ACOUSTIC STUDIO

The Star – Former Part 3A Approval MP08_0098 Section 4.55(2) – Modification Application 20 Foundation Theatres New Live Entertainment Venue

Noise & Vibration Impact Assessment

8 May 2026

Address Unit 27, 43-53 Bridge Road,
Stanmore NSW 2048 Australia

Phone +61 2 9557 6421

Email mail@acousticstudio.com.au

Contact for this report
Jason Cameron

jason.cameron@acousticstudio.com.au

Document Information

Project & Number	The Star – Former Part 3A Approval MP08_0098Section 4.55(2) – Modification Application 20 Foundation Theatres New Live Entertainment Venue	FOU-3673
Title	Noise & Vibration Impact Assessment	
Reference	20260508 FOU3673.0003.Rep.DA.v1.docx	
Client	Foundation Theatres	

Organisation	Circulation	Delivered via
Foundation Theatres	Stephen Sablatnig, Paul Rigby	Email

Revision History

Revision	Date	Description	Prepared by	Reviewed by
Draft 1	05/05/2026	Draft 1 for Client Review	Isaac Bradbury Vyshakh Menon	Jason Cameron
Issue 1	08/05/2026	Issue 1	Isaac Bradbury, Jason Cameron	Jason Cameron

Member of the Association of
Australasian Acoustical Consultants

Disclaimer

This report takes into account the particular instructions and requirements of our Client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Executive Summary

The New Live Entertainment Venue (the Project) consists of a redevelopment of an existing space within The Star, Pyrmont.

This report presents the noise and vibration impact assessment for both the operational and construction stage of the Project.

The following aspects of noise impact are assessed for the operational stage of the Project:

- Noise emissions from external mechanical plant
- Noise emissions from patrons accessing the New Live Entertainment Venue space
- Noise emissions from events inside the New Live Entertainment Venue
- Noise emissions from vehicle movements accessing carparks and loading dock areas from additional traffic on public roads generated by the redevelopment
- Traffic noise intrusion

All operational noise impacts are expected to comply with relevant criteria, provided that the following recommendations are followed:

- Music and patron noise / activity from the New Live Entertainment Venue performance space are managed in accordance with the assumptions made herein.
- Acoustic louvres are provided for the rooftop chiller plant room.
- Emergency system / plant tests are carried out during the day.
- During any night-time (10pm-8am) use of the loading dock, potential for noise impact should be minimised by employing operational management controls such as minimising truck idling at the loading dock / loading dock entry.
- Acoustic doors are provided for all New Live Entertainment Venue external doors, and doors should remain closed during high noise-level events.
- An operational Sound Management Plan is prepared, followed and updated as required. An example Sound Management Plan is included for guidance.

A high-level construction noise and vibration assessment indicates that providing localised acoustic screening for the noisiest rooftop demolition works will ensure that construction noise levels meet the project NMLs at all but one noise-sensitive receiver. With screening in place, the predicted worst-case construction noise level at the worst-affected receiver is 3 dB above the Noise Affected Management Level (NML), and below the Highly Noise Affected Management Level (HNML).

All feasible and reasonable work practices should be applied to mitigate the noise emissions from construction activities. All potentially impacted residents should also be informed of the nature of works to be carried out, the expected noise levels and duration, as well as contact details. The noise management and mitigation measures provided in Section 0 should be followed at all times, and a Construction Noise and Vibration Management Plan (CNVMP) should be prepared by the Contractor when details of the construction staging and plant and equipment are available.

Contents

Executive Summary			**2**
1	**Introduction**		**5**
	1.1	Purpose of this report	5
	1.2	Background	6
	1.3	Summary of proposed development (Acoustic context)	6
	1.4	Existing and proposed site operations and plans	7
		1.4.1 Existing operations	7
		1.4.2 Proposed operations	7
	1.5	Key acoustic considerations	16
2	**Site and Surrounding Environment**		**17**
	2.1	Site description	17
	2.2	Site and surrounding land uses	17
	2.3	Noise sensitive receivers and noise survey locations	21
	2.4	Internal adjacent receivers – The Star	23
3	**Existing Noise Environment**		**24**
	3.1	Noise survey approach	24
	3.2	On-site observations	24
	3.3	Unattended measurements	24
	3.4	Attended measurements	27
	3.5	Noise Survey comparison with previous assessment(s) and adopted background noise levels	28
		3.5.1 WSPPB NIA and Acoustic Studio previously recorded noise levels	28
		3.5.2 Noise Logger #3	28
		3.5.3 Adopted background noise levels	28
4	**Project Specific Noise and Vibration Criteria**		**29**
	4.1	Applicable standards and Guidelines	29
	4.2	Establishing project operational noise criteria	29
		4.2.1 Previously established criteria	29
		4.2.2 Operational noise emissions	31
		4.2.3 Off-site road traffic noise	35
		4.2.4 External noise intrusion	35
		4.2.5 Construction noise and vibration	36
	4.3	Summary of project specific operational noise criteria	38
5	**Operational Noise Emission Assessment and Recommendations**		**39**
	5.1	Operational assessment methodology	39
	5.2	On-site noise sources – general	39
		5.2.1 Mechanical Plant – Noise Emissions	39
		5.2.2 Traffic noise emissions (offsite; road traffic)	43
		5.2.3 Traffic noise emissions (On site; carpark and loading dock)	43
	5.3	On-site noise sources – music and patrons	44
		5.3.1 New Live Entertainment Venue amplified music assessment	44
		5.3.2 New Live Entertainment Venue patron noise assessment	46

5.3.3 Patron Noise from foyer / access / queueing areas 47
5.3.4 Sleep disturbance from patrons and sound systems 47
5.3.5 Discussion of sound system and patron noise emissions 47
5.4 POEO offensive noise assessment 48

6 External Noise Intrusion 49
6.1 External noise impacts on the Project 49

7 Construction Noise and Vibration Assessment 50
7.1 Construction noise and vibration assumptions 50
7.1.1 Timeline 50
7.1.2 Construction work staging 50
7.1.3 Hours of work 50
7.1.4 Noise and vibration sources 51
7.2 Assessment Methodology 53
7.3 Construction-related road traffic noise 54

8 Construction Noise and Vibration Management and Mitigation 55
8.1 General noise control elements 55
8.1.1 Plant and equipment 55
8.1.2 On-site noise management 55
8.1.3 Consultation, notification and complaints handling 56
8.1.4 Work scheduling 56
8.1.5 Mandatory site rules of conduct 56
8.2 Communication and complaints 56
8.3 Timing of works 57
8.4 Equipment and plant selection 57
8.5 Assessment of construction vibration 58
8.5.1 Vibration sources and high-level assessment 58
8.5.2 Vibration management approach 58
8.5.3 Dilapidation survey 58
8.6 Noise monitoring and reporting 59
8.7 Construction noise and vibration compliance 59

Appendix A Noise Logger Data
Appendix B Operational Noise Guidelines
Appendix C Construction Noise and Vibration Guidelines
Appendix D Sound Management Plan – Example
Appendix E Standards and Guidelines

1 Introduction

1.1 Purpose of this report

This Noise and Vibration Impact Assessment (NVIA) been prepared on behalf of Foundation Theatres to assess the potential noise and vibration impacts associated with the proposed modification and fit-out of the New Live Entertainment Venue site ('the site') at The Star, Pyrmont. The NVIA will form part of the Modification Application (MA).

The application seeks approval under Section 4.55(2) of the Environmental Planning and Assessment Act 1979 (EP&A Act) to modify Development Consent MP08_0098 (a former Part 3A approval) for the site located at 20–80 Pyrmont Street, Pyrmont. The works relate to Levels 03 to 05 of the northern portion of the existing Outdoor Gaming Area / Pirrama Road Entertainment Deck and associated rooftop plant area. The proposal involves alterations and additions to the existing Sovereign Expansion structure (referred to as the Whale Tail). The key components of the modification include:

- Reconfiguration of Levels 03 and 05 to convert the existing food, beverage, and gaming areas on the Entertainment Deck into a new live entertainment venue to be operated by Foundation Theatres.
- Introduction of a new mezzanine level (Level 04), replacing the current void space to improve internal functionality and spatial efficiency.
- Construction of a new plant and rigging enclosure on Level 05, supporting the operational requirements of the proposed entertainment venue.

The NVIA has been undertaken to address potential impacts associated with:

- operational noise, including entertainment noise (music and patron activity);
- mechanical plant and building services noise;
- patron movement and associated external activity;
- traffic and servicing noise; and
- construction noise and vibration.

The objectives of this assessment and report are to:

- Identify noise and/or vibration sensitive receivers that will potentially be affected by the construction and operational phases of the Project proposals.
- Determine existing ambient and background noise levels at the nearest noise sensitive receivers that surround the site.
- Establish the appropriate noise and vibration assessment criteria in accordance with the relevant standards and guidelines.
- Carry out an assessment to determine whether the relevant criteria can be achieved based on proposed operations and likely construction methods.
- Where applicable, provide recommendations for any necessary acoustic control measures that will need to be incorporated into the development or use in order to ensure compliance with the assessment criteria.

1.2 Background

The site forms part of the approved Star Casino complex at Pyrmont (operator Star Entertainment Group Limited (SEGL)) which operates under Major Project Approval MP08-0098, including subsequent modifications (notably Modification 14), for which a comprehensive Noise Impact Assessment was previously undertaken by WSP | Parsons Brinckerhoff (September 2016[1]) ("WSPPB NIA").

The Modification 14 assessment established a site-wide acoustic framework for the control of operational noise emissions, including:

- Condition E1 – Noise Control – Plant and Machinery;
- Condition F5 – Music and Patron Noise Emission Criteria; and
- Condition D11 – Construction Hours of Work

These MP08-0098 approval conditions define the overarching requirements for environmental noise emissions from the site and were supported by detailed background noise monitoring and assessment of mechanical plant, patron activity, and entertainment noise sources. The assessment concluded that, subject to appropriate acoustic design and management measures, the approved development would comply with the nominated criteria and would not result in adverse impacts at nearby sensitive receivers.

The current proposal relates to substantial internal modifications within an existing tenancy, including the introduction of a performance-based entertainment venue, together with minor modifications to external mechanical plant.

While the primary building envelope and façade will remain largely unchanged from those previously assessed, the proposed change in use introduces a change in internal noise generation characteristics, including amplified music, performance sound, and altered patron activity. In addition, the proposal has the potential to modify external noise emissions through;

- changes in patron arrival, dispersal, and congregation patterns, particularly during evening and late-night periods;
- redistribution of internal and external circulation paths;
- changes in traffic generation and vehicle movements associated with event-based operation; and
- modifications to mechanical plant and building services.

The proposed change in use necessitates a targeted reassessment of operational noise sources, with particular focus on entertainment noise breakout, patron activity, plant noise, and associated traffic movements.

The criteria established in the WSPPB NIA included for completeness in Section 4.2.1.

1.3 Summary of proposed development (Acoustic context)

Foundation Theatres plans to transform the existing Level 3 cold shell space into an entertainment space.

The proposed development comprises:

- Internal fit-out and change of use to a performance venue, including bar.
- Installation and operation of amplified sound systems.
- Internal reconfiguration affecting patron capacity and distribution.
- Modification and/or replacement of external mechanical plant, including Level 05 Rooftop plant extension.
- Minor associated changes to patron access, circulation, and transport activity.

See Section 1.4.2, plus Figure 1 through Figure 8 for the site existing and proposed operations and plans.

[1] *Modification 14 Planning Submission, Engineering Advice, NOISE IMPACT ASSESSMENT,* Revision 06, prepared by WSP | Parsons Brinckerhoff issued 16/09/2016 : https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=MP08_0098-MOD-14%2120190821T013713.301%20GMT

For further detailed project description, please refer to the main submission prepared by the planner, Planning & Co, the Architectural Drawings prepared by Altis Architecture, and the other accompanying technical documents that form part of the MA.

1.4 Existing and proposed site operations and plans

1.4.1 Existing operations

The space is currently an unoccupied and un-used cold shell space, approved for use as a restaurant.

1.4.2 Proposed operations

The proposal includes use of the space as an Entertainment Venue and bar. A resident show will initially operate a show with the following details:

Capacity

- 450 Patrons, 50 staff, total 500.

Show times are expected to be:

- Wednesday to Sunday: 7pm
- Thursday to Saturday: 7pm and 9.30pm
- Saturday and Sunday (Matinee): 4pm
- Possible Tuesday 6 or 7pm show in some weeks of the year

General operational details

The show is approximately 90 minutes long and patrons at the last show each day will be encouraged to remain in the venue for approximately 90 minutes after the show finishes, which will mean there will be patrons in the venue on a regular basis after midnight Thursday to Sunday.

The liquor licence allows trade Monday to Saturday between 10am and 3am the next day, plus on Sundays between 10am and 1am the next day. Trading after 1am will occur infrequently, but is still considered as a possibility since the venue will retain the ability to trade to the full extent that the licence allows.

Patrons will arrive approximately 90 minutes pre show and, except for the last show of the day, are expected to leave promptly at the conclusion of the performance.

Rehearsals are likely to be in the afternoons, Tuesday to Friday from 12pm.

Bump in and Bump Out is likely to be between 7am and midnight, Monday to Saturday and will occur very infrequently. Shows are anticipated to run for 3 to 5 years in the venue.

Regular proposed servicing operations and hours (cleaning, maintenance, contractor access) is typically assumed to occur between 7am and 5pm Monday to Friday, and 7am to 1pm for cleaners only on Saturday and Sunday.

Deliveries will be between 9am and 5pm Monday to Friday.

Refer to Figure 1 through Figure 8 for the existing and proposed site plans.

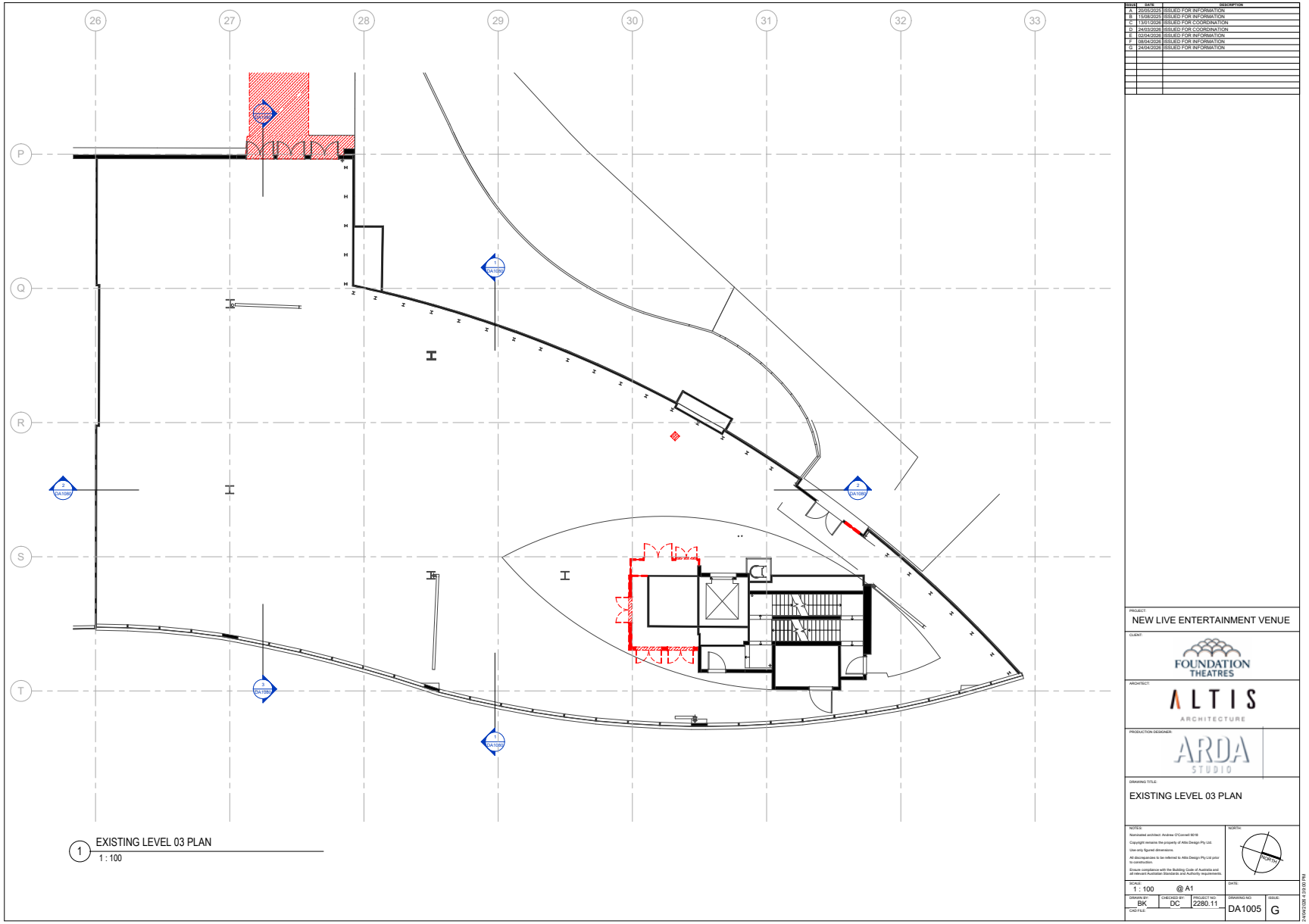


Figure 1
Existing L03 Plan

Source: Atlis Architecture

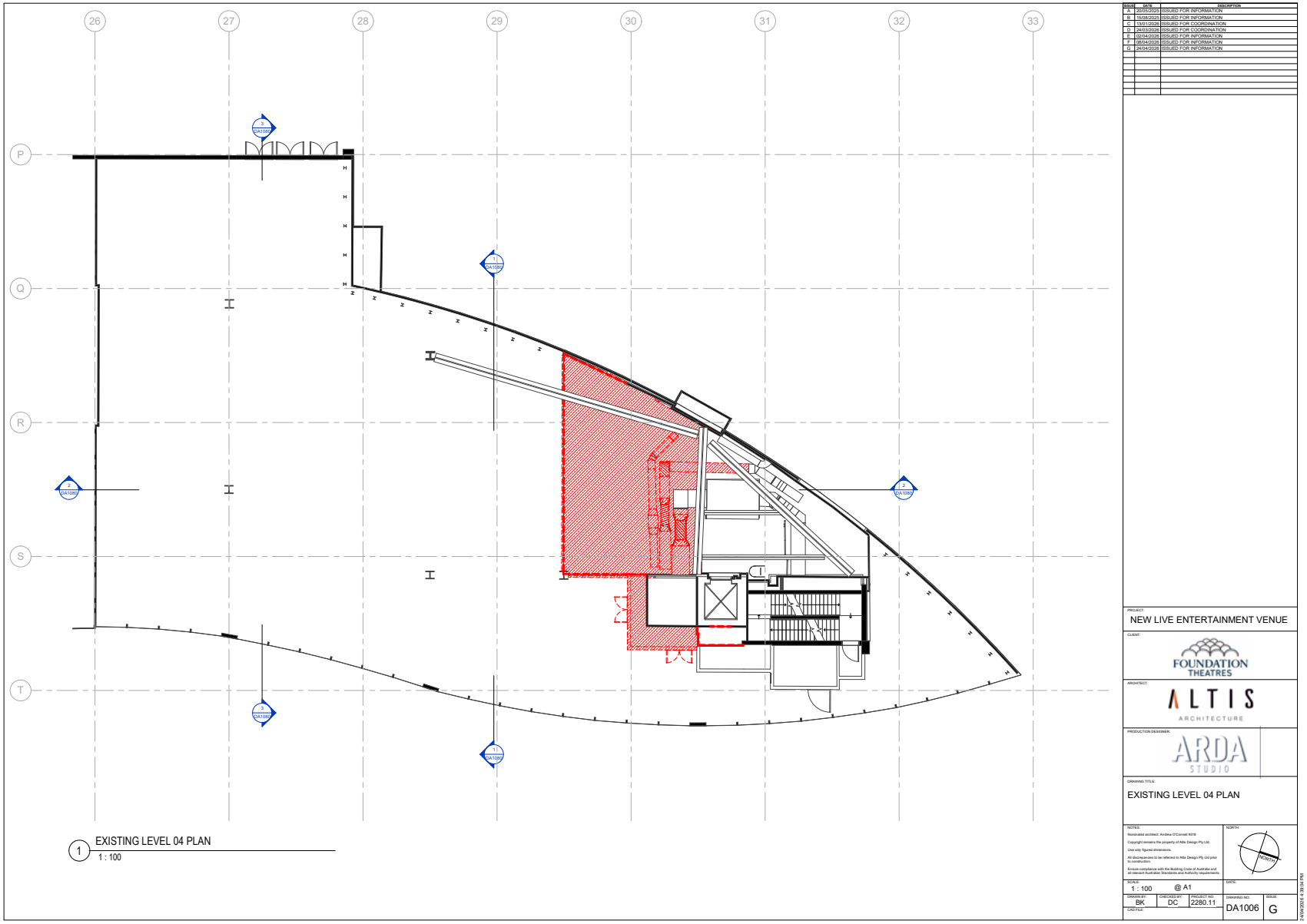


Figure 2
Existing L04 Plan

Source: Atlis Architecture

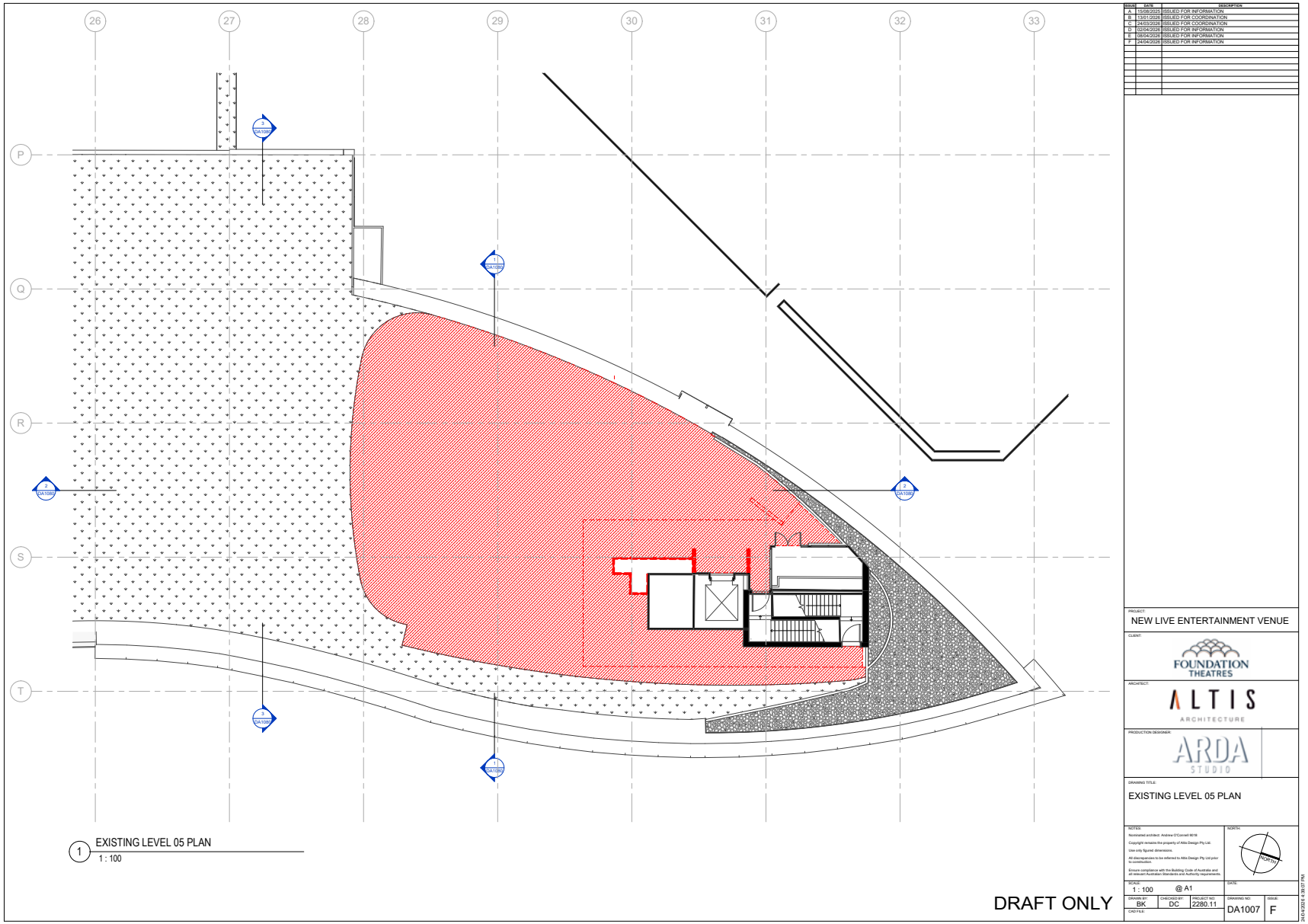


Figure 3
Existing L05 Plan

Source: Atlis Architecture

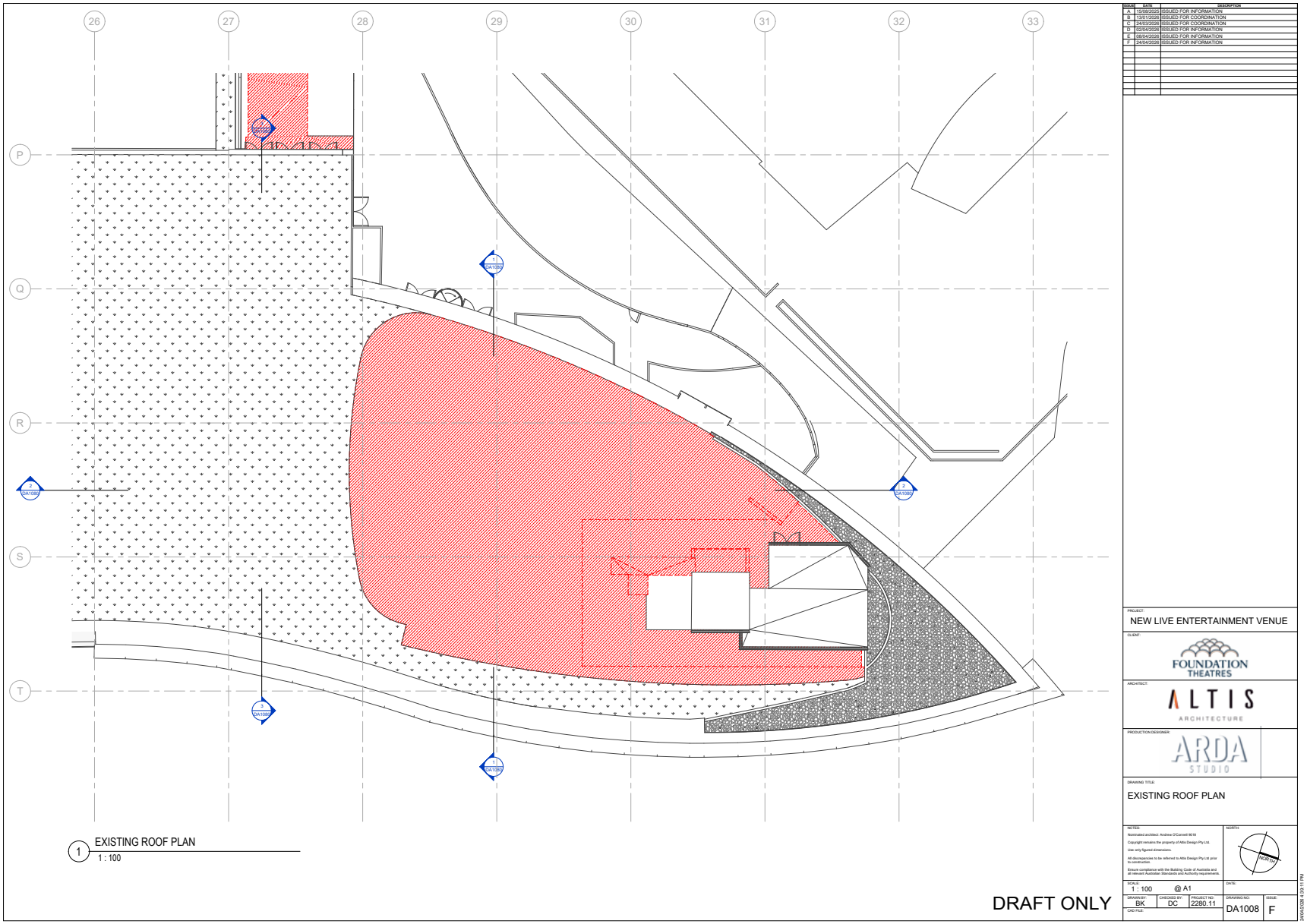


Figure 4
Existing Roof Plan

Source: Atlis Architecture

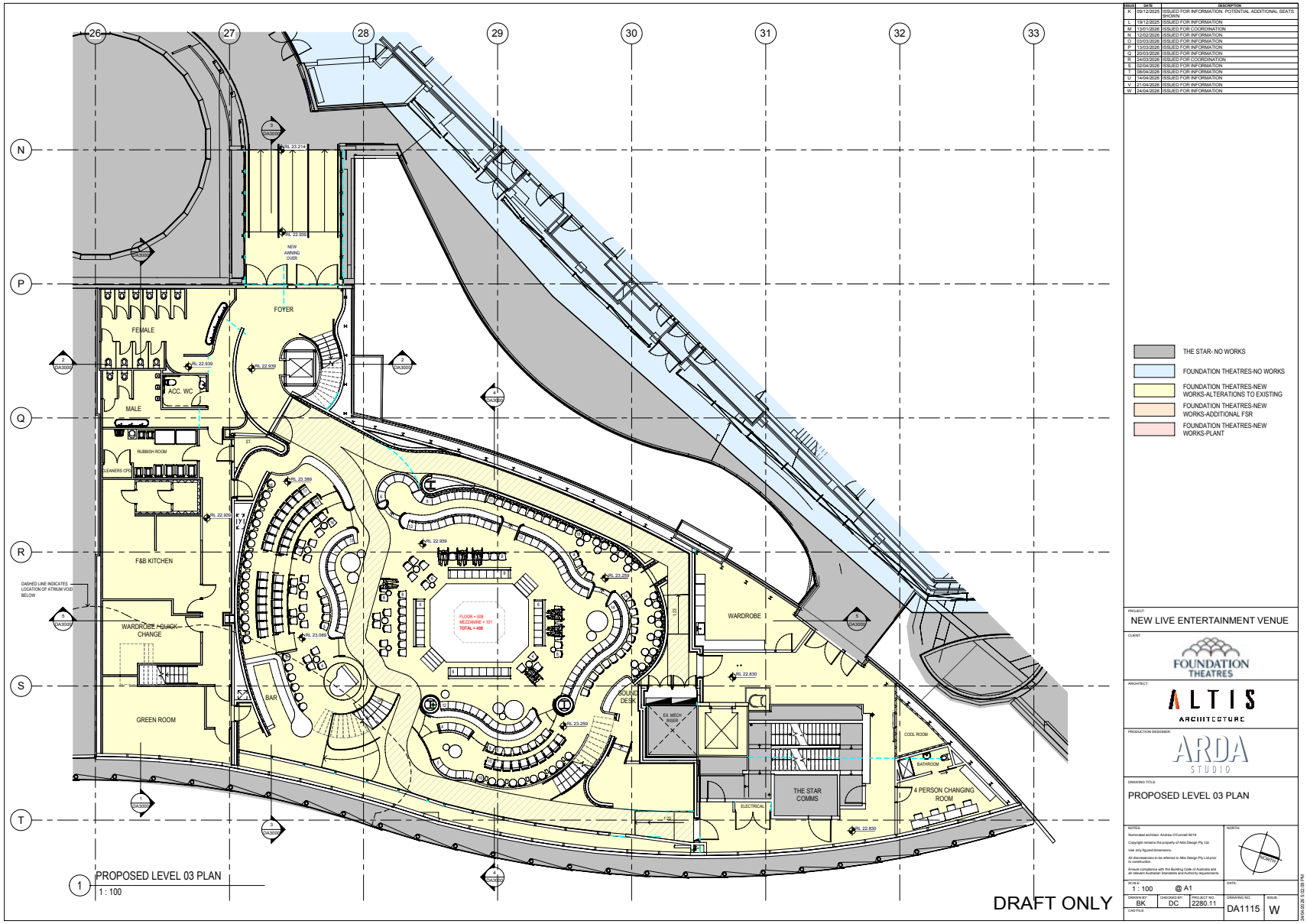


Figure 5
Proposed L03 Plan

Source: Atlis Architecture

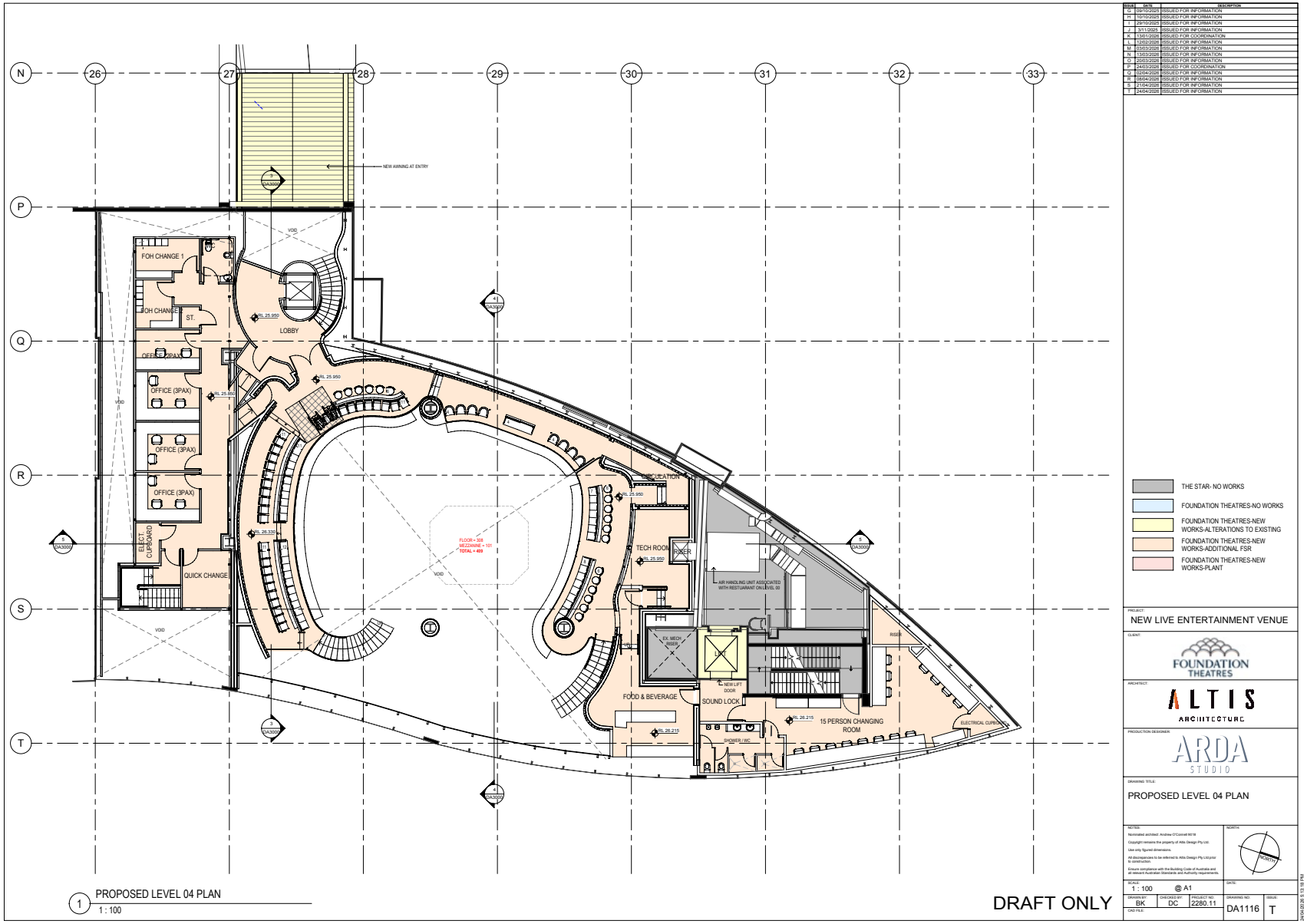


Figure 6
Proposed L04 Plan

Source: Atlis Architecture

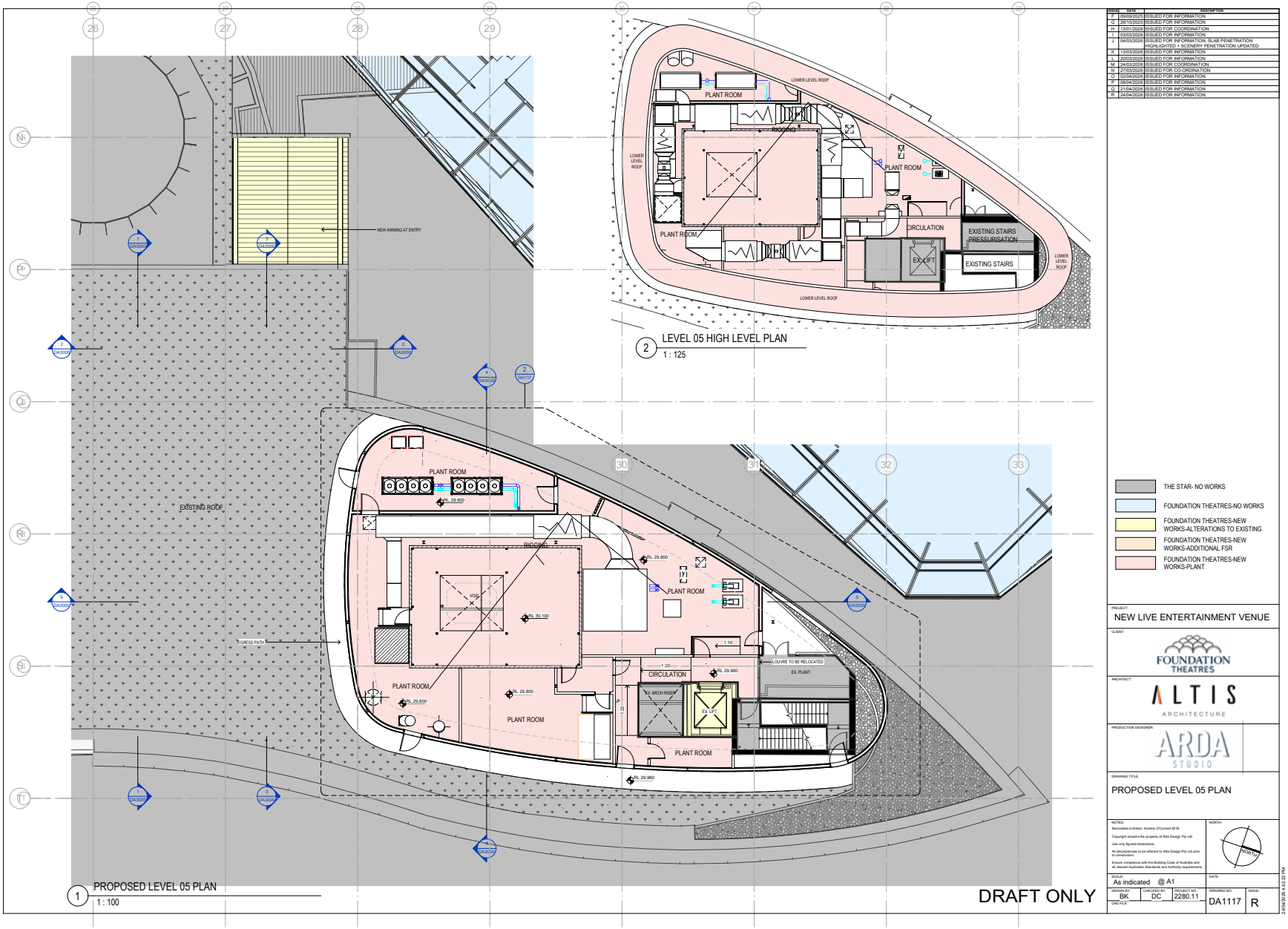


Figure 7
Proposed L05 Plan

Source: Atlis Architecture

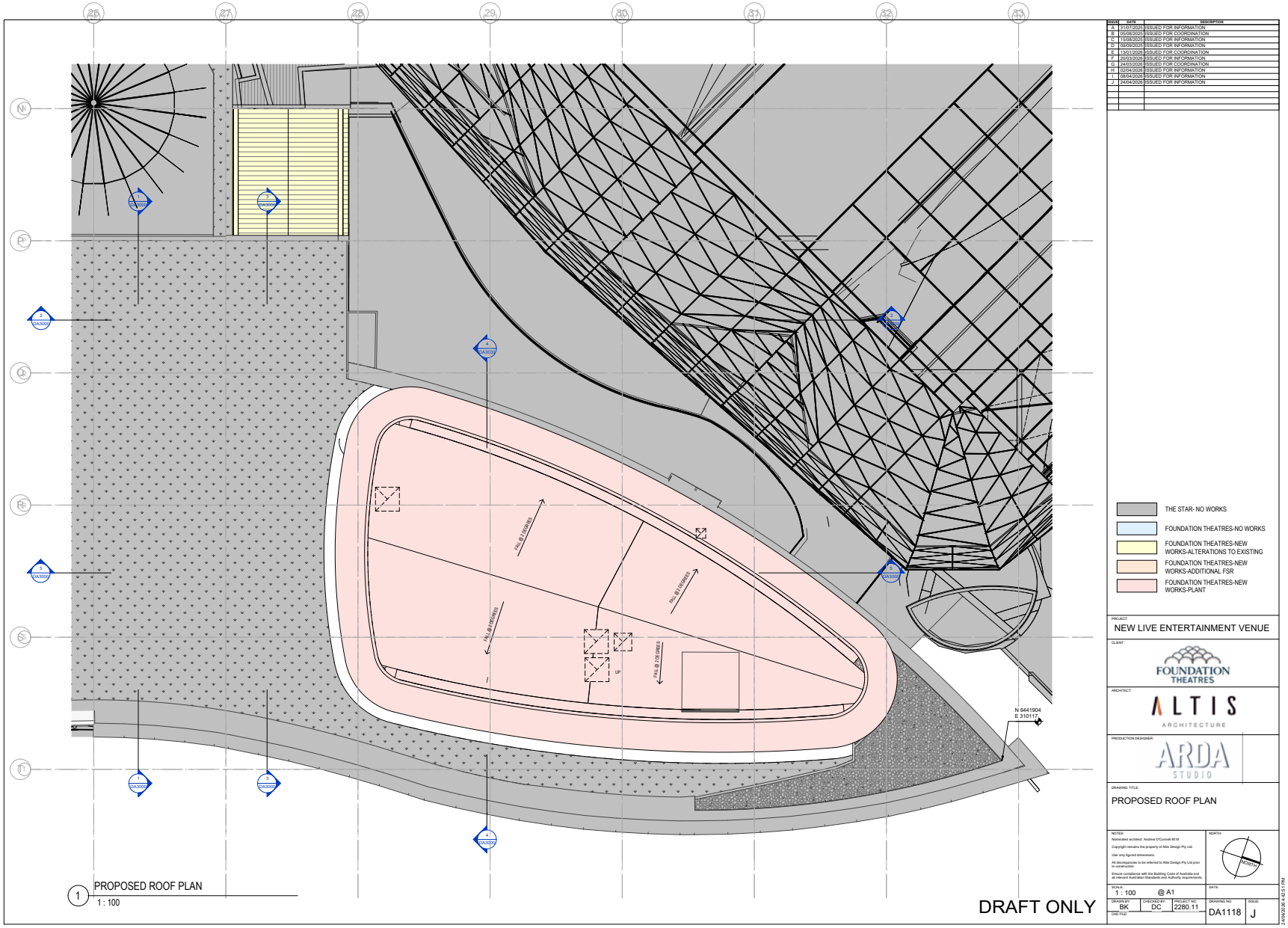


Figure 8
Proposed Roof Plan

Source: Atlis Architecture

1.5 Key acoustic considerations

From an acoustic perspective, the primary noise sources associated with the proposal include:

- **Entertainment Noise Sources**
  - amplified music and performance sound;
  - patron noise within the venue;
  - patron ingress and egress activity at entry/exit points.
- **Mechanical and Building Services Noise**
  - HVAC systems, exhaust fans, condensers and associated plant.
- **Ancillary and External Noise Sources**
  - patron congregation in external areas;
  - car parking and pick-up/drop-off activity, plus loading dock and service vehicles as part of the modifications (if any)
  - traffic movements on surrounding roads; and
  - servicing and operational activities.
- **Construction Noise and Vibration**

Noise emissions from each operation need to be managed to limit environmental noise impacts on nearby commercial (including hotel) and residential receivers.

While the majority of noise generation will occur internally, the transmission of noise through the building façade and other breakout pathways represents the primary mechanism for potential impact at nearby residential receivers.

The existing building envelope plus new and existing internal structures will also need to consider the potential for environmental noise intrusion and inter-occupancy noise transfer between noise-sensitive spaces.

Construction activities may have a temporary noise impact on sensitive receivers inside and outside the premises – particularly The Star Casino and Hotels, plus nearby residential receivers.

This noise and vibration impact assessment (NVIA) considers these issues in detail.

2 Site and Surrounding Environment

2.1 Site description

The site is located within The Star at Pyrmont, Sydney. The Star is located within an urban environment at Pyrmont and comprises a large mixed-use entertainment complex operating on a 24-hour basis.

The local environment characterised by medium levels of activity throughout the day, and during the evening / night, particularly at the weekend, characterised by;

- road traffic noise;
- general urban activity; and
- background noise typical of an inner-city mixed-use precinct.

2.2 Site and surrounding land uses

The Star and the project site are zoned as E2 – Commercial Centre.

A mix of commercial and residential buildings exists around the site, as per the NSW Planning map in Figure 9.

Existing neighbouring buildings and receivers that surround the site include:

- Existing commercial and retail receivers on Pirrama Road / Edward Street, and directly adjacent to the site as part of The Star. The latter include Astral Tower and Residences at The Star and The Darling (hotels), plus The Star Sydney Hotel and The Star Events Centre.
- The New Live Entertainment Venue space is also directly adjacent to a number of existing internal spaces, including The Star gaming and circulation areas on Level 5 plus Foundation Theatres spaces on Level 4.
- Residential receivers surrounding the site on Pyrmont Street, Jones Bay Rd, Pirrama Rd, Edward St and Union St.
- Public park areas to the north / north east.
- Local road infrastructure including Pyrmont Street, Pirrama Road and Jones Bay Road.

The following figures present the approximate site location and local context and land uses.

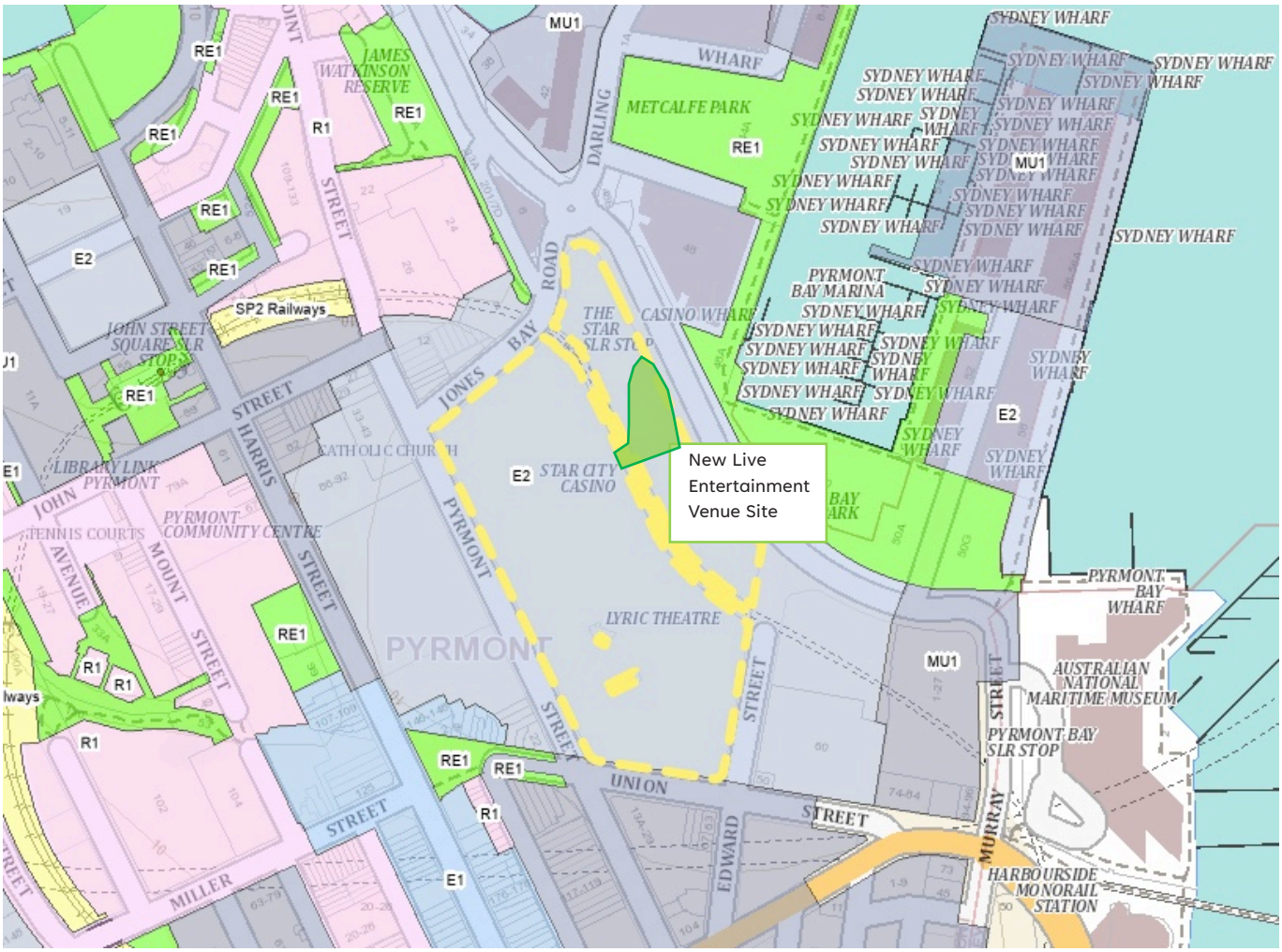


Figure 9 Site Zoning

Source: NSW Planning Portal Spatial Viewer https://www.planningportal.nsw.gov.au/spatialviewer/

Figure 10 Site aerial and neighbouring land uses

Source: Apple Maps

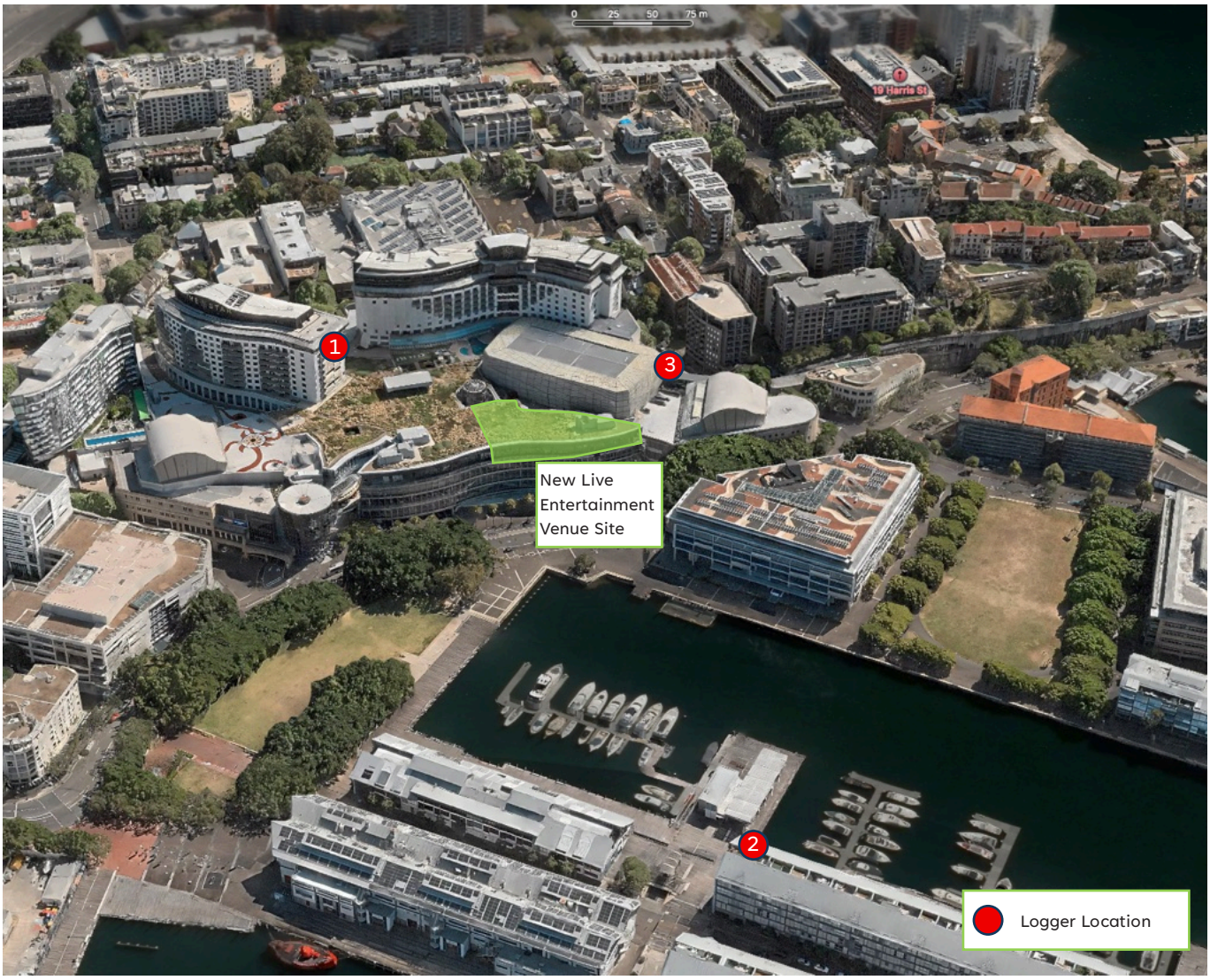


Figure 11 Site 3D, with residential receiver long-term noise logger locations shown

Source: Apple Maps

2.3 Noise sensitive receivers and noise survey locations

A summary of the potentially affected nearest receivers surrounding the development site is presented in Table 1.

Table 1 Nearest noise and vibration sensitive receivers surrounding the Project site

Receiver type	Indicator	Address / Description		Approx. building levels above ground	Approx. distance from site – closest receiver to closest point of site, m
Residential	R1	2 Jones Bay Road		9	80
	R2	Sydney Wharf Apartments		4	200
	R3	18 Pyrmont St		2	110
	R4	33-43 Pyrmont St		2	150
	R5	91 and 93 Pyrmont St		2	190
	R6	Pyrmont St Residences 56 Pirrama Rd		2	220
	R7	31-33 Union St		2	240
Hotel	H1*	The Star Grand Hotel – North building		16	65
	H2*	The Star Grand Hotel – South building		16	90
Commercial	C1	48 Pirrama Rd		5	40
	C2*	The Star – mixed commercial/retail		1 to 4	10
	C3*	Foundation Theatres - Events Centre		7	10
	C4A*	The Star – internal spaces	Sovereign Room (private gaming)	4	Internal adjacent
	C4B*		Semi-enclosed transient spaces	4	
	C5	52 Pirrama Rd		3	150
	C6	77-89 Pyrmont St and 94-136 Harris St		5-7	130
	C7	13-29 Union St		2	230
	C8	60 Union St		5	130
Passive Recreation	P1	Pyrmont Bay Park		-	70

NOTES:

* Receivers are within The Star complex. Noise impacts between internal receivers are managed via The Star lease agreements. Whilst not reported herein, potential for internal noise impacts has been considered as part of the overall noise impact assessment. Refer also to Section 2.4.

Rows highlighted are considered the reasonably most affected receivers, and are used as the nominated 'worst-case' receivers for assessment within this report. Where compliance is demonstrated at these receivers, all other receivers are also expected to comply.

A map of the site and surrounding noise-sensitive receivers relevant to this assessment is provided in Figure 12.

The acoustic survey locations are also included.

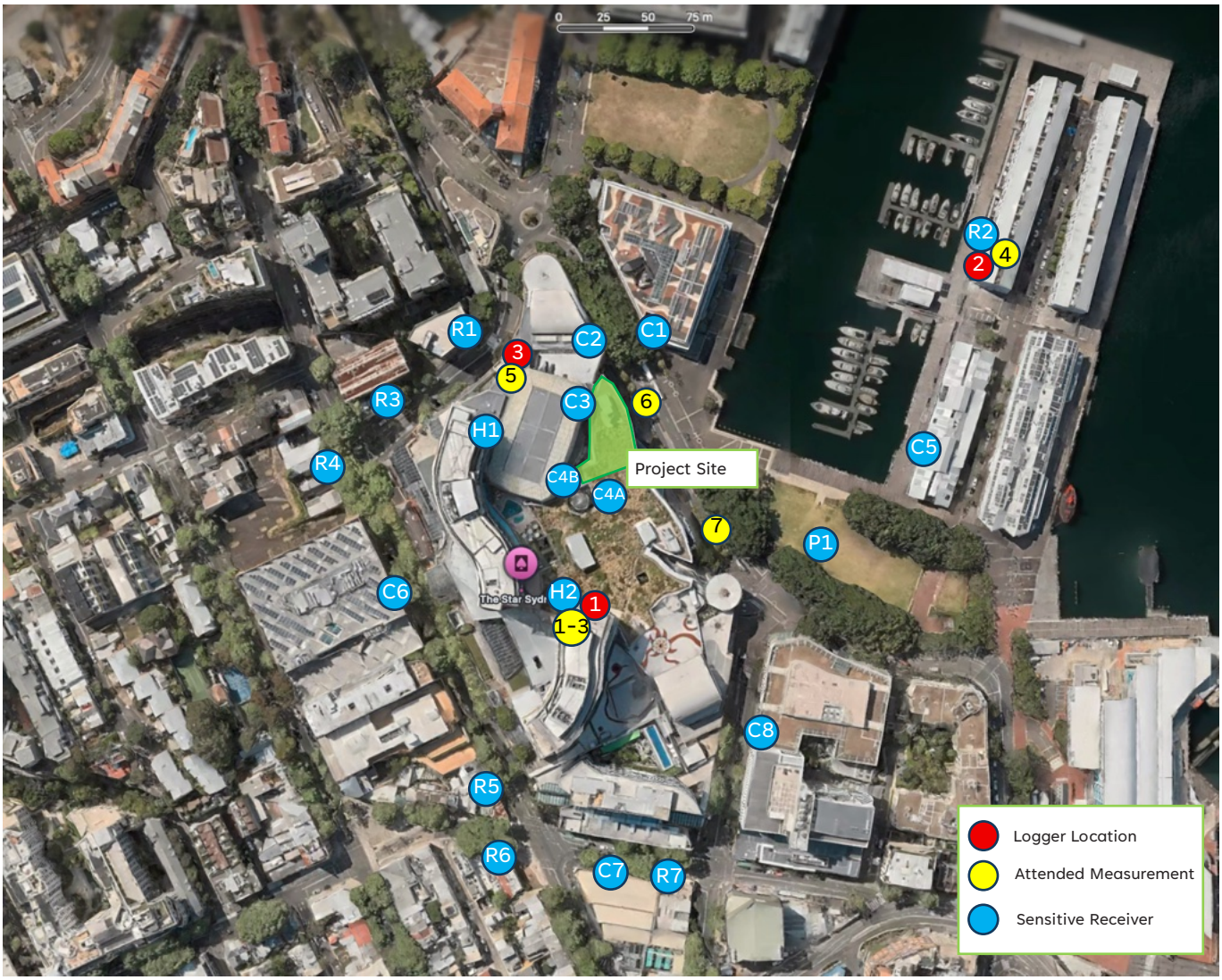


Figure 12 Map of site, surrounding sensitive receivers and noise survey locations

Source: Apple Maps

2.4 Internal adjacent receivers – The Star

Receivers located within the subject site, including areas within the same tenancy or under common ownership, are not considered noise-sensitive receivers for the purposes of environmental plant noise assessment in accordance with the NSW EPA Noise Policy for Industry (2017), which applies to separate premises. As such, quantitative compliance assessment of plant noise has focused on *external* receivers and independently occupied surrounding properties.

Notwithstanding this, consideration has been given to internal amenity and operational functionality to ensure that noise levels within the premises remain suitable for the intended use – for both plant noise and entertainment noise.

Construction activities are assessed under NSW EPA Interim Construction Noise Guideline, which considers impacts on occupants irrespective of land ownership. Potential impacts to internal areas during construction are, therefore, considered and are to be managed through standard construction noise mitigation assessment and measures.

3 Existing Noise Environment

3.1 Noise survey approach

To characterise the current acoustic environment, a program of unattended noise monitoring has been undertaken at representative receiver locations in the vicinity of the site.

The monitoring has been carried out in accordance with relevant NSW guidelines and includes measurement of:

- L_{Aeq} (equivalent continuous sound level).
- L_{A90} (background noise level).
- Statistical noise descriptors across day, evening and night periods.
- Octave-band data for establishing criteria for music and patron noise.

Monitoring locations have been selected to be representative of the nearest and most affected receivers, with consideration of those previously identified in the Modification 14 assessment.

3.2 On-site observations

The acoustic environment is dominated by:

- Rooftop exhaust fans and condenser units.
- Light traffic noise.
- General urban activity.

3.3 Unattended measurements

Long-term unattended noise monitoring was carried out with the following noise loggers:

- Ngara noise logger (serial no. 878190).
- Svantek 971 noise logger (serial no. 107445).

The locations of the logger installations are shown in Figure 12 and further details are given in Table 2.

Table 2 Noise logger details

Location	Description	Measurement period	Measurement Dates	Comments
Logger #1	Located on the balcony of the Star Hotel, facing North. **Representative of receiver H2.**	14 days	10th March 2026 – 23rd March 2026	Ngara Logger.
Logger #2	Located on the balcony of Sydney Wharf Apartments – Building D **Representative of receiver R2.**	14 days	8th April 2026 – 22 April 2026	Svantek 971 logger.
Logger #3	Located on the western side of the New Live Entertainment Venue Site, on the roof of the Casino. **Representative of receiver R1.**	13 days*	9th April 2026 – 22 April 2026	Ngara logger. This location is representative of the background noise environment at the residential apartments at 2 Jones Bay Road. * NOTE: Due to a technical fault, this logger recorded less than 7 days of useable data. Refer to Section 3.5.

The calibration of the loggers was checked before and after use and no variations were noted. Graphs presenting summaries of the measured daily noise data are attached in **Appendix A.** This data has been filtered to remove periods affected by adverse weather conditions based on weather information.

The Rating Background Noise (RBL) levels derived according to the NPfI and average ambient noise levels for the same periods are provided in Table 3.

Table 3 Results of long-term background and ambient noise monitoring

Location	L_{A90} RBL Rating Background Noise (dB)			L_{Aeq} Ambient Noise Levels (dB)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger #1	52	55	52	56	58	55
Logger #2	47	47	41	52	51	47
Logger #3	54	54	50	58	57	54

The octave-band L_{90} levels measured for each of the time periods as defined in the Liquor and Gaming Standard Conditions are used to derive the noise limits for music and patron noise emissions, and are presented in Tables 4 to 6.

Table 4 Summary of octave-band background noise levels at Logger #1 (Receiver H2)

Time period	L_{A90} (dB)	Octave Band L_{90} level (dB) / Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
7am – Midnight	**52**	56	55	55	50	49	47	43	45	40
Midnight – 7am	**51**	55	52	52	46	46	43	40	48	29

Table 5 Summary of octave-band background noise levels at Logger #2 (Receiver R2)

Time period	L_{A90} (dB)	Octave Band L_{90} level (dB) / Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
7am – Midnight	**50**	54	55	53	50	47	45	40	31	21
Midnight – 7am	**44**	50	50	48	43	42	40	35	24	13

Table 6 Summary of octave-band background noise levels at Logger #3 (Receiver R1)

Time period	L_{A90} (dB)	Octave Band L_{90} level (dB) / Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
7am – Midnight	**54**	59	63	61	55	49	49	45	43	30
Midnight – 7am	**51**	56	56	57	51	45	44	42	42	28

3.4 Attended measurements

Short-term attended measurements were also carried out to validate the representative locations of the unattended noise monitoring locations. The details are provided in Table 7, with locations indicated in Figure 12.

Table 7 Summary of attended measurement (simultaneous with loggers) results

Location	Date and Time	Length	Attended results		Simultaneous logger results			Comments
			L_{A90} (dB)	L_{Aeq} (dB)	L_{A90} (dB)	L_{Aeq} (dB)	Logger	
Attended #1	10/03/2026 15:18	10 Mins	54	56	54	57	#1	Day-time measurement at the location of logger #1 (During Deployment).
Attended #2	24/03/2026 15:08	15 Mins	54	55	N/A	N/A	#1	Day-time measurement at the location of logger #1 (During Collection).
Attended #3	30/03/2026 22:08	15 Mins	53	53	N/A	N/A	#1	Night-time measurement at the location of logger #1 Background was dominated by kitchen exhaust fans to the right side of the apartment.
Attended #4	08/04/2026 09:00	15 Mins	47	51	47	51	#2	Day-time measurement at the location of logger #2, on the balcony of Sydney Wharf Apartments.
Attended #5	09/04/2026 11:41	15 Mins	55	57	55	58	#3	Day-time measurement at the location of logger #3, above the roof of the Star Casino.

Additional attended measurements were conducted along Pirrama Road, adjacent to the north-eastern façade of The Star, to establish representative traffic noise levels impacting this façade. These are summarised in Tables 8 and 9.

Table 8 Attended measurement results and comments

Location	Date and Time	Length	Attended results		Comments
			L_{A90} (dB)	L_{Aeq} (dB)	
Attended #6	08/04/2026 09:28	10 min	57	66	Along Pirrama Rd near Light Rail entrance
Attended #7	08/04/2026 09:46	15 min	54	63	Along Pirrama Rd near Lyric Theatre entrance. The Octave Band Leq values are in Table 9.

Table 9 Octave-band traffic noise levels at Logger #1

Time period	L_{Aeq} (dB)	Octave Band L_{eq} level (dB) / Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
9 am (morning peak)	**63**	67	66	63	60	59	61	55	48	41

3.5 Noise Survey comparison with previous assessment(s) and adopted background noise levels

3.5.1 WSPPB NIA and Acoustic Studio previously recorded noise levels

The measured background noise levels have been compared with those adopted in the WSPPB NIA, and for previous projects at The Star completed by Acoustic Studio.

This comparison indicates that;

- the current acoustic environment is generally consistent with that previously characterised; and
- any variations in background noise levels are within the range typically expected for an urban environment of this nature.

Accordingly, the updated monitoring also provides confirmation and validation of current conditions.

3.5.2 Noise Logger #3

Due to a technical fault, noise logger #3 deployed for this project recorded less than 7 days of valid data as required by the NSW EPA NPI. However, we have compared data collected with previous data recorded at the same locations by Acoustic Studio for previous DA/MAs, and note the following:

- Daytime and Evening – Noise logger #3 recorded comparable noise levels to the previous assessments.
- Night – Noise logger #3 recorded noise levels up to 4 dB lower than previous assessments.

3.5.3 Adopted background noise levels

For the purposes of this assessment, the measured background noise levels from the noise surveys have been adopted as the basis for establishing current noise criteria, noting:

- Logger #1 data will be used to establish criteria for receiver H2.
- Logger #2 data will be used to establish criteria for receiver R2.
- Logger #3 data will be used to establish criteria for receiver R1, noting that this data was observed to be equal-to or lower-than previous assessments and, therefore, establishes more stringent / conservative criteria for the nighttime period.

4 Project Specific Noise and Vibration Criteria

4.1 Applicable standards and Guidelines

The relevant policies and/or guidelines for each aspect of the Project are listed in Table 10.

A full list of standards and guidelines including publication dates is provided in **Appendix E.**

Table 10 Summary of applicable guidelines

Acoustic Consideration	Applicable Standard / Guideline	Relevant Section in Report
Operational Noise Emissions		
On-site Noise Sources – General	POEO Act 1997 CoS DCP NSW Noise Policy for Industry (NPfI)	Section 4.2.2
On-site Noise Sources – Music and Patron	NSW Liquor and Gaming L10 criteria CoS Environmental Noise Technical Requirements NSW Vibrancy Reforms	
Off-site Road Traffic Noise	CoS DCP NSW Road Noise Policy (RNP)	Section 4.2.3
External Noise Intrusion		
Traffic Noise Intrusion	CoS DCP NSW Infrastructure SEPP NSW Development near Rail Corridors and Busy Roads - Interim Guideline	Section 4.2.4
Construction Noise and Vibration		
Noise	NSW Interim Construction Noise Guideline (ICNG)	Section 4.2.5
Vibration	NSW Assessing Vibration, a Technical Guideline (AVTG)	

The following Sections outline the relevant project-specific noise and vibration targets based on the noise monitoring results and application of the relevant standards and guidelines.

4.2 Establishing project operational noise criteria

4.2.1 Previously established criteria

Table 11 presents the proposed site wide acoustic conditions from the Modification 14 WSPPB NIA planning acoustic assessment report, based upon the conditions in Major Project Approval MP08-0098.

This is presented for comparison only, as criteria for this project have been established separately.

Table 11 WSPPB NIA Recommended Criteria for site-wide adoption under Mod 14

Conditions	Details	Comments
E1 Noise Control – Plant and Machinery	Noise associated with the operation of any plant, machinery or other equipment on the site, shall not give rise to anyone or more of the following: 1. Transmission of "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any place of different occupancy. 2. A sound pressure level at any affected residential property that exceeds the background (LA90, 15 minute) noise level by more than 5 dB(A). The background noise level must be measured in the absence of noise emitted from the premises. The source noise level must be assessed as a LAeq, 15 minute.	Matches Major Project Approval MP08_0098 Condition E1 with only amendment being removal of "inaudibility" clause.
F5 Noise (Patron and music)	Noise caused by the approved use including music and other activities must comply with the following criteria: 1. The use must not result in the transmission of "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any place of different occupancy. 2. The L10 noise level emitted from the use must not exceed 5 dB above the background (L90) noise level in any Octave Band Centre Frequency (31.5 Hz to 8kHz inclusive) between the hours of 7.00am and 12.00 midnight when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use. 3. The L10 noise level emitted from the use must not exceed the background (L90) noise level in any Octave Band Centre Frequency (31.5 Hz to 8kHz inclusive) between the hours of 12.00 midnight and 7.00am when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use. 4. 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 8kHz inclusive) by more than 3 dB when assessed indoors at any affected commercial premises.	Matches Major Project Approval MP08_0098 Condition F5 with only amendment being removal of "inaudibility" clause.
D11 Construction Hours of Work	The hours of construction, including the delivery of materials to and from the site, shall be restricted as follows: 1. between 7:00 am and 5.30 pm, Mondays to Fridays inclusive; 2. between 8:00 am and 3.00 pm, Saturdays; 3. between 9:00 am and 3.30 pm, Mondays to Fridays for mechanical rock blasting; 4. no work on Sundays and public holidays. Works may be undertaken outside these hours where: 1. the delivery of materials is required outside these hours by the Police or other authorities; 2. it is required in an emergency to avoid the loss of life, damage to property and/or to prevent environmental harm; and 3. residents likely to be affected by the works are notified of the timing and duration of works.	Matches Major Project Approval MP08_0098 Condition D11 with additional clauses to reference relevant NSW construction noise guidance.

4.2.2 Operational noise emissions

On-site Noise Sources – General

Applicable project-specific noise criteria for on-site noise sources are derived based on the measured noise levels detailed in Section 3.3 and following the NSW EPA Noise Policy for Industry procedure for deriving Project Noise Trigger Levels (PNTL). Table 12 details the corresponding targets of allowable noise emission from external plant and equipment (plus other on-site operations) at the nearest receiver boundary. The full criteria derivation procedure is provided in Appendix B.

Table 12 NSW NPfI Project Noise Trigger Levels (PNTL)

Receiver	Period	Project Noise Trigger Level (PNTL) $L_{eq,15min}$ dB(A)
Residential Receiver R1 (Urban) (Logger #3)	Day (7am*-6pm)	58
	Evening (6pm-10pm)	48
	Night (10pm-7am*)	43
Residential Receiver R2 (Urban) (Logger #2)	Day (7am*-6pm)	52
	Evening (6pm-10pm)	48
	Night (10pm-7am*)	43
Hotel Receiver H2 (Logger #1)	Day (7am*-6pm)	63
	Evening (6pm-10pm)	53
	Night (10pm-7am*)	48
Passive Recreation	When in use	53
Commercial	When in use	63

*8am for Sundays and Public Holidays

Sleep Disturbance

The Sleep Disturbance Screening Criteria are presented in Table 13.

Table 13 Sleep disturbance screening criteria

Receiver		Night Time RBL	$L_{Aeq,15min}$ Screening Criteria (dB)	Screening Criteria L_{AFmax}, (dB)
Residential	R1	50	55	65
	R2	41	46	56
Commercial & Hotel	H2	52	57	67

*8am for Sundays and Public Holidays

On-site Noise Sources – Music and Patrons

Protection of the Environment Operation Act (POEO) 1997

The Protection of the Environment Operations (POEO) Act 1997 defines "Offensive Noise" as follows:

"...

- **a** *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*
  - **i** *is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or*
  - **ii** *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*
- **b** *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances, prescribed by the regulations. ..."*

Further advice on the assessment of "Offensive Noise" is provided in the Noise Guide for Local Government (NGLG), 2010, which provides a checklist (shown below) of items that may be considered.

Whilst the POEO Act is typically applied as a compliance check, it is also considered a relevant tool/checklist in the planning stages of a development proposal.

Offensive noise test: Checklist of considerations

Q1: Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?

This establishes that the noise is likely to be heard by neighbours. Its volume alone may be annoying. An example would be music being played at a very high volume in a residence so it can be heard over very noisy activity outside, such as construction work. The noise may also be loud relative to the background noise. An example would be loud fireworks set off late at night. Noise measurements using a sound level meter would help to determine how loud the noise is relative to the background noise level in the area.

Q2: Does the noise include characteristics that make it particularly irritating?

The presence of tones, impulses or fluctuations in volume can make people more likely to react to the noise. These can be judged subjectively but noise measurements will help to quantify the extent of these characteristics. Examples might be screeching sounds from poorly maintained equipment or a 'beeper' alarm that uses a pulsed sound made up of one or two alternating frequency tones, usually higher pitched, that are louder than the background noise in the area.

Q3: Does the noise occur at times when people expect to enjoy peace and quiet?

People usually expect their surroundings to be quieter during the evening and at night. Talk to the complainants about how the noise affects them to see if it is interfering unreasonably with their comfort at home. Is it regularly disturbing their sleep, making it difficult to have a conversation, study, read or hear the TV? Noise that regularly disturbs sleep is likely to be considered offensive by complainants and this should be taken into account in your assessment.

Q4: Is the noise atypical for the area?

Where noise from an activity that is causing nuisance is new or unusual for an area, people are more likely to react. Look at the typical uses of the area and determine whether the activity is consistent with the local environmental plan. An example might be a rock drill used on a residential construction site.

Q5: Does the noise occur often?

Noise can be more annoying when it occurs frequently. Examples might be a leaf blower used every morning or a band that practises frequently without regard to the impact on neighbours.

Q6: Are a number of people affected by the noise?

Only one person needs to be affected by the noise for it to be deemed offensive. However, talking to other neighbours likely to be exposed to the same noise about how it affects them may assist in deciding what action to take. Some councils have a policy of requiring a minimum number of complaints from different individuals before taking formal action.

Figure 13 NGLG Offensive Noise Checklist

Liquor & Gaming NSW (L&GNSW) & NSW Vibrancy Reforms Act 2023

Noise emission from music and patron noise is historically assessed against the Liquor and Gaming NSW (L&GNSW) L10 criteria, as a reference level to indicate potential impact. For venues that hold a liquor license, L&GNSW may also impose the L10 criteria as license conditions on the venues' liquor licenses following investigation in a statutory disturbance complaint.

- *The LA10* noise level emitted from the licensed premises shall not exceed the background noise level (LA90) in any Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) by more than 5dB between 07:00am and 12:00 midnight at the boundary of any affected residence.*
- *The LA10* noise level emitted from the licensed premises shall not exceed the background noise level (LA90) in any Octave Band Centre Frequency (31.5Hz – 8kHz inclusive) between 12:00 midnight and 07:00am at the boundary of any affected residence.*
- **Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 07:00am.*

These criteria form the basis of the current noise emission limits in the MP 08_0098 MOD 14 Condition F5:

32. Condition F5 is amended by the insertion of **bold and underlined** words / numbers as follows:

F5 Noise

Cumulative noise caused by the approved use including music and other activities must comply with the following criteria:

1. The use must not result in the transmission of "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any place of different occupancy **outside the boundary;**
2. The L10 noise level emitted from the use must not exceed 5dB above the background (L90) noise level in any Octave Band Centre Frequency (31.5 Hz to 8kHz inclusive) between the hours of 7.00am and 12.00 midnight when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use.
3. The L10 noise level emitted from the use must not exceed the background (L90) noise level in any Octave Band Centre Frequency (31.5 Hz to 8kHz inclusive) between the hours of 12.00 midnight and 7.00am when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use.
4. Notwithstanding compliance with (1) and (2) 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.
5. 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 8kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises.

Notwithstanding the above, the NSW 24-Hour Economy Legislation Amendment (Vibrancy Reforms) Act 2023 establishes that L&GNSW is the primary regulator of entertainment noise from licensed premises. As such, the application and enforcement of specific noise limits may ultimately be determined through the liquor licensing framework rather than development consent conditions.

For the purposes of this assessment, the L&GNSW LA10 criteria have been adopted as a conservative and industry-recognised baseline for the assessment of music and patron noise impacts at residential receivers. This approach provides a robust indication of potential acoustic impacts and demonstrates that the proposed development is capable of achieving a high level of acoustic amenity. Final operational noise limits and compliance requirements at all receivers (not just residential) will be subject to determination by the relevant consent authority and, where applicable, L&GNSW through the liquor licensing process.

The applicable noise limits for music and patron based on the measured noise levels detailed in Section 3.3 are given in Table 14. The threshold of hearing is also provided, and where the calculated noise limit is lower than the hearing threshold, the hearing threshold is used as the criterion.

Table 14 Music and patron noise emission criteria (Residential Receiver R1, external boundary)

Time period	L_{A10} (dB)	Octave Band L_{10} level (dB) / Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Threshold of Hearing	-	*51*	*32*	*18*	*9*	*3*	*2*	*-6*	*-6*	*6*
7am – Midnight (BG + 5dB)	**59**	64	68	66	60	54	54	49	48	35
Midnight – 7am (BG + 0dB)	**51**	56	56	57	51	45	44	42	42	28
Midnight – 7am internal inaudibility (BG – 10dB)	**41**	46	46	47	41	35	34	32	32	18

Table 15 Music and patron noise emission criteria (Residential Receiver R2, external boundary)

Time period	L_{A10} (dB)	Octave Band L_{10} level (dB) / Octave Band Centre Frequency (Hz)								
		31.5	63	125	250	500	1000	2000	4000	8000
Threshold of Hearing	-	*51*	*32*	*18*	*9*	*3*	*2*	*-6*	*-6*	*6*
7am – Midnight (BG + 5dB)	**55**	59	60	58	55	52	50	45	36	26
Midnight – 7am (BG + 0dB)	**44**	50	50	48	43	42	40	35	24	13
Midnight – 7am internal inaudibility (BG – 10dB)	**34**	40	40	38	33	32	30	25	14	3

Note: Cumulative noise from Star Casino Operations

The following is an extract from the NSW Department of Planning & Environment MP 08_0098 MOD 14 Environmental Assessment Report (Section 75I of the *Environmental Planning and Assessment Act 1979),* September 2017:

"...5.3.1 Operational Noise...

...The Department has reviewed the existing conditions and notes that if each individual premises generated noise to the upper limits of Condition F5, the noise generated by the Star Casino, cumulatively, could exceed the requirements of Condition F5. This would potentially cause offensive and adverse impacts on the surrounding area while technically complying with the requirements of the Major Project Approval...".

Acoustic Studio has considered the following with relation to cumulative noise:

- Cumulative noise from multiple operations within venues at The Star has the potential to exceed the maximum noise criteria presented above, but only during periods of simultaneous usage plus with similar noise emission levels and characteristics. The likelihood / risk of this happening is unknown. However, we consider it unlikely to occur regularly, if at all.
- The noise emission criteria established in this section, and for the subsequent assessment in Section 5.3, are considered conservative. They are derived from lowest measured background noise levels at respective receiver location. Also, the assessment incorporates conservative contingencies (for source sound levels, building envelope sound reduction, sound transmission paths, screening, etc) to ensure that the predicted noise emission levels from this project are generally below (rather than meet) the criteria.

City of Sydney

The City of Sydney *Standard Conditions of Consent* (SCC) plus the *Environmental Noise Technical Requirements* (ENTR) (October 2025) have been considered and incorporated as supplementary design and assessment benchmarks.

The SCC criteria are essentially the same as those used by LGNSW for licensed premises. Therefore, compliance with the LGNSW criteria in for residential receivers will also ensure compliance with the CoS criteria.

This ENTR document also provides prescriptive acoustic requirements in alignment with L&GNSW and Vibrancy Reforms that may be referenced by conditions of consent, particularly in relation to entertainment noise and the control of amplified sound, and are again essentially the same as those used by LGNSW for licensed premises.

4.2.3 Off-site road traffic noise

This report assesses changes in character, location and potential increase in traffic noise associated with the project.

Traffic noise due to construction activities is also considered.

Applicable criteria for existing residences affected by additional traffic on existing roads generated by the Project development are derived according to the NSW EPA Road Noise Policy 2011 and summarized in Table 16. This includes additional traffic during construction stage, and during operational stage.

Table 16 Road traffic noise criteria

Receiver	Assessment Criteria (external) (dB)	
	Day (7am to 10pm)	Night (10pm to 7am)
Major Road	L_{Aeq}(15 hour) 60	L_{Aeq}(9 hour) 55
	Existing traffic L_{Aeq}(15 hour) + 12	Existing traffic L_{Aeq}(9 hour) + 12
Local Roads	L_{Aeq}(1 hour) 55	L_{Aeq}(1 hour) 50

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"*... [in relation to existing noise levels] ...*"represents a minor impact that is considered barely perceptible to the average person".*

The Australian Standard AS 3671-1989 *Acoustics – Road traffic noise intrusion – Building Siting and Construction* (for guidance only; applies to siting of the receiver buildings) has a different emphasis, in that it aims to identify appropriate intrusive road traffic noise criteria in different building types. This is only relevant for the noise intrusion considerations for proposed noise sensitive spaces inside the building.

In the absence of directly applicable guidelines, policies or standards for assessing road traffic noise impacts from the Project, Acoustic Studio's approach is to examine the increase in traffic noise events and levels for most-affected sensitive receivers

4.2.4 External noise intrusion

Environmental and traffic noise intrusion has been considered with reference to relevant NSW guidance, including the NSW EPA *Noise Policy for Industry*, the *NSW Road Noise Policy*, and AS/NZS 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors*.

Based on the relatively low existing ambient noise environment and the substantial façade construction proposed for the performance venue, external noise ingress is assessed to be negligible in the context of the intended internal sound levels.

On this basis, no project-specific intrusion criteria have been derived, and detailed assessment of external noise ingress has not been undertaken within this report.

4.2.5 Construction noise and vibration

Airborne Noise Management Levels

The NSW EPA Interim Construction Noise Guideline 2009 (ICNG) defines standard construction hours during which the construction Noise Affected Management Level (NML, $L_{Aeq,15min}$) is 10 dB above the applicable period background noise level. A strong justification is required for conducting works outside standard construction hours, and the NML during these periods is significantly lower. The ICNG also defines Highly Noise Affected Management Levels (HNML) above which point there may be a strong community reaction against the noise.

Table 2 in Section 4.1.1 of the ICNG provides the NMLs for residential receivers while Section 4.1.3 of the ICNG provides the NMLs for commercial receivers. The project-specific construction NMLs are shown in Table 17, based on the measured background noise levels at the site (in Section 3.3 – also refer to Appendix A).

Table 17 Project-specific construction Noise Management Levels for airborne noise

Receiver		Period	RBL dB	NML $L_{Aeq,15min}$ dB	HNML $L_{Aeq,15min}$ dB
Residential	R1	Recommended Standard Hours (Monday to Friday 7am to 6pm Saturday 8am to 1pm)	54	64 (RBL + 10 dB)	75
	R2		47	57 (RBL + 10 dB)	75
Commercial (including H1 and H2 Hotels)		When in use	-	70 (external)	-

Airborne noise management levels for non-residential receivers

Table 18 Noise criteria for airborne noise – non-residential receivers

Occupancy	Management level $L_{eq\ (15\ min)}$
Offices, retail outlets	70 dB(A) - External
Passive recreation areas	60 dB(A) - External
Active recreation areas	65 dB(A) - External

Where receiver types are not defined, the ICNG refers to AS2107 maximum design noise levels as guidance for setting internal noise management levels.

For pedestrian walkways, Acoustic Studio recommends applying a construction noise management level of 60-65 $dBL_{Aeq(15minutes)}$. This aligns with passive and active recreation area noise management levels.

Ground-borne Noise Management Levels

The ICNG recommends ground-borne noise management levels at residences affected by nearby construction activities. Ground-borne or structure-borne noise is noise generated by vibration transmitted through the ground or structure and is re-radiated as audible airborne noise.

The ground-borne noise management levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of occupants during the more sensitive time periods.

Table 19 Residential construction noise criteria for ground-borne noise

Time of Day	Management level $L_{eq\ (15\ min)}$
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Acoustic Studio considers that it is highly unlikely that ground / structure-borne noise will be audible, certainly above airborne noise, for the closest residential receivers to the Project site.

However, it is possible that structure-borne noise from some heavy internal demolition works will affect the guest rooms of the closest Hotel within The Star (The Darling). Therefore, if and where heavy internal demolition works are proposed outside of standard construction hours, the Contractor will be required to first determine that the structure-borne noise levels within adjacent Hotel guestrooms will not exceed the Noise Management Levels in Table 19.

See Appendix C for more information.

Construction Vibration

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary vibration management levels are summarised in Appendix C.

4.3 Summary of project specific operational noise criteria

Table 20 Operational noise criteria for all typical sources

Period	Plant, Maintenance, and on-site traffic applicable at receiver boundaries	
	NPI PNTL $L_{eq\ (15\text{-}minute)}$, dBA	Sleep Disturbance L_{AMax}, dBA ≤ RBL+ 15dB
Day (7am-6pm)	Residential R1 : 58 Residential R2 : 52 Commercial : 63 Passive Recreation : 48	n/a
Evening (6pm-10pm)	Residential R1 : 48 Residential R2 : 48 Commercial : 63 Passive Recreation : 48	n/a
Night (10pm-7am)	Residential R1 : 43 Residential R2 : 43 Commercial : 63 Passive Recreation : 48	Residential R1 : 65 Residential R2 : 56

Period	Sound System & Patrons MOD 14 / LGNSW / CoS Project Criteria, L10 [Note 1]	Overall dB(A)	Octave band centre frequency, Hz 31.5	63	125	250	500	1k	2k	4k	8k
7am to midnight	R1 Residential Boundary	**59**	64	68	66	60	54	54	49	48	35
	R2 Residential Boundary	**55**	59	60	58	55	52	50	45	36	26
Midnight to 7am	R1 Residential Boundary	**51**	56	56	57	51	45	44	42	42	28
	R2 Residential Boundary	**44**	50	50	48	43	42	40	35	24	13
When in Use	Commercial (C1)	**63**					-				
When in Use	Passive Recreation (P1)	**48**					-				

Note 1 : The criteria nominated for sound system and patron noise are not strict noise limits. These criteria are derived from the MOD 14 Condition F5 / LGNSW / CoS SCC "L_{A10} criteria" and represent benchmarks which may be used in evaluating compliance with the Protection of the Environment Operation Act (POEO) 1997 plus NSW Vibrancy Reforms Act 2023.

Note: Cumulative noise from The Star Operations

Acoustic Studio considers the criteria established suitably account for and address the NSW Department of Planning & Environment MP 08_0098 MOD 14 comment regarding cumulative noise. Refer to Section 4.2.2.

5 Operational Noise Emission Assessment and Recommendations

The proposal has been assessed based on information provided by the Architect (Altis Architecture) and the Proponent (Foundation Theatres).

5.1 Operational assessment methodology

The acoustic assessment has considered the following:

- The Project will generally be open and in use as an entertainment venue between 7am and midnight / 3am. Amplified music at show levels will occur up to midnight. Between midnight and 7am, amplified music will be approximately 5 to 10 dB below the maximum show levels presented herein.
- Noise levels from the New Live Entertainment Venue space and access areas have been considered as continuous source over a 15-minute assessment period to provide a worst-case.
- Noise predictions at the nearest residential and commercial receivers consider the total noise contribution from all noise sources.
- Distance attenuation, with conservative estimates for attenuation due to shielding from buildings, intervening topography and ground absorption.
- Operational noise emissions from the proposed New Live Entertainment Venue space have been established based on measurements undertaken by Acoustic Studio at comparable shows in alternative locations, and these have been used in conjunction with Acoustic Studio calculations in order to provide increased accuracy and validation of the operational noise emissions assessment.
- Lowest measured background noise levels have been used to provide a worst-case scenario.

5.2 On-site noise sources – general

5.2.1 Mechanical Plant – Noise Emissions

Plant associated with the operation of the Project should be controlled to ensure external noise emissions meet the noise emission criteria, are not intrusive and do not impact on the amenity of nearby receivers.

Rooftop plant locations, plant selections and sound power levels have been provided by the mechanical consultant at draft design stage, and are considered typical for the assessment.

New rooftop plant includes:

- Within enclosed plant area:
  - AHU-1; AHU-2 located on level 4 within building
  - Smoke Exhaust Fans SEF-1, SEF-2 and SEF-3
  - Kitchen Exhaust fan KEF-L5K-03
  - Pumps; Pump-1 and Pump-2
- External / exposed
  - Chillers CH-1 and CH-2
  - Outdoor VRF heat pump units x2

Most plant will operate during opening hours. Air conditioning units will operate as required, using timers and settings to only serve occupied spaces where practicable. Other plant may operate normally at any time of the day or night-time period (between 10pm and 8am) all plant may be operating (excluding emergency smoke exhaust systems – unless there is an emergency).

In addition to operating during an emergency / fire situations, the smoke exhaust fans may operate at a reduced capacity during normal operations to provide exhaust air for the new performance space.

New rooftop plant location and plan is located as shown in the following figures.

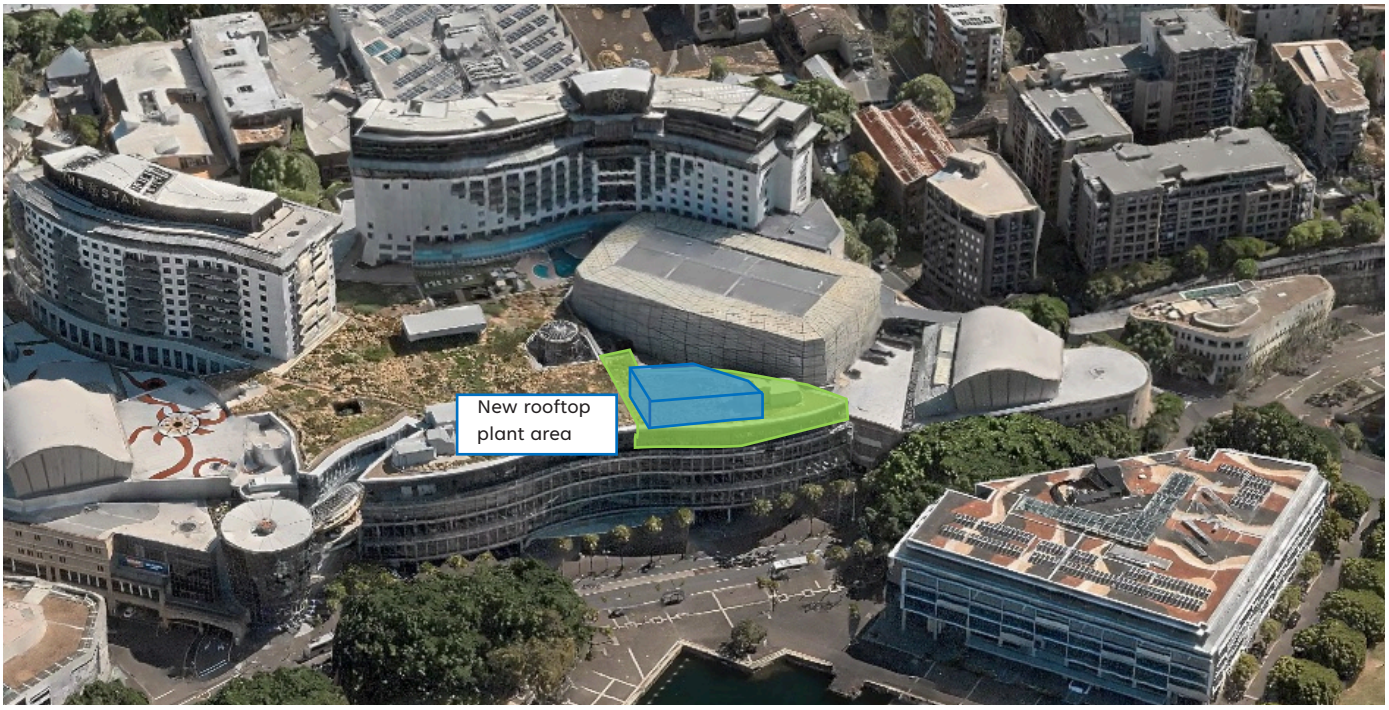


Figure 14 Rooftop plant location (approximate)

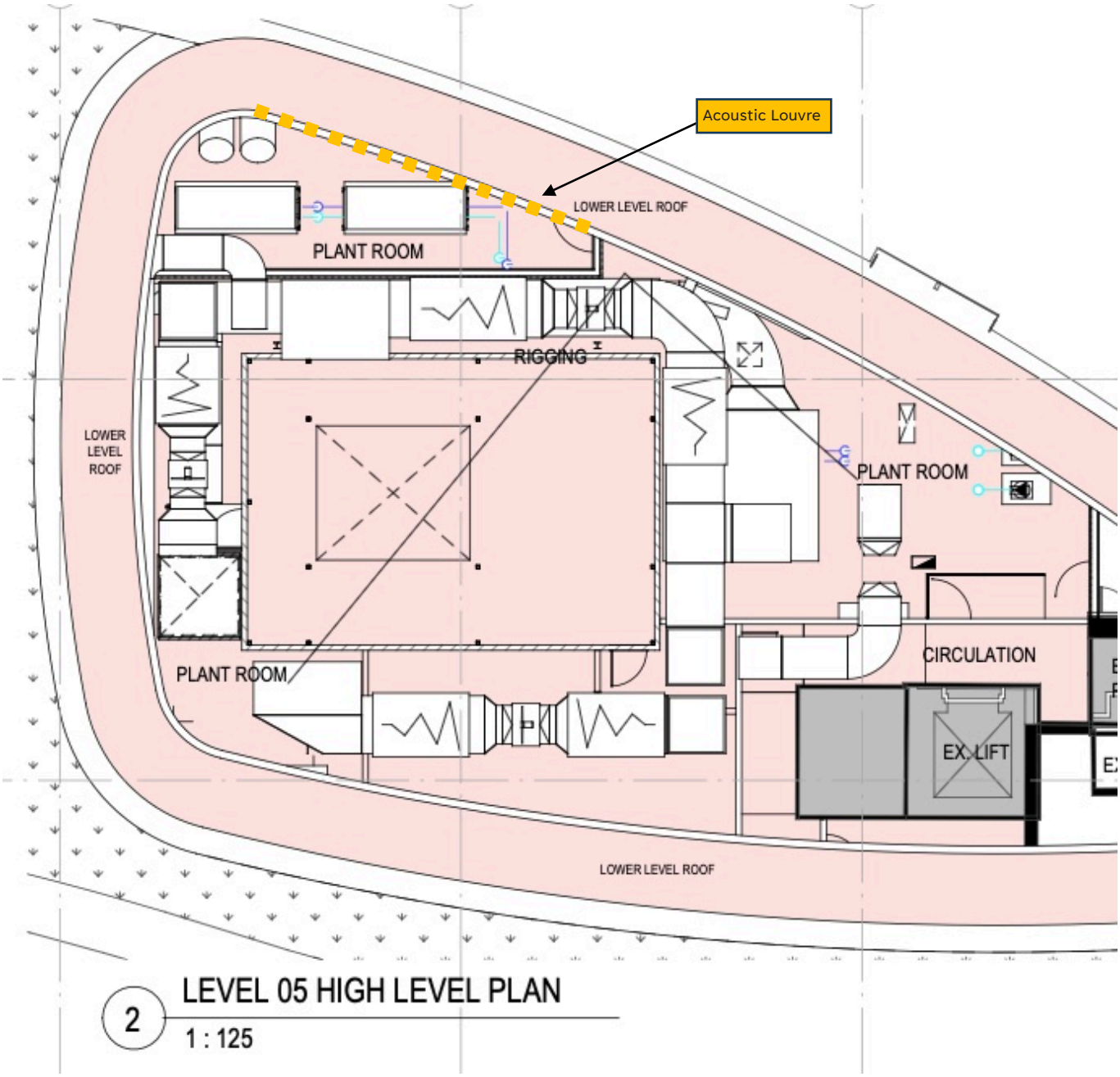


Figure 15 Rooftop plant plan, with recommended acoustic treatment location (approximate)

The sound power levels of rooftop plant items considered in the assessment are provided in Table 21.

Table 21 Plant source levels (provided by mechanical consultant)

Location	Noise source		Octave Band Sound Power Levels (SWL) (dB) / Centre Frequency (Hz)								dB	dBA
			63	125	250	500	1000	2000	4000	8000		
External units	Chiller 1 & 2 (180 kW)		-	-	-	-	-	-	-	-	-	**85**
	VRF 1 & 2 (40kW)		-	-	-	-	-	-	-	-	-	**83**
Internal / ducted	KEF-5K-03	Inlet	93	89	96	102	103	97	89	84	**107**	-
		Outlet	101	103	104	103	101	99	95	91	**110**	-
		Breakout	97	93	88	85	81	79	63	60	**99**	-
	SEF x 3; -1, -2, -3	Inlet	99	98	95	95	92	91	88	83	**103**	-
		Outlet	98	95	95	94	92	91	98	83	**103**	-
		Breakout	95	86	79	75	69	65	56	53	**96**	-
	AHU-1 (10,000 L/s)		87	93	89	87	86	81	72	65	-	**90**
	AHU-2 (2,400 L/s)		79	84	80	78	77	72	64	56	-	**81**

Assessment

Acoustic Studio makes the following general comments:

- New plant will be mostly located in a new plantroom extension located on the roof (Level 05), with the exposed chillers and VRF units being the dominant sources of plant noise emissions.
- The most restrictive noise targets for the new plant are as follows, applicable at the closest residential receivers (Receiver R1, 2 Jones Bay Rd Watermark Tower)
  - 58 dB(A) during daytime and
  - 48 dB(A) during evening
  - 43 dB(A) during night-time

In order to meet the noise levels at the relevant receiver boundaries, Acoustic Studio recommends:

- Acoustic louvres will need to be provided (as indicated in Figure 15) to meet the environmental noise criteria.
- Attenuation or internally-lined ductwork required for fans in order to meet both internal and environmental noise criteria, particularly for the Smoke / General Exhaust and Kitchen Exhaust fans.
- Noise emissions from final external plant selections may also be controlled via a combination of:
  - natural screening provided by existing buildings, structure and topography; and
  - additional localised acoustic screening as required.

During the detailed design stage, the acoustic consultant will provide detailed design advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

Additional considerations

Tonality is a potential feature of chillers. An allowance must be made to apply a 5 dB adjustment for tonal noise for these plant items, if tonality is unavoidable in the final plant selection. From the data available it is unlikely that tonality penalty will need to be applied.

Emergency plant such as smoke exhaust fans and fire pumps has the potential to cause noise disturbance. Generally, the noise emissions criteria for emergency systems are relaxed due to their life safety function. However, because they need to be regularly tested, it is still important to ensure that the test regime is not unduly impactful. For this reason, emergency system tests should be carried out during the day, when receivers are least noise-sensitive.

5.2.2 Traffic noise emissions (offsite; road traffic)

We understand that the project will result in no significant changes to road traffic or car park use - resulting in no noticeable change in noise emissions (in terms of $L_{Aeq(1hr)}$ or $L_{Aeq(Day/Evening/Night)}$).

Generally, an increase of more than 50% in traffic volumes compared with existing volumes would generate a 2 dB or more increase, which the RMS *Road Noise Policy* (Section 4) states is the increase in noise which is likely to become noticeable.

Therefore, given the project will result in no significant changes to road traffic or car park use, there will also be no noticeable change in road traffic noise associated with the operational phase of this project when assessed in accordance with the RMS *Road Noise Policy* Section 4.

5.2.3 Traffic noise emissions (On site; carpark and loading dock)

No permanent changes to the carpark are proposed as part of the Project.

Similarly, no changes to operational noise in the loading areas, including waste removal, are expected. Loading activities are generally to be limited to typical business hours.

Therefore the project is not expected to result in any carpark or loading area noise impacts

5.3 On-site noise sources – music and patrons

5.3.1 New Live Entertainment Venue amplified music assessment

During typical events within the New Live Entertainment Venue, amplified music and speech will be played inside which may break out via the glazing, roof and other façade/building envelope areas.

Operational sound levels for the sound system inside the New Live Entertainment Venue are based on acoustic measurements undertaken by Acoustic Studio within similar shows plus measurements by Acoustic Studio for a range of amplified musical and drama events at multiple venues.

These levels are conservative and represent the typical worst case (noisiest) event types presented in the New Live Entertainment Venue Space.

Table 22 New Live Entertainment Venue event source sound levels

Noise source	Sound pressure level, dB re 20 µPa / OB Centre Frequency (Hz)									dBA
	31.5	63	125	250	500	1k	2k	4k	8k	
Internal reverberant amplified music sound level, L_{10}	90 - 95	100-105	100-105	90 - 95	85 - 90	85 - 90	85 - 90	80 - 85	75 - 80	**95 - 100**

Generally, to reduce noise breakout from the New Live Entertainment Venue, acoustic doors with acoustic seals are required for all external façade doors, and doors are required to remain closed during highest noise-level events.

The tables below present the assessment of noise emissions from amplified music within the New Live Entertainment Venue affecting the closest noise-sensitive receivers.

Table 23 Predicted amplified music sound levels (L10) from sound systems in the new performance space and assessment against environmental noise criteria at residential receiver location R1

Receiver	Source	Description	Sound pressure level, dB re 20 µPa									
			dB(A)	Octave band centre frequency, Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
Residential, External – R1	New Live Entertainment Venue Space	Internal Sound Level, L_{10}	**95 -100**	90 - 95	100-105	100 - 105	90 - 95	85 - 90	85 - 90	85 - 90	80 - 85	75 - 80
		Predicted Level at receiver (Residential R1), L_{10}	**<40**	56	50	43	<30	<20	<20	<10	<10	<10
		Environmental Project Criteria (7am-midnight), L_{10}	**59**	64	68	66	60	54	54	49	48	35
		Complies?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Table 24 Predicted amplified music sound levels (L10) from sound systems in the new performance space and assessment against environmental noise criteria at residential receiver location R2

Receiver	Source	Description	Sound pressure level, dB re 20 µPa									
			dB(A)	Octave band centre frequency, Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
Residential, External – R2	New Live Entertainment Venue Space	Internal Sound Level, L_{10}	**95 -100**	90 - 95	100-105	100-105	90 - 95	85 - 90	85 - 90	85 - 90	80 - 85	75 - 80
		Predicted Level at receiver (Residential R2), L_{10}	**<40**	53	47	40	<30	<20	<20	<10	<10	<10
		Environmental Project Criteria, L_{10}	**55**	59	60	58	55	52	50	45	36	26
		Complies?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

Table 25 Predicted amplified music sound levels (L10) from sound systems in the new performance space and assessment against environmental noise criteria at commercial receiver location C1

Receiver	Source location and condition	Description	Sound pressure level, Overall dB(A) re 20 µPa
Commercial, External – C1	New Live Entertainment Venue	Internal Sound Level, L_{eq}	95
		Maximum Predicted Level at receiver C1, L_{eq}	<40
		Environmental Project Criteria, L_{eq}	63
		Complies?	**Yes**

Table 30 Predicted amplified music sound levels (L10) from sound systems in the new performance space and assessment against environmental noise criteria at passive outdoor recreation (park) receiver location P1

Receiver	Source location and condition	Description	Sound pressure level, Overall dB(A) re 20 µPa
Passive Outdoor Recreation, Park P1	New Live Entertainment Venue	Internal Sound Level, L_{eq}	95
		Maximum Predicted Level at receiver P1, L_{eq}	<30
		Environmental Project Criteria, L_{eq}	48
		Complies?	**Yes**

5.3.2 New Live Entertainment Venue patron noise assessment

Source Noise Levels

Table 26 shows typical sound levels expected from patrons in the new venue.

The patron source noise levels are considered to be conservative (i.e. higher than normally expected in practice), as it is generally unlikely that almost half of the patrons will be shouting/screaming at once. However, this conservative approach has been adopted to account for the potential worst-case scenario, and has been calibrated against measured noise levels from a similar show and occupancy.

Table 26 Sound levels (L_{eq} @ 1 m) likely to be generated by patrons visiting the Project

Description	Sound pressure level, dB re 20µPa									
	Overall dB(A)	Octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
L_{eq} of 1 adult shouting/screaming	**82**	20	20	30	55	65	75	70	65	55
L_{eq} of 450 patrons half shouting/screaming (+3 dB Lombard effect)	**105**	43	43	53	78	88	98	93	88	78

Assessment

Patron noise from the Project has been estimated for the following scenario:

- General patron noise from up to 450 people, with half of the people shouting/screaming inside the venue.

As shown below, the conservative patron noise predictions in Table 27 comply with the most-stringent of the noise emission criteria (nighttime) for the closest residential receivers. Therefore, compliance is expected at all receivers at all times.

Table 27 Predicted highest expected patron noise levels (L10) at the nearest residential receiver (R1) due to patrons in the new venue

Receiver	Source location and condition	Description	Sound pressure level, dB re 20 µPa									
			dB(A)	Octave band centre frequency, Hz								
				31.5	63	125	250	500	1k	2k	4k	8k
Residential, R1	New LEV, 450 people, half shouting / screaming, doors closed	Internal Sound Level, L_{10}	**105**	43	43	53	78	88	98	93	88	78
		Predicted Level at receiver, L_{10}	**<20**	<10	<10	<10	<10	<20	<20	<10	<10	<10
		Environmental Project Criteria, L_{10}, midnight-7am	**51**	56	56	57	51	45	44	42	42	28
		Complies?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

5.3.3 Patron Noise from foyer / access / queueing areas

In addition to the above assessment, we note that the existing internal / external foyer areas are remaining in the same locations within the existing Star envelope. This is at the western-side of the site, and partially enclosed / shielded from the closest residential receivers. Also, the peak occupancy for the existing areas will remain unchanged from the existing.

Therefore, with no changes proposed to the existing foyers / patron approach areas, noise emissions from the these to external receivers will remain unchanged from the existing and comply with all applicable noise criteria at all receivers at all times.

5.3.4 Sleep disturbance from patrons and sound systems

The NPI describes two methods for assessing the risk of Sleep Disturbance.

- Event $L_{Aeq,15min}$ 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or
- Event L_{AFmax} 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.

The predictions presented in Section 5 show that overall $L_{A10,15min}$ levels from patron and sound system noise from indoor sources, are predicted to be less than RBL + 5 dB.

The $L_{A10,15min}$ is the highest 10% of the noise levels measured over a 15-minute period and is generally expected to be approximately 3-5 dB higher than the sound energy average $L_{Aeq,15min}$ for the same sounds measured over the same period. Therefore compliance with the first Sleep Disturbance condition is met.

The $L_{A10,15min}$ is typically 5-10 dB below the $L_{Amax,15min}$ for the same sounds measured over the same period. Therefore the $L_{Amax,15min}$ is expected to be less than RBL + 15 dB, which meets the second Sleep Disturbance screening level.

If the sound system sound levels from the new performance space are controlled to meet the allowable sound levels presented in Section 5.3, and patron numbers are managed as per the assumptions herein, noise emissions are considered unlikely to cause sleep disturbance.

5.3.5 Discussion of sound system and patron noise emissions

Acoustic Studio has undertaken a noise impact assessment which considers patron and sound system noise break-out to the neighbourhood and adjacent buildings.

The assessment is based on the proposed uses for the various areas of the building.

Section 5.3 demonstrates that the Project operations inside the new venue will comply with the project criteria at all octave bands at the nearest residential and commercial receivers, plus with overall noise criteria at the adjacent parks.

Furthermore, because the general operations are not expected to change from the pre-existing / current uses and approval for the building, environmental noise levels will be no higher than those currently experienced at all affected receivers.

See **Appendix D** for example guidance on sound management plan which outlines general best practice procedures for ongoing management.

5.4 POEO offensive noise assessment

We have assessed the potential for offensive noise in accordance with the checklist considerations outlined in the Noise Guideline for Local Council, and we make the following comments.

- The predicted noise levels (associated with noise emissions from the proposed development) at the nearest affected residential receiver boundaries are not loud in an absolute sense and are not loud relative to the background noise level, with similar ambient levels having been measured at the nearest residential receivers on Jones Bay Road.
- Patron noise from inside the venue will meet applicable criteria. Noise from the carpark and loading area use will not change from current operations.
- The proposal will not result in noticeable changes to operations and, therefore, the noise emissions are considered typical for the current noise environment at and around the site.

With consideration of the predicted noise levels outlined in Section 6 that show compliance with the relevant objective criteria, and the comments above, the development is not expected to generate offensive noise during the proposed operating hours.

Based on the findings of the assessment, it is recommended as best practice that the following measures continue to be applied:

- Shift managers and Project staff are to be briefed on the need to manage the premises such that excessively noisy or rowdy patron activity is not tolerated, particularly outdoors for patrons arriving or leaving.

6 External Noise Intrusion

6.1 External noise impacts on the Project

The local noise environment is relatively quiet for an Urban location. Noise events which might affect the Project spaces include emergency vehicle sirens, the occasional large vehicle pass-by, and outdoor events in the nearby parks or harbour.

The existing and new elements of the building envelope will be required to manage noise *emissions* to the external environment, and also to control noise from new plant.

Based on this, the sound insulation performance of the final external structures – roof, walls and façade, will be sufficient to reduce external noise sources to acceptable levels within all areas of the building.

7 Construction Noise and Vibration Assessment

7.1 Construction noise and vibration assumptions

7.1.1 Timeline

The preliminary construction program is as follows:

- Construction expected to start in early 2027.
- Duration approximately 9 months.

7.1.2 Construction work staging

The project construction program and staging have not yet been developed in detail.

We understand that the most intensive works will include demolition of internal structural elements, which are the focus of this high-level assessment.

7.1.3 Hours of work

The hours of work affect community noise impacts. This is due to the fluctuations of ambient noise through the day, and the type of activities typically conducted by the community during Day, Evening and Night.

Standard construction hours defined in the *Interim Construction Noise Guidelines* (7am – 6pm, Monday to Friday, and 8am – 1pm, Saturday) are considered the least sensitive times of day.

Generally, the proposed works hours for this project are currently during standard construction hours, as follows:

- Weekdays 7am to 6pm (Standard construction hours)
- Saturdays 8am to 1pm (Standard construction hours)

Works will typically not be carried out on:

- Saturdays and Sundays that form part of a public holiday weekend
- Sundays and Public Holidays

Some construction works may be considered outside of the standard construction hours, where noise and vibration impacts are determined to meet the noise management levels and vibration limits. These works may include works such as internal fit-out works where the building envelope is extensively complete.

Noise mitigation measures will be described within the CNVMP prepared by the Contractor.

Construction vehicles may enter the work site during the following hours:

- Weekdays 7am to 6pm
- Saturdays 8am to 1pm

It is noted that for the purposes of road traffic noise assessments, the hours before 7am are considered to be “night time” and are typically considered to be times when residential receivers are more sensitive to road traffic noise. For the purposes of construction noise assessments, the hours before 8am are considered to be more noise-sensitive.

The Contractor’s Construction Noise and Vibration Management Plan (CNVMP) must state the hours of work, and any deviations to the schedule must be assessed and approved prior to commencing the altered works schedule.

7.1.4 Noise and vibration sources

While the construction plant and equipment to be used during each construction stage is not available at the moment, the following assessment is based on the indicative plant items typically used during demolition.

For this assessment a jackhammer has been selected as a typical worst case noise source for the expected highest intensity works. To establish the likely worst-case construction noise impact, the jackhammer is assessed at roof level – *externally*. The majority of demolition works will occur *internally* – within the envelope of the existing building.

The final plant selection will be confirmed when the Contractor is engaged at a later time. The Contractor is responsible for preparing a Works Plan and Schedule, including an updated noise and vibration impact assessment (CNVIA) and management plan (CNVMP) for the proposed methods and timing of each stage of work.

Indicative noise sources during each construction stage are identified in Table 28. Typical sound power levels associated with each noise source have been extracted from AS 2436-2010 Table A1, using the mid-point typical level.

The ICNG imposes a 5 dB penalty for sources with a tonal or impulsive noise content, or associated with high vibration levels. Table 28 identifies the characteristics of plant that will attract penalties and included in the equivalent sound power level of each plant item. The tonal penalty is also applied to vehicles with tonal reversing alarms. We have not included the penalty for potential tonal reversing alarms in the predictions, as non-tonal or broadband reversing alarms do not attract this 5 dB penalty and is considered best practice. This should be taken into consideration during equipment selection, and if non-tonal alternative is not available, a 5dB penalty should be added.

To minimise vibration impacts to the neighbouring residential properties, particularly those immediately adjacent to the site, the following principles / approaches will be adopted within the contractor's demolition and excavation methodology:

- Demolition will be undertaken using small machines and hand techniques where possible.
- Detailed consultation will be undertaken with the owner and occupier of adjacent internal spaces to communicate the acceptable limits of noise and vibration, discuss preferred operating times and limiting the overall duration of any disruptive works.

Table 28 Typical mid-point sound power levels (L_{wA}) of plant typical to proposed construction, and equivalent L_w including time correction and penalties

Plant	Typical L_{wA}	% of time operating	5 dB penalty?	Equivalent L_{wA} (including penalties)
Excavator with hammer / breaker	125	50%	Y	127
Jack hammers	121	30%	Y	121
Concrete saw	117	30%	Y	117
Hand tools (electric)	102	30%		97
Front end loader	113	50%		110
Truck (>20 tonne)	107	50%		104
Vacuum truck	110	100%		110
Truck (dump)	117	20%		115
Crane (tower)	105	50%		102
Mobile Franna crane	98	50%		95
Hand tools (electric)	102	30%		97
Concrete agitator truck	109	100%		109
Concrete pump truck	108	100%		108
Concrete pencil vibrator	103	100%		103
Machine mounted percussive drill	116	20%	Y	114
Forklift	106	100%		106
Truck (>20 tonne)	107	50%		104
Impact wrench / rattle gun	101	50%	Y	103
Piling (bored)	111	100%		111
Hand tools (electric)	102	30%		97
Forklift	106	50%		103
Truck (>20 tonne)	107	50%		104
Vehicle (light commercial e.g. 4WD)	106	30%		101
Chainsaw, petrol	111	30%		106
Excavator	107	50%		104
Compactor	113	50%		110
Roller (vibratory)	108	100%	Y	113
Wacker packer	100	50%	Y	102
Asphalt paver	108	50%		105
Tactile marking machine	105	100%		105
Tip truck (tipping soil)	90	20%		83

Note: noise levels are from TfNSW Construction Noise and Vibration Guideline – Public Transport Infrastructure (September 2023), TfNSW RMS Construction Noise and Vibration Guideline (Roads) (CNVG, 2024), AS2436:2010, UK DEFRA 2005, internal Acoustic Studio records and database.

7.2 Assessment Methodology

In accordance with the ICNG, a CNVIA shall consider the noise impact from each category of major works as follows:

- Noise predictions at receiver boundaries carried out for the jackhammer example – at roof level, and external to the building.
- Equipment modelled as a point noise source.
- To provide a realistic worst case $L_{eq\ (15min)}$ prediction, it shall be assumed that most equipment is used continuously over the assessment period.
- Predictions shall only consider the distance attenuation between source and receiver, unless works are carried out behind existing structures which provide shielding.
- Where appropriate, and accepting that the site is small, it shall be assumed that works activities in various parts of the site may be carried out simultaneously.
- In accordance with the proposed work hours, noise predictions are to be compared with Standard work hours' noise management levels.
- Vibration levels are difficult to predict without detailed material and structural information which affects the vibration at source (related to the material being worked on), and the vibration transmission through the receiving structure. Therefore vibration risks are to be initially assessed at a high level, based on measurements taken at other construction sites. Where vibration risks are found to be 'high', this high-level assessment is to then be verified, prior to works commencing, via on-site pilot testing.
- It will be necessary to confirm vibration through monitoring early in any works phase that involves high-vibration activities such as excavating, to re-assess whether levels are expected to exceed applicable criteria at any heritage or historically significant structures.
- Predicted Construction Noise Levels

The predicted airborne construction noise levels at each sensitive receiver are given in Table 29, with the predicted levels above Noise Affected Management Level marked in bold. As the predicted noise levels (with no mitigation) are above the Noise Affected Management Level at some receiver locations, we have assumed a 10 dB screening attenuation in the assessment. This, therefore, assumes temporary construction screening is provided for the jackhammer / demolition activities occurring at roof level and external to the building.

Table 29 Predicted construction noise levels for airborne noise

Receiver	Period	Predicted construction noise levels (including 10 dB screening attenuation)	NML $L_{Aeq,15min}$ dB	HNML $L_{Aeq,15min}$ dB
R1	Recommended Standard Hours (Monday to Friday 7am to 6pm, Saturday 8am to 1pm)	48	64	75
R2		**60**	57	75
H2	When in use	68	70	-
C1	When in use	61	70	-
P1	When in use	61	60	-

Pending the findings of the contractor's detailed construction noise and vibration impact assessment (CNVIA), general comments are provided as follows:

- There will likely be times / situations when demolition, excavation and new-build works are likely to exceed NMLs, particularly when works occur in the areas closer to sensitive receivers.
- For each of these activities, the noise control measures and construction best practices presented in Section 0 shall be considered and implemented wherever reasonable and feasible to minimise the noise impacts on the neighbourhood.
- Local hoardings or noise curtains are required at the northern and western worksite boundaries as a minimum, and may be required on other boundaries depending on the final construction work methods and plant selections. When works are moving around the site, including mobile cranes, jackhammers, and concrete saws, local "noise curtains" such as EchoBarrier will assist with reducing noise near the source.
- If generators are required for the site set-up, petrol generators should be considered instead of diesel.
- Truck access should be limited to designated time periods and site access gates should be as far as possible from sensitive enclosures and well-used walkways. Vehicle pathways to and from the site should be arranged to minimise the need for reversing. Where reversing is necessary, the contractor should only use tonal reversing or movement alarms if a broadband option is not available. Typically, non-tonal reversing alarms should be fitted vehicles regularly accessing the site.

Further noise and vibration controls to be considered are discussed in detail in Section 0.

7.3 Construction-related road traffic noise

Construction-related road traffic is a temporary noise source but one which requires assessment and management, particularly for heavy vehicles accessing the site.

Truck arrivals to, and departures from, site should be scheduled to occur outside the busiest traffic periods, but where possible should also avoid noise-sensitive night-time periods.

The temporary additional traffic increase on surrounding streets due to construction will be minimal, totalling far less than 5% additional vehicles to the existing traffic.

The increases in road traffic due to construction will result in below the 2 dB increase considered to be noticeable from the RNP. However, it is also important to recognise that heavy vehicles associated with construction can generate maximum noise levels which are higher than general car traffic, and can lead to greater disturbance than cars.

Access routes should be limited to main roads and avoid local residential streets wherever possible. Engine braking should be avoided, speed limits strictly observed, and heavy braking and accelerating avoided.

These noise avoidance driver behaviours may need to be enforced through observation and monitoring, and all contractors and subcontractors are to be made aware of the need for noise-considerate driver behaviour when travelling to and from the work site.

8 Construction Noise and Vibration Management and Mitigation

8.1 General noise control elements

The noise and vibration objectives, management and mitigation measures in environmental assessment documentation are based on an initial design and construction methodology, in accordance with the ICNG. It is expected that the works methodology and staging may be altered. Consequently, it may be necessary to update the assessment and associated noise management plan at several stages throughout the project.

As a general rule for best practices, prevention and elimination of noise should be applied as universal work practice during construction, especially when construction works are to be undertaken outside recommended standard hours. These mitigation measures are based on the ICNG.

Where elimination and prevention are not feasible options, the reduction of noise at the source and control of the transmission path between the construction site and the receiver are the preferred options for noise minimisation through engineering and/or administration controls.

Construction noise should be managed by implementing the strategies listed below:

8.1.1 Plant and equipment

- Use quieter work methods.
- Use quieter equipment.
- Use mobile noise curtains for external works with noisy hand-held tools
- For noisy works, consider carrying out in continuous blocks not exceeding 3 hours each, with a minimum respite period of one hour between each block
- Operate plant in a quiet and effective manner.
- Plant used intermittently to be throttled down or shut down.
- Use mains power supply where possible, rather than use generators.
- Use one larger generator to power multiple plant items (ensuring safe cabling). Use petrol generators instead of diesel generators.
- Switch off generators when not in use, particularly during out-of-hours work periods.
- Maintain equipment regularly.
- Where appropriate, obtain acoustic test certificates for equipment.

8.1.2 On-site noise management

- Strategically locate equipment and plant. Locate generators away from sensitive receivers.
- Avoid the use of reversing alarms through site layout to minimise reversing, or provide for alternative systems such as non-tonal reversing alarms.
- Maximise shielding in the form of existing structures or temporary barriers.
- Enclose the work site as far as possible from receivers, and use hoarding. Noise reductions of at least 10 dB are expected due to hoarding.
- Schedule the construction of barriers and structures so they can be used as early as possible.
- Consider signage at walkways affected by construction noise.
- Manage waste removal from the site to minimise noise impacts.
- Reduce noise from metal chutes and bins by placing damping material in the bin.

- Locate waste deposit bins as far as possible from sensitive receivers.
- Where possible, carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.
- Delivery vehicles should be fitted with straps rather than chains for unloading, wherever possible.
- Keep windows closed during all internal works.

8.1.3 Consultation, notification and complaints handling

- Provide information to affected receivers before and during construction as required.
- Maintain good communication between the community and project staff.
- Have a documented complaints process and keep register of any complaints.
- Give complaints a fair hearing and provide for a quick response.
- Implement all feasible and reasonable measures to address the source of complaint.

8.1.4 Work scheduling

- Schedule activities to minimise noise impacts.
- Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
- Avoid simultaneous operation of noisy plant within discernible range of a sensitive receiver. Ensure noisy plant schedules are clear in Works Plan.
- Keep truck drivers informed of designated routes, parking locations and delivery hours.
- Schedule deliveries to planned construction hours only.

8.1.5 Mandatory site rules of conduct

- Avoid the overuse of public address systems, radios or stereos outdoors.
- No swearing or unnecessary shouting.
- No unnecessary dropping of materials from height, throwing of metal items, and slamming of doors.
- No extended periods of engine idling.

8.2 Communication and complaints

In accordance with the ICNG, there must be a system and procedure for addressing complaints should they arise. The following procedures are an example of the procedures that should be adopted for complaints relating to noise.

Upon receipt of a complaint The Contractor shall:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position;
- Establish from the monitoring equipment if the allowable noise levels have been complied with;
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted;
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is considered to be creating excessive noise (i.e. noticeably higher than expected from the activity), the activity should be immediately stopped. Where stopping the activity would create a safety issue, the activity may be permitted to continue only as long as is necessary to make the area safe. The activity should then cease.

Any activity which is directed to cease due to excessive noise shall not recommence until the Project Manager is satisfied that the requirements of the relevant criteria can be met and has given permission to recommence the activity.

The Site Supervisor shall ensure that a report of any incident is provided to the Project Manager.

The Project Manager shall provide a report on the incident to the relevant stakeholders.

The Contractor shall provide a 24 hour telephone contact number and this number shall be prominently displayed on the site.

8.3 Timing of works

Where the assessment of proposed construction activities indicates that noise levels are likely to exceed the relevant criteria at receivers surrounding the site, the following noise control measures together with best practices detailed in the previous sections shall be considered in order to minimise the noise impacts, in accordance with the ICNG.

- Construction activities should typically occur during the prescribed standard hours (at the least sensitive times of the day).
- Where work must be carried out during noise sensitive periods, residents and commercial receivers should be informed, and management principles be in place to ensure a minimal amount of impact. This may include:
  - Do not use noise sensitive equipment likely to exceed the relevant criteria i.e. rock-breakers, concrete cutters and sledgehammers.
  - Where possible, limit construction works to those internal to the building so as to contain the noise and minimise noise emissions externally.
  - Outside standard hours, only carry out activities at locations where compliance with the criteria (RBL+5) can be achieved.

8.4 Equipment and plant selection

The assessment shall be based on typical noise sources defined in AS 2436-2010. The contractor shall aim to choose the quietest pieces of equipment where feasible and reasonable, in accordance with the ICNG. If the final equipment selection varies significantly from items specified in Table 28, it is recommended that an additional assessment be carried out for those noise sources, and revisions made to the construction noise management plan where necessary (refer Section 8.7).

Where key pieces of equipment are found to dominate the overall noise contribution at the receiver position including, where possible, alternative methods or selection of quieter equipment shall be considered. Lessening the time in use and ensuring equipment is not used simultaneously will further reduce the noise impact at residents.

Where possible, reduce the number of noise sources/activities running simultaneously at the same location if the predicted noise level from concurrent use exceeds NMLs.

Limit the number of site vehicles such as dump trucks at any one time.

A screen or enclosure should be considered for use when carrying out external building works that are predicted to exceed the noise management level at environmental receivers. Typically screens and enclosures constructed with plywood will be sufficient. Reference shall also be made to specific screening and enclosures detailed in Appendix F of AS 2436:2010. Alternatively, proprietary site screening products such as EchoBarrier can be used.

8.5 Assessment of construction vibration

8.5.1 Vibration sources and high-level assessment

Potential sources of vibration and ground-borne noise during the Project works are likely to include:

- Demolition and excavation plant including rock-breaking and jackhammers.
- Grinding, cutting and drilling of existing building structures.

Vibration and ground-borne noise impacts are likely to be highest during the demolition and excavation stages of the project, when equipment such as rock breakers and jackhammers are used.

Based on the minimum working distances provided in Table 46, we anticipate that construction works will result in no adverse vibration impacts at any receiver buildings. However, the human comfort target may be exceeded at receivers within 100 m from the highest vibration generating equipment, including large vibratory rollers, large hydraulic hammers, and compactors. Generally these can be managed by choosing smaller equipment with lower vibration level generation and/or scheduling to reduce the vibration dose.

When engaged, the Contractor shall carry out a preliminary vibration assessment at the commencement of operations for each vibration generating to determine whether the existence of significant vibration levels justifies a more detailed investigation.

8.5.2 Vibration management approach

The levels of vibration generated by the construction activities are site specific and depend upon the type of activity, the particular equipment used, and the proximity of the construction activity to the nearest occupied spaces within the affected properties.

When appointed, the Contractor shall carry out a review of vibration generated by these construction activities, and assess these against the criteria for human comfort and building damage provided in Appendix C.

A preliminary vibration review of the Contractor's work methods and plant selections shall be carried out to confirm whether vibration mitigation will be necessary for any equipment or processes on the site.

If the preliminary review indicates that vibration levels might exceed the relevant criteria, then vibration mitigation and management measures will need to be put in place to ensure vibration impacts are minimised as far as possible.

It is the contractor's responsibility to identify potential vibration generating sources in the proposed work methods, in accordance with the ICNG and reference vibration standards and guidelines.

The contractor shall refer to the demolition, excavation, piling, and landscaping plans to determine where rock cutting, excavation, or other vibration-generating activities are to occur. The contractor shall refer to the Structural Engineer's report and plans to identify structurally sensitive or historic or sensitive structures requiring protection from vibration.

8.5.3 Dilapidation survey

Vibration-intensive activities often warrant condition surveys and monitoring.

The Contractor is required to conduct a dilapidation survey up to 50 m from the work site prior to high vibration works. This will be particularly important for any adjacent heritage-listed buildings or structures.

The purpose of the dilapidation or condition survey is to identify existing damage and cracks.

8.6 Noise monitoring and reporting

During any stage in construction that is expected to exceed the recommended noise management level by more than 10 dB, even with mitigation measures in place, the Contractor should consider implementing environmental noise monitoring.

The location of monitors should represent the most affected receiver(s).

Additional positions may also be selected, or the monitor relocated at different stages of construction, to correspond with the location of construction activities as they progress to different locations within the development site.

It is recommended that noise monitoring be carried out for a minimum of one week during the period where the greatest impacts are expected, or for the duration of the noisy works (whichever is less). Based on the predicted noise levels in Section 7.2, this is expected to be during Stage 1: Demolition works.

Monitoring results should be reviewed at the end of the week / period. However, it may be necessary for them to be reviewed on more regular intervals depending on the type of work and level of noise / vibration expected. The requirement for further monitoring will then be reviewed after this time, or sooner if deemed necessary by the Acoustic Consultant and Project Manager.

8.7 Construction noise and vibration compliance

This report establishes applicable noise and vibration criteria for the proposed works. Potential vibration effects have been identified.

The contractor will typically need to prepare a detailed Construction Noise and Vibration Noise Management Plan (CNVMP) for the works once the demolition and construction method is more progressed.

The CNVMP will need to outline the proposed stages of work, plant and equipment to be used, and times of day during each week that construction is expected to occur. The documents will need to demonstrate that all feasible and reasonable measures will be identified and applied to meet the relevant Noise Management Levels and vibration targets.

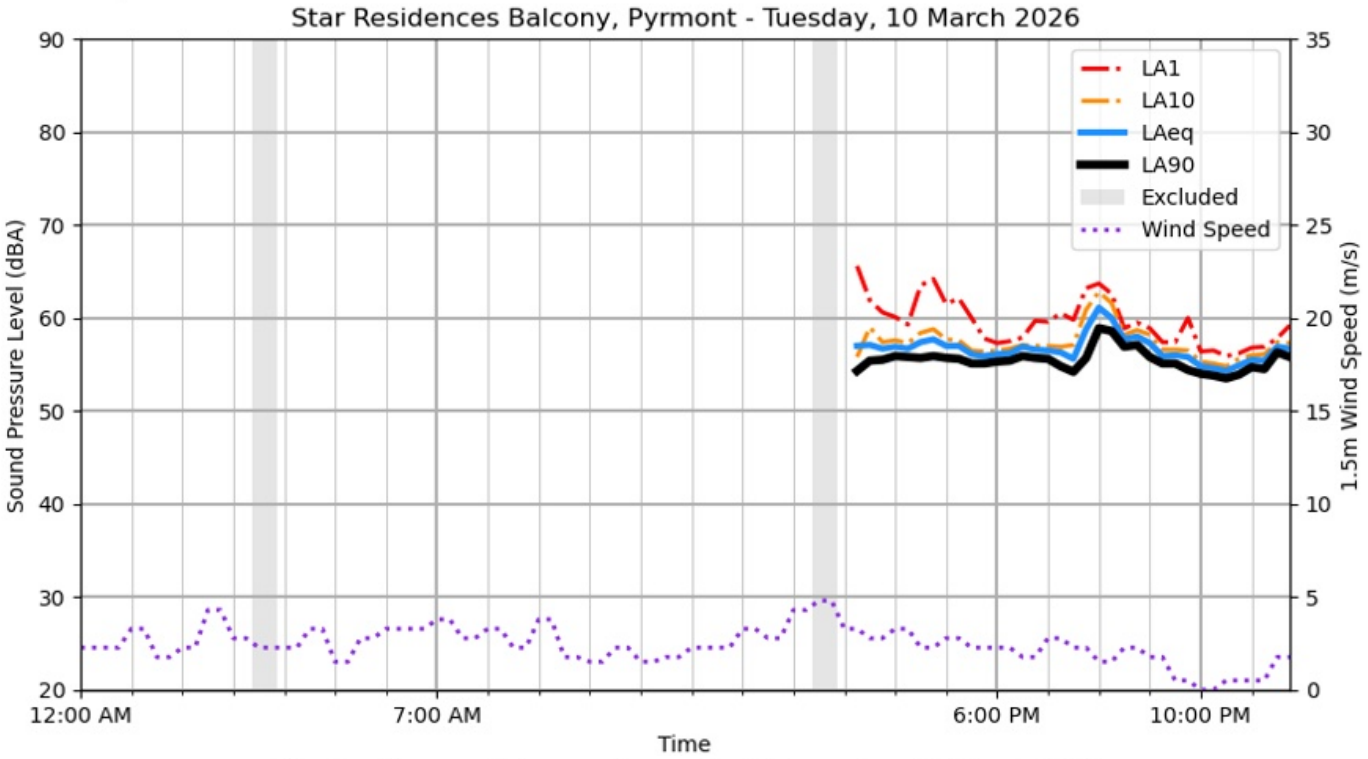
There is no predicted exceedance above the Highly Noise Affected Management Level based on the current plant assumptions. However, in case that the final plant selection is noisier than assumed (e.g., if tonal reversing or movement alarms have to be used which will result in a 5dB penalty, or if impact sheet piling or vibratory piling needs to be used), there may be some exceedance above HNML at some receiver locations. Any expected exceedance will require a detailed analysis of construction methods. Respite periods may be needed if high noise levels are expected for several days in a row. Community consultation is likely to be required.

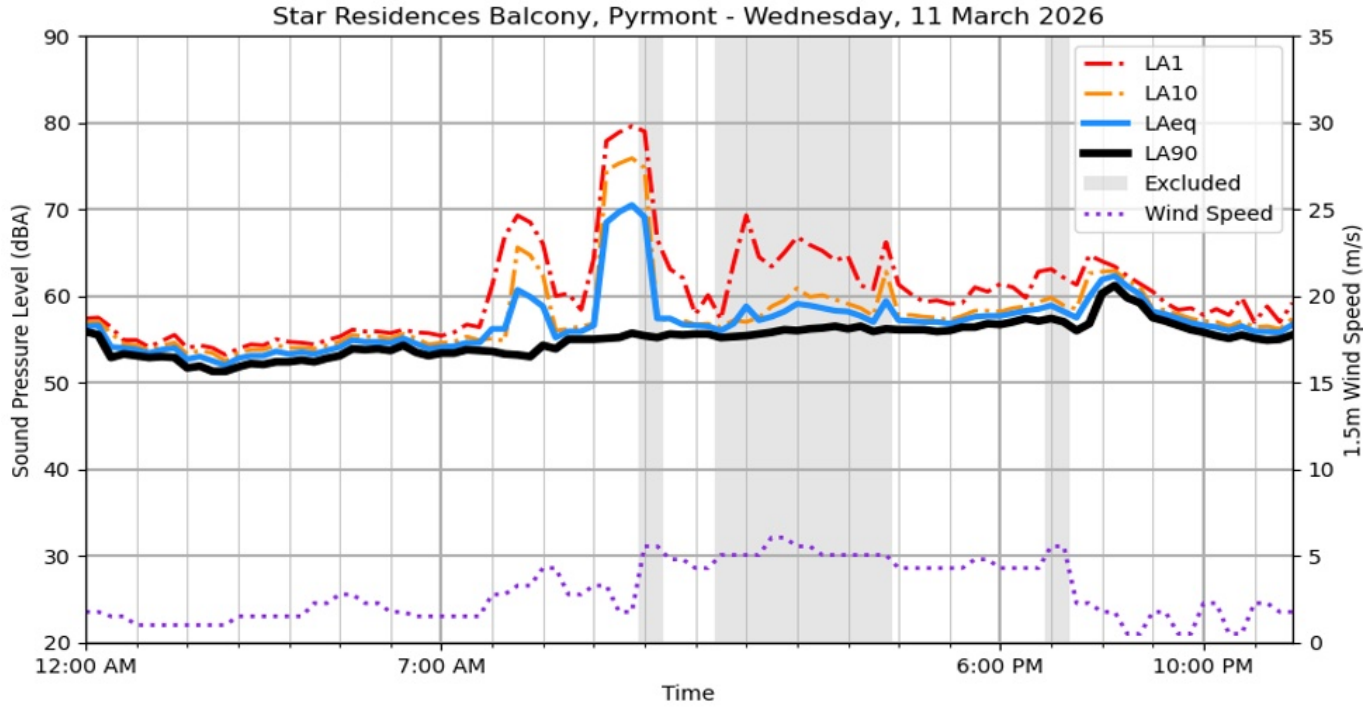
Particular consideration of construction-related road traffic noise impacts is required. Construction vehicles should be restricted to main roads away from residential receivers wherever possible, and drivers should be made aware of noise-mitigating driver behaviour.

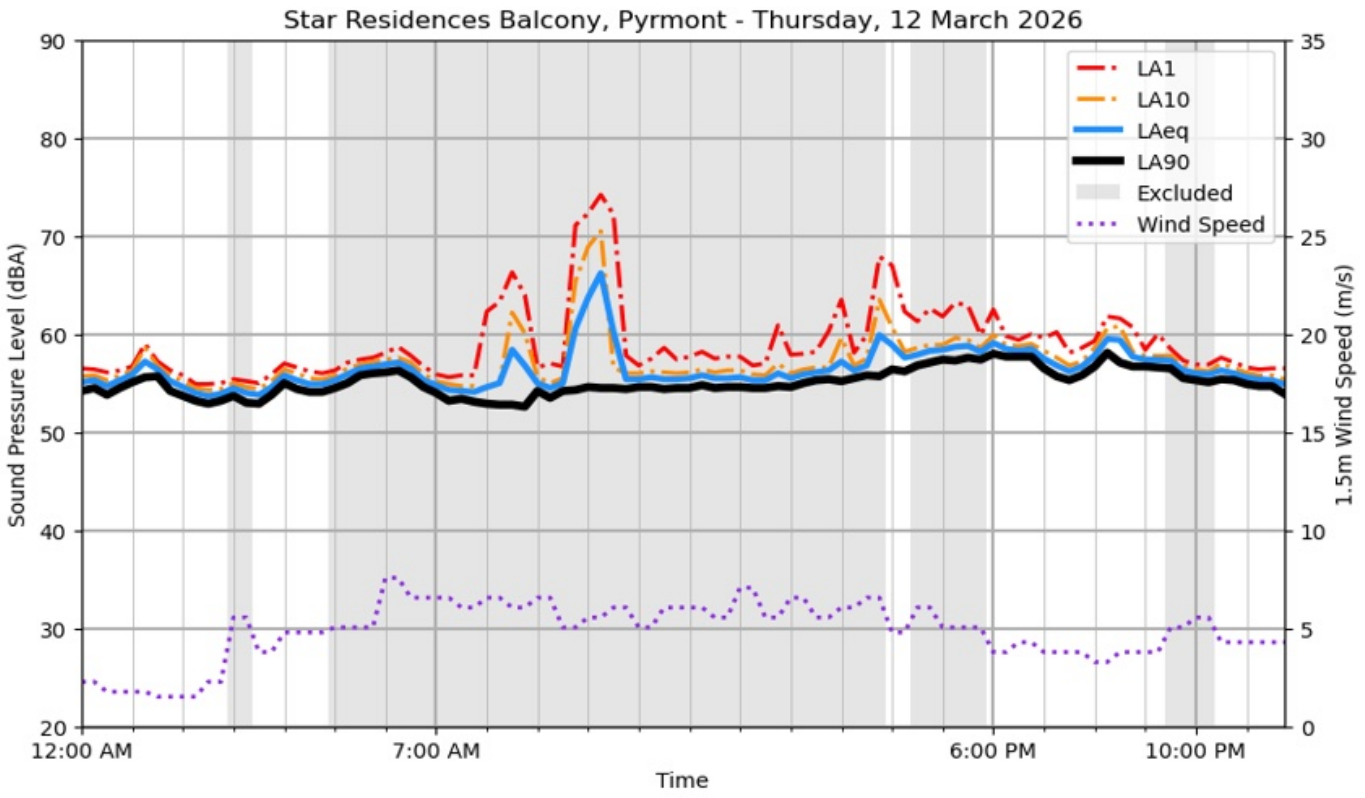
Dilapidation surveys are recommended for nearby residential plus any nearby historic or heritage structures, in order to ensure that vibration-generating construction activities do not affect the structures.

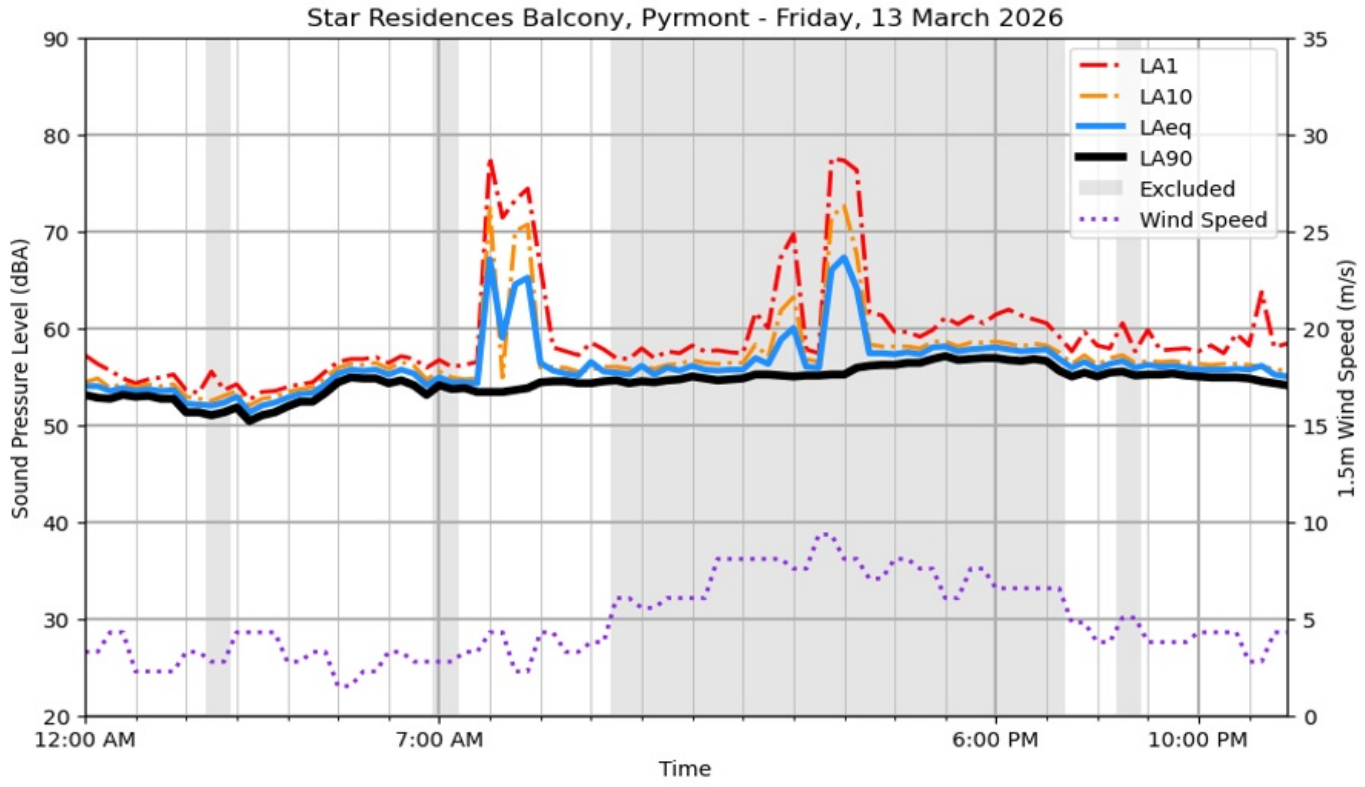
Appendix A Noise Logger Data

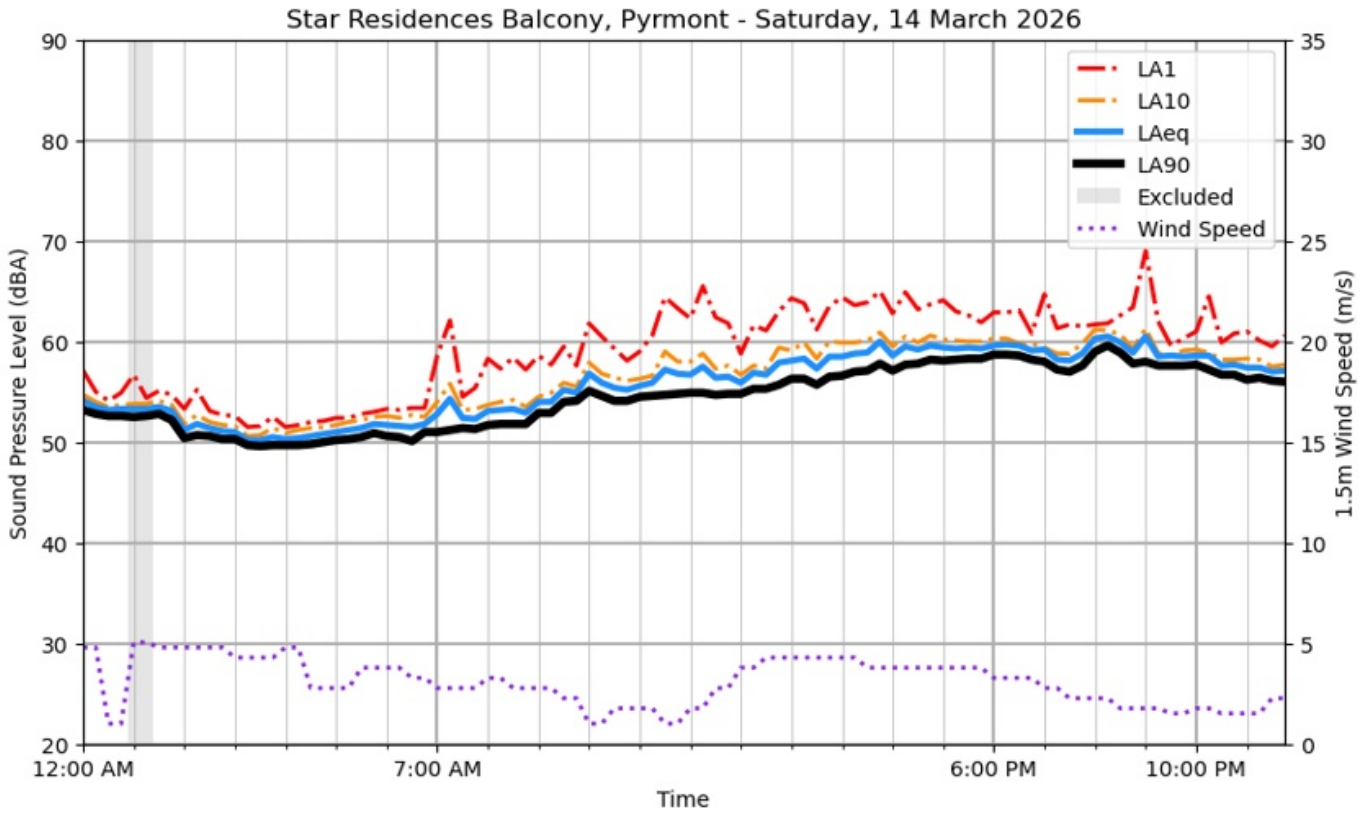
A.1 Logger #1: The Star Grand Hotel – South building

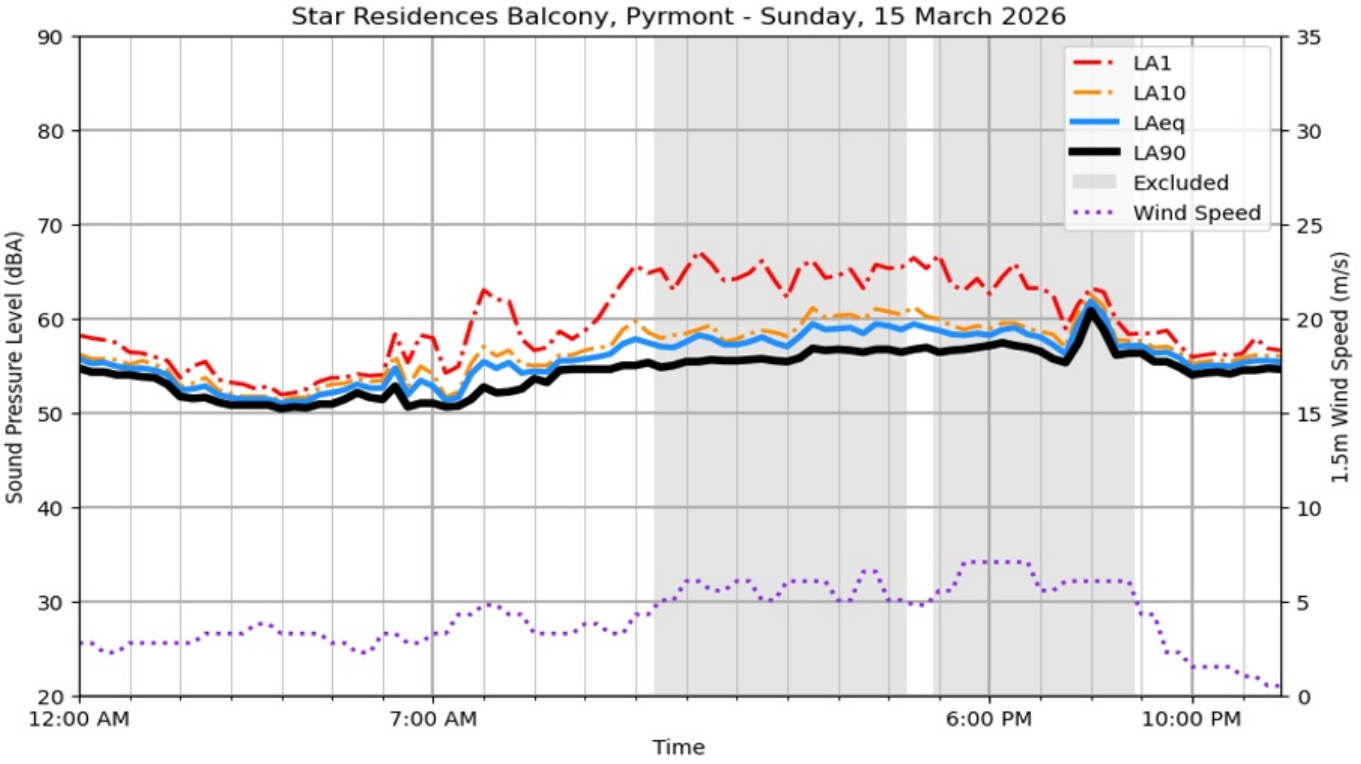


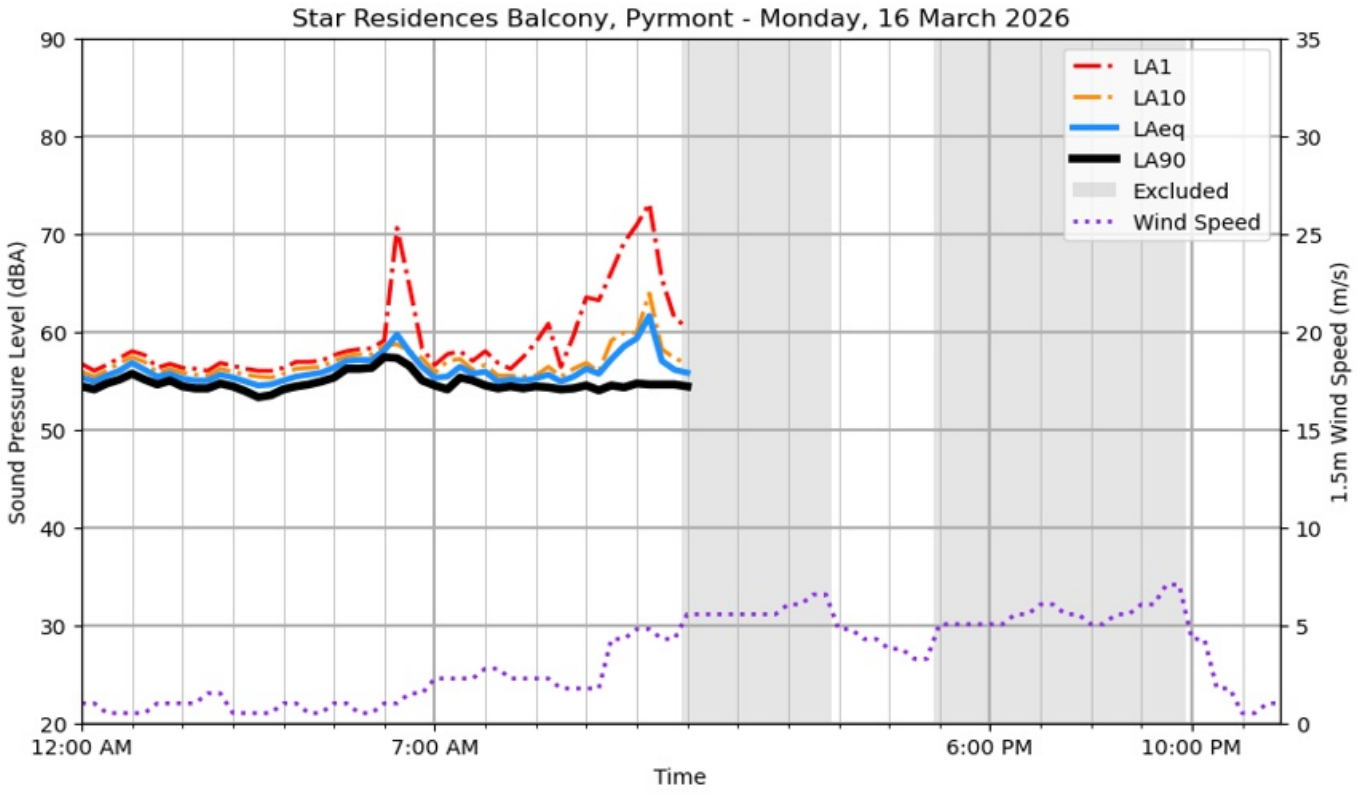


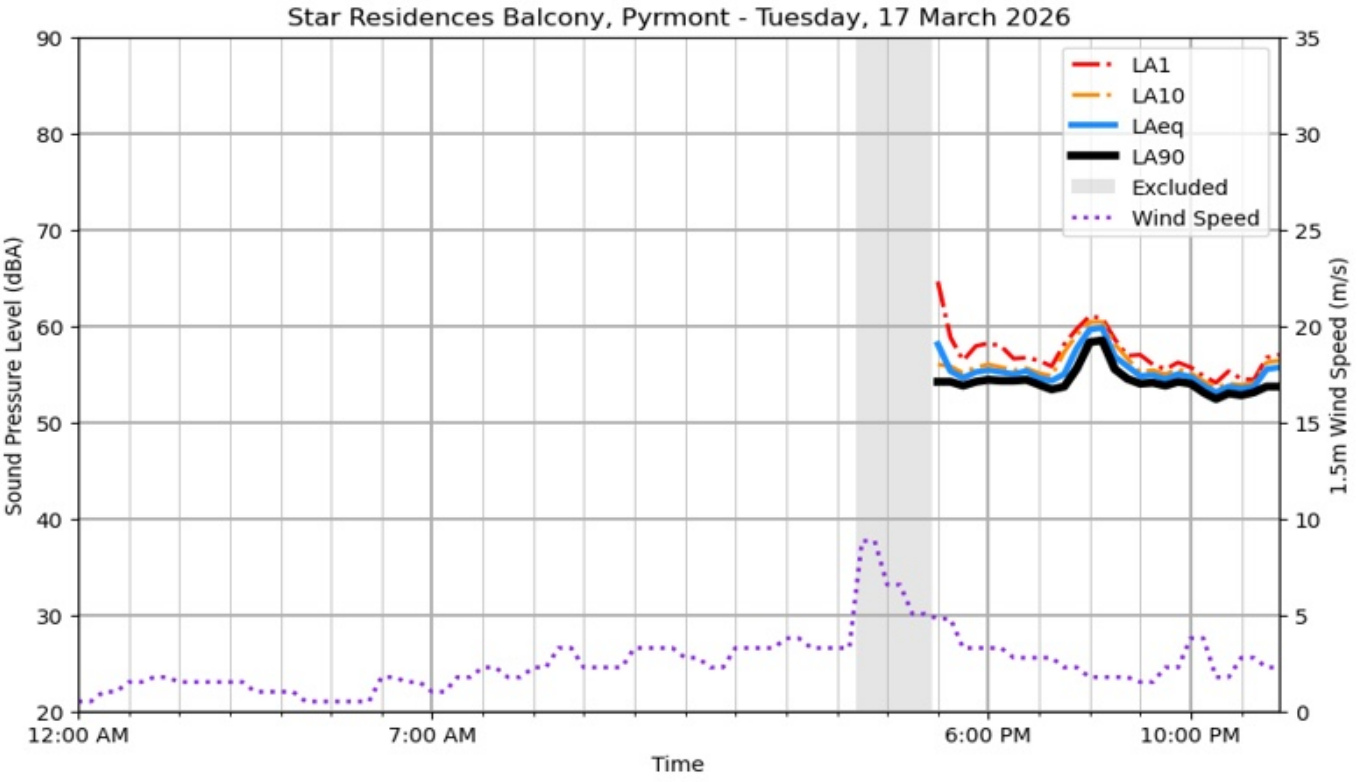

Star Residences Balcony, Pyrmont - Thursday, 12 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
12:00 AM
7:00 AM
6:00 PM
10:00 PM
Time

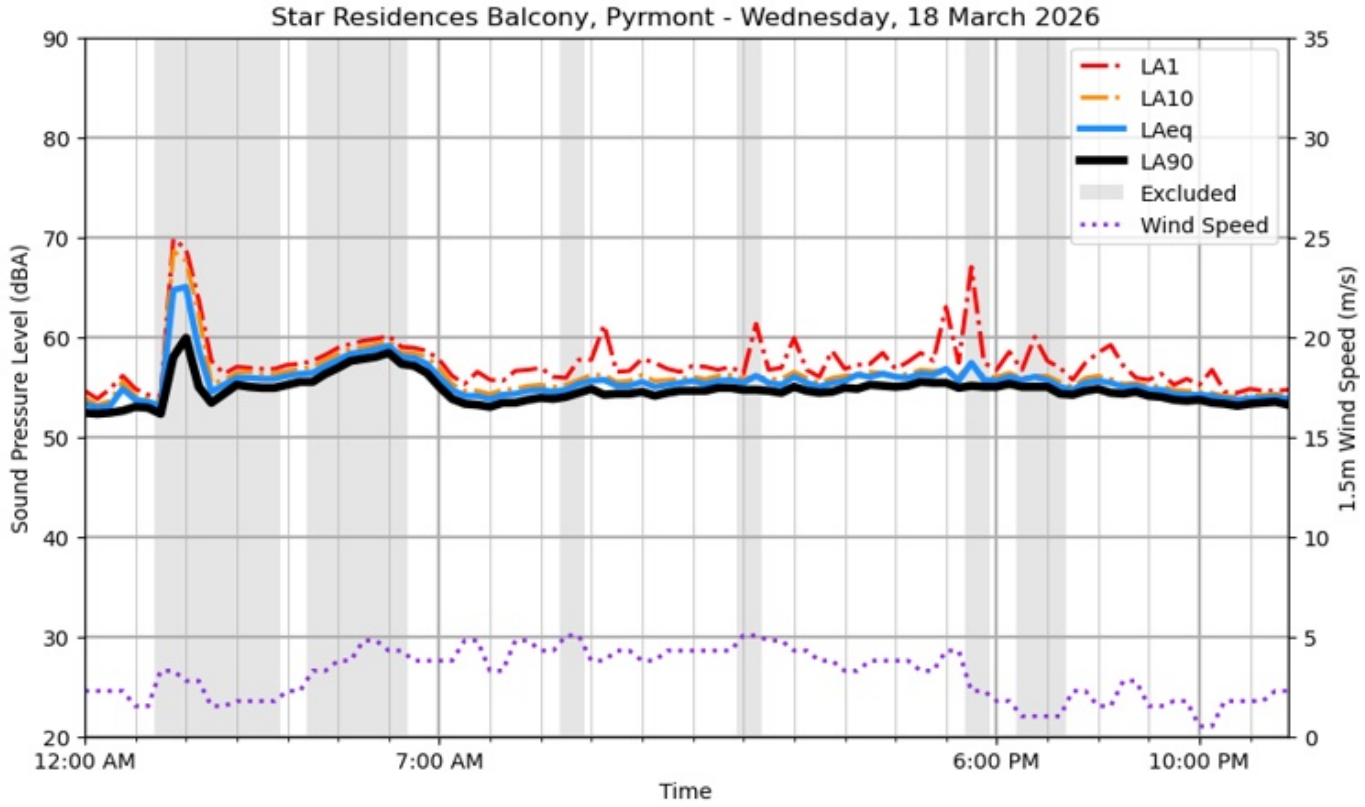

Star Residences Balcony, Pyrmont - Friday, 13 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
12:00 AM
7:00 AM
6:00 PM
10:00 PM
Time

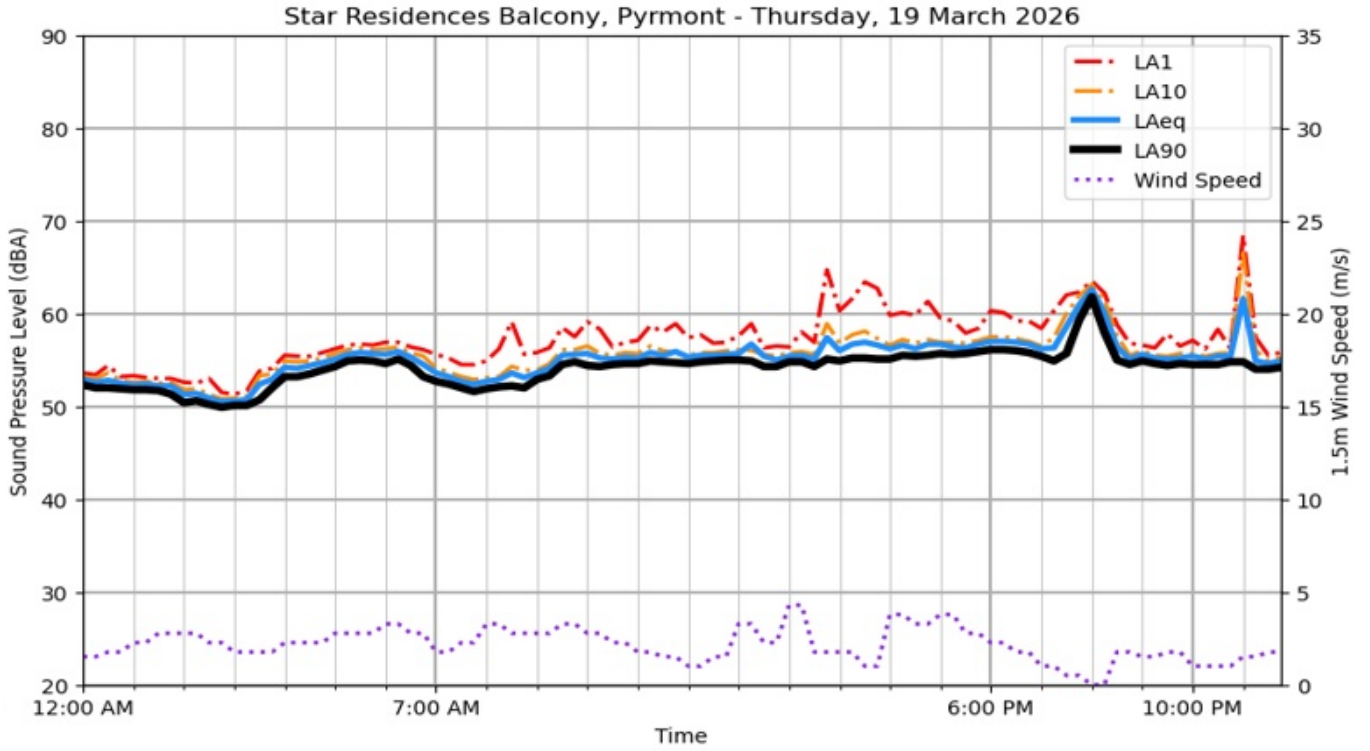

Star Residences Balcony, Pyrmont - Saturday, 14 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

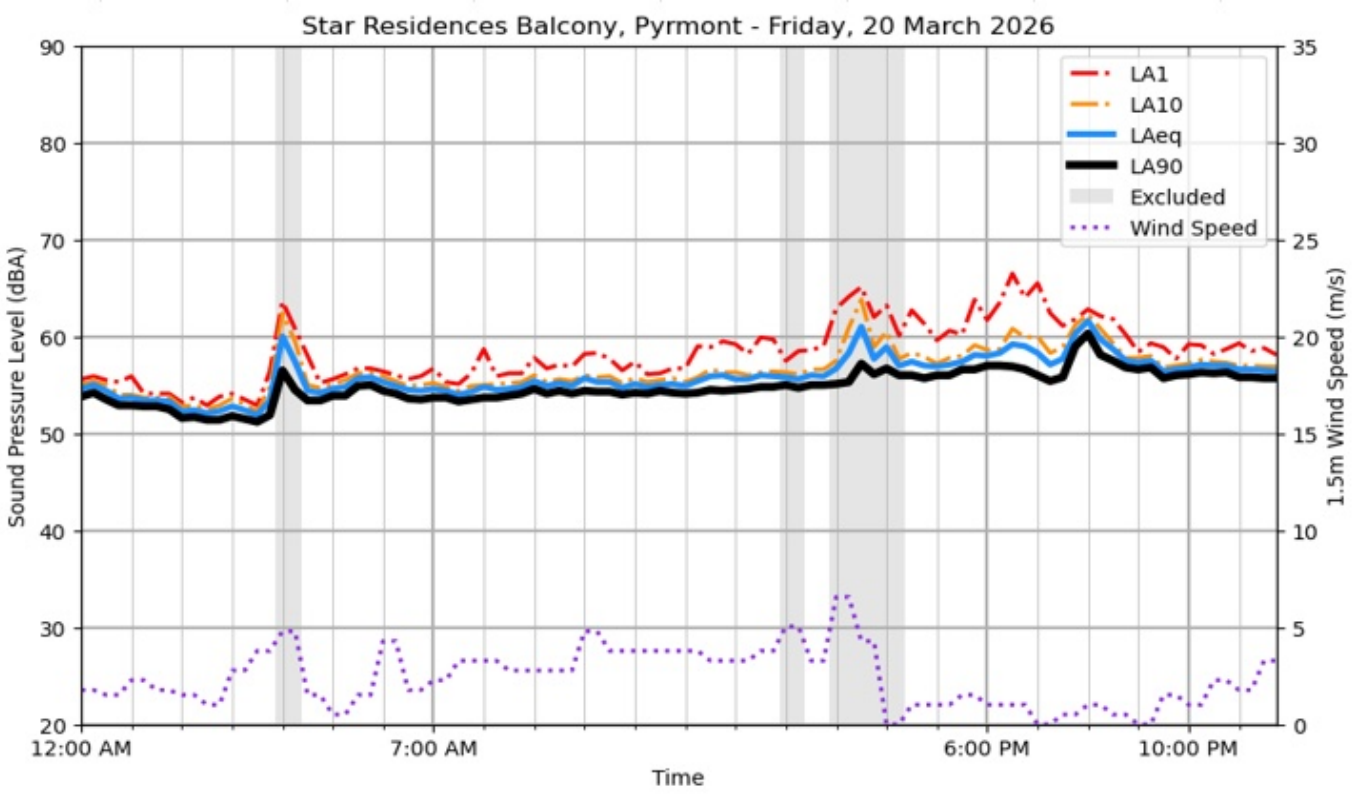

Star Residences Balcony, Pyrmont - Sunday, 15 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

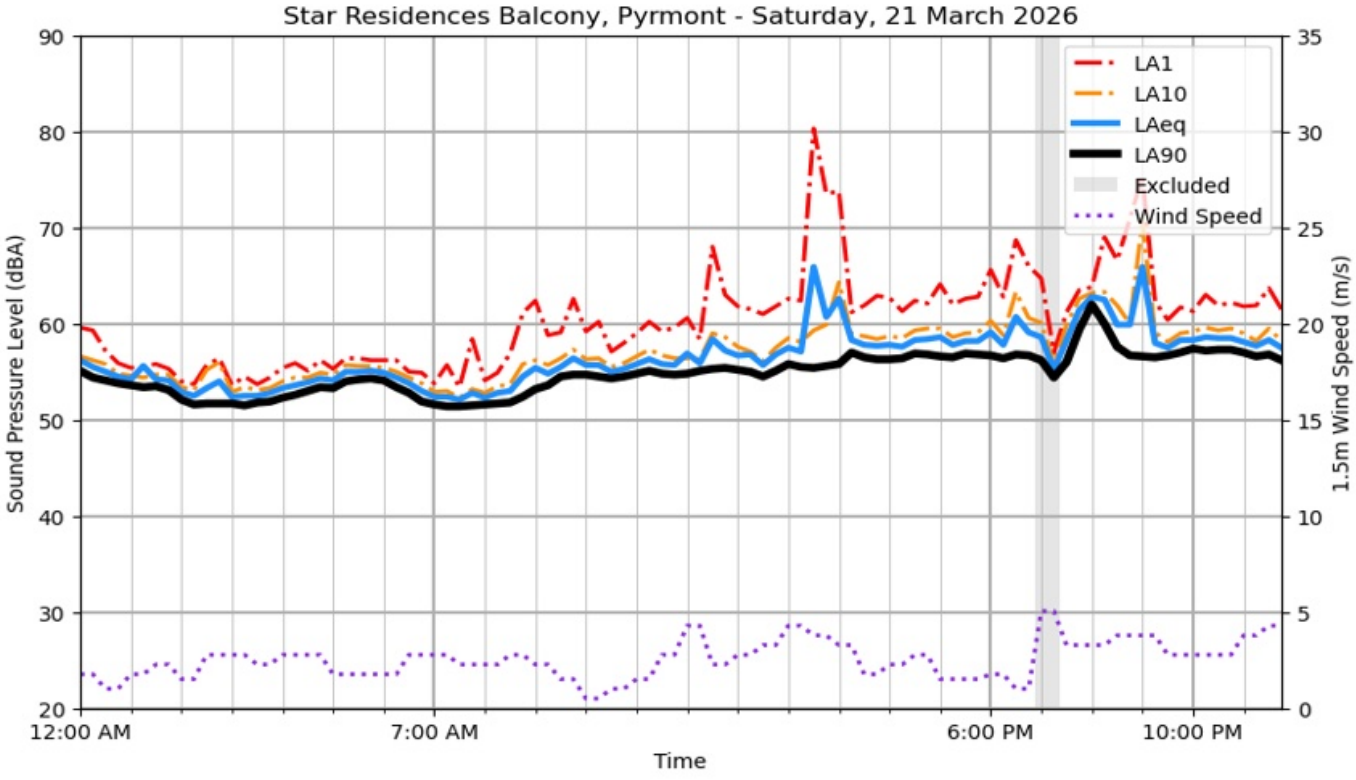

Star Residences Balcony, Pyrmont - Monday, 16 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

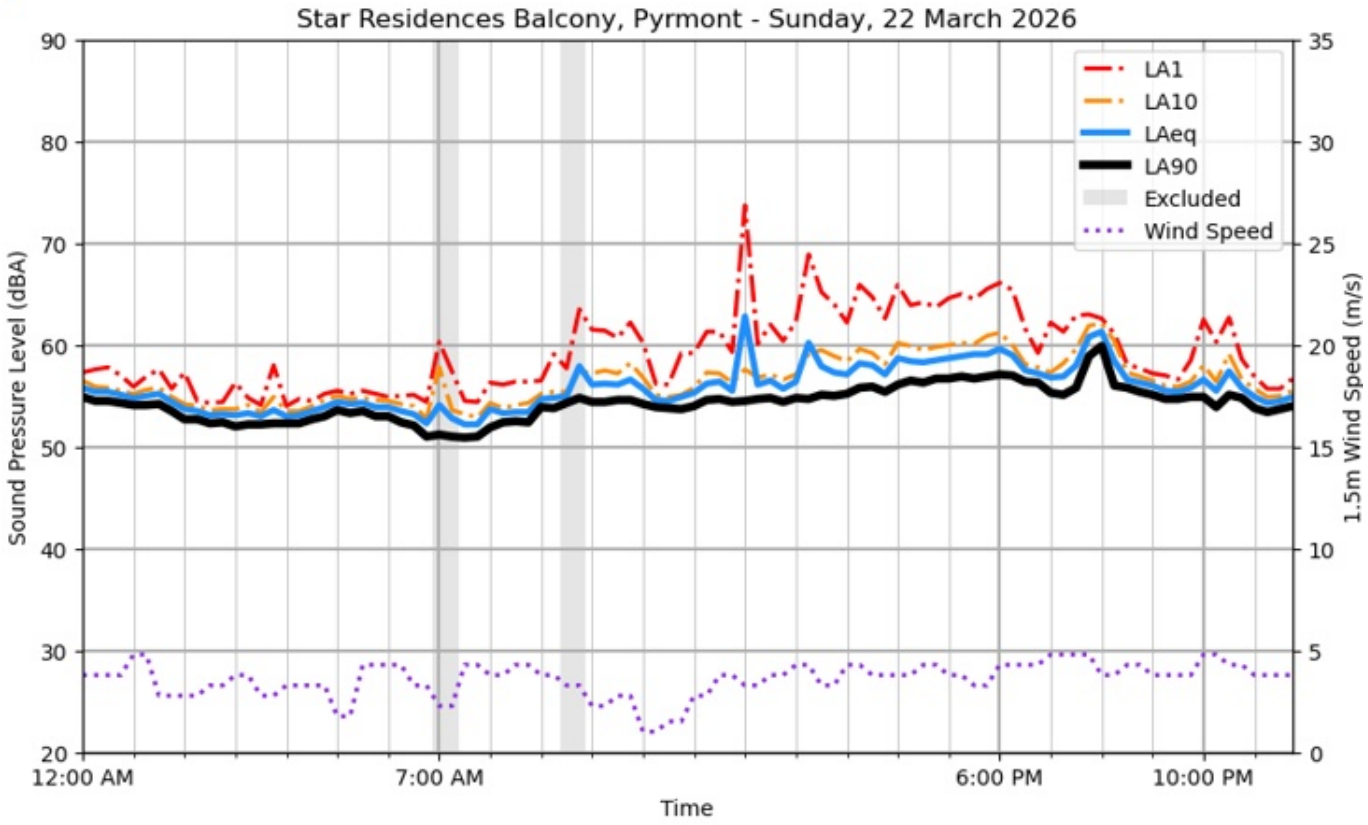

Star Residences Balcony, Pyrmont - Tuesday, 17 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

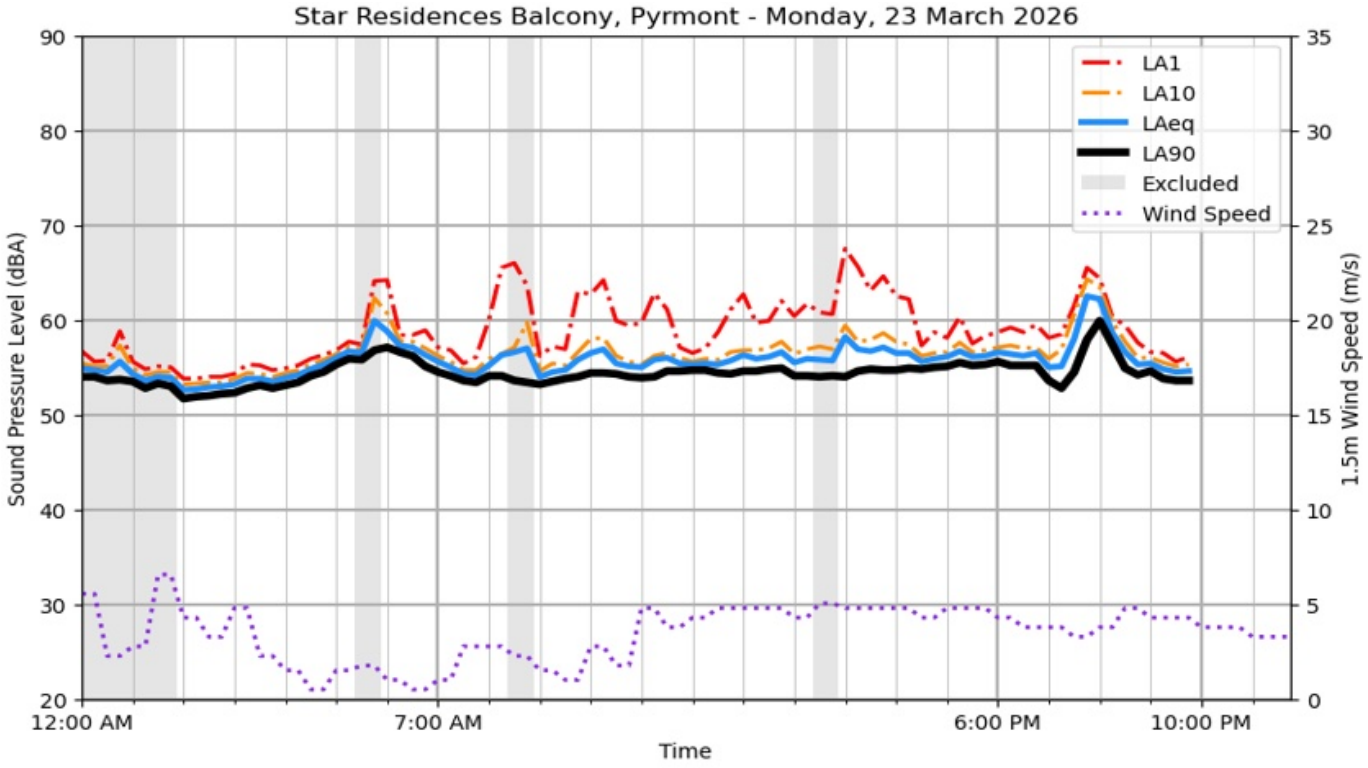

Star Residences Balcony, Pyrmont - Wednesday, 18 March 2026
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM


Star Residences Balcony, Pyrmont - Thursday, 19 March 2026
LA1
LA10
LAeq
LA90
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

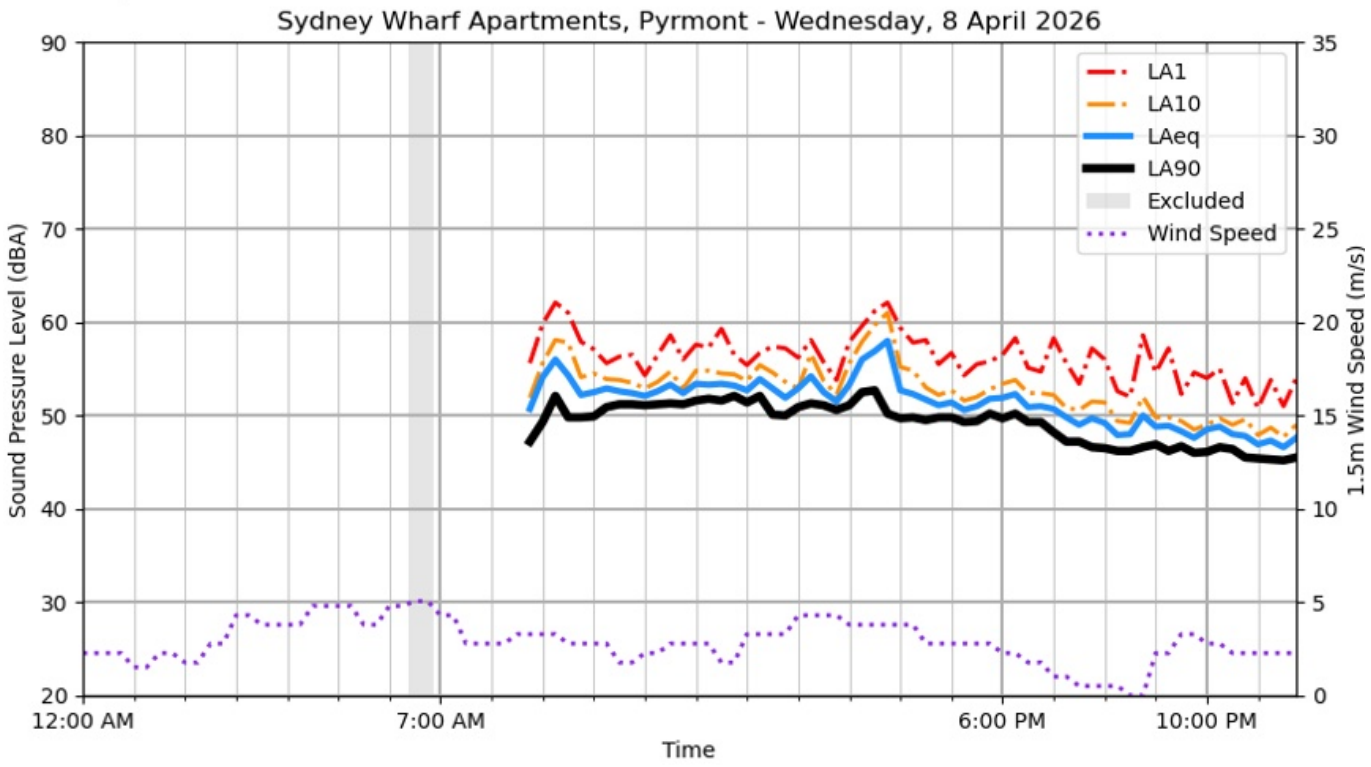

Star Residences Balcony, Pyrmont - Friday, 20 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
12:00 AM
7:00 AM
6:00 PM
10:00 PM
Time

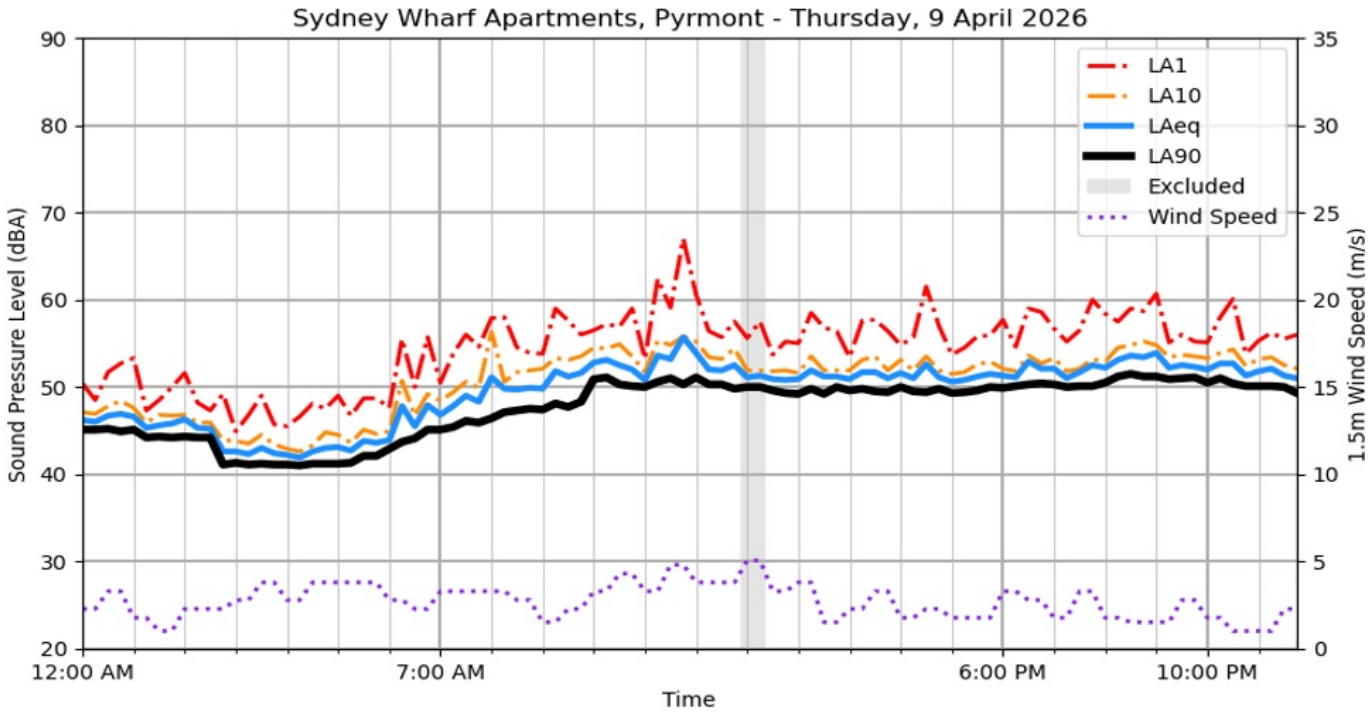

Star Residences Balcony, Pyrmont - Saturday, 21 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
12:00 AM
7:00 AM
6:00 PM
10:00 PM
Time

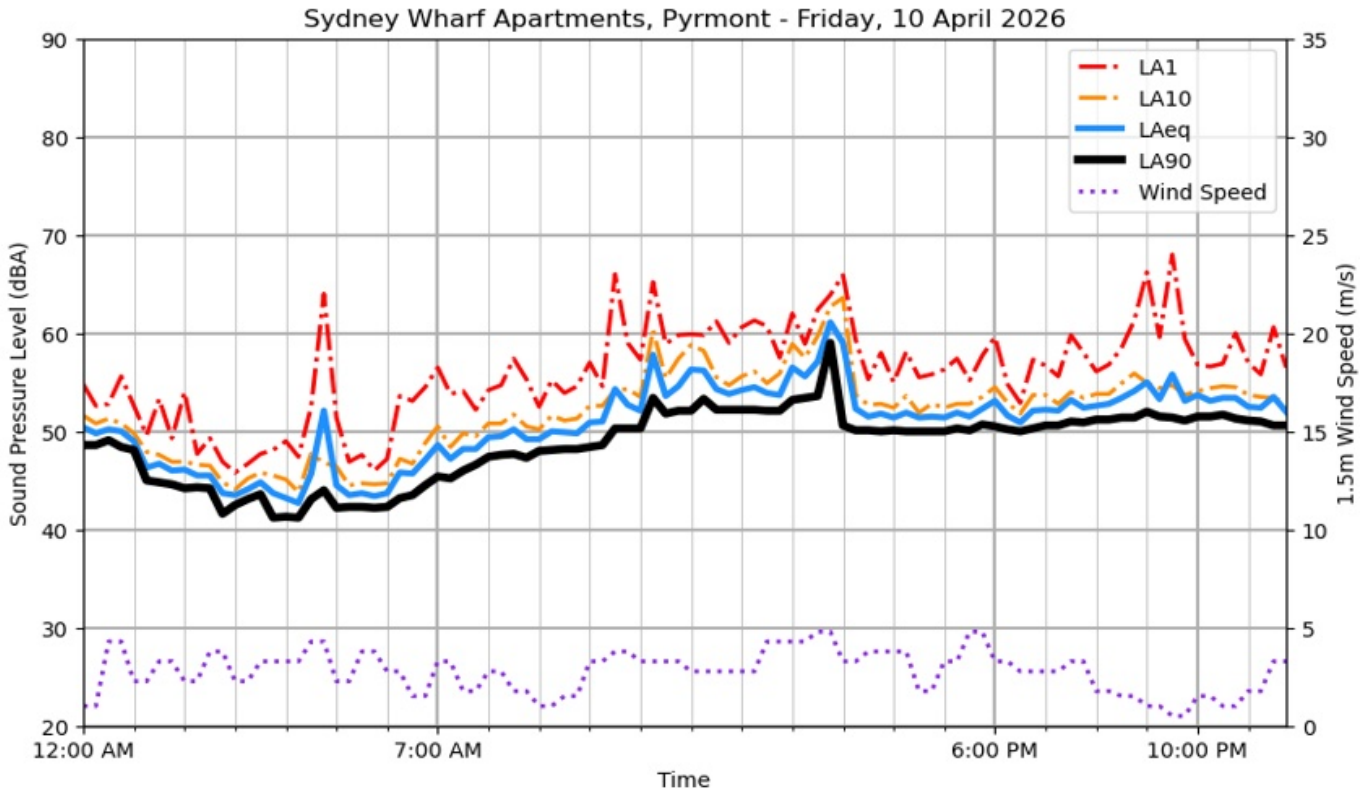

Star Residences Balcony, Pyrmont - Sunday, 22 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
12:00 AM
7:00 AM
6:00 PM
10:00 PM
Time

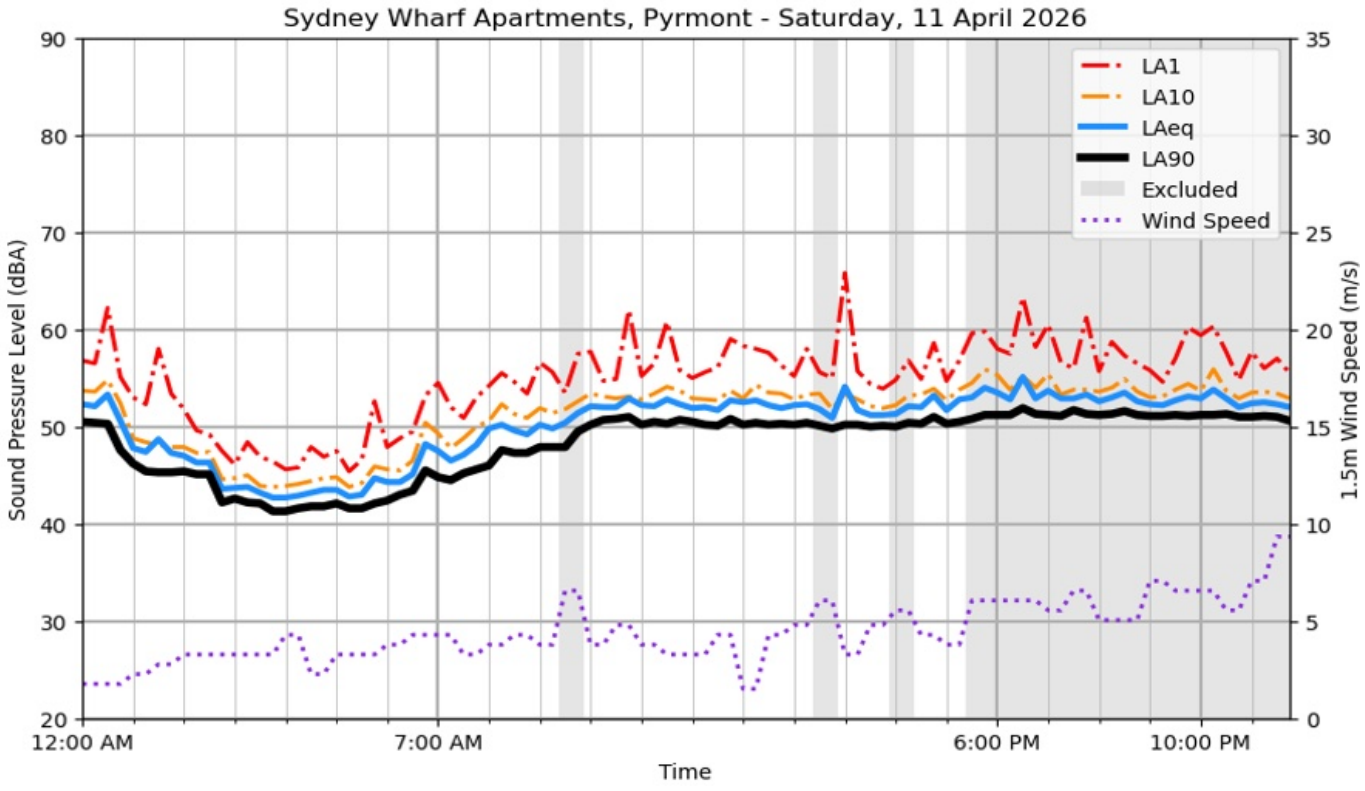

Star Residences Balcony, Pyrmont - Monday, 23 March 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
12:00 AM
7:00 AM
6:00 PM
10:00 PM
Time

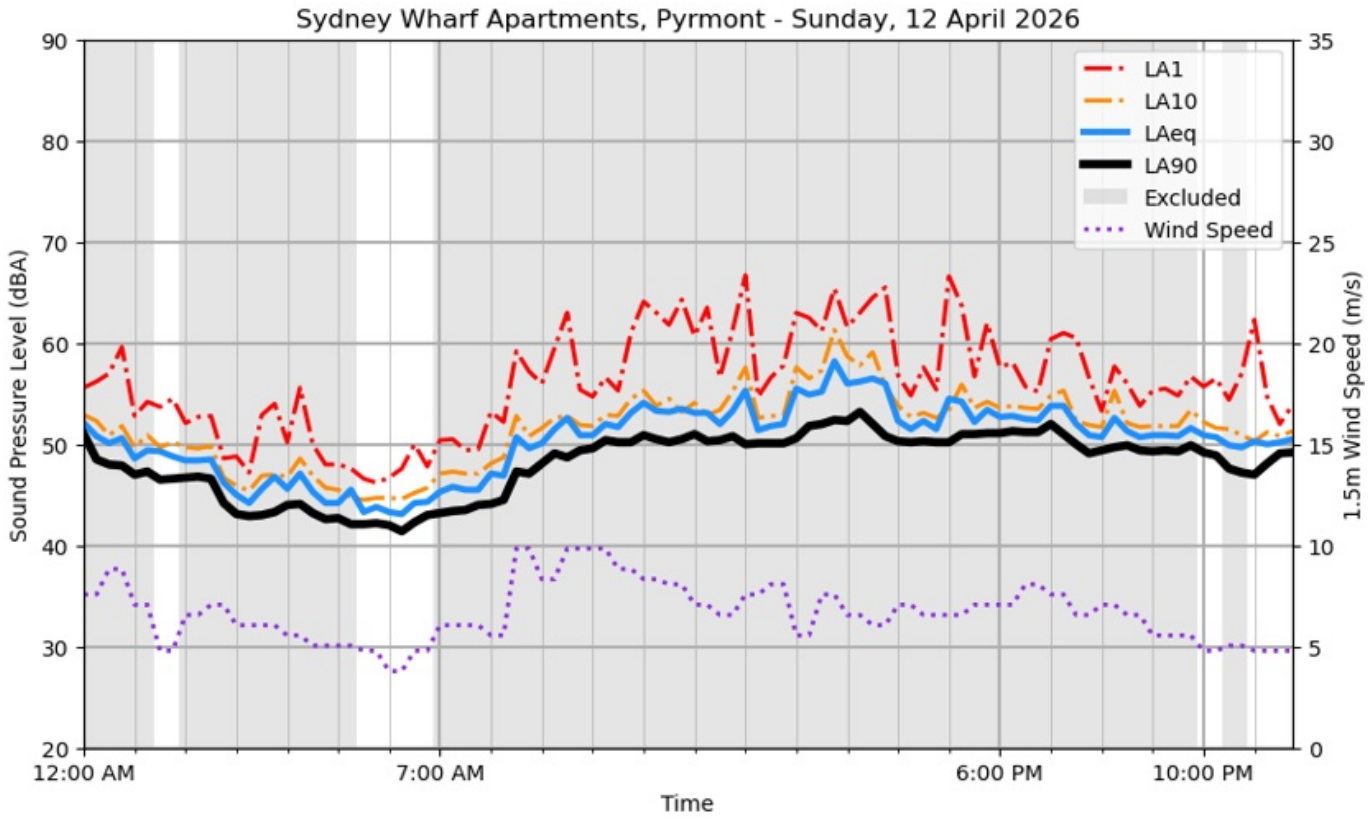
A.2 Logger #2: Sydney Wharf Apartments

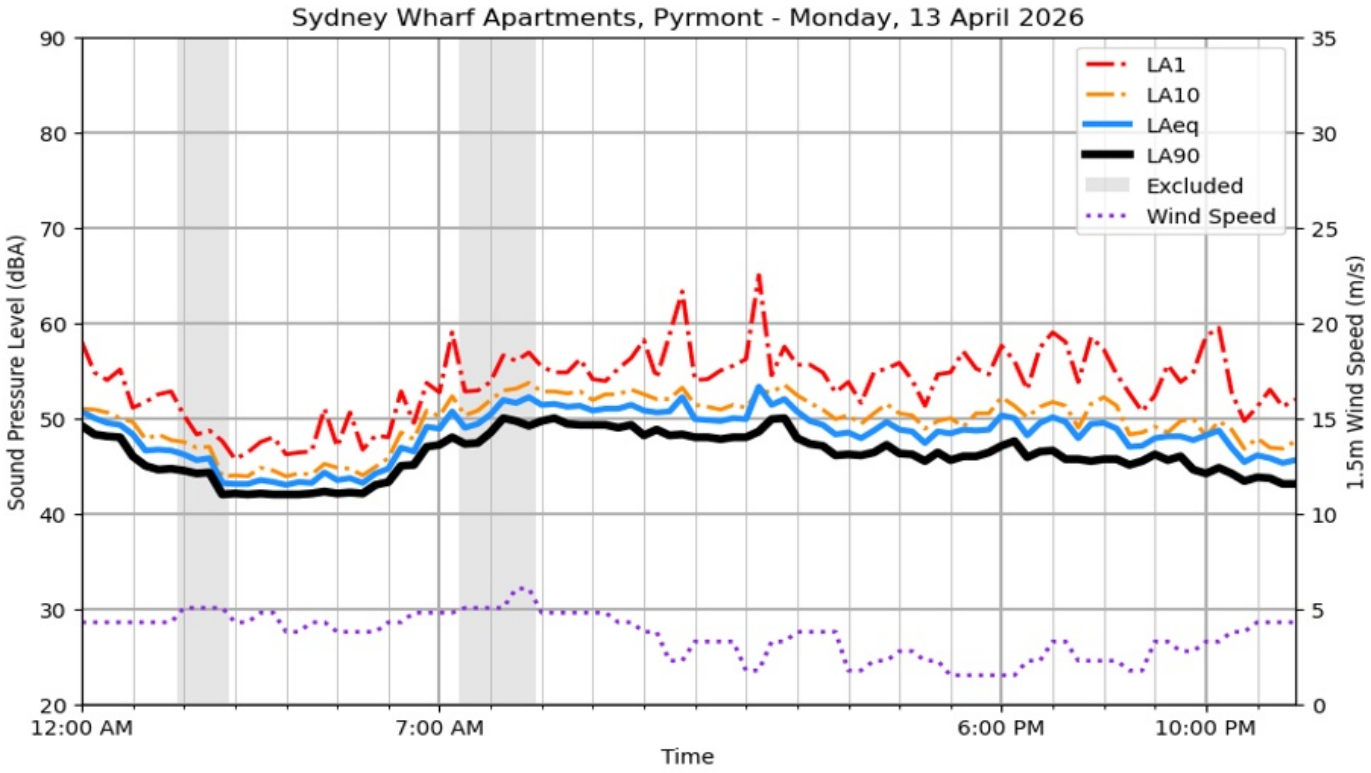


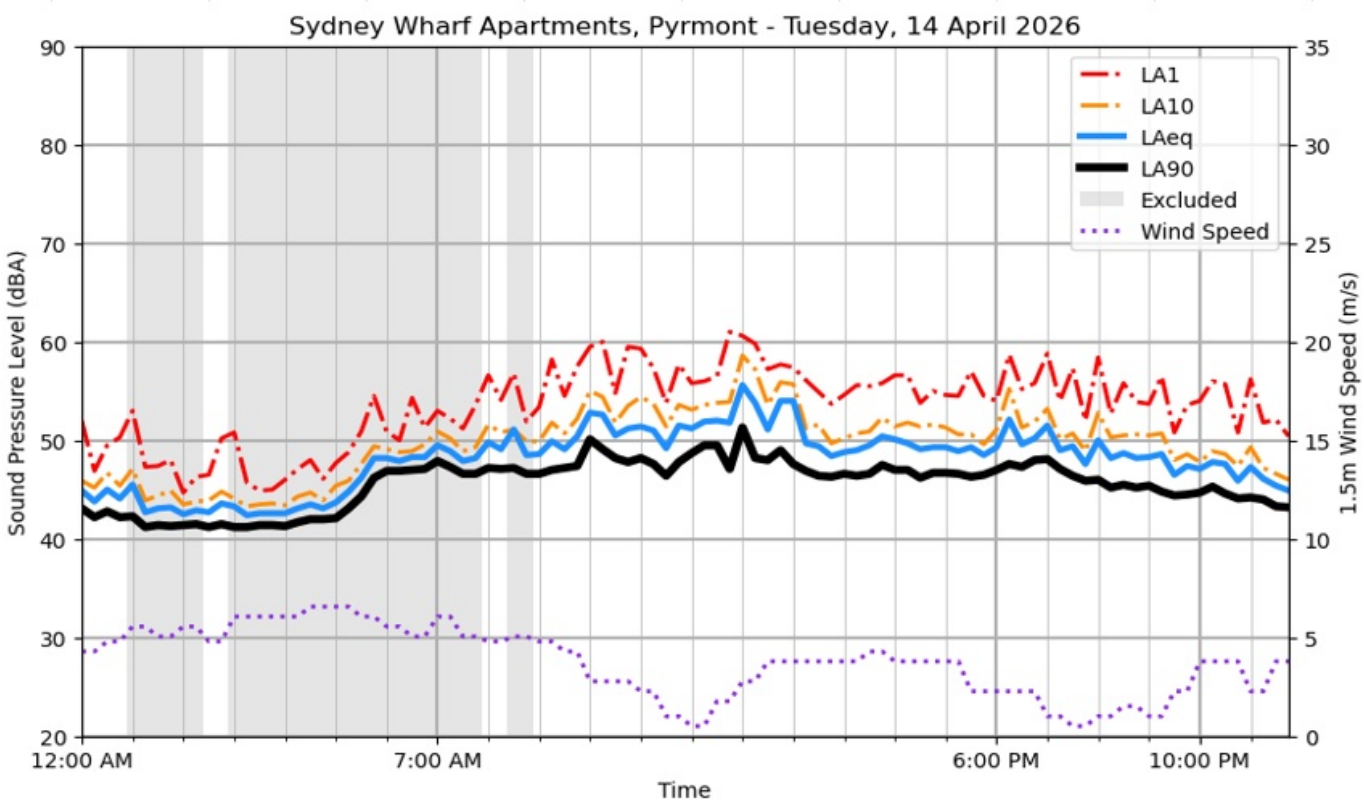


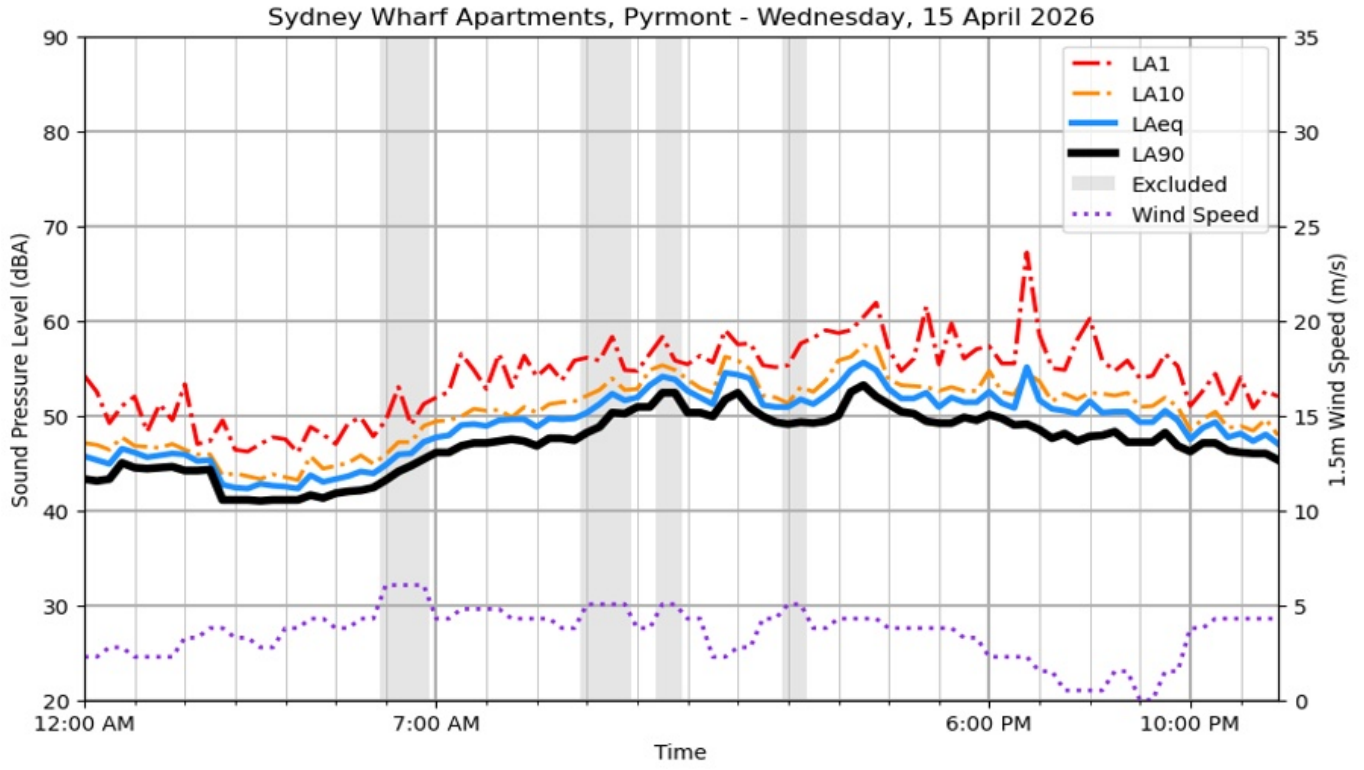

Sydney Wharf Apartments, Pyrmont - Friday, 10 April 2026
LA1
LA10
LAeq
LA90
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

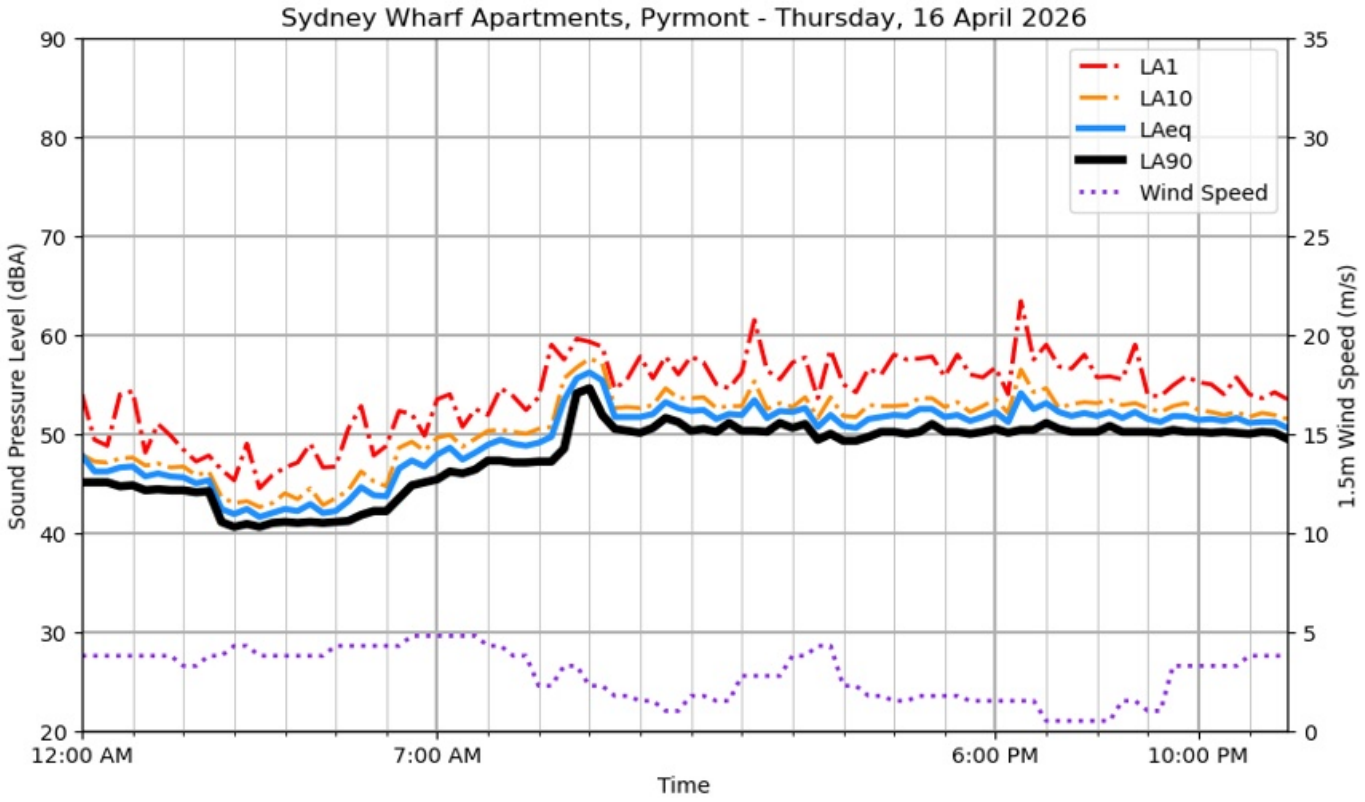

Sydney Wharf Apartments, Pyrmont - Saturday, 11 April 2026
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

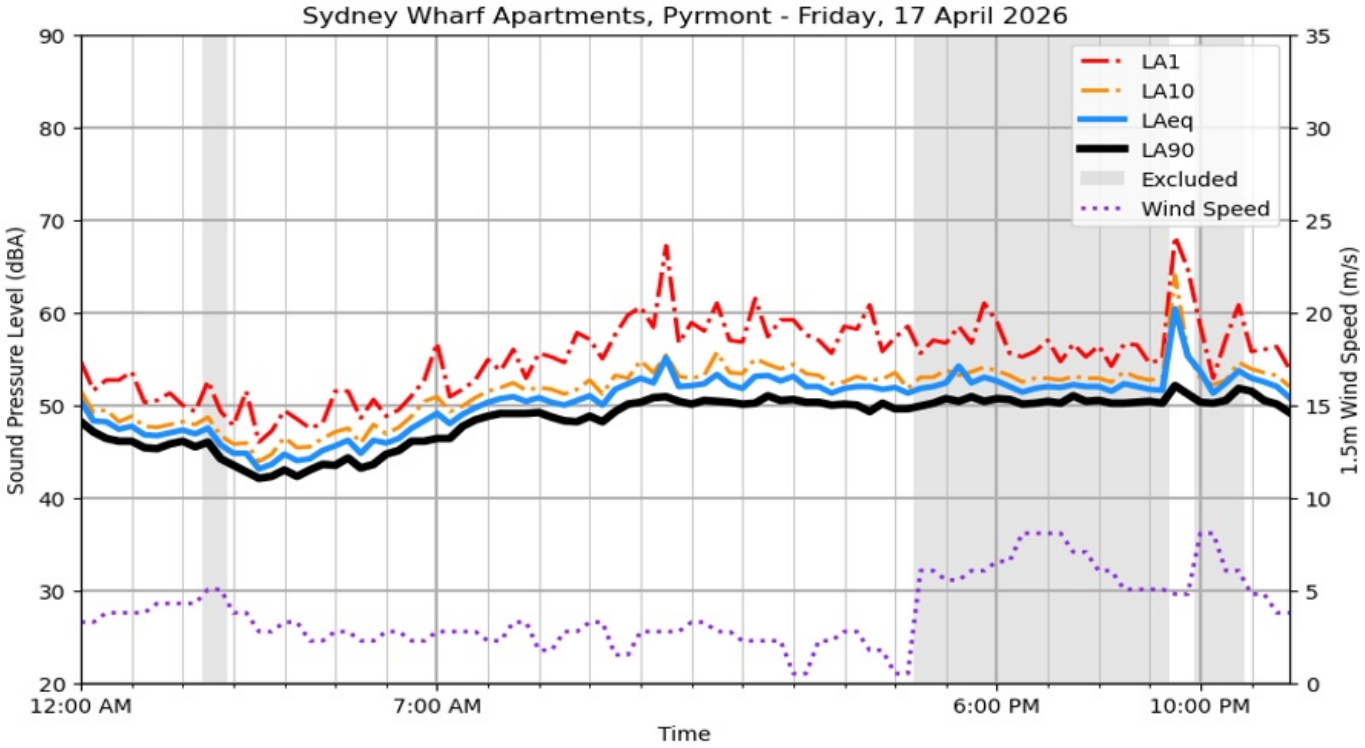

Sydney Wharf Apartments, Pyrmont - Sunday, 12 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

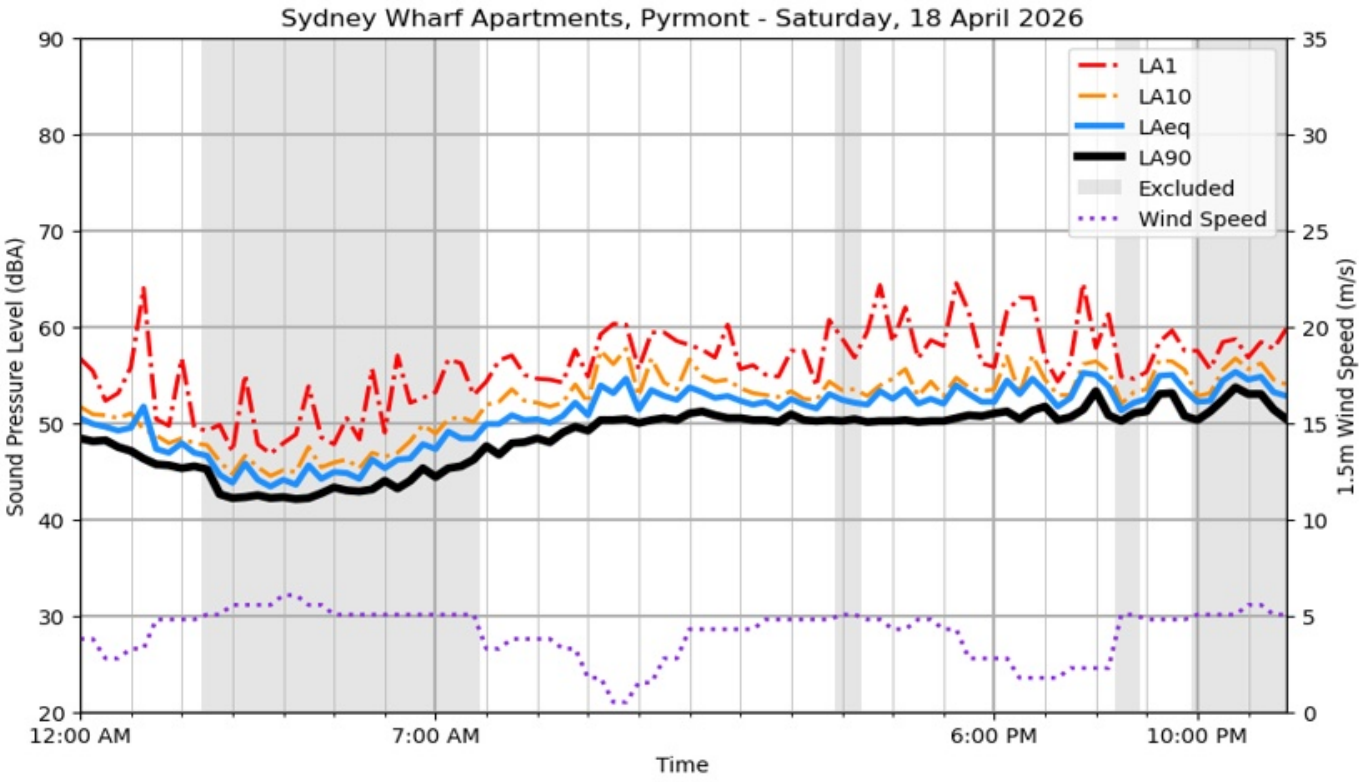

Sydney Wharf Apartments, Pyrmont - Monday, 13 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

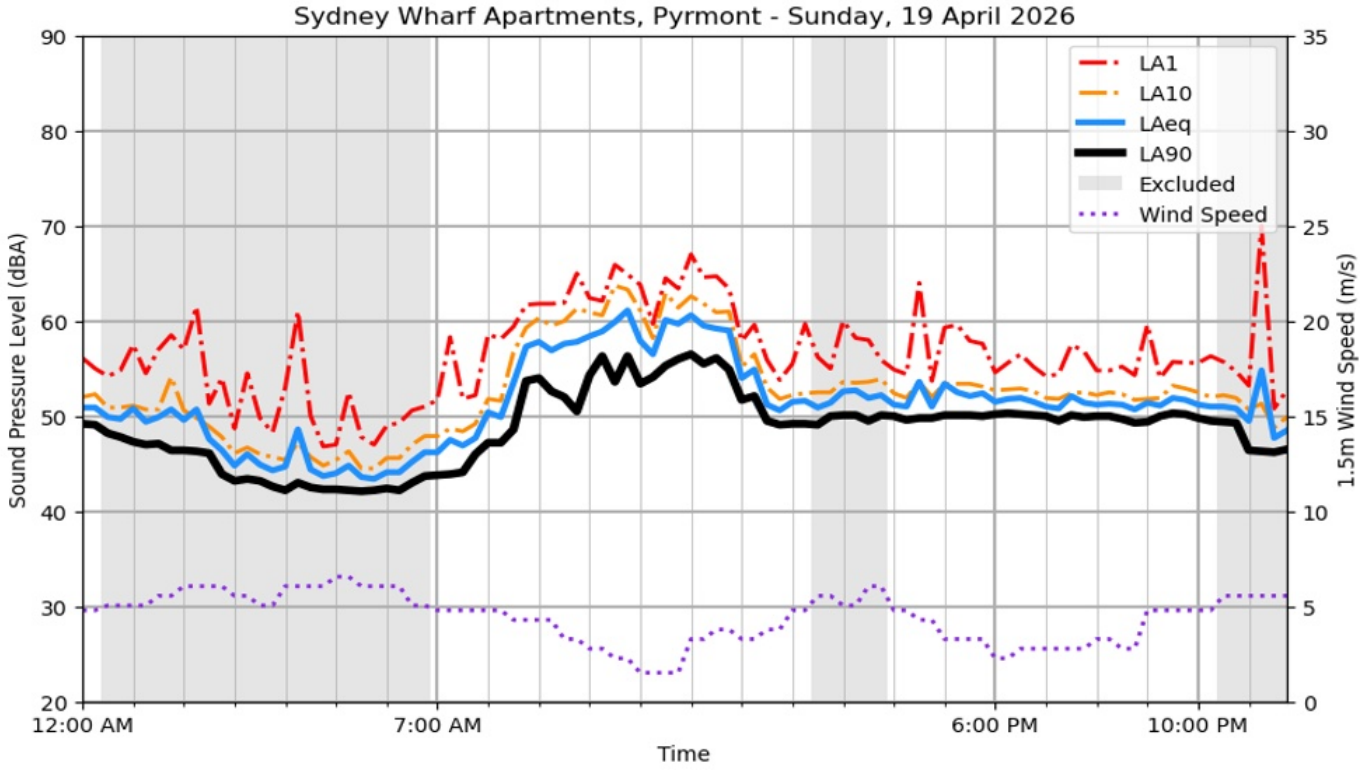

Sydney Wharf Apartments, Pyrmont - Tuesday, 14 April 2026
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

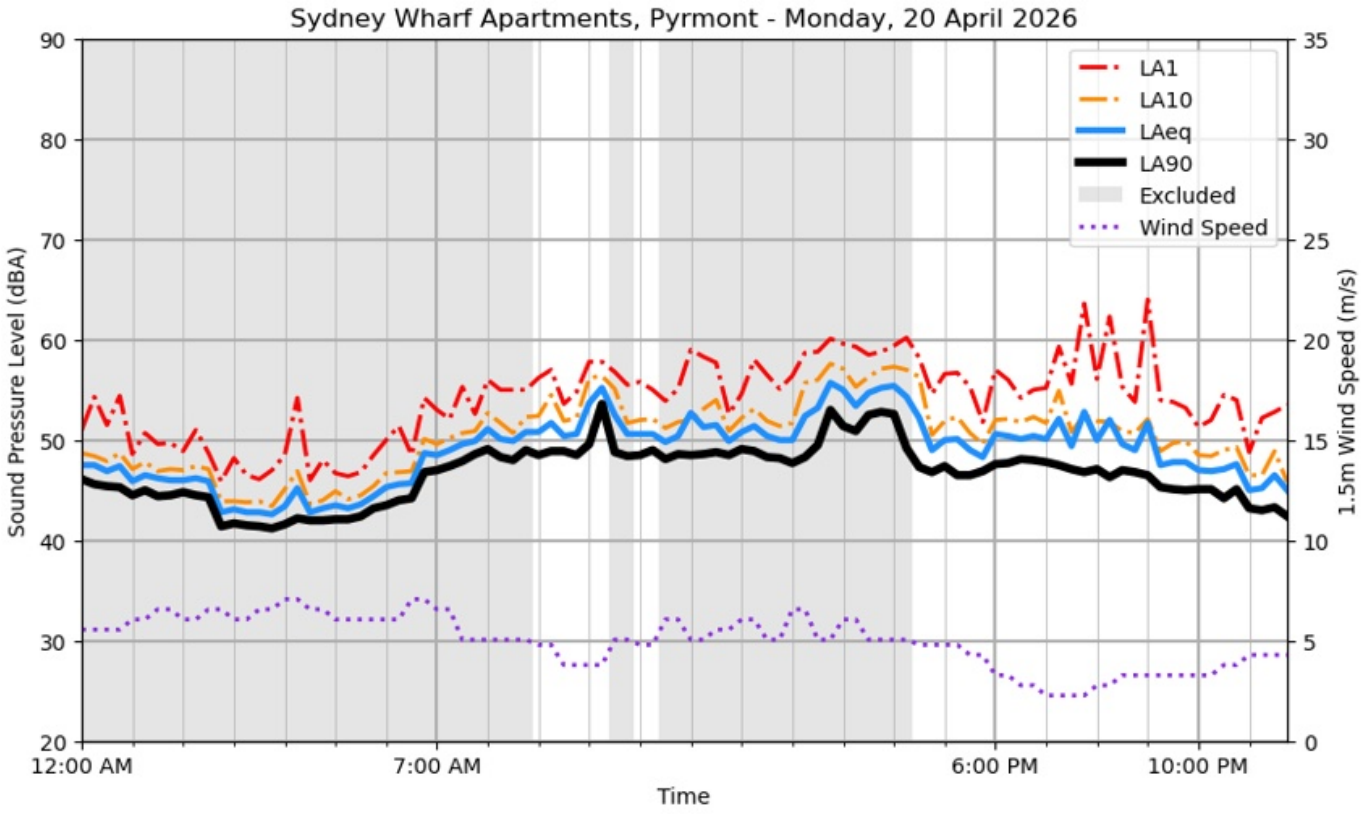

Sydney Wharf Apartments, Pyrmont - Wednesday, 15 April 2026
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

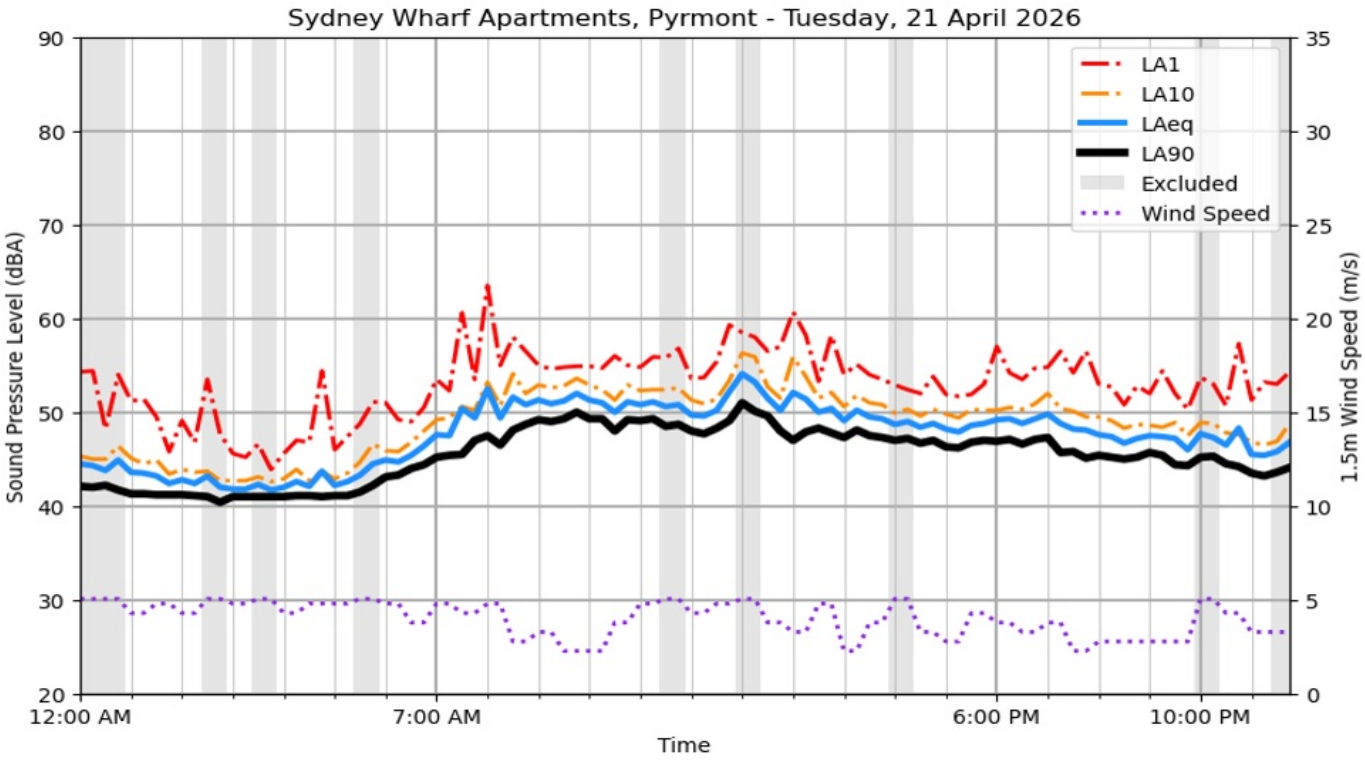

Sydney Wharf Apartments, Pyrmont - Thursday, 16 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Wind Speed


Sydney Wharf Apartments, Pyrmont - Friday, 17 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

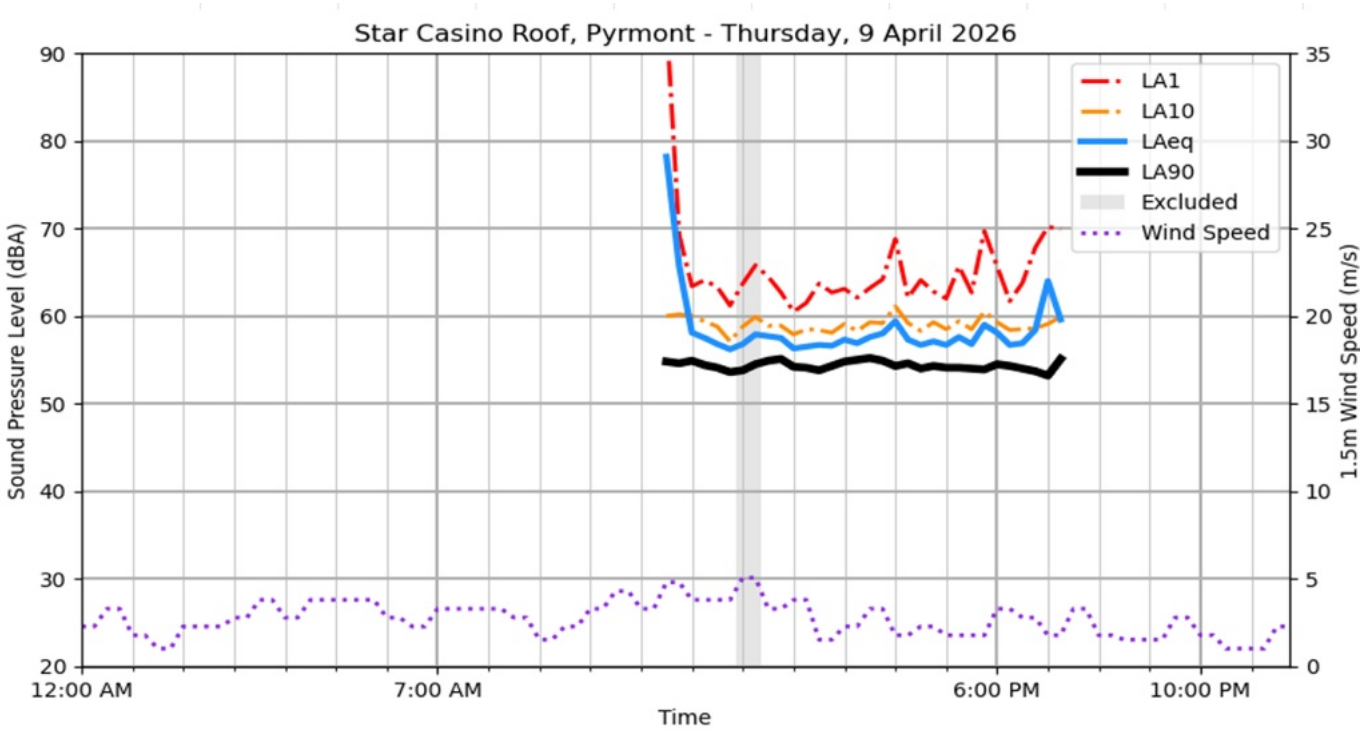

Sydney Wharf Apartments, Pyrmont - Saturday, 18 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

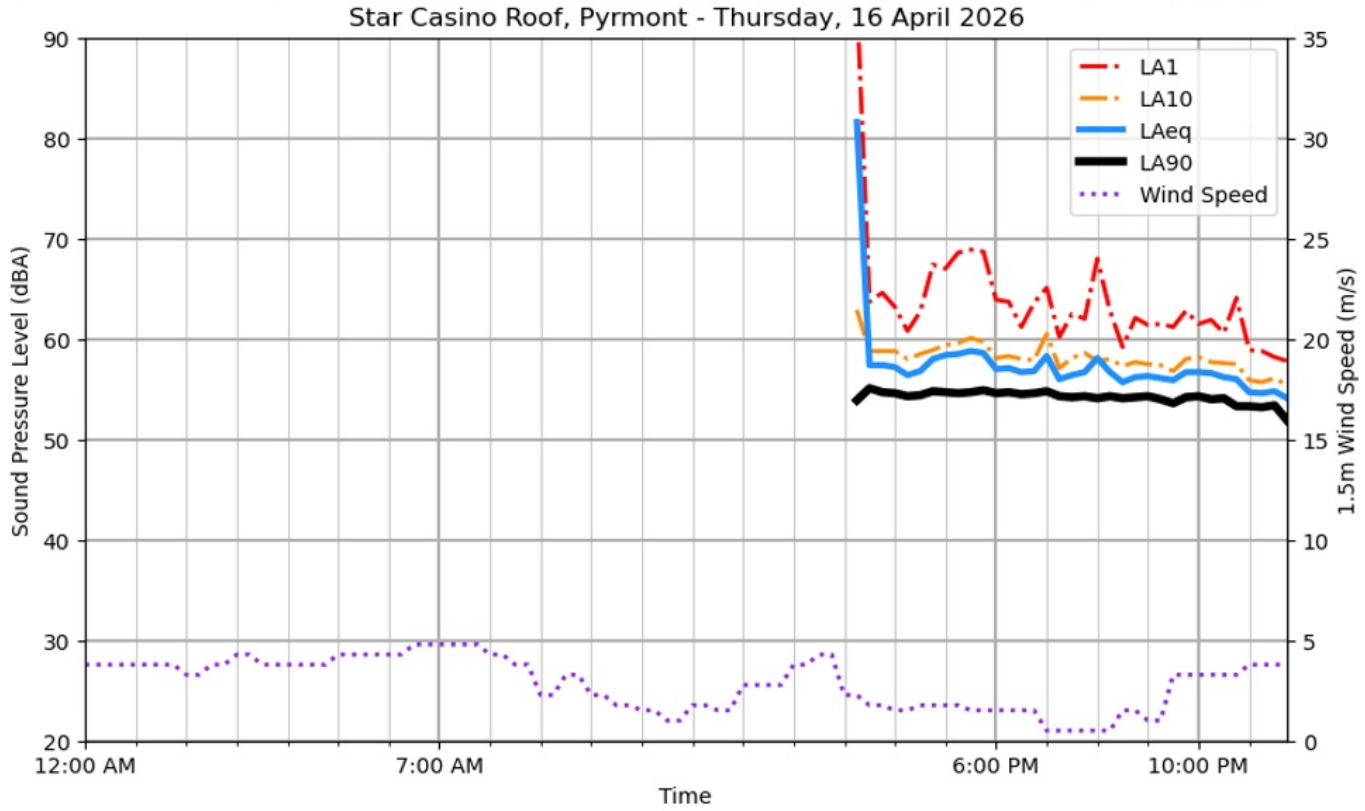

Sydney Wharf Apartments, Pyrmont - Sunday, 19 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

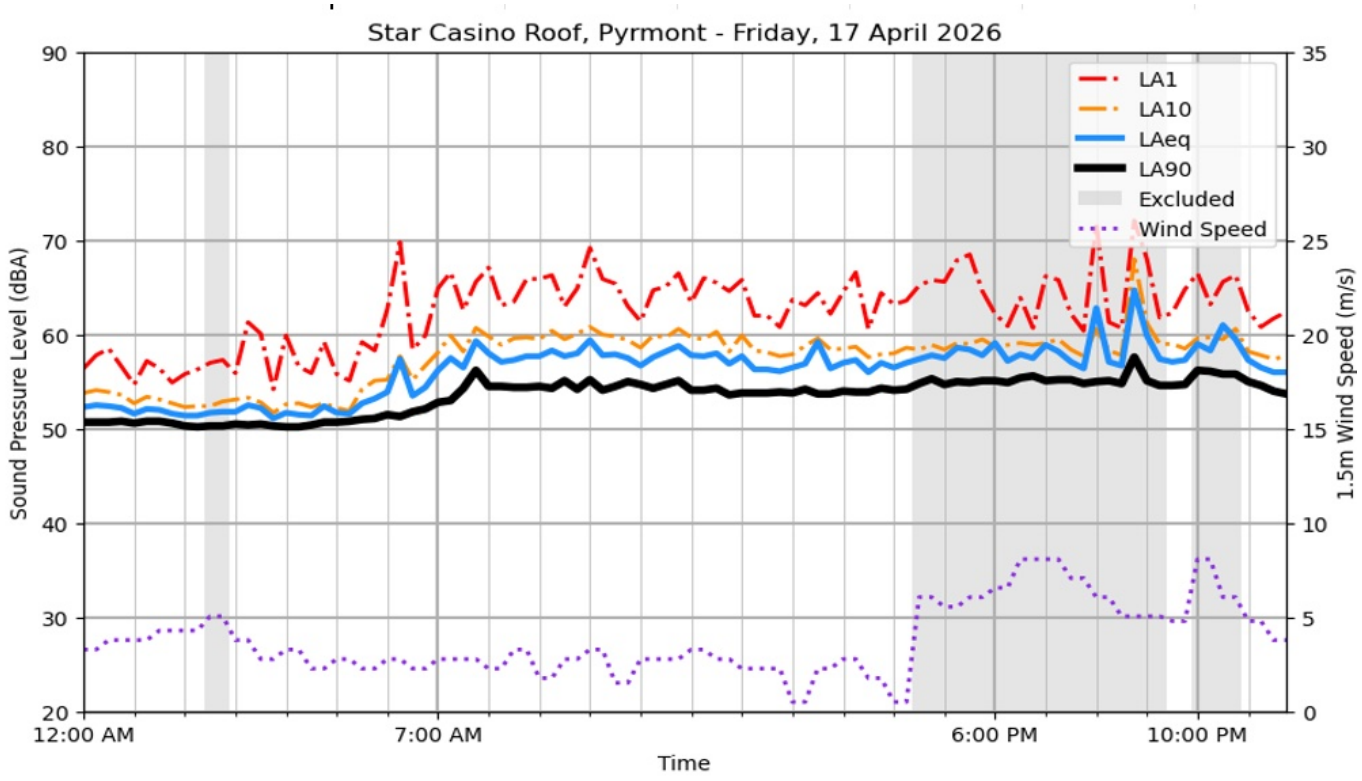

Sydney Wharf Apartments, Pyrmont - Monday, 20 April 2026
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

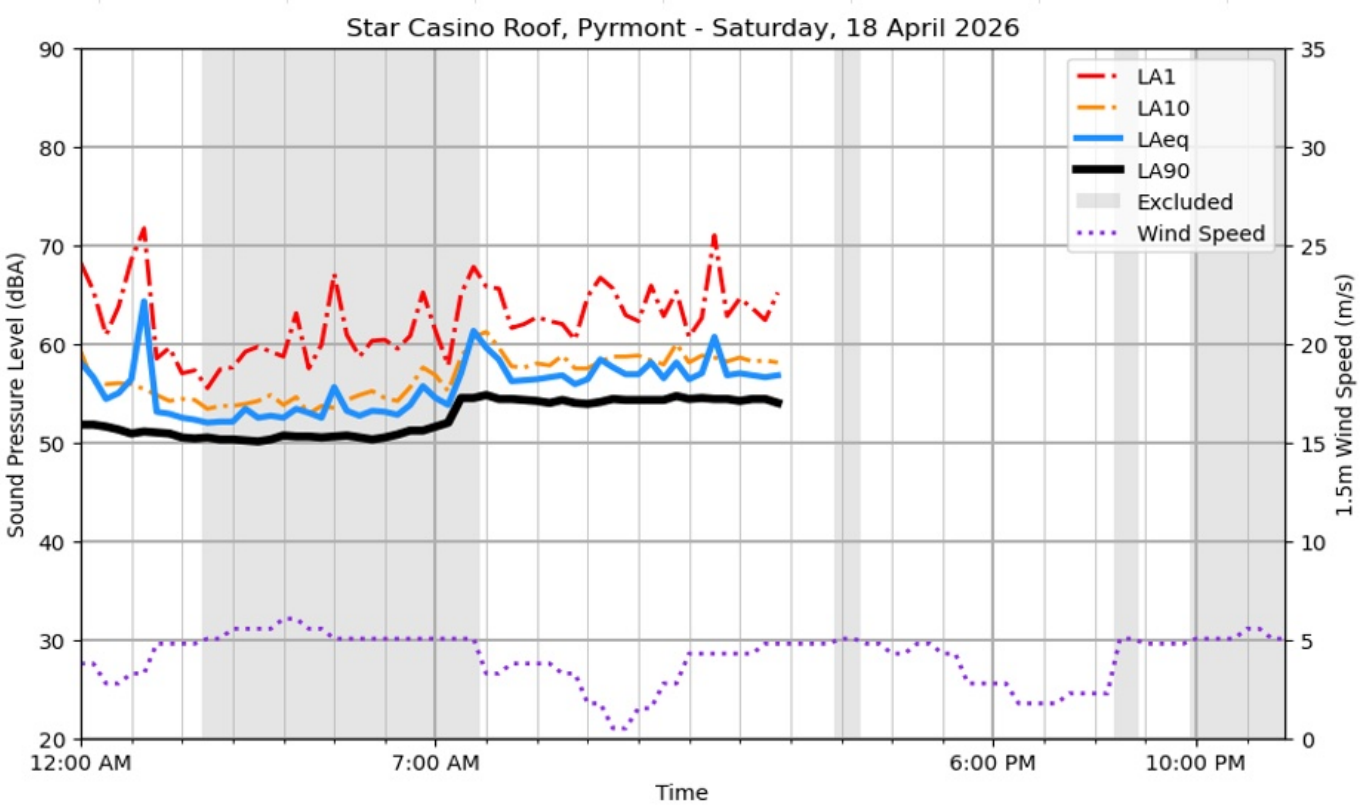

Sydney Wharf Apartments, Pyrmont - Tuesday, 21 April 2026
LA1
LA10
LAeq
LA90
Excluded
Wind Speed
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM

A.3 Logger #3:


Star Casino Roof, Pyrmont - Thursday, 9 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed


Star Casino Roof, Pyrmont - Thursday, 16 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Wind Speed


Star Casino Roof, Pyrmont - Friday, 17 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed


Star Casino Roof, Pyrmont - Saturday, 18 April 2026
Sound Pressure Level (dBA)
1.5m Wind Speed (m/s)
Time
12:00 AM
7:00 AM
6:00 PM
10:00 PM
LA1
LA10
LAeq
LA90
Excluded
Wind Speed

Appendix B Operational Noise Guidelines

The NSW EPA Noise Policy for Industry 2017 (NPfI) provides guidance on methodology for determining limiting noise criteria for external noise emissions from industrial-type noise associated with a development.

The criteria have two components:

- Intrusiveness Noise Level – controlling intrusive noise impacts in the short term for residences.
- Amenity Noise Level (ANL) – maintaining noise level amenity for particular land uses for residences and other land uses.

Applying the more stringent of the two criteria provides the Project Noise Trigger Level (PNTL).

The NSW NPfI considers the following when establishing the criteria:

- The existing Ambient (Leq) and Background noise levels (L90) that surround the site.
- The time of day that the noise generating development will be in operation, defined by the following:
  - Day (7am to 6pm).
  - Evening (6pm to 10pm).
  - Night (10pm to 7am).

    Note: There will be situations that call for different assessment periods. For example, where early morning (5am to 7am) operations are proposed, it may be unreasonable to expect such operations to be assessed against the night-time project noise trigger levels – especially if existing background noise levels are steadily rising in these early morning hours.
- The type of receivers.
- The type of area that the development site and its nearest receivers are located.
- The type of noise source and its characteristics.

Further guidance on establishing the criteria can be found in the in the sections below and in the NPfI document.

B.1.1. Establishing NPfI Criteria

The main source of noise break-out from the proposal to the environment will be noise from the new mechanical plant associated with the proposal (i.e. new heat pumps). The environmental noise impact of the site has been assessed in accordance with the NSW NPfI.

As discussed, the NSW NPfI sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the Project Noise Trigger Level (PNTL).

It is noted that the NSW NPfI also provides:

- Recommended noise levels for specific receiver types and the type of area they are located within.
- Modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source is not to be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria only relate to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured – if it

approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.

The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project noise trigger level

For the new plant in the Project, the more stringent of the intrusive and the amenity criteria sets the PNTL. The derivation of the PNTL is provided below.

STEP 1 - Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from $L_{A90,15min}$ measured at Location #2 during the long-term noise survey in accordance with the methodology prescribed in NSW NPfI.

Three time periods are considered (consistent with the operating times and the time of day classifications in the NSW NPfI):

- Day 7am to 6pm
- Evening 6pm to 10pm
- Night 10pm to 7am

The estimated RBLs and ambient noise levels are shown below in Table 30.

Table 30 Long-term background and ambient noise levels based on NSW NPfI

Location	L_{A90} RBL Rating Background Noise (dB)			L_{Aeq} Ambient Noise Levels (dB)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger #1	52	55	52	56	58	55
Logger #2	47	47	41	52	51	47
Logger #3	54	54	50	58	57	54

STEP 2 - Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

$$L_{Aeq,15minute} = RBL \text{ plus } 5 \text{ dB(A)} \text{ (Equation 1)}$$

The intrusiveness criteria have been determined from the RBLs presented in Table 30 for each period. The Intrusiveness noise levels are only applied to residential receivers.

Table 31 Intrusiveness noise levels

Location	L_{A90} RBL Rating Background Noise (dB)			Intrusiveness criteria (dB)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger #1	52	55	52	57	57[1]	57
Logger #2	47	47	41	52	52	46
Logger #3	54	54	50	59	59	55

Note: 1: The evening RBL exceeds the daytime value. In accordance with the NPfI, the evening intrusiveness noise level has been capped at the daytime value, as the evening period is considered more sensitive and a higher criterion derived solely from an elevated background would be inconsistent with community expectations for noise control during this period.

STEP 3 – Determination of project amenity noise levels

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined is to remain below the recommended Amenity Noise Levels (ANL) specified in Table 2.2 of the NSW NPfI where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

The recommended ANL represents the objective for total industrial noise at a receiver location, whereas the project ANL represents the objective for noise from a single industrial development at a receiver location.

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

Project ANL = Recommended ANL minus 5 dB(A) (Equation 2)

As the site and surrounding receivers are located within the Campbelltown city centre with high traffic volumes on several of the surrounding roads, and the measured RBL are above the 45 in the day, 40 in the evening, and 35 in the night, residential receivers of the project are considered to be in the Urban residential receiver category as per NSW NPfI Table 2.3 reproduced in Figure 16.

Table 2.3 provides guidance on assigning residential receiver noise categories; however, careful judgement based on site-specific circumstances and consultation with the relevant planning/licensing authority may be required in some circumstances.

Table 2.3: Determining which of the residential receiver categories applies.

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

Notes: *As cited in Standard Instrument – Principal Local Environmental Plan, New South Wales Government, Version 15 August 2014. RBL = rating background noise level.

Figure 16 Copy of NPfI Table 2.3 - guidance on residential receiver category

The recommended ANLs relevant to this project are specified in Table 32.

Table 32 Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

Receiver	Period	Recommended ANL $L_{Aeq(period)}$, dB(A)
Residential (Urban)	Day (7am*-6pm)	60
	Evening (6pm-10pm)	50
	Night (10pm-7am*)	45
Hotels, motels, holiday accommodation, etc.	Day (7am*-6pm)	65
	Evening (6pm-10pm)	55
	Night (10pm-7am*)	50
Active recreation	When in use	55
Commercial	When in use	65

*8am for Sundays and Public Holidays

The following exceptions to the above method to derive the project ANL apply:

Exception A – In areas with high traffic noise levels

The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the L_{Aeq} noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period(traffic)}$ minus 15 dB(A).

This high traffic project amenity noise level may be applied only if all the following apply:

- traffic noise is identified as the dominant noise source at the site,
- the existing traffic noise level (determined using the procedure outlined in Section A2, Fact Sheet A of NSW NPfI, measuring traffic instead of industrial noise) is 10 dB or more above the recommended ANL for the area, and
- it is highly unlikely traffic noise levels will decrease in the future.

For each assessment period where these traffic noise provisions apply, the High Traffic Project ANL is to be used for industrial development, derived from the $L_{Aeq,period(traffic)}$ as:

High Traffic Project ANL = $L_{Aeq,period(traffic)}$ minus 15 dB(A) (Equation 3)

Exception B – In proposed developments in major industrial clusters

The recommended amenity noise level from Table B3 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.

The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section B.3 can be applied.

However, where a greenfield or redevelopment of an existing cluster of industry consisting of multiple new noise-generating premises is proposed, the approach for determining the project amenity noise level in Section B.3 is not applicable and the approach below is to be applied.

For the new multiple premises or redevelopment of existing clusters of industry, for each individual premise,

Individual Project ANL = $10Log_{10}(10^{(L\ -\ 5\ dB/10)}/N)$ dB(A) (Equation 4)

where L is the relevant recommended ANL from Table B3 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing L_{Aeq} industrial noise levels are more than 5 dB lower than the relevant recommended ANL, the above equation can be modified to reflect “L” in lieu of “L – 5 dB”.

Exception C – When existing noise level is high

Where the resultant project ANL is 10 dB or more lower than the existing industrial noise level. In this case the project ANL can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

Exception D – Where cumulative noise need not be considered

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 the relevant ANL is assigned as the project ANL for the development.

Where the project ANL applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2 of the NSW NPfI.

Table 33 Determination of Project Amenity Noise Levels for residential and commercial receivers

Receiver	Period	Recommended ANL $L_{Aeq(period)}$, dB(A)	Calculation	Project ANL $L_{Aeq(15min)}$, dB(A)
Residential (Urban)	Day (7am*-6pm)	60	Eq 2 (no exceptions) + 3dB	58
	Evening (6pm-10pm)	50	Eq 2 (no exceptions) + 3dB	48
	Night (10pm-7am*)	45	Eq 2 (no exceptions) + 3dB	43
Hotels, motels, holiday accommodation, etc.	Day (7am*-6pm)	65	Eq 2 (no exceptions) + 3dB	63
	Evening (6pm-10pm)	55	Eq 2 (no exceptions) + 3dB	53
	Night (10pm-7am*)	50	Eq 2 (no exceptions) + 3dB	48
Active recreation	When in use	50	Eq 2 (no exceptions) + 3dB	48
Commercial	When in use	65	Eq 2 (no exceptions) + 3dB	63

Note: 1: 8am for Sundays and Public Holidays

Project noise trigger level

The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTL are shown in Table 34 below (the limiting criteria for each PNTL are shown in bold).

Table 34 Determination of Project Noise Trigger Levels for the Site

Receiver	Period	Project Intrusiveness Noise Level, dB(A)	Project Amenity Noise Level, dB(A)	Project Trigger Level, dB(A)
(residential urban) (logger #1)	Day (7am[1]-6pm)	**57**	58	57
	Evening (6pm-10pm)	57[2]	**48**	48
	Night (10pm-7am[1])	57	**43**	43
(residential urban) (logger #2)	Day (7am[1]-6pm)	**52**	58	52
	Evening (6pm-10pm)	52	**48**	48
	Night (10pm-7am[1])	46	**43**	43
(residential urban) (logger #3)	Day (7am[1]-6pm)	59	**58**	58
	Evening (6pm-10pm)	59	**48**	48
	Night (10pm-7am[1])	55	**43**	43
(hotel)	Day (7am[1]-6pm)	/	**63**	63
	Evening (6pm-10pm)	/	**53**	53
	Night (10pm-7am[1])	/	**48**	48
(passive recreation)	When in use	/	**48**	48
(commercial)	When in use	/	**63**	63

Note: 1: 8am for Sundays and Public Holidays

2: The evening RBL exceeds the daytime value. In accordance with the NPfI, the evening intrusiveness noise level has been capped at the daytime value, as the evening period is considered more sensitive and a higher criterion derived solely from an elevated background would be inconsistent with community expectations for noise control during this period.

The measured evening Rating Background Level (57 dB(A)) exceeds the daytime RBL, which would ordinarily yield a higher intrusiveness noise level. In accordance with the NSW EPA Noise Policy for Industry, the evening intrusiveness noise level has been capped at the daytime value, as the evening period is considered more sensitive and a higher criterion derived solely from an elevated background would be inconsistent with community expectations for noise control during this period.

B.1.2. Sleep Disturbance (Residential Receivers)

Noise sources with the potential for sleep disturbance are likely to occur during night-time (10pm to 7am) operational and construction works activities.

The NSW NPfI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq,15min}$ and/or L_{AFmax} noise levels at the receivers. It suggests Sleep Disturbance Screening Criteria of:

- Event $L_{Aeq,15min}$ 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or
- Event L_{AFmax} 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.

The screening levels based on the measured background noise of the site are shown in Table 35.

Table 35 Sleep Disturbance Screening Criteria for the Site

Receiver	Night Time RBL	$L_{Aeq,15min}$ Screening Criteria (dB)	Screening Criteria L_{AFmax}, (dB)
R1	52	57	67
R2	41	46	56
R3	50	55	65

If the $L_{Aeq,15min}$ noise level above background is less than 5 dB and/or maximum noise emergence above background is less than 15 dB, then the noise is considered unlikely to cause sleep disturbance. If the screening test level is exceeded, then further assessment of sleep disturbance effects is warranted.

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,\ (15\ minute)}$ by more than 5 dB(A) and 15 dB(A) respectively are screening criteria for the purpose of assessing potential impacts from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance Screening Criteria is exceeded, the detailed analysis is to cover the extent to which the noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the RNP.

Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10pm and 7am);
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

A further consideration for sleep awakening is whether the environmental noise has changed. Section 5.3 "Response to a Change in Noise Level" of the RNP states:

"While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. [...] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB(A) in maximum noise levels."

Section 5.4 of the RNP, "Sleep Disturbance", states that:

"From the research on sleep disturbance to date it can be concluded that:

- Maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep;
- One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly."

The internal noise levels provided in the RNP are related to potential sleep awakening.

Typically noise impact assessments consider the worst-case scenario, including when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB(A) attenuation from outside to inside through the open window. This situation is considered likely during warmer seasons. When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB(A).

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests (extract from RNP Section 5.4 above) that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these events occur no more than twice in one night.

Table 36 Sleep Awakening Level

Residential Receiver Location	Period	Sleep Awakening Level L_{AFmax}, dB(A)
All	Night (10pm to 7am)	60 to 65

Appendix C Construction Noise and Vibration Guidelines

C.1 Noise

The relevant guideline applied for the assessment of construction noise is the NSW EPA *Interim Construction Noise Guideline 2009* (ICNG). This guideline provides construction Noise Management Levels for Residential, Commercial, and Industrial noise receivers as follows.

C.1.1. Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction Noise Management Levels that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 37 outlines the methodology for determining construction Noise Management Levels at nearby residential receivers surrounding the development site based on existing background noise levels.

Table 37 Residential construction Noise Management Levels for airborne noise as outlined in the ICNG

Time of Day	Management level LAeq (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 + 10 dB	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 + 5 dB	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 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2.

C.1.2. Non-Residential Receivers: Commercial, Industrial and Educational Receivers

The ICNG also provides recommended construction Noise Management Levels for commercial, industrial and educational facilities surrounding a construction site, which are as follows:

Table 38 Industrial, commercial, educational and hospital construction Noise Management Levels for airborne noise

Occupancy	Management level $L_{eq,15\ min}$, dB(A)
Offices, retail outlets, commercial	70 - External
Hospital wards and operating theatres	45 - Internal / 65 - External[2]
Classrooms at schools and other educational institutions	45 - Internal / 65 - External[3]

C.2 Ground borne noise

The ICNG recommends ground-borne noise management levels at residences affected by nearby construction activities. Ground-borne or structure-borne noise is noise generated by vibration transmitted through the ground or structure and is re-radiated as audible airborne noise.

The ground-borne noise levels presented in Table 39 below are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of occupants during the more sensitive time periods.

Table 39 Residential construction noise criteria for ground-borne noise

Time of Day	Management level $L_{eq\ (15\ min)}$
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Pilot testing will be required, during the daytime, to determine this. This will involve pre-demolition testing of the proposed OOH demolition works within the project site whilst structure-borne noise levels are assessed from within the closest and most-affected guest rooms of The Darling Hotel.

If the Noise Management Levels in Table 39 are exceeded, these works will not be undertaken at night – unless effective noise mitigation can be implemented.

[2] Minimum 20 dB loss from a closed façade typical of commercial or hospital ward.
[3] Where internal noise levels are specified, the NSW NPfI assessment methodology states that in cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB above internal noise levels apply assuming a window opened sufficiently to provide ventilation.

C.3 Vibration

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment
- Structural damage

Relevant management levels for each of these are detailed in the sections that follow.

C.3.1. Human Comfort

The DEC AVTG provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus targets for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- Continuous vibration continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted rms acceleration values.
- Impulsive vibration is 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.
- Intermittent vibration can be defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of vibration dose values.

Examples of these vibration types are provided in the table below.

Table 40 Examples of vibration types

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	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.	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.

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 41. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Table 41 Preferred & maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 42 sets out the acceptable VDV values for intermittent vibration.

Table 42 Acceptable vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime		Night-time	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas	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

C.3.2. Structural Damage

Vibration-induced damage of buildings and structures is a common concern, but it is actually rare in practice. This explains why there is limited reliable data on the threshold of vibration-induced damage in buildings and there is no directly relevant Australian Standard. There are guidelines available in a number of international standards, although these vary significantly.

German Standard

The relevant German standard is *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures" (Feb 1999)*. This standard gives guidelines for short-term and steady state structural vibration.

The short-term vibration limits as follows:

Table 43 Guideline Values of Vibration Velocity, vi, for Evaluating the Effects of Short-term Vibration

Structural type	Vibration Velocity, v_i, in mm/s			
	Foundation			Plane of floor of uppermost full storey
	less than 10 Hz	10 to 50 Hz	50 to 100 Hz	Frequency mixture
Commercial, Industrial or Similar	20	20 to 40	40 to 50	40
Dwellings or Similar	5	5 to 15	15 to 20	15
Particularly Sensitive	3	3 to 8	8 to 10	8

The guidelines note that: "provided the values given in Table 43 are observed, damage due to vibration, in terms of a reduction in utility value, is unlikely to occur. If the values of Table 43 are exceeded, it does not necessarily follow that damage will occur. Should these values be significantly exceeded, further investigation is necessary."

British Standard

The relevant standard is BS7385: Part 2: 1993. This standard was developed from an extensive review of UK data, relevant national and international documents and other published data, which yielded very few cases of vibration-induced damage. This standard contains the most up-to-date research on vibration damage in structures. Part 2 of the standard gives specific guidance on the levels of vibration below which building structures are considered to be at minimal risk.

The Standard proposes the following limits on the foundations of the buildings:

Table 44 Transient Vibration Guide Values for Cosmetic Damage

Structural type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz to 15 Hz	15Hz and above
Unreinforced or light framed structures **Residential or light commercial type buildings**	15mm/s @ 4Hz increasing to 20mm/s @ 15Hz	20mm/s @ 15Hz increasing to 50mm/s @ 40Hz and above

The standard states in Annex A, that … "the age and existing condition of a building are factors to consider in assessing the tolerance to vibration. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground-borne disturbance". It is recommended that buildings of importance be considered on a case-by-case basis with detailed engineering analysis being carried out if necessary.

Annex B of the Standard gives a breakdown of data that would be recorded. Included in this are details of the building structure, such as general condition of the structure, list of defects, photographs, details of all major extensions, repairs and renovations. A crack exposure report would be prepared both pre and post exposure, both internally and externally.

Australian Standard

There is no specific Australian Standard referring to structural vibration in buildings. There is however AS 2187.2 - 2006, which, in Appendix J, recommends maximum peak particle velocities, measured at the ground surface due to blasting. The lower recommended peak particle velocity is 10 mm/s. The standard states however, that structures that may be particularly susceptible to ground-borne vibration would be examined on an individual basis. It is suggested that in the absence of a particular site-specific study then a maximum peak particle velocity of 5 mm/s is used.

Summary

Table 45 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

Table 45 Summary of vibration limits

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above1	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s	For buildings particularly susceptible to vibration. Limit is for peak resultant particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

C.3.3. Minimum Working Distances

Indicative minimum working distances provided in Table 46 may be used as a screening test for risks of damage or human comfort impacts on receivers. If receivers are within the minimum working distance, there is a risk of impact which should be mitigated via works practices or management measures as appropriate.

Table 46 Recommended indicative minimum working distances for vibration-generating plant and equipment[1]

Plant item	Approx. size / weight / model	Minimum distance – cosmetic damage – residential / light framed (BS 7385)[2]	Minimum distance – structurally unsound heritage 2.5mm/s (DIN 4150)[3]	Minimum distance – human response (Day) (AVTG)[2]
Vibratory roller (steady state; start up and power down distances may be larger)	< 50kN (1-2 tonne)	5m	11m	15m
	50-100kN (2-4 tonne)	6m	14m	20m
	100-200kN (4-6 tonne)	12m	27m	40m
	200-300kN (7-13 tonne)	15m	33m	100m
	> 300kN (13-18 tonne)	20m	44m	100m
	> 300kN (> 18 tonne)	25m	55m	100m
Vibratory roller – smooth drum	4-6 tonnes	12m	27m	40m
Padfoot roller (non-vibratory)		8m	15m	35m
Small hydraulic hammer	(3-5 tonne excavator)	2m	6m	15m
Small hydraulic hammer	300kg (5-12 tonne excavator)	2m	5m	7m
Medium hydraulic hammer	900 kg (12-18 tonne excavator)	7m	15m	23m
Large hydraulic hammer	1600kg (18-34 tonne excavator)	22m	55m	73m
Large hydraulic hammer	47T	30m	60m	80m
Jackhammer	Handheld	1m (nominal)	3m	Avoid contact with structure
Rotary rock grinder		8m	20m	40m
Ripper		2m	6m	15m
Plate compactor		11m	23m	43m
Compactor (non-vibratory)	32 tonne	15m	30m	40m
Large trucks, large bulldozers	(D10 with ripper)	4m	7m	13m
Excavator, tracked	< 30 tonne, travelling / digging	4m	9m	15m
Tracked crane, idling		1m	4m	10m
Concrete saw	on ground slabs and pavements	1m	2m	2m

[1] These are estimated only, and will depend on site ground characteristics, building construction, equipment size and usage, and time + duration of vibration-generating activities (for human response and sensitive equipment), among other factors.

[2] Transport for NSW Infrastructure and Services *Construction Noise and Vibration Strategy* (2018)

[3] Acoustic Studio derived from TfNSW data and applying distance attenuation across assumed soil on rock, per methodology described in Amick & Gendreau, *Construction Vibrations and their Impact on Vibration-Sensitive Facilities*, ASCE Construction Congress 6 (2000)

Appendix D Sound Management Plan – Example

1. Overview

This Sound Management Plan (SMP) example has been prepared to outline the general approach to managing noise emissions associated with live performance events at the New Live Entertainment Venue space. The SMP provides a framework of reasonable and practicable measures to minimise potential noise impacts on surrounding sensitive receivers, while enabling the ongoing operation of high-quality entertainment within the venue.

The measures outlined herein are intended to be flexible and adaptive, recognising that event formats and operational requirements may vary over time.

2. General Acoustic Management Approach

Live music and associated sound system operation will be managed to minimise off-site noise emission through a combination of system design, operational control, and responsive management practices. Key principles include:

- Utilisation of professional-grade sound systems designed to **optimise sound coverage within audience areas** while limiting spill beyond the venue.
- Consideration of **loudspeaker placement and orientation** to reduce direct noise propagation toward nearby sensitive receivers.
- Management of **low-frequency energy**, which has greater potential to propagate off-site, through appropriate system tuning and control.
- Use of the building structure as primary acoustic containment, with **doors and openings managed where practicable** during performances.

3. Operational Controls

Operational practices will be implemented to provide a practical level of noise management without unduly constraining event delivery:

- Sound levels will be managed by experienced audio personnel during events.
- Pre-event soundchecks will be undertaken to establish appropriate operating levels.
- Where required, indicative internal sound level targets (e.g. at front-of-house mixing position) may be adopted as a guide to assist in managing off-site impacts.
- Events will be scheduled within approved operating hours in accordance with relevant consent conditions.

4. Monitoring and Adaptive Management

A responsive and adaptive approach to noise management will be adopted:

- Noise monitoring may be undertaken during initial events, or where warranted, to better understand the relationship between internal sound levels and external noise outcomes.
- Observations and, where available, measurement data will be used to refine operational practices over time.
- Where potential off-site impacts are identified, reasonable and practicable adjustments (e.g. minor level reductions or system tuning) will be implemented.

5. Patron and Crowd Noise

Noise associated with patrons entering, exiting, and congregating around the venue will be managed through standard venue operations, including:

- Encouraging orderly dispersal of patrons at the conclusion of events.
- Use of venue staff and security personnel to manage patron behaviour where required.
- Signage or announcements, where appropriate, encouraging patrons to be mindful of nearby residents, particularly during late evening periods.

Given the established entertainment context of The Star Sydney, patron noise is expected to be consistent with typical existing activity levels at the site.

6. Traffic and Vehicle Noise

Traffic associated with event attendance will primarily utilise the existing road network and established access arrangements for The Star Sydney. Noise from vehicle movements is expected to be consistent with typical background traffic conditions in the locality.

No significant increase in traffic noise impacts is anticipated as a result of the proposed events.

7. Complaints Handling

A complaints management process will be implemented as part of standard venue operations:

- A contact point will be available for receiving noise-related feedback.
- Any complaints received will be reviewed and, where appropriate, inform adjustments to operational practices.

8. Ongoing Review

The SMP will be subject to periodic review as part of normal venue operations. This will allow for refinement of management measures over time, ensuring that noise impacts remain appropriately managed while maintaining the viability of live performance events.

Appendix E Standards and Guidelines

The following acoustic standards and guidelines have been considered in establishing noise and vibration criteria and assessment for this project.

[1] NSW Protection of the Environmental Operations (POEO) Act 1997.

[2] NSW Department of Environment and Climate Change (DECC) *Interim Construction Noise Guideline* (ICNG) 2009.

[3] NSW Department of Environment and Conservation (DEC) *Assessing Vibration: A Technical Guideline* (AVTG) 2006.

[4] NSW EPA *Road Noise Policy* (RNP) 2011.

[5] NSW EPA *Noise Policy for Industry* (NSW NPI) 2017.

[6] Australian Standard AS 2436:2010 *Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites*

[7] Australian Standard AS 2107:2016 *Acoustics – Recommended design sound levels and reverberation times for building interiors*

[8] Australian Standard AS 1055:1997 *Acoustics – Description and Measurement of Environmental Noise*

[9] Australian Standard AS 2670.2:1990 *Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)*

[10] British Standards Institution BS 6472:1992 *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*

[11] British Standard BS7385: Part 2: 1993 *Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration*

[12] City of Sydney *Construction Hours/Noise within the Central Business District* (2002)

[13] City of Sydney *Environmental Noise Technical Requirements* (2025)

[14] Liquor & Gaming NSW (L&GNSW), *Sound regulation for licensed venues – LA10 noise criteria*, NSW Government.

ACOUSTIC STUDIO

Address Unit 27, 43-53 Bridge Road,
Stanmore NSW 2048 Australia

Phone +61 2 9557 6421

Email mail@acousticstudio.com.au