedules to limit impact to adjacent residential premises.

Table 4: Schedule for deliveries affecting residential premises

General deliveries[1]	
Monday to Saturday	7am to 10pm
Sundays and public holidays	9am to 10pm
Deliveries with truck-mounted refrigeration units	
Monday to Saturday	7am to 10pm
Sundays and public holidays	9am to 10pm

Note 1: All ancillary motors or trucks should be turned off whilst making the delivery.

4.2.4. Waste removal

EPA Victoria Publication 1254.2 "*Noise control guidelines*" includes noise control guidelines for industrial and domestic waste collection when there is the risk to impact residential premises. Annoyance created by waste collection tends to intensify in the early-morning period (i.e., before 7 am).

Where a residential area is impacted by noise from the collection of refuse, then the guideline suggests that collections be restricted to the times contained within the schedule in Table 5.

Table 5: Schedule for garbage trucks (industrial / commercial collection).

Collections per week	Days	Industrial / Commercial Waste	Domestic / Residential Waste
1	Monday to Saturday	6:30am to 8pm	6am to 6pm
	Sundays and public holidays	9am to 8pm	N/A
≥2	Monday to Saturday	7am to 8pm	7am to 6pm
	Sundays and public holidays	9am to 8pm	N/A

Collection of commercial refuse should also follow the following guidelines:

- Refuse bins should be located within the site at locations that minimise the likelihood of noise impacts to residential premises.
- Compaction should be carried out while the vehicle is moving.
- Bottles should not be broken up at collection site.
- Noisy verbal communication between operators should be avoided where possible.

4.2.5. Swimming pool

The Environment Protection Regulations 2021 (EPR2021) address various sources of noise, specifying prohibited times for noise emissions from these designated sources.

Noise is deemed unreasonable if it occurs during these prohibited hours and is audible to occupants in habitable rooms of neighbouring residences.

For swimming pool, spa or water pumps except when used to fill a heat tank.

- Monday to Friday before 7 am and after 10 pm.

4.2.6. Summary of noise emission requirements for the project

Table 6 below presents a summary of plant noise emission limits for the proposed development.

Table 6: Summary of plant noise emission requirements.

Noise Source	Metric	Period	Overall Noise Limit dB(A)
Commercial uses (i.e. mechanical plant, substation)	$L_{Aeq,T}$	Day	58
	$L_{Aeq,T}$	Evening	51
	$L_{Aeq,T}$	Night	48
Domestic fixed plant (i.e. balcony condenser units)	$L_{Aeq,T}$	Day	L_{A90} + 5dB
	$L_{Aeq,T}$	Evening	L_{A90} + 5dB
	$L_{Aeq,T}$	Night	Inaudible

4.3 Internal Noise Levels – External Noise Intrusion

4.3.1. Traffic noise intrusion

Australian Standard AS/NZS 2107:2016 also provides recommended design noise levels for building interiors. These recommendations are also applicable to the project and drive internal noise design targets for spaces not addressed by the planning scheme requirements.

Design noise levels from the standard are applicable to steady and quasi-stead noise, this includes contributions from intrusive noise through the building envelope and internally generated noise from building services.

Table 7 below shows the recommended internal noise levels for various spaces within the project.

Table 7: Design Sound Levels for Difference Areas of Occupancy in Buildings – AS/NZS 2107

Type of occupancy/activity	Design sound level ($L_{Aeq,t}$) range, dB
Houses and Apartments near major roads	
Apartments common areas (e.g. amenities, foyer, lift lobby)	45 to 50
Living areas	35 to 45
Sleeping areas (night-time)	35 to 40
General office areas	40 to 45
Retail tenancies	< 50

5_Acoustic Recommendations

5.1 Environmental Noise Emission

5.1.1. Mechanical services

Commercial Plant

The noise emission limits presented in Section 4.2.1 are applicable to future mechanical plant associated with commercial uses within the proposed development. The majority of external commercial mechanical equipment is expected to be located on the rooftop level.

At this stage of the project, no mechanical equipment data is available to undertake a formal compliance assessment. Preliminary advice on the noise level of the mechanical plant area are provided below:

- The total acoustic power generated each plant room for both Tower A and Tower B should not exceed 90dBA SWL re 1pW during daytime.
- The total acoustic power generated each plant room for both Tower A and Tower B should not exceed 83dBA SWL re 1pW during evening.
- The total acoustic power generated each plant room for both Tower A and Tower B should not exceed 80dBA SWL re 1pWduring nighttime.

Detailed review and assessment of the proposed external equipment is to be undertaken once plant items and locations have been selected to ensure compliance with the applicable noise emission criteria.

In the event of predicted noise exceedance, standard mitigating noise controls which may be implemented to achieve compliance include but are not limited to:

- Infill of plant screening to present solid acoustic barriers.
- Installation of absorption elements
- Selection of quieter plant models
- Installation of attenuators and / or acoustic louvres

5.1.2. Substation

The noise emission limits presented in Section 4.2.1 are applicable to the future substation and associated ventilation equipment located on Ground level of the development, facing the Little George Street.

Substations noise emission levels are not available at the time of writing this report. A preliminary noise assessment has been undertaken with an assumed spectrum of the substation based on standard substation noise data. The nearest affected receivers are the residents to the north along the Little Goerge Street.

The assessment assumes that the substation and associated ventilation equipment may run at any time (i.e. before 7:00am) and therefore has been assessed to the most stringent noise limits (i.e. night-time limits).

To ensure compliance with the EPA Publication 1826.4 noise limits presented in Section 4.2.1 of this report, the substation and associated ventilation equipment must not exceed the value presented in Table 8 and should be free of audible tonality.

Table 8: Maximum Permissible Sound Pressure Level for Ground Level Substation.

Item	Maximum Sound Pressure Level @ 1m from substation door, dB(A)
Ground Level Substation	60

Should substation noise emission include tonal components, the presented limit in Table 8 shall be adjusted to include the applicable penalty as per Publication 1826.4.

5.1.3. Carpark entry door

The noise emission limits presented in Section 4.2.1 are applicable to the future car park motorised entry door located on Ground level of the development facing the Little George Street.

The make and model of the carpark roller door is not available for acoustic review at this early stage.

The following recommendations are made for the carpark roller door to minimise the adverse noise impacts of any operations at night, when sleep disturbance at nearby residential apartments may be of consideration:

- Roller door motor, operating mechanism for the guide rails, door panel and supports must be selected to achieve sound pressure levels not greater than 60 dB(A) measured at 1m.
- If the door impacts rigid surfaces at the ends of its travel once it is adjusted for general use, rubber sealing strips at the point of contact should be used.
- The motor, operating mechanism, and connection of any associated guide rails and the like are to be isolated from the building structure using isolation mounts such as 9mm thick, 50mm durometer rubber waffle pad with appropriate rubber isolating washers. The proposed details must be submitted to the acoustic consultant for review prior to installation.

5.2 External Noise Intrusion

To assess the noise impact from nearby road to the façade of the proposed development, a 3D noise model was prepared using commercial software suite 'CadnaA' noise modelling software (Version 2023).

The 3D model was created for the site and its surroundings. The effects of the environment (built and natural) were considered for the propagation of sound to estimate the resulting noise impact on the façade.

The calculation method used to assess the noise at the façade of the proposed development was made following CoRTN (traffic noise), and ISO 9613 (propagation) within CadnaA.

The noise model was calibrated using the noise levels captured during the noise survey, along with traffic volumes from surrounding roads.

5.2.1. Building envelope acoustic treatment

All glazing performance requirements presented in this section are based on acoustic requirements only. Structural, thermal and any other considerations will be considered during design development for the final façade glazing system (i.e. double glazing, single glazed units etc.).

Façade element sound insulation minimum requirements are provided in Table 9 along with recommended glazing arrangements considered to achieve the performance requirements.

Table 9: Required Façade Performance and recommended glazing systems.

Type	Minimum Sound Insulation Performance	Recommended Glazing System
Glazing	R_w 33	6mm glass // 12mm air gap // 6mm glass
Non-glazing	R_w50	All solid elements of the façade

Note: Glazing frame and seals are to achieve the performance of the minimum sound insulation requirements listed above.

6_Construction Noise & Vibration

As of November 2020, Publication 1254 has been superseded by Publication 1834 "Civil construction, building and demolition guide" with respect to construction noise.

The sections below outline the recommended construction site operating hours for construction noise and vibration as per recommendations in Publication 1834.

This section may be superseded by guidance provided within a future Construction Management Plan.

6.1 Construction Site Operating Hours

All noise and vibration are expected to be minimised at all times. Limiting times of operation of noisy equipment, vehicles and operations is an effective way of reducing noise and vibration. The below sections prescribe the allowed working hours for construction noise and vibration.

6.1.1. Normal Working Hours

Publication 1834 defines 'normal working hours' for commercial construction and demolition sites as:

- 7 am — 6 pm Monday to Friday
- 7 am — 1 pm Saturdays

Noise associated with works within these periods should be minimised as far as practicable.

6.1.2. Outside Normal Working Hours (Weekend/Evening Work Hours)

Publication 1834 defines 'outside normal working hours' for commercial construction and demolition sites as:

- 6 pm — 10 pm Monday to Friday
- 1 pm — 10 pm Saturdays
- 7 am — 10 pm Sundays and public holidays

Any works required to be conducted within these periods should adhere to requirements laid out in Section 4.4 of Publication 1834.

7_Conclusion

An acoustic assessment has been conducted for the proposed residential development at 23-47 Villiers Street, North Melbourne. This report provides criteria and in-principle design requirements to achieve the proposed statutory and required acoustic design criteria.

A site noise survey has been conducted to capture existing ambient and background noise levels present at the site and is presented in Section 3_ of this report.

Applicable environmental noise emission criteria for the development have been established based on measured site background noise levels and methodology laid out in EPA Publication 1826.4 as presented in Section 4.2.1 of this report.

At this stage of the project, no mechanical equipment data is available to undertake a detailed assessment. Review and assessment of the proposed external equipment is to be undertaken once plant items and locations have been finalised to ensure compliance with the applicable noise emission criteria, as presented in Section 5.1.1 of this report.

Environmental noise emission from the substation and car park entry door have been undertaken by VA to the nearby sensitive areas. Maximum sound pressure levels have been provided in Section 5.1.2 and Section 5.1.3 in order to meet the noise limits presented in Section 4.2.1.

Building envelope acoustic performance requirements have been provided to achieve design internal noise levels in accordance with recommended criteria (see Section 4.3). Performance requirements for façade glazing are presented in Section 5.2.1.

Appendix A Glossary

Ambient Noise	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Background Noise	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the LA90 noise level.
Decibel [dB]	The units of sound pressure level.
dB(A)	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Intermittent Noise	Level that drops to the background noise level several times during the period of observation.
L_{Amax}	The maximum A-weighted sound pressure level measured over a period.
L_{AFmax}	The maximum A-weighted sound pressure level measured over a period. 'F'(fast) time weighting - Sound level meter design-goal time constant which is 0.125 seconds.
L_{A90}	A-weighted, sound level just exceeded for 90% of the measurement period and calculated by statistical analysis. See also the background noise level.
$L_{Aeq,T}$	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection	Sound wave changed in direction of propagation due to a solid object met on its path.
R_w	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
Sound Pressure Level, L_p	The level of sound measured on a sound level meter and expressed in decibels (dB). Where $L_P = 10 \log10(Pa/Po)^2$ dB (or 20 log10 (Pa/ Po) dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20 x 10^{-6} Pa) for airborne sound. Lp varies with distance from a noise source.
Sound Power Level, L_w	The sound power level of a noise source is the inherent noise of the device. Therefore, sound power level does not vary with distance from the noise source or with a different acoustic environment. $L_w = L_p + 10 \log10$ 'a' dB,re: 1pW, (10-12 watts) where 'a' is the measurement noise-emission area (m^2) in a free field.