Newell Highway Heavy Duty Pavements, Narrabri to Moree

Operational traffic and construction noise and vibration assessment report

Roads and Maritime Services | May 2018

NSW GOVERNMENT

Contents

Executive Summary

Overview

This report presents an assessment of potential construction and operational noise and vibration impacts associated with major pavement upgrades to five segments of the Newell Highway between Narrabri and Moree in north west NSW (the proposal).

Impacts during construction

Regarding construction noise, the assessment predicted that noise management levels determined using background noise monitoring data and guidance from the NSW Environment Protection Authority were likely to be exceeded at some nearby receiver locations' particularly along segments N2M02 and N2M03 which pass through the villages of Edgeroi and Bellata respectively. Standard measures in line with Roads and Maritime Services Construction Noise and Vibration Guideline (CNVG), were recommended, as well as guidance for the management of residual noise issues after the application of these standard measures as applicable and consistent with actions agreed as part of the proposal notification process. Regarding vibration, measures were recommended in line with NSW Environment Protection Authority policy to manage potential issues during the works, as well as specific additional actions to mitigate the potential for human comfort impacts during compaction activities, as well as impacts at nearby heritage areas. Noise from traffic generated during construction was assessed to be negligible using Roads and Maritime's assessment tool.

Impacts during operations

Operational road noise impacts as a result of the proposal were quantitatively assessed using a site noise model developed in SoundPlan 7.4. The model was prepared in accordance with guidance from Roads and Maritime noise representatives and assessed against the requirements presented in Roads and Maritime and NSW Environment Protection Authority policies and documents. The assessment found that operational road noise impacts would be minimal, and that no specific operational measures would be required in-line with Roads and Maritime's mitigation evaluation procedures.

1. Introduction

Roads and Maritime Services (Roads and Maritime) proposes to carry out major pavement upgrades to five segments of the Newell Highway between Narrabri and Moree (the highway) in north west NSW within the existing road corridor (the proposal). Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Roads and Maritime to assess the potential for environmental impacts associated with the proposal, and to prepare a *Review of Environmental Factors* (REF). This Operational Traffic and Construction Noise and Vibration Assessment (OTCNVA) has been prepared to evaluate the potential for noise or vibration impacts from construction and operation of the proposal, and would support the REF.

In meeting the above objective, the aims of this report are to:

- Describe key details of the proposal, including any aspects particularly relevant to noise and vibration (**Section 2**)
- Detail the method used to evaluate potential noise and vibration impacts (**Section 3**)
- Identify surrounding potentially affected receivers within the proposal study area (**Section 2**)
- Characterise key features of the existing local noise environment (**Section 5**)
- Determine criteria for assessing potential impacts using guidance presented in the relevant policies and guidelines (**Section 6**)
- Evaluate potential noise and vibration impacts during all phases of the proposal (**Section 7**)
- Recommend suitable mitigation and management measures as necessary (**Section 8**).

In preparing this OTCNVA, guidance for assessing and reporting of potential impacts has been followed from Roads and Maritime' procedure, *Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report* (POTCNVAR), (Roads and Maritime, 2016). **Table B1** in **0** lists where each relevant requirement is addressed in this report.

2. Proposal description

This section of the report provides an overview of the proposal, and identifies key noise and vibration-related risks.

2.1 Design overview

The proposal comprises of the upgrade of five segments of the Newell Highway between Narrabri and Moree in north west NSW to a heavy duty pavement. The proposal forms part of the *Newell Highway Corridor Strategy* (Transport for NSW, 2015) to provide an efficient and sustainable corridor that caters for increasing growth and improves safety along the Newell Highway. The upgrades are needed to address issues related to limited residual design life; road structural limitations; heightened risk of surface failure caused by rainfall; increasing forecast freight and tourism traffic; and increasing maintenance costs and reducing road safety.

Key features of the proposal are:

- Upgrading and resurfacing five segments of the existing highway between Narrabri and Moree to a heavy duty (HD) pavement
- Road widening to provide 3.5-metre-wide lanes and two metre shoulders
- Provision of a one-meter-wide painted median
- Road widening on one side or both sides of the highway
- Provision of 1.5 kilometre long overtaking lanes at five locations (three northbound and two southbound)
- Upgrading of the existing intersections along the highway to channelised intersection right hand turn, with an axillary left hand turn intersection treatments
- Provision of a central two-way right turn lane at Bellata
- Provision of three-meter-wide shoulders for 30 meters on either side of property accesses
- Upgrading drainage to improve the highway flood immunity up to a minimum 5-year average recurrence interval where feasible and reasonable
- Property acquisitions as required
- Utility relocations as required
- Temporary construction ancillary facilities, including construction compounds, stockpile sites and erosion and sedimentation measures within the road corridor.

The combined length of the five upgrade segments about 30 kilometres. The location and intended works in each of the five segments are described below in **Table 2-1**.

Table 2-1 Segment locations and proposed works

Segment	Location	Proposed works
N2M01	6.4 kilometres to 12.9 kilometres north of Narrabri	Upgrading 6.5 kilometres of the Newell Highway
N2M02	15.6 kilometres to 25.9 kilometres north of Narrabri at Edgeroi	• Upgrading 10.3 kilometres of the Newell Highway • Two overtaking lanes – northbound and southbound
N2M03	46.8 kilometres to 51.3 kilometres north of Narrabri at Bellata	• Upgrading 4.5 kilometres of the Newell Highway • One northbound overtaking lane
N2M04	52.4 kilometres to 58.3 kilometres north of Narrabri, north of Bellata	Upgrading 5.9 kilometres of Newell Highway
N2M05	88.4 kilometres to 96.3 kilometres north of Narrabri, south of Moree	• Upgrading 7.9 kilometres of the Newell Highway • Two overtaking lanes – northbound and southbound

2.2 Road project classification

Sections 5 and 6 of the *Noise Criteria Guideline* (NCG), (Roads and Maritime, 2015) describe three different classifications of road projects; 'new roads', 'redeveloped roads', and 'minor works'. These classifications inform the criteria and way that potential impacts are required to be assessed. Based on this guidance, works at each segment along the Project were classified as listed below in **Table 2-2**.

Table 2-2 Road project classification for each segment

Segment	NCG road project classification	Justification for classification
N2MS1	Minor works with one section constituting a 'new road', with associated transition zones.	Widening, curve straightening or adjustment of the corridor where the upgraded road pavement has been substantially realigned, with other sections where the extent of realignment is within 6 times the total existing lane width.
N2MS2	Minor works	Minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments; not intended to increase the carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic and as such are not considered new or redeveloped road projects.
N2MS3	Minor works	
N2MS4	Minor works	
N2MS5	Minor works	

2.3 Details of construction

2.3.1 Duration and timing

The road upgrades would commence in 2020 and be completed in 2022. The proposal would generally be completed within standard hours as defined in the *Interim Construction Noise Guidelines* (ICNG), (DECC, 2009) reproduced below in **Table 2-3.**

Table 2-3 ICNG standard hours for construction

Period	Details
Standard hours of construction	• Monday to Friday 7 am to 6 pm • Saturday 8 am to 1 pm • No work on Sundays or public holidays.

2.3.2 Methodology and temporary ancillary facilities

Conventional construction methods used on other similar road pavement upgrade projects are expected to be applied. As such, the noise from the following default construction scenarios were evaluated:

- C01 – Site establishment
- C02 – Utility adjustments
- C03 – Corridor clearing
- C04 – Bulk earthworks
- C05 – Drainage infrastructure
- C06 – Paving / asphalting
- C07 – Re-surfacing works
- C08 – Road furniture installation.

Sound power levels (SWLs) for these assessment scenarios were adopted from Roads and Maritime's *Construction Noise Estimator* (CNE)

A number of temporary ancillary facilities would also be established to support activities during construction. It is expected that the following construction operations would occur at these sites:

- Housing of a main compound including site offices, workshops, storage areas and first-aid facilities
- Plant and materials storage and handling, as well as worker parking
- Operation of other facilities such as an asphalt batch plant, crushing plant or other materials processing facilities as identified to be necessary by the construction contractor during detailed design.

At this stage, the locations, specific uses and number of ancillary facilities are not known and would be confirmed by the construction contractor prior to commencement of construction. It is expected that noise and vibration impacts associated with the establishment and then operation of these facilities during construction would be reviewed once these details are confirmed.

2.3.3 Plant and equipment

A variety of different plant and equipment would be used during the proposal. And indicative list is provided below which is expected to be updated by the construction contractor during detailed design.

- Excavators
- Scrapers
- Water carts
- Stabilisers
- Bobcats
- Bitumen sprayers
- Truck-mounted lime spreaders
- Bulldozers
- Compacting equipment
- Materials trucks
- Graders
- Loaders
- Backhoes
- Aggregate spreading trucks
- Light vehicles
- Hand tools
- Lighting towers
- Line marking plant

A temporary asphalt batch plant is also expected to be required, though the location and need for this facility would similarly be decided by the construction contractor during detailed design.

2.4 Identification of key noise and vibration-related risks

Based on the details of the proposal provided in **Section 2.1**, **Section 2.2** and **Section 2.3** the following key noise and vibration-related risks were identified:

- **Noise impacts during construction:** The proposal has a 3-year duration and includes works which would be completed outside standard hours. That the proposal comprises of five separate work areas and that the road upgrades would be completed in a sequential manner means that receivers would not be affected for this full duration. Still, works outside standard hours present a greater risk of amenity and other impacts (e.g. sleep disturbance) for the proposal. As such, noise impacts associated with construction was considered as a key risk for this assessment.
- **Vibration impacts during construction:** Some vibration-intensive plant and equipment would be required during the proposal which presents a potential human comfort and building cosmetic damage-related risk for nearby receivers. For this reason, vibration impacts during construction was identified as another key risk to be evaluated during this assessment.
- **Changes in operational noise levels:** Though the proposal is not intended to increase the carrying capacity of the proposal or alter the composition of vehicle types, in some locations it will result in changes to the distance of the flow of traffic from nearby receivers as well as the relative road to receiver height orientation (noting the goal of improving the flood resilience of the road as a key design objective). When resulting changes in noise levels at nearby receivers are significant and other fixed noise level criteria are also exceeded, mitigation measures may be required. Thus changes in operational traffic noise levels was the other key risk associated with the proposal.

3. Method of assessment

The methodology used to evaluate the potential for noise or vibration impacts from the proposal included:

- **Identifying key noise and vibration construction and operational process:** The proposal was reviewed to determine the primary noise and vibration risks to surrounding sensitive receivers. This stage of the assessment is described above in **Section 2.4**.
- **Describing surrounding noise and vibration-sensitive receivers within the study area:** Nearby noise-sensitive receivers were identified using aerial imagery. Designated land uses were determined from the Local Environment Plan (LEP) accessed via the NSW Department of Planning and Environment Planning Portal. Heritage building and structures particularly susceptible to vibration impacts from the proposal were identified from *Aboriginal and Historic Archaeological Survey Report: Newell Highway HD Pavements – Narrabri to Moree,* (OzArk, 2018). The receivers and land uses within the study area of this assessment are identified in **Section 4.2**.
- **Characterising the existing noise environment:** Noise monitoring was completed as part of the assessment to understand existing noise levels typical at the receivers identified around the proposal. Details and results of this monitoring are presented and discussed in **Section 5**.
- **Reviewing the policy setting and determining assessment criteria:** Relevant policies and guidelines were reviewed with criteria for assessing potential impacts associated with the proposal developed in accordance with this guidance. This section of the assessment is outlined in **Section 6**.
- **Evaluation of the potential for impacts:** To evaluate the potential for noise impacts at the identified surrounding sensitive receiver areas during construction and operations, a model was developed using the SoundPlan 7.4 predictive software package. Key acoustic features of the existing environment were incorporated into the model including terrain, surrounding buildings, ground and air absorption, receivers, and local meteorological conditions. Sound power levels for construction noise sources were derived from Roads and Maritime' guidance material, with road noise levels estimated for the different assessment scenarios considered using site traffic data and standard corrections applied for assessments in NSW as consistent with the *Noise Model Validation Guideline* (NMVG), (Roads and Maritime, 2018), as well as guidance from *Evaluation of Calculation of Road Traffic Noise in Australia,* (Peng, Kessissoglou & Parnell, 2017). The noise model was used to predict construction and operational noise levels at surrounding receivers and to determine whether exceedances of the established criteria (**Section 6)** would occur. This aspect of the assessment is presented in **Section 7**.

  Groundbourne vibration and noise arising from construction traffic are also assessed in **Section 7**. The potential for groundbourne vibration impacts during construction were evaluated using guidance for safe setback distances from vibration-generating plant and equipment, and prediction methods from relevant standards. Noise associated with additional traffic generated during construction was quantitatively reviewed using Roads and Maritime's CNE tool.
- **Development of monitoring and management measures:** Where noise or vibration impacts have been identified, the report recommends mitigation and management measures (**Section 8**) in-line with the related policies and guidelines.

4. Surrounding landscape and receivers

This section of the report defines the study areas around each segment of the proposal and identifies nearby noise and vibration-sensitive receivers.

4.1 Study areas

The CNE was used to define the study area for the purpose of evaluating noise impacts during construction. Based on the loudest default construction phase considered (bulk earthworks), background monitoring data collected as part of the study (described in detail below in **Section 5**), and that works are expected to be undertaken during standard hours; a study area of 2,000 meters around each segment was applied. This was reduced in some areas where significant building shielding was present Consistent with Section 6 of the NCG, an operational noise study area of 600 meters was considered around each of the road upgrade segments. The following section describes the noise-sensitive receivers identified within each study area.

4.2 Noise-sensitive receivers

Most of the works are located in sparsely developed areas with only a small number of surrounding sensitive receivers, though portions of N2M02, N2M03 and N2M05 pass or approach more populated areas. The receiving environment around each segment is summarised below, with each receiver location identified in **0** .

4.2.1 Segment N2M01

Nine (9) residential receivers were identified within the N2M01 study area. The nearest (R008) is located approximately 160 meters from the proposal, with a total of seven set within 600 meters. One non-residential sensitive receiver was also identified within this study area; the University of Sydney Research Institute facility, for which construction noise impacts were evaluated. Details of each N2M01 receiver assessed are listed in **Appendix 0**.

4.2.2 Segment N2M02

18 residential receivers are located within the vicinity of segment N2M02, with most set within the small village of Edgeroi. The nearest residential receivers (R018 and R019) are located within 30 meters of the proposal, with 12 located inside the operational noise study area. Two non-residential receivers are set near N2M02; Edgeroi rail siding and storage facility and Edgeroi Fuel Shop. **Appendix 0** summarises each receiver assessed around N2M02.

4.2.3 Segment N2M03

76 residential receivers were identified around N2M03. Most are located in the village of Bellata, with the nearest located along the Newell Highway and along intersecting streets including Temi Street, North Street, Wilga Street and Oak Street. Several non-residential receivers are also located within the vicinity of the N2M03 work area including several shops and industrial facilities; a community centre; two public outdoor recreational areas; a place of worship; and a school. A full list of receivers around N2M03 is provided in **Appendix 0**.

4.2.4 Segment N2M04

Six residential and one commercial receiver are located near segment N2M04. Of the six residential receivers, only one is set within 600 meters of the proposal (R103) which is located approximately 220 meters away. **Appendix 0** lists details of each receiver around N2M04.

4.2.5 Segment N2M05

Segment N2M05 approaches the southern outskirts of Moree; a regionally significant and more populated township. Noise impacts were assessed at 129 residential receivers around N2M05, with most noted to be more than 600 meters from the proposal. The nearest residential receivers, R126 and R127 were identified to be around 140 meters away. Impacts were also evaluated at a number of non-residential receivers including several commercial and industrial facilities off the Newell Highway, Burrington Road and Des Young Drive; Moree Airport; The Bureau of Meteorology Moree Meteorological Office; and a nearby place of worship. Details for each of the residential and non-residential receiver identified around N2M05 are listed in **Appendix 0**.

4.3 Vibration-sensitive receivers

Whilst all receivers and surrounding structures are sensitive to vibration impacts, heritage and precision industries are typically more susceptible and are subject to more stringent criteria. **Table 4-1** lists Aboriginal and non-Aboriginal heritage structures identified within the vicinity of the proposal in the assessment report, *Aboriginal and Historic Archaeological Survey Report, Newell Highway HD Pavements: Narrabri to Moree,* (OzArk, 2018):

Table 4-1 Vibration-sensitive receivers

Segment	Aboriginal / non-Aboriginal	Details	Approximate distance from proposal (meters)
N2M02	Aboriginal	BC-HW17-ST1 (Modified tree)	Less than 50 meters
N2M03	Aboriginal	BL-HW17-ST1 (Modified tree)	Less than 50 meters
	Non-Aboriginal	1012 LS Rowe Stock & Station Agents	Less than 50 meters
	Non-Aboriginal	1013 AB Meppem & Co	Less than 50 meters
	Non-Aboriginal	1014 Bellata Post Office	Less than 50 meters
	Non-Aboriginal	1015 Oldhams Smallgoods	Less than 50 meters
	Non-Aboriginal	1016 Bellata Police Station	Less than 50 meters
N2M04	Aboriginal	TC-HW17-ST1 (Modified tree)	Less than 50 meters

No precision industries were identified within the vicinity of the proposal.

5. Existing noise environment

5.1 Monitoring approach

To understand existing noise levels around at sensitive receivers around the proposal, background noise monitoring was completed. Noise monitoring was undertaken at each of the locations listed below in **Table 5-1** using Type 1 NGARA noise logging devices. Each device was set up consistent with *Australian Standard AS1055:1997 Acoustics – Description and measurement of environmental noise Part 1: General procedures*. The noise logging devices were installed for a period or at least seven days consistent with the long-term method for determining background noise levels described in Section 3 of the *NSW Industrial Noise Policy,* (NSW Environment Protection Authority, 2000) and the POTCNVA. The devices were set in 48 kHz mode, allowing the capture of audio files and 1/3 octave data for post-processing purposes. Details are summarized below in **Table 5-1**.

Table 5-1 Noise monitoring details

Location ID	Address	Noise logger ID	Nearest upgrade segment	Dates deployed/ collected	Measurement position
NM01	13012 Newell Highway	8780b8	N2M, Segment 2	29/11/17 to 13/12/17	Façade
NM02	2 Burrington Road, Moree	8780ba	N2M, Segment 5		Façade
NM03	'Kelldale', 22315 Newell Highway	8780a8	MN, Segment 1	30/11/17 to 7/12/17[#]	Façade
NM04	24291 Newell Highway	87813b	MN, Segment 2	29/11/17 to 13/12/17	Façade

[#] Battery died on 7 December 2017, but logger was collected 13/12/17

It is noted that the logger at location NM01 failed, and as such results are only described for the remaining three locations.

5.2 Post-processing and results

Results were post-processed to eliminate extraneous features and develop the data into the relevant metrics for assessment. The data were filtered to remove data affected by extraneous weather conditions including precipitation and wind speeds greater than 5 m/s at an elevation of 1.5 metres. Data from the nearest Bureau of Meteorology (BoM) Moree Airport automatic weather station (Moree Airport, no. 053115) were used to perform this filtering. Noting that the wind speed data was collected from these stations at the standard instrument height of 10 metres, the method outlined in *Converting Bureau of Meteorology Wind Speed Data to local Wind Speeds at 1.5m Above Ground Level,* (Gowan, Karantonis and Rofail, 2004) was used to convert this information to equivalent wind speeds 1.5 metres above ground level. Finally, the data were processed into the relevant metrics for assessment of construction and operational impacts. Results rounded to the nearest 0.1 dB(A) are displayed below in **Table 5-2**. It is noted that the term 'RBL' refers to the median value of monitored background noise levels measured over each period. 'L_{Aeq}' is the equivalent continuous sound level or energy-time average for the relevant period of monitoring.

Table 5-2 Noise monitoring results

Location	Road noise results L_{Aeq} dB(A)		Construction noise results dB(A)					
			Day (7am to 6pm)		Evening (6pm to 10pm)		Night (10 pm to 7am)	
	Day (15 hour)	Night (9 hour)	RBL	L_{Aeq}	RBL	L_{Aeq}	RBL	L_{Aeq}
NM02	57.7	54.7	39.0	56.7	40.4	59.0	37.4	54.7
NM03	56.7	53.2	39.3	56.8	33.4	53.2	39.0	55.5
NM04	51.6	46.2	29.9	51.4	34.9	46.2	30.9	46.2

As displayed, higher background noise levels were recorded at monitoring locations NM02 and NM03 which are both located near busier sections of the Newell Highway more affected by local traffic movements than at NM04. High ‘evening’ and ‘night’ time RBLs at each of the monitoring locations was found to be attributable to the high frequency of moderate winds during evening and night time periods, though as above it is noted that wind speeds greater than 5 m/s were excluded from the analysis.

Levels recorded at NM02 were used to characterise background noise conditions at receivers within 200 meters of the Newell Highway and/or otherwise located in areas also affected by reasonable local traffic movements, whereas the measurements collected at NM04 were used as an estimate of background noise levels at more distant and remote receivers for the purpose of assessing construction noise impacts.

6. Policy setting

Guidance from the following policies and guidelines have been considered as part of this assessment:

- ICNG, (DECC, 2009)
- *Construction Noise and Vibration Guideline* (CNVG), (Roads and Maritime, 2016)
- NCG, (Roads and Maritime, 2015)
- *Noise Mitigation Guideline* (NMG), (Roads and Maritime, 2015)
- *Noise Model Validation Guideline* (NMVG), (Roads and Maritime, 2018)
- *NSW Road Noise Policy* (RNP), (DECCW, 2011)
- *Environmental Noise Management Manual* (ENMM), (Roads and Traffic Authority, 2001)
- *Assessing Vibration: a technical guideline*, (DECC, February 2006)
- *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* [BS 6472-1: 2008]
- *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundbourne vibration* [BS7385-2:1993]
- *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives*
- *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures* [DIN 4150-3:1999-02]
- *NSW Industrial Noise Policy,* (EPA, 2000)
- *Noise Policy for Industry*, (EPA, 2017).

Relevant requirements for assessment and guidance values/criteria for the purpose of assessing this proposal from these policies and guidelines are discussed below.

6.1 Construction noise

Noise arising from Roads and Maritime projects, including ‘minor works’ and ‘maintenance works’ requires assessment under the CNVG. The CNVG refers to guidance in ICNG which presents guidance values to assist with the management of noise impacts, rather than strict numeric criteria.

The ICNG describes two methods for assessing noise impacts from construction activities; the quantitative method which is suited to noise intensive works and / or proposals running longer than three weeks; and a qualitative method which is suited for minor, short-term (i.e. duration less than three weeks) activities which would occur during standard hours of construction. Owing to the expected duration of the proposal and the need for the proposal to be completed outside the standard hours of construction, a quantitative approach was considered for this assessment.

The ICNG recommends establishing noise management levels (NMLs) at receiver locations adjacent to the works, using information on the existing background noise level at these locations. Where NMLs may be exceeded as a result of the proposed works and there is potential for adverse noise impacts to occur, appropriate management measures should be implemented.

Table 6-1 details the method for determining NMLs for residential receivers potentially affected by the proposed upgrade. Often works that may cause inconvenience within the community (e.g. traffic congestion) or safety concerns are done outside standard hours. NMLs during these periods are presented in the table for works ‘Outside recommended standard hours’.

Table 6-1 Procedure for establishing construction NMLs at residential receivers, (ICNG, DECC 2009)

Time of day	Noise management level $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected (RBL + 10 dB)	The noise affected level represents the point above which there may be some community reaction to noise. - Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 the duration, as well as contact details.
	Highly noise affected (75 dB(A))	The highly noise affected level represents the point above which there may be strong community reaction to noise. - 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: 1. 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 2. 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 (RBL + 5 dB)	- 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 - Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community - For guidance on negotiating agreements see Section 7.2.2 of the ICNG (DECC, 2009).

Considering the background noise statistics (RBLs) presented in **Table 5-2** and the guidance from the ICNG above in **Table 6-1**, the following NMLs have been established to manage noise impacts during construction.

Table 6-2 Construction noise management levels

Noise catchment area	Applies to	Noise management level (NML) $L_{eq\ 15\ minute}$ dB(A)			
		Standard hours of construction	Outside standard hours of construction		
			Day (1 pm to 6 pm Saturday and 8 am to 6 pm Sunday)	Evening (6pm to 10 pm)	Night (10 pm to 7 am [8 am on Weekends])
NCA01	Receivers in developed areas and within 200 m of the Newell Highway	49	45[#]	45	42
NCA02	Remote receivers	40	40[#]	40	36

It is noted that the NML for day time works outside standard hours were adjusted so that they were not lower than the evening and night time values.

The ICNG also provides guidance for other types of receivers. Recommended management levels for relevant receiver types within the vicinity of the proposal and construction compound areas have been reproduced below.

Table 6-3 Noise management levels for non-residential land uses (ICNG, DECC 2009)

Land use	Management level $L_{Aeq\ 15\ minute}$ dB(A) (when in use)
Educational facilities	45 dB(A) internal noise level
Place of worship	45 dB(A) internal noise level
Commercial premises	70 dB(A) external noise level
Industrial premises	75 dB(A) external noise level
Outdoor recreational area (passive)	60 dB(A) external noise level
Community center	50 dB(A) internal noise level

Noting that the ICNG NMLs for educational facilities, places of worship and community centres are expressed as an internal level, a conservatively estimated transmission loss of 10 dB(A) has been applied (equivalent to an open window as detailed in *Australia Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites* [AS2436-2010]) to develop external NMLs for these types of receivers.

6.1.1 Sleep disturbance

Noise impacts or events that can cause interruptions to sleeping patterns are considered separately to noise levels during works outside standard hours. The proposal is generally expected to be completed during standard hours of construction, though pavement stabilisation activities may be required to be undertaken outside standard hours owing to road access and safety reasons. As such, sleep disturbance impacts were considered as part of this assessment.

The ICNG does not provide a specific method for assessment of potential sleep disturbance noise impacts; and guidance on the acceptability of these events is taken from the RNP.

The RNP provides two criteria:

- Sleep disturbance screening criterion – used to identify situations where there is the potential for sleep disturbance
- Sleep disturbance awakening criterion – levels below which awakening is unlikely to occur.

The sleep disturbance screening criterion recommends that where the $L_{A1\ (1\ minute)}$ does not exceed the $L_{A90\ (15\ minute)}$ by 15 dB(A) or more, sleep disturbance impacts are likely to be maintained at an acceptable level. The $L_{A1,\ (1\ minute)}$ descriptor is meant to represent a maximum noise level when measured using a 'fast' time response.

The sleep disturbance awakening criterion is the threshold at which an awakening reaction is likely to occur. Research discussed in the RNP identified this threshold to be an internal bedroom noise level of around 50 to 55 dB(A).

Windows often allow the greatest amount of sound transmission from outside to inside across a building façade. Noting guidance presented in AS2436-2010, Where bedrooms are ventilated by an opened window, a sleep disturbance awakening criterion measured outside the bedroom window of 60 to 65 dB(A) less the conversion from $L_{AEq\ 15\ minute}$ to an $L_{A\ 1\ minute}$ (conservatively assumed to be 10 dB(A) would generally apply (i.e. 55 dB(A)).

6.1.2 Construction traffic noise

Section 9 of the CNVG provides guidance for the assessment of noise associated with additional traffic generated during construction. This guidance was adopted for this assessment and has been reproduced below:

> *'For RMS projects an initial screening test should first be applied by evaluating whether noise levels will increase by more than 2dB(A) due to construction traffic or a temporary reroute due to a road closure. Where increases are 2dBA or less no further assessment is required.*
>
> *Where noise levels increase by more than 2dB(A) (i.e.2.1 dBA) further assessment is required using Roads and Maritimes Criteria Guideline. This documents RMS' approach to implementing the Road Noise Policy. Consideration should be given under the Noise Criteria Guideline as to whether construction traffic or temporary reroute triggers new road criteria due to changes in road category'.*

6.2 Construction vibration

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

6.2.1 Human comfort

With respect to human comfort, vibration arising from construction activities must comply with criteria presented in *Assessing Vibration: a technical guideline*, (DECC, February 2006) and *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* [BS 6472-1: 2008]. DECC, 2006 identifies three different forms of vibration associated with construction activities:

- Continuous: uninterrupted vibration occurring over a defined period
- Impulsive: short-term (typically less than two seconds) bursts of vibration which occurs up to three times over an assessment period
- Intermittent: interrupted periods of continuous or repeated impulsive vibration, or continuous vibration that varies significantly in magnitude.

Continuous vibration may result from steady road traffic or steady use of construction equipment (e.g. generator). Impulsive vibration may arise during the loading or unloading of heavy equipment or materials or infrequent use of hammering equipment. Intermittent vibration may arise from the varied use of construction equipment (i.e. a dump truck moving around a site, idling while being loaded with materials, and then dumping the materials) or repeated high-noise activities such as hammering, piling or cutting.

Preferred and maximum values of human exposure for continuous and impulsive vibrations are listed in *Assessing Vibration: a technical guideline*, (DECC, February 2006) as outlined below.

Table 6-4 Preferred and maximum values for continuous and impulsive vibration acceleration (m/s^2) 1-80 Hz (DECC, 2006)

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	X and y axis	z-axis	X and y axis
Continuous vibration					
Critical areas[2]	Day or night	0.0050	0.0036	0.010	0.0072
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night	0.020	0.014	0.040	0.028
Workshops	Day or night	0.04	0.029	0.080	0.058
Impulsive vibration					
Critical areas[2]	Day or night	0.0050	0.0036	0.010	0.0072
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night	0.64	0.46	1.28	0.92
Workshops	Day or night	0.64	0.46	1.28	0.92

[1] Daytime is 7am to 10pm. Night-time is 10pm to 7am

[2] includes hospital operating theatres or precision laboratories.

Intermittent vibration is assessed differently; using vibration does values (VDV). Preferred and maximum VDVs are also provided in *Assessing Vibration: a technical guideline*, (DECC, February 2006) and have been reproduced below.

Table 6-5 Preferred and maximum VDVs for intermittent vibration (ms$^{-1.75}$), (DECC, 2006)

Location	Day time (7 am to 10 pm)		Night time (10 pm to 7 am)	
	Preferred VDV	Maximum VDV	Preferred VDV	Maximum VDV
Critical areas[1]	0.10	0.20	0.10	0.2
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

[1] Includes operating theatres, precision laboratories and other areas where vibration-sensitive activities may occur.

6.2.2 Buildings and structures

Section J4.4.3 of *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives* provides frequency-dependent guide levels for cosmetic damage to structures arising from vibration. These levels are adopted from *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundbourne vibration* [BS7385-2:1993] and are shown below in **Table 6-6**.

Table 6-6 Vibration guide values for cosmetic building damage, (BS7385-2: 1993)

Line	Type of building	Peak particle velocity (PPV) mm/s		
		4 to 15 Hz	15 to 40 Hz	40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50		
2	Un-reinforced or light-framed structures Residential or light commercial type buildings	15 to 20	20 to 50	50

Guidance for more sensitive structures is presented in the German Guideline, *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures* (DIN 4150-3:1999-02). Vibration velocities not exceeding 3 mm/s at 1 to 10 Hz are recommended in this standard.

6.2.3 Construction Noise and Vibration Guideline

Section 7 of the CNVG recommends safe working distances for achieving human comfort (*Assessing Vibration: a technical guideline*, (DECC, February 2006) and cosmetic building damage (BS7385-2:1993) criteria for a range of different plant and equipment. These have been reproduced below.

Table 6-7 Recommended safe working distances for vibration-intensive plant and equipment, (CNVG, Roads and Maritime 2016)

Plant	Rating / description	Safe working distance (meters)	
		Cosmetic damage (BS7385-2: 1993)	Human response (DECC, 2006)
Vibratory Roller	<50 kN (typically 1-2 tonne) <100 kN (typically 2-4 tonne) <200 kN (typically 4-6 tonne) <300 kN (typically 7-13 tonne) >300 kN (typically 13-18 tonne) >300 kN (> 18 tonne)	5 metres 6 metres 12 metres 15 metres 20 metres 25 metres	15 m to 20 metres 20 metres 40 metres 100 metres 100 metres 100 metres
Small hydraulic hammer	300 kg – 5 to 12 tonne excavator	2 metres	7 metres
Medium hydraulic hammer	900 kg – 12 to 18 tonne excavator	7 metres	23 metres
Large hydraulic hammer	1600 kg – 18 to 34 tonne excavator	22 metres	73 metres
Vibratory pile driver	Sheet piles	2 to 20 metres	20 metres
Pile boring	≤800 mm	2 metres (nominal)	4 metres
Jackhammer	Hand held	1 metres (nominal)	2 metres

6.3 Operational noise

In 2015, Roads and Maritime formalised the NCG, NMG and other supporting documents such as the *Noise Validation Guideline* to further define and standardize the methods, for monitoring, modelling and processes for determining requirements for mitigation from the guidance presented in the RNP. The first stage of assessment requires evaluation of operational noise levels from year of opening (i.e. 'build year', 2022) and 10 years after opening (i.e. 'future year', 2032) against the applicable NCG/RNP criteria. Criteria relevant to the residential receiver (R008) within the study area around segment N2M01 involving 'new' and 'redeveloped' 'Freeway/arterial/sub-arterial' road are shown below in **Table 6-8**. This receiver may be exposed to noise from both 'new' and 'redeveloped' road upgrade areas, and as such 'transition zone' criteria were applied as outlined in Section 7.1 of the NCG.

Table 6-8 Road noise control criteria

Road category	Type of project/land use	Assessment criteria dB(A)	
		Day (15 hour)	Night (9 hour)
Freeway/arterial/sub-arterial roads	1. Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq\ (15hr)}$ 55 (external)	$L_{Aeq\ (9hr)}$ 50 (external)
	2. Existing residences affected by noise from redevelopment of existing freeway/arterial/sub-arterial roads	$L_{Aeq\ (15hr)}$ 60 (external)	$L_{Aeq\ (9hr)}$ 55 (external)
	3. New road corridor/redevelopment of existing road/land use development with potential to generate additional traffic on existing road	Existing $L_{Aeq\ (15hr)}$ (external) + 12 dB(A)	Existing $L_{Aeq\ (9hr)}$ (external) + 12 dB(A)

The remaining road upgrade segments all comprise of 'minor works'. For these types of projects, it must first be evaluated whether noise levels increase by 2.1 dB(A) or more relative to existing levels at the worst-affected residential receiver. If this is found to be the case, all sensitive receivers within the study area must be assessed against this relative increase criterion, as well as the applicable road type criteria from the NCG and RNP reproduced below. It is noted that 'transition zones' requirements do not need to be considered for 'minor works'.

6.3.1 Sleep disturbance

A guide for assessing the potential for sleep disturbance within residences from the proposal's vehicle passbys is provided in the RNP:

> *'Triggers for, and effects of sleep disturbance from, exposure to intermittent noise such as noise from road traffic are still being studied. There appears to be insufficient evidence to set new indicators for potential sleep disturbance due to road traffic noise. The NSW Roads and Traffic Authority's Practice Note iii (NSW Roads and Traffic Authority 2008a) outlines a protocol for assessing and reporting on maximum noise levels and the potential for sleep disturbance'*

ENMM Practice Note iii indicates that:

- Maximum internal noise levels below 50–55 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum internal noise levels of 65–70 dB(A) are not likely to significantly affect health and wellbeing.

Given the that it is generally accepted that the level of traffic noise within a dwelling having its windows open is 10 dB(A) lower than the corresponding noise level immediately outside the facade (refer to the ICNG), these internal noise goals may be re-expressed as external noise goals as follows:

- Maximum external noise levels below 60–65 dB(A) are unlikely to cause awakening reactions, and
- One or two noise events per night with maximum external noise levels of 75-80 dB(A) are not likely to significantly affect health and wellbeing.

A ‘maximum noise event’ is defined as any vehicle pass-by for which

$$L_{Amax} - L_{Aeq(1\ hour)} \geq 15\ dB(A)$$

ENMM Practice Note iii states that the maximum noise level assessment should be used as a tool to help prioritise and rank mitigation strategies, but should not be applied as a decisive criterion in itself.

6.3.2 Mitigation qualification

The NMG provides guidance for managing and controlling operational road noise, and describes triggers for determining whether a receiver qualifies for other forms of noise mitigation after noise has been minimised by all feasible and reasonable methods during ‘corridor planning and road design stages’, and residual impacts have still been predicted. These triggers are:

- The predicted total noise level to a receiver in the Project ‘build year’ is 5 dB(A) or more above the relevant NCG noise criterion (this is termed the cumulative limit) and it is the proposal road noise that contributes most to this increase
- The noise level contribution from the road Project is greater than either 65 dB(A)$L_{eq,15hour}$ during daytime periods or 60 dB(A)$L_{eq,15hour}$ during night periods (such an affected receiver is referred to as ‘acute’)
- The predicted total noise level to a receiver for the Project ‘build year’ both exceeds the NCG noise criterion and the increase in noise created by the Project (i.e. the ‘build’ scenario minus the ‘no build’ scenario noise level) is 2.1 dB(A) or more.

These triggers include the situation where the ‘no build’ operational road noise levels are below the NCG and RNP fixed criteria listed above.

7. Impact Assessment

This section of the assessment describes the methods applied and results obtained from the assessment of different potential noise and vibration-related impacts associated with the proposal.

7.1 Construction noise

7.1.1 Setup details

To evaluate potential noise impacts during construction, a site noise model was developed using the SoundPlan 7.4 acoustic software package. Predictions were compared against the NMLs developed in **Section 6.1** to determine the potential for impacts. **Table 7-1** lists the inputs used in the noise model.

Table 7-1 Construction noise model setup details

Model input	Details
Topography	Terrain data was derived from NSW Land Property Information (LPI) 20 m resolution bare earth Digital Elevation Model (DEM).
Buildings	Footprints for receiver and other ancillary buildings were determined from aerial photography. Heights were estimated from Google Street view, or otherwise, assuming a building floor height of 3 meters per level.
Non-building receiver areas	Set at a height of 1.5 meters around the worst affected areas of these locations.
Ground absorption	A ground absorption coefficient of 0.75 was applied, consistent with the NMVG
Noise sources	Activity sound power levels were adopted from Roads and Maritime's CNE.
Meteorology	Moderately adverse wind conditions
Prediction method	The *ISO 9613-2: 1996* acoustic prediction algorithm was applied in the model.

7.1.2 Predicted impacts

Construction noise impacts were evaluated at each receiver identified in **0** for all of the eight construction scenarios listed in **Section 2.3.2**. The range of results and impacts are summarised and discussed around each segment below, with detailed results for each receiver presented in **0**, and mitigation and management measures discussed in **Section 8.1**.

Segment N2M01

As summarised in **Table 7-2**, noise levels from construction activities associated with segment N2M01 resulted in some exceedances at surrounding receivers. Levels greater than NMLs for standard hours of construction were predicted at seven (7) residential receivers, with exceedances greater than 10 dB(A) predicted at R003 during construction phases C03 and C04.

Table 7-2 Summary of construction noise results for receivers around N2M01

NCA	Receivers	Noise management levels $L_{eq\ 15\ minute}$ dB(A)				Range of predicted results $L_{eq\ 15\ minute}$ dB(A)
		Standard hours of construction	Outside standard hours			
			Day (1 pm to 6 pm Saturday and 8 am to 6 pm Sunday)	Evening (6pm to 10 pm)	Night (10 pm to 7 am [8 am on Weekends])	
NCA01	R008	49	45	45	42	43 to 56
NCA02	R001 to R007, R009	40	40	40	36	Less than 20 to 52

Segment N2M02

Around N2M02, 13 residential receivers were predicted to experience noise levels above NMLs for standard hours. Levels up to 75 dB(A) during phase C04 were predicted at receivers R018 and R019, with exceedances greater than 10 dB(A) predicted at six receivers during at least one or more phases of construction. Noise levels exceeding the ICNG 'highly noise affected' value of 75 dB(A) was also predicted at CIR003 during C04.

Table 7-3 Summary of construction noise results for receivers around N2M02

NCA	Receivers	Noise management levels $L_{eq\ 15\ minute}$ dB(A)				Range of predicted results $L_{eq\ 15\ minute}$ dB(A)
		Standard hours of construction	Outside standard hours			
			Day (1 pm to 6 pm Saturday and 8 am to 6 pm Sunday)	Evening (6pm to 10 pm)	Night (10 pm to 7 am [8 am on Weekends])	
NCA01	R017 to R024	49	45	45	42	43 to 75
NCA02	R010 to R016, R025 and R026	40	40	40	36	21 to 53

Segment N2M03

The highest number construction noise exceedances were predicted at receivers around segment N2M03. As displayed in **Table 7-4**, levels well above NMLs for standard hours were predicted at some of the nearest receiver locations. Five residential and four commercial/industrial receivers were predicted to be 'highly noise affected' during construction phase C04. No impacts were predicted at the nearby educational, place of worship and community facility receivers.

Table 7-4 Summary of construction noise results for receivers around N2M03

NCA	Receivers	Noise management levels $L_{eq\ 15\ minute}$ dB(A)				Range of predicted results $L_{eq\ 15\ minute}$ dB(A)
		Standard hours of construction	Outside standard hours			
			Day (1 pm to 6 pm Saturday and 8 am to 6 pm Sunday)	Evening (6pm to 10 pm)	Night (10 pm to 7 am [8 am on Weekends])	
NCA01	R028 to R098	49	45	45	42	21 to 80
NCA02	R027, R099 to R102	40	40	40	36	24 to 52

Segment N2M04

Only two residential receivers were predicted to experience noise levels exceeding NMLs for standard hours around N2M04. The highest predicted exceedance was 13 dB(A) above standard hours NMLs at R103 during phase C04.

Table 7-5 Summary of construction noise results for receivers around N2M04

NCA	Receivers	Noise management levels $L_{eq\ 15\ minute}$ dB(A)				Range of predicted results $L_{eq\ 15\ minute}$ dB(A)
		Standard hours of construction	Outside standard hours			
			Day (1 pm to 6 pm Saturday and 8 am to 6 pm Sunday)	Evening (6pm to 10 pm)	Night (10 pm to 7 am [8 am on Weekends])	
NCA02	R103 to R107	40	40	40	36	Less than 20 to 53

Segment N2M05

Noise impacts from segment N2M05 construction activities were predicted to be low. Levels exceeding NMLs for standard hours were predicted at 17 receivers, although in all cases levels the extent of the exceedance was less than 10 dB(A).

Table 7-6 Summary of construction noise results for receivers around N2M05

NCA	Receivers	Noise management levels $L_{eq\ 15\ minute}$ dB(A)				Range of predicted results $L_{eq\ 15\ minute}$ dB(A)
		Standard hours of construction	Outside standard hours			
			Day (1 pm to 6 pm Saturday and 8 am to 6 pm Sunday)	Evening (6pm to 10 pm)	Night (10 pm to 7 am [8 am on Weekends])	
NCA01	R115 to R127, R131 to R236	49	45	45	42	20 to 58
NCA02	R108 to R114, R128 to R130	40	40	40	36	Less than 20 to 47

7.2 Construction traffic noise

The CNE was used to assess potential impacts arising from construction traffic. Impacts were evaluated at the nearest residential receivers in relation to 60 km/hr and 110 km/hr sections of the proposal. 2018 existing traffic conditions were conservatively applied (presented in **0**), with additional traffic generated during construction assessed to be approximately 25 and 45 light and heavy vehicle movements per day, and 16 and 28 light and heavy vehicle movements per night. All input information applied in the CNE is displayed in **0**. The assessment predicted that at these most-affected residential locations, day and night time equivalent noise levels would increase by 0.2 and 0.5 dB(A) respectively; below the 2.1 dB(A) allowance adopted in the CNVG.

7.3 Construction vibration

Some vibration-intensive equipment may be used during the proposal including compaction equipment. Relevant recommended safe setback distances to maintain building cosmetic and human comfort criteria for these types of plant are reproduced below in **Table 7-7**.

Table 7-7 Recommended safe setback distances for relevant vibration-generating plant

Plant	Rating / description	Safe working distance (meters)	
		Cosmetic damage (BS7385-2: 1993)	Human response (DECC, 2006)
Vibratory Roller	<50 kN (typically 1-2 tonne) <100 kN (typically 2-4 tonne) <200 kN (typically 4-6 tonne) <300 kN (typically 7-13 tonne) >300 kN (typically 13-18 tonne) >300 kN (> 18 tonne)	5 metres 6 metres 12 metres 15 metres 20 metres 25 metres	15 m to 20 metres 20 metres 40 metres 100 metres 100 metres 100 metres

Considering these safe working setback distances and the distance to nearby structures and receivers, there is some potential for building cosmetic and human comfort impacts at the nearest receivers around Edgeroi and Bellata in segments N2M02 and N2M03, should this setback distances not be adhered to.

Regarding the identified heritages structures/items described above in **Section 4.3**, peak particle velocities were determined for different setback distances from different sizes of vibratory rollers and operating settings (low and high amplitude) were predicted using the methods detailed in *British Standard BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites* (BS 5228-1:2009. This is presented below in **Table 7-8**, with the lower value related to relating to operations in 'low amplitude mode' (i.e. lower vibratory setting for the drum) and the higher value relevant to operations completed in 'high amplitude mode'. Provided that these setback distances are adhered to, it is expected that impacts vibration-related impacts at these locations would be avoided.

Table 7-8 Guidance for avoiding vibration-related damage to surrounding heritage items

Vibratory roller details		Peak particle velocity (ppv) mm/s at specified distance					
Size	Specifics	1 meter	2 meters	5 meters	10 meters	20 meters	50 meters
Small	4 tonne, 0.8-meter drum width	40	21	7	3	1	0.3
Medium	11 tonne, 2.1-meter drum width	39 to 120	26 to 79	11 to 35	5 to 16	2 to 6	0.6 to 1.8
Large	19 tonne, 2.1-meter drum width	50 to 152	33 to 100	15 to 44	7 to 20	3 to 8	0.7 to 2.2

7.4 Operational noise

7.4.1 Assessment scenarios

Assessment of the proposal's operational noise impacts compares the modelled traffic noise levels resulting from the "Build" and "No Build" (ie "Do Nothing") options. In accordance with the RNP, the following four scenarios were modelled, where 2022 is taken to be the year of opening of the proposal:

- Year of Opening – 2022, No Build (Existing) - Modelling is based on 2022 traffic volumes on the unchanged (existing) road alignment
- Year of Opening – 2022, Build - Modelling is based on 2022 traffic volumes on the upgraded road alignment
- 10 Years after Opening – 2032, No Build - Modelling is based on 2032 traffic volumes on an unchanged road alignment
- 10 Years after Opening – 2032, Build - Modelling is based on 2032 traffic volumes on the upgraded road alignment.

7.4.2 Operational modelling inputs

The most significant factors in determining the level of noise received from a road are the receiver's distance from the road, screening, ground absorption, the type and volume of vehicles, vehicles speeds and the road surface type. The road and traffic parameters used and values adopted in the noise modelling are listed below in **Table 7-9**.

Table 7-9 Operational noise model setup details

Parameter	Details
Facades	• Standard +2.5 dB(A) correction applied to account for façade reflection
Source corrections	• Corrections for temperature and traffic mix were applied as presented in *Evaluation of Calculation of Road Traffic Noise in Australia,* (Peng, Kessissoglou & Parnell, 2017). • Surface corrections of -0.4 dB(A) and 0 dB(A) were applied to the existing (spray seal) and proposed (DGA) scenarios. The value for the existing scenarios was determined from available traffic composition data using the composite pavement correction formula, and the value for the proposed scenarios was adopted from the NMVG.
Traffic speeds	Posted traffic speeds.
Buildings	• Footprints taken from aerial photography • Heights determined from site inspections and Google Streetview.
Terrain	Terrain data was derived from NSW Land Property Information (LPI) 20 m resolution bare earth Digital Elevation Model (DEM).
Ground surface / absorption	A ground absorption coefficient of 0.75 was applied given the mostly undeveloped nature of the assessment setting.
Source heights / corrections	Traffic has been divided into the following source heights and energy levels: • Car tyres and engines / 0.5 m / 100 % • Truck tyres / 0.5 m / 25 % • Truck engines / 1.5 m / 60 % • Truck exhaust / 3.6 m / 15 %
L_{A10} to L_{Aeq} conversion	- 3 dB(A) (applied at all receivers)

The traffic data applied in the assessment was supplied by Roads and Maritime. At their advice, 2 and 2.4% annual growth factors were applied to the light and heavy vehicle flows to estimate traffic flows for the two design horizons considered in the assessment (i.e. 2022 and 2032).

7.4.3 Predicted impacts

The relative increase in noise levels was reviewed at the most affected receiver along each noise segment. As displayed, day and night time noise levels did not increase by 2.1 dB(A) or more at the most affected receivers along any of the five segments.

Table 7-10 Review of relative change in noise levels at most-affected receiver

Minor works road segment	Assessment year	Receiver experiencing highest change	Highest change in day time noise levels $L_{Aeq\ (15hr)}$	Highest change in night time noise levels $L_{Aeq\ (9hr)}$	Day time noise levels complies with +2.1 dB(A) allowance?	Night time noise levels complies with +2.1 dB(A) allowance?	If no, below NCG day time criteria ($L_{Aeq\ (15hr)}$ 60 (external))?	If no, below NCG night time criteria ($L_{Aeq\ (9hr)}$ 55 (external))?
N2M01	2022	R004	+1.6	+1.6	Yes	Yes	N/A	N/A
	2032	R004	+1.5	+1.6	Yes	Yes	N/A	N/A
N2M02	2022	R014	+1.2	+1.2	Yes	Yes	N/A	N/A
	2032	R014	+1.2	+1.2	Yes	Yes	N/A	N/A
N2M03	2022	R076	+1.8	+1.8	Yes	Yes	N/A	N/A
	2032	R095	+1.8	+1.8	Yes	Yes	N/A	N/A
N2M04	2022	R103	+0.6	+0.6	Yes	Yes	N/A	N/A
	2032	R103	+0.6	+0.6	Yes	Yes	N/A	N/A
N2M05	2022	R221	+0.6	+0.6	Yes	Yes	N/A	N/A
	2032	R221	+0.6	+0.6	Yes	Yes	N/A	N/A

7.4.4 Maximum noise level review

In general, it is expected that the new DGA pavement would reduce noise levels associated with wheel and road interactions; particularly for light vehicles. In the middle and northern sections of segment N2M01 and the northern portion of segment N2M03 the proposal involves straightening the road, which is expected to reduce associated noise effects resulting from heavy vehicles. There are no geometric features of the road along segments N2M02, N2M04 and N2M05 which might affect the frequency of maximum noise events, particularly from heavy vehicles (i.e. features lending to acceleration and deceleration). Where overtaking lanes will be added along N2M02, N2M03 and N2M05 there is the potential for additional maximum traffic-related noise events at nearby receivers.

8. Control measures

8.1 Construction noise

The construction noise assessment identified that additional measures may be required at some nearby receivers in addition to the standard measures presented in Appendix B of the CNVG (reproduced in **Appendix H** of this report). Consistent with guidance outlined in Appendix C of the CNVG for additional mitigation, the following additional measures are also recommended during the proposal.

These measures are for worst-case circumstances and should be reviewed in relation to the specific location(s) of the works noting the linear nature of the proposal and implemented accordingly. Similarly, should works be required outside standard hours, additional measures should be determined in line with Appendix C of the CNVG.

Table 8-1 Additional measures based on predicted results and present construction methodology

Segment	Impact level	Receivers and (work phase)	Standard hours additional mitigation measures
N2M01	'Moderately intrusive', 10 to 20 dB(A) above NML	R003 (C03, C04)	Notification, monitoring
	'Highly intrusive, > 20 dB(A) above NML	None	Notification, monitoring
	'Highly noise affected', >75 dB(A)	None	Notification, monitoring, specific engagement, respite offering
N2M02	'Moderately intrusive', 10 to 20 dB(A) above NML	R015 (C03, C04) R018, R019 (C01, C02, C05, C08) R021, R023 (C01 to C07)	Notification, monitoring
	'Highly intrusive, > 20 dB(A) above NML	R018, R019 (C03, C04, C06, C07)	Notification, monitoring
	'Highly noise affected', >75 dB(A)	CIR003 (C04)	Notification, monitoring, specific engagement, respite offering
N2M03	'Moderately intrusive', 10 to 20 dB(A) above NML	R028, R057, R076 (C08) R029, R058, R088, R089, R091 (C04) R040, R072, R092, R094, R097 (C01 to C03, C05 to C07) R041, 57 (C08) R042, R055, R070, R071, R077, R090, R101 (C03, C04) R043, R056 (C03, C04, C06, C07) R073, R075, R093 (C01, C02, C05 to C08) R074 (C01, C02, C05, C08) R098, R023 (C01 to C07)	Notification, monitoring
	'Highly intrusive, > 20 dB(A) above NML	R028, R057, R076 (C01 to C07) R040, R072, R092, R094, R097 (C04) R041, R057 (C01 to C07) R072 (C01 to C03, C05 to C07) R073, R075, R093 (C03, C04) R074 (C03, C04, C06, C07)	Notification, monitoring
	'Highly noise affected', >75 dB(A)	R029 (C04) R041, R057, R076 (C03, C04) CIR006 (C02, C03, C04, C06, C07) CIR007 (C04)	Notification, monitoring, specific engagement, respite offering

Segment	Impact level	Receivers and (work phase)	Standard hours additional mitigation measures
		CIR008 (C03, C04, C06, C07)	
N2M04	'Moderately intrusive', 10 to 20 dB(A) above NML	R103 (C03, C04)	Notification, monitoring
	'Highly intrusive, > 20 dB(A) above NML	None	Notification, monitoring
	'Highly noise affected', >75 dB(A)	None	Notification, monitoring, specific engagement, respite offering
N2M05	'Moderately intrusive', 10 to 20 dB(A) above NML	None	Notification, monitoring
	'Highly intrusive, > 20 dB(A) above NML	None	Notification, monitoring
	'Highly noise affected', >75 dB(A)	None	Notification, monitoring, specific engagement, respite offering

8.2 Construction vibration

Assessing Vibration: a technical guideline, (DECC, February 2006) provides general guidance for limiting vibration impacts during construction. Relevant recommendations have been reproduced below, and should be considered as appropriate.

Table 8-2 Vibration management measures from DECC, 2006.

Control measurer	Details
Controlling vibration levels from the source	• Choosing alternative, lower-impact equipment or methods wherever possible • Scheduling the use of vibration-causing equipment at the least sensitive times of the day (wherever possible) • Locating high vibration sources as far away from sensitive receiver areas as possible • Sequencing operations so that vibration-causing activities do not occur simultaneously • Keeping equipment well maintained • Do not conduct vibration intensive works within the building damage distances outlined in Table 4 1. Where possible, avoid the use of vibration intensive plant within the nominated human comfort distances.
Consultation	• Informing nearby receivers about the nature of construction stages and the vibration-generating activities.

In addition to these measures, care should be taken to avoid the use of vibratory compaction equipment within the setback distances recommended to avoid human comfort impacts as relevant above in **Table 6-7**. Where this isn't possible, an attendee should be present during the works to suspend activities in the instance of any issues or complaints. Wherever practical, static compaction techniques should be utilised for compaction required within the applicable setback distances recommended to avoid human comfort impacts. The same should be applied should the setback distances for heritage items identified in **Table 7-7** not be possible.

8.3 Operations

Along all of the 'minor' works sections of the proposal, there were no instances of 1) increases in day or night time operational noise levels of 2.1 dB(A) or more and 2) exceedance of the NCG criteria. At the only receiver (R008) located within the vicinity of a 'new' segment of road associated with the proposal, levels were also not found to increase by 2.1 dB(A) or more. Thus it can be concluded that operational noise measures would not be required as part of the proposal.

9. Conclusion

A quantitative assessment was undertaken to determine potential noise and vibration impacts associated with proposed upgrades along the Newell Highway between Narrabri and Moree, NSW as part of the proposal. Regarding construction noise, the assessment predicted that NMLs which were determined through the completion of background noise monitoring, were likely to be exceeded at some nearby receiver locations' particularly along segments N2M02 and N2M03 which pass through the villages of Edgeroi and Bellata respectively. Standard measures in line with the CNVG were recommended, as well as guidance for the management of residual noise issues after the application of standard measures from the CNVG, as applicable and consistent with actions agreed as part of the proposal notification process. Regarding vibration, measures were recommended in line with *Assessing Vibration: a technical guideline*, (DECC, February 2006) to manage potential issues during the works, as well as specific additional actions to mitigate the potential for human comfort impacts during compaction activities, as well as impacts at nearby heritage areas. Noise from traffic generated during construction was assessed to be negligible using the CNE tool.

Operational noise impacts were assessed against guidance presented in the RNP, NCG and NMG. This review identified that operational impacts were expected to be minimal, and not of a nature requiring specific operational mitigation measures as described in the NMG.

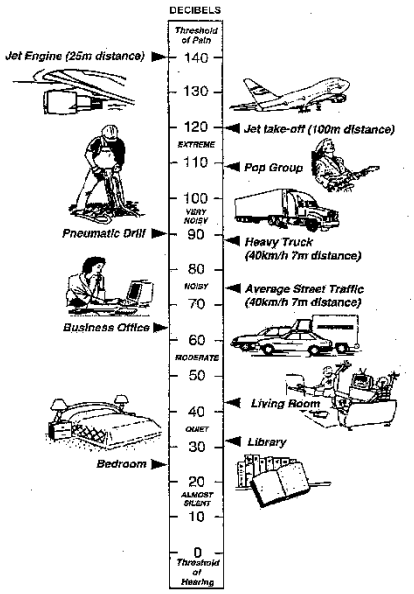
10. References

- *Assessing Vibration: a technical guideline*, (DECC, February 2006)
- *Australian Standard AS1055:1997 Acoustics – Description and measurement of environmental noise Part 1: General procedures.*
- *Australian Standard AS2187.2 – 2006 Explosives – Storage and use Part 2: Use of explosives.*
- *Australia Standard AS2436-2010 Guide to noise and vibration control on construction, demolition and maintenance sites.*
- *British Standard 6472-1: 2008 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting* [BS 6472-1: 2008]
- *British Standard BS7385: 1990 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundbourne vibration* [BS7385-2:1993]
- *British Standard BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites*
- *Converting Bureau of Meteorology Wind Speed Data to local Wind Speeds at 1.5m Above Ground Level,* (Gowan, Karantonis and Rofail, 2004)
- *Evaluation of Calculation of Road Traffic Noise in Australia,* (Peng, Kessissoglou & Parnell, 2017).
- *DIN 4150-3 Structural vibration Part 3: Effects of vibration on structures* [DIN 4150-3:1999-02].
- *Interim Construction Noise Guidelines*, (DECC, 2009) CNVG*,* (Roads and Maritime, 2016)
- *Noise Criteria Guideline* , (Roads and Maritime, 2015)
- *Noise Mitigation Guideline*, (Roads and Maritime, 2015)
- *Noise Model Validation Guideline*, (Roads and Maritime, 2018)
- *Noise Policy for Industry*, (EPA, 2017)
- *NSW Road Noise Policy*, (DECCW, 2011)
- *NSW Industrial Noise Policy,* (EPA, 2000)
- *OzArk, 2018 Aboriginal and Historic Archaeological Survey Report, Newell Highway HD Pavements: Narrabri to Moree*
- *Preparing an Operational Traffic and Construction Noise and Vibration Assessment Report* (POTCNVAR)*,* (Roads and Maritime, 2016).

Appendix A. Glossary of key terms

A-weighted sound pressure	The human ear is not equally sensitive to sound at different frequencies. People are more sensitive to sound in the range of 1 to 4 kHz (1000 – 4000 vibrations per second) and less sensitive to lower and higher frequency sound. During noise measurement an electronic '*A-weighting*' frequency filter is applied to the measured sound level *dB(A)* to account for these sensitivities. Other frequency weightings (B, C and D) are less commonly used. Sound measured without a filter is denoted as linear weighted dB(linear).
Ambient noise	The **total** noise in a given situation, inclusive of all noise source contributions in the near and far field.
Community annoyance	**Includes** noise annoyance due to: ▪ character of the noise (e.g. sound pressure level, tonality, impulsiveness, low-frequency content) ▪ character of the environment (e.g. very quiet suburban, suburban, urban, near industry) ▪ miscellaneous circumstances (e.g. noise avoidance possibilities, cognitive noise, unpleasant associations) ▪ human activity being interrupted (e.g. sleep, communicating, reading, working, listening to radio/TV, recreation).
Compliance	The process of checking that source noise levels meet with the noise limits in a statutory context.
Cumulative noise level	The total level of noise from all sources.
Extraneous noise	Noise resulting from activities that are not typical to the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.
Feasible and reasonable measures	Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors: ▪ Noise mitigation benefits (amount of noise reduction provided, number of people protected). ▪ Cost of mitigation (cost of mitigation versus benefit provided).

	▪ Community views (aesthetic impacts and community wishes). ▪ Noise levels for affected land uses (existing and future levels, and changes in noise levels).
Impulsiveness	Impulsive noise is noise with a high peak of short duration or a sequence of these peaks. Impulsive noise is also considered annoying.
Low frequency	Noise containing major components in the low-frequency range (20 to 250 Hz) of the frequency spectrum.
Noise criteria	The general set of non-mandatory noise levels for protecting against intrusive **noise** (for example, background noise plus 5 dB) and loss of amenity (e.g. noise levels for various land use).
Noise level (goal)	A noise level that should be adopted for planning purposes as the highest acceptable noise level for the specific area, land use and time of day.
Noise limits	Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels, which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.
Performance-based goals	Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.
Rating Background Level (RBL)	The rating background level is the overall single figure background level representing each day, evening and night time period. The rating background level is the 10th percentile min L_{A90} noise level measured over all day, evening and night time monitoring periods.
Receptor	The noise-sensitive land use at which noise from a development can be heard.
Sleep disturbance	Awakenings and disturbance of sleep stages.
Sound and decibels (dB)	**Sound** (or noise) is caused by minute changes in atmospheric pressure that are detected by the human ear. The ratio between the quietest noise audible and that which should cause permanent hearing damage is a million times the change in sound pressure. To simplify this range the sound pressures are logarithmically converted to decibels from a reference level of 2 x 10-5 Pa. The picture below indicates typical noise levels from common noise sources.



dB is the abbreviation for decibel – a unit of sound measurement. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.

Sound power Level (SWL)

The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in *dB(A)*.

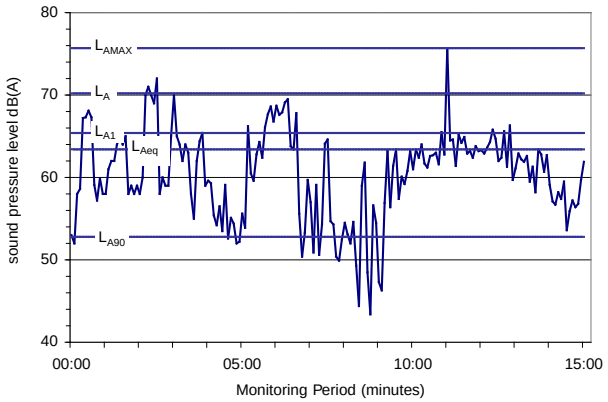
Sound Pressure Level (SPL)

The level of noise, usually expressed as SPL in *dB(A)*, as measured by a standard sound level meter with a pressure microphone. The sound pressure level in *dB(A)* gives a close indication of the subjective loudness of the noise.

Statistic noise levels

Noise levels varying over time (e.g. community noise, traffic noise, construction noise) are described in terms of the statistical exceedance level.

A hypothetical example of A weighted noise levels over a 15 minute measurement period is indicated in the following figure:



Key descriptors:

L_{Amax} Maximum recorded noise level.

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} Noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level.

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound.

L_{A90} Noise level exceeded for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).

Threshold	The lowest sound pressure level that produces a detectable response (in an instrument/person).
Tonality	Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 2 to 5 dB(A) penalty is typically applied to noise sources with tonal characteristics

Appendix B. Summary of where POTCNVAR requirements are addressed in this report

Table B1 Summary of where POTCNVAR requirements are addressed in this report

POTCNVAR requirement	Content	Where addressed in this report
Introduction: Provide background and an overview of the project; outlining why the project is being considered.	• A definitions page… to outline some of the common acronyms and abbreviations used throughout the report.	**0**
	• The location description should include factors such as the amount /density of residential and/or other dwelling types in the vicinity of the proposal. Other important factors to be included in the introduction include: - Current posted speed - Existing road features including road alignment and gradient; surface material; lanes and lane widths; and special provisions such as guardrails and cycleways.	**Section 2**
	• Surrounding landscape/topography	**Section 4**
	• The objectives of the assessment report.	**Section 1**
Existing ambient noise environment: Noise Catchment Areas – to group together receivers with similar noise levels or impacted by the same work.	• Any noise catchment areas (NCAs) should be described in this section, both within the text and graphically, and show receiver type and ID. • Overlays outlining the NCAs should be provided on orthorectified aerial imagery. • For ease of reference all residences should be numbered.	**Section 5**
Existing ambient noise environment: Noise monitoring and analysis – to document the monitoring locations and discuss the monitoring analysis procedures and the outcome of monitoring	• The monitoring and analysis procedures should include: - A brief description of prevailing ambient noise environment; - Documentation of the location of the noise monitors, including an indication of the distance to the nearest road; - Location of sensitive receivers with respect to the noise monitoring locations; - Orthorectified aerial imagery maps showing the locations of the noise monitoring - Site photographs identifying the noise logger and position; - The type of equipment used; - The sample period and settings used; - Calibration check and drift; - Meteorological data; and - Corrections applied. • A discussion on the recorded noise levels (i.e. L_{A10}, L_{A90}, L_{Aeq} and L_{Amax}) and dominant sources should be included.	**Section 5**
Noise criteria: To apply relevant NCG criteria to potentially affected receivers	• Define the study area (not the same as NCA) and noise criteria for noise sensitive receivers using the NCG; • Assigning criteria at residences requires consideration of the road's functional class and also whether the road is redeveloped or a new road. Assign new, redeveloped, transition zone or relative increase criteria to residences depending on how the project will influence noise levels. For each façade of the residence the most stringent applicable criteria will be used in the assessment. Separate tables assessing the relative increase criterion are not required.	**Section 6**

POTCNVAR requirement	Content	Where addressed in this report
	• Provide noise criteria in tabulated format for residential land uses as well as for other sensitive land uses. • Provide noise criteria on orthorectified aerial imagery maps. Additionally, these maps need to identify whether the project has been substantially realigned or not.	
	• Explanations of modelling scenarios required under the NSW Road Noise Policy (RNP) should be provided, including model validation scenario, year of opening 'build' and 'no build' scenarios and design year 'build' and 'no build' scenarios	**Section 7.4**
Triggers for qualifying a receiver for consideration of noise mitigation: To describe the triggers used to qualify a receiver for consideration of noise mitigation	• Outline NMG triggers that result in a receiver to qualify for consideration of noise mitigation	**Section 6.3** and **Section 8**
Operational noise assessment: Modelling methodology – to describe the procedures, scenarios and inputs used to construct the noise model	• Provide a discussion of the modelling methodology including modelling procedures as well as modelling scenarios. The procedure should describe the UK Department of Environment Calculation of Road Traffic Noise (CoRTN), including any modifications (if algorithms other than CoRTN are used, they must be justified and explained). A summary of the modelling inputs and software used may be best formatted in a simple table identifying the input parameter and source of the parameter. • Provide summaries of the computational algorithms used and justification for their selection as well as the location of noise sensitive dwellings. • Modelling scenarios should reflect the existing road alignment and the proposed design, (i.e. model validation scenario, year of opening 'build' and 'no build' scenarios and design year 'build' and 'no build' scenarios.	**Section 7.4**
Operational noise assessment: Traffic modelling parameters – to describe the traffic input parameters used in the model	• Tabulated traffic modelling parameters to allow for easy comparisons, and should contain tabulations of existing Annual Average Daily Traffic (AADT), Austroads vehicle classifications as well as predictions for the day and night periods for design year, future existing and project opening year for each of these parameters. A statement identifying speeds and pavement surfaces during modelling should also be provided.	**Section 7.4** and **Appendix G**
Operational noise assessment: Model validation – to give an indication of the difference between measured and predicted noise levels at noise monitoring locations	• Any discrepancies must be discussed and accounted for where necessary. • These can be summarized into Table format for ease of comparison.	**N/A**
Operational noise assessment: Predicted noise levels – to describe the main findings of the noise modelling, including relationship of noise	• The predicted noise level results are best summarised into an 'Operational Noise Predictions Table'. This table should clearly indicate the differences between the noise levels existing on the road and those predicted to exist with the implementation of the proposal. These must be compared with the noise criteria set in the NCG and existing noise levels to identify the likely changes in traffic noise with the implementation of the proposal.	**Section 7.4**

POTCNVAR requirement	Content	Where addressed in this report
levels and the relevant criteria	• Tabulated noise levels for all receiver locations and noise contour maps must be provided for LAeq (15hr) Day, LAeq (9hr) Night for existing and future scenarios outlined in modelling methodology. The contour maps should generally be presented at intervals of 5 dBA, and the contour values should be clearly identified and overlaid on orthorectified aerial imagery maps with all sensitive noise receivers and design alignment identified. The contours should extend to a noise level at 5 dBA (where feasible), below the noise criteria. Difference noise contour maps (i.e. Build option minus No Build option) also need to be included. • Other forms of graphical illustration should also be included where it adds value to the assessment report.	
Operational noise assessment: Sensitivity analysis – to properly account for future potential changes in road conditions	• A sensitivity analysis may be performed or risk allowance included ensuring that any variation in noise levels due to potentially increased speeds/traffic flows etc. are properly accounted for. • This section may not be required in all cases (see Sensitivity Analysis on Page 7). Please consult the Project Manager.	-
Operational noise assessment: Design of noise mitigation measures – to discuss noise mitigation options and the relative changes on noise levels with their implementation.	• The NMG is to be used as a basis for determining the eligibility for noise mitigation. All available options for reducing noise impacts, and preferred option(s), based on assessment of likely effectiveness, costs, practicality, any community preferences, aesthetics, shall be discussed in the report. The preferred noise mitigation measure should detail complete justification of treatment recommendations (if any). Where total noise level at receivers exceed the controlling criterion established using the NCG, mitigation options should be investigated in accordance with the NMG (where possible, external options such as quieter pavement surfaces and/or barriers are preferred over architectural treatments). • Table 5 in Annexure A describes noise levels with barrier options as well as whether architectural treatment would be offered. • A discussion of the tabulated results should analyse which residences are above the criteria and should be considered for mitigation options. Residences may be broken down into their relative NCAs where appropriate, to assign area noise levels and determine how many architectural treatments may be required within each NCA.	**Section 8**
Maximum noise level assessment for road traffic: Determine the frequency of occurrence of maximum noise events from road traffic to assist prioritization of noise mitigation	• Although there are no specific criteria relating to sleep disturbance, the RNP provides some guidance on noise levels and health affects from awakening. • Provide an evaluation of prevailing maximum noise level impact and changes in impact attributable to the project. Consideration should be given to engine compression brakes where relevant. This evaluation should include, as a minimum, the tabulation of measured or representative predicted maximum noise levels, showing; maximum noise levels, the value of LAMAX - LAeq and the number of noise events on an hourly basis for a 'typical night'	N/A
Construction noise and vibration assessment: Describes management levels for construction noise and criteria for construction vibration and blasting and discusses the potential	• Noise: This section should contain - - Construction timing, program plan and identification of receivers; - Methods of construction to be used; - The relative distances of construction work from noise sensitive locations and receivers; - Construction noise management levels and predictions at residences and other sensitive receivers; - Ground borne noise at residences (for example tunnels or deep cuts); and	**Section 2.3** and **Section 7.1**

POTCNVAR requirement	Content	Where addressed in this report
noise and vibration impacts on noise sensitive receivers from construction activities	- A description of site compounds, stockpile areas, truck movements, traffic routes, etc.	
	• If work is likely to be scheduled outside normal working hours this should be addressed with respect to the CNVG's recommended strategies to minimize impact. • Where sensitive receivers will be impacted, work outside standard hours should be undertaken as a last resort and must be justified.	N/A
	• An indicative description of the types of plant, equipment and construction activities to be included in the project construction should be provided. For example a table of construction equipment and activities and their relative sound power / vibration levels.	**Section 2.3**
	• Derive noise management levels from background noise levels established from noise monitoring where appropriate. Provide a table summarising project specific noise management levels based on the Rating Background Level (RBL) descriptor for day, evening and night • Noise management levels must be clearly stated and noise levels in exceedance of predicted levels must be discussed.	**Section 6.1**
	• Where work will occur at night (i.e. between 10pm and 7am) report maximum noise levels from construction activities, what activities are involved, the expected frequency of maximum noise level events, compare range of maximum noise level events with existing ambient maximum levels. • Further guidance on the assessment of potential construction noise impacts and the identification of effective noise control practices is provided in the CNVG.	N/A
	• Predicted noise levels and/or exceedance must be shown on orthorectified imagery at all affected receivers (i.e. above NML). Other relevant map contents also need to be included to make information accessible and transparent • Predicted noise levels need to be summarised in the body of the report.	**Section 7.1**
	• Vibration: - Assess vibration impact, where relevant, using the CNVG. Discussion should be in regard to human comfort and building damage and may include recommendations for vibration monitoring and dilapidation surveys of potentially affected dwellings. - A table outlining typical vibration levels from construction plant to be used should be inserted. - Heritage items should also be taken into consideration. For example, if a heritage building is in close proximity to project works, lighter machinery may need to be considered.	**Section 7.3**
	• Blasting: - Assess blasting impact using the CNVG where relevant.	N/A
	• Mitigation: - A discussion of the range of best economically and technically available options/best practice measures that may be implemented to manage the construction noise and vibration impacts should also be provided.	**Section 8**
Conclusion	• A summary of: - The data collected and a discussion of the outcomes. - Interpretation of the results of the assessment including potential impacts.	**Section 9**

POTCNVAR requirement	Content	Where addressed in this report
	- Potential mitigation measures and changes in noise levels with and without mitigation scenarios.	
Appendices: To provide detailed information pertaining to data collected; used to allow the main report to remain concise/uncluttered	• The appendices may contain: - Tables of calculated noise levels at residences. - Copies of figures; including NCAs, noise criteria, noise contour maps and receiver/monitoring locations. - Graphical presentation of measured noise data. - Tables/information where noise mitigation for individual receivers could not be contained in the main body of the report due to a large number of receivers.	**Appendix B** to **Appendix G**

Appendix C. Sensitive receiver tables

N2M01

Table 10-1 N2M01 residential receivers

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R001	769713.17	6647436.74	530 m	C and O
R002	771518.59	6649350.91	1550 m	C
R003	770141.50	6649975.58	260 m	C and O
R004	770490.42	6650233.75	420 m	C and O
R005	769332.65	6650137.42	500 m	C and O
R006	769966.28	6650947.68	320 m	C and O
R007	769768.45	6651077.50	550 m	C and O
R008	770551.15	6651256.95	160 m	C and O
R009	772196.45	6654367.06	1,900 m	C

Table 10-2 N2M01 non-residential receivers

Receiver ID	Type	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
		X (m)	Y (m)		
CIR001	Commercial/Industrial	769797.52	6647860.66	Varies, 80 m at nearest	C

N2M02

Table 10-3 N2M02 residential receivers

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R010	769742.40	6656653.67	1,400 m	C
R011	770199.42	6657805.11	1,400 m	C
R012	770424.61	6657786.73	1,200 m	C
R013	771850.92	6658355.67	350 m	C and O
R014	771928.15	6658428.57	450 m	C and O
R015	770692.92	6662102.69	240 m	C and O
R016	770772.26	6663625.03	700 m	C
R017	769880.39	6665148.53	170 m	C and O
R018	769732.45	6665185.04	30 m	C and O
R019	769732.21	6665203.06	30 m	C and O

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R020	769864.98	6665224.16	170 m	C and O
R021	769753.31	6665251.66	60 m	C and O
R022	769859.29	6665295.99	170 m	C and O
R023	769756.63	6665303.81	70 m	C and O
R024	769839.84	6665336.29	160 m	C and O
R025	770720.98	6665682.66	1,060 m	C
R026	770077.79	6665822.48	440 m	C and O

Table 10-4 N2M02 non-residential receivers

Receiver ID	Type	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
		X (m)	Y (m)		
CIR002	Industrial	769560.70	6665063.11	70 m	C
CIR003	Commercial/Industrial	769724.26	6665286.01	30 m	C

N2M03

Table 10-5 N2M03 residential receivers

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R027	768981.62	6685220.91	1,150 m	C
R028	769501.87	6686637.82	15 m	C and O
R029	769584.85	6686632.73	100 m	C and O
R030	769673.70	6686628.82	190 m	C and O
R031	769700.70	6686624.51	210 m	C and O
R032	769718.31	6686625.69	230 m	C and O
R033	769721.84	6686580.68	235 m	C and O
R034	769777.42	6686586.16	290 m	C and O
R035	769773.11	6686631.95	290 m	C and O
R036	769810.29	6686630.77	320 m	C and O
R037	769857.26	6686687.14	370 m	C and O
R038	769778.59	6686694.57	290 m	C and O
R039	769721.84	6686700.44	235 m	C and O
R040	769521.83	6686739.97	40 m	C and O
R041	769508.92	6686820.60	15 m	C and O
R042	769583.28	6686849.96	100 m	C and O

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R043	769582.50	6686806.12	90 m	C and O
R044	769647.47	6686807.29	160 m	C and O
R045	769668.22	6686858.57	180 m	C and O
R046	769725.36	6686761.89	240 m	C and O
R047	769785.63	6686744.67	295 m	C and O
R048	769780.16	6686840.56	290 m	C and O
R049	769858.43	6686854.65	370 m	C and O
R050	769863.91	6686817.47	375 m	C and O
R051	769855.30	6686782.64	365 m	C and O
R052	769937.89	6686749.37	450 m	C and O
R053	769803.64	6686913.36	315 m	C and O
R054	769787.98	6686956.03	300 m	C and O
R055	769580.54	6686926.67	90 m	C and O
R056	769577.41	6686963.07	85 m	C and O
R057	769506.96	6686962.29	15 m	C and O
R058	769592.68	6687082.06	105 m	C and O
R059	769647.08	6687012.78	150 m	C and O
R060	769731.62	6687050.74	240 m	C and O
R061	769724.19	6687008.47	240 m	C and O
R062	769803.64	6687011.21	320 m	C and O
R063	769855.76	6687023.90	360 m	C and O
R064	769965.15	6687083.46	475 m	C and O
R065	769840.88	6687099.20	350 m	C and O
R066	769780.74	6687114.51	295 m	C and O
R067	769714.30	6687117.99	220 m	C and O
R068	769666.53	6687125.20	175 m	C and O
R069	769640.43	6687136.05	150 m	C and O
R070	769593.99	6687171.99	100 m	C and O
R071	769591.64	6687197.22	95 m	C and O
R072	769530.96	6687144.22	40 m	C and O
R073	769519.24	6687202.06	30 m	C and O
R074	769513.90	6687227.96	20 m	C and O
R075	769514.97	6687246.52	25 m	C and O
R076	769506.48	6687289.89	20 m	C and O
R077	769590.51	6687270.97	100 m	C and O
R078	769645.80	6687206.04	155 m	C and O

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R079	769648.08	6687248.54	160 m	C and O
R080	769664.30	6687297.27	175 m	C and O
R081	769714.42	6687288.21	220 m	C and O
R082	769722.94	6687246.04	235 m	C and O
R083	769726.87	6687188.40	240 m	C and O
R084	769807.03	6687182.17	320 m	C and O
R085	769652.11	6687364.80	160 m	C and O
R086	769656.51	6687394.94	165 m	C and O
R087	769646.98	6687421.07	160 m	C and O
R088	769594.08	6687365.68	105 m	C and O
R089	769593.09	6687424.64	100 m	C and O
R090	769570.26	6687457.99	80 m	C and O
R091	769590.68	6687481.43	100 m	C and O
R092	769527.97	6687419.40	35 m	C and O
R093	769514.94	6687459.39	25 m	C and O
R094	769521.73	6687555.64	35 m	C and O
R095	768929.75	6686823.46	535 m	C and O
R096	770959.76	6687366.50	1,465 m	C
R097	769525.83	6687827.58	40 m	C and O
R098	769539.10	6687804.86	55 m	C and O
R099	769912.33	6687851.30	430 m	C and O
R100	768445.54	6688289.23	1,020 m	C
R101	769245.72	6689286.38	250 m	C and O

Table 10-6 N2M03 non-residential receivers

Receiver ID	Type	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
		X (m)	Y (m)		
CIR004	Commercial/Industrial	769301.93	6684652.88	1,615 m	C
CIR005	Commercial/Industrial	769301.62	6686983.03	60 m	C
CIR006	Commercial/Industrial	769503.34	6687001.79	10 m	C
CIR007	Commercial/Industrial	769446.42	6687136.92	25 m	C
CIR008	Commercial/Industrial	769510.43	6687171.83	10 m	C
CIR009	Commercial/Industrial	769779.70	6687274.84	290 m	C
RC3001	Recreational	769454.86	6686961.30	15 m	C
RC3002	Recreational	769656.03	6686931.21	170 m	C

Receiver ID	Type	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
		X (m)	Y (m)		
ED2001	Educational	769933.29	6686940.93	440 m	C
CM6001	Community	769652.05	6687070.19	160 m	C
CH4001	Place of worship	769864.52	6686933.90	375 m	C

N2M04

Table 10-7 N2M04 residential receivers

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R102	769123.35	6690462.69	1,440 m	C
R103	769622.97	6693053.60	220 m	C and O
R104	767580.36	6695355.18	1,810 m	C
R105	768397.74	6695423.06	980 m	C
R106	770835.47	6696194.38	1,435 m	C
R107	770473.12	6698692.97	1,400 m	C

Table 10-8 N2M04 non-residential receivers

Receiver ID	Type	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
		X (m)	Y (m)		
CIR010	Commercial/Industrial	769756.89	6696523.37	370 m	C

N2M05

Table 10-9 N2M05 residential receivers

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R108	774066.04	6726976.88	440 m	C and O
R109	773838.22	6727289.18	765 m	C
R110	773658.63	6727387.53	965 m	C
R111	773239.26	6727693.44	1,470 m	C
R112	772999.15	6727587.07	1,655 m	C
R113	773306.46	6728516.49	1,775 m	C
R114	774770.50	6729089.05	800 m	C
R115	775934.99	6729009.91	240 m	C and O

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R116	776318.02	6730372.87	155 m	C and O
R117	776321.39	6730410.71	145 m	C and O
R118	776338.65	6730407.25	165 m	C and O
R119	776363.54	6730401.99	190 m	C and O
R120	776381.17	6730397.11	210 m	C and O
R121	776404.02	6730391.29	230 m	C and O
R122	776417.00	6730450.28	225 m	C and O
R123	776396.13	6730462.91	200 m	C and O
R124	776378.48	6730466.98	180 m	C and O
R125	776357.64	6730472.55	165 m	C and O
R126	776336.75	6730476.50	140 m	C and O
R127	776350.81	6730530.02	140 m	C and O
R128	774704.70	6732069.27	1,780 m	C
R129	774738.55	6732138.23	1,750 m	C
R130	777263.55	6731578.17	790 m	C
R131	775331.29	6734364.48	1,460 m	C
R132	775346.36	6734362.16	1,450 m	C
R133	775366.06	6734356.75	1,430 m	C
R134	775384.61	6734353.28	1,415 m	C
R135	775397.36	6734353.28	1,400 m	C
R136	775418.61	6734349.03	1,380 m	C
R137	775434.07	6734348.25	1,370 m	C
R138	775454.93	6734342.84	1,350 m	C
R139	775472.32	6734340.91	1,330 m	C
R140	775487.39	6734338.59	1,320 m	C
R141	775485.84	6734258.61	1,270 m	C
R142	775491.64	6734378.78	1,340 m	C
R143	775474.25	6734386.89	1,360 m	C
R144	775453.77	6734394.23	1,380 m	C
R145	775432.91	6734397.32	1,400 m	C
R146	775412.04	6734388.05	1,410 m	C
R147	775371.47	6734390.37	1,440 m	C
R148	775523.32	6734267.11	1,245 m	C
R149	775525.64	6734281.41	1,250 m	C
R150	775544.57	6734270.59	1,230 m	C
R151	775564.28	6734265.57	1,210 m	C

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R152	775585.92	6734272.14	1,200 m	C
R153	775603.69	6734253.59	1,175 m	C
R154	775622.62	6734262.09	1,165 m	C
R155	775641.55	6734242.00	1,135 m	C
R156	775650.05	6734257.07	1,140 m	C
R157	775738.15	6734164.72	1,010 m	C
R158	775525.25	6734331.64	1,290 m	C
R159	775538.00	6734328.55	1,275 m	C
R160	775555.39	6734324.30	1,260 m	C
R161	775574.32	6734321.59	1,240 m	C
R162	775589.01	6734316.57	1,230 m	C
R163	775606.01	6734315.02	1,215 m	C
R164	775620.30	6734313.48	1,205 m	C
R165	775644.26	6734308.84	1,180 m	C
R166	775659.33	6734307.30	1,170 m	C
R167	775677.49	6734302.27	1,155 m	C
R168	775691.78	6734303.43	1,140 m	C
R169	775706.47	6734299.96	1,130 m	C
R170	775727.72	6734293.00	1,110 m	C
R171	775743.17	6734289.14	1,095 m	C
R172	775762.88	6734287.21	1,090 m	C
R173	775787.99	6734279.86	1,060 m	C
R174	775799.58	6734303.05	1,070 m	C
R175	775806.93	6734327.39	1,080 m	C
R176	775815.04	6734340.14	1,085 m	C
R177	775819.29	6734357.53	1,095 m	C
R178	775823.93	6734371.44	1,100 m	C
R179	775829.72	6734389.60	1,110 m	C
R180	775837.45	6734402.73	1,120 m	C
R181	775842.47	6734420.51	1,130 m	C
R182	775844.02	6734437.89	1,140 m	C
R183	775850.97	6734457.21	1,150 m	C
R184	775847.88	6734473.05	1,170 m	C
R185	775845.56	6734489.67	1,180 m	C
R186	775846.34	6734517.87	1,200 m	C
R187	775845.95	6734544.15	1,230 m	C

Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R188	775842.09	6734562.69	1,245 m	C
R189	775827.40	6734599.40	1,280 m	C
R190	775808.86	6734599.40	1,290 m	C
R191	775805.38	6734551.10	1,255 m	C
R192	775804.61	6734519.81	1,240 m	C
R193	775786.45	6734505.12	1,230 m	C
R194	775799.58	6734464.17	1,190 m	C
R195	775803.45	6734440.98	1,170 m	C
R196	775792.63	6734423.21	1,160 m	C
R197	775760.56	6734384.19	1,150 m	C
R198	775770.22	6734363.71	1,130 m	C
R199	775762.49	6734340.91	1,120 m	C
R200	775736.22	6734340.14	1,135 m	C
R201	775723.08	6734344.39	1,150 m	C
R202	775701.44	6734364.48	1,180 m	C
R203	775675.17	6734345.94	1,180 m	C
R204	775659.71	6734355.98	1,205 m	C
R205	775638.46	6734355.59	1,215 m	C
R206	775618.76	6734360.62	1,230 m	C
R207	775597.51	6734367.19	1,250 m	C
R208	775574.32	6734362.16	1,265 m	C
R209	775552.30	6734368.73	1,285 m	C
R210	775534.14	6734374.91	1,310 m	C
R211	775832.43	6734649.63	1,320 m	C
R212	775812.72	6734651.18	1,335 m	C
R213	775792.79	6734697.57	1,385 m	C
R214	775813.59	6734710.37	1,385 m	C
R215	775826.31	6734734.11	1,400 m	C
R216	775868.29	6734739.73	1,385 m	C
R217	775890.91	6734723.14	1,350 m	C
R218	775868.88	6734768.97	1,410 m	C
R219	775920.42	6734733.33	1,350 m	C
R220	775960.39	6734730.51	1,330 m	C
R221	775931.33	6734763.28	1,375 m	C
R222	775929.95	6734786.20	1,395 m	C
R223	775930.53	6734808.74	1,415 m	C

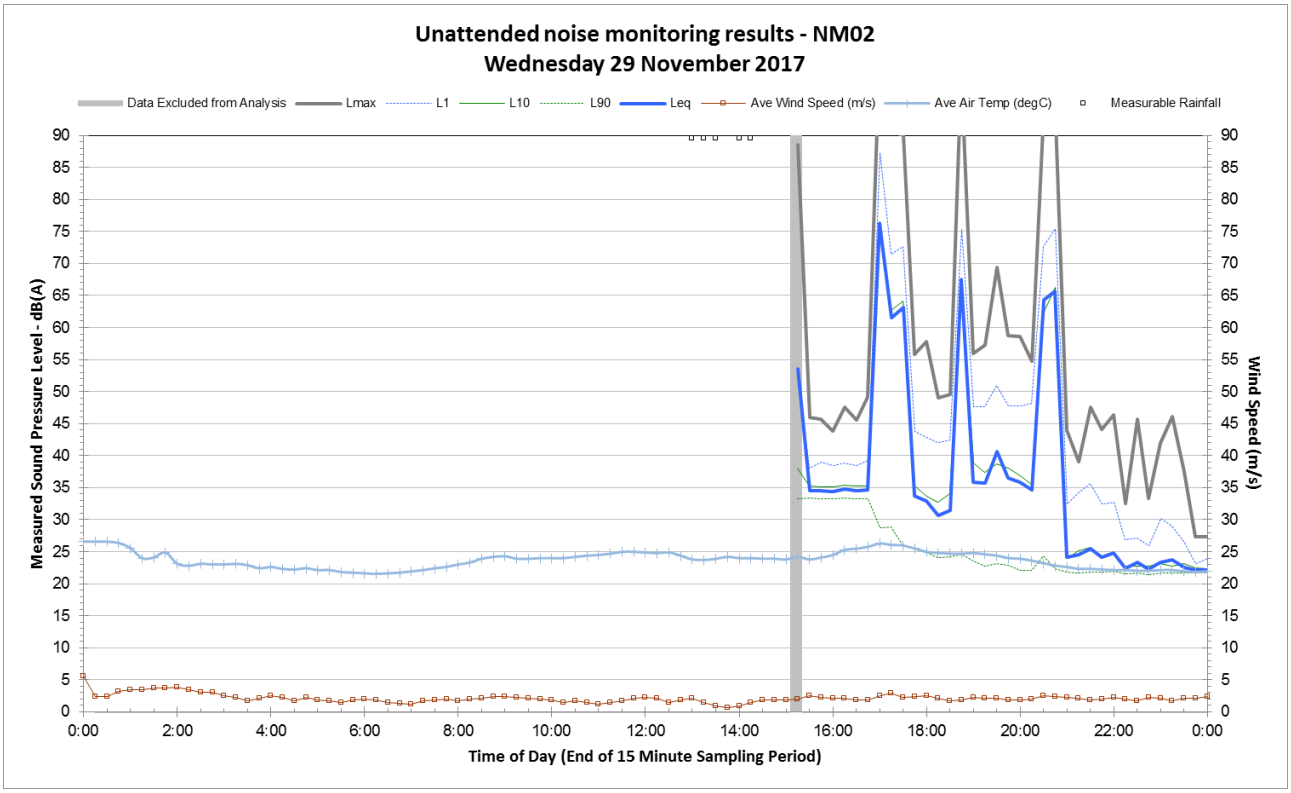
Receiver ID	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
	X (m)	Y (m)		
R224	775976.27	6734776.02	1,370 m	C
R225	775976.49	6734803.80	1,395 m	C
R226	775973.48	6734826.43	1,415 m	C
R227	775967.37	6734842.93	1,435 m	C
R228	775945.79	6734842.67	1,445 m	C
R229	775937.20	6734896.34	1,495 m	C
R230	775936.30	6734939.59	1,535 m	C
R231	775964.22	6734936.63	1,520 m	C
R232	775962.34	6734898.61	1,485 m	C
R233	776017.92	6734943.54	1,505 m	C
R234	776017.87	6734924.28	1,490 m	C
R235	776015.15	6734905.54	1,475 m	C
R236	776011.29	6734877.19	1,450 m	C

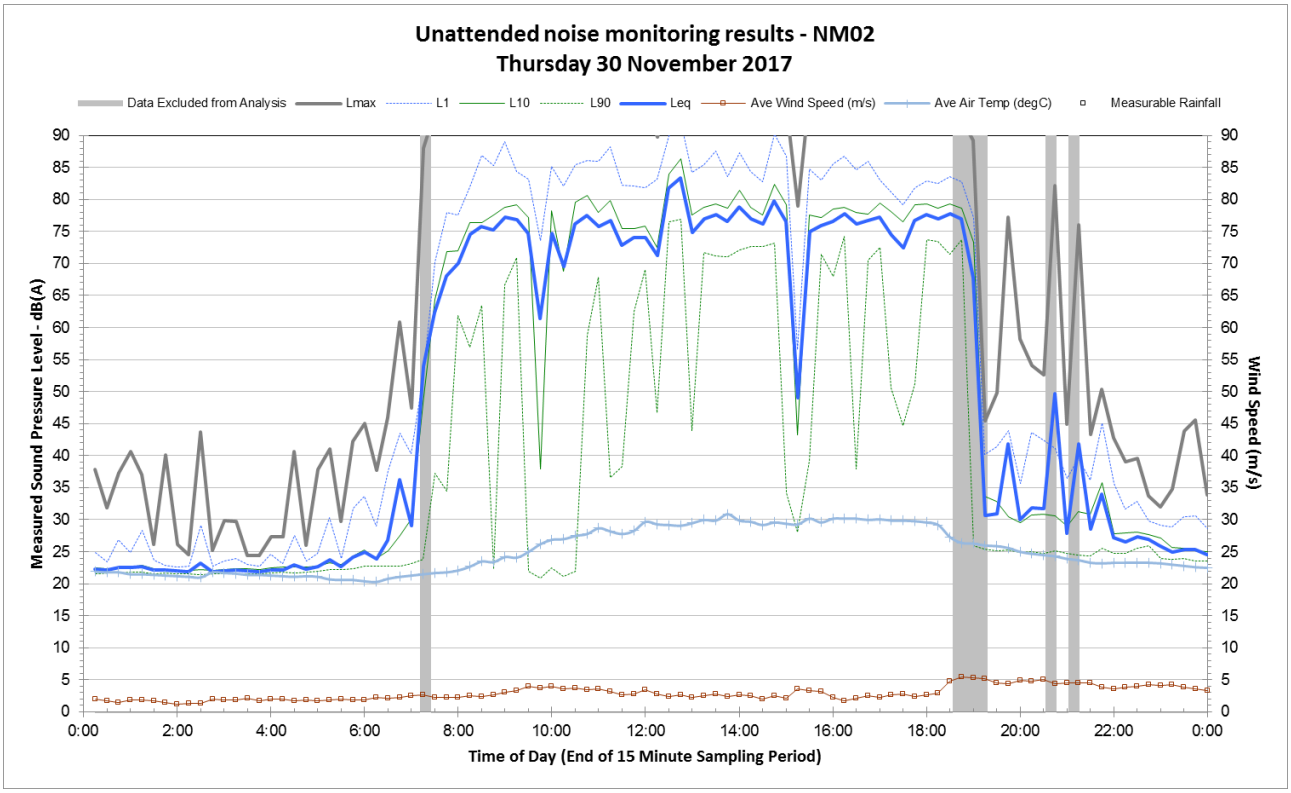
Table 10-10 N2M05 non-residential receivers

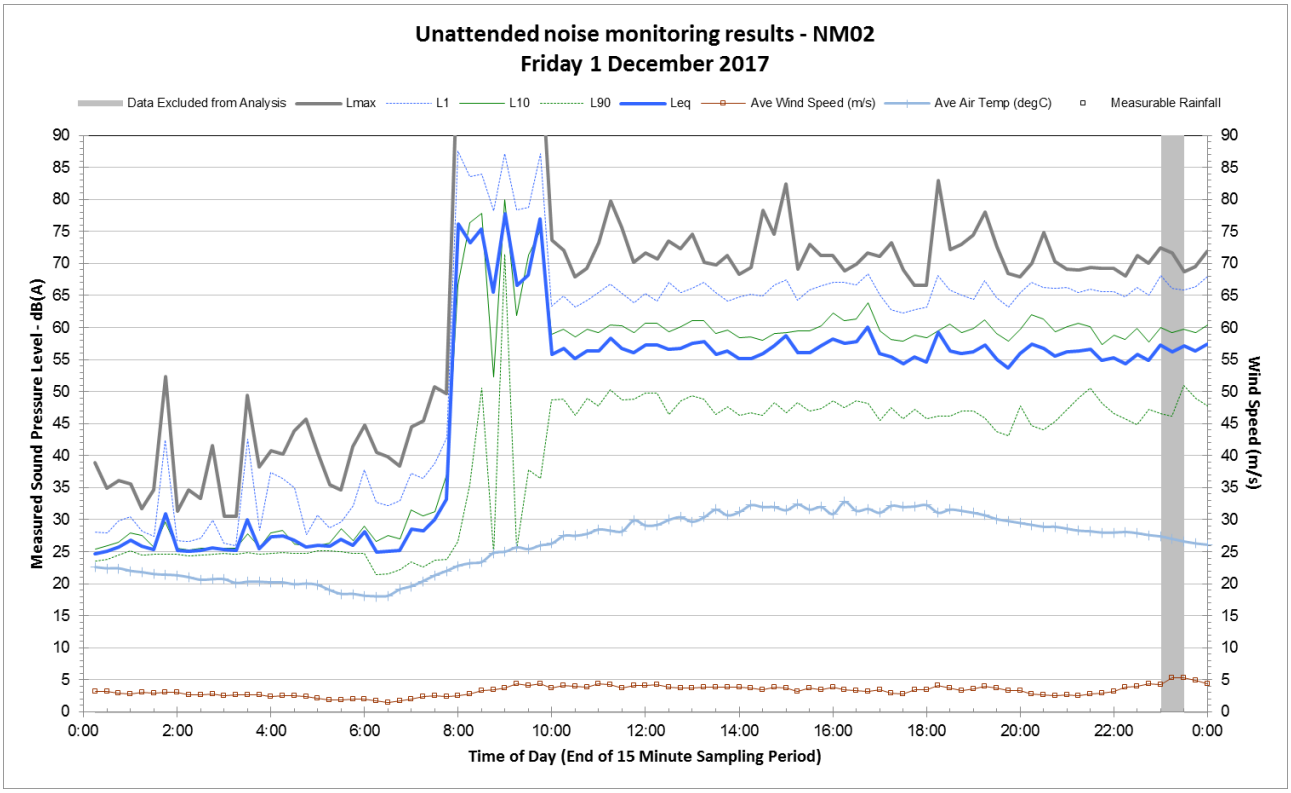
Receiver ID	Type	Approximate location		Approximate distance from the proposal (m)	Applicable to construction (C) and operations (O)?
		X (m)	Y (m)		
CIR011	Commercial	776002.82	6728176.85	700 m	C
CIR012	Commercial	775826.66	6729086.06	105 m	C
CIR013	Commercial	776784.40	6728966.40	1,020 m	C
CIR014	Commercial	776165.78	6729833.13	125 m	C
CIR015	Commercial	776373.89	6729675.82	420 m	C
CIR016	Commercial	776912.55	6729777.34	925 m	C
CIR017	Commercial	776745.61	6730136.17	615 m	C
CIR018	Commercial	776246.94	6730182.02	140 m	C
CIR019	Commercial	776698.55	6733628.44	90 m	C
CIR020	Commercial	776347.83	6733621.30	130 m	C
CIR021	Commercial	775911.57	6734193.95	905 m	C
CIR022	Commercial	775908.55	6734110.33	840 m	C
CIR023	Commercial	775865.87	6734007.30	795 m	C
CIR024	Commercial	775845.03	6733948.79	790 m	C
CIR025	Commercial	775834.49	6733887.32	770 m	C
CIR026	Commercial	775781.84	6734107.18	940 m	C
CIR027	Commercial	775956.80	6734318.47	975 m	C
CH4002	Place of worship	775903.97	6734542.91	1,190 m	C

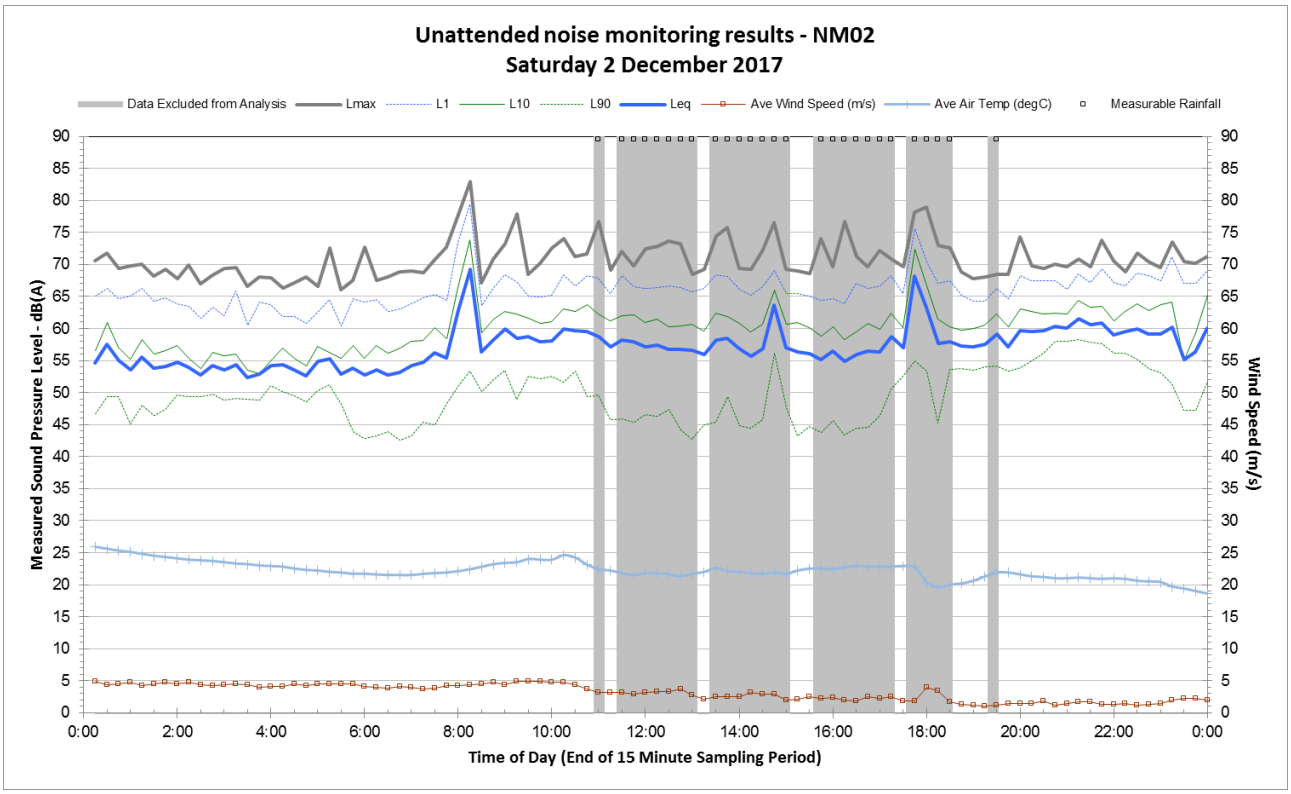
Appendix D. Background noise monitoring results

Noise monitoring location NM02




Unattended noise monitoring results - NM02
Thursday 30 November 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Friday 1 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Saturday 2 December 2017
Data Excluded from Analysis
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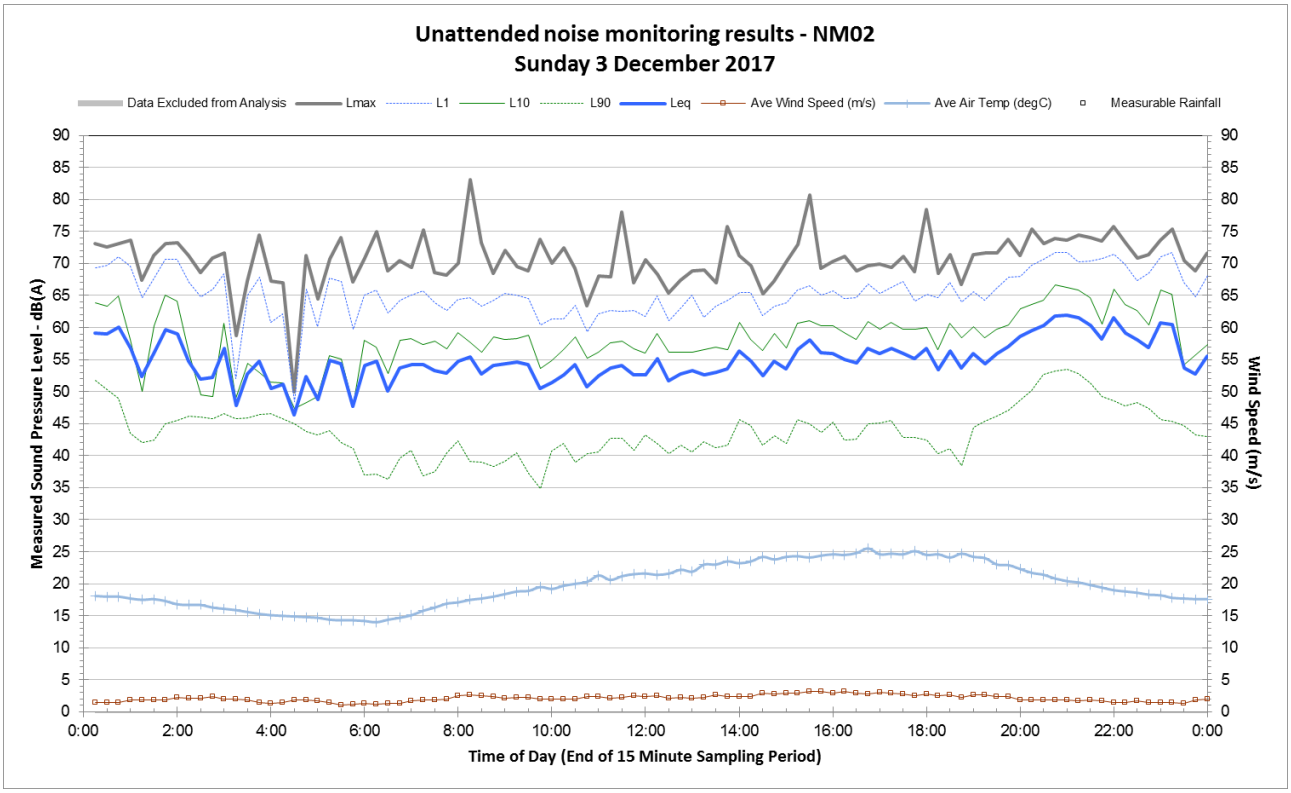
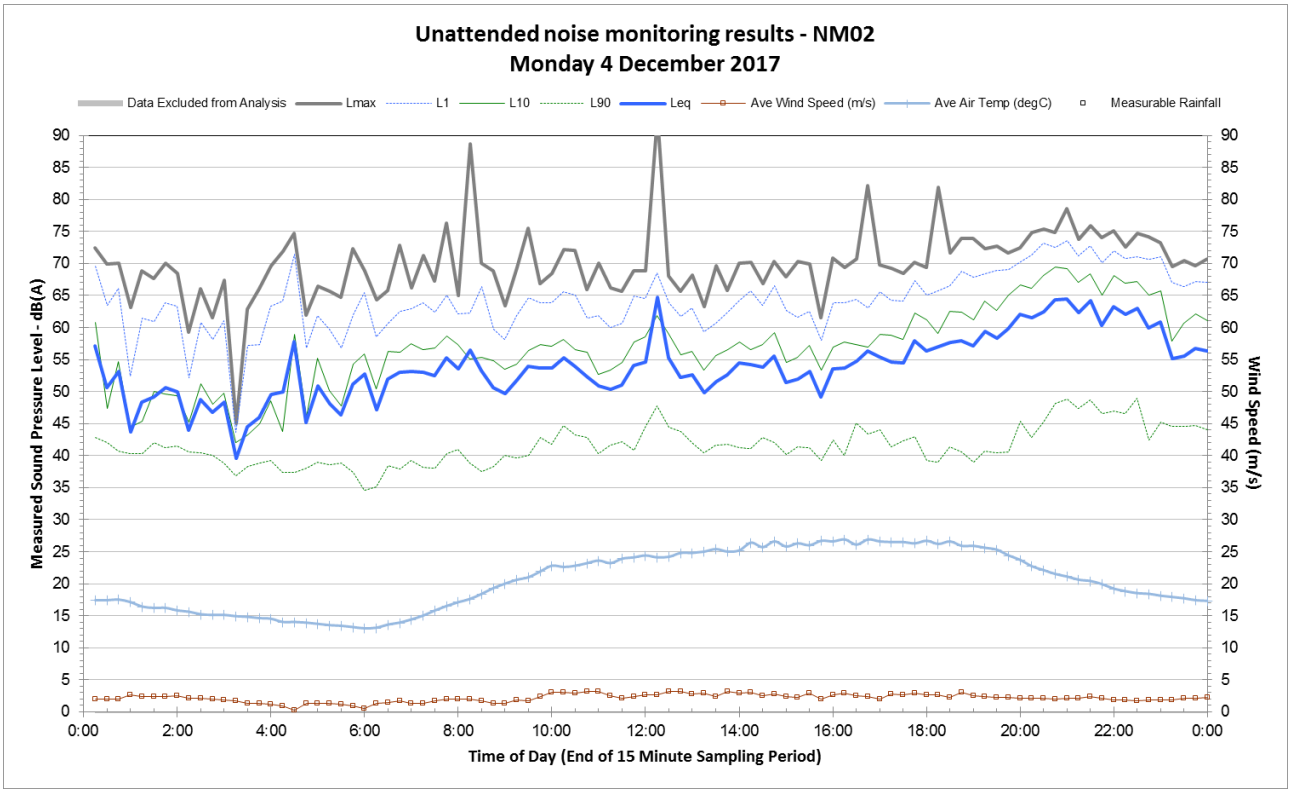
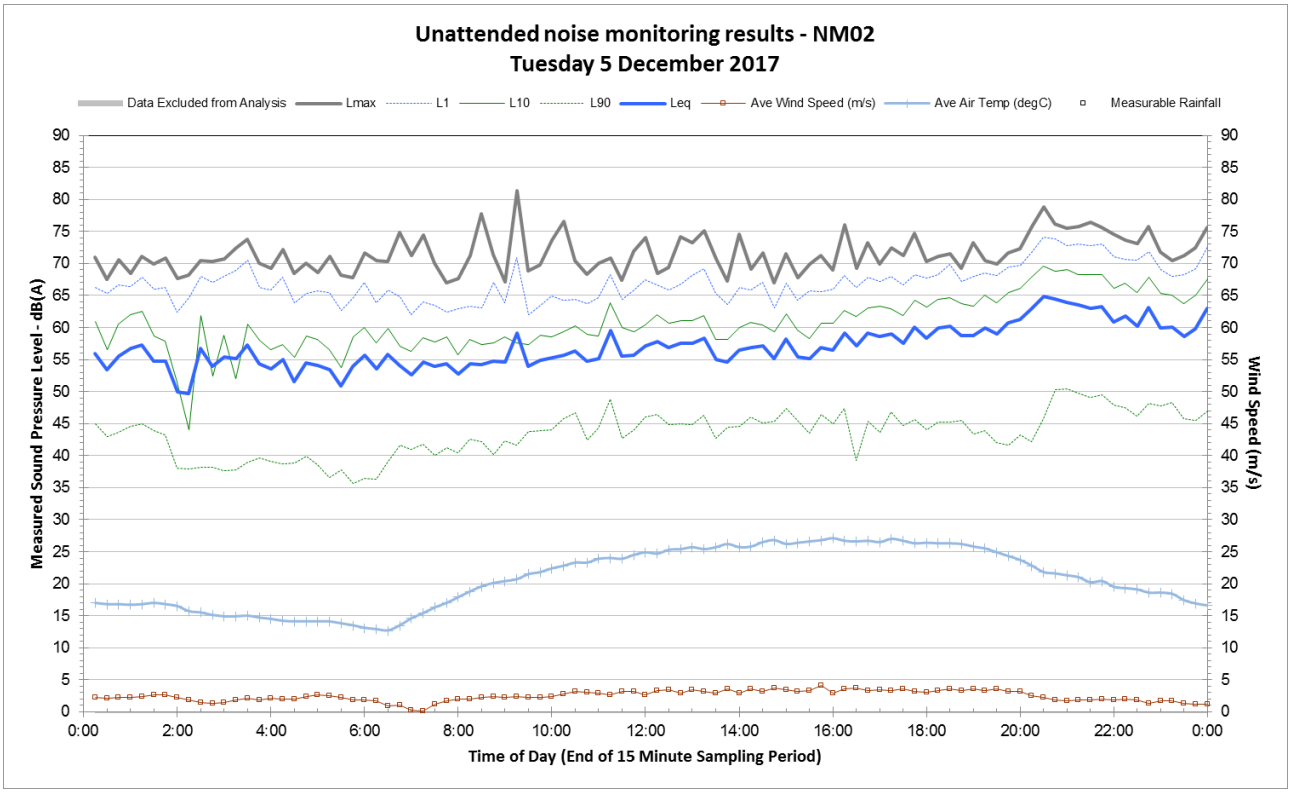
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Sunday 3 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Monday 4 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Tuesday 5 December 2017
Data Excluded from Analysis
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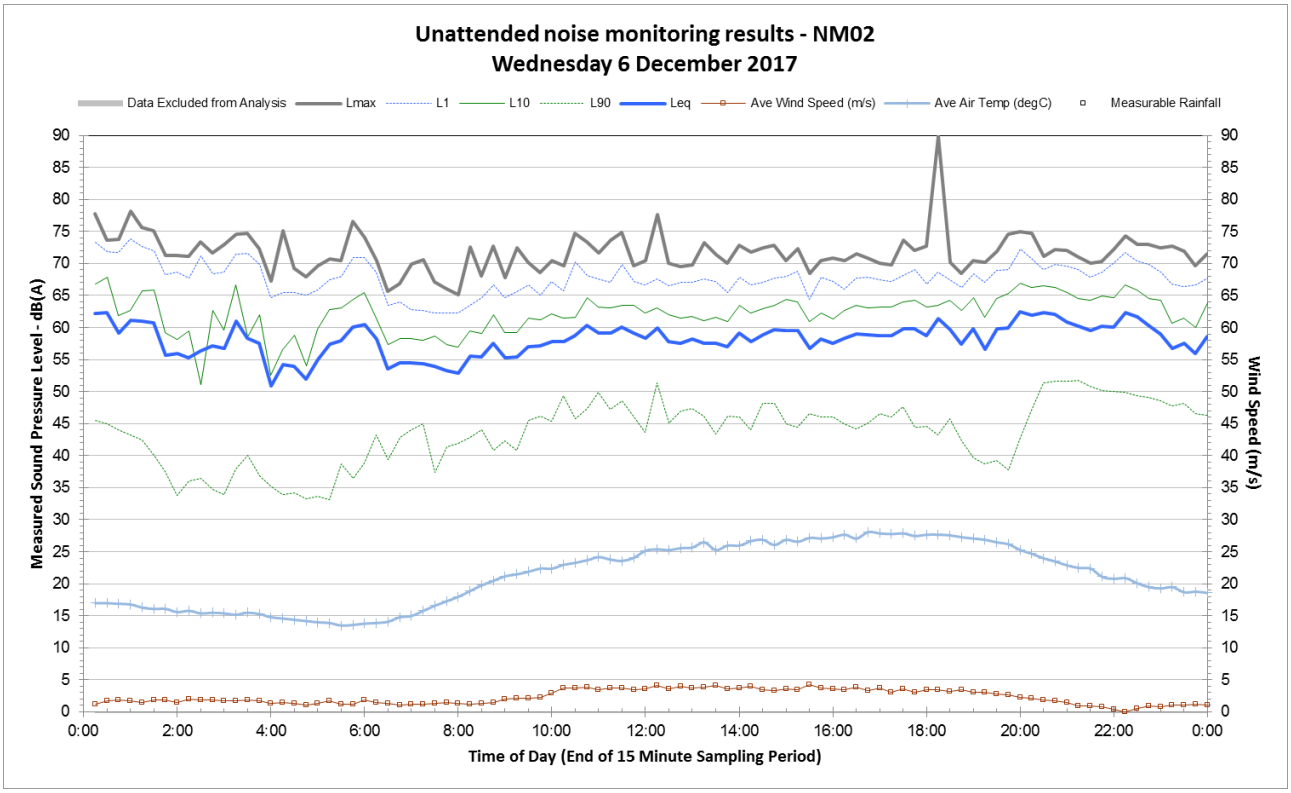
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Wednesday 6 December 2017
Data Excluded from Analysis
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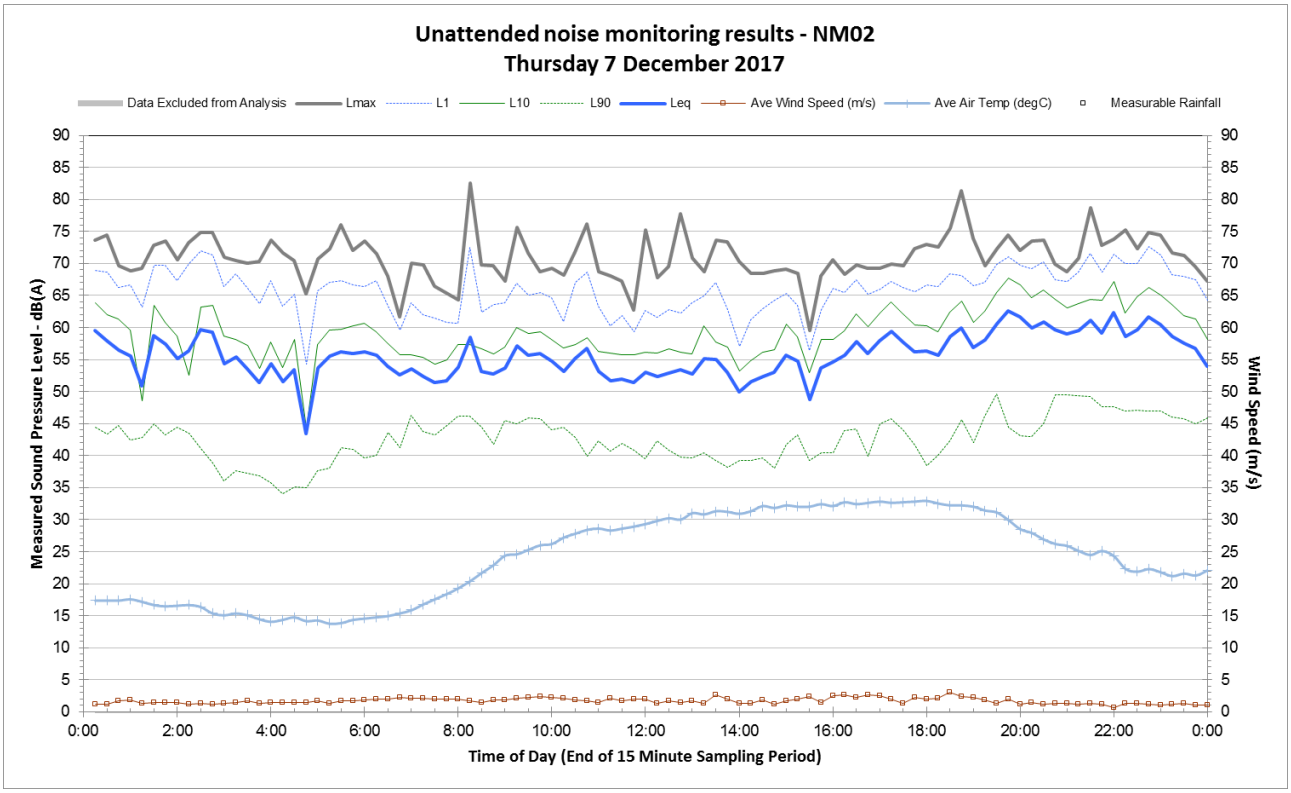
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)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Thursday 7 December 2017
Data Excluded from Analysis
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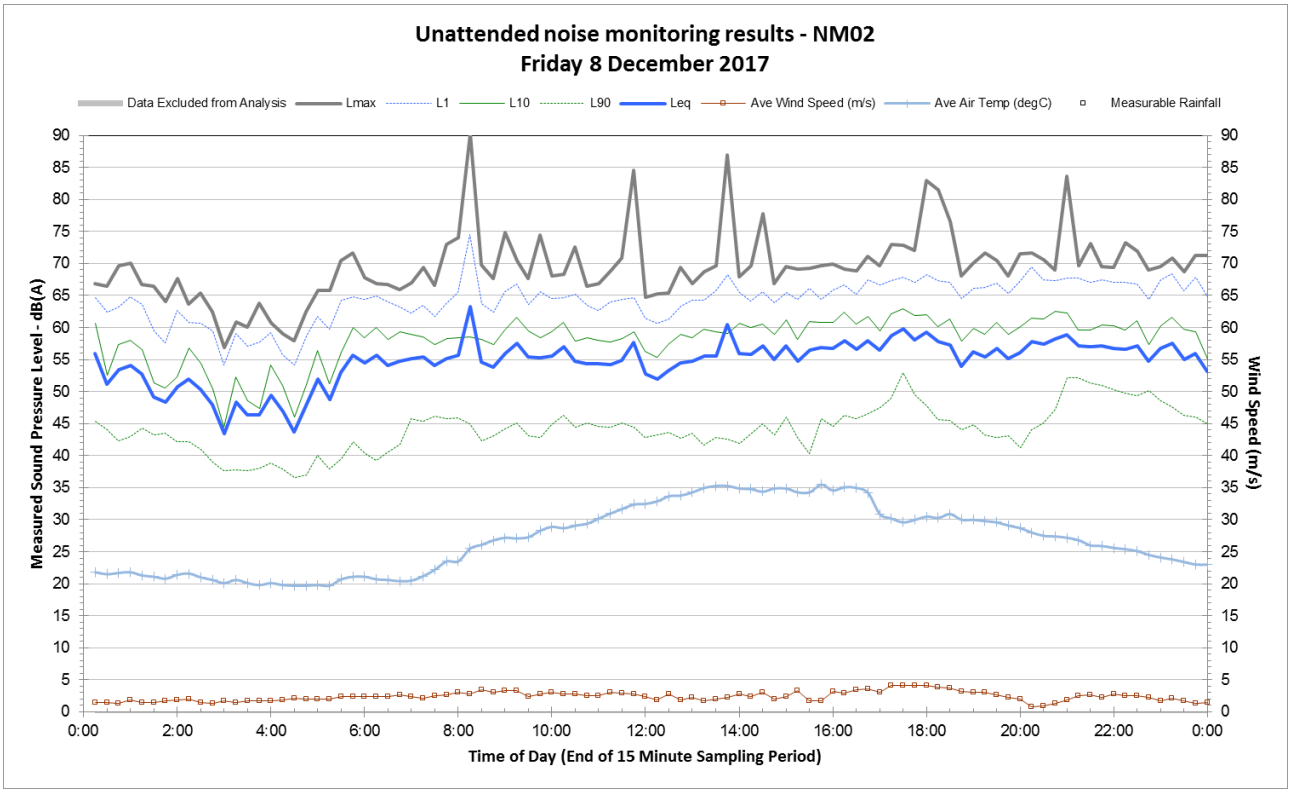
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Friday 8 December 2017
Data Excluded from Analysis
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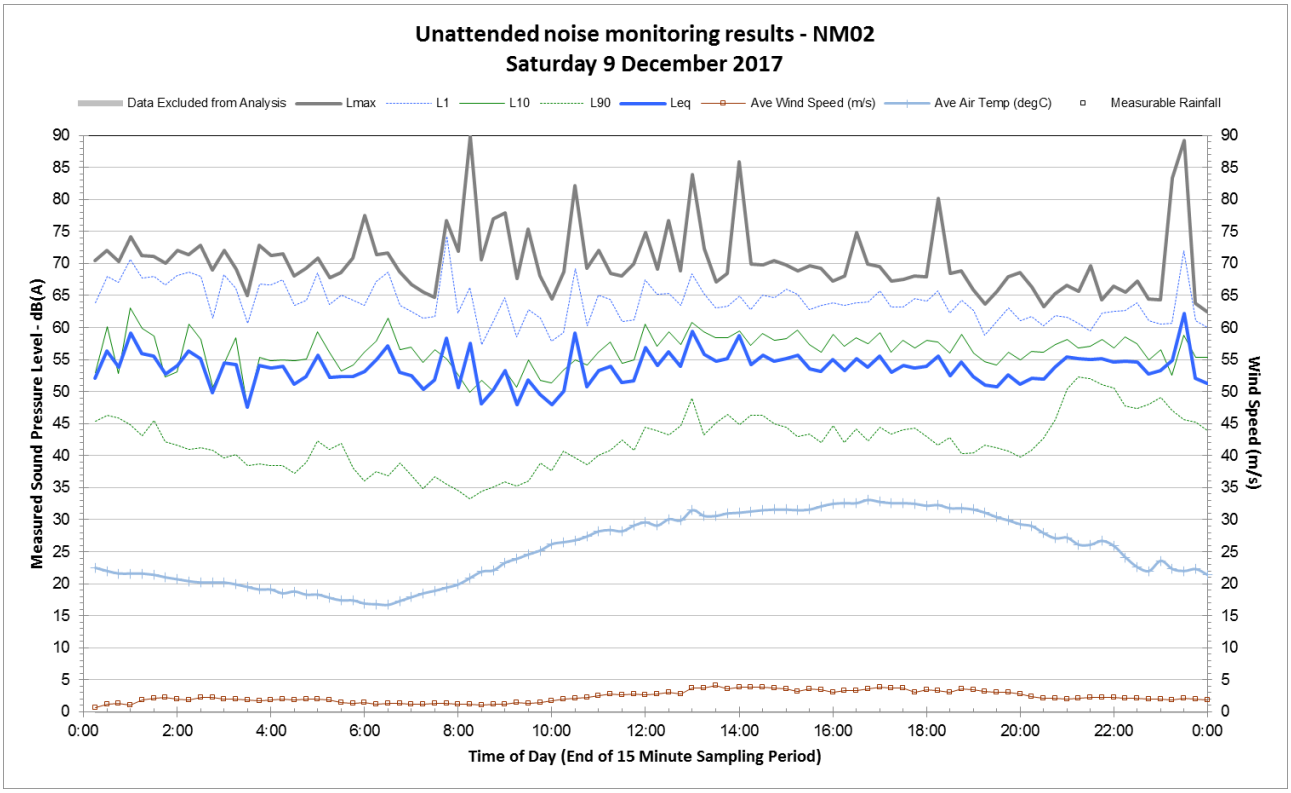
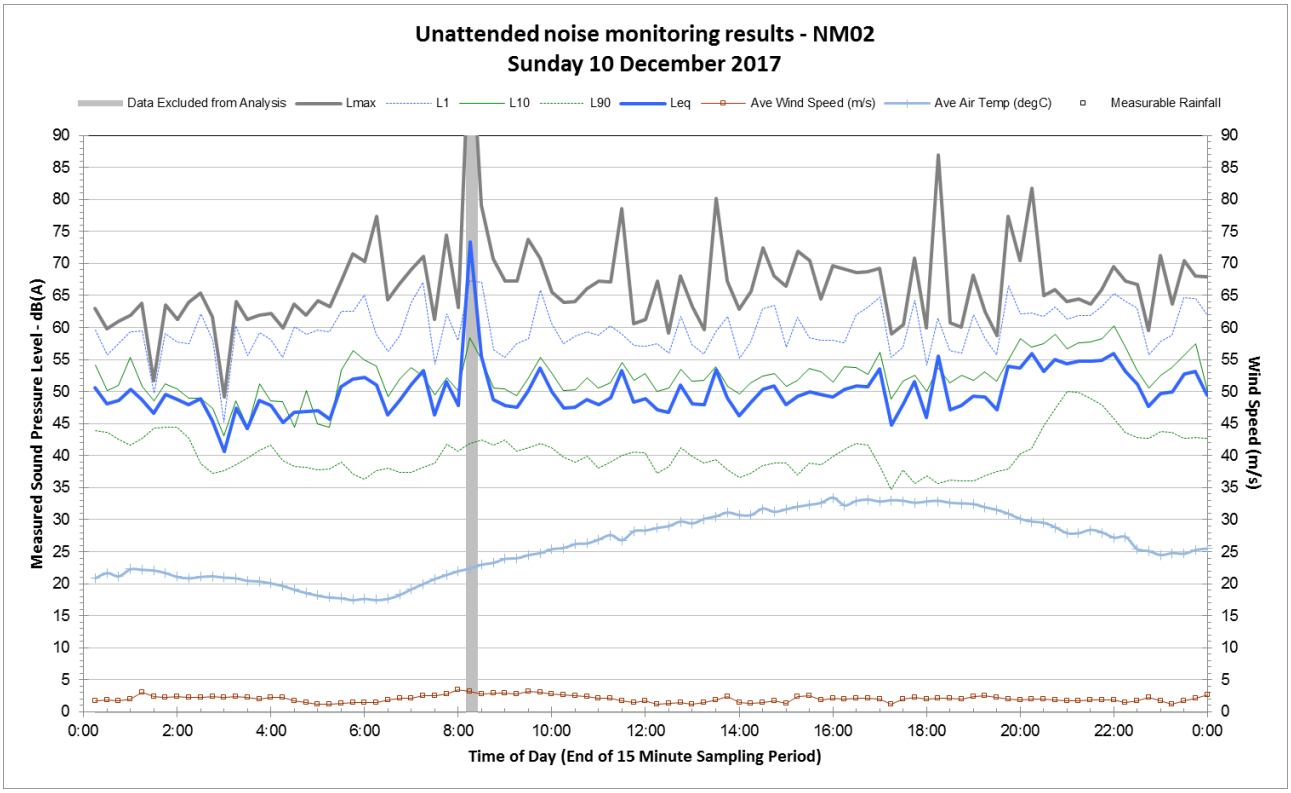
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Saturday 9 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)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Sunday 10 December 2017
Data Excluded from Analysis
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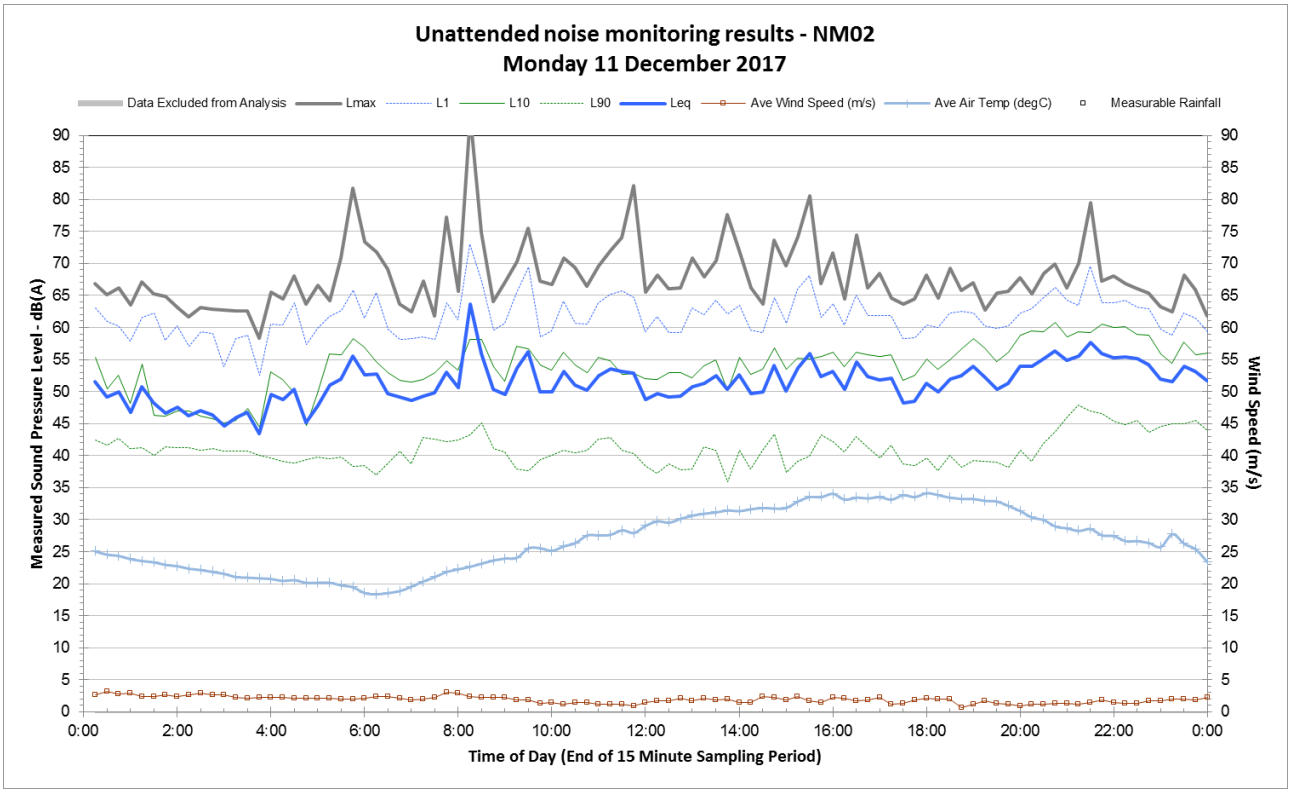
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Monday 11 December 2017
Data Excluded from Analysis
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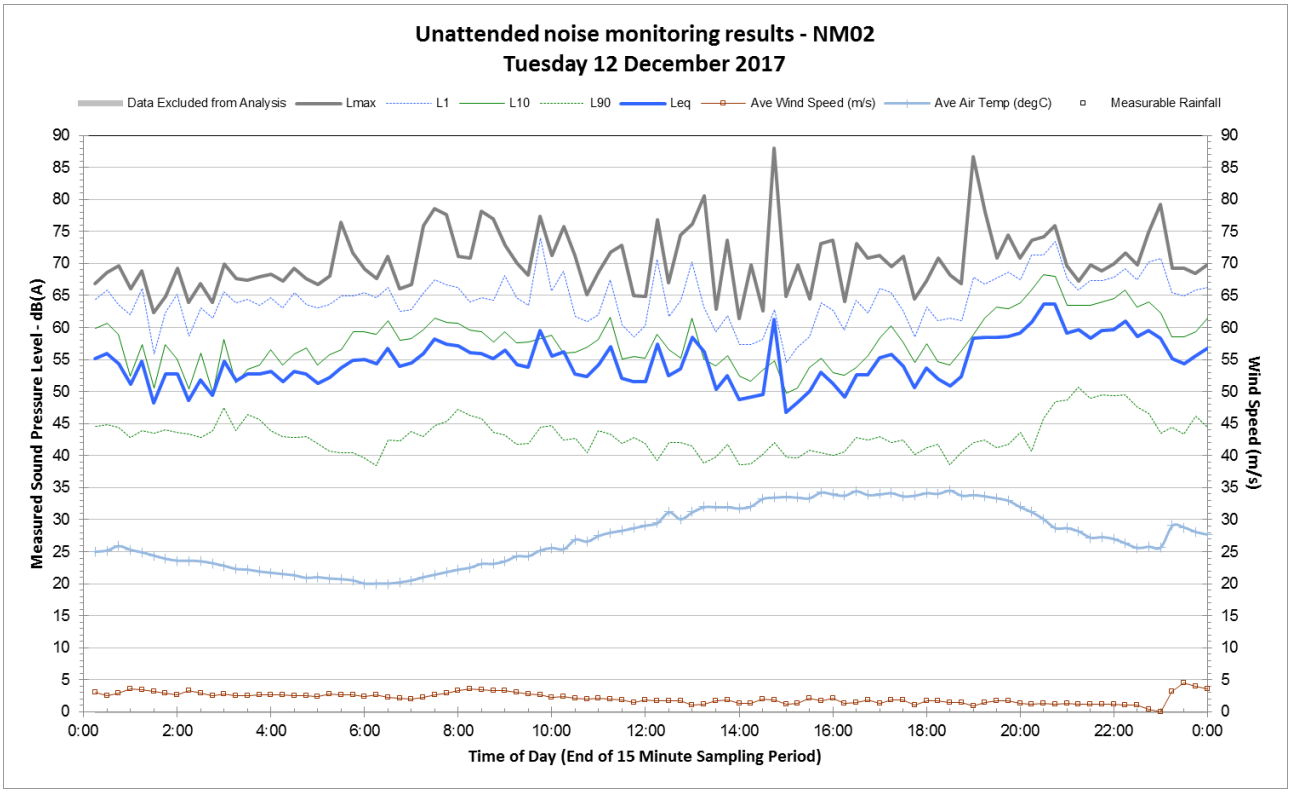
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
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Data Excluded from Analysis
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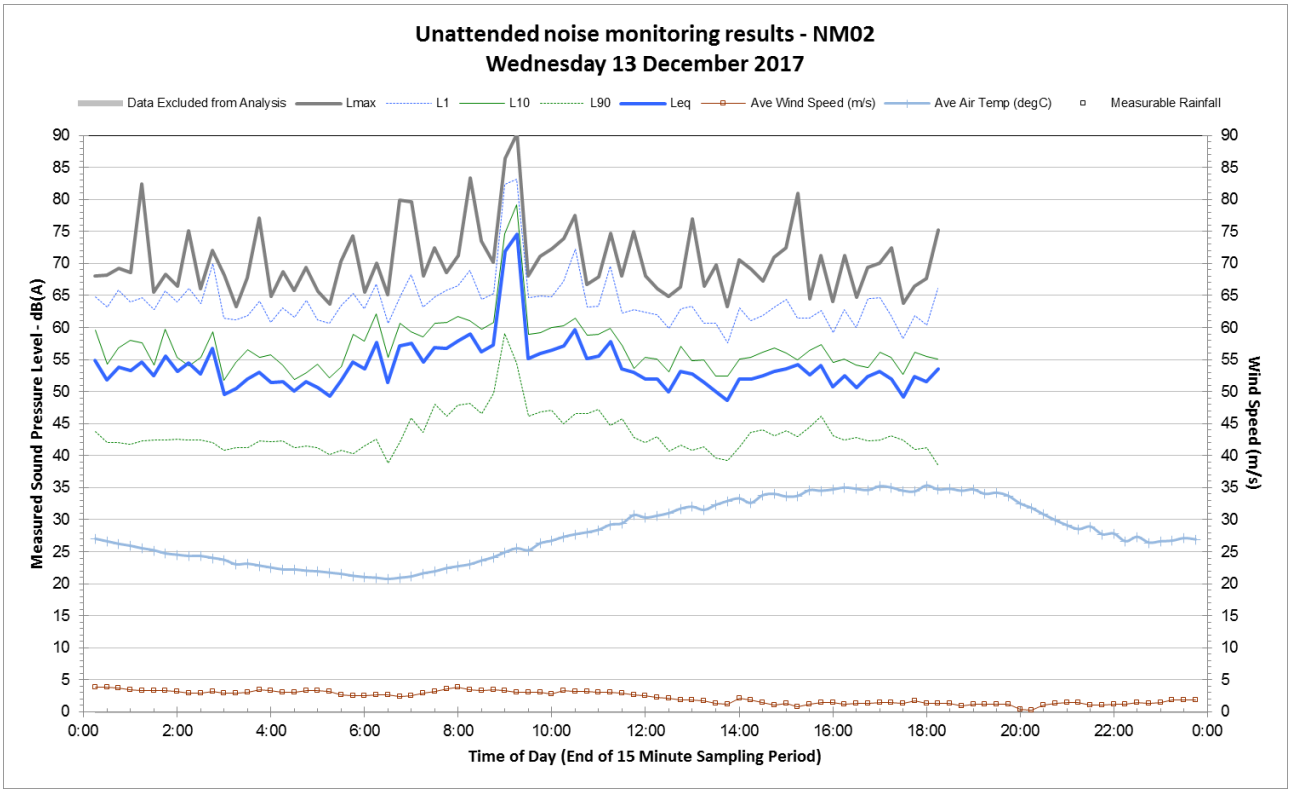
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM02
Wednesday 13 December 2017
Data Excluded from Analysis
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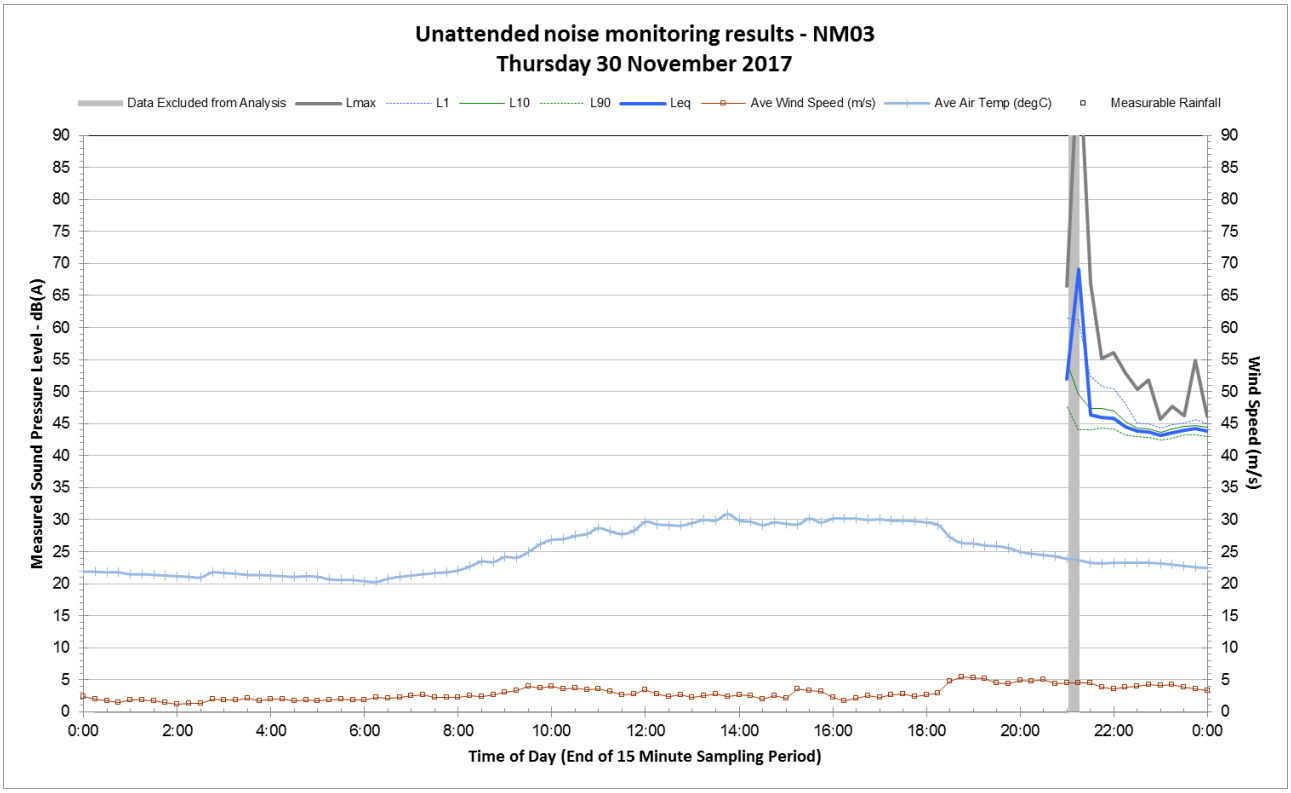
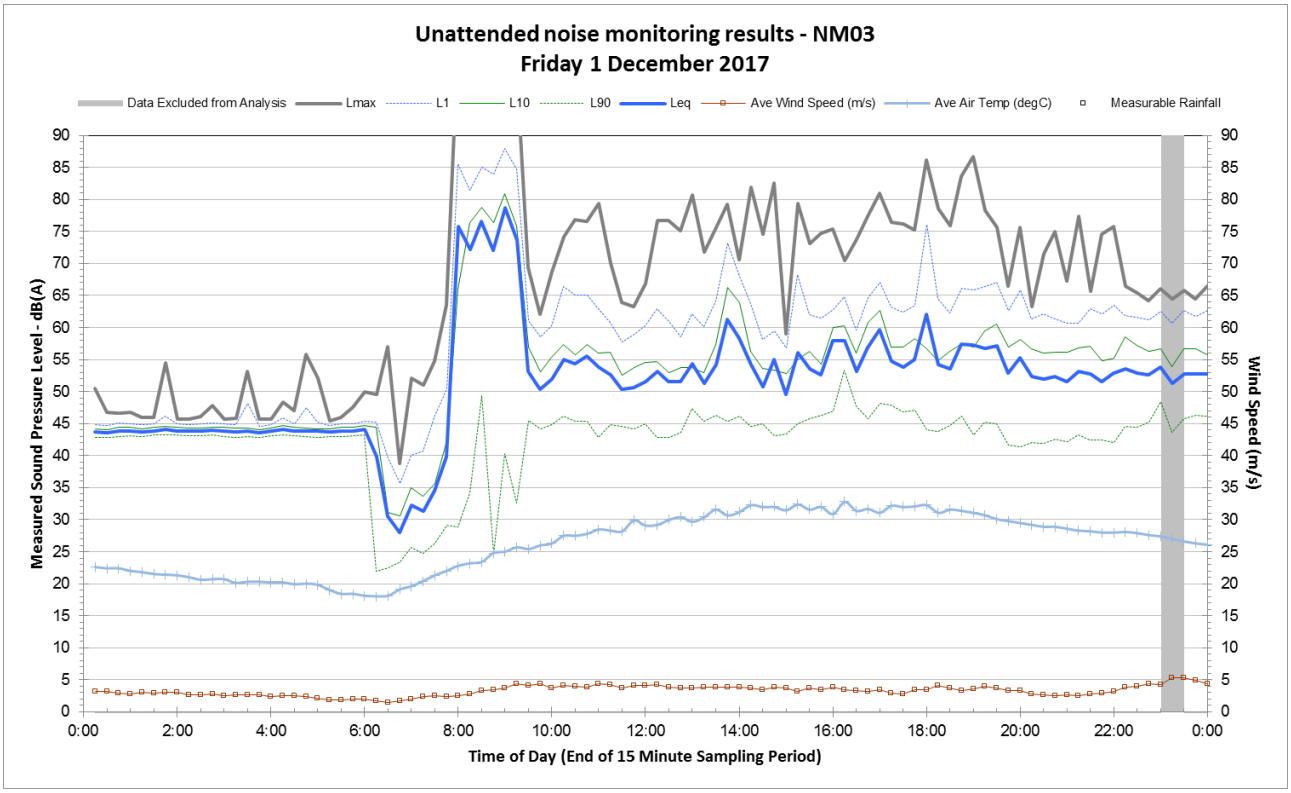
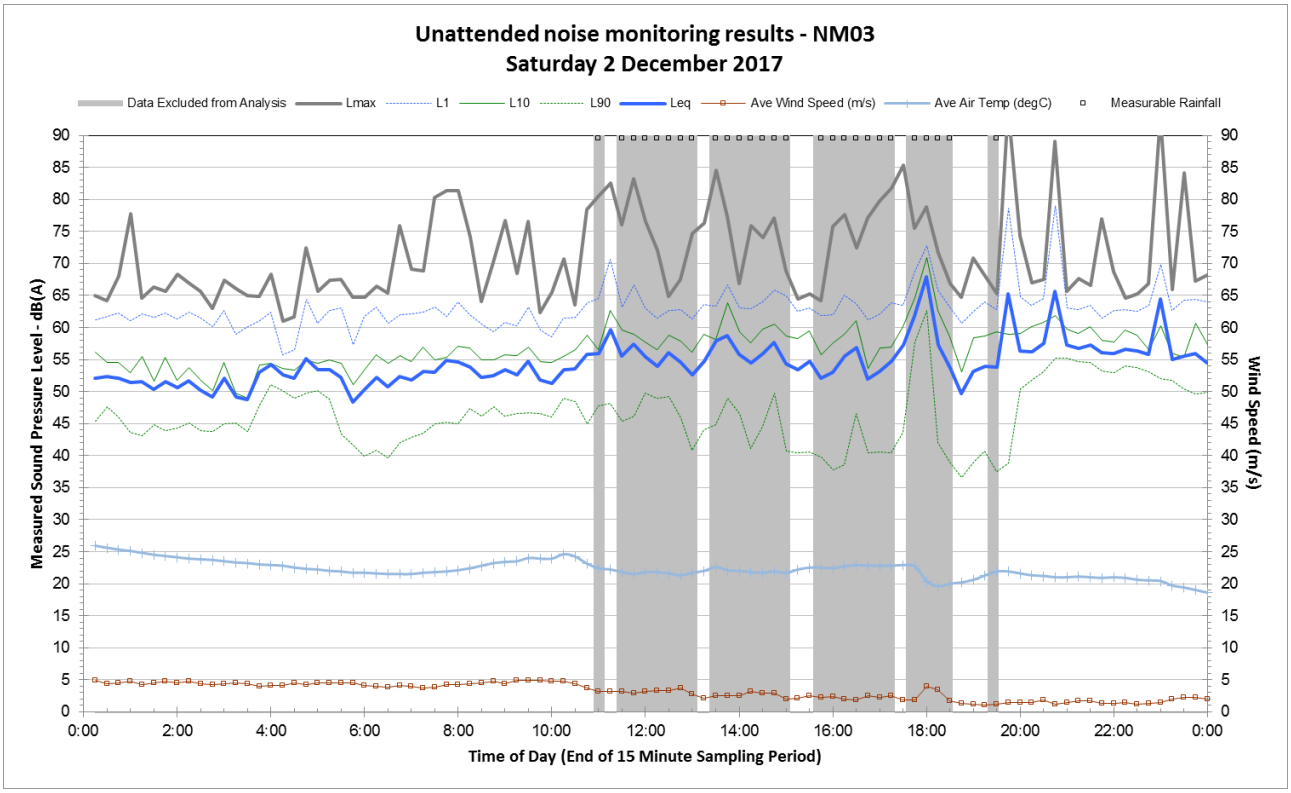
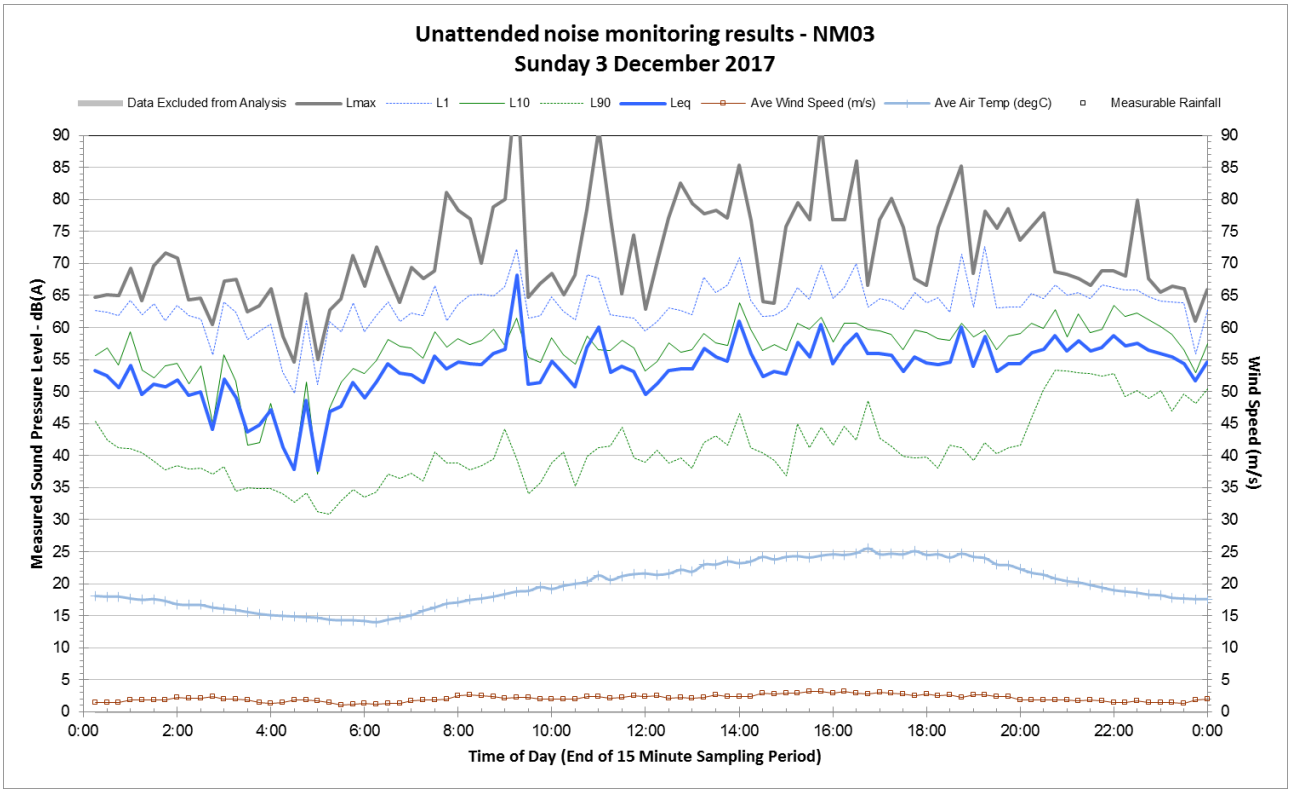
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

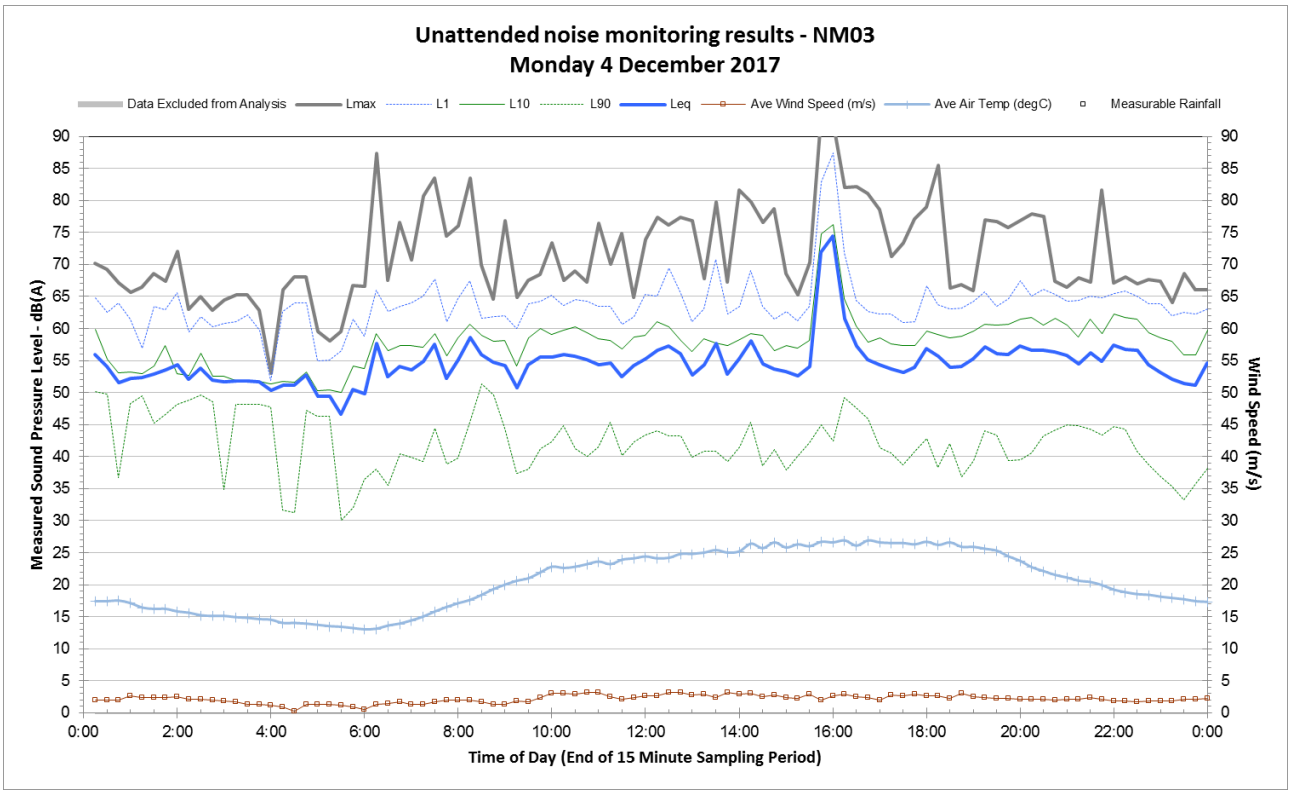
Noise monitoring location NM03

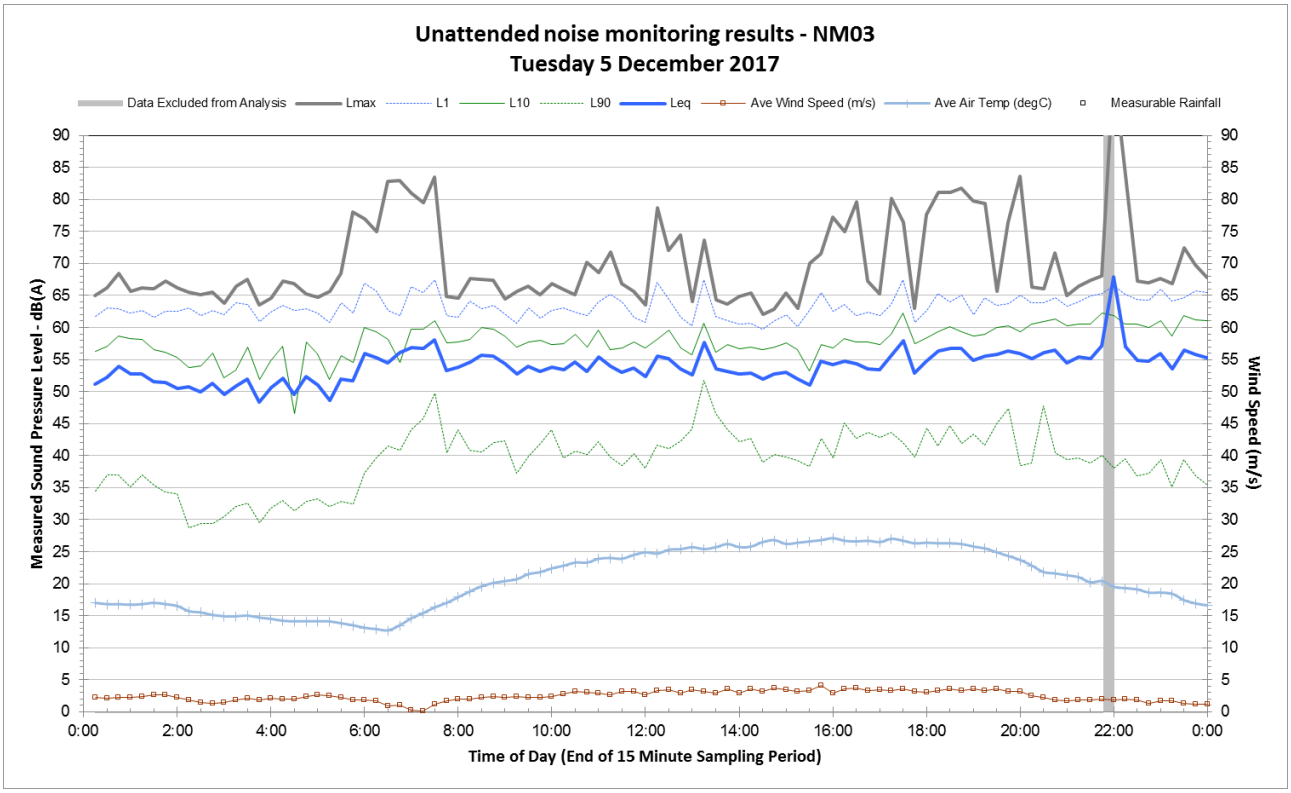


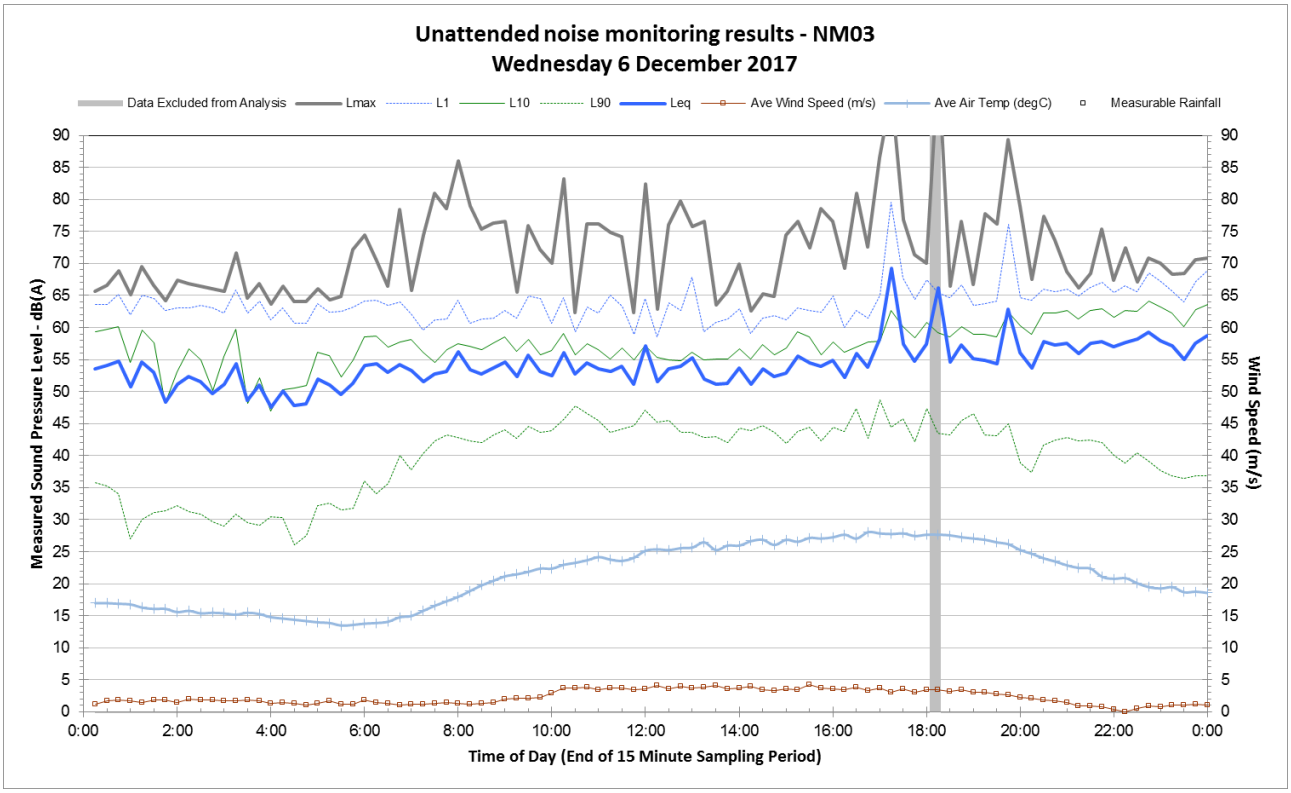


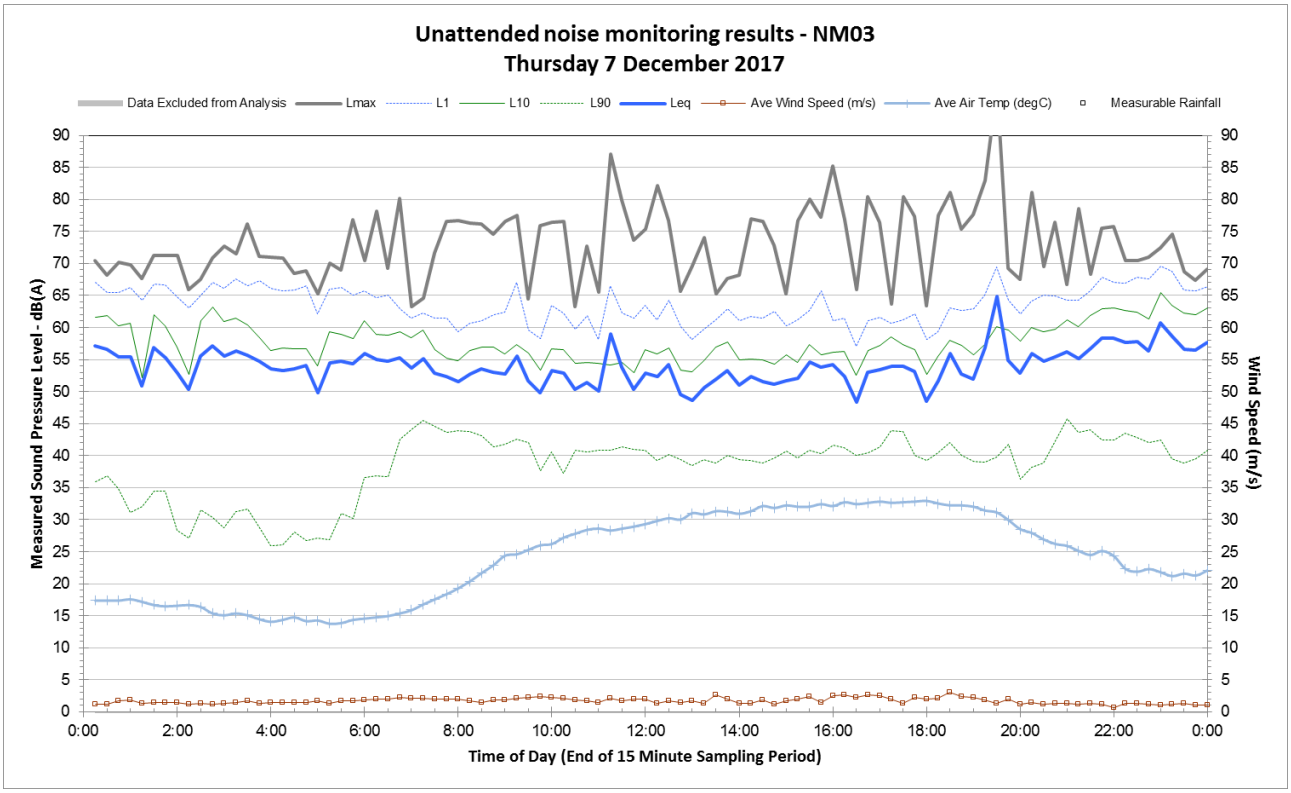

Unattended noise monitoring results - NM03
Saturday 2 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

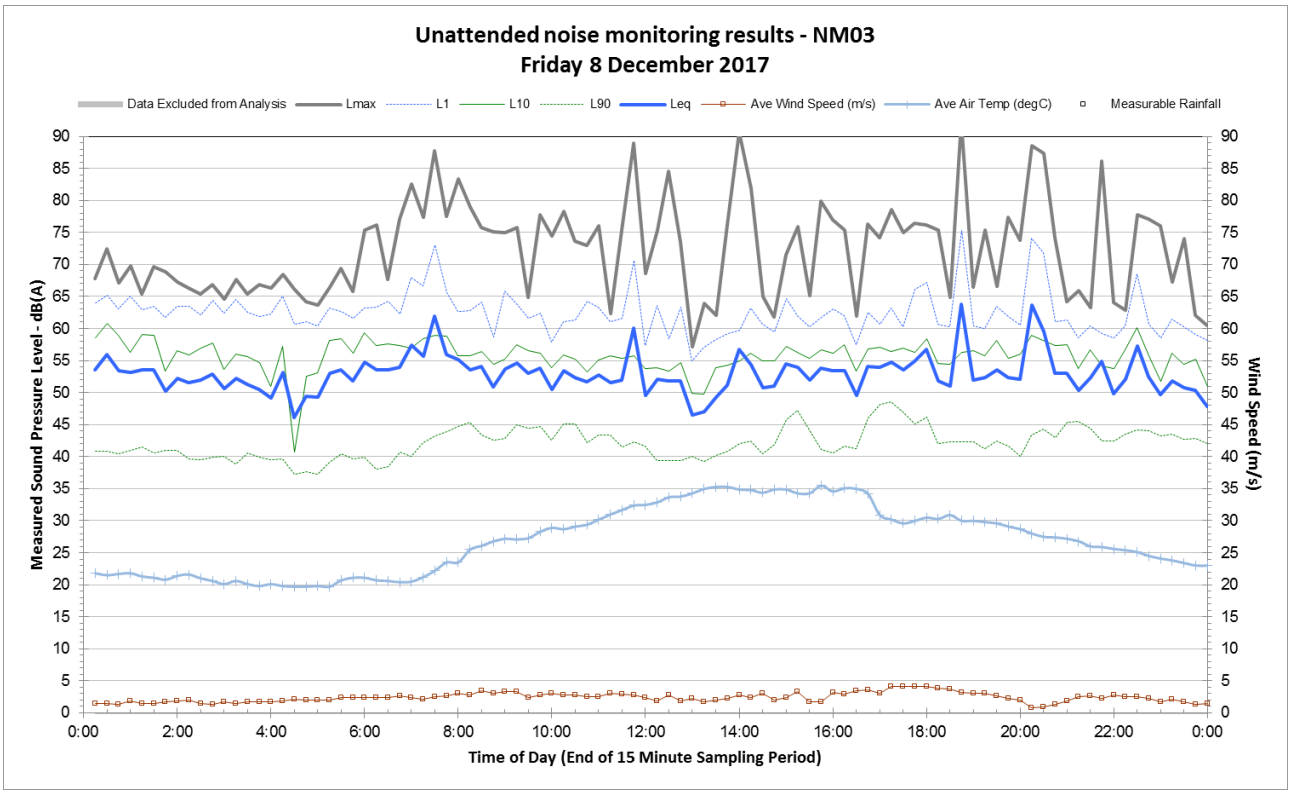

Unattended noise monitoring results - NM03
Sunday 3 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

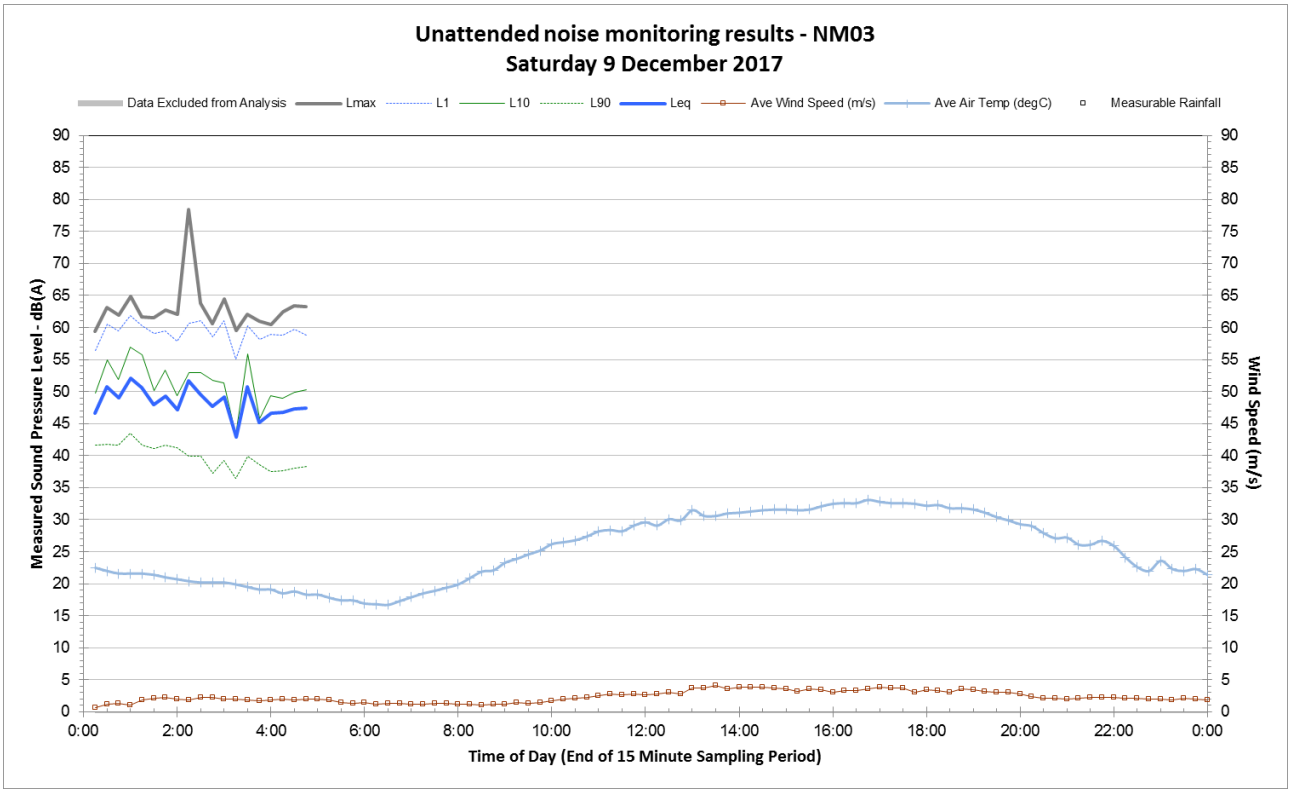

Unattended noise monitoring results - NM03
Monday 4 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM03
Tuesday 5 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

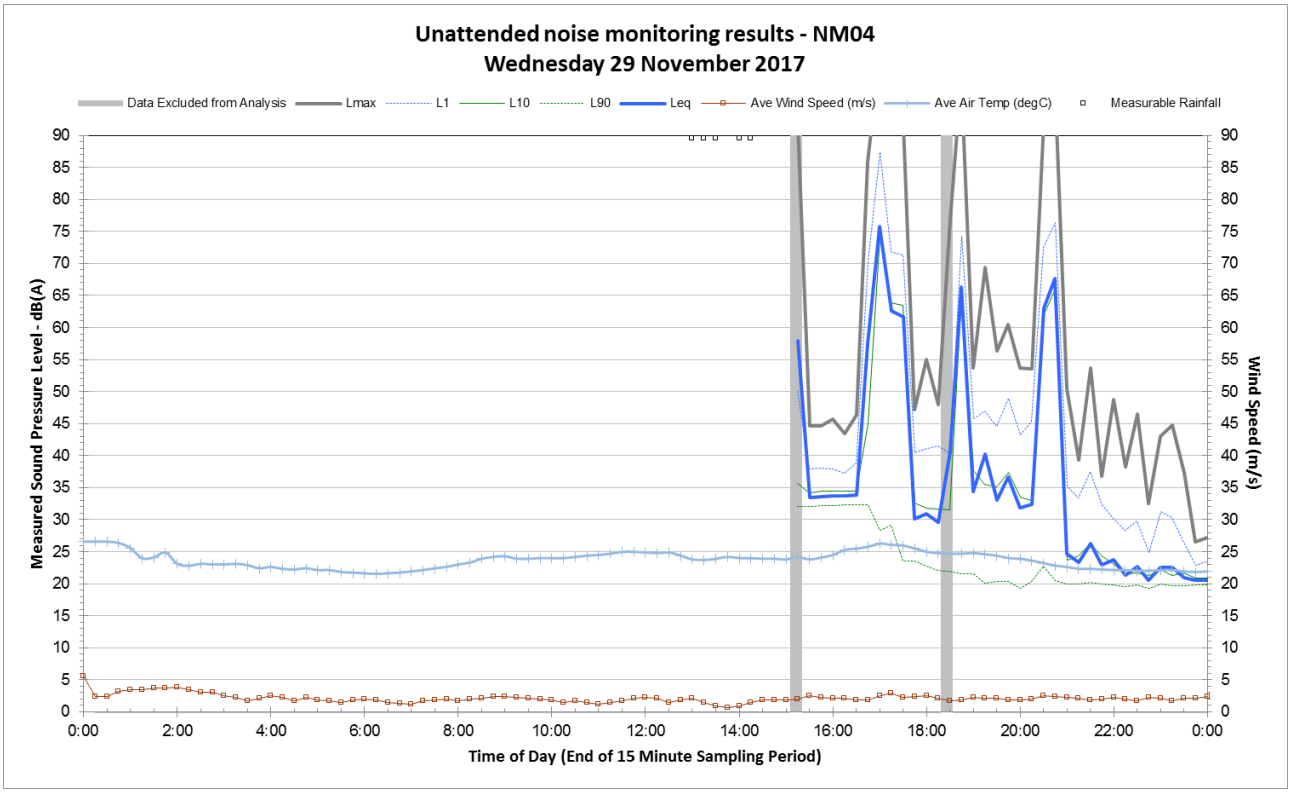

Unattended noise monitoring results - NM03
Wednesday 6 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

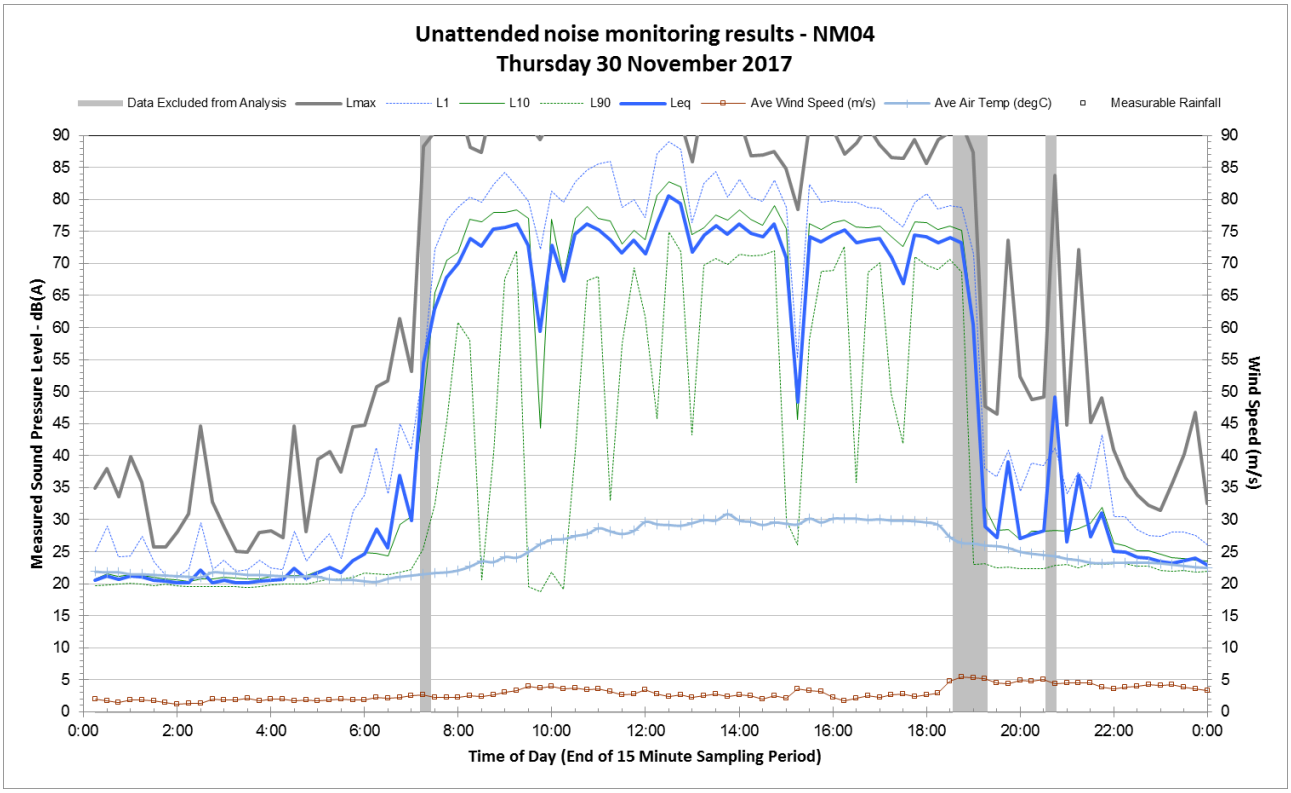

Unattended noise monitoring results - NM03
Thursday 7 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

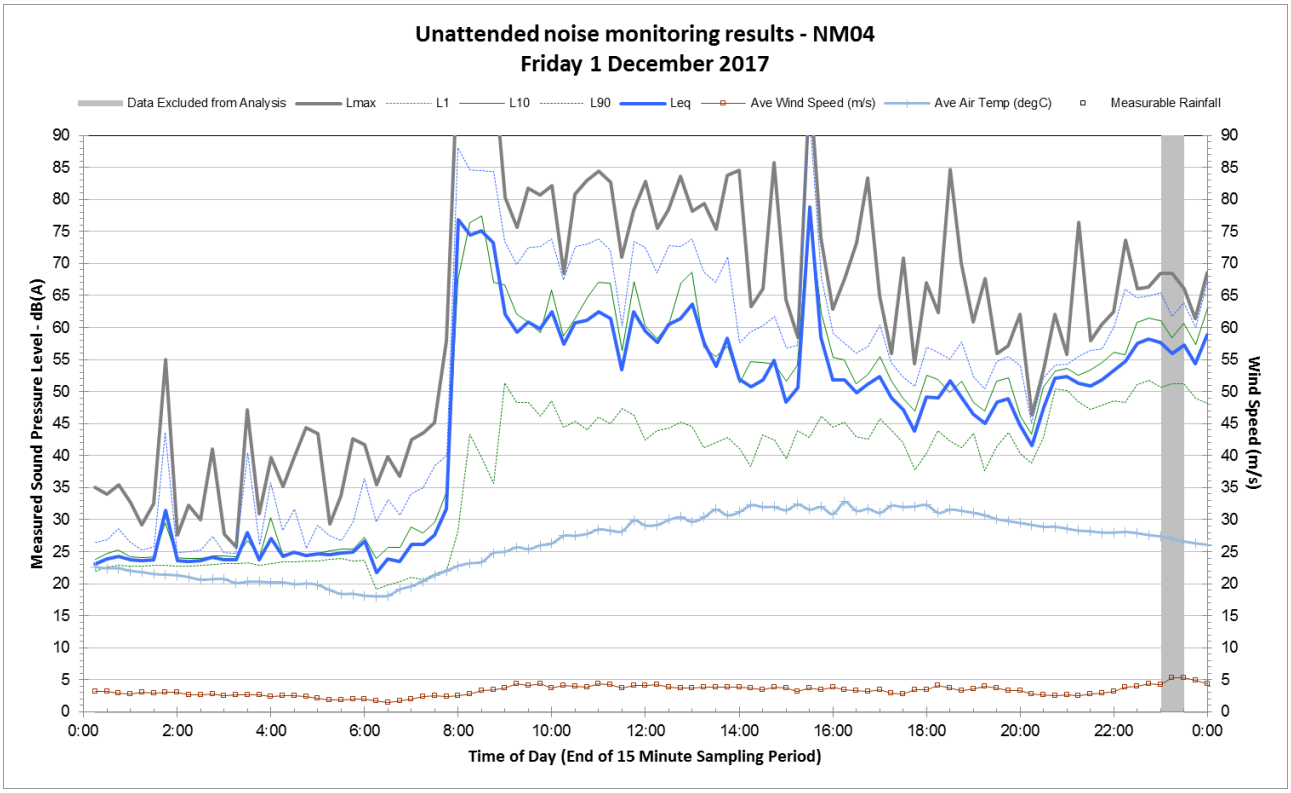

Unattended noise monitoring results - NM03
Friday 8 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

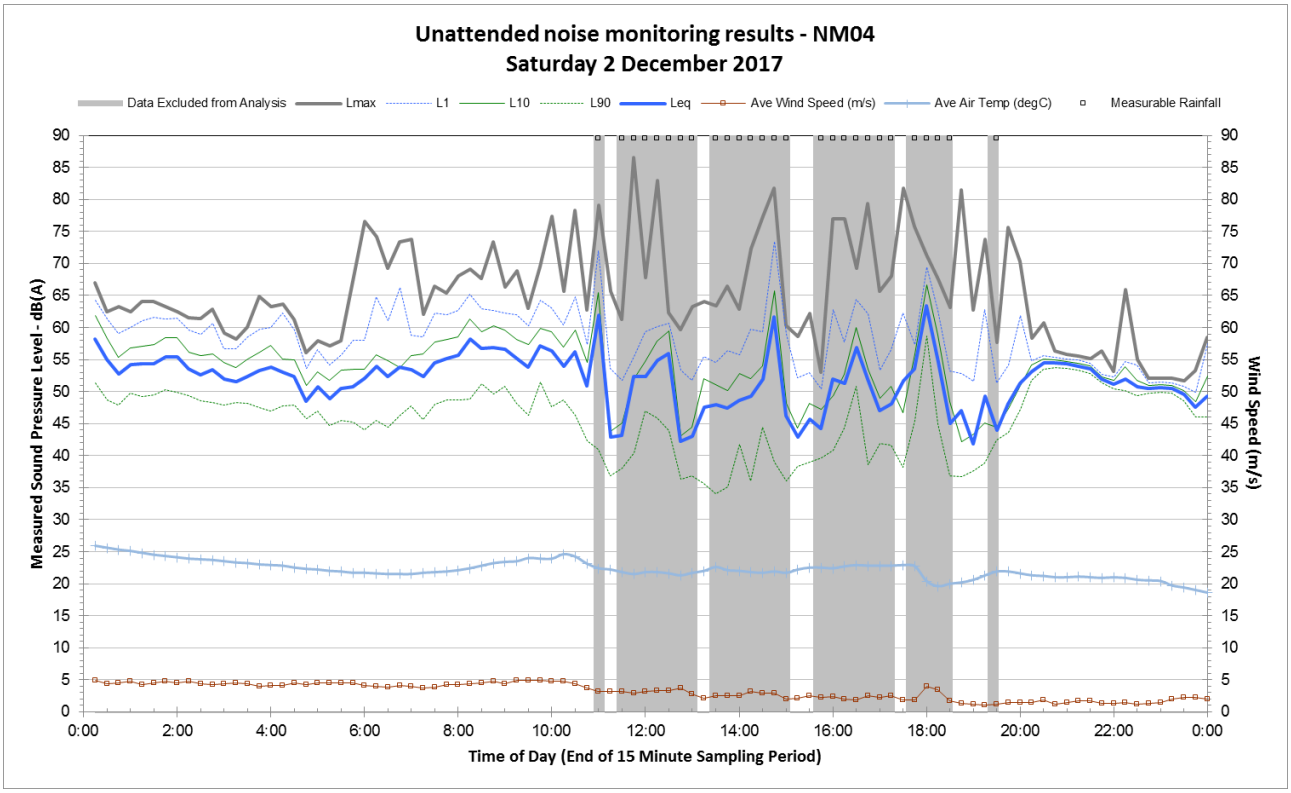

Unattended noise monitoring results - NM03
Saturday 9 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

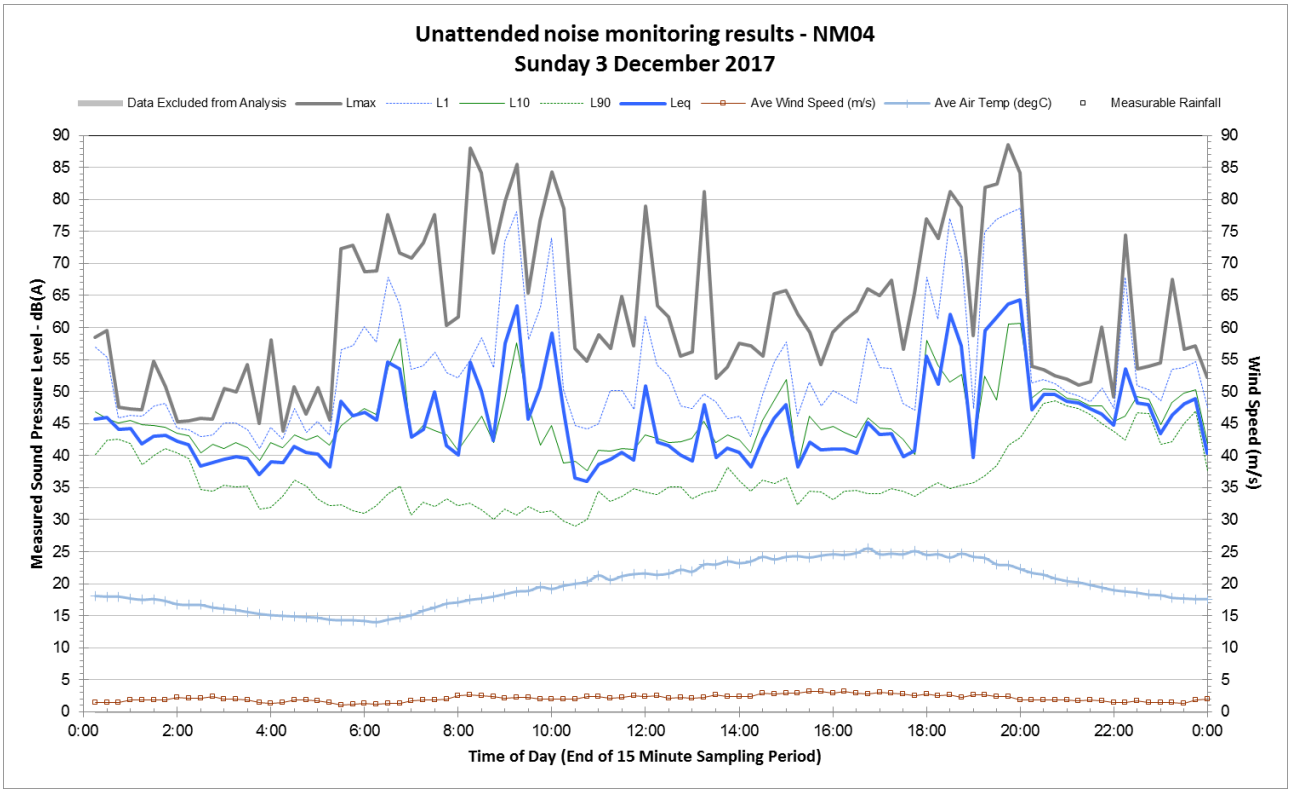
Noise monitoring location NM04

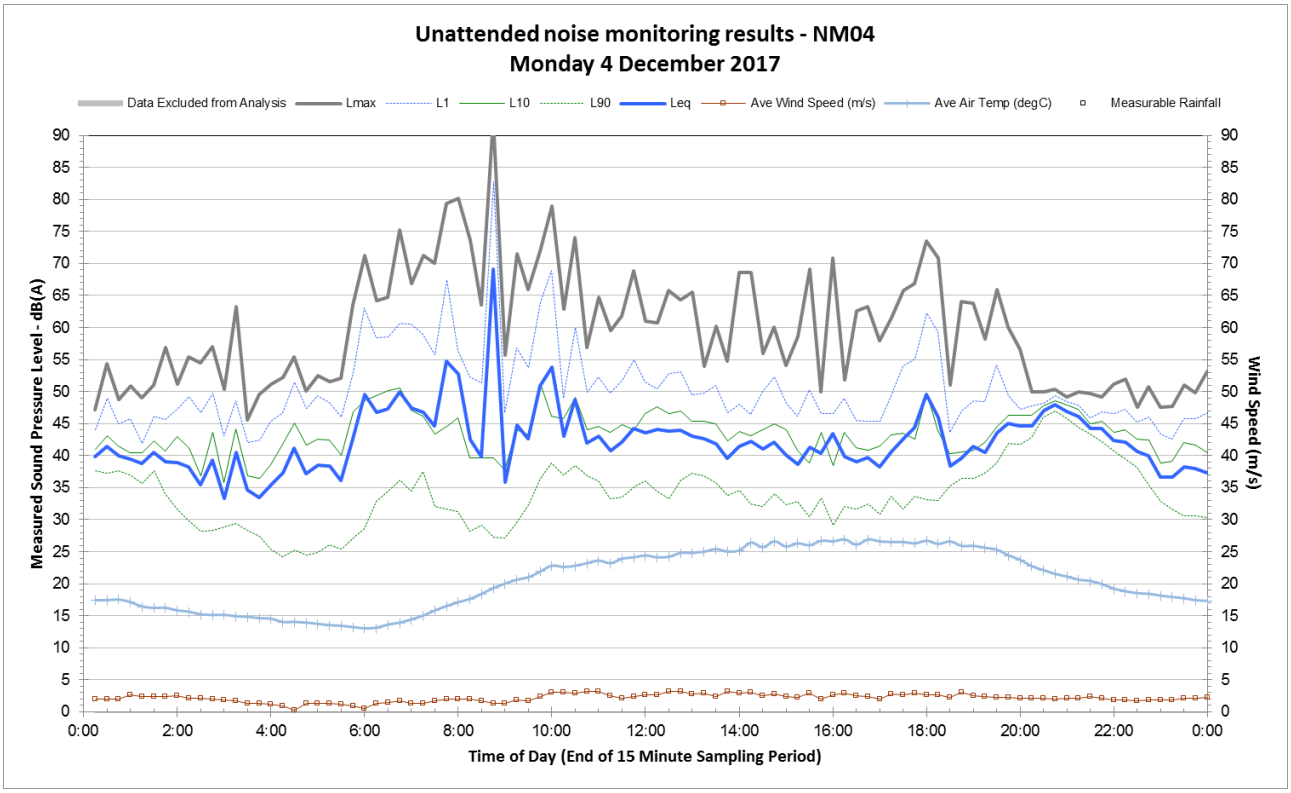


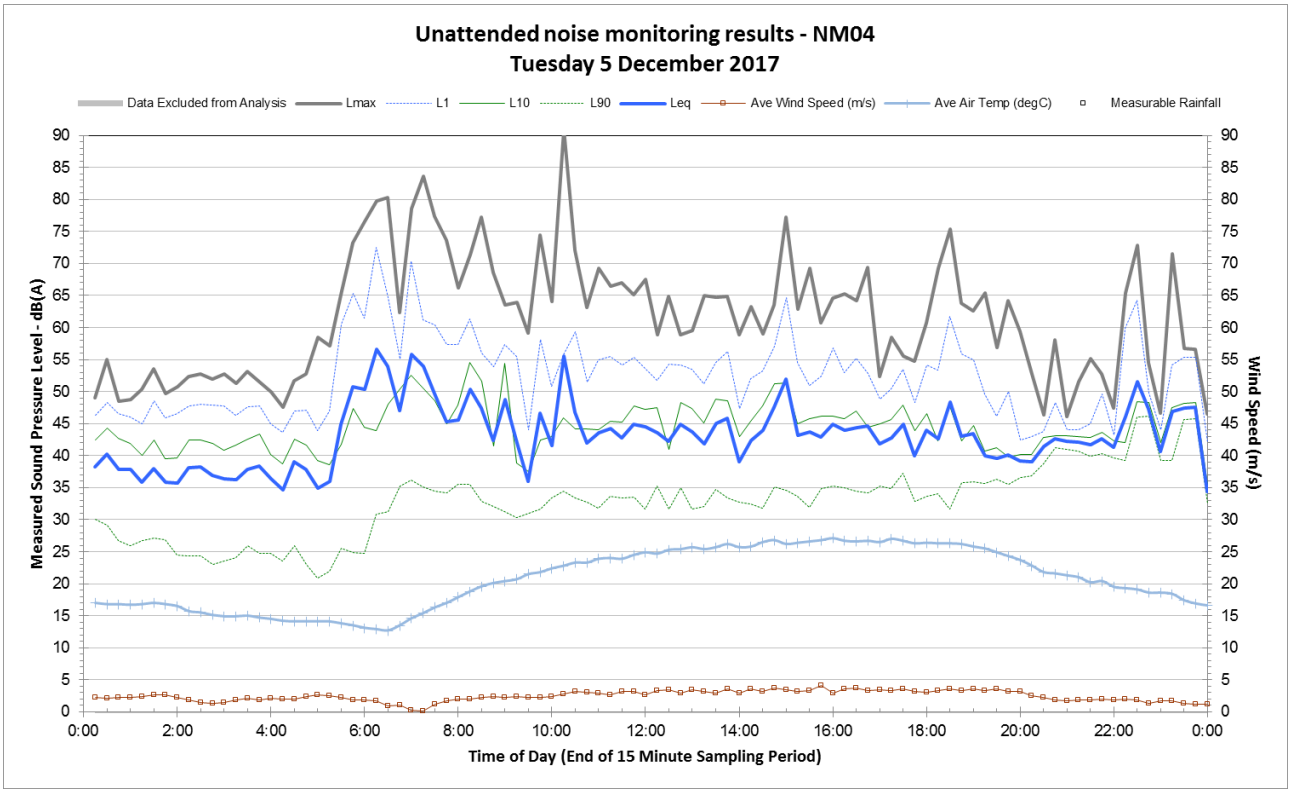


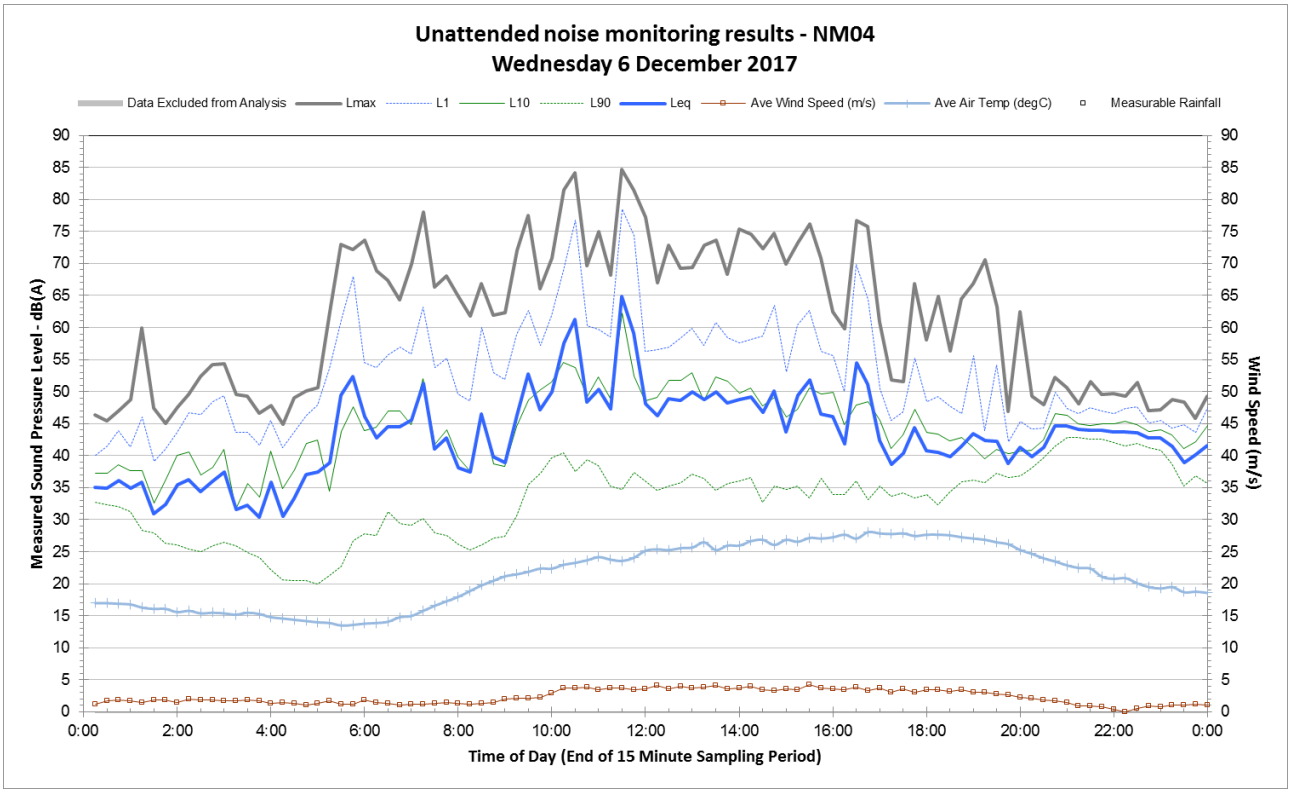

Unattended noise monitoring results - NM04
Friday 1 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

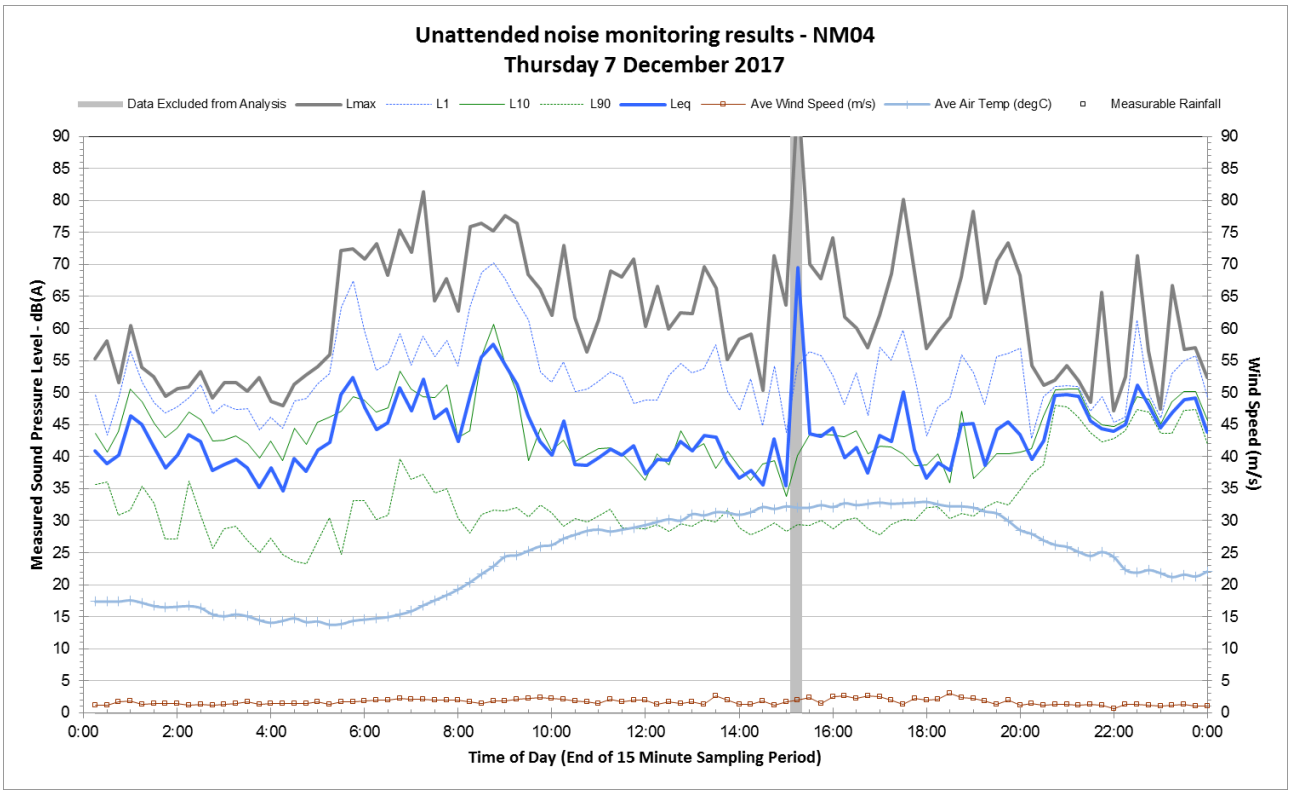

Unattended noise monitoring results - NM04
Saturday 2 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

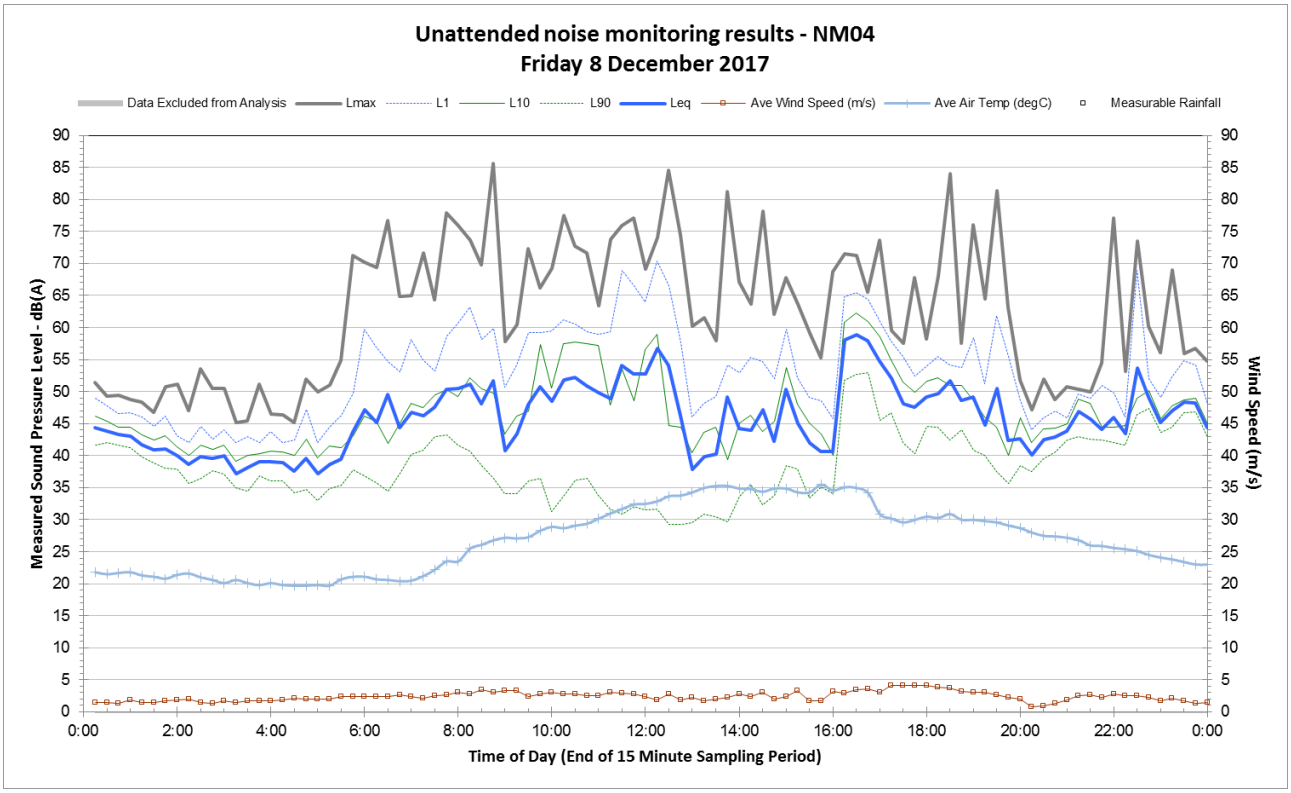

Unattended noise monitoring results - NM04
Sunday 3 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

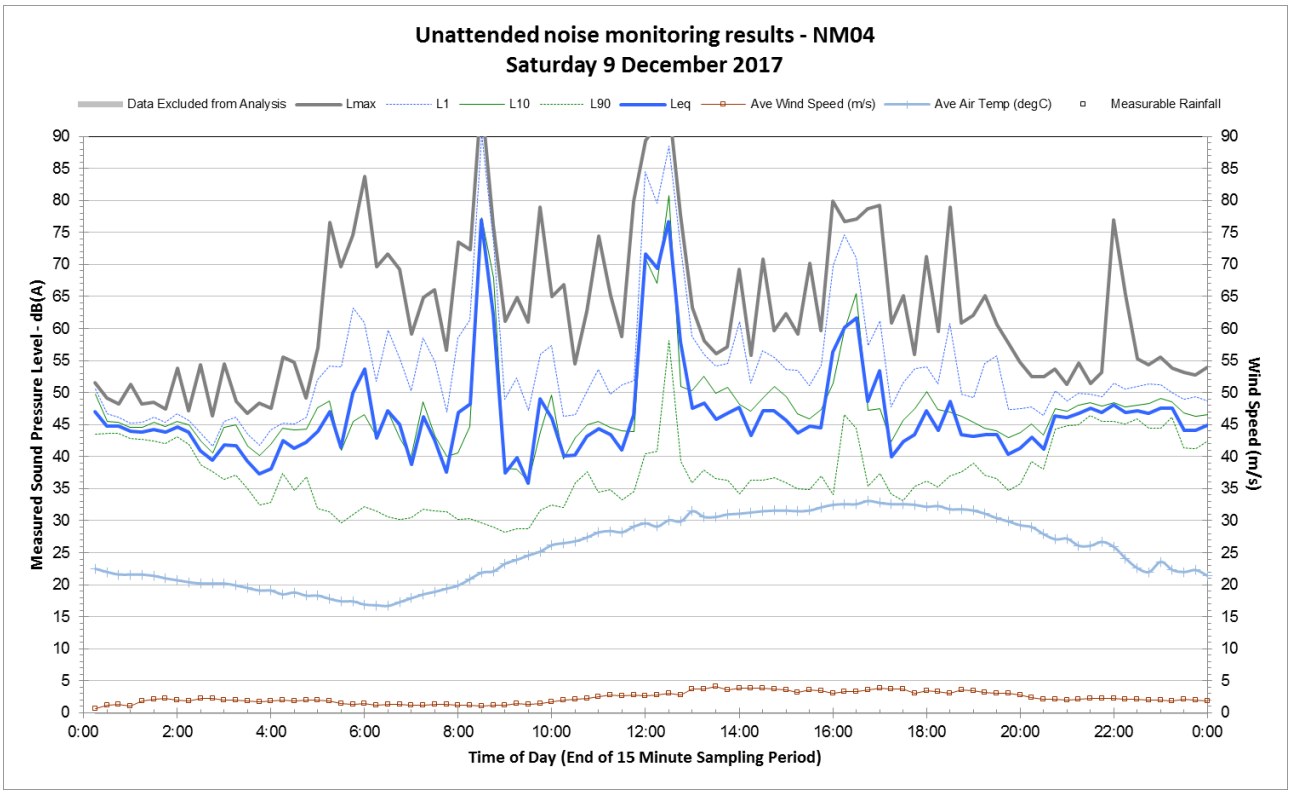

Unattended noise monitoring results - NM04
Monday 4 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

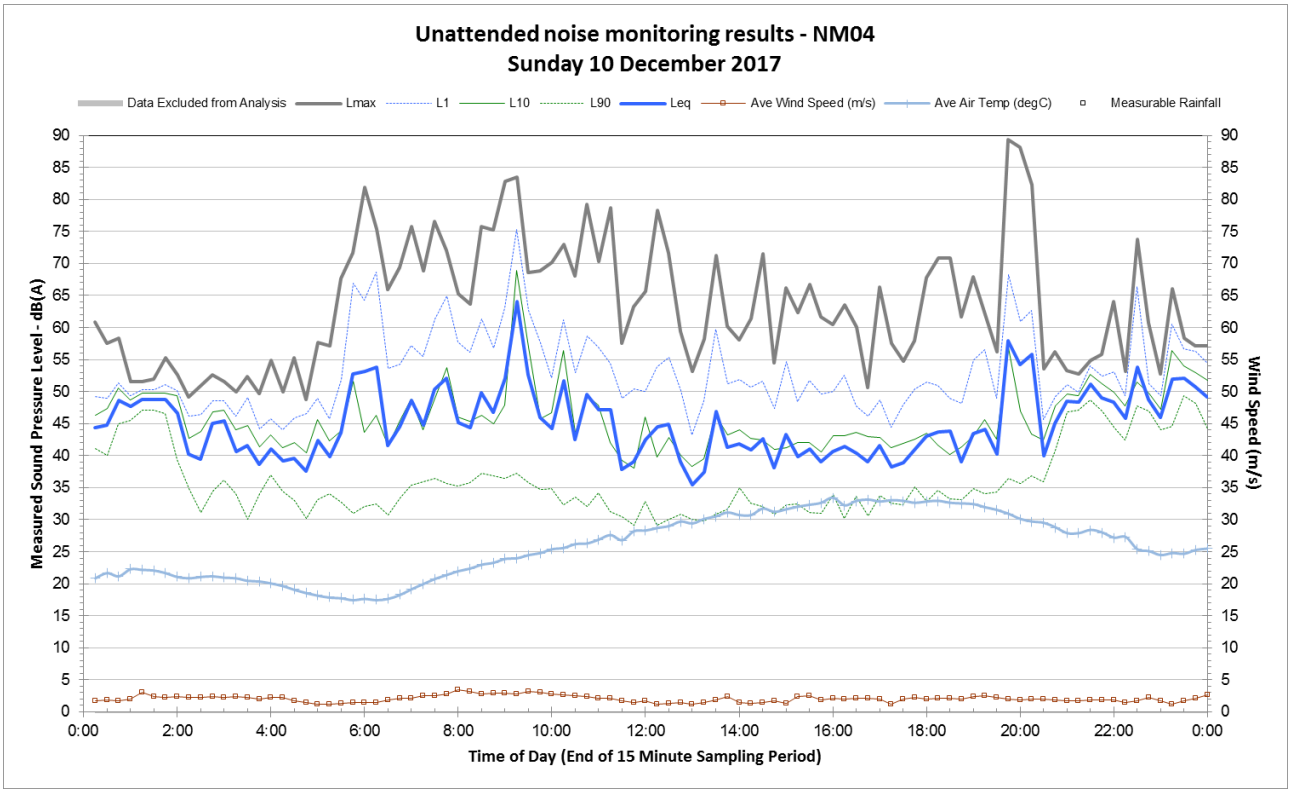

Unattended noise monitoring results - NM04
Tuesday 5 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

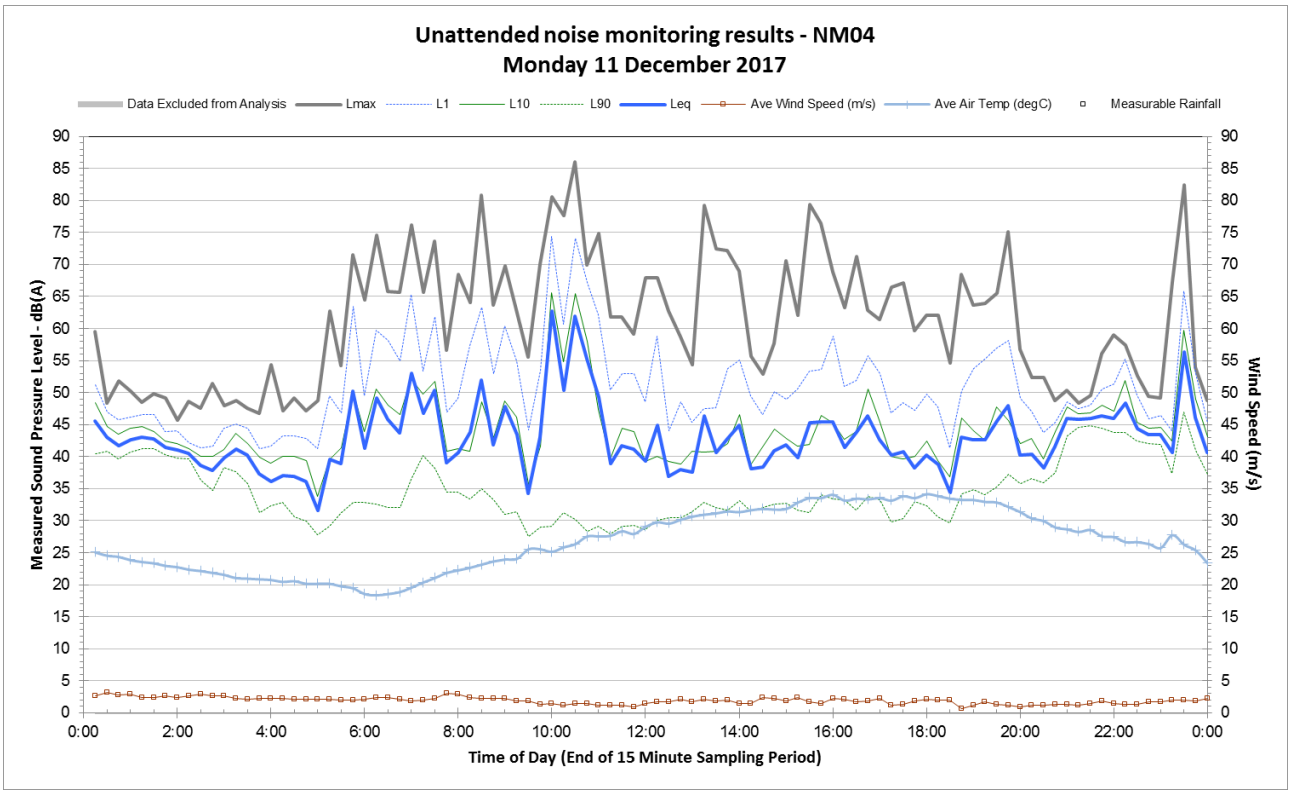

Unattended noise monitoring results - NM04
Wednesday 6 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

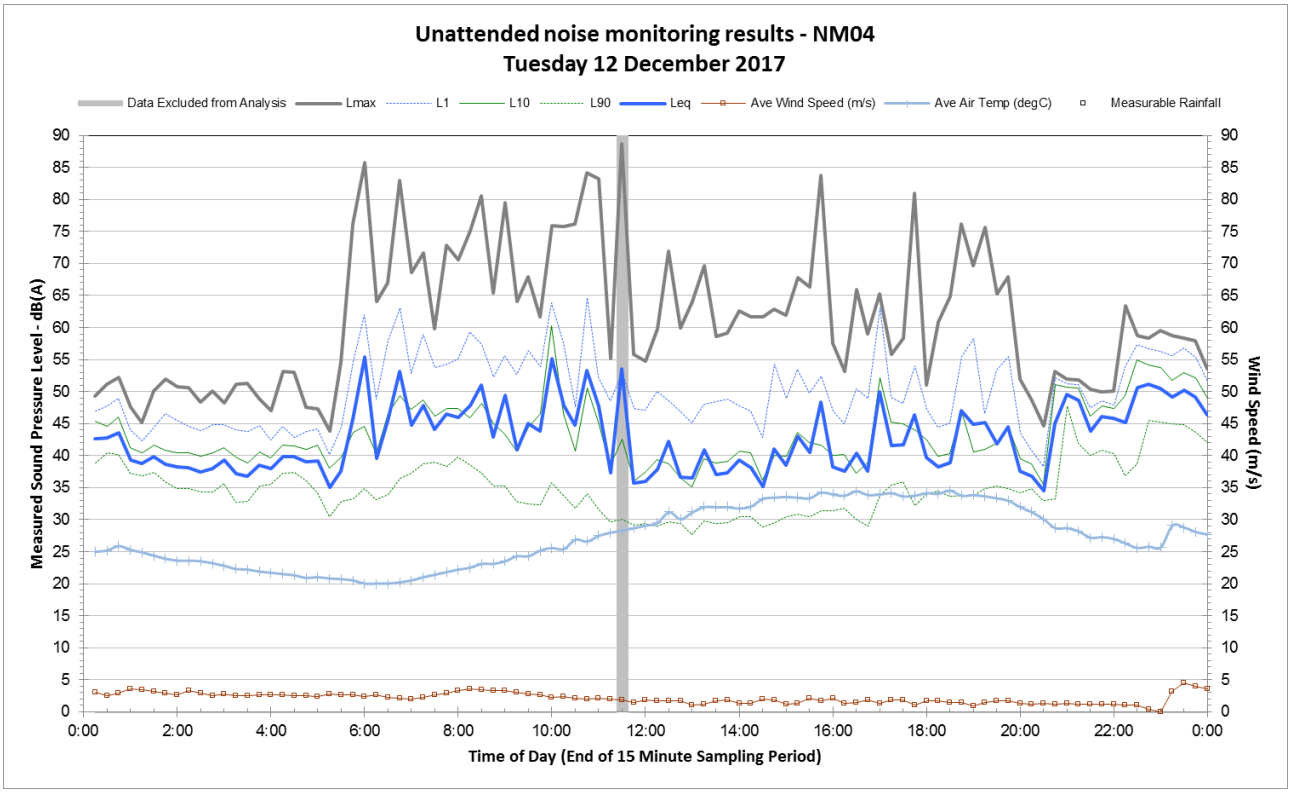

Unattended noise monitoring results - NM04
Thursday 7 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

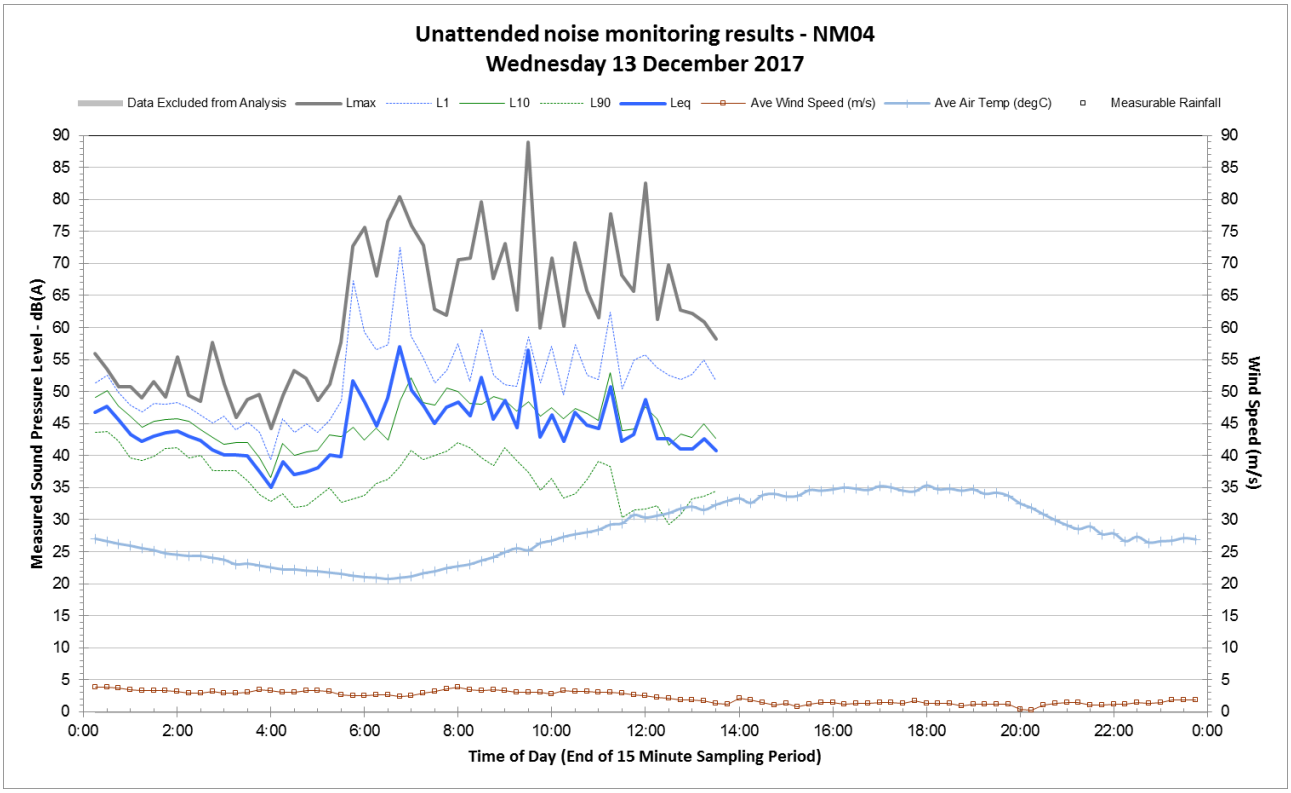

Unattended noise monitoring results - NM04
Friday 8 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM04
Saturday 9 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM04
Sunday 10 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM04
Monday 11 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM04
Tuesday 12 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)


Unattended noise monitoring results - NM04
Wednesday 13 December 2017
Data Excluded from Analysis
Lmax
L1
L10
L90
Leq
Ave Wind Speed (m/s)
Ave Air Temp (degC)
Measurable Rainfall
Measured Sound Pressure Level - dB(A)
Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00

Appendix E. Detailed results – Construction noise

Legend

Receiver type:	NMLs:	Construction Assessment scenarios:
• 'R' = Residential • 'C' = Commercial • 'I' = Industrial • 'RC' = Recreational • 'ED' = Educational • 'CH' = Place of worship • 'CM' = Community	• 'SH' = Standard hours • 'OSH - D' = Outside standard hours, day • 'OSH - E' = Outside standard hours, evening • 'OSH - N' = Outside standard hours, night	• 'C01' = Site establishment • 'C02' = Utility adjustments • 'C03' = Corridor clearing • 'C04' = Bulk earthworks • 'C05' = Drainage infrastructure • 'C06' = Paving / asphalting • 'C07' = Re-surfacing works • 'C08' = Road furniture installation

Key	<10 dB(A) above day time NMLs	10 to 20 dB(A) above day time NMLs	>20 dB(A) above day time NMLs

N2M01

Table E1 Detailed construction noise results – receivers along N2M01

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R001	R	40	40	40	36	55	40	41	46	48	40	43	43	35
R002	R	40	40	40	36	55	25	26	31	33	25	28	28	20
R003	R	40	40	40	36	55	44	45	50	52	44	47	47	39
R004	R	40	40	40	36	55	39	40	45	47	39	42	42	34
R005	R	40	40	40	36	55	37	38	43	45	37	40	40	32
R006	R	40	40	40	36	55	41	42	47	49	41	44	44	36
R007	R	40	40	40	36	55	36	37	42	44	36	39	39	31
R008	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R009	R	40	40	40	36	55	23	24	29	31	23	26	26	18
CIR001	C	70				-	55	56	61	55	56	61	63	55

N2M02

Table E2 Detailed construction noise results – receivers along N2M02

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R010	R	40	40	40	36	55	26	27	32	34	26	29	29	21
R011	R	40	40	40	36	55	27	28	33	35	27	30	30	22
R012	R	40	40	40	36	55	29	30	35	37	29	32	32	24
R013	R	40	40	40	36	55	40	41	46	48	40	43	43	35
R014	R	40	40	40	36	55	38	39	44	46	38	41	41	33
R015	R	40	40	40	36	55	45	46	51	53	45	48	48	40
R016	R	40	40	40	36	55	34	35	40	42	34	37	37	29

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R017	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R018	R	49	45	45	42	55	67	68	73	75	67	70	70	62
R019	R	49	45	45	42	55	67	68	73	75	67	70	70	62
R020	R	49	45	45	42	55	50	51	56	58	50	53	53	45
R021	R	49	45	45	42	55	58	59	64	66	58	61	61	53
R022	R	49	45	45	42	55	50	51	56	58	50	53	53	45
R023	R	49	45	45	42	55	60	61	66	68	60	63	63	55
R024	R	49	45	45	42	55	49	50	55	57	49	52	52	44
R025	R	40	40	40	36	55	29	30	35	37	29	32	32	24
R026	R	40	40	40	36	55	39	40	45	47	39	42	42	34
CIR002	I	75				-	55	56	61	63	55	58	58	50
CIR003	C	70				-	68	69	74	76	68	71	71	63

N2M03

Table E3 Detailed construction noise results – receivers along N2M03

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R027	R	40	40	40	36	55	29	30	35	37	29	32	32	24
R028	R	49	45	45	42	55	71	72	77	79	71	74	74	66
R029	R	49	45	45	42	55	52	53	58	60	52	55	55	47
R030	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R031	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R032	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R033	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R034	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R035	R	49	45	45	42	55	43	44	49	51	43	46	46	38
R036	R	49	45	45	42	55	44	45	50	52	44	47	47	39
R037	R	49	45	45	42	55	40	41	46	48	40	43	43	35
R038	R	49	45	45	42	55	43	44	49	51	43	46	46	38
R039	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R040	R	49	45	45	42	55	63	64	69	71	63	66	66	58
R041	R	49	45	45	42	55	72	73	78	80	72	75	75	67
R042	R	49	45	45	42	55	53	54	59	61	53	56	56	48
R043	R	49	45	45	42	55	56	57	62	64	56	59	59	51
R044	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R045	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R046	R	49	45	45	42	55	44	45	50	52	44	47	47	39
R047	R	49	45	45	42	55	42	43	48	50	42	45	45	37
R048	R	49	45	45	42	55	43	44	49	51	43	46	46	38
R049	R	49	45	45	42	55	43	44	49	51	43	46	46	38
R050	R	49	45	45	42	55	40	41	46	48	40	43	43	35
R051	R	49	45	45	42	55	40	41	46	48	40	43	43	35
R052	R	49	45	45	42	55	38	39	44	46	38	41	41	33
R053	R	49	45	45	42	55	42	43	48	50	42	45	45	37
R054	R	49	45	45	42	55	42	43	48	50	42	45	45	37

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R055	R	49	45	45	42	55	54	55	60	62	54	57	57	49
R056	R	49	45	45	42	55	55	56	61	63	55	58	58	50
R057	R	49	45	45	42	55	71	72	77	79	71	74	74	66
R058	R	49	45	45	42	55	52	53	58	60	52	55	55	47
R059	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R060	R	49	45	45	42	55	44	45	50	52	44	47	47	39
R061	R	49	45	45	42	55	44	45	50	52	44	47	47	39
R062	R	49	45	45	42	55	42	43	48	50	42	45	45	37
R063	R	49	45	45	42	55	42	43	48	50	42	45	45	37
R064	R	49	45	45	42	55	38	39	44	46	38	41	41	33
R065	R	49	45	45	42	55	41	42	47	49	41	44	44	36
R066	R	49	45	45	42	55	42	43	48	50	42	45	45	37
R067	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R068	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R069	R	49	45	45	42	55	49	50	55	57	49	52	52	44
R070	R	49	45	45	42	55	55	56	61	63	55	58	58	50
R071	R	49	45	45	42	55	55	56	61	63	55	58	58	50
R072	R	49	45	45	42	55	62	63	68	70	62	65	65	57
R073	R	49	45	45	42	55	65	66	71	73	65	68	68	60
R074	R	49	45	45	42	55	68	69	74	76	68	71	71	63
R075	R	49	45	45	42	55	66	67	72	74	66	69	69	61
R076	R	49	45	45	42	55	71	72	77	79	71	74	74	66
R077	R	49	45	45	42	55	55	56	61	63	55	58	58	50
R078	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R079	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R080	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R081	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R082	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R083	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R084	R	49	45	45	42	55	42	43	48	50	42	45	45	37
R085	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R086	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R087	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R088	R	49	45	45	42	55	52	53	58	60	52	55	55	47
R089	R	49	45	45	42	55	52	53	58	60	52	55	55	47
R090	R	49	45	45	42	55	54	55	60	62	54	57	57	49
R091	R	49	45	45	42	55	52	53	58	60	52	55	55	47
R092	R	49	45	45	42	55	62	63	68	70	62	65	65	57
R093	R	49	45	45	42	55	66	67	72	74	66	69	69	61
R094	R	49	45	45	42	55	63	64	69	71	63	66	66	58
R095	R	49	45	45	42	55	37	38	43	45	37	40	40	32
R096	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R097	R	49	45	45	42	55	62	63	68	70	62	65	65	57
R098	R	49	45	45	42	55	59	60	65	67	59	62	62	54
R099	R	40	40	40	36	55	39	40	45	47	39	42	42	34
R100	R	40	40	40	36	55	30	31	36	38	30	33	33	25
R101	R	40	40	40	36	55	44	45	50	52	44	47	47	39
R102	R	40	40	40	36	55	39	40	45	47	39	42	42	34

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
CIR004	C	70				-	25	26	31	33	25	28	28	20
CIR005	I	75				-	57	58	63	65	57	60	60	52
CIR006	C	70				-	75	76	81	83	75	78	78	70
CIR007	C	70				-	68	69	74	76	68	71	71	63
CIR008	C	70				-	73	74	79	81	73	76	76	68
CIR009	C	70				-	43	44	49	51	43	46	46	38
RC3001	RC	60				-	69	70	75	77	69	72	72	64
RC3002	RC	60				-	47	48	53	55	47	50	50	42
ED2001	ED	55				-	41	42	47	49	41	44	44	36
CM6001	CM	60				-	48	49	54	56	48	51	51	43
CH4001	CH	55				-	40	41	46	48	40	43	43	35

N2M04

Table E4 Detailed construction noise results – receivers along N2M04

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R103	R	40	40	40	36	55	45	46	51	53	45	48	48	40
R104	R	40	40	40	36	55	24	25	30	32	24	27	27	19
R105	R	40	40	40	36	55	30	31	36	38	30	33	33	25
R106	R	40	40	40	36	55	26	27	32	34	26	29	29	21
R107	R	40	40	40	36	55	29	30	35	37	29	32	32	24
CIR010	I	75					40	41	46	48	40	43	43	35

N2M05

Table E5 Detailed construction noise results – receivers along N2M05

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R108	R	40	40	40	36	55	39	40	45	47	39	42	42	34
R109	R	40	40	40	36	55	33	34	39	41	33	36	36	28
R110	R	40	40	40	36	55	31	32	37	39	31	34	34	26
R111	R	40	40	40	36	55	26	27	32	34	26	29	29	21
R112	R	40	40	40	36	55	25	26	31	33	25	28	28	20
R113	R	40	40	40	36	55	24	25	30	32	24	27	27	19

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R114	R	40	40	40	36	55	33	34	39	41	33	36	36	28
R115	R	49	45	45	42	55	44	45	50	52	44	47	47	39
R116	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R117	R	49	45	45	42	55	49	50	55	57	49	52	52	44
R118	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R119	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R120	R	49	45	45	42	55	45	46	51	53	45	48	48	40
R121	R	49	45	45	42	55	44	45	50	52	44	47	47	39
R122	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R123	R	49	45	45	42	55	46	47	52	54	46	49	49	41
R124	R	49	45	45	42	55	47	48	53	55	47	50	50	42
R125	R	49	45	45	42	55	48	49	54	56	48	51	51	43
R126	R	49	45	45	42	55	49	50	55	57	49	52	52	44
R127	R	49	45	45	42	55	50	51	56	58	50	53	53	45
R128	R	40	40	40	36	55	24	25	30	32	24	27	27	19
R129	R	40	40	40	36	55	24	25	30	32	24	27	27	19
R130	R	40	40	40	36	55	33	34	39	41	33	36	36	28
R131	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R132	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R133	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R134	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R135	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R136	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R137	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R138	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R139	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R140	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R141	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R142	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R143	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R144	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R145	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R146	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R147	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R148	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R149	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R150	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R151	R	49	45	45	42	55	31	32	37	39	31	34	34	26
R152	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R153	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R154	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R155	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R156	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R157	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R158	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R159	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R160	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R161	R	49	45	45	42	55	28	29	34	36	28	31	31	23

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R162	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R163	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R164	R	49	45	45	42	55	31	32	37	39	31	34	34	26
R165	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R166	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R167	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R168	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R169	R	49	45	45	42	55	32	33	38	40	32	35	35	27
R170	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R171	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R172	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R173	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R174	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R175	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R176	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R177	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R178	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R179	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R180	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R181	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R182	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R183	R	49	45	45	42	55	31	32	37	39	31	34	34	26
R184	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R185	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R186	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R187	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R188	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R189	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R190	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R191	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R192	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R193	R	49	45	45	42	55	31	32	37	39	31	34	34	26
R194	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R195	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R196	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R197	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R198	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R199	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R200	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R201	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R202	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R203	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R204	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R205	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R206	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R207	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R208	R	49	45	45	42	55	28	29	34	36	28	31	31	23
R209	R	49	45	45	42	55	28	29	34	36	28	31	31	23

Receiver ID	Type	NMLs $L_{eq\ 15\ minute}$ dB(A)				Sleep Dist.	Predicted noise levels $L_{eq\ 15\ minute}$ dB(A)							
		SH	OSH - D	OSH - E	OSH - N		C01	C02	C03	C04	C05	C06	C07	C08
R210	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R211	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R212	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R213	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R214	R	49	45	45	42	55	29	30	35	37	29	32	32	24
R215	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R216	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R217	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R218	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R219	R	49	45	45	42	55	30	31	36	38	30	33	33	25
R220	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R221	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R222	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R223	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R224	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R225	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R226	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R227	R	49	45	45	42	55	25	26	31	33	25	28	28	20
R228	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R229	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R230	R	49	45	45	42	55	27	28	33	35	27	30	30	22
R231	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R232	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R233	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R234	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R235	R	49	45	45	42	55	26	27	32	34	26	29	29	21
R236	R	49	45	45	42	55	26	27	32	34	26	29	29	21
CIR011	I	75					34	35	40	42	34	37	37	29
CIR012	I	75					53	54	59	61	53	56	56	48
CIR013	I	75					30	31	36	38	30	33	33	25
CIR014	I	75					51	52	57	59	51	54	54	46
CIR015	I	75					39	40	45	47	39	42	42	34
CIR016	I	75					32	33	38	40	32	35	35	27
CIR017	I	75					36	37	42	44	36	39	39	31
CIR018	I	75					49	50	55	57	49	52	52	44
CIR019	I	75					55	56	61	63	55	58	58	50
CIR020	I	75					50	51	56	58	50	53	53	45
CIR021	I	75					31	32	37	39	31	34	34	26
CIR022	I	75					32	33	38	40	32	35	35	27
CIR023	I	75					33	34	39	41	33	36	36	28
CIR024	I	75					35	36	41	43	35	38	38	30
CIR025	I	75					33	34	39	41	33	36	36	28
CIR026	I	75					31	32	37	39	31	34	34	26
CIR027	C	70					31	32	37	39	31	34	34	26
CH4002	CH	55					28	29	34	36	28	31	31	23

Appendix F. CNE inputs and results

Transport Roads & Maritime Services

Construction Road Traffic Noise Estimator

Please input information into yellow cells
Please pick from drop-down list in orange cells

Ground type	Rural
Road surface	DGA
Road type	Freeway/arterial/sub-arterial road

Note that a road is new if a road's functional class changes during construction. For example, rerouting traffic from an arterial road temporarily to a collector road changes the functional class of the collector road for the duration of the temporary reroute.

	Day	Night
Noise criteria (residences)	60	55
Existing speed	60	60
Speed during construction	60	60

	Day (7am to 10pm)		Night (10pm to 7am)		Worst Case 1-hour Day		Worst Case 1-hour Night	
Existing traffic	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
Direction (1)	1,042	564	98	85	21	21	10	5
Direction (2)	841	459	82	127	7	7	5	2
Additional traffic								
Direction (1)	13	23	8	14	11	7	6	2
Direction (2)	13	23	8	14	1	0	0	0

	Day	Night
Change in noise levels (dBA)	0.2	0.5
Mitigation level (dBA)	60	55
Is the change in noise level greater than 2.0 dBA?	No	No
Require consideration of additional mitigation measures?	No	No
Mitigation distance (m)		

To assess noise impacts from construction traffic or a temporary reroute due to a road closure or both an initial screening test should be undertaken by evaluating whether noise levels will increase by more than 2dB(A). Where increases are 2dBA or less then no further assessment is required. Where noise levels increase by more than 2dBA (2.1dBA) and noise levels exceed the controlling criterion then the receiver qualifies for consideration of noise mitigation under the Noise Mitigation Guideline. [note: the assessment methodology is similar to minor works so in any instance the only trigger for noise mitigation under the NMG shall be due to noise level increase]

Mitigation Measures

Management of construction related traffic or traffic reroutes noise should as a minimum include the following controls:
- Scheduling and routing of vehicle movements
- Speed of vehicles
- Driver behaviour and avoidance of the use of engine compression brakes
- Ensuring vehicles are adequately silenced before allowing them to access the site

Where noise impacts are greater than one year then consideration should be given to the following measures where feasible and reasonable:
- temporary noise barriers
- at-receiver noise mitigation

Feasible and reasonable considerations should also include:
- time of day of the noise increase and exceedance of criteria
- time of use of affected receivers
- how many decibels the noise levels are to increase
- how long the mitigation will provide benefit to the receiver during the project

lculating noise level at the receiver

Distance to receiver (m)	
Direction (1)	15
Direction (2)	18.5

	Day	Night
Predicted noise levels (dBA) @ 1m from the façade	64.7	59.8

Note that noise reports usually present noise levels rounded to the nearest integer and differences between two noise levels rounded to a single decimal

Figure F1 Predicted change in noise levels as a result of the construction traffic at nearest receiver to 60 km/hr upgrade area

Transport Roads & Maritime Services

Construction Road Traffic Noise Estimator

Please input information into yellow cells
Please pick from drop-down list in orange cells

Ground type	Rural
Road surface	DGA
Road type	Freeway/arterial/sub-arterial road

Note that a road is new if a road's functional class changes during construction. For example, rerouting traffic from an arterial road temporarily to a collector road changes the functional class of the collector road for the duration of the temporary reroute.

	Day	Night
Noise criteria (residences)	60	55
Existing speed	110	110
Speed during construction	110	110

	Day (7am to 10pm)		Night (10pm to 7am)		Worst Case 1-hour Day		Worst Case 1-hour Night	
Existing traffic	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles	Light vehicles	Heavy vehicles
Direction (1)	1,042	564	98	85	21	21	10	5
Direction (2)	841	459	82	127	7	7	5	2
Additional traffic								
Direction (1)	13	23	8	14	14	7	8	2
Direction (2)	13	23	8	14	1	0	0	0

	Day	Night
Change in noise levels (dBA)	0.2	0.5
Mitigation level (dBA)	60	55
Is the change in noise level greater than 2.0 dBA?	No	No
Require consideration of additional mitigation measures?	No	No
Mitigation distance (m)		

To assess noise impacts from construction traffic or a temporary reroute due to a road closure or both an initial screening test should be undertaken by evaluating whether noise levels will increase by more than 2dB(A). Where increases are 2dBA or less then no further assessment is required. Where noise levels increase by more than 2dBA (2.1dBA) and noise levels exceed the controlling criterion then the receiver qualifies for consideration of noise mitigation under the Noise Mitigation Guideline. [note: the assessment methodology is similar to minor works so in any instance the only trigger for noise mitigation under the NMG shall be due to noise level increase]

Mitigation Measures
Management of construction related traffic or traffic reroutes noise should as a minimum include the following controls:
- Scheduling and routing of vehicle movements
- Speed of vehicles
- Driver behaviour and avoidance of the use of engine compression brakes
- Ensuring vehicles are adequately silenced before allowing them to access the site

Where noise impacts are greater than one year then consideration should be given to the following measures where feasible and reasonable:
- temporary noise barriers
- at-receiver noise mitigation

Feasible and reasonable considerations should also include:
- time of day of the noise increase and exceedance of criteria
- time of use of affected receivers
- how many decibels the noise levels are to increase
- how long the mitigation will provide benefit to the receiver during the project

ılculating noise level at the receiver

Distance to receiver (m)	
Direction (1)	40
Direction (2)	43.5

	Day	Night
Predicted noise levels (dBA) @ 1m from the façade	62.3	57.4

Note that noise reports usually present noise levels rounded to the nearest integer and differences between two noise levels rounded to a single decimal

Figure F2 Predicted change in noise levels as a result of the construction traffic at nearest receiver to 110 km/hr upgrade area.

Appendix G. Traffic data used for operational noise modelling

Table F1 AADT Traffic input data

Road section	Direction	Time period	Vehicle classification	Measurement year (2012)	Existing conditions (2018)	Year of opening (2022)	Design year (2032)
Newell Highway, Narrabri to Moree Site 91.020	Northbound	Day (7am to 10pm)	Light (Class 1-2)	925	1,042	1,128	1,375
			Heavy (Class 3-12)	489	564	620	786
			Total	1,514	1,605	1,747	2,160
		Night (10pm to 7am)	Light (Class 1-2)	87	98	106	129
			Heavy (Class 3-12)	74	85	94	119
			Total	161	183	200	248
	Southbound	Day (7am to 10pm)	Light (Class 1-2)	747	841	911	1,110
			Heavy (Class 3-12)	398	459	505	640
			Total	1,145	1,300	1,415	1,750
		Night (10pm to 7am)	Light (Class 1-2)	73	82	89	108
			Heavy (Class 3-12)	110	127	139	177
			Total	183	209	228	285

Appendix H. Standard construction noise measures

Standard measures

Action required	Applies to	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation measures	Long term projects (greater than 6 weeks) Airborne noise. Ground-borne noise & vibration.	Periodic notification (monthly letterbox drop or equivalent) detailing proposed dates, alternative dates for wet weather and hourly activity plan for night works. website Project Infoline Construction Response Line email distribution list Community Based Forums (if required by approval conditions).
	Short term projects (6 weeks or less) including scheduled maintenance Airborne noise. Ground-borne noise & vibration	Notification within 4 weeks prior to works detailing proposed dates, alternative dates for wet weather and hourly activity plan for night works. website Project Infoline Construction Response Line email distribution list Community Based Forums (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: all project specific and relevant standard noise and vibration mitigation measures relevant licence and approval conditions permissible hours of work any limitations on high noise generating activities location of nearest sensitive receivers construction employee parking areas designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures.
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under Appendix C of the CNVG a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.

Action required	Applies to	Details
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period	Airborne noise Ground-borne noise & vibration	As a guide high noise and vibration generating activities near receivers should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum respite period of one hour between each block. The duration of each block of work and respite should be flexible to accommodate the usage and amenity at nearby receivers. Unless negotiated with the community with consultation documented and approved by RMS project manager or permitted under the license there should be no more • 2 consecutive evenings or nights per week; and • 3 evenings or nights per week; and • 6 evenings or nights per month. For night work these periods of work should be separated by not less than one week.
Equipment selection	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels	Airborne noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.
Rental plant and equipment	Airborne noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.

Action required	Applies to	Details
Use and siting of plant	Airborne noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work cannot be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Blasting regime	Airborne noise Ground-borne vibration	The noise and vibration impacts of blasting operations can be minimised by: Choosing the appropriate blast charge configurations Ensuring appropriate blast-hole preparation Optimising blast design, location, orientation and spacing Selecting appropriate blast times, and

Action required	Applies to	Details
		Utilising knowledge of prevailing meteorological conditions. AS 2187.2 Explosives-Storage, transport and use, Part 2: Use of Explosives provides more detailed advice on ground vibration and airblast overpressure impact minimisation options.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commissions 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc	Airborne noise	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor controls		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.