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WREN STREET, BOWEN HILLS - STAGE 2

MIXED USE DEVELOPMENT

NOISE IMPACT ASSESSMENT

Commissioned by:	Wren Street Health Investments Pty Ltd
Date:	13 November 2024
Project number:	5843
Version:	V.3
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EXECUTIVE SUMMARY

Wren Street Health Investments Pty Ltd are proposing a mixed use development (Stage 2) project on a site located at the south-east corner of Wren and Campbell Streets, Bowen Hills. The site is currently occupied as a building (1/2 land area for stage 1) with 9 Levels of parking, medical/commerical tenancies (Gnd to L4). Stage 2 involves additional medical/commerical tenancy (Gnd to L4), parking, residential tower (L8 to L29) and roof top bar. The site is shown on Figure 1 and described as Lot 24 on SP276528.

Palmer Acoustics (Australia) Pty Ltd has been commissioned to provide a noise impact assessment addressing noise from the Inner-City Bypass (ICB) into the proposed stage 2 of the development and noise from the proposed rooftop bars onto nearby residences. The site is located within the Bowen Hills PDA Development Scheme jurisdiction.

Since the Bowen Hills PDA Development Scheme does not provide noise criteria for noise emission from the proposed development to adjacent noise-sensitive receivers. We propose to adopt the Brisbane City Council (BCC) noise emission criteria for this assessment.

Based on the results presented, we conclude:

- The site lies within the the BCC transport noise corridor of Inner City Bypass (ICB).
- Noise from the nearby concrete batching plant complies with the BCC industrial amenity overlay code with a closed façade and min Rw35 rating.
- The Bowen Hills PDA requires that residential constructions comply with the provisions of QDC MP4.4. An alternative solution was proposed based on AS2107 internal noise levels with AS3671 façade Rw calculations.
- Noise from the rooftop bars will comply with BCC Day and night time limits at the nearest residential building. Amplified music level is allowed on the rooftop bars from 90dB(A) during the day and 84dB(A) at night.
- Several acceptable acoustic treatment/management options can be implemented for the rooftop bar.
- Noise emissions from rooftop patrons' noise will comply with BCC day and night time limits at the nearby residential building.

To ensure compliance with the requirements of the Bowen Hills PDA Development Scheme for the control of noise we recommended

- The external glazing system of the proposed residential tower be a minimum of Rw35 rating for glazing (windows and doors).
- The stage 2 residential units and medical suites external building façade be upgraded. Higher rating must applied to the external façade glazing as stated in Appendix A or minimum Rw35 glazing.
- Amplified music treatment options for the rooftop bars in Section 8.3.
- Mechanical plant noise emissions be controlled to the limits expressed in Table 19.

CONTENTS

1.0 INTRODUCTION

Wren Street Health Investments Pty Ltd are proposing a mixed use development (Stage 2) project on a site located at the south-east corner of Wren and Campbell Streets, Bowen Hills. The site is currently occupied as a building (1/2 land area for stage 1) with 9 Levels of parking, medical/commerical tenancies (Gnd to L4). Stage 2 involves additional medical/commerical tenancy (Gnd to L4), parking, residencetial tower (L8 to L29) and roof top bar. The site is shown on Figure 1 and described as Lot 24 on SP276528.

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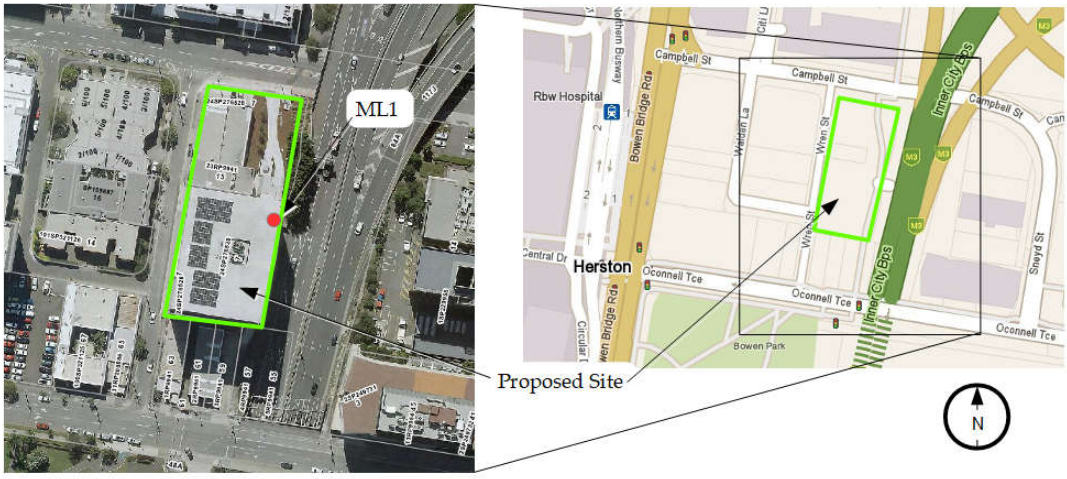

Figure 1: Locality

1.1 Existing site and surroundings

The site is currently occupied by the Stage 1 building. Under the Bowen Hills PDA Development Scheme, the site is subject to transport and entertainment noise. The site is surrounded by commercial/mix-used buildings on three sides of the property boundaries with two levels of residential on the north(across Campbell St) and Inner-City Bypass on the east.

The site is inside the Brisbane City Plan Transport overlay map. Under the PDA scheme in section 2.5.9.3 Development is oriented, designed and constructed to:

1. Reduce exposure to noise impact from designated transport noise corridors. *Refer to Brisbane City Plan Transport Noise overlay map.*
2. Reduce the exposure of residential uses to noise impacts from lawfully operating entertainment venues. *A building is designed and constructed to achieve a minimum reduction in sound pressure level between the exterior of the building and the bedroom or living room, of $L_{Leq,T}$ 20dB at 63Hz where near a*

lawfully operating entertainment venue. Residents living near lawfully operating entertainment venues also need to be aware that noise levels will be relatively higher both inside and outside of residences.

1.2 Proposed Development

The mix-use development consists of medical/ commercial tenancies on the lower floors, parking on levels 5 to 10, and apartments from levels 8 to 29. A communal recreational podium area with pool, indoor gym, outdoor seating is located on levels 11 & 12 and rooftop bars and sky garden. The development is illustrated in Figure 2.

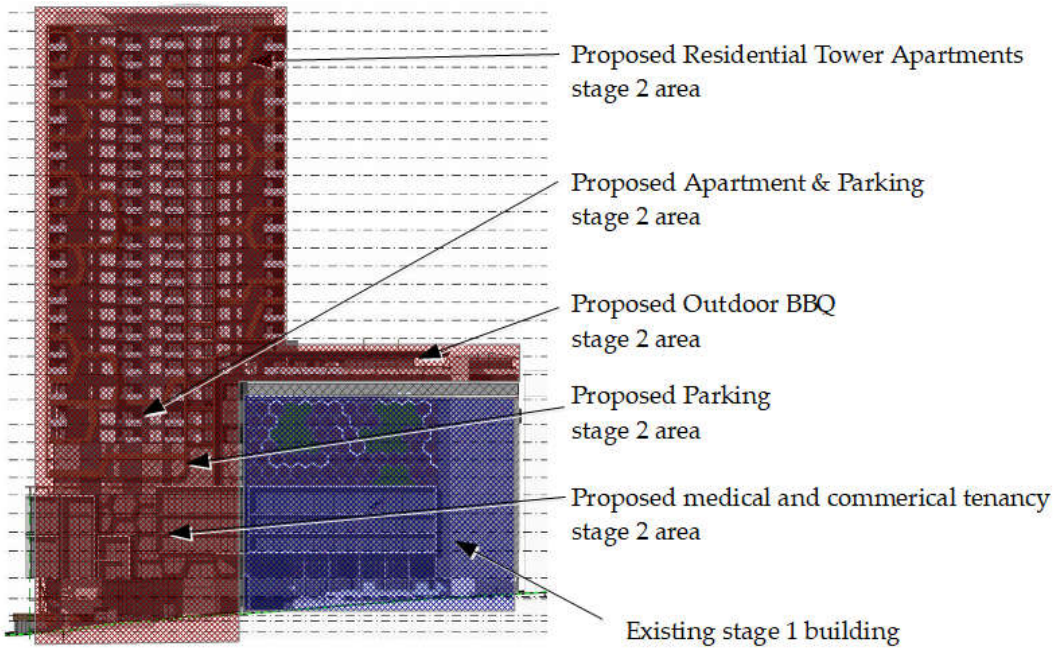

Figure 2: Proposed Stage 2 Development

1.3 Noise Assessment

<u>For residential apartments</u>

This assessment undertakes an environmental assessment, acoustic modelling predicting current and future road traffic noise levels onto the proposed residential facades and common areas using Environmental Noise Modelling and Mapping Software. For this purpose, we use the Predictor-LimA computer software acceptable to both the Department of Infrastructure, Local Government and Planning and SARA.

We propose to establish design internal noise levels as a means of satisfying the performance requirement to *Adequately Protect*. An alternative solution calculation for the façade attenuation performance specification (Rw) of a particular building component (e.g., windows) may be calculated per Australian Standard AS3671 1989 *Road Traffic Noise Intrusion – Building Siting and Construction*.

Within MP4.4 reference is made to the Department of Transport and Main Roads (TMR) policy "Development Affected by Environmental Emissions from Transport Policy Version 4 (October 2017). This policy calls for an internal noise criterion for accommodation activities, all habitable rooms, of ≤ 35 dB(A) $L_{eq\ (1hr)}$ (maximum hour over 24 hours).

Further MP 4.4 references AS2107:2000 *Acoustics-Recommended design sound levels and reverberation times for building interiors.* Based on this standard the internal noise criteria are the maximum recommended design sound levels presented in Table 1 of AS/NZ2107:2000. Relevant parts of AS2107 are extracted as Table 1, below.

Table 1: AS2107 Extract

TABLE 1 RECOMMENDED DESIGN SOUND LEVELS FOR DIFFERENT AREAS OF OCCUPANCY IN BUILDINGS			
Type of occupancy/activity	Recommended design sound level, L_{Aeq}, dB(A)		Recommended reverberation time (T), s
	Satisfactory	Maximum	
7 RESIDENTIAL BUILDINGS Houses and apartments near major roads- - Living areas - Sleeping areas - Work areas - Apartment common areas (e.g. foyer, lift lobby)	 35 30 35 45	 **45** **40** **45** **55**	Note 3 (Reverberation time should be minimised as far as practicable for noise control)

As the site is within the noise overlay of a major road it is appropriate to consider *Houses and apartments near major roads*- The applicable criteria are a limit of 40 dB(A) $L_{Aeq\ (1\ hour)}$ inside bedrooms and 45 dB(A) $L_{Aeq\ (1\ hour)}$ in living and work areas. Kitchens and studies are deemed work areas.

AS2107:2016 is the current edition of the standard. This edition presents a "Design sound level range" rather than the recommended levels of the referenced edition. The maximum of the design range for the categories stated above is the same as presented in Table 1, above.

For Medical, Commercial and Retail

The development is commercial or retail only and therefore, is not subject to the QDC provisions for development in a noise corridor.

The design of sensitive medical suites facing the ICB features a closed façade i.e. fully air-conditioned and external windows closed. Recommended internal noise levels are proposed as per the Association of Australasian Acoustical Consultants (AAAC) – Guideline for Healthcare Facilities. Table 1 of the guideline presents a summary of recommended internal noise criteria. Applicable extracts are presented as Table 2, below.

Table 2: Extract from AAAC Guide Table 1

Usage	Continuous Noise target	Transient noise target
Facility areas		
Consulting, examination, interview, counselling/bereavement	$L_{Aeq,T}$ 45 dB	L_{Amaxs} 55 dB
Speech and Language therapy	$L_{Aeq,T}$ 40 dB	L_{Amaxs} 50 dB
Dental Clinics	$L_{Aeq,T}$ 45 dB	-
Kitchens, sterilisation and service areas	$L_{Aeq,T}$ 50 dB	-
Public areas		
Corridors and Lobby spaces	$L_{Aeq,T}$ 50 dB	
Family and parent lounges	$L_{Aeq,T}$ 45 dB	
Waiting rooms and reception areas	$L_{Aeq,T}$ 45 dB	L_{Amaxs} 65 dB
Staff areas		
Open plan offices	$L_{Aeq,T}$ 45 dB	-
Private Offices	$L_{Aeq,T}$ 40 dB	-
Utility rooms	$L_{Aeq,T}$ 50 dB	-

The noise levels presented above are intended to represent the summation of external noise intrusion into sensitive spaces and therefore include noise intrusion from mechanical plant and vehicle movements both on and off site.

1.4 Department of State Development and Infrastructure Information Request

The Minister for the Economic Development Queensland (MEDQ) has requested further information on the development as below.

25. Noise Quality

- *The Acoustic Report prepared by Palmer Acoustics has been reviewed by Council. The report is generally consistent with the Noise impact assessment PSP and the relevant use codes of the Brisbane City Plan 2014, however the following acoustic matters require further clarification:*

  a. *The report has not addressed industrial noise emissions into the sensitive uses as per PO3 of the Industrial amenity overlay code. This is required as the site is approximately 270m from a concrete batching plant which is defined as a "High impact industry" use.*

  b. *The report is required to ensure appropriate building materials are used to mitigate impacts from noise on residents. This can be achieved by demonstrating compliance with PO21 of the Multiple dwelling code.*

Response to information request

2.0 BRISBANE CITY PLAN NOISE LIMITS

2.1 Industrial Amenity Overlay Code

The development (sensitive use) within the industrial amenity area is compatible with nearby existing industrial use (Concrete Batching plant) that have a potential for off-site noise emissions. The industrial amenity overlay code, Performance Outcome PO3, extracted in Table 3, below

Table 3: Extract from Table 8.2.13.3.A—Performance outcomes and acceptable outcomes

Performance outcomes	Acceptable outcomes
PO3 Development is located, designed and constructed to achieve the noise (planning) criteria in Table 8.2.13.3.E to protect the development from adverse noise impacts. Note—A noise impact assessment report prepared in accordance with the Noise impact assessment planning scheme policy can assist in demonstrating achievement of this performance outcome.	**AO3** Development for a sensitive use is located no closer than: a. 150m to a medium impact industry A or sewage treatment plant; b. 250m to a medium impact industry B, waste transfer station or landfill; c. 500m to a high impact industry or special industry.

Table 4: 8.2.13.3.E Noise (planning) Criteria

Location where the Criteria applies inside a sensitive use	**Adjusted equivalent continuous sound pressure level (LAeq,adj,T) to be achieved during day, evening and night time periods**			**Maximum sound pressure level (LAmax) to be achieved during the night time period**
	Day LAeq,adj,11hr	**Evening** LAeq,adj,4hr	**Night** LAeq,adj,9hr	**Night** 10pm-7am
Sleeping areas	35dB(A)	35dB(A)	30dB(A)	45dB(A)
Other habitable rooms	35dB(A)	35dB(A)	35dB(A)	-
Low frequency noise criteria for specified sources				
Noise intrusion into habitable rooms	60dB(C)	60dB(C)	Sleep areas: 55dB(C) Other habitable rooms: 60dB(C)	N/A

2.2 Multiple Dwelling Code

The acoustic performance requirement for the façades of multiple dwelling constructions in a mixed use zone are presented in the Performance Outcome PO21, extracted in Table 5, below.

Table 5: Extract from Table 9.3.14.3.A—Criteria for assessable development

Performance outcomes	Acceptable outcomes
PO21 Development in a zone in the centre zones category or the Mixed use zone must: (a) be located, designed and constructed to protect bedrooms and other habitable rooms from exposure to noise arising from non-residential activities outside the building; (b) be designed and constructed to achieve a minimum reduction in sound pressure level between the exterior of the building and the bedrooms or indoor primary living areas of 30dBA.	**AO21** Development in a zone in the centre zones category or the Mixed use zone has a minimum acoustic performance of: (a) Rw 35 for glazing (windows and doors) where total area of glazing is greater than 1.8m2; (b) Rw 32 for glazing (windows and doors) where total area of glazing is less than or equal to 1.8m2.

The stated intention of the performance outcome is to be applied to all façades of a development irrespective of their orientation in relation to the boundaries of the zone and consequent exposure to mixed use related intrusive noise.

3.0 EQUIPMENT AND PROCEDURES

3.1 Measurement Procedures

Ambient noise levels were measured over a 7-day period commencing Thursday, 7 July 2023. The measurement location is shown in Figure 1. The logger was set to record 15-minute statistics over the logging period. The weather during the logging period was dry with clear and cool nights. The result of the logging is presented graphically in Figure 3, below.

3.2 Instrumentation

The following instruments were used to measure the ambient noise levels:

- BSWA 309 data logger #2 (serial No 560526)
- B & K 4230 Calibrator (serial number 2153030)

The operation of the sound level measuring equipment was field checked before and after the measurements and was found to be within 0.2dB of the reference signal. The equipment used in this assessment has current calibration certificates from a NATA acredited calibration laboratory.

4.0 AMBIENT NOISE LEVELS

The typical average ambient noise levels measured at ML1 are presented in Table 6. ML1 is located on level 9, with an open façade parking. The noise sources present during the survey included:

- Road traffic noise;

Table 6: Measured Ambient Noise Levels ML1

Time	Measured Noise Levels[1] dB(A)[2]					
	L_{Amax}[3]	L_{A01}[4]	L_{A10}[5]	L_{A90}[6]	L_{Aeq}[7]	RBL[8]
Day: 7 am to 6 pm	82	78	75	72	74	72
Evening: 6 pm to 10 pm	80	76	73	68	72	68
Night: 10 pm to 7 am	76	73	70	59	68	58

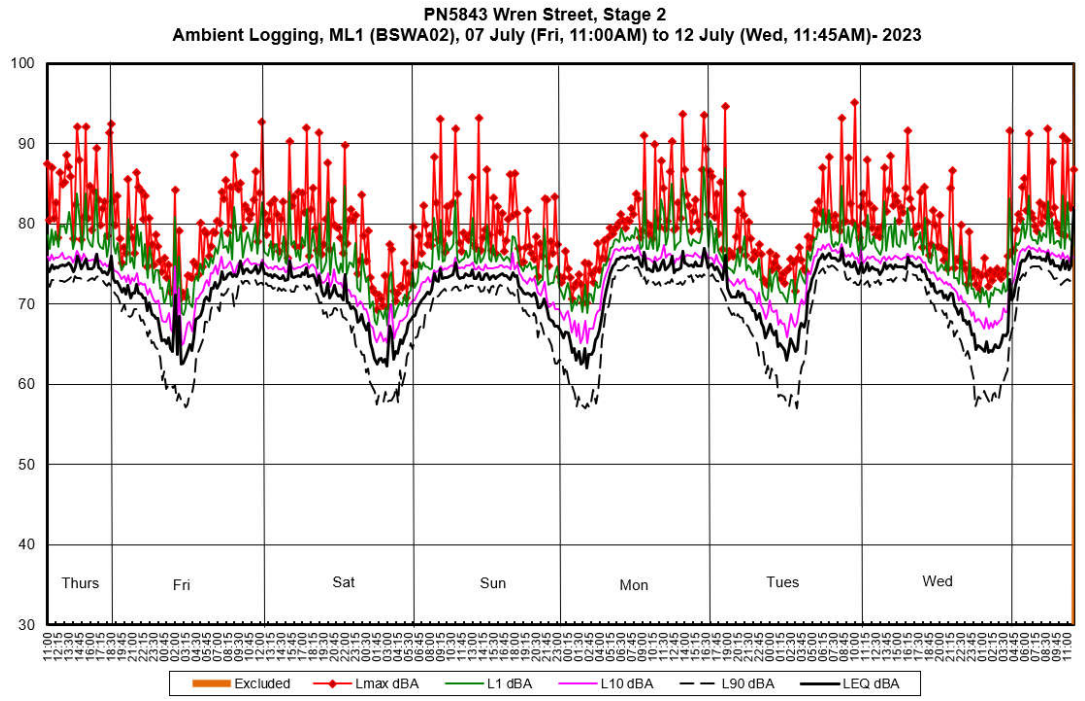

Figure 3: Ambient noise logging record -15 minutes data

[1] *Average noise levels throughout the period, with the exception of L_{A90} which is the average below the median noise levels for the period.*
[2] *dB(A) decibels, A-weighted*
[3] *L_{Amax} refers to the maximum a-weighted sound pressure level occurring during the sampling period*
[4] L_{A01} *for a specified time interval, means the A-weighted sound pressure level that is equalled for 1% of the interval*
[5] L_{A10} *for a specified time interval, means the A-weighted sound pressure level that is equalled or exceeded for 10% of the interval*
[6] *L_{A90} refers to the noise level exceeded 90% of the time period, commonly referred to as the background noise level*
[7] L_{Aeq} *for a specified time interval, means the time average A-weighted sound pressure level, within the meaning given by AS1055.1 for the interval*
[8] RBL refers to the Rating Background Level as defined in BCC Planning Scheme

5.0 NOISE INTRUSION FROM THE ICB

5.1 Measured Noise Levels

Table 7: Measured road traffic noise levels at ML1

Road Traffic Noise Descriptor	Measured value	Offset from $L_{A10\ (18\ Hour)}$
$L_{A10\ (18\ hour)}$[9]	74.3	-
$L_{Aeq\ (day)}$[10]	75.9	1.7
$L_{Aeq\ (night)}$[11]	73.7	-0.6

5.2 Existing and Future Traffic Volumes

The existing and future traffic flows for the ICB were taken from previous reporting of the site, ex Veitch Lister Consulting. Predicted traffic flows are based upon a ten-year projection and incorporate growth calculated from the provided data. Existing and predicted traffic volumes are set out in Tables **8** & 9.

Table 8: Existing and future traffic flows

Road	AADT[12]			Commercial Vehicles %	Speed
	2014	2026	2033		
To Lutwyche Road	16,961	22,529	26,587	21.5	60-70km/h
To ICB (northbound)	28,407	29,231	29,723	12.6	60-70km/h
From ICB (southbound)	26,892	27,014	27,085	14.2	70-60km/h
From Lutwyche Road	20,286	30,349	38,388	19.4	70-60km/h

5.3 Verification of Traffic Noise Model

The Predictor 3D traffic noise computer model has been used to predict the road traffic noise levels at the proposed site. This program uses the algorithms from the *Calculation of Road Traffic Noise* UK Department of Transport (1992) traffic noise prediction model. To determine the validity of the model, the measured noise levels have been compared to the predicted noise levels for the existing scenario. All surrounding buildings have been included in the modelling of the site.

[9] $L_{A10\ (18\ hour)}$ *for a specified time interval, means the arithmetic average of 18 individual* $L_{A10(1hour)}$ *levels measured between 6:00 am and midnight on the day*

[10] $L_{Aeq\ (day)}$ *for a specified time interval, means the maximum time average A-weighted sound pressure level, within the meaning given by AS1055.1, for the interval 6:00 am to 10:00 pm*

[11] $L_{Aeq\ (night)}$ *for a specified time interval, means the maximum time average A-weighted sound pressure level, within the meaning given by AS1055.1, for the interval 10:00 pm to 6:00 am*

[12] *Annual average daily traffic volume*

Table 9: Inputs into the road traffic noise prediction model for the existing scenario 2023

Parameter	Lutwyche Rd		ICB	
	To	From	To	From
18 hour road traffic volume (vehicles)	20,985	29,023	26,983	27,441
Traffic composition (%CV)	21.5%	19.4%	12.6%	14.2%
Traffic speed (km/h)	70to 60 limit – assessed as 65 kph for max. hour			
Road gradient	Included in acoustic model			
Free field/façade corrected	façade			
Receiver height (m)	42.7m (Level 9 parking)			
Road surface	Impervious (no correction)			
Distance from road to receiver	22m to centre line			

The road traffic noise prediction model generated an existing traffic noise level of 75.2dB (façade reflected). The measured noise level was 74.3 dB (façade reflected). The prediction error is within the allowable tolerance of ± 2 dB.

5.4 Assessed Road Traffic Noise Intrusion Levels

Road traffic noise levels have been predicted for the 2033 scenario based on the traffic volumes presented in Table **8** and the parameters in Table 9. Traffic speed was assessed as 65 kph during the peak hour. Noise level predictions are presented in Table 10. The modelling points were located on the Receiver heights are 1.5m above the FFL.

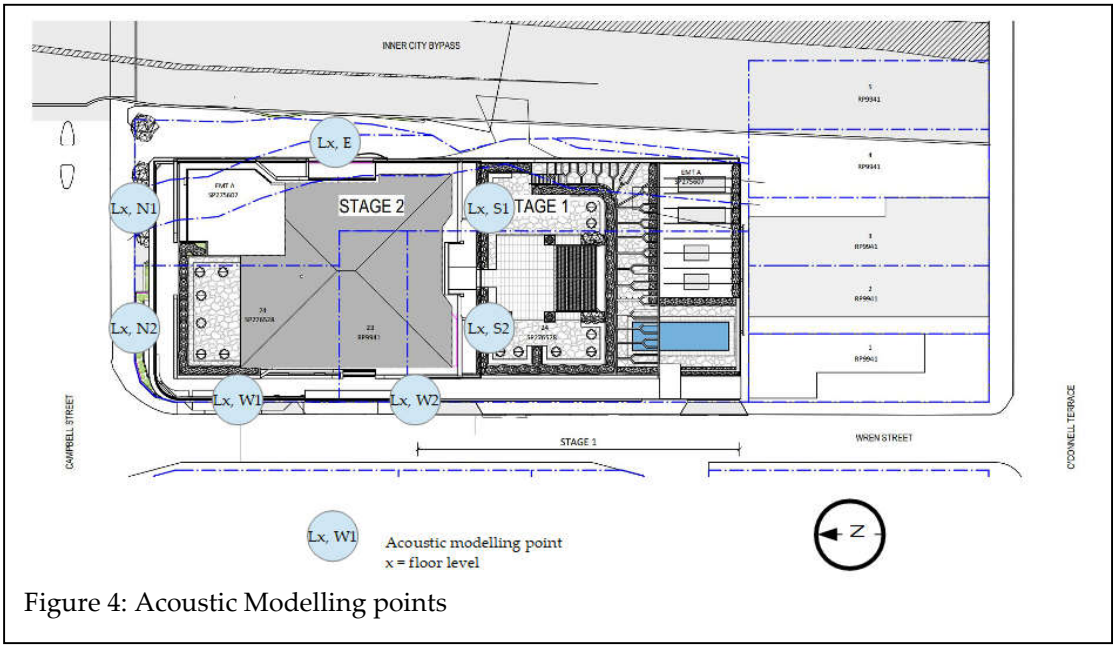

Figure 4: Acoustic Modelling points

The predicted future traffic noise impact levels are presented in Table 10.

Table 10: Predicted future traffic noise levels

Location (Ref Figure 4)	Receptor height (m)	Predicted Noise Levels dB(A)		
		$L_{A10\ (18\ hour)}$	$L_{Aeq\ (day)}$	$L_{Aeq\ (night)}$
L8 N	34.07	72	73	71
L9 N	37.17	72	73	71
L10 N	41.67	72	73	71
L8 W1	33.57	45	47	45
L9 W1	36.67	45	47	44
L10 W1	41.17	45	46	44
L8 W2	31.61	45	47	45
L9 W2	34.71	45	47	44
L10 W2	39.21	45	46	44
L11 E	42.71	77	78	76
L15 E	55.51	75	77	75
L20 E	71.51	74	76	74
L25 E	87.51	73	74	72
L30 E	103.51	72	73	71
L30 N1	105.6	69	71	69
L25 N1	89.6	70	72	70
L20 N1	73.6	71	73	71
L15 N1	57.6	73	74	72
L11 N1	44.8	74	75	73
L30 N2	106.69	68	70	68
L25 N2	90.69	69	71	69
L20 N2	74.69	70	72	70
L15 N2	58.69	71	73	71
L11 N2	45.89	72	73	71
L30 S1	102.82	68	70	68
L25 S1	86.82	69	71	69
L20 S1	70.82	70	71	69
L15 S1	54.82	65	67	65
L11 S1	42.02	-	-	-
L30 S2	102.87	63	65	63
L25 S2	86.87	61	62	60
L20 S2	70.87	54	56	54
L15 S2	54.87	49	51	48
L11 S2	42.07	-	-	-
L30 W1	106.58	46	48	46
L25 W1	90.58	42	44	41
L20 W1	74.58	43	44	42
L15 W1	58.58	44	45	43
L11 W1	45.78	44	46	44
L30 W2	103.76	43	45	42
L25 W2	87.76	42	44	41
L20 W2	71.76	43	44	42

Location (Ref Figure 4)	Receptor height (m)	Predicted Noise Levels dB(A)		
		$L_{A10\ (18\ hour)}$	$L_{Aeq\ (day)}$	$L_{Aeq\ (night)}$
L15 W2	55.76	44	45	43
L11 W2	42.96	45	46	44
LG E	-0.75	-	-	-
L1 E	6.88	80	82	80
L2 E	11.68	80	82	80
L3 E	14.98	80	82	79
L4 E	18.28	80	81	79
LG N1	20.46	76	77	75
L1 N1	17.16	76	77	75
L2 N1	13.86	76	78	75
L3 N1	9.06	76	78	75
L4 N1	1.43	65	66	64
LG N2	21.43	73	75	72
L1 N2	18.13	73	75	73
L2 N2	14.83	73	75	73
L3 N2	10.03	73	74	72
L4 N2	2.4	67	69	67
LG W1	21.13	47	49	47
L1 W1	17.83	46	47	45
L2 W1	14.53	46	47	45
L3 W1	9.73	46	47	45
L4 W1	2.1	45	47	45
LG W2	19.18	45	47	45
L1 W2	15.88	46	47	45
L2 W2	12.58	46	47	45
L3 W2	7.78	46	47	45
L4 W2	0.15	45	47	45
L11 Outdoor	55.00	57	-	-

The centre of the communal space (L11) achieved noise impact levels of 57 dB(A) $L_{A10\ (18\ hour)}$. This level is below the SARA outdoor noise limit of 60dB(A) $L_{A10\ (18\ hour)}$. Therefore no further treatment will be required to levels 11 & 12 communal outdoor space.

The proposed minimum acoustic treatment for living and bedroom windows and doors is 10.38mm laminated glazing in a commercial frame with acoustic seals. This construction will achieve the requirement stated in the Bowen Hills PDA Development Scheme (minimum reduction of 20dB at 63Hz).

5.5 Façade attenuation requirements

To determine the extent of the Attenuation required to comply with the internal noise criteria, the Rw value for a particular building component (e.g. windows) may be calculated in

accordance with Australian Standard AS3671 1989 *Road Traffic Noise Intrusion – Building Siting and Construction*. The calculations for the glazing required to meet this performance are presented in Figure 5, below. The calculations are presented as for a base build, i.e. traffic noise into the full tenancy.

Once tenancy fit-out plans are available we recommend that the required glazing performance be recalculated based on the proposed room uses, e.g. private office, and glazing sizes. The complete list of the Façade Calculation is presented in Appendix A.

Room/Apt No.	Room type	Element	Impact dB(A)	Criteria	Element Area (m2)	Floor Area (m2)	Height (m)	RT60 (s)	C	Rw
Eastern facade										
Lower Ground	Tenency	Glazing (14000 x 2600)	75	45	36.40	82.6	2.7	0.7	1	34
Ground	Tenency - Medical	Glazing (20000 x 2600)	75	45	52.00	240.0	2.7	0.7	1	31
Mezzanine	Tenency - Medical	Glazing (15000 x 2600)	75	45	39.00	225.0	2.7	0.7	1	30
Level 1	Tenency - Medical	Glazing (33000 x 2600)	82	45	85.80	1056.0	2.7	0.7	2	37
Level 2-3	Tenency - Medical	Glazing (32000 x 2600)	77	45	83.20	1056.0	2.7	0.7	2	32
Level 4	Tenency - Medical	Glazing (32000 x 2600)	81	45	85.80	1056.0	2.7	0.7	2	36
Level 1-4	Private Office facing ICB	Glazing(33000 x 2600)	81	40	7.80	12.0	2.7	0.5	1	46
Northern facade										
Lower Ground	Tenency	Glazing (14000 x 2600)	74	45	36.40	82.6	2.7	0.7	1	34
Ground	Tenency - Medical	Glazing (20000 x 2600)	74	45	52.00	240.0	2.7	0.7	1	31
Mezzanine	Tenency - Medical	Glazing (15000 x 2600)	74	45	39.00	225.0	2.7	0.7	1	30
Level 1	Tenency - Medical	Glazing (33000 x 2600)	78	45	85.80	1056.0	2.7	0.7	2	33
Level 2-3	Tenency - Medical	Glazing (32000 x 2600)	78	45	83.20	1056.0	2.7	0.7	2	32
Level 4	Tenency - Medical	Glazing (32000 x 2600)	77	45	85.80	1056.0	2.7	0.7	2	32
Level 1-4	Private Office facing ICB	Glazing(33000 x 2600)	77	40	7.80	12.0	2.7	0.5	1	42
Room/Apt No.	**Room type**	**Element**	**Impact dB(A)**	**Criteria**	**Element Area (m2)**	**Floor Area (m2)**	**Height (m)**	**RT60 (s)**	**C**	**Rw**
1101	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	73	45	5.04	29.6	2.7	0.7	1	29
	Bedroom1	Sliding Door (2100 x 2100)	69	40	4.41	11.5	2.7	0.5	1	32
	Bedroom2	Window (2800 x 2100)	44	40	5.88	10.9	2.7	0.5	1	8
1102	Lounge	Sliding Door (2000 x 2100)	46	45	4.20	22.4	2.7	0.7	1	2
	Bedroom	Window (1400 x 2000)	44	40	2.80	22.4	2.7	0.5	1	1
1103	Lounge, Dining & Kitchen	Sliding Door (4600 x 2100)	46	45	9.66	24.8	2.7	0.7	1	5
	Bedroom 1	Window (1500 x 2100)	44	40	3.15	12.0	2.7	0.5	1	4
	Bedroom 2	Window (2300 x 2100)	44	40	4.83	9.6	2.7	0.5	1	7
1104	Lounge, Dining & Kitchen	Sliding Door (5700 x 2100)	46	45	11.97	32.2	2.7	0.7	1	5
	Bedroom 1	Window (2300 x 2100)	44	40	4.83	11.6	2.7	0.5	1	7
	Bedroom 2	Window (2200 x 2100)	44	40	4.62	12.5	2.7	0.5	1	6
1105	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	46	45	4.83	31.5	2.7	0.7	1	1
	Bedroom 1	Window (2000 x 2100)	44	40	4.20	9.9	2.7	0.5	1	7
	Bedroom 2	Window (1100 x 2100)	44	40	2.31	10.2	2.7	0.5	1	4
1106, 1108	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	78	45	4.83	31.5	2.7	0.7	1	33
	Bedroom 1	Window (2000 x 2100)	76	40	4.20	9.9	2.7	0.5	1	39
	Bedroom 2	Window (1100 x 2100)	76	40	2.31	10.2	2.7	0.5	1	36
1107	Lounge, Dining & Kitchen	Sliding Door (5700 x 2100)	78	45	11.97	32.2	2.7	0.7	1	37
	Bedroom 1	Window (2300 x 2100)	76	40	4.83	11.6	2.7	0.5	1	39
	Bedroom 2	Window (2200 x 2100)	76	40	4.62	12.5	2.7	0.5	1	38
1109	Lounge	Sliding Door (2000 x 2100)	78	45	4.20	22.4	2.7	0.7	1	34
	Bedroom	Window (1400 x 2000)	76	40	2.80	22.4	2.7	0.5	1	34
1110	Lounge	Sliding Door (2300 x 2100)	75	45	4.83	21.1	2.7	0.7	2	35
	Lounge	Window (2300 x 2100)	78	45	4.83	21.1	2.7	0.7	2	38
	Bedroom 1	Window (2100 x 2100)	76	40	4.41	10.2	2.7	0.5	1	39
	Bedroom 2	Window (1800 x 2100)	76	40	3.78	9.9	2.7	0.5	1	38
	Bedroom 3	Window (3800 x 2100)	73	40	7.98	9.6	2.7	0.5	1	39
1111	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	75	45	8.61	27.0	2.7	0.7	1	33
	Bedroom 1	Window (1500 x 2100)	73	40	3.15	12.0	2.7	0.5	1	34
1112	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	73	45	8.61	27.0	2.7	0.7	1	31
	Bedroom 1	Window (1500 x 2100)	71	40	3.15	12.0	2.7	0.5	1	32
Community area	Lounge	Glazing (25000 x 2600)	78	45	52.50	225.0	2.7	0.7	1	35

Figure 5: Façade calculations

Notes to Figure 5:

- The ratings specified are minimum levels to meet internal requirements. If a higher level of internal amenity is desired, consideration should be given to providing glazing systems that achieve greater acoustic isolation.
- The glazing options specified in Figure 5 should be used as a guide only. An assessment should be made once architectural details are finalised. The Rw ratings for a particular glazing component must comply with the relevant standards when testing under AS1276 – 1999 *Acoustics – Rating of Sound Insulation in Buildings of Building Elements Part 1* – Airb*orne Sound Insulation*. Test certification from the glazing supplier is required to confirm these ratings.
- The calculations are based on non-glazed façade component attenuation rating of >10 above the rating of the enclosed glazing, e.g. Rw>48 (lined concrete construction) for facades containing Rw 38 windows. If façade ratings do not equal or exceed this rating, calculation of individual component rating will be required.

Response to point b

5.6 Overall external glazing treatments

As per the Bowen Hills PDA Development Scheme (minimum reduction of 20dB at 63Hz), minimum external glazing requires Rw35 rating. All apartments in this development also require a minimum of Rw35 rated glazing system, as per BCC multiple dwelling code, stated in Section 2.2.

Please make sure that the higher glazing rating is applied between Appendix A or minimum Rw35 rating for all external glazing to the development.

5.7 Private open spaces - Balconies

Balconies facing north, east & south will be subjected to elevated road traffic noise levels. Accordingly, we recommend that the balustrades be constructed to be gap-free.

6.0 GLAZING OPTIONS

To fulfil the requirements of NCC Section J the eastern façade will require double glazing in the approximate form of 6mm glazing – 12mm air gap – 6mm glazing (6-12-6).

From Insul calculations, glazing can be expected to have the following ratings:

Glazing form	Glass type	Expected performance
6-12-6	Float/Float	Rw35
6.38-12-6	Laminated/Float	Rw39
6-12-10.38	Float/Laminated	Rw42
6.38 -12-10.38	Laminated/Laminated	Rw42
10.38-12-6-100-6	Laminated/float/float	Rw49

Response to point A

7.0 NOISE INTRUSION FROM CONCRETE BATCHING PLANT

The concrete batching plant (5A Horace St, Windsor) is approximately 270m away from the development site. The operating hours from the online website (Boral Concrete Windsor) Monday – Friday 5:30am – 4:45pm and Saturday 5:30am – 12pm, Sunday closed.

This office has conducted noise measurements of typical concrete batching plant activities, as presented in below.

Table 11: Typical maximum measured noise levels from concrete batching plant activities

Source	Noise Level dB(A) L_{Amax}	Noise Level dB(A) L_{Aeq}	Noise Level dB(A) L_{Ceq}
Concrete Batching plant	76dB @ 15m	74dB @ 15m	90dB @ 15m
Front-end loader – forward & reverse w/alarm	79dB @ 20m	73dB @ 20m	88dB @ 20m

Our predicted noise levels from the concrete batching plant to the proposed development have the following noise attenuation:

- Distance attenuations: from 15m to 270m (-25dB) and from 20m to 270m (-23dB)
- Minimum external glazing Rw35. A minimum transmission loss through the external facade will be -29dB.

The predicted LAeq calculation, based on the above attenuations, is presented in Table 12.

Table 12: Predicted concrete batching plant noise impacts – LAeq

Source	Distance Attenuation	Façade attenuation (closed façade) Rw35	Noise Level dB(A) at proposed residence	Complies With internal Noise Limits 35/35/30dB(A)
			L_{Aeq}	
Concrete Batching plant 74dB @15m	-25dB (15m to 270m)	-29 dB	20 dB(A)	Yes/Yes/Yes
Front-end loader – forward & reverse w/alarm 73dB @ 20m	-23dB (20m to 270m)	-29 dB	21 dB(A)	Yes/Yes/Yes
Sum			24 dB(A)	Yes/Yes/Yes

The predicted LAMax calculation, based on the above attenuations, is presented in Table 13.

Table 13: Predicted concrete batching plant noise impacts – LAMax

Source	Distance Attenuation	Façade attenuation (closed façade) Rw35	Noise Level dB(A) at proposed residence	Complies With internal Noise Limit at night 45dB(A)
			L_{AMax}	
Concrete Batching plant 76dB @15m	-25dB (15m to 270m)	-29 dB	22 dB(A)	Yes
Front-end loader – forward & reverse w/alarm 79dB @ 20m	-23dB (20m to 270m)	-29 dB	27 dB(A)	Yes
Sum			30 dB(A)	Yes

The predicted LCeq calculation, based on the above attenuations, is presented in Table 14.

Table 14: Predicted concrete batching plant noise impacts – LCeq

Source	Distance Attenuation	Façade attenuation (closed façade) Rw35	Noise Level dB(A) at proposed residence	Complies With internal Noise Limits 60/60/55dB(A)
			L_{Ceq}	
Concrete Batching plant 90dB @15m	-25dB (15m to 270m)	-29 dB	36 dB(A)	Yes/Yes/Yes
Front-end loader – forward & reverse w/alarm 88dB @ 20m	-23dB (20m to 270m)	-29 dB	36 dB(A)	Yes/Yes/Yes
Sum			39 dB(A)	Yes/Yes/Yes

From Tables 12-14, noise from the concrete batching plant requires a min Rw35 sliding windows and doors system (closed) to comply with the BCC at day and night noise limits. Therefore no further acoustic treatments will be required.

8.0 NOISE EMISSION

Noise emanating from the proposed development includes the following sources:

- Amplified music from rooftop bar to nearby residents

Continuous noises

- Noise from mechanical plant

8.1 Bowen Hills PDA Development Scheme

Under the PDA scheme in section 2.5.9.3 Development is oriented, designed and constructed to:

1. Reduce exposure to noise impact from designated transport noise corridors. *Refer to Brisbane City Plan Transport Noise overlay map.*
2. Reduce the exposure of residential uses to noise impacts from lawfully operating entertainment venues. *A building is designed and constructed to achieve a minimum reduction in sound pressure level between the exterior of the building and the bedroom or living room, of $L_{Leq,T}$ 20dB at 63Hz where near a lawfully operating entertainment venue. Residents living near lawfully operating entertainment venues also need to be aware that noise levels will be relatively higher both inside and outside of residences.*

Since the Bowen Hills PDA Development Scheme does not provide noise criteria for noise emission from the proposed development to adjacent noise-sensitive receivers. It is proposed to adopt Brisbane City Council (BCC) noise emission criteria for the following assessment. A study has been conducted to assess compliance with the acoustic requirements outlined in the BCC City Plan 2014.

(i) BCC Centre or Mixed use Code

The performance outcomes and emission limits are presented in Table 9.3.3.3A of the code; partially extracted as Table 15 - **18**, below. Table 16 has been edited with data from Table 6 to reflect the derived limits. The emission limits are summarised in Table 19.

Table 15: Extract from Table 9.3.3.3.A—Performance outcomes and acceptable outcomes

Performance outcomes	Acceptable outcomes
Section A—If for self-assessable or assessable development	
PO1 Development: (a) has hours of operation which are controlled so that the use does not detrimentally impact on the amenity of adjoining residents; (b) does not result in noise emissions that exceed the noise (planning) criteria in Table 9.3.3.3.F, low frequency noise criteria in Table 9.3.3.3.G and night-time noise criteria in Table 9.3.3.3.H in a sensitive zone or a nearby	**AO1.1** Development: (a) for accommodation activities, dwelling unit or emergency services has unlimited hours of operation; (b) for a club, if licensed, bar function facility, hotel or nightclub entertainment facility does not generate noise which is clearly audible and detectable, or impacts on the amenity of a resident in a dwelling or other sensitive use.

Performance outcomes	Acceptable outcomes
Section A—If for self-assessable or assessable development	
sensitive use, except music noise where located in a Special entertainment precinct identified in a neighbourhood plan.	(c) for any other use: (i) where in the Principle centre zone or Major centre zone has unlimited hours of operation; (ii) where in the District centre zone, Neighbourhood centre zone or Mixed use zone: (A) has hours of operation, including for deliveries, which are limited to 6am to 10pm; or (B) does not generate noise which is clearly audible and disturbing in a dwelling or other sensitive use; **AO1.2** Development ensures mechanical plant or equipment is acoustically screened from an adjoining sensitive use.

Table 16: 9.3.3.3.F noise (planning) Criteria

Criteria location	Intrusive noise criteria	Acoustic amenity criteria		
	Day, evening and night LAeq,adj,T are not greater than the RBL plus the value in this column for the relevant criteria location, where T equals: Day: 11hr Evening: 4hr Night: 9hr	**Day, evening and night LAeq,adj,T are not greater than the values in the below columns for the relevant criteria location, where T equals:** Day: 11hr Evening: 4hr Night: 9hr		
		Day	**Evening**	**Night**
At a sensitive use in the mixed use zone	Day 5dB(A) – 77dB(A) Evening 5dB(A) – 73dB(A) Night 5dB(A) – 63dB(A)	60dB(A)	55dB(A)	50dB(A)

Table 17: 9.3.3.3.G —Low frequency noise criteria

Criteria location	Day (7am-6pm) $L_{Ceq,adj,11hr}$ is not greater than the following values at the relevant criteria location	Evening (6pm-10pm) LCeq,adj,4hr is not greater than the following values at the relevant criteria location	Night (10pm-7am) LCeq,adj,9hr is not greater than the following values at the relevant criteria location
At a sensitive use in the mixed use zone	75dB(C)	75dB(C)	70dB(C)

Table 18: 9.3.3.3.H Night time noise criteria

Criteria location	**Where the existing** $L_{Aeq,9hr}$ night **at the criteria location is:**	**Average of the highest 15 single** L_{Amax} **events over a given night (10pm-7am) period is not greater than the following values at the relevant criteria location:**	**The absolute highest single** L_{Amax} **event over a given night (10pm-7am) period is not greater than the following values at the relevant criteria location:**
External to a sensitive use located in a Mixed use zone	Not applicable	65dB(A)	70dB(A)

Most stringent noise criteria are used. Refer to Table 19 below.

Table 19: Noise emission standards for the protection of residential amenity

Noise level at the boundary of premises			
Time Period	**Derived Noise Limit** $L_{Aeq,\ adj,T}$ **dB(A)**	**Noise Limit** $L_{Ceq,\ adj,1\ hour}$ **dB(A)**	**Derived Noise Limit** $L_{AMax,\ adj,T}$ **dB(A)**
Day - 7am-6pm	60dB(A)	75 dB(C)	-
Evening - 6pm-10pm	55dB(A)	75 dB(C)	-
Night - 10pm-7am	50dB(A)	70 dB(C)	65-70dB(A)

From the BCC Noise Impact Assessment Planning Scheme Policy (NIAPSP) we note: "*L_{Amax} assessment only applies to 'specified noise sources' which are defined as: impact noises; hammering; loading/unloading; dropping items; beepers, alarms, bells, phones, sirens; power tools; valve releases; air brakes; and door slamming. Note—People Noise and vehicle pass-by noise (engine, exhaust, induction, tyres) are specifically excluded.*"

The development will have amplified music and people noise from the rooftop outdoor area of the building. The people noise is excluded from the L_{AMax} noise. Therefore the night L_{AMax} noise limits do not apply to the noise assessment below.

8.2 Noise Sources

The assessment of patron noise is applied to the rooftop bar as follows:

- A maximum of 300 people in the rooftop bar area and 300 people in the rooftop outdoor bar.

Based on the conference paper, "Crowd Noise Study" by Ron Rumble and UQ, the following equation is used for design purposes:

- L_{WA10} = 15 x log N + 67dB(A) where N is a crowd size
- L_{WAeq} = 15 x log N + 64dB(A) where N is a crowd size

Based on the patron numbers presented above, the source noise Sound Power Levels (SWL) are predicted as 106dB L_{WAeq} for 600 people. The sound pressure levels (SPL) at 10m, are presented below.

- The source noise of 300 patrons in the rooftop indoor bar area is 76dB $L_{Aeq,}$ at 10m.
- The source noise of 300 patrons in the rooftop outdoor bar area is 76dB $L_{Aeq,}$ at 10m

This office has conducted noise measurements of typical function activities with amplified music as presented in Table 20 below.

Table 20: Typical maximum measured noise levels from amplified music activities

Source	Noise Level @ 3m dB(A) L_{Aeq}	Noise Level @ 3m dB(A) L_{Ceq}
Amplified music inside the function area	90dB	95dB

8.3 Assessment – Rooftop bars

There are two bars on the rooftop, one bar is located the inside the building and the other bar is located in the outdoor area. The proposed rooftop bar has the following façades and predicted sound reduction index (Rw) rating:

- external walls are minimum 6.38mm thick laminated glazing (Rw 32 closed façade),
- roof system with insulation (Rw22)

Where emission criteria are expressed as Leq values and noise emissions are not continuous, the number and duration of events must be estimated. Predicted noise emissions from the activities inside the bar are presented in Table 21. The assumed number and duration of events have been added to the table.

Table 21: Typical maximum derating from typical function music amplified music

Source	Duration (second) / Number of events (Total No. hours (h) or minute (m) in that time period)		
	Day (11h)	Evening (4h)	Night (9h)
Function activities – amplified music	60/360 Total (5h/11h)	60/180 Total (3h/4h)	60/240 Total (4h/9h)

The closest residents are located across Campbell Street. The distance between the nearest residence (off site) and the proposed rooftop bar is close to 100m.

(i) BCC Acoustic Amenity – Off site residences

The predicted noise level from the rooftop bar (amplified music) to the sensitive receivers through the glazed wall façade system is presented in Table 22. The presented calculation is based on the following:

- distance attenuation of 6 dB per doubling of distance,
- The transmission loss of a open glazing to the residences is min -6dB
- L_{Aeq} energy averaging for Day 11 hours, Evening 4 hours and Night 9 hours.

Table 22: Predicted rooftop bar (amplified music) noise impacts residences - L_{eq}

Source Paths	Distance & façade Attenuation	Energy Averaging D/E/N	Noise Level dB(A) at residences	Complies With Noise Limits 60/55/50dB(A)
			L_{Aeq} D/E/N	
Amplified music inside the bar with open façade 90dB(A)	-30 dB & -6dB	-3/-1/-4 dB	51/52/50 dB(A)	Yes
Amplified music on the outdoor bar area 90dB(A)	-30 dB & 0dB	-3/-1/-4 dB	57/58/55 dB(A)	Yes/No/No
Sum			58/59/57 dB(A)	Yes/No/No

Amplified music playing up to 90dB(A) in the internal bar complies with BCC day and night noise limits. The amplified music (accumulative sum) in the internal bar and outdoor bar exceeds the evening and night time limits. The amplified music level will comply with BCC day and night noise limits when applying the following treatment options. If higher amplified music levels is required, additional acoustic treatment/ management options be required, i.e. close façades or upgrade façade acoustic rating.

Proposed treatment option 1: Reducing the amplified music level in the rooftop outdoor bar to 70dB(A) in the evening and nighttime.

Proposed treatment option 2: Close the façade of the internal bar and reduce the amplified music level in the rooftop outdoor bar to below 84dB(A) level.

In the later stages of the project, acoustic treatment must be finalised depending on the amplified music level of the bar by the bar operator.

(ii) BCC low frequency – off site residences

The predicted noise level from the rooftop bars to nearest residences (100m away) through the wall and roof façades at low frequency is presented in Table 23.

The proposed acoustic treatment from section 8.3(i), are presented below:

- distance attenuation of 6 dB per doubling of distance,
- The transmission loss of open glazing to the residences is min -6dB

Table 23: Predicted music (low frequency noise) impacts to nearby residences – L_{Ceq}

Source	Noise level@ 3m L_{Ceq}	Distance Attenuation	Façade Attenuation	Noise Level dB(A) at residence L_{Ceq}	Complies With Noise Limits of 70dB(C)
Internal bar Music on (open façade)	95dB	-30dB (3m to 100m)	-6 dB	59dB	Yes
Outdoor bar Music on	95dB	-30dB (3m to 100m)	-0 dB	65dB	Yes

From Table 23, the amplified music from both rooftop bars complies with BCC night time operation for low-frequency noise limit. No acoustic treatment is required.

(iii) Amplified music impact to on site residences

The predicted noise level from the rooftop bar (amplified music) to the sensitive receivers (on Level 29 apartments) through the 200mm thick concrete slab system is presented in Table 24. The presented calculation is based on the following:

- distance attenuation of 6 dB per doubling of distance,
- Closed façade for the indoor bar with amplified upto 90dB(A) @ 3m from speakers;
- Amplified music level for the outdoor bar upto 74dB(A) @ 3m from speakers;
- The transmission loss of 200mm thick concrete slab is min -50dB (Rw56)
- A 60mm high rubber pad timber floating floor (3x20mm plywood) – for impact isolation. This applies to the indoor and outdoor bars and the kitchen.
- A 2.0m high glass noise barrier wall around the perimeter of the outdoor bar.
- L_{Aeq} energy averaging for Day 11 hours, Evening 4 hours and Night 9 hours.

Table 24: Predicted rooftop bar (amplified music) noise impacts to L29 residences - L_{eq}

Source Paths	Distance & façade Attenuation	Energy Averaging D/E/N	Noise Level dB(A) at residences	Complies With Noise Limits 60/55/50dB(A)
			L_{Aeq} D/E/N	
Amplified music inside the bar through floor slab 90dB(A)	+10 dB & -50dB	-3/-1/-4 dB	47/48/46 dB(A)	Yes
Amplified music on the outdoor bar area 74dB(A)	-2 dB & -20dB	-3/-1/-4 dB	49/50/48 dB(A)	Yes
Sum			51/52/50 dB(A)	Yes

From the above floor treatment, amplified music levels and 2m high barrier around the perimeter of the outdoor bar, the amplified music (accumulative sum) in the internal bar and outdoor bar comply with day and night time limits. If higher levels are required indoors, this space must be constructed as a "room-within-room" with a 100mm concrete slab floating floor.

In the later stages of the project, acoustic treatment must be finalised depending on the amplified music level of the bar by the bar operator.

8.4 Patron Noise

Assuming a maximum crowd size of 600 patrons in the rooftop bars. The source noise Sound Power Level (SWL) is expected 106dB L_{WAeq}. Allow for 300 patrons in the indoor bar (open façade) is 101dB L_{WAeq} and 300 patrons in the outdoor bar is 101dB L_{WAeq}.

For the 300 patron noise on the rooftop indoor bars, conversion from SWL to sound pressure level (SPL) at 10m is 76dB(A) $L_{eq.}$ Distance attenuation from rooftop to residences across Campbell St (10m to 100m) is 30 dB and -6dB for inside to outside adjustment, the predicted noise impact level of 76 – 30 - 6 = 40 dB(A).

For the 300 patron noise on the rooftop outdoor bar the conversion from SWL to sound pressure level (SPL) at 10m is 76dB(A) $L_{eq.}$ Distance attenuation from the rooftop to residences across Campbell St (10m to 100m) is 30 dB, the predicted noise impact level of 76 – 30 = 46 dB(A).

The sum of 300 patrons on the indoor bar and 300 patrons on the outdoor bar is 47dB(A). This level is below the night time planning criteria. Therefore no acoustic treatment is required.

8.5 Assessment – Mechanical plant noise

All pool/spa plant and equipment will be placed in the pool equipment room. Therefore there will be no noise significant emission onto the neighbouring residences.

For other plant and equipment, i.e. carpark exhaust, AC units designs for mechanical services have not yet been completed and plant selections and locations are unknown. Therefore, we are only able to recommend design limits for the control of mechanical plant noise emissions at the nearest noise sensitive receptor. If detailed design is required, the design criteria are extracted from Table 19, above.

To comply with these limits, there are a number of engineering solutions available. Low noise levels are achieved by the engineered selection and application of:

- Low sound power level equipment;
- Silencers;
- Acoustic enclosures;
- Noise barriers;
- Vibration isolation systems.

The application of such principles and treatments, along with providing maximum separation distances between noise sources and sensitive areas will ensure that noise from plant and equipment complies with limits.

9.0 CONCLUSIONS

Based on the results presented, we conclude:

- The site lies within the the BCC transport noise corridor of Inner City Bypass (ICB).
- Noise from the nearby concrete batching plant complies with the BCC industrial amenity overlay code with a closed façade.
- The Bowen Hills PDA requires that residential constructions comply with the provisions of QDC MP4.4. An alternative solution was proposed based on AS2107 internal noise levels with AS3671 façade Rw calculations.
- Noise emissions from the rooftop bars will comply with BCC Day and night time limits at the nearest residential building. Amplified music level is allowed on the rooftop bars from 90dB(A) during the day and reduced to 84dB(A) at night.
- Several acceptable acoustic treatment/management options can be implemented for the rooftop bar.
- Noise emissions from rooftop patrons' noise will comply with BCC day and night time limits at the nearby residential building.

To ensure compliance with the requirements of the Bowen Hills PDA Development Scheme for the control of noise we recommended

- The external glazing system of the proposed residential tower requires a minimum of Rw35 glazing (windows and doors).
- The stage 2 residential units and medical suites external building façade construction be upgraded. Higher rating must applied to the external façade glazing as stated in Appendix A or minimum Rw35 glazing.
- Amplified music treatment options for the rooftop bars in Section 8.3.
- Mechanical plant noise emissions be controlled to the limits expressed in Table 19.

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APPENDIX A

Room/Apt No.	Room type	Element	Impact dB(A)	Criteria	Element Area (m2)	Floor Area (m2)	Height (m)	RT60 (s)	C	Rw
Eastern facade										
Lower Ground	Tenency	Glazing (14000 x 2600)	75	45	36.40	82.6	2.7	0.7	1	**34**
Ground	Tenency - Medical	Glazing (20000 x 2600)	75	45	52.00	240.0	2.7	0.7	1	**31**
Mezzanine	Tenency - Medical	Glazing (15000 x 2600)	75	45	39.00	225.0	2.7	0.7	1	**30**
Level 1	Tenency - Medical	Glazing (33000 x 2600)	82	45	85.80	1056.0	2.7	0.7	2	**37**
Level 2-3	Tenency - Medical	Glazing (32000 x 2600)	77	45	83.20	1056.0	2.7	0.7	2	**32**
Level 4	Tenency - Medical	Glazing (32000 x 2600)	81	45	85.80	1056.0	2.7	0.7	2	**36**
Level 1-4	Private Office facing ICB	Glazing(33000 x 2600)	81	40	7.80	12.0	2.7	0.5	1	**46**
Northern facade										
Lower Ground	Tenency	Glazing (14000 x 2600)	74	45	36.40	82.6	2.7	0.7	1	**34**
Ground	Tenency - Medical	Glazing (20000 x 2600)	74	45	52.00	240.0	2.7	0.7	1	**31**
Mezzanine	Tenency - Medical	Glazing (15000 x 2600)	74	45	39.00	225.0	2.7	0.7	1	**30**
Level 1	Tenency - Medical	Glazing (33000 x 2600)	78	45	85.80	1056.0	2.7	0.7	2	**33**
Level 2-3	Tenency - Medical	Glazing (32000 x 2600)	78	45	83.20	1056.0	2.7	0.7	2	**32**
Level 4	Tenency - Medical	Glazing (32000 x 2600)	77	45	85.80	1056.0	2.7	0.7	2	**32**
Level 1-4	Private Office facing ICB	Glazing(33000 x 2600)	77	40	7.80	12.0	2.7	0.5	1	**42**
801, 901 & 1001	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	73	45	5.04	29.6	2.7	0.7	1	**29**
	Bedroom1	Sliding Door (2200 x 2100)	71	40	4.62	10.9	2.7	0.5	1	**34**
	Bedroom2	Window (2800 x 2100)	45	40	5.88	10.9	2.7	0.5	1	**8**
802, 902 & 1002	Lounge	Sliding Door (2000 x 2100)	47	45	4.20	22.4	2.7	0.7	1	**2**
	Bedroom	Window (1400 x 2000)	45	40	2.80	22.4	2.7	0.5	1	**2**
803, 903 &1003	Lounge, Dining & Kitchen	Window (4600 x 2100)	47	45	9.66	24.8	2.7	0.7	1	**6**
	Bedroom 2	Window (2300 x 2100)	45	40	4.83	9.6	2.7	0.5	1	**8**
	Bedroom 1	Window (1500 x 2100)	45	40	3.15	12.0	2.7	0.5	1	**5**
804, 904 & 1004	Lounge, Dining & Kitchen	Sliding Door (2100 x 2100)	47	45	4.41	29.1	2.7	0.7	1	**2**
	Bedroom	Sliding Door (2100 x 2100)	45	40	4.41	29.1	2.7	0.5	1	**3**

Room/Apt No.	Room type	Element	Impact dB(A)	Criteria	Element Area (m2)	Floor Area (m2)	Height (m)	RT60 (s)	C	Rw
1101	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	73	45	5.04	29.6	2.7	0.7	1	29
	Bedroom1	Sliding Door (2100 x 2100)	69	40	4.41	11.5	2.7	0.5	1	32
	Bedroom2	Window (2800 x 2100)	44	40	5.88	10.9	2.7	0.5	1	8
1102	Lounge	Sliding Door (2000 x 2100)	46	45	4.20	22.4	2.7	0.7	1	2
	Bedroom	Window (1400 x 2000)	44	40	2.80	22.4	2.7	0.5	1	1
1103	Lounge, Dining & Kitchen	Sliding Door (4600 x 2100)	46	45	9.66	24.8	2.7	0.7	1	5
	Bedroom 1	Window (1500 x 2100)	44	40	3.15	12.0	2.7	0.5	1	4
	Bedroom 2	Window (2300 x 2100)	44	40	4.83	9.6	2.7	0.5	1	7
1104	Lounge, Dining & Kitchen	Sliding Door (5700 x 2100)	46	45	11.97	32.2	2.7	0.7	1	5
	Bedroom 1	Window (2300 x 2100)	44	40	4.83	11.6	2.7	0.5	1	7
	Bedroom 2	Window (2200 x 2100)	44	40	4.62	12.5	2.7	0.5	1	6
1105	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	46	45	4.83	31.5	2.7	0.7	1	1
	Bedroom 1	Window (2000 x 2100)	44	40	4.20	9.9	2.7	0.5	1	7
	Bedroom 2	Window (1100 x 2100)	44	40	2.31	10.2	2.7	0.5	1	4
1106, 1108	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	78	45	4.83	31.5	2.7	0.7	1	33
	Bedroom 1	Window (2000 x 2100)	76	40	4.20	9.9	2.7	0.5	1	39
	Bedroom 2	Window (1100 x 2100)	76	40	2.31	10.2	2.7	0.5	1	36
1107	Lounge, Dining & Kitchen	Sliding Door (5700 x 2100)	78	45	11.97	32.2	2.7	0.7	1	37
	Bedroom 1	Window (2300 x 2100)	76	40	4.83	11.6	2.7	0.5	1	39
	Bedroom 2	Window (2200 x 2100)	76	40	4.62	12.5	2.7	0.5	1	38
1109	Lounge	Sliding Door (2000 x 2100)	78	45	4.20	22.4	2.7	0.7	1	34
	Bedroom	Window (1400 x 2000)	76	40	2.80	22.4	2.7	0.5	1	34
1110	Lounge	Sliding Door (2300 x 2100)	75	45	4.83	21.1	2.7	0.7	2	35
	Lounge	Window (2300 x 2100)	78	45	4.83	21.1	2.7	0.7	2	38
	Bedroom 1	Window (2100 x 2100)	76	40	4.41	10.2	2.7	0.5	1	39
	Bedroom 2	Window (1800 x 2100)	76	40	3.78	9.9	2.7	0.5	1	38
	Bedroom 3	Window (3800 x 2100)	73	40	7.98	9.6	2.7	0.5	1	39
1111	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	75	45	8.61	27.0	2.7	0.7	1	33
	Bedroom 1	Window (1500 x 2100)	73	40	3.15	12.0	2.7	0.5	1	34
1112	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	73	45	8.61	27.0	2.7	0.7	1	31
	Bedroom 1	Window (1500 x 2100)	71	40	3.15	12.0	2.7	0.5	1	32
Community area	Lounge	Glazing (25000 x 2600)	78	45	52.50	225.0	2.7	0.7	1	35

Room/Apt No.	Room type	Element	Impact dB(A)	Criteria	Element Area (m2)	Floor Area (m2)	Height (m)	RT60 (s)	C	Rw
1201	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	73	45	5.04	29.6	2.7	0.7	1	**29**
	Bedroom1	Sliding Door (2100 x 2100)	69	40	4.41	11.5	2.7	0.5	1	**32**
	Bedroom2	Window (2800 x 2100)	44	40	5.88	10.9	2.7	0.5	1	**8**
1202	Lounge	Sliding Door (2000 x 2100)	46	45	4.20	22.4	2.7	0.7	1	**2**
	Bedroom	Window (1400 x 2000)	44	40	2.80	22.4	2.7	0.5	1	**1**
1203	Lounge, Dining & Kitchen	Sliding Door (4600 x 2100)	46	45	9.66	24.8	2.7	0.7	1	**5**
	Bedroom 1	Window (1500 x 2100)	44	40	3.15	12.0	2.7	0.5	1	**4**
	Bedroom 2	Window (2300 x 2100)	44	40	4.83	9.6	2.7	0.5	1	**7**
1204	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	51	45	5.04	29.6	2.7	0.7	1	**6**
	Bedroom1	Sliding Door (2100 x 2100)	48	40	4.41	11.5	2.7	0.5	1	**11**
	Bedroom2	Window (2800 x 2100)	44	40	5.88	10.9	2.7	0.5	1	**8**
1205	Lounge	Sliding Door (2000 x 2100)	51	45	4.20	22.4	2.7	0.7	1	**6**
	Bedroom	Window (1400 x 2000)	48	40	2.80	22.4	2.7	0.5	1	**6**
1206	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	67	45	8.61	27.0	2.7	0.7	1	**25**
	Bedroom 1	Window (1500 x 2100)	65	40	3.15	12.0	2.7	0.5	1	**25**
1207	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	78	45	5.04	29.6	2.7	0.7	1	**34**
	Bedroom1	Sliding Door (2100 x 2100)	76	40	4.41	11.5	2.7	0.5	1	**38**
	Bedroom2	Window (2100 x 2100)	76	40	4.41	10.9	2.7	0.5	1	**39**
1208	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	78	45	4.83	31.5	2.7	0.7	1	**33**
	Bedroom 1	Window (2000 x 2100)	76	40	4.20	9.9	2.7	0.5	1	**39**
	Bedroom 2	Window (1100 x 2100)	76	40	2.31	10.2	2.7	0.5	1	**36**
1209	Lounge	Sliding Door (2000 x 2100)	78	45	4.20	22.4	2.7	0.7	1	**34**
	Bedroom	Window (1400 x 2000)	76	40	2.80	22.4	2.7	0.5	1	**34**
1210	Lounge	Sliding Door (2300 x 2100)	75	45	4.83	21.1	2.7	0.7	2	**35**
	Lounge	Window (2300 x 2100)	78	45	4.83	21.1	2.7	0.7	2	**38**
	Bedroom 1	Window (2100 x 2100)	76	40	4.41	10.2	2.7	0.5	1	**39**
	Bedroom 2	Window (1800 x 2100)	76	40	3.78	9.9	2.7	0.5	1	**38**
	Bedroom 3	Window (3800 x 2100)	73	40	7.98	9.6	2.7	0.5	1	**39**
1211	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	75	45	8.61	27.0	2.7	0.7	1	**33**
	Bedroom 1	Window (1500 x 2100)	73	40	3.15	12.0	2.7	0.5	1	**34**
1212	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	73	45	8.61	27.0	2.7	0.7	1	**31**
	Bedroom 1	Window (1500 x 2100)	71	40	3.15	12.0	2.7	0.5	1	**32**

Room/Apt No.	Room type	Element	Impact dB(A)	Criteria	Element Area (m2)	Floor Area (m2)	Height (m)	RT60 (s)	C	Rw
1301 - 1901	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	73	45	5.04	29.6	2.7	0.7	1	29
	Bedroom1	Sliding Door (2100 x 2100)	69	40	4.41	11.5	2.7	0.5	1	32
	Bedroom2	Window (2800 x 2100)	44	40	5.88	10.9	2.7	0.5	1	8
1302 - 1902	Lounge	Sliding Door (2000 x 2100)	46	45	4.20	22.4	2.7	0.7	1	2
	Bedroom	Window (1400 x 2000)	44	40	2.80	22.4	2.7	0.5	1	1
1303 - 1903	Lounge, Dining & Kitchen	Sliding Door (4600 x 2100)	46	45	9.66	24.8	2.7	0.7	1	5
	Bedroom 1	Window (1500 x 2100)	44	40	3.15	12.0	2.7	0.5	1	4
	Bedroom 2	Window (2300 x 2100)	44	40	4.83	9.6	2.7	0.5	1	7
1304 - 1904	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	51	45	5.04	29.6	2.7	0.7	1	6
	Bedroom1	Sliding Door (2100 x 2100)	48	40	4.41	11.5	2.7	0.5	1	11
	Bedroom2	Window (2800 x 2100)	44	40	5.88	10.9	2.7	0.5	1	8
1305 - 1905	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	51	45	8.61	27.0	2.7	0.7	1	9
	Bedroom 1	Window (1500 x 2100)	48	40	3.15	12.0	2.7	0.5	1	9
1306 - 1906	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	67	45	8.61	27.0	2.7	0.7	1	25
	Bedroom 1	Window (1500 x 2100)	65	40	3.15	12.0	2.7	0.5	1	25
1307 - 1907	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	78	45	5.04	29.6	2.7	0.7	1	34
	Bedroom1	Sliding Door (2100 x 2100)	76	40	4.41	11.5	2.7	0.5	1	38
	Bedroom2	Window (2100 x 2100)	76	40	4.41	10.9	2.7	0.5	1	39
1308 - 1908	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	78	45	4.83	31.5	2.7	0.7	1	33
	Bedroom 1	Window (2000 x 2100)	76	40	4.20	9.9	2.7	0.5	1	39
	Bedroom 2	Window (1100 x 2100)	76	40	2.31	10.2	2.7	0.5	1	36
1309 - 1909	Lounge	Sliding Door (2000 x 2100)	78	45	4.20	22.4	2.7	0.7	1	34
	Bedroom	Window (1400 x 2000)	76	40	2.80	22.4	2.7	0.5	1	34
1310 - 1910	Lounge	Sliding Door (2300 x 2100)	75	45	4.83	21.1	2.7	0.7	2	35
	Lounge	Window (2300 x 2100)	78	45	4.83	21.1	2.7	0.7	2	38
	Bedroom 1	Window (2100 x 2100)	76	40	4.41	10.2	2.7	0.5	1	39
	Bedroom 2	Window (1800 x 2100)	76	40	3.78	9.9	2.7	0.5	1	38
	Bedroom 3	Window (3800 x 2100)	73	40	7.98	9.6	2.7	0.5	1	39
1311 - 1911	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	75	45	8.61	27.0	2.7	0.7	1	33
	Bedroom 1	Window (1500 x 2100)	73	40	3.15	12.0	2.7	0.5	1	34
1312 - 1912	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	73	45	8.61	27.0	2.7	0.7	1	31
	Bedroom 1	Window (1500 x 2100)	71	40	3.15	12.0	2.7	0.5	1	32

Room/Apt No.	Room type	Element	Impact dB(A)	Criteria	Element Area (m2)	Floor Area (m2)	Height (m)	RT60 (s)	C	Rw
2001 - 2901	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	72	45	5.04	29.6	2.7	0.7	1	**27**
	Bedroom1	Sliding Door (2100 x 2100)	68	40	4.41	11.5	2.7	0.5	1	**30**
	Bedroom2	Window (2800 x 2100)	42	40	5.88	10.9	2.7	0.5	1	**6**
2002 - 2902	Lounge	Sliding Door (2000 x 2100)	44	45	4.20	22.4	2.7	0.7	1	**0**
	Bedroom	Window (1400 x 2000)	42	40	2.80	22.4	2.7	0.5	1	**0**
2003 - 2903	Lounge, Dining & Kitchen	Sliding Door (4600 x 2100)	44	45	9.66	24.8	2.7	0.7	1	**3**
	Bedroom 1	Window (1500 x 2100)	42	40	3.15	12.0	2.7	0.5	1	**3**
	Bedroom 2	Window (2300 x 2100)	42	40	4.83	9.6	2.7	0.5	1	**6**
2004 - 2904	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	56	45	5.04	29.6	2.7	0.7	1	**11**
	Bedroom1	Sliding Door (2100 x 2100)	54	40	4.41	11.5	2.7	0.5	1	**16**
	Bedroom2	Window (2800 x 2100)	42	40	5.88	10.9	2.7	0.5	1	**6**
2005 - 2905	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	56	45	8.61	27.0	2.7	0.7	1	**14**
	Bedroom 1	Window (1500 x 2100)	54	40	3.15	12.0	2.7	0.5	1	**14**
2006 - 2906	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	71	45	8.61	27.0	2.7	0.7	1	**29**
	Bedroom 1	Window (1500 x 2100)	69	40	3.15	12.0	2.7	0.5	1	**30**
2007 - 2907	Lounge, Dining & Kitchen	Sliding Door (2400 x 2100)	76	45	5.04	29.6	2.7	0.7	1	**31**
	Bedroom1	Sliding Door (2100 x 2100)	74	40	4.41	11.5	2.7	0.5	1	**36**
	Bedroom2	Window (2100 x 2100)	74	40	4.41	10.9	2.7	0.5	1	**36**
2008 - 2908	Lounge, Dining & Kitchen	Sliding Door (2300 x 2100)	76	45	4.83	31.5	2.7	0.7	1	**31**
	Bedroom 1	Window (2000 x 2100)	74	40	4.20	9.9	2.7	0.5	1	**36**
	Bedroom 2	Window (1100 x 2100)	74	40	2.31	10.2	2.7	0.5	1	**34**
2009 - 2909	Lounge	Sliding Door (2000 x 2100)	76	45	4.20	22.4	2.7	0.7	1	**31**
	Bedroom	Window (1400 x 2000)	74	40	2.80	22.4	2.7	0.5	1	**31**
2010 - 2910	Lounge	Sliding Door (2300 x 2100)	73	45	4.83	21.1	2.7	0.7	2	**32**
	Lounge	Window (2300 x 2100)	76	45	4.83	21.1	2.7	0.7	2	**35**
	Bedroom 1	Window (2100 x 2100)	74	40	4.41	10.2	2.7	0.5	1	**36**
	Bedroom 2	Window (1800 x 2100)	74	40	3.78	9.9	2.7	0.5	1	**36**
	Bedroom 3	Window (3800 x 2100)	71	40	7.98	9.6	2.7	0.5	1	**36**
2011 - 2911	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	73	45	8.61	27.0	2.7	0.7	1	**31**
	Bedroom 1	Window (1500 x 2100)	71	40	3.15	12.0	2.7	0.5	1	**31**
2012 - 2912	Lounge, Dining & Kitchen	Sliding Door (4100 x 2100)	72	45	8.61	27.0	2.7	0.7	1	**30**
	Bedroom 1	Window (1500 x 2100)	70	40	3.15	12.0	2.7	0.5	1	**30**