Parramatta Eels National Rugby League Club: Centre of Excellence & Community Facilities

SEARs Noise and Vibration Assessment

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Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Daytime	Between 10 pm and 7 am Monday to Saturday, and 10 pm to 8 am Sundays and Public holidays as defined in the NPI.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of loudness.
dB(A)	'A' Weighted sound level in dB.
Evening	Between 6 pm and 10 pm as defined in the NPI.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
INCG	New South Wales Department of Environment & Climate Change (now Environment Protection Authority) *Interim Construction Noise Guideline*, 2009.
NPI	New South Wales Environmental Protection Authority *Noise Policy for Industry*, 2017.
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally a residential premises boundary) is greater than 5 dB(A) above the background noise level.
L_{10}	Noise level exceeded for 10% of the measurement time. The L_{10} level is commonly referred to as the average maximum noise level.
L_{90}	Noise level exceeded for 90% of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum measured sound pressure level in the time period.
mm/s	Millimetres per second—units of vibration velocity.
Night-time	Between 10 pm and 7 am Monday to Saturday, and 10 pm to 8 am Sundays and Public holidays as defined in the NPI.
Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (Day/Evening/Night). For the short-term method, the RBL is simply the measured $L_{90,15min}$ noise level. For the long-term method, it is the median value of all measured background levels during the relevant assessment period.

Table of Contents

1 Introduction

The Parramatta National Rugby League Club Limited is proposing to develop the Parramatta Eels National Rugby League Club: Centre of Excellence & Community Facilities at Kellyville Memorial Park, 8 Memorial Avenue, Kellyville.

The Department of Planning, Industry & Environment (DPIE) has issued the Secretary's Environmental Assessment Requirements (SEARs) for the preparation of an Environmental Impact Statement (EIS). SEAR Section 17 defines the requirement for a Noise and Vibration Assessment as part of the EIS:

> The EIS must include a noise and vibration assessment in accordance with the relevant EPA guidelines. This assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and outline the proposed management and mitigation measures that would be implemented

Relevant Policies and Guidelines:

- NSW Noise Policy for Industry (EPA 2017)
- Interim Construction Noise Guideline (DECC 2009)
- Assessing Vibration: A Technical Guideline (DEC 2006)

This report has been prepared to address SEAR 17 and:

- Defines noise and vibration assessment criteria for the construction and operation of the Centre of Excellence and Community Facility.
- Identifies likely construction phase noise and vibration impacts and recommends management procedures to be implemented during construction.
- Provides a preliminary assessment of operational noise from the development to demonstrate that with appropriate controls in place, criteria can be achieved.

1.1 Project description

The proposed development will provide state of the art facilities which enable physical recreation opportunities in conjunction with improved facilities for staff, players and existing users of the site. The proposed development will be integrated with the existing recreational landscape of the site and complement the upgrades to the existing playing fields being undertaken by Council. The proposed development is defined as a Recreation facility (major), and includes the following components:

- Construction of high-performance Centre of Excellence in the north east of the site adjacent to Training Field 2:
  - Elite level gymnasium.
  - Medical and rehabilitation facilities.
  - Aquatic recovery and rehabilitation pools.
  - Lecture theatre and meeting rooms.
  - Player education and study areas.
  - Administration offices for the Parramatta Eels.
  - New female facilities including a dedicated female change room, cubicle toilets and showers.
  - Balcony and terrace area.
  - End of Trip Facilities and bicycle parking.
  - Refuse Area.
- Construction of a Community Facility, including a grandstand with approximately 1,500 seats in the centre of the site adjacent to the Main Playing Field 3:
  - Unisex changerooms and amenities.
  - Referee changeroom and amenities.
  - First Aid/Medical room.
  - Community gymnasium.

  - Café/kiosk.
  - Concourse terrace.
  - Multipurpose community function room with kitchen and amenities.
  - Refuse Area.
  - Bicycle parking.
- Solar arrays will be included on the roof of both the Centre of Excellence and Community Facility.
- Additional 40 car parking spaces for the proposed facility to operate in conjunction with existing at grade car parking already constructed by Council.
- Additional landscaping throughout the development footprint.
- Removal of a small number of trees internal to the site, however noting perimeter trees will be retained where not affected by the proposed building footprints.
- Hours of operation for the Centre of Excellence and Community Facility are 5:00am to 12:00am, however the following key times are likely:
  - Centre of Excellence: 7.00am - 7.00pm
  - Community Facility: 7.00am - 10.00pm

The site is bounded by Memorial Avenue to the north and Stone Mason Drive to the east. Playing fields are located to the west of the buildings and council reserves are to the south. Figure 1 shows the proposed site location.

Several noise and vibration sensitive land uses are located in the immediate vicinity of the site as shown in Figure 1, including residential receivers located on Gormon Avenue, Stone Mason Drive and McKellar Court. Non-residential land uses are outlined in Section 2.3, however there are no non-residential receivers located directly adjacent to the site.

Figure 1 Centre of Excellence and Community Facilities

1.1.1 Construction

An indicative construction staging for noise and vibration assessment purposes is presented in Table 1.

Table 1 Indicative construction staging

Stage	Description
Site establishment and enabling works	Services diversions and vegetation clearance.
Demolition	Demolition works
Retaining piles and excavation	Piling works and bulk excavation
Substructure	Creation of substructure.
Frame	Creation of building superstructure.
Facade works	Construction of building façade
Internal works and fitout	Internal works and fitout of all levels.

It is planned that works would be undertaken during standard construction hours as follows:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays.

1.1.2 Operation

The predominant operational noise consideration for the development will be associated with sporting events, carpark noise and the mechanical plant.

2 Existing Ambient Acoustic Environment

2.1 Unattended noise monitoring

Unattended noise monitoring conducted in accordance with the NSW EPA's Noise Policy for Industry (NPI) has been used to establish existing conditions at the following locations around the site:

- L1 – Off Stonemason Drive on the Kellyville Park side near Towell Way
- L2 – At the end of McKellar Court at the south west end of Kellyville Park

The unattended measured noise levels are presented in Table 2. Detailed charts presenting measured noise levels versus time overlaid with weather data for the monitoring period are presented in Appendix A.

Table 2 Unattended monitoring results

Location[1]	Rating Background Level, dB(A) L_{90}[2]			Ambient noise level, dB(A) L_{eq}		
	Day 7 am–6 pm	Evening 6 pm–10 pm	Night 10 pm–7 am	Day 7 am–6 pm	Evening 6 pm–10 pm	Night 10 pm–7 am
L1 – Stone Mason Drive	44	39	31	55	55	44
L2 – Mckellar Court	42	39	31	53	51	47

(1) Refer to Figure 1 for the location of the monitoring.

(2) The Rating Background Level is a measure of the typical minimum steady background noise level for each time of day.

2.1.1 Instrumentation

Noise logging was conducted using two Rion noise loggers bearing the serial numbers 00841630 and 772983. Field calibration was conducted at the commencement and conclusion of the logging period and no significant calibration drift was observed.

The noise loggers were configured to record all relevant noise indices, including background noise level (L_{A90}) and equivalent continuous noise levels (L_{Aeq}). Samples were accumulated at 15-minute intervals. The time response of the logger was set to 'fast'.

Attended measurements were conducted using a Rion NL-52 sound level meter bearing the serial number 820944. Field calibration was conducted before and after the measurements and no significant calibration drift was observed. Each measurement was for a period of 15 minutes with the meter response set to 'fast'.

The noise logger at Stone Mason Drive was vandalised on 16 September 2021 and so data from that that point forward has been excluded.

Noise measurements were taken in general accordance with AS1055.1.

2.1.2 Weather conditions

It is a requirement that noise data is captured during periods of favourable weather conditions avoiding adverse impacts of wind and rain on background noise levels. In order to assess weather conditions for the measurement period, half-hourly weather data was obtained from the Bureau of Meteorology (BOM) weather observation station ID 60800 at Richmond.

Noise data has been excluded from the processed results if:

- Rain was observed during a measurement period, and/or
- Wind speed exceeded 5 m/s (18 km/h) at the measurement height of 1.5 m above ground. Wind data obtained from the BOM is presented as the value at 10 m above ground.

The BOM wind speed data obtained for this report was measured at a height of 10 m above ground level. It is therefore necessary to apply a correction factor in order to estimate the wind speed at the height of the logger (1.5 m).

The methodology to formulate a correction factor has been derived[1]. The correction multiplier for the measured wind speed at 10 m is derived by the following formula:

$$W_{1.5}=W_{10}\times\left(\frac{M_{1.5,cat}}{M_{10,cat}}\right)$$

where:

$W_{1.5}$ = Wind speed at height of 1.5 m
W_{10} = Wind speed at height of 10 m
$M_{1.5,cat}$ = AS 1170 multiplier for receiver height of 1.5 m and terrain category
$W_{10,cat}$ = AS 1170 multiplier for receiver height of 10 m and terrain category

Noise logging data that has been excluded due to adverse weather conditions is identified in the overall summary and daily noise logging graphs presented in Appendix A.

2.2 Attended noise monitoring

Attended monitoring was conducted at locations around the site on Wednesday, 6 October 2021. The monitoring was conducted between 3:00 pm and 6:00 pm.

The measured noise levels at each location are shown in Table 3, with the measurement locations shown on Figure 1.

Table 3 Attended monitoring results on Wednesday, 6 October 2021

Location	Measured noise level, dB(A)			
	L_{max}	L_{10}	L_{eq}	L_{90}
A1 – The corner of Stonemason Drive and Kennedy Avenue	71	53	51	43
A2 – McKellar Court across from number 26	71	50	47	40
A3 – At the south western corner of the baseball field	60	46	44	39
A4 – On Stonemason drive midway between Memorial Avenue and Abbottsford Road	68	58	55	45

[1] Gowen, T., Karantonis, P. & Rofail, T. (2004), *Converting Bureau of Meteorology wind speed data to local wind speeds at 1.5m above ground level*, Proceedings of ACOUSTICS 2004

Location	Measured noise level, dB(A)			
	L_{max}	L_{10}	L_{eq}	L_{90}
A5 – On Memorial Avenue near the midpoint of the two northern playing fields	89	76	73	58
A6 – At the northern extent of Severn Vale Drive	69	53	47	46

2.3 Noise catchment areas

Based on the results of the noise monitoring conducted around the site, six noise catchment areas (NCAs) have been defined to aid in description of predicted noise levels and potential impacts around the site. Receivers directly adjacent to the site are residential. Some non-residential receivers are located remote from the site and include commercial, medical, and childcare receivers.
The NCAs have been defined as shown on Figure 2 and are broadly described as follows:

- NCA01: North of the site: Predominantly residential receivers with non-residential receivers including a Medical Centre at 17 Windsor Road and childcare centres located at 3/5 President Road and 13 Burns Road.
- NCA02: East of the site, comprising residential receivers.
- NCA03: South east of the site, comprising residential receivers.
- NCA04: South of the site: Predominantly residential receivers with non-residential receivers including a Medical Centre located at 39 Fairway Drive.
- NCA05: South west of the site, comprising residential receivers.
- NCA06: West of the site: Predominantly residential receivers with non-residential receivers including a childcare centre located at 41 Grace Crescent and the commercial property located at 2 Hector Court.

Some receivers located in NCA05 have been newly constructed and do not have addresses assigned to each property as per the time of this reports writing. Receiver identification numbers are shown in the context of the site in Appendix B.

Acoustic criteria have been applied based on the ambient noise conditions observed on site.

Figure 2 Noise catchment areas

3 Construction Noise Criteria

3.1 Construction noise

Construction noise in New South Wales is assessed using the Department of Environment & Climate Change (now Environment Protection Authority) *Interim Construction Noise Guideline* (ICNG).

The ICNG aims to manage noise from construction works regulated by the EPA. It is also intended to provide guidance to other interested parties in the management of construction noise, and has therefore been adopted for this construction noise assessment. The ICNG prescribes $L_{eq,15min}$ Noise Management Levels (NML) for sensitive receivers as part of a quantitative construction noise assessment. Where the predicted or measured construction noise level exceeds these management levels, then all feasible and reasonable work practices should be implemented to reduce construction noise, and community consultation regarding construction noise is required to be undertaken.

3.1.1 Standard Working Hours

The ICNG recommends standard working hours for construction as follows:

- Monday to Friday, 7 am to 6 pm
- Saturday, 8 am to 1 pm
- No work on Sundays or Public Holidays

To encourage work during the Standard Working Hours, and to reflect the lower impact of work at these times, the ICNG prescribes less stringent Standard Working Hours NMLs.

It should be noted that the Standard Working Hours are only applicable to residential (or similar) land uses. At educational or commercial land uses, where evening amenity and sleeping is not a concern, the impact of construction noise is assessed based on the times that the land use operates.

3.1.2 Residential land uses

The NMLs prescribed for residential land uses by the ICNG are presented in Table 4. The levels apply at the most exposed property boundary of the noise sensitive receiver at a height of 1.5 metres above ground level.

3.1.3 Other sensitive land uses

The ICNG also prescribes NMLs for other sensitive land uses, including educational buildings and offices. The NMLs for relevant land uses are summarised in Table 5 and apply only when those land uses are in use.

For those receivers where an internal NML applies, it is common to assume an outdoor-to-indoor noise reduction of 10 dB(A). This is based on a standard residential building facade with windows kept open.

Table 4 Noise management levels for residential land uses

Time of day	NML, $L_{eq,15min}$	Application notes
Recommended Standard Working Hours	Noise affected: RBL + 10 dB(A)	May be some community reaction to noise. • Where the predicted or measured construction noise level exceeds the noise affected level, all feasible and reasonable work practices should be applied to meet the noise affected level. • All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and duration, and provided with site contact details.
	Highly noise affected: 75 dB(A)	May be strong community reaction to noise. • Where construction noise is predicted or measured to be above this level, the relevant authority may require respite periods that restrict the hours that the very noisy activities can occur. • Respite activities would be determined taking into account times identified by the community when they are less sensitive to noise, and if the community is prepared to accept a longer period of construction to accommodate respite periods.
Outside recommended Standard Working Hours	Noise affected: RBL + 5 dB(A)	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the affected noise level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the affected noise level, the proponent should negotiate with the affected community.

Table 5 ICNG noise management levels for other sensitive land uses

Land use	NML $L_{eq,15min}$ (applies when property in use)
Classrooms at schools and other educational institutions	Internal noise level of 45 dB(A)
Hospital wards and operating theatres	Internal noise level of 45 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation).	External noise level of 60 dB(A)
Offices, retail outlets	External noise level of 70 dB(A)

3.1.4 Noise Management Levels

Table 6 summarises the NMLs applicable to sensitive land uses around the site during the construction phase. The NMLs are based on the background noise levels from unattended monitoring.

Table 6 Noise Management Levels

Land use	NML for time period, dB(A)			
	Standard Working Hours	Out of Hours Day[1] (Saturday afternoon & Sundays)	Out of Hours Evening[2]	Out of Hours Night[3]
NCA01, 02 and 03	54	49	44	36
NCA 04, 05, 06	52	47	44	36
Commercial	70	70	70	70
Industrial	75	75	75	75
Classrooms at schools and other educational institutions	45[2]	45[2]	45[2]	45[2]
Hospital wards and operating theatres	45[2]	45[2]	45[2]	45[2]
Places of worship	45[2]	45[2]	45[2]	45[2]
Active recreation areas	65	65	65	65
Passive recreation Areas	60	60	60	60

(1) Any out of hours work occurring between 7 am and 6 pm.

(2) Any out of hours work occurring between 6 pm and 10 pm.

(3) Any out of hours work occurring between 10 pm and 7 am.

3.2 Construction vibration

Ground vibration generated by construction can have a range of effects on buildings and building occupants. The main effects are generally classified as:

- human disturbance – disturbance to building occupants: vibration which inconveniences or interferes with the activities of the occupants or users of the building
- effects on building structures – vibration which may compromise the condition of the building structure itself.

In general, vibration criteria for human disturbance are more stringent than vibration criteria for effects on buildings. Building occupants will normally feel vibration readily at levels well below those which may cause a risk of cosmetic or structural damage to a structure. However, it may not always be practical to achieve the human comfort criteria. Furthermore, unnecessary restriction of construction activities can prolong construction works longer than necessary, potentially resulting in other undesirable effects for the local community.

Construction vibration criteria have been adopted from the following sources:

- Cosmetic and structural damage to buildings: German Standard DIN 4150-3[2]
- Human comfort: *Assessing Vibration – A Technical Guideline: DEC 2006* (the Vibration Guideline)

3.2.1 Cosmetic and structural damage

DIN 4150-3 summarises structural and cosmetic damage assessment criteria for different types of buildings, which are presented in Table 3, which are widely used for the assessment of construction vibration effects on buildings in Australia. The criteria are specified as Peak Particle Velocity (PPV) levels measured in any direction at or adjacent to the building foundation.

Table 3 DIN 4150-3 vibration cosmetic and structural damage criteria

Structure type	Peak Particle Velocity (PPV), mm/s			
	Foundation of structure			Vibration at horizontal plane of highest floor at all frequencies
	<10 Hz	10-50 Hz	50-100 Hz	
Buildings used for commercial, industrial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwelling and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in rows 1 and 2, and are of great intrinsic value (e.g. heritage-listed buildings)	3	3 to 8	8 to 10	8

DIN 4150-3 states that exposing buildings to vibration levels higher than that recommended would not necessarily result in damage. Rather, it recommends these values as maximum levels of short-term construction vibration at which experience has shown damage reducing the serviceability of structures will not occur due to vibration effects.

[2] German Standard DIN 4150-3, 1999, *Structural Vibration – Part 3: Effects of vibration on structures*.

DIN 4150-3 is considered to be suitable for the assessment of both structural and cosmetic damage as it considers a reduction in serviceability of the structure is deemed to have occurred if cracks form in plastered surfaces of walls, existing cracks in the building are enlarged or partitions become detached from loadbearing walls or floors.

3.2.2 Human comfort

The ICNG recommends that vibration from construction works be assessed under *Assessing Vibration – a technical guideline* (the Vibration Guideline), consistent with the SEARs issued by DPIE. The vibration assessment criteria defined in the Vibration Guideline are for human comfort and represent goals that, where exceeded, require the application of all feasible and reasonable mitigation measures. Where the maximum value cannot be feasibly and reasonably achieved, the operator would need to negotiate directly with the affected community.

The Vibration Guideline defines vibration assessment criteria for continuous, impulsive and intermittent vibration. Vibration can be classified according to the following definitions:

- Continuous vibration: continues uninterrupted for a defined period. Applies to continuous construction activity such as tunnel boring machinery.
- Impulsive vibration: rapid build-up to a vibration peak followed by damped decay or the sudden application of several cycles of vibration at approximately the same magnitude providing that the duration is short. Applies to very occasional construction activities that create distinct events such as dropping of heavy equipment.
- Intermittent vibration: interrupted periods of continuous vibration (such as a drill) or repeated periods of impulsive vibration (such as a pile driver).

The majority of construction activities as part of the proposed works would be expected to be continuous or intermittent in nature.

Table 7 presents the management levels for continuous and impulsive vibration at different land uses. The management levels specified are as overall unweighted RMS vibration velocity levels. The Vibration Guideline specifies the management levels as suitable for vibration sources predominantly in the frequency range 8-80 Hz as would be expected for construction vibration.

Table 7 RMS velocity management levels for continuous and impulsive vibration

Land use	Continuous vibration – RMS vibration velocity, mm/s		Impulsive vibration – RMS vibration velocity, mm/s	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.1	0.2	0.1	0.2
Residences and hospital wards – daytime[2]	0.2	0.4	6.0	12.0
Residences and hospital wards – night time[3]	0.14	0.28	2.0	4.0
Offices, schools	0.4	0.8	13.0	26.0
Workshops	0.8	1.6	13.0	26.0

(1) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

For intermittent vibration, the Vibration Dose Value (VDV) is used as the metric for assessment as it accounts for the duration of the source, which will occur intermittently over the assessment period. The VDV management levels at different land uses for intermittent vibration sources are presented in Table 8.

Table 8 VDV management levels for intermittent vibration

Land use	VDV – intermittent vibration, m/s$^{1.75}$	
	Preferred	Maximum
Critical areas[1]	0.1	0.2
Residences and hospital wards – daytime[2]	0.2	0.4
Residences and hospital wards – night time[3]	0.13	0.26
Offices, schools	0.4	0.8
Workshops	0.8	1.6

(1) Critical operating areas include precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

3.2.3 Minimum working distances

The *Construction Noise and Vibration Guideline (CNVG)* (NSW Government, 2006) provides guidelines for minimum working distances for vibration-intensive activities with respect to the stated standards and guidelines. The minimum working distances for building damage should be complied with at all times. The distances are noted as being indicative and are likely to vary depending on the particular item of plant and local geotechnical conditions. The minimum working distances apply to addressing the risk of cosmetic (minor – easily reparable) damage of typical buildings under typical geotechnical conditions.

Where vibration intensive works are required to be undertaken within the specified minimum working distances, vibration monitoring should be undertaken to ensure acceptable levels of vibration are satisfied.

In relation to human comfort, the minimum working distances relate to continuous vibration. For most construction activities, vibration emissions would be intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods may be allowed.

Table 9 presents the recommended minimum working distances for vibration intensive plant.

Table 9 Recommended safe working distances for vibration intensive plant

Plant Item	Rating/Description	Minimum Working Distance – Cosmetic Damage (BS7385)	Minimum Working Distance – Human Response (OH&E Guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	Five metres	15 metres to 20 metres
	< 100 kN (Typically 2-4 tonnes)	Six metres	20 metres
	< 200 kN (Typically 4-6 tonnes)	12 metres	40 metres
	< 300 kN (Typically 7-13 tonnes)	15 metres	100 metres
	> 300 kN (Typically 13-18 tonnes)	20 metres	100 metres
	> 300 kN (> 18 tonnes)	25 metres	100 metres

Plant Item	Rating/Description	Minimum Working Distance – Cosmetic Damage (BS7385)	Minimum Working Distance – Human Response (OH&E Guideline)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	Two metres	Seven metres
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	Seven metres	23 metres
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 metres	73 metres
Vibratory Pile Driver	Sheet piles	2 metres to 20 metres	20 metres
Pile Boring	≤ 800 mm	2 metres (nominal)	Four metres
Jackhammer	Hand held	1 metres (nominal)	Two metres

3.3 Construction road noise criteria

The NSW Road Noise Policy (RNP) provides guidance, criteria and procedures for assessing noise impacts from existing, new and redeveloped roads and traffic generating developments. The assessment of road traffic noise impacts on public roads is assessed under the RNP.

Road traffic generated by the operation of the Project will not increase from the existing operational traffic volumes, and as such, there will be no increase to the existing road traffic. Hence, road traffic noise impact due to operational noise will not be assessed in this study.

The construction of the Project will generate additional traffic on surrounding public roads, such as construction worker car movements and delivery and construction vehicle movements. Once construction is complete, project traffic is expected to return to levels similar to the current situation.

The RNP details a number of noise assessment criteria for various road categories and land uses.

The Application Notes for the RNP state that;

> *'for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.*'

If road traffic noise during the Project construction is within 2 dB(A) of current levels then the objectives of the RNP are met and no specific mitigation measures are required. Where the Project road traffic noise levels exceed 2 dB(A) of current levels than the consideration should be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the RNP criteria as presented in Table 10.

Table 10 RNP Residential Road Traffic Noise Criteria

Road Category	Type of Project/Land Use	Assessment Criteria – dB(A)	
		Day 7am to 10pm	Night 10pm to 7am
Local roads	Existing residences affected by additional traffic on existing local roads by land use developments.	$L_{Aeq,15hr}$ 55(external)[1]	$L_{Aeq,9hr}$ 50 (external)[1]

(1) The assessment criteria for external noise levels apply at 1 metre from the facade of any affected residential receiver

An estimation of the anticipated noise level contribution of construction traffic on local roads has been conducted using the TfNSW Construction Noise Estimator Tool. The following indicative construction road traffic volumes have been assumed for Stone Mason Drive:

- 30 two-way light vehicle movements per hour.
- 2 two-way heavy vehicle movements per hour.

The following has been determined:

- A typical $L_{Aeq(1\ hour)}$ noise level contribution of 52 dB(A) has been predicted for construction scenarios.
- A total combined noise level of 57 dB(A) is predicted with a noise level increase of 2 dB or less, noting that the existing daytime L_{Aeq} noise level is approximately 55 dB(A) outside of peak times.
- Therefore, no further assessment of construction road traffic is required.

4 Operational Noise Criteria

This assessment sets forth three scenarios for assessment of operational noise. Detailed information relating to assumptions and inclusions for noise modelling of each are included in Section 6. These are summarised as follows:

- Normal Operations (NPI Assessment)
  - Day to day operation of the Centre of Excellence and Community Facilities including the use of the car park, mechanical services associated with each building, use of the fields by the Parramatta Eels for training and practice and use of the fields and facilities in line with pre-existing operations (including community sport).
  - Assessed in accordance with the NPI.
- Event Scenario 1 (Parramatta Eels Pathway Game Day) – Not assessed under NPI
  - Less frequent occurrence than normal operations including community sport.
  - Intermediate capacity spectators and players (up to 695 people)
  - Assessed with reference to the Environmental Noise Control Manual (ENCM)
- Event Scenario 2 (Parramatta Eels Elite Level Game Day) – Not assessed under NPI
  - Less frequent occurrence than Pathway Game days.
  - Maximum capacity spectators and players (up to 2,870 people)
  - Assessed with reference to the Environmental Noise Control Manual (ENCM)

4.1 Noise Policy for Industry (NPI)

The NPI sets two separate noise criteria to meet desirable environmental outcomes:

- Intrusiveness – steady-state noise from the site should be controlled to no more than 5 dB(A) above the background noise level in the area. In this case, the steady-state L_{eq} noise level should not exceed the RBL measured for different time periods in the environment. The intrusiveness criterion is measured over a 15-minute period.
- Amenity – amenity criteria are set based on the land use of an area. It requires noise levels from new industrial noise sources to consider the existing industrial noise level such that the cumulative effect of multiple sources does not produce noise levels that would significantly exceed the amenity criteria. As the amenity criteria is provided in the NPI document as a period level i.e. between 7am and 6pm for day time activities, 3 dB is added to the amenity noise level to approximately represent a 15-minute period for direct comparison to the intrusiveness criterion.

Internal and external noise criteria are also set by the NPI for non-residential land uses such as hospital wards, educational facilities and active recreation areas.

Both intrusiveness and amenity criteria are derived from the ambient noise survey and the NPI. They are then compared with each other and the lowest and most stringent noise level is adopted to represent the project specific noise criterion for the relevant time period, daytime, evening and night-time.

4.1.1 Normal operations

Table 11 presents the NPI noise emission criteria for residential land uses respectively. Table 11 also presents the background noise levels applicable to each NCA.

Table 11 NPI noise emission criteria for residential land uses

Location	NPI Noise Level (dB re 20 µPa) during Period		
Residential receivers	**Daytime 07:00 – 18:00**	**Evening 18:00 – 22:00**	**Night-time 22:00 – 07:00**
L1 Stone Mason Drive (NCA01, NCA02 and NCA03)			
Rating Background Level (RBL)	44	39	31
Intrusive criterion (RBL + 5 dB)	**49**	44	**36**
Amenity Criterion (NPI amenity level – 5 dB + 3 dB) (Suburban)	(55-5+3) = 53	(45-5+3) = **43**	(40-5+3) = 38
Resulting NPI project specific criteria for residential land uses[2]	**49**	**43**	**36**
L2 Mckellar Court (NCA04, NCA05 and NCA06)			
Rating Background Level (RBL)	42	39	31
Intrusive criterion (RBL + 5 dB)	**47**	44	**36**
Amenity Criterion (NPI amenity level – 5 dB + 3 dB) (Suburban)	(55-5+3) = 53	(45-5+3) = **43**	(40-5+3) = 38
Resulting NPI project specific criteria for residential land uses[2]	**47**	**43**	**36**

(1) An urban classification has been adopted for the site, described as an area with an acoustical environment that is dominated by 'urban hum', having mostly traffic and/or industrial related sound sources.

(2) The project-specific criteria are the lowest of the Intrusive criterion and the Amenity criterion for new sources for each time period.

4.1.2 Non-residential receivers

The project amenity noise levels applicable to an activity are defined by the recommended noise levels listed below (*Table 2.2* of the *EPA Noise Policy for Industry*) minus 5 dB(A). The project amenity noise criteria are presented in Table 12 below for non-residential receivers.

Table 12 Project Amenity Noise Criteria

Receiver Type	Noise Amenity Area	NPI Recommended Amenity Levels $L_{eq,\ 15minute}$ dB(A)
Non-residential	Commercial	(65-5+3^2=) 63
Non-residential	Industrial	(70-5+3^2=) 68
Non-residential	Places of Worship[1]	(40-5+10+3^2=) 48
Non-residential	School Classrooms[1]	(35-5+10+3^2=) 43
Non-residential	Hospitals	(35-5+10+3^2=) 43^1 (equivalent external) (50-5+3^2=) 48 (external)

Receiver Type	Noise Amenity Area	NPI Recommended Amenity Levels $L_{eq,\ 15minute}$ dB(A)
Non-residential	Passive Recreation	(50-5+3^2=) 48 (external)

4.1.3 Environmental Noise Control Manual (ENCM) – Event operations

Large sporting events are specifically excluded from the NPI. In the absence of current specific assessment criteria and methodologies for sporting events, reference is made to the largely superseded ENCM which includes guidance in relation the assessment of noise from athletic events including football games.

The following guideline value is provided where the site is operational and does not represent a new noise source:

- $L_{A10(15\ minute)}$ less than or equal to RBL + 10 dB.
- Furthermore, the ENCM states that the noise levels should be considered guidelines and that variations can be made based on local conditions.
- Where offensive noise occurs athletic sporting events should be restricted to:
  - 7 am to 6 pm any weekday.
  - 8 am to 6 pm Saturdays and Sundays.
  - 6 pm to 10 pm two nights per week excluding Sundays or Public Holidays.
  - Where no offensive noise occurs, the above restrictions would not apply.
  - In the context of the sporting event assessment offensive noise is considered to be noise levels resulting from the operation of the event that exceeds the guideline values provided below.

Guidance from the ENCM as detailed in Table 13 has been used as a screening approach to assess the potential impacts from the identified event scenarios. In line with operational noise control management of similar events at other facilities, it is recommended that a Noise Management Plan be developed and implemented where potential exceedance of the ENCM noise levels are predicted. The Noise Management Plan would seek to balance the level of noise with the frequency of occurrence of the event.

Table 13 ENCM Athletic Event Noise Level Guidance

Location	$L_{A10(15minute)}$ Noise Level (dB re 20 µPa) during Period	
Residential receivers	**Daytime 07:00 – 18:00**	**Evening 18:00 – 22:00**
L1 Stone Mason Drive (NCA01, NCA02 and NCA03)		
Rating Background Level (RBL)	44	39
Event criterion (RBL + 10 dB)	54	44
L2 Mckellar Court (NCA04, NCA05 and NCA06)		
Rating Background Level (RBL)	42	39
Event criterion (RBL + 10 dB)	52	49

4.2 Operational road traffic noise criteria

The NSW Road Noise Policy (RNP) provides guidance, criteria and procedures for assessing noise impacts from existing, new and redeveloped roads and traffic generating developments. The assessment of road traffic noise impacts on public roads is assessed under the RNP.

The operation of the Project will generate additional traffic on surrounding public roads.

The RNP details a number of noise assessment criteria for various road categories and land uses. Road access to the facility will be Stone Mason Drive, which would be considered a local road.

The Application Notes for the RNP state that;

> *'for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.'*

If road traffic noise during the operation is within 2 dB(A) of current levels then the objectives of the RNP are met and no specific mitigation measures are required. Where the Project road traffic noise levels exceed 2 dB(A) of current levels than the consideration should be given to the actual noise levels associated with construction traffic and whether or not these levels comply with the RNP criteria as presented in Table 14.

Table 14 RNP Residential Road Traffic Noise Criteria

Road Category	Type of Project/Land Use	Assessment Criteria – dB(A)	
		Day 7am to 10pm	Night 10pm to 7am
Local Road	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15hr}$ 55 (external)[1]	$L_{Aeq,9hr}$ 50 (external)[1]

(2) The assessment criteria for external noise levels apply at 1 metre from the facade of any affected residential receiver

4.3 Sleep disturbance

As stated in the NPI the potential for sleep disturbance from maximum noise level events generated by premises during the night-time period needs to be considered. The term "sleep disturbance" is considered to be both awakenings and disturbance to sleep stages.

To evaluate potential sleep disturbance or awakening issues associated with the construction of the Project the NPI screening method has been adapted as follows. There is limited potential for sleep disturbance or awakening issues to occur, where:

- The predicted project night-time noise level ($L_{eq,\ 15\ minute}$ in dB(A)) at any residential receptor remains below 40 dB(A) (or the prevailing night-time background noise level plus 5 dB(A)), whichever is the greater.
- The predicted project night-time noise level (L_{max} in dB(A)) at any residential receptor remains below 52 dB(A) (or the prevailing night-time background noise level plus 15 dB(A)), whichever is the greater.
- The 52 dB(A) L_{Amax} noise level would apply to this project.

5 Construction Assessment

5.1 Construction noise

5.1.1 Construction noise sources

Table 15 summarises the assumed sound power levels (L_W) for the major construction noise sources which we expect would be on site during each phase. The sound power levels have been based on data obtained from previous measurements conducted by Resonate and those within the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*. An overall sound power level for each phase has also been assumed based on the loudest typical source(s) operating for each works phase.

Table 15 Construction noise source sound power levels

Stage	Typical plant items	Assumed sound power level, dB(A)
Site establishment and enabling works	Large excavator	111
	Vibratory roller[1]	107
	Concrete truck	109
	Concrete pump	107
	Large truck	108
	Chainsaw	114
	Typical overall sound power level	**112**
Demolition	Large excavator	111
	Rockbreaker[1]	121
	Crane	106
	Pneumatic jackhammer[1]	109
	Large truck	108
	Typical overall sound power level	**118**
Retaining piles and excavation	Bored piling rig	111
	Large excavator	111
	Crane	106
	Large truck	108
	Typical overall sound power level	**112**
Substructure	Crane	106
	Large excavator	111
	Pneumatic jackhammer[1]	109
	Concrete truck	109
	Concrete pump	107

Stage	Typical plant items	Assumed sound power level, dB(A)
	Large truck	108
	Typical overall sound power level	**114**
Frame	Concrete truck	109
	Concrete pump	107
	Crane	106
	General hand tools	98
	Large truck	108
	Typical overall sound power level	**111**
Facade works	Crane	106
	General hand tools	98
	Large truck	108
	Typical overall sound power level	**107**
Internal works and fitout	General hand tools	98
	Compressor	94
	Portable generator	95
	Typical overall sound power level	**84[2]**

(1) Results include a 5 dB penalty to account for 'annoying' characteristics.

(2) Includes a 15 dB(A) indoor-to-outdoor reduction in noise levels for internal works.

5.1.2 Typical construction noise levels during Standard Works Hours

Typical worst-case construction noise levels are to be predicted using a three-dimensional environmental noise model of the site and surrounds, developed in SoundPLAN version 8.2 environmental noise modelling software, including:

- topography
- building structures
- ground absorption (ground assumed to be 50% absorptive and 50% reflective)
- air absorption
- attenuation with distance.

Predictions have been carried out based on the environmental noise prediction algorithms documented in ISO 9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors -- Part 2: General method of calculation*. This provides predictions typical of conditions where the receiver is downwind of the source or where there is a moderate ground-based temperature inversion.

It is important to note that these predictions are typical worst-case predictions as they assume that:

- The construction works are occurring at the nearest point to each receiver and that the receiver is located at the most exposed position.
- The noisiest construction sources are operating continuously for the entire 15-minute period. This will not occur at all times as equipment will regularly be stood down or idled while other activities are undertaken.

Typical worst-case predicted noise levels are shown in Table 16 for each sensitive-receiver location and each phase of works. Noise levels are predicted to exceed the relevant Standard Work Hours NMLs for all activities with the exception of those occurring inside the new buildings (such as fitout works).

As seen in Table 16 properties are predicted to be in the highly noise affected category (predicted sound pressure level > 75 dB(A)) in NCA01 and NCA02 during demolition.

Table 16 Typical worst-case external construction noise levels for Standard Working Hours

NCA	Typical worst-case external construction noise level for phase during Standard Working Hours, dB(A) L_{eq}						
	Site establishment	Demolition	Retaining piles and excavation	Substructure	Frame	Facade works	Internal works and fitout
1	69	**76**	65	72	65	66	38
2	74	**80**	69	**76**	68	67	39
3	67	73	63	70	61	64	36
4	67	74	63	70	61	62	34
5	64	70	59	66	58	57	29
6	66	72	61	69	60	59	31

A description of predicted noise levels per NCA are discussed below with reference to subjective effects of changes to sound levels as shown in Table 17. Noise contours of predicted construction noise levels are also presented in Appendix C. Exceedances of standard working hours criteria are expected across all noise catchment areas, during site establishment, demolition, retaining piles and excavation, substructure, frame, and façade works as seen in Table 18.

Table 17 Subjective effect of changes to sound levels

Change in sound level, dB	Subjective change in apparent loudness
1	Not perceptible
2 – 3	Just perceptible
5	Clearly noticeable
10	Half or twice as loud
20	Much quieter or louder

NCA01

NCA01 is expected to be the most impacted by Demolition works. Demolition noise levels are predicted to range from *Clearly Noticeable* to *Twice as Loud* as existing background noise levels. 2 Bugle Circuit and Receiver 1537 are predicted to be highly noise affected with a predicted sound pressure level of 80 dB(A). Predicted noise levels during site establishment, retaining piles and excavation, substructure works, frame works and façade works are expected to

be *Clearly Noticeable* at most receivers in NCA01, with some receivers on the north western and north eastern flank of the NCA experiencing just perceptible noise levels.

NCA02

NCA02 is expected to be most impacted by noise from demolition and substructure works. The noise levels from demolition works are predicted to result in noise levels approximately *Twice as Loud* as the background noise levels across the entire noise catchment area.

The following ten receivers, located in closest proximity to the works along Bugle Circuit and Stone Mason Drive are predicted to be highly noise effected during demolition works;

- 1 Bugle Circuit
- 2 Bugle Circuit
- 3 Bugle Circuit
- 3/4 Bugle Circuit
- 6 Bugle Circuit
- Receivers located on Stone Mason Drive, QGIS ID's as shown in Appendix B:
  - 356, 936, 1016, 1537, 1890,

Noise levels during site establishment, retaining piles and excavation, frame works, and façade works are expected to exceed daytime NMLs and are likely to be clearly noticeable throughout the NCA. During substructure works 2 Bugle Circuit is expected to be highly affected.

NCA03

NCA03 is expected to be most impacted by noise from demolition and substructure works. The noise levels from demolition works are predicted to result in noise levels approximately *Twice as Loud* as the background noise levels across the NCA. Noise levels during site establishment, retaining piles and excavation, frame works and façade works are predicted to exceed the daytime NMLs and are likely to be *Clearly Noticeable* throughout the NCA.

NCA04

NCA04 is expected to have an average NML exceedance of approximately 15 dB (more than *Twice as Loud*) during demolition. No receivers are predicted to be highly noise affected. Substructure works are also predicted to result in noise levels in the *Clearly Noticeable* range. Noise levels from site establishment, retaining piles and excavation frame works and façade works would be considered as *Clearly Noticeable*.

NCA05

NCA05 is expected to be most impacted by noise from demolition and substructure works. The noise levels from demolition works are predicted to result in noise perceptibly *Twice as Loud* as the background noise level across the NCA. Noise levels during site establishment, retaining piles and excavation, frame works and façade works are expected to exceed daytime NMLs and will be clearly noticeable throughout the catchment area.

NCA06

NCA06 is expected to be most impacted by noise from demolition works, which is predicted to be perceptibly *Twice as Loud* as the background noise level across the NCA. Noise levels from site establishment and substructure works are expected to be *Clearly Noticeable*. Retaining piles and excavation and façade works noise levels are predicted to be *Barely Perceptible*.

Recommendations for construction noise management are provided in Section 5.3.

Table 18 Predicted number of exceedances and average exceedance in dB(A) for Standard Working Hours

NCA	Site Establishment		Demolition		Retaining piles and excavation		Substructure		Frame		Façade works	
	No.	Average NML exceedance dB(A)	No.	Average NML exceedance dB(A)	No.	Average NML exceedance dB(A)	No.	Average NML exceedance dB(A)	No.	Average NML exceedance dB(A)	No.	Average NML exceedance dB(A)
1	156	5	241	9	56	4	201	6	50	4	61	4
2	160	7	183	12	96	5	177	9	92	5	106	5
3	90	6	98	12	44	4	93	8	35	3	54	4
4	58	8	64	13	42	5	63	9	40	4	24	5
5	56	4	71	9	17	3	66	6	13	2	11	2
6	131	4	205	8	30	3	175	5	21	3	20	3

5.2 Construction vibration

Table 19 summarises recommended safe working distances for key vibration-generating activities that would be expected during the construction phase, based on prior measurements conducted by Resonate. The closest receivers to the works are approximately 35 metres northeast of the site boundary of the construction site. Works to be undertaken within the typical safe working distance for occupant comfort and building damage should be subject to a vibration management plan.

Table 19 Recommended safe working distances for key vibration generating activities

Plant	Rating	Typical safe working distance for occupant comfort, m		Typical safe working distance for building damage, m	
		Preferred vibration target	Maximum vibration target	Heritage structure	Commercial building
Vibratory roller	< 7t	≥ 35	≥ 20	≥ 10	≥ 2
	7t – 12t	≥ 50	≥ 30	≥ 15	≥ 5
	≥ 13t	≥ 75	≥ 40	≥ 20	≥ 10
Small hydraulic hammer	300 kg – 5 to 12T excavator	≥ 12	≥ 7	≥ 5	≥ 2
Medium hydraulic hammer	900 kg – 12 to 18T excavator	≥ 35	≥ 23	≥ 15	≥ 7
Large hydraulic hammer	1600 kg – 18 to 34T excavator	≥ 65	≥ 45	≥ 35	≥ 22
Excavator	Large excavator digging	≥ 25	≥ 15	≥ 5	≥ 1
Bored piling	≤ 800mm	≥ 20	≥ 10	≥ 2	≥ 1
Jackhammer	Handheld	–(1)	–(1)	≥ 3	≥ 1

5.3 Construction noise and vibration management measures

To manage the potential impact of noise and vibration during construction, reasonable and feasible management measures and work practices should be implemented as detailed below.

5.3.1 Construction Noise and Vibration Management Plan

Prior to the commencement of major construction works, the contractor should develop a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP should:

- identify relevant construction noise and vibration criteria as detailed in this report
- identify neighbouring sensitive land uses for noise and vibration
- summarise key noise- and vibration-generating construction activities and the associated predicted levels at neighbouring land uses
- identify reasonable and feasible work practices to be implemented during the works
- summarise stakeholder consultation and complaints handling procedures for noise and vibration.

5.3.2 Stakeholder consultation

Nearby stakeholders should be consulted prior to the works and kept regularly informed of potential noise and vibration impacts from the works. Specifically, this would involve:

- Residential receivers on Bugle Circuit
- Residential receivers on Stone Mason Drive

A noise and vibration complaints handling procedure and register should be developed and implemented during construction.

5.3.3 Work programming

Work should be programmed such that particularly noisy works occur during Standard Working Hours wherever feasible, namely:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays.

If high noise works are to occur outside of the Standard Working Hours and later than 1 pm on a Saturday, then the CNVMP should define an approval process for undertaking out of hours works and for identifying reasonable and feasible mitigation measures to be implemented.

Consideration of a respite regime where particularly highly intensive activities are programmed to occur at times identified by the community when they are less sensitive to noise.

5.3.4 Truck movements and site access

Truck movements during long term construction projects have the potential to cause annoyance for sensitive receivers, even where trucks may be travelling on sealed roads. The design and selection of site access routes shall consider the potential disturbance to residents. In particular:

- site access and delivery points shall be located as far away from residences as possible
- truck movements shall use arterial roads and be diverted away from residential streets where feasible
- deliveries to/from site shall not occur during the night time period where possible.

5.3.5 Site management

Site management procedures should include the following:

- processes that generate lower noise levels should be selected where feasible
- noisy plant should be located as far away from residences as is practical to allow efficient and safe completion of the task
- the potential shielding provided by site topography and intervening buildings should be considered in locating equipment
- site compounds should be located as far away as possible from residences
- equipment that is used intermittently should be shut down or throttled down to a minimum during periods where it is not in use
- works should be planned to minimise the reduce the noise from reversing signals
- warning horns should not be used as signalling devices
- two-way radios should be set to the minimum effective volume
- noise associated with packing up plant and equipment at the end of works should be minimised.

5.3.6 Equipment management

Equipment management should include the following:

- selection of low-noise plant and equipment where possible
- equipment should be well maintained
- equipment should have quality mufflers and silencers installed where relevant
- equipment not in use on site should be shut down
- tasks should be completed using the minimum feasible power and equipment.

6 Operational Noise Assessment

The Centre of Excellence & Community Facilities proposes to host sporting events varying in scale relative to the normal daily operational scenario. These events would have higher associated noise emissions as a result of the increased number of spectators, athletes and car park usage.

As such this assessment has been divided into three scenarios representative of proposed events at the facility.

- Normal Operations (NPI Assessment)
  - Day to day operation of the Centre of Excellence & Community Facilities including the use of the car park, mechanical services associated with each building, use of the fields by the Parramatta Eels for training and practice and use of the fields and facilities in line with pre-existing operations (including community sport).
  - Assessed in accordance with the NPI.
- Event Scenario 1 (Parramatta Eels Pathway Game Day) – Not assessed under NPI
  - Less frequent occurrence than normal operations including community sport. Typically occurring on Saturday and Sunday.
  - Intermediate capacity spectators, officials, volunteers and players (up to approximately 695 people)
  - Assessed with reference to the Environmental Noise Control Manual (ENCM)
  - These games form part of the existing operations of the site and not considered a new or additional operational noise source.
- Event Scenario 2 (Parramatta Eels Elite Level Game Day) – Not assessed under NPI
  - Maximum capacity spectators, officials, volunteers and players (up to approximately 2,870 people)
  - Assessed with reference to the Environmental Noise Control Manual (ENCM)
  - These events are forecast to occur up to 4 to 5 days per year.

6.1 Mechanical plant noise assessment

6.1.1 Operational scenarios

An assessment of externally located or externally discharging mechanical plant and equipment noise levels has been undertaken in order to demonstrate that the requirements of the NPI can be met at nearby noise sensitive receivers.

A list of proposed plant and equipment is provided in Table 20 together with maximum allowable sound power levels for each. Table 20 also identifies which plant items would not be operational during the night-time period.

It should be noted that plant and equipment with different sound power levels may be selected as part of the detailed design process. It may be necessary to incorporate additional noise control measures such as internally lined (acoustically absorptive) duct work, use of attenuators or additional noise barriers as necessary to meet the NPI requirements.

Table 20 Mechanical services Sound Power Levels and Indicative Times of Operation

Plant Item	Maximum recommended sound power level dB(A)	Operational during the night-time period 10:00 pm- 7:00 am (Yes/No)
CU-COE.1	83	Yes
CU-COE.2	83	Yes
CU-COE.3	83	Yes
AHU-COE.1	79	Yes
AHU-COE.2	80	Yes
AHU-COE.5	82	Yes
B218 Toilet Exhaust-COE	41[1]	No
B101 Exhaust-COE	44[1]	No
B220 Kitchen Exhaust-COE	80[1]	No
CU.COE.4	76	Yes
CU-CF.1	87	Yes
CU-CF.2	87	Yes
CU-CF.3	87	Yes
CU-CF.4	87	Yes
A203 Café Toilet Exhaust-CF	46[1]	No
A212 Supply Air-CF	58[1]	No
A204 Kitchen Exhaust-CF	84[1]	No

(1) Sound power level from internal plant at exhaust/supply

6.1.2 Description of architectural noise controls

The project incorporates three externally located plant areas. Each plant area is bounded by a wall on all sides. The location and height above local ground level for each wall are shown in Figure 3. The walls are required to be solid and continuous with no gaps. The height and location of walls may be optimised during the detailed design phase. These walls have been coordinated with the design team to allow for the selected external plant to comply with the NPI criteria.

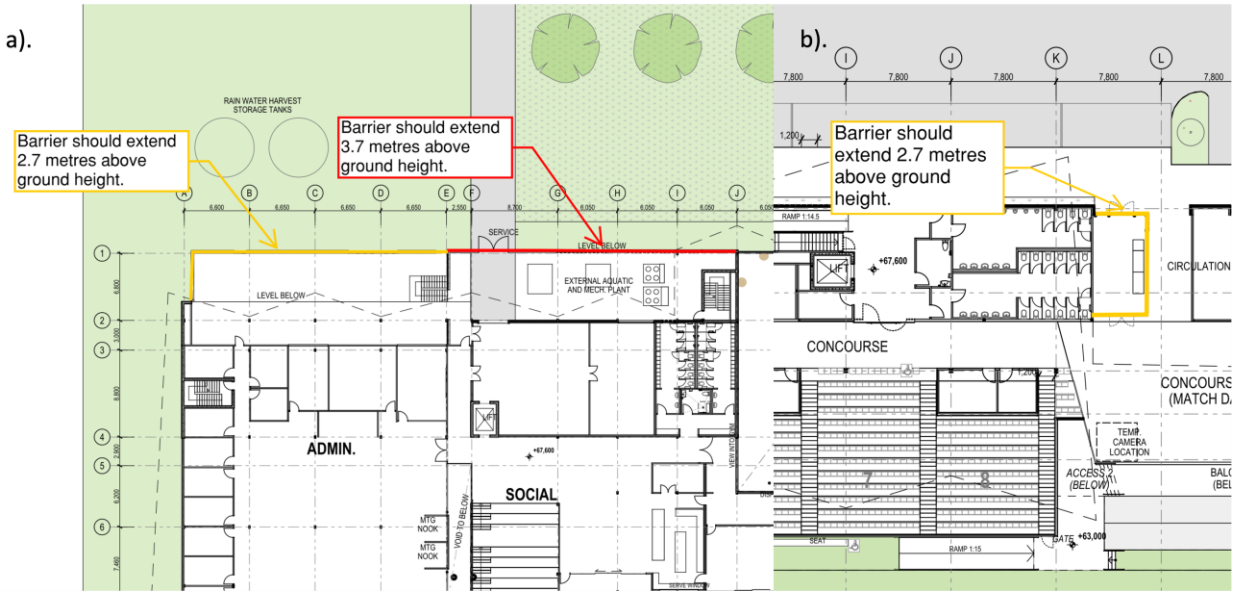


Figure 3 Plant area wall heights a). Centre of Excellence and b). Community Facilities

6.1.3 Predicted noise levels

A 3D noise model of the project and surrounding area has been developed. The noise model includes;

- 3D elevation contours
- Buildings
- Noise sources including external mechanical equipment and car park/personnel related noise levels associated with the normal operational scenario described in Section 4.
- Ground absorption

Predicted noise levels for the daytime, evening and night-time periods are presented in Table 21. Noise levels are presented for the most potentially affected receivers within each NCA.

Table 21 Predicted noise levels from mechanical services (including car park and personnel for normal operations)

Sensitive Receiver	Daytime 07:00 – 18:00			Evening 18:00 – 22:00			Night-time 22:00 – 07:00		
	Predicted SPL dB(A)	Criteria $L_{Aeq,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{Aeq,15min}$	Complies (✓/✗)	Predicted SPL dB(A)	Criteria $L_{Aeq,15min}$	Complies (✓/✗)
Gormon Avenue (NCA01)	43	49	✓	43	43	✓	34	36	✓
Stone Mason Drive & Bugle Circuit (NCA02)	43	49	✓	43	43	✓	36	36	✓
Stone Mason Drive (NCA03)	37	49	✓	37	43	✓	36	36	✓
McKellar Court (NCA04)	36	47	✓	36	43	✓	34	36	✓
2 Balmoral Road (NCA05)	34	47	✓	34	43	✓	33	36	✓
Severn Vale Drive (NCA06)	36	47	✓	36	43	✓	35	36	✓

A review of Table 21 shows that compliance with the NPI criteria is predicted during the daytime, evening and night-time periods with the implementation of the noise barriers and maximum sound power levels as presented in Table 20 and Figure 3 respectively.

6.2 Car park and sporting event noise emissions

Car park and sporting related noise emissions have been predicted for the identified scenarios. It should be noted that the total predicted noise level for each scenario includes a contribution from the mechanical plant.

6.2.1 Carpark noise assumptions

An assessment of noise levels associated with the use of the car park was conducted for each of the identified operational scenarios. Table 22 provides assumed noise source levels and the estimated number of noise events per the 15-minute assessment period.

Table 22 Typical car park noise sources

Noise Source	Distance to source (m)	Duration (seconds)	$L_{eq,T}$ dB (A)	Assumed maximum events per 15 minutes
Car door closure	1	1	75	77
Car engine start	1	2	72	39
Car pass-by	1	20	76	77

The following assumptions have been made for car park noise level predictions:

- The site will incorporate car parking as follows:
  - Northern car park: 223 existing car parking spaces.
  - Northern car park: 40 additional car parking spaces proposed.
  - South western car park: 67 existing car parking spaces.
- The Traffic Impact Assessment noted that the total peak hour vehicle movements relating to the use of the site is 254.
- This would relate to approximately 77 vehicle movements in a peak 15-minute period on the basis that the peak 15-minute period would see approximately 30% of the vehicle movements during the peak one hour.
- All noise sources including car door closures, engine starts and car pass-bys have been treated as if they all occur at a location within the carpark that is nearest to the residential receivers. The method of predicting vehicle noise from the nearest single location is conservative as the car door closures and ignition noise sources would be spread out across the car park at varying distances from the receiver.
- The aforementioned peak vehicle movement projection has been used to predicted noise levels however it should be noted that the overall car park capacity would increase by only 14% over the existing capacity (290 spaces to 330 spaces).

6.2.2 Sporting activity noise assumptions

The following assumptions have been made in relation to sporting activity (athlete and spectator) noise emissions:

- The number of players and athletes assumed to be on site is presented in Table 23 and distributed across the site as follows:
  - Normal operations: Evenly distributed across the site.
  - Event Scenario 1: Evenly distributed across the site including 25 % of spectators using the grandstand.
  - Event Scenario 2: Approximately 1000 standing spectators evenly distributed across the site and approximately 1,500 seated spectators using the grandstand.
- An average $L_{A10(15\text{-minute})}$ sound power level per person of 77 dB(A) has been used. This factors the rise and fall of spectator and player noise levels over a typical 15-minute period during a game. This acknowledges that there will be a continuous level of underlying spectator noise with short-term increase in noise due to spectator cheering and players shouting and that not all people would be vocal at the same time.
- It is assumed that the player to spectator ratio would be higher during normal operations compared to the event scenarios.
- Player and spectator noise sources have been modelled at a height of 1.5 m above ground level.

Table 23 Number of people per assessment scenario

Number of players, officials and volunteers			Number of Spectators Present		
Normal Operations	Event Scenario 1 – Parramatta Eels Pathway Game	Event Scenario 2 – Parramatta Eels Game Day	Normal Operations	Event Scenario 1 – Parramatta Eels Pathway Game	Event Scenario 2 – Parramatta Eels Game Day
65	215	170	80	480	2,700

6.2.3 Car park and sporting event noise predictions

Predicted noise levels for each scenario are presented below.

Normal operations (NPI Assessment)

Predicted noise levels for the most potentially affected noise sensitive receiver within each NCA are presented in Table 24. The combined car park, mechanical services and sporting activity noise levels are predicted to comply with the NPI criteria during the daytime, evening and night-time periods and the use of the car park would be at a minimum. As described in Section 6.1, the extent of operational external mechanical plant would be reduced during the night-time period and there would not be any sporting activities occurring during this time.

Table 24 Normal Operation – Predicted Noise Levels

Sensitive Receiver	Daytime 07:00 – 18:00			Evening 18:00 – 22:00			Night-time 22:00 – 07:00[1]		
	Predicted SPL dB(A)	Criteria $L_{Aeq,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{Aeq,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{Aeq,15min}$	Compliance (✓/✗)
Gormon Avenue (NCA01)	43	49	✓	43	43	✓	34	36	✓
Stone Mason Drive & Bugle Circuit (NCA02)	43	49	✓	43	43	✓	36	36	✓
Stone Mason Drive (NCA03)	41	49	✓	41	43	✓	33	36	✓
McKellar Court (NCA04)	40	47	✓	40	43	✓	35	36	✓
Balmoral Road (NCA05)	38	47	✓	38	43	✓	33	36	✓
Severn Vale Drive (NCA06)	40	47	✓	40	43	✓	35	36	✓

(1) Any sporting related activities would not occur during the night-time period.

Event Scenario 1 – Parramatta Eels Pathway Game (ENCM Screening Assessment)

Predicted noise levels for the most potentially affected noise sensitive receiver within each NCA are presented in Table 25. The combined car park, mechanical services and sporting activity noise levels are predicted to:

- Comply with the ENCM screening assessment criteria at all locations during the daytime and evening periods.
- The Parramatta Eels Pathway Games (including potential overlay with normal community use) would not occur during the night-time period and hence this scenario has not been assessed.
- Whilst exceedances of the screening criteria have not been predicted, measures to minimise potential impacts on the adjacent community should be implemented where reasonable and feasible to do so. Recommended noise management measures are discussed in Section 6.5.

Table 25 Event Scenario 1 – Predicted Noise Levels

Sensitive Receiver	Daytime 07:00 – 18:00			Evening 18:00 – 22:00			Night-time 22:00 – 07:00[1]		
	Predicted SPL dB(A)	Criteria $L_{A10,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{A10,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{A10,15min}$	Compliance (✓/✗)
Gormon Avenue (NCA01)	48	54	✓	48	48	✓	N/A	41	N/A
Stone Mason Drive & Bugle Circuit (NCA02)	47	54	✓	47	48	✓	N/A	41	N/A
Stone Mason Drive (NCA03)	47	54	✓	47	48	✓	N/A	41	N/A
McKellar Court (NCA04)	48	52	✓	48	48	✓	N/A	41	N/A
Balmoral Road (NCA05)	44	52	✓	44	48	✓	N/A	41	N/A
Severn Vale Drive (NCA06)	47	52	✓	47	48	✓	N/A	41	N/A

(1) The Parramatta Eels Pathway Games (including potential overlay with normal community use) would not occur during the night-time period and hence this scenario has not been assessed.

Event Scenario 2 – Parramatta Eels Elite Level Game Day (ENCM Screening Assessment)

Predicted noise levels for the most potentially affected noise sensitive receiver within each NCA are presented in Table 26. The combined car park, mechanical services and sporting activity noise levels are predicted to:

- Daytime:
  - Comply with the ENCM screening assessment criteria at NCAs 1, 2, 3 and 5 and marginally exceed the screening criteria at NCAs 4 and 6 by between 1 dB and 2 dB.
- Evening:
  - Comply with the ENCM screening assessment criteria at NCAs 2 and 3 and exceed the screening criteria at NCAs 1, 4, 5 and 6 by between 2 dB and 8 dB.
- Night-time
  - Elite Level Games would not occur during the night-time period and hence this scenario has not been assessed.
- Potential exceedances of the screening criteria do not mean that the events should not take place but indicates that measures should be implemented to minimise potential impacts where reasonable and feasible to do so. Recommended noise management measures are discussed in Section 6.5. It must be noted that these events are to be subject to the Event Management Plan as developed in consultation with and approved by the Hills Shire Council.

Table 26 Event Scenario 2 – Predicted Noise Levels

Sensitive Receiver	Daytime 07:00 – 18:00			Evening 18:00 – 22:00			Night-time 22:00 – 07:00[1]		
	Predicted SPL dB(A)	Criteria $L_{A10,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{A10,15min}$	Compliance (✓/✗)	Predicted SPL dB(A)	Criteria $L_{A10,15min}$	Compliance (✓/✗)
Gormon Avenue (NCA01)	53	54	✓	53	48	✗	N/A	41	N/A
Stone Mason Drive & Bugle Circuit (NCA02)	47	54	✓	47	48	✓	N/A	41	N/A
Stone Mason Drive (NCA03)	47	54	✓	47	47	✓	N/A	41	N/A
McKellar Court (NCA04)	54	52	✗	54	48	✗	N/A	41	N/A
Balmoral Road (NCA05)	50	52	✓	50	48	✗	N/A	41	N/A
Severn Vale Drive (NCA06)	53	52	✗	53	48	✗	N/A	41	N/A

(1) Elite Level Games would not occur during the night-time period and hence this scenario has not been assessed.

6.3 Operational road traffic noise

6.3.1 Assumptions and noise level predictions

An assessment of operational road traffic noise has been undertaken for each operational scenario. The following assumptions were made in undertaking the assessment:

- Most potentially affected receivers due to increases in road traffic noise are located on Stone Mason Drive with an offset distance of approximately 12 m from the nearest lane.
- A speed of 50 km/h, CORTN road traffic noise algorithm.
- The existing measured ambient L_{Aeq} noise levels were approximately 55 dB(A) on average and up to approximately 61 dB(A) during the peak hour periods which is already above the Road Noise Criteria for local roads.
- It was noted whilst on site that road traffic on Memorial Avenue provides a reasonable contribution to the measured noise levels.
- The Traffic Impact Assessment Report provided the following information relating to peak vehicle movements likely to be generated by the site:
  - 254 movements into and out of the site during the evening peak one-hour period.
  - Approximately 25% and 40% of movements would move between Memorial Avenue and the Site in the outbound and inbound directions respectively.
  - Approximately 75% and 60% of movements would move between Fairway Drive and the Site in the outbound and inbound directions respectively.
- This results in an $L_{Aeq(1hour)}$ noise level contribution from the site of approximately 58 dB(A) resulting in a predicted total peak hour noise level of 63 dB(A). This translates to an increase of 2 dB over the existing maximum peak hour noise level.
- Additional reasonable and feasible mitigation measures are not required on the basis that the peak period noise levels are not predicted to increase by more than 2 dB.
- Notwithstanding the above, is also noted that an upgrade to Memorial Avenue is currently under construction which will provide for an upgraded entry and exit to Stone Mason Drive. The Noise and Vibration Impact Assessment Report associated with the Memorial Avenue Upgrade Project Review of Environmental Factors noted the following with respect to potential at-property acoustic treatment:
- *'The project area is currently being urbanised with new residential developments under construction. The Hills Shire Council Development Control Plan (DCP) requires new developments to provide noise mitigation to achieve the noise goals outlined in the NSW State Environmental Planning Policy (Infrastructure) 2007. Responsibility for noise mitigation for these recent developments lies with the developer. Consistent with Council DCP and the REF for the [Memorial Avenue Upgrade] project, whilst all receivers within the study area have been assessed, post 2008 developments have not been considered for noise mitigation.'*

6.4 Sleep disturbance

The operation of the mechanical plant and equipment would result in steady state continuous noise emissions without impulsive noise events. Therefore, the L_{eq} based assessment would control the mitigation outcomes and sleep disturbance impacts relating to mechanical plant and equipment are not anticipated on this basis.

During the night-time period, other noise sources that have the potential to result in sleep disturbance impacts are car park noise sources such as cars starting and door slams. The use of the car park after 10 pm would be at minimum and also noting that a significant proportion of the car park is pre-existing and would not represent new noise sources from a sleep disturbance perspective. It is on this basis that new sleep disturbance impacts are not anticipated due to car park operations.

6.5 Operational noise management measures

6.5.1 Mechanical plant and equipment

The building design incorporates the following operational noise control measures relating to mechanical plant and equipment:

- Plant areas are bounded by solid walls. The height and location of walls may be optimised during the detailed design phase. These walls have been coordinated with the design team to allow for the selected external plant to comply with the NPI criteria.
- Maximum allowable sound power levels have been provided based on current equipment selections. These could be varied in future stages of design in parallel with additional or complementary measures to maintain predicted noise levels.
- Externally discharging plant would include appropriate attenuation in the form of silencers, louvres, internally lined duct work and the like.
- Plant and equipment have been located within internal plant rooms where possible to do so.

6.5.2 Sporting activity noise

Whilst the aforementioned assessment indicates that event noise levels may exceed the screening criteria at times during the Elite Level games, it does not necessarily mean that they should not proceed but it highlights the need to implement noise management measures to minimise potential impacts where reasonable and feasible to do so. These events are to be subject to the Event Management Plan as developed in consultation with and approved by the Hills Shire Council. Noise management measures may include the following which could be incorporated into the overall plan of management for the site:

- Reduce the number of higher noise events.
  - The current strategy would be for the Elite Level Game Days to occur twice per year.
- Providing marshalling to usher visitors onto the site encouraging quiet arrival and departure noting the proximity of the adjacent residential area.
- Providing sufficient alternative transportation (such as shuttle buses) to the site for the Elite Level Games Days do reduce pressure on the nearby local road network.

6.5.3 Operational road traffic noise management measures include use of the car park

Noise management measures may include the following which could be incorporated into the overall plan of management for the site:

- Driving to the speed limit.
- Limiting unnecessary acceleration and braking.
- Encouraging users of the site to find a parking space promptly and minimise idling time.
- Implement drop off and pick off points for shuttle buses and the like that are located away from adjacent sensitive receivers insofar as practical.

6.5.4 Future commercial tenancies

The future commercial tenancies would be required to implement appropriate noise control and management measures as relevant to the proposed use such that the operational noise objectives for the site achieved. These may include:

- Mechanical services noise control
- Other environmental noise emissions such as music or patron noise.

7 Conclusion

Resonate Consultants has been engaged to prepare a construction and operational noise and vibration impact assessment for the proposed Centre of Excellence & Community Facilities.

Construction noise and vibration predictions have been undertaken in accordance with the ICNG. Construction noise levels are predicted to be greatest within 20-200 meters of proposed construction works. The receivers likely to experience the highest noise levels are located directly opposite the site in NCA01 and NCA02. The highest noise levels are likely to occur during demolition and substructure works. Construction noise mitigation measures are described in Section 5.3.

Adverse impacts due to construction vibration are not considered likely however minimum working distances for high vibration generating plant have been provided and additional mitigation such as vibration monitoring would be triggered where work inside the minimum working distances is required.

Operational noise level predictions have demonstrated that compliance with all project criteria could be achieved during the normal operational scenario.

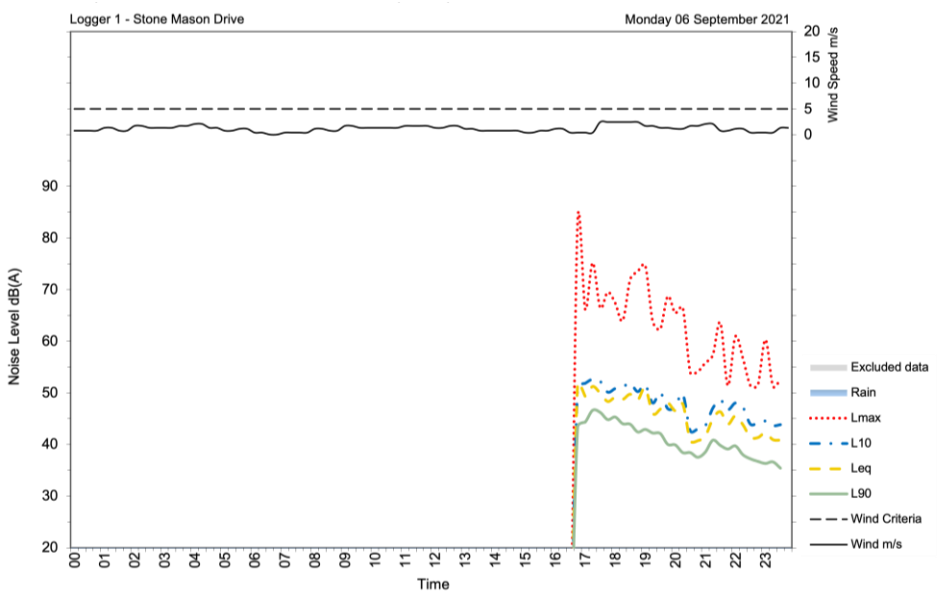
Assessment of noise emissions from the Event Scenarios including the Parramatta Eels elite level games indicates that noise levels may exceed the screening criteria at times. This does not necessarily mean that the events should not proceed but it highlights the need to implement reasonable and feasible noise management measures to minimise potential impacts. These measures are described in Section 6.5.

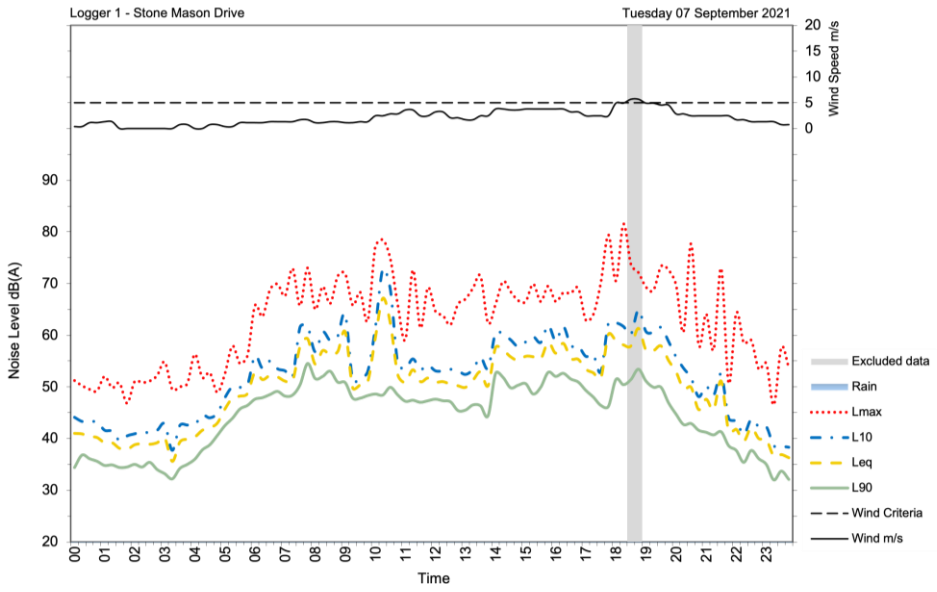
Appendix A—Unattended noise monitoring information

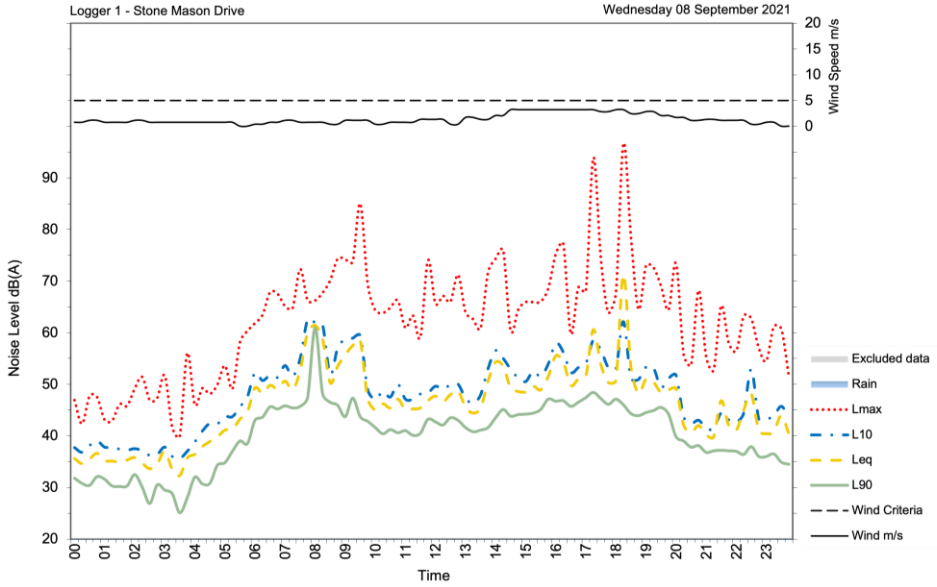
An initial unattended environmental noise survey was conducted during the period 6 September to 19 September 2021. The noise logging was conducted at two locations, with positions shown on Figure 1. The noise logger at Stone Mason Drive was vandalised on 16 September 2021 and was rendered non-operational from that point onward.

For reference, a weekly chart showing the graphed noise logging results is shown in the tables below for each noise logging location.

L1 Stone Mason Drive






Logger 1 - Stone Mason Drive
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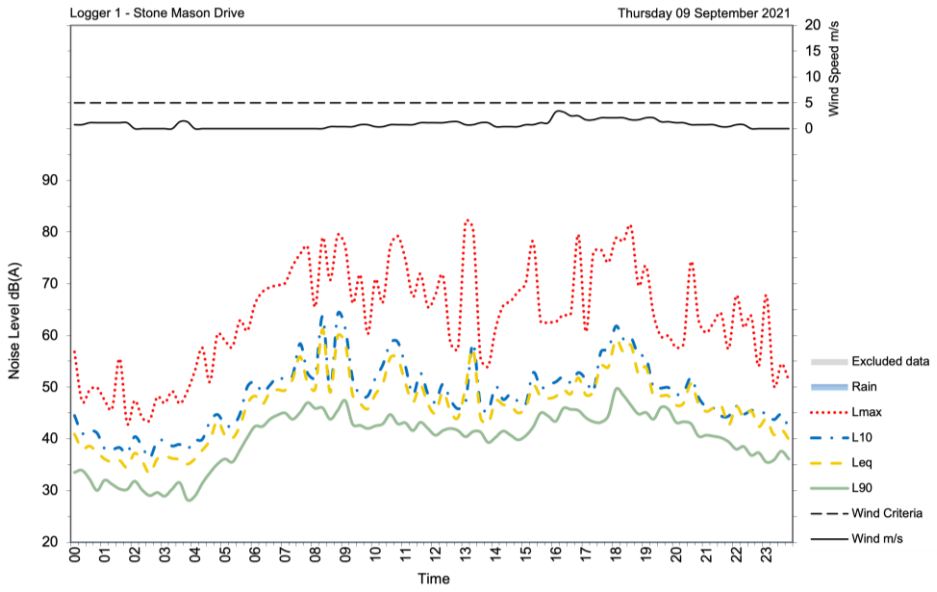
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s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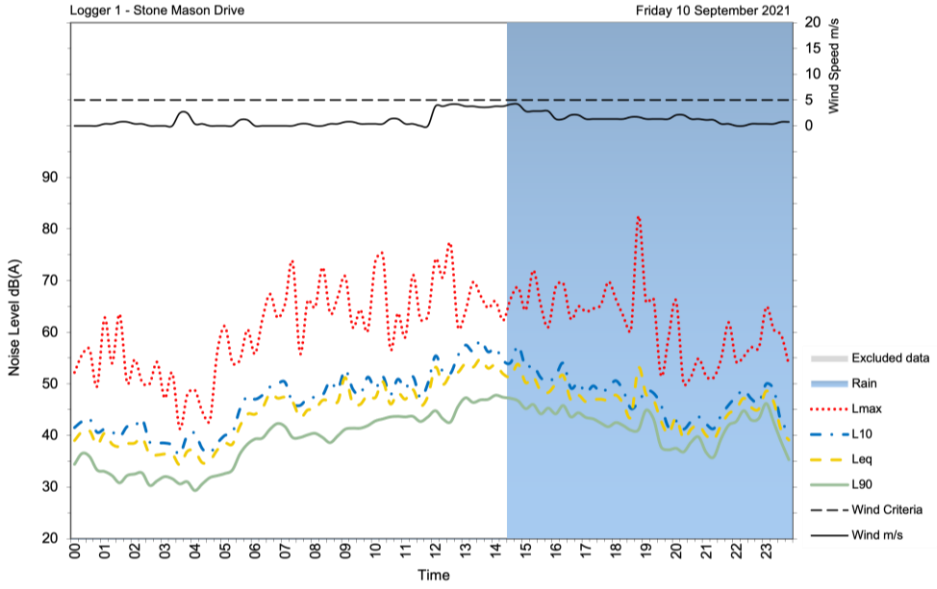
Wind Criteria
Wind m/s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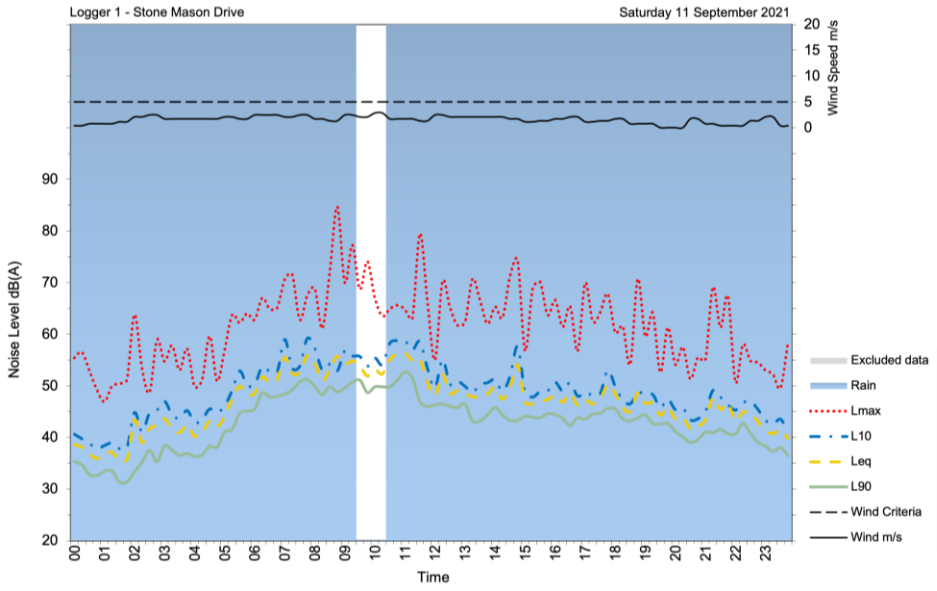
Wind Criteria
Wind m/s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Time
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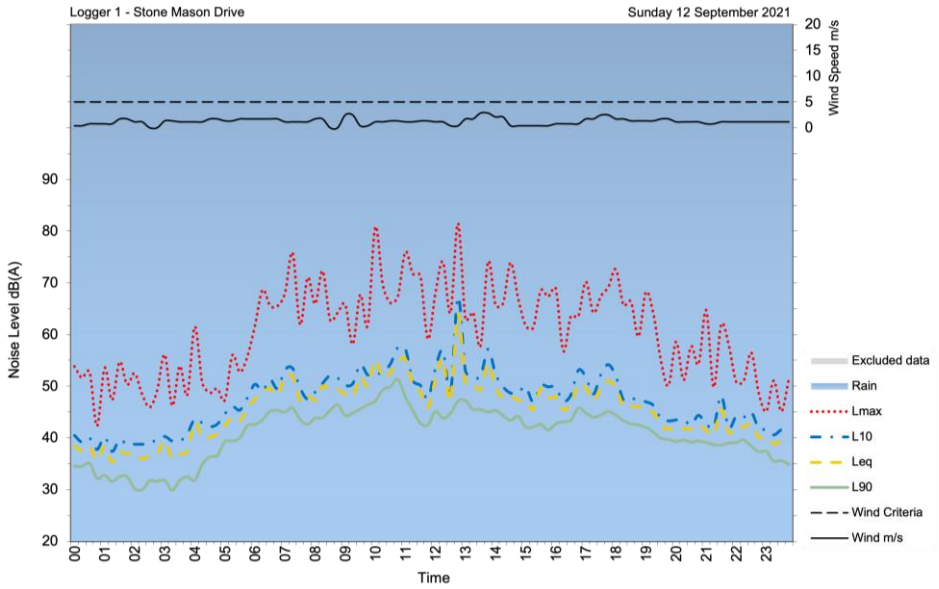
Wind Criteria
Wind m/s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Noise Level dB(A)
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Leq
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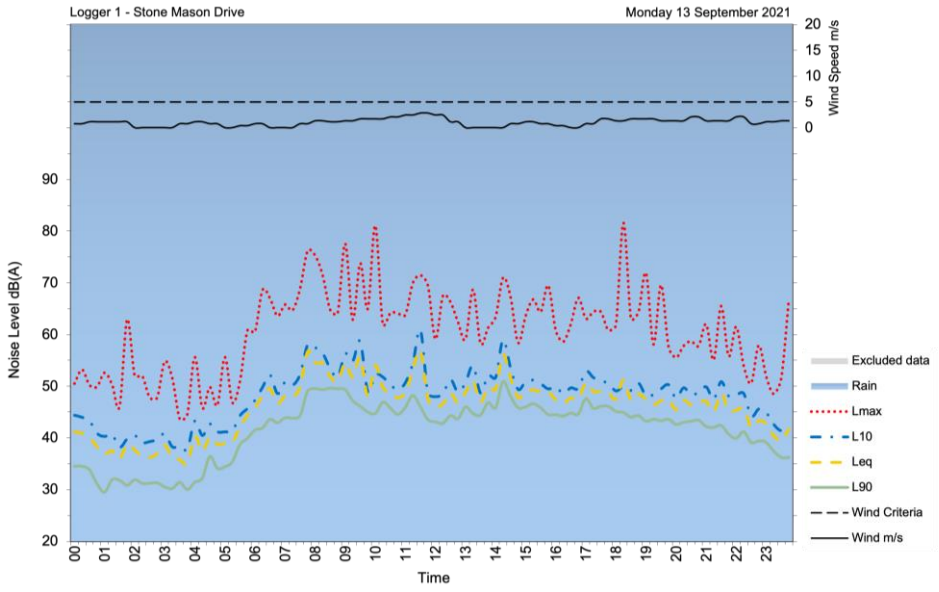
Wind Criteria
Wind m/s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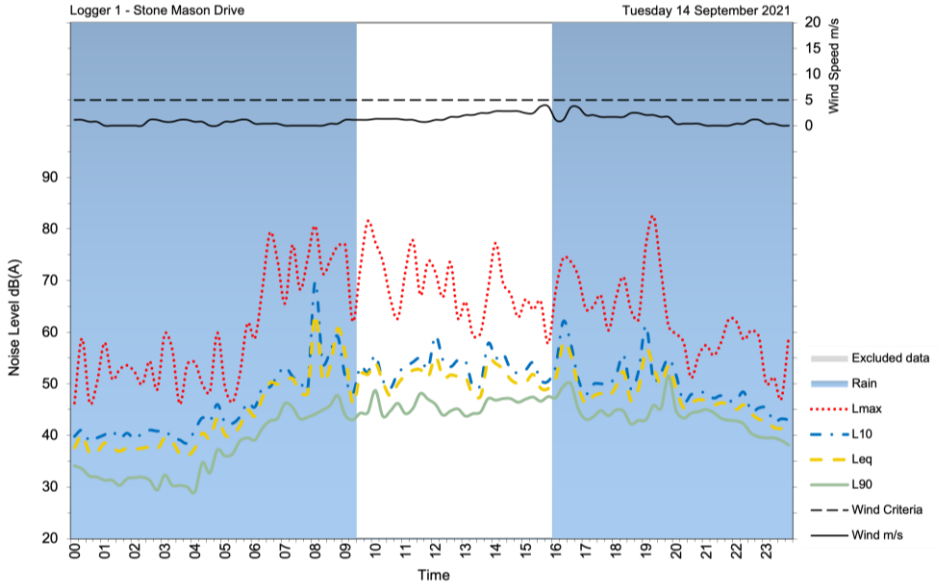
Wind m/s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Leq
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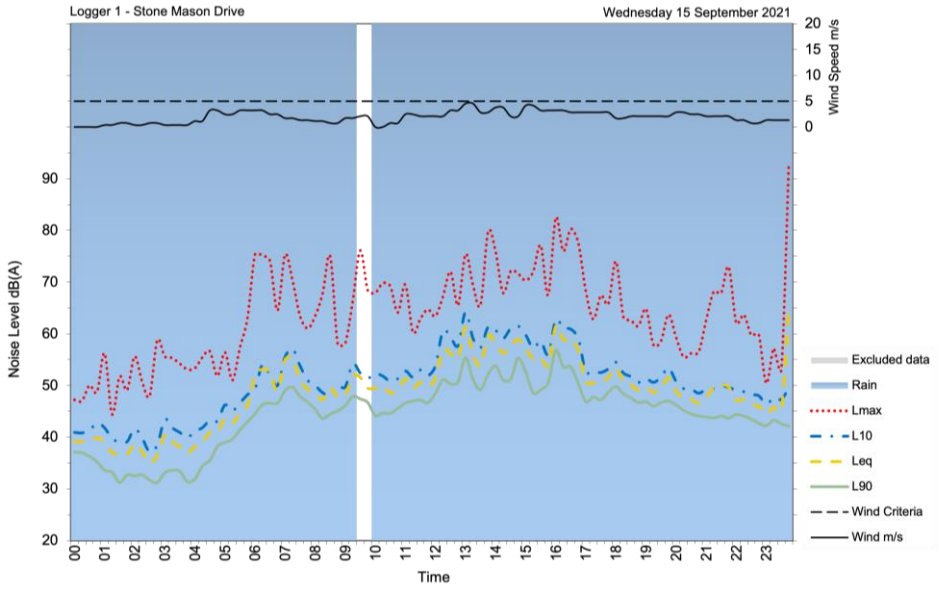
Wind m/s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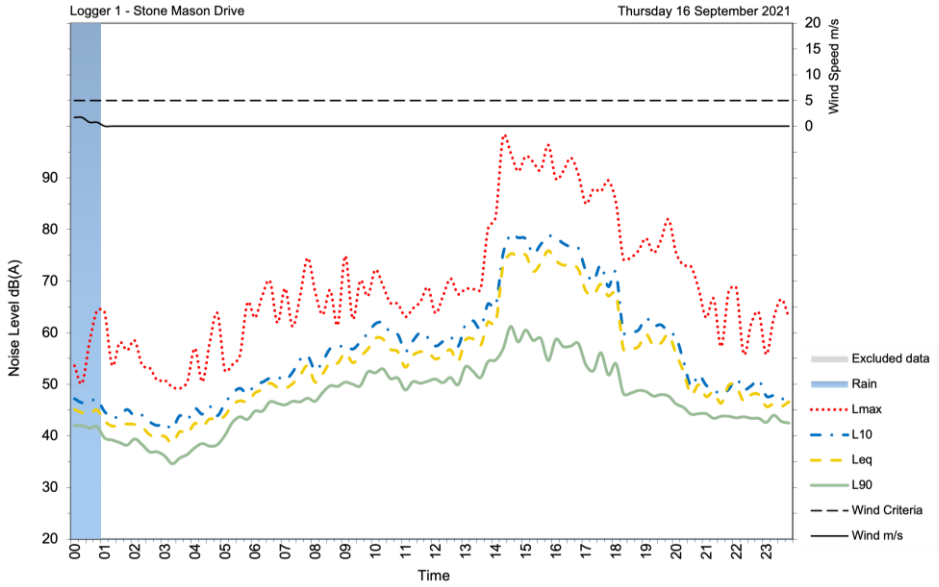
Wind Criteria
Wind m/s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Wind Criteria
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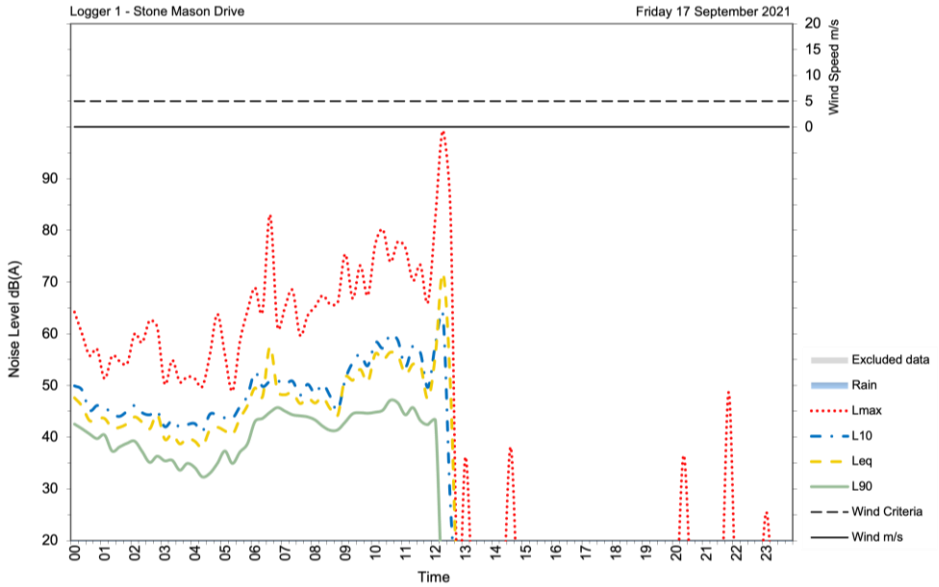
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Leq
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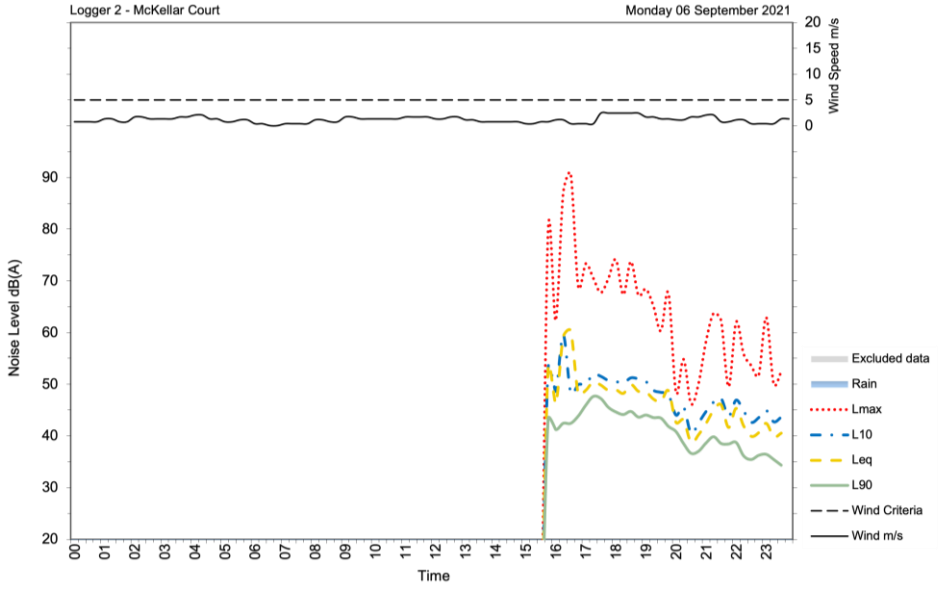
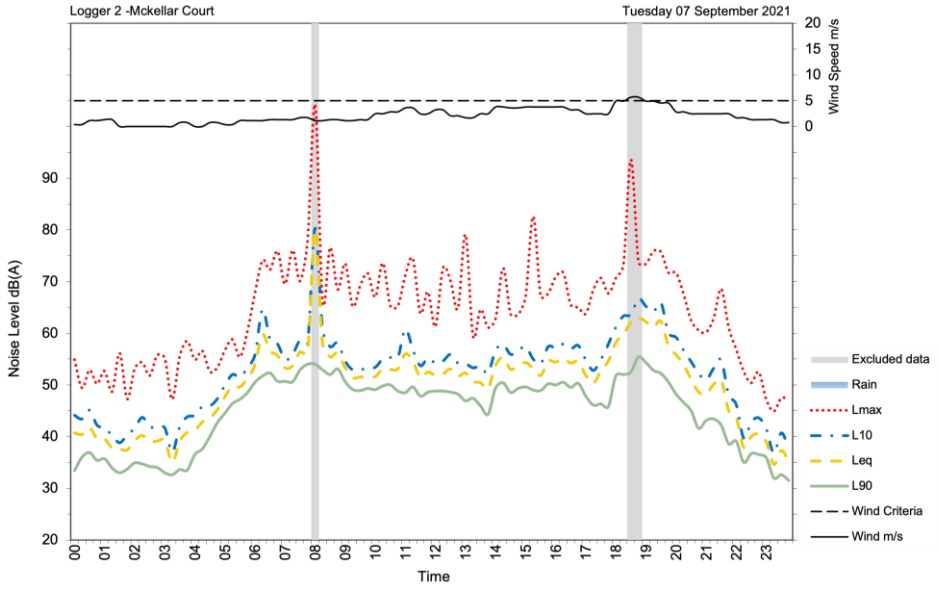
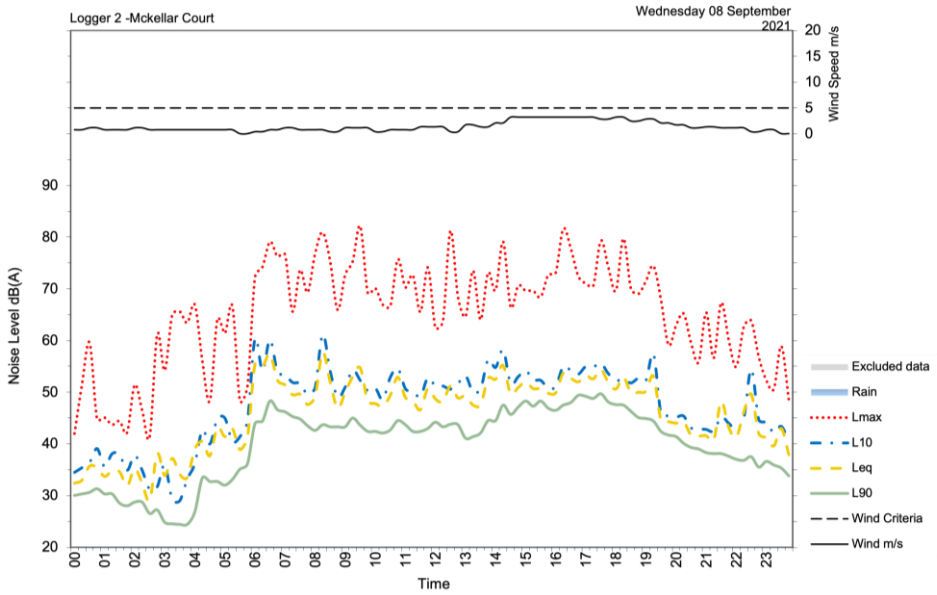
Wind Criteria
Wind m/s

L2 McKellar Court



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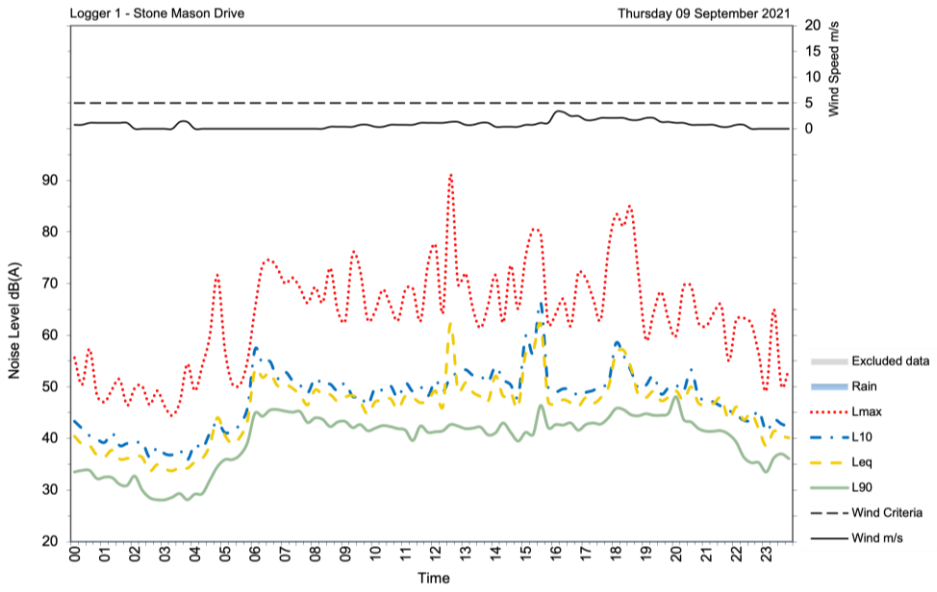
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s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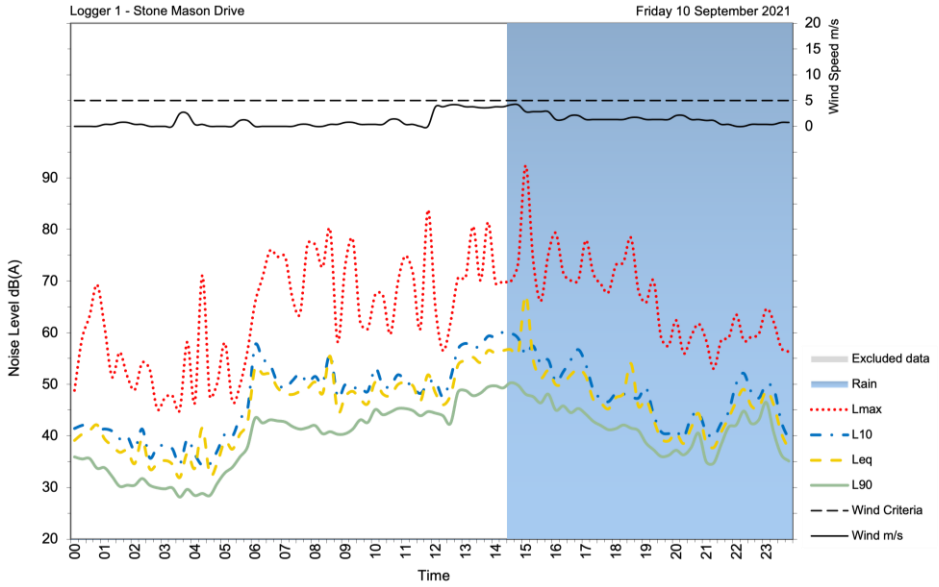
Wind Criteria
Wind m/s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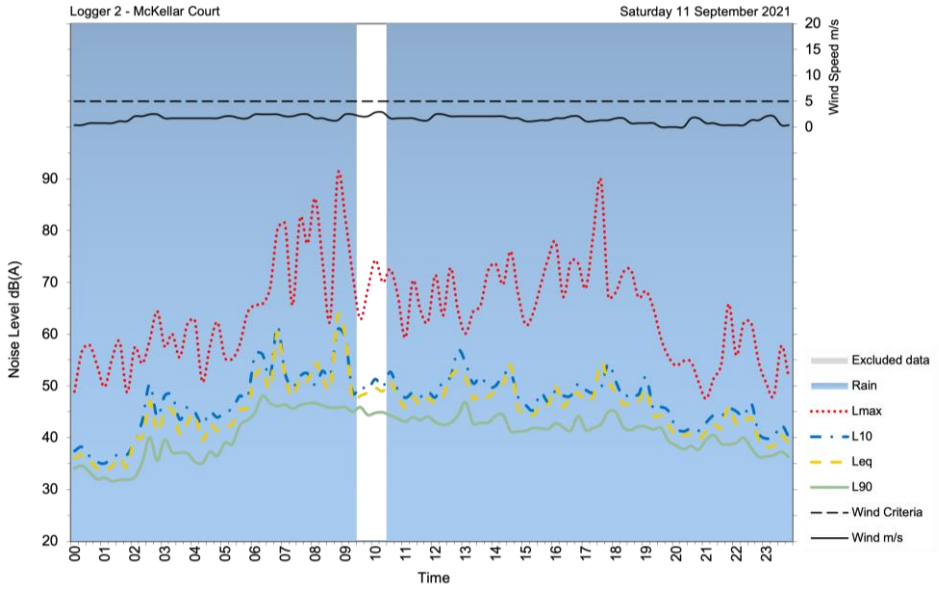
Wind Criteria
Wind m/s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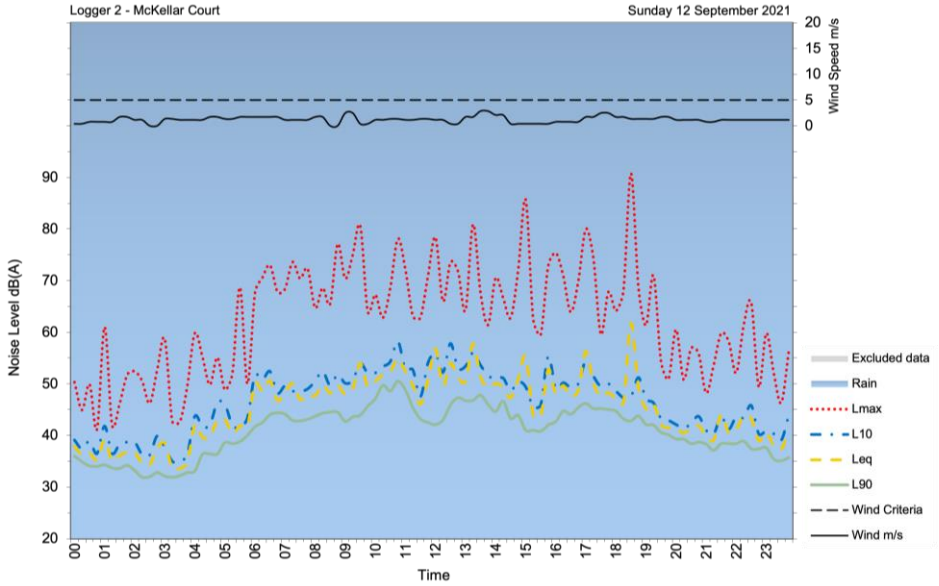
Wind Criteria
Wind m/s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Noise Level dB(A)
Time
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Rain
Lmax
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Leq
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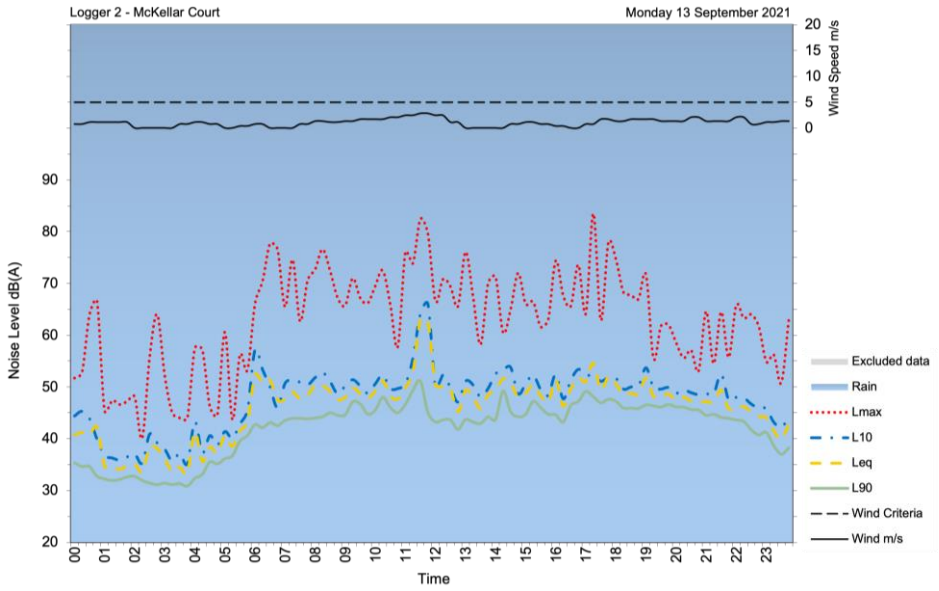
Wind Criteria
Wind m/s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Noise Level dB(A)
Time
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Leq
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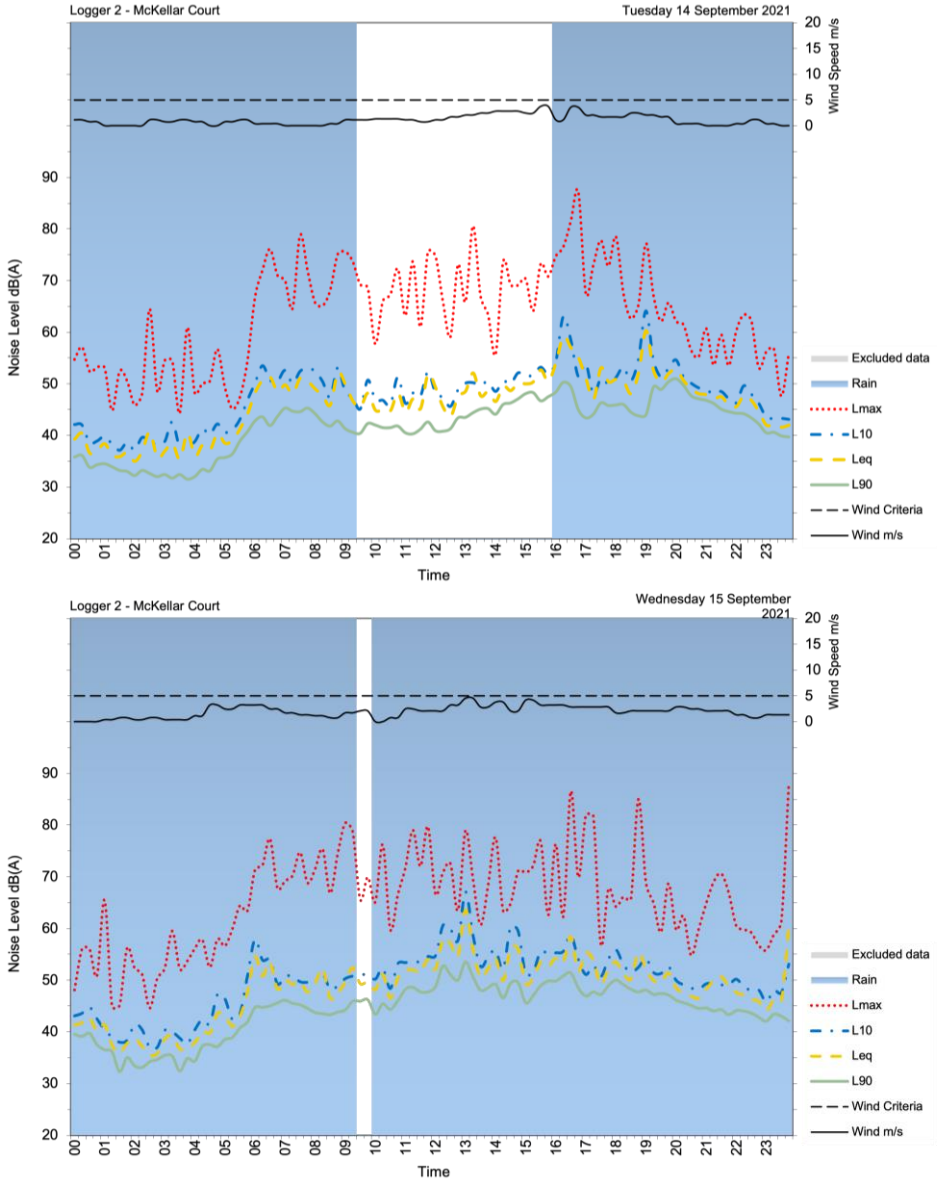
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Noise Level dB(A)
Wind Speed m/s
Time
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Rain
Lmax
L10
Leq
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Wind Criteria
Wind m/s
Logger 2 - McKellar Court
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Wind Speed m/s
Time
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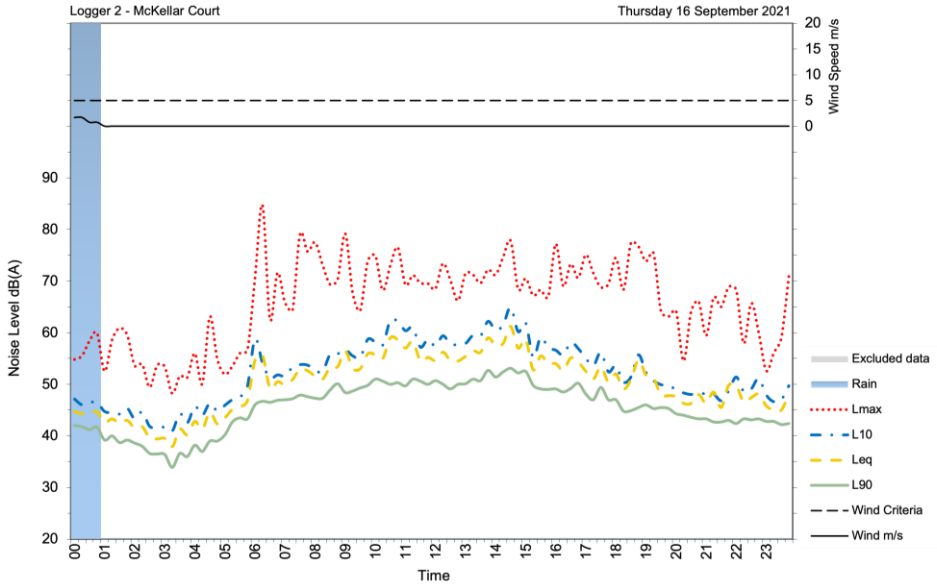
Wind Criteria
Wind m/s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Leq
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Wind Criteria
Wind m/s


Logger 2 - McKellar Court
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Wind Speed m/s
Time
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Lmax
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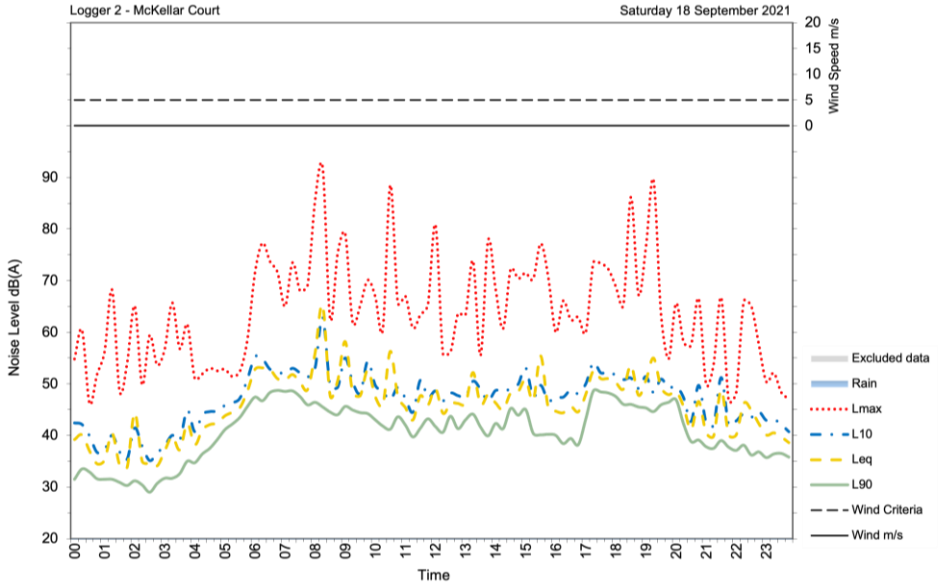
Leq
L90
Wind Criteria
Wind m/s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Wind Speed m/s
Time
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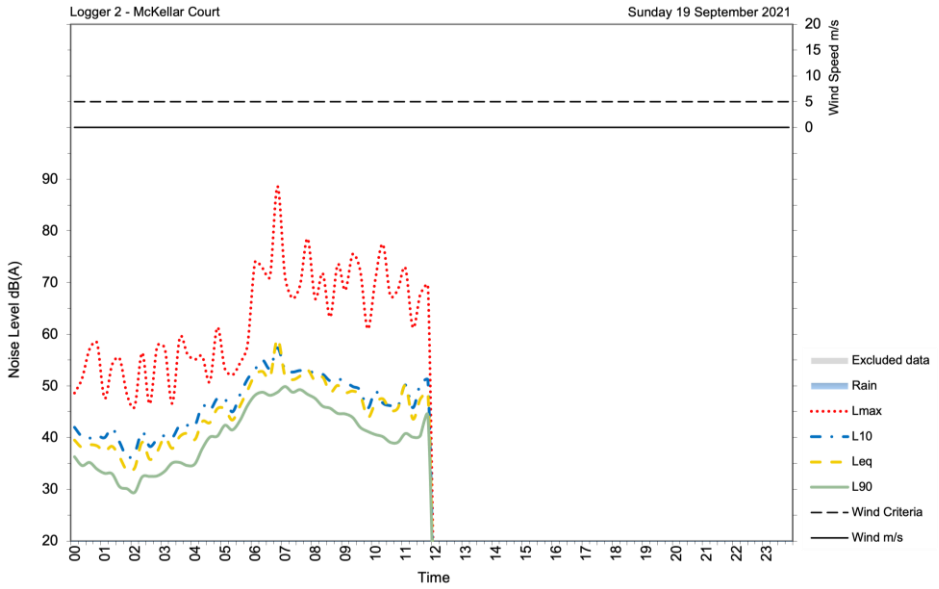
Wind Criteria
Wind m/s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Sunday 19 September 2021
Noise Level dB(A)
Wind Speed m/s
Time
Excluded data
Rain
Lmax
L10
Leq
L90
Wind Criteria
Wind m/s

Appendix B—Receiver ID’s

Centre of Excellence & Community Facilities

Receiver Locations

PROJECT NUMBER	S200367
DRAWN BY	AR
DATE ISSUED	May 2021

Legend

- Recievers
- Site Boundary

0 30 N 60 90 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Receiver Locations

PROJECT NUMBER	S200367
DRAWN BY	AR
DATE ISSUED	May 2021

Legend

- Recievers
- Site Boundary

0 20 N 40 60 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Receiver Locations

PROJECT NUMBER	S200367
DRAWN BY	AR
DATE ISSUED	May 2021

Legend

- Recievers
- Site Boundary

0 10 N 20 30 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Receiver Locations

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Receiver Locations

PROJECT NUMBER	S200367
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Legend

- Recievers
- Site Boundary

0 10 20 30 m

N

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Receiver Locations

PROJECT NUMBER	S200367
DRAWN BY	AR
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Legend

- Recievers
- Site Boundary

0 30 N 60 90 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Appendix C—Construction Noise Contours

Centre of Excellence & Community Facilities

Site Establishment

Page 1 of 7

PROJECT NUMBER	S200367
DRAWN BY	AR
DATE ISSUED	Oct 2021
CLIENT	HB Arch
PREDICTION METHOD	Concawe
GROUND ABSORPTION	G=0.4
RECEIVER HEIGHT	1.5 m AGL
TEMP	24ºC
RH	70%

Legend

Predicted noise level - dB(A)

- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 - 85

Recievers

Site Boundary

N

0 30 60 90 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

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Recievers

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Datum WGS 84, Projection UTM ZONE 50S

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Page 3 of 7

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Centre of Excellence & Community Facilities

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Recievers

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Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Retaining Piles and Excavation

PROJECT NUMBER	S200367
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Recievers

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Recievers

Site Boundary

0 30 60 90 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Substructure Works

Page 1 of 7

PROJECT NUMBER	S200367
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Recievers

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Centre of Excellence & Community Facilities

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Frame Works

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Recievers

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Resonate

Centre of Excellence & Community Facilities

Facade Works

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TEMP	24ºC
RH	70%

Legend

Predicted noise level - dB(A)

- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80

Recievers

Site Boundary

N

0 20 40 60 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate

Centre of Excellence & Community Facilities

Facade Works

PROJECT NUMBER	S200367
DRAWN BY	AR
DATE ISSUED	Oct 2021
CLIENT	HB Arch
PREDICTION METHOD	Concawe
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Recievers

Site Boundary

0 10 N 20 30 m

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Recievers

Site Boundary

0 30 N 60 90 m

Datum WGS 84, Projection UTM ZONE 50S

Resonate