ADP
Consulting : Engineering

Eden Gardens Redevelopment, 307 Lane Cove Road, Macquarie Park

Noise Impact Assessment Report

Prepared for: Eden Gardens & Garden Centres Pty Ltd

Project No: SYD0684
Date: 17 February 2021
Revision: 02

ADP Consulting : Engineering

Creating great environments with great people

Project:	Eden Gardens Redevelopment, 307 Lane Cove Road, Macquarie Park
Location:	307 Lane Cove Road Macquarie Park, NSW 2113
Prepared by:	ADP Consulting Pty Ltd Level 3, 8 Spring Street Sydney NSW 2000
Project No:	SYD0684
Revision:	02
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Rev	Date	Comment	Author	Signature	Technical Review	Signature	Authorisa-tion & QA	Signature
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Project Team	
Client / Principal	Eden Gardens & Garden Centres
Architect	DKO Architecture

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1. Introduction

1.1 Document purpose

ADP Consulting Pty Ltd has been retained by Eden Gardens & Garden Centres to undertake acoustic engineering services for the proposed redevelopment located at 307 Lane Cove Road, Macquarie Park.

This report is prepared to provide acoustic design advice for documentation by others and addresses the impact on nearby sensitive receivers from the operation of the proposed redevelopment.

The design criteria and acoustic treatment concepts in this report demonstrate the pathways by which these shall be addressed by ADP Consulting and the project team through further analysis, recommendations and coordination as the design progresses.

It is the responsibility of the relevant design team disciplines and contractor to ensure the implementation of the acoustic intent of this document, including compliance with criteria, codes, standards, specification etc.

1.2 Referenced drawings, codes and standards

The following drawings, conditions guidelines, standards, regulatory requirements and other project-specific information has been referenced in preparing this report:

- DKO Architecture's architectural drawing package, dated 3 February 2021 (Architectural drawings)
- 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) (AS 2670.2)
- AS/NZS 1668.1:2015 The Use of Ventilation and Air Conditioning in Buildings Part 1: Fire and Smoke Control in Buildings (AS/NZS 1668.1)
- AS/NZS 2107:2016 Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors (AS/NZS 2107)
- Assessing Vibration: A Technical Guideline – NSW Department of Environment and Conservation, dated February 2006 (AVTG)
- BS 6472–1992 – Evaluation of Human Exposure to Whole-Body Vibration in Buildings (1 to 80 Hz) (BS 6472)
- NSW EPA's Noise Policy for Industry, dated October 2017 (NPfI)
- The City of Ryde Development Consent 1034/200, dated 3 June 2003 (Development Consent)
- On-premises Liquor Licence, No. LIQO624013620, dated 25 July 2005 (Liquor Licence)

1.3 Project summary

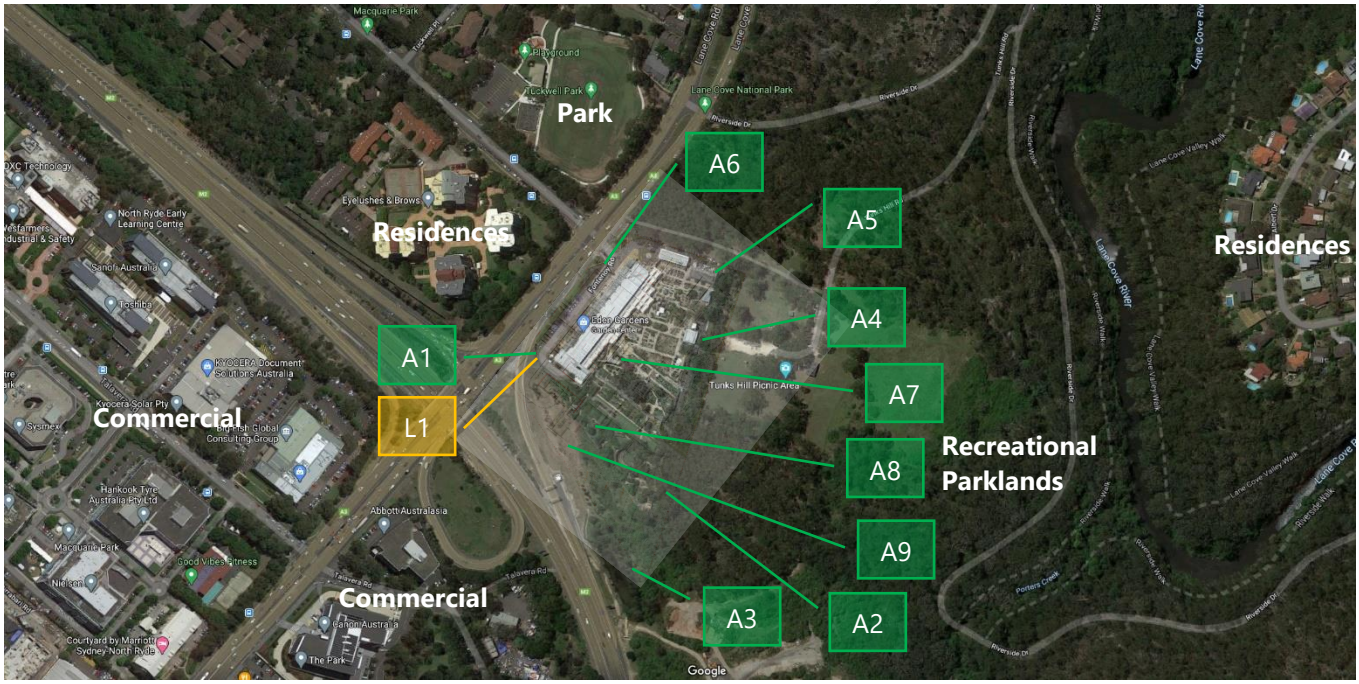
The proposed development comprises construction of a multi-use development. The Architectural Drawings show that the proposed redevelopment will consist of:

- Commercial podium and tower on lower ground and up to level 17
- Function Centres on lower ground and ground
- Food and beverage on ground
- Neighbourhood retail on ground
- End on trip facilities on lower ground
- Active and wellness zones on lower ground and levels 1-4
- Loading dock on ground level
- Service/store on lower ground and ground
- Plant areas on level 5 and roof

1.4 Site plan

Figure 1 provides a site plan of the proposed development and surrounds and noise measurement locations (A1-A9 for attended and L1 for long term).

Figure 1 Site plan and noise measurement locations



2. Site investigations and noise measurements

2.1 Site investigations

Based on our site survey and investigations we have identified the following receivers as being the nearest noise sensitive premises affected by noise emission from the proposed development:

- Commercial and mixed-use premises to the south and southwest opposite the M2 and Lane Cove Road
- Parks, including:
  - Tuckwell Park to the north opposite Lane Cove Road
  - Lane Cove National Park directly adjacent to the south and east that includes picnic areas
- Residences, including:
  - High rise residential to the northwest opposite Lane Cove Road
  - Residences to the east, approximately 500m away
- The development itself that includes:
  - Services requiring noise attenuation and vibration isolation to ensure low indoor noise levels in occupied areas and compliance with noise emission regulations
  - An expected standard of amenity compliant with all applicable codes, regulatory requirements, client brief and/or other standards

2.2 Noise measurement equipment

The following instrumentation was used for noise measurements and analysis:

- NTi XL2 Integrating Sound Level Meter (S/N: A2A-14848-E0)
- NTi type 1 microphone – comprising of:
  - NTi MA220 preamplifier (S/N: 7632)
  - NTi MC230A capsule (S/N: A16344)
- Larson Davis Sound Calibrator CAL200 (S/N: 15635)
- Infobyte iM4 Integrating-Averaging Sound Level Meter – noise logger (S/N: 101)

All instrument systems are laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The measurement system was also field calibrated prior to and after noise surveys. Calibration drift was found to be less than 0.3dB during measurements. No adjustments for instrument drift during the measurement period were warranted.

2.3 Attended noise measurements

Attended noise measurements were conducted on the proposed development site on Wednesday 24 October 2018 and Friday 16 November 2018 at locations A1 to A9, to quantify traffic noise levels in the area.

Table 1 presents the noise levels of the attended measurements at the locations shown in Figure 1.

Table 1 Attended noise measurements, dB(A)

Location	Start Time	Location and Comments	L_{Aeq}	L_{A90}
Wednesday 24 October 2018				
A1	3.02pm	**Southwestern boundary** – The character of noise comprised of: > Traffic along adjacent roads	69	64
A2	3.31pm	**Southeastern boundary** – The character of noise comprised of: > Traffic along adjacent roads > Aircraft	64	61
A3	3.50pm	**Southeastern boundary** – The character of noise comprised of: > Traffic	62	58
A4	4.07pm	**Eastern boundary** – The character of noise comprised of: > Traffic	56	50
A5	4.25pm	**Northeastern boundary** – The character of noise comprised of: > Traffic > Nature (birds) > Aircraft	56	52
A6	4.49pm	**Western boundary** (5m from Lane Cove Road) – The character of noise comprised of: > Traffic	75	62
Friday 16 November 2018				
A7	2.51pm	**High level** (on structure) – The character of noise comprised of: > Traffic dominated by tyre noise on M2 > Note that the water feature was off	62	60
A7	3.07pm	**Mid height level** (below structure in the open in front of bamboo terrace) – The character of noise comprised of: > Traffic dominated by tyre noise on M2 > Note that the water feature was off	59	55
A8	3.23pm	**8m east of reflection pool** – The character of noise comprised of: > Traffic dominated by tyre noise on M2 > Nature noises (birds and crickets)	59	54
A9	3.37pm	**Southern edge of property** – The character of noise comprised of: > Traffic	63	60

2.4 Unattended noise measurements

Unattended noise measurements were conducted at Location L1 (shown in Figure 1) on the southwestern boundary of the development between Thursday 8 November 2018 and Friday 16 November 2018.

The long-term logger was chosen to collect background noise in the area to set noise emission criteria for the development. These criteria have been presented in Section 3.5 of this report.

Background and equivalent continuous sound levels at location L1 are summarised in Table 2.

Table 2 Unattended noise measurements at location L1, dB(A)

Noise Measurement	**Daytime** (07:00-18:00)	**Evening** (18:00-22:00)	**Night-time** (22:00-07:00)
Repeatable – L_{Aeq}	71	69	68
Rating Background Level (RBL) – L_{A90}	61	59	47

3. Noise emission criteria

Noise emission restrictions apply to future tenant activity and mechanical plant and equipment systems. These must be planned, designed and installed to include suitable sound attenuation, vibration isolation, and other necessary acoustic treatments.

The NPfI requires that trigger levels be calculated from the intrusiveness and amenity criteria. The NPfI also includes the application of modifying factors for undesirable noise characteristics, up to a maximum of 10dB.

3.1 Noise intrusiveness

The NPfI states that the intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5dB.

Table 4 schedules the noise intrusion level criteria in accordance with the NPfI, calculated with the background noise levels presented in Section 2.3 and Section 2.4.

3.2 Noise amenity

The NPfI describes methodology to limit the increases in noise levels from the introduction of new noise sources in an area. The NPfI recommends that the maximum ambient noise should not exceed the levels in Table 2.2 of the NPfI.

Table 4 summarises the project amenity noise levels (as described in Table 2.2 of the NPfI).

3.2.1 High traffic noise emission criteria

The NPfI states that in areas with high transportation noise, the noise may be high enough to make noise sources from industrial sources to effectively inaudible. In such cases the project amenity noise level may be derived from the $L_{Aeq,\ period(traffic)}$ minus 15dB(A).

The high traffic project amenity noise level should be applied if all the following apply:

- *Traffic noise is identified as the dominant noise source at the site*
- *The existing traffic noise level is 10dB or more above the recommended amenity noise level for the area*
- *It is highly unlikely traffic noise will decrease in the future*

As the existing traffic noise levels on the M2 and Lane Cove Road are more than 10dB above the recommended amenity noise levels (Day: 60dB(A), Evening: 50dB(A) and Night: 45dB(A)) for the area, and traffic noise is the dominant noise source in the area, the high traffic noise emission criteria shall be applied to nearest sensitive residential receivers on the northwestern side of the proposed development for the evening and night time periods only.

The current annual average daily traffic volume in accordance with the NSW Government's Roads and Maritime Services website is more than 40,000 vehicles, with allowances being made for a future increase in traffic volumes.

3.3 Modifying factors

For noise emissions from the proposed development with undesirable characteristics such as; tonality, low frequency, impulsiveness and intermittency, adjustments (as per Fact Sheet C of the NPfI and in Appendix B) need to be included. These modifying factors include a 5dB penalty for each undesirable characteristic. A maximum penalty of 10dB for 2 or more undesirable characteristics is to be applied.

It should be noted that during the detailed design / construction phase of the project, if the design team / contractor makes selections of equipment which include one or more of these undesirable noise characteristics, a modifying factor will be applied.

3.4 Transient noise events – Sleep disturbance

Night-time noises, which occur infrequently and for short durations of time, have the potential to cause sleep disturbances. Such noise sources may include operation of loading docks, refuse collection and other activities.

Table 3 presents recommended sleep disturbance criteria based on the NPfI and the measured background noise levels presented in Section 2.3 and 2.4. Noise emission from such short duration noise events should be controlled to meet these criteria to reduce the risk of sleep disturbance to residences at night.

Table 3 Noise emission criteria – Transient noise events

Activity	**Noise descriptor**	**Internal noise criterion L_{Amax}, dB(A)**
Operation of loading dock, refuse collection, etc.	$L_{Aeq,\ 15min}$	52
	L_{AFmax}	62

3.5 Noise emission criteria summary (NPfI)

The project specific trigger levels have been derived using the methodology presented in the NPfI and are scheduled in Table 4 and Table 5. We note that these trigger levels have been derived from the background noise levels measured at Location L1.

Table 4 Noise emission criteria summary

Time of operation	**Site specific noise limits**				
	Intrusive, $L_{Aeq,15min}$	**Recommended amenity, $L_{Aeq,\ Period}$**	**Project amenity, $L_{Aeq,\ Period}$**	**Project amenity, $L_{Aeq,\ 15min}$**	**Project trigger levels, $L_{Aeq,\ 15min}$**
Day (7am to 6pm)	66	60	55	58	**58**
Evening (6pm to 10pm)	64	54	49	52	**52**
Night (10pm to 7am)	52	53	48	51	**51**

Table 5 Noise emission criteria – other

Receiver	Time of operation	Site specific noise limits			
		Recommended amenity, $L_{Aeq, Period}$	**Project amenity, $L_{Aeq, Period}$**	**Project amenity, $L_{Aeq, 15min}$**	**Project trigger levels, $L_{Aeq, 15min}$**
Commercial	When in use	65	60	63	**63**
Active recreation area (e.g. sports field)	Day	56	51	54	**54**
	Evening and night	55	50	53	**53**
Passive recreational areas (e.g. national park)	Day	56	51	54	**54**
	Evening and night	54	49	52	**52**

It should be noted that the cumulative noise emission from the operations of the proposed development are to meet the project trigger levels presented in Table 4 and Table 5. Careful planning and coordination with the project design team should be undertaken so that these criteria are complied with.

3.6 Liquor & Gaming NSW

Noise emission restrictions apply to future entertainment music noise. Live and pre-recorded music must be planned, designed and installed to include suitable sound attenuation and other necessary acoustic treatments. This report provides an approach that needs to be incorporated in the proposed development to meet the noise emission requirements of Liquor & Gaming NSW.

The below criteria are applicable at the nearest sensitive receivers (multi-residential development to the northwest).

The operating period times relevant to the day/evening period are dependent on the number of events / operations proposed per week. The Liquor Licence states the following:

> *The L_{A10} noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5Hz - 8kHz inclusive) by more than 5dB between 07:00 am and 12:00 midnight at the boundary of any affected residence.*

We measured the noise levels over 8 consecutive nights between Thursday 8 November 2018 and Friday 16 November 2018 and found that, during the quietest period of the night was between 10pm and 11pm. Table 6 schedules the adjusted noise levels for the typical quietest night-time period when the entertainment areas are operational.

Table 6 Liquor & Gaming NSW night period noise limits

Descriptor	Frequency (Hz) – dB									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dB(A)**
Base noise level, L_{90} (dB)	62	63	57	53	52	52	48	40	33	**56**
Noise limit, L_{10} (dB)	67	68	62	58	57	57	53	45	38	**61**

4. Internal noise and vibration requirements

4.1 AS/NZS 2107:2016

Indoor background noise levels in terms of Sound Pressure Level (SPL) and reverberation times (seconds) deemed acceptable to the majority of reasonable occupants are published in AS/NZS 2107. We have summarised the recommended indoor noise levels and reverberation times for the proposed development in Table 7.

These limits apply to continuous or sources of noise internal to the proposed development and include plant equipment, lifts, traffic, etc.

Furthermore, the façade should be designed so that the noise levels presented in Table 7 are complied with.

Table 7 Internal design sound pressure levels and reverberation time recommendations

Type of occupancy	Design SPL, L_{Aeq}, dB(A)	Reverberation Time, seconds
Offices	40 to 45	0.4 to 0.6
Retail	< 55	Minimise
Function rooms / restaurants / F&B	40 to 50	Minimise (ADP recommends <1.0 second)
Lobbies and foyers	45 to 50	< 1.0
Toilets and end of trip facilities	45 to 55	–
Kitchen, laundry and maintenance areas	< 55	–
Enclosed car parks and loading bay	< 65	–

4.2 Fire mode noise conditions

Some building systems only operate in fire mode and during periodic testing, so they do not add to background noise under typical conditions. According to AS/NZS 1668.1:2015, these systems are subject to noise limits, presented in Table 8, relating not to occupant comfort but rather to occupant distress and the intelligibility of emergency commands. Here, the 65 dB(A) limit supports the audibility of fire alarms (min. 75 dB(A) at bedheads per AS 1670.1).

Table 8 Fire mode maximum sound pressure levels

Area type	Maximum SPL, L_{Aeq}, dB(A)
Occupied Area	65
Fire-isolated exit (e.g. fire stair)	80

4.3 Internal vibration requirements

Vibration is the oscillation of an object, structure, or surface at frequencies typically below 20 Hz, which is inaudible but instead can be "felt". **Structure-borne sound** means oscillation at frequencies higher than 20Hz, resulting in audible noise, which is transmitted through rigid building elements and radiated by surfaces.

Human response to building vibration is a complex phenomenon. There is great variability in the vibration tolerance of humans, and as a result, human comfort criteria cannot robustly be defined and quantified. Acceptable values of human exposure to vibration depend on human activity and the character of the vibration, and they are further influenced by individual attitudes, expectations, and perceptibility.

Limits for vibration of the building structure potentially affecting human comfort have been derived from AS 2670.2 and BS 6472, both of which are referenced and discussed practically in the AVTG. These standards propose maximum vibration levels in terms of baseline curves and multiplication factors. For the purpose of minimising the disturbing perceptibility of vibration within the occupied areas of this development, Table 9 specifies appropriate limits for floor vibration in a simplified form.

Table 9 Vibration limits

Type of occupancy	**Time**	**Continuous vibration limits:** **r.m.s. acceleration (m/s^2)** **Preferred / maximum**	**Impulsive vibration limits:** **r.m.s. acceleration (m/s^2)** **Preferred / maximum**	**Intermittent vibration limits:** **Vibration Dose Value VDV ($m/s^{1.75}$)** **Preferred / maximum**
Offices, retail, circulation / other occupied ventilated space	Day or night	0.020 / 0.040	0.640 / 1.280	0.40 / 0.80
Residences	Day	0.010 / 0.020	0.300 / 0.600	0.20 / 0.40
	Night	0.007 / 0.014	0.100 / 0.200	0.13 / 0.26

4.4 Internal design noise and vibration criteria summary

Table 10 summarises the indoor noise and vibration criteria for the proposed development in accordance with the Australian Standards.

Table 10 Internal design noise summary

Assessment Type	Neighbourhood Retail	Function rooms, restaurants, F & B	General office areas	Corridors, voids and lobbies	Toilets	Carparks
Internal noise levels						
Traffic noise intrusion – L_{Aeq} dB(A)	52	47	42	47	–	–
Mechanical services – L_{Aeq} dB(A)	52	47	42	47	55	< 65
Lift plant – L_{Aeq} dB(A)	50 + free of tonal components	45 + free of tonal components	40 + free of tonal components	50 (passby) 60 (operation)	–	–
Emergency plant – L_{Aeq} dB(A)	65	65	65	65	65	80
Internal Reverberation Time (RT_{60})						
Decay time – seconds	< 1.0	< 1.0	0.4 to 0.6	< 1.0	–	–
Internal Acoustics						
Concrete slabs	200mm slab with treated floor such as carpet or acoustic underlay if required, R_w 50				–	Avoid polished floors
Fit-out capability, between floors and between offices and meeting rooms at façade (transoms and mullions) – **R_w 50**					–	–
Walls	Between tenancies– **R_w 45**				R_w 45	–
Ceiling reflection treatment	Maximise	Maximise	Absorptive treated ceilings, NRC 0.6 minimum CAC 40 dB or equivalent		–	–
Building Floor Vibration						
Human comfort – Figure 5a Curve (AS2670.2:1990)	4	4	2	4	–	–

5. Noise assessment and recommendations

5.1 Noise intrusion – Glazing

The site is impacted by road traffic along the M2 and Lane Cove Road. This is the main source of external noise that will affect the façade of the proposed site. External noise measurements scheduled in Section 2.3 and 2.4 have been used to determine the façade glazing treatment presented in this section.

Indicative glazing requirements are presented in, with a mark-up of façade treatment locations provided in Table 11.

Table 11 Minimum glazing performance requirements

Location	Indicative glazing construction	Minimum glazing octave band insertion loss – dB, Hz								
		63	125	250	500	1k	2k	4k	8k	R_w
Office tower	6mm monolithic / 12mm air space / 12mm monolithic	22	26	25	32	36	34	37	40	**34**
All other locations	10mm monolithic	22	27	31	35	32	33	44	44	**34**

We understand that these glazing recommendations will be refined at a later stage and the following considerations will need to be accounted for. These include:

- Selection of glazing supplier (framing systems and ultimately acoustic performance of the glazing system as a whole)
- If required, reassess noise intrusion based on glazing sizes and any changes made
- Structural requirements
- Thermal requirements

5.2 Mechanical plant and equipment

At time of writing, the design has not progressed sufficiently to be able to complete a mechanical plant and equipment noise emission assessment. It is anticipated that provision has been included in the current scheme to incorporate standard acoustic treatment, such as silencers, barriers, acoustically lined ductwork, acoustic louvres, etc. to meet the noise emission requirements of Section 3.5.

Generally, the following allowances should be made for in the design:

- Support points for major plant items should be structurally rigid. Mid span areas of floor slab should be avoided where practical. Ideally columns, thick structural slabs or very stiff beams should be provided in such cases
- 200mm concrete slabs and precast/in-situ concrete walls surrounding plant rooms

- Vibration isolators for equipment rotating plant and machinery located in plant rooms with >90% isolation efficiency
- Plant complete with associated motor and drive assemblies should be mounted on rigid integral steel chassis or concrete inertia blocks
- All penetrations to plant rooms should be properly dimensioned, packed and sealed
- Main services ducts and pipes to have their own individual penetrations, with suitable spacing to allow good sealing
- Allowance for acoustic attenuation treatments e.g. internal lining to air inlets and discharges to meet external noise emission criteria
- For major equipment such as chillers and cooling towers, allow for local stiffening of the plant room floor
- Speed controllers, if used, should be of good quality and compatible with the motor model. Poor quality controllers can result in significant increase in motor noise, as much as 10dB(A), with an offensive characteristic such as high frequency tone
- Selection of low noise fans, allowance for smooth airflow conditions in ductwork, use of attenuators and lined duct work while minimising regenerated noise at bends, take-offs and transitions
- Selection of plant and acoustic measures such as; silencers and enclosures, that will ensure that noise emission levels presented in Section 3.5 are complied with

5.3 Loading dock

A loading dock is included within the proposed development, located on the northern side of the building with the entrance and exit on Lane Cove Road.

We understand that the loading dock will be used during the day and evening periods only (7am to 10pm).

We have calculated that during the loading and unloading of trucks, the noise level at the closest and most sensitive receivers (to the northwest) will be 44dB(A). This noise level complies with the Day (58dB(A)) and Evening (52dB(A)) criteria presented in Section 3.5 and no further acoustic measures are required.

5.4 Function areas noise emission assessment and recommendations

We understand that the existing Development Consent and Liquor Licence allows for the following times of operation for each of the spaces:

- **Café and Café Terrace**
  - 7 days – 7am to 11pm
- **Training and Function rooms** (including the Theatre Terrace, Topiary Garden, Gallery and Gallery Terrace, Bamboo Terrace, Lily Terrace, NSW Cancer Council Daffodil and Memorial Garden and Rainforest Terrace)**:**
  - 7 days – 12 midday to 11pm

In addition to the above, the following additional areas are proposed:

- **Restaurant (Ground):**
  - Monday to Friday 7am – 11pm
  - Saturday & Sunday 8am – 11pm

- **Food & Beverage (Ground):**
  - Monday to Friday 7am – 6pm
  - Saturday & Sunday 8.30am – 6pm

We understand that for entertainment purposes, and based on past history, DJ's and the occasional live bands will be used.

Table 12 schedules the external noise levels, and receiver calculated noise levels. We note that external noise levels are typical and conservatively high.

Table 12 Music noise levels and calculated noise levels at sensitive receivers

L_{10} (dB) – Sound pressure levels	**Frequency (Hz) – dB**									
	31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dB(A)**
Noise limit, L_{10} (dB) untill 11pm	67	68	62	58	57	57	53	45	38	**61**
External music and patron noise	78	84	89	92	94	91	84	79	73	**95**
Noise levels at residences to the northwest	41	45	50	53	55	52	44	38	26	**56**
Compliance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	**Yes**

Table 12 demonstrates compliance for external noise levels until 11pm. We note that internal noise levels will be similar to that of external noise levels. This would therefore imply that compliance is achieved for both internal and external noise sources.

6. Conclusion

A site investigation of the proposed redevelopment site and surrounds at 307 Lane Cove Road, Lane Cove has been completed to determine existing noise levels for the environment and surrounds for a proposed redevelopment of the site.

Current regulations and standards associated with the development have been reviewed and assessed in accordance with existing site constraints. The construction standards have been provided to satisfy the local council and other relevant standards.

ADP Consulting believe there are no site conditions, statutory or other requirements that would preclude this development from complying with the criteria defined in this report.

The design criteria and acoustic treatment concepts in this report demonstrate the pathways by which these shall be addressed by ADP Consulting and the project team through further analysis, recommendations and coordination as the design progresses.

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Appendix A
Glossary of acoustic terms

Air-borne sound

The sound emitted directly from a source into the surrounding air, such as speech, television or music.

Ambient sound

Of an environment: the all-encompassing sound associated with that environment, being a composite of sounds from many sources, near and far. This is normally taken to be the L_{Aeq} value.

Background noise level

The average of the lowest levels of the noise levels measured in an affected area in the absence of noise from occupants and from unwanted external ambient noise sources. Usually the L_{A90} value represents the background noise level.

dB(A)

Unit of acoustic measurement weighted to approximate the sensitivity of human hearing to sound frequency.

Decibel scale

The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. Therefore, a 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. It is generally accepted that a 10 dB increase in the sound pressure level corresponds to a perceived doubling in loudness.

Examples of decibel levels of common sounds are as follows:

- 0 dB(A) Threshold of human hearing
- 30 dB(A) A quiet country park
- 40 dB(A) Whisper in a library
- 50 dB(A) Open office space
- 70 dB(A) Inside a car on a freeway
- 80 dB(A) Outboard motor
- 90 dB(A) Heavy truck pass-by
- 100 dB(A) Jackhammer / Subway train
- 110 dB(A) Rock Concert
- 115 dB(A) Limit of sound permitted in industry
- 120 dB(A) 747 take off at 250 metres

Frequency

The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high-pitched sound and a low frequency to a low-pitched sound.

L_{90}, L_{10}, etc

A statistical measurement giving the sound pressure level which is exceeded for the given percentile of a measurement period (i.e. L_{90} is the level which is exceeded for 90 percent of a measurement period). L_{90} is commonly referred to as a basis for measuring the background sound level.

$L_{Aeq,T}$

The equivalent continuous A-weighted sound pressure level. The value of the A-weighted sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same A-weighted sound energy as the actual time-varying sound.

L_{Amax}

The maximum sound pressure level measured over the measurement period.

L_{Amin}

The minimum sound pressure level measured over the measurement period.

Day

Referred to as the period between 7am and 6pm for Monday to Saturday and 8am to 6pm for Sundays and Public Holidays.

Evening

Referred to as the period between 6pm and 10pm for Monday to Sunday and Public Holidays.

Night

Referred to as the period between 10pm and 7am for Monday to Saturday and 10pm to 8am for Sundays and Public Holidays.

Assessment background level (ABL)

The overall background noise level on each day, evening and night periods for each day of the noise monitoring.

Rating background level (RBL)

The overall background level on each day, evening and night periods for the entire length of noise monitoring.

Reverberation

The persistence, after emission by the source has stopped, of a sound field in an enclosure.

Sound isolation

A reference to the degree of acoustical separation between two spaces. Sound isolation may refer to sound transmission loss of a partition or to noise reduction from any unwanted noise source. The term 'sound isolation' does not specify any grade or performance quality and requires the units to be specified for any contractual condition.

Sound pressure level, L_p, dB of a sound

A measurement obtained directly obtained using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the R.M.S. sound pressure to the reference sound pressure of 20 micro Pascals.

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Appendix B
Noise Policy for Industry

Fact Sheet C: Corrections for annoying noise characteristics

C1 Introduction

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level. On the other hand, some sources may cause less annoyance where only a single event occurs for a limited duration. This section outlines the correction factors to be applied to the source noise level at the receiver before comparison with the project noise trigger levels specified in Section 2, to account for the additional annoyance caused by these modifying factors.

The modifying factor corrections should be applied having regard to:

> the contribution noise level from the premises when assessed/measured at a receiver location, and

> the nature of the noise source and its characteristics (as set out in this fact sheet).

Table C1 sets out the corrections to be applied. The corrections specified for tonal, intermittent and low-frequency noise are to be added to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. The adjustments for duration are to be applied to the criterion.

Table C1 Modifying factor corrections (see definitions in Section C2)

Factor	Assessment/ measurement	When to apply	Correction[1]	Comments
Tonal noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method (*ISO1996.2-2007 – Annex D*).	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB[2,3]	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. Note: Narrow-band analysis using the reference method in *ISO1996-2:2007,* *Annex C* may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.

Factor	Assessment/ measurement	When to apply	Correction[1]	Comments
Low-frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10– 160 Hz	Measure/assess source contribution C- and A-weighted $L_{eq,T}$ levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and: > where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period > where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2- dB(A) positive adjustment applies for the daytime period	2 or 5 dB[2]	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.	5 dB	Adjustment to be applied for **night- time only**.

Factor	Assessment/ measurement	When to apply	Correction[1]	Comments
Duration	Single-event noise duration may range from 1.5 min to 2.5 h.	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum adjustment	Refer to individual modifying factors.	Where two or more modifying factors are indicated.	Maximum correction of 10 dB(A)[2] (excluding duration correction).	

Notes:

- Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.
- Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.
- Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the *ISO1996-2:2007* standard.

C2 Definitions to support the modifying factor corrections

Tonal noise: noise containing a prominent frequency and characterised by a definite pitch.

Low-frequency noise: noise with an unbalanced spectrum and containing major components within the low-frequency range (10–160 Hz) of the frequency spectrum.

Table C2 One-third octave low-frequency noise thresholds

Hz/dB(Z)	One-third octave $L_{Zeq,15min}$ threshold level												
Frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB(Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

Notes:

- dB(Z) = decibel (Z frequency weighted).
- For the assessment of low-frequency noise, care should be taken to select a wind screen that can protect the microphone from wind-induced noise characteristics at least 10 dB below the threshold values in Table C2 for
- wind speeds up to 5 metres per second. It is likely that high performance larger diameter wind screens (nominally 175 mm) will be required to achieve this performance (Hessler, 2008). In any case, the performance of the wind screen and wind speeds at which data will be excluded needs to be stated.
- Low-frequency noise corrections only apply under the standard and/or noise-enhancing meteorological conditions.

- Where a receiver location has had architectural acoustic treatment applied (including alternative means of mechanical ventilation satisfying the Building Code of Australia) by a proponent, as part of consent requirements or as a private negotiated agreement, alternative external low-frequency noise assessment criteria may be proposed to account for the higher transmission loss of the building façade.
- Measurements should be made between 1.2 and 1.5 metres above ground level unless otherwise approved through a planning instrument (consent/approval) or environment protection licence, and at locations nominated in the development consent or licence.

Intermittent noise: noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB(A); for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.

Correction for duration: this is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the LAeq,15min equivalent noise criterion is shown in Table C3 for the duration of the event. This adjustment is designed to account for unusual and one-off events, and does not apply to regular and/or routine high-noise level events.

Table C3 Adjustment for duration

Allowable duration of noise (one event in any 24-hour period)	**Allowable exceedance of $L_{Aeq,15min}$ equivalent project noise trigger level at receptor for the period of the noise event, dB(A)**	
	Daytime and evening (7am–10pm)	**Night-time (10pm–7am)**
1 to 2.5 hours	2	Nil
15 minutes to 1 hour	5	Nil
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
less than 1.5 minutes	20	10

Note: Where the duration of the noise event is smaller than the duration of the project noise trigger level (that is, less than 15 minutes) the allowable adjusted project noise trigger level becomes:

$$10Log_{10}((10^{\frac{PNTL}{10}} x \left(\frac{900 - duration}{900}\right)) + (10^{\frac{PNTL+allowable\ exceedance\ (Table\ C3)}{10}} x\ duration))$$

Maximum correction: the maximum correction to be applied to the predicted or the measured level where two or more modifying factors are present. The maximum adjustment is 10 dB(A) where the noise contains two or more modifying factors (excluding the duration correction).

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