APPENDIX

J

Construction Noise and Vibration Technical Report

PART 1 OF 2

Main Report, Appendices A and B

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Inland Rail North Star to NSW/QLD Border

Appendix J: Construction Noise and Vibration Technical Report

Australian Rail Track Corporation

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Abbreviations

Abbreviation	Explanation
ABL	Assessment Background Level - The overall background level for each day, evening and night period for each day of the noise monitoring.
AGL	Above Ground Level
ANZEC	Australia and New Zealand Environment Council
ARTC	Australian Rail Track Corporation Ltd
AS	Australian Standard
BS	British Standard
CEMP	Construction Environmental Management Plan
CNVMP	Construction Noise and Vibration Management Plan
DEC	Department of Environment and Conservation
DECC	Department of Environment Climate Change
DECCW	Department of Environment Climate Change and Water
DIN	Deutsches Institut für Normung
ECRTN	Environmental Criteria for Road Traffic Noise
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
IEC	International Electrotechnical Commission
Inland Rail	Melbourne to Brisbane Inland Rail
IS	Infrastructure Sustainability
ISCA	Infrastructure Sustainability Council of Australia
km	kilometres
m	metres
NATA	National Association of Testing Authorities
NCA	Noise Catchment Area
NML	noise management levels
NSW	New South Wales
PPV	Peak Particle Velocity
the Proponent	Australian Rail Track Corporation Ltd
QLD	Queensland
RBL	Rating Background Level - The overall background level for each day, evening and night period for the entire length of noise monitoring.
VDV	Vibration Dose Values

Glossary

Term	Explanation
Sound power level	The total sound emitted by a source.
Sound pressure level	The amount of sound at a specified point.
Decibel [dB]	The measurement unit of sound.
A Weighted decibels [dB(A)]	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows: ■ 0 dB(A) Threshold of human hearing ■ 30 dB(A) A quiet country park ■ 40 dB(A) Whisper in a library ■ 50 dB(A) Open office space ■ 70 dB(A) Inside a car on a freeway ■ 80 dB(A) Outboard motor ■ 90 dB(A) Heavy vehicle pass-by ■ 100 dB(A) Jackhammer/Subway train ■ 110 dB(A) Rock Concert ■ 115 dB(A) Limit of sound permitted in industry ■ 120 dB(A) 747 take off at 250 m
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
L_{max}	The maximum sound pressure level measured over the measurement period.
L_{min}	The minimum sound pressure level measured over the measurement period.
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10}.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90}.
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L_{90} sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The L_{eq} sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.

Term	Explanation
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the entire length of noise monitoring.

Table note:

* Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 “Acoustics – Glossary of terms and related symbols”, the EPA’s Noise Policy for Industry and the EPA’s NSW Road Noise Policy

Executive summary

The construction noise impact assessment has been carried out in accordance with the Interim Construction Noise Guideline and the Secretary's Environmental Assessment Requirements. Reasonable worst case construction scenarios have been assessed.

The assessment of noise associated with the construction of the proposal and associated borrow pits indicates some exceedances of the noise management levels at some receivers.

The 'Drainage works and earthworks' construction stage is predicted to have the greatest impact from construction noise, however other construction stages may have greater overall impact depending on actual timing and duration of each construction stage.

Measures have been recommended to mitigate noise impacts upon nearby sensitive receivers. Specific noise management and mitigation measures would be detailed in the contractor's Construction Noise and Vibration Management Plan (CNVMP) and are likely to include the following:

- Effective community consultation
- Training of construction site workers
- Use of temporary noise barriers
- Monitoring
- Appropriate selection and maintenance of equipment
- Scheduling of work for less sensitive time periods
- Situating plant in less noise sensitive locations
- Construction traffic management
- Respite periods.

An assessment of the likely construction traffic indicated that while increases in road traffic noise of more than 2 dB(A) may occur the road traffic noise levels would remain below the NSW Road Noise Policy criteria. Therefore, no further assessment is required, in accordance with the NSW Road Noise Policy.

Minimum working distances for vibration intensive construction work are presented. Equipment size would be selected by the contractor taking into account the minimum working distances and the distance between the area of construction and the most affected sensitive receiver. If works need to be carried out within minimum working distances, vibration monitoring would be carried out.

Operational noise and vibration associated with the rail line is covered in a separate technical report (refer EIS Appendix K – Operational noise and vibration); however, this assessment includes an operational assessment of the North Star construction camp and a number of road realignments.

An operational noise impact assessment was undertaken in accordance with the NSW Environment Protection Agency's (NSW EPA's) document Noise Policy for Industry for the operation of the North Star construction camp.

The results of the operational noise assessment show that predicted noise levels due to the operation of the proposed construction camp located in North Star may exceed the project noise trigger levels by 1 dB(A) at up to three receiver locations under worst case meteorological conditions.

It should be noted that when assessing the significance of residual noise impacts, the Noise Policy for Industry states that exceedances of up to 2 dB(A) are considered "negligible". The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls.

Indicative normal operational noise levels from the construction camp, under worst case meteorological conditions are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, it is concluded that no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance.

A desktop assessment of the road realignment of the Bruxner Way was undertaken in order to predict the potential noise impacts associated with the alteration of the alignment closer to residential receivers. This assessment was conducted in accordance with the relevant criteria outlined in the NSW Road Noise Policy for road redevelopments. It was found that noise levels at the most affected receiver are predicted to increase by up to 0.3 dB(A) due to the proposed realignment. Therefore, no further consideration is necessary at this preliminary stage.

1 Introduction

1.1 Proposal background

The Inland Rail program will provide a dedicated rail corridor between Melbourne and Brisbane via regional Victoria, New South Wales (NSW) and Queensland (QLD). The Australian Government has appointed the Australian Rail Track Corporation (ARTC) to deliver Inland Rail, in partnership with the private sector. The 1,700 km route is being delivered in thirteen distinct project sections.

The North Star to NSW/QLD border section of Inland Rail (hereafter referred to as proposal) comprises approximately 30 km of dual gauge track from North Star to the NSW/QLD Border. The proposal would utilise the existing rail line at North Star and travel north where new track would be constructed north of Whalan Creek and continue to the NSW/QLD border.

1.2 Key features of the proposal

The proposal consists of the key features listed in Table 1.1.

Table 1.1 Key features of the proposal

Aspect	Description
New track	■ Approximately 25 km of new track within the existing, non-operational Boggabilla rail corridor ■ Approximately 5 km of new track within a greenfield rail corridor
Crossing loop, maintenance siding and turnouts	■ One crossing loop, designed to accommodate trains up to 1,800 m long ■ Turnouts will be provided on either end of the crossing loop to allow trains to be guided from one track to another ■ A one-ended siding (approximately 250 m long) will be incorporated into the crossing loop for maintenance purposes. It will be connected to the southern end of the crossing loop via a low-speed turn out.
Bridges	■ Eleven new bridges ■ This includes an approximately 1.8 km long viaduct over the Macintyre River and Whalan Creek, which are major watercourses. The viaduct is located in both NSW and Queensland; therefore, potential impacts will be assessed under the *Environmental Planning and Assessment Act 1979* (NSW) by this EIS, and under the *State Development and Public Works Organisation Act 1971* (QLD) by the NSW/QLD Border to Gowrie Inland Rail project EIS.
Drainage	■ Reinforced concrete pipe culverts and reinforced concrete box culverts ■ Scour protection measures will generally be installed around culverts to prevent erosion ■ Embankment and catch drains adjacent to the proposed alignment to divert surface runoff to the nearest bridge or culvert location
Road rail interfaces	■ Work on new and existing level crossings ■ Signalling and communications infrastructure
Road realignments	■ Minor realignment of Bruxner Way near where the proposal transitions from the existing, non-operational Boggabilla rail corridor to the greenfield rail corridor
Earthworks	■ To achieve flood immunity, the majority of the proposal is elevated on a fill embankment. The embankment height is typically less than 2 m; however, in the lead up to the Macintyre River Viaduct, the height increases to approximately 7.5 m. ■ No significant cuttings (> 10 m) are proposed
Ancillary works	■ Ancillary infrastructure including utilities, signalling and communications infrastructure, fencing and signage

1.3 Purpose of this report

This technical report provides a construction noise and vibration impact assessment of the proposal and has been prepared to support the Inland Rail North Star to NSW/QLD border Environmental Impact Statement (EIS). The construction of the proposal has been assessed using the applicable noise and vibration guidelines. Operational noise from roads which would be realigned as a result of the construction of the rail track and level crossings has also been assessed in this report.

1.4 Scope of this report

The scope of this noise and vibration impact assessment was to:

- Identify nearby sensitive receivers potentially affected by the proposal
- Establish construction noise management levels (NMLs) based upon the measured background noise levels, the Interim Construction Noise Guideline and the Noise Policy for Industry
- Establish construction and operational road traffic criteria in accordance with the NSW Road Noise Policy and the Noise Criteria Guideline
- Undertake a construction noise and vibration impact assessment of the construction works and borrow pits in accordance with the relevant guidelines, including consideration of cumulative impacts
- Undertake an operational noise impact assessment of the proposed road re-alignments at nearby sensitive receivers, in accordance with the NSW Road Noise Policy
- Undertake an operational noise impact assessment of the proposed construction camp located in North Star
- Assess the noise impact resulting from construction activities and provide noise control recommendations, where required, including buffer distances, silencing treatment of mobile plant, management of mobile plant, community consultation and other management mitigation measures, such as respite periods
- Review vibration intensive construction works and recommend minimum working distances and mitigation measures where required, including the use of alternative equipment and construction methods, respite periods and other management mitigation measures
- Recommend indicative operational noise mitigation measures where required.

1.5 Report limitations

The findings of this report are based on the information provided to date, and may change at the detailed design phase of the proposal. Should the detailed design differ from that information, the impact to nearby receivers may differ from the findings presented in this report.

Operational noise and vibration associated with the rail line will be covered in a separate technical report covered in a project wide (Inland Rail) operational assessment.

2 Assessment requirements for the proposal

The requirements stated in the following documentation have been used as the basis for the following construction noise and vibration impact assessment:

- Relevant legislation
- Secretary's Environmental Assessment Requirements (SEARs).

The SEARs include requirements that are to be assessed within the wider EIS report to ensure compliance. Relevant requirements for noise and vibration during construction of the proposal are detailed throughout the report. The location of where the SEARs requirements have been addresses in this report has been provided in Section 2.2.

2.1 Legislation, policies, standards and guidelines

The following have been considered for this noise and vibration assessment:

- *Protection of the Environment Operations Act 1997* (NSW)
- Protection of the Environment Operations (Noise Control) Regulation 2017 (NSW)
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration, Australian and New Zealand Environment Council (ANZEC), 1990
- Assessing Vibration: A Technical Guideline, Department of Environment and Conservation (DEC), 2006
- Interim Construction Noise Guideline, Department of Environment and Climate Change (DECC), 2009
- Noise Policy for Industry, NSW Environment Protection Authority (EPA), 2017
- Rail Infrastructure Noise Guideline, NSW Environment Protection Authority (EPA), 2013
- Construction Noise and Vibration Strategy, Transport for New South Wales (TfNSW), 2018
- NSW Road Noise Policy, Department of Environment, Climate Change and Water (DECCW), 2011
- Noise Mitigation Guideline, Roads and Maritime Services, 2015
- Noise Criteria Guideline, Roads and Maritime Services, 2015
- German Standard DIN 4150: Part 3 1999 Structural Vibration in Buildings - Effects on Structures, 1999
- British Standard 6472: Part 1 2008 Evaluation of Human Exposure to Vibration in Buildings, 2008
- Australian Standard AS 1055-2018 – Acoustics – Description and measurement of environmental noise, 2018
- Australian Standard AS2436-2010, Guide to noise and vibration control on construction, demolition and maintenance sites, 2010
- British Standard 5228: Part 1 2009 Code of practice for noise and vibration control on construction and open sites, 2009
- Development near Rail Corridors and Busy Roads – Interim Guideline, NSW Department of Planning (DoP), 2008
- Sustainable Design Guidelines Version 4.0, Transport for New South Wales (TfNSW), 2017
- IS Technical Manual Version 1.2, Infrastructure Sustainability Council of Australia (ISCA), 2018

Applicable criteria and potential mitigation measures are included within this document to adequately assess noise and vibration impacts associated with construction works. This report outlines the applicable criteria and preliminary requirements.

2.2 Secretary's Environmental Assessment Requirements

This technical report has been prepared in accordance with the SEARs issued for the proposal on 8 August 2018 by the Secretary of the Department of Planning, Industry and Environment (NSW).

The SEARs relevant to this technical assessment are presented in Table 2.1, alongside the relevant sections of this report which address the requirements.

Table 2.1 Secretary's Environmental Assessment Requirements and relevant report sections

Key Issue and desired performance outcome	SEARs	Sections where requirements are addressed
14. Noise and Vibration - Amenity Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the project are effectively managed to protect the amenity and well-being of the community.	1. The Proponent must assess construction and operational noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to sensitive receivers including small businesses, and include consideration of sleep disturbance and, as relevant, the characteristics of noise and vibration (for example, low frequency noise).	Sections 5, 6 and 7
	2. The Proponent's assessment of construction and operational noise and vibration impacts must consider activities within the proposed corridor and activities at ancillary sites, including but not limited to borrow sites, and vehicle movements associated with the proposal, including haulage vehicles.	Section 5
	3. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Section 4.4 and 5.8
15. Noise and Vibration - Structural Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings and items including Aboriginal places and environmental heritage. Increases in noise emissions and vibration affecting environmental heritage as defined in the *Heritage Act 1977* (NSW) during operation of the project are effectively managed.	1. The Proponent must assess construction and operation noise and vibration impacts in accordance with relevant NSW noise and vibration guidelines. The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	Section 5.7
	2. The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required.	Section 4.4
19. Waste All wastes generated during the construction and operation of the project are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully and in a manner that protects environmental values.	2. The Proponent must assess potential environmental impacts from the excavation, handling, storage on site and transport of the waste particularly, with relation to sediment/leachate control, noise and dust.	Section 5

2.3 Infrastructure Sustainability Council of Australia

The Infrastructure Sustainability Council of Australia (ISCA) is the peak industry body for advancing sustainability in Australia's infrastructure. ISCA developed and administers the Infrastructure Sustainability (IS) rating scheme. IS evaluates the sustainability (including environmental, social, economic and governance aspects) of infrastructure projects and assets. The IS rating scheme offers credits for construction and operational noise and vibration.

2.3.1 Infrastructure Sustainability Council of Australia noise benchmarks

Table 2.2 presents the IS Dis-2 noise benchmarks.

Table 2.2 Dis-2 noise benchmarks

	Level 1	Level 2	Level 3
Benchmark	Measures to mitigate noise during construction and operation have been identified and implemented. AND Monitoring of noise is undertaken at appropriate intervals and in response to complaints during construction and operation.	The requirements for Level 1 are achieved. AND For construction, modelling and monitoring demonstrates no recurring or major divergences from the noise management process in ISCA approved noise guidelines. AND For operation, modelling and monitoring demonstrates no recurring or major exceedances of noise goals.	The requirements for Level 2 are achieved. AND For construction, modelling and monitoring demonstrates no divergence from the noise management process in ISCA approved noise guidelines. AND For operation, modelling and monitoring demonstrates no exceedances of noise goals.
Evidence	Construction and Operational Noise and Vibration Technical Report.	The evidence for level 1.	The evidence for level 1.

2.3.1.1 Evidence of noise benchmarks

Section 3.3 sets out measurements which were completed to provide inputs into the construction and operational noise modelling. Sections 5.3 and 6.1 presents the construction and operational noise modelling methodology. Sections 7.1 and 7.2 detail the construction and operational noise controls which have been identified and will be implemented during the project. A noise monitoring program will be implemented to confirm the construction noise levels.

With the implementation of these construction and operational controls the IS performance requirements will be met.

2.3.2 Infrastructure Sustainability Council of Australia vibration benchmarks

Table 2.3 presents the IS Dis-3 vibration benchmarks.

Table 2.3 Dis-3 vibration benchmarks

	Level 1	Level 2	Level 3
Benchmark	Measures to mitigate vibration during construction and operation have been identified and implemented. AND Monitoring of vibration is undertaken at appropriate intervals and in response to complaints during construction and operation.	The requirements for Level 1 are achieved. AND For construction, modelling and monitoring demonstrates no exceedances of vibration goals for structural damage to buildings and structures. AND For operation, modelling demonstrates no recurring or major exceedances of vibration goals for human comfort criteria. AND No physical damage has been caused to any buildings or structures by vibration caused by construction.	The requirements for Level 2 are achieved. AND For operation, modelling demonstrates no exceedances of vibration goals for human comfort criteria.
Evidence	Construction and Operational Noise and Vibration Technical Report.	The evidence for level 1.	The evidence for level 1.

2.3.2.1 Evidence of vibration benchmarks

Section 3.3 sets out measurements which were completed to provide inputs into the construction vibration modelling. Section 4.3 presents the relevant construction vibration criteria, whilst Section 4.4 presents blasting criteria. Section 5.7 presents the recommended minimum working distances for vibration intensive construction works to meet both the human comfort and structural damage criteria. Section 5.8 provides indicative maximum charge mass for blasting. A vibration monitoring program will be implemented to confirm the construction vibration levels.

Provided the guidelines and recommendations outlined in these report sections are adhered to, the IS performance requirements will be met.

3 Existing noise environment

3.1 Site description

The land around the proposal is predominantly disturbed rural land, the proposal crosses a number of local and private roads, creeks and privately owned properties. There are a number of scattered rural residential along the proposal site. The proposal would also intersect the Bruxner Way approximately 1 kilometre (km) south of the NSW/QLD border. The work would commence approximately 900 metres (m) north of the North Star village and continue to the NSW/QLD border, with a proposed laydown area located on the northern outskirts of North Star. There are no major towns located along the proposal site between North Star and NSW/QLD border. The town of Boggabilla and the Aboriginal community of Toomelah are located along the NSW/QLD border, approximately 7 km and 2 km from the proposal respectively.

3.2 Sensitive receivers

The Interim Construction Noise Guideline outlines the sensitive land uses that could be potentially impacted by construction noise and vibration as follows:

- Residences
- Classrooms
- Hospitals
- Places of worship
- Passive recreation areas such as outdoor grounds used for teaching
- Active recreation areas such as parks and sports grounds.

Other land uses that may, at times, be sensitive to noise from construction include:

- Commercial premises, such as film and television studios, research facilities, entertainment spaces, temporary accommodation (such as caravan parks and camping grounds), child care centres, restaurants, office premises and retail spaces
- Industrial premises.

Residential and non-residential sensitive receivers potentially affected by the construction and operation of the proposal have been identified throughout the study area. The main study area for this assessment generally extends 2 km either side of the alignment and therefore excludes Boggabilla from this assessment. The study area extends from North Star in the south to the NSW/QLD border in the north and includes Toomelah.

To assist in determining noise criteria for the receivers surrounding the proposal site, the study area was split into five noise catchment areas (NCAs). The noise environment within each noise catchment area is considered to be comparable and has been used to develop assessment criteria for similar noise environments. The location of noise catchment areas is shown in Appendix A.

Additionally, receivers within 2 km of proposed borrow pits have been identified. These receivers are predominantly outside the main study area, with the exception of some receivers within NCAs 2 & 3. This has been discussed in Section 5.5.

3.3 Noise and vibration monitoring

3.3.1 Methodology

Ambient noise and vibration monitoring was conducted at six locations within the proposal area during June and July 2018. This included both long term monitoring and short-term attended measurements, which was conducted to meet the requirements of the SEARs for NS2B. These measurements were completed in order to:

- Determine the background noise level, as part of the construction noise impact assessment and the assessment of the proposed construction camp
- Obtain ambient pre-construction vibration levels for use in the construction vibration impact assessment.

Attended noise measurements were carried out to provide additional information about the existing noise environment and the most significant noise sources.

3.3.2 Instrumentation

3.3.2.1 Noise instrumentation

Details of the noise loggers used for unattended long term noise monitoring are presented in Table 3.1. The noise monitoring locations are shown in Appendix A.

Table 3.1 Noise monitoring details

Monitor ID	Address	Start date	End date	Logger type	Serial number
NS2B_NL_01	5 Edward Street, North Star, NSW	17/10/2018	31/10/2018	01dB CUBE	11100
NS2B_NL_02	7114 North Star Road, North Star, NSW	18/10/2018	1/11/2018	01dB CUBE	10835
NS2B_NL_03	7409 North Star Road, North Star, NSW	13/09/2018	27/09/2018	01dB CUBE	11096
NS2B_NL_04	21930 Bruxner Way, Boggabilla, NSW	8/10/2018	16/10/2018	01dB CUBE	11098
NS2B_NL_05	3870 Tucka Tucka Road, Boggabilla, NSW	17/10/2018	2/11/2018	01dB CUBE	11096
NS2B_NL_06	Toomelah Pumping Station, Toomelah	22/10/2018	2/11/2018	01dB CUBE	10824

The location of NS2B_NL_06 was selected in consultation with ARTC in an attempt to monitor noise levels representative of those at Toomelah. Upon processing the data however, it was found that the results at this location were heavily affected by operational noise from the nearby pumping station. The measurements did not meet the requirements for background noise monitoring outlined in the Noise Policy for Industry and were not considered to be representative of the surrounding noise environment, therefore these data have been excluded from the assessment. Noise monitoring data from NS2B_NL_05 was instead used for determining relevant noise criteria for the region around Toomelah due to the similar rural nature of ambient noise at both locations.

The sound level meter used to conduct attended noise measurements was a SVAN 957 (S/N: 27554). All acoustic instrumentation used for the assessment comply with the requirements of AS IEC 61672.1-2004 Electroacoustics – Sound level meters – Specifications and were calibrated before and after monitoring sessions with a drift in calibration not exceeding ± 0.5 dB.

All instruments used were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years).

3.3.2.2 Vibration instrumentation

Details of the equipment used for attended vibration monitoring are presented in Table 3.2.

Table 3.2 Vibration monitoring details

Monitor ID	Address	Equipment type	Serial number
NS2B_NL_01	5 Edward Street, North Star, NSW	SVAN 957	27554
NS2B_NL_02	7114 North Star Road, North Star, NSW	SVAN 957	27554
NS2B_NL_03	7409 North Star Road, North Star, NSW	SVAN 957	27554
NS2B_NL_04	21930 Bruxner Way, Boggabilla, NSW	SVAN 957	27554
NS2B_NL_05	3870 Tucka Tucka Road, Boggabilla, NSW	SVAN 957	27554

3.3.3 Unattended background noise monitoring results

A noise logger measures the noise level over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period respectively. The L_{A1} is indicative of maximum noise levels due to individual noise events. The L_{A90} is considered to be the background noise level. The L_{Aeq} is the energy averaged sound level over the measurement period. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

The assessment background level (ABL) is established by determining the lowest tenth-percentile level of the L_{A90} noise data acquired over each period of interest. The background noise level or rating background level (RBL) representing the day, evening and night-time assessment periods is based on the median of individual ABLs determined over the entire monitoring duration. The RBL is representative of the average minimum background sound level, or simply the background level.

Noise logger reports including graphical representations of the logging results, a summary of the results and the measurement locations are provided in Appendix B. A summary of the measured L_{A90} background noise levels and existing L_{Aeq} ambient noise levels is presented in Table 3.3

Table 3.3 Existing background and ambient noise levels

Monitoring location	Rating background level, dB(A)			Ambient noise levels, dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
NS2B_NL_01	34	32	25	57	53	48
NS2B_NL_02	26	28	34	47	49	45
NS2B_NL_03	30	26	23	51	46	45
NS2B_NL_04	32	46	30	56	55	49
NS2B_NL_05	33	31	26	54	52	52

Table notes:

1 In accordance with the Noise Policy for Industry, time of day is defined as follows:
- Day – the period from 7.00 am to 6.00 pm Monday to Saturday or 8.00 am to 6.00 pm on Sundays and public holidays.
- Evening – the period from 6.00 pm to 10.00 pm.
- Night – the remaining periods.

3.3.4 Attended noise monitoring

Attended noise monitoring was conducted at the five unattended monitoring locations between September and October 2018. Each measurement was conducted over a 15 minute period. Weather conditions were clear on the day of monitoring, with no wind. The monitoring results from the attended measurements are presented in Table 3.4.

Table 3.4 Attended noise monitoring results

Monitoring location	Date	Time	Description	$L_{Amax,15min}$, dB(A)	$L_{A10,15min}$, dB(A)	$L_{Aeq,15min}$, dB(A)	$L_{A90,15min}$, dB(A)
NS2B_NL_01	17/10/2018	13:45	▪ Noise environment dominated by infrequent road traffic noise ▪ Car pass-by 60-74 dB(A) ▪ Truck 75 dB(A) ▪ Ambient noise level 35-38 dB(A) in absence of road traffic	80	52	59	35
NS2B_NL_02	18/10/2018	12:45	▪ Car pass-by 54-58 dB(A) ▪ Truck 70 dB(A)	79	47	52	32
NS2B_NL_03	13/09/2018	13:15	▪ Distant road traffic noise 33-35 dB(A) ▪ Birds just audible 31-40 dB(A)	65	42	40	27
NS2B_NL_04	16/10/2018	13:45	▪ Rural environmental noise dominant ▪ Car pass-by 48-54 dB(A) ▪ Truck 69 dB(A) ▪ Dogs barking	69	47	50	34
NS2B_NL_05	16/10/2018	17:16	▪ Rural environmental noise dominant ▪ Bird noise clearly audible	68	55	51	35

3.3.5 Attended vibration monitoring

Table 3.5 contains the noise measurement site summary showing the average Peak Particle Velocity (PPV) noise levels from the monitoring period. The PPV level is typically used to represent the levels where structural damage would occur to buildings and infrastructure. The calculated average is the arithmetic average for the measurement period. Sources of extraneous vibration contributing to higher than typical levels include vehicle movements, wind gusts and nearby fauna.

Table 3.5 Background vibration measurements

Site	Date	Time	Average measured PPV, mm/s
NS2B_NL_01	17/10/2018	2.27 pm	1.1
NS2B_NL_02	1/11/2018	9.09 am	0.1
NS2B_NL_03	27/09/2018	12.15 pm	0.9
NS2B_NL_04	28/09/2018	9.34 am	1.1
NS2B_NL_05	2/11/2018	8.51 am	0.1

4 Assessment criteria

4.1 Construction noise criteria

The Interim Construction Noise Guideline is a NSW Government document that identifies ways to manage impacts of construction noise on residences and other noise sensitive land uses. It is the principal guideline for the assessment and management of construction noise in NSW and is used to establish construction noise management levels (NML).

As the proposed works are expected to continue for a period of more than three weeks, and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on 'reasonable' worst case construction scenarios, has been carried out for these works. Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers using environmental noise modelling software and compared to the noise management levels, derived in accordance with the Interim Construction Noise Guideline.

Where an exceedance of the NMLs is predicted, the Interim Construction Noise Guideline advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially impacted residents of the nature of the work to be carried out, the expected noise level and duration, as well as contact details.

Where construction noise levels reach 75 dB(A) residential receivers can be considered as 'highly noise affected' and the proponent should, in consultation with the community, consider restricting hours to provide respite periods.

The Interim Construction Noise Guideline defines what is considered to be feasible and reasonable as follows:

- Feasible

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given proposal constraints such as safety and maintenance requirements.

- Reasonable

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

Additionally the Interim Construction Noise Guideline notes that strong justification is required for work that is proposed outside of standard working hours.

Provided in Table 4.1 are the NMLs for residential receivers, and guidance on how they should be applied during different times of day as defined in Table 2 of the Interim Construction Noise Guideline.

Table 4.1 Noise management levels at residences (from Table 2 Interim Construction Noise Guideline)

Time of day[1]	Management level, $L_{Aeq,15min}$ dB(A)[2]	How to apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB(A)	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 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: i) 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 ii) 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)	■ 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 Interim Construction Noise Guideline.

Table notes:

1 Recommended standard hours are taken from the Interim Construction Noise Guideline. It should be noted from Section 2.2 of the Interim Construction Noise Guideline, these hours are not mandatory. This is discussed further in Section 4.1.1.

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

4.1.1 Construction hours

The work required for the proposal would be carried out during both standard construction hours and out of hours. Standard construction hours recommended in the Interim Construction Noise Guideline are as follows:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm Saturdays
- No work on Sundays or public holidays.

Noise-generating works would be completed on a 7-day schedule between 6.30 am and 6.00 pm, with preparation works involving non-noisy activities to be completed between 6.00 am and 6.30 am each day. Activities such as piling and concrete pours would occur during night-time hours. ARTC has undertaken community and stakeholder engagement, as well as negotiation with the Environment Protection Authority to undertake works in these hours, which have been agreed upon.

As stated in Section 2.2 of the Interim Construction Noise Guideline, these standard construction hours are not mandatory. Community consultation has been undertaken to determine if additional construction hours would be acceptable to the community to reduce the overall construction program. Given the typical distances from the proposal site to the sensitive receivers construction noise levels are unlikely to be very intrusive.

In addition, there are some works which must be undertaken outside of standard working hours. The most common reasons for works that might be undertaken out of hours include:

- The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads
- Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm
- Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours
- Public infrastructure works that shorten the length of the project and are supported by the affected community
- Works where a need to operate outside the recommended standard hours e.g. to facilitate completion of concrete pours etc is demonstrated and justified.

4.1.2 Construction noise management levels

Provided in Table 4.2 are the applicable NMLs for the proposal, based on the RBLs in Table 3.3 and noise management levels in Table 4.1.

Table 4.2 External construction noise criteria

NCA	Period	RBL L_{A90} dB(A)	Standard hours noise management levels, $L_{Aeq,15min}$ dB(A)	Out-of-hours noise management levels, $L_{Aeq,15mins}$ dB(A)
1	Day	35[1]	45	40
	Evening	32	-	37
	Night	30[1]	-	35
2	Day	35[1]	45	40
	Evening	30[1]	-	35
	Night	30[2]	-	35
3	Day	35[1]	45	40
	Evening	30[1]	-	35
	Night	30[1]	-	35
4	Day	35[1]	45	40
	Evening	35[2]	-	40
	Night	30	-	35
5	Day	35[1]	45	40
	Evening	31	-	36
	Night	30[1]	-	35

Table notes:

1. In accordance with Noise Policy for Industry Table 2.1, a minimum RBL has been adopted where the measured RBL is less than 35 dB(A) during the day, 30 dB(A) in the evening, or 30 dB(A) at night.
2. The Noise Policy for Industry indicates that the community generally expects a greater control of noise during the evening and night as compared to the day time. Therefore, the rating background level used for the evening is set to no more than that for the daytime and the night-time to no more than the daytime or evening.

Table 4.3 provides the NMLs for applicable to non-residential receivers such as commercial premises and places of worship.

Table 4.3 Noise at sensitive land uses (other than residences)

Type of occupancy/activity	Internal noise level $L_{Aeq,15min}$, dB(A)	
Classrooms at schools and other educational institutions	Internal noise Level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Place of worship	Internal noise level	45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level	65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific use.	

4.1.3 Sleep disturbance criteria

The Interim Construction Noise Guideline requires a sleep disturbance analysis to be completed where construction work is planned to extend over more than two consecutive nights. The analysis should consider the likely maximum noise level, and the extent and the number of times that the maximum noise level exceeds the sleep disturbance screening level. The Interim Construction Noise Guideline makes reference to the NSW Environment Criteria for Road Traffic Noise (NSW EPA, 1999) (ECRTN), now superseded by the NSW Road Noise Policy (DECCW 2011), for guidance in assessing the potential for sleep disturbance.

The NSW Road Noise Policy contains a review of research into sleep disturbance which represents NSW EPA advice on the subject of sleep disturbance due to noise events. It concludes that having considered the results of research to date that, 'Maximum internal noise levels below 50 to 55 dB(A) are unlikely to cause awakening reactions'. Therefore, given that an open window provides around 10 dB in noise attenuation from outside to inside, external noise levels of 60 to 65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers have been determined and are presented in Table 4.4. As part of the assessment the predicted maximum noise levels will be first compared against the screening criteria. If the screening criterion is exceeded the maximum noise levels are then compared against the awakening reaction criteria.

Table 4.4 Sleep disturbance criteria

NCA	Night-time RBL, L_{A90}, dB(A)	Sleep disturbance screening level, $L_{A1,1min}$, dB(A)	Awakening reaction $L_{A1,1min}$, dB(A)
NCA1	30[1]	45	65
NCA2	30[2]	45	65
NCA3	30[1]	45	65
NCA4	30	45	65
NCA5	30[1]	45	65

Table notes:

1. In accordance with Noise Policy for Industry Table 2.1, a minimum RBL has been adopted where the measured RBL is less than 30 dB(A) at night.
2. The Noise Policy for Industry indicates that the community generally expects a greater control of noise during the evening and night as compared to the day time. Therefore, the rating background level used for the night-time is set to no more than the daytime or evening.

4.1.4 Construction road traffic noise criteria

Noise from construction traffic on public roads is not covered by the Interim Construction Noise Guideline. However the Interim Construction Noise Guideline does refer to the ECRTN, now superseded by the NSW Road Noise Policy, for the assessment of noise arising from construction traffic on public roads.

To assess noise impacts from construction traffic in accordance with the NSW Road Noise Policy, an initial screening test should be carried out by evaluating whether existing road traffic noise levels would increase by more than 2 dB(A). Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion in the NSW Road Noise Policy, then noise mitigation should be considered for those receivers affected. The NSW Road Noise Policy does not require assessment of noise impact to commercial or industrial receivers.

4.2 Cumulative construction noise assessment

To assess cumulative construction noise within the proposal area other 'major' projects which are planned to be in construction simultaneously with this proposal are identified. The other projects must be in close enough proximity to influence noise levels at sensitive receivers potentially affected by this proposal.

4.3 Construction vibration criteria

The relevant standards/guidelines for the assessment of construction vibration are summarised in Table 4.5.

Table 4.5 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 – Part 3 – Structural Vibration in Buildings – Effects on Structures (DIN 4150)
Human comfort (tactile vibration) [1]	Assessing Vibration: A Technical Guideline[1]

Table note:

1 This document is based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1 to 80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the Environment Protection Authority still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed, i.e. human disturbance or discomfort
- Those in which the integrity of the building or the structure itself may be prejudiced
- Those where the building contents may be affected

Therefore, vibration levels at sensitive receiver locations must be controlled so as to prevent discomfort, and in some cases, structural damage.

4.3.1 Structural damage

At present, no Australian Standards exist for the assessment of building damage caused by vibration.

DIN 4150 provides recommended maximum levels of vibration that reduce the likelihood of building damage caused by vibration and are presented in Table 4.6. DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage.

Table 4.6 DIN 4150.3 Structural damage 'safe limits' for building vibration

Group	Type of structure	PPV in mm/s			
		At foundation at a frequency of			Vibration at the horizontal plane of the highest floor
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz[1]	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use (i.e. residential)	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 or 2 and have intrinsic value (e.g. heritage-listed)	3	3 to 8	8 to 10	8

Table note:

1 For frequencies above 100 Hz, the higher values in the 50 to 100 Hz column should be used.

'Damage' is defined by DIN 4150.3 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load-bearing walls. DIN 4150.3 also states that when vibrations higher than the 'safe limits' are present, it does not necessarily follow that damage will occur.

DIN 4150.3 also provides guideline values for evaluating the effects of vibration on buried pipework, summarised in Table 4.7.

Table 4.7 DIN4150.3 guideline values for evaluating the effects of short-term vibration on buried pipework

Line	Pipe material	Guideline values for velocity measured on the pipe (mm/s)
1	Steel (including welded pipes)	100
2	Clay, concrete, reinforced concrete, pre-stressed concrete, metal (with or without flange)	80
3	Masonry, plastic	50

4.3.2 Human comfort

Humans are sensitive to vibration such that they can detect vibration levels well below those required to cause any risk of damage to a building or its contents. Criteria to avoid annoyance are therefore more stringent than those to prevent structural damage.

4.3.2.1 Intermittent vibration

The assessment of intermittent vibration outlined in Assessing Vibration: A Technical Guideline (DEC 2006) is based on Vibration Dose Values (VDVs). The VDV accumulates the vibration energy received over the day time and night time periods.

Acceptable VDVs for intermittent vibration arising from construction activities are listed in Table 4.8. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period.

Table 4.8 Acceptable vibration dose values for intermittent vibration

Category	Human comfort, VDV (m/s$^{1.75}$)	
	Daytime[1]	Night-time[1]
Critical areas[2]	0.10 (depending on its use, only applied if occupied)	0.10 (depending on its use, only applied if occupied)
Residences	0.20	0.13
Offices, schools, educational institutions and places of worship	0.40	0.40
Non-sensitive structures of reinforced concrete or steel construction. (e.g. factories and Workshops)	0.80 (only applied if occupied)	0.80 (only applied if occupied)

Table notes:

1 Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.
2 Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472–1992.

4.4 Blasting

Blasting is currently proposed to take place for excavation of borrow material from borrow pits. Construction blasting can result in two adverse environmental effects – airblast and ground vibration. The airblast and ground vibration produced may cause human discomfort and may have the potential to cause damage to structures, architectural elements and services.

Two guidelines have been considered as part of this assessment:

- Australian and New Zealand Environment Council (ANZEC) Guidelines – Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration
- Australian Standard 2187.2-2006 Explosives - Storage and Use Part 2: Use of Explosives – Appendix J.

The ANZEC Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration has been adopted by the Environment Protection Authority as comfort criteria to minimise annoyance and discomfort to persons at noise sensitive sites (e.g. residences, hospitals, schools etc) as a result of blasting. The guidelines are not intended to provide structural damage criteria. However they do provide a conservative approach to the assessment of potential impacts on structures as minimising human annoyance and comfort would inherently minimise structural damage.

AS 2187.2 recommends ground vibration limits which are consistent with the ANZEC guidelines but provides more detail with respect to criteria for human comfort and structural damage. This includes consideration of different types of structures such as more sensitive masonry and plasterboard buildings and less sensitive reinforced concrete buildings. AS 2187.2-2006 notes that damage (even of a cosmetic nature) has not been found to occur at airblast levels below 133 dB (linear peak).

4.4.1 Blasting criteria

In relation to airblast overpressure, the following criteria have been adopted from the ANZEC guidelines:

- Less than or equal to 115 dB(linear) peak for 95 per cent of total blasts over 12 months
- Less than 120 dB(linear) peak for any blasts.

For the purposes of this proposal, the AS 2187.2 ground vibration criteria have been considered and are summarised in Table 4.9. AS 2187.2 recommends that if the prescribed limits in Table 4.9 cannot be achieved, an agreement may be reached with the landowner permitting higher levels.

The blast vibration criteria identified in the ANZEC guidelines are considered conservative and were originally developed to protect communities exposed to long-term blasting operations such as mining sites. For projects such as this with a shorter duration of blasting, a higher vibration criterion may be reasonable.

Table J4.5 (A) in Appendix H of AS2187.2 presents vibration limits designed to safeguard human comfort in relation to blasting that have been used by some authorities, as it defines clearer vibration limits which are dependent on the specific duration of the work. Based on the limitations of the ANZEC guideline and further guidance in AS2187.2, a human comfort vibration limit of 10 mm/s (peak particle velocity) for blasting operations lasting less than 12 months has been adopted for this proposal.

Table 4.9 Blasting ground vibration criteria summary

Category	Human comfort	Structural damage[1]
Sensitive structures (e.g. residential, theatres, schools etc.)	5 mm/s for 95% blasts per year 10 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply[2]	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Occupied non-sensitive structures of reinforced concrete or steel construction (e.g. factories and commercial premises)	25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacture's specifications or levels that can be shown to adversely affect the equipment operation.	50 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply*
Occupied non-sensitive structures that include masonry, plaster and plasterboard in their construction (e.g. factories and commercial premises)	25 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacture's specifications or levels that can be shown to adversely affect the equipment operation.	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Unoccupied non-sensitive structures of reinforced concrete or steel construction (e.g. factories and commercial premises)	N/A	50 mm/s maximum unless agreement is reached with the occupier that a higher limit may apply*
Unoccupied non-sensitive structures that include masonry, plaster and plasterboard in their construction	N/A	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Table notes:

1 The values above are less stringent than those in DIN 4150. This is because DIN 4150 considers resonance in buildings from continuous vibration. Due to the short duration of blasting events the propensity for resonance within buildings is minimal, giving rise to higher criteria.

2 Blast vibration criteria identified in the ANZEC are considered conservative and were originally developed to protect communities exposed to long-term blasting operations such as mining sites. For proposals such as this, with a shorter duration of blasting of two months or less, a higher vibration criterion may be reasonable. For this proposal, the location of the blast moves along the alignment such that any one receiver is affected for short period of time. Table J4.5(A) in Appendix H of AS2187 presents vibration limits designed to safeguard human comfort in relation to blasting that have been used by some authorities, as it defines clearer vibration limits which are dependent on the specific duration of the proposal. Based on the limitations of the ANZEC guideline and further guidance in AS2187, a human comfort vibration limit of 10 mm/s (peak particle velocity) for blasting operations lasting less than 12 months has been adopted for this proposal.

The measurement of vibration should be taken at any point on 'noise sensitive sites' which is at least the longest dimension of the foundation of a building or structure away from such buildings or structure.

These requirements do not cover high rise buildings, buildings with long span floors, specialist structures such as reservoirs, dams and hospitals, or buildings housing scientific equipment sensitive to vibration. These require special considerations, which may necessitate taking additional measurements on the structure itself. Particular attention should be given to the response of suspended floors in residential buildings.

4.4.2 Recommended hours and frequency of blasting activities

The ANZEC guidelines recommend that:

- Blasting should generally only be permitted during the hours of 9.00 am to 5.00 pm Monday to Saturday. Blasting should not take place on Sundays or public holidays
- Blasting should generally take place no more than once per day.

The recommended restrictions on times and frequency of blasting do not apply to those premises where the effects of the blasting are not perceived at noise sensitive sites. In addition, it should be noted that the recommendation of blasting taking place no more than once per day is taken to mean no one sensitive receiver should not be affected by blasting more than once per day. Land owner consultation will occur prior to any blasting activity.

4.5 Non-rail operational noise criteria

4.5.1 Operational noise trigger levels – construction camp

To provide accommodation for construction workers a construction camp has been proposed within North Star. Although the camp is associated solely with construction works the nature of noise produced by the operation of the camp is not considered to be typical of construction noise. Therefore, the potential operational impacts of this camp have been assessed in accordance with the Noise Policy for Industry. The Noise Policy for Industry provides noise trigger levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable noise mitigation measures. The assessment procedure for industrial noise sources has two components that must be considered:

- Controlling intrusive noise impacts in the short term for residences
- Maintaining noise level amenity for residences and other land uses

4.5.1.1 Intrusive noise impacts

The Noise Policy for Industry states that the intrusiveness of an industrial noise source may generally considered acceptable if the level of noise from the source (L_{Aeq} level), measured over a 15 minute period, does not exceed the background noise level measured by more than 5 dB. The RBL is the background noise level to be used for assessment purposes and is determined by the methods given in Fact Sheet B of the Noise Policy for Industry. Adjustments are to be applied to the level of noise produced if the noise at the receiver contains annoying characteristics such as tonality or impulsiveness.

The proposal intrusiveness noise levels are presented in Table 4.10. It should be noted that the construction camp is located entirely within North Star and as such, only residents within NCA1 have been considered in this assessment

Table 4.10 Proposal intrusiveness noise level

Receivers	Time of day[1]	RBL, dB(A)[2]	Intrusiveness noise level RBL + 5 dB(A), $L_{Aeq,15min}$
Residential	Day	35[3]	40
	Evening	32	37
	Night	30[3]	35

Table notes:

1 In accordance with the Noise Policy for Industry, time of day is defined as follows:
Day – the period from 7.00 am to 6.00 pm Monday to Saturday or 8.00 am to 6.00 pm on Sundays and public holidays.
Evening – the period from 6.00 pm to 10.00 pm.
Night – the remaining periods.
2 Based on noise levels measured at NS2B_NL_01.
3 In accordance with Noise Policy for Industry Table 2.1, a minimum RBL has been adopted where the measured RBL is less than 35 dB(A) during the day, 30 dB(A) in the evening, or 30 dB(A) at night.

4.5.1.2 Protecting noise amenity

To limit continuing increases in noise levels, the maximum ambient noise level resulting from all industrial noise sources in an area should not normally exceed the acceptable levels specified in Table 2.2 of the Noise Policy for Industry. As per the definitions of receiver types in Table 2.3 of the Noise Policy for Industry, residential receivers likely to be affected by noise from the construction camp are classed as being rural residential. To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise. The project amenity level is equal to the amenity noise level - 5 dB(A). The project amenity level is converted from a period level to 15 minute level by adding 3 dB. The resultant noise amenity level for each type of receiver is shown in Table 4.11.

Table 4.11 Recommended L_{Aeq} noise levels from industrial noise sources

Type of receiver	Indicative noise amenity area	Time of day	Recommended amenity noise level, $L_{Aeq\ (period)}$	Project amenity noise level, $L_{Aeq,15min}$
Residential	Rural	Day	50	48
		Evening	45	43
		Night	40	38
Active recreational area	All	When in use	55	53
Industrial premises	All	When in use	70	68
School classroom – internal	All	Noisiest 1-hour period when in use	45	43
Commercial premises	All	When in use	65	63

4.5.1.3 Project noise trigger levels

The project noise trigger level is the lower of the intrusiveness and amenity noise levels. Provided in Table 4.12 are the established project noise trigger levels for the assessment locations in close proximity to the construction camp. Table 4.12 presents the project noise trigger levels for the day, evening and night-time periods.

Table 4.12 Operational noise criteria

Receiver type	Assessment period	Intrusive noise levels, $L_{Aeq,15min}$	Amenity noise levels, $L_{Aeq,15min}$	Project noise trigger levels, $L_{Aeq,15min}$
Residential	Day	40	48	40
	Evening	37	43	37
	Night	35	38	35
Active recreational area	When in use	-	53	53
Industrial premises	When in use	-	68	68
School classroom – internal	Noisiest 1-hour period when in use	-	43	43
Commercial premises	When in use	-	63	63

4.5.1.4 Tonality and Noise Policy for Industry modifying factors

Noise emissions can have “annoying characteristics” such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content. Penalties of up to a maximum of 10 dB may be applied where the subject noise has such characteristics at the receiver location.

4.5.1.5 Maximum noise level assessment

The Noise Policy for Industry requires the potential for sleep disturbance to be assessed by considering maximum noise level events during the night-time period.

Where the subject development/premises night-time noise levels at a residential receiver location exceed the following screening levels:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- $L_{A,max}$ 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater
- A detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in Table 4.13.

Table 4.13 Night-time sleep disturbance criteria, dB(A)

Noise catchment area	Night-time RBL, $L_{A90,15min}$	Sleep disturbance screening levels	
		$L_{Aeq,15min}$	L_{AFmax}
NCA1	30	40	52

4.5.2 Operational road traffic noise – road realignment

The realignment of one road is proposed within the study area, and consists of a 1.3 km stretch of the Bruxner Way, approximately 4.9 km south of the State border along the proposed alignment. A desktop assessment approach has been implemented for the proposal. The assessment has been completed in accordance with the EPA's document NSW Road Noise Policy.

Table 4.14 presents the NSW Road Noise Policy assessment criteria for existing residences with potential to be affected from redevelopment of existing roads. The external criteria are assessed at 1 m from the affected residential building facades and at a height of 1.5 m from the floor.

Table 4.14 Road traffic assessment criteria for residential land uses

Road category	Type of project/land use	Assessment criteria, dB(A)	
		Day (7.00 am to 10.00 pm)	Night (10.00 pm to 7.00 am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by noise from **redevelopment** of existing freeway/arterial/sub-arterial roads	$L_{Aeq, (15\ hour)}$ 60 (external)	$L_{Aeq, (9\ hour)}$ 55 (external)
Local roads	Existing residences affected by noise from **redevelopment** of existing local roads	$L_{Aeq, (1\ hour)}$ 55 (external)	$L_{Aeq, (1\ hour)}$ 50 (external)

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB(A) represents a minor impact that is considered barely perceptible to the average person.

5 Construction noise assessment

5.1 Construction stages and scheduling

Construction activities to be carried out as part of the proposal are outlined in Table 5.1. The work has been grouped into six distinct construction stages based on proposed construction activities.

Table 5.1 Construction stages and scheduling

Construction stage	Activities
Site establishment/laydown areas	■ Establishment of site compounds/laydown areas, site facilities and camps ■ Treatment of contaminated sites ■ Haul road and access roads construction ■ Haul road maintenance
Drainage works and earthworks	■ Clearing and grubbing/topsoil stripping ■ Import general fill ■ Place and compact general fill ■ Import structural fill ■ Place structural fill ■ Install cross drainage
Bridge and road works	■ Substructure/foundations construction ■ Pile construction ■ Superstructure construction ■ Road works
Track works	■ Capping material import ■ Capping material placement ■ Bottom ballast ■ Sleeper installation ■ Rail installation ■ Top ballast ■ Track tamping and regulating ■ Rail stressing
Testing, commissioning and reinstatement	■ Demobilising laydown areas and associated facilities ■ Removing all materials, waste and redundant structures from the construction site ■ Installing permanent fencing ■ Restoring disturbed areas ■ Decommissioning temporary fencing and access tracks that will not be used during the operation phase

5.2 Plant and equipment levels

Table 5.2 presents the typical sound power levels of the construction equipment to be used for each construction stage. These sound power levels are typical values taken from data provided in Australian Standard AS2436-2010, Guide to noise and vibration control on construction, demolition and maintenance sites and British Standard 5228: Part 1 2009 Code of practice for noise and vibration control on construction and open sites as well as FFJV's noise database.

These sound power levels assume equipment is modern and in good working order. In FFJV's experience, L_{A1} sound power levels of construction activities are typically up to eight decibels above L_{Aeq} sound power levels.

For the noise assessment, the following construction scenarios have been considered with an indicative construction duration which would be confirmed during detailed design. Recommendations to control noise are provided in Section 7. The modelled scenarios include all equipment that could be reasonably assumed to be operating at the same time for an entire 15 minute period.

During the detailed design local site conditions and changes in work practices may cause some variation in the equipment used. While the equipment may vary, other major infrastructure projects have shown that due to the conservative approach to noise predictions, received noise levels are unlikely to be appreciably higher than those predicted in this assessment.

This approach is used at this point in the assessment to ensure that identified impacts are not under-predicted and adequate noise management and mitigation measures are considered early in the proposal.

Table 5.2 Typical sound power levels of construction equipment

Construction stage	Indicative Duration	Equipment	Sound power level, dB(A)
Site establishment Laydown areas (used intermittently)	6 months	Trucks[1]	100
		Crane	98
		Concrete mixer	90
		Chainsaw	110
		Chipper	120
		Grader	107
		40t Excavator	107
		Welding equipment[1]	110
		Front end loader[1]	103
		Water cart	109
		Total[4]	**122**
Drainage works and earthworks	14 months	Jackhammer	108
		Generator	93
		Crushing plant	117
		Boring machine	107
		Backhoe	95
		Dozer	107
		40t Excavator	107
		Trucks	100
		Scraper	107
		Water cart	109
		Front end loader	103
		Compactor	106
		Grader	107
		15t Roller	102
		Total[4]	**120**
Bridge works[3]	20 months	40t Excavator	107
		Impact Piling Rig	117
		Concrete truck	108
		Concrete pump	106
		Drilling rig	111
		Boring machine	107

Construction stage	Indicative Duration	Equipment	Sound power level, dB(A)
		Trucks	100
		Welding equipment	110
		Generator	93
		Crane	98
		Total[4]	**120**
Road works[3]	8 months	30t Excavator	103
		Trucks	100
		Crane	98
		Concrete truck	108
		Concrete pump	106
		Generator	93
		Compactor	106
		Grader	107
		Seal spray rig	106
		15t roller	102
		Water cart	109
		Line marking equipment	102
		Total[4]	**116**
Track works	8 months	Tamper	102
		Regulator	102
		40t Excavator	107
		Dump truck	100
		Water cart	109
		Trucks	100
		Dozer	107
		Dynamic track stabiliser	102
		Lighting rig	93
		15t Roller	102
		Skid steer loader	104
		Grader	107
		Front end loader	103
		Clip up machine	85
		Rail rake	94
		Welding equipment	110
		Ballast train	102
		Total[4]	**117**
Testing, commissioning and reinstatement	6 months	Grader	107
		30t Excavator	103
		Milling machine	108
		Water cart	109
		Trucks	100
		Generator	93

Construction stage	Indicative Duration	Equipment	Sound power level, dB(A)
		Oxy torch	93
		Sprayer truck	106
		Total[4]	**114**

Table notes:

1 Equipment likely to be used in laydown areas only.
2 Sound power level represents either site setup works or laydown area activities.
3 Bridge works and road works have been assessed as a single scenario to maintain consistency
4 The total level is the logarithmic sum of sound power levels of all equipment that has been assumed to be operating simultaneously

5.3 Noise modelling methodology

Noise levels due to the construction activities shown in Table 5.1 and Table 5.2 were predicted at nearby noise sensitive receivers using SoundPLAN v8.0 noise modelling software. The CONCAWE method was used, it is especially suited to predicting noise propagation over large distances as it accounts for a range of atmospheric conditions that can significantly influence the propagation of noise over large distances.

The noise model was created to represent 'reasonable' worst periods of construction work.

The following features were included in the noise model:

- Ground topography
- Ground absorption and reflection
- Receivers
- Construction noise sources.

It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and the location of the plant equipment.

5.3.1 Construction modelling assumptions

The following assumptions were made in modelling the construction noise scenarios:

- All equipment would be operating simultaneously, which is unlikely hence a conservative assumption
- Equipment was assumed to be operating at the closest point in the proposal area to each receiver, in order to present the worst case scenario. In reality the equipment would only be closest point to each receiver for a limited period of the durations presented in Table 5.2.
- Neutral atmospheric conditions i.e. relatively calm, no wind.

5.4 Predicted construction noise impacts

A summary of the predicted construction noise impacts associated with each stage of construction are presented for the standard hours construction activities in Table 5.3 and for out of hours construction activities in Table 5.4. Out of hours work has been conservatively assessed against the more stringent night-time criteria. Appendix C presents the L_{Aeq} noise level contours for the construction activities for individual properties.

The tables present the noise management levels and the highest predicted construction noise levels at a noise sensitive receiver for each noise catchment area. The tables also present the number of receivers where the construction noise levels are predicted to exceed the NML and the highly noise affected level for each noise catchment area.

It is important to consider that this assessment is representative of the worst case 15 minute period of construction activity, while the construction equipment is at the nearest location to each sensitive receiver location. The assessed scenario does not represent the ongoing day to day noise impact at noise sensitive receivers for an extended period of time.

Particularly noisy activities, such as piling, are likely to persist for only a portion of the overall construction period. In addition, the predictions use the shortest separation distance to each sensitive receiver, however in reality vary between plant and sensitive receivers. For works that move along the rail alignment, rather than works located at a construction compound noise exposure at each receiver would reduce due to increases in distance loss as the works progress along the alignment.

The construction staging is indicative and is subject to change during detailed design.

Table 5.3 Predicted construction noise impacts – Standard hours

NCA	Noise management level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers where NML is exceeded			Number of highly noise affected receivers
			Number of properties where noise levels exceed NML - 1 to 10 dB(A)	Number of properties where noise levels exceed NML - 11 to 20 dB(A)	Number of properties where noise levels exceed NML - > 20 dB(A)	
Site establishment and laydowns						
NCA1	45	59	27	1	0	0
NCA2	45	53	4	0	0	0
NCA3	45	49	2	0	0	0
NCA4	45	45	0	0	0	0
NCA5	45	43	0	0	0	0
Drainage works and earthworks						
NCA1	45	37	0	0	0	0
NCA2	45	78	2	0	1	1
NCA3	45	64	1	1	0	0
NCA4	45	75	0	0	1	1
NCA5	45	41	0	0	0	0
Bridge and road works						
NCA1	45	< 20	0	0	0	0
NCA2	45	69	2	0	1	0
NCA3	45	42	0	0	0	0
NCA4	45	29	0	0	0	0
NCA5	45	40	0	0	0	0
Track works						
NCA1	45	34	0	0	0	0
NCA2	45	75	2	0	1	1
NCA3	45	61	1	1	0	0
NCA4	45	72	0	0	1	0
NCA5	45	38	0	0	0	0

NCA	Noise management level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers where NML is exceeded			Number of highly noise affected receivers
			Number of properties where noise levels exceed NML - 1 to 10 dB(A)	Number of properties where noise levels exceed NML - 11 to 20 dB(A)	Number of properties where noise levels exceed NML - > 20 dB(A)	
Testing commissioning and reinstatement						
NCA1	45	31	0	0	0	0
NCA2	45	72	2	0	1	0
NCA3	45	58	1	1	0	0
NCA4	45	69	0	0	1	0
NCA5	45	35	0	0	0	0

Table 5.4 Predicted construction noise impacts – Out-of-hours (Night-time)

NCA	Noise management level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers where the NML is exceeded			
			Number of properties where noise levels exceed NML - < 5 dB(A)	Number of properties where noise levels exceed NML – 5 to 15 dB(A)	Number of properties where noise levels exceed NML – 16 to 25 dB(A)	Number of properties exceeding NML - > 25 dB(A)
Site establishment and laydowns						
NCA1	35	59	15	27	1	0
NCA2	35	53	0	4	0	0
NCA3	35	49	3	2	0	0
NCA4	35	45	3	0	0	0
NCA5	35	43	3	0	0	0
Drainage works and earthworks						
NCA1	35	37	7	0	0	0
NCA2	35	78	1	2	1	1
NCA3	35	64	4	1	1	0
NCA4	35	75	1	0	1	1
NCA5	35	41	2	0	0	0
Bridge and road works						
NCA1	35	< 20	0	0	0	0
NCA2	35	69	0	2	1	0
NCA3	35	42	1	0	0	0
NCA4	35	29	0	0	0	0
NCA5	35	40	2	0	0	0
Track works						
NCA1	35	34	0	0	0	0
NCA2	35	75	1	2	1	1
NCA3	35	61	1	1	1	0
NCA4	35	72	0	0	1	0
NCA5	35	38	2	0	0	0

NCA	Noise management level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers where the NML is exceeded			
			Number of properties where noise levels exceed NML - < 5 dB(A)	Number of properties where noise levels exceed NML – 5 to 15 dB(A)	Number of properties where noise levels exceed NML – 16 to 25 dB(A)	Number of properties exceeding NML - > 25 dB(A)
Testing commissioning and reinstatement						
NCA1	35	31	0	0	0	0
NCA2	35	72	1	2	1	0
NCA3	35	58	0	1	1	0
NCA4	35	69	0	0	1	0
NCA5	35	35	0	0	0	0

Given the relatively large distances to sensitive receivers construction noise levels are relatively low at receivers. However, some exceedances of the noise management levels would be expected.

The scenario resulting in the highest construction noise levels at receivers would be during drainage works and earthworks, however a maximum of two receivers would be highly noise affected at any time.

Recommendations to mitigate construction noise impacts have been provided in Section 7.

5.4.1 Sleep disturbance assessment

Sleep disturbance is assessed using an $L_{A1(1\ min)}$ parameter, which is considered to be the maximum noise level excluding extraneous noise events. For construction works that are proposed to be undertaken out-of-hours a sleep disturbance assessment has been undertaken. The noise modelling results are provided in Table 5.5 with predicted noise levels compared with the sleep disturbance screening criteria and the awakening reaction criteria.

Table 5.5 Predicted $L_{A1,1min}$ sleep disturbance impacts at residential receivers

NCA	Sleep disturbance criteria	Maximum $L_{A1,1min}$ noise level	Number of properties impacted - Sleep disturbance exceedances	Number of properties impacted - Awakening reaction
Site establishment and laydowns				
NCA1	45	67	42	1
NCA2	45	61	4	0
NCA3	45	57	5	0
NCA4	45	53	2	0
NCA5	45	51	2	0
Drainage works and earthworks				
NCA1	45	45	0	0
NCA2	45	86	4	1
NCA3	45	72	5	1
NCA4	45	83	1	1
NCA5	45	49	2	0
Bridge and road works				
NCA1	45	< 20	0	0
NCA2	45	77	3	1
NCA3	45	50	1	0
NCA4	45	37	0	0

NCA	Sleep disturbance criteria	Maximum $L_{A1,1min}$ noise level	Number of properties impacted - Sleep disturbance exceedances	Number of properties impacted - Awakening reaction
NCA5	45	48	2	0
Track works				
NCA1	45	42	0	0
NCA2	45	83	4	1
NCA3	45	69	2	1
NCA4	45	80	1	1
NCA5	45	46	2	0
Testing commissioning and reinstatement				
NCA1	45	39	0	0
NCA2	45	80	4	1
NCA3	45	66	2	1
NCA4	45	77	1	1
NCA5	45	43	0	0

A number of exceedances of the sleep disturbance screening criteria have been predicted due to the night-time construction works associated with all construction stages. Typically, up to three residential receivers in any noise catchment area may experience noise levels which exceed the awakening reaction criterion.

5.5 Borrow pits assessment

5.5.1 Assessment methodology

Noise levels due to the use of borrow pits were predicted at nearby noise sensitive receivers using the same methodology and assumptions for other construction activities outlined in Sections 5.3 and 5.4.

The proposal is directly related to construction activities associated with the proposal and the works would be temporary and would take place over a defined term (rather than indefinitely). On this basis the Interim Construction Noise Guideline is the appropriate policy under which to assess the noise impacts of the proposal.

Receivers identified for the assessment of noise from borrow pits are typically outside the main study area, with the exception of some receivers within NCAs 2 and 3. As a result, these receivers do not fall within a Noise Catchment Area. Given their rural and relatively isolate locations they have been assigned the minimum RBLs presented in the Noise Policy for Industry as a conservative assumption. All receivers within 2 km of each borrow pit have been identified for assessment.

Table 5.6 details the borrow pits identified for assessment and the associated equipment intended to be operating. Note that Site 2 includes provision for a crushing plant.

Table 5.6 Proposed borrow pits and equipment

Site name	Equipment	Sound power level, dB(A)
Site 2	Crushing plant	117
	Front end loader	103
	40t Excavator	107
	Water cart	109
	Trucks	100
	Total	**118**
Sites 1, 4, 5, 7, 7b, 8, 9, 11, 13, 25 and 26	Front end loader	103
	40t Excavator	107
	Water cart	109
	Trucks	100
	Total	**112**

5.5.2 Predicted noise impacts

A summary of the predicted construction noise impacts associated with the borrow pits are presented for the standard hours construction activities in Table 5.7 and for out of hours construction activities in Table 5.8. Out of hours work has been conservatively assessed against the more stringent night-time criteria.

The tables present the noise management levels and the highest predicted construction noise levels at a noise sensitive receiver for each noise catchment area under consideration. The tables also present the number of receivers where the construction noise levels are predicted to exceed the NML and the highly noise affected level for each noise catchment area. Receivers which are outside the NCAs identified within the main study area have been given a 'Not Applicable' classification.

Table 5.7 Predicted borrow pits noise impacts – Standard hours

NCA	Noise management level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers where NML is exceeded			Number of highly noise affected receivers
			Number of properties exceeding NML - 1 to 10 dB(A)	Number of properties exceeding NML - 11 to 20 dB(A)	Number of properties exceeding NML - > 20 dB(A)	
Borrow pits						
NCA2	45	49	2	0	0	0
NCA3	45	50	3	0	0	0
N/A	45	49	13	0	0	0

Table 5.8 Predicted borrow pits noise impacts – Out-of-hours (Night-time)

NCA	Noise management level, dB(A)	Maximum L_{Aeq} noise level, dB(A)	Number of receivers where the NML is exceeded			
			Number of properties exceeding NML - < 5 dB(A)	Number of properties exceeding NML – 5 to 15 dB(A)	Number of properties exceeding NML – 16 to 25 dB(A)	Number of properties exceeding NML - > 25 dB(A)
Borrow pits						
NCA2	35	49	0	2	0	0
NCA3	35	50	2	3	0	0
N/A	35	49	10	13	0	0

Given the relatively large distances to sensitive receivers construction noise levels are relatively low at receivers. However, some exceedances of the noise management levels would be expected.

Recommendations to mitigate noise impacts have been provided in Section 7.

5.5.2.1 Sleep disturbance assessment

Sleep disturbance is assessed using an $L_{A1(1\ min)}$ parameter, which is considered to be the maximum noise level excluding extraneous noise events. For works that are proposed to be undertaken out-of-hours a sleep disturbance assessment has been undertaken. The noise modelling results are provided in Table 5.9 with predicted noise levels compared with the sleep disturbance screening criteria and the awakening reaction criteria.

Table 5.9 Predicted LA1,1min sleep disturbance impacts at residential receivers

NCA	Sleep disturbance criteria	Maximum $L_{A1,1min}$ noise level	Number of properties impacted - Sleep disturbance exceedances	Number of properties impacted - Awakening reaction
Borrow pits				
NCA2	45	57	2	0
NCA3	45	58	5	0
N/A	45	57	23	0

A number of exceedances of the sleep disturbance screening criteria have been predicted due to the night-time construction works. However, no receivers are predicted to experience noise levels which exceed the awakening reaction criterion.

5.6 Construction traffic assessment

Construction vehicle movements and existing traffic flows have been based the Traffic Impact Assessment prepared for the North Star to NSW/QLD Border EIS (FFJV 2020). Construction traffic movements outlined in this assessment were used to conservatively assess the noise impacts resulting from construction traffic.

Table 5.10 presents the existing and additional traffic flows along roads within NSW considered to be predominantly utilised by construction traffic, including staff travel to site, delivery of construction materials and traffic accessing borrow pits.

Table 5.10 Existing traffic flows and additional traffic flows due to construction traffic

Road	Existing daily traffic flow		Additional daily traffic flow		Relative noise increase, dB(A)
	Light	Heavy	Light	Heavy	
Cunningham Highway - Between NSW/QLD Border and Leichhardt Highway	1,933	1,530	0	47	0.1
Cunningham Highway - Between Leichardt Highway and Yelarbon-Keetah Road	821	786	0	3	0.0
Cunningham Highway - Between Yelarbon-Keetah Road and Millmerran Inglewood Road	962	800	0	3	0.0
Gore Highway - Between Millmerran Inglewood Road and Bunkers Hill School Road	2,103	1,018	0	3	0.0
Leichardt Highway - Between Cunningham Highway and Hunt Street	1,638	1,288	0	45	0.1
Millmerran Inglewood Road - Between Cunningham Highway and Gore Highway	244	125	0	3	0.1

Road	Existing daily traffic flow		Additional daily traffic flow		Relative noise increase, dB(A)
	Light	Heavy	Light	Heavy	
Toowoomba Cecil Plains Road - Between McDougall Street and Troys Road	4,382	1,660	0	3	0.0
Toowoomba Cecil Plains Road - Between Troys Road and Hursley Road	2,811	630	0	3	0.0
Toowoomba Cecil Plains Road - Between Hursley Road and Wellcamp Westbrook Road	2,811	630	0	3	0.0
Gwydir Highway - Between Bent Street and New England Highway	1,275	357	0	0	0.0
Gwydir Highway - Between New England Highway and Campbell Street	1,275	357	0	0	0.0
Gwydir Highway - Between Campbell Street and Stephem Street	1,275	357	0	0	0.0
Newell Highway - Between NSW/QLD border and Bruxner Way	3,008	1,465	0	96	0.2
Newell Highway - Between Bruxner Way and Letter Box Road	3,008	1,465	0	48	0.1
New England Highway - Between Gwydir Highway and Gwydir Highway	1,836	558	0	0	0.0
Summerland Way - Between Trenayr Road and Turf Street	3,133	569	0	0	0.0
Bent Street - Between Craig Street and Gwydir Highway	3,680	649	0	0	0.0
Clark Road - Between Clark Road and Trenayr Road	736	130	0	0	0.0
Craig Street - Between Villiers Street and Clarence Street	6,993	1,234	0	0	0.0
Craig Street - Between Clarence Street and Bent Street	6,993	1,234	0	0	0.0
Dobie Street - Between Villers Street and Summerland Way	6,993	1,234	0	0	0.0
Villers Street - Between Craig Street and Dobie Street	6,993	1,234	0	0	0.0
Trenayr Road - Between Summerland Way and Clark Road	3,680	649	0	0	0.0
Boodle Street - Between Boodle Street and Hunt Street	736	130	0	45	0.8
Hunt Street - Between Leichardt Hwy and Boodle Street	736	130	0	45	0.8
Bruxner Way - Between North Star Road and Borrow Pit Site 11 Access Road	400	112	0	333	4.9
Bush Access Road - Full extent	14	10	0	286	14.2
County Boundary Road - Between Croppa Moree Road and Gil Gil Creek Road	237	78	0	286	5.6
Croppa Creek Road - Between I B Bore Road and Croppa Moree Road	237	78	0	286	5.6
Croppa Moree Road - Between Croppa Creek Road and County Boundary Road	237	78	151	135	3.8
Edwards Street - Between North Star Road and I B Bore Road	237	78	0	446	7.1

Road	Existing daily traffic flow		Additional daily traffic flow		Relative noise increase, dB(A)
	Light	Heavy	Light	Heavy	
Forest Creek Road - Between North Star Road and Forest Creek Road Borrow Pit	14	10	0	67	8.4
Gil Gil Creek Road - Between County Boundary Road and Johnston Borrow Pit Access	237	78	0	286	5.6
I B Bore Road - Between Edwards Street and Croppa Creek Road	237	78	0	286	5.6
North Star Road - Between Moree Plains Shire Council Boundary and Edwards Street	237	78	253	337	6.4
North Star Road - Between Edwards St and Getta Getta Road	237	78	235	210	5.0
North Star Road - Between Getta Getta Road and Warialda Road	237	78	0	286	5.5
Scotts Road - Between North Star Road and Hohns Road	237	78	0	95	2.7
Stephen Street - Between Long Street and Gwydir Highway	1,275	357	0	0	0.0
Warialda Road - Between North Star Road and Stephen Street	1,275	357	0	0	0.0
Campbell Street - Between Byron Street and Otho Street	1,275	357	0	0	0.0
Bruxner Way - Between Newell Highway and Tucka Tucka Road	400	112	0	146	2.7
Bruxner Way - Between Tucka Tucka Road and North Star Road	400	112	44	110	2.3
Hohns Road - Between Hohns Road and Borrow Pit Site 5	237	78	0	95	2.6
Letter Box Road - Between Newell Highway and Borrow Pit Site 13 Access Road	237	78	0	48	1.5
North Star Road - Between Bruxner Way and Gwydir Shire Council boundary	243	55	53	43	1.9
River Road - Full Extent	14	10	0	64	8.1
Tucka Tucka Road - Between Bruxner Way to Gwydir Shire Council Boundary	285	33	9	19	1.0
Blackwell Road - Between Bunkers Hill School Road and Macaulay Road	431	150	0	3	0.1
Bunkers Hill School Road - Between Gore Highway and Blackwell Road	458	118	0	3	0.1
Macaulay Road - Between Blackwell Road and Wellcamp Westbrook Road	523	122	0	3	0.1
Wellcamp Westbrook Road - Between Macaulay Road and Toowoomba Cecil Plains Road	667	121	0	3	0.1

Table note:

1 Where heavy vehicle percentage has not been provided, a value of 20% has been assumed.

For several roads intended to be used to carry construction traffic the maximum predicted increase in noise level is greater than 2.0 dB(A). For these roads where the relative noise increase is predicted to be greater than 2.0 dB(A), a further calculation has been undertaken to verify that predicted noise levels at the nearest affected receiver are below the relevant criteria outlined in the NSW Road Noise Policy and can be found in Section 4.1.4. These roads have been assessed against the more stringent night-time criteria as a conservative assumption. The results of this desktop assessment are provided in Table 5.11.

Table 5.11 **Predicted road traffic noise levels for roads where noise levels are predicted to increase by 2 dB(A) or more due to construction traffic**

Road	Road Type[1]	Criteria, dB(A)	Predicted noise level, dB(A)
Bruxner Way - Between North Star Road and Borrow Pit Site 11 Access Road	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	49
Bush Access Road - Full extent	Local Road	$L_{Aeq,1hr}$ 50	46
County Boundary Road - Between Croppa Moree Road and Gil Gil Creek Road	Local Road	$L_{Aeq,1hr}$ 50	40
Croppa Creek Road - Between I B Bore Road and Croppa Moree Road	Local Road	$L_{Aeq,1hr}$ 50	39
Croppa Moree Road - Between Croppa Creek Road and County Boundary Road	Local Road	$L_{Aeq,1hr}$ 50	49
Edwards Street - Between North Star Road and I B Bore Road	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	53
Forest Creek Road - Between North Star Road and Forest Creek Road Borrow Pit	Local Road	$L_{Aeq,1hr}$ 50	36
Gil Gil Creek Road - Between County Boundary Road and Johnston Borrow Pit Access	Local Road	$L_{Aeq,1hr}$ 50	37
I B Bore Road - Between Edwards Street and Croppa Creek Road	Local Road	$L_{Aeq,1hr}$ 50	43
North Star Road - Between Moree Plains Shire Council Boundary and Edwards Street	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	40
North Star Road - Between Edwards St and Getta Getta Road	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	51
North Star Road - Between Getta Getta Road and Warialda Road	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	41
Scotts Road - Between North Star Road and Hohns Road	Local Road	$L_{Aeq,1hr}$ 50	31
Bruxner Way - Between Newell Highway and Tucka Tucka Road	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	50
Bruxner Way - Between Tucka Tucka Road and North Star Road	Freeway/Arterial/Sub-arterial Road	$L_{Aeq,9hr}$ 55	44
Hohns Road - Between Hohns Road and Borrow Pit Site 5	Local Road	$L_{Aeq,1hr}$ 50	32
River Road - Full Extent	Local Road	$L_{Aeq,1hr}$ 50	40

Table note:

1 Road type as defined in the NSW Road Noise Policy

As Table 5.11 shows, given the low volumes of traffic on these roads and/or the large distances to receivers, the traffic noise levels are less than the NSW Road Noise Policy criteria as presented in Table 4.14. As a result, no further assessment of construction traffic is required at this stage.

5.7 Construction vibration assessment

Vibration intensive work is likely to be undertaken at times as part of the construction works. This may include the use of piling rigs and vibratory rolling activities.

In order to comply with the cosmetic/structural damage and human discomfort criteria presented in Section 4.3 the minimum working distances presented in Table 5.12 should not be encroached.

Table 5.12 Recommended minimum working distances for vibration intensive equipment

Equipment	Rating/description	Minimum working distance, metres	
		Cosmetic damage[1]	Human response
Vibratory roller	1-2 tonne	5	15
	2-4 tonne	6	20
	4-6 tonne	12	40
	7-13 tonne	15	100
	13-18 tonne	20	100
	> 18 tonne	25	100
Pile driver – vibratory	Sheet piles	2 to 20	20
Piling rig – bored	≤ 800 mm	2 (nominal)	N/A
Piling rig – hammer	12 t down force	15	50

Table note:

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

The minimum working distances presented in Table 5.12 assume individual items of plant would be operating independently. Concurrent operation of vibration intensive equipment should be avoided, however if it is necessary to operate multiple items of equipment concurrently close to the minimum working distance then vibration monitoring is recommended.

The primary form of mitigation of vibration would be ensuring vibration intensive works do not occur within the minimum working distances. If vibration intensive works are planned within the minimum working distances identified, alternative equipment would be identified and vibration monitoring would be implemented. Further mitigation of vibration would not be required where the minimum working distances are adhered to.

The minimum working distances for cosmetic damage are general considered to be conservative and working within them will not necessarily result in damage, however as factors such as work practices and intervening ground conditions can affect vibration levels, vibration monitoring is recommended within these distances, and should be carried out at the beginning of the work in order to refine the minimum working distances for site specific conditions.

5.8 Blasting

Blasting is currently proposed to take place for excavation of borrow material from borrow pits. Impacts created by blasting are largely dependent on the blast methodology. The size of the charge, spaces between charge and timing between charges results in a large variability in the vibration generated by a blast. This variability necessitates the use of a specialised blast consultant to design blasts to achieve compliance with the applicable vibration criteria.

Using the equation J7.3 provided in AS2187.2-2006, the maximum effective charge mass per delay to achieve compliance with the vibration criteria is calculated to be 2.5 kilograms at a distance from charge of 100 metres, which is the location of the nearest sensitive receiver. This is based on site and rock property constants as recommended in AS2187.2-2006 for confined blasthole charges.

It is recommended that a certified blast engineer undertake test blasts when undertaking blasting in new areas across the project. The blast should be designed to ensure compliance with the blast criteria identified in this report.

5.9 Cumulative construction noise impacts

Table 5.13 details major projects which may be in construction simultaneously with this proposal and close enough to contribute to cumulative noise levels at sensitive receivers potentially affected by this proposal.

Table 5.13 Major proposed projects nearby to NS2B

Project and Proponent	Location	Description	EIS status	Relationship to NS2B
Border to Gowrie – Inland Rail (ARTC)	New South Wales/Queensland Border to Gowrie	Comprises approximately 146 km of new dual gauge track and 78 km of upgraded track from the NSW/QLD border, near Yelarbon, to Gowrie Junction, north west of Toowoomba in Queensland.	Project feasibility	Potential overlap on construction commencement for B2G and finalisation of NS2B
Narrabri to North Star – Inland Rail (ARTC)	Narrabri (NSW) to the village of North Star in NSW	An upgrade to approximately 188 km of track within the existing rail corridor and construction of approximately 1.6 km of new rail corridor.	Project assessment (late 2017 – late 2018)	Potential overlap of finalisation of N2NS and commencement of NS2B

Simultaneous noise from construction works of sections B2G or N2NS has the potential to increase noise levels at nearby sensitive receivers affected by noise from this proposal. Noise levels as a result of the cumulative impacts could increase by as much as 3 dB(A) higher than the maximum noise level of either section construction works. Although 3 dB(A) is generally considered just discernible, the cumulative impact of noise would be managed as far as possible by the contractors to ensure that the potential for adverse impacts at sensitive receivers is minimised. In addition any overlap of construction works is likely to be for a limited period.

6 Operational noise assessment

6.1 Assessment methodology

Noise emissions from the proposed construction camp were predicted at nearby receiver locations based on typical operational noise from such facilities. This typical scenario was modelled to assess the potential for noise emissions to impact nearby sensitive receivers, and achieve the project noise trigger levels presented in Section 4.5. The predicted noise levels are presented in Section 6.5. This assessment has been based upon 24 hour operation of the facility. It should be noted that the siting of all operational equipment assessed in this section is indicative based on the proposed location of the construction camp, and would be reviewed during detailed design.

6.2 Modelling

Noise levels from the proposed operation of the construction camp have been predicted at nearby noise sensitive receivers using SoundPLAN v8.0 (industry standard) noise modelling software. The operational noise levels were predicted using an implementation of CONCAWE[1] algorithms in the SoundPLAN noise propagation software. Both neutral and worst case meteorological conditions have been assumed, with the following parameters:

- Neutral meteorological conditions – Pasquill-Gillford stability category D with wind speed up to 0.5 m/s at 10 m
- Worst case meteorological conditions – Pasquill-Gillford stability category D with wind speed up to 3 m/s at 10 m.

The noise model takes into account significant noise sources and locations, screening effects, receiver locations, ground topography and noise attenuation due to geometrical spreading, air absorption, ground absorption and the effects of the prevailing weather conditions. The noise model was based on ground topography, indicative site layout and indicative plant equipment sound power levels in a worst case 15 minute period. The proposed site layout also assumes that a 3 metre barrier fence is erected around the northern and western perimeter of the camp.

All predicted noise levels are free field and 1.5 m above ground level at the most-affected point within a residential property boundary within 30 m of the nearest facade.

6.3 Construction camp noise sources

This section discusses the assumed sources of noise emission from the construction camp. The activities are generally categorised into the following two groups:

- Steady-state or quasi steady-state noise sources which typically produce continuous and consistent noise levels
- Discrete noise, which occurs infrequently and for short durations of time. This type of noise includes vehicle reversing alarms, car door slams etc.

6.3.1 Mechanical plant

At this stage, specific operational plant is not known, however a selection of typical mechanical plant has been implemented into the noise model. The plant has been selected for modelling at this preliminary stage, and further assessment should be undertaken during detailed design once specific details of the construction camp are known. Noise from mechanical plant is considered steady state noise.

[1] CONCAWE – The oil companies' international study group for conservation of clean air and water – Europe (established in 1963) Report 4/81 "The propagation of noise from petroleum and petrochemical complexes to neighbouring communities".

If either the number of plant items increases, or the assumed sound power levels are higher than that of the individual proposed unit to be used, then a reassessment of the potential noise impacts is recommended.

The sound power levels of a typical domestic air conditioning condenser unit are presented in Table 6.1. In addition, the assessment has also included the provision of a sewage treatment facility and a generating set of a typical size for this construction camp.

Table 6.1 Modelled operational mechanical plant sound power levels

Plant type	Quantity	Overall sound power level, dB(A)	Octave band frequency – Hz, dB							
			63	125	250	500	1000	2000	4000	8000
Condenser unit	96	61	69	63	60	59	56	51	45	48
Generating Set	1	101	-	-	-	-	-	-	-	-
Sewage treatment facility	1	89	-	-	-	-	-	-	-	-

6.3.2 Vehicle operations

Buses and light vehicles would be used to transport workers between the construction camp and the various work sites at the start and end of shifts. Table 6.2 presents sound power levels for the bus movements around the construction camp. It has been assumed that one bus and two light vehicles will be entering and leaving the campground in a typical worst case 15 minute period.

Table 6.2 Vehicle operation sound power levels

Source description	Overall sound power level, dB(A)	Octave band frequency – Hz, dB							
		63	125	250	500	1000	2000	4000	8000
Bus	102	96	101	104	99	97	94	88	82
Light vehicle	88	95	89	86	84	84	80	76	72

6.4 Meteorological conditions

Noise levels were predicted at noise sensitive receivers during the following meteorological conditions, as presented in Table 6.3.

Table 6.3 Standard and worst case meteorological conditions

Meteorological conditions	Meteorological parameters
Standard meteorological conditions	Stability category D with wind speed up to 0.5 m/s at 10 m Above Ground Level (AGL)
Worst case meteorological conditions	Stability category D with light winds (up to 3 m/s at 10 m AGL) and/or stability category F with winds up to 2 m/s at 10 m AGL

The highest predicted noise levels out of the two worst case meteorological conditions have been presented in the results in Section 6.5.

6.5 Predicted construction camp noise impacts

6.5.1 L_{Aeq} noise levels

The predicted noise levels and environmental nose limits for the operation of the construction camp are presented in Table 6.4 and Table 6.5. As the location of the construction camp is confined to the southern extent of the study area, only receivers within NCA1 have been assessed. A graphical representation of results has been presented in Appendix D.

Table 6.4 Noise levels at all NCA1 receiver locations – daytime

Receiver ID	Use	Proposal noise trigger levels, dB(A)	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
6	Residential	40	31	-	33	-
7	Residential	40	29	-	31	-
8	Residential	40	30	-	32	-
9	Residential	40	29	-	31	-
10	Residential	40	32	-	34	-
11	Residential	40	30	-	33	-
12	Residential	40	30	-	32	-
13	Residential	40	31	-	33	-
14	Residential	40	24	-	26	-
15	Residential	40	32	-	34	-
16	Residential	40	30	-	32	-
17	Residential	40	31	-	33	-
18	Residential	40	30	-	32	-
19	Residential	40	29	-	31	-
20	Residential	40	33	-	35	-
21	Residential	40	32	-	34	-
22	Active Recreation	53	42	-	44	-
23	Residential	40	29	-	32	-
24	Commercial	63	33	-	36	-
25	Commercial	63	34	-	36	-
26	Commercial	63	33	-	35	-
27	Residential	40	31	-	33	-
28	Residential	40	30	-	32	-
29	Residential	40	31	-	33	-
30	Residential	40	21	-	22	-
31	Residential	40	20	-	22	-
32	Commercial	63	30	-	32	-
33	Residential	40	31	-	33	-
34	Residential	40	34	-	36	-
35	Residential	40	32	-	35	-
36	Residential	40	30	-	32	-
37	Shed	-	20	-	22	-

Receiver ID	Use	Proposal noise trigger levels, dB(A)	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
38	Residential	40	34	-	36	-
39	Residential	40	33	-	35	-
40	Industrial	68	29	-	31	-
41	Residential	40	30	-	33	-
42	Residential	40	33	-	35	-
43	Shed	-	20	-	22	-
44	Shed	-	21	-	23	-
45	Residential	40	31	-	33	-
46	Residential	40	32	-	34	-
47	Residential	40	32	-	34	-
48	Shed	-	34	-	36	-
49	Residential	40	31	-	33	-
50	Residential	40	33	-	35	-
51	Residential	40	33	-	35	-
52	School	43	31	-	34	-
53	School	43	32	-	34	-
54	School	43	27	-	29	-
55	School	43	28	-	30	-
56	School	43	29	-	31	-
57	Residential	40	33	-	35	-
58	Residential	40	34	-	36	-
59	School	43	28	-	31	-
60	Industrial	68	29	-	31	-
61	Residential	40	32	-	34	-
62	Residential	40	32	-	34	-
63	Residential	40	32	-	34	-
64	Industrial	68	33	-	35	-
65	Industrial	68	29	-	31	-
66	Residential	40	30	-	32	-
67	Residential	40	30	-	32	-
68	Industrial	68	29	-	31	-
69	Industrial	68	25	-	26	-

Table 6.5 Noise levels at all NCA1 receiver locations – night-time

Receiver ID	Use	Proposal noise trigger levels, dB(A)	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
6	Residential	35	31	-	33	-
7	Residential	35	29	-	31	-
8	Residential	35	30	-	32	-
9	Residential	35	29	-	31	-

Receiver ID	Use	Proposal noise trigger levels, dB(A)	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
10	Residential	35	32	-	34	-
11	Residential	35	30	-	33	-
12	Residential	35	30	-	32	-
13	Residential	35	31	-	33	-
14	Residential	35	24	-	26	-
15	Residential	35	32	-	34	-
16	Residential	35	30	-	32	-
17	Residential	35	31	-	33	-
18	Residential	35	30	-	32	-
19	Residential	35	29	-	31	-
20	Residential	35	33	-	35	-
21	Residential	35	32	-	34	-
22	Active Recreation	-	42	-	44	-
23	Residential	35	29	-	32	-
24	Commercial	-	33	-	36	-
25	Commercial	-	34	-	36	-
26	Commercial	-	33	-	35	-
27	Residential	35	31	-	33	-
28	Residential	35	30	-	32	-
29	Residential	35	31	-	33	-
30	Residential	35	21	-	22	-
31	Residential	35	20	-	22	-
32	Commercial	-	30	-	32	-
33	Residential	35	31	-	33	-
34	Residential	35	34	-	36	1
35	Residential	35	32	-	35	-
36	Residential	35	30	-	32	-
37	Shed	-	20	-	22	-
38	Residential	35	34	-	36	1
39	Residential	35	33	-	35	-
40	Industrial	-	29	-	31	-
41	Residential	35	30	-	33	-
42	Residential	35	33	-	35	-
43	Shed	-	20	-	22	-
44	Shed	-	21	-	23	-
45	Residential	35	31	-	33	-
46	Residential	35	32	-	34	-
47	Residential	35	32	-	34	-
48	Shed	-	34	-	36	-
49	Residential	35	31	-	33	-

Receiver ID	Use	Proposal noise trigger levels, dB(A)	Neutral conditions		Worst case meteorological conditions	
			Result	Exceed	Result	Exceed
50	Residential	35	33	-	35	-
51	Residential	35	33	-	35	-
52	School	-	31	-	34	-
53	School	-	32	-	34	-
54	School	-	27	-	29	-
55	School	-	28	-	30	-
56	School	-	29	-	31	-
57	Residential	35	33	-	35	-
58	Residential	35	34	-	36	1
59	School	-	28	-	31	-
60	Industrial	-	29	-	31	-
61	Residential	35	32	-	34	-
62	Residential	35	32	-	34	-
63	Residential	35	32	-	34	-
64	Industrial	-	33	-	35	-
65	Industrial	-	29	-	31	-
66	Residential	35	30	-	32	-
67	Residential	35	30	-	32	-
68	Industrial	-	29	-	31	-
69	Industrial	-	25	-	26	-

6.5.2 Maximum noise level assessment

The sleep disturbance noise levels associated with the operation of the construction camp were predicted at nearby receivers within NCA1 under worst case meteorological conditions. The results are presented in Table 6.6. No exceedance of the sleep disturbance criteria is predicted.

Table 6.6 Predicted L_{Aeq} and L_{Amax} noise levels for maximum noise level assessment

Receiver ID	Use	Sound pressure level, L_{Aeq}, dB(A)			Sound pressure level, L_{Amax}, dB(A)		
		Screening level	Result	Exceedance	Screening level	Result	Exceedance
6	Residential	40	33	-	52	<20	-
7	Residential	40	31	-	52	<20	-
8	Residential	40	32	-	52	<20	-
9	Residential	40	31	-	52	<20	-
10	Residential	40	34	-	52	<20	-
11	Residential	40	33	-	52	<20	-
12	Residential	40	32	-	52	20	-
13	Residential	40	33	-	52	<20	-
14	Residential	40	26	-	52	<20	-
15	Residential	40	34	-	52	20	-
16	Residential	40	32	-	52	<20	-

Receiver ID	Use	Sound pressure level, L_{Aeq}, dB(A)			Sound pressure level, L_{Amax}, dB(A)		
		Screening level	Result	Exceedance	Screening level	Result	Exceedance
17	Residential	40	33	-	52	<20	-
18	Residential	40	32	-	52	<20	-
19	Residential	40	31	-	52	<20	-
20	Residential	40	35	-	52	20	-
21	Residential	40	34	-	52	<20	-
22	Residential	-	44	-	-	37	-
23	Residential	40	32	-	52	<20	-
24	Residential	-	36	-	-	21	-
25	Residential	-	36	-	-	22	-
26	Residential	-	35	-	-	21	-
27	Residential	40	33	-	52	<20	-
28	Residential	40	32	-	52	21	-
29	Residential	40	33	-	52	20	-
30	Residential	40	22	-	52	<20	-
31	Residential	40	22	-	52	<20	-
32	Residential	-	32	-	-	21	-
33	Residential	40	33	-	52	20	-
34	Residential	40	36	-	52	23	-
35	Residential	40	35	-	52	21	-
36	Residential	40	32	-	52	<20	-
37	Residential	-	22	-	-	<20	-
38	Residential	40	36	-	52	23	-
39	Residential	40	35	-	52	22	-
40	Residential	-	31	-	-	<20	-
41	Residential	40	33	-	52	20	-
42	Residential	40	35	-	52	22	-
43	Residential	-	22	-	-	<20	-
44	Residential	-	23	-	-	<20	-
45	Residential	40	33	-	52	20	-
46	Residential	40	34	-	52	21	-
47	Residential	40	34	-	52	23	-
48	Residential	-	36	-	-	26	-

6.5.3 Discussion

Results of the operational noise assessment of the proposed construction camp show that there are three predicted exceedances of the operational project noise trigger levels during the night-time for worst case meteorological conditions. All other scenarios under consideration are expected to comply with the operational noise trigger levels. The noise levels at these receivers are expected to exceed the project noise trigger levels by up to 1 dB(A) and are located along Wilby Street, North Star.

It should be noted that when assessing the significance of residual noise impacts, the Noise Policy for Industry states that exceedances of up to 2 dB(A) are considered “negligible”. The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. This is discussed further in Section 4.1 and 4.2 of the Noise Policy for Industry.

Indicative normal operational noise levels from the construction camp, under worst case meteorological conditions are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, it is concluded that no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance.

6.5.4 Operational road traffic noise assessment

In assessing the potential noise impacts of the proposed realignment of the Bruxner Way, a desktop assessment has been implemented, taking into consideration the nearest sensitive receivers to the proposed works, as well as the realignment distance to predict the change in noise levels brought about by the realignment of the road closer to residents.

The nearest residential receiver to the proposed road realignment is located at 21930 Bruxner Way, Boggabilla, 2.3 km from the proposed road realignment. In addition, the maximum road realignment distance is 160 m from the existing road corridor. Table 6.7 presents a summary of the predicted noise increase due to the proposed realignment of the Bruxner Way at the closest residential receiver.

Table 6.7 Summary of potential road traffic noise increase due to road realignment

Location	Existing distance to nearest receiver, m	New alignment – distance to nearest receiver, m	Increase in noise levels, dB(A)
Bruxner Way	2,300	2,140	0.3

It should be noted from Section 4.5.2 that an increase of up to 2 dB(A) represents a minor impact that is barely perceptible to the average person. As such, a predicted increase of 0.3 dB(A) is considered to comply with the relevant NSW Road Noise Policy criteria and no further assessment is considered necessary at this stage.

7 Mitigation measures

7.1 Construction noise mitigation

The construction noise and vibration assessment presented in Section 5 detailed a number of exceedances of the noise management levels for this proposal. These were predicted as a result of various different construction activities as well as the use of borrow pits. A number of exceedances of the 'highly noise affected' criteria have also been predicted within the study area. As a result of these exceedances, the following standard and proposal specific mitigation measures have been identified.

Table 7.1 presents the standard mitigation measures which should be considered and implemented where feasible and reasonable.

Table 7.1 Standard noise mitigation measures to be implemented

Delivery phase	Aspect	Proposed mitigation measures
Detailed design	Construction noise and vibration impacts on sensitive receivers	■ A Noise and Vibration Management Sub-plan will be developed as a component of the construction environmental management plan. This Sub-plan will include: – Construction noise and vibration criteria for the proposal. – Location of sensitive receivers in proximity to the construction area – Specific management measures for activities that could exceed the construction noise and vibration criteria ■ Notification process within the community engagement plan (including who to contact in the event of a complaint) to advise of significant works with potential for noise nuisance or vibration at sensitive receivers and surrounding residences/premises ■ Noise management measures including controlling noise and vibration at the source, controlling noise and vibration on the source to receiver transmission path and controlling noise and vibration at the receiver wherever feasible and reasonable. ■ Requirements for training, inspections, corrective actions, monitoring, notification and classification of environmental incidents/complaints, record keeping ■ Confirm the proximity of sensitive receivers to finalised locations for construction activities, laydown areas and other construction-phase facilities. Continued consultation with potentially affected landholders and stakeholders to communicate the anticipated scheduling of construction works and the activities that may occur in proximity to each receiver.
Pre-construction	Pre-condition surveys	■ Building condition/dilapidation surveys should be undertaken at receivers identified as being particularly sensitive to vibration, including the heritage buildings. Building surveys should also be undertaken at vibration sensitive receivers which are expected to exceed the structural damage vibration limits given by DIN 4150.3.
Construction	Consultation	■ A complaint hotline will be established for the project to enable members of the public to notify ARTC of issues, including the generation of excessive noise and/or vibration
	Monitoring	■ Noise and vibration monitoring will be undertaken to verify compliance with construction phase criteria at locations and at times nominated in the Noise and Vibration Management Sub-plan. ■ Noise and/or vibration monitoring may be undertaken in response to legitimate noise or vibration complaints to assess compliance of construction activities against adopted criteria

Delivery phase	Aspect	Proposed mitigation measures
	Construction work hours	■ Works in the vicinity of sensitive receivers and/or outside of the proposed construction hours should be completed in accordance with the requirements of the Interim Construction Noise Guideline. ■ Extended working hours outside of the nominated work hours for the proposal should be considered permissible where there are no nearby sensitive receivers or impacts to receivers can be appropriately managed ■ Time differences between NSW and Queensland from October to April must be considered when conducting works near the NSW/QLD border. Works should be considered to be occurring outside standard hours if the time at nearby sensitive receivers is outside standard hours
	Equipment selection	■ Equipment selections will be reviewed with a preference for adopting quieter and non-vibratory plant items near sensitive receivers, where feasible and reasonable. ■ Appropriately sized equipment will be selected for the task, such as vibratory compactors and rock excavation equipment.
	Blasting	■ Vibration impacts from blasting will be assessed by the Contractor once the locations and depths of blasting and the charges to be used are confirmed. This assessment will confirm which receivers at which blasting impacts are expected to exceed the nominated blasting vibration criteria. ■ Where blasting impacts are expected to exceed the vibration limits, the following measures are recommended where practicable: – Reducing the charge size by use of delays and reduced charge masses – Ensuring adequate blast confinement to minimise the amount of overpressure – Avoiding secondary blasting where possible. The use of rock breakers or drop hammers may be an acceptable alternative – Avoiding blasting during heavy cloud cover or during strong winds blowing towards sensitive receivers – Establishing a blasting timetable through community consultation for example, blasts times negotiated with surrounding sensitive receivers ■ Residents, occupants and other stakeholders within 2 km radius of a blast location will be notified a minimum of three calendar days in advance of a blast occurring
	Use and siting of plant	■ Where possible, the duration of simultaneous operation of noise or vibration-intensive plant will be minimised. Plant and equipment used intermittently or no longer in use will be throttled or shut down ■ Noise-emitting plant and equipment will be orientated away from sensitive receivers where feasible and reasonable ■ Construction plant, vehicles and machinery will be maintained and operated in accordance with manufacturer's instructions to minimise noise and vibration emissions
	Construction traffic	■ Where feasible and reasonable, unsealed areas should be graded regularly, and potholes sealed access roads and hardstand areas filled in to reduce noise from construction vehicles ■ Where feasible and reasonable, construction traffic should be kept to a minimum. ■ The speed of construction traffic should be minimized near noise sensitive receivers

7.2 Construction camp noise mitigation

The results of the operational noise assessment in Section 5.9 show that predicted noise levels due to the operation of the proposed construction camp located in North Star may exceed the project noise trigger levels by 1 dB(A) at up to three receiver locations.

It should be noted that when assessing the significance of residual noise impacts, the Noise Policy for Industry states that exceedances of up to 2 dB(A) are considered “negligible”. The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. This is discussed further in Section 4.1 and 4.2 of the Noise Policy for Industry.

Indicative normal operational noise levels from the construction camp, under worst case meteorological conditions are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, it is concluded that no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance of the refined camp layout and position.

8 Conclusions

8.1 Construction noise

A construction noise impact assessment for works associated with construction works, including borrow pits, has been carried out in accordance with the Interim Construction Noise Guideline and the SEARs. Reasonable worst case construction scenarios have been assessed.

The assessment of noise associated with the construction of the proposal indicates some exceedances of the noise management levels at some receivers. The magnitude and number of exceedances are detailed in Section 5.

The 'Drainage works and earthworks' construction stage is predicted to have the greatest impact from construction noise, however other construction stages may have greater overall impact depending on actual timing and duration of each construction stage.

Measures have been recommended to mitigate construction noise impacts upon nearby sensitive receivers.

The final number, degree and nature of these measures would be selected by the contractor and be largely dependent on the construction strategy and work carried out. Specific noise management and mitigation measures would be detailed in the contractor's Construction Noise and Vibration Management Plan (CNVMP). The recommended management and mitigation measures which would be considered in the plan include:

- Effective community consultation
- Training of construction site workers
- Use of temporary noise barriers
- Monitoring
- Appropriate selection and maintenance of equipment
- Scheduling of work for less sensitive time periods
- Situating plant in less noise sensitive locations
- Construction traffic management
- Respite periods.

8.2 Construction traffic

An assessment of the likely construction traffic indicated that while increases in road traffic noise of more than 2 dB(A) may occur the road traffic noise levels would remain below the NSW Road Noise Policy criteria. Therefore, no further assessment is required, in accordance with the Environment Protection Authority's NSW Road Noise Policy.

8.3 Construction vibration

Minimum working distances for vibration intensive construction work are presented in Section 5.7. Equipment size would be selected by the contractor taking into account the minimum working distances and the distance between the area of construction and the most affected sensitive receiver. If works are needed to be carried out within minimum working distances, vibration monitoring would be carried out. Heritage and other sensitive structures would need to be considered on a case-by-case basis, dependent on their sensitivity.

8.4 Construction camp noise

An operational noise impact assessment was undertaken in accordance with the Environment Protection Authority's document Noise Policy for Industry. The results of the operational noise assessment in Section 5.9 show that predicted noise levels due to the operation of the proposed construction camp located in North Star may exceed the project noise trigger levels by 1 dB(A) at up to three receiver locations.

It should be noted that when assessing the significance of residual noise impacts, the Noise Policy for Industry states that exceedances of up to 2 dB(A) are considered "negligible". The exceedances would not be discernible by the average listener and therefore would not warrant receiver-based treatments or controls. This is discussed further in Section 4.1 and 4.2 of the Noise Policy for Industry.

Indicative normal operational noise levels from the construction camp, under worst case meteorological conditions are expected to comply with sleep disturbance L_{Aeq} and L_{Amax} screening levels at all nearby residential receivers during the night-time period.

As a result, it is concluded that no additional mitigation measures would be required as a result of the operation of the proposed construction camp. However, the assumptions, proposed equipment and sound power levels should be re-examined during the detailed design phase to ensure compliance.

8.5 Operational road traffic noise – road realignments

A desktop assessment of the road realignment of the Bruxner Way was undertaken in order to predict the potential noise impacts associated with the alteration of the alignment closer to residential receivers. This assessment was conducted in accordance with the relevant criteria outlined in the NSW Road Noise Policy for road redevelopments.

In cases where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB(A) represents a minor impact that is considered barely perceptible to the average person.

As the nearest residential receiver is located 2,300 m away from the section of road to be realigned, it was found that noise levels at the most affected receiver are not predicted to increase by more than 0.3 dB(A) due to the proposed realignment. Therefore, no further consideration is necessary at this stage.

9 References

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APPENDIX J

Construction Noise and Vibration Technical Report

Appendix A Site Overview

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

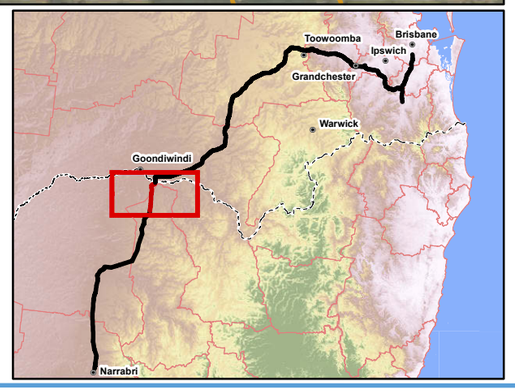
Boggabilla
Toomelah
North Star
NL1
NL2
NL3
NL4
NL5
NL6
NCA1
NCA2
NCA3
NCA4
NCA5
5
10
15
20
25
30
Robinsons Rd
Lowes Rd
Carrigan Rd
Toenda Bus Rd
Willaroo Rd
Avondale Rd
Adavale Rd
Letter Box Rd
Dorans Rd
Newell Hwy
Holms Rd
Mistake Rd
I B Bore Rd
Coolanga Rd
Limebon Rd
Milroy Rd
North Star Rd
Keetah Rd
Tarwoona Rd
Tucka Tucka Rd
Holdfast Rd
Bruxner Way
Forest Creek Rd
Goat Rd
Peates Rd
Yetman West Rd
Warialda Rd
Bedwell Downs Rd
Getta Getta Rd

Legend

- 5 Chainage (km)
- Localities
- Loggers
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- NSW/QLD border
- NCAs

A3 scale: 1:225,000

0 1.5 3 4.5 6 7.5km



Future Freight
Integrating Community, Environment and Engineering

Issue date: 30/10/2019 Version: 1
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border
Appendx A: Site overview

APPENDIX

J

Construction Noise and Vibration Technical Report

Appendix B Unattended Noise Monitoring Summaries

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Noise Logger Report

5 Edward Street, North Star

Item	Information
Logger Type	CUBE
Serial number	11100
Address	5 Edward Street, North Star
Location	Front Yard
Facade / Free Field	Free Field
Environment	

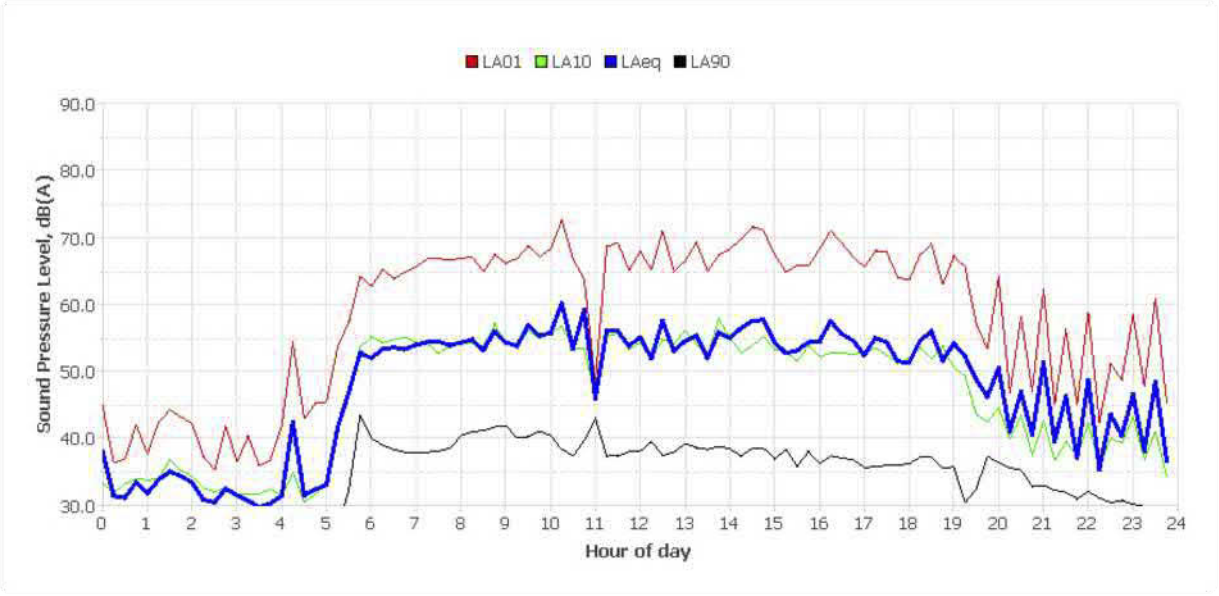
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Oct 17 2018	-	54	44	-	32	-	54	44
Thu Oct 18 2018	56	54	51	34	31	-	56	51
Fri Oct 19 2018	56	51	48	33	32	27	55	48
Sat Oct 20 2018	55	55	47	36	-	29	55	47
Sun Oct 21 2018	55	54	52	32	27	26	55	52
Mon Oct 22 2018	56	51	48	32	32	24	55	48
Tue Oct 23 2018	62	50	49	34	32	25	61	49
Wed Oct 24 2018	56	54	47	31	33	26	55	47
Thu Oct 25 2018	59	53	48	37	32	26	58	48
Fri Oct 26 2018	56	52	45	35	29	25	55	45
Sat Oct 27 2018	53	52	48	31	27	23	53	48
Sun Oct 28 2018	54	53	46	32	28	23	54	46
Mon Oct 29 2018	57	55	46	37	31	25	56	46
Tue Oct 30 2018	57	51	48	35	32	24	56	48
Wed Oct 31 2018	56	-	46	-	-	-	56	46
Summary	**57**	**53**	**48**	**34**	**32**	**25**	**56**	**48**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

Typical Day



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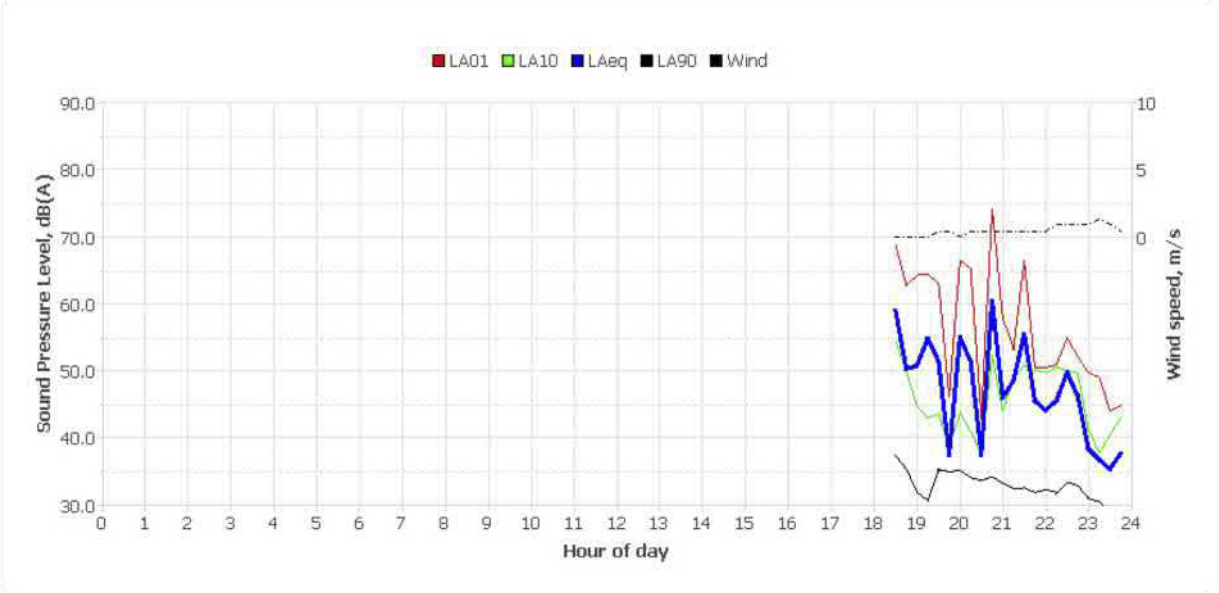

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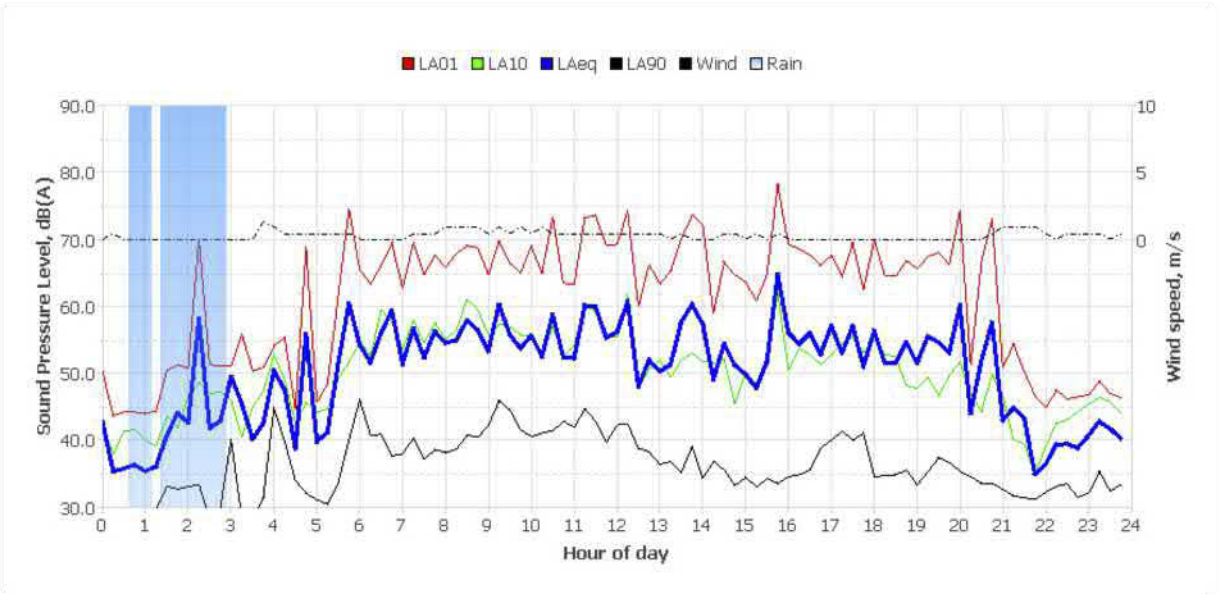

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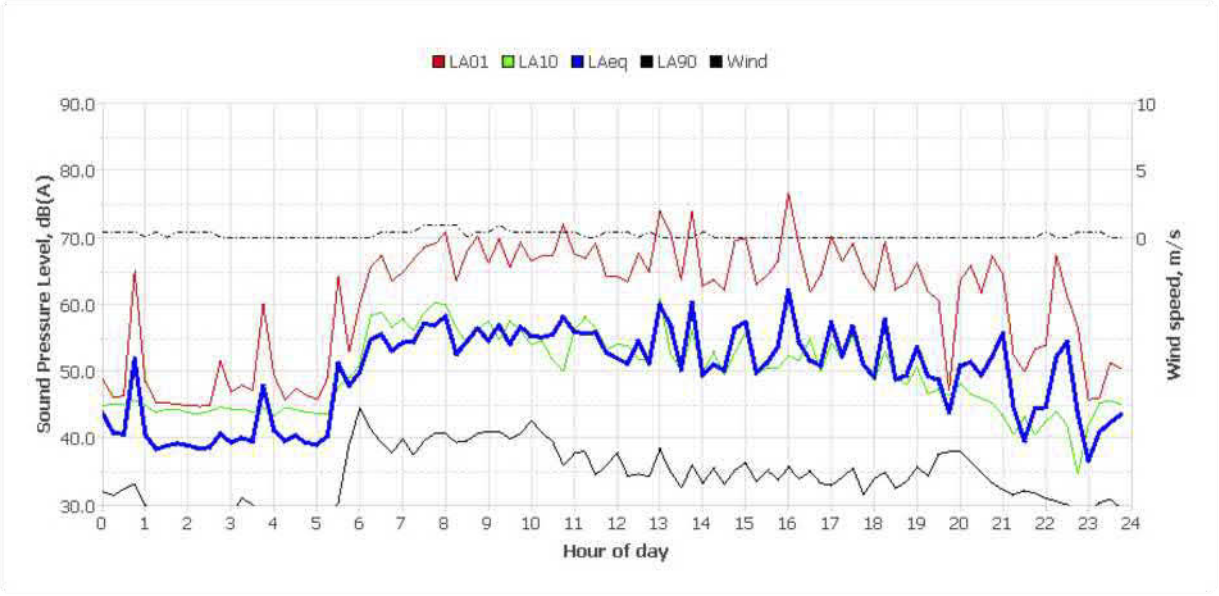

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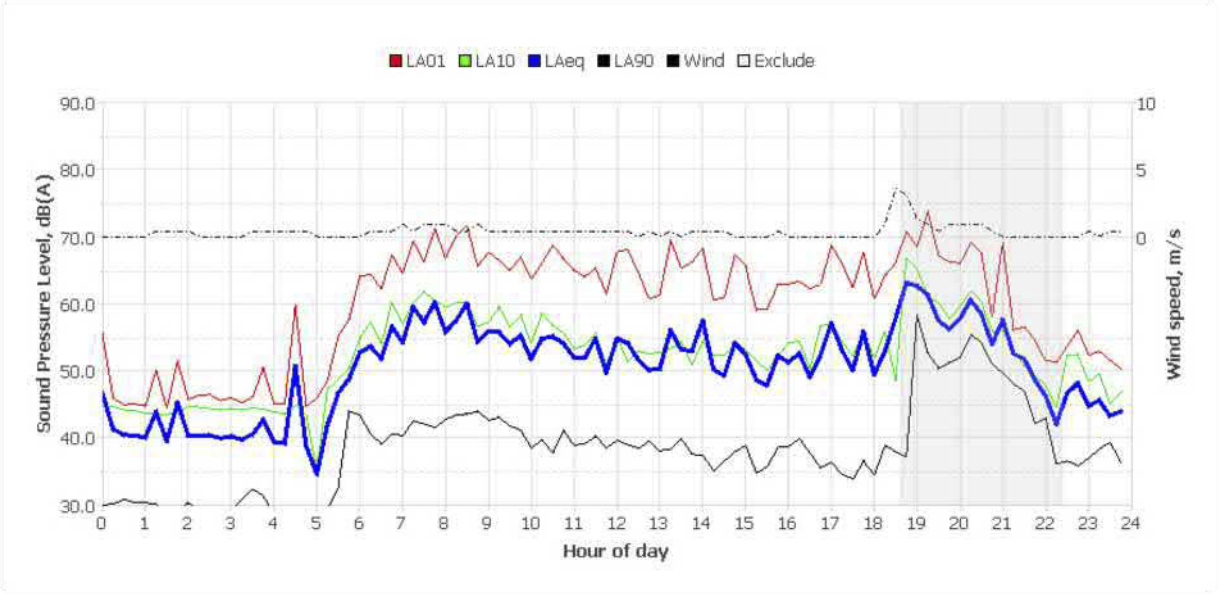

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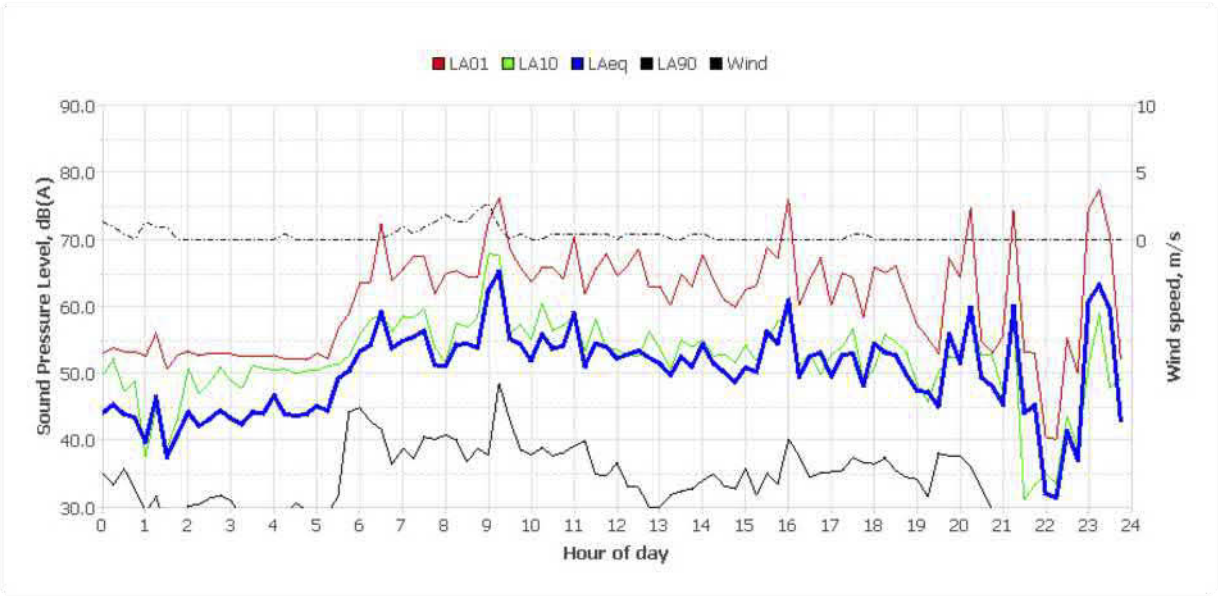

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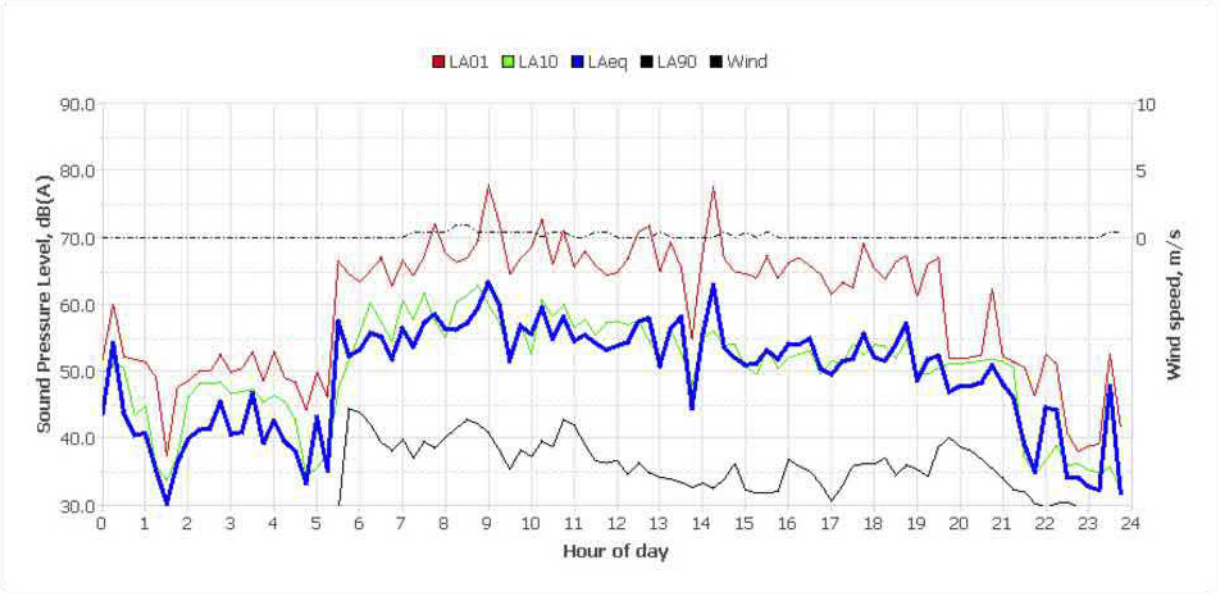

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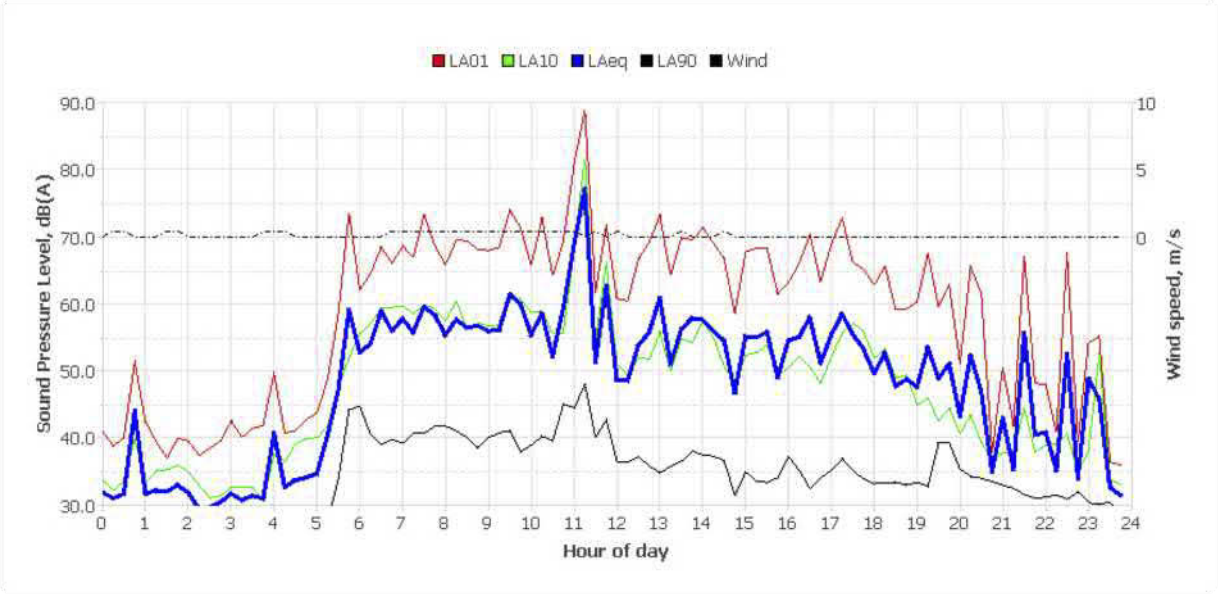

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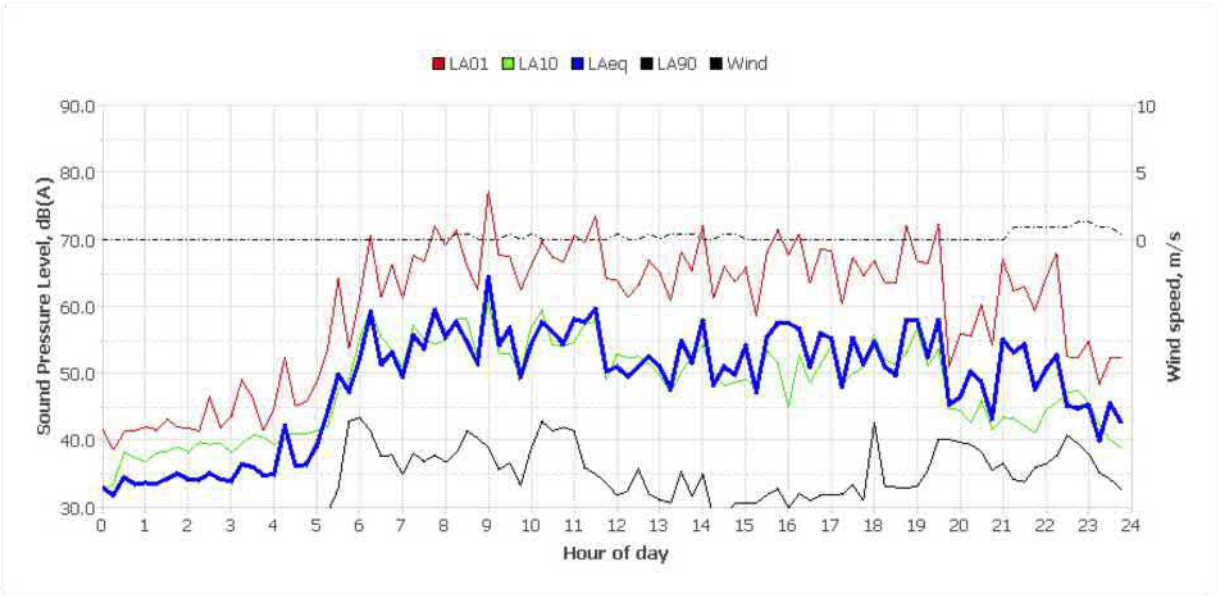

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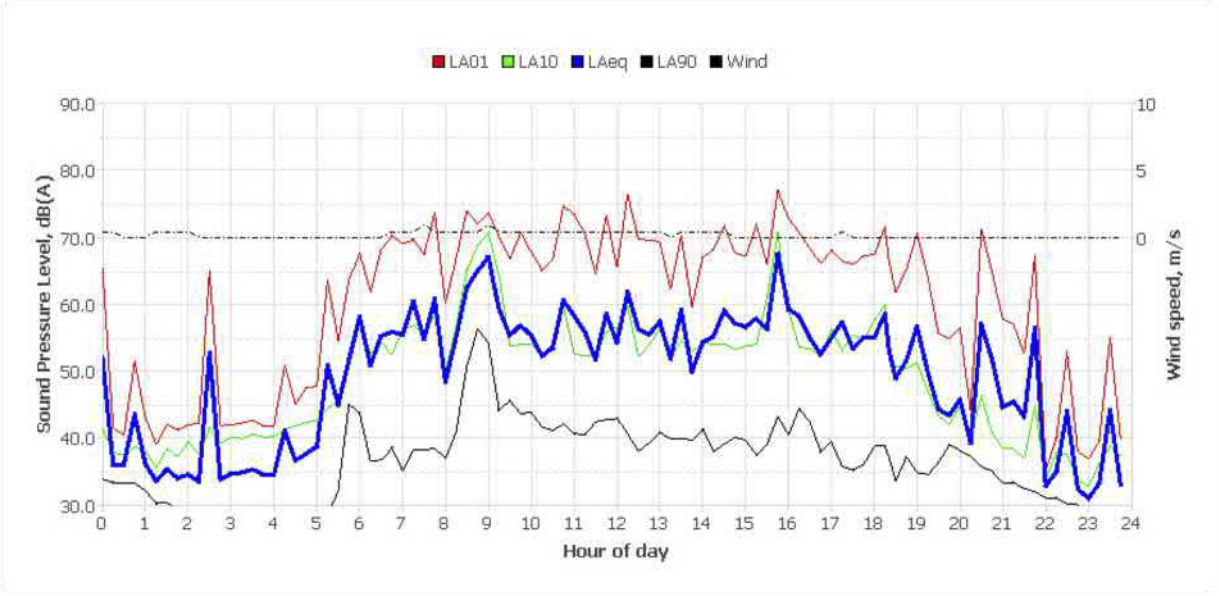

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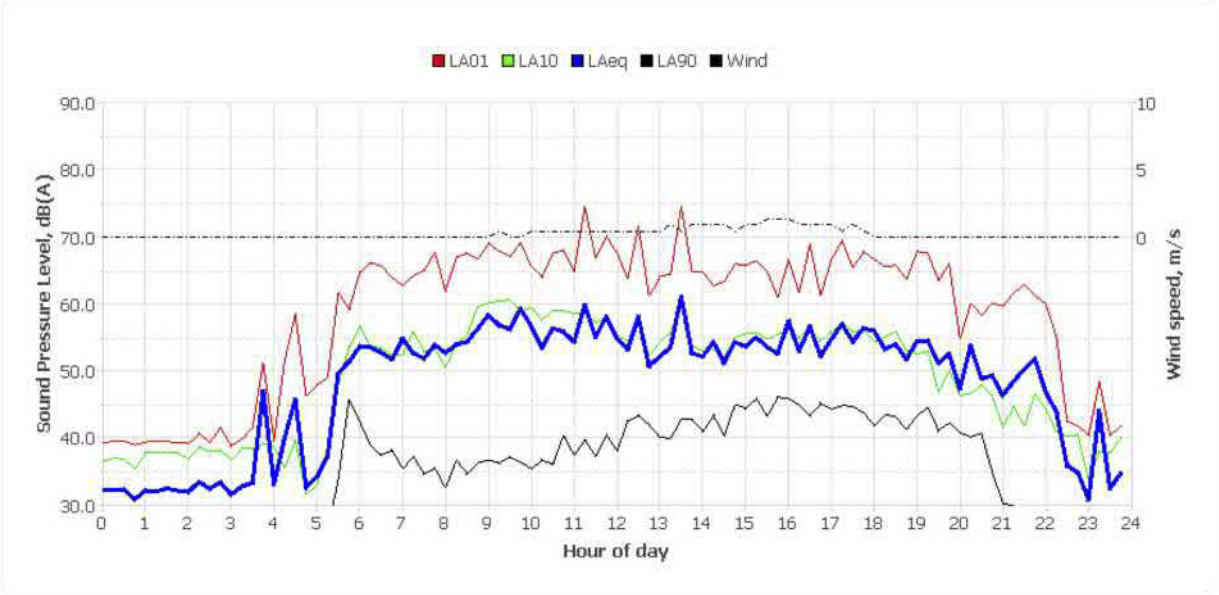

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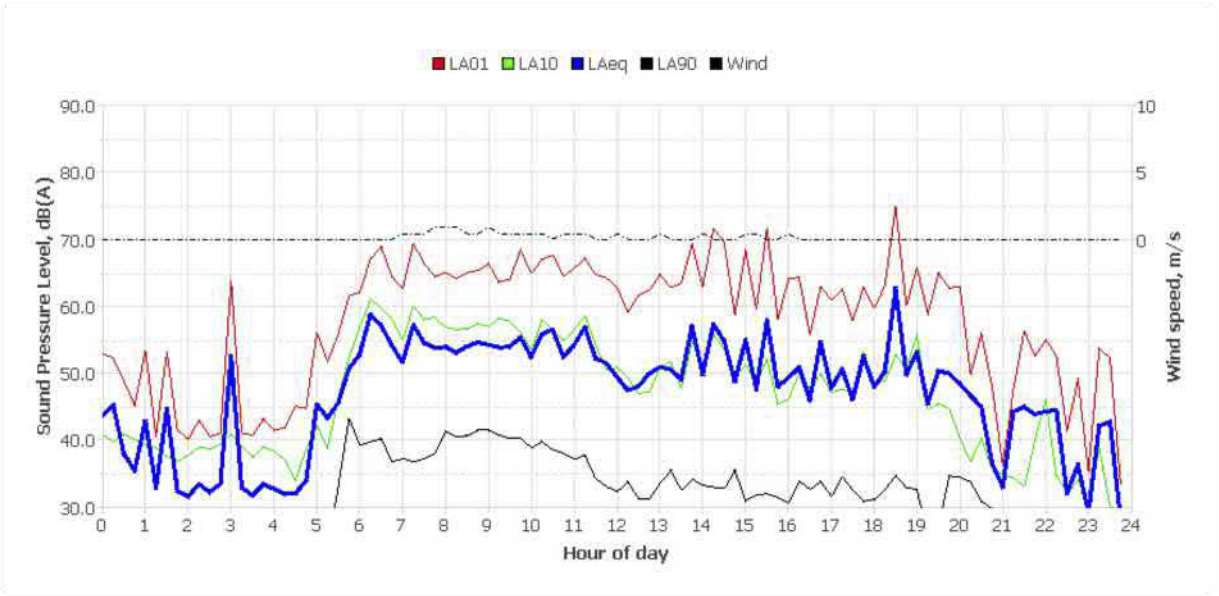

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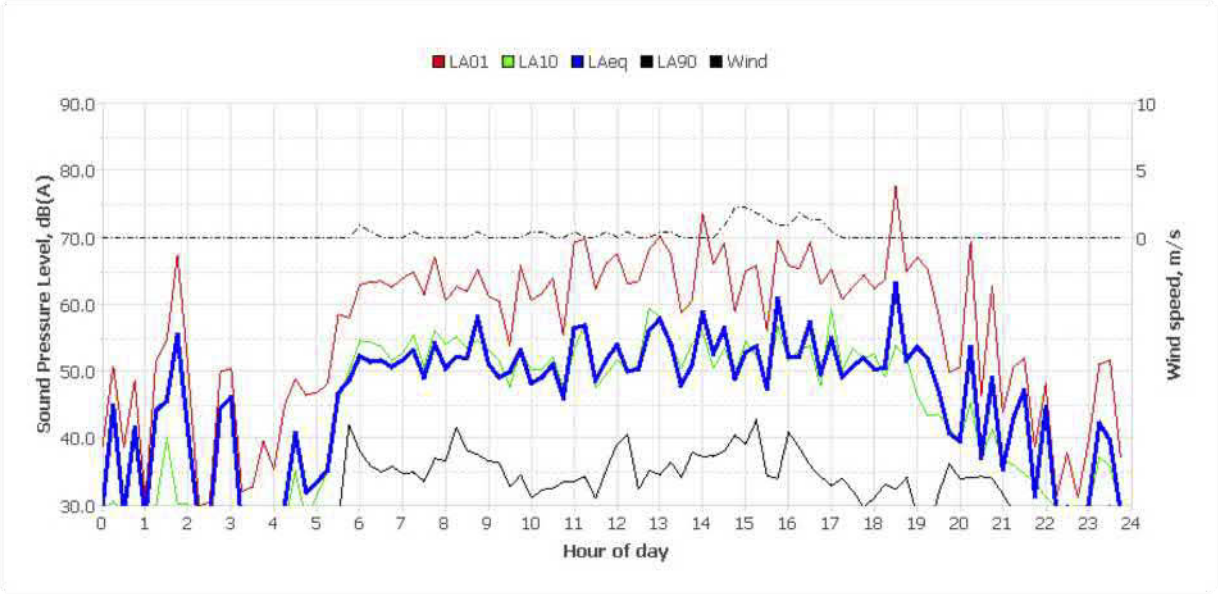

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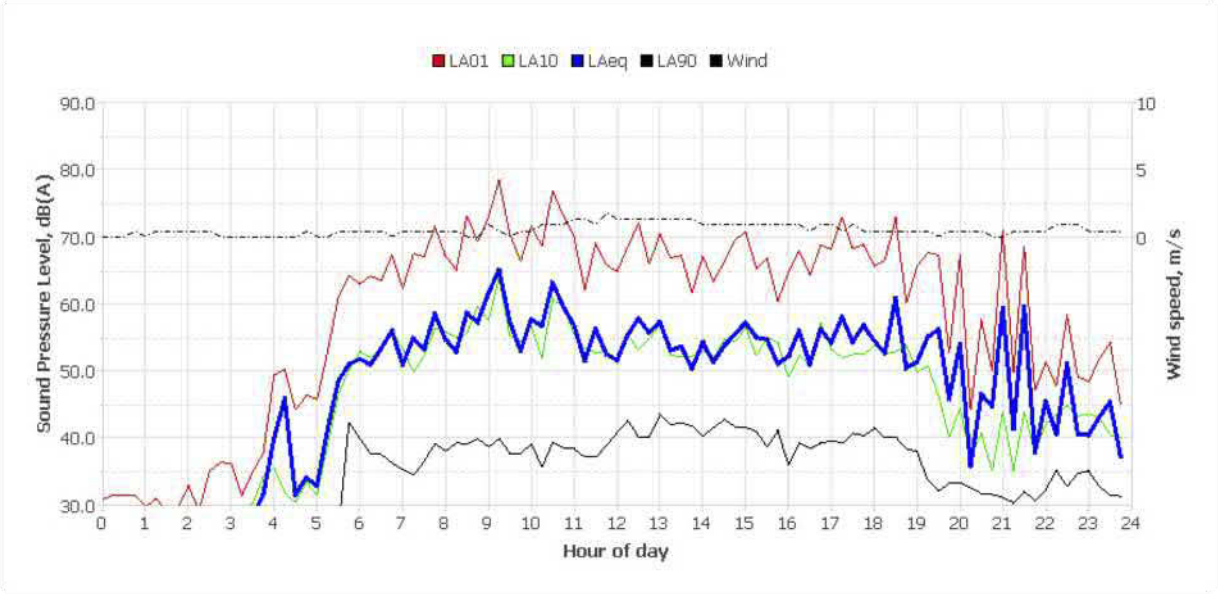

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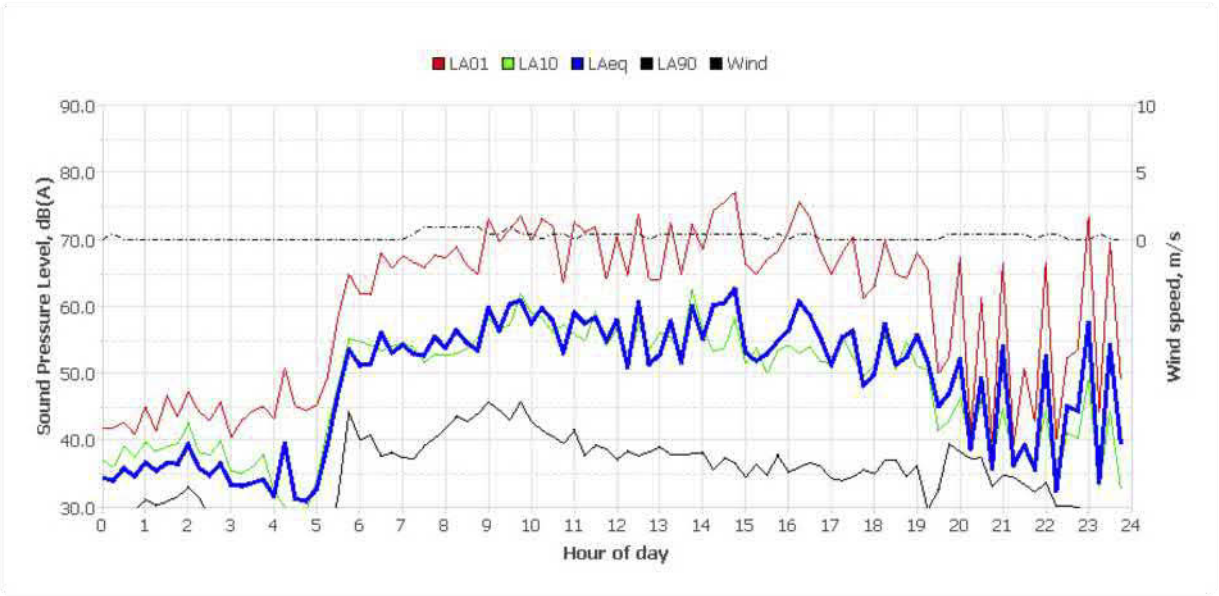

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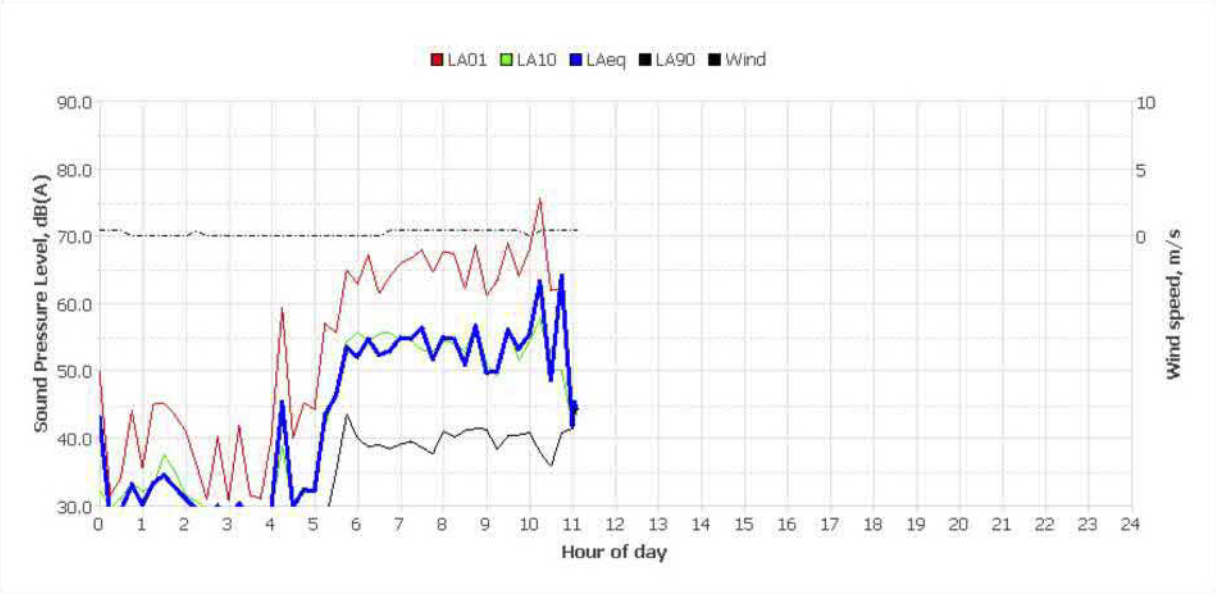


Noise Logger Report

7114 North Star Road, North Star

Item	Information
Logger Type	CUBE
Serial number	10835
Address	7114 North Star Road, North Star
Location	Front Yard
Facade / Free Field	Free Field
Environment	

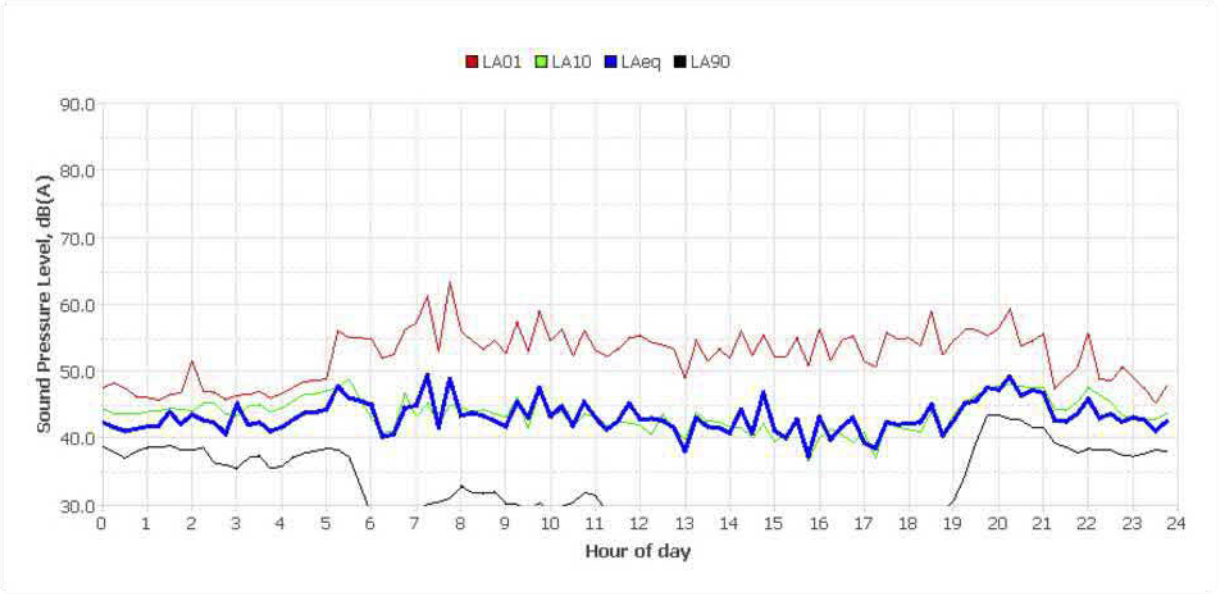
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Thu Oct 18 2018	48	54	41	-	28	-	51	41
Fri Oct 19 2018	45	45	44	26	27	34	45	44
Sat Oct 20 2018	44	50	44	30	-	35	45	44
Sun Oct 21 2018	48	50	48	27	39	37	49	48
Mon Oct 22 2018	47	47	46	25	-	-	47	46
Tue Oct 23 2018	46	45	45	25	-	37	46	45
Wed Oct 24 2018	46	55	47	24	-	38	48	47
Thu Oct 25 2018	52	49	46	31	31	38	51	46
Fri Oct 26 2018	47	49	46	27	30	37	48	46
Sat Oct 27 2018	42	48	46	23	24	30	45	46
Sun Oct 28 2018	45	45	44	23	27	31	45	44
Mon Oct 29 2018	45	44	42	28	32	32	45	42
Tue Oct 30 2018	46	46	45	26	27	29	46	45
Wed Oct 31 2018	43	47	43	23	24	29	44	43
Thu Nov 1 2018	48	-	44	-	-	-	48	44
Summary	**47**	**49**	**45**	**26**	**28**	**34**	**47**	**45**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

Typical Day



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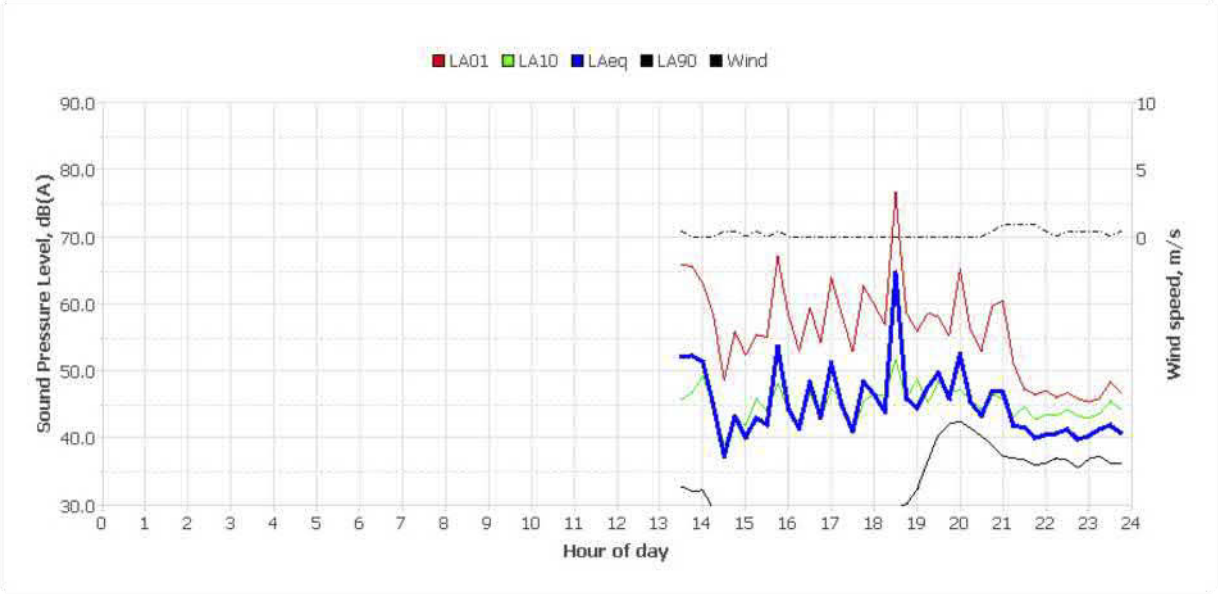

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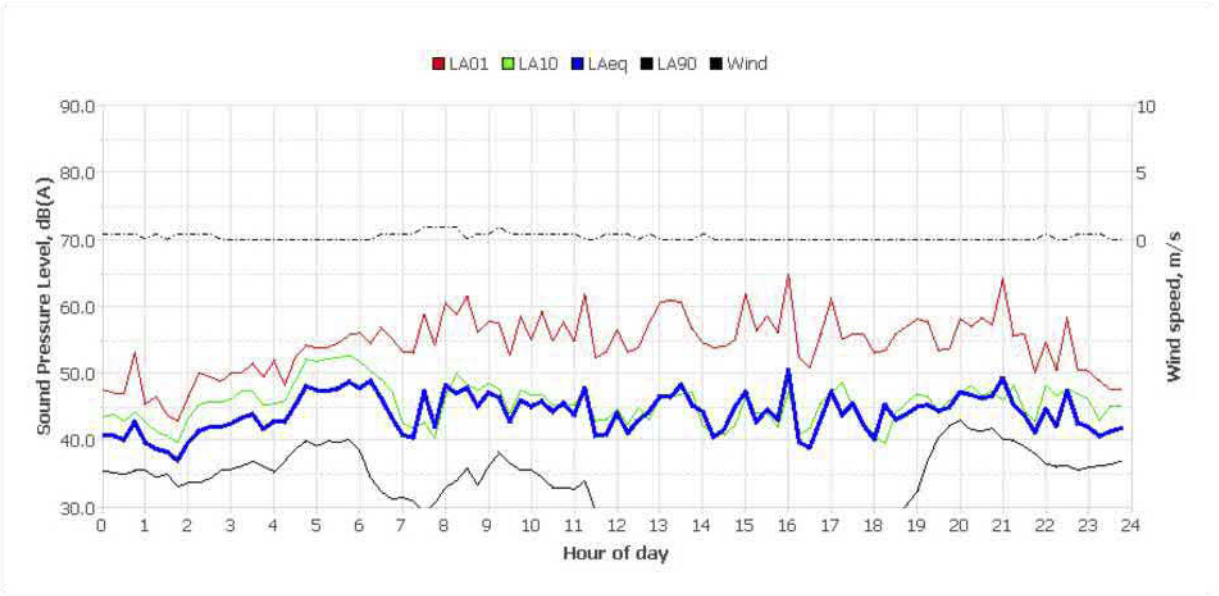

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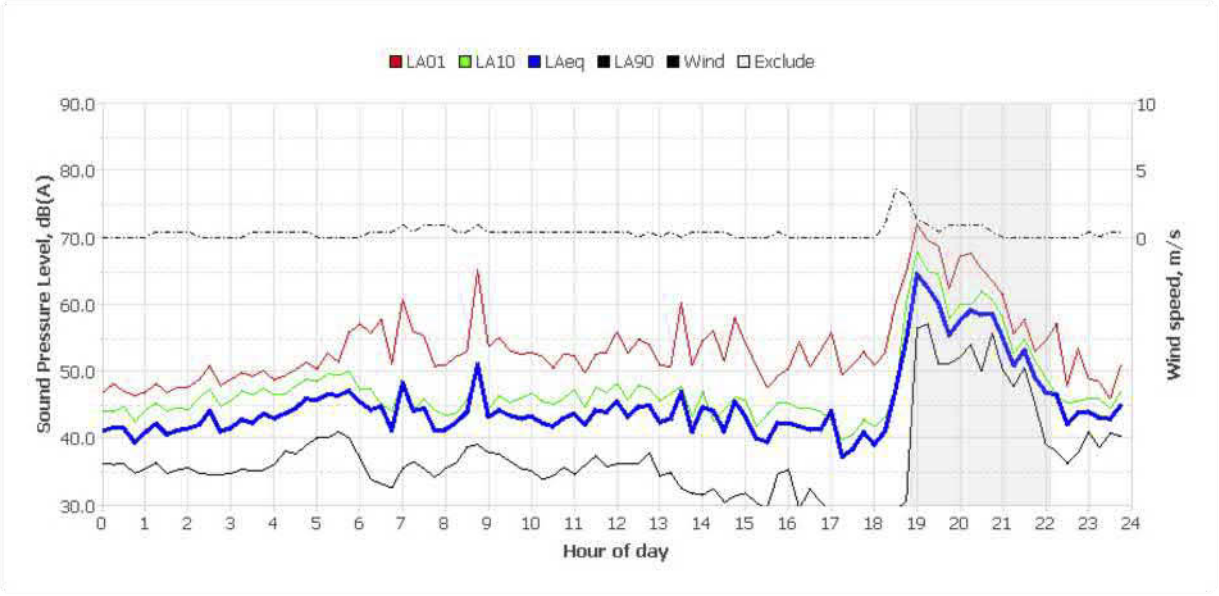

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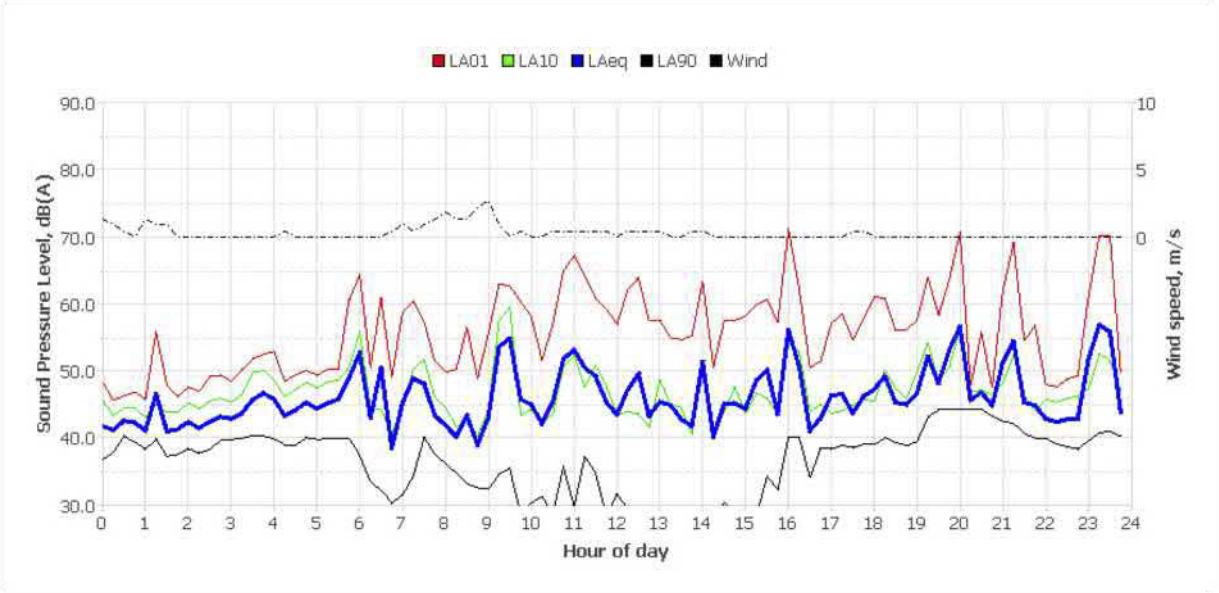

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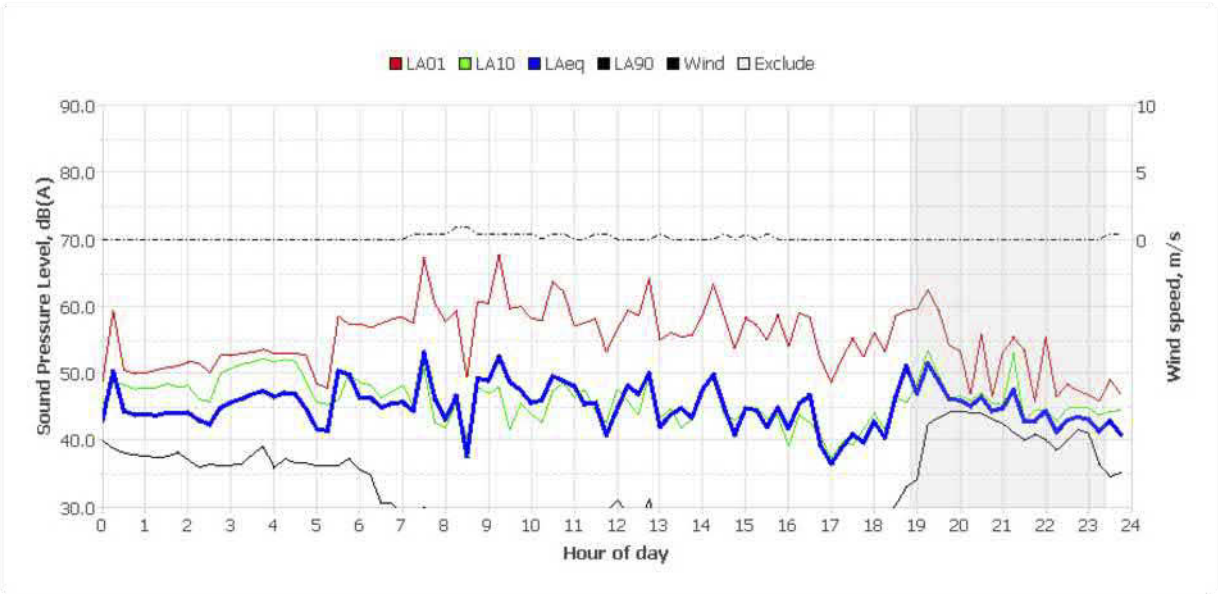

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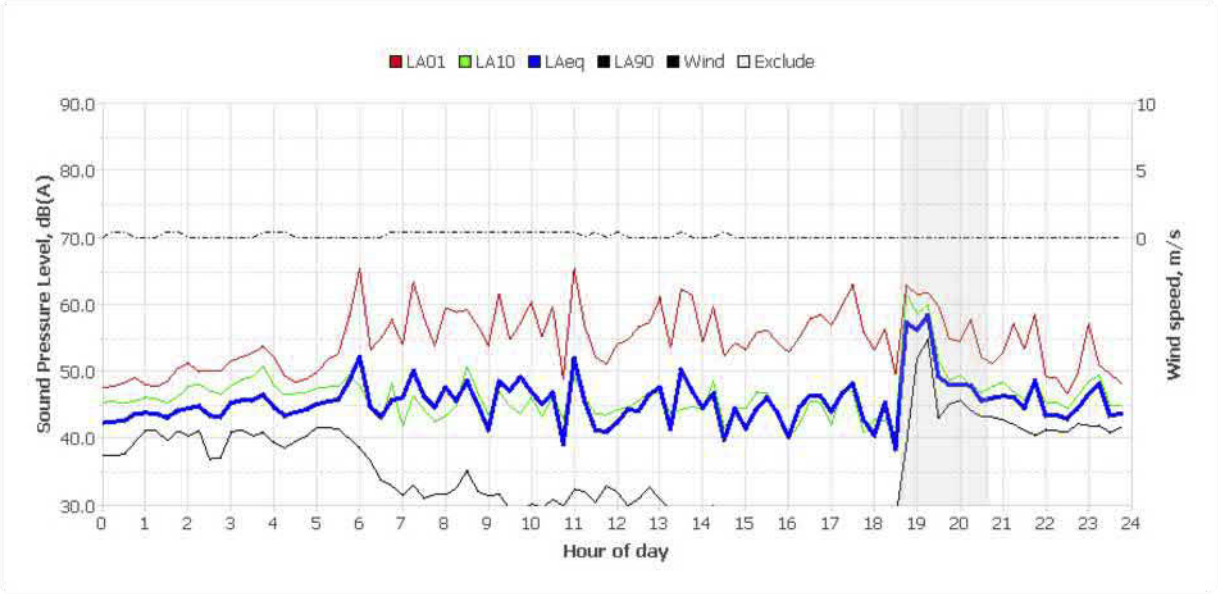

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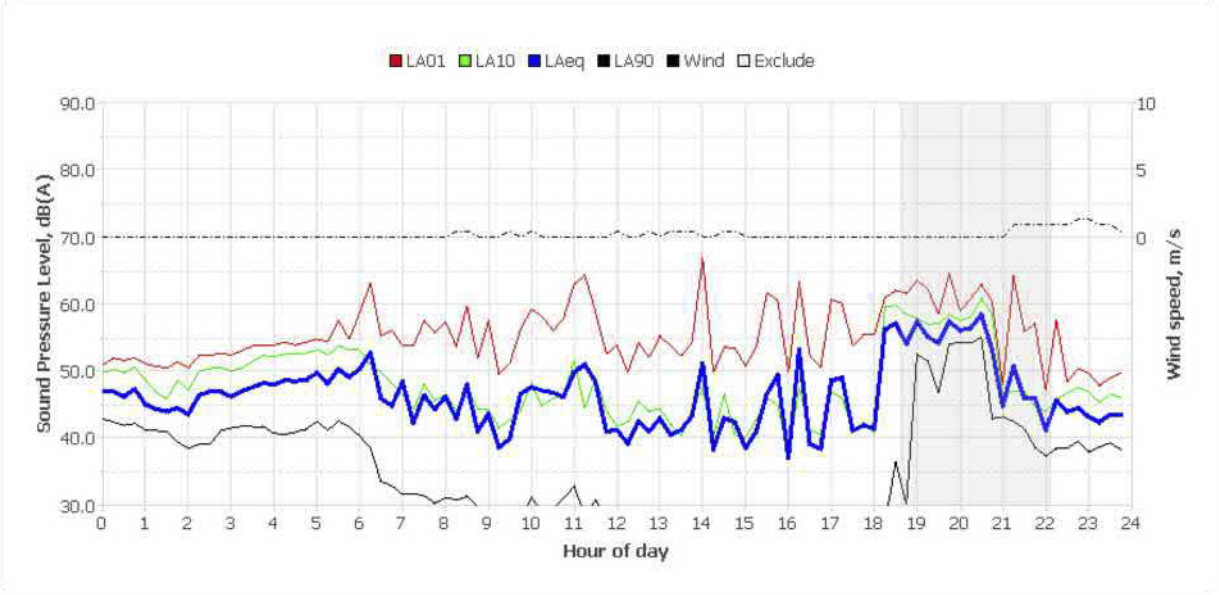

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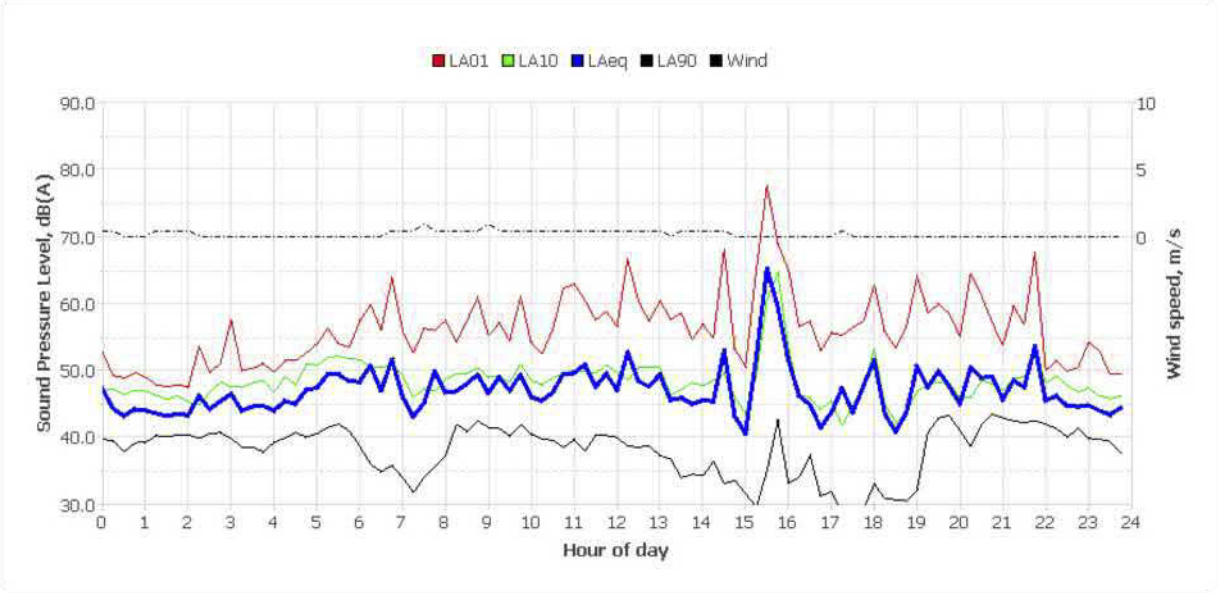

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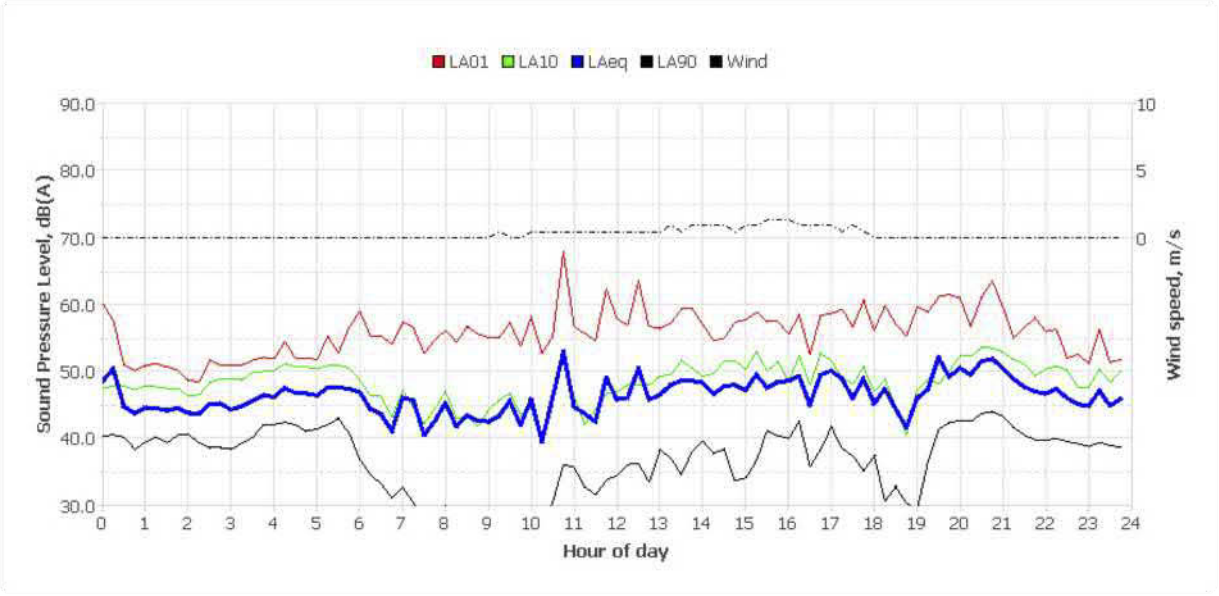

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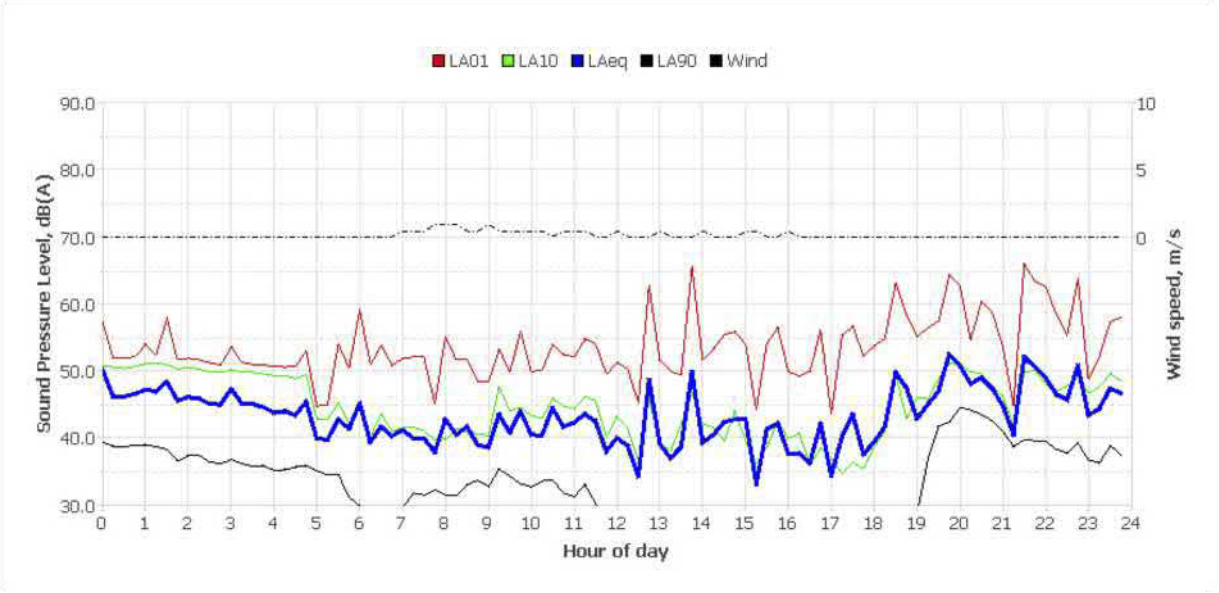
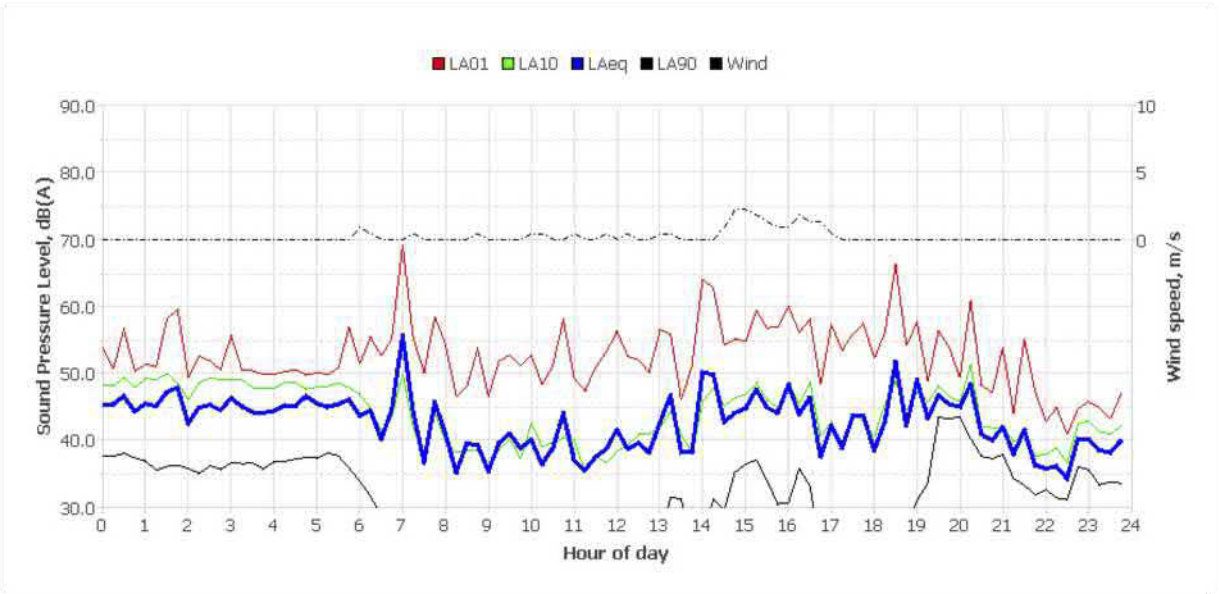
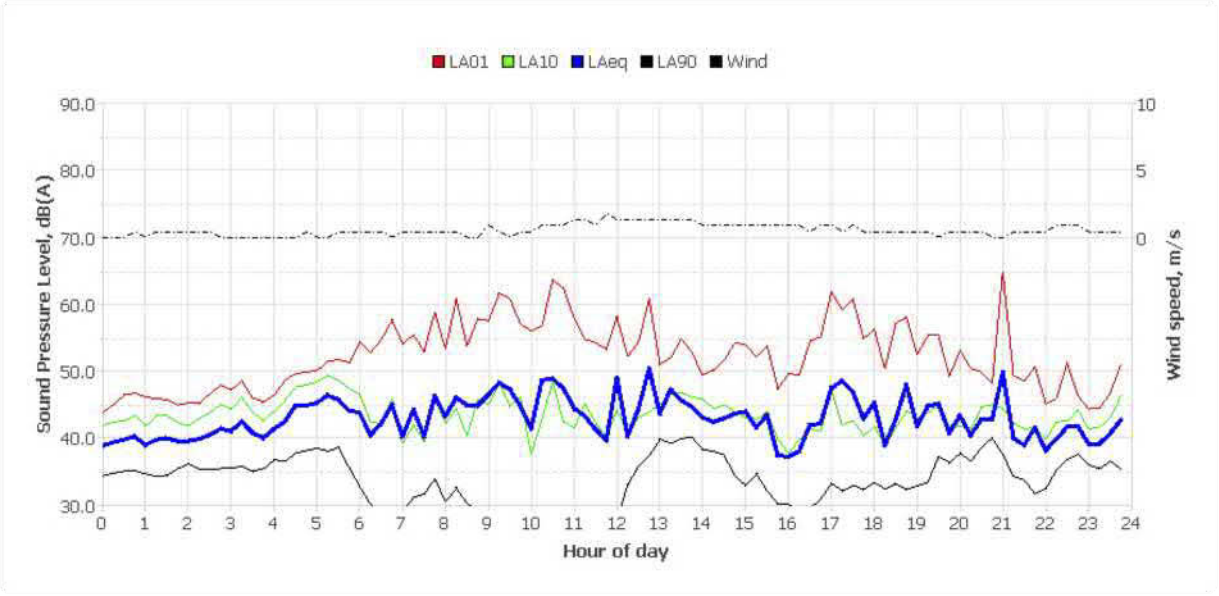


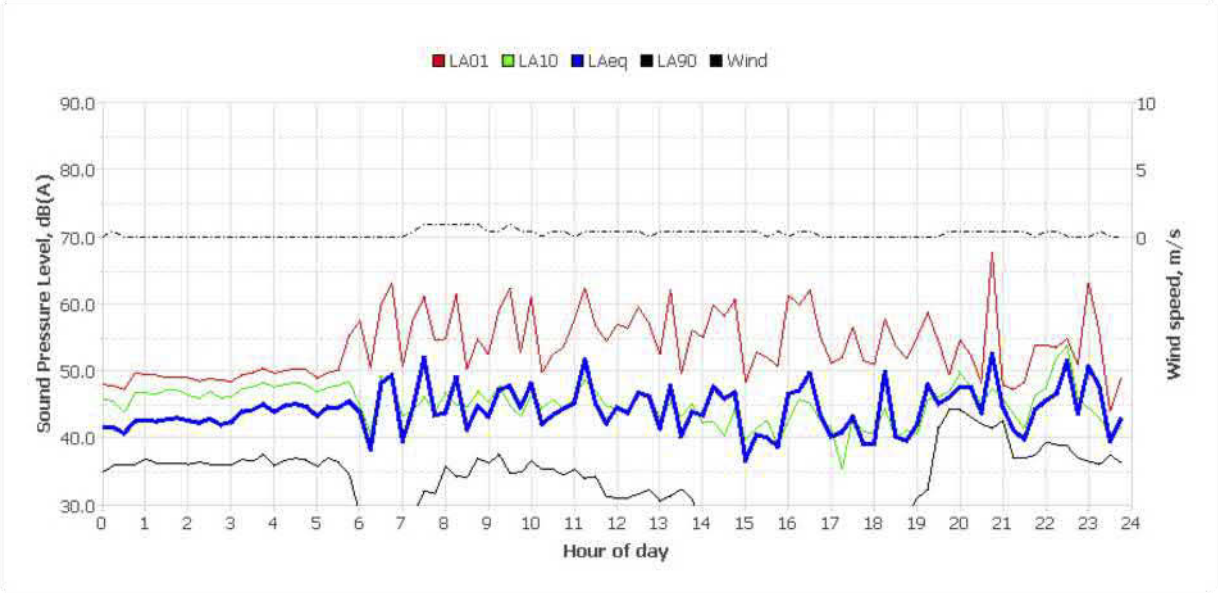
Sunday, 28 Oct 2018



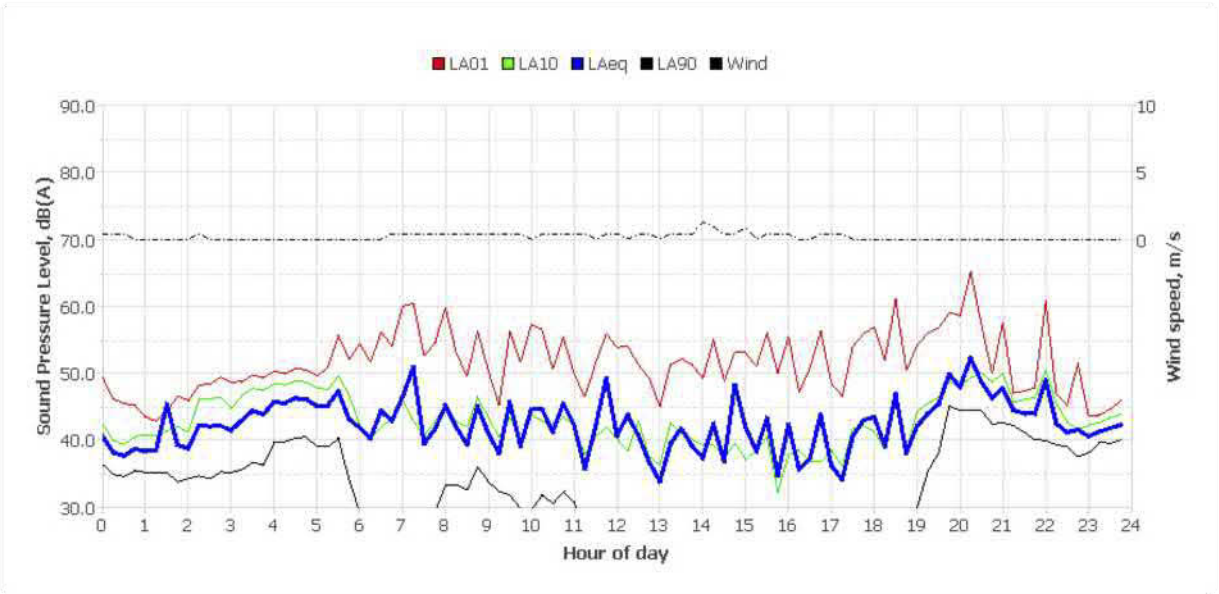
Monday, 29 Oct 2018



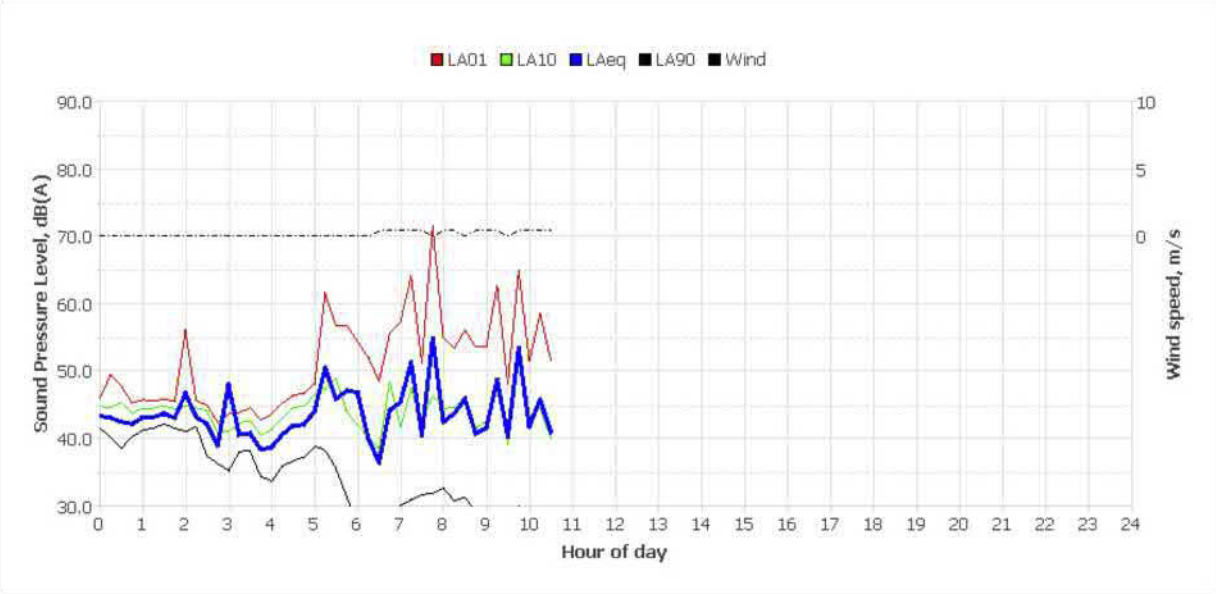
Tuesday, 30 Oct 2018



Wednesday, 31 Oct 2018



Thursday, 01 Nov 2018



Noise Logger Report

7409 North Star Road, North Star

Item	Information
Logger Type	CUBE
Serial number	11096
Address	7409 North Star Road, North Star
Location	Front Yard
Facade / Free Field	Free Field
Environment	

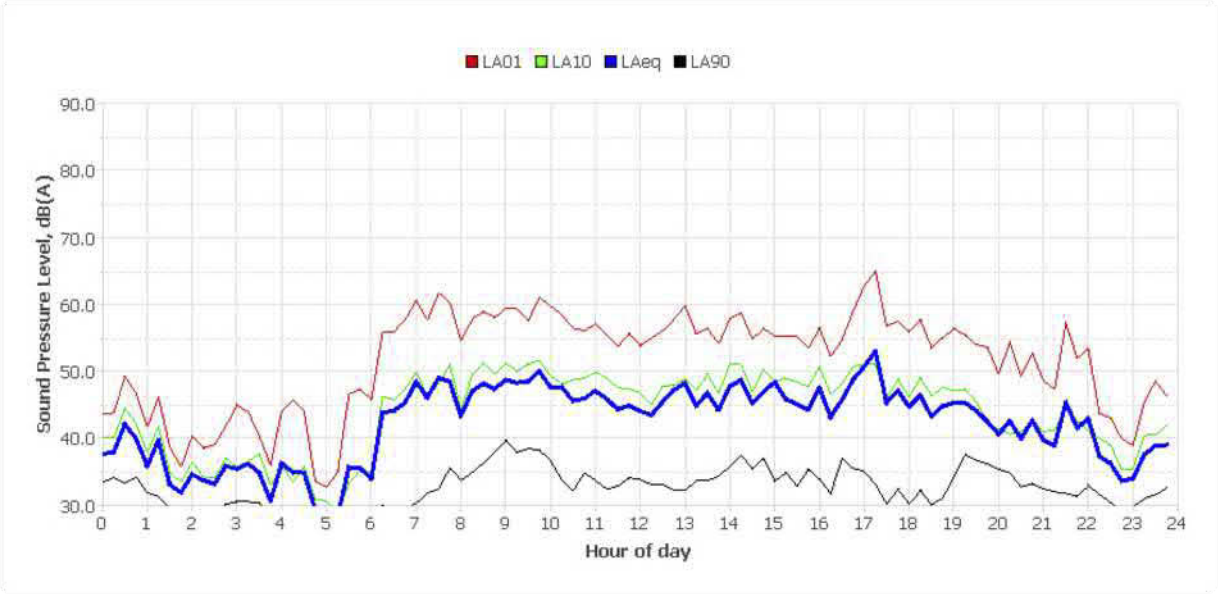
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Thu Sep 13 2018	41	42	42	-	25	-	42	42
Fri Sep 14 2018	46	45	37	27	22	20	46	37
Sat Sep 15 2018	52	41	41	35	28	20	51	41
Sun Sep 16 2018	54	46	55	42	25	27	53	55
Mon Sep 17 2018	47	44	45	27	23	24	47	45
Tue Sep 18 2018	51	46	40	31	28	24	50	40
Wed Sep 19 2018	56	41	45	41	27	23	54	45
Thu Sep 20 2018	55	52	36	35	31	19	54	36
Fri Sep 21 2018	47	39	35	27	-	22	47	35
Sat Sep 22 2018	48	44	38	25	-	-	48	38
Sun Sep 23 2018	49	47	38	28	-	19	49	38
Mon Sep 24 2018	48	49	47	28	30	23	48	47
Tue Sep 25 2018	49	45	46	30	25	23	48	46
Wed Sep 26 2018	50	42	40	30	26	22	49	40
Thu Sep 27 2018	46	-	38	-	-	-	46	38
Summary	**51**	**46**	**45**	**30**	**26**	**23**	**50**	**45**

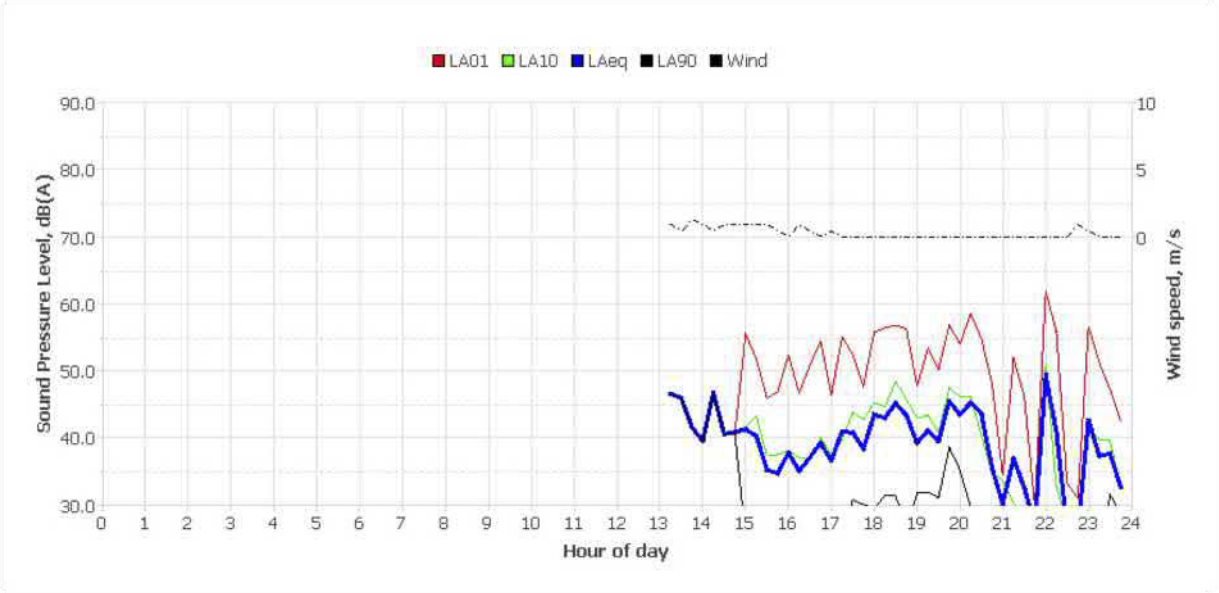
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

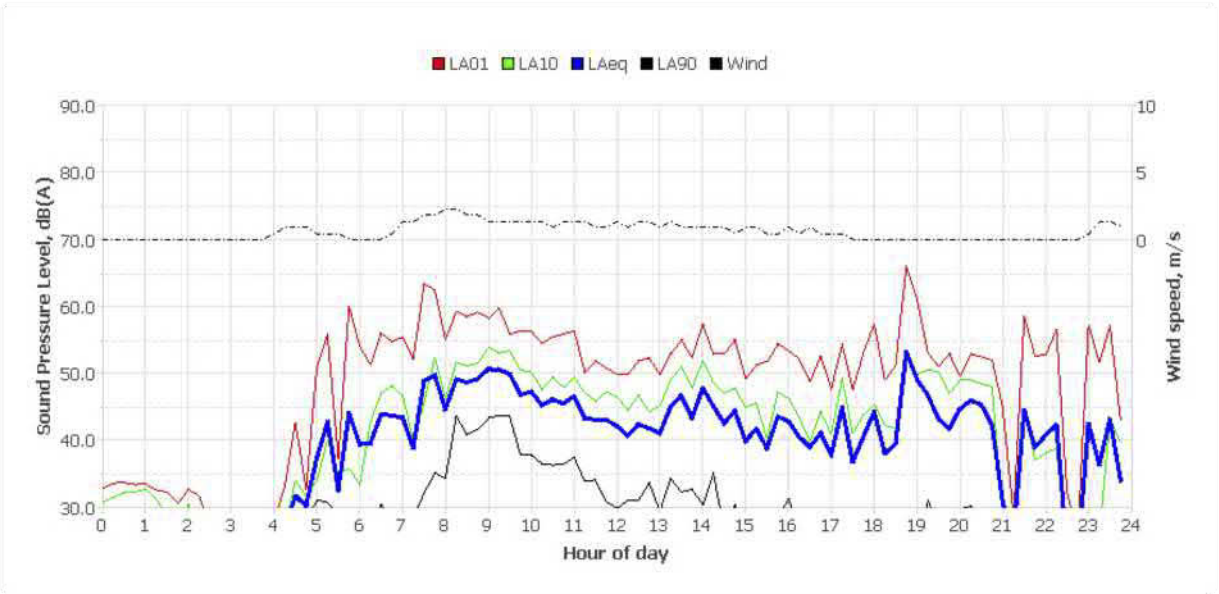
Typical Day



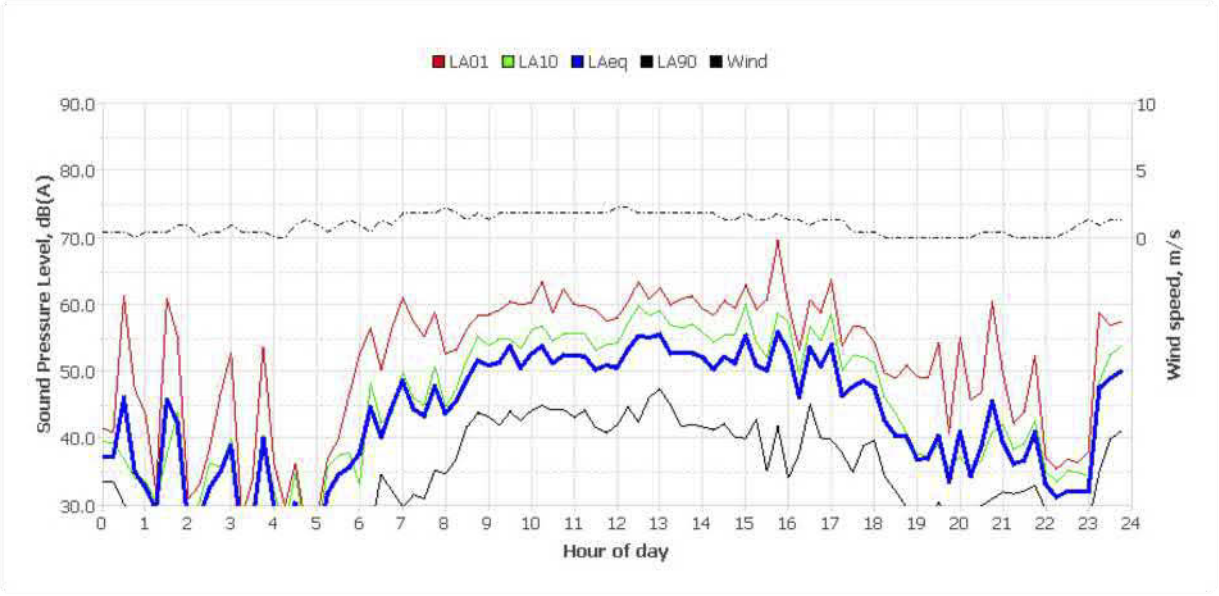
Thursday, 13 Sep 2018



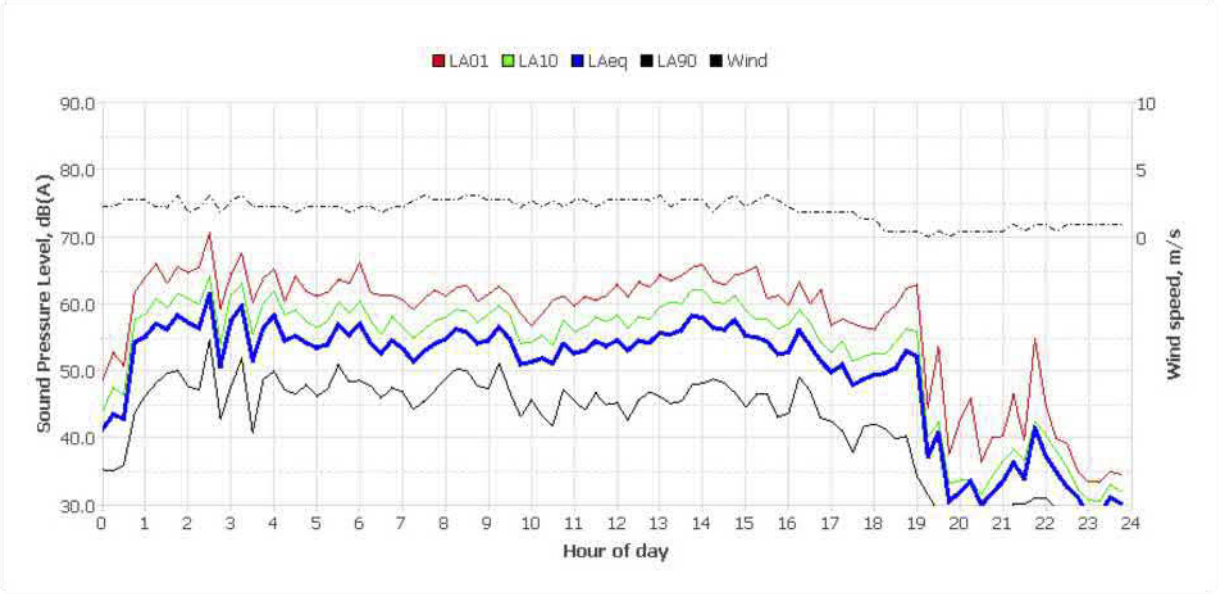
Friday, 14 Sep 2018



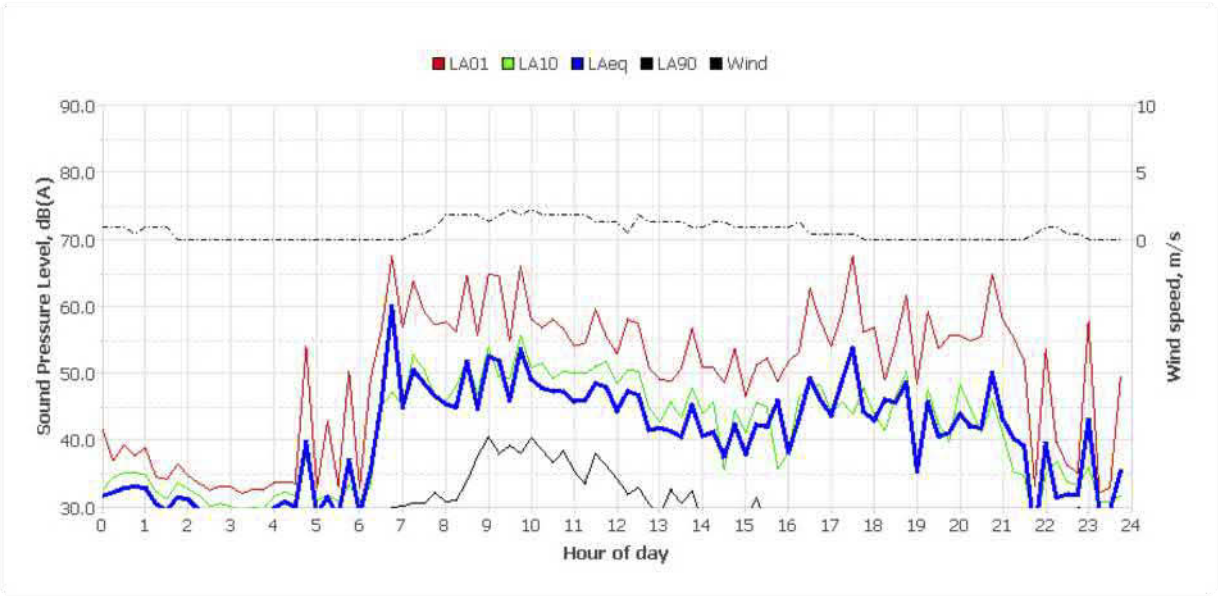
Saturday, 15 Sep 2018



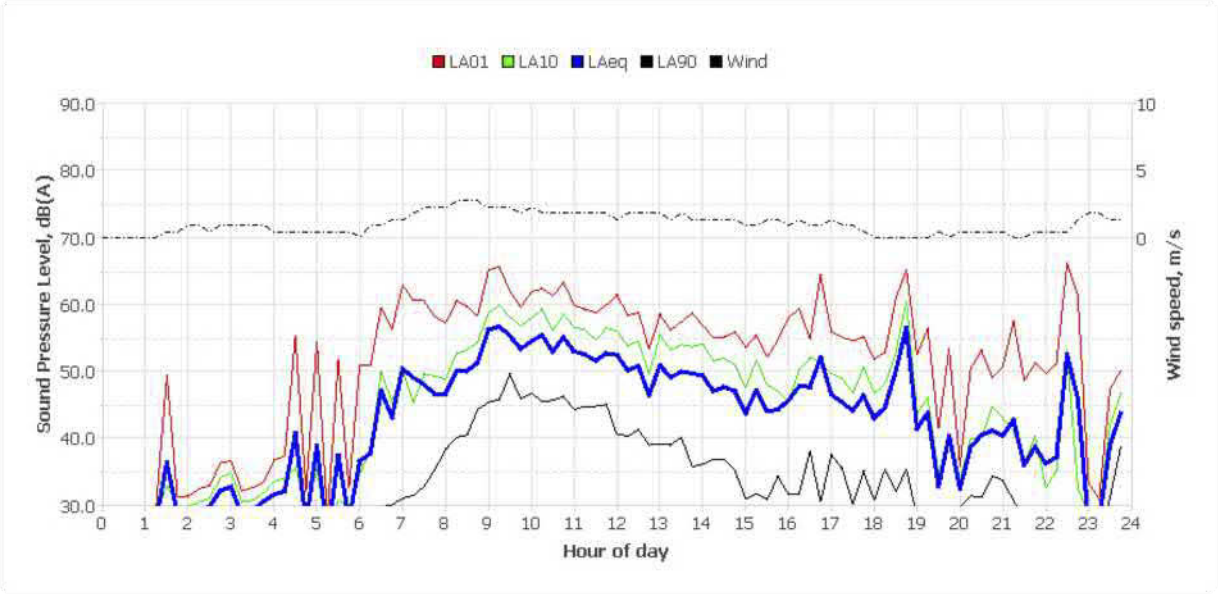
Sunday, 16 Sep 2018



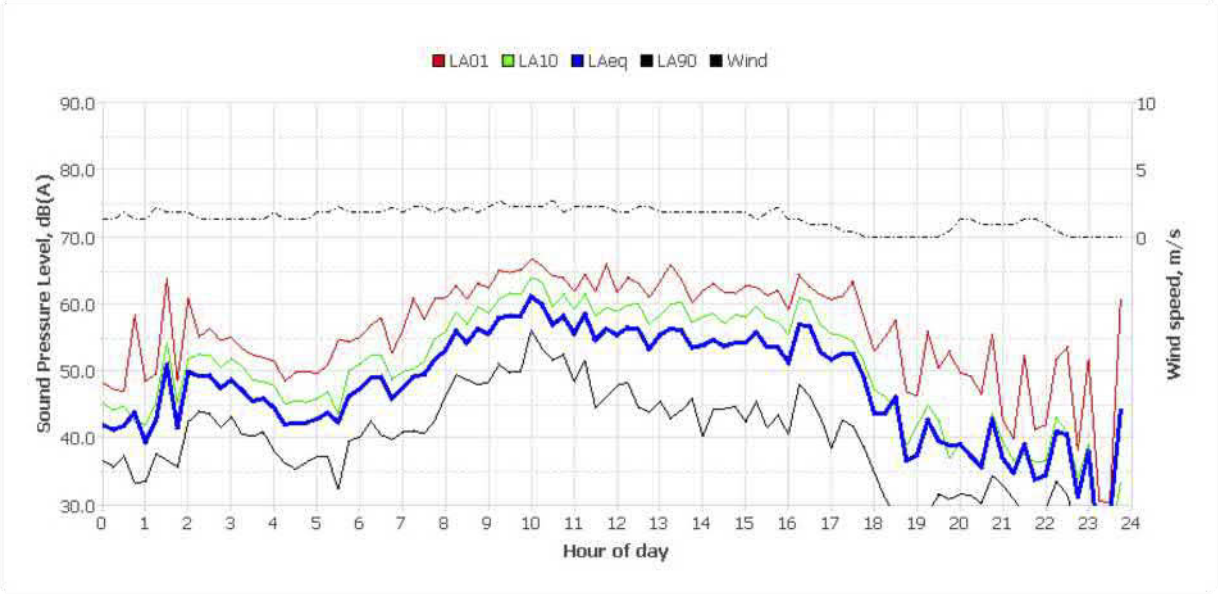
Monday, 17 Sep 2018



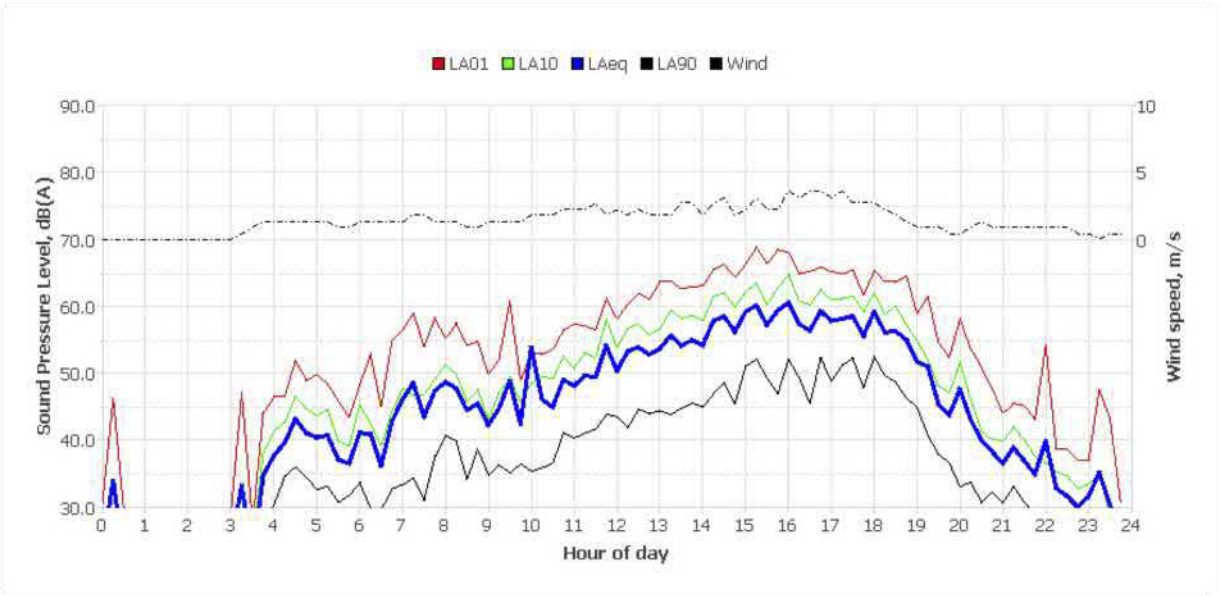
Tuesday, 18 Sep 2018



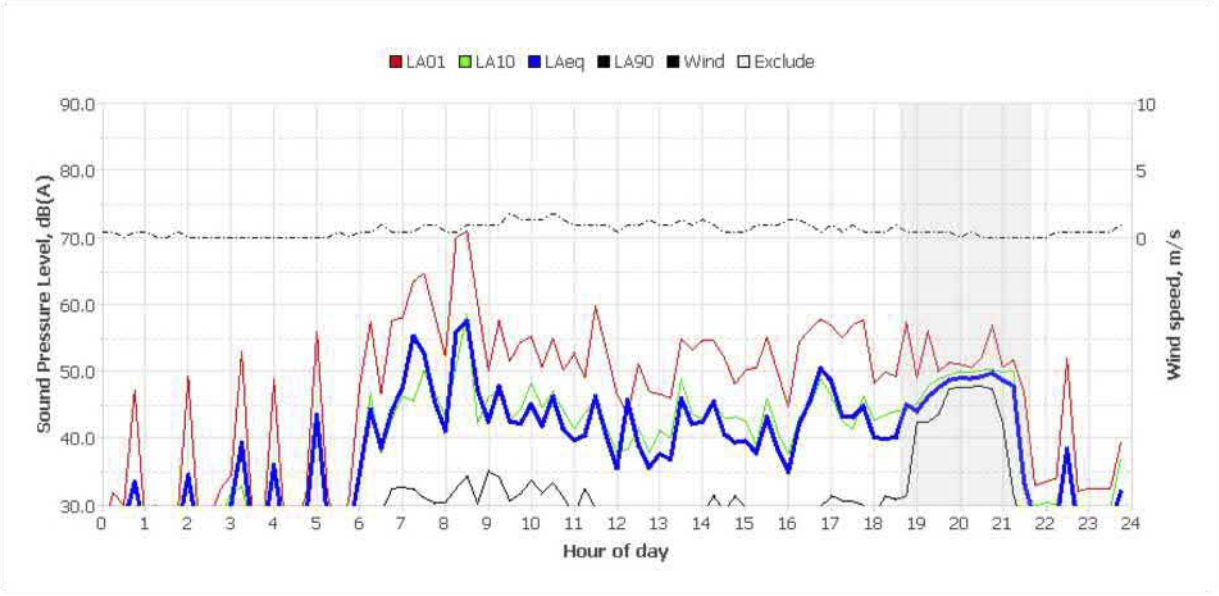
Wednesday, 19 Sep 2018



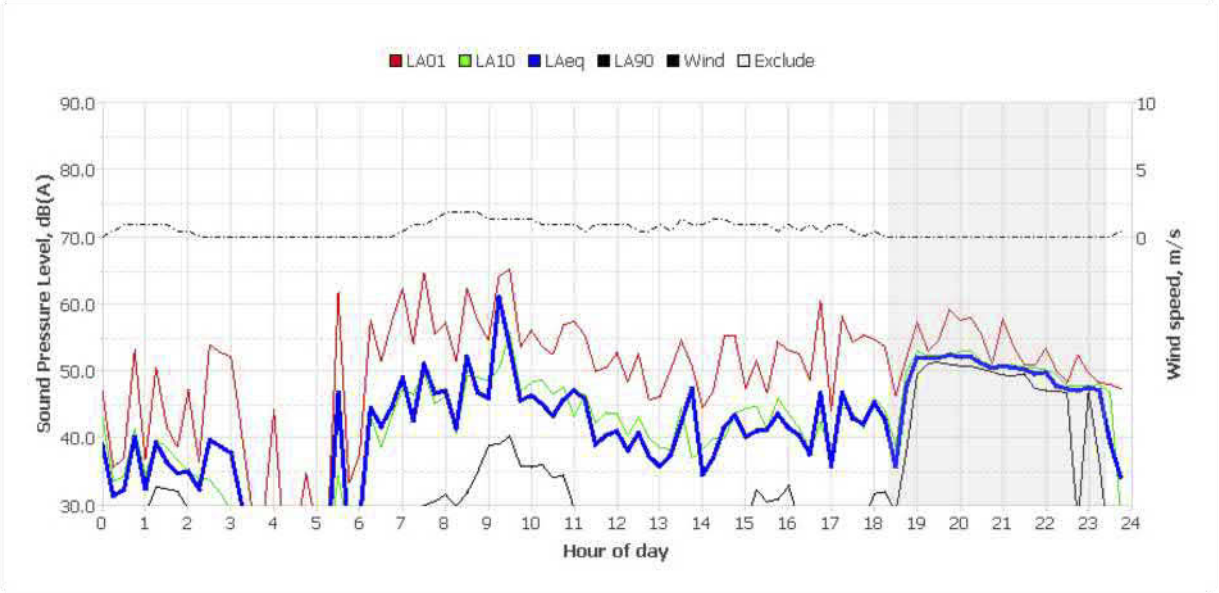
Thursday, 20 Sep 2018



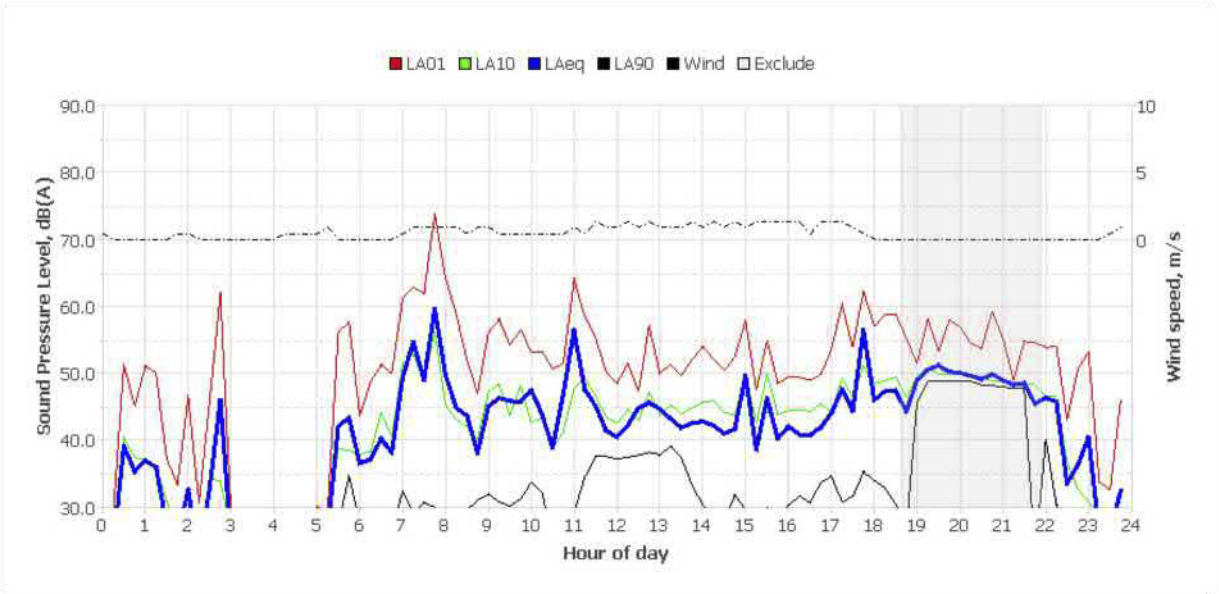
Friday, 21 Sep 2018



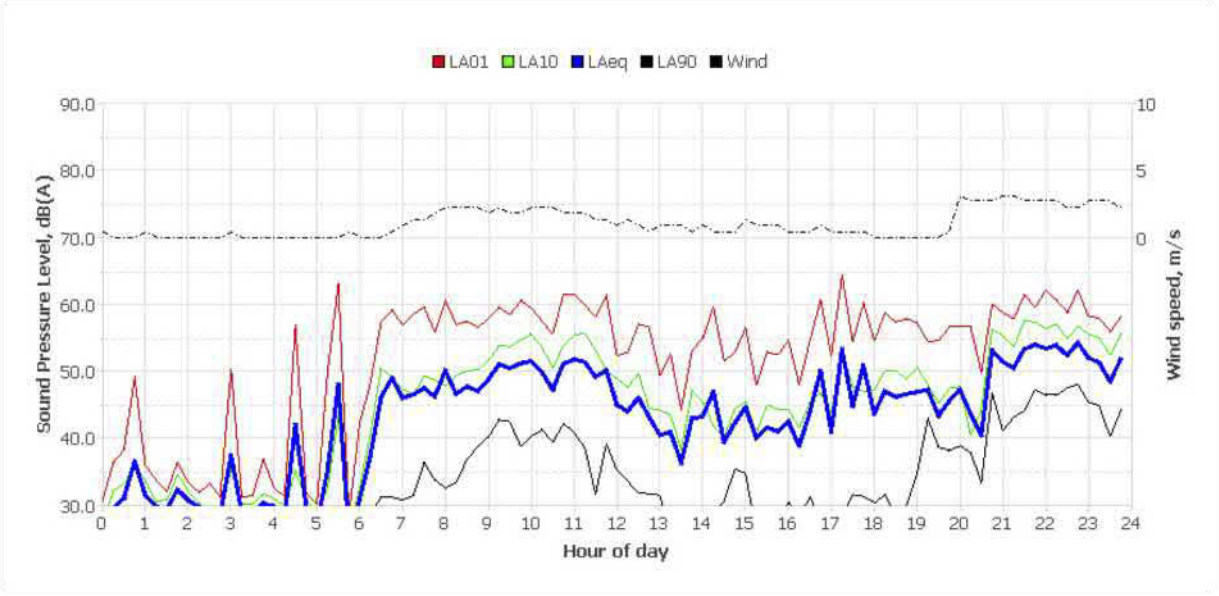
Saturday, 22 Sep 2018



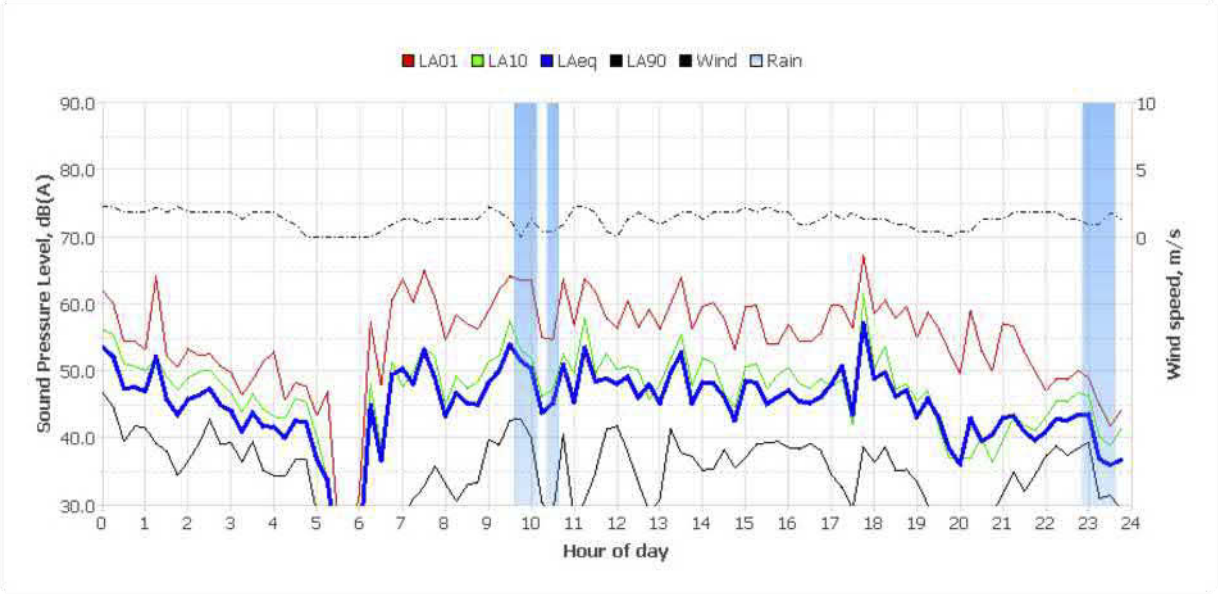
Sunday, 23 Sep 2018



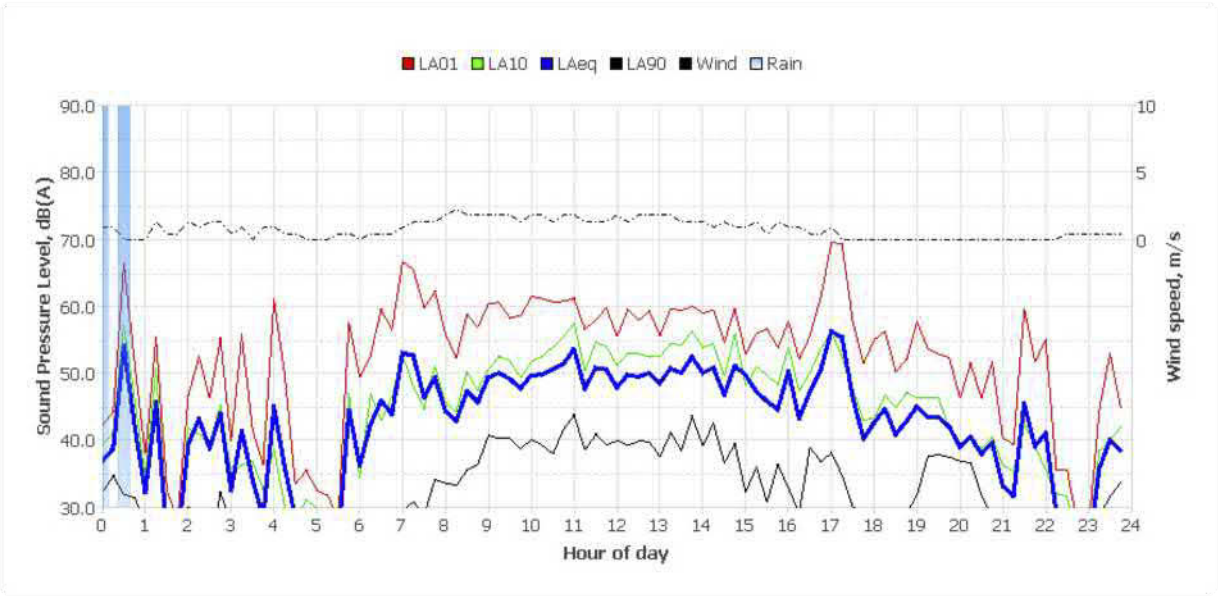
Monday, 24 Sep 2018



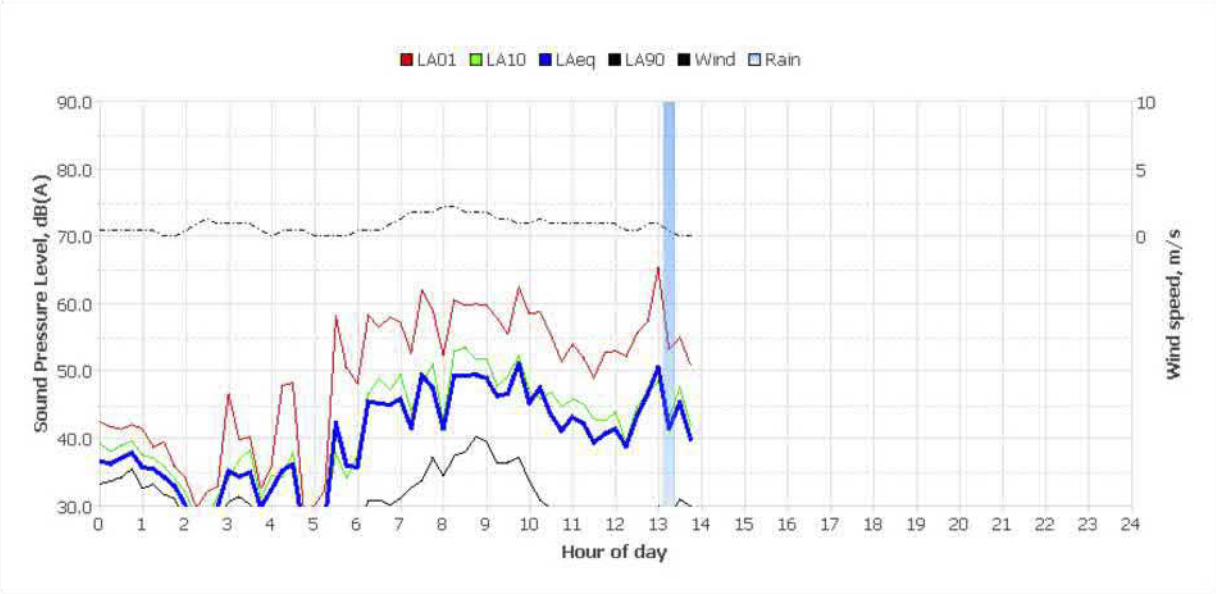
Tuesday, 25 Sep 2018



Wednesday, 26 Sep 2018



Thursday, 27 Sep 2018



Noise Logger Report

21930 Bruxner Highway, Boggabilla

Item	Information
Logger Type	CUBE
Serial number	11098
Address	21930 Bruxner Highway, Boggabilla
Location	Front Yard
Facade / Free Field	Free Field
Environment	

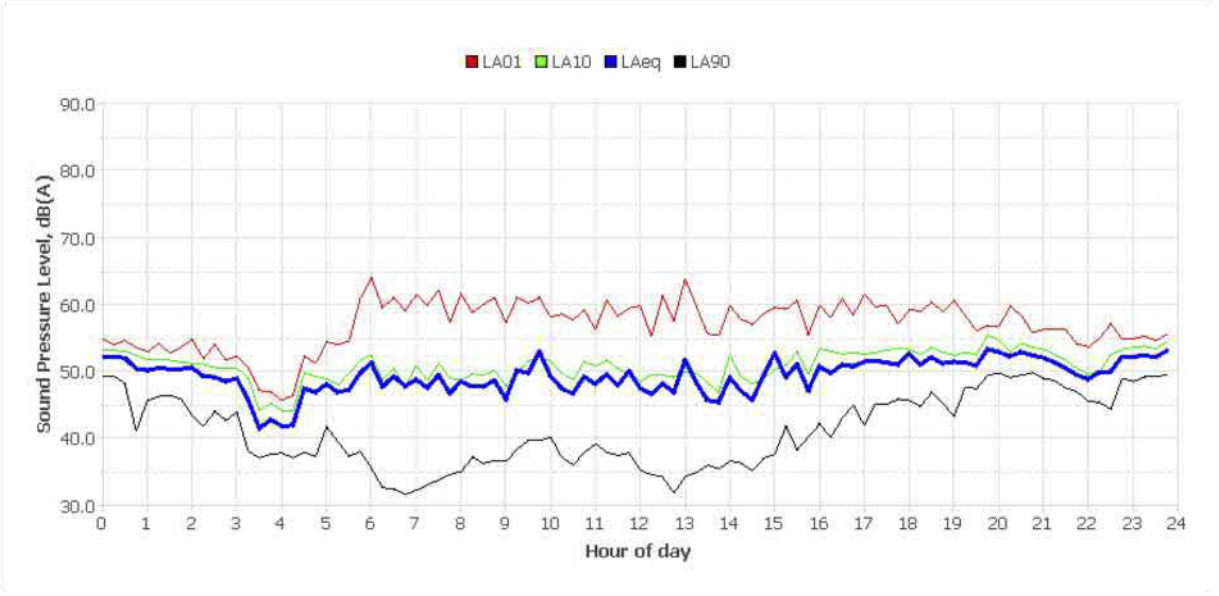
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Mon Oct 8 2018	46	45	49	-	-	-	46	49
Tue Oct 9 2018	47	50	45	28	-	27	48	45
Wed Oct 10 2018	49	59	47	32	-	27	54	47
Thu Oct 11 2018	64	60	47	-	48	33	63	47
Fri Oct 12 2018	51	50	48	-	-	-	51	48
Sat Oct 13 2018	51	53	51	33	44	-	52	51
Sun Oct 14 2018	57	49	45	32	-	-	57	45
Mon Oct 15 2018	50	51	49	30	46	37	51	49
Tue Oct 16 2018	49	-	52	-	-	-	49	52
Summary	**56**	**55**	**49**	**32**	**46**	**30**	**56**	**49**

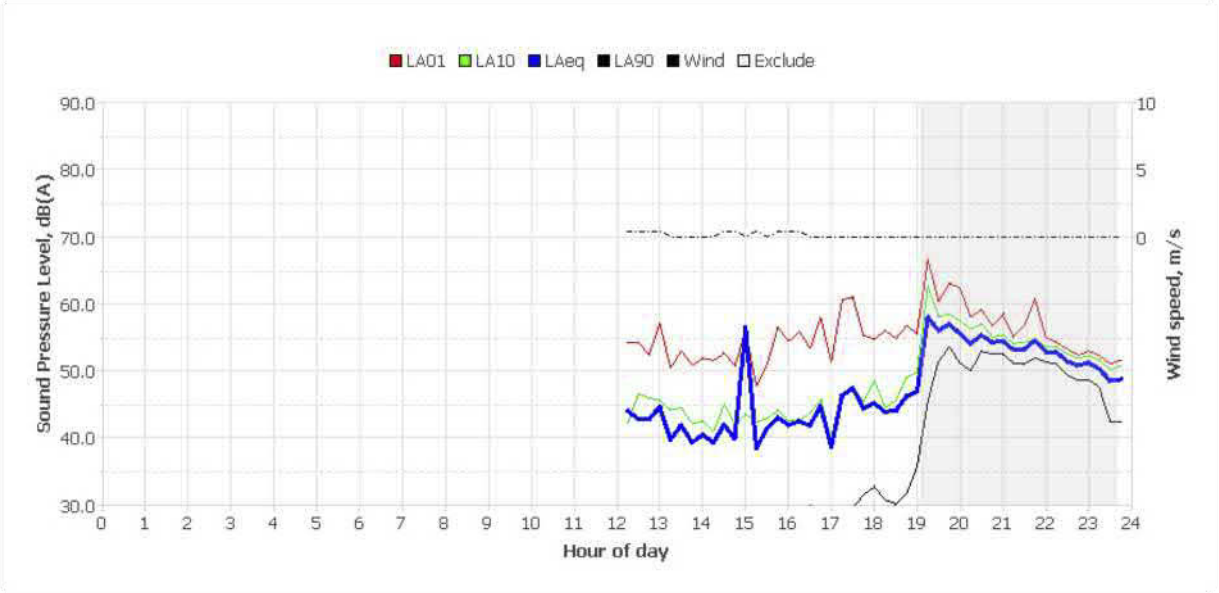
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
	

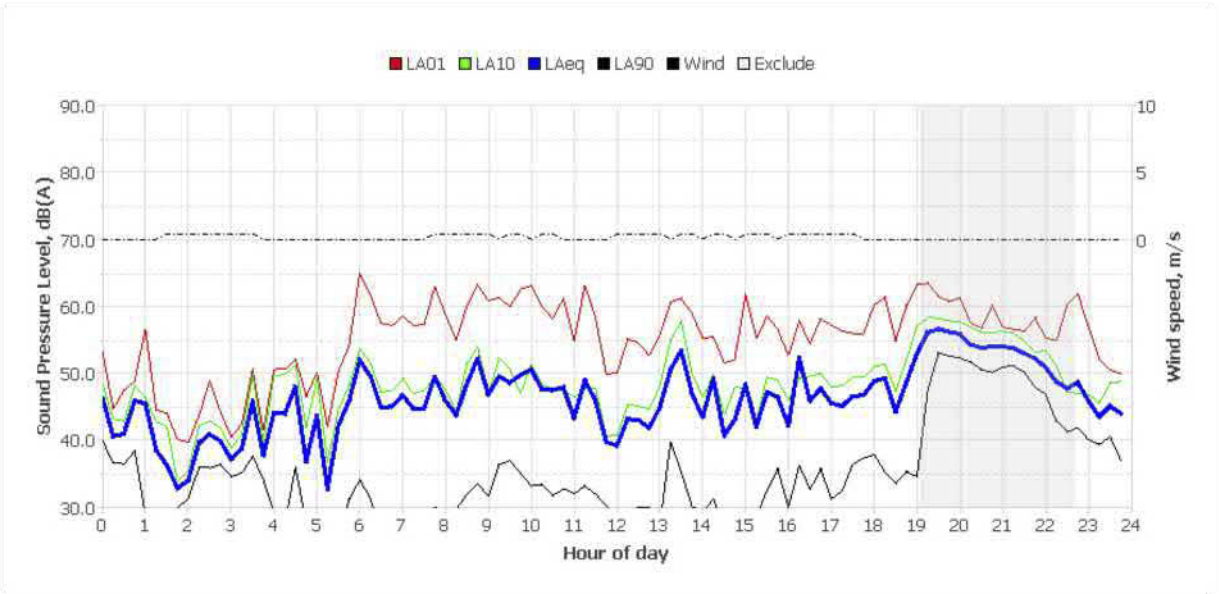
Typical Day



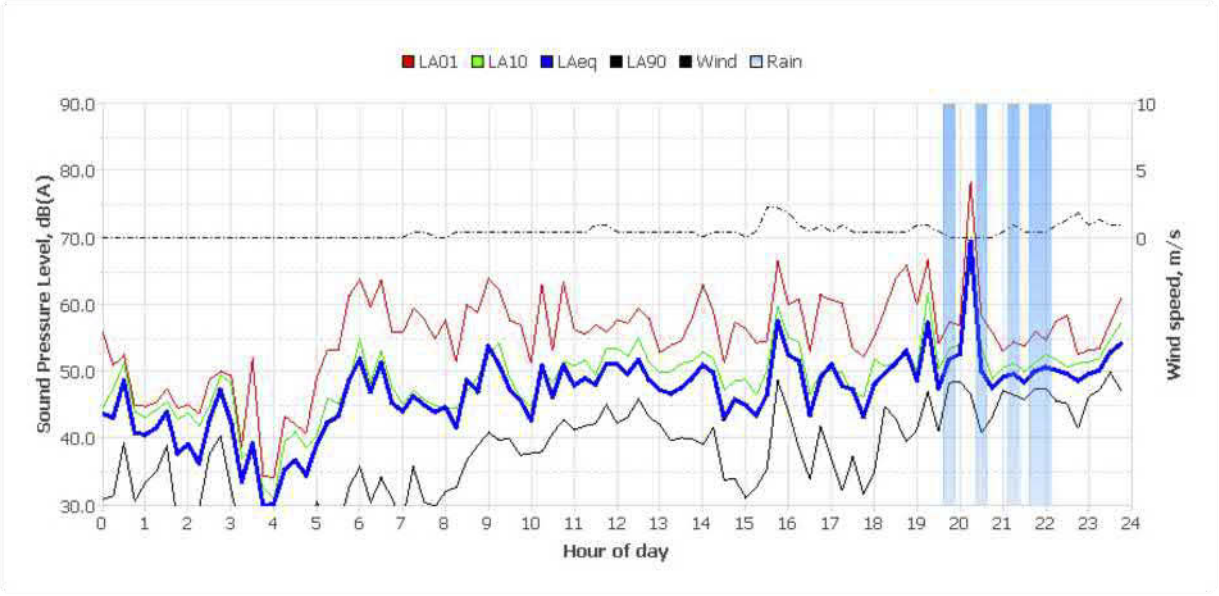
Monday, 08 Oct 2018



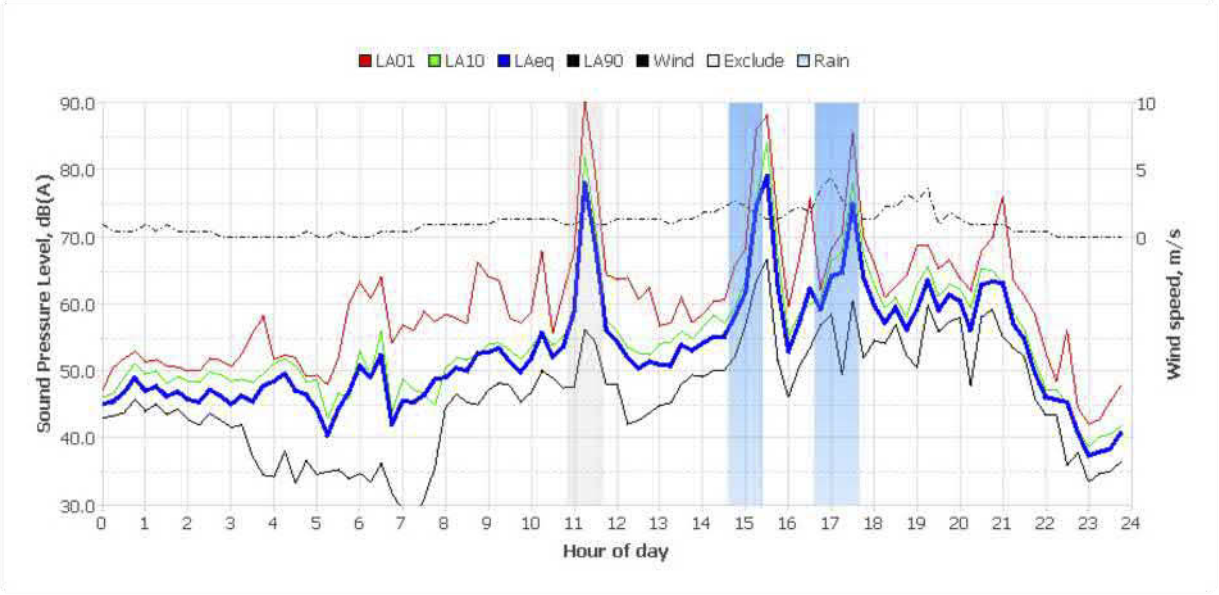
Tuesday, 09 Oct 2018



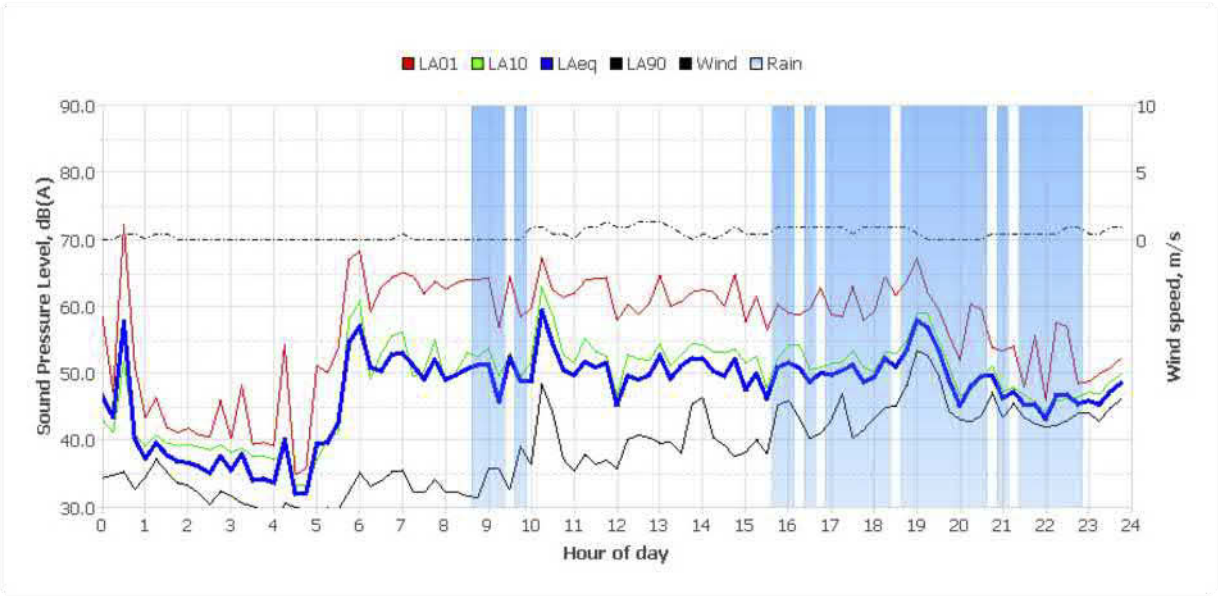
Wednesday, 10 Oct 2018



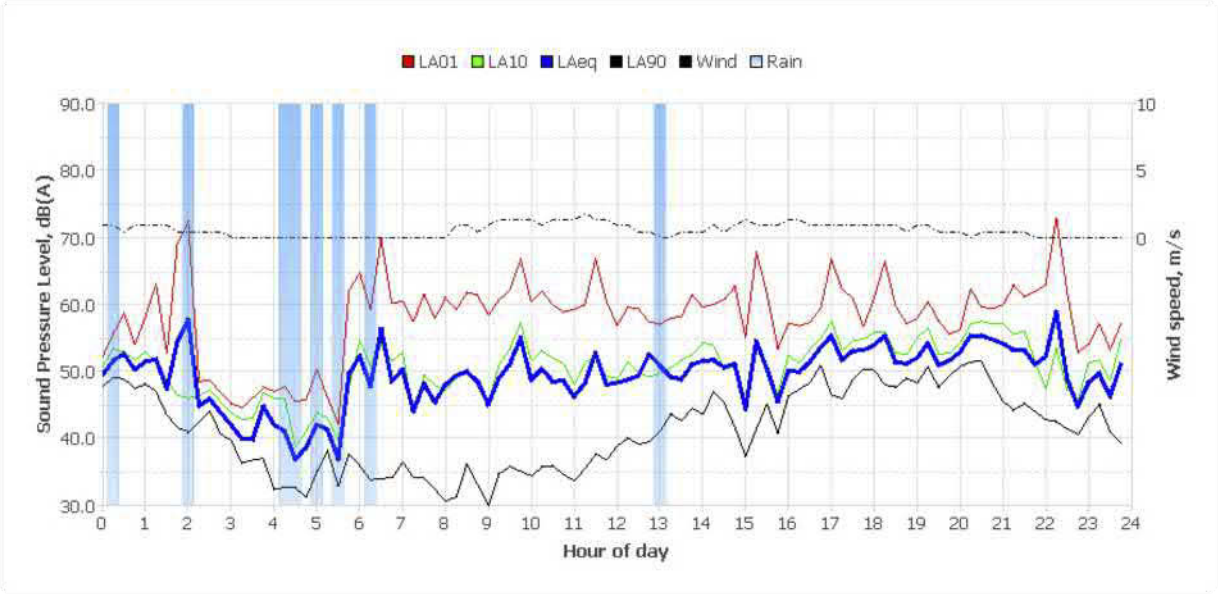
Thursday, 11 Oct 2018



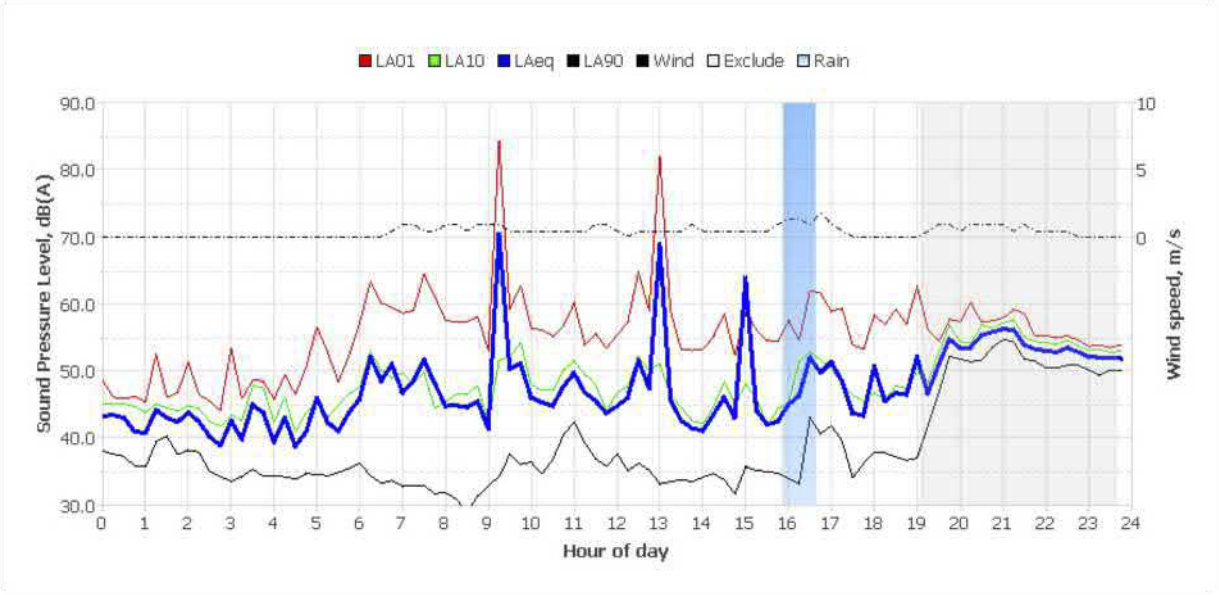
Friday, 12 Oct 2018



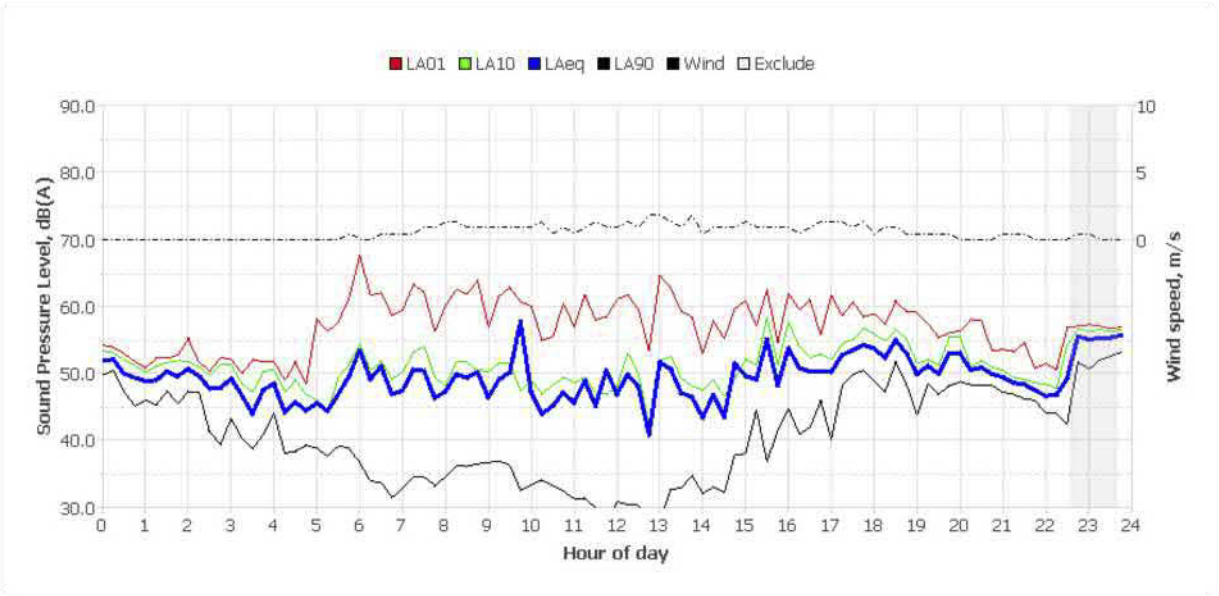
Saturday, 13 Oct 2018



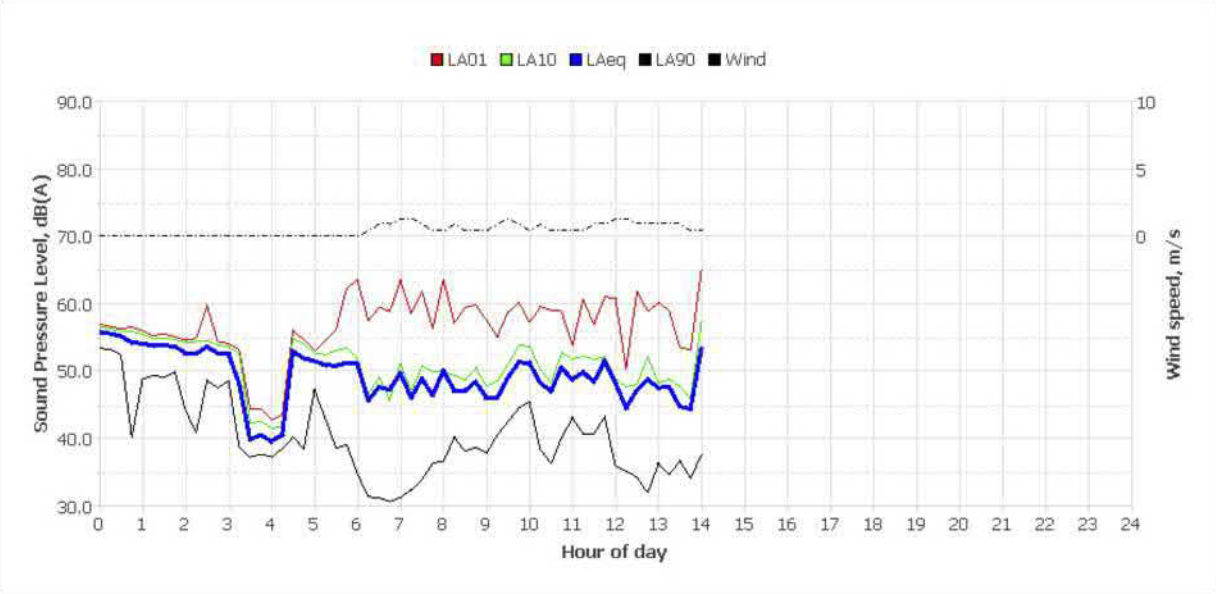
Sunday, 14 Oct 2018



Monday, 15 Oct 2018



Tuesday, 16 Oct 2018



Noise Logger Report

3780 Tucka Tucka Road, Boggabilla

Item	Information
Logger Type	CUBE
Serial number	11096
Address	3780 Tucka Tucka Road, Boggabilla
Location	Front Yard
Facade / Free Field	Free Field
Environment	

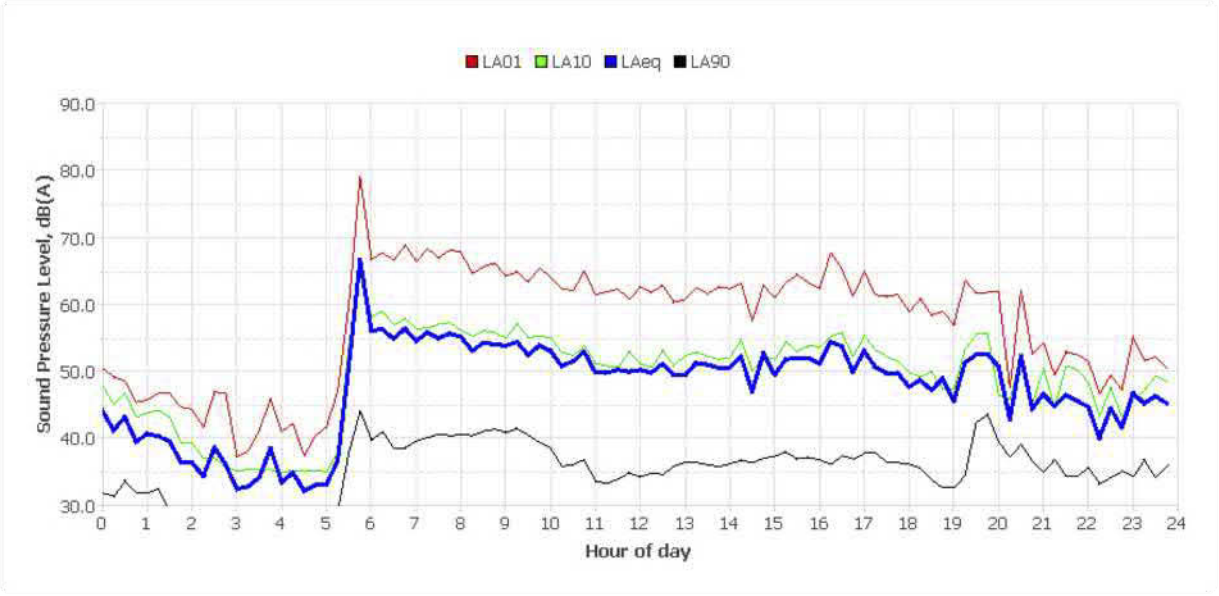
Measured noise levels

Logging Date	L_{Aeq} Day	Eve	Night	ABL Day	Eve	Night	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$
Wed Oct 17 2018	-	52	43	-	33	-	52	43
Thu Oct 18 2018	53	54	51	31	31	-	53	51
Fri Oct 19 2018	56	47	47	31	30	28	54	47
Sat Oct 20 2018	54	54	49	33	-	29	54	49
Sun Oct 21 2018	55	56	55	33	31	25	55	55
Mon Oct 22 2018	53	51	54	31	30	26	53	54
Tue Oct 23 2018	55	49	48	33	31	27	54	48
Wed Oct 24 2018	57	49	51	37	29	25	55	51
Thu Oct 25 2018	55	54	52	37	32	27	55	52
Fri Oct 26 2018	55	53	49	36	28	25	54	49
Sat Oct 27 2018	53	51	46	29	28	24	52	46
Sun Oct 28 2018	55	48	47	30	26	24	54	47
Mon Oct 29 2018	54	51	51	37	28	27	53	51
Tue Oct 30 2018	56	50	51	34	33	28	55	51
Wed Oct 31 2018	53	49	58	34	34	27	53	58
Thu Nov 1 2018	52	51	51	33	31	25	52	51
Fri Nov 2 2018	54	-	57	-	-	-	54	57
Summary	**54**	**52**	**52**	**33**	**31**	**26**	**54**	**52**

Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

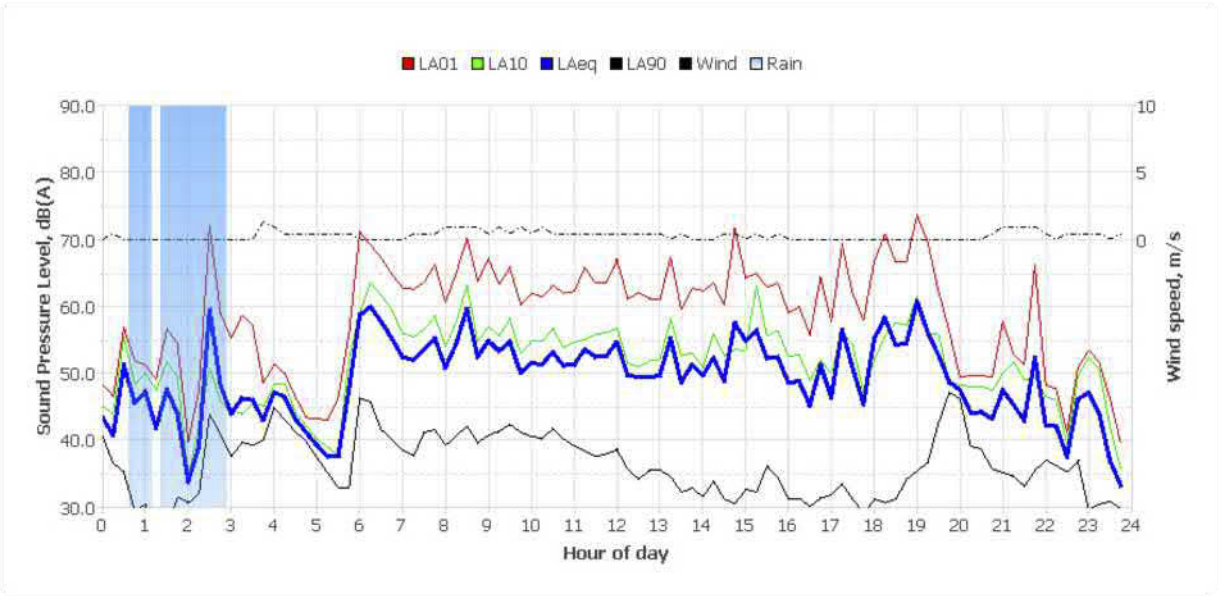
Logger Location	Logger Deployment Photo
	

Typical Day

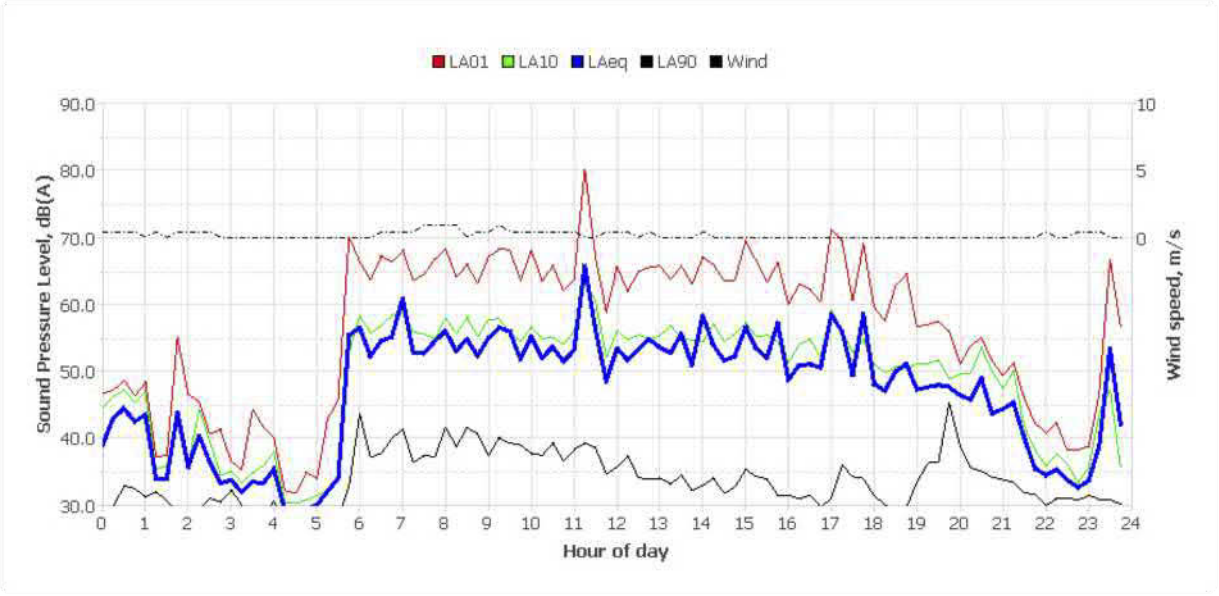


Wednesday, 17 Oct 2018

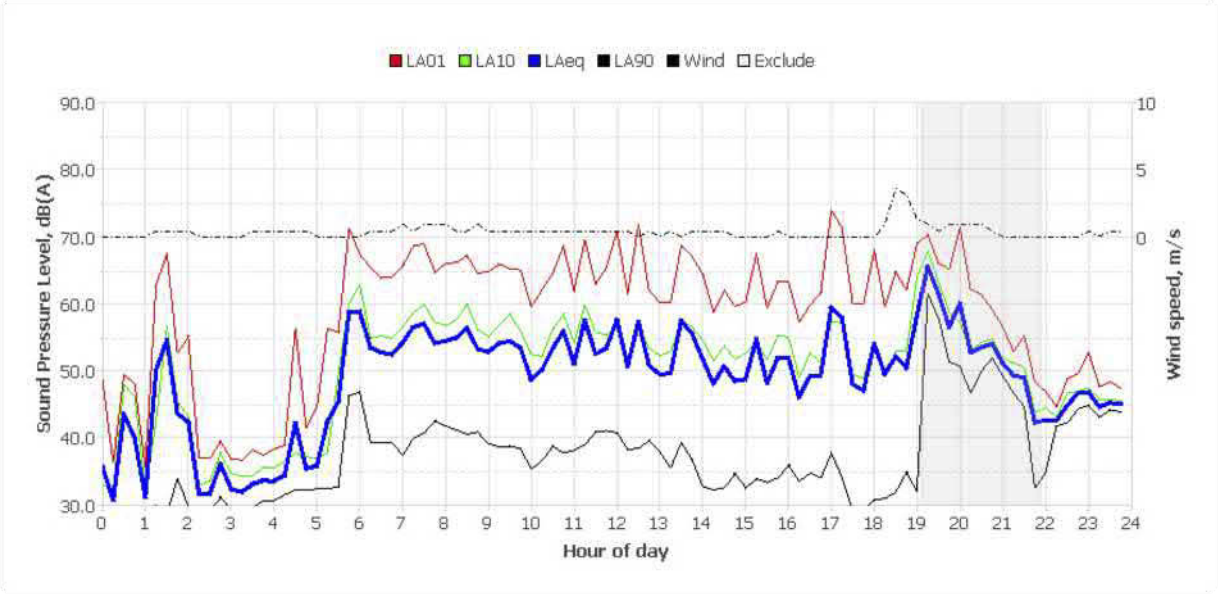
Thursday, 18 Oct 2018



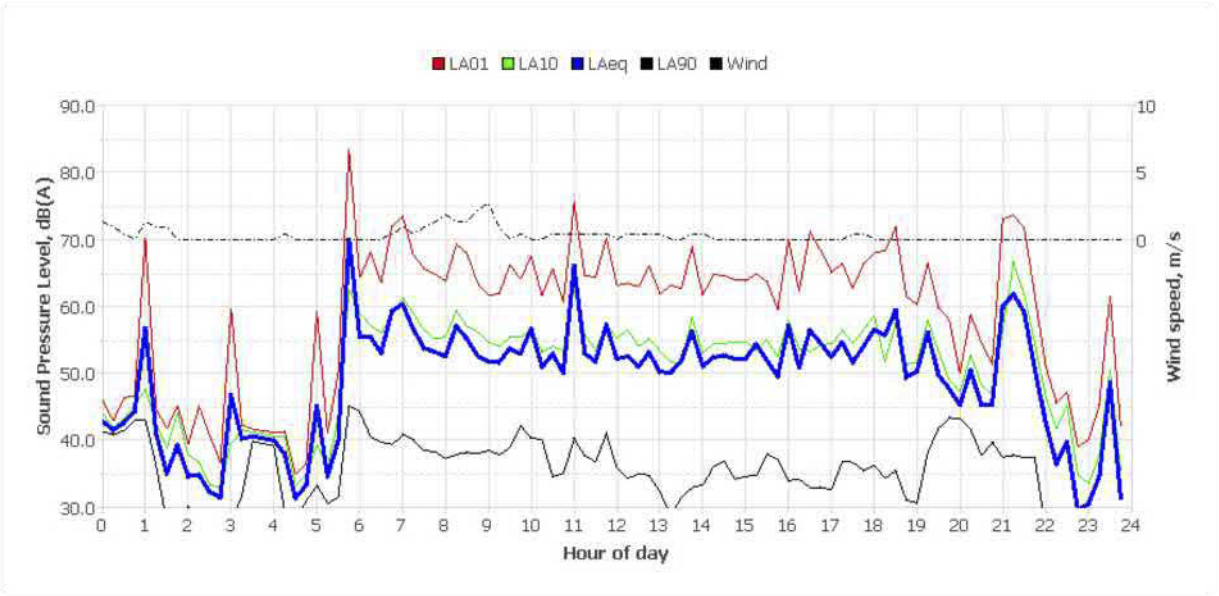
Friday, 19 Oct 2018



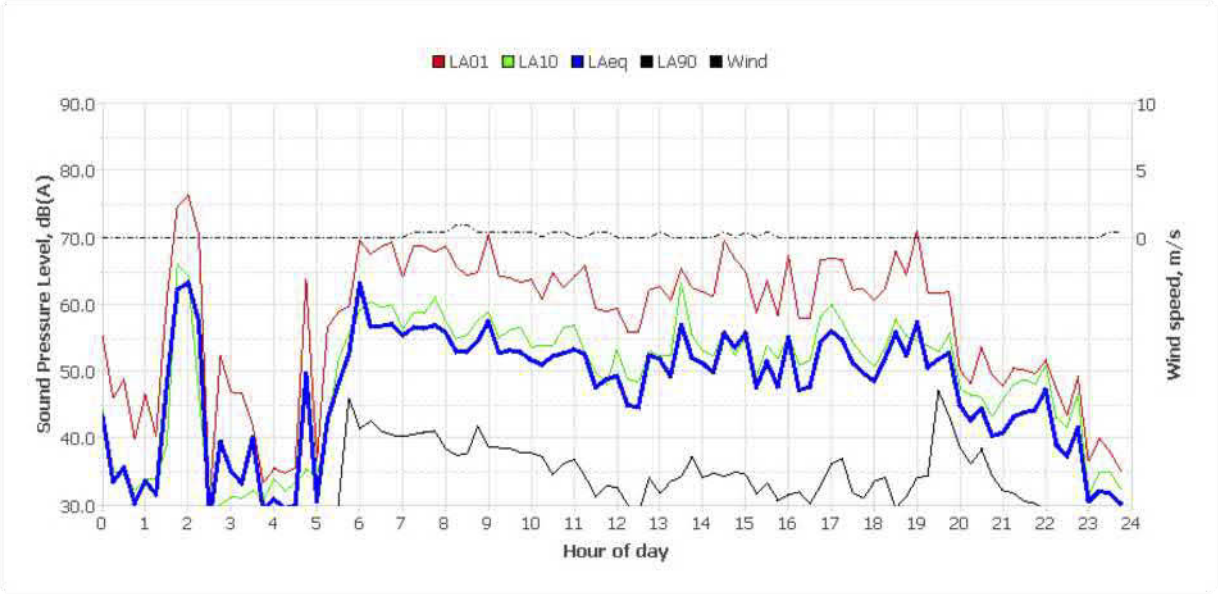
Saturday, 20 Oct 2018



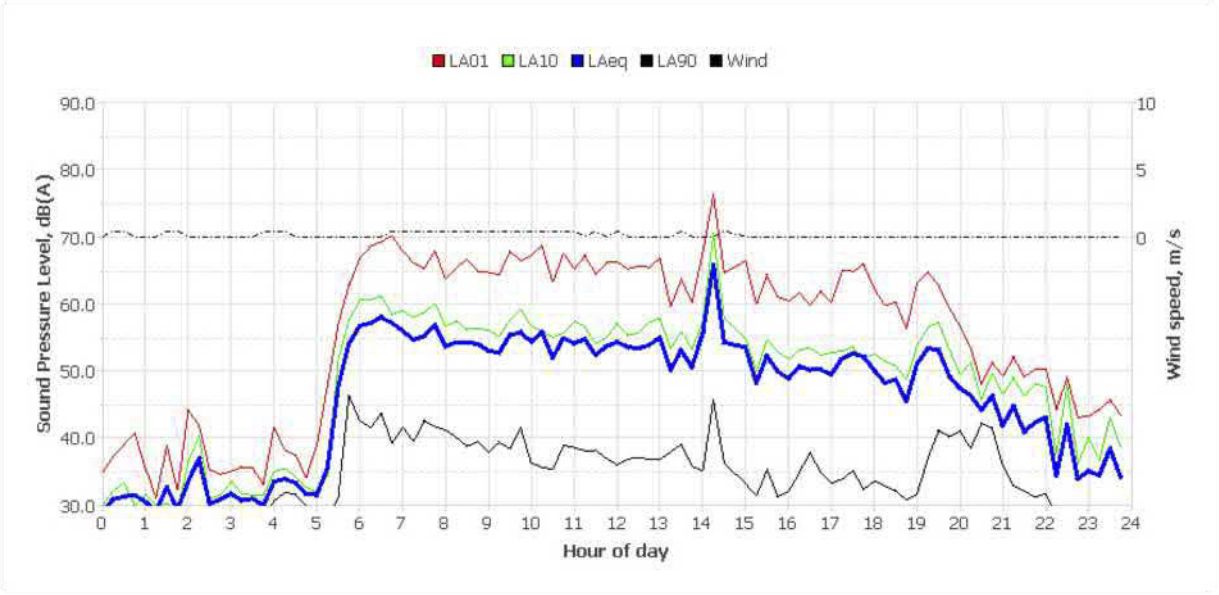
Sunday, 21 Oct 2018



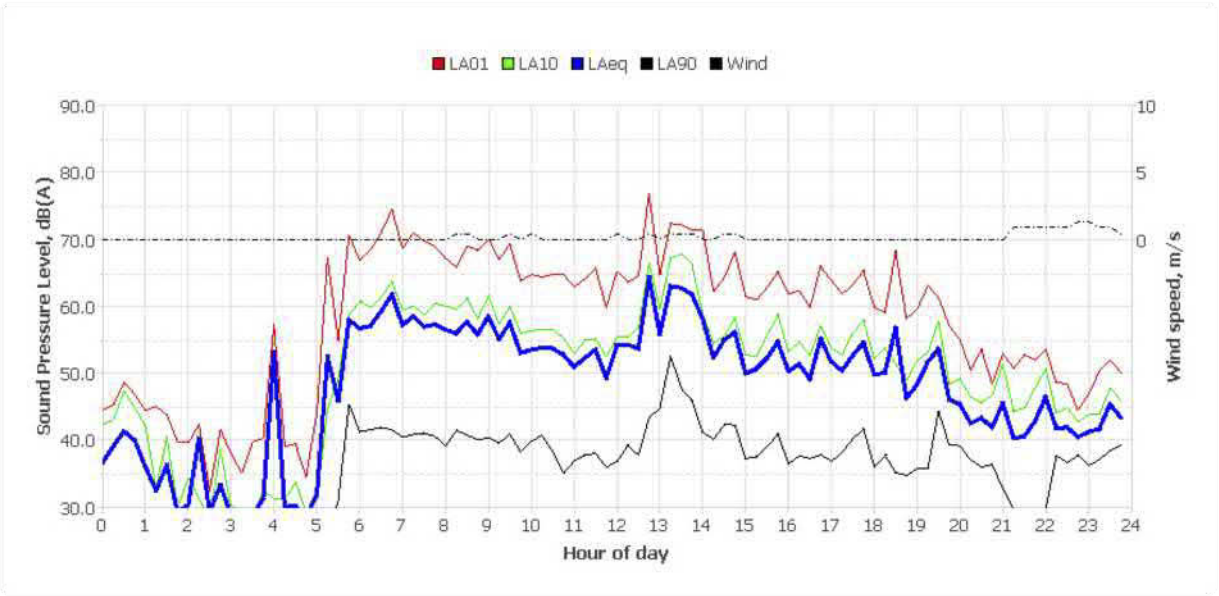
Monday, 22 Oct 2018



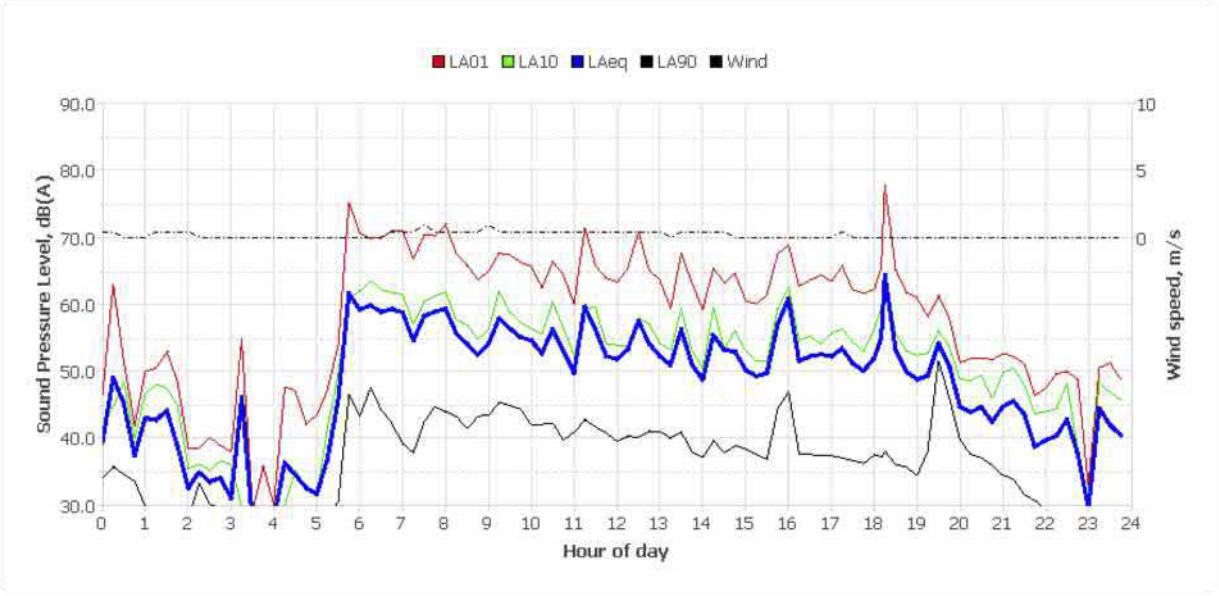
Tuesday, 23 Oct 2018



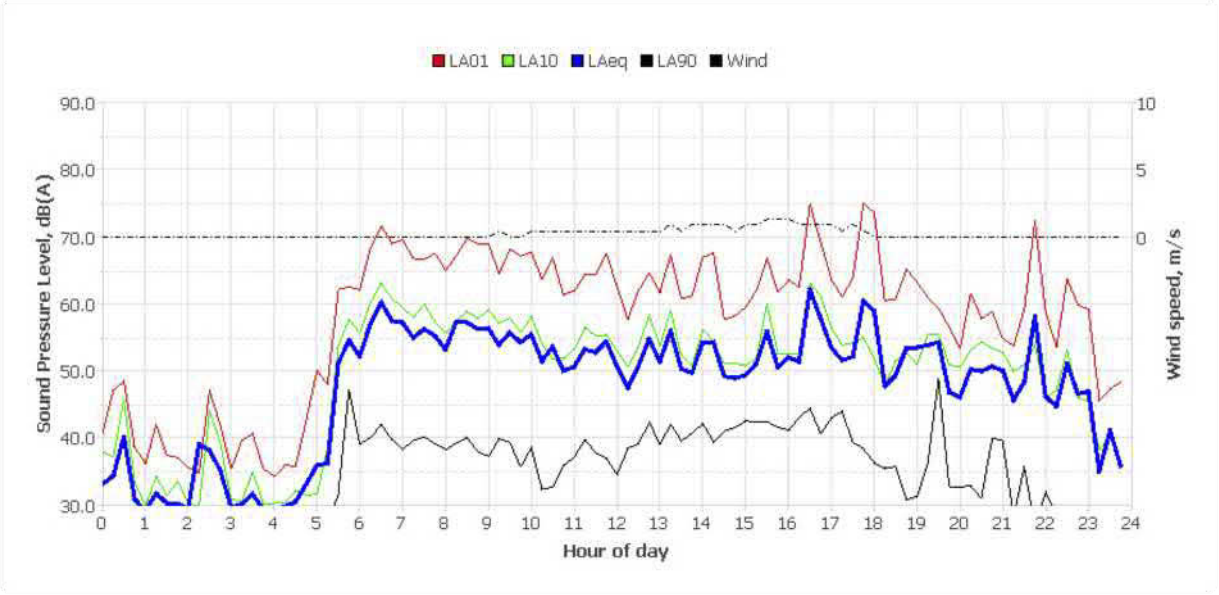
Wednesday, 24 Oct 2018



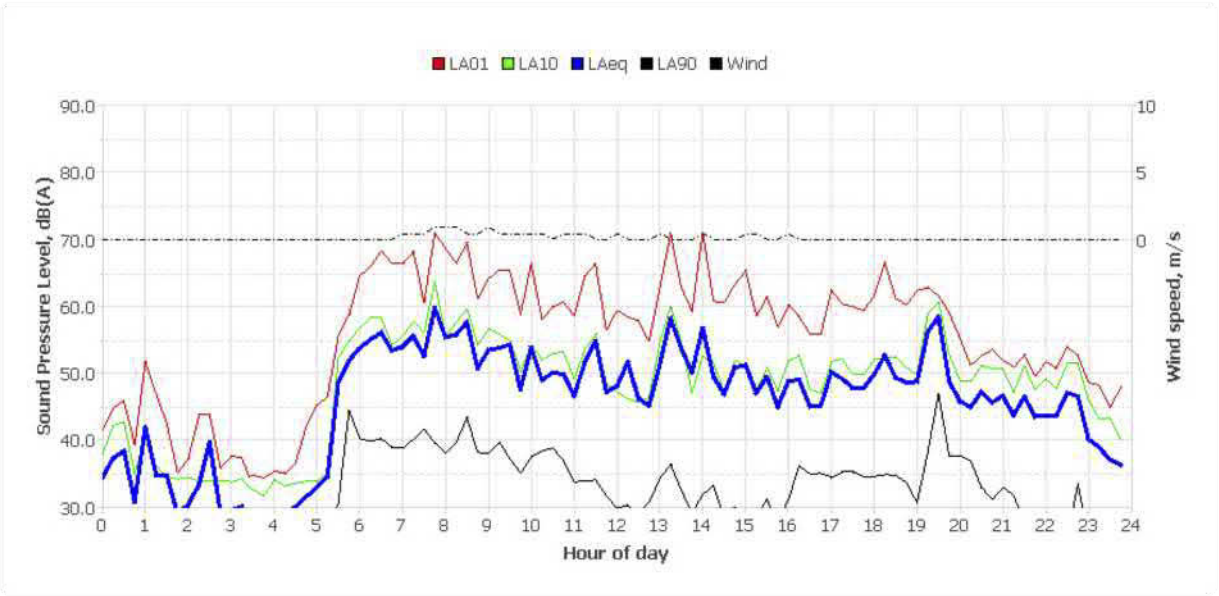
Thursday, 25 Oct 2018



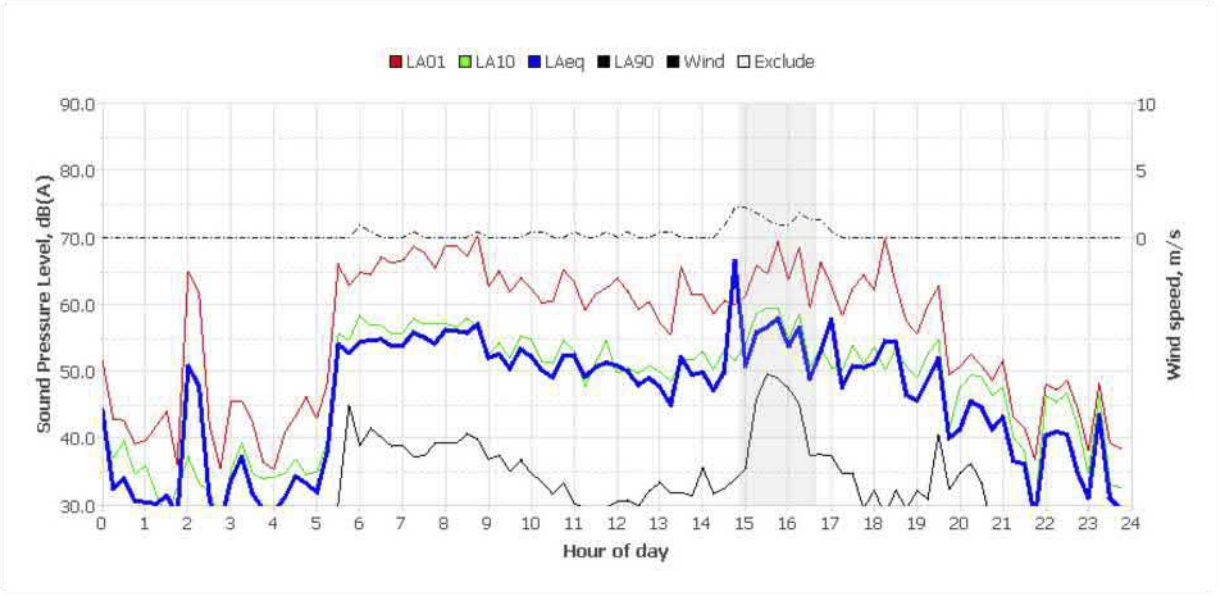
Friday, 26 Oct 2018



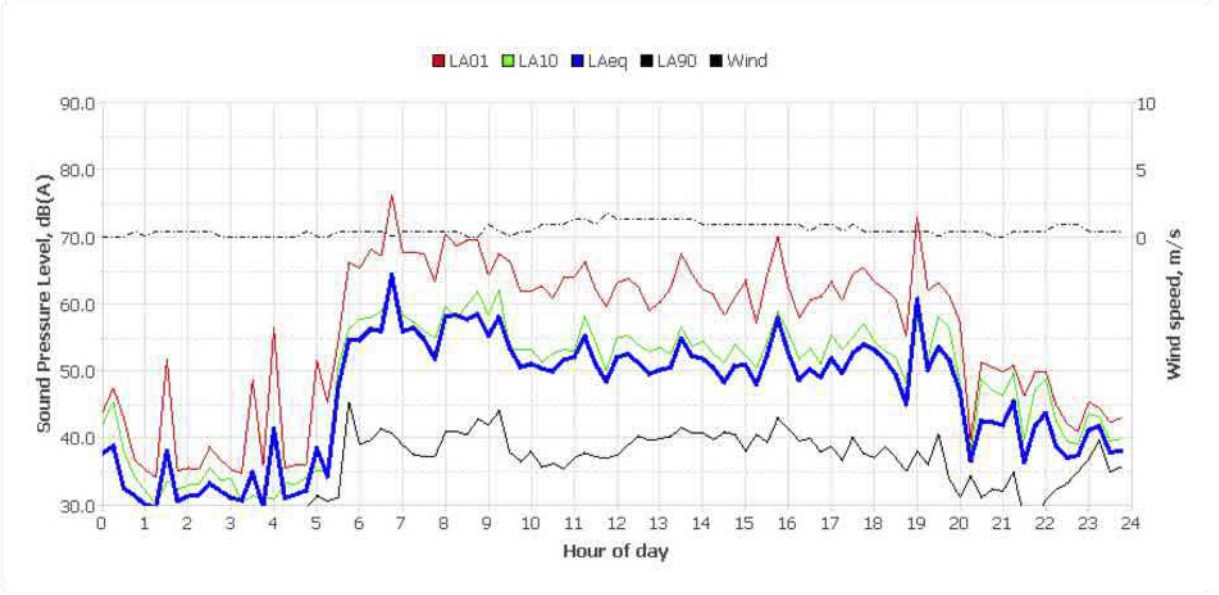
Saturday, 27 Oct 2018



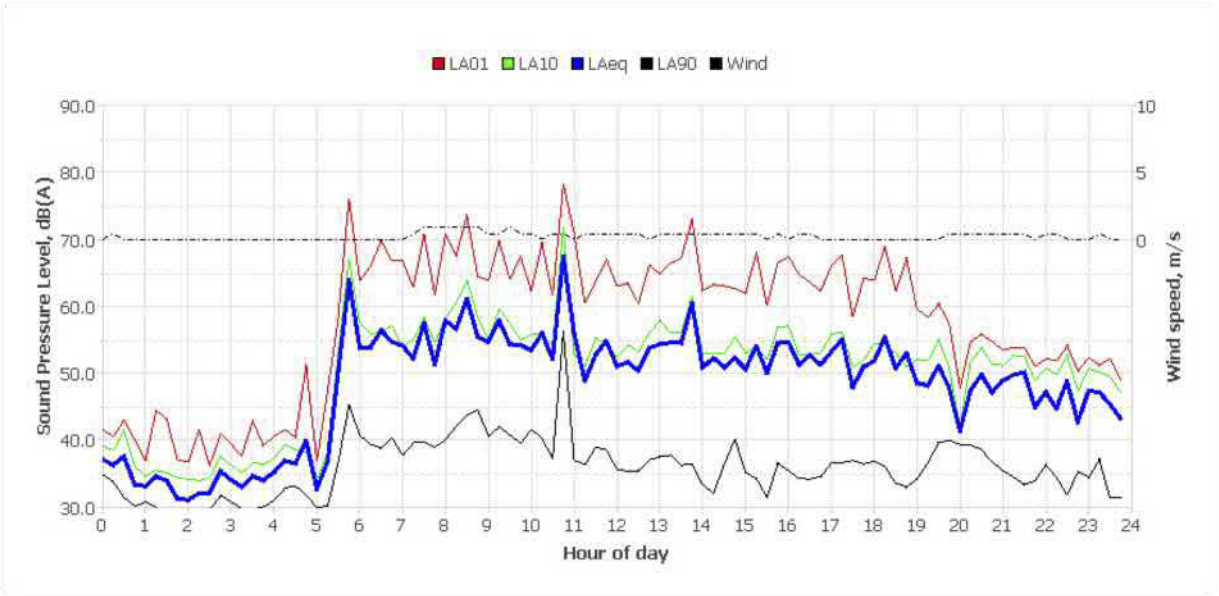
Sunday, 28 Oct 2018



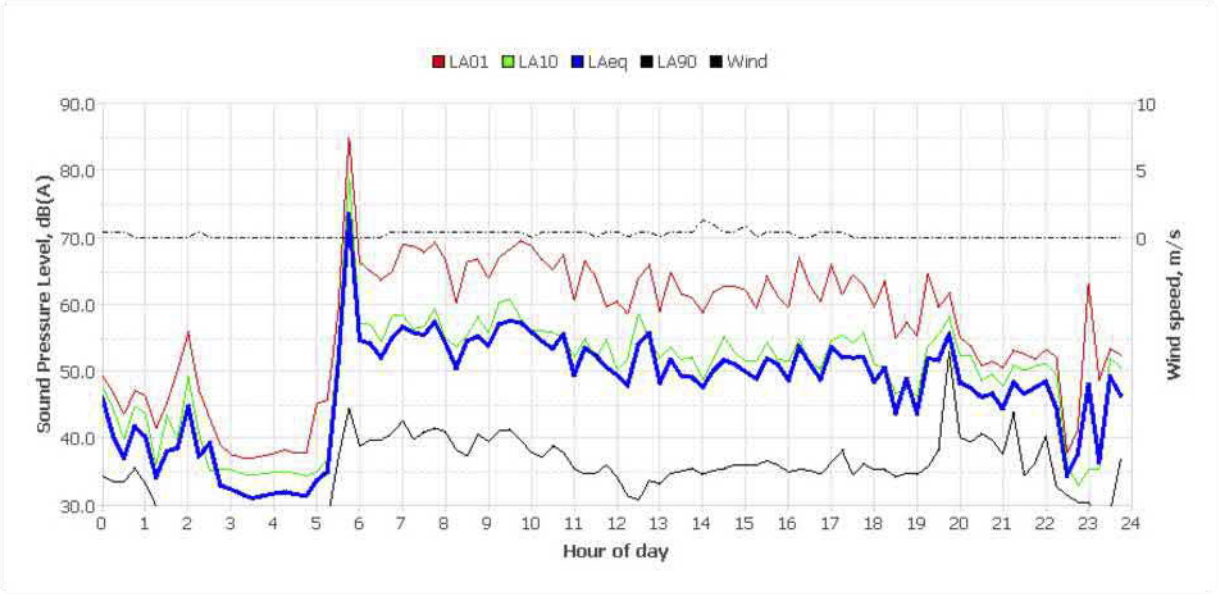
Monday, 29 Oct 2018



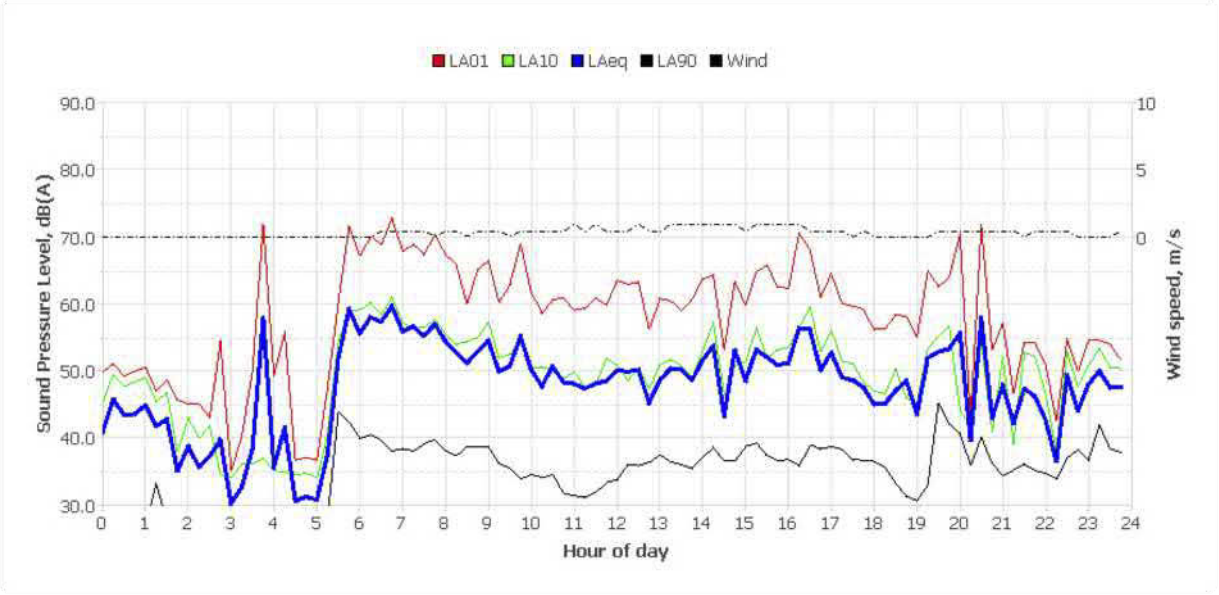
Tuesday, 30 Oct 2018



Wednesday, 31 Oct 2018



Thursday, 01 Nov 2018



Friday, 02 Nov 2018