

Noise and Vibration Impact Assessment Acoustic Advice

Project:	Project Hive – Denman Site		
Our reference:	703100925	Revision:	2
Prepared by:	Jacob McGrath	Date:	07/12/2023
Approved by:	Lindsay Speyers	Checked by:	Tom Krikke
Subject:	Acoustic Advice – Noise and Vibration Impact Assessment		

1 Purpose

The purpose of this advice is to provide a Noise Impact Assessment for the BESS (Battery Energy Storage System) site located in Denman, NSW that is associated with the Project Hive energy network project by the Clean Energy Transfer Fund, for which Mott MacDonald are the owner's engineer for the delivery of the project.

Project Hive integrates ten (10) sub-5MW BESS in the Hunter Valley regional area, resulting in a co-ordinated 200MWh capacity. This innovative concept enables rapid deployment of coordinated and cost-effective energy storage solutions, while deferring electrical network investment and promoting more renewable energy sources on the grid.

The Project Hive development in Denman, NSW is located at 105 Merriwa Road (Lot 21 DP 731407) in the Muswellbrook Shire Council Local Government Area (LGA) and proposes a single BESS site with a connection point to the existing grid infrastructure.

The site features equipment with noise-generating potential which are in the vicinity of sensitive receivers, requiring an assessment of noise/vibration impacts in accordance with the NSW Environmental Protection Authority (EPA) and other local requirements.

For the purposes of preparing a Noise and Vibration Impact Assessment (NVIA) outlining the noise and vibration opportunities and constraints, the relevant noise and vibration criteria have been included within this report and are discussed in further detail. Acoustic criteria are applicable for both the operation and the construction of the project.

Recommendations for the acoustic design and treatment of the project have provided to minimise the acoustical impact of the development to surrounding receivers, based on the relevant noise and vibration criteria applicable within the Muswellbrook Shire Council LGA and the State of NSW.

Specific acoustic designs/solutions are still being investigated by the project team and have not yet been finalised. Several options are being considered including but not limited to the provision of quieter equipment selections, quieter alternative components like fans in the selected equipment and specific treatments like acoustic attenuators, lining, enclosures and barriers.

To this end, this NVIA doesn't propose a specific acoustic design/solution and instead presents a performance-solution approach, which clearly states the criteria/treatment requirements but allows for the specific solutions to be developed in future as the design progresses.

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

2 Site

2.1 Site Overview

The Project Hive development at 105 Merriwa Road, Denman NSW (Lot 21 DP 731407) proposes a single BESS site. The Denman site comprises a total land area of approximately 1,400m². The Denman site is considered to be in the Hunter Valley regional area and is specifically located in the Muswellbrook Shire Council LGA.

The site comprises the following equipment with noise-generating potential:

- Twelve (12) individual BESS battery containers
- One (1) Power Conversion System (PCS) inverter container, which also contains one (1) transformer

The Denman site is surrounded by:

- The Golden Highway to the east, which features one (1) lane of traffic in each direction with a posted speed of 80km/h for the section heading north from the site and 60km/h for the section heading south from the site into town
- Rural/residential properties with detached dwellings, located in all directions at varying distances
- Other non-residential rural uses such as agricultural and livestock farming
- A rail corridor to the west which features Denman Station (historical, not in use) which is located further south along the rail line
- The existing grid infrastructure which is located adjacent to the Golden Highway to the east and provides a connection path/point for the BESS site

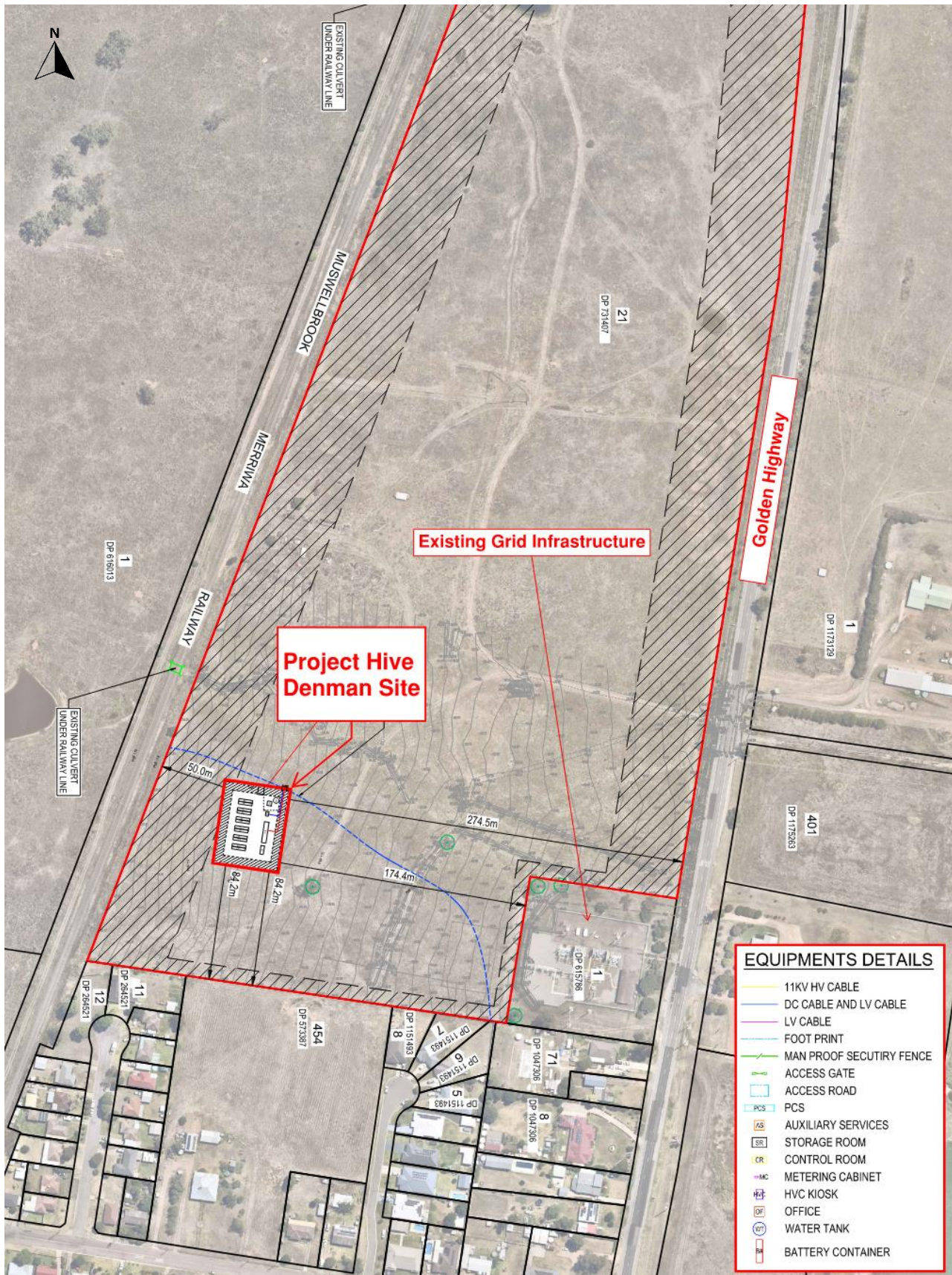


Figure 1: Site Overview and Equipment Layout

2.2 Site Location and Sensitive Receivers

The Project Hive Denman site is located in E4 – General Industrial zoning. The existing grid infrastructure to the east is designated as SP2 – Infrastructure – Substation zoning and another SP2 – Infrastructure – Rail Infrastructure zone is located to the west. The residential areas to the south and west are located in RU5 - Village zoning and there is a sparser region of rural area to the east on the opposite side of the Golden Highway which is designated as RU1 – Primary Production zoning. A small park area is located west adjoining the rail corridor and is zoned as RE1 – Public Recreation.

The site is within proximity to the following sensitive receivers, with their respective zoning sourced from NSW Planning Portal Spatial Viewer and included in Figure 2. The description of each identified receiver and its classification per the NSW Noise Policy for Industry (NPfI) is summarised in Table 1.



Figure 2: Site Location, Surrounding Sensitive Receivers and Respective Zoning, Including Noise Monitor Location

Table 1: Sensitive Receiver Details

Receiver ID	Type of Receiver ¹	Description	Min. Distance ²
R1	Rural residential	Detached dwelling at 15 Kerrabee Close	140m
R2	Rural residential	Detached dwelling at 13 Kerrabee Close	160m
R3	Rural residential	Detached dwelling at 11 Kerrabee Close	180m
R4	Rural residential	Detached dwelling at 146 Palace Street (Golden Hwy)	240m
R5	Rural residential	Detached dwelling at 110 Merriwa Road	330m
R6	Rural residential	Detached dwelling at 120 Merriwa Road	440m
R7	Rural residential	Detached dwelling at 184 Almond Street	340m

Receiver ID	Type of Receiver ¹	Description	Min. Distance ²
R8	Rural residential	Detached dwelling at 8 Fontana Way	100m
R9	Rural residential	Detached dwelling at 7 Fontana Way	120m
R10	Passive recreation	Small public park at 9 Fontana Way	110m
R11	Industrial premises	Existing grid infrastructure (substation) at same site at 105 Merriwa Road	180m

Note 1: Receiver types have been assigned in accordance with the NSW NPfl based on existing noise environment. Refer to Section 4.1.2.

Note 2: The minimum distances between the Project Hive Denman site and the surrounding sensitive receivers in this table are approximations. Precise equipment layouts and distances between individual plant/equipment items have been considered in the assessment in the sections below.

3 Existing Noise Environment

3.1 Unattended Noise Survey

Unattended noise monitoring was undertaken to determine existing ambient and background noise levels over the long-term.

Noise monitoring was conducted between Thursday 5 October 2023 and Thursday 19 October 2023. The noise monitor was installed at the 105 Merriwa Road site near the existing residences on Kerrabee Close and also the existing grid infrastructure, as presented in Figure 2.

The noise monitoring was conducted at the most-affected noise sensitive receivers and the measured noise levels are summarised in Table 2.

Table 2: Summary of unattended noise monitoring

Location	Rated Background Levels dB(A) L_{90}			Measured Ambient Levels dB(A) $L_{eq,Period}$		
	Daytime	Evening	Night-time	Daytime	Evening	Night-time
105 Merriwa Road site	38	32	29	53	50	51
Note 1: Time of day is defined as per the Noise Policy for Industry 2017 and are day – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays, evening – the period from 6pm to 10pm, night – the remaining periods.						

Further details of the unattended noise monitoring including logger graphs is included as Appendix A.

3.2 Attended Noise Survey

An attended noise survey was undertaken to verify existing ambient and background noise levels over the short-term.

Attended noise measurements were conducted on Friday 20 October 2023. The measurements were conducted in accordance with Australian Standard AS 1055-2018 “Acoustics - Description and measurement of environmental noise”.

The noise measurements were conducted at the most-affected noise sensitive receivers and the measured noise levels are summarised in Table 3.

Table 3: Summary of attended noise survey

Location	Date, Start Time & Weather	Measured Levels, dB(A), 15 min			Description of Noise Environment and dB(A), L_{max} Levels due to Specific Events
		L_{eq}	L_{90}	L_{max}	
105 Merriwa Road site	20/10/2023 2:00 am Wind: 1m/s (SE) Temp: 29°C Cloud: 0 okta	42	35	55	Birds: 35-50 Plane: 35-40 Insects: 33-43 Road traffic: 44-55 Sawing at residence: 30-33 (short duration)

4 Noise and Vibration Criteria

4.1 Operational Environmental Noise Emission Criteria

The close proximity of sensitive receptors, in particular residential properties, requires criteria for noise emissions from the project to be established. Noise emissions from the operation of the project to nearby noise sensitive receivers have been assessed.

4.1.1 Muswellbrook Shire Council

Considering that the development is located on land that is zoned as E4 – General Industrial per the NSW Planning Portal Spatial Viewer, the Muswellbrook Local Environmental Plan 2009 and the associated Muswellbrook Development Control Plan (DCP) 2009 does not establish any specific noise emission criteria for this land use.

However, the DCP notably refers to the NSW Industrial Noise Policy 2000 (INP) which has been superseded by the NSW Noise Policy for Industry 2017 (NPfI) to protect the amenity of surrounding receivers to the development.

As per the guidance notes in the NPfI, compliance with the NPfI is expected to result in compliance with the DCP. Therefore, this assessment will adopt the criteria and recommendations of the NPfI and is further discussed below.

4.1.2 Noise Policy for Industry 2017

The NSW NPfI sets out NSW EPA requirements for assessment and management of noise from industry in NSW. The NSW NPfI prescribes methods for determining the statutory environmental noise limits that apply to noise sensitive receivers with regards to individual noise sources only.

The assessment procedure for industrial noise sources has three components:

- Controlling intrusive noise impacts in the short term for residential receivers
- Maintaining noise level amenity for particular land uses for residences and other land uses; and
- Maximum noise level assessment for the potential of sleep disturbance during night-time.

In assessing the noise impact of industrial sources, all components must be considered for residential noise sensitive receivers. In most cases, only one will become the limiting criterion and form the project-specific noise levels for the industrial source under assessment. The intrusive noise and sleep disturbance criteria do not apply to non-residential receivers, instead the amenity criterion is applicable to these receivers.

For a residence, the project noise trigger level and maximum noise levels are to be assessed at the reasonably most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence, but not closer than 3 metres to a reflective surface and at a height of between 1.2–1.5 metres above ground level.

4.1.2.1 Project Intrusiveness Noise Level

The assessment requirements for intrusive noise due to industrial sources state:

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level by more than 5 dB when beyond a minimum threshold.

The prescribed intrusiveness criterion for residential receivers may be summarised as:

$$L_{Aeq, 15\text{-minute}} \leq \text{Rating Background Level (RBL, } L_{A90}) + 5 \text{ dB}$$

Minimum assumed RBLs apply in this policy. These result in minimum intrusiveness noise levels as follows:

Table 4: Minimum assumed RBLs and project intrusiveness noise levels – Sourced from NSW NPfI

Time of Day ¹	Minimum Assumed RBL, dB(A)	Minimum Project Intrusiveness Noise Levels, dB(A), $L_{eq,15\ min}$
Day	35	40
Evening	30	35
Night	30	35

Note 1: Time of day is defined as per the Noise Policy for Industry 2017 and are day – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays, evening – the period from 6pm to 10pm, night – the remaining periods.

An acoustic site survey has been undertaken, and a summary of the results is included in Section 3.1. Subsequently, the intrusiveness criterion is established and captured in Table 6.

4.1.2.2 Project Amenity Noise Level

To limit continuing increases in noise levels from application of the intrusiveness level criteria alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels prescribed in the NSW NPfI where feasible and reasonable.

The recommended amenity noise levels (ANL) represent the objective for total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

Based on the surrounding receivers and their respective zoning as identified in Figure 2 and Table 1, the relevant amenity noise levels outlined in Table 2.2 of the NPfI are summarised in Table 5 below.

It should be noted that the project amenity noise level is based on a generally recommended amenity deemed suitable for a given area as defined by the EPA. These recommendations should be validated with site-specific long-term unattended noise measurements and any discrepancies identified and adjusted accordingly.

Table 5: Amenity Noise Levels – Sourced from NSW NPfI

Receiver	Noise Amenity Area	Time of Day	Recommended Amenity Noise Level, dB(A), $L_{eq, period}$	Project Amenity Noise Level ² , dB(A), $L_{eq,15\ min}$
Residential	Rural ¹	Day	50	48
		Evening	45	43
		Night	40	38
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50	48
Industrial premises	All	When in use	70	68

Note 1: The NSW NPfI defines a Rural receiver category as being an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse.

Typical existing Rating Background Levels (RBLs) would be:

- Daytime: <40 dB(A)
- Evening: <35 dB(A)
- Night: <30dB(A)

Note 2: The NSW NPfI defines the project amenity noise level for industrial developments to be equal to the recommended amenity noise level minus 5 dB. In addition, to standardise the time periods for the intrusiveness and amenity noise levels, the policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period} + 3$ dB.

4.1.2.3 Project Noise Trigger Level

Based on the measured noise levels and the derived project amenity noise levels, site-specific project noise trigger levels are derived and summarised in Table 6.

Table 6: Project amenity and intrusiveness noise levels and the subsequently derived project noise trigger levels

Location	Time of Day ¹	Project Amenity Noise Level, dB(A), $L_{Aeq,15min}$	Project Intrusiveness Noise Level, dB(A), $L_{Aeq,15min}$	Project Noise Trigger Level, dB(A), $L_{Aeq,15min}$
Receivers R1 to R9 – Rural Residential	Day	48	43	43
	Evening	43	37	37
	Night	38	35 ²	35
Receiver R10 – Passive Recreation	When in use	48	-	48
Receiver R11 – Industrial Premises	When in use	68	-	68

Note 1: Time of day is defined as per the Noise Policy for Industry 2017 and are day – the period from 7am to 6pm Monday to Saturday or 8am to 6pm on Sundays and public holidays, evening – the period from 6pm to 10pm, night – the remaining periods.

Note 2: The measured Rating Background Levels (RBLs) from the onsite unattended monitoring (Table 2) were at or fell below the minimum assumed RBLs applicable in the NSW NPfI. The resulting Minimum Project Intrusiveness Noise Levels from Table 4 have therefore been applied.

4.1.2.4 Maximum Noise Level Event Assessment

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

Where the night-time noise emission levels due to industrial sources at a residential receiver exceed the following criteria, a detailed maximum noise level event assessment should be undertaken:

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

Sleep disturbance criteria has been derived for each critical receiver and are included in Table 7.

Table 7: Project sleep disturbance criteria

Location	Project Sleep Disturbance	
	dB(A) $L_{Aeq,15min}$	dB(A) L_{Fmax}
Receivers R1 to R9 – Rural Residential	40	52

4.2 Construction Noise and Vibration Criteria

4.2.1 Construction Noise

The NSW Interim Construction Noise Guideline 2009 (ICNG) has been adopted to establish the relevant noise criteria to protect the amenity of surrounding receivers due to construction related noise emissions.

4.2.1.1 Residential Receivers

Noise Management Levels (NML) are the level of noise above which receivers are considered to be 'noise affected'. They are based on the measured background noise level (RBL) plus an additional allowance of 10 dB during standard hours and 5 dB outside of standard hours.

Where construction noise levels are above 75 dB(A) at residential receivers during standard hours, they are considered 'highly noise affected' and require additional considerations to mitigate potential impacts.

Table 8: Construction noise management levels for residential receivers and working hours (Source: Table 2 of the NSW ICNG)

Time of Day (per NSW ICNG)	NML, dB(A), $L_{eq,15\ min}^{1,2}$	How to Apply
		The noise affected level represents the point above which there may be some community reaction to noise.
Recommended standard hours:	Noise affected	<ul style="list-style-type: none"> Where the predicted or measured dB(A) $L_{eq,15\ min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
Monday – Friday: 7:00 am – 6:00 pm	RBL + 10 dB (= 48 dB(A))	
Saturday: 8:00 am – 1:00 pm		The highly noise affected level represents the point above which there may be strong community reaction to noise.
No work on Sundays or public holidays	Highly noise affected	
	75 dB(A)	<ul style="list-style-type: none"> Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ol style="list-style-type: none"> times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences). if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected	<ul style="list-style-type: none"> A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level.
	RBL + 5 dB (Evening = 37 dB(A)) (Night = 35 dB(A))	

Time of Day (per NSW ICNG)	NML, dB(A), $L_{eq,15\ min}^{1,2}$	How to Apply
		<ul style="list-style-type: none"> Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2: The RBL is the overall background noise level representing each assessment period (NSW ICNG day/evening/night) over the whole monitoring period. The term RBL is described in detail in the NSW NPfI.

4.2.1.2 Other Sensitive Land Uses

The NSW ICNG provides maximum noise levels for premises other than residential receivers as summarised in Table 9. External noise levels are to be assessed at the most affected point within 50 m of the area boundary.

Table 9: Construction noise management levels at sensitive land uses (other than residences) (Source: Table 3 of the NSW ICNG)

Receiver (applies when properties are being used)	NML, dB(A), $L_{eq,15\ minute}$
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	60 (external)

4.2.2 Construction Traffic Noise

The RNP provides guidance on the assessment of noise impacts from road traffic noise on sensitive receivers.

It is anticipated that construction traffic would access the site via the Golden Highway, therefore the freeway/arterial/sub-arterial roads criteria would apply for additional traffic from construction works. Table 10 presents a summary of the applicable criteria for residential receivers.

Table 10: Road traffic noise criteria for residential receivers on existing roads affected by additional traffic from land use developments

Road Type	Road Traffic Noise Criteria, dB(A), $L_{eq\ 1hr}$	
	Day (7am to 10pm)	Night (10pm to 7am)
Freeway/arterial/sub-arterial roads	60 (external)	55 (external)

4.2.3 Construction Vibration

Vibration associated with construction activities can result in impacts on human comfort or the damage of physical structures such as dwellings. These two impacts have different criteria, with the effects of vibration on human comfort having a lower threshold.

Importantly, cosmetic damage is regarded as minor in nature; it is readily repairable and does not affect a building's structural integrity. If there is no significant risk of cosmetic damage, then structural damage is not considered a risk. Additionally, due to the development's location within proximity to surrounding receivers, it is unlikely that structural damage is to occur to the surrounding receivers.

4.2.3.1 Human Comfort (Amenity)

Table 11 presents the limits (vibration dose values) above which there is considered to be a risk that the amenity and comfort of people occupying buildings would be affected by intermittent vibration from construction works. These limits are sourced from *Assessing Vibration: A Technical Guideline* (AVTG) (NSW DEC, 2006).

Table 11: Human comfort (amenity) guideline vibration limits (intermittent work and continuous vibrations)

Location	Assessment Period	Vibration Dose Value, $\text{m/s}^{1.75}$		Weighted RMS Values For Continuous Vibration Acceleration (m/s^2) 1-80 Hz			
		Preferred values	Maximum values	Preferred z-axis values	Preferred x&y - axes values	Max. z-axis values	Max. x&y -axes values
Residences	Daytime	0.20	0.40	0.010	0.0071	0.020	0.014
	Night time	0.13	0.26	0.007	0.005	0.014	0.010
Workshops	Day- or night-time	0.80	1.60	0.040	0.029	0.080	0.058

4.2.3.2 Cosmetic Building Damage and Structural Integrity

There are no vibration limits for building damage and structural integrity in the AVTG. Therefore, the limits set out in *British Standard BS 7385-2: Evaluation and Measurement for Vibration in Buildings Guide to Damage Levels from Ground-borne Vibration* are typically adopted in NSW.

A summary of the limits is provided in Table 12. These peak vibration limits are set so that the risk of cosmetic damage is minimal. They have been placed at the lowest level above which damage has been credibly demonstrated. The limits also assume that the equipment causing the vibration is only used intermittently.

Table 12: BS 7385-2 Guideline vibration limits for cosmetic damage

Group	Type Of Structure	Peak Component Particle Velocity, mm/s^1		
		4–15 Hz	15–40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial or heavy commercial buildings	50		
2	Un-reinforced or light framed structures Residential or light commercial buildings	15 – 20 ²	20 – 50	50

Note 1: Values referred to are at the base of the building, on the side of the building facing the source of vibration (where feasible).

Note 2: At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

5 Operational Noise Impact Assessment

5.1 Input Parameters and Assumptions

Environmental noise emissions from the noise-generating plant/equipment associated with the Project Hive site at Denman have been assessed.

Noise modelling has been conducted using the software SoundPLAN Version 8.2. The noise model considered multiple factors, including local terrain, geometrical spreading and shielding from the terrain.

This noise modelling has been conducted as a desktop study; no noise monitoring or noise model verification has been undertaken for this assessment. The specific inputs to the noise model are summarised in Table 13.

Table 13: Noise model inputs

Item	Description
Calculation method	ISO9613-2:1996 - Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation
Ground topography	From existing topographical maps provided by ELVIS Spatial Data (1m resolution).
Ground absorption	<u>BESS Site Bounds</u> : Set at 0% absorption (hard ground) due to the BESS site areas mostly consisting of primarily concrete, gravel or other hard surfaces. <u>Surrounding Areas to Receivers</u> : Set at 60% (partially absorptive ground) due to presence of existing fields with some grass cover and other vegetation beyond the BESS site areas.
Receiver locations	All the relevant receivers are single-storey buildings and no consideration of multi-storey buildings was required. For the ground-level receivers the assessment points have been modelled as being the most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the reasonably most-affected point within 30 metres of the residence, and at a height of between 1.5 metres above ground level. This is in accordance with the NSW NPfl.
Plant/equipment selections	Plant/equipment acoustic data in the form of Sound Power Levels (SWLs) have been provided by the project team and from the BESS/Inverter manufacturer Sungrow – these SWLs are presented in Table 14.
Plant/equipment heights	<u>BESS Battery Containers</u> : 2.6 metres <u>PCS Inverter Container</u> : 2.9 meters
Plant/equipment operation	The noise-generating plant/equipment, being the BESS battery containers and PCS inverter container, have all been assumed to be operating at 100% duty/speed/noise-output on continual basis (24 hours, 7 days a week), with the exception of the PCS inverter container which is “running as a 5MW generator with 72.5% of rated power”. This was advised by the project team.

In accordance with the NSW NPfl, the noise impact assessment has been conducted with 1/3 octave band acoustic data to allow for the assessment of the “tonal noise” and “low-frequency noise” modifying factor corrections (adjustments) and determine if the selected plant/equipment items have such “annoying” characteristics that must be penalised in the assessment.

Table 14: Selected plant/equipment sound power level spectra, dB

1/3 Octave Band Frequency (Hz)	BESS Battery Containers (Selected Model: Sungrow ST2752UX)	PCS Inverter Container (Selected Model: Sungrow SC6900UD, running as a 5MW generator with 72.5% of rated power and including a transformer)
25	82	86
32	81	88
40	82	88
50	85	87
63	78	86
80	77	85
100	82	87
125	81	84
160	78	86
200	83	83
250	95 ¹	87
315	86	92
400	85	85
500	85	82
630	82	82
800	80	80
1000	80	77
1250	76	76
1600	78	76
2000	77	75
2500	74	76
3150	73	74
4000	71	67
5000	69	85 ¹
6300	75 ¹	73
8000	62	70
10000	61	68
12500	60	67
16000	56	63
20000	59	56
Overall dB(A)	91	92

Note 1: It has been calculated that this plant/equipment selection has a tonality characteristic at this 1/3 octave band that may require a +5dB modifying factor corrections in accordance with the NSW NPfl. Actual assessment is based on noise emission levels at the receivers rather than being based on the source noise levels above. Refer to the assessment results presented in Section 5.4.

Note: The assessment of low-frequency characteristics is calculated based on the noise emission levels at the receivers. Refer to the assessment results presented in Section 5.4. A full low-frequency Modifying Factor Correction assessment per NSW NPfl couldn't be conducted as Mott MacDonald were only provided 1/3 octave band Sound Power Level data for the selected plant/equipment in the range from 25Hz to 20000Hz, whilst the NSW NPfl calls for low-frequency assessment down to the 10Hz 1/3 octave band. If the selected plant/equipment has noise emission contributions at these low frequency octave bands then these should be highlighted and further detailed equipment acoustic data provided for additional acoustic assessment.

5.2 Modelling Scenarios and Acoustic Treatments

In developing the noise impact assessment and through discussions with the project team, Mott MacDonald have determined and present the following two (2) modelling/design scenarios:

- Scenario 1: Currently Selected Plant/Equipment – Only Acoustic Treatment as Acoustic Barrier Fence
- Scenario 2: Currently Selected Plant/Equipment – Acoustic Barrier Fence PLUS Additional Acoustic Treatments on the BESS Battery Containers and PCS Inverter Container (per Table 15 below)

Both Scenario 1 and Scenario 2 give consideration to a nominal 3.0m tall acoustic barrier around the perimeter of the BESS site (i.e. a single barrier system enclosing all plant/equipment). These approximately 3.0m tall fences are understood to be required on the project for visual screening and security, but they have the added benefit of providing a noise reduction if appropriately designed.

The following specific requirements are provided for this acoustic barrier fence:

- Constructed to a nominal height of 3.0 metres above the ground level where BESS equipment will be located, however the specific height shall be based on the highest point of the plant/equipment contained within:
 - Based on the equipment heights provided and listed in Table 13, where the tallest equipment is the PCS Inverter Container at 2.9 metres tall, the barrier shall be detailed to extend at least 0.1 metres above the top of this equipment to ensure shielding and noise reduction.
 - The required final heights of these acoustic barriers shall also consider the site ground levels, slab levels, top of unit treatments like attenuators (if considered) and any other structures or footings which could increase the highest point of the plant/equipment and require a barrier taller than the nominal 3.0 metres.
- Constructed around the perimeter of the BESS site such that a blocked line of sight between the residential neighbours and plant/equipment items is always maintained.
- Constructed to be free of gaps and holes along the entire specified length and height.
- Constructed using solid materials that are rigid and achieve a minimum surface density of at least 12.5kg/m². Acceptable materials that could be considered include:
 - 50mm thick masonry (e.g. precast concrete, concrete blockwork, brickwork)
 - 1.6mm thick steel
 - 9mm compressed fibre cement sheet
 - 10mm thick Perspex; or,
 - Other alternatives could be considered provided they meet the recommended minimum surface density requirements
- Note that the required height of the noise barrier could be achieved through the combination of earth mounding and acoustic fencing – the lower portion may be earth mound whilst the upper portion may be fencing to the required minimum height above the top of the plant/equipment.

It should be noted from the Scenario 1 results presented in Table 16 that this already allowed for nominal 3.0m tall acoustic barrier was not a sufficient acoustic treatment on its own to achieve the applicable noise criteria at the sensitive residential receivers.

For Scenario 2, consideration was given to developing and incorporating additional acoustic treatments on the BESS Battery Containers and PCS Inverter Container (which are the predominant sources of noise) to achieve the required compliance.

Specific acoustic treatment solutions have not been included in this report. Several options are still being considered and assessed by the project team and client. The final selected acoustic treatments are recommended to achieve the minimum noise reduction in Table 15 (which considers the equipment Sound Power Levels and tonal components documented in Table 14) to allow for achieving noise emission compliance at the surrounding receivers.

Table 15: Additional acoustic treatment recommendations for the BESS Battery Containers and PCS Inverter Container (in the form of a minimum noise reduction)

Plant/Equipment	Minimum Noise Reduction, dB(A)
BESS Battery Containers	15
PCS Inverter Container	16

5.3 Allowance for Alternative Assessments/Solutions

It is recommended that an alternative assessment and additional acoustic designs/solutions could be presented, provided that the alternative assessments/solutions comply with the site-specific operational noise criteria identified in Section 4.1.

The recommended minimum noise reduction in Table 15 above, can be achieved by a range, or combination, of acoustic treatment solutions including, but not limited to:

- Providing acoustically treated ventilation paths e.g. acoustic attenuators, acoustic louvres, lined ductwork
- Replacement or modification of noise emitting equipment e.g. alternative fans, compressors, transformers etc.
- Providing additional acoustic barriers/fencing, including additional localised barriers around the equipment
- Providing acoustic enclosures such as localised hoods to place over the equipment or providing an arrangement with acoustically rated air paths

This Noise Impact Assessment conducted by Mott MacDonald and the additional acoustic treatment recommendation presented in Table 15 has been somewhat simplified to allow for a singular recommended reduction that could be applied to all the key noise plant/equipment items (being the BESS containers and PCS Inverter container) and lead to noise emission compliance at the surrounding receivers.

An alternative assessment could be developed that refines the acoustic treatment recommendations – an alternative assessment may consider reduced treatments for plant/equipment that is located away from the sensitive receivers and increased treatments for plant/equipment that face or are located closer to the sensitive receivers.

5.4 Results

Noise emissions from the operation of the identified plant/equipment has been modelled at the surrounding receivers. The noise impacts and any applicable Modifying Factor Corrections from the NSW NPfI have been assessed at each receiver and are summarised in Table 16.

Table 16: Calculated noise levels at the identified sensitive residential receivers, $L_{eq,15min}$, dB(A)

[illegible]

Additionally, Table 17 summarises the calculated noise levels for non-residential receivers for the same design/modelling scenarios.

Table 17: Calculated noise levels at the identified non-residential receivers, $L_{eq,15min}$, dB(A)

Receiver	R10 – Passive Recreation	R11 – Industrial Premises
Scenario 1:		
Currently Selected Plant/Equipment – Only Treatment as Acoustic Barrier Fence		
Most Stringent Criteria per NSW NPfl	When in use: 48	When in use: 58
Modelled Noise Levels at Receivers	44	41
Modifying Factor Correction – Tonal Noise	+5	+5
Modifying Factor Correction – Low-Frequency Noise	n/a	n/a
Calculated Noise Levels at Receivers inc. Corrections	49	46
Complies?	NO (+1)	YES
Scenario 2:		
Currently Selected Plant/Equipment – Acoustic Barrier Fence PLUS Additional Acoustic Treatment on BESS Battery Containers and PCS Inverter Container (per Table 15)		
Most Stringent Criteria per NSW NPfl	When in use: 48	When in use: 58
Modelled Noise Levels at Receivers	29	26
Modifying Factor Correction – Tonal Noise	+5	+5
Modifying Factor Correction – Low-Frequency Noise	n/a	n/a
Calculated Noise Levels at Receivers inc. Corrections	34	31
Complies?	YES	YES

Sleep Assessment:

It is noted that an assessment of sleep disturbance impacts and comparison to the L_{max} maximum noise criteria stated in Table 7 has not been undertaken as:

- The continuous noise emissions from the equipment on the site and comparison to the NSW NPfl Project Noise Trigger Level ($L_{eq,15 min}$) would dictate the assessment.
- It is anticipated that there would be little to no intermittent, impulsive maximum noise event emissions from the plant/equipment, such as sudden bangs, knocks, beeps etc., that would require assessment and all noise emissions would be continuous and regular per the point above – if there would be any such maximum event noise sources on the BESS site then these should be highlighted for further acoustic assessment.

5.5 Discussion

From the results presented in Table 16 and Table 17 above it has been determined that additional acoustic treatments are required on the BESS Battery Containers and PCS Inverter Container (which are the predominant sources of noise) to achieve noise emission compliance.

It can be seen from Table 16 that in both Scenario 1 and Scenario 2 the highest noise impacts occur at the receivers located in closest proximity to the BESS site – these are Receiver R8 (Detached dwelling at 8 Fontana Way), Receiver R1 (Detached dwelling at 15 Kerrabee Close) and Receiver R9 (Detached dwelling at 7 Fontana Way). It follows that if compliance is achieved at these closest receivers then compliance would follow at the receivers located further away, where additional noise attenuation with distance is afforded.

A specific acoustic treatment solution hasn't been provided as several options are still being considered and assessed by the project team – refer to Section 5.3 for a list of indicative acoustic treatments (e.g. attenuators, equipment/fan reselelections) that could be considered to achieve the compliance stated in Scenario 2 above.

It should be noted that acoustic treatment may affect the mechanical performance of the selected equipment (e.g. ventilation, temperatures). Any nominated acoustic treatments shall be reviewed for mechanical suitability (and by other disciplines e.g. fire engineering) and accepted by the equipment supplier/manufacturer.

It has been recommended that an alternative assessment and additional acoustic designs/solutions could be presented, provided that the alternative assessments/solutions comply with the site-specific operational noise criteria identified in Section 4.1. Refer to commentary provided in Section 5.3.

6 Construction Noise and Vibration Impact Assessment

Before commencement of construction works, the contractor should prepare a Construction Noise and Vibration Management Plan (CNVMP) per the requirements of the NSW Interim Construction Noise Guideline 2009 (ICNG). The CNVMP would consider measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable. The CNVMP should include a detailed noise assessment updated to consider potential noise impacts at all affected properties.

7 Conclusion

Mott MacDonald have been engaged to undertake a Noise Impact Assessment for the single BESS site located in Denman, NSW that is associated with the Project Hive energy network project by the Clean Energy Transfer Fund.

The existing noise environment at the site/surrounds has been quantified and the sensitive receivers (i.e. existing residences) surrounding the site have been identified. This included unattended long-term noise monitoring was undertaken between Thursday 5 October 2023 and Thursday 19 October 2023, with supplementary attended noise measurements conducted on Friday 20 October 2023.

The relevant site-specific noise and vibration criteria have been defined for the construction and operational phases in accordance with the NSW EPA's NPfl and other local requirements from the Muswellbrook Shire Council, based on the results of the unattended long-term noise monitoring.

Noise modelling has been completed to assess operational noise emission impacts. Two (2) scenarios were considered and the following notable outcomes are listed below:

- Scenario 1: Currently Selected Plant/Equipment – Only Acoustic Treatment as Acoustic Barrier Fence
- Scenario 2: Currently Selected Plant/Equipment – Acoustic Barrier Fence PLUS Additional Acoustic Treatments on the BESS Battery Containers and PCS Inverter Container (per Table 15)

Several acoustic suppression options are available including, but not limited, to the provision of quieter equipment selections, quieter alternative components such as fans in the selected equipment and specific treatments such as acoustic attenuators, lining, enclosures and barriers.

It is considered that during the finalisation of the detailed design for the Construction Certificate the noise suppression options would be proven. The plant would not be able to operate unless it was certified as adhering to the mandated noise levels.

It has been recommended that an alternative assessment and additional acoustic designs/solutions could be presented, provided that the alternative assessments/solutions comply with the site-specific operational noise criteria identified in Section 4.1. Refer to commentary provided in Section 5.3.

The construction noise and vibration criteria have been established in accordance with the NSW ICNG and other relevant standards to allow for compliance for construction related noise emissions and vibration in terms of human comfort and cosmetic building damage. Once the construction methodology/staging is known then a specific construction phase noise/vibration assessment can be developed. It is recommended that before commencement of construction works, the relevant contractor should prepare a CNVMP per the requirements of the NSW ICNG.

From this Noise Impact Assessment, no major constraints have been identified for either the operational or construction acoustic impacts of this project and it is anticipated that compliance with applicable noise and vibration criteria can be achieved provided appropriate acoustic controls are put in place.

Appendix A – Noise Monitoring Details

Appendix A.1 – Installation Location

The unattended noise monitor was installed at the 105 Merriwa Road site and located near the existing residences on Kerrabee Close as presented in Figure 2 in the report body and in Figure 3 below.



Figure 3: Unattended Noise Monitoring Installation Location

Appendix A.2 – Weather Data

A Misol WH65LP Automatic Weather Station (AWS) was positioned alongside the unattended noise monitor at the 105 Merriwa Road site for the duration of the monitoring programme. The AWS was configured to record wind speed, wind direction, rain fall, temperature and humidity. It is noted that a weather station was deployed rather than utilising available Bureau of Meteorology (BOM) weather data due to the distance from the site to the nearest BOM weather station. This weather data has been integrated and periods of adverse weather conditions (e.g. wind speeds exceeding 5m/s and/or rain volumes greater than 0.5 mm per the NSW NPfI) have been excluded from the results of the unattended noise monitoring.

Appendix A.3 – Instrumentation

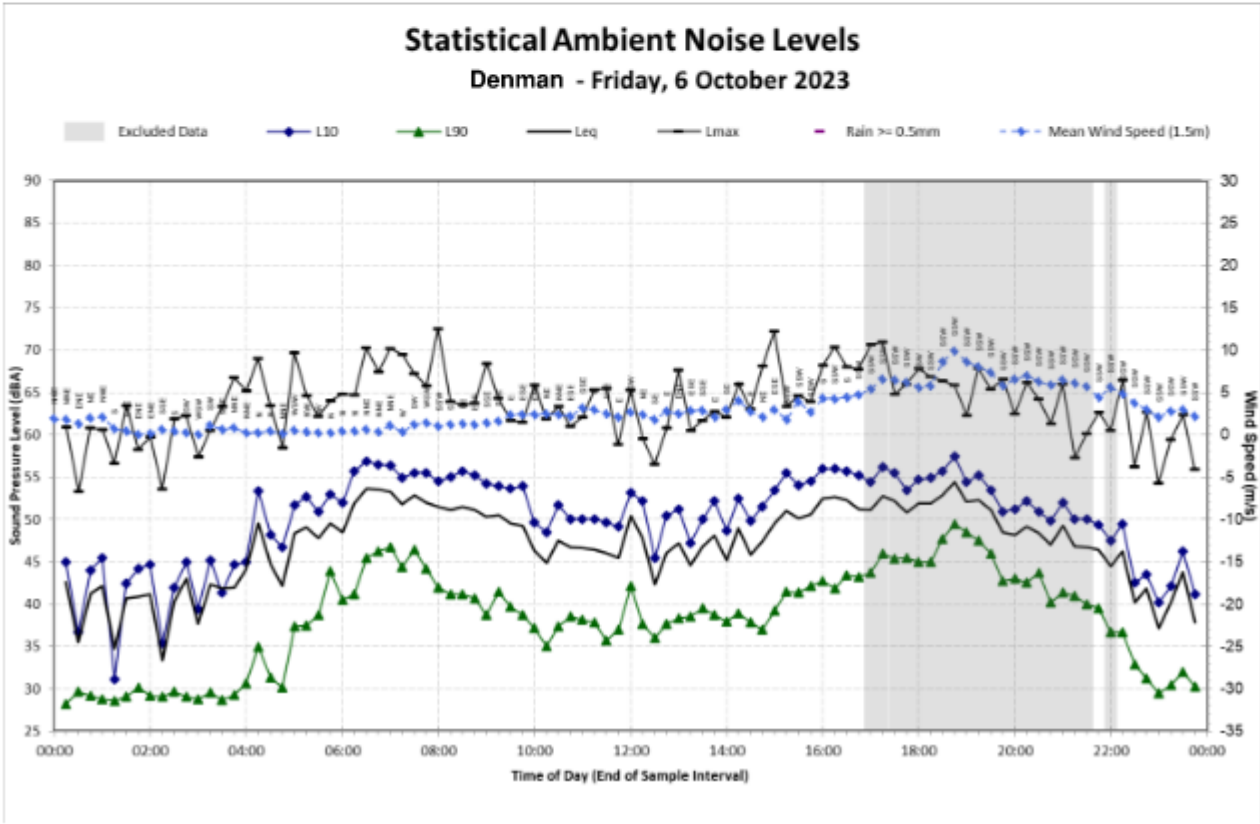
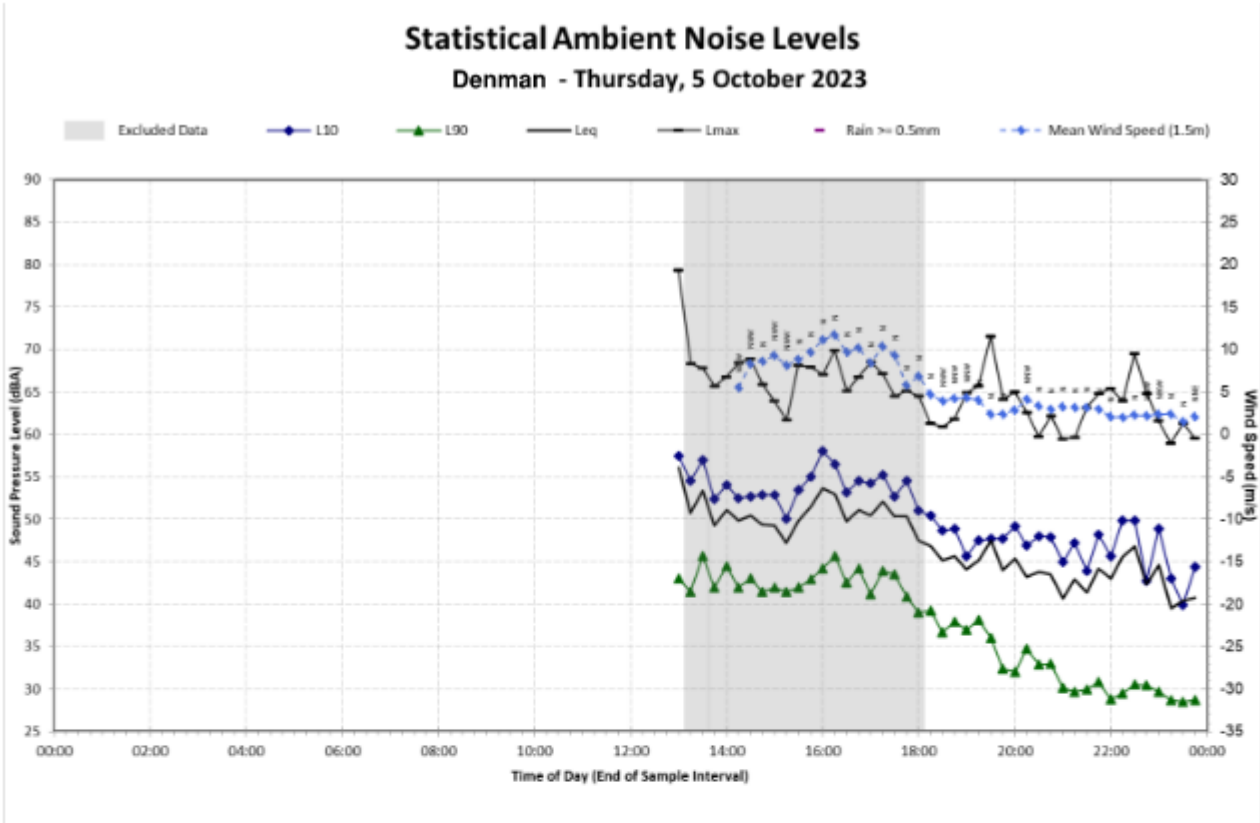
The acoustic instrumentation utilised throughout the site noise monitoring adheres to requirements of Section B1.1 of the NSW NPfI and carries current manufacturer or relevant calibration certificates. A schedule of the instrumentation utilised, including information on makes/models and calibration, is presented in Table 18.

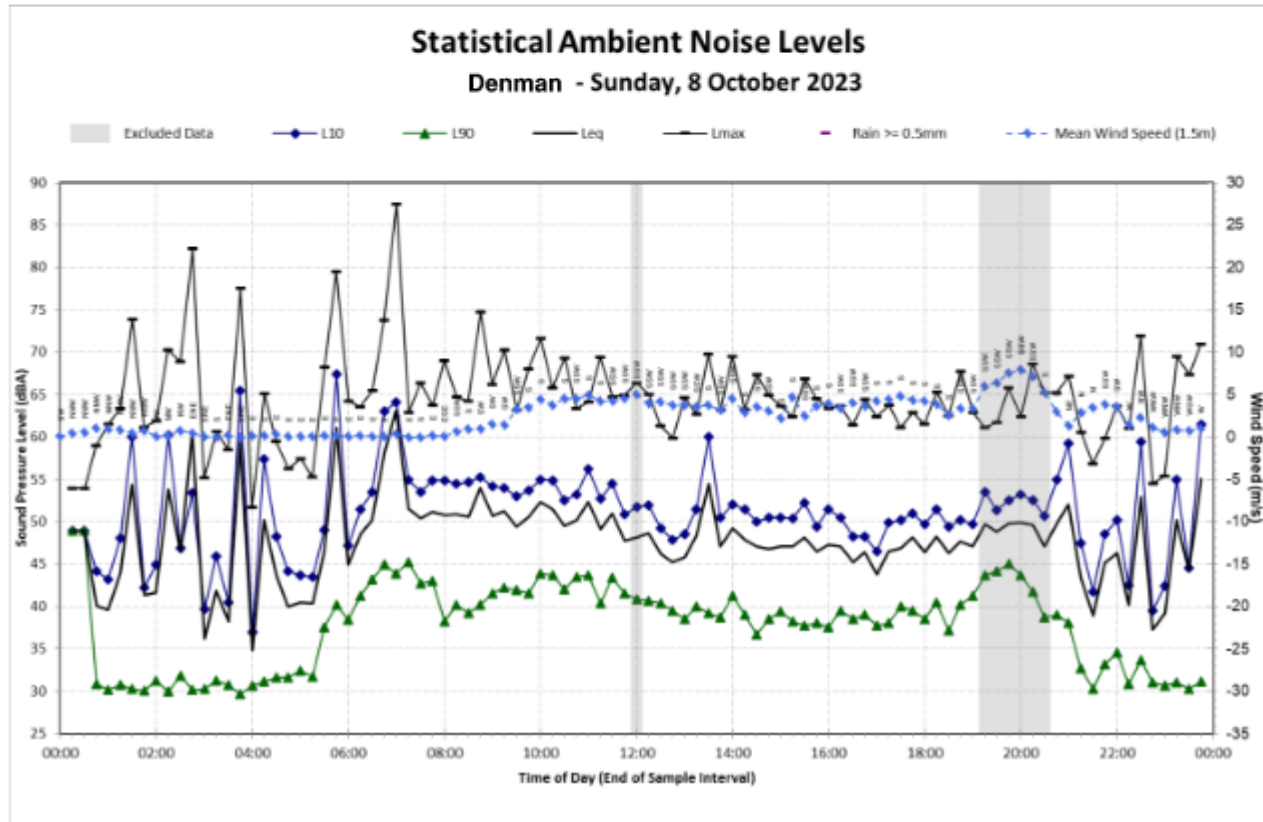
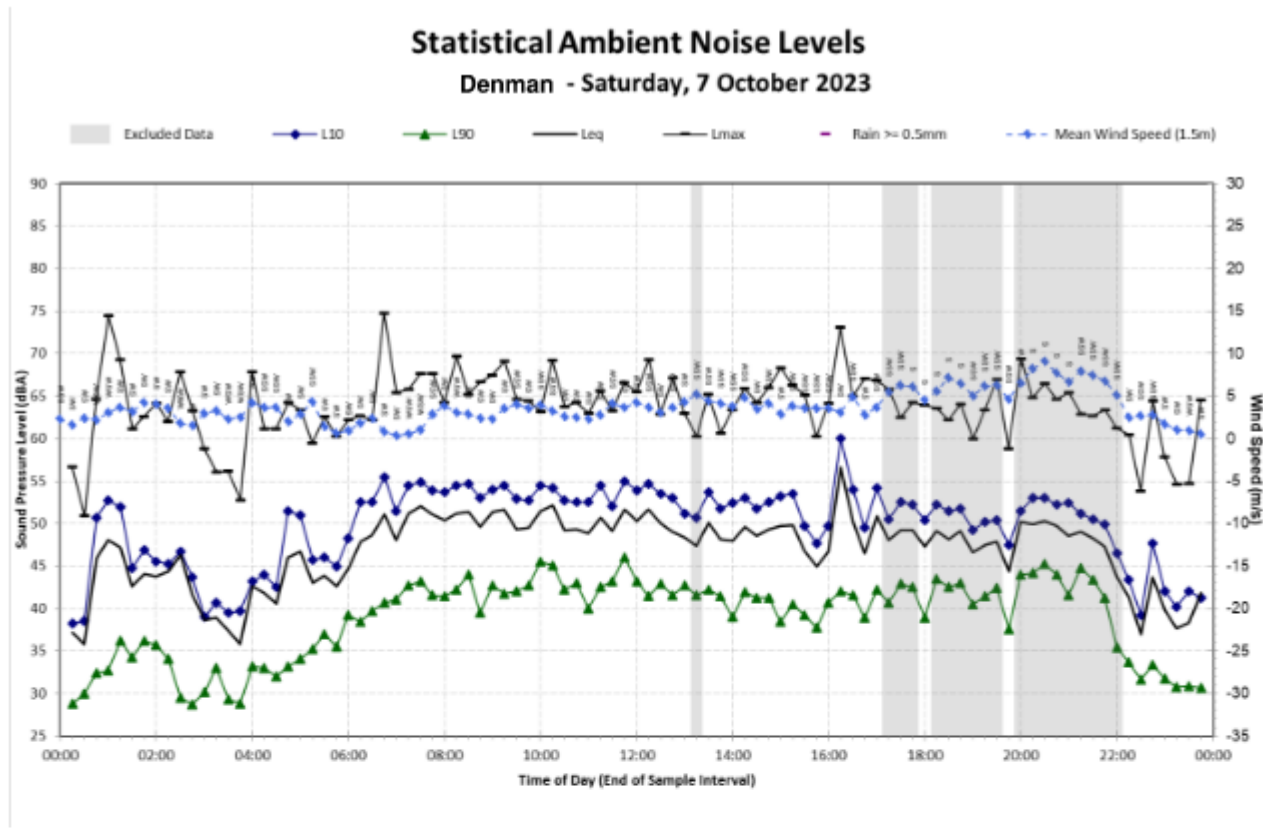
Table 18: Schedule of acoustic instrumentation utilised

Instrumentation	Make/Model	Type/Class	Serial No.	Date of Last Calibration
Noise Monitor (Unattended)	BSWA Tech. 308	Class 1	600114	30 June 2022
Sound Level Meter (Attended)	Brüel & Kjær 2250	Class 1	3024546	28 April 2023
Acoustic Calibrator	Svante SV30A	Class 1	24889	22 May 2023

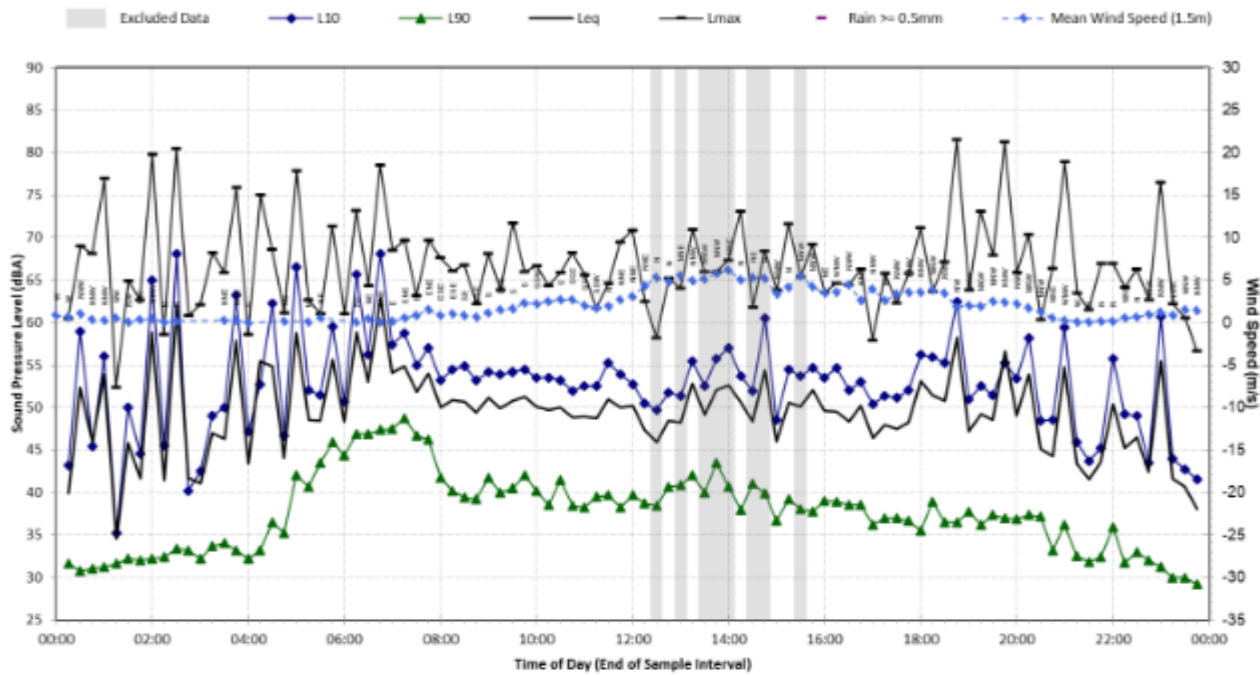
All logging instrumentation was programmed to continuously record statistical noise level indices in 15-minute intervals. Instrument calibration was checked before and after each measurement survey, with calibration found to be within the acceptable tolerance of ± 0.5 dB.

Appendix A.4 – Logger Graphs

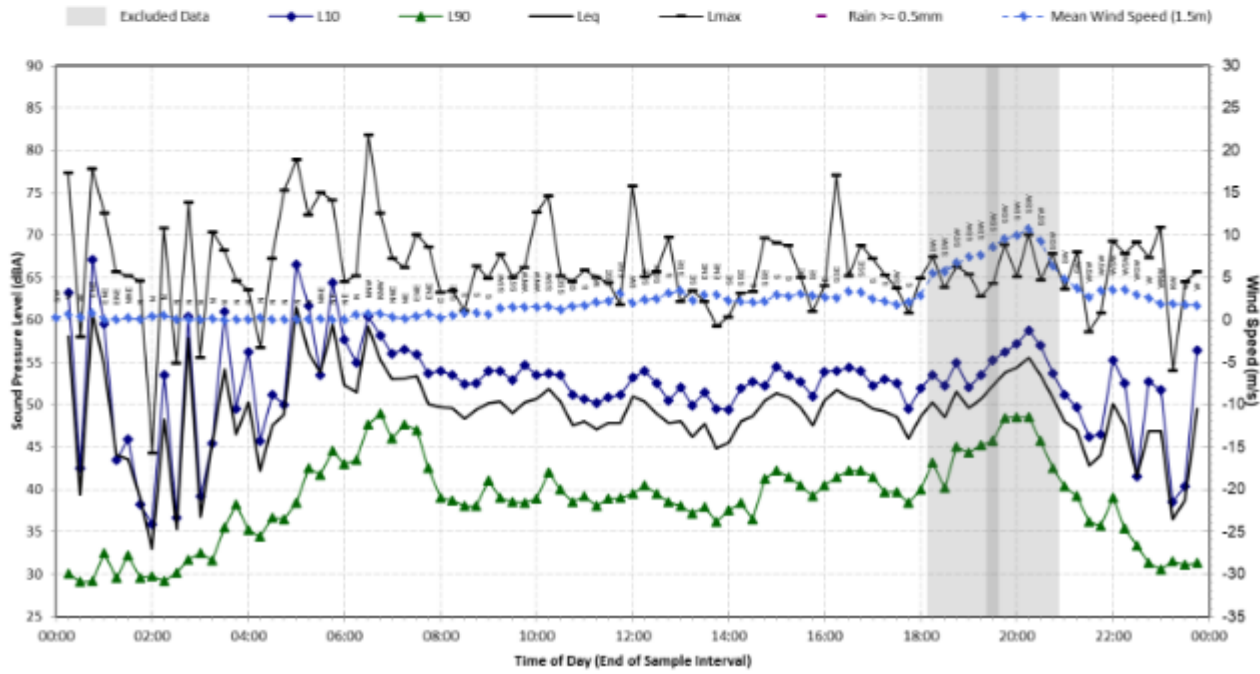


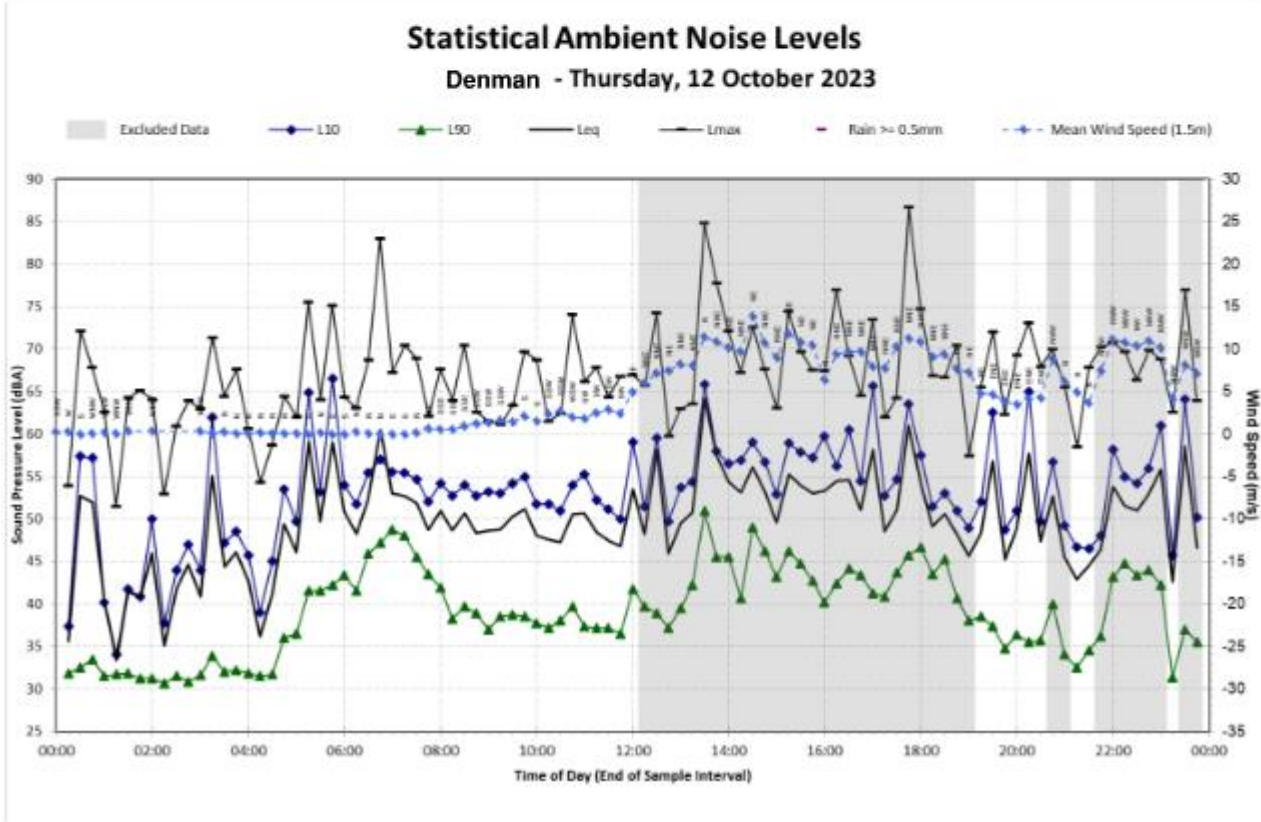
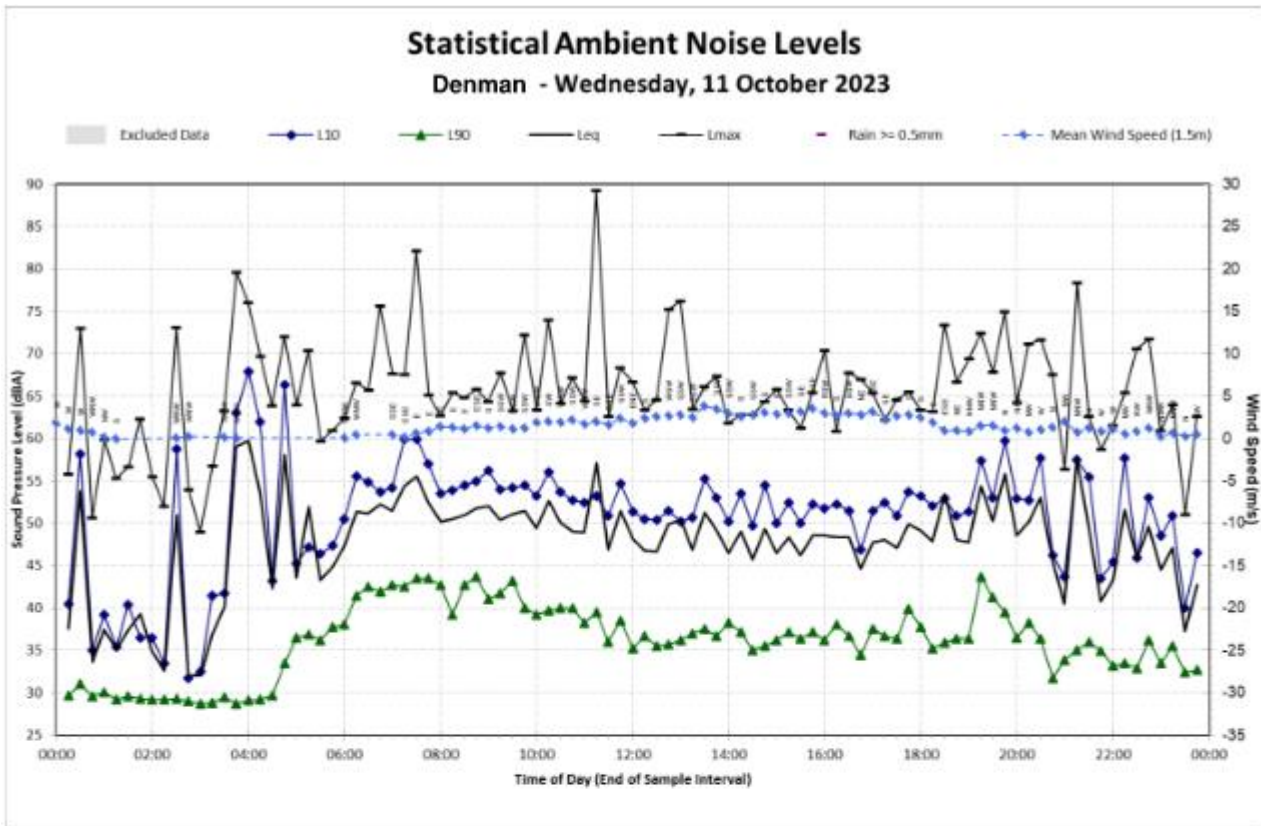


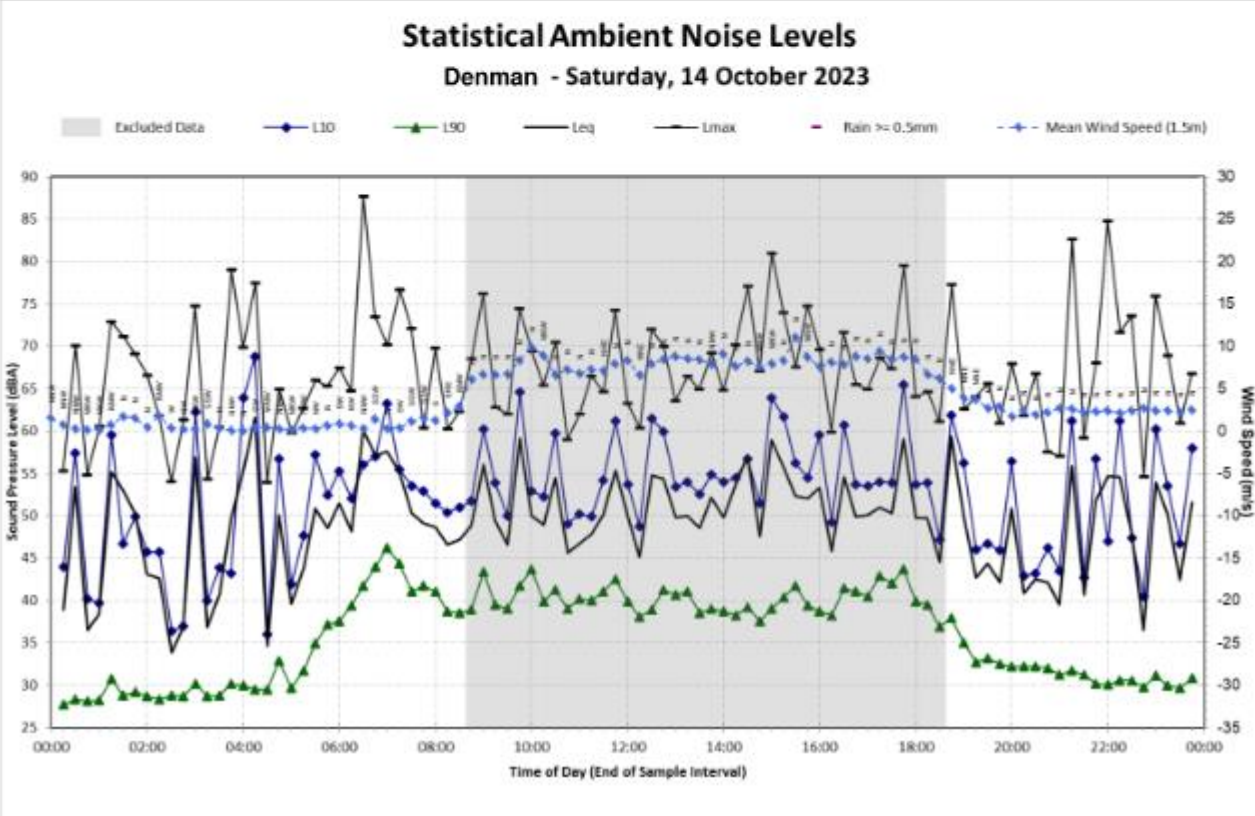
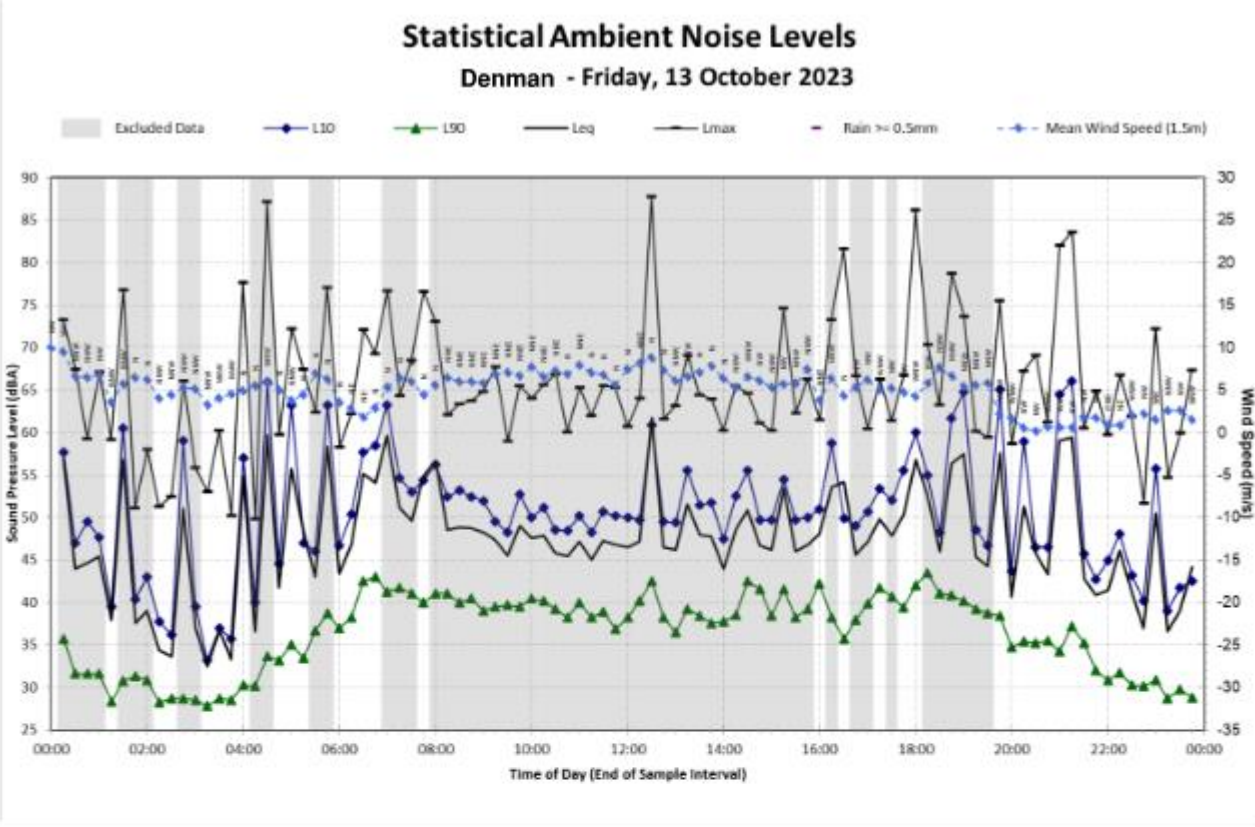
Statistical Ambient Noise Levels
Denman - Monday, 9 October 2023

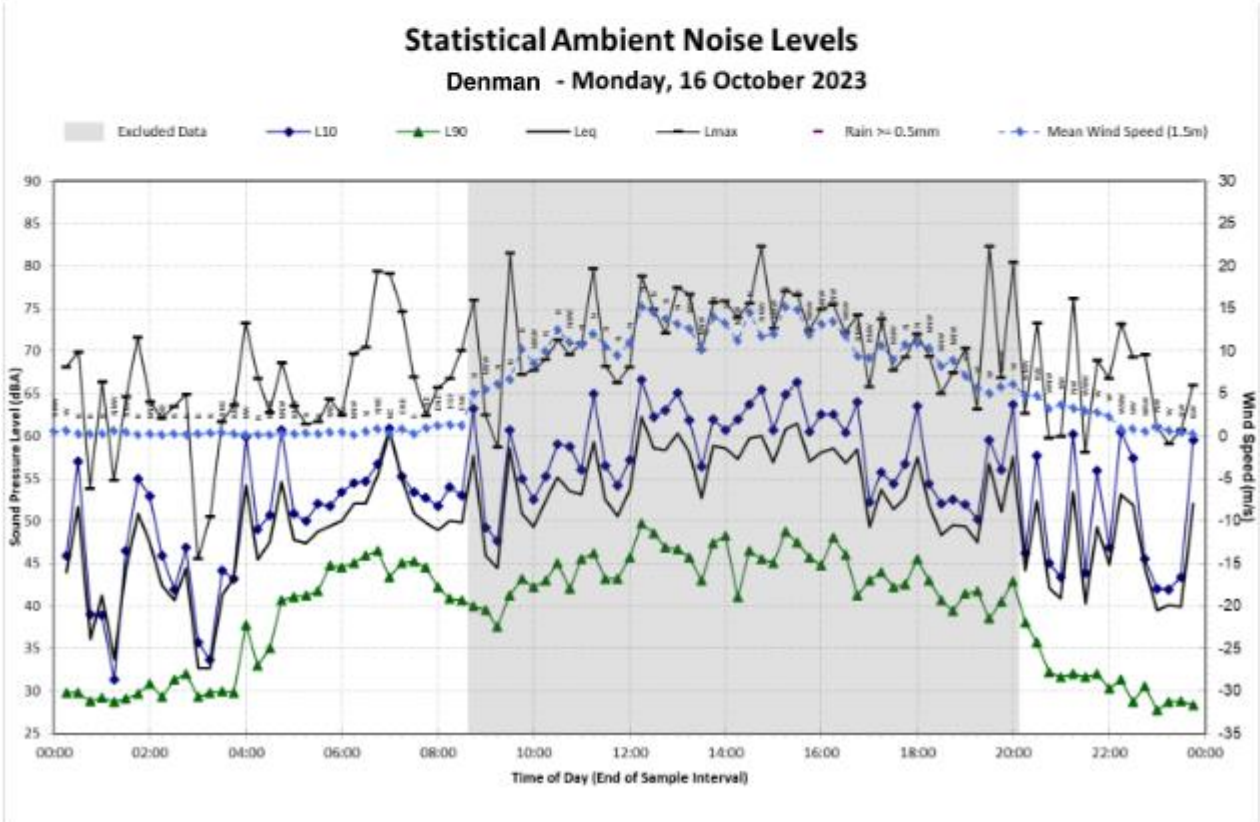
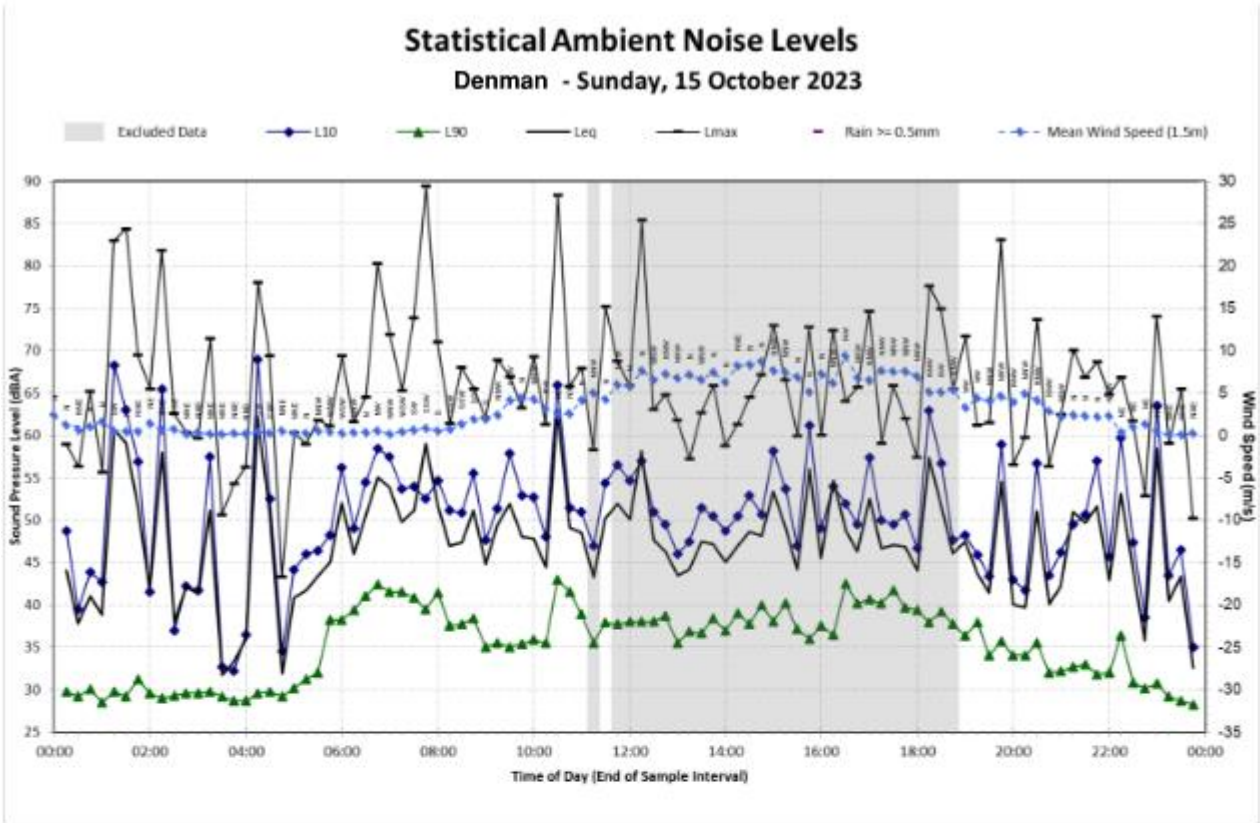


Statistical Ambient Noise Levels
Denman - Tuesday, 10 October 2023

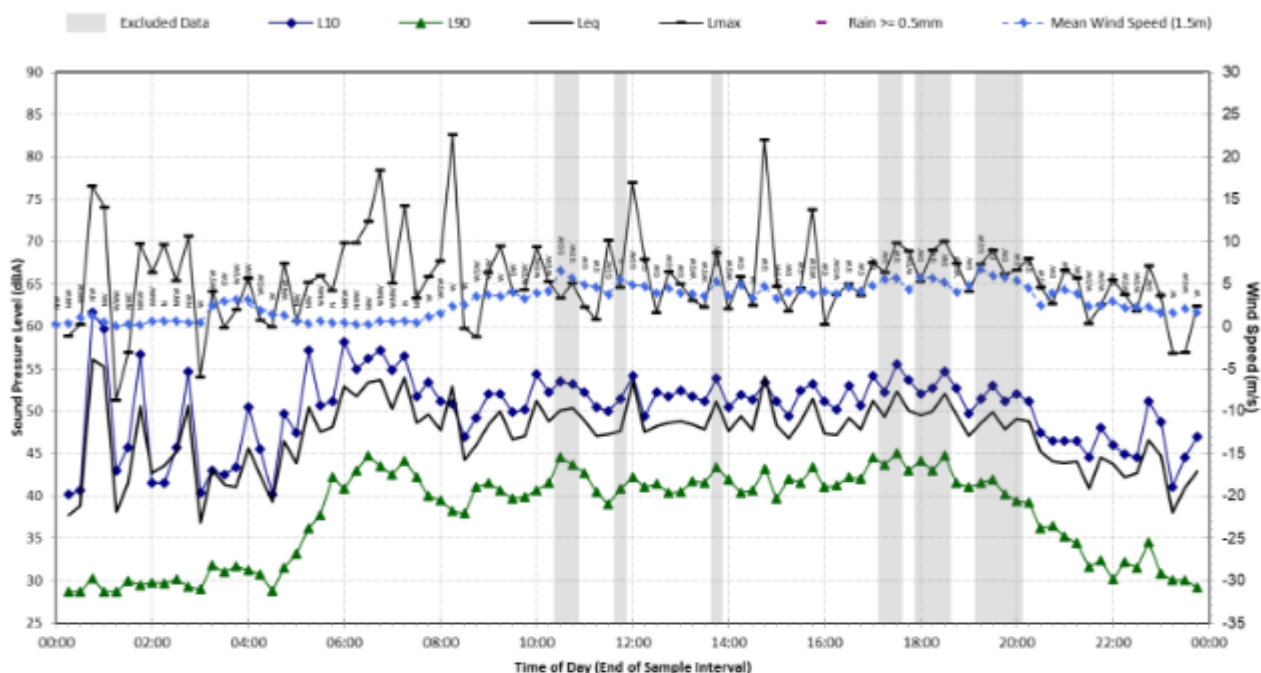








Statistical Ambient Noise Levels Denman - Tuesday, 17 October 2023



Statistical Ambient Noise Levels Denman - Wednesday, 18 October 2023

