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164-194 WILLIAM STREET, WOOLLOOMOOLOO

SSDA Noise and Vibration Assessment

28 August 2025

William Street Residential Pty Ltd

TM358-04F01 SSDA Acoustic Assessment (r1)

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Executive summary

This Noise and Vibration Impact Assessment has been prepared by Renzo Tonin & Associates to accompany the proposed State Significant Development Application (SSDA) for a mixed-use infill affordable housing development at 164-172 and 174-194 William Street Woolloomooloo. The site is made up of two (2) lots. The legal description of the site is outlined in Table 1.

Table 1 - Legal Description

Property Address	Title Description
164-172 William Street, Woolloomooloo	Lot 52 in DP1049805
174-194 William Street, Woolloomooloo	Lot 1 in DP816050

This report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (SSD-80211463).

This report concludes that the proposed development is suitable and warrants approval subject to the implementation of the following mitigation measures.

- Upgraded façade treatments to protect future residents from road traffic noise from William Street and to a lesser extent Forbes and Dowling Streets, and rail noise from the Eastern Suburbs line to the North (partially screened by adjacent buildings).
- Upgraded façade and dedicated treatments for acoustically attenuated natural ventilation.
- Defining noise emission goals to neighbours for services and equipment noise (preliminary assessment of key plant items indicates compliance is feasible subject to detailed design).
- Defining construction noise and vibration management measures to be employed by the ultimate building contractors.

Following the implementation of the above mitigation measures, the remaining impacts are appropriate.

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1 Introduction

Renzo Tonin & Associates was engaged by William Street Residential Pty Ltd to undertake a Noise and Vibration Impact Assessment in accordance with the technical requirements of the Secretary's Environmental Assessment Requirements (SEARs), and in support of the State Significant Development Application (SSD-80211463) for the proposed mixed-use infill affordable housing development at 164-172 and 174-194 William Street Woolloomooloo.

Following the Design Excellence Competition, the scheme has been revised to include In-fill Affordable Housing (IAH) in line with the NSW Government's policy under the State Environmental Planning Policy (Housing) 2021 (Housing SEPP). This policy allows for a 30% increase in Floor Space Ratio (FSR) and building height when 15% of the total FSR is provided as affordable housing for 15 years. The proposed development meets these criteria and is eligible for the bonus uplift.

The purpose of the project is to facilitate the delivery of a high-quality mixed-use development containing residential and retail uses as well as a centrally located park, public domain improvements and improved through-site connectivity at a strategically located site. The proposal seeks to deliver a built form outcome that responds appropriately to its location on William Street in Woolloomooloo and in close proximity to Kings Cross Station and the Sydney CBD. Furthermore, the proposed scheme seeks to deliver an outcome that is consistent with the desired and evolving character of the Woolloomooloo and Potts Point area.

Specifically, this SSDA seeks consent for:

- 227 apartments (167 market housing, 60 affordable housing units
- Ground floor retail and commercial uses with 7 – 18 storeys of residential tower across four buildings being:

FJC - William Street (West)
FJC - William Street (East)
Studio Bright – Forbes Street
Tribe Studio – Dowling Street

- A publicly accessible central park
- Public domain works and improved through-site links
- Four basement levels for parking, services and storage
- Vehicular and loading access from Forbes Street

This report has been prepared in response to the requirements contained within SEARs dated 21 February 2025 and issued for SSD-80211463. Specifically, this report has been prepared to respond to the SEARs requirement issued below.

Table 2 - SEARs Requirements for Noise and Vibration

SEARs Item	Issue and Assessment Requirements	Section Reference (this Report)
10.	Provide a noise and vibration impact assessment prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented. Noise and Vibration Impact Assessment	This report

The SSDA seeks consent for demolition of structures, excavation and associated construction works for:

- 227 apartments (167 market housing, 60 affordable housing units)
- Ground floor retail and commercial uses with 7 – 18 storeys of residential tower across four buildings being:
    - FJC - William Street (West)
    - FJC - William Street (East)
    - Studio Bright – Forbes Street
    - Tribe Studio – Dowling Street
- A publicly accessible central park
- Public domain works and improved through-site links
- Four basement levels for parking, services and storage
- Vehicular and loading access from Forbes Street.

Fronting to William Street, there is retail on Ground, with basement store, and commercial above on Level 1. Fronting to Forbes Street, Dowling Street and the park and East-West through site link are one to two storey retail tenancies.

The development includes two North-South through site links from William Street into the publicly accessible park in the centre of the site – the western connection is covered by building above whilst the eastern link is open to the sky. The remainder of the buildings on site are proposed for residential uses. A mix of housing styles has been selected to respond to the surroundings, with terrace homes at low level in the North mirroring the neighbouring terraces in Forbes Street.

This assessment addresses:

- Goals for operational noise emissions from the Site for future assessment
- The impact of external noise (traffic, entertainment noise) on the Site and determine building shell acoustic treatments to ensure suitable levels of amenity for future occupants of the site. This includes a review of potential natural ventilation opportunities at the Site

As part of this assessment, Renzo Tonin & Associates undertook long-term unattended noise monitoring and short term noise measurements at the Site in order to examine both the traffic noise levels impacting the Site and the background noise environment (as is necessary for a study of potential noise emission). External facade treatments for control of external noise are recommended in Section 5.2 of this report to comply with the relevant acoustic criteria. All windows and exterior doors shall incorporate full perimeter acoustic seals.

Operational noise mitigation recommendations to protect nearby noise sensitive development is set out in Section 6.2 (in-principle only given the early stage of the design).

The following project architectural drawing sets were reviewed during the assessment:

- Whole of development: Architectural set for SSDA by FJC, dated 15/08/2025

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.

2 Site Description

The site is located at 164-172 and 174-194 William Street Woolloomooloo within the City of Sydney LGA. The site is comprised of multiple allotments and is legally described as:

- 164-172 William Street, Woolloomooloo (Lot 52 in DP1049805)
- 174-194 William Street, Woolloomooloo (Lot 1 in DP816050)

The land size totals 6,398m^2 and consists of a southern frontage to William Street, an eastern frontage to Dowling Street, a western frontage to Forbes Street and northern frontage to Judge Lane.

The immediate urban context surrounding the site is characterised by a mix of medium density residential, commercial, and retail uses. The site is in close proximity to Hyde Park, The Domain, and Rushcutters Bay Reserve. There are a number of educational and health services in proximity to the site, providing ample infrastructure support for the community.

William Street, to which the site fronts, is a classified road providing connection between the Eastern Suburbs of Sydney and the CBD. Vehicle access is currently provided from six points on the site from Judge Lane, Forbes Street, and Dowling Street. Pedestrian access to the site is currently available from all frontages. The main source of noise in the immediate surroundings is from road traffic on William Street. To a lesser extent there are noise impacts from the Eastern Suburbs railway line to the North.

Figure 1 - Aerial view of the subject site and surrounding receivers

3 Project description

The SSDA seeks consent for demolition of structures, excavation and associated construction works for:

- 227 apartments (167 market housing, 60 affordable housing units)
- Ground floor retail and commercial uses with 7 – 18 storeys of residential tower across four buildings being:
    - FJC - William Street (West)
    - FJC - William Street (East)
    - Studio Bright – Forbes Street
    - Tribe Studio – Dowling Street
- A publicly accessible central park
- Public domain works and improved through-site links
- Four basement levels for parking, services and storage
- Vehicular and loading access from Forbes Street.

Fronting to William Street, there is retail on Ground, with basement store, and commercial above on Level 1. Fronting to Forbes Street, Dowling Street and the East-West through site link are one to two storey retail tenancies.

The development includes two North-South through site links from William Street into the publicly accessible park in the centre of the site – the western connection is covered by building above whilst the eastern link is open to the sky. The remainder of the buildings on site are proposed for residential uses.

4 Existing Noise Environment

The noise survey conducted for the Site used data from unattended long-term noise monitors to establish the existing ambient and background noise environment.

4.1 Noise survey

4.1.1 Unattended Noise Monitors

Two long-term unattended noise monitors were installed on site:

- One noise monitor (L1) was installed on the Level 3 terrace of the existing commercial building at the corner of William Street and Forbes Street from Thursday 18th November 2021 to Thursday 25th November 2021, facing William Street. This is representative of traffic noise impacts on the William Street façade, as well as background noise for William Street residential receivers.
- One noise monitor (L2) was installed on the top floor of the Bayswater Car Rentals building on the North Eastern corner of the site, facing North. It was installed on site from the 15th of November 2021 to the 25th of November 2021. This location is representative of the noise environment of the adjacent residential receivers and of rail noise incident on the bulk of the Northern façade (which is mostly screened from direct rail noise by the existing neighbouring buildings.

The monitoring locations are depicted in Figure 1. These locations were selected as they were both secure and will provide background noise levels indicative of what would be experienced at nearby development.

The noise monitor records noise levels on a continuous basis and stores data every fifteen minutes. The noise loggers were calibrated before and after measurements and no significant deviation in calibration was noted. The noise monitoring equipment used here complies with Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and is designated as Type 2 instruments suitable for field use.

The graphical recorded output from the long term noise monitoring is included in APPENDIX E.

4.1.2 Background Noise Results

The following tables present the background and environmental noise results obtained from the unattended noise monitors. Note that noise events on the William Street location from emergency services vehicle sirens has been excluded from assessment.

Table 3: Background and ambient noise levels – Logger L1 – William Street – 18/12/21 to 25/11/21

Time of Day	Rating Background Noise Level dB(A) $L_{90\ (15min)}$	Ambient Noise Level dB(A) $L_{eq\ (15min)}$
Day (7am to 6pm)	62	71
Evening (6pm to 10pm)	60	69
Night (10pm to 7am)	49	67
Early Night Shoulder (10pm - midnight)	57	68

Table 4: Background and ambient noise levels – Logger L2 – Judge Lane 15/12/21 to 25/11/21

Time of Day	Rating Background Noise Level dB(A) $L_{90\ (15min)}$	Ambient Noise Level dB(A) $L_{eq\ (15min)}$
Day (7am to 6pm)	57	54
Evening (6pm to 10pm)	47	51
Night (10pm to 7am)	44	47
Early Night Shoulder (10pm - midnight)	45	48

4.1.3 Traffic and Rail Noise Results

The following tables present the road traffic and rail noise results obtained from the unattended noise monitors. Note that noise events on the William Street location from emergency services vehicle sirens has been excluded from assessment. The following levels include façade reflection.

Table 5: Road traffic noise levels – Logger L1 – William Street – 18/11/21 to 25/11/21

Time of Day	Period Average Noise Level dB(A) $L_{eq\ (9hour)}$ / $L_{eq\ (15hour)}$	Worst 1 hour Traffic Noise Level dB(A) $L_{eq\ (worst\ 1hour)}$
Day (7am to 10pm)	73	74
Night (10pm to 7am)	69	71

Table 6: Environmental and rail noise levels (partial screening from surrounding buildings) – Logger L2 – Judge Lane 15/12/21 to 25/11/21

Time of Day	Period Average Noise Level dB(A) $L_{eq\ (9hour)}$ / $L_{eq\ (15hour)}$	Worst 1 hour Traffic Noise Level dB(A) $L_{eq\ (worst\ 1hour)}$
Day (7am to 10pm)	56	57
Night (10pm to 7am)	50	52

4.2 Short Term Noise Measurements

In addition to long-term unattended noise monitoring, short term attended monitoring was undertaken on Forbes Street, with a direct line of site to the rail carriageway (there was no suitable safe location to install a noise monitor with a clear view of the rail line). Refer to Figure 1 for location. Attended noise measurements were made using a Type 1 sound analyser set on fast response mode.

The noise levels measured on Forbes Street are representative of the ambient noise impacts onto the proposed new residential dwellings, with full line of sight to the rail line.

4.2.1 Attended rail noise measurements

Attended noise measurements of rail passbys were undertaken on Forbes Street on the 25th of November 2021. Review of timetable has calculated the period average and worst 1 hour rail levels, assuming direct line of sight from the receiver to the rail line.

Table 7: Period Noise Levels from attended rail noise measurements at Forbes St and Judge Lane 25/11/21 - assuming direct line of sight to rail

Time of Day	Period Average Noise Level dB(A) $L_{eq\ (9hour)}$ / $L_{eq\ (15hour)}$	Worst 1 hour Rail Noise Level dB(A) $L_{eq\ (worst\ 1hour)}$
Day (7am to 10pm)	55	58
Night (10pm to 7am)	51	54

5 Noise intrusion assessment

This section addresses external noise impacts on the proposed development, being:

- Road traffic noise from William Street.
- Rail noise from the Eastern Suburbs Rail Line.
- Patron noise from outdoor dining in the lane way (East-West through site link)

5.1 Noise intrusion criteria

This section sets out target internal noise levels within new apartments. This will in turn enable the design of façade elements (glazing and fresh air ventilation) which is addressed in detail in sections 5.2, 5.3 and APPENDIX D.

The airborne noise criteria for this development are based on the following documents:

1. State Environment Planning Policy (Transport & Infrastructure) 2021 ('T&ISEPP')
2. Department of Planning (DoP) publication "*Development Near Rail Corridors & Busy Roads – Interim Guideline*" 2008 ('DoP Guideline')
3. City of Sydney Council Development Control Plan 2012 (effective 14 December 2012)
4. City of Sydney - Sydney Development Control Plan 2012 - Policy and housekeeping - Amendments (Draft DCP amended November 2024)
5. Australian Standard AS/NZS 2107:2016 "Acoustics – Recommended design sound pressure levels and reverberation times for building interior"
6. Proposed patron noise criteria, following logic from the Barangaroo South precinct

The sections relating to acoustics for each of the above documents are summarised in APPENDIX B

5.1.1 T&ISEPP/ DoP Guideline

The State Environment Planning Policy (Transport & Infrastructure) 2021 "T&ISEPP" clause 2.120 relates to impacts from road noise and vibration on non-road developments and applies to developments on sites adjacent to roads with an AADT greater than 20,000 vehicles. On that basis, it is applicable to William Street boundary and affected facades. Further, the Department of Planning (DoP) publication "*Development Near Rail Corridors & Busy Roads – Interim Guideline*" 2008 ('DoP Guideline') is also recommended to be used for other sites affected by road traffic noise (but below the mandatory trigger). Based on the traffic noise levels measured in Section 3.5, it is evident that the Site is affected by road traffic noise from William Street and therefore the requirements set out by the T&ISEPP and DoP Guideline were considered for this assessment. Clause 2.119 also considers impacts of noise from classified roads on adjacent development, but the numerical acoustic requirements are in Clause 2.120.

Table 8: T&ISEPP Internal Noise Criteria

Condition	Occupancy	Design Internal Noise Level
Naturally ventilated – windows closed	Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	40 dB(A) $L_{eq\ 15hr}$
Naturally ventilated – windows open	Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	50 dB(A) $L_{eq\ 15hr}$

Under the DoP Guideline, if the noise impacts on a location are greater than the "naturally ventilated – windows open" values noted in Table 8 above, then alternative ventilation should be provided to the requirements of the Building Code of Australia (so that the occupants can leave the windows closed but still be provided with fresh air). Whilst neither the DoP Guideline nor the T&ISEPP define internal noise guidelines for the noise created by the alternative ventilation system, the internal noise from the ventilation system is usually assessed with the other internal mechanical noise and designed to comply with AS2107:2016 design internal noise goals (or similar).

5.1.2 City of Sydney

5.1.2.1 DCP2012

City of Sydney DCP 2012 has acoustic requirements for road traffic noise intrusion in Section 4.3.2.11, items 7 and 8.

In addition, City of Sydney Council also requires residential developments to implement acoustic measures to reduce the impact of noise from existing or planned external sources including busy roads, adjoining industries, live music venues and public parks and plazas. The City of Sydney Council DCP 2012 stipulates that the repeatable maximum LAeq (1 hour) for residential and serviced apartments must not exceed the following levels.

Table 9: City of Sydney DCP 2012 Internal Noise Criteria

Condition	Occupancy	Design Internal Noise Level
Naturally ventilated – windows closed	Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	45 dB(A) $L_{eq\ worst\ 1hr}$
Naturally ventilated – windows open	Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	55 dB(A) $L_{eq\ worst\ 1hr}$
Windows / doors closed and air-conditioning operating – see below	Bedroom (10pm – 7am)	38 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	48 dB(A) $L_{eq\ worst\ 1hr}$

Whilst the City of Sydney DCP 2012 does not expressly state that when the air conditioning is operating that it includes a fresh air source, we assume (and recommend) that it does and so interpret Section 4.3.2.11 item 8 internal noise levels to be "Windows closed and alternative ventilation operating". The DCP does not define the breakdown between the contribution of noise through the glass versus from the ventilation system, which gives the acoustic consultant has a little flexibility, as long as the

cumulative complies with the target internal noise level. It is common for the through glass path in bedrooms to be allocated 35dB(A) and the ventilation also 35dB(A) for a sum of 38dB(A). Similarly for living rooms, 45dB(A) through the glass and 45dB(A) from the ventilation, for a sum of 48dB(A).

5.1.2.2 City of Sydney DCP proposed Policy and Housekeeping amendments

The City of Sydney Council has proposed to make changes to the DCP through the "Policy and Housekeeping" Amendments. At the time of writing, we understand that the Council may have voted to adopt the proposed changes but that they have not yet been formally adopted. Under the Sydney Development Control Plan 2012 – Policy and housekeeping – Amendments, Amendment 7 (starting p180) relates to proposed changes to environmental noise intrusion criteria for residential development in a proposed new Section 3.13.4. Of that section, provision 6 states the following:

"The repeatable maximum internal sound levels for noise sensitive land uses other than dwellings must be in accordance with relevant policies and guidelines."

Provision 7 (p182) of the proposed Section 3.13.4 outlines the repeatable maximum internal sound levels for dwellings. The criteria are summarised in Table 10.

Table 10: City of Sydney "Housekeeping amendments" Internal Noise Criteria

Provision 7 subpart	Condition	Occupancy	Internal Sound Level
a) Where natural ventilation is provided through windows and doors	Windows closed	Bedroom (7am – 10pm)	40 dB(A) $L_{eq\ worst\ 1hr}$
		Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ worst\ 1hr}$
		All other habitable rooms (7am – 10pm)	40 dB(A) $L_{eq\ 15hour}$
		All other habitable rooms (10pm – 7am)	40 dB(A) $L_{eq\ 9hour}$
	Windows open	Bedroom (7am – 10pm)	50 dB(A) $L_{eq\ worst\ 1hr}$
		Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ worst\ 1hr}$
		All other habitable rooms (7am – 10pm)	50 dB(A) $L_{eq\ 15hour}$
		All other habitable rooms (10pm – 7am)	50 dB(A) $L_{eq\ 9hour}$
b)	Natural ventilation through other means (such as plenum), with the ventilation system open (combined noise through glass and vent)	Bedroom (7am – 10pm)	40 dB(A) $L_{eq\ worst\ 1hr}$
		Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ worst\ 1hr}$
		All other habitable rooms (7am – 10pm)	40 dB(A) $L_{eq\ 15hour}$
		All other habitable rooms (10pm – 7am)	40 dB(A) $L_{eq\ 9hour}$
c)	Ventilation is provided by a mechanical system, including the noise from the ventilation system operating (combined noise through glass and from mech vent)	Bedroom (7am – 10pm)	40 dB(A) $L_{eq\ worst\ 1hr}$
		Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ worst\ 1hr}$
		All other habitable rooms (7am – 10pm)	40 dB(A) $L_{eq\ 15hour}$
		All other habitable rooms (10pm – 7am)	40 dB(A) $L_{eq\ 9hour}$

Subpart d) of Provision 7 requires that "natural ventilation and noise requirements consistent with (a) or (b) must be met concurrently for all apartments."

At the end of provision 7, there is also a note that "The above noise levels represent the combined noise from all external sources and any ventilation system noise when operating normally." However, that is

not true for the case where natural ventilation is provided through windows and doors, but the windows are closed in subpart a). In that scenario, the window is closed and so the internal noise level is only through the glass. When a room is naturally ventilated by "other means" such as a plenum, the target internal noise level is proposed to be 10dB quieter than the windows open case. This has the potential to cause inequity between rooms or between apartments at the changeover point where the external noise level shifts from being compliant with windows open, to requiring an acoustically treated natural ventilation path.

5.1.2.3 Discussion

Given that significant work had already been undertaken in the development of the acoustic strategy and associated design to date, we propose to keep the existing rather than undertake significant amendments to address the City of Sydney DCP proposed Policy and Housekeeping Amendments. In respect of environmental noise intrusion, we propose to continue with the strategy previously approved by City of Sydney Council as outlined in the report: "164-192 William Street, Sydney - Design Competition - Acoustic Briefing Notes and Natural Ventilation Briefing Notes", ref. no. TM358-03 Acoustic Brief Design Comp (r5) dated 2 April 2024 and prepared by Renzo Tonin and Associates (with input from Flux on the ventilation) as outlined in the following sections.

5.1.2.4 Road Traffic Noise Intrusion - Under Naturally Ventilated Conditions

Road traffic noise intrusion criteria (excluding retail noise) under naturally ventilated conditions are considered for the following scenarios:

- Scenario 1 - Internal noise goals for apartments with windows open.
- Scenario 2 (if scenario 1 cannot be achieved) - Internal noise goals for windows closed, but a supplementary passive ventilation system in operation.

For the above two scenarios, the $L_{eq\ 15hr}$ and $L_{eq\ 9hr}$ have been used, which is in accordance with the ADG and T&ISEPP and the DoP Guideline. These were previously approved by Council as part of the Design Competition Briefing.

The goals are as follows:

Table 11: Natural Ventilation Internal Noise Targets

Condition	Occupancy	Design Internal Noise Level
Naturally ventilated – windows open	Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	50 dB(A) $L_{eq\ 15hr}$
Windows Closed but Supplementary Natural Ventilation (via acoustic plenum).	Bedroom (10pm – 7am)	38 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	48 dB(A) $L_{eq\ 15hr}$

On applying these noise goals, the following approach will be adopted:

- Can the apartment comply with the *Naturally ventilated – windows open* goals? There criteria apply if the natural ventilation is provided by any form of window opening including windows opening onto protected balconies. If so – no further analysis is required.

- For apartments where fresh air cannot be provided by an open window without exceeding noise targets, and supplementary fresh air is provided by acoustic or similar – the *Windows Closed & Natural Ventilation Open* apply.

Design initiatives should be investigated to increase the proportion of apartments which can be ventilated through the windows open pathway, rather than needing to use plenums (either direct to façade or via a protected balcony).

5.1.3 Patron noise within a precinct

For noise impacts within the Precinct, design internal noise goals (cumulative) are proposed. The goals are those applied by Wilkinson Murray at the Barangaroo South Precinct which were informed by controls applied in New York and San Francisco.

Noise limits are proposed for two scenarios:

- Noise targets within apartments when apartment windows are closed and

- Noise targets within apartments when apartment windows are open (or using an acoustic plenum for natural ventilation).

When the windows are closed, the proposed combined patron and music internal noise levels from the active street-fronts of the through site retail link are follows:

- Daytime/Evening (7am to 10pm):
  - 38dB(A) $L_{eq(15min)}$ in bedrooms (internally, windows closed); and
  - 43dB(A) $L_{eq(15min)}$ in living rooms (internally, windows closed);
- Late Evening (10pm - midnight):
  - 35dB(A) $L_{eq(15min)}$ in bedrooms (internally, windows closed); and
  - 40dB(A) $L_{eq(15min)}$ in living rooms (internally, windows closed).
- Overnight (midnight to 7am): Each of the new tenancies inaudible at any residential receptor.

It is anticipated that not all of the tenancies would operate past 10pm in the evening and that the outdoor dining would cease at midnight. Further, the commercial tenants would be responsible for the assessment of noise emissions from the use of their tenancy as part of their DA for the use. As an

estimate, it is assumed that after 10pm, only half of the outdoor dining seats is occupied (evenly distributed).

Under the original Barangaroo South study by Wilkinson Murray compliance with internal noise goals relied on transmission loss of the façade but they were silent on ventilation, and so it is assumed that the apartments were provided with alternative ventilation.

For this project, we utilise similar controls to those recently approved on Surry Hills Shopping Village, that the internal noise goals with the windows open are 10dB louder than the windows closed objective. This is also a similar logic to that applied for the DoP Guideline, where provision of alternative ventilation is recommended if the windows open level exceeds the windows closed level by more 10 dB.

When apartments are naturally ventilated either with windows open or an open acoustic plenum or protected balcony with open windows for natural ventilation, the proposed noise limits are as follows:

- Day/Evening (7am to 10pm):
    - Living: 53dB(A) $L_{eq(15min)}$ inside the apartment (internally, window/plenum open).
    - Bedroom: 48dB(A) $L_{eq(15min)}$ inside the apartment (internally, window/plenum open).
- Late Evening/Early Night (10pm to midnight):
    - Living: 50dB(A) $L_{eq(15min)}$ inside the apartment (internally, window/plenum open).
    - Bedroom: 45dB(A) $L_{eq(15min)}$ inside the apartment (internally, window/plenum open).
- Overnight (midnight to 7am): Each of the new tenancies inaudible at any residential receptor.

5.1.4 Noise Intrusion Criteria Used for Assessment

The internal noise criteria for this development taking into account T&ISEPP, DoP Guideline, ADG, and Council DCP are presented in Table 12 below. For commercial zones, Australian Standard AS/NZS 2107:2016 has been used to set the project internal noise goals. In addition, Table 13 presents internal windows closed and windows open criteria for patron noise within the precinct.

Table 12: Maximum Internal Noise Criteria for Road Traffic Noise

Condition	Occupancy	Design Internal Noise Level
Residential apartments – consolidated criteria T&ISEPP and City of Sydney agreed		
Windows closed	Bedroom (10pm – 7am)	35 dB(A) $L_{eq\ worst\ 1hr}$
	Living / Dining /Kitchen (24 hours)	40 dB(A) $L_{eq\ 15hr}$
Naturally ventilated – windows open	Bedroom (10pm – 7am)	45 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	50 dB(A) $L_{eq\ 15hr}$
Windows Closed but Supplementary Natural Ventilation (via acoustic plenum).	Bedroom (10pm – 7am)	38 dB(A) $L_{eq\ 9hr}$
	Living / Dining /Kitchen (24 hours)	48 dB(A) $L_{eq\ 15hr}$

Condition	Occupancy	Design Internal Noise Level
Common Area/ Lobby (AS/NZS 2107)		
Windows and doors closed	Lobby & common areas	40-50 dB(A) $L_{eq\ 15hr}$
Retail/Commercial (AS/NZS 2107)		
Windows and doors closed	Small retail stores	40-50 dB(A) $L_{eq\ 15hr}$

1. In respect of the Council criteria, these are also the target internal noise levels in the event that an acoustic plenum is used in order to provide natural ventilation of the apartment, as requested by City of Sydney Council on a recent similar project.

2. In respect of the T&ISEPP criteria, these are also the target internal noise levels in the event that an acoustic plenum is used in order to provide natural ventilation of the apartment

The following table presents the criteria for patron and music noise intrusion into the apartments within the precinct.

Table 13: Maximum Internal Noise Criteria for Patron Noise

Condition	Occupancy	Design Internal Noise Level
Residential Units (proposed criteria)		
Internally, windows closed	Bedroom (7am - 10pm)	38 dB(A) $L_{eq\ (15min)}$
	Living (7am - 10pm)	43 dB(A) $L_{eq\ (15min)}$
	Bedroom (10pm – 12am)	35 dB(A) $L_{eq\ (15min)}$
	Living (10pm – 12am)	40 dB(A) $L_{eq\ (15min)}$
Internally, windows open or plenum open	Bedroom (7am - 10pm)	48 dB(A) $L_{eq\ (15min)}$
	Living (7am - 10pm)	53 dB(A) $L_{eq\ (15min)}$
	Bedroom (10pm – 12am)	45 dB(A) $L_{eq\ (15min)}$
	Living (10pm – 12am)	50 dB(A) $L_{eq\ (15min)}$

When apartment windows are naturally ventilated/windows open, the allowable external noise levels for compliance across an open window/plenum are as follows:

- Day/Evening (7am to 10pm):
    - Living: 53dB(A) Leq(15min) inside the apartment.
        - This would equate to an outdoor noise level of:

          63dB(A) outside the apartment window (assuming the apartment window is left open)

          73dB(A) outside (assuming the apartment is ventilated using an acoustic plenum or a protected balcony).
    - Bedroom: 48dB(A) Leq(15min) inside the apartment.
        - This would equate to an outdoor noise level of:

          58dB(A) outside the apartment window (assuming the apartment window is left open) or

68dB(A) outside (assuming the apartment is ventilated using an acoustic plenum) or a protected balcony.

- Late Evening (10pm to midnight):
  - Living: 50dB(A) Leq(15min) inside the apartment.
    - This would equate to an outdoor noise level of:

      60dB(A) outside the apartment window (assuming the apartment window is left open)

      70dB(A) outside (assuming the apartment is ventilated using an acoustic plenum or a protected balcony).
  - Bedroom: 45dB(A) Leq(15min) inside the apartment.
    - This would equate to an outdoor noise level of:

      55dB(A) outside the apartment window (assuming the apartment window is left open) or

      65dB(A) outside (assuming the apartment is ventilated using an acoustic plenum) or a protected balcony.

5.2 Recommendations – External (Traffic and Environmental) Noise Intrusion

To meet internal noise criteria and natural ventilation requirements the following is proposed.

On William Street, protected balconies are to be used to protect some of the most affected occupants from wind and to provide some mitigation of road traffic noise to the external space. The permanent opening shall be at the top, the full width of the balcony and equivalent to 25% of the face area of the balcony. In addition, it is expected that the soffit and one wall will need to be lined with absorptive lining with an NRC of not less than 0.8 (to be confirmed during detailed design). Protected balconies are anticipated to be used for the first four levels

5.2.1 Glazing Design Requirements

Refer to Table 14 below for indicative glazing treatment required for each façade of the residential development. Refined assessments of road traffic noise intrusion will need to be undertaken throughout the design process prior to Construction Certificate.

Windows to apartments can be openable (at the discretion of the occupant) however when closed, the minimum acoustic performance requirements of the window in frame must comply with the table below.

Table 14: Recommended Glazing Treatment – residential

Facade	Building Level	Room Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Indicative Glazing Configuration	Laboratory Test Reference
William Street – glazing direct to external façade	1-15	Bedroom	R_W 45	11.52mm laminated / 140mm airgap / 10mm float	ESTIMATE
		Living Room	R_W 45	11.52mm laminated / 140mm airgap / 10mm float	ESTIMATE
William Street – glazing direct to external façade and East and West within 10m of William St Boundary	16	Bedroom	R_W 36	12.38mm laminated glass or 12.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE
William Street – glazing from protected balcony to room	1-2	Bedroom	R_W 36	12.38mm laminated glass or 12.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE
		Living Room	R_W 35	10.38mm laminated glass or 10.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE
North-South through site link, south of the central corridor	1-7	Bedroom	R_W 45	11.52mm laminated / 140mm airgap / 10mm float	ESTIMATE
		Living Room	R_W 45	11.52mm laminated / 140mm airgap / 10mm float	ESTIMATE
North-South through site link south of the central corridor	8-17	Bedroom	R_W 42	10.38mm laminated / 140mm airgap / 6mm float	ESTIMATE
		Living Room	R_W 40	6.38mm laminated / 140mm airgap / 6mm float	ESTIMATE
North-South through site link, north of the central corridor	1-17	Bedroom	R_W 36	12.38mm laminated glass or 12.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE
		Living Room	R_W 35	10.38mm laminated glass or 10.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE
Forbes Street – up to 10m from William St boundary - glazing direct to external facade	1-8	Bedroom	R_W 42	10.38mm laminated / 140mm airgap / 6mm float	ESTIMATE
		Living Room	R_W 40	6.38mm laminated / 140mm airgap / 6mm float	ESTIMATE
Dowling Street – up to 10m from William St boundary - glazing direct to external facade	1-17	Bedroom	R_W 42	10.38mm laminated / 140mm airgap / 6mm float	ESTIMATE
		Living Room	R_W 40	6.38mm laminated / 140mm airgap / 6mm float	ESTIMATE
Forbes/Dowling Streets facades and North and facing laneway glazing – remaining direct external facade	G-17	Bedroom	R_W 32	6.38mm laminated glass or 6.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE
		Living Room	R_W 32	6.38mm laminated glass or 6.38mm laminated glass/ 12mm airgap/ 6mm glass	ESTIMATE

Facade	Building Level	Room Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Indicative Glazing Configuration	Laboratory Test Reference

By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the partition, a higher rating implying a higher sound reduction performance.

Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.

LEGEND where no appropriate test certificate exists:

1. ESTIMATE: 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.
2. ESTIMATE – APPROVED FOR CONSTRUCTION: Use of the form of construction is approved prior to laboratory certification. To complete the quality control of the design process and confirm the acoustical performance of the construction, we recommend testing in a laboratory to confirm the Rw rating as soon as practicable. In the case of impact rating for floor systems, no particular impact rating is guaranteed to comply with either the Building Code of Australia or Strata Scheme Management Act and hence carpet runners may still be required.
3. ESTIMATE – TEST NOT REQUIRED: Use of the form of construction is approved without laboratory certification. The STC/Rw of the form of construction exceeds the project requirements.
4. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

NOTES FOR GLAZING CONSTRUCTIONS:

5. 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.
6. The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.
7. 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.
8. The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site.
9. 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.
10. 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.

GENERAL

11. The sealing of all gaps in partitions is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.
12. Check design of all junction details with acoustic consultant prior to construction.
13. Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.
14. The information provided in this table is subject to modification and review without notice.
15. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.

For the retail tenancies, 12.38mm laminated glass (glass-in-frame performance of Rw 36) is proposed facing William Street and the corner tenancies to Forbes and Dowling Streets, whilst the remaining retail on Forbes/Dowling could be 6.38mm laminated (glass-in-frame performance of Rw 32).

For the retail tenancies facing into the through site link, 6.38mm laminated would be sufficient for noise intrusion, but for noise emissions from the use of those tenancies (the DA for the use of the tenancy would be the responsibility of the tenant), thicker glass may be required for noise emissions to receivers within the precinct or external to it.

5.2.2 External walls

The dominant path of external noise ingress into building interior is via windows and doors. Assessment and recommendations in regard to external noise intrusion has accordingly been made with respect to the windows and doors. It is therefore recommended that the external walls have a sound isolation rating (R_w) at least 15dB higher than that of the glazing specified in the above, to maintain the acoustic integrity of the overall facade system.

At present, all external wall elements are assumed to be masonry (constructions are not specified at Concept stage) and no further upgrade is required for acoustic purposes. In the event that light weight external wall systems are proposed, this will need to be reviewed in detail at the Construction Certificate (CC) stage to determine if additional internal plasterboard lining to the wall system will be required.

5.2.3 Roof and ceiling

Similar to the external wall design, the roof/ceiling construction can generally provide acoustic performances well in excess of glazing or doors. The roof construction should have a sound isolation rating (R_w) at least 10dB higher than that of the glazing on its facade.

At present, all external roof elements are assumed to be concrete (constructions are not specified at Concept stage) and no further upgrade is required for acoustic purposes. In the event that light weight roof systems are proposed, this will need to be reviewed in detail at CC stage to determine if additional internal plasterboard lining to the ceiling system will be required.

5.3 Provision of natural ventilation (fresh air) to apartments

The Site lies in an area that is significantly impacted by external noise sources. The primary external noise sources are road traffic (William Street) and from urban hum/roof top plant and equipment of other buildings in the vicinity.

For buildings located in noisy areas, there are a number of documents that provide acoustic guidance:

- The City of Sydney DCP and the *Alternative Natural Ventilation of Apartments in Noisy Environments* document.
- NSW Planning document *Development Near Major Roads and Rail Corridors (Interim Guideline).*
- The Apartment Design Guide.

A key consideration in these documents is the inter-relationship between the control of external noise and the provision of fresh air/ventilation of the apartments (as control of external noise will typically require that windows of an apartment are closed, and therefore prevent the fresh air ingress into the apartment via an open window).

These guidelines apply to apartments and serviced apartments, but not to hotel rooms.

How these seemingly conflicting design objectives are addressed is discussed in detail below.

5.3.1 Planning Controls

Relevant planning controls are identified below.

5.3.1.1 City of Sydney Planning Controls

Section 4.2.3.11 of the City of Sydney DCP states in subsections 7 and 8:

(7) The repeatable maximum $L_{Aeq(1hr)}$ for residential buildings and services apartment must not exceed the following levels:

a. for closed windows and doors:

(i) 35dB for bedrooms (10pm-7am) and

(ii) 45dB(A) for main living areas (24 hours)

b. for open windows and doors:

(i) 45dB for bedrooms (10pm-7am) and

(ii) 55dB(A) for main living areas (24 hours)

(8) Where the natural ventilation of a room cannot be achieved, the repeatable maximum $L_{Aeq\ (1hr)}$ level in a dwelling when doors and windows are shut and air-conditioning is operating must not exceed:

a. 38dB for bedrooms (10pm-7am) and

b. 48dB for main living areas (24 hours)

5.3.1.2 Development Near Rail Corridors and Major Roads (Interim Guideline)

NSW Planning document *Development Near Rail Corridors and Major Roads* sets internal noise goals for developments near noisy road/rail corridors. The guideline sets internal noise goals within dwellings for both windows open and windows closed conditions, namely:

- Windows closed:
  - Bedrooms: 35dB(A)$L_{eq9hr(night)}$.
  - Other Habitable Rooms: 40dB(A)$L_{eq15hr(Day)}$ and 40dB(A)$L_{eq9hr(Night)}$
- Windows open:

  If internal noise levels with windows or doors open exceed the criteria by more than 10dB(A), the

design of the ventilation for these rooms should be such that the occupants can leave windows closed if they so desire and also to meet the ventilation requirements of the Building Code of Australia.

5.3.1.3 The Apartment Design Guide (ADG) 2015

The Apartment Design Guide contains provisions with respect to natural ventilation (Section 4B) and for developments in areas with high external noise levels (Section 4J).

Natural ventilation of apartments typically relies on an opening (window or similar) to allow fresh air to an apartment. Obviously in an area of high external noise, opening a window may result in an excessively high internal noise level. The question then arises of how sections 4B and 4J are satisfied simultaneously.

5.3.1.4 Precinct patron noise

The following table presents the criteria for patron noise intrusion into the apartments within the precinct.

Table 15: Maximum Internal Noise Criteria for Patron Noise

Condition	Occupancy	Design Internal Noise Level
Residential Units (proposed criteria)		
Internally, windows closed	Bedroom (7am - 10pm)	38 dB(A) $L_{eq\ (15min)}$
	Living (7am - 10pm)	43 dB(A) $L_{eq\ (15min)}$
	Bedroom (10pm – 12am)	35 dB(A) $L_{eq\ (15min)}$
	Living (10pm – 12am)	40 dB(A) $L_{eq\ (15min)}$
Internally, windows open or plenum open	Bedroom (7am - 10pm)	48 dB(A) $L_{eq\ (15min)}$
	Living (7am - 10pm)	53 dB(A) $L_{eq\ (15min)}$
	Bedroom (10pm – 12am)	45 dB(A) $L_{eq\ (15min)}$
	Living (10pm – 12am)	50 dB(A) $L_{eq\ (15min)}$

The residential apartments worst affected by the on site patron noise are on Level 1, facing North and overlooking the East-West through -site-link, where the predicted façade noise level is 59dB(A) up to 10pm and 56dB(A) from 10pm to midnight.

Assuming a 10dB noise reduction across a window open for natural ventilation, Living Rooms are predicted to comply with the internal noise goal (windows open) at all times.

For bedrooms on Level 1, for technical compliance, fresh air would need to be brought in through either a semi-protected balcony with open window/door beyond, or where the room only has one window and it sits directly into the façade (and not to a balcony), then a plenum may be used. However, for the window direct to façade case, given that only a marginal exceedance of the design internal noise goal would be predicted with the window open (a 1dB exceedance, which is imperceptible to the average listener), there would not be a significant loss of amenity if the plenum were omitted. If required, the

outside dimensions of the plenum would be in the order of 300mm x 1700mm x 1700mm long (subject to detailed design), with the acoustic portion of the plenum being nominally 270mm x 1700mm and 1000mm long with 50mm thick internal duct lining. The remainder of the length would be occupied by weather louvres, transition zones and fly-screen. An operable door is required which provides access to the fly-screen for cleaning and also ensures the resident can close the plenum if they wish.

For bedrooms on level 2 and up, internal windows open goals would be achieved without the need for a semi-protected balcony.

5.3.2 Proposed Acoustic Design Measures Relating to Apartment Ventilation

For the subject development, extensive efforts have been made to incorporate the design guidance of the ADG to achieve an outcome that is consistent with the DCP, the ADG and *Development Near Rail Corridors and Major Roads* document.

5.3.2.1 Compliance with Council Controls (City of Sydney DCP and *Alternative Ventilation in Noisy Environments*) and *Development Near Rail Corridors and Major Roads (Interim Guideline)*

A two step approach is adopted in order to comply with Councils DCP and in the development of a natural ventilation strategy:

- Step 1 – are the "open window" criteria from section 4.2.3.11 (7)b of the DCP met. If so, there is no acoustic treatment required (acoustic plenums) needed to window openings.
- Step 2 – if the "open window" acoustic criteria cannot be met with an open window solution, acoustic plenums are designed such that the closed window criteria of 4.2.3.11(8) are met when it is in use and 4.2.3.11(7)a are achieved when the plenum is closed.
- In all cases, regardless of how the apartment is ventilated (open window, acoustic plenum or other), the glazing to the apartments is designed such that compliance with internal noise level requirements of DCP section 4.2.3.11(7)a and the *Development Near Rail Corridors and Major Roads (Interim Guideline)* are achieved when the windows are closed.
- In respect of the North-South through-site-link, the acoustic model has taken into account that there are no doors either on the William Street end or the laneway end.

In conducting the analysis and acoustic design Renzo Tonin and Associates have relied on advice from Che Wall and Helda Lim of FLUX, including their report "164-172 and 174-194 William St Woolloomooloo – Alternative Natural Ventilation Report", dated 20 August 2025" for the open areas required to provide sufficient passive ventilation.

- Use of cross ventilation as a means to naturally ventilate apartments. A cross ventilated apartment will draw air through it more efficiently than an apartment with single frontage. The size of the window openings needed to naturally ventilate an apartment that is cross ventilated is significantly smaller compared to what is required for an apartment with a single frontage. This enables a reduction of the size of the window opening required in order to naturally ventilate apartments.

Such refined design is not warranted at Concept DA, but would be undertaken for detailed Development Application.

- Use of semi-protected balcony with the soffit balcony lining (50mm thick Echosoft or equal) and low height window openings (below balustrade level to enable the balustrade to provide acoustic screening) to reduce road traffic noise level incident on the window opening.
- Use of protected balcony with a 1.8m high balustrade with absorptive lining to the balcony soffit and one wall (50mm thick Echosoft or equal), and either an open door/window beyond, or plenum, as applicable.

Adopting the above enables a greater percentage of apartments to meet the DCP "windows open" criteria and avoids the need for acoustically treated passive ventilators.

For apartments where (even after the above design principals have been adopted) the design still cannot meet the "window open" criteria, an acoustic plenum is proposed (which is designed to meet the "windows closed" criteria of 4.2.3.11(8) when the plenum is in use and 4.2.3.11(7)a when the resident closes the plenum. (Refer FLUX report "164-172 and 174-194 William St Woolloomooloo – Alternative Natural Ventilation Report" for indicative plenum design, an excerpt of which is included in APPENDIX D). In some cases, those plenums are also required to draw fresh air from protected balconies (rather than the external façade).

The current ventilation strategy proposed is as follows:

North West Building (Forbes Street and away from William St) North, South, East and West facades: Naturally ventilated (conventional, windows open).

North East Building (Dowling Street and away from William St) North, South, East and West facades: Naturally ventilated (conventional, windows open).

North-South through site link, North of central corridor: Naturally ventilated (conventional, windows open).

North-South through site link, South of central corridor: refer to William Street treatments.

North and South façades facing East-West through site link: Naturally ventilated (conventional, windows open), with the exception of Level 1, north facing bedrooms, which are to have either a plenum (for rooms with only one window, which is straight onto the façade) or a semi-protected balcony from which low level windows open is then acoustically acceptable. Living rooms can open directly to façade with simple windows open.

Forbes and Dowling Streets, >10m to <40m from William St boundary: Low level awning window to semi-protected balcony with absorptive soffit; or alternatively, a protected balcony with open window or a plenum.

Forbes and Dowling Streets, <10m from William St boundary: refer to William Street treatments.

William Street, Level 17: Open windows facing North/East.

William Street- Level 14-16: Open windows after the setback

William Street- Level 8-13: Plenum to semi-protected balcony; or plenum to façade when balcony not available.

William Street- Levels 3 to 7: Plenum to semi-protected balcony; or plenum to façade when balcony not available. For the Living areas in the William St East building, with the balconies on the North side of the apartment within the through site link, those living areas can be windows open (off the balcony)

William Street- Levels 1 to 2:

Protected balcony and off that each room has an air supply plenum

- Bedrooms and Living Areas: Each room has an air supply plenum, nominal overall dimensions of approximately 300mm x 2700mm in elevation and approximately 2100mm to 2900mm long (final dimensions would be determined during detailed design). The acoustic treatment within the plenum would consist of 10 off 270mm high x 260mm wide x 1400mm to 2200mm long with 50mm thick internal lining (stacked one on top of the other for a completed height of nom 2700mm). The remainder of the length would be occupied by weather louvres, transition zones and fly-screen. An operable door is required which provides access to the fly-screen for cleaning and also ensures the resident can close the plenum if they wish.
- Studio: Each studio has an air supply plenum, nominal overall dimensions of approximately 450mm x 2700mm in elevation and approximately 2100mm to 2900mm long. The acoustic treatment within the plenum would consist of 10 off 270mm high x 260mm wide x 1400mm to 2200mm long with 50mm thick internal lining (stacked one on top of the other for a completed height of nom 2700mm). The remainder of the length would be occupied by weather louvres, transition zones and fly-screen. An operable door is required which provides access to the fly-screen for cleaning and also ensures the resident can close the plenum if they wish.

Where there is no balcony and direct connection to the façade is required, the following is proposed:

- Studio: Each studio has an air supply plenum, nominal overall dimensions of approximately 450mm x 2700mm in elevation and approximately 4200mm long. The acoustic treatment within the plenum would consist of 10 off 270mm high x 450mm wide x 3500mm long with 50mm thick internal lining (stacked one on top of the other for a completed height of nom 2700mm). The remainder of the length would be occupied by weather louvres, transition zones and fly-screen. An operable door is required which provides access to the fly-screen for cleaning and also ensures the resident can close the plenum if they wish.
- Bedroom: Each bedroom has an air supply plenum, nominal overall dimensions of approximately 300mm x 2700mm in elevation and approximately 4200mm long. The acoustic treatment within the plenum would consist of 10 off 270mm high x 260mm wide x 3500mm long with 50mm thick internal lining (stacked one on top of the other for a completed height of nom 2700mm). The remainder of the length would be occupied by weather louvres, transition zones and fly-screen. An operable door is required which provides access to the fly-screen for cleaning and also ensures the resident can close the plenum if they wish.

5.3.2.2 ADG – Objective 4J1 – Design Guidance and Response

To minimise impacts the following design solutions may be used:

- *Physical separation between buildings and the noise or pollution source*. Physical separation is provided by locating the retail at ground level, and residential apartments located above (also consistent with Figure 4J.4 of the ADG). The building fabric itself (acoustically rated glazing) is a physical form of separation between the apartment and the noise source.
- *Residential uses are located perpendicular to the noise source and where possible buffered by other uses.* The entire site has been designed with this guidance in mind. The number of apartments directly facing the primary noise source are minimised, and private open space is oriented to the north where it is less noise affected.
- *Non-residential buildings are site to be parallel with the noise source to provide a continuous building that shields residential uses and communal open space.* This is clearly addressed in the design, with the lower levels dedicated to retail uses. Communal open space is located at the rear and on the roofs where noise screening from the roads is maximised.
- *Non-residential uses are located at lower levels vertically separating the residential component from the noise or pollution source*. *Setbacks to the underside of the residential floor levels should increase relative to traffic volumes and other noise sources*. Again, this is demonstrated by the lower levels being dedicated to non-residential use and all but the apartments directly facing William Street being benefited by acoustic shielding from the continuous building along that facade.
- *Buildings should respond to both solar access and noise. Where solar access is away from the noise source, dual aspect apartments with shallow building depths are preferable*. At the subject site, William Street runs along the Southern boundary of the Site. Apartments are typically orientated to the north-east, north or northwest to take advantage of good solar access to the north and views to the east and west. Building depth is shallow and architects have maximised apartments on the William Street facade to have dual aspects where practical.
- *Landscape design reduces the perception of noise and acts as a filter for air pollution generated by traffic and industry*. Subject to detailed design but roof areas are mostly proposed to be vegetated and is largely screened from William Street by the building itself.

5.3.2.3 ADG – Objective 4J2 – Design Guidance and Response

Design solutions to mitigate noise include:

- *Limiting the number and size of openings facing noise sources.* This is clearly met by the development's four building approach - with building bulk on William Street providing acoustic screening to the building behind. The Northern Façade of the South buildings are relatively sheltered, as are the windows facing into the through site links. Of those that face William Street some have dual aspect so that there are facades with a lesser noise impact. Bladed features have

also been utilised to minimise direct traffic noise to pop out windows in the through site link to maximise the number of rooms that can be ventilated windows open.

- *Providing seals to prevent noise transfer through gaps*. All operable window and door elements will have acoustic seals.
- *Using double or acoustic glazing, acoustic louvres or enclosed balconies.* Acoustic glazing will be used extensively on the project. Protected balconies are proposed to William Street façade and wrapping around the corners of Forbes and Dowling Streets.
- *Using materials with mass and or sound insulation or absorption properties eg solid balcony balustrades, external screens and soffits*. Acoustic lining to underside of soffit and a solid balustrade (glass) will be adopted where appropriate. This lining is used in conjunction with solid balustrades and low height window openings to enable natural ventilation without use of plenum in some apartments.

In light of the above, the nominated acoustic strategy has been tested on the reference scheme and the acoustic design is consistent with all Council DCP and guidelines, the Development Near Rail Corridors and Busy Roads and with the ADG, specifically the concurrent compliance with section 4B (Natural Ventilation) and 4J (Noise Pollution).

6 Noise Emission Assessment

6.1 Noise Emission Criteria

6.1.1 Patron and Music Noise

For noise from licensed premises to residential receivers external to the site, we propose that the City of Sydney Council standard noise conditions be applied.

NOISE - LICENSED PREMISES

a. The LA10 noise level emitted from the use must not exceed the background noise level (LA90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 5dB between the hours of 7.00am and 12.00 midnight when assessed at the boundary of any affected residence.

b. The LA10 noise level emitted from the use must not exceed the background noise level (LA90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 12.00 midnight and 7.00am when assessed at the boundary of any affected residence.

c. Notwithstanding compliance with (a) and (b) above, the noise from the use must not be audible within any habitable room in any residential property between the hours of 12.00 midnight and 7.00am.

d. The L10 noise level emitted from the use must not exceed the background noise level (L90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises.

e. The use of the premise must be controlled so that any emitted noise is at a level so as not to create an "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.

In addition, we propose alternative criteria for apartments within the precinct site.

Wilkinson Murray (WM) published the Barangaroo South Master Plan Noise Assessment (Report No.: 10232-BN-1; Version: G), which set the patron and music noise emission goals for Barangaroo South. This Master Plan set out noise emission goals to existing residential receivers external to the site and to the facades of the residential buildings within Barangaroo itself.

In respect of existing residential receivers external to Barangaroo, WM noted that patron and music noise emissions from a single tenancy should be assessed and managed in accordance with the Standard City of Sydney Council – Entertainment Noise conditions (Refer above – Noise – Licensed Premises). However, given that each existing residential receiver could be impacted by multiple tenancies, as a further control to protect the amenity of the receivers WM recommended that a cumulative assessment of noise emissions from the operation of multiple tenancies should be

undertaken. WM proposed that cumulative patron LAeq noise levels from the Barangaroo precinct achieve a criterion of background +5dB prior to 12 midnight and background + 0dB after 12 midnight.

In respect of impacts on the residential buildings within Barangaroo South, WM drew on case studies from New York and San Francisco to set project internal noise goals for patron and music noise with windows closed. The proposed limits were as follows:

- Day/Evening (7am to 10pm):
    - Living: 43dB(A) $L_{eq(15min)}$
    - Bedroom: 38dB(A) $L_{eq(15min)}$
- Night (10pm to midnight):
    - Living: 40dB(A) $L_{eq(15min)}$
    - Bedroom: 35dB(A) $L_{eq(15min)}$

Cumulative goals for patron $L_{Aeq\ (15min)}$ noise within the precinct to residential receivers external to the site:

- 7am to midnight: background +5dB;
- Midnight to 7am: background + 0dB

It is proposed to apply the same project internal noise goals (windows closed) and cumulative patron noise to external receivers for the William Street precinct.

The WM Masterplan Assessment did not discuss the requirements for ventilation. However, given that the transmission loss of the residential façade was used in the calculation of the allowable level outside the façade for compliance internally, it is a reasonable assumption that windows are required to be closed for environmental noise intrusion and ventilation is provided either mechanically, or through an acoustically attenuated natural ventilation solution. For this project it is proposed to define the naturally ventilated (which could be through an acoustically attenuated natural ventilation solution) project internal patron noise goals as 10dB above the windows closed criteria. The proposed naturally ventilated internal patron noise goals are therefore as follows:

- Day/Evening (7am to 10pm):
    - Living: 53dB(A) $L_{eq(15min)}$
    - Bedroom: 48dB(A) $L_{eq(15min)}$
- Late Evening/Early Night (10pm to midnight):
    - Living: 50dB(A) $L_{eq(15min)}$
    - Bedroom: 45dB(A) $L_{eq(15min)}$

6.1.2 Noise other than Patron Music Noise (Plant and Equipment etc)

Council have advised that their typically imposed condition of consent is as follows:

> *NOISE – COMMERCIAL PLANT / INDUSTRIAL DEVELOPMENT*
>
> *a. Noise from commercial plant and industrial development must not exceed a project amenity/.intrusiveness noise level or maximum noise level in accordance with relevant requirements of the NSW EPA Noise Policy for Industry (NPfI) unless agreed to by the City's Area Planning Manager. Further:*
>
> *i. The Background noise monitoring must be carried out in accordance with the long-term methodology in Fact Sheet B of the NPfI unless otherwise agreed by the City's Area Planning Manager.*
>
> *ii. Commercial plant is limited to heating, ventilation, air conditioning, refrigeration and energy generation equipment.*
>
> *b. An LAeq,15mi (noise level) emitted from the development must not exceed the La90,15min (background noise level) by more than 3dB when assessed inside any habitable room of any affected residence or noise sensitive commercial premises at any time. Further:*
>
> *i. Background noise measurements must not include noise from the development but may include noise from necessary ventilation at the affected premise.*
>
> *ii. 1 of the NSW EPA Industrial Noise Policy are applicable.*
>
> *c. Corrections in fact Sheet C of the NPfI are applicable to relevant noise from the development measured in accordance with this condition, however duration corrections are excluded from commercial use.*

6.1.3 EPA Noise Policy for Industry

The NSW Environment Protection Authority (EPA) sets out noise criteria in its Noise Policy for Industry (NPfI) to control the noise emission from industrial sources.

The NPfI sets noise emission goals based on two sets of acoustic criteria:

- Intrusive criteria and
- Amenity Criteria

6.1.3.1 Intrusiveness Criteria

These criteria require that industrial noise does not exceed the background noise level by an excessive margin, preventing significant changes in the noise characteristic pertinent to the development site and surrounds. This is commonly referred to as the 'background plus 5' criterion. That is, the noise level from new industrial development, assessed in periods of 15 minutes, should not exceed the existing background noise level (measured in the absence of that development) by more than 5dB(A).

6.1.3.2 Amenity and Project Amenity Criteria

Amenity criteria serve primarily to avoid "noise creep" – for example, if a number of industrial noise sources are permitted to increase the background noise level by 5dB(A) (as permitted by the Intrusiveness Criteria) there would be a point where the cumulative noise level is unacceptable.

A limit on the ultimate acceptable noise level is therefore included in the NPfI as a way of ensuring that cumulative noise impact from industrial growth is curtailed. This limit is set using the Amenity and Project Amenity Criteria. These criteria are determined with reference to ambient noise conditions and the land use of nearby development (residential, commercial, industrial etc).

The Amenity Noise Level is found in table 2.2 of the Noise Policy for Industry.

It is the *Project* Amenity Criteria that sets a site-specific noise emission goal for a development. The Project Amenity Noise Level is typically 2dB(A) below the Amenity Noise level unless there is an exception (discussed in more detail after the following table).

Table 16: NPfI Recommended Amenity Noise Levels

Type of Receiver	Noise Amenity Area	Time of Day	Recommended amenity noise level, L_{Aeq}, dB
Residential	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See column 4	5 dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
Commercial premises	All	When in use	65

Notes:
1. Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am.
2. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
3. The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

In accordance with Section 2.4 of the NPfI, the following **exceptions** to Table 16 apply:

- In areas with high traffic noise levels.
- For proposed developments in major industrial clusters.
- In areas with high levels of pre-existing industrial noise. For example, where the resultant Project Amenity Noise level is 10dB, or more, lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases Amenity Noise Level, as opposed to the Project Amenity Noise level, is adopted.

Given the high noise levels on William Street, there is a potential exception to the typical Project Amenity Noise Level.

For high traffic noise areas, the following procedure applies:

- Does the existing traffic noise level exceed the Amenity Noise Level by 10dB(A)?
- If so, and if the traffic noise level unlikely to decrease in the future – the Project Amenity Noise level *may* be calculated by subtracting 15dB(A) from the measured road traffic noise level.

Table 17 to Table 18 summarises the NPfI criteria for nearby residential receivers.

Table 17: Project noise trigger level for noise emission from industrial noise (EPA NPfI) – residential receivers on William Street

Time of Day	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
	Rating Background Level (RBL) L_{A90}	Intrusiveness Trigger Level, $L_{Aeq, 15minute}$ (RBL+5)	Recommended Amenity Noise Level (RANL), $L_{Aeq, period}$	Project Amenity Noise Level (PANL), $L_{Aeq, period}$	Measured $L_{Aeq, period}$ existing noise levels	Traffic noise exceed the RANL by more than 10dB?	Existing noise level unlikely to decrease in future?	Exceptions to PANL? $L_{Aeq, period}$	Project Noise Trigger Level $L_{Aeq, 15minute}$ dB(A)
Day (7am to 6pm)	62	67	60	55	71	Yes	Yes	71-15=56	59
Evening (6pm to 10pm)	60	65	50	45	69	Yes	Yes	69-15=54	57
Night (10pm to 7am)	49	54	45	40	67	Yes	Yes	67-15=62	54

Explanatory notes:

Column 1 – RBL measured in accordance with the NPfI and outlined in the results of the long-term noise monitoring has been summarised in accordance with NPfI requirements and are presented in Table 3 above.

Column 4 – Project Amenity Noise Level determined based on 'Residential - urban' area in Table 2.2 (Amenity noise levels) of the EPA's NPfI minus 5dB

Column 5 – Measured in accordance with the NPfI

Column 8 - Determined in accordance with Section 2.4 of the NPfI.

Column 9 – Project Noise Trigger Level is the lower value of project intrusiveness noise level and project amenity noise level. In accordance with Section 2.2 of the NPfI, $L_{Aeq, 15minute}$ is calculated as $L_{Aeq, period}$ + 3dB(A)

Table 18: Project noise trigger level for noise emission from industrial noise (EPA NPfI) – residential receivers on Forbes Street, Dowling Street and Judge Lane

Time of Day	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9
	Rating Background Level (RBL) L_{A90}	Intrusiveness Trigger Level, $L_{Aeq, 15minute}$ (RBL+5)	Recommended Amenity Noise Level (RANL), $L_{Aeq, period}$	Project Amenity Noise Level (PANL), $L_{Aeq, period}$	Measured $L_{Aeq, period}$ existing noise levels	Traffic noise exceed the RANL by more than 10dB?	Existing noise level unlikely to decrease in future?	Exceptions to PANL?	Project Noise Trigger Level $L_{Aeq, 15minute}$ dB(A)
Day (7am to 6pm)	57	62	60	55	54	No	Yes	None	58
Evening (6pm to 10pm)	47	52	50	45	51	No	Yes	None	48
Night (10pm to 7am)	44	49	45	40	47	No	Yes	None	43

Explanatory notes:

Column 1 – RBL measured in accordance with the NPfI and outlined in the results of the long-term noise monitoring has been summarised in accordance with NPfI requirements and are presented in Table 4above.

Column 4 – Project Amenity Noise Level determined based on 'Residential - urban' area in Table 2.2 (Amenity noise levels) of the EPA's NPfI minus 5dB

Column 5 – Measured in accordance with the NPfI

Column 8 - Determined in accordance with Section 2.4 of the NPfI.

Column 9 – Project Noise Trigger Level is the lower value of project intrusiveness noise level and project amenity noise level. In accordance with Section 2.2 of the NPfI, $L_{Aeq, 15minute}$ is calculated as $L_{Aeq, period}$ + 3dB(A)

6.2 Noise Emission Assessment

External noise emissions from the base building construction would be from traffic generated by the development and mechanical plant and equipment.

At this stage the carpark entry/exit and Loading Dock are shown to enter the site from Forbes Street as this seems the most practical location given the existing road arrangement surrounding the site. Additional noise from traffic generated by the proposed development could impact the amenity of surrounding residents and so criteria are presented in Section 6.2.1 with preliminary discussion.

Mechanical plant and equipment will be required to serve the residential apartments, retail tenancies, carparks and common areas. Noise emission goals have been defined and preliminary noise management guidance is provided in Section 6.2.2.

6.2.1 Generated traffic noise

Table 19 sets out the assessment criteria for residences to be applied to particular types of projects, road category and land use. These criteria are for assessment against façade corrected noise levels when measured in front of a building façade. In Table 3, freeways, arterial roads and sub-arterial roads are grouped together and attract the same criteria.

Table 19: Road traffic noise assessment criteria for residential land uses

Road category	Type of project/land use		Assessment criteria – dB(A)	
			Day 7:00am-10:00pm	Night 10:00pm-7:00am
Freeway/ arterial/ sub-arterial roads	1.	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq,(15\ hour)}$ 55 (external)	$L_{Aeq,(9\ hour)}$ 50 (external)
	2.	Existing residences affected by noise from redevelopment of existing freeway / arterial / sub-arterial roads	$L_{Aeq,(15\ hour)}$ 60 (external)	$L_{Aeq,(9\ hour)}$ 55 (external)
	3.	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments	$L_{Aeq,(15\ hour)}$ 60 (external)	$L_{Aeq,(9\ hour)}$ 55 (external)
Local roads	4.	Existing residences affected by noise from new local road corridors	$L_{Aeq,(1\ hour)}$ 55 (external)	$L_{Aeq,(1\ hour)}$ 50 (external)
	5.	Existing residences affected by noise from redevelopment of existing local roads		
	6.	Existing residences affected by additional traffic on existing local roads generated by land use developments		

Note: Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near busy roads (see Appendix C10).

Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria.

In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

For existing residences and other sensitive land uses affected by *additional traffic on existing roads generated by land use developments*, any increase in the total traffic noise level (where the assessment criteria cannot be achieved) should be limited to 2 dB above that of the corresponding 'no build option'.

Based on the long term unattended and attended measurements conducted on site, the existing noise levels on Forbes Street (local road) already exceed the criteria nominated in Table 19. On that basis, noise from additional traffic generated by the development should not increase the existing noise level by more than 2dB.

Analysis of the existing and future traffic generation were calculated by TTPP. They predict a reduction in weekday morning and evening peak hour trip generation, with the worst case for additional traffic generation predicted to occur around midday on Saturday when the proposal is predicted to result in the order of 17 additional vehicle trips. Taking into account the traffic distribution presented in Figure 7.4 of the TTPP assessment, this would result in small but not noticeable (<2dB) increase in the existing traffic noise at the nearest residential receivers on Forbes Street (the worst affected receivers on the Local Road).

6.2.2 Patron noise

Noise emissions from the use of the outdoor dining areas within the East-West through site link have been assessed to both the receivers on site and receivers external to the site.

The inputs were as follows:

- 71dB(A) $L_{eq(15min)}$ contribution per patron (based on previous measurements undertaken by this office);
- Patron outdoor dining areas fully occupied (based on seating plan provided in the reference package) before 10pm;
- After 10pm, the patron numbers reduce by half, but are evenly distributed around the outdoor dining areas - this results in a 3dB reduction in the source noise level (and corresponding receiver noise level.

Based on the above, the predicted levels at receivers are as follows:

- 7am to 10pm - outdoor areas filled to capacity:
    - 49dB(A) $L_{eq(15min)}$ to nearest external residence on Forbes Street;
    - 44dB(A) $L_{eq(15min)}$ to nearest external residence on Dowling Street.
- 10pm to midnight - outdoor areas filled to half capacity:

- 46dB(A) $L_{eq(15min)}$ to nearest external residence on Forbes Street;
- 41dB(A) $L_{eq(15min)}$ to nearest external residence on Dowling Street.

Each of the above is compliant with the cumulative patron noise goal of background + 5dB(A) to any residential receiver external to the site.

Further, based on the above assumptions and the preliminary patron layouts, noise emissions from the outdoor dining associated with any one tenancy is predicted to comply with the City of Sydney Council Noise- Licensed Premises criteria.

6.2.3 Mechanical plant and equipment

Noise from plant and equipment is assessed with reference to the EPA Noise Policy for Industry (criteria as outlined in Section 5.1.3.

The details of the mechanical plant and equipment servicing this development are yet to be finalised at this stage of the development, but preliminary review of carpark exhaust and supply and the air conditioning, hot water and stair pressurisation indicate that compliance with NPfI targets is readily achievable for noise to neighbours. Therefore, the noise impacts from mechanical plant and equipment should be undertaken during the Detailed Design stage of the project.

However, we note:

- It is likely that primary ventilation plant and equipment items will either be located in the basement or at roof level.
- If located within the basement, noise emission control will be readily achievable using in duct lining or silencers or similar between fan and opening to atmosphere.
- Detailed acoustic review to be conducted at CC stage, once plant and equipment items are designed and selections finalised.
- Acoustic treatments must be sufficient such plant noise emissions are compliant with the EPA Noise Policy for Industry or other condition of consent that is applied.

7 Construction noise objectives

A detailed Excavation and Construction Management Plan should be prepared for the site prior to the issue of Construction Certificate detailing the site specific plant and equipment to be used, expected periods of construction, and noise and vibration management treatments and procedures to be implemented.

7.1 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 7-1 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 7-1: 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.

Table 7-2: Noise Affected Noise Management Levels - Standard Construction Hours

Receiver	RBL, L_{A90} Day (7am - 6pm)	Noise Management Level, $L_{Aeq(15min)}$
William St residential receivers	62	RBL + 10 = 72
Forbes, Dowling and Judge receivers	57	RBL + 10 = 67

Sensitive Land Use

Table 7-3 below (reproduced from Table 2 of the ICNG) sets out the noise management levels for various sensitive land use developments.

Table 7-3: Noise at commercial receivers

Land use	Management level, LAeq (15 min) – applies when land use is being utilised
Commercial and retail (external)	70dB(A)

7.2 Construction source noise levels

A detailed assessment of construction noise will need to be undertaken at the conclusion of the detailed design phase when there is more certainty on the equipment and methodologies that will be used to construct the building. However, this section presents a preliminary assessment of noise emissions from the construction stage.

Table 7-4 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

Plant item	Plant description	Sound power levels
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.

Given the proximity of receivers surrounding the site, it is likely that some residential receivers will be classed as Highly Affected Receivers. We would not anticipate that classification would extend for the whole of the construction period, but rather when work is undertaken near the shared boundary. Once the façade is installed, it is anticipated that internal fitout would be below the Noise Management Levels at receivers. The detailed construction noise management plan should take into account the construction program and schedule to manage noise impacts to neighbours.

7.3 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.

8 Construction Vibration Objectives

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 below.

A detailed construction vibration management plan shall be prepared toward the conclusion of the detailed design phase with input from the building contractor, so that it can take into account the proposed construction methodologies and equipment.

8.1 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 8-1 provides definitions and examples of each type of vibration.

Table 8-1: 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.

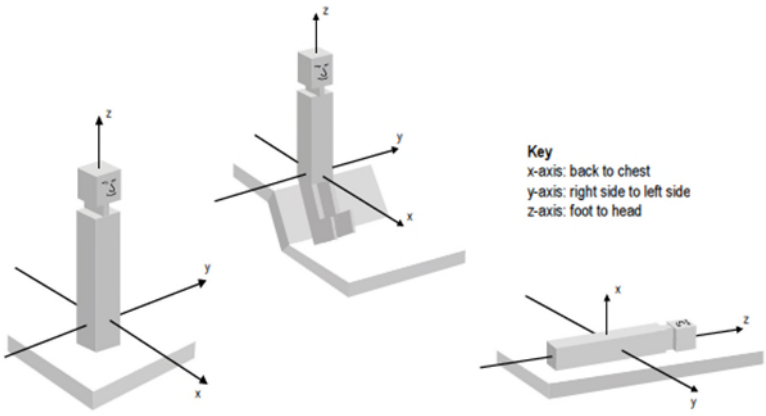
Source: Assessing Vibration; a technical guideline, Department of Environment & Climate Change, 2006

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 2. 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 2: 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 8-2.

Table 8-2: 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:
16. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
17. 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 8-3

Table 8-3: 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:
18. Daytime is 7:00am to 10:00pm and night-time is 10:00pm to 7:00am
19. 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

8.2 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.

8.2.1.1 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 8-4 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 8-4: 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

8.2.1.2 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 8-5.

Table 8-5: 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

8.2.2 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.

8.2.3 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 8-6 below.

Table 8-6: 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 8-5 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 8-6 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.

8.3 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 8-7, however these should be verified with site measurements

Table 8-7 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.

The most sensitive assets to be protected will beL

- Cross City Tunnel adjacent the site to the West
- Residential dwellings adjacent to the North and opposite on Judge Lane
- Mixed use developments to the East, West and South.

Some neighbouring residential receiver dwellings are within the safe working and so on site measurements will be required prior to/at the commencement of work to determine the site specific vibration impacts. Further, a detailed construction vibration management plan will need to be prepared as part of the detailed design phase, once more detail is known of the particular equipment to be used on site. It is likely that vibration monitoring will be required during excavation and the construction of the building structure (would not be required during fitout).

9 Conclusion

Renzo Tonin & Associates has completed a Noise and Vibration Impact Assessment of the proposed mixed used development at 164-172 and 174-194 William Street Woolloomooloo.

The assessment includes the investigation of noise emissions onto the Site and noise emission goals from the use of the Site. The assessment has found that:

- Reasonable controls can be incorporated into the building design to comply with relevant Council and NSW Planning Guidelines with respect to internal noise levels from road traffic on-site patron noise sources. Indicative requirements are detailed in Section 5.2 and 5.3.
- The noise emissions from the site are predicted to comply with the requirements of the NSW EPA road traffic noise, and to be capable of complying with the relevant EPA and Council noise emission acoustic criteria at neighbours after the detailed design of the development. This includes the determination of specific mitigation methods in keeping with the general advice nominated in Section 6.2.3 being implemented in accordance with the project trigger noise levels in Section 6.1.3.2.
- It is proposed that construction noise shall be managed in accordance with NSW EPA Interim Construction Noise Guideline. Further that the construction vibration shall be managed with Assessing Vibration: A Technical Guideline, along with additional internal standards.

On the basis of the above, noise and vibration impacts of the development are being addressed and the development is suitable for approval.

APPENDIX A Glossary of Terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
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.
Assessment period	The period in a day over which assessments are made.
Assessment Point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken or estimated.
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 L90 noise level (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of common sounds in our daytime environment:
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.

threshold of hearing	0 dB	The faintest sound we can hear
	10 dB	Human breathing
almost silent	20 dB	
	30 dB	Quiet bedroom or in a quiet national park location
generally quiet	40 dB	Library
	50 dB	Typical office space or ambience in the city at night
moderately loud	60 dB	CBD mall at lunch time
	70 dB	The sound of a car passing on the street
loud	80 dB	Loud music played at home
	90 dB	The sound of a truck passing on the street
very loud	100 dB	Indoor rock band concert
	110 dB	Operating a chainsaw or jackhammer
extremely loud	120 dB	Jet plane take-off at 100m away
threshold of pain	130 dB	
	140 dB	Military jet take-off at 25m away

Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive noise	Having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent noise	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.
L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound	A fluctuation of air pressure which is propagated as a wave through air.
Sound absorption	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound level meter	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound pressure level	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound power level	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise	Containing a prominent frequency and characterised by a definite pitch.

APPENDIX B Assessment and Design Methodology

B.1 Sydney City Council Development Control Plan 2012

Sydney Council is the regulatory authority for the proposed development. Internal noise criteria are stipulated in Council's Development Control Plan 2012 Part 4.2.3.11 – Acoustic Privacy which states the following:

4.2.3.11 Acoustic privacy

(1) A Noise Impact Assessment prepared by a suitably qualified acoustic consultant may be required when submitting a development application for commercial and retail uses which may affect the acoustic privacy of the adjacent residential use.

(2) Where necessary, a residential development is to include acoustic measures to reduce the impact of noise from external sources.

(3) Development is to incorporate measures that reduce the entry of noise from external sources into dwellings.

(4) Where possible, the attenuation of noise at its source is preferred. Where this option is adopted, the applicant will need to demonstrate that the measures to be undertaken:

(a) have the consent of relevant parties associated with that noise source; and

(b) last for the life of the development proposal.

(5) The repeatable maximum LAeq (1 hour) for residential buildings and serviced apartments must not exceed the following levels:

(a) for closed windows and doors:

(i) 35dB for bedrooms (10pm-7am); and

(ii) 45dB for main living areas (24 hours).

(b) for open windows and doors:

(i) 45dB for bedrooms (10pm-7am); and

(ii) 55dB for main living areas (24 hours).

(6) Where natural ventilation of a room cannot be achieved, the repeatable maximum LAeq (1hour) level in a dwelling when doors and windows are shut and air conditioning is operating must not exceed:

(a) 38dB for bedrooms (10pm-7am); and

(b) 48dB for main living areas (24 hours).

(7) These levels are to include the combined measured level of noise from both external sources and the ventilation system operating normally.

(8) To limit the transmission of noise to and between dwellings, all floors are to have a weighted standardised impact sound level (L'nT,w) less than or equal to 55 where the floor separates a habitable room and another habitable room, bathroom, toilet, laundry, kitchen, plant room, stairway, public corridor, hallway and the like.

(9) The overall design and layout of dwellings, where appropriate, is to include:

(a) a limit on window size and number where oriented towards an intrusive noise source;

(b) seals at entry doors to reduce noise transmission from common corridors or outside the building;

(c) minimisation of the number of shared walls with other dwelling units;

(d) storage, circulation areas, and non habitable rooms to buffer noise from external sources;

(e) double or acoustic glazing;

(f) operable screens to balconies; and

(g) continuous walls to ground level courtyards, where there would be no conflict with streetscape, security or other amenity requirements.

(10) The consent authority should not grant consent to a mixed-use development which includes two or more dwellings unless it is satisfied that separate lift access and a separate entrance will be provided for use exclusively for the dwellings.

B.2 State Environmental Planning Policy (Transport and Infrastructure) 2021

The NSW State Environmental Planning Policy (Transport and Infrastructure) 2021 commenced on 1 March 2022 and consolidated a number of former state environmental planning policies. The former State Environmental Planning Policy (Infrastructure) 2007 (known as 'ISEPP') has been integrated into "Chapter 2 Infrastructure" of the Transport and Infrastructure SEPP.

Chapter 2 of the Transport and Infrastructure SEPP aims to facilitate the effective delivery of infrastructure across NSW. The aim of the Chapter includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

Pertinent to noise assessment, the Transport and Infrastructure SEPP includes the following sections:

2.100 Impact of rail noise or vibration on non-rail development

7. This section applies to development for any of the following purposes that is on 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-

f. a building for residential use,

g. a place of public worship,

h. a hospital,

i. an educational establishment or centre-based child care facility.

8. 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 clause and published in the Gazette.

9. 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 7am,

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

2.102 Major development within Interim Metro Corridor

1. This section applies to land within the City of Sydney that is within the Interim Metro Corridor.

…3 A consent authority must not grant consent to major development on land to which this section applies if the development would have an adverse affect on the viability of the proposed metro, including by increasing the likely cost of developing the proposed metro.

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 clause 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 7am,*

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

    c. *(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.*

B.2.1 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

To support the ISEPP (which is now consolidated into the Transport and Infrastructure SEPP), the NSW Department of Planning released the *Development near Rail Corridors and Busy Roads – Interim Guideline* (December 2008). The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality. While the Transport and Infrastructure SEPP applies only to roads with an AADT greater than 20,000 vehicles, the guideline is also recommended for other road traffic noise affected sites.

B.2.2 Clarification of Transport and Infrastructure SEPP noise limits

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 Transport and Infrastructure SEPP 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 in order to meet the internal noise requirements of the Transport and Infrastructure SEPP. The equivalent external goals have been determined on the following basis:

- The 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 criteria with windows open is therefore 10dB(A) above the criteria explicitly outlined in the Transport and Infrastructure SEPP.
- 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 Building Code of Australia (BCA) ventilation requirements.

Table 8 presents the Transport and Infrastructure SEPP internal noise criteria along with the equivalent external noise criteria for residential premises.

Table 8: Transport and Infrastructure SEPP noise criteria for new residential development

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

Notes: * Requisite for 20,000AADT Roads only under Transport and Infrastructure SEPP 2021.

^ Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals 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 BCA 2011 requirements.

B.3 Australian/New Zealand Standard AS/NZS 2107:2016

As traffic noise levels are not constant, an L_{eq} noise level descriptor is used when assessing this type of noise source. The L_{eq} is the mean energy level of the noise being measured, and has been found to accurately describe the level of annoyance caused by traffic noise.

This standard provides recommended noise levels for steady state such as noise from building services and quasi-steady state sounds, such as traffic and industrial noise. The noise levels recommended in AS/NZS 2107:2016 take into account the function of the area and apply to the sound level measured within the space unoccupied although ready for occupancy.

This standard recommends the following noise levels for residential buildings.

Table 9: Recommended design sound levels for different areas of occupancy in buildings

Type of occupancy/ activity	Recommended design sound level, L_{Aeq}, dB(A)		Recommended reverberation time (T),s
	Satisfactory	Maximum	
5 OFFICE BUILDINGS			
General office areas	40	45	0.4 to 0.6
Private offices	35	40	0.6 to 0.8
Public spaces	40	50	0.5 to 1.0
Reception areas	40	45	0.6 to 0.8
Rest rooms and break-out spaces	40	45	0.4 to 0.6
Toilets	45	55	-
Undercover carparks	-	<65	-
7 RESIDENTIAL BUILDINGS (see Note 7 and Clause 5.2)			
Houses in areas with negligible transportation -			
Sleeping areas	25	30	-
Houses and apartments near minor roads -			
Living areas	30	40	-
Sleeping areas	30	35	-
Work areas	35	40	-
Apartment common areas (e.g. foyer, lift lobby)	45	50	-
Houses and apartments near major roads -			
Living areas	35	45	-
Sleeping areas	35	40	-
Work areas	35	45	-
Apartment common areas (e.g. foyer, lift lobby)	45	50	-
8 SHOP BUILDINGS			
Enclosed carparks	-	<65	-
Show rooms	-	<50	See Note 3
Small retails stores (general)	-	<50	See Note 3
Specialty Shops (where detailed discussion is necessary in transactions)	-	<45	See Note 3

NOTES:

20. The recommended design sound levels are for a fully fitted out and completed building. Attention is drawn to the additive noise effect of many machines within the same area and adjacent areas. Allowance for the total number and type of noise sources should therefore be made in the selection of equipment and in the design of building spaces. A building owner or developer may consider an allowance of 3-5 dB(A) to be appropriate.
21. Recommended reverberation time is 10 percent to 20 percent higher than Curve 1 of Appendix A.
22. Reverberation time should be minimized as far as practicable for noise control.
23. Certain teaching spaces, including those intended for students with learning difficulties and students with English as a second language, should have reverberation times at the lower end of the specified range.
24. Specialist advice should be sought for these spaces.
25. A very wide range of noise levels can occur in the occupied state in spaces housing manufacturing processes, and the levels are primarily subject to control as part of a noise management program (see AS/NZS 1269.2). The possibilities for segregating very noisy processes from quieter ones by partitioning vary between particular industries and plants. For reasons such as these, it is difficult to make generalized recommendations for desirable, or even maximum, design levels for the unoccupied state, but one guiding

Type of occupancy/ activity	Recommended design sound level, L_{Aeq}, dB(A)		Recommended reverberation time (T),s
	Satisfactory	Maximum	

principle may still be observed - when the activity in one area of a manufacturing plant is halted, it is desirable that the local level should if possible drop to 70 dB(A) or lower to permit speech communication without undue effort.

26. In situations where traffic noise levels may vary widely over a 24-hour period, measurements to assess compliance with this Standard should be taken at the relevant time and for an appropriate measurement period according to the area of occupancy or activity in the building. Where traffic noise fluctuates rapidly with the passage of individual vehicles, the community reaction may not correlate well with the equivalent continuous noise level as measured.

27. The overall sound pressure level in dB(A) should conform to the recommended design sound level given in Table 1. In these spaces, a balanced sound pressure level across the full frequency range is essential. These spaces should therefore be evaluated in octave bands across the full frequency spectrum. The recommended maximum sound pressure levels for the individual octave bands corresponding to the overall dB(A) value are given in Appendix C.

28. In spaces in which high quality sound recordings are to be made, the levels set for low frequency octave bands should not be exceeded (see Appendix C). Subsequent replay of the recordings may cause an amplification of the ambient sound resulting in an overemphasis of its low-frequency components. Specialist advice should always be sought when these spaces are being designed. In some circumstances, for purposes of very high quality recording, lower levels than those specified in Table 1 may be required.

APPENDIX C Internal sound insulation

C.1 National Construction Code 2022

The National Construction Code of Australia (NCC) outlines minimum requirements for inter-tenancy (party) walls and ceiling/ floors to maintain privacy. This includes the incorporation of penetration of a service through a floor or through more than one sole-occupancy unit.

NCC nominates required Weighted Sound Reduction Indexes (R_w) and spectrum adaptation factor (C_{tr}) for partition constructions, of different space/ activity types in adjoining units. The R_w and $R_w + C_{tr}$ are single number descriptors for quantifying the attenuating performance of partitions for typical intrusive noises produced inside residences. The higher the rating, the greater the isolation provided by the partition.

Spectrum adaptation factors are commonly used to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others insulate.

The adaptation factor C_{tr} has now been introduced for most building elements which require an airborne sound insulation rating. The only exception is a wall which separates a dwelling from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification. Therefore, both the C_{tr} factor and the R_w of the building element will need to be considered in most cases.

The C_{tr} factor takes into account lower frequency level sounds, and has been chosen in large part, in recognition of the problem of the high bass frequency outputs of modern home theatre systems and music reproduction equipment.

The Deemed-to-Satisfy Provisions also have impact sound insulation requirements for floors. The terms to describe the impact sound insulation of the floor is the weighted normalised impact sound pressure level ($L_{n,w}$). The lower the $L_{n,w}$ of the floor, the better the performance of the floor in terms of impact sound insulation.

The following section represents a summary of acoustic provisions outlined in the Part F5 of the NCC.

C.2 Sound insulation provision of NCC 2022

The acoustic provisions for inter-tenancy walls and floors in Class 2 and 3 buildings are outlined in the National Construction Code of Australia and the following is an extract from the NCC:

> *"F5.2 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 (R_w) or weighted sound reduction index with spectrum adaptation term ($R_w + C_{tr}$) determined in accordance with AS/NZS 1276.1 or ISO 717.1 using results from laboratory measurements; or

b. comply with Specification F5.2.

F5.3 Determination of impact sound insulation ratings

a. A floor in a building required to have an impact sound insulation rating must –

i. have the required value for weighted normalised impact sound pressure level with spectrum adaptation term ($L_{n,w}$) determined in accordance with AS/ISO 717.2 using results from laboratory measurements; or

ii. comply with Specification F5.2.

b. A wall in a building required to have an impact sound insulation rating must –

i. for a Class 2 or 3 building be of discontinuous construction;

c. For the purposes of this part, discontinuous construction means a wall having a minimum 20 mm cavity between 2 separate leaves, and

i. for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and

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

F5.4 Sound insulation rating of floors

a. A floor in a Class 2 or 3 building must have an $R_w + C_{tr}$ (airborne) not less than 50 and an $L_{n,w}$ (impact) not more than 62 if it separates –

i. sole-occupancy units; or

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

F5.5 Sound insulation rating of walls

a. A wall in a Class 2 or 3 building must –

i. have an $R_w + C_{tr}$ (airborne) not less than 50, if it separates sole-occupancy units; and

ii. have an R_w (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

iii. comply with F5.3(b) if it separates:

(A) 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

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

b. 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 R_w not less than 30.

c. Where a wall required to have sound insulation has a floor above, the wall must continue to –

i. the underside of the floor above; or

ii. a ceiling that provides the sound insulation required for the wall.

F5.6 Sound insulation rating of services

a. If a duct, 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 $R_w + C_{tr}$ (airborne) not less than –

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

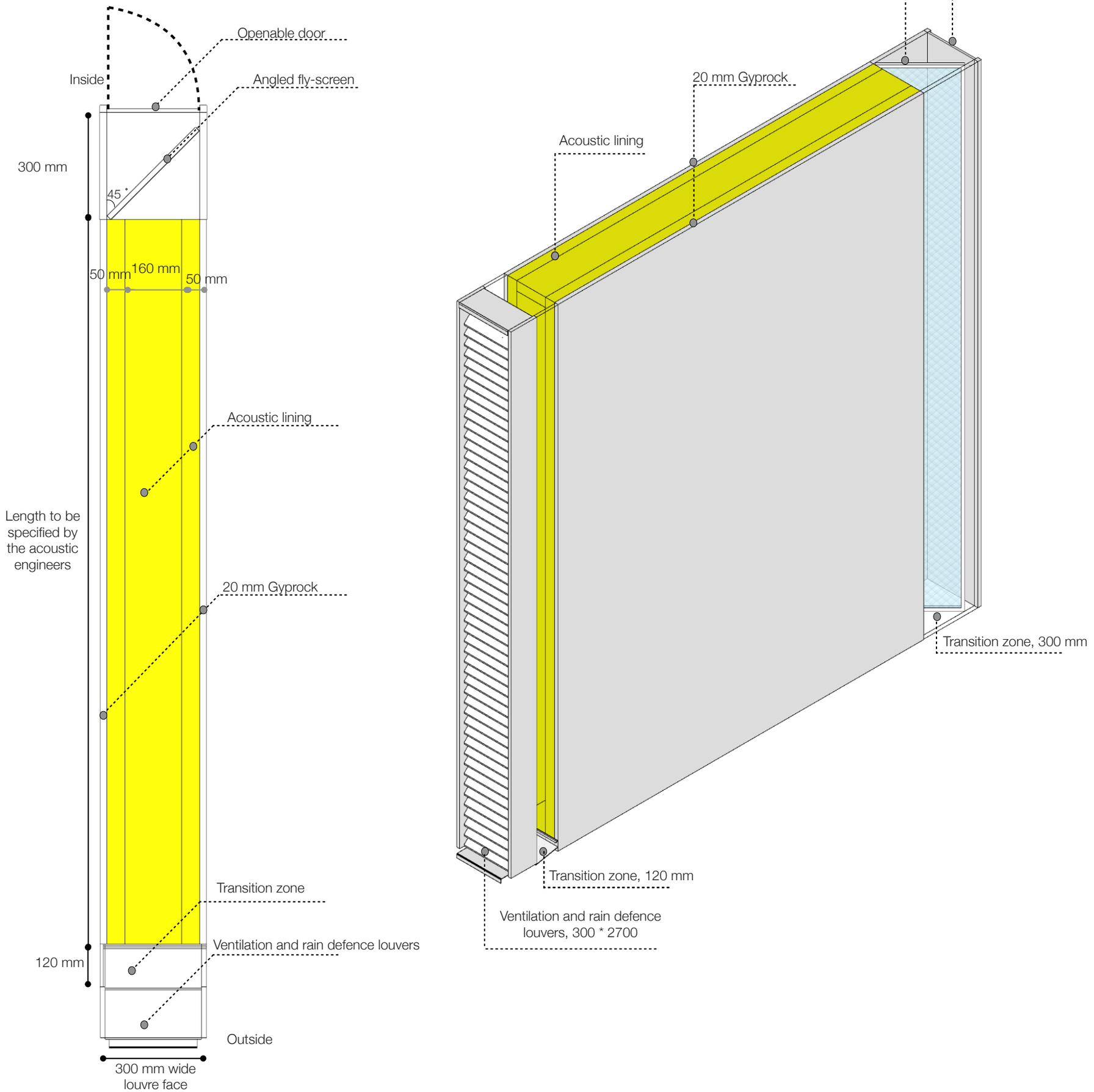
ii. 25 if the adjacent room is a kitchen or non-habitable room.

b. If a storm water pipe passes through a sole-occupancy unit it must be separated in accordance with (a)(i) and (ii).

F5.7 Sound insulation of pumps

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

APPENDIX D Typical Acoustic Plenum Detail


Openable door
Inside
Angled fly-screen
300 mm
45 °
50 mm
160 mm
50 mm
Acoustic lining
Length to be specified by the acoustic engineers
20 mm Gyprock
Transition zone
120 mm
Ventilation and rain defence louvers
Outside
300 mm wide louvre face
Angled fly-screen
Openable door
20 mm Gyprock
Acoustic lining
Transition zone, 300 mm
Transition zone, 120 mm
Ventilation and rain defence louvers, 300 * 2700

APPENDIX E Results of Unattended Noise Monitoring

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Acoustics
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Structural Dynamics

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Level 3 terrace facing William St

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017

Periods with insufficient results excluded	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Thursday-18-November-2021	-	-	48	-	-	66
Friday-19-November-2021	62	-	-	71	-	-
Saturday-20-November-2021	60	61	-	70	69	-
Sunday-21-November-2021	-	-	49	-	-	67
Monday-22-November-2021	62	60	49	71	69	67
Tuesday-23-November-2021	62	60	48	71	69	66
Wednesday-24-November-2021	62	-	52	71	-	69
Thursday-25-November-2021	-	-	-	-	-	-
Representative Weekday[5]	**62**	**60**	**48**	**71**	**69**	**67**
Representative Weekend[5]	**60**	**61**	**49**	**70**	**69**	**67**
Representative Week[5]	**62**	**60**	**49**	**71**	**69**	**67**

Notes:

1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm

3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. 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.

Level 3 terrace facing William St

Road / Rail Noise Monitoring Results (at one metre from façade)

Periods with insufficient results excluded	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	**Day[1]**	**Night[2]**	**Day - Up[4]**	**Day - Low[5]**	**Night - Up[4]**	**Night - Low[5]**
Thursday-18-November-2021	-	69	-	-	71	62
Friday-19-November-2021	73	69	74	72	71	65
Saturday-20-November-2021	72	-	73	71	-	-
Sunday-21-November-2021	-	69	-	-	72	63
Monday-22-November-2021	73	69	74	71	72	64
Tuesday-23-November-2021	73	69	74	71	71	63
Wednesday-24-November-2021	-	71	-	-	73	67
Thursday-25-November-2021	-	-	-	-	-	-
Representative Weekday[3]	**73**	**69**	**74**	**71**	**71**	**64**
Representative Weekend[3]	**72**	**69**	**73**	**71**	**72**	**63**
Representative Week[3]	**73**	**69**	**74**	**71**	**71**	**64**

Notes:

1. Day is 7:00am to 10:00pm 2. Night is 10:00pm to 7:00am 3. Median of daily L_{Aeq}

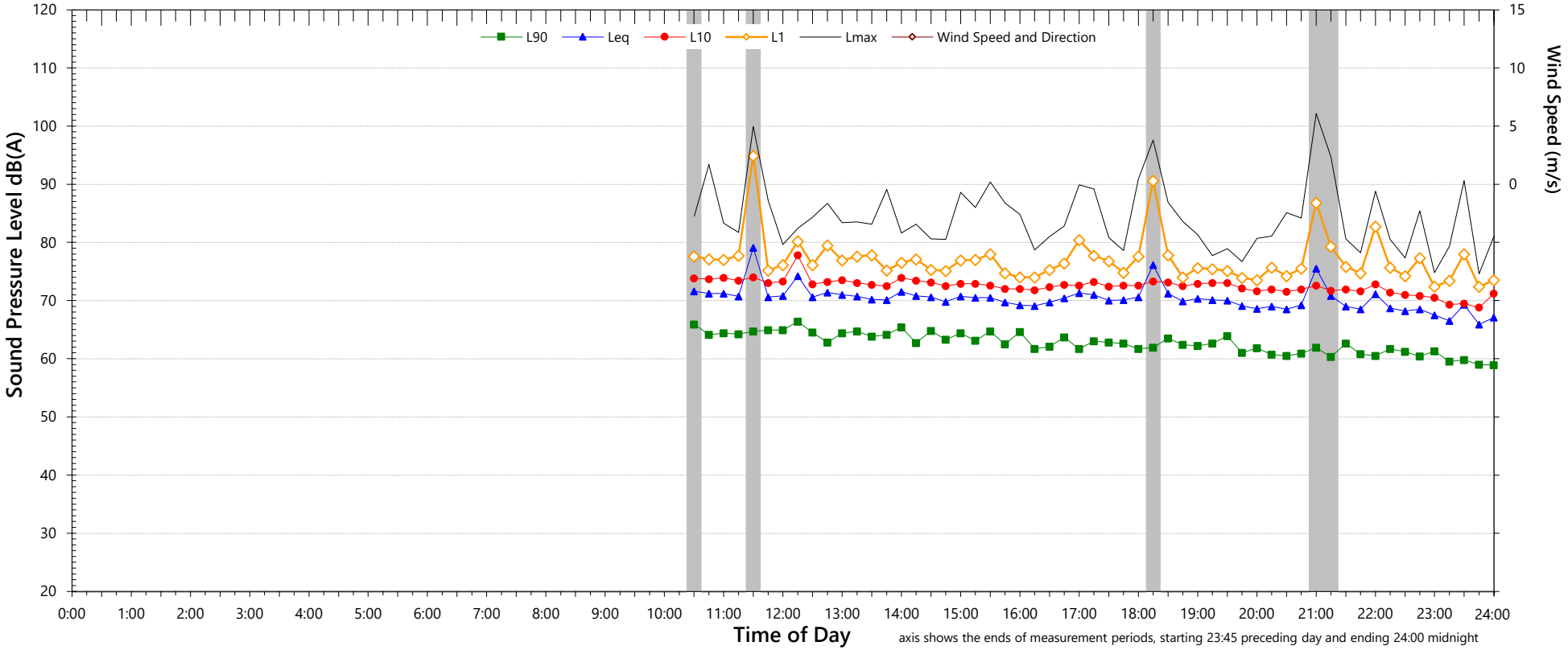
4. Upper 10th percentile $L_{Aeq\ 1hr}$ 5. Lower 10th percentile $L_{Aeq\ 1hr}$

6. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Thursday, 18 November 2021



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	-	-	48
L_{Aeq}	-	-	66

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	77	to	91
L_{AFMax} - L_{Aeq} (Range)	15	to	23

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	-	69
$L_{Aeq\ 1hr}$ upper 10 percentile	-	71
$L_{Aeq\ 1hr}$ lower 10 percentile	-	62

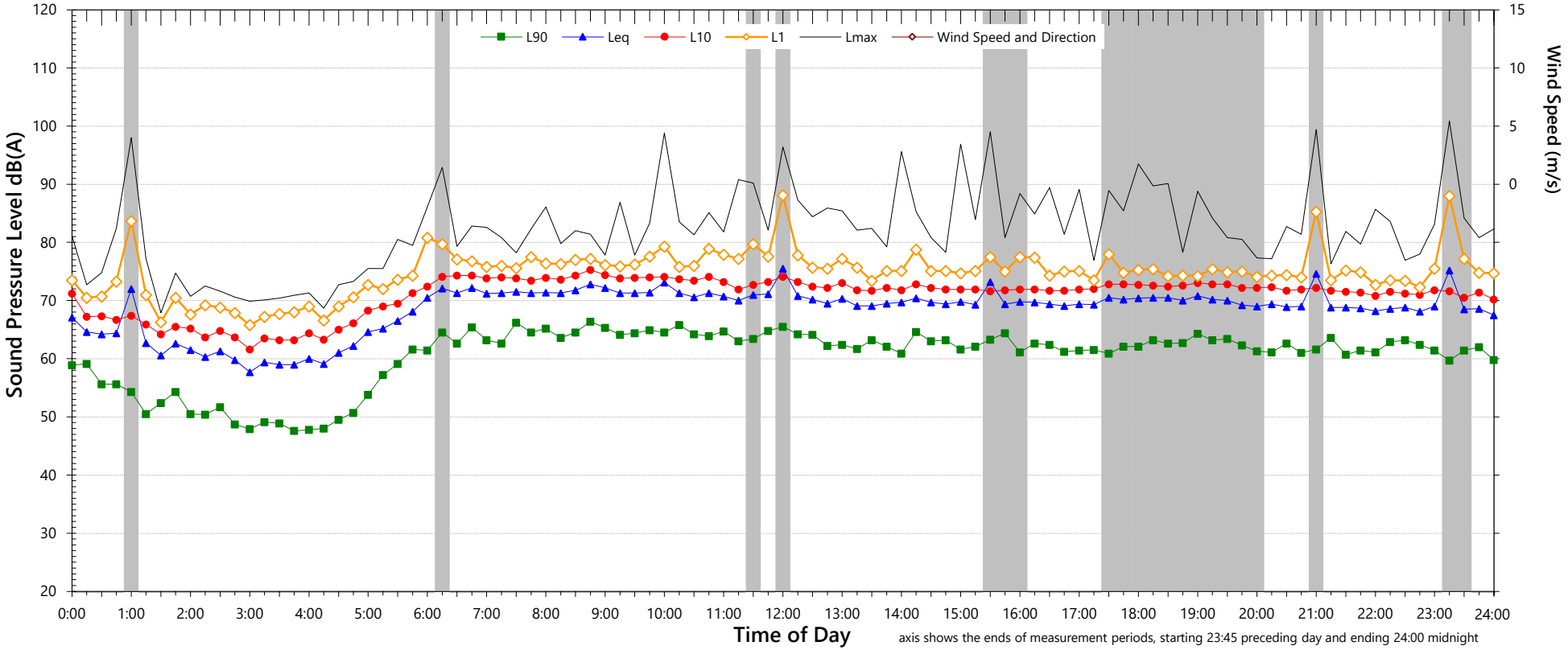
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Friday, 19 November 2021



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	62	-	-
L_{Aeq}	71	-	-

NSW Road Noise Policy (1m from facade)	(see note 6)	
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	73	69
$L_{Aeq\ 1hr}$ upper 10 percentile	74	71
$L_{Aeq\ 1hr}$ lower 10 percentile	72	65

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	80	to	88
L_{AFMax} - L_{Aeq} (Range)	15	to	23

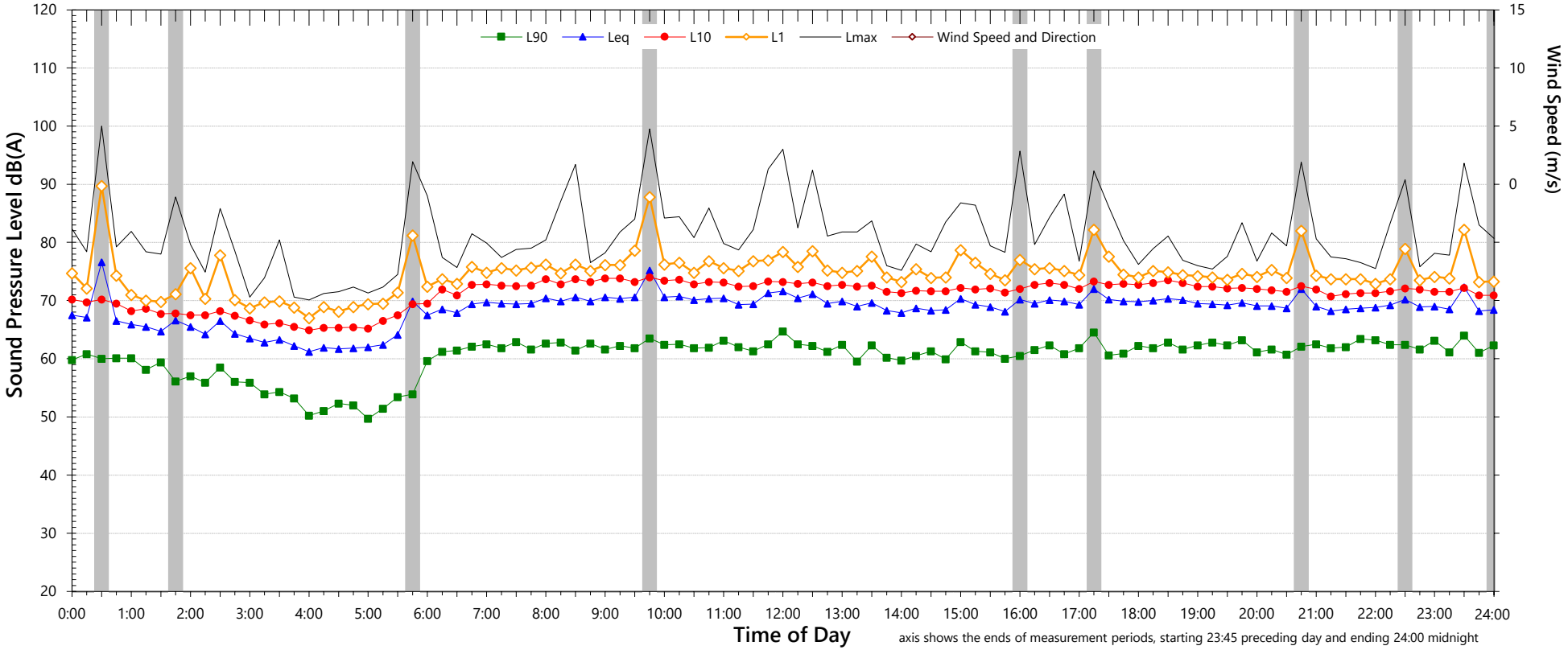
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Saturday, 20 November 2021



axis shows the ends of measurement periods, starting 23:45 preceding day and ending 24:00 midnight

NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	60	61	-
L_{Aeq}	70	69	-

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	94	to	94
L_{AFMax} - L_{Aeq} (Range)	24	to	24

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	72	-
$L_{Aeq\ 1hr}$ upper 10 percentile	73	-
$L_{Aeq\ 1hr}$ lower 10 percentile	71	-

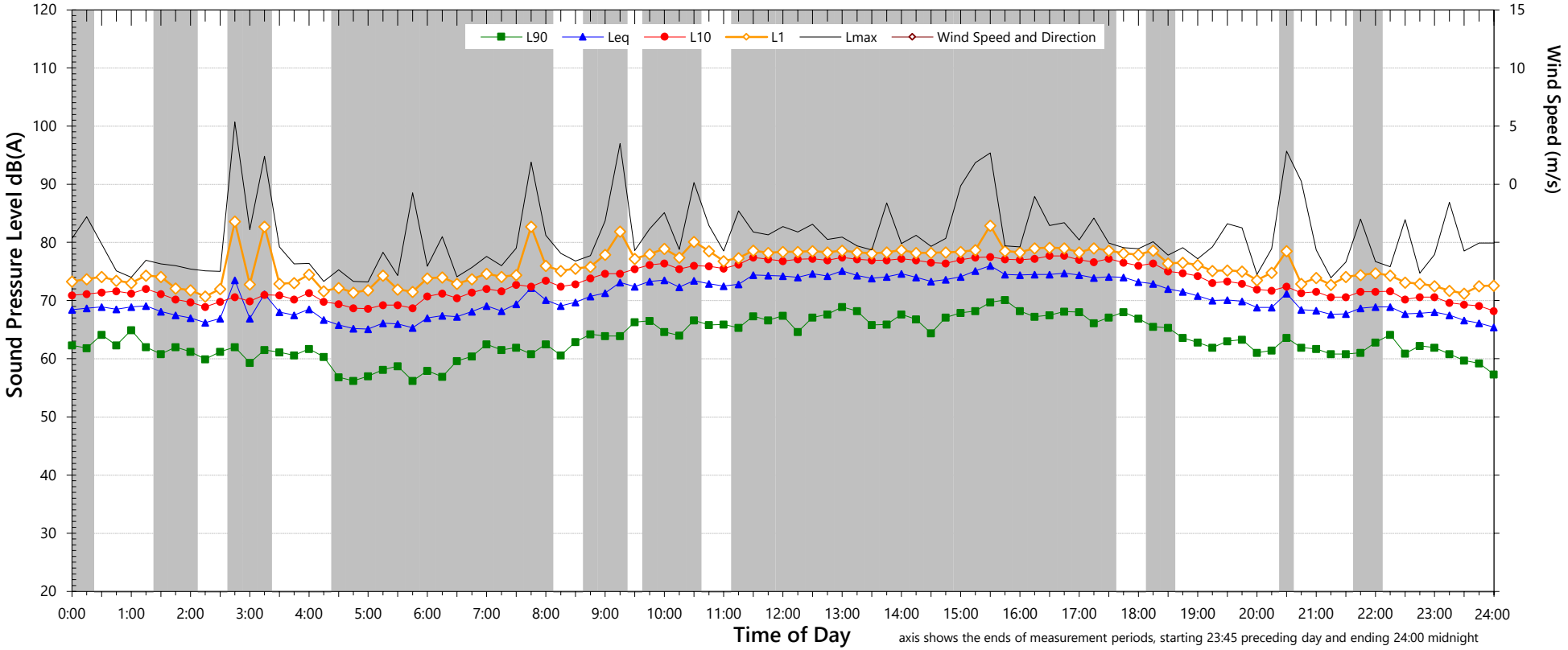
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Sunday, 21 November 2021



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	-	-	49
L_{Aeq}	-	-	67

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	78	to	87
L_{AFMax} - L_{Aeq} (Range)	16	to	26

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	-	69
$L_{Aeq\ 1hr}$ upper 10 percentile	-	72
$L_{Aeq\ 1hr}$ lower 10 percentile	-	63

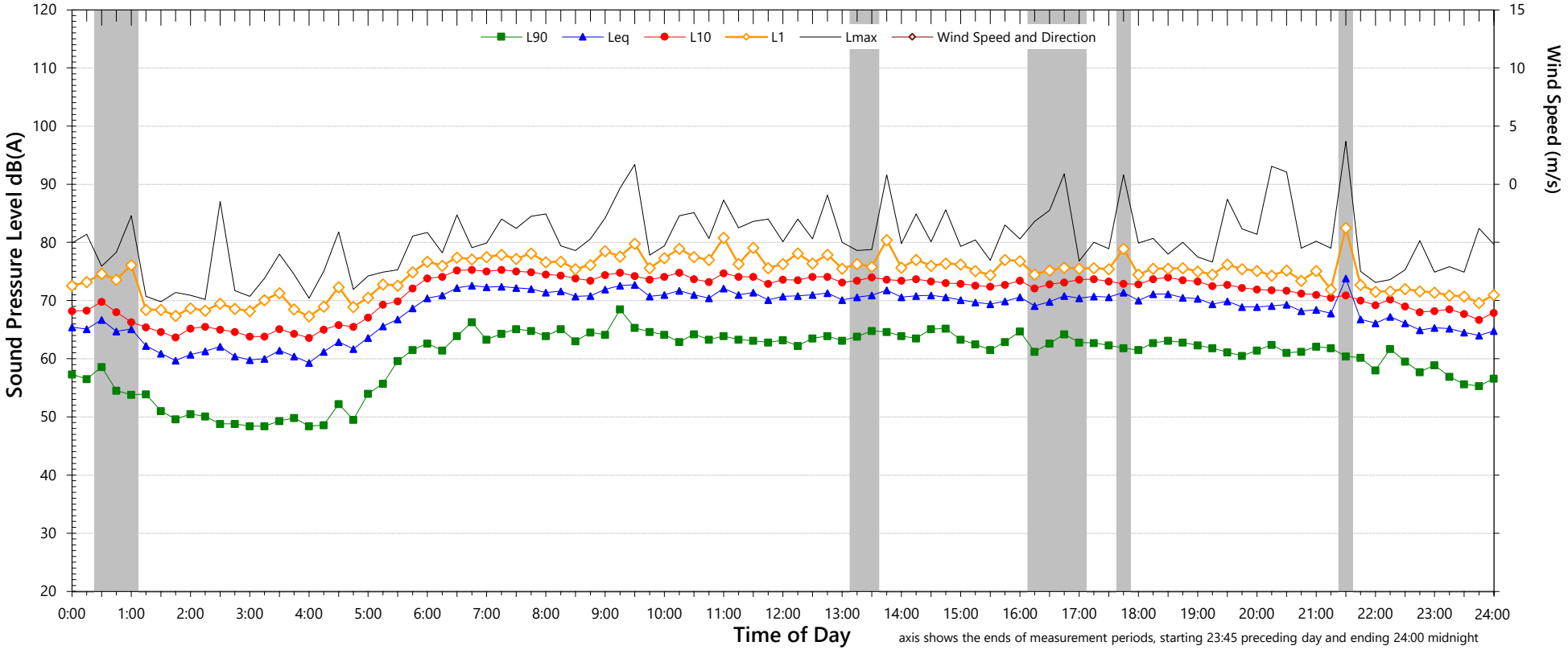
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Monday, 22 November 2021



axis shows the ends of measurement periods, starting 23:45 preceding day and ending 24:00 midnight

NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	62	60	49
L_{Aeq}	71	69	67

NSW Road Noise Policy (1m from facade)	(see note 6)	
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	73	69
$L_{Aeq\ 1hr}$ upper 10 percentile	74	72
$L_{Aeq\ 1hr}$ lower 10 percentile	71	64

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	80	to	89
L_{AFMax} - L_{Aeq} (Range)	16	to	25

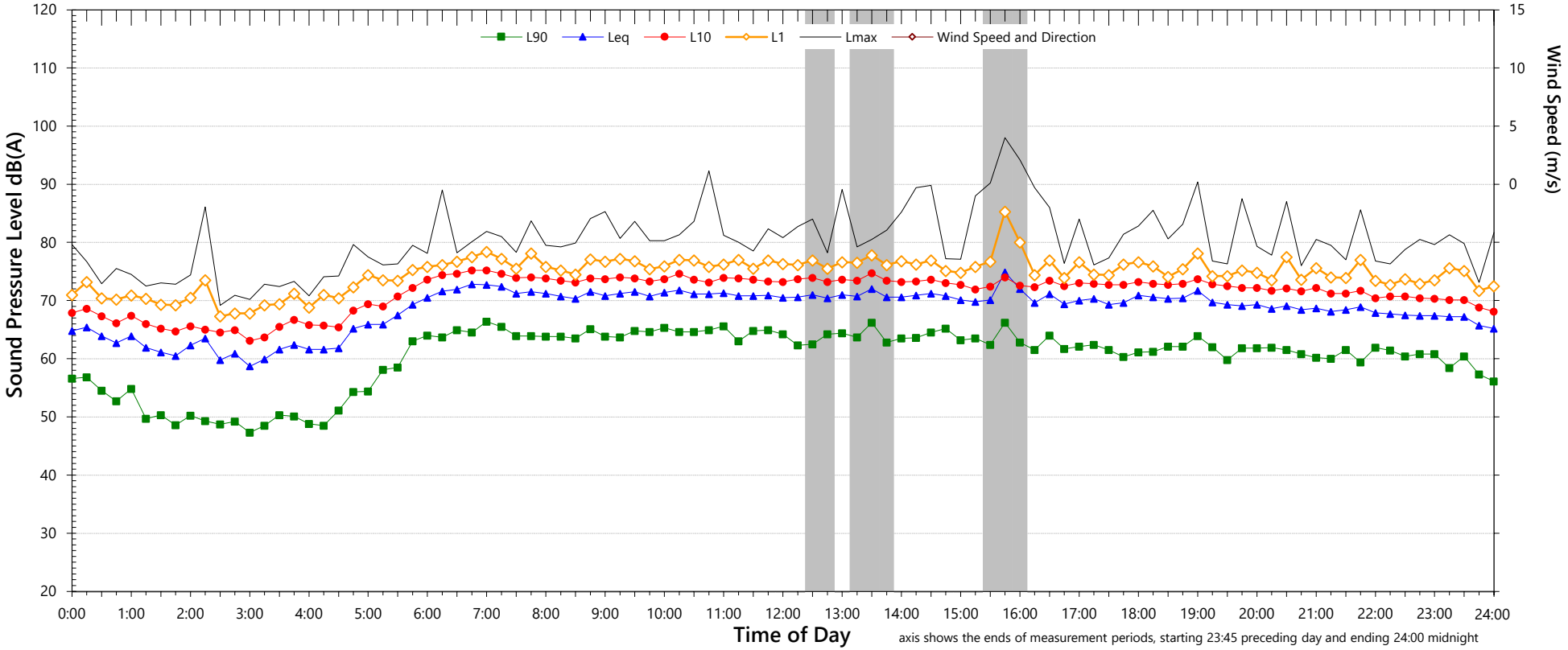
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Tuesday, 23 November 2021



NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	62	60	48
L_{Aeq}	71	69	66

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	76	to	85
L_{AFMax} - L_{Aeq} (Range)	15	to	19

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	73	69
$L_{Aeq\ 1hr}$ upper 10 percentile	74	71
$L_{Aeq\ 1hr}$ lower 10 percentile	71	63

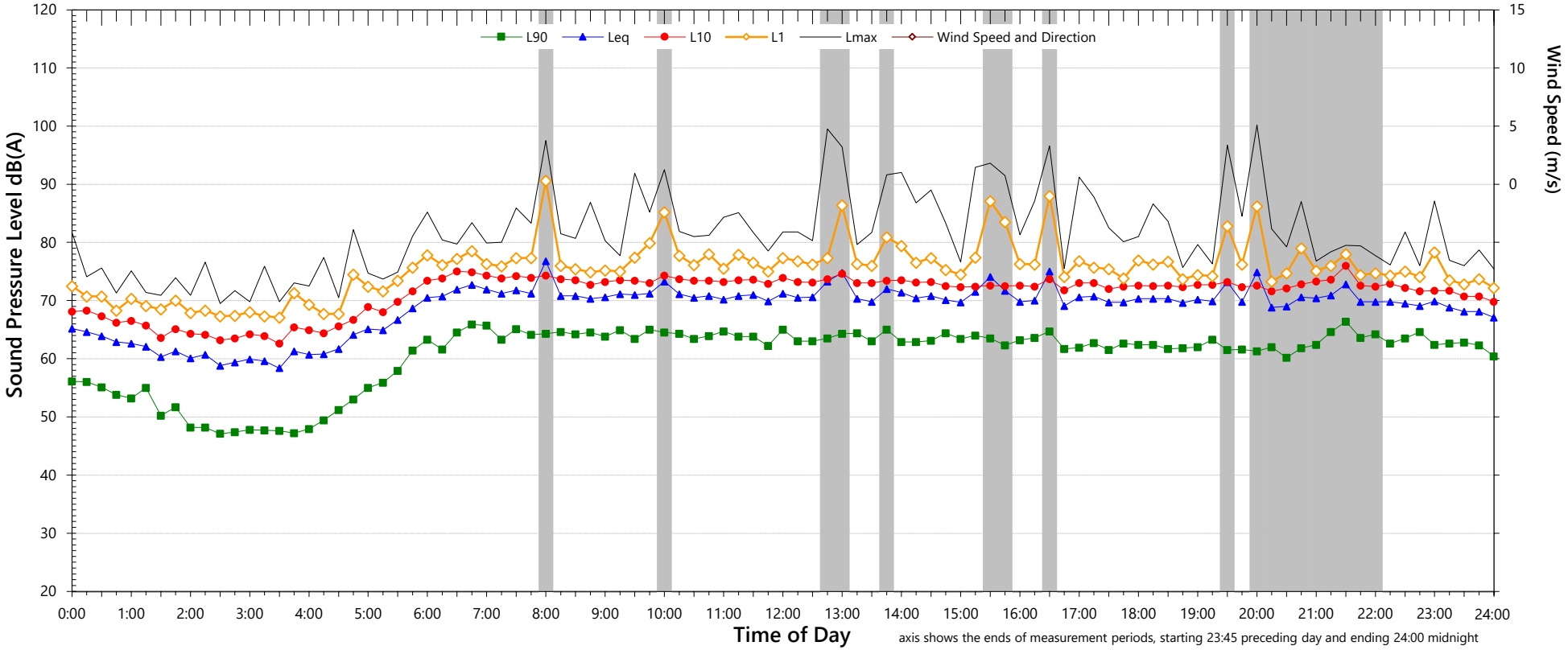
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Wednesday, 24 November 2021



axis shows the ends of measurement periods, starting 23:45 preceding day and ending 24:00 midnight

NSW Noise Policy for Industry (Free Field)			
Descriptor	Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL	62	-	52
L_{Aeq}	71	-	69

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	-	71
$L_{Aeq\ 1hr}$ upper 10 percentile	-	73
$L_{Aeq\ 1hr}$ lower 10 percentile	-	67

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	87	to	97
L_{AFMax} - L_{Aeq} (Range)	17	to	23

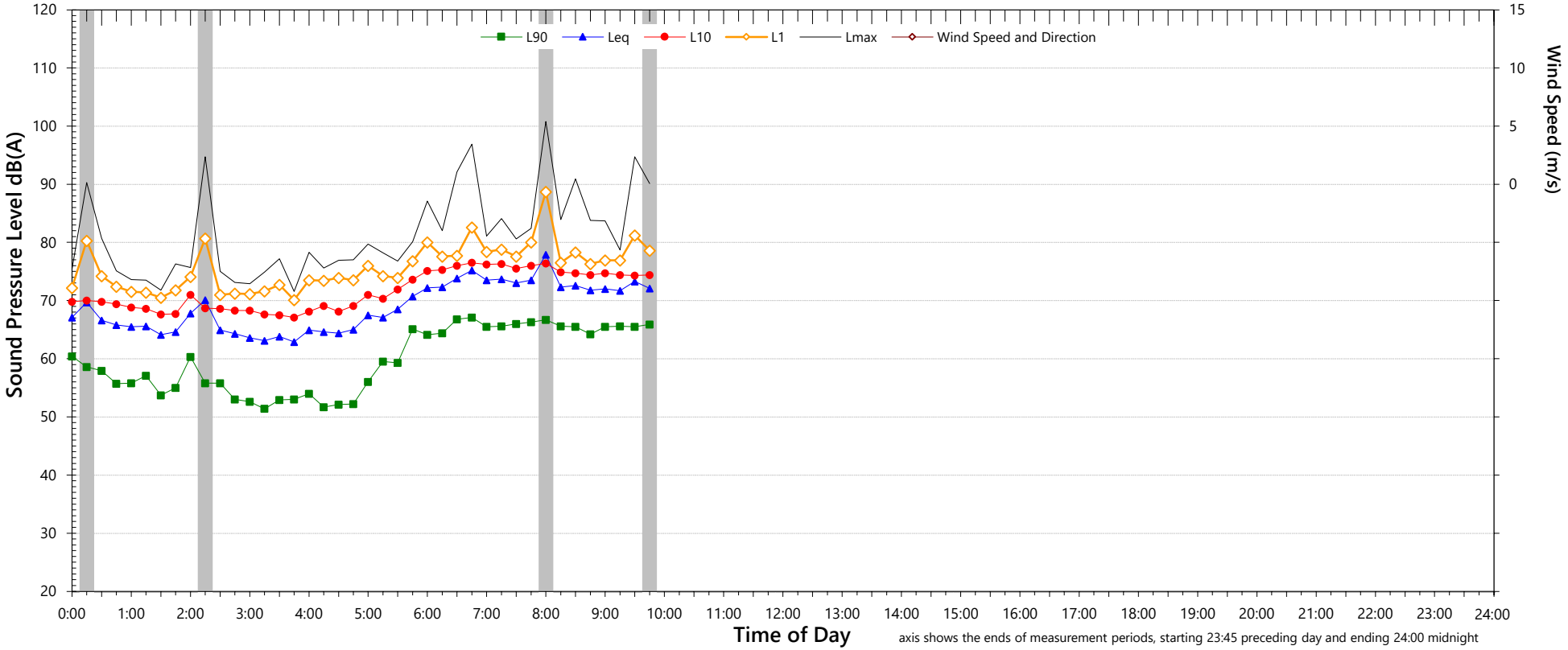
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

Level 3 terrace facing William St

Thursday, 25 November 2021



NSW Noise Policy for Industry (Free Field)			
Descriptor	**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{A90} ABL	-	-	-
L_{Aeq}	-	-	-

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	-	to	-
L_{AFMax} - L_{Aeq} (Range)	-	to	-

NSW Road Noise Policy (1m from facade)		(see note 6)
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	-	-
$L_{Aeq\ 1hr}$ upper 10 percentile	-	-
$L_{Aeq\ 1hr}$ lower 10 percentile	-	-

Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured in free-field; tabulated results facade corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

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North Building L3 facing North

Background & Ambient Noise Monitoring Results - NSW 'Noise Policy for Industry', 2017

Periods with insufficient results excluded	L_{A90} Background Noise Levels[4]			L_{Aeq} Ambient Noise Levels		
Date	**Day[1]**	**Evening[2]**	**Night[3]**	**Day[1]**	**Evening[2]**	**Night[3]**
Monday-15-November-2021	-	47	44	-	50	47
Tuesday-16-November-2021	50	46	44	54	55	47
Wednesday-17-November-2021	50	48	45	53	51	48
Thursday-18-November-2021	51	48	45	54	54	47
Friday-19-November-2021	51	47	45	54	51	47
Saturday-20-November-2021	48	47	47	54	50	49
Sunday-21-November-2021	47	45	44	53	48	46
Monday-22-November-2021	50	45	45	54	50	47
Tuesday-23-November-2021	50	46	44	54	51	47
Wednesday-24-November-2021	50	49	44	54	52	48
Thursday-25-November-2021	-	-	-	-	-	-
Representative Weekday[5]	**50**	**47**	**44**	**54**	**52**	**47**
Representative Weekend[5]	**47**	**46**	**45**	**53**	**49**	**48**
Representative Week[5]	**50**	**47**	**44**	**54**	**51**	**47**

Notes:

1. Day is 7:00am to 6:00pm on all days except Sundays and Public Holidays when it is 8:00am to 6:00pm 2. Evening is 6:00pm to 10:00pm

3. Night is the remaining periods 4. Assessment Background Level (ABL) for individual days 5. Rating Background Level (RBL) for L_{A90} and logarithmic average for L_{Aeq} 6. Leq is calculated in the free field. 2.5dB is subtracted from results if logger is placed at façade 7. 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.

North Building L3 facing North

Road / Rail Noise Monitoring Results (at one metre from façade)

Periods with insufficient results excluded	L_{Aeq} Noise Levels		$L_{Aeq\ 1hr}$ Noise Levels			
Date	**Day[1]**	**Night[2]**	**Day - Up[4]**	**Day - Low[5]**	**Night - Up[4]**	**Night - Low[5]**
Monday-15-November-2021	-	50	-	-	51	45
Tuesday-16-November-2021	56	49	58	54	52	45
Wednesday-17-November-2021	55	50	57	52	53	46
Thursday-18-November-2021	57	50	58	54	52	46
Friday-19-November-2021	56	50	57	52	51	46
Saturday-20-November-2021	56	51	58	52	52	50
Sunday-21-November-2021	54	49	56	50	51	46
Monday-22-November-2021	55	49	57	52	51	47
Tuesday-23-November-2021	56	49	57	52	52	45
Wednesday-24-November-2021	56	50	57	54	52	47
Thursday-25-November-2021	-	-	-	-	-	-
Representative Weekday[3]	**56**	**50**	**57**	**52**	**52**	**46**
Representative Weekend[3]	**55**	**50**	**57**	**51**	**51**	**48**
Representative Week[3]	**56**	**50**	**57**	**52**	**52**	**46**

Notes:

1. Day is 7:00am to 10:00pm 2. Night is 10:00pm to 7:00am 3. Median of daily L_{Aeq}

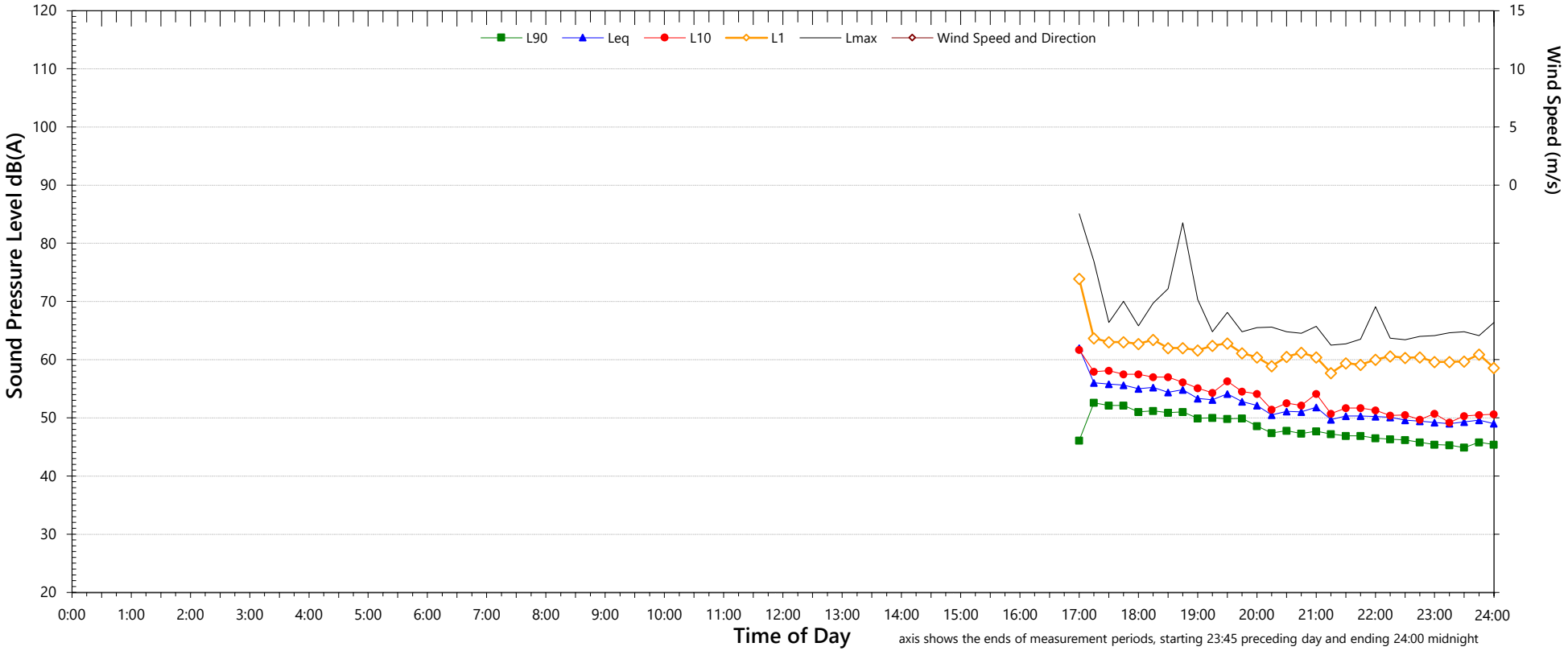
4. Upper 10th percentile $L_{Aeq\ 1hr}$ 5. Lower 10th percentile $L_{Aeq\ 1hr}$

6. Values are calculated at the facade. 2.5dB is added to results if logger is placed in the free field

Unattended Noise Monitoring Results

North Building L3 facing North

Monday, 15 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		**Day**[2]	**Evening**[3]	**Night**[4 5]
L_{A90} ABL		-	47	44
L_{Aeq}	(see note 6)	-	50	47

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	66	to	90
L_{AFMax} - L_{Aeq} (Range)	15	to	35

NSW Road Noise Policy (1m from facade)		
Descriptor	**Day**	**Night**[5]
	7am-10pm	**10pm-7am**
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	-	50
$L_{Aeq\ 1hr}$ upper 10 percentile	-	51
$L_{Aeq\ 1hr}$ lower 10 percentile	-	45

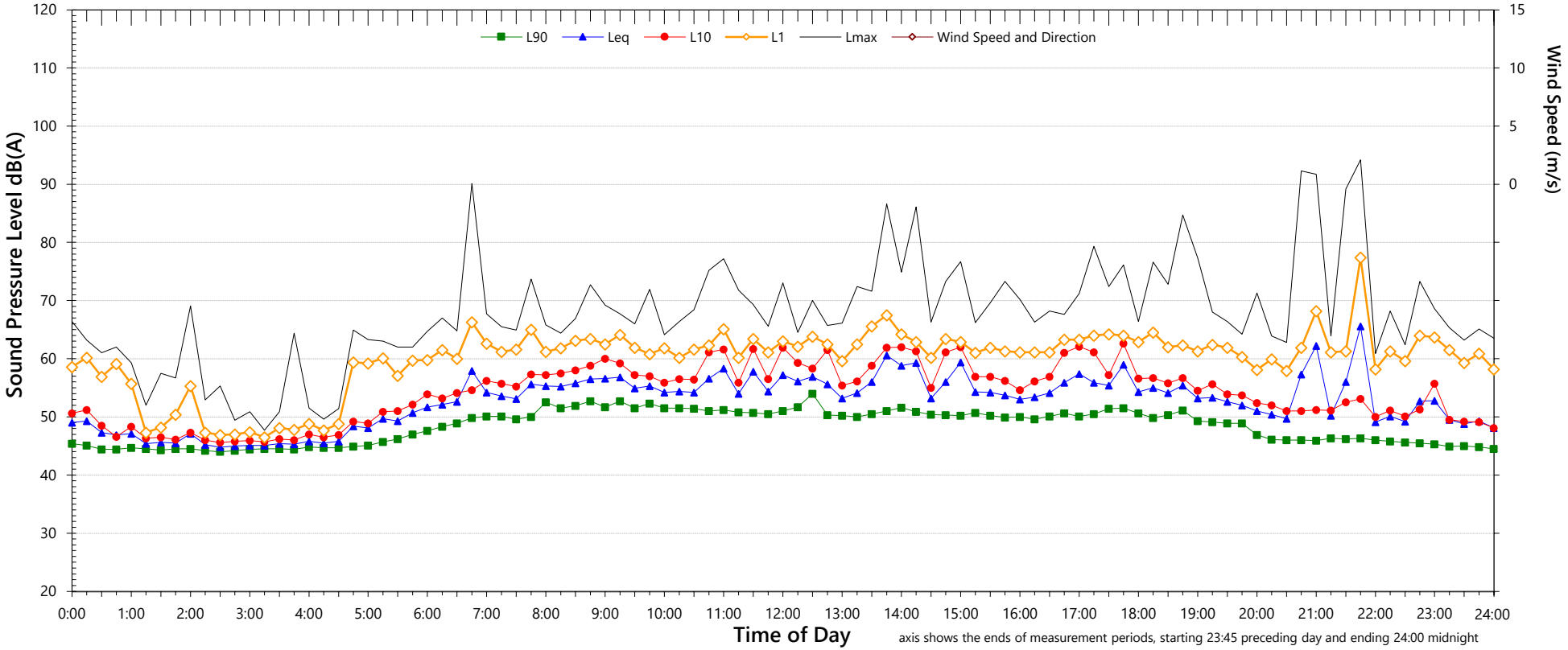
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Tuesday, 16 November 2021



axis shows the ends of measurement periods, starting 23:45 preceding day and ending 24:00 midnight

NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		50	46	44
L_{Aeq}	(see note 6)	54	55	47

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	65	to	75
L_{AFMax} - L_{Aeq} (Range)	16	to	22

NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	56	49
$L_{Aeq\ 1hr}$ upper 10 percentile	58	52
$L_{Aeq\ 1hr}$ lower 10 percentile	54	45

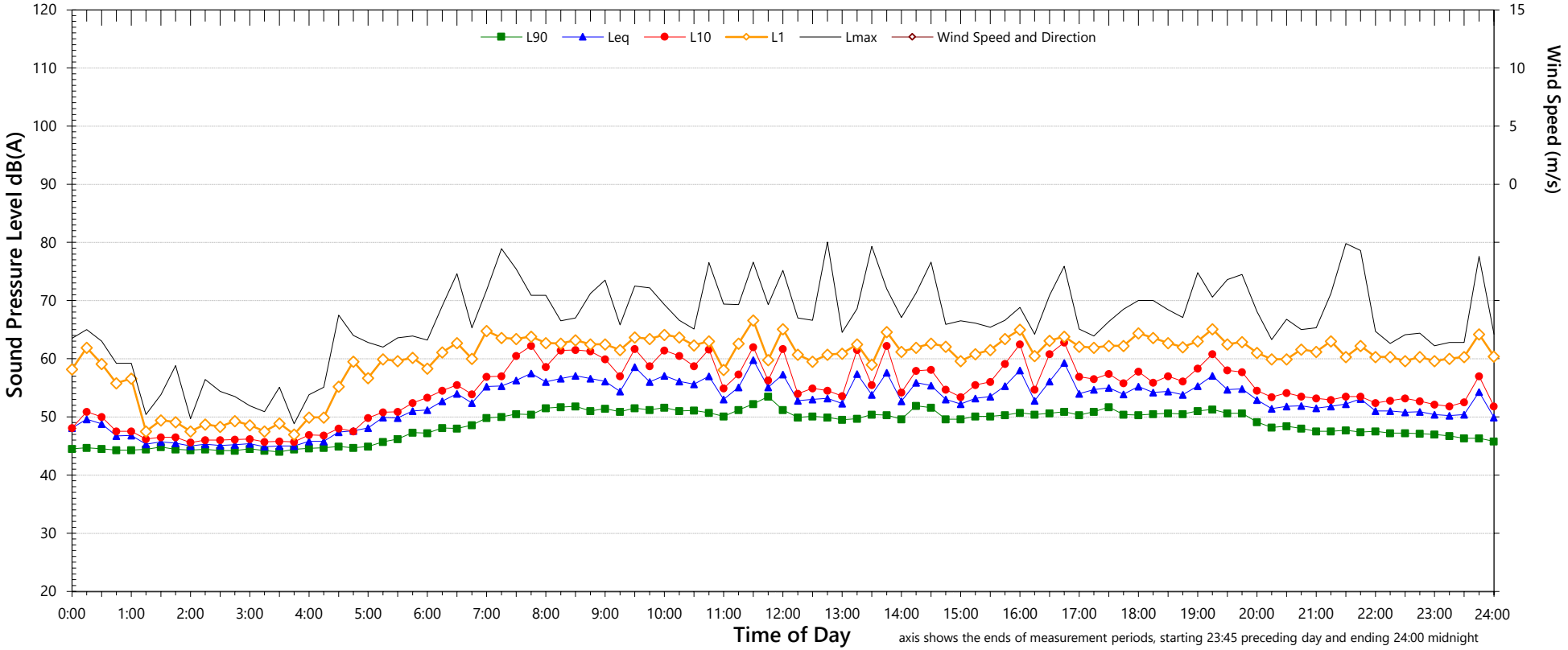
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Wednesday, 17 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		50	48	45
L_{Aeq}	(see note 6)	53	51	48

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	65	to	82
L_{AFMax} - L_{Aeq} (Range)	16	to	27

NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	55	50
$L_{Aeq\ 1hr}$ upper 10 percentile	57	53
$L_{Aeq\ 1hr}$ lower 10 percentile	52	46

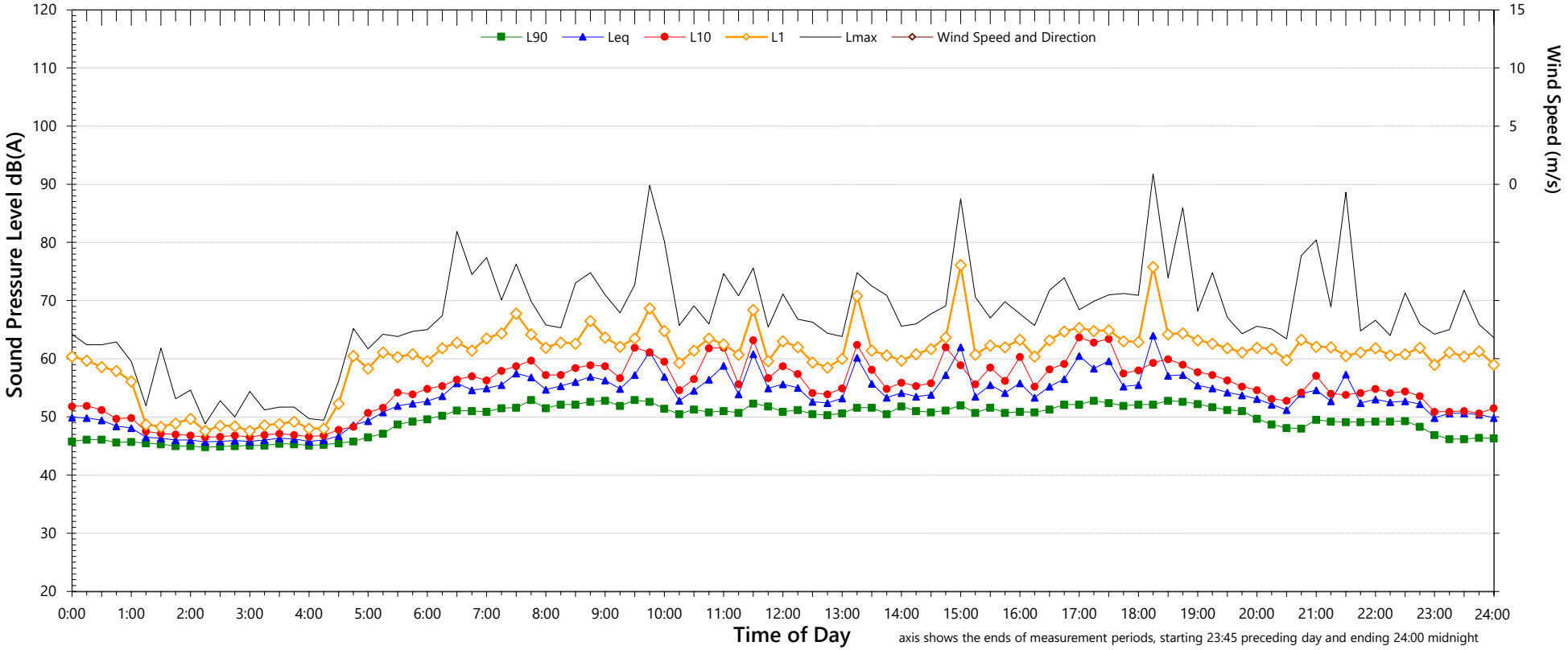
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Thursday, 18 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		**Day**[2]	**Evening**[3]	**Night**[4 5]
L_{A90} ABL		51	48	45
L_{Aeq}	(see note 6)	54	54	47

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	66	to	79
L_{AFMax} - L_{Aeq} (Range)	18	to	26

NSW Road Noise Policy (1m from facade)		
Descriptor	**Day**	**Night**[5]
	7am-10pm	**10pm-7am**
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	57	50
$L_{Aeq\ 1hr}$ upper 10 percentile	58	52
$L_{Aeq\ 1hr}$ lower 10 percentile	54	46

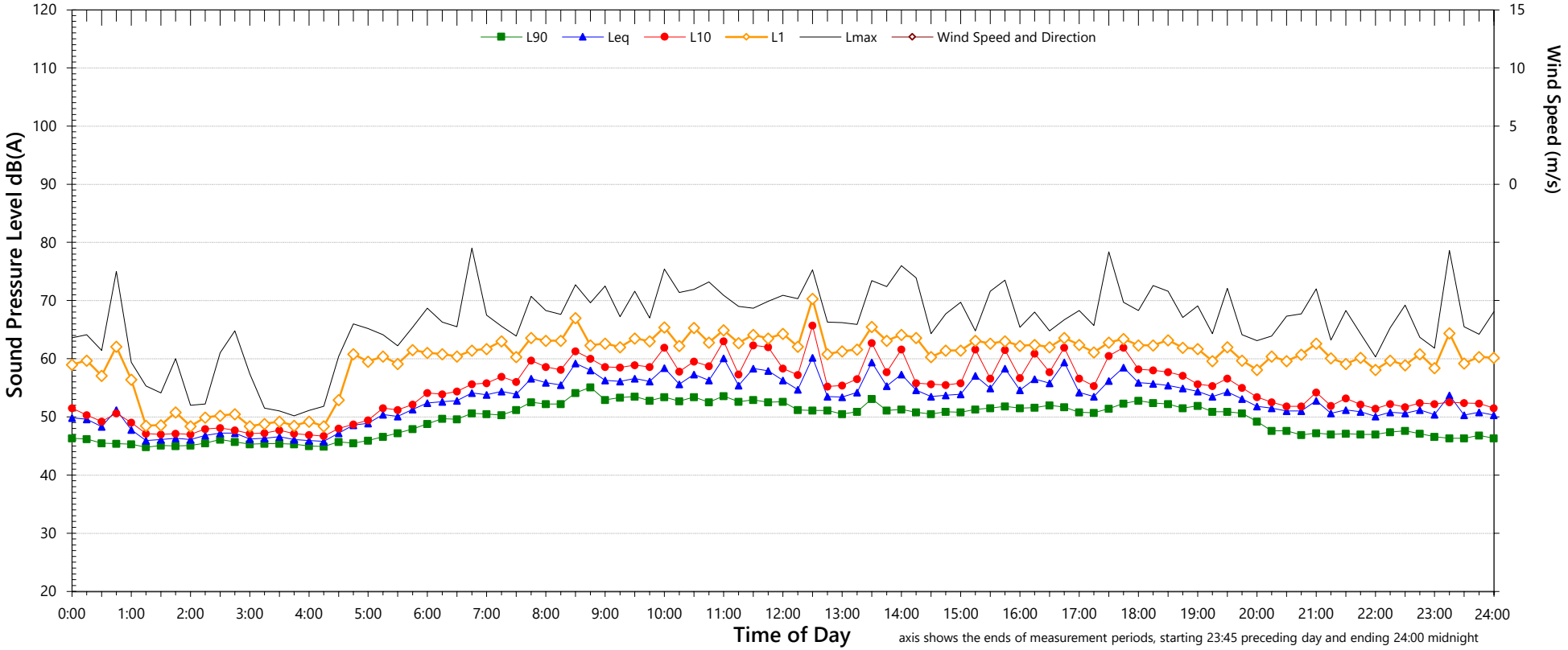
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Friday, 19 November 2021



axis shows the ends of measurement periods, starting 23:45 preceding day and ending 24:00 midnight

NSW Noise Policy for Industry (Free Field)				
Descriptor		**Day[2]**	**Evening[3]**	**Night[4 5]**
L_{A90} ABL		51	47	45
L_{Aeq}	(see note 6)	54	51	47

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	65	to	79
L_{AFMax} - L_{Aeq} (Range)	15	to	27

NSW Road Noise Policy (1m from facade)		
Descriptor	**Day**	**Night[5]**
	7am-10pm	**10pm-7am**
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	56	50
$L_{Aeq\ 1hr}$ upper 10 percentile	57	51
$L_{Aeq\ 1hr}$ lower 10 percentile	52	46

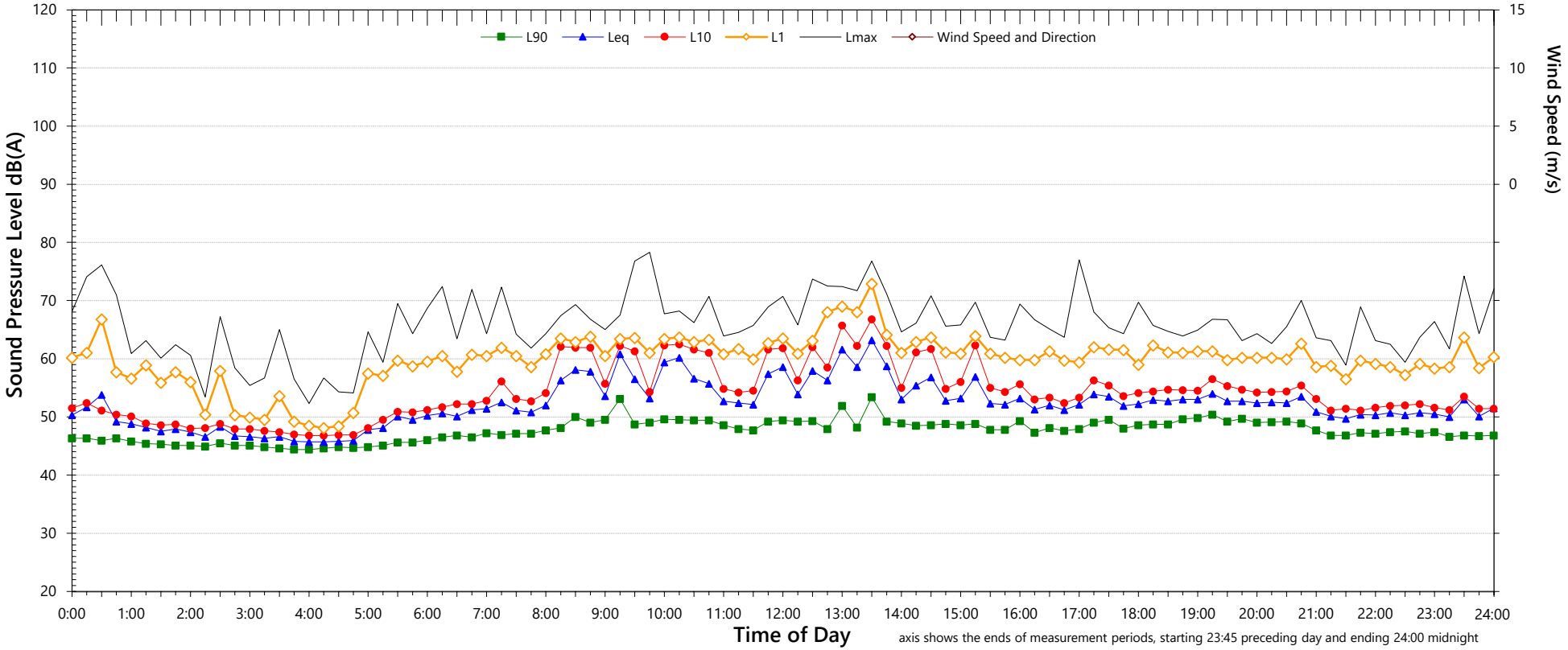
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Saturday, 20 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		48	47	47
L_{Aeq}	(see note 6)	54	50	49

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	66	to	84
L_{AFMax} - L_{Aeq} (Range)	16	to	34

NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	56	51
$L_{Aeq\ 1hr}$ upper 10 percentile	58	52
$L_{Aeq\ 1hr}$ lower 10 percentile	52	50

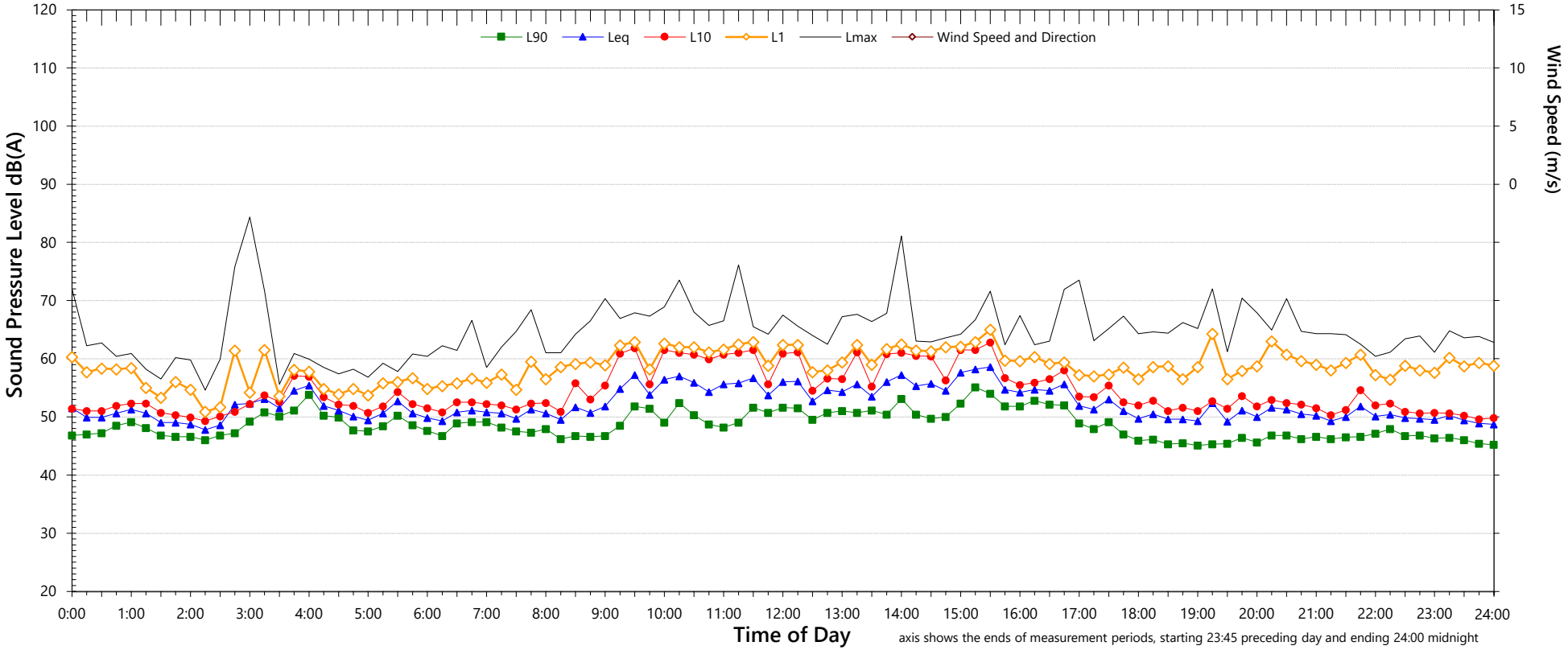
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Sunday, 21 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		47	45	44
L_{Aeq}	(see note 6)	53	48	46

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	66	to	69
L_{AFMax} - L_{Aeq} (Range)	15	to	19

NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	54	49
$L_{Aeq\ 1hr}$ upper 10 percentile	56	51
$L_{Aeq\ 1hr}$ lower 10 percentile	50	46

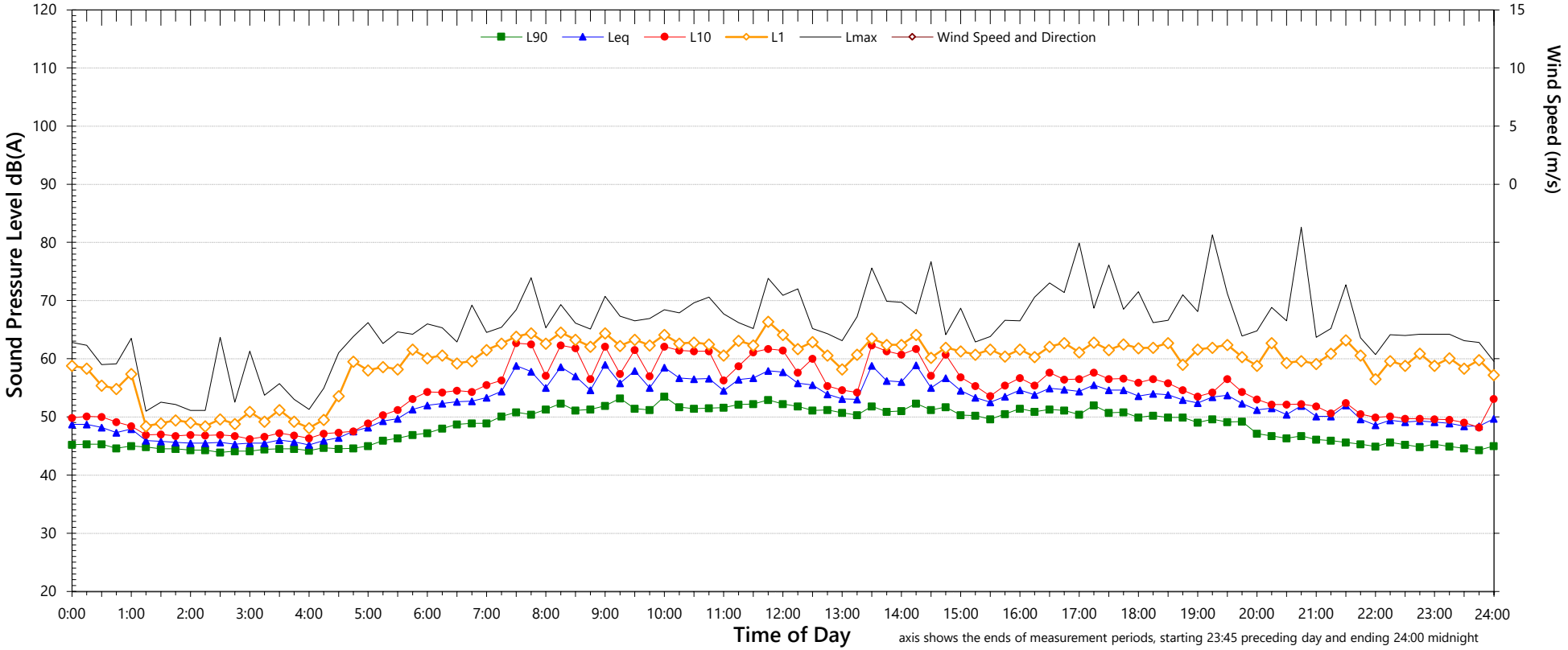
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Monday, 22 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		50	45	45
L_{Aeq}	(see note 6)	54	50	47

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	66	to	70
L_{AFMax} - L_{Aeq} (Range)	15	to	20

NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	55	49
$L_{Aeq\ 1hr}$ upper 10 percentile	57	51
$L_{Aeq\ 1hr}$ lower 10 percentile	52	47

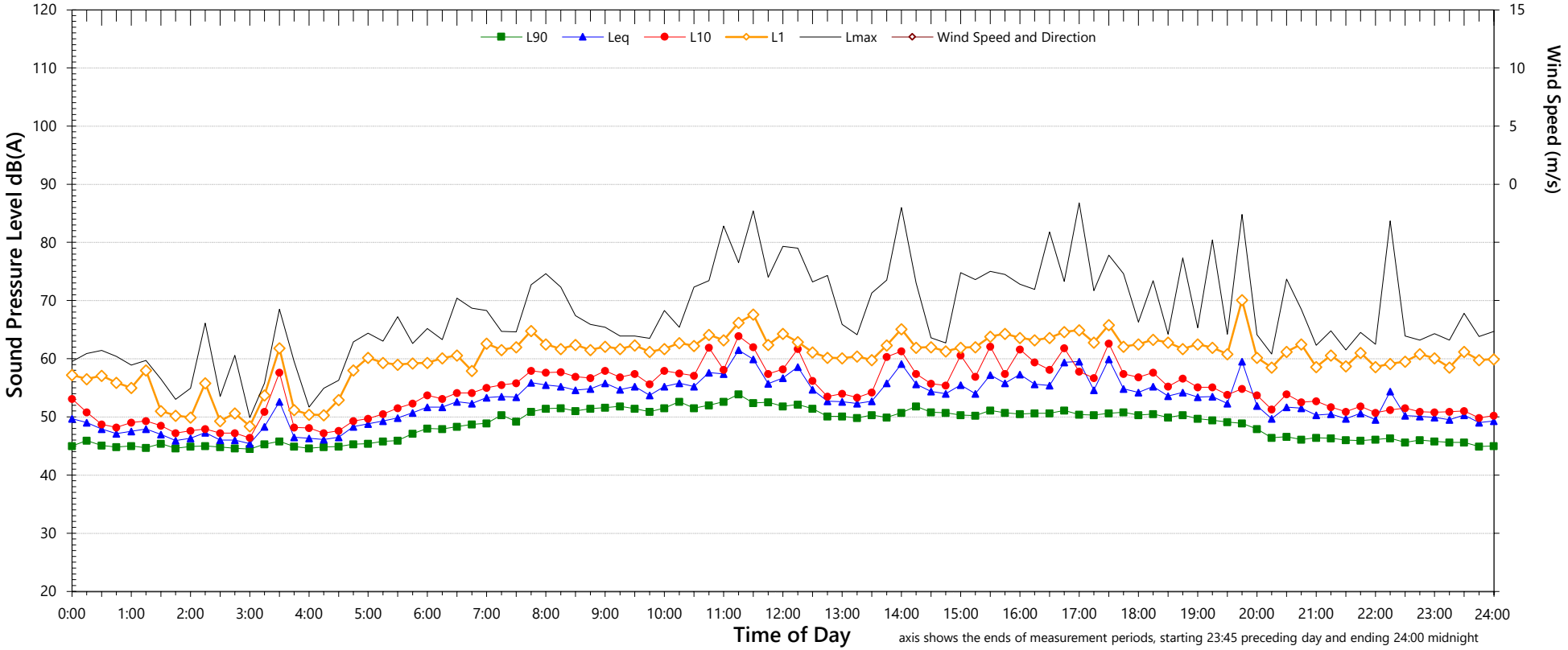
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Tuesday, 23 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		**Day**[2]	**Evening**[3]	**Night**[4 5]
L_{A90} ABL		50	46	44
L_{Aeq}	(see note 6)	54	51	47

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	65	to	84
L_{AFMax} - L_{Aeq} (Range)	16	to	32

NSW Road Noise Policy (1m from facade)		
Descriptor	**Day**	**Night**[5]
	7am-10pm	**10pm-7am**
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	56	49
$L_{Aeq\ 1hr}$ upper 10 percentile	57	52
$L_{Aeq\ 1hr}$ lower 10 percentile	52	45

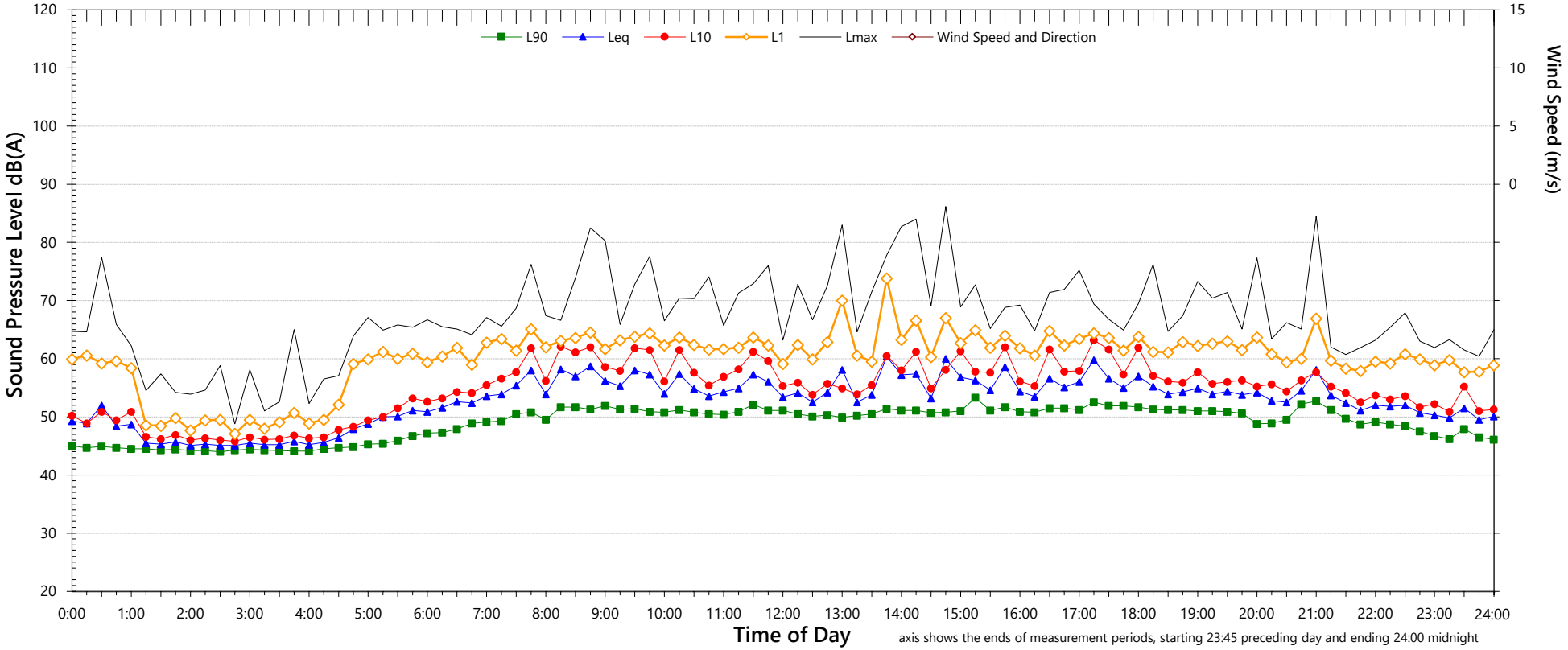
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Wednesday, 24 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		50	49	44
L_{Aeq}	(see note 6)	54	52	48

Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	66	to	78
L_{AFMax} - L_{Aeq} (Range)	17	to	27

NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	56	50
$L_{Aeq\ 1hr}$ upper 10 percentile	57	52
$L_{Aeq\ 1hr}$ lower 10 percentile	54	47

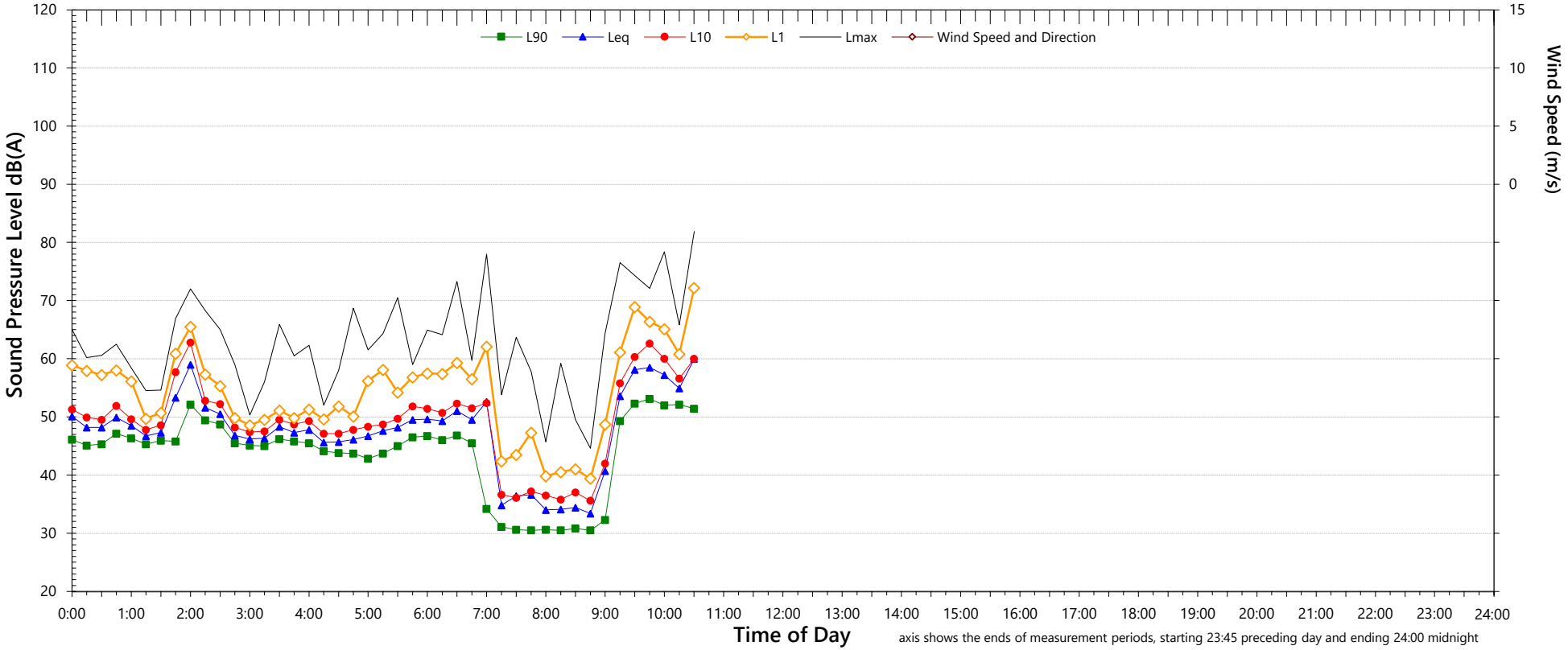
Notes:

1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

Unattended Noise Monitoring Results

North Building L3 facing North

Thursday, 25 November 2021



NSW Noise Policy for Industry (Free Field)				
Descriptor		Day[2]	Evening[3]	Night[4 5]
L_{A90} ABL		-	-	-
L_{Aeq}	(see note 6)	-	-	-

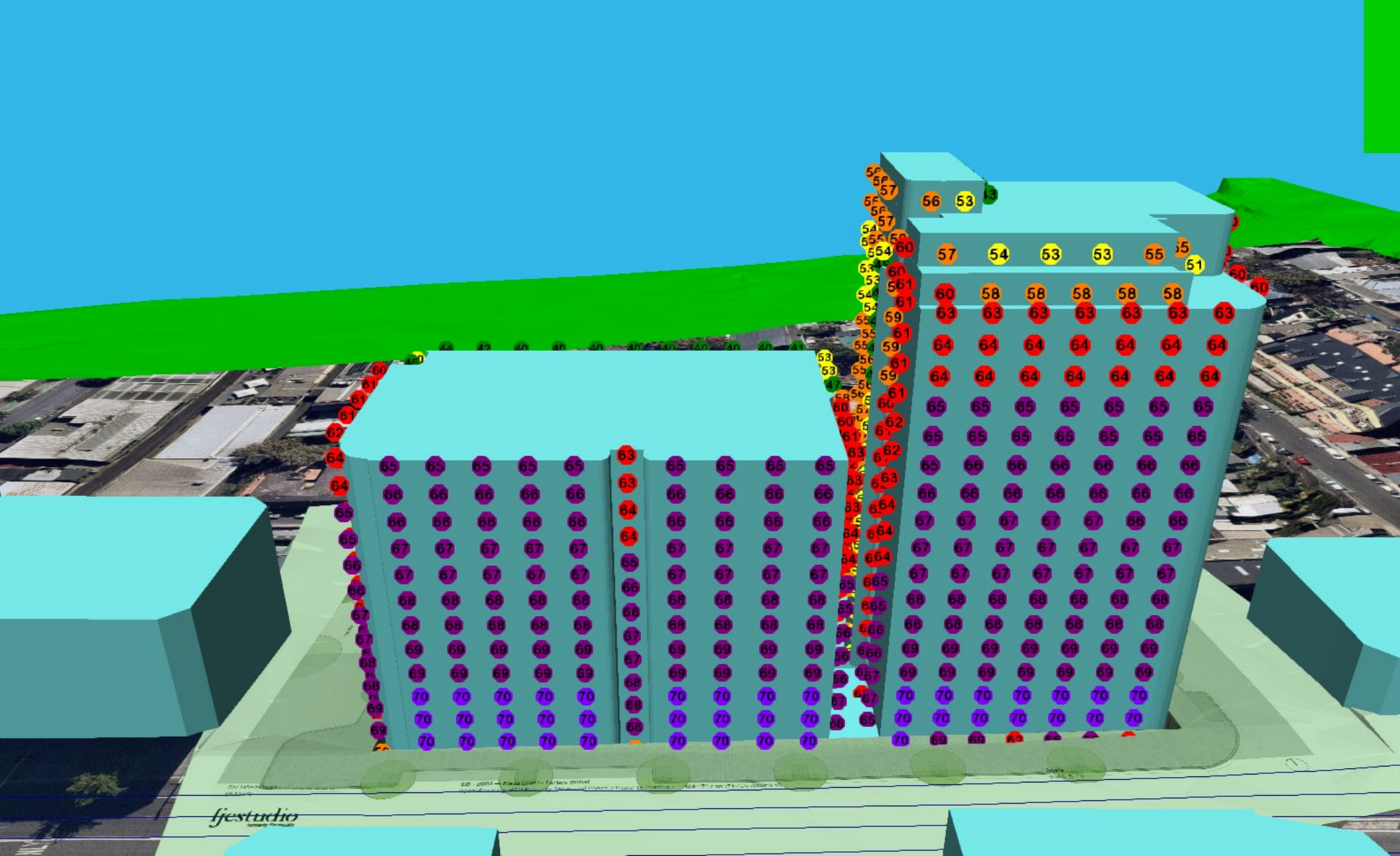
Night Time Maximum Noise Levels			(see note 7)
L_{AFMax} (Range)	-	to	-
L_{AFMax} - L_{Aeq} (Range)	-	to	-

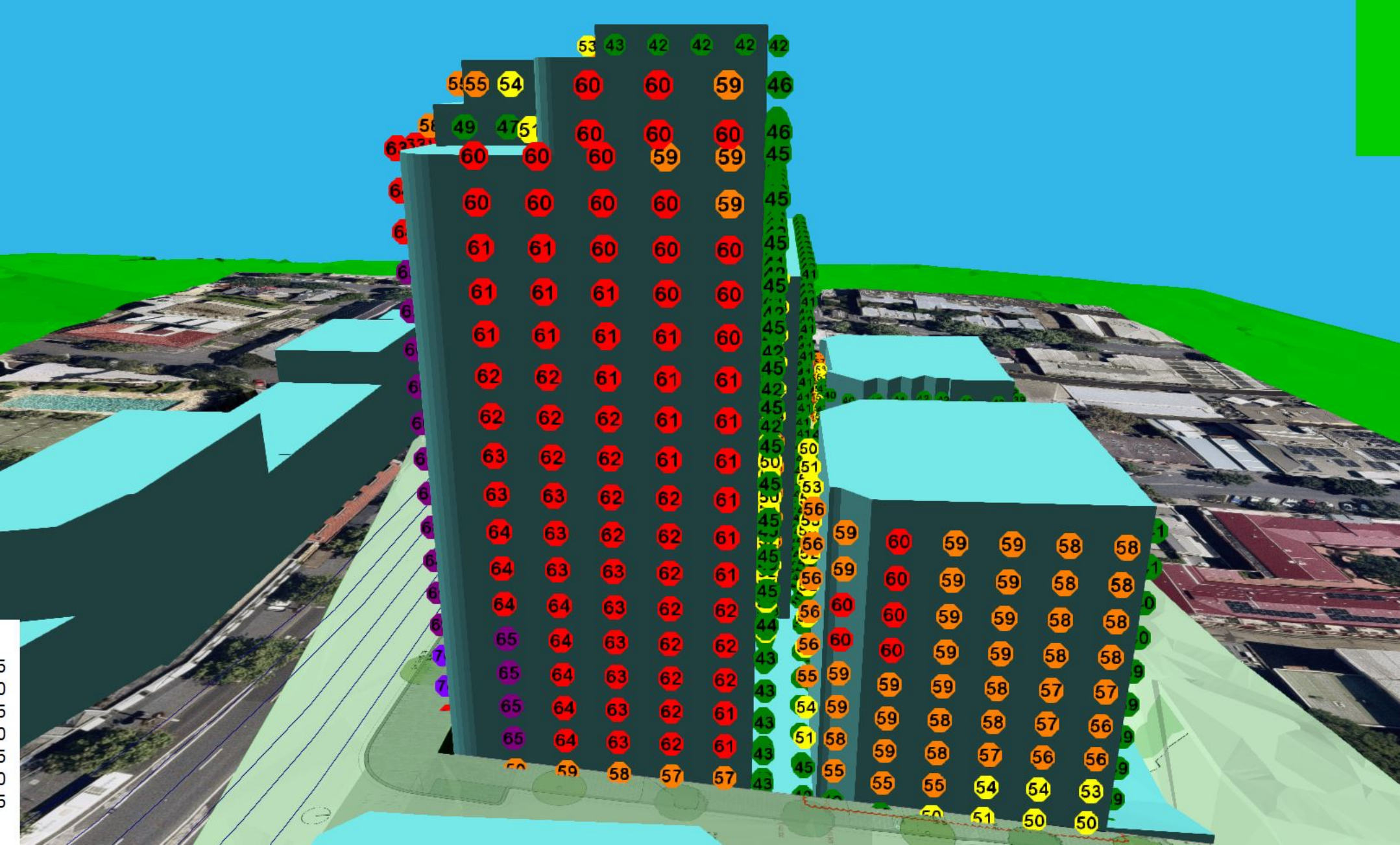
NSW Road Noise Policy (1m from facade)		
Descriptor	Day	Night[5]
	7am-10pm	10pm-7am
$L_{Aeq\ 15\ hr}$ and $L_{Aeq\ 9\ hr}$	-	-
$L_{Aeq\ 1hr}$ upper 10 percentile	-	-
$L_{Aeq\ 1hr}$ lower 10 percentile	-	-

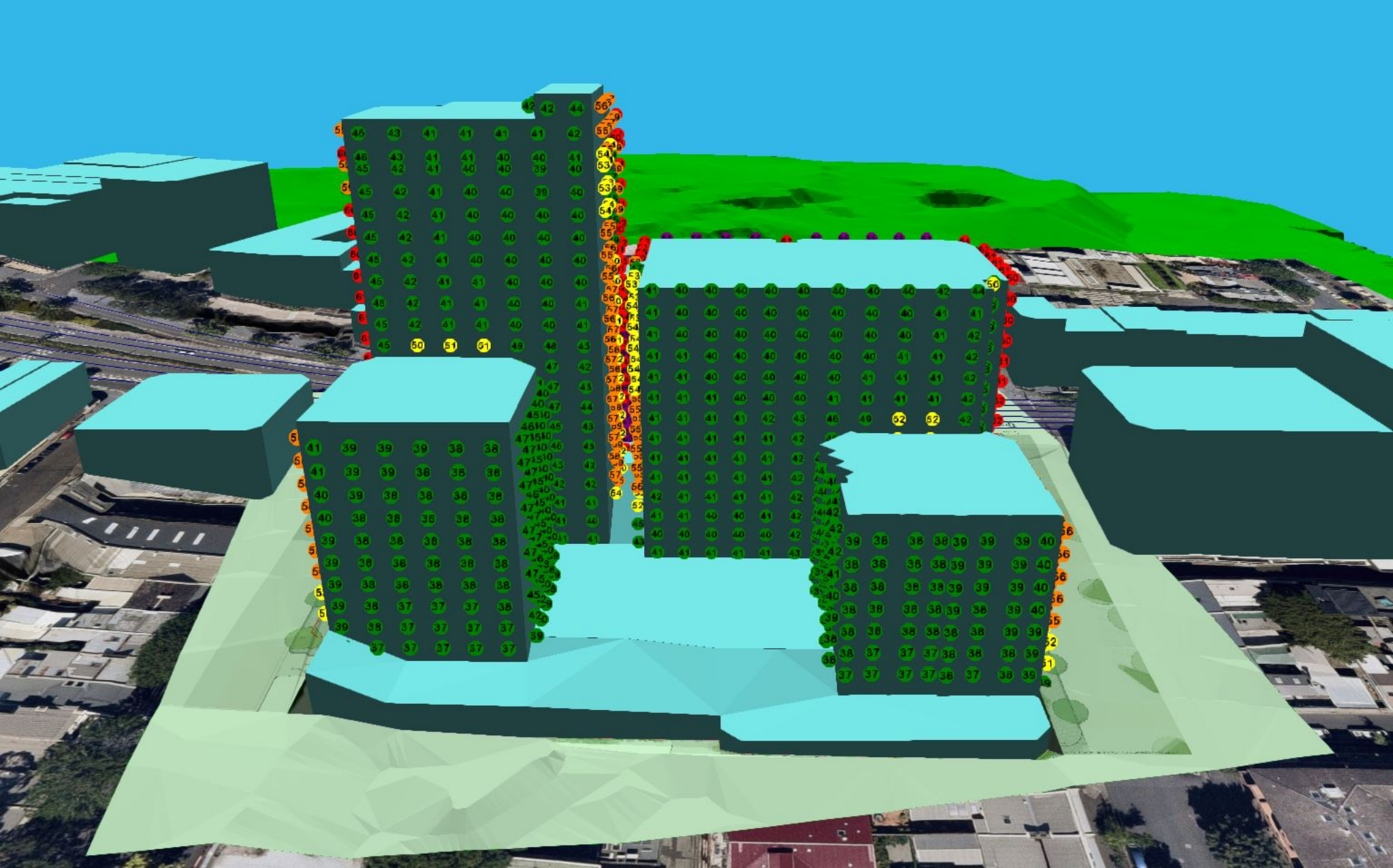
Notes:

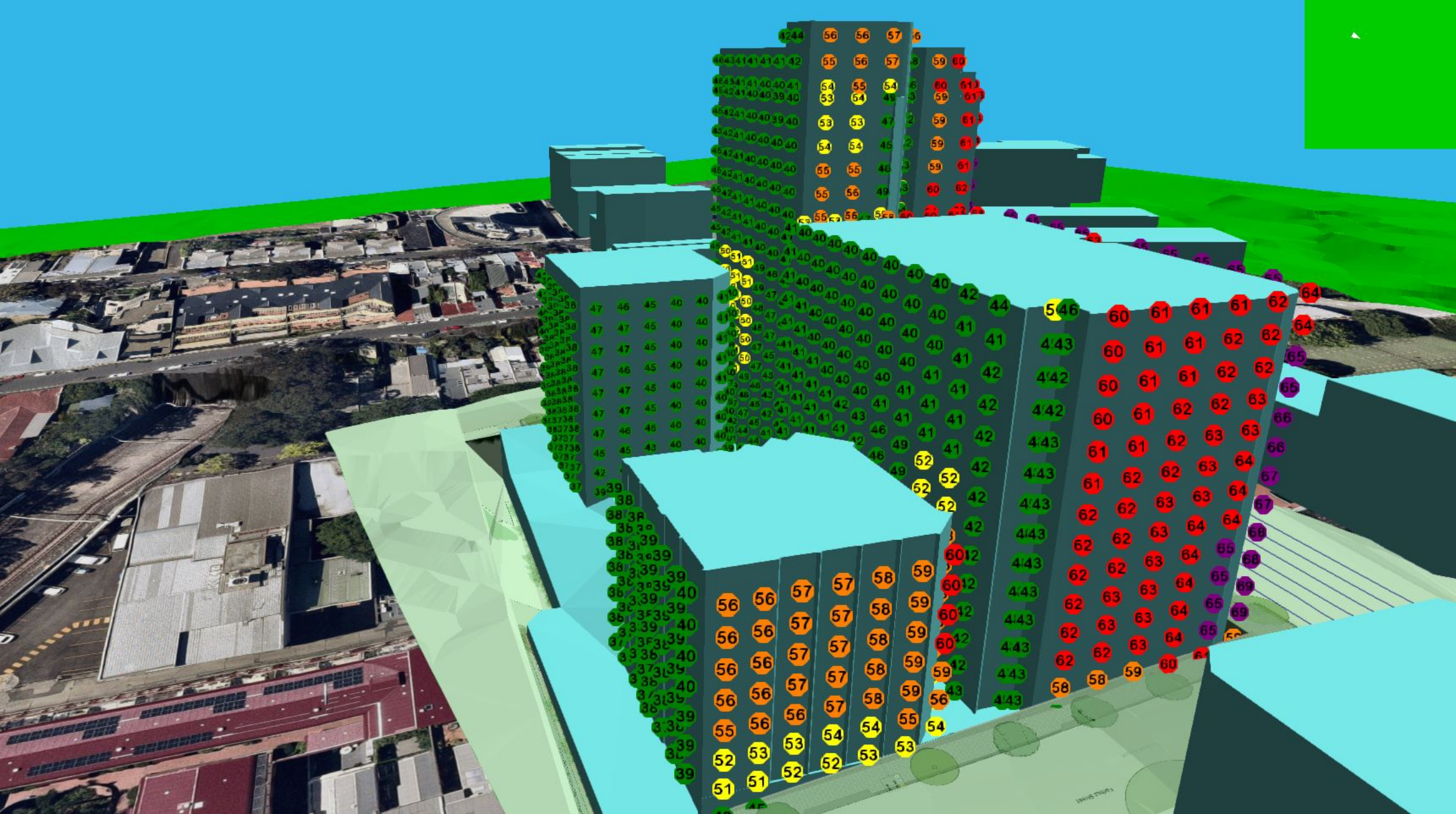
1. Shaded periods denote measurements adversely affected by rain, wind or extraneous noise - data in these periods are excluded from calculations.
2. "Day" is the period from 8am till 6pm on Sundays and 7am till 6pm on other days
3. "Evening" is the period from 6pm till 10pm
4. "Night" relates to the remaining periods
5. "Night" relates to period from 10pm on this graph to morning on the following graph.
6. Graphed data measured 1m from facade; tabulated results free-field corrected
7. 1-hour values for L_{AFMax} are shown only where L_{AFMax} >65dB(A) and where L_{AFMax}- L_{Aeq} ≥15dB(A)

APPENDIX F Results of Traffic Noise Modelling William, Forbes and Dowling

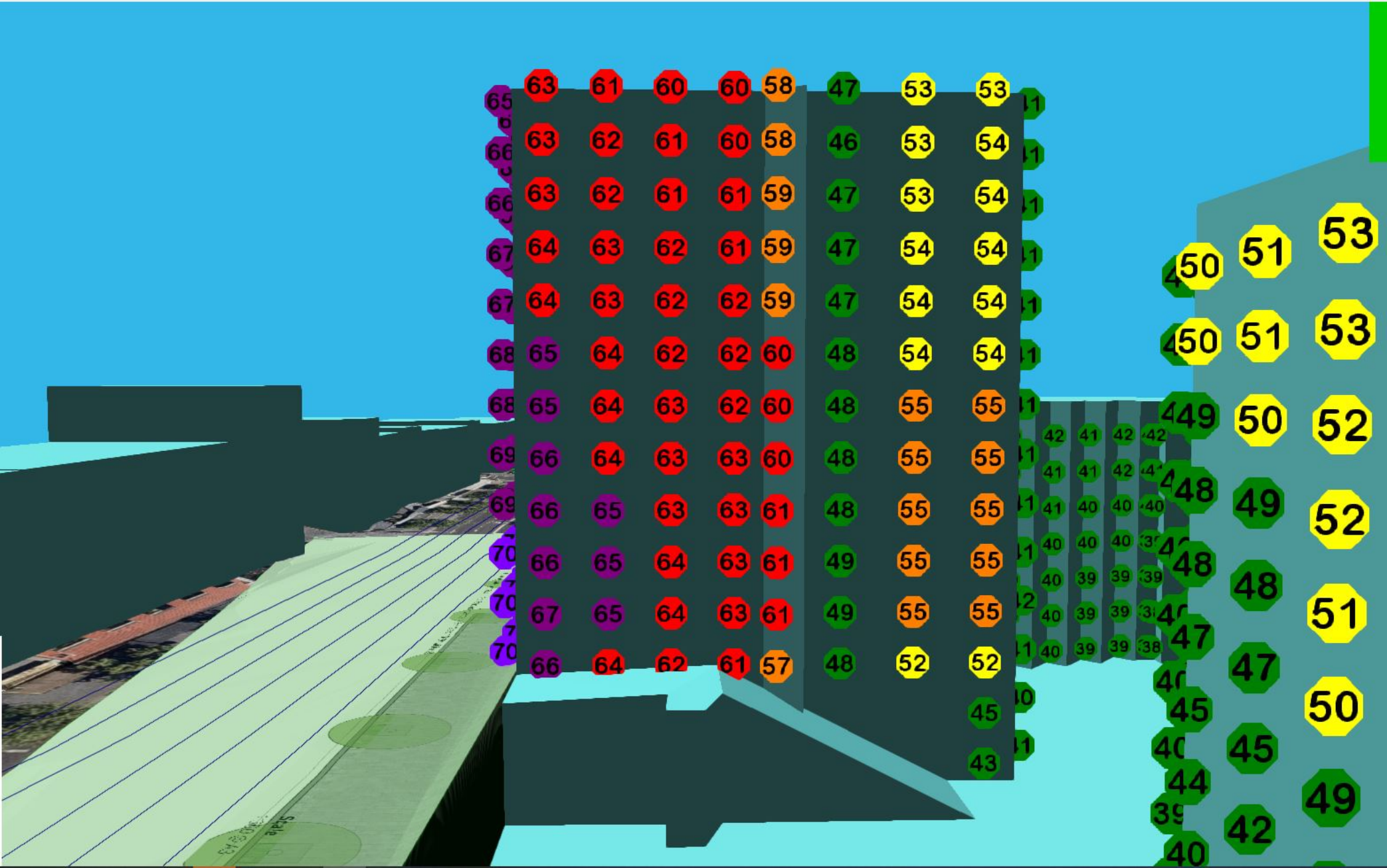

fjestudio

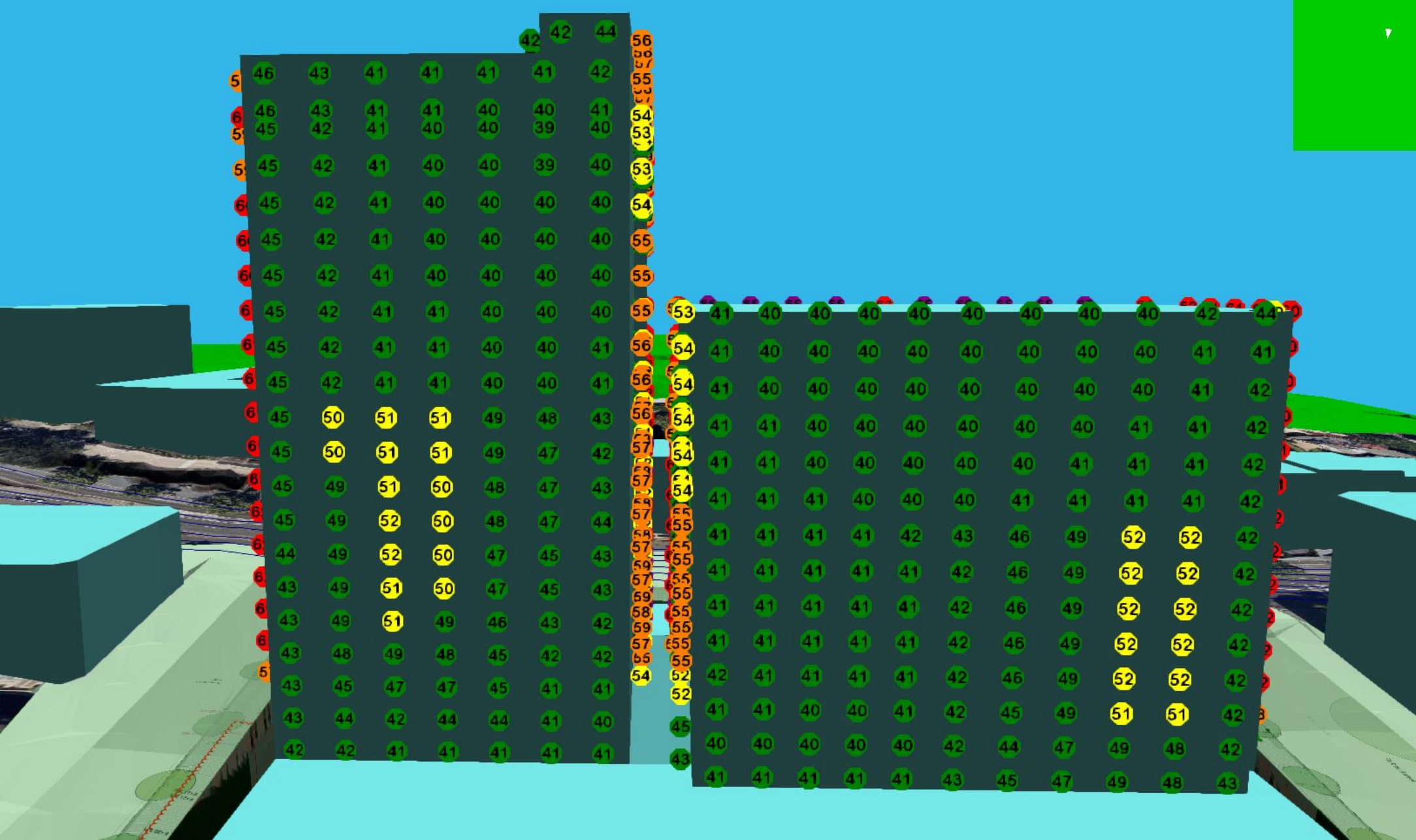


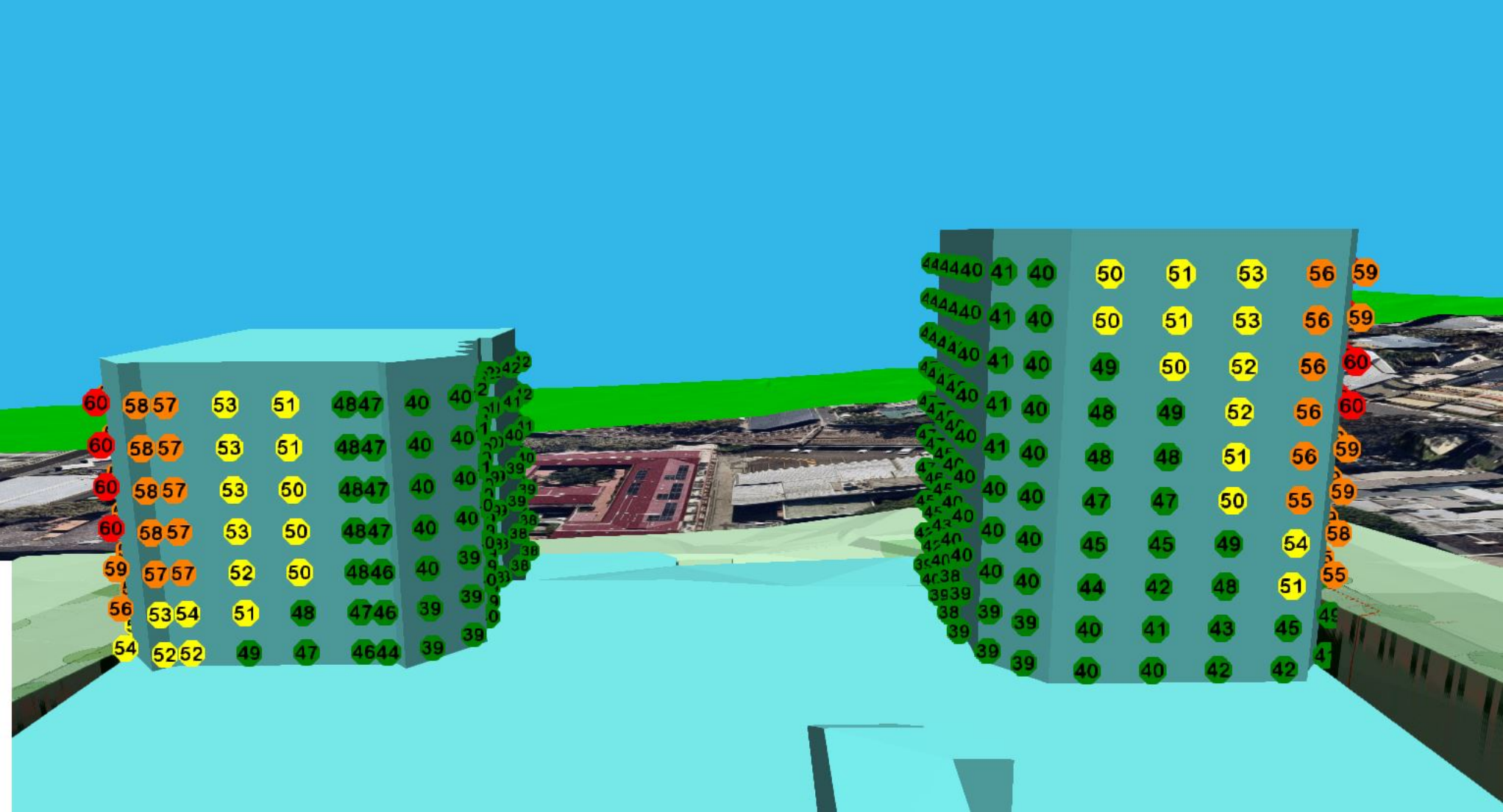




APPENDIX G Results of Traffic Noise Modelling to Lane







APPENDIX H Results of Patron Noise Modelling