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NEXTDC

NEXTDC SC2

Noise and Vibration Impact Assessment

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1. Introduction

This report presents the noise impact assessment for the NEXTDC SC2 Sunshine Coast Data Centre ('the proposal'). The proposal is located at Lot 10 South Sea Islander Way, Maroochydore Queensland.

This document:

- Identifies the existing noise environment surrounding the proposal site;
- Summarises the relevant noise criteria for noise emissions from the proposal site;
- Predicted the noise impacts from external noise sources onto surrounding noise sensitive receivers;
- Outlines how noise impacts will be minimised or mitigated.

A glossary of acoustic terminology is included in Appendix A.

1.1 Project background

NEXTDC is an established and growing data centre developer and operator. Since its inception thirteen years ago, NEXTDC has developed multiple premium quality data centres nationally, all certified to the industry's highest standards. NEXTDC continue to grow their pipeline of world-class, next-generation data centres in Australian cities, with the latest expansion being the SC2 facility at Lot 10, South Sea Islander Way, Maroochydore QLD 4558 Australia, directly adjacent to the existing SC1 facility. The SC2 facility is to comprise a multi-level data centre with a total capacity of 6MW IT, as well as collaboration and mission critical (MCX) office space.

1.2 Site description

The proposal site is legally identified as Lot 10 on SP305311 and is bounded by South Sea Islander Way, Sunshine Coast Parade, Future Way and Red Bill Lane. The site is located within Sunshine Coast Council local government area and within the Maroochydore City Centre Priority Development Area (PDA) [1] as part of a new central business district for the Sunshine Coast.

In its existing state, the proposal site comprises undeveloped land utilised as an at-grade car park.

The proposal site is presented in Figure 1. Figure 2 shows the proposal site within the context of the current layout of the Core Business Precinct within the Maroochydore City Centre PDA [1].

Figure 1: Site location and proposed SC2 data centre site

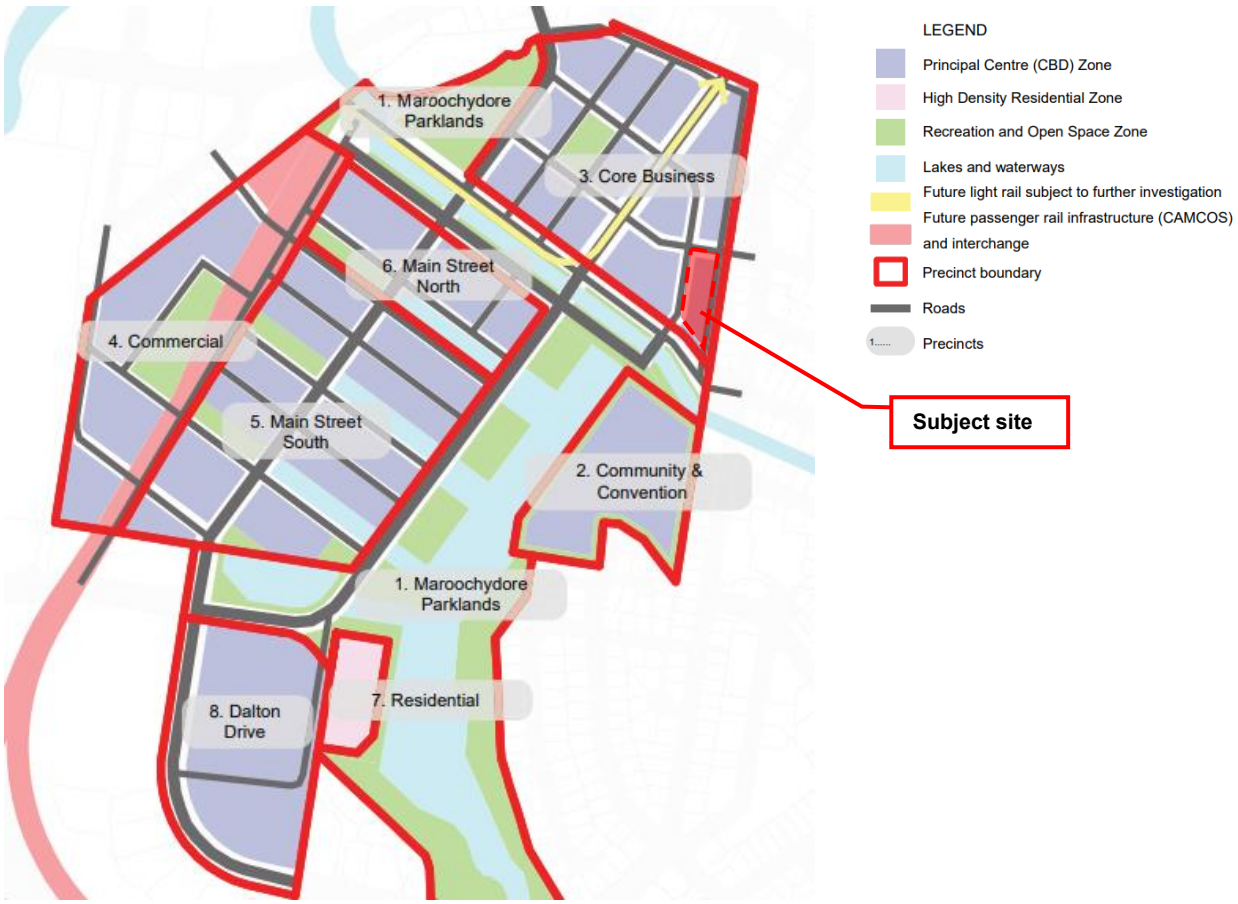


Figure 2: Site location in context of the Maroochydore City Centre Priority Development Area [1]

2. Existing environment

2.1 Noise measurement locations

Noise measurements are ideally carried out at the nearest or most potentially affected locations surrounding a development. An alternative, representative location should be established in the case of access restrictions or if a safe and secure location cannot be identified. Furthermore, representative locations may be established in the case of multiple receivers as it is usually impractical to carry out measurements at all locations surrounding a site.

The noise monitoring results are used to derive noise criteria and qualify the noise environment at nearby noise sensitive receivers.

Long-term unattended and short-term attended monitoring was conducted at locations presented in Table 1 and shown in Figure 3.

Table 1: Noise monitoring locations

Type	Purpose	ID	Location	Description
Long-term unattended	Establish criteria	L1	48 Maud Street, Maroochydore	On the western boundary of 48 Maud Street adjacent to Lot 10 South Sea Islander Way and Red Bill Lane.
Short-term attended	Quantify and qualify noise levels surrounding site	S1	10 South Sea Islander Way, Maroochydore	Near the centre of the proposal site on Lot 10 South Sea Islander Way.
		S2	48 Maud Street, Maroochydore	In the front yard of 44 Maud Street (NEXTDC SC1) facing intersection of Future Way and Maud Street.

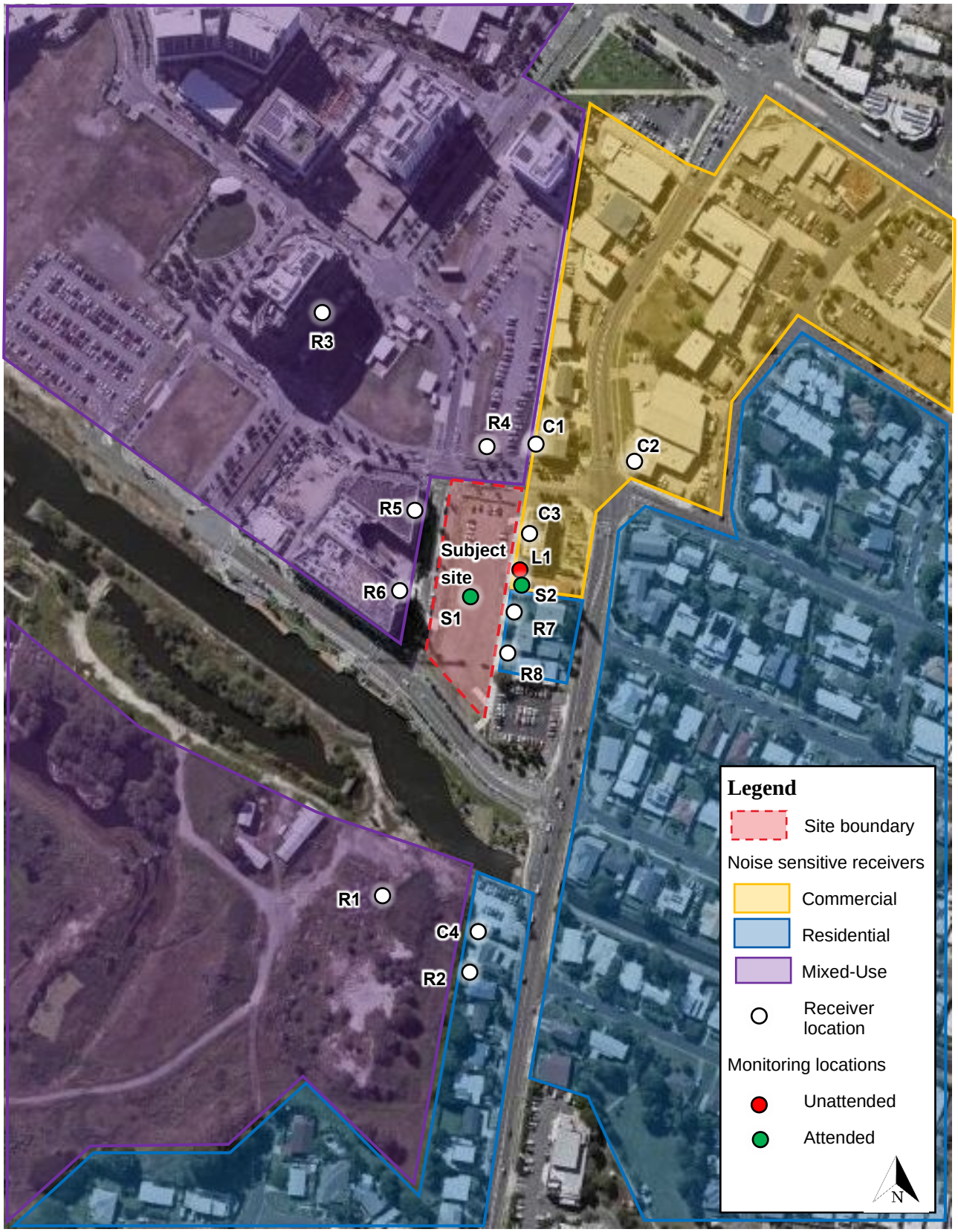


Figure 3: Noise monitoring locations and identified sensitive receivers

2.2 Noise measurement results

2.2.1 Unattended long-tern noise monitoring

Long-term noise monitoring was carried out from Tuesday 16 to Thursday 25 July 2024. The noise monitor was set to record noise levels in "A" weighting, fast response using 15-minute statistical intervals. Ambient noise monitoring was conducted in accordance with Australian Standard *AS1055:2018 Acoustics – Description and measurement of environmental noise* [2] and EPA *Noise Measurement Manual* (2000) [3].

Table 2 summarises the background and ambient noise level results. The long-term noise monitoring detailed noise level Vs time history graphs are presented in Appendix B.

Table 2: Long-term noise monitoring results, dB(A)

Location	Time period[1]	Rating background level, dB L_{A90}	Ambient noise level, dB L_{Aeq}
L1 – 48 Maud Street	Day	48	64
	Evening	43	53
	Night	40	49

Notes:

1. Day: 7:00-18:00
   Evening: 18:00-22:00
   Night: 22:00-07:00

2.2.2 Attended short-term noise monitoring

Short-term attended noise measurements were undertaken on Friday 22 March and Tuesday 16 July 2024 at locations shown in Figure 3. The measured noise levels are summarised in Table 3.

Table 3: Short-term noise monitoring results, dB(A)

Location	Date and start time	Measured levels dB(A)		Measurement notes
		$L_{A90(15min)}$	$L_{Aeq(15min)}$	
S1	22/03/24 4:28pm	49	53	Background was controlled by Maud Street traffic. No tonal sources of note.
S1	22/03/24 10:16pm	44	48	Background was controlled by Maud Street traffic. No tonal sources of note.
S2	16/07/24 3:47pm	50	55	Background was controlled by Maud Street traffic. No tonal sources of note.

2.3 Assessment locations

The closest noise sensitive receivers surrounding the site are described in Table 4, and graphically represented in Figure 3. Note, two of these assessment locations (i.e. R1 and R4) are currently vacant lots but have zoned for multi-storey development according to the Maroochydore City Centre PDA [1]. Although there are currently no planning approvals or development applications for these receiver locations, they have been included in the assessment with assumed building heights based on height restrictions detailed in the Maroochydore City Centre PDA [1].

Table 4: Assessment locations

Receiver ID	Receiver type	Address	No. of floors
R1[1]	Residential	Future residential - 201SP321694, Sunshine Coast Council	15
R2		68 Maud St, Maroochydore	2
R3		54 First Ave Maroochydore	16
R4[1]		Future residential - 50SP305312, Sunshine Coast Council	15

R5		20 South Sea Islander Way, Maroochydore	9
R6		20 South Sea Islander Way, Maroochydore	15
R7		50 Maud St, Maroochydore	2
R8		52 Maud St, Maroochydore	3
C1	Commercial	40 Maud St, Maroochydore	3
C2		35 Maud St, Maroochydore	2
C3		44 Maud St, Maroochydore	3
C4		66 Maud St, Maroochydore	1

Notes:

1. Currently vacant lot – number of floors assumed to be 15 floors based on maximum building height restriction of 60 m as per the Maroochydore City Centre PDA [1].

3. Acoustic criteria

3.1 Sunshine Coast Council (SCC) Planning Scheme 2014

Schedule 6, Section 15.4 (SC6.15.4) of Sunshine Coast Planning Scheme 2014 (Amended 11 June 2018) [4] states the following:

"SC6.15.4 Advice for preventing or minimising nuisance emissions and imissions associated with noise and/or vibration

The following is advice for achieving Performance Outcomes PO1 and PO2 of ***Table 9.4.3.3.1 (Performance outcomes and acceptable outcomes for assessable development)*** *of the* ***Nuisance code*** *where there is potential for noise and/or vibration emissions or imissions to cause environmental harm or nuisance at a sensitive land use:-*

(a) compliance with Performance Outcomes PO1 and PO2 of ***Table 9.4.3.3.1 (Performance outcomes and acceptable outcomes for assessable development)*** *of the* ***Nuisance code*** *may be demonstrated in part or aided by the submission of a noise impact assessment report prepared by a competent person, which properly addresses, describes or includes the following:-*

(i) a location plan identifying the subject site and sensitive land uses or the nearest potentially sensitive land uses to the subject site and any significant features such as topographic variation, barriers and intervening buildings;

(ii) the results of measurements of background LA90 noise levels using an appropriate methodology at a location representative of the nearest potentially affected sensitive land uses to the subject site in the absence of noise emissions from the subject site, with:-

(A) the background noise levels to include time periods that are most likely to be sensitive from a noise perspective (generally at night); and

(B) the background noise level to be completed for a sufficient period of time to establish 'the average minimum background noise levels' for the locality;

(iii) comparison of the background noise level with predicted source noise levels using an appropriately recognised methodology and criteria, from the proposed activity at the nearest potentially affected sensitive land uses to determine compliance with criteria as defined in Schedule 1 of the Environmental Protection (Noise) Policy 2008; and

(iv) specification of appropriate control and mitigation measures as necessary;"

The Nuisance code is provided in Section 9.4.3 of the Sunshine Coast Planning Scheme 2014. Section 9.4.3.3 provides performance outcomes and acceptable outcomes. Acoustic performance outcomes and acceptable outcomes relevant to the Proposal has been reproduced in Table 5.

Table 5: Sunshine Coast Planning Scheme 2014 – performance and acceptable outcomes for assessable development

Performance Outcomes		**Acceptable Outcomes**	
Acoustic Amenity and Noise[1]			
PO1	Development, other than development involving live entertainment or amplified music in a designated special entertainment precinct or as part of a temporary event, is located, designed, constructed and operated to ensure that noise emissions do not unreasonably impact on surrounding sensitive land uses having regard to the location and setting of the development. Note—this performance outcome applies even if noise emissions are generated by sensitive land uses, from sources such as communal areas, service areas, plant and equipment (e.g. air conditioning units) and the like.	AO1.1	Development, other than development in a designated special entertainment precinct, involving live entertainment or amplified music is designed and constructed to achieve an amplified music noise level external to existing or approved affected residences of:- (a) LA10 not greater than 5dB(A) above the background noise levels LA90 from 6am to 10pm; and (b) LOCT10 not greater than 8dB above the octave band background noise levels LOCT90 from 10pm to 6am.

			Note: Acceptable outcome AO1 is provided as a guide only. A higher or lower noise level may be appropriate depending on the location, setting and context of the proposed development.
		AO1.2	For development not involving live entertainment or amplified music, no acceptable outcome provided.

Notes:
1. Council will take the order of occupancy of new and existing noise sources into consideration in implementing Performance Outcome PO1 of this code. The intent of this performance outcome is not to require existing lawful uses control noise emissions in response to encroachment by new noise sensitive development.

As this development does not involve live entertainment or amplified music, no acceptable outcomes are provided, hence no targets are considered applicable.

3.2 Environmental Protection (Noise) Policy 2019

The Environmental Protection Policy (EPP) (Noise) 2019 [5] is enshrined under the Environment Protection Act 1994 [6] to govern noise emissions in Queensland.

The EPP (Noise) 2019 [5]:

a. Identifies and declares the environmental values of the acoustic environment to be protected;
b. States acoustic quality objectives that are directed at enhancing or protecting the environmental values; and
c. Provides a framework for making consistent, equitable and informed decisions that relate to the acoustic environment.

Schedule 1 of the EPP (Noise) 2019 [5] presents outdoor and indoor acoustic quality objectives during the day, evening and night-time periods. The acoustic quality objectives for sensitive receivers are reproduced in Table 6 below. The objectives are presented in terms of the adjusted L_{Aeq}, L_{A10} and L_{A1} noise levels over a 1-hour time period.

Table 6: EPP (Noise) 2019 Acoustic Quality Objectives [5]

Sensitive receptor	Time of day	Acoustic quality objectives (measured at the receptor) dB(A)			Environmental value
		$L_{Aeq,adj,1hr}$	$L_{A10,adj,1hr}$	$L_{A1,adj,1hr}$	
Residence (for outdoors)	Daytime and evening	50	55	65	Health and wellbeing
Residence (for indoors)	Daytime and evening	35	40	45	Health and wellbeing
	Night-time	30 (40)[1]	35 (45)[1]	40 (50)[1]	Health and wellbeing, in relation to the ability to sleep
Commercial and retail activity (for indoors)	When the activity is open for business	45 (55)[1]	-	-	Health and wellbeing, in relation to the ability to converse

Notes:

1. Value in bracket denotes equivalent external acoustic quality objective based on a 10 dB(A) façade transmission loss.

This proposal is anticipated to contain plant and equipment generating steady-state noise emissions (i.e. continuous noise emissions). It is anticipated that the L_{Amax} levels of the plant and equipment will be approximately 1-3 dB(A) higher than the L_{Aeq} levels. Noting that the L_{A10} and L_{A1} criteria are 5 and 10 dB(A) higher than the L_{Aeq} criteria, compliance with the L_{Aeq} criteria should ensure compliance with both the L_{A10}

and L_{A1} criteria. Hence, this assessment of noise impacts for site operations has been carried out against the L_{Aeq} targets only.

The EPP (Noise) 2019 [5] also refers to background noise creep stating "that to the extent that it is reasonable to do so, noise must be dealt with in a way that ensures background creep in an area or place is prevented or minimised.

The definition of "background noise creep" is not provided quantitatively in the EPP (Noise) 2019 [5]. In absence of a quantitative definition, reference can be made to the Environmental Protection Act 1994 [6].

3.3 Environment Protection Act 1994

The object of this Act is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development). The Environment Protection Act 1994 (EP Act) [6] defines default noise standards applicable to different noise source emissions.

Relevant requirements are summarised below reproduced from Section 440U and 440V of the EP Act.

Section 440U Air-conditioning equipment

(1) This section applies to premises at or which there is air-conditioning equipment.

(2) An occupier of the premises must not use, or permit the use of, the equipment on any day—

a. Before 7a.m, if it makes a noise of more than 3dB(A) above the background level; or

b. from 7a.m. to 10p.m, if it makes a noise of more than 5dB(A) above the background level; or

c. after 10p.m, if it makes a noise of more than 3dB(A) above the background level.

Section 440V Refrigeration equipment

(1) This section applies to a person who is—

*a. an occupier of premises at or for which there is plant or equipment for refrigeration (**refrigeration equipment**); or*

b. an owner of refrigeration equipment that is on or in a vehicle, other than a vehicle used or to be used on a railway.

(2) The person must not use, or permit the use of, the refrigeration equipment on any day—

a. Before 7a.m, if it makes a noise of more than 3dB(A) above the background level; or

b. from 7a.m. to 10p.m, if it makes a noise of more than 5dB(A) above the background level; or

c. after 10p.m, if it makes a noise of more than 3dB(A) above the background level.

(3) In this section—

Vehicle includes a trailer.

In absence of definition for background creep in the EPP (Noise) 2019 [5], reference can be made to the above sections from the EP Act [6] for appropriate noise limits to minimise background noise creep from plant noise from the development. Criteria for background noise creep can be summarised as follows:

- From 7am to 10pm – Background noise (RBL) + 5 dB(A)
- From 10pm to 7am – Background noise (RBL) + 3 dB(A)

3.4 Project noise planning assessment criteria

The most stringent of the aforementioned applicable criteria will form the project specific noise planning criteria for the development during its proposed operational periods. Table 7 summarises the $L_{Aeq,T}$ based criteria.

Table 7: Project specific assessment criteria

Time period	Rating background level (RBL) dB(A)	EPP – Acoustic Quality (Outdoors)	EP Act Default Noise Standards (Section 440U and 440V)	Noise planning criteria[1]
Residences				
Day	48	50 $dBL_{Aeq,t}$	53 $dBL_{Aeq,t}$	50 $dBL_{Aeq,t}$
Evening	43	50 $dBL_{Aeq,t}$	48 $dBL_{Aeq,t}$	48 $dBL_{Aeq,t}$
Night	40	40 $dBL_{Aeq,t}$	43 $dBL_{Aeq,t}$	40 $dBL_{Aeq,t}$
Commercial and retail activity				
When activity is open for business	-	55 $dBL_{Aeq,t}$	-	55 $dBL_{Aeq,t}$

Note:

1. Based on lowest applicable criteria

For the day and night-time periods, the EPP (Noise) 2019 [5] acoustic quality objectives form the most stringent criteria applicable to the proposed development. Compliance with these criteria will protect the external amenity of outdoor spaces and in doing so will also protect the internal amenity of the building for typical building design.

3.4.1 Critical power failure

There are no specific criteria for emergency plant. Nevertheless, design criteria for the development includes scheduled testing of emergency plant. However, targets are not considered reasonable for critical power failure conditions and would be considered unreasonable to implement further noise treatment due to low likelihood of this scenario. Furthermore, if power failure was to occur, the duration of an outage would be expected to be hours rather than days.

4. Operational noise assessment

4.1 Noise sources

The noise sources on site are outlined in Table 8. Details of plant items modelled are outlined along with associated sound power levels.

This list is a preliminary list of primary equipment. Some equipment items may be redundant, may share loads, may operate at no load, or may be switched off, thereby reducing sound power levels. This assessment therefore represents a conservative assessment scenario.

Noise emissions from all equipment is characterised as steady-state sound in accordance with AS1055:2018 [2] i.e. constant noise emissions.

Note that all primary noise generating plant and equipment are located on the roof level with no ventilation openings on the building facades from the data halls. Furthermore, emergency generators, transformers and load bank are proposed to be located within dedicated enclosures at rooftop level.

Table 8: Project equipment, quantities and noise levels (per unit)

Equipment	Details	No. of	Noise level, dB(A) per item	Octave Band Spectra dB(Z) per item							
				63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Cooling towers	Series 3000 (2021 WQF) S3E-1222-14J/H Whisper Quiet - 80% Capacity	6	L_w 72	75	75	69	64	66	68	59	54
Diesel generators (backup power only)	Penske 2000kWe MTU generator Parratech enclosure Intake louvre dimensions: louvre size 1 (width = 3.9m, height = 2.6m) / louvre size 2 (width = 2.95m, height = 2.6m). Discharge louvre dimensions: width = 2.95m, height = 2.0m. Canopy wall dimensions: short side (width = 2.95m, height = 3.75m) / long side (width = 12.0m, height = 3.75m).	4	Exhaust Flue: L_w 81	92	86	85	76	69	70	70	61
			Intake: L_w 73	82	86	59	48	45	46	55	72
			Outlet: L_w 75	84	88	61	50	47	48	57	74
			Canopy walls: L_w 69	79	83	63	58	62	56	26	29
Transformers (enclosure)	Housed in acoustic enclosure	6	L_w 65	78	73	69	63	56	49	41	29

Equipment	Details	No. of	Noise level, dB(A) per item	Octave Band Spectra dB(Z) per item							
				63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Load bank (enclosure)	Housed in acoustic enclosure with dimensions: length = 6.0m, width = 3.5m, height = 2.5m.	1	L_w 91	98	96	80	84	87	83	77	69
OAP unit	Amcor HTC1800-90P3	4	Combined intake and case breakout L_w 75	77	79	73	72	70	66	61	54
Admin condenser unit	-	1	L_w 75	79	79	76	73	69	66	63	55
Battery/electrical room condenser unit	-	13	L_w 65	69	69	66	63	59	56	53	45
Automatic waste disposal system	Envac system located internally on ground floor. Expected operation to be 30 seconds up to 4 times per day	1	L_p at 1 metre 59	48	50	55	50	52	50	50	46

4.2 Assessment scenarios

To assess potential noise impacts during operation, two scenarios comprising primary noise generating equipment have been developed based on our understanding of the project. These scenarios are considered representative of the noisiest operational activities likely to occur and are described below and in Table 9.

- **Standard operation (24-hours):** assumes all non-emergency equipment operating (excludes standby plant). This scenario is expected to occur 24-hours a day and, therefore, must satisfy the night-time noise criteria.
- **Maintenance operation (daytime only):** assumes all non-emergency equipment operating (excludes standby plant), one (1) emergency generator and one (1) load bank operating for routine maintenance testing. This scenario is only expected to occur during the day (07:00-18:00) and, therefore, must satisfy the daytime noise criteria.

Table 9 outlines the operating scenarios considered in this assessment. The scenarios are considered representative of the noisiest operational activities likely to occur.

Table 9: Modelling scenarios and corresponding plant and equipment

Project equipment	**Model scenarios**	
	Standard operation (24-hours)	**Maintenance operation (daytime only)**
	Number of equipment modelled in 15-minute assessment period	
Cooling Towers	6	6
Diesel generators (backup power only)	0	1[1]
Transformer (enclosed)	6	6
Load bank	0	1[1]
OAP unit	4	4
Admin condenser unit	1	1
Battery/electrical room condenser unit	13	13
Automatic waste disposal system	1	1

Note:

1. Refer to Figure 4 for location of diesel generator and load bank considered in maintenance operation model scenario.

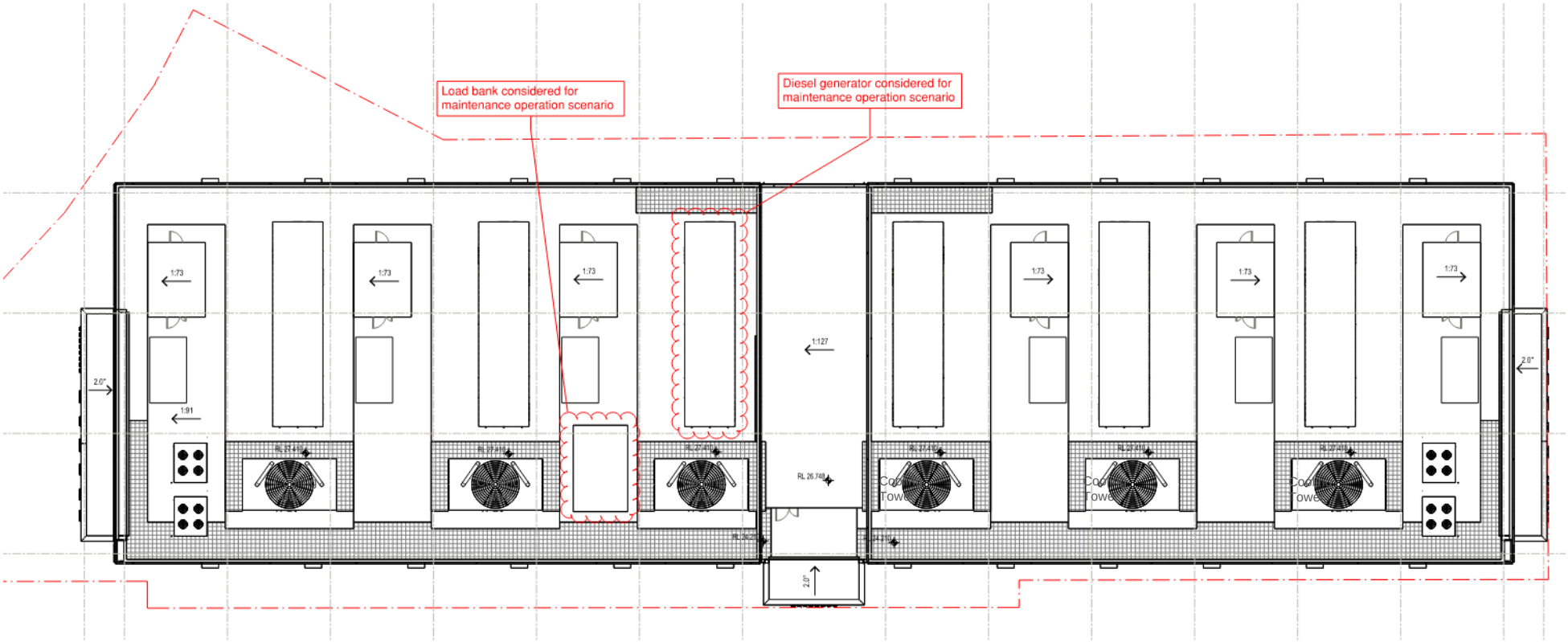


Figure 4: Location of diesel generator and load bank considered in maintenance operation model scenario

4.3 Modelling methodology

Preliminary noise levels for the whole site have been predicted to the identified nearest sensitive receivers using SoundPlan 9.0 using ISO9613-2:1996 [7]. The model includes:

- Receivers listed in Section 2.3
- Activity noise sources listed in Section 4.1
- On-site and surrounding buildings; and
- Ground terrain and absorption

4.4 Predicted noise levels

Table 10 summarises predicted noise levels for each model scenario based on assessment scenarios presented in Table 7 and mitigation measures detailed in Section 4.5.

Operations are assessed against the most stringent applicable planning criterion (i.e. 24 hours operations against night, maintenance operations against day). Furthermore, assessment locations generally consist of multiple receiver locations to evaluate noise impacts over increasing levels of multi-storey buildings. However, only the highest predicted noise level per assessment location is presented. Detailed receiver location noise levels are presented in Appendix C.

Table 10: Predicted mitigated noise levels, dB $L_{Aeq,15min}$

Assessment location	Worst affected floor	Standard operations (24 hours, assessed to most stringent night criteria)			Maintenance operations (day criteria)		
		Noise planning criteria	Predicted noise level[1]	Compliance	Noise planning criteria	Predicted noise level[1]	Compliance
R1	F 14	40	28	Yes	50	36	Yes
R2	F 1	40	18	Yes	50	24	Yes
R3	F 15	40	27	Yes	50	31	Yes
R4	F 14	40	38	Yes	50	43	Yes
R5	F 8	40	37	Yes	50	43	Yes
R6	F 14	40	41 (40[2])	Marginal (Yes[2])	50	48	Yes
R7	F 1	40	33	Yes	50	37	Yes
R8	F 2	40	32	Yes	50	35	Yes
C1	F 3	55	24	Yes	55	28	Yes
C2	F 1	55	22	Yes	55	28	Yes
C3	F 2	55	35	Yes	55	38	Yes
C4	GF	55	18	Yes	55	24	Yes

Note:

1. Highest predicted noise level per assessment location.
2. Predicted noise level based on a 100% operating assumption, value in brackets represents anticipated noise level and compliance based on nominal reduced operating assumption.

Results show compliance with the most stringent noise planning criteria is achieved for both standard operations and maintenance operations at all assessment location with the exception of location R6.

A marginal one (1) dBA exceedance has been predicted at assessment location R6 during the night-time period for standard operations when assessed against the most stringent night-time criteria. It is noted that

compliance would be achieved when assessed against the *EP Act Default Noise Standards* (night-time criteria of 43 dBA as per Table 7).

In Arup experience, during the critical evening and night-time periods, cooling plant run at a lower operating load and therefore lower noise level. The reduced load operating conditions has not been sourced at this stage and therefore, a marginal exceedance has been predicted based on a conservative 100% operating assumption. However, in reality, compliance is anticipated to be met.

Additionally, plant and equipment selections will be further refined during the detailed design of the project and quieter plant selections will be investigated with the suppliers.

Section 4.5 details noise mitigation measures to be implemented.

4.5 Mitigation measures

Note, the following noise mitigation requirements are based on current architectural and building services design including preliminary equipment selections and associated noise levels. If design development results in significant changes to layout, systems design and equipment noise levels the following required noise mitigation measures will be subject to review and modification. As such, alternative noise mitigation measures may be suitable provided the noise planning criteria in Table 7 are satisfied.

4.5.1 Level 4 roof top parapet

To control noise impacts from Level 4 rooftop plant and equipment, the parapet has been relied upon to provide acoustic screening. The parapet is required to be solid/impervious (i.e. no louvres – must have solid backing material such as FC sheeting etc.) and extend to the height indicated in the architectural drawings.

The screen in expected to extend around all four sides of the Level 4 roof perimeter as indicated in Figure 5.

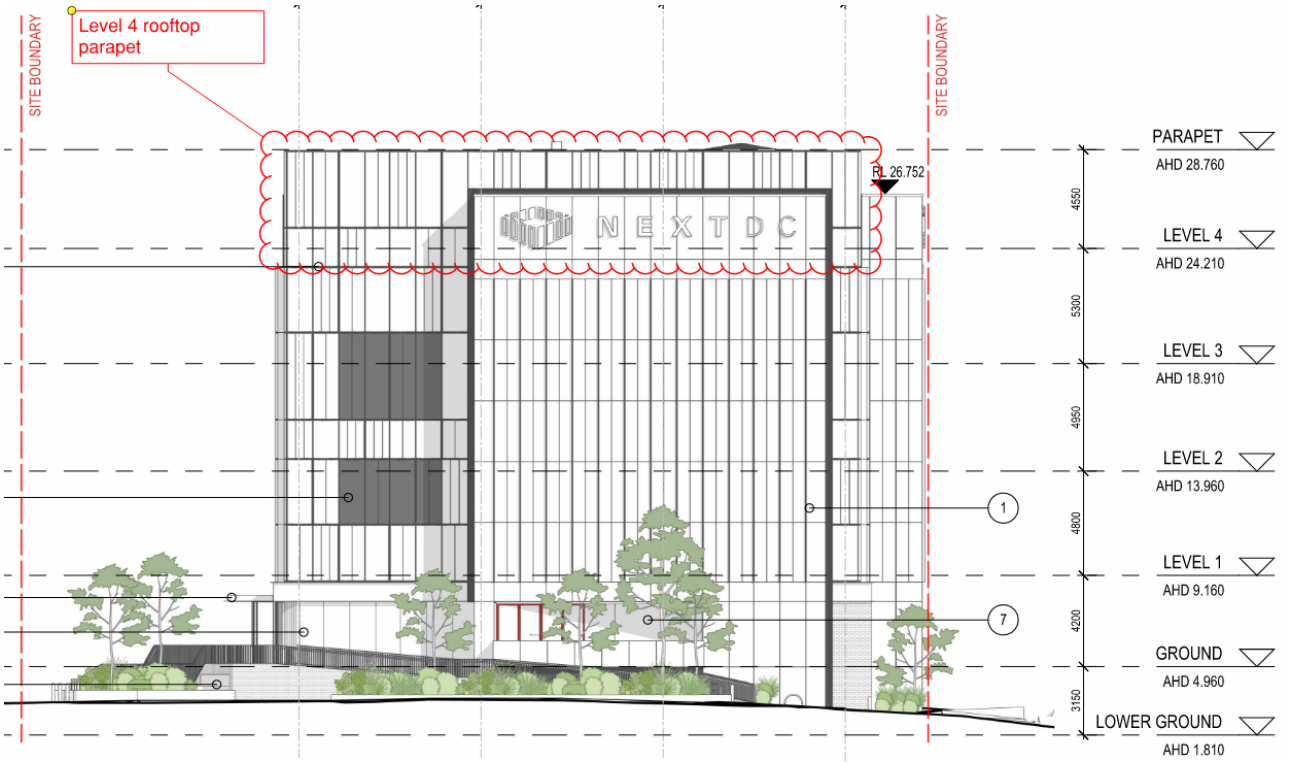


Figure 5: Level 4 rooftop parapet to provide acoustic screening

4.5.2 Cooling towers

Cooling towers shall be selected such that the total sound power level does not exceed the total sound power level stated in Table 8 (i.e. **72 L_{Aeq} dB**) and free of tonal, impulsive and modulating noise characteristics.

4.5.3 Condenser units

Condenser units to service administration spaces and electrical rooms as well as the OAP units shall be selected such that the total sound power level of the casing and intake/outlet openings do not exceed the total sound power levels stated in Table 8.

4.5.4 Back-up diesel generators

The generator set shall be provided with a dedicated acoustic enclosure to meet the following acoustic performance with the generator working at full load:

Table 11: Generator requirements

Item	Sound level description and assumed surface areas	L_{eq}, dB(A)
Sound pressure levels[1, 2]		
Generator exhaust	Lp @ 1 m	73
Generator enclosure walls *(Enclosure walls consist of a long side and a short side)*	Lp @ 1 m 12 m x 3.75 m (L x H)	56
	Lp @ 1 m 2.95 m x 3.75 m (L x H)	60
Generator intake louvres *(Intake tower consists of three louvres on three faces)*	Lp @ 1 m 3.9 m x 2.6 m (L x H)	66
	Lp @ 1 m 3.9 m x 2.6 m (L x H)	66
	Lp @ 1 m 2.95 m x 2.6 m (L x H)	65
Generator discharge louvre *(Discharge tower consists of one louvre on one face)*	Lp @ 1 m Louvre size: 2.95 m x 2.0 m	67

Notes:

1 – Noise emission from the acoustic enclosure shall be free of tonal, impulsive and modulating noise.

2 – Sound pressure levels are indicative only, as sound power will be dependent on surface area and size of components.

The following are typically required for the dedicated generator building to meet the acoustic performance:

- Generator exhaust attenuators shall be included in the acoustic enclosure. Allowance should be made for two silencers (absorptive and reactive) on the combustion exhaust.
- Attenuators and/or acoustic/weather louvres shall be included in the acoustic enclosure for air intake and discharge. The Contractor is responsible for ensuring that the selected attenuators and acoustic/weather louvers are appropriate for use with the generator and the environment in which they are located, taking account of allowable pressure losses etc.
- The enclosure shall be sealed airtight between panels at connections and access doors.
- Vibration isolators shall be included to control vibration and vibration-induced noise emission.
- The dedicated acoustic enclosure shall be installed in accordance with the manufacturer's instructions and ensure the acoustic performance is not compromised due to poor installation.

4.5.5 Load bank

The load bank shall be provided with a dedicated acoustic enclosure to meet the following acoustic performance working at full load:

Table 12: Load bank requirements

Item	Sound level description	L_{eq}, dB(A)
Sound power level[1]		
Load Bank	L_w 2.5 m x 6.0 m x 2.5 m (W x L x H) (Within acoustic enclosure)	90

Notes:

1 - Noise emission from the acoustic enclosure shall be free of tonal, impulsive and modulating noise.

4.5.6 Transformers

Transformers shall be selected such that the total sound power level of the casing/enclosure does not exceed the total sound power level stated in Table 8 (i.e. **65 L_{Aeq} dB**).

4.6 Loading dock operations

Loading dock activities, including deliveries, are proposed to take place within the loading dock on the lower ground floor. Access to the loading bay is via Red Bill Lane as shown in Figure 6.

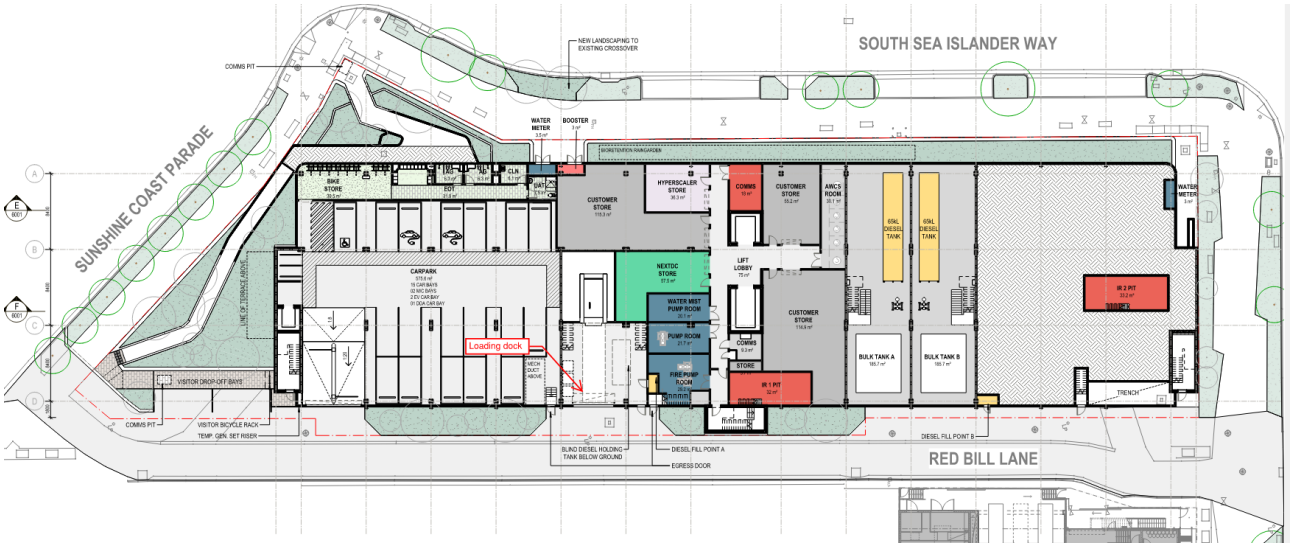


Figure 6: Loading dock access

Sound power levels associated with loading dock activities are presented in Table 13.

Table 13: Loading dock activities and associated sound power levels

Noise Source	Descriptor	dB(A)	Octave Band Centre Frequency – Hz, dB(Z)									Quantity operating in worst case 15 minutes
			31.5	63	125	250	500	1 k	2 k	4 k	8 k	
Rigid truck travelling along driveway – time corrected 24 hours	L_{Aeq}	64	78	71	62	63	60	59	58	52	46	2 events representing truck arriving and leaving
Moving of large containers during the day (7am to 6pm)	L_{Aeq}	88	98	97	93	88	84	82	78	73	63	1 continuous event over 5 minutes
Moving of small deliveries, eg. boxes, during evening and night (after 6pm before 7am)	L_{Aeq}	78	88	87	83	78	74	72	68	63	53	1 continuous event over 30 seconds

Predicted noise levels at the worst affected residential receiver, R7 (50 Maud Street), located opposite Red Bill Lane from the loading dock, are presented in Table 14.

Table 14: Loading dock assessment

Receiver	**Loading dock activities within worst case 15 minutes**	**$dBL_{Aeq(15minute)}$ assessment**		
		Predicted Noise level	**Noise planning criteria**	**Compliance**
Day	Truck entering and leaving, containers being dropped and moved	50	50	Yes
Evening	Truck entering and leaving, small deliveries, eg. boxes being moved	40	48	Yes
Night			40	Yes

5. Construction noise and vibration

Noise from construction/building work is regulated by the Environmental Protection Act 1994 [6] or Local Council (i.e. Sunshine Coast Council) in the event Council has developed its own laws for construction/building work noise. In lieu of Sunshine Coast Council providing a specific framework and/or noise criteria for construction/building work noise, default noise standards in the Environmental Protection Act 1994 (EP Act) [6] shall apply.

Note, the EP Act [6] default noise standards do not include numerical criteria for periods where audible construction noise is permitted (see Section5.1). On this basis, a preliminary quantitative noise impact assessment has not been undertaken. However, anticipated construction activities, plant and equipment noise sources and recommended construction noise and vibration mitigation and management procedure have been provided as part of a qualitative assessment. Furthermore, it is expected that a detailed construction noise and vibration impact assessment and management plan will be prepared by the construction contractor when actual activities and construction equipment is known.

5.1 Environment Protection Act 1994

Pursuant to the Environmental Protection Act 1994 [6], all development involving the emission of noise from building and/or construction activities, must ensure that the emissions are in accordance with the requirements of the EP Act [6].

The EP Act [6] prescribes that:

Section 440R Building work

(1) A person must not carry out building work in a way that makes an audible noise—

a. on a business day or Saturday, before 6.30a.m. or after 6.30p.m; or

on any other day, at any time.

(2) The reference in subsection (1) to a person carrying out building work—

a. includes a person carrying out building work under an owner-builder permit; and

b. otherwise, does not include a person carrying out building work at premises that are the person's principal place of residence.

Note: A request can be made to work outside of these hours by submitting an Environmental Management Plan for assessment and obtaining an endorsed decision from the Environmental Management delegate Development Assessment.

5.2 Anticipated construction activities and durations

Construction/building work is expected to involve the stages and approximate durations outlined in Table 15.

Table 15: Construction stages

Stage	Anticipated duration
Stage 1: Site establishment and excavation	1 month
Stage 2: Pavement and road works	2 months
Stage 3: Building construction	10 months
Stage 4: Plant installation and connection (staged)	Unspecified

5.3 Anticipated construction plant and equipment

Table 16 summarises anticipated construction equipment and associated sound power levels determined by reference to AS2436 [8], BS5228-1 [9] and Arup's measurement database.

Table 16: Equipment and plant sound power levels

Plant item	Plant item SWL, dB(A)	% of use in worst case 15 mins	Construction Phases			
			Site establishment and excavation	Pavement & road works	Building construction	Plant installation and connection
Backhoe	108	100	1			
Compactor	115	100	1	1		
Concrete Pump	106	100		1	1	
Concrete Pump Truck[3]	113	100		1	1	
Concrete Saw	122	100		1	1	
Crane (Franna)	98	100			1	
Crane (Tower)	105	100			1	
Excavator (30t) + hydraulic hammer	122	100	3	1		
Generator (Diesel)	113	100	1	1	1	
Grader	115	100	1	1		
Jack Hammer	121	100		1		
Loader (Front-end) (23t)	112	100	1	1		
Roller (Smooth-drum)	107	100		1		
Roller (Vibrator)	112	100	2			
Scraper	116	100	1			
Truck > 20 tonne	107	100	1	1		
Truck (Water Cart)	108	100	2	2	1	
Vehicle (Light Commercial e.g. 4WD)	111	100	2	2	2	1

Notes:

1. Penalty applied for impulsive noise characteristics.
2. All plant items are considered 'non-steady sounds' except the generator which is considered to be 'steady sound'.
3. As defined in AS2436.

5.4 Qualitative assessment

Considering the anticipated construction stages, stage durations, construction equipment and associated sound power levels in addition to small separation distances to neighbouring development, construction noise impacts are expected.

Section 5.5 provides recommended construction noise and vibration mitigation and management measures for consideration.

5.5 Construction noise and vibration management

The contractor will have a key role in managing the noise and vibration levels during the works to reduce noise and vibration as far as is reasonably practicable. However, a summary of recommended construction noise and vibration mitigation measures are presented in Table 17.

Table 17: Recommended construction noise and vibration mitigation and management measures

ID	Impacts	Mitigation	Responsi-bility	Timing
Construction				
Noise and vibration management plan	Adverse noise and vibration impacts	A Construction Noise and Vibration Management Plan shall be prepared prior to the issuing of a Construction Certificate. This will specify the actual plant to be used and will include updated estimates of the likely levels of noise and the scheduling of activities.	Contractor	Construction
Staffing	Adverse noise and vibration impacts	Appointing a named member of the site staff who will act as the Responsible Person with respect to noise and vibration; Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise; Ensuring good work practices are adopted to avoid issues such as noise from dropped items, noise from communication radios is kept as low as is practicable; Avoid the use of radios or stereos outdoors; and Avoid shouting and minimise talking loudly and slamming vehicle doors.	Contractor	Construction
Plant and equipment	Adverse noise impacts	Where possible stationary equipment should be located behind structures such as demountable buildings or stockpiles to maximise shielding to receivers; Consider using electric / hydraulic equipment where possible Using the smallest equipment as is practical All plant and equipment used on site must be: maintained in a proper and efficient condition; and operated in a proper and efficient manner. Turn off all vehicles, plant and equipment when not in use Ensuring that the Responsible Person checks the conditions of the powered equipment used on site daily to ensure plant is properly maintained and that noise is kept as low as practicable.	Contractor	Construction
Scheduling	Adverse noise impacts	Ensure that the Responsible Person controls the working hours on site to ensure that work is only done during the acceptable periods (7am to 6pm on weekdays and 8am to 1pm on Saturdays. No work on Sundays or public holidays) High noise activities will be programmed to occur during the standard construction hours wherever possible and will be scheduled with due consideration to the nearest sensitive receivers.	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Work site training	Adverse noise impacts	'Toolbox talks' will be held at regular intervals with the contractor workers, including discussion of noise and vibration mitigation, monitoring and assessment. These topics will also be covered under induction processes. Operate two-way radios at the minimum effective volume, and avoid shouting or whistling at the site. Identification of all reasonable and feasible noise mitigation methods will be conducted by the Responsible Person on a daily basis during noisy works. The Responsible Person will have the authority to modify work practices in response to complaints, where this is considered appropriate.	Contractor	Construction
Community liaison	Adverse noise and vibration impacts	Ensuring that the Responsible Person keeps the local community advised on expected activities and coordinates scheduling and locations of noisy works around any critical user events where practicable. This shall include face to face meetings with nearby receivers if requested and a letter box drop, and shall include close liaison with neighbours during construction. Maintaining appropriate records of complaints to include timing, reported issues, actions taken and measures to be included for on-going works. The complaints log will need to be filed with the Responsible Person.	Contractor	Construction
Reversing alarms	Adverse noise impacts	The use of audible movement alarms of a type that would minimise noise impacts on surrounding noise sensitive receivers must be implemented. Where practicable, broadband, non-tonal reversing alarms should be utilised on site equipment. Ensure that the difference in volume between the reversing warning devices and the base machine noise level (at maximum governed speed under no load at any given test location) is minimised (in accordance with International Standard ISO9533:2010 [7]), and ensure that warning devices are no more than 5 dB above the Australian Standard level;	Contractor	Construction
Material handling	Adverse noise and vibration impacts	Avoid dropping equipment/materials from a height or into trucks. Where practicable, use sound dampening material to cover the surfaces on to which any materials must be dropped.	Contractor	Construction
Equipment Location	Adverse noise impacts	Site noisy equipment away from noise-sensitive areas. Plant known to emit noise strongly in one direction is to be orientated so that the noise is directed away from noise-sensitive areas; Locate site access roads and site compounds as far away as possible from noise sensitive receptors; Plan truck movements to avoid residential streets where possible;	Contractor	Construction

ID	Impacts	Mitigation	Responsi-bility	Timing
Vibration management	Adverse vibration impacts	The safe working distances presented in Table 18 should be maintained between activities and buildings and structures. Distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. The contractor will be required to manage vibration as well as noise and make use of best practice in the management of vibration using simple and practicable techniques such as avoiding dropping heavy items. Where vibration intensive works are required within the minimum working distances outlined in Table 18, vibration monitoring at the nearest potential affected building should be considered, where real-time alerts can be generated when measured vibration levels exceed criteria. Less vibration intensive methods of construction would then be required, such as the use of lower capacity equipment over a longer duration. Given the structures immediately adjacent to the site, adverse effects to both human comfort and structural damage are possible if management measures are not adhered to.	Contractor	Construction

Considering deep and/or extensive excavation works are not proposed at this stage, vibration impacts are expected to be minimal. Notwithstanding, Table 18 provides recommended minimum working distances for vibration intensive plant typically used during construction. These are based on international standards and guidance.

Table 18: Recommended minimum working distances for vibration intensive plant

Plant Item	Rating / Description	Minimum working distance	
		Cosmetic damage[1] (BS 7385 [10])	Human response (OH&E Vibration Guideline [11])
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg – 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure
Piling rig	Diesel impact piling	To be developed as part of the CNVMP[2]	

Note:

1. More stringent conditions may apply to heritage or other sensitive structures

2. (**C**onstruction **N**oise and **V**ibration **M**anagement **P**lan). Once piling details such as impact frequency and energy is known.

6. Conclusion

A noise and vibration impact assessment has been carried out for the proposed NEXTDC SC2 Data Centre in accordance with the requirements of the Queensland Environmental Protection Act 1994 and other relevant planning regulations and guidelines regarding operational and construction phases of the development respectively.

The operational noise assessment established noise planning criteria, identified the primary noise generating items of plant and equipment, established key assessment scenarios, summarised noise prediction results and investigated in principle noise mitigation measures necessary to satisfy the most stringent planning criteria. Compliance is predicted at all assessment locations under all scenarios for all time periods with the recommended noise mitigation measures.

Regarding construction, while specific activities and work schedules are not yet known, criteria and standard hours of construction are identified. A preliminary qualitative noise assessment has been carried out which suggests anticipated construction activities, while not required to satisfy a numerical criterion during standard hours of operation, is expected to result in noise impacts at nearby surrounding developments. Recommended construction noise and vibration mitigation and management measures are provided in Section 5.5, however, it is expected that a detailed construction noise and vibration impact assessment and management plan will be prepared by the construction contractor.

It is recommended compliance with established criteria is included into Approval Conditions.

7. References

[1] Sunshine Coast Regional Council, “Maroochydore City Centre Priority Development Area Development Scheme,” March 2024. [Online]. Available: https://publicdocs.scc.qld.gov.au/hpecmwebdrawer/RecordHtml/23662257. [Accessed 2024].

[2] Standards Australia, “AS 1055 Acoustics—Description and measurement of environmental noise,” Standards Australia, Sydney, 2018.

[3] Department of Environment and Science, “Noise Measurement Manual,” 10 March 2020. [Online]. Available: https://www.des.qld.gov.au/policies?a=272936:policy_registry/eis-tm-noise-measurement-manual.pdf. [Accessed 2024].

[4] Sunshine Coast Regional Council, “Sunshine Coast Planning Scheme 2014,” 21 May 2014. [Online]. Available: https://www.sunshinecoast.qld.gov.au/development/planning-documents/sunshine-coast-planning-scheme-2014/view-the-sunshine-coast-planning-scheme-2014-text. [Accessed 2024].

[5] Department of Environment and Science, “Environmental Protection (Noise) Policy,” 1 September 2019. [Online]. Available: https://www.legislation.qld.gov.au/view/pdf/asmade/sl-2019-0154. [Accessed 2024].

[6] The State of Queensland, “Environmental Protection Act 1994,” Office of the Queensland Parliamentary Counsel, Brisbane, 1994.

[7] International Organization for Standardization, “ISO 9533:2010 Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria,” International Organization for Standardization, Geneva, 2010.

[8] Standards Australia, “AS 2436-2010 - Guide to noise and vibration control on construction, demolition and maintenance sites,” Standards Australia, 2010.

[9] BSI Standards Limited 2014, “BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites,” BSI Standards Limited 2014, London, 2009+A1:2014.

[10] British Standards Institution, *BS 7385-2: 1993 Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from groundborne vibration,* London: British Standards Institution, 1993.

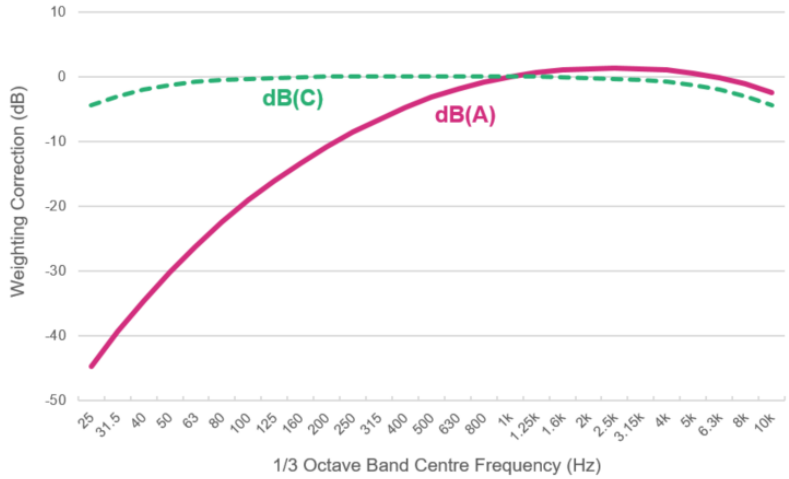
[11] Department of Environment and Conservation NSW, “Assessing Vibration: a technical guideline,” Department of Environment and Conservation NSW, Sydney, 2006.

[12] International Organization for Standardization, *ISO 9613-2 Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation,* Switzerland: International Organization for Standardization, 1996.

Appendix A

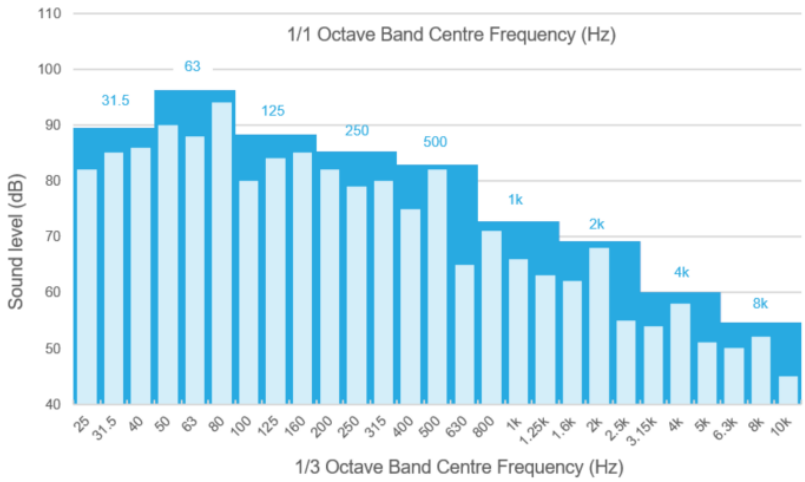
Acoustic terminology

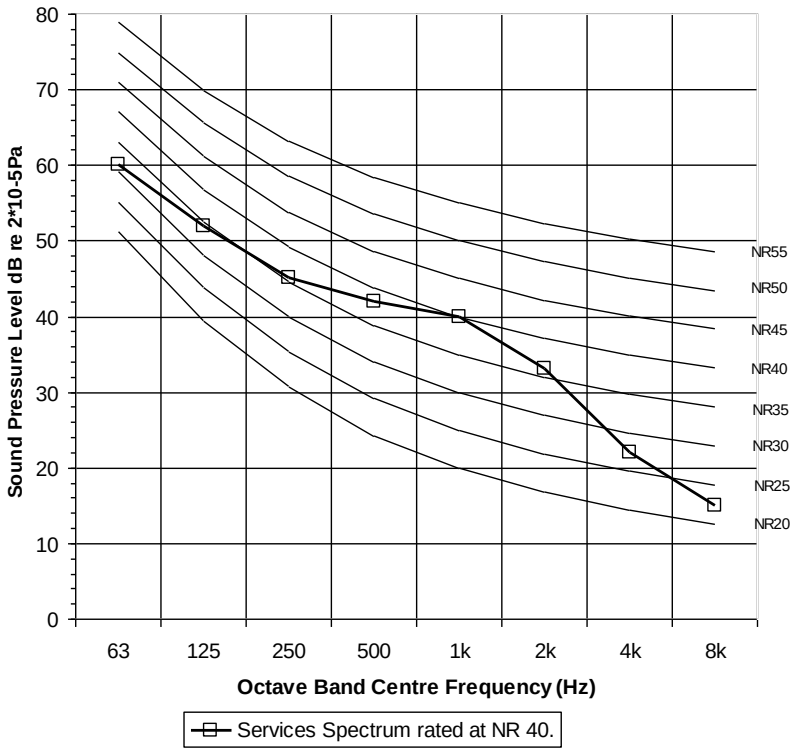
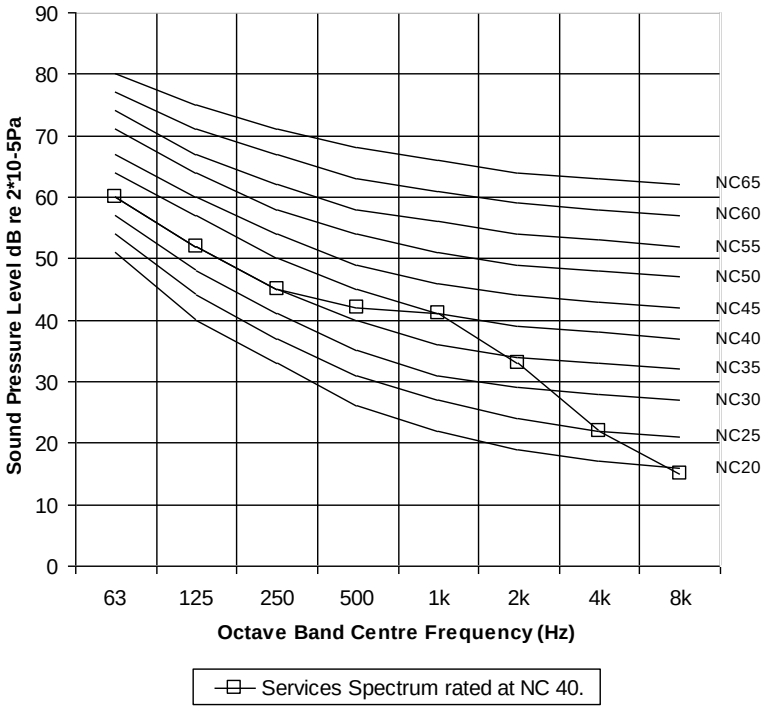
Term	Definition
Absorption Coefficient, α	The amount of sound absorbed by a material, defined as the ratio of the amount of acoustic absorption of the material (in units of sabins) to the material's surface area. Absorption coefficient is broadly equivalent to the proportion of sound energy absorbed by the material typically from 0 to 1. Noise-reduction Coefficient (NRC): The arithmetic average of the sound-absorption coefficients of a material at 250 Hz, 500 Hz, 1 kHz and 2 kHz. It is a simplified single-number index that provides an indication of the sound absorbing efficiency of a material. Weighted absorption coefficient (α_w): The weighted absorption coefficient, defined in ISO 11654 is a frequency-weighted single number absorption coefficient used to categorise the overall absorption effectiveness of a material. Descriptors are used to indicate if the material absorbs strongly at high (H), mid (M) and/or low (L) frequencies – e.g. a material may be rated as α_w 0.85(LH), which indicates that it strongly absorbs at both low and high frequencies. Materials can also be assigned into five absorption classes, with Class A having the highest absorption and Class E having the lowest absorption.
Ambient noise level	The ambient noise level is the overall noise level measured at a location from multiple noise sources. When assessing noise from a particular development, the ambient noise level is defined as the remaining noise level in the absence of the specific noise source being investigated. For example, if a fan located on a building is being investigated, the ambient noise level is the noise level from all other sources without the fan operating, such as traffic, birds, people talking and other noise from other buildings.
Background noise level	The background noise level is the noise level that is generally present at a location at all or most times. Although the background noise may change over the course of a day, over shorter time periods (e.g. 15 minutes) the background noise is almost-constant. Examples of background noise sources include steady traffic (e.g. motorways or arterial roads), constant mechanical or electrical plant and some natural noise sources such as wind, foliage, water and insects. Assessment Background Level (ABL): A single-number figure used to characterise the background noise levels from a single day of a noise survey. ABL is derived from the measured noise levels for the day, evening or night time period of a single day of background measurements. The ABL is calculated to be the tenth percentile of the background L_{A90} noise levels – i.e. the measured background noise is above the ABL 90% of the time. Rating Background Level (RBL / min$L_{A90,1hour}$): A single-number figure used to characterise the background noise levels from a complete noise survey. The RBL for a day, evening or night time period for the overall survey is calculated from the individual Assessment Background Levels (ABL) for each day of the measurement period, and is numerically equal to the median (middle value) of the ABL values for the days in the noise survey.
Decibel (dB)	The logarithmic scale used to measure sound and vibration. Human hearing is not linear and involves hearing over a large range of sound pressures, which would be challenging to present on a linear scale. A logarithmic scale allows all sound levels to be expressed based on how loud they are relative to a reference sound (typically 20 µPa, which is the approximate human threshold of hearing). For sound in other media (e.g. underwater noise) a different reference level (1 µPa) is used instead. An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB.
dB weighting curves	The frequency of a sound affects its perceived loudness and human hearing is less sensitive at low and very high frequencies. When seeking to represent the summation of sound pressure levels across the frequency range of human hearing into a single number, weighting is typically applied. Most commonly, A-weighting, denoted as dB(A), is used for environmental noise assessment. This is often supplemented by the linear or C-weighting curves, where there is the potential for excess low-frequency sound at higher sound pressure levels.

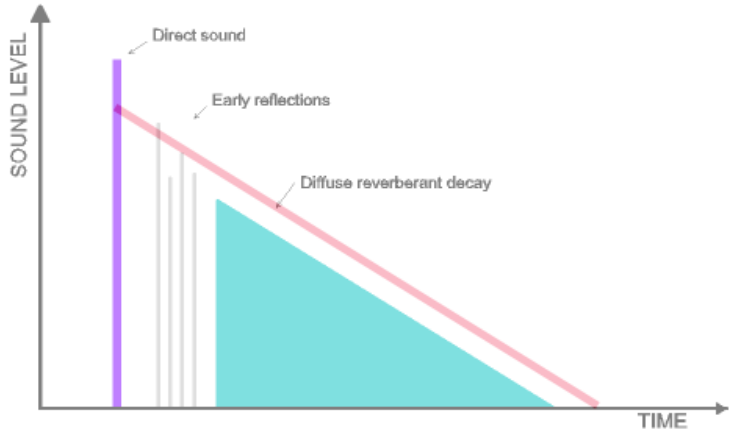
Term	Definition
	
dB(A)	dB(A) denotes a single-number sound pressure level that includes a frequency weighting ('A-weighting') to reflect the subjective loudness of the sound level. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, and so the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A). Some typical dB(A) levels are shown below.

Sound Pressure Level, dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street
70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

dB_{peak}	The peak value is the maximum amplitude identified during a measurement period.
dB_{rms}	The root mean squared (rms) value takes into account both time history variation and energy content. The rms value is typically equal to 0.707 ($1/\sqrt{2}$) times the peak value
Frequency	Frequency is the number of cycles per second of a sound or vibration wave. In musical terms, frequency is described as 'pitch'. Sounds towards the lower end of the human hearing frequency range are perceived as "bass" or 'low-pitched' and sounds with a higher frequency are perceived as 'treble' or 'high pitched'. The unit of frequency is the hertz (Hz), which is identical to cycles per second. A thousand Hz is generally denoted as kHz. Human hearing ranges approximately from 20 Hz to 20 kHz. While single weighted sound pressure levels simplify the assessment and evaluation of sound levels, frequency analysis is often undertaken. 'Octave bands', either 1/1 or 1/3 octave bands are most commonly utilised and are referred to by the nominal centre frequency of the band (e.g. 31.5 Hz), while being the summation of all frequencies between a defined lower and upper frequency.

Term	Definition
	
Impact Sound Pressure Level	The technical parameter used to determine impact sound isolation of floors is the impact sound pressure level, L_i. In the laboratory, the weighted normalised impact sound pressure level, $L_{n,w}$, is used to represent the impact sound isolation as a single figure. On site, the weighted normalised apparent impact sound pressure level, $L'_{n,w,}$ and the weighted standardised apparent impact sound pressure level, $L'_{n,Tw}$, are used to represent the impact sound isolation of a floor as a single figure. These single weighted values are determined by comparing the spectral impact sound pressure levels (as defined in ISO 140-6 and ISO 140-7) with reference values outlined in AS/NZS ISO 717.2.
$L_{1(period)}$	The sound level exceeded for 1% of the measurement period. For example, 65 $dBL_{A1,1min}$ indicates that the A-weighted sound level would not exceed 65 dB for more than 0.6 seconds in the 1-minute measurement period.
$L_{10(period)}$	The sound level exceeded for 10% of the measurement period, or alternatively, the sound levels would be lower for 90% of the time. The L_{10} is often defined as the 'average maximum' sound levels, as in AS1055-1978 with the advent of statistical sound level meters.
$L_{90(period)}$	The sound level exceeded for 90% of the measurement period. The L_{90} is often defined as the 'average minimum' or 'background' noise level for a period of measurement. For example, 45 $dBL_{A90,15min}$ indicates that the sound level is higher than 45 dB(A) for 90% of the 15-minute measurement period.
$L_{eq(period)}$	The equivalent ('eq') continuous sound level, used to describe the level of a time-varying sound or vibration measurement. The L_{eq} is often defined as the 'average' level, and mathematically, is the energy-average level over a measurement period – i.e. the level of a constant sound that contains the same sound energy as the measured sound.
L_{max}	The L_{max} is the 'absolute maximum' level of a sound or vibration recorded over the measurement period. As the L_{max} is often caused by an instantaneous event, it can vary significantly between measurements.
Noise Rating (NR) Curves	A set of internationally-agreed octave band sound pressure level curves, based on the concept of equal loudness. The curves are commonly used to define building services noise limits. The 'NR' value is obtained by plotting the octave band spectrum on the set of standard curves. The highest value curve which is reached by the spectrum is the NR value. Shown below is a mechanical plant noise spectrum at NR 40.

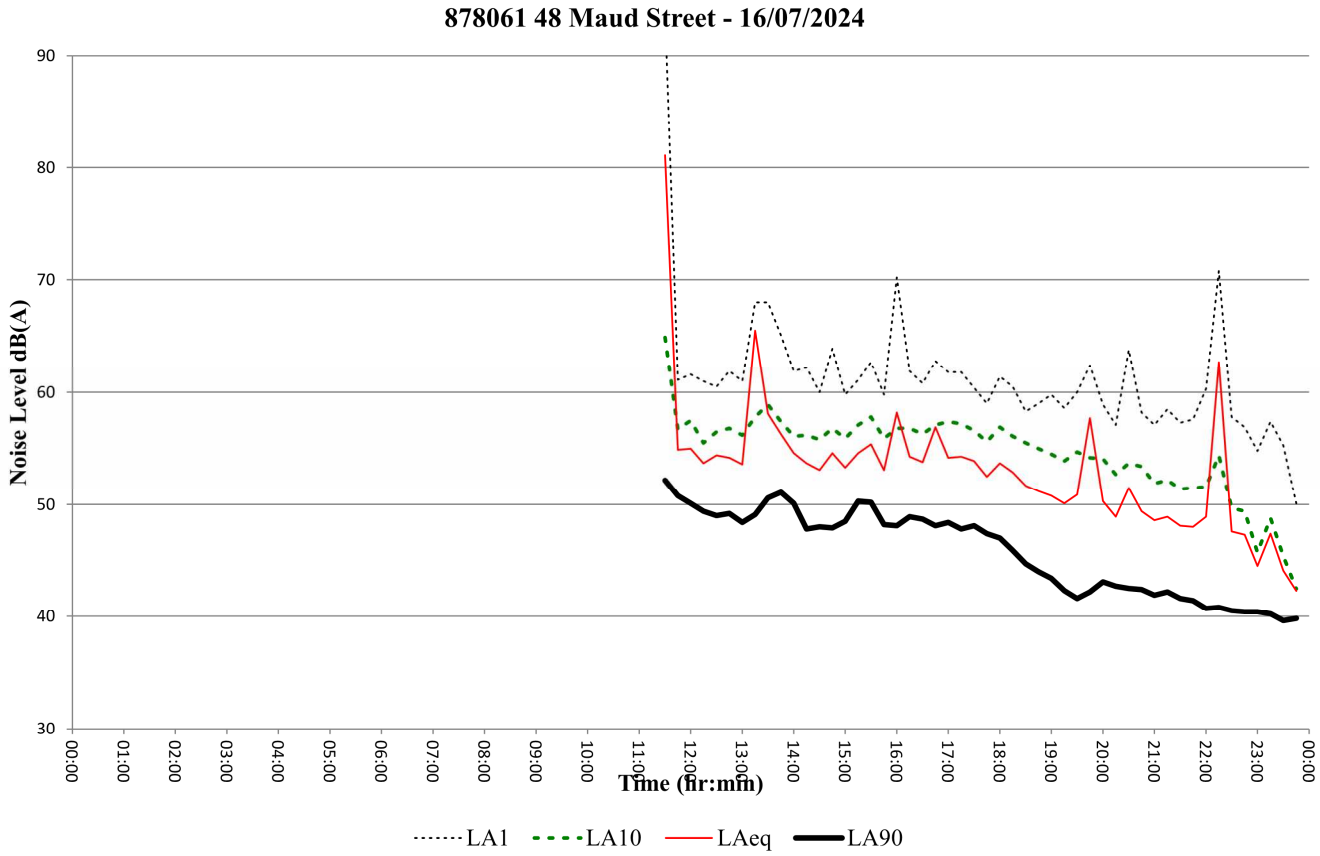
Term	Definition
	
Noise Criteria (NC) Curves	Originally developed in the USA, the curves are commonly used to define building services noise limits. The NC value is obtained by plotting the octave band spectrum of a noise measurement on the set of standard curves. The highest value curve reached by the spectrum is the NC value. Shown below is a mechanical plant noise spectrum equivalent to NC 40. 
Peak Particle Velocity (PPV)	The highest velocity of a particle (such as part of a building structure) as it vibrates. PPV is commonly used as a vibration criteria, and is often interpreted as a PPV based on the L_{max} or $L_{max,spec}$ index.
Reverberation Time (T_{60})	The time, in seconds, taken for a sound within a space to decay by 60 dB after the sound source has stopped is denoted at the reverberation time (RT).

<table>
<tr><th>Term</th><th>Definition</th></tr>
<tr><td></td><td>The RT is an important indicator of the subjective acoustic within a space. A long RT subjectively corresponds to an acoustically ‘live’ space, while a short RT subjectively corresponds to an acoustically ‘dead’ space.
Examples of typical design reverberation times are provided below:
<table>
<tr><th>Mid-frequency reverberation time, s</th><th>Example</th></tr>
<tr><td>< 0.1</td><td>Anechoic – little to no reverberation</td></tr>
<tr><td>0.1 – 0.4</td><td>Call centres</td></tr>
<tr><td>0.4 – 0.6</td><td>Library</td></tr>
<tr><td>0.6 – 0.8</td><td>Offices / board rooms</td></tr>
<tr><td>0.8 – 1.0</td><td>Small auditorium for speech</td></tr>
<tr><td>1.0 – 1.2</td><td>Music studios</td></tr>
<tr><td>1.2 – 1.5</td><td>Chamber music venues</td></tr>
<tr><td>1.5 – 2.0</td><td>Orchestral music venues</td></tr>
<tr><td>2.0 – 3.0</td><td>Church</td></tr>
<tr><td>3.0 – 8.0</td><td>Cathedral</td></tr>
</table>

</td></tr>
<tr><td>Sound Level Difference (D)</td><td>Used to quantify the sound insulation between two spaces and is equal to the difference in sound level between the rooms within a particular frequency band. For example, if the sound level in the source room is 100 dB and the sound level in the adjacent room is 75 dB, the sound level difference is 25 dB for that frequency band.
The weighted sound level difference, D_w, as defined in AS/NZS ISO 717.1, is used to provide a single-number descriptor to describe the overall performance of a partition across multiple frequency bands. Note however that D_w is only calculated over a frequency range from 100 Hz to 3.15 kHz and hence sound outside of this range is excluded from calculation of D_w – particularly low frequency (bass) sound below 100 Hz.
Also used are the weighted normalised level difference ($D_{n,w}$), which corrects the measured sound level difference to a reference sound absorption area in the receiving room, or the weighted standardised level difference ($D_{nT,w}$), which corrects the measurements to a reference reverberation time in the receiving room.
These single numbers are determined by comparing the spectral sound insulation test results (as defined in ISO 140-4) with reference values, as outlined in AS/NZS ISO 717.1.</td></tr>
<tr><td>Sound Power and Sound Pressure</td><td>The sound power level (L_w) of a source is a measure of the total acoustic power radiated by a source. The sound pressure level (L_p) varies as a function of the environment and distance from a source.
The sound power level is an intrinsic characteristic of a source (analogous to its mass), which is not affected by the environment within which the source is located.</td></tr>
<tr><td>Sound Reduction Index (R)</td><td>A measure of the sound level loss through a material for a particular frequency band. Sound reduction index is sometimes also referred to as transmission loss. It is a property of the component, unlike the sound level difference, which is affected by the common area between the rooms and the acoustics of the receiving room. R is the ratio (expressed in decibels) of the sound energy transmitted through the building element to the sound energy incident on the building element for a particular frequency band.</td></tr>
</table>

Term	Definition
	The weighted sound reduction index, R_w, is a single figure description of sound reduction index across multiple frequency bands and is defined in BS EN ISO 717-1: 1997. R_w values are calculated from measurements in an acoustic laboratory. Note however that R_w is only calculated over a frequency range from 100 Hz to 3.15 kHz and hence sound outside of this range is excluded from calculation of R_w – particularly low frequency (bass) sound below 100 Hz. Sound insulation ratings derived from site measurements are referred to as apparent sound reduction index (R'_w) ratings.
Spectrum Adaptation Terms (C and C_{tr})	C and C_{tr} denote a spectrum adaptation (in dB) that are added to the R_w or D_w value of a partition to adjust for different sound characteristics. C is used to measure the performance of a partition for medium to high-frequency sound sources, such as speech. C_{tr} is used to measure the performance of a partition for low-frequency sound sources such as road traffic. The values of C and C_{tr} are dependent on the construction of the partition and are usually negative quantities, they typically increase the R_w requirement of a partition. For example, for a partition with an R_w of 56 dB and C_{tr} -6 dB, the R_w+C_{tr} is only 50 dB. The overall performance of the partition is quoted as the sum of the R_w value and the spectrum adaptation terms, e.g. D_w+C 55 dB; R_w+C_{tr} 60 dB.
Structureborne noise	The transmission of noise energy as vibration of building elements. The energy may then be re-radiated as airborne noise. Structureborne noise is controlled by structural discontinuities, i.e. expansion joints and floating floors.
Vibration	Waves in a solid material are called ‘vibration’, as opposed to similar waves in air, which are called ‘sound’ or ‘noise’. If vibration levels are high enough, they can be felt; usually vibration levels must be much higher to cause structural damage. A vibrating structure (e.g. a wall) can cause airborne noise to be radiated, even if the vibration itself is too low to be felt. Structureborne vibration limits are sometimes set to control the noise level in a space. Vibration levels can be described using measurements of displacement, velocity and acceleration. Velocity and acceleration are commonly used for structureborne noise and human comfort. Vibration is described using either metric units (such as mm, mm/s and mm/s^2) or else using a decibel scale.

Appendix B

Noise monitoring graphs


878061 48 Maud Street - 16/07/2024
Noise Level dB(A)
90
80
70
60
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00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
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11:00
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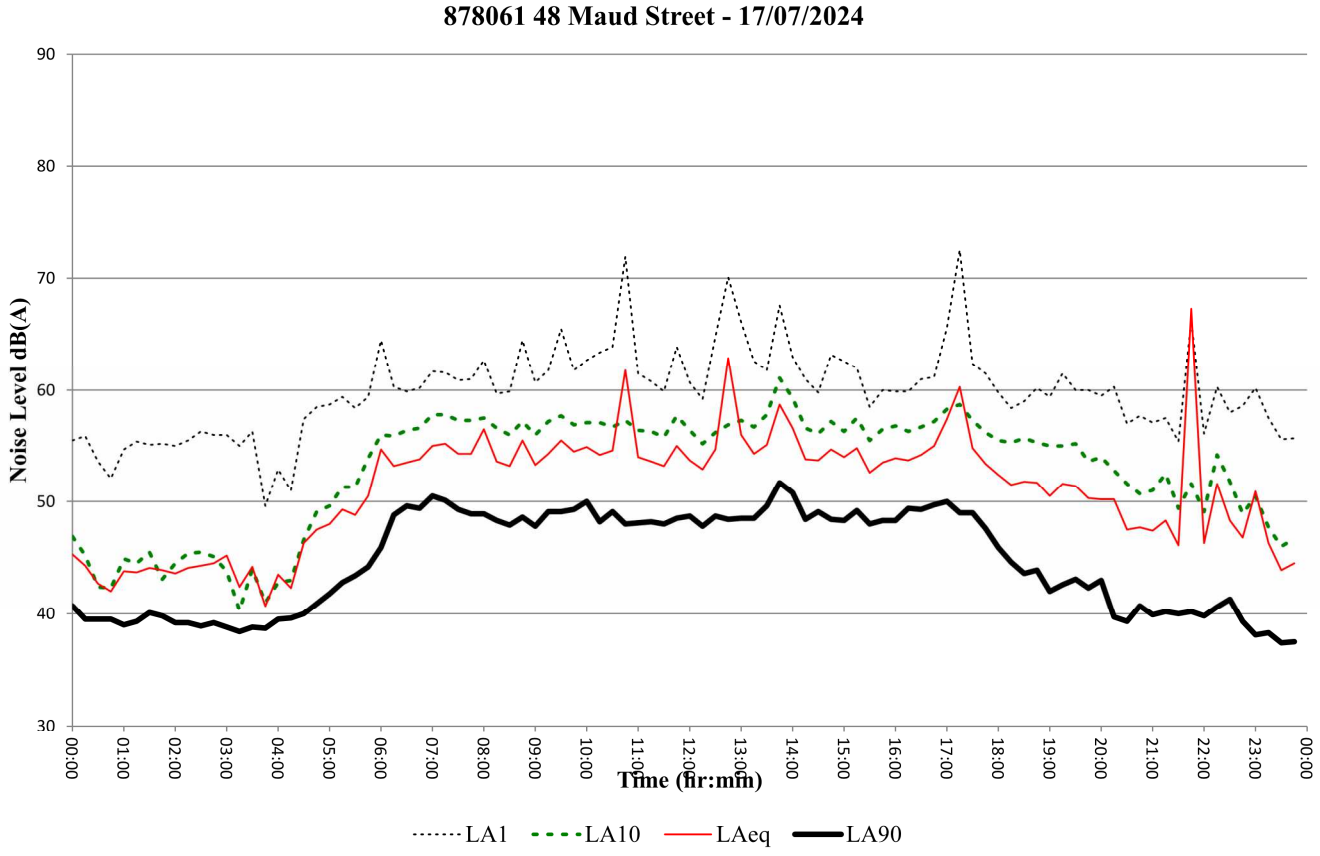
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00
Time (hr:mm)
LA1
LA10
LAeq
LA90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Noise Level dB(A)
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80
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03:00
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23:00
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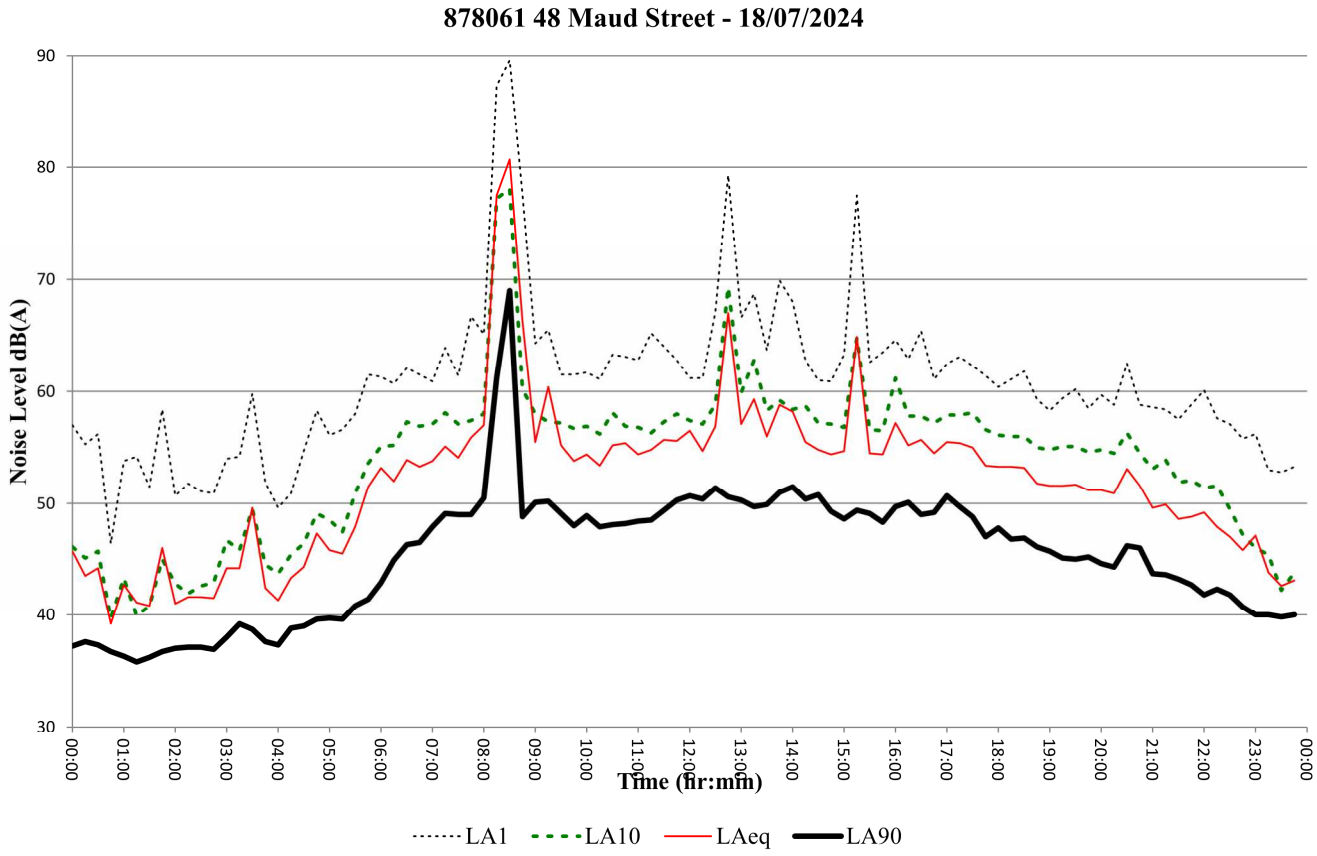
Time (hr:mm)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 18/07/2024
Noise Level dB(A)
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80
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04:00
05:00
06:00
07:00
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16:00
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21:00
22:00
23:00
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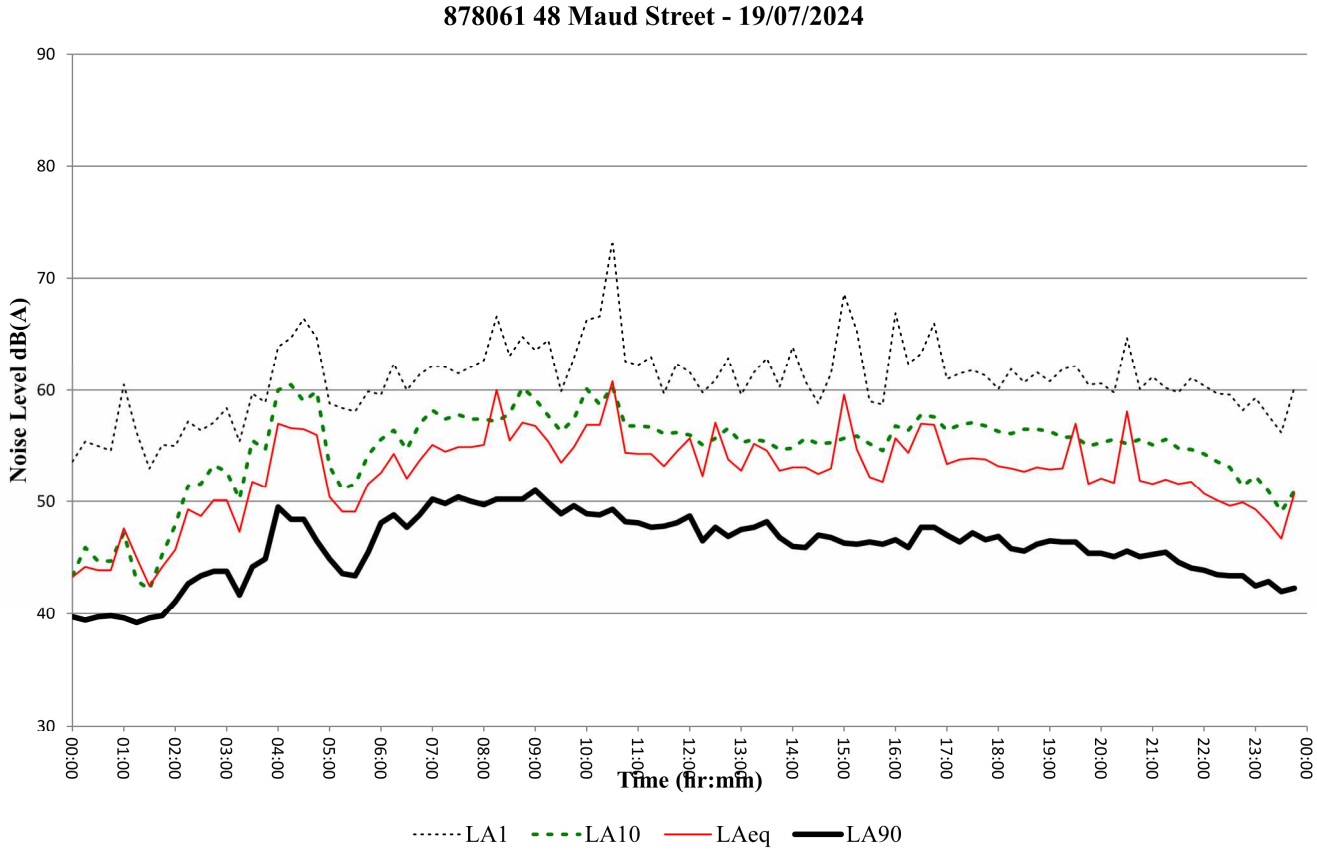
Time (hr:mn)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 19/07/2024
Noise Level dB(A)
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80
70
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00:00
01:00
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04:00
05:00
06:00
07:00
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16:00
17:00
18:00
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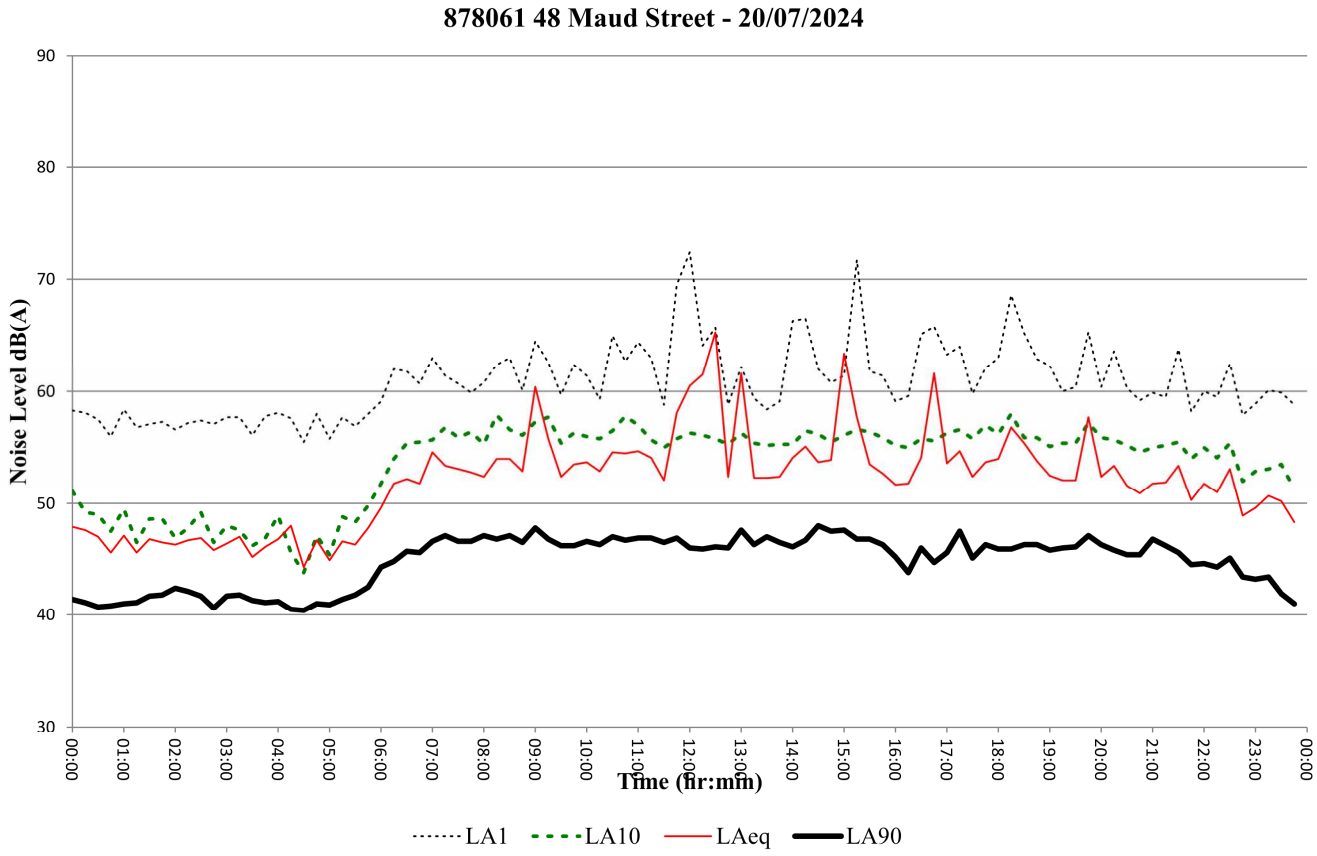
21:00
22:00
23:00
00:00
Time (hr:mn)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 20/07/2024
Noise Level dB(A)
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80
70
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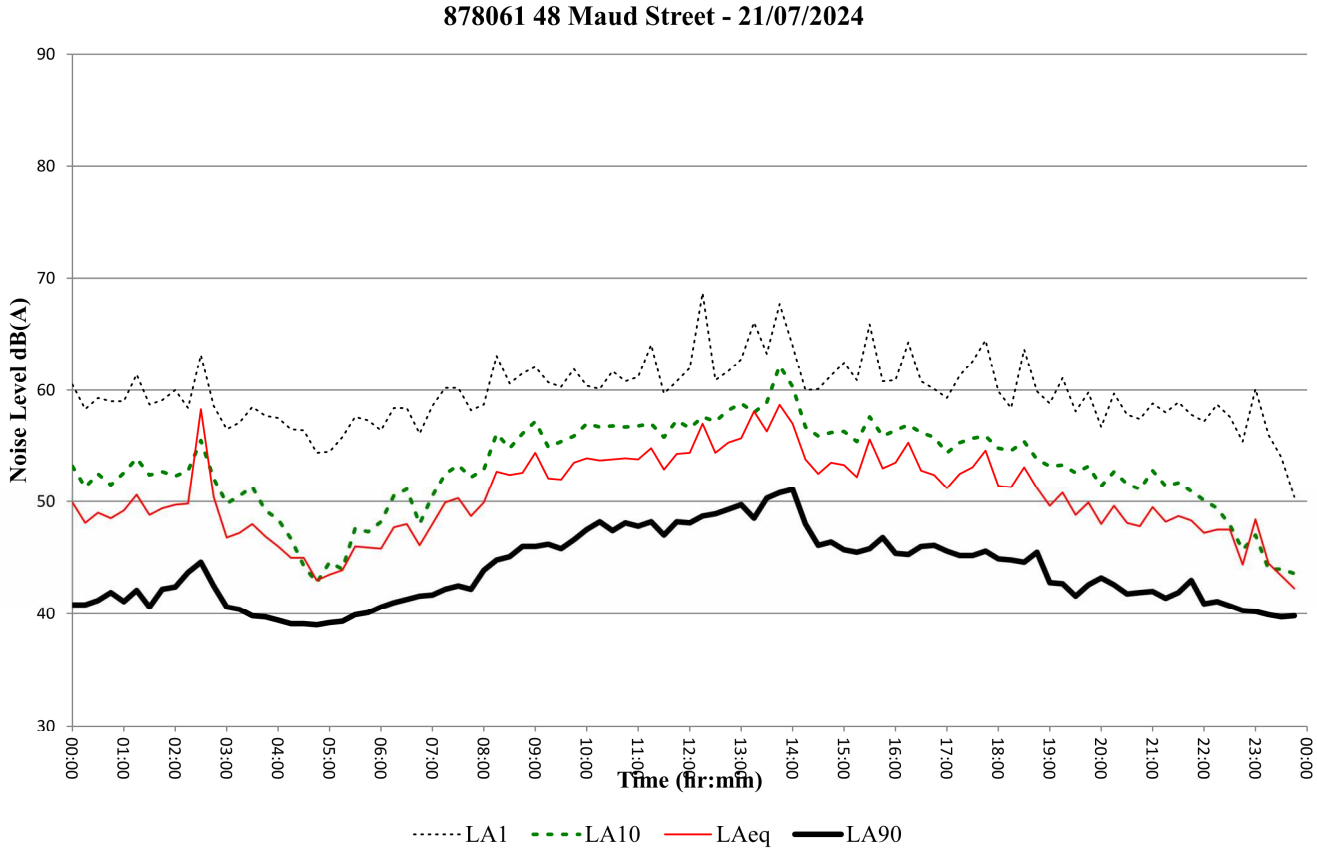
22:00
23:00
00:00
Time (hr:mn)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 21/07/2024
Noise Level dB(A)
90
80
70
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16:00
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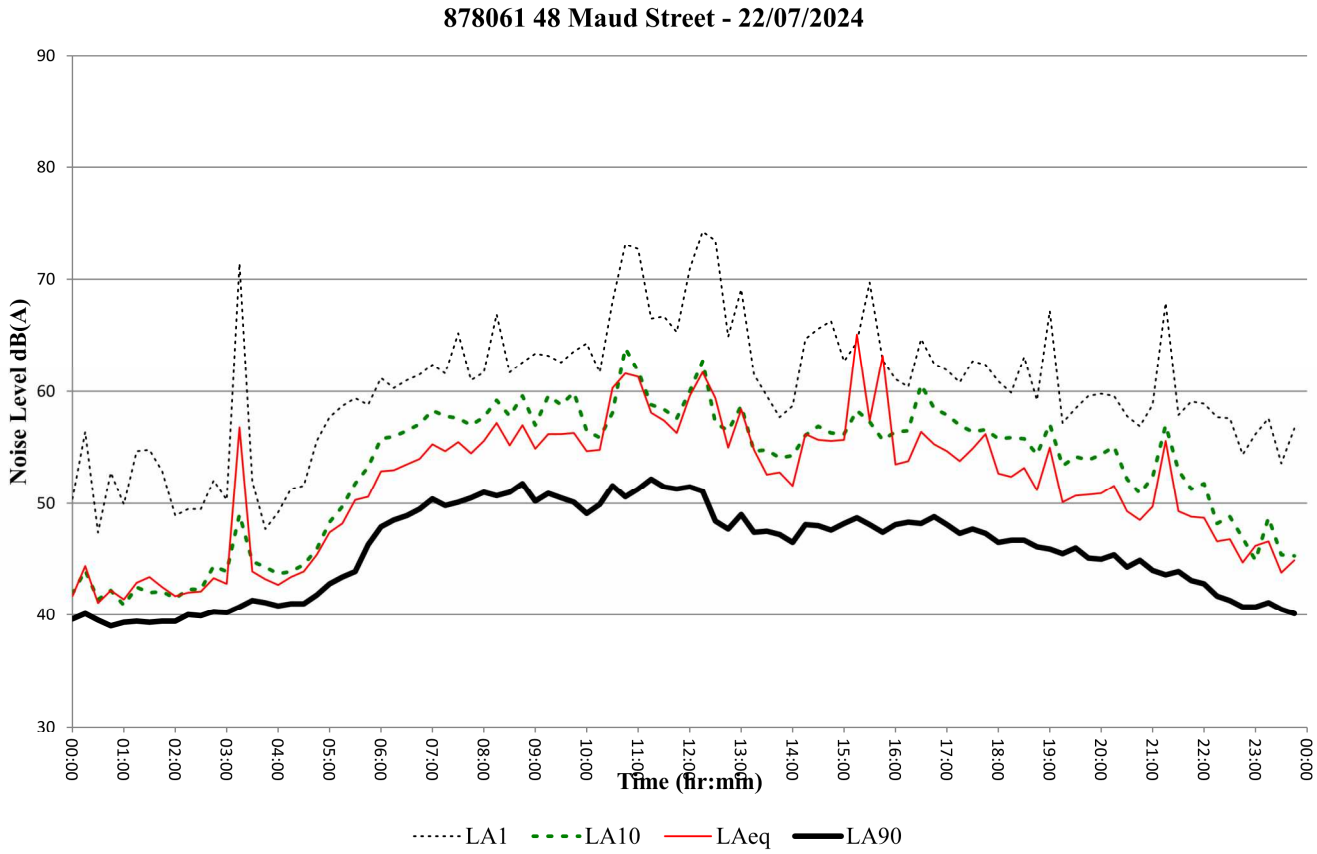
20:00
21:00
22:00
23:00
00:00
Time (hr:mn)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 22/07/2024
Noise Level dB(A)
90
80
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06:00
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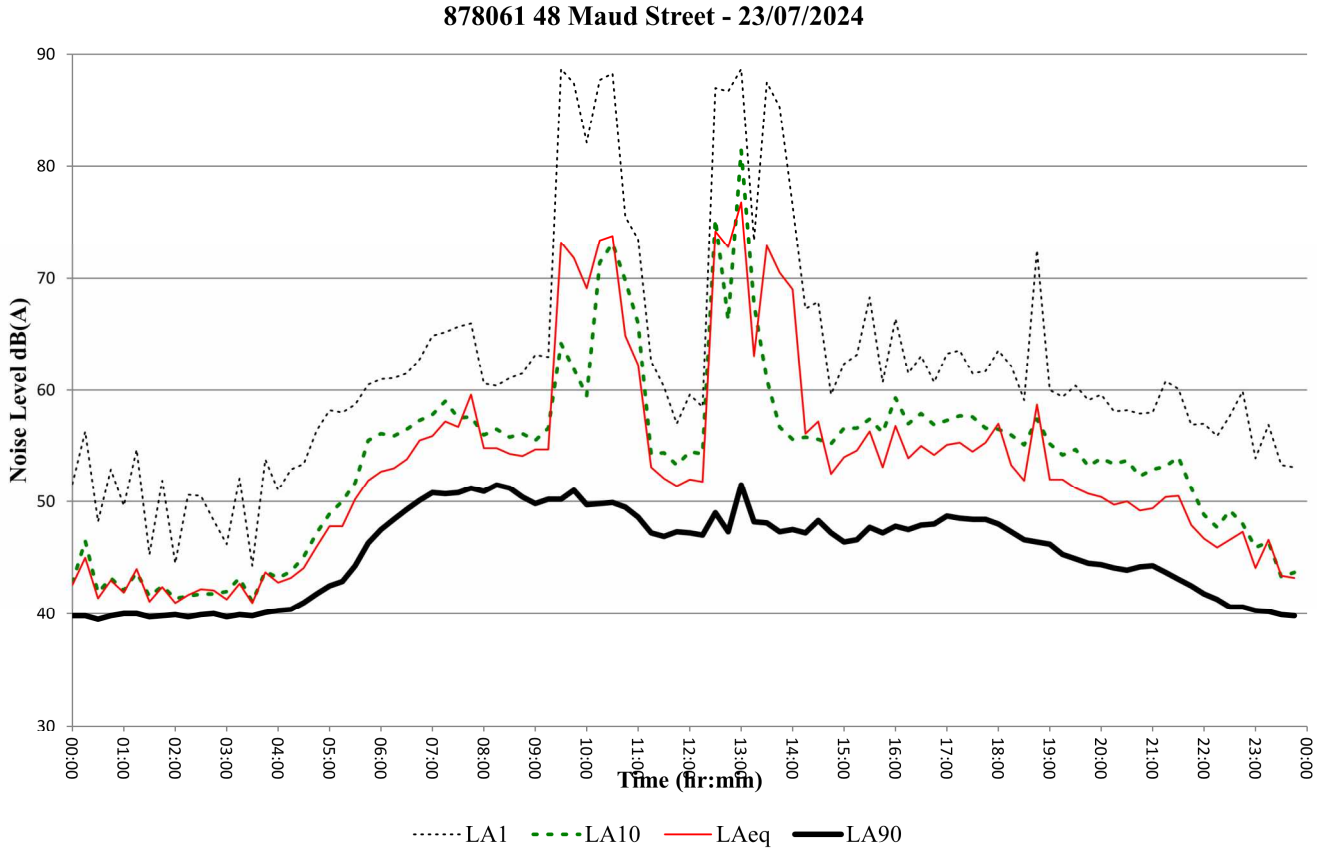
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
00:00
Time (hr:mm)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 23/07/2024
Noise Level dB(A)
90
80
70
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23:00
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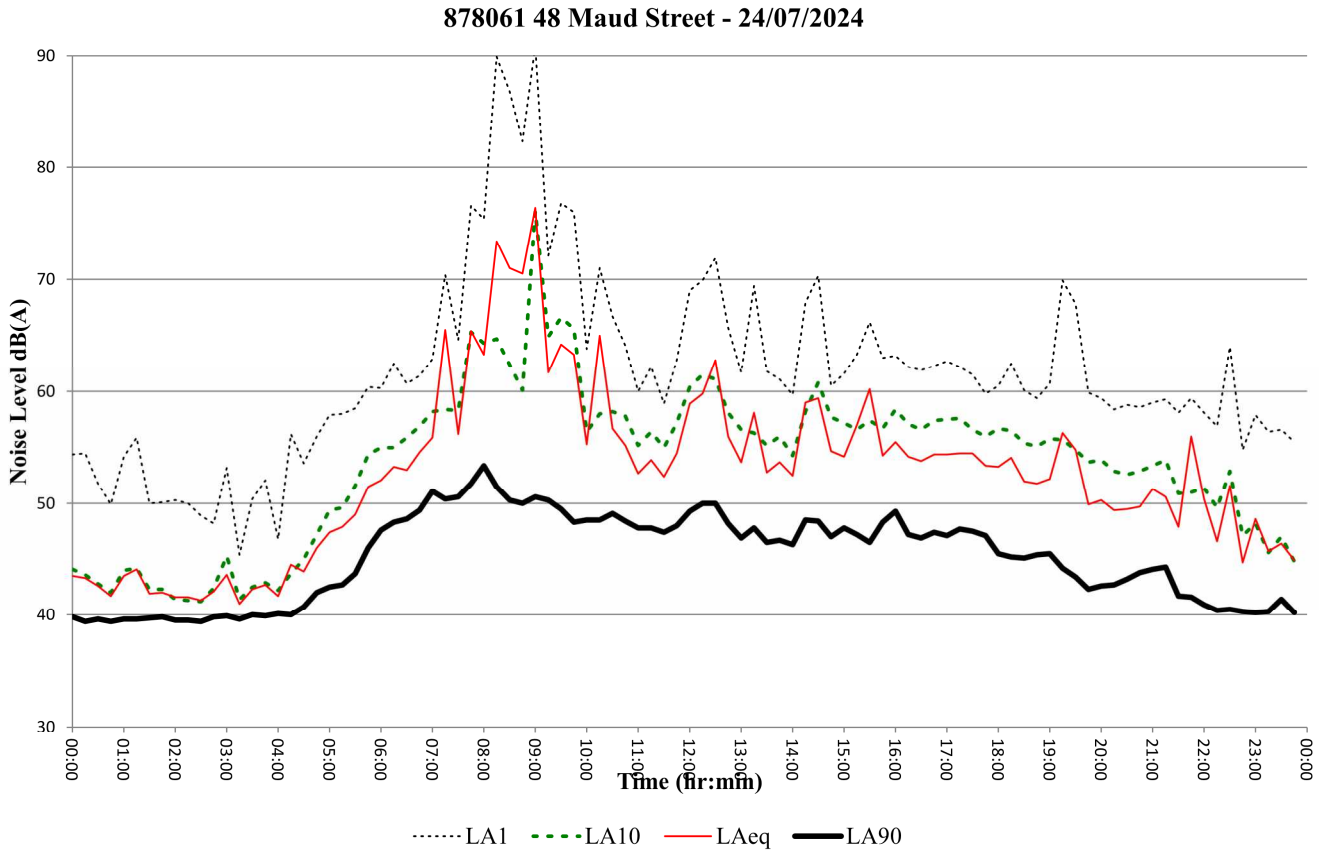
Time (hr:mm)
LA1
LA10
LAeq
LA90


878061 48 Maud Street - 24/07/2024
Noise Level dB(A)
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80
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00:00
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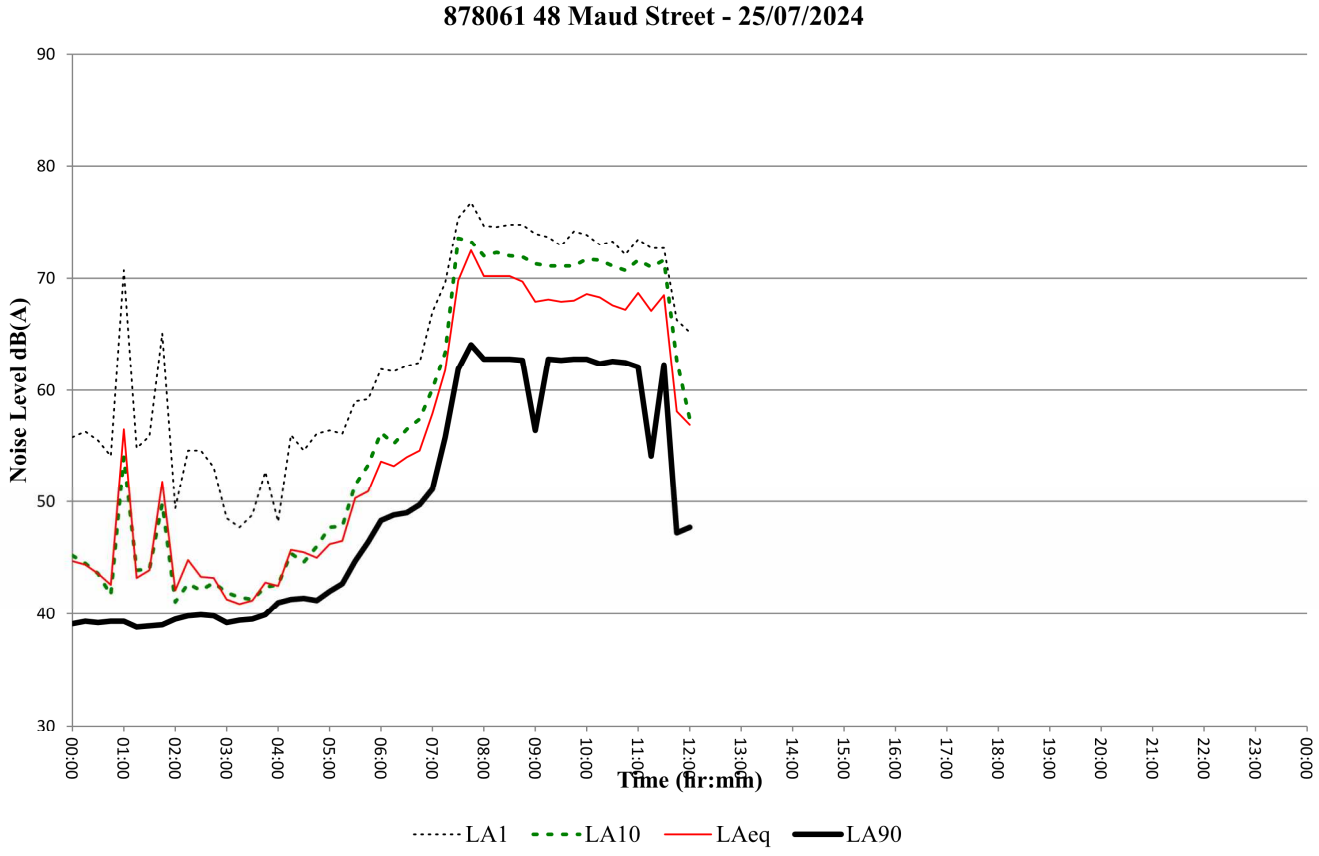
Time (hr:mn)
LA1
LA10
LAeq
LA90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Noise Level dB(A)
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00:00
01:00
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04:00
05:00
06:00
07:00
08:00
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16:00
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21:00
22:00
23:00
00:00
Time (hr:mn)
LA1
LA10
LAeq
LA90

Appendix C

Predicted noise levels at all floor levels

Predicted mitigated noise levels, dB $L_{Aeq,15min}$

Assessment location	Floor	Standard operations			Maintenance operations		
		Noise planning criteria	Predicted noise level	Compliance	Noise planning criteria	Predicted noise level	Compliance
R1	GF	40	16	Yes	50	23	Yes
R1	F 1	40	18	Yes	50	24	Yes
R1	F 2	40	19	Yes	50	25	Yes
R1	F 3	40	20	Yes	50	26	Yes
R1	F 4	40	21	Yes	50	27	Yes
R1	F 5	40	22	Yes	50	29	Yes
R1	F 6	40	24	Yes	50	30	Yes
R1	F 7	40	25	Yes	50	32	Yes
R1	F 8	40	26	Yes	50	33	Yes
R1	F 9	40	26	Yes	50	34	Yes
R1	F 10	40	27	Yes	50	34	Yes
R1	F 11	40	27	Yes	50	35	Yes
R1	F 12	40	28	Yes	50	35	Yes
R1	F 13	40	28	Yes	50	35	Yes
R1	F 14	40	28	Yes	50	36	Yes
R2	GF	40	12	Yes	50	21	Yes
R2	F 1	40	18	Yes	50	24	Yes
R3A	GF	40	15	Yes	50	20	Yes
R3A	F 1	40	16	Yes	50	20	Yes
R3A	F 2	40	17	Yes	50	21	Yes
R3A	F 3	40	18	Yes	50	22	Yes
R3A	F 4	40	19	Yes	50	22	Yes
R3A	F 5	40	20	Yes	50	23	Yes
R3A	F 6	40	20	Yes	50	24	Yes
R3A	F 7	40	21	Yes	50	25	Yes
R3A	F 8	40	22	Yes	50	26	Yes
R3A	F 9	40	22	Yes	50	27	Yes

Assessment location	Floor	Standard operations			Maintenance operations		
		Noise planning criteria	Predicted noise level	Compliance	Noise planning criteria	Predicted noise level	Compliance
R3A	F 10	40	23	Yes	50	27	Yes
R3A	F 11	40	24	Yes	50	28	Yes
R3A	F 12	40	24	Yes	50	28	Yes
R3A	F 13	40	25	Yes	50	29	Yes
R3A	F 14	40	25	Yes	50	30	Yes
R3A	F 15	40	26	Yes	50	30	Yes
R3B	GF	40	16	Yes	50	20	Yes
R3B	F 1	40	16	Yes	50	21	Yes
R3B	F 2	40	17	Yes	50	22	Yes
R3B	F 3	40	18	Yes	50	22	Yes
R3B	F 4	40	19	Yes	50	23	Yes
R3B	F 5	40	19	Yes	50	24	Yes
R3B	F 6	40	20	Yes	50	25	Yes
R3B	F 7	40	21	Yes	50	26	Yes
R3B	F 8	40	22	Yes	50	27	Yes
R3B	F 9	40	22	Yes	50	28	Yes
R3B	F 10	40	23	Yes	50	27	Yes
R3B	F 11	40	24	Yes	50	28	Yes
R3B	F 12	40	25	Yes	50	29	Yes
R3B	F 13	40	25	Yes	50	30	Yes
R3B	F 14	40	26	Yes	50	30	Yes
R3B	F 15	40	27	Yes	50	31	Yes
R4	GF	40	21	Yes	50	27	Yes
R4	F 1	40	22	Yes	50	28	Yes
R4	F 2	40	23	Yes	50	28	Yes
R4	F 3	40	24	Yes	50	29	Yes
R4	F 4	40	26	Yes	50	31	Yes
R4	F 5	40	28	Yes	50	33	Yes
R4	F 6	40	32	Yes	50	37	Yes
R4	F 7	40	35	Yes	50	40	Yes

Assessment location	Floor	Standard operations			Maintenance operations		
		Noise planning criteria	Predicted noise level	Compliance	Noise planning criteria	Predicted noise level	Compliance
R4	F 8	40	37	Yes	50	42	Yes
R4	F 9	40	38	Yes	50	43	Yes
R4	F 10	40	38	Yes	50	43	Yes
R4	F 11	40	38	Yes	50	43	Yes
R4	F 12	40	37	Yes	50	43	Yes
R4	F 13	40	37	Yes	50	43	Yes
R4	F 14	40	37	Yes	50	43	Yes
R5	F 1	40	24	Yes	50	33	Yes
R5	F 2	40	25	Yes	50	34	Yes
R5	F 3	40	26	Yes	50	35	Yes
R5	F 4	40	28	Yes	50	36	Yes
R5	F 5	40	29	Yes	50	37	Yes
R5	F 6	40	32	Yes	50	38	Yes
R5	F 7	40	35	Yes	50	41	Yes
R5	F 8	40	37	Yes	50	43	Yes
R6	F 1	40	25	Yes	50	35	Yes
R6	F 2	40	26	Yes	50	36	Yes
R6	F 3	40	27	Yes	50	36	Yes
R6	F 4	40	29	Yes	50	37	Yes
R6	F 5	40	30	Yes	50	38	Yes
R6	F 6	40	32	Yes	50	40	Yes
R6	F 7	40	35	Yes	50	42	Yes
R6	F 8	40	38	Yes	50	45	Yes
R6	F 9	40	39	Yes	50	47	Yes
R6	F 10	40	40	Yes	50	48	Yes
R6	F 11	40	40	Yes	50	48	Yes
R6	F 12	40	**41**	**Marginal**[1]	50	48	Yes
R6	F 13	40	**41**	**Marginal**[1]	50	48	Yes
R6	F 14	40	**41**	**Marginal**[1]	50	48	Yes
R7	GF	40	32	Yes	50	36	Yes

Assessment location	Floor	Standard operations			Maintenance operations		
		Noise planning criteria	Predicted noise level	Compliance	Noise planning criteria	Predicted noise level	Compliance
R7	F 1	40	33	Yes	50	37	Yes
R8	GF	40	30	Yes	50	34	Yes
R8	F 1	40	32	Yes	50	35	Yes
R8	F 2	40	31	Yes	50	35	Yes
C1	GF	55	24	Yes	55	28	Yes
C1	F 1	55	24	Yes	55	28	Yes
C1	F 2	55	24	Yes	55	28	Yes
C2	GF	55	22	Yes	55	28	Yes
C2	F 1	55	22	Yes	55	28	Yes
C3	GF	55	34	Yes	55	36	Yes
C3	F 1	55	35	Yes	55	37	Yes
C3	F 2	55	35	Yes	55	38	Yes
C4	GF	55	18	Yes	55	24	Yes

1. This one (1) dBA exceedance is considered to be marginal and has been predicted based on a 100% operating assumption. During critical evening and night-time periods, operating loads would be reduced and compliance is anticipated.